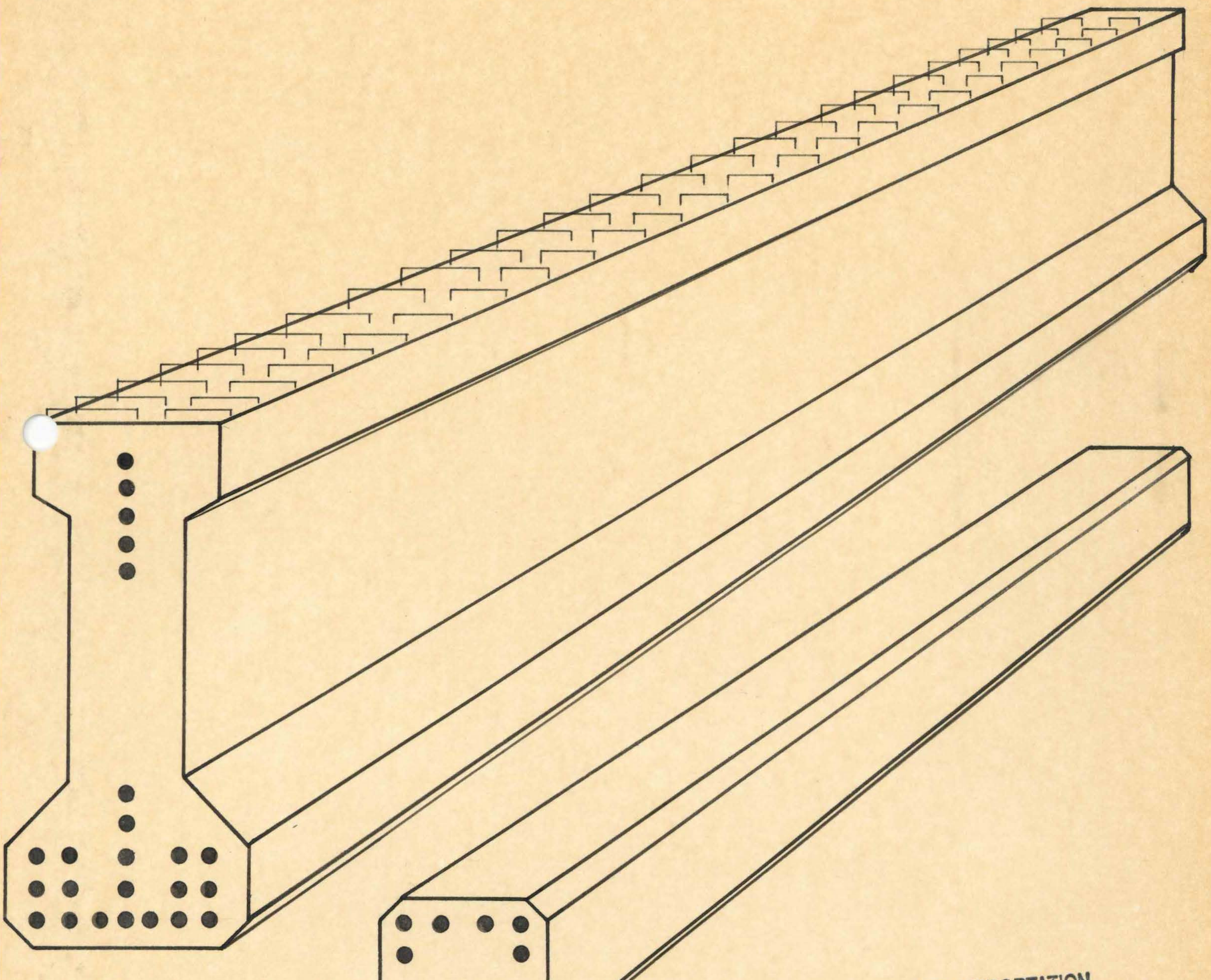
INSPECTOR'S HANDBOOK

PRESTRESSED CONCRETE UNITS



IOWA STATE HIGHWAY COMMISSION
AMES IOWA
JANUARY 1969

PRESTRESSED CONCRETE UNITS

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INTRODUCTION

This manual has been compiled for the purpose of giving the inspector a more uniform method of inspecting the production of precast-prestressed concrete products.

Since this manual is written by inspectors, it is intended to supplement but not replace the Iowa Standard Specifications. It is not the intention to deviate from the development and use of equal or more adequate methods which may be developed and used in other plants.

In writing this manual, information was compiled to give the inspector the basic knowledge needed to perform his duties. The inspector should be completely informed of all phases of the operation and familiarize himself with the plans, specifications and special provisions and should review and discuss them with the producer so that no misunderstanding concerning interpretations will arise during the course of production.

The inspector should observe all significant phases of construction, not only to assure conformity with the plans and specifications, but also to make certain that no materials or construction methods are used which will result in inferior members.

TABLE OF CONTENTS

TABLE OF CONTENTS

Appendix Cont'd.

Project Plans

Project plans is where the work in prestressed precast concrete begins. The cover sheet to a set of plans has general information on bridge location, stationing, project number and design number. Information particular to a materials inspector are the number and type of beams, the standards and revisions to use and special provisions. Once the standard is determined, the inspector may refer to an enlarged set of all standards.

Specifications

The specifications are found under section 2407 of the Standard Specifications. The inspector must be completely familiar with the requirements of the section.

Standards

Most of the design requirements can be taken from standards. To identify standards, start with a series of H-14 and a series of 4100. Both of these series contain several individual standard sheets and cover beams in groups of A, B and C Beams. Identifying mark of each group is the depth of the beam cross-section: A-2'8", B-3'3", C-3'9". An exception is series C-A Beams which are also 3'9". Each group contains 7 or 9 different beams. Reference to beams will be made by letter and number, example a B-7 can easily be found on the standards.

Materials

The materials used in prestressed and precast concrete shall meet the requirements of Part IV for the respective material and the following:

A. Aggregates; Section 4110, 4115 and 2407.02A shall apply. The aggregates should be inspected and approved before arriving at the plant. At the plant, aggregates should be handled and stockpiled properly to prevent any segregation or contamination. Frozen aggregate will not be incorporated in a mix. In cold weather when heating is required, the water and aggregates may be heated by an acceptable manner as stated in section 2403.07 in the Standard Specification. In extremely hot weather it may be necessary to sprinkle the aggregate piles.

B. Admixtures: Section 2407.02B shall apply

C. Prestressing Steel: Article 4151.04 shall apply. The inspector shall select a 6' sample from every reel for testing. Each sample will be identified by reel number and sent to Ames. In addition to the information called for on form #193 should be: the number of feet per reel, the strand size and quality such as 270K. The 270K refers to a particular strength of steel. The inspector will receive the test results for the reel to be used for elongation computations.

Materials Cont'd.

D. Reinforcing Steel: Paragraph 4151.02 shall apply. The steel may come from an approved source having been previously inspected and approved or it will be sampled by the inspector for testing in Ames. The steel sample should be 2 bars 42" long per each size of bar per shipment. The two bars can represent 10 tons or fraction thereof. All samples will be accompanied by a #193 sample identification form, and the individual samples will be identified by their respective heat numbers.

E. Steel Sole and Masonry Plates, Section 2508 and Articles 4152.02 and 4152.03 shall apply. The inspector shall secure proper certification or approval to conform with Section 2508.00. The details for assembling the sole and masonry can be found on Standards. In a set of project plans these details may seem small and easy to overlook. Areas to be painted will be indicated on plans and procedure will be Article 4152.02.

F. Neoprene Bearing Pads. Article 4191.08 shall apply. If the bearing pads are handled through the plant the inspector should secure the proper certification or approval and see that the right size pads are taken from stock to be sent to the project.

G. Bolts and other fastenings. Section 2407.02 shall apply.

Proportioning Equipment

A. Whatever type plant is employed in the batching of concrete, the proportioning equipment must be approved. If the producer has his own batch plant, it must be calibrated at least once a year or as many times as necessary in order to comply with the applicable requirements of Section 2403.07 of the Standard Specifications. This not only includes the cement and aggregate scales and the water delivery system, but the dispensing equipment for incorporating ad-mixtures in the concrete mix. It is up to the producer to see that his batch plant is kept in good working condition, replacing all worn parts that necessitate an adequate operation.

