Section 4

Quality Concrete

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Basics of Concrete

What is Concrete?

- Concrete in its basic form is a mixture of three components: Portland Cement, water and aggregate.
- The aggregates are generally divided into two groups: sand and coarse aggregate
- Modifiers and chemical admixtures are added to change the characteristics of the concrete.

Hydration

The chemical reaction between cementitious particles and water that transforms the mix of materials into a strong solid mass.

Hydration Process

Cement Reaction

C_3S + H ⇨ C-S-H + CaOH

(Lime) (Water) (Cement) (Calcium Hydroxide)

C_3S = Tricalcium Silicate $(3CaO)(SiO_2)$

H = H_2O

C-S-H = Calcium Silicate Hydrate gel (indefinite composition)

What is Portland Cement?

Portland Cement is a binding material that is manufactured from limestone, iron ore, silica sand and alumina.

Portland Cement is produced in a plant where raw materials are heated in a rotary kiln. The heat from the kiln causes a chemical reaction that converts the raw materials to clinker. Then the clinker is pulverized to form the cement.

Modifiers (02030)

Modifiers that have cementitious properties and may be substituted for cement include:

- Fly Ash
- Silica Fume (Microsilica)
- Slag

Hydration Process

Cement Reaction

$C_3S + H \Rightarrow C\text{-}S\text{-}H + CaOH$

Pozzolanic Reaction

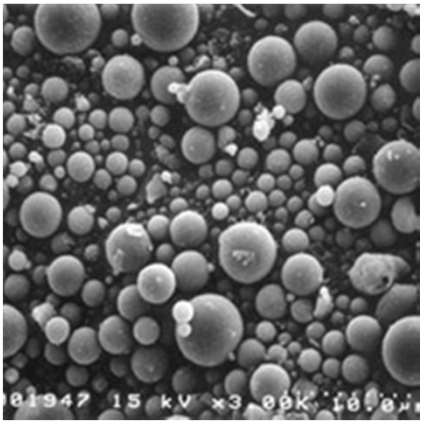
$CaOH + S \Rightarrow C\text{-}S\text{-}H$

S = Silicate (SiO_2)

What is Fly Ash?

- It is a byproduct of the combustion of pulverized coal in electric generation plants.
- During combustion the coal's mineral impurities fuse in suspension and are carried away by the exhaust gases. As the material cools and solidifies into spherical glassy particles, it is collected by electrostatic precipitators or bag filters.
- It is a pozzolan. When mixed with lime and water, the Calcium Hydroxide byproduct combines with it to form a cementitious material.

Fly Ash



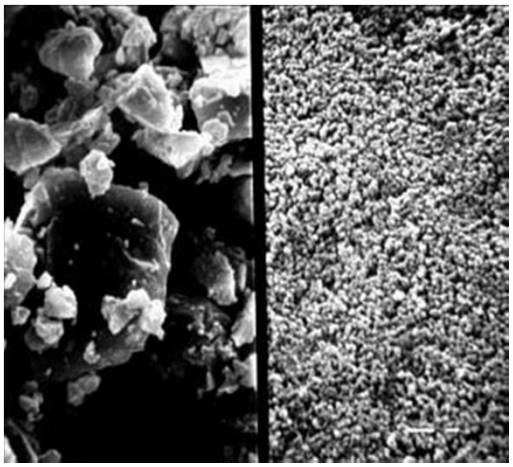
Fly Ash Properties

- Requires less water
- Improves workability
- Less bleeding
- Less segregation
- Lower heat of hydration
- Retards the setting of concrete

What is Silica Fume (Microsilica)?

- It is a very fine noncrystalline silica produced in electric arc furnaces as a byproduct of the production of elemental silicon or alloys containing silicon.
- It is a pozzolan. When mixed with lime and water, the Calcium Hydroxide byproduct combines with it to form a cementitious material.

Cement / Microsilica



Properties of Silica Fume (Microsilica)

- Reduces bleed water
- Reduces segregation
- Stickier mix and more difficult to finish
- Aids pumpability

Properties of Silica Fume (Microsilica)

- Increases plastic shrinkage cracking
- Reduces Permeability
- Increases density
- Conductivity of 1,000 coulombs vs. 2,500 coulombs for regular concrete

What is Slag?

- It is a byproduct of the manufacture of iron during the use of a blast furnace.
- Slag is the molten material that floats to the surface on top of the molten iron. It is quenched with water in a process known as granulation and then ground to become ground granulated blast-furnace slag (GGBFS).

Slag Cement (GGBFS) is a hydraulic cement with the following properties:

- Better workability
- Higher compressive & flexural strengths
- Lower permeability
- Improved resistance to aggressive chemicals

Microsilica Concrete
Vs.
High Performance Concrete

Microsilica Concrete (MC)

- Used on deck structural overlays.
- Current mix designs are made up of approximately 4% silica fume.
- Largest aggregate size is 3/8″

High Performance Concrete (HPC)

- Defined as concrete with conductivity of less than 1,000 coulombs.
- Used on bridge decks.

Chemical Admixtures (02040)

Chemical Admixtures

- Super Set Extenders
- Retarders
- Water Reducers
- Air Entrainment
- Accelerators
- Slump Stabilizers

Concrete Strength

Compressive Strength

Manual of Concrete Practice

308R-4

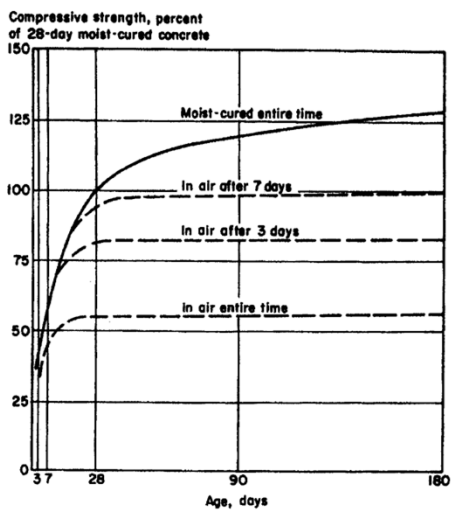


Fig 1.4—Compressive strength of 150 x 300 mm (6 x 12 in.) cylinders as a function of age for a variety of curing conditions (Kosmatka and Panarese 1988).

Abrasion Resistance

Manual of Concrete Practice

308R-12

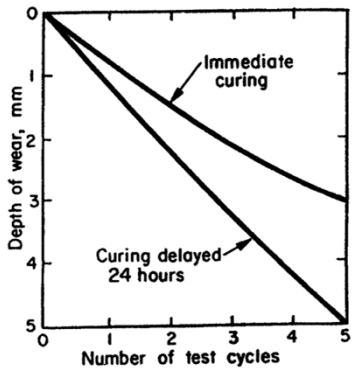


Fig. 1.13—Sawyer (1957) demonstrated the effects of delaying curing on abrasion resistance (1 mm = 0.04 in).

Strength vs. Age

Manual of Concrete Practice

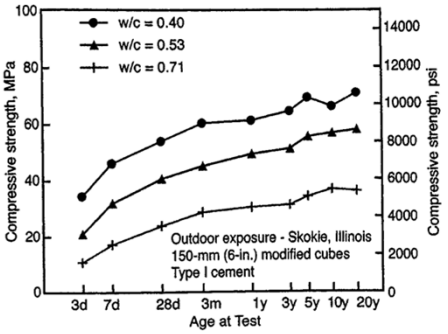


Fig. 1-14. Concrete strength gain versus time for concrete exposed to outdoor conditions. Concrete continues to gain strength for many years when moisture is provided by rainfall and other environmental sources (Wood 1992).

W/C Ratio Example

One 10 yard truck of concrete mix has:

1800 lbs water

6000 lbs cementitious material

W/C Ratio = 1800 lbs / 6000 lbs = 0.30

W/C Ratio Example

What happens if the truck driver adds 10 gallons of water on the jobsite to his truck?

1800 lbs water + 10 gal (8.34 lbs/gal)
6000 lbs cementitious material

W/C Ratio = 1883 lbs / 6000 lbs = 0.314 = 0.31

W/C Ratio Exercise 1

One 8 yard truck of concrete mix has:

1872 lbs water
4800 lbs cementitious material

W/C Ratio =

W/C Ratio Exercise 2

One 8 yard truck of concrete mix has:

1872 lbs water

4800 lbs cementitious material

What is W/C Ratio if 10 gal of water are added onsite?

