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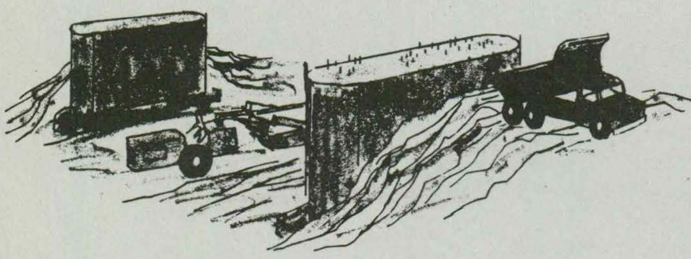
INSPECTOR'S HANDBOOK

PIERS AND ABUTMENTS



IOWA STATE HIGHWAY COMMISSION

AMES, IOWA

1969

PIERS AND ABUTMENTS

James Hart
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INTRODUCTION

This handbook is an inspector's aid. It was written by two inspectors to bring together all of the most-often-needed information involved in their work.

Much care has been taken to detail each phase of construction, with particular attention to the requirements and limitations of specifications. All applicable specification interpretations in Instructions to Resident Engineers have been included.

The beginning inspector should look to the handbook as a reference for standards of good practice. The Standard Specifications and Special Provisions should not, however, be overlooked as the basic sources of information on requirements and restrictions concerning workmanship and materials.

CONTENTS

PIERS AND ABUTMENTS

Plans, Special Provisions, etc.

Before commencing field inspection, the inspector should make sure that he has all of the necessary reference material.

Plans

Check for any revisions of the plans and void any sheets that have been revised. Check with the contractor to see that he is using revised plans in case of revision.

Special Provisions and Supplemental Specifications

These will be listed with the proposal form. The inspector should make sure that he has a copy of the Special Provisions and Supplemental Specifications that pertain to the job.

Contract

Have a copy of the contract. Note each contract item. Records will have to be kept on each item for payment. Also note the beginning and completion dates.

Standard Specification Book

Check the Supplemental Specifications for any revisions of the Standard Specifications. Make a note on the article that has been revised in the Standard Specification Book. This will prevent mistakenly using a specification article that has been changed.

Instructions to Resident Engineers

The inspector should have a copy of all the Instructions to Resident Engineers which pertain to the project on which he is working.

Field Record Book

A record must be kept on each contract item, approved materials, staking diagrams, cross-sections, daily happenings, etc. In short, a story and record of the project. Do not rely on your memory or scratch pad notes.

Construction Field Manual

This manual is intended only as a guide and an aid to field forces. It covers most phases of construction and discusses numerous typical problems that might arise. The plans and specifications will govern in case of conflict.

STAKING AND LOCATION

Plans for all structures are prepared by the Design Department and furnished to the field forces. The field forces must study the plans to get each situation well in mind before staking is begun. It should be determined beforehand exactly what lines are to be staked. Careful and accurate work is mandatory both for alignment and elevations. Keeping in mind a mental picture of the completed structure will help get the skew the right way. Lines must be run from known established points to ensure the location of the desired stationing of the starting point. Run in enough centerline to eliminate errors. Stakes used should be substantial and protected from disturbance. Place stakes outside the area of contemplated work. Check each span distance individually and then check the overall distance from abutment to abutment. Check bench mark elevations against points of known elevations. A staking diagram of the structure must be recorded in the field book. This sketch must show the exact location of each stake and all distances recorded. It must show the measurements made as checks on the accuracy of the staking layout.

Avoid the errors of turning the wrong skew angle, using wrong span measurements, using wrong centerlines, and misreading the foot mark on the tape and rod. Centerline of road is not always the centerline of bridge.

The Commission is responsible for the staking done by the survey crew. The inspector should become familiar with all of the right-of-way lines and see that the contractor stays within these lines.

STORAGE OF MATERIALS

All materials must be stored in neat piles. Reinforcing steel must be placed on blocks or skids so that it remains above ground. It must be so stored that it can be readily inspected. All lumber and forms should be stacked in neat piles above the ground. Beams and girders must be stored on skids, in the same position and with the same supports which they will have on the bridge. This is mandatory for prestressed concrete beams.

The contractor is responsible for all materials delivered to the project. If material has become damaged it may be rejected even though it has been previously accepted.

CLEARING AND GRUBBING

All trees, stumps and brush that must be removed to complete the work will be considered as a part of the contract for the structure. As a part of the contract for a structure, the engineer may order the removal of trees and stumps which are near to but not on the site of the work, if their presence will interfere with the completion of adjacent parts of the improvement of which the structure is a part and if their later removal by usual methods would endanger the structure. No blasting can be done within 50 feet of any completed part of the structure.

EXCAVATION

Measurement of all Class 20,21,23, and 24 excavation must be computed by the cross-section method or by other appropriate methods. Areas to be excavated must be cross-sectioned before the excavation operations begin and again after the excavation has been completed, or the actual size (length, width, and depth) of the excavation can be measured after excavation operations are completed. The figures must be recorded in the field book for computation purposes. The specification limits for computing excavation quantities are as follows:

1) No measurement will be made of the material removed outside areas bounded by vertical planes parallel to the boundaries of the structure or part of structure

and located as follows:

> For concrete structures, or those parts of concrete structures without footings, 18 inches outside the horizontal projection of the structure; for concrete structures with footings, 18 inches outside the footing; for timber abutments and wing walls, 24 inches behind the backing plank; for anchor rods, 12 inches on each side of the rod; for deadmen, the face of the deadmen on one side and 24 inches outside the deadmen on the other face.

2) When the footing is to rest on firm earth care must be taken not to disturb the bottom of the excavation. After the excavation is completed, the inspector must check the depth of the excavation and character of the foundation material.
3) If suitable, the excavated material will be used for backfilling, and any excess material must be disposed of in a manner that will leave the site in a neat condition.
4) Class 20 excavation is above the classification line and normally dry; but it may be wet due to high water.
5) Class 21 excavation is below the classification line and is normally wet.
6) Class 22 excavation is the rock encountered in excavation for structures.
7) Class 23 excavation is usually designated for culvert excavation when rock is anticipated.
8) Class 24 excavation is obtained from borrow areas for furnishing fill material.
9) Extra depth excavation is paid for at increased rates on bridges.

Upon written order of the engineer, the contractor must excavate for footings to depths below those shown on the plans. When extra depth excavation exceeds 6 feet, it will be paid for as extra work. When the extra depth does not exceed 6 feet, payment will be made for each extra foot of depth at the following percentages of the contract unit price for the excavation:

Depth	Excavation Above Classification Line	Excavation Below Classification Line
First foot	100%	100%
Second Foot	120%	140%
Third foot	130%	160%
Fourth foot	140%	180%
Fifth foot	150%	200%
Sixth foot	160%	220%

In case the plans fail to show the elevation of the classification line, low water elevation will be considered the excavation classification line.

BACKFILLING

Material used for backfilling must be free from spongy or vegetable substances, free from frozen material, and free from boulders or broken concrete over 8 inches in the greatest dimension.

At the time soil is placed for backfill, its moisture content must not be greater than 110% of the optimum. Excavated material which contains excessive moisture must be wasted and not used for backfilling or in approach fills.

If the soil is too dry to compact properly, the engineer may order extra work that the contractor moisten the soil uniformly before it is placed and compacted in the backfill.

The backfilling material of all abutments and wing walls on primary bridge projects and, when specified, for abutments and wing walls on secondary projects will be granular backfill. Granular backfill must be constructed in layers of not more than 8 inches. Each layer must be thoroughly tamped. The engineer may require the granular material to be moistened with water during the backfilling operation.

Backfill material may be placed in water only when the removal of the water from the area to be backfilled is impractical, as around piers or abutments located within the waterway. Backfill material placed in water need not be aritificially consolidated.

Backfill material placed above water line must be placed in layers not more than 8 inches in loose thickness. Each layer must be thoroughly compacted before material for the next layer is placed. All compaction must be accomplished by rolling with an approved roller or by tamping with a mechanical tamper.

No backfill is to be placed against concrete abutments, piers, arches, or wing walls or against timber abutments or wing walls which depend upon cast-in-place concrete deadmen for anchorage until the concrete is 7 days old and has developed a modulus of rupture of 550 psi or more. If the strength of the concrete is not determined, backfilling operations must wait until the concrete is 14 days old.

No backfilling is to be placed against timber abutments or wing walls until all required anchor rods are in place and ready to function. Neither is any backfill to be placed against any timber abutment or wing wall which is designed to gain support from a superstructure until the superstructure is in place and permanently fastened to the substructure.