B. Mixer trucks which are used in conjunction with dry batch plants should be checked. Just as a batch plant has to function adequately, to properly batch materials in precise amounts, so must the delivery trucks deliver a consistantly uniform concrete. Your attention is called to the Specifications covering the Mixer Performance Evaluation as set forth in February 1968 on form #526A. An example of the form used in the evaluation of mixer trucks is shown in the appendix. The sheet shows with a specific load of concrete, with so many revolutions and a determined slump, the consistancy of the concrete will be uniform throughout the load. Thus setting the limits on the operational procedure of the truck. If at anytime an inspector is not satisfied

Proportioning Equipment Cont'd.

with the efficiency of a mixer truck, he may choose to run a check on the truck to determine whether it still operates as originally approved.

Stressing

To stress a line of beams start with the correct standard. Most strand information can be taken from the tables on the standard under the correct beam designation. First the strand size and number of strands are determined. Strands will be listed as straight strands and deflected strands. There is a side view and an end section shown for each beam and from these the correct placement and pattern can be determined.

Introduction to Prestressing Terms

Prestressing steel consists of 7 wrapped wires. Prestressing steel may be referred to as strands, tendons or cable. The cables are secured on each end by strand vises, and when two cables are joined, cable savers are required. A cable saver represents two strand vises back to back. When cable savers are used they require a correction in elongation equal to the correction of two strand vises, and must be used outside of the cast unit.

Each size cable will have a design load assigned to it. See Section 2407.06 of Standard Specifications. Producing this load will always be determined by calculations, and carried out by measurements. Gages will be used with stressing operations to verify or check the work but not to determine the stress itself.

Stressing Cont'd.

Cable elongation will be the method for calculating the stretch. To calculate the elongation for straight cables make use of the following equation:

$$\Delta = \frac{PL}{AE}$$

Δ = Elongation in inches

P = Tension force in pounds, determined by Specifications.

L = Distance in inches between end anchors of strands.

A = Cross-sectional area of strand in square inches.

E = Moduli of elasticity of steel strand.

The inspector makes use of a modification of this equation in actual practice. The elongation (or Δ) on Ames test reports appears as elongation in inches per inch of bed, noted as stretch required in inches per inch. This leaves only the length of the bed in inches to be multiplied by the elongation factor to yield the total elongation for the bed.

Example:
Given length of cable 300' and test results on cable reel, elongation inch per inch = .00673.

300' X 12" X .00673 = 24.23

The above example is for one reel of cable only, used in the line. Two reels may be used alternately in a line if the test results are within 0.00009 of the same.

Example: Reel No. T80020-07 = 0.00673 in./in.
Reel No. T80020-03 = 0.00665 in./in.

Stressing Cont'd.

The average test would be 0.00669 in./in. and would be used for calculation purposes.

These basic calculations must be corrected for temperature at the time of stressing and errors and adjustments that are made on the bed.

Strands are pulled in and set in the end. To start with all cables are given 1000# or some previously agreed initial tension. This is applied to each cable individually to take up slack and give each cable the same length to start the jacking process. This 1000# is not allowed for in above calculation. In the basic formula, $\Delta = \frac{PL}{AE}$, the load P can be decreased by 1000# to allow for the original 1000#.

There are other losses to consider. The strand vises may slip 1/8" in gripping the strand. With a vise at each end would be ¼". The jacking equipment and rods that anchor the jacking heads will elongate and give losses, may be from 3/16 to 3/8. The huge bulk heads have even been found to deflect. These losses must be searched out and evaluated for each plant. The losses may be evaluated and added to the original calculation, or they may be balanced against the original tension force and only the difference, if any, added or subtracted.

Stressing Cont'd.

All calculations are made on the basis of 70° F. and shall be adjusted for in increments of 10° F. See Section 2407.06.

Temperatures below 70° F. shorten the strands and requires an increase in elongation of 1.0% per 10 degrees.

Temperatures above 70° F. lengthen the cables and require a decrease in elongation of 1.0% per 10° F.

Example:

Previous calculated elongation = 24.23"
Temperature = 40° F.
Temperature difference is 30° below 70° or 3-10° increments.

$$\begin{array}{r} 24.23 \\ \underline{.03} \\ .7269 \end{array}$$

Temperature correction is .73.
Corrected elongation is 24.23 + 0.73 = 24.96"

Uncalculated losses may occur during the jacking of the cables if a strand vise slips more than 1/8". To check this, mark all cables with chalk at a set distance of 2 or 3" from the strand vises, after the 1000# has been applied. After jacking out all cables completely, go back and measure all marks to see if a greater slippage occurred. If slippage was considerably greater than expected, it may be necessary to go back and make corrections.

Actual jacking is done with hydraulic rams or jacking equipment. The most common types will jack all cables at once, instead of jacking one strand at a time. Control of stressing is best

Stressing Cont'd.

achieved by measuring the calculated elongation on the travel of the ram or some related part of the jacking apparatus. The most accurate way to check the stretch is actual measurements of the cable during the stressing operation, but this is extremely dangerous and is not recommended. The dangers involved are the possibility of a cable breaking or pulling loose from an anchor. A loose cable has tremendous force and whip lash action may cover a large area. For these reasons there should not be anyone on the bed to measure elongation or otherwise during the actual stressing operation.

After the stressing operation has been completed, all cables should be checked for broken strands. A chart was devised to show the number of possible broken strands that would be acceptable according to the type of beam. See Appendix B for this chart.

All stressing equipment should have gages accurate within 5%. See Section 2407.04C. These gages are used for checking results. When large differences occur the calculations and procedures should be reviewed and gage readings evaluated. When problems possibly arise stressing operations should stop until a solution is found or the problem proven not to exist.

It is required to have gages on jacking equipment. Things to remember are the huge size and bulkiness of the jacking equipment

Stressing Cont'd.

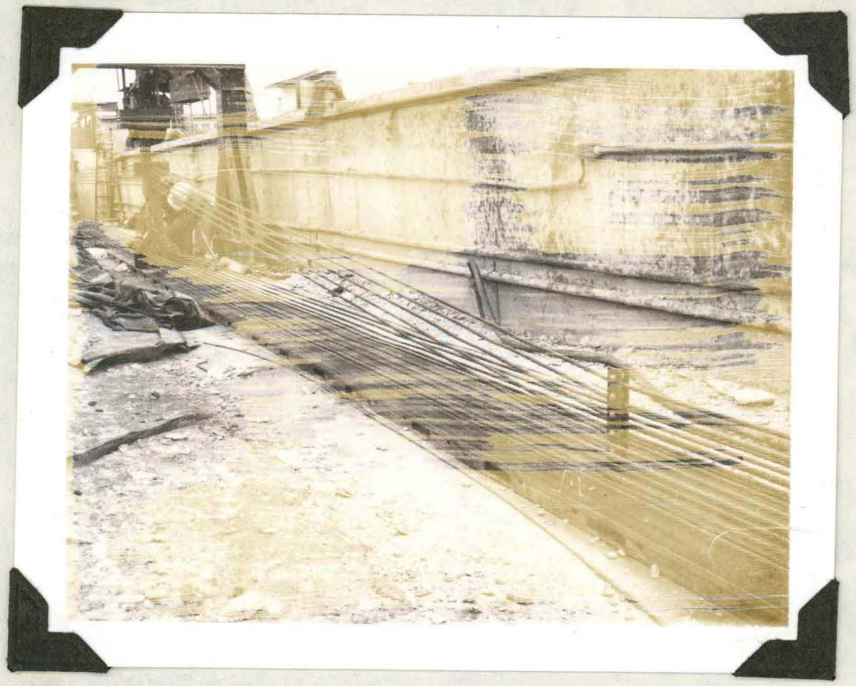
and how susceptible it may be to changing frictional forces. Yet unmentioned are deflect cables. These cables always vary in frictional force, due to degree of deflection and number of deflection points. These deflect cables are only partially stressed when the hydraulic jacking is complete. Therefore gages will not show a complete total load nor can the straight cables be verified because of the fact they may be combined with the deflected cables.

