LEVEL I
PORTLAND CEMENT CONCRETE
Instruction Manual 2007 – 2008

TECHNICAL TRAINING AND CERTIFICATION PROGRAM

Iowa Department of Transportation
HIGHWAY DIVISION

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Iowa Department of Transportation
Technical Training and Certification Program

COURSE EVALUATION SHEET

In an effort to improve the Iowa DOT Technical Training and Certification Program, we ask that you fill out this evaluation form after you have taken the exam. Thank you for your cooperation.

Course: _____ Location: _____

Instructor: _____

1. What type of agency are you employed by?

   _____

2. Please rate the following portion of the course on a scale of 1-5. 1 = Poor, 5 = Excellent

   Facility: _____

   Material: _____

   Instructors: _____

   Course Activities: _____
   (lectures, videos, demonstrations, etc.)

3. Are there any changes you would like to see made in the course?

   _____

   _____

REMARKS:

CONCRETE TESTS SUMMARY

Test	IM	Importance	Requirement	Specifications
Sampling Concrete	327	To properly secure concrete samples to ensure accurate readings of air, slump, and strength.	When possible, sample from last point of placement. Air contents and slump vary depending on type and point of placement.	Varies with type of work, i.e., paving vs ready mix.
Temperature	385	To determine temperature of concrete being placed. Concrete in cold weather must attain a minimum strength to be able to withstand one freeze thaw cycle without cracking. Concrete in hot weather must be cured properly to prevent plastic shrinkage cracking.	During hot weather conditions, temperature of concrete may attribute to high w/c ratio, workability problems, and difficulty entraining air. Possible solutions include using ice in water, paving at night, place curing as soon as possible, etc. During cold weather, temperature may attribute to slow strength gain and indicate a need for protection. Generally, concrete hydrates best at 55 F. Temperatures below 40 F and above 90 F require attention to curing and protection.	2301.19 Pavement 2403.11 Structures
Slump	317	To determine the batch-to-batch consistency of a particular mix. It is not a measure of workability. May give an indication of the w/c ratio of a particular mix. Increasing slump by adding water may cause mix to segregate during placement.	In general, 3 to 4" slump is a maximum for normal concrete mixes. Testing not required in slipform paving because too much slump will cause the pavement edge to slump. HRWR's may be used to increase slump (8" or more) and prevent segregation. Rule of Thumb: Adding 1 gallon of water per cubic yard increases slump 1".	Slipform paving – none Varies with type of work IM 204

CONCRETE TESTS SUMMARY

Air	318	To determine if adequate air is entrained in concrete to provide freeze thaw resistance for long-term durability. Concrete is porous and water travels in and out of pores. Since water expands 9% when frozen, air voids provide pressure relief, otherwise the frozen water will crack the concrete.	In general, 6% air content for in-place concrete is required to provide protection. Specifications require higher amounts to account for loss during placement, especially with vibration. Generally, high air contents do not affect durability as air content being too low does. Main affect of higher air content is reduced strength. Rule of thumb: A 1% increase in air content decreases compressive strength approximately 5%.	Varies with type of work IM 204
Unit Weight	340	To determine unit weight of concrete. Unit weight gives an indication of problems in batch weights and yield. Since air weighs nothing, but occupies a volume, air content may be determined from unit weight. It may also be used to give an indication of an air meter problem and used to help with correlation problems.	Ensure concrete is properly consolidated, struck off, and sides are cleaned. Improperly striking off surface and excess material on container will affect results. Rule of thumb: A 1% change in air content approximately equals change in unit weight of 0.5 lbs/ ft3.	
Making and Curing Beams	328	To cast and cure flexural strength beams and ensure accurate strength test. Beams used for payment or QMC should be consolidated in accordance with AASHTO T23, by rodding or vibration.	Ensure proper consolidation, entrapped air and voids in concrete will reduce beam strength. **Improper curing will increases moisture loss in beam causing lower strengths.** Since specimens are small, improper protection from cold or hot weather affects early and later strengths. Beams delivered any distance should be protected from impact loading and wrapped in wet burlap and plastic to prevent moisture loss.	IM 204

CONCRETE TESTS SUMMARY

Testing Beams Center Point Third Point	316 ASTM C 78	To determine if a pavement may be loaded or structural forms may be removed and loaded in flexure.	Ensure proper loading rate for accurate reading on load. Generally, 500 psi center point loading is required to open pavement to traffic. 550 psi is required for flexural loading of structural concrete. A 28 day strength of 640 psi third point loading is required for QMC paving.	2301.31 Pavement 2403.18 & 19 Structures
Making and Curing Cylinders	315	To cast and cure cylinders and ensure accurate compressive strength test.	Ensure proper consolidation, entrapped air and voids in concrete will reduce cylinder strength. Improper curing will increases moisture loss in beam causing lower strengths. Since specimens are small, improper protection from cold or hot weather affects early and later strengths. Cylinders delivered any distance should be protected from impact loading and wrapped in wet burlap and plastic to prevent moisture loss.	IM 204
Testing Cylinders	315	To determine compressive strength of structures. Determining accurate compressive strength is essential to prevent failure.	Majority of bridges and structures designed for a minimum of 3500 psi. HPC bridges designed for a minimum of 5000 psi. Precast and prestress concrete require minimum strengths before removing from beds and transporting.	

CONCRETE TESTS SUMMARY

Maturity	383	To determine strength of in-place concrete, non-destructively, using curing temperature. Since concrete gains strength with time and temperature, the time and temperature a given mix is subjected to can be related to the strength. Maturity method involves 3 steps 1) Strength maturity relationship developed on first day paving. 2) Temperature is monitored in pavement or structure and maturity (TTF) calculated. 3) Validate curve monthly.	General TTF values range from 900 to 2000°C•hr. Values of TTF are generally higher when using blended cements due to the slower setting characteristics. Since w/c ratio has biggest impact on strength, curve development should be performed with concrete at highest w/c ratio anticipated. Since specimens are small, beams should be protected during curve development. Temperature of beam is important, refer to IM 383. Opening of pavement or structure responsibility of engineer.	

ROUNDING & DECIMALS

Rounding is uniform throughout the certification training. You would look at the place to the right of the number you are rounding to and if it is 5 or above round up or 4 and below round down.

Examples:

Rounding to whole numbers-
130.5 = 131 130.4 = 130 130.46 = 130

Rounding to tenths-
130.55 = 130.6 130.54 = 130.5 130.646 = 130.6

Rounding to hundredths-
130.555 = 130.56 130.544 = 130.54 130.5545 = 130.55

Rounding to thousandths-
130.5555 = 130.556 130.5544 = 130.554 130.55546 = 130.555

There are many equations used in Level II PCC to obtain percentages, weights, ratios, etc. The answers to these equations are expressed with the decimals in different locations. The following is a listing of how many places to round each answer.

Specific Gravity – hundredths – 2.62 2.77

Moisture – tenths – 2.7 0.6

Air - tenths - 6.5 5.8

Slump - 1/4 inch - 3 1/2 2 3/4

Beam Size - hundredths - 6.02 5.98

Absolute Volumes – thousandths - .082 .334

Water Cement Ratio (W/C) – thousandths - .480 .468

Cement Yield – tenths – 99.7 100.3

Pounds (lbs) – whole - 1450 385

Gallon (gal) – whole - 28 34

Cement Tons – hundredths - 2514.05 1883.27

Cubic Yards – hundredths – 117.00 54.50
(Concrete is batched in ¼ cubic yard increments)

There will be given numbers that are used in calculations that may be rounded differently than shown above. When given a number for use in a calculation, use the number in the form required. For example: 8.33 lbs./gal; 62.4 lbs. = unit weight of water, etc.

TECHNICAL TRAINING & CERTIFICATION PROGRAM

GENERAL

The purpose of the Technical Training & Certification Program is to ensure Quality Control (QC)/Quality Assurance (QA) and Acceptance of Aggregates, Hot Mix Asphalt (HMA), Portland Cement Concrete (PCC), Grade Inspection, Precast and Prestressed Concrete, and Pavement Profiles and to ensure proper documentation of quality control/quality assurance and acceptance procedures and test results by industry and Contracting Authority personnel.

This Instructional Memorandum (IM) explains the requirements to become certified and to remain certified to perform inspection and testing in the State of Iowa. This IM also describes the duties, responsibilities and the authority of persons assigned the position of Certified Technician in any of the above areas for construction or maintenance projects. Appendix C of this IM lists what tests and procedures the technician is qualified to perform for each level of certification they obtain.

Through a cooperative program of training, study, and examination, personnel of the construction industry, State DOT, and other Contracting Authorities will be able to provide quality management and certified inspection. Quality control/quality assurance and acceptance sampling, testing and inspection will be performed by certified personnel and documented in accordance with the IMs.

A technician who is qualified and holds a valid certification(s) shall perform quality control/quality assurance and acceptance at a production site, proportioning plant, or project site. Responsibilities cannot be delegated to non-certified technicians. The duties of a Certified Technician may be assigned to one or more additional Certified Technicians.

The Technical Training & Certification Program will be carried out in accordance with general policy guidelines established or approved by the Highway Division Director. A Board of Certification composed of the following members will advise the Director:

Director – Office of Materials
Director – Office of Construction
Representative of District Materials Engineers**
Representative of District Construction Engineers**
Representative of Associated General Contractors (AGC of Iowa)
Representative of Iowa Concrete Paving Association (ICPA)
Representative of Asphalt Paving Association of Iowa (APAI)
Representative of Iowa Ready Mixed Concrete Association (IRMCA)
Representative of Iowa Limestone Producers Association (ILPA)
Representative of County Engineers
Coordinator of Technical Training & Certification Program**

** Appointed by Program Director

The Director of the Office of Materials will be the Program Director. Coordinators will be appointed by the Program Director to assist in administration of the program and to handle such planning, administration, and coordinating functions as may be needed.

TRAINING

The Iowa DOT will provide the training necessary to become certified or an agency approved by the Program Director. Producers/Contractors are encouraged to conduct their own pretraining program. A complete listing of training opportunities is available in the Technical Training & Certification Program's Information and Registration Booklet or at the Technical Training & Certification Program website, www.iowa.gov/dot/materials/training.htm. This book is available at any of the Iowa DOT Materials Offices. They may also be obtained from the ICPA, IRMCA, ILPA, and APAI.

CERTIFICATION REQUIREMENTS

1. A candidate must attend instruction and pass the examination(s) for all levels of certification prepared and presented by the Program Director or someone designated by the Program Director. If the new candidate fails the examination, they will have one opportunity to retake the examination. The retake must be completed within six months of the original exam. If they fail the retake of the examination, they will need to attend the training again before taking the examination the third time. If an individual is recertifying they will have only one opportunity to take the examination. If they fail the examination they must take the applicable training before retaking the examination.

2. All prerequisites shall be met before the applicant may attend the next level of training for the certification desired. A listing of certification levels and prerequisites is located in Appendix A.

3. Once the candidate has met all the criteria and has received certification, it is recommended the Certified Technician work under the supervision of an experienced technician until they become efficient in the inspection and testing methods they will be performing.

   An individual requesting to become certified as a Precast/Prestress Concrete Technician is required to obtain forty hours of experience assisting in quality control inspection at an approved plant before certification will be issued. The experience must be documented and shall be approved by the District Materials Engineer. This experience must be completed within two years from the date the individual attended the training.

4. Registered Professional Engineers, engineering graduates, and geology graduates from accredited institutions will be exempt from the training requirement in the areas they have had instruction. In order to obtain certification for any technical level, these persons must pass all applicable tests for the level of certification they wish to obtain. All certificates issued in accordance with these requirements will be subject to the same regulations concerning expiration, recertification, etc., as applies to certificates obtained via training and examinations.

Out-of-state technicians will be issued certifications when the following criteria are met:

1. The applicant must be certified in another state or shall have received equivalent training, if the state does not have a certification program, in each level of certification they are requesting.
2. The applicant must pass an examination for each level of certification desired, which will be administered by the Iowa Department of Transportation. Failure of the examination shall require the applicant to take the applicable schooling before they can retake the exam.
3. The applicant must follow the prerequisite requirements of the Technical Training & Certification Program.

Out-of-state applications should be submitted to the District Materials Office closest to the home location of the applicant. Copies of all the applicant's certifications must accompany the application.

CERTIFICATION

Upon successfully completing the requirements for certification, the Program Director will issue a certificate and a pocket certification card. This certification is not transferable. A certification shall be valid for five years.

CERTIFICATION IDENTIFICATION

The certificate will contain letters that identify the District of record, the certificate holder, certification number, the level of certification, and the expiration date of each level.

The assigned certification number may change if the certificate holder changes their residence.

RENEWAL OF CERTIFICATION

A certification shall be valid through December 31st of the fifth year. A 90-day grace period will be allowed. If the individual has not renewed their certification within the 90-day grace period, they are automatically decertified. The individual may obtain certification by taking the examination for the level of certification they are requesting. If the individual does not take the examination within one year after their certification(s) expire, i.e., 12/31/expiration year, they must retake all applicable schooling and pass the examinations. If an applicant becomes decertified in any level of certification and that certification is a prerequisite for other levels of certification the applicant will also be decertified in those related levels of certification.

All certified technicians will be required to pass an examination in each level of certification they hold before recertification will be issued. Failure of any level shall require the applicant to retake the applicable schooling and pass the test.

The certificate holder shall be responsible for applying for certification renewal and for maintaining a current address on file with the appropriate District Materials Office.

Technicians certified as Level I HMA and/or Level II PCC shall attend a minimum of two update classes each in the five-year period between certification and each recertification. The Iowa DOT or an agency or organization approved by the TTCP will hold these classes. These update classes will be listed in the Technical Training & Certification Program Booklet and on the program website, or the certified technician may contact the Iowa DOT for information. If an individual does not attend the two update classes required before their certification expires, they must take the entire schooling and pass the examination for the certification required.

The certified technician will not receive credit for the following:

1. More than one update per training season in each level of certification.
2. An update taken during the same training season in which the individual recertified.

UNSATISFACTORY PERFORMANCE NOTICE

A certified technician failing to perform the required specified duties or inadequately performing these duties, will receive an Unsatisfactory Notice (Office of Materials IM 213, Appendix B).The notice will be from the District Materials Engineer in the District where the failure occurred. This notice and all supporting documentation will be placed in the technician's permanent file with the District Materials Office in which the technician resides. The notice will also be placed on the statewide computer file.

SUSPENSION & DECERTIFICATION

A three-month suspension will be given upon receipt of two Unsatisfactory Performance Notices. Technicians that are suspended shall not perform any duties of the applicable certification, including any duties for which the affected certification is a prerequisite.

Technicians are eligible to be reinstated after the three-month suspension and successful completion of the applicable recertification test(s).

Technicians are subject to decertification when they receive a third Unsatisfactory Performance Notice.

Certified Technicians will be decertified for any of the following reasons:

The certificate will become invalid for the following reasons:

1. Failure of the certificate holder to renew the certificate prior to regular expiration as described above.
2. Use of false or fraudulent information to secure or renew the certificate.
3. Use of false or fraudulent actions or documentation by the certificate holder.
4. Not performing tests and technician duties properly and in accordance to specifications.

Action will be effective on the date the Program Director issues the suspension or decertification notice.

Technicians that are decertified shall not perform any duties requiring certification. Technicians may request reinstatement after one year.

Appeals and reinstatement requests shall be submitted in writing to the Program Director. Appeals and reinstatement requests will be considered by the Certification Board.

If reinstatement is authorized, the applicant must attend and successfully complete the applicable certification courses.

FUNCTIONS & RESPONSIBILITES

A certificate holder at each production site, project site, proportioning plant, or laboratory will perform duties. The certified technician shall perform quality control testing in accordance with specified frequencies and submit designated reports and records.

The specification requirement for materials testing by a certified technician does not change the supplier's responsibilities to furnish materials compliant with the specification requirements.

The District Materials Engineer and/or Project Engineer will be responsible for monitoring the sampling, testing, production inspection activities and quality control performed by the contractor. A monitor shall have satisfactorily completed the training and be certified for the level of technician they are monitoring.

The District Materials Engineer and/or Project Engineer will have authority and responsibility to question and where necessary, require changes in operations and quality control to ensure specification requirements are met.

QUALITY CONTROL, TESTING, & DOCUMENTATION

The QC Technician shall be present whenever construction work related to production activity, such as stockpiling or other preparatory work, requires record development and/or documentation is in progress. The QC Technician's presence is normally required on a continuing basis beginning one or more days before plant operation begins and ending after plant shut down at the completion of the project. The work shall be performed in a timely manner and at the established frequencies.

The QC Technician's presence is not normally required during temporary plant shut downs caused by conditions, such as material shortages, equipment failures, or inclement weather.

All quality control activities and records shall be available and open for observation and review by representatives of the contracting authority.

Reports, records, and diaries developed during progress of construction activities will be filed as directed by the Contracting Authority and will become the property of the Contracting Authority.

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined not more than $10,000 or imprisoned not more than 5 years or both"

NON-FEDERAL AID PROJECTS

Iowa Code 714.8, subsection 3, defines fraudulent practices. "A person who does any of the following acts is guilty of a fraudulent practice. Subsection 3, Knowingly executes or tenders a false certification under penalty of perjury, false affidavit, or false certificate, if the certification, affidavit, or certificate is required by law or given in support of a claim for compensation, indemnification, restitution, or other payment." Depending on the amount of money claimed for payment, this could be a Class C or Class D felony, with potential fines and/or prison.

The above codes refer to the individual making the false statement. **Standard Specification Article 1102.03, paragraph C. section 5 refers to the Contractor.**

Article 1102.03, paragraph C, section 5 states, "A contractor may be disqualified from bidder qualification if or when: The contractor has falsified documents or certifications, or has knowingly provided false information to the Department or the Contracting Authority."

CERTIFICATION LEVELS

CERTIFICATION LEVEL	TITLE	PRE-REQUISITES
	AGGREGATE	
Level I Aggregate	Certified Sampling Technician	None
Level II Aggregate	Certified Aggregate Technician	Level I Aggregate
	PORTLAND CEMENT CONCRETE	
Level I PCC**	PCC Testing Technician	None
Level II PCC	PCC Plant Technician	Level II Aggregate & Level I PCC
Level III PCC	PCC Mix Design Technician	Level II PCC
	HOT MIX ASPHALT	
HMA Sampler	HMA Sampler	None
Level I HMA	HMA Technician	Level II Aggregate
Level II HMA	HMA Mix Design Technician	Level I HMA
	PROFILOGRAPH	
Profilograph	Profilograph Technician	None
	PRESTRESS	
Prestress	Prestress Technician	Level I PCC or ACI Grade I *If the technician will be performing gradations, they will need to be Aggregate Level II- certified.*

**American Concrete Institute (ACI) Grade I certification will be acceptable as a portion of the Level I PCC training.

UNSATISFACTORY PERFORMANCE NOTICE

Issued To: _____ Date: _____

_____

_____

This notice is to inform you that your performance as a Certified Inspector/Technician was unsatisfactory for the reason(s) listed below.

This notice will be placed in your permanent file with the District Materials Office in which you reside. It will also be placed on the statewide computer file.

The goal of the Technical Training and Certification Program (TTCP) is to work with contractors, producers, cities, and counties to continually improve the quality of Iowa's construction projects. We hope you will work with us to achieve this goal.

Unsatisfactory Performance:

_____

_____

_____

_____

_____

_____

_____

_____
District Materials Engineer

cc: Program Director – Materials Engineer, Ames
TTCP Coordinator
Resident Construction Engineer

CERTIFIED TECHNICIANS QUALIFICATIONS

Tests and Procedures the Certified Technician is qualified to perform for each level of certification.

LEVEL I AGGREGATE

- IM 204 - Inspection of Construction Project Sampling & Testing (when material is incorporated)
- IM 209, App. C - Aggregate Specification Limits & Sampling & Testing Guide (when material is produced)
- IM 301 - Aggregate Sampling Methods

LEVEL II AGGREGATE

- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 302 - Sieve Analysis of Aggregates
- IM 306 - Determining the Amount of Material Finer Than #200 (75µm) Sieve in Aggregate
- IM 307 - Determining Specific Gravity of Aggregate
- IM 308 - Determining Free Moisture & Absorption of Aggregate
- IM 336 - Methods of Reducing Aggregate Field Samples to Test Samples
- IM 344 - Determining the Amount of Shale in Fine Aggregate
- IM 345 - Determining the Amount of Shale in Coarse Aggregate

LEVEL I PCC

- IM 204 - Inspection of Construction Project Sampling & Testing
- IM 208 - Materials Laboratory Qualification Program
- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 315 - Method of Protecting, Curing, Making & Testing Concrete Cylinders
- IM 316 - Flexural Strength of Concrete
- IM 317 - Slump of Hydraulic Cement Concrete
- IM 318 - Air Content of Freshly-Mixed Concrete by Pressure
- IM 327 - Sampling Freshly-Mixed Concrete
- IM 328 - Making, Protecting, and Curing Concrete Flexural Specimens
- IM 340 - Weight Per Cubic Foot, Yield, & Air Content (Gravimetric) of Concrete
- IM 383 - Testing the Strength of PCC Using the Maturity Method
- IM 385 - Temperature of Freshly-Mixed Concrete
- IM 525 - Designing Flowable Mortar
- Iowa 410-B - Method of Test for Flow of Grout Mixtures
- AASHTO T97 - Third Point Loading

LEVEL II PCC

- IM 527 - Paving Plant Inspection
- IM 528 - Structural Concrete Plant Inspection
- IM 529 - PC Concrete Proportions

LEVEL III PCC

- IM 530 - Quality Management & Acceptance of PC Concrete Pavement
- IM 531 - Test Method for Combining Aggregate Gradations
- IM 532 - Aggregate Proportioning Guide for Portland Cement Concrete Pavement

HMA SAMPLER

- IM 322 - Method of Sampling Uncompacted Hot Mix Asphalt
- IM 323 - Method of Sampling Asphaltic Materials

LEVEL I HMA

- IM 204 - Inspection of Construction Project Sampling & Testing
- IM 208 - Materials Laboratory Qualification Program
- IM 216 - Guidelines for Verifying Certified Testing Results
- IM 320 - Method of Sampling Compacted Asphalt Mixtures
- IM 321 - Method of Test for Compacted Density of Hot Mix Asphalt (HMA) (Displacement)
- IM 322 - Method of Sampling Uncompacted Hot Mix Asphalt
- IM 323 - Method of Sampling Asphaltic Materials
- IM 325 - Compacting Asphalt Concrete by the Marshall Method
- IM 325G - Method of Test for Determining the Density of Hot Mix Asphalt (HMA) Using the Superpave Gyratory Compactor (SGC)
- IM 337 - Determining Thickness of Completed Courses of Base, Subbase, & Hot Mix Asphalt
- IM 350 - Maximum Specific Gravity of Hot Mix Asphalt (HMA) Mixtures
- IM 357 - Preparation of Hot Mix Asphalt (HMA) Mix Samples for Test Specimens
- IM 501 - Asphaltic Terminology, Equations & Example Calculations
- IM 508 - Hot Mix Asphalt (HMA) Plant Inspection
- IM 509 - Tank Measurement & Asphalt Cement Content Determination
- IM 511 - Control of Hot Mix Asphalt (HMA) Mixtures
- IM 514 - Correlation of Field Density for Hot Mix Asphalt (HMA) Paving

LEVEL II HMA

- IM 380 - Vacuum-Saturated Specific Gravity & Absorption of Combined or Individual Aggregate Sources
- IM 510 - Method of Design of Hot Mix Asphalt (HMA) Mixes
- AASHTO T176 - Plastic Fines in Graded Aggregate & Soils by use of Sand Equivalent Test
- AASHTO T304 - Uncompacted Void Content of Fine Aggregate
- ASTM D 4791 - Flat Particles, Elongated Particles, or Flat & Elongated Particles in Coarse Aggregate

PROFILOGRAPH

- IM 341 - Determining Pavement & Bridge Ride Quality

PRESTRESS

- IM 570 - Precast & Prestressed Concrete Bridge Units

AGGREGATE TECHNICIAN DUTIES

Duties of the Aggregate Technician are detailed in IM 209 and the IM 300 Series and consist of, but are not limited to the following:

A. Sampling

1. Obtain representative samples by approved method(s).
2. Sample at required frequencies.
3. Identify samples with pertinent information such as:
   a. Type of material
   b. Intended use
   c. Production beds working depth
   d. Sampling method

B. Gradation Testing

1. Follow appropriate gradation testing methods.
2. Maintain current applicable specifications.
3. Post test results within 24 hours of sampling.

C. Other Testing as Required (specific gravity, moisture, deleterious material, etc.)

1. Follow appropriate testing methods.
2. Maintain current applicable specifications.
3. Complete required reports.

D. Sampling & Testing Equipment

1. Clean and check testing sieves for defects.
2. Assure scale accuracy.
3. Maintain sampling and testing equipment.

E. Communication

1. Notify the District Materials office for production start-up or changes.

2. Relay test results to appropriate production or supervisory personnel.

3. Report failing test results immediately to appropriate personnel (including District Materials office) and assure remedial actions are taken.

F. General

1. Monitor stockpiling procedures to avoid contamination and excess segregation.

2. Assure proper identification of stockpiles.

3. Assure specification requirements for intended use are met before shipment.

4. Assure sampling locations are safe.

5. Assure proper bedding planes or production depths are maintained.

G. Documentation

1. Report all production test results of certified aggregates on Form #821278 and distribute as required.

2. Assure "plant production log" is maintained.

PORTLAND CEMENT CONCRETE (PCC) TECHNICIAN DUTIES
PAVING & STRUCTURAL CONCRETE

The Quality Control Technician shall have no other duties while performing certified inspection duties. The District Materials Engineer may approve all quality control activities be performed by a single certified technician for low production situations.

Many of the duties of the PCC Level II Technician are detailed in IM 527 (Paving) and IM 528 (Structural) and consist of, but are not limited to the following:

A. Stockpiles

1. Assure proper stockpiling procedures.
2. Prevent intermingling of aggregates.
3. Prevent contamination.
4. Prevent segregation.

B. Plant Facilities

1. Assure safe sampling locations.
2. Check for equipment compliance.
3. Assure proper laboratory location and facilities.

C. Calibration

1. Be present during calibration (paving).
2. Check plant calibration (structural).
3. Assure proper batch weights.

D. Cement (Fly Ash) & Aggregate Delivery

1. Check for proper sources and certification.
2. Document quantities delivered.
3. Monitor condition of shipments.

E. Plant Sampling

1. Check aggregate gradations by obtaining, splitting, and testing samples.
2. Check aggregate moistures and specific gravity.

F. Proportion Control

1. Check scale weights and operation.
2. Check admixture dispensers.
3. Check mixing time and revolutions.
4. Check cement yield. (Paving plant only, unless over 10,000 cu. yds.)

G. Concrete Tests

1. Cure flexural test specimens.
2. Test flexural specimens (Contract agency will perform test in structural plant).
3. Conduct maturity testing.

H. Test Equipment

1. Clean and maintain scales, screens, pycnometers and beam molds, and laboratory facility.

I. Documentation

1. Prepare daily plant reports (paving), weekly plant reports (structures).
2. Document all checks and test results in the field book.
3. Maintain daily diary of work activity.

HOT MIX ASPHALT (HMA) TECHNICIAN INSPECTION DUTIES

The following is a list of the duties that must be performed by the Certified Level I HMA Technicians doing quality control work for the Contractor on all projects where the Quality Management-Asphalt (QM-A) specification applies.

These duties consist of, but are not limited to, the following:

A. Aggregate Stockpiles.

1. Assure proper stockpiling of aggregate deliveries. (stockpile build & additions) (daily check list, IM 508)
   a. Prevent intermingling of aggregates.
   b. Check for and prevent contamination.
   c. Prevent segregation.
   d. Check for oversize material.
2. Document certified aggregate deliveries. (each delivery) (plant book, IM 508)
   a. Obtain truck tickets.
   b. Check for proper certification.
   c. Check for proper approved source.
   d. Enter deliveries in Plant Book Program, Aggregate Certification page.
3. Observe loader operation. (daily) (daily check list, IM 508)
   a. Check for proper stockpile to bin match-up.
   b. Check that loader does not get stockpile base material in load.
   c. Check that loader does not intermingle aggr. by overloading bins.

B. Asphalt Binder Delivery. (each delivery) (plant report & plant book, IM 508 & 509)

1. Check that material is pumped into correct tank.
2. Document Deliveries.
   a. Obtain truck tickets.
   b. Check for proper approved source.
   c. Check for proper certification.
   d. Check for proper grade.
   e. Check for addition of liquid anti-strip if required.
   f. Check if weight per gallon or specific gravity has changed.
   g. Enter deliveries into Plant Book Program, Asphalt Binder Shipment Log page.

C. Plant Operations. (daily)

1. Prepare Plant Report Program for daily entries. (plant report, IM 511)

    a. Enter Date.
    b. Enter Report Number.
    c. Enter expected tonnage for the day.
    d. Enter any proportion or target changes that apply.

2. Aggregate Delivery System. (daily check list, IM 508)

    a. Check for proper cold feed gate settings.
    b. Check for proper cold feed belt speed settings.
    c. Check for proper moisture setting (drum plants).
    d. Monitor RAP proportions

3. Mixing System. (daily check list, spec 2303.03, IM 508)

    a. Check for proper asphalt binder delivery setting.
    b. Check for proper interlock operation.
    c. Monitor coating of aggregates.
    d. Monitor mixing time (batch plants).

4. Loading System. (daily check list, spec 2303.03 & 2001.01, IM 508)

    a. Check hopper/silo gates for proper open/close
    b. Check trucks for proper loading and possible segregation.
    c. Check trucks for diesel fuel contamination in box and remove contaminated trucks from service (5 hrs with box raised).

5. Asphalt Binder Quantity Determination. (plant report, IM 508 & 509)

    a. Perform start-up tank stick measurement before mix production begins (if applicable).
    b. Perform final tank stick measurement after mix production is done (if applicable).
    c. Perform intermediate tank stick measurements as needed.
    d. If using meter for quantity, obtain totalizer printout readings and periodically check against tank stick readings.
    e. If using batch count for quantity, obtain printouts of each batch and add up the asphalt binder used for total quantity.

D. Plant Operations. (2 hour intervals) (plant report, IM 508)

1. Temperatures.

    a. Monitor and record mix temperature at discharge into truck box.
    b. Monitor and record asphalt binder temperature.

c. Monitor and record air temperature.

2. Observe plant operation for any irregularities.

E. Weighing Equipment.

1. Proportioning scales (batch plants). (min. 1/day) (spec 2001.07 & .20) (daily check list, IM 508)
   a. Perform sensitivity checks of scales.
   b. Check for interference at scale pivot points.

2. Pay Quantity Scales. (min. 1/day) (spec 2001.07 & .20, IM 508) (daily check list, plant book)
   a. Regularly perform check weighing comparisons with a certified scale as necessary. (min. 1st day and one additional if >5000 tons, and as directed by Engineer)
   b. Perform sensitivity checks of scales.
   c. Check for interference at scale pivot points.
   d. Perform verification weighing (truck platform scales).

3. Weigh Belts. (daily) (daily check list)
   a. Check weigh belt for excess clinging fines that effects speed reading.
   b. Check weigh belt for interference at bridge pivot points.
   c. Check for proper span setting.

4. Enter scale checks in Plant Book Program, Daily Check List or Plant Scale Checks page. (daily) (plant book)

F. Plant Sampling. (daily) (spec 2303.04, IM 204 & 511)

1. Obtain cold-feed gradation samples as directed by Contracting Authority personnel per IM 301and IM 204.

2. Obtain asphalt binder samples as directed by Contracting Authority personnel per IM 323 and IM 204.

3. Enter sample data into Plant Book Program, Sample Log page.

4. Obtain cold-feed moisture samples at a minimum of every ½ day (drum mix plants).

G. Field Sampling (if not performed by others). (daily) (spec 2303.04, IM 204 & 511)

1. Obtain uncompacted mix random samples as directed by Contracting Authority personnel, and identify time, station, lift and side.

3. Obtain compacted mix core random samples as directed by Contracting Authority personnel.

H. Testing. (daily) (spec 2303.04, IM 204 & 511)

1. Field cores.

    a. Provide properly calibrated equipment for Contracting Authority technician's use.
    b. Obtain and record core location station and offset information.
    c. Obtain copy of core thickness measurements from Contracting Authority Technician.
    d. Obtain copy of core weights from Contracting Authority technician.
    e. Record weights and thickness in Plant Report Program.
    f. Enter sample data into Plant Book Program Sample Log page.

2. Uncompacted mix.

    a. Properly store Contracting Authority secured portion of paired sample.
    b. Split Contractor half of paired sample into test portions as per IM 357.
    c. Perform gyratory compaction as per IM 325G.
    d. Perform bulk specific gravity test of laboratory-compacted specimen as per IM 321.
    e. Perform maximum specific gravity test as per IM 350.
    f. Enter test data into Plant Report Program.
    g. Submit secured samples to DOT District Lab.
    h. Enter sample data into Plant Book Program, Sample Log page.

3. Aggregate.

    a. Split one sample each day as directed by Contracting Authority personnel and provide half for testing by Contracting Authority.
    b. Perform gradation analysis as per IM 302 and enter weights into Plant Report Program.
    c. Perform moisture tests and enter weights into Plant Book Program, Plant Moistures page (drum mix plants).

4. Testing Lab Qualification. (as needed) (IM 208 & 511)

    a. Record all HMA sample validations with DOT on form 235.
    b. Document corrective actions taken when not correlating.
    c. Document all test equipment calibrations.
    d. Update IM's, test procedures and specs as required.