Where backfill is required on both sides of a concrete wall, abutment, pier, wing, etc., filling operations must proceed simultaneously on both sides of the structure so that the two fills are kept at approximately the same elevation at all times.

COFFERDAMS

Cofferdams must be constructed in a substantial manner and capable of satisfactorily resisting the earth and water pressures without appreciable displacement. The contractor may be required to submit plans for the engineer's approval.

The bottom of the sheeting is to be driven sufficiently below the bottom of the footing to obtain stability, and the top of the sheeting must be of sufficient height to prevent overflow from reasonable rise of the stream.

With approval of the engineer, steel bracing may be allowed to be encased in the concrete if it will not be exposed and can be cut off flush with the surface of the concrete.

A clear space of at least 18 inches is to be provided on all sides between the footing and the cofferdam. The cofferdam can not be used as a form for the concrete footing, but may be used as the form for a seal coat.

Pumps of sufficient capacity must be used to keep the excavation reasonably free of water until the concrete is poured.

WELLPOINT SYSTEMS

On occasion the water cannot be controlled by the use of cofferdams and pumps, or the contractor may find this method too costly. Under these conditions, the contractor may elect to use an open pit with a wellpoint system to control the water. A wellpoint system is effective in sandy soils. A wellpoint system will consist of the points, the header pipe and the pump. The points should reach to below the bottom of footing elevation. The number of points depends on the type of soil and the amount of water to be controlled.

BERM CONSTRUCTION AND SETTLEMENT

Any berm construction required by the plans shall be a compacted embankment the full width and height of the roadway. Major berms are usually constructed by the grading contractor. The plans will note if there is to be a waiting period before driving piles, to allow time for the berms to settle.

When the plans do indicate such a waiting period, settlement plates are placed in these berms. The settlement plates are 3′ x 3′ metal plates set 6 inches below the natural ground line. A three-foot section of pipe is connected to the plate and as the berm is constructed additional pieces of pipe are added. The survey crews take elevation shots on top of the pipe sections at least weekly. These elevations are plotted on a settlement curve to determine the amount of settlement. This curve will show when the berm has completed its settlement. In case berm settlement is completed earlier than the prescribed delay period, approval for early abutment construction may be obtained from the Construction Department.

If an abutment was constructed on a berm that has not completed settling, the abutment could settle along with the berm, or the berm could settle away from the abutment. The underlying soils and the size of the berm will determine the length of time needed for settlement.

FOUNDATION TREATMENT

After excavating to the required elevation, if the bottom of the excavation is of an unstable nature, the engineer may require that the foundation be treated by excavating below the required elevation then backfilling with suitable granular material. Payment is limited to $5.00 per cubic yard for the combined excavation and granular backfill.

Due to the nature of footing work and locations, it is anticipated that the bottom of many excavations for footings will be wet and may become muddy. A muddy condition may be present without the existence of an unstable condition. It is the contractor's full responsibility to prepare and maintain the bottom of the excavation to an acceptable condition prior to and during the placement of the footing. This may be accomplished by providing better drainage, the removal of mud and the replacement with granular or any other approved practical method that will reduce an unacceptable muddy condition to a tolerable condition.

When the footing is to rest on firm earth, special care must be taken not to disturb the bottom of the excavation.

If rock foundation is encountered, the excavation must be so done as to allow the rock to be exposed and prepared for receiving the concrete.

FORMING

All concrete for bridge construction must be formed. The forms may be of metal, plywood, surfaced lumber or other approved material, backed by suitable studding and walers, mortar tight and of sufficient strength to hold the concrete without bulging. Forms must be so designed and constructed that they may be removed without injury to the concrete. All sharp corners must be filleted with a ¾ inch fillet strip. The forms must be cleaned and oiled before use.

REINFORCING STEEL

Reinforcing steel must be of the size and type specified on the plans. At the time the steel comes in contact with concrete, it must be free from dirt, oil, paint, scaly rust or other foreign substances other than soft red rust. Reinforcing steel must be bent or straightened without heating. It must be held securely in place during the placing and hardening of the concrete. Where practicable, reinforcing steel will be supported on metal chairs approved by the engineer. The metal chairs must either have upturned legs or a horizontal bar stop welded at the base of the leg.

Concrete block inserts, bricks, stones, wood blocks, and similar materials must not be used for supporting reinforcement.

Bar splices must have the lap shown on the plans. The plans will specify the minimum clear distance from the face of concrete to reinforcing steel. Before any concrete is placed in a section, a check must be made to see that all the bars called for on the plans are in place, that they are spaced as shown on the plans, and are securely fastened in place.

CONSTRUCTION JOINTS IN PIERS

Permissible construction joints in piers will be shown on the plans. The surface of the concrete in horizontal joints, except in the areas near the forms, must be left rough to increase bond with the concrete to be placed later. A ¾ inch beveled strip must be placed at the top surface of the concrete adjacent to the form. Keyways of not less than 1½ inches by 3 inches wood strips must be embedded in the concrete.

Succeeding layers of concrete in tapered edges must be so formed by an insert to obtain a 6-inch thickness of concrete.

Construction joints in unreinforced concrete in addition to the keyway must have steel dowels, a minimum of ¾ inch diameter, placed at two-foot centers around the edge of the section. The dowels must project at least one

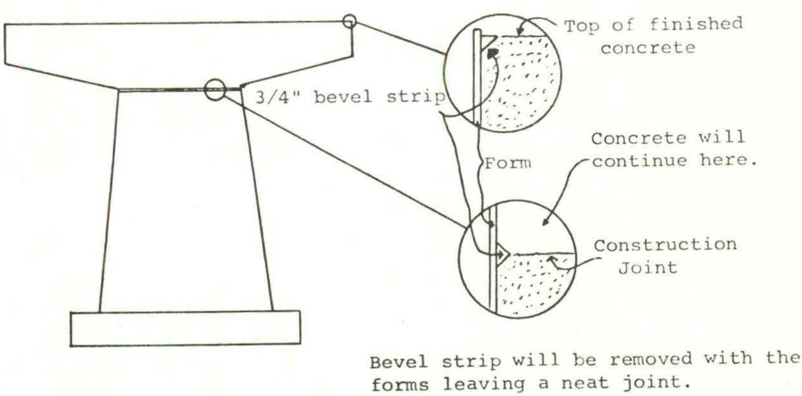


Figure 1 – Use of Bevel Strips

foot into each section.

If the volume of concrete for the pour is too great or for some other reason the pour is interrupted, an additional joint may be placed. These joints must be placed so they will not impair the strength and appearance of the structure.

Any alterations should be discussed with the engineer before they are constructed.

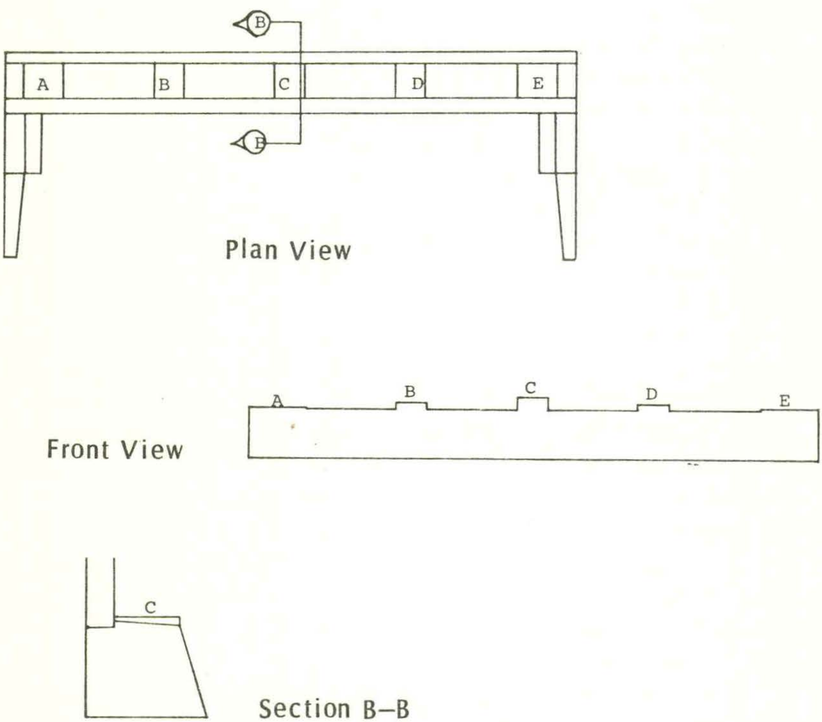


Figure 2 – Abutment Bridge Seats. Bridge Seats are the areas where the beams rest on the abutments and piers. Areas A through E are bridge seats. Because they directly affect beam elevation, design specifications must be followed closely.