The best gaging system could be a dynometer which checks stress on an individual cable. This gage is placed on the cable and cannot be removed, therefore the stress can be checked periodically during stressing and at any desired time until the prestress force is released into the beams. By nature of strict stressing procedures, any cable should be considered representative in the use of dynometers. The number of dynometers to be used will be recommended by the engineer.

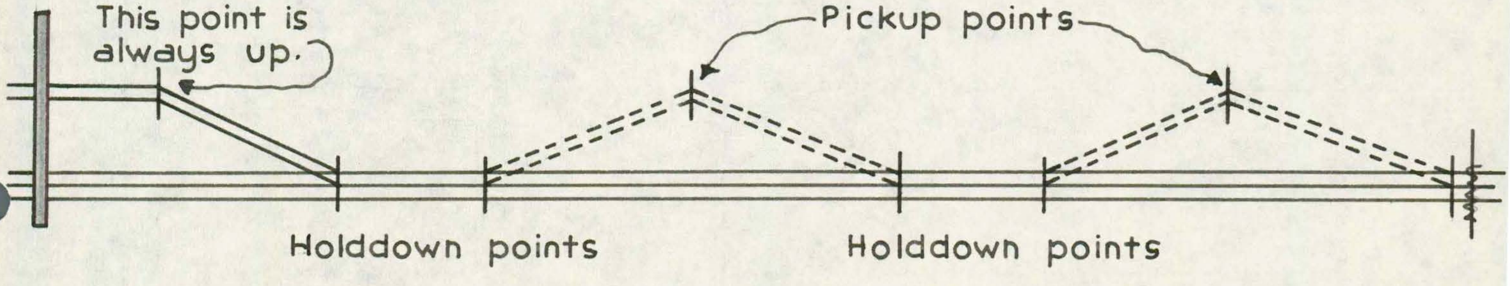
If split jacking heads are used for stressing, the gaging results would not be the same as discussed above.

Stressing operations thus far will apply for piling, beams with all straight cables, and the straight portions of beams containing both straight and deflect cables.

Stressing Cont'd.



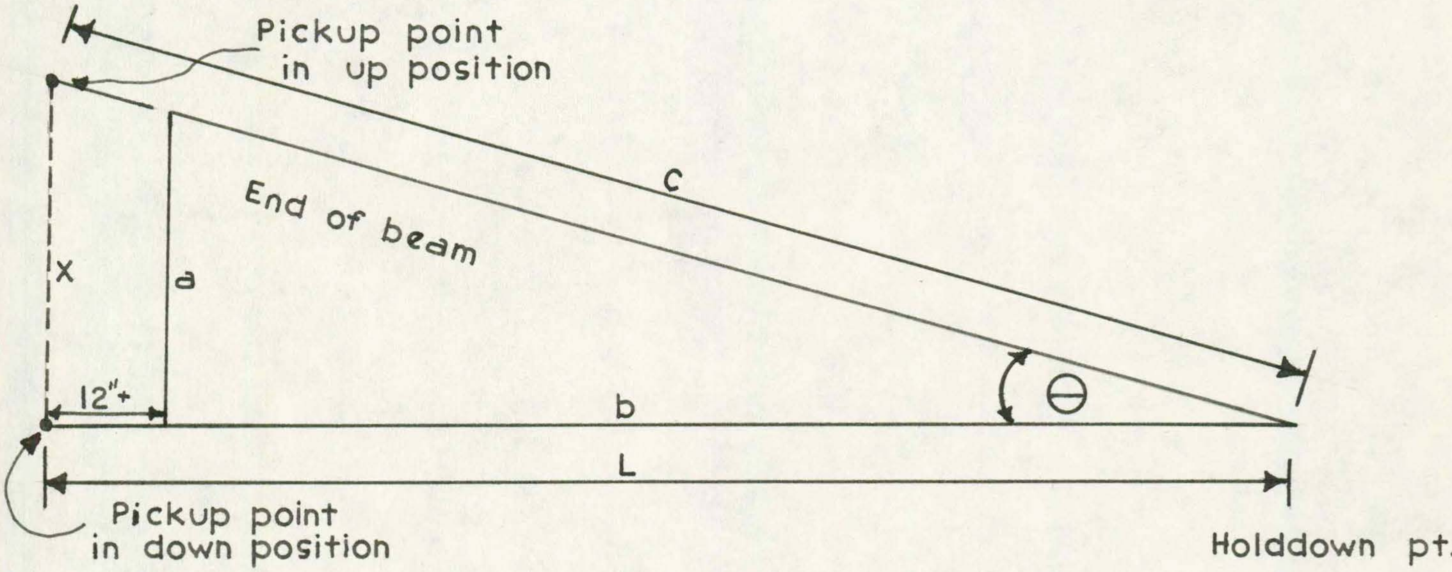
Drape strands or deflected strands are shown in the picture in a final position. These cables are normally partially stressed in a down position as shown in the diagram and raised to final position (shown by dashes) to complete the stressing operation.



Stressing cont'd.

The exact position of a drape cable is shown on the Standards. The difference in cable length from the down position to the final draped position must be calculated and becomes part of the total elongation of the draped cables.

To figure the difference in cable length, draw a diagram of the cables in the down and up position representing 1/2 of the beam:



On this sketch, C is the unknown cable length that must be found. "L" is found by actually measuring the cable from holddown point to pick-up point. The 12" shown is the distance from pick-up point back to the end of the beam. If the standards call for 12" of cable projection then this distance has to be 12" or more. "A" is the vertical height of cable pickup at the beam end. This is determined by the two positions of the cable shown on the end view of the standards. "b" in this example is L-12".

Stressing Cont'd.

There are two ways to solve this problem, by trigonometry or by Pythagorean Theorem. First using Trigonometry:

$\frac{A}{B}$ = tangent θ establishing θ we can say Cos $\theta = \frac{L}{C}$ and solve for C.

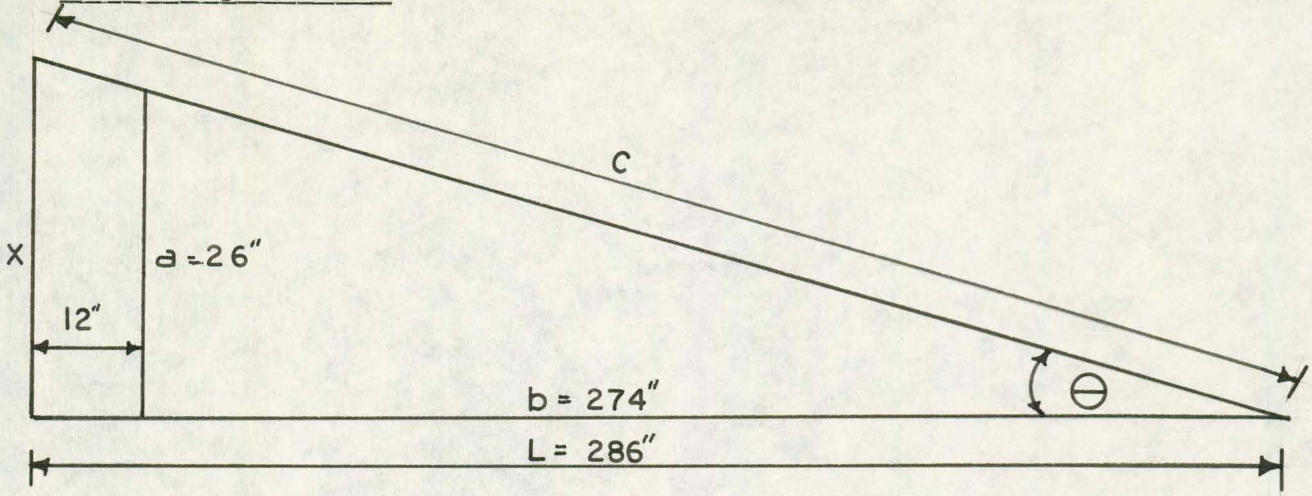
C-L = Elongation or the stretch gained in moving the cable from position L to position C.

