Manufacturing Methods
Reinforced Concrete Pipe and Boxes

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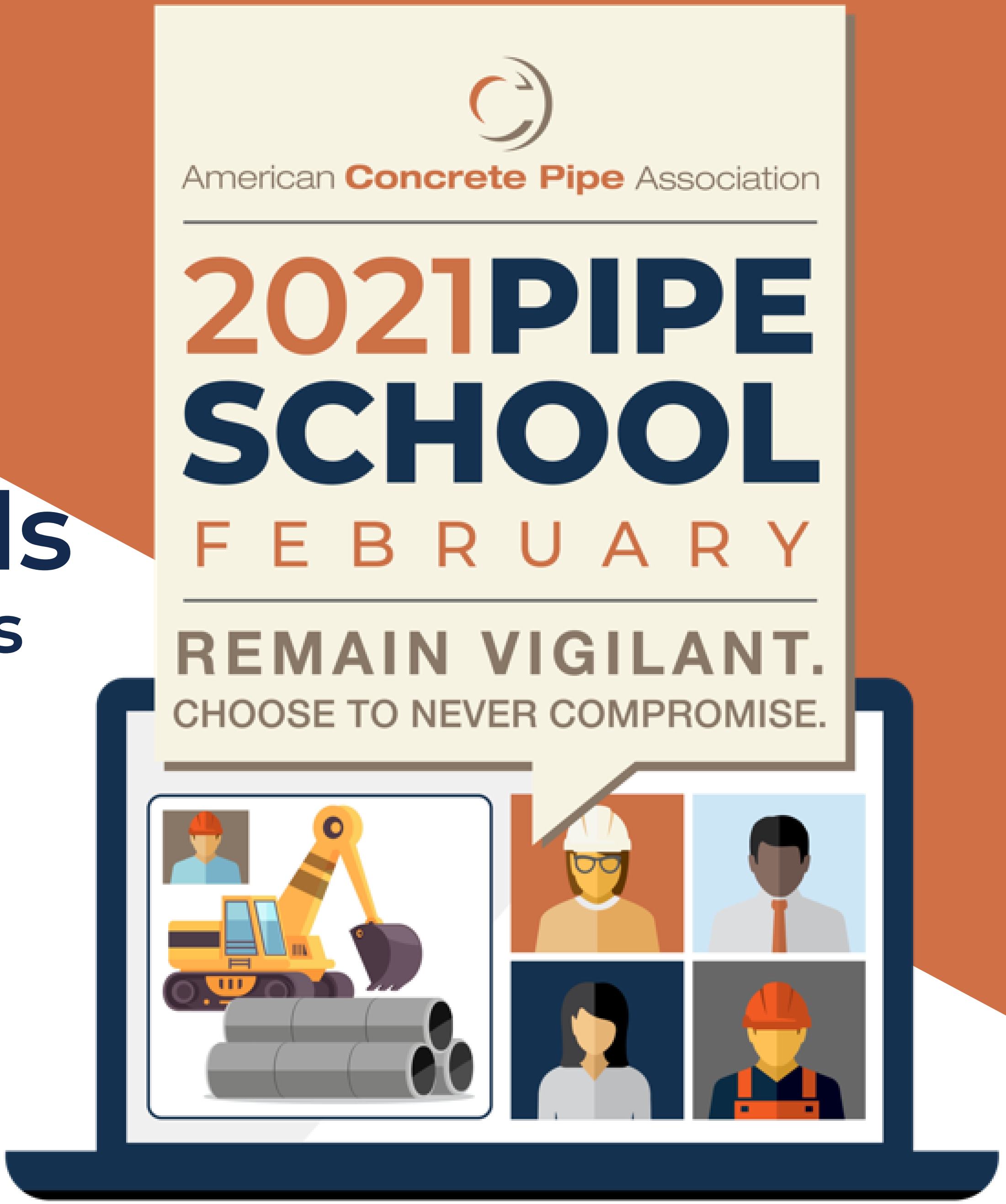


PIPE SCHOOL

Today’s Agenda

Mix Designs
Batching
Box Culvert Reinforcing Cages
Box Culvert Production Method
Pipe Reinforcing Cages
Pipe Production Methods
Curing

PIPE SCHOOL

Learning Outcomes

1. Describe the ingredients in any concrete mix design.
2. Explain the importance of the water to cement ratio.
3. Describe the key components of a batching system.
4. Explain how to calculate the area of steel for a given pipe design.
5. Explain the key differences between wet cast and dry cast manufacturing.
6. Describe the concept of packerhead pipe manufacturing.
7. Describe the two key factors of accelerated concrete curing.

Mix Designs

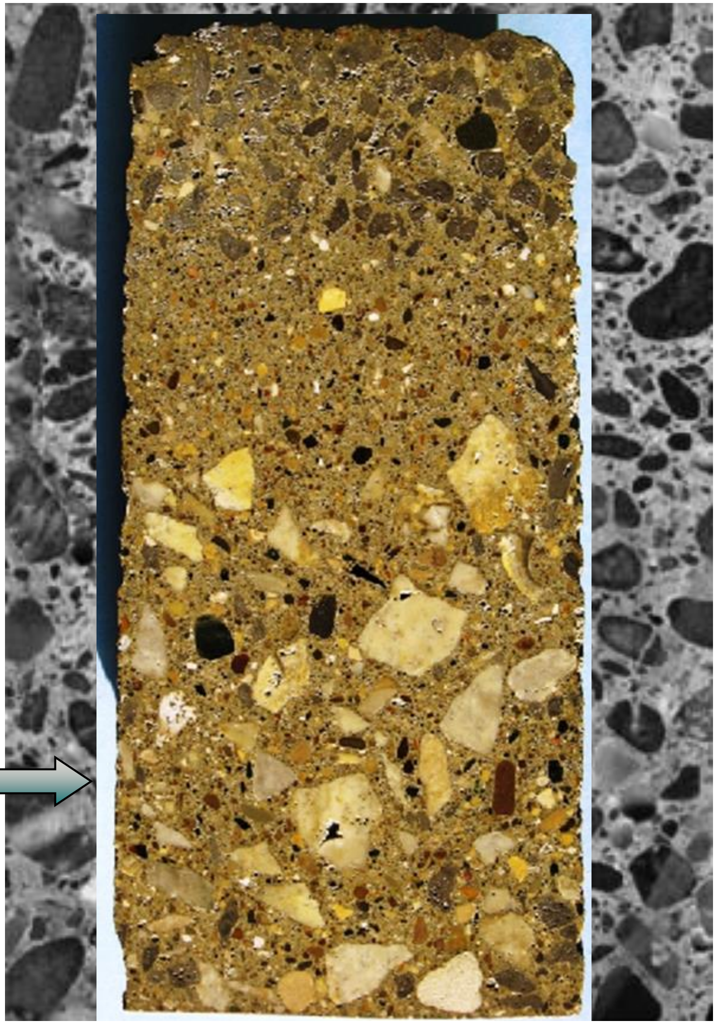
Mix Designs

What is Hydraulic Cement Concrete?

A homogeneous mixture of aggregates held together by a hardened hydraulic cement paste

While concrete looks simple, it is really a highly complex material

What can be said about this sample of concrete?



PIPE SCHOOL

Mix Designs

Hydraulic Cement Concrete – Two Primary Components

Cement Paste

Portland Cement

Water

Admixtures

Aggregates

Coarse & Fine Aggregates

Water needs to be drinkable or meet ASTM 1602

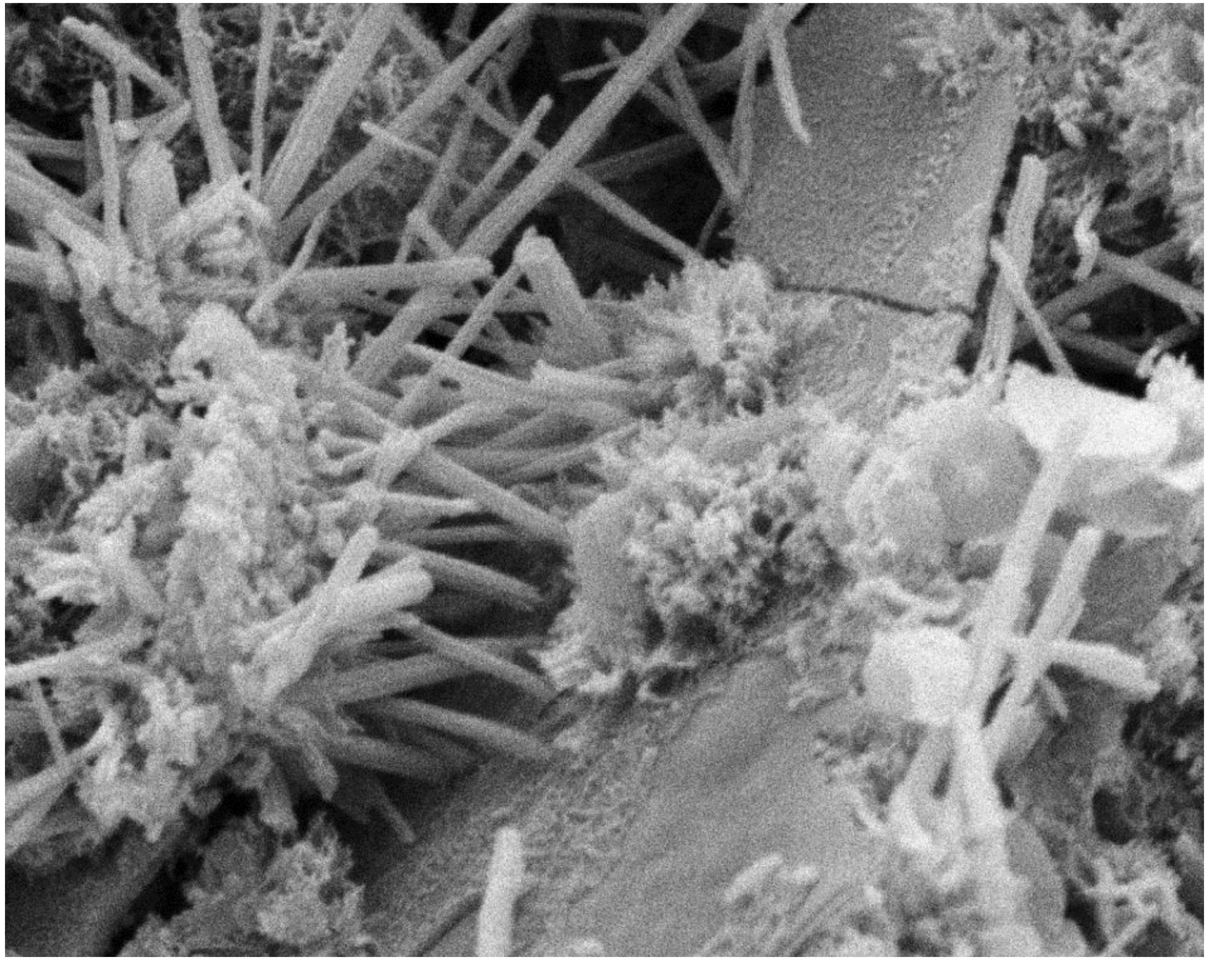
Mix Designs

Cement Hydration

Hydration is a chemical reaction between cement and water.

Hydration produces three things:

- <u>**Calcium Silicate Hydrate**</u> (CSH) gel that hold aggregates in place and gives concrete its strength (glue)
- <u>**Heat**</u>
- <u>**Calcium Hydroxide**</u> that fills the remaining voids, does not contribute much to strength



Mix Designs

Water / Cement Ratio

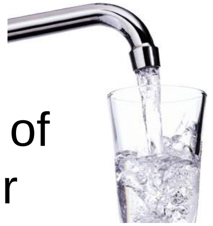
It's a calculation:

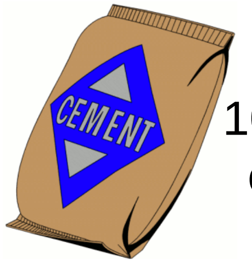
w/c ~ lbs. of water / lbs. of cement

w/c_m ~ lbs. of water / lbs. of cementitious

Often when w/c is discussed its really w/c_m that is intended as the reference

45 lbs of water





100 lbs of cement

= Water cement ratio

0.45 expressed as decimal

ASTM C76 sets limits on water and cement content:

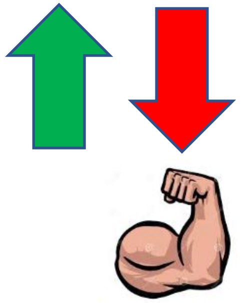
Maximum w/c ratio = 0.53

Minimum cementitious = 470 lb/yd^3 (5 sack)

Mix Designs

Water, Cement, Aggregates & Admixtures

H_2O

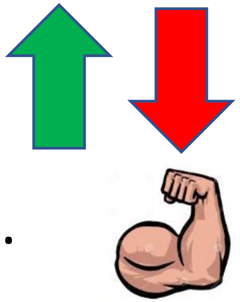


As the water to cement ratio increases, the strength of a concrete mix decreases.