I. Documentation. (daily) (spec 2303.04, plant report, plant book, IM 204, 511 & 508)

1. Prepare computerized Daily Plant Report (form 241).

    a. Check that all data is correct.
    b. Check that all data is complete.
    c. Compute moving averages for gradation and lab voids.
    d. Compute tons of mix used to date.
    e. Enter mix adjustment data on report.
    f. Check for spec compliance.
    g. Immediately report non-complying results.
    h. Obtain and record mat temperatures and stationing.
    i. Provide daily Plant Report printout to DME.

2. Maintain a daily diary of work activity in Plant Report Program.

    a. Record weather conditions.
    b. Record daily high and low temperatures.
    c. Record sunrise and sunset times.
    d. Record any interruptions to plant production.
    e. Record any other significant events.

3. Copy and export daily data and paste into control charts program.

4. Enter all asphalt binder or aggregate proportion changes in Plant Book Program, Mix Adjustments page.

5. Enter tack shipment quantities in Plant Book Program, Tack Shipment Log page.

6. Total all truck tickets delivered to project and deduct any waste to determine HMA pay quantity.

J. Miscellaneous. (daily) (daily check list, IM 208 & 511)

1. Fill out Plant Book Program, Daily Check List page.

2. Clean lab.

3. Back-up computer files.

4. Dispose of samples as directed by District Lab.

5. Clean and maintain lab equipment.

K. Independent Assurance Duties. (Every 3 months) (IM 205 & 216)

1. Pick up HMA and aggregate proficiency sample from District Lab.
2. Test aggregate proficiency sample for gradation per IM 302.
3. Test HMA proficiency sample per IM 357, 325G, 321 & 350.
4. Report test results on proficiency samples to Central Materials Office per IM 205.

L. Project Duties. (1/project) (IM 508 & 511)

1. Be in possession of appropriate mix design.
2. Be present during plant calibration.
3. Observe scale calibrations.
4. Perform plant site and set-up inspection and fill out Plant Site Inspection List.
5. Set up Plant Report and Plant Book Programs and enter all project information to create Project Master files at beginning of project.
6. Check that release agents used in truck boxes are on the approved list in IM 491.15
7. Copy all computer files and provide to the Contracting Authority at completion of project.
8. Copy all paperwork and control charts and provide to the Contracting Authority at completion of project.

PRESTRESS TECHNICIAN DUTIES

Duties of the Prestress Technician are detailed in IM 570 and consist of, but are not limited to the following:

A. Pre-pour

1. Identify and document materials requiring outside fabrication inspection.
2. Identify potential fabrication or production problems and notify Iowa DOT inspectors.
3. Verify that all materials incorporated meet the requirements of the contract documents.
4. Review concrete placement documents for strand locations.
5. Check tension calculations.
6. Measure elongation and gauge pressure during tensioning.
7. Check hold down and insert locations.
8. Check stress distributions.
9. Check steel reinforcement and placement.
10. Check strand position.
11. Check condition of pallet.
    a. Level
    b. Holes
    c. Gaps
    d. Other deformities
12. Determine moisture of aggregates.
13. Check form condition and placement.
    a. Oil
    b. Line alignment level
    c. Tightness

B. Concrete Placement

1. Check on use of an approved mix design and batching operations (sequence).
2. Assure appropriate placement and proper vibration techniques.
3. Measure and record concrete temperature.
4. Assure test cylinders are properly made.
5. Assure appropriate finish.
6. Assure appropriate curing operations.

C. Post-pour

1. Check temperature and record during curing process.
2. Assure concrete strength has been met prior to releasing the line.
3. Assure proper detensioning procedure.
4. Check unit for defects and obtain approval for repairs.
5. Identify and store cylinders with the respective units.
6. Check beam ends for fabrication in accordance with the plans.
7. Assure exterior sides of facia beams are grouted.
8. Inspect after patching and desired surfacing.
9. Measure and record overall dimensions of beam.
10. Measure and record camber at release and compare to design camber.
11. Check and/or measure and record lateral sweep before shipping.
12. Assure proper cylinder cure.

PROFILOGRAPH TECHNICIAN DUTIES

Duties of the Profilograph Technician are detailed in IM 341 and consist of, but are not limited to the following:

A. Test pavement for smoothness criteria.

B. Evaluate and certify test results.

   1. Certified person that reduces trace must sign certified test report.

   2. Profilograms become part of permanent project record.

C. Documentation

   1. Certified Profilograph Test report must include following statement:

      This is to certify that all testing and trace reduction herein described has been performed according to applicable contract specifications and requirements.

GUIDELINES FOR VALIDATING TEST RESULTS

GENERAL

Agency laboratory and field personnel validate testing by Contractor and producer personnel on a regular basis. Tolerances given herein are for use as guides to flag test result variations that indicate a possible discrepancy.

TOLERANCES

The tolerances shown in the following listing apply to the difference between Contractor and producer test results and verification test results. When the tolerances are exceeded, an immediate investigation must be made to determine possible cause so that any necessary corrections can be made.

TEST NAME	TEST METHOD	TOLERANCE
Slump of PC Concrete	IM 317	1/4 in. (6 mm)
Air Content of PC Concrete	IM 318	0.4%
Length of Concrete Cores	IM 347	0.10 in. (2 mm)
Free Moisture in Aggregate, by Pycnometer	IM 308	0.2%
Specific Gravity of Aggregate, by Pycnometer	IM 307	0.02
Moisture in Aggregate, by Hot Plate		0.3%
Wet Density by Nuclear Gauge, Soils & Bases kg/m³)	IM 334	2.0 lb./ft.³ (32
G_{mm} Maximum Specific Gravity	IM 350	0.010
G_{mb} Density of HMA Concrete, by Displacement	IM 321	0.020
G*/Sin Delta	T315	10% of mean
% Binder, Ignition Oven	IM 338	0.3%
G_{sa} Apparent Specific Gravity	IM 380	0.010
G_{sb} Bulk Specific Gravity	IM 380	0.028
Percent Absorption	IM 380	0.37%
Fine Aggregate Angularity	T304	2
Sand Equivalency	T176	10 % of mean

Pavement Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		1.0 in./mi. (16 mm/km)
6.1 to 20.0 (96 to 315)		2.0 in./mi. (32 mm/km)
20.1 to 40.0 (316 to 630)		3.0 in./mi. (47 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Pavement Profile Index (0.0" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
25.0 (395) or less		3.0 in./mi. (47 mm/km)
25.1 to 40.0 (396 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		5.0 in./mi. (79 mm/km)
Bridge Profile Index (0.2" blanking band)	IM 341	
Verification Profile Index Test Result		
Inches/mile (mm/km)		
6.0 (95) or less		2.0 in./mi. (32 mm/km)
6.1 to 20.0 (96 to 315)		3.0 in./mi. (47 mm/km)
20.1 to 40.0 (316 to 630)		4.0 in./mi. (63 mm/km)
More than 40.0 (630)		6.0 in./mi. (95 mm/km)

TOLERANCES FOR AGGREGATE GRADATIONS

Determining the precision of an aggregate sieve analysis presents a special problem because the result obtained with a sieve is affected by the quantity of material retained on the sieve and by results obtained on sieves coarser than the sieve in question. Tolerances are, therefore, given for different ranges of percentage of aggregate passing one sieve and retained on the next finer sieve used.

Comparisons of test results are made on each fraction of the sample, expressed in percent that occurs between consecutive sieves.

NOTE: Tolerances for aggregate gradations are only valid if the two tests were made on a split sample. Experience has shown that improper sample reduction, as well as differences in test procedures can contribute to results being out of tolerance. When a comparison exceeds the tolerance limits, a review of the test procedures and equipment will be performed. Where practical, additional comparisons will be done with similar equipment and methods.

Table 1 Tolerances for All Aggregates Except HMA-Combined Aggregate

	Size Fraction Between Consecutive Sieves, %*	Tolerance, %
Coarse Portion:	0.0 to 3.0	2
#4 Sieve and larger	3.1 to 10.0	3
	10.1 to 20.0	5
	20.1 to 30.0	6
	30.1 to 40.0	7
	40.1 to 50.0	9
Fine portion:	0.0 to 3.0	1
#8 Sieve and smaller	3.1 to 10.0	2
	10.1 to 20.0	3
	20.1 to 30.0	4
	30.1 to 40.0	4

Table 2 Tolerances for All HMA-Combined Aggregate

Size Fraction Between Consecutive Sieves, %*	Tolerances
0.0 to 3.0	2
3.1 to 10.0	3
10.1 to 20.0	5
20.1 to 30.0	6
30.1 to 40.0	7
40.1 to 50.0	9

*The verification test analysis fraction is used to find the proper tolerance.

COMPARISON OF AGGREGATE GRADATIONS

Use of these tolerances is explained in the following examples. Computer spreadsheets to perform the analysis are available on the Iowa DOT Materials Office website. Use of the spreadsheets is preferred when possible. Appendix A contains a copy of the printouts from the spreadsheets.

Example 1 - PC Concrete Coarse Aggregate

Sieve Size	DOT Coarse Aggr Percent Passing	Prod./CPI Coarse Aggr Percent Passing	DOT Coarse Aggr Percent Retained	Prod./CPI Coarse Aggr Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5"/37.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
1"/25.0mm	97.1	99.1	2.9	0.9	2.0	2	Yes
3/4"/19.0mm	72.2	65.1	24.9	34.0	9.1	6	No
1/2"/12.5mm	38.1	34.9	34.1	30.2	3.9	7	Yes
3/8"/9.5mm	12.0	8.8	26.1	26.1	0.0	6	Yes
#4/4.75mm	0.6	0.2	11.4	8.6	2.8	5	Yes
#8/2.36mm	0.5	0.2	0.1	0.0	0.1	1	Yes
Minus #200	0.3	0.2	0.3	0.2	0.1	1	Yes

The size fraction between consecutive sieves is found by calculating the difference between the percent passing reported for the two sieves. For example, the fraction between the 1.5 in. (37.5 mm) and 1 in. (25 mm) sieves for the above verification test is 100.0 - 97.1 = 2.9%. Between the 1/2 in. (12.5 mm) and 3/8 in. (9.5mm) sieves it is 38.1 – 12.0 = 26.1%. Since nothing passes the pan, the size fraction between the #200 sieve and the pan is equal to the percent passing the #200.

The example shows the fraction between each pair of consecutive sieve sizes for both tests and the difference between these fractions for both tests. The difference is compared with the applicable tolerance to determine a disposition. In this example, a suspect result is found in the fraction between the 1 in. (25 mm) and 3/4 in. (19 mm) sieves. Since the suspect difference is due primarily to the percent passing results on the 3/4 in. (19 mm) sieves, it is these results that should at least be investigated first. Only further investigation can determine which 3/4 in. (19 mm) sieve, if any is faulty.

NOTE: The applicable tolerance changes between #4 and #8 size fractions.

Example 2 - PC Concrete Fine Aggregate

Sieve Size	DOT Fine Aggregate Percent Passing	Prod./CPI Fine Aggregate Percent Passing	DOT Fine Aggregate Percent Retained	Prod./CPI Fine Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
3/8"/9.5mm	100.0	100.0	0.0	0.0	0.0	2	Yes
#4/4.75mm	95.0	95.0	5.0	5.0	0.0	3	Yes
#8/2.36mm	87.8	86.3	7.2	8.7	1.5	2	Yes
#16/1.18mm	72.0	71.5	15.8	14.8	1.0	3	Yes
#30/600um	44.0	43.8	28.0	27.7	0.3	4	Yes
#50/300um	12.2	13.0	31.8	30.8	1.0	4	Yes
#100/150um	1.5	1.3	10.7	11.7	1.0	3	Yes
Minus #200	0.4	0.4	0.4	0.4	0.0	1	Yes

Example 3 - HMA Combined Aggregate

		Sieve Sizes										
		1"	3/4"	1/2"	3/8"	4	8	16	30	50	100	200
	Specs.											
	D.O.T.		100	99.1	87.3	68.8	54.2	41.4	28.2	15.5	9.1	6.9
	Prod./C.P.I.		100	98.8	86.1	74.9	56.1	41.9	28.7	15.1	10.9	8.6

D.O.T. % Retained	Prod./C.P.I. % Retained	Diff.	Tol. %	Comply (Y/N)
NA	NA	0.0	2	Y
0.9	1.2	0.3	2	Y
11.8	12.7	0.9	5	Y
18.5	11.2	7.3	5	N
14.6	18.8	4.2	5	Y
12.8	14.2	1.4	5	Y
13.2	13.2	0.0	5	Y
12.7	13.6	0.9	5	Y
6.4	4.2	2.2	3	Y
2.2	2.3	0.1	2	Y
6.9	8.6	1.7	3	Y

D.O.T. FBR: _____

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9

NOTE: The applicable tolerance for this combined aggregate sample is from Table 2. In this example, the suspect fractions would indicate a possible problem for two pairs of consecutive sieve sizes involving the #4 (4.75 mm) sieves. This evidence and the difference in the test values found for the #4 (4.75 mm) sieves, strongly point to an error in one of the #4 (4.75 mm) sieve results.

When RAP mixes are used, the comparison data is of the composite gradation results and not of the cold feed.

PC CONCRETE GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

Rev 05/03

Iowa Department Of Transportation

Reported Gradation & IM 216 Comparison Report

Form 200

Project No.: _____ Intended Use: _____
(Paving, Structure, Patching, Incidental

Contract ID: _____

County: _____

Contractor/Producer: _____

Design No.: _____

Coarse Agg. T203 A No.: _____

Fine Agg. T203 A No.: _____

Proper Equipment: _____

Applicable Specs.: _____

	Good	Fair	Poor
Care of Equipment:			
Sampling Procedure:			
Splitting Procedure:			
Sieving to Completion:			
Computations:			
Reporting:			

DOT Tested By: _____ Cert. No.: _____ Date: _____

Contr./Prod. Tested By: _____ Cert. No.: _____ Date: _____

			Sieve Sizes - Percent Passing											
Grad No.	Sample ID	**Specs**	**1 1/2"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**#4**	**#8**	**#16**	**#30**	**#50**	**#100**	**#200**
		DOT												
		Contr./Prod.												

Grad No.	Sample ID		**Specs**											
		DOT												
		Contr./Prod.												

Sieves	DOT % Retained	Contr./Prod. % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	NA	NA	0.0	2	Y
1 - 3/4	NA	NA	0.0	2	Y
3/4 - 1/2	0.0	0.0	0.0	2	Y
1/2 - 3/8	0.0	0.0	0.0	2	Y
3/8 - 4	0.0	0.0	0.0	2	Y
4 - 8	0.0	0.0	0.0	1	Y
8 - 200	0.0	0.0	0.0	1	Y
200	0.0	0.0	0.0	1	Y

3/8 - 4	0.0	0.0	0.0	2	Y
4 - 8	0.0	0.0	0.0	1	Y
8 - 16	0.0	0.0	0.0	1	Y
16 - 30	0.0	0.0	0.0	1	Y
30 - 50	0.0	0.0	0.0	1	Y
50 - 100	0.0	0.0	0.0	1	Y
100 - 200	0.0	0.0	0.0	1	Y
200	0.0	0.0	0.0	1	Y

Size Fraction Between Consecutive Sieves, %			Tolerance, %
Coarse Aggregate:			
0.0	to	3.0	2
3.1	to	10.0	3
10.1	to	20.0	5
20.1	to	30.0	6
30.1	to	40.0	7
40.1	to	50.0	9
Fine Aggregate:			
0.0	to	3.0	1
3.1	to	10.0	2
10.1	to	20.0	3
20.1	to	30.0	4
30.1	to	40.0	4

Remarks: _____

Distribution_____ Central Materials_____ Dist. Materials_____ Contr./Producer_____ Proj. Engineer_____ Technician_____

HMA GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

Rev 05/03

Iowa Department Of Transportation

Form 201

Reported Gradation & IM 216 Comparison Report

Project No.: _____

Contract ID: _____ Intended Use: _____

County: _____

Contractor/Producer: _____

Mix Design No.: _____

		Good	Fair	Poor
Mix Change (Y/N):	Care of Equipment:			
Date of Change:	Sampling Procedure:			
Total, % Asphalt (Pb):	Splitting Procedure:			
Effective % Asphalt (Pbe):	Sieving to Completion:			
Proper Equipment:	Computations:			
Applicable Specs.:	Reporting:			

DOT Tested By: _____ Cert. No.: _____ Date: _____

Contr./Prod. Tested By: _____ Cert. No.: _____ Date: _____

			Sieve Sizes - Percent Passing										
			1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
		Specs.												
Sample ID		DOT												
Sample ID		Contr./Prod.												

Sieves	DOT % Retained	Contr./Prod. % Retained	Diff.	Tol. %	Comply (Y/N)
1 1/2 - 1	NA	NA	0.0	2	Y
1 - 3/4	NA	NA	0.0	2	Y
3/4 - 1/2	NA	NA	0.0	2	Y
1/2 - 3/8	NA	NA	0.0	2	Y
3/8 - 4	NA	NA	0.0	2	Y
4 - 8	NA	NA	0.0	2	Y
8 - 16	NA	NA	0.0	2	Y
16 - 30	NA	NA	0.0	2	Y
30 - 50	NA	NA	0.0	2	Y
50 - 100	NA	NA	0.0	2	Y
100 - 200	NA	NA	0.0	2	Y
200	NA	NA	0.0	2	Y

DOT Gyratory Filler/Bitumen Ratio

0.00

Sieve Fraction Between Consecutive Sieves, %			Tolerance, %
0.0	To	3.0	2
3.1	To	10.0	3
10.1	To	20.0	5
20.1	To	30.0	6
30.1	To	40.0	7
40.1	To	50.0	9

Remarks: _____

Distribution_____ Central Materials_____ Dist Materials_____ Contr./Producer_____ Proj. Engineer_____ Technician_____

QMC GRADATION COMPARISON REPORT

(Computer Spreadsheet Available on Iowa DOT Office of Materials Web Site)

QMC Gradation Correlation I.M. 216

Project No.: _____

Contract ID: _____ Date Sampled: _____

Plant Name: _____ County: _____ Gradation Date: _____

Contractor: _____ Mix Design Number: _____ Design No.: _____

Coarse Agg. Source: _____ Intermediate Agg. Source: _____ Fine Agg. Source: _____

Monitor: _____ Cert. No.: _____ Proper Equipment: _____

C.P.I.: _____ Cert. No.: _____ Specification: _____

Sieve Size	D.O.T. Coarse Agg Percent Passing	Prod. / C. P. I. Coarse Agg Percent Passing	D.O.T. Coarse Agg Percent Retained	Prod. / C. P. I. Coarse Agg Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5" / 37.5mm							
1" / 25.0mm							
3/4" / 19.0mm							
1/2" / 12.5mm							
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
Minus #200							

Sieve Size			D.O.T. Intermediate Aggregate Percent Retained	Prod. / C. P. I. Intermediate Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
1.5" / 37.5mm							
1" / 25.0mm							
3/4" / 19.0mm							
1/2" / 12.5mm							
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
Minus #200							

Sieve Size	D.O.T. Fine Aggregate Percent Passing	Prod. / C. P. I. Fine Aggregate Percent Passing	D.O.T. Fine Aggregate Percent Retained	Prod. / C. P. I. Fine Aggregate Percent Retained	Fraction Difference	Applicable Tolerance	Complies
3/8" / 9.5mm							
#4 / 4.75mm							
#8 / 2.36mm							
#16 / 1.18mm							
#30 / 600um							
#50 / 300um							
#100 / 150um							
Minus #200							

Care of Equipment	☐ GOOD	☐ FAIR	☐ POOR	Comments: _____
Sampling Procedure	☐ GOOD	☐ FAIR	☐ POOR	
Splitting Procedure	☐ GOOD	☐ FAIR	☐ POOR	
Sieving to Completion	☐ GOOD	☐ FAIR	☐ POOR	
Computations	☐ GOOD	☐ FAIR	☐ POOR	
Reporting	☐ GOOD	☐ FAIR	☐ POOR	cc: _____

*****GENERAL REWRITE – PLEASE READ CAREFULLY.*****

INSPECTION OF CONSTRUCTION PROJECT SAMPLING & TESTING

INTRODUCTION

The Iowa Department of Transportation (DOT) has established a Quality Assurance Program (IM 205) to assure that the quality of materials and construction workmanship incorporated into all highway construction projects is in reasonable conformity with the requirements of the approved plans and Specifications, including approved changes. It consists of an Acceptance Program and an Independent Assurance Program (IAP), both of which are based on test results obtained by qualified persons and equipment.

The acceptance portion of the program covers quality control (QC) sampling and testing and verification sampling and testing. The IAP portion of the program covers the evaluation of all sampling and testing procedures, personnel, and equipment used as part of an acceptance decision (includes Contractor, Contracting Agency, and consultant).

ACCEPTANCE PROGRAM FOR MATERIALS

To fulfill the materials acceptance requirements, several methods are used by the DOT.

Sampling & Testing (Test Report)
Certification
Approved Sources
Approved Shop Drawings
Approved Catalog Cut
Fabrication Report
Visual Approval by the Engineer

In many cases more than one method may be required for acceptance in the 204 Appendices and tables in the back of this guide. For some new or special materials, the Materials Engineer may need to determine the most appropriate acceptance requirements.

In order to provide the Contractor the opportunity to construct a project with minimal sampling and testing delays, inspection is performed at the source for many materials. Source inspection may consist of inspecting process control, sampling for laboratory testing or a combination of these procedures. All source-inspected or certified materials are subject to inspection at the project site prior to being incorporated into the work. Project site inspections are for identification of materials with test reports and for any unusual alterations of the characteristics of the material due to handling or other causes. Verification samples secured by project Agency personnel of source-inspected, certified, or project processed materials are also required for some materials in order to secure satisfactory validation for acceptance.

When certification procedures are required, the Contractor may, on the Contractor's own responsibility and at the Contractor's risk, incorporate these materials into the work. Acceptance will be based on satisfactory certification and compliance of the test results of any verification samples. When verification samples are not required, acceptance will be based on satisfactory certification.

A. SAMPLING & TESTING (TEST REPORT)

When a material is sampled and tested, the results will be documented on a construction form or a test report. There is quality control sampling and testing done by the Contractor or producer and verification sampling testing done by the Project Engineer, the District Materials Engineer, the Central Materials Laboratory, or an independent laboratory.

In many cases, in addition to sampling and testing, some other type of acceptance method will also be required. Sampling and testing may be done at the project, supplier, or source depending on which is the most appropriate.

B. CERTIFICATION OF COMPLIANCE

For many materials a fabricator, manufacturer, or supplier is required to provide the Project Engineer with a certification document stating that the material meets the requirements of the plans and specifications. In most cases, the fabricator, manufacturer, or supplier must also be on an approved list in the IM. For some of these materials, sampling and testing is also required before final acceptance. The certification comes in a variety of forms:

- Stamped or preprinted on truck tickets as with aggregates,
- Stamped or preprinted on invoices as with Portland Cement and asphalt binder,
- Stamped or printed on the Mill Analysis as with reinforcing steel, structural steel, and other metals,
- Furnished as a separate document with each shipment as with zinc-silicate paint, engineering fabrics, epoxy coatings, and dowel baskets,
- Stamped or printed on a list of materials for each shipment as with CMP, concrete pipe, clay tile, and corrugated plastic subdrain,
- In the form of a guaranteed analysis as with seed labels.

The inspector will verify that the certification has been received by documenting it in the project materials book. Certifications are Type A, Type C, Type D, or other type as required by the Engineer or IM.

Type A Certification

A Type A certification is a laboratory report with test results and a certification statement stating that the materials furnished comply with the specifications. The tests may be conducted in the manufacturer laboratory or another qualified laboratory. The test samples must be from the lots of material shipped.

Type C Certification

A Type C certification is a paper prepared by the manufacturer or producer stating that the materials furnished are in accordance wit the specifications. The applicable specification article or Office of Materials IM number is identified in the certification.

Type D Certification

A Type D certification is a letter or paper prepared by an approved manufacturer stating that the materials furnished comply with the applicable specifications of the Iowa Department of Transportation.

C. APPROVED SOURCE

(May also be referred to as "Approved Producer, Approved Supplier, Approved Fabricator, or Approved Brand") The source, producer, and the material must be evaluated and approved by the Office of Materials according to the appropriate Office of Materials IM in order to be used on a project. Once a letter of approval is issued, the source or producer is approved for use on projects (with the exception of steel fabricators). Approved lists are issued biannually for general information only. Approval for a source or producer may be rescinded at any time if it no longer meets the requirements of the IM.

The project inspector will document information about this material such as product name, source, date, producer, and lot number in the project materials book.

Most approved sources also require a certification.

D. APPROVED WAREHOUSE STOCK

For some items made up of miscellaneous materials, inspection and approval will be done by the District Materials Engineer at the supplier's warehouse.

E. APPROVED SHOP DRAWING & APPROVED CATALOG CUT

This information must be submitted to, and reviewed by the Iowa DOT Central Design Offices, before the material can be incorporated in the project.

F. FABRICATION REPORT

The project inspector must have a copy of the final fabrication report prior to incorporating the item into the project. The report will vary depending on the Materials IM requirements for the item fabricated. Final acceptance is by construction personnel at the project site, and is based on the proper documentation and the condition of the component.

G. VISUAL APPROVAL BY PROJECT ENGINEER

(May also be referred to as "As Per Plan, Approved By RCE, or Manufacturer Recommendations") The project inspector must document information about this material such as product name, source, producer, lot number and date produced in the project materials book. The inspector will make sure the material meets the requirements of the plans, the Engineer, or the manufacturer before the material is used. Visual approval requires construction personnel to visually inspect the material to determine if it complies with the specifications. Visual approval is appropriate for non-critical items such as mulch or sod stakes, where compliance can be readily determined by visual means. If there are questions on specification compliance, samples will be taken for testing.

INDEPENDENT ASSURANCE PROGRAM

The IAP evaluates all sampling and testing procedures, personnel, and equipment used as part of an acceptance decision (Includes Contractor, Contracting Agency, and consultant). Independent assurance includes evaluation based on:

Calibration checks
Split samples
Proficiency samples
Observation of sampling and testing performance

The test method and the frequency of test are in the Appendices. Calibration checks and proficiency samples testing is covered in IM 208.

SMALL QUANTITIES

Refer to Appendix X.

IM 204 Appendixes

Appendix A	Roadway & Borrow Excavation & Embankments
Appendix B	Soil Aggregate Subbase
Appendix C	Modified Subbase
Appendix D	Granular Subbase
Appendix E	Portland Cement Concrete Pavement, Pavement Widening, Base Widening, Curb & Gutter & Paved Shoulders
Appendix F	Hot Mix Asphalt (QMA)
Appendix H	Structural Concrete, Reinforcement, Foundations & Substructures, Concrete Structures, Concrete Floors, & Concrete Box, Arch & Circular Culverts
Appendix I	Concrete Drilled Shaft Foundations
Appendix K	Cold-In-Place Recycled Asphalt Pavement
Appendix L	Granular Surfacing/Driveway Surfacing
Appendix M	Concrete Bridge Floor Repair & Overlay & Surfacing
Appendix P	Surface Treatment (Seal Coat, Slurry, Joint Repair, Crack Filling & Fog Seal)
Appendix T	Base Repair, Pavement Repair
Appendix U	Granular Shoulders
Appendix V	Subdrains
Appendix W	Water Pollution Control, Erosion Control
Appendix X	Acceptance of Small Quantities of Materials
Appendix Z	Supplemental Guide, Basis of Acceptance

October 16, 2007
Supersedes October 17, 2006

ROADWAY & BORROW EXCAVATION & EMBANKMENTS

Section 2102 & 2107

Matls. IM 204
Appendix A (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Special Backfill														
Crushed Stone (4132.02)		AS 209												
Crushed Concrete (4132.02)		209												
RAP (2303.02) Gravel (4132.03)		AS 209												
Granular Backfill		AS 209												
Engineering Fabric (4196)	Quality	AS 496.01												
GRADE INSPECTION														
Special & Select Backfill Compaction Control	Moisture	309, 310						V	RCE	1/lift/ 1500 ft.	1 lb	RCE	Field Book	
Moisture & Density Compaction Control	Density (Proctor) Moisture	309, 310						V	RCE	1/soil class 1/lift/1500 ft.	25 lb 1lb	RCE	Field Book	
Compacted Materials	Density	311, 326, 334						V	RCE	1/lift/mile or 1/1500 cy		RCE	Field Book	Unless otherwise specified or directed

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 16, 2007
Supersedes October 17, 2006

ROADWAY & BORROW EXCAVATION & EMBANKMENTS

Section 2102 & 2107

Matls. IM 204
Appendix A (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Special Backfill														
Crushed Stone (4132.02)		AS 209												
Crushed Concrete (4132.02)		209												
RAP (2303.02) Gravel (4132.03)		AS 209												
Granular Backfill		AS 209												
Engineering Fabric (4196)	Quality	AS 496.01												
GRADE INSPECTION														
Special & Select Backfill Compaction Control	Moisture	309, 310						V	RCE	1/lift/ 450 m	0.5 kg	RCE	Field Book	
Moisture & Density Compaction Control	Density (Proctor) Moisture	309, 310						V	RCE	1/soil class 1/lift/450 m	12 kg 0.5 kg	RCE	Field Book	
Compacted Materials	Density	311, 326, 334						V	RCE	1/lift/1.5 km or 1/1150 m^3		RCE		Unless otherwise specified or directed

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

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SOIL AGGREGATE SUBBASE

Section 2110

Matls. IM 204
Appendix B

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Granular Surfacing Material (4120)		AS 209												
GRADE INSPECTION														
Mixed Materials (2110)	Density (Proctor)	309						V	RCE	2/mile (min. 2/proj.)	5000 gm	RCE	Field Book	Change of Soil type requires additional Proctors
Uncompacted Mixture	Pulverization Moisture	2" Sieve Visual						V	RCE	2/mile		RCE	Field Book	
Compacted Mixture (2110)	Density Thickness Width	311, 312, 334 337						V	RCE	2/mile		RCE	Field Book	
Finished Subbase	Cross Section	Stringline						V	RCE	10/mile		RCE	Field Book	Template for secondary park & institutional roads

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 17, 2006
Supersedes October 18, 2005

MODIFIED SUBBASE
Section 2115

Matls. IM 204
Appendix C (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate	Quality Gradation	AS 209												
Recycled Products														
Composite	Gradation	*As Per Spec.												
PCC Pavement	Gradation	*As Per Spec.												
Rap		*As Per Spec.												
GRADE INSPECTION														
Compacted Subbase	Density	*As Per Spec.						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	3/2 lane mi.		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	10/mi.		RCE	Field Book	
	Cross Section (Other)	Template						V	RCE	3/mi.		RCE	Field Book	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* Use Current Specification for Modified Subbase

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

MODIFIED SUBBASE

Section 2115

Matls. IM 204
Appendix C (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate	Quality Gradation	AS 209												
Recycled Products														
Composite	Gradation	*As Per Spec.												
PCC Pavement	Gradation	*As Per Spec.												
Rap		*As Per Spec.												
GRADE INSPECTION														
Compacted Subbase	Density	*As Per Spec.						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	2/2 lane km		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	6/km		RCE	Field Book	
	Cross Section (Other)	Template						V	RCE	2/km		RCE	Field Book	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* Use Current Specification for Modified Subbase

October 17, 2006
Supersedes October 18, 2005

GRANULAR SUBBASE
Section 2111

Matls. IM 204
Appendix D (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate (4121)	Quality Gradation	AS 209												
PCC Pavement	Gradation	209												
GRADE INSPECTION														
Compacted Subbase (2111)	Density	By Specification						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	3/2 lane mi.		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	10/ mi.		RCE	Field Book	
	Cross Section (Others)	Template						V	RCE	3/mi		RCE	Field Book	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Sampling & Testing Guide-Minimum Frequency

October 17, 2006
Supersedes October 18, 2005

GRANULAR SUBBASE

Section 2111

Matls. IM 204
Appendix D (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Natural Aggregate (4121)	Quality Gradation	AS 209												
PCC Pavement	Gradation	209												
GRADE INSPECTION														
Compacted Subbase (2111)	Density	By Specification						V	RCE			RCE	Field Book	
Dimensions	Thickness Width	337						V	RCE	2/2 lane km		RCE	Field Book	
	Cross Section (Primary)	Stringline						V	RCE	6/km		RCE	Field Book	
	Cross Section (Others)	Template						V	RCE	2/km		RCE	Field Book	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Fine (4110)		AS 209												
Aggregate-Coarse (4115), Intermediate		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compounds (4105)	Lab-Tested													
Clear Curing Compounds (4105)		AB 405.07												
Air Entraining Admixture (4103)	Quality	AB 403												
Water Reducing Admix. (4103)	Quality	AB 403												
Retarding Admixture (4103)	Quality	AB 403												
Joint Sealer (4136.02)	Lab Tested	436.01, 436.02,436.03												
Backer Rod (4136.02)	Lab Tested	AB 436.04												
Mixing Water (4102)	Lab Tested							V	RCE/ CONTR	1/ source	1 pint	CTRL		Not required for potable water from municipal supply

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Steel Reinforcement (4151)														
Dowels	Quality	AS 451												
Tie Bars	Quality	AS 451												
General Use	Quality	AS 451												
PLANT INSPECTION														
Aggregates-Fine (4110/4111)	Grad * QMC	302 306 336	CONTR	1/1500cy	IM 301	CONTR	800240	IA V	DME RCE CONTR	1/100,000 sy, sample 1/day, test 1st day + 2/lot	IM 301 IM 301	DME RCE/ DME		See Notes See IM 213
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 sy, sample 1/day, test 1st day + 1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308, 527	CONTR	1/half day	1000 gm	CONTR								Not applicable with probe
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMP. SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregates-Coarse (4115), Intermediate	Grad * QMC	302 306 336	CONTR	QMC 1/1500 cy	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/100,000 sy Sample 1/day,test 1st day+2/lot	IM 301 IM 301	DME RCE/ DME		See Notes
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 sy, sample 1/day, test 1st day + 1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308	CONTR	1/half day	IM 301	CONTR								
	Sp. Gr.	307	CONTR	IM 527	IM 301	CONTR								
	Quality	AS 209						V	DME	1/100,000 sy	50 lb	CTRL		
Portland Cement (4101)	Quality	AS Cert D		Each Load				V	DME	1/100,000 sy	15 lb	CTRL		
	Cement Yield		CONTR	1/10,000 cy		CONTR	820912							
Fly Ash	Quality	AS Cert D		Each Load			800240	V	DME	1/100,000 sy	15 lb	CTRL		
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert		Each Load				V	DME	1/100,000 sy	15 lb	CTRL		
Air Admixture	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		Sample batches not previously reported or as required by DME
Water Reducer	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		
Retarding Admixture	Quality	AS 403						V	DME	1/batch	1 pint	CTRL		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: Quality samples not required when mix quantity is less than 2000 sq. yds., except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	S&T TYPE	SAMP. BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	
GRADE INSPECTION														
Chloride Solution	Concentration	373	RCE	1/day										
Steel Reinforcement:														
Dowels	Quality	AS 451.03B						V	DME	1/District/Yr	2 ft	CTRL		
Dowel Basket Assembly	Quality	AS 451 Cert D 451.03B												
Tie Bars	Quality	AS 451						V	DME	1/District/Yr	2 ft	CTRL		
General Use	Quality	AS 451						V	DME	1/District/Yr	48 in	CTRL		
Curing Compound	Quality	Tested 4105						V	DME	1/batch	1/qt	CTRL		Sample batches not previously reported or as required by DME
Plastic Concrete	Air	318 327	QMC CONTR	QMC only 2301.04C 1/350 cy		QMC CONTR	E115	IA V	DME RCE	1/100,000 sy 2301.04C 1/700 cy, 1/100 cy for transit mixer		DME RCE		Min. 1 test/pour
	Slump	317						V	RCE	1/700 cy, min 1/pour		RCE		For hand finish or fixed form only
	Grade Yield		RCE	1/1000 cy		RCE								
	Beams**	316, 327, 328	RCE	2/day		RCE	E115							
Hardened Concrete	Thickness*	346, 347						IA V	DME RCE/ CONTR	1/2000 sy	10%	DME RCE		
	Smoothness	341 Cert. Test Rept.	CONTR		100%	CONTR		V	DME		10%	DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

*IA thickness cores sent to Central Lab for additional project information testing (Interstate and Primary only.)