By the other method we take (A) from Standards and (B & L) from actual measurements. By similar triangles:

$\frac{A}{B} = \frac{X}{L}$ and solve for X. Then $L^2 + X^2 = C^2$ or $C=\sqrt{L^2+X^2}$

Again C - L = Elongation or stretch gained from position L to position C.

Stressing Cont'd.



Example of a B-7

L = 286" from actual bed measurements.
12" was predetermined from cable extensions.
A = 26" from Standards
Find - C-L

Trigonometry Method:

$\frac{A}{B}$ = Tangent θ

$\frac{26}{274}$ = Tangent θ

.0949 = Tangent θ
$5^{o}20'30''$ = θ

COS θ = $\frac{L}{C}$

.99554 = $\frac{286}{C}$

C = 287.28

C-L = Elongation
287.28 - 286.0 = 1.28" ←

Pythagorean Theorem

$\frac{A}{B} = \frac{X}{L}$

$\frac{26}{274} = \frac{X}{286}$

27.14" = X

$X^2 + L^2 = C^2$
$737 + 81{,}796 = C^2$
$C^2 = 82{,}533$

$C = \sqrt{82{,}533}$
C = 287.28
C - L = Elongation
287.28 - 286.00 = 1.28" ←

Stressing Cont'd.

Things to note are as follows: Each beam in the line will have 2 angles, such as the above examples, except the two end beams. One angle may always be in the up position and not have a change in length. When measuring holddowns check that they conform to standard dimensions, as stated in the notes on the plans. Each standard has a holddown tolerance given of .05 of the length of the beam and indicates which way it must be applied. For this reason it is necessary to measure each L and calculate each (C-L) in a given line of beams. The total of all increments (C-L) is the total length gained in final pick-up of the cables. This total distance must be subtracted from the elongation figured for straight cables.

Example: Straight cable elongation = 24.73"

Length gained in deflect position = 6.23"

$$\begin{array}{r} 24.73 \\ \underline{-6.23} \\ 18.50 \end{array}$$

This means drape strands must be jacked out 18½" then by means of pick-ups the last 6¼" will be added and the combination will give the correct total of 24 3/4".

On systems where all cables are jacked simultaneous, the straight strands only will be jacked out 6¼" then the draped strands added and all cables jacked out another 18½". When correct pick-ups

Stressing Cont'd.

are made all strands will equal 24 3/4".

When working with short beams and a long bed it is possible that the elongation due to pick-ups will exceed the elongation of straight cables. If this happens the strands must be jacked on a partially draped trajectory, or the number of beams cut back to where normal procedures are used. To jack in a partially draped trajectory requires additional calculations and should be approved by the engineer.

The operation of picking up the cables is best achieved by lifting all points simultaneously. This holds friction distribution to a minimum. If this is impractical, the lifting should start at a point nearest the middle and then alternately on each side with the end being last. The pick-ups should only be lifted 1/2 of the required height the first time and make the second 1/2 on the same pattern as the first. All methods of making pick-ups must be approved by the engineer.

Dynometers can be checked, as work progresses, to prevent an over-stress of the cables.

Deflection points are controlled by holdups and holddowns. Within these devices, each strand is to be supported on a freely rotating metal pulley not less than 7/8 inches diameter.

Stressing Cont'd.

The pick-ups are used many times and will need repair. The rollers wear from stress and are exposed to extreme rusting conditions. Holddowns are only used once as they become incorporated in the beam.

Keeping records of elongation may be done in any manner suggested by the engineer. A sample of an elongation form is shown in Appendix C.

The upper right hand corner has general information. Line 2 information is found on standards or equals (19 cables X 28,900 pounds per cable). Line 3 identifies the cable used and the Ames elongation factor in inches per inch. Line 4 is the initial tension used to take sag out of the cables. Line 5 makes the inspector aware of losses and how to compensate for them. In this example it has been found the losses will balance the original 1000# and no further corrections were necessary. Information for line 7 may be computed on back of the form or supplemental sheets. The rest of the form should be self explanatory.

Placing Reinforcing Steel

All regular reinforcement shall be carefully and accurately placed and secured in the proper position according to the plans. See Section 2407.05.

The upper right hand corner of the beam standard sheets contains the Reinforcing Bar List. On this list all steel will be listed under the respective beam designations, such as B-1, B-2, etc.. The left column is the bar designation and a sketch of the shape. Examples of these are as follows: 6A1, 4B3 and 6B4, etc. The numbers 6 - 4 - 6 indicate bar sizes, called 6 bar or 4 bar. Bar sizes are indicated in 1/8's of an inch, such as 6 bar = 6/8 or 3/4" and 4 bar = 4/8 or 1/2". The letters A and B indicate bar shape such as a straight bar or a bent shape. The last number indicates one or more related shapes. To use this table look across from bar designation and under the desired beam column and find the number of pieces required and the total length of that piece. The right edge of this table shows specific dimensions for bending the special shapes. All dimensions are out to out except as shown. The placement of each individual bar is noted on side view and end view of the beams. The bars here are also identified by bar designation 6A1, 4B3, 6B4, etc.

Placing Reinforcing Steel Cont'd.

These bars may be securely tied together or spot welded to form rigid cages or assemblies. If welding is used it is not to be figured as a strength aid or should it reduce the effective cross-sectional area of the steel. Welding should not be done in the presence of the prestressing tendons unless they are thoroughly protected from heat and splatter. For this reason it is practical to weld in a removed area and bring the finished assemblies to the line for final tying and positioning. There are a few shapes, such as a 3D bar on most standards, that are not practical to weld. If most of these bars are tied to one or two individual cables it may be necessary to put chairs under the cables to prevent sagging.

After all bars are placed and secured any tie wire ends should be bent in so as not to touch the forms when in place. There may also be alignment adjustments in the steel after the forms are placed.

Forms

Forms will be true to dimensions as shown on the plans, true to line, and be mortar tight. The forms should be rigid enough so as not to sag or bulge under placement and vibration of concrete. The inside will be smooth and not have any dents or projections.

The pallets will also be covered by these specifications, plus the inspector must check the chamfer strip. The chamfer strip is supposed to be fastened solidly to the pallet, so to be mortar tight and not cause mortar leakage.

The end plates are also another part of the form that must be tight fitting to the forms. Gaps left between the end plate and forms will also cause mortar leakage.

Section 2407.04B of the Standard Specifications will apply to the forms.

Pouring

Each plant has a mix design set up to be used in precast and prestressed construction. The design limits shall conform with Section 2407.03 of the Standard Specifications. The inspector should check the batch plant before and during the pour for the correct weighing of materials.

Concrete shall not be placed when the atmospheric temperature is below 35 degrees F. without written permission of the Engineer. In November of 1965 permission was granted to pour concrete at an equivalent temperature of 10^{o} under certain conditions. A chart was devised to give the equivalent temperature by the surrounding air temperatures and wind velocities. See Appendix D for this chart.

After the mixer truck has reached its destination there are many things an inspector checks before the concrete is placed in the forms. Each truck must have the required minimum revolutions registered on its counter. The inspector also should note that during the mixing operation the drum turns only at the manufacturers recommended speed. If any water is added to the load before pouring, an additional 30 revolutions are required. Once the pour has started from an individual load, at no time will the concrete be retempered. The inspector should also pay special attention to the time interval between loads to make sure the 30 minute allowable limit between successive batches is not

Pouring Cont'd.

exceeded. When a series of units are cast in a line, the entire series of units shall be cast in one continuous operation.

There has to be a closely guarded control on the slump of concrete poured. Many factors are dependent on the consistency of the concrete. In order to control the camber of prestressed beams, a working limit of from 2 to 4 inches of slump is desired. Other reasonable working limits may be agreed upon between the engineer and the producer. See Appendix E for Method of Test for Slump of Portland Cement Concrete.

When all pre-inspection checks have been made, the concrete may be placed in the forms. Because of the depth of the forms, two lifts are required. Concrete shall be dropped vertically into the forms. The chute should be inspected to see that the concrete can pass quickly and freely and is deep enough to handle the lowest slumps used. When the concrete is placed, vibration is needed for consolidation. Vibrators are not used for the horizontal travel of concrete through the forms, so the concrete should be placed to it's nearest final position, to prevent as much shifting as possible.

