
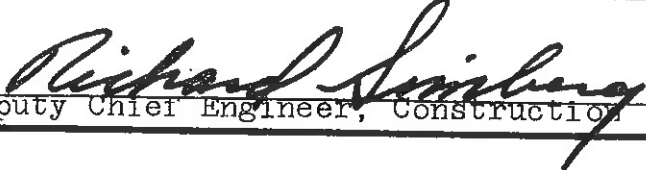


TO: Director, Preliminary Plan Review Bureau	 ENGINEERING INSTRUCTION NEW YORK STATE DEPARTMENT OF TRANSPORTATION
	SUBJECT: INSPECTION GUIDE FOR BRIDGE DECK CONSTRUCTION Subject Code: 7.30
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Asst. Deputy Chief Engineer, Construction 	

TO ALL REGIONAL DIRECTORS

There is probably no more crucial item in our construction program than that of proper bridge deck construction. The attached inspection guide, prepared by Mr. Langhorst of this office and reviewed by Structures and Materials, should be studied carefully by the EIC and his inspectors well in advance of the work.

It is obvious from even a cursory review of the attached material that proper deck construction requires a great deal of work and inspection. Although all of the points are important, we have learned from our failures that the following two are of overwhelming import.

1 - PROPER CONCRETE COVER OVER THE TOP REBARS

It has become apparent from nationwide studies that infiltration of chlorides down to the top steel causes it to corrode and expand thereby spalling the concrete. Inadequate cover hastens and worsens this condition. Of course, a concrete cover which has been well sprinkled by a mason to ease his finishing work is little better than no cover at all. We would rather have a slightly rougher deck for many years than a smoother one for only a few. However, if the guide is followed such a compromise should not be necessary.

2 - PROPER AMOUNT OF AIR ENTRAINMENT IN THE CONCRETE

Without this the deck will scale and deteriorate. After that it will be a close race between more severe scaling and infiltration of chlorides to the top steel to establish which cause will first render the bridge unusable.

It is our intent to again review the inspection guide this winter in light of Regional comments based on its usage during the remainder of this construction season. In the interim, the guide should be distributed and used on all ongoing projects where bridge decks will be placed this year.

RNS:LG
Attachment

PREL.	FINAL
PHOTOGRAM.	LANDSCAPE
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FACILITIES DESIGN SUBDIVISION	
SEP 4 1973	
MAGNOLIA D. GRAHAM	

POINTS TO LOOK FOR WHEN INSPECTING
THE
PLACING, FINISHING AND CURING
OF
INTEGRAL WEARING COURSE BRIDGE DECKS

(A Do's and Don'ts List)

A properly constructed bridge deck should be durable, safe, and ride well. This means it should be of the best quality construction, true to line and grade, ride smoothly, and have the proper surface texture so that it will perform its intended function in proper fashion throughout its intended life with little or no maintenance. This is a "tall order" for any structure and requires careful attention to detail throughout the design and construction phases. The construction phase is even more demanding when integral wearing course design is used because with it you only get one chance. Both the triumphs and the errors remain for all to see and feel during the useful life of the structure.

Some of the more common failings of our integral wearing course bridge decks have been cracking, spalling, scaling, rough ride (both short bumps and long ones), and relatively slick or slippery surface. These can be minimized or eliminated by following proper construction practices and procedures. Accordingly, there follows a list of some of the many practices and procedures that should be followed or avoided, as the case may be, in the placing, finishing, and curing of integral wearing course bridge decks. They have been grouped as follows:

- I - General
- II - Structural Steel Operations
- III - Forming Operations
- IV - Reinforcing Steel Operations
- V - Bridge Finishing Machine Preparation
- VI - Concrete Operations
 - A. Prior to Placing Concrete
 - B. Placing Concrete
 - C. Finishing Concrete
 - D. Curing of Concrete

I - GENERAL

All operations in the construction of a bridge deck have their effect on the final product but TWO of the MOST CRITICAL FACTORS on the durability of the structure are the PROPER CONCRETE AIR ENTRAINMENT and the PROPER CONCRETE COVER OVER THE REINFORCING STEEL. BE SURE THAT THE CONTRACTOR AND HIS MATERIAL SUPPLIER UNDERSTAND THAT THE SPECIFICATIONS AND MATERIALS METHOD 9.2 WILL BE FOLLOWED TO THE LETTER. BE EQUALLY SURE THAT THE CONTRACTOR PLACES HIS REINFORCING STEEL ACCORDING TO THE PLANS AND ADEQUATELY TIES AND ANCHORS IT SO THAT IT WILL REMAIN IN THAT LOCATION THROUGHOUT THE CONCRETING OPERATIONS. IT SHOULD BE PHYSICALLY RESTRAINED FROM FLOATING IN THE PLASTIC CONCRETE. THE PLACEMENT OF CONCRETE SHALL NOT BE ALLOWED IF THE ABOVE CRITERIA ARE NOT MET.