Vibrating Concrete

View PCA Video

VC 108 ’83

Vibrators
540.23 & 540.48(c)

- Minimum of 4,500 impulses per minute.
- Use min. of two vibrators on deck pours and for other placements exceeding 50 cy per hour except seals and drilled shafts.
- Use proper vibrating techniques.

Vibra-Tak

VIBRA-TAK Slide Rule Tachometer Page 1 of 1

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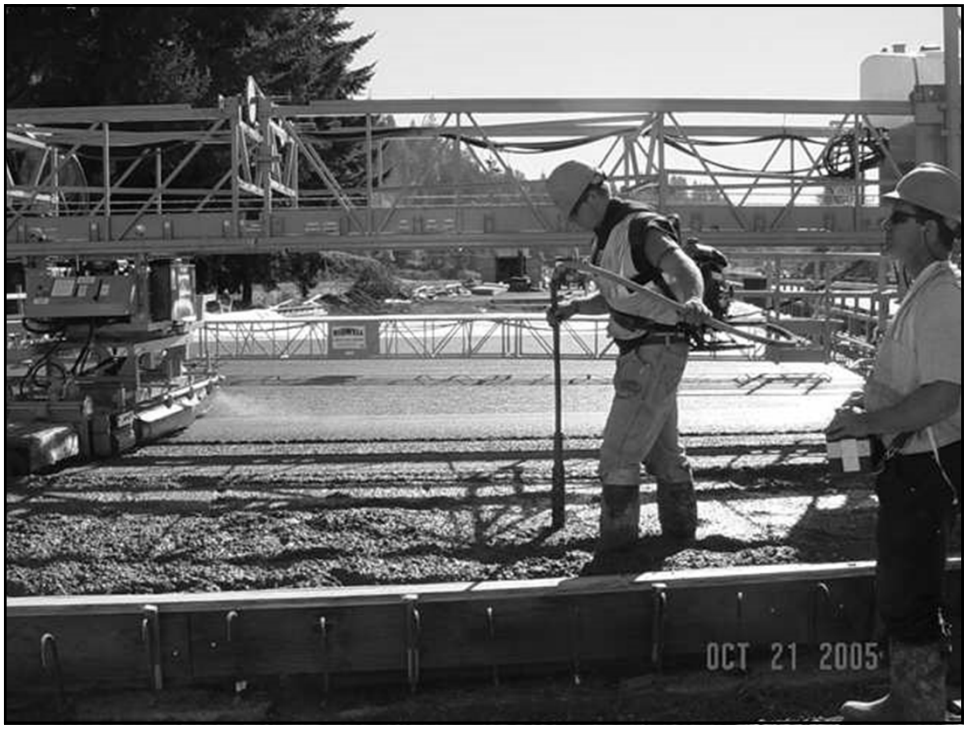
http://www.vibra-tak.com/index.html 9/30/2010

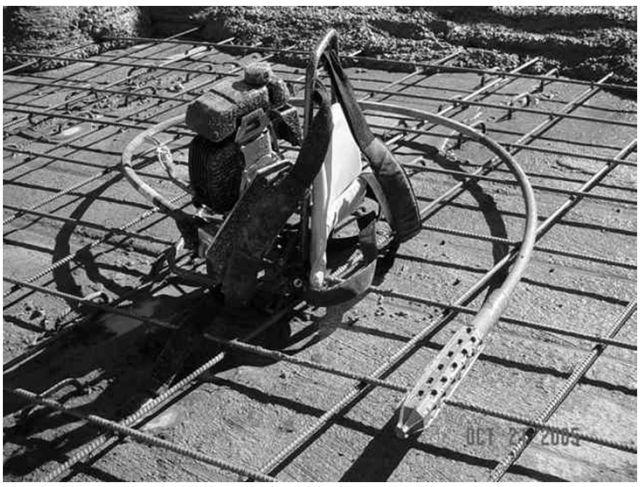
Checking Vibrator

Proper Vibrating Techniques (540.48(c))

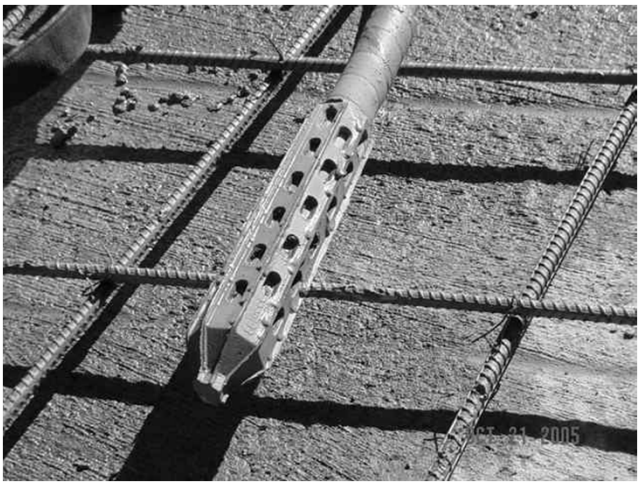
- Apply vertically at points uniformly spaced not more than 1½ times the radius of action
- Do not use vibrators to move concrete
- Lowering it into the concrete through the full depth of each layer.
- Penetrating into the previous layer on multilayer pours.
- Avoid direct contact with form faces and reinforcement.



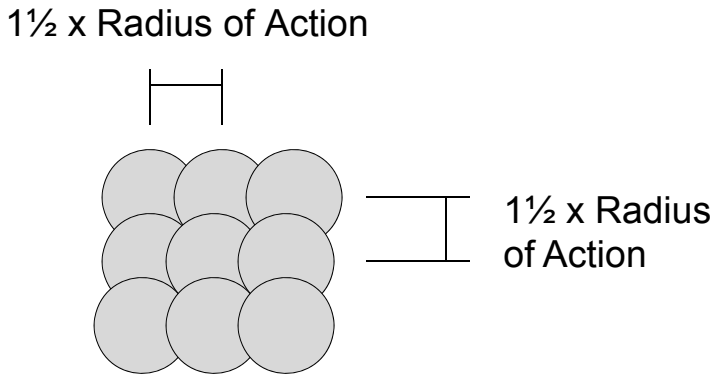
Backpack Vibrator



Rubber Sleeved for Epoxy Coated Bar (540.23)



Vibration Insertion Points



Vibration Spacing Exercise

- Draw the radius of action for 9 insertion points if the insertion spacing is 2 x the radius of action.

- What results would you expect from this type of spacing?

Poor Vibration on Column

Concrete Vibrators and Grinders

JOB PROVEN RUGGED

OZTEC

MADE WITH PRIDE IN THE USA

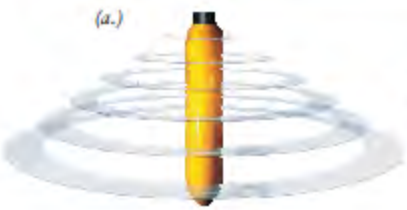
It must say "OZTEC" to be the industry's best concrete vibrator

RubberHead®

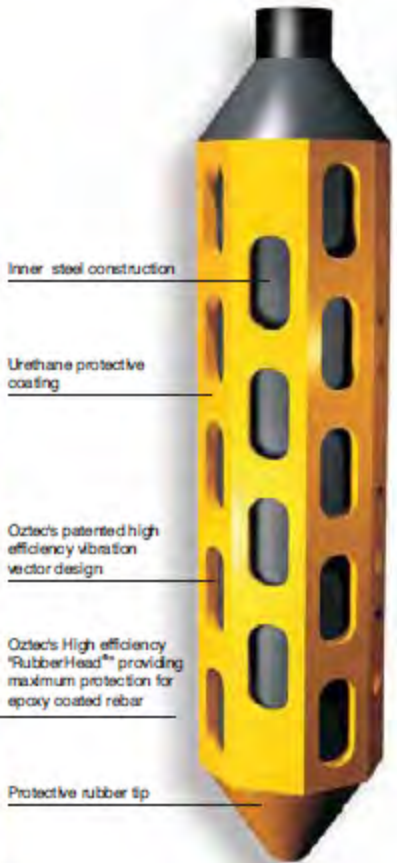
Why the Oztec's patented "RubberHead®" outperforms any other type of Vibrator.

(a.) When a smooth vibrator head (round, square or any other shape) is lowered into a relatively stiff concrete batch, the front or nose of the vibrator drills a hole. It pushes away concrete faster than it can return. Result, shock waves produced mostly from the vibrator's front end.

(b.) Oztec's patented "RubberHead®" has a large number of openings which allow wet concrete to cool the inner shell. These openings act like "suction cups", which keeps concrete in contact with the entire length of the vibrator head, sending strong shock waves into the mass.