There are two types of vibrators that can be used. One is the hand vibrator, or internal vibrator. The other is the external vibrator which is connected to the forms. To comply with

Pouring Cont'd.

Section 2407.09 of the Standard Specifications, the concrete shall be consolidated by small diameter vibrators. In this case the hand vibrator will always be used, but in many cases the hand and form vibrators are used in conjunction with each other.

The inspector should take note as to the proper procedure in operating a vibrator. It shall be inserted vertically and allowed to sink of it's own weight to the bottom of the layer and slowly withdrawn. The results of the vibration procedures used can be seen in the surface condition of the concrete. If there is honeycomb, stone or mortar pockets or excessive air bubbles, then a more satisfactory procedure in vibration should be sought. The forms should be over-filled and screeded off. All exposed surfaces will comply with Section 2403.23B of the Standard Specifications. The top surface of the beam will be smoothed off with a wooden trowel and surface marks will be made on top 3" apart with a narrow line no deeper than 1/16 inch.

Piling

Piling should be poured in the same manner as beams except only one lift is required because of the depth of the form. Internal vibrators are mostly used in this operation. The vibration procedures are the same in all prestressed and precast concrete work. The finish will be a steel trowel finish with chamfered edges. All details concerning the type and steel placement are indicated on the piling Standard P10A. The date, number, size of unit and the identification of the driving end is to be marked into the concrete during pour. It is imperative that the driving end be identified because it is the end with extra reinforcement. The date is necessary to establish the minimum 14 day curing period before driving. The compressive strengths shall comply with Section 2407.03 of the Standard Specification.

Curing

In all prestressed and precast operations, the curing methods shall comply with the requirements stated in Section 2407.10 of the Standard Specifications. The time period from the termination of the pour, through the initial set and final curing period is the most critical phase of concrete production. It is important to have a well established and well controlled operation.

A. Hot Weather:

The retention of moisture in concrete is the principal objective during hot weather pouring. It may be necessary to place wet burlap over the exposed part of the unit and to utilize some type of sprinkler or soaker system. Care should be taken as not to jeopardize the finished surface. Cylinders made during the pour should be treated in a like manner, with a piece of wet burlap

Curing Cont'd.

placed over it.

B. Cold Weather:

There are many problems encountered during this period because of the rapid changes in weather conditions. Certain precautions may have to be taken. Cold temperatures and high winds would require a double covering of the members. One important factor in obtaining an adequate cure is the producing of a proper curing chamber through-out the line. There must be free circulation around the sides and the top of the units. If this is not accomplished, hot spots will result, where portions of the line would receive more than the desired amount of steam, while other areas would not be cured sufficiently. If the inspector notes there is inadequate covering at the ends of the beams around the pick-ups, it may be necessary to place a temperature recording point near this area. This way, he can show the recorded results to the producer and bring about a more suitable method of covering.

If a cylinder is tested and the required compressive strength is achieved, the stress shall be released into the beams. At this point the steam application can be terminated and the temperature lowered at a rate not

Curing Cont'd.

more than 40° per hour until the interior of the concrete is equal to the surrounding air temperature. In all cases the concrete shall be covered for a minimum period of 24 hours after casting. Side forms may be removed during this period if the cover is immediately replaced.

Cylinders

A. Making Cylinders:

The reason for making cylinders is to determine whether the concrete used in the fabrication of precast or prestressed units was proportioned, mixed and cured properly in order to meet the compression requirements in Section 2407.03 of the Standard Specifications.

There are two types of cylinder molds, horizontal and vertical. Vertical cylinder molds are not commonly used because of the time involved in the capping procedures later. The horizontal type is mostly used because of the machined surfaces at each end of the mold. A compression test can readily be made on this type. There is probably no set standard or method of making a horizontal cylinder. It is a simple operation, which requires very little time and effort, but is one that is very important.

One method is filling the cylinder mold in two lifts. Each lift should be rodded or vibrated sufficiently enough as to consolidate the concrete as well as possible. You will be able to tell the results of your efforts when you strip the cylinders.

Cylinders Cont'd.

B. Curing the Cylinders:

The producer should supply the inspector with adequate facilities with which to cure the cylinders properly. After stripping, each cylinder should be identified as to date and unit poured. Cylinders should be kept in water at a desired temperature between 65 and 70 degrees. Lime dust should be sprinkled periodically in the water to help the curing operation. All cylinders are cured equally in this manner to achieve the required compressive strength.

C. Testing of Cylinders:

In order to release a line of prestressed beams or piling a cylinder has to be tested. The cylinder, after taken from the line, should be allowed to cool. There is an estimated loss in strength if a hot cylinder was to be tested. There are two types of compression machines used. One which is afforded to the inspector by the Iowa Highway Commission, is the hand-operated hydraulic testing machine. The producer might also maintain an electric compression machine. Both of these machines are graduated to 500 pound sub-graduations. These machines will determine the total load of the concrete tested.

Cylinders Cont'd.

In order to figure the compressive strength in pounds per square inch, a formula is used:

$$PSI = \frac{\text{Total Load in Pounds}}{\text{Area in Square Inches}}$$

An example of a sample problem is 142,000 pounds registered on the machine. The dimensions of the concrete cylinder is 6"x12". In order to find the area one uses the formula $A = \pi r^2$. The radius being 3" so inserting the values, the area should be $\pi \times 3^2$ or 28.274 square inches.

Continuing: $PSI = \frac{142,000}{28.274} = 5020$

Accuracy is only required to the nearest ten pounds. It would be impractical to run these calculations every time a compression test was required, so a conversion chart was devised as the one shown in Appendix. The inspector can readily find the PSI which pertains to the total load reading on the compression machine.

As stated in Section 2407.03 of the Standard Specifications there are strength requirements at designated ages. It is recommended that four or five cylinders be made for each pour.

Cylinders Cont'd.

These cylinders may be used in the following manner:

A. One cylinder for release if no failures occur.

B. One cylinder 28 day test.

C. One cylinder to Ames (At least one per project or 5 per month.)

D. Extra cylinders (If not used for above, can be tested periodically for shipping or at 7 days to acquire a history of strengths.)

Detensioning

Detensioning is the operation of releasing the prestress force into units. See Section 2407.07. This cannot be done until the units have reached the release strength of 4500 psi.

Detensioning may be discussed as single or multiple strand release and drape strand release.

1. Whenever drape strands are used in a beam they should be released first. There are a few exceptions to this rule involving the relationship of beam weight and hold down forces. These exceptions are not discussed here and should not be used without the approval of the engineer.
   a. The drape strands may be released one at a time by heating to failure. They may be cut at each end simultaneous or alternately at each pickup point. If there are 8 or more deflect strands they may be released 2 at a time in approved sequences.
   b. The deflect strands may be released by lowering the holdup devices at the beam ends as near simultaneously as practical. If the load at the pickups has to be assumed by some other system to release locks, nuts, etc., care must be taken to not cause cracking in the members due to releasing.
2. The hold down devices should be released next and any rods or bolts removed from the bottom.

Detensioning Cont'd.

3. Release the straight strands last by either the single or multiple strand method.

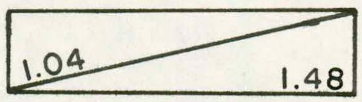
   a. Single strand release is accomplished by heating a strand simultaneously at both ends of the prestressing bed. The strands should be cut in accordance with an approved pattern or schedule. The heating of a strand should cover 5" or 6" and be gradual.

   b. Multiple strand release. This method allows the hydraulic jack to take up all the load and then release the total load slowly. A problem to watch is when the jack assumes the total load that it doesn't assume an extra load and crack the units. When all prestress is released into the beams, the beams are to be separated from each other, leaving strand projections as is detailed on the standards.

Camber

Camber is the deflection which occurs in prestressed members, due to bending, resulting from the distribution of stressing forces. This deflection is an upward movement from true flatness.