CONCRETING OPERATIONS

The plans will note where the different classes of concrete are to be used. The plant inspector will check the batch weights and mixing operations at the ready-mix plant and make out a delivery ticket on each load of concrete. Refer to the Ready Mix Plant Inspection Handbook for plant control and operations and proper methods of running all tests.

The inspector at the jobsite will run slump and air tests and check the delivery ticket. The slump of the concrete must not exceed 4 inches. The air content of the concrete, after vibration should be from 5 to 7 percent. Since the average loss of air through vibration is from ¾ to 1 percent, the air content of the concrete as it comes from the mixer should be from 6 to 7½ percent. All concrete must be in place in the forms within 1½ hours after being mixed. All concrete must be consolidated by vibrating units operating at not less than 3500 cycles per minute. Spading may be necessary along forms to prevent honeycomb. Concrete must not be caused to flow inside the forms by vibrating or puddling. Care must be used to avoid any segregation of the mix. When placed, the bottom of the bucket or the point of the chute must be as close as possible to the point of deposit. The free fall of concrete for bridge construction must not exceed 3 feet. When the free fall exceeds 3 feet, a flexible metal tremie must be used to slow the flow of concrete to its place of deposit.

After the concrete has been deposited and vibrated, it must be struck off to the required elevation. The surface must then be worked with a wood float until the surface is uniformly smooth, dense and true.

Bridge seat elevations must be set with a level to the exact elevation called for on the plans at the time the concrete is being finished. This method takes away some of the danger of low bridge seats caused by form settlement.

After constructing the first pier or abutment, the inspector must use this pier or abutment as a reference for elevation and span distance for the remaining piers and abutments.

If you are constructing a bridge with two abutments and two piers, the following steps must be taken to ensure against errors:

1) After the first pier has been formed the design elevation must be shot on the form. The centerline of roadway and centerline of pier bearing must also be located.

   After placing the concrete, while it is still in a plastic condition, these things must be rechecked and the proper corrections made.

2) After the first pier is constructed, the inspector must establish definite centerlines and elevation on the first pier, and use these reference points for all the remaining piers and abutment construction.

FORM REMOVAL

Removal of forms must be done with care to prevent damage to green concrete. Forms for vertical surfaces may be removed after 24 hours in favorable weather and if no damage is done to the concrete. Forms supporting the concrete may be removed after the concrete is 5 days old, providing it has developed a modulus of rupture of 550 psi or more. If no beams are made or tested, such forms must remain in place for 14 days.

CONCRETE FINISHING

The top surfaces of piers and abutments require a Class 1 floated surface finish. A Class 1 finish consists of overfilling the forms with concrete and striking it off at the required elevation and then working the surface thoroughly with a wood float until it is uniformly smooth, dense, and true.

Immediately after form removal,all formed concrete surfaces must be given a Class 2 stripdown finish. Rods and other devices used as form ties must be removed to the extent contemplated in their design. Paper tubes must be removed. All wires must be cut flush and then driven ¼ inch below the surface. All fins and irregular projections must be removed. All cavities produced by form ties, all other holes and honeycomb, etc. must be saturated with water and carefully filled with a mortar of cement and fine aggregate. Shallow voids other than honeycomb will not be considered as holes and need not be filled.

Immediately after the Class 2 finish has been completed, surfaces requiring a Class 3 rubbed finish will be worked. The entire surface must be rubbed with a number 16 carborundum brick and water. Rubbing must continue until the surface is covered with a lather derived from the surface being finished.

A Class 3 finish applies to all exposed surfaces of concrete handrails (except the underside), rail posts and curbs. The backface of the curb must be given a Class 2 finish unless it is clearly visible from the roadway or sidewalk of the bridge. Tops of curbs or safety curbs more than 12 inches wide must be given a Class 1 floated finish. On grade-separation structures, all vertical or nearly vertical surfaces of piers, abutments, wing walls, curbs, sidewalks and the outside of exterior girders visible from any traveled way must be given a Class 3 rubbed finish to an elevation 1 foot below finished ground line. The vertical or nearly parallel surfaces not more than 100 feet apart require a Class 3 rubbed finish.

CURING OF CONCRETE

Proper curing of concrete is very important in getting a strong, durable concrete. Curing operations should begin as soon after the finishing operations as possible without marring the surface. The exposed surfaces may be covered with burlap, straw, sand, etc. kept wet continuously for four days. If forms are removed before the concrete is 60 hours old, the concrete must be cured until it is four days old. No further curing is required for these surfaces if forms are left in place at least 60 hours.

An alternate method of curing is by the use of curing compound. Immediately after finishing operations are completed the surface must be coated with white curing compound at a rate of not more than 135 square feet per gallon. Curing compound must not be used on surfaces against which concrete is to be placed.

Surfaces may also be covered with approved paper or plastic.

PLACING AND PROTECTION IN COLD WEATHER

No concrete can be placed without the specific permission of the engineer when the air temperature is at or below 40 degrees. No frozen materials can be used in the concrete and the concrete must not be deposited against forms or any other material having temperatures below 40 degrees.

In addition to adequate protection for the concrete against freezing and chilling, the contractor may also have to heat the water or aggregates or both. Heating of water or aggregate is required if any frozen material is to be used or when the concrete cannot be produced at the minimum temperature of 50 degrees.

The specifications state the concrete shall be produced so that when deposited in the forms it will have a temperature not less than 50 degrees F or more than 80 degrees F. The first 72 hours the concrete and the air surrounding it must be maintained between 50 and 100 degrees and the next 48 hours it must be maintained at 40 degrees to 100 degrees. After the curing period, the temperature of the concrete shall be reduced at a rate of not more than 5 degrees per hour and 20 degrees in 24 hours to the outside air temperature.

There are two acceptable types of protection for pouring in cold weather. One method is housing the complete section to be poured. This is usually done with two by four frames covered with plastic. When housing large areas such as piers or abutments more than 12 feet high, diaphragms have to be provided dividing the housing into separate sections not more than 12 feet in height, controlling the vertical distribution of heat. During the curing period the concrete must be protected from local overheating and from drying.

Heaters placed in the housing may not be open-flame type heaters. They must be securely anchored and guyed to prevent movement or overturning due to thawing. None of the exposed metal may be in direct contact with the flame.

An attendant with at least one nonfreezing fire extinguisher of adequate capacity must be on duty at all times during which heat is being applied to a structure. All combustible material used for the housing must be firmly secured to prevent contact with any source of heat. If hay or straw is used for the protection of slabs, the lower one-fourth of the depth of the hay or straw must be thoroughly wetted with water when placed.

With the approval of the engineer, forms insulated with 2 inch bats of fiberglass, rockwool, balsam wool or similar commercial material may be used in place of housing the complete section to be poured. When using insulated forms, exposed horizontal surfaces have to be protected with a similar layer of insulation or an adequate layer of hay or straw properly secured.

Temperature control, using insulated forms, is very difficult to accomplish. Under certain circumstances the forms can be loosened slightly to control temperatures that exceed 100 degrees. With proper maintenance of the insulation, minimum temperature requirements should not be a problem.

Concrete at least one foot below ground water level may be flooded with a minimum depth of one foot of water in place of other curing and protecting methods. When this is done, the concrete cannot be exposed to freezing temperatures within ten days.

If the methods of protecting concrete above ground level prove to be inadequate to maintain the required temperatures, additional protection and heating methods must be provided.

INTEGRAL ABUTMENTS

In structures with integral abutments, the abutments are designed to move to allow for the expansion and contraction of the structure. The abutments are tied into the deck so that the deck and abutments act as one. To allow the abutments to move, the piling are driven in oversize holes and the top six feet are not backfilled. Care must be used to exclude concrete from drilled holes. Forming around the piling with plywood, etc., will be necessary to exclude concrete from the drilled holes.

BACKFILLING ABUTMENTS WITH GRANULAR MATERIAL –DRAIN TILE–

Full compliance with the specifications is necessary to avoid settlement of the overlying pavement at the ends of bridges. No backfill is to be placed against concrete abutments until the concrete is seven days old and has developed a modulus of rupture of 550 psi or more. If no test is made – 14 days.