As the surface area of the aggregate increases the more water will be needed to maintain a given slump.

- Coarser Surface Texture
- Particle Shape
- Particle Size Distribution

Air



As the air content increases, the strength of the concrete decreases.

Admixtures are added to modify properties of fresh and cured concrete.

Mix Designs

Water, Cement, Aggregates & Admixtures

Wet-Mix – 3" Slump

Wet-Mix – Self Consolidating Concrete

Dry-Mix
Zero Slump

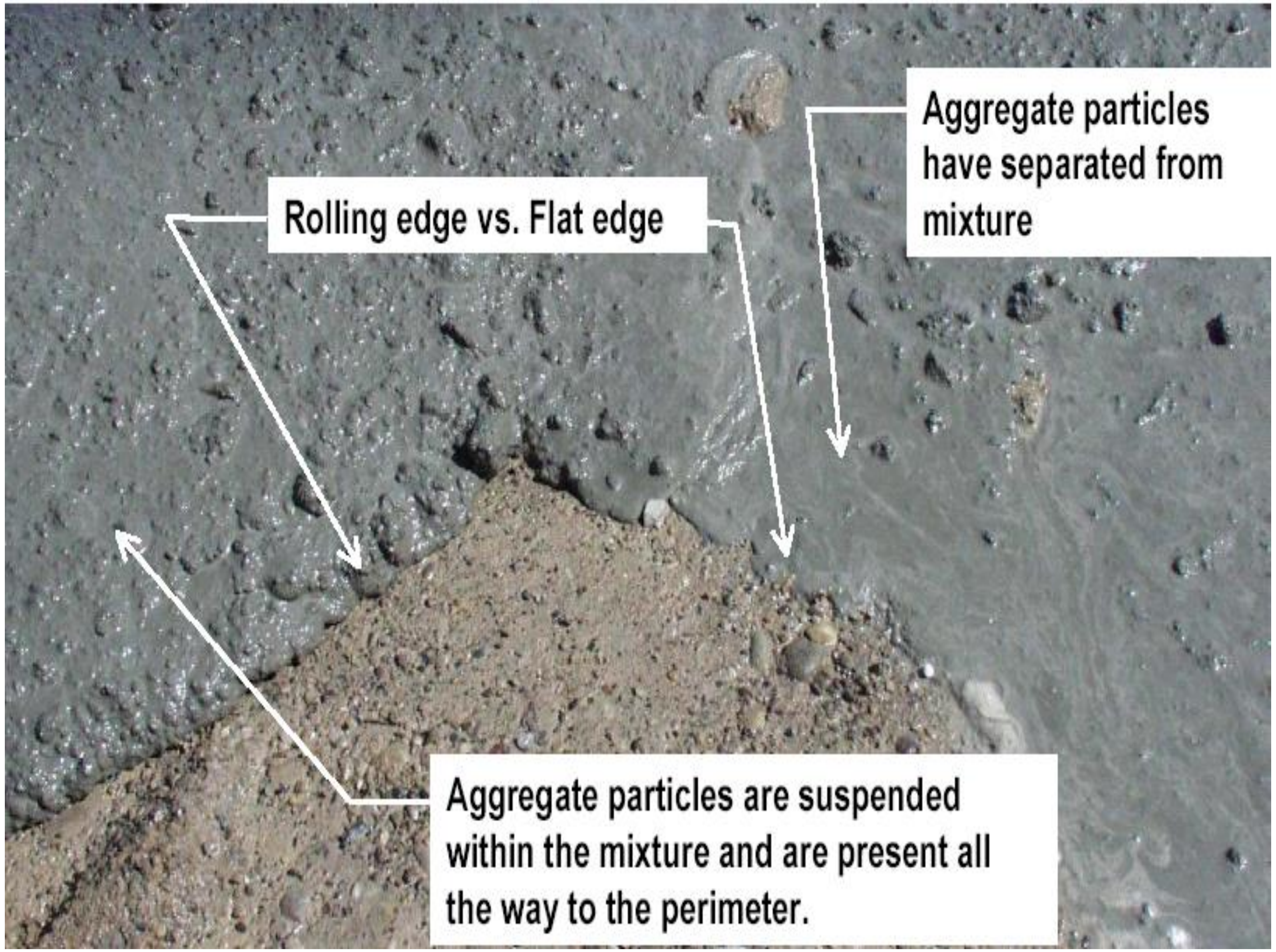
Mix Designs

Self Consolidating Concrete

SCC is more than flowable concrete

It is a highly engineered fluid with unique Rheological (flow) properties

This is not SCC. You cannot just add water or admix and get SCC!



Which Mix?

	Wet-Mix	Dry-Mix
w/c	0.45	0.35
slump	+	0 or -
initial set	4 hours	<1 hour

ASTM C76 sets limits on water and cement content:
Maximum w/c ratio = 0.53
Minimum cementitious = 470 lb/yd^3 (5 sack)

CONCRETE BATCH CALCULATIONS

Description:	6000 psi - No Fly Ash						Date:	
MATERIAL SOLID UNIT WEIGHTS =Specific Gravity x 62.4								
Cement:	3.15	x 62.4 =	196.56	pcf		Air Content Projected		
Fly Ash	2.26	x 62.4 =	141.02	pcf				
Stone:	2.63	x 62.4 =	164.11	pcf		1	% Entrained	
Sand:	2.61	x 62.4 =	162.86	pcf		1	% Entrapped	
1000 SP-MN	1.198	x 62.4 =	74.76	pcf		2.0	Total	
Add #2	1.2	x 62.4 =	74.88	pcf				
						Moisture Content Aggregates		
		Stone	1620	47.37%		3.00	% Stone	
		Sand	1800	52.63%		4.50	% Sand	
MOISTURE COMPENSATION		w/c ratio	0.3					
	Cement (# as weighed)	580	x 1.00 =	580.00	lbs. (act)			
	Fly Ash (# as weighed)	0	x 1.00 =	0.00	lbs. (act)			
	Stone (# as weighed)	1668.60	/ 1+ % =	1618.54	lbs. (act)			
	Sand (# as weighed)	1881.00	/ 1+ % =	1796.36	lbs. (act)			
	Aggregate Water			134.70	lbs.			
	Water Added (gallons)	4.71	x 8.35 =	39.27	lbs.			
	Add #1 (fl.oz.)		=	0.00	lbs.			
	Add #2 (fl.oz.)		=	0.00	lbs.			
BATCH CALCULATIONS								
	Solid Vol. Cement =	580.00	lbs. /	196.56	(unit wt.) =	2.95	cu.ft.	
	Solid Vol. Fly Ash =	0.00	lbs. /	141.02	(unit wt.) =	0.00	cu.ft.	
	Solid Vol. Stone =	1618.54	lbs. /	164.11	(unit wt.) =	9.86	cu.ft.	
	Solid Vol. Sand =	1796.36	lbs. /	162.86	(unit wt.) =	11.03	cu.ft.	
	Aggregate Water =	134.70	lbs. /	62.40	(unit wt.) =	2.16	cu.ft.	
	Added Water =	39.27	lbs. /	62.40	(unit wt.) =	0.63	cu.ft.	
	Volume Add #1 =	0.00	lbs. /	74.76	(unit wt.) =	0.00	cu.ft.	
	Volume Add #2 =	0.00	lbs. /	74.88	(unit wt.) =	0.00	cu.ft.	
					Materials =	26.63	cu.ft.	
					Air =	0.54	cu.ft.	
					YIELD =	27.17	cu.ft.	
						1.01	cu.yd.	
CUBIC YARD CALCULATIONS								
Cement:	580.00	# (act.) /	1.006	cu. yd. / batch =		576.27	lbs/cu.yd.	
Fly Ash:	0.00	# (act.) /	1.006	cu. yd. / batch =		0.00	lbs/cu.yd.	
Stone:	1618.54	# (act.) /	1.006	cu. yd. / batch =		1608.15	lbs/cu.yd.	
Sand:	1796.36	# (act.) /	1.006	cu. yd. / batch =		1784.82	lbs/cu.yd.	
Tot. Water:	173.98	# (act.) /	1.006	cu. yd. / batch =		172.86	lbs/cu.yd.	
Add #1:	0.00	# (act.) /	1.006	cu. yd. / batch =		0.00	lbs/cu.yd.	
Add #2:	0.00	# (act.) /	1.006	cu. yd. / batch =		0.00	lbs/cu.yd.	
					Total Wt. =	4142.10	lbs/cu.yd.	
						2.07	ton/cu.yd.	
					Unit Wt. =	153.41	pcf	
WATER/CEMENT RATIO BY WEIGHT								
	172.86	# water /	576.27	# cement =	0.30			
CEMENT FACTOR								
	576.27	lbs. / cu.yd. / 94 #/bag =			6.13	bags/yd.	13.91%	Cementitious
							0.00%	Fly Ash
	Signature:___________________________					Date:___________________		

