11.60 DECKS AND OVERLAYS

11.61 DECK OVERLAY PREPARATION

Securing an adequate bond at the interface of the existing prepared deck surface and proposed overlay course is essential in obtaining a durable and maintenance free bridge deck system. General surface preparation requires milling, shotblasting, and/or sandblasting depending on the surface condition or amount of existing surface material to be removed. Any reinforcing bar which is exposed must be sandblasted to remove all rust, contaminants, and unsound concrete. Also, prior to placing the grout, the surface must receive an air blast to remove dust and other foreign particles from the prepared surface.

The surface, once cleaned, must remain clean until the grout and concrete is placed. There have been cases where the prepared deck surface has become contaminated during the decking operations by concentrated traffic of vehicles transporting the concrete. This is especially true when the skid-steer type loaders are used to transport mix. The deck surface is contaminated by the abrasive action between the concrete surface and the rubber tires, and also from oil and other foreign material tracked in from off the bridge. Contamination can be recognized by discoloration or oil on the deck surface. Contamination is especially noticeable in the wheel paths used by the vehicles.

Core specimens taken and tested for bond strength from areas as mentioned above showed a marked decrease in bond strength between the interfaces.

To prevent the cleaned deck surface from being contaminated by traffic, the contractor shall cover any prepared surface with sheets of plywood, multiple layers of plastic, or other suitable material. To ensure a clean surface prior to placement of the overlay system, areas which become contaminated shall be resandblasted followed by an air blast.

Class A Floor Repair

Removal for Class A Bridge Floor Repair will no longer be determined by electrical corrosion detection during construction. Unless plans specify definite limits for Class A repair, repair removals will include only the actual spalled and hollow areas found during construction.

District Maintenance Engineers or the Office of Bridge Maintenance and Inspection will supply a preliminary audible and/or visual survey to the Office of Bridges and Structures, who will place that information on a plan sheet. On special occasions, an electrical corrosion detection plot may be requested.

Unless the Office of Bridge Maintenance and Inspection or Office of Bridges and Structures determines a need for adjustment, plans will show one plot based on the audible and visual survey. The plan diagram will be entitled "Survey Plot" with date of survey given. Plan note will be as follows:

> *"Plan quantity of floor repair is based on the 'Survey Plot' as shown on Design Sheet ____. Hatched portions represent Class A Bridge Floor Repair; cross-hatched portions represent Class B Bridge Floor Repair. Actual spalled and hollow areas as determined by the project engineer at the time of construction shall be repaired. The entire concrete surface of the bridge floor, including areas over bridge floor repair shall have bridge floor overlay."*

Class A Surface Preparation

A. On bridge deck repair work, some contractors have used an uncontrolled depth scarifier to remove concrete down to the top of the reinforcing steel in Class A repair areas. This "grind until you hit steel" method of removal results in damage to the reinforcing steel. Not only have bars been partially cut, but some have been severed completely or torn out of the floor.

   In many instances the re-bars have been reduced in cross section area by rust action. Any further reduction in diameter of the bars by grinding results in a decreased load carrying and load distribution capacity of the floor system.

   Therefore, the above method of concrete removal in Class A areas shall not be permitted. All methods of concrete removal must be submitted to the project engineer for approval. Other methods, which may utilize the Gallion Scarifier in removing concrete without damaging steel, may be submitted to the project engineer for approval. It is recommended that removal practices be discussed at preconstruction meetings. Emphasis needs to be placed on how the contractor will prevent steel damage.

B. *Specification 2413.03, C, 3, b* states in part, "... at the direction of the engineer limited areas of removal greater than 50% of the floor thickness may be removed" without continuing removal to full depth. These limited areas would be included in measurements as though "Class A Bridge Floor Repair."

   "Limited areas" have been defined as maximum of 1 m^2 (9 square feet). Deteriorated concrete must be removed even if below the reinforcing steel. Areas having *more than* 1 m^2 (9 square feet) and more than 50% of the deck thickness in one location should be totally removed as Class B bridge floor repair. It was not the intent of the specifications to pay extra for these small normally isolated areas of over depth Class A floor repair.

   For concrete slab or voided slab bridges, the Office of Bridges and Structures shall be contacted to obtain guidance and approval for any removal below the top mat of reinforcing steel. Generally, repairs requiring removal below the top mat will be restricted to longitudinal strips not exceeding 1 meter (3 feet) in width. This restriction is to ensure that structural integrity of the deck section is maintained. The Office of Bridges and Structures will provide project specific guidance based on field determined conditions of the bridge deck.

Work on Adjacent Lanes

Specification 2413.03, H, 9 permits limited work on an area adjacent to a previously placed lane during the 72-hour curing period. Basically, any operation which interferes with the curing process shall be for a minimal time only in a limited affected area. Operations that could potentially damage previously placed surface are restricted as noted in *Specification 2413.03, H, 9.*

For instance, this does not mean that the contractor can fold back a strip of burlap for the entire length of a lane prior to sawing the outer 150 to 225 mm (6 to 9 inch) width strip of the previously placed overlay and then replace the burlap several hours later. This work can be accomplished by folding back a strip of burlap several meters (feet) in length just ahead of the saw and replacing the wet burlap immediately after sawing.

Obtaining a continuous wet cure, especially at an early age in the curing period, is EXTREMELY important in securing a sound durable deck overlay.

Should the 72 hour wet curing process be interrupted for more than one hour (accumulated time), the affected overlay area should be removed and replaced at contractor's expense.

Rule-of-Thumb:
If work cannot be completed within an hour exposure period, the contractor shall be required to accomplish preparation work after curing period has expired.

11.62 SEQUENCE OF POURING

To prevent stress cracking of bridge floors, the sequence of pouring bridge floor sections, either with or without the use of retarders, is very important.

Bridge plans require a placement sequence as indicated by the encircled numbers on the concrete placement diagram in the plans. (Refer to *Example Concrete Placement Diagrams*, *Appendix 11-19*.) Note that positive moment sections are placed first, with the adjacent negative moment sections placed during subsequent pours. Check for plan notes on both noncontinuous and continuous placements that may indicate specific intervals between pouring adjacent positive and negative moment sections.

Check the "concrete placement diagram" sheet because some projects will state that no alternate placement sequences will be allowed. Others will note:

"Alternate procedures for placing slab concrete may be submitted for approval..."

In cases where plans allow alternates, those requests shall be forwarded by the project engineer to the Office of Construction for evaluation and approval. All requests for alternatives need to include:

- Desired sequence of placement
- Estimated time elapsed between initial batching and final placement (haul time). Maximum time by specification is 90 minutes.
- Anticipated rate of concrete placement in cubic meters (cubic yards) per hour
- Estimated concrete temperature at time of placement
- Brand of retarding admixture, if any, to be used
- Maximum air temperature anticipated during concrete placement

A. Sequence of Placement
When plans allow alternatives, the contractor needs to request a change and choose an alternate placement sequence. The project engineer must then determine if that request meets requirements of the concrete placement diagram shown on the plans. Example diagrams shown in *Appendix 11-19* are the sequences normally shown on the plans. Other sequences are shown when special conditions exist. Review assures that a contractor's request does not violate placement sequence required.

B. Haul Time and Placement Rate
Project engineers must review the contractor's estimate of haul time and placement rate to determine if times are realistic. If estimates appear unrealistic, times must be adjusted to practical values. Haul time must include time elapsed from batching (addition of mix water) to placement of concrete in the forms. Placement rate should be measured in cubic meters (cubic yards) of concrete placed per hour.

With present placement equipment, approximately 50 cubic meters (cubic yards) per hour should be the maximum anticipated to calculate retarder needed for completion of the placement.

C. Maximum Air Temperature
No continuous placement is to be attempted when temperature forecast is above 30°C (85°F). This value is still being evaluated on a yearly basis. As each new season begins, be sure to confirm the maximum placement temperature with the Office of Construction.