Before backfilling bridge abutments, all loose material must be removed so that firm rolled fill is exposed. The entire excavation behind the abutment, after removal of loose material, must be backfilled, using approved granular backfill material. It is not necessary to excavate to the lines shown as the limit for granular backfill, if the embankment is undisturbed since originally compacted. Granular material must be placed in not more than 8 inch loose layers. Each layer must be thoroughly tamped or vibrated to ensure compaction. The granular material must have sufficient moisture to facilitate compaction. Do not permit dumping of granular material directly from the truck into the hole to be backfilled. Backfill must be brought up to the elevation shown on the plans.

The required drain tile must be placed behind the abutment as shown on the plans. The length of drain tile must be measured and recorded for pay purposes. Test reports for both granular material and drain tile are required.

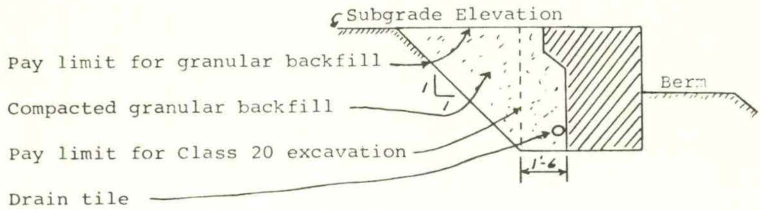


Figure 3 – Excavation beyond the limits shown must also be backfilled with granular material.

SUBJECTING CONCRETE TO EXTERIOR LOADS DUE TO SETTING BEAMS ON PIERS AND ABUTMENTS

The following is a guide to use along with the specifications for subjecting concrete to exterior loads.

Beams may be set on piers and abutments as follows:

1) On diaphragm piers, beams may be set after twenty-four hours as long as doing so does not mar or chip the concrete surface.
2) No beams can be set on pedestal, P10A, or T piers until the concrete is seven days old and the modulus of rupture is 550 psi or more. If no test beams are made, the time must be extended to 14 days.
3) On stub abutments, steel beams and girders may be set the same as No.1.
4) Concrete beams on stub abutments may be set the same as No. 2.
5) On full abutments concrete beams may be set the same as No. 1.
6) In cooler weather, the minimum time of 24 hours should be increased to 48 hours.

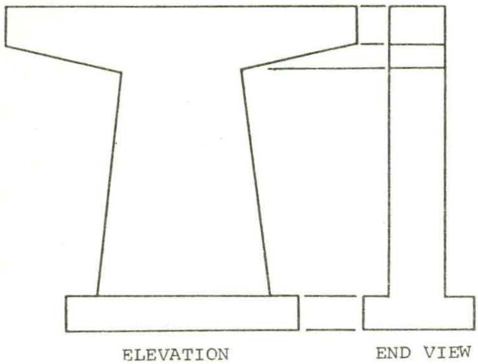


Figure 4 – Concrete T Pier

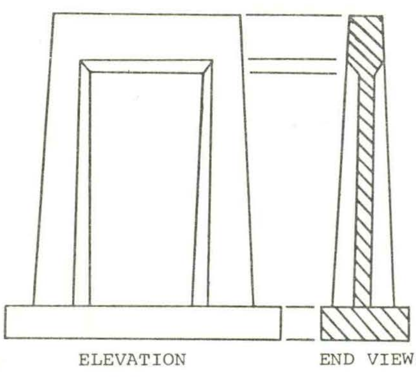


Figure 5 – Concrete Diaphragm Pier

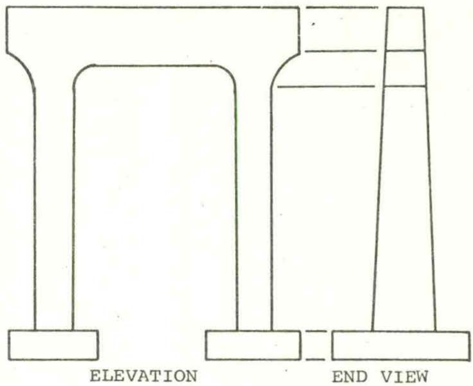


Figure 6 – Concrete Pedestal Pier without Strut

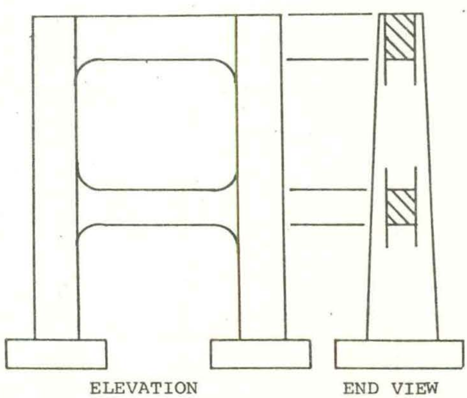


Figure 7 – Concrete Pedestal Pier with Strut

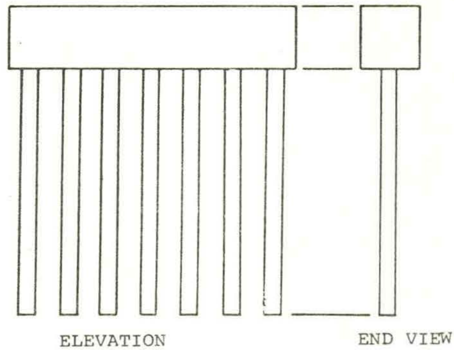


Figure 8 – P 10 A Pier

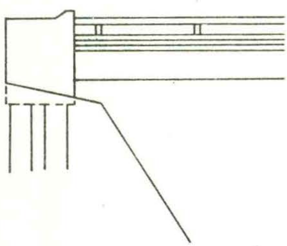


Figure 9 – Stub Abutment

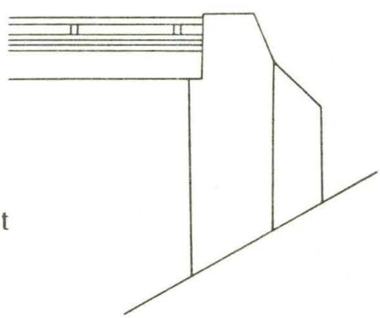


Figure 10 – Full Abutment

PREPARATION OF BEARING AREA

After the substructure is completed and before setting any masonry plates, elevation shots must be taken on all of the bridge seats. If the seat elevations were shot at the time the concrete was being finished, there should be little or no error in the elevations. See "Concreting Operations." In case there is an error, now is the time to make any corrections in the bearing areas rather than wait until the steel is set and find that there will be critical areas of thickening or thinning of the floor depth. It should be kept in mind that thinning of the floor should be avoided but must not exceed ¼ inch over a high spot. Thickening must be limited to a maximum of ¾ inch over a low spot.

If all the seats are high or low by approximately the same amount, it may be possible to raise or lower the finish grade line of the floor and this would compensate for the error in the seat elevations.

In case of critical errors in seat elevations, consult the engineer.

Let's say that you shot the bridge seat elevations on two piers and two abutments of a bridge. All of the elevations are correct except that one bearing area on each pier and one abutment are .05 high. These three areas would definitely cause trouble in the floor thickness. The easiest possible solution would be to grind the three areas down thus eliminating critical thinning of the floor.

Say there were three bearing areas that were .05 low. Here the engineer might find it desirable to have a steel plate placed beneath the masonry plate thus raising the beam and avoiding floor thickening.

It is of utmost importance that the bridge seats be finished to design elevation at the time the concrete is poured.

The masonry plates must have a full uniform bearing upon the concrete. Bridge seats of piers and abutments which are improperly finished, deformed,or irregular within the bearing area of masonry plates must be corrected before the plates are placed. The bearing area of the bridge seat must be painted with red lead paint. Upon the painted surface, place three layers of 12 to 14 ounce duck, swabbed freely with paint between the successive layers. The masonry plate must be placed while the paint is plastic.

SETTING ANCHOR BOLTS

When so provided on the plans, anchor bolts will be set in the fresh concrete. When anchor bolts are to be set during the placing of the concrete, they must be held firmly in a rigid template which spans the concrete with sufficient clearance to permit proper finishing of the surface of the concrete. The template must remain in place until the concrete has hardened. Anchor bolts must be set accurately at points specified on the plans. The span distances are very important here.

When anchor bolts are not preset, holes must be drilled into the concrete. The holes must have diameters approximately twice that of the anchor bolts. They must be drilled to the required depth and perpendicular to the plane of the bridge seat. The holes must be protected from freezing water. After drilling, drop anchor bolts into dry holes to assure proper fit. Remove the bolt and fill the hole 2/3 full with a mortar composed of 1 part cement and 1 part sand, with sufficient water to make it workable. Then force the bolt into the mortar. Remove all excess mortar that is forced out of the hole.