Damage caused by a standard steel vibrator head.



Available Sizes: (dia. x length)

- 1 7/8"x14"
- 2 1/2"x14"
- 2 3/4"x14"
- 2 3/4"x6" (short, for slabs)

Prove it to yourself!

Before you purchase a high cycle system with expensive generators or controllers, call 800-533-9055 or visit our web site to arrange a demonstration on your job site.

Selection Chart

All Heads, Shafts and Power Units Are Interchangeable*

1. Select Head Size **2.** Select Shaft Length **3.** Select Power Unit (Do Not Exceed Maximum Head Size)

HEADS

Steel

	Part No.
*3/4"	HP 075 OZ
1"	H 100 OZ
1 1/4"	H 125 OZ
1 1/2"	H 150 OZ
1 3/4"	H 175 OZ
2"	H 200 OZ
2 1/2"	H 250 OZ

Short Heads

	Part No.
*3/4 x 6"	HSP 075 OZ
1 1/4 x 6"	HS 125 OZ
1 3/4x 6"	HS 175 OZ

* Pencil Head requires Pencil Shafts

High Efficiency RubberHead*

	Part No.
1 7/8"	HR 188 OZ
2 1/2"	HR 250 OZ
2 3/4"	HR 275 OZ
2 3/4x6"	HSR 275 OZ

Rubber noses
Available for all steel heads. Add "RT" to Steel Head Part No.

SHAFTS

	Part No.
2'	FS 02 OZ
5'	FS 05 OZ
7'	FS 07 OZ
10'	FS 10 OZ
12'	FS 12 OZ
14'	FS 14 OZ
16'	FS 16 OZ
18'	FS 18 OZ
21'	FS 21 OZ

Pencil Shafts

3'	FSP 03 OZ
6'	FSP 06 OZ
9'	FSP 09 OZ
11'	FSP 11 OZ
15'	FSP 15 OZ
20'	FSP 20 OZ

POWER UNITS

Electric Motors

Model	Amps	HP	Maximum Head Size Steel	Rubber
1.2 OZ	9	1 1/4	1 1/2"	None
1.8 OZ	15	1 3/4	1 3/4"	None
2.4 OZ	17	2 1/4	2"	1 7/8" 2 3/4" short
3.2 OZ	19	3 1/4	2 1/2"	2 3/4"

Gas Engines

Back Packs

BP - 35	–	1 3/4	1 1/2"	None
BP - 50a	–	2 1/2	2 1/2"	2 1/2" 2 3/4" short

Carry Handle Models (Briggs & Stratton/Honda)

GV-5	–	5/5.5	2 1/2"	2 3/4"

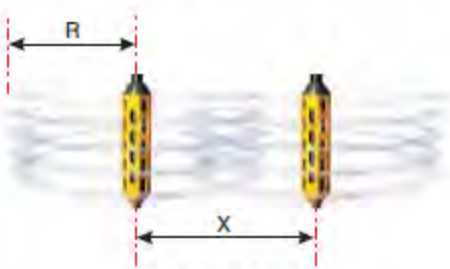
Wheelbarrow (Briggs & Stratton/Honda)

GV-5W	–	5/5.5	2 1/2"	2 3/4"

All Oztec vibrators meet or exceed ACI specification #309

Radius of Action - The most important bit of information needed for complete consolidation.
Radius of Action is the distance from the center of the vibrator to the outer edge, where complete consolidation takes place (see diagram). For quality concrete Oztec lists conservative values for "Radius of Action". Complete consolidation is necessary for low slump concrete with close meshed reinforcement bars, high strength concrete and architectural concrete. Radius of Action can be twice the listed values when slump is high or super plastisizers are used. It is important these values are used only as a general guide. Specifications are subject to change.

Head Diameter	Radius of Action (R - inches)	X = 1 1/2 Times Radius of Action	Amplitude Centerline to Side (inches)	Centrifugal Force (pounds)	Compaction Rate (cu. yds. / hour)
		Steel Heads			
3/4"	3	5	0.03	155	1-3
1"	4	6	0.04	220	2-4
1 1/4"	5	8	0.04	510	2-5
1 1/2"	6	9	0.05	920	5-8
1 3/4"	9	14	0.08	1200	8-16
2"	11	17	0.075	1500	12-20
2 1/2"	13	20	0.08	1850	23-30
		Rubber Heads			
1 1/2"	9	13.5	0.075	1050	9-13
1 7/8"	11	16	0.09	1400	10-18
2 1/2"	14	20	0.12	1900	14-22
2 3/4"	18	27	0.12	2100	25-35
2 3/4" short	15	22	0.12	1100	9-15



R - Radius of Action
X - Insertion Spacing

Tips & Suggestions

"The benefits of even the finest concrete vibrator are lost if the proper operating technique is not followed".

Proper vibrating techniques will:

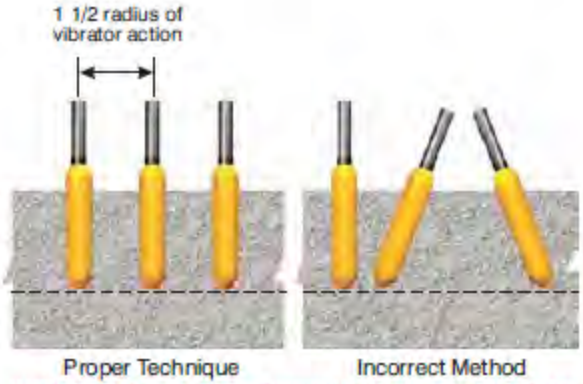
- Produce concrete with the maximum strength and qualities designed in the mix.
- Bond rebar to maximize strength.
- Slow penetration of rust causing liquids by increasing density.
- Eliminate rock pockets and lift lines.
- Minimize patchwork, improving surface appearance by removing trapped air.

Proper consolidation techniques will not:

- Cause segregation in well designed concrete.
- Eliminate a significant amount of entrained air.
- Normally damage the lower layers, as long as the concrete in these lower layers becomes plastic under the vibrating action.

For Quality Concrete, Oztec Suggests:

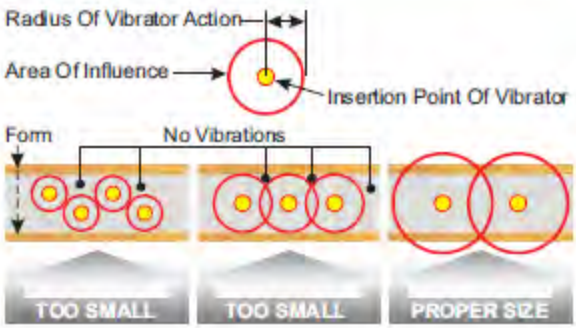
1. Select the largest vibrator suitable for the job.
2. Insert the vibrator vertically, allowing it to sink to the desired depth by its own weight. Forcing it may lock it between rebars.
3. Hold the vibrator 5 to 15 seconds then slowly lift vibrator up, staying behind the trapped air's upward movement. Allow about 15 seconds for each 2 foot distance to avoid re-trapping air.
4. A slight up and down movement will close the hole formed by the vibrator.
5. Withdraw the vibrator quickly when near the top to prevent churning air into the top layer.
6. Move vibrator and re-insert at a distance 1 ½ times the Radius of Action...As shown in the diagrams.
7. Allow vibrator to pass 3 to 6 inches into the preceding layer to ensure knitting the two layers together, ensuring a good bond and preventing "lift lines" when forms are removed.
8. Try to limit pours to 2 to 3 feet high, so air has less resistance to escape.
9. Do Not use vibrator to move concrete laterally...it causes segregation (use a shovel). Place vibrator in the center of mounds to knock them down.



IMPORTANT: Trapped air moves upward in the mix from 1 to 3 inches per second. (1 inch in near 0 slump; 3 inches in 4 to 5 inch slump).

Consolidation eliminates pockets of aggregate and air bubbles maximizing strength, eliminating surface voids, bringing sufficient fine material to the surface and against the forms to produce the desired finish. Vibrators consolidate concrete by sending out shock waves which allows aggregate to "float" freely while pushing lighter trapped air up and out of the mix. Vibrators allow pouring stiff mixtures which are stronger, more economical and result in less segregation, less bleeding and less shrinkage cracks.

You know that you have consolidated concrete properly when a thin line of mortar appears along the form near the vibrator or the coarse aggregate disappears into the concrete.



Extension Cord Wire Size Per UL Specifications

Too light an extension cord can cause poor performance and motor burn out.

