A long, narrow concrete bridge spans a wide river. The bridge is made of a single, continuous concrete slab. On either side of the bridge, the sandy banks are cluttered with construction materials, including bags of cement, rebar, and other debris. There are also some pieces of construction equipment, such as a small crane or generator. The river is wide and calm, with some ripples on the surface. In the background, there are rolling hills covered in trees with autumn foliage. The sky is clear and blue. The overall scene is one of a large-scale construction project in a natural setting.

# Chapter 8 - Concrete

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# Chapter 8 - Concrete

⌘ Concrete is formed from a hardened mixture of cement, water, sand, rock, air and certain admixtures through the chemical reaction called Hydration.



# Chapter 8 - Concrete

⌘ Nearly every structure constructed in SD will utilize concrete in one form or another.



⌘ The chapter will cover concrete from the point it is delivered to the construction site in its plastic state to its use in its final position.

# Inspection at Plant:

This is covered in the Concrete Plants Manual

## ⌘ Haul ticket

SOUTH DAKOTA		DOT-75 (1-64)
<b>MATERIALS AND WEIGHT TICKETS</b>		
PROJECT	S 6490 (1)	
MATERIAL	CLASS A	
DATE	6-10	19 89
TANK OR CAR NO.	3	M. GALS.
TRUCK NO.		LANE
GROSS WT.		SECTION
TARE WT.		STATION
NET WT.		SPREAD
TONS.		END STA.
WEIGHER		CHECKER
CONCRETE MIX (TREATED MAT'L S)	WATER: MAX 794	ACTUAL 750
TIME START MIX	2:16 P	BATCH SIZE 3 C.Y.
DISCHARGED		
REVOLUTIONS: RATE		INSPECTORS:
FINAL INITIAL	761	PLANT
NET		PLACING
REMARKS:		
No. D 623255	BOOK QUANTITY	
	PREV. TICKET	
	THIS TICKET	
	TOTAL	
LEAVE THIS SLIP IN BOOK		

- Project
- Material
- Date
- Truck Number
- Water: Maximum
- Water: Actual
- Batch Size
- Time Start Mix
- Inspector: Plant
- Revolution: Initial

# Inspection at Delivery



- ⌘ Your inspection of the concrete begins when the concrete reaches the structure site.
- ⌘ Your inspection focuses on items that affect the strength and durability of the concrete.
- ⌘ You will be tasked with performing the fresh concrete testing and also to closely monitor the operations of the pour.

# Inspection at Delivery



- ⌘ Time Limits
  - ⌘ Amount of Mixing
  - ⌘ Slump
  - ⌘ Air Content
  - ⌘ Temperature
  - ⌘ Concrete Cylinders
  - ⌘ Unit Weight
- ⌘ Inspection items which ultimately affect strength and durability of concrete

# Time Limits



- ⌘ If concrete placement takes too long, it will start to “set up”.
- ⌘ The following limits have been specified:
  - ☒ Concrete mixed in hauling unit (Redi-mix truck)
    - **50 – 80° F**  
Discharge within 90 min. & screed within 105 min.
    - **80 – 90° F**  
Discharge within 45 min. & screed within 60 min.
  - ☒ Concrete not mixed in hauling unit (uncommon for structures)
    - **50 – 80° F - Discharge within 45 min. & screed within 60 min.**
    - **80 – 90° F - Discharge within 30 min. & screed within 45 min.**

# Amount of Mixing



⌘ Transit mixed concrete - 70 revolutions (minimum)  
- 100 revolutions (maximum)

⌘ Undermixed

Segregation

Coarse aggregate not fully coated

Strength will be low

⌘ Overmixed

Grinding action produces fines - reduces slump

Percent of air is reduced

Temperature of concrete is raised

Strength will decrease



# Sampling Concrete

- ⌘ Samples of bridge deck concrete should be taken after placement on the bridge deck.
- ⌘ Sample tested within 15 minutes from time taken
- ⌘ Protect sample from sunlight and wind until used
- ⌘ Do not use concrete that has been previously used in the air test for any other test
- ⌘ Leave sample taken from a mobile mixer in a covered container for 5 minutes before testing for slump and air



# Slump



## ⌘ Specifications:

Structural Concrete = 1 to 4 1/2 inches  
(Check first load and every 2 hours)

Bridge Deck = 1 to 3 1/2 inches  
(Check first load and every hour after)

**Rule of thumb: For 1 Cu. Yd. of Concrete  
+ 1 gallon of water = + 1 inch slump**

# Air Content



## ⌘ Specifications:

All concrete except bridge decks = 5.0% - 7.5%

Bridge deck concrete = 5.5% - 7.5%

**Adding water will increase slump and air content.  
Adding admixture to increase air content and will  
increase slump.**

# Temperature



## ⌘ Specifications:

Structural Concrete = 50 – 90° F

Bridge Deck = 50 – 80° F

(max. temp. 85° F if cooling procedures are followed prior to pour)

# Concrete Cylinders



- ⌘ Requirements: One set of four cylinders per day for each 150 cu yds of concrete
- ⌘ Covered with wet burlap and poly
- ⌘ Protected at a temperature between 60 – 80° F
- ⌘ Not moved after set occurs and no vibrations
- ⌘ Within  $24 \pm 8$  hours, strip from mold and store in saturated lime water holding tank
- ⌘ One cylinder broke in Central Lab at 28 days - other one for backup. Other two for early breaks.

# Concrete Placement Equipment



- ⌘ Chutes
- ⌘ Concrete Buckets
- ⌘ Concrete Buggies
- ⌘ Hoppers and Drop Tubes
- ⌘ Tremie Pipes
- ⌘ Concrete Pumps
- ⌘ Conveyor Belts

