ST-008 Appendix IX-B: APLT Reports

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	4:46:49 PM	Test ID	**PT01**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.91244	Longitude:	91.17163	Elev. (ft):	701
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0456	0.0202	0.0204	**0.0287**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0347*	*0.0228*	*0.0205*	**0.0260**
1	Load	2	3534	5	*5.0*	*0.0560*	*0.0347*	*0.0370*	**0.0426**
1	Load	3	5301	7.5	*7.5*	*0.0736*	*0.0466*	*0.0482*	**0.0561**
1	Load	4	7069	10	*10.0*	*0.0941*	*0.0572*	*0.0697*	**0.0737**
1	Load	5	8836	12.5	*12.5*	*0.1069*	*0.0687*	*0.0834*	**0.0863**
1	Load	6	10603	15	*15.0*	*0.1244*	*0.0798*	*0.0980*	**0.1008**
1	Unload	7	7069	10	*10.0*	*0.1165*	*0.0770*	*0.0944*	**0.0960**
1	Unload	8	3534	5	*4.9*	*0.1025*	*0.0679*	*0.0811*	**0.0838**
1	Unload	9	1767	2.5	*2.4*	*0.0934*	*0.0570*	*0.0743*	**0.0749**
1	Unload	10	0	0	*0.0*	*0.0788*	*0.0508*	*0.0627*	**0.0641**
2	Load	11	3534	5	*5.0*	*0.0933*	*0.0571*	*0.0742*	**0.0749**
2	Load	12	7069	10	*10.0*	*0.1067*	*0.0726*	*0.0865*	**0.0886**
2	Load	13	10603	15	*14.9*	*0.1249*	*0.0822*	*0.1001*	**0.1024**
2	Unload	14	1767	2.5	*2.5*	*0.0947*	*0.0580*	*0.0757*	**0.0761**
2	Unload	14	0	0	*0.0*	*0.0814*	*0.0524*	*0.0668*	**0.0669**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **156**
k_u (pci) @ δ = 0.05 in.: **129**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	6.5
E_1 (psi)	2,660
k'_u (pci)	131
k_u (pci)	129

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0717	0.0617
E_1 (psi)	2,818	3,222
k'_{u1} (pci)	139	162
k_{u1} (pci)	136	156
Second Loading Cycle		
δ_2 (in.)	0.0243	
E_2 (psi)	6,952	
k'_{u2} (pci)	411	
k_{u2} (pci)	336	
E_2 / E_1 or k_2 / k_1 Ratio	2.5	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

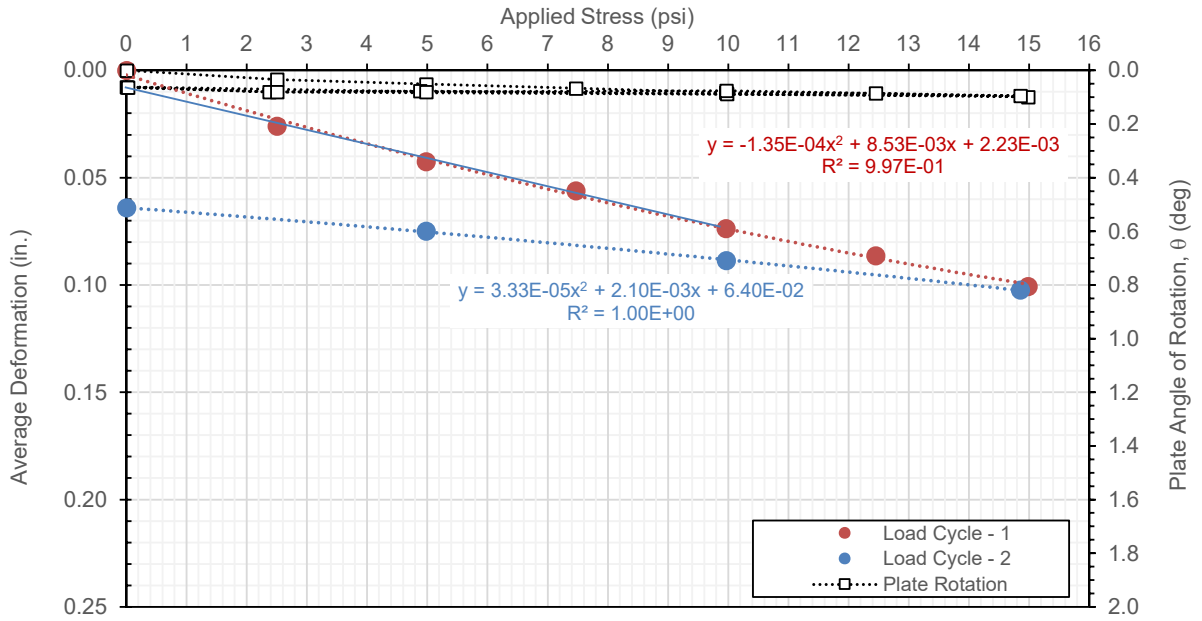
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.35E-04	a_1	3.33E-05	θ_{max} (deg)	0.0989
a_2	8.53E-03	a_2	2.10E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	5:38:06 PM	Test ID	**PT02**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.910628	Longitude:	91.171647	Elev. (ft):	725
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0084	0.0095	0.0064	**0.0081**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0195*	*0.0100*	*0.0137*	**0.0144**
1	Load	2	3534	5	*5.0*	*0.0326*	*0.0183*	*0.0266*	**0.0258**
1	Load	3	5301	7.5	*7.5*	*0.0435*	*0.0256*	*0.0359*	**0.0350**
1	Load	4	7069	10	*10.0*	*0.0529*	*0.0329*	*0.0457*	**0.0438**
1	Load	5	8836	12.5	*12.5*	*0.0622*	*0.0401*	*0.0523*	**0.0515**
1	Load	6	10603	15	*14.9*	*0.0715*	*0.0469*	*0.0618*	**0.0600**
1	Unload	7	7069	10	*10.0*	*0.0667*	*0.0432*	*0.0564*	**0.0554**
1	Unload	8	3534	5	*4.7*	*0.0588*	*0.0384*	*0.0502*	**0.0491**
1	Unload	9	1767	2.5	*2.2*	*0.0530*	*0.0341*	*0.0456*	**0.0442**
1	Unload	10	0	0	*0.0*	*0.0448*	*0.0293*	*0.0366*	**0.0369**
2	Load	11	3534	5	*5.1*	*0.0542*	*0.0354*	*0.0462*	**0.0453**
2	Load	12	7069	10	*10.0*	*0.0628*	*0.0409*	*0.0536*	**0.0524**
2	Load	13	10603	15	*15.0*	*0.0715*	*0.0472*	*0.0633*	**0.0607**
2	Unload	14	1767	2.5	*2.3*	*0.0535*	*0.0348*	*0.0471*	**0.0451**
2	Unload	14	0	0	*0.0*	*0.0461*	*0.0300*	*0.0391*	**0.0384**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **210**
k_u (pci) @ δ = 0.05 in.: **217**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	11.9
E_1 (psi)	4,491
k'_u (pci)	239
k_u (pci)	217

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0437	0.0437
E_1 (psi)	4,336	4,336
k'_{u1} (pci)	229	229
k_{u1} (pci)	210	210
Second Loading Cycle		
δ_2 (in.)	0.0157	
E_2 (psi)	9,770	
k'_{u2} (pci)	638	
k_{u2} (pci)	473	
E_2 / E_1 or k_2 / k_1 Ratio	2.3	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

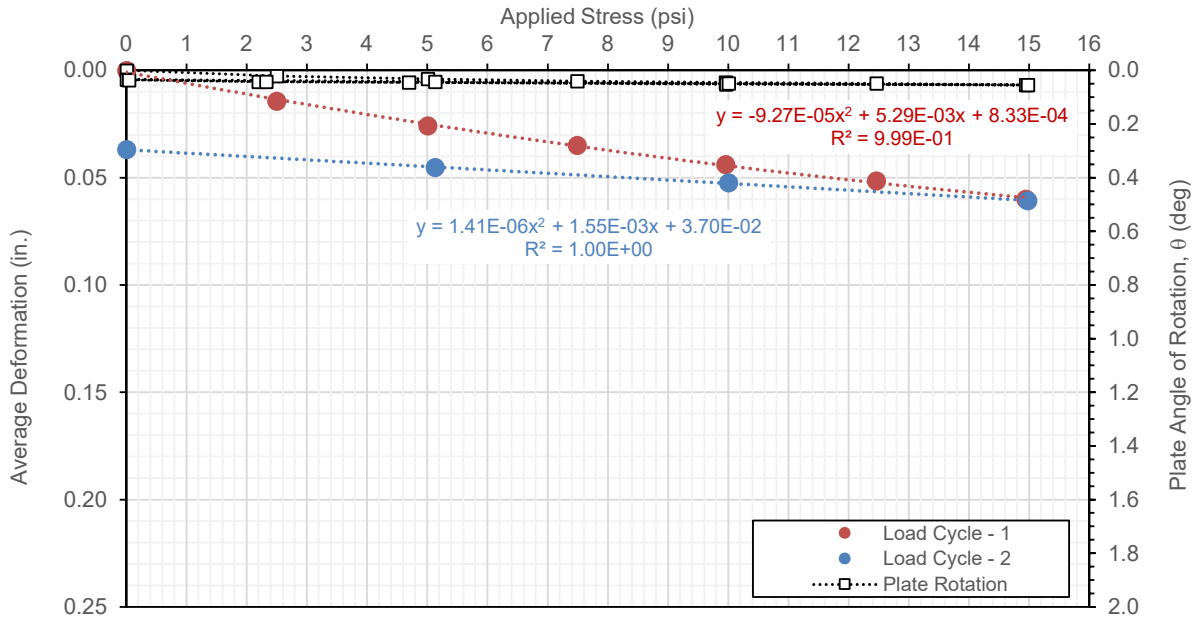
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-9.27E-05	a_1	1.41E-06	θ_{max} (deg)	0.0547
a_2	5.29E-03	a_2	1.55E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	6:19:42 PM	Test ID	**PT03**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.909765	Longitude:	91.171468	Elev. (ft):	728
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0075	0.0080	0.0115	**0.0090**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0125*	*0.0088*	*0.0139*	**0.0117**
1	Load	2	3534	5	*5.0*	*0.0207*	*0.0174*	*0.0270*	**0.0217**
1	Load	3	5301	7.5	*7.4*	*0.0281*	*0.0249*	*0.0370*	**0.0300**
1	Load	4	7069	10	*10.0*	*0.0360*	*0.0322*	*0.0464*	**0.0382**
1	Load	5	8836	12.5	*12.4*	*0.0447*	*0.0405*	*0.0554*	**0.0469**
1	Load	6	10603	15	*14.8*	*0.0529*	*0.0472*	*0.0636*	**0.0546**
1	Unload	7	7069	10	*10.0*	*0.0488*	*0.0430*	*0.0600*	**0.0506**
1	Unload	8	3534	5	*4.9*	*0.0419*	*0.0379*	*0.0537*	**0.0445**
1	Unload	9	1767	2.5	*2.4*	*0.0371*	*0.0343*	*0.0489*	**0.0401**
1	Unload	10	0	0	*0.0*	*0.0316*	*0.0285*	*0.0415*	**0.0339**
2	Load	11	3534	5	*4.9*	*0.0379*	*0.0344*	*0.0486*	**0.0403**
2	Load	12	7069	10	*10.0*	*0.0452*	*0.0406*	*0.0566*	**0.0475**
2	Load	13	10603	15	*15.0*	*0.0535*	*0.0477*	*0.0647*	**0.0553**
2	Unload	14	1767	2.5	*2.5*	*0.0379*	*0.0353*	*0.0504*	**0.0412**
2	Unload	14	0	0	*0.0*	*0.0326*	*0.0298*	*0.0430*	**0.0351**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **233**
k_u (pci) @ δ = 0.05 in.: **242**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	13.6
E_1 (psi)	5,002
k'_u (pci)	272
k_u (pci)	242

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0385	0.0385
E_1 (psi)	4,811	4,811
k'_{u1} (pci)	260	260
k_{u1} (pci)	233	233
Second Loading Cycle		
δ_2 (in.)	0.0137	
E_2 (psi)	10,843	
k'_{u2} (pci)	732	
k_{u2} (pci)	524	
E_2 / E_1 or k_2 / k_1 Ratio	2.3	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

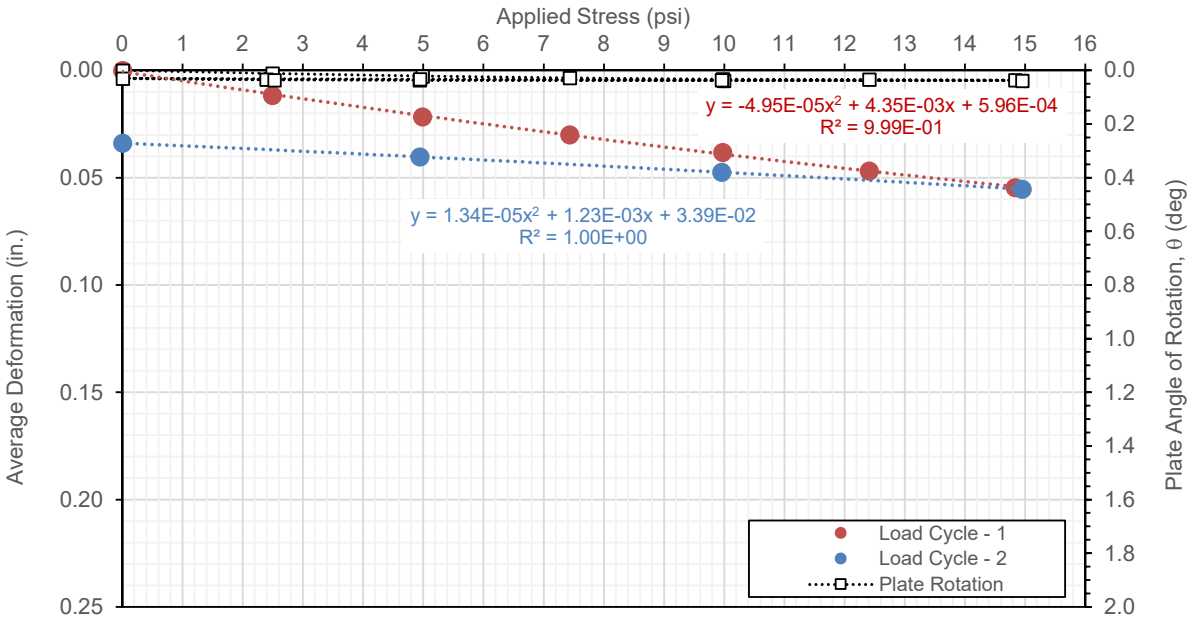
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

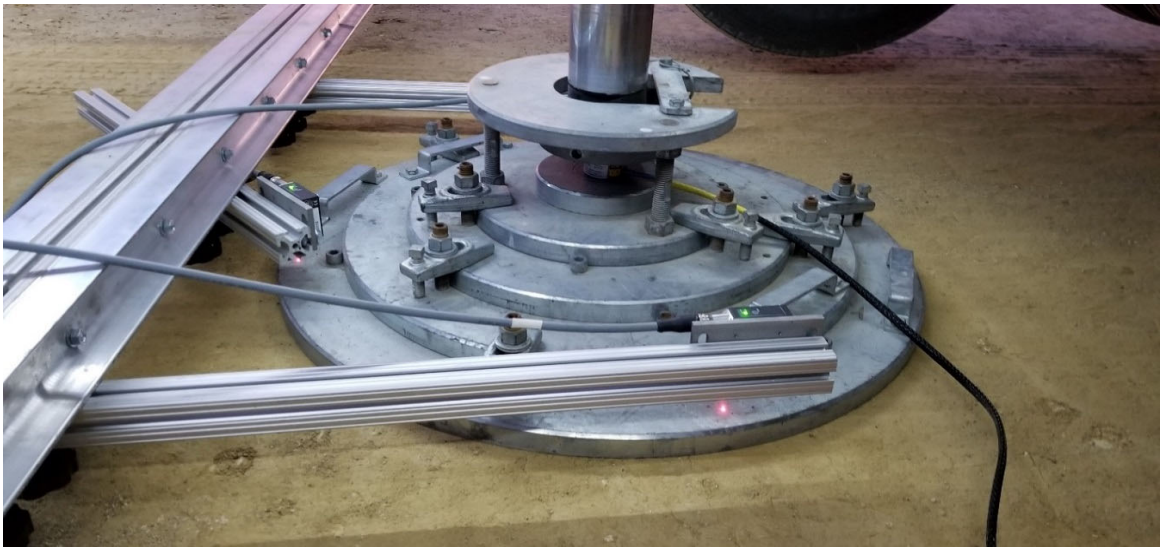
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-4.95E-05	a_1	1.34E-05	θ_{max} (deg)	0.0382
a_2	4.35E-03	a_2	1.23E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	7:36:01 PM	Test ID	**PT04**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.90950	Longitude:	91.17142	Elev. (ft):	714
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0072	0.0024	0.0084	**0.0060**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0184*	*0.0050*	*0.0140*	**0.0125**
1	Load	2	3534	5	*5.0*	*0.0229*	*0.0103*	*0.0279*	**0.0204**
1	Load	3	5301	7.5	*7.5*	*0.0365*	*0.0157*	*0.0365*	**0.0296**
1	Load	4	7069	10	*10.0*	*0.0524*	*0.0195*	*0.0510*	**0.0410**
1	Load	5	8836	12.5	*12.5*	*0.0655*	*0.0251*	*0.0590*	**0.0499**
1	Load	6	10603	15	*15.0*	*0.0661*	*0.0307*	*0.0722*	**0.0563**
1	Unload	7	7069	10	*9.8*	*0.0639*	*0.0264*	*0.0670*	**0.0524**
1	Unload	8	3534	5	*5.0*	*0.0617*	*0.0223*	*0.0597*	**0.0479**
1	Unload	9	1767	2.5	*2.5*	*0.0490*	*0.0198*	*0.0551*	**0.0413**
1	Unload	10	0	0	*0.0*	*0.0413*	*0.0154*	*0.0488*	**0.0352**
2	Load	11	3534	5	*5.0*	*0.0508*	*0.0199*	*0.0550*	**0.0419**
2	Load	12	7069	10	*9.9*	*0.0642*	*0.0244*	*0.0642*	**0.0509**
2	Load	13	10603	15	*15.0*	*0.0726*	*0.0307*	*0.0749*	**0.0594**
2	Unload	14	1767	2.5	*2.5*	*0.0551*	*0.0199*	*0.0574*	**0.0442**
2	Unload	14	0	0	*0.0*	*0.0542*	*0.0166*	*0.0522*	**0.0410**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **226**
k_u (pci) @ δ = 0.05 in.: **232**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	12.9
E_1 (psi)	4,793
k'_u (pci)	258
k_u (pci)	232

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0399	0.0399
E_1 (psi)	4,677	4,677
k'_{u1} (pci)	251	251
k_{u1} (pci)	226	226
Second Loading Cycle		
δ_2 (in.)	0.0156	
E_2 (psi)	9,815	
k'_{u2} (pci)	642	
k_{u2} (pci)	475	
E_2 / E_1 or k_2 / k_1 Ratio	2.1	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

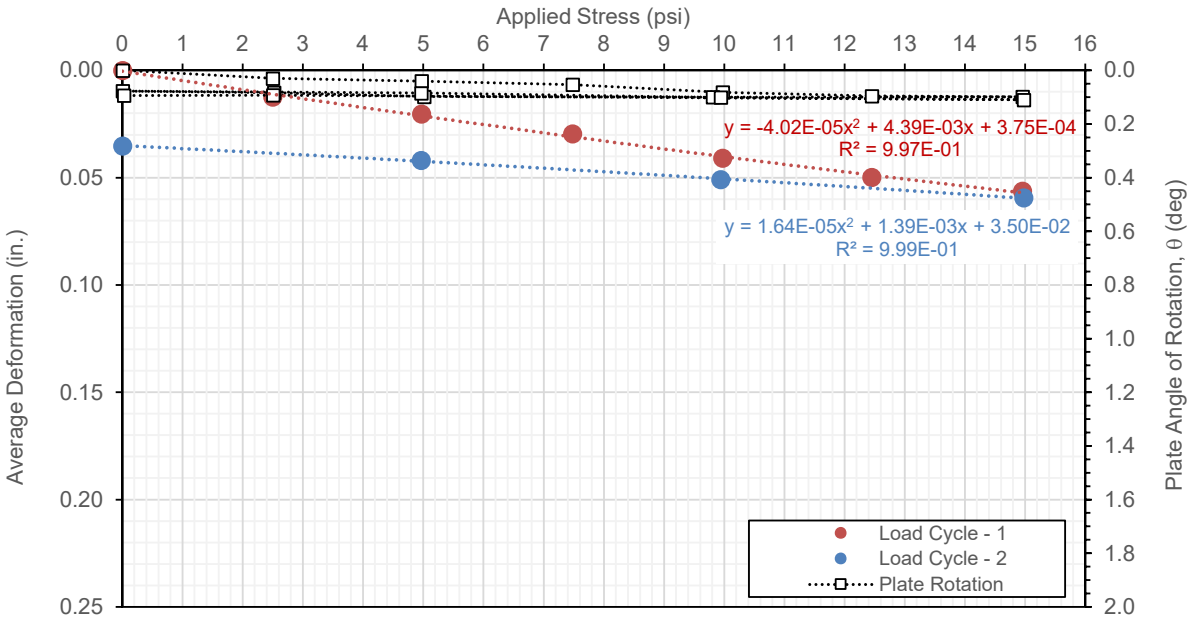
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

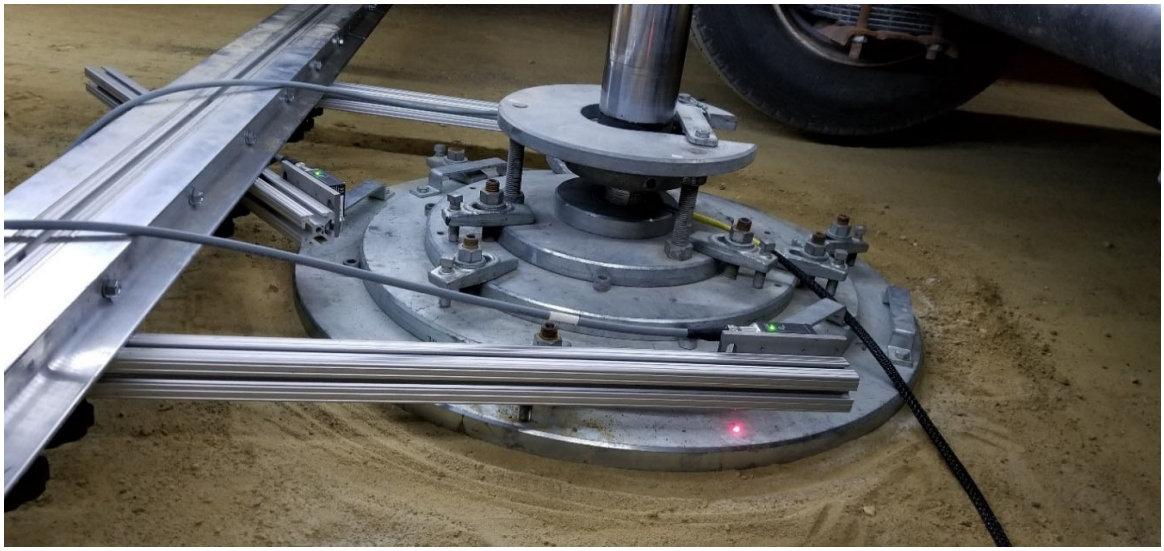
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-4.02E-05	a_1	1.64E-05	θ_{max} (deg)	0.1098
a_2	4.39E-03	a_2	1.39E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	8:14:57 PM	Test ID	**PT05**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.90888	Longitude:	91.17129	Elev. (ft):	711
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0098	0.0163	0.0121	**0.0127**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0152*	*0.0185*	*0.0154*	**0.0164**
1	Load	2	3534	5	*5.0*	*0.0263*	*0.0300*	*0.0234*	**0.0266**
1	Load	3	5301	7.5	*7.5*	*0.0351*	*0.0395*	*0.0308*	**0.0351**
1	Load	4	7069	10	*9.9*	*0.0425*	*0.0471*	*0.0377*	**0.0424**
1	Load	5	8836	12.5	*12.4*	*0.0500*	*0.0540*	*0.0430*	**0.0490**
1	Load	6	10603	15	*15.0*	*0.0554*	*0.0604*	*0.0487*	**0.0548**
1	Unload	7	7069	10	*10.0*	*0.0521*	*0.0559*	*0.0453*	**0.0511**
1	Unload	8	3534	5	*5.0*	*0.0461*	*0.0492*	*0.0411*	**0.0455**
1	Unload	9	1767	2.5	*2.5*	*0.0425*	*0.0445*	*0.0380*	**0.0417**
1	Unload	10	0	0	*0.0*	*0.0359*	*0.0363*	*0.0340*	**0.0354**
2	Load	11	3534	5	*5.0*	*0.0431*	*0.0455*	*0.0381*	**0.0422**
2	Load	12	7069	10	*10.0*	*0.0502*	*0.0530*	*0.0431*	**0.0488**
2	Load	13	10603	15	*15.0*	*0.0564*	*0.0617*	*0.0501*	**0.0561**
2	Unload	14	1767	2.5	*2.5*	*0.0435*	*0.0456*	*0.0395*	**0.0429**
2	Unload	14	0	0	*0.0*	*0.0368*	*0.0376*	*0.0354*	**0.0366**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **239**
k_u (pci) @ δ = 0.05 in.: **238**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	13.3
E_1 (psi)	4,923
k'_u (pci)	267
k_u (pci)	238

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0422	0.0373
E_1 (psi)	4,463	4,941
k'_{u1} (pci)	237	268
k_{u1} (pci)	216	239
Second Loading Cycle		
δ_2 (in.)	0.0136	
E_2 (psi)	10,896	
k'_{u2} (pci)	737	
k_{u2} (pci)	527	
E_2 / E_1 or k_2 / k_1 Ratio	2.4	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

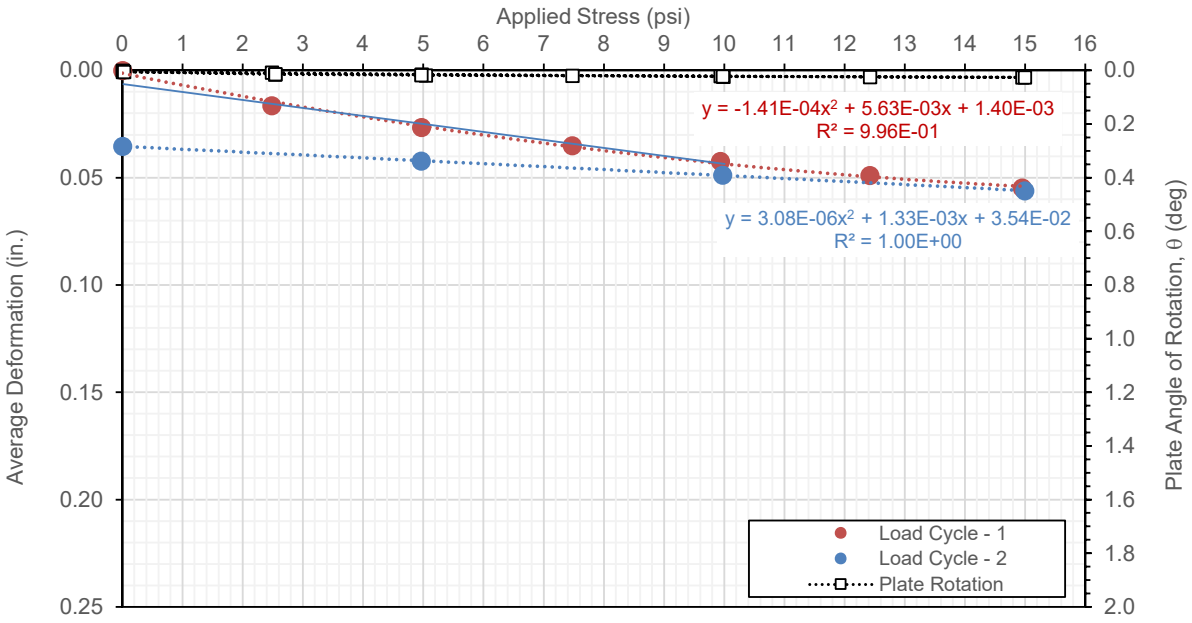
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

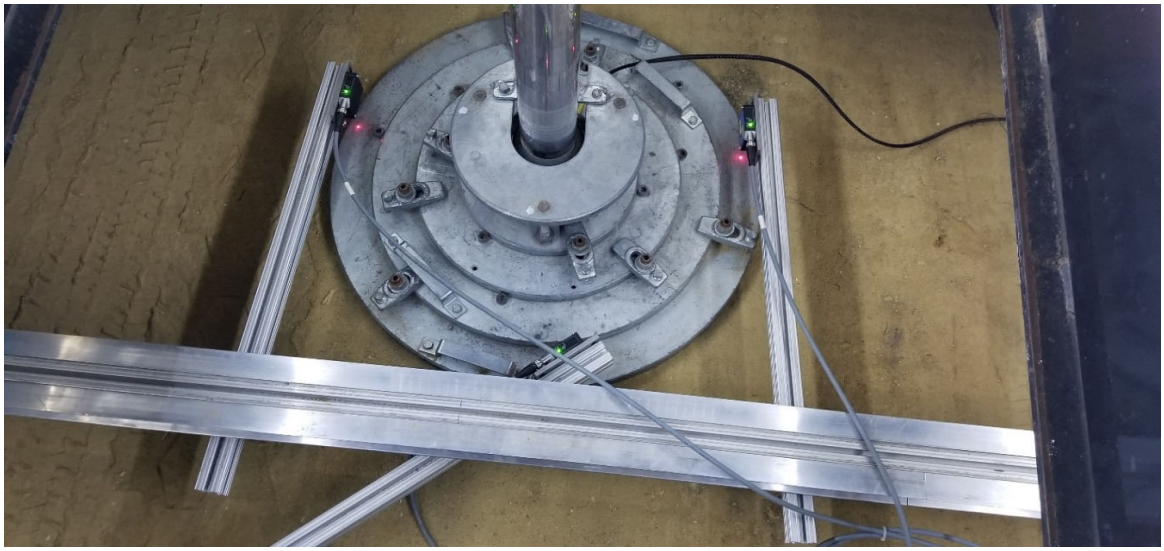
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.41E-04	a_1	3.08E-06	θ_{max} (deg)	0.0257
a_2	5.63E-03	a_2	1.33E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	8:57:41 PM	Test ID	**PT06**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.9076	Longitude:	91.1711	Elev. (ft):	718
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0232	0.0111	0.0403	**0.0249**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0257*	*0.0197*	*0.0509*	**0.0321**
1	Load	2	3534	5	*5.0*	*0.0488*	*0.0368*	*0.0801*	**0.0552**
1	Load	3	5301	7.5	*7.5*	*0.0729*	*0.0514*	*0.1052*	**0.0765**
1	Load	4	7069	10	*10.0*	*0.0939*	*0.0656*	*0.1266*	**0.0954**
1	Load	5	8836	12.5	*12.4*	*0.1128*	*0.0788*	*0.1446*	**0.1121**
1	Load	6	10603	15	*15.0*	*0.1313*	*0.0934*	*0.1636*	**0.1294**
1	Unload	7	7069	10	*10.0*	*0.1241*	*0.0866*	*0.1589*	**0.1232**
1	Unload	8	3534	5	*5.0*	*0.1092*	*0.0765*	*0.1512*	**0.1123**
1	Unload	9	1767	2.5	*2.5*	*0.0981*	*0.0672*	*0.1415*	**0.1023**
1	Unload	10	0	0	*0.0*	*0.0823*	*0.0538*	*0.1302*	**0.0888**
2	Load	11	3534	5	*4.9*	*0.0983*	*0.0662*	*0.1399*	**0.1014**
2	Load	12	7069	10	*10.0*	*0.1146*	*0.0800*	*0.1543*	**0.1163**
2	Load	13	10603	15	*15.0*	*0.1314*	*0.0943*	*0.1653*	**0.1303**
2	Unload	14	1767	2.5	*2.5*	*0.0989*	*0.0673*	*0.1430*	**0.1030**
2	Unload	14	0	0	*0.0*	*0.0839*	*0.0557*	*0.1325*	**0.0907**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **124**
k_u (pci) @ δ = 0.05 in.: **94**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.7
E_1 (psi)	1,950
k'_u (pci)	94
k_u (pci)	94

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0948	0.0798
E_1 (psi)	2,170	2,555
k'_{u1} (pci)	105	125
k_{u1} (pci)	105	124
Second Loading Cycle		
δ_2 (in.)	0.0274	
E_2 (psi)	6,336	
k'_{u2} (pci)	365	
k_{u2} (pci)	306	
E_2 / E_1 or k_2 / k_1 Ratio	2.9	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

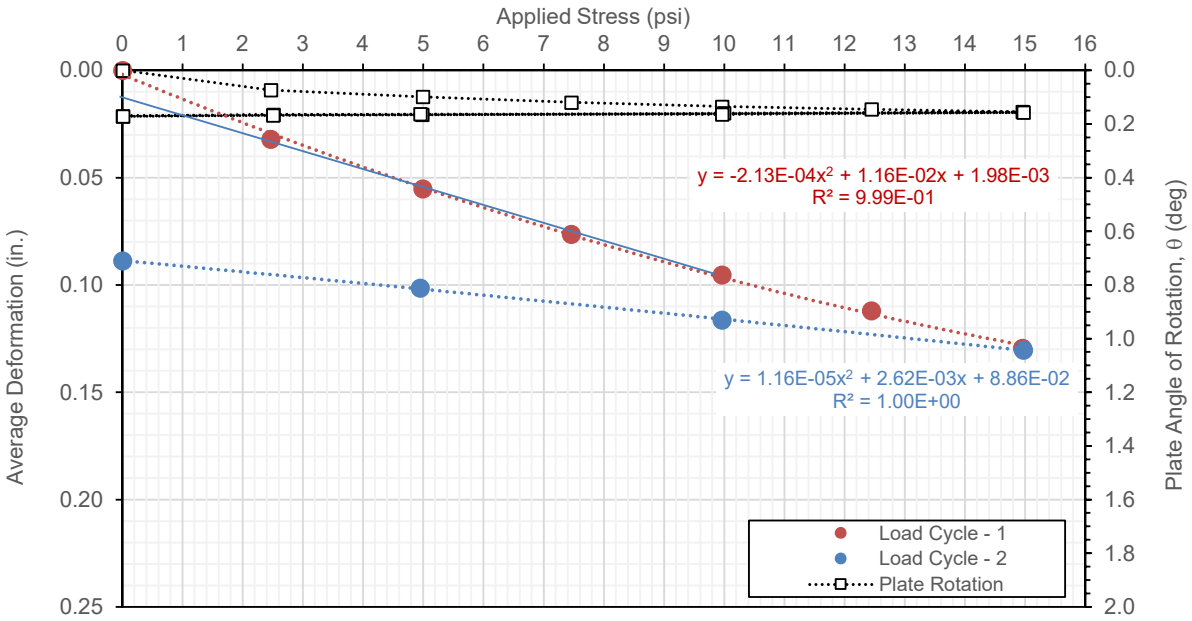
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.13E-04	a_1	1.16E-05	θ_{max} (deg)	0.1714
a_2	1.16E-02	a_2	2.62E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	9:41:27 PM	Test ID	**PT07**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.90636	Longitude:	91.17096	Elev. (ft):	724
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0150	0.0122	0.0153	**0.0142**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0207*	*0.0140*	*0.0230*	**0.0192**
1	Load	2	3534	5	*5.0*	*0.0353*	*0.0233*	*0.0412*	**0.0332**
1	Load	3	5301	7.5	*7.5*	*0.0478*	*0.0327*	*0.0581*	**0.0462**
1	Load	4	7069	10	*10.0*	*0.0606*	*0.0437*	*0.0733*	**0.0592**
1	Load	5	8836	12.5	*12.5*	*0.0752*	*0.0563*	*0.0908*	**0.0741**
1	Load	6	10603	15	*15.0*	*0.0865*	*0.0679*	*0.1042*	**0.0862**
1	Unload	7	7069	10	*10.0*	*0.0792*	*0.0596*	*0.0962*	**0.0783**
1	Unload	8	3534	5	*5.0*	*0.0673*	*0.0497*	*0.0839*	**0.0670**
1	Unload	9	1767	2.5	*2.5*	*0.0591*	*0.0432*	*0.0746*	**0.0590**
1	Unload	10	0	0	*0.0*	*0.0499*	*0.0353*	*0.0627*	**0.0493**
2	Load	11	3534	5	*5.0*	*0.0605*	*0.0440*	*0.0749*	**0.0598**
2	Load	12	7069	10	*10.0*	*0.0729*	*0.0548*	*0.0891*	**0.0723**
2	Load	13	10603	15	*15.0*	*0.0858*	*0.0672*	*0.1045*	**0.0859**
2	Unload	14	1767	2.5	*2.5*	*0.0607*	*0.0438*	*0.0757*	**0.0601**
2	Unload	14	0	0	*0.0*	*0.0512*	*0.0362*	*0.0644*	**0.0506**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **161**
k_u (pci) @ δ = 0.05 in.: **159**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	8.3
E_1 (psi)	3,283
k'_u (pci)	165
k_u (pci)	159

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0594	0.0594
E_1 (psi)	3,334	3,334
k'_{u1} (pci)	168	168
k_{u1} (pci)	161	161
Second Loading Cycle		
δ_2 (in.)	0.0229	
E_2 (psi)	7,288	
k'_{u2} (pci)	436	
k_{u2} (pci)	352	
E_2 / E_1 or k_2 / k_1 Ratio	2.2	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

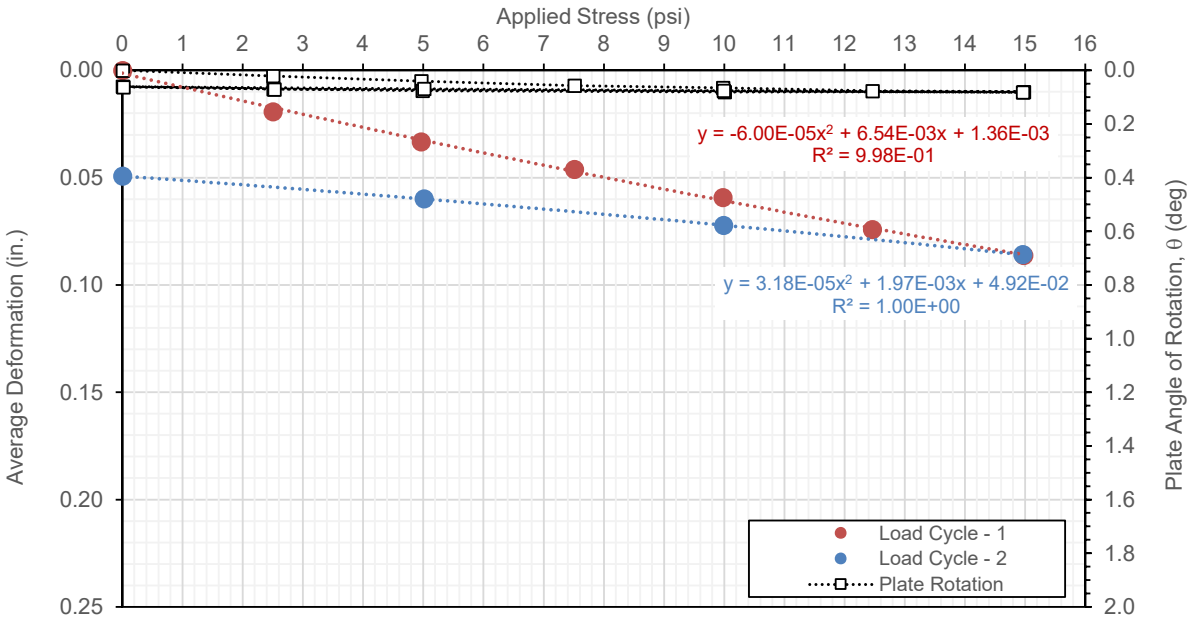
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-6.00E-05	a_1	3.18E-05	θ_{max} (deg)	0.0822
a_2	6.54E-03	a_2	1.97E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	10:27:50 PM	Test ID	**PT08**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.90557	Longitude:	91.17092	Elev. (ft):	713
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0080	0.0123	0.0084	**0.0096**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0130*	*0.0146*	*0.0139*	**0.0138**
1	Load	2	3534	5	*5.0*	*0.0244*	*0.0226*	*0.0255*	**0.0242**
1	Load	3	5301	7.5	*7.5*	*0.0334*	*0.0305*	*0.0359*	**0.0333**
1	Load	4	7069	10	*10.0*	*0.0430*	*0.0395*	*0.0457*	**0.0428**
1	Load	5	8836	12.5	*12.4*	*0.0526*	*0.0485*	*0.0560*	**0.0524**
1	Load	6	10603	15	*15.0*	*0.0624*	*0.0589*	*0.0683*	**0.0632**
1	Unload	7	7069	10	*10.0*	*0.0559*	*0.0524*	*0.0611*	**0.0564**
1	Unload	8	3534	5	*5.0*	*0.0484*	*0.0428*	*0.0524*	**0.0479**
1	Unload	9	1767	2.5	*2.5*	*0.0425*	*0.0377*	*0.0472*	**0.0425**
1	Unload	10	0	0	*0.0*	*0.0357*	*0.0295*	*0.0397*	**0.0349**
2	Load	11	3534	5	*5.0*	*0.0444*	*0.0389*	*0.0482*	**0.0439**
2	Load	12	7069	10	*10.0*	*0.0524*	*0.0479*	*0.0572*	**0.0525**
2	Load	13	10603	15	*15.0*	*0.0632*	*0.0600*	*0.0686*	**0.0639**
2	Unload	14	1767	2.5	*2.5*	*0.0435*	*0.0392*	*0.0481*	**0.0436**
2	Unload	14	0	0	*0.0*	*0.0364*	*0.0307*	*0.0411*	**0.0361**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **214**
k_u (pci) @ δ = 0.05 in.: **217**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	11.9
E_1 (psi)	4,492
k'_u (pci)	239
k_u (pci)	217

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0425	0.0425
E_1 (psi)	4,434	4,434
k'_{u1} (pci)	235	235
k_{u1} (pci)	214	214
Second Loading Cycle		
δ_2 (in.)	0.0179	
E_2 (psi)	8,831	
k'_{u2} (pci)	559	
k_{u2} (pci)	427	
E_2 / E_1 or k_2 / k_1 Ratio	2.0	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

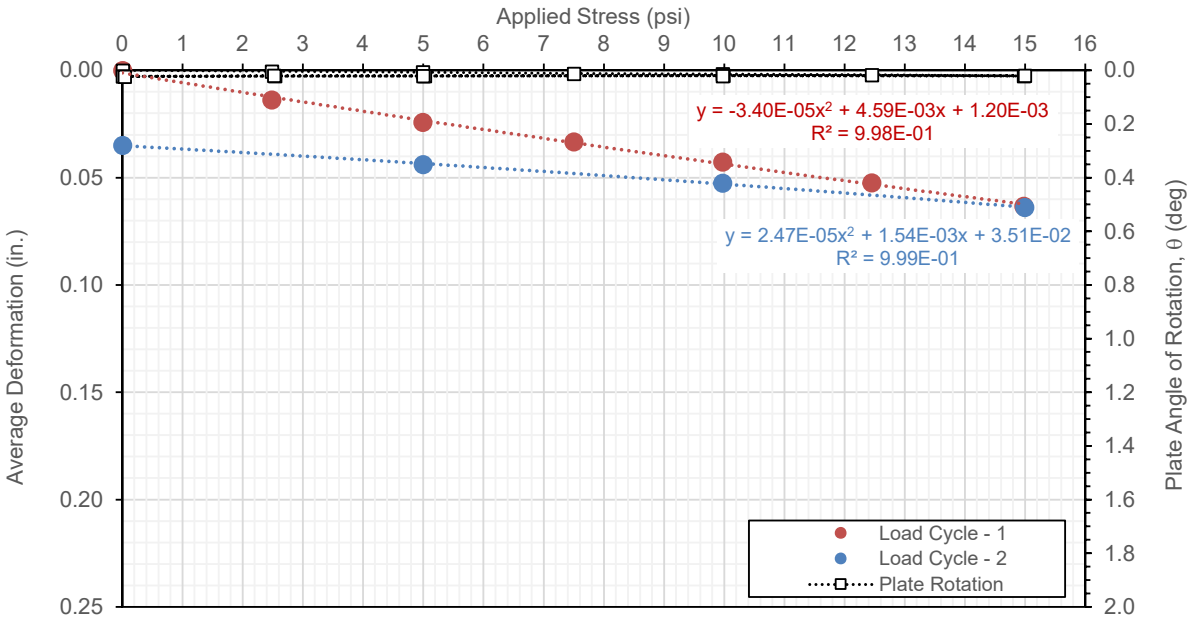
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.40E-05	a_1	2.47E-05	θ_{max} (deg)	0.0230
a_2	4.59E-03	a_2	1.54E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	11:18:03 PM	Test ID	**PT09**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.903988	Longitude:	91.170932	Elev. (ft):	701
Comments:	Aggregate subbase over compacted subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0170	0.0127	0.0189	**0.0162**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0253*	*0.0316*	*0.0148*	**0.0239**
1	Load	2	3534	5	*5.0*	*0.0416*	*0.0528*	*0.0246*	**0.0397**
1	Load	3	5301	7.5	*7.5*	*0.0563*	*0.0713*	*0.0318*	**0.0531**
1	Load	4	7069	10	*10.0*	*0.0674*	*0.0865*	*0.0409*	**0.0649**
1	Load	5	8836	12.5	*12.5*	*0.0784*	*0.1009*	*0.0463*	**0.0752**
1	Load	6	10603	15	*15.0*	*0.0885*	*0.1140*	*0.0527*	**0.0851**
1	Unload	7	7069	10	*10.0*	*0.0832*	*0.1090*	*0.0482*	**0.0801**
1	Unload	8	3534	5	*5.0*	*0.0771*	*0.1015*	*0.0426*	**0.0737**
1	Unload	9	1767	2.5	*2.5*	*0.0726*	*0.0971*	*0.0368*	**0.0689**
1	Unload	10	0	0	*0.0*	*0.0663*	*0.0901*	*0.0281*	**0.0615**
2	Load	11	3534	5	*5.0*	*0.0739*	*0.0983*	*0.0381*	**0.0701**
2	Load	12	7069	10	*10.0*	*0.0810*	*0.1062*	*0.0463*	**0.0779**
2	Load	13	10603	15	*15.0*	*0.0909*	*0.1166*	*0.0545*	**0.0873**
2	Unload	14	1767	2.5	*2.5*	*0.0743*	*0.0997*	*0.0383*	**0.0707**
2	Unload	14	0	0	*0.0*	*0.0686*	*0.0926*	*0.0293*	**0.0635**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **189**
k_u (pci) @ δ = 0.05 in.: **139**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	7.1
E_1 (psi)	2,875
k'_u (pci)	143
k_u (pci)	139

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0646	0.0496
E_1 (psi)	3,098	3,898
k'_{u1} (pci)	155	202
k_{u1} (pci)	150	189
Second Loading Cycle		
δ_2 (in.)	0.0167	
E_2 (psi)	9,325	
k'_{u2} (pci)	600	
k_{u2} (pci)	451	
E_2 / E_1 or k_2 / k_1 Ratio	3.0	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

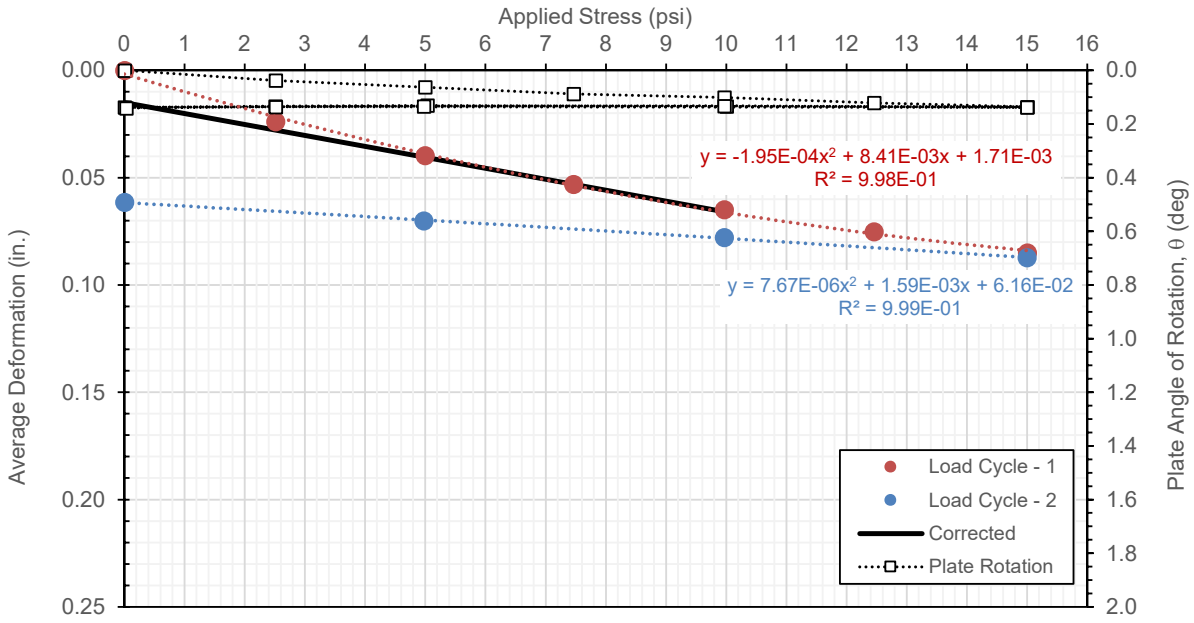
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

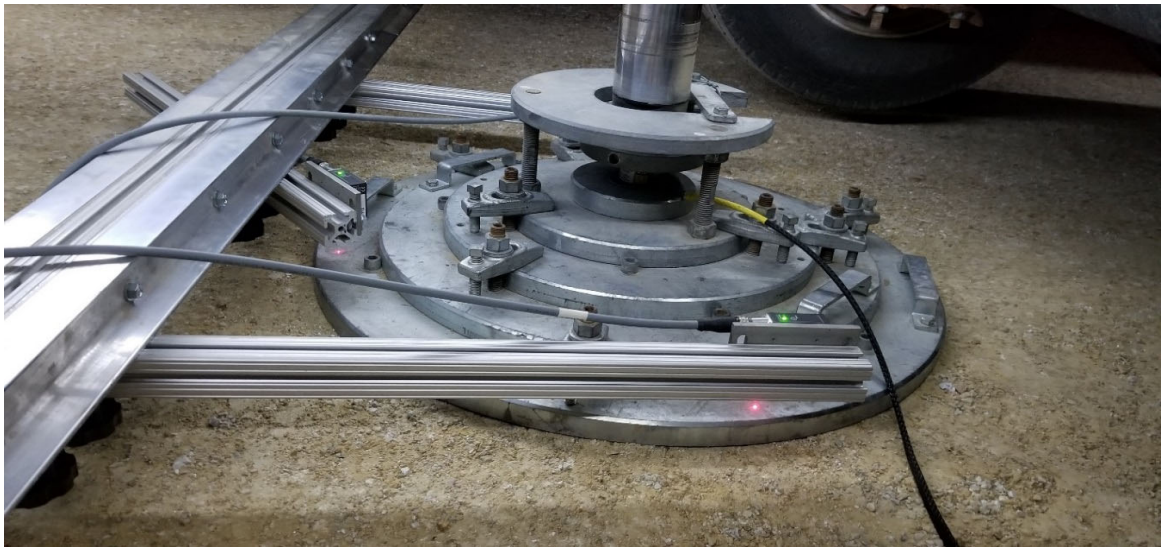
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.95E-04	a_1	7.67E-06	θ_{max} (deg)	0.1409
a_2	8.41E-03	a_2	1.59E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/23/2019	Time:	11:59:01 PM	Test ID	**PT10**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.90399	Longitude:	91.17092	Elev. (ft):	698
Comments:	Aggregate Base (access road) over compacted subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0251	0.0128	0.0288	**0.0223**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0362*	*0.0190*	*0.0425*	**0.0326**
1	Load	2	3534	5	*5.0*	*0.0583*	*0.0351*	*0.0686*	**0.0540**
1	Load	3	5301	7.5	*7.5*	*0.0762*	*0.0503*	*0.0874*	**0.0713**
1	Load	4	7069	10	*10.0*	*0.0908*	*0.0636*	*0.1036*	**0.0860**
1	Load	5	8836	12.5	*12.4*	*0.1049*	*0.0772*	*0.1188*	**0.1003**
1	Load	6	10603	15	*15.0*	*0.1174*	*0.0893*	*0.1323*	**0.1130**
1	Unload	7	7069	10	*10.0*	*0.1119*	*0.0847*	*0.1270*	**0.1079**
1	Unload	8	3534	5	*5.0*	*0.1045*	*0.0780*	*0.1166*	**0.0997**
1	Unload	9	1767	2.5	*2.5*	*0.0980*	*0.0720*	*0.1084*	**0.0928**
1	Unload	10	0	0	*0.0*	*0.0907*	*0.0655*	*0.0967*	**0.0843**
2	Load	11	3534	5	*5.0*	*0.1000*	*0.0730*	*0.1102*	**0.0944**
2	Load	12	7069	10	*10.0*	*0.1100*	*0.0821*	*0.1250*	**0.1057**
2	Load	13	10603	15	*15.0*	*0.1214*	*0.0923*	*0.1392*	**0.1176**
2	Unload	14	1767	2.5	*2.5*	*0.1018*	*0.0749*	*0.1126*	**0.0965**
2	Unload	14	0	0	*0.0*	*0.0946*	*0.0689*	*0.1022*	**0.0886**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **138**
k_u (pci) @ δ = 0.05 in.: **101**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.1
E_1 (psi)	3,532
k'_u (pci)	101
k_u (pci)	101

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0858	0.0708
E_1 (psi)	4,055	4,843
k'_{u1} (pci)	117	141
k_{u1} (pci)	116	138
Second Loading Cycle		
δ_2 (in.)	0.0214	
E_2 (psi)	13,057	
k'_{u2} (pci)	467	
k_{u2} (pci)	372	
E_2 / E_1 or k_2 / k_1 Ratio	3.2	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

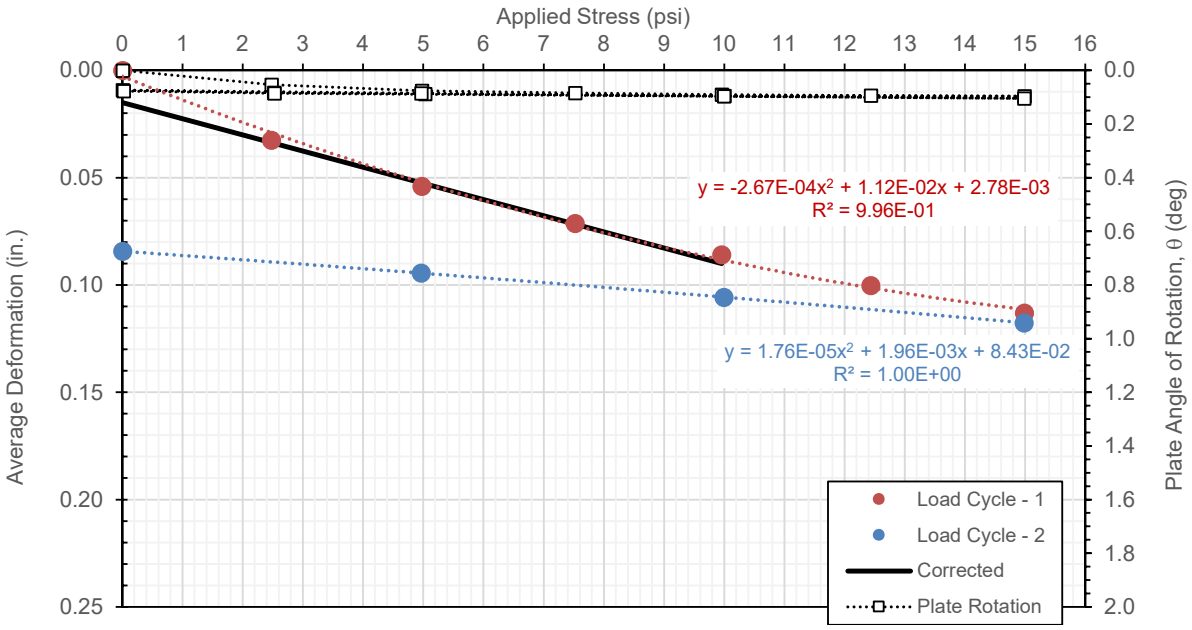
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.67E-04	a_1	1.76E-05	θ_{max} (deg)	0.1046
a_2	1.12E-02	a_2	1.96E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	10/24/2019	Time:	12:44:22 AM	Test ID	**PT11**
Tested By	PV, DW	Location:	US61	Sta.	NA
Latitude:	40.90707	Longitude:	91.17110	Elev. (ft):	714
Comments:	Compacted Subgrade (Select)				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0210	0.0322	0.0164	**0.0232**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0343*	*0.0467*	*0.0265*	**0.0358**
1	Load	2	3534	5	*5.0*	*0.0646*	*0.0816*	*0.0505*	**0.0656**
1	Load	3	5301	7.5	*7.5*	*0.0931*	*0.1148*	*0.0745*	**0.0941**
1	Load	4	7069	10	*10.0*	*0.1211*	*0.1458*	*0.0973*	**0.1214**
1	Load	5	8836	12.5	*12.5*	*0.1465*	*0.1779*	*0.1192*	**0.1479**
1	Load	6	10603	15	*15.0*	*0.1734*	*0.2105*	*0.1428*	**0.1756**
1	Unload	7	7069	10	*10.0*	*0.1606*	*0.1958*	*0.1333*	**0.1632**
1	Unload	8	3534	5	*5.0*	*0.1407*	*0.1727*	*0.1155*	**0.1430**
1	Unload	9	1767	2.5	*2.5*	*0.1251*	*0.1546*	*0.1013*	**0.1270**
1	Unload	10	0	0	*0.0*	*0.1077*	*0.1330*	*0.0884*	**0.1097**
2	Load	11	3534	5	*5.0*	*0.1261*	*0.1544*	*0.1017*	**0.1274**
2	Load	12	7069	10	*10.0*	*0.1492*	*0.1819*	*0.1214*	**0.1508**
2	Load	13	10603	15	*15.0*	*0.1749*	*0.2137*	*0.1440*	**0.1775**
2	Unload	14	1767	2.5	*2.5*	*0.1285*	*0.1581*	*0.1043*	**0.1303**
2	Unload	14	0	0	*0.0*	*0.1122*	*0.1385*	*0.0907*	**0.1138**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **83**
k_u (pci) @ δ = 0.05 in.: **78**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	3.9
E_1 (psi)	1,614
k'_u (pci)	78
k_u (pci)	78

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1212	0.1212
E_1 (psi)	1,707	1,707
k'_{u1} (pci)	83	83
k_{u1} (pci)	83	83
Second Loading Cycle		
δ_2 (in.)	0.0410	
E_2 (psi)	4,568	
k'_{u2} (pci)	244	
k_{u2} (pci)	221	
E_2 / E_1 or k_2 / k_1 Ratio	2.7	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

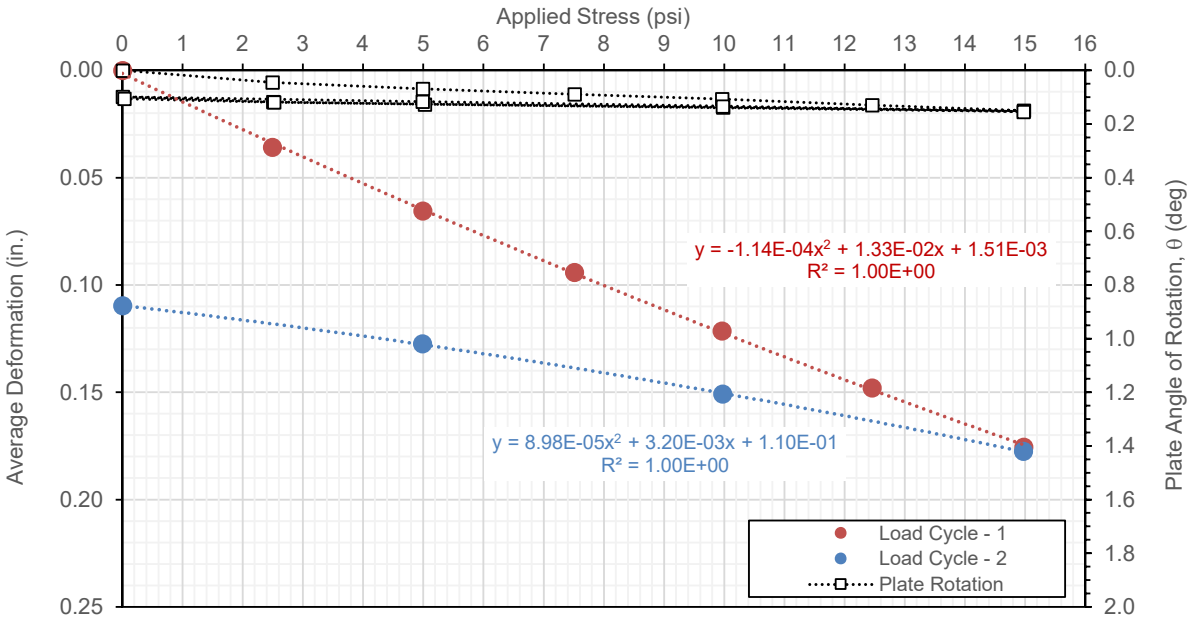
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

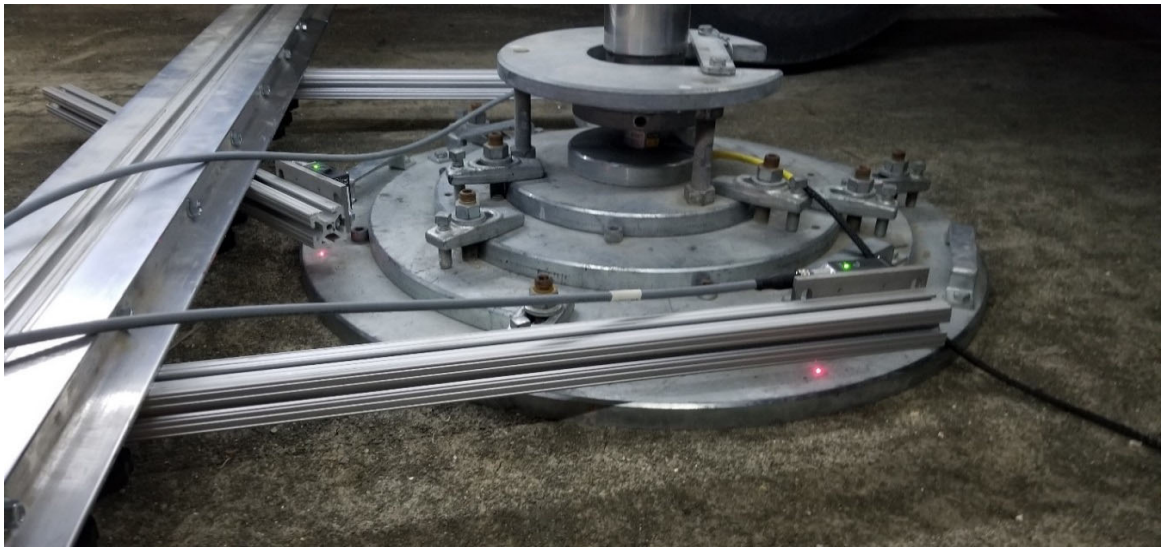
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.14E-04	a_1	8.98E-05	θ_{max} (deg)	0.1541
a_2	1.33E-02	a_2	3.20E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/27/2019	Time:	12:31:31 PM	Test ID	**Hwy20_1**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.4550	Longitude:	92.3096	Elev. (ft):	NA
Comments:	Recycled PCC granular subbase over special backfill and subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0336	0.0420	0.0291	**0.0349**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.4*	*0.0443*	*0.0468*	*0.0431*	**0.0447**
1	Load	2	3534	5	*4.8*	*0.0766*	*0.0726*	*0.0740*	**0.0744**
1	Load	3	5301	7.5	*7.2*	*0.1055*	*0.0970*	*0.1015*	**0.1013**
1	Load	4	7069	10	*9.6*	*0.1295*	*0.1172*	*0.1245*	**0.1238**
1	Load	5	8836	12.5	*12.0*	*0.1550*	*0.1387*	*0.1495*	**0.1477**
1	Load	6	10603	15	*14.4*	*0.1780*	*0.1584*	*0.1711*	**0.1692**
1	Unload	7	7069	10	*9.6*	*0.1726*	*0.1525*	*0.1663*	**0.1638**
1	Unload	8	3534	5	*4.8*	*0.1606*	*0.1392*	*0.1545*	**0.1514**
1	Unload	9	1767	2.5	*2.4*	*0.1508*	*0.1295*	*0.1446*	**0.1417**
1	Unload	10	0	0	*0.0*	*0.1371*	*0.1150*	*0.1300*	**0.1274**
2	Load	11	3534	5	*4.8*	*0.1496*	*0.1283*	*0.1430*	**0.1403**
2	Load	12	7069	10	*9.6*	*0.1640*	*0.1431*	*0.1580*	**0.1550**
2	Load	13	10603	15	*14.5*	*0.1820*	*0.1606*	*0.1762*	**0.1730**
2	Unload	14	1767	2.5	*2.4*	*0.1571*	*0.1356*	*0.1491*	**0.1473**
2	Unload	14	0	0	*0.0*	*0.1454*	*0.1225*	*0.1368*	**0.1349**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **92**
k_u (pci) @ δ = 0.05 in.: **67**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	3.4
E_1 (psi)	2,366
k'_u (pci)	67
k_u (pci)	67

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1274	0.1084
E_1 (psi)	2,755	3,238
k'_{u1} (pci)	78	92
k_{u1} (pci)	78	92
Second Loading Cycle		
δ_2 (in.)	0.0291	
E_2 (psi)	10,263	
k'_{u2} (pci)	344	
k_{u2} (pci)	292	
E_2 / E_1 or k_2 / k_1 Ratio	3.7	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

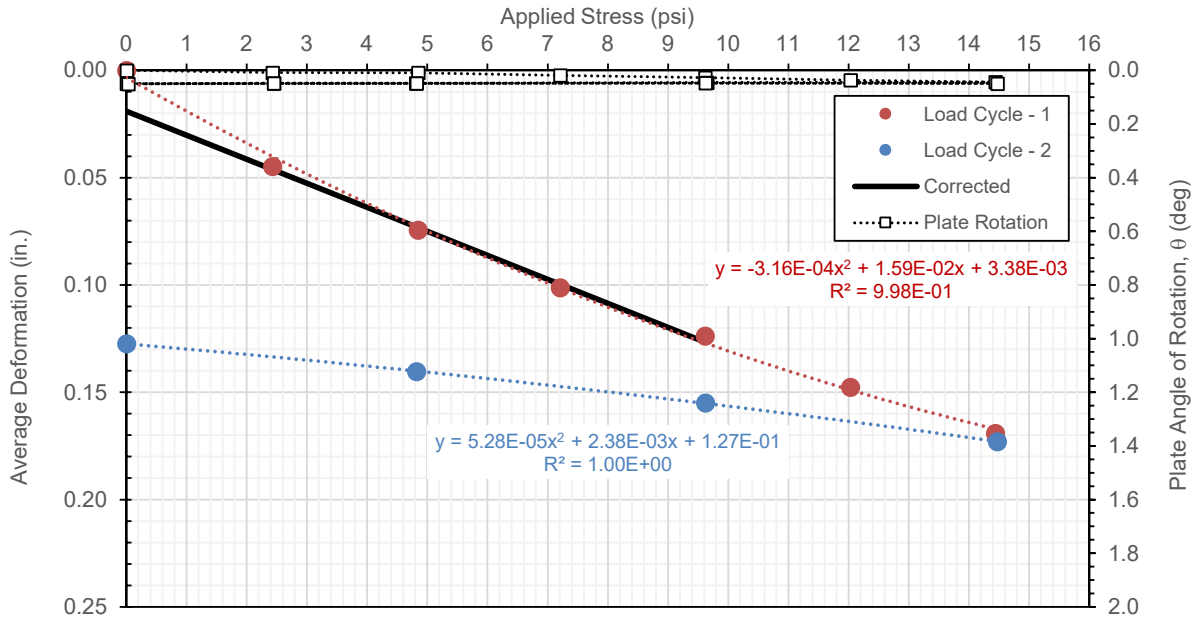
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

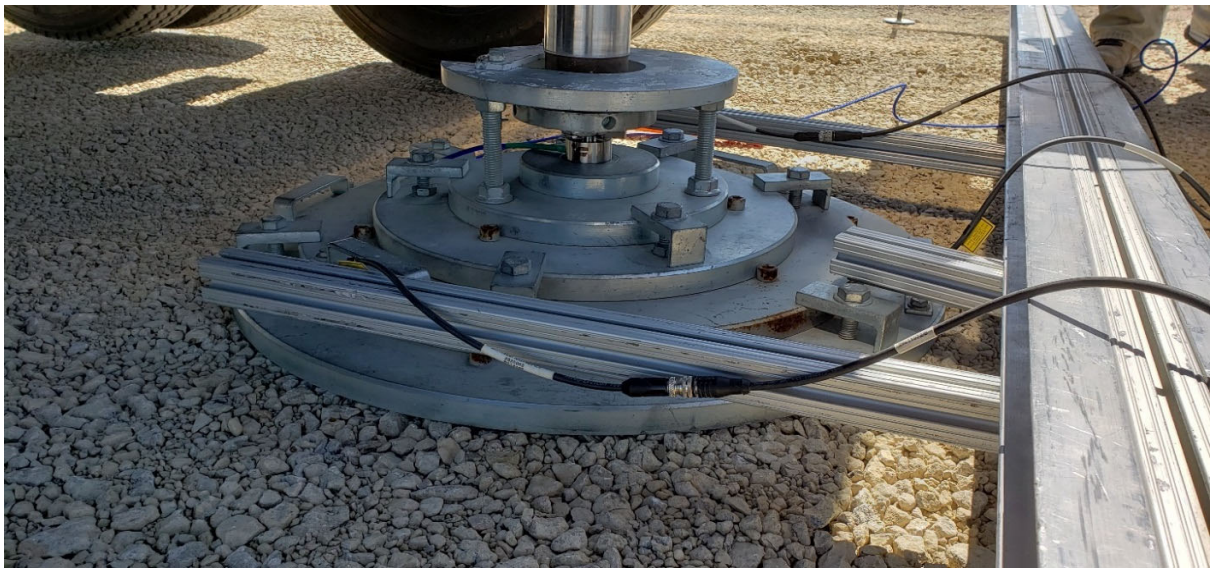
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.16E-04	a_1	5.28E-05	θ_{max} (deg)	0.0511
a_2	1.59E-02	a_2	2.38E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/27/2019	Time:	1:35:22 PM	Test ID	**Hwy20_2**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.454972	Longitude:	92.309847	Elev. (ft):	NA
Comments:	Recycled PCC granular subbase over special backfill and subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0420	0.0291	0.0349	**0.0353**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.4*	*0.0539*	*0.0445*	*0.0544*	**0.0509**
1	Load	2	3534	5	*4.8*	*0.0901*	*0.0772*	*0.0888*	**0.0854**
1	Load	3	5301	7.5	*7.2*	*0.1218*	*0.1042*	*0.1234*	**0.1165**
1	Load	4	7069	10	*9.6*	*0.1486*	*0.1318*	*0.1498*	**0.1434**
1	Load	5	8836	12.5	*12.1*	*0.1736*	*0.1537*	*0.1741*	**0.1672**
1	Load	6	10603	15	*14.4*	*0.1933*	*0.1753*	*0.1938*	**0.1875**
1	Unload	7	7069	10	*9.5*	*0.1896*	*0.1710*	*0.1907*	**0.1838**
1	Unload	8	3534	5	*4.6*	*0.1789*	*0.1577*	*0.1792*	**0.1719**
1	Unload	9	1767	2.5	*2.4*	*0.1714*	*0.1487*	*0.1689*	**0.1630**
1	Unload	10	0	0	*0.0*	*0.1572*	*0.1330*	*0.1559*	**0.1487**
2	Load	11	3534	5	*4.8*	*0.1730*	*0.1492*	*0.1699*	**0.1640**
2	Load	12	7069	10	*9.6*	*0.1839*	*0.1641*	*0.1857*	**0.1779**
2	Load	13	10603	15	*14.4*	*0.1970*	*0.1783*	*0.2025*	**0.1926**
2	Unload	14	1767	2.5	*2.4*	*0.1768*	*0.1544*	*0.1757*	**0.1689**
2	Unload	14	0	0	*0.0*	*0.1653*	*0.1424*	*0.1651*	**0.1576**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **82**
k_u (pci) @ δ = 0.05 in.: **56**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	2.8
E_1 (psi)	1,972
k'_u (pci)	56
k_u (pci)	56

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1461	0.1221
E_1 (psi)	2,402	2,874
k'_{u1} (pci)	68	82
k_{u1} (pci)	68	82
Second Loading Cycle		
δ_2 (in.)	0.0306	
E_2 (psi)	9,846	
k'_{u2} (pci)	327	
k_{u2} (pci)	281	
E_2 / E_1 or k_2 / k_1 Ratio	4.1	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

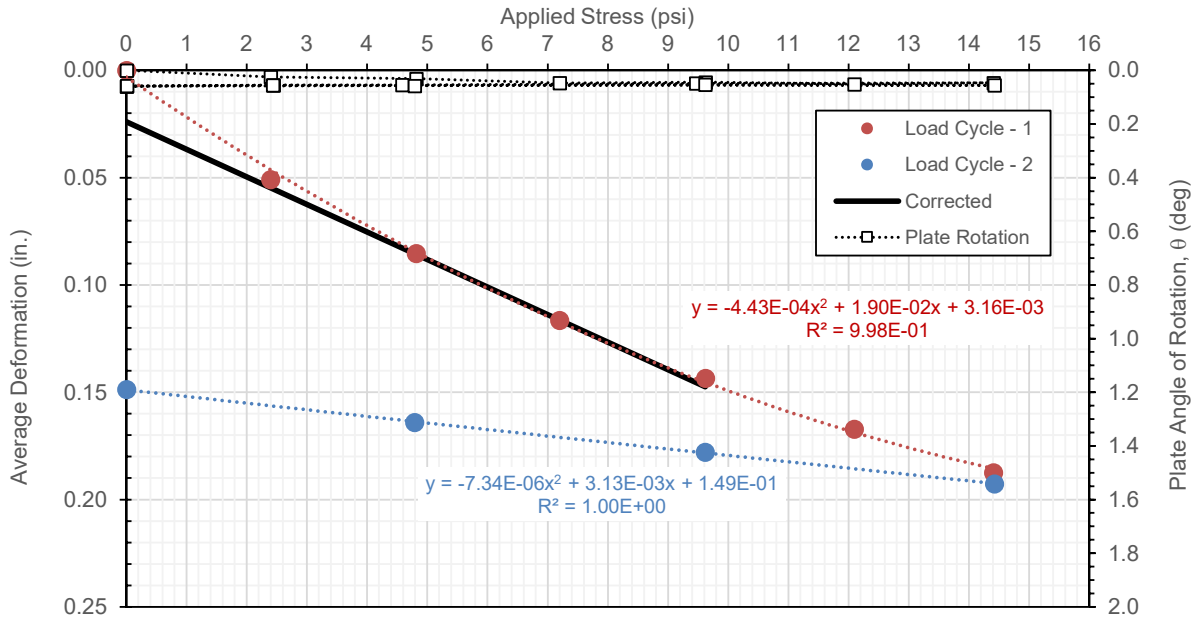
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-4.43E-04	a_1	-7.34E-06	θ_{max} (deg)	0.0601
a_2	1.90E-02	a_2	3.13E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/27/2019	Time:	2:32:29 PM	Test ID	**Hwy20_3**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.454858	Longitude:	92.310278	Elev. (ft):	NA
Comments:	Recycled PCC granular subbase over special backfill and subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*2.0*	0.0517	0.0251	0.0347	**0.0372**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.4*	*0.0430*	*0.0455*	*0.0428*	**0.0438**
1	Load	2	3534	5	*4.8*	*0.0734*	*0.0829*	*0.0728*	**0.0764**
1	Load	3	5301	7.5	*7.2*	*0.1004*	*0.1148*	*0.1016*	**0.1056**
1	Load	4	7069	10	*9.6*	*0.1237*	*0.1398*	*0.1245*	**0.1293**
1	Load	5	8836	12.5	*12.0*	*0.1465*	*0.1634*	*0.1475*	**0.1525**
1	Load	6	10603	15	*14.4*	*0.1734*	*0.1929*	*0.1714*	**0.1792**
1	Unload	7	7069	10	*9.5*	*0.1655*	*0.1835*	*0.1639*	**0.1710**
1	Unload	8	3534	5	*4.8*	*0.1541*	*0.1722*	*0.1534*	**0.1599**
1	Unload	9	1767	2.5	*2.4*	*0.1453*	*0.1635*	*0.1453*	**0.1514**
1	Unload	10	0	0	*0.0*	*0.1337*	*0.1510*	*0.1341*	**0.1396**
2	Load	11	3534	5	*4.8*	*0.1471*	*0.1645*	*0.1463*	**0.1526**
2	Load	12	7069	10	*9.6*	*0.1621*	*0.1802*	*0.1596*	**0.1673**
2	Load	13	10603	15	*14.5*	*0.1811*	*0.2001*	*0.1786*	**0.1866**
2	Unload	14	1767	2.5	*2.4*	*0.1537*	*0.1728*	*0.1525*	**0.1597**
2	Unload	14	0	0	*0.0*	*0.1421*	*0.1599*	*0.1410*	**0.1477**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **88**
k_u (pci) @ δ = 0.05 in.: **65**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	3.3
E_1 (psi)	2,294
k'_u (pci)	65
k_u (pci)	65

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.1331	0.1141
E_1 (psi)	2,637	3,076
k'_{u1} (pci)	75	88
k_{u1} (pci)	75	88
Second Loading Cycle		
δ_2 (in.)	0.0294	
E_2 (psi)	10,163	
k'_{u2} (pci)	340	
k_{u2} (pci)	290	
E_2 / E_1 or k_2 / k_1 Ratio	3.9	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

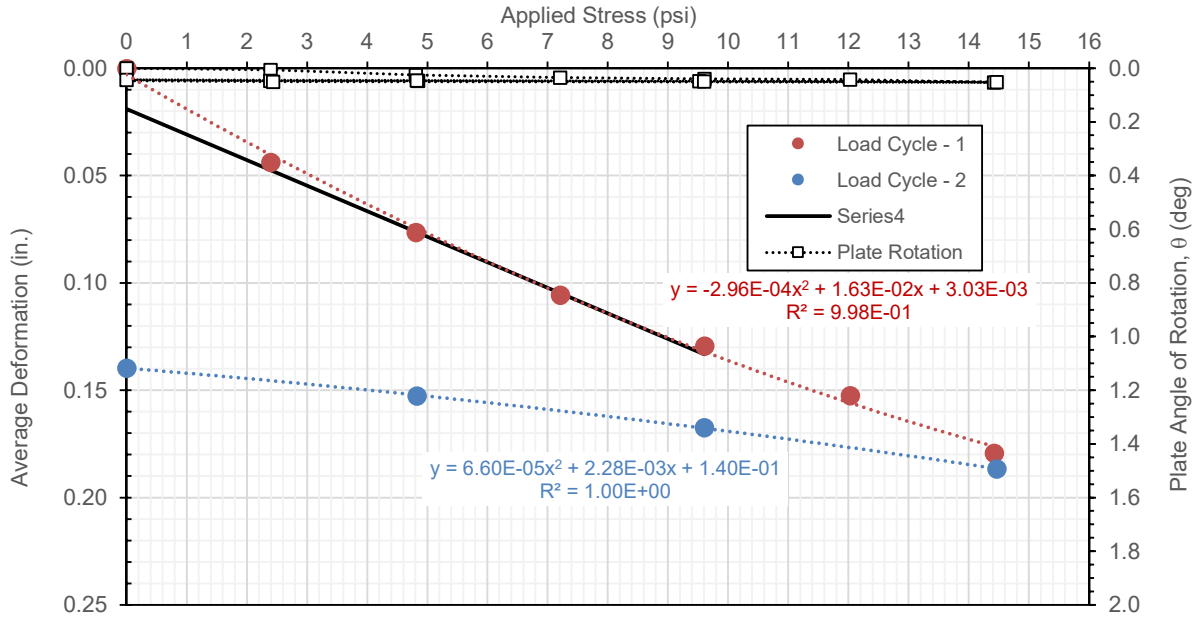
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

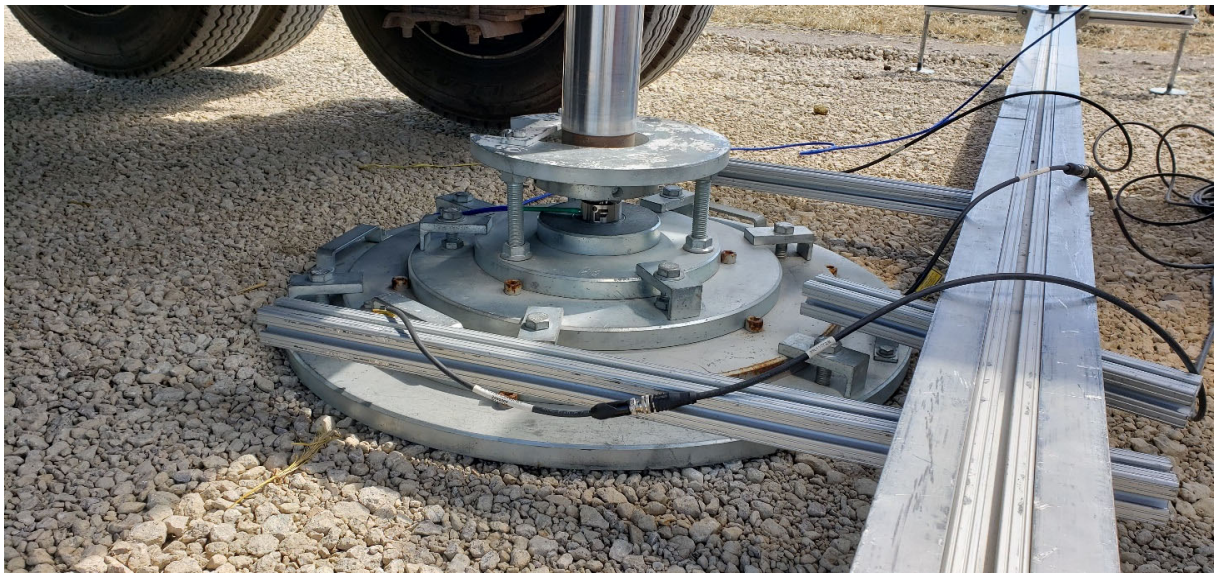
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.96E-04	a_1	6.60E-05	θ_{max} (deg)	0.0524
a_2	1.63E-02	a_2	2.28E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/27/2019	Time:	7:48:24 PM	Test ID	**HWY20_7**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.454248	Longitude:	92.313363	Elev. (ft):	NA
Comments:	Recycled PCC special backfill over subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*2.0*	0.0305	0.0353	0.0329	**0.0329**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.8*	*0.0460*	*0.0536*	*0.0515*	**0.0504**
1	Load	2	3534	5	*4.9*	*0.0846*	*0.0928*	*0.0931*	**0.0902**
1	Load	3	5301	7.5	*7.4*	*0.1227*	*0.1301*	*0.1326*	**0.1285**
1	Load	4	7069	10	*10.0*	*0.1539*	*0.1610*	*0.1652*	**0.1600**
1	Load	5	8836	12.5	*12.4*	*0.1864*	*0.1955*	*0.1992*	**0.1937**
1	Load	6	10603	15	*14.9*	*0.2185*	*0.2286*	*0.2308*	**0.2260**
1	Unload	7	7069	10	*10.0*	*0.2097*	*0.2198*	*0.2225*	**0.2173**
1	Unload	8	3534	5	*4.9*	*0.1925*	*0.2024*	*0.2058*	**0.2002**
1	Unload	9	1767	2.5	*2.5*	*0.1802*	*0.1901*	*0.1941*	**0.1881**
1	Unload	10	0	0	*0.0*	*0.1596*	*0.1700*	*0.1723*	**0.1673**
2	Load	11	3534	5	*5.0*	*0.1783*	*0.1883*	*0.1915*	**0.1860**
2	Load	12	7069	10	*9.9*	*0.2004*	*0.2101*	*0.2132*	**0.2079**
2	Load	13	10603	15	*15.0*	*0.2296*	*0.2380*	*0.2425*	**0.2367**
2	Unload	14	1767	2.5	*2.5*	*0.1890*	*0.1976*	*0.2043*	**0.1970**
2	Unload	14	0	0	*0.0*	*0.1710*	*0.1808*	*0.1855*	**0.1791**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **68**
k_u (pci) @ δ = 0.05 in.: **55**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	2.8
E_1 (psi)	1,932
k'_u (pci)	55
k_u (pci)	55

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1627	0.1477
E_1 (psi)	2,157	2,376
k'_{u1} (pci)	61	68
k_{u1} (pci)	61	68
Second Loading Cycle		
δ_2 (in.)	0.0413	
E_2 (psi)	7,715	
k'_{u2} (pci)	242	
k_{u2} (pci)	220	
E_2 / E_1 or k_2 / k_1 Ratio	3.6	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

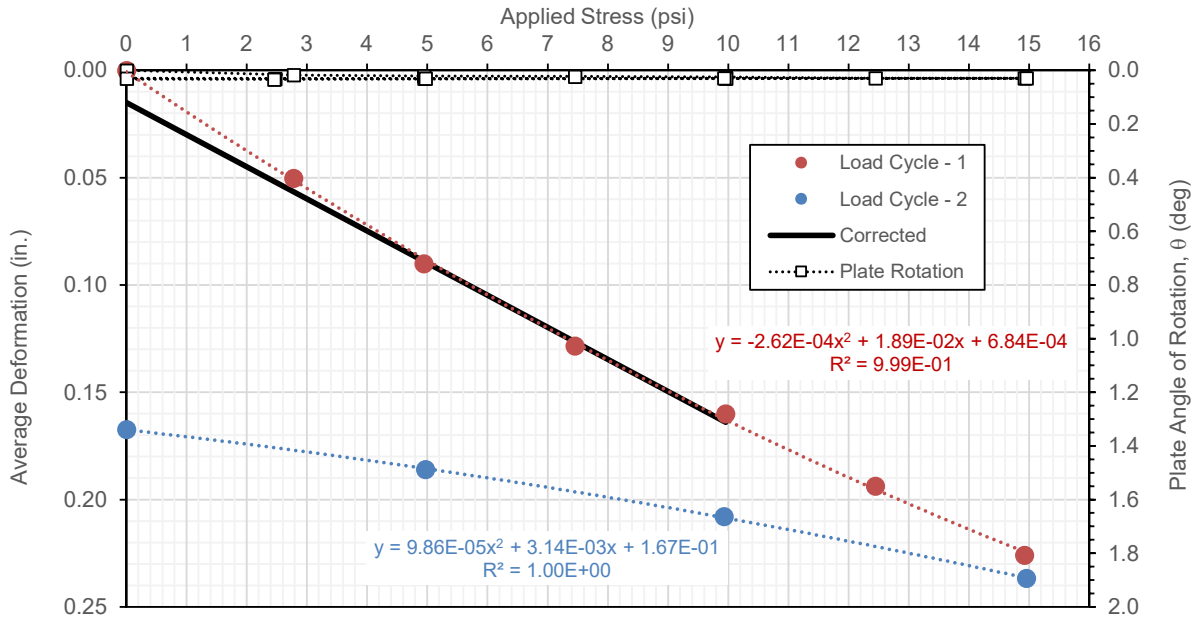
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.62E-04	a_1	9.86E-05	θ_{max} (deg)	0.0336
a_2	1.89E-02	a_2	3.14E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/27/2019	Time:	8:51:15 PM	Test ID	**HWY20_8**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.453557	Longitude:	92.316057	Elev. (ft):	NA
Comments:	Recycled PCC special backfill over subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.1	0.0133	0.0071	0.0131	0.0111
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.5	0.0212	0.0162	0.0187	0.0187
1	Load	2	3534	5	5.0	0.0373	0.0340	0.0315	0.0343
1	Load	3	5301	7.5	7.7	0.0533	0.0647	0.0414	0.0531
1	Load	4	7069	10	9.9	0.0674	0.0906	0.0505	0.0695
1	Load	5	8836	12.5	12.4	0.0798	0.1074	0.0606	0.0826
1	Load	6	10603	15	14.9	0.0941	0.1267	0.0718	0.0976
1	Unload	7	7069	10	10.0	0.0885	0.1202	0.0652	0.0913
1	Unload	8	3534	5	5.0	0.0790	0.1109	0.0542	0.0813
1	Unload	9	1767	2.5	2.3	0.0710	0.1030	0.0450	0.0730
1	Unload	10	0	0	0.0	0.0593	0.0910	0.0310	0.0605
2	Load	11	3534	5	5.0	0.0710	0.1029	0.0453	0.0731
2	Load	12	7069	10	9.9	0.0837	0.1155	0.0594	0.0862
2	Load	13	10603	15	14.9	0.0991	0.1327	0.0749	0.1022
2	Unload	14	1767	2.5	2.4	0.0746	0.1078	0.0471	0.0765
2	Unload	14	0	0	0.0	0.0650	0.0972	0.0346	0.0656

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **153**
k_u (pci) @ δ = 0.05 in.: **140**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	7.2
E_1 (psi)	4,905
k'_u (pci)	143
k_u (pci)	140

Modulus at target/design applied stress

	First Loading Cycle	Corr. for Seating
δ_1 (in.)	0.0682	0.0632
E_1 (psi)	5,004	5,355
k'_{u1} (pci)	147	158
k_{u1} (pci)	143	153
Second Loading Cycle		
δ_2 (in.)	0.0261	
E_2 (psi)	11,169	
k'_{u2} (pci)	383	
k_{u2} (pci)	318	
E_2 / E_1 or k_2 / k_1 Ratio	2.2	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

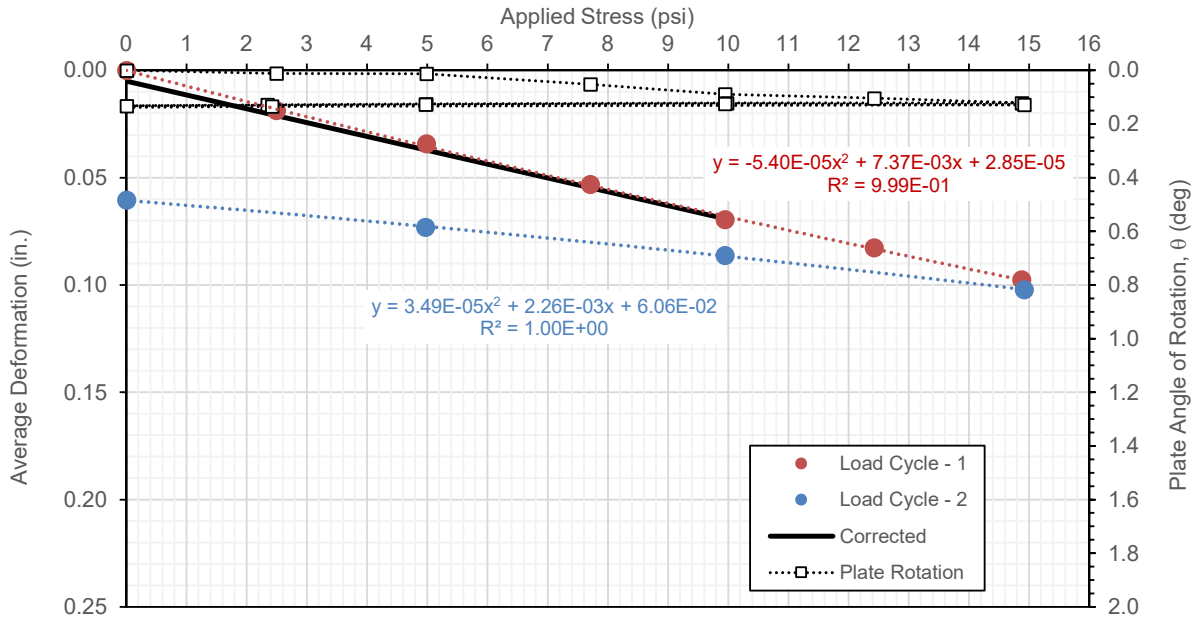
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

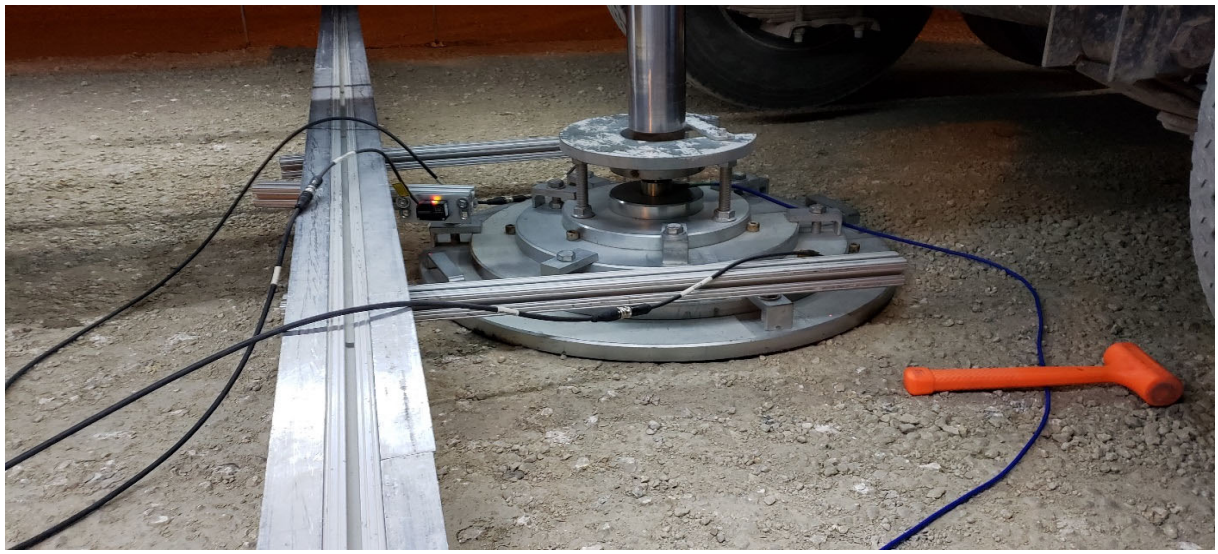
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-5.40E-05	a_1	3.49E-05	θ_{max} (deg)	0.1381
a_2	7.37E-03	a_2	2.26E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/27/2019	Time:	9:35:49 PM	Test ID	**HWY20_9**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.453593	Longitude:	92.315935	Elev. (ft):	NA
Comments:	Recycled PCC special backfill over subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.1	0.0136	0.0322	0.0103	0.0187
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.5	0.0273	0.0348	0.0295	0.0305
1	Load	2	3534	5	5.0	0.0485	0.0599	0.0528	0.0538
1	Load	3	5301	7.5	7.4	0.0678	0.0788	0.0720	0.0729
1	Load	4	7069	10	9.9	0.0872	0.0995	0.0936	0.0935
1	Load	5	8836	12.5	12.7	0.1040	0.1176	0.1121	0.1112
1	Load	6	10603	15	14.9	0.1198	0.1330	0.1318	0.1282
1	Unload	7	7069	10	10.0	0.1125	0.1257	0.1240	0.1207
1	Unload	8	3534	5	4.8	0.0994	0.1126	0.1109	0.1076
1	Unload	9	1767	2.5	2.5	0.0894	0.1028	0.1010	0.0977
1	Unload	10	0	0	0.0	0.0728	0.0872	0.0857	0.0819
2	Load	11	3534	5	5.1	0.0885	0.1020	0.1005	0.0970
2	Load	12	7069	10	9.9	0.1060	0.1191	0.1175	0.1142
2	Load	13	10603	15	14.9	0.1246	0.1387	0.1373	0.1335
2	Unload	14	1767	2.5	2.4	0.0929	0.1069	0.1050	0.1016
2	Unload	14	0	0	0.0	0.0771	0.0916	0.0900	0.0862

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **118**
k_u (pci) @ δ = 0.05 in.: **98**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.9
E_1 (psi)	3,442
k'_u (pci)	98
k_u (pci)	98

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.0928	0.0838
E_1 (psi)	3,763	4,147
k'_{u1} (pci)	108	119
k_{u1} (pci)	107	118
Second Loading Cycle		
δ_2 (in.)	0.0324	
E_2 (psi)	9,406	
k'_{u2} (pci)	309	
k_{u2} (pci)	268	
E_2 / E_1 or k_2 / k_1 Ratio	2.5	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

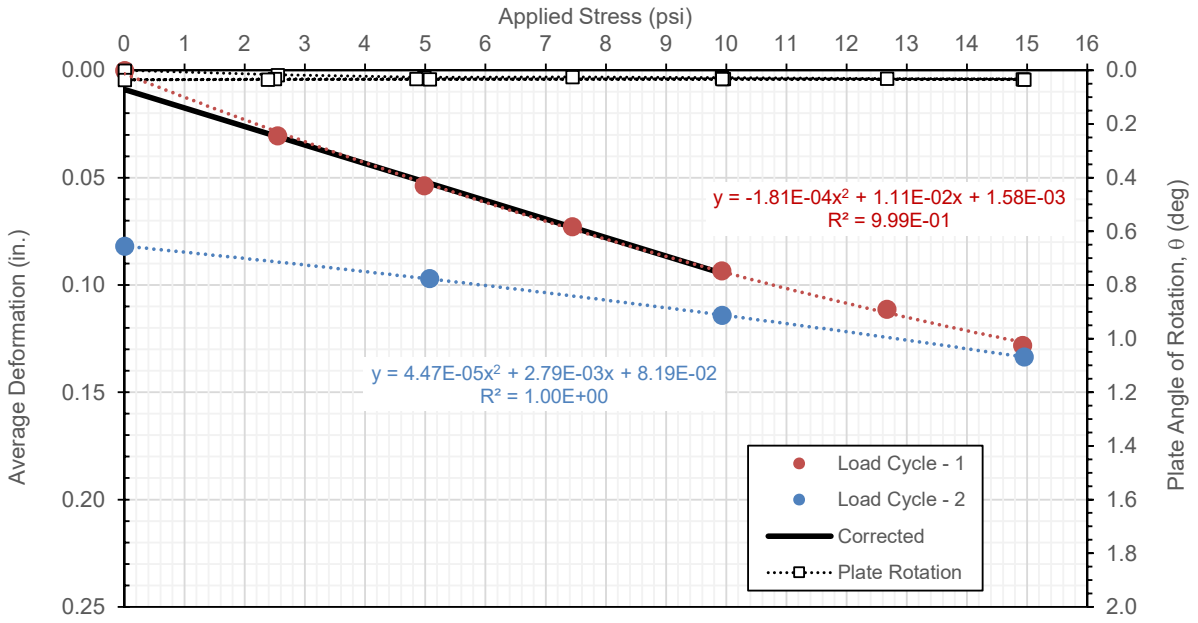
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