Batching

Proper Aggregate Storage

Minimize Segregation

Do not store in conical piles

Store in horizontal layers

Batching

Proper Aggregate Storage

Minimize Segregation

- Do not store in conical piles
- Store in horizontal layers

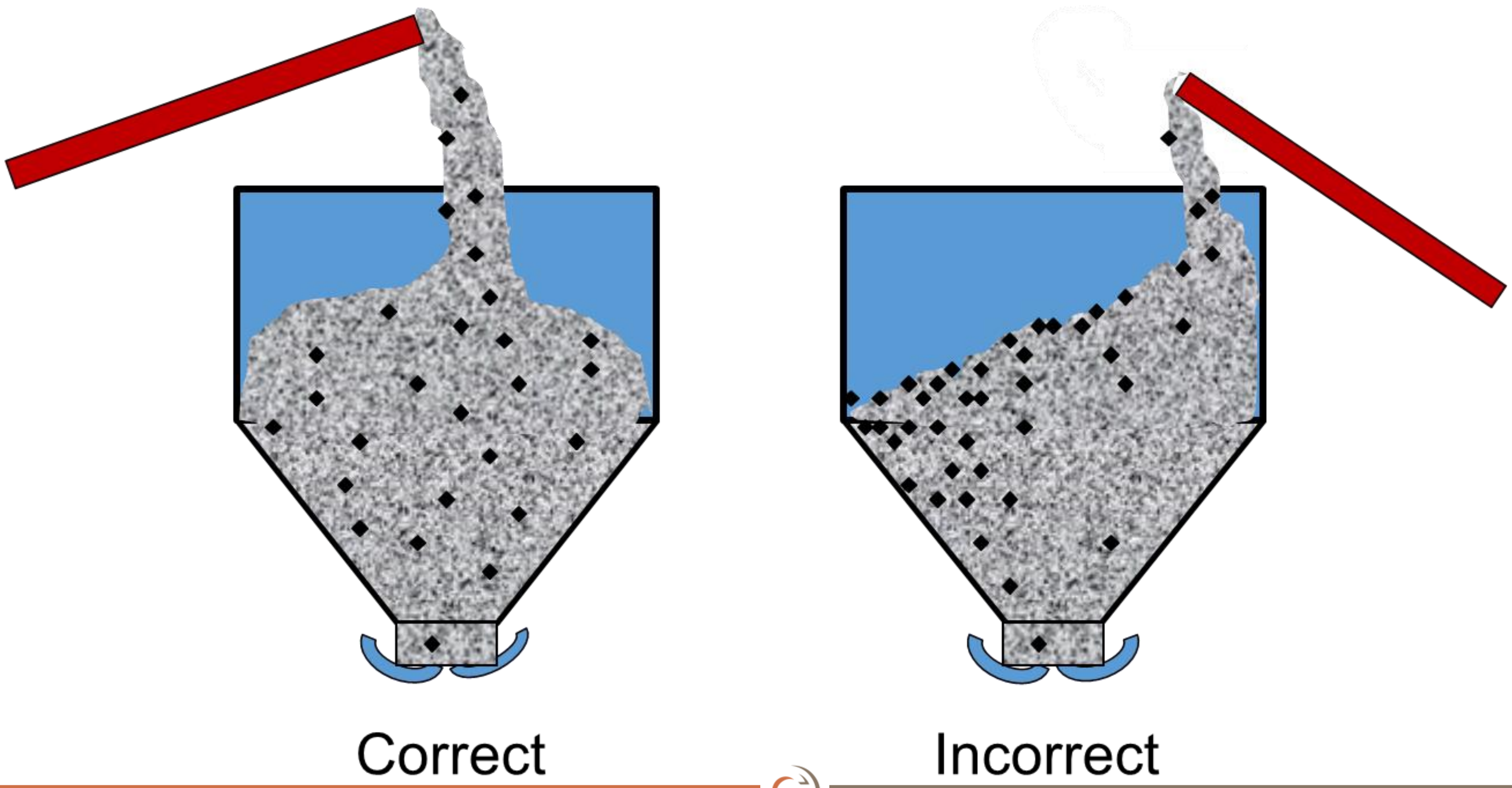
Prevent Contamination

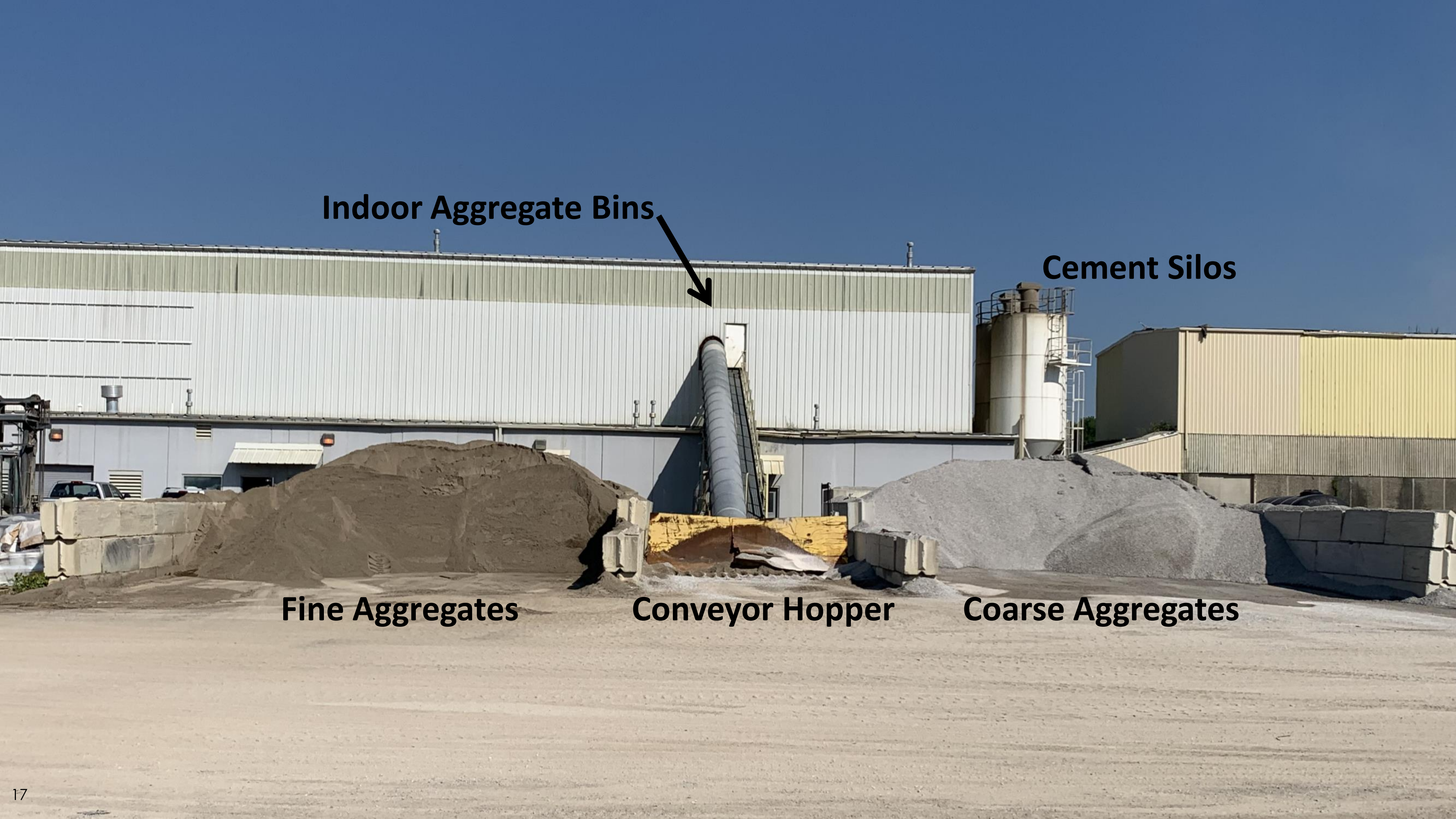
- Store on slabs or planking
- Have storage bins separated by walls

Keep gradations within specified limits

Batching

Filling Aggregate Bins




Indoor Aggregate Bins
Cement Silos
Fine Aggregates
Conveyor Hopper
Coarse Aggregates


Skip Hoist
Aggregate Bins
Mixer
Control Room
Weigh Belt

Batching

Typical Batching Tolerances – ASTM C94

• Cementitious	+/- 1%
• Total Water	+/- 3%
• Fine Aggregates	+/- 2%
• Coarse Aggregates	+/- 2%
• Cum. Aggregates	+/- 1%
• Admixes	+/- 3%
• Calibrate scales annually	

Batching

Keys to Quality Batching

Accuracy of Weighing

Scales must hang free and not leak

Scales must empty completely

Check zero weight on a regular basis

Compensating for Moisture in Aggregates

Required for batch consistency & strengths

Maintains production efficiency

Sequencing of Materials

Follow mixer manufacture's recommendations

Mixing

Mixers

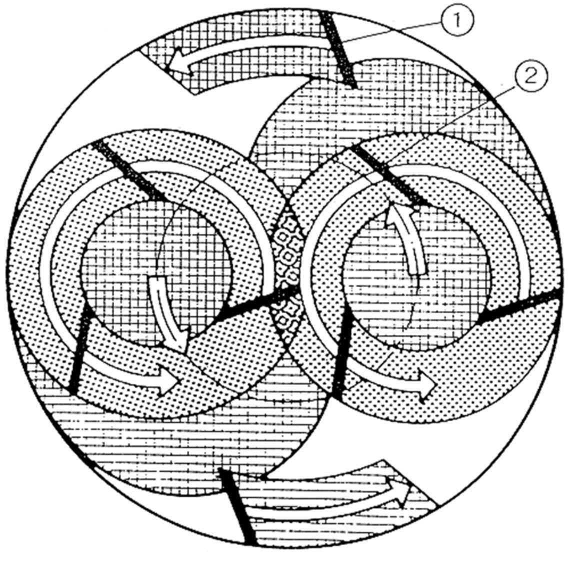
Mixer Output

- Quantity of concrete needed per day
- Quantity of concrete needed per hour

Output is measured in:

- ft^3
- yd^3
- m^3

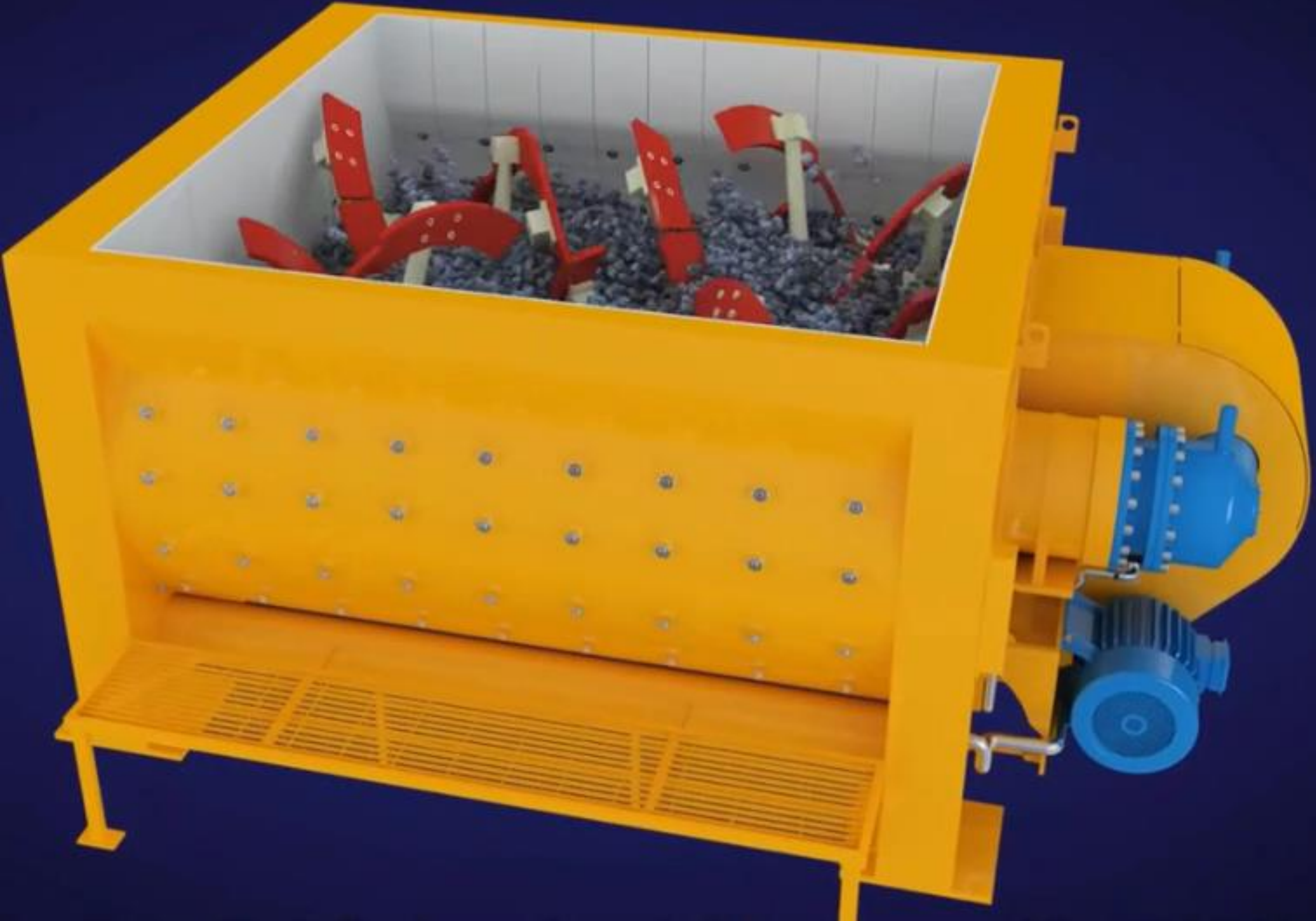
Actual capacity typically 2/3 of rated capacity



COUNTER CURRENT MIXER

Mixing

Single Shaft Paddle Mixer



Twin Shaft Ribbon Mixer

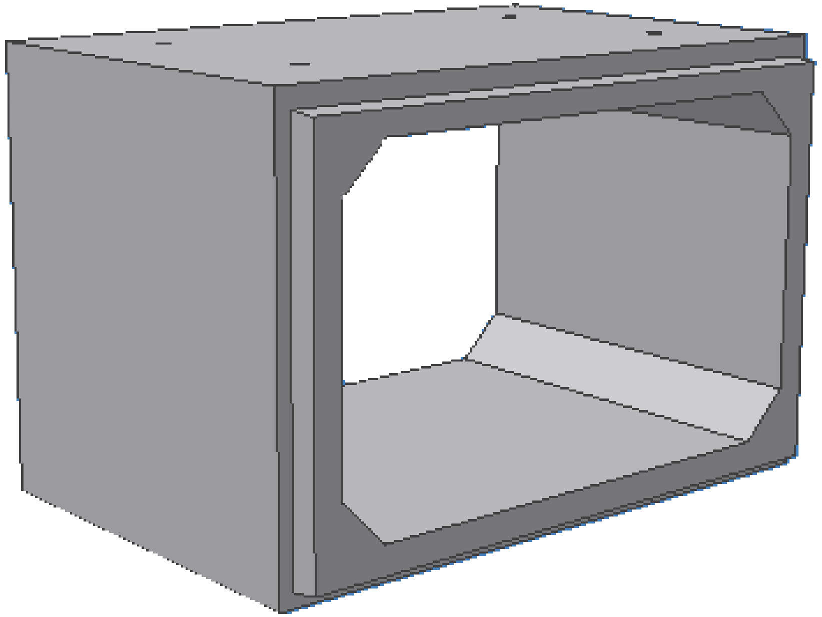

Wiggert+Co.
PCS
ADVANCED CONCRETE TECHNOLOGIES
+1028 lbs
0 lbs
+ 430 lbs
- 10 kg
ROCK
SAND
WARNING HAZARD!
Disconnect main power supply before opening control cabinet !