The drilling of anchor bolt holes must be kept in mind when placing the reinforcing steel in the tops of piers and abutments. Shifting the reinforcing steel slightly may later allow the holes to be drilled without running into a reinforcing bar.

In some cases the steel beam or girder may have to be swung into position, the anchor bolt location marked on the bridge seat, and the beam swung back out of the way to facilitate the drilling of the holes. The contractor will not be allowed to drill the hole into the concrete through the masonry plate. The hole or slot in the masonry plate is only slightly larger than the anchor bolt and the drilled hole must be approximately twice the diameter of the bolt.

SETTING BEAMS

Beams and girders delivered to the job site must be kept clean and free from injury by rough handling. Any member that is slightly bent or twisted must not be placed until its defects are corrected. Members seriously damaged will be rejected. Beams and girders must be stored upright on skids, in the same position and with the same supports which they will have on the bridge. This is very important with concrete beams. All of the steel diaphragms, braces, etc. must be stored above ground on suitable skids or platforms.

Falsework or other approved means must be used for supporting the steel beams during erection. The method used must be capable of supporting the full weight of the steel without appreciable settlement.

All members and parts must be accurately assembled as shown on the plans and all match-marks must be followed. Bearing surfaces and surfaces to be in permanent contact with each other must be cleaned before the members are assembled.

Temporary connection of the main member must have at least 25% of the holes filled with drift pins, and another 25% filled with high strength bolts or temporary fitting up bolts drawn up snugly.

Before beginning field riveting or tongueing bolts in the splice connections, the beams must be adjusted to correct grade and alignment. The correct elevation of the splices must be figured from the "as fabricated and erected" diagram. In case of splice connections on either side of the piers, these connections must be balanced. In other words, do not have one end spliced high and the other end low. Jack the splices so that they are both equal distance above or below the design elevation. This will prevent severe thickening or thinning of the floor over these points.

Main splice connections must be made with high strength bolts, nuts and washers or with hot driven rivets. Holes for unfinished bolts and high strength bolts must permit the free entry of the bolt without driving. Holes must not be more than 1/16 inch in diameter greater than the nominal bolt diameter. Holes for ribbed and turned bolts must be carefully reamed to a driving fit with the bolt.

Surfaces of bolted parts adjacent to the bolt head and nuts must be parallel. Bolted parts must fit solidly together when assembled without any sort of gaskets.

After permanent bolting or riveting of the splices has been completed, inspected, and accepted, the falsework may be removed and the span swung free on its permanent supports. All main connections must be fully bolted or riveted before the span is swung free except that milled compression chord connections will be permanently bolted or riveted after the span is swung.

HIGH-STRENGTH BOLTING

The length of high-strength bolts must be such that when tightened there will not be less than ¼ inch or more than 7/16 inch of bolt protruding from the nut.

Bolts must be assembled with one hardened washer under the bolt or the nut depending upon which one is turned in tightening.

The contact surfaces must be free of all dirt, paint, etc. that would interfere with the development of friction between parts.

Torque and tension are two different methods of testing bolt strength and tightness. Torque is the amount of work in foot-pounds applied to a nut and bolt. Tension is the stretching force applied to a bolt

The following procedure is the method by which the inspector must test all high-strength bolts to ensure compliance with the specifications. Be sure to notice that different size diameter bolts have different torque and tension requirements.

Torque can be tested with manual or power torque wrenches. The most common method is the manual torque wrench. The testing shall be done in the presence of the inspector by loosening the nut and retightening it with the manual torque wrench to the minimum torque required. The position of the nut relative to the bolt before loosening and after tightening will indicate the degree of tension. At least 10 percent of the bolts in the joint must be tested. Should this procedure show that 20 percent or more of the bolts tested have insufficient torque, all bolts in the joint must be tested.

When using the power torque wrench to determine torque values, the manufacturer's recommendations must be followed. The wrench should be kept in proper working condition. This wrench should be checked in the presence of the inspector at least once each half day.

The specifications in the future may require bolt tension tests. This test may be accomplished with calibrated wrenches also.

When calibrated wrenches are used to provide the bolt tensions specified, their setting must be such as to produce a bolt tension five to ten percent in excess of the value required.

A device capable of indicating actual bolt tension will be required, to use for calibrating the wrenches used in testing. The size of the bolt will determine the minimum bolt tension in pounds required. These wrenches must be calibrated at least once each day.

When using manual torque wrenches to test tension, the torque indication corresponding to the calibrating tension must be noted and used for testing the tightened bolts.

The inspector must observe the calibration of the wrenches and the installation and tightening of the bolts to determine that a proper procedure is being followed.

Three bolts of the same grade and size as those being used are to be placed individually in the calibration device to test the tension.

Bolts placed in the structure must be inspected by applying, in the tightening direction, the inspecting wrench at its job-inspecting torque to 10 percent of the bolts, but not less than two bolts in each connection. If no nut or bolt head is turned by the application of the job-inspecting torque, the connection is properly tightened. If any nut or bolt head is turned by the application of the torque wrench, the nut or bolts that turn must be retightened and retested; or at the erector's option, he may retighten the complete connection and resubmit the connection for inspection.

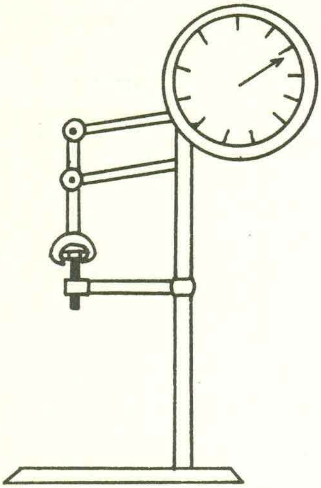


Figure 11 – Tension. The number of pounds exerted in pulling a bolt apart is its tension (pulling strength).

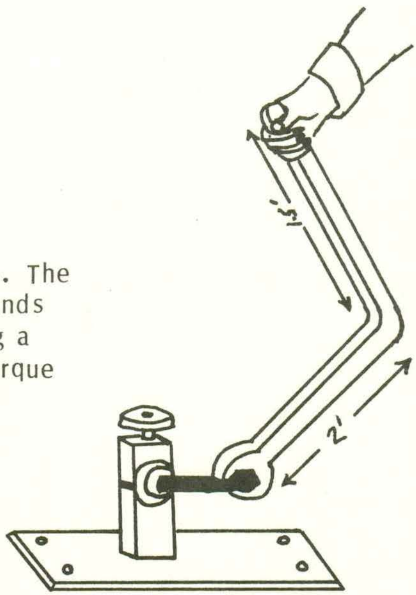


Figure 12 – Torque. The number of foot-pounds exerted in twisting a bolt apart is its torque valve.

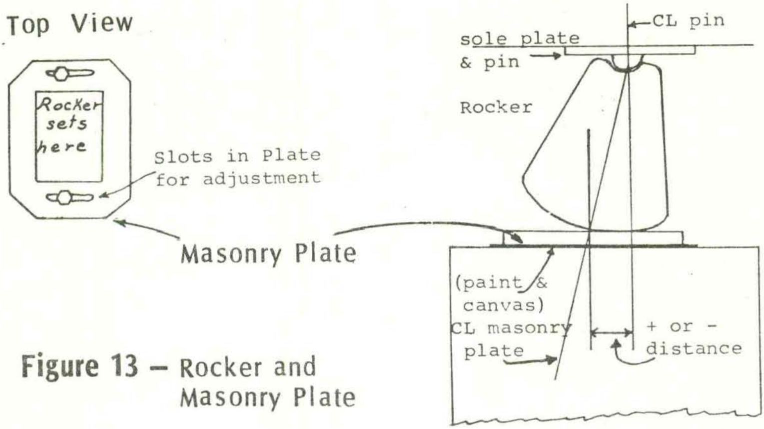


Figure 13 – Rocker and Masonry Plate

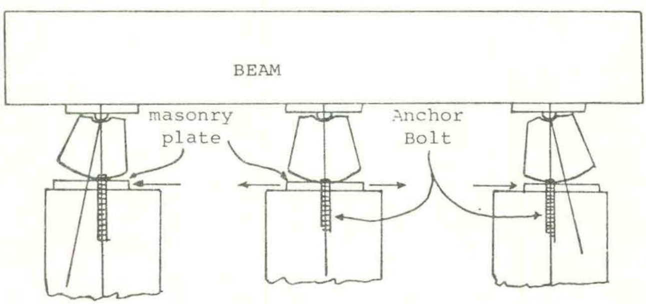


Figure 14 – Rockers and masonry plates must be adjusted after the steel is bolted and resting on its permanent supports. Rocker bearings must be adjusted to allow movement due to temperature changes and substructure flexing. The masonry plate is moved slightly forward or back to adjust the bearing. The mean temperature assumed in determining temperature movement is 50 degrees Fahrenheit. Plans contain a table showing rocker settings for temperatures above and below 50 degrees Fahrenheit.