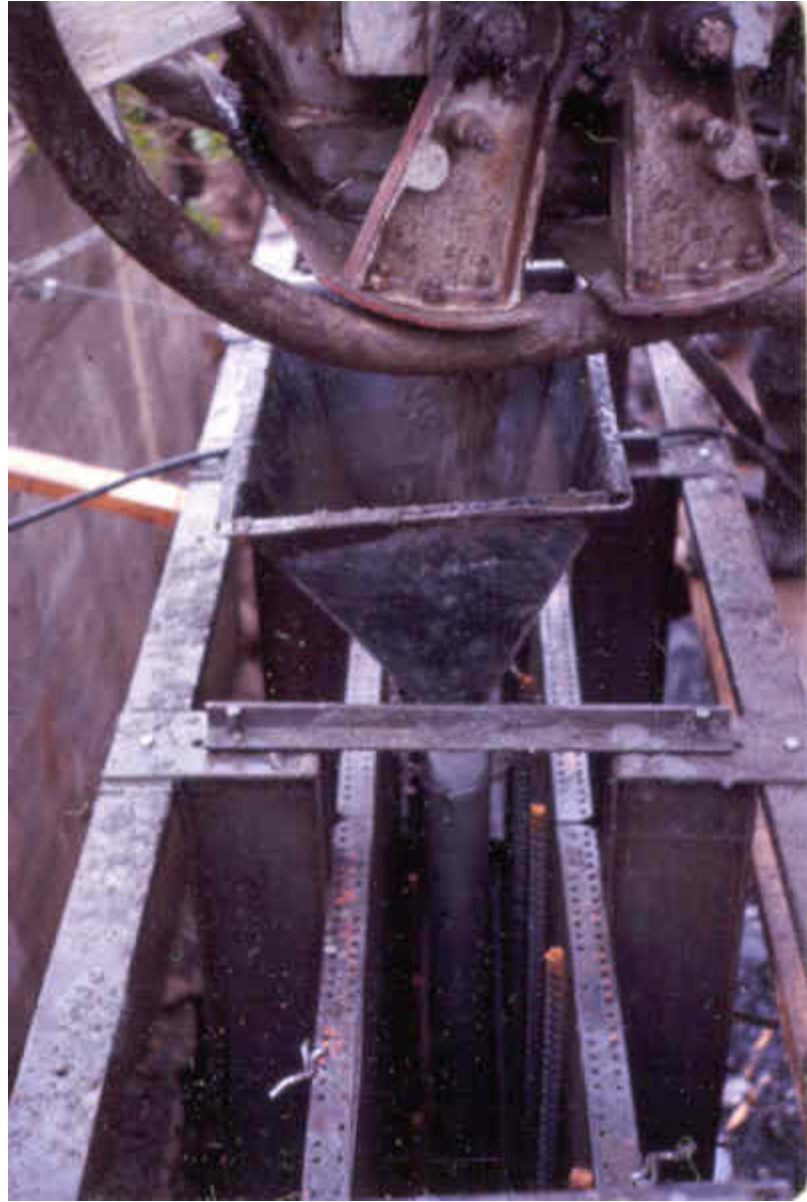










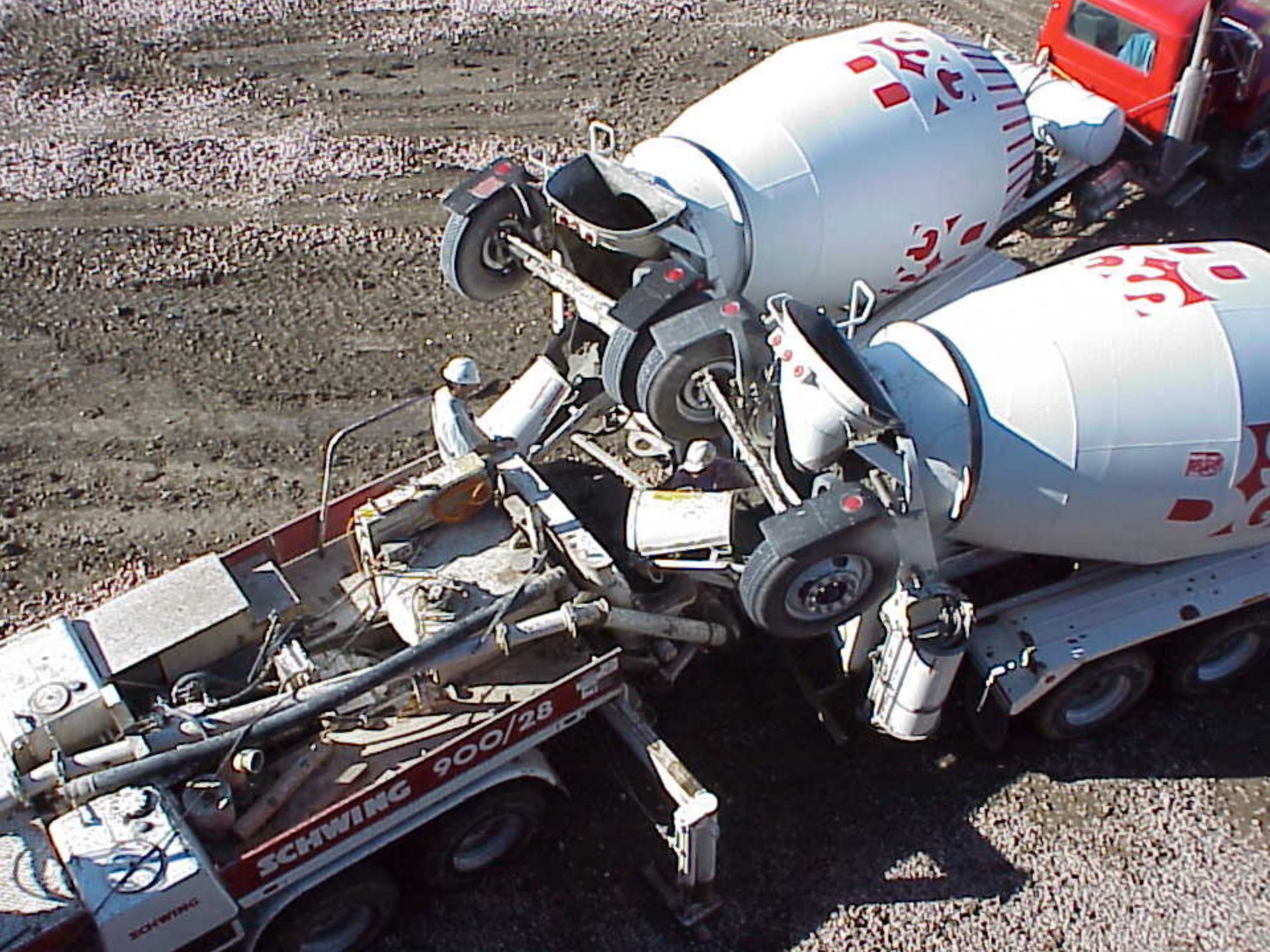
















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# General Concrete Placement

# General Concrete Placement



- ① Time Requirements
- ② Placement Pattern
- ③ Consolidation
- ④ Water Infiltration
- ⑤ Cold Weather Requirements
- ⑥ Hot Weather Requirements (bridge deck)

# ① Time Requirements

- ⌘ Place concrete at a rate such that a layer does not “set up” before next layer is placed
- ⌘ Concrete delivery intervals should not exceed 30 minutes

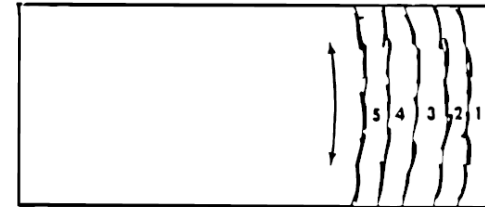




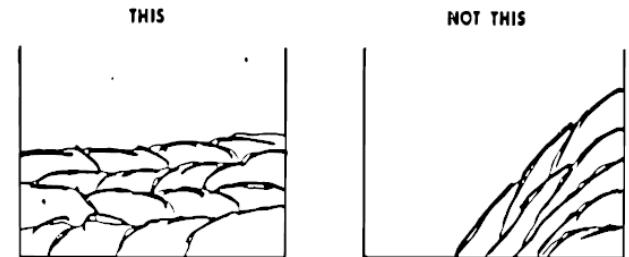
## ② Placement Patterns

⌘ Do not allow concrete to be dumped in piles. Concrete will segregate if the Contractor tries to move it from piles. Rock is heavy enough to stay put and only the mortar will tend to move.

⌘ Floors, decks and other large areas - Start at one end and move towards the other, spreading evenly over the entire width.



⌘ Walls - Layers should not be more than 6 - 12 inches deep and uniformly placed. Do not allow concrete layers to be sloped as segregation can occur.















## ③ Consolidation



- ⌘ Eliminating voids and settling of concrete is achieved by use of vibrators thus ensuring uniform density of mix
- ⌘ Spud vibrators should be used in a vertical manner every 12 - 18 inches apart and in a grid pattern
- ⌘ Vibrators should penetrate into previous lift
- ⌘ Do not use them to move the concrete







## ④ Water Infiltration



- ⌘ Seeping water can affect the quality and durability of the concrete thus requiring care in eliminating it from the excavation before concrete placement.
- ⌘ 3 Methods to deal with seeping water:
  - 1. Pump water out using a sump - low spot in excavation for collection point of water**
  - 2. Place a foundation seal**
  - 3. Place the concrete under water**

# ⑤ Cold Weather Requirements

- ⌘ Placement of concrete bridge decks is not permitted from November 1 - April 1
- ⌘ Ground must not be frozen or frost on reinforcing steel or forms
- ⌘ Use high-low thermometers especially when housing and heating



# ⑤ Cold Weather Requirements

## Protection Period



### ⌘ Concrete Temperatures:

- First 72 hours (3 days), 50 – 100° F
- Next 48 hours (2 days), 40 – 100° F
- Extra day of protection above 40 degrees F for each day temperature falls below the specified temp during these 5 days
- If housed and heated then removed after 5 days, temperature of concrete can not drop more than 40 degrees in each 24 hour period
- If an extra bag of cement is added to mix or if high early cement is allowed, first 72 hours, 60 – 100° F