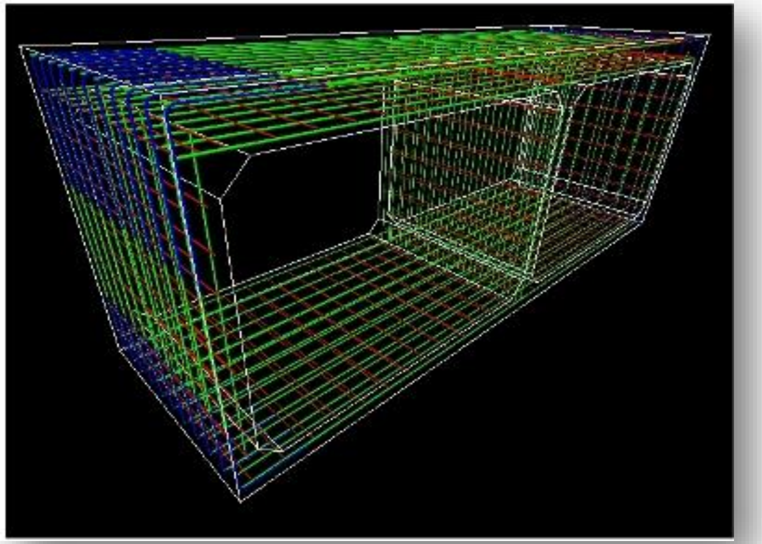
PIPE SCHOOL

Box Reinforcing

BOXCAR OR Eriksson Culvert

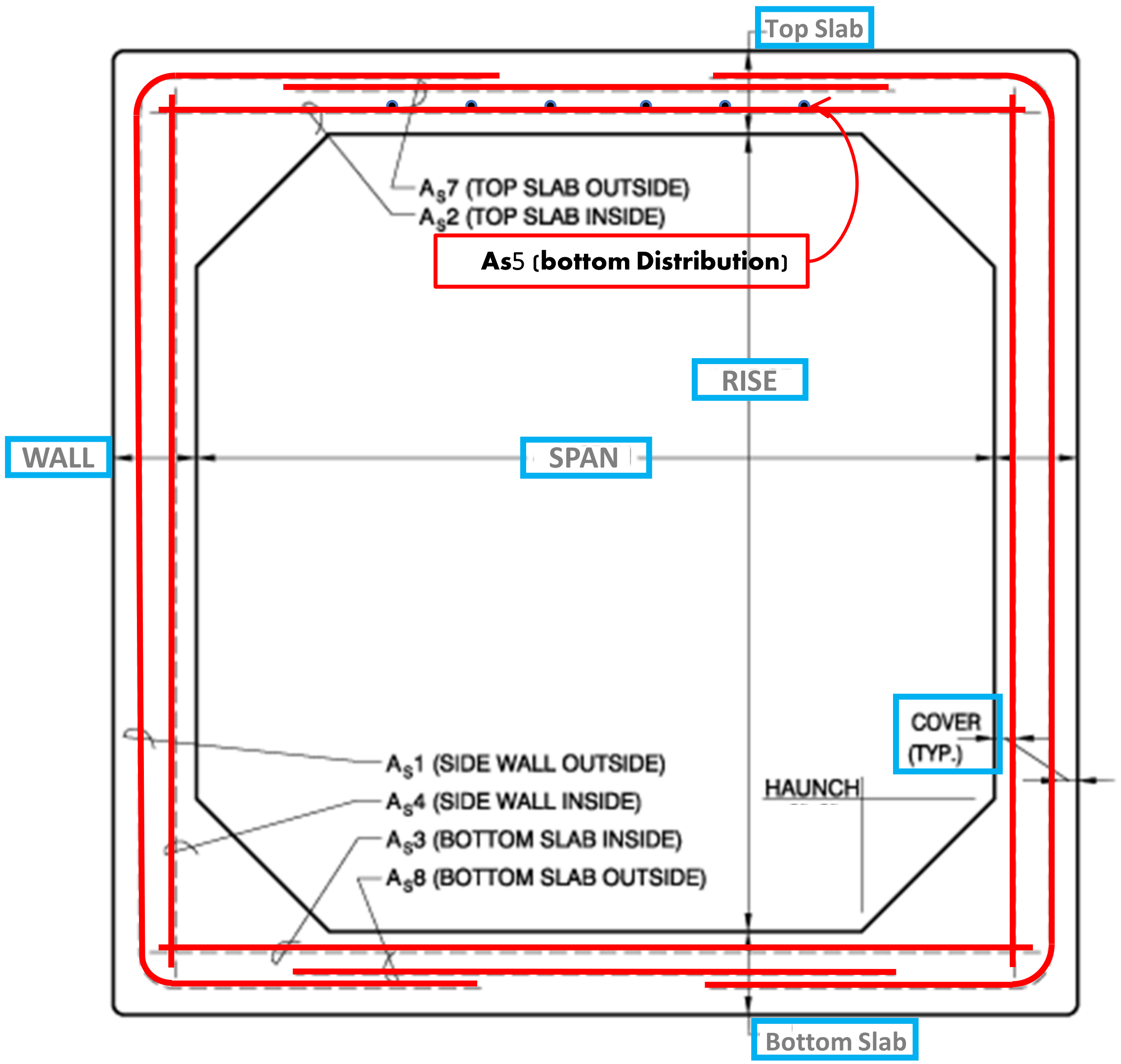
A Better Way to Design Precast/CIP Box Culverts





- AREMA / AASHTO / ASTM C 1577 DESIGN
- 3D WIREFRAME GENERATION
- LOAD RATING CAPABILITIES

Typical Box Reinforcing Nomenclature

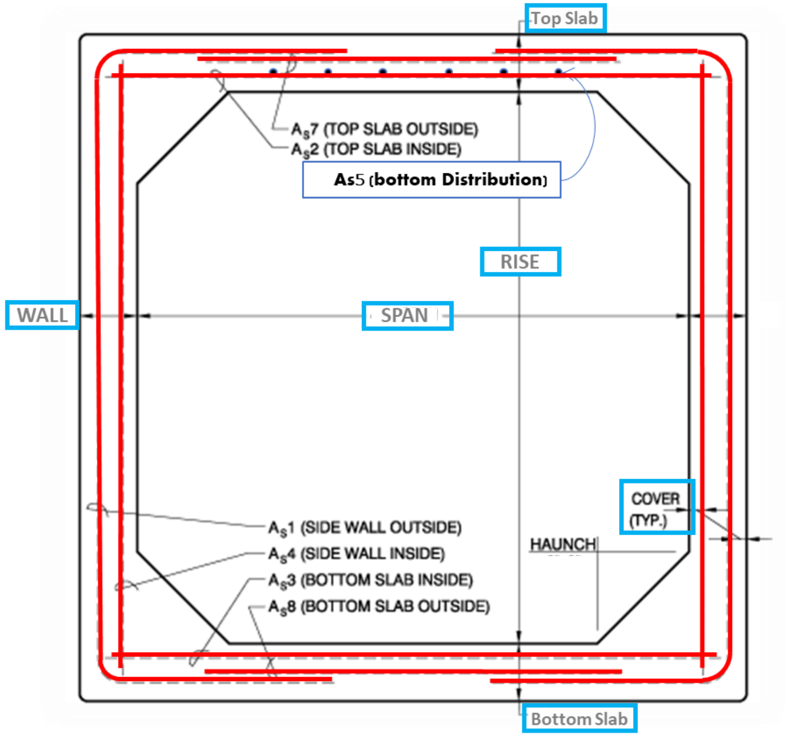


- ❑ Span, Rise, Walls
- ❑ Top Slab
- ❑ Bottom Slab
- ❑ Clear Cover Over Reinforcing
- ❑ 5000 psi Concrete
- ❑ As1 – (Side Wall Outside)
- ❑ As2 – (Top Slab Inside)
- ❑ As3 – (Bottom Slab Inside)
- ❑ As4 – (Side Wall Inside)
- ❑ As5 – (Top Slab Inside Distribution)
- ❑ As7 – (Top Slab Outside)
- ❑ As8 – (Bottom Slab outside)

…shall contain sufficient longitudinal wires extending through the box section to maintain the shape and position of the reinforcement.

Box Reinforcing

Welded Wire Reinforcement – ASTM A1064



- Span, Rise, Walls
- Top Slab
- Bottom Slab
- Clear Cover Over Reinforcing
- 5000 psi Concrete

- As1 – (Side Wall Outside)
- As2 – (Top Slab Inside)
- As3 – (Bottom Slab Inside)
- As4 – (Side Wall Inside)

- As5 – (Top Slab Inside Distribution)
- As7 – (Top Slab Outside)
- As8 – (Bottom Slab outside)

Each Mat is Custom Designed and Ordered per Structural Design

PIPE SCHOOL

Box Reinforcing

Mesh Benders for Cage Fabrication

Box Reinforcing

Mesh Benders for Cage Fabrication

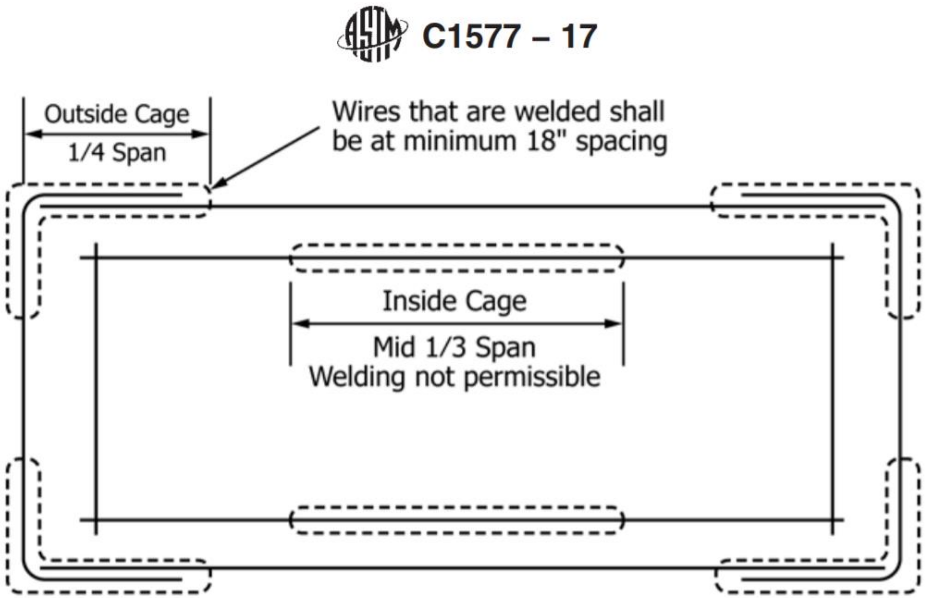
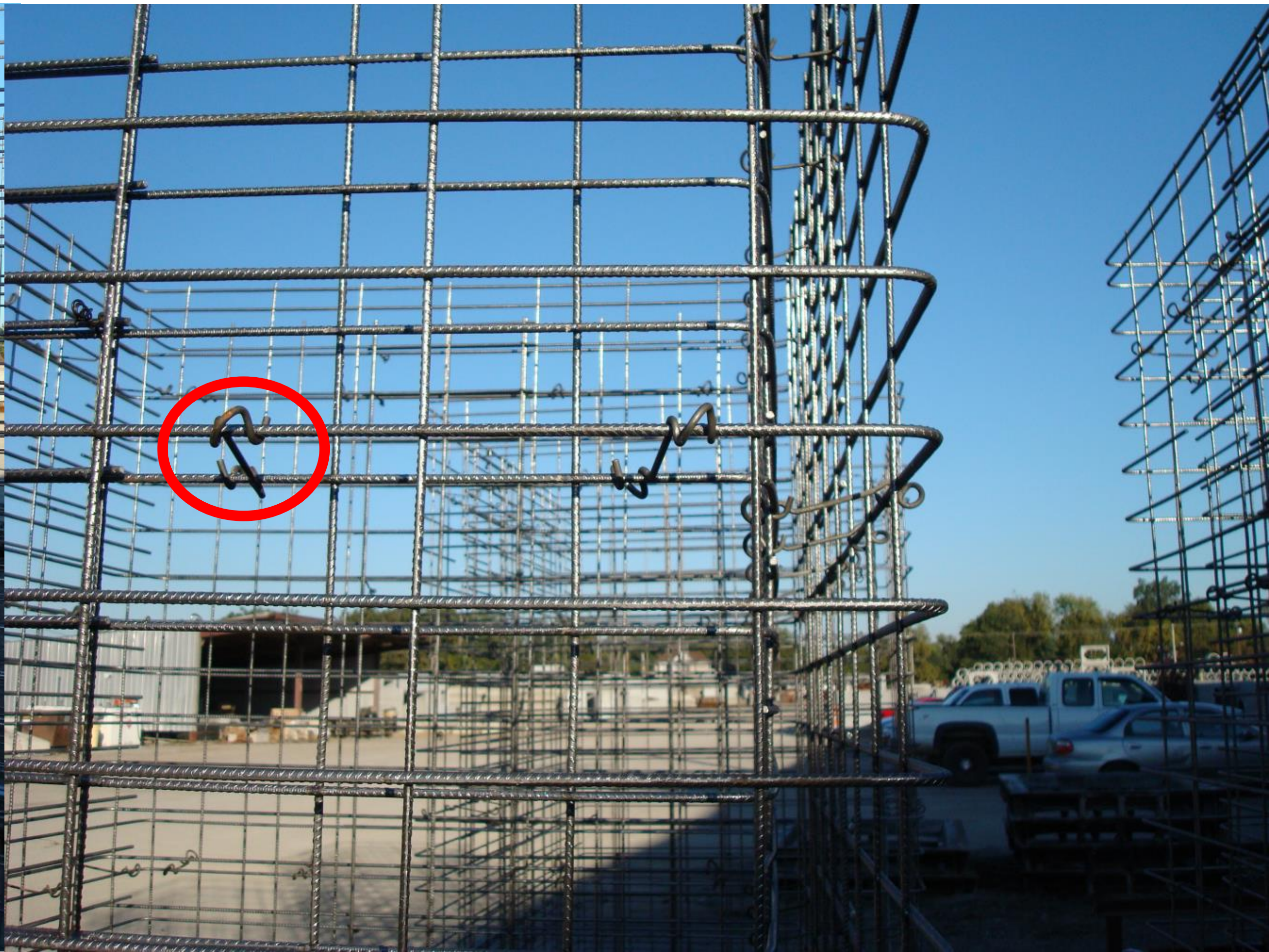
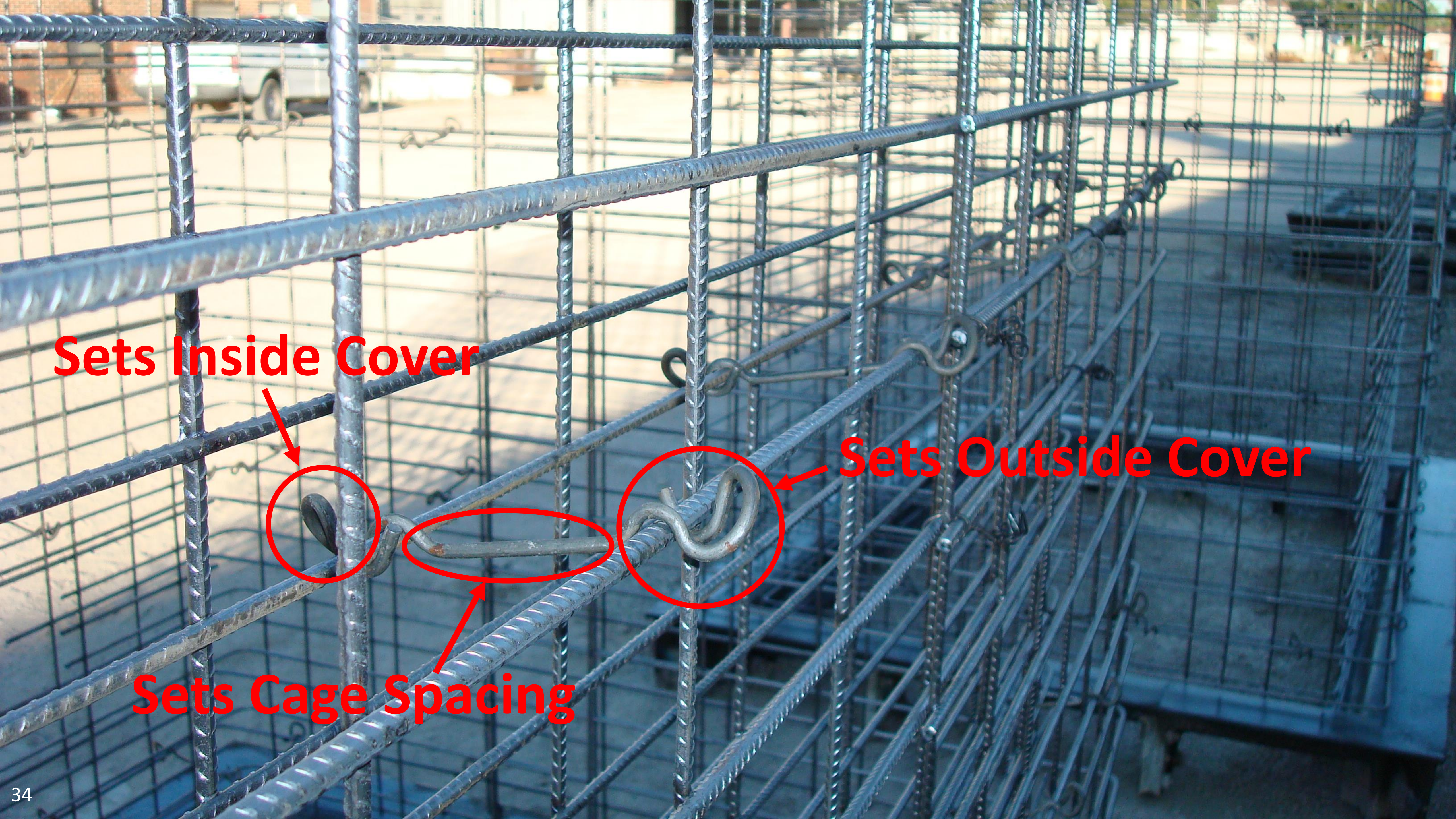