D. Concrete Temperature
Working time of concrete varies with the temperature of concrete, and concrete temperature varies with the temperature of different materials used in the mix. In order to determine the dosage rate of retarder, an estimate of the mix temperature must be made. The following are suggested estimating methods:

- The temperature of concrete from previous placements could be taken.
- If a ready mix producer is placing concrete the day before a deck placement, this concrete could be checked for concrete temperature.
- A computer program has been developed for calculation of theoretical rate of evaporation using Excel. This program incorporates the charts from the specifications in a formula table included on report Forms NH-65 and NH-65M. The program simplifies the determination of the theoretical rate of evaporation and enables the user to perform trial evaluations for possible changes in air temperature, relative humidity, plastic concrete temperature, and wind velocity. A copy of the Excel program for theoretical rate of evaporation is available at

English- http://www.iowa.dot.gov/construction/theoretical_evaporation_rate.xls

Metric- http://www.iowa.dot.gov/construction/evaporation_rate_metric.xls

Regardless of the method used, make the best estimate of what the concrete temperature will be, probably during the warmest part of the day and go with it. Remember, concrete shall not be placed in new decks if the concrete temperature is above 32°C (90°F).

Use of Retarders
Several brands of retarding admixture are approved for use in maintaining concrete plastic during bridge deck placement and dead load deflection. (Refer to *Materials I.M 403 Appendix B*.) All brands do not retard the set of concrete for the same amount of time; therefore, it is important to know which brand will be used. Retarders are not to be used when the anticipated temperature of the mix is below 13°C (55°F); however, placement requirements must be met within the initial set time indicated for the non-retarded concrete.

Retarding admixtures require a concrete temperature of 13°C (55°F) or greater in order to activate and effectively retard the set of concrete. If the proposed placement cannot be accomplished within the initial set time for non-retarded concrete, the concrete mix temperature will have to be increased through the use of heated materials. When heated materials are used, it is recommended that a concrete mix temperature of 18°C (65°F) be targeted for effective activation of retarding admixtures.

A. Non-continuous Beam Bridge

EXAMPLE:
A contractor requests to be allowed to place concrete full-width and full-length of a prestressed concrete beam bridge requiring the quantities of concrete shown on *Example Concrete Placement Diagram*, *Appendix 11-19*. Assume, concrete can be hauled and placed at a rate of 30 cubic meters (40 cubic yards) per hour. Anticipated concrete temperature is 24°C (75°F). POZZOLITH 100XR retarder has been requested for use.

Since the beams of a concrete beam bridge are not continuous over the piers, no upward deflection can be transmitted from span to span. For example: During concrete placement in span 3, no uplift exists in span 2 or span 4. However, the beam ends at pier 2 must be free to rotate as load is placed throughout the positive moment area of span 3.

NOTE: It is important for the concrete to remain plastic at pier 2 until placement is complete throughout the positive moment section of span 3. This will eliminate the possibility of stress cracking the slab over the pier.

Now calculate the minimum initial set time required for the largest combination of negative and positive moment sections. Based on the example diagram the largest combination sections would be either Sections 5 & 1 or Sections 7 & 4 with a total concrete quantity of 70 cubic meters (92 cubic yards) . This is equal to the haul time plus the time required to place all of section 5 and section 1. One hour is added to the minimum required time as a safety factor.

English Units

Placement time = 92 yd^3 ÷ 40 yd^3/hr. =	2.3 hrs.
Haul time =	1.0 hr.
Minimum working time limit =	3.3 hrs.
Safety factor =	1.0 hr.
Total	4.3 hrs.

Metric Units

Placement time = 70 m^3 ÷ 30 m^3/hr. =	2.3 hrs.
Haul time =	1.0 hr.
Minimum working time limit =	3.3 hrs.
Safety factor =	1.0 hr.
Total	4.3 hrs.

Referring to *Materials I.M. 403 Appendix B*, non-retarded concrete will remain plastic for only 2.5 hours at 24°C (75°F). However, concrete will remain plastic at 24°C (75°F) for 6.1 hours if POZZOLITH 100XR is added at the rate of 89 ml per 45.4 kg (3 ounces per 100 pounds) of cement for Type I/II cement with no fly ash. Thus, the contractor's request to place concrete in a full-width continuous pour may be approved provided POZZOLITH 100XR retarding admixture is used.

B. Continuous Beam or Girder Bridge

Contractor requests to pour concrete full-width and full-length of two-span continuous beam or girder bridges will not be approved. Problems of girder uplift at the abutments and very large deadload deflections greatly increase the potential for deck cracking.

Requests to pour concrete full-width and full-length on other multi-span continuous beam or girder bridges may be submitted for review and approval. Approvals will be based upon a review of any specific project limitations, contractor's production capability, and contractor's past performance results from continuous placements.

EXAMPLE:

A contractor requests to be allowed to place concrete full-width and full-length of a continuous welded plate girder bridge requiring the quantities of concrete shown on *Example Concrete Placement Diagrams*, *Appendix 11-19*. They can realistically haul and place concrete at a rate of 30 cubic meters (40 cubic yards) per hour. Maximum anticipated concrete temperature is 24°C (75°F). Brand of retarder requested is Daratard 17.

Since the beams of this structure are continuous over the piers, upward deflection can be transmitted to span 2 during concrete placement in span 3. Therefore, it is important for the concrete to remain plastic in the major portion of span 2 until placement is complete throughout the positive moment section of span 3. Experience indicates that stress cracking will not occur if the concrete in the positive moment section of span 2 remains plastic until such time as placement is complete in span 3 positive moment section.

Now calculate the minimum initial set time required for the largest combination of positive-negative-positive moment sections. Based on the example diagram the largest combination sections would be either Sections 1, 5, & 3 or Sections 2, 7, & 4 with a total concrete quantity of 109 cubic meters (142 cubic yards). This is equal to the haul time plus the time required to place all of Sections 1, 5, & 3. One hour is added to the minimum required time as a safety factor.

English Units

Placement time = 142 yd^3 ÷ 40 yd^3 /hr. =	3.6 hrs.
Haul time =	<u>1.0 hr.</u>
Minimum working time limit =	4.6 hrs.
Safety factor =	<u>1.0 hr.</u>
Total	5.6 hrs.

Metric Units

Placement time = 109 m^3 ÷ 30 m^3/hr. =	3.6 hrs.
Haul time =	<u>1.0 hr.</u>
Minimum working time limit =	4.6 hrs.
Safety factor =	<u>1.0 hr.</u>
Total	5.6 hrs.

Referring to *Materials I.M. 403 Appendix B*, it can be seen that Daratard 17 added at a rate of 89 ml per 45.4 kg (3 ounces per 100 pounds) of cement for Type I/II cement with no fly ash will retard the set of concrete for only 4.3 hours. However, if the amount of Daratard is increased to 118 ml per 45.4 kg (4 ounces per 100 pounds) of cement for Type I/II cement with no fly ash, set will be retarded for 6.6 hours. Therefore, the contractor's request to place concrete in a full-width continuous pour may be approved if Daratard 17 is added at the rate of 118 ml per 45.4 kg (4 ounces per 100 pounds) of cement.

C. Continuous Concrete Slab Bridges
Bridge plans do not require a specific placement sequence for floors of concrete slab bridges, but merely indicate locations of permissible transverse joints. Typically, floors of concrete slabs are supported by falsework of relatively short spans. As such there is almost no vertical movement of the floor during concrete placement. Continuous placement can be made at a placement rate sufficient to ensure concrete is placed without forming cold joints.

The use of retarding admixture is not required, but may be necessary if falsework spans are of such a length that will permit deflection. No payment would be made for these situations since it was the contractor's choice to design long falsework spans. Special instructions requiring specific placement sequences will be noted either on the plans or as a condition of review of the falsework plans.