# ⑤ Cold Weather Requirements

## Housing and Heating



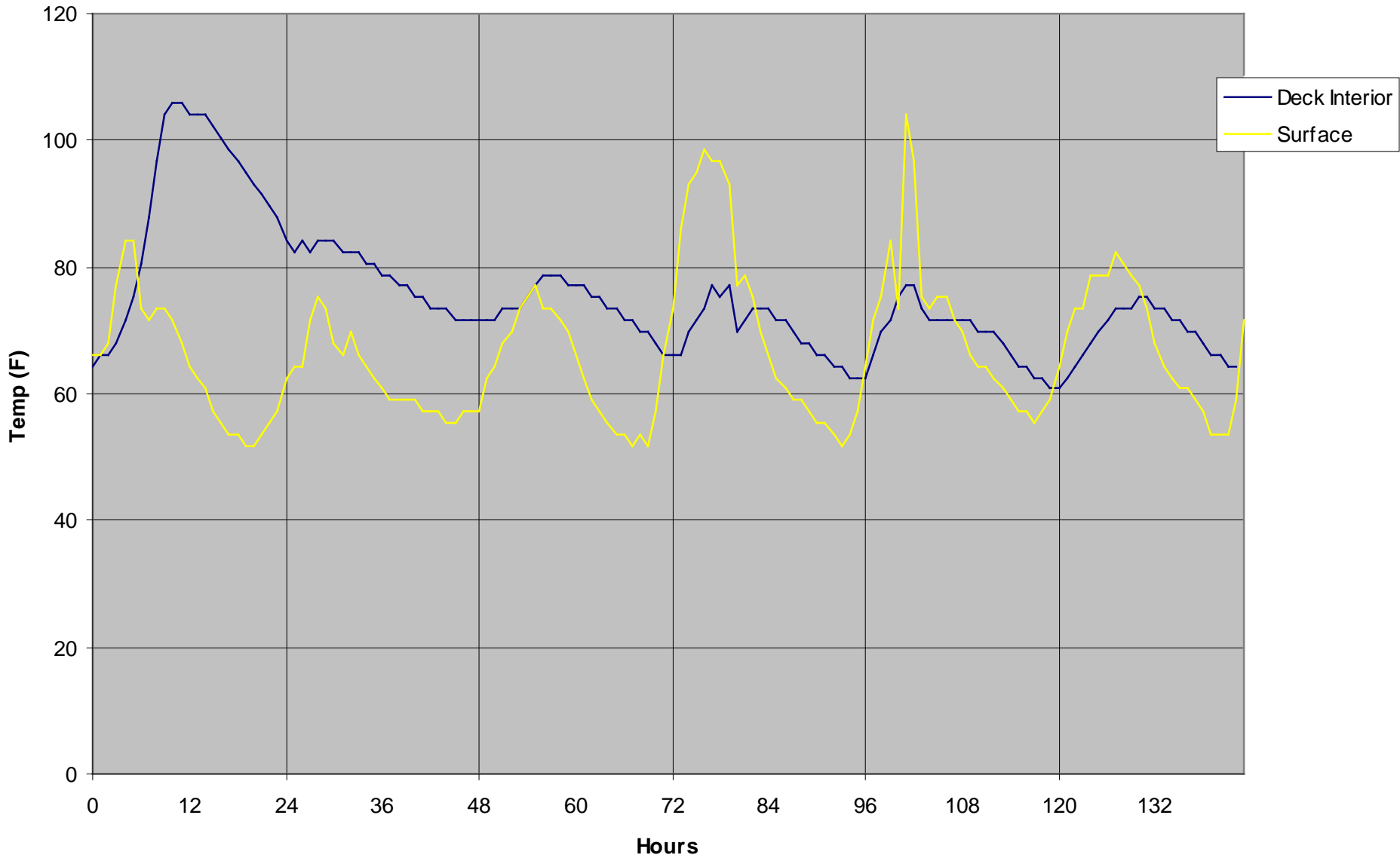
- **Plan for use of high-low thermometers - place between insulation and concrete at locations most likely to freeze**
- **Use enclosures and insulating blankets - secure from windy conditions**
- **Don't allow it to get too hot - have someone monitor enclosure**
- **Steam heat is the best due to moisture. Dry heat will pull the moisture out of the concrete.**
- **Cold Weather Concrete Temperature Record - DOT 227**
- **Spec also allows the Contractor to flood the concrete a min depth of 1' for 10 days.**







# Concrete Temps - Spans 10 & 11



# ⑥ Hot Weather Requirements (Bridge Deck Concrete)

⌘ Bridge Deck Concrete = 50 – 80° F

⌘ Bridge Deck Concrete = 50 – **85° F** if:

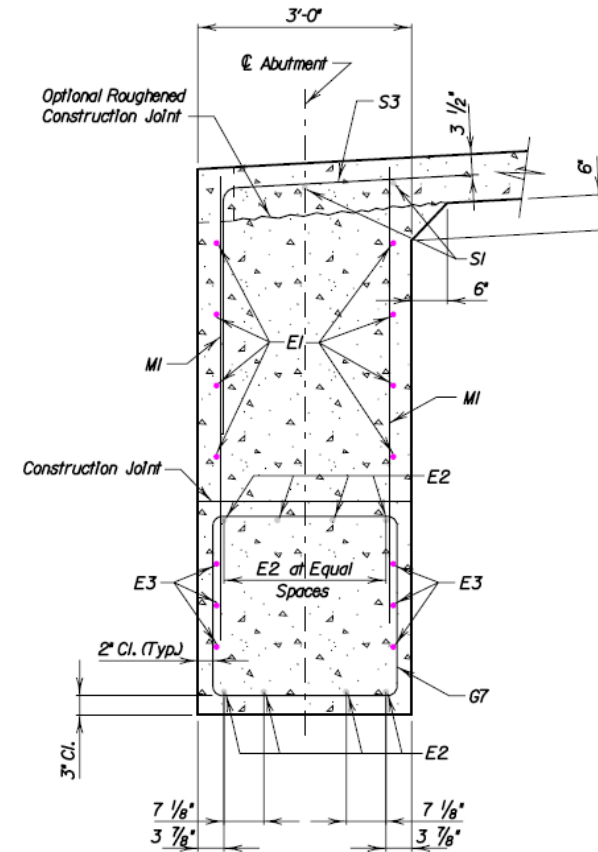
- Rock pile is prewet a couple of days before pour
- Minimum rate of pour of 40 Cu. Yds. per hour or minimum plans rate is maintained
- Wet burlap and poly is placed as soon as concrete is finished
- If ambient temperature > 80° F - continuous fogging shall be used

# Joints

# Joints

## Construction Joints or Expansion Joints

⌘ **Construction Joints** -  
used when there is no  
way to place all the  
concrete at one time.



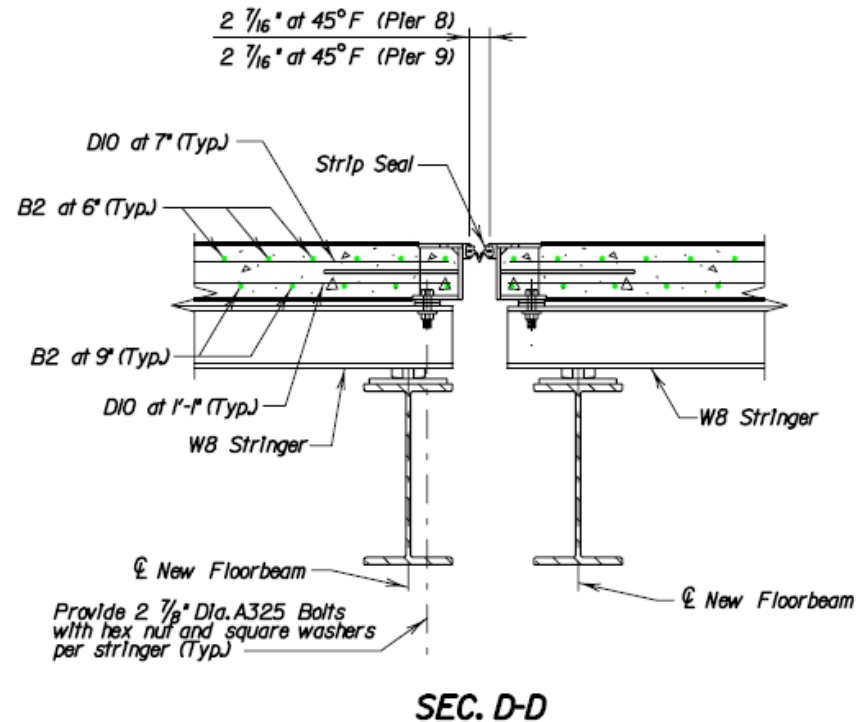
SEC. B - B



# Joints

## Construction Joints or Expansion Joints

⌘ **Expansion Joints** - provides a connection for different units of the structure but does not create a bond between them.





