54TH TURBOMACHINERY & 41ST PUMP SYMPOSIA

SEPTEMBER 16-18, 2025 | HOUSTON, TEXAS | GEORGE R. BROWN CONVENTION CENTER

API 686 Foundation and Grouting Systems

Dan Termunde
Chris Matthews-Ewald

ITW

Chockfast®

Dan Termunde

- Regional Sales Manager – Petrochemical Market
- Located in NW Indiana
- Industry Experience of 18 years
- Support Owners, Engineers, EPC's, Contractors, and Distributor Partners
- API 686 Technical Committee Member, Chapter 5

Chris Matthews-Ewald

- Senior Applications Engineer, Epoxy Technologies
- Located in Eastern North Carolina
- 16 years experience in Petrochemical & Heavy Industries markets
- Support Owners, Engineers, EPC's, Contractors, and Distributor Partners
- API 686 Technical Committee Member, Chapter 5

Agenda

- Equipment System
- Foundation Design
- Epoxy Grout Physical Properties & Testing
- API 686 Installation Procedure

Equipment System

Equipment System

Dynamic Equipment

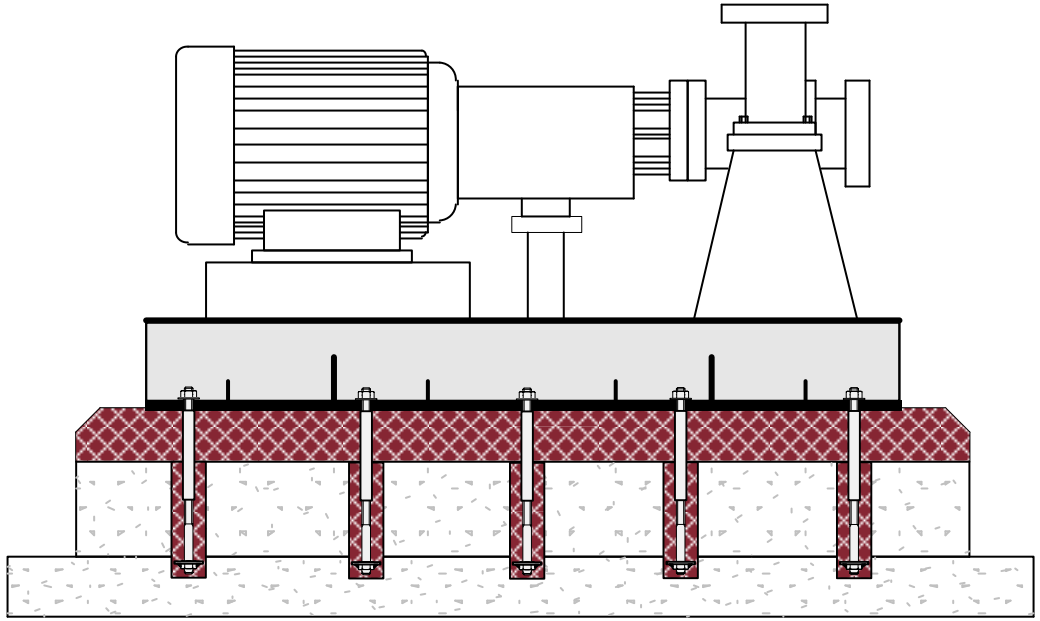
Baseplate

Transfer Medium

Anchor Bolts/Leveling Devices

Concrete Block

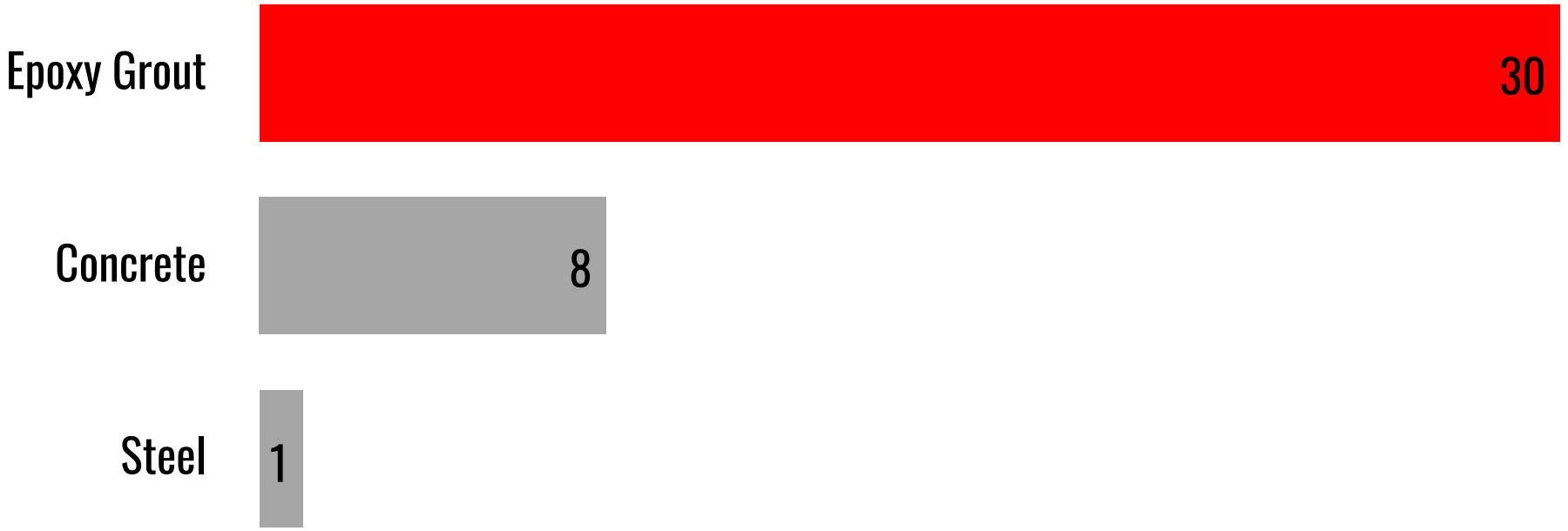
Mat/Sub-surface/Soil



An Equipment System is more than individual components placed together

Equipment System

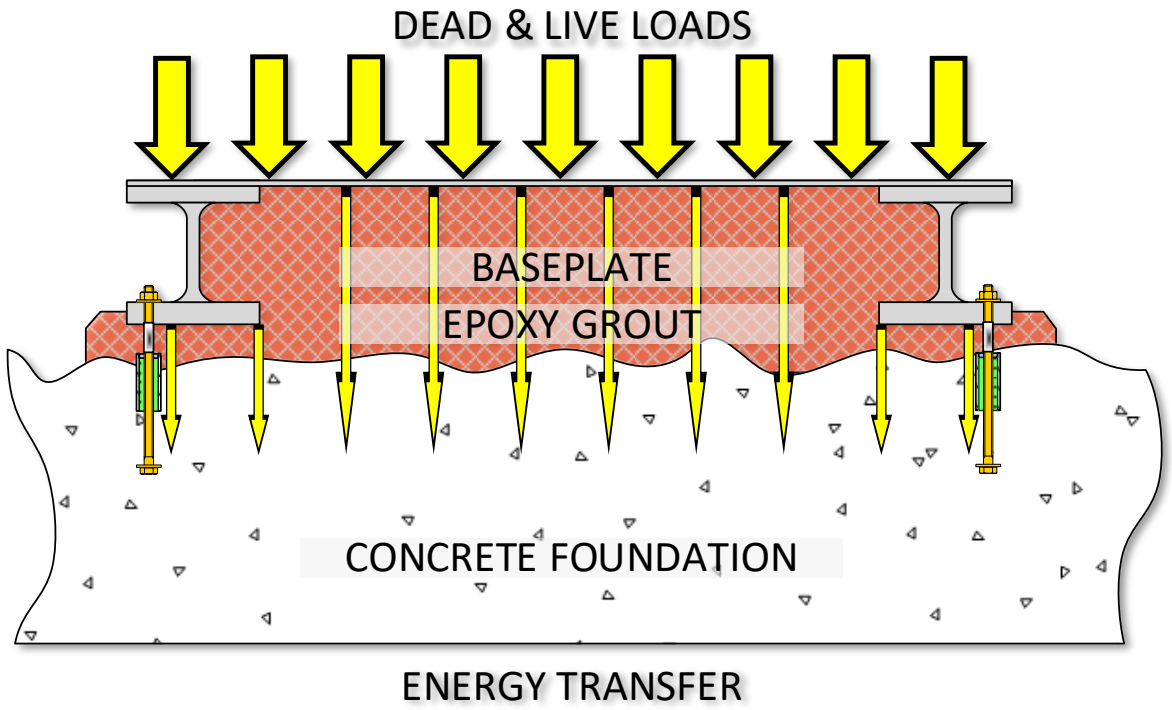
Epoxy grouts have 30x the vibration damping capability of steel.
Relative damping efficiency of common foundation construction materials.