D. Summary
The project engineer should review all proposals for alternate procedures before forwarding to the Office of Construction for approval. When the contractor's proposal meets all requirements shown on the plans and retarder is used in accordance with *Materials I.M. 403 Appendix B*, a proposed placement sequence may be approved. When requirements are not met, the contractor may:
- Increase the placement rate
- Use longitudinal construction joint provided on the plans
- Increase the rate of addition of retarding admixture, up to maximum allowable limits
- Or otherwise meet the placement requirements

Addition of a retarder is not required when the placement sequence shown on the plans for non-continuous bridges is followed.

For continuous bridges, retarder may be needed when placing adjacent positive moment sections. The contractor could place Sections 1 and 2 the same day probably without retarder. Then Sections 3 and 4 should not be placed until enough strength has developed in Sections 1 and 2 so the uplift would not crack the concrete.

When the guidelines of this instruction are followed, approval from the Construction Office is not required.

Concrete Bridge Floors
Specification 2428 shall apply to smoothness of the completed deck surface for primary, non-primary, and interstate projects and when specifically required for other projects. This includes bridges over 30 m (100 feet) in length except concrete slab bridges. Construction of smooth-riding and maintenance-free bridge floors requires particular attention and care by the inspector and contractor. The following sections should be reviewed and kept in mind when preparing for such work.

A. Grades for Screeds
Grades for screeds or finishing machine rails must be carefully determined. Proper allowance above this grade must be made for the deflection due to the weight of the concrete. On steel beam bridges, the allowance is the encircled figure shown on the deflection diagram. On prestressed concrete beam bridges, subtract the slab in place deflection from the total "as erected" deflection to get the deflection due to the weight of concrete. On prestressed concrete beam bridges, the deflection of the 1/4 point is about 3/4 of the deflection at midpoint. To simplify the calculation of deck grades for prestressed concrete beam bridges, an Excel spreadsheet has been developed and is available at

English - http://www.iowa.dot.gov/construction/ebeamgr.xls

Metric - http://www.iowa.dot.gov/construction/mbeamgr.xls

Recent plans for Iowa DOT steel girder and concrete beam bridges include additional information for determination of bridge deck grades. The information is provided in a “Table of Beam Line Haunch Elevations”. This table is developed by the designer and provides the theoretical elevation of bottom of deck (ie: top of girder or beam) plus the deadload deflection. This table of elevations can be used to compare directly with the actual field surveyed top of girder/beam elevations at the plan shot locations. The comparison of the theoretical elevation and actual field survey elevation provides the information for anticipated embedment or haunch and grade information for setting deck forms. This “Table of Beam Line Haunch Elevations” provides a simpler process for calculating bridge deck grades. For additional guidance in the use of this plan information contact the Office of Construction.

Since the deflection due to the weight of reinforcing steel is very small, it may be neglected. Thus elevation shots on the beams may be taken before the reinforcing bars are placed and the grades then computed.

On pretensioned prestressed concrete beam bridges, the concrete beams are fabricated with camber in the beams to provide for the dead load deflection that will occur when the deck concrete is placed. The camber fabricated in concrete beams can vary some from the designed theoretical camber and result in the need for grade adjustments when determining bridge deck grades. This has been a common issue with the Iowa DOT bulb tee beam designs. The plans specify allowable haunch and embedment limits for the determination of bridge deck grades. These limits are established to ensure that the beam stirrups on the top of the beams will project at least 2 ½ inches into the bridge deck to satisfy the designed composite connection with the bridge deck. In some instances, the establishment of bridge deck grades results in haunches which are greater than what the design allows. In those cases, the locations of excess haunch are addressed by the addition of supplemental haunch reinforcing at each affected beam stirrup to ensure the required composite connection with the bridge deck. When excess haunch conditions are encountered there needs to be a determination whether the costs for the supplemental haunch reinforcing and increased concrete in the haunch on the beam should be reimbursed to the contractor. The basis for compensating the contractor must satisfy two criteria; 1) the substructure beam seat elevations must be within +/- 0.02 feet of the plan specified elevations and 2) the PPC beam camber must be within the specification tolerance of +/- 30 percent of the plan theoretical. When both of these are satisfied and supplemental haunch reinforcing is required, the contractor should be compensated for the costs of materials and labor for the supplemental haunch reinforcing and the additional PPC beam haunch concrete that exceeds the designed nominal haunch.

B. Screed Clearance Block
Specifications require the clear distance of top reinforcement to be checked by attaching a block 6 mm (1/4 inch) less in depth than the specified clearance to the finish machine. The finish machine with block attached is to be passed over the entire floor.

Be sure the finishing machine is setup and operated "exactly" as it will be used during the placement. There have been instances where the check pass was made, then prior to actual placement a working platform was added to the machine's truss beam. This additional weight caused a twist in the machine, dropping the trailing screed edge, and reduced the slab thickness by 6 mm (1/4 inch).

C. Screed/Finish Machine Support
Typically, finish machines are guided and supported on a pipe rail. Rigidity of this rail is essential for a uniform deck thickness, proper cross slope/crown, and smooth ride. Support is provided from the subdeck through rail supports (rail feet). Both of these work together and failure of either system is disastrous.

NOTE: ***Rarely will it be allowed to support a finish machine by placing the rail supports directly on the bridge beam***.

D. Subdeck Support System
The contractor needs to include special precautions when selecting and placing overhang subdeck form braces (Stand-off Jacks). Consideration must include the mass (weight) of:

- Concrete placed beyond the centerline of the outside beam (Concrete is 2,400 kg/m^3 [150 lbs./cubic foot])
- The finishing machine and any working bridges
- Reinforcing steel (Steel is 7,850 kg/m^3 [490 lbs./cubic foot])
- Any personnel who will be working on the overhang
- Subdeck and framing members, plus any miscellaneous equipment

Typically, the total of all loads plus a large factor of safety is accounted for by reducing the distance between the jacks. The inspector should always question, and note in the diary, situations where jacks appear to be:

- Inadequately fastened to the beam
- Spaced too far apart to support the load
- In disrepair or of poor quality

Specification 2412.03, A, 2 states that temporary welds will not be authorized, unless otherwise approved by the Engineer, to attach hangers to steel beams to support floor form joists. *Materials I.M. 558, Field Welding Inspection Manual*, also does not permit any welding to the top flange of steel members for supporting floor form joists. *Materials I.M. 558* does permit welding of hangers to shear studs on steel beams subject to specific requirements. Welding of hangers to shear stirrups on concrete beams would also be permitted subject to the requirements of *Materials I.M. 558* provided the shear stirrups are not epoxy coated.

E. Screed Support System
Rail supports (rail feet) are available in many different configurations and vary from a triangular/square shape to a round "cupped" base. Most have an adjustable center post and a saddle to set the rail in. These supports provide for rail stability and support the finish machine. Again, spacing of the supports is the most effective means to assure adequate support and often the supports are tied down to the subdeck. By reducing the spacing between supports:
- Load is more evenly distributed to the subdeck.
- Potential for bases to "dig" into the subdeck is reduced.
- Rail stability is increased against tip-over.

During the finish machine's "dry run" the inspector should watch for:
- Rail and support stability (No lateral or longitudinal movement)
- Does the rail remain seated in the saddle? Any tendency for the rail to "lift-up," either ahead or behind the machine, is an indication of the rail sagging under the machine. To cure the problem, additional supports must be added or the supports being used must be adjusted to evenly carry the load.
- Loose or moving support bases. This indicates improper center post adjustment.
- Sagging or deflection in the subdeck is an indication of inadequate subdeck support.

F. Consistency of Concrete
The consistency of concrete must be watched closely to maintain uniform slump and air. Uniformity is vital for proper finishing.

G. Unacceptable Practices
1. Addition of water to the surfacing while finishing is strictly forbidden. Not only are air voids in the surface concrete reduced, but the mix's water/cement ratio is affected thereby lowering resistance to salt action resulting in early scaling and a defective floor.