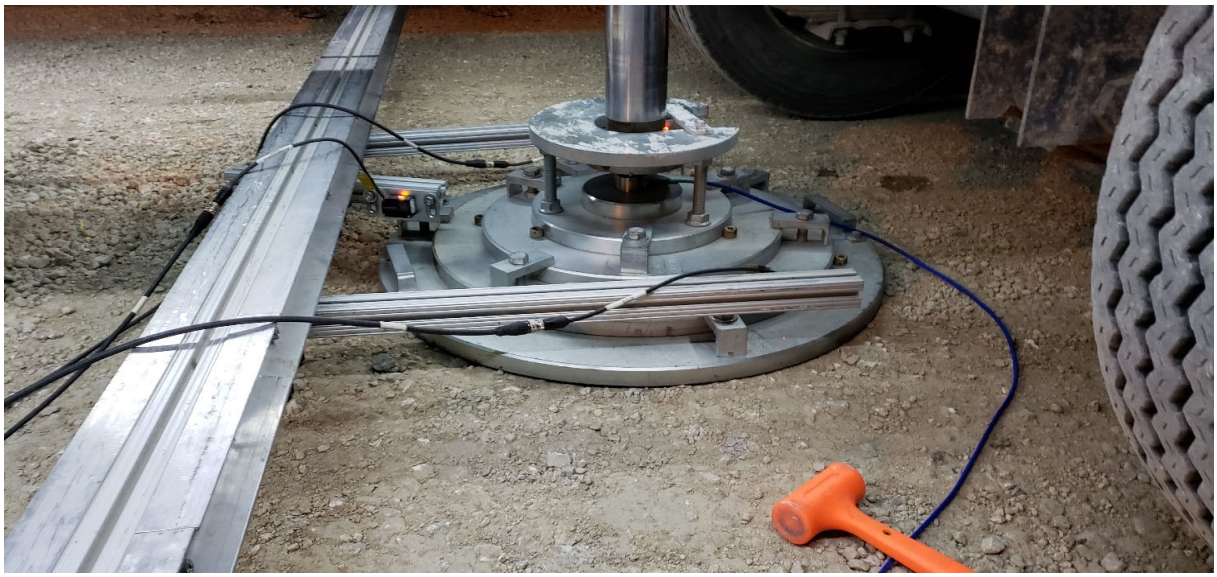
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.81E-04	a_1	4.47E-05	θ_{max} (deg)	0.0352
a_2	1.11E-02	a_2	2.79E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/27/2019	Time:	10:10:49 PM	Test ID	**HWY20_10**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.45360	Longitude:	92.31580	Elev. (ft):	NA
Comments:	Recycled PCC special backfill over subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.1	0.0130	0.0155	0.0117	0.0134
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.5	0.0263	0.0268	0.0224	0.0252
1	Load	2	3534	5	5.0	0.0508	0.0466	0.0432	0.0469
1	Load	3	5301	7.5	7.5	0.0703	0.0640	0.0597	0.0647
1	Load	4	7069	10	10.0	0.0895	0.0831	0.0775	0.0834
1	Load	5	8836	12.5	12.5	0.1065	0.0995	0.0945	0.1002
1	Load	6	10603	15	14.9	0.1247	0.1152	0.1103	0.1167
1	Unload	7	7069	10	10.0	0.1175	0.1078	0.1038	0.1097
1	Unload	8	3534	5	5.0	0.1052	0.0944	0.0924	0.0974
1	Unload	9	1767	2.5	2.5	0.0957	0.0827	0.0822	0.0869
1	Unload	10	0	0	0.0	0.0830	0.0647	0.0663	0.0713
2	Load	11	3534	5	5.0	0.0957	0.0837	0.0830	0.0875
2	Load	12	7069	10	10.0	0.1110	0.1006	0.0980	0.1032
2	Load	13	10603	15	14.9	0.1308	0.1218	0.1166	0.1231
2	Unload	14	1767	2.5	2.5	0.1013	0.0877	0.0879	0.0923
2	Unload	14	0	0	0.0	0.0890	0.0700	0.0733	0.0774

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **129**
k_u (pci) @ δ = 0.05 in.: **112**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.6
E_1 (psi)	3,930
k'_u (pci)	113
k_u (pci)	112

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0832	0.0762
E_1 (psi)	4,171	4,525
k'_{u1} (pci)	120	131
k_{u1} (pci)	119	129
Second Loading Cycle		
δ_2 (in.)	0.0325	
E_2 (psi)	9,391	
k'_{u2} (pci)	308	
k_{u2} (pci)	268	
E_2 / E_1 or k_2 / k_1 Ratio	2.3	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

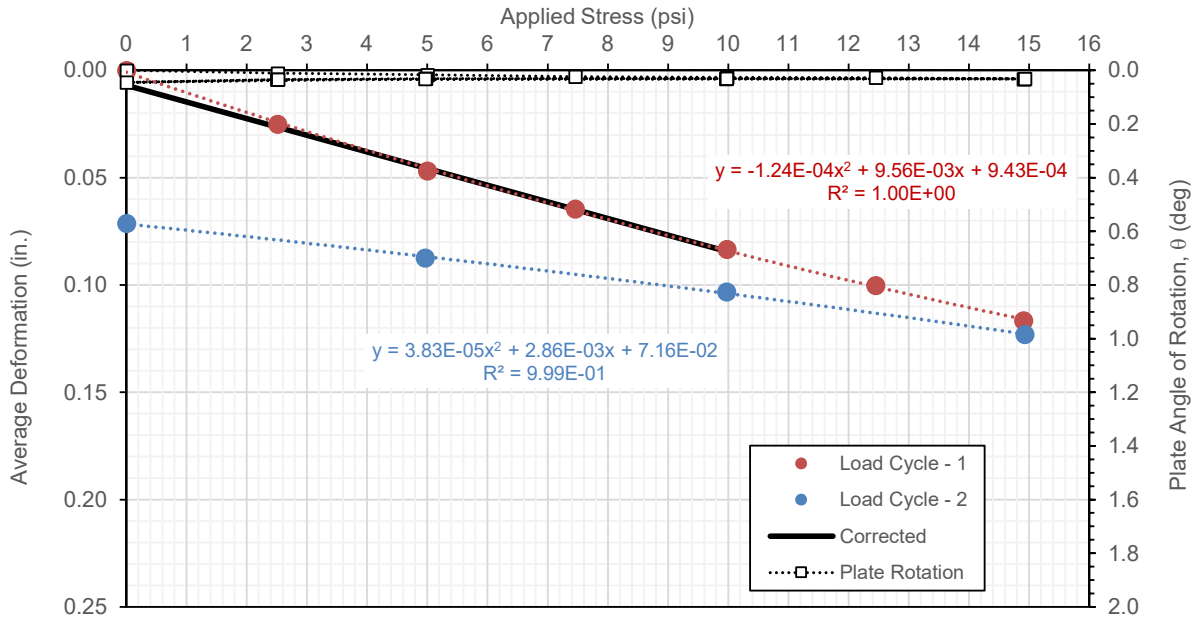
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

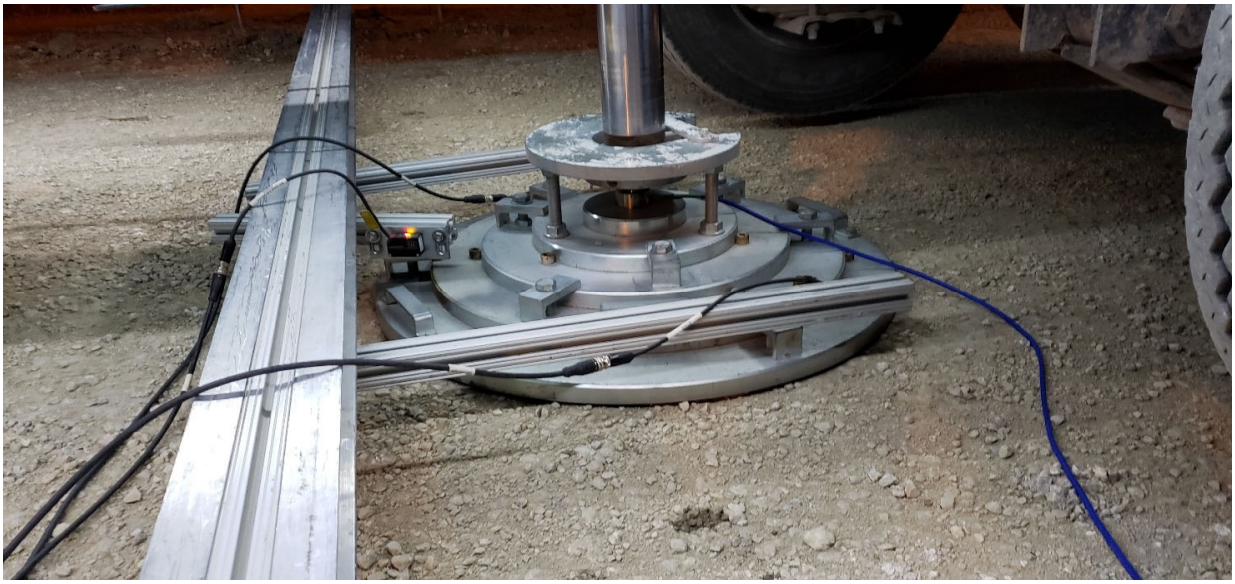
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.24E-04	a_1	3.83E-05	θ_{max} (deg)	0.0448
a_2	9.56E-03	a_2	2.86E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/5/2019	Time:	11:10:20 AM	Test ID	**Iowa_AID_HWY20_21**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.45306	Longitude:	92.34063	Elev. (ft):	NA
Comments:	Recycled PCC granular subbase over special backfill and subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.1	0.0246	0.0202	0.0207	0.0218
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.5	0.0362	0.0365	0.0322	0.0350
1	Load	2	3534	5	5.0	0.0620	0.0640	0.0540	0.0600
1	Load	3	5301	7.5	7.5	0.0834	0.0897	0.0717	0.0816
1	Load	4	7069	10	9.9	0.1038	0.1120	0.0904	0.1021
1	Load	5	8836	12.5	12.5	0.1215	0.1289	0.1045	0.1183
1	Load	6	10603	15	14.9	0.1398	0.1475	0.1201	0.1358
1	Unload	7	7069	10	10.0	0.1346	0.1435	0.1165	0.1315
1	Unload	8	3534	5	5.0	0.1242	0.1337	0.1074	0.1218
1	Unload	9	1767	2.5	2.4	0.1181	0.1270	0.1015	0.1155
1	Unload	10	0	0	0.0	0.1109	0.1189	0.0950	0.1083
2	Load	11	3534	5	5.0	0.1225	0.1302	0.1029	0.1185
2	Load	12	7069	10	10.0	0.1321	0.1401	0.1134	0.1285
2	Load	13	10603	15	14.9	0.1463	0.1560	0.1268	0.1430
2	Unload	14	1767	2.5	2.5	0.1267	0.1348	0.1084	0.1233
2	Unload	14	0	0	0.0	0.1186	0.1266	0.1006	0.1153

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **112**
k_u (pci) @ δ = 0.05 in.: **87**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.3
E_1 (psi)	3,040
k'_u (pci)	87
k_u (pci)	87

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1010	0.0890
E_1 (psi)	3,475	3,915
k'_{u1} (pci)	99	112
k_{u1} (pci)	99	112
Second Loading Cycle		
δ_2 (in.)	0.0208	
E_2 (psi)	13,337	
k'_{u2} (pci)	480	
k_{u2} (pci)	380	
E_2 / E_1 or k_2 / k_1 Ratio	3.8	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

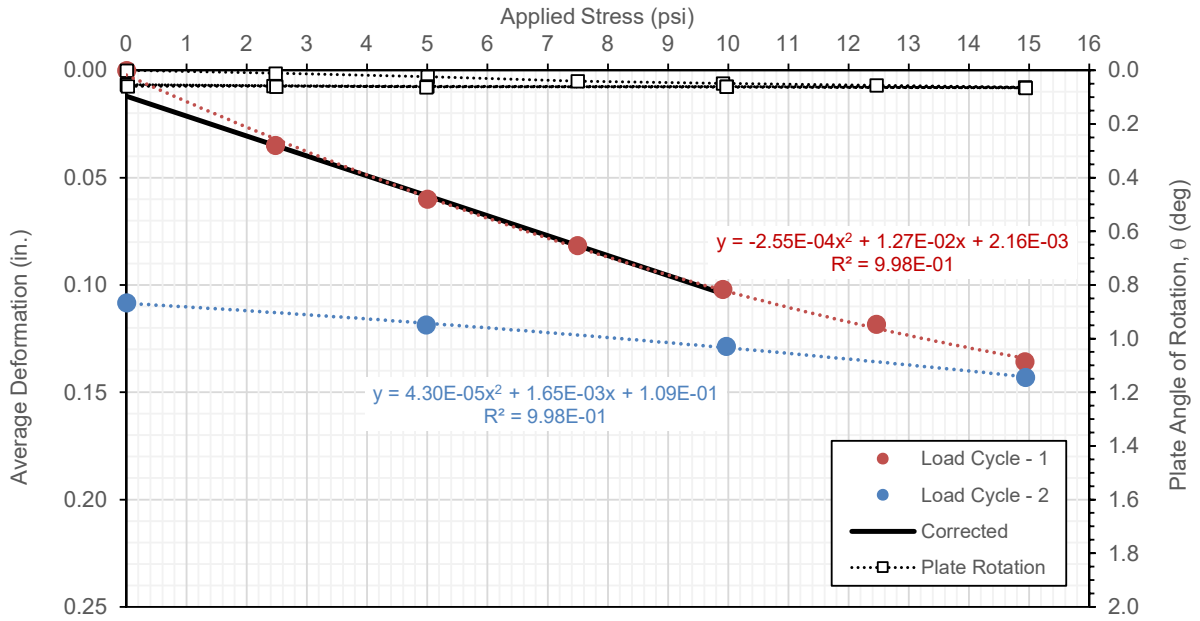
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.55E-04	a_1	4.30E-05	θ_{max} (deg)	0.0655
a_2	1.27E-02	a_2	1.65E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/5/2019	Time:	12:17:03 PM	Test ID	**Iowa_AID_HWY20_22**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.45305167	Longitude:	92.33863167	Elev. (ft):	NA
Comments:	Recycled PCC granular subbase over special backfill and subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.1	0.0305	0.0310	0.0427	0.0347
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.5	0.0365	0.0347	0.0415	0.0376
1	Load	2	3534	5	5.0	0.0637	0.0582	0.0700	0.0639
1	Load	3	5301	7.5	7.5	0.0834	0.0773	0.0902	0.0836
1	Load	4	7069	10	9.9	0.1009	0.0929	0.1095	0.1011
1	Load	5	8836	12.5	12.4	0.1146	0.1054	0.1268	0.1156
1	Load	6	10603	15	14.9	0.1272	0.1182	0.1417	0.1290
1	Unload	7	7069	10	10.0	0.1245	0.1146	0.1387	0.1259
1	Unload	8	3534	5	5.0	0.1185	0.1098	0.1329	0.1204
1	Unload	9	1767	2.5	2.5	0.1137	0.1061	0.1287	0.1162
1	Unload	10	0	0	0.0	0.1051	0.0990	0.1214	0.1085
2	Load	11	3534	5	5.0	0.1141	0.1056	0.1300	0.1165
2	Load	12	7069	10	9.9	0.1231	0.1131	0.1373	0.1245
2	Load	13	10603	15	14.9	0.1329	0.1223	0.1485	0.1346
2	Unload	14	1767	2.5	2.5	0.1196	0.1101	0.1339	0.1212
2	Unload	14	0	0	0.0	0.1100	0.1036	0.1273	0.1137

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **122**
k_u (pci) @ δ = 0.05 in.: **82**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.1
E_1 (psi)	2,886
k'_u (pci)	82
k_u (pci)	82

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1007	0.0807
E_1 (psi)	3,484	4,291
k'_{u1} (pci)	99	124
k_{u1} (pci)	99	122
Second Loading Cycle		
δ_2 (in.)	0.0163	
E_2 (psi)	16,083	
k'_{u2} (pci)	613	
k_{u2} (pci)	458	
E_2 / E_1 or k_2 / k_1 Ratio	4.6	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

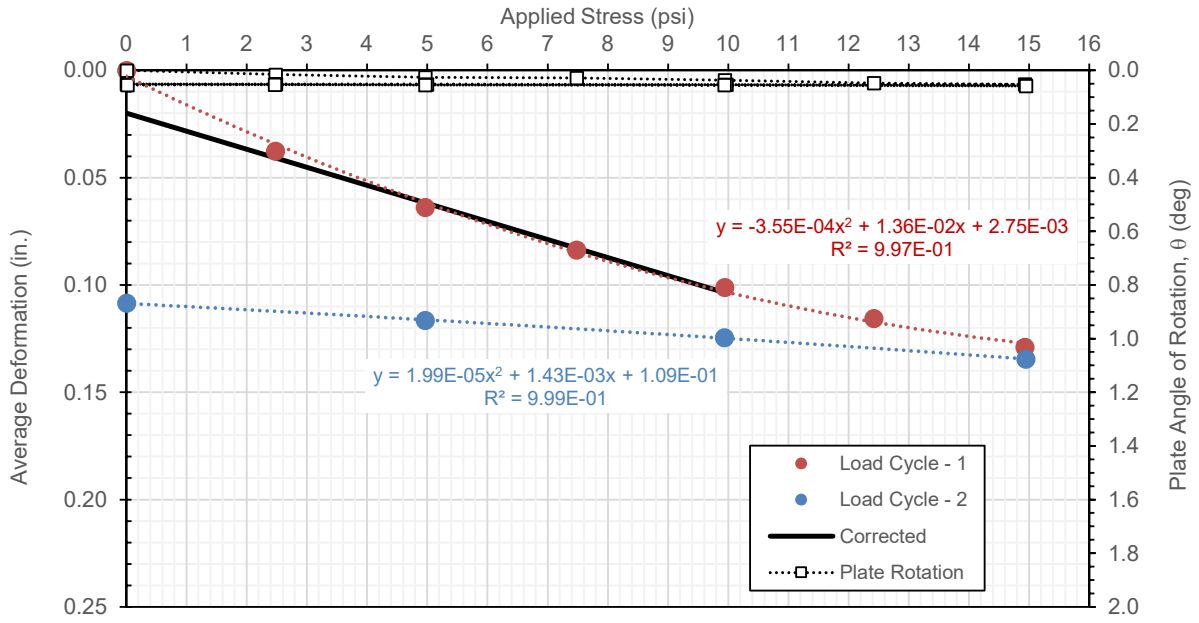
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.55E-04	a_1	1.99E-05	θ_{max} (deg)	0.0580
a_2	1.36E-02	a_2	1.43E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/5/2019	Time:	1:20:02 PM	Test ID	**Iowa_AID_HWY20_23**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.45296	Longitude:	92.33595	Elev. (ft):	NA
Comments:	Recycled PCC granular subbase over special backfill and subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.1	0.0235	0.0265	0.0183	0.0227
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.5	0.0288	0.0256	0.0234	0.0259
1	Load	2	3534	5	5.0	0.0472	0.0435	0.0429	0.0445
1	Load	3	5301	7.5	7.4	0.0627	0.0579	0.0596	0.0601
1	Load	4	7069	10	9.9	0.0768	0.0730	0.0754	0.0751
1	Load	5	8836	12.5	12.4	0.0880	0.0841	0.0870	0.0864
1	Load	6	10603	15	14.6	0.0987	0.0941	0.0999	0.0976
1	Unload	7	7069	10	9.9	0.0952	0.0903	0.0971	0.0942
1	Unload	8	3534	5	5.0	0.0874	0.0827	0.0902	0.0868
1	Unload	9	1767	2.5	2.4	0.0820	0.0778	0.0862	0.0820
1	Unload	10	0	0	0.0	0.0737	0.0697	0.0789	0.0741
2	Load	11	3534	5	5.0	0.0821	0.0777	0.0856	0.0818
2	Load	12	7069	10	9.9	0.0904	0.0870	0.0936	0.0903
2	Load	13	10603	15	14.9	0.1009	0.0985	0.1044	0.1012
2	Unload	14	1767	2.5	2.5	0.0843	0.0828	0.0897	0.0856
2	Unload	14	0	0	0.0	0.0761	0.0738	0.0813	0.0771

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **155**
k_u (pci) @ δ = 0.05 in.: **120**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	6.1
E_1 (psi)	4,208
k'_u (pci)	121
k_u (pci)	120

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.0743	0.0623
E_1 (psi)	4,633	5,427
k'_{u1} (pci)	135	161
k_{u1} (pci)	132	155
Second Loading Cycle		
δ_2 (in.)	0.0165	
E_2 (psi)	15,957	
k'_{u2} (pci)	606	
k_{u2} (pci)	455	
E_2 / E_1 or k_2 / k_1 Ratio	3.4	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

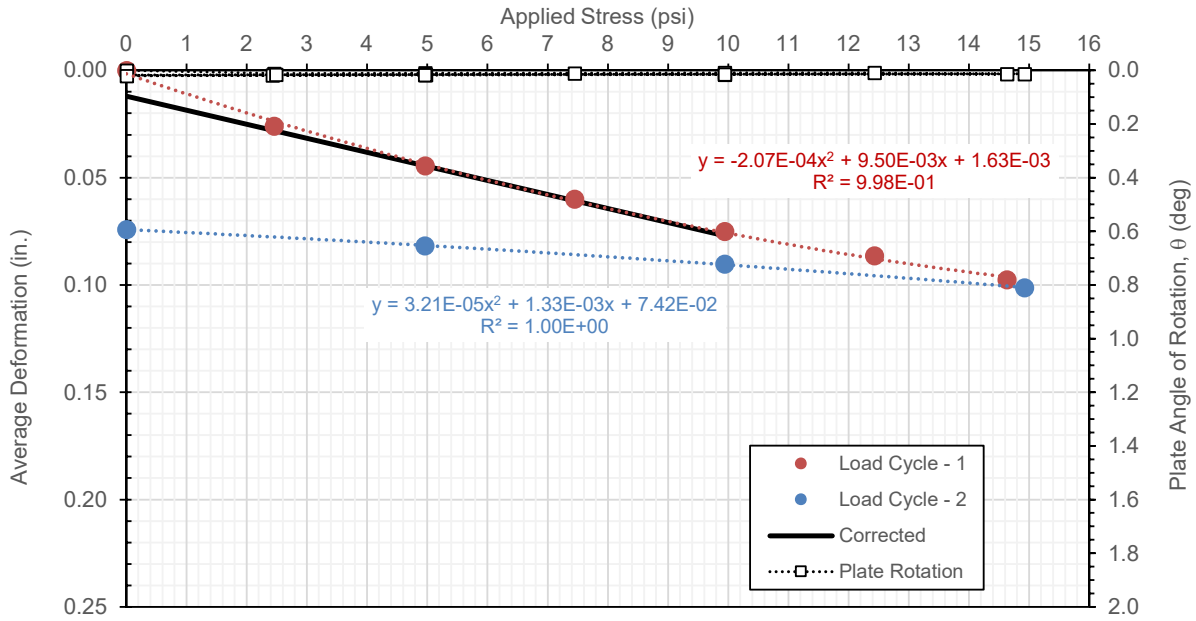
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.07E-04	a_1	3.21E-05	θ_{max} (deg)	0.0205
a_2	9.50E-03	a_2	1.33E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/5/2019	Time:	2:18:44 PM	Test ID	**Iowa_AID_HWY20_24**
Tested By	HG, DW	Location:	Hwy 20	Sta.	NA
Latitude:	42.45296	Longitude:	92.33424	Elev. (ft):	NA
Comments:	Recycled PCC granular subbase over special backfill and subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.1	0.0207	0.0219	0.0200	0.0209
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.5	0.0260	0.0257	0.0267	0.0262
1	Load	2	3534	5	5.0	0.0446	0.0443	0.0468	0.0452
1	Load	3	5301	7.5	7.5	0.0592	0.0597	0.0627	0.0605
1	Load	4	7069	10	10.0	0.0754	0.0757	0.0796	0.0769
1	Load	5	8836	12.5	12.4	0.0902	0.0898	0.0950	0.0917
1	Load	6	10603	15	14.9	0.1040	0.1044	0.1085	0.1056
1	Unload	7	7069	10	9.9	0.0995	0.1003	0.1045	0.1014
1	Unload	8	3534	5	4.9	0.0927	0.0938	0.0985	0.0950
1	Unload	9	1767	2.5	2.5	0.0878	0.0888	0.0940	0.0902
1	Unload	10	0	0	0.0	0.0792	0.0815	0.0865	0.0824
2	Load	11	3534	5	5.0	0.0879	0.0895	0.0944	0.0906
2	Load	12	7069	10	10.0	0.0964	0.0975	0.1024	0.0988
2	Load	13	10603	15	14.9	0.1079	0.1084	0.1135	0.1099
2	Unload	14	1767	2.5	2.5	0.0914	0.0927	0.0979	0.0940
2	Unload	14	0	0	0.0	0.0837	0.0858	0.0911	0.0869

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **141**
k_u (pci) @ δ = 0.05 in.: **120**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	6.1
E_1 (psi)	4,208
k'_u (pci)	121
k_u (pci)	120

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0764	0.0694
E_1 (psi)	4,519	4,932
k'_{u1} (pci)	131	144
k_{u1} (pci)	129	141
Second Loading Cycle		
δ_2 (in.)	0.0167	
E_2 (psi)	15,781	
k'_{u2} (pci)	598	
k_{u2} (pci)	450	
E_2 / E_1 or k_2 / k_1 Ratio	3.5	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

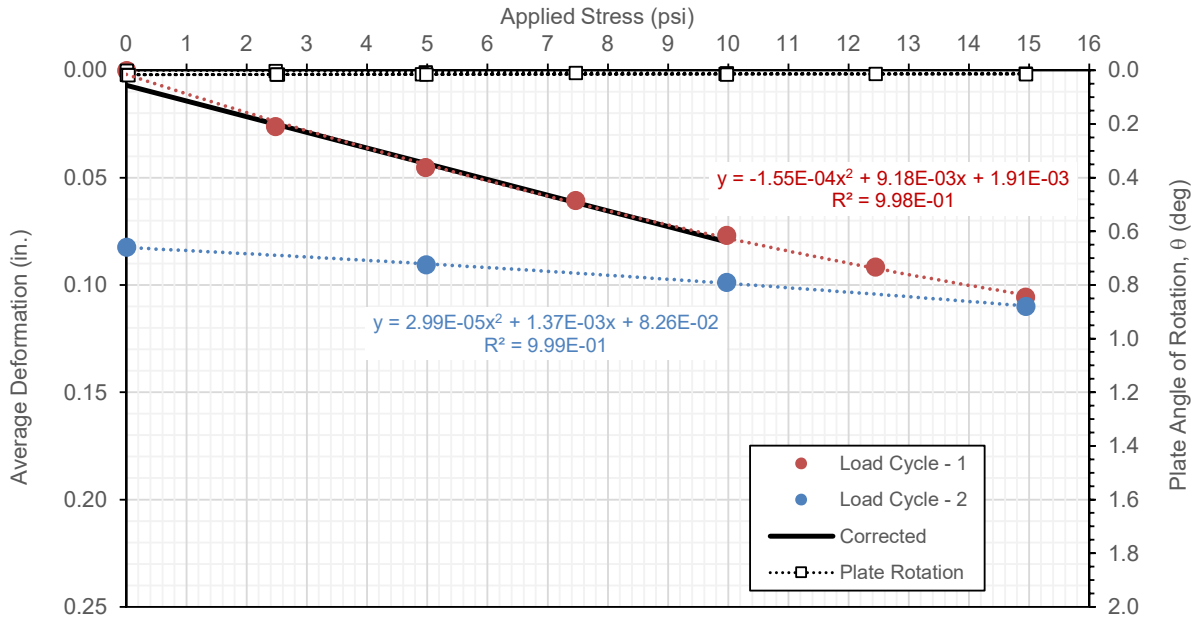
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Blackhawk County, IA

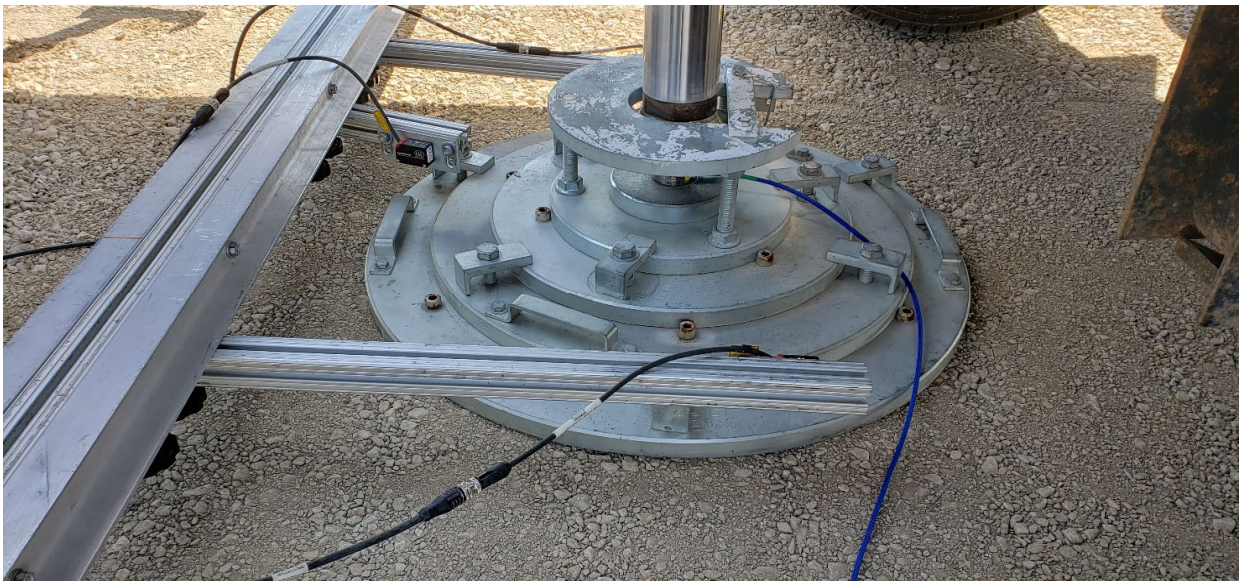
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.55E-04	a_1	2.99E-05	θ_{max} (deg)	0.0168
a_2	9.18E-03	a_2	1.37E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/16/2020	Time:	5:21:00 PM	Test ID	**PT1**
Tested By	HG/DW	Location:	US 61	Sta.	NA
Latitude:	40.90812	Longitude:	91.17113	Elev. (ft):	NA
Comments:	Compacted granular subbase.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0209	0.0195	0.0142	**0.0182**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0467*	*0.0436*	*0.0567*	**0.0490**
1	Load	2	3534	5	*5.0*	*0.0880*	*0.0859*	*0.1001*	**0.0913**
1	Load	3	5301	7.5	*7.5*	*0.1266*	*0.1230*	*0.1424*	**0.1307**
1	Load	4	7069	10	*10.0*	*0.1640*	*0.1619*	*0.1848*	**0.1702**
1	Load	5	8836	12.5	*12.4*	*0.1987*	*0.1962*	*0.2197*	**0.2048**
1	Load	6	10603	15	*15.0*	*0.2346*	*0.2377*	*0.2559*	**0.2427**
1	Unload	7	7069	10	*9.9*	*0.2221*	*0.2224*	*0.2423*	**0.2289**
1	Unload	8	3534	5	*5.0*	*0.1981*	*0.1980*	*0.2171*	**0.2044**
1	Unload	9	1767	2.5	*2.5*	*0.1789*	*0.1773*	*0.1946*	**0.1836**
1	Unload	10	0	0	*0.0*	*0.1442*	*0.1438*	*0.1548*	**0.1476**
2	Load	11	3534	5	*5.0*	*0.1742*	*0.1731*	*0.1903*	**0.1792**
2	Load	12	7069	10	*10.0*	*0.2073*	*0.2096*	*0.2306*	**0.2158**
2	Load	13	10603	15	*15.0*	*0.2431*	*0.2422*	*0.2654*	**0.2502**
2	Unload	14	1767	2.5	*2.5*	*0.1859*	*0.1857*	*0.2028*	**0.1914**
2	Unload	14	0	0	*0.0*	*0.1534*	*0.1518*	*0.1633*	**0.1562**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **62**
k_u (pci) @ δ = 0.05 in.: **55**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**2.7**
E_1 (psi)	**1,919**
k'_u (pci)	**55**
k_u (pci)	**55**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1694**	**0.1604**
E_1 (psi)	**2,072**	**2,188**
k'_{u1} (pci)	**59**	**62**
k_{u1} (pci)	**59**	**62**
Second Loading Cycle		
δ_2 (in.)	**0.0677**	
E_2 (psi)	**5,040**	
k'_{u2} (pci)	**148**	
k_{u2} (pci)	**144**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.4**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

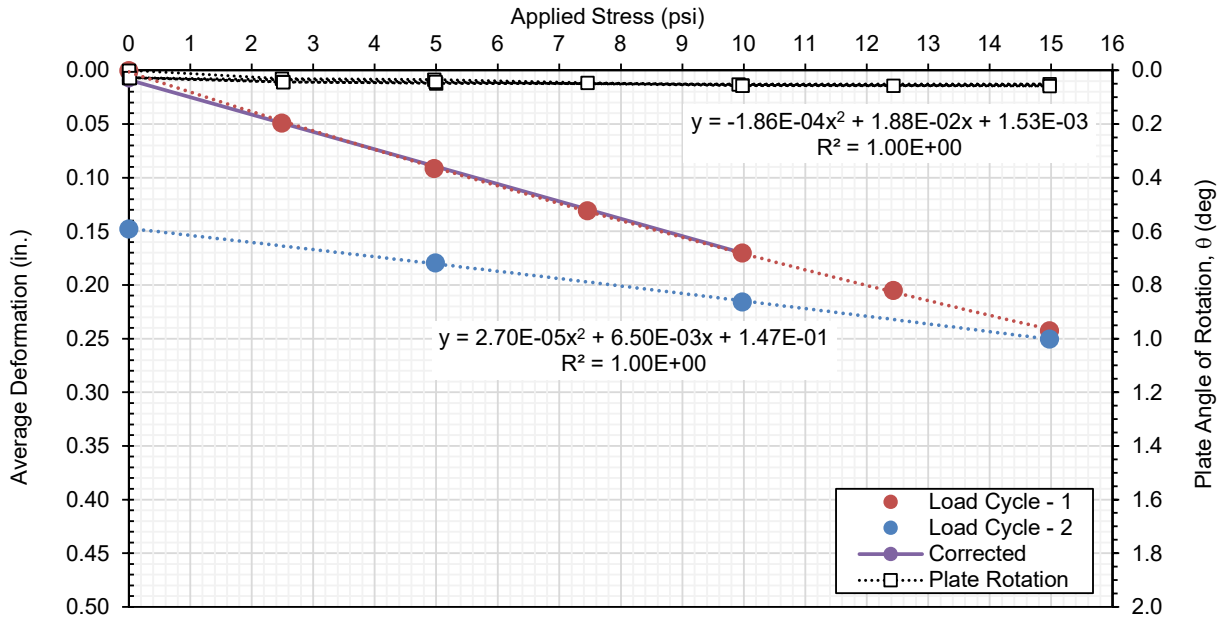
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.86E-04	a_1	2.70E-05	θ_{max} (deg)	0.0579
a_2	1.88E-02	a_2	6.50E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/16/2020	Time:	6:12:48 PM	Test ID	**PT3**
Tested By	HG/DW	Location:	US 61	Sta.	NA
Latitude:	40.907853	Longitude:	91.171062	Elev. (ft):	NA
Comments:	Compacted granular subbase.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0292	0.0016	0.0228	**0.0179**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0415*	*0.0158*	*0.0363*	**0.0312**
1	Load	2	3534	5	*5.0*	*0.0690*	*0.0312*	*0.0501*	**0.0501**
1	Load	3	5301	7.5	*7.5*	*0.0927*	*0.0400*	*0.0719*	**0.0682**
1	Load	4	7069	10	*10.0*	*0.1097*	*0.0572*	*0.0899*	**0.0856**
1	Load	5	8836	12.5	*12.5*	*0.1369*	*0.0709*	*0.1063*	**0.1047**
1	Load	6	10603	15	*15.0*	*0.1549*	*0.0839*	*0.1122*	**0.1170**
1	Unload	7	7069	10	*9.7*	*0.1396*	*0.0724*	*0.1093*	**0.1071**
1	Unload	8	3534	5	*5.0*	*0.1327*	*0.0611*	*0.0931*	**0.0956**
1	Unload	9	1767	2.5	*2.5*	*0.1248*	*0.0509*	*0.1036*	**0.0931**
1	Unload	10	0	0	*0.0*	*0.1086*	*0.0312*	*0.0738*	**0.0712**
2	Load	11	3534	5	*5.0*	*0.1251*	*0.0503*	*0.0991*	**0.0915**
2	Load	12	7069	10	*10.0*	*0.1350*	*0.0654*	*0.1059*	**0.1021**
2	Load	13	10603	15	*14.8*	*0.1599*	*0.0847*	*0.1161*	**0.1202**
2	Unload	14	1767	2.5	*2.5*	*0.1307*	*0.0690*	*0.0968*	**0.0988**
2	Unload	14	0	0	*0.0*	*0.1195*	*0.0557*	*0.0846*	**0.0866**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **129**
k_u (pci) @ δ = 0.05 in.: **106**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**5.3**
E_1 (psi)	**3,735**
k'_u (pci)	**107**
k_u (pci)	**106**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.0852**	**0.0762**
E_1 (psi)	**4,080**	**4,527**
k'_{u1} (pci)	**117**	**131**
k_{u1} (pci)	**116**	**129**
Second Loading Cycle		
δ_2 (in.)	**0.0327**	
E_2 (psi)	**9,334**	
k'_{u2} (pci)	**306**	
k_{u2} (pci)	**266**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.3**	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

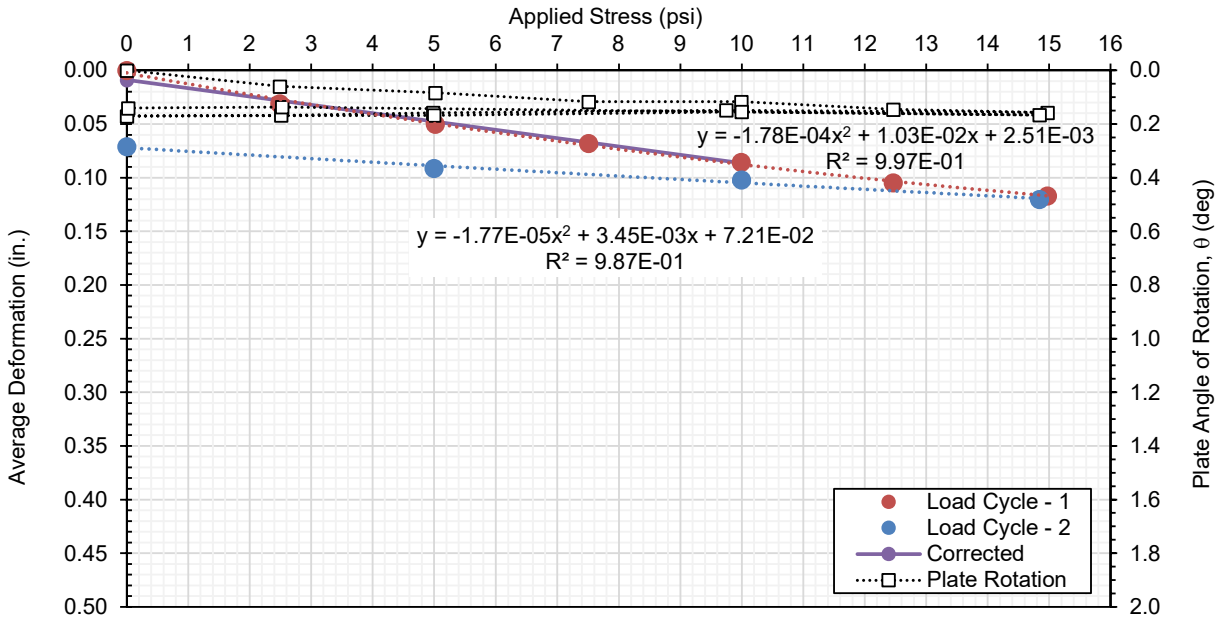
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US61, Des Moines County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.78E-04	a_1	-1.77E-05	θ_{max} (deg)	0.1710
a_2	1.03E-02	a_2	3.45E-03		
R^2	1.00	R^2	0.99		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/25/2020	Time:	10:34:00 AM	Test ID	**PT_1**
Tested By	CV	Location:	Hwy 20 Frontage Road	Sta.	NA
Latitude:	42.44037	Longitude:	-90.79285	Elev. (ft):	1011.8
Comments:	Macadam Stone Base				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0337	0.0552	0.0564	**0.0484**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0490*	*0.0774*	*0.0833*	**0.0699**
1	Load	2	3534	5	*5.0*	*0.0841*	*0.1250*	*0.1374*	**0.1155**
1	Load	3	5301	7.5	*7.5*	*0.1127*	*0.1625*	*0.1732*	**0.1495**
1	Load	4	7069	10	*10.0*	*0.1393*	*0.1871*	*0.2070*	**0.1778**
1	Load	5	8836	12.5	*12.5*	*0.1635*	*0.2154*	*0.2378*	**0.2055**
1	Load	6	10603	15	*14.9*	*0.1822*	*0.2370*	*0.2578*	**0.2257**
1	Unload	7	7069	10	*10.0*	*0.1778*	*0.2343*	*0.2558*	**0.2226**
1	Unload	8	3534	5	*5.0*	*0.1738*	*0.2275*	*0.2491*	**0.2168**
1	Unload	9	1767	2.5	*2.5*	*0.1672*	*0.2203*	*0.2440*	**0.2105**
1	Unload	10	0	0	*0.0*	*0.1562*	*0.2100*	*0.2323*	**0.1995**
2	Load	11	3534	5	*5.0*	*0.1677*	*0.2205*	*0.2440*	**0.2107**
2	Load	12	7069	10	*10.0*	*0.1782*	*0.2331*	*0.2528*	**0.2214**
2	Load	13	10603	15	*15.0*	*0.1926*	*0.2475*	*0.2726*	**0.2375**
2	Unload	14	1767	2.5	*2.5*	*0.1763*	*0.2355*	*0.2552*	**0.2223**
2	Unload	15	0	0	*0.0*	*0.1672*	*0.2194*	*0.2427*	**0.2098**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **72**
k_u (pci) @ δ = 0.05 in.: **43**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**2.2**
E_1 (psi)	**1,458**
k'_u (pci)	**43**
k_u (pci)	**43**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1780**	**0.1380**
E_1 (psi)	**1,887**	**2,434**
k'_{u1} (pci)	**56**	**72**
k_{u1} (pci)	**56**	**72**
Second Loading Cycle		
δ_2 (in.)	**0.0226**	
E_2 (psi)	**11,996**	
k'_{u2} (pci)	**443**	
k_{u2} (pci)	**357**	
E_2 / E_1 or k_2 / k_1 Ratio	**6.4**	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

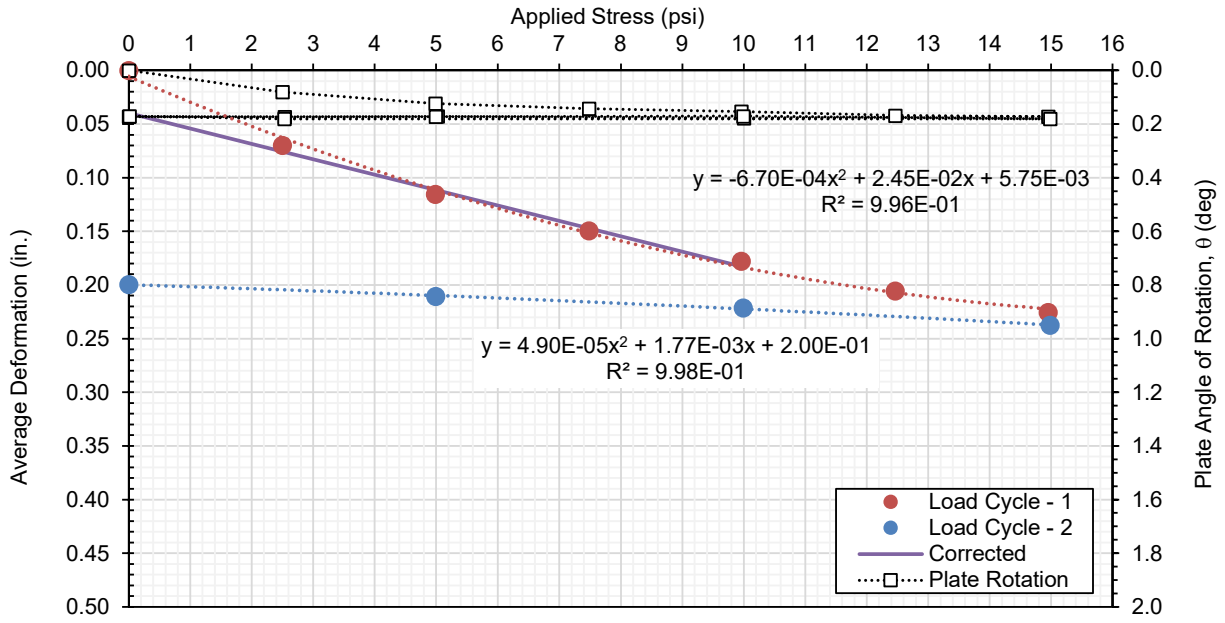
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy20, Dubuque, IA

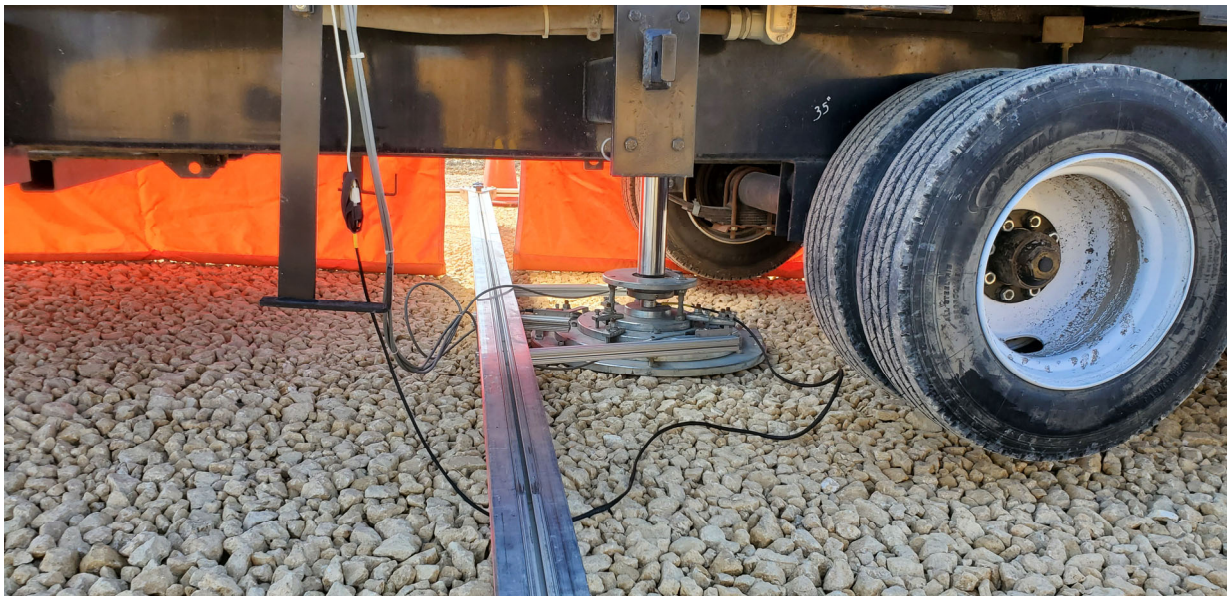
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-6.70E-04	a_1	4.90E-05	θ_{max} (deg)	0.1811
a_2	2.45E-02	a_2	1.77E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy20, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/25/2020	Time:	11:45:39 AM	Test ID	**PT_2**
Tested By	CV	Location:	Hwy 20 Frontage Road	Sta.	NA
Latitude:	42.440390	Longitude:	-90.792723	Elev. (ft):	1012.0
Comments:	Macadam Stone Base				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0313	0.0267	0.0096	**0.0225**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0456*	*0.0529*	*0.0197*	**0.0394**
1	Load	2	3534	5	*5.0*	*0.0700*	*0.0953*	*0.0373*	**0.0675**
1	Load	3	5301	7.5	*7.5*	*0.1030*	*0.1232*	*0.0492*	**0.0918**
1	Load	4	7069	10	*10.0*	*0.1246*	*0.1469*	*0.0624*	**0.1113**
1	Load	5	8836	12.5	*12.4*	*0.1411*	*0.1739*	*0.0783*	**0.1311**
1	Load	6	10603	15	*14.9*	*0.1623*	*0.1996*	*0.0899*	**0.1506**
1	Unload	7	7069	10	*10.0*	*0.1536*	*0.1972*	*0.0861*	**0.1457**
1	Unload	8	3534	5	*5.0*	*0.1427*	*0.1894*	*0.0823*	**0.1381**
1	Unload	9	1767	2.5	*2.5*	*0.1422*	*0.1791*	*0.0785*	**0.1333**
1	Unload	10	0	0	*0.0*	*0.1350*	*0.1638*	*0.0673*	**0.1220**
2	Load	11	3534	5	*5.0*	*0.1338*	*0.1792*	*0.0788*	**0.1306**
2	Load	12	7069	10	*10.0*	*0.1577*	*0.1982*	*0.0847*	**0.1469**
2	Load	13	10603	15	*15.0*	*0.1701*	*0.2177*	*0.0977*	**0.1618**
2	Unload	14	1767	2.5	*2.5*	*0.1550*	*0.1938*	*0.0841*	**0.1443**
2	Unload	15	0	0	*0.0*	*0.1388*	*0.1788*	*0.0768*	**0.1315**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **98**
k_u (pci) @ δ = 0.05 in.: **77**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**3.9**
E_1 (psi)	**2,591**
k'_u (pci)	**77**
k_u (pci)	**77**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1119**	**0.1019**
E_1 (psi)	**3,003**	**3,298**
k'_{u1} (pci)	**89**	**98**
k_{u1} (pci)	**89**	**98**
Second Loading Cycle		
δ_2 (in.)	**0.0240**	
E_2 (psi)	**11,420**	
k'_{u2} (pci)	**416**	
k_{u2} (pci)	**340**	
E_2 / E_1 or k_2 / k_1 Ratio	**3.8**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

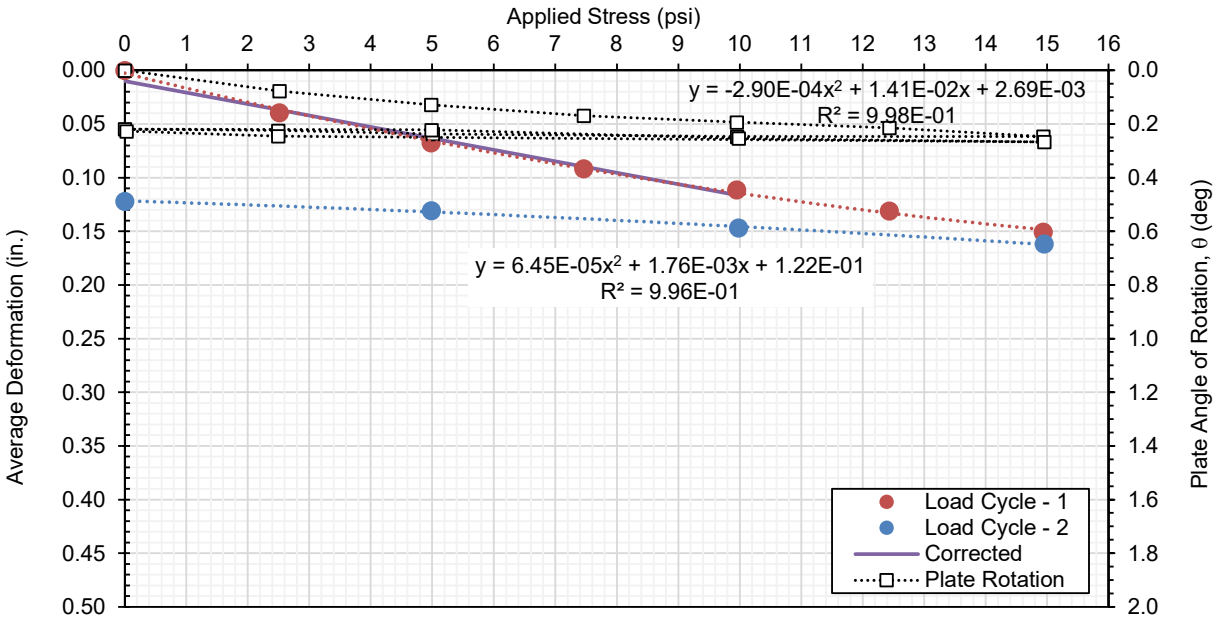
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy20, Dubuque, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.90E-04	a_1	6.45E-05	θ_{max} (deg)	0.2666
a_2	1.41E-02	a_2	1.76E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy20, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/25/2020	Time:	12:38:59 PM	Test ID	**PT_3**
Tested By	CV	Location:	Hwy 20 Frontage Road	Sta.	NA
Latitude:	42.44055	Longitude:	-90.79201	Elev. (ft):	1011.6
Comments:	Macadam Stone Base				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0261	0.0433	0.0191	**0.0295**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.6*	*0.0528*	*0.0743*	*0.0438*	**0.0570**
1	Load	2	3534	5	*5.0*	*0.0836*	*0.1095*	*0.0756*	**0.0896**
1	Load	3	5301	7.5	*7.5*	*0.1164*	*0.1401*	*0.1072*	**0.1212**
1	Load	4	7069	10	*9.9*	*0.1562*	*0.1746*	*0.1353*	**0.1554**
1	Load	5	8836	12.5	*12.4*	*0.1895*	*0.2059*	*0.1684*	**0.1879**
1	Load	6	10603	15	*14.9*	*0.2225*	*0.2347*	*0.1992*	**0.2188**
1	Unload	7	7069	10	*9.9*	*0.2147*	*0.2294*	*0.1917*	**0.2119**
1	Unload	8	3534	5	*4.9*	*0.1976*	*0.2079*	*0.1776*	**0.1944**
1	Unload	9	1767	2.5	*2.5*	*0.1836*	*0.2037*	*0.1658*	**0.1844**
1	Unload	10	0	0	*0.0*	*0.1609*	*0.1784*	*0.1479*	**0.1624**
2	Load	11	3534	5	*5.0*	*0.1828*	*0.2004*	*0.1645*	**0.1826**
2	Load	12	7069	10	*10.0*	*0.2054*	*0.2236*	*0.1879*	**0.2056**
2	Load	13	10603	15	*14.9*	*0.2350*	*0.2457*	*0.2151*	**0.2319**
2	Unload	14	1767	2.5	*2.5*	*0.1980*	*0.2178*	*0.1815*	**0.1991**
2	Unload	15	0	0	*0.0*	*0.1781*	*0.2008*	*0.1599*	**0.1796**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **70**
k_u (pci) @ δ = 0.05 in.: **59**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**2.9**
E_1 (psi)	**1,971**
k'_u (pci)	**59**
k_u (pci)	**59**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1536**	**0.1436**
E_1 (psi)	**2,187**	**2,339**
k'_{u1} (pci)	**65**	**70**
k_{u1} (pci)	**65**	**70**
Second Loading Cycle		
δ_2 (in.)	**0.0435**	
E_2 (psi)	**7,076**	
k'_{u2} (pci)	**230**	
k_{u2} (pci)	**211**	
E_2 / E_1 or k_2 / k_1 Ratio	**3.2**	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

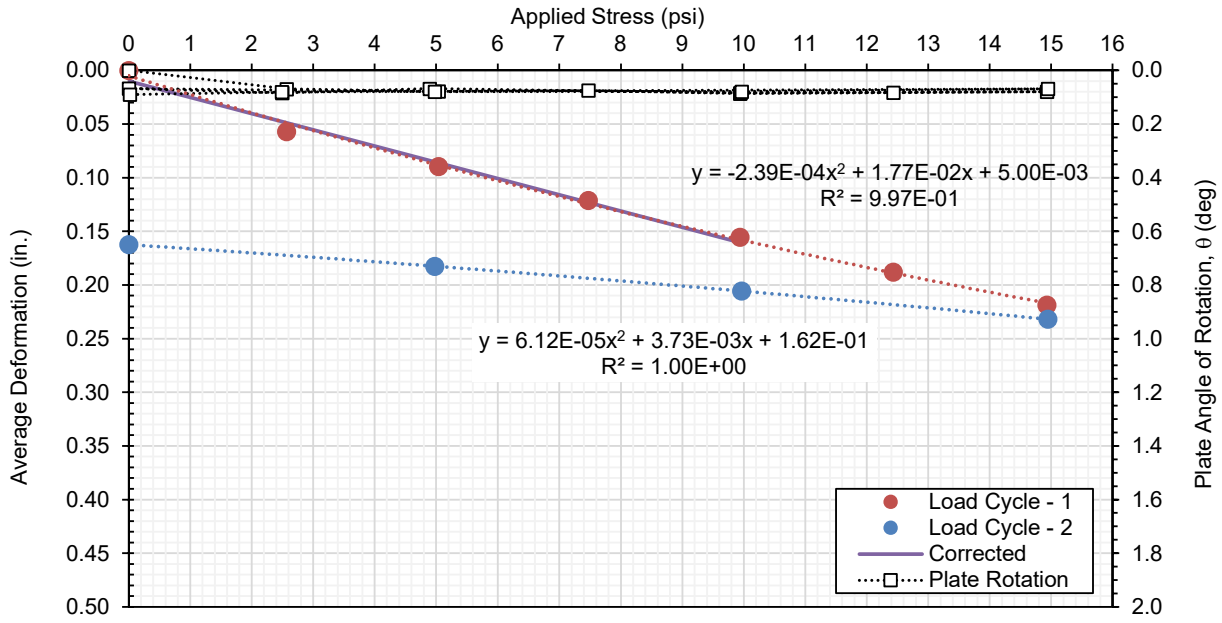
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy20, Dubuque, IA

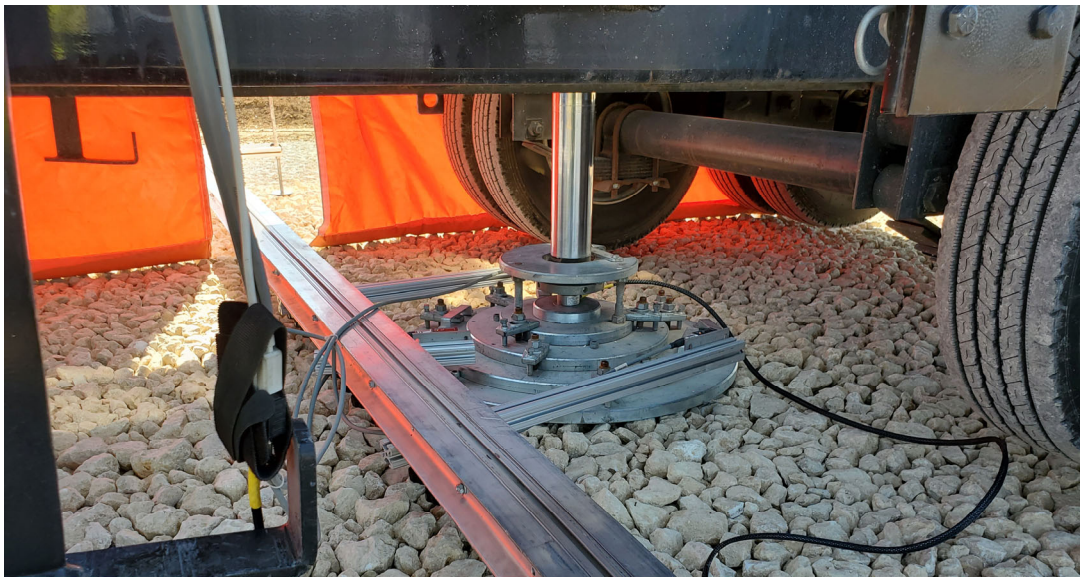
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.39E-04	a_1	6.12E-05	θ_{max} (deg)	0.0902
a_2	1.77E-02	a_2	3.73E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy20, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/25/2020	Time:	1:42:45 PM	Test ID	**PT_4**
Tested By	CV	Location:	Hwy 20 Frontage Road	Sta.	NA
Latitude:	42.44112	Longitude:	-90.79076	Elev. (ft):	1010.0
Comments:	Macadam Stone Base				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0298	0.0224	0.0120	**0.0214**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0622*	*0.0433*	*0.0202*	**0.0419**
1	Load	2	3534	5	*5.0*	*0.1012*	*0.0718*	*0.0382*	**0.0704**
1	Load	3	5301	7.5	*7.5*	*0.1377*	*0.0986*	*0.0564*	**0.0976**
1	Load	4	7069	10	*9.9*	*0.1651*	*0.1148*	*0.0721*	**0.1173**
1	Load	5	8836	12.5	*12.4*	*0.1935*	*0.1366*	*0.0862*	**0.1387**
1	Load	6	10603	15	*14.9*	*0.2225*	*0.1585*	*0.0956*	**0.1589**
1	Unload	7	7069	10	*10.0*	*0.2179*	*0.1562*	*0.0927*	**0.1556**
1	Unload	8	3534	5	*5.0*	*0.2063*	*0.1520*	*0.0875*	**0.1486**
1	Unload	9	1767	2.5	*2.5*	*0.1961*	*0.1475*	*0.0838*	**0.1424**
1	Unload	10	0	0	*0.0*	*0.1801*	*0.1410*	*0.0751*	**0.1320**
2	Load	11	3534	5	*5.0*	*0.1993*	*0.1481*	*0.0839*	**0.1438**
2	Load	12	7069	10	*9.9*	*0.2141*	*0.1555*	*0.0899*	**0.1532**
2	Load	13	10603	15	*14.9*	*0.2330*	*0.1701*	*0.1028*	**0.1686**
2	Unload	14	1767	2.5	*2.5*	*0.2078*	*0.1576*	*0.0884*	**0.1512**
2	Unload	15	0	0	*0.0*	*0.1914*	*0.1518*	*0.0812*	**0.1415**

Plate Diameter:	*30.0*	in.	
Shape factor:	**2.67**		
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate	
Poisson's ratio:	*0.4*		
Design Stress:	*10.0*	psi	**AASHTO T222 Method** k_{u1} (pci) @ design stress: **107**
Target Deformation:	*0.05*	in.	**PCA Design Criteria** k_u (pci) @ δ = 0.05 in.: **73**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**3.6**
E_1 (psi)	**2,443**
k'_u (pci)	**73**
k_u (pci)	**73**

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	**0.1180**	**0.0930**
E_1 (psi)	**2,847**	**3,592**
k'_{u1} (pci)	**85**	**107**
k_{u1} (pci)	**85**	**107**
Second Loading Cycle		
δ_2 (in.)	**0.0221**	
E_2 (psi)	**12,185**	
k'_{u2} (pci)	**452**	
k_{u2} (pci)	**363**	
E_2 / E_1 or k_2 / k_1 Ratio	**4.3**	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

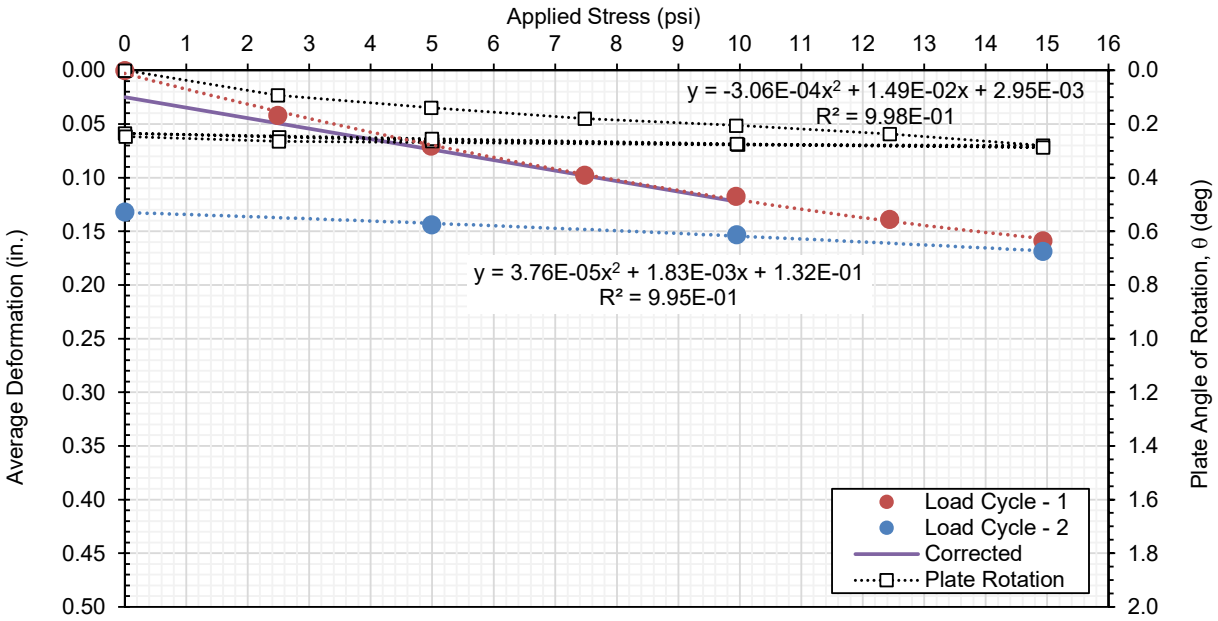
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy20, Dubuque, IA

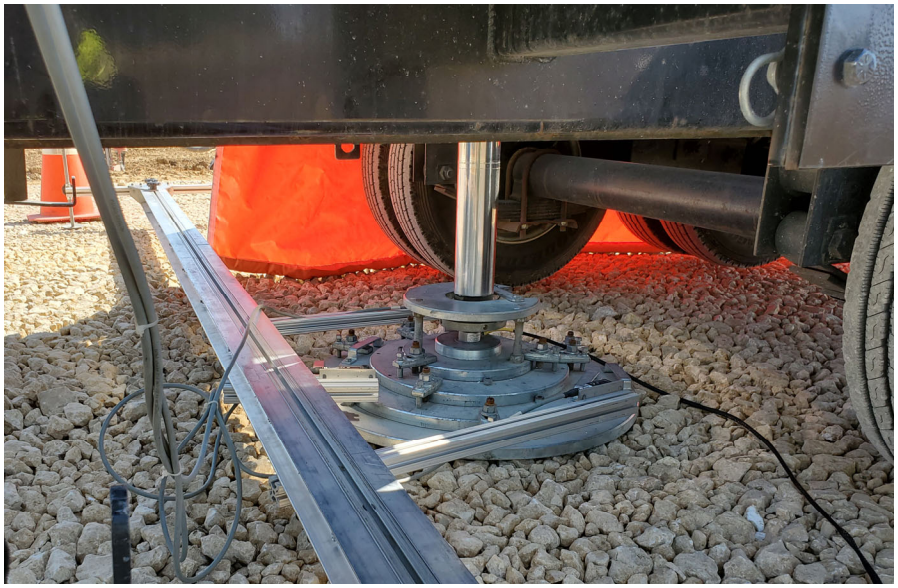
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.06E-04	a_1	3.76E-05	θ_{max} (deg)	0.2873
a_2	1.49E-02	a_2	1.83E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy20, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/30/2020	Time:	9:36:25 AM	Test ID	**PT_1**
Tested By	CV	Location:	Hwy 20 frontage road	Sta.	NA
Latitude:	42.44447	Longitude:	90.78222	Elev. (ft):	1110.1
Comments:	Modified Subbase - Crushed limestone.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0141	0.0174	0.0097	**0.0137**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0266*	*0.0268*	*0.0173*	**0.0236**
1	Load	2	3534	5	*5.0*	*0.0520*	*0.0511*	*0.0324*	**0.0452**
1	Load	3	5301	7.5	*7.5*	*0.0726*	*0.0713*	*0.0468*	**0.0636**
1	Load	4	7069	10	*10.0*	*0.0917*	*0.0893*	*0.0605*	**0.0805**
1	Load	5	8836	12.5	*12.4*	*0.1100*	*0.1073*	*0.0725*	**0.0966**
1	Load	6	10603	15	*14.9*	*0.1276*	*0.1267*	*0.0878*	**0.1140**
1	Unload	7	7069	10	*10.0*	*0.1225*	*0.1206*	*0.0817*	**0.1083**
1	Unload	8	3534	5	*5.0*	*0.1109*	*0.1114*	*0.0735*	**0.0986**
1	Unload	9	1767	2.5	*2.5*	*0.1030*	*0.1056*	*0.0685*	**0.0924**
1	Unload	10	0	0	*0.0*	*0.0911*	*0.0958*	*0.0588*	**0.0819**
2	Load	11	3534	5	*5.0*	*0.1041*	*0.1039*	*0.0661*	**0.0914**
2	Load	12	7069	10	*10.0*	*0.1146*	*0.1154*	*0.0755*	**0.1018**
2	Load	13	10603	15	*14.9*	*0.1296*	*0.1296*	*0.0880*	**0.1157**
2	Unload	14	1767	2.5	*2.5*	*0.1078*	*0.1111*	*0.0698*	**0.0962**
2	Unload	15	0	0	*-0.1*	*0.0963*	*0.1030*	*0.0632*	**0.0875**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **130**
k_u (pci) @ δ = 0.05 in.: **116**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.8
E_1 (psi)	3,889
k'_u (pci)	117
k_u (pci)	116

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0808	0.0758
E_1 (psi)	4,106	4,355
k'_{u1} (pci)	124	132
k_{u1} (pci)	122	130
Second Loading Cycle		
δ_2 (in.)	0.0202	
E_2 (psi)	13,060	
k'_{u2} (pci)	495	
k_{u2} (pci)	389	
E_2 / E_1 or k_2 / k_1 Ratio	3.2	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

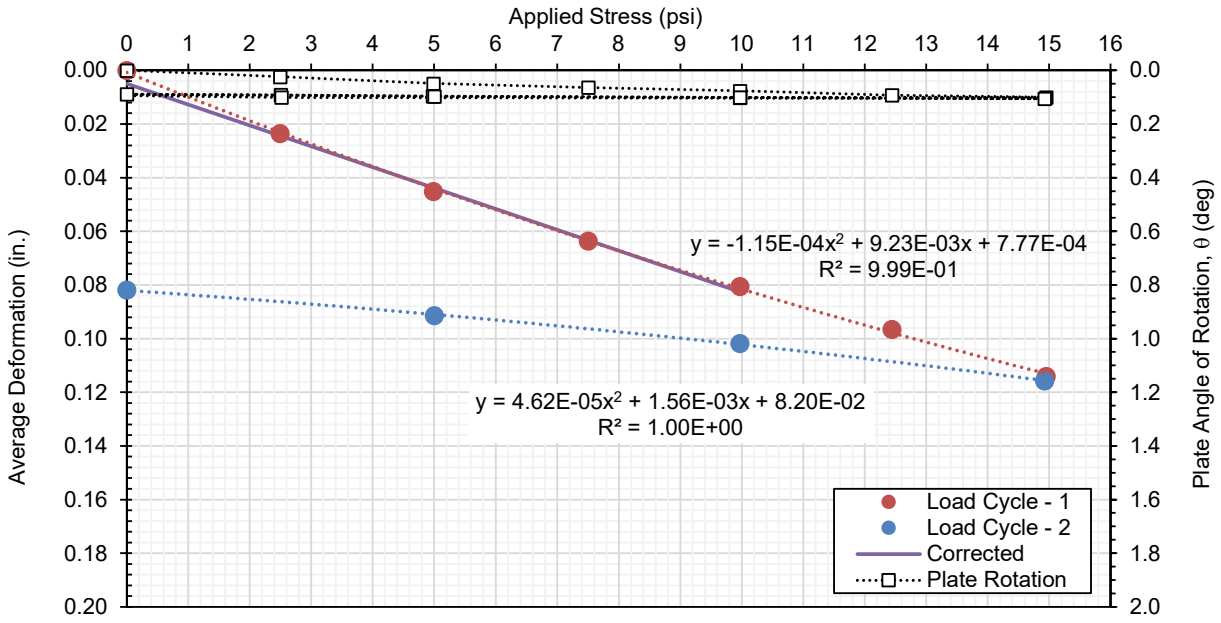
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Dubuque, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.15E-04	a_1	4.62E-05	θ_{max} (deg)	0.1060
a_2	9.23E-03	a_2	1.56E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/30/2020	Time:	12:08:18 PM	Test ID	**PT_3**
Tested By	CV	Location:	Hwy 20 frontage road	Sta.	NA
Latitude:	42.445292	Longitude:	90.781013	Elev. (ft):	1100.4
Comments:	Modified Subbase - Crushed limestone.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0357	0.0214	0.0204	**0.0258**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0378*	*0.0261*	*0.0333*	**0.0324**
1	Load	2	3534	5	*5.0*	*0.0654*	*0.0394*	*0.0497*	**0.0515**
1	Load	3	5301	7.5	*7.4*	*0.0872*	*0.0487*	*0.0601*	**0.0653**
1	Load	4	7069	10	*10.0*	*0.1041*	*0.0592*	*0.0711*	**0.0781**
1	Load	5	8836	12.5	*12.4*	*0.1216*	*0.0695*	*0.0829*	**0.0913**
1	Load	6	10603	15	*14.9*	*0.1394*	*0.0803*	*0.0949*	**0.1049**
1	Unload	7	7069	10	*10.0*	*0.1292*	*0.0730*	*0.0885*	**0.0969**
1	Unload	8	3534	5	*5.0*	*0.1176*	*0.0695*	*0.0845*	**0.0905**
1	Unload	9	1767	2.5	*2.5*	*0.1095*	*0.0649*	*0.0803*	**0.0849**
1	Unload	10	0	0	*0.0*	*0.0892*	*0.0568*	*0.0723*	**0.0727**
2	Load	11	3534	5	*5.0*	*0.1103*	*0.0641*	*0.0806*	**0.0850**
2	Load	12	7069	10	*9.9*	*0.1260*	*0.0723*	*0.0891*	**0.0958**
2	Load	13	10603	15	*14.9*	*0.1467*	*0.0859*	*0.1015*	**0.1114**
2	Unload	14	1767	2.5	*2.5*	*0.1134*	*0.0684*	*0.0854*	**0.0891**
2	Unload	15	0	0	*0.0*	*0.0935*	*0.0578*	*0.0728*	**0.0747**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.00**	
Material Type:	*B.*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **154**
k_u (pci) @ δ = 0.05 in.: **112**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.7
E_1 (psi)	2,833
k'_u (pci)	113
k_u (pci)	112

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.0778	0.0628
E_1 (psi)	3,189	3,870
k'_{u1} (pci)	129	159
k_{u1} (pci)	127	154
Second Loading Cycle		
δ_2 (in.)	0.0239	
E_2 (psi)	8,607	
k'_{u2} (pci)	419	
k_{u2} (pci)	342	
E_2 / E_1 or k_2 / k_1 Ratio	2.7	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

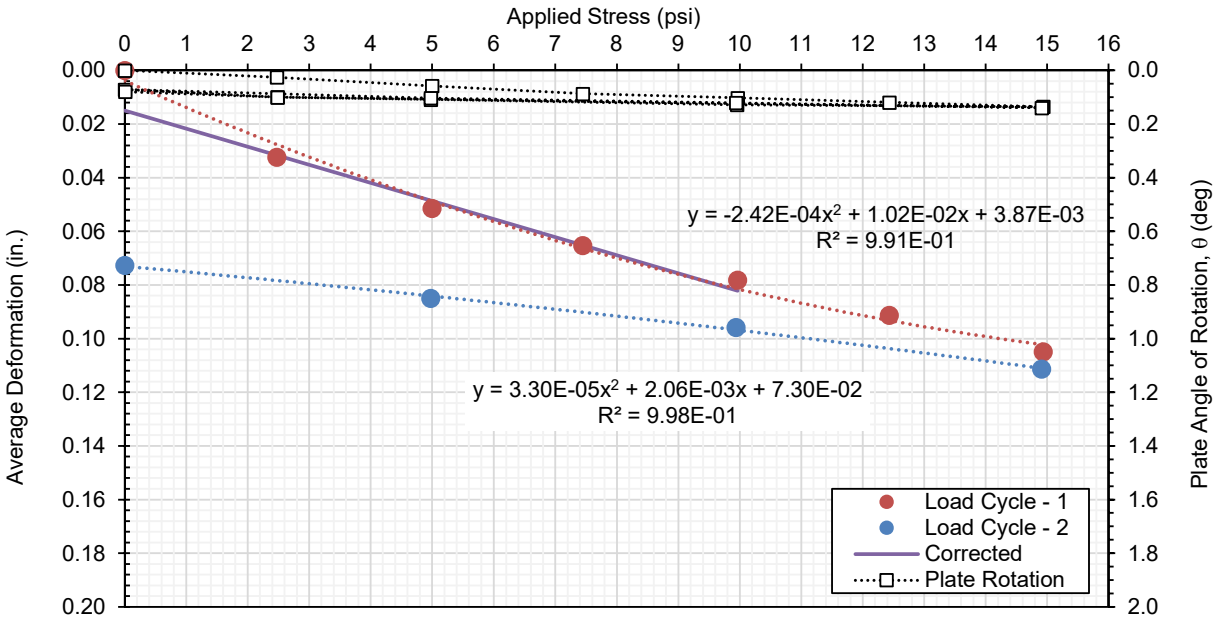
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Dubuque, IA

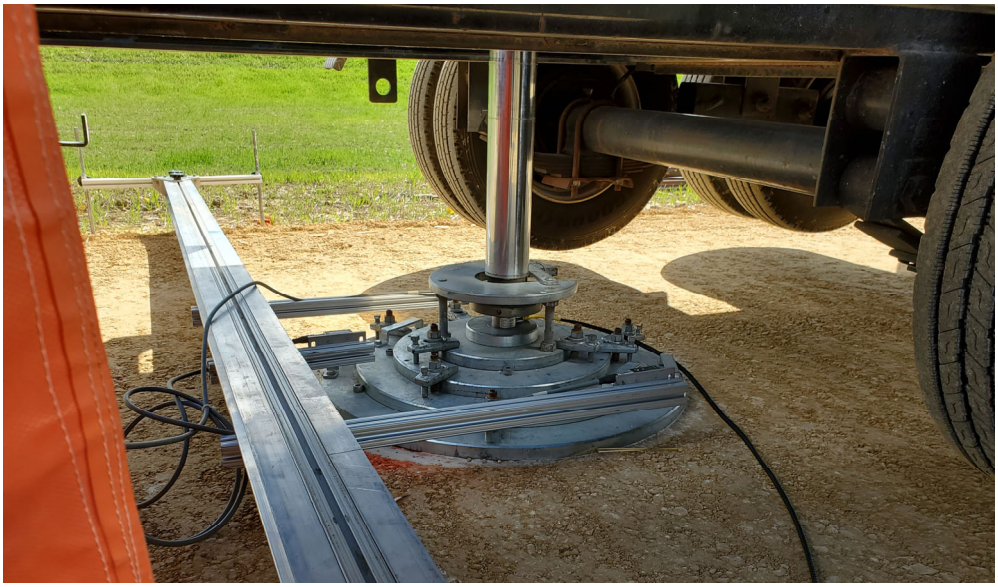
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.42E-04	a_1	3.30E-05	θ_{max} (deg)	0.1395
a_2	1.02E-02	a_2	2.06E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	9/30/2020	Time:	2:20:35 PM	Test ID	**PT_5**
Tested By	CV	Location:	Hwy 20 frontage road	Sta.	NA
Latitude:	42.445850	Longitude:	90.780403	Elev. (ft):	1074.0
Comments:	Modified Subbase - Crushed limestone.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0163	0.0108	0.0114	**0.0129**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0295*	*0.0167*	*0.0207*	**0.0223**
1	Load	2	3534	5	*5.0*	*0.0494*	*0.0263*	*0.0313*	**0.0357**
1	Load	3	5301	7.5	*7.5*	*0.0668*	*0.0367*	*0.0426*	**0.0487**
1	Load	4	7069	10	*9.9*	*0.0825*	*0.0467*	*0.0540*	**0.0611**
1	Load	5	8836	12.5	*12.4*	*0.0973*	*0.0560*	*0.0640*	**0.0724**
1	Load	6	10603	15	*14.9*	*0.1140*	*0.0670*	*0.0775*	**0.0862**
1	Unload	7	7069	10	*10.0*	*0.1074*	*0.0635*	*0.0740*	**0.0816**
1	Unload	8	3534	5	*5.0*	*0.0978*	*0.0579*	*0.0686*	**0.0748**
1	Unload	9	1767	2.5	*2.5*	*0.0889*	*0.0542*	*0.0653*	**0.0694**
1	Unload	10	0	0	*0.0*	*0.0747*	*0.0469*	*0.0579*	**0.0598**
2	Load	11	3534	5	*5.0*	*0.0929*	*0.0561*	*0.0673*	**0.0721**
2	Load	12	7069	10	*10.0*	*0.1048*	*0.0638*	*0.0751*	**0.0812**
2	Load	13	10603	15	*14.9*	*0.1224*	*0.0732*	*0.0855*	**0.0937**
2	Unload	14	1767	2.5	*2.5*	*0.0978*	*0.0599*	*0.0716*	**0.0764**
2	Unload	15	0	0	*0.0*	*0.0826*	*0.0526*	*0.0643*	**0.0665**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.00**	
Material Type:	*B.*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **177**
k_u (pci) @ δ = 0.05 in.: **154**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**8.0**
E_1 (psi)	**3,888**
k'_u (pci)	**160**
k_u (pci)	**154**

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.0604**	**0.0534**
E_1 (psi)	**4,006**	**4,459**
k'_{u1} (pci)	**166**	**187**
k_{u1} (pci)	**159**	**177**
Second Loading Cycle		
δ_2 (in.)	**0.0222**	
E_2 (psi)	**9,120**	
k'_{u2} (pci)	**451**	
k_{u2} (pci)	**362**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.3**	

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

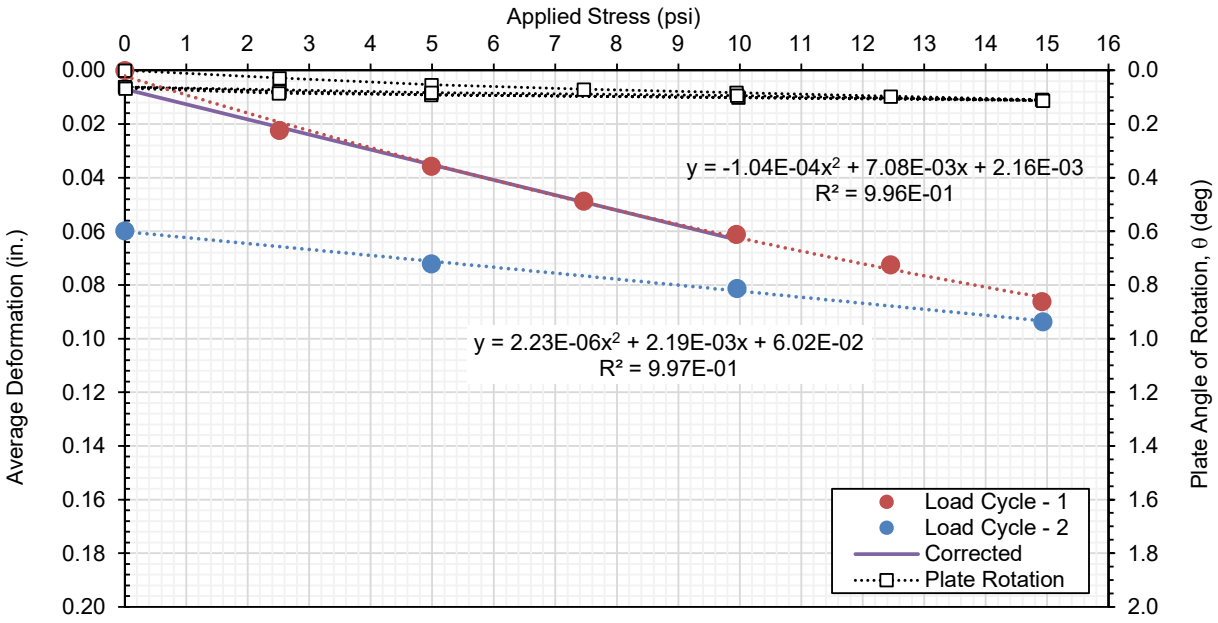
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 20, Dubuque, IA

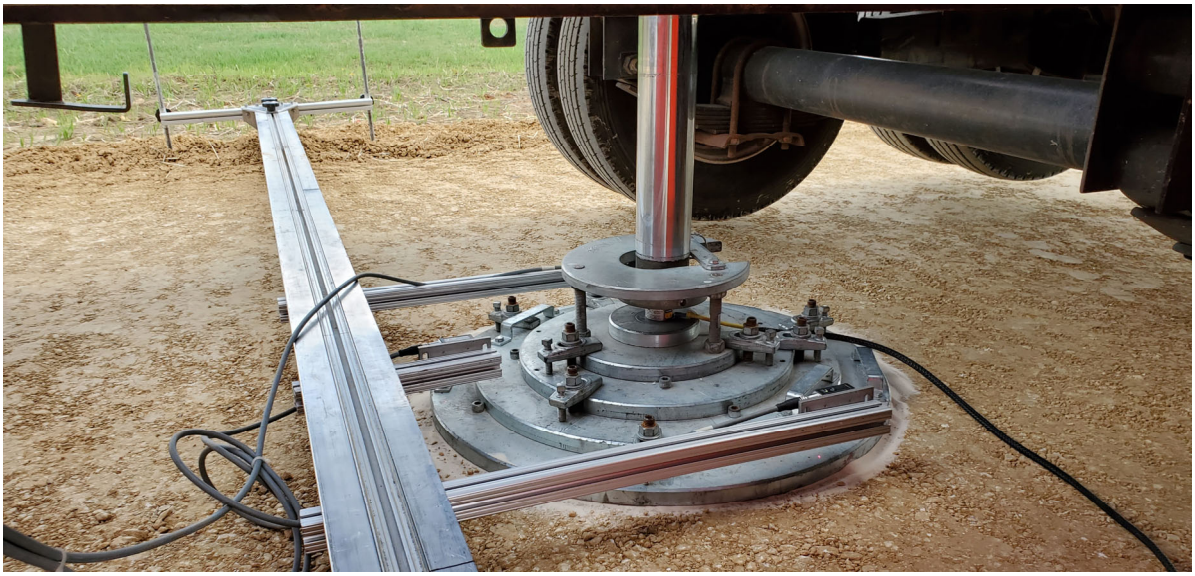
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.04E-04	a_1	2.23E-06	θ_{max} (deg)	0.1130
a_2	7.08E-03	a_2	2.19E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/13/2020	Time:	9:54:59 AM	Test ID	**PT1**
Tested By	CV/HG	Location:	US52 West of Holy Cross	Sta.	NA
Latitude:	-90.999881	Longitude:	42.595387	Elev. (ft):	1078.9
Comments:	Modifed Subbase material consisting of a mixture of Recycled PCC & RAP				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0162	0.0108	0.0131	**0.0134**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0338*	*0.0383*	*0.0340*	**0.0353**
1	Load	2	3534	5	*5.0*	*0.0643*	*0.0725*	*0.0678*	**0.0682**
1	Load	3	5301	7.5	*7.5*	*0.1008*	*0.1111*	*0.1052*	**0.1057**
1	Load	4	7069	10	*10.0*	*0.1378*	*0.1460*	*0.1466*	**0.1434**
1	Load	5	8836	12.5	*12.5*	*0.1763*	*0.1892*	*0.1900*	**0.1851**
1	Load	6	10603	15	*15.0*	*0.2136*	*0.2201*	*0.2317*	**0.2218**
1	Unload	7	7069	10	*10.0*	*0.2024*	*0.2149*	*0.2189*	**0.2121**
1	Unload	8	3534	5	*5.0*	*0.1803*	*0.1919*	*0.1955*	**0.1893**
1	Unload	9	1767	2.5	*2.5*	*0.1678*	*0.1726*	*0.1749*	**0.1718**
1	Unload	10	0	0	*0.0*	*0.1444*	*0.1536*	*0.1465*	**0.1482**
2	Load	11	3534	5	*5.0*	*0.1684*	*0.1815*	*0.1756*	**0.1752**
2	Load	12	7069	10	*10.0*	*0.1919*	*0.2121*	*0.2074*	**0.2038**
2	Load	13	10603	15	*15.0*	*0.2338*	*0.2376*	*0.2501*	**0.2405**
2	Unload	14	1767	2.5	*2.5*	*0.1769*	*0.1904*	*0.1946*	**0.1873**
2	Unload	15	0	0	*0.0*	*0.1534*	*0.1659*	*0.1656*	**0.1616**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **69**
k_u (pci) @ δ = 0.05 in.: **73**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**3.6**
E_1 (psi)	**2,438**
k'_u (pci)	**73**
k_u (pci)	**73**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1440**	**0.1440**
E_1 (psi)	**2,333**	**2,333**
k'_{u1} (pci)	**69**	**69**
k_{u1} (pci)	**69**	**69**
Second Loading Cycle		
δ_2 (in.)	**0.0563**	
E_2 (psi)	**5,674**	
k'_{u2} (pci)	**178**	
k_{u2} (pci)	**169**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.4**	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

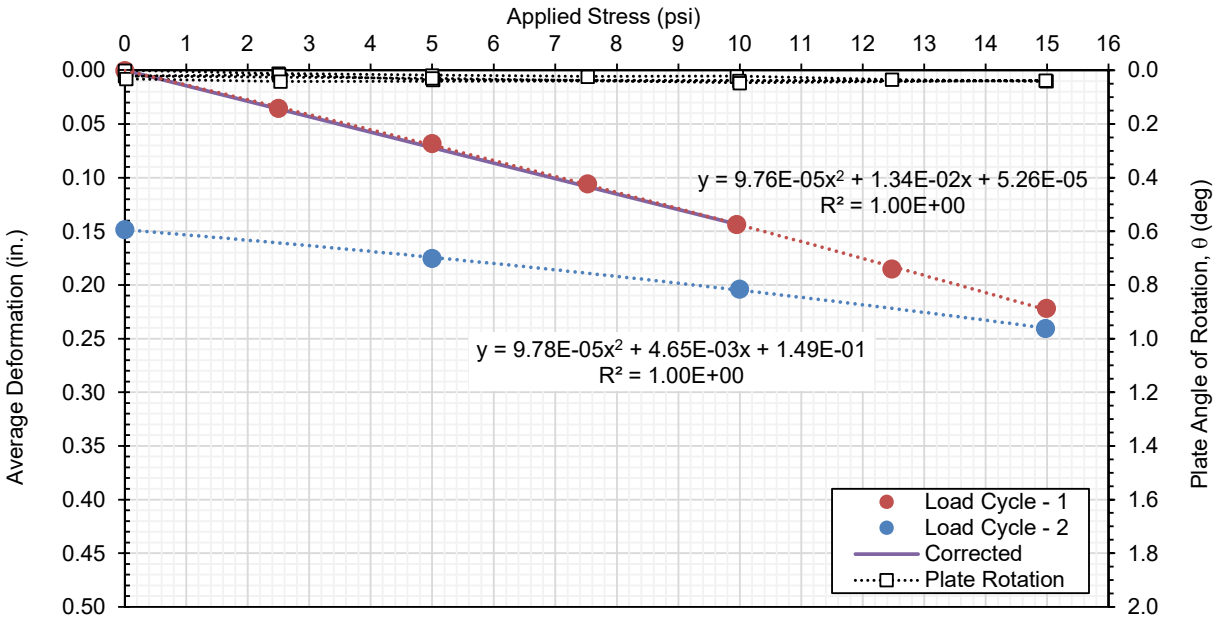
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	9.76E-05	a_1	9.78E-05	θ_{max} (deg)	0.0466
a_2	1.34E-02	a_2	4.65E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/13/2020	Time:	1:06:03 PM	Test ID	**PT2**
Tested By	CV/HG	Location:	US52 West of Holy Cross	Sta.	NA
Latitude:	42.595397	Longitude:	-91.001380	Elev. (ft):	1069.1
Comments:	Modifed Subbase material consisting of a mixture of Recycled PCC & RAP				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0322	0.0311	0.0309	**0.0314**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0354*	*0.0385*	*0.0430*	**0.0390**
1	Load	2	3534	5	*5.0*	*0.0551*	*0.0579*	*0.0633*	**0.0588**
1	Load	3	5301	7.5	*7.5*	*0.0697*	*0.0752*	*0.0826*	**0.0758**
1	Load	4	7069	10	*10.0*	*0.0891*	*0.0898*	*0.1006*	**0.0932**
1	Load	5	8836	12.5	*12.5*	*0.1127*	*0.1046*	*0.1195*	**0.1123**
1	Load	6	10603	15	*14.9*	*0.1250*	*0.1206*	*0.1350*	**0.1268**
1	Unload	7	7069	10	*10.0*	*0.1227*	*0.1172*	*0.1312*	**0.1237**
1	Unload	8	3534	5	*5.0*	*0.1165*	*0.1098*	*0.1237*	**0.1167**
1	Unload	9	1767	2.5	*2.5*	*0.1157*	*0.1083*	*0.1222*	**0.1154**
1	Unload	10	0	0	*0.0*	*0.1113*	*0.1045*	*0.1187*	**0.1115**
2	Load	11	3534	5	*5.0*	*0.1149*	*0.1099*	*0.1233*	**0.1160**
2	Load	12	7069	10	*10.0*	*0.1198*	*0.1163*	*0.1295*	**0.1219**
2	Load	13	10603	15	*15.0*	*0.1329*	*0.1254*	*0.1409*	**0.1331**
2	Unload	14	1767	2.5	*2.5*	*0.1229*	*0.1173*	*0.1310*	**0.1237**
2	Unload	15	0	0	*0.0*	*0.1166*	*0.1121*	*0.1254*	**0.1180**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **135**
k_u (pci) @ δ = 0.05 in.: **96**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**4.8**
E_1 (psi)	**3,212**
k'_u (pci)	**96**
k_u (pci)	**96**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.0922**	**0.0722**
E_1 (psi)	**3,623**	**4,552**
k'_{u1} (pci)	**108**	**139**
k_{u1} (pci)	**108**	**135**
Second Loading Cycle		
δ_2 (in.)	**0.0108**	
E_2 (psi)	**21,033**	
k'_{u2} (pci)	**927**	
k_{u2} (pci)	**626**	
E_2 / E_1 or k_2 / k_1 Ratio	**5.8**	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

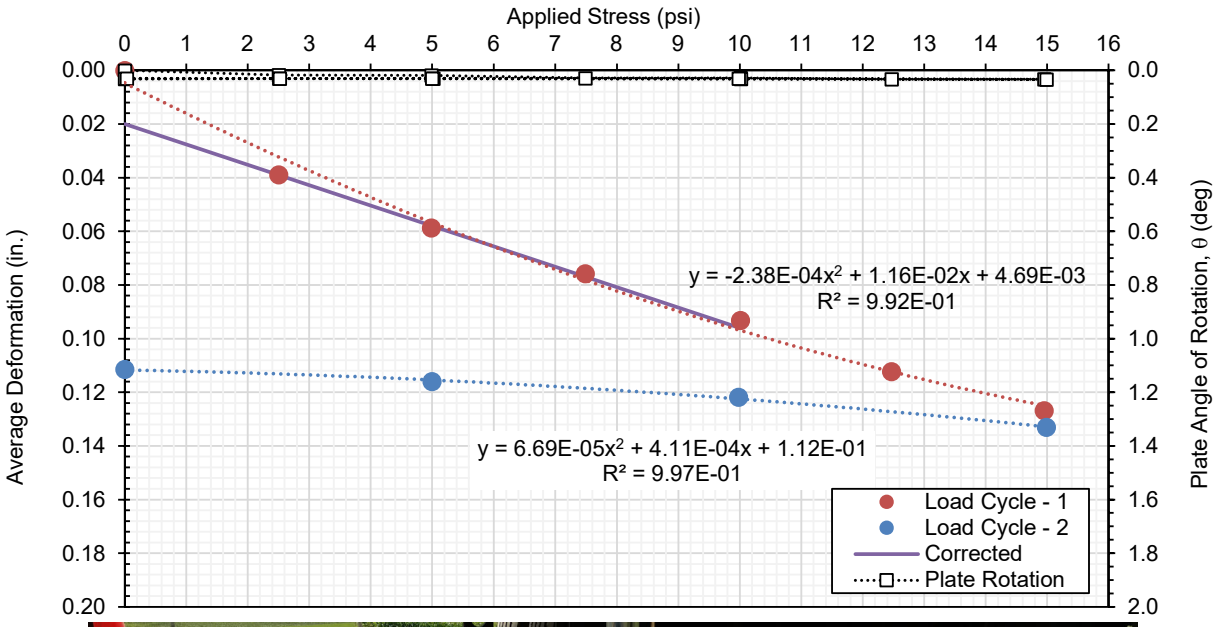
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.38E-04	a_1	6.69E-05	θ_{max} (deg)	0.0340
a_2	1.16E-02	a_2	4.11E-04		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/13/2020	Time:	2:37:37 PM	Test ID	**PT4**
Tested By	CV/HG	Location:	US52 West of Holy Cross	Sta.	NA
Latitude:	42.595430	Longitude:	-91.005494	Elev. (ft):	1086.9
Comments:	Modifed Subbase material consisting of a mixture of Recycled PCC & RAP				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0321	0.0383	0.0337	**0.0347**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0353*	*0.0396*	*0.0447*	**0.0399**
1	Load	2	3534	5	*5.0*	*0.0654*	*0.0634*	*0.0761*	**0.0683**
1	Load	3	5301	7.5	*7.5*	*0.0980*	*0.0840*	*0.1026*	**0.0948**
1	Load	4	7069	10	*10.0*	*0.1257*	*0.1064*	*0.1282*	**0.1201**
1	Load	5	8836	12.5	*12.5*	*0.1504*	*0.1269*	*0.1579*	**0.1451**
1	Load	6	10603	15	*15.0*	*0.1784*	*0.1477*	*0.1836*	**0.1699**
1	Unload	7	7069	10	*10.0*	*0.1675*	*0.1372*	*0.1705*	**0.1584**
1	Unload	8	3534	5	*5.0*	*0.1531*	*0.1228*	*0.1540*	**0.1433**
1	Unload	9	1767	2.5	*2.5*	*0.1388*	*0.1113*	*0.1419*	**0.1307**
1	Unload	10	0	0	*0.0*	*0.1273*	*0.0978*	*0.1270*	**0.1174**
2	Load	11	3534	5	*5.0*	*0.1386*	*0.1101*	*0.1451*	**0.1312**
2	Load	12	7069	10	*10.0*	*0.1686*	*0.1269*	*0.1648*	**0.1534**
2	Load	13	10603	15	*15.0*	*0.1895*	*0.1502*	*0.1895*	**0.1764**
2	Unload	14	1767	2.5	*2.5*	*0.1545*	*0.1158*	*0.1512*	**0.1405**
2	Unload	15	0	0	*0.0*	*0.1378*	*0.1023*	*0.1377*	**0.1259**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **93**
k_u (pci) @ δ = 0.05 in.: **76**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**3.8**
E_1 (psi)	**2,570**
k'_u (pci)	**76**
k_u (pci)	**76**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1196**	**0.1076**
E_1 (psi)	**2,809**	**3,123**
k'_{u1} (pci)	**84**	**93**
k_{u1} (pci)	**84**	**93**
Second Loading Cycle		
δ_2 (in.)	**0.0354**	
E_2 (psi)	**8,370**	
k'_{u2} (pci)	**282**	
k_{u2} (pci)	**249**	
E_2 / E_1 or k_2 / k_1 Ratio	**3.0**	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