**None required when maturity is used. Quality samples not required when mix quantity is less than 2000 sq. yds., except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer. **NOTE:** Form #E115 available from the Office of Construction.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Fine (4110)		AS 209												
Aggregate-Coarse (4115), Intermediate		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compounds (4105)	Lab-Tested													
Clear Curing Compounds (4105)		AB 405.07												
Air Entraining Admixture (4103)	Quality	AB 403												
Water Reducing Admix. (4103)	Quality	AB 403												
Retarding Admixture (4103)	Quality	AB 403												
Joint Sealer (4136.02)	Lab Tested	436.01, 436.02,436.03												
Backer Rod (4136.02)	Lab Tested	AB 436.04												
Mixing Water (4102)	Lab Tested							V	RCE/ CONTR	1/source	0.5 L	CTRL		Not required for potable water from municipal supply

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Steel Reinforcement (4151)														
Dowels	Quality	AS 451												
Tie Bars	Quality	AS 451												
General Use	Quality	AS 451												
PLANT INSPECTION														
Aggregates-Fine (4110/4111)	Grad * QMC	302 306 336	CONTR	1/1200 m^3	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/100,000 m^2, sample 1/day, test 1st day + 2/lot	IM 301 IM 301	DME RCE/ DME		See Notes See IM 213
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 m^2 Sample 1/day, test 1st day+1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308, 527	CONTR	1/half day	1000 gm	CONTR								Not applicable with probe
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregates-Coarse (4115), Intermediate	Grad * QMC	302 306 336	CONTR	1/1200m³	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/100,000 m² Sample 1/day,test 1st day+2/lot	IM 301 IM 301	DME RCE/ DME		See Notes
	Grad * Non-QMC	302 306 336	CONTR	1/day	IM 301	CONTR		IA V	DME RCE/ CONTR	1/100,000 m² Sample 1/day, test 1st day+1/lot	IM 301 IM 301	DME RCE/ DME		
	Moist	308	CONTR	1/half day	IM 301	CONTR								
	Sp. Gr.	307	CONTR	IM 527	IM 301	CONTR								
	Quality	AS 209						V	DME	1/100,000 m²	22kg	CTRL		
Portland Cement (4101)	Quality	AS Cert D		Each Load				V	DME	1/100,000 m²	7 kg	CTRL		
	Cement Yield		CONTR	1/7500m³		CONTR	820912							
Fly Ash	Quality	AS Cert D		Each load			800240	V	DME	1/100,000 m²	7 kg	CTRL		
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert		Each load				V	DME	1/100,000 m²	7 kg	CTRL		
Air Admixture	Quality	AS 403						V	DME	1/batch	0.5 L	CTRL		Sample batches not previously reported or as required by DME
Water Reducer	Quality	AS 403						V	DME	1/batch	0.5 L	CTRL		
Retarding Admixture	Quality	AS 403						V	DME	1/batch	0.5 L	CTRL		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

* A system approach to independent assurance may be applied, at the discretion of the DME.

NOTE: When Certified Plant Inspection is not provided, the engineer is responsible for performing quality control sampling and testing.

NOTE: Quality samples not required when mix quantity is less than 2000 m², except for curing compound.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

Sampling & Testing Guide-Minimum Frequency

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

October 16, 2007
Supersedes April 17, 2007

Section 2122, 2201, 2213, 2301, 2302, 2310, SS-01046

Matls. IM 204
Appendix E (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMP. SIZE	TEST BY	REPT.	S&T TYPE	SAMP. BY	FREQ.	SAMP. SIZE	TEST BY	REPT.	
GRADE INSPECTION														
Chloride Solution	Concentration	373	RCE	1/day										
Steel Reinforcement:														
Dowels	Quality	AS 451.03B						V	DME	1/District/Yr	0.5 m	CTRL		
Dowel Basket Assembly	Quality	AS 451 Cert D 451.03B												
Tie Bars	Quality	AS 451						V	DME	1/District/Yr	0.5 m	CTRL		
General Use	Quality	AS 451						V	DME	1/District/Yr	1 m	CTRL		
Curing Compound	Quality	Tested 4105						V	DME	1/batch	1/L	CTRL		Sample batches not previously reported or as required by DME
Plastic Concrete	Air	318 327	QMC CONTR	QMC only 2301.04C 1/275 m³		QMC CONTR	E115	IA V	DME RCE	1/100,000 m² 2301.04C 1/550m³ 1/75 m³ for transit mixer		DME RCE		Min. 1 test/pour
	Slump	317						V	RCE	1/550 m³, min. 1/pour		RCE		For hand finish or fixed form only
	Grade Yield		RCE	1/750 m³		RCE								
	Beams**	316, 327, 328	RCE	2/day		RCE	E115							
Hardened Concrete	Thickness*	346, 347						IA V	DME RCE/ CONTR	1/2000 m²	10%	DME RCE		
	Smoothness	341Cert. Test Report	CONTR		100%	CONTR		V	DME		10%	DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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CONTR-Contractor

IA-Independent Assurance
V-Verification

QMC-Quality Management Concrete

*IA thickness cores sent to Central Lab for additional project information testing (Interstate and Primary only.)

PORTLAND CEMENT CONCRETE PAVEMENT, PAVEMENT WIDENING, BASE WIDENING CURB & GUTTER, & PAVED SHOULDERS

**None required when maturity is used. Quality samples not required when mix quantity is less than 2000 m², except for curing compound.
NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.
NOTE: Form #E115 available from the Office of Construction.

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT

Section 2303, 2213, & 2114

Matls. IM 204
Appendix F (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Coarse (4127)		AS 209												
Aggregates-Fine (4127)		AS 209												
Hydrated Lime (4126/4127)		AS 491.04												
Asphalt Binder		AS 437												
Emulsions & Cutbacks		AS 437												
Release Agent		AB 491.15												
PLANT INSPECTION														
Aggregates (2303)	Quality							V	DME	1/20,000 Ton	50 lb.	CTRL		
Combined Aggregate (4126, 4127)	Gradation		RCE/ CONTR	1/lot	IM 301	CONTR		V IA	RCE/ CONTR	Sample 1/day, Test 1st day + 20% Systems Approach*	IM 301	DME/ RCE	IM 216 IM 216	
	Moisture		CONTR	1 / half day	1000 gm	CONTR								Dryer Drum Plants Only

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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IA-Independent Assurance
V-Verification

*A project approach may be applied at the discretion of the DME at the frequency 1/project.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT

Section 2303, 2213, & 2114

Matls. IM 204
Appendix F (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Mineral Filler								V	DME	1/project	5 kg	DME	821278	
Asphalt Binder	DSR	AS Cert D						V	RCE/ CONTR	Sample 1/day Test 1st 3days + 1/week	4 oz tin	DME		Log all shipments
	Quality							V IA	DME	1/20,000 T of Mix Systems Approach	1 qt	CTRL		
Cutback		AS 329												Log all shipments
Emulsion	Residue	AS 360						V	RCE	1/project	1 qt	DME		Plastic bottle required
GRADE INSPECTION														
Uncompacted Mixture:	Lab Density & Lab Voids	321, 350 325G	RCE/ CONTR	As per 2303	30 lb	CONTR		V IA	RCE/ CONTR	As per 2303 Test 1/day Systems Approach	30 lb	DME		May be adjusted by DME as per 2303
Compacted Mixture	Density, Thickness & Voids	320, 321 337	RCE/ CONTR	Lot	7/lot	RCE		IA	DME	1 lot/project*		DME		
	Smoothness	341	CONTR	100%	100%	CONTR		V	DME	10%		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* A system approach may be applied at the discretion of the DME.

NOTE: Verification not required under 2000 tons of mix.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT
Section 2303, 2113, & 2114

Matls. IM 204
Appendix F (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ. Note 1	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Coarse (4127)		AS 209												
Aggregates-Fine (4127)		AS 209												
Hydrated Lime (4126/4127)		AS 491.04												
Asphalt Binder		AS 437												
Emulsions & Cutbacks		AS 437												
Release Agent		AS 491.15												
PLANT INSPECTION														
Aggregates (2303)	Quality							V	DME	1/20,000 Mg	22 kg	CTRL		
Combined Aggregate (4126, 4127)	Gradation		RCE/ CONTR	1/lot	IM 301	CONTR		V IA	RCE/ CONTR	Sample 1/day, Test 1st day + 20% Systems Approach*	IM 301	DME/RCE DME	IM 216 IM 216	
	Moisture		CONTR	1/halfday	1000 gm	CONTR								Dryer Drum Plants Only

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

*A project approach may be applied at the discretion of the DME at the frequency 1/project.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

April 17, 2007
Supersedes October 17, 2006

HOT MIX ASPHALT

Section 2303, 2113, & 2114

Matls. IM 204
Appendix F (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Mineral Filler								V	DME	1/project	5 kg	DME	821278	
Asphalt Binder	DSR	AS Cert D						V	RCE/ CONTR	Sample 1/day, Test 1st day + 20%	120 ml	DME		Log all shipments
	Quality							V IA	DME	Systems Approach	1 L	CTRL		
Cutback	Quality Viscosity	AS 329												Log all shipments
Emulsion	Residue	AS 360						V	RCE	1/project	1 L	DME		Plastic bottle required
GRADE INSPECTION														
Uncompacted Mixture:	Lab Density & Lab Voids	321, 350 325G	RCE/ CONTR	As per 2303	14 kg	CONTR		V IA	RCE/ CONTR	As per 2303, Test 1/day Systems Approach	14 kg	DME		May be adjusted by DME as per 2303
Compacted Mixture	Density Thickness Voids	320, 321 337	RCE/ CONTR	Lot	7/lot	RCE		IA	DME	1/lot/project		DME		
	Smoothness	341	CONTR	100%	100%	CONTR		V	DME	10%		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

* A system approach may be applied at the discretion of the DME.

NOTE: Verification not required under 2000 Mg of mix.

NOTE: RCE/CONTR indicates that the contractor shall assist in the sampling at the direction of and witnessed by the project engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Granular Backfill (4133)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality							V	RCE	1/project	1 L	CTRL	731	Not required for potable water from Municipal Supply
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Water reducing Admixture	Quality	AS 403												Sample batches not previously reported or as required by DME
Curing Compound, White (4105)	Lab Tested	AS 405						V	DME	1/batch	1qt	CTRL		
Curing Compound, Clear (4105)		AS 405.07												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
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Cert D-Type D Certification

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V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMS	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Pre-formed Joint Sealer (4136)	Lab-Tested	AS 436.02 436.05												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Steel Pile (4167)	Quality	467												
Concrete Pile (4166)	Quality	AS 570												
Timber Pile (4165)	Quality	Cert A 462 AS												
Timber (4162) & Lumber (4163		Treated-Cert A 462 AS												
Concrete Anchors	Quality	AS 453.09												
Epoxy Grout	Quality	AS 491.11												
Concrete Sealer	Quality	AS 491.12												
Subdrain Pipe (4143)	Quality	AS 443, 448												
Neoprene Bearing Pads (4195)		AS 495.03												
Bronze Bearing Plates (4190.03)		AS D/Cert A												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Steel Masonry Plate (4152)		ASD/Cert A												
Precast Units (2407)	Quality	AS 570												
Anchor Bolts (lighting, signing, handrail) (4153)	Lab Tested	ASD												
Structural Steel (4152)	Quality	Cert A												Monitor Sample According to plans or other instructions
Aluminum Bridge Rail & Anchor Assembly		ASD												
Conduit (Electrical) (4185.10)) Steel		AS												
Conduit (Plastic) (4185.10)	Lab Tested							V	DME	1/size	4'	CTRL		
Bentonite		Visual												
Flowable Mortar	Lab Tested	Approved Trial Mix 525, 375												Tested by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/1000 cy Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May Use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1-1000 cy Sample 1/wk Test 1st day +20%	IM 301 IM 301	RCE		May Use System App.
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/1000 cy Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May Use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/1000 cy Sample 1/wk Test 1st day +20%	IM 301 IM 301	DME RCE		May Use System App.
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/1000 cy	50 lb	CTR L		(1)
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/1000 cy	15 lb	CTR L		(1)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) These verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Fly Ash	Quality	AS Cert D		Each Load			800240							
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert D		Each Load										
Air-Entraining Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		(1) Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	RCE	1/batch	0.5 L	CTRL		
Water Reducing Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		
GRADE INSPECTION														
Plastic Concrete	Air Content	316, 327					E145*	IA V	DME RCE	1/1000 cy 1/30 cy		DME RCE		DME may adjust
	Slump	317, 327						IA V	DME RCE	1/1000 cy 1/30 cy		Witness Only RCE		DME may adjust
	Beams	316, 327, 328							RCE	2/placement		RCE		If required per 2403.18 and 2403.19
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) These verification samples for concrete materials not required when mix quantity is less than 50 cu. yd.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

*Available from the Office of Construction.

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TES BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	IM 451	6 ft	CTRL		
Reinforcing Steel Epoxy Coated (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	1 bar	6 ft	CTRL		Will be acceptance tested for coating
Steel Pile (4167)	Quality	AS Cert A		Each Heat			Field Book		DME	IM 467		CTRL		
Timber Pile (4165)	Quality	AS 462 Cert A						V	DME	IM 467		CTRL		No grade requirement Charge numbers on butt end.
Anchor Bolts (lighting, signing, handrail)	Lab Tested	ASD						V	DME	1/project	1 bolt w/nut & washer	CTRL		Sample only if not source inspected
Steel Masonry Plates (4152)		ASD Cert A		Each Shipment			Field Book							Approved by Materials Department
Bronze Bearing Plates (4190.03)	Lab Tested							V	DME	1/project	1 only	CTRL		Sample only if not source inspected
Neoprene Bearing Pads (4195)		AS 495.03		Each Shipment			820905							
Alum. Bridge Rail & Anchor Assembly		ASD		Each Shipment			Field Book							Approved By Materials Dept.
Drains (Std Steel Pipe)(as per plan)	Dimensions Galvanized	ASD Visual 332						V	DME	1/project		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Timber (4162) & Lumber (4163)	Quality	AS 462 Treated-Cert A												
Subdrain Pipe (4143)	Quality	AS Cert D 443, 448		Each Shipment										
Flowable Mortar (2506)	Flow Test	375	RCE	As needed for Project Control		RCE	830211							Mix Design approval by DME
Bentonite	Flow Test	Visual 375				RCE								
Smoothness (2317)	Profilometer	Cert. Test Report 341	CONTR	Each Project	Each Wheelpath	CONTR	821301	V		10%	DME			

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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IA-Independent Assurance
V-Verification

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STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Granular Backfill (4133)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality								RCE	1/project	1 L	CTRL	731	Not required for potable water from Municipal Supply
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Water reducing Admixture	Quality	AS 403												
Curing Compound, White (4105)	Lab Tested	405						V	DME	1/batch	1 qt	CTRL		
Curing Compound, Clear (4105)		AS 405.07												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
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V-Verification

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Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

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Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Preformed Joint Sealer (4136)	Lab-Tested	AS 436.02 436.05												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Steel Pile (4167)	Quality	467												
Concrete Pile (4166)	Quality	AS 570												
Timber Pile (4165)	Quality	Cert A AS 462												
Timber (4162) & Lumber (4163)		Treated-Cert A 462												
Concrete Anchors	Quality	AS 453.09												
Epoxy Grout	Quality	AS 491.11												
Concrete Sealer	Quality	AS 491.12												
Subdrain Pipe (4143)	Quality	AS 443, 448												
Neoprene Bearing Pads (4195)		AS 495.03												
Bronze Bearing Plates (4190.03)		ASD/Cert A												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
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Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPT.	
SOURCE INSPECTION														
Steel Masonry Plate (4152)		ASD/Cert A												
Precast Units (2407)	Quality	AS 570												
Anchor Bolts (lighting, signing, handrail) (4153)	Lab Tested	ASD												
Structural Steel (4152)	Quality	Cert A												Monitor Sample According to plans or other instructions
Aluminum Bridge Rail & Anchor Assembly		ASD												
Conduit (Electrical) (4185.10) Steel)		AS												
Conduit (Plastic) (4185.10)	Lab Tested							V	DME	1/size	1 m with coupling	C TRL		
Bentonite		Visual												
Flowable Mortar	Lab Tested	Approved Trial Mix 525, 375												Tested by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
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Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/750 m³ Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/750 m³ Sample 1/wk Test 1st day +20%	IM 301 IM 301	DME RCE		May use System App.
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation Deck	302, 306 336	CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/750 m³ Sample & Test 1/deck/wk	IM 301 IM 301	DME RCE		May use System App.
	Gradation All other		CONTR	IM 528	IM 301	CONTR		IA V	DME RCE/ CONTR	1/750 m³ Sample 1/wk Test 1st day +20%k	IM 301 IM 301	DME RCE		May use System App.
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/750 m³	22 kg	CTRL		(1)
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/750 m³	7 kg	CTRL		(1)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) These verification samples for concrete materials not required when mix quantity is less than 40 m³.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Fly Ash	Quality	AS Cert D		Ea Load			800240							
GGBFS(Ground Granulated Blast Furnace Slag)	Quality	AS Cert D		Ea Load				V	DME	1/750 m^3	7 kg	CTRL		
Air Entraining Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		(1) Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	RCE	1/batch	0.5 L	CTRL		
Water Reducing Admixture (4103)		AS 403						V	RCE	1/batch	0.5 L	CTRL		
GRADE INSPECTION														
Plastic Concrete	Air Content	316, 327					M145*	IA V	DME RCE	1/750 m^3 1/25 m^3		DME RCE		DME may adjust
	Slump	317, 327						IA V	DME RCE	1/750m^3 1/25 m^3		Witness Only RCE		DME may adjust
	Beams	316, 327, 328							RCE	2/placement		RCE		If required per 2403.18 & 2403.19
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) These verification samples for concrete materials not required when mix quantity is less than 40 m^3.

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

*Available from the Office of Construction.

Sampling & Testing Guide-Minimum Frequency

STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	IM 451	2 m	CTRL		
Reinforcing Steel Epoxy Coated (4151)	Quality	AS Cert A		Each Shipment			Field Book	V	DME	1 bar	2 m	CTRL		Will be acceptance tested for coating
Steel Pile (4167)	Quality	AS Cert A		Each Heat			Field Book	V	DME	IM 467		CTRL		
Timber Pile (4165)	Quality	AS 462 Cert A						V	DME	IM 462		CRTL		No grade requirement Charge numbers on butt end.
Anchor Bolts (lighting, signing, handrail)	Lab Tested	ASD						V	DME	1/project	1 bolt w/nut & washer	CTRL		Sample only if not source inspected
Steel Masonry Plates (4152)		ASD Cert A		Each Shipment			Field Book							Approved by Materials Department
Bronze Bearing Plates (4190.03)	Lab Tested							V	DME	1/project	1 only	CTRL		Sample only if not source inspected
Neoprene Bearing Pads (4195)		AS 495.03		Each Shipment			820905							
Alum. Bridge Rail & Anchor Assembly		ASD		Each Shipment			Field Book							Approved By Materials Dept.
Drains (Std Steel Pipe)(as per plan)	Dimensions Galvanized	ASD Visual 332						V	DME	1/project		DME	Test Report	

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

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V-Verification

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STRUCTURAL CONCRETE, REINFORCEMENT, FOUNDATIONS & SUBSTRUCTURES, CONCRETE STRUCTURES, CONCRETE FLOORS, & CONCRETE BOX, ARCH & CIRCULAR CULVERTS

October 16, 2007
Supersedes April 17, 2007

Sections 2403, 2404, 2405, 2406, 2412, & 2415

Matls. IM 204
Appendix H (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Timber (4162) & Lumber (4163)	Quality	AS 462 Treated-Cert A		Each Shipment										
Subdrain Pipe (4143)	Quality	AS Cert D 443, 448		Each Shipment										
Flowable Mortar (2506)	Flow Test	375	RCE	As needed for Project Control		RCE	830211							Mix Design approval by DME
Bentonite	Flow Test	Visual 375				RCE								
Smoothness (2317)	Profilometer	Cert. Test Rpt. 341	CONTR	Each Project	Each Wheelpath	CONTR	821301	V		10%		DME		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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IA-Independent Assurance
V-Verification

NOTE: RCE/CONTR indicates that the Contractor shall assist in the sampling at the direction of and witnessed by the Project Engineer.

Sampling & Testing Guide-Minimum Frequency

CONCRETE DRILLED SHAFT FOUNDATIONS

October 17, 2006
Supersedes October 18, 2005

SS-01032

Matls. IM 204
Appendix I

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate-Fine (4110)		AS 209												
Aggregate-Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
Mixing Water (4102)	Quality								DME	1/project	1 quart	CTRL	731	Not required for potable water from Municipal Supply
Air Entraining Admixture	Quality	AS 403												
Retarding Admixture	Quality	AS 403												
Reinforcing Steel Bars (4151)	Quality	AS 451												
Permanent Casing	Quality	Cert A												According to plans or other instructions
Drilling Slurry		Visual DS-01038												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
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IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

October 17, 2006
Supersedes October 18, 2005

Matls. IM 204
Appendix I

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregate- Fine (4110)	Gradation	302, 306 336	CONTR	3/lot	IM 301	CONTR	800240	IA V	DME RCE/ CONTR	1/1000 cy 1st day+20%	IM 301 IM 301	DME RCE		System Approach Applicable
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR								See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Coarse (4115)	Gradation	302, 306 336	CONTR	3/lot	IM 301	CONTR		IA	DME RCE/ CONTR	1/1000 cy 1st day+20%	IM 301 IM 301	DME RCE		System Approach Applicable
	Moisture	308, 528	CONTR	1/lot	2000gm	CONTR								
	Sp. Gr.	307	CONTR	IM 528	2000gm	CONTR								
	Quality	AS 209						V	DME	1/1000 cy	50 lb	CTRL		
Portland Cement	w/c ratio	528	CONTR	1/pour		CONTR								
	Quality	AS Cert D						V	DME	1/1000 cy	15 lb	CTRL		
Fly Ash	Quality	AS Cert D		Each Load			800240							
Air-Entraining Admixture (4103)		AS 403						V	DME	1/batch	1 pint	CTRL		Sample lots not previously reported or as required by DME
Retarding Admixture		AS 403						V	DME	1/batch	1 pint	CTRL		Sample lots not previously reported or as required by DME

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

Sampling & Testing Guide-Minimum Frequency

CONCRETE DRILLED SHAFT FOUNDATIONS

SS-01032

October 17, 2006
Supersedes October 18, 2005

Matls. IM 204
Appendix I

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Plastic Concrete	Air Content	316, 327					E145*	IA	RCE	1/30 cy		RCE		DME may adjust
	Slump	317, 327	RCE	1/30 cy		RCE		IA	DME	1/30 cy		RCE		DME may adjust
	Cylinders								DME	3/project		DME		Primary Projects Only (Information only)
Reinforcing Steel (4151)	Quality	AS Cert A		Each Shipment			Field Book							
Metal Access Pipe		Visual												
Drilling Slurry	Density, Viscosity, pH, Sand Content	387	CONTR	1/ 2 hours		CONTR								1/ 4 hours if consistent
Crosshole Sonic Log Test		SS-01032	CONTR	1/shaft		CONTR	Report, Analysis, Inter-pretation							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

Quality samples not required when mix quantity is less than 50 cu. yd.

*Available from the Office of Construction.

October 17, 2006
Supersedes April 18, 2006

COLD-IN-PLACE RECYCLED ASPHALT PAVEMENT

Section 2318, DS-01076

Matls. IM 204
Appendix K (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Asphalt Stabilizing Agent	Quality	AS 437												
GRADE INSPECTION														
RAP (2318.02)	Max Size		RCE	1st day + 1/week	10 lb	RCE		V						
Stabilizing Agent (Engr. Emulsion)	Quality Residue	Cert D 360						V	RCE/CONTR RCE/CONTR	1/project 1/day (2)	1 qt 1 qt	CTRL DME		Must use plastic bottle for emulsion
Stabilizing Agent (Foamed Asphalt)	Quality DSR	Cert D						V	RCE/CONTR RCE/CONTR	1/project 1/day (2)	1 qt 1 qt	CTRL DME		
Stabilizing Agent (Std. Emulsion)	Quality Residue	Cert D 360						V	RCE	1/day(2)	1 qt	DME		Must use plastic bottle for emulsion
Uncompacted Mixture	Moisture Density	504 504						V	RCE	1/lot	30 lb	DME		Sealed Container
Compacted Mixture	Moisture(1) Density	504 504	CONTR CONTR	10/lot 10/lot		CONTR CONTR								Witnessed by RCE
Smoothness		DS-01076 only												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) See IM 504 for Day 1 moisture correction factor.
(2) The sample from the first day and 1/week shall be forwarded to the District Laboratory for testing. The other samples shall be retained for submission in the event of a failing test result.

October 17, 2006
Supersedes April 18, 2006

COLD-IN-PLACE RECYCLED ASPHALT PAVEMENT

Section 2318

Matls. IM 204
Appendix K (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Asphalt Stabilizing Agent (2318.02)	Quality	AS 437												
GRADE INSPECTION														
RAP 2318.02	Max Size		RCE	1st day + 1/ week	5 kg	RCE								
Stabilizing Agent (Engr. Emulsion)	Quality Residue	Cert D 360	RCE	1/day (2)	1 L	DME		V	RCE	1/project	1 L	CTRL		Must use plastic bottle for emulsion
Stabilizing Agent (Foamed Asphalt)	Quality DSR	Cert D	RCE	1/day (2)	90 ml tin	DME		V	RCE	1/project	1 L	CTRL		
Stabilizing Agent (Std. Emulsion)	Quality Residue	Cert D 360	RCE	1/day (2)	1 L	DME								Must use plastic bottle for emulsion
Uncompacted Mixture (2318.04)	Moisture Density	504 504	RCE RCE	1/lot 1/lot	14 kg 14 kg	DME DME								Sealed Container
Compacted Mixture (2318.04)	Moisture(1) Density	504 504	CONTR CONTR	10/lot 10/lot		CONTR CONTR								Witnessed by RCE

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

(1) See IM 504 for Day 1 moisture correction factor.
(2) The sample from the first day and 1/week shall be forwarded to the District Laboratory for testing. The other samples shall be retained for submission in the event of a failing test result.

October 17, 2006
Supersedes October 18, 2005

GRANULAR SURFACING/DRIVEWAY SURFACING

Sections 2312 & 2315

Matls. IM 204
Appendix L (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Class C Gravel (4120.03)	Gradation Quality	AS 209												
Class A Crushed Stone (4120.04)	Gradation Quality	AS 209												
Class B Crushed Stone (4120.05)	Gradation Quality	AS 209												
Class D Crushed Stone (4120.06)	Gradation Quality	AS 209												
Aggregate for Type B, AC or cold laid Bituminous Concrete (for driveways only)	Gradation Quality	AS 209												
Crushed Stone Base (For driveways only) (4122)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Slope		RCE	3/mi.			Field Book							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 17, 2006
Supersedes October 18, 2005

GRANULAR SURFACING/DRIVEWAY SURFACING

Sections 2312 & 2315

Matls. IM 204
Appendix L (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Class C Gravel (4120.03)	Gradation Quality	AS 209												
Class A Crushed Stone (4120.03)	Gradation Quality	AS 209												
Class B Crushed Stone (4120.03)	Gradation Quality	AS 209												
Class D Crushed Stone (4120.03)	Gradation Quality	AS 209												
Aggregate for Type B, AC or cold laid Bituminous Concrete (For driveways only)	Gradation Quality	AS 209												
Crushed Stone Base (For driveways only) (4122)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Slope		RCE	2/km			Field Book							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 16, 2007
Supersedes October 17, 2006

CONCRETE BRIDGE FLOOR REPAIR & OVERLAY & SURFACING

Section 2413

Matls. IM 204
Appendix M

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates-Fine (4110)		AS 209												
Aggregates-Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Mixing Water (4102)	Quality	Lab Tested						V	RCE	1/source	1 qt.	CTRL		Not needed for potable Municipal Water
Air Entraining Admixture (4103)	Quality	AS 403												
Water Reducing Admixture (4103)	Quality	AS 403												
Retarding Admixture (4103)		AS 403												
Curing Compound (4105)	Lab Tested	405						V	DME	1/batch	1 pt	CTRL		Sample lots not previously reported
PLANT INSPECTION														
Aggregate-Fine (4110)		AS Cert A												
Aggregate-Coarse (4115)	Quality	AS Cert A						V	DME	1/project	50 lb	CTRL		DME may adjust frequency
Portland Cement (4101)	Quality	AS Cert D						V	DME	1/project	15 lb	CTRL		
Air Entraining Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported
Water Reducing Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported
Retarding Admixture (4103)		AS 403						V	RCE	Each batch	1 pt	CTRL		Sample if not previously reported

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 16, 2007
Supersedes October 17, 2006

CONCRETE BRIDGE FLOOR REPAIR & OVERLAY & SURFACING

Section 2413

Matls. IM 204
Appendix M

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Plastic Concrete (2413)	Air	318, 327						V	RCE	1/100 sy		RCE		
	Slump	317, 327						V	RCE	1/100 sy		RCE		
	Density	358						V	RCE	See Note		RCE		For Class O PCC only. (1)
	Thickness								RCE	3/50 sy		RCE		
	Cylinders							V	DME	3/project		DME		Primary Projects only (Information Only)
Concrete Sealer (2413.09)	Quality	AS 491.12												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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(1) Nuclear density testing frequency for each placement shall be one test within 5 feet (1500 mm) of the beginning and end of the placement and additional tests shall be equally spaced a maximum of 100 feet (30 000 mm) throughout the length of the placement. Each placement shall have a minimum of three nuclear density tests.