Motor model#	Amps @120v	50ft	100ft	150ft	200ft	300ft
1.2	9	14	14	12	10	8
1.8	15	14	12	10	8	8
2.4	17	14	12	8	8	8
3.2	19	12	12	8	8	6

One page is not sufficient to describe the full scope of vibrating concrete. A fine source for more complete information are publications from ACI.

Placement Methods

- Concrete pump
- Crane & bucket method
- Conveyor belt
- Mix truck & chute

Concrete Pump Hopper

Concrete Pump

Concrete Pump Hose

00540.22 (a)

1″ Aggregate
Use 4″ Hose

1 1/2″ Aggregate
Use 5″ Hose

Crane & Bucket

Mix Truck & Chute

Weather & Temperature Limits

Cold Weather Placement

Cold Weather Placement 540.49 (2)

- If air temperature is, or forecast to be, below 40°F the day of placement or the next 7 days (14 days for decks), an approved plan is required.
- Keep foundation, form surfaces and reinforcing steel free of frost and ice.
- Temperature of the mix to be at least 60°F when placed in the forms.

Cold Weather Placement Cont'd

If air temperature is below 40˚F either:

- Heat mixing water to a temperature of at least 70˚F but not more than 150˚F, or
- Heat the aggregates with either steam or dry heat.
- The temperature of concrete with heated aggregate, heated water or both shall not exceed 80˚F before placing.

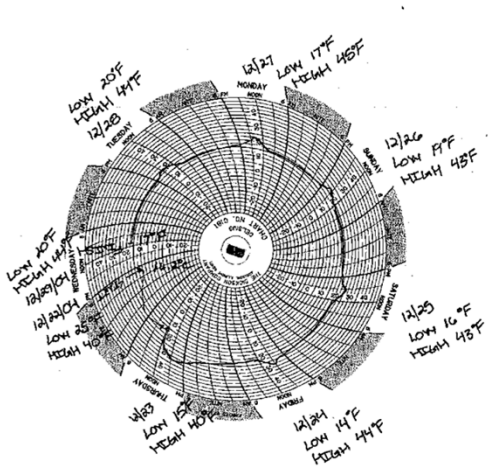
Enclosures

If enclosures are used, do the following:

- Record air temperature with a 24-hour recording thermometer.
- Supply heat with a means of maintaining curing moisture.
- Maintain the air temperature in the enclosure between 60°F and 80°F for a period of 7 days (14 days for decks) after placing concrete.

24-Hour Recording Thermometer

24-Hour Temperature Recording



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Insulated Forms
540.49 (2)(c)

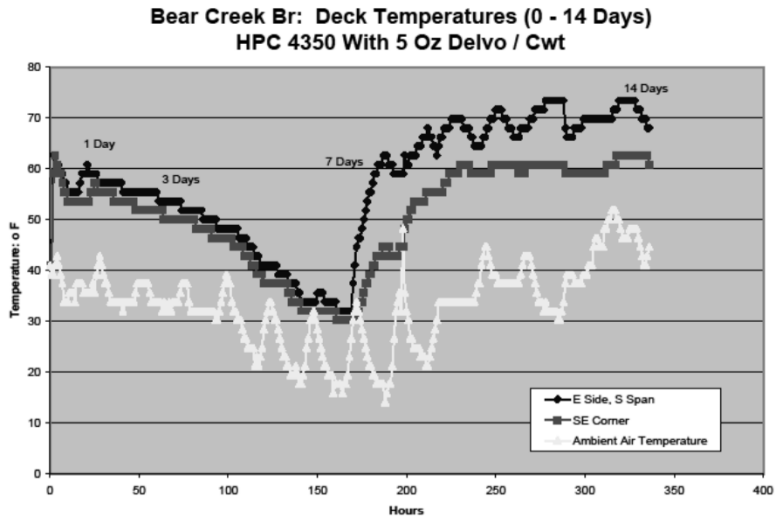
Insulated forms capable of maintaining the surface of the concrete temperature At Least:

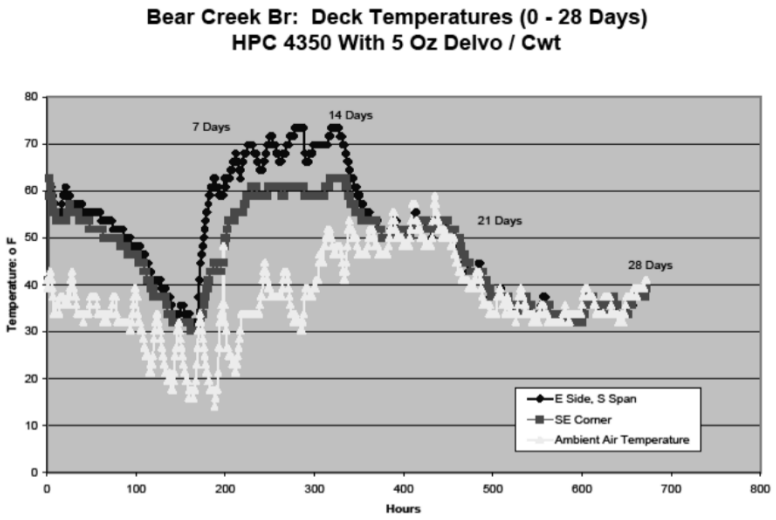
50°F for a period of seven days
(14 days for decks)

May be used instead of enclosures and heating.

Heating Under Bridge

Bear Creek Deck Temperatures





Heating In Overhang Area

Hot Weather Placement

Hot Weather Placement

- When concrete temperature approaches 80°F take appropriate action to lower the concrete temperature.
  - Add ice in place of water
  - Night placements
- Do not place concrete on or in forms if surface temperature of the forms or reinforcing steel is 90°F or above.

Deck Placement
540.49(b)

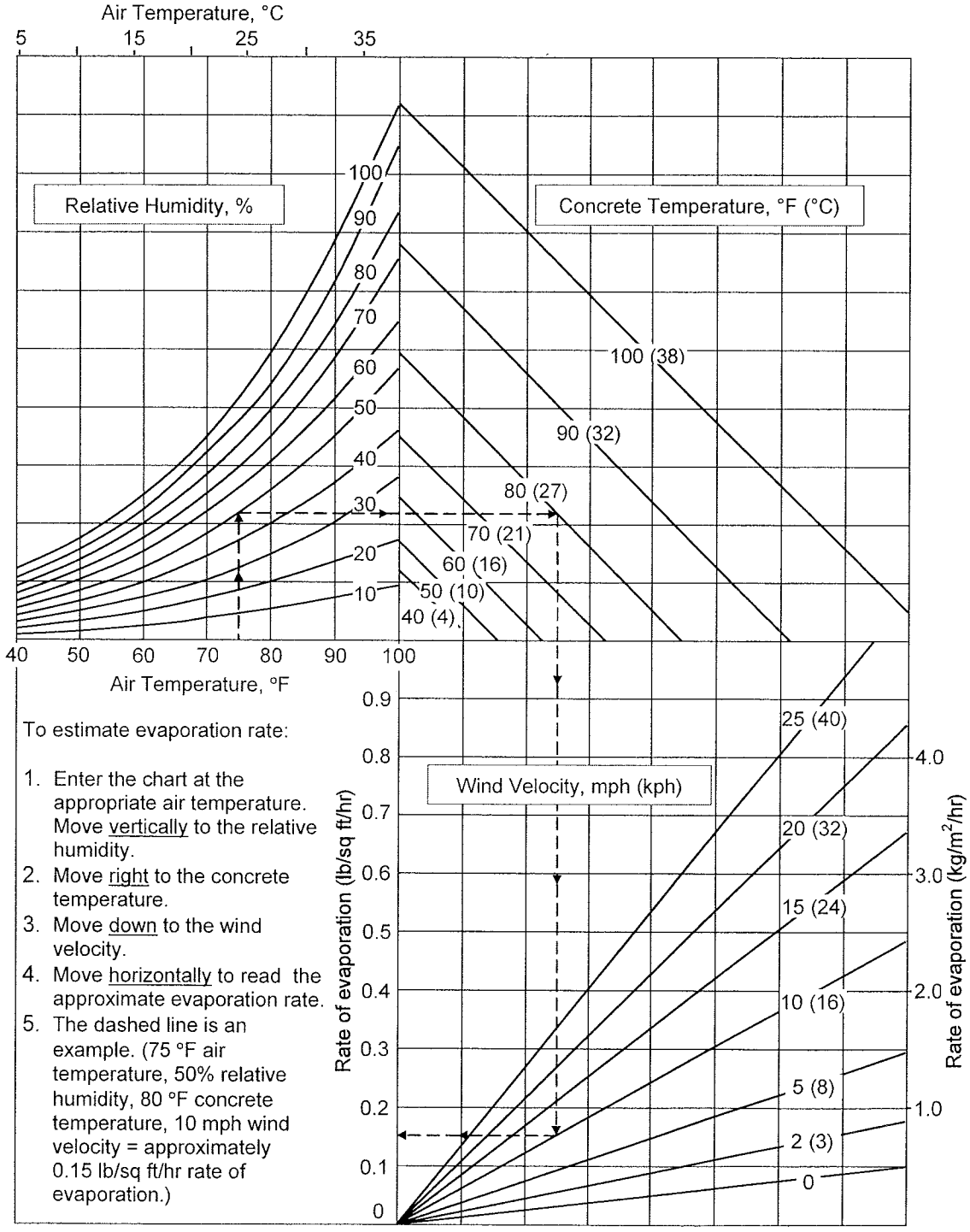
- Only if precipitation is not forecast between 2 hours before and 2 hours after the scheduled placement duration.
- An acceptable forecast will have less than 30% chance of precipitation for the entire placement window.