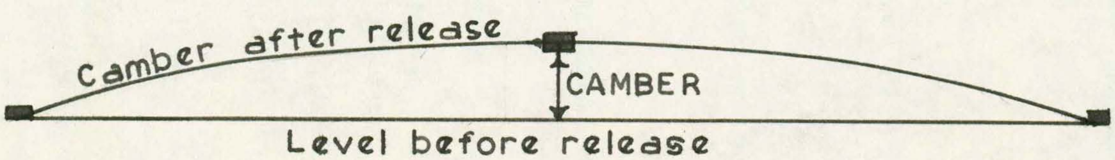
Camber information can be found on a chart in the right-hand corner of the Standards. Information may appear as follows:



The first number 1.04 is the anticipated camber at release. The second number is camber just before slab is placed.

Equipment for checking camber includes: string, spring scale, rule and marking pencils. The string should be of good quality, not absorbant and not highly affected by sag. Wet string will sag and stretch enough to impair accuracy.

Checking camber requires two steps. First step establishes near level reference lines on the beams before any stress is released into the beams. The second step releases the beam allowing the middle of the beam to hump up establishing the camber. Then recheck the level line and the difference is the camber reading. An example referring to top or bottom of beam would look as follows:



Camber Cont'd.

The reference marks on the example would be a mark an inch long on each end of the beam and one mark in the middle. The marks are most easily placed on the top or bottom flange. It is suggested the end marks be a set distance like 2" or 3" from top or bottom of beam and made with a gage if possible. This insures the marks can be exactly replaced if original marks are removed by sandblasting or grouting, etc.

The original mark in the middle is established by holding the string on the end marks and pulling with a uniform tension. The mark in the middle then includes any sag in the string. Later when the beams are cambered it is assumed the string will sag the same and the difference between the first mark and the string will be true camber. Camber is taken at the time of release and again when the beams are shipped.

Sandblasting

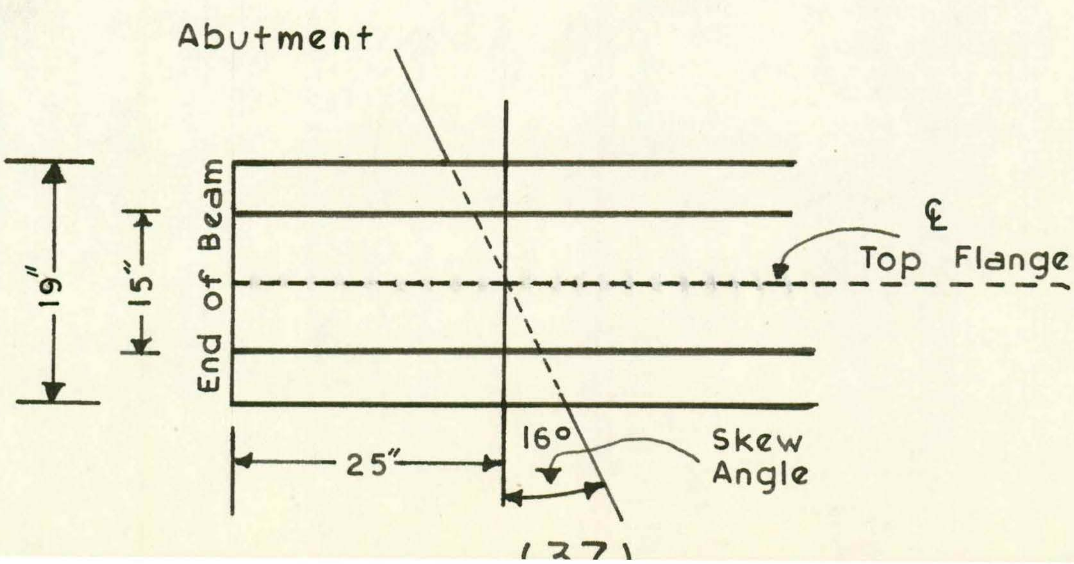
This technique is used for the purpose of removing laitance thus improving bonding properties. The portions of the prestress beams that are to be embedded in the abutment and pier diaphragms shall be roughened by sandblasting or other approved methods to provide suitable bond between the beam and the diaphragm in accordance with Article 2403.15 of the specifications. It is the inspectors job to check sandblasting procedures and results. An inspector must go to the plans to find the correct dimensions. Therefore, the inspector must determine two basic dimensions, at the abutment and the pier. From the plans he must find how far the beam will extend into the abutment, and how much of each beam at the piers will be poured with concrete.

Generally, the inspector is concerned with two types of bridges, straight or skewed. The straight bridge is where the piers are perpendicular to the center line of roadway, while the skewed bridge has the piers at an angle other than 90° to the centerline of the road. When the inspector finds the dimension of one beam in a span, this dimension can usually be used for all the beams in that span because all members may be parallel. The exception to this rule is where an on or off ramp is incorporated into the bridge. A specific number of beams of each span may have a different skew to be figured individually.

Sandblasting Cont'd.

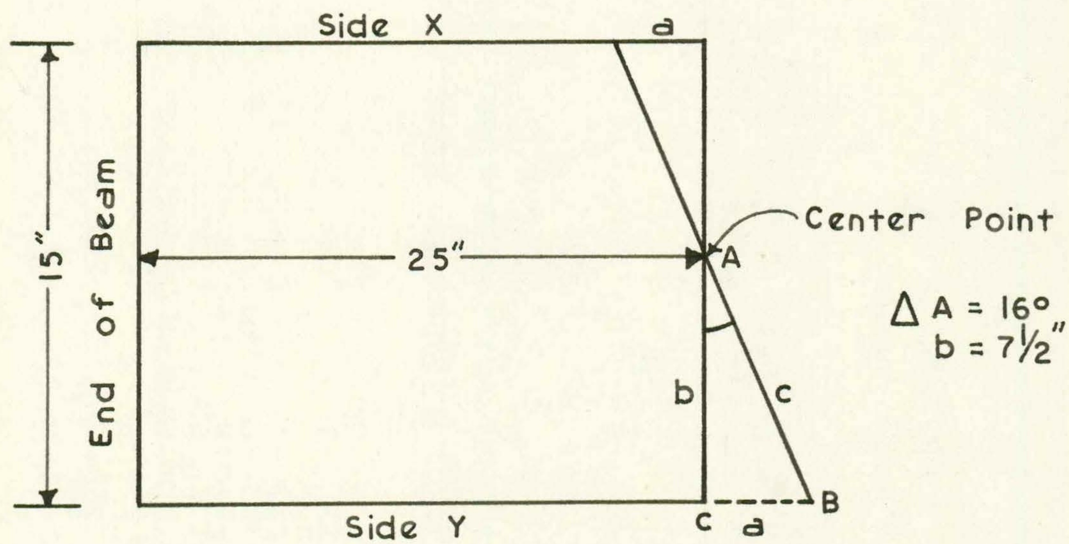
There are bridge plans that do not give the needed information for sandblasting. This situation exemplifies the need for the inspector to be able to read plans and standards. In the straight bridge one dimension is required. In the abutment details on the plans the top view is given. The required distance is figured from the center of the top flange. The producer will make his sandblasting marks equal distance on each side of the beam, since the beam and the abutment are perpendicular.

In finding the required distances on a skewed bridge the inspector goes through much of the same procedure, except a few more computations are needed. One must find the centerpoint, where the center of the top flange intersects with the abutment. Because of the skew angle there will be two dimensions required. One side of the beam will be sandblasted more than the other. An example of how to find these distances is shown: Note: Areas adjacent to sandblasting shall be protected.



Sandblasting Cont'd.

In this example certain things are assumed. From the plans the inspector has found the center point distance to be 25", also the top flange is known to be 15" wide, and the skew angle is found from the plans to be 16°. One can set up a simple trigonometry problem. Using the triangle below distance "a" is required.



$$\text{Tangent } A = \frac{a}{7.5} \qquad a - 2\ 1/8"$$

Tables and Trigonometry functions are shown in the back of all field books.

The inspector can now determine the sandblasting dimensions:

Length of side X = 25" - 2 1/8"

Length of side Y = 25" + 2 1/8"

Grouting

In prestressed beams, because of their irregular shapes, imperfections in the surface of the concrete (such as air voids) are encountered. The outer surface of all exterior beams or units of highway grade separations shall be finished in accordance with Section 2407.14 of the Standard Specifications.