October 17, 2006
Supersedes April 19, 2005

SURFACE TREATMENT (Seal Coat, Slurry, Joint Repair, Crack Filling, Fog Seal)

Section 2307, 2319, 2540, 2544, 2306, 2308

Matls. IM 204
Appendix P (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates (4125)	Quality Gradation	AS 209												
Emulsions/ Cutbacks	Quality	AS												
Emulsion & Aggregate	Compatibility	349							DME	1/ source	1 qt & 10lb	DME/ CTRL		Seal Coat
Emulsion & Aggregate	Mix Design													Slurry
GRADE INSPECTION														
Aggregate	Quality Gradation	Cert D 301						V	DME	1/proj.	50 lb	CTRL		Seal Coat
Emulsion	Quality Residue Compatibility	Cert D 323, 360 349	RCE RCE	1/20,000 gal 1st day+ 1/week	1 qt 1 qt & 10 b	DME DME	Fieldbook(2)							Seal Coat/Slurry(1) Seal Coat
Cutback	Quality Viscosity Anti-Strip	Cert D 323, 329 AS 323, 374	RCE	1/20,000 gal	1 qt	DME	Fieldbook(2)							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
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V-Verification

Emulsion samples in plastic bottles only.
No samples required for joint repair, crack filling, and fog seal. Acceptance based on certification only.
(1) Samples of emulsion for slurry are required for full width placement only.
(2) Log all shipments

October 16, 2007
Supersedes October 17, 2006

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

Matls. IM 204
Appendix T

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregates Fine (4110)		AS 209												
Aggregates Coarse (4115)		AS 209												
Portland Cement (4101)	Quality	AS 401												
Fly Ash (4108)	Quality	AS 491.17												
GGBFS (Ground Granulated Blast Furnace Slag)	Quality	AS 491.14												
Curing Compound (4105)	Lab Tested	405												
Air Entraining Admixture (4103)	Quality	AS 403												
Granular Backfill	Gradation Quality	AS CERT AS CERT												
Drain Tubing	Quality	AS 443												
Epoxy Grout		AS 491.11												
Joint Seal (4136.02)	Lab Tested	436.01 AS 436.02												
Backer Rod (4136.02)		AS 436.04												
Steel Reinforcing	Quality	AS 451												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 16, 2007
Supersedes October 17, 2006

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

Matls. IM 204
Appendix T

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
PLANT INSPECTION														
Aggregates-Coarse (4115)	Grad	302 306 336	CONTR	1/lot	IM 301	CONTR		V	RCE/ CONTR	1st day +20%	IM 301	RCE		
	Moist	308	CONTR	1 / half day	1000 gm	CONTR								
	Sp. Gr.	307	CONTR	IM 527	1000 gm	CONTR								
	Quality	AS 209												
Aggregate- Fine (4110)	Gradation	302, 306 336	CONTR	1/lot	IM 301	CONTR	830211	V	RCE/ CONTR	1st day+ 20%	IM 301 IM 301	RCE		
	Moisture	308, 528	CONTR	1/lot	1000 gm	CONTR	830211							See IM 528 if Moisture Probe is used
	Sp. Gr.	307	CONTR	IM 528	1000 gm	CONTR	830211							
	Quality	AS 209												
Portland Cement (4101)	Quality	AS CERT D		Each Load										
Fly Ash	Quality	AS CERT D		Each Load										
Air Entraining Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		Sample lots not previously reported or as directed by DME
Water Reducing Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		
Retarding Admixture		AS 403						V	DME	1/batch	1 pt	CTRL		

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification
CONTR-Contractor

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office

IA-Independent Assurance
V-Verification

October 16, 2007
Supersedes October 17, 2006

BASE REPAIR (2212), PAVEMENT REPAIR (PATCHES)

Sections 2529 & 2530

Matls. IM 204
Appendix T

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE, & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Uncompacted HMA Mixture		Scale ticket with JMF number												Job Mix Formula (JMF) approved by DME
Plastic Concrete	Air Slump	318 327 318 327						V V	RCE RCE	2/half day 2/half day		RCE RCE		
Reinforcing Steel Epoxy-Coated Steel	Quality Quality	AS 451 AS 451		Each Shipment										
Calcium Chloride	Concentr.	373	RCE	1/lot		RCE								
Smoothness for Compacted HMA or Hardened Conc. (2529.10)		341	CONTR			CONTR								Approval by DME See Plans/Specs for exclusions

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 17, 2006
Supersedes October 18, 2005

GRANULAR SHOULDERS
Section 2121

Matls. IM 204
Appendix U (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate (4120.02)	Gradation Quality	AS 209												
Aggregate (Paved Shoulder Fillets) (4120.07)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Section	Template	RCE	3/mile 3/mile 3/mile		RCE	Field Book							
Aggregate (Paved Shoulder Fillets)	Gradation	Certification												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 17, 2006
Supersedes October 18, 2005

GRANULAR SHOULDERS

Section 2121

Matls. IM 204
Appendix U (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Aggregate (4120.02)	Gradation Quality	AS 209												
Aggregate (Paved Shoulder Fillets) (4120.07)	Gradation Quality	AS 209												
GRADE INSPECTION														
Dimensions	Thickness Width Cross Section	Template	RCE	2/km 2/km 2/km		RCE	Field Book							
Aggregate (Paved Shoulder Fillets)	Gradation	Certification												

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 17, 2006
Supersedes April 15, 2003

SUBDRAINS
Section 2502

Matls. IM 204
Appendix V (US) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Drain Tubing (4143)	Quality	AS 443												
Rodent Guard (4143.01)		AS 443.01												
Subdrain Outlet (4143)		AS												
Porous Backfill (4131)	Quality Gradation	AS 209												
Granular Backfill (4133)	Quality Gradation	AS 209												
Class A (Outlets) (4120.04)	Quality Gradation	AS 209												
GRADE INSPECTION														
Drain Tubing (4143)	Quality	AS												
Engineering Fabric (4196)		AS 496.01												
Subdrain Outlet	Quality	AS Cert D												
Porous Backfill (4131)	Gradation	AS Cert A		Each Shipment										
Granular Backfill (4133)	Gradation	AS Cert A		Each Shipment										
Class A (Outlets) (4120.04)	Gradation	AS Cert A		Each Shipment										
Metal Posts (4154.09)		Visual	RCE											

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

October 17, 2006
Supersedes April 15, 2003

SUBDRAINS
Section 2502

Matls. IM 204
Appendix V (Metric) Units

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
SOURCE INSPECTION														
Drain Tubing (4143)	Quality	AS 443												
Rodent Guard (4143.01)		AS 443.01												
Subdrain Outlet (4143)		AS												
Porous Backfill (4131)	Quality Gradation	AS 209												
Granular Backfill (4133)	Quality Gradation	AS 209												
Class A (Outlets) (4120.04)	Quality Gradation	AS 209												
GRADE INSPECTION														
Drain Tubing (4143)	Quality	AS												
Engineering Fabric (4196)		AS 496.01												
Subdrain Outlet	Quality	AS Cert D												
Porous Backfill (4131)	Gradation	AS Cert A		Each Shipment										
Granular Backfill (4133)	Gradation	AS Cert A		Each Shipment										
Class A (Outlets) (4120.04)	Gradation	AS Cert A		Each Shipment										
Metal Posts (4154.09)		Visual	RCE											

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

WATER POLLUTION CONTROL
EROSION CONTROL

October 17, 2006
Supersedes April 18, 2006

Section 2525, 2601

Matls. IM 204
Appendix W

MATERIAL OR CONSTRUCTION ITEM	TESTS	METHOD OF ACCEPTANCE & RELATED IMs	QUALITY CONTROL					INDEPENDENT ASSURANCE & VERIFICATION S&T						REMARKS
			SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	S&T TYPE	SAMPLE BY	FREQ.	SAMPLE SIZE	TEST BY	REPORT	
GRADE INSPECTION														
Seeds 4169.02		Cert A												
Fertilizer 4169.03		AS 469.03												
Inoculants 4169.04		Seed Manufacturer Recommendation												
Sticking Agent		Manufacturer Recommendation												
Sod 4169.07		Visual				RCE	Field Book							
Mulch 4169.07		Visual				RCE	Field Book							
Stakes for Sod		Visual				RCE	Field Book							
Jute mesh 4169.10a		Visual				RCE	Field Book							
Wire Staples 4169.10b		Visual				RCE	Field Book							
Wood Excelsior Mat 4169.10c		Visual				RCE	Field Book							
Engineering Fabrics		AS IM 496.01					Field Book							
Silt Fence Wire and Posts (Std. Rd. Plan RC-16)		Visual				RCE	Field Book							

AS-Approved Source
ASD-Approved Shop Drawing
S&T-Sampling & Testing

Cert A-Type A Certification
Cert C-Type C Certification
Cert D-Type D Certification

RCE-Resident Construction Engineer/Project Engineer
DME-District Materials Engineer
CTRL-Central Materials Office
CONTR-Contractor

IA-Independent Assurance
V-Verification

****THIS IS A NEW APPENDIX. – PLEASE READ CAREFULLY.****

October 17, 2006
New Issue

ACCEPTANCE OF SMALL QUANTITIES OF MATERIALS

Material	Maximum Quantity	Specifications	Alternate Acceptance Method
Beads, Glass	0.5 mi. application	4184	Visual
Dowel Baskets, Epoxy-coated	25		Visual & Field Check
Fly Ash	5 ton		Approved Source & Type
Hardware for Timber	100 lbs.	4153.07	Visual
Joint Filler, Preformed	50 ft.	4136.03	Visual & Dimension
Lighting Material-Conduit & Fittings	100 ft	4185.10	Visual & Brand Name
Paint, Bridge	5 gal.	4182	Visual & Brand Name
Pipe, Welded Steel for Bridge Railing	100 ft.	4153.05	Letter of Compliance

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Abrasives for Blast Cleaning	482.03				Approved Source			Note brand in field book
Admixture-Air Entraining	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Corrosion Inhibitor	402	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Retarder	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Admixture-Water Reducer	403	4103	1 pt.	DME or RCE	Approved Source Batch (Lot)		Project	Contact District Matls.
Aggregates-Non-proportioned	209	4110-4133			Approved Source/Certified Truck Tickets, (Form #821278)	D	Source	Certified Ticket for pay items by weight
Aggregates-Proportioned	209 & 204	4110-4133	IM 301	CONTR/RCE/ DME	Approved Source/Certified Truck Tickets, (Form #821278)	D	Source Project	
Aluminum, Structural		4190.01			Approved Shop Drawing & Fabrication Report			
Anchor Bolts	453.08	2522.04, D 4185.02, A 4187.01, C	1 bolt, nut & washer per size, per project	DME	Approved Source/Test Report/Steel Mill Certifications	A		
Anchors, Concrete	453.09				Approved Source			
Anti-Strip Agent	491.16				Approved Source			
Arrow Panels, Solar-Assisted	486.12	2528.06			Approved Source			
Asphalt Binder	437	4137	1 4-oz. tin	CONTR/DME	Approved Source/Certification/Test Rpt.	D	Source Project	
Asphalt, Cutback	437	4138	1 qt. tin	RCE	Approved Source/Certification/Test Rpt.	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Asphalt, Emulsified	437	4140	1 qt. bottle	RCE	Approved Source/Certification/Test Rpt.	D	Source	Project verification for seal coat
Attenuators -see crash cushion								
Attenuators, Guardrail					As per plan			
Backer Rod for Cold Pour Joint Seal	436.04	4136.02, C			Approved Source			
Backer Rod for Hot Pour Joint Seal	436.04	4136.02C			Approved Source			
Barrier Rail, Precast Concrete	571	2513			Approved Source/DOT Stamp/Fabrication Report		Source	
Beads, Glass	484	4184	1 qt.	DME	Approved Source		Subcontr.	
Bearing, Bronze		4190.03	1/project	DME	Test Report			
Bearing, Lead		4195.01			Certification	D		
Bearing, Neoprene	495.03	4195.02	1/pad	DME	Fabrication Report/Approved Source		Fabricator	
Bentonite Clay					Visual Approval by RCE			
Bolts, Nuts & Washers, Structural	453.06B	4153.06	Per IM 453.06B	DME	Certification/Rotational Capacity Test/Test Report	A		
Calcium Chloride Solution	373	4194.01	4 lbs. or 1 qt.	RCE	Test by RCE			
Caulking Compound		4192			Visual Approval by RCE			
Concrete, Special Sections	445	4145 4149.02, B			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp,Certification	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Concrete, Modular & Segmental Block	445.04				Approved Source/Certification	D		
Concrete, Precast Box Culvert	445.02	2415			Approved source, Approved Shop Drawing, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Concrete, Prestressed, Precast Units	570	2407			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Fabrication Report		Source	
Concrete Sealer	491.12	4139			Approved Source			
Conduit – See Lighting Matl.								
Curing Matls., Burlap		4104			Visual Approval by RCE			
Curing Matls., Clear	405.07	4105.07			Approved Source			
Curing Matls., Dark-colored	437	4105.06			Approved Source		Source	
Curing Matls., Plastic Film		4106.02			Visual Approval by RCE			
Curing Matls., White Pigmented	405	4105.05	1 qt.	DME	Batch (Lot) Accept		Source	
Crash Cushion	455	2509			Approved Source, Certification if source not clearly marked	D		
Delineators–See Signing Matls.								
Detectable Warning Panels	411	2511.02			Approved Source			
Dowel-See Steel Reinforcement								

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Drainage Trough, Elastomeric Bridge Joints	494				Approved Source			
Drains, Floor		2406.05			Approved Shop Drawing & Fabrication Report			
Drums, Channelizing	488.02	4188.02			Approved Source			
Epoxy-coated Steel-See Steel Reinforcement								
Epoxy Injection Resin	491.19				Approved Source			
Erosion Control, Fertilizer	469.03	4169.03			Approved Source			If material is suspect, DME will sample
Erosion Control, Fungicide		4169.05			Seed Manufacturing Recommendation			
Erosion Control, Inoculant		4169.04			Seed Manufacturing Recommendation			
Erosion Control, Jute Mesh		4169.10, A			Visual Approval by RCE			
Erosion Control, Mulch		4169.08			Visual Approval by RCE			
Erosion Control, Seed	469.02	4169.02			Certification	A		
Erosion Control, Silt Fence Fabric	496.01	4196.01			Approved Source			
Erosion Control, Silt Fence Wire & Posts		Std. Road Plan RC-16 Series			Visual Approval by RCE			
Erosion Control, Sod		4169.07			Visual Approval by RCE			
Erosion Control, Sod Stakes		4169.09			Visual Approval by RCE			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Erosion Control, Sticking Agent		4169.06			Seed Manufacturing Recommendation			
Erosion Control, Wire Staples		4169.10, B			Visual Approval by RCE			
Erosion Control, Wood Excelsior Mat	469.10				Approved Source			
Expansion Device, Steel		4152.02			Approved Shop Drawing & Fabrication Report			
Expansion Tube		4191.01, B			Visual Approval by RCE			
Fabric Engineering	496.01	4196.01			Approved Source			
Fasteners, Aluminum Structural	486	4190.02			Fabrication Report			
Fence, Barbed Wire		4154.04			Visual Approval by RCE			
Fence, Brace for Field Fence		4154.08			Visual Approval by RCE			
Fence, Tie & Tension Wire		4154.05			Visual Approval by RCE			
Fence, Chain Link Fabric	454.10	4154.03	1/source/yr		Approved Source/Certification		Project	
Fence, Chain Link Fittings		4154.11			Visual Approval by RCE			
Fence, Chain Link Posts, Braces, & Rails	454.10	4154.10	1/source/yr		Approved Source/Certification		Project	
Fence, Field Fence Fabric		4154.02			Visual Approval by RCE			
Fence, Gate		4154.12			Visual Approval by RCE			
Fence, Misc. Hardware					Visual Approval by RCE			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Fence, Orange Mesh Safety	488.03	4188.03			Approved Source			
Fence, Silt-See Erosion Control								
Fence, Staples		4154.06			Visual Approval by RCE			
Fence, Steel Line Posts		4154.09			Visual Approval by RCE			
Fence, Wood Fence Post	462	4154.07			Approved Source/Certification	D		
Fertilizer-See Erosion Control								
Fly Ash	491.17	4108	10 lbs.	DME	Approved Source/Certification	D	Project Source	Verification on paving only
Galvanized Items		4100.07		DME	Test Report by District Materials			
GGBFS	491.14	4100.08			Approved Source/Certification	D	Source Project	
Grating (Aluminum)		4187.01, A			Approved Shop Drawing & Fabrication Report			
Grout, Hydraulic Cement	491.13				Approved Source			
Grout, Polymer	491.11				Approved Source			
Guardrail, Box-beam Median Barrier		4155.06			Approved Shop Drawing & Fabrication Report			
Guardrail, Cable		4155.06	6 ft.	DME	Test Report by Central Lab			
Guardrail, High Tension Cable	455.01	SS-01048			Approved Source/Certification	D		
Guardrail, Formed Steel Beam	455.02	4155.02			Approved Source			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Guardrail, Steel Posts		4155.05			Mill Test Report	A		
Guardrail, Wood Posts	462	4155.04			Approved Source/Certification	A		
Iron Castings, Utility Access Covers, etc.	453.04	4153.04			Certification & Proper Identification Imprint	A		
Iron Castings, Utility Access Adjustment Rings	449.05				Approved Source/Certification	D		
Iron Bridge Rockers		4153.04			Approved Shop Drawing & Fabrication Report			
Joint Filler, Flexible Foam-Type CF & EF Joints	436.05	4136.03, B 4136.03, D			Approved Source			
Joint Filler, Type E Joint	436.03	4136.03, A			Approved Source			
Joint Filler, Bituminous	436.03	4136.03, A			Approved Source			
Joint Sealer for Concrete Sewer Pipes	491.09	4149.08			Approved Source			
Joint Sealer, Elastomeric (Neoprene)	436.02	4136.03			Approved Source			
Joint Sealer, Poured	436.01	4136.02, A			Approved Source			
Keyway		4191.01, A			Visual Approval by RCE			
Lighting Material, Aluminum Poles	557	4185.02, E			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Circuit Test		2523.21		Contractor	Test Report (Contractor) Form #820928			
Lighting Material, Connectors		4185.11			Approved Catalog Cut			
Lighting Material, Contactors		4185.05			Approved Catalog Cut			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Lighting Material, Control Cabinet		4185.07			Approved Shop Drawing & Catalog Cut			
Lighting Material, Conduit & Fittings, Plastic		4185.10	4'-Plastic	DME	Test Report			
Lighting Material, Conduit & Fittings, Steel	485.10	4185.10			Approved Source			
Lighting Material, Ground Rods & Clamps		4185.04			Visual			
Lighting Material, Handholes	445	4185.08			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Lighting Material, Junction Boxes		4185.09			Approved Catalog Cut			
Lighting Material, Lighting Tower	557	2522.04			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Lowering Device		2522.06			Approved Shop Drawing & Fabrication Report			
Lighting Material, Luminaries		4185.03			Approved Catalog Cut			
Lighting Material, Photoelectric Control		4185.06			Approved Catalog Cut			
Lighting Material, Sealant for Traffic Loop Detectors	491.18				Approved Source			
Lighting Material, Steel Poles	557	4185.02, D			Approved Shop Drawing/Approved Source/Certification	D		

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Lighting Material, Underground Warning Tape		2523.13			Visual Approval by RCE			
Lighting Material, Wire & Cable		4185.12			Approved Catalog Cut & Certification	D		DME may obtain verification samples
Lighting Material, Wood Poles	462	4185.02, F			Approved Source/Certification	D		
Lighting Material, Fasteners for Poles	453.09	4185.02, A	1 each type	DME	Test Report & Approved Shop Drawing			
Lighting Material, Mastarms	557	4185.02, B			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Slip Base	557	4185.02			Approved Shop Drawing/Approved Source/Certification	D		
Lighting Material, Transformer Base	557	4185.02, C			Approved Shop Drawing/Approved Source/Certification	D		
Markers (reflective) for Guardrail & Concrete Barrier Rail	486.08	4186.08			Approved Source			
Markers, Raised Pavement	483.07	2527.02, E			Approved Source			
Mastarms-See Lighting Materials								
Paint, Epoxy Aluminum	482.04				Approved Source			
Paint, Traffic-VOC-Compliant Solvent-borne	483.03	4183.03			Approved Source			
Paint, Traffic Waterborne	483.03	4183.04			Approved Source		Subcontr.	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Paint, Waterborne Acrylic Finish (Bridge Paint)	482.05	4182.03			Approved Source/Certification	D		
Paint, Zinc-rich Epoxy	482.02	4182.02			Approved Source/Certification	D		
Paint, Zinc-silicate Solvent-borne	482.05	4182.02			Approved Source/Certification	D		
Patch Material, Rapid-set Concrete	491.20				Approved Source			
Pedestrian Bridge, Pre-engineered	557				Approved Source/Approved Shop Drawing			
Piling, Concrete	570	4166			Approved Source, Fabricator's trade mark, Date of Manufacture, Certified stamp, Fabrication Report		Source	
Piling, Steel	467	4167			Approved Source/Mill Certification	A	Project	
Pipe, ABS Sewer/PVC	443, 446	4146.04 4146.05			Approved Source/Certification	D	Source	
Pipe, Clay Sewer		4149.02, A	2 each	DME	Test Report			
Pipe, Concrete	445	4145			Approved Fabricator, Fabricator's trade mark, Date of Manufacture, Certified stamp, Certification	D	Source	
Pipe, Corrugated Aluminized	441	4141			Approved Source/Certification			
Pipe, Corrugated Polyethylene 3-10 in.	443	4146.02 4143.02			Approved Source		Source	
Pipe, Corrugated Polyethylene 12-36 in.	446	4146.02			Approved Source/Certification	D	Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Pipe, Corrugated Steel	441	4141			Approved Source/Certification	D	Fabricator	
Pipe, Ductile Iron Sewer		4149.02, C			Certification	A		
Pipe, Polyethylene Sewer	443, 446	4146.03			Approved Source/Certification	D	Source	
Pipe, Rodent Guard for PE Pipe	443.01	4143.01, B			Approved Source			
Pipe, Rodent Guard for CMP Pipe	443.01	4143.01, B			Approved Source			
Pipe, Concrete Subdrain Tile	448	4148			Approved Source/Certification	C	Source	
Pipe, Corrugated Metal Subdrain Outlet	441	4141			Approved Source/Certification	D	Fabricator	
Pipe, Corrugated Polyethylene Subdrain	443	4143.01, B			Approved Source		Source	
Pipe, Welded Steel for Bridge Rail (See Railing, Bridge)								
Pipe, Horizontal Subdrain	443	4143.01, A			Approved Source		Source	
Plant Material, Fertilizer	469.03	4170.09, B			Approved Source			
Plant Material, Mulch	470	4170.09, D		RCE	Field Review Report			
Plant Materials, Plants	470	4170.01-4170.08		Roadside Development	Field Review Report			Rpt. Issued-Roadside Development
Portland Cement Concrete Premix Pack	447				Approved Source/Certification	C	Source	
Portland Cement, All Types	401	4101	10 lbs.	DME	Approved Source/Certification	D	Project Source	

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Railing, Bridge		4153.05			Approved Source/Approved Shop Drawing/Fabrication Report			
Reflective Sheeting-See Signing Material								
Release Agent	491.15				Approved Source			
Sealant, Traffic Loop-See Lighting Material								
Seed-See Erosion Control								
Signing Material, Delineator Posts		4186.10, C	1 each supplier	DME	Test Report			
Signing Material, Delineators	486.07	4186.07			Approved Source		Project	
Signing Material, Finished Sign	486	4186			Fabrication Report/Approved Source/Certification	D	Source	
Signing Material, Fasteners		4186.06			Fabrication Report			
Signing Material, Reflective	486.03	4186.03			Approved Source		Source	
Signing Material, Sign Panels		4186.02			Approved Shop Drawing & Fabrication Report			
Signing Material, Sign Support Structures	557	4187			Approved Source/Approved Shop Drawing/Fabrication Report			
Signing Material, Stainless Steel Fasteners	453.07		1 per size per proj.	DME	Approved Source/Mill Certification	A	Project	
Signing Material, Steel Posts		4186.10			Approved Shop Drawing & Fabrication Report			

October 16, 2007
Supersedes October 17, 2006

SUPPLEMENTAL GUIDE – BASIS OF ACCEPTANCE

Matls. IM 204
Appendix Z

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Signing Material, Wood Posts	462	4186.10			Approved Source/Certification	A		
Signing Material, Galvanized Items		4100.07			Test Report by District Materials			
Sod-See Erosion Control								
Steel Castings		4153.03			Approved Source/Catalog Cut			
Steel Masonry Plates		4152.02			Mill Certification	A		
Steel Pile, Welded		4153.05			Approved Shop Drawing & Fabrication Report			
Steel, Pins/Rollers, Cold Finished		4153.02			Approved Source/Catalog Cut			
Steel, Pins/Rollers, Forged		4153.01			Approved Source/Catalog Cut			
Steel Reinforcement, Basket Assemblies	451.03B	4151.02			Approved Source/Certification	D		
Steel Reinforcement, Epoxy-coated	451.03B	4151.03, B	6 ft.	DME	Approved Source/Mill Certifications & Epoxy Certification/Test Report	A	Project	Test sample should be 3 ft. away from end of the bar.
Steel Reinforcement, Epoxy-coated Tie Bars	451.03B	4151.02, A	1 per project per year		Approved Source/Certification	D	Project	
Steel Reinforcement, Epoxy-coated Dowels	451.03B	4151.02	1 per project per year		Approved Source/Certification	D	Project	
Steel Reinforcement, Galvanized	451	4151.03, A	3 ft.	DME	Mill Certifications & Test Report for Galvanizing	A	Project	
Steel Reinforcement, Uncoated	451	4151	*6 ft. of most common	DME	Approved Source/Mill Certification	A	Project	*Proj. quant. under 45T Cert. Only, 45T+ 1 samp.

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Steel Reinforcement, Wire Mesh	451	4151.04	2 ft. x 2 ft.	DME	Approved Supplier or Distributor. Steel Reinforcement/Certification	A	Supplier	1 sample per source per year
Steel Mechanical Splicers for Reinforcement	451				Approved Source/Mill Certification/Epoxy Certification		Project	Need: Certification Statement, Project #, Quantity, Heat #
Steel Structural	557, 561 to 565	2408 4152			Approved Source/Approved Shop Drawing/Fabrication Report/Mill Certifications	A		
Step Irons for Utility Access		4149.06			Fabrication Report			
Structural Items, Other					Approved Shop Drawing & Fabrication Report			
Structural Plate (Arches)	444	4144	Visual	RCE	Approved Source/Certification Statement	C		
Studs, Shear	453.10				Approved Source/Certification	A		
Surface Finish, Special	491.10	2403.21, C			Approved Source			
Tape, Pavement Marking	483.06	2527.02, A			Approved Source			
Torque Calibration Machine (skidmore)		2408.38, C	Calibrate every 6 mo.	CTRL	Test Report			
Torque Wrench		2408.38, C	Calibrate every 6 mo.	CTRL	Test Report			
Traffic Signalization, Electrical Tests		2525.03, A, 3b 2525.06, A		Contractor	Test Report (Contractor) Form #820928			
Water		4102	1 qt. per source	DME	Test Report or City Water Supply			

Material	IM	Spec.	Sample Size	Sampled By	Basis of Acceptance	Cert. Type	Verification	Other Details
Wire & Cable-See Lighting Material								
Wood, Hardware for Timber Structure	462	4153.07	1 ea. type		Test Report			
Wood, Timber Piles	462	4165			Approved Source/Certification	A		Charge number on butt ends
Wood, Treated Posts	462	4164			Approved Source/Certification	A		
Wood, Treated Timber & Lumber	462	4162			Approved Source/Certification	A		
Wood, Untreated Timber & Lumber	462	4162	Visual	RCE	Quality grad mark or certification of grade on items requiring grade			

SAMPLING FRESH CONCRETE

Concrete is required to be sampled at the plant or project site for use in a variety of tests. Concrete samples need to be representative of the concrete being poured on a project.

Concrete is sampled by both contractors and agencies for use in tests to determine air, slump, unit weight, and temperature and for making strength specimens.

Test results will not be accurate unless the sample used to run these tests was properly secured. Concrete should be sampled from the last point of placement unless it is being secured from a mixer truck. Improper sampling or sampling from an incorrect location could cause air content and slump to vary which could affect the strength of the concrete.

IM 327 explains the proper sampling procedure for fresh concrete.

October 17, 2006 Matls. IM 327
Supersedes April 30, 2002

SAMPLING FRESHLY MIXED CONCRETE

SCOPE

This procedure provides instruction for obtaining samples of fresh concrete for new construction or repair. Sources covered include grade, ready mix truck, mobile mixer, pump or conveyor placement systems, and concrete slab as placed.

SIGNIFICANCE

Testing fresh concrete in the field begins with obtaining and preparing the sample to be tested. Standardized procedures for obtaining a representative sample from various types of mixing and/or agitating equipment have been established. Specific time limits regarding when tests for temperature, slump, and air content must be started and for when the molding of test specimens must begin are also established.

Technicians must refrain from obtaining the sample too quickly. Doing so would be a violation of the specifications under which the concrete is being supplied and it may result in a nonrepresentative sample of concrete. Every precaution must be taken to obtain a sample that is truly representative of the entire batch and then to protect that sample from the effects of evaporation, contamination, and physical damage.

PROCEDURE

A. Apparatus

1. Wheelbarrow or other nonabsorbent container
2. Cover for wheelbarrow or container (plastic, canvas, or burlap)
3. Shovel
4. 5-gal. (19 L) bucket for water

B. Testing Procedure

For acceptance testing, obtain representative samples from the last practical point before incorporation, but before consolidation.

1. Sampling from Grade

   Sample after the concrete in the transport vehicle has been discharged onto the grade. To ensure a representative sample, obtain concrete from at least five different locations in the pile and combine into one test sample. Avoid contamination with subgrade material or prolonged contact with absorptive subgrade.

2. Sampling from Ready Mix Truck

   Sample the concrete after a minimum of 1/2 yd.^{3} (1/2 m^3) of concrete has been discharged. Do not obtain samples until after all of the water has been added to the mixer. Do not obtain samples from the very first or last portions of the batch discharge. Sample by repeatedly passing a receptacle through the entire discharge stream or by completely diverting the discharge into a sample container. Regulate the rate of discharge of the batch by the rate of revolution of the drum and not by the size of the gate opening.

3. Sampling from Mobile Mixer

   Discharge the concrete into a container or power buggy sufficiently large enough to accommodate the entire batch. Secure a representative sample after the batch has been deposited by obtaining one shovel full, more or less, from each of at least three different positions in the container or power buggy.

4. Sampling from Pump or Conveyor Placement Systems

   Sample after a minimum of 1/2 yd.^{3} (1/2 m^3) of concrete has been discharged. Do not obtain samples until after all of the pump slurry has been eliminated. Sample by repeatedly passing a receptacle through the entire discharge system or by completely diverting the discharge into a sample container. Do not lower the pump arm from the placement position to ground level for ease of sampling, as it may modify the air content of the concrete being sampled. Do not obtain samples from the very first or last portions of the batch discharge.

5. Sampling from Concrete Slab as Placed

   Mark the approximate location of concrete placed on grade and sampled for air content. After the paver has passed the marked location, remove the sample from the slab, approximately in line with a vibrator and within an 18 in. x 18 in. (500 mm x 500 mm) square area to a depth approximately two-thirds of the pavement thickness. The sample should be obtained a minimum of 12 in. (300 mm) from the edge of slab to prevent extra handwork in maintaining the pavement edge.

Transport samples to the place where fresh concrete tests are to be performed and specimens are to be molded. Protect the sample from direct sunlight, wind, rain, and sources of contamination.

Complete test for temperature and start tests for slump and air content within five minutes of obtaining the sample. Complete tests as quickly as possible. Start molding specimens for strength tests within 15 minutes of obtaining the sample.

Review Questions
Sampling Freshly Mixed Concrete
IM 327

1. This method covers sampling from five types of mixers or placement systems, four of which are _____, _____, _____, and _____.

2. When sampling from a stationary or revolving drum truck mixer, how must the concrete be sampled during discharge of the batch?

3. The concrete sample must be protected from contamination, _____, _____, and _____.

4. What time limits are specified for testing after obtaining a sample?

5. What determines the number of sample locations needed for a concrete sample on the grade?

CONCRETE TEMPERATURE

The temperature of fresh concrete is taken when it is placed. Hot and cold weather have effects on the concrete and the hydration process.

The temperature is normally monitored by the Iowa DOT. The temperature will give the indication if concrete may require special attention in the curing and protection areas. Concrete in cold weather must attain a minimum strength to be able to withstand one freeze/thaw cycle without cracking. Concrete must be cured properly to prevent plastic shrinkage cracking.

The temperature of the concrete must be taken properly to get an accurate reading. If the base of the thermometer is not properly covered the reading will be incorrect. During hot weather conditions, temperature of concrete may be the reason for high water/cement ratio, workability problems, and make it difficult to entrain air. Ice may be added in the water or night paving may be an option. During cold weather the temperature may contribute to slow strength gain and indicate a need for protection. Concrete hydrates best at 55°F. Temperatures below 40°F and above 90°F require attention with curing and protection.

IM 385 gives the proper procedure for testing the temperature on fresh concrete.

TEMPERATURE OF FRESHLY MIXED CONCRETE

SCOPE

This test method covers the determination of temperature of freshly mixed Portland Cement Concrete.

This standard may involve hazardous materials, operations, and equipment. This standard does not address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices.

SIGNIFICANCE & USE

This test method provides a means for measuring the temperature of freshly mixed concrete. It may be used to verify conformance to a specified requirement for temperature of concrete. For specification compliance, temperature shall be measured by means of an immersion temperature-measuring device. Infrared thermometers may be used for information purposes only.

PROCEDURE

A. Apparatus

1. Container. The container shall be made of nonabsorptive material and large enough to provide at least 3 in. (75 mm) of concrete in all directions around the sensor of the temperature-measuring device; the concrete cover shall also be at least three times the nominal maximum size of the coarse aggregate.

2. Temperature-measuring Device. The temperature-measuring device shall be capable of reading the temperature of the freshly mixed concrete to ±1°F (±0.5°C) throughout the entire temperature range likely to be encountered in the fresh concrete. Liquid-in-glass thermometers having a range of 0°F to 120°F (-18°C to 49°C) are satisfactory. Other thermometers of the required accuracy, including the metal immersion type, are acceptable.