   If finishing is a problem, "CONFILM" (a Master Builders evaporation retardant product) can be applied to the struck-off surface. This product reduces surface evaporation, but causes no detrimental surface effects when used as explained in the following. The product is typically applied following final surface finishing to minimize surface moisture loss until the wet cure has been placed. The product must not be used as a finishing aid since the water in the product would be worked into the concrete surface and will change the water/cement ratio. If additional surface finishing is necessary following application, the finishing must not be done until the “sheen” on the surface of the concrete from the water in the product has gone. This will indicate that the water is no longer present and only the barrier film from the product remains.

2. Excessive manipulation of the concrete is detrimental to its durability and should be avoided. Concrete is best when it is placed, finished, and cured with the least amount of disturbance.

3. Excessive floating, over-vibration, and adding water are sure to cause scaling. Concrete must be spread during the dumping process, not piled up and caused to flow by use of a vibrator. Vibration should be done so no area is over-vibrated, yet all is vibrated.

4. All footprints should be vibrated before the finish machine finishes the concrete.

5. Excess cement-sand paste removed from in front of the finishing machine drum must not be allowed to be deposited in the bridge deck gutter area. This paste, when removed, should be distributed across the unfinished concrete mix for blending and reconsolidation through vibration. This is to prevent the development of weak areas in the concrete deck surface due to insufficient aggregate distribution.

6. Concrete tools, such as shovels and concrete rakes, shall not be cleaned by hitting the tools on epoxy coated reinforcing steel. Impacting epoxy coated reinforcing steel with any tool will damage the epoxy coating protection of the bar. Tools are to be cleaned by hand or taken outside the concrete placement area to impact the tool on objects that are not part of the permanent structure to remove any built-up concrete on the tool.

H. Use of Finishing Machine

An approved finishing machine is required on all primary, non-primary, and interstate bridges over 20 m (60 feet) long *(Specification 2412.03, D, 2, a and/or 2413.03, A, 4, c)*. Care must be taken to adjust the screeds to proper crown. Support rails must extend beyond the bridge at both ends at proper grade and sufficient distance to accommodate the machine. This permits finishing to begin promptly at the start of the run and also permits the required straightedging to proceed on schedule at the end of the run.

I. Straightedging

Following the finishing machine, the plastic concrete should be checked for smoothness with straightedges a minimum of 3 m (10 foot) in length. The straightedges should be placed on the surface from a vertical position, not pushed or pulled over the surface. Checks of the surface with a straightedge are used as a spot monitoring of smoothness and are not required to be made continuously for the full length of the placement. Irregularities can be detected by comparing the deck surface with the straightedge. Irregularities noted at this time should be corrected. If bull-floating (mopping) is needed to close up the surface, it should always be followed by a smoothness check with the straightedge.

J. Transverse Grooving

After straightedging, and as soon as practical following finishing, the entire traffic surface, except areas within approximately 600 mm (2 feet) from the curbs, shall be given a suitable transverse grooving.
Do not overlap the grooving.

Recent changes have been made in the grooving of bridge decks, bridge deck overlays, bridge approaches, and overlay of bridge approaches. Project plans are including notes that state that transverse grooving or tining in plastic concrete will not be allowed. In lieu of this, the plans are requiring that longitudinal grooving is to be cut in the hardened concrete. This is currently being addressed as notes in the plans, but will be included in future Specification revisions. Be alert for these notes on future projects.

K. Retarders

When retarding admixtures are required to maintain concrete plasticity during dead load deflection for continuous placement on bridge decks, the cost of the retarding admixture will be the responsibility of the contractor requesting an alternate placement sequence.

L. Adequate Labor Force

At preplacement meetings talk about and, before starting a placement, be sure the contractor has:

- Proper and adequate materials to protect the placement (including pre-wetted burlap for deck curing)
- Adequate numbers of sufficiently skilled laborers available
- Proper tools on the job
- Arranged for the rate of delivery of concrete to make the placement operation efficient

20 cubic meters (or 20 cubic yards) per hour should be a minimum, depending on the quantity of concrete to be placed. Any method of delivery to the deck should be checked to see that rate of placement can be such that finishing operations can proceed at a steady pace, with final finishing completed before the concrete starts its initial set.

M. Curing

Curing operations are extremely important.

Prior to initiating a bridge deck or bridge deck overlay placement, the contractor shall have all burlap needed for curing, prewetted and stockpiled at the end of the bridge ready for placement. This should be discussed at the Prepour Meeting. **If the prewetted burlap has not been prepared and/or the Contractor does not have the equipment and personnel dedicated for the burlap placement, the start of concrete placement should not begin until the contractor has appropriately prepared the burlap curing materials and arranged for placement personnel.** This guideline has been established due to repeated incidents of lack of prepared curing materials and significantly late placement. The intent is to immediately place prewetted burlap after final finishing.

Interstate and Primary Projects

With the change to cutting longitudinal grooves in the surface of bridge deck s and bridge deck overlays, the old method of transverse grooving in plastic concrete was eliminated. With this out of the placement sequence, we are now able to expedite wet burlap cure within 10 minutes of final finishing. As such, there is also no need to apply white pigmented curing compound, therefore it has also been eliminated from the placement process. Minor marring of the surface can be allowed in order to ensure that the wet burlap cure is expedited. Burlap must be wet before placing. In hot, dry weather, it is better to be a little early than late with burlap cover.

An hour or so later, the second layer of burlap should be laid and both kept thoroughly wet for the curing period.

Other Projects

Due to the additional costs associated with cutting longitudinal grooves in the surface of bridge decks and bridge deck overlays as opposed to transverse grooving in plastic concrete during the placement, the Specifications are being retained for Other Projects to use white pigmented curing compound as part of the curing process.

Immediately after final finishing and transverse grooving the area finished shall be covered with white-pigmented curing compound. Application of white-pigmented curing compound provides a preliminary surface seal to minimize surface moisture loss until the continuous wet cure process is in place. NOTE: Surface moisture loss will still occur, to some degree, even with white-pigmented curing compound covering the concrete surface. Expediting wet burlap and the continuous wet cure process is critical.

Application and time of placement of cure is critical toward preventing plastic shrinkage cracking of the deck surface. The rate of cure application, uniformity of coverage, and length of time between final finishing and cure application must be closely monitored. Delayed application, inadequate cure rate and/or coverage combined with even the slightest wind velocity can result in plastic shrinkage cracking of the deck surface. Due to the natural shrinkage of concrete as it cures, these plastic shrinkage cracks can propagate into full-depth cracks. Prior to placing curing compound, exposed reinforcing steel for the barrier rail shall be protected with a suitable covering to prevent pigment contamination.

Materials I.M. 405 requires the District Materials personnel to approve, by lot number, all white cure compounds. Be sure this approval has been secured prior to starting the deck pour.

NOTE: Clear curing compound is accepted by manufacturer with a yearly recertification by that manufacturer. Check with the District Materials Office, because a random sampling of clear cure prior to incorporation may be required.

After curing compound is applied, the surface must be covered with wet burlap as soon as possible. Minor marring of the surface can be allowed in order to ensure the wet burlap cure is expedited. Burlap must be wet before placing. In hot, dry weather, it is better to be a little early than late with burlap cover. An hour or so later, the second layer of burlap should be laid and both kept thoroughly wet for the curing period.

Optional methods of curing bridge floors are listed in *Specification 2412.03, E, 1, b*. Since shrinkage cracks are due to rapid loss of surface moisture before the concrete has attained adequate strength, it is imperative that curing protection be initiated before much evaporation can occur (other than free surface water).

N. Cold Weather Placement

On account of the high incidence of shrinkage cracks due to artificial heat during the protection period, no bridge floors will be constructed during cold weather except with the special permission of the Office of Construction. It is anticipated that flooring will be allowed during that portion of the winter season when insulated forms alone (using heated concrete) are sufficient protection. Normally, this time is after March 1 and before December 1.

The placement of bridge deck floors should typically be performed during the time of the year when the air temperatures are near or above 40˚F. There may be instances (ie: critical bridges that must be completed and opened to traffic) when other measures must be taken to accomplish the bridge deck placement. For those situations, the following guidance is recommended to make decisions on the placement of a bridge deck during times of cold weather.