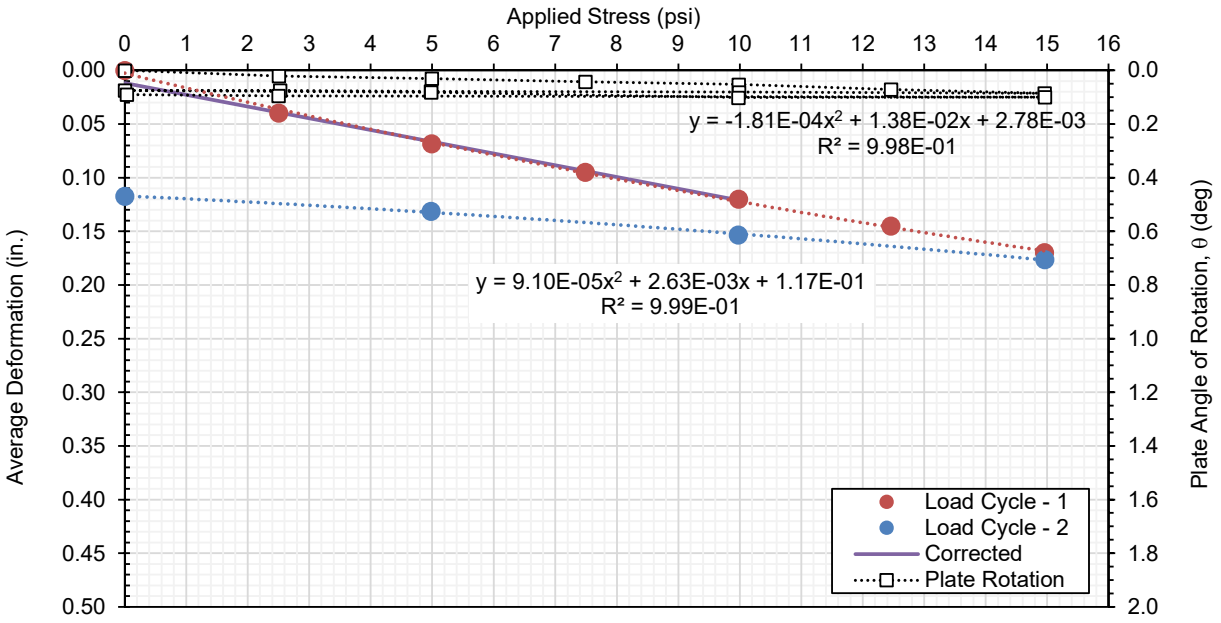
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque, IA

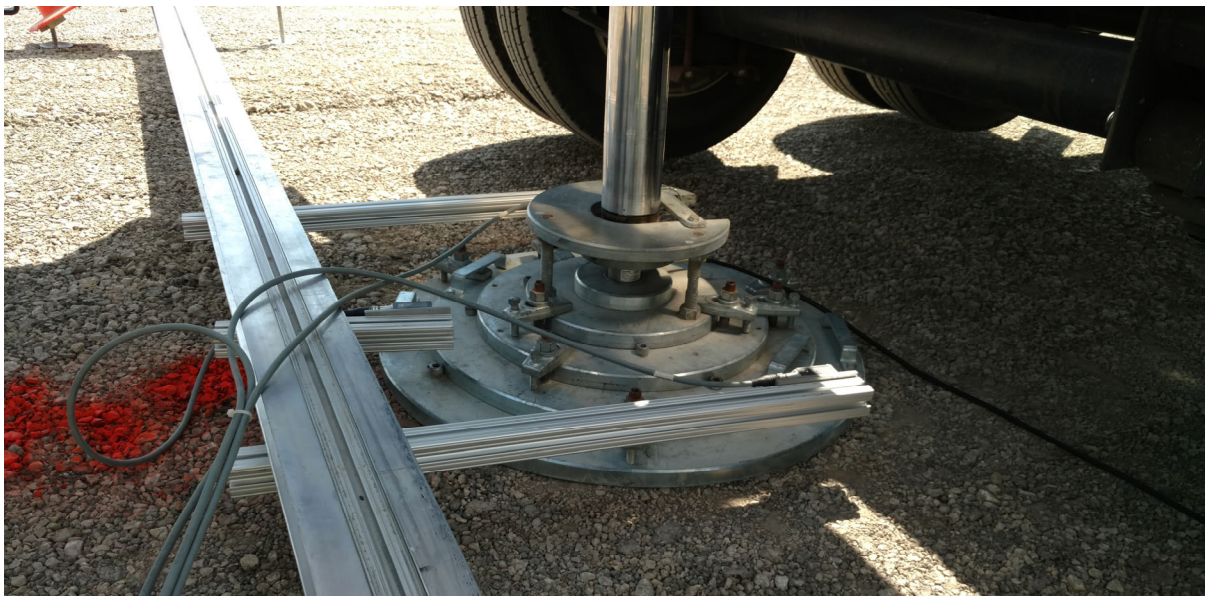
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.81E-04	a_1	9.10E-05	θ_{max} (deg)	0.1015
a_2	1.38E-02	a_2	2.63E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/12/2020	Time:	11:09:59 AM	Test ID	**PT1**
Tested By	CV/HG	Location:	US52	Sta.	NA
Latitude:	42.596330	Longitude:	91.022152	Elev. (ft):	254.7
Comments:	Cement Stabilized subgrade				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0087	0.0099	0.0063	**0.0083**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0176*	*0.0116*	*0.0109*	**0.0134**
1	Load	2	3534	5	*5.0*	*0.0320*	*0.0268*	*0.0216*	**0.0268**
1	Load	3	5301	7.5	*7.5*	*0.0473*	*0.0386*	*0.0331*	**0.0397**
1	Load	4	7069	10	*10.0*	*0.0643*	*0.0529*	*0.0461*	**0.0544**
1	Load	5	8836	12.5	*12.5*	*0.0822*	*0.0688*	*0.0590*	**0.0700**
1	Load	6	10603	15	*15.0*	*0.1000*	*0.0838*	*0.0721*	**0.0853**
1	Unload	7	7069	10	*10.0*	*0.0885*	*0.0731*	*0.0630*	**0.0749**
1	Unload	8	3534	5	*5.0*	*0.0704*	*0.0564*	*0.0486*	**0.0585**
1	Unload	9	1767	2.5	*2.5*	*0.0579*	*0.0479*	*0.0391*	**0.0483**
1	Unload	10	0	0	*0.0*	*0.0422*	*0.0312*	*0.0276*	**0.0337**
2	Load	11	3534	5	*5.0*	*0.0610*	*0.0491*	*0.0408*	**0.0503**
2	Load	12	7069	10	*10.0*	*0.0823*	*0.0675*	*0.0572*	**0.0690**
2	Load	13	10603	15	*15.0*	*0.1052*	*0.0892*	*0.0759*	**0.0901**
2	Unload	14	1767	2.5	*2.5*	*0.0624*	*0.0508*	*0.0423*	**0.0518**
2	Unload	15	0	0	*0.0*	*0.0465*	*0.0349*	*0.0306*	**0.0374**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **174**
k_u (pci) @ δ = 0.05 in.: **175**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	9.3
E_1 (psi)	3,466
k'_u (pci)	185
k_u (pci)	175

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0545	0.0545
E_1 (psi)	3,441	3,441
k'_{u1} (pci)	184	184
k_{u1} (pci)	174	174
Second Loading Cycle		
δ_2 (in.)	0.0355	
E_2 (psi)	4,926	
k'_{u2} (pci)	282	
k_{u2} (pci)	249	
E_2 / E_1 or k_2 / k_1 Ratio	1.4	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

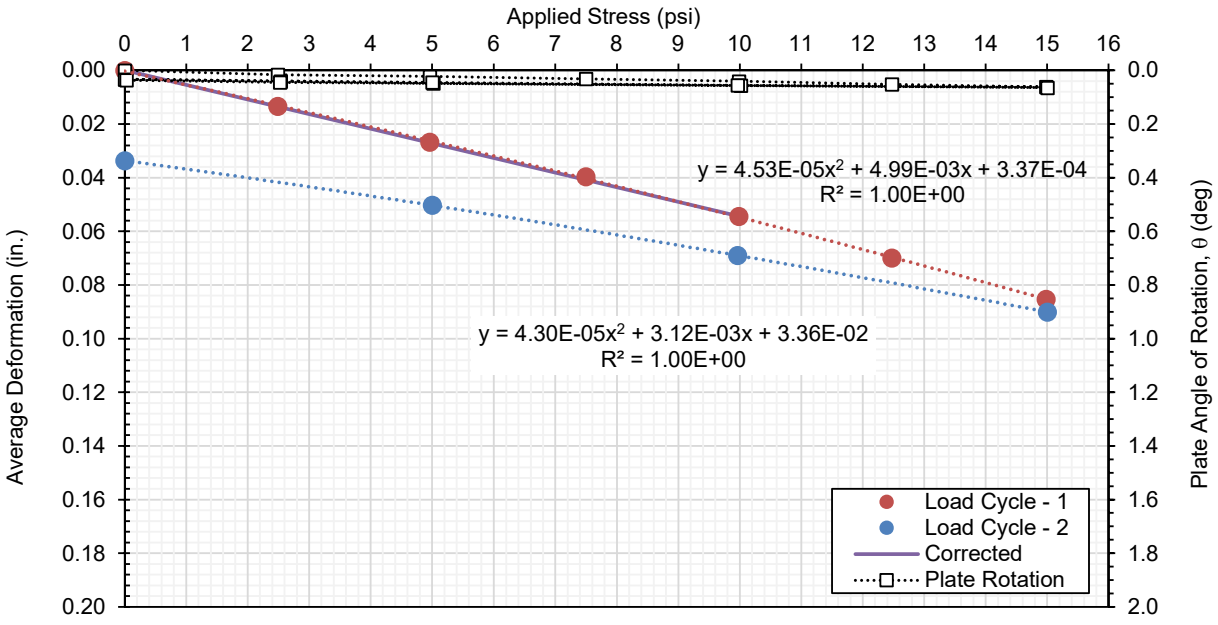
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	4.53E-05	a_1	4.30E-05	θ_{max} (deg)	0.0649
a_2	4.99E-03	a_2	3.12E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/12/2020	Time:	12:13:11 PM	Test ID	**PT2**
Tested By	CV/HG	Location:	US52	Sta.	NA
Latitude:	42.59744	Longitude:	91.02566	Elev. (ft):	254.7
Comments:	Cement Stabilized Subgrade				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0084	0.0139	0.0084	**0.0102**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0134*	*0.0131*	*0.0111*	**0.0125**
1	Load	2	3534	5	*5.0*	*0.0255*	*0.0262*	*0.0225*	**0.0247**
1	Load	3	5301	7.5	*7.5*	*0.0376*	*0.0364*	*0.0333*	**0.0357**
1	Load	4	7069	10	*10.0*	*0.0510*	*0.0503*	*0.0460*	**0.0491**
1	Load	5	8836	12.5	*12.4*	*0.0651*	*0.0607*	*0.0584*	**0.0614**
1	Load	6	10603	15	*15.0*	*0.0798*	*0.0736*	*0.0712*	**0.0749**
1	Unload	7	7069	10	*10.0*	*0.0704*	*0.0638*	*0.0624*	**0.0655**
1	Unload	8	3534	5	*5.0*	*0.0548*	*0.0531*	*0.0502*	**0.0527**
1	Unload	9	1767	2.5	*2.5*	*0.0435*	*0.0425*	*0.0420*	**0.0427**
1	Unload	10	0	0	*0.0*	*0.0305*	*0.0338*	*0.0320*	**0.0321**
2	Load	11	3534	5	*5.0*	*0.0461*	*0.0463*	*0.0443*	**0.0455**
2	Load	12	7069	10	*10.0*	*0.0662*	*0.0609*	*0.0589*	**0.0620**
2	Load	13	10603	15	*15.0*	*0.0839*	*0.0778*	*0.0757*	**0.0792**
2	Unload	14	1767	2.5	*2.5*	*0.0453*	*0.0447*	*0.0449*	**0.0450**
2	Unload	15	0	0	*0.0*	*0.0317*	*0.0352*	*0.0343*	**0.0338**

Plate Diameter:	*30.0*	in.
Shape factor:	**1.57**	
Material Type:	*a*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **191**
k_u (pci) @ δ = 0.05 in.: **191**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	10.2
E_1 (psi)	3,776
k'_u (pci)	205
k_u (pci)	191

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0488	0.0488
E_1 (psi)	3,778	3,778
k'_{u1} (pci)	205	205
k_{u1} (pci)	191	191
Second Loading Cycle		
δ_2 (in.)	0.0298	
E_2 (psi)	5,667	
k'_{u2} (pci)	335	
k_{u2} (pci)	286	
E_2 / E_1 or k_2 / k_1 Ratio	1.5	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

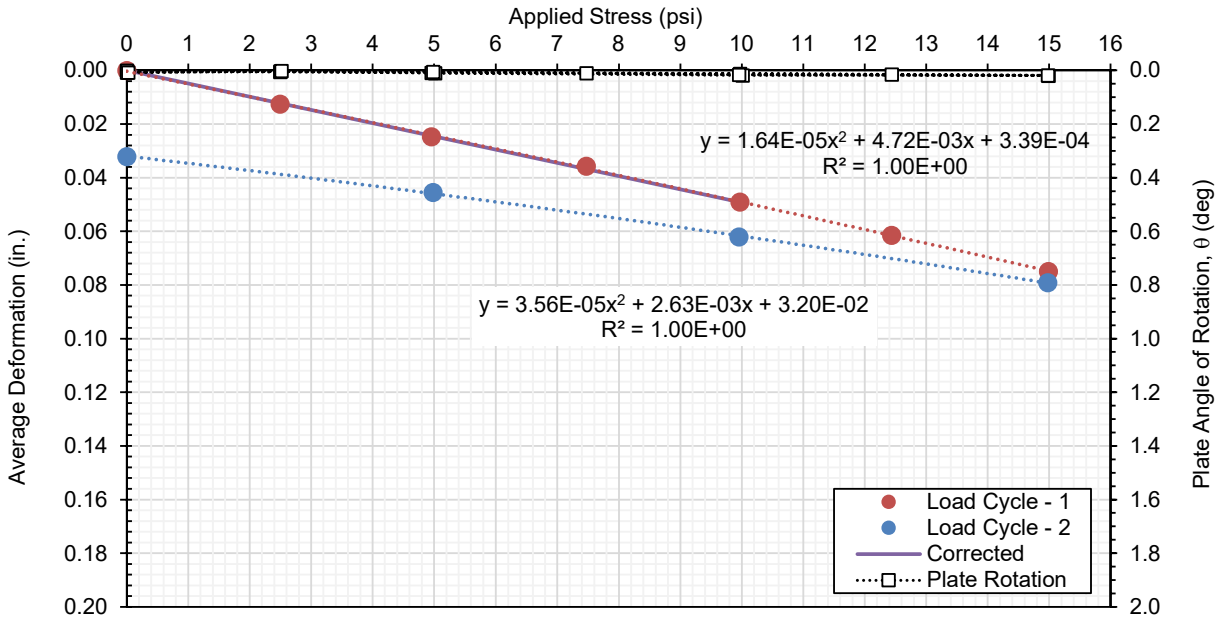
In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	1.64E-05	a_1	3.56E-05	θ_{max} (deg)	0.0195
a_2	4.72E-03	a_2	2.63E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/12/2020	Time:	1:16:54 PM	Test ID	**PT3**
Tested By	CV/HG	Location:	US52	Sta.	NA
Latitude:	42.595365	Longitude:	91.008097	Elev. (ft):	379.7
Comments:	Cement Stabilized Subgrade				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0234	0.0081	0.0110	**0.0142**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0111*	*0.0103*	*0.0074*	**0.0096**
1	Load	2	3534	5	*5.0*	*0.0236*	*0.0218*	*0.0168*	**0.0208**
1	Load	3	5301	7.5	*7.5*	*0.0355*	*0.0305*	*0.0215*	**0.0292**
1	Load	4	7069	10	*10.0*	*0.0380*	*0.0414*	*0.0295*	**0.0363**
1	Load	5	8836	12.5	*12.4*	*0.0477*	*0.0507*	*0.0395*	**0.0460**
1	Load	6	10603	15	*15.0*	*0.0546*	*0.0605*	*0.0475*	**0.0542**
1	Unload	7	7069	10	*10.0*	*0.0514*	*0.0548*	*0.0442*	**0.0502**
1	Unload	8	3534	5	*5.0*	*0.0430*	*0.0436*	*0.0326*	**0.0397**
1	Unload	9	1767	2.5	*2.5*	*0.0364*	*0.0373*	*0.0254*	**0.0330**
1	Unload	10	0	0	*0.0*	*0.0326*	*0.0264*	*0.0206*	**0.0265**
2	Load	11	3534	5	*5.0*	*0.0367*	*0.0399*	*0.0265*	**0.0344**
2	Load	12	7069	10	*9.9*	*0.0472*	*0.0510*	*0.0396*	**0.0459**
2	Load	13	10603	15	*14.9*	*0.0640*	*0.0636*	*0.0474*	**0.0583**
2	Unload	14	1767	2.5	*2.5*	*0.0391*	*0.0399*	*0.0295*	**0.0362**
2	Unload	15	0	0	*0.0*	*0.0335*	*0.0280*	*0.0240*	**0.0285**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*a*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **237**
k_u (pci) @ δ = 0.05 in.: **244**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	13.8
E_1 (psi)	4,829
k'_u (pci)	275
k_u (pci)	244

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0376	0.0376
E_1 (psi)	4,696	4,696
k'_{u1} (pci)	266	266
k_{u1} (pci)	237	237
Second Loading Cycle		
δ_2 (in.)	0.0193	
E_2 (psi)	7,988	
k'_{u2} (pci)	519	
k_{u2} (pci)	404	
E_2 / E_1 or k_2 / k_1 Ratio	1.7	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

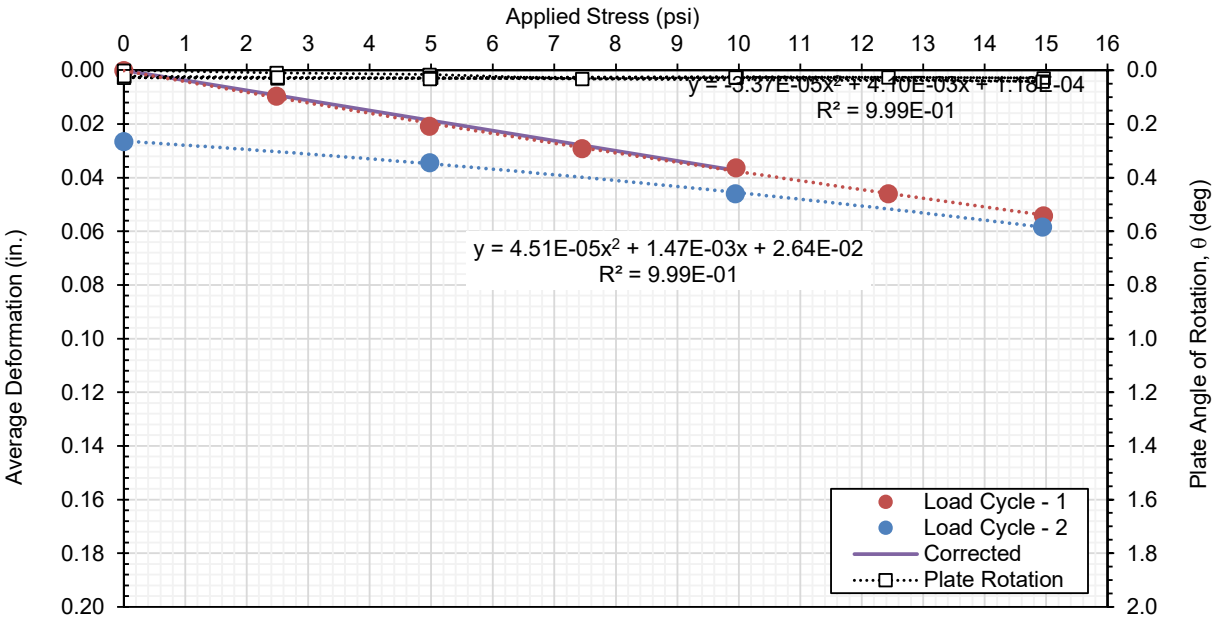
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque, IA

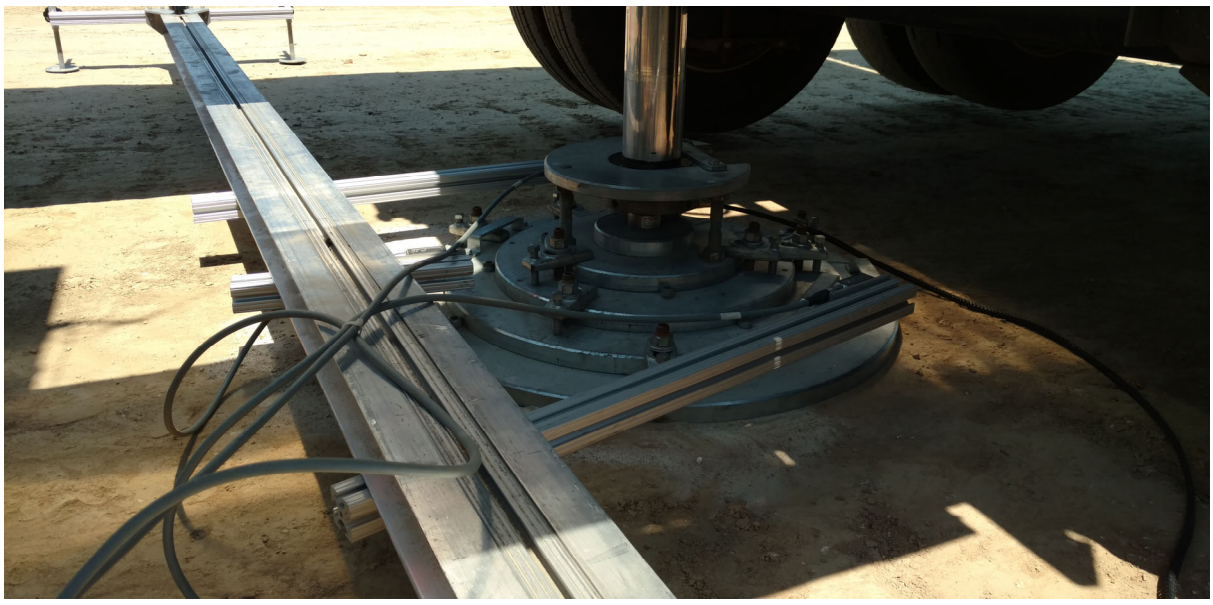
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.37E-05	a_1	4.51E-05	θ_{max} (deg)	0.0416
a_2	4.10E-03	a_2	1.47E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/12/2020	Time:	2:02:59 PM	Test ID	**PT4**
Tested By	CV/HG	Location:	US52	Sta.	NA
Latitude:	42.595337	Longitude:	91.008512	Elev. (ft):	371.1
Comments:	Compacted select subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0132	0.0094	0.0256	**0.0161**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0225*	*0.0202*	*0.0272*	**0.0233**
1	Load	2	3534	5	*5.0*	*0.0422*	*0.0425*	*0.0472*	**0.0440**
1	Load	3	5301	7.5	*7.5*	*0.0642*	*0.0666*	*0.0695*	**0.0668**
1	Load	4	7069	10	*10.0*	*0.0825*	*0.0896*	*0.0903*	**0.0875**
1	Load	5	8836	12.5	*12.5*	*0.1048*	*0.1170*	*0.1141*	**0.1119**
1	Load	6	10603	15	*14.9*	*0.1260*	*0.1449*	*0.1383*	**0.1364**
1	Unload	7	7069	10	*10.0*	*0.1170*	*0.1351*	*0.1295*	**0.1272**
1	Unload	8	3534	5	*5.0*	*0.1080*	*0.1191*	*0.1166*	**0.1146**
1	Unload	9	1767	2.5	*2.5*	*0.0973*	*0.1057*	*0.1043*	**0.1024**
1	Unload	10	0	0	*0.0*	*0.0818*	*0.0879*	*0.0914*	**0.0870**
2	Load	11	3534	5	*5.0*	*0.0911*	*0.1036*	*0.1032*	**0.0993**
2	Load	12	7069	10	*10.0*	*0.1118*	*0.1236*	*0.1190*	**0.1181**
2	Load	13	10603	15	*15.0*	*0.1341*	*0.1495*	*0.1414*	**0.1417**
2	Unload	14	1767	2.5	*2.5*	*0.0997*	*0.1119*	*0.1129*	**0.1082**
2	Unload	15	0	0	*0.0*	*0.0869*	*0.0953*	*0.0988*	**0.0937**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*a*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **112**
k_u (pci) @ δ = 0.05 in.: **114**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.8
E_1 (psi)	2,261
k'_u (pci)	115
k_u (pci)	114

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0884	0.0884
E_1 (psi)	2,221	2,221
k'_{u1} (pci)	113	113
k_{u1} (pci)	112	112
Second Loading Cycle		
δ_2 (in.)	0.0311	
E_2 (psi)	5,477	
k'_{u2} (pci)	321	
k_{u2} (pci)	277	
E_2 / E_1 or k_2 / k_1 Ratio	2.5	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

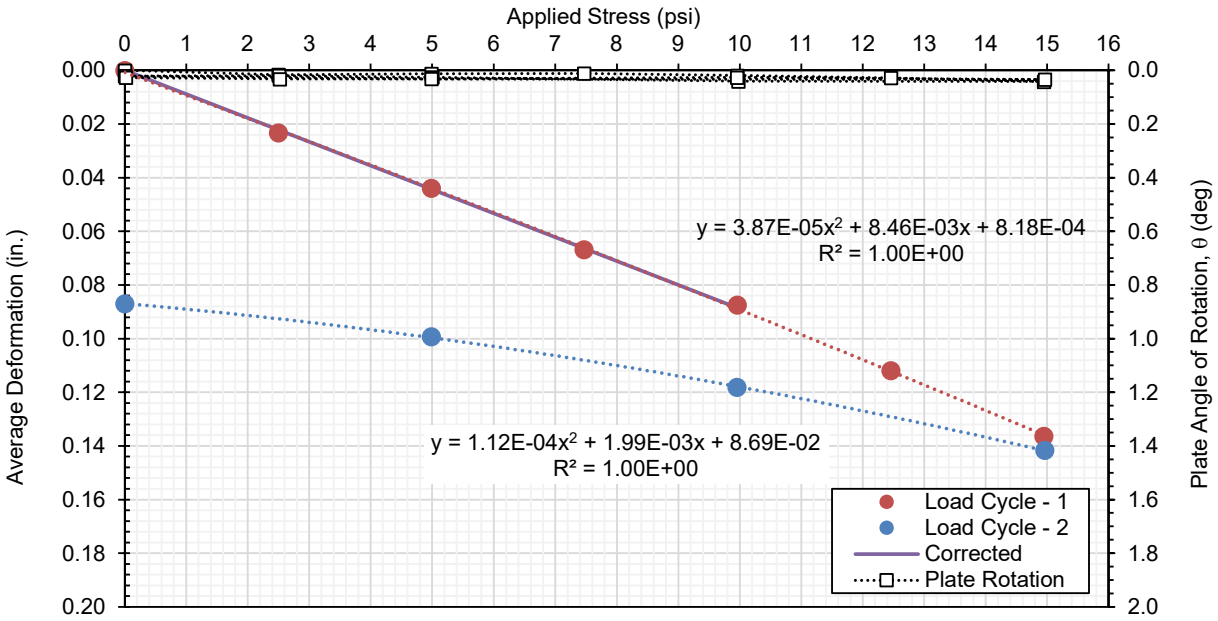
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	3.87E-05	a_1	1.12E-04	θ_{max} (deg)	0.0422
a_2	8.46E-03	a_2	1.99E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/12/2020	Time:	2:47:34 PM	Test ID	**PT5**
Tested By	CV/HG	Location:	US52	Sta.	NA
Latitude:	42.595348	Longitude:	91.009025	Elev. (ft):	376.6
Comments:	Compacted select subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0197	0.0162	0.0127	**0.0162**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0188*	*0.0203*	*0.0189*	**0.0194**
1	Load	2	3534	5	*5.0*	*0.0363*	*0.0421*	*0.0376*	**0.0387**
1	Load	3	5301	7.5	*7.5*	*0.0508*	*0.0617*	*0.0594*	**0.0573**
1	Load	4	7069	10	*9.9*	*0.0677*	*0.0818*	*0.0798*	**0.0764**
1	Load	5	8836	12.5	*12.4*	*0.0846*	*0.1022*	*0.1013*	**0.0960**
1	Load	6	10603	15	*14.9*	*0.1037*	*0.1207*	*0.1215*	**0.1153**
1	Unload	7	7069	10	*10.0*	*0.0964*	*0.1157*	*0.1180*	**0.1100**
1	Unload	8	3534	5	*5.0*	*0.0857*	*0.1016*	*0.1060*	**0.0978**
1	Unload	9	1767	2.5	*2.5*	*0.0772*	*0.0918*	*0.0996*	**0.0895**
1	Unload	10	0	0	*0.0*	*0.0648*	*0.0765*	*0.0843*	**0.0752**
2	Load	11	3534	5	*4.9*	*0.0772*	*0.0918*	*0.0987*	**0.0892**
2	Load	12	7069	10	*9.9*	*0.0887*	*0.1074*	*0.1110*	**0.1024**
2	Load	13	10603	15	*14.9*	*0.1062*	*0.1260*	*0.1287*	**0.1203**
2	Unload	14	1767	2.5	*2.5*	*0.0834*	*0.0980*	*0.1036*	**0.0950**
2	Unload	15	0	0	*0.0*	*0.0736*	*0.0835*	*0.0948*	**0.0840**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*a*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **128**
k_u (pci) @ δ = 0.05 in.: **114**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.8
E_1 (psi)	2,257
k'_u (pci)	115
k_u (pci)	114

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0769	0.0769
E_1 (psi)	2,532	2,532
k'_{u1} (pci)	130	130
k_{u1} (pci)	128	128
Second Loading Cycle		
δ_2 (in.)	0.0279	
E_2 (psi)	5,968	
k'_{u2} (pci)	358	
k_{u2} (pci)	302	
E_2 / E_1 or k_2 / k_1 Ratio	2.4	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

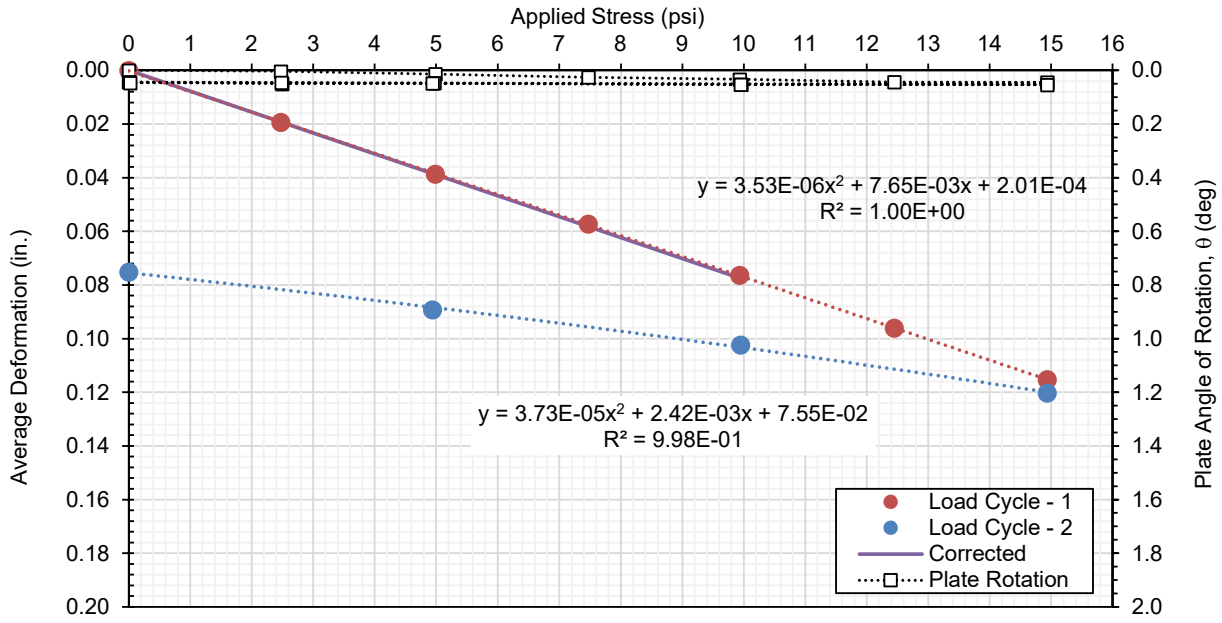
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque, IA

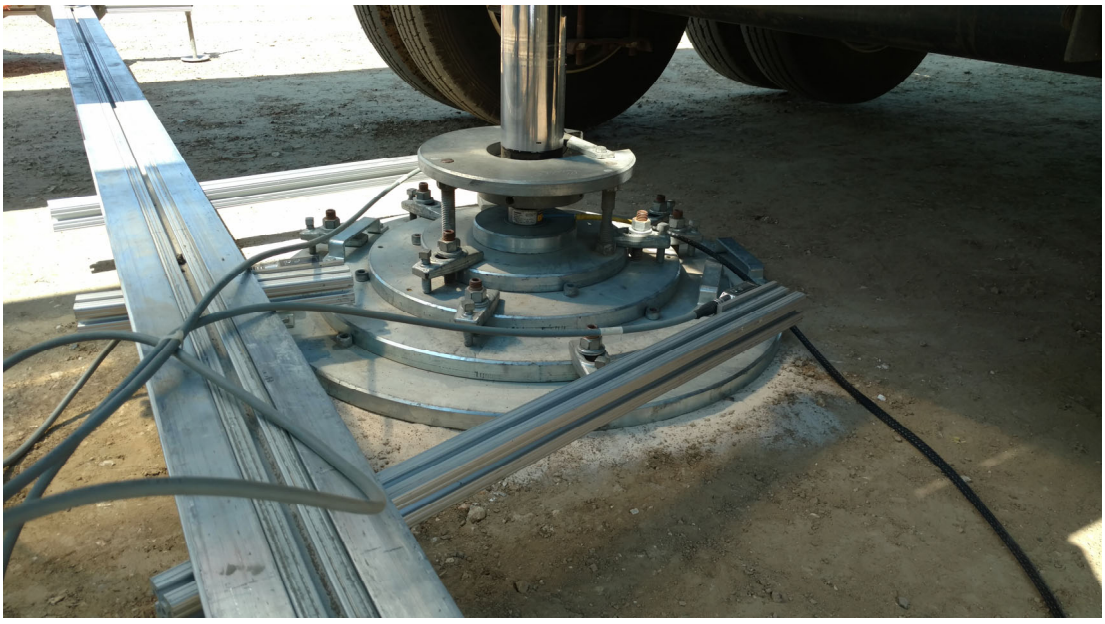
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	3.53E-06	a_1	3.73E-05	θ_{max} (deg)	0.0541
a_2	7.65E-03	a_2	2.42E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/12/2020	Time:	4:17:59 PM	Test ID	**PT6**
Tested By	CV/HG	Location:	US52 West of Holy Cross	Sta.	NA
Latitude:	42.597945	Longitude:	91.027205	Elev. (ft):	341.9
Comments:	Cement Stabilized Subgrade, over culvert				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0219	0.0099	0.0024	**0.0114**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0183*	*0.0050*	*0.0066*	**0.0100**
1	Load	2	3534	5	*5.0*	*0.0310*	*0.0086*	*0.0095*	**0.0164**
1	Load	3	5301	7.5	*7.5*	*0.0415*	*0.0109*	*0.0112*	**0.0212**
1	Load	4	7069	10	*10.0*	*0.0509*	*0.0125*	*0.0140*	**0.0258**
1	Load	5	8836	12.5	*12.4*	*0.0577*	*0.0143*	*0.0157*	**0.0292**
1	Load	6	10603	15	*15.0*	*0.0636*	*0.0162*	*0.0175*	**0.0325**
1	Unload	7	7069	10	*10.0*	*0.0616*	*0.0151*	*0.0162*	**0.0309**
1	Unload	8	3534	5	*5.0*	*0.0585*	*0.0140*	*0.0147*	**0.0290**
1	Unload	9	1767	2.5	*2.5*	*0.0547*	*0.0129*	*0.0133*	**0.0270**
1	Unload	10	0	0	*0.0*	*0.0484*	*0.0118*	*0.0114*	**0.0239**
2	Load	11	3534	5	*5.0*	*0.0566*	*0.0134*	*0.0136*	**0.0279**
2	Load	12	7069	10	*10.0*	*0.0614*	*0.0148*	*0.0152*	**0.0305**
2	Load	13	10603	15	*15.0*	*0.0656*	*0.0164*	*0.0173*	**0.0331**
2	Unload	14	1767	2.5	*2.5*	*0.0574*	*0.0136*	*0.0135*	**0.0282**
2	Unload	15	0	0	*0.0*	*0.0516*	*0.0120*	*0.0107*	**0.0248**

Plate Diameter:	*30.0*	in.
Shape factor:	**1.57**	
Material Type:	*a*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **371**
k_u (pci) @ δ = 0.05 in.: **275**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**15.9**
E_1 (psi)	**5,440**
k'_u (pci)	**319**
k_u (pci)	**275**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.0254**	**0.0214**
E_1 (psi)	**6,430**	**7,351**
k'_{u1} (pci)	**393**	**466**
k_{u1} (pci)	**325**	**371**
Second Loading Cycle		
δ_2 (in.)	**0.0068**	
E_2 (psi)	**17,515**	
k'_{u2} (pci)	**1,480**	
k_{u2} (pci)	**885**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.7**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

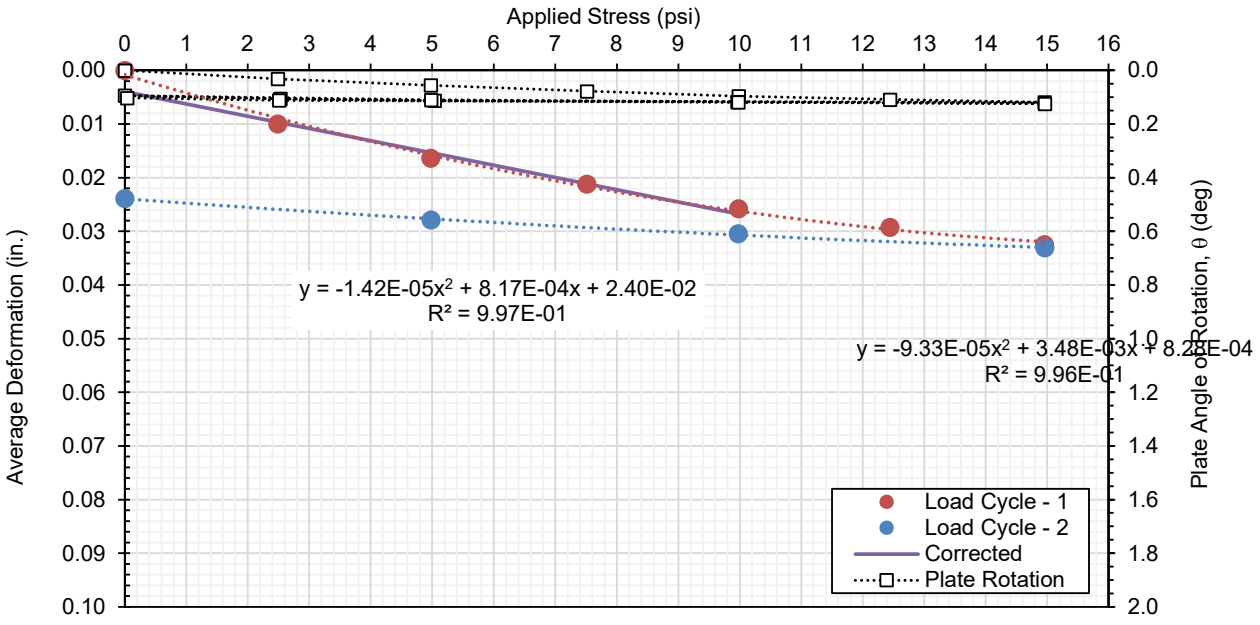
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US52, Dubuque, IA

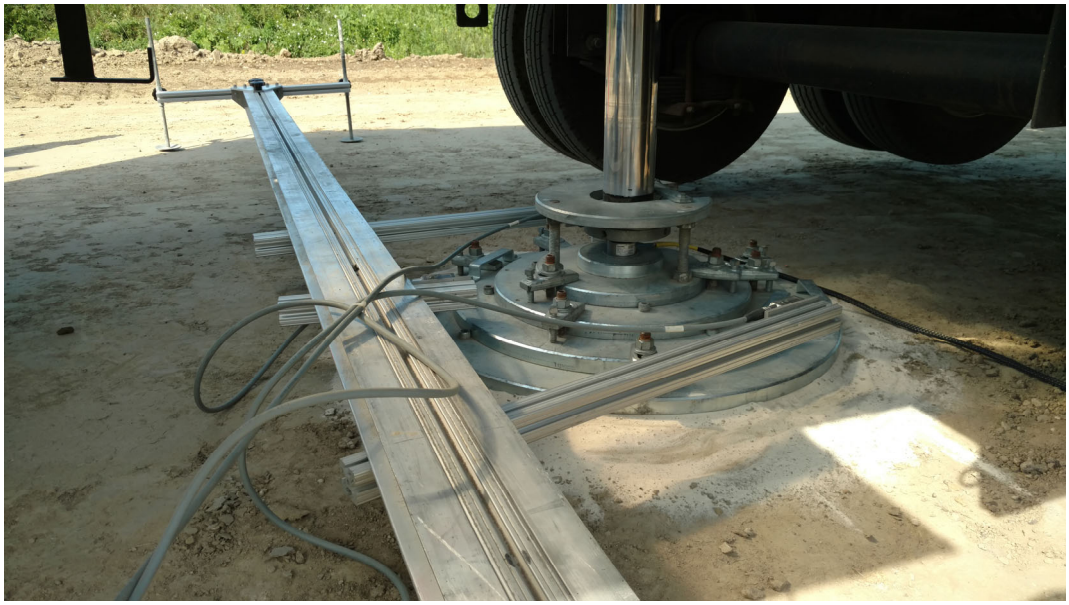
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-9.33E-05	a_1	-1.42E-05	θ_{max} (deg)	0.1242
a_2	3.48E-03	a_2	8.17E-04		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US52, Dubuque, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/18/2020	Time:	2:10:58 PM	Test ID	**PT3**
Tested By	HG	Location:	I-80	Sta.	NA
Latitude:	41.688742	Longitude:	-92.876293	Elev. (ft):	957
Comments:	Reworked subgrade with nominal 24 inches thick granular treatment over clay subgrade, with biaxial geogrid at the interface. Granular layer thickness interpreted as about 26 inches from DCP profile.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0159	0.0137	0.0804	**0.0367**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0217*	*0.0196*	*0.0474*	**0.0295**
1	Load	2	3534	5	*4.9*	*0.0413*	*0.0448*	*0.0715*	**0.0525**
1	Load	3	5301	7.5	*7.5*	*0.0565*	*0.0567*	*0.0873*	**0.0669**
1	Load	4	7069	10	*9.9*	*0.0734*	*0.0731*	*0.1041*	**0.0835**
1	Load	5	8836	12.5	*12.4*	*0.0848*	*0.0793*	*0.1184*	**0.0942**
1	Load	6	10603	15	*14.6*	*0.0982*	*0.0962*	*0.1323*	**0.1089**
1	Unload	7	7069	10	*9.7*	*0.0924*	*0.0886*	*0.1274*	**0.1028**
1	Unload	8	3534	5	*5.0*	*0.0800*	*0.0756*	*0.1168*	**0.0908**
1	Unload	9	1767	2.5	*2.5*	*0.0752*	*0.0696*	*0.1058*	**0.0835**
1	Unload	10	0	0	*0.0*	*0.0625*	*0.0554*	*0.0958*	**0.0712**
2	Load	11	3534	5	*5.0*	*0.0751*	*0.0717*	*0.1047*	**0.0838**
2	Load	12	7069	10	*10.0*	*0.0857*	*0.0851*	*0.1228*	**0.0979**
2	Load	13	10603	15	*14.7*	*0.1009*	*0.1025*	*0.1347*	**0.1127**
2	Unload	14	1767	2.5	*2.4*	*0.0761*	*0.0753*	*0.1054*	**0.0856**
2	Unload	14	0	0	*0.0*	*0.0650*	*0.0604*	*0.0972*	**0.0742**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **166**
k_u (pci) @ δ = 0.05 in.: **106**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.3
E_1 (psi)	3,726
k'_u (pci)	107
k_u (pci)	106

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0824	0.0574
E_1 (psi)	4,213	5,836
k'_{u1} (pci)	121	174
k_{u1} (pci)	120	166
Second Loading Cycle		
δ_2 (in.)	0.0268	
E_2 (psi)	10,951	
k'_{u2} (pci)	373	
k_{u2} (pci)	312	
E_2 / E_1 or k_2 / k_1 Ratio	2.6	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

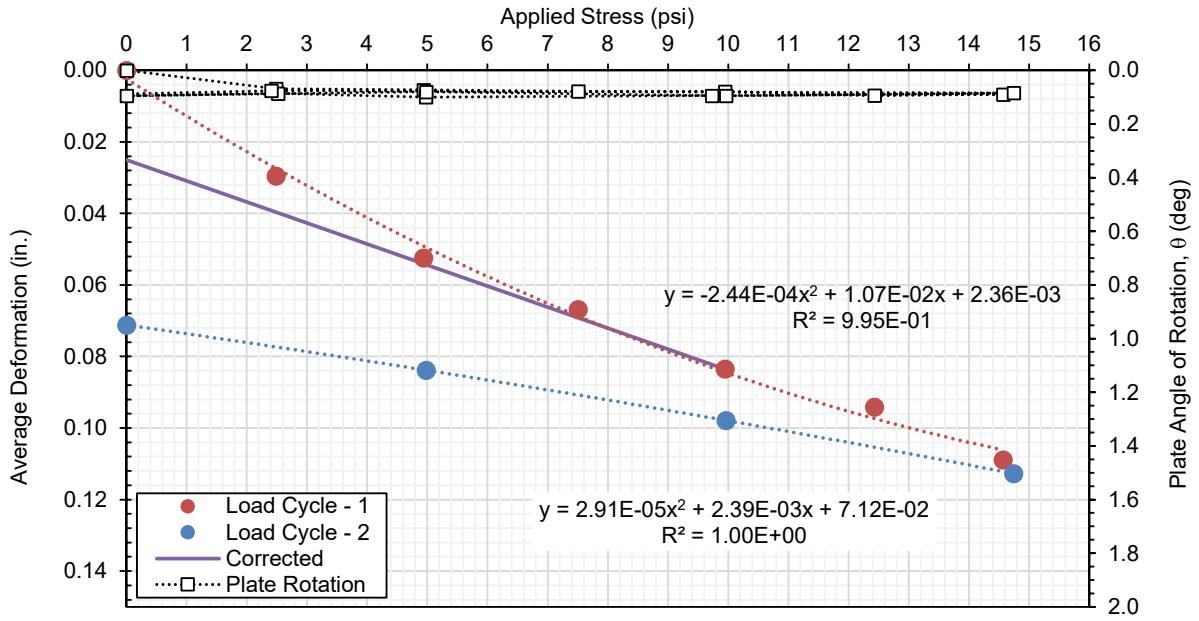
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: I80, Jasper County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.44E-04	a_1	2.91E-05	θ_{max} (deg)	0.0997
a_2	1.07E-02	a_2	2.39E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/18/2020	Time:	2:39:04 PM	Test ID	**PT4**
Tested By	HG	Location:	I-80	Sta.	NA
Latitude:	41.68890	Longitude:	-92.87589	Elev. (ft):	948
Comments:	Reworked subgrade with nominal 24 inches thick granular treatment over clay subgrade, with biaxial geogrid at the interface. Granular layer thickness interpreted as about 26 inches from DCP profile.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0060	0.0158	0.0391	**0.0203**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0163*	*0.0267*	*0.0433*	**0.0288**
1	Load	2	3534	5	*5.0*	*0.0335*	*0.0459*	*0.0668*	**0.0488**
1	Load	3	5301	7.5	*7.5*	*0.0493*	*0.0622*	*0.0864*	**0.0660**
1	Load	4	7069	10	*10.0*	*0.0662*	*0.0765*	*0.1038*	**0.0821**
1	Load	5	8836	12.5	*12.4*	*0.0813*	*0.0908*	*0.1183*	**0.0968**
1	Load	6	10603	15	*15.0*	*0.1016*	*0.1045*	*0.1312*	**0.1124**
1	Unload	7	7069	10	*10.0*	*0.0948*	*0.0966*	*0.1239*	**0.1051**
1	Unload	8	3534	5	*5.0*	*0.0836*	*0.0861*	*0.1122*	**0.0939**
1	Unload	9	1767	2.5	*2.5*	*0.0754*	*0.0762*	*0.1039*	**0.0851**
1	Unload	10	0	0	*0.0*	*0.0634*	*0.0654*	*0.0906*	**0.0731**
2	Load	11	3534	5	*5.0*	*0.0767*	*0.0776*	*0.1050*	**0.0864**
2	Load	12	7069	10	*9.9*	*0.0904*	*0.0924*	*0.1191*	**0.1006**
2	Load	13	10603	15	*14.9*	*0.1064*	*0.1082*	*0.1352*	**0.1166**
2	Unload	14	1767	2.5	*2.5*	*0.0802*	*0.0804*	*0.1075*	**0.0894**
2	Unload	14	0	0	*0.0*	*0.0687*	*0.0695*	*0.0949*	**0.0777**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **154**
k_u (pci) @ δ = 0.05 in.: **110**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.6
E_1 (psi)	2,283
k'_u (pci)	111
k_u (pci)	110

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.0817	0.0627
E_1 (psi)	2,499	3,178
k'_{u1} (pci)	122	159
k_{u1} (pci)	121	154
Second Loading Cycle		
δ_2 (in.)	0.0278	
E_2 (psi)	6,263	
k'_{u2} (pci)	360	
k_{u2} (pci)	303	
E_2 / E_1 or k_2 / k_1 Ratio	2.5	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

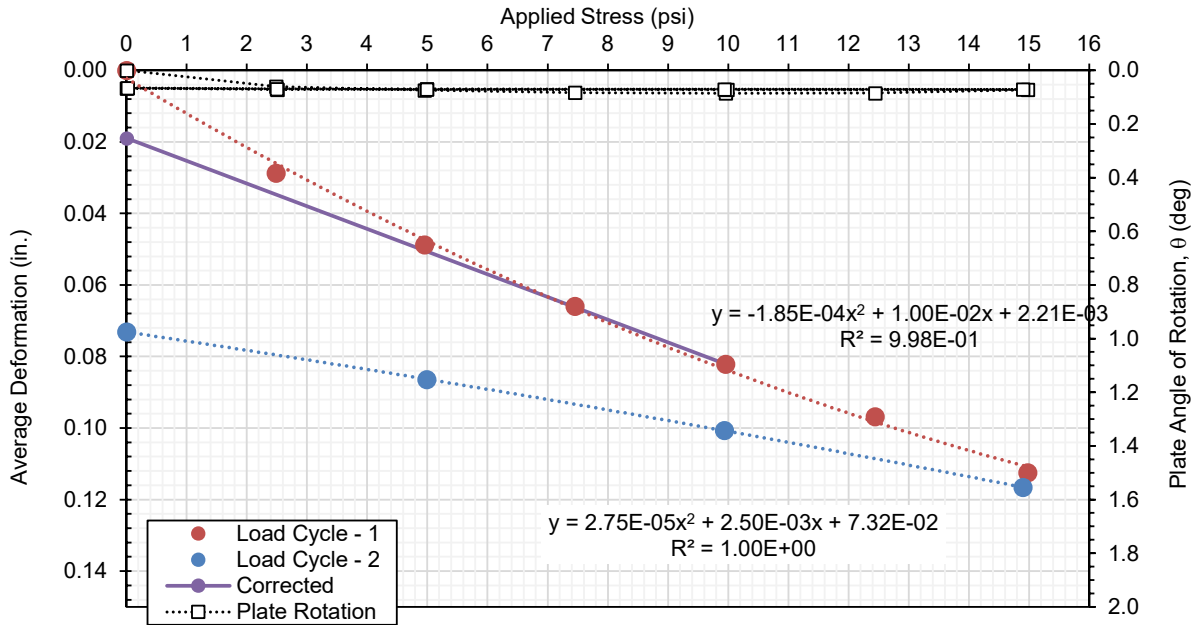
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: I80, Jasper County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.85E-04	a_1	2.75E-05	θ_{max} (deg)	0.0857
a_2	1.00E-02	a_2	2.50E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/18/2020	Time:	3:10:52 PM	Test ID	**PT5**
Tested By	HG	Location:	I-80	Sta.	NA
Latitude:	41.689217	Longitude:	-92.875048	Elev. (ft):	919
Comments:	Reworked subgrade with nominal 24 inches thick granular treatment over clay subgrade, with biaxial geogrid at the interface.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0081	0.0161	0.0319	**0.0187**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0211*	*0.0272*	*0.0227*	**0.0237**
1	Load	2	3534	5	*5.0*	*0.0354*	*0.0443*	*0.0380*	**0.0392**
1	Load	3	5301	7.5	*7.5*	*0.0457*	*0.0551*	*0.0517*	**0.0508**
1	Load	4	7069	10	*10.0*	*0.0585*	*0.0703*	*0.0642*	**0.0643**
1	Load	5	8836	12.5	*12.4*	*0.0681*	*0.0751*	*0.0731*	**0.0721**
1	Load	6	10603	15	*15.0*	*0.0792*	*0.0881*	*0.0854*	**0.0842**
1	Unload	7	7069	10	*9.9*	*0.0739*	*0.0814*	*0.0796*	**0.0783**
1	Unload	8	3534	5	*5.0*	*0.0650*	*0.0729*	*0.0715*	**0.0698**
1	Unload	9	1767	2.5	*2.6*	*0.0543*	*0.0622*	*0.0603*	**0.0589**
1	Unload	10	0	0	*0.0*	*0.0502*	*0.0572*	*0.0563*	**0.0545**
2	Load	11	3534	5	*5.0*	*0.0593*	*0.0708*	*0.0657*	**0.0653**
2	Load	12	7069	10	*10.0*	*0.0696*	*0.0766*	*0.0752*	**0.0738**
2	Load	13	10603	15	*15.0*	*0.0807*	*0.0902*	*0.0873*	**0.0861**
2	Unload	14	1767	2.5	*2.5*	*0.0597*	*0.0706*	*0.0661*	**0.0655**
2	Unload	14	0	0	*0.0*	*0.0522*	*0.0607*	*0.0577*	**0.0568**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **202**
k_u (pci) @ δ = 0.05 in.: **145**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**7.4**
E_1 (psi)	**5,073**
k'_u (pci)	**149**
k_u (pci)	**145**

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	**0.0626**	**0.0456**
E_1 (psi)	**5,403**	**7,098**
k'_{u1} (pci)	**160**	**219**
k_{u1} (pci)	**154**	**202**
Second Loading Cycle		
δ_2 (in.)	**0.0199**	
E_2 (psi)	**13,798**	
k'_{u2} (pci)	**502**	
k_{u2} (pci)	**393**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.6**	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

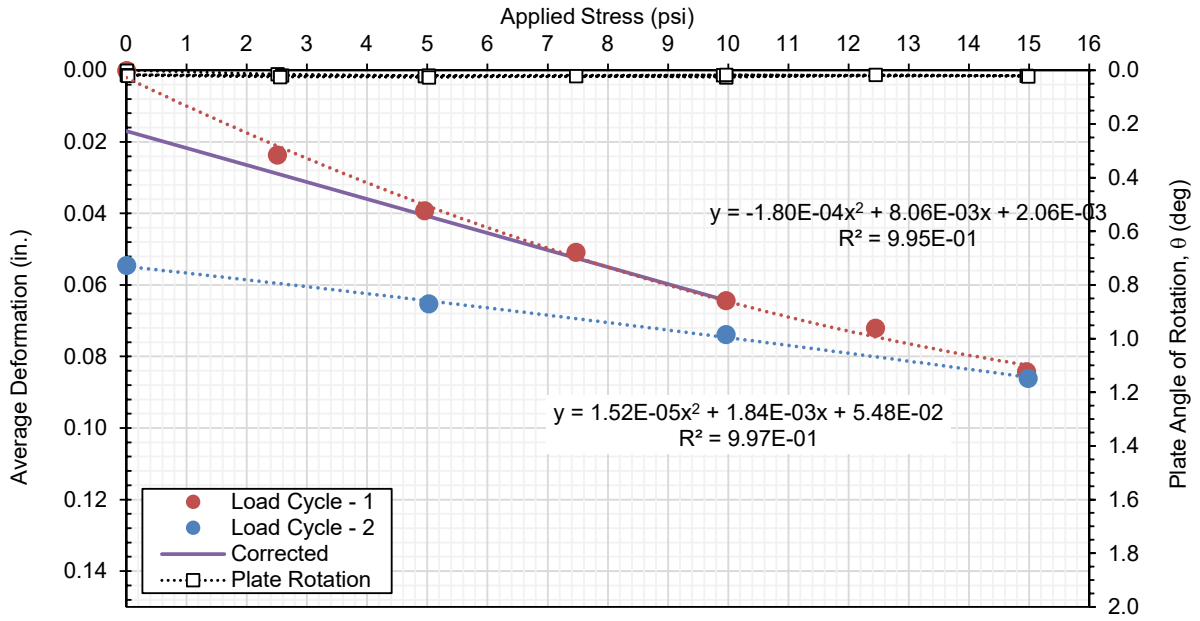
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: I80, Jasper County, IA

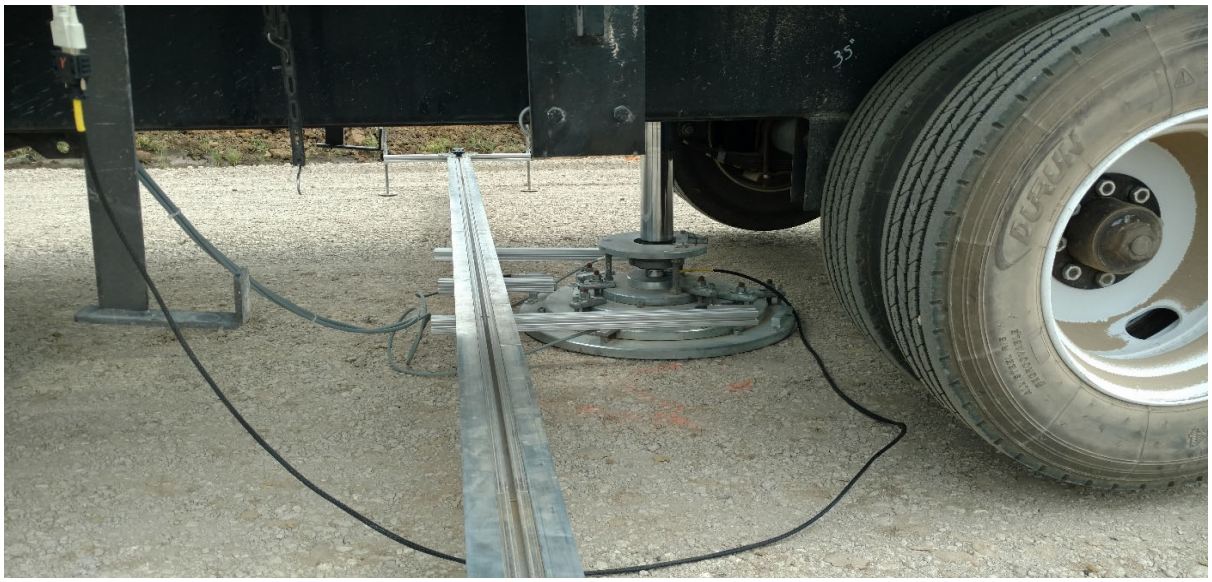
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.80E-04	a_1	1.52E-05	θ_{max} (deg)	0.0260
a_2	8.06E-03	a_2	1.84E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/18/2020	Time:	3:36:53 PM	Test ID	**PT6**
Tested By	HG	Location:	I-80	Sta.	NA
Latitude:	41.689315	Longitude:	-92.8747150	Elev. (ft):	961
Comments:	Reworked subgrade with nominal 24 inches thick granular treatment over clay subgrade, with biaxial geogrid at the interface.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0428	0.0390	0.0467	**0.0428**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0233*	*0.0549*	*0.0300*	**0.0361**
1	Load	2	3534	5	*5.0*	*0.0420*	*0.0871*	*0.0447*	**0.0579**
1	Load	3	5301	7.5	*7.5*	*0.0574*	*0.1043*	*0.0564*	**0.0727**
1	Load	4	7069	10	*10.0*	*0.0692*	*0.1196*	*0.0670*	**0.0853**
1	Load	5	8836	12.5	*12.4*	*0.0809*	*0.1354*	*0.0772*	**0.0978**
1	Load	6	10603	15	*15.0*	*0.0909*	*0.1443*	*0.0847*	**0.1066**
1	Unload	7	7069	10	*10.0*	*0.0870*	*0.1414*	*0.0810*	**0.1031**
1	Unload	8	3534	5	*5.0*	*0.0801*	*0.1353*	*0.0749*	**0.0968**
1	Unload	9	1767	2.5	*2.5*	*0.0749*	*0.1248*	*0.0687*	**0.0895**
1	Unload	10	0	0	*0.0*	*0.0680*	*0.1191*	*0.0616*	**0.0829**
2	Load	11	3534	5	*5.0*	*0.0761*	*0.1281*	*0.0705*	**0.0916**
2	Load	12	7069	10	*10.0*	*0.0846*	*0.1396*	*0.0791*	**0.1011**
2	Load	13	10603	15	*14.9*	*0.0939*	*0.1486*	*0.0878*	**0.1101**
2	Unload	14	1767	2.5	*2.5*	*0.0778*	*0.1301*	*0.0714*	**0.0931**
2	Unload	14	0	0	*0.0*	*0.0709*	*0.1210*	*0.0637*	**0.0852**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **172**
k_u (pci) @ δ = 0.05 in.: **96**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.8
E_1 (psi)	3,383
k'_u (pci)	96
k_u (pci)	96

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0852	0.0552
E_1 (psi)	4,081	6,033
k'_{u1} (pci)	117	181
k_{u1} (pci)	116	172
Second Loading Cycle		
δ_2 (in.)	0.0181	
E_2 (psi)	14,841	
k'_{u2} (pci)	552	
k_{u2} (pci)	423	
E_2 / E_1 or k_2 / k_1 Ratio	3.6	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

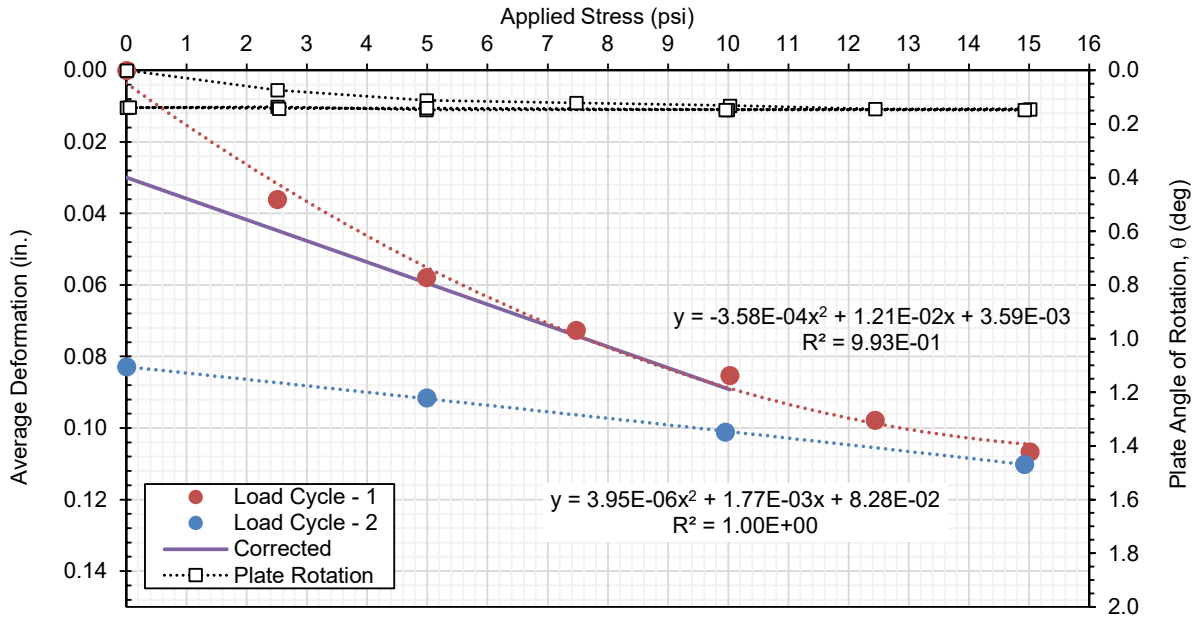
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: I80, Jasper County, IA

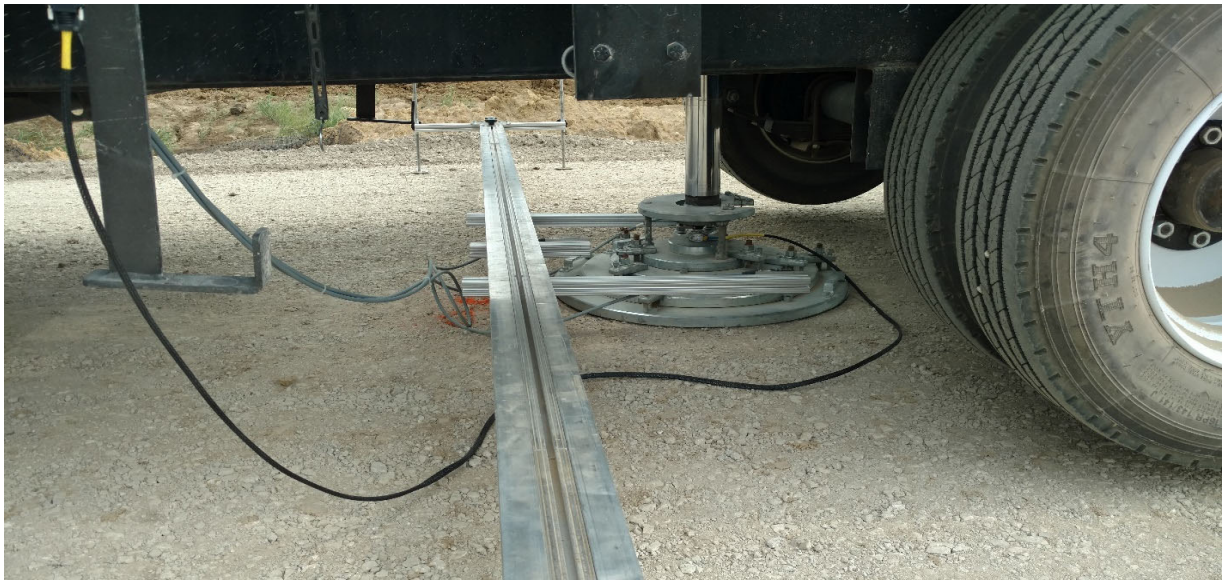
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.58E-04	a_1	3.95E-06	θ_{max} (deg)	0.1477
a_2	1.21E-02	a_2	1.77E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/18/2020	Time:	4:13:11 PM	Test ID	**PT7**
Tested By	HG	Location:	I-80	Sta.	NA
Latitude:	41.6899133	Longitude:	-92.873095	Elev. (ft):	922
Comments:	Reworked subgrade with granular treatment over clay subgrade, with biaxial geogrid at the interface. About 15 in. granular layer over subgrade, per DCP profile.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0174	0.0169	0.0171	**0.0171**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0293*	*0.0258*	*0.0306*	**0.0285**
1	Load	2	3534	5	*5.0*	*0.0590*	*0.0471*	*0.0557*	**0.0539**
1	Load	3	5301	7.5	*7.5*	*0.0896*	*0.0734*	*0.0814*	**0.0815**
1	Load	4	7069	10	*10.0*	*0.1233*	*0.0988*	*0.1055*	**0.1092**
1	Load	5	8836	12.5	*12.5*	*0.1531*	*0.1223*	*0.1298*	**0.1351**
1	Load	6	10603	15	*14.8*	*0.1801*	*0.1447*	*0.1534*	**0.1594**
1	Unload	7	7069	10	*10.0*	*0.1646*	*0.1335*	*0.1420*	**0.1467**
1	Unload	8	3534	5	*5.0*	*0.1413*	*0.1184*	*0.1232*	**0.1276**
1	Unload	9	1767	2.5	*2.4*	*0.1285*	*0.1008*	*0.1096*	**0.1130**
1	Unload	10	0	0	*0.0*	*0.1000*	*0.0746*	*0.0864*	**0.0870**
2	Load	11	3534	5	*5.0*	*0.1287*	*0.1000*	*0.1094*	**0.1127**
2	Load	12	7069	10	*10.0*	*0.1550*	*0.1222*	*0.1329*	**0.1367**
2	Load	13	10603	15	*15.0*	*0.1834*	*0.1518*	*0.1605*	**0.1652**
2	Unload	14	1767	2.5	*2.5*	*0.1319*	*0.1050*	*0.1146*	**0.1172**
2	Unload	14	0	0	*0.0*	*0.1085*	*0.0809*	*0.0931*	**0.0942**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **93**
k_u (pci) @ δ = 0.05 in.: **92**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.6
E_1 (psi)	3,224
k'_u (pci)	92
k_u (pci)	92

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1082	0.1072
E_1 (psi)	3,243	3,273
k'_{u1} (pci)	92	93
k_{u1} (pci)	92	93
Second Loading Cycle		
δ_2 (in.)	0.0503	
E_2 (psi)	6,535	
k'_{u2} (pci)	199	
k_{u2} (pci)	186	
E_2 / E_1 or k_2 / k_1 Ratio	2.0	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

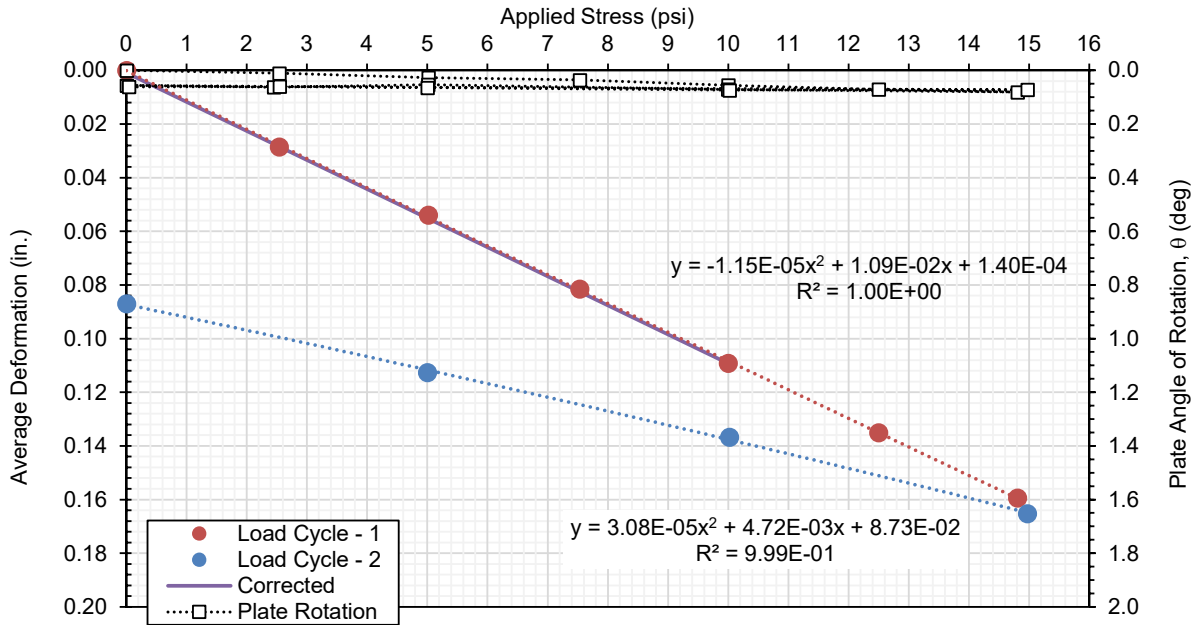
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: I80, Jasper County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.15E-05	a_1	3.08E-05	θ_{max} (deg)	0.0813
a_2	1.09E-02	a_2	4.72E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US61, Des Moines County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/20/2020	Time:	9:53:06 AM	Test ID	**PT1**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.12796000	Longitude:	-91.55020000	Elev. (ft):	765.6
Comments:	Granular Subbase - Recycled PCC				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0595	0.0144	0.0233	**0.0324**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0457*	*0.0314*	*0.0257*	**0.0343**
1	Load	2	3534	5	*5.0*	*0.0681*	*0.0516*	*0.0448*	**0.0548**
1	Load	3	5301	7.5	*7.5*	*0.0871*	*0.0698*	*0.0548*	**0.0705**
1	Load	4	7069	10	*10.0*	*0.0993*	*0.0911*	*0.0635*	**0.0847**
1	Load	5	8836	12.5	*12.4*	*0.1132*	*0.1018*	*0.0752*	**0.0967**
1	Load	6	10603	15	*15.0*	*0.1269*	*0.1114*	*0.0864*	**0.1082**
1	Unload	7	7069	10	*9.9*	*0.1237*	*0.1094*	*0.0832*	**0.1055**
1	Unload	8	3534	5	*5.0*	*0.1201*	*0.1032*	*0.0795*	**0.1009**
1	Unload	9	1767	2.5	*2.5*	*0.1164*	*0.0988*	*0.0767*	**0.0973**
1	Unload	10	0	0	*0.0*	*0.1098*	*0.0940*	*0.0724*	**0.0921**
2	Load	11	3534	5	*5.0*	*0.1173*	*0.0994*	*0.0774*	**0.0980**
2	Load	12	7069	10	*9.9*	*0.1231*	*0.1080*	*0.0834*	**0.1049**
2	Load	13	10603	15	*14.9*	*0.1307*	*0.1137*	*0.0902*	**0.1115**
2	Unload	14	1767	2.5	*2.5*	*0.1214*	*0.1024*	*0.0821*	**0.1019**
2	Unload	15	0	0	*0.0*	*0.1167*	*0.0962*	*0.0780*	**0.0970**

Plate Diameter:	*30.0*	in.	
Shape factor:	**2.67**		
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate	
Poisson's ratio:	*0.4*		
Design Stress:	*10.0*	psi	**AASHTO T222 Method** k_{u1} (pci) @ design stress: **175**
Target Deformation:	*0.05*	in.	**PCA Design Criteria** k_u (pci) @ δ = 0.05 in.: **100**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**5.0**
E_1 (psi)	**3,372**
k'_u (pci)	**101**
k_u (pci)	**100**

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	**0.0840**	**0.0540**
E_1 (psi)	**3,957**	**5,882**
k'_{u1} (pci)	**119**	**185**
k_{u1} (pci)	**118**	**175**
Second Loading Cycle		
δ_2 (in.)	**0.0128**	
E_2 (psi)	**18,529**	
k'_{u2} (pci)	**782**	
k_{u2} (pci)	**551**	
E_2 / E_1 or k_2 / k_1 Ratio	**4.7**	

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

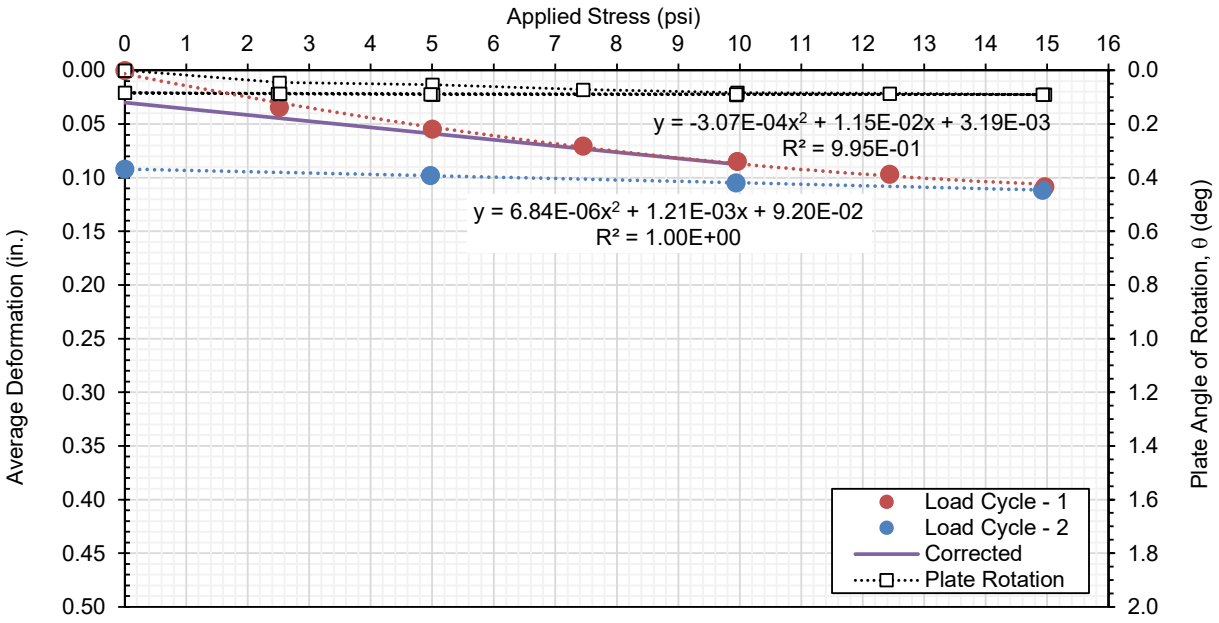
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

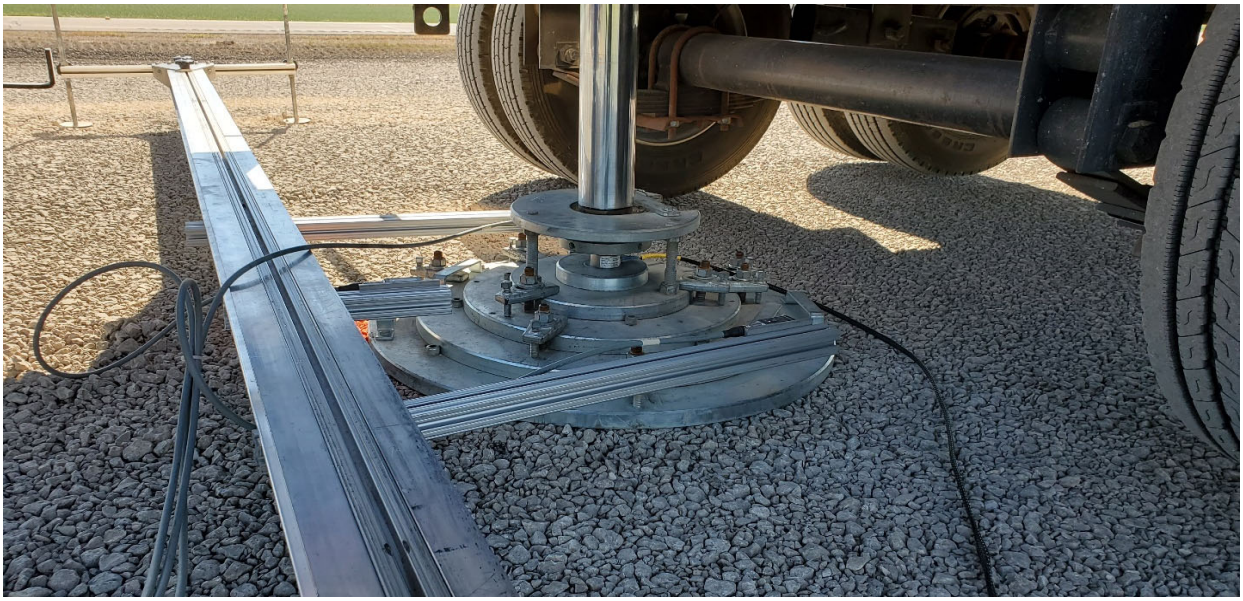
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.07E-04	a_1	6.84E-06	θ_{max} (deg)	0.0906
a_2	1.15E-02	a_2	1.21E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/20/2020	Time:	10:46:10 AM	Test ID	**PT2**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.1289997	Longitude:	-91.550179	Elev. (ft):	771.1
Comments:	Granular Subbase - Recycled PCC				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0270	0.0200	0.0203	**0.0224**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0529*	*0.0445*	*0.0410*	**0.0461**
1	Load	2	3534	5	*5.0*	*0.0970*	*0.0876*	*0.0796*	**0.0880**
1	Load	3	5301	7.5	*7.5*	*0.1373*	*0.1272*	*0.1166*	**0.1270**
1	Load	4	7069	10	*9.9*	*0.1785*	*0.1675*	*0.1549*	**0.1670**
1	Load	5	8836	12.5	*12.4*	*0.2163*	*0.2052*	*0.1936*	**0.2050**
1	Load	6	10603	15	*14.9*	*0.2552*	*0.2439*	*0.2324*	**0.2439**
1	Unload	7	7069	10	*9.9*	*0.2466*	*0.2354*	*0.2229*	**0.2350**
1	Unload	8	3534	5	*5.0*	*0.2326*	*0.2178*	*0.2072*	**0.2192**
1	Unload	9	1767	2.5	*2.5*	*0.2199*	*0.2029*	*0.1938*	**0.2055**
1	Unload	10	0	0	*0.0*	*0.1994*	*0.1798*	*0.1716*	**0.1836**
2	Load	11	3534	5	*5.0*	*0.2192*	*0.2018*	*0.1919*	**0.2043**
2	Load	12	7069	10	*9.9*	*0.2407*	*0.2263*	*0.2147*	**0.2272**
2	Load	13	10603	15	*14.9*	*0.2702*	*0.2593*	*0.2462*	**0.2586**
2	Unload	14	1767	2.5	*2.5*	*0.2360*	*0.2179*	*0.2071*	**0.2203**
2	Unload	15	0	0	*0.0*	*0.2159*	*0.1954*	*0.1863*	**0.1992**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **60**
k_u (pci) @ δ = 0.05 in.: **57**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**2.9**
E_1 (psi)	**1,920**
k'_u (pci)	**57**
k_u (pci)	**57**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1672**	**0.1672**
E_1 (psi)	**2,009**	**2,009**
k'_{u1} (pci)	**60**	**60**
k_{u1} (pci)	**60**	**60**
Second Loading Cycle		
δ_2 (in.)	**0.0446**	
E_2 (psi)	**6,923**	
k'_{u2} (pci)	**224**	
k_{u2} (pci)	**206**	
E_2 / E_1 or k_2 / k_1 Ratio	**3.4**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

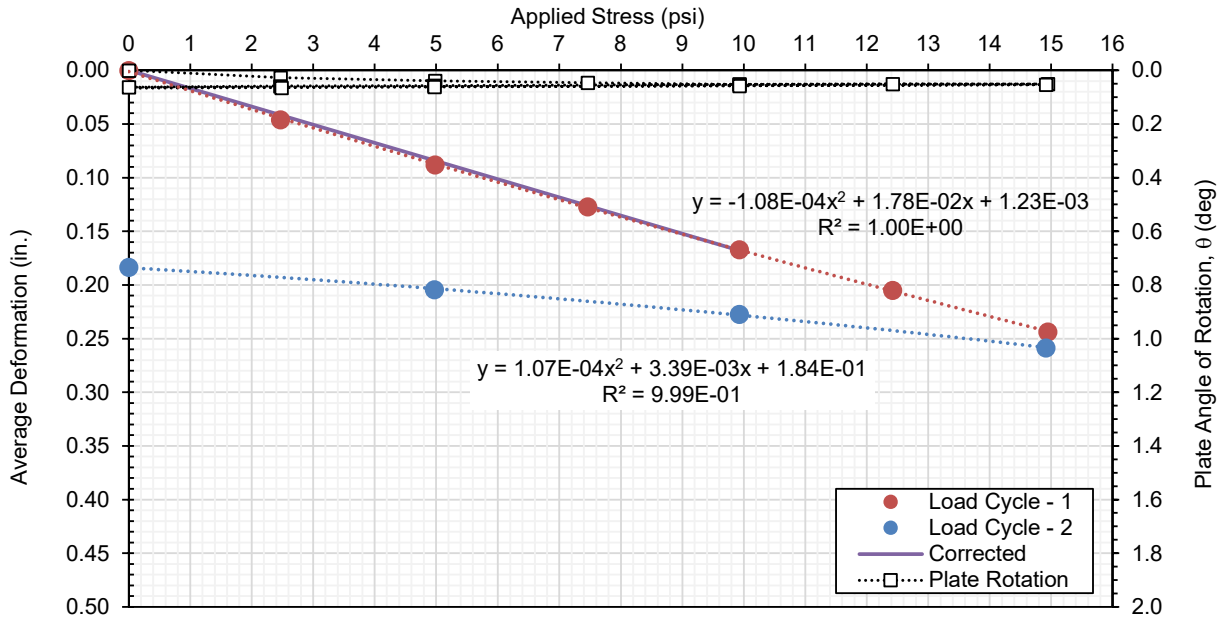
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.08E-04	a_1	1.07E-04	θ_{max} (deg)	0.0669
a_2	1.78E-02	a_2	3.39E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/20/2020	Time:	11:46:47 AM	Test ID	**PT3**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.129364	Longitude:	-91.550180	Elev. (ft):	776.8
Comments:	Granular Subbase - Recycled PCC				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0264	0.0223	0.0139	**0.0208**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0539*	*0.0481*	*0.0437*	**0.0486**
1	Load	2	3534	5	*5.0*	*0.1010*	*0.0942*	*0.0822*	**0.0925**
1	Load	3	5301	7.5	*7.5*	*0.1472*	*0.1412*	*0.1256*	**0.1380**
1	Load	4	7069	10	*10.0*	*0.1882*	*0.1839*	*0.1627*	**0.1783**
1	Load	5	8836	12.5	*12.4*	*0.2296*	*0.2283*	*0.2034*	**0.2205**
1	Load	6	10603	15	*15.0*	*0.2694*	*0.2631*	*0.2439*	**0.2588**
1	Unload	7	7069	10	*10.0*	*0.2613*	*0.2545*	*0.2312*	**0.2490**
1	Unload	8	3534	5	*5.0*	*0.2422*	*0.2331*	*0.2125*	**0.2293**
1	Unload	9	1767	2.5	*2.5*	*0.2303*	*0.2184*	*0.1985*	**0.2157**
1	Unload	10	0	0	*0.0*	*0.2044*	*0.1866*	*0.1706*	**0.1872**
2	Load	11	3534	5	*5.0*	*0.2278*	*0.2171*	*0.1963*	**0.2138**
2	Load	12	7069	10	*10.0*	*0.2531*	*0.2429*	*0.2235*	**0.2398**
2	Load	13	10603	15	*15.0*	*0.2882*	*0.2851*	*0.2581*	**0.2771**
2	Unload	14	1767	2.5	*2.5*	*0.2449*	*0.2343*	*0.2109*	**0.2300**
2	Unload	15	0	0	*0.0*	*0.2221*	*0.2071*	*0.1864*	**0.2052**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **56**
k_u (pci) @ δ = 0.05 in.: **53**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**2.6**
E_1 (psi)	**1,771**
k'_u (pci)	**53**
k_u (pci)	**53**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1797**	**0.1797**
E_1 (psi)	**1,870**	**1,870**
k'_{u1} (pci)	**56**	**56**
k_{u1} (pci)	**56**	**56**
Second Loading Cycle		
δ_2 (in.)	**0.0540**	
E_2 (psi)	**5,881**	
k'_{u2} (pci)	**185**	
k_{u2} (pci)	**175**	
E_2 / E_1 or k_2 / k_1 Ratio	**3.1**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

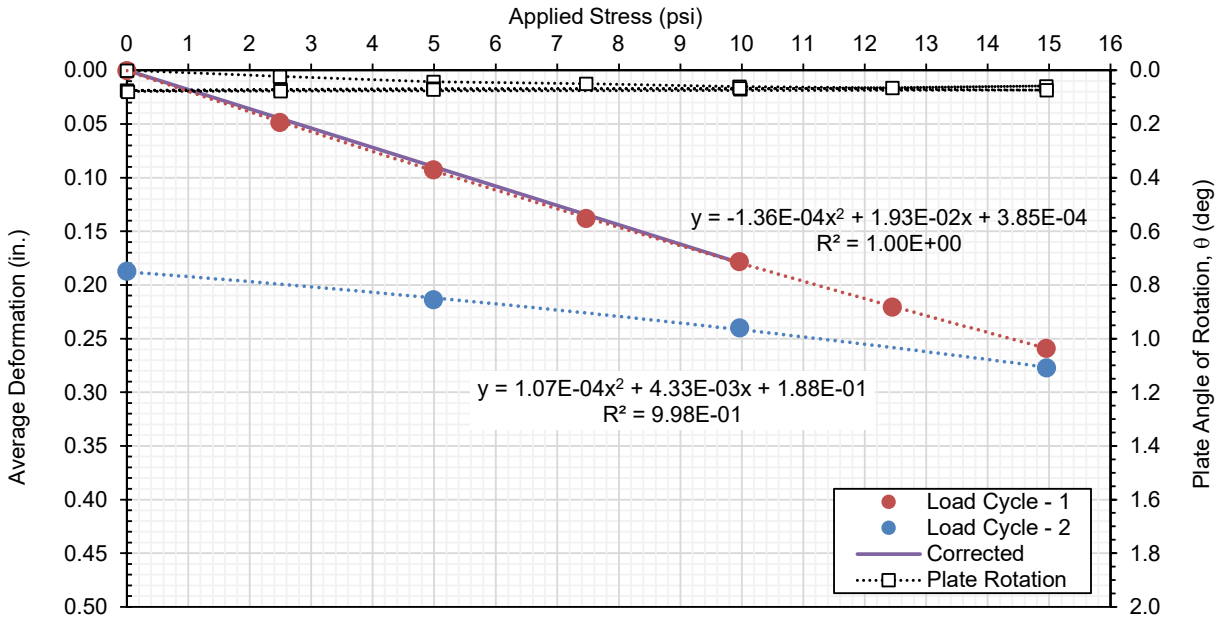
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

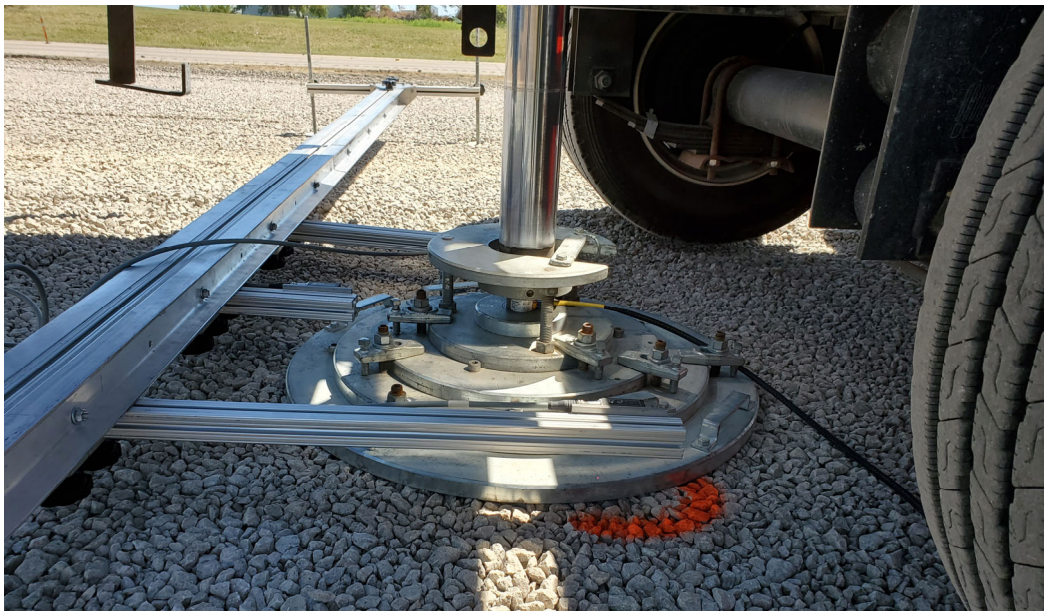
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.36E-04	a_1	1.07E-04	θ_{max} (deg)	0.0791
a_2	1.93E-02	a_2	4.33E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/20/2020	Time:	1:05:34 PM	Test ID	**PT4**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.131118	Longitude:	-91.550126	Elev. (ft):	788.3
Comments:	Granular Subbase - Recycled PCC				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0490	0.0266	0.0172	**0.0309**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0493*	*0.0424*	*0.0331*	**0.0416**
1	Load	2	3534	5	*5.0*	*0.0838*	*0.0774*	*0.0597*	**0.0736**
1	Load	3	5301	7.5	*7.5*	*0.1091*	*0.1005*	*0.0784*	**0.0960**
1	Load	4	7069	10	*10.0*	*0.1392*	*0.1203*	*0.0941*	**0.1179**
1	Load	5	8836	12.5	*12.5*	*0.1581*	*0.1416*	*0.1087*	**0.1361**
1	Load	6	10603	15	*14.9*	*0.1796*	*0.1620*	*0.1245*	**0.1554**
1	Unload	7	7069	10	*10.0*	*0.1743*	*0.1575*	*0.1190*	**0.1503**
1	Unload	8	3534	5	*5.0*	*0.1632*	*0.1486*	*0.1111*	**0.1410**
1	Unload	9	1767	2.5	*2.4*	*0.1539*	*0.1412*	*0.1057*	**0.1336**
1	Unload	10	0	0	*0.0*	*0.1470*	*0.1316*	*0.0975*	**0.1254**
2	Load	11	3534	5	*5.0*	*0.1587*	*0.1420*	*0.1071*	**0.1360**
2	Load	12	7069	10	*10.0*	*0.1832*	*0.1542*	*0.1159*	**0.1511**
2	Load	13	10603	15	*14.9*	*0.1896*	*0.1730*	*0.1289*	**0.1638**
2	Unload	14	1767	2.5	*2.5*	*0.1703*	*0.1525*	*0.1111*	**0.1446**
2	Unload	15	0	0	*0.0*	*0.1512*	*0.1410*	*0.1038*	**0.1320**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **100**
k_u (pci) @ δ = 0.05 in.: **72**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**3.6**
E_1 (psi)	**2,405**
k'_u (pci)	**72**
k_u (pci)	**72**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1174**	**0.1004**
E_1 (psi)	**2,861**	**3,346**
k'_{u1} (pci)	**85**	**100**
k_{u1} (pci)	**85**	**100**
Second Loading Cycle		
δ_2 (in.)	**0.0251**	
E_2 (psi)	**11,017**	
k'_{u2} (pci)	**398**	
k_{u2} (pci)	**328**	
E_2 / E_1 or k_2 / k_1 Ratio	**3.9**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