3. Thermometer Marking. Partial-immersion liquid-in-glass thermometers (and possibly other types) shall have a permanent mark to which the device must be immersed without applying a correction factor.

4. Reference Temperature-measuring Device. The reference temperature-measuring device shall be a liquid-in-glass thermometer readable to 0.5°F (0.2°C) that has been verified and calibrated. The calibration certificate or report indicating conformance to ASTM E77 requirements shall be available for inspection.

B. Calibration of Temperature-measuring Device

1. Each temperature-measuring device used for determining the temperature of freshly mixed concrete shall be calibrated before initial use, or whenever there is a question of accuracy. This calibration shall be performed by comparing the readings on the temperature-measuring device at two temperatures at least 27°F (15°C) apart.

C. Sampling Concrete

1. The temperature of freshly mixed concrete may be measured in the transporting equipment providing the sensor of the temperature-measuring device has at least 3 in. (75 mm) of concrete cover in all directions around it.

2. If the transporting equipment is not used as the container, a sample shall be prepared as follows:

   a. Immediately prior to sampling the freshly mixed concrete, dampen (with water) the sample container.

   b. Sample the freshly mixed concrete in accordance with IM 327.

   c. Place the freshly mixed concrete into the container. (**NOTE:** When concrete contains a nominal maximum size of aggregate greater than 3 in. (75 mm), it may require 20 minutes after mixing before the temperature is stabilized.)

   d. Complete the temperature measurement of the freshly mixed concrete within five minutes after obtaining the sample.

D. Test Procedure

1. Place the temperature-measuring device in the freshly mixed concrete, so the temperature-sensing portion is submerged in a minimum of 3 in. (75 mm) of concrete. Gently press the concrete around the temperature-measuring device at the surface of the concrete so the ambient air temperature does not affect the reading.

2. Leave the temperature-measuring device in the freshly mixed concrete for a minimum period of two minutes or until the temperature reading stabilizes, then read and record the temperature.

3. Complete the temperature measurement of the freshly mixed concrete within five minutes of obtaining the sample.

4. Record the measured temperature of the freshly mixed concrete to the nearest 1°F (0.5°C).

Review Questions
Temperature of Freshly Mixed Concrete
IM 385

1. Why is the temperature of concrete generally taken?

2. Summarize the specifications for the temperature measuring device.

3. The temperature measuring device shall be calibrated _____, or whenever there is a question of _____.

4. What special procedures are required when taking the temperature of concrete containing coarse aggregate over 75 mm (3 in.)?

5. After the temperature of the concrete is read, what is then required?

CONCRETE SLUMP

The slump of concrete is used to determine the consistency of the freshly mixed concrete. The slump test needs to be properly performed to determine if the concrete is within specification limits.

Contractors and agencies perform slump on structures, formed paving, patching, and other types of concrete pours as required per specification.
There are occasions when slump may be increased by adding High Range Water Reducers.

The slump test needs to be run in the specified time requirement or there is the possibility of an erroneous result. Proper consolidation of the concrete in the slump cone is necessary for correct measurements. Target slump is normally 3 inches. Normally when one gallon of water per cubic yard of concrete is added, the slump will increase approximately one inch.

IM 317 gives the proper procedure for performing a slump test. IM 204 specifies the testing frequencies.

SLUMP OF HYDRAULIC CEMENT CONCRETE

SCOPE

This procedure provides instructions for determining the slump of hydraulic cement concrete. It is not applicable to non-plastic or non-cohesive concrete, nor when the maximum size of the coarse aggregate is over 2 in. (50 mm).

SIGNIFICANCE

The slump test is used to determine the consistency of concrete. Consistency is a measure of the relative fluidity or mobility of the mixture. Slump does not measure the water content or workability of the concrete. While it is true that an increase or decrease in the water content will cause a corresponding increase or decrease in the slump of the concrete, many other factors can cause slump to change without any change to water content. One cannot assume that the water/cement ratio is being maintained simply because the slump is within specification limits.

PROCEDURE

A. Apparatus

1. Slump Cone. The slump cone shall conform to AASHTO T 119: The mold shall be provided with foot pieces and handles. The mold may be constructed either with or without a seam. The interior of the mold shall be relatively smooth and free from projections such as protruding rivets. The mold shall be free of dents. A mold that clamps to a rigid non-absorbent base plate is acceptable provided the clamping arrangement is such that it can be fully released without movement of the mold.

2. Tamping Rod. The tamping rod shall be 5/8 in. (16 mm) in diameter and approximately 24 in. (600 mm) in length, having a hemispherical tip.

3. Scoop.

4. Tape Measure or Ruler. These should have at least 1/8 in. (5 mm) gradations.

5. Base. The base shall be rigid with a non-absorbent surface on which to set the slump cone.

B. Test Procedure

1. Obtain the sample in accordance with IM 327.

2. Dampen the inside of the cone and place it on a dampened, rigid, non-absorbent surface that is level and firm.

3. Stand on both foot pieces in order to hold the mold firmly in place.

4. Fill the cone 1/3-full in volume, to a depth of 2 5/8 in. (67 mm) in depth.

5. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete. For this bottom layer, incline the rod slightly and make approximately half the strokes near the perimeter, and then progress with vertical strokes, spiraling toward the center.

6. Fill the cone 2/3-full in volume, to a depth of 6 1/8 in. (155 mm) in depth.

7. Consolidate this layer with 25 strokes of the tamping rod, just penetrating into, but not through, the bottom layer. Distribute the strokes evenly.

8. Fill the cone to overflowing.

9. Consolidate this layer with 25 strokes of the tamping rod, just penetrating into, but not through, the second layer. Distribute the strokes evenly. If the concrete falls below the top of the cone, stop, add more concrete, and continue rodding for a total of 25 strokes. Keep an excess of concrete above the top of the mold at all times. Distribute strokes evenly as before.

10. Strike off the top surface of concrete with a screeding and rolling motion of the tamping rod.

11. Clean the overflow concrete away from the base of the mold.

12. Remove the mold from the concrete by raising it carefully in a vertical direction. Raise the mold 12 in. (300 mm) in 5 ± 2 seconds by a steady upward lift with no lateral or torsional motion being imparted to the concrete.

    The entire operation from the start of the filling through removal of the mold shall be carried out without interruption and shall be completed within an elapsed time of 2 1/2 minutes.

13. Invert the slump cone and set it next to the specimen.

14. Lay the tamping rod across the mold so it is over the test specimen.

15. Measure the distance between the bottom of the rod and the displaced original center of the top of the specimen to the nearest 1/4 in. (6 mm).

NOTE: If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample. If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of the concrete from the mass of the specimen, the concrete probably lacks the plasticity and cohesiveness necessary for the slump test to be applicable.

Air and Slump Tests

Line No.: ____________ **Page No.:** ___________

Contractor: ______________________ **Category No.:** ___________

Project No.: ____________________________ **Contract ID:** ______________

Date	Location	Mix Type	Air (%)	Slump (In)	Application	Remarks	By

Review Questions
Slump of Hydraulic Cement Concrete
IM 317

1. Describe the mold used for making the slump test.

2. The surface on which the slump cone will be placed must be _____.

3. The approximate concrete depth (in vertical distance) after placing the first layer is _____ and the second layer is _____.

4. When rodding the bottom layer, the tamping rod must be _____ to uniformly distribute the strokes.

5. If, while rodding the top layer, the concrete drops below the top of the slump cone, what must be done?

6. The measurement for slump is make from the top of the mold to what point of the concrete specimen?

7. While the technician is checking the slump of the concrete, there is a decided falling away or shearing off of the concrete from one side of the sample. What should the technician do?

CONCRETE AIR TEST BY THE PRESSURE METHOD

Air tests are ran on fresh concrete to determine the amount of entrained air in the concrete mixture. Proper test procedures are required so an accurate percentage of entrained air in the concrete can be determined and specifications are met.

Knowing the entrained air content is important on both structures and paving projects and is tested by both the contractor and agency. Adequate air content in concrete is necessary to provide freeze/thaw resistance for long term durability. Since concrete is porous, water will invade the pores and expand when frozen which will crack the concrete, without air voids to provide relief from the pressure of frozen water.

The concrete needs to be placed and consolidated in the air meter properly or the air reading could be erroneous. It is important the air meters are cleaned and calibrated annually and calibrated as needed throughout the construction season. The air meter should be transported in the proper storage container to prevent damage to the gauge. The air meter should be kept clean and free of hardened concrete. Normally a 6% in place air content is required to provide the needed protection. Specifications require higher amounts to account for air loss due to vibration of the concrete. Normally a one percent increase in air content decreases compressive strength approximately 5%.

IM 318 gives the proper procedure for testing entrained air and calibration of the air meter. IM 204 specifies the testing frequencies.

October 17, 2006 Matls. IM 318
Supersedes April 19, 2005

AIR CONTENT OF FRESHLY MIXED CONCRETE BY PRESSURE

SCOPE

This test method describes the procedure for determining the air content of freshly mixed concrete by one form of pressure method.

PROCEDURE

NOTE: Certain coarse aggregates in east central Iowa will cause air meter readings to indicate higher air content than is actually in the concrete. An aggregate correction factor must be applied to correct the air content. The District Materials Engineer will supply the correction factor when using these aggregates. AASHTO T152 requires an aggregate correction factor for all concrete; however, it typically is not large enough for most aggregates to require adjustment.

A. Apparatus

1. All apparatus used shall incorporate the requirements of Section 2a, under Apparatus, of AASHTO Designation T-152. While there are several meters, which meet these requirements, the directions given below in B., Test Procedure, apply to the Washington-type presently in use by the Iowa Department of Transportation.

   NOTE: It is recommended that a calibration be performed prior to any new pour.

B. Test Procedure (For use with Washington-Type Air Meter)

1. Calibration of Apparatus (Water Method)

   a. To calibrate the apparatus, first fill the measuring bowl with water, then withdraw measured amounts of water corresponding to definite percentages of air in the base. After each increment of water is withdrawn, pump air into the head until a predetermined initial pressure line on the dial is reached.

   b. Open the operating valve and read the air content directly from the dial. The reading on the dial is compared to the known amount of air in the base and suitable corrections made. Consult air meter box lid for more explicit calibration instruction.

2. Calibration of Apparatus (Plug Method)

   a. To calibrate the apparatus, first fill the measuring bowl with water, and then insert the calibration plug. Place the head on the unit and pump air into the head until a predetermined initial pressure line on the dial is reached.

b. Using a rubber syringe, inject water through one petcock until all the air is expelled through the opposite petcock. Jar the base to insure removal of all air. Leave petcocks open.

c. Stabilize dial hand at proper initial pressure line by pumping or bleeding off, as needed, while lightly tapping the backside of the dial with the fingers. Inject water through the petcock again to make sure all the air is expelled.

d. Close both petcocks and press down on the thumb lever exhausting air into the base. The dial should read 5% air for each calibration plug in the measuring bowl with a maximum variation of ±0.2% air. Two plugs may also be used to get a 10% air reading. The gauge is set to 5.0% when calibrated in the Central Laboratory. If the reading is off by more than ±0.2% at either 5% or 10% setting, the gauge should be returned to the Central Laboratory for repair.

3. Operation of Apparatus (Determination of Air Content of Concrete)

a. Fill the base with a sample of fresh concrete placing the concrete in the base in three equal layers. Rod each layer twenty-five times with the tamping rod provided with the meter. For slumps less than 1 in. (25mm), the sample may need to be consolidated by internal vibration.

b. Do not allow the rod to forcibly strike the bottom of the base while rodding the bottom layer. The rod should just penetrate the underlying layer when rodding the upper layers. Care should also be taken to avoid hitting the top edge of the base with the tamping rod.

c. Tap the sides of the base 10-15 times with a rubber mallet after rodding each layer to close the holes left by the rod.

d. A clean, smooth surface on the top edge of the base is necessary to insure a tight seal with the cover. Strike off base, level full, with the straight edge furnished. Wipe the top edge of the base clean to insure a tight seal with the cover.

e. Clamp cover on with petcocks open.

f. With the built in pump, pump air into the air chamber atop the cover until the pressure indicator points to the proper initial pressure line on the gauge. **NOTE:** The pump stem may need a light coat of oil to slide freely. Too much oil on the stem will fill the pump chamber and block the air valve causing the pump to fail.

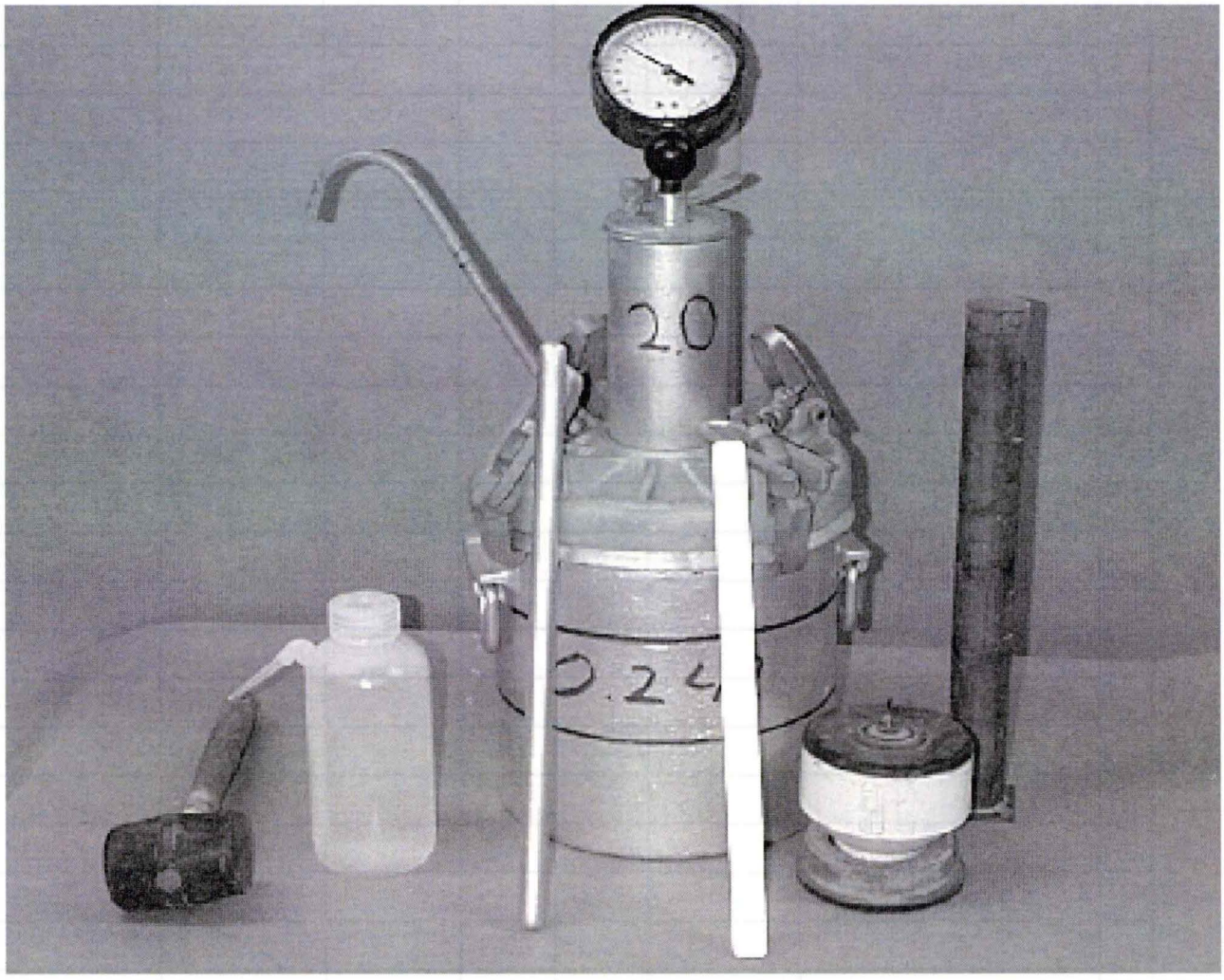
g. Using a rubber syringe, inject water through one petcock until all the air is expelled through the opposite petcock. Jar the base to insure removal of all air. Leave petcocks open. **NOTE:** Use care if injecting water through opposite petcock to not add air bubbles. When jarring the base to remove the air, the base shall not be tilted more than 2 inches (50 mm) from horizontal.

The sequence of Steps f. and g. may be interchanged without adversely effecting the test result.

h. Stabilize dial hand at the proper initial pressure line by pumping or bleeding off, as needed, while lightly tapping the backside of the dial with the fingers. Inject water through the petcock again to make sure all the air is expelled.

i. Close both petcocks. Press down on lever to release air into the base. Hold lever down a few seconds lightly tapping the backside of the dial with your fingers until the dial stabilizes. Observe the dial reading before letting up on the lever. Record the dial reading.

j. Open petcocks to release pressure, and then remove cover. Empty the concrete from base, clean up base, cover with petcocks left opened.



Air Meter and Calibrating Accessories

Air and Slump Tests

Line No.: _____ Page No.: _____

Contractor: _____ Category No.: _____

Project No.: _____ Contract ID: _____

Date	Location	Mix Type	Air (%)	Slump (In)	Application	Remarks	By

Review Questions
Air Content of Freshly Mixed Concrete by the Pressure Method
IM 318

1. Describe the calibration process.

2. How many times is each layer of concrete rodded?

   What care should be taken when rodding each layer?

3. After rodding each layer, what should be done to the measure before adding another layer of concrete?

4. Describe the procedure for determining air content after the cover has been clamped onto the base.

UNIT WEIGHT, YIELD, and AIR OF CONCRETE

The unit weight of concrete is determined to give an indication of problems in batch weights and yield. Air content can also be determined by performing a unit weight test.

A unit weight test can be performed by both contractors and agencies to assist in determining if the batch weights need to be adjusted due to incorrect yields. This test is not used in the acceptance of concrete, only for information purposes.

The air meter base is used in the test to determine unit weight. The concrete needs to be consolidated and struck off properly. There can be no concrete on the sides of the air meter base since the weight of the concrete and base is determined and must be accurate or results will be affected. Air content can also be determined by running this test and could be used if correlation problems are occurring.

IM 340 explains the proper procedure and calculations for determining unit weight, yield, and air content.

WEIGHT PER CUBIC FOOT, YIELD & AIR CONTENT (GRAVIMETRIC) OF CONCRETE

SCOPE

This procedure covers the determination of density, or unit weight of freshly mixed concrete. It also provides formulas for calculating the volume of concrete produced from a mixture of known quantities of component materials.

SIGNIFICANCE

The unit weight is a useful tool in determining the concrete batch yield and air content. Since air adds no weight to the concrete and only occupies a volume, the unit weight of the concrete gives a very good indication of the air content of the concrete. Normal weight concrete is in the range of 140 - 150 lbs./cu. ft. For normal weight concrete, a change in unit weight of 1.5 lbs./cu. ft. relates to approximately a 1 percent change in air content. Using the unit weight to indicate air content can also prevent any discrepancies between air meters.

PROCEDURE

A. Apparatus

1. Measure: May be the base of the air meter used for determining air content from IM 318. Otherwise, it shall be a metal container meeting the requirements of AASHTO T-121. The capacity and dimensions of the measure shall conform to those specified in Table 1.

2. Balance or scale: Accurate to 0.3 percent of the test load at any point within the range of use.

3. Tamping Rod: 5/8 in. (16 mm) diameter and approximately 24 in. (600 mm) long, having a hemispherical tip.

4. Vibrator: 7000 vibrations per minute, 0.75 in. to 1.50 in. (19 mm to 38 mm) in diameter, at least 3 in. (75 mm) longer than the section being vibrated for use with low slump concrete.

5. Scoop

6. Strike-off Plate: A flat rectangular metal plate at least 1/4 in. (6 mm) thick or a glass or acrylic plate at least 1/2 in. (12 mm) thick, with a length and width at least 2 in. (50mm) greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight and smooth within tolerance of 1/16 in. (1.5mm).

7. Mallet: With a rubber or rawhide head having a mass of 1.25 ± 0.5 lb. (0.57 ± 0.23 kg) for use with measures of 1/2 ft.^{3} (0.014 m^3) or less, or having a mass of 2.25 ± 0.5 lb. (1.02 ± 0.23 kg) for use with measures of 1 ft.^{3} (0.028 m^3).

Table 1
Dimensions of Measures

Capacity M^3 (ft. ^{3})	Inside Diameter mm (in.)	Inside Height mm (in.)	Minimum Thickness mm (in.) Bottom	Wall	Nominal Maximum Size of Coarse Aggr. mm(in.)
0.0071	203 ± 2.54	213 ± 2.54	5.1	3.0	25
(1/4)	(8.0 ± 0.1)	(8.4 ± 0.1)	(0.20)	(0.12)	(1)
0.0142	254 ± 2.54	279 ± 2.54	5.1	3.0	50
(1/2)	(10.0 ± 0.1)	(11.0 ± 0.1)	(0.20)	(0.12)	(2)
0.0283	356 ± 2.54	284 ± 2.54	5.1	3.0	76
(1)	(14.0 ± 0.1)	(11.2 ± 0.1)	(0.20)	(0.12)	(3)

Measure may be the base of the air meter used in IM 318.

B. Calibration of Measuring Bowl

1. Determine the weight of the dry measure and strike-off plate.

2. Fill the measure with water at a temperature between 16°C and 29°C (60°F and 85°F) and cover with the strike-off plate in such a way as to eliminate bubbles and excess water.

3. Wipe dry the measure and cover plate, being careful not to lose any water from the measure.

4. Determine the weight of the measure, strike-off plate, and water in the measure.

5. Determine the weight of the water in the measure by subtracting the weight in Step 1 from the weight in Step 4.

6. Measure the temperature of the water and determine its density from Table 2, interpolating as necessary.

7. Calculate the volume of the measure, V_m, by dividing the weight of the water in the measure by the density of the water at the measured temperature, from Table 2.

Example: $V_m = \frac{15.57}{62.274}$ $V_m = 0.250$ ft.^{3}

Table 2
Unit Weight of Water
15°C to 30°C

°C	(°F)	kg/m³	(lb./ft. ³)	°C	(°F)	kg/m³	(lb./ft. ³)
15	(59.0)	999.10	(62.372)	23	(73.4)	997.54	(62.274)
15.6	(60.0)	999.01	(62.366)	23.9	(75.0)	997.32	(62.261)
16	(60.8)	998.94	(62.361)	24	(75.2)	997.29	(62.259)
17	(62.6)	998.77	(62.350)	25	(77.0)	997.03	(62.243)
18	(64.4)	998.60	(62.340)	26	(78.8)	996.77	(62.227)
18.3	(65.0)	998.54	(62.336)	26.7	(80.0)	996.59	(62.216)
19	(66.2)	998.40	(62.328)	27	(80.6)	996.50	(62.209)
20	(68.0)	998.20	(62.315)	28	(82.4)	996.23	(62.192)
21	(69.8)	997.99	(62.302)	29	(84.2)	995.95	(62.175)
21.1	(70.0)	997.97	(62.301)	29.4	(85.0)	995.83	(62.166)
22	(71.6)	997.77	(62.288)	30	(86.0)	998.65	(62.156)

C. Testing Procedure

NOTE: There are two methods of consolidating the concrete – rodding and vibration. If the slump is greater than 3 in. (75 mm), consolidation is by rodding. When the slump is 1 to 3 in. (25 to 75 mm), internal vibration or rodding can be used to consolidate the sample, but the method used must be that required by the agency in order to obtain consistent, comparable results. For slumps less than 1 in. (25 mm), the sample may be consolidated by internal vibration.

1. Determine the weight of the dry measure.
2. Obtain the sample in accordance with IM 327. Testing may be performed in conjunction with IM 318. When doing so, this test should be performed prior to IM 318. **NOTE:** If the two tests are being performed using the same sample, this test shall begin within five minutes of obtaining the sample.
3. Dampen the inside of the measure.
4. Fill the measure approximately 1/3-full with concrete.
5. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete. Rod throughout its depth without hitting the bottom too hard.
6. Tap the sides of the measure smartly 10 to 15 times with the mallet to close voids and release trapped air.
7. Add the second layer, filling the measure about 2/3-full.
8. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in. (25 mm) into the bottom layer.
9. Tap the sides of the measure smartly 10 to 15 times with the mallet.

10. Add the final layer, slightly overfilling the measure.

11. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 1 in. (25 mm) into the second layer.

12. Tap the sides of the measure smartly 10 to 15 times with the mallet.

    NOTE: The measure should be slightly over full, about 1/8 in. (3 mm) above the rim. If there is a great excess of concrete, remove a portion with the scoop. If the measure is under full, add a small quantity. This adjustment may be done only after consolidating the final layer and before striking off the surface of the concrete.

13. Strike off the surface of the concrete and finish it smoothly with a sawing action of the strike-off plate using great care to leave the pot just full. The surface should be smooth and free of voids.

14. Clean off all excess concrete from the exterior of the measure including the rim.

15. Determine and record the weight of the measure and the concrete.

16. If the air content of the concrete is to be determined, proceed to Step E of IM 318.

D. Calculations

Unit Weight (density) – Calculate the net weight, W_3, of the concrete in the measure by subtracting the weight of the measure, W2, from the gross weight of the measure plus the concrete, W1. Calculate the density, ρ, by dividing the net weight, W_3, by the volume, V_m, of the measure as shown below.

$$W_1 - W_2 = W_3 \qquad \text{Example: } 42.8 - 7.6 = 35.2 \text{ lb.}$$

$$\rho = \frac{W_3}{V_m} \qquad \text{Example: } \rho = \frac{35.2 \text{ lb.}}{0.249 \text{ cu. ft.}} = 141.37/\text{cu.ft.}$$

Theoretical unit weight (air-free basis) – The theoretical unit weight, T, is the total weight of materials batched divided by the absolute volume of materials batched on an air-free basis.

Using the actual batch weights and absolute volumes, sum the following:

	Weight	SpGr	Abs. Vol.	Example Abs. Vol. Calc.
Cement	477	3.14	0.090	= 477/(3.14 x 62.4 x 27)
Fly Ash	84	2.68	0.019	
Total Water	220	1.00	0.131	
(Plant, aggr., grade)				
Fly Ash	84	2.68	0.019	
Total Water	220	1.00	0.131	
(Plant, aggr., grade)				

Aggregate, SSD Dry Batch Weights			
Fine	1246	2.65	0.279
Intermediate	364	2.57	0.084
Coarse	1451	2.57	0.335
Total	3842		0.938

Theoretical unit weight (cu. Ft.) = $\frac{\text{Batch weight}}{\text{Abs. Vol. x 27}}$

$= \frac{3842}{0.938 \times 27}$

= 151.7 lbs./cu. ft.

Air Content – Air content is calculated by subtracting the unit weight, ρ, from the theoretical unit weight, T, divided by the theoretical unit weight, T, multiplied by 100 as shown below.

$$A = \frac{T - \rho}{T} \times 100$$

Example: $$A = \frac{151.7 \text{ lbs./cu. yd.} - 141.37 \text{ lbs./cu. yd.}}{151.7 \text{ lbs./cu. yd.}} \times 100 = 6.8\%$$

Theoretical Unit Weight = 151.7

The theoretical unit weight, T, is the total weight of materials batched divided by the absolute volume of materials batched on an air free basis.

Relative Batch Yield – Calculate the yield, Y, or volume of concrete produced per cubic yard, by dividing the total weight of the cubic yard batched, W_t, by 27, then dividing by the density, ρ, of the concrete as shown below.

$$Y = \frac{W_1 \div 27}{\rho}$$

Example: $$Y = \frac{3842 \text{ lbs. batched per cu. yd.} \div 27}{141.37 \text{ lb./cu. ft.}} = 1.007 \text{ cu. yd.}$$

Unit Weight & Air Content

For theoretical unit weight & air calculations

	Weight(SSD)	Sp. G.	Abs. Vol.
	Enter	*Enter*	
Cement	477	3.14	0.090
Fly ash	84	2.68	0.019
Water	224	1.00	0.133
Sand	1160	2.65	0.260
Intermediate	350	2.57	0.081
Coarse	1400	2.57	0.323
Total	3695		0.906

For Batch Yield Calculations

	Wet Batch Weights
	Enter
Cement	477
Fly ash	84
Mix Water	220
Sand	1277
Intermediate	377
Coarse	1490
Total	3925

Theoretical Unit Weight (air free)

per cubic yard

$$\frac{3695 \text{ lbs}}{0.906 \text{ yds}} = 4079.72 \text{ lbs/cu yd}$$

per cubic foot

$$\frac{4079.72 \text{ lbs/yd3}}{27 \text{ ft3/yd3}} = 151.10 \text{ lbs/cu. ft}$$

Actual Unit Weight (cubic foot)

Weight Air Pot + Concrete = 43.60 <---- *Enter*

Weight Air Pot = 8.10 <---- *Enter*

Weight of Concrete = 35.50

Volume of container = 0.248 <---- *Enter*

$$\text{Actual Unit Weight} = \frac{35.50}{0.248} = 143.15 \text{ lbs/cu. ft.}$$

Yield

Yield (ft3) = $\frac{3925}{143.15} =$ **27.42** ft3

Yield (yd3) = $\frac{27.42}{27} =$ **1.016** yd3

Yield greater than 1.00 indicates excess concrete batched.
Yield less than 1.00 indicates concrete batch is short of designed.
Approximately 1% air increase reduces unit weight 0.5 lbs/ft3

Air Content

$$\frac{\text{Theo. Unit Wt.} - \text{Actual Unit Wt.}}{\text{Theo. Unit Wt.}} \times 100$$

$$\frac{151.10 - 143.15}{151.10} \times 100 = \textbf{5.26 \%}$$

Review Questions
Weight Per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete
IM 340

1. What is the required shape of the tamping end of the rod?

2. Air meter bases used for this test must conform to what test method?

3. If, after consolidation of the final layer, the concrete level is 1/4 in. above the top of the measure, what should be done?

4. After completing the strike-off procedure, what must be done before determining the weight of the measure and sample?

UNIT WEIGHT, YIELD, AND AIR CONTENT
WORK PROBLEM #1

Net Weight in lbs. = Weight of measure + concrete – weight of empty measure.

Density (Unit Weight) = $\frac{\text{Net Weight}}{\text{Volume of Measure}}$

Yield = $\frac{\text{Total Batch Weight}}{\text{Density of Concrete}}$

Air Content = $\frac{\text{(Theoretical unit weight (air free) – Unit weight)}}{\text{Theoretical unit weight (air free)}} \times 100$

Calculate the unit weight of the following mix:

- **Theoretical unit weight (air free) 151.1 lbs./ft.^{3}**
- **Weight of concrete and meter base: 43.6 lbs.**
- **Weight of meter base: 8.1 lbs.**
- **Volume of meter base: .248 ft.^{3}**

Unit Weight = _____

Calculate the yield in yd.^{3}:

- **Total of all materials batched in 7 yd.^{3} = 27475 lbs.**
- **Unit weight of concrete: ÷ _____**
- **Number of ft.^{3} in 1 yd.^{3} ÷ _____**

Yield in yd.^{3} = _____

Reminder: 27 ft.^{3} = 1 yd.^{3}

Calculate Air Content Using Unit Weight:

Air Content = _____%

UNIT WEIGHT, YIELD, AND AIR CONTENT
WORK PROBLEM #2

Calculate the unit weight of the following mix:

- **Theoretical unit weight (air free)** **151.5 lbs./ft.^{3}**
- **Weight of concrete and meter base:** **87.5 lbs.**
- **Weight of meter base:** **16.4 lbs.**
- **Volume of meter base:** **.496 ft.^{3}**

Unit Weight = _____

Calculate the yield in yd.^{3}:

- **Total Weight of all material batched in 7 yd.^{3} = 28100**
- **Unit weight of concrete:** **÷ _____**
- **Number of ft.^{3} in 1 yd.^{3}** **÷ _____**

Yield in yd.^{3} = _____

Reminder: 27 ft.^{3} = 1 yd.^{3}

Calculate Air Content Using Unit Weight:

Air Content = _____%

UNIT WEIGHT, YIELD, AND AIR CONTENT
WORK PROBLEM #3

Calculate the unit weight of the following mix:

- **Theoretical unit weight (air free)** **150.7 lbs./ft.^{3}**
- **Weight of concrete and meter base:** **44.0 lbs.**
- **Weight of meter base:** **7.7 lbs.**
- **Volume of meter base:** **.250 ft.^{3}**

Unit Weight = _____

Calculate the yield in yd.^{3}:

- **Total Weight of all material batched in 7 yd.^{3} = 27170**
- **Unit weight of concrete:** **÷ _____**
- **Number of ft.^{3} in 1 yd.^{3}** **÷ _____**

Yield in yd.^{3} = _____

Reminder: 27 ft.^{3} = 1 yd.^{3}

Calculate Air Content Using Unit Weight:

Air Content = _____%

MAKING AND CURING FLEXURAL SPECIMENS (CONCRETE BEAMS)

Concrete beams are used to determine the flexural strength of concrete. Beams need to be properly molded to ensure the strength of the concrete is correctly determined.

Concrete beams are used by contractors and agencies on structures and paving projects. Concrete beams are also used in the development of the maturity curve for projects where maturity testing is used for opening strengths.