Deck Placement
540.49(b) – Cont'd

- Provide a forecast to the Engineer 1 hour before placement.
- Evaporation rate less than 0.10 pounds per square foot of surface area per hour.

00540.49(b)

FIGURE 00540-1 SURFACE EVAPORATION FROM CONCRETE [1]



[1] Based on ACI 305 R, "Hot Weathering Concreting"

Kestrel Meters

Surface Evaporation Rate Exercise

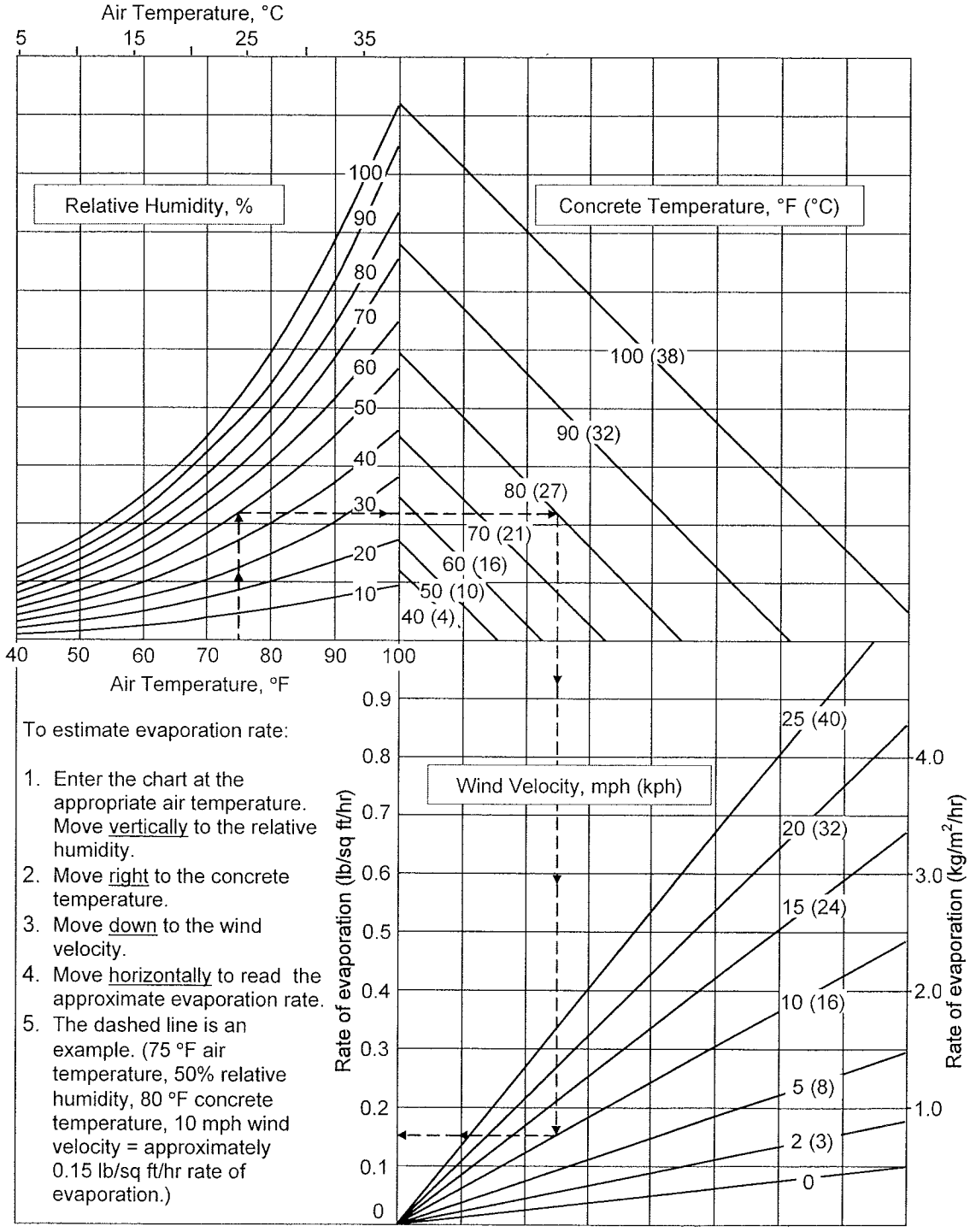
- Air Temperature is 55°F
- Humidity is 20%
- Mix Temperature is 75°F
- Wind Speed is 5mph

The surface evaporation rate is _____.

Do you allow a deck pour to start with these conditions? _____.

00540.49(b)

FIGURE 00540-1 SURFACE EVAPORATION FROM CONCRETE [1]



[1] Based on ACI 305 R, "Hot Weathering Concreting"

Preparations for Concrete

Before concrete is ordered:

- Verify that an approved mix design is on file with the Material Section.
- Verify that the contractor has adequate resources for the pour:
  - A steady supply of Concrete
  - Adequate Labor and Equipment
  - Back-up Equipment at the jobsite

Delivery of the Concrete

Check delivery tickets for:

- Proper Project
- Concrete Class Per Plans and Mix Design
- Batch Time
  - Concrete Must Be in FINAL POSITION within 90 Minutes of Initial Batch Time.

(00540.48(a))

Delivery of the Concrete – Cont'd

- Sample, Test, and Check Temperature as required.
- If out of spec, test each truck until 2 consecutive loads meet specs. (00540.16)
- Wet down forms and foundation just before placement but no standing water.

Sampling & Testing

Slump

Air

Concrete Temperature

Cylinders

Placing Concrete (00540.48(a))

- Place concrete as close as possible to final position.
- Use appropriate chutes, drop buckets, pumps, conduits, etc.

  Do not drop concrete more than 5 feet.
  (exception is drilled shafts with dry hole)

- Place concrete in layers not to exceed 18 inches in depth.

4′ lifts during pour in abutment wall?

Placing Concrete – Cont'd

- Rate of delivery should be continuous without interruptions of more than 20 minutes. (00540.47)
- Deck placement to proceed at 20 ft/hr minimum. (00540.48(g))
- Proceed up grade from the lowest deck elevation. (00540.48(g))

Concrete Consolidating

See Section 3, Quality Concrete,
For Proper Vibration Methods.

Joints

Joints

- Construction
- Expansion
- Contraction

Construction Joint

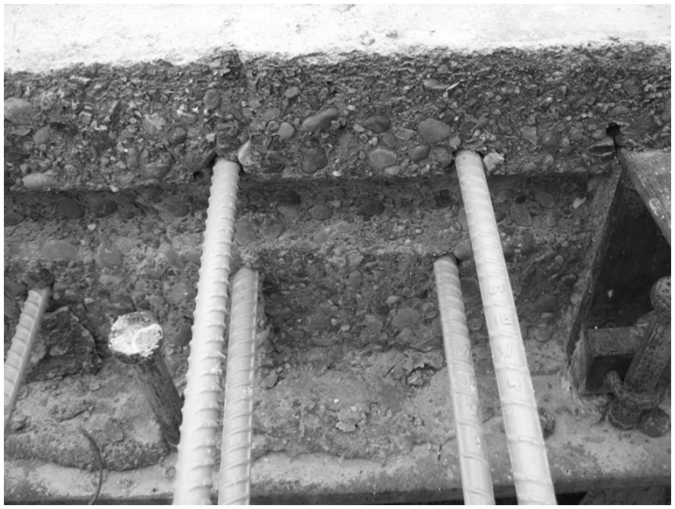
Used as a break between concrete pours

Construction Joint in Abutment with Chamfers?