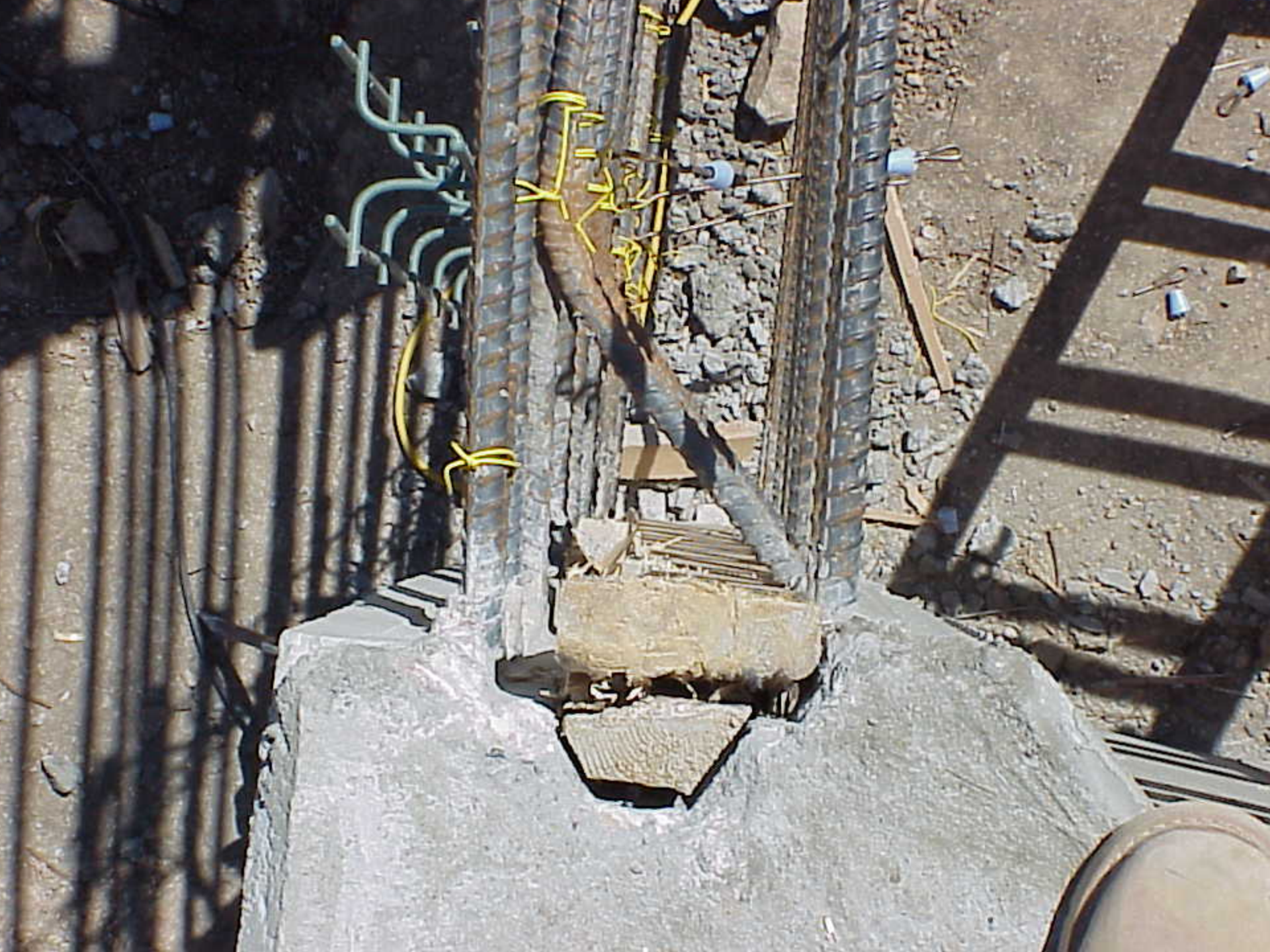




# Construction Joints



- ⌘ Formed Joint - Form is placed and concrete is consolidated up to the form. (header)
- ⌘ Keyways - Are indentations in concrete that provide for load transfer. They can be used in formed or roughened joints
  - Usually made of beveled wood - oiled
  - Should be as continuous as possible









# Construction Joints



## ⌘ Emergency Construction Joints

- Used when Contractor is unable to supply concrete because of time limits, equipment breakdowns, or when weather conditions warrant one
- The location is not as critical for walls, floors, or columns although concrete should be fairly level
- There are some key locations for these joints on various bridge decks
- Contact Office of Bridge Design if one is used

Figure 8.36 Emergency Construction Joint Locations for Continuous Concrete Bridge Slabs

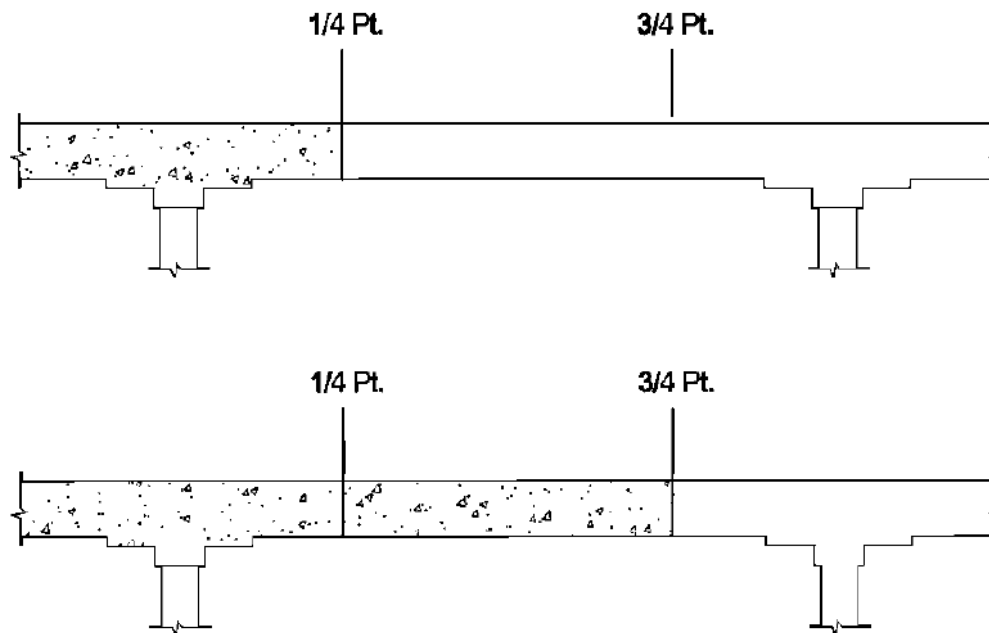
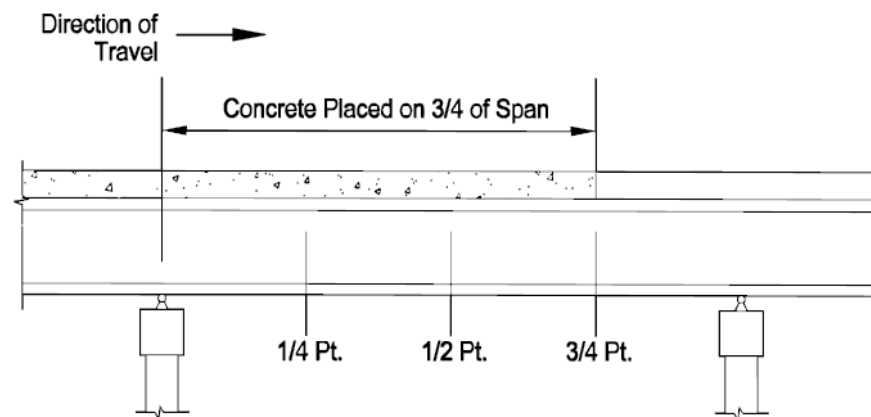
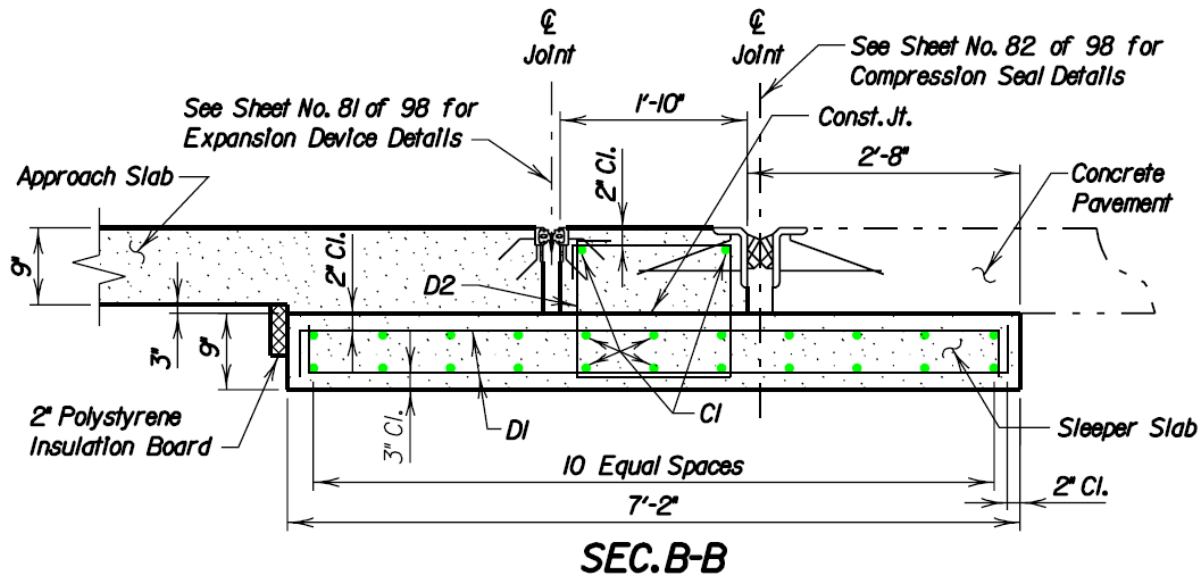


Figure 8.37 Emergency Construction Joint Locations for Continuous Composite Girder Bridge Slabs