The concrete beam needs to be properly consolidated to remove voids in the concrete, which will reduce strength. The molded beam must be handled carefully when moving or transporting. They can not be allowed to move around in the back of the vehicle and need to protected against any impact. Beams should be protected when being transferred by wrapping in wet burlap and plastic to prevent moisture loss. It is important the beam is stored properly and kept moist until breaking. Moisture loss will cause lower strength. If the beam is not properly protected hot or cold weather will affect the strength.

IM 328 explains the proper procedure for making and curing concrete beams.
IM 204 specifies the testing frequencies.

October 17, 2006
Supersedes April 20, 2004

Matls. IM 328

MAKING, PROTECTING & CURING CONCRETE FLEXURAL STRENGTH FIELD SPECIMENS

SCOPE

This method covers procedures for making, protecting and curing flexural strength field specimens sampled from concrete being used in construction.

PROCEDURE

A. Apparatus

1. 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm) beam mold. The molds provided will comply with the requirements of AASHTO T-23 for dimensions, construction, materials, smoothness and straightness.

2. Shovel (square point).

3. Rubber hammer or equivalent

4. Wood float or equivalent.

B. Test Procedure

Specimens molded for determination of compliance with strength specifications shall be cast and cured according to AASHTO T-23.

1. Secure the concrete sample in accordance with IM 327, Method of Sampling Concrete for Slump, Air Content and Strength Testing. Specimens shall be molded on a level, rigid, horizontal surface as near as practicable to the place where they will be stored during the first 20 ± 4 hours. All jarring, striking, tilting or scarring (however, preliminary markings with a nail or other sharp object within 4 in. (100 mm) of the beam end will be permitted) of the specimen surface shall be avoided if moving immediately after striking off is necessary. Place the concrete in the mold in two equal layers and thoroughly spade each layer with the shovel. Use special care consolidating the sides and after spading each layer strike the sides of the form with a rubber hammer or equivalent until the spading marks are closed. Strike off the excess concrete and smooth the surface with as little manipulation of the concrete as possible. Excessive spading and smoothing must be avoided.

   When consolidating by vibration, fill concrete in one layer. Insert the vibrator at intervals not exceeding 6 in. (150 mm) along the centerline of the long dimension of the specimen, avoiding the exact center of the beam. Sufficient vibration is achieved as soon as the surface has become relatively smooth. Avoid overvibration which may cause segregation. After vibrating, strike the sides of the form with a rubber hammer 10 to 15 times to release any air bubbles that may have been trapped.

When consolidating by rodding, specimens shall receive 60 roddings evenly distributed over two equal layers with a 5/8 in. (16 mm) rod. The bottom layer shall be rodded throughout its depth. For the upper layer, the rod shall penetrate 1 in. (25 mm) into the underlying layer. After rodding each layer, strike the sides of the form with a rubber hammer 10 to 15 times to release any air bubbles that may have been trapped.

2. Immediately after smoothing protect the freshly made beam against moisture loss by evaporation, against rapid temperature increase caused by the combined effects of hot weather, bright sun, and the chemical hydration process and against freezing or near freezing temperature. It is generally practical to apply the same protection to the test specimen that is applied to the represented pavement or structure. This is not absolutely necessary, however, so long as the three conditions outlined above are satisfied.

3. On the day after the specimens are made and when they have reached an age of 16 to 24 hours, move the specimens while still in the molds to the location of final storage and curing, generally the concrete plant inspector's laboratory. The beams, even with the molds in place, must be handled carefully to avoid injury. A slight jar or bump may cause cracking which may be invisible at the time but which may become apparent with later handling or as premature failure during testing.

4. Remove the specimens from the molds (generally at the plant), clean, oil, reassemble and return the molds to the sampling location (generally at the direction of the paving or grade inspector).

5. Assign a chronological number, which corresponds with the day the beam was made to each beam. Begin with number 1. When more than one beam is made on a given day use capital letters A, B, C, etc., following the number which identifies the day to identify the daily making sequence. When two or more mixers are operated on separate sections of a project use a separate letter identification preceding the number assigned to the beams made from each respective mixer. Clean the beam and mark the numbers on the smooth bottom of the beam as cast. The numbers should be neatly made, and should be 4 to 8 inches (100 to 200 mm) from the end of the beam. When freshly marked specimens are being placed in storage, cover the marked section with a small board to keep the sand out of the marking.

6. Store the specimens in a wetted sand filled pit of adequate size to accommodate all specimens made on the project or in lime saturated water. A pit 4' x 6' x 18" (1.2 m x 1.8 m x 0.5 m) is normally adequate. Place the specimens on a reasonable smooth bed of sand and cover them completely with additional sand. If the temperature in the sand-filled pit drops below 40°F (4°C) remove the specimens and place them under wetted burlap in a heated enclosure or in lime saturated water. Maintain the specimens in a continually wet condition, and above 40°F (4°C) until they are tested. **NOTE:** Lime-saturated water is prepared by mixing 1 ounce (28 gm) of hydrated lime with 1 gallon (3.8 liters) of water.

Concrete Beam Mold

Review Questions
Making, Protecting, and Curing
Concrete Flexural Strength Field Specimens
IM 328

1. What size mold is used in making flexural strength specimens?

2. Immediately after smoothing the beam, it needs to be protected from what?

   1. _____

   2. _____

   3. _____

3. At what age do the beams need to be so they can be moved to storage?

4. How should the specimens be maintained until they are tested?

TESTING FLEXURAL SPECIMENS (CONCRETE BEAMS)

Center-Point Loading

Flexural specimens referred to as concrete beams are use to determine the flexural strength of concrete. Beams need to be tested properly to ensure the strength of the concrete is correctly determined.

Contractors and agencies on structures and paving projects use concrete beams. Concrete beams are also used in the development of the maturity curve for projects where maturity testing is used for opening strengths.

When testing concrete beams always ensure that the proper loading rate is used. It is important to remember to keep beams moist until they are tested. Beams need to be measured correctly and placed in the beam testing machine properly or the strength reading will not be accurate. The strength for flexural specimens is measured in pounds per square inch (psi).

IM 316 explains the proper method for testing flexural specimens. IM 204 specifies the testing frequencies.

Third-Point Loading

Flexural Specimens are tested by third-point loading procedures for QMC and FAA projects. The test method for third-point loading is AASHTO Designation T 97-97 and ASTM Designation C 78-94. When the project requires third-point loading refer to the above Designation for correct testing procedures.

FLEXURAL STRENGTH OF CONCRETE

SCOPE

This test method is used for determining the flexural strength of concrete by the use of a simple beam with center-point loading.

PROCEDURE

A. Apparatus

1. Hydraulic testing machines provided on Portland Cement Concrete paving projects shall conform to AASHTO T-177. The hydraulic machine consists of a frame to hold the specimen, a hand-operated hydraulic jack, and a pressure gauge to read the load. Practically all of the hydraulic machines have a micro pump in the loading line to facilitate control of the last half of the load within specifications, and without pause in loading. A calibration sheet is included with each machine of this type. Additional equipment needed includes a caliper, plastic ruler and a tri-square. The hydraulic test machine needs to be calibrated annually by the DOT Central Laboratory. Calibration sheets with each machine will indicate the date last calibrated.

B. Test Specimen

1. The test specimen shall have approximate dimensions of 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm). The test specimen shall be kept wet until the time of the test.

C. Test Procedure

1. Either before or after the beam is placed in the testing machine, draw a reference line on the top and bottom of the beam, as cast, about 10 in. (250 mm) from the end of the specimen. The two reference lines should be exactly opposite each other. A line drawn across the bottom of the beam, as placed in the machine, will meet these two lines, and will be perpendicular to them. The bottom of the beam as placed in the machine will be the side of the beam as cast.

2. Insert the stirrup pins in the slots at the bottom of the stirrups to prevent the stirrups from swinging while the beam is being placed in the machine. This also assures that the support bearings are in the correct position.

3. Place the beam in the testing machine so that the two reference lines on the side of the beam are directly under the centerline of the center bearing. The maximum fiber stress during application of the load will occur in the outer fiber in the line drawn across the bottom of the beam, this line being directly under the load.

4. Rotate the micro pump handle counter-clockwise to expose the maximum number of threads, and close the loading valve on the pump.

5. Apply a small initial load, and remove the stirrup pins.

6. The load may be applied rapidly up to approximately 50 percent of the estimated breaking load with the pump handle. The final half of the loading is accomplished by turning the crank of the micro pump, at a rate that the extreme fiber stress does not exceed 150 psi (1.0 MPa) per minute. This is approximately 1200 pounds (500 kg) per minute on the test gauge.

7. Make measurements to the nearest 0.02 in. (0.5 mm) to determine the average width and average depth of the specimen at the section of failure.

8. Measure the distance from the line drawn at the center of the span to the location of the break on the bottom side of the beam as tested. If this distance exceeds 1 1/2 in. (40 mm), the test results will not be used in determining when a pavement can be opened to traffic, when forms may be removed from a structure, or when a concrete structure can be subjected to exterior loads, which produce flexure.

D. Calculations

1. From the calibration sheet furnished with each machine, determine the corrected load placed upon the beam. The machine should be calibrated annually.

2. Calculate the modulus of rupture as follows:

$$R = \frac{3P\,l}{2bd^2}$$

Where:

R = Modulus of rupture, MPa or psi.
P = Corrected load indicated, N or lb.
l = Span length, mm or in., between supports (or 18 in. or 457 mm)
b = Width of beam at point of fracture, mm or in.
d = Depth of beam at point of fracture, mm or in.

3. The typical range of modulus of rupture should be from 300 psi to 700 psi (2 MPa to 5 MPa). Report the modulus of rupture to the nearest 5 psi (0.05 MPa).

E. The following figure shows the beam as cast, and the beam as placed in the flexural testing machine.

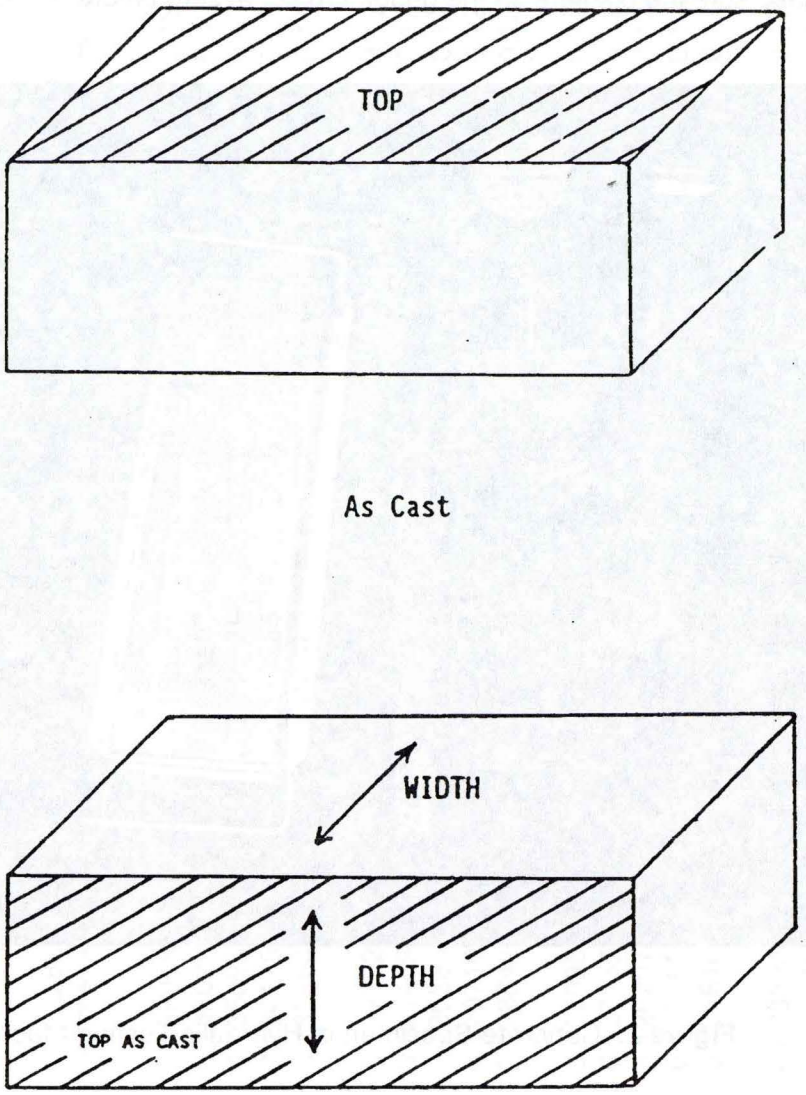


Figure 1

F. Precautions

Always make sure the pointers on the gauge are set at zero before any loading begins.

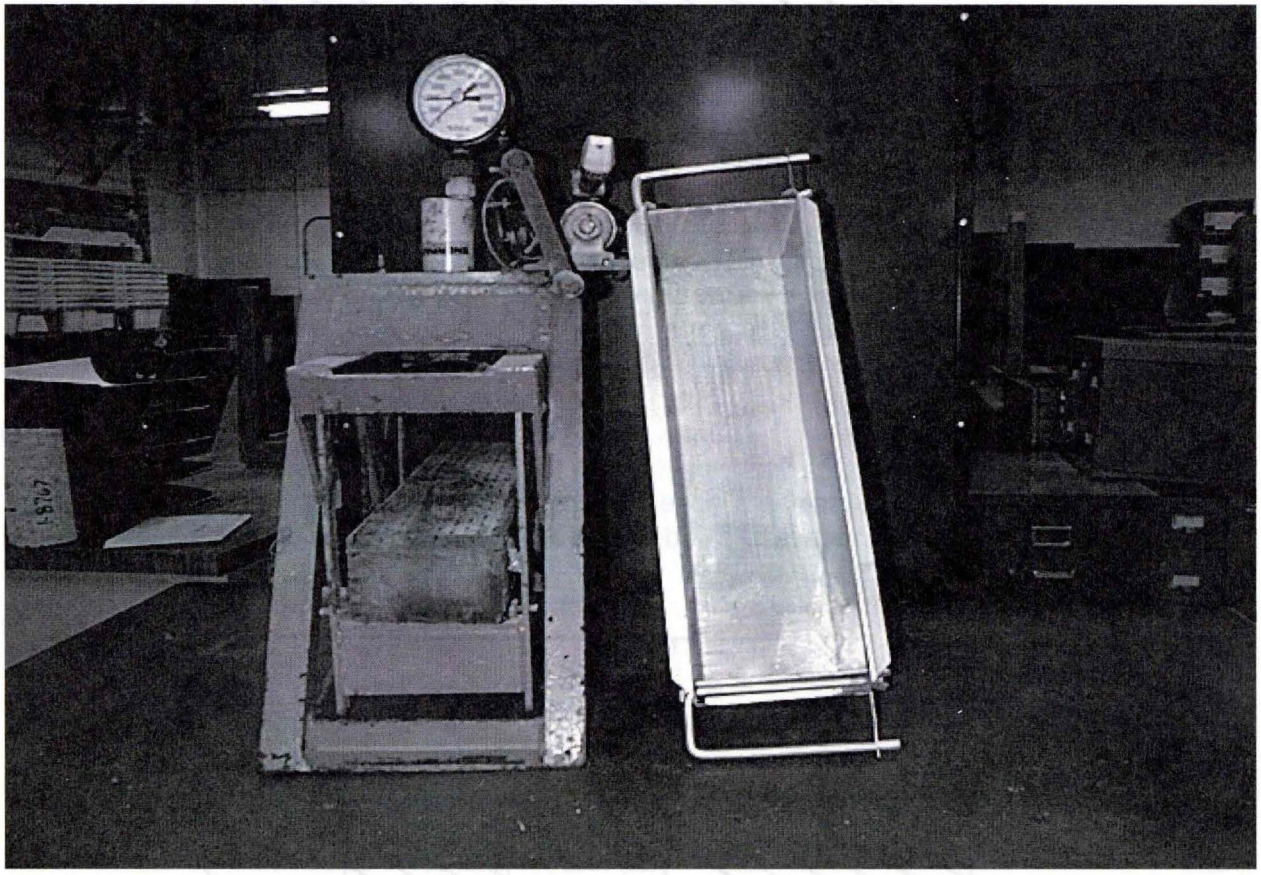


Figure 2. Concrete Specimen in Hydraulic Testing Machine

Concrete Beam Coefficients
US Units

Width (in.)

Depth (in.)	5.82	5.84	5.86	5.88	5.9	5.92	5.94	5.96	5.98
5.8	0.137907	0.137434	0.136965	0.136499	0.136037	0.135577	0.135121	0.134667	0.134217
5.82	0.136960	0.136491	0.136025	0.135563	0.135103	0.134647	0.134193	0.133743	0.133296
5.84	0.136024	0.135558	0.135095	0.134636	0.134179	0.133726	0.133276	0.132829	0.132384
5.86	0.135097	0.134634	0.134175	0.133718	0.133265	0.132815	0.132368	0.131924	0.131482
5.88	0.134179	0.133720	0.133264	0.132810	0.132360	0.131913	0.131469	0.131028	0.130589
5.9	0.133271	0.132815	0.132362	0.131911	0.131464	0.131020	0.130579	0.130141	0.129706
5.92	0.132372	0.131919	0.131469	0.131022	0.130577	0.130136	0.129698	0.129263	0.128831
5.94	0.131482	0.131032	0.130585	0.130141	0.129700	0.129261	0.128826	0.128394	0.127965
5.96	0.130602	0.130154	0.129710	0.129269	0.128831	0.128395	0.127963	0.127534	0.127107
5.98	0.129729	0.129285	0.128844	0.128406	0.127970	0.127538	0.127109	0.126682	0.126258
6	0.128866	0.128425	0.127986	0.127551	0.127119	0.126689	0.126263	0.125839	0.125418
6.02	0.128011	0.127573	0.127137	0.126705	0.126275	0.125849	0.125425	0.125004	0.124586
6.04	0.127165	0.126729	0.126297	0.125867	0.125441	0.125017	0.124596	0.124178	0.123762
6.06	0.126327	0.125894	0.125465	0.125038	0.124614	0.124193	0.123775	0.123359	0.122947
6.08	0.125497	0.125067	0.124640	0.124216	0.123795	0.123377	0.122962	0.122549	0.122139
6.1	0.124675	0.124249	0.123824	0.123403	0.122985	0.122569	0.122157	0.121747	0.121340
6.12	0.123862	0.123438	0.123016	0.122598	0.122182	0.121770	0.121360	0.120952	0.120548
6.14	0.123056	0.122635	0.122216	0.121801	0.121388	0.120978	0.120570	0.120166	0.119764
6.16	0.122259	0.121840	0.121424	0.121011	0.120601	0.120193	0.119789	0.119387	0.118987
6.18	0.121469	0.121053	0.120639	0.120229	0.199822	0.119417	0.119015	0.118615	0.118219

Modulus of Rupture = Total Load X Coefficient
R (in psi) = P (in lbs.) X Coefficient (in in-2)

Concrete Beam Coefficients
US Units

Width (in.)

Depth (in.)	6	6.02	6.04	6.06	6.08	6.1	6.12	6.14	6.16
5.8	0.133769	0.133325	0.132883	0.132445	0.132009	0.131576	0.131146	0.130719	0.130295
5.82	0.132852	0.132410	0.131972	0.131536	0.131103	0.130674	0.130247	0.129822	0.129401
5.84	0.131943	0.131505	0.131069	0.130637	0.130207	0.129780	0.129356	0.128935	0.128516
5.86	0.131044	0.130609	0.130176	0.129747	0.129320	0.128896	0.128475	0.128056	0.127640
5.88	0.130154	0.129722	0.129292	0.128865	0.128442	0.128020	0.127602	0.127186	0.126773
5.9	0.129273	0.128844	0.128417	0.127993	0.127572	0.127154	0.126738	0.126326	0.125915
5.92	0.128401	0.127975	0.127551	0.127130	0.126712	0.126296	0.125884	0.125473	0.125066
5.94	0.127538	0.127114	0.126693	0.126275	0.125860	0.125447	0.125037	0.124630	0.124225
5.96	0.126683	0.126263	0.125845	0.125429	0.125017	0.124607	0.124199	0.123795	0.123393
5.98	0.125838	0.125419	0.125004	0.124592	0.124182	0.123775	0.123370	0.122968	0.122569
6	0.125000	0.124585	0.124172	0.123762	0.123355	0.122951	0.122549	0.122150	0.121753
6.02	0.124171	0.123758	0.123348	0.122941	0.122537	0.122135	0.121736	0.121340	0.120946
6.04	0.123350	0.122940	0.122533	0.122129	0.121727	0.121328	0.120931	0.120537	0.120146
6.06	0.122537	0.122130	0.121726	0.121324	0.120925	0.120528	0.120134	0.119743	0.119354
6.08	0.121732	0.121328	0.120926	0.120527	0.120130	0.119737	0.119345	0.118957	0.118570
6.1	0.120935	0.120533	0.120134	0.119738	0.119344	0.118953	0.118564	0.118178	0.117794
6.12	0.120146	0.119747	0.119350	0.118957	0.118565	0.118176	0.117790	0.117407	0.117025
6.14	0.119365	0.118968	0.118574	0.118183	0.117794	0.117408	0.117024	0.116643	0.116264
6.16	0.118591	0.118197	0.117805	0.117417	0.117030	0.116647	0.116266	0.115887	0.115511
6.18	0.117824	0.117433	0.117044	0.116658	0.116274	0.115893	0.115514	0.115138	0.114764

Modulus of Rupture = Total Load X Coefficient
R (in psi) = P (in lbs) X Coefficient (in in-2)

Concrete Beam Coefficients
Metric Units

Depth (mm) \ Width (mm)	147.5	148	148.5	149	149.5	150	150.5	151	151.5	152
147	0.000215	0.000214	0.000214	0.000213	0.000212	0.000211	0.000211	0.000210	0.000209	0.000209
147.5	0.000214	0.000213	0.000212	0.000211	0.000211	0.000210	0.000209	0.000209	0.000208	0.000207
148	0.000212	0.000211	0.000211	0.000210	0.000209	0.000209	0.000208	0.000207	0.000207	0.000206
148.5	0.000211	0.000210	0.000209	0.000209	0.000208	0.000207	0.000207	0.000206	0.000205	0.000205
149	0.000209	0.000209	0.000208	0.000207	0.000207	0.000206	0.000205	0.000204	0.000204	0.000203
149.5	0.000208	0.000207	0.000207	0.000206	0.000205	0.000204	0.000204	0.000203	0.000202	0.000202
150	0.000207	0.000206	0.000205	0.000204	0.000204	0.000203	0.000202	0.000202	0.000201	0.000200
150.5	0.000205	0.000204	0.000204	0.000203	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199
151	0.000204	0.000203	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199	0.000198	0.000198
151.5	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199	0.000198	0.000198	0.000197	0.000196
152	0.000201	0.000200	0.000200	0.000199	0.000198	0.000198	0.000197	0.000196	0.000196	0.000195
152.5	0.000200	0.000199	0.000198	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194
153	0.000199	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193
153.5	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191
154	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190
154.5	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189
155	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188
155.5	0.000192	0.000192	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187
156	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187	0.000186	0.000185
156.5	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187	0.000186	0.000185	0.000185	0.000184
157	0.000189	0.000188	0.000187	0.000187	0.000186	0.000185	0.000185	0.000184	0.000184	0.000183

Modulus of Rupture = Total Load X Coefficient
R (in MPa) = P (in N) X Coefficient (in mm-2)

Concrete Beam Coefficients
Metric Units

Depth (mm) \ Width (mm)	152.5	153	153.5	154	154.5	155	155.5	156	156.5	157
147	0.000208	0.000207	0.000207	0.000206	0.000205	0.000205	0.000204	0.000203	0.000203	0.000202
147.5	0.000207	0.000206	0.000205	0.000205	0.000204	0.000203	0.000203	0.000202	0.000201	0.000201
148	0.000205	0.000205	0.000204	0.000203	0.000203	0.000202	0.000201	0.000201	0.000200	0.000199
148.5	0.000204	0.000203	0.000203	0.000202	0.000201	0.000201	0.000200	0.000199	0.000199	0.000198
149	0.000202	0.000202	0.000201	0.000200	0.000200	0.000199	0.000199	0.000198	0.000197	0.000197
149.5	0.000201	0.000200	0.000200	0.000199	0.000199	0.000198	0.000197	0.000197	0.000196	0.000195
150	0.000200	0.000199	0.000198	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194
150.5	0.000198	0.000198	0.000197	0.000197	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193
151	0.000197	0.000196	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191
151.5	0.000196	0.000195	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190
152	0.000195	0.000194	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189
152.5	0.000193	0.000193	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188
153	0.000192	0.000191	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000187
153.5	0.000191	0.000190	0.000190	0.000189	0.000188	0.000188	0.000187	0.000186	0.000186	0.000185
154	0.000190	0.000189	0.000188	0.000188	0.000187	0.000186	0.000186	0.000185	0.000185	0.000184
154.5	0.000188	0.000188	0.000187	0.000186	0.000186	0.000185	0.000185	0.000184	0.000184	0.000183
155	0.000187	0.000186	0.000186	0.000185	0.000185	0.000184	0.000183	0.000183	0.000182	0.000182
155.5	0.000186	0.000185	0.000185	0.000184	0.000183	0.000183	0.000182	0.000182	0.000181	0.000181
156	0.000185	0.000184	0.000184	0.000183	0.000182	0.000182	0.000181	0.000181	0.000180	0.000179
156.5	0.000184	0.000183	0.000182	0.000182	0.000181	0.000181	0.000180	0.000179	0.000179	0.000178
157	0.000182	0.000182	0.000181	0.000181	0.000180	0.000179	0.000179	0.000178	0.000178	0.000177

Modulus of Rupture = Total Load X Coefficient
R (in MPa) = P (in N) X Coefficient (in mm-2)

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
Flexural Strength - Beams Center Point Loading

Project _____ Contract # _____ County _____ Lab No. _____ THRU _____

Producer _____ Plant _____ Contractor _____

Unit of Material 6" X 6" X 20" Beams Mix Type _____

Sampled by _____ Date Received _____ Date Reported _____

Tested by _____

Lab No.	Senders No.	Date Made	Beam No.	% Air Content ASTM C-231	Slump (in.) ASTM C-143	w/c	Date Tested	Age (days)	Width (in.)	Depth (in.)	Total Load (lbs)	Strength (psi)

REMARKS * POOR CONSOLIDATION

Tested in accordance with ASTM C-78

Signed _____

Review Questions
Flexural Strength of Concrete
Using Simple Beam with Center-Point Loading
IM 316

1. The _____ of the beam as placed in the machine will be the _____ of the beam as cast.

2. The load may be applied rapidly up to approximately what percent of the estimated breaking load?

3. On the final half of the loading the crank should be turned not to exceed how many pounds per minute on the test gauge?

4. If the distance of the break from the line drawn exceeds _____ inches, the result should not be used.

Calculate the modulus of rupture as follows:

$$R = \frac{3PL}{2bd^2}$$

Where:

R = Modulus of rupture in lb./in.², or megapascals
P = Maximum applied load indicated in lb., or newtons
l = Span length in inches, or millimeters between supports
b = Width of beam in inches, or millimeters
d = Depth of beam in inches, or millimeters

P = 4800

$$R = \frac{3x4800x18}{2x6.00x5.80^2} \qquad \frac{259200}{403.68} = 642 \text{ psi}$$

Using coefficient from table: 4800 x .133769 = 642 psi

Using the following information, determine modulus of rupture.

Given:

1. Width of beam = 6.08
   Depth of beam = 6.06
   Actual load = 5020

2. Width of beam = 6.02
   Depth of beam = 6.04
   Actual load = 4810

3. Width of beam = 6.06
   Depth of beam = 6.00
   Actual load = 5700

4. Width of beam = 6.04
   Depth of beam = 6.06
   Actual load = 5340

MAKING AND CURING CONCRETE CYLINDERS
IM 315

Concrete cylinders are used to determine the compressive strength of concrete. Cylinders need to be properly molded, cured, and tested to ensure the strength of the concrete is correctly determined.

The contractor in prestress/precast plants and for High Performance Concrete (HPC) projects uses concrete cylinders. The strength of a cylinder is tested to determine when a prestressed unit reaches specified strength to remove forms, move, or ship. The Iowa DOT uses concrete cylinders for informational purposes on structures and as acceptance on HPC.

The cylinder needs to be properly consolidated to remove entrapped air and voids in the concrete. Improperly consolidated specimens can reduce the strength. Improperly curing the specimen can also cause lower strengths. The cylinder needs to be protected from cold or hot weather since temperatures can affect both early and late strengths. Cylinders need to be transported carefully, making sure they are not jarred, bumped, or allowed to roll around. The cylinder also needs to be protected from moisture loss during transporting by wrapping it in wet burlap and plastic. Curing the specimen incorrectly will cause strength loss when tested.

IM 315 gives the proper procedure for making, curing, and testing concrete cylinders. IM 204 specifies the testing frequencies.

METHOD OF MAKING, PROTECTING, CURING & TESTING CONCRETE CYLINDERS

SCOPE

This method covers procedures for making, protecting, and curing, according to AASHTO) T23. This method also covers testing concrete cylinder specimens for compressive strength. This test procedure is a supplement and not a replacement for the beam test to determine when a structure may be put in service.

HEADER

I. MAKING, PROTECTING & CURING SPECIMENS

A. Apparatus for Making Specimens

1. 6 in. x 12 in. (152.4 mm x 304.8 mm) or 4 in. x 8 in. (101.6 mm x 203.2 mm) steel, brass, or single-use plastic vertical molds meeting the requirements of AASHTO M205.

2. Molds shall be either of the vertical or horizontal type.

3. Tamping rods shall comply with AASHTO T23.

4. Internal or external vibrators may be used. They shall comply with AASHTO T23 with the exception that the diameter of the vibrating element of the internal vibrator shall vary for each specimen size, as stated below. External vibrators shall be either a table type or a plank type.

5. Rubber hammer or equivalent

6. Wood float or equivalent

B. Making Test Specimens

1. The concrete shall be sampled in accordance with IM 327, Sampling Freshly Mixed Concrete.

2. Before casting specimens, the inside surfaces of the steel or brass molds should be clean and treated with a thin coating of light grease or form oil.

3. Consolidation may be rodding with a tamping rod, or by vibration, either internal or external. Concrete with slump greater than 3 inches (75 mm) shall be consolidated by rodding. Concrete with slump of 1 inch to 3 inches (25 mm to 75 mm) shall be consolidated by rodding or vibration. Concrete with slump of less than1 inch (25 mm) shall be consolidated by vibration.

a. Rodding. 4 in. x 8 in. (101.6 mm x 203.2 mm) vertical specimens shall receive 25 roddings evenly distributed over two equal layers and 6 in x 12 in. (152.4 mm x 304.8 mm) vertical specimens shall receive 25 roddings evenly distributed over three equal layers. The bottom layer shall be rodded throughout its depth. For each upper layer, the rod shall penetrate 1/2 inch (13 mm) into the underlying layer. After rodding each layer, the sides and ends of the mold shall be tapped with a rubber hammer until the surface of the concrete is relatively smooth. Use an open hand to tap the single-use molds. After consolidation, strike off the horizontal surface and finish with a float or trowel.

b. Internal Vibration. The diameter of the vibrating element shall be 3/4 inch to 1 inch (19 mm to 25 mm) for the 4 in. x 8 in. (101.6 mm x 203.2 mm) specimens. The diameter of the vibrating element shall be 3/4 inch to 1 1/2 inch (19 mm to 38 mm) for 6 in. x 12 in. (152.4 mm x 304.8 mm) specimens. The molds shall be filled in two equal layers. Each layer shall be vibrated only long enough to make the surface relatively smooth. The time required will vary with the consistency of the concrete. Over vibration may cause segregation. In compacting the concrete, the vibrator shall not rest on or touch the sides of the mold. When vibrating the top layer, the element shall penetrate about 1/2 inch (13 mm) into the bottom layer. After vibrating, tap the sides of the mold with a rubber hammer to ensure removal of entrapped air bubbles at the surface of the mold. Use an open hand to tap the single-use molds. When consolidation is complete, strike off and finish with a wood float or trowel.

c. External Vibration. Each layer shall be vibrated only until the surface is relatively smooth. Take care to ensure that the mold is rigidly attached or securely held against the vibrating table or vibrating surface. After consolidation, strike off and finish with a trowel or float.

C. Protecting & Curing

1. Initial Curing. During the first 24 hours after molding, specimens shall be stored under conditions that maintain the temperature immediately adjacent to the specimens in the range of 50°F to 80°F (10°C to 27°C) and prevent loss of moisture from the specimens. This may be done by covering specimens with wet burlap and placing a plastic sheet over the burlap, or use other suitable methods to ensure that the foregoing requirements are met.

2. Curing to Determine Form Removal Time or When a Structure May be Put in Service. Cure test specimens as nearly as practicable in the same manner as the concrete in the structure. After 48 ± 4 hours, remove specimens from the molds. They shall be stored as near as possible to the point in the structure they represent and shall be afforded the same temperature protection and moisture environment as the structure until the time of testing. Specimens shall be tested while in the moisture condition resulting from the curing they receive.

3. Curing To Check the Adequacy of Laboratory Mix Proportions for Strength or As a Basis For Acceptance or For Quality Control. For this purpose, specimens are to be removed from the molds at the end of 16 to 24 hours and stored in a moist condition at 68°F to 81.5°F (20°C to 27.5°C) until the time of test. This condition can be met by immersion in saturated limewater. **NOTE:** Lime-saturated water is prepared by mixing 1 oz. (28 g) of hydrated lime, meeting the requirements of ASTM C977, with 1 gallon (3.8 liters) of water.