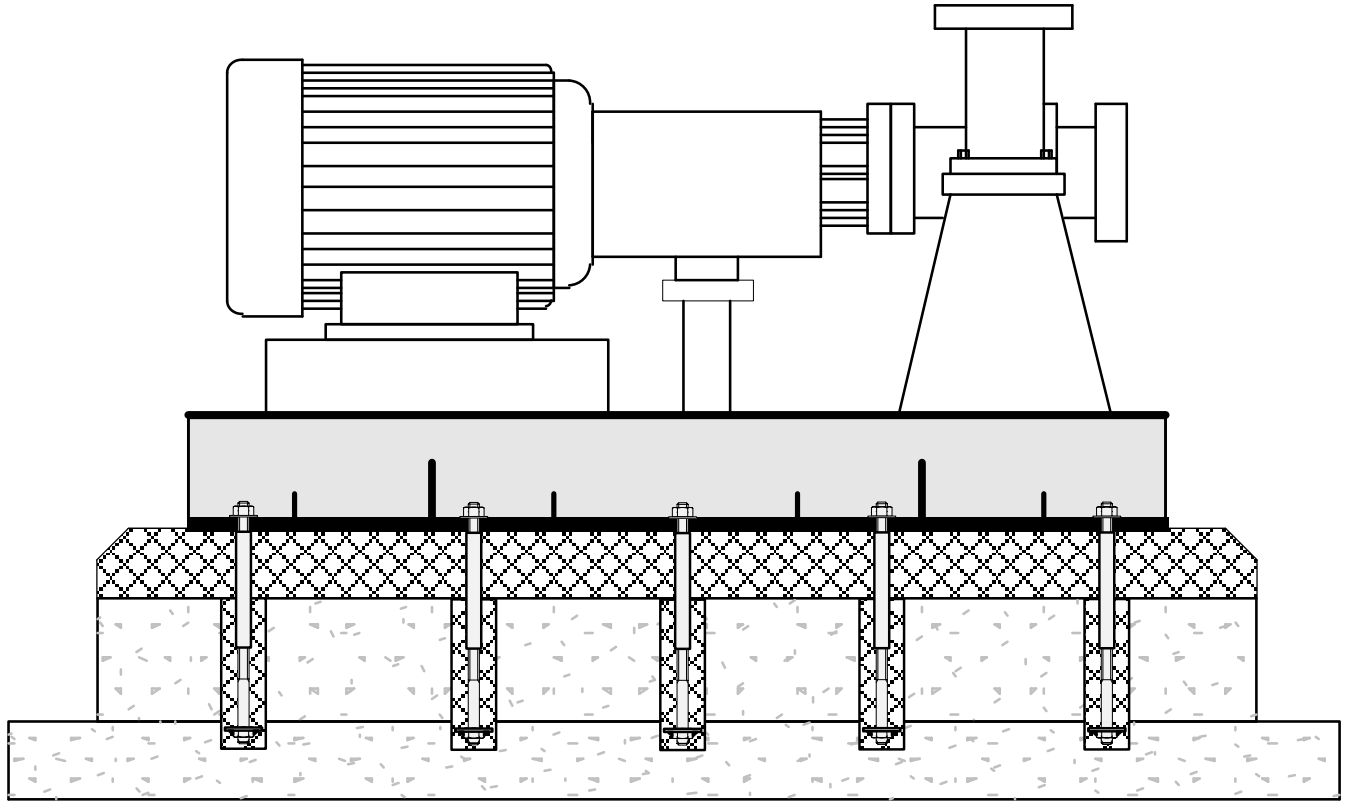
Source: ITW Technology Test Report 04-1996