Criteria for Cold Weather Bridge Deck Placements

1. Forecasted temperature and weather conditions shall be reviewed jointly by the Project Engineer and Contractor. Air temperature during concrete placement shall be 40˚F or above, except that the placement may be initiated at temperatures in the mid 30's when the daytime highs are projected to reach 40˚F or above. To initiate a bridge deck placement at temperatures less than 40˚F, provisions shall be taken to cover the deck and provide supplemental heat to ensure the reinforcing steel, concrete, and decking surfaces are warmed to 40˚F or above. The length of deck to be covered and supplemental heating provided should be based upon the projected temperature at the start of the placement, the proposed placement rate, and the estimated time before the air temperature will reach 40˚F or above.

2. The concrete hydration process typically will peak in 20 hours after the concrete is placed. The first 12 – 15 hours of the hydration process, following the placement, is critical relative to freezing temperatures. If the hydration process can proceed to 15 hours without the concrete being subjected to freezing, freezing temperatures after 15 hours are not critical to damaging the deck concrete (free-water has been released). Low temperatures after 15 hours shall be limited to projected temperatures not less than 25˚F.

3. Air temperatures in the range of 25 - 40˚F will have an effect on maintaining the; 1) bridge deck concrete temperature at 50˚F or above for the first 48 hours and 2) concrete strength development. Monitoring of the concrete temperatures during the curing period shall be performed with provisions for protection of the concrete implemented to ensure 50˚F is maintained in the concrete deck. To ensure that the bridge deck concrete temperature is maintained above 50˚F, it may be necessary for the contractor to; 1) place plastic and insulated blankets over the bridge deck concrete, 2) utilize a ground heater loop system to provide supplemental heat on the bridge deck concrete surface, and 3) operate the continuous wet sprinkling of the bridge deck concrete surface on an intermittent basis provided the surface of the bridge deck is always maintained wet.

NOTE: The use of fly ash and/or GGBFS (slag) in the bridge deck concrete mix will slow the heat of hydration and concrete strength development. Due to this, the length of time the bridge deck concrete will need to be maintained at or above 50˚F must be considered and addressed.

O. Floor Drains

Check floor drain locations against floor grades to be sure deck surface will drain. Adjustments of drain height may be advantageous on every flat grade surface. Also, at this time, study the discharge area from the floor drain for potential damage to features under the structure such as shoulders, railroads, or berm slopes.
Major problems foreseen should be brought to the attention of the Office of Construction.

Placement Methods
Distribution of ready mix concrete from the truck to the bridge deck by concrete pump, conveyors, or crane & bucket is a regularly used procedure. The practice is common where access is difficult except at ends of the structure.

Placement of concrete by pump or conveyors is regulated by *Specification 2403.03, C, 2*; *Paragraphs a, b, c, and d* are especially appropriate to pumped concrete.

Rules of Thumb:

1. Use of aluminum materials for the conveyance of concrete is prohibited by *Specification 2403.03, C, 2, b.* Concrete being conveyed by aluminum materials can abrade the aluminum resulting in the release of aluminum particles. These aluminum particles can chemically react with portland cement causing an abnormal increase in air content of the concrete and cause an increase in volume.

   Examples of conveyance equipment would be tremies, pump conduit/tubing, crane buckets, etc. Forming materials made from aluminum or with aluminum surfaces that will come into contact with concrete are not restricted provided:
   - They are not used to convey concrete, and
   - Quality of the forming materials conforms to *Specification 2403.03, B, 5.*

2. Concrete for slump and air tests should be obtained from the point of discharge to forms.

3. Air and slump tests performed on the bridge deck during deck pour must contend with vibration of the reinforcing steel and may affect test results.

4. Air content of concrete varies with slump, air temperature, humidity, and mixing time. It is also affected by distance being pumped or conveyed, number of drops (i.e. elbows), distance of unrestricted free fall, only to name a few.

5. Slump can be affected by pumping or use of conveyors due to additional mixing action. Slump uniformity is important for proper finishing.

6. Back up pumping and conveyor equipment, in case of breakdown, is most important when this equipment provides the only access to the placement area.

7. When concrete is placed on the floor by pumping or conveyor, the pump conduit or conveyor must be supported by floor forms rather than on reinforcing steel. Besides being quite heavy when full of concrete, the conduit transmits vibrations from the pump to the reinforcing steel. These vibrations can be quite detrimental, especially when transmitted to floor areas where concrete has taken initial set.

8. The walkway provided for foot travel directly on reinforcing steel can most appropriately be placed adjacent to pump conduit so as to accommodate the placement and removal of conduit sections.

9. Some method should be devised to clean up concrete that may spill from the belt placer or pump conveyor.

10. Pumped or conveyed concrete can be transported a considerable distance and to considerable heights with good results. The key is to move the material as close to horizontal as possible, keep restrictions and drops to a minimum, and eliminate free fall as much as practical. (Free fall can also occur in the pump pipe and between conveyors as well as in the forms.)

11.63 INSTALLATION OF JOINTS

Preformed Neoprene Joints

Preformed neoprene expansion joints are used on a large number of bridges. Most of these installations are at the abutments of prestress bridges over 80 m (265 feet) in length. This type of joint may also be used at one or more piers on long, multi-unit, prestress bridges.

A. Inspection Checklist

Neoprene cellular joints, if properly installed, provide a leak-proof joint capable of functioning within expansion limits of the bridge. To insure that a joint will function properly, there are a number of precautions that should be noted regarding the installation of this type of joint. Precautions:

1. A neoprene seal can be placed in two positions, one correct and one incorrect. Make sure that the seal is not installed upside down or sideways.
2. Position of the 13 x 6 mm (1/2 x 1/4 inch) keeper bars on vertical face of the expansion plate angles has to be consistent with the recommendations of the manufacturer of the neoprene seal. The depth that a seal is set varies greatly with the different manufacturers.
3. The neoprene seal has to be installed so bottom of the seal touches top of the 13 x 6 mm (1/2 x 1/4 inch) keeper bars, but should not be forced past the keeper bars.
4. Make sure expansion opening between angles of the expansion device are consistent with the expansion setting shown on design plans and that the same expansion opening is maintained from gutter to gutter.
5. The neoprene seal must project beyond the outside edge of slab as shown on the plans.

B. Summary

When uncertain as to which side of the seal is top, or when the position of keeper bars is in question, the contractor must be required to submit drawings prepared by manufacturer which indicate correct position of installation.

Steel Extruded Expansion Joints (Strip Seals)

Strip seal joints are the current joint design being used on new bridges and as replacement for preformed neoprene and sliding plate joints on existing bridges that are rehabilitated. As with preformed neoprene joints, strip seals are commonly used at the abutments of prestress bridges over 80 m (265 feet) in length. They may also be used at one or more piers on long, multi-unit, prestress bridges.

Strip seal joints consist of two extruded steel channels that extend across the full width of the bridge roadway. The steel channels terminate within the concrete bridge barrier rail with the ends of the channels angled up within the barrier rail section. Previous designs provided for a 30 degree channel angle, but current projects are using a 60 degree channel angle (ie: double 30 degree).
The channel angle in the barrier rail is intended to contain water in the gutter area and prevent water from draining out the ends of the strip seal joint. To ensure this, both the

end of the channel and low point of the neoprene gland trough must be a minimum of 100 mm (4 inches) above the gutter line.