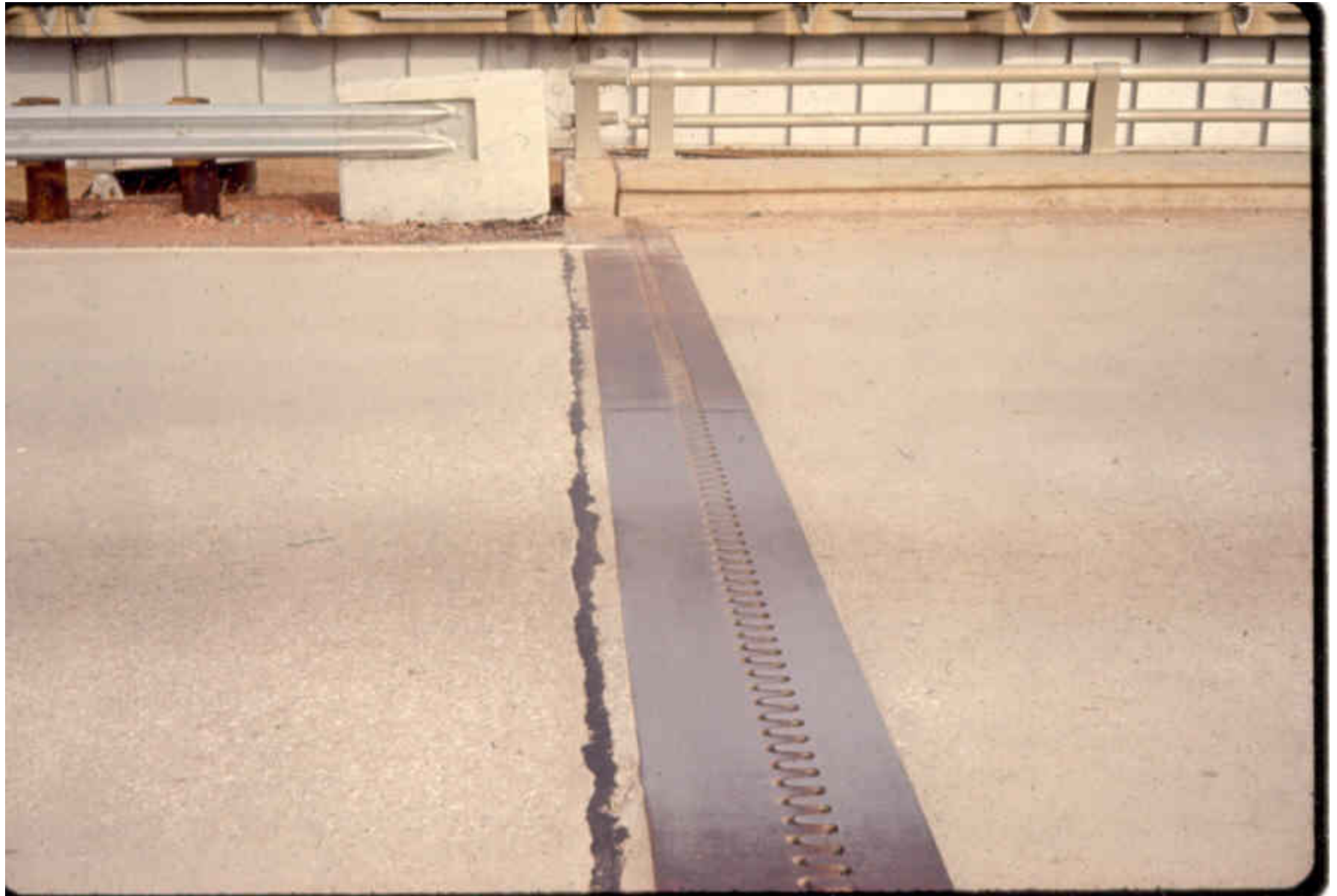
# Expansion Joints

- ⌘ Accommodates movement of concrete because of thermal temperature changes.  
(Provides room for the concrete to expand)









# Expansion Joints



## ⌘ Strip Seal Expansion Joint

- Usually over abutments or in approach slabs
- Installation is critical for long life - follow shop plans and manufacturer's installation instructions
- Note: Using plenty of lubricant adhesive during installation of the neoprene seal is a key to proper and easy installation



# Box Culverts

# Cast-in-place Box Culverts



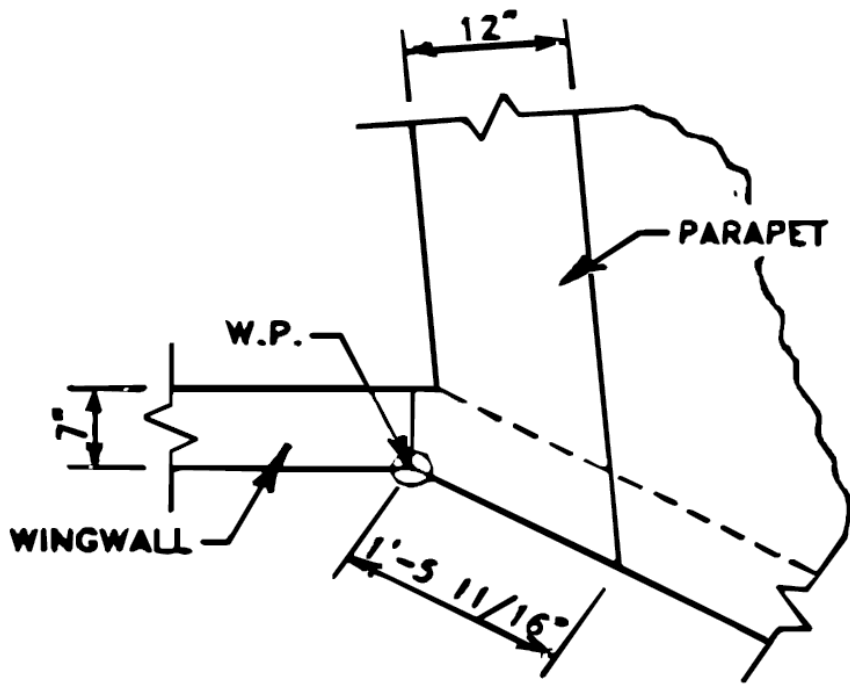
## ⌘ Placement Sequence

- Work progresses from the ground up – Undercut, Bottom slab, walls, top slab
- Occasionally a Contractor will want to pour walls and top slab together - ok for small boxes
- Concrete must remain plastic in walls and top slab when pouring them together



# Cast-in-place Box Culverts

## Working Points



**DETAIL "Y"**

⌘ Commonly mislocated

⌘ All dimensions for wingwall and resteel placement is referenced to this working point



# Cast-in-place Box Culverts

## Joints



### ⌘ Box Culvert Joints

- Plans will show keyways in most joints
- Horizontal joints may be made as roughened joints in lieu of keyways by plan note
- Vertical joints must have keyways
- Joints between barrel sections must have keyways
- Entire barrel section joint will have drainage fabric wrapped completely around it and glued down

# Precast Box Culverts



- ⌘ Fabricated in a precast concrete product supplier's yard
- ⌘ Shop plans and copy of design computations to the Office of Bridge Design 30 days prior to fabrication for approval
- ⌘ Installation of sections should be from the shop plans and not the construction plans as they provide erection and placement sequencing



# Bridge Deck Concrete

# Bridge Deck Concrete Prepour



- ⌘ Pre-pour Deck Inspection: Spec Book Sec. 460.3 J requires this inspection.
  - Contractor advises the Engineer 24 hours in advance of the time when the deck preparation will be complete and ready for inspection.
  - Engineer contacts the Office of Bridge Design to schedule a date/time for this inspection.
  - Primary focus of pre-pour inspection is to verify all items are in place and all formwork and equipment is ready for the concrete pour.
  - Prepour Inspection Checklist

# U:\br\Construction\ Checklist

## SDDOT BRIDGE DECK PREPOUR CHECKLIST

PROJECT: \_\_\_\_\_ COUNTY \_\_\_\_\_ STR. NO. \_\_\_\_\_

DECK THICKNESS: \_\_\_\_\_ HAUNCH: \_\_\_\_\_ SPAN LENGTH: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_

**Specifications:**

Slump 1-3 ½  
Air 5.5%-7.5%  
W/C Ratio Design Mix Max.

**Concrete Temp. Requirements:**

At Placement 50 – 80 Degrees  
After Placement Above 50 Deg. For 72 Hours  
Above 40 Deg. Next 48 Hours

**Concrete Delivery Requirements:**

Continuously Agitated:  
Below 79 Degrees – 90 min. to discharge  
Above 80 Degrees – 45 min. to discharge  
Contractor has additional 15 minutes to screed conc.

Not Agitated During Transit:

Below 79 Degrees – 45 min. to discharge  
Above 80 Degrees – 30 min. to discharge  
Contractor has additional 15 minutes to screed conc.

Interval Between Batches

No more than 30 minutes

**Deck Forms:**

Dimensions Correct?  
Length, Width, etc. ?  
Falsework In Accordance with Plans?  
Mortar Tight?  
Blown Off?  
Chamfer & Drip Strips in Place?  
Adequate Walkway & Handrail?  
Paving Blocks Installed?