1. Proper planning should be undertaken by both the contractor and the inspection force in advance of actual construction. Such planning should include a job meeting to discuss in detail the backup measures, equipment and procedures that will be employed by the contractor. A major point of discussion should be the provision of adequate delivery of concrete and sufficient placing equipment to insure that the placement can be accomplished in sufficient time to avoid concrete set prior to completion of finishing operations.
2. As an Engineer or inspector, make sure that you are completely familiar with the specifications for all of the items and materials including any special specifications, special notes and all pertinent addenda to the specifications along with appropriate materials methods, etc.

II - STRUCTURAL STEEL OPERATIONS AS RELATED TO PLACING, FINISHING AND CURING

1. Approved shop drawings for the structural steel should be studied and the fabricated members supplied should conform to them. Particular attention should be paid to proper camber and you should be alert for improper sweeps, bends, or twists in the members both before and after they are bolted up in their final position.
2. Don't permit field welding unless specifically called for in the plans or specifications or approved by appropriate authorities. Remember that welding can cause localized stress concentrations and distortions.
3. Make sure that the studs or other form of shear connectors are correct as to size, spacing and proper welds.

III - FORMING OPERATIONS AS RELATED TO PLACING, FINISHING AND CURING

1. Forms should be adequate to support the loads to be applied and they should be properly supported. This is the con-

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tractor's responsibility but you should be alert to any obvious weaknesses in the installation and call them to his attention.

2. Make sure that you and the contractor are both in agreement on haunch depths before setting forms. Check and record haunch depths after installation of forms. This is especially critical on stay-in-place forms since the support angles which control the haunch depth are permanently welded to the beams.
3. When stay-in-place forms are authorized and used, be sure the direction of lap in the forms is correct relative to the direction of concrete placement. The form section being loaded with concrete should lap over the ahead unloaded section of form in order to prevent separation of the two sections.

IV - REINFORCING STEEL OPERATIONS AS RELATED TO PLACING, FINISHING AND CURING

1. Reinforcing bars should be properly handled, stored and installed. Proper bar spacing should be maintained both horizontally and vertically. This means that all straight bars must be reasonably straight. Bars should be free of loose scale, grease, dirt, and mortar.
2. Use only approved chairs to support reinforcing steel. They should be of the proper height to provide the correct bar spacing, clearance, and cover. They should be used in sufficient numbers to insure adequate and proper support, and to insure that proper clearance and spacing will be maintained when concrete is placed. Bar mats should not sag excessively when walked on by workmen and inspectors. Remember that at least four or five workmen will probably be standing on the bar mat during placement operations. In the area of maximum dead load camber (mid-span for simple beams) make sure the reinforcing steel is adequately tied down to the forms to insure that it will follow the forms as the camber comes out of the beams, thereby insuring the proper cover on the bars.
3. Make sure that bars are adequately supported at transverse joints. They should not flex down into the end haunch area when walked upon.
4. Make sure that proper clearance is maintained between bars, joint assemblies and side forms. Check the plans for proper clearances.

V - BRIDGE FINISHING MACHINE PREPARATION

1. Make sure that the finishing machine is approved by the Deputy Chief Engineer (Structures) and make sure that it is in satisfactory operating condition.
2. If possible, obtain a copy of the operating instructions for the finishing machine and become familiar with it before making the dry run. It is the contractor's responsibility to adjust and operate the machine but inspector familiarization can be beneficial.
3. Remember that screed rail positioning and support is one of the critical factors in deck construction. They should not sag or wobble under the weight or action of the finishing machine.
4. If screed rails are to be supported on the fascia forms, adequate bracing should be supplied to properly resist both the deflection under the load of the finishing machine and the lateral movement caused by the oscillation of the machine.
5. Consider the longitudinal wheel base of the finishing machine when adjusting screed rails on multi-span structures. In setting the rails, take into account the fact that, with a long wheel base finishing machine, one end will be on the adjacent unloaded span while the other end will be on the loaded span (where the dead load camber has or will come out) as you load the end of the span with fresh concrete.
6. When structures with sizable skews are to be poured, extra care and planning is needed. Review in advance with the contractor the relative merits and deficiencies of operating the finishing machine parallel to the skew vs. at right angles to the centerline. Since there are drawbacks to each method, the procedures to be employed to minimize said drawbacks should be discussed and thoroughly understood by all parties well in advance of starting any pour.
7. In setting up the finishing machine and in making the dry run be sure you take into account any differences in dead load deflection characteristics between the fascia girders and interior girders.
8. Check clearances in a dry run over the entire span to be paved the day before the pour. When all is in order, it would be a good idea to lock or seal the adjustment controls in some manner so they will not be altered before placement begins. Some last minute clearance checks just before pouring may be good insurance and reassuring to all involved.
9. If the finishing machine has hydraulically operated actions, take care to see that they do not leak fluid onto or into the concrete. The machine should be monitored for hydraulic fluid leaks throughout the placing and finishing operations