Strip seal joints are more effective in sealing the expansion joint and preventing leakage of water through the joint and onto the substructure units. For strip seals to function effectively they must be installed correctly and maintained on a regular basis. To insure that strip seal joints function properly, there are a number of precautions that should be noted regarding the installation of this type of joint. Precautions:

- Steel extrusion must be installed approximately 5 mm (1/4 inch) below the intended finished concrete surface to prevent impact from snow plow blades. This must be closely checked with the deck finishing machine during the ‘dry run’.
- Installation of the steel extrusion must include an anchorage system provided by the manufacturer designed to securely hold the steel extrusion and enable adjustment for alignment, grade, and setting of joint opening.
- Steel extrusion splice joints shall be fully welded as specified in the contract documents.
- Prior to the placement of the bridge deck the top of the steel extrusion must be sealed off to prevent concrete from falling into the joint and channel sections which would inhibit correct installation of the strip seal gland.
- After placement of the bridge deck against one side of the steel extrusion, the opposing side of the steel extrusion must be adjusted to provide for the correct joint opening. The expansion joint settings are identified in the plans at various temperatures. The setting for the joint opening is based on the temperature of the shaded side of the concrete deck at the time remaining concrete is to be placed against the joint.
- During concrete placement for the bridge barrier rail the area adjacent to and immediately under each steel extrusion must be filled with concrete and the concrete surface finished flush to the top surface of the steel extrusion. This will ensure that gutter water drainage will not leak under the steel extruded expansion joint.
- Prior to installation of the strip seal gland the steel channels must be thoroughly cleaned of any potential obstructions or film that would inhibit proper installation of the gland lugs into the channel.
- During installation make sure that the ends of the strip seal gland extend sufficiently beyond the ends of the steel extrusion so that the gland can be trimmed level with the top of the steel extrusion as detailed in the plans. Trimming the end of the gland level with the top of the steel extrusion is critical to maintain the gland trough at the required height to prevent leakage. Both the top of the steel extrusion ends and the lowest point of the gland trough must be 4 inches above the deck concrete surface at the gutter to ensure that surface drainage will not leak through the end of the joint.
- Following installation of the strip seal gland the top and bottom of the joint must be thoroughly inspected to insure the gland lugs are securely locked into the steel channel. A field check to verify that the strip seal gland is securely installed is required and the plans will include notes regarding the testing procedure. Water can be applied to the joint and also ponded in the gutter area to check for leaks through the gland lugs at the channel. Also during this inspection make sure the joint area is

completely clear of any concrete, debris, or other obstructions which could prevent the joint from functioning properly. This is particularly important near the ends of the steel extrusion in the concrete barrier rail joint location.

11.64 BRIDGE FLOORS

Finishing and Equipment

Rails used to support the finishing machine on bridge deck overlay projects shall be set so rails extend beyond each end of the bridge.

On some bridges, the wing post has been modified to accept steel formed barrier rails. Specifically, rails have been offset or repositioned to clear the wing post. In these situations, it is impractical to set a continuous straight line of support rails past the wing post. Generally this leaves a small area of deck surface adjacent to the face of curb which is not machine finished. This area may be finished by hand methods, or air screeds, using hand-held concrete vibrators.

Profile Grades - Overlays

Plans for bridge deck overlay projects provide a "surface raise" dimension. This value shall be considered a minimum and screed guides shall be adjusted to achieve a smooth profile.

BE CAREFUL: In some instances the finishing machine rails have been adjusted to obtain a smooth profile to the extent that the thickness of the overlay placed was excessive. This is a concern:

- To the contractor because of the extra volume of concrete required
- To the designers because of additional dead load to the structure (Any increase in the dead load to the superstructure decreases the live load capacity of the bridge.)

In achieving a smooth profile grade, the grade line should not be increased by more than 6 mm (1/4 inch) over the raise specified on the plans. However, a raise of 13 mm (1/2 inch) may be permitted provided the rise does not affect more than 33% of the deck area and the existing profile grade justifies the additional thickness.

If a preliminary field examination indicates that a surface raise in excess of 13 mm (1/2 inch) is necessary to achieve an acceptable grade line, a provision must be made to determine the overrun of concrete mix used in excess of the 13 mm (1/2 inch) plan surface raise. This will necessitate taking extra depth checks during placement and possibly cross-sections of the existing deck surface and sections after the overlay is placed. Payment for the overrun will be by a Change Order extending the unit price for concrete.

Approval by the Office of Construction will be necessary prior to placing an overlay greater than plan thickness when:

- Additional thickness is equal to or less than 13 mm (1/2 inch) and the area of overdepth is greater than 30% of the overlay.
- Additional thickness is greater than 13 mm (1/2 inch) and this area is greater than 10% of the overlay.

Transverse Grooving

Over the past few years the texturing of bridge deck floors and deck overlays resulted in a number of different types of grooving devices being used to groove deck surfaces. Combs with various tine widths, shapes, spacing, and a fluted magnesium float have

been used to groove surfaces.
Research on tine texture and spacing pattern has been conducted to evaluate the impacts on tire noise. The outcome of the research findings has resulted in changes to the spacing pattern for tine texture on bridge decks and deck overlays.

Specifications require that a broom or comb shall be:
- A single row of spring steel tines
- Rectangular in cross section 3 mm +/- 0.5 mm (1/8 inch +/- 1/64 inch) wide
- Randomly spaced from 20 mm to 40 mm (3/4 inch to 1 5/8 inch) with no more than 50% of the spacing exceeding 30 mm (1 ¼ inch) with a minimum of four different spacings in a 0.6 m (2 foot) width
- Of sufficient length, thickness and resilience to form grooves approximately 3 to 5 mm (1/8 to 3/16 inch) deep in the plastic concrete
- Grooving shall be transverse to the centerline of roadway unless specified otherwise in the contract documents (ie: grinding longitudinal texture grooving).

Longitudinal Grooving In Hardened Concrete
Recent changes have been made in the grooving of bridge decks, bridge deck overlays, bridge approaches, and overlay of bridge approaches. Project plans are including notes that state that transverse grooving or tining in plastic concrete will not be allowed. In lieu of this, the plans are requiring that longitudinal grooving is to be cut in the hardened concrete. This is currently being addressed as notes in the plans, but will be included in future Specification revisions. Be alert for these notes on future projects.

For staged bridge projects (ie: bridge replacements, bridge deck overlays, etc.) where the plans specify longitudinal grooving in hardened concrete, the plans will provide an option for interim “coarse broom” surface texture to be used for staged traffic surfaces. The purpose for the optional interim “coarse broom” surface texture is to enable the contractor to reduce their mobilization of grooving equipment to one event instead of multiple mobilizations. If the contractor opts to use the interim “coarse broom” surface texture, they will be permitted to complete all stages of deck work before being required to do longitudinal grooving. The intent is that within 30 days following the completion of all stages, the contractor will complete the required longitudinal grooving of the deck surface. “Coarse broom” surface texture will not be permitted as a traffic surface texture during winter months, so regardless of the status of completed stages, the contractor will be required to longitudinally groove prior to winter weather.

Missed Texturing
There will be times, due to various reasons, when texturing will have to be omitted from a pour. One such event could be when inclement weather catches a pour and covering prevents texturing. Obviously this condition is ***NOT*** desirable, however, what if?

EXAMPLE #1: A deck or an overlay is being placed and the texturing has to be omitted:
1. Implement any required protection/curing procedures and do nothing until after the deck has cured.
2. After full cure time has expired, grind in the required texture.

EXAMPLE #2: A subdeck is being placed where an overlay is required, often the plans will require some type of texturing. Such texturing is intended to improve the overlay's bond. If conditions during the pour present a situation where texturing has to be omitted:
1. Implement any required protection/curing procedures and do nothing until after the deck has cured.

2. After full cure time has expired, evaluate the amount of area and locations which are not textured.
3. Check for rain damage on the whole surface in question.
4. If the area is relatively small, with respect to the whole deck, omit any after the fact texturing. However, in these areas, require the contractor to place extra effort into the sandblasting operation.

11.65 CONCRETE

Concrete Mobile Mixers

Continuous concrete mobile mixers are equipped with a recording water meter, as well as a cement meter - register. It is possible to determine, within a reasonable degree of accuracy, the water/cement ratio of the concrete mix. Since moisture tests to determine the water in the aggregates are not routinely performed, a precise water/cement ratio cannot be made. It will provide relative data with regard to the mix that has not been obtainable.