**Resteel:**

Bottom Cover 1" (+ ¼", - 0")  
Ht. Top Mat \_\_\_\_\_ (± ¼")  
Top Mat Tied Down  
Conc. Bridge 12' Square  
Girder Bridge: Tied to Shear  
@ 8' Spacing

Bar Intersections Tied?  
Adequate Chairs?  
C1 Bars: 1" Clr. Back, 2" Clr. Front  
Bent Cap Neg. Mom. Bars (A4)  
Height From Bottom \_\_\_\_\_  
Required Lap Length?  
Epoxy Coated Rebar Damage?

**Deck Drains:**

Number: \_\_\_\_\_  
Spacing: \_\_\_\_\_

**Rail Anchors:**

Number: \_\_\_\_\_  
Spacing: \_\_\_\_\_

**Concrete Delivery:**

Where is Plant?  
Moistures Taken?  
Aggregate & A.E.A. Samples Taken?

**Concrete Trucks:**

Radios?  
Rev. Counters? (Req'd)  
Water Meters?  
How Long in Transit?  
Batch Sizes?

**Concrete Placement:**

How Placed?  
If Buckets, How Many?  
How Many Vibrators?  
How Many Backups?  
Vibrator Operators Trained?

**Concrete Finishing & Curing:**

Finish Machine Set Up?  
Rails Checked?  
Extends off Deck?  
Crown Set?  
Backup Engine?  
Carpet Drag & Tine?  
Certs or Approved List?  
Power Sprayer?  
Backup Sprayer?  
Wet Burlap and Poly?  
Curb Finishers Trained?

**Testing Equipment:**

Cylinders  
Air Meter  
Slump Cone  
Rubber Mallet  
Thermometers, Hi-Lo  
Water Bottles  
Trowels  
Rod

**SPECIAL ITEMS:**

\_\_\_\_\_  
\_\_\_\_\_

# Bridge Deck Concrete Prepour

- ⌘ Contractor should have the following items ready before the prepour inspection:
- Formwork and decking complete and joints mortar tight
  - Reinforcing steel is in place at correct locations
  - Screed rails set and adjusted to final grade
  - Finish machine set up and adjusted to proper crown and depth of slab
  - Safety railing installed
  - Contractor & Concrete Supplier representatives at prepour inspection with Bridge Construction Engineer and project engineer



# Bridge Deck Finish Machines



- ⌘ Approved deck finish machine required on bridge deck pours - special equipment designed to trim and finish bridge slab
- ⌘ Usually Bidwell or Gomaco
- ⌘ Machine mounts on a paving carriage that travels on screed rails set on each side of the deck
- ⌘ Screed rails and finish machine should be set up and adjusted for correct grade, camber and slab depth prior to the prepour inspection





# Bridge Deck Finish Machines

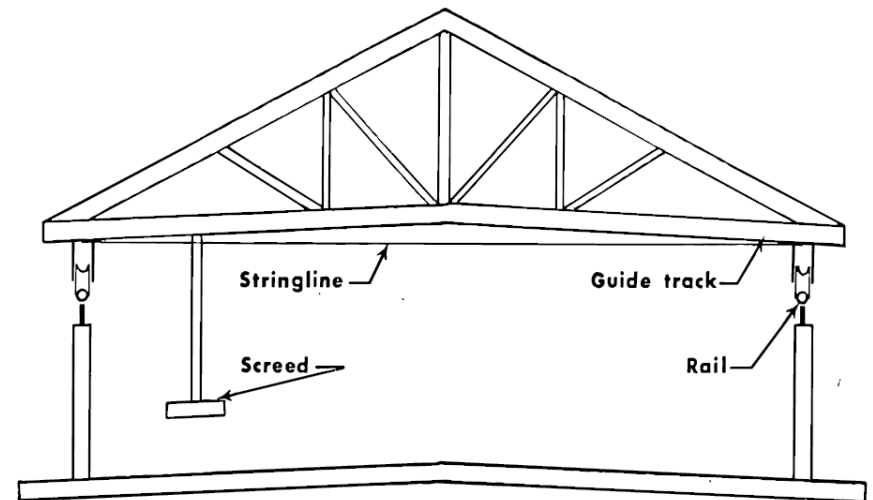
## Crown Check

### ⌘ Setting up the finish machine

- Finish machine should be set to match the skew of the bridge

Figure 8.45 Setting Up the Finish Machine

- Check crown using a string line stretched between points on the screed guide track



(account for variations such as skew or offset centerline)

# Bridge Deck Finish Machines Screed Rails (Slab Bridge)



## ⌘ Setting the screed rails - Continuous Concrete Bridge

- Get fixed distance from top of deck to rail. Move screed over next to curb.
- Take a shot on top of rail and bottom of screed. The difference provides the constant distance the rail should be set above the top of concrete elevation.
- + Lumber crush - Contractor to provide
- + Add this sum to the elevations on the curb and centerline elevation diagram in plans to get the elevations for the rail

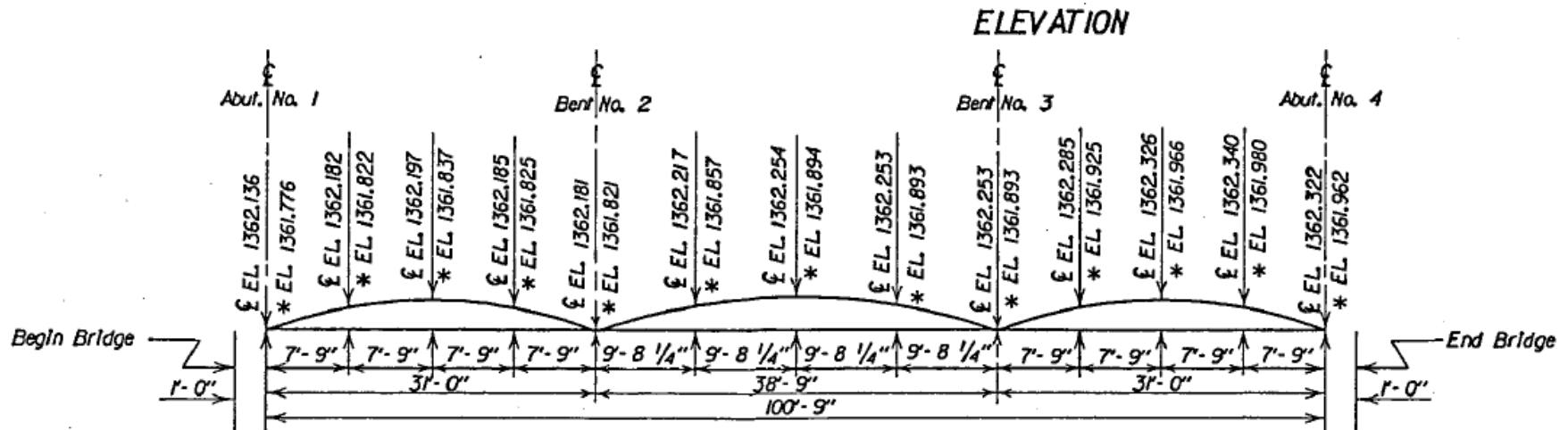


Constant used to calculate rail elevations

# Bridge Deck Finish Machines Screed Rails (Slab Bridge)

## ⌘ Calculation

$$\begin{aligned} \text{Rail Elevation} &= \text{Curb Elevation (from diagram in plans)} \\ &+ \text{Constant} \quad + \text{Lumber Crush} \end{aligned}$$



Elevations Indicated with \* are Top of Finished Slab at Curbs, and with £ are Top of Finished Slab at £ Roadway. Camber for Dead Load Deflection Plus Plastic Flow, shown on Sheet No. 7 of 14, have been Included In the elevations shown above.

# Bridge Deck Finish Machines

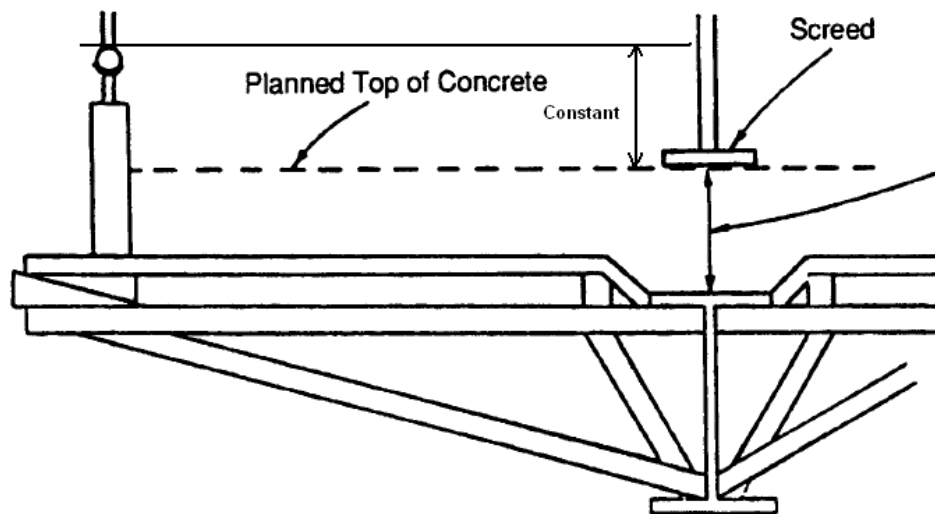
## Screed Rails (Girder Bridge)

### ⌘ Setting the screed rails - Girder Bridges

- Constant distance is from top of rail to bottom of screed
- Move screed directly over outside girder at a shot point
- Knee braces sag – Generally 3/8"
- Rail elevation = Constant + sag + slab form elevations of the exterior girder given in the plans

### ⌘ Calculation

☒ Rail Elevation = Slab Form Elevation (from diagram in plans) + Constant + Sag



This distance should equal the amount of fill marked on the steel at the check points.