FIG. 9 Critical Zones of High Stress Where Welding is Restricted

Box Reinforcing

Wire Cage Spacers




Sets Inside Cover
Sets Outside Cover
Sets Cage Spacing

Box Forms

Box Forms

Wet Cast Forms

Cast with Normal Slump Concrete or SCC

Choice of Internal or External Vibration

Concrete Must Reach “Stripping” Strength

Generally, One Casting per Day

Outer Form Must be “Unbolted” to Remove

Inner Core Has a Collapsing Mechanism

Box Forms

Wet Cast Forms

- Collapsing Inner Core
- Walls Pull Away From Inner Box Surface
- Taper Not Required
- Lubrication Required at Hinges
- Cleaning and Maintenance Required

Box Forms

Dry Cast Forms

External Vibration (Outer Form or Core)

Cast with Zero Slump Concrete

Outer Form and Core Tapered for Stripping

Form Strip or Core Strip

Product Stripped Immediately After Casting

Multiple Pours per Shift – Dictated by:

- Fill Cycle Time
- Number of Pallets

Box – Wet Cast

Box – Wet Cast

Box – Wet Cast

Box – Wet Cast


Top Ties
Bottom Ties

TAYLOR


Bell Forming Header

PIPE SCHOOL

Box – Dry Cast

PIPE SCHOOL

Box – Dry Cast

Form Strip

Outer Form Being Lowered into Position

Electric Vibrators

Pallet Locks

Cage in Position

Spigot Forming Pallet

PIPE SCHOOL

Box – Dry Cast

Form Strip

Stationary Core (Slight Taper)

Pit Mounted Core

Walking / Working Level

Box – Dry Cast

Form Strip

Outer Form (Slight Taper)

Pit Mounted Core

Walking / Working Level

Box – Dry Cast

Form Strip

Pouring Funnel

Stationary Core (Slight Taper)

Reinforcing Cages

Outer Form

Box – Dry Cast

Form Strip

Bell Forming Header

Formed Bell
(excess concrete will be removed)

Box – Dry Cast

Form Strip

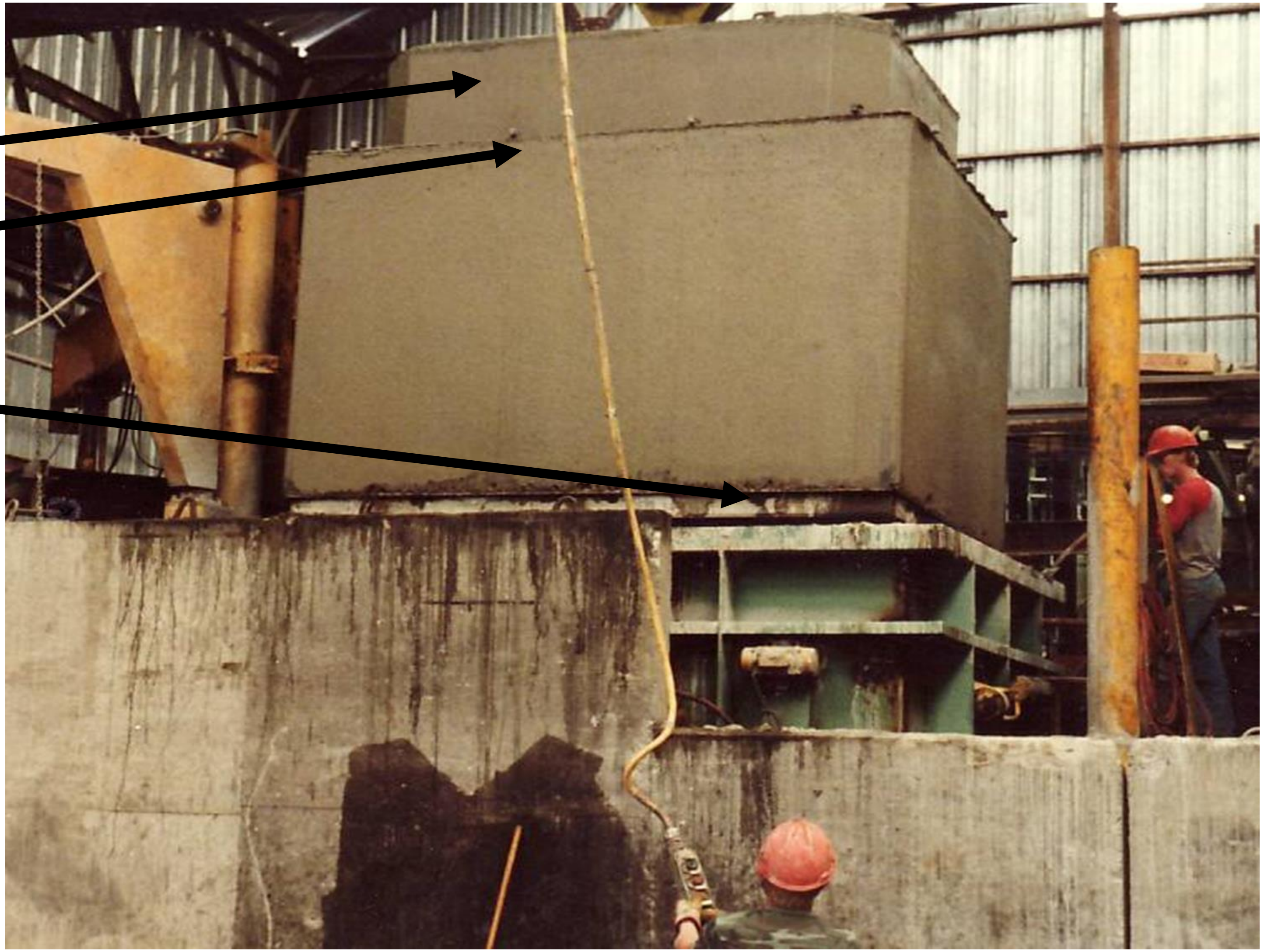
Box – Dry Cast

Core Strip

Core Stripped w/ Box

Special Short Box

Box Sitting on Pallet



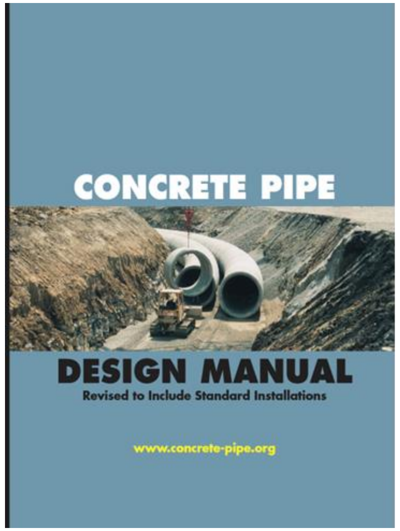
Box – Dry Cast

Pipe Reinforcing

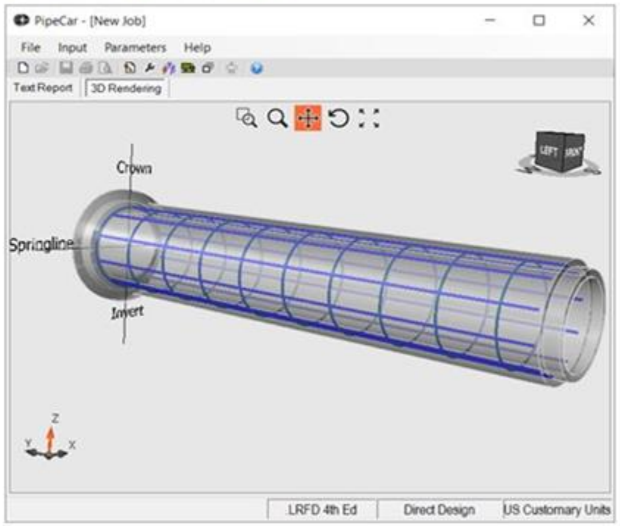
PIPE SCHOOL

Pipe Reinforcing

Pipe Design Methods



Introducing *Eriksson Pipe*

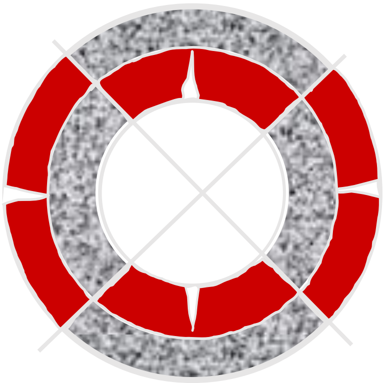


Indirect Design

Direct Design

Pipe Reinforcing

Steel Cage – Why & Where?



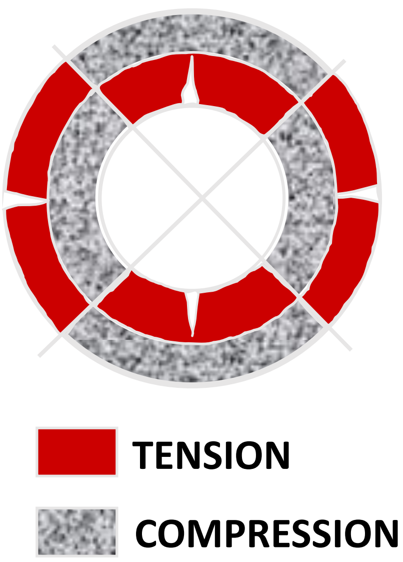
TENSION

COMPRESSION

Minimum cover = 1”
Wall < 2-1/2” – minimum cover = 3/4”

Pipe Reinforcing

Steel Cage – Why & Where?