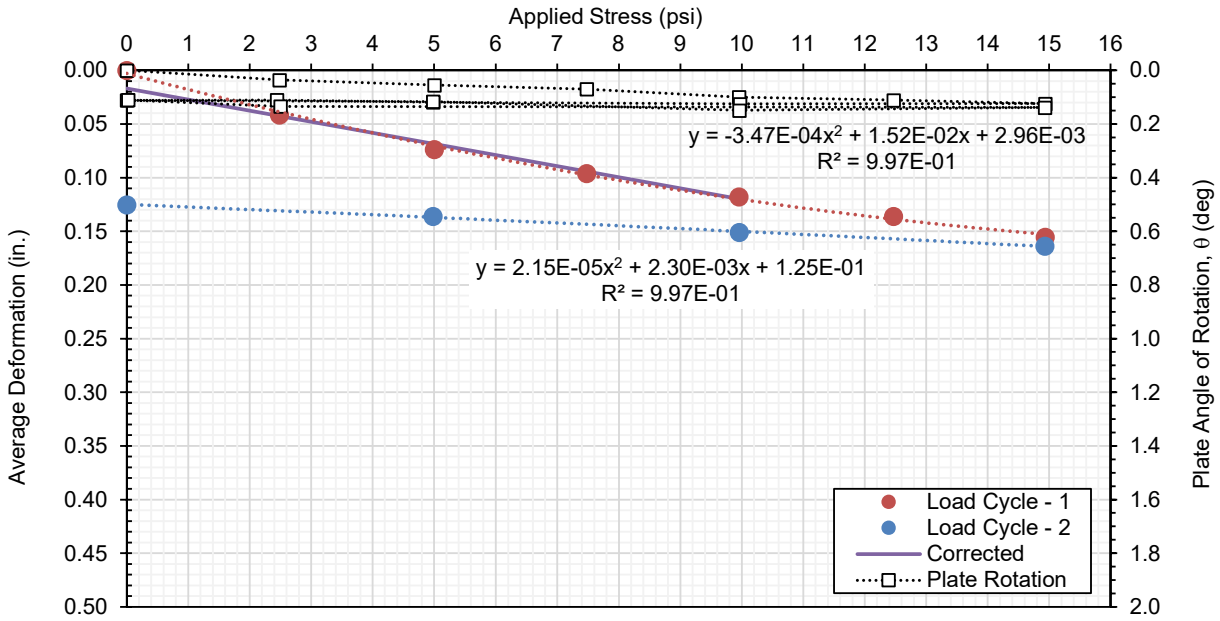
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.47E-04	a_1	2.15E-05	θ_{max} (deg)	0.1490
a_2	1.52E-02	a_2	2.30E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/20/2020	Time:	2:04:28 PM	Test ID	**PT5**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.131559	Longitude:	-91.550125	Elev. (ft):	791.0
Comments:	Granular Subbase - Recycled PCC				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0338	0.0232	0.0276	**0.0282**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0348*	*0.0384*	*0.0410*	**0.0381**
1	Load	2	3534	5	*5.0*	*0.0549*	*0.0642*	*0.0679*	**0.0624**
1	Load	3	5301	7.5	*7.5*	*0.0858*	*0.0814*	*0.0880*	**0.0850**
1	Load	4	7069	10	*10.0*	*0.1047*	*0.1039*	*0.1058*	**0.1048**
1	Load	5	8836	12.5	*12.5*	*0.1101*	*0.1201*	*0.1230*	**0.1177**
1	Load	6	10603	15	*15.0*	*0.1362*	*0.1347*	*0.1385*	**0.1364**
1	Unload	7	7069	10	*10.0*	*0.1328*	*0.1300*	*0.1354*	**0.1327**
1	Unload	8	3534	5	*5.0*	*0.1262*	*0.1244*	*0.1285*	**0.1264**
1	Unload	9	1767	2.5	*2.5*	*0.1160*	*0.1181*	*0.1232*	**0.1191**
1	Unload	10	0	0	*0.0*	*0.1079*	*0.1065*	*0.1161*	**0.1102**
2	Load	11	3534	5	*5.0*	*0.1070*	*0.1176*	*0.1232*	**0.1159**
2	Load	12	7069	10	*10.0*	*0.1240*	*0.1263*	*0.1319*	**0.1274**
2	Load	13	10603	15	*15.0*	*0.1448*	*0.1446*	*0.1445*	**0.1446**
2	Unload	14	1767	2.5	*2.5*	*0.1287*	*0.1263*	*0.1291*	**0.1280**
2	Unload	15	0	0	*0.0*	*0.1147*	*0.1182*	*0.1224*	**0.1184**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **120**
k_u (pci) @ δ = 0.05 in.: **83**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**4.1**
E_1 (psi)	**2,788**
k'_u (pci)	**83**
k_u (pci)	**83**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1026**	**0.0826**
E_1 (psi)	**3,274**	**4,019**
k'_{u1} (pci)	**97**	**121**
k_{u1} (pci)	**97**	**120**
Second Loading Cycle		
δ_2 (in.)	**0.0173**	
E_2 (psi)	**14,739**	
k'_{u2} (pci)	**579**	
k_{u2} (pci)	**439**	
E_2 / E_1 or k_2 / k_1 Ratio	**4.5**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

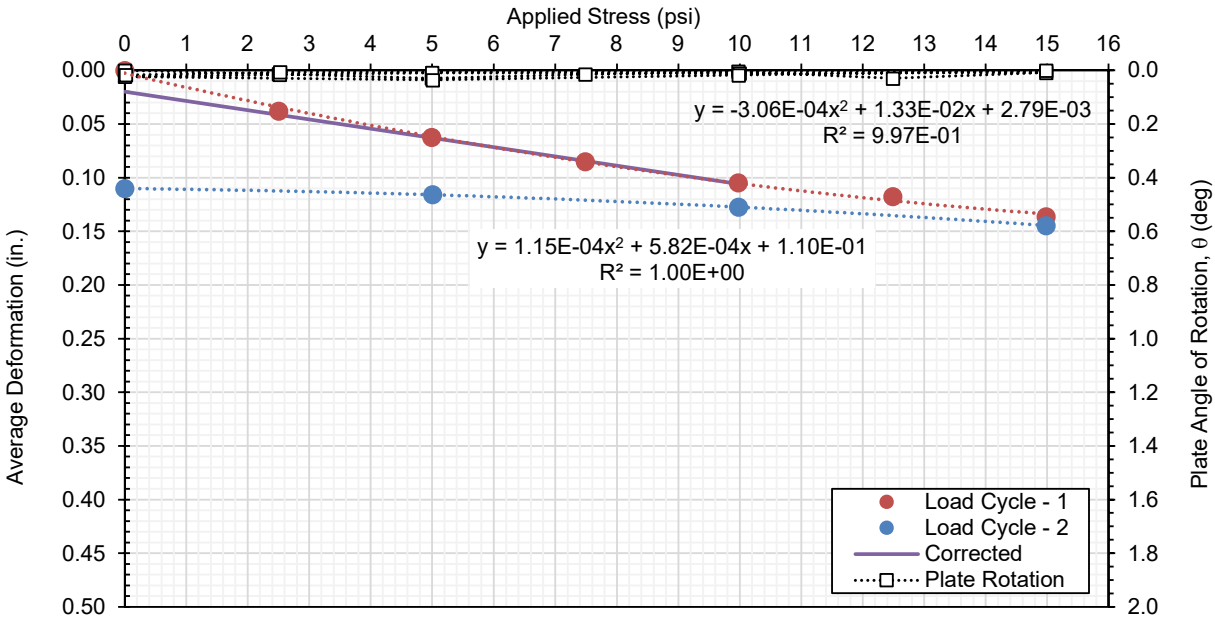
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

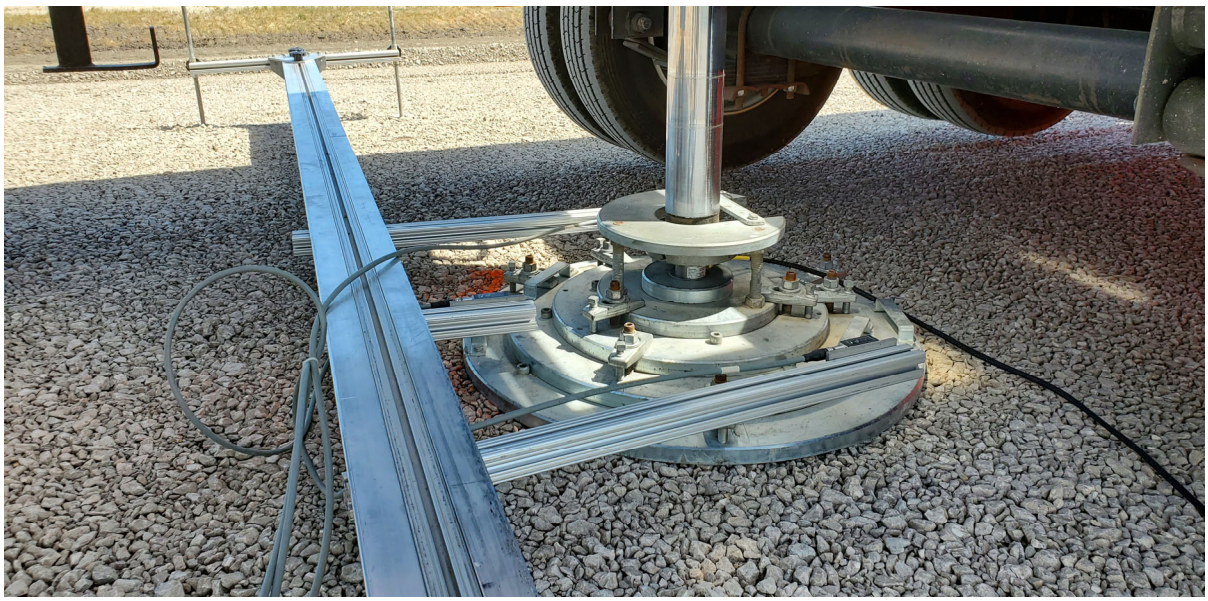
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.06E-04	a_1	1.15E-04	θ_{max} (deg)	0.0362
a_2	1.33E-02	a_2	5.82E-04		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/21/2020	Time:	10:27:29 AM	Test ID	**PT1**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.148936	Longitude:	-91.550000	Elev. (ft):	805.9
Comments:	Subgrade-Select				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0101	0.0055	0.0049	**0.0068**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.4*	*0.0139*	*0.0127*	*0.0115*	**0.0127**
1	Load	2	3534	5	*5.0*	*0.0227*	*0.0187*	*0.0213*	**0.0209**
1	Load	3	5301	7.5	*7.5*	*0.0325*	*0.0251*	*0.0320*	**0.0299**
1	Load	4	7069	10	*10.0*	*0.0426*	*0.0356*	*0.0416*	**0.0399**
1	Load	5	8836	12.5	*12.4*	*0.0473*	*0.0418*	*0.0525*	**0.0472**
1	Load	6	10603	15	*14.9*	*0.0520*	*0.0492*	*0.0625*	**0.0545**
1	Unload	7	7069	10	*9.9*	*0.0501*	*0.0431*	*0.0573*	**0.0502**
1	Unload	8	3534	5	*5.0*	*0.0494*	*0.0408*	*0.0511*	**0.0471**
1	Unload	9	1767	2.5	*2.5*	*0.0409*	*0.0373*	*0.0447*	**0.0410**
1	Unload	10	0	0	*0.0*	*0.0252*	*0.0303*	*0.0373*	**0.0309**
2	Load	11	3534	5	*4.9*	*0.0474*	*0.0391*	*0.0454*	**0.0440**
2	Load	12	7069	10	*10.0*	*0.0485*	*0.0424*	*0.0536*	**0.0482**
2	Load	13	10603	15	*14.9*	*0.0508*	*0.0558*	*0.0663*	**0.0576**
2	Unload	14	1767	2.5	*2.5*	*0.0382*	*0.0400*	*0.0492*	**0.0424**
2	Unload	15	0	0	*0.0*	*0.0285*	*0.0342*	*0.0412*	**0.0347**

Plate Diameter:	*30.0*	in.
Shape factor:	**1.57**	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **258**
k_u (pci) @ δ = 0.05 in.: **242**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**13.6**
E_1 (psi)	**4,780**
k'_u (pci)	**272**
k_u (pci)	**242**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.0388**	**0.0339**
E_1 (psi)	**4,579**	**5,113**
k'_{u1} (pci)	**258**	**295**
k_{u1} (pci)	**231**	**258**
Second Loading Cycle		
δ_2 (in.)	**0.0187**	
E_2 (psi)	**8,176**	
k'_{u2} (pci)	**535**	
k_{u2} (pci)	**413**	
E_2 / E_1 or k_2 / k_1 Ratio	**1.8**	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

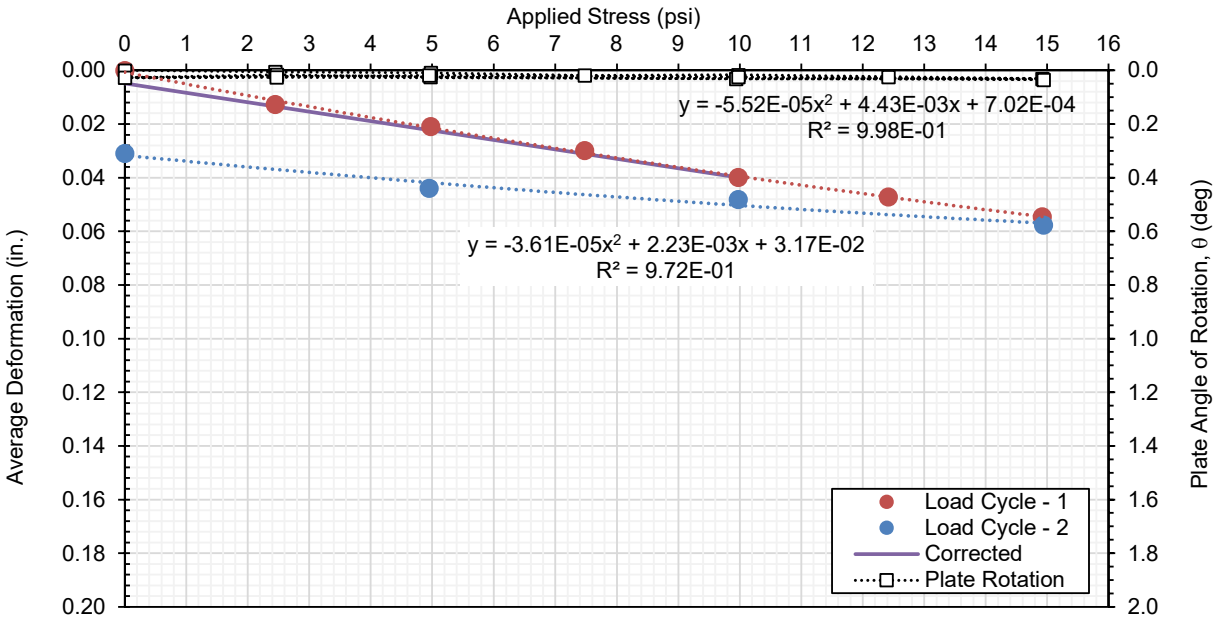
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

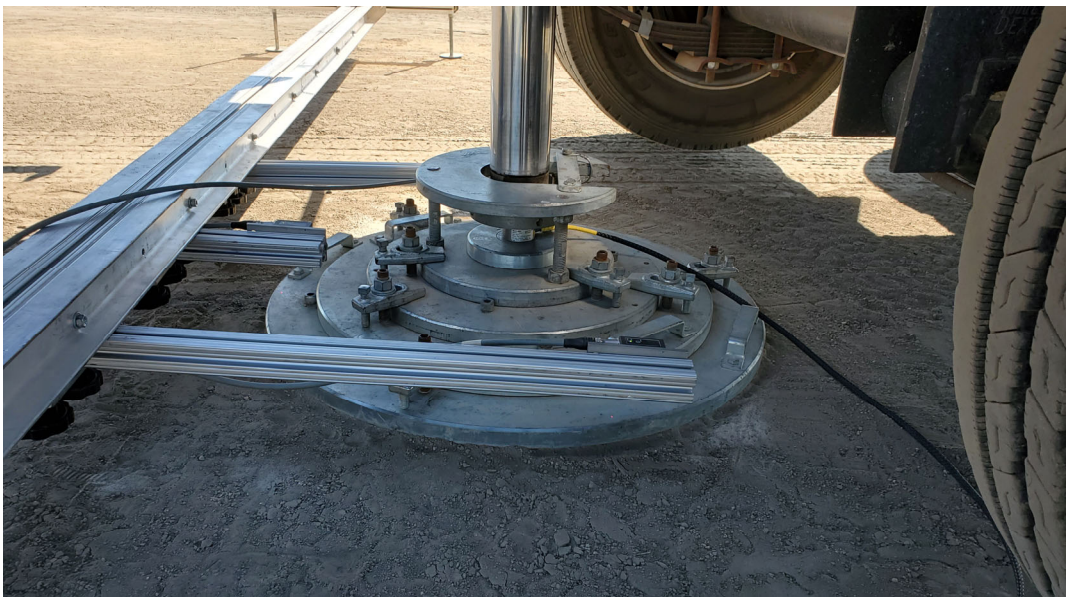
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-5.52E-05	a_1	-3.61E-05	θ_{max} (deg)	0.0350
a_2	4.43E-03	a_2	2.23E-03		
R^2	1.00	R^2	0.97		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/21/2020	Time:	11:20:58 AM	Test ID	**PT2**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.14969	Longitude:	-91.54999	Elev. (ft):	807.6
Comments:	Subgrade-Select				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0098	0.0069	0.0066	**0.0078**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0107*	*0.0080*	*0.0100*	**0.0096**
1	Load	2	3534	5	*5.0*	*0.0207*	*0.0141*	*0.0171*	**0.0173**
1	Load	3	5301	7.5	*7.5*	*0.0260*	*0.0201*	*0.0246*	**0.0236**
1	Load	4	7069	10	*9.9*	*0.0351*	*0.0246*	*0.0300*	**0.0299**
1	Load	5	8836	12.5	*12.4*	*0.0360*	*0.0302*	*0.0358*	**0.0340**
1	Load	6	10603	15	*14.9*	*0.0416*	*0.0365*	*0.0433*	**0.0405**
1	Unload	7	7069	10	*10.0*	*0.0457*	*0.0329*	*0.0409*	**0.0398**
1	Unload	8	3534	5	*5.0*	*0.0423*	*0.0275*	*0.0356*	**0.0352**
1	Unload	9	1767	2.5	*2.4*	*0.0404*	*0.0255*	*0.0320*	**0.0326**
1	Unload	10	0	0	*0.0*	*0.0282*	*0.0222*	*0.0282*	**0.0262**
2	Load	11	3534	5	*5.0*	*0.0403*	*0.0257*	*0.0328*	**0.0329**
2	Load	12	7069	10	*9.9*	*0.0413*	*0.0318*	*0.0392*	**0.0374**
2	Load	13	10603	15	*15.0*	*0.0535*	*0.0387*	*0.0455*	**0.0459**
2	Unload	14	1767	2.5	*2.5*	*0.0417*	*0.0277*	*0.0352*	**0.0349**
2	Unload	15	0	0	*0.0*	*0.0312*	*0.0246*	*0.0309*	**0.0289**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **335**
k_u (pci) @ δ = 0.05 in.: **396**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	25.3
E_1 (psi)	7,829
k'_u (pci)	506
k_u (pci)	396

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0295	0.0245
E_1 (psi)	5,723	6,632
k'_{u1} (pci)	339	409
k_{u1} (pci)	289	335
Second Loading Cycle		
δ_2 (in.)	0.0119	
E_2 (psi)	11,511	
k'_{u2} (pci)	840	
k_{u2} (pci)	582	
E_2 / E_1 or k_2 / k_1 Ratio	2.0	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

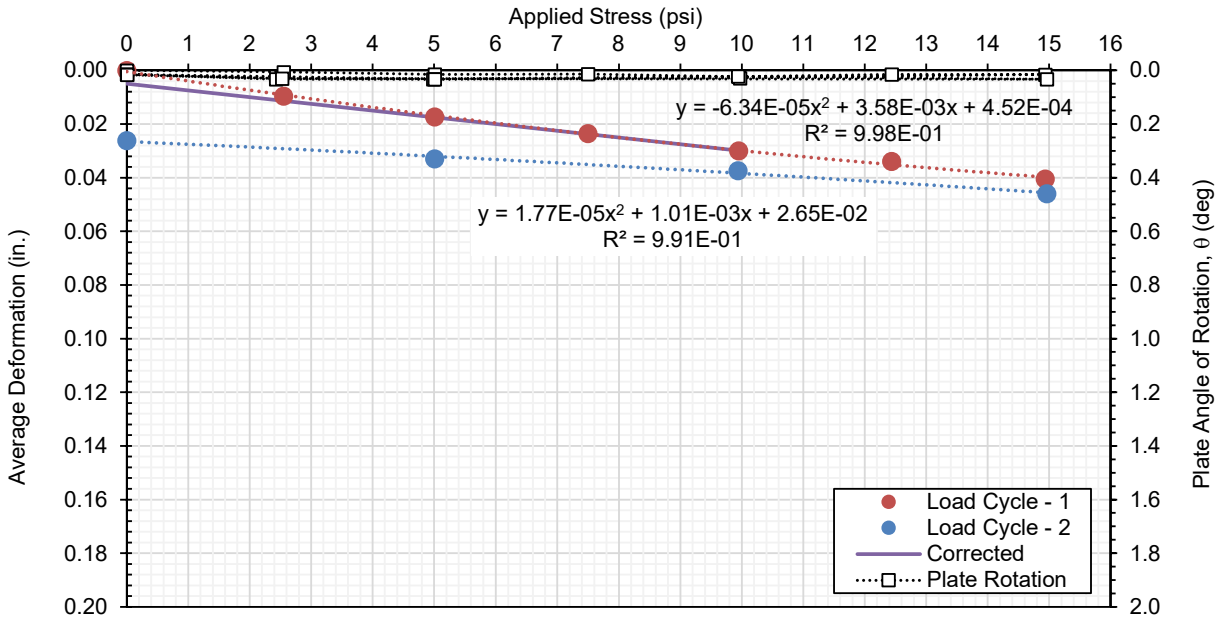
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

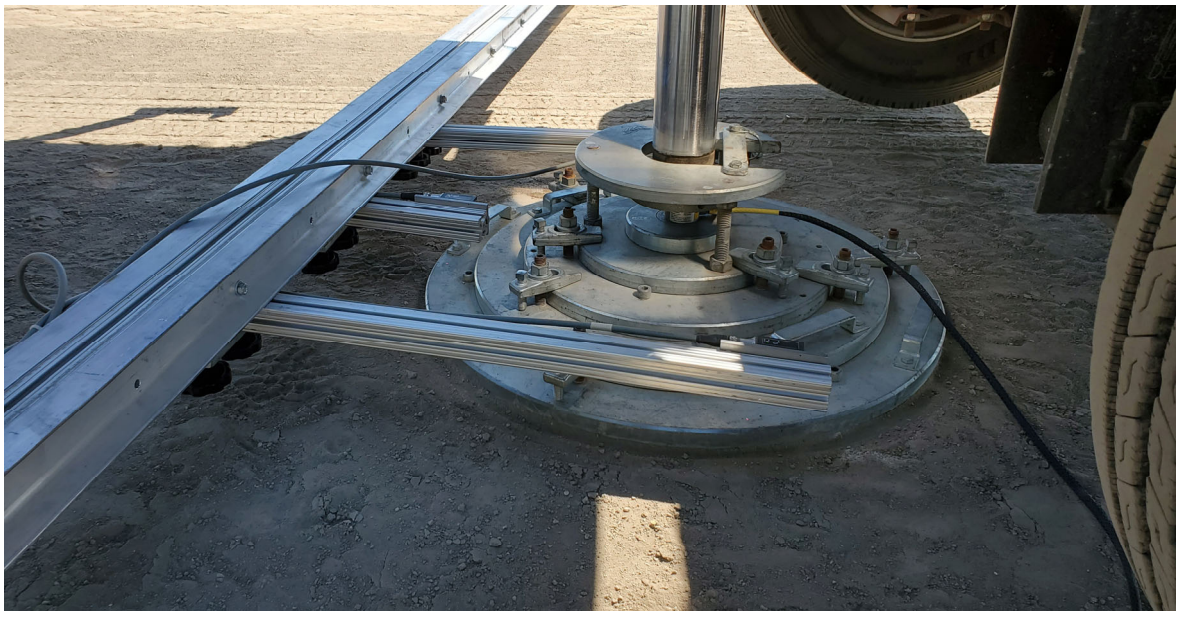
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-6.34E-05	a_1	1.77E-05	θ_{max} (deg)	0.0330
a_2	3.58E-03	a_2	1.01E-03		
R^2	1.00	R^2	0.99		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/21/2020	Time:	12:10:33 PM	Test ID	**PT3**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.15003	Longitude:	-91.54999	Elev. (ft):	809.5
Comments:	Subgrade-Select				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0042	0.0063	0.0103	**0.0069**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.6*	*0.0160*	*0.0052*	*0.0183*	**0.0132**
1	Load	2	3534	5	*5.0*	*0.0250*	*0.0116*	*0.0317*	**0.0228**
1	Load	3	5301	7.5	*7.5*	*0.0377*	*0.0203*	*0.0405*	**0.0328**
1	Load	4	7069	10	*10.0*	*0.0465*	*0.0253*	*0.0514*	**0.0410**
1	Load	5	8836	12.5	*12.5*	*0.0541*	*0.0317*	*0.0576*	**0.0478**
1	Load	6	10603	15	*15.0*	*0.0649*	*0.0408*	*0.0666*	**0.0574**
1	Unload	7	7069	10	*10.0*	*0.0593*	*0.0356*	*0.0629*	**0.0526**
1	Unload	8	3534	5	*5.0*	*0.0521*	*0.0302*	*0.0583*	**0.0468**
1	Unload	9	1767	2.5	*2.5*	*0.0488*	*0.0276*	*0.0562*	**0.0442**
1	Unload	10	0	0	*0.0*	*0.0463*	*0.0255*	*0.0520*	**0.0413**
2	Load	11	3534	5	*5.0*	*0.0480*	*0.0281*	*0.0561*	**0.0441**
2	Load	12	7069	10	*10.0*	*0.0553*	*0.0340*	*0.0605*	**0.0499**
2	Load	13	10603	15	*15.0*	*0.0665*	*0.0439*	*0.0683*	**0.0596**
2	Unload	14	1767	2.5	*2.5*	*0.0525*	*0.0313*	*0.0579*	**0.0472**
2	Unload	15	0	0	*0.0*	*0.0486*	*0.0274*	*0.0541*	**0.0434**

Plate Diameter:	*30.0*	in.
Shape factor:	*1.57*	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **232**
k_u (pci) @ δ = 0.05 in.: **232**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	12.9
E_1 (psi)	4,587
k'_u (pci)	258
k_u (pci)	232

Modulus at target/design applied stress

	First Loading Cycle	Corr. for Seating
δ_1 (in.)	0.0407	0.0387
E_1 (psi)	4,399	4,586
k'_{u1} (pci)	246	258
k_{u1} (pci)	222	232
Second Loading Cycle		
δ_2 (in.)	0.0088	
E_2 (psi)	14,430	
k'_{u2} (pci)	1,138	
k_{u2} (pci)	729	
E_2 / E_1 or k_2 / k_1 Ratio	3.3	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

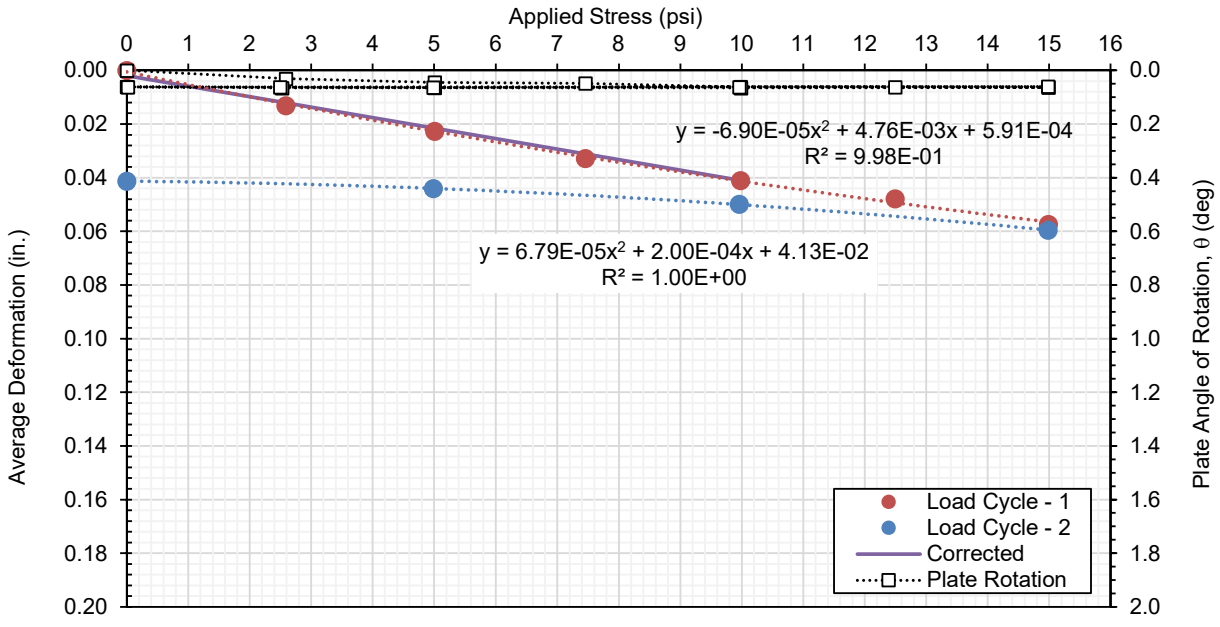
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

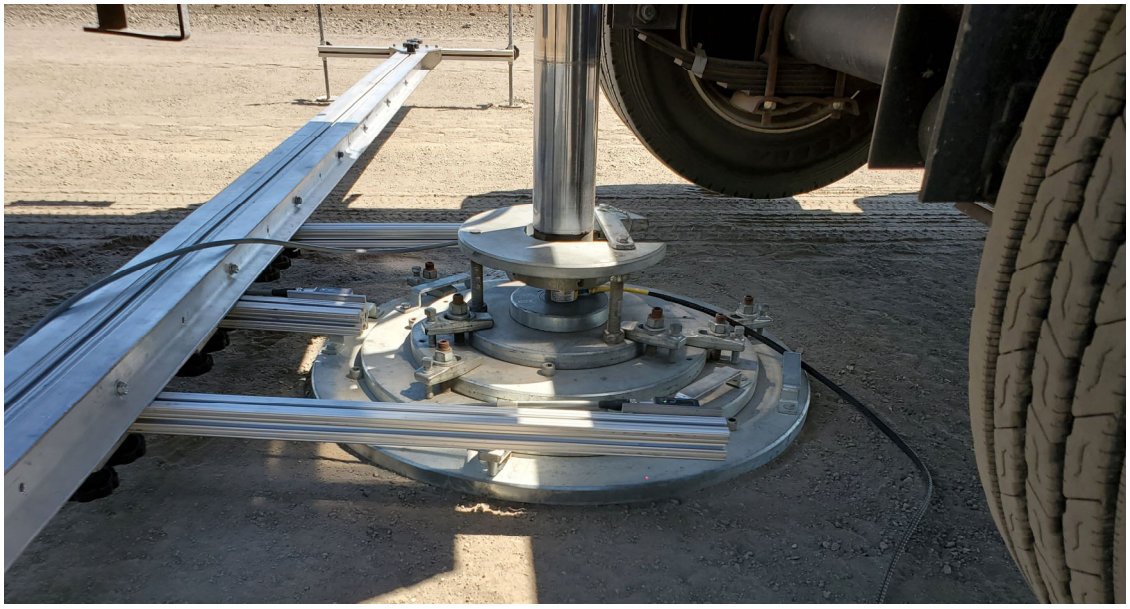
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-6.90E-05	a_1	6.79E-05	θ_{max} (deg)	0.0656
a_2	4.76E-03	a_2	2.00E-04		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	8/21/2020	Time:	1:06:04 PM	Test ID	**PT4**
Tested By	KG/CV	Location:	US13	Sta.	NA
Latitude:	42.15045	Longitude:	-91.54999	Elev. (ft):	808.6
Comments:	Subgrade-Select				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0182	0.0053	0.0286	**0.0174**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0212*	*0.0105*	*0.0340*	**0.0219**
1	Load	2	3534	5	*5.0*	*0.0383*	*0.0267*	*0.0564*	**0.0405**
1	Load	3	5301	7.5	*7.5*	*0.0565*	*0.0452*	*0.0780*	**0.0599**
1	Load	4	7069	10	*10.0*	*0.0748*	*0.0631*	*0.0974*	**0.0784**
1	Load	5	8836	12.5	*12.4*	*0.0953*	*0.0827*	*0.1168*	**0.0983**
1	Load	6	10603	15	*15.0*	*0.1152*	*0.1035*	*0.1385*	**0.1191**
1	Unload	7	7069	10	*10.0*	*0.1090*	*0.0975*	*0.1317*	**0.1127**
1	Unload	8	3534	5	*5.0*	*0.0949*	*0.0833*	*0.1204*	**0.0995**
1	Unload	9	1767	2.5	*2.5*	*0.0861*	*0.0743*	*0.1102*	**0.0902**
1	Unload	10	0	0	*0.0*	*0.0728*	*0.0614*	*0.0973*	**0.0772**
2	Load	11	3534	5	*5.0*	*0.0859*	*0.0731*	*0.1097*	**0.0896**
2	Load	12	7069	10	*10.0*	*0.1012*	*0.0874*	*0.1246*	**0.1044**
2	Load	13	10603	15	*14.9*	*0.1216*	*0.1082*	*0.1436*	**0.1245**
2	Unload	14	1767	2.5	*2.5*	*0.0926*	*0.0796*	*0.1171*	**0.0964**
2	Unload	15	0	0	*0.0*	*0.0798*	*0.0672*	*0.1050*	**0.0840**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **125**
k_u (pci) @ δ = 0.05 in.: **125**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	6.3
E_1 (psi)	2,477
k'_u (pci)	127
k_u (pci)	125

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0787	0.0787
E_1 (psi)	2,479	2,479
k'_{u1} (pci)	127	127
k_{u1} (pci)	125	125
Second Loading Cycle		
δ_2 (in.)	0.0277	
E_2 (psi)	6,011	
k'_{u2} (pci)	361	
k_{u2} (pci)	304	
E_2 / E_1 or k_2 / k_1 Ratio	2.4	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

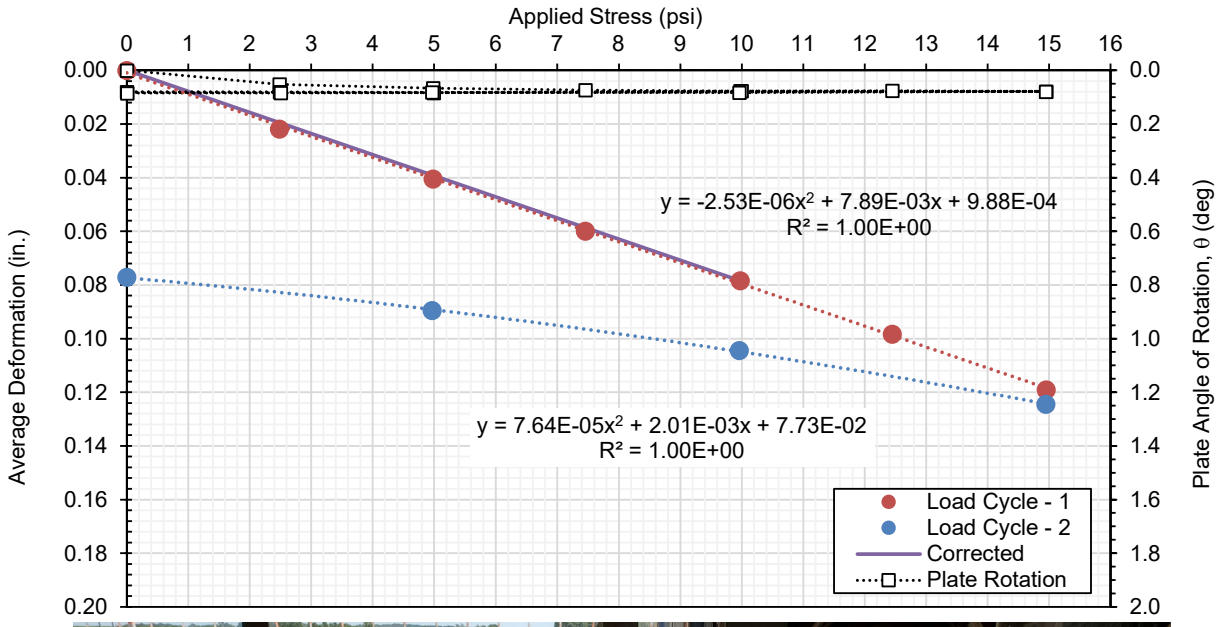
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US13, Linn, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.53E-06	a_1	7.64E-05	θ_{max} (deg)	0.0848
a_2	7.89E-03	a_2	2.01E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US13, Linn, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/29/2020	Time:	8:24:40 AM	Test ID	**PT1**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.580326	Longitude:	-96.313265	Elev. (ft):	1042.8
Comments:	Compacted special backfill.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	2.2	0.0206	0.0255	0.0142	0.0201
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	0.0	0.0000	0.0000	0.0000	0.0000
1	Load	1	1767	2.5	2.2	0.0417	0.0433	0.0334	0.0395
1	Load	2	3534	5	4.6	0.0867	0.0858	0.0727	0.0817
1	Load	3	5301	7.5	7.1	0.1260	0.1226	0.1062	0.1183
1	Load	4	7069	10	9.6	0.1674	0.1643	0.1494	0.1604
1	Load	5	8836	12.5	12.1	0.2062	0.2058	0.1863	0.1994
1	Load	6	10603	15	14.6	0.2498	0.2518	0.2325	0.2447
1	Unload	7	7069	10	9.7	0.2386	0.2390	0.2108	0.2295
1	Unload	8	3534	5	4.6	0.2168	0.2154	0.1904	0.2076
1	Unload	9	1767	2.5	2.1	0.1991	0.1953	0.1771	0.1905
1	Unload	10	0	0	0.0	0.1734	0.1670	0.1499	0.1634
2	Load	11	3534	5	4.6	0.1993	0.1963	0.1760	0.1905
2	Load	12	7069	10	9.6	0.2289	0.2292	0.2029	0.2203
2	Load	13	10603	15	14.6	0.2674	0.2700	0.2440	0.2604
2	Unload	14	1767	2.5	2.2	0.2159	0.2134	0.1913	0.2069
2	Unload	14	0	0	-0.3	0.1927	0.1872	0.1681	0.1827

Plate Diameter:	30.0	in.
Shape factor:	2.67	
Material Type:	B	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	0.35	
Design Stress:	10.0	psi
Target Deformation:	0.05	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **61**
k_u (pci) @ δ = 0.05 in.: **60**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	3.0
E_1 (psi)	2,122
k'_u (pci)	60
k_u (pci)	60

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.1651	0.1651
E_1 (psi)	2,126	2,126
k'_{u1} (pci)	61	61
k_{u1} (pci)	61	61
Second Loading Cycle		
δ_2 (in.)	0.0605	
E_2 (psi)	5,573	
k'_{u2} (pci)	165	
k_{u2} (pci)	159	
E_2 / E_1 or k_2 / k_1 Ratio	2.6	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

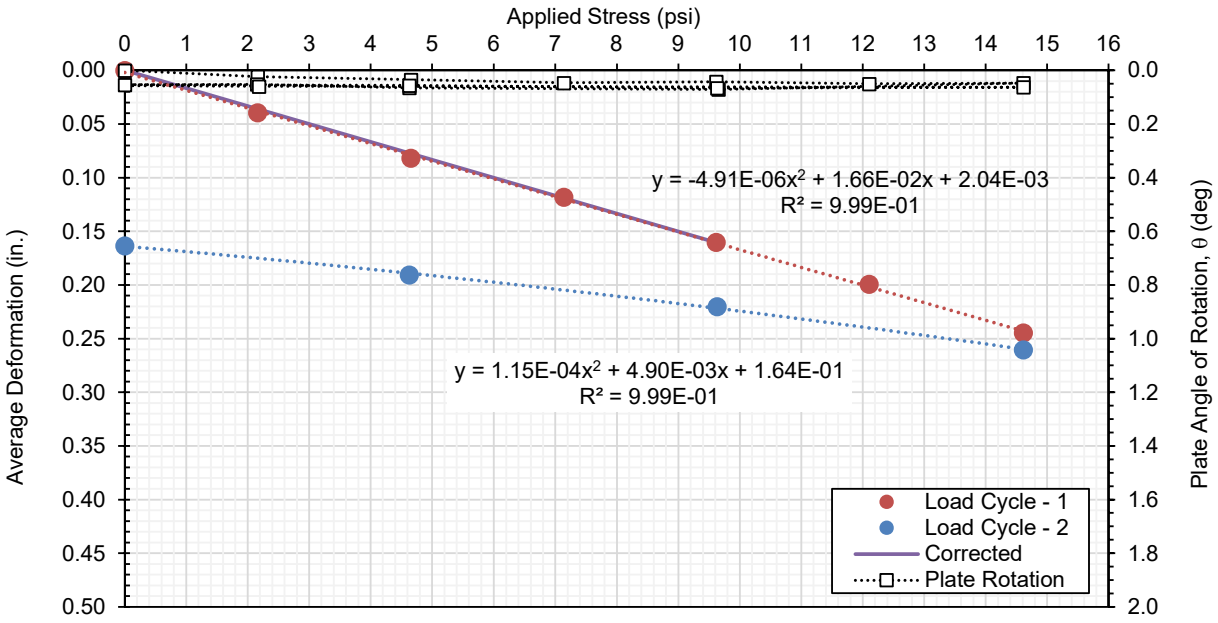
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-4.91E-06	a_1	1.15E-04	θ_{max} (deg)	0.0714
a_2	1.66E-02	a_2	4.90E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/29/2020	Time:	10:00:51 AM	Test ID	**PT3**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.57913	Longitude:	-96.31429	Elev. (ft):	1042.1
Comments:	Compacted special backfill.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0746	0.0599	0.0371	**0.0572**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.1498*	*0.1293*	*0.1078*	**0.1289**
1	Load	2	3534	5	*5.0*	*0.3003*	*0.2507*	*0.2129*	**0.2546**
1	Load	3	5301	7.5	*7.5*	*0.4266*	*0.3675*	*0.3110*	**0.3684**
1	Load	4	7069	10	*9.9*	*0.5721*	*0.4849*	*0.4134*	**0.4901**
1	Load	5	8836	12.5	*12.4*	*0.7025*	*0.6061*	*0.5098*	**0.6061**
1	Load	6	10603	15	*14.9*	*0.8408*	*0.7133*	*0.6001*	**0.7181**
1	Unload	7	7069	10	*10.0*	*0.8130*	*0.6875*	*0.5803*	**0.6936**
1	Unload	8	3534	5	*5.0*	*0.7461*	*0.6306*	*0.5393*	**0.6387**
1	Unload	9	1767	2.5	*2.5*	*0.6963*	*0.5760*	*0.5045*	**0.5923**
1	Unload	10	0	0	*0.0*	*0.6072*	*0.5126*	*0.4499*	**0.5232**
2	Load	11	3534	5	*5.0*	*0.6988*	*0.5796*	*0.5057*	**0.5947**
2	Load	12	7069	10	*9.9*	*0.7844*	*0.6514*	*0.5551*	**0.6636**
2	Load	13	10603	15	*14.9*	*0.9038*	*0.7556*	*0.6350*	**0.7648**
2	Unload	14	1767	2.5	*2.5*	*0.7562*	*0.6347*	*0.5440*	**0.6450**
2	Unload	14	0	0	*0.0*	*0.6643*	*0.5646*	*0.4838*	**0.5709**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **20**
k_u (pci) @ δ = 0.05 in.: **20**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**1.0**
E_1 (psi)	**689**
k'_u (pci)	**20**
k_u (pci)	**20**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.4905**	**0.4905**
E_1 (psi)	**716**	**716**
k'_{u1} (pci)	**20**	**20**
k_{u1} (pci)	**20**	**20**

Second Loading Cycle

δ_2 (in.)	**0.1449**
E_2 (psi)	**2,422**
k'_{u2} (pci)	**69**
k_{u2} (pci)	**69**
E_2 / E_1 or k_2 / k_1 Ratio	**3.4**

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

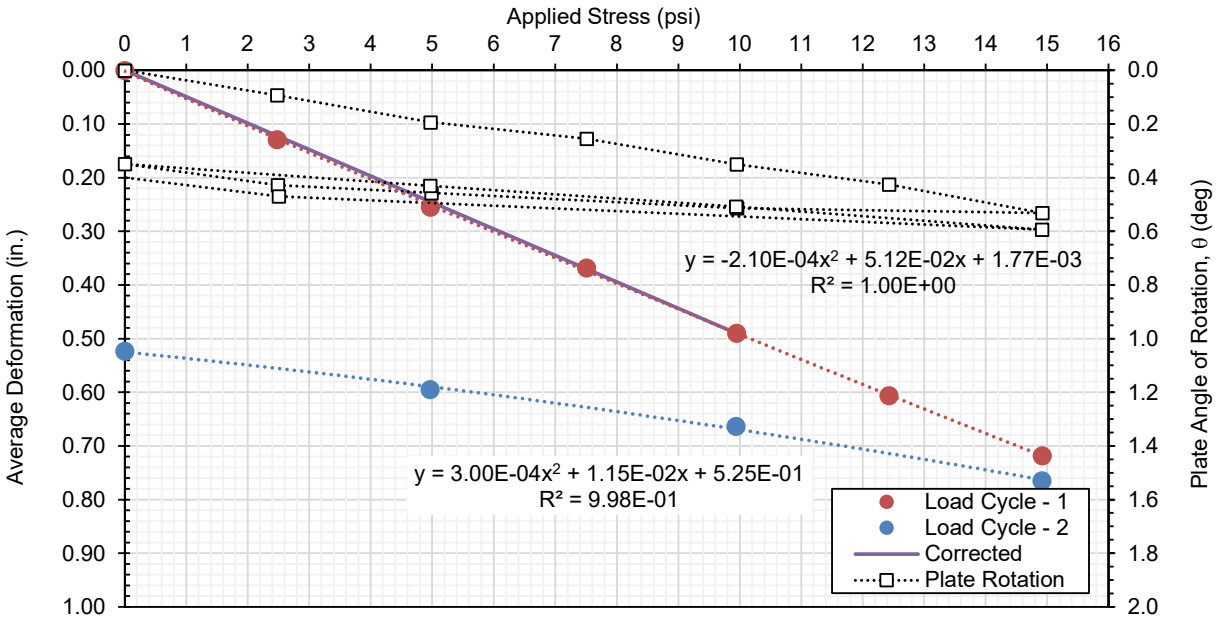
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

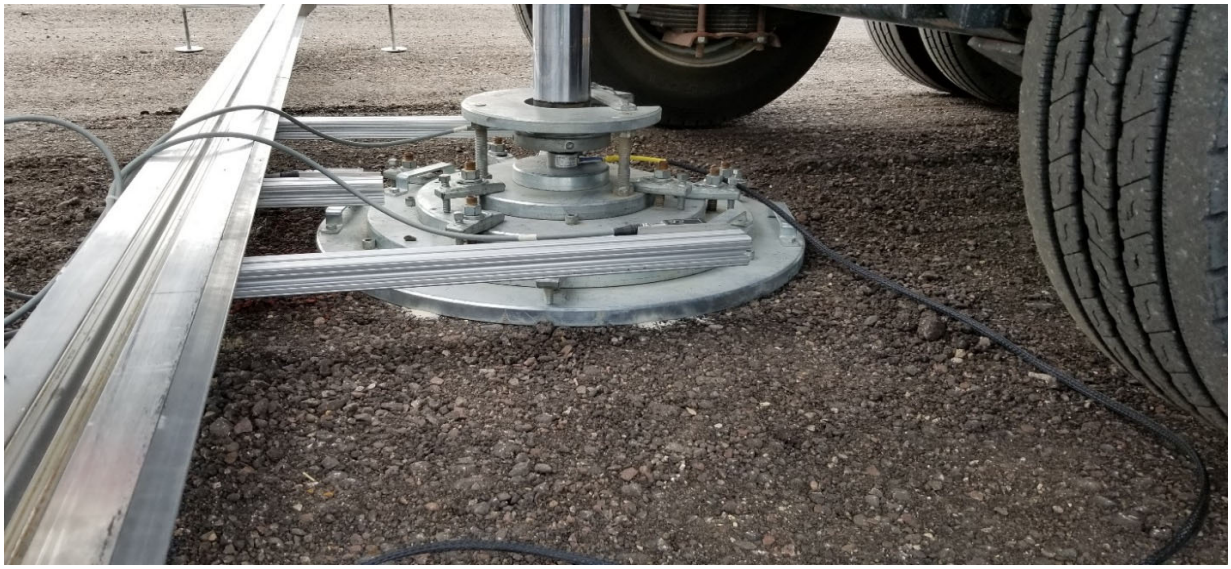
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.10E-04	a_1	3.00E-04	θ_{max} (deg)	0.5938
a_2	5.12E-02	a_2	1.15E-02		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/29/2020	Time:	10:46:47 AM	Test ID	**PT4**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.57886	Longitude:	-96.31453	Elev. (ft):	1043.0
Comments:	Compacted special backfill.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0244	0.0170	0.0125	**0.0180**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0560*	*0.0487*	*0.0423*	**0.0490**
1	Load	2	3534	5	*5.0*	*0.1192*	*0.1042*	*0.0920*	**0.1051**
1	Load	3	5301	7.5	*7.5*	*0.1870*	*0.1653*	*0.1481*	**0.1668**
1	Load	4	7069	10	*10.0*	*0.2455*	*0.2212*	*0.2020*	**0.2229**
1	Load	5	8836	12.5	*12.4*	*0.3129*	*0.2818*	*0.2594*	**0.2847**
1	Load	6	10603	15	*14.9*	*0.3832*	*0.3445*	*0.3172*	**0.3483**
1	Unload	7	7069	10	*10.0*	*0.3681*	*0.3261*	*0.3016*	**0.3319**
1	Unload	8	3534	5	*5.0*	*0.3299*	*0.2939*	*0.2678*	**0.2972**
1	Unload	9	1767	2.5	*2.5*	*0.3032*	*0.2676*	*0.2440*	**0.2716**
1	Unload	10	0	0	*0.0*	*0.2617*	*0.2283*	*0.2055*	**0.2319**
2	Load	11	3534	5	*5.0*	*0.3095*	*0.2720*	*0.2451*	**0.2755**
2	Load	12	7069	10	*10.0*	*0.3538*	*0.3186*	*0.2881*	**0.3202**
2	Load	13	10603	15	*14.9*	*0.4195*	*0.3771*	*0.3436*	**0.3801**
2	Unload	14	1767	2.5	*2.5*	*0.3364*	*0.2968*	*0.2664*	**0.2999**
2	Unload	14	0	0	*0.0*	*0.2915*	*0.2549*	*0.2259*	**0.2574**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **44**
k_u (pci) @ δ = 0.05 in.: **47**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**2.3**
E_1 (psi)	**1,649**
k'_u (pci)	**47**
k_u (pci)	**47**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.2260**	**0.2260**
E_1 (psi)	**1,553**	**1,553**
k'_{u1} (pci)	**44**	**44**
k_{u1} (pci)	**44**	**44**
Second Loading Cycle		
δ_2 (in.)	**0.0901**	
E_2 (psi)	**3,870**	
k'_{u2} (pci)	**111**	
k_{u2} (pci)	**110**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.5**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

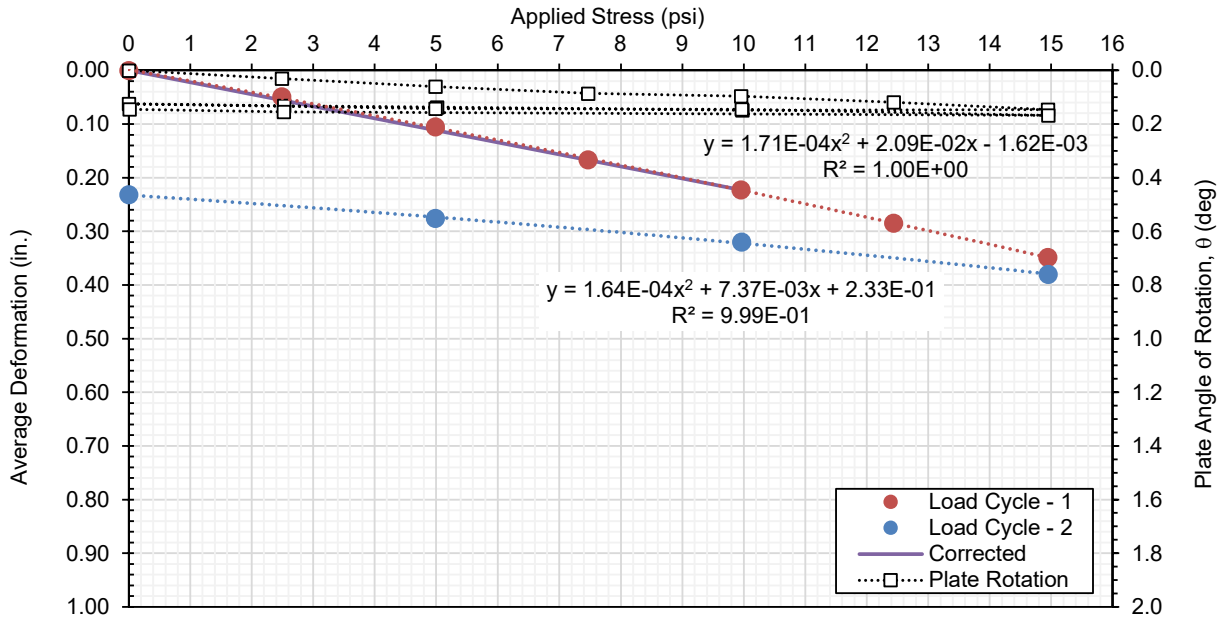
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	1.71E-04	a_1	1.64E-04	θ_{max} (deg)	0.1677
a_2	2.09E-02	a_2	7.37E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/29/2020	Time:	11:34:13 AM	Test ID	**PT5**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.578576	Longitude:	-96.314760	Elev. (ft):	1043.2
Comments:	Compacted special backfill.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0221	0.0183	0.0176	**0.0193**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0341*	*0.0273*	*0.0257*	**0.0291**
1	Load	2	3534	5	*5.0*	*0.0626*	*0.0506*	*0.0462*	**0.0531**
1	Load	3	5301	7.5	*7.5*	*0.0848*	*0.0720*	*0.0656*	**0.0742**
1	Load	4	7069	10	*9.9*	*0.1040*	*0.0910*	*0.0824*	**0.0925**
1	Load	5	8836	12.5	*12.4*	*0.1241*	*0.1134*	*0.1015*	**0.1130**
1	Load	6	10603	15	*14.9*	*0.1424*	*0.1319*	*0.1186*	**0.1310**
1	Unload	7	7069	10	*10.0*	*0.1363*	*0.1249*	*0.1138*	**0.1250**
1	Unload	8	3534	5	*5.0*	*0.1269*	*0.1155*	*0.1045*	**0.1156**
1	Unload	9	1767	2.5	*2.5*	*0.1199*	*0.1077*	*0.0963*	**0.1079**
1	Unload	10	0	0	*0.0*	*0.1077*	*0.0973*	*0.0870*	**0.0974**
2	Load	11	3534	5	*5.0*	*0.1175*	*0.1068*	*0.0937*	**0.1060**
2	Load	12	7069	10	*9.9*	*0.1292*	*0.1196*	*0.1075*	**0.1188**
2	Load	13	10603	15	*14.9*	*0.1477*	*0.1383*	*0.1222*	**0.1361**
2	Unload	14	1767	2.5	*2.5*	*0.1247*	*0.1160*	*0.1016*	**0.1141**
2	Unload	14	0	0	*0.0*	*0.1150*	*0.1061*	*0.0922*	**0.1044**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **112**
k_u (pci) @ δ = 0.05 in.: **99**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.9
E_1 (psi)	3,464
k'_u (pci)	99
k_u (pci)	99

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0937	0.0887
E_1 (psi)	3,727	3,929
k'_{u1} (pci)	107	113
k_{u1} (pci)	106	112
Second Loading Cycle		
δ_2 (in.)	0.0216	
E_2 (psi)	12,951	
k'_{u2} (pci)	462	
k_{u2} (pci)	369	
E_2 / E_1 or k_2 / k_1 Ratio	3.5	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

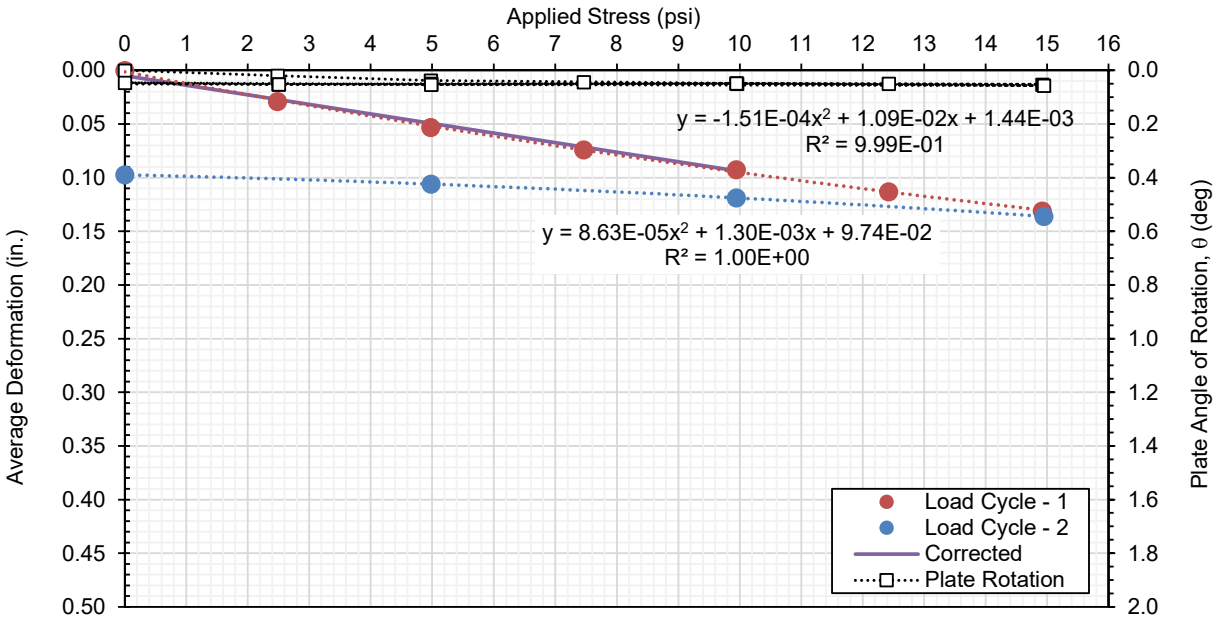
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.51E-04	a_1	8.63E-05	θ_{max} (deg)	0.0570
a_2	1.09E-02	a_2	1.30E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/28/2020	Time:	1:50:33 PM	Test ID	**PT1**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.595652	Longitude:	-96.304440	Elev. (ft):	1049.1
Comments:	Compacted Select Subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0004	0.0101	0.0141	**0.0082**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0007*	*0.0197*	*0.0207*	**0.0137**
1	Load	2	3534	5	*5.0*	*0.0012*	*0.0385*	*0.0360*	**0.0252**
1	Load	3	5301	7.5	*7.5*	*0.0018*	*0.0554*	*0.0508*	**0.0360**
1	Load	4	7069	10	*10.0*	*0.0024*	*0.0722*	*0.0665*	**0.0470**
1	Load	5	8836	12.5	*12.4*	*0.0030*	*0.0891*	*0.0781*	**0.0567**
1	Load	6	10603	15	*14.9*	*0.0035*	*0.1054*	*0.0913*	**0.0667**
1	Unload	7	7069	10	*10.0*	*0.0031*	*0.0950*	*0.0820*	**0.0601**
1	Unload	8	3534	5	*5.0*	*0.0026*	*0.0807*	*0.0697*	**0.0510**
1	Unload	9	1767	2.5	*2.5*	*0.0022*	*0.0686*	*0.0602*	**0.0437**
1	Unload	10	0	0	*0.0*	*0.0016*	*0.0522*	*0.0463*	**0.0334**
2	Load	11	3534	5	*5.0*	*0.0022*	*0.0717*	*0.0623*	**0.0454**
2	Load	12	7069	10	*10.0*	*0.0029*	*0.0888*	*0.0755*	**0.0557**
2	Load	13	10603	15	*15.0*	*0.0037*	*0.1117*	*0.0976*	**0.0710**
2	Unload	14	1767	2.5	*2.5*	*0.0023*	*0.0749*	*0.0637*	**0.0470**
2	Unload	14	0	0	*0.0*	*0.0017*	*0.0573*	*0.0504*	**0.0365**

Plate Diameter:	*30.0*	in.
Shape factor:	**1.57**	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **209**
k_u (pci) @ δ = 0.05 in.: **199**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	10.8
E_1 (psi)	4,123
k'_u (pci)	216
k_u (pci)	199

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0468	0.0438
E_1 (psi)	4,093	4,327
k'_{u1} (pci)	214	228
k_{u1} (pci)	198	209
Second Loading Cycle		
δ_2 (in.)	0.0231	
E_2 (psi)	7,239	
k'_{u2} (pci)	432	
k_{u2} (pci)	350	
E_2 / E_1 or k_2 / k_1 Ratio	1.8	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

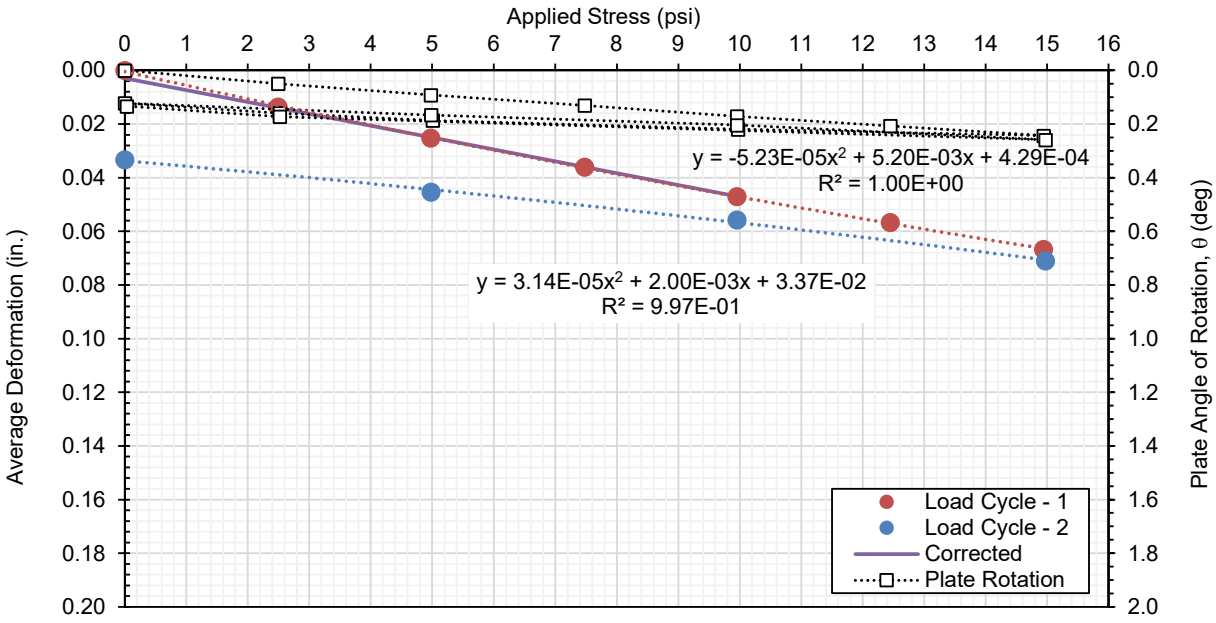
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-5.23E-05	a_1	3.14E-05	θ_{max} (deg)	0.2588
a_2	5.20E-03	a_2	2.00E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/28/2020	Time:	2:38:58 PM	Test ID	**PT2**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.596136	Longitude:	-96.304220	Elev. (ft):	1049.3
Comments:	Compacted Select Subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0070	0.0102	0.0217	**0.0130**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0127*	*0.0151*	*0.0310*	**0.0196**
1	Load	2	3534	5	*5.0*	*0.0224*	*0.0262*	*0.0474*	**0.0320**
1	Load	3	5301	7.5	*7.5*	*0.0335*	*0.0383*	*0.0653*	**0.0457**
1	Load	4	7069	10	*10.0*	*0.0442*	*0.0482*	*0.0830*	**0.0585**
1	Load	5	8836	12.5	*12.5*	*0.0530*	*0.0579*	*0.0939*	**0.0683**
1	Load	6	10603	15	*14.9*	*0.0632*	*0.0670*	*0.1113*	**0.0805**
1	Unload	7	7069	10	*10.0*	*0.0561*	*0.0604*	*0.1035*	**0.0733**
1	Unload	8	3534	5	*5.0*	*0.0478*	*0.0507*	*0.0893*	**0.0626**
1	Unload	9	1767	2.5	*2.5*	*0.0424*	*0.0443*	*0.0779*	**0.0549**
1	Unload	10	0	0	*0.0*	*0.0310*	*0.0345*	*0.0582*	**0.0412**
2	Load	11	3534	5	*5.0*	*0.0449*	*0.0472*	*0.0816*	**0.0579**
2	Load	12	7069	10	*10.0*	*0.0542*	*0.0585*	*0.0948*	**0.0692**
2	Load	13	10603	15	*14.9*	*0.0660*	*0.0696*	*0.1118*	**0.0825**
2	Unload	14	1767	2.5	*2.5*	*0.0447*	*0.0472*	*0.0802*	**0.0574**
2	Unload	14	0	0	*0.0*	*0.0348*	*0.0370*	*0.0609*	**0.0443**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **183**
k_u (pci) @ δ = 0.05 in.: **163**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	8.5
E_1 (psi)	3,366
k'_u (pci)	170
k_u (pci)	163

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0573	0.0513
E_1 (psi)	3,442	3,786
k'_{u1} (pci)	175	195
k_{u1} (pci)	166	183
Second Loading Cycle		
δ_2 (in.)	0.0288	
E_2 (psi)	6,093	
k'_{u2} (pci)	348	
k_{u2} (pci)	295	
E_2 / E_1 or k_2 / k_1 Ratio	1.8	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

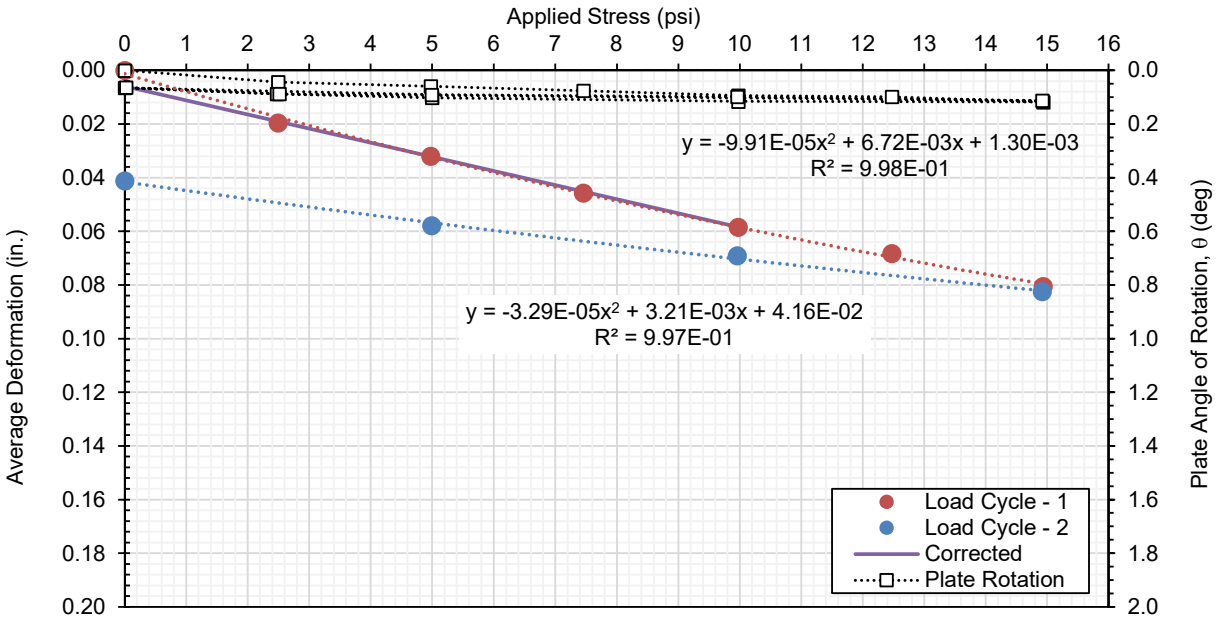
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-9.91E-05	a_1	-3.29E-05	θ_{max} (deg)	0.1180
a_2	6.72E-03	a_2	3.21E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/28/2020	Time:	3:25:27 PM	Test ID	**PT3**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.596382	Longitude:	-96.304094	Elev. (ft):	1049.2
Comments:	Compacted Select Subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0084	0.0109	0.0062	**0.0085**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0154*	*0.0161*	*0.0104*	**0.0139**
1	Load	2	3534	5	*5.0*	*0.0268*	*0.0282*	*0.0161*	**0.0237**
1	Load	3	5301	7.5	*7.5*	*0.0397*	*0.0410*	*0.0274*	**0.0360**
1	Load	4	7069	10	*9.9*	*0.0510*	*0.0517*	*0.0359*	**0.0462**
1	Load	5	8836	12.5	*12.4*	*0.0606*	*0.0620*	*0.0435*	**0.0554**
1	Load	6	10603	15	*14.9*	*0.0705*	*0.0721*	*0.0528*	**0.0652**
1	Unload	7	7069	10	*9.9*	*0.0636*	*0.0654*	*0.0475*	**0.0588**
1	Unload	8	3534	5	*5.0*	*0.0536*	*0.0567*	*0.0366*	**0.0490**
1	Unload	9	1767	2.5	*2.3*	*0.0453*	*0.0504*	*0.0310*	**0.0422**
1	Unload	10	0	0	*0.0*	*0.0345*	*0.0435*	*0.0198*	**0.0326**
2	Load	11	3534	5	*5.0*	*0.0484*	*0.0538*	*0.0323*	**0.0448**
2	Load	12	7069	10	*9.9*	*0.0602*	*0.0650*	*0.0433*	**0.0562**
2	Load	13	10603	15	*15.0*	*0.0729*	*0.0772*	*0.0533*	**0.0678**
2	Unload	14	1767	2.5	*2.5*	*0.0485*	*0.0547*	*0.0304*	**0.0445**
2	Unload	14	0	0	*0.0*	*0.0375*	*0.0467*	*0.0195*	**0.0346**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **209**
k_u (pci) @ δ = 0.05 in.: **203**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	11.0
E_1 (psi)	4,205
k'_u (pci)	221
k_u (pci)	203

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0459	0.0439
E_1 (psi)	4,161	4,320
k'_{u1} (pci)	218	228
k_{u1} (pci)	201	209
Second Loading Cycle		
δ_2 (in.)	0.0238	
E_2 (psi)	7,077	
k'_{u2} (pci)	420	
k_{u2} (pci)	342	
E_2 / E_1 or k_2 / k_1 Ratio	1.7	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

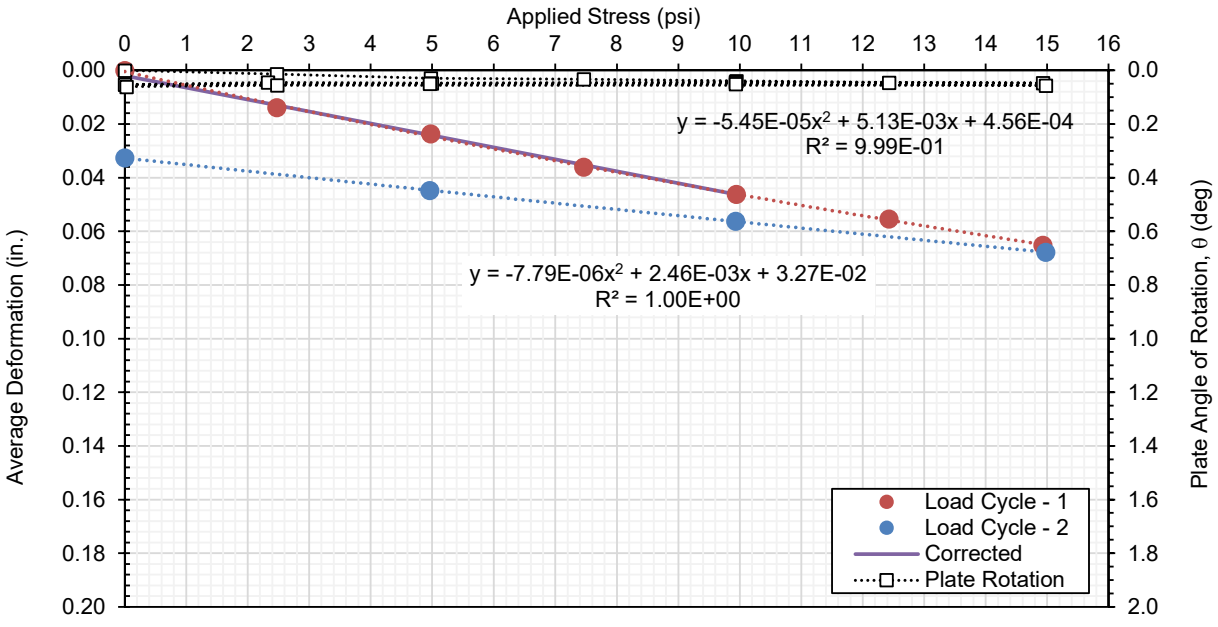
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-5.45E-05	a_1	-7.79E-06	θ_{max} (deg)	0.0609
a_2	5.13E-03	a_2	2.46E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/28/2020	Time:	4:10:49 PM	Test ID	**PT4**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.596718	Longitude:	-96.303929	Elev. (ft):	1049.0
Comments:	Compacted Select Subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0059	0.0069	0.0124	**0.0084**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0154*	*0.0112*	*0.0119*	**0.0129**
1	Load	2	3534	5	*5.0*	*0.0287*	*0.0224*	*0.0237*	**0.0250**
1	Load	3	5301	7.5	*7.5*	*0.0374*	*0.0320*	*0.0322*	**0.0339**
1	Load	4	7069	10	*10.0*	*0.0477*	*0.0417*	*0.0443*	**0.0445**
1	Load	5	8836	12.5	*12.4*	*0.0567*	*0.0512*	*0.0523*	**0.0534**
1	Load	6	10603	15	*15.0*	*0.0655*	*0.0599*	*0.0619*	**0.0624**
1	Unload	7	7069	10	*10.0*	*0.0582*	*0.0529*	*0.0534*	**0.0548**
1	Unload	8	3534	5	*5.0*	*0.0479*	*0.0419*	*0.0449*	**0.0449**
1	Unload	9	1767	2.5	*2.5*	*0.0395*	*0.0345*	*0.0356*	**0.0365**
1	Unload	10	0	0	*0.0*	*0.0269*	*0.0246*	*0.0254*	**0.0257**
2	Load	11	3534	5	*5.0*	*0.0411*	*0.0353*	*0.0356*	**0.0374**
2	Load	12	7069	10	*10.0*	*0.0537*	*0.0473*	*0.0489*	**0.0500**
2	Load	13	10603	15	*15.0*	*0.0670*	*0.0601*	*0.0630*	**0.0634**
2	Unload	14	1767	2.5	*2.5*	*0.0422*	*0.0354*	*0.0365*	**0.0380**
2	Unload	14	0	0	*0.0*	*0.0292*	*0.0262*	*0.0264*	**0.0273**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **220**
k_u (pci) @ δ = 0.05 in.: **211**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	11.5
E_1 (psi)	4,365
k'_u (pci)	231
k_u (pci)	211

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0443	0.0413
E_1 (psi)	4,288	4,547
k'_{u1} (pci)	226	242
k_{u1} (pci)	207	220
Second Loading Cycle		
δ_2 (in.)	0.0244	
E_2 (psi)	6,947	
k'_{u2} (pci)	410	
k_{u2} (pci)	336	
E_2 / E_1 or k_2 / k_1 Ratio	1.6	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

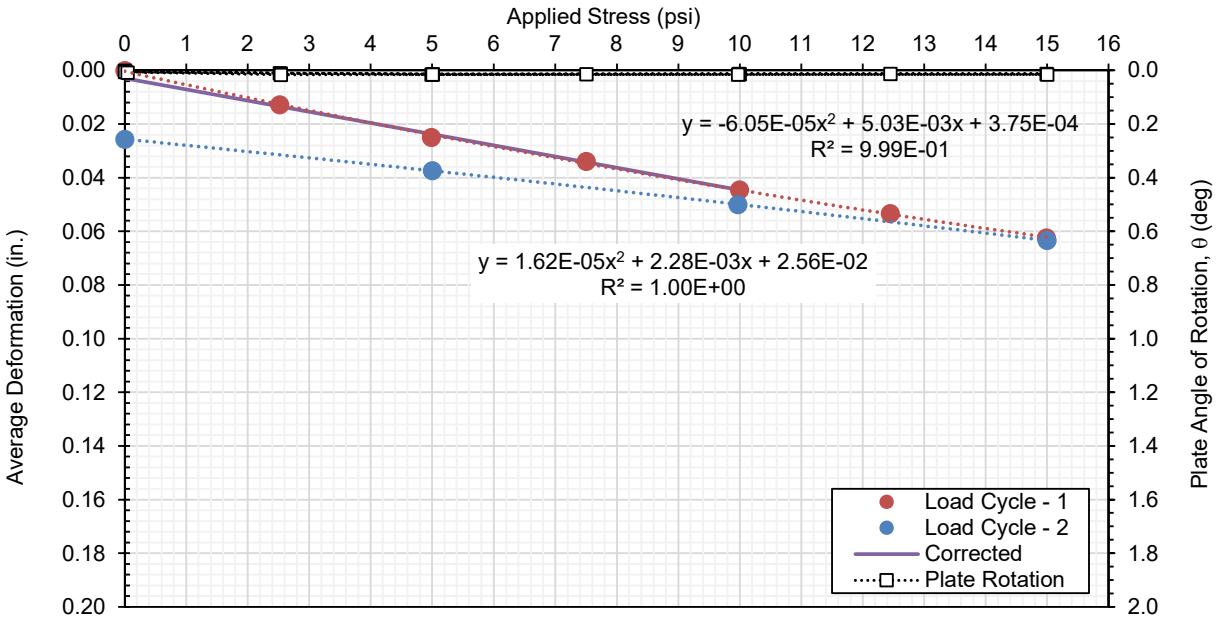
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-6.05E-05	a_1	1.62E-05	θ_{max} (deg)	0.0161
a_2	5.03E-03	a_2	2.28E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/28/2020	Time:	5:00:26 PM	Test ID	**PT5**
Tested By	CV/HG	Location:	Hwy 75 SB Lane	Sta.	NA
Latitude:	42.596912	Longitude:	-96.303818	Elev. (ft):	1049.1
Comments:	Compacted Select Subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.9*	0.0045	0.0126	0.0199	**0.0123**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0096*	*0.0259*	*0.0339*	**0.0231**
1	Load	2	3534	5	*5.0*	*0.0209*	*0.0483*	*0.0555*	**0.0416**
1	Load	3	5301	7.5	*7.5*	*0.0340*	*0.0669*	*0.0754*	**0.0588**
1	Load	4	7069	10	*10.0*	*0.0471*	*0.0851*	*0.0942*	**0.0755**
1	Load	5	8836	12.5	*12.4*	*0.0597*	*0.1016*	*0.1120*	**0.0911**
1	Load	6	10603	15	*15.0*	*0.0736*	*0.1184*	*0.1305*	**0.1075**
1	Unload	7	7069	10	*10.0*	*0.0648*	*0.1081*	*0.1211*	**0.0980**
1	Unload	8	3534	5	*5.0*	*0.0522*	*0.0933*	*0.1053*	**0.0836**
1	Unload	9	1767	2.5	*2.6*	*0.0361*	*0.0708*	*0.0837*	**0.0635**
1	Unload	10	0	0	*0.0*	*0.0315*	*0.0622*	*0.0762*	**0.0566**
2	Load	11	3534	5	*5.0*	*0.0439*	*0.0836*	*0.0972*	**0.0749**
2	Load	12	7069	10	*9.9*	*0.0589*	*0.1022*	*0.1162*	**0.0924**
2	Load	13	10603	15	*14.9*	*0.0760*	*0.1226*	*0.1392*	**0.1126**
2	Unload	14	1767	2.5	*2.5*	*0.0454*	*0.0845*	*0.1014*	**0.0771**
2	Unload	14	0	0	*0.0*	*0.0340*	*0.0666*	*0.0810*	**0.0605**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **142**
k_u (pci) @ δ = 0.05 in.: **125**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	6.3
E_1 (psi)	2,585
k'_u (pci)	127
k_u (pci)	125

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0753	0.0683
E_1 (psi)	2,696	2,946
k'_{u1} (pci)	133	146
k_{u1} (pci)	130	142
Second Loading Cycle		
δ_2 (in.)	0.0363	
E_2 (psi)	5,046	
k'_{u2} (pci)	275	
k_{u2} (pci)	244	
E_2 / E_1 or k_2 / k_1 Ratio	1.9	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

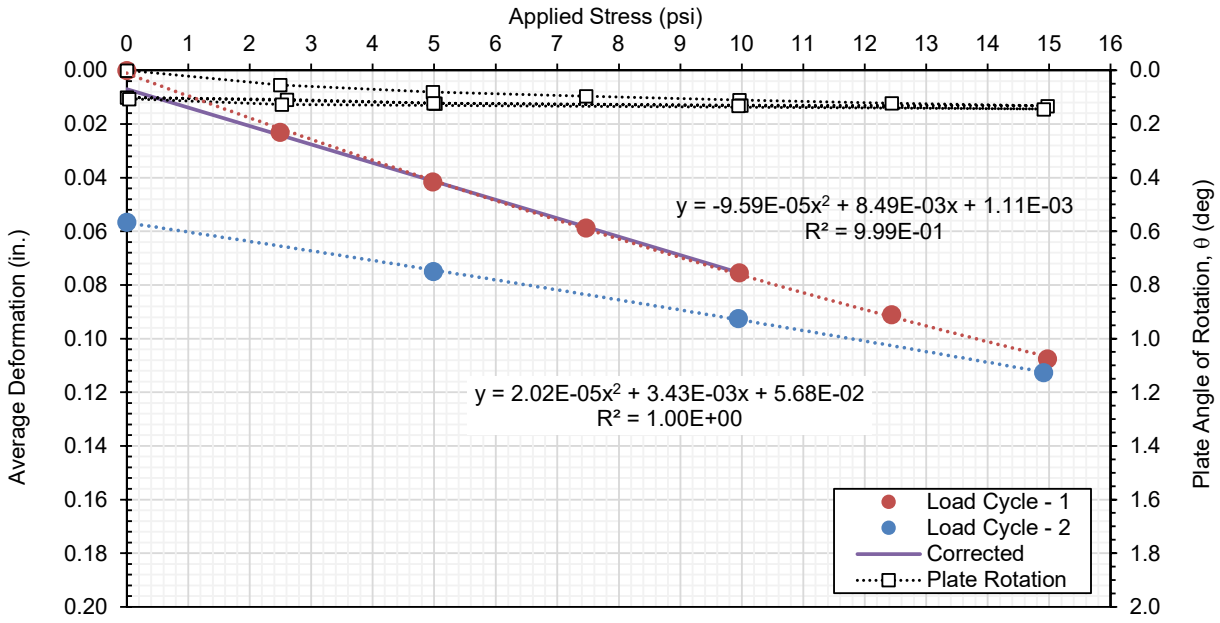
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-9.59E-05	a_1	2.02E-05	θ_{max} (deg)	0.1445
a_2	8.49E-03	a_2	3.43E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 75, Plymouth County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/7/2020	Time:	10:22:43 AM	Test ID	**PT1**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964378	Longitude:	-92.369427	Elev. (ft):	850.1
Comments:	Compacted Granular Subbase - One vibratory roller mapping pass.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0128	0.0184	0.0135	**0.0149**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0361*	*0.0293*	*0.0328*	**0.0327**
1	Load	2	3534	5	*5.0*	*0.0620*	*0.0511*	*0.0554*	**0.0562**
1	Load	3	5301	7.5	*7.5*	*0.0853*	*0.0711*	*0.0752*	**0.0772**
1	Load	4	7069	10	*10.0*	*0.1064*	*0.0905*	*0.0911*	**0.0960**
1	Load	5	8836	12.5	*12.5*	*0.1263*	*0.1093*	*0.1093*	**0.1149**
1	Load	6	10603	15	*15.0*	*0.1469*	*0.1274*	*0.1259*	**0.1334**
1	Unload	7	7069	10	*9.8*	*0.1406*	*0.1206*	*0.1201*	**0.1271**
1	Unload	8	3534	5	*5.0*	*0.1304*	*0.1122*	*0.1113*	**0.1179**
1	Unload	9	1767	2.5	*2.3*	*0.1213*	*0.1047*	*0.1031*	**0.1097**
1	Unload	10	0	0	*0.0*	*0.1094*	*0.0952*	*0.0954*	**0.1000**
2	Load	11	3534	5	*5.0*	*0.1221*	*0.1056*	*0.1047*	**0.1108**
2	Load	12	7069	10	*10.0*	*0.1365*	*0.1182*	*0.1177*	**0.1241**
2	Load	13	10603	15	*14.9*	*0.1558*	*0.1344*	*0.1335*	**0.1412**
2	Unload	14	1767	2.5	*2.4*	*0.1307*	*0.1129*	*0.1111*	**0.1182**
2	Unload	14	0	0	*0.0*	*0.1186*	*0.1028*	*0.1012*	**0.1075**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **119**
k_u (pci) @ δ = 0.05 in.: **95**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.7
E_1 (psi)	1,958
k'_u (pci)	95
k_u (pci)	95

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0958	0.0828
E_1 (psi)	2,149	2,470
k'_{u1} (pci)	104	121
k_{u1} (pci)	104	119
Second Loading Cycle		
δ_2 (in.)	0.0243	
E_2 (psi)	6,958	
k'_{u2} (pci)	411	
k_{u2} (pci)	337	
E_2 / E_1 or k_2 / k_1 Ratio	3.2	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

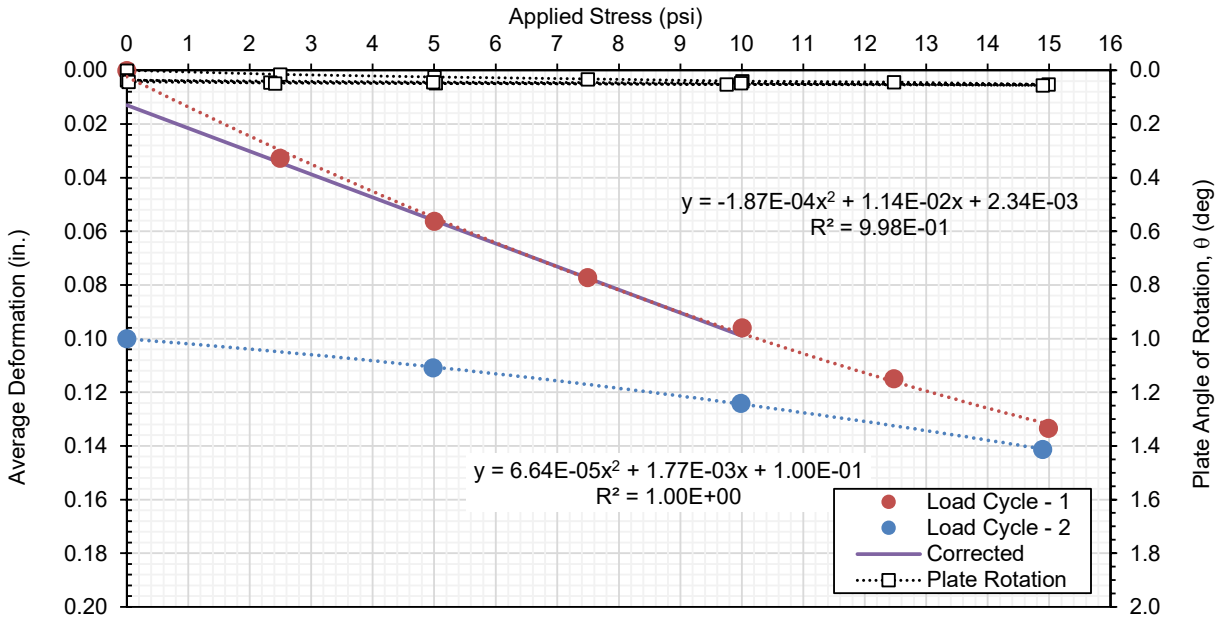
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

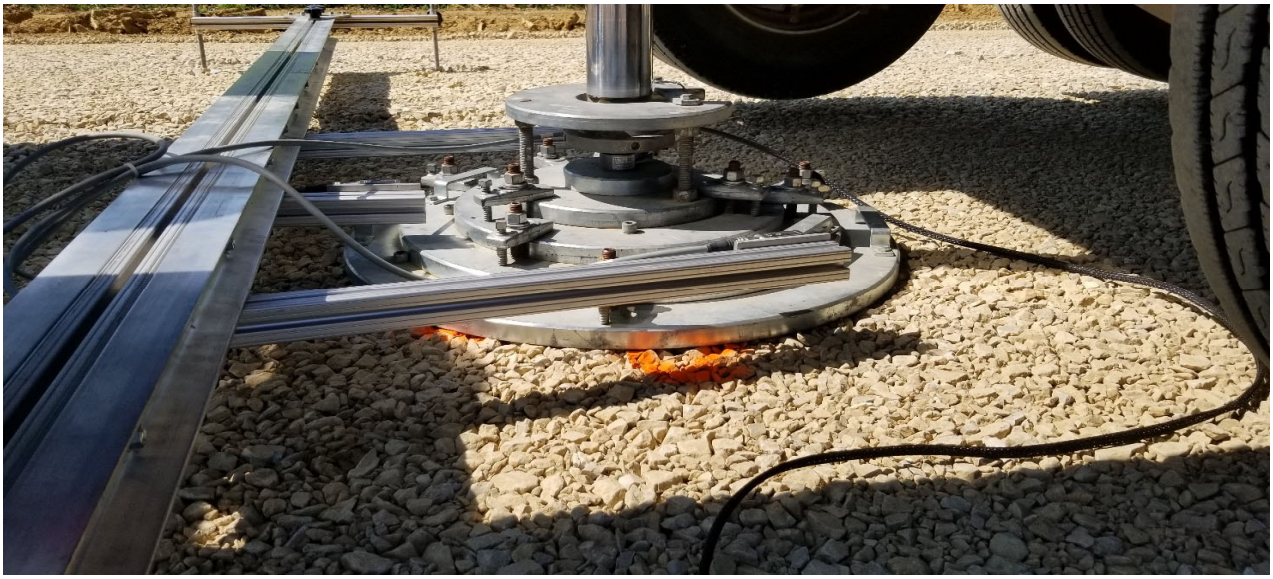
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.87E-04	a_1	6.64E-05	θ_{max} (deg)	0.0558
a_2	1.14E-02	a_2	1.77E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/7/2020	Time:	12:09:09 PM	Test ID	**PT2**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964381	Longitude:	-92.368396	Elev. (ft):	851.5
Comments:	Compacted Granular Subbase - One vibratory roller mapping pass.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0199	0.0300	0.0294	**0.0264**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0255*	*0.0415*	*0.0407*	**0.0359**
1	Load	2	3534	5	*5.0*	*0.0491*	*0.0736*	*0.0720*	**0.0649**
1	Load	3	5301	7.5	*7.5*	*0.0704*	*0.1044*	*0.1004*	**0.0918**
1	Load	4	7069	10	*10.0*	*0.0924*	*0.1352*	*0.1279*	**0.1185**
1	Load	5	8836	12.5	*12.5*	*0.1157*	*0.1643*	*0.1549*	**0.1450**
1	Load	6	10603	15	*15.0*	*0.1379*	*0.1939*	*0.1842*	**0.1720**
1	Unload	7	7069	10	*9.8*	*0.1267*	*0.1825*	*0.1702*	**0.1598**
1	Unload	8	3534	5	*5.0*	*0.1123*	*0.1673*	*0.1539*	**0.1445**
1	Unload	9	1767	2.5	*2.5*	*0.0996*	*0.1548*	*0.1396*	**0.1313**
1	Unload	10	0	0	*0.0*	*0.0825*	*0.1367*	*0.1196*	**0.1129**
2	Load	11	3534	5	*5.0*	*0.0982*	*0.1537*	*0.1385*	**0.1301**
2	Load	12	7069	10	*10.0*	*0.1191*	*0.1752*	*0.1615*	**0.1519**
2	Load	13	10603	15	*14.7*	*0.1418*	*0.2016*	*0.1884*	**0.1772**
2	Unload	14	1767	2.5	*2.5*	*0.1076*	*0.1669*	*0.1501*	**0.1415**
2	Unload	14	0	0	*-0.1*	*0.0903*	*0.1493*	*0.1316*	**0.1238**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **91**
k_u (pci) @ δ = 0.05 in.: **80**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.0
E_1 (psi)	1,656
k'_u (pci)	80
k_u (pci)	80

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1182	0.1102
E_1 (psi)	1,750	1,877
k'_{u1} (pci)	85	91
k_{u1} (pci)	85	91
Second Loading Cycle		
δ_2 (in.)	0.0391	
E_2 (psi)	4,757	
k'_{u2} (pci)	256	
k_{u2} (pci)	230	
E_2 / E_1 or k_2 / k_1 Ratio	2.7	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

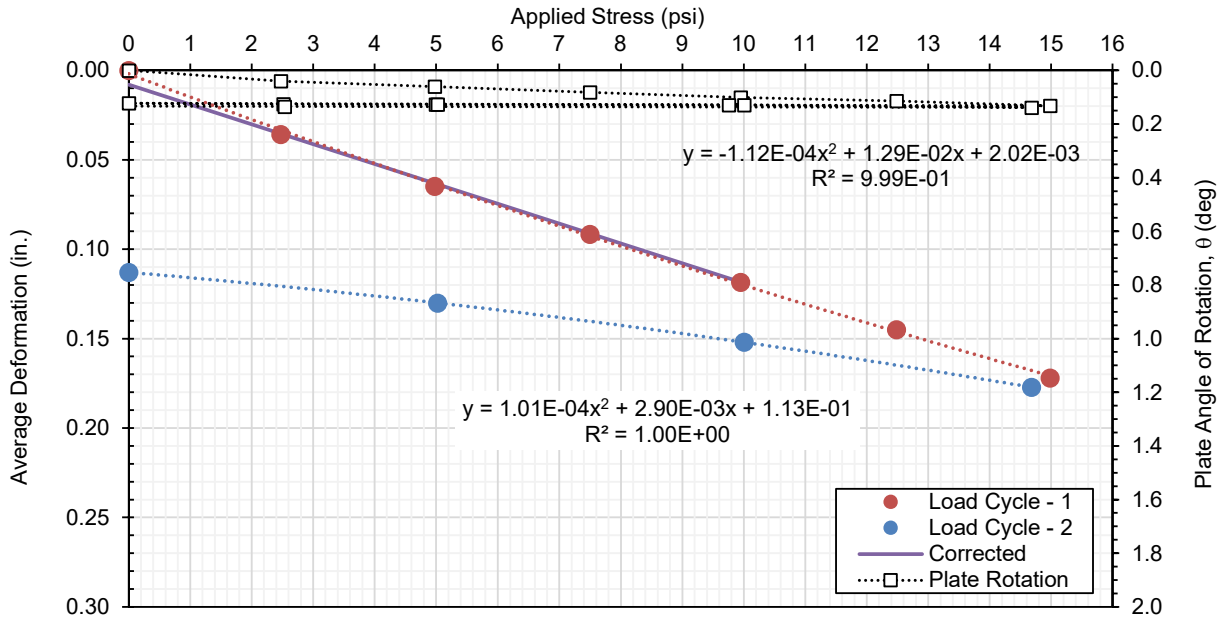
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.12E-04	a_1	1.01E-04	θ_{max} (deg)	0.1386
a_2	1.29E-02	a_2	2.90E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/7/2020	Time:	1:02:40 PM	Test ID	**PT3**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964377	Longitude:	-92.366947	Elev. (ft):	850.2
Comments:	Compacted Granular Subbase - One vibratory roller mapping pass.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0204	0.0320	0.0380	**0.0301**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0370*	*0.0412*	*0.0439*	**0.0407**
1	Load	2	3534	5	*5.0*	*0.0552*	*0.0596*	*0.0672*	**0.0607**
1	Load	3	5301	7.5	*7.5*	*0.0822*	*0.0804*	*0.0919*	**0.0849**
1	Load	4	7069	10	*10.0*	*0.0987*	*0.0974*	*0.1118*	**0.1026**
1	Load	5	8836	12.5	*12.5*	*0.1157*	*0.1129*	*0.1335*	**0.1207**
1	Load	6	10603	15	*15.0*	*0.1358*	*0.1275*	*0.1533*	**0.1389**
1	Unload	7	7069	10	*10.0*	*0.1263*	*0.1201*	*0.1469*	**0.1311**
1	Unload	8	3534	5	*5.0*	*0.1173*	*0.1150*	*0.1308*	**0.1210**
1	Unload	9	1767	2.5	*2.3*	*0.1120*	*0.1129*	*0.1258*	**0.1169**
1	Unload	10	0	0	*0.0*	*0.1008*	*0.0989*	*0.1120*	**0.1039**
2	Load	11	3534	5	*5.0*	*0.1079*	*0.1051*	*0.1233*	**0.1121**
2	Load	12	7069	10	*10.0*	*0.1232*	*0.1185*	*0.1371*	**0.1263**
2	Load	13	10603	15	*15.0*	*0.1438*	*0.1380*	*0.1569*	**0.1462**
2	Unload	14	1767	2.5	*2.5*	*0.1221*	*0.1189*	*0.1324*	**0.1245**
2	Unload	14	0	0	*0.0*	*0.1051*	*0.1088*	*0.1180*	**0.1106**

Plate Diameter:	*30.0*	in.
Shape factor:	**1.57**	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **115**
k_u (pci) @ δ = 0.05 in.: **86**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**4.3**
E_1 (psi)	**1,787**
k'_u (pci)	**86**
k_u (pci)	**86**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1011**	**0.0861**
E_1 (psi)	**2,045**	**2,379**
k'_{u1} (pci)	**99**	**116**
k_{u1} (pci)	**99**	**115**
Second Loading Cycle		
δ_2 (in.)	**0.0224**	
E_2 (psi)	**7,429**	
k'_{u2} (pci)	**447**	
k_{u2} (pci)	**359**	
E_2 / E_1 or k_2 / k_1 Ratio	**3.6**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