Owner Impact

- **Main Goals:**
  - Reduced Maintenance
  - Increased Reliability
  - Extend MTBF
- **Averting Downtime:**
  - Optimize Planned Downtime
  - Prevent Unplanned Downtime
- **Costs:**
  - Repair Cost
  - Production Loss

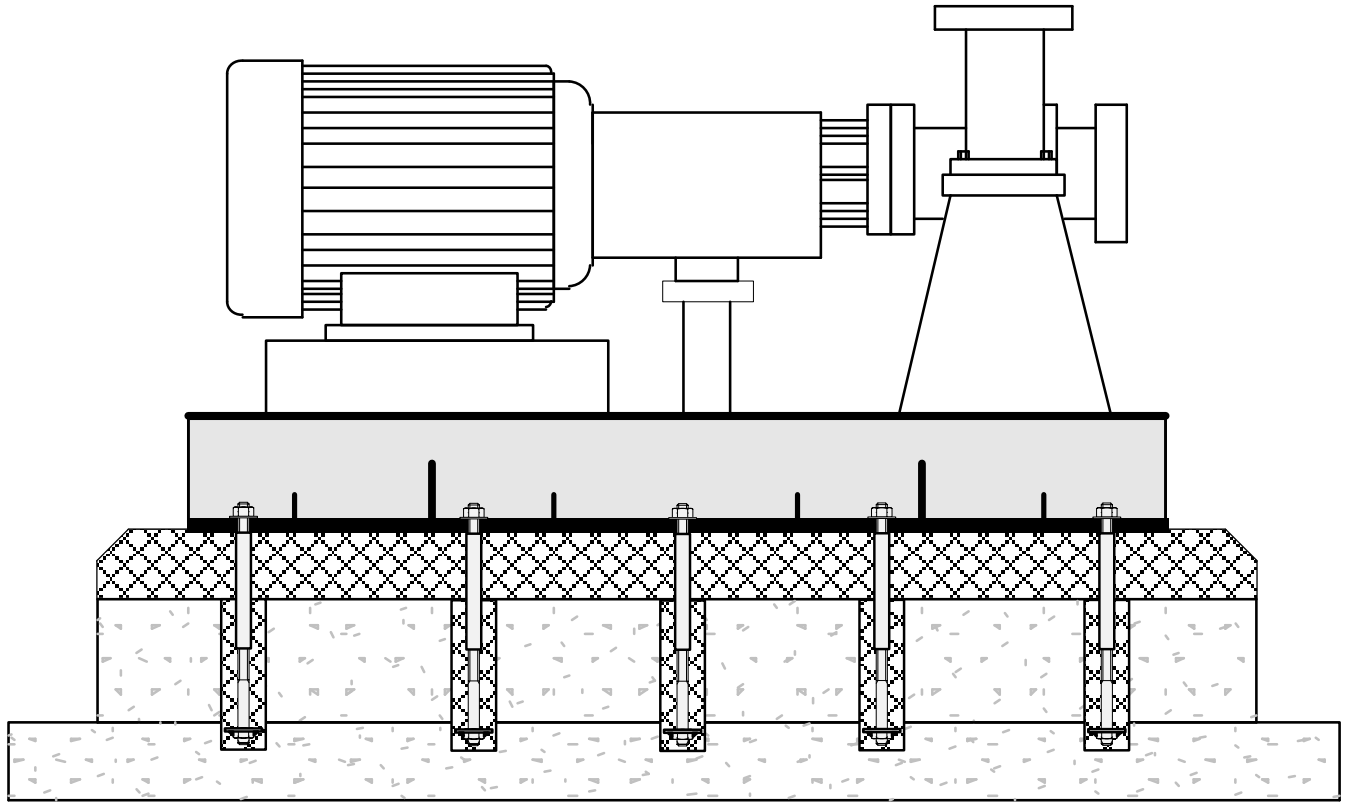