# Bridge Deck Finish Machines

## Screed Rails



- The finish machine should be set over the support points when figuring elevations. This puts the dead load of the machine on the forming and forces the rail to fit tightly in the saddles (eliminates sag).
- After the rail is set, run finish machine the entire length of deck as well as back and forth across deck, checking slab thickness and resteel cover

# Bridge Deck Finish Machines Screed Rails (During Pour)



## ⌘ Checking the screed rails during concrete placement

- Best not to adjust rails during pour
- Take depth checks while pouring
- Tolerances in depth:
  - + 1/4" to - 1/8" of plans depth



# Bridge Deck Finish Machines

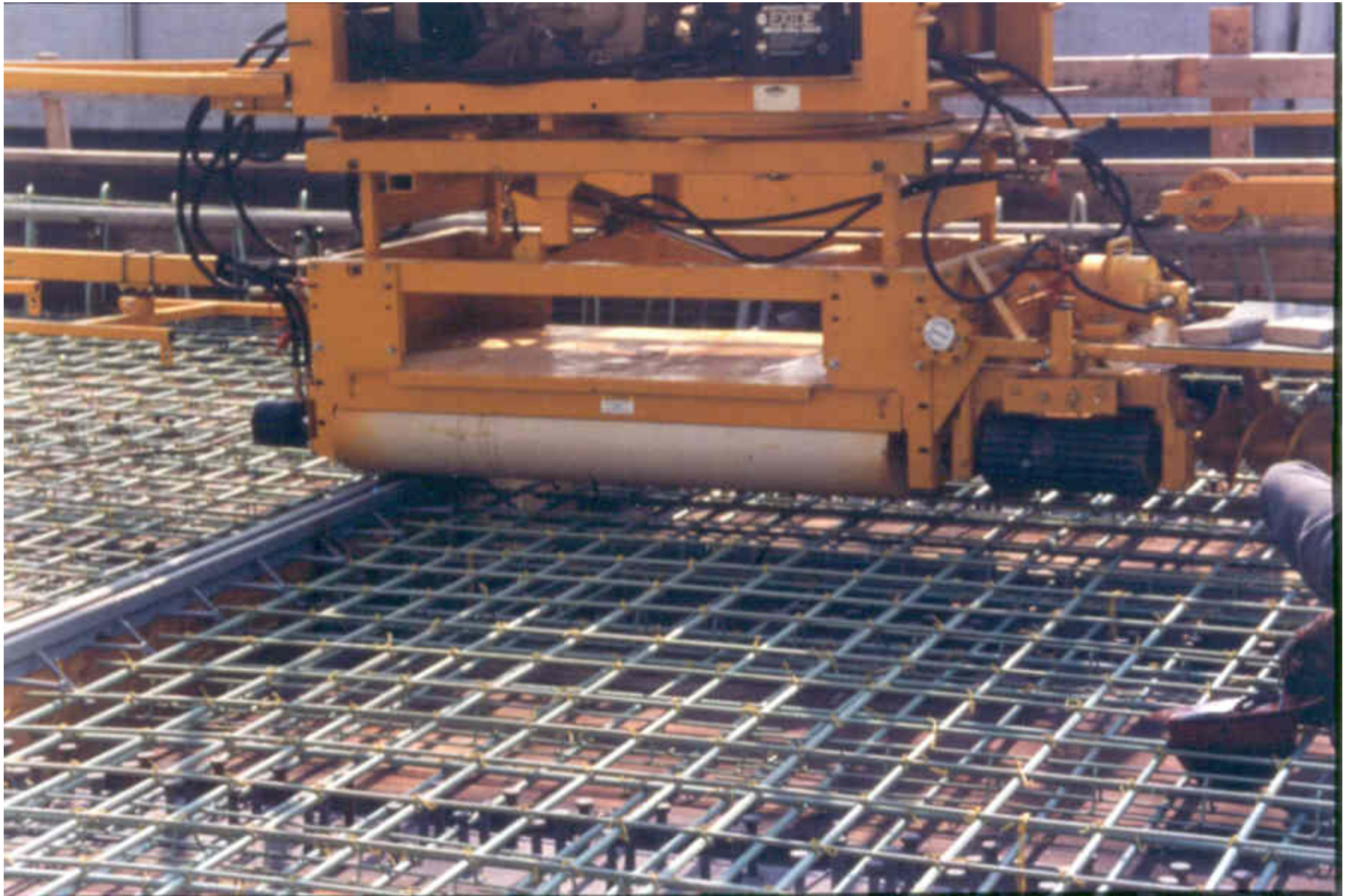
## Concrete Placement

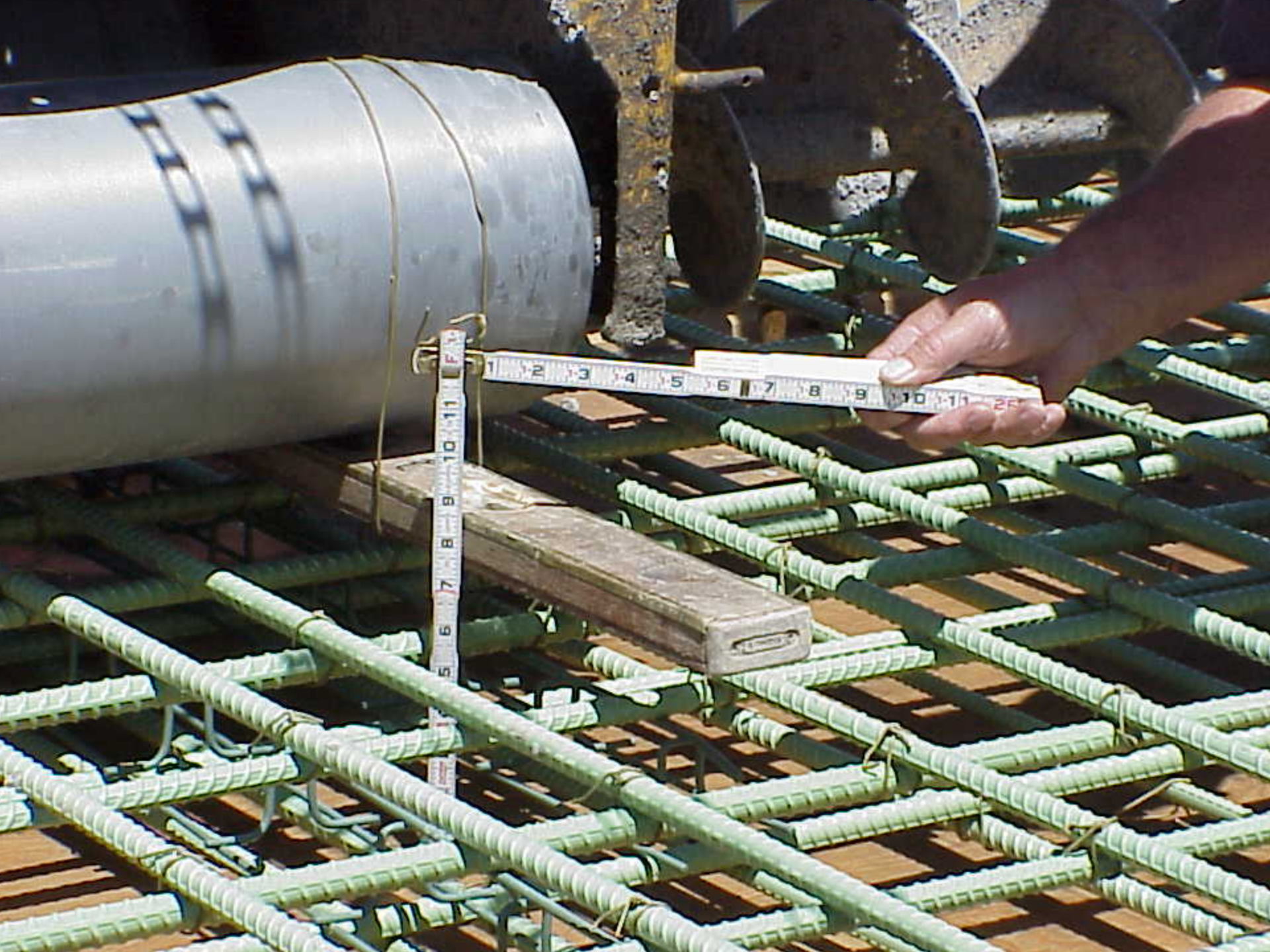


### ⌘ Monitoring finish machine during concrete placement:

- Keep head of concrete in front of screed as it's finishing
- Each pass of finish machine should overlap the last pass
- Concrete placement should be done on the skew angle of a skewed bridge. This will keep the deflections of the girders the same.