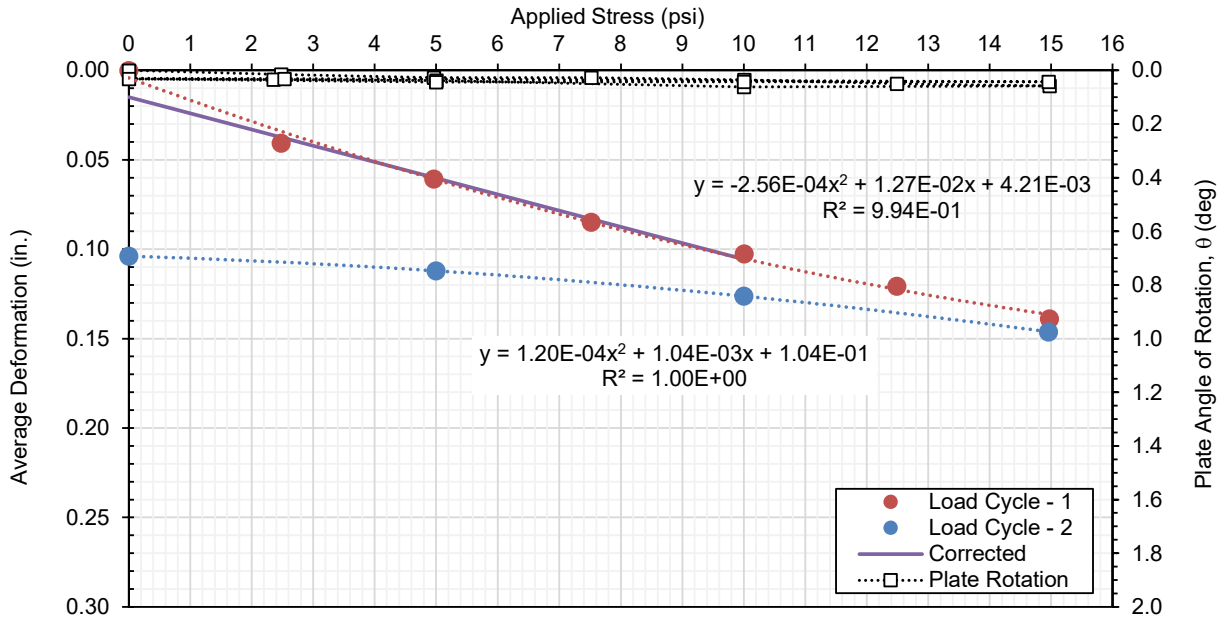
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.56E-04	a_1	1.20E-04	θ_{max} (deg)	0.0618
a_2	1.27E-02	a_2	1.04E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/7/2020	Time:	1:50:40 PM	Test ID	**PT4**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964371	Longitude:	-92.366367	Elev. (ft):	851.2
Comments:	Compacted Granular Subbase - One vibratory roller mapping pass.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0210	0.0271	0.0270	**0.0251**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0369*	*0.0344*	*0.0371*	**0.0361**
1	Load	2	3534	5	*5.0*	*0.0619*	*0.0556*	*0.0597*	**0.0591**
1	Load	3	5301	7.5	*7.5*	*0.0807*	*0.0735*	*0.0800*	**0.0781**
1	Load	4	7069	10	*10.0*	*0.0992*	*0.0901*	*0.0974*	**0.0956**
1	Load	5	8836	12.5	*12.4*	*0.1169*	*0.1056*	*0.1146*	**0.1124**
1	Load	6	10603	15	*15.0*	*0.1370*	*0.1236*	*0.1346*	**0.1317**
1	Unload	7	7069	10	*9.7*	*0.1289*	*0.1172*	*0.1272*	**0.1244**
1	Unload	8	3534	5	*5.0*	*0.1208*	*0.1069*	*0.1158*	**0.1145**
1	Unload	9	1767	2.5	*2.4*	*0.1154*	*0.1007*	*0.1099*	**0.1087**
1	Unload	10	0	0	*0.0*	*0.1046*	*0.0904*	*0.0967*	**0.0972**
2	Load	11	3534	5	*5.0*	*0.1139*	*0.1000*	*0.1084*	**0.1074**
2	Load	12	7069	10	*9.9*	*0.1248*	*0.1138*	*0.1208*	**0.1198**
2	Load	13	10603	15	*14.7*	*0.1447*	*0.1314*	*0.1397*	**0.1386**
2	Unload	14	1767	2.5	*2.5*	*0.1213*	*0.1064*	*0.1153*	**0.1143**
2	Unload	14	0	0	*0.0*	*0.1115*	*0.0969*	*0.1023*	**0.1036**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **123**
k_u (pci) @ δ = 0.05 in.: **93**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	4.7
E_1 (psi)	1,931
k'_u (pci)	93
k_u (pci)	93

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0949	0.0799
E_1 (psi)	2,168	2,552
k'_{u1} (pci)	105	125
k_{u1} (pci)	105	123
Second Loading Cycle		
δ_2 (in.)	0.0233	
E_2 (psi)	7,193	
k'_{u2} (pci)	429	
k_{u2} (pci)	348	
E_2 / E_1 or k_2 / k_1 Ratio	3.3	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

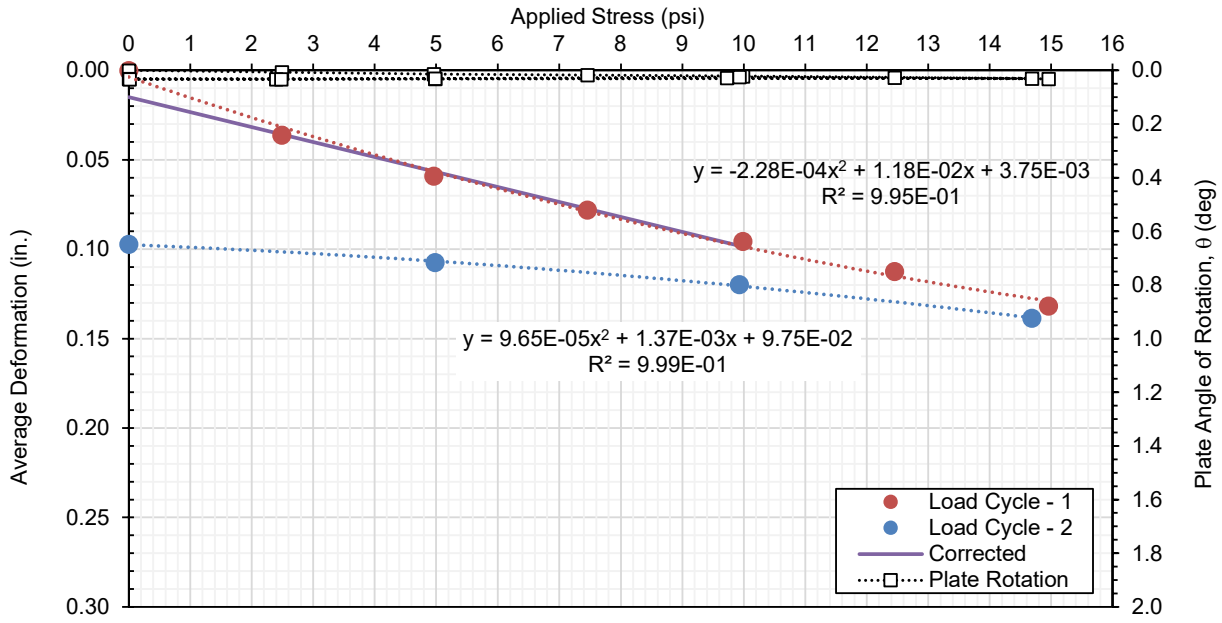
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.28E-04	a_1	9.65E-05	θ_{max} (deg)	0.0329
a_2	1.18E-02	a_2	1.37E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/7/2020	Time:	3:40:36 PM	Test ID	**PT5**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964376	Longitude:	-92.366061	Elev. (ft):	849.9
Comments:	Compacted Granular Subbase - One vibratory roller mapping pass.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0353	0.0269	0.0556	**0.0393**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0259*	*0.0199*	*0.0397*	**0.0285**
1	Load	2	3534	5	*5.0*	*0.0404*	*0.0374*	*0.0585*	**0.0454**
1	Load	3	5301	7.5	*7.5*	*0.0518*	*0.0520*	*0.0729*	**0.0589**
1	Load	4	7069	10	*10.0*	*0.0642*	*0.0648*	*0.0926*	**0.0739**
1	Load	5	8836	12.5	*12.5*	*0.0758*	*0.0751*	*0.1076*	**0.0862**
1	Load	6	10603	15	*15.0*	*0.0904*	*0.0907*	*0.1202*	**0.1004**
1	Unload	7	7069	10	*10.0*	*0.0856*	*0.0843*	*0.1153*	**0.0951**
1	Unload	8	3534	5	*4.9*	*0.0764*	*0.0768*	*0.1094*	**0.0876**
1	Unload	9	1767	2.5	*2.4*	*0.0705*	*0.0722*	*0.1028*	**0.0818**
1	Unload	10	0	0	*0.0*	*0.0632*	*0.0632*	*0.0906*	**0.0723**
2	Load	11	3534	5	*5.0*	*0.0724*	*0.0699*	*0.1041*	**0.0821**
2	Load	12	7069	10	*10.0*	*0.0836*	*0.0836*	*0.1138*	**0.0937**
2	Load	13	10603	15	*15.0*	*0.0972*	*0.0944*	*0.1291*	**0.1069**
2	Unload	14	1767	2.5	*2.5*	*0.0775*	*0.0792*	*0.1099*	**0.0889**
2	Unload	14	0	0	*0.0*	*0.0689*	*0.0638*	*0.0990*	**0.0772**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **157**
k_u (pci) @ δ = 0.05 in.: **125**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	6.4
E_1 (psi)	2,591
k'_u (pci)	127
k_u (pci)	125

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.0723	0.0613
E_1 (psi)	2,798	3,244
k'_{u1} (pci)	138	163
k_{u1} (pci)	135	157
Second Loading Cycle		
δ_2 (in.)	0.0213	
E_2 (psi)	7,709	
k'_{u2} (pci)	469	
k_{u2} (pci)	373	
E_2 / E_1 or k_2 / k_1 Ratio	2.8	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

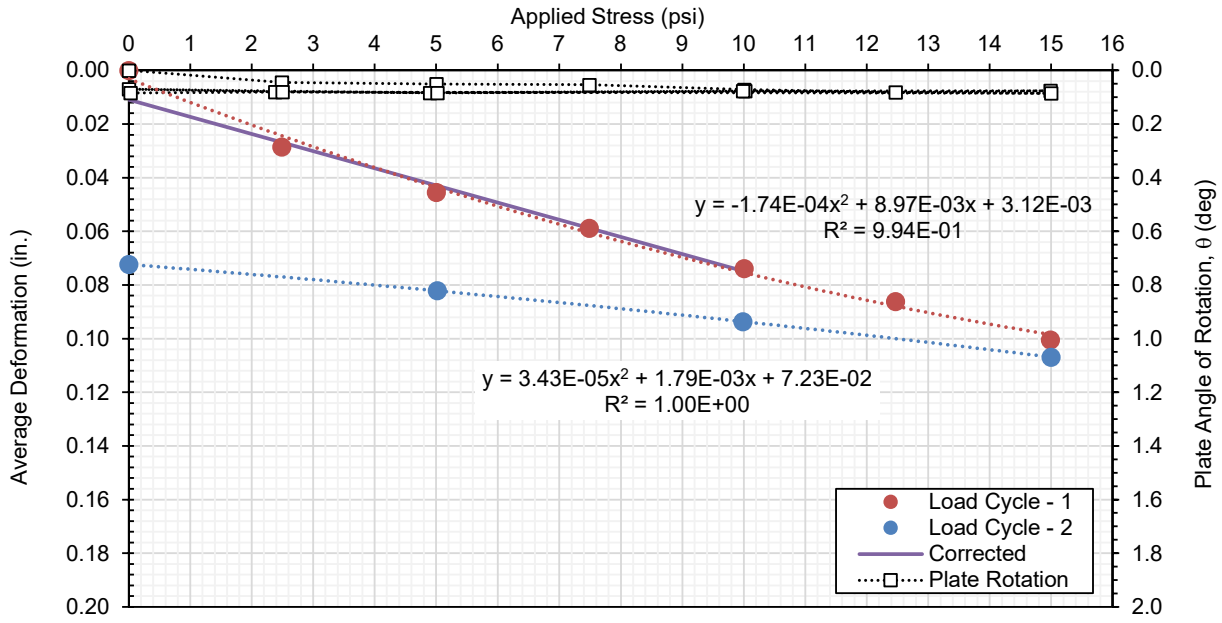
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

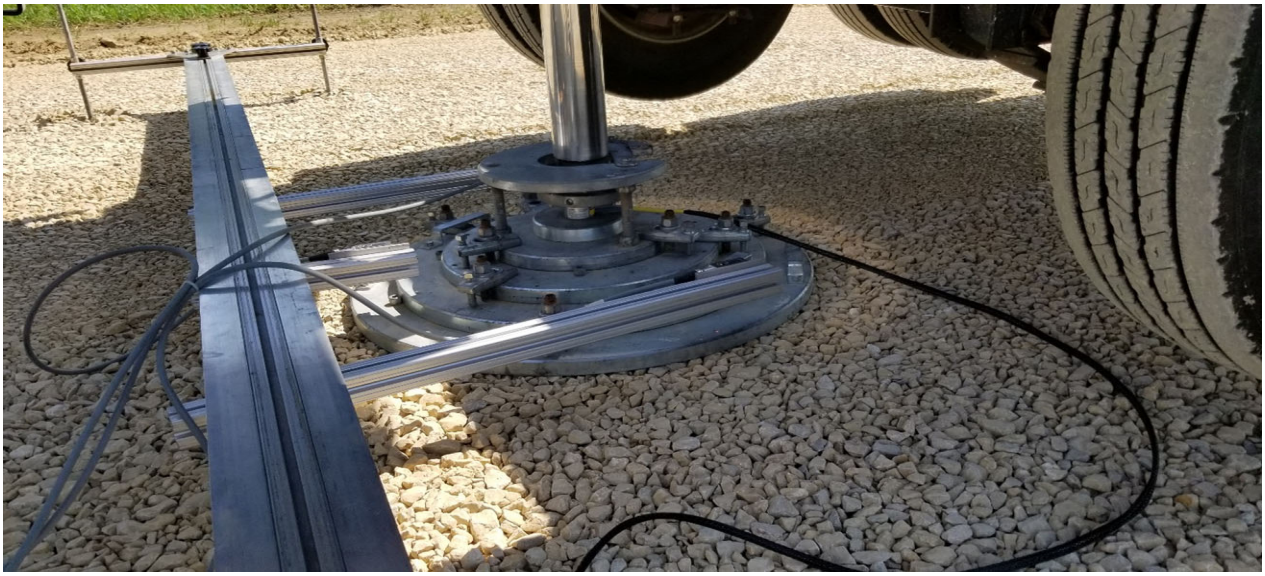
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.74E-04	a_1	3.43E-05	θ_{max} (deg)	0.0852
a_2	8.97E-03	a_2	1.79E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/8/2020	Time:	10:52:15 AM	Test ID	**PT8**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964344	Longitude:	-92.353246	Elev. (ft):	835.5
Comments:	Compacted Granular Subbase - Test performed after eight vibratory roller passes.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0224	0.0114	0.0204	**0.0181**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0315*	*0.0196*	*0.0258*	**0.0257**
1	Load	2	3534	5	*5.0*	*0.0447*	*0.0338*	*0.0484*	**0.0423**
1	Load	3	5301	7.5	*7.5*	*0.0616*	*0.0547*	*0.0670*	**0.0611**
1	Load	4	7069	10	*10.2*	*0.0843*	*0.0735*	*0.0851*	**0.0810**
1	Load	5	8836	12.5	*12.5*	*0.1044*	*0.0880*	*0.1009*	**0.0978**
1	Load	6	10603	15	*15.0*	*0.1173*	*0.1063*	*0.1225*	**0.1153**
1	Unload	7	7069	10	*10.0*	*0.1037*	*0.1005*	*0.1149*	**0.1064**
1	Unload	8	3534	5	*5.0*	*0.0956*	*0.0881*	*0.0997*	**0.0945**
1	Unload	9	1767	2.5	*2.5*	*0.0886*	*0.0810*	*0.0914*	**0.0870**
1	Unload	10	0	0	*0.0*	*0.0766*	*0.0716*	*0.0820*	**0.0767**
2	Load	11	3534	5	*5.0*	*0.0914*	*0.0812*	*0.0921*	**0.0883**
2	Load	12	7069	10	*10.0*	*0.1057*	*0.0972*	*0.1091*	**0.1040**
2	Load	13	10603	15	*15.0*	*0.1222*	*0.1115*	*0.1274*	**0.1204**
2	Unload	14	1767	2.5	*2.5*	*0.0957*	*0.0877*	*0.0979*	**0.0938**
2	Unload	15	0	0	*0.0*	*0.0864*	*0.0779*	*0.0886*	**0.0843**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **137**
k_u (pci) @ δ = 0.05 in.: **122**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**6.2**
E_1 (psi)	**4,102**
k'_u (pci)	**124**
k_u (pci)	**122**

Modulus at target/design applied stress

	First Loading Cycle	Corr. for Seating
δ_1 (in.)	**0.0785**	**0.0715**
E_1 (psi)	**4,216**	**4,593**
k'_{u1} (pci)	**127**	**140**
k_{u1} (pci)	**125**	**137**
Second Loading Cycle		
δ_2 (in.)	**0.0270**	
E_2 (psi)	**10,427**	
k'_{u2} (pci)	**371**	
k_{u2} (pci)	**310**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.5**	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

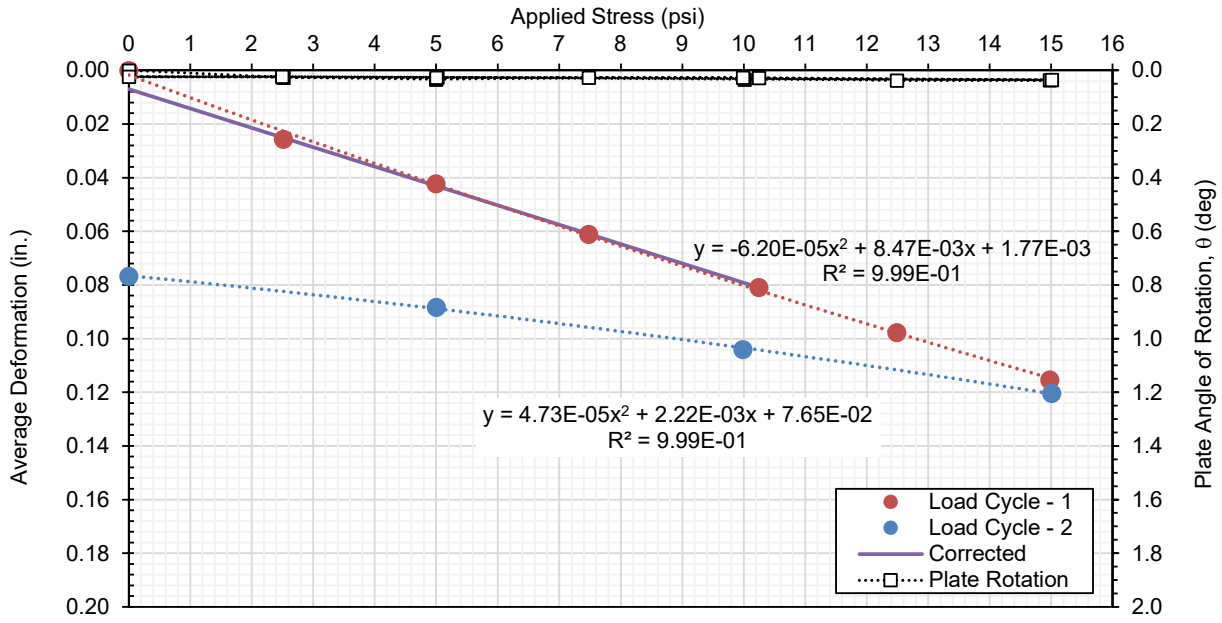
In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

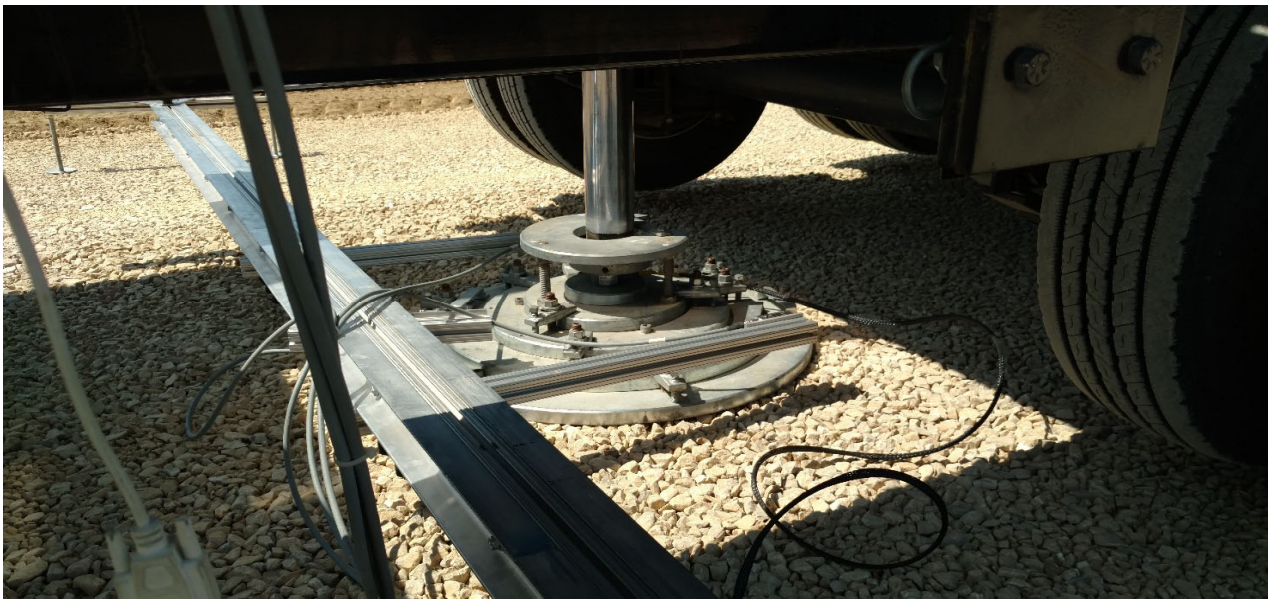
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-6.20E-05	a_1	4.73E-05	θ_{max} (deg)	0.0379
a_2	8.47E-03	a_2	2.22E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/8/2020	Time:	12:27:19 PM	Test ID	**PT9**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964366	Longitude:	-92.352954	Elev. (ft):	837.4
Comments:	Compacted Granular Subbase - Test performed after eight vibratory roller passes.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0172	0.0092	0.0063	**0.0109**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0212*	*0.0256*	*0.0225*	**0.0231**
1	Load	2	3534	5	*5.0*	*0.0320*	*0.0421*	*0.0411*	**0.0384**
1	Load	3	5301	7.5	*7.5*	*0.0565*	*0.0615*	*0.0527*	**0.0569**
1	Load	4	7069	10	*10.0*	*0.0650*	*0.0693*	*0.0601*	**0.0648**
1	Load	5	8836	12.5	*12.5*	*0.0813*	*0.0876*	*0.0789*	**0.0826**
1	Load	6	10603	15	*15.0*	*0.0983*	*0.1056*	*0.0943*	**0.0994**
1	Unload	7	7069	10	*10.0*	*0.0968*	*0.1009*	*0.0877*	**0.0952**
1	Unload	8	3534	5	*5.0*	*0.0872*	*0.0897*	*0.0818*	**0.0862**
1	Unload	9	1767	2.5	*2.5*	*0.0738*	*0.0858*	*0.0734*	**0.0776**
1	Unload	10	0	0	*0.0*	*0.0619*	*0.0778*	*0.0659*	**0.0685**
2	Load	11	3534	5	*5.0*	*0.0725*	*0.0869*	*0.0767*	**0.0787**
2	Load	12	7069	10	*10.0*	*0.0893*	*0.0994*	*0.0842*	**0.0910**
2	Load	13	10603	15	*14.9*	*0.0959*	*0.1100*	*0.0995*	**0.1018**
2	Unload	14	1767	2.5	*2.5*	*0.0774*	*0.0909*	*0.0786*	**0.0823**
2	Unload	15	0	0	*0.0*	*0.0724*	*0.0858*	*0.0703*	**0.0762**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **154**
k_u (pci) @ δ = 0.05 in.: **140**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**7.2**
E_1 (psi)	**4,701**
k'_u (pci)	**143**
k_u (pci)	**140**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.0674**	**0.0624**
E_1 (psi)	**4,842**	**5,185**
k'_{u1} (pci)	**148**	**160**
k_{u1} (pci)	**144**	**154**
Second Loading Cycle		
δ_2 (in.)	**0.0221**	
E_2 (psi)	**12,173**	
k'_{u2} (pci)	**452**	
k_{u2} (pci)	**362**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.5**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

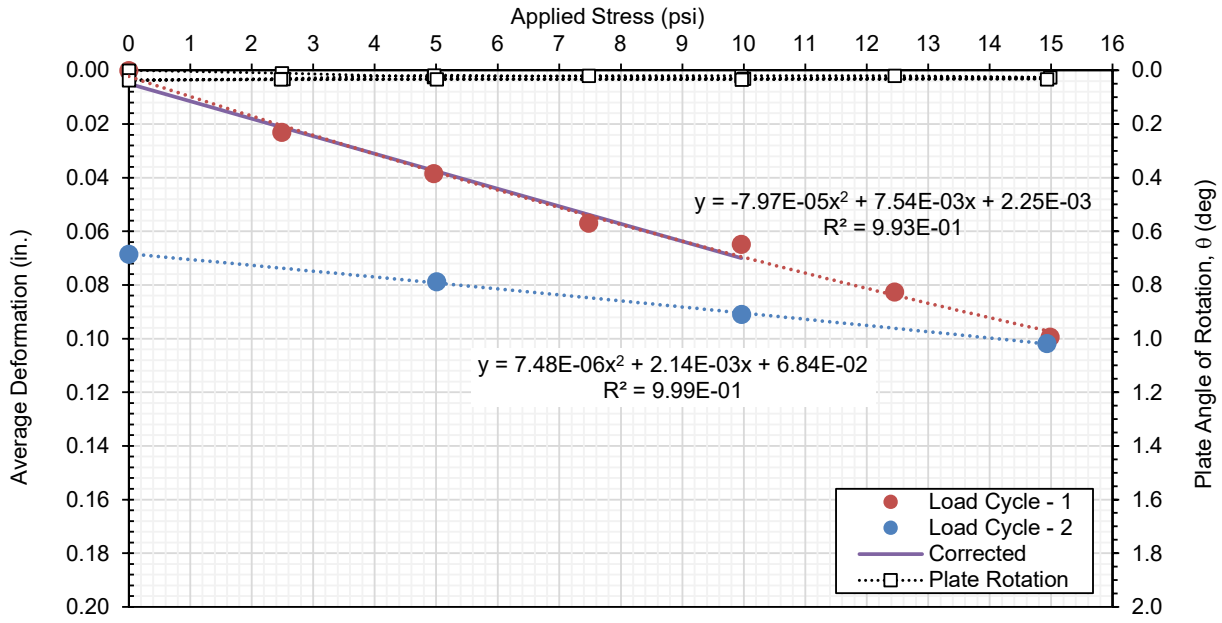
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

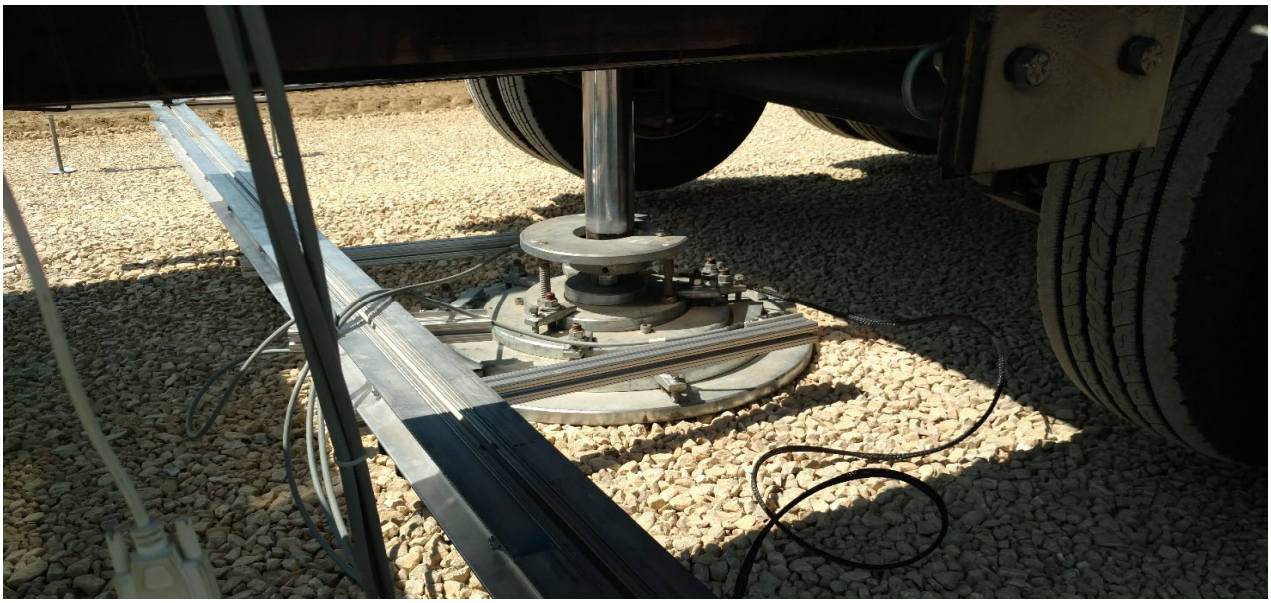
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-7.97E-05	a_1	7.48E-06	θ_{max} (deg)	0.0371
a_2	7.54E-03	a_2	2.14E-03		
R^2	0.99	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/8/2020	Time:	1:58:28 PM	Test ID	**PT11**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964353	Longitude:	-92.352097	Elev. (ft):	835.4
Comments:	Compacted Granular Subbase - Test performed after sixteen vibratory roller passes.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0101	0.0107	0.0048	**0.0085**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0191*	*0.0344*	*0.0262*	**0.0266**
1	Load	2	3534	5	*5.0*	*0.0339*	*0.0583*	*0.0438*	**0.0453**
1	Load	3	5301	7.5	*7.5*	*0.0488*	*0.0789*	*0.0594*	**0.0624**
1	Load	4	7069	10	*10.3*	*0.0622*	*0.0984*	*0.0737*	**0.0781**
1	Load	5	8836	12.5	*12.4*	*0.0770*	*0.1173*	*0.0884*	**0.0942**
1	Load	6	10603	15	*15.0*	*0.0920*	*0.1363*	*0.1023*	**0.1102**
1	Unload	7	7069	10	*10.0*	*0.0845*	*0.1284*	*0.0945*	**0.1025**
1	Unload	8	3534	5	*5.0*	*0.0754*	*0.1192*	*0.0863*	**0.0936**
1	Unload	9	1767	2.5	*2.5*	*0.0688*	*0.1124*	*0.0800*	**0.0871**
1	Unload	10	0	0	*0.0*	*0.0578*	*0.1001*	*0.0700*	**0.0760**
2	Load	11	3534	5	*5.0*	*0.0693*	*0.1128*	*0.0813*	**0.0878**
2	Load	12	7069	10	*10.0*	*0.0782*	*0.1236*	*0.0895*	**0.0971**
2	Load	13	10603	15	*15.0*	*0.0951*	*0.1412*	*0.1038*	**0.1133**
2	Unload	14	1767	2.5	*2.5*	*0.0702*	*0.1159*	*0.0814*	**0.0891**
2	Unload	14	0	0	*0.0*	*0.0592*	*0.1038*	*0.0717*	**0.0782**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **145**
k_u (pci) @ δ = 0.05 in.: **120**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**6.1**
E_1 (psi)	**4,048**
k'_u (pci)	**122**
k_u (pci)	**120**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.0771**	**0.0671**
E_1 (psi)	**4,286**	**4,862**
k'_{u1} (pci)	**130**	**149**
k_{u1} (pci)	**128**	**145**
Second Loading Cycle		
δ_2 (in.)	**0.0222**	
E_2 (psi)	**12,159**	
k'_{u2} (pci)	**451**	
k_{u2} (pci)	**362**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.8**	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

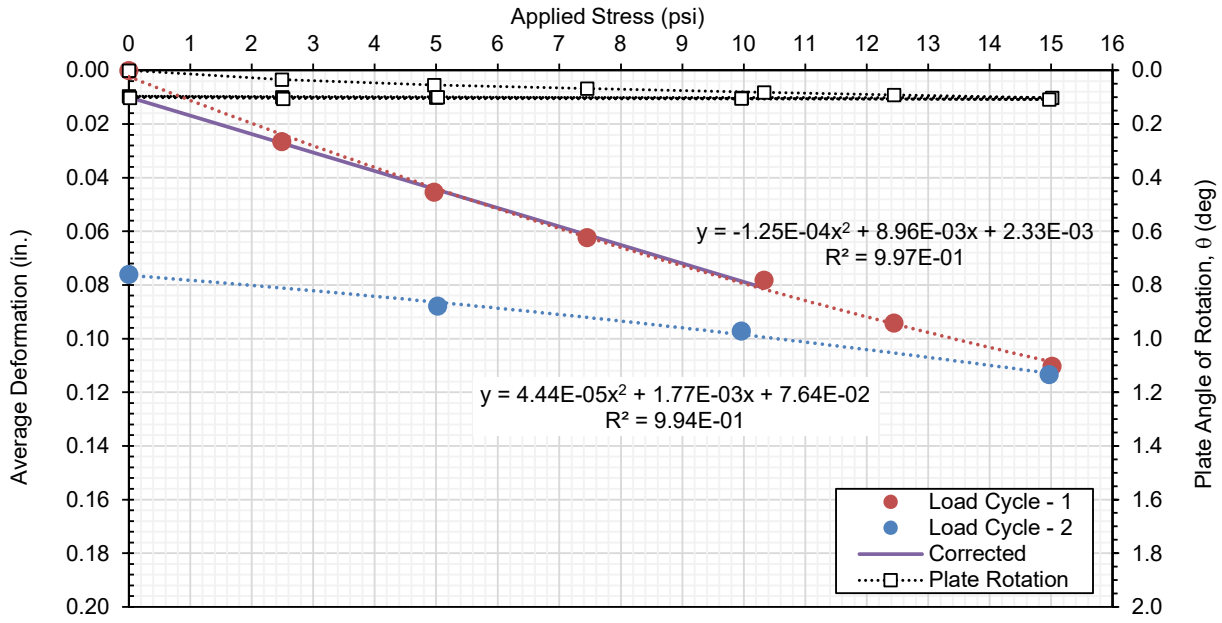
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

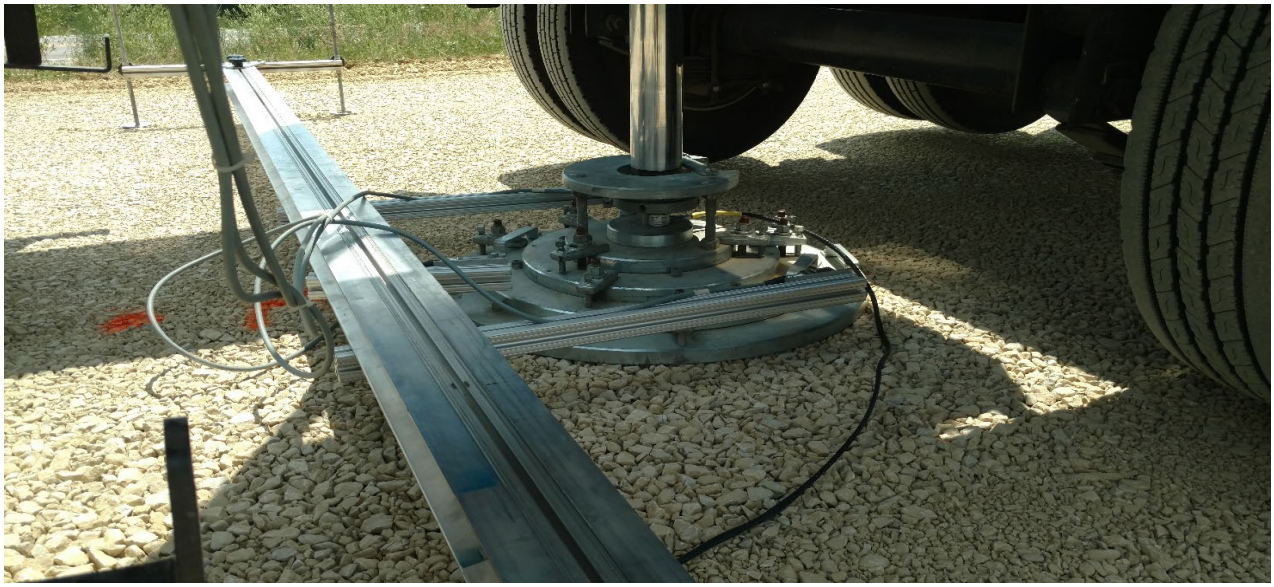
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.25E-04	a_1	4.44E-05	θ_{max} (deg)	0.1080
a_2	8.96E-03	a_2	1.77E-03		
R^2	1.00	R^2	0.99		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/8/2020	Time:	2:47:08 PM	Test ID	**PT12**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964348	Longitude:	-92.351224	Elev. (ft):	834.0
Comments:	Compacted Granular Subbase - Test performed after sixteen vibratory roller passes.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0168	0.0098	0.0053	**0.0106**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0399*	*0.0280*	*0.0161*	**0.0280**
1	Load	2	3534	5	*5.0*	*0.0604*	*0.0472*	*0.0296*	**0.0457**
1	Load	3	5301	7.5	*7.5*	*0.0814*	*0.0643*	*0.0450*	**0.0636**
1	Load	4	7069	10	*10.0*	*0.1019*	*0.0784*	*0.0579*	**0.0794**
1	Load	5	8836	12.5	*12.4*	*0.1217*	*0.0943*	*0.0711*	**0.0957**
1	Load	6	10603	15	*15.0*	*0.1414*	*0.1076*	*0.0871*	**0.1120**
1	Unload	7	7069	10	*10.0*	*0.1353*	*0.1023*	*0.0803*	**0.1060**
1	Unload	8	3534	5	*5.0*	*0.1232*	*0.0937*	*0.0706*	**0.0958**
1	Unload	9	1767	2.5	*2.5*	*0.1141*	*0.0859*	*0.0623*	**0.0874**
1	Unload	10	0	0	*0.0*	*0.1021*	*0.0783*	*0.0535*	**0.0780**
2	Load	11	3534	5	*5.0*	*0.1150*	*0.0859*	*0.0629*	**0.0880**
2	Load	12	7069	10	*9.9*	*0.1287*	*0.0985*	*0.0729*	**0.1001**
2	Load	13	10603	15	*15.0*	*0.1470*	*0.1140*	*0.0886*	**0.1166**
2	Unload	14	1767	2.5	*2.5*	*0.1199*	*0.0927*	*0.0655*	**0.0927**
2	Unload	14	0	0	*0.0*	*0.1091*	*0.0824*	*0.0554*	**0.0823**

Plate Diameter:	*30.0*	in.	
Shape factor:	*2.67*		
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate	
Poisson's ratio:	*0.4*		
Design Stress:	*10.0*	psi	**AASHTO T222 Method** k_{u1} (pci) @ design stress: **141**
Target Deformation:	*0.05*	in.	**PCA Design Criteria** k_u (pci) @ δ = 0.05 in.: **117**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.9
E_1 (psi)	3,937
k'_u (pci)	118
k_u (pci)	117

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.0790	0.0690
E_1 (psi)	4,193	4,744
k'_{u1} (pci)	127	145
k_{u1} (pci)	125	141
Second Loading Cycle		
δ_2 (in.)	0.0225	
E_2 (psi)	12,034	
k'_{u2} (pci)	445	
k_{u2} (pci)	358	
E_2 / E_1 or k_2 / k_1 Ratio	2.9	

Plate Bending Correction for

$k'_u \geq 100 \; and \; 1{,}000 \; pci$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

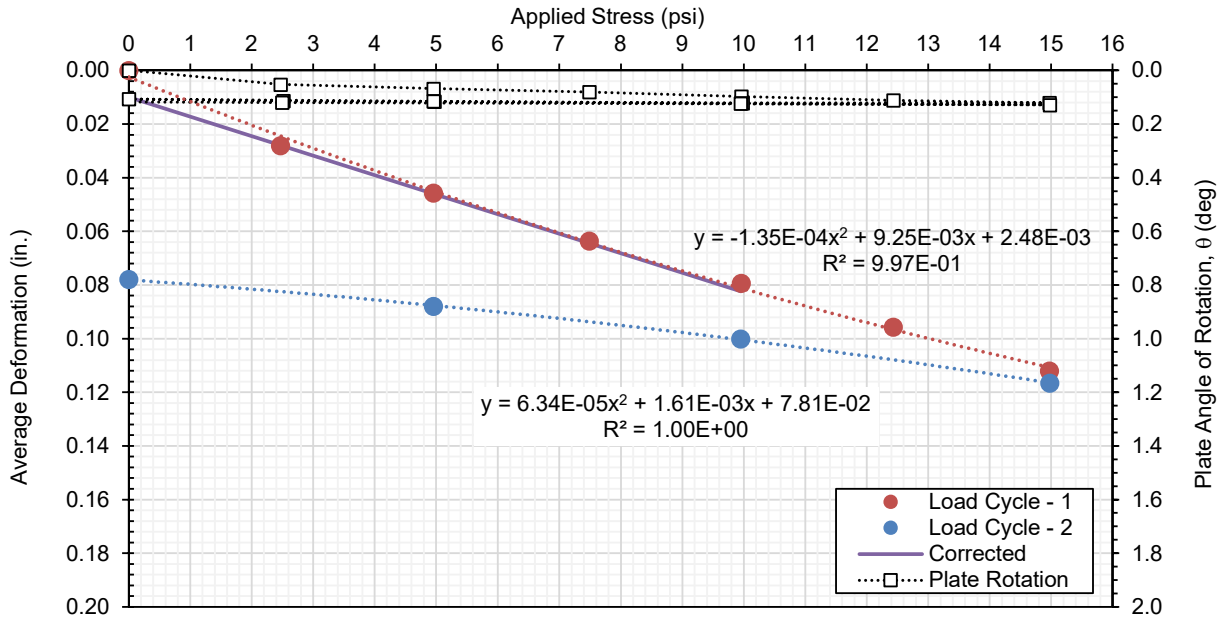
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

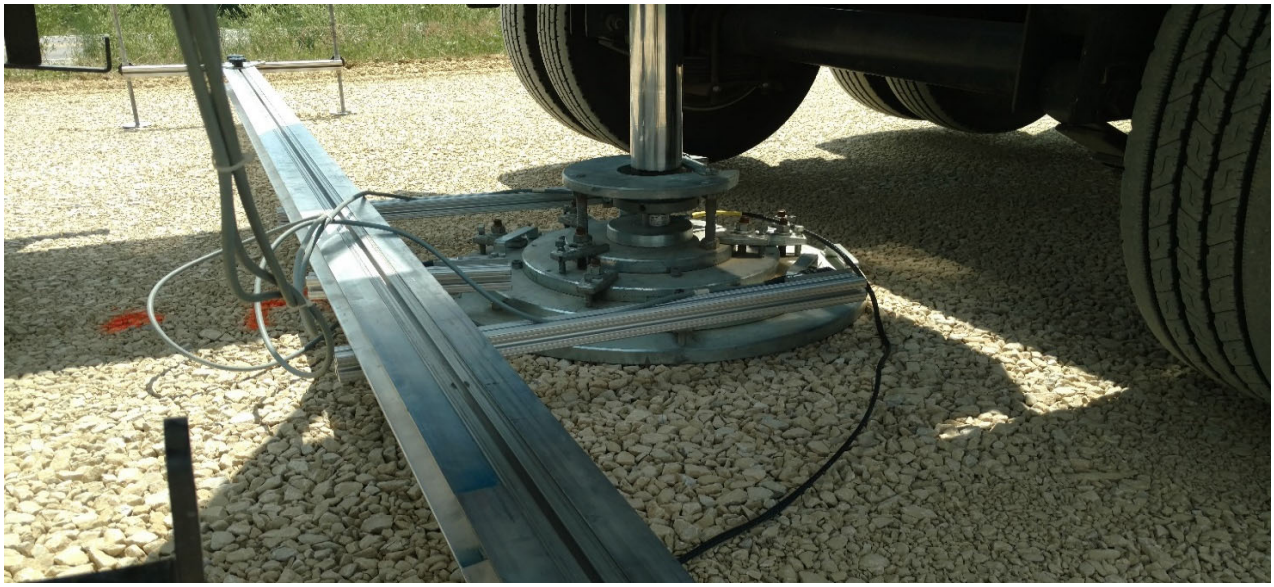
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-1.35E-04	a_1	6.34E-05	θ_{max} (deg)	0.1292
a_2	9.25E-03	a_2	1.61E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	7/8/2020	Time:	3:33:58 PM	Test ID	**PT13**
Tested By	CV/HG	Location:	US 30 East of V18 (EB)	Sta.	NA
Latitude:	41.964343	Longitude:	-92.350810	Elev. (ft):	835.5
Comments:	Compacted Granular Subbase - Test performed after eight vibratory roller passes.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0239	0.0228	0.0195	**0.0221**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0343*	*0.0427*	*0.0337*	**0.0369**
1	Load	2	3534	5	*5.0*	*0.0582*	*0.0720*	*0.0603*	**0.0635**
1	Load	3	5301	7.5	*7.5*	*0.0805*	*0.0995*	*0.0825*	**0.0875**
1	Load	4	7069	10	*10.0*	*0.1015*	*0.1215*	*0.1016*	**0.1082**
1	Load	5	8836	12.5	*12.4*	*0.1227*	*0.1430*	*0.1219*	**0.1292**
1	Load	6	10603	15	*15.0*	*0.1441*	*0.1661*	*0.1416*	**0.1506**
1	Unload	7	7069	10	*10.0*	*0.1365*	*0.1590*	*0.1360*	**0.1438**
1	Unload	8	3534	5	*5.0*	*0.1210*	*0.1455*	*0.1216*	**0.1294**
1	Unload	9	1767	2.5	*2.5*	*0.1106*	*0.1362*	*0.1129*	**0.1199**
1	Unload	10	0	0	*0.0*	*0.0932*	*0.1218*	*0.0933*	**0.1028**
2	Load	11	3534	5	*5.0*	*0.1095*	*0.1367*	*0.1116*	**0.1193**
2	Load	12	7069	10	*10.0*	*0.1284*	*0.1540*	*0.1300*	**0.1374**
2	Load	13	10603	15	*15.0*	*0.1504*	*0.1760*	*0.1482*	**0.1582**
2	Unload	14	1767	2.5	*2.5*	*0.1172*	*0.1458*	*0.1172*	**0.1268**
2	Unload	14	0	0	*0.0*	*0.1013*	*0.1325*	*0.1070*	**0.1136**

Plate Diameter:	*30.0*	in.
Shape factor:	**2.67**	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.4*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **104**
k_u (pci) @ δ = 0.05 in.: **83**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	**4.1**
E_1 (psi)	**2,778**
k'_u (pci)	**83**
k_u (pci)	**83**

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	**0.1083**	**0.0953**
E_1 (psi)	**3,103**	**3,510**
k'_{u1} (pci)	**92**	**105**
k_{u1} (pci)	**92**	**104**
Second Loading Cycle		
δ_2 (in.)	**0.0349**	
E_2 (psi)	**8,486**	
k'_{u2} (pci)	**287**	
k_{u2} (pci)	**253**	
E_2 / E_1 or k_2 / k_1 Ratio	**2.7**	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

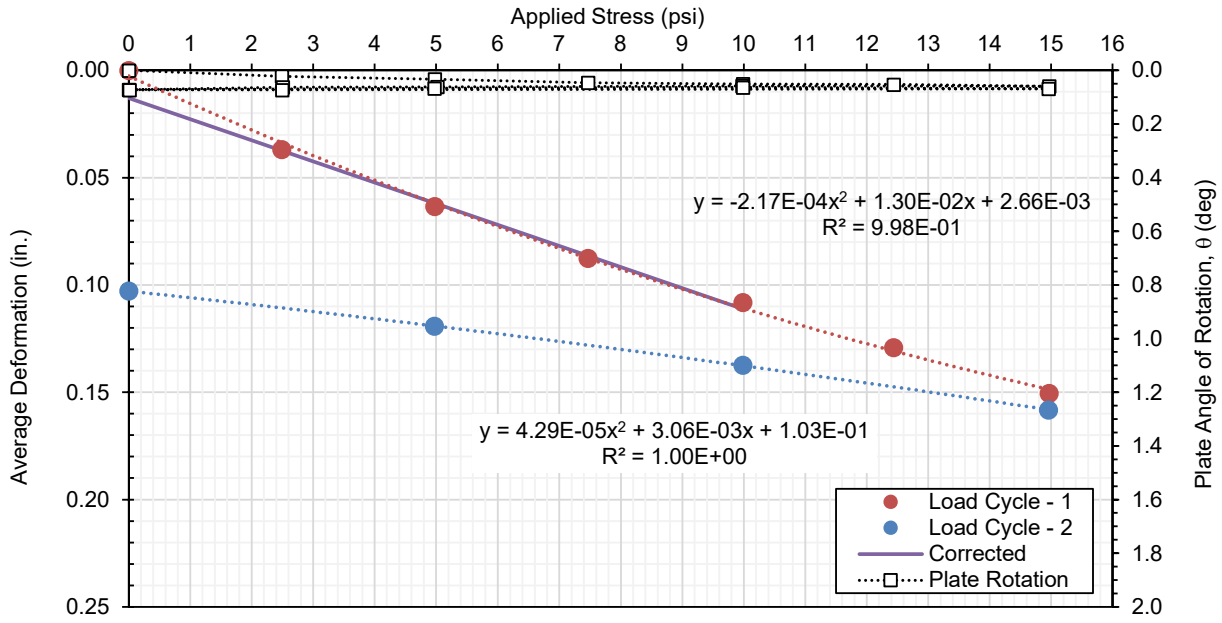
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

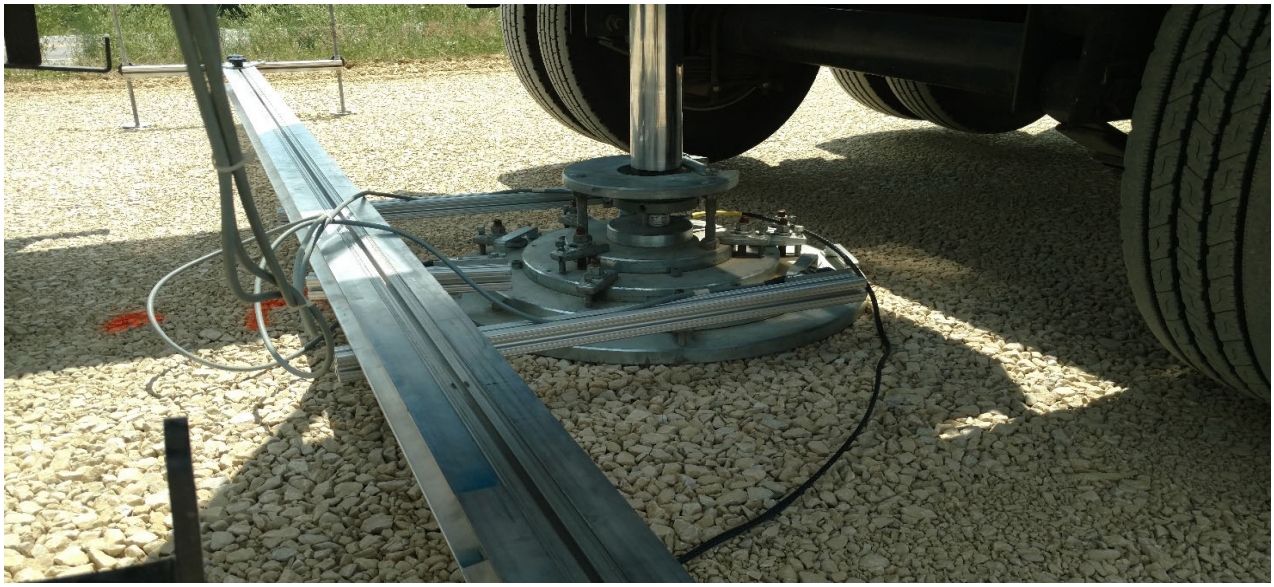
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.17E-04	a_1	4.29E-05	θ_{max} (deg)	0.0733
a_2	1.30E-02	a_2	3.06E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/25/2020	Time:	4:53:23 PM	Test ID	**PT_3**
Tested By	CV/DW	Location:	US 30 West of V18	Sta.	NA
Latitude:	41.964290	Longitude:	92.393578	Elev. (ft):	NA
Comments:	Compacted Subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0087	0.0023	0.0234	**0.0115**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0375*	*0.0139*	*0.0375*	**0.0296**
1	Load	2	3534	5	*5.0*	*0.0738*	*0.0314*	*0.0521*	**0.0524**
1	Load	3	5301	7.5	*7.5*	*0.0936*	*0.0492*	*0.0641*	**0.0690**
1	Load	4	7069	10	*9.9*	*0.1048*	*0.0653*	*0.0758*	**0.0820**
1	Load	5	8836	12.5	*12.5*	*0.1188*	*0.0813*	*0.0870*	**0.0957**
1	Load	6	10603	15	*15.0*	*0.1261*	*0.0948*	*0.0985*	**0.1065**
1	Unload	7	7069	10	*10.0*	*0.1234*	*0.0892*	*0.0956*	**0.1028**
1	Unload	8	3534	5	*5.0*	*0.1179*	*0.0788*	*0.0873*	**0.0947**
1	Unload	9	1767	2.5	*2.5*	*0.1073*	*0.0696*	*0.0818*	**0.0862**
1	Unload	10	0	0	*0.0*	*0.0819*	*0.0570*	*0.0756*	**0.0715**
2	Load	11	3534	5	*5.0*	*0.1085*	*0.0690*	*0.0825*	**0.0867**
2	Load	12	7069	10	*10.0*	*0.1220*	*0.0842*	*0.0940*	**0.1001**
2	Load	13	10603	15	*15.0*	*0.1299*	*0.0999*	*0.1040*	**0.1112**
2	Unload	14	1767	2.5	*2.5*	*0.1110*	*0.0740*	*0.0871*	**0.0907**
2	Unload	14	0	0	*0.0*	*0.0866*	*0.0613*	*0.0791*	**0.0757**

Plate Diameter:	*30.0*	in.
Shape factor:	2.67	
Material Type:	*B*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **145**
k_u (pci) @ δ = 0.05 in.: **103**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.2
E_1 (psi)	3,616
k'_u (pci)	103
k_u (pci)	103

Modulus at target/design applied stress

		Corr. for Seating
First Loading Cycle		
δ_1 (in.)	0.0829	0.0669
E_1 (psi)	4,186	5,093
k'_{u1} (pci)	121	149
k_{u1} (pci)	119	145
Second Loading Cycle		
δ_2 (in.)	0.0286	
E_2 (psi)	10,400	
k'_{u2} (pci)	350	
k_{u2} (pci)	296	
E_2 / E_1 or k_2 / k_1 Ratio	2.5	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

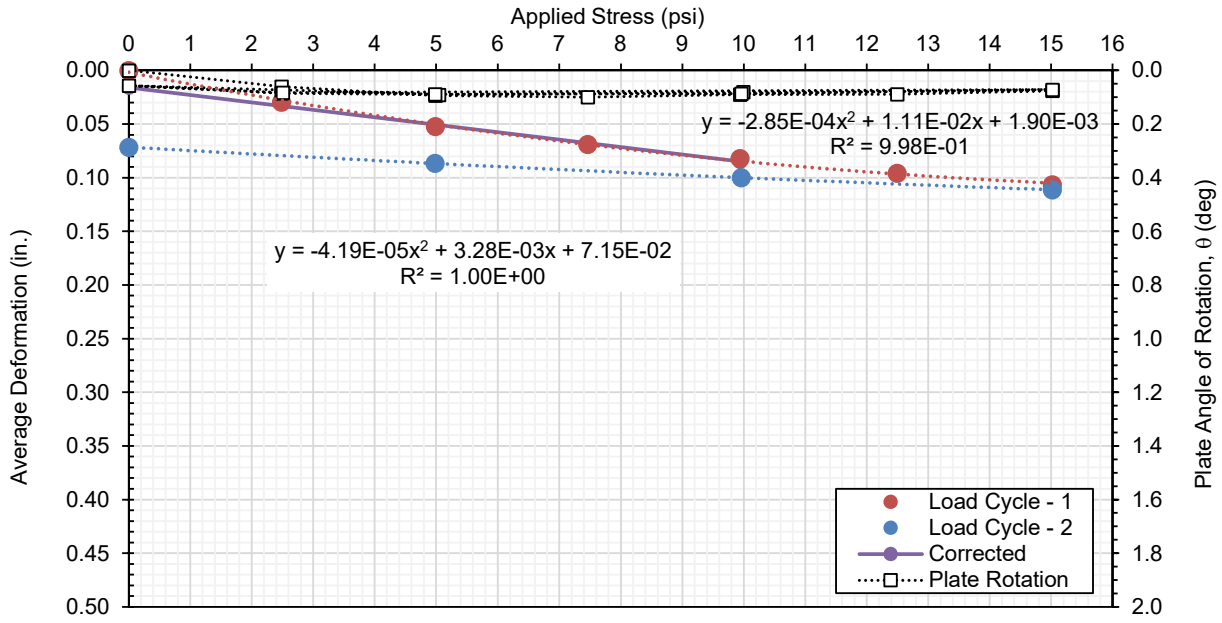
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-2.85E-04	a_1	-4.19E-05	θ_{max} (deg)	0.0997
a_2	1.11E-02	a_2	3.28E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/30/2020	Time:	10:25:22 AM	Test ID	**PT1**
Tested By	CV/HG	Location:	US 30 East of V18	Sta.	NA
Latitude:	41.964313	Longitude:	-92.252048	Elev. (ft):	254.6
Comments:	Compacted subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0167	0.0087	0.0111	**0.0122**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0423*	*0.0231*	*0.0264*	**0.0306**
1	Load	2	3534	5	*4.9*	*0.0829*	*0.0517*	*0.0596*	**0.0647**
1	Load	3	5301	7.5	*7.5*	*0.1198*	*0.0870*	*0.0947*	**0.1005**
1	Load	4	7069	10	*10.0*	*0.1595*	*0.1201*	*0.1307*	**0.1368**
1	Load	5	8836	12.5	*12.5*	*0.2005*	*0.1592*	*0.1710*	**0.1769**
1	Load	6	10603	15	*15.0*	*0.2450*	*0.1919*	*0.2102*	**0.2157**
1	Unload	7	7069	10	*10.0*	*0.2313*	*0.1786*	*0.1965*	**0.2021**
1	Unload	8	3534	5	*5.0*	*0.2081*	*0.1532*	*0.1711*	**0.1775**
1	Unload	9	1767	2.5	*2.5*	*0.1880*	*0.1363*	*0.1517*	**0.1587**
1	Unload	10	0	0	*0.0*	*0.1613*	*0.1094*	*0.1235*	**0.1314**
2	Load	11	3534	5	*5.0*	*0.1853*	*0.1335*	*0.1497*	**0.1561**
2	Load	12	7069	10	*10.0*	*0.2162*	*0.1637*	*0.1843*	**0.1881**
2	Load	13	10603	15	*14.8*	*0.2612*	*0.2076*	*0.2269*	**0.2319**
2	Unload	14	1767	2.5	*2.5*	*0.2020*	*0.1481*	*0.1650*	**0.1717**
2	Unload	14	0	0	*0.0*	*0.1759*	*0.1212*	*0.1401*	**0.1457**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **73**
k_u (pci) @ δ = 0.05 in.: **77**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	3.9
E_1 (psi)	1,593
k'_u (pci)	77
k_u (pci)	77

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.1379	0.1379
E_1 (psi)	1,500	1,500
k'_{u1} (pci)	73	73
k_{u1} (pci)	73	73
Second Loading Cycle		
δ_2 (in.)	0.0575	
E_2 (psi)	3,431	
k'_{u2} (pci)	174	
k_{u2} (pci)	166	
E_2 / E_1 or k_2 / k_1 Ratio	2.3	

Plate Bending Correction for

$k'_u \geq 100$ *and* $1{,}000$ *pci*

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

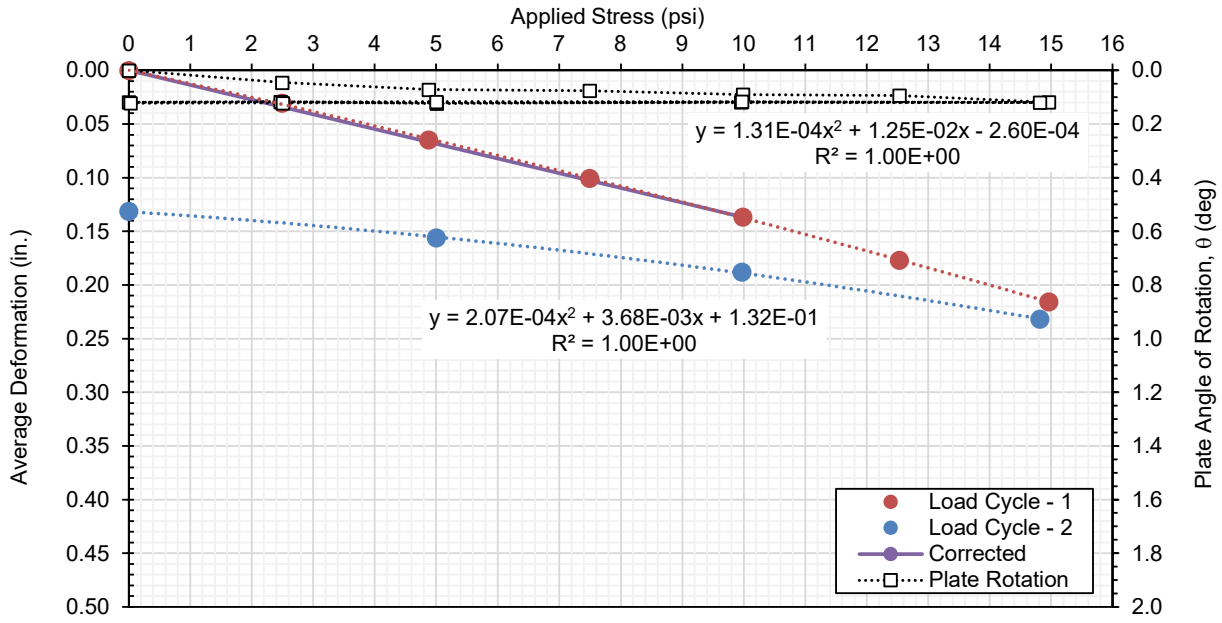
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	1.31E-04	a_1	2.07E-04	θ_{max} (deg)	0.1236
a_2	1.25E-02	a_2	3.68E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/30/2020	Time:	11:15:40 AM	Test ID	**PT2**
Tested By	CV/HG	Location:	US 30 East of V18	Sta.	NA
Latitude:	41.964425	Longitude:	-92.366805	Elev. (ft):	NA
Comments:	Compacted subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0066	0.0081	0.0191	**0.0113**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0078*	*0.0087*	*0.0168*	**0.0111**
1	Load	2	3534	5	*5.0*	*0.0147*	*0.0176*	*0.0292*	**0.0205**
1	Load	3	5301	7.5	*7.5*	*0.0248*	*0.0271*	*0.0418*	**0.0312**
1	Load	4	7069	10	*10.0*	*0.0344*	*0.0364*	*0.0546*	**0.0418**
1	Load	5	8836	12.5	*12.5*	*0.0434*	*0.0452*	*0.0642*	**0.0509**
1	Load	6	10603	15	*15.0*	*0.0563*	*0.0569*	*0.0772*	**0.0635**
1	Unload	7	7069	10	*10.0*	*0.0488*	*0.0496*	*0.0693*	**0.0559**
1	Unload	8	3534	5	*5.0*	*0.0412*	*0.0416*	*0.0605*	**0.0477**
1	Unload	9	1767	2.5	*2.5*	*0.0350*	*0.0358*	*0.0535*	**0.0415**
1	Unload	10	0	0	*0.0*	*0.0265*	*0.0267*	*0.0413*	**0.0315**
2	Load	11	3534	5	*5.0*	*0.0348*	*0.0358*	*0.0543*	**0.0416**
2	Load	12	7069	10	*10.0*	*0.0441*	*0.0441*	*0.0641*	**0.0508**
2	Load	13	10603	15	*15.0*	*0.0583*	*0.0588*	*0.0805*	**0.0659**
2	Unload	14	1767	2.5	*2.5*	*0.0378*	*0.0384*	*0.0577*	**0.0446**
2	Unload	14	0	0	*0.0*	*0.0316*	*0.0323*	*0.0489*	**0.0376**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **220**
k_u (pci) @ δ = 0.05 in.: **219**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	12.1
E_1 (psi)	4,533
k'_u (pci)	242
k_u (pci)	219

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0412	0.0412
E_1 (psi)	4,552	4,552
k'_{u1} (pci)	243	243
k_{u1} (pci)	220	220
Second Loading Cycle		
δ_2 (in.)	0.0200	
E_2 (psi)	8,112	
k'_{u2} (pci)	501	
k_{u2} (pci)	392	
E_2 / E_1 or k_2 / k_1 Ratio	1.8	

Plate Bending Correction for

$$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$$

$$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

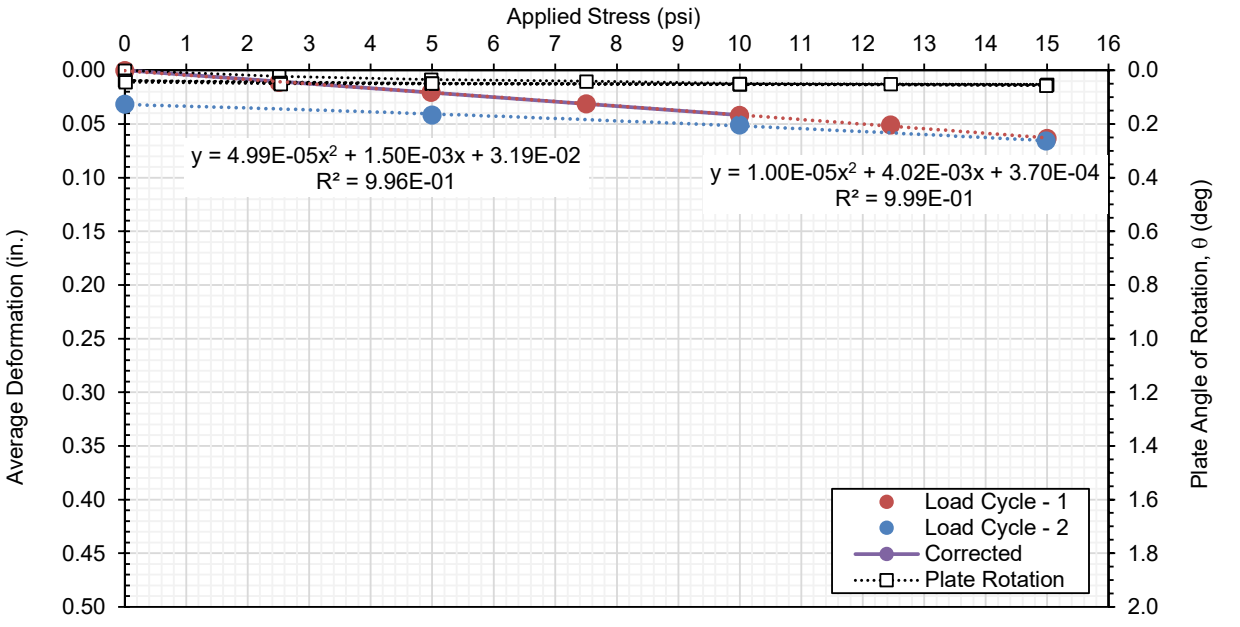
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

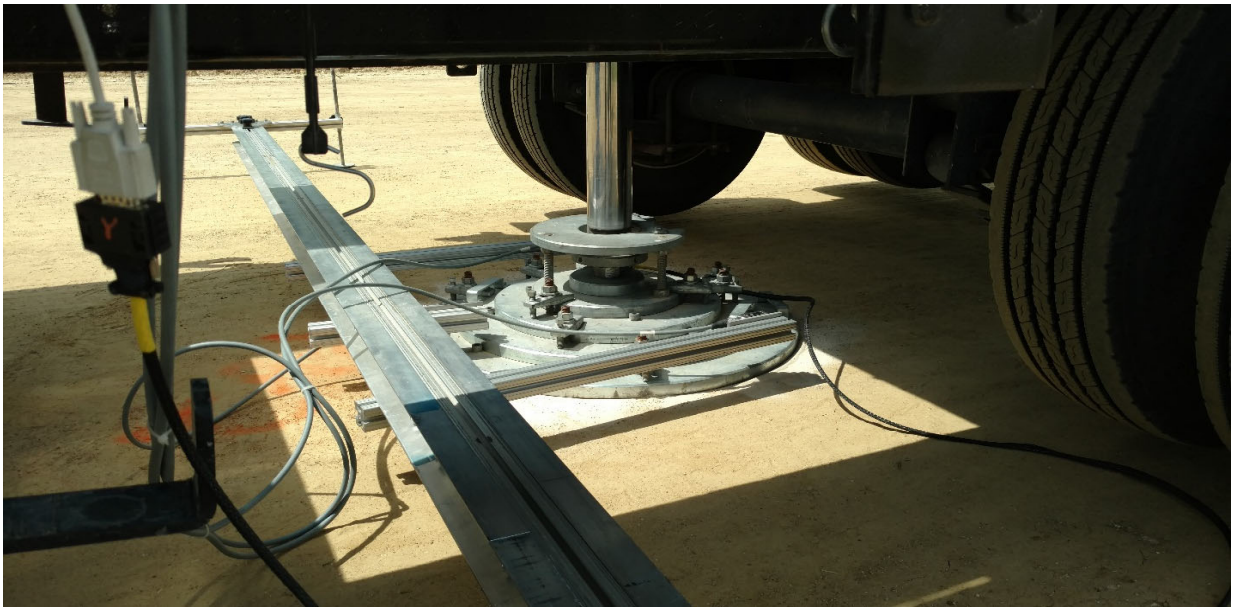
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	1.00E-05	a_1	4.99E-05	θ_{max} (deg)	0.0560
a_2	4.02E-03	a_2	1.50E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/30/2020	Time:	12:13:23 PM	Test ID	**PT3**
Tested By	CV/HG	Location:	US 30 East of V18	Sta.	NA
Latitude:	41.96440	Longitude:	-92.36604	Elev. (ft):	NA
Comments:	Compacted subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0120	0.0075	0.0068	**0.0088**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0208*	*0.0098*	*0.0185*	**0.0164**
1	Load	2	3534	5	*4.9*	*0.0357*	*0.0203*	*0.0331*	**0.0297**
1	Load	3	5301	7.5	*7.5*	*0.0497*	*0.0315*	*0.0469*	**0.0427**
1	Load	4	7069	10	*10.0*	*0.0649*	*0.0435*	*0.0596*	**0.0560**
1	Load	5	8836	12.5	*12.5*	*0.0794*	*0.0571*	*0.0728*	**0.0698**
1	Load	6	10603	15	*15.0*	*0.0931*	*0.0694*	*0.0833*	**0.0819**
1	Unload	7	7069	10	*10.0*	*0.0903*	*0.0663*	*0.0803*	**0.0790**
1	Unload	8	3534	5	*5.0*	*0.0798*	*0.0570*	*0.0708*	**0.0692**
1	Unload	9	1767	2.5	*2.5*	*0.0746*	*0.0510*	*0.0645*	**0.0634**
1	Unload	10	0	0	*0.0*	*0.0627*	*0.0409*	*0.0523*	**0.0519**
2	Load	11	3534	5	*5.0*	*0.0713*	*0.0478*	*0.0626*	**0.0606**
2	Load	12	7069	10	*10.0*	*0.0803*	*0.0573*	*0.0721*	**0.0699**
2	Load	13	10603	15	*15.0*	*0.1002*	*0.0749*	*0.0890*	**0.0880**
2	Unload	14	1767	2.5	*2.5*	*0.0780*	*0.0530*	*0.0664*	**0.0658**
2	Unload	14	0	0	*0.0*	*0.0690*	*0.0449*	*0.0564*	**0.0568**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **175**
k_u (pci) @ δ = 0.05 in.: **169**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	8.9
E_1 (psi)	3,484
k'_u (pci)	177
k_u (pci)	169

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0560	0.0540
E_1 (psi)	3,507	3,619
k'_{u1} (pci)	178	185
k_{u1} (pci)	170	175
Second Loading Cycle		
δ_2 (in.)	0.0188	
E_2 (psi)	8,513	
k'_{u2} (pci)	533	
k_{u2} (pci)	412	
E_2 / E_1 or k_2 / k_1 Ratio	2.4	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

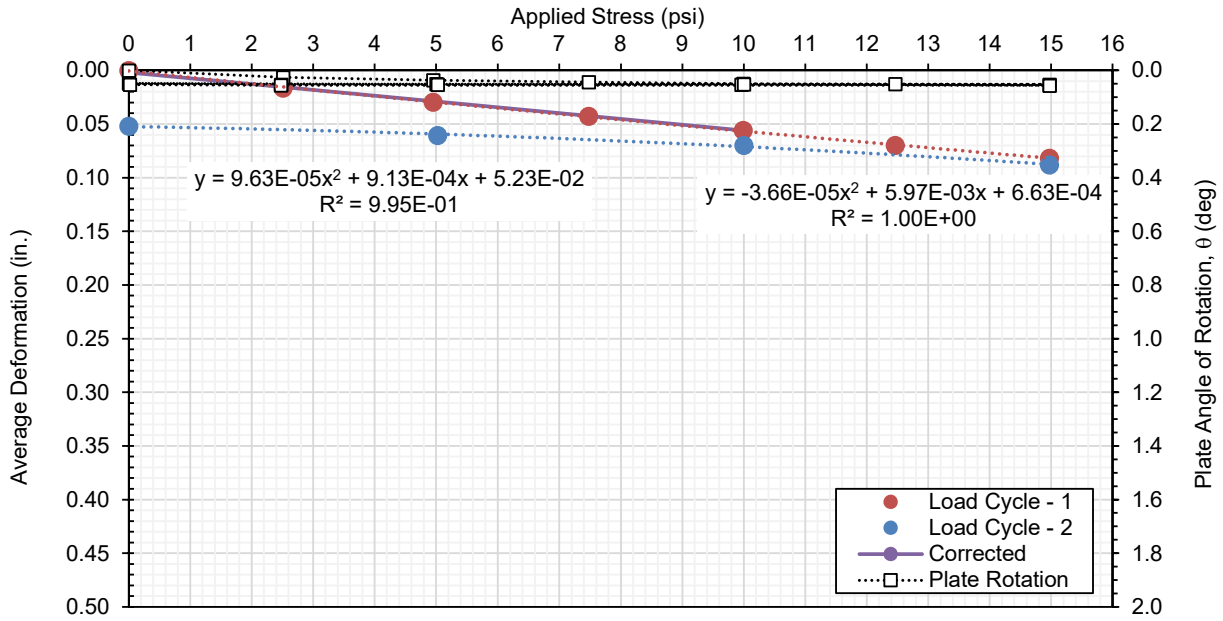
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	-3.66E-05	a_1	9.63E-05	θ_{max} (deg)	0.0560
a_2	5.97E-03	a_2	9.13E-04		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/30/2020	Time:	2:01:37 PM	Test ID	**PT4**
Tested By	CV/HG	Location:	US 30 East of V18	Sta.	NA
Latitude:	41.964379	Longitude:	92.351486	Elev. (ft):	254.7
Comments:	Compacted subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0155	0.0092	0.0095	**0.0114**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0235*	*0.0266*	*0.0252*	**0.0251**
1	Load	2	3534	5	*5.0*	*0.0616*	*0.0499*	*0.0327*	**0.0481**
1	Load	3	5301	7.5	*7.5*	*0.0806*	*0.0721*	*0.0544*	**0.0690**
1	Load	4	7069	10	*10.0*	*0.1247*	*0.0947*	*0.0728*	**0.0974**
1	Load	5	8836	12.5	*12.5*	*0.1535*	*0.1211*	*0.0884*	**0.1210**
1	Load	6	10603	15	*15.0*	*0.1831*	*0.1491*	*0.1137*	**0.1486**
1	Unload	7	7069	10	*10.0*	*0.1679*	*0.1401*	*0.1082*	**0.1387**
1	Unload	8	3534	5	*5.0*	*0.1557*	*0.1245*	*0.0893*	**0.1232**
1	Unload	9	1767	2.5	*2.5*	*0.1356*	*0.1118*	*0.0787*	**0.1087**
1	Unload	10	0	0	*0.0*	*0.1225*	*0.0941*	*0.0699*	**0.0955**
2	Load	11	3534	5	*5.0*	*0.1379*	*0.1114*	*0.0769*	**0.1087**
2	Load	12	7069	10	*10.0*	*0.1592*	*0.1329*	*0.1004*	**0.1309**
2	Load	13	10603	15	*15.0*	*0.1907*	*0.1583*	*0.1191*	**0.1561**
2	Unload	14	1767	2.5	*2.5*	*0.1502*	*0.1217*	*0.0867*	**0.1195**
2	Unload	14	0	0	*0.0*	*0.1311*	*0.1030*	*0.0753*	**0.1031**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **104**
k_u (pci) @ δ = 0.05 in.: **108**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.4
E_1 (psi)	2,223
k'_u (pci)	108
k_u (pci)	108

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0953	0.0953
E_1 (psi)	2,158	2,158
k'_{u1} (pci)	105	105
k_{u1} (pci)	104	104
Second Loading Cycle		
δ_2 (in.)	0.0348	
E_2 (psi)	5,228	
k'_{u2} (pci)	287	
k_{u2} (pci)	253	
E_2 / E_1 or k_2 / k_1 Ratio	2.4	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

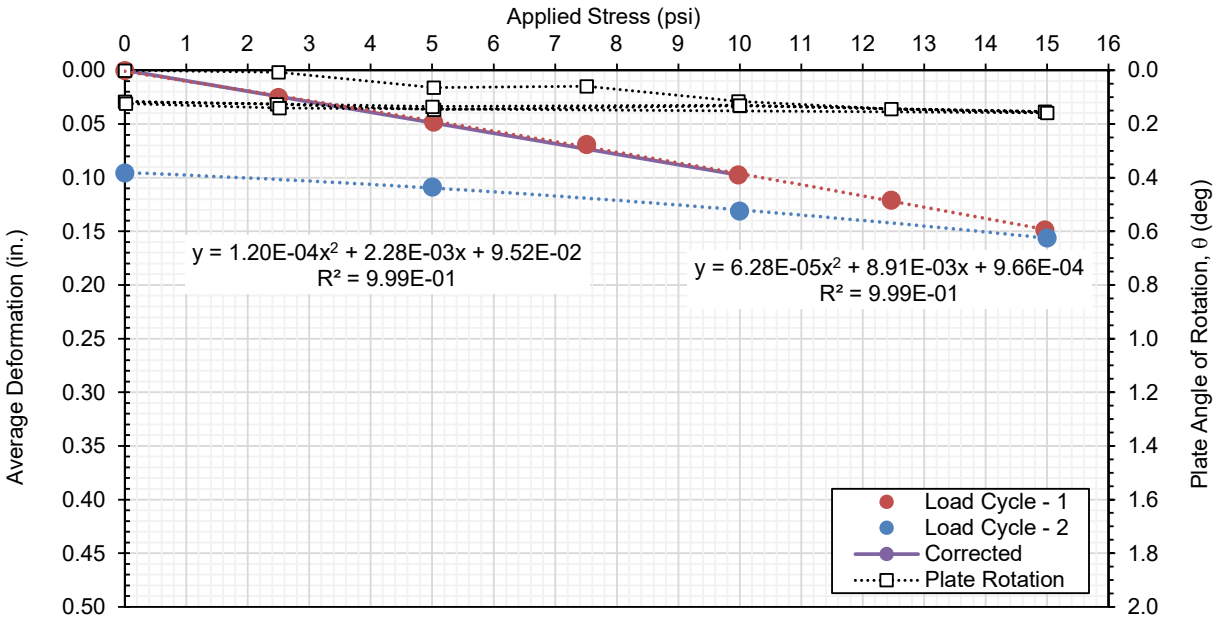
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

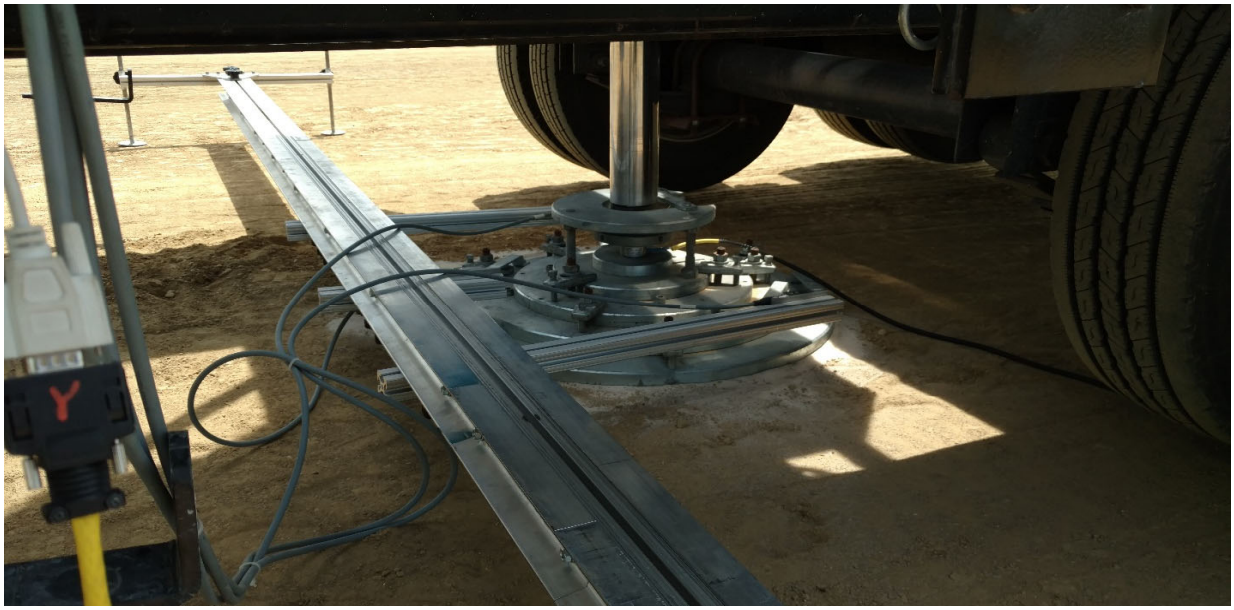
ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	6.28E-05	a_1	1.20E-04	θ_{max} (deg)	0.1582
a_2	8.91E-03	a_2	2.28E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.





In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-Situ Static Plate Load Test: Two Loading Cycles.				
Date:	6/30/2020	Time:	2:54:58 PM	Test ID	**PT5**
Tested By	CV/HG	Location:	US 30 East of V18	Sta.	NA
Latitude:	41.964379	Longitude:	92.351486	Elev. (ft):	254.7
Comments:	Compacted subgrade.				

Cycle	Stage	Load Step	Target Applied Load (lbs)	Target Applied Stress (psi)	Actual Applied Stress (psi)	Deformation (in.) Sensor 1	Sensor 2	Sensor 3	Average Def. (in.)
0	Seating	0	1414	2	*1.8*	0.0224	0.0109	0.0296	**0.0209**
Zero load and deformation sensors after applying the seating stress.									
1	Seating	0	0	0	*0.0*	*0.0000*	*0.0000*	*0.0000*	**0.0000**
1	Load	1	1767	2.5	*2.5*	*0.0189*	*0.0204*	*0.0283*	**0.0225**
1	Load	2	3534	5	*5.0*	*0.0363*	*0.0404*	*0.0511*	**0.0426**
1	Load	3	5301	7.5	*7.5*	*0.0580*	*0.0621*	*0.0713*	**0.0638**
1	Load	4	7069	10	*10.0*	*0.0858*	*0.0850*	*0.1013*	**0.0907**
1	Load	5	8836	12.5	*12.5*	*0.1150*	*0.1100*	*0.1295*	**0.1181**
1	Load	6	10603	15	*14.9*	*0.1475*	*0.1376*	*0.1535*	**0.1462**
1	Unload	7	7069	10	*10.0*	*0.1366*	*0.1302*	*0.1453*	**0.1374**
1	Unload	8	3534	5	*5.0*	*0.1212*	*0.1128*	*0.1303*	**0.1214**
1	Unload	9	1767	2.5	*2.4*	*0.1051*	*0.1002*	*0.1128*	**0.1061**
1	Unload	10	0	0	*0.0*	*0.0864*	*0.0811*	*0.0951*	**0.0875**
2	Load	11	3534	5	*5.0*	*0.1046*	*0.0990*	*0.1129*	**0.1055**
2	Load	12	7069	10	*10.0*	*0.1285*	*0.1191*	*0.1330*	**0.1268**
2	Load	13	10603	15	*14.9*	*0.1580*	*0.1473*	*0.1570*	**0.1541**
2	Unload	14	1767	2.5	*2.5*	*0.1135*	*0.1072*	*0.1220*	**0.1142**
2	Unload	14	0	0	*0.0*	*0.0985*	*0.0882*	*0.1065*	**0.0978**

Plate Diameter:	*30.0*	in.
Shape factor:	1.57	
Material Type:	*A*	A = Cohesive, B = Granular, C = Intermediate
Poisson's ratio:	*0.35*	
Design Stress:	*10.0*	psi
Target Deformation:	*0.05*	in.

AASHTO T222 Method
PCA Design Criteria

k_{u1} (pci) @ design stress: **110**
k_u (pci) @ δ = 0.05 in.: **118**

Modulus at target deformation

Stress @ δ = 0.05 in. (psi)	5.9
E_1 (psi)	2,435
k'_u (pci)	119
k_u (pci)	118

Modulus at target/design applied stress

	First Loading Cycle	*Corr. for Seating*
δ_1 (in.)	0.0900	0.0900
E_1 (psi)	2,282	2,282
k'_{u1} (pci)	111	111
k_{u1} (pci)	110	110
Second Loading Cycle		
δ_2 (in.)	0.0397	
E_2 (psi)	4,695	
k'_{u2} (pci)	252	
k_{u2} (pci)	227	
E_2 / E_1 or k_2 / k_1 Ratio	2.1	

Plate Bending Correction for

$k'_u \geq 100 \text{ and } 1{,}000 \text{ pci}$

$k_u = -39.9178 + 5.5076\,[k'_u]^{0.7019}$

In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus

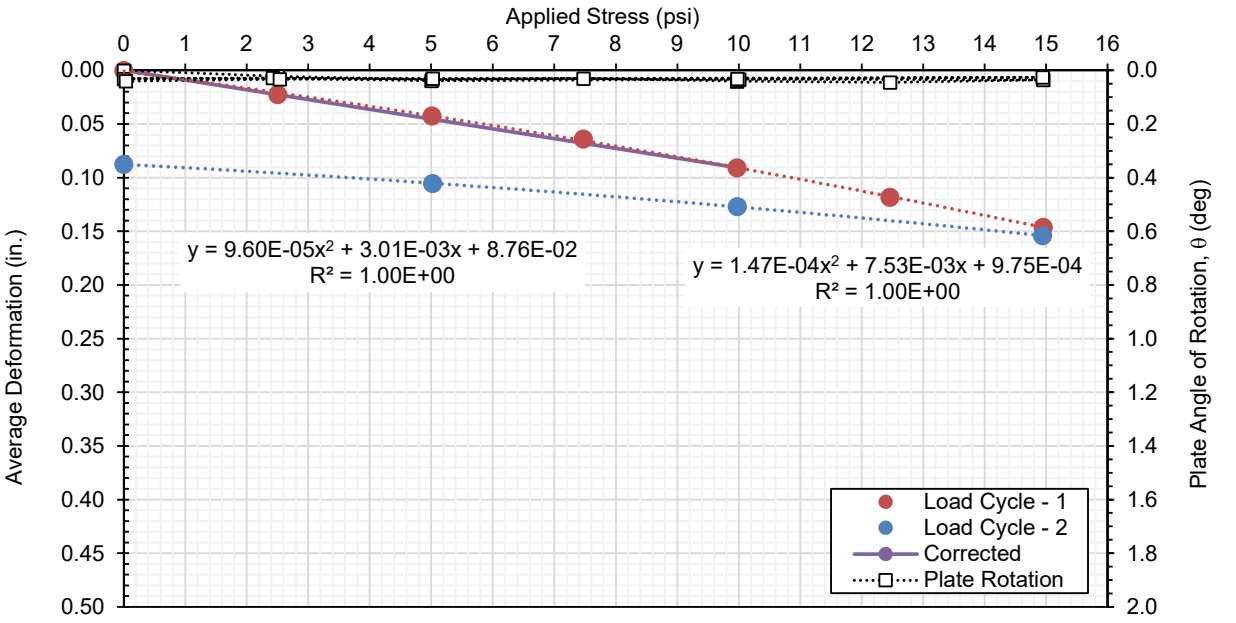
Project Name: Iowa TDIP-AID Demonstration Project
Project ID: SIA-00003
Location: US30, Tama County, IA

ingios GEOTECHNICS

Polynomial Fit Parameters

First Cycle		*Second Cycle*			
a_1	1.47E-04	a_1	9.60E-05	θ_{max} (deg)	0.0447
a_2	7.53E-03	a_2	3.01E-03		
R^2	1.00	R^2	1.00		

NOTES:
1. Test performed per AASHTO T222/ASTM D1196.
2. k-value determined using:
   (a) calculated stress at 0.05 in. plate deformation (δ) for first loading cycle, per PCA design guidelines, and
   (b) for a defined target stress and calculating corresponding plate deformations using polynomial fit parameters.