Equipment System Design – Overall System



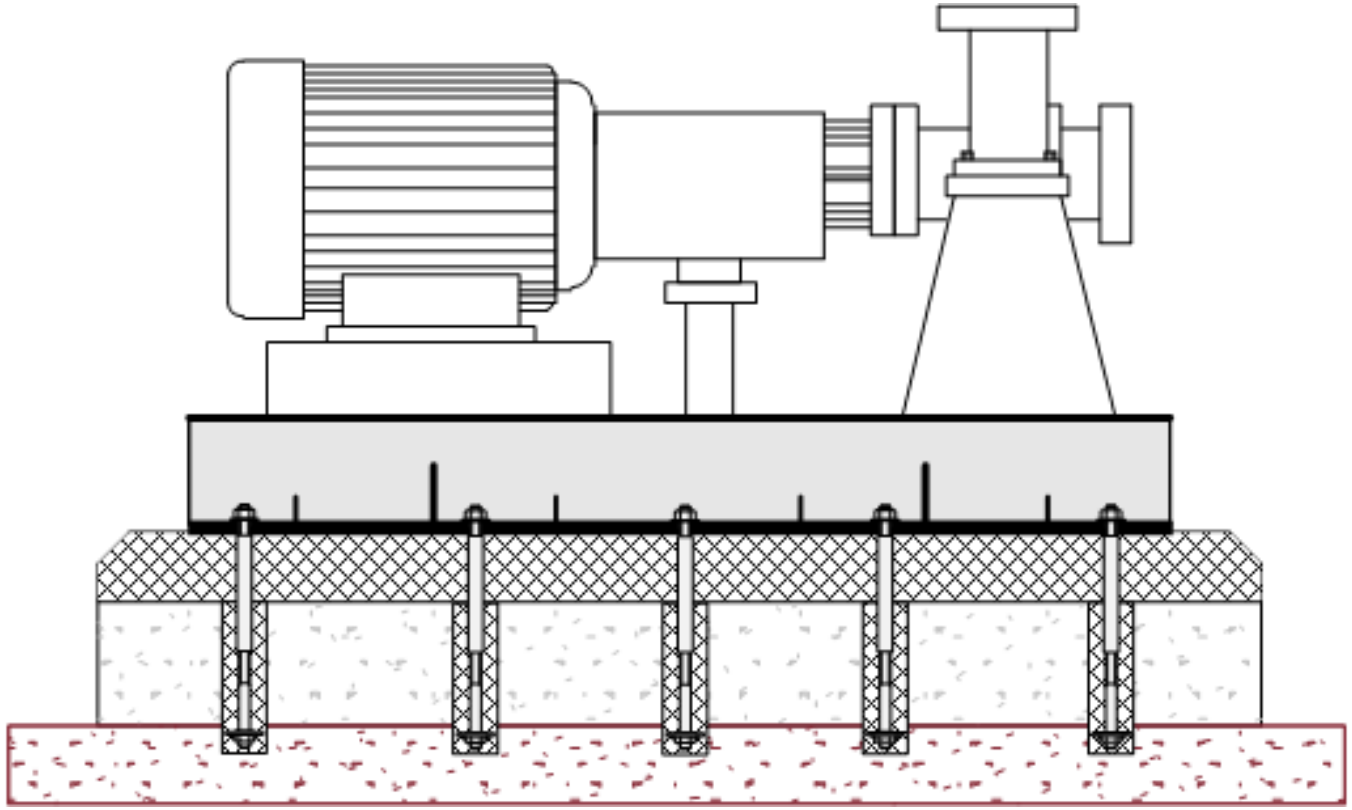
- Overall goal is to create an interconnected system
- Poorly designed systems prone to
  - ↑ vibrations
  - ↓ life of wear components
  - ↑ mechanical failures