Construction Joints

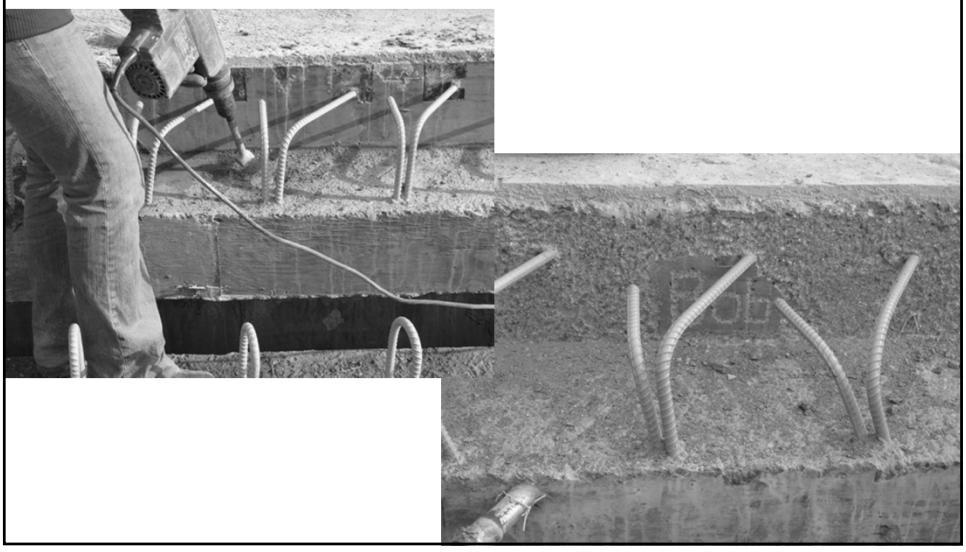
- Only at Planned/Approved locations.
- “Roughened-surface” only or “shear-key” with roughened surface per plans.
- At least 50 % laitance removal
- Pre-wet for next pour.

Deck Cold Joint With Keyway & Using Concrete Surface Retarder



Roughened Surface On Stemwall Using Surface Retarder

Roughened Surface On Deck Joint With Bush Hammer



Roughened Surface On Deck Joint With Scabbler

Expansion Joints

Expansion Joints

Allows movement between adjoining parts of a structure where expansion and contraction will occur.

Expansion joints use compressible material or open space to allow the structure to expand or contract without breaking the concrete.

Expansion Joint

Expansion Joint

Expansion Joints?

Expansion Joints

See Section 14, Deck Construction,
for Deck Expansion Joints

Contraction Joints

Contraction Joint

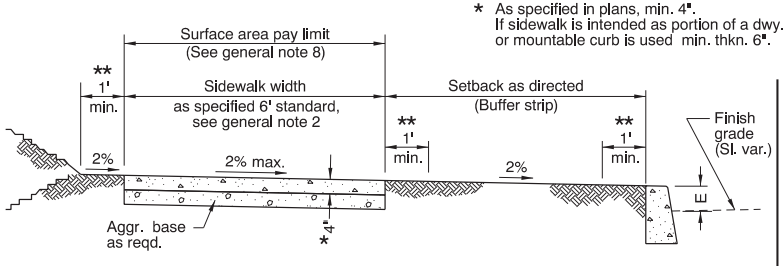
A formed or tooled groove in the concrete surface that creates a weakened plane to control where cracking will occur.

Contraction Joints

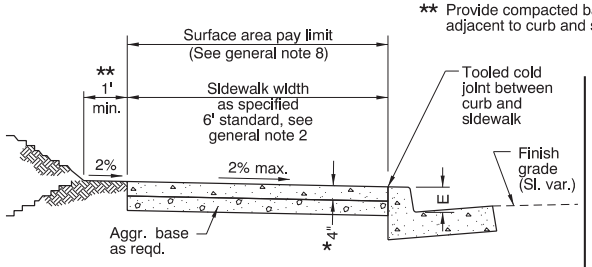
5′ max

Spacing

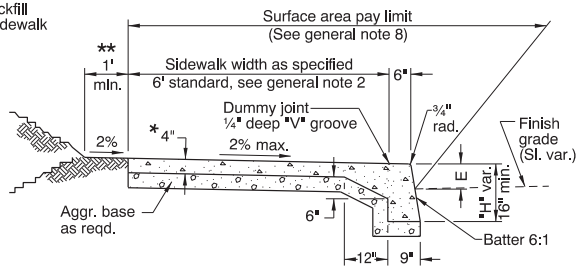
RD720



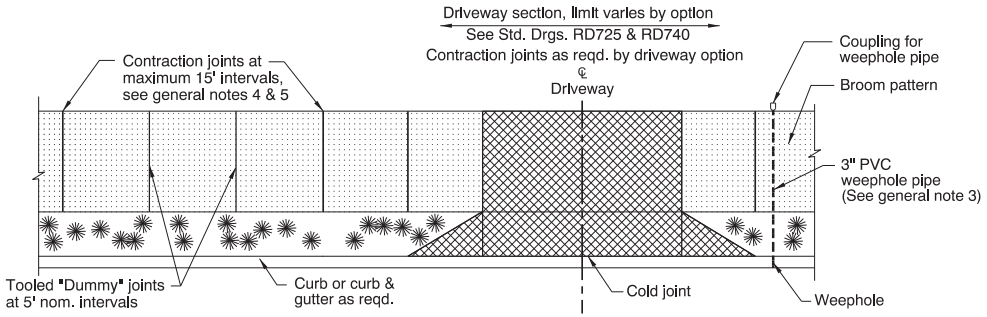
TYPICAL SETBACK SIDEWALK CROSS SECTION
E = curb exposure, see general note 6



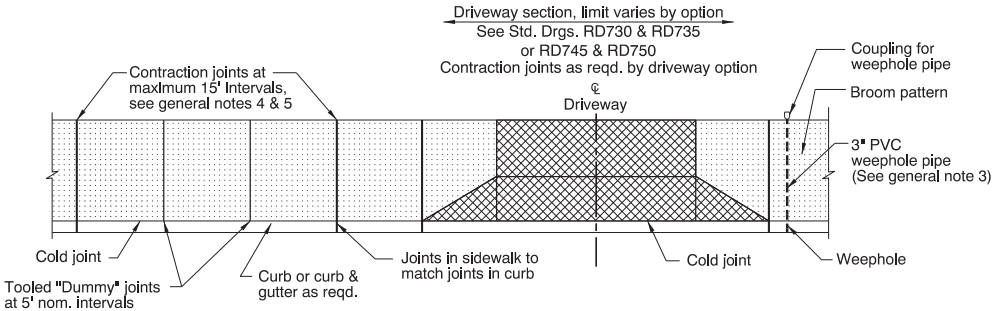
TYPICAL CURB SIDEWALK CROSS SECTION
E = curb exposure, see general note 6



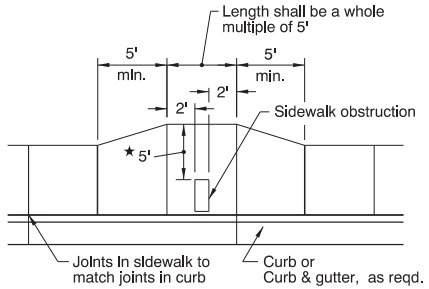
TYPICAL MONOLITHIC CURB & SIDEWALK
E = curb exposure, see general note 6



TYPICAL PLAN VIEW - SEPARATED SIDEWALK

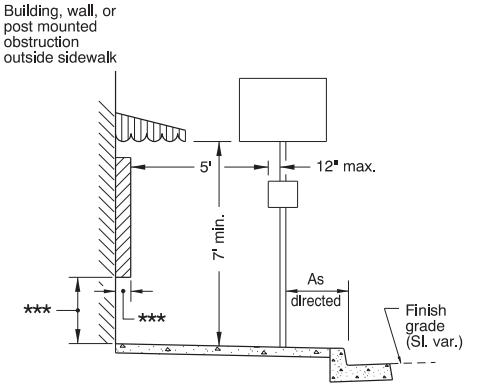


TYPICAL PLAN VIEW - CURB LINE SIDEWALK



* When site constraints prohibit a 5' passage, the Engineer may direct this to be reduced, but no less than 4'.