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as well. The same holds true for grease that may drip onto or into the concrete. See that gobs of excess grease are removed before they get into the concrete.

VI - CONCRETE OPERATIONS

A. PRIOR TO PLACING CONCRETE

1. Check the placing sequence on the plans (if any) and follow it. Don't deviate from it without prior approval from the Deputy Chief Engineer (Structures). If changes are made, make sure that all interested parties are aware of them in advance.
2. In the absence of specific instructions to the contrary, concrete should usually be placed from the fixed end towards the expansion end.
3. Make sure that adequate men and equipment are on hand to do the work and meet emergencies. Spare vibrators must be on hand. If backup equipment is called for, it should be on hand.
4. Make sure that an adequate and timely supply of concrete that meets our specifications will be available throughout the pour.
5. If belts are to be used to deliver concrete to the placement site, they should be equipped with discharge hoods at transfer points to minimize segregation and reduce spillage. Adequate measures should be taken to insure that dried spillage is not incorporated into the bridge deck concrete. Scrapers should be utilized to keep the cement paste in the mix and off the conveyor belt.
6. Make sure that forms are properly cleaned before allowing concrete to be placed. Compressed air or a vacuum cleaner should be used to clean them. All rubbish, sawdust, dirt, nails, and other foreign matter must be removed.
7. An adequate supply of approved covering material shall be maintained at the bridge site during and immediately after the pour in case of inclement weather or the malfunction of spray curing equipment.
8. If a retarder is to be employed, go over its use carefully with the contractor well in advance of the pour. Discuss the problems associated with its use as well as the expected results. Make sure that the proper amount is used for the intended results. Remember that the addition of retarder will affect the amount of entrained air. The addition of a retarder will usually increase the amount of entrained air; therefore, the dosage rate of the air-entrainment

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agent should be reduced accordingly. The first few batches of concrete with retarder should be checked for air content.

9. If possible, have two work bridges available for use (one for the finishers and one for the cure application).
10. Prior to placing concrete, make sure that all expansion bearings are clear and free to move as the dead load camber comes out.
11. Check the weather forecast before starting a pour.

Hot Weather Concreting Precautions

- a. Conditions of low humidity (40-50%), high temperatures (85-95°), and excessive wind velocity (15-30 mph), occurring together will cause the evaporation rate of the moisture in the concrete to exceed the bleeding rate. This will cause a crust to form on the surface of the plastic concrete, even when retarders are used and will result in screeding and finishing problems.
 - b. When the previously noted conditions are unavoidable, the use of a fog spray and/or a monomolecular film application is recommended.
 - c. Alternate concrete truck delivery systems should be considered, and, if possible, an on-site supply of cooled mixing water should be made available.
 - d. Windscreens may prove beneficial if excessive wind is unavoidable on a deck pour.
12. No concrete should be placed until the Engineer gives approval to do so. All checking, other than a few last minute checks, should be done the day before the pour. The entire section to be poured should be ready before allowing the placement of the first concrete.

VI - CONCRETE OPERATIONS

B. PLACING CONCRETE

TWO OF THE MOST CRITICAL FACTORS IN BRIDGE DECK CONSTRUCTION ARE PROPER CONCRETE AIR ENTRAINMENT AND PROPER CONCRETE COVER OF THE REINFORCING STEEL (ESPECIALLY THE TOP STEEL). MAKE SURE THE REINFORCING STEEL IS ADEQUATELY TIED AND ANCHORED SO THAT IT WILL NOT "FLOAT" TO THE SURFACE, AND FOLLOW THE PLANS, SPECIFICATIONS AND MATERIALS METHOD 9.2 TO THE LETTER. DO NOT ALLOW THE PLACEMENT OF CONCRETE WHEN THE ABOVE ARE NOT COMPLIED WITH.