Equipment System Design – Overall System



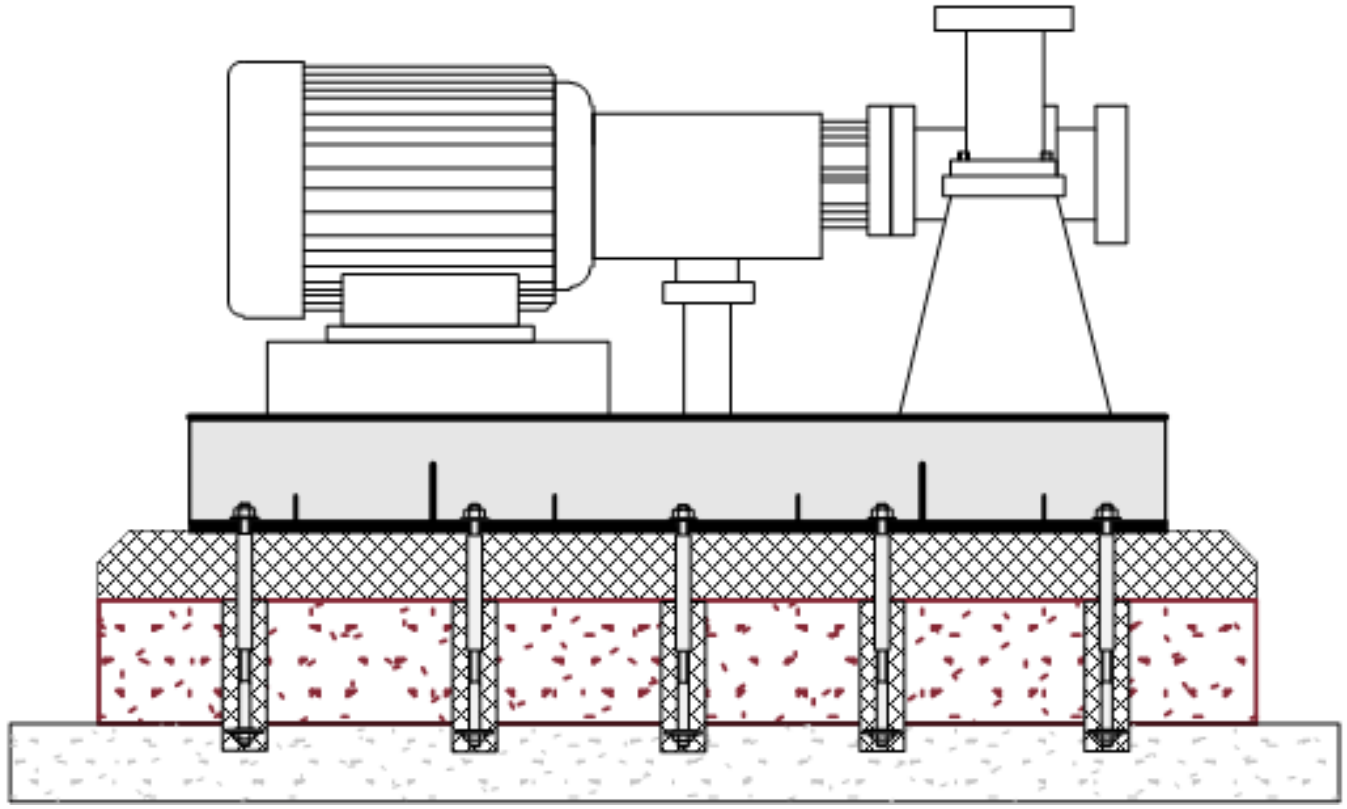
- Foundation design should interconnect components without breaks or separations
- Must define scope of system
- Can combine multiple machines into a single mat
  - Requires thorough understanding of dynamic and static loads
  - mechanical failures