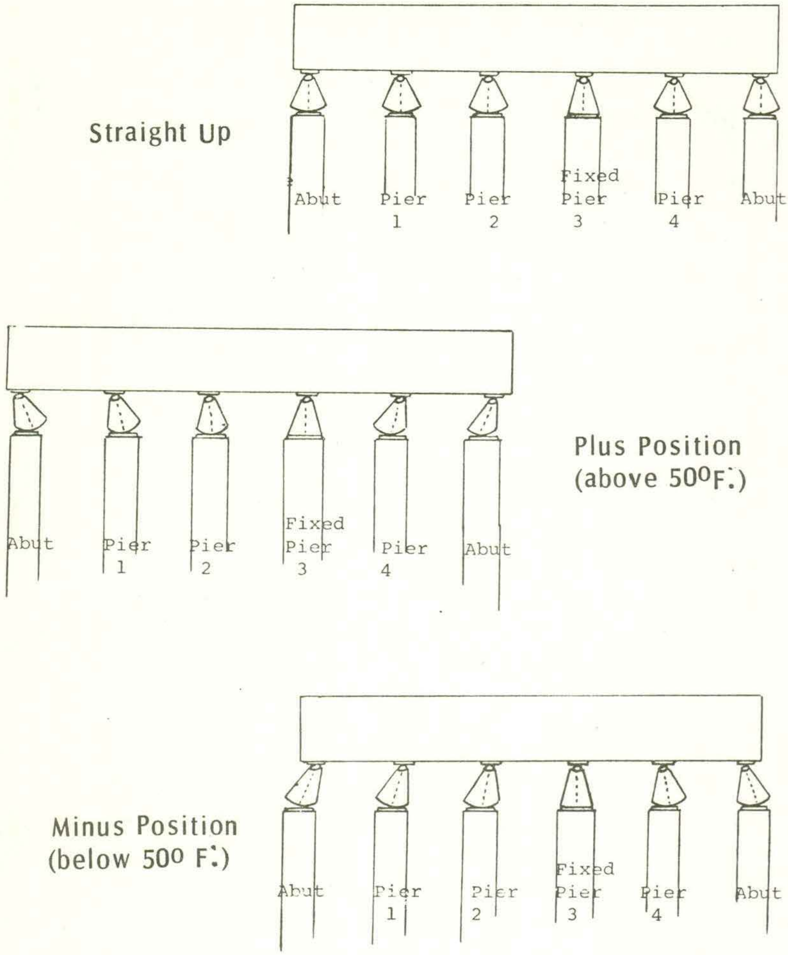


Figure 15 – Setting Rocker Bearings. Assuming a mean temperature of 50 degrees Fahrenheit, the rockers should be set straight up when the temperature is 50 degrees Fahrenheit. When the temperature falls below 50 degrees Fahrenheit, the beams contract, causing the rockers to tilt toward the fixed shoe. When the temperature climbs above 50 degrees Fahrenheit, the beams expand, causing the rockers to tilt away from the fixed shoe.

BACKWALLS AND EXPANSION JOINTS

Backwalls on steel structures can be constructed in two separate pours.

The lower section, from the paving notch down, cannot be poured until the structural steel has been set. With the structural steel in place, the masonry plates can be adjusted to get the proper setting on the rockers. If this section was poured before setting the steel, and an error was made in constructing the abutment, it would be impossible to make the proper adjustments.

The top section of the backwall must not be poured until the deck is completed. Finishing the backwall to the same gradeline as the floor is the best procedure.

Backwall construction on steel structures involves the setting of the expansion plate. The expansion plate is set at the correct elevation by shimming between the anchor plates and the girder.

After the floor has been poured, the only adjustment on the backwall section of the expansion plate is the dimension given on the plans for the temperature at the time of setting.

The area of the expansion plate that slides on the top of the backwall curb must be greased and lined with tar paper to ensure against bond between the expansion plate and the backwall concrete. A depression in the top of the curb must be formed to accommodate the expansion plate when the floor is at maximum expansion.

After the concrete has become set enough to support the plate, the bolts holding the two plates together must be removed. If this is not done, the cool night temperature could cause contraction of the deck and the expansion plate as a unit, would pull out of the freshly poured backwall concrete.

Prestressed concrete beam bridges with integral abutments do not have expansion plate devices. Provision is made for the abutments to move as the bridge superstructure expands or contracts. The beams are not attached to the pier caps and the mastic in the construction joint allows free movement between them.

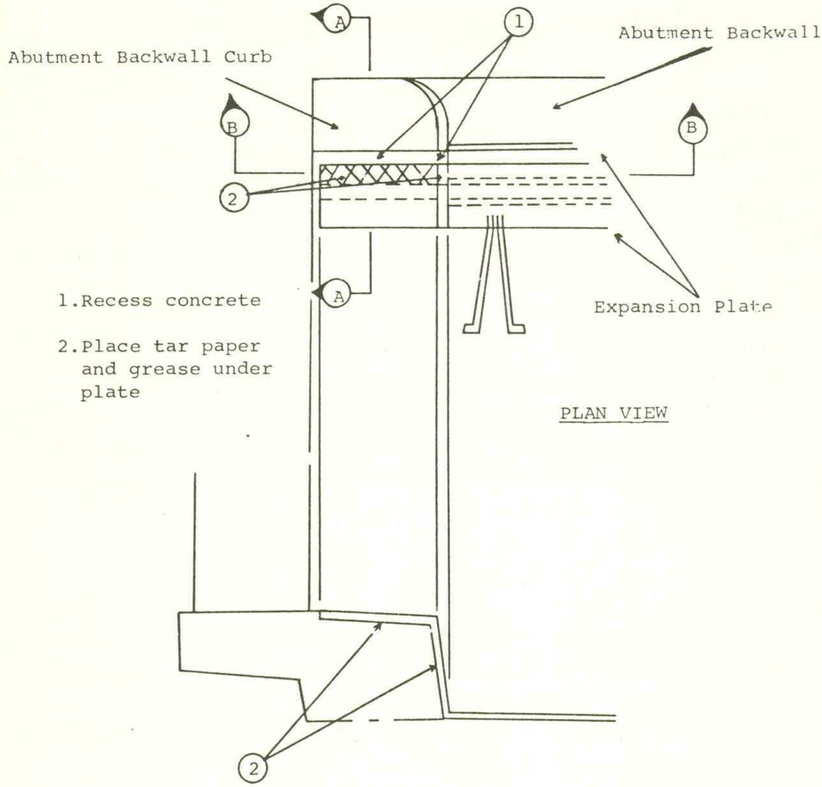
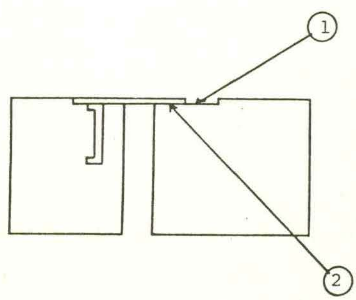


Figure 16 – Section B–B

Figure 17 – Section A–A



DIAPHRAGMS (PRESTRESSED BEAM BRIDGES)

Pier diaphragms are poured monolithic with the bridge floor. The intermediate diaphragms may be poured ahead of the floor.

Two major points of concern to the inspector are reinforcing clearance and mastic placement. Since these two phases are completed prior to placing deck steel, it is important to do the job correctly the first time.

It is of major importance to place the mastic correctly. It is required that there be absolutely no bond between the diaphragms and pier cap. After completion of the pour all mastic should be exposed.

Before the deck pour make sure the reinforcing has clearance and that there is no debris in the diaphragm forms.

SLOPE PROTECTION

The grade for slope protection of the berms must be smoothed and consolidated at an elevation which provides the thickness of concrete required.

The earth surface must be sprinkled early enough ahead of concrete placement to prevent any muddy conditions. No subgrade paper or membrane will be required.

The reinforcing steel must be supported by metal pins which will be left in place, or by movable supports meeting with the approval of the engineers. The reinforcement must be securely tied to prevent movement during the pour.