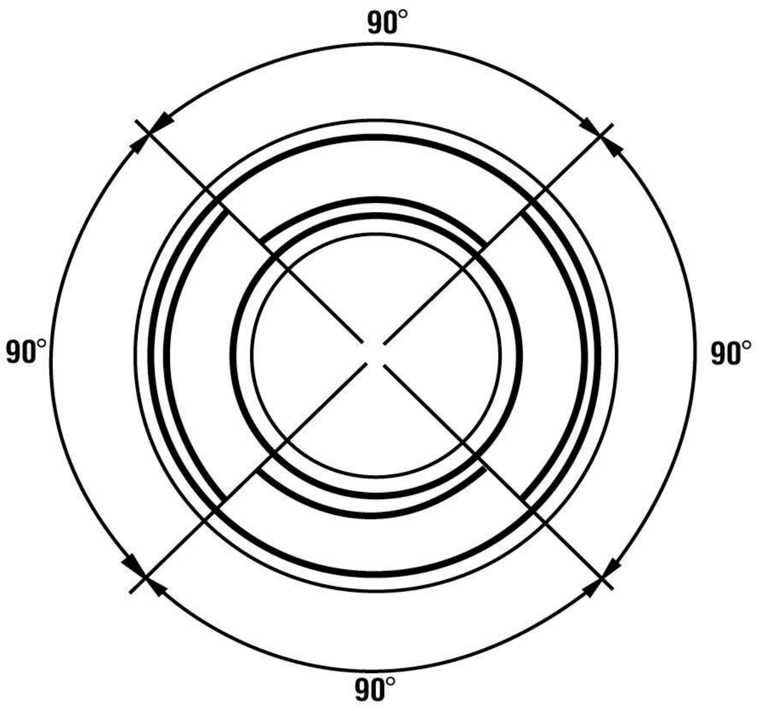


Figure 2.2. Quadrant Reinforcement Provides Additional Reinforcement in Tension Zones of Pipe Wall.

Pipe Reinforcing

Steel Cage – Why & Where?

C76 – 18

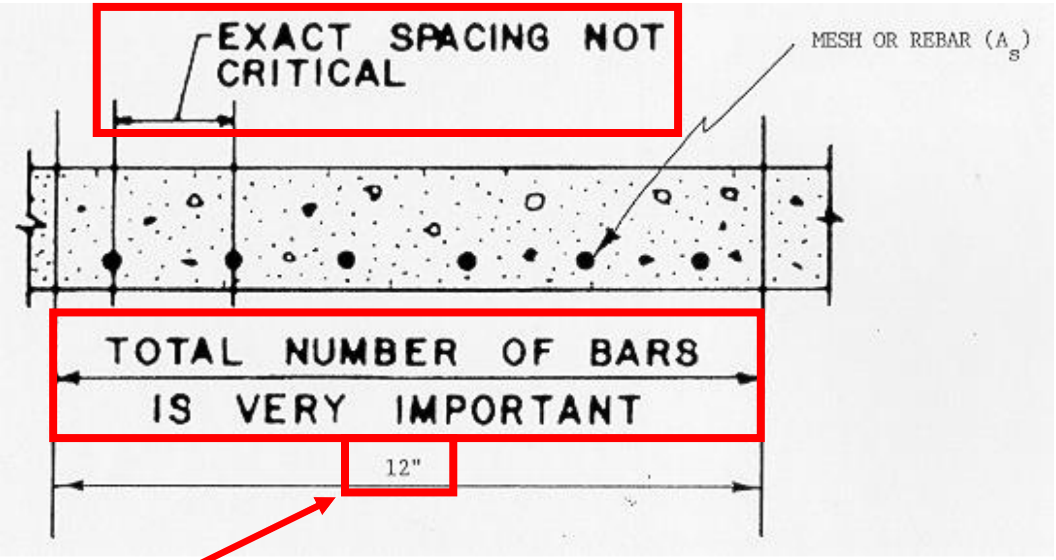
TABLE 4 Design Requirements for Class IV Reinforced Concrete Pipe[A]

NOTE 1—See Section 5 for basis of acceptance specified by the owner.

The strength test requirements in pounds-force per linear foot of pipe under the three-edge-bearing method shall be either the D-load (test load expressed in pounds-force per linear foot per foot of diameter) to produce a 0.01-in. crack, or the D-loads to produce the 0.01-in. crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in feet.

D-load to produce a 0.01-in. crack	2000
D-load to produce the ultimate load	3000

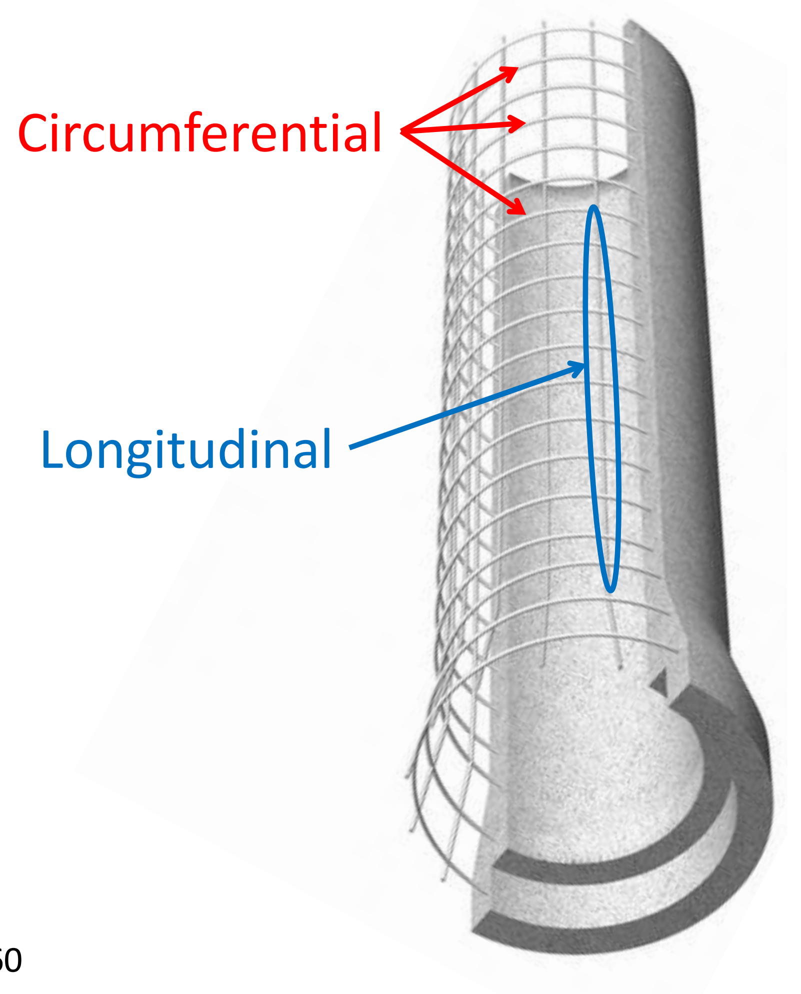
Internal Designated Diameter, in.	Reinforcement, $in.^2$/linear ft of pipe wall											
	Wall A				Wall B				Wall C			
	Concrete Strength, 5000 psi				Concrete Strength, 4000 psi				Concrete Strength, 4000 psi			
	Wall Thickness, in.	Circular Reinforcement[B]		Elliptical Reinforcement[C]	Wall Thickness, in.	Circular Reinforcement[B]		Elliptical Reinforcement[C]	Wall Thickness, in.	Circular Reinforcement[B]		Elliptical Reinforcement[C]
		Inner Cage	Outer Cage			Inner Cage	Outer Cage			Inner Cage	Outer Cage	
12	1¾	0.15	...	...	2	0.07	...	...	2¾	0.07[D]	...	...
15	1⅞	0.16	...	...	2¼	0.10	...	...	3	0.07[D]	...	...
18	2	0.17	...	0.15	2½	0.14	...	0.11	3¼	0.07[D]	...	0.07[D]
21	2¼	0.23	...	0.21	2¾	0.20	...	0.17	3½	0.07[D]	...	0.07[D]
24	2½	0.29	...	0.27	3	0.27	...	0.23	3¾	0.07	0.07	0.08
27	2⅝	0.33	...	0.31	3¼	0.31	...	0.24	4	0.08	0.07	0.09
30	2¾	0.38	...	0.35	3½	0.35	...	0.27	4¼	0.09	0.07	0.10
33	[A]	...	...	...	3¾	0.27	0.16	0.30	4½	0.11	0.07	0.12
36	[A]	...	...	...	4	0.30	0.18	0.33	4¾	0.14	0.08	0.15
42	[A]	...	...	...	4½	0.35	0.21	0.39	5¼	0.20	0.12	0.21
48	[A]	...	...	...	5	0.42	0.24	0.47	5¾	0.26	0.16	0.29
54	[A]	...	...	...	5½	0.50	0.30	0.55	6¼	0.34	0.20	0.38
					Concrete Strength, 5000 psi							

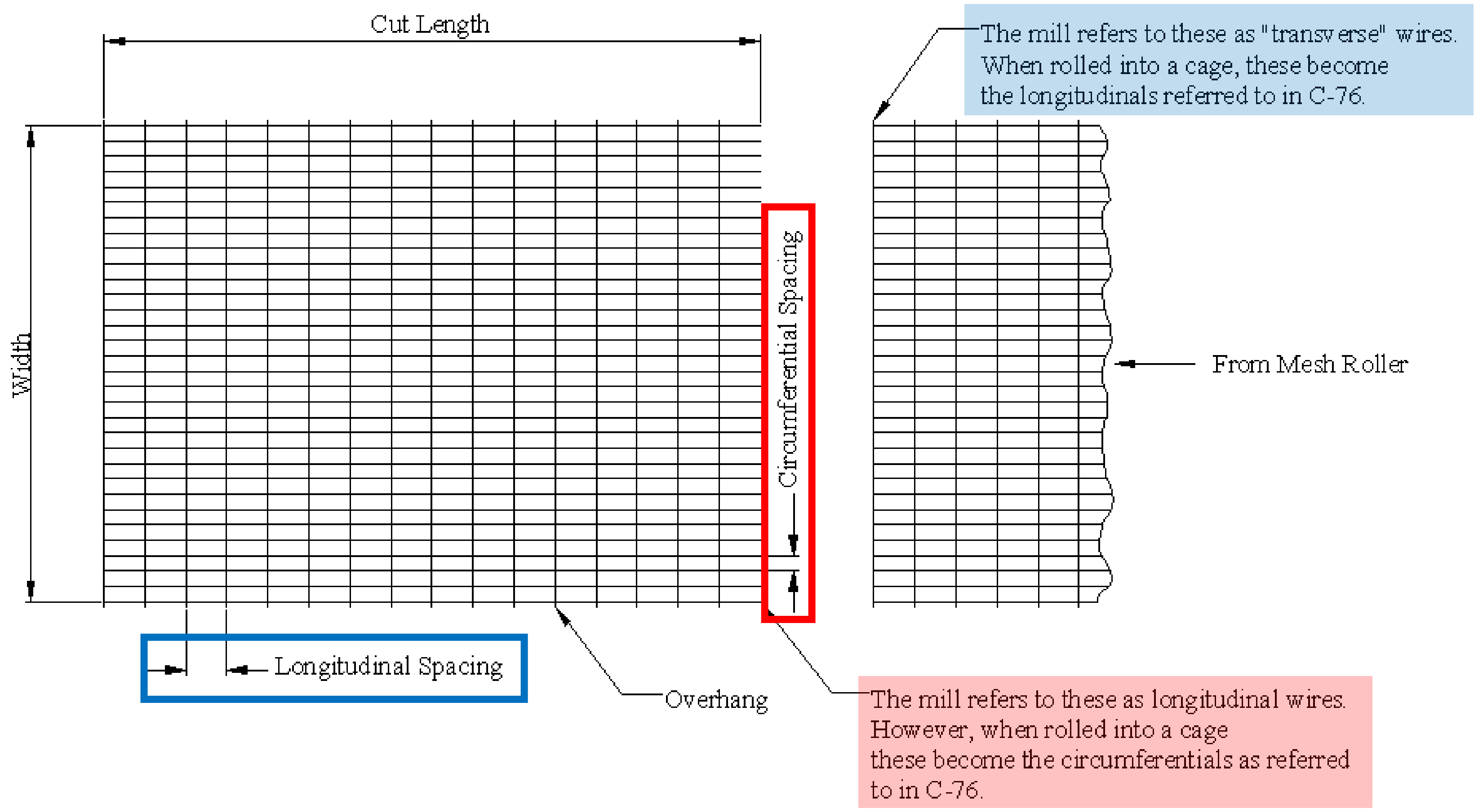


0.10 in^2/linear ft of pipe wall

Pipe Reinforcing

Steel Cage – Welded Wire Fabric





PIPE SCHOOL

Pipe Reinforcing

Steel Cage – Welded Wire Fabric

Spacing between longitudinals

Area of one circumferential wire (.025 sq. in.)