Data from bridge deck repair projects of the last several seasons have been reviewed. The evaluation indicates that the actual water/cement ratios are very close to the design, or intended, water/cement ratio. Therefore, no maximum or limiting water/cement ratio specification for the low slump, bridge repair concrete is recommended. The water/cement ratio of low slump concrete need not be determined for bridge overlay surface courses.

The witnessing and documentation of the dilution procedure of the air and water reducing admixtures must be observed.

Existing specifications presently allow a mobile concrete mixer to be used for certain structural concrete repair, if part of a bridge deck repair project *(Specification 2413)*, and also for barrier rails on the same type of projects *(Specification 2513)*. For these, and any other concrete construction for which the project engineer might authorize this equipment, a water/cement ratio limit is specified. Thus, the water/cement ratio must be checked, and documented, for compliance when low-slump concrete is not being produced.

Frequency of Checks

Since cement registers and water meters are continuously recording, a water/cement ratio check may be made at any interval, e.g. hourly, half days, or at the end of a placement. A minimum of one check per day's placement should be made and documented.

Density Testing – Class O PCC

Durable, low maintenance bridge decks require impermeable (very dense) concrete. Therefore, checking density during placement is an essential part of deck surfacing and overlay inspection. Test frequencies for determining the density of bridge deck surfacing and overlays are listed in *Material's I.M. 204, Appendix M-2*.

Nuclear density testing frequency is based on a minimum of three nuclear density tests for each placement. Testing frequency of nuclear density testing for each placement shall be one test within 5 feet (1500 mm) of the beginning and end of the placement and additional tests shall be equally spaced a maximum of 100 feet (30 000 mm) throughout the length of the placement.

- For a deck length of approximately 70 m (225 feet) or less, take a minimum of 3 tests during each placement event. Test locations should be approximately equally spaced longitudinally within the placement area.
- For structures having deck lengths greater than approximately 70 m (225 feet), take a minimum of 3 tests in the first 70 m (225 feet), and then test at least once every 40 m (130 feet) per placement length thereafter.

It is always desirable to take more than the minimum nuclear density tests per length of overlay placed. If densities are at or near the lower specification limits, additional testing will need to be performed.

C. Vibrating Mix at Test Well Location
On some projects, contractors have been vibrating the concrete mix in the test well with a hand-held vibrator prior to passage of the finishing machine. This practice will not be permitted.

If the oscillating screed vibrators are functioning properly, complying density of the concrete mix in the test well will be obtained without any difficulty. Obtaining required density at test well locations, without supplemental vibration, assures us that the contractors' equipment and placement procedures are capable of producing the desired results throughout the overlay being placed.

D. Density Test Wells on Bridge Deck Repair Projects
It has been the practice on bridge deck repair projects to utilize locations of the Class A Bridge Floor Repair areas for nuclear test wells. Continue to use these areas where it is practical to do so.

Occasionally a deck repair job may only have a minimal quantity of Class A Bridge Floor Repair and the location of these repairs are not always at the optimum spacing for nuclear density checks. If this is the case, additional test wells should be constructed in the bridge floor prior to placing the overlay. Typically, wells need to be about 250 mm x 250 mm x 40 mm (10 inch x 10 inch x 1.5 inch). Note: The depth of 40 mm (1.5 inch) is in addition to the normal 50 mm (2 inch) overlay thickness.

Test wells constructed by the contractor will be measured and paid for as Class A Bridge Floor Repairs.

11.66 APPROACH SECTIONS

Approach Pavements to Bridge Abutments

The construction of approach pavements at the location of the bridge abutment paving notch (ledge) has been a source of confusion for some time. When should the approach pavement be tied to the abutment paving notch? Should a ‘CF’ joint or an ‘E’ joint be installed between the end of the bridge deck and the approach pavement? The answer to these questions is based upon an understanding of “Movable” and “Fixed” abutments.

Plan Tabulation 112-6, “Tabulation of Bridge Approach Section,” identifies for each bridge approach whether the abutment is ‘Movable’ or ‘Fixed.’ The *Standard Road Plans RK Series* provides the details for bridge approach pavement construction. *Standard Road Plan RK-19A* and RK-20(1) provides specific details for ‘Movable’ and ‘Fixed’ abutment conditions.

The ‘Movable’ or ‘Fixed’ term refers to the vertical edge at the bridge end against which the approach pavement is to be placed. One other aspect that must be evaluated is whether the vertical bridge end and the ledge upon which the approach pavement is placed are rigidly attached (i.e. do they move together or are they independent of each other in movement?).

The RK-20 series of bridge approach standards is a new design being used on all interstate and primary projects. The new approach design is intended to address improvements in the bridge approach pavement structure to mitigate approach failure due to potential settlement under the approach slab. The design has increased the reinforcing in the first slab section off the end of the bridge to enable the slab to carry traffic loads even when a void develops below the slab. The second slab section off the end of the bridge has also been reinforced. In addition, for the ‘Movable’ abutment a reinforced concrete ‘lug’ has been incorporated into the first slab section. The intent of this ‘lug’ is to prevent the approach slab from being displaced as the bridge abutment moves.

Continuing research is under way to identify the causes of void development under the approach pavement behind bridge abutments. Further improvements in design and construction practices are anticipated in the future to address the void development problem.

NOTE: The RK-19 series standards have been retained for use by counties and cities on secondary projects should they choose not to use the new RK-20 series standards.

‘Movable’ Abutments

A ‘Movable’ abutment is one which is rigidly attached to the superstructure and therefore ‘moves’ with the superstructure when it expands or contracts from thermal movement (Refer to *Standard Road Plan RK-19A, Detail “A,” Movable Abutment Bridge*) *or RK-20(1), Detail “A”, Movable Abutment*).

There are two types of ‘Movable’ abutment designs. These are explained by the following situations:

Situation 1: If there is no joint in the bridge deck adjacent to the bridge end and the ledge on which the approach pavement is placed moves together with the vertical bridge end, the abutment is considered ‘Movable.’ In this situation, places a ‘CF’ Joint at the vertical interface between the approach pavement and the bridge end. Do not use dowels in this situation to attach the approach pavement to the ledge.

Situation 2: This situation occurs in many older bridges and is uniquely different from the first situation. As explained in the following, in this ‘Movable’ abutment design, the abutment is NOT rigidly attached to the superstructure.

If there is no joint adjacent to the bridge end and the vertical bridge end can move independently of the ledge on which the approach pavement sits, then the end of the bridge would be considered ‘Movable’ and the ledge would be considered ‘Fixed.’ In this situation, it would be advantageous to dowel the approach pavement into the ‘Fixed’ ledge of the abutment and place some type of expansion joint material (possibly ‘CF’, ‘E’ or other material) against the ‘Movable’ bridge end.

Consideration must be given to the ledge width and the thermal movement of the bridge end (i.e. bridge length and type) when determining the joint material to be used at each location. Material capable of 25 mm +/- (1 inch +/-) of movement (i.e.: 50 mm (2 inch) joint width of 'CF' material) should be capable of handling movements for this 'Movable' abutment design. If the ledge width is too narrow to accommodate the approach pavement and the joint material used, the ledge may have to be widened.

'Fixed' Abutments
A 'Fixed' abutment is one that is unattached to the superstructure and therefore allows thermal movement to take place independently in the superstructure while the abutment remains 'Fixed' in position. (Refer to *Standard Road Plan RK-19A, Detail "A," Fixed Abutment Bridge*) *or RK-20(1), Detail "A", Fixed Abutment*).

There is typically one type of 'Fixed' abutment which is explained in the following:

If there is a joint in the bridge deck adjacent to the end of the bridge (within one or two feet), the vertical bridge end will be considered 'Fixed' and the ledge on which the approach pavement will be placed is rigidly attached to the vertical bridge end. Note that the joint in the bridge deck could be a sliding plate, a strip seal, a compression seal (armored or unarmored) or preformed joint material. For the 'Fixed' abutment design, place an 'E' joint at the vertical interface between the approach pavement and the bridge end. Use dowels to attach the approach pavement to the ledge it will sit on.