The concrete for slope protection has to be placed at a stiff consistency to permit placement and consolidation on the slope. Proper conditions can be obtained by light mechanical vibrating or spading. Insuring against honeycomb is essential. The joints must be keyed and doweled according to the plans. The pour should be made in alternate horizontal strips. Best results are attained by starting at the bottom of a strip and proceeding up the slope.

The slopes must be cured in the same manner as all structural concrete.

REMOVAL OF STRUCTURES

Unless otherwise specified, all materials will remain the property of the contracting authority. It is also assumed that parts other than concrete and masonry will be reused unless this violates the plans or special provisions.

Unless otherwise directed by the engineer, all members of steel structures must be separated at field connections. All members must be clearly and neatly matchmarked with white paint before dismantling.

Special care has to be taken during concrete deck removal not to damage any structural beam members under the deck. When using large concrete breaking equipment or a headache ball do not work directly over the beam. The impact of the headache ball will bend the flanges on the beams if the ball is dropped directly over the beam.

Generally, the substructure above the bed of the stream or one foot below finished ground line and any portion of the old structure that may interfere with the new construction, must be removed. At times, the plans or Special Provisions could change this.

Blasting is permitted as long as it does not endanger adjacent property and is completed prior to construction of any part of the new structure. Blasting cannot be permitted on any removal that is to be reused.

All structural steel members must be stored according to the plans or as directed by the engineer.

When disposing of broken concrete, all material must be disposed of in a manner which will avoid damage to adjacent property and creating of unsightly conditions.

PAINTING STEEL STRUCTURES

The painting of steel structures will include proper preparation of surfaces to be painted. These surfaces must be free of all dirt, dust, grease, oil, tallow or any other substance that should interfere with the paint bonding to the steel. To sufficiently prepare a surface for painting, it may be necessary to use chisels and wire brushes to remove all concrete and mortar splashes from the surface. All surfaces should be wiped clean with a cloth and, when necessary to remove greasy or oily substances, washed with gasoline or benzine and allowed to dry before painting.

The steel surfaces, unless otherwise specified, will receive one shop coat and two field coats of paint.

Specifications require that after the steel has been fabricated, it must be blast cleaned and shop painted. Contact surfaces, such as field connections, need not be painted. These surfaces must be shop painted after erection. All surfaces which are accesible before and inaccessible after erection, must receive the three required coats of paint in the shop. The underside portions of an expansion plate not in contact with concrete would be an example.

Shopcoat

The shopcoat is to consist of Redlead Shop Coat paint. This paint will be used by field forces to repaint any damaged areas caused while in transit orerection and to paint the field connections.

First Field Coat

This paint is to be First Field Coat Red Lead, unless otherwise specified.

On grade separation structures, the plans may require surfaces exposed from the roadway, beneath the structure, to be painted gray. In such cases, the paint shall be tinted to match the contracting authority's sample.

Second Field Coat

The second field coat of paint is to be Foliage Green Paint, with the same exception as the first field coat noted above.

No paint may be applied when the temperature is below 40 degrees Fahrenheit except with the permission of the engineer. No paint will be applied to surfaces that are not free of moisture or frost or whenever weather, temperature, or humidity conditions would adversely affect the quality of the painting.

The inspector has to be extremely cautious of windy conditions, especially in urban areas because of the fine paint mist drifting onto surrounding areas.

Paint must be thoroughly mixed so that the pigment is completely in suspension and the consistency is uniform. It must be kept at this consistency while being applied, without any thinning.

The paint must be smoothly and uniformly spread so the surface will be properly covered with no excess of paint collecting on any one area. Paint may be applied by hand brushes or by suitable power sprayers, except steel handrail post mounted on concrete, which must be brush painted.

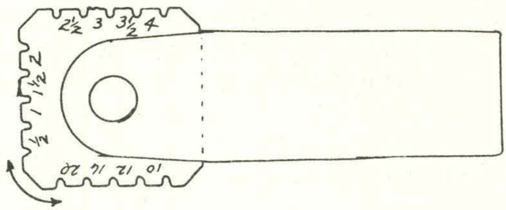
A proper application by spray methods must produce a fine, even spray without the addition of thinners. In cool weather, the paint may be warmed to reduce viscosity by placing the containers in warm water or heating them on radiators. Any accumulations of paint or runs must be brushed out to produce smooth, uniform results.

Spray painting requires precautions to ensure full and complete painting, without spraying the adjoining concrete and adjacent structure.

The paint may also be applied by hand brushes, not exceeding four inches in width. Surfaces inaccessible to a brush may be painted with sheep skin daubers.

The drying time for each coat of paint will vary with the weather conditions. A minimum of two days under good conditions is required.

Each individual coat of paint must be applied to a minimum wet thickness of two mills per coat. A thickness gauge can be obtained to determine the thickness.



Square wheel may be rotated.

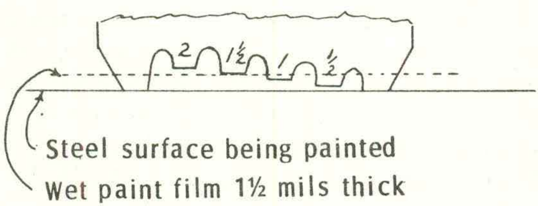


Figure 18 – Paint Gage. Place gage against painted surface. Remove gage and read paint thickness by observing which projections have touched the paint.

MATERIAL REPORTS

The materials used on the work must meet all quality requirements of the contract. The contractor must notify the engineer of his proposed suppliers prior to delivery. In the case of cement and aggregates, the inspection is normally made at the source. Shipments of this material must be accompanied with a stamped certified ticket verifying the inspection. The inspector must pick up these tickets and examine them before accepting the material for use. It is necessary to make reports to district materials giving them the amount of aggregates received to date. They, in turn, will issue an approval for the amount received.

In the case of reinforcing steel, air entraining agents, and other items used, the approval at the source will normally be forwarded to district materials and they will write up an approval for the amount of the shipment and forward to the Resident Construction Engineer's office.

If materials are on hand for which you do not have approvals, notify the contractor that you must have approvals before the items are incorporated. He has the responsibility to furnish these approvals. You may be able to implement the process by contacting your office. Sometimes a phone call to the inspecting office may produce a verbal approval, which is acceptable temporarily, and might prevent a delay to the contractor.

A record of material approvals must be kept in a field book with a separate page or two for each item used.

DIARY

The daily diary should be a complete story of the job as it progresses. Record the weather conditions, temperature, time started and stopped, number of men working that day, etc. Note any delays, conversations pertaining to the project, visitors and their comments, and describe the work that was actually done that day.

Above all, make your entries in the diary every day while the events are fresh in your mind. Do not rely on your memory or scratch pad notes; and if in doubt as to whether something should be recorded or not, record it anyway. Sign or initial each entry.

DOCUMENTATION

All contract items must be documented in the field record book. The record book should contain a detailed account of work performed. The records must show actual quantities placed, cubic yards of concrete, pounds of reinforcing steel, and lengths of all piling, etc. Record actual measurements of slope protection, approach paving, length of handrail, guard rail and drain tile, etc. Some items can be recorded and documented by actual count. Cross-sections and actual measurements must be recorded and computations shown for excavations. Record scale tickets on granular backfill, etc. The quantity of each contract item must be documented.

CONCRETE RECORDS (211B)

Although the concrete is normally batched out by a plant inspector, the inspector at the bridge site must keep the record of materials used and concrete placed. He must first set up a form in his field book and keep a complete record which will be reported on the 211B. The Resident Construction Engineer must report each week on Form 211B a summary of materials required and materials received for each active project as identified by test report numbers. These test reports will be mailed directly to the Resident Construction Engineer from the inspector of the material tested. Form 211B will also show the record of proportions used in producing concrete for the project.

1) Materials Quantities – Quantities of various materials required may be obtained from plan quantities for work covered by contract. For example, assume:

Concrete	1,256 cu.yds.
Structural steel	240 lbs.

Reinforcing steel . . . . 107,879 lbs.
Prestressed concrete beams . 38 @ 50′
Creosoted piling . . . . 125 @ 35′

Consult Section 2403 of Standard Specifications and the construction plans to determine the class of concrete to be used. Then obtain from the contractor the mix number and size of mixer he intends to use.

a) Calculate barrels of cement required – From specifications Mix No. C4 required 1.665 barrels of cement per cubic yard. Total barrels of cement required:

1256 c.y. x 1.665 bbls. per c.y.
= 2091 bbls.

b) Quantities of aggregate required – Proportions are stated in absolute volumes per unit volume of concrete.