REQUIRED SIDEWALK WIDENING AROUND OBSTRUCTIONS



*** Objects with base below 2'-4" may protrude any distance as long as the 5' circulation path is maintained. When an object with a base higher than 2'-4" protrudes further than 4" provide a curb below protrusion to delineate edge.

CLEAR CIRCULATION PATH

General conflguratlon of drlveway pay limit (See general note 8), varies by option.

GENERAL NOTES FOR ALL DETAILS:

1. Include additional paved or unpaved 2' clearance to vertical faces higher than 5' such as retaining walls, sound walls, fences and buildings.
2. Curb type and sidewalk width as shown on plans or as directed. On sldewalks 8' and wlder, provlde a longltudlnal jolnt at the mldpolnt.
3. Install 3" pvc weephole pipes in sidewalks where shown on plans, and allowed by jurisdiction. Place contraction joint over top of pipe.
4. Const. expansion joints at 200' maximum spacing, and at points of tangency, and at ends of each driveway. For monolithic curb & sidewalk, const. expansion joints at 45' maximum spacing.
5. Const. contraction joints at 15' maximum spacing, and at ends of each driveway and ramp.
6. For curb details, see Std. Drgs. RD700 & RD701.
7. Sidewalk details are based on United States Access Board Standards.
8. For driveway details not shown, see Std. Drgs. RD725, RD730, RD735, RD740, RD745 & RD750.

The selection and use of this Standard Drawing, while designed in accordance with generally accepted engineering principles and practices, is the sole responsibility of the user and should not be used without consulting a Registered Professional Engineer.

CALC. BOOK NO. N/A

BASELINE REPORT DATE 23-JUL-2012

NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications

OREGON STANDARD DRAWINGS

SIDEWALKS

2008

DATE	REVISION DESCRIPTION
06-2009	REVISED DETAILS & NOTES
12-2009	REVISED DETAILS, DETAIL TITLES & NOTES
07-2012	REVISED DETAILS, REVISED & ADDED NOTES

rd720.dgn 23-JUL-2012

RD720

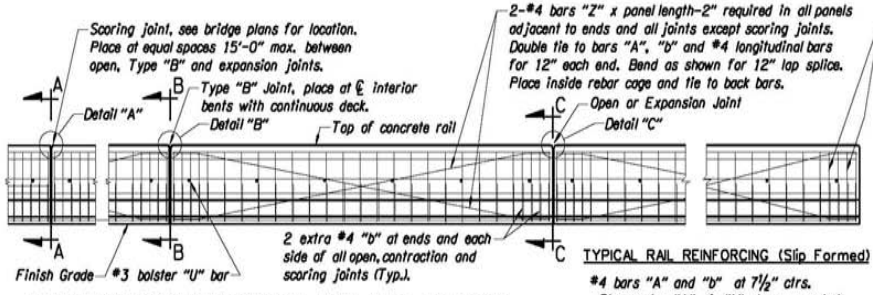
Effective Date: December 1, 2013 - May 31, 2014

Contraction Joints

15′ max Spacing 00759.49

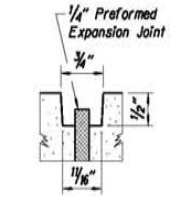
Contraction Joints

15′ max Spacing (BR200)



ELEVATION~CONCRETE BRIDGE RAIL (Slip Formed)

ELEVATION~CONCRETE BRIDGE RAIL (Fixed Forms)

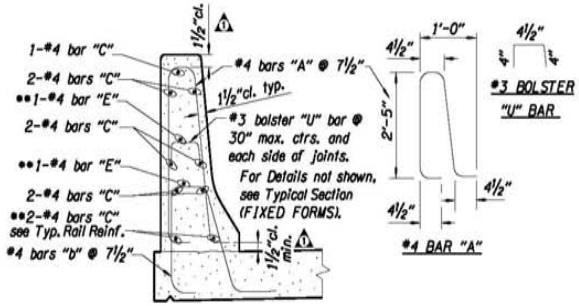


TYPE 'B' JOINT SCORING DETAIL

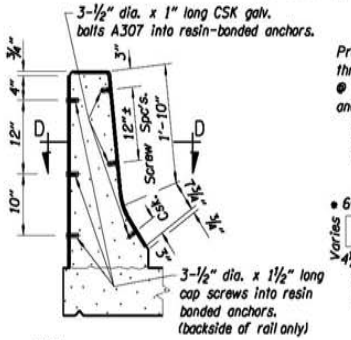
TYPICAL RAIL REINFORCING (Slip Formed)

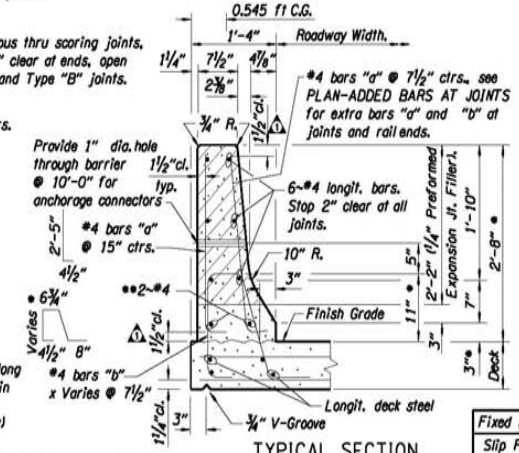
#4 bars "A" and "b" at 7½" ctrs.
Place extra "A" & "b" bars as noted.
7-#4 bars "C", stop 2" clear at ends and all joints.
••2-#4 bars "C" (bottom 2 bars)
••2~#4 Bar "E"
See Elevation for "Z" bars.

① ••continuous thru scoring joints, stop 2" clear at ends, open joints and Type "B" joints.

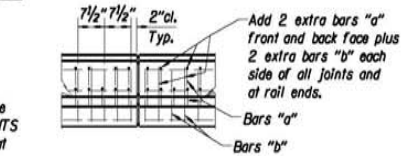


TYPICAL SECTION (Slip Formed)





TYPICAL SECTION (FIXED FORMS)



PLAN~ADDED BARS AT JOINTS

NOTE:
• Top of parapet shall be 2'-8" above finish grade. Increase dimensions marked thus (•) by depth of A.C.W.S.

ESTIMATED QUANTITIES

		2'-8" Ht.	1" added Ht.
	Concrete	2.23 ft.³/ft.	0.11 ft.³/ft.
Fixed Forms	Bars "a" & longit.	10.81 #/ft.	——
Slip Forms	Bars "A, C & E"	14.83 #/ft.	——
	Rail Weight	335 #/ft.	15 #/ft.

Bar weight assume joints at 15'-0" ctrs.

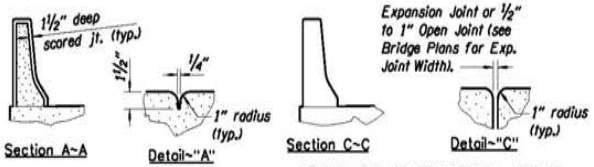
NOTE:
Details shown are general details only and should be modified as needed to fit specific project requirements.

EXPANSION JOINT COVER PLATE
(When Required by Bridge Plans)

② NOTE:
See BR203 for rail on end panel.

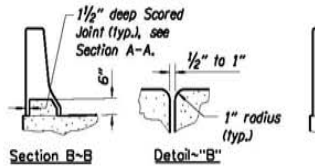
Design Capacities
Rw= 59.5 kips
Lc= 4.123 ft.
Mc= 13.2 K-ft./ft.
Center of gravity = 0.545 ft.

GENERAL NOTES:
Provide reinforcing steel conforming to ASTM A706 or AASHTO M31 (ASTM A615) Grade 60.
Provide concrete Class 3300 - 1½" or ¾"
Provide steel cover plates conforming to AASHTO M183. (ASTM A36). Hot dip galvanize after fabrication.
At skewed bents make joints parallel to the center line of the bent unless shown otherwise on the detail plans.

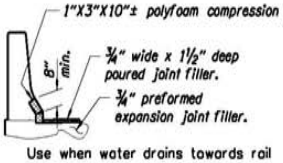


SCORING JOINT DETAILS
SLIP-FORMED OR FIXED FORMS

OPEN OR EXPANSION JOINT DETAILS

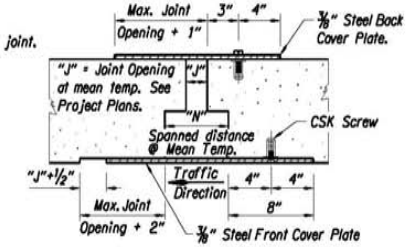


TYPE "B" JOINT DETAILS
(SLIP-FORMED)



Use when water drains towards rail and no deck joint seal is used.