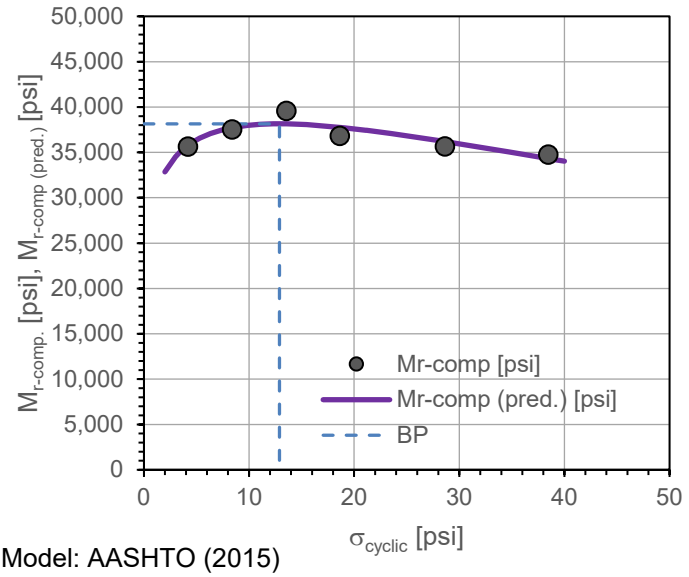
In-situ Modulus of Subgrade Reaction (k) and Elastic Modulus	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	US30, Tama County, IA

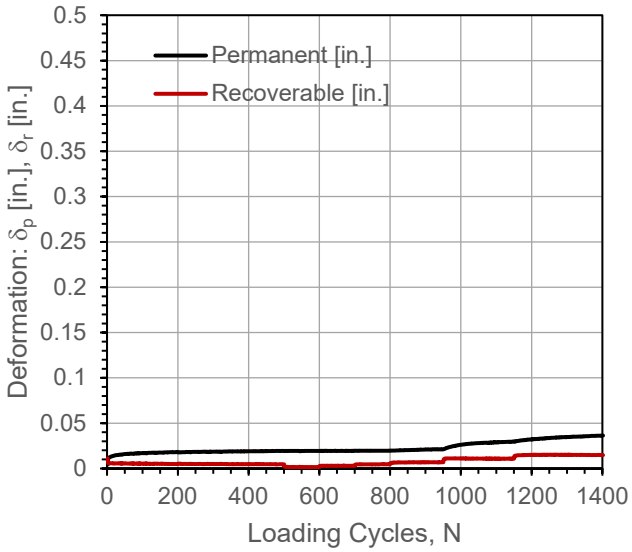
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	11:53:50 AM	Test ID	**pt_1**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.41759	Longitude,W:	94.69376	Elev. (ft):	386.5
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.55	---	---	0.0194	---	0.107	---
1	100	4.18	35,643	35,761	0.0193	-0.0001	0.042	Y
2	100	8.38	37,527	37,728	0.0195	0.0001	0.002	Y
3	100	13.55	39,579	38,145	0.0196	0.0003	0.152	Y
4	150	18.62	36,809	37,767	0.0212	0.0019	0.590	Y
5	200	28.62	35,655	36,196	0.0297	0.0103	0.646	N
6	250	38.46	34,755	34,325	0.0363	0.0169	0.628	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,739.5	1.46E-07
k^*_2	0.154	7.65E-02
k^*_3	-1.273	5.57E-02
Adj. R^2	0.707	
Std. Error [psi]	804	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	38,151
$\sigma_{cyclic\text{-}BP}$ [psi]	12.9

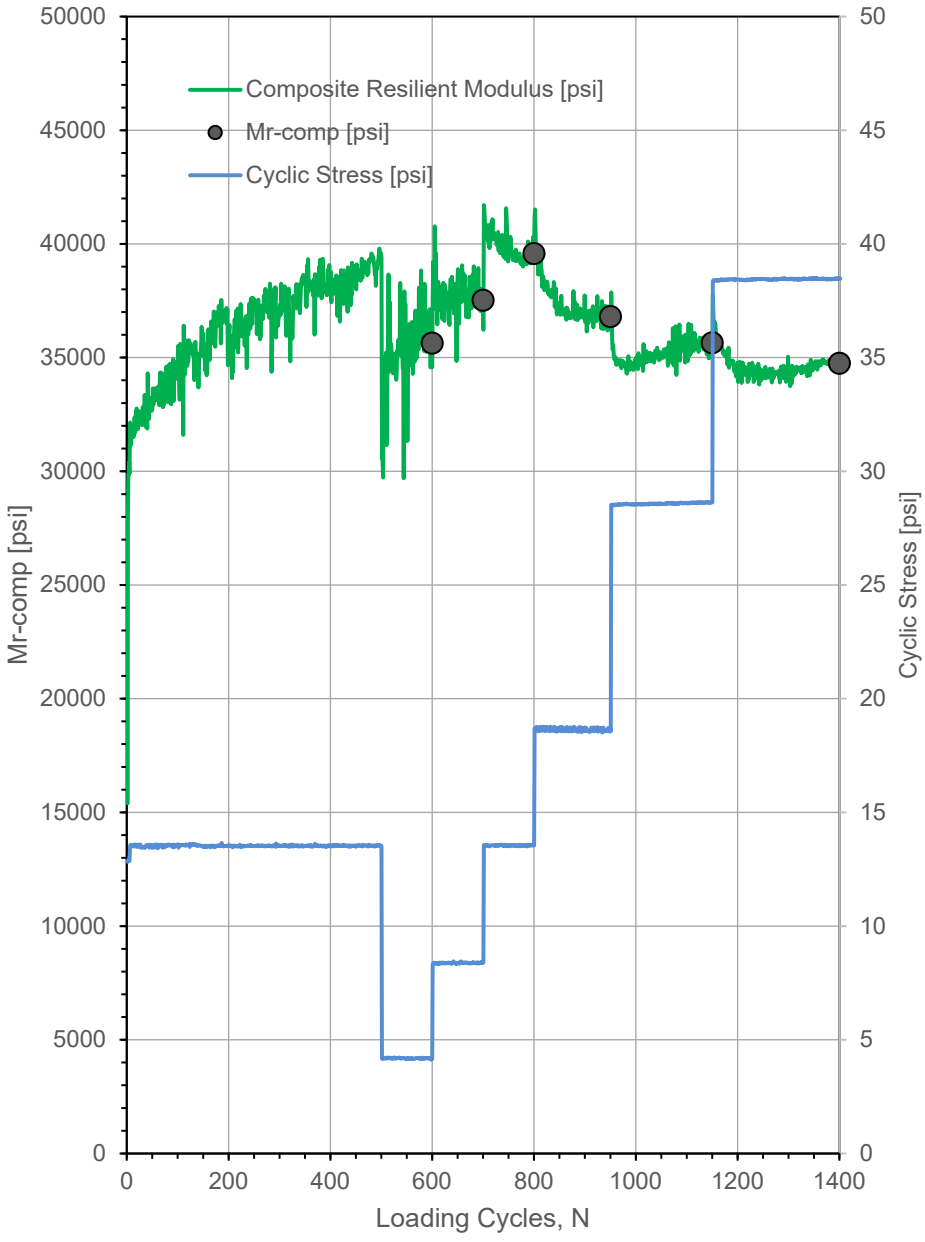
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	11:53:50 AM	Test ID	**pt_1**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417591	Longitude,W:	94.693764	Elev. (ft):	386.5
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	32,853
3	34,509
4	35,602
5	36,371
6	36,929
7	37,338
8	37,636
9	37,850
10	37,997
11	38,090
12	38,139
13	38,151
14	38,133
15	38,089
16	38,023
17	37,938
18	37,837
21	37,459
22	37,314
23	37,160
24	37,000
25	36,834
26	36,663
27	36,488
28	36,309
29	36,127
30	35,942
31	35,755
32	35,567
33	35,377
34	35,185
35	34,993
36	34,801
37	34,607
38	34,414
39	34,220
40	34,027



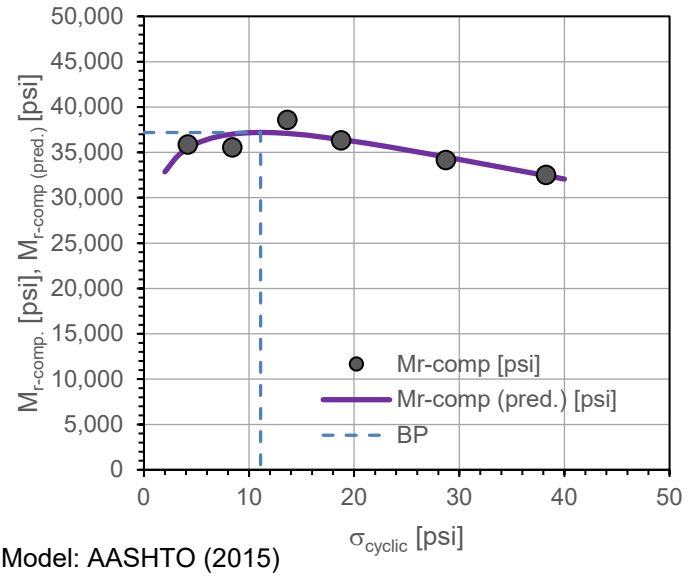
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

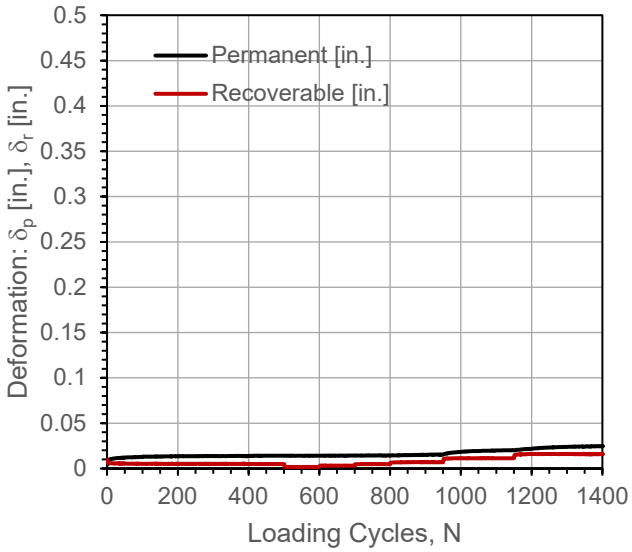
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	12:29:36 PM	Test ID	**pt_2**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.41759	Longitude,W:	94.69351	Elev. (ft):	387.2
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.64	---	---	0.0141	---	0.083	---
1	100	4.17	35,861	35,444	0.0141	0.0000	-0.013	Y
2	100	8.40	35,542	37,023	0.0142	0.0001	0.097	Y
3	100	13.64	38,582	37,083	0.0144	0.0003	0.079	Y
4	150	18.75	36,326	36,433	0.0153	0.0012	0.471	Y
5	200	28.72	34,155	34,490	0.0201	0.0060	0.499	Y
6	250	38.25	32,508	32,436	0.0246	0.0105	0.601	N



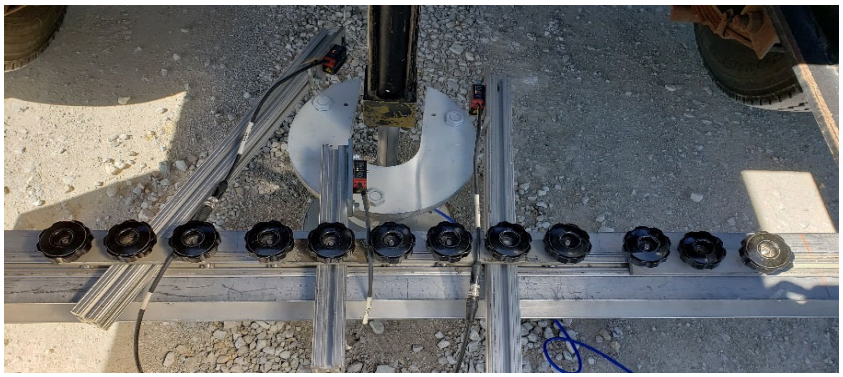


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,718.0	2.55E-07
k^*_2	0.145	1.27E-01
k^*_3	-1.372	7.16E-02
Adj. R^2	0.719	
Std. Error [psi]	952	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	37,194
$\sigma_{cyclic\text{-}BP}$ [psi]	11.1



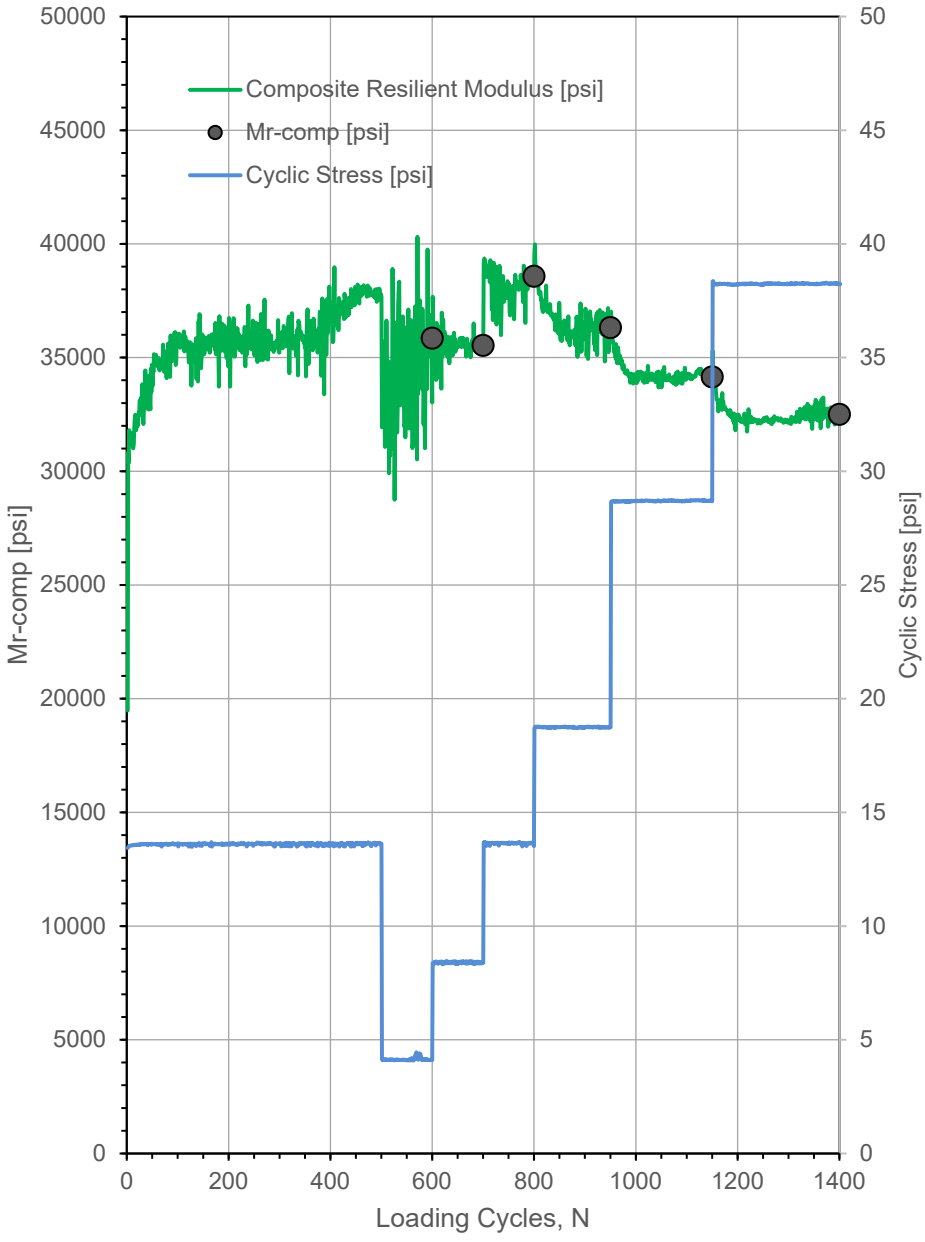
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	12:29:36 PM	Test ID	**pt_2**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417587	Longitude,W:	94.693512	Elev. (ft):	387.2
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	32,857
3	34,354
4	35,317
5	35,973
6	36,430
7	36,747
8	36,961
9	37,096
10	37,170
11	37,194
12	37,178
13	37,129
14	37,053
15	36,953
16	36,835
17	36,700
18	36,552
21	36,042
22	35,856
23	35,664
24	35,467
25	35,266
26	35,061
27	34,853
28	34,642
29	34,430
30	34,216
31	34,002
32	33,786
33	33,570
34	33,353
35	33,137
36	32,921
37	32,705
38	32,490
39	32,276
40	32,063



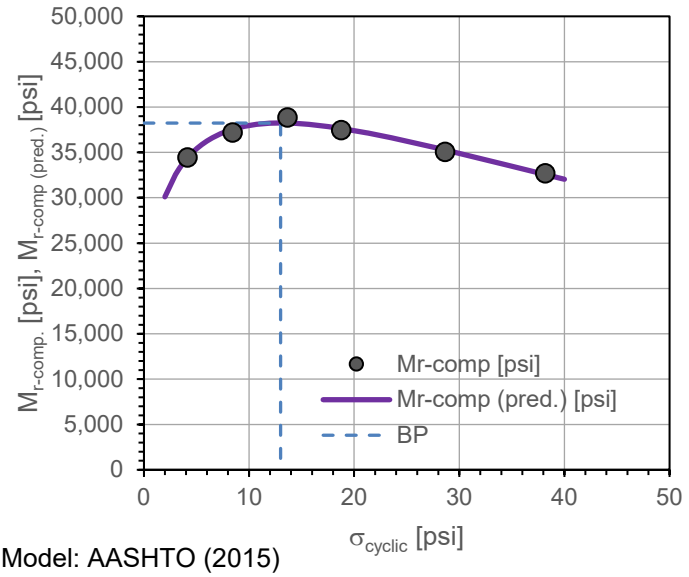
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

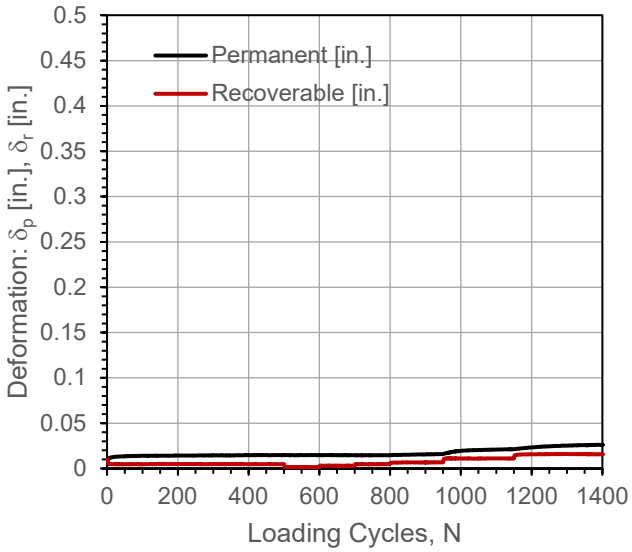
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	1:05:25 PM	Test ID	**pt_3**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417606	Longitude,W:	94.693390	Elev. (ft):	384.3
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.65	---	---	0.0147	---	0.056	---
1	100	4.14	34,445	34,385	0.0147	0.0001	0.018	Y
2	100	8.42	37,182	37,545	0.0147	0.0000	-0.034	Y
3	100	13.65	38,843	38,228	0.0147	0.0000	0.057	Y
4	150	18.77	37,446	37,643	0.0159	0.0012	0.448	Y
5	200	28.64	35,047	35,271	0.0213	0.0066	0.522	N
6	250	38.16	32,683	32,564	0.0262	0.0116	0.624	N



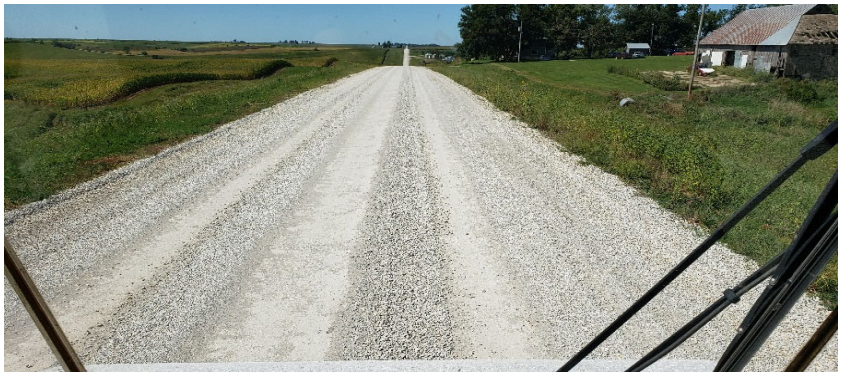


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,826.5	1.11E-08
k^*_2	0.244	2.10E-03
k^*_3	-1.998	1.48E-03
Adj. R^2	0.970	
Std. Error [psi]	385	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	38,237
$\sigma_{cyclic\text{-}BP}$ [psi]	13.0



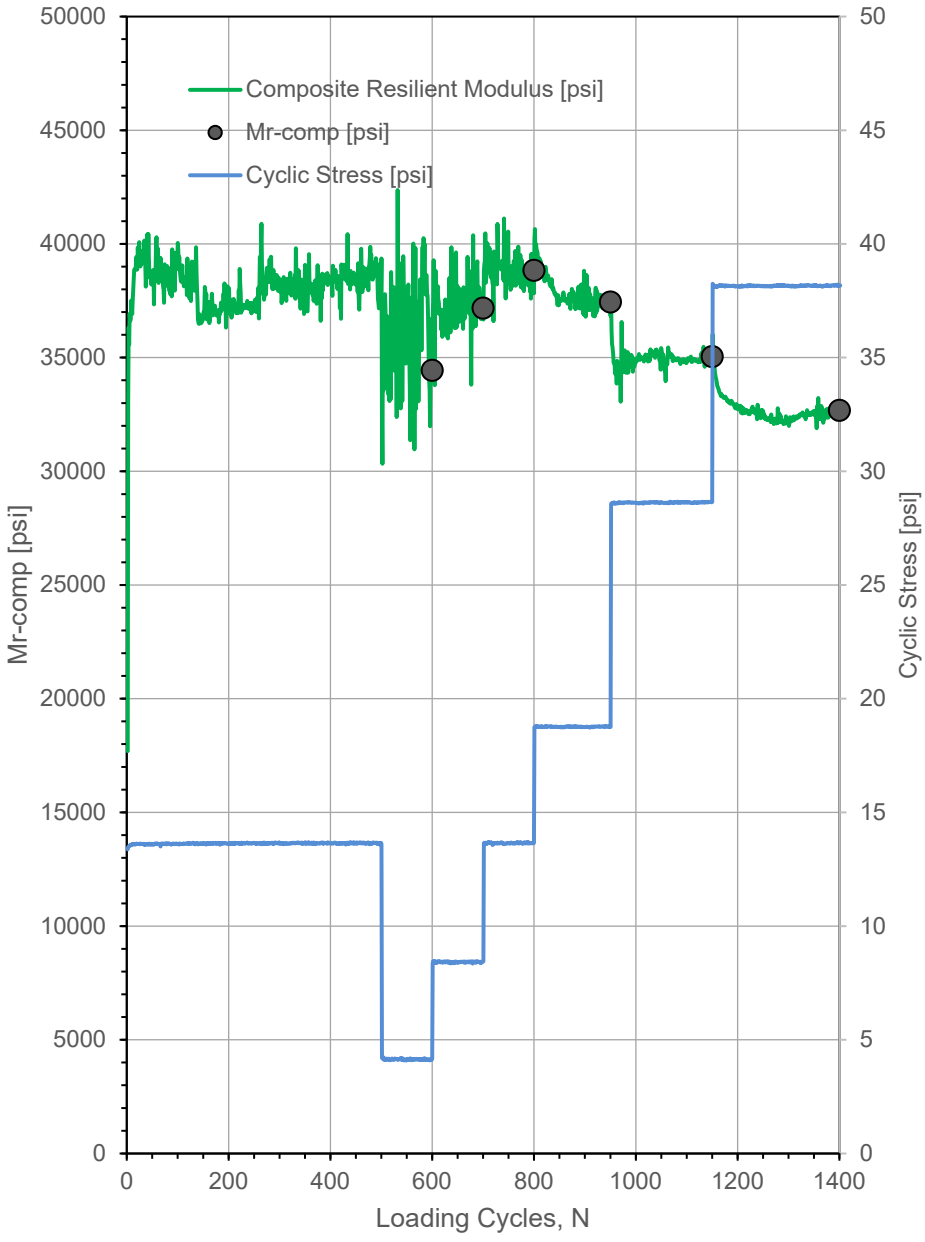
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	1:05:25 PM	Test ID	**pt_3**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417606	Longitude,W:	94.693390	Elev. (ft):	384.3
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	30,095
3	32,544
4	34,202
5	35,389
6	36,261
7	36,908
8	37,385
9	37,730
10	37,970
11	38,125
12	38,210
13	38,237
14	38,216
15	38,153
16	38,055
17	37,928
18	37,775
21	37,199
22	36,976
23	36,742
24	36,497
25	36,244
26	35,984
27	35,718
28	35,446
29	35,171
30	34,892
31	34,611
32	34,327
33	34,042
34	33,756
35	33,470
36	33,183
37	32,897
38	32,610
39	32,325
40	32,041



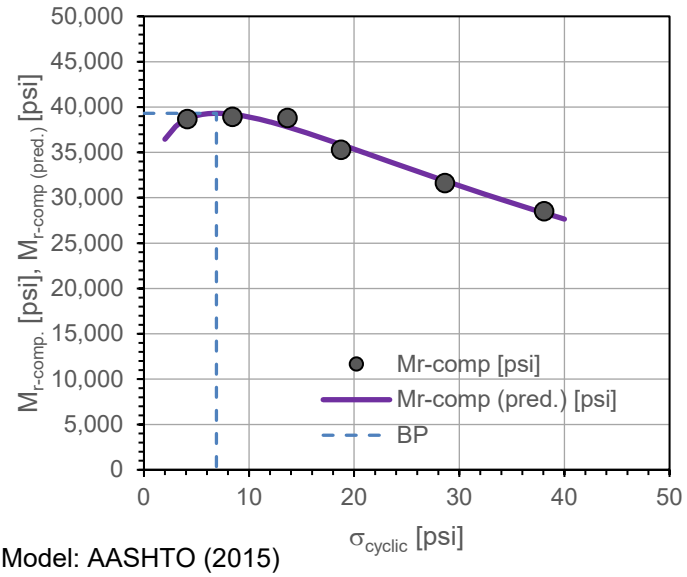
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

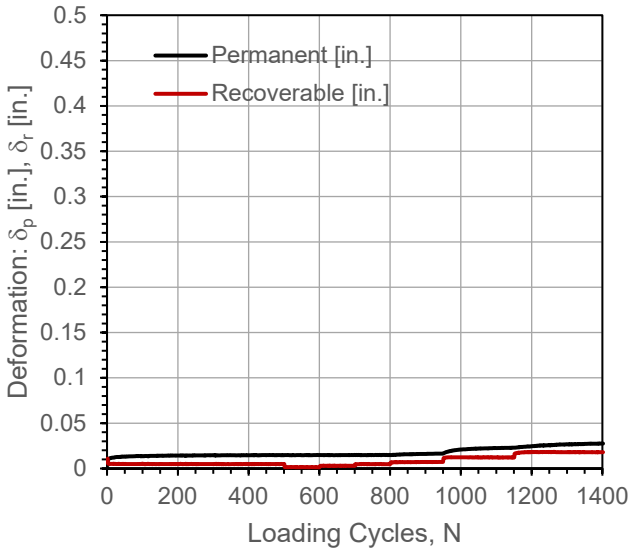
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	1:40:29 PM	Test ID	**pt_4**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417587	Longitude,W:	94.693222	Elev. (ft):	385.7
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.64	---	---	0.0146	---	0.071	---
1	100	4.12	38,668	38,689	0.0148	0.0002	-0.007	Y
2	100	8.41	38,926	39,206	0.0149	0.0002	-0.032	Y
3	100	13.64	38,786	37,821	0.0149	0.0003	0.043	Y
4	150	18.75	35,280	35,869	0.0164	0.0018	0.567	Y
5	200	28.63	31,621	31,858	0.0228	0.0082	0.465	Y
6	250	38.06	28,506	28,320	0.0275	0.0129	0.672	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

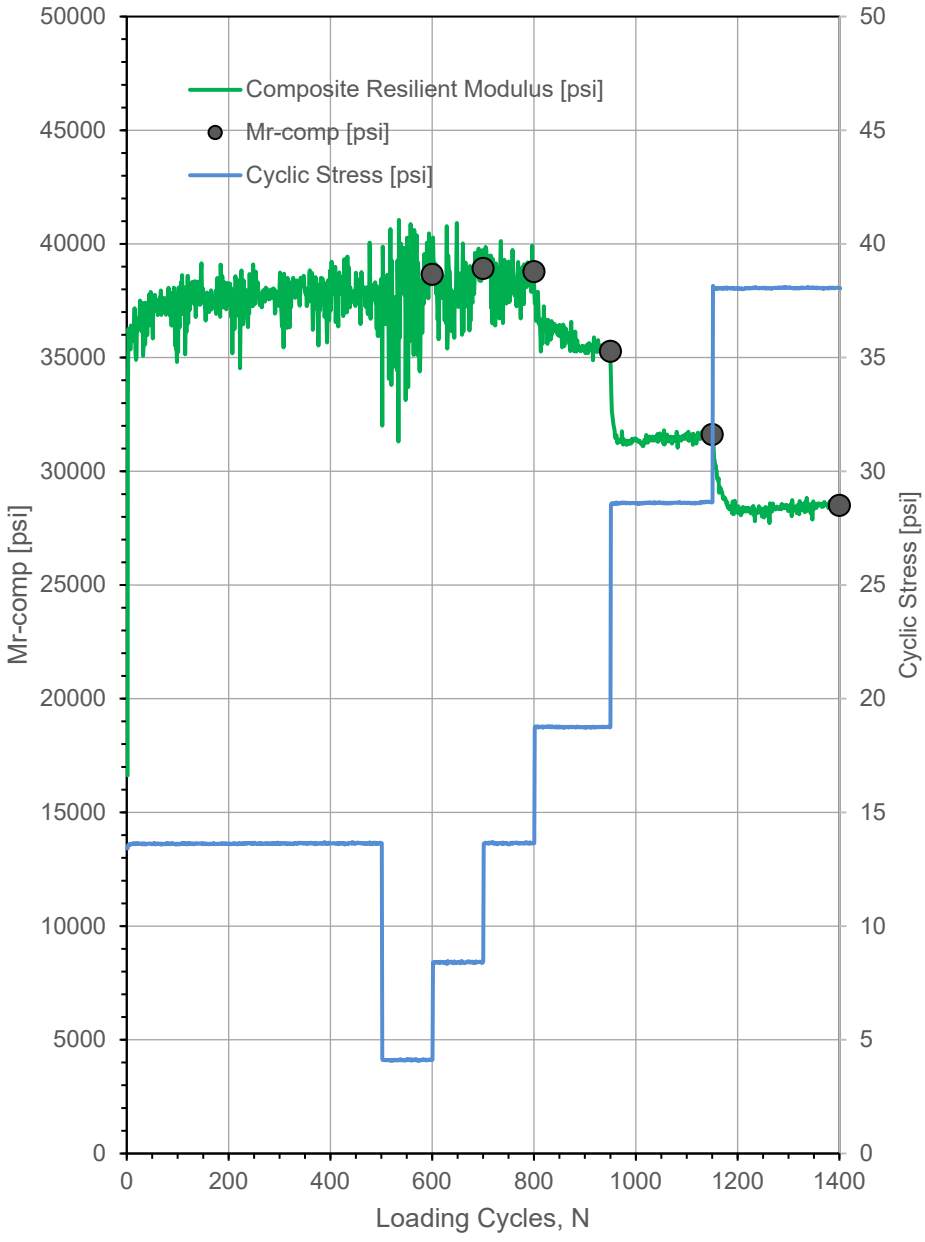
Parameter	Value	P-Value
k^*_1	3,074.9	4.15E-08
k^*_2	0.148	2.98E-02
k^*_3	-2.150	4.41E-03
Adj. R^2	0.981	
Std. Error [psi]	594	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	39,315
$\sigma_{cyclic\text{-}BP}$ [psi]	6.9

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	1:40:29 PM	Test ID	**pt_4**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417587	Longitude,W:	94.693222	Elev. (ft):	385.7
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	36,444
3	37,843
4	38,624
5	39,055
6	39,262
7	39,315
8	39,256
9	39,113
10	38,908
11	38,654
12	38,362
13	38,040
14	37,695
15	37,332
16	36,955
17	36,567
18	36,170
21	34,953
22	34,543
23	34,133
24	33,724
25	33,316
26	32,910
27	32,507
28	32,107
29	31,711
30	31,319
31	30,930
32	30,546
33	30,167
34	29,792
35	29,422
36	29,057
37	28,697
38	28,341
39	27,991
40	27,646



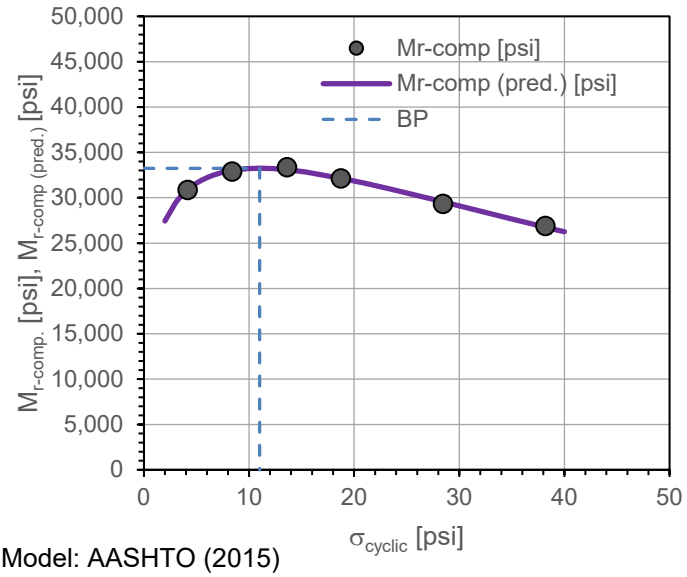
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

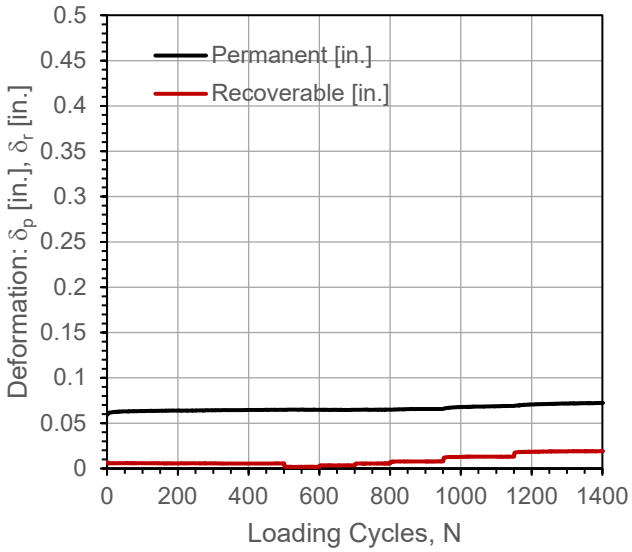
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	2:19:08 PM	Test ID	**pt_5**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.41760	Longitude,W:	94.69301	Elev. (ft):	382.5
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.60	---	---	0.0647	---	0.012	---
1	100	4.14	30,862	30,856	0.0648	0.0001	0.000	Y
2	100	8.38	32,890	33,020	0.0647	0.0001	-0.065	Y
3	100	13.60	33,352	33,080	0.0650	0.0003	0.156	Y
4	150	18.73	32,123	32,151	0.0657	0.0010	0.406	Y
5	200	28.44	29,319	29,548	0.0690	0.0043	0.396	Y
6	250	38.18	26,876	26,762	0.0724	0.0077	0.494	Y





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,533.9	2.65E-09
k^*_2	0.226	6.17E-04
k^*_3	-2.157	2.75E-04
Adj. R^2	0.994	
Std. Error [psi]	197	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		33,245
	$\sigma_{cyclic\text{-}BP}$ [psi]	11.0

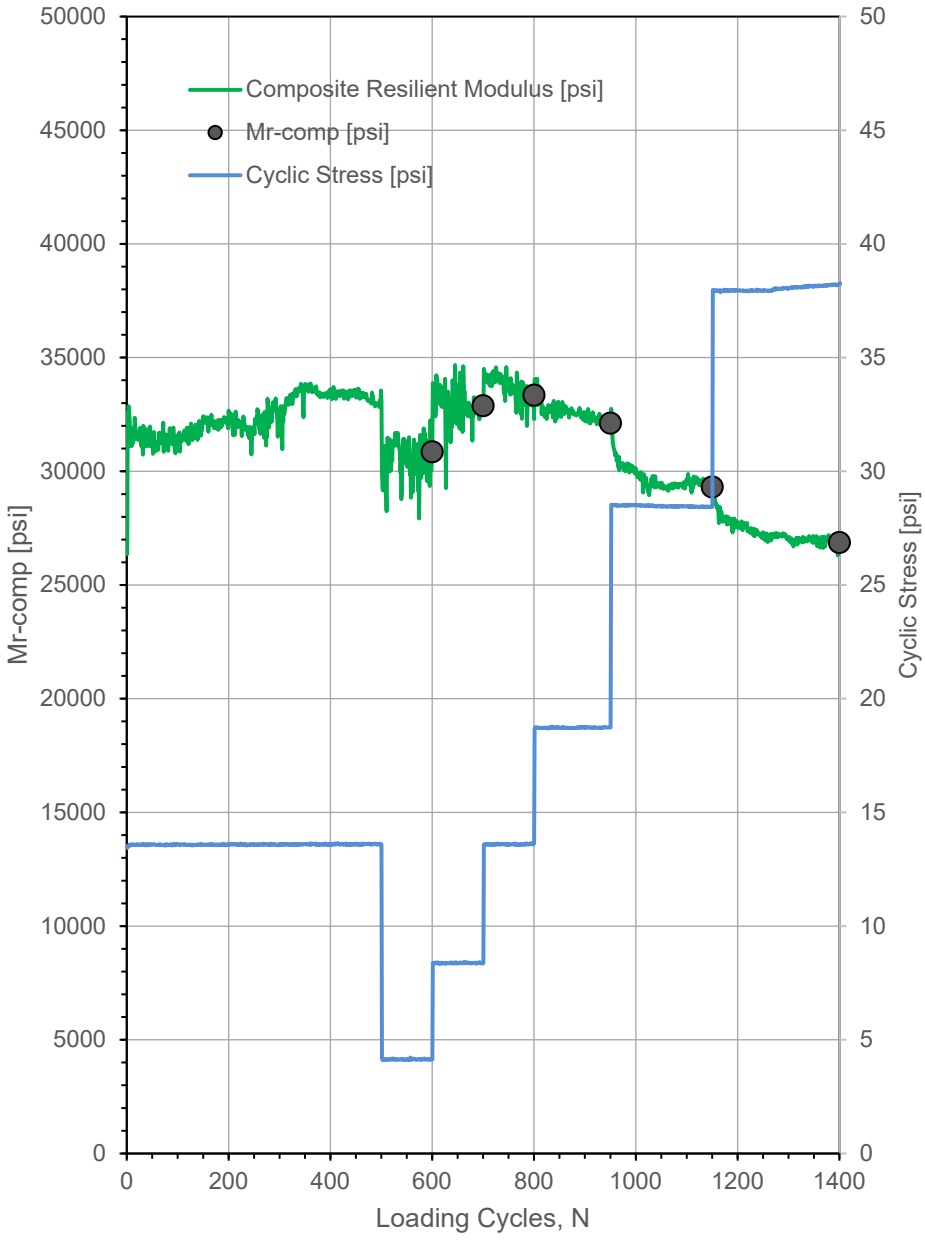
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	2:19:08 PM	Test ID	**pt_5**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417595	Longitude,W:	94.693008	Elev. (ft):	382.5
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	27,452
3	29,421
4	30,709
5	31,596
6	32,217
7	32,649
8	32,940
9	33,122
10	33,218
11	33,245
12	33,217
13	33,143
14	33,031
15	32,887
16	32,718
17	32,526
18	32,315
21	31,600
22	31,341
23	31,075
24	30,803
25	30,526
26	30,245
27	29,961
28	29,675
29	29,388
30	29,099
31	28,811
32	28,522
33	28,234
34	27,947
35	27,661
36	27,376
37	27,093
38	26,812
39	26,533
40	26,257



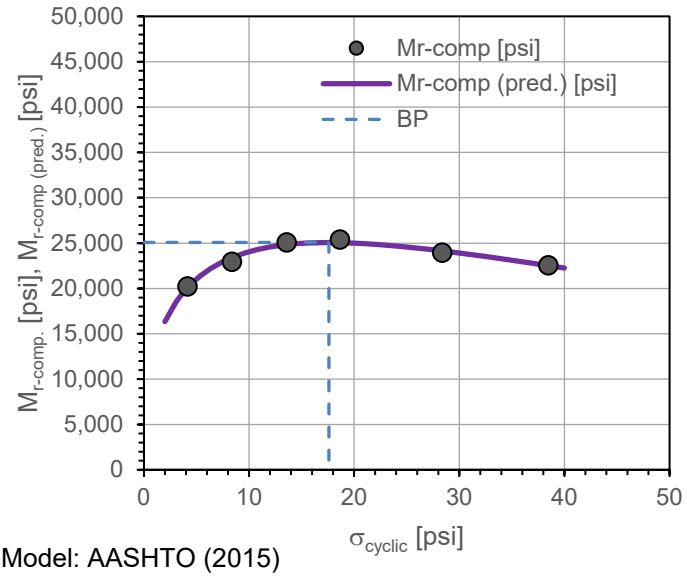
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

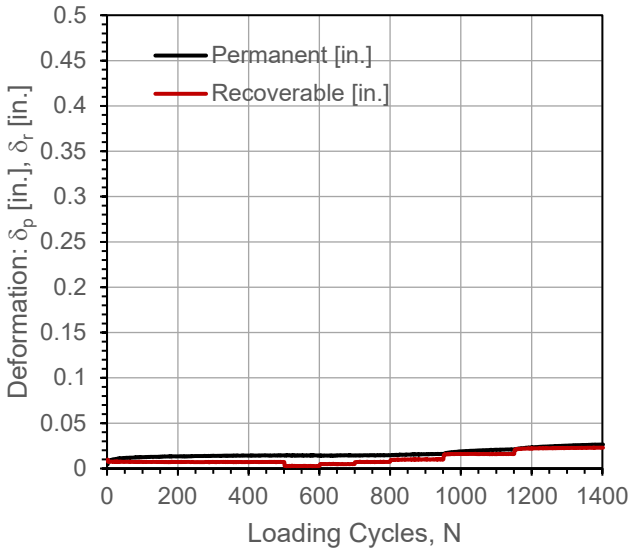
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	3:00:20 PM	Test ID	**pt_6**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.41761	Longitude,W:	94.68527	Elev. (ft):	412.2
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.57	---	---	0.0144	---	0.115	---
1	100	4.14	20,215	20,072	0.0141	-0.0004	-0.096	Y
2	100	8.37	22,924	23,404	0.0145	0.0000	0.200	Y
3	100	13.57	25,061	24,836	0.0145	0.0001	0.128	Y
4	150	18.65	25,376	25,059	0.0161	0.0017	0.455	Y
5	200	28.37	23,941	24,152	0.0212	0.0067	0.529	N
6	250	38.46	22,551	22,532	0.0265	0.0120	0.640	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,742.3	3.26E-08
k^*_2	0.351	1.73E-03
k^*_3	-2.217	2.60E-03
Adj. R^2	0.969	
Std. Error [psi]	326	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		25,071
	$\sigma_{cyclic\text{-}BP}$ [psi]	17.6

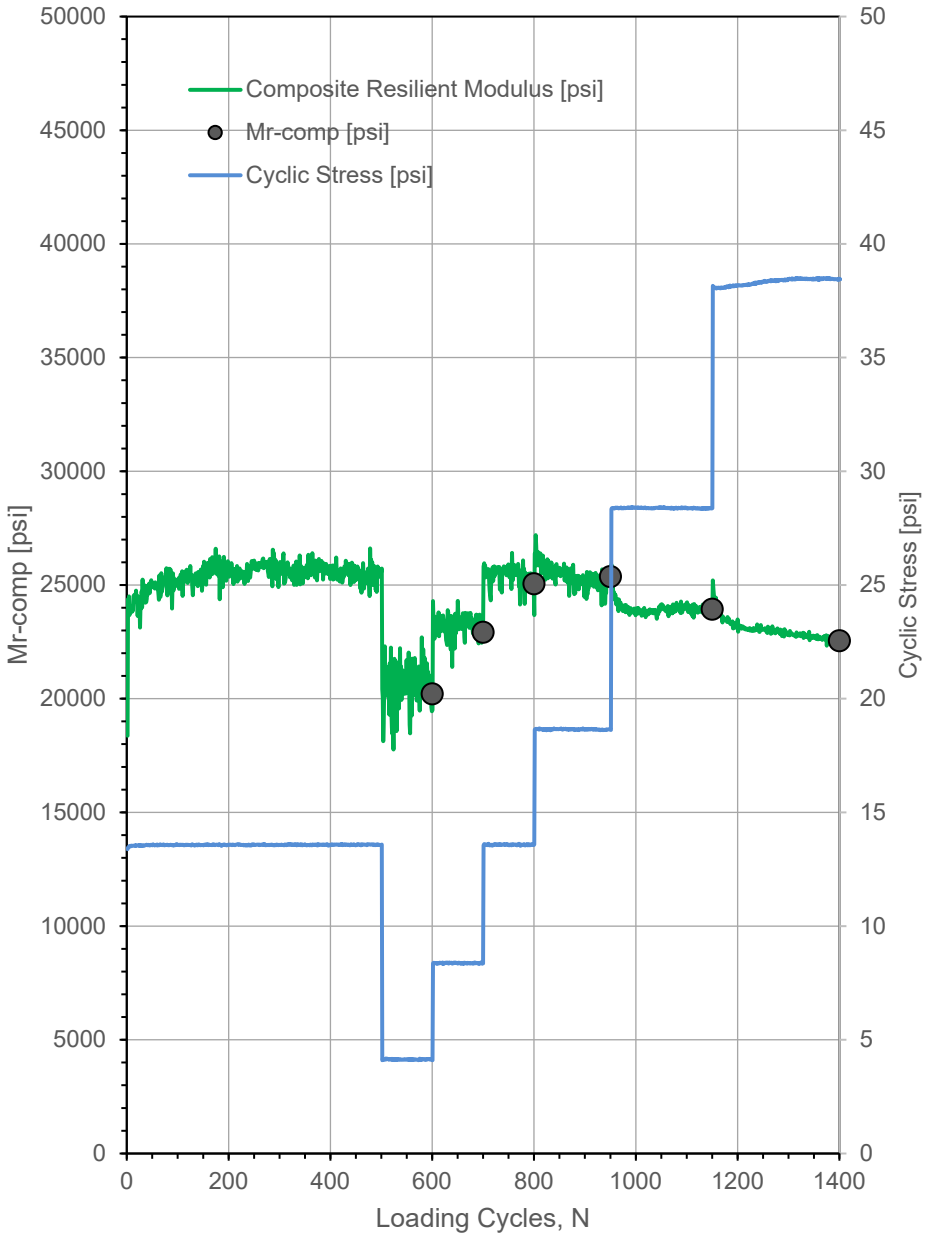
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	3:00:20 PM	Test ID	**pt_6**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417614	Longitude,W:	94.685272	Elev. (ft):	412.2
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	16,333
3	18,403
4	19,900
5	21,041
6	21,936
7	22,649
8	23,221
9	23,682
10	24,051
11	24,346
12	24,577
13	24,755
14	24,887
15	24,980
16	25,038
17	25,067
18	25,070
21	24,952
22	24,879
23	24,792
24	24,694
25	24,584
26	24,465
27	24,338
28	24,204
29	24,063
30	23,916
31	23,765
32	23,609
33	23,449
34	23,287
35	23,121
36	22,953
37	22,784
38	22,612
39	22,440
40	22,266



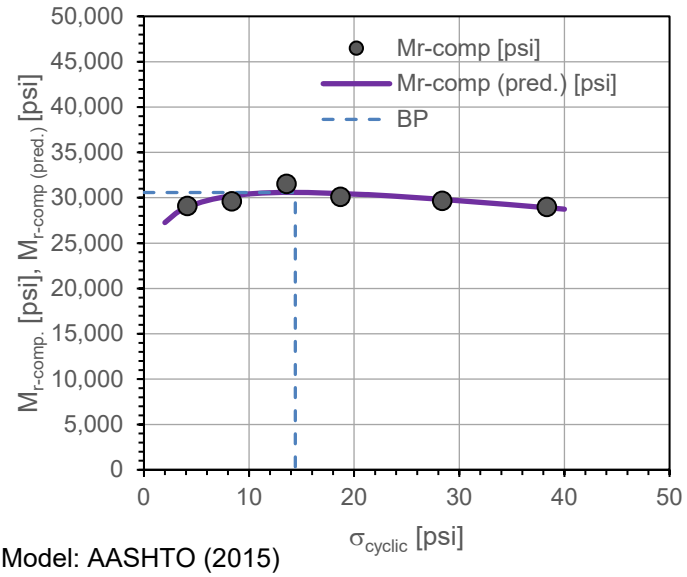
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

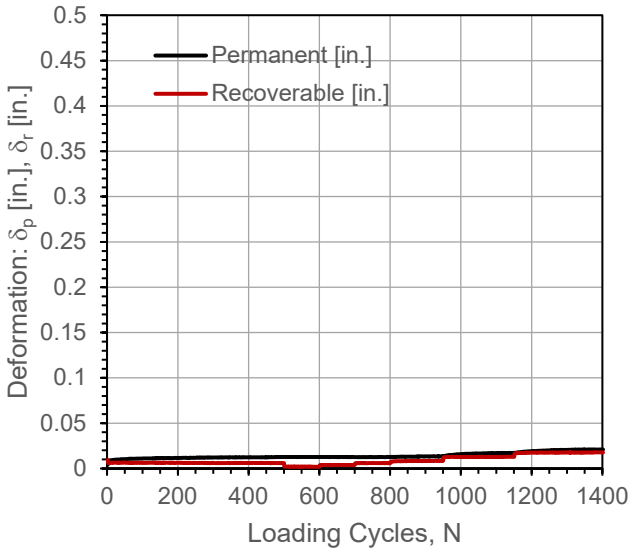
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	3:40:10 PM	Test ID	**pt_7**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.41760	Longitude,W:	94.68398	Elev. (ft):	417.4
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.56	---	---	0.0126	---	0.093	---
1	100	4.12	29,092	28,964	0.0126	0.0000	0.017	Y
2	100	8.35	29,599	30,209	0.0127	0.0001	-0.048	Y
3	100	13.56	31,531	30,575	0.0128	0.0002	0.104	Y
4	150	18.68	30,094	30,476	0.0134	0.0008	0.483	Y
5	200	28.36	29,650	29,812	0.0172	0.0046	0.450	Y
6	250	38.33	28,989	28,894	0.0210	0.0084	0.580	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

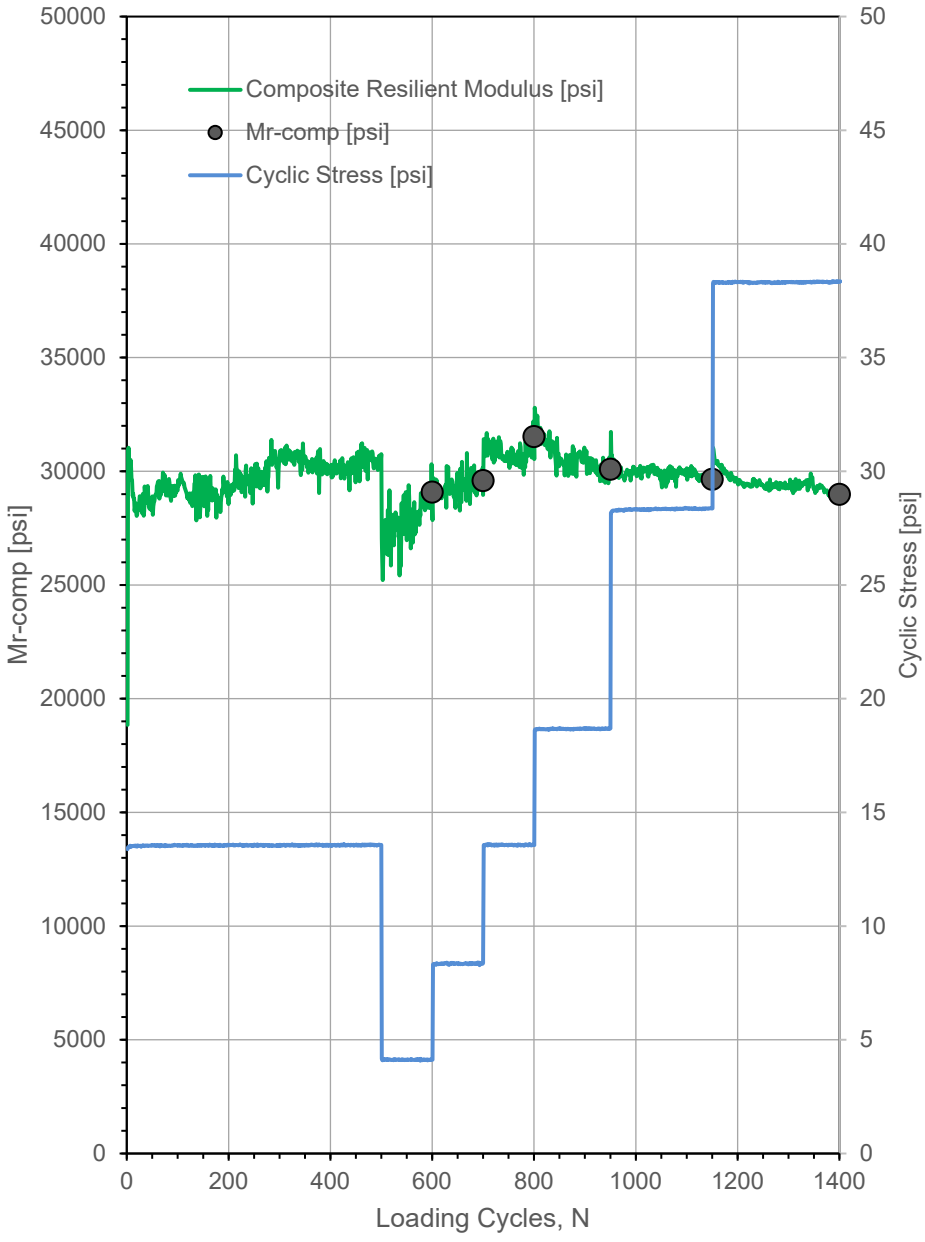
Parameter	Value	P-Value
k^*_1	2,136.8	8.52E-08
k^*_2	0.108	1.00E-01
k^*_3	-0.814	9.37E-02
Adj. R^2	0.569	
Std. Error [psi]	486	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	30,580
$\sigma_{cyclic\text{-}BP}$ [psi]	14.4

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	3:40:10 PM	Test ID	**pt_7**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417603	Longitude,W:	94.683983	Elev. (ft):	417.4
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	27,261
3	28,247
4	28,899
5	29,362
6	29,704
7	29,960
8	30,153
9	30,299
10	30,406
11	30,483
12	30,534
13	30,565
14	30,579
15	30,577
16	30,563
17	30,538
18	30,504
21	30,356
22	30,294
23	30,228
24	30,158
25	30,084
26	30,006
27	29,926
28	29,843
29	29,758
30	29,670
31	29,581
32	29,491
33	29,399
34	29,306
35	29,212
36	29,118
37	29,022
38	28,926
39	28,830
40	28,733



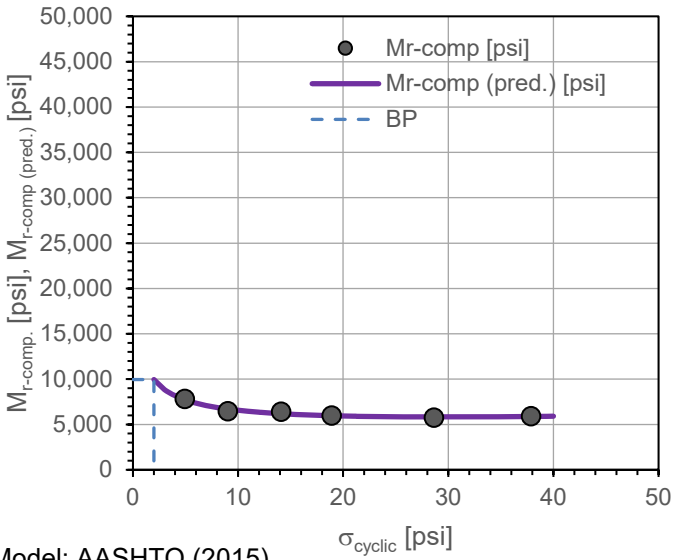
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

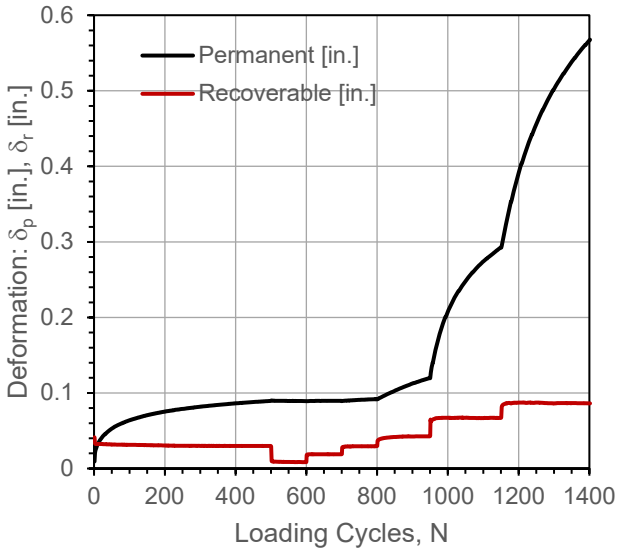
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	4:36:12 PM	Test ID	**pt_8**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417381	Longitude,W:	94.657326	Elev. (ft):	399.3
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.09	---	---	0.0895	---	0.262	---
1	100	4.92	7,816	7,726	0.0892	-0.0003	-0.386	Y
2	100	9.02	6,445	6,700	0.0896	0.0001	0.261	Y
3	100	14.09	6,406	6,185	0.0918	0.0023	0.625	N
4	150	18.89	5,975	5,964	0.1198	0.0303	0.930	N
5	200	28.62	5,751	5,832	0.2927	0.2032	0.736	N
6	250	37.87	5,905	5,880	0.5665	0.4771	0.884	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	451.9	4.63E-07
k^*_2	-0.328	2.38E-02
k^*_3	1.371	8.26E-02
Adj. R^2	0.943	
Std. Error [psi]	174	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		9,961
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

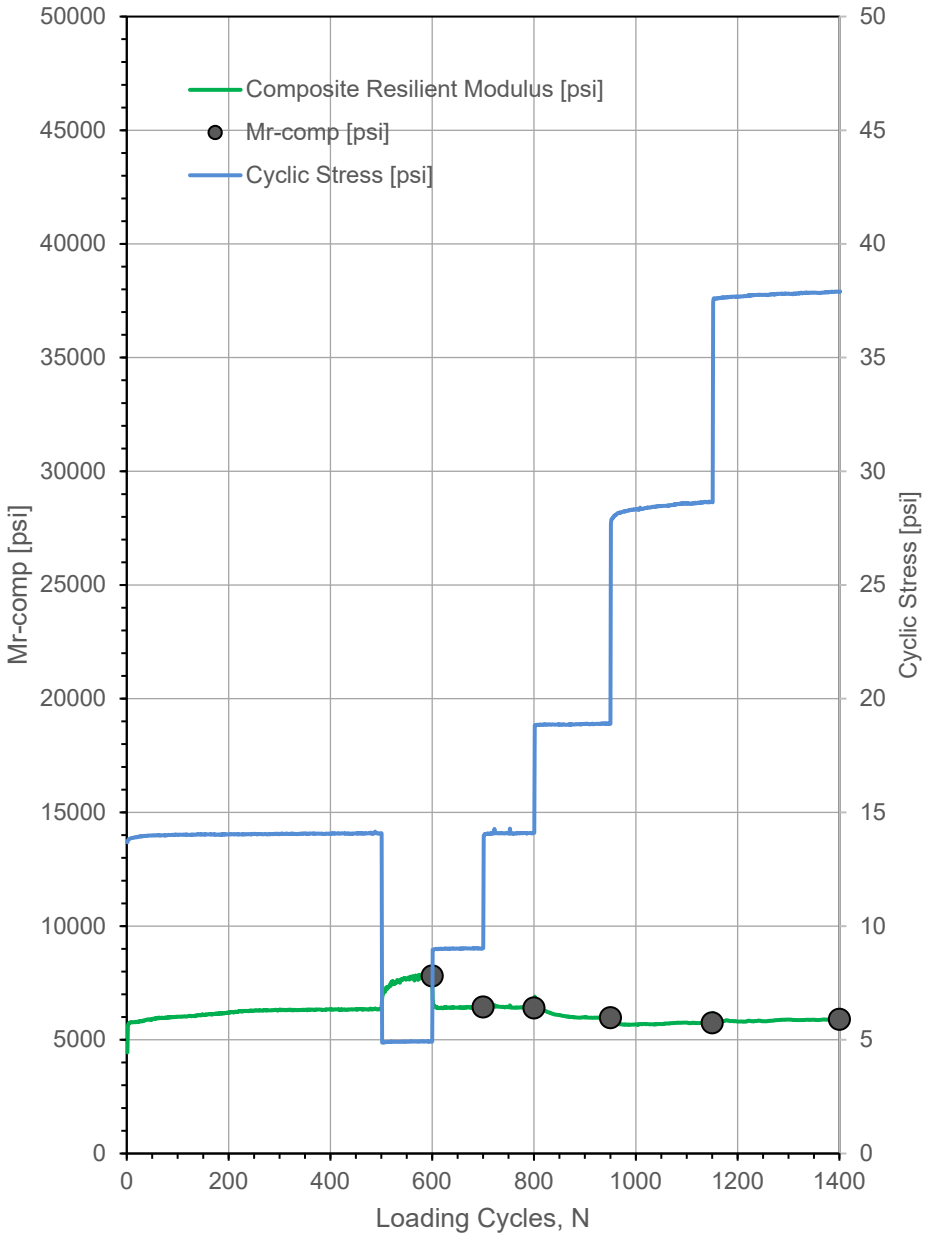
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/13/2019	Time:	4:36:12 PM	Test ID	**pt_8**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	41.417381	Longitude,W:	94.657326	Elev. (ft):	399.3
Comments:	Crushed limestone modified subbase over subgrade with geogrid at the interface.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	9,961
3	8,847
4	8,165
5	7,696
6	7,351
7	7,085
8	6,874
9	6,703
10	6,562
11	6,445
12	6,346
13	6,262
14	6,190
15	6,129
16	6,077
17	6,032
18	5,994
21	5,909
22	5,890
23	5,874
24	5,860
25	5,850
26	5,842
27	5,837
28	5,833
29	5,832
30	5,832
31	5,834
32	5,837
33	5,841
34	5,847
35	5,854
36	5,863
37	5,872
38	5,882
39	5,893
40	5,905



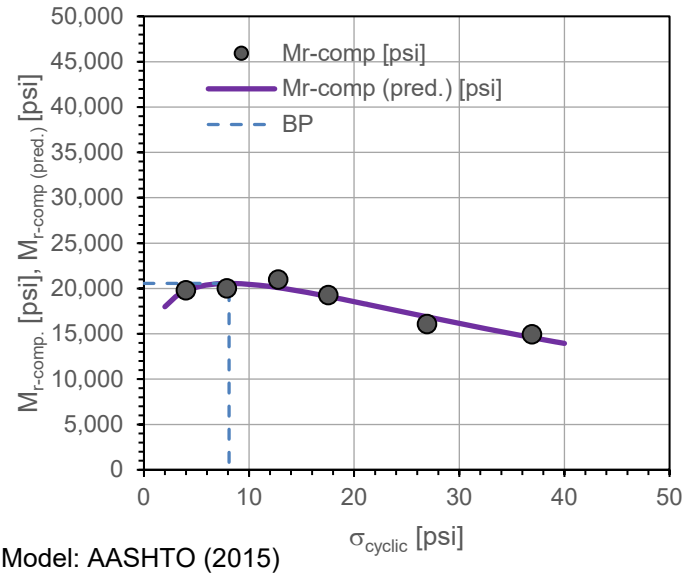
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	160th St., Adair County, IA

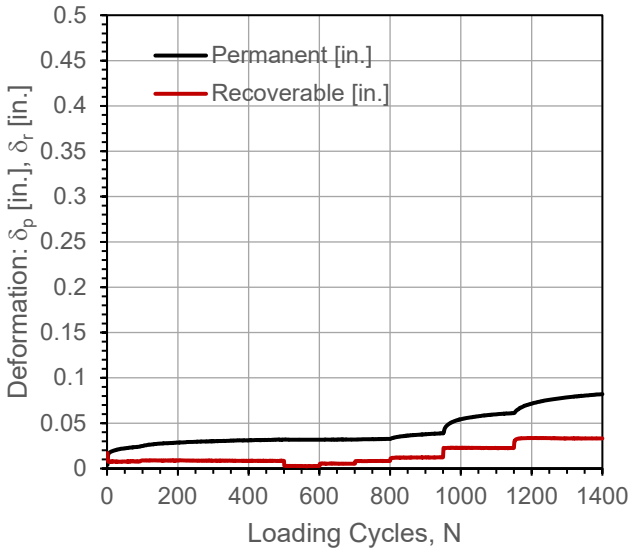
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	10:40:16 AM	Test ID	**Hwy20_pt_11**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.45317	Longitude,W:	92.31841	Elev. (ft):	879.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	12.76	---	---	0.0318	---	0.164	---
1	100	3.97	19,788	19,723	0.0317	-0.0001	-0.179	Y
2	100	7.88	20,003	20,556	0.0319	0.0001	0.329	Y
3	100	12.76	20,967	20,098	0.0327	0.0008	0.495	Y
4	150	17.53	19,263	19,128	0.0388	0.0069	0.583	N
5	200	26.92	16,074	16,876	0.0611	0.0293	0.472	N
6	250	36.90	14,939	14,593	0.0820	0.0502	0.571	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,654.8	6.81E-07
k^*_2	0.214	8.84E-02
k^*_3	-2.673	2.53E-02
Adj. R^2	0.921	
Std. Error [psi]	648	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	20,558
$\sigma_{cyclic\text{-}BP}$ [psi]	8.1

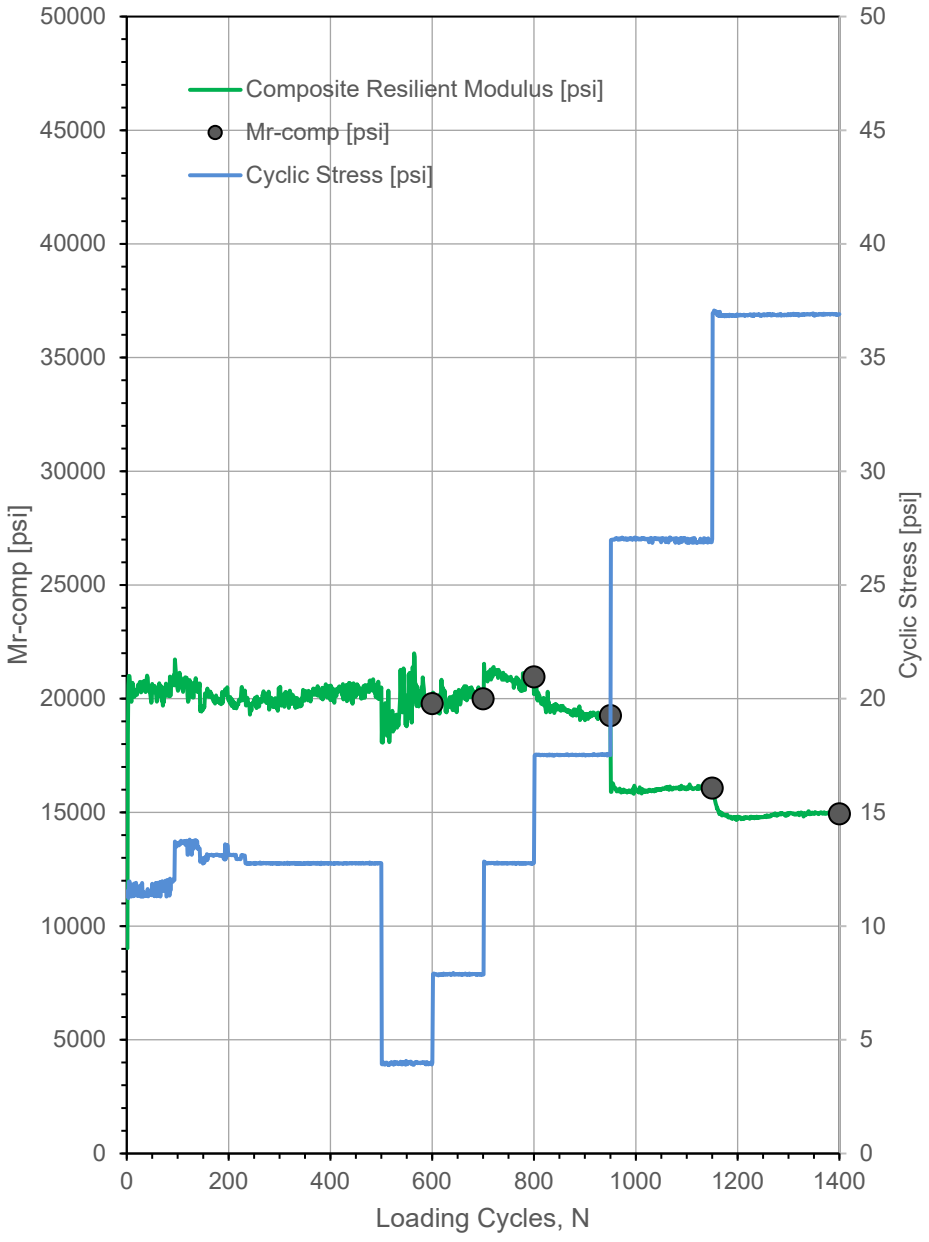
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	10:40:16 AM	Test ID	**Hwy20_pt_11**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.453170	Longitude,W:	92.318415	Elev. (ft):	879.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	17,987
3	19,077
4	19,736
5	20,144
6	20,387
7	20,515
8	20,558
9	20,537
10	20,467
11	20,358
12	20,220
13	20,057
14	19,874
15	19,677
16	19,467
17	19,248
18	19,021
21	18,312
22	18,070
23	17,827
24	17,584
25	17,341
26	17,099
27	16,858
28	16,618
29	16,381
30	16,145
31	15,912
32	15,682
33	15,454
34	15,229
35	15,007
36	14,788
37	14,572
38	14,360
39	14,150
40	13,944



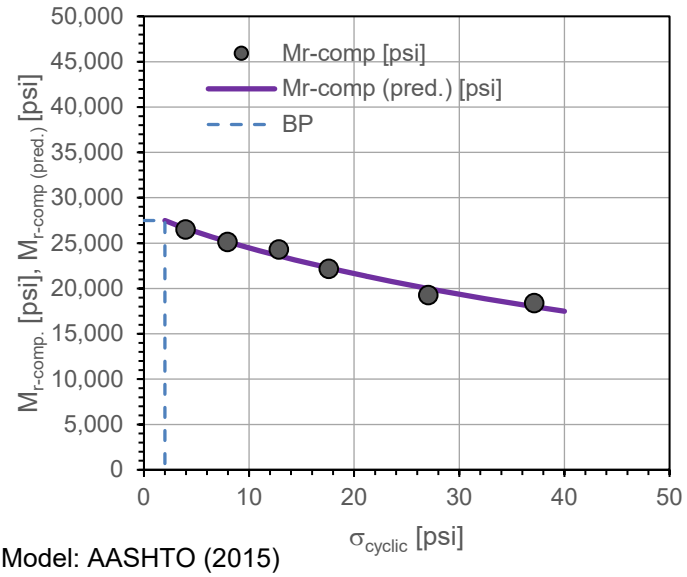
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

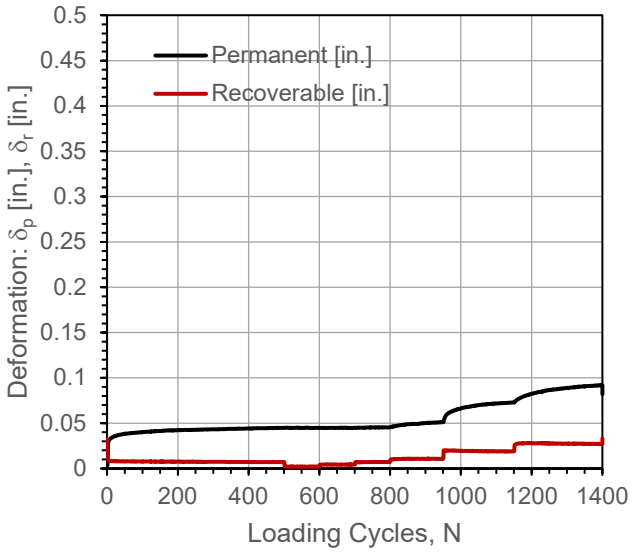
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	11:23:47 AM	Test ID	**Hwy20_pt_12**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.453069	Longitude,W:	92.319122	Elev. (ft):	883.2
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	12.82	---	---	0.0448	---	0.097	---
1	100	3.96	26,504	26,639	0.0448	0.0000	-0.079	Y
2	100	7.94	25,121	25,167	0.0450	0.0002	0.094	Y
3	100	12.82	24,283	23,610	0.0454	0.0006	0.424	Y
4	150	17.58	22,157	22,269	0.0512	0.0064	0.581	N
5	200	27.04	19,254	19,991	0.0729	0.0281	0.458	N
6	250	37.12	18,386	17,997	0.0920	0.0472	0.599	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,903.4	2.17E-07
k^*_2	-0.008	9.00E-01
k^*_3	-1.278	6.43E-02
Adj. R^2	0.972	
Std. Error [psi]	535	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	27,489
$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

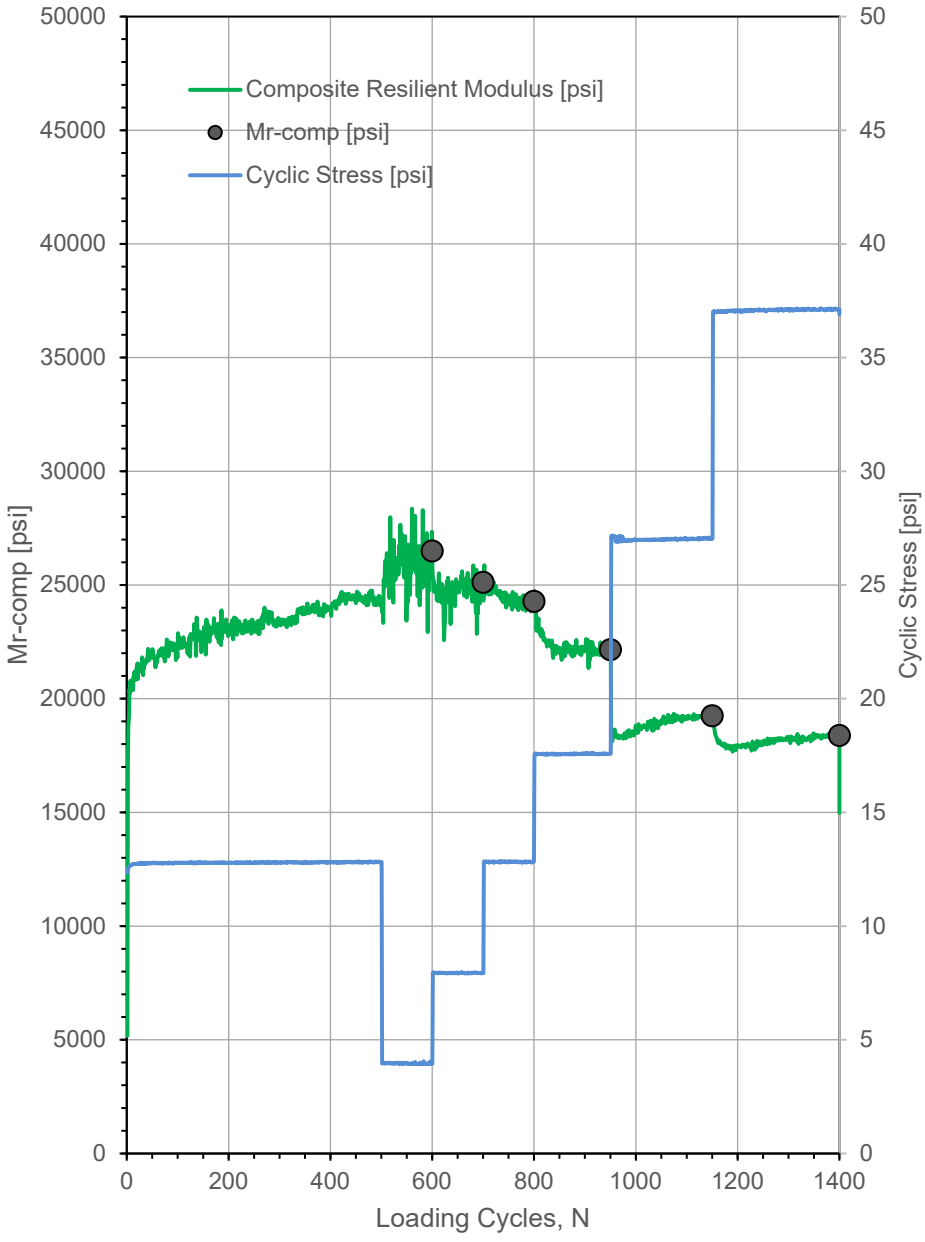
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	11:23:47 AM	Test ID	**Hwy20_pt_12**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.453069	Longitude,W:	92.319122	Elev. (ft):	883.2
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	27,489
3	27,037
4	26,621
5	26,229
6	25,854
7	25,495
8	25,147
9	24,810
10	24,484
11	24,166
12	23,857
13	23,556
14	23,263
15	22,977
16	22,697
17	22,424
18	22,157
21	21,392
22	21,148
23	20,909
24	20,674
25	20,445
26	20,220
27	20,000
28	19,784
29	19,573
30	19,365
31	19,162
32	18,962
33	18,766
34	18,574
35	18,385
36	18,200
37	18,018
38	17,839
39	17,664
40	17,491



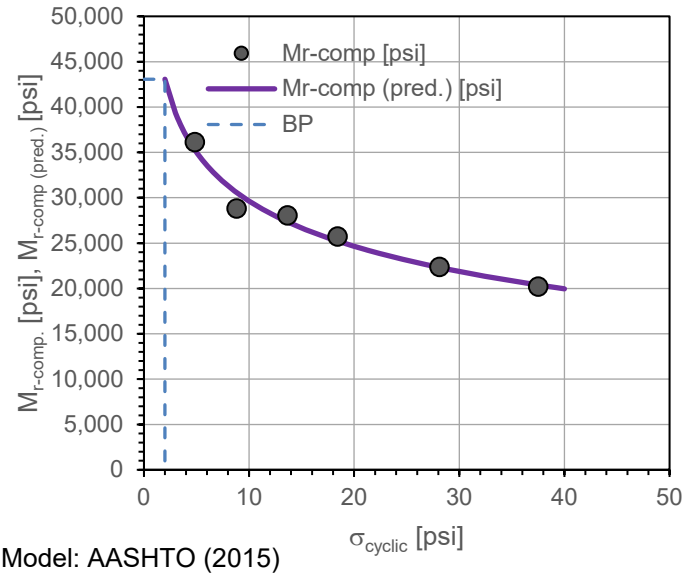
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

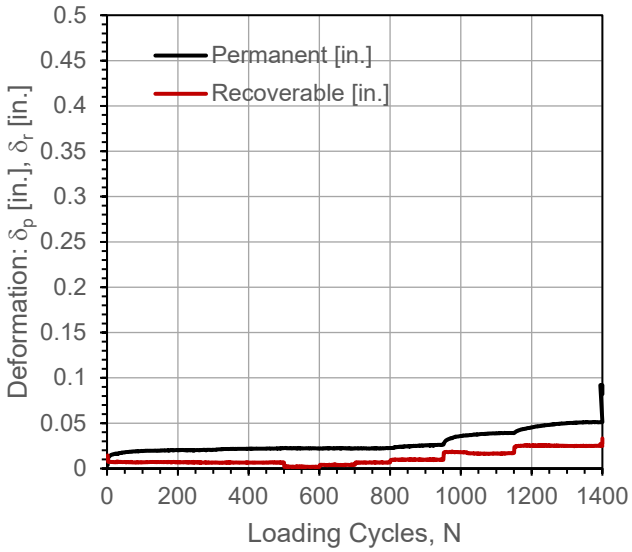
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	12:05:56 PM	Test ID	**Hwy20_pt_13**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.453084	Longitude,W:	92.319280	Elev. (ft):	883.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.65	---	---	0.0223	---	0.114	---
1	100	4.83	36,122	35,294	0.0221	-0.0002	-0.089	Y
2	100	8.80	28,802	30,584	0.0222	-0.0001	0.058	Y
3	100	13.65	28,048	27,358	0.0225	0.0002	0.137	Y
4	150	18.42	25,722	25,231	0.0261	0.0038	0.592	N
5	200	28.10	22,367	22,323	0.0390	0.0167	0.462	N
6	250	37.50	20,200	20,389	0.0512	0.0289	0.563	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,314.3	5.11E-07
k^*_2	-0.213	1.21E-01
k^*_3	-0.392	6.12E-01
Adj. R^2	0.963	
Std. Error [psi]	1,051	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		43,078
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

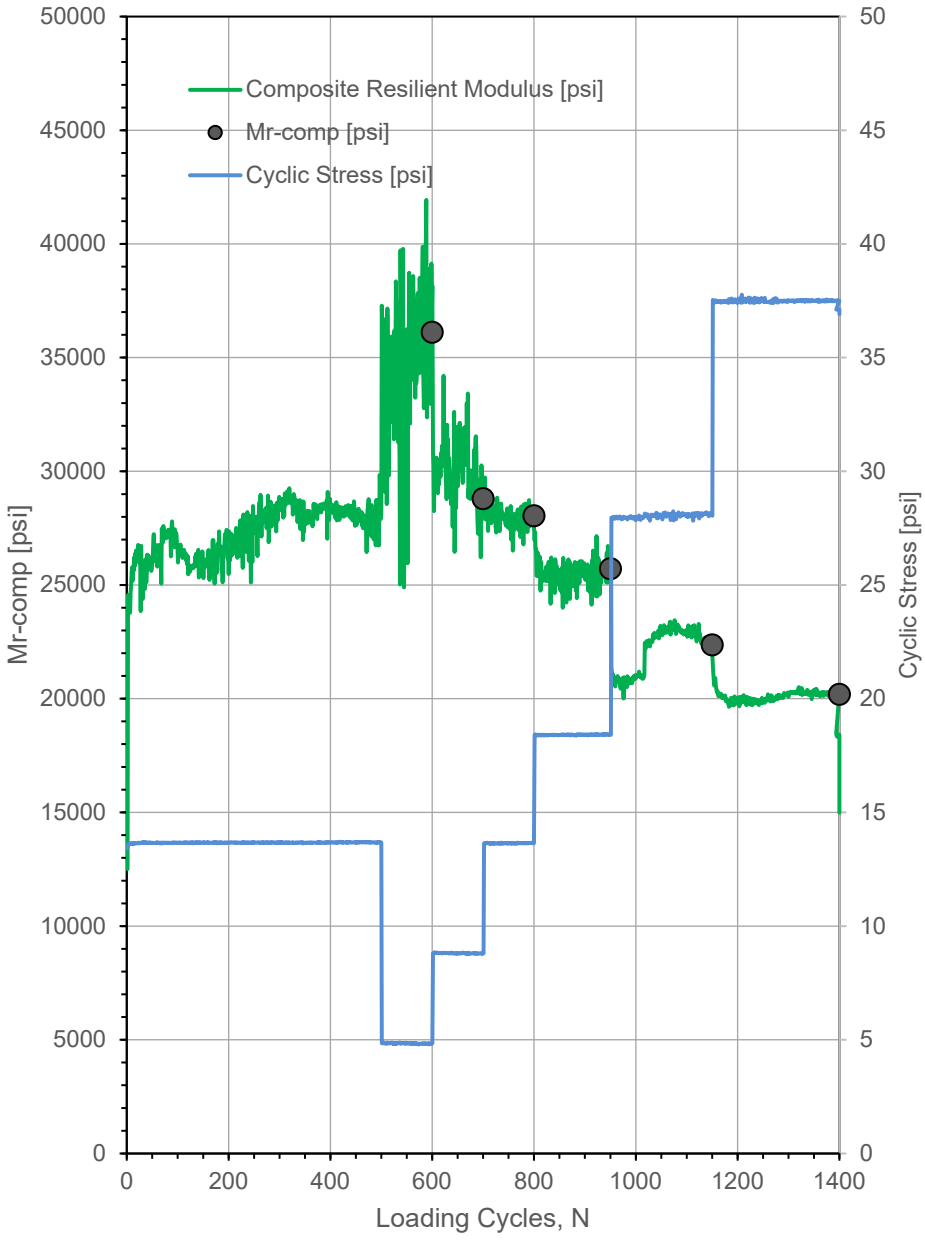
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	12:05:56 PM	Test ID	**Hwy20_pt_13**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.453084	Longitude,W:	92.319280	Elev. (ft):	883.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	43,078
3	39,354
4	36,866
5	35,015
6	33,548
7	32,338
8	31,310
9	30,417
10	29,629
11	28,925
12	28,288
13	27,707
14	27,174
15	26,681
16	26,222
17	25,794
18	25,392
21	24,318
22	23,996
23	23,690
24	23,398
25	23,118
26	22,851
27	22,594
28	22,347
29	22,110
30	21,881
31	21,660
32	21,447
33	21,241
34	21,041
35	20,848
36	20,660
37	20,478
38	20,302
39	20,130
40	19,963



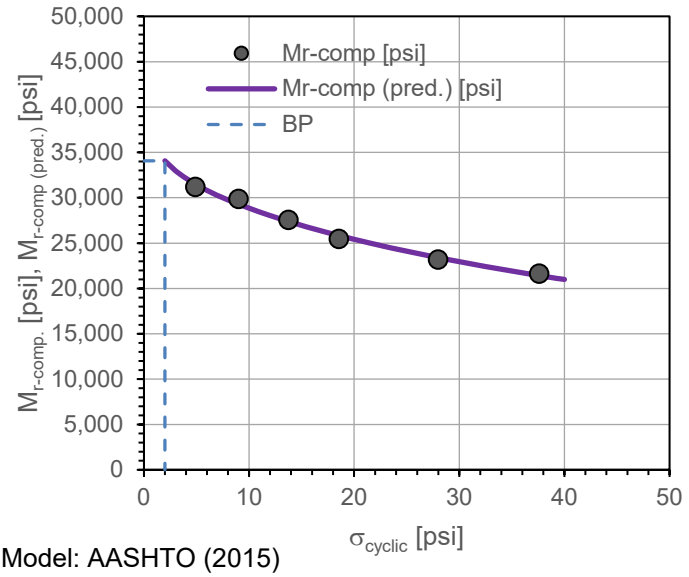
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

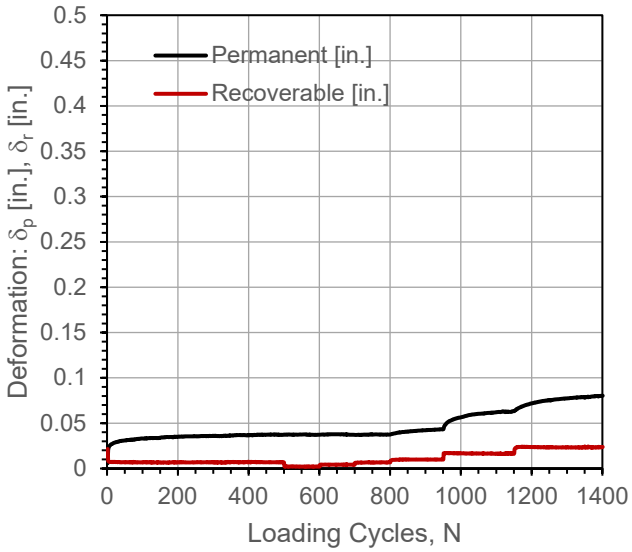
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	12:40:31 PM	Test ID	**Hwy20_pt_14**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.453025	Longitude,W:	92.319575	Elev. (ft):	885.5
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.75	---	---	0.0372	---	0.104	---
1	100	4.87	31,197	31,505	0.0373	0.0000	-0.145	Y
2	100	8.98	29,862	29,282	0.0372	-0.0001	0.005	Y
3	100	13.75	27,552	27,391	0.0374	0.0001	0.387	Y
4	150	18.53	25,447	25,849	0.0432	0.0060	0.625	N
5	200	27.98	23,187	23,405	0.0634	0.0262	0.481	N
6	250	37.60	21,630	21,427	0.0804	0.0431	0.601	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,215.3	3.90E-08
k^*_2	-0.057	2.70E-01
k^*_3	-0.939	4.95E-02
Adj. R^2	0.987	
Std. Error [psi]	418	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		34,075
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

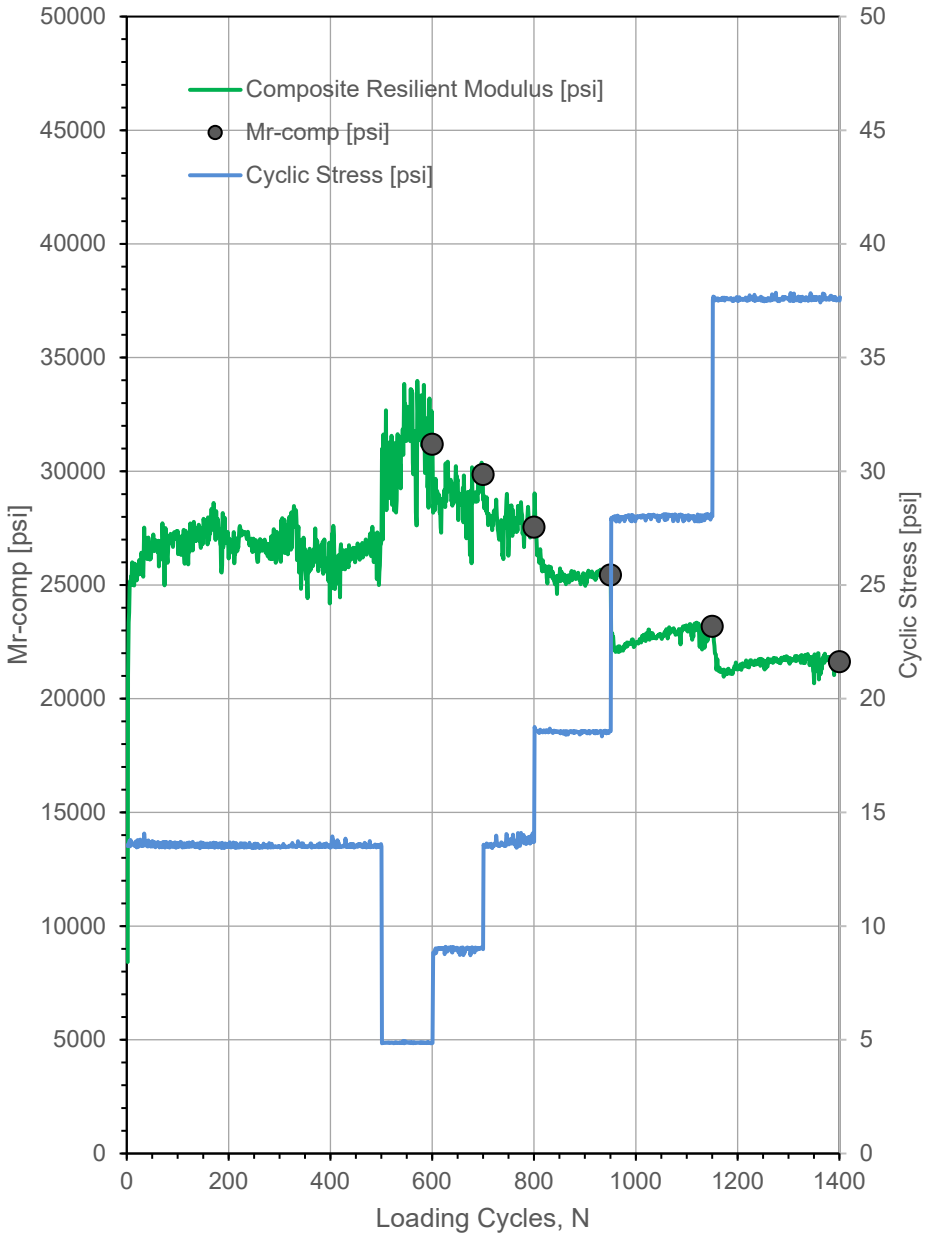
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	12:40:31 PM	Test ID	**Hwy20_pt_14**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.453025	Longitude,W:	92.319575	Elev. (ft):	885.5
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	34,075
3	32,975
4	32,128
5	31,421
6	30,804
7	30,250
8	29,744
9	29,275
10	28,837
11	28,424
12	28,032
13	27,659
14	27,302
15	26,960
16	26,631
17	26,314
18	26,008
21	25,147
22	24,877
23	24,614
24	24,359
25	24,110
26	23,867
27	23,631
28	23,400
29	23,174
30	22,954
31	22,739
32	22,528
33	22,322
34	22,120
35	21,922
36	21,729
37	21,539
38	21,353
39	21,170
40	20,991



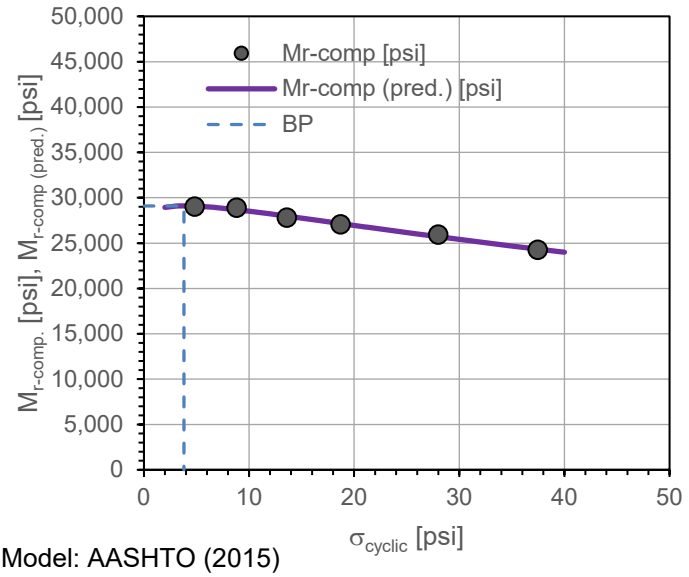
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

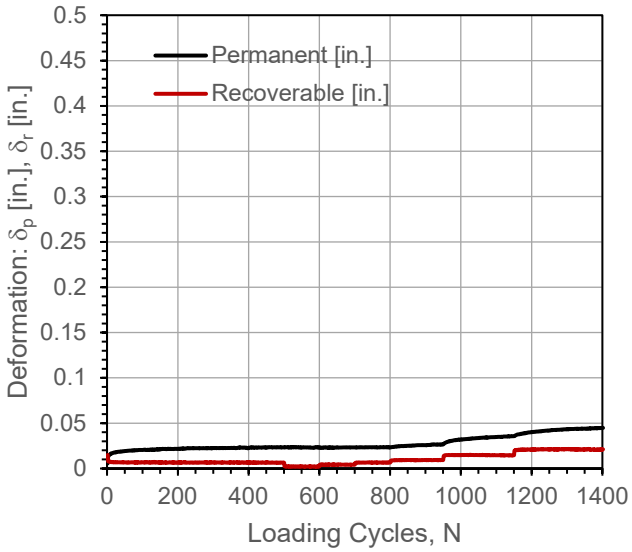
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	1:14:55 PM	Test ID	**Hwy20_pt_15**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452995	Longitude,W:	92.319861	Elev. (ft):	887.1
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.58	---	---	0.0234	---	0.102	---
1	100	4.81	29,025	29,077	0.0232	-0.0001	-0.147	Y
2	100	8.80	28,887	28,678	0.0233	-0.0001	0.132	Y
3	100	13.58	27,801	27,979	0.0233	-0.0001	0.162	Y
4	150	18.70	27,057	27,168	0.0265	0.0031	0.601	N
5	200	27.99	25,934	25,715	0.0356	0.0122	0.491	N
6	250	37.46	24,257	24,342	0.0448	0.0214	0.541	N



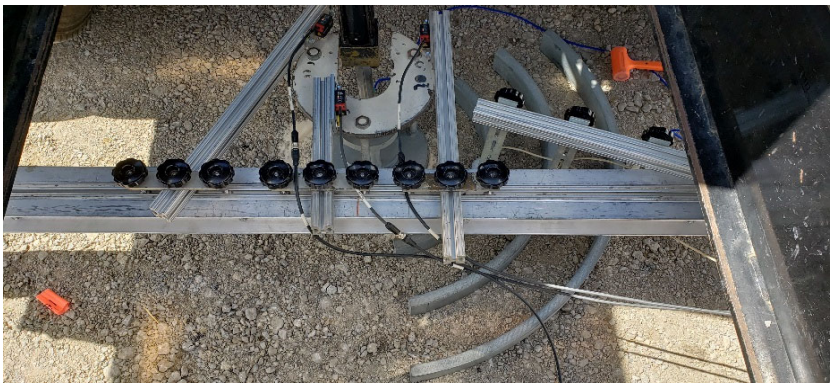


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,084.6	4.00E-09
k^*_2	0.034	1.77E-01
k^*_3	-0.863	7.80E-03
Adj. R^2	0.989	
Std. Error [psi]	190	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		29,104
	$\sigma_{cyclic\text{-}BP}$ [psi]	3.8



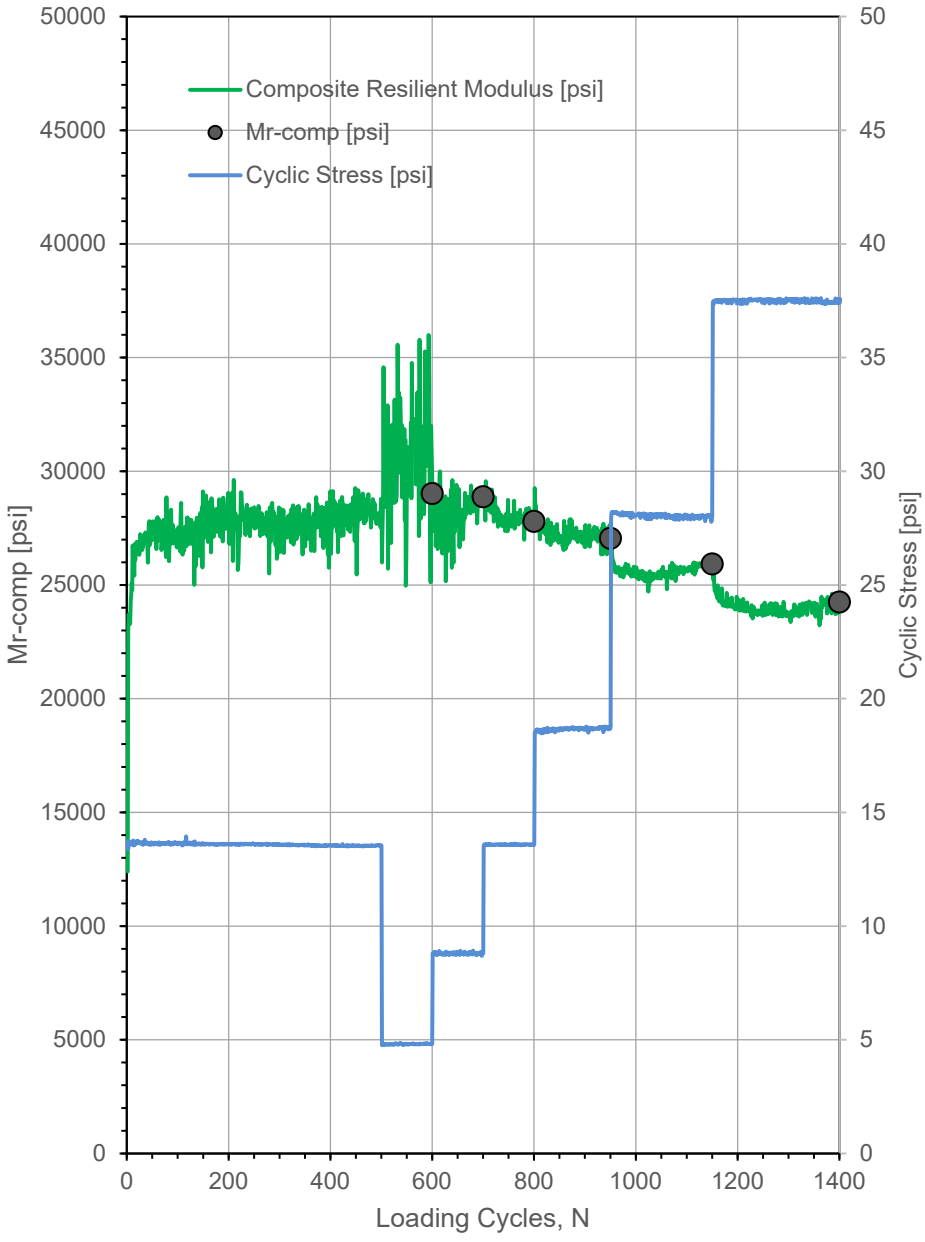
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	1:14:55 PM	Test ID	**Hwy20_pt_15**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452995	Longitude,W:	92.319861	Elev. (ft):	887.1
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	28,939
3	29,078
4	29,103
5	29,067
6	28,994
7	28,896
8	28,780
9	28,652
10	28,515
11	28,371
12	28,222
13	28,069
14	27,914
15	27,757
16	27,598
17	27,439
18	27,280
21	26,802
22	26,643
23	26,486
24	26,329
25	26,174
26	26,019
27	25,866
28	25,714
29	25,563
30	25,414
31	25,265
32	25,119
33	24,973
34	24,829
35	24,687
36	24,546
37	24,406
38	24,268
39	24,131
40	23,995



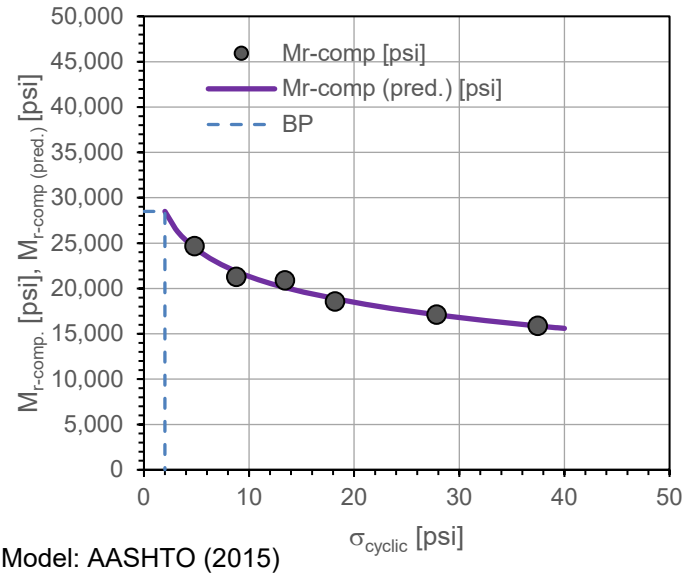
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

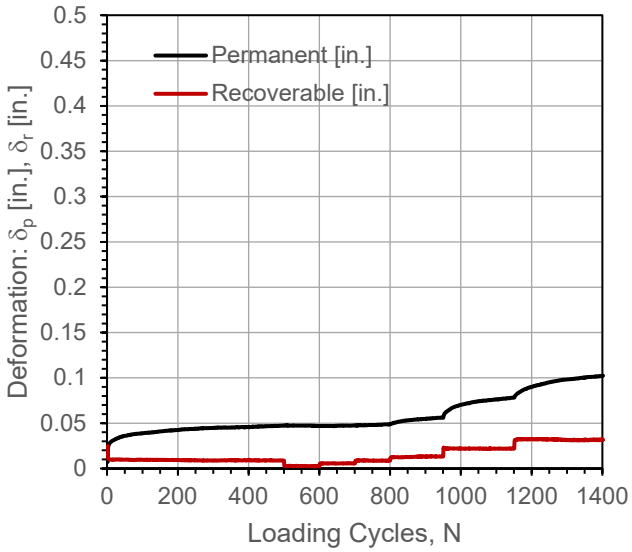
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	1:50:37 PM	Test ID	**Hwy20_pt_16**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452946	Longitude,W:	92.320403	Elev. (ft):	889.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.40	---	---	0.0473	---	0.136	---
1	100	4.80	24,654	24,477	0.0469	-0.0004	-0.142	Y
2	100	8.77	21,279	21,892	0.0473	0.0000	0.278	Y
3	100	13.40	20,886	20,126	0.0488	0.0015	0.525	Y
4	150	18.16	18,562	18,869	0.0561	0.0088	0.591	N
5	200	27.84	17,112	17,103	0.0782	0.0309	0.489	N
6	250	37.46	15,871	15,871	0.1022	0.0549	0.578	N



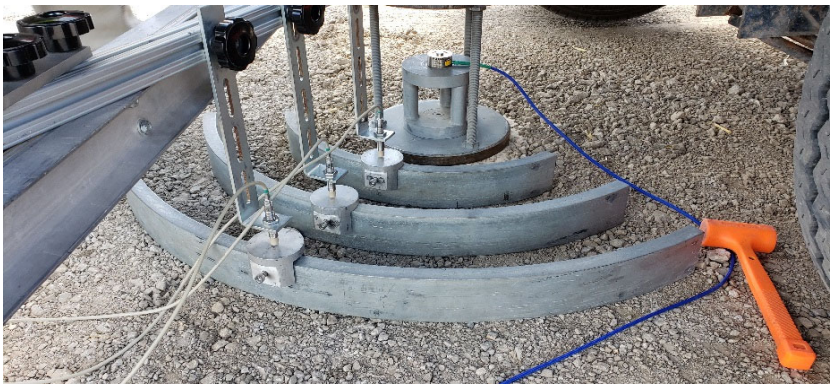


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,621.4	1.94E-07
k^*_2	-0.162	9.79E-02
k^*_3	-0.349	5.18E-01
Adj. R^2	0.974	
Std. Error [psi]	513	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	28,496
$\sigma_{cyclic\text{-}BP}$ [psi]	2.0