4. Steam Curing. When artificial heat is used to accelerate curing, concrete specimens shall be placed with the unit being cured and shall receive the same curing as the concrete they represent. Prior to testing the specimens, the temperature of the concrete shall be lowered to the temperature of the surrounding air at a rate not to exceed 40°F (22°C).

5. Special care must be given to ensure that specimens are not damaged during handling. For 16 to 24 hours after molding, specimens shall not be moved.

II. TESTING CONCRETE SPECIMENS FOR COMPRESSION

A. Apparatus

1. The testing machine shall conform to AASHTO T22. Manually operated testing machines will be accepted.

B. Time of Testing

1. Make compression tests of moist cured specimens as soon as practicable after removal from curing. Keep specimens moist by use of wet burlap or other suitable covering, which will ensure similar protection until actual time of testing.

2. The time to test specimens otherwise cured will be as directed by the engineer.

C. Test Specimens

1. Neither end of compressive test specimens when tested shall depart from the perpendicularity to the axis by more than 0.5 degrees [approximately 1/8 in. in 12 in. (3 mm in 300 mm)]

2. The ends of the specimens that are not plane within 0.002 in. (0.05 mm) shall be capped. The planeness of the ends of every tenth specimen should be checked by means of a straightedge and feeler gauge, making a minimum of three measurements on different diameters, to insure that the end surfaces do not depart from a plane by more than 0.002 in. (0.05 mm).

3. The top surface of vertically cast specimens shall be capped.

D. Capping

1. Capping equipment and procedures shall comply with that described in AASHTO T231.

2. Hardened specimens, which have been moist-cured, may be capped with a neat Portland Cement paste or sulfur mortar meeting the requirements set forth below:

   a. The Portland Cement in neat Portland Cement caps shall conform to AASHTO M85, Type I or Type III.

   b. Sulfur mortar shall conform to the compositional and compressive strength requirements of ASTM C287 for sulfur mortar, and shall be capable of developing a strength of at least 4000 psi (27.6 MPa) in two hours when tested as 2-inch (50-mm) cubes.

3. Specimens, which are to be tested in an air-dry condition, should, be capped with sulfur mortar.

4. If it is found necessary to cap specimens, and equipment and facilities for capping are not available, arrangements should be made to test such specimens at the Central Laboratory or other qualified laboratory.

E. Test Procedure

1. Placing Specimen

   a. Place the plain (lower) bearing block with its hardened face up, on the table or platen of the testing machine directly under the spherically seated (upper) bearing block.

   b. Wipe clean the bearing faces of the upper and lower bearing blocks and of the test specimen.

   c. Carefully align the axis of the specimen with the center thrust of the spherically seated block.

   d. As the spherically seated block is brought to bear on the specimen, rotate its moveable portion gently by hand so that uniform seating is obtained.

2. Rate of Loading

   a. Apply the load continuously and without shock. Apply the load at a constant rate within the range of 20 to 50 psi (138 kPa to 345 kPa) per second. During the application of the first half of the estimated maximum load, a higher rate of loading may be permitted.

   b. Do not make any adjustment in the controls of the testing machine while the specimen is yielding, especially in the period just before failure.

c. Increase the load until the specimen yields or fails, and record the maximum load carried by the specimen during test.

d. Note the type of failure (Figure 1) and the appearance of the concrete if the break appears to be abnormal.

F. Calculations

1. Calculate the compressive strength of the specimen by dividing the maximum load carried by the specimen during the test by the cross sectional area, and express the result to the nearest 10 psi (0.1 MPa). The attached tables may be used to facilitate these computations.

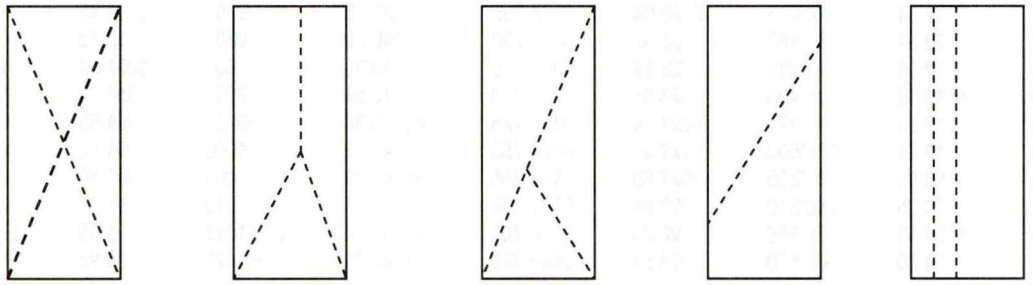


Figure 1. Compressive Fracture Types

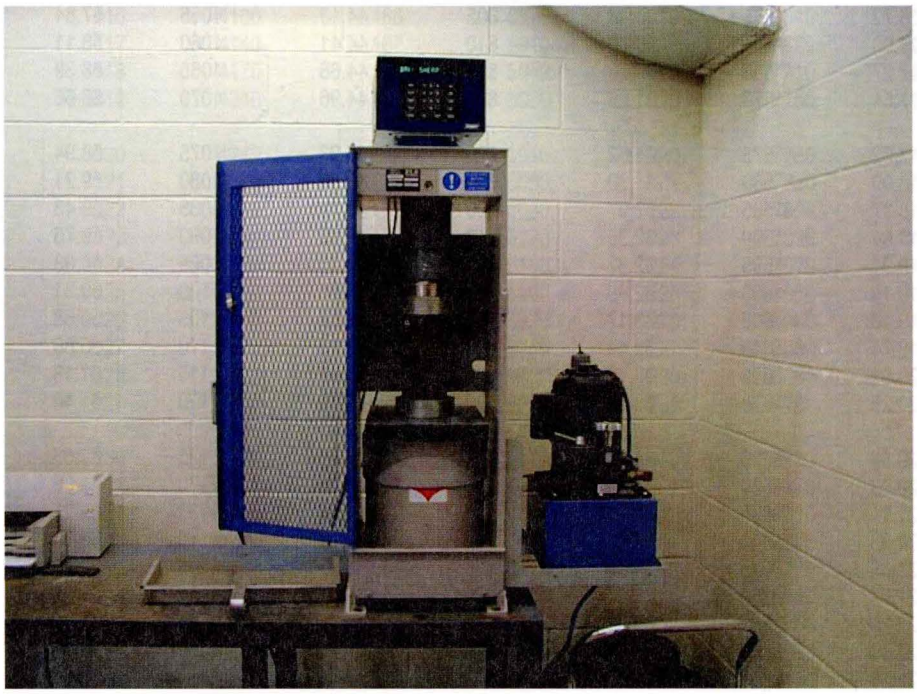


Figure 2. Compression Testing Machine

Table for Computing MPa/1000 kPa on 6 in. to 12 in. (154.mm x 304.8 mm) Cylinders
Area = 0.01824m²

Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa
175	9.59	425	23.30	675	37.01	925	50.71	1175	64.42
180	9.87	430	23.57	680	37.28	930	50.99	1180	64.69
185	10.14	435	23.85	685	37.55	935	51.26	1185	64.97
190	10.42	440	24.12	690	37.83	940	51.54	1190	65.24
195	10.69	445	24.40	695	38.10	945	51.81	1195	65.52
200	10.96	450	24.67	700	38.38	950	52.08	1200	65.79
205	11.24	455	24.95	705	38.65	955	52.36		
210	11.51	460	25.22	710	38.93	960	52.63		
215	11.79	465	25.49	715	39.20	965	52.91		
220	12.06	470	25.77	720	39.47	970	53.18		
225	12.34	475	26.04	725	39.75	975	53.45		
230	12.61	480	26.32	730	40.02	980	53.73		
235	12.88	485	26.59	735	40.30	985	54.00		
240	13.16	490	26.86	740	40.57	990	54.28		
245	13.43	495	27.14	745	40.84	995	54.55		
250	13.71	500	27.41	750	41.12	1000	54.82		
255	13.98	505	27.69	755	41.39	1005	55.10		
260	14.25	510	27.96	760	41.67	1010	55.37		
265	14.53	515	28.23	765	41.94	1015	55.65		
270	14.80	520	28.51	770	42.21	1020	55.92		
275	15.06	525	28.78	775	42.49	1025	56.20		
280	15.35	530	29.06	780	42.76	1030	56.47		
285	15.63	535	29.33	785	43.04	1035	56.74		
290	15.90	540	29.61	790	43.31	1040	57.02		
295	16.17	545	29.88	795	43.59	1045	57.29		
300	16.45	550	30.15	800	43.86	1050	57.57		
305	16.72	555	30.43	805	44.13	1055	57.84		
310	17.00	560	30.70	810	44.41	1060	58.11		
315	17.27	565	30.98	815	44.68	1065	58.39		
320	17.54	570	31.25	820	44.96	1070	58.66		
325	17.82	575	31.52	825	45.23	1075	58.94		
330	18.09	580	31.80	830	45.50	1080	59.21		
335	18.37	585	32.07	835	45.78	1085	59.48		
340	18.64	590	32.35	840	46.05	1090	59.76		
345	18.91	595	32.62	845	46.33	1095	60.03		
350	19.19	600	32.89	850	46.60	1100	60.31		
355	19.46	605	33.17	855	46.88	1105	60.58		
360	19.74	610	33.44	860	47.15	1110	60.86		
365	20.01	615	33.72	865	47.42	1115	61.13		
370	20.29	620	33.99	870	47.70	1120	61.40		
375	20.56	625	34.27	875	47.97	1125	61.68		
380	20.83	630	34.54	880	48.25	1130	61.95		
385	21.11	635	34.81	885	48.52	1135	62.23		
390	21.38	640	35.09	890	48.79	1140	62.50		
395	21.66	645	35.36	895	49.07	1145	62.77		
400	21.93	650	35.64	900	49.34	1150	63.05		
405	22.20	655	35.91	905	49.62	1155	63.32		
410	22.48	660	36.18	910	49.89	1160	63.60		
415	22.75	665	36.46	915	50.16	1165	63.87		
420	23.03	670	36.73	920	50.44	1170	64.14		

(Load in Thousands)

Table for Computing lb./in.² on 6 in. x 12 in. Cylinders
Area = 28.2744 in.²

Load	Psi	Load	Psi	Load	Psi	Load	Psi	Load	Psi
40	1410	90	3180	140	4950	190	6720	240	8490
41	1450	91	3220	141	4990	191	6760	241	8520
42	1490	92	3250	142	5020	192	6790	242	8560
43	1520	93	3290	143	5060	193	6830	243	8590
44	1560	94	3320	144	5090	194	6860	244	8630
45	1590	95	3360	145	5130	195	6900	245	8670
46	1630	96	3400	146	5160	196	6930	246	8700
47	1660	97	3430	147	5200	197	6970	247	8740
48	1700	98	3470	148	5230	198	7000	248	8770
49	1730	99	3500	149	5270	199	7040	249	8810
50	1770	100	3540	150	5310	200	7070	250	8840
51	1800	101	3570	151	5340	201	7110	251	8880
52	1840	102	3610	152	5380	202	7140	252	8910
53	1870	103	3640	153	5410	203	7180	253	8950
54	1910	104	3680	154	5450	204	7220	254	8980
55	1950	105	3710	155	5480	205	7250	255	9020
56	1980	106	3750	156	5520	206	7290	256	9050
57	2020	107	3780	157	5550	207	7320	257	9090
58	2050	108	3820	158	5590	208	7360	258	9120
59	2090	109	3860	159	5620	209	7390	259	9160
60	2120	110	3890	160	5660	210	7430	260	9200
61	2160	111	3930	161	5690	211	7460	261	9230
62	2190	112	3960	162	5730	212	7500	262	9270
63	2230	113	4000	163	5760	213	7530	263	9300
64	2260	114	4030	164	5800	214	7570	264	9340
65	2300	115	4070	165	5840	215	7600	265	9370
66	2330	116	4100	166	5870	216	7640	266	9410
67	2370	117	4140	167	5910	217	7670	267	9440
68	2410	118	4170	168	5940	218	7710	268	9480
69	2440	119	4210	169	5980	219	7750	269	9510
70	2480	120	4240	170	6010	220	7780		
71	2510	121	4280	171	6050	221	7820		
72	2550	122	4310	172	6080	222	7850		
73	2580	123	4350	173	6120	223	7890		
74	2620	124	4390	174	6150	224	7920		
75	2650	125	4420	175	6190	225	7960		
76	2690	126	4460	176	6220	226	7990		
77	2720	127	4490	177	6260	227	8030		
78	2760	128	4530	178	6300	228	8060		
79	2790	129	4560	179	6330	229	8100		
80	2830	130	4600	180	6370	230	8130		
81	2860	131	4630	181	6400	231	8170		
82	2900	132	4670	182	6440	232	8210		
83	2940	133	4700	183	6470	233	8240		
84	2970	134	4740	184	6510	234	8280		
85	3010	135	4770	185	6540	235	8310		
86	3040	136	4810	186	6580	236	8350		
87	3080	137	4850	187	6610	237	8380		
88	3110	138	4880	188	6650	238	8420		
89	3150	139	4920	189	6680	239	8450		

(Load in Thousands)

Table for Computing lb./in.² on 4 in. x 8 in. Cylinders
Area = 12.5666 in.²

Load	Psi	Load	Psi	Load	Psi	Load	Psi
10	800	50	3980	90	7160	130	10350
11	880	51	4060	91	7240	131	10420
12	950	52	4140	92	7320	132	10500
13	1030	53	4220	93	7400	133	10580
14	1110	54	4300	94	7480	134	10660
15	1190	55	4380	95	7560	135	10740
16	1270	56	4460	96	7640	136	10820
17	1350	57	4540	97	7720	137	10900
18	1430	58	4620	98	7800	138	10980
19	1510	59	4700	99	7880	139	11060
20	1590	60	4770	100	7960	140	11140
21	1670	61	4850	101	8040	141	11220
22	1750	62	4930	102	8120	142	11300
23	1830	63	5010	103	8200	143	11380
24	1910	64	5090	104	8280	144	11460
25	1990	65	5170	105	8360	145	11540
26	2070	66	5250	106	8440	146	11620
27	2150	67	5330	107	8520	147	11700
28	2230	68	5410	108	8590	148	11780
29	2310	69	5490	109	8670	149	11860
30	2390	70	5570	110	8750	150	11940
31	2470	71	5650	111	8830	151	12020
32	2550	72	5730	112	8910	152	12100
33	2630	73	5810	113	8990	153	12180
34	2710	74	5890	114	9070	154	12260
35	2790	75	5970	115	9150	155	12330
36	2860	76	6050	116	9230	156	12410
37	2940	77	6130	117	9310	157	12490
38	3020	78	6210	118	9390	158	12570
39	3100	79	6290	119	9470	159	12650
40	3180	80	6370	120	9550	160	12730
41	3260	81	6450	121	9630	161	12810
42	3340	82	6530	122	9710	162	12890
43	3420	83	6610	123	9790	163	12970
44	3500	84	6680	124	9870	164	13050
45	3580	85	6760	125	9950	165	13130
46	3660	86	6840	126	10030	166	13210
47	3740	87	6920	127	10110	167	13290
48	3820	88	7000	128	10190	168	13370
49	3900	89	7080	129	10270	169	13450

Table for Computing MPa on 4 in. x 8 in. (101.6 mm x 203.3 mm) Cylinders
Area = 0.008107 m²

Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa	Load (kN)	MPa
45	5.55	245	30.22	445	54.89	645	79.56
50	6.17	250	30.84	450	55.51	650	80.18
55	6.78	255	31.45	455	56.12	655	80.79
60	7.40	260	32.07	460	56.74	660	81.41
65	8.02	265	32.69	465	57.36	665	82.03
70	8.63	270	33.30	470	57.97	670	82.64
75	9.25	275	33.92	475	58.59	675	83.26
80	9.87	280	34.54	480	59.21	680	83.88
85	10.48	285	35.15	485	59.82	685	84.49
90	11.10	290	35.77	490	60.44	690	85.11
95	11.72	295	36.39	495	61.06	695	85.73
100	12.34	300	37.01	500	61.68	700	86.35
105	12.95	305	37.62	505	62.29	705	86.96
110	13.57	310	38.24	510	62.91	710	87.58
115	14.19	315	38.86	515	63.53	715	88.20
120	14.80	320	39.47	520	64.14	720	88.81
125	15.42	325	40.09	525	64.76	725	89.43
130	16.04	330	40.71	530	65.38	730	90.05
135	16.65	335	41.32	535	65.99	735	90.66
140	17.27	340	41.94	540	66.61	740	91.28
145	17.89	345	42.56	545	67.23	745	91.90
150	18.50	350	43.17	550	67.84	750	92.51
155	19.12	355	43.79	555	68.46	755	93.13
160	19.74	360	44.41	560	69.08	760	93.75
165	20.35	365	45.02	565	69.69		
170	20.97	370	45.64	570	70.31		
175	21.59	375	46.26	575	70.93		
180	22.20	380	46.87	580	71.54		
185	22.82	385	47.49	585	72.16		
190	23.44	390	48.11	590	72.78		
195	24.05	395	48.72	595	73.39		
200	24.67	400	49.34	600	74.01		
205	25.29	405	49.96	605	74.63		
210	25.90	410	50.57	610	75.24		
215	26.52	415	51.19	615	75.86		
220	27.14	420	51.81	620	76.48		
225	27.75	425	52.42	625	77.09		
230	28.37	430	53.04	630	77.71		
235	28.99	435	53.66	635	78.33		
240	29.60	440	54.27	640	78.94		

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS

CEMENT
R. KINKADE

CONCRETE COMPRESSION

Project _____ Contract # _____ County _____ Lab No. _____ thru _____

_____ Plant _____ Contractor _____

_____ Producer _____ Mix Type: _____

_____ Unit of Material 4 x 8 Cylinders Description _____

Sampled by _____ Date Received _____ Date Reported _____

C-231Tested by _____ C-143 Tested by _____ C-39 Tested by _____

Lab No.	Senders No.	Date Made	Cylinder No.	% Air Content ASTM C-231	Slump (in.) ASTM C-143	Date Tested	Age (days)	Diameter (in.)	Cross Sectional Area (sq.in.)	Total Load (lbs)	Strength (psi) ASTM C-39	Type of Failure

REMARKS _____

_____

Signed _____

Review Questions
Making & Testing Concrete Cylinders
IM 315

1. To consolidate the concrete in the cylinder if the slump is greater than 3 inches, a _____ should be used.

2. If the cylinder is 6 in. x 12 inches the concrete should be put into the mold in _____ equal layers.

3. How should the specimens be stored for the first 24 hours?

4. When should the specimens be removed from the molds?

5. It is important that the specimen be kept _____ until testing.

6. The top surface of vertically cast specimens shall be capped.

   True _____ False _____

7. The load should be applied at a constant rate within the range of _____ to _____ psi per second.

MATURITY TESTING OF CONCRETE

Maturity testing is performed to determine the strength of in-place concrete, using a non-destructive method by using curing temperatures. Concrete gains strength with time and temperature so by monitoring the time and temperature factors, strength can be estimated.

Maturity testing is performed and monitored by both contractors and agencies. The use of the maturity method allows contractors to open pavements earlier than when beams are used to determine pavement strength.

Developing a maturity curve and the monitoring of the time, temperature factor to calculate strength are both important pieces in the strength calculation. The calculations need to be properly performed or the strength could be incorrect. Water/ cement ratio (w/c) has a big impact on strength so the curve development should be performed with concrete at the highest w/c anticipated. The beams that are made for the maturity curve should be cast according to IM 328 and tested according to IM 316 to ensure the curve is properly developed.

IM 383 explains the proper procedure to use maturity testing on a project.
IM 204 specifies testing frequencies.

October 17, 2006
Supersedes April 18, 2006

TESTING THE STRENGTH OF PORTLAND CEMENT CONCRETE USING THE MATURITY METHOD

GENERAL

This IM outlines the procedure for using the maturity concept as a nondestructive method to determine concrete strength.

This is a two-step procedure. First, a relationship must be established between the maturity values and the concrete strength as measured by destructive methods (that is, through testing of beams or cylinders). The development of the maturity-strength curve shall be done in the field at the beginning of construction using project materials and the project proportioning and mixing equipment. The second step is the instrumentation of the concrete to be measured. Temperature probes are installed in the concrete and the temperature is measured. From those measurements, along with the age at which the measurements were taken, maturity values are determined. A maturity meter or temperature-measuring device and a computer or calculator may also be used to determine the maturity values.

The contractor and the agency shall jointly develop a plan for performing the maturity testing. The plan shall include:

1. The contractor shall be responsible for the development of the maturity curve. The curve development shall be monitored by the contracting agency.
2. The temperature monitoring process of the constructed pavement or structure shall be the responsibility of the contractor and shall be monitored by the contracting agency. Determining that sufficient strength has been achieved shall remain the responsibility of the engineer. The contractor shall provide documentation of maturity testing before a pavement section may be opened to traffic, a structure may be loaded, or the forms may be removed.

For concrete furnished from a construction or stationary mixer, which is in place prior to construction of the specified project, a maturity curve may be established ahead of actual construction of the specified project. The test specimens shall be cast with concrete made from the same plant and using the same materials source as will be used in the specified project. The agency shall be informed and have an opportunity to observe the development of the maturity curve.

THE MATURITY CONCEPT

The hydration of cement and gain in strength of the concrete is dependent on both curing time and temperature. Thus, the strength of the concrete may be expressed as some function of time and temperature. This information can then be used to determine the strength of concrete without conducting physical tests. The time-temperature function commonly used is the maturity concept proposed by Nurse-Saul (ASTM C1074),

$$M\ (^{\circ}C \times \text{hours}) = \sum [(T - T_0)\ \Delta t]$$

Where M is the maturity in °C-hours [M is also termed the time-temperature factor (TTF)], Δt is the time interval in hours (or days), T is the average concrete temperature during the time interval Δt, and T_0 is the datum temperature at which concrete ceases to gain strength with time. The value of T_0 = 14°F (-10°C) is most commonly used. As a result, Equation 1 becomes:

$$M\ (°C \times \text{hours}) = \sum [(T + 10)\ \Delta t] \quad \text{Equation 2}$$

ESTABLISHMENT OF MATURITY-STRENGTH RELATIONSHIP

Precaution: When the concrete temperature is below 50°F (10°C), maturity strength development will cause over extended TTF values. Development of strength maturity relationship should be performed on concrete with temperatures above 50°F (10°C).

When air temperatures are expected to fall below 40°F (4°C), place the beams on a piece of foam board or plywood to prevent the cold ground from lowering beam temperatures. Placing insulation over the beams to retain heat may also be warranted.

To establish a maturity-strength relationship for a concrete mix, a maturity meter or other maturity and continual temperature profiling system and a hydraulic testing machine are needed. The following procedure shall be used: **(NOTE: Before using any maturity meter, check to be sure the datum temperature is set to -10°C.)** The procedure to check or change the datum temperature is included at the end of this IM

1. Cast a minimum of twelve (12) 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm) beams, as per IM 328. Test the entrained air content and slump of the concrete being used to cast the beams, as per IM 327. Record these values. The concrete shall meet specifications. Since there is a direct relationship between w/c ratio and strength, the concrete used to develop the maturity-strength relationship shall be at the maximum w/c ratio expected during production. The beams shall be cast from a batch of at least 3m³ (3 cu. yd.).

2. Embed a thermocouple wire near each end of a test beam (when flexural strength is to be determined) to monitor the temperature. This beam will be the last to be tested. A probe shall be inserted near each beam end to the approximate mid-depth and such that they are approximately 3 in. (75 mm) from each side and each end. Loop the wire around the beam box handles to prevent the wire from being inadvertently pulled out of the beam. The average of the two readings will be used in the development of the maturity-strength curve. When a maturity meter is used, the meter computes the values. Twelve (12) test specimens shall be tested as described in #4 below.

3. Cast, cure, and test the beams at the plant site. Test in accordance to IM 316. This will allow a maturity meter to be protected from the weather and theft. The meter can be stored in a lab trailer or vehicle with the probes run outside to the beam in the sandpit. The beams shall be covered with plastic immediately after casting and prior to form removal. If possible, wet burlap should be placed over the surface of the beams under the plastic. The forms shall be removed the following day. Cure all beams in a pit of wet sand after form removal, until they are tested.

4. Determine maturity values and strength at four different ages. Test three specimens for strength at each age and calculate the average strength at each age. The maturity value shall be calculated from a temperature reading at the time the specimen is tested for strength. The tests shall be spaced such that they are performed at somewhat consistent intervals of time and span a range in strength that includes the opening strength desired. The table below gives suggested maturity values for each test of three standard mixture classes. This is only a guide and may need to be modified, depending on specific mixtures and conditions.

Approximate Maturity Values (TTF)

	Test 1	Test 2	Test 3	Test 4
A Mix	750	1500	2500	3500
B Mix	1500	3500	5500	7500
C Mix	750	1500	2500	3500
M Mix	600	1200	2000	3000

These values assume opening strength for pavements of 3.45 MPa (500 psi) for the A, B and C mixtures, and a five-hour opening for the M mixture with calcium chloride. If the maturity curve is intended for use in determining the time to begin joint sawing, testing must begin at lower maturity values.

For structural concrete, a minimum flexural strength of 3.8 MPa (550 psi) is required before concrete may be subjected to flexural loading. Strength requirements vary for determining when forms for roofs of culverts may be removed (See Article 2403.18). Testing intervals may need to be increased over those for paving.

The first test (Test 1), for Class C mixes, normally would be performed at an age of approximately twelve (12) hours when hot, summer temperatures prevail. During cooler conditions, the first test may be performed at the beginning of the day following the casting of test specimens.

Additional test specimens may be cast at a later time and tested at earlier ages to add data to the strength-maturity relationship as an aid to determining the appropriate time to saw.

5. Plot the measured strength against the corresponding values of maturity at different ages, as determined by the maturity meter or by hand methods. Use a computer program provided by the District Materials Concrete Technician to determine maturity-strength relationship. The TTF number corresponding to the opening strength or the flexural loading strength/form removal strength of the structure shall be used to determine when the pavement has reached opening strength or the structure has reached the required loading strength. An example of the Maturity-Strength Development form, generated by the computer program, is included at the end of this IM This form shall be signed by the contractor/contractor representative and reviewed by the DME. Copies will be provided to the Project Engineer, DME, Central Materials, PCC Engineer, and the contractor.

FIELD PROCEDURE

Equipment

1. 12 - 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm) beam molds
2. 1 each shovel (square point), rubber hammer or equivalent, and wood float or equivalent
3. 1 each hydraulic testing machine – center point leading flexural
4. 1 each maturity meter or other maturity and temperature profiling system
5. 1 each hand-held thermometer or other continual temperature-monitoring device
6. Type T thermocouple wire
7. Connectors

Placement of the Temperature Probes

Strip the coating from each end of the two wires and twist the ends together before inserting them into the fresh concrete.

For pavements, insert the temperature probe into the concrete until the end is at approximately the pavement mid-depth and 1.6 feet (0.5 m) from the edge of the pavement. The wire ends are the points at which the temperature measurement is taken. Insertion may be accomplished by attaching the wire ends to a wooden dowel and embedding it into the slab. Check to ensure the concrete is consolidated around the dowel. The portion of the dowel that protrudes above the pavement should be cut or broken off after the testing is completed.

Probes may be placed at any point along the pavement slab. A minimum of two probes shall be placed in each day's placement. On days when there is a large difference between daytime high temperatures and nighttime low temperatures, placing additional probes near the beginning of the day's run and at a point near the midday location would provide helpful information. This would be helpful to those sawing the pavement as well as those determining the opening time. It has been found that the concrete does not always gain strength at the same rate. Therefore the concrete placed during the middle of the day can gain strength faster than the concrete placed at the beginning of the day.

For structures, a minimum of two probes shall be attached to the reinforcing steel near the edge at the upper corner of the exposed surface. (See Figure 1 at the end of this IM.) The probe should be wrapped around the rebar and taped with approximately 1 to 2 inches (25 to 50 mm) extending below the rebar to prevent the probe from damage and removal during concrete placement. The rebar should also be taped 2 to 3 inches (50 to 75 mm) on both sides of the probe location to prevent contact with the reinforcing steel. (See Figure 2 at the end of this IM.)

Data Collection

The other probe wire ends, not placed in the concrete, shall be connected to a plug, unless the temperature-measuring device must be connected to the probe directly with bare wires. The plug is then inserted into the maturity meter or thermal meter. Normally a thermal meter can be used to collect field data. Be careful to connect the copper wire to the copper plug prong (+).

When a thermal meter is used, the wire is connected to the meter each time a temperature is taken. Then the wire is disconnected and the value recorded. A Maturity Data Recording Sheet is provided at the end of this IM, which may be used to record the temperature readings and calculate the maturity values.

Do not disconnect the wire from the maturity meter until the test is completed. The data collection must be uninterrupted. Also the maturity meter must be protected from rain or water. If water finds its way inside the meter, permanent damage will result.

Once the wires are placed, an initial temperature of the concrete shall be taken and recorded, when a thermal meter is being used. Temperature readings should be taken in the morning and late afternoon, when one first arrives on the project and before one leaves for the day, as a minimum for standard A, B and C mixtures. For the fast-setting mixtures, readings should be taken every few hours, depending on weather conditions and mixture. If a maturity meter is being used, it should be connected to the probe as soon as possible to begin data collection.

Measuring the Maturity

For pavements, the maturity number can be read directly from the maturity meter or calculated from the temperature readings obtained by the thermal meter or other continual temperature-monitoring device. This number is then used to enter the strength-maturity chart that was established as described above and strength is then determined. **NOTE:** An instruction sheet will accompany each maturity meter. It is important to follow these instructions to initialize the instrument.

For structures, a maturity number can be read directly from the maturity meter or calculated from the temperature readings that shall be obtained from a continual temperature-monitoring device.

Implementation

For pavements, when used at the contractor's option, it is the intent of the procedure to use the maturity method to open the pavement to traffic from the very first day of paving, including the days of development of new curves.

Pavement placed on the first day during development of the strength-maturity curve may be opened when either of the following criteria has been met:

1. The TTF of the slab, or structure, meets or exceed the opening TTF as determined by the strength-maturity curve being developed.

2. At a particular test age, the average strength of the three beams used for development of the strength-maturity curve meets or exceeds the required opening strength.

For structures, since maturity is to be used on units exposed to flexural loading, the maturity curve should be developed early in the project during placement of concrete exposed to compressive stress. If this is not possible, concrete placed on the same day as development of the strength-maturity curve may be loaded at a particular age using either of the first day placement criteria required for pavements.

Validation

Once per month, validation tests shall be conducted to determine if concrete strength is being represented by the current maturity curve. Cast and cure three (3) beams using the same procedure and manner as used to develop the current maturity curve. Test all three beams as close as possible to the maturity value determined to represent the opening strength of the pavement or the flexural loading strength or form removal strength of the structure.

For pavements, if the average calculated strength value at the TTF the validation beams were tested is within the range of ±50 psi (0.34 MPa) of the original curve, the original curve shall be considered validated. If the average calculated strength at the TTF the validation beams were tested is lower than the minimum range (-50 psi (-0.34 MPa)) of the original maturity curve, a new maturity curve shall be developed. If the average calculated strength at the TTF the validation beams were tested is greater than the maximum range (+50 psi (+0.34 MPa)) of the original maturity curve, a new maturity curve may be developed at the contractor's option.

For structures, if the average calculated strength is greater than the original curve at the TTF the validation beams were tested, the original curve shall be considered validated. If the average calculated strength is less than the original maturity curve at the TTF the validation beams were tested, a new maturity curve shall be developed.

An example of the Validation of the Maturity Curve is included at the end of this IM. Signed copies shall be provided to the RCE, DME, Central Materials, PCC Engineer, and the contractor.

This validation procedure is a check to ensure the mix is basically the same as originally tested. If the test results indicate a new curve must be developed, this should be done in a timely manner. The curve currently being used shall be continued until new beams can be cast and at that point the implementation procedure described above shall be followed.

Factors Requiring a New Curve

Changes in material sources, proportions, and mixing equipment all affect the maturity value of a given concrete mixture. Development of a new maturity curve due to material source or proportion changes in a concrete mix may be waived by use of the validation procedure.

The following will require a new curve to be developed:

- The average calculated strength at the TTF the validation beams were tested is lower than the minimum range (-50 psi (-0.34 MPa)) of the original maturity curve (pavements only).
- The w/c ratio of the production concrete exceeds the w/c ratio of the concrete used to develop the strength-maturity curve by more than 0.02.

Calibration

Maturity meters shall be calibrated yearly to ensure proper temperature sensing. The calibration may be performed at the Central Laboratory, before the start of each construction. To ensure accurate temperature measurement, the maturity meter should also be checked periodically against a certified thermometer or other calibrated meter.

EXAMPLE

Maturity - Field Data

Project : FM-67(25)--55-67 Date Placed: 8/12/1999 Maturity Curve #: 1
County : MONONA Mix: C-3WR-C-15
Contractor:

TTF Required for Opening or Loading : 1585

SITE 1 | *Section of Pavement for Opening or Structural Unit for Loading by Maturity* | Probe # 1

Structual Unit or Probe Location From: | Probe Location To:

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
08/12/99	09:00 AM	0.00	22	0	0	
	01:00 PM	4.00	29	142	142	
	05:30 PM	8.50	25	167	309	
08/13/99	08:00 AM	23.00	19	464	773	
	02:30 PM	29.50	22	198	971	
08/14/99	08:00 AM	47.00	21	551	1522	
	01:30 PM	52.50	20	168	1690	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: 1690 Value in box should be greater than or equal to required TTF.