Basically, grouting does not add any strength to the beam, but does give protection from weathering as well as a uniform appearance. In cold weather beams should be grouted before they are allowed to cool to freezing temperatures. It is reasonable to assume that if it is too hot or cold for concreting, the same would apply to grouting. The surface finish shall be cured in a manner satisfactory to the engineer, and heat curing may be required in cold weather. When finished the surface shall be free from stain and shall have a uniform color.

Patching

Patching limitations shall be approved by the engineer. The size of the patch may be determined by its location on the beam in respect to critical areas. Patching may be limited on the bottom of members or over bearing points. In checking honeycomb the porous or segregated areas should be chipped away to determine the extent of damage and also establish a sound base for patching. In the preparation of broken areas all loose and fractured particles should be removed. If chipping or removing of fractured pieces exposes a main bar or cable, the engineer should be consulted. There are many practices associated with good patching:

1. Areas to be patched must be protected from the weather. Small amounts of concrete are rapidly affected by heat, cold and rapid drying conditions.
2. Use thoroughly mixed concrete made of sand and cement in proportions approved by the engineer.
3. The area to be patched must be clean and thoroughly wet prior to patching.
4. A film of cement and water with the consistancy of paint may be brushed over the area just before the patch material is applied.
5. The patch should be placed firmly and slightly overfilled.

Patching Cont'd.

6. The patch should be then trimmed and worked to final dimensions.
7. Always keep the patch wet until cured.
8. The patch must be wet cured for a recommended period of 3 days.
9. Application of steam is not recommended in the patching operation.

When a damaged beam is considered to be of a patchable nature, it should not be accepted until the patch is completely cured and found to be sound quality.

Final Inspection

There are requirements which cannot be checked until after the unit is finished. For this reason the producer is responsible for making production measurements and the beam shall be accepted on the basis of end results. Details of final inspection are:

Camber: Before a beam is shipped a final camber is taken. Refer to the correct standard to find the shipping camber.

Straightness: The deviation of true straightness is referred to as sweep. As stated in Section 2407.12 of the Standard Specifications, the allowable limit will not exceed 1/8 inch per ten feet. The inspector should check both the top and bottom flanges. All other physical dimensions of the unit will also be checked to make sure all requirements are met.

Length: The length of beams after stressing shall not vary from design length by more than 3/8 inch. The inspector should check the plans for the designed length. It should be noted that in finding the length from the plans or standards, the length is designated from center of bearing to center of bearing. The inspector must add the 6" additional length on each end of the beam to determine the actual outer dimension.

Cables: Beams that are to have exposed cables are to be treated in a manner that is stated on the plans.

Final Inspection Cont'd.

Coil Ties: Coil tie placements on the beams must be checked. Details of locations are shown on the plans. It is imperative that coil ties are placed in the right position. The diaphragms are designated for certain locations between the beams, if all the coil tie placements are not correct, the diaphragms cannot be constructed without re-drilling the coil ties or relocating the diaphragms.

Hold Downs: The inspector should check to see that on beams with deflected cables, the hold down assemblies are properly filled with grout. This being an opening in the bottom of the beam, should be covered not only for appearance sake, but for any weathering actions that could take place.

Sole Plates: The producer, during fabrication places the sole plates. It is the inspectors job to check whether the placement has been altered through any means of vibration or other causes. Sole plates must be cast correctly whenever used and require the close attention of both the producer and inspector.

Piling: Piling shall have the cables ground flush on the driving end. In examining the units for cracks, water can be used over the whole surface to make any cracks more apparent.

Handling & Storage: The inspector must make sure all units are handled and stored properly. All units must be handled

Final Inspection Cont'd.

by the lifting handles constructed in the unit. They shall not be lifted or strained until the required strength is developed.

In placing of prestressed beams on supporting blocks the overhang will not exceed 5% of the length of the beam. It is very important to have a level yarding area. Sweep or twist can be permanently set in a beam through a period of time when beams are improperly yarded. A suitable base for the yarding area is necessary. If yarding blocks were able to settle into the ground, the beam might be put under stresses which may result in cracking. It would be very impractical for a producer to take the time, effort and expense to fabricate these units adequately and then through improper yarding mehtods cause the rejection of such items.

When the stamp of approval has been applied by the inspector to a particular unit, this signifies that all requirements have been met by the producer.

Forms and Record Keeping

For an inspector to do his work correctly and efficiently, he must record all the required information from fabrication to shipping. A complete set of records is needed and is the responsibility of the inspector. The inability to establish an adequate system can put both the producer and the inspector in a precarious situation.

Each plant inspector has his own system of recording information. Here is an example of a form that could be used.

Beam Check List

This form as shown in Appendix H could be used in the initial and final inspection prior to shipping. All beams of a specific project are listed as well as all the required tests needed for approval. For an example the actural length of the unit is 35'2¼" which is ¼" from the design length. Any deviations from design limits shall be recorded so the inspector will have a permanent record if any questions as to acceptability were to arise.

Field Book

This book can be utilized in many ways. One example is setting up a pour book as shown in Appendix I . An inspector can record the necessary information of any unit of any pour. Any questions as to a variance of camber or any other problems that could arise later could be answered from all the information compiled in this book. These examples are only aids to all plant inspectors. Each inspector

Field Book Cont'd.

inspector may use his own ingenuity to find the best methods of recording information. If in any way he wishes to improve this form or field book, it is in his best interest to do so.

Shipping Reports

The form used for the reporting of Prestressed and Precast Bridge Units is the materials Form 598 as shown as appendix J. This form is self-explanatory and each column shall be filled as the form states. The only entry that needs to be added is the shipping camber information. Sample units were entered to give the inspector an example of how this form is properly made out.

The inspector shall use the assignment codes and any other information afforded to him for the distribution of the reports. The reporting of miscellaneous material such as bearing pads and steel I Beams may be placed at the bottom of this report or on the test report - Miscellaneous Materials Form 258.

REPORT OF TRANSIT
MIXER PERFORMANCE

Company Name ______________________________

Address (Central Office) ______________________________

Mixer Identification and Condition

Assigned headquarters ______________________________
Manufacturer ______________________________
MMB Rating ______________ Year New ______________
Serial Number ______________________________
Mixing Speed ______________ to ______________ RPM
Blade Height, Dimension X ______________ Y ______________
Hardened Concrete Present, Yes ________ No ______________

Description of Batch Tested

Batch Size ______________ Cu. Yds. ______________
Ribbon Charged, Yes ______________ No ______________
Slump, 2/10 Position ______________ in., 9/10 Position ____ in.
Revolutions Mixed ______________ Air Content ______________ %
Mixing Speed ______________ RPM

Other Mixers Represented

	1	2	3	4	5
Serial No.					
Blade Height X					
Blade Height Y					
Hard Conc. Pres. Yes					
No					

Test Performed by ______________________________

Title ______________________________

Date ______________________________

Observer (if present) ______________________________

(A)

Standard Beam	Total Number Of 1/2" ϕ Strands	Total As	2% As *	2% As 0.153/7	In a single beam or one line of beams cast with common strands, The allowable number of strands with failure of one wire in a 7-wire strand shall not exceed th following.
A1	8	1.224	0.0244	1.1	1
A2	9	1.377	0.0275	1.3	1
A3	11	1.683	0.0336	1.54	1
A4	13	1.989	0.0397	1.82	1
A5	15	2.395	0.0459	2.10	2
A6	18	2.745	0.0550	2.52	2
A7	22	3.366	0.0673	3.09	2
B1	8	1.224	0.0244	1.12	1
B2	9	1.377	0.0275	1.26	1
B3	11	1.683	0.0336	1.54	1
B4	12	1.836	0.0367	1.68	1
B5	14	2.142	0.0428	1.96	1
B6	16	2.448	0.0489	2.24	2
B7	19	2.907	0.0581	2.67	2
B8	24	3.672	0.0734	3.37	2
B9	26	3.978	0.0795	3.65	2
C1	14	2.142	0.0428	1.96	1
C2	16	2.448	0.0489	2.24	2
C3	19	2.907	0.0581	2.67	2
C4	21	3.213	0.0624	2.94	2
C5	24	3.672	0.0734	3.37	2
C6	26	3.978	0.0795	3.65	2
C7	30	4.590	0.0918	4.21	2
CA1	7	1.071	0.0214	0.98	None
CA2	7	1.071	0.0214	0.98	None
CA3	8	1.224	0.0224	1.12	1
CA4	10	1.530	0.0306	1.40	1
CA5	11	1.683	0.0336	1.54	1
CA6	13	1.989	0.0397	1.82	1

* See Article "Wire Failures in Prestressing Tendons" on Page 16 in Tentative Standards for Prestressed Concrete Piles, Slabs, I-Beam, Bridge Beams for Bridges. Interim Manual for inspection of such Construction prepared by Joint Committee of AASHO and PCI.