Bridge Approach Tapers
On deck overlay construction, normally some treatment of the approach is necessary and will be indicated on the plans. It must be noted that tapers will no longer be placed by Maintenance. Watch the contract documents for bid items for ACC material. For projects where asphalt tapers are proposed and no quantity for ACC is given, a Change Order will be required.

Shoulder Maintenance
When temporary concrete barrier rails are used on deck repair and overlay jobs, traffic is constricted into a narrower lane. This in turn could cause a rapid deterioration of shoulders at bridge approaches and require the following corrective measures:

A. Ruts developing in earth and granular shoulders should be maintained as necessary with a granular surfacing material. A Change Order will be issued for this work.
B.
C. Ruts and loss of asphaltic cement concrete surfacing on Interstate shoulders should be maintained using an asphalt cement concrete pre-mix, hot mix, or some similar treatment to minimize the development of holes or ruts. A Change Order will be issued for this work unless there is an ACC contract item for shoulder maintenance and even then it may have to be extended.

C. When shoulder strengthening was not included as a bid item, but is needed for the project, justification for the Change Order must consider:
   1. Present shoulder construction and experience with shoulder stability in the immediate area
   2. Traffic volumes, percent of trucks, and duration of potential problem

11.67 SMOOTHNESS OF BRIDGE DECKS

Checklist

The following items should be checked and procedures followed prior to, during, and after the overlay is placed to insure a smooth riding deck surface:

- Guide rails are used to support and guide the finishing machine. Check for rail deflection during passage of finish machine. Any vertical or horizontal movement could compromise smoothness and rideability. Request that the contractor readjust anchor legs and/or tie-downs.

- Check that all propulsion and control equipment are fully operational prior to placing concrete. The contractor shall traverse the finishing machine over the entire length of section to be placed. This not only serves to verify that equipment and control systems are functioning properly, but also provides a check to assure that screeds are adjusted for proper crown and height above existing surface.

- Sufficient materials (water, cement, aggregate, and admixtures) are available on site to complete the intended placement in a continuous operation.

- The contractor may have to limit size of placement or provide additional mixers:
  1. If a mobile mixer is not large enough to provide adequate volume for the placement, or
  2. There is no provision for recharging.

- Ensure that adequate number of vehicles are available at the work site to transport mix from mixer to the placement area at a volume necessary to provide a uniform rate of forward progress. Any equipment working on the deck should be checked for oil and hydraulic fluid leaks.

- Contractor must provide sufficient, trained personnel to carry out the various phases of deck placement. Timeliness is of utmost importance during placement operations. Be sure specialized crafts, such as finishers, are adequately represented and preferably have only one task during the placement.

- If deck vibration due to traffic is excessive, the contractor shall provide necessary flaggers to reduce traffic speed during the decking operations and until concrete has attained an initial set.

- Check plastic concrete for smoothness with straightedges a minimum of 3 m (10 foot) in length. The straightedges should be placed on the surface from a vertical position, not pushed or pulled over the surface. Checks of the surface with a straightedge are used as a spot monitoring of smoothness and are not required to be made continuously for the full length of the placement. Irregularities can be detected by comparing the deck surface with the straightedge. Irregularities noted at this time should be corrected.

  NOTE: When Specification 2428 is not specified in the contract, the contractor is only required to perform a straight edge check and make correction of irregularities in the plastic concrete during the concrete placement. Any roughness or ½ inch bumps that result in the finished bridge deck concrete surface that are determined to need correction will require additional payment to the contractor to perform the correction(s).

Specification 2428

This specification deals with deck smoothness, pay incentives, and price reductions. Some highlights are:

A. It covers all bridge decks and overlays greater than 30 m (100 feet), including any approach work. This applies to primary, non-primary, and interstate work unless specifically excluded by the contract documents. Profilograph testing is to be performed for all work and is to include a minimum of 100 feet (30 m) beyond the approach section when there is adjoining pavement. An average profile index for smoothness is to be calculated for all work areas except exclusions as stated in *Specification 2428.03, D.* For the excluded areas, the profilograph is to be used only for evaluation of 0.5 inch (13 mm) bumps and dips and determination of needed areas of correction.

B. Profilograph testing of each wheel path of each lane will be required. However, wheel paths per lane will be averaged together for a profile index.

C. On new bridge decks the whole bridge is considered as 1 section.
   - For bridges greater than 237 m (778 feet), segments are each lane. A segment length is less than, or equal to 160 m (0.1 mile).
   - For bridges equal to, or less than 237 m (778 feet), each lane will be a segment.

   NOTE: 5.0 m (16 feet) from each abutment and from each expansion joint will be blanked out for index calculation.

D. For overlays where the expansion joint is **NOT** new or replaced , segments are:
   - For expansion joints greater than 237 m (778 feet), segments are each lane between joints. A segment length is less than, or equal to 160 m (0.1 mile).
   - For expansion joints equal to, or less than 237 m (778 feet), each lane between joints will be a segment.

E. Testing Times
   - For placement lengths less than 30 meters (100 feet), a trace, index, and final evaluation is due within 14 days of completing the deck pouring. (Lengths are to be considered **"CONTINUOUS and CONTIGUOUS PLACEMENTS."**)

   - For placement lengths equal to, or greater than 30 m (100 feet):
     1. The first 2 placements are due by noon of the 5th day following each placement.
     2. For 3 or more placements, a trace and index for every 3rd placement is due by the 5th day following its placement.
     3. For single-pour bridges, a final trace and index and the final evaluation are due within two weeks following placement.

F. Surface Correction
   Shall be by grinding or other approved methods.

   Grinding head is to be at least 0.6 m (24 inches) wide. It is preferable to have a head 0.9 m (36 inches) wide.

   Correction will follow *Specification 2532*.
   NOTE: This could be a problem if the project engineer approves any correction

method other than grinding.

If a surface correction is made, a second trace will be needed to evaluate effectiveness of the correction.

G. Incentives
Incentive pay schedule is given in the *Specification 2428*.05, A.

The ***initial profile index*** will be used for incentive evaluation.

Each segment must not have any penalty areas to be considered for incentive pay.

Grinding any segment of the deck ***disqualifies*** that segment of the deck for incentive pay.

Incentive index for:
- New decks is 190 mm or less per km (12 inches or less per mile)
- Overlay decks is 65 mm or less per km (4 inches or less per mile)

H. Price Reduction
Reduction price schedule is provided in the *Specification 2428, 05, B*.

The ***final profile index*** will be used for reduction evaluation.

Contractor may grind to avoid price reduction.
- New Bridges: No price reduction if ground equal to, or less than a final index of 350 mm per km (22 inches per mile).
- Overlays: No price reduction if ground equal to, or less than a final index of 240 mm per km (15 inches per mile).

Price reduction is mandatory if the ***final index*** is:
- New Bridges: Equal to, or greater than 350.1 mm, **BUT** less than 630.1 mm per km (22.1 inches, **BUT** less than 40.1 inches per mile).
- Overlays: Equal to, or greater than 240.1 mm, **BUT** less than 470.1 mm per km (15.1 inches, BUT less than 30.1 inches per mile).

Grinding is mandatory for:
- New Decks with a final profile index greater than 630 mm per km (40 inches per mile).
- Overlays with a final profile index greater than 470 mm per km (30 inches per mile).

Surface Checking
A 3 m (10 foot) surface check shall be conducted on all bridges, bridge approaches, deck overlays, and overlay of approaches not covered by the Smoothness Specification. Surface areas inaccessible to profilometer shall also be checked.

On some projects only one wheel path may be included in the placement width. For price adjustment or incentive pay, only the portion within the traveled lane shall apply.

Variable width sections for on and off ramps, which are outside the through traveled lane, will be checked with the surface checker.