SITE 2 | *Section of Pavement for Opening or Structural Unit for Loading by Maturity* | Probe #

Structual Unit or Probe Location - From: | To Probe Location:

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
		0.00		0	0	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: Value in box should be greater than or equal to required TTF.

cc: RCE, Central Materials, Contractor

Contractor Representative

Agency Representative

Maturity - Field Data

Project : _____ Date Placed: _____ Maturity Curve #: _____
County : _____ Mix: _____
Contractor: _____

TTF Required for Opening or Loading :	

SITE 1	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*	Probe #	

Structual Unit or Probe Location From:		Probe Location To:	

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
		0.00		0	0	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: _____ Value in box should be greater than or equal to required TTF.

SITE 2	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*	Probe #	

Structual Unit or Probe Location - From:		To Probe Location:	

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
		0.00		0	0	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: _____ Value in box should be greater than or equal to required TTF.

cc: RCE, Central Materials, Contractor

_____ *Contractor Representative*

_____ *Agency Representative*

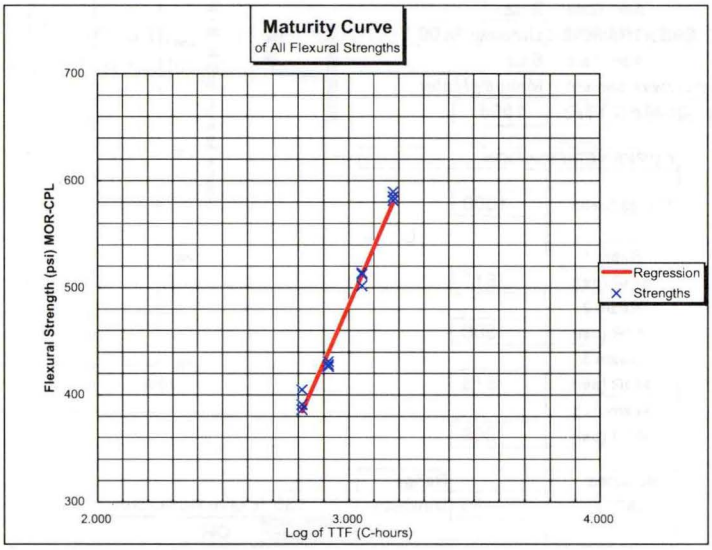
MATURITY - STRENGTH DEVELOPMENT MOR-CPL

COUNTY: Polk
CURVE #: 1
PROJ. #: IM-35-5(99)
MONITOR: Jenkins
REP/CONTRACTOR: Manatt's
INSPECTOR: Smith
DATE: 05/05/03

BEAM #	LOAD AT BREAK (lbs)	TABLE VALUE (lbs)	BREAK LOCATION (in)	WIDTH (in)	DEPTH (in)	FLEXURAL COEFFICIENT	FLEXURAL STRENGTH CPL (psi)	AGE AT BREAK (days)	TTF CH 1	TTF CH 2	AVERAGE TTF	BEAM TEMP (AVG)
	Enter	*Enter*	*Enter*	*Enter*	*Enter*			*Enter*	*Enter*	*Enter*		*Enter*
1	3000	3100	0.5	5.98	6.02	0.124586	386	24	650	650	650	26
2	3100	3250	0.5	6.00	6.01	0.124584	405	24	650	650	650	26
3	3050	3150	0.5	6.00	6.02	0.124171	391	24	650	650	650	26
4	3450	3400	0.5	5.98	6.00	0.125418	426	38	800	850	825	24
5	3550	3450	0.5	6.00	6.00	0.125000	431	38	800	850	825	24
6	3500	3425	0.5	6.00	6.00	0.125000	428	38	800	850	825	24
7	4000	4100	0.5	5.98	6.00	0.125418	514	55	1100	1150	1125	22
8	3990	4000	0.5	5.98	6.00	0.125418	502	55	1100	1150	1125	22
9	4000	4100	0.5	6.00	6.00	0.125000	513	55	1100	1150	1125	22
10	4600	4650	0.5	6.00	6.00	0.125000	581	72	1500	1500	1500	23
11	4700	4680	0.5	6.00	6.00	0.125000	585	72	1500	1500	1500	23
12	4750	4700	0.5	5.98	6.00	0.125418	589	72	1500	1500	1500	23

MIX INFORMATION	*Enter*
AIR:	7.2
SLUMP:	2
w/c:	0.41
MIX:	C-4WR-C15
FLY ASH SOURCE:	Port Neal #4
GGBFS SOURCE:	
CEMENT SOURCE:	Lehigh
COARSE AGGREGATE SOURCE:	Ames Mine
INTERM. AGGREGATE SOURCE:	
FINE AGGREGATE SOURCE:	Vandalia
WATER REDUCER BRAND:	Daratard 17
Add. Rate:	2 oz.
AIR ADMIXTURE BRAND:	Daravair 1400
Add. Rate:	6 oz.
METHOD OF DEVELOPMENT:	Maturity Meter
Desired Flexural Strength (MOR-CPL):	500 psi

REQUIRED TTF:	1066



Certified Contractor Representative - _____
Signature

Maturity Curve Reviewed - _____
Testing Engineer

cc: RCE, DME, Central Materials, Contractor

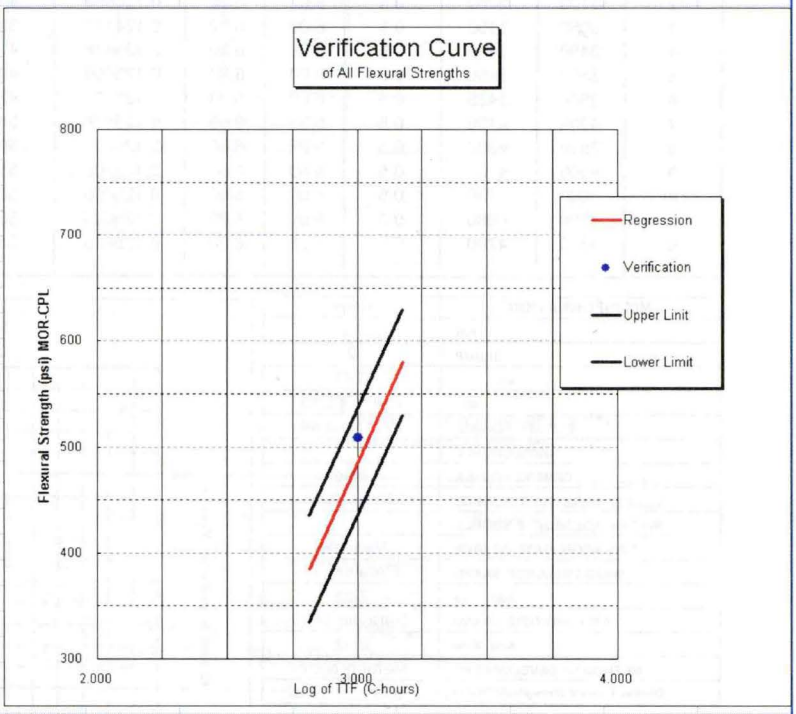
Comments:

VERIFICATION OF MATURITY CURVE

CURVE #: 1 | MONITOR: Jenkins | INSPECTOR: Smith
PROJ. #: IM-35-5(99) | CONTRACTOR: Manatt's | Verification DATE: 6/11/03

BEAM #	LOAD AT BREAK (lbs)	TABLE VALUE (lbs)	BREAK LOCATION (in)	WIDTH (in)	DEPTH (in)	FLEXURAL COEFFICIENT	FLEXURAL STRENGTH (psi)	AGE AT BREAK (DAYS)	TTF CH 1	TTF CH 2	AVERAGE TTF
	Enter	Enter	Enter	Enter	Enter			Enter	Enter	Enter	
1	4000	4100	0.5	6.00	6.00	0.125000	513	39	1000	1000	1000
2	3990	4000	0.5	6.00	6.00	0.125000	500	39	1000	1000	1000
3	4000	4100	0.5	6.00	6.00	0.125000	513	39	1000	1000	1000

AIR:	6.9	Enter
SLUMP:	2.5	Enter
w/c:	0.42	Enter
MIX:	C-4WR-C15	
FLY ASH:	Port Neal #4	
GGBFS:	0	
CEMENT:	Lehigh	
COARSE AGGREGATE:	Ames Mine	
INTERM. AGGREGATE:	0	
FINE AGGREGATE:	Vandalia	
WATER REDUCER:	Daratard 17	
Add. Rate:	2 oz.	
AIR ENTRAINER:	Daravair 1400	
Add. Rate:	6 oz.	
Method of Development:	Maturity Meter	
REQUIRED TTF:	**1066**	



CURVE VERIFICATION	
TTF @ Break	1000
Beam 1 MOR (psi)	513
Beam 2 MOR (psi)	500
Beam 3 MOR (psi)	513
Beam Avg. MOR (psi)	508

Calculated psi @ TTF	485	Range	
		Minimum	435
		Maximum	535

Curve Verification: **OK**

Comments:

Verification strength above the upper limit does not require a new curve.

Certified Maturity Contractor Representative - _____ Signature

Maturity Curve Verification Reviewed - _____ Testing Engineer

cc: RCE, DME, Central Materials, Contractor

MATURITY.XLS
Jul-01

Procedure to Determine Datum Temperate Setting for Humboldt Maturity Meters

Key	Displays
Press **ENTER**	PRESENT VALUES CH 1 Temp: XX
Press **REC**	RECORDING 1. START
Press **REC**	SETUP 1. DATUM TEMP
Press **ENTER**	SETUP DATUM TEMP: -10

If datum temperature is not set to -10° C, press the up (↑) or down (↓) arrows to set the maturity meter to –10. Then press ENTER to save the settings.

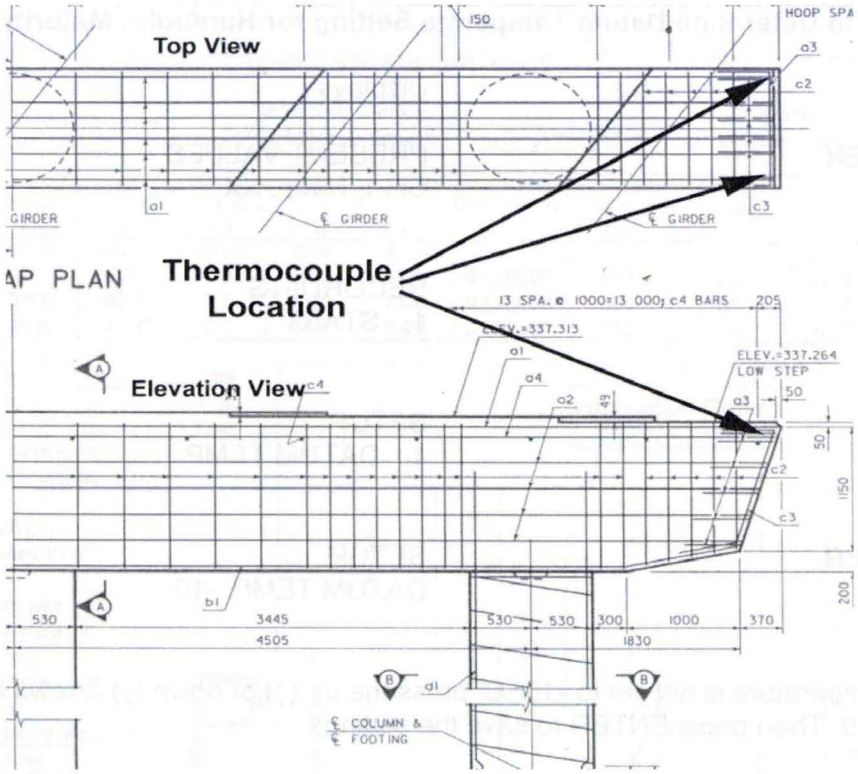


Figure 1. Typical thermocouple location placement in pier cap Use similar method for thermocouple placement in other structural elements.

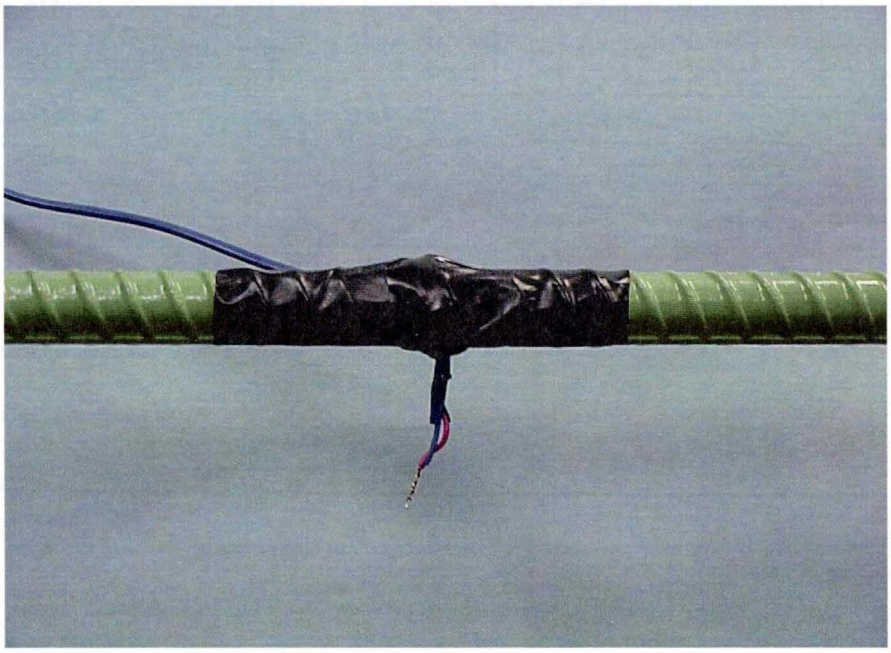


Figure 2. Typical attachment of thermocouple to reinforcing steel

Maturity - Field Data

Form M142

Project : _____ Date Placed: _____ Maturity Curve #: _____

County : _____ Mix: _____

Contractor: _____

TTF Required for Opening or Loading : _____

SITE 1 | *Section of Pavement for Opening or Structural Unit for Loading by Maturity* | **Probe #** _____

Structual Unit or Probe Location From: _____ **Probe Location To:** _____

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
		0.00		0	0	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: _____ **Value in box should be greater than or equal to required TTF.**

SITE 2 | *Section of Pavement for Opening or Structural Unit for Loading by Maturity* | **Probe #** _____

Structual Unit or Probe Location - From: _____ **To Probe Location:** _____

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
		0.00		0	0	

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: _____ **Value in box should be greater than or equal to required TTF.**

cc: RCE, Central Materials, Contractor

Contractor Representative

Agency Representative

Review Questions
Strength of Portland Cement Concrete
Using the Maturity Method
IM 383

1. What are the two steps in using the maturity process?

   1. _____
   2. _____

2. What are the two factors that the strength of concrete is dependent upon?

3. How many beams are cast to develop a maturity curve?

4. What is the minimum size batch of concrete used to cast beams for maturity?

5. When developing a curve, maturity values are determined at how many different ages?

6. Where are the probes placed in the fresh concrete after it is placed on the grade?

7. What is the minimum amount of probes that shall be placed in each day's placement?

8. How often are validation tests conducted?

9. How many beams are cast for validation tests?

Maturity or TTF (°C x hr)

$= \sum(((Temp_1 + Temp_2)/2)\,\Delta\, T_{hrs})$

= Sum of (Average Temperature in °C + 10) x (Time in hours)

Readings:

Age (hrs)	Temp °C	TTF	Sum of TTF	
0	34.6	0		
12	34.6	535	0+535 =	535
23	42.9	536	535+536 =	1071
37	30.7	655	655+1071 =	1726

TTF @ 12 hours = ((34.6 + 34.6)/2 + 10)x(12-0)
= (34.6 + 10)x12
= 535

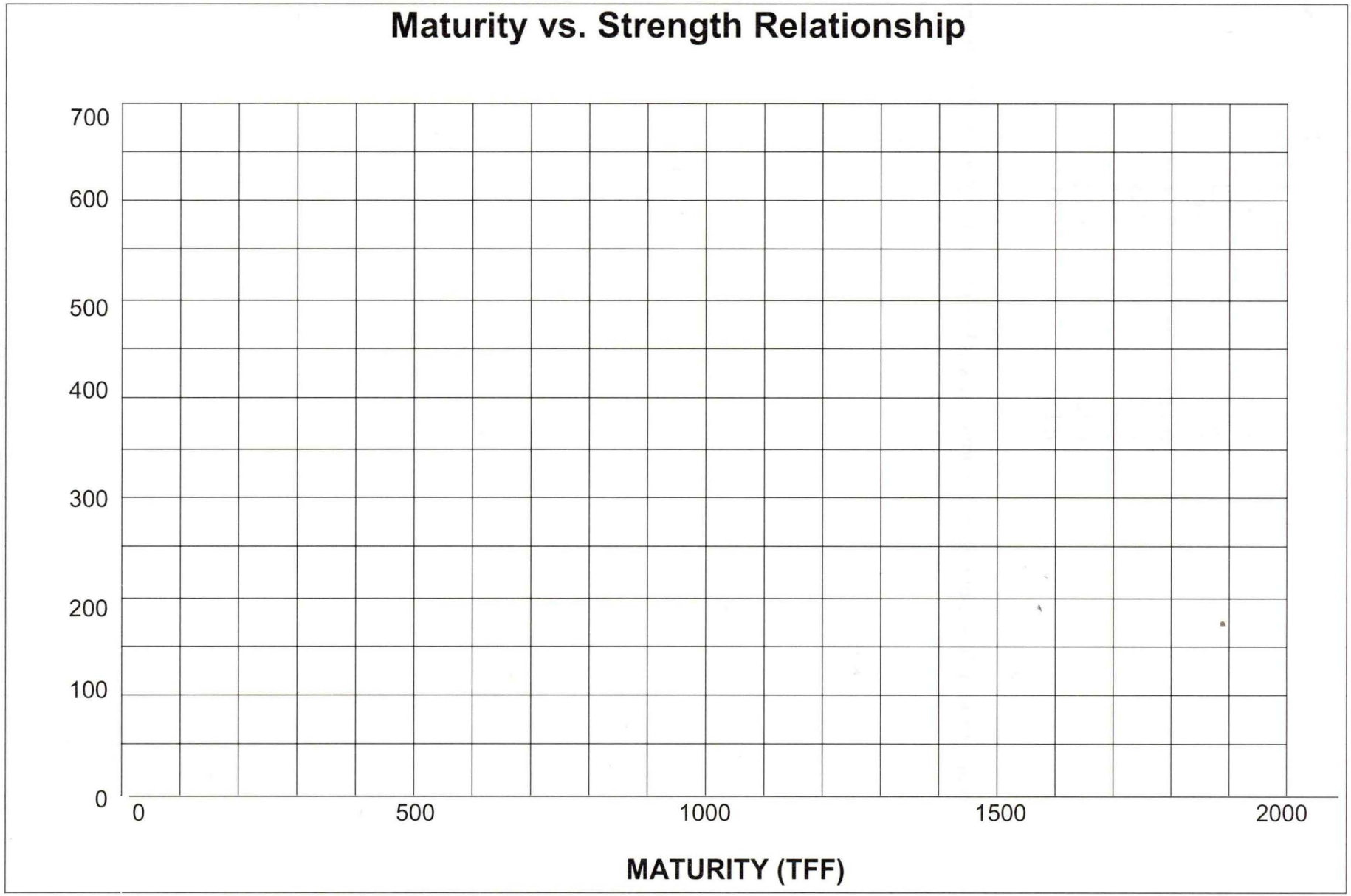
TTF @ 23 hours =((34.6 + 42.9)/2 + 10)x(23-12)
= (38.75 + 10)x11
= 536

TTF @ 37 hours = ((30.7 + 42.9)/2) + 10)x(37 – 23)
= (36.8 + 10)x14
= 655

Given:

Maturity Values (TTF)	Average Flexural Strengths (psi)
435	180
616	363
1749	509
1922	565

Plot the Maturity vs. Strength curve and determine the TTF value for opening strength of 500 psi.


Maturity vs. Strength Relationship
Modulus of Rupture, psi
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
MATURITY (TFF)

Given:

Temp (°C)	Age (hrs)
19.6	0.0
17.9	14.0
22.9	20.0
17.1	38.5
21.3	44.0
20.3	86.5

Calculate the maturity value (TTF) for each time interval and the TTF sum value.

Given:

Temp (°C)	Age (hrs)
22.2	0.0
19.0	16.5
26.5	23.5
15.9	39.5
20.2	46.0
14.8	63.0

Calculate the maturity value (TTF) for each time interval and the TTF sum value.

Maturity - Field Data

Form M142

Project : _____ Date Placed: _____ Maturity Curve #: _____

County : _____ Mix: _____

Contractor: _____

TTF Required for Opening or Loading :	

SITE 1	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*		Probe #	

Structual Unit or Probe Location From:		Probe Location To:	

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
08/08/03	10:00 A.M.	0.00	19.7	0	0	
08/08/03	5:00 P.M.		20.3	0		
08/09/03	9:00 A.M.		17.6	0		
08/09/03	4:00 P.M.		18.9	0		
08/10/03	8:00 A.M.		17.4	0		
08/10/03	2:00 P.M.		19.2	0		

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10\right)(Age_i - Age_{i-1})$$

TTF: _____ **Value in box should be greater than or equal to required TTF.**

Maturity - Field Data

Form M142

Project : _____ Date Placed: _____ Maturity Curve #: _____
County : _____ Mix: _____
Contractor: _____

TTF Required for Opening or Loading :	

SITE 1	*Section of Pavement for Opening or Structural Unit for Loading by Maturity*		Probe #	

Structual Unit or Probe Location From:		Probe Location To:	

Date *Enter*	Time *Enter*	Age (hours) *Enter*	Temp (deg C) *Enter*	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) *Enter*
07/01/03	8:00 A.M.	0.00	18.1	0	0	
07/02/03	9:00 A.M.		17.3	0		
07/02/03	3:00 P.M.		21.7	0		
07/03/03	10:00 A.M.		19.6	0		
07/03/03	4:00 P.M.		22	0		
07/05/03	7:00 A.M.		17.8	0		

$$TTF_i = \left(\frac{Temp_i + Temp_{i-1}}{2} + 10 \right) (Age_i - Age_{i-1})$$

TTF: _____ **Value in box should be greater than or equal to required TTF.**

Measuring Length of Drilled Concrete Cores

Core lengths are measured to determine the thickness of Portland cement concrete pavements.

An incentive is given to the Contractor based on thickness of the cores over design thickness. When cores greater than one inch deficient in length are found, more cores will be taken to determine the area of removal.

Core locations are determined by the District Materials Engineer to ensure random locations are used. Cores are drilled by the contractor and witnessed by the agency. Cores shall be measured on the grade by the agency or taken into immediate possession. In order to avoid problems with core diameter, check that the core diameter is 4 inches when the first cores are drilled. A 4.25" outside diameter (OD) bit will produce 4" cores.

Core ends must be free of conditions not typical of the surfaces of the structure. Remove pieces of aggregate subbase stuck on the core. A large screwdriver, hammer, and wire brush may be used to force subbase material from the bottom of the core. Use enough force to remove the material, but not cause damage to the core. If aggregates are firmly cemented, or encased with mortar, it may not be possible to remove them without damage to the core.

The length of the cores is determined in accordance with Material IM 347. Before any measurements of the core length are made, calibrate the apparatus with suitable gauges so errors caused by mechanical imperfections are known.

Cores should be measured in English units. Read each of the nine measurements directly to 0.10 in. (2.5 mm), and interpolate to the nearest 0.05 in. (1 mm) by estimation. The spreadsheet available from the Office of Materials will convert to Metric units when required. The spreadsheet can be used to determine the thickness incentive in accordance with Materials IM 346.

The core on the left is an example of a core that has been properly cleaned before measuring. The core on the right is an example of a core that has excessive material that needs to be removed prior to measurement.

MEASURING LENGTH OF DRILLED CONCRETE CORES

SCOPE

This method covers the procedure for determining the length of a core drilled from a PC Concrete structure, particularly from a PC Concrete pavement. The procedure is a modification of AASHTO T 148.

PROCEDURE

A. Apparatus

1. The apparatus consists of a calipering device that will measure the length of axial elements of the core.

2. The apparatus is designed so the specimen is held with its axis in a horizontal position by guide rods when making circumferential measurements, and a stand placed upon the guide rods for making a center measurement. The device is equipped with an auxiliary wheel that rests on the specimen and is calibrated such that one-half of a revolution of the wheel represents one-eighth the circumference of a 4 in. (100 mm) diameter core.

3. The device is constructed so the specimen is brought into contact with a single flat-faced probe 3/8 in. (10 mm) in diameter mounted on a fixed end of the device.

4. The measuring rod, which makes contact with the end surface of the specimen, is rounded to a radius of 1/8 in. (3 mm) and is mounted on a moveable plate, which in turn is mounted on guide rods. One guide rod is provided with a scale on which the length readings are made. The graduations of the scale are spaced at 0.10 in. (2.5 mm) intervals.

5. The apparatus provides for the accommodation of specimens of different nominal lengths over a range of 4 to 11 in. (100 mm to 275 mm).

6. The calipering apparatus is designed so it is possible to make a length measurement at the center of the specimen and at eight additional points spaced equally along the circumference of a circle whose center point coincides with the end area of the specimen and whose radius is not less than one-half, nor more than three-fourths, of the radius of the specimen.

7. The apparatus is stable and sufficiently rigid to maintain its shape and alignment without a distortion or deflection of more than 0.01 in. (0.25 mm) during all normal measuring operations.

B. Test Specimens

1. Cores used as specimens for length measurement must be in every way representative of the concrete in the structure from which they are removed. The specimen is to be drilled with the axis normal to the surface of the structure, and the ends must be free from all conditions not typical of the surfaces of the structure. Cores that show abnormal defects or that have been damaged appreciably in the drilling operation should not be used.

C. Test Procedure

1. Before any measurements of the core length are made, calibrate the apparatus with suitable gauges so errors caused by mechanical imperfections are known. When these errors exceed 0.01 in. (0.25 mm), suitable corrections must be applied to the core length measurements.

2. Place the stand on the guide rods and place the specimen on the stand for the center point measurement. The smooth end of the core, that is, the end that represents the upper surface of a pavement slab or a formed surface in the case of other structures is to be positioned facing the fixed end of the measuring device. Bring the specimen into contact with the stud in the fixed end, slide the movable plate until it is in contact with the specimen and record the length.

3. Remove the stand, place the specimen directly on the guide rods and make another measurement as described in C2.

4. Place the small auxiliary wheel on the specimen so the scribed marks on the wheel are in alignment. Rotate the specimen until the marks are again in alignment (1/2 revolution of the wheel) and make another measurement. Continue in this manner until eight measurements in addition to the center measurements have been made.

5. Read each of the nine measurements directly to 0.10 in. (2.5 mm), and interpolate to the nearest 0.05 in. (1 mm) by estimation.

6. If, in the course of the measuring operation, it is discovered that at one or more of the eight circumferential measuring points the surface of the specimen is not representative of the general plane of the core end because of a small projection or depression, rotate the specimen slightly about its axis, and make another set of measurements with the specimen in the new position. If the center measurement is not representative of the general plane of the core end, it should not be used in computing the length of the core.

7. If some damage from drilling is apparent, no measurements are to be made in the damaged area. Reposition the core to avoid the areas when measuring the length. If these areas cannot be avoided, the length measurements made in these areas are not to be used in computing the length of the core. In no case, are fewer than seven measurements to be used in determining the core length.

D. Report

1. The individual observations are to be recorded to the nearest 0.05 in. (1 mm) and the average of the nine measurements expressed to the nearest 0.05 in. (1 mm) and shall be reported as the length of the concrete core.

E. Precautions

1. Be careful to move the core away from the stud in the fixed end slightly when turned, so the stud will retain its proper length and shape.

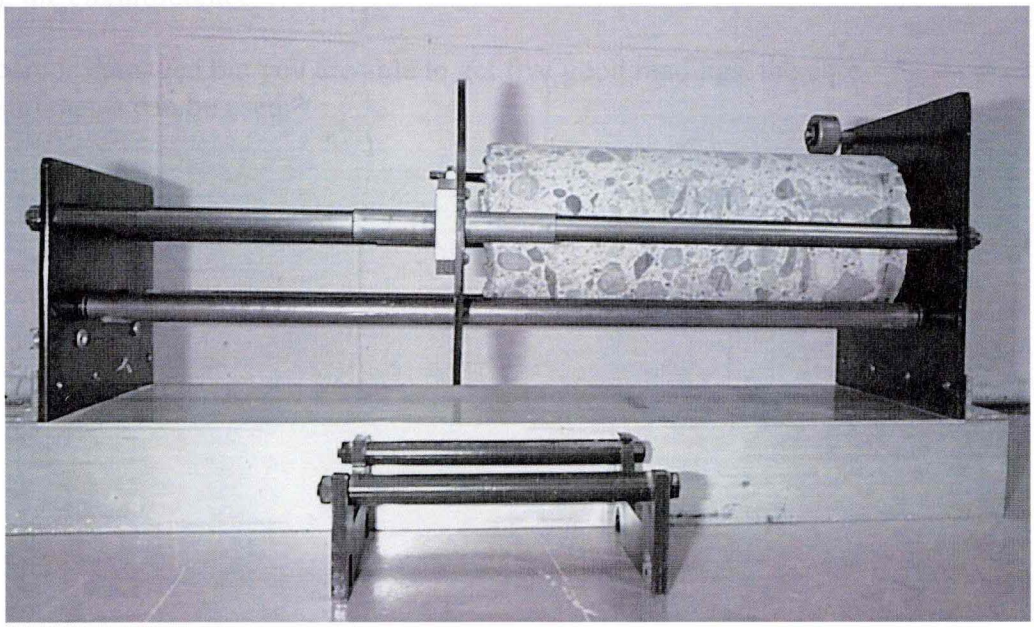


Figure 1. Concrete Core in Measuring Apparatus

Review Questions
Measuring Length
Of Drilled Concrete Cores
IM 347

1. The testing apparatus will measure cores _____ inches in diameter and between _____ and _____ inches in length.

2. The ends of the core must be free from all conditions not typical of the surfaces of the structure, such as subbase materials.

   True _____

   False _____

3. Measurements are taken in the _____ and at _____ additional points along the circumference.

4. If a core is damaged but you are able to get five good readings, the core measurements can be used.

   True _____

   False _____

FLOWABLE MORTAR

The time of efflux of flowable mortar is determined to ensure adequate filling ability. There are critical and non-critical flow times that need to be determined by testing the mix.

Flowable mortar designs are performed by the Iowa DOT. Testing for flow times is done at the project by the contractor or DOT.

The design of the flowable mortar mix is important to ensure the mixture has adequate filling ability and can meet the flow times required. Inadequate mix design and flowing ability of a flowable mortar may cause voids under pavements and structures, which could eventually cause failures. When air is added to flowable mortar the flow is increased. There is a critical flow time for the inside of culverts, between beams, and under bridges, which is 10-16 seconds. The non-critical flow time for open trenches or below beams is 10-26 seconds.

IM 525 explains how to design flowable mortar and Iowa Test Method 410-B explains how to test for flow.

METHOD OF TEST FOR FLOW OF GROUT MIXTURES (Flow Cone Methods)

SCOPE

This method of test covers the procedure to be used both in the laboratory and in the field for determining the flow of grout mixtures by measuring the time of efflux of a specified volume of grout from a standardized flow cone.

The procedure is a modification of Corp of Engineers Method CRD-C611-80.

APPARATUS

1. Flow cone as specified in the Corp of Engineers CRD-C611-80.
2. Stop watch accurate and readable to 0.2 second.
3. 10-inch level.
4. Calibration jug or container to hold a quantity of water equal to 1725 ml.

CALIBRATION OF CONE

1. The flow cone shall be firmly mounted in such a manner that the top will be level and the cone free from vibration (use firm, level space area such as board or slump cone base).
2. Level the cone by adjusting the mounting forks.
3. Close the discharge tube of the cone by placing a finger over the lower end.
4. Introduce 1725 $\pm$ 1 ml of water into the cone.
5. Adjust the pointer so that the point just comes into contact with the water.

SAMPLE

1. The sample shall consist of 1725 $\pm$ 1 ml of grout.

PROCEDURE

1. Moisten the inside surface of the flow cone.
2. Place a finger over the discharge opening.
3. Introduce grout into the cone until the grout surface rises into contact with the

pointer.

4. Start the stop watch and remove the finger simultaneously.

5. Stop the stop watch at the first break in the continuous flow of grout from the discharge opening (when the cone is essentially empty).

6. Read time of efflux of the grout (which is the time indicated by the stop watch).

Note 1: If there is a break in the continuity of discharge prior to essential emptying of the cone, then, it is an indication that the grout is too thick to be properly tested for flow by this method.

Note 2: If the sand used in the grout mixture is larger than 1/4 inch size, then the sample should be sieved through a 1/4" sieve cloth prior to being introduced to the flow cone.

REPORT

1. Average time of efflux to the nearest second.

2. Composition of the sample.

3. Information and observation of the physical characteristics of the sample.

Grout Flow Cone

Review Questions
Test for Flow of Grout Mixtures

1. During the testing procedure is the flow cone moistened or left dry?

2. The stop watch is stopped when _____.

3. What does it mean if there is a break of continuity of the discharge before the cone is empty?

4. Describe the steps in calibrating a flow cone.