DETAIL "D"



SECTION D-D

CALC. BOOK NO.

BASELINE REPORT DATE 01-JUL-2009

NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications

The selection and use of this Standard Drawing, while designed in accordance with generally accepted engineering principles and practices, is the sole responsibility of the user and should not be used without consulting a Registered Professional Engineer.

OREGON STANDARD DRAWINGS

CONCRETE
BRIDGE RAIL
TYPE "F"

2008

	DATE	REVISION DESCRIPTION
①	07-09	Added 1¼" cl. and •• note
②	07-10	Added note

br200.dgn 05-10

BR200

Effective Date: December 1, 2012 - May 31, 2013

1:24 - BR200

Curing Concrete

Concrete must be properly cured to obtain the design strength and to minimize shrinkage cracks.

Curing Concrete 540.51

- With water
- 7 days or as specified (14 days for decks)
- As soon after placement as possible without causing damage
- On decks cover with initial covering immediately after finishing and within 20ft and 20 minutes of deck machine

Cure?

Cure?

Concrete Is Dry

Abutment Not Well Covered

Dry Concrete

Abutment Has Plastic, But No Burlap and Dry Concrete

Curing Concrete Cont'd
540.51

- Do not interrupt the cure for more than 1 hour during the 7-day cure (14 day for decks).
- Add additional cure time if temperature drops below 45°F 540.51 (c).

Deck Curing
540.49 (b)

- Provide wind breaks, fog nozzles or any other approved method to prevent premature drying.

  Premature drying is defined as evaporation of 0.10 pounds or more per square foot per hour, as determined from Figure 00540-1.

- Cover with single layer of clean initial covering immediately after finishing concrete.

Deck Curing Cont'd

- Cover with:
  - Material of sufficient length to reach from side to side unless approved lengthwise.
  - Wet burlap having dry mass of 10 oz. per yard for 40″ wide (presoak with wetting agent before using).
  - Dry polypropylene material. Fog material immediately after placing to dampen without causing running water.

Deck Curing Cont'd

- Cover within one hour with polyethylene film
  - 4 mil thickness
  - Clear or white when the air temperature is expected to go above 65°F, black at other times. Once a type of film has been selected do not change it during the cure period. 540.51(b)

Deck Curing Cont'd

- Soak the deck to keep it saturated at all times during the curing period.

Oregon Department of Transportation

Post Pour Checklist

Project Information

Project Name (Section) | Contract No.

Highway | Federal Aid No.

Contractor or Subcontractor

Placement Description:

Cure Materials 540.51	Placed Yes	Placed No	Placed N/A	Date/Time Placed	Remarks
Burlap	☐	☐	☐		
Polypropylene	☐	☐	☐		
Polyethylene (plastic)	☐	☐	☐		
Continuous water for decks	☐	☐	☐		
Soaker hoses at 10 feet on decks	☐	☐	☐		

Water Source:

Joint Preparation 540.43(a) When

How	

Cold Weather Protection 540.29(a) Plan Approved: ☐ Yes ☐ No Date Approved:

Description	
Temp. Monitoring	

CURE DURATION	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
Wet Cure	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Protection	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forms Removed	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

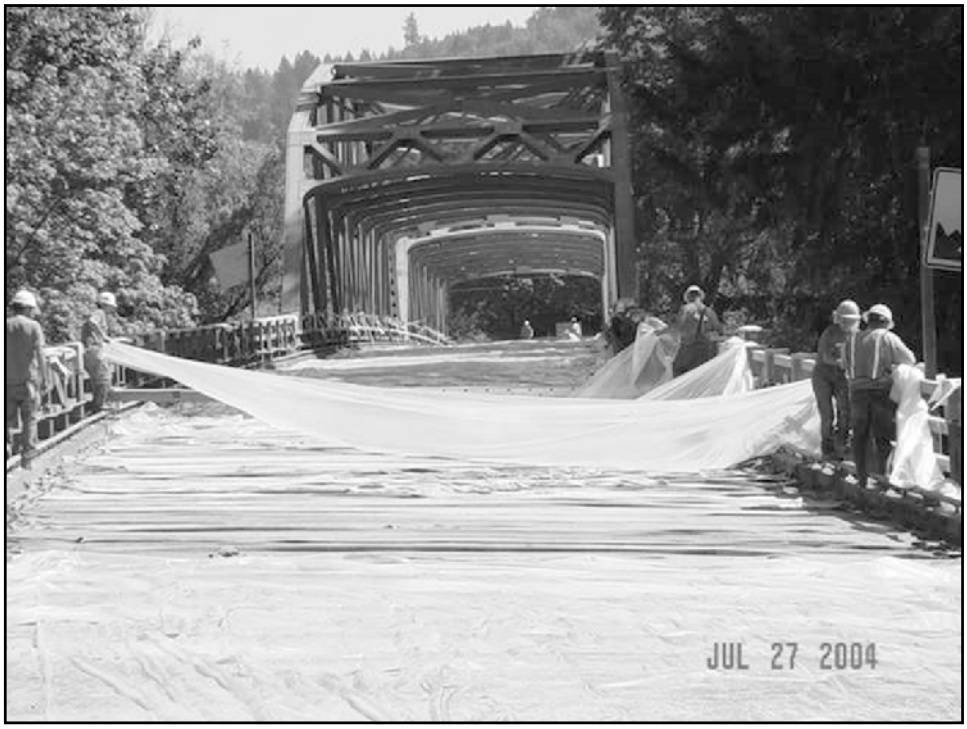
WEATHER	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
High Temp														
Low Temp														
Sky Conditions														

Curing Compound on Non-Structural Items (only if approved)

Area (yd^2) | Amount Applied (gallons) | Rate | gallon/yd^2

Remarks

Prepared by | Work Date


JUL 27 2004

JUL 27 2004

DEC 21 2004

DEC 21 2004

DEC 21 2004

DEC 21 200

C 21 2004

DEC 2 2004

DEC 2 2004

DEC 2 2004

DEC 2 2004

Cure in Rail Area?

80°, color of plastic? Cure at rails?

Marks from cure boards

Shrinkage Cracks, Cure Was Blown Off

Surface Finishing

Surface Finishing

Concrete surfaces are finished to:

- Seal the surface from water and other elements that can rust or corrode metal ties and reinforcement within the concrete.
- Provide a uniform, pleasing appearance for surfaces that will remain visible to the public.

Classes of Surface Finishes 540.53

- General Surface Finish
- Class 1 Surface Finish (Ground & Coated)
- Class 2 Surface Finish (Ground, Floated & Coated)

General Surface Finish

- Remove exposed metal to a depth of 1”, 2” on structures within 25 miles of Pacific Ocean.
- Remove rock pockets and unsound concrete.
- Repair all air pockets over 1/4 inch in depth and all form tie removals, rock pockets, and unsound concrete and fill with an approved patching material.

General Surface Finish Cont’d

- Repair all bulges, fins, depressions, stains, or discoloration, on exposed surfaces, to produce a smooth, uniform surface with smooth uniform lines and appearance.
- The Engineer will determine the extent of the required repairs.

General Surface Finish on Wingwalls

Class 1 Surface Finish (Ground and Painted)

- Complete the general surface finish.
- Grind the surface to remove all laitance and surface film.
- Saturate the surface with water and paint, while damp with a latex emulsion paint. A minimum of two coats of latex emulsion paint shall be applied.

Class 1 Surface Finish Cont'd (Ground and Painted)

- The second coat may be applied any time after the previous coat, when touched lightly, does not adhere to the finger.
- Additional coats may be required to provide uniformity in coverage and color.
- Sand may be added to the latex emulsion paint to help achieve a uniform surface.

Class 1 Finish on Pier

Class 2 Surface Finish (Ground, Floated & Painted)

- Complete the general surface finish.
- Grind the surface to remove all laitance and surface film.
- Float the surface with a rubber or sponge float, using a paste of fine sand, cement, water and bonding agent to fill all air holes or voids, and to bring the surface to a uniform texture.

Class 2 Surface Finish Cont'd (Ground, Floated & Painted)

- Keep the retextured surface damp a min. of 12 hours or until the paste has set, whichever is longer.
- If dusting occurs after the retextured surface sets and is rubbed, then it should be refinished.
- After the paste has set for a minimum of 24 hours, the surface shall be saturated with water and painted the same as the Class 1 Surface Finish.

Class 2 Finish