Equipment System Design – Subsurface/Soil



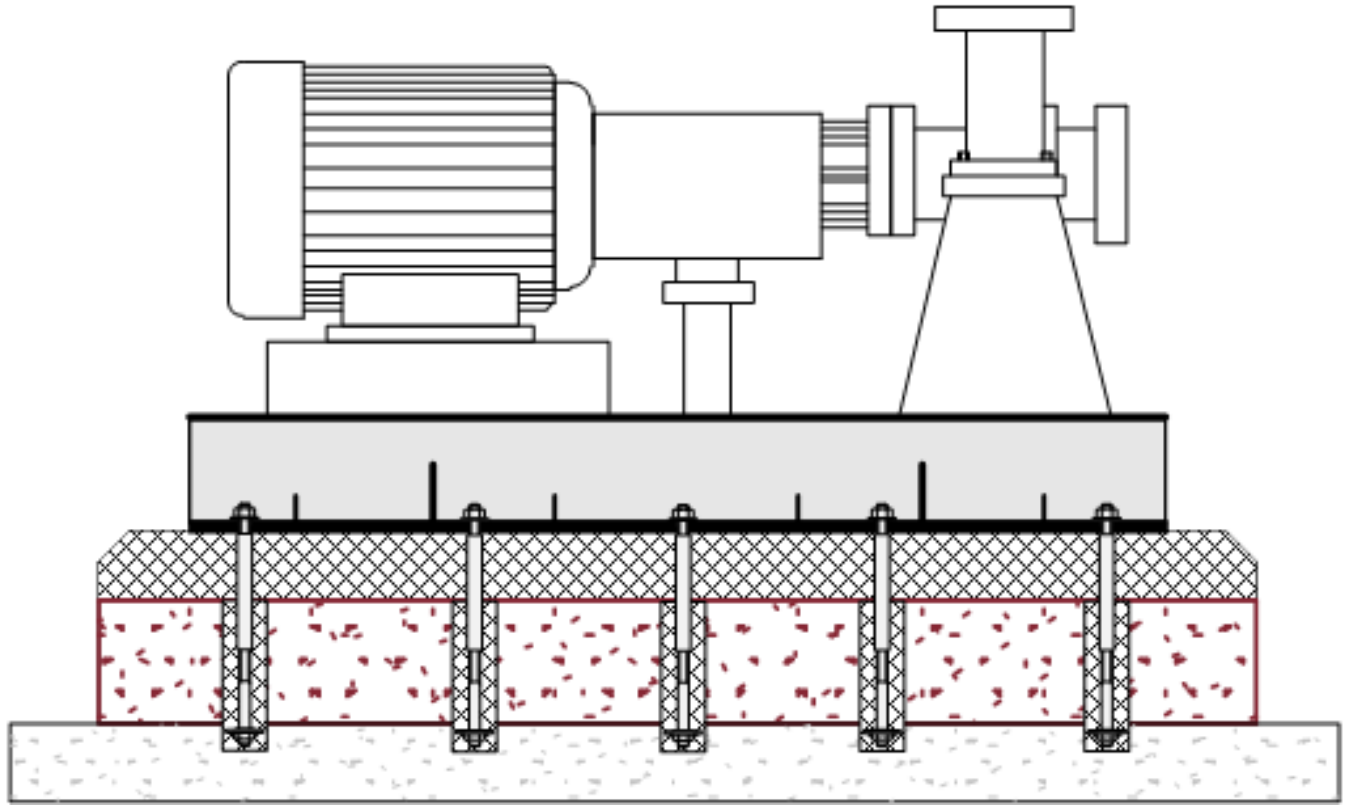
- Not exceed allowable bearing capacity of soil
  - Combined loads ≤ 75%
- Prevent settling of foundation systems
  - Must be large enough size
  - Could lead to piping stress or damage, loss of alignment