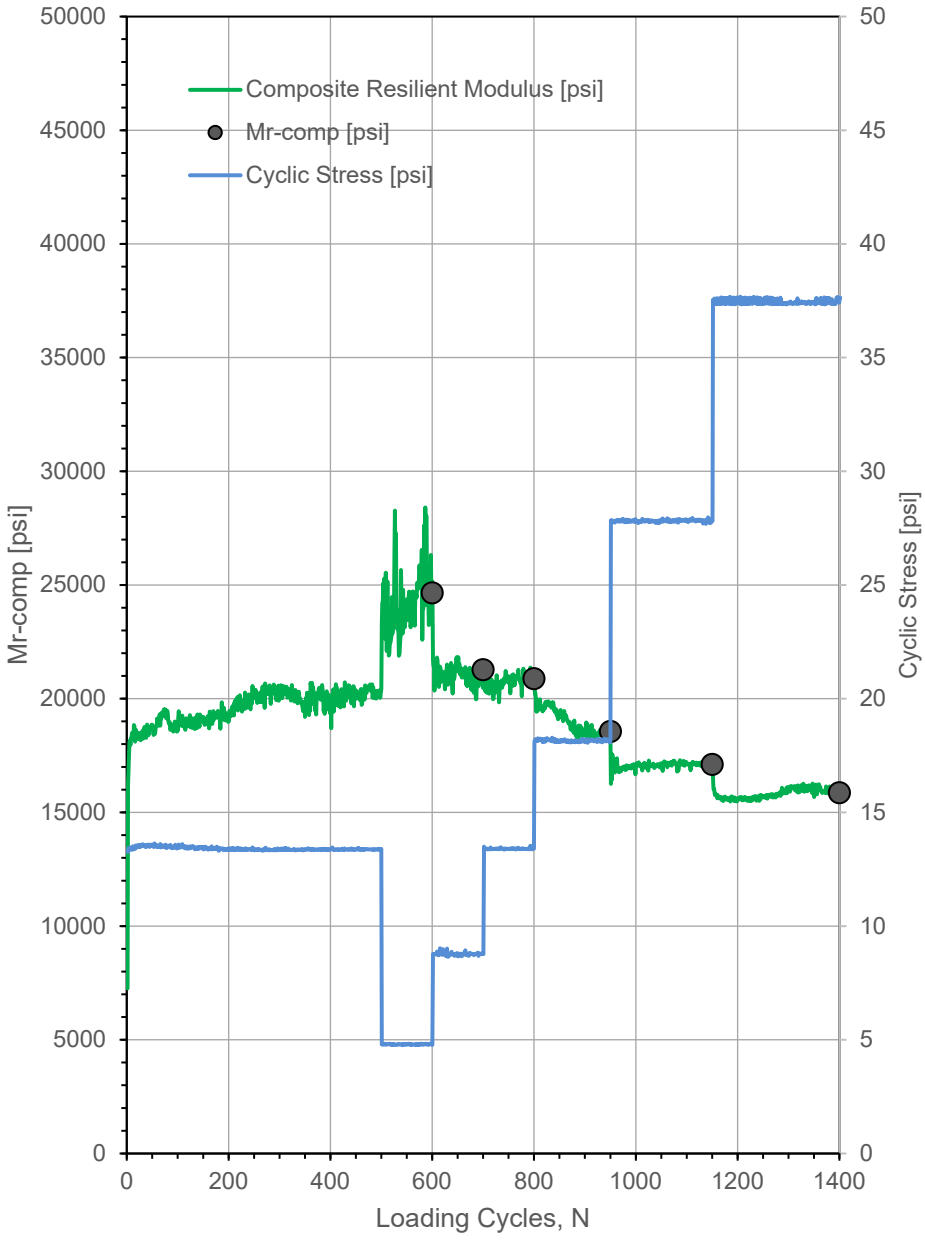
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	1:50:37 PM	Test ID	**Hwy20_pt_16**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452946	Longitude,W:	92.320403	Elev. (ft):	889.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	28,496
3	26,587
4	25,284
5	24,299
6	23,508
7	22,848
8	22,281
9	21,785
10	21,344
11	20,946
12	20,584
13	20,252
14	19,945
15	19,659
16	19,393
17	19,142
18	18,906
21	18,269
22	18,077
23	17,893
24	17,717
25	17,548
26	17,386
27	17,230
28	17,079
29	16,934
30	16,793
31	16,657
32	16,525
33	16,398
34	16,274
35	16,153
36	16,036
37	15,922
38	15,811
39	15,703
40	15,598



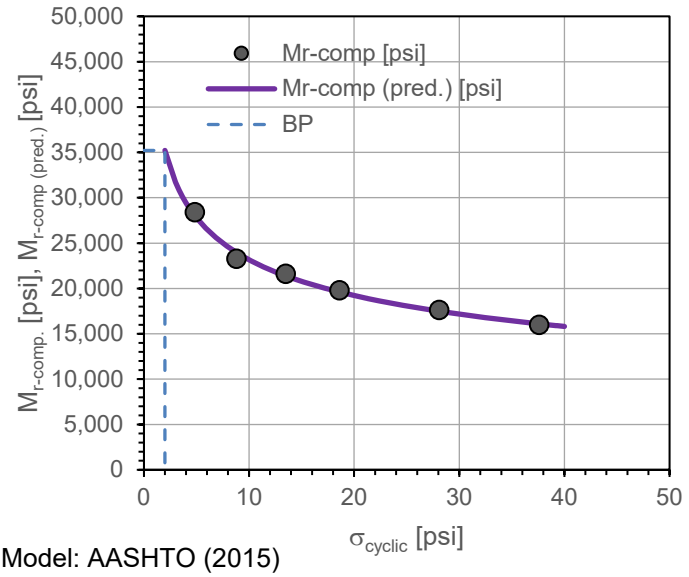
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

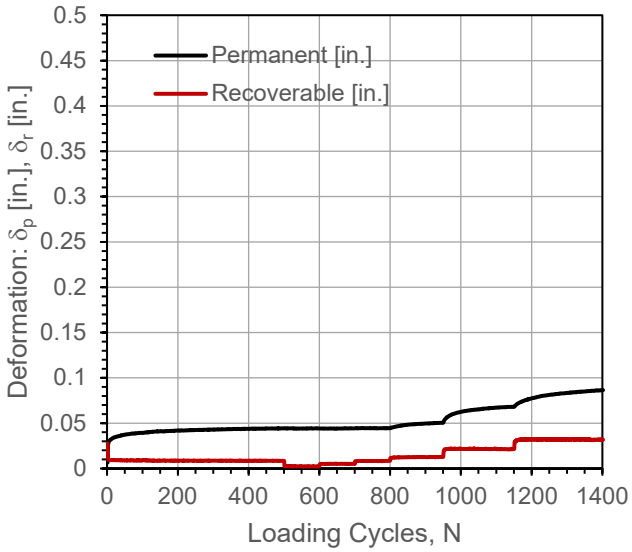
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	2:27:01 PM	Test ID	**Hwy20_pt_17**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452920	Longitude,W:	92.320772	Elev. (ft):	891.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.48	---	---	0.0443	---	0.098	---
1	100	4.83	28,408	28,053	0.0441	-0.0002	-0.089	Y
2	100	8.79	23,264	23,984	0.0442	0.0000	0.114	Y
3	100	13.48	21,610	21,400	0.0445	0.0002	0.056	Y
4	150	18.59	19,792	19,612	0.0505	0.0062	0.571	N
5	200	28.07	17,620	17,495	0.0681	0.0238	0.485	N
6	250	37.59	15,971	16,101	0.0866	0.0423	0.567	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,794.4	7.68E-08
k^*_2	-0.254	1.56E-02
k^*_3	-0.119	7.61E-01
Adj. R^2	0.990	
Std. Error [psi]	430	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	35,213
$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

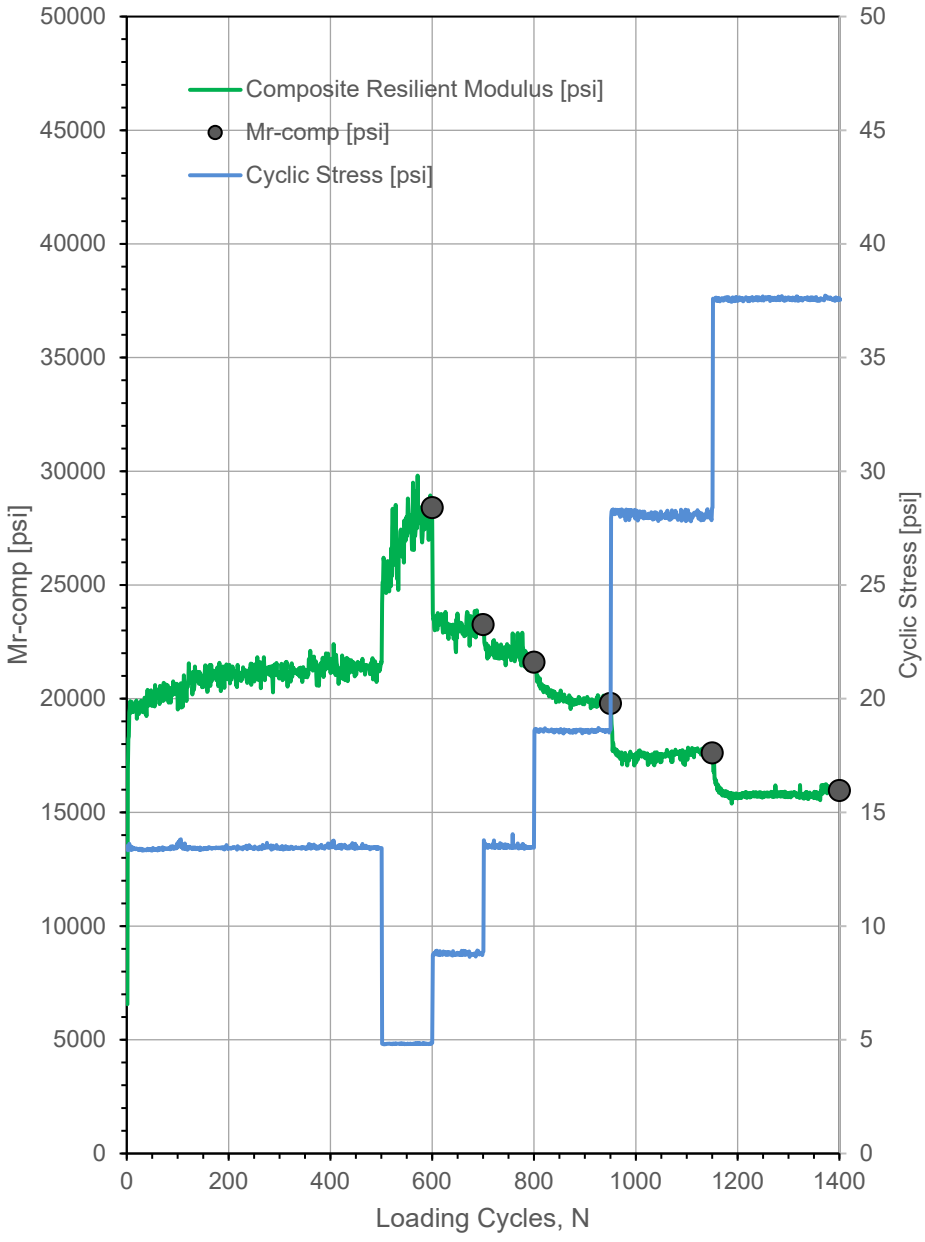
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	2:27:01 PM	Test ID	**Hwy20_pt_17**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452920	Longitude,W:	92.320772	Elev. (ft):	891.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	35,213
3	31,728
4	29,457
5	27,800
6	26,511
7	25,463
8	24,585
9	23,832
10	23,176
11	22,596
12	22,078
13	21,609
14	21,183
15	20,792
16	20,432
17	20,098
18	19,787
21	18,968
22	18,725
23	18,496
24	18,279
25	18,072
26	17,875
27	17,687
28	17,508
29	17,335
30	17,170
31	17,011
32	16,859
33	16,712
34	16,570
35	16,433
36	16,301
37	16,173
38	16,050
39	15,930
40	15,814



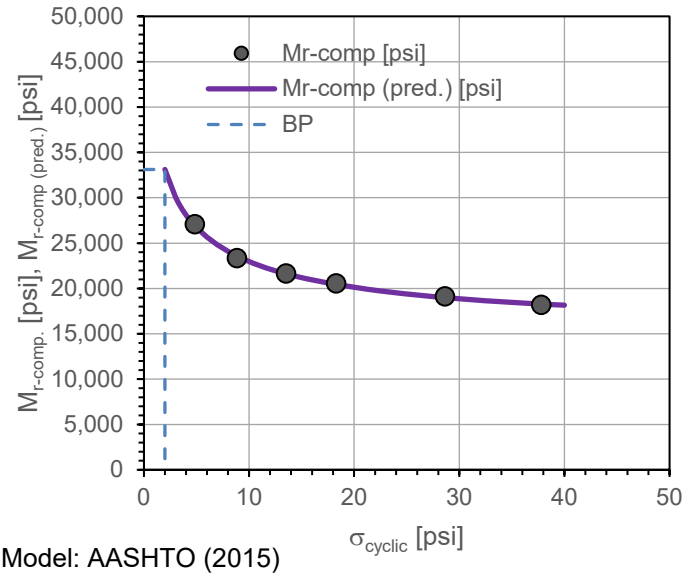
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

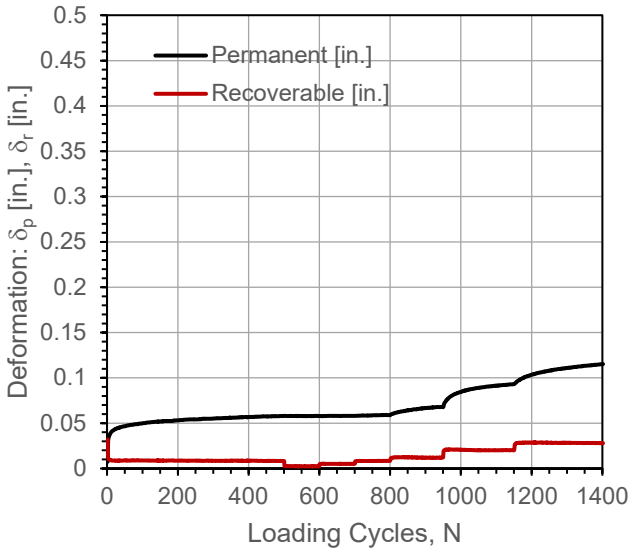
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	3:03:09 PM	Test ID	**Hwy20_pt_18**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452886	Longitude,W:	92.321204	Elev. (ft):	893.8
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.51	---	---	0.0580	---	0.114	---
1	100	4.84	27,070	26,931	0.0579	-0.0001	-0.095	Y
2	100	8.83	23,334	23,589	0.0580	0.0001	0.132	Y
3	100	13.51	21,635	21,632	0.0588	0.0009	0.497	Y
4	150	18.27	20,542	20,448	0.0678	0.0099	0.635	N
5	200	28.62	19,114	18,994	0.0930	0.0351	0.499	N
6	250	37.80	18,185	18,282	0.1151	0.0572	0.635	N



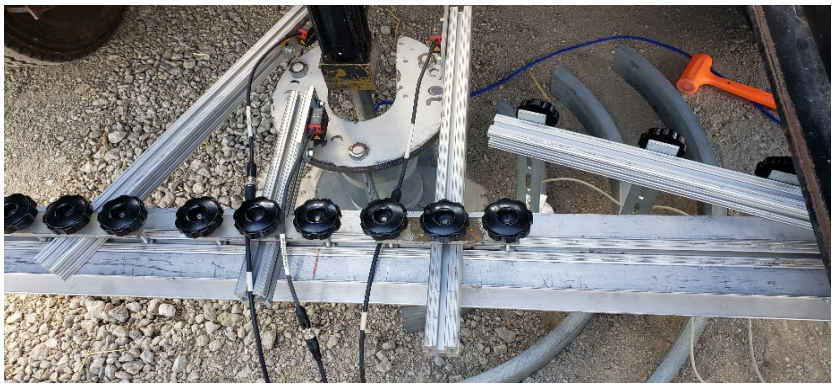


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,679.3	5.24E-09
k^*_2	-0.248	1.28E-03
k^*_3	0.426	6.06E-02
Adj. R^2	0.997	
Std. Error [psi]	170	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		33,117
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0



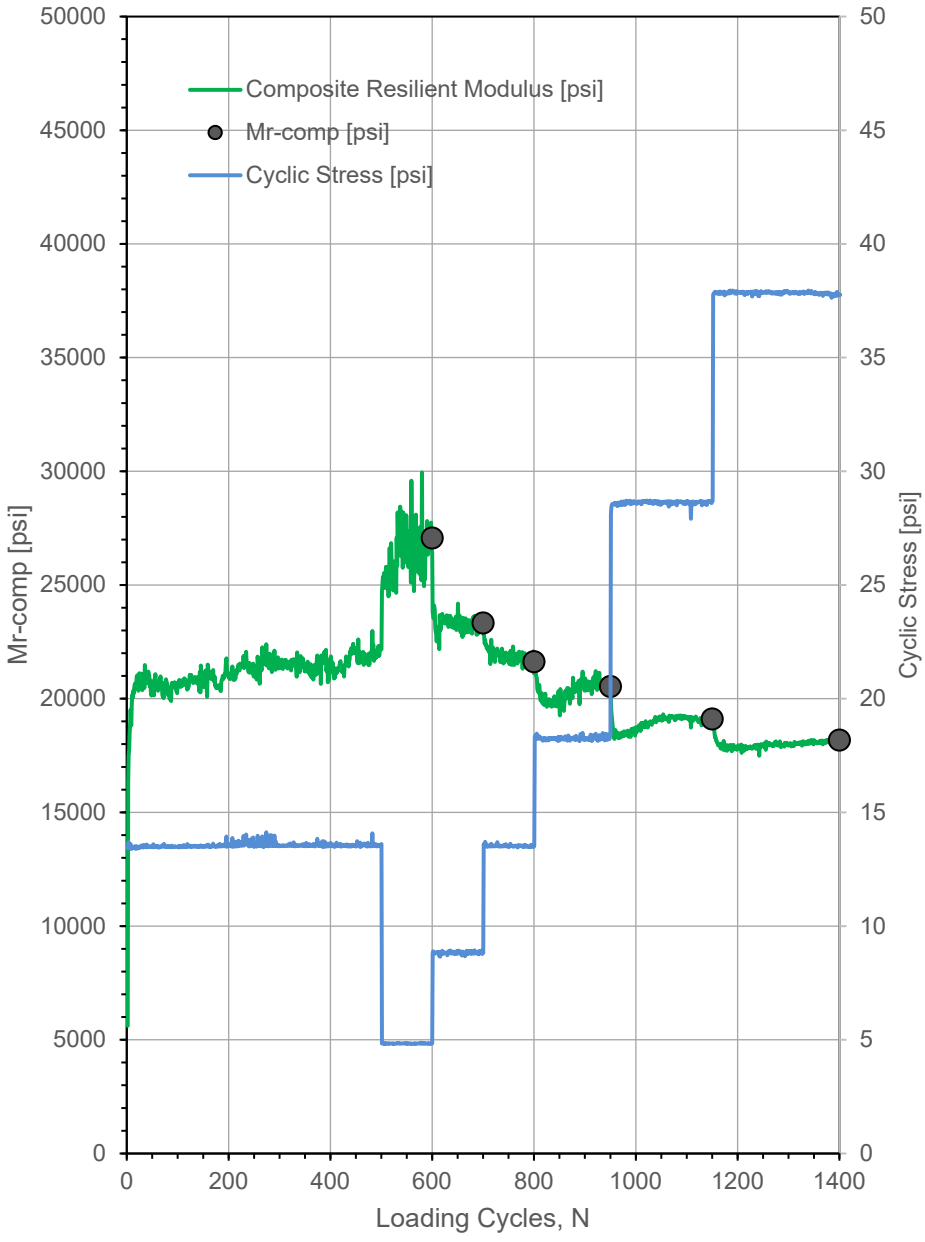
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	3:03:09 PM	Test ID	**Hwy20_pt_18**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452886	Longitude,W:	92.321204	Elev. (ft):	893.8
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	33,117
3	30,079
4	28,129
5	26,729
6	25,656
7	24,798
8	24,091
9	23,495
10	22,983
11	22,538
12	22,146
13	21,797
14	21,485
15	21,204
16	20,948
17	20,715
18	20,502
21	19,956
22	19,800
23	19,655
24	19,519
25	19,392
26	19,273
27	19,161
28	19,056
29	18,957
30	18,863
31	18,774
32	18,691
33	18,611
34	18,536
35	18,464
36	18,396
37	18,331
38	18,270
39	18,211
40	18,155



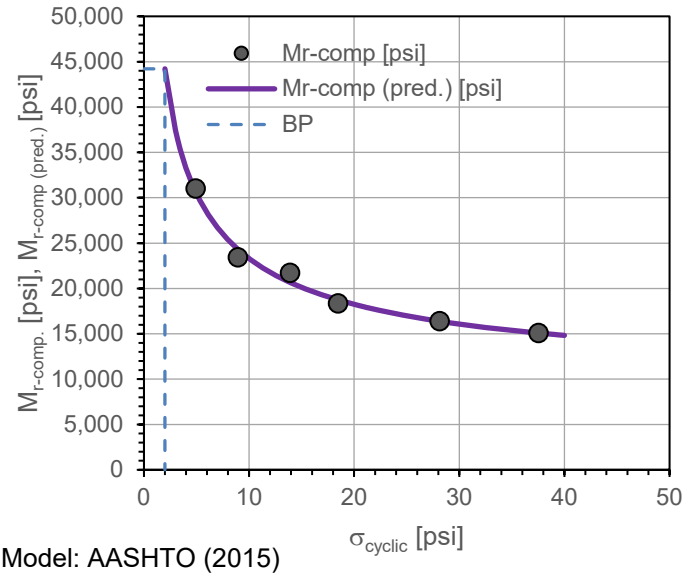
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

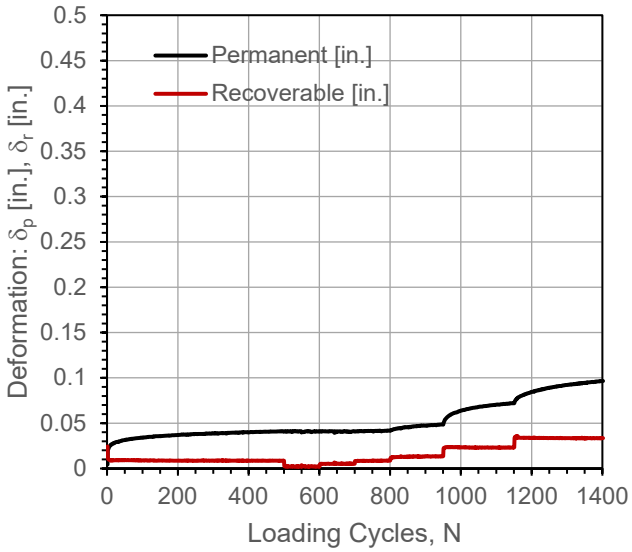
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	4:19:11 PM	Test ID	**Hwy20_pt_19**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452897	Longitude,W:	92.321681	Elev. (ft):	895.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.90	---	---	0.0409	---	0.136	---
1	100	4.90	31,018	30,709	0.0406	-0.0003	-0.034	Y
2	100	8.93	23,430	24,325	0.0411	0.0002	-0.059	Y
3	100	13.90	21,722	20,682	0.0416	0.0007	0.232	Y
4	150	18.45	18,345	18,747	0.0486	0.0077	0.574	N
5	200	28.13	16,385	16,383	0.0721	0.0312	0.494	N
6	250	37.53	15,081	15,082	0.0966	0.0557	0.531	N



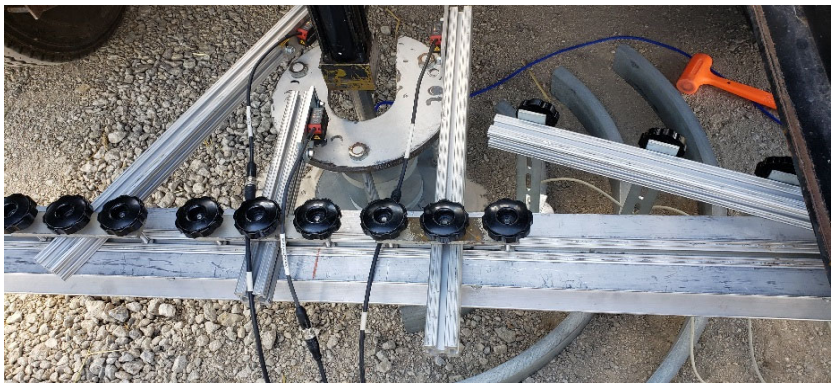


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,828.1	4.28E-07
k^*_2	-0.424	1.91E-02
k^*_3	0.532	4.67E-01
Adj. R^2	0.984	
Std. Error [psi]	724	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		44,215
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0



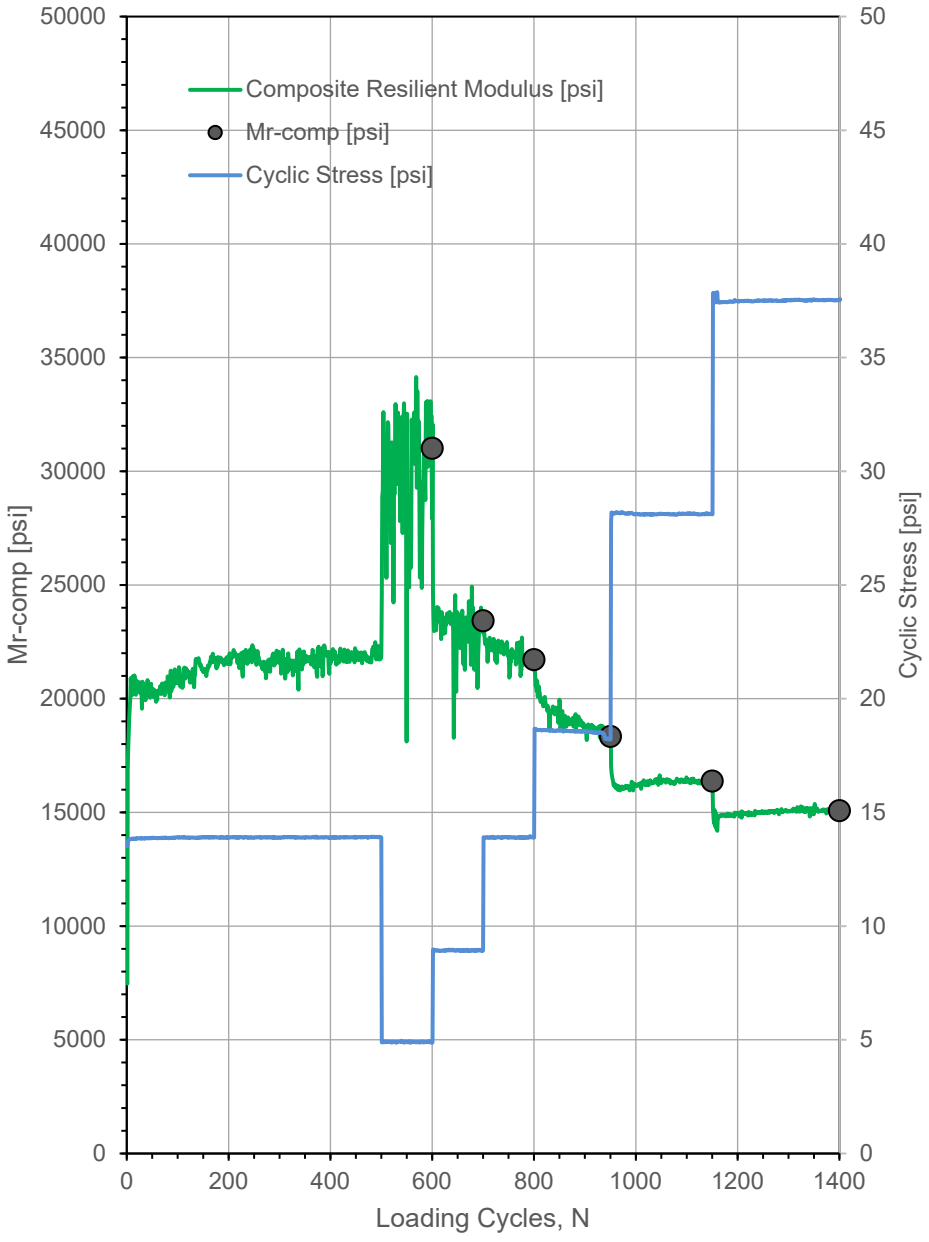
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	4:19:11 PM	Test ID	**Hwy20_pt_19**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452897	Longitude,W:	92.321681	Elev. (ft):	895.7
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	44,215
3	37,435
4	33,317
5	30,473
6	28,357
7	26,704
8	25,367
9	24,256
10	23,316
11	22,507
12	21,802
13	21,180
14	20,627
15	20,131
16	19,683
17	19,276
18	18,905
21	17,960
22	17,690
23	17,440
24	17,206
25	16,987
26	16,781
27	16,588
28	16,406
29	16,234
30	16,072
31	15,918
32	15,772
33	15,633
34	15,501
35	15,375
36	15,255
37	15,141
38	15,031
39	14,927
40	14,826



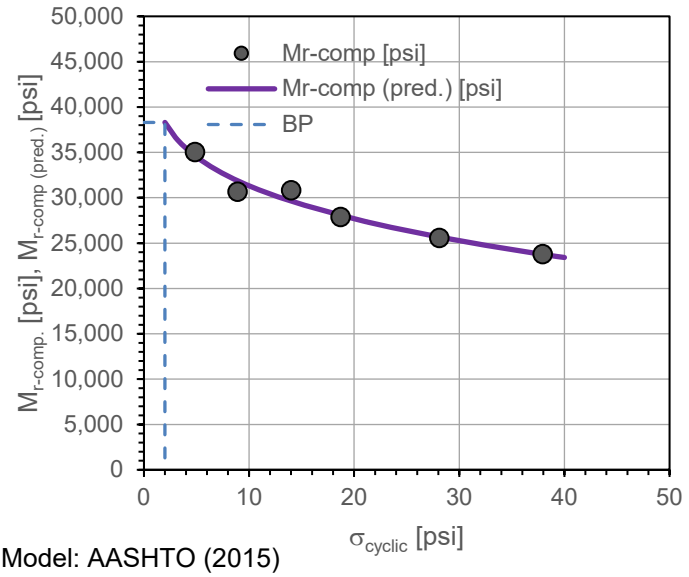
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

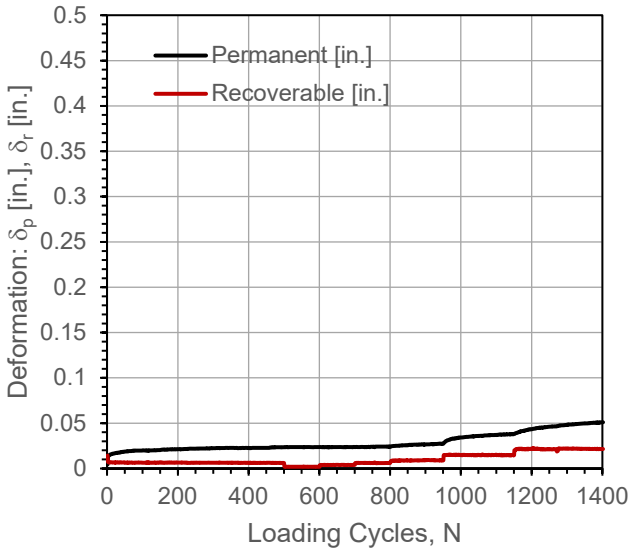
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	3:44:25 PM	Test ID	**Hwy20_pt_20**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452811	Longitude,W:	92.322270	Elev. (ft):	898.9
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.99	---	---	0.0235	---	0.115	---
1	100	4.84	35,033	34,621	0.0236	0.0001	0.017	Y
2	100	8.90	30,655	31,879	0.0237	0.0002	0.052	Y
3	100	13.99	30,811	29,634	0.0237	0.0002	0.326	Y
4	150	18.70	27,870	28,068	0.0272	0.0037	0.492	Y
5	200	28.10	25,558	25,679	0.0380	0.0145	0.478	N
6	250	37.93	23,774	23,770	0.0510	0.0275	0.623	N



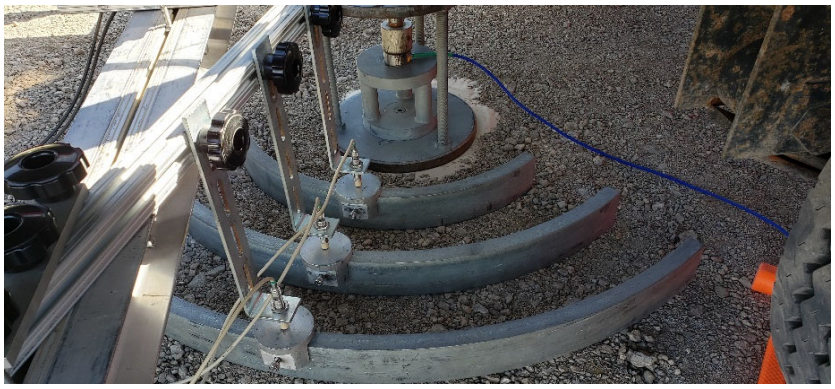


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,372.7	2.42E-07
k^*_2	-0.094	3.14E-01
k^*_3	-0.633	3.25E-01
Adj. R^2	0.953	
Std. Error [psi]	863	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		38,313
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0



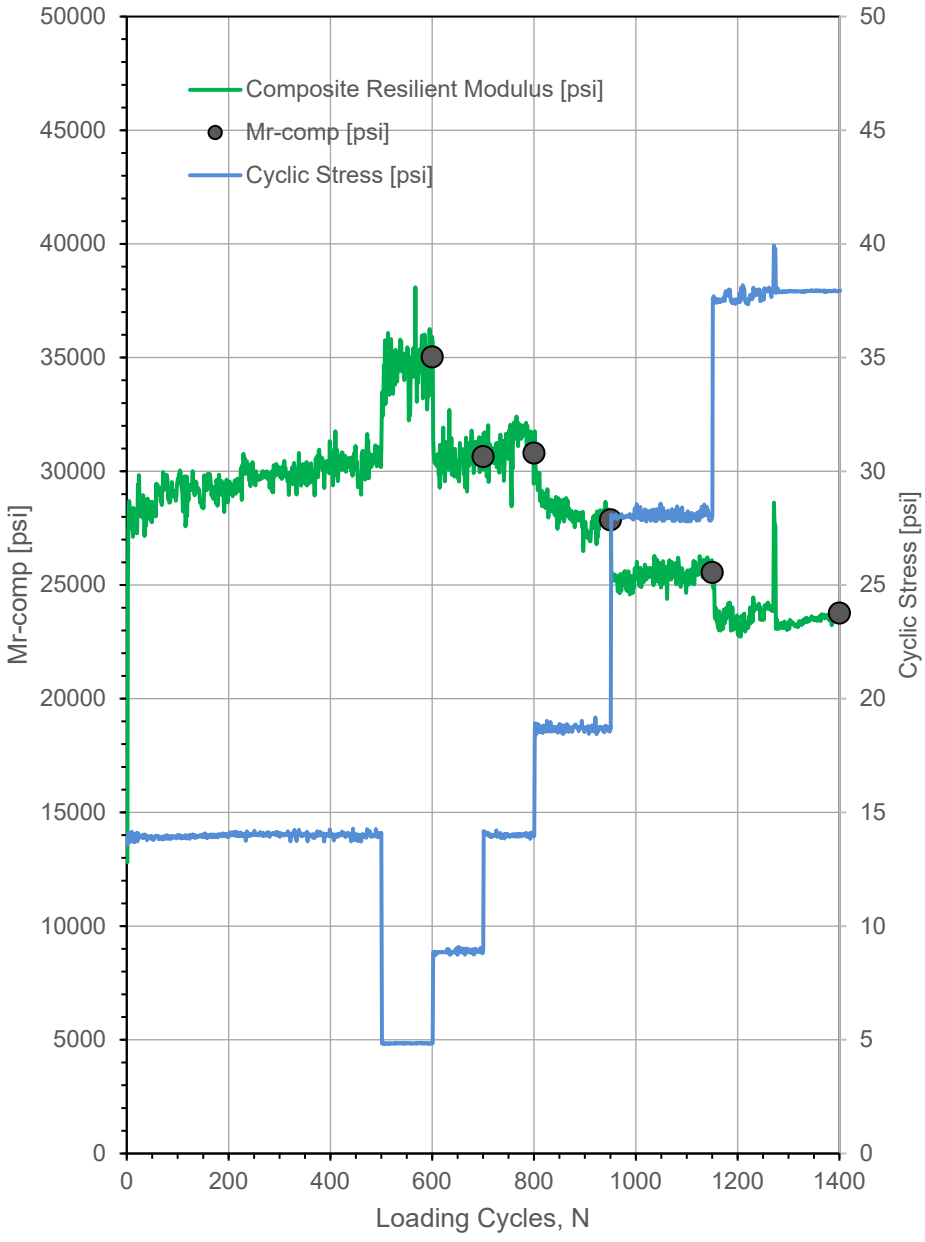
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	8/28/2019	Time:	3:44:25 PM	Test ID	**Hwy20_pt_20**
Tested By	DW, HG	Location:	Hwy 20	Sta.	NA
Latitude,N:	42.452811	Longitude,W:	92.322270	Elev. (ft):	898.9
Comments:	RPCC special backfill layer over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	38,313
3	36,645
4	35,440
5	34,485
6	33,685
7	32,994
8	32,380
9	31,828
10	31,322
11	30,856
12	30,422
13	30,015
14	29,632
15	29,269
16	28,925
17	28,596
18	28,282
21	27,412
22	27,144
23	26,884
24	26,633
25	26,389
26	26,153
27	25,924
28	25,701
29	25,484
30	25,273
31	25,067
32	24,867
33	24,671
34	24,480
35	24,293
36	24,111
37	23,932
38	23,757
39	23,586
40	23,419



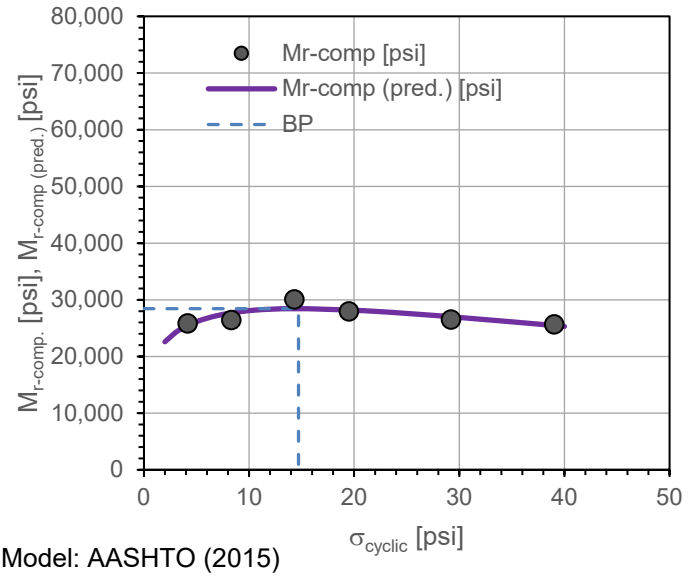
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 20, Blackhawk County, IA

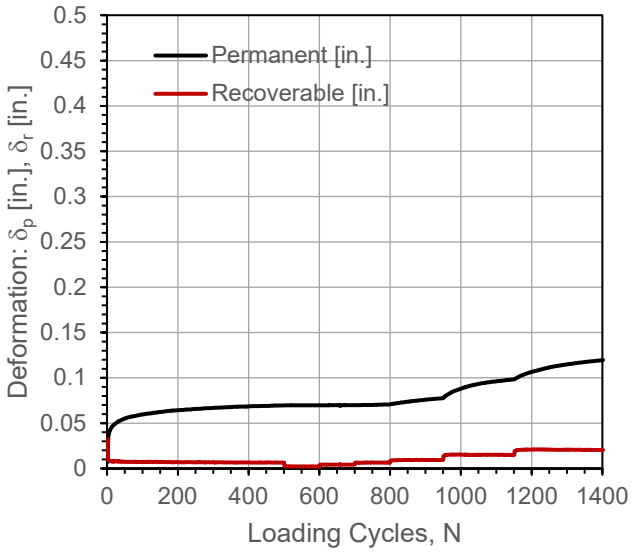
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	12:17:45 PM	Test ID	**Iowa_AID_Hwy52_pt_1**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593464	Longitude,W:	90.972130	Elev. (ft):	366.8
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.30	---	---	0.0696	---	0.133	---
1	100	4.14	25,828	25,488	0.0697	0.0001	0.004	Y
2	100	8.31	26,420	27,698	0.0699	0.0003	0.029	Y
3	100	14.30	30,063	28,432	0.0707	0.0011	0.558	Y
4	150	19.50	27,926	28,211	0.0775	0.0079	0.694	N
5	200	29.20	26,500	27,018	0.0984	0.0288	0.649	N
6	250	39.03	25,662	25,464	0.1195	0.0499	0.729	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,030.5	6.42E-07
k^*_2	0.214	9.74E-02
k^*_3	-1.575	9.32E-02
Adj. R^2	0.571	
Std. Error [psi]	861	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	28,434
$\sigma_{cyclic\text{-}BP}$ [psi]	14.7

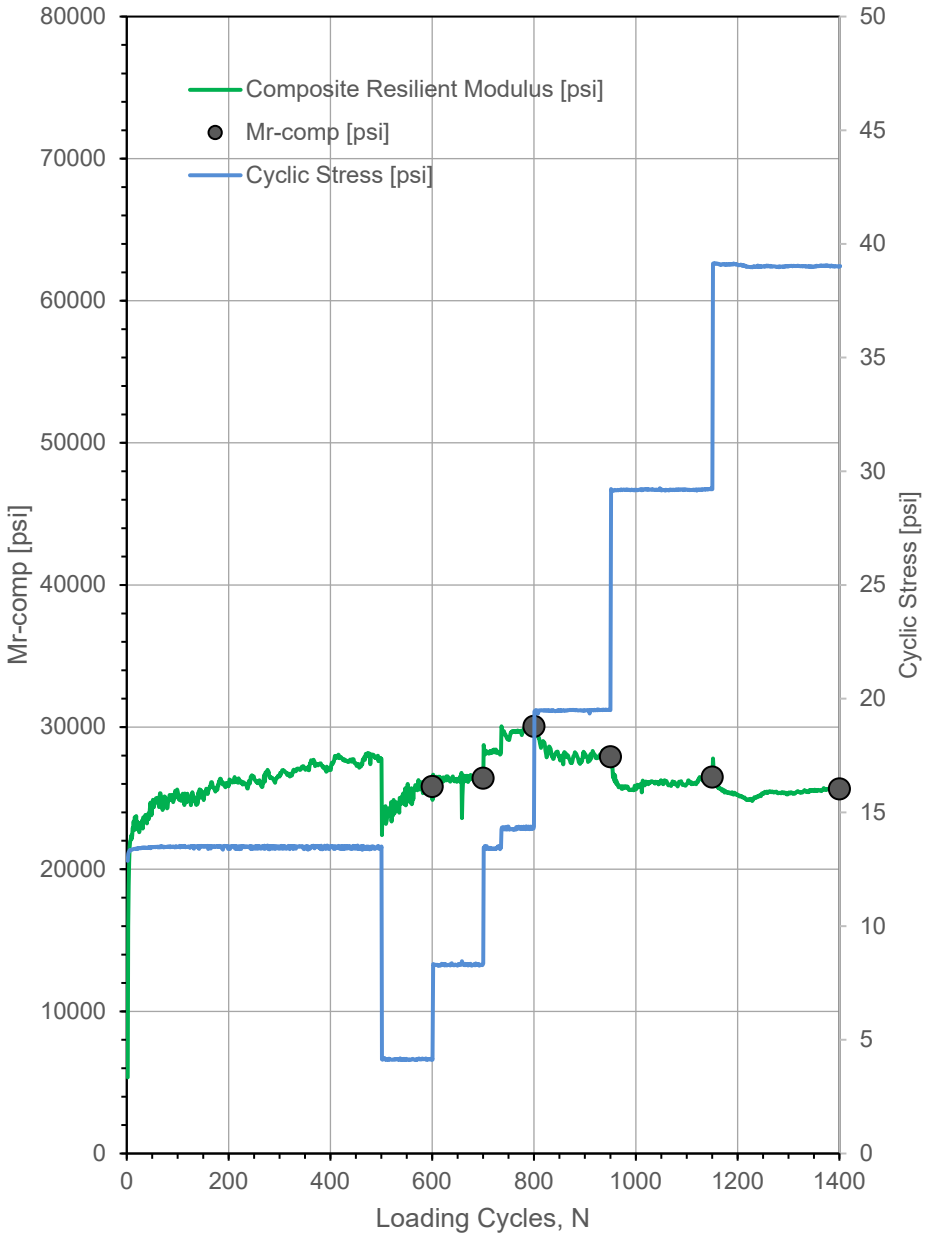
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	12:17:45 PM	Test ID	**Iowa_AID_Hwy52_pt_1**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593464	Longitude,W:	90.972130	Elev. (ft):	366.8
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	22,586
3	24,232
4	25,356
5	26,172
6	26,784
7	27,249
8	27,606
9	27,877
10	28,080
11	28,228
12	28,330
13	28,395
14	28,427
15	28,433
16	28,415
17	28,377
18	28,322
21	28,073
22	27,969
23	27,855
24	27,735
25	27,607
26	27,474
27	27,336
28	27,193
29	27,047
30	26,898
31	26,745
32	26,591
33	26,434
34	26,276
35	26,116
36	25,955
37	25,794
38	25,632
39	25,469
40	25,306



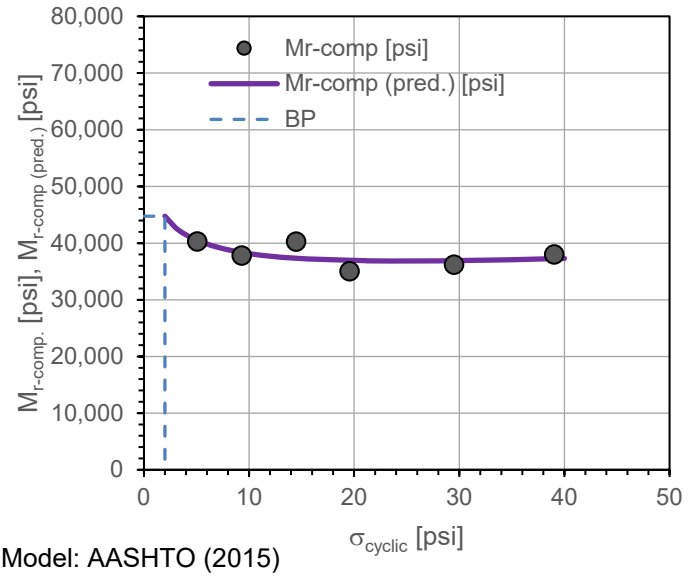
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

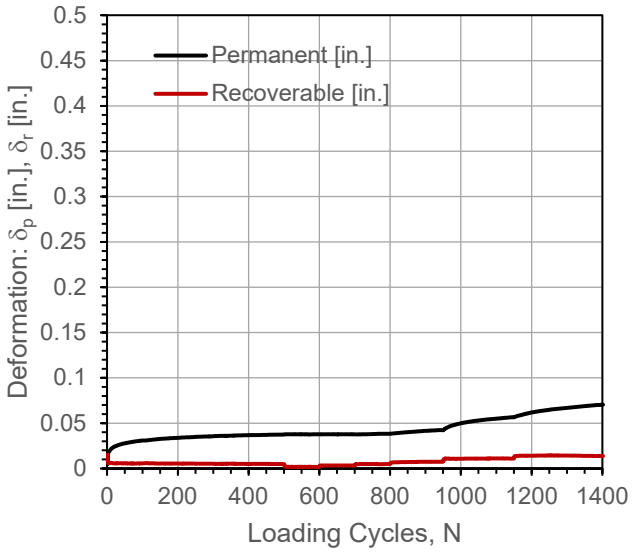
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	12:49:27 PM	Test ID	**Iowa_AID_Hwy52_pt_2**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593479	Longitude,W:	90.971970	Elev. (ft):	362.4
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.47	---	---	0.0375	---	0.156	---
1	100	5.07	40,277	40,454	0.0378	0.0003	0.043	Y
2	100	9.29	37,782	38,374	0.0377	0.0002	0.000	Y
3	100	14.47	40,242	37,348	0.0383	0.0009	0.572	Y
4	150	19.55	35,014	36,953	0.0422	0.0047	0.785	N
5	200	29.49	36,180	36,907	0.0566	0.0191	0.649	N
6	250	39.02	37,989	37,271	0.0703	0.0329	0.685	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,589.3	1.05E-06
k^*_2	-0.130	4.08E-01
k^*_3	0.619	5.47E-01
Adj. R^2	0.245	
Std. Error [psi]	1,187	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	44,761
$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

No Picture

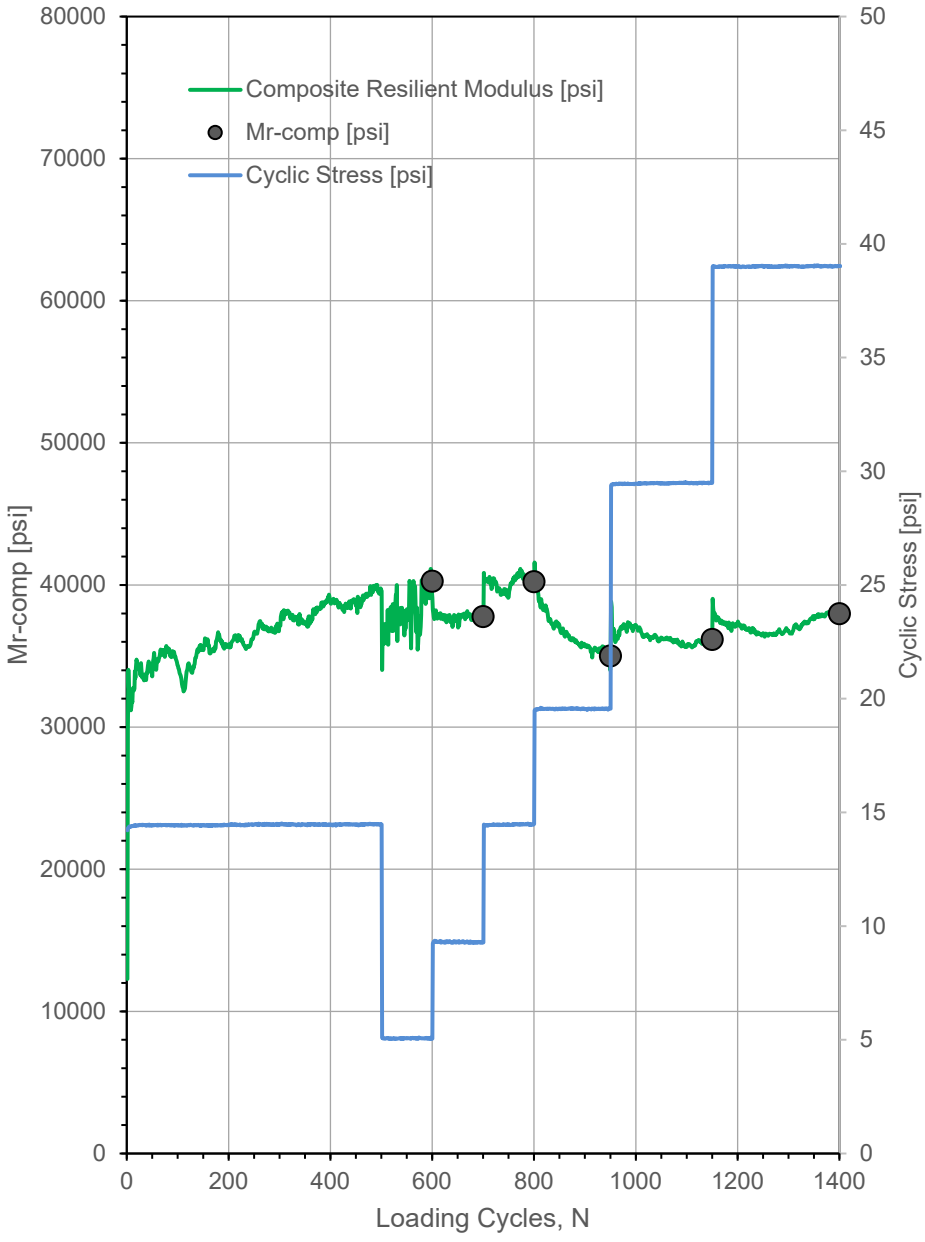
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	12:49:27 PM	Test ID	**Iowa_AID_Hwy52_pt_2**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593479	Longitude,W:	90.971970	Elev. (ft):	362.4
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	44,761
3	42,740
4	41,436
5	40,507
6	39,807
7	39,261
8	38,823
9	38,466
10	38,172
11	37,927
12	37,723
13	37,551
14	37,407
15	37,287
16	37,186
17	37,102
18	37,034
21	36,901
22	36,877
23	36,860
24	36,852
25	36,849
26	36,853
27	36,863
28	36,877
29	36,896
30	36,919
31	36,946
32	36,977
33	37,011
34	37,048
35	37,087
36	37,129
37	37,174
38	37,221
39	37,270
40	37,321



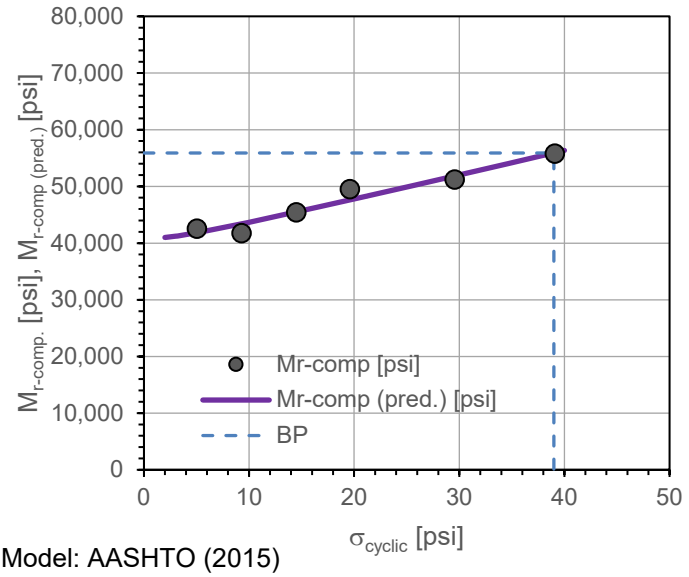
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

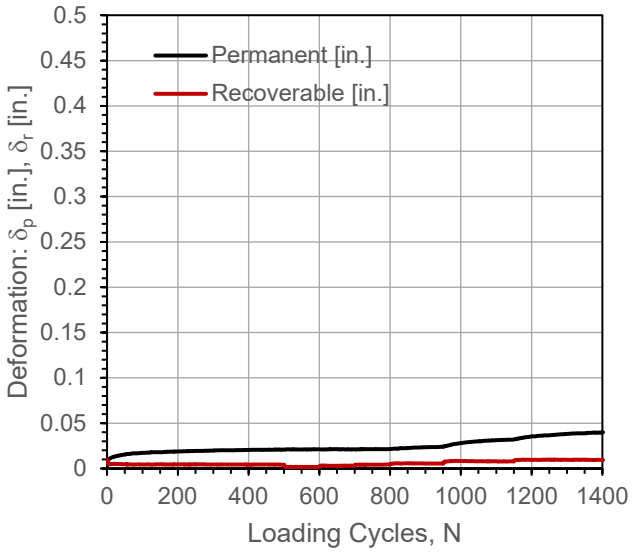
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	1:20:30 PM	Test ID	**Iowa_AID_Hwy52_pt_3**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593510	Longitude,W:	90.971611	Elev. (ft):	361.8
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.49	---	---	0.0208	---	0.156	---
1	100	5.04	42,546	41,846	0.0212	0.0004	0.101	Y
2	100	9.29	41,738	43,408	0.0211	0.0003	0.119	Y
3	100	14.49	45,426	45,487	0.0213	0.0005	0.208	Y
4	150	19.58	49,496	47,597	0.0241	0.0033	0.620	N
5	200	29.55	51,212	51,829	0.0321	0.0113	0.701	N
6	250	39.09	55,766	55,945	0.0398	0.0190	0.675	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,681.3	2.32E-07
k^*_2	-0.014	8.70E-01
k^*_3	1.079	1.46E-01
Adj. R^2	0.938	
Std. Error [psi]	1,326	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	55,907
$\sigma_{cyclic\text{-}BP}$ [psi]	39.0

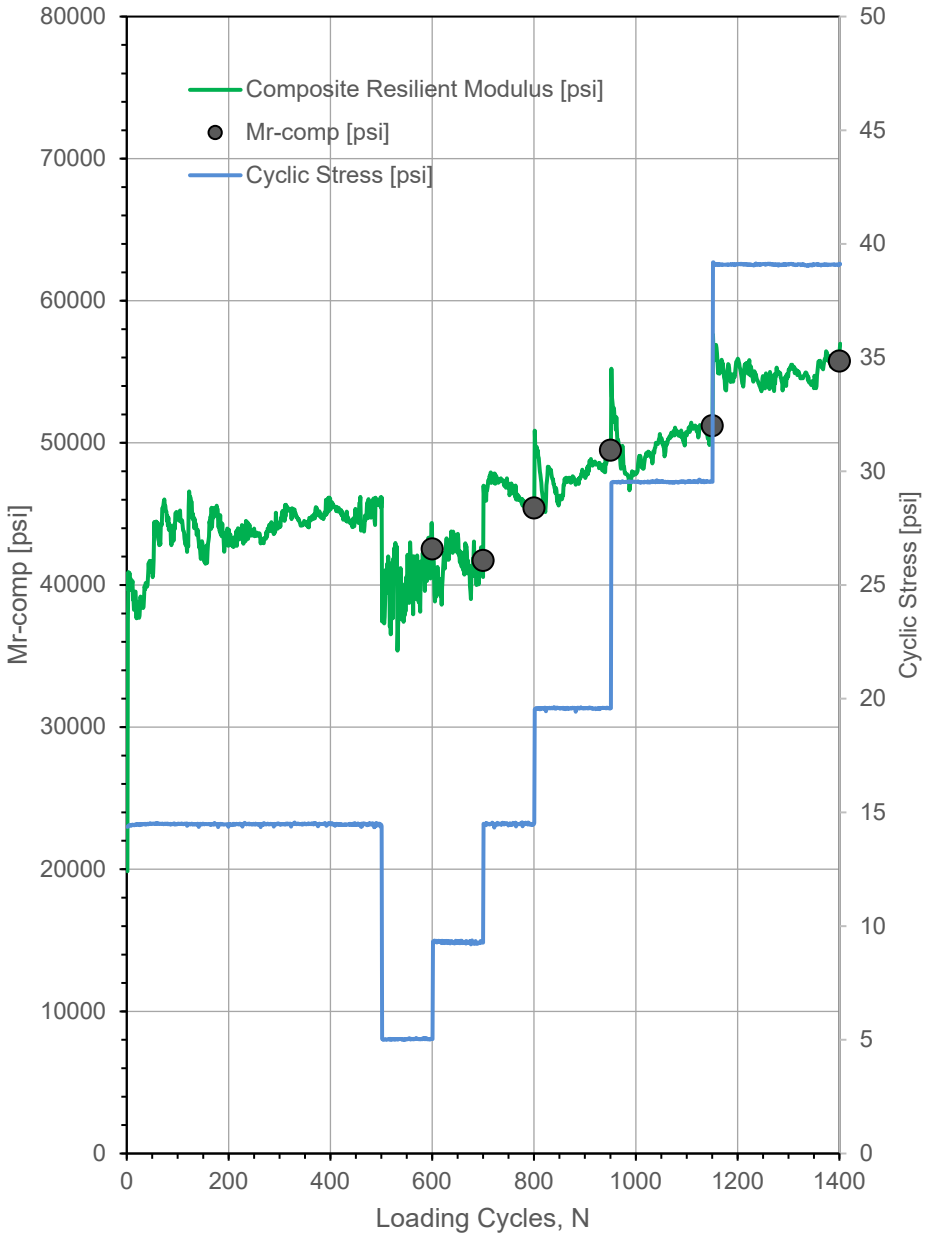
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	1:20:30 PM	Test ID	**Iowa_AID_Hwy52_pt_3**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593510	Longitude,W:	90.971611	Elev. (ft):	361.8
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	41,001
3	41,222
4	41,509
5	41,833
6	42,179
7	42,541
8	42,915
9	43,297
10	43,686
11	44,080
12	44,479
13	44,882
14	45,288
15	45,697
16	46,108
17	46,521
18	46,937
21	48,192
22	48,613
23	49,036
24	49,459
25	49,884
26	50,310
27	50,736
28	51,163
29	51,591
30	52,020
31	52,450
32	52,880
33	53,311
34	53,742
35	54,174
36	54,606
37	55,039
38	55,473
39	55,907
40	56,342



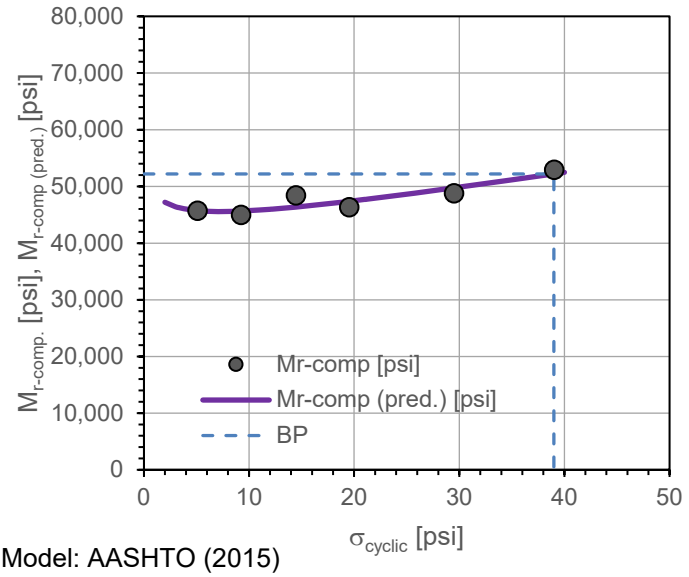
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

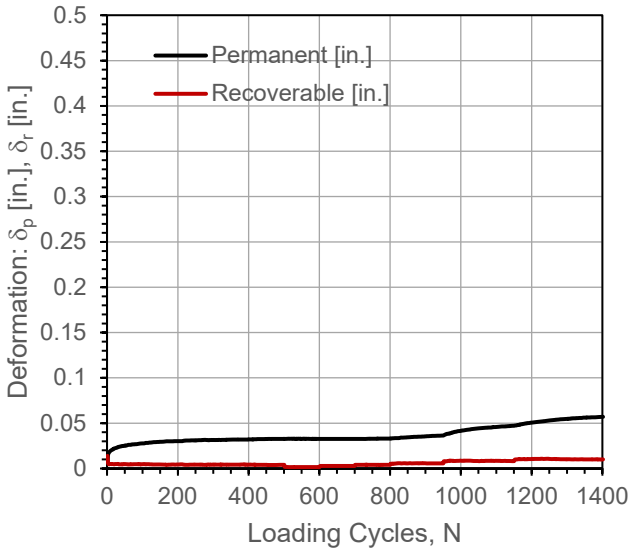
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	1:50:44 PM	Test ID	**Iowa_AID_Hwy52_pt_4**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593513	Longitude,W:	90.971581	Elev. (ft):	360.6
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.45	---	---	0.0326	---	0.139	---
1	100	5.10	45,693	45,715	0.0327	0.0001	-0.010	Y
2	100	9.24	44,972	45,641	0.0326	0.0000	-0.038	Y
3	100	14.45	48,403	46,346	0.0329	0.0003	0.362	Y
4	150	19.53	46,315	47,360	0.0363	0.0037	0.664	N
5	200	29.50	48,771	49,737	0.0471	0.0145	0.676	N
6	250	39.03	52,937	52,216	0.0570	0.0244	0.734	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,925.4	1.94E-07
k^*_2	-0.065	4.72E-01
k^*_3	0.895	1.91E-01
Adj. R^2	0.787	
Std. Error [psi]	1,214	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	52,209
$\sigma_{cyclic\text{-}BP}$ [psi]	39.0

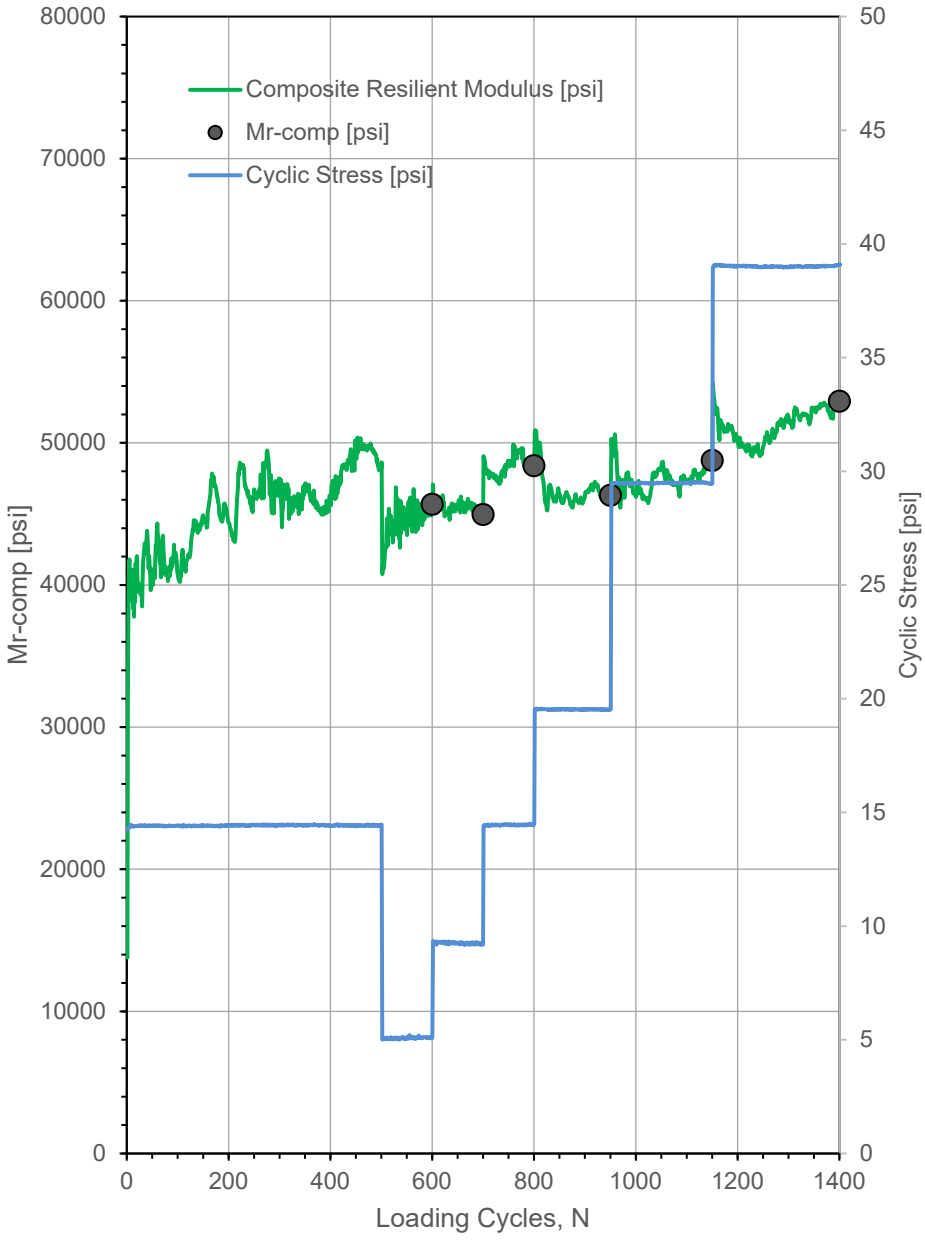
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	1:50:44 PM	Test ID	**Iowa_AID_Hwy52_pt_4**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593513	Longitude,W:	90.971581	Elev. (ft):	360.6
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	47,199
3	46,408
4	45,975
5	45,732
6	45,607
7	45,560
8	45,570
9	45,623
10	45,709
11	45,820
12	45,953
13	46,103
14	46,268
15	46,445
16	46,633
17	46,830
18	47,035
21	47,687
22	47,915
23	48,148
24	48,384
25	48,624
26	48,866
27	49,112
28	49,360
29	49,611
30	49,864
31	50,118
32	50,375
33	50,633
34	50,892
35	51,153
36	51,415
37	51,679
38	51,943
39	52,209
40	52,475



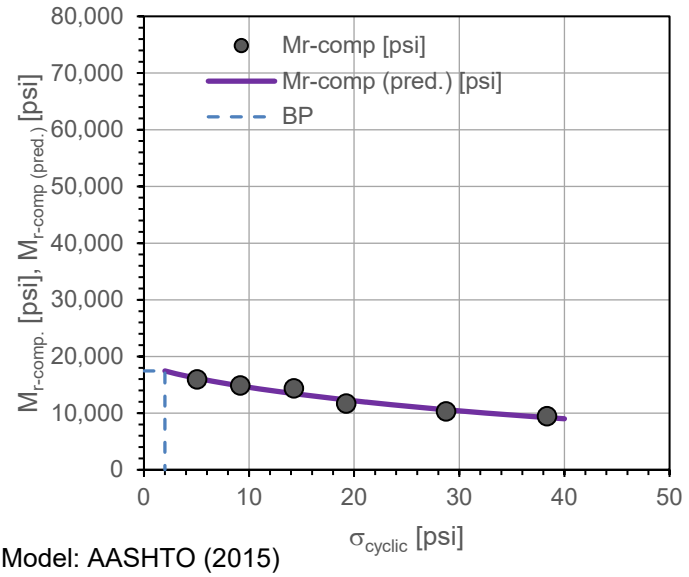
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

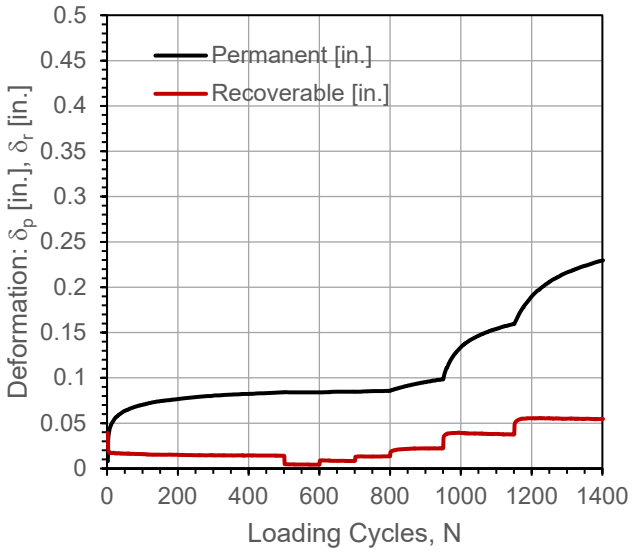
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	2:32:35 PM	Test ID	**Iowa_AID_Hwy52_pt_5**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.594460	Longitude,W:	90.971771	Elev. (ft):	367.3
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.26	---	---	0.0840	---	0.158	---
1	100	5.04	15,937	16,143	0.0840	0.0000	-0.306	Y
2	100	9.16	14,879	14,801	0.0847	0.0006	0.583	Y
3	100	14.26	14,357	13,445	0.0857	0.0017	0.516	Y
4	150	19.23	11,669	12,332	0.0984	0.0143	0.770	N
5	200	28.73	10,300	10,597	0.1595	0.0755	0.638	N
6	250	38.33	9,457	9,217	0.2295	0.1454	0.755	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,196.8	1.41E-06
k^*_2	-0.026	8.60E-01
k^*_3	-1.748	1.51E-01
Adj. R^2	0.948	
Std. Error [psi]	589	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	17,458
$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

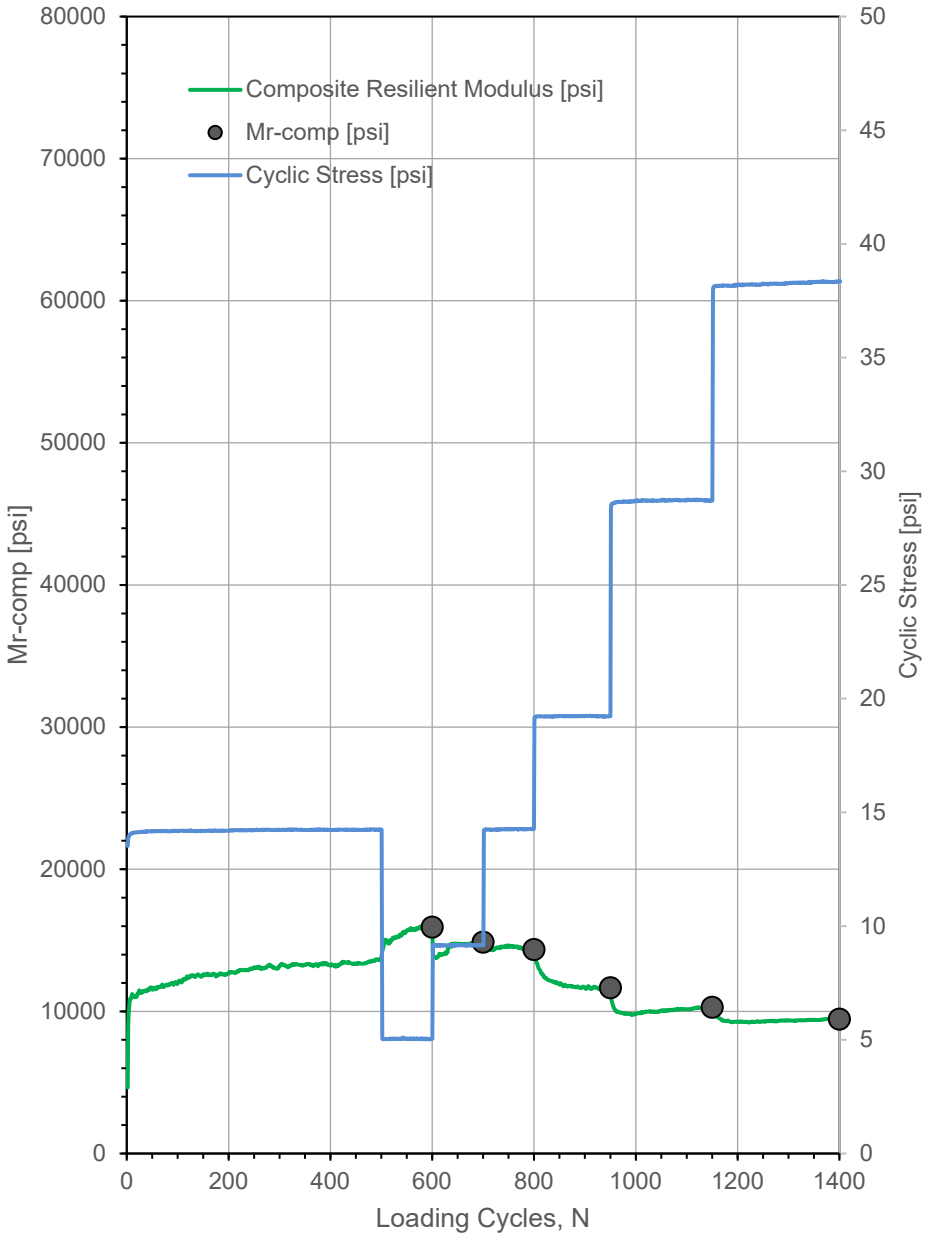
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	2:32:35 PM	Test ID	**Iowa_AID_Hwy52_pt_5**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.594460	Longitude,W:	90.971771	Elev. (ft):	367.3
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	17,458
3	16,967
4	16,542
5	16,158
6	15,801
7	15,467
8	15,150
9	14,848
10	14,559
11	14,281
12	14,014
13	13,757
14	13,509
15	13,269
16	13,036
17	12,811
18	12,592
21	11,974
22	11,780
23	11,590
24	11,406
25	11,227
26	11,052
27	10,882
28	10,716
29	10,554
30	10,396
31	10,242
32	10,092
33	9,945
34	9,802
35	9,662
36	9,525
37	9,391
38	9,260
39	9,132
40	9,007



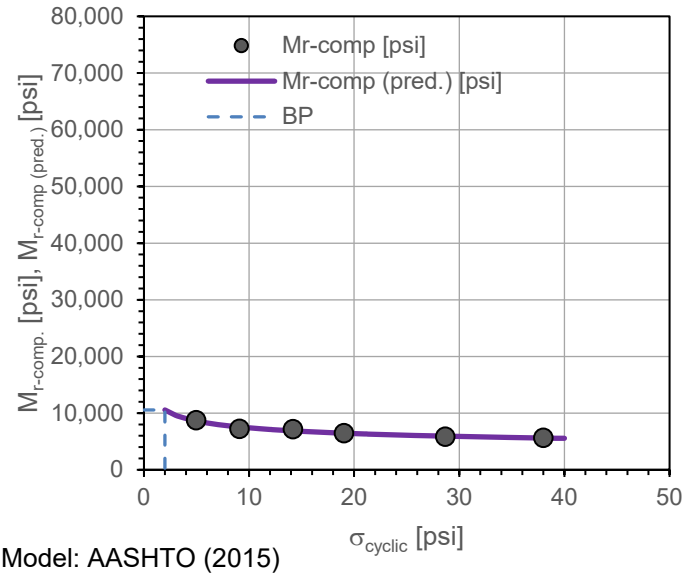
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

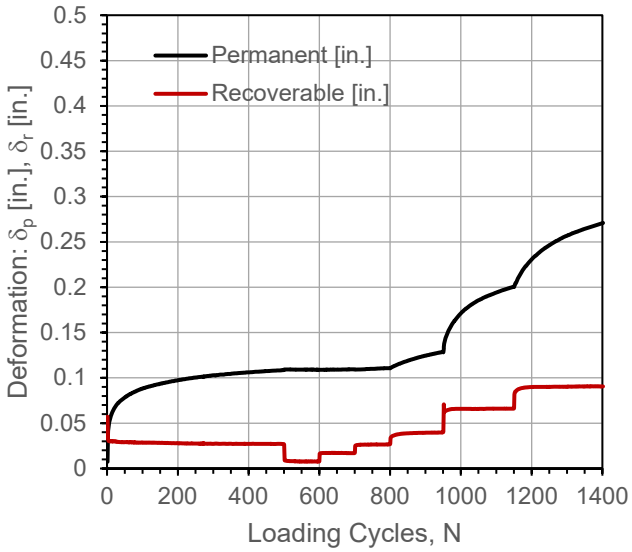
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	3:17:00 PM	Test ID	**Iowa_AID_Hwy52_pt_6**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.594624	Longitude,W:	90.971786	Elev. (ft):	368.1
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.16	---	---	0.1086	---	0.178	---
1	100	4.96	8,741	8,624	0.1090	0.0003	-0.304	Y
2	100	9.08	7,215	7,555	0.1094	0.0008	0.371	Y
3	100	14.16	7,171	6,868	0.1108	0.0021	0.727	N
4	150	19.03	6,453	6,454	0.1286	0.0200	0.801	N
5	200	28.66	5,846	5,933	0.2006	0.0920	0.641	N
6	250	37.99	5,634	5,609	0.2706	0.1620	0.704	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	552.9	7.05E-07
k^*_2	-0.226	9.22E-02
k^*_3	0.101	8.84E-01
Adj. R^2	0.956	
Std. Error [psi]	234	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		10,551
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

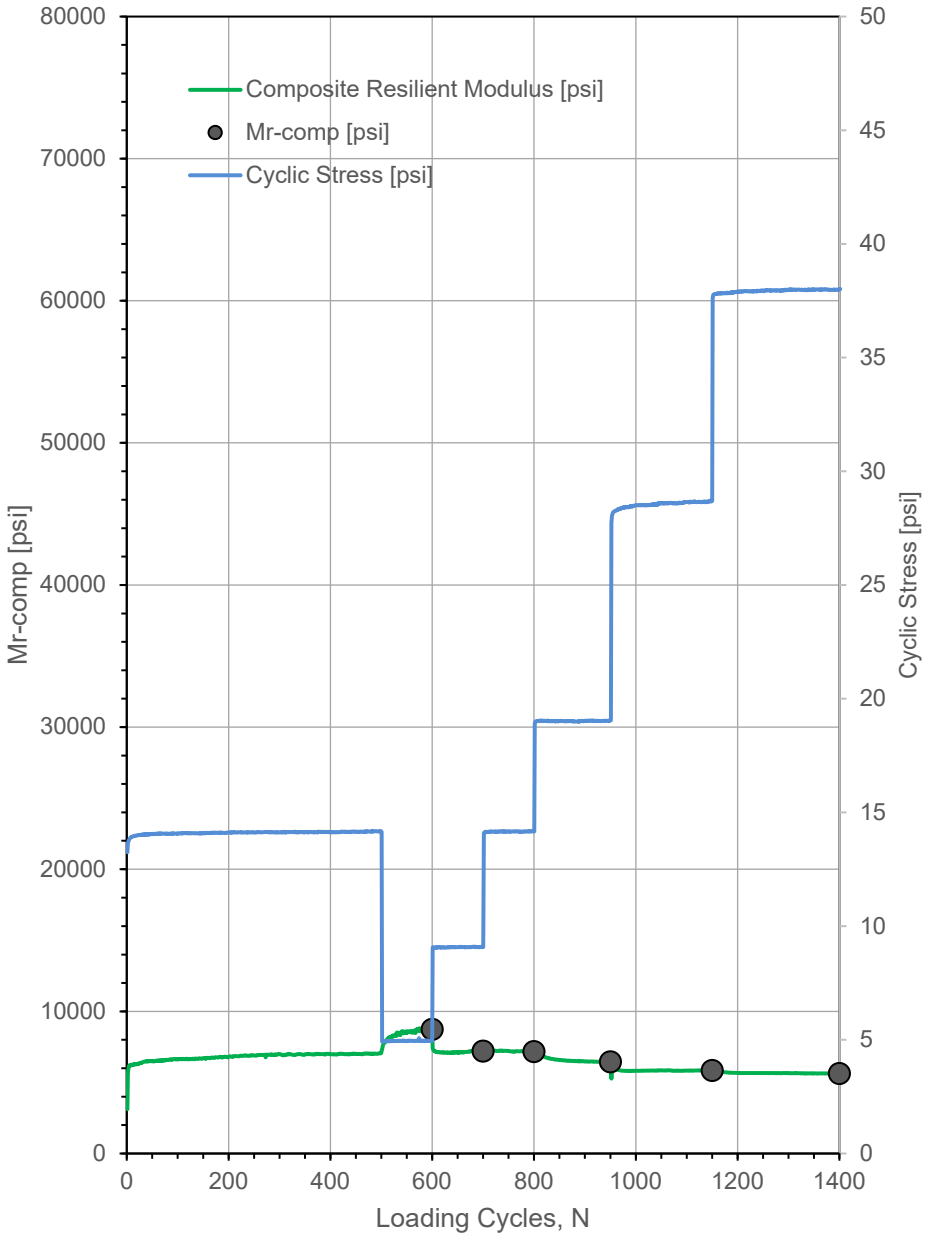
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	3:17:00 PM	Test ID	**Iowa_AID_Hwy52_pt_6**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.594624	Longitude,W:	90.971786	Elev. (ft):	368.1
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	10,551
3	9,639
4	9,043
5	8,608
6	8,269
7	7,995
8	7,765
9	7,569
10	7,399
11	7,249
12	7,115
13	6,994
14	6,884
15	6,784
16	6,693
17	6,608
18	6,529
21	6,323
22	6,262
23	6,205
24	6,151
25	6,100
26	6,052
27	6,005
28	5,961
29	5,919
30	5,879
31	5,840
32	5,803
33	5,768
34	5,734
35	5,701
36	5,669
37	5,638
38	5,609
39	5,580
40	5,553



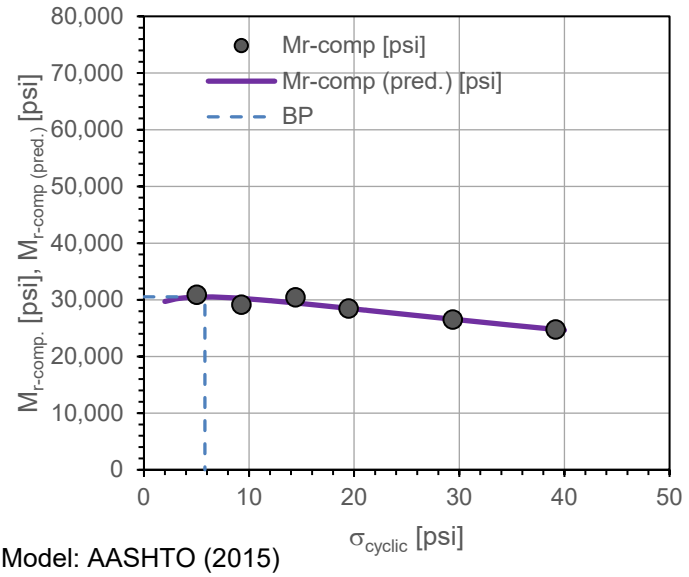
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

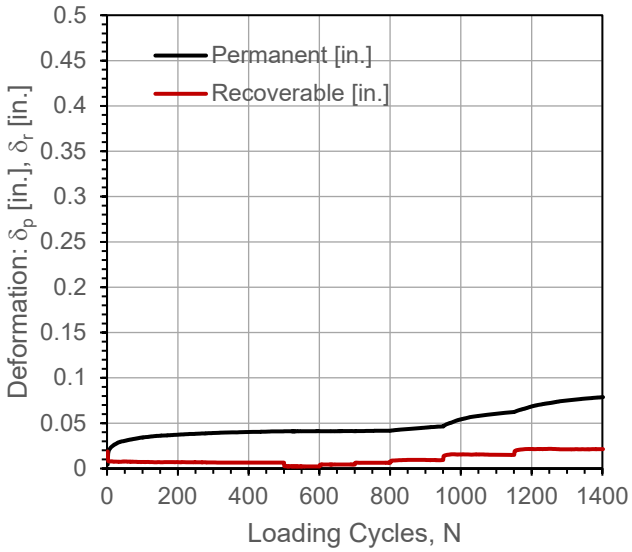
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	5:13:48 PM	Test ID	**Iowa_AID_Hwy52_pt_7**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593410	Longitude,W:	90.973175	Elev. (ft):	358.9
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.42	---	---	0.0410	---	0.158	---
1	100	5.01	30,868	30,492	0.0412	0.0002	0.036	Y
2	100	9.26	29,117	30,258	0.0412	0.0003	0.184	Y
3	100	14.42	30,421	29,450	0.0417	0.0007	0.456	Y
4	150	19.46	28,441	28,498	0.0464	0.0054	0.801	N
5	200	29.37	26,501	26,572	0.0624	0.0214	0.646	N
6	250	39.15	24,746	24,784	0.0787	0.0378	0.761	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,238.2	1.66E-07
k^*_2	0.067	4.13E-01
k^*_3	-1.162	9.46E-02
Adj. R^2	0.892	
Std. Error [psi]	741	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		30,509
	$\sigma_{cyclic\text{-}BP}$ [psi]	5.8

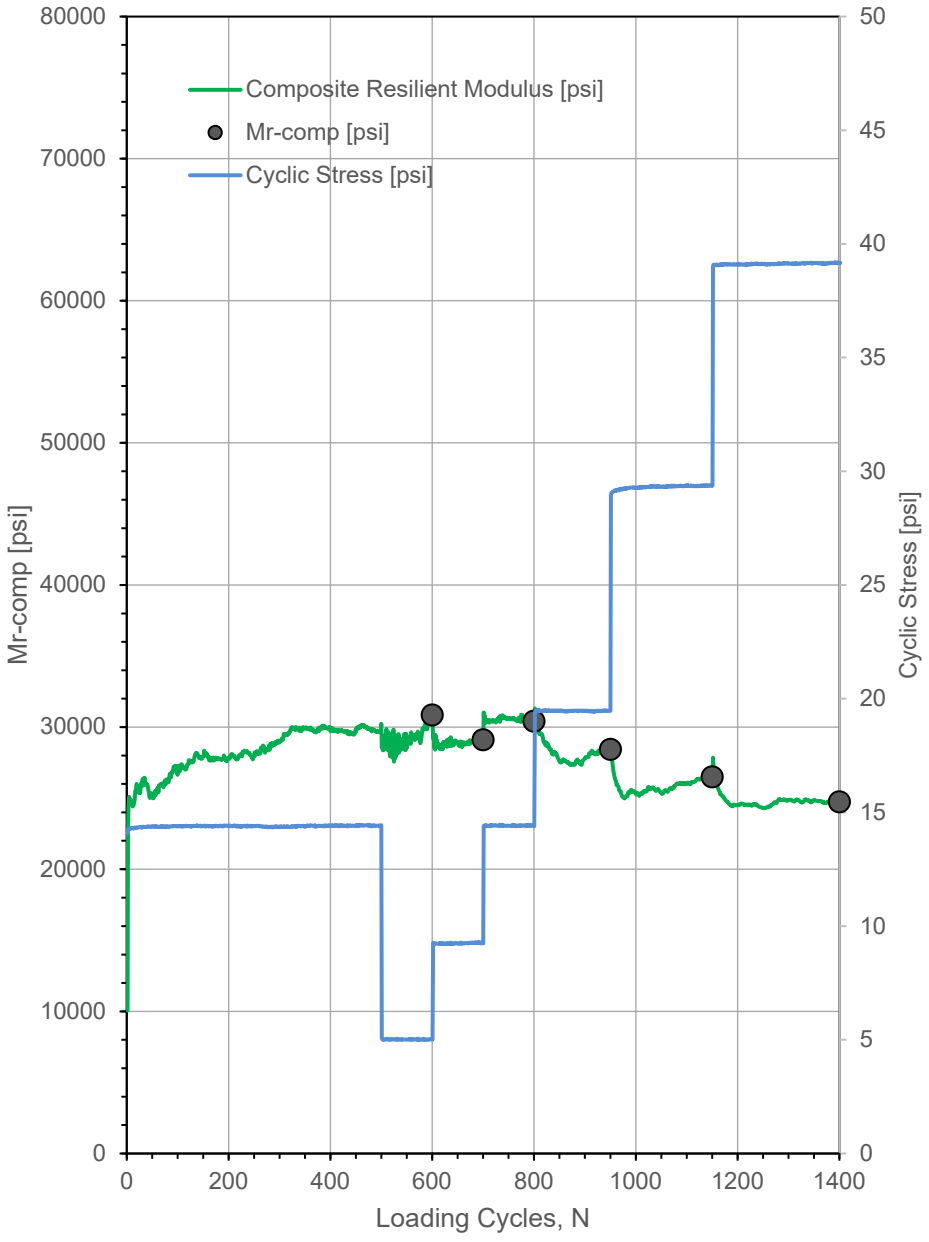
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	5:13:48 PM	Test ID	**Iowa_AID_Hwy52_pt_7**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593410	Longitude,W:	90.973175	Elev. (ft):	358.9
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	29,716
3	30,171
4	30,395
5	30,491
6	30,508
7	30,470
8	30,394
9	30,289
10	30,162
11	30,019
12	29,863
13	29,698
14	29,524
15	29,344
16	29,159
17	28,971
18	28,780
21	28,197
22	28,001
23	27,806
24	27,610
25	27,415
26	27,220
27	27,026
28	26,834
29	26,642
30	26,452
31	26,264
32	26,076
33	25,891
34	25,707
35	25,524
36	25,343
37	25,164
38	24,987
39	24,811
40	24,638



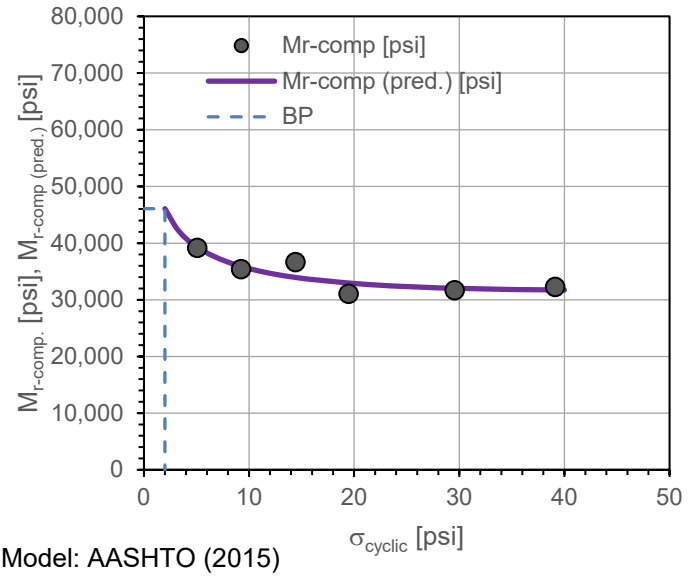
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

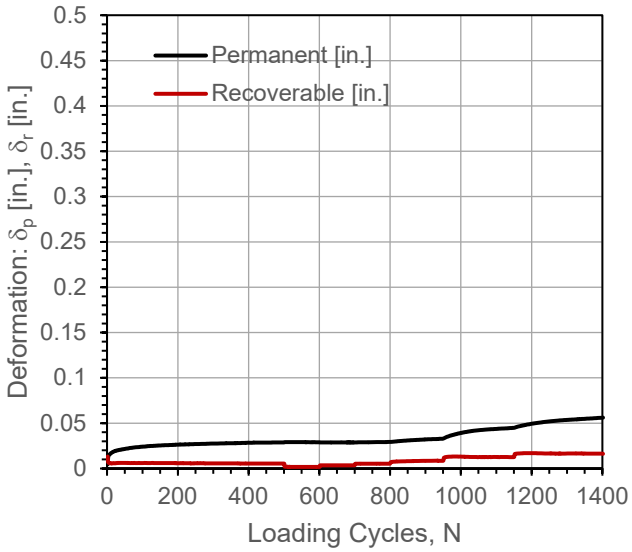
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	5:52:52 PM	Test ID	**Iowa_AID_Hwy52_pt_8**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593204	Longitude,W:	90.967224	Elev. (ft):	347.5
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.41	---	---	0.0288	---	0.147	---
1	100	5.06	39,136	39,305	0.0289	0.0001	-0.077	Y
2	100	9.23	35,379	35,908	0.0288	0.0000	0.019	Y
3	100	14.41	36,625	33,963	0.0292	0.0004	0.385	Y
4	150	19.46	31,039	32,957	0.0329	0.0041	0.716	N
5	200	29.55	31,661	32,032	0.0448	0.0160	0.655	N
6	250	39.11	32,246	31,756	0.0560	0.0272	0.683	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,483.3	1.13E-06
k^*_2	-0.192	2.58E-01
k^*_3	0.603	5.63E-01
Adj. R^2	0.724	
Std. Error [psi]	1,509	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		46,066
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

No Picture

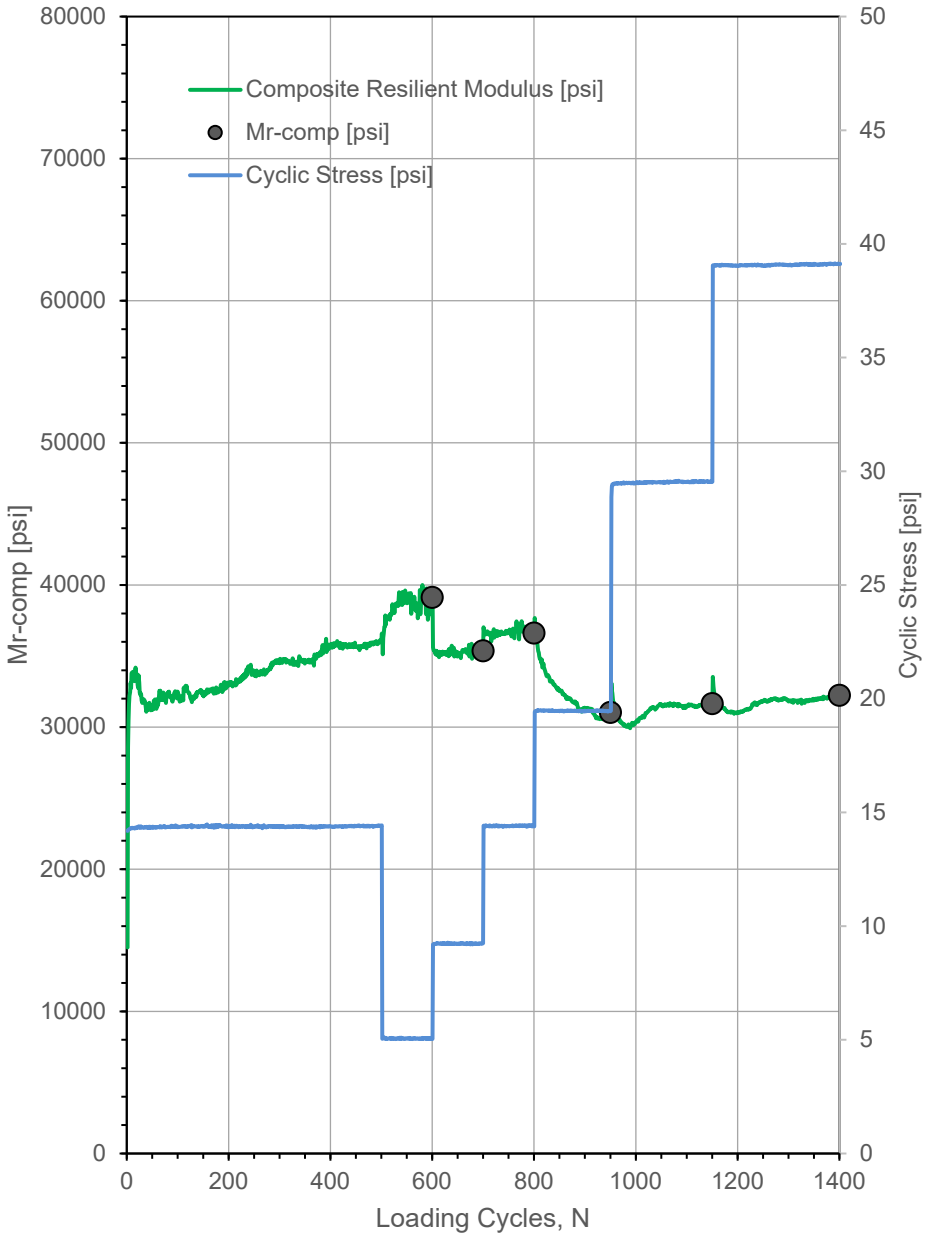
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	5:52:52 PM	Test ID	**Iowa_AID_Hwy52_pt_8**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593204	Longitude,W:	90.967224	Elev. (ft):	347.5
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	46,066
3	42,891
4	40,843
5	39,375
6	38,255
7	37,366
8	36,640
9	36,034
10	35,521
11	35,081
12	34,699
13	34,366
14	34,072
15	33,813
16	33,582
17	33,377
18	33,193
21	32,746
22	32,626
23	32,518
24	32,420
25	32,332
26	32,253
27	32,182
28	32,118
29	32,060
30	32,009
31	31,964
32	31,923
33	31,888
34	31,856
35	31,829
36	31,806
37	31,787
38	31,770
39	31,757
40	31,747