ELONGATION FORM

Project I-IG-29-3(12)55-04-7
County POTTAWATTAMIE
Design No. 968
Contractor HERBERGER
Pour Ident. #4 B-7
Date Elongated 1-19-68
Bed WEST 363'
Temperature 19º
Computed by Inspector
Checked by Inspector

1. Strand Size and Type 1/2" 270K

2. Total Force All Strands Tensioned Simultaneously 549,000

3. Strand Ident.(s) and Elongation Factor(s)

T-80084-5 = .00661
T-80084-1 = .00665

AVE. = .00663

4. Initial Tensioning Force per Strand 1000#

5. Chuck Slip, Anchor Movement, Rod. Elongation, etc. (Specify)
1/4 3/16 3/16 3/16

6. Elongation of Straight Cables (Bed L. x Elong. Factor 28.84"
(363' x 12" x .00663)

7. Deflect Cables Length Gained in Final Draped Position 10.38"

8. Temperature Correction to be applied +1.44"

9. Procedure in Actual Elongation

(1) Apply 1000# to all straight cables and jackout to 10 3/8"

(2) Apply 1000# to all deflect strands and continue jacking to 28.84" + 1.44" — Make pickups in proper order.

28.84
1.44
30.28

10. Check
Actual Final Elongation 30 1/4"
Actual Jacked Guage Pressure
Corrected Dynomometer Reading 29,800

Plant Wilson Concrete Co.

Location Avery, Nebraska

(C)

IOWA STATE HIGHWAY COMMISSION
AMES, IOWA 50010

When the wind velocity is greater than indicated on this chart for any given air temperature the equivalent temperature is below 10^{o} F.

Air Temp. (^{o}F)	Wind Velocity (MPH)
35	30
34	27
32	22
30	18
28	15
26	13
24	11
22	10
20	9
18	8
16	7
14	6
12	6
10	5

Anytime the existing temperature is below 35^{o} the wind velocity would be estimated and the equivalent temperature level determined. When the equivalent temperature is 10^{o}F. or above and is expected to remain above 10^{o} for the time required to complete the units involved concrete may be placed if the forms are covered and preheated and the concrete temperature controlled. All forms should be covered with a suitable cover prior to placing the concrete and the entire line should be preheated to at least 40^{o}F. The covers would be removed only where the concrete is being placed and finished and immediately replaced on the finished units. At no time during the concreting operation will the concrete temperature be allowed to fall below 40^{o} F. This procedure should be followed until the concrete for the entire line has been placed.

If it is desired to place concrete when the equivalent temperature is below 10^{o}F. Suitable housing would be required to control the surrounding temperature. Approval of this housing system would be based on consideration of the temperature effect of the entire line.

The above information was copied from a letter from T. E. McElherne.
Dated: November 18, 1965
Copied: February 16, 1967
Copied: January 27, 1969

(D)

Iowa State Highway Commission
Materials Department
Method of Test for Slump
of
Portland Cement Concrete

Scope:

This test method is used for determining the slump of concrete both in the laboratory and in the field.

Procedure:

A. Apparatus:

1. Mold for slump test.
2. Tamping Rod (5/8" x 24" with a hemispherical tip)

B. Sample:

1. The sample of concrete from which test specimens are made shall be representative of the entire batch and shall be obtained in accordance with the method of sampling fresh concrete.

C. Test Procedure:

1. Dampen the mold and place it on a flat, moist, nonabsorbent surface. Hold it in place by standing on the two foot pieces.
2. Fill the mold in three layers, each approximately one-third the volume of the mold.

(F)

3. Rod each layer with 25 strokes of the tamping rod. The bottom layer is rodded throughout its depth and successive layers are so rodded as to slightly penetrate the underlying layer. If the rodding operation results in subsidence of the concrete below the top edge of the mold, add additional concrete to keep an excess above the top of the mold at all times.
4. After the top layer has been rodded, strike off the surface of the concrete by means of a screeding and rolling motion of the tamping rod. Remove the mold immediately from the concrete by raising it carefully in a vertical direction. The operation of raising the mold shall be performed in approximately 5 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 the removal of the mold shall be completed within an elapsed time of 1-1/2 minutes.
5. Immediately measure the slump by determining the difference between the height of the mold and the height at the vertical axis of the specimen. If the concrete decidedly falls away or shears off, the test should be disregarded.
6. Record the measurement to the nearest 1/4 inch.

TABLE FOR COMPUTING POUNDS PER SQ. IN. ON 6" x 12" CYLINDERS

Area - 28.2744 in. Load in Thousands

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		

(G)

BEAM CHECK LIST

REMARKS:

PROJECT I-IG-29-3(12)55-04-78
CONTRACTOR Herberger Constr.
COUNTY Pottawattamie
DESIGN 968
DATE 1969

Beam No.	Release Camber	Sweep	Length	Shipping Camber	Cables Coil Ties	Sole Plates Sand Blast	Checked By
B-7	1"	1/8 per 10 ft.	59'2"	1½"		No Sole plates	
413	13/16	1/8	+1/4	1 1/4	O.K.	Sand Blast O.K.	Inspector
414	7/8	3/16	+3/8	1 1/8	"	"	"
415	7/8	1/8	+1/4	1 3/8	"	"	"
416	15/16	1/8	+1/8	1 1/4	"	"	"
417	13/16	3/16	+1/4	1 3/8	"	"	"

(H

Pour No. 10 B-2

Beam No.	51	52	53	54	55
Mix Temp.	74°	70°		63°	
Slump	2½"		2"	2¾"	
Finish	o.k. ———				

Remarks:

Steel placement and form joints checked. One joint fixed before pour.

Date: 1-30-69

Air Temp: 28° Wind 0

Start time: 1:30 p.m.

Finish time: 4:10 p.m.

Weather Conditions: Cloudy and Calm.

(I)

Matls. 598
Nov. 1958

Ames
Robert Bortle
James Presnell
File

DESIGN NO. 968 COUNTY Pottawattamie

GROUP NO. ____ PROJECT I-IG-29-3(12)55-04-78

REPORT NO. A69B 27-29

IOWA STATE HIGHWAY COMMISSION
MATERIALS DEPARTMENT

PRESTRESSED AND PRECAST BRIDGE UNITS

Shipped to Herberger Construction Date January 20, 1969

Producer Wilson Concrete Co.

Plant Location Avery, Nebraska

Type of Material: No. of Bridge Beams 3 No. of Bridge Units ____ No. of Sheet Piles ____

No. of Bearing Piles ____ No. of Backing Plank ____ ____ ____

Process: "Check One" Precast [ ] Pretensioned [XXX] Post Tensioned [ ]

The following units have been shipped by the producer shown above. An Iowa State Highway Commission inspector was present when these units were made, and the test specimens were prepared by him.

Unit Number	Length of Unit	Date Made	Test Specimen Lab No.	Test Specimen Age When Tested	Compressive Strength, psi	Camber
1-10	34'2"x3'3"	1-17-69		13 days	5660 psi	1/8"
1-11	" "	" "		"	"	3/16"
1-12	" "	" "		"	"	1/8"

Note to Engineers and Inspectors: These units should be inspected by you at the destination for damage due to handling and shipping, also for State Approval Stamp. Approved if stamped

Reported by: Inspector
Materials Inspector

(.1)