Length of roll

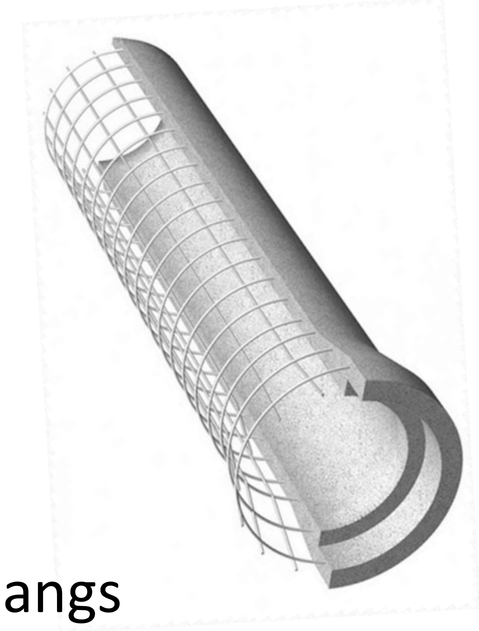
3x8 W2.5xW2.0 93”x 600’ 1/2x1/2

Spacing between circumferentials

Overhangs

Area of one longitudinal wire (.02 sq. in.)

Width of mesh from top to bottom circumferential



W = Plain/Smooth, D = Deformed

Pipe Reinforcing

Steel Cage – Welded Wire Fabric

How do I use this information?

	D-load to produce the ultimate load								3000
	Reinforcement, in.^{2}/linear ft of pipe wall								
	Wall A				Wall B				
Internal Designated Diameter, in.	Concrete Strength, 5000 psi				Concrete Strength, 4000 psi				
	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.
12	1¾	0.15	. . .	. . .	2	0.07		. . .	2¾
15	1⅞	0.16	. . .	. . .	2¼	0.10	. . .	. . .	3
18	2	0.17	. . .	0.15	2½	0.14	. . .	0.11	3¼
21	2¼	0.23	. . .	0.21	2¾	0.20	. . .	0.17	3½
24	2½	0.29	. . .	0.27	3	0.27	. . .	0.23	3¾

3x8 W2.5xW2.0 93”x 600’ 1/2x1/2

$$A = 0.025 \times \frac{12}{3} = 0.10 \text{ in}^2/\text{ft}$$

W = Plain/Smooth, D = Deformed

Pipe Reinforcing

Steel Cage – Welded Wire Fabric

How do I use this information?

	D-load to produce the ultimate load								3000
	Reinforcement, in.²/linear ft of pipe wall								
	Wall A				Wall B				
	Concrete Strength, 5000 psi				Concrete Strength, 4000 psi				
Internal Designated Diameter, in.	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.
12	1¾	0.15	. . .	. . .	2	0.07	[illegible]	. . .	2¾
15	1⅞	0.16	. . .	. . .	2¼	0.10	. . .	. . .	3
18	2	0.17	. . .	0.15	2½	0.14	. . .	0.11	3¼
21	2¼	0.23	. . .	0.21	2¾	0.20	. . .	0.17	3½
24	2½	0.29	. . .	0.27	3	0.27	. . .	0.23	3¾

3x8 W2.5xW2.0 93”x 600’ 1/2x1/2

$$A = 0.025 \times \frac{12}{3} = 0.10\ \text{in}^2/\text{ft}$$

W = Plain/Smooth, D = Deformed

PIPE SCHOOL

Pipe Reinforcing

Steel Cage – Welded Wire Fabric

How do I use this information?

Internal Designated Diameter, in.	D-load to produce the ultimate load								3000
	Reinforcement, in.²/linear ft of pipe wall								
	Wall A				Wall B				
	Concrete Strength, 5000 psi				Concrete Strength, 4000 psi				
	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.
12	1¾	0.15	. . .	. . .	2	0.07	. . .	. . .	2¾
15	1⅞	0.16	. . .	. . .	2¼	0.10	. . .	. . .	3
18	2	0.17	. . .	0.15	2½	0.14	. . .	0.11	3¼
21	2¼	0.23	. . .	0.21	2¾	0.20	. . .	0.17	3½
24	2½	0.29	. . .	0.27	3	0.27	. . .	0.23	3¾

2x6 W4.5xW2.5 93”x 600’ 1/2x1/2

$$A = 0.045 \times \frac{12}{2} = 0.27\ \text{in}^2/\text{ft}$$

W = Plain/Smooth, D = Deformed


CAUTION

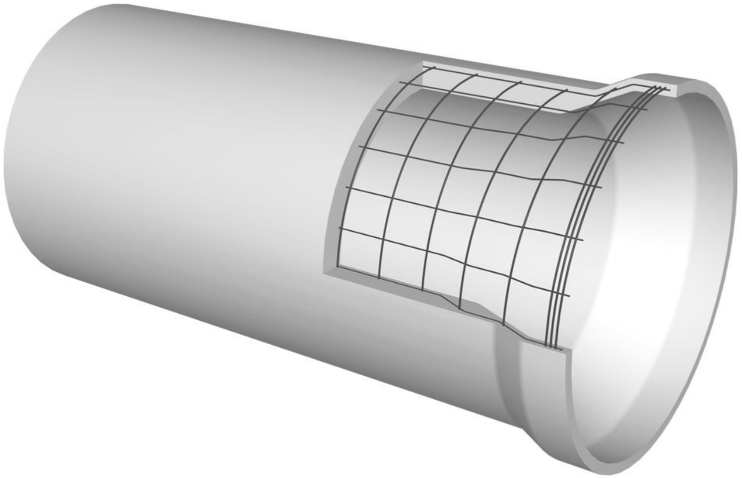
Pipe Reinforcing

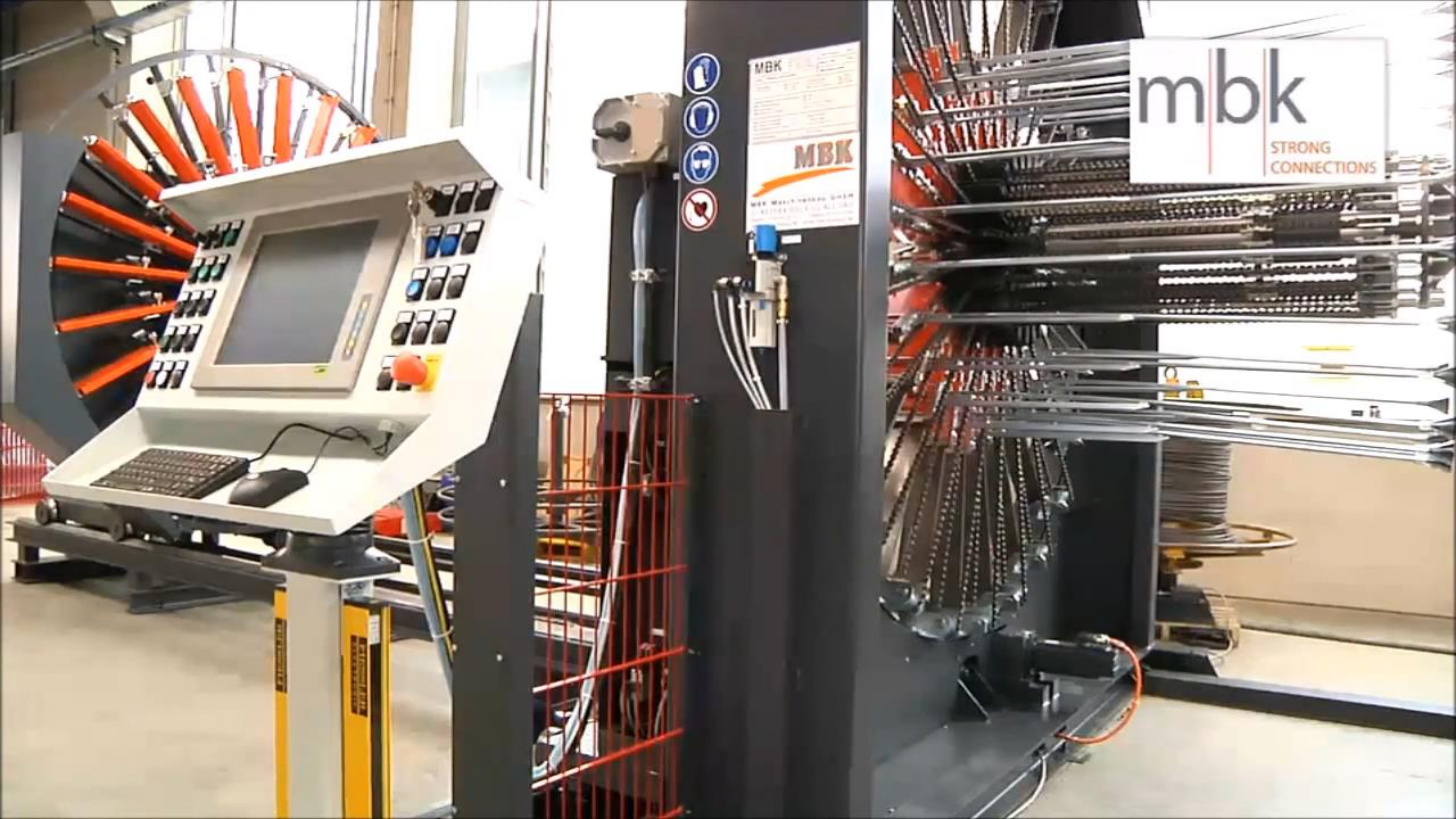
Steel Cage – Cage Machines

Use reels of cold drawn steel wire.

Longitudinal wires hand fed or continuous feed.

Circumferential wire spacing (pitch) is adjustable.




MBK
MBK
mbk
STRONG
CONNECTIONS

Pipe Forms

Pipe Forms

Wet Cast Forms

Cast with Normal Slump Concrete or SCC

Choice of Internal or External Vibration

Concrete Must Reach “Stripping” Strength

Generally, One Casting per Day

Outer Form Must be “Expanded” to Remove

Inner Core Has a Collapsing Mechanism

PIPE SCHOOL

Pipe Forms

Dry Cast Forms

Cast with Zero Slump Concrete

Form Strip

External Vibration (Outer Form or Core)

Outer Form and Core Tapered for Stripping

Product Stripped Immediately After Casting

Multiple Pours per Shift – Dictated by:

Fill Cycle Time

Number of Pallets

PIPE SCHOOL

Pipe Production

Wet Cast

Vibratory

Packerhead

Pipe – Wet Cast

PIPE SCHOOL

Pipe – Wet Cast

PIPE SCHOOL

Pipe – Vibratory

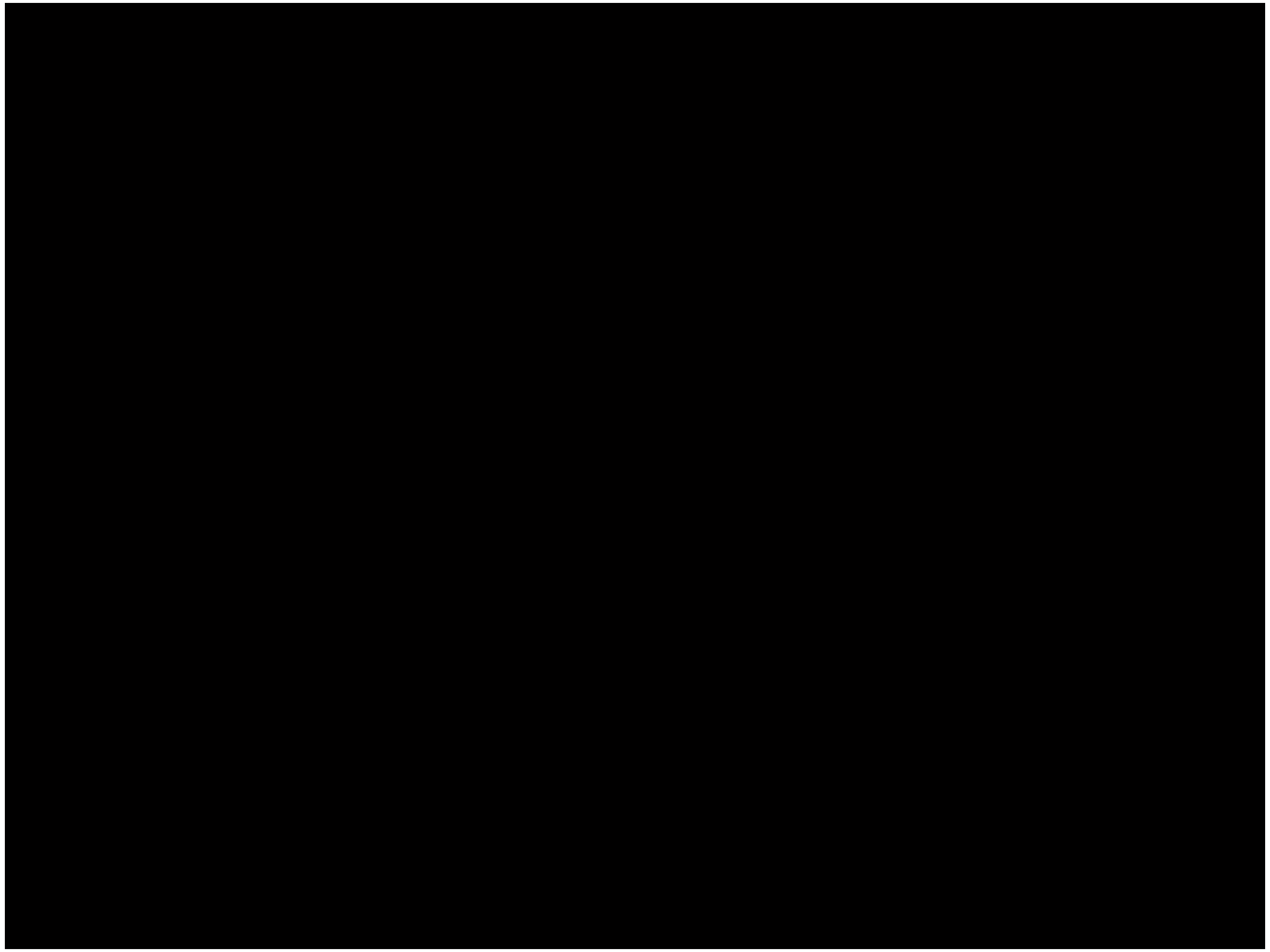

Conveying Concrete to Machine
From Freshly Cast Pipe

Pipe – Joints

Pipe – Vibratory

Pipe – Packerhead

Counter Rotating Packerhead
Eliminates Cage Twist



Pipe – Packerhead

Curing

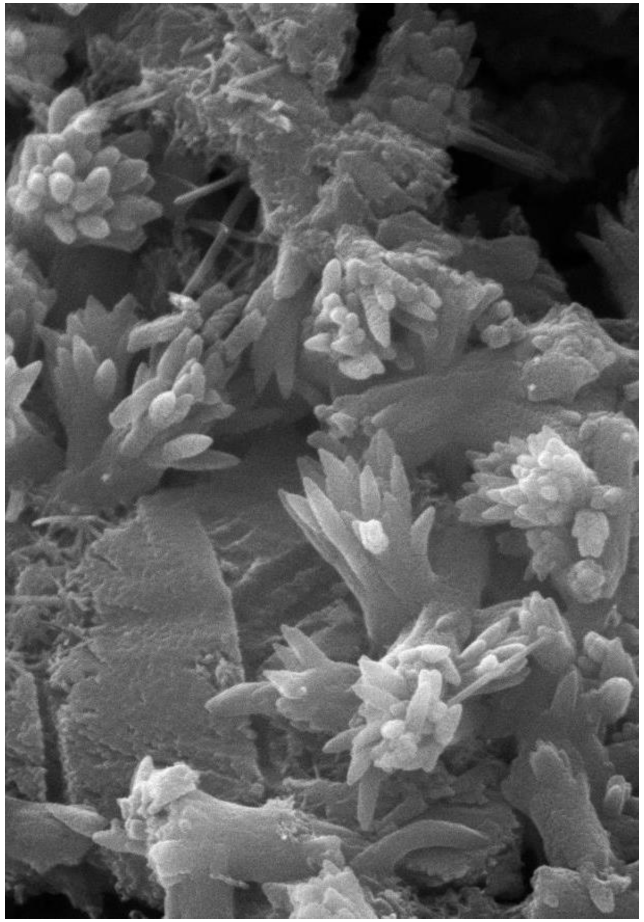
Curing – What is It?

Hardening of Concrete

Hydration is a chemical reaction between cement and water.

Hydration produces three things:

- **Calcium Silicate Hydrate** (CSH) gel that hold aggregates in place and gives concrete its strength (glue)
- **Heat**
- **Calcium Hydroxide** that fills the remaining voids, does not contribute much to strength



Accelerated Curing

- Rate of hydration increases as ambient temperature increases

Curing

Curing – Essentials

Controlling Moisture in Concrete is Crucial

Maintain Temperature

Reduces Permeability

Essential for structural water tightness

Improves durability

Volume stability (reduces shrinkage cracks)

Optimal Strength is Achieved

Curing

Curing – Essentials

Maintaining Moisture in Concrete is Crucial

Accelerates strength gain

Fogging

Water misters

Burlap covers

Plastic wraps

Curing compounds

Optimal Strength is Achieved

PROBLEM – WE CAN'T WAIT 28 DAYS

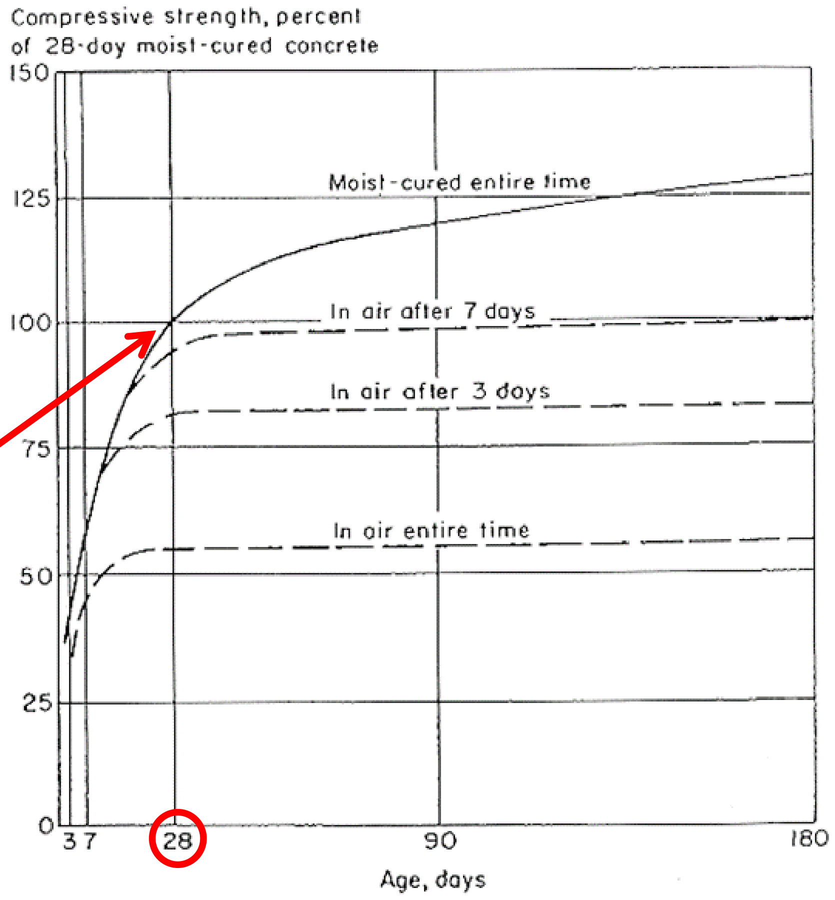


Fig. 10-1. Concrete strength increases with age as long as moisture and a favorable temperature are present for hydration of cement. Reference 10-16.

Curing

Curing – Essentials

The Answer is Steam Curing

Accelerates Strength Gain Dramatically

Initial delay

Temperature increase

Holding maximum temperature

Reduce temperature

Optimal Strength is Achieved

28 Day Strengths Achieved in 24-72 Hours

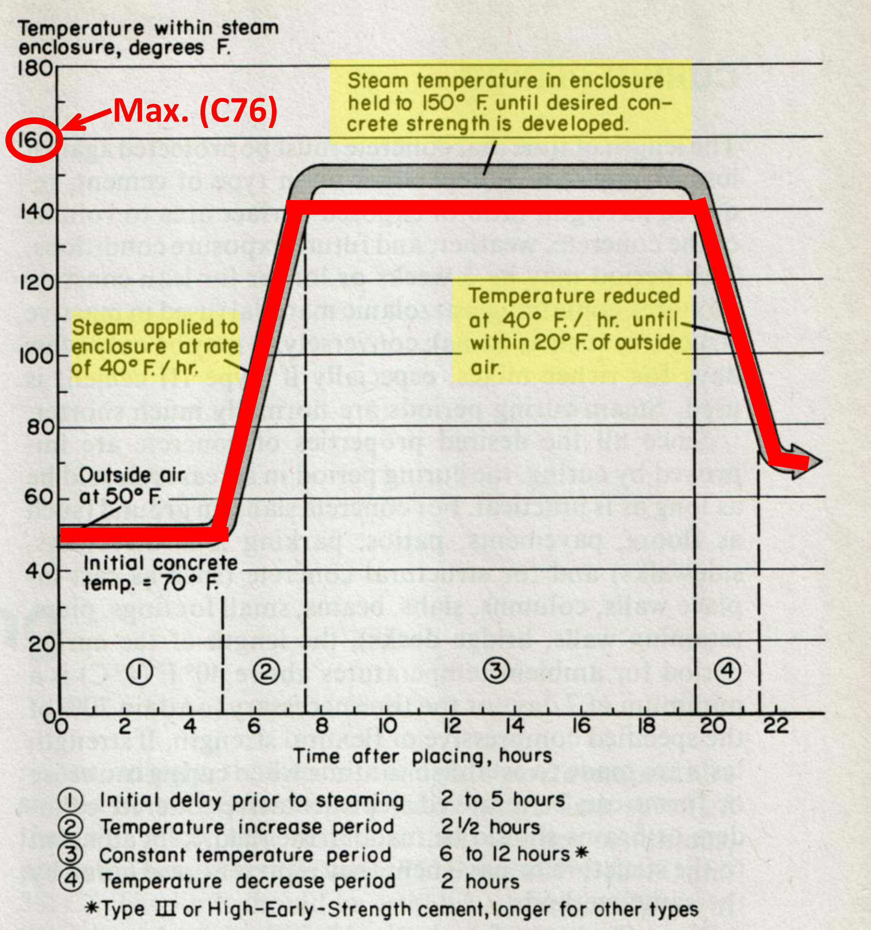


Fig. 10-6. A typical atmospheric steam-curing cycle (idealized).

PIPE SCHOOL

Curing

Curing – Essentials

Additional Methods to Accelerate Strength Gain

Two Classes of Admixtures

Set accelerator

Strength accelerator

Calcium Chloride should ***NOT*** be used in Precast Reinforced Concrete

It is not an anti-freeze agent

Can cause reinforcement corrosion

Will cause aluminum to corrode (conduit in precast structures)

Non-Chloride accelerators are available but not as effective as Calcium Chloride

Curing

Curing – Essentials

Final Thoughts

Type III cement always an option (cost)

High temperature with low humidity can crack product

Cover wet cast forms – supply live steam

Provide curing chambers

PIPE SCHOOL

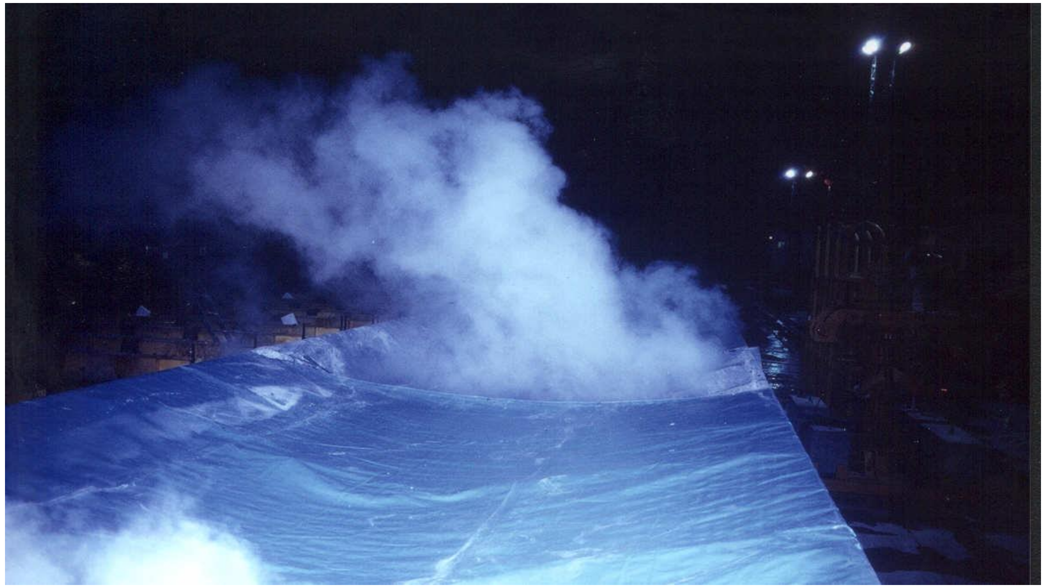
Curing

Curing – Essentials

Curing Chambers

Steam should only flow out of the bottom of the cell

No Steam leakage out of top or sides



APPLY

Consider everything that we just covered and think about how you might use this information when you are back in your workplace.

Thank You!

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