For Mix C4, the unit absolute volume for both sand and coarse aggregate is .330931. A volume of 1256 cubic yards of concrete requires 1256 x .330931 which equals 415.6 cubic yards of coarse aggregate and 415.6 fine aggregate, absolute volume.

To convert these absolute volumes to weight, multiply by the weight per cubic foot of aggregate, which is specific gravity times 62.4 lbs. per cubic foot (weight of water).

For sand with a specific gravity of 2.66:

2.66 x 62.4 = 165.984 lbs. per cu. ft.

For coarse aggregate with a specific gravity of 2.69:

2.69 x 62.4 = 167.856 lbs. per cu. ft.

Total tons of sand required for C4 mix:

$$\frac{415.6 \times 27 \times 165.984}{2000} = 931.3 \text{ tons}$$

Total tons of rock required for C4 mix

$$\frac{415.6 \times 27 \times 167.856}{2000} = 941.8 \text{ tons}$$

These are dry weights and contain no allowance for waste or moisture. The specific gravities of aggregates from the various Iowa producers are listed in Instructional Manual 527 (available from the Materials Department upon request).

2) Report on Concrete Placed – Report the proportions used in structural concrete and the quantities of concrete placed on the reverse side of Form 211B.

Batch weight tables (Matls. 653 and 654) showing the correct cement and aggregate batch weights for different specific gravities and volumes of aggregate for all structural concrete mixes are available from the Materials Department. The tables show the batch weights for 3-sack, 4-sack, and 1-cubic yard batches.

DRY BATCH WEIGHTS OF MATERIALS FOR C4 MIX
(Example Using 1 Cubic Yard Batch)

Mix No.	Material	Size Batch C.F.		Absolute Volume		Specific Gravity		Weight Water C.F.		Dry Batch Weights
C4	Sand	27	X	.330931	X	2.66	X	62.4	=	1483
C4	Rock	27	X	.330931	X	2.69	X	62.4	=	1500
C4	Cement	27	X	.118330	X	3.14	X	62.4	=	626
C4	Water	27	X	.159808	X	1	X	62.4	=	269
Air entrainment				.060000						
				1.000000						

Column A – Item number – Use design number from plans.

Column B – Date poured.

Column C – Mix number – C4.

Column D – Number of batches poured. From batch meter or counting full bags of cement before and after pouring. When using ready-mixed concrete, list number of cubic yards.

Column E – and F – Record the dry batch weights of sand and rock in these columns.

Column G – and H – Percent of free moisture in fine and coarse aggregate. Determine percent of moisture by pycnometer method.

Column I – Total water used per batch. This item consists of free water in materials plus water added at the mixer. Example: If sand contains 3.2% moisture: 1483 ÷ 96.8 x 100 = 1532 actual batch weight. 1532 – 1483 = 49# free water in sand. If rock contains 0.6% moisture: 1500 ÷ 99.4 x 100 = 1509 actual batch weight, 1509 – 1500 = 9# free water in rock. Total water used per batch equals water added at mixer plus 49# + 9# of water in the aggregates.

Column J – Percent of sand in pit run. This percentage will be shown on materials inspector's report, Form 300, if pit run gravel is used.

Column K – Actual cement batch weight used. Since there is no moisture correction to be made, it is figured as shown in the example for C4 mix.

Column L and M – Actual aggregate batch weights (corrected for moisture determined by pycnometer tests), as the example for Column I shows.

Column N – Cubic yards of concrete placed. Calculate from plans, cubic yards in portion of structure poured.

Column O – Required pounds of cement. Cubic yards placed (Column N) times pounds required per cubic yard.

Column P – Cement used, pounds. Column D times number of pounds of cement per batch.

Column Q – Percent used/required. Divide Column P by Column O times 100.

Column R – Give in terms of cubic yards, bags or mixer size, the size of batch being poured.

Remarks – Use this column to identify portion of structure poured.

3) Disposition of Report – The original and one copy of the report shall be sent to the District Office. The District Office will forward the original to the Ames Office of the Materials Department.

   One copy shall be retained in the Resident Construction Engineer's Office.

Form 211-B

Iowa State Highway Commission

MATERIALS DEPARTMENT

WEEKLY REPORT OF INSPECTION OF BRIDGE MATERIAL

County: Polk
Project: I-IG-35-3(2)77
Design No.: 6657
Group No.: 6
Report No.: 3
Date of Report: April 21, 1968

Contractor: Iowa Bridge Co. Report for week ending: April 21 1968 % Completed: 12

Location: C.L. Station 1050+62 Date Started: April 2 1968 Date Completed: ______ 19___

Approximate Quantities Required

Cement Bbl.	Sand and Pit Run Gravel—Tons	Screened Gravel and Crushed Stone—Tons	Steel Lbs.	Lumber and Piling	Paint and Miscellaneous
2091	931	942	Reinf. - 197,879 Stru. - 240	Creo. Piling - 4375 L.F.	Conc. Beams 38 @ 50'

Source of Materials Used

Penn Dixie	Conc. Mat'ls Co.	Conc. Mat'ls Co	Pitts Des Moines Steel Co	Pioneer Lumber Co.	Prestressed Conc. of Iowa
Des Moines, Iowa	Des Moines	Des Moines	Des Moines	Ankeny, Iowa	Iowa Falls, Iowa

Approximate Quantities Received This Week

	Cement		Sand and Pit Run Gravel Tons		Screened Gravel Stone Tons		Steel Lbs.		Lumber and Piling		Paint and Miscellaneous	
	Lab. No.	Bbls.	Lab. No.	Tons	Lab. No.	Tons	Lab. No.	Lbs.	Lab. No.	Bd. Ft. and Lin. Ft.	Lab. No.	
	AC9-148	200	D59AC80	100	D59AC81	100	D59S 103	15,488	D59M 285	350	237-241 245-249 261-269	20 @ 50'
Total		200		100		100		15488		350		20
Total Fwd.		1000		300		300		80000		4025		18
Total to Date		1200		400		400		95488		4375		38

Signed ______________________

Title ______________________

Figure 19 – Form 211B (front)

REPORT OF PROPORTIONS USED IN STRUCTURAL CONCRETE

County Polk Project No. I-IG-35-3(2)77 Group No. 6 Design No. 6657 Report No. 3

Contractor Iowa Bridge Co. Date April 21, 1968

A Item No. and Unit Poured (Design No.)	B Date Poured	C Mix No.	D No. Batches	E Dry Batch Weights P. R. or Sand Lb.	F Dry Batch Weights Coarse Agg. Lb.	G Percent Moisture P. R. or Sand	H Percent Moisture Coarse Agg.	I Total Water Used Per Batch Lb.	J % Sand in Pit Run	K Actual Batch Weights Cement Lb.	L Actual Batch Weights P. R. or Sand Lb.	M Actual Batch Weights Coarse Agg. Lb.	N Cubic Yards Required (Plan Quantity)	O Cement Required Lb.	P Cement Used Lb.	Q Cement % Used Lb.	R Size of Batch	Remarks (See Table Below)
6657	4-17-68	C4	15	1483	1500	3.2	0.6	269		626	1532	1509	14.8	9265	9390	101.3	1c.y.	East Abut. Footing
6657	4-17-68	C4	28	1483	1500	3.2	0.6	269		626	1532	1509	27.1	16965	17528	103.3	1c.y.	East Pier Footing
6657	4-18-68	C4	9	1483	1500	3.0	0.4	266		626	1529	1506	9.0	5634	5634	100.0	1c.y.	West Pier Column

	N	O	P	Q
Total Cu. Yds. Req.				
Total This Report	50.9	31864	32552	102.2
Total Last Report	112.1	70175	72005	102.6
Total to Date	163.0	102039	104557	102.5

Concrete Mixer: — Truck

Make Transit Mixer

Size Number 7 c.y.

Source of Aggregates: Fine Conc. Mat'ls. Co.

Course Conc. Mat'ls. Co.

Specific Gravity: Fine 2.66 Coarse 2.69

Concrete used ____ Plain. ✓ Air Entrained.

Air Entraining Agent Added Protex

Percent Air Entrained 6.0

Period covered by this report: April 16 to April 21

ADDITIONAL TREATMENT OF CONCRETE	
S	Heated water only with no protection
T	Heated materials with no protection
U	Protected concrete but did not heat materials
V	Heated materials and protected concrete
W	Retarder used in concrete

(Signed) ____________ Inspector.

Figure 20 — Form 211B (back)

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