Equipment System Design – General Concrete



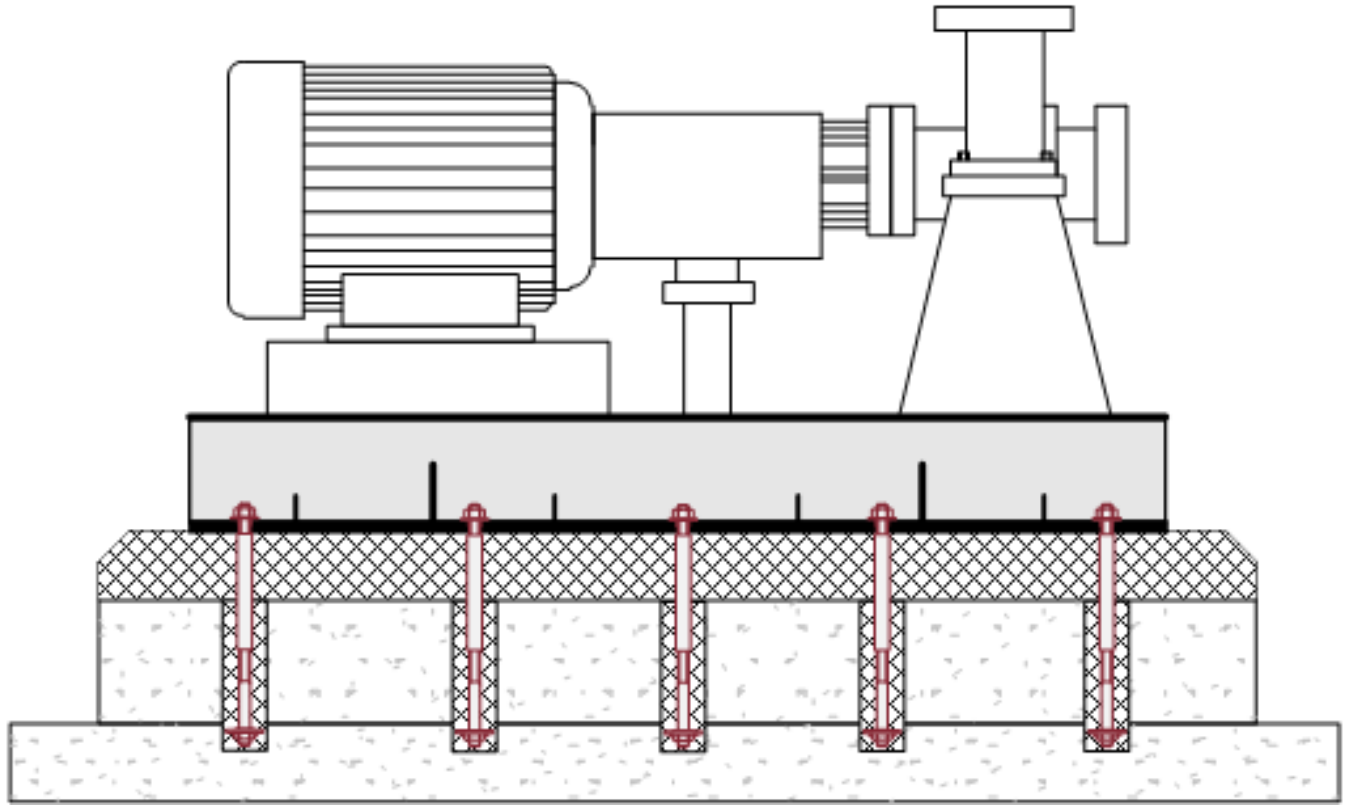
- Min. 28 MPa (4000 psi) comp. str.
  - High early may be used
- Top of Concrete to allow min. 25-mm (1-in.) of grout
- Reinforcing bar spacing less than 300 mm (12 in.) on center
  - Min. size 12.7 mm (#4)
  - Covered by at least 75-mm (3-in) of concrete

Equipment System Design – Concrete Block



- Machine & driver share a common block.
- Block mass should be
  - 2-3x mass of centrifugal and rotary screw machines
  - 5x mass reciprocal machines.
- Min. 100-mm (4-in) above surrounding grade

Equipment System Design – Anchor Bolts



- Mount equipment feet to mounting plate
- For High lateral or shear loading, consider shear attachments.