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1. A continuous supply of quality concrete that meets our specifications is needed. It should be workable to facilitate finishing. Quality concrete is a subject in itself and will not be covered here.
2. Try to keep slump and air consistent from load to load. Uniformity is the name of the game.
3. Concrete should be placed in a uniform pattern ahead of the finishing machine. Match the placing rate to the finishing machine speed. In general try to keep the distance between the finishing machine and placing operations minimized commensurate with the placing procedures. Don't permit concrete to be placed far in advance along the fascias. Such a practice can result in substandard deck thickness and clearance due to uneven loss of dead load camber between interior and fascia girders.
4. Place concrete to the proper level in advance of the finishing machine. Do not allow the contractor to move large quantities of concrete with the finishing machine.
5. Concrete should be deposited uniformly over the deck surface. Don't permit an entire bucket to be discharged in one spot. If concrete has to be moved, it should be via shovel or hoe or similar means such that segregation will not occur. DO NOT ALLOW CONCRETE TO BE SPREAD WITH A VIBRATOR.
6. Make sure the concrete is properly and adequately vibrated to avoid air pockets, but be careful not to overvibrate and cause segregation.
7. Try to avoid delays in placing concrete, but if they do occur, take steps to slow up the drying of fresh, unfinished concrete. Wet curing blankets will help, but they shouldn't be so wet that water drips out of them onto the fresh, unfinished concrete. The protective devices to be used should be readily available. Use good judgment and avoid the possibility of cold joints.

VI - CONCRETE OPERATIONS

C. FINISHING CONCRETE

1. Do not permit workmen to walk on, or climb upon, the finishing machine during a pour (except for the necessary operators). The extra weight can increase the deflection of the finishing machine and cause insufficient cover and/or deck thickness as well as ripples in the deck.

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2. Make sure that the proper roll of concrete is maintained on the screed. For full width screeds that oscillate transversely, it should be more or less uniform across its full length. Don't let the roll disappear at any spot or spots.

When a single operation (strike-off and finishing) machine of the revolving cylinder or cone type is employed, the manufacturers recommendations should be followed as to roll of concrete in front of the cylinder or cone. In general, it should probably extend about two thirds of the length of the cylinder or cone, beginning at the front end. The roll should not reach the back end of the cylinder or cone.

3. Spot check depth of concrete and depth of cover on reinforcing steel after passage of the finishing machine.
4. An adequate number of finishers should be available. One should work each fascia and a sufficient number should be available (depending upon deck width and amount of finishing required) to finish the main portions of the deck.
5. The finishers should be alert to the fact that the timing of their operation relative to passage of the finishing machine will change throughout the day. On a hot summer's day, sizable air temperature changes can occur between early morning and early afternoon together with changes in wind intensity. All these affect the drying of the concrete surface. The finishers must adjust their operations to cope with these changes. Don't let the finishing lag far behind the placing unless mandated by very slow drying conditions.
6. Try to keep hand finishing to a minimum. Do just enough to close up the small surface voids and secure a smooth surface within our tolerances. Try to minimize or eliminate the use of bull floats as they often tend to build in ripples as a reflection of the reinforcing pattern when too much pressure is applied. Check the surface with the proper straight edge.
7. Don't permit the addition of water by the finishers. This changes the water/cement ratio of the surface layer and will result in weaker surface concrete that will probably scale or wear early. We want sound concrete from top to bottom over the full expanse of the deck. It is not desirable, but, still preferable, to have a rough deck rather than a "watered down one".
8. Apply the prescribed surface texture at the proper time.

VI - CONCRETE OPERATIONS

D. CURING OF CONCRETE

1. Apply an approved curing compound at the proper time (as soon as the bleed water sheen leaves the concrete). Don't wait too long. Remember, its purpose is to keep the mix water available to hydrate the cement rather than to be lost through evaporation.
2. Apply approved curing covers at the proper time. Keep all covers properly overlapped. Rips or tears in the covers or loose fitting covers permit unwanted evaporation of moisture from the concrete. Keep wet type covers wet at all times throughout the prescribed period of cure. Don't "tent" the covers.
3. Special care should be given to insure proper curing of the deck concrete in the fascia area when the reinforcing steel protrudes. Fit wet type blanket covers tightly in and around the protruding reinforcing steel and keep it properly wetted down. Get them on early.
4. When filling the cavities in the deck that result from the removal of pipe sleeve screed rail supports, be aware of the fact that any water trapped in them that is not removed will freeze and probably damage the concrete. When the pipe sleeve screed rail support fits over a stud that is welded to the top of the girder the annular space formed around the stud is particularly susceptible to entrapment of water and subsequent freezing damage.