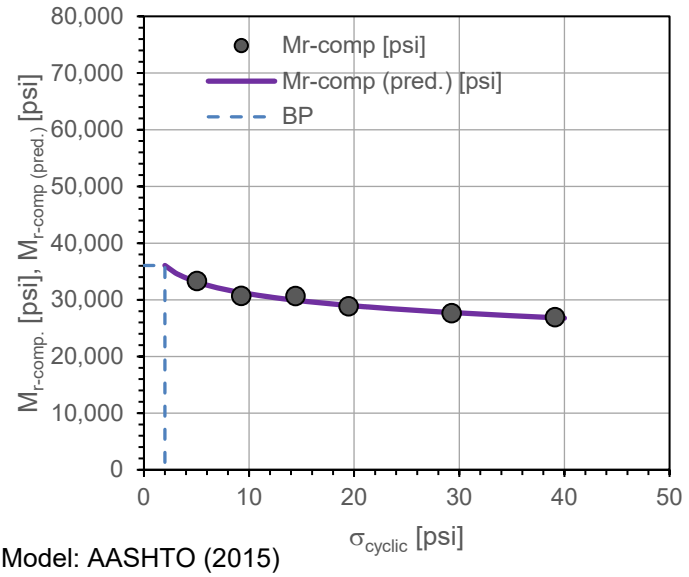
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

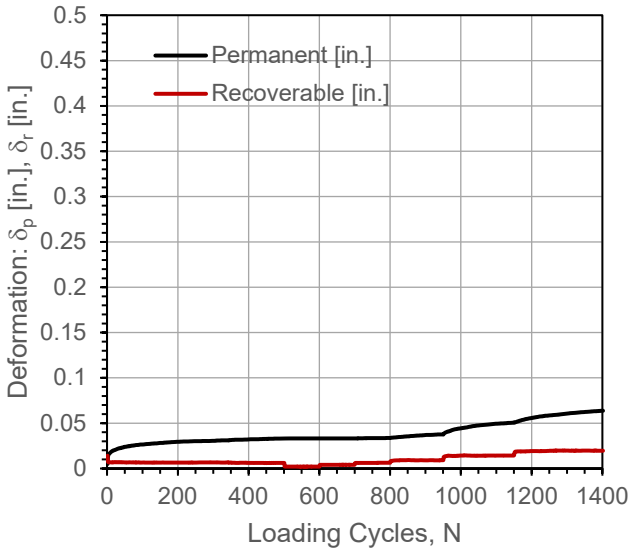
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	6:27:17 PM	Test ID	**Iowa_AID_Hwy52_pt_9**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593174	Longitude,W:	90.966820	Elev. (ft):	349.6
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.41	---	---	0.0330	---	0.163	---
1	100	5.03	33,304	33,138	0.0331	0.0001	-0.003	Y
2	100	9.25	30,674	31,275	0.0331	0.0001	0.070	Y
3	100	14.41	30,653	29,933	0.0336	0.0006	0.357	Y
4	150	19.47	28,828	29,015	0.0376	0.0046	0.676	N
5	200	29.27	27,616	27,757	0.0506	0.0175	0.575	N
6	250	39.09	26,907	26,848	0.0637	0.0307	0.697	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,222.0	4.02E-08
k^*_2	-0.088	1.42E-01
k^*_3	-0.103	7.55E-01
Adj. R^2	0.956	
Std. Error [psi]	483	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		36,046
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

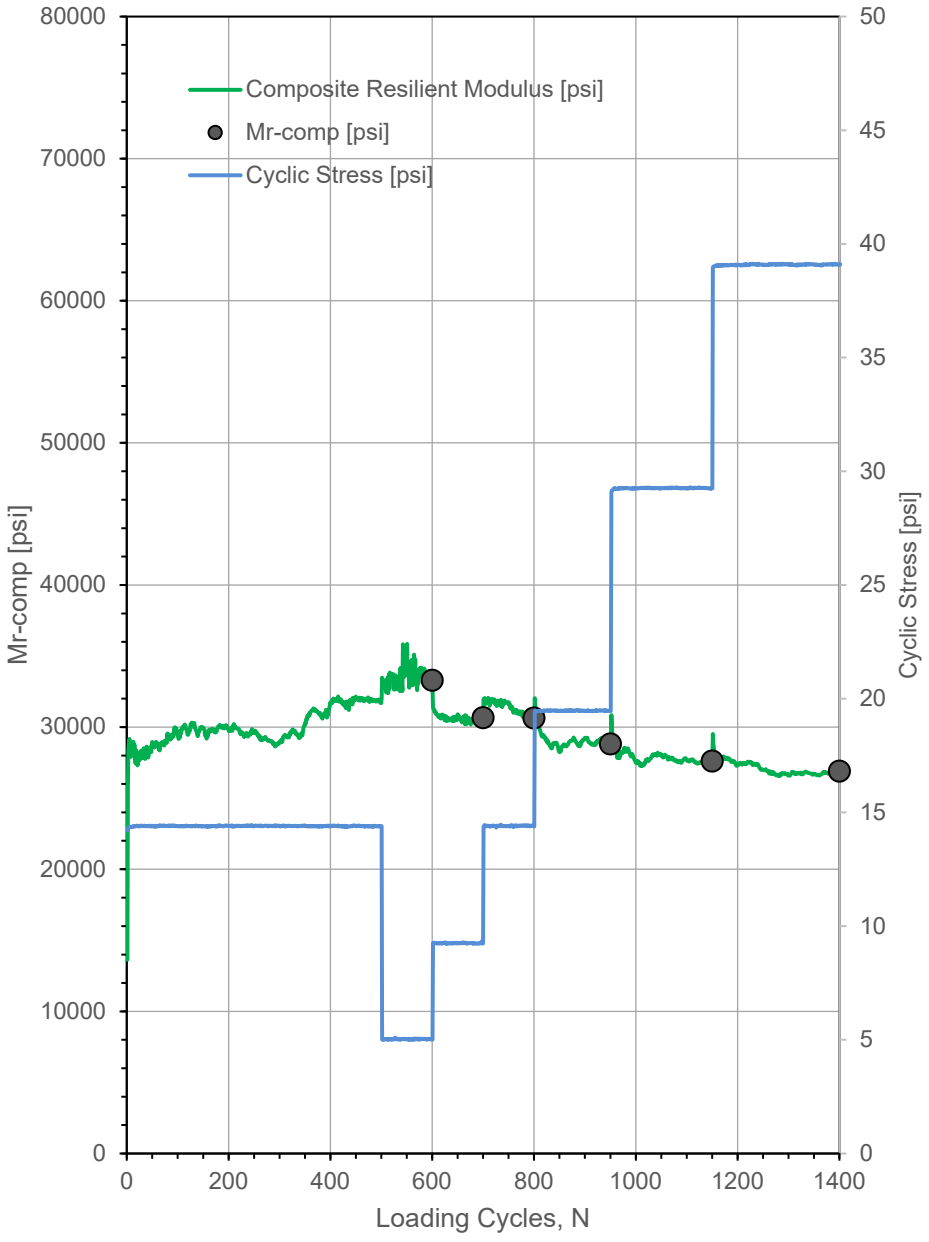
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	6:27:17 PM	Test ID	**Iowa_AID_Hwy52_pt_9**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.593174	Longitude,W:	90.966820	Elev. (ft):	349.6
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	36,046
3	34,749
4	33,846
5	33,155
6	32,595
7	32,124
8	31,718
9	31,360
10	31,040
11	30,751
12	30,487
13	30,245
14	30,020
15	29,810
16	29,614
17	29,429
18	29,255
21	28,783
22	28,640
23	28,503
24	28,372
25	28,246
26	28,125
27	28,008
28	27,895
29	27,786
30	27,680
31	27,578
32	27,478
33	27,382
34	27,288
35	27,197
36	27,108
37	27,022
38	26,937
39	26,855
40	26,775



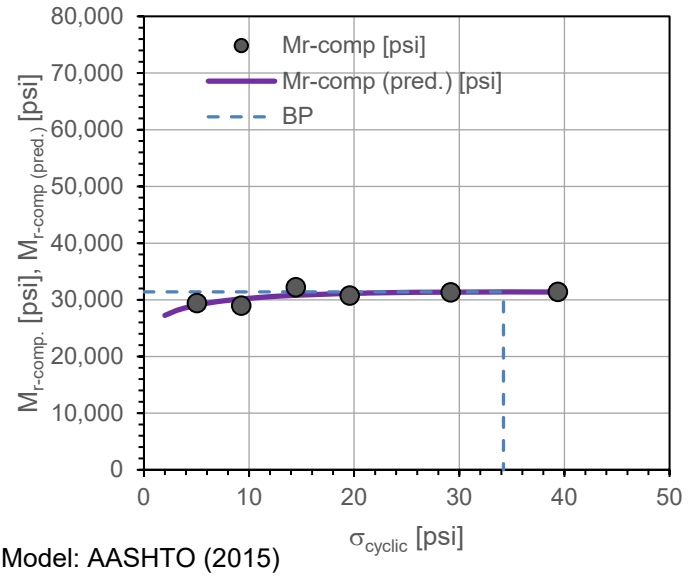
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

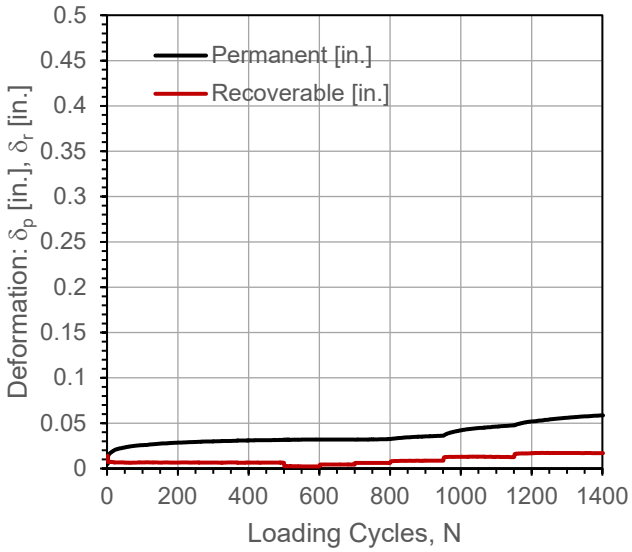
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	6:59:16 PM	Test ID	**owa_AID_Hwy52_pt_10**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.592865	Longitude,W:	90.965225	Elev. (ft):	354.8
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.44	---	---	0.0317	---	0.157	---
1	100	5.03	29,413	29,070	0.0319	0.0002	0.126	Y
2	100	9.25	28,949	30,155	0.0319	0.0002	0.149	Y
3	100	14.44	32,215	30,800	0.0325	0.0008	0.379	Y
4	150	19.57	30,720	31,128	0.0362	0.0045	0.690	N
5	200	29.17	31,287	31,369	0.0476	0.0159	0.626	N
6	250	39.37	31,375	31,374	0.0586	0.0270	0.665	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,046.0	3.07E-07
k^*_2	0.081	4.18E-01
k^*_3	-0.302	6.41E-01
Adj. R^2	0.400	
Std. Error [psi]	695	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	31,392
$\sigma_{cyclic\text{-}BP}$ [psi]	34.2

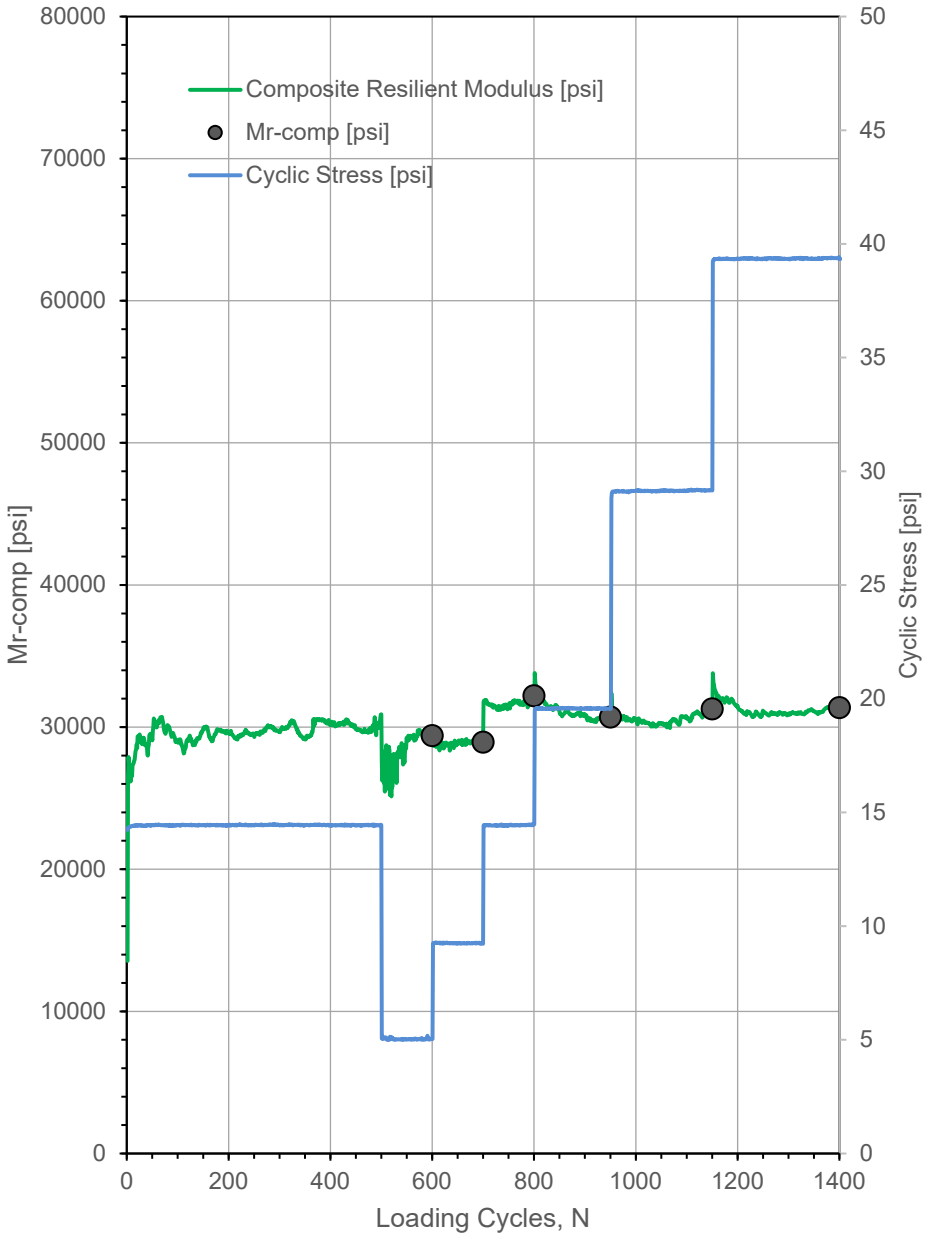
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/4/2019	Time:	6:59:16 PM	Test ID	**owa_AID_Hwy52_pt_10**
Tested By	DW, HG	Location:	Hwy 52	Sta.	NA
Latitude,N:	42.592865	Longitude,W:	90.965225	Elev. (ft):	354.8
Comments:	Crushed limestone modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	27,235
3	28,055
4	28,626
5	29,058
6	29,401
7	29,680
8	29,913
9	30,110
10	30,279
11	30,425
12	30,552
13	30,664
14	30,761
15	30,847
16	30,923
17	30,990
18	31,049
21	31,188
22	31,223
23	31,254
24	31,281
25	31,305
26	31,325
27	31,342
28	31,356
29	31,367
30	31,376
31	31,383
32	31,388
33	31,391
34	31,392
35	31,392
36	31,390
37	31,387
38	31,382
39	31,376
40	31,369



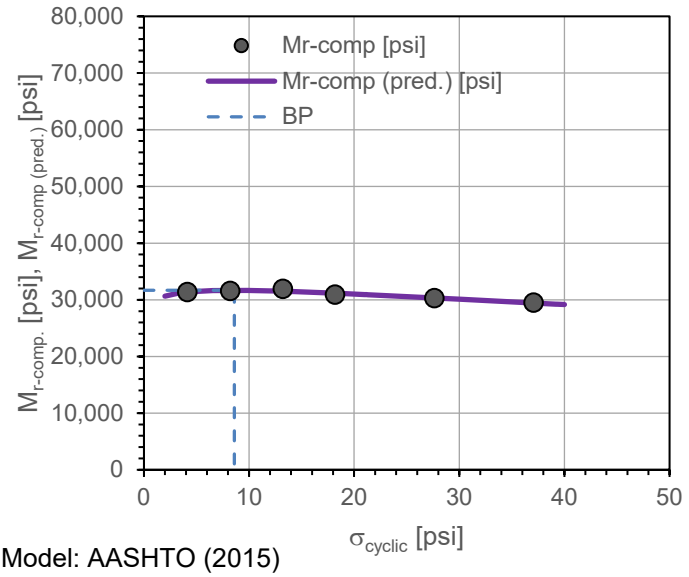
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 52, Dubuque County, IA

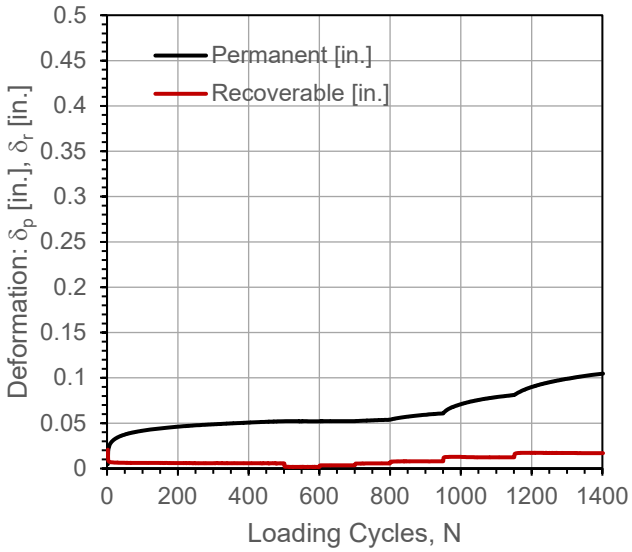
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	11:48:29 AM	Test ID	**owa_AID_Hwy175_pt_1**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.310223	Longitude,W:	93.568382	Elev. (ft):	344.1
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.20	---	---	0.0522	---	0.172	---
1	100	4.12	31,355	31,357	0.0521	-0.0001	-0.203	Y
2	100	8.20	31,552	31,670	0.0522	0.0000	0.147	Y
3	100	13.20	31,906	31,519	0.0538	0.0016	0.641	N
4	150	18.17	30,899	31,172	0.0607	0.0086	0.691	N
5	200	27.62	30,279	30,333	0.0811	0.0289	0.637	N
6	250	37.07	29,504	29,440	0.1046	0.0524	0.757	N



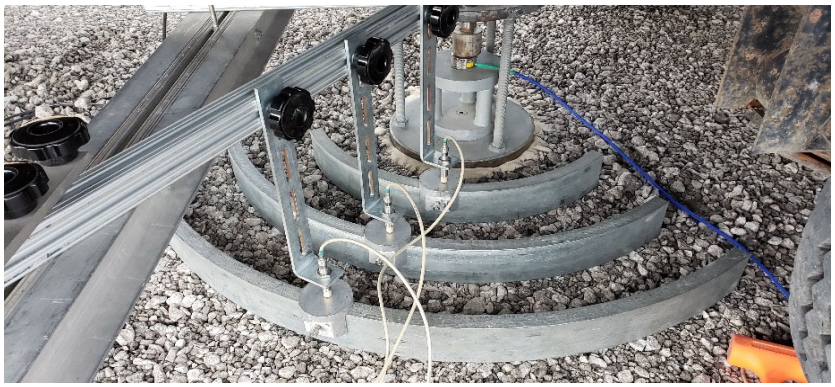


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,234.9	5.74E-09
k^*_2	0.050	7.70E-02
k^*_3	-0.592	2.35E-02
Adj. R^2	0.923	
Std. Error [psi]	239	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	31,672
$\sigma_{cyclic\text{-}BP}$ [psi]	8.6



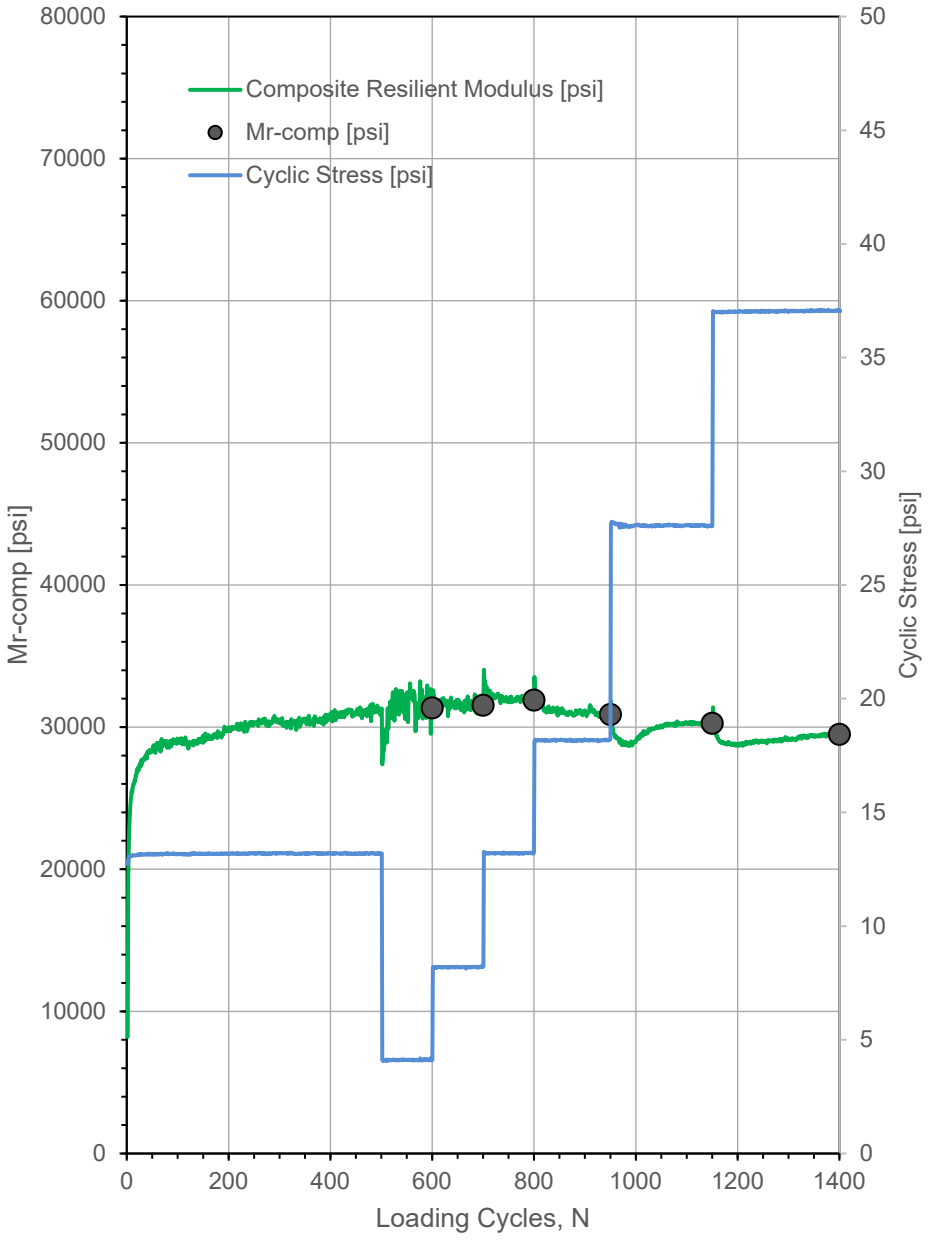
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	11:48:29 AM	Test ID	**owa_AID_Hwy175_pt_1**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.310223	Longitude,W:	93.568382	Elev. (ft):	344.1
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	30,649
3	31,079
4	31,334
5	31,493
6	31,589
7	31,644
8	31,668
9	31,670
10	31,653
11	31,623
12	31,581
13	31,530
14	31,472
15	31,407
16	31,337
17	31,263
18	31,185
21	30,935
22	30,847
23	30,758
24	30,667
25	30,576
26	30,483
27	30,390
28	30,297
29	30,203
30	30,108
31	30,014
32	29,919
33	29,824
34	29,730
35	29,635
36	29,541
37	29,446
38	29,352
39	29,259
40	29,166



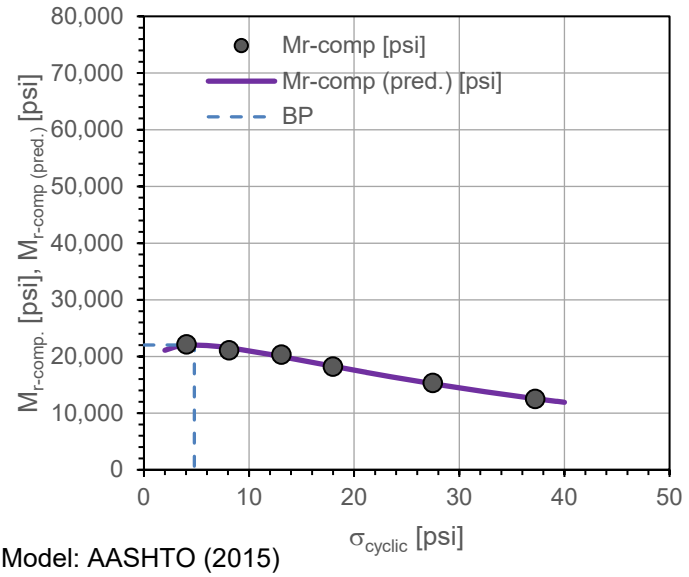
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

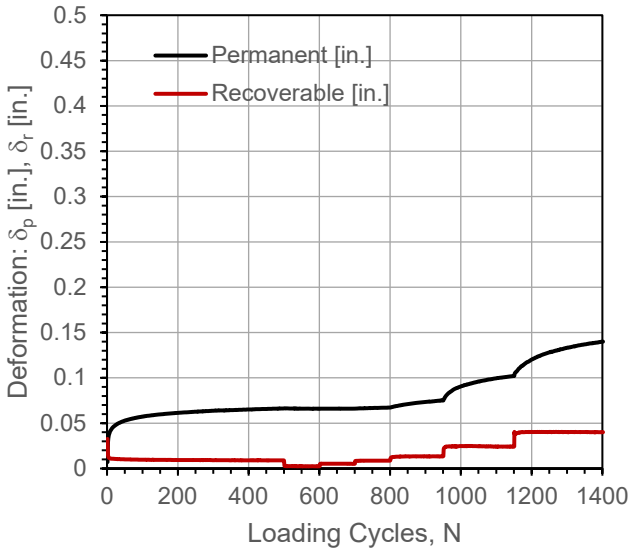
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	12:22:57 PM	Test ID	**owa_AID_Hwy175_pt_2**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.309765	Longitude,W:	93.568489	Elev. (ft):	347.9
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.07	---	---	0.0662	---	0.130	---
1	100	4.05	22,134	21,969	0.0659	-0.0003	-0.288	Y
2	100	8.10	21,064	21,521	0.0661	-0.0001	0.180	Y
3	100	13.07	20,320	19,988	0.0672	0.0010	0.459	Y
4	150	17.96	18,195	18,286	0.0751	0.0089	0.749	N
5	200	27.47	15,323	15,194	0.1022	0.0360	0.600	N
6	250	37.21	12,492	12,567	0.1399	0.0737	0.605	N



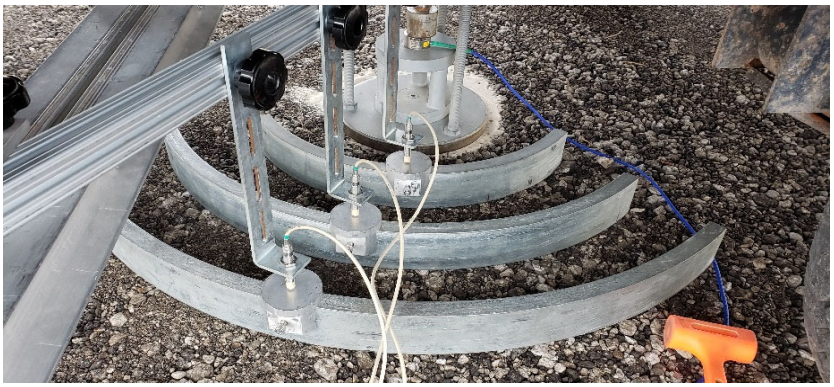


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,814.6	4.39E-08
k^*_2	0.148	2.49E-02
k^*_3	-3.034	1.40E-03
Adj. R^2	0.993	
Std. Error [psi]	307	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	22,012
$\sigma_{cyclic\text{-}BP}$ [psi]	4.8



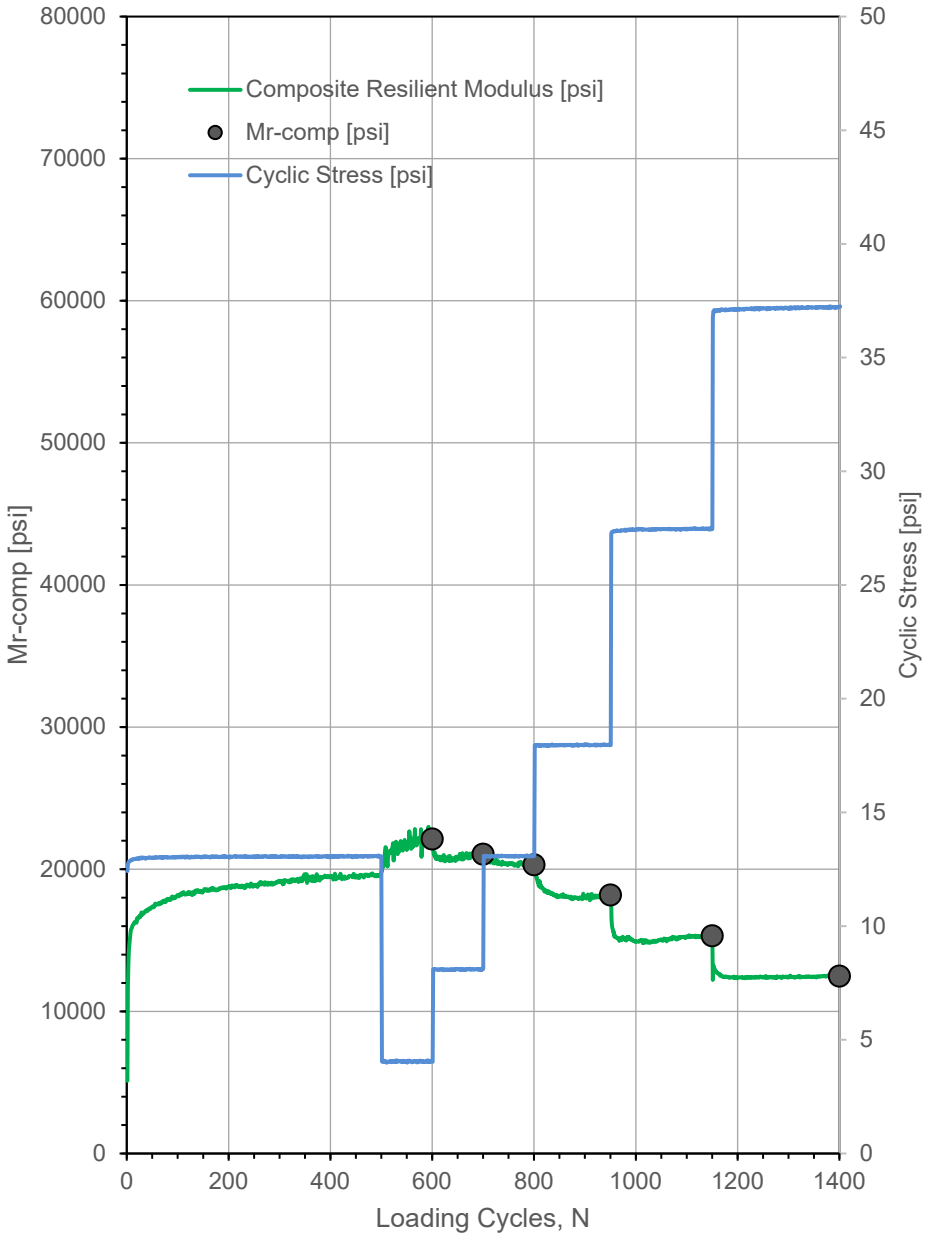
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	12:22:57 PM	Test ID	**owa_AID_Hwy175_pt_2**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.309765	Longitude,W:	93.568489	Elev. (ft):	347.9
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	21,104
3	21,714
4	21,963
5	22,010
6	21,931
7	21,767
8	21,546
9	21,283
10	20,991
11	20,678
12	20,350
13	20,012
14	19,668
15	19,320
16	18,970
17	18,621
18	18,274
21	17,250
22	16,917
23	16,590
24	16,267
25	15,951
26	15,640
27	15,336
28	15,037
29	14,744
30	14,458
31	14,177
32	13,903
33	13,634
34	13,371
35	13,115
36	12,863
37	12,618
38	12,378
39	12,144
40	11,914



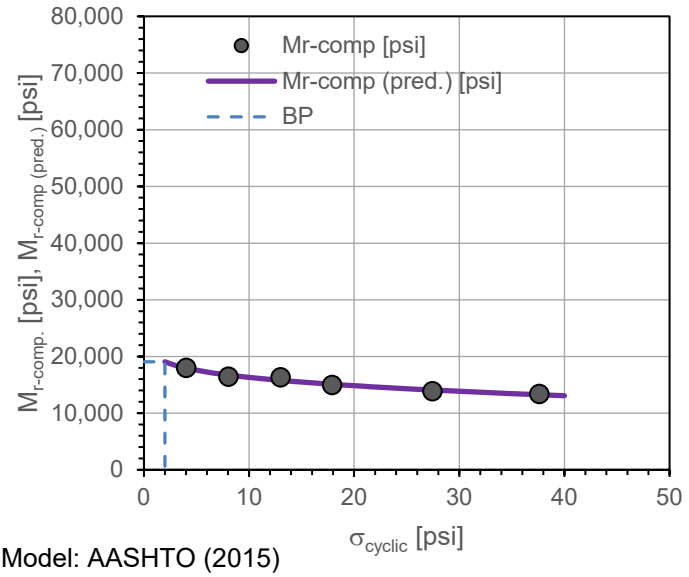
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

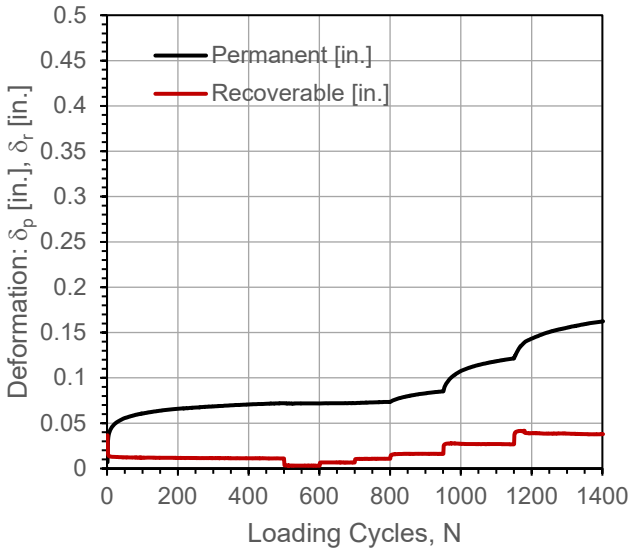
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	12:55:49 PM	Test ID	**owa_AID_Hwy175_pt_3**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.309067	Longitude,W:	93.568710	Elev. (ft):	343.8
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	12.99	---	---	0.0721	---	0.143	---
1	100	4.02	17,981	17,930	0.0719	-0.0002	0.049	Y
2	100	8.03	16,407	16,719	0.0721	0.0001	0.334	Y
3	100	12.99	16,309	15,782	0.0735	0.0015	0.541	Y
4	150	17.89	14,946	15,094	0.0852	0.0131	0.726	N
5	200	27.44	13,861	14,079	0.1215	0.0495	0.577	N
6	250	37.60	13,364	13,250	0.1622	0.0901	0.567	N



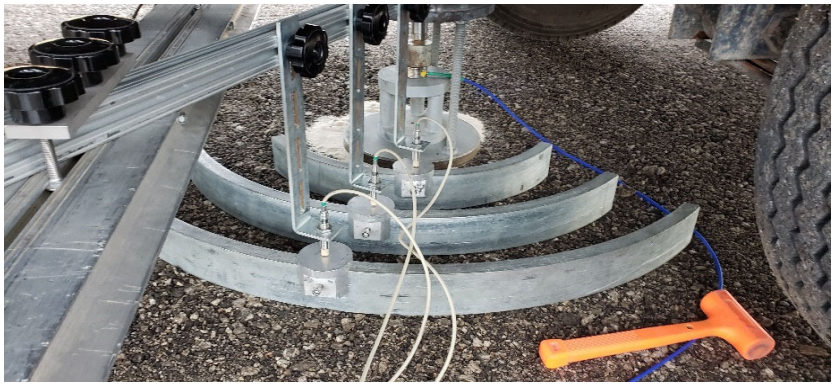


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,202.9	1.43E-07
k^*_2	-0.074	2.32E-01
k^*_3	-0.463	2.96E-01
Adj. R^2	0.962	
Std. Error [psi]	334	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	19,064
$\sigma_{cyclic\text{-}BP}$ [psi]	2.0



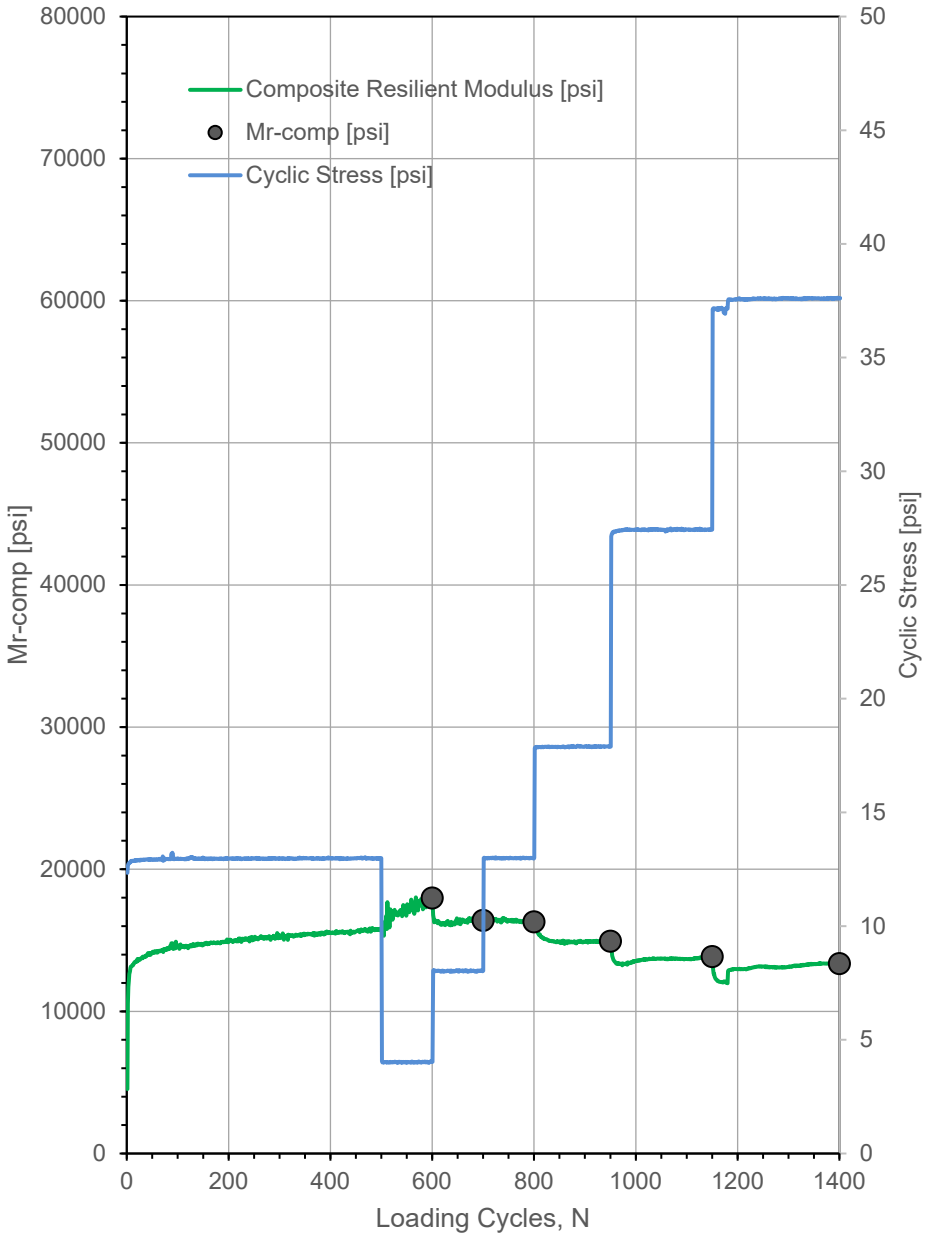
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	12:55:49 PM	Test ID	**owa_AID_Hwy175_pt_3**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.309067	Longitude,W:	93.568710	Elev. (ft):	343.8
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	19,064
3	18,411
4	17,937
5	17,560
6	17,244
7	16,969
8	16,726
9	16,506
10	16,304
11	16,117
12	15,944
13	15,780
14	15,626
15	15,480
16	15,341
17	15,208
18	15,081
21	14,728
22	14,619
23	14,513
24	14,410
25	14,310
26	14,213
27	14,119
28	14,027
29	13,938
30	13,851
31	13,766
32	13,683
33	13,602
34	13,522
35	13,445
36	13,369
37	13,294
38	13,221
39	13,150
40	13,079



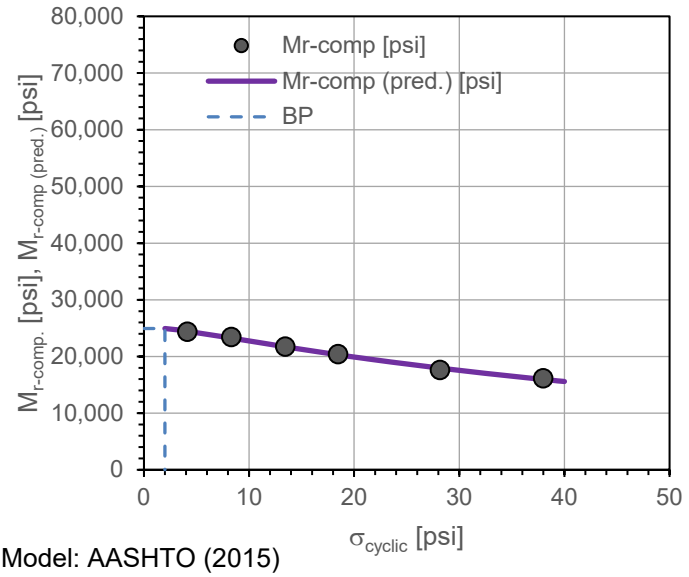
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

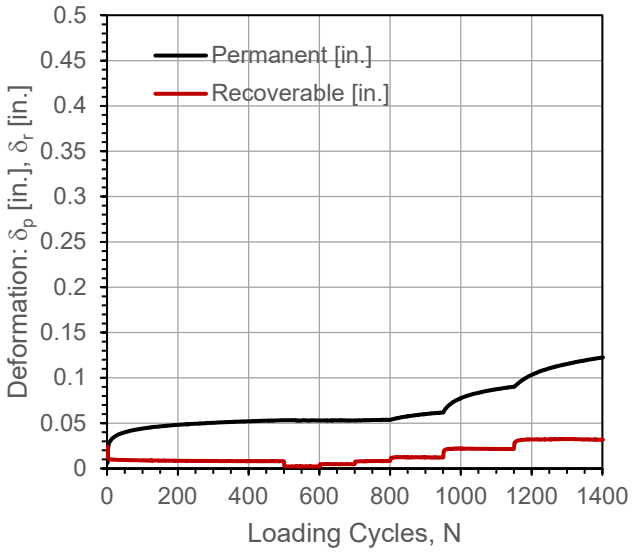
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	1:30:28 PM	Test ID	**owa_AID_Hwy175_pt_4**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.308228	Longitude,W:	93.568916	Elev. (ft):	345.9
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.44	---	---	0.0532	---	0.151	---
1	100	4.12	24,362	24,471	0.0530	-0.0002	-0.209	Y
2	100	8.31	23,425	23,241	0.0530	-0.0002	0.097	Y
3	100	13.44	21,730	21,714	0.0537	0.0005	0.514	Y
4	150	18.46	20,391	20,315	0.0618	0.0086	0.775	N
5	200	28.16	17,617	17,949	0.0902	0.0370	0.632	N
6	250	37.98	16,125	15,953	0.1224	0.0692	0.697	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,801.4	1.97E-08
k^*_2	0.023	4.73E-01
k^*_3	-1.607	4.14E-03
Adj. R^2	0.995	
Std. Error [psi]	218	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		24,939
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

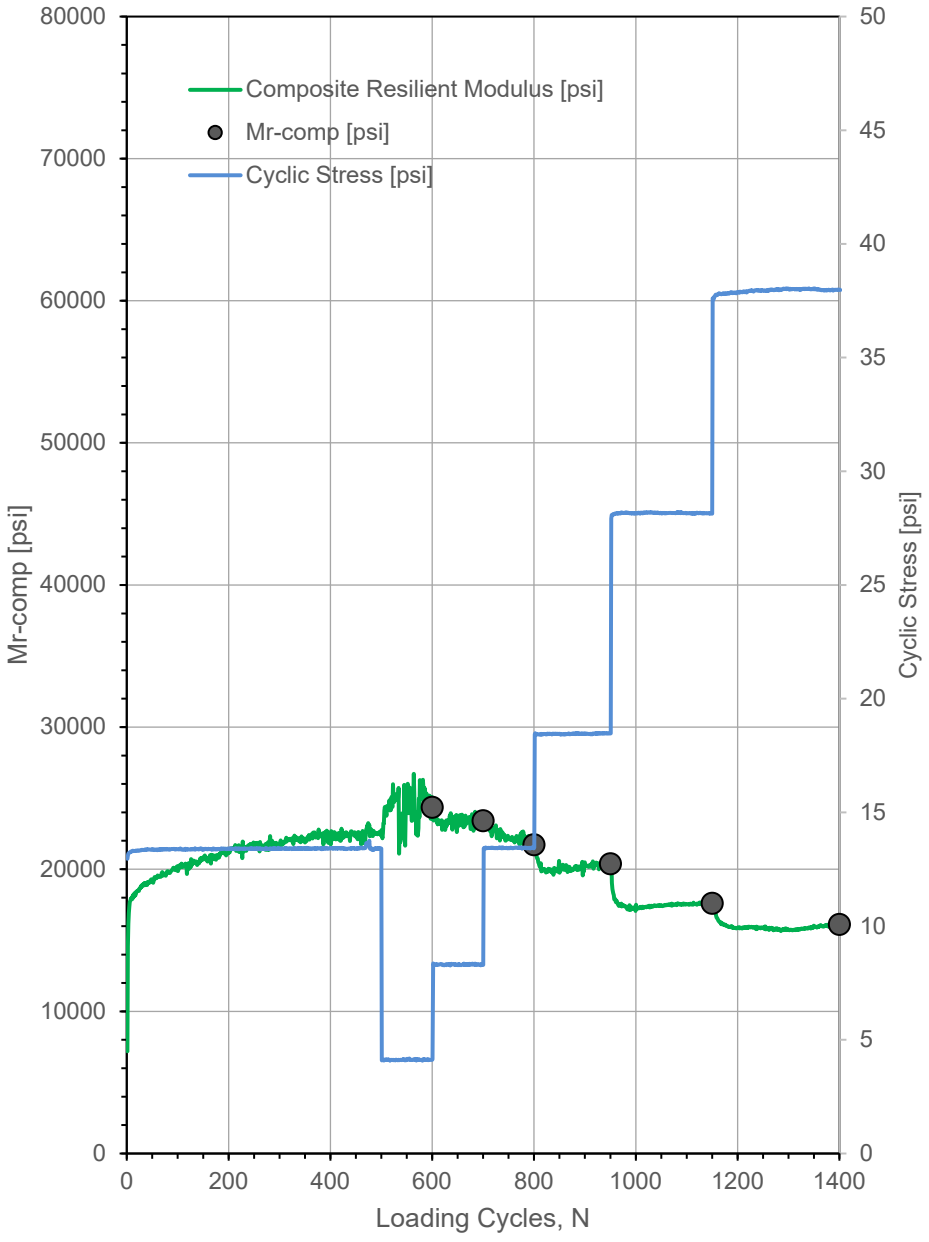
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	1:30:28 PM	Test ID	**owa_AID_Hwy175_pt_4**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.308228	Longitude,W:	93.568916	Elev. (ft):	345.9
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	24,939
3	24,751
4	24,504
5	24,228
6	23,937
7	23,638
8	23,336
9	23,032
10	22,730
11	22,430
12	22,133
13	21,840
14	21,551
15	21,266
16	20,986
17	20,710
18	20,439
21	19,654
22	19,402
23	19,155
24	18,912
25	18,673
26	18,439
27	18,210
28	17,984
29	17,763
30	17,546
31	17,333
32	17,124
33	16,919
34	16,718
35	16,520
36	16,326
37	16,136
38	15,949
39	15,765
40	15,585



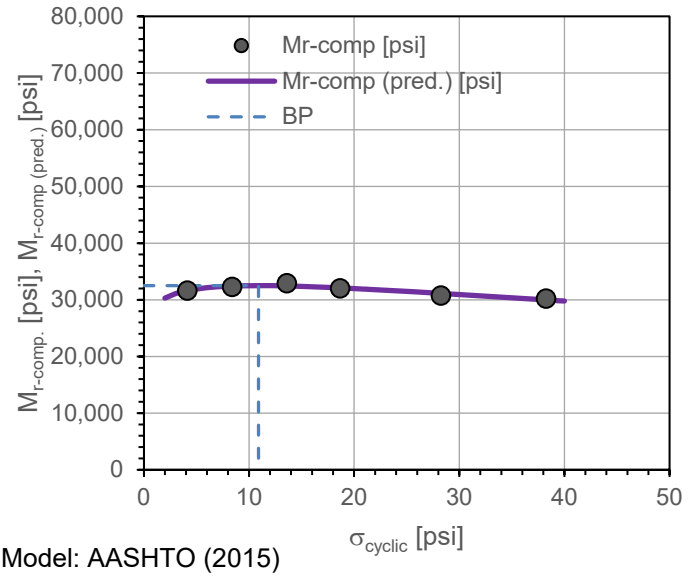
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

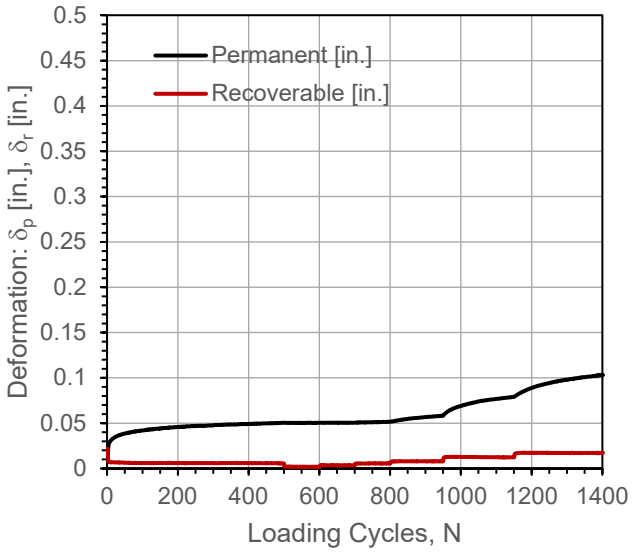
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	2:07:40 PM	Test ID	**owa_AID_Hwy175_pt_5**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307961	Longitude,W:	93.568977	Elev. (ft):	340.6
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.59	---	---	0.0504	---	0.138	---
1	100	4.12	31,619	31,630	0.0505	0.0001	-0.060	Y
2	100	8.38	32,266	32,432	0.0505	0.0001	0.087	Y
3	100	13.59	32,915	32,449	0.0515	0.0011	0.479	Y
4	150	18.66	32,016	32,110	0.0583	0.0079	0.775	N
5	200	28.25	30,722	31,134	0.0789	0.0285	0.620	N
6	250	38.24	30,210	29,984	0.1032	0.0528	0.732	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,307.0	1.36E-08
k^*_2	0.083	4.57E-02
k^*_3	-0.798	2.25E-02
Adj. R^2	0.882	
Std. Error [psi]	325	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	32,511
$\sigma_{cyclic\text{-}BP}$ [psi]	10.9

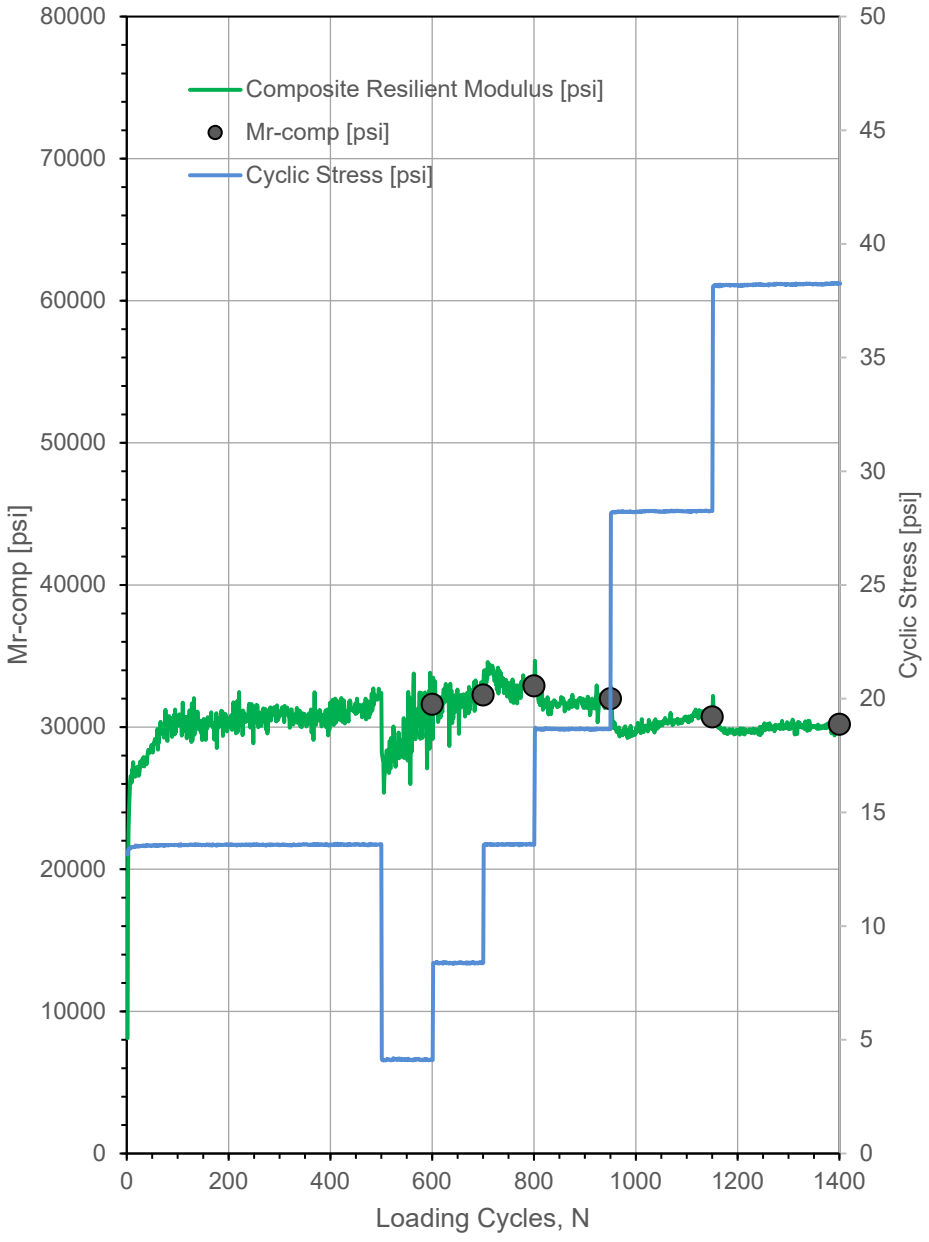
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	2:07:40 PM	Test ID	**owa_AID_Hwy175_pt_5**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307961	Longitude,W:	93.568977	Elev. (ft):	340.6
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	30,306
3	31,088
4	31,581
5	31,913
6	32,142
7	32,299
8	32,403
9	32,468
10	32,502
11	32,510
12	32,499
13	32,471
14	32,430
15	32,377
16	32,314
17	32,243
18	32,165
21	31,899
22	31,801
23	31,701
24	31,597
25	31,491
26	31,383
27	31,274
28	31,162
29	31,050
30	30,937
31	30,822
32	30,708
33	30,592
34	30,476
35	30,360
36	30,244
37	30,128
38	30,012
39	29,896
40	29,780



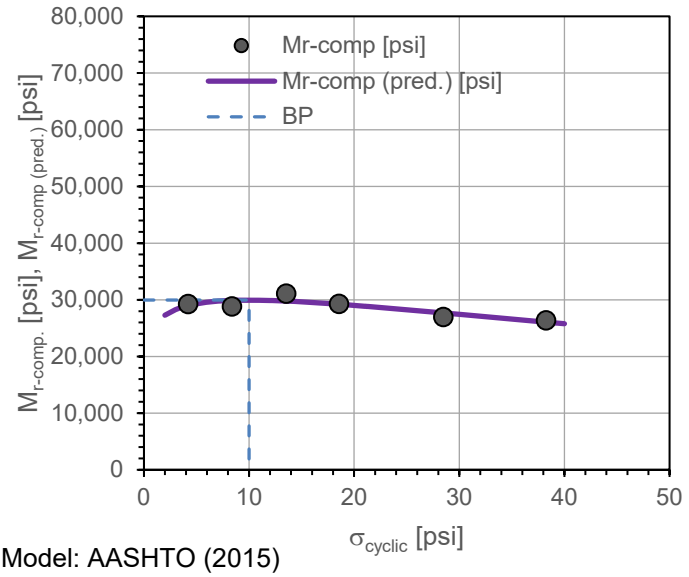
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

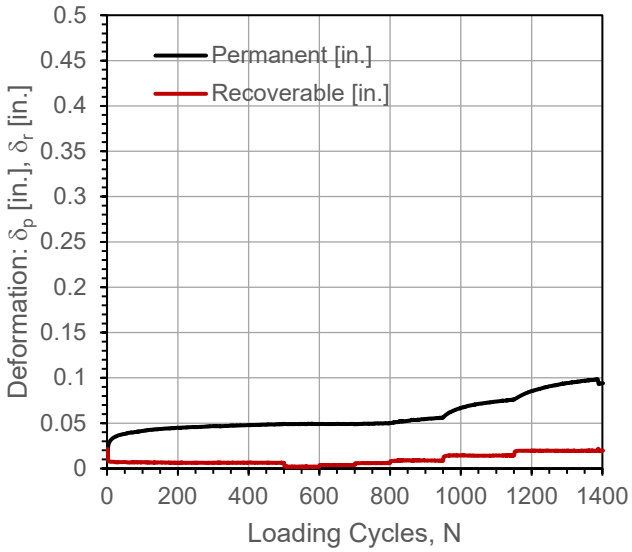
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	2:41:52 PM	Test ID	**owa_AID_Hwy175_pt_6**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307884	Longitude,W:	93.568993	Elev. (ft):	341.7
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.52	---	---	0.0489	---	0.125	---
1	100	4.20	29,241	28,986	0.0490	0.0000	0.084	Y
2	100	8.37	28,814	29,899	0.0489	-0.0001	-0.008	Y
3	100	13.52	31,073	29,788	0.0502	0.0012	0.577	Y
4	150	18.55	29,255	29,224	0.0562	0.0073	0.696	N
5	200	28.48	26,950	27,685	0.0761	0.0271	0.627	N
6	250	38.24	26,371	26,062	0.0940	0.0451	0.706	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,187.0	3.50E-07
k^*_2	0.120	2.09E-01
k^*_3	-1.246	1.07E-01
Adj. R^2	0.700	
Std. Error [psi]	809	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	29,948
$\sigma_{cyclic\text{-}BP}$ [psi]	10.0

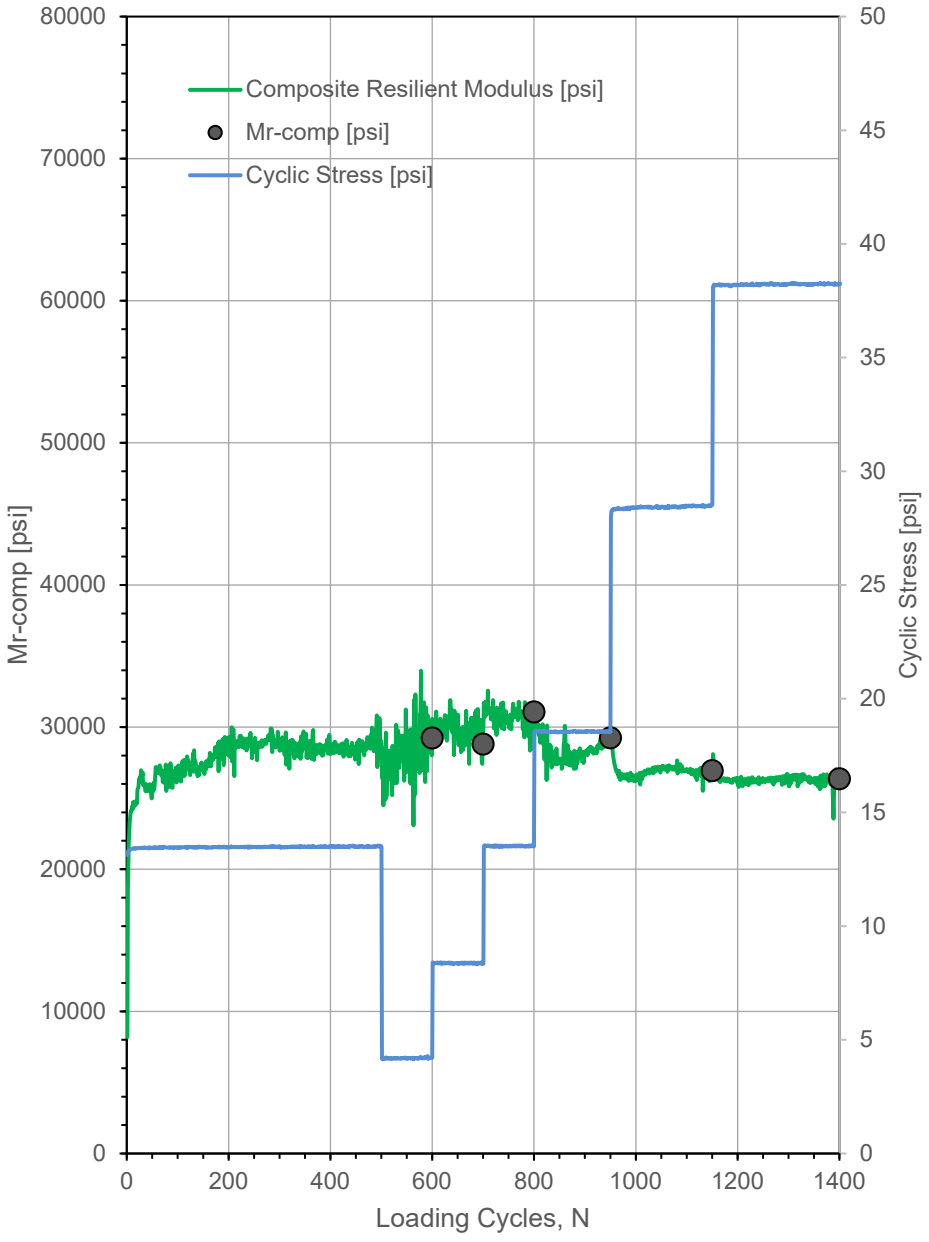
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	2:41:52 PM	Test ID	**owa_AID_Hwy175_pt_6**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307884	Longitude,W:	93.568993	Elev. (ft):	341.7
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	27,273
3	28,268
4	28,891
5	29,303
6	29,579
7	29,760
8	29,871
9	29,930
10	29,948
11	29,933
12	29,891
13	29,828
14	29,747
15	29,652
16	29,543
17	29,425
18	29,297
21	28,876
22	28,725
23	28,571
24	28,413
25	28,254
26	28,092
27	27,928
28	27,764
29	27,598
30	27,432
31	27,265
32	27,098
33	26,931
34	26,765
35	26,598
36	26,432
37	26,267
38	26,102
39	25,938
40	25,774



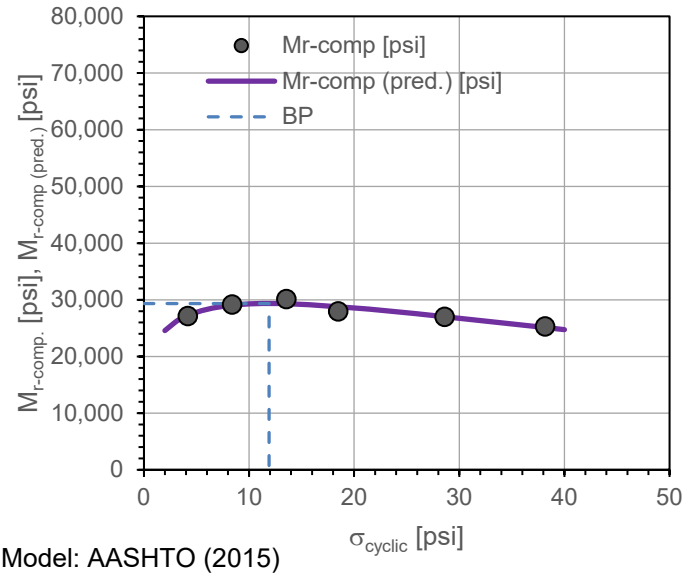
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

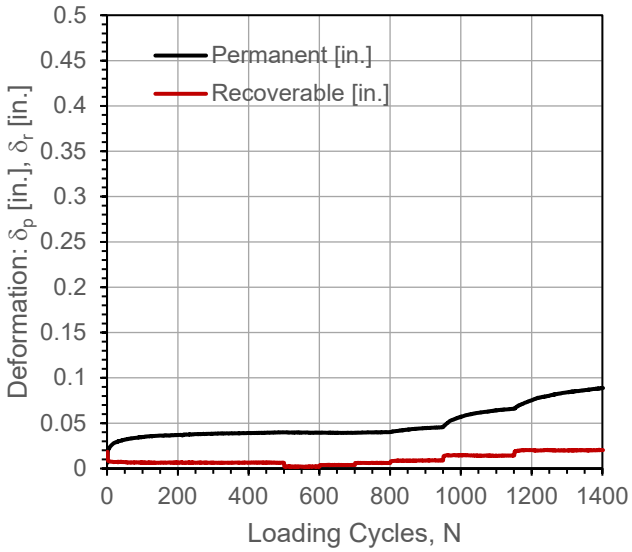
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	3:13:51 PM	Test ID	**owa_AID_Hwy175_pt_7**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307831	Longitude,W:	93.569008	Elev. (ft):	340.3
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.55	---	---	0.0398	---	0.126	---
1	100	4.17	27,127	27,265	0.0395	-0.0003	-0.205	Y
2	100	8.38	29,163	29,054	0.0394	-0.0004	-0.143	Y
3	100	13.55	30,109	29,301	0.0402	0.0004	0.360	Y
4	150	18.47	27,938	28,808	0.0456	0.0057	0.722	N
5	200	28.60	26,981	27,026	0.0660	0.0261	0.569	N
6	250	38.15	25,272	25,111	0.0887	0.0489	0.704	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,167.1	1.00E-07
k^*_2	0.195	2.89E-02
k^*_3	-1.722	1.70E-02
Adj. R^2	0.875	
Std. Error [psi]	568	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		29,342
	$\sigma_{cyclic\text{-}BP}$ [psi]	11.9

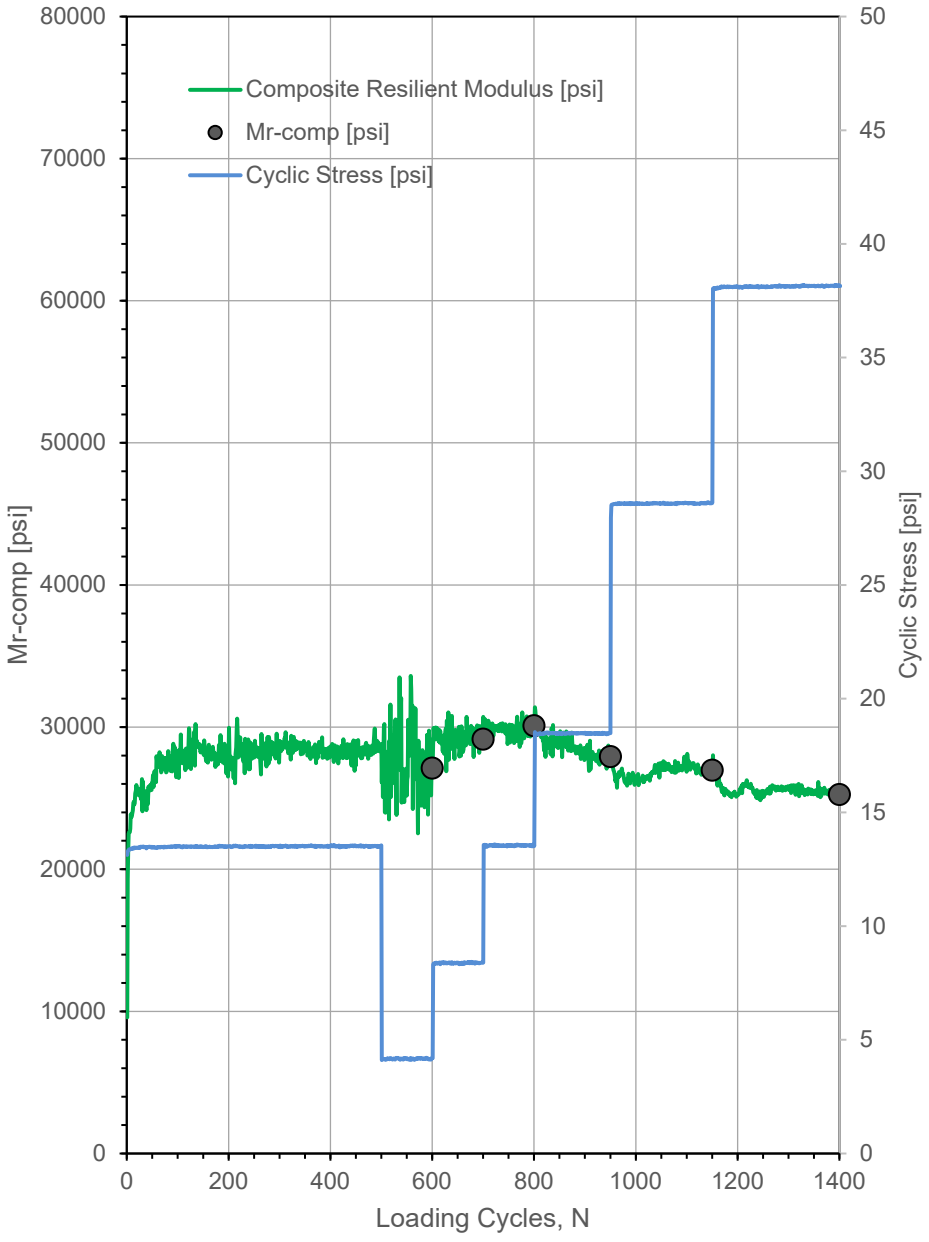
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	3:13:51 PM	Test ID	**owa_AID_Hwy175_pt_7**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307831	Longitude,W:	93.569008	Elev. (ft):	340.3
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	24,560
3	26,108
4	27,129
5	27,841
6	28,352
7	28,718
8	28,977
9	29,154
10	29,266
11	29,325
12	29,342
13	29,323
14	29,275
15	29,203
16	29,109
17	28,998
18	28,871
21	28,423
22	28,256
23	28,082
24	27,902
25	27,718
26	27,530
27	27,338
28	27,143
29	26,947
30	26,749
31	26,549
32	26,348
33	26,147
34	25,946
35	25,744
36	25,543
37	25,342
38	25,141
39	24,942
40	24,743



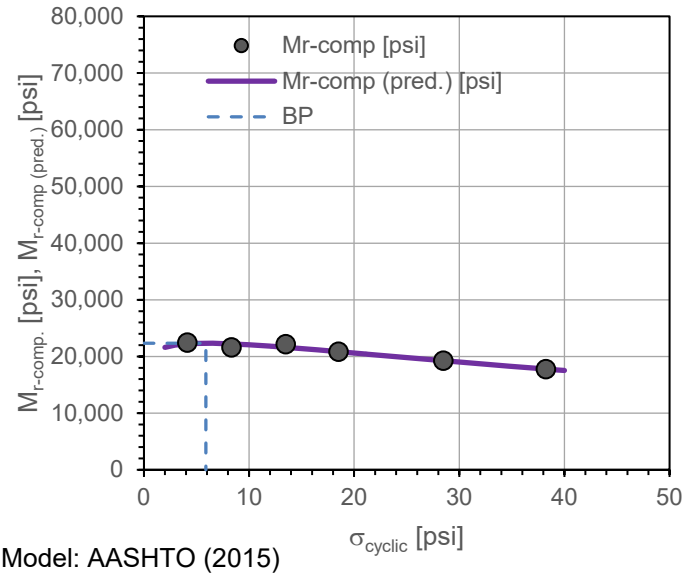
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

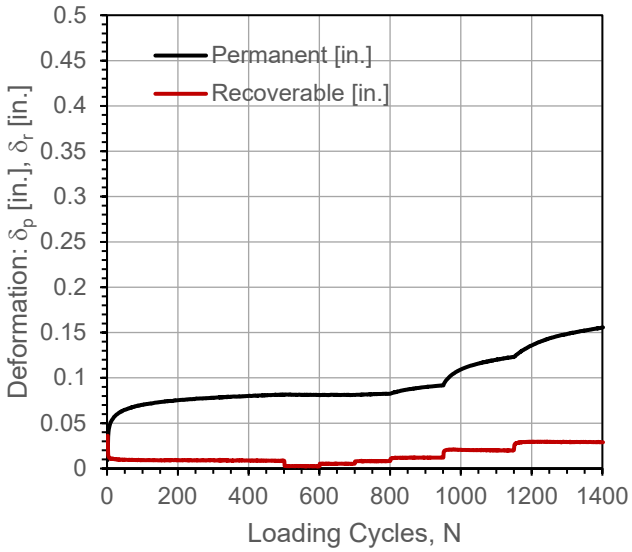
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	3:45:34 PM	Test ID	**owa_AID_Hwy175_pt_8**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307671	Longitude,W:	93.569046	Elev. (ft):	341.2
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	13.49	---	---	0.0814	---	0.131	---
1	100	4.12	22,437	22,233	0.0810	-0.0004	-0.222	Y
2	100	8.33	21,582	22,225	0.0811	-0.0003	0.098	Y
3	100	13.49	22,160	21,617	0.0824	0.0010	0.438	Y
4	150	18.50	20,814	20,852	0.0917	0.0103	0.727	N
5	200	28.48	19,238	19,252	0.1230	0.0417	0.632	N
6	250	38.23	17,745	17,782	0.1555	0.0741	0.693	N



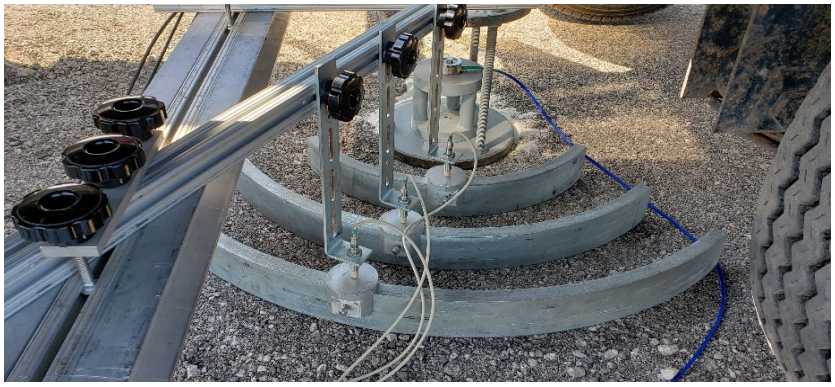


Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,657.4	9.28E-08
k^*_2	0.080	1.81E-01
k^*_3	-1.338	2.79E-02
Adj. R^2	0.944	
Std. Error [psi]	425	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]	22,332
$\sigma_{cyclic\text{-}BP}$ [psi]	5.9



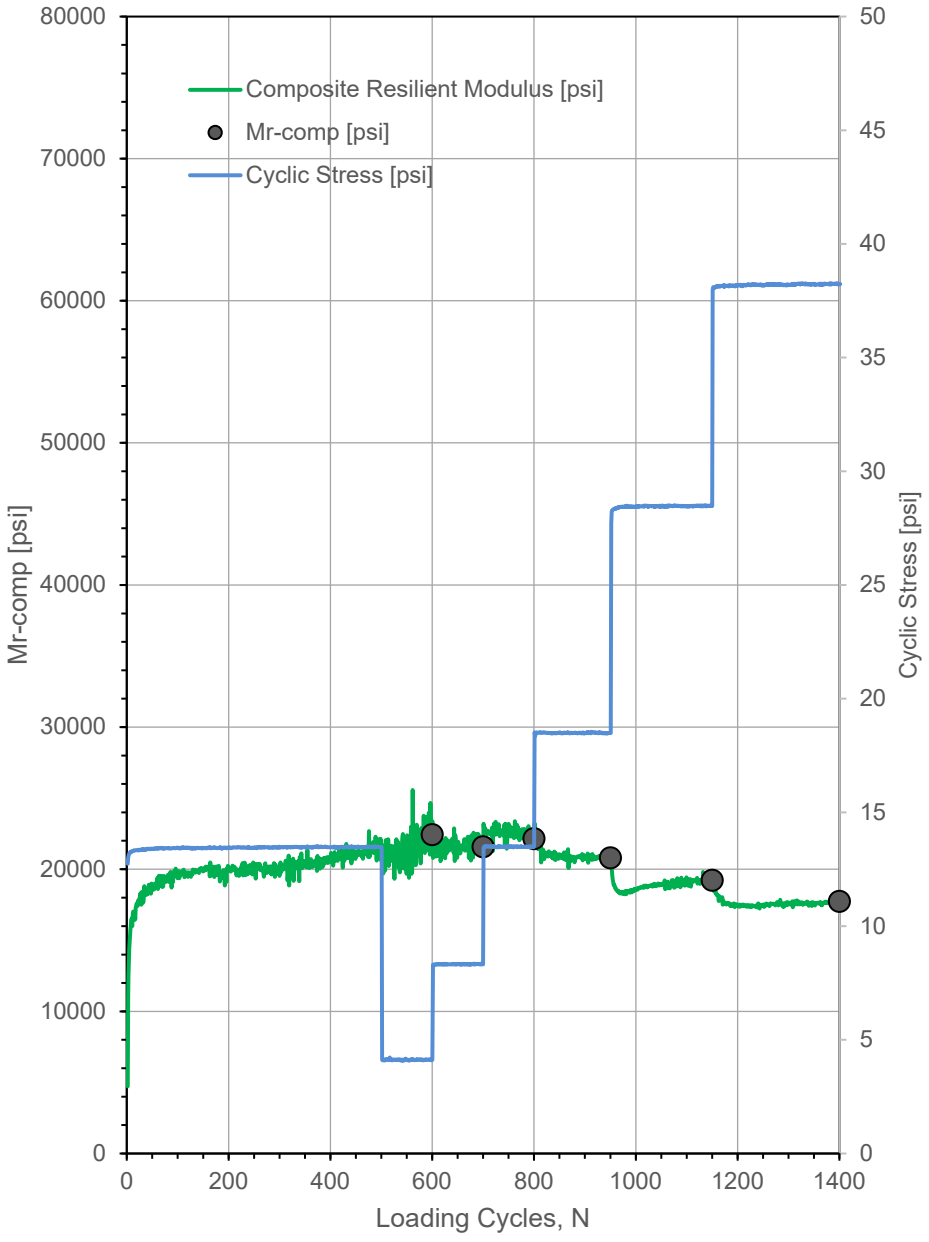
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	3:45:34 PM	Test ID	**owa_AID_Hwy175_pt_8**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307671	Longitude,W:	93.569046	Elev. (ft):	341.2
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	21,614
3	22,015
4	22,217
5	22,309
6	22,331
7	22,307
8	22,249
9	22,166
10	22,065
11	21,949
12	21,822
13	21,686
14	21,544
15	21,396
16	21,244
17	21,089
18	20,931
21	20,450
22	20,289
23	20,128
24	19,966
25	19,806
26	19,646
27	19,486
28	19,328
29	19,171
30	19,015
31	18,860
32	18,706
33	18,554
34	18,403
35	18,254
36	18,107
37	17,960
38	17,816
39	17,673
40	17,531



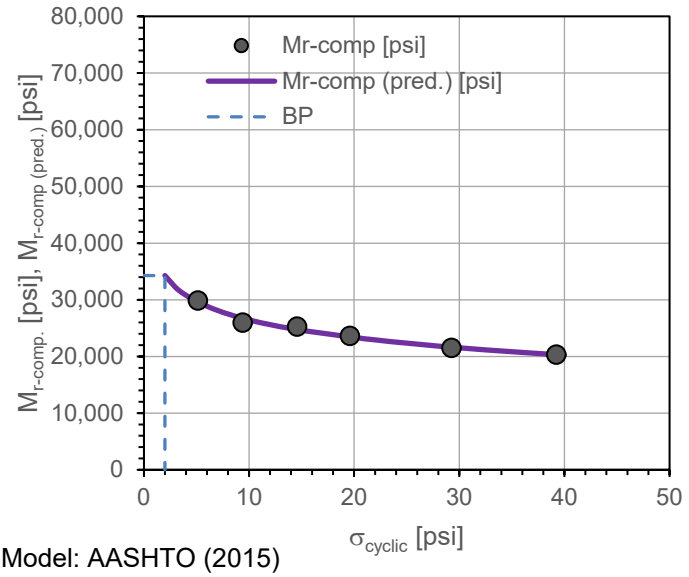
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

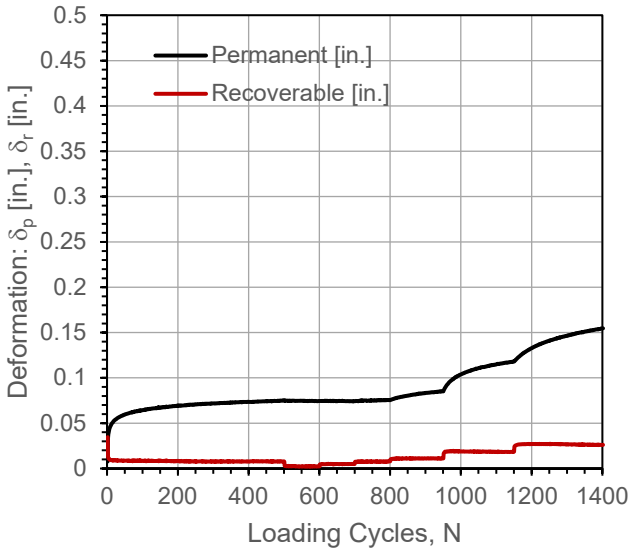
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	4:33:26 PM	Test ID	**owa_AID_Hwy175_pt_9**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307621	Longitude,W:	93.569054	Elev. (ft):	339.9
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.56	---	---	0.0749	---	0.131	---
1	100	5.13	29,872	29,570	0.0744	-0.0005	-0.281	Y
2	100	9.39	25,960	26,755	0.0743	-0.0006	-0.184	Y
3	100	14.56	25,257	24,767	0.0754	0.0005	0.420	Y
4	150	19.58	23,604	23,438	0.0851	0.0102	0.744	N
5	200	29.25	21,503	21,641	0.1179	0.0430	0.624	N
6	250	39.22	20,316	20,322	0.1546	0.0797	0.722	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	1,977.3	7.09E-08
k^*_2	-0.148	7.07E-02
k^*_3	-0.248	5.42E-01
Adj. R^2	0.979	
Std. Error [psi]	497	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		34,270
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

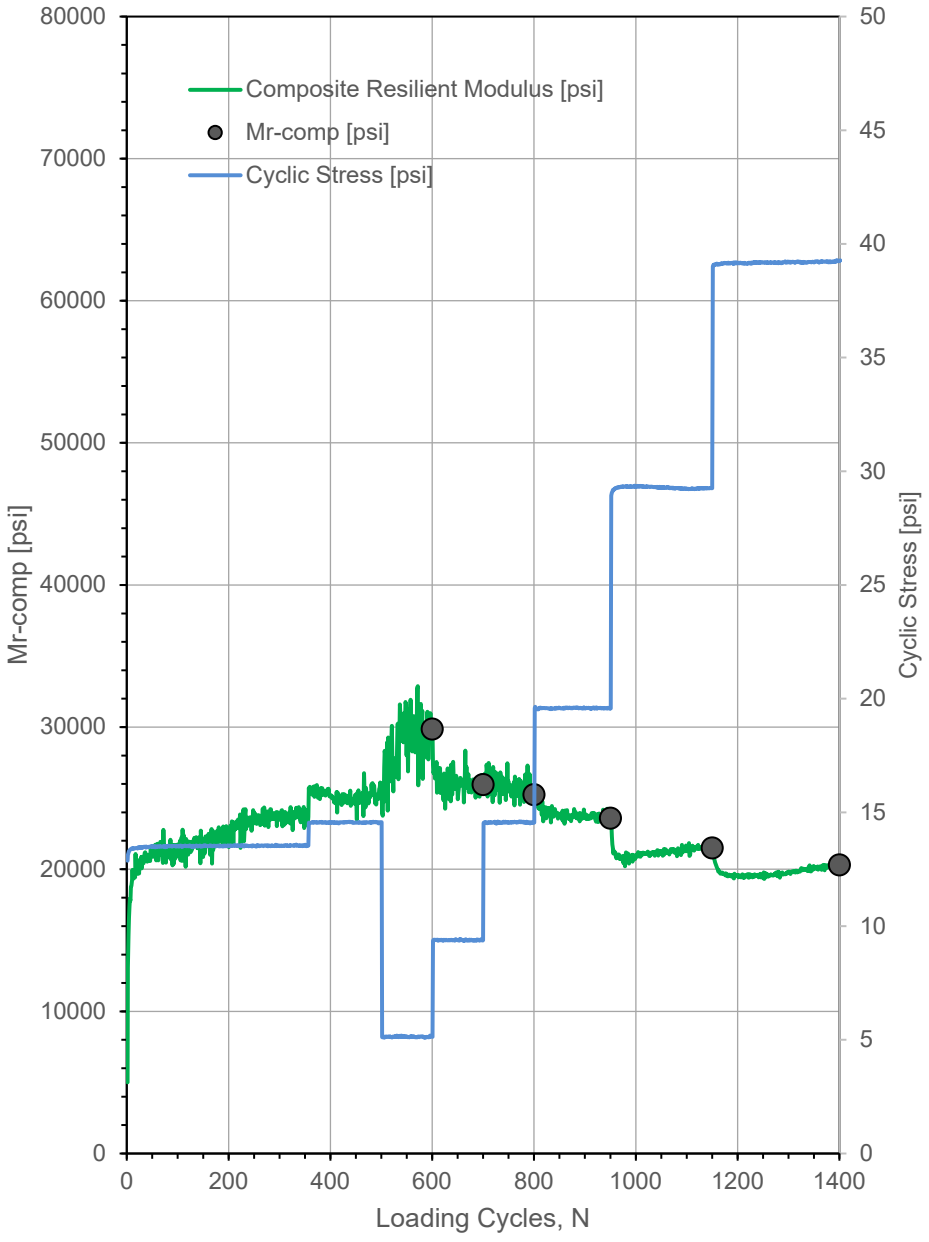
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	4:33:26 PM	Test ID	**owa_AID_Hwy175_pt_9**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307621	Longitude,W:	93.569054	Elev. (ft):	339.9
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	34,270
3	32,189
4	30,767
5	29,692
6	28,828
7	28,107
8	27,489
9	26,948
10	26,467
11	26,034
12	25,639
13	25,278
14	24,944
15	24,634
16	24,344
17	24,072
18	23,816
21	23,125
22	22,917
23	22,717
24	22,527
25	22,344
26	22,168
27	21,999
28	21,836
29	21,679
30	21,527
31	21,379
32	21,237
33	21,099
34	20,965
35	20,834
36	20,708
37	20,584
38	20,464
39	20,348
40	20,234



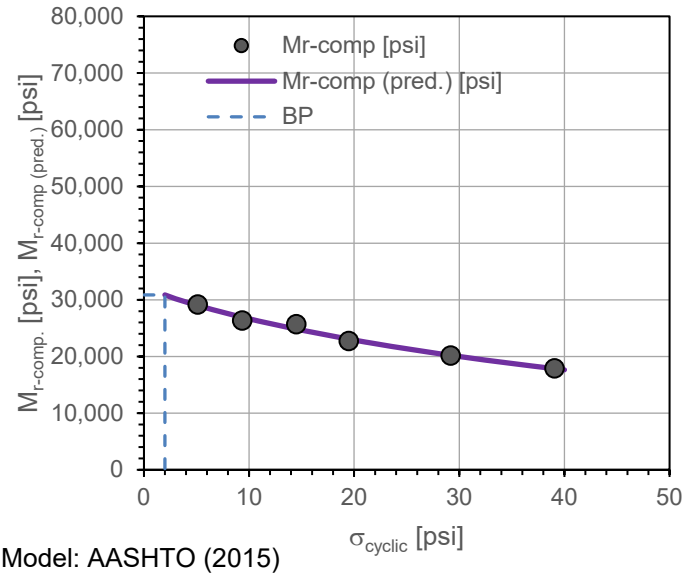
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

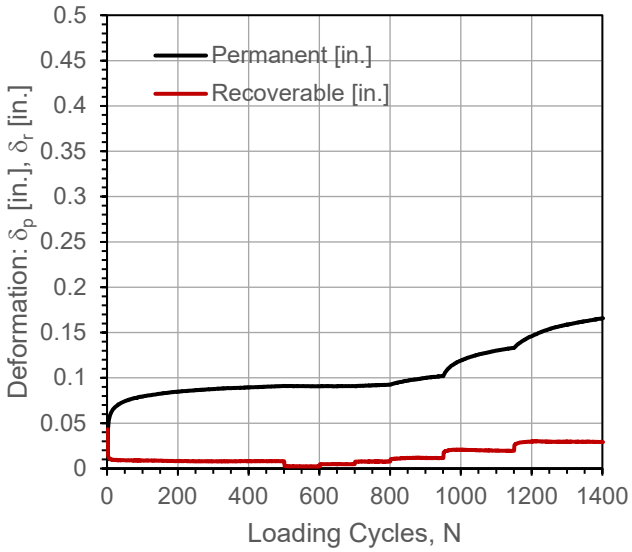
ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	5:08:18 PM	Test ID	wa_AID_Hwy175_pt_10
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307419	Longitude,W:	93.569092	Elev. (ft):	337.5
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

Step	N	σ_{cyclic} [psi]	$M_{r\text{-}comp}$ [psi]	$M_{r\text{-}comp\ (pred.)}$ [psi]	δ_p [in.]	$\Delta\delta_p$ [in.]	$=\Delta\log(\delta_p)/\Delta\log(N)$	Near-linear Elastic
Conditioning	500	14.49	---	---	0.0910	---	0.118	---
1	100	5.11	29,146	28,993	0.0908	-0.0003	-0.227	Y
2	100	9.34	26,342	26,945	0.0909	-0.0001	0.109	Y
3	100	14.49	25,683	24,839	0.0924	0.0014	0.495	Y
4	150	19.48	22,717	23,069	0.1019	0.0109	0.783	N
5	200	29.18	20,148	20,203	0.1330	0.0420	0.633	N
6	250	39.05	17,894	17,858	0.1655	0.0745	0.715	N





Model: AASHTO (2015)

$$M_{r-comp} = k_1^* P_a \left(\frac{\theta}{P_a}\right)^{k_2^*} \left(1 + \frac{\tau_{oct}}{P_a}\right)^{k_3^*}$$

Parameter	Value	P-Value
k^*_1	2,134.8	1.01E-07
k^*_2	-0.014	8.33E-01
k^*_3	-1.543	3.31E-02
Adj. R^2	0.983	
Std. Error [psi]	550	

$M_{r\text{-}comp\ (pred.)\text{-}BP}$ [psi]		30,866
	$\sigma_{cyclic\text{-}BP}$ [psi]	2.0

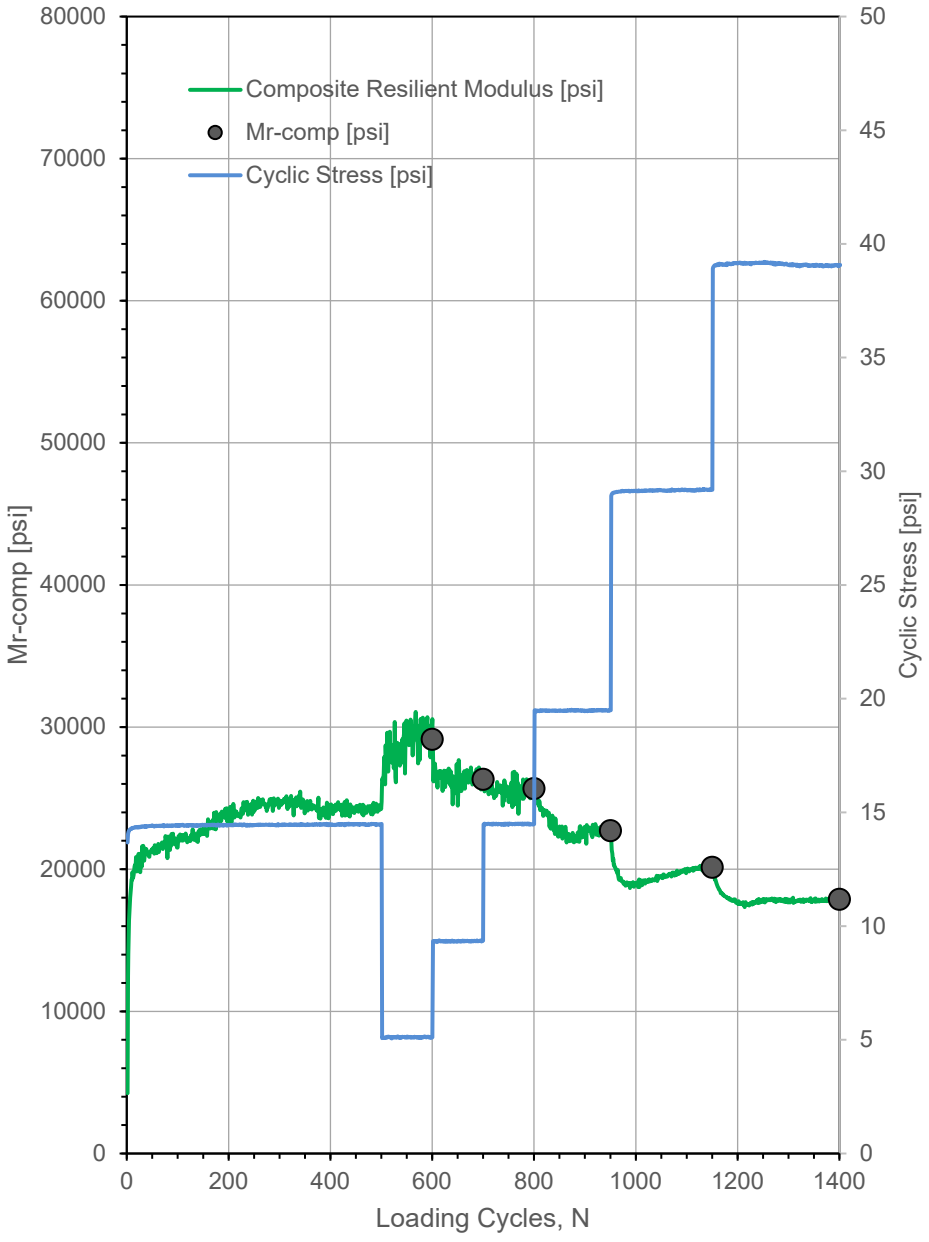
In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS

Automated Plate Load Test [APLT]

Test:	In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent (5, 10, 15, 20, 30, 40)				
Date:	9/3/2019	Time:	5:08:18 PM	Test ID	**wa_AID_Hwy175_pt_10**
Tested By	DW, HG	Location:	Hwy 175	Sta.	NA
Latitude,N:	42.307419	Longitude,W:	93.569092	Elev. (ft):	337.5
Comments:	Recycled Aggregate modified subbase over subgrade. Testing completed after VIC mapping.				

σ_{cyclic} [psi]	$M_{r\text{-comp (pred.)}}$ [psi]
2	30,866
3	30,202
4	29,606
5	29,053
6	28,531
7	28,034
8	27,557
9	27,099
10	26,657
11	26,229
12	25,815
13	25,414
14	25,024
15	24,646
16	24,278
17	23,919
18	23,570
21	22,576
22	22,261
23	21,953
24	21,653
25	21,359
26	21,073
27	20,793
28	20,519
29	20,251
30	19,989
31	19,733
32	19,483
33	19,237
34	18,997
35	18,762
36	18,532
37	18,306
38	18,085
39	17,869
40	17,656



In-situ Resilient Modulus [Mr]: Cyclic Loading, Composite, Stress-Dependent	
Project Name:	Iowa TDIP-AID Demonstration Project
Project ID:	SIA-00003
Location:	Hwy 175, Hamilton County, IA

ingios GEOTECHNICS