Finishing

# Finishing

- ⌘ Fill small honeycomb holes and holes left by ties
- ⌘ Honeycombing may occur when concrete is not consolidated properly. Small areas of honeycombing can be chipped out to solid concrete and repaired.
- ⌘ Remove all loose material, clean, and dampen exposed concrete before patching with grout.























# Rubbed, Brushed or Commercial Finishes



## ⌘ Rubbed, Brushed or Commercial Finish

- All railing, curbs, parapets, wings, and other surfaces in which the traveling public can see
- Not required on wing walls and parapets of box culverts, wingwalls and backsides of curbs on bridges

### **CLASS B COMMERCIAL TEXTURE FINISH**

1. A Class B commercial texture finish shall be applied to all exposed surfaces of new Pier concrete not covered by the Concrete Protective Coating.

### **SPECIAL SURFACE FINISH**

Special surface finish shall be applied to the existing concrete surfaces designated on the plans in accordance with Section 460.3.M.2 of the Construction Specifications.

# Rubbed Finish



- ⌘ Surfaces shall be thoroughly wetted with a brush and rubbed with a medium coarse carborundum stone or an abrasive using a small amount of mortar
- ⌘ All form marks and projections shall be removed with this finish
- ⌘ Surface shall have a smooth texture and uniform color



# Brushed Finish



- ⌘ Permitted only if it is accomplished within 12 hours of concrete placement - Remove forms when concrete can stand firm without slumping
- ⌘ Surface worked with a rubber float which may be dipped in a very wet fine sand/cement grout mixture
- ⌘ A soft bristle brush shall be used to smooth the surface, leaving a fine grained, smooth, sanded texture



# Commercial Texture Finish



- ⌘ Use products on the approved products list only
- ⌘ APL lists two classes: Class A & Class B
- ⌘ Unless otherwise specified, Class A system shall be used
- ⌘ Contractor is to provide a copy of manufacture's recommendations for application.
- ⌘ Finish shall provide a uniform color and texture
- ⌘ Finish shall be applied when it will not be scuffed up by other work performed by the Contractor









# Special Surface Finish

⌘ Same as Class B Commercial Texture Finish except abrasive blast cleaning is required (power washing is not allowed)

- Used on surfaces designated in the plans
- Only Class B system from approved product list



# Float Finish

---

- ⌘ Unformed surfaces shall be given a float finish (Except bridge deck surface)



# Bridge Deck Finish

- ⌘ Surface struck off and finished by an approved finishing machine
  - Self-propelled rotating cylinder type
  - Span the concrete placement width
  - Cylinders and augers shall spread and consolidate the concrete to the established profile and grade
  - Capable of going forward and back



# Bridge Deck Finish

- Final finish on bridge deck done by carpet drag to provide a surface micro texture
- Surface also given a transverse metal-tine finish  
Groove depth:  $3/16'' \pm 1/16''$   
Random spacing of tines
- Test hardened surface for smoothness in accordance with SD417 of the Materials Manual:  
Permissible surface deviation:  $1/8''$  in 10'







Curing



# Curing of Concrete: Membrane Curing Compound



- ⌘ Apply as soon as bleed water sheen leaves concrete surface
- ⌘ A liquid that forms a watertight seal on the concrete surface which retards evaporation of the surface moisture - applied uniformly by spraying
- ⌘ TEST: One 8 oz. sample sent to Central Lab for testing  
(mix thoroughly before sampling)
- ⌘ CERTIFICATION:  
Approved Product or Certificate of Compliance before application



**ShopKo**

**OfficeMax**



# Other Curing Methods



- ⌘ Burlap Blankets - Not Burleen
- ⌘ Paper or Plastic Sheets - Poly
- ⌘ Wetted Earth, Sand, or Straw
- ⌘ Continuous Wetting - soaker hoses, lawn sprinklers, fogging
- ⌘ Leaving Forms in Place













# Special Provisions

# Special Provision for Bridge Deck Curing & Finishing.

- ⌘ Nighttime Pour if daytime temperatures forecasted above 80° F
- ⌘ Fogging system required and demonstrated at the prepour inspection.
- ⌘ Wet burlap within 25 feet of finish machine
- ⌘ 7 days of wet cure (no curing compound required)



# Special Provision for Concrete Penetrating Sealer.



- ⌘ Work consists of furnishing & applying a sealer to a properly prepared bridge deck.
- ⌘ Acceptable sealers listed on the APL.
- ⌘ Contractor shall furnish manufacturer's technical data sheets and sufficient evidence that the sealer has not exceeded the manufacturer's specified shelf life a minimum of 5 days prior to application.



# Special Provision for Concrete Penetrating Sealer.



## ⌘ Surface Protection & Preparation:

- Deck surface protected from contamination by covering until surface prep for sealer begins.
- Deck surface cleaned by powerwashing.
- Detergent cleaning along with abrasive blast cleaning will be required if oil or grease spilled on the surface.
- Cleaning shall not cause damage to surface or expose the coarse aggregate.
- Cleaned surface shall appear uniform in color & texture.
- Required to mask off all joints, strip seals, etc. prior to sealing. Sealer may damage these materials.

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## ⌘ Sealer Application:

- Air & concrete temp between 40 – 100° F , unless otherwise recommended by the manufacturer.
- Should not applied when windy or if rain is anticipated within 24 hours.
- Concrete cured for 28 days prior to application of sealer. Can be applied after 14 days if no evidence of moisture in concrete when tested in accordance with ASTM D4263 (plastic sheet test) & concrete has obtained > 80% of design strength.
- Surface allowed to dry for min. of 3 days after power-washing or precipitation.
- Blow off dust/debris just prior to sealer application.

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## ⌘ Sealer Application:

- Spray on sealer at the manufacturer's recommended rate or to refusal, whichever is achieved first. Refusal is defined as sealer remains on surface without soaking in.
- If plans specify a grooved bridge deck, the grooving shall be done prior to sealer application.
- Traffic or pavement markings will not be allowed on sealed surface until the solution has completely penetrated and the treated surface is dry.



# Form Removal

# Form Removal

- Concrete must be self-supporting before forms and falsework are removed

- Strength/Time requirements must be met before forms are removed. (Sec. 460.P)

**Table 1**

Structural Elements	Formwork/Form Removal		Placement of Superimposed Elements	
	Concrete Strength psi (MPa)	Time	Concrete Strength psi (MPa)	Time
Footings/Sleeper Slabs	800 (6)	24 hrs.	1600 (11)	72 hrs.
Columns/Pier Walls	800 (6)	24 hrs.	2000 (14)	12 days
Abutment/Sills	800 (6)	24 hrs.	3000 (21)	20 days
Bent Caps/Pier Caps	2400 (17)	15 days	3000 (21)	20 days
Grout Pads	800 (6)	24hrs.	2000 (14)	12 days
Concrete Diaphragms	800 (6)	24 hrs.	2000 (14)	12 days
Bridge Decks:				
Girder Bridges	2000 (14)	12 days	1200 (8)	48 hrs.
Continuous Conc. Bridges	2400 (17)	15 days	1200 (8)	48 hrs.
Rigid Frame Bridges	2400 (17)	15 days	1200 (8)	48 hrs.
Other Deck Slabs	2000 (14)	12 days	1200 (8)	48 hrs.
Box Culvert:				
Floor, Wingwall Footings	800 (6)	24 hrs.	1600 (11)	72 hrs.
Walls	800 (6)	24 hrs.	3000 (21)	20 days
Top Slab	2000 (14)	12 Days	1200 (8)	48 hrs.
Other Vertical Surfaces not Carrying Load	800 (6)	24 hrs.		

- Be present when forms and falsework are removed - remove slowly so that concrete can pick up the load steadily

# Application of Live Load

- ⌘ Full design strength and all falsework removed prior to backfilling and applying highway live loads.
- ⌘ Exceptions are footings and columns cannot be backfilled until permission has been given by the Engineer.
- ⌘ Should not drive vehicles over box culverts with fill depths of less than the design fill.



# Swiss Hammer Testing

⌘ The swiss hammer is a device that can quickly approximate the compressive strength of in-place concrete.



⌘ It can be used for the following purposes:

- ☒ Removing forms.
- ☒ Opening the structure to traffic.
- ☒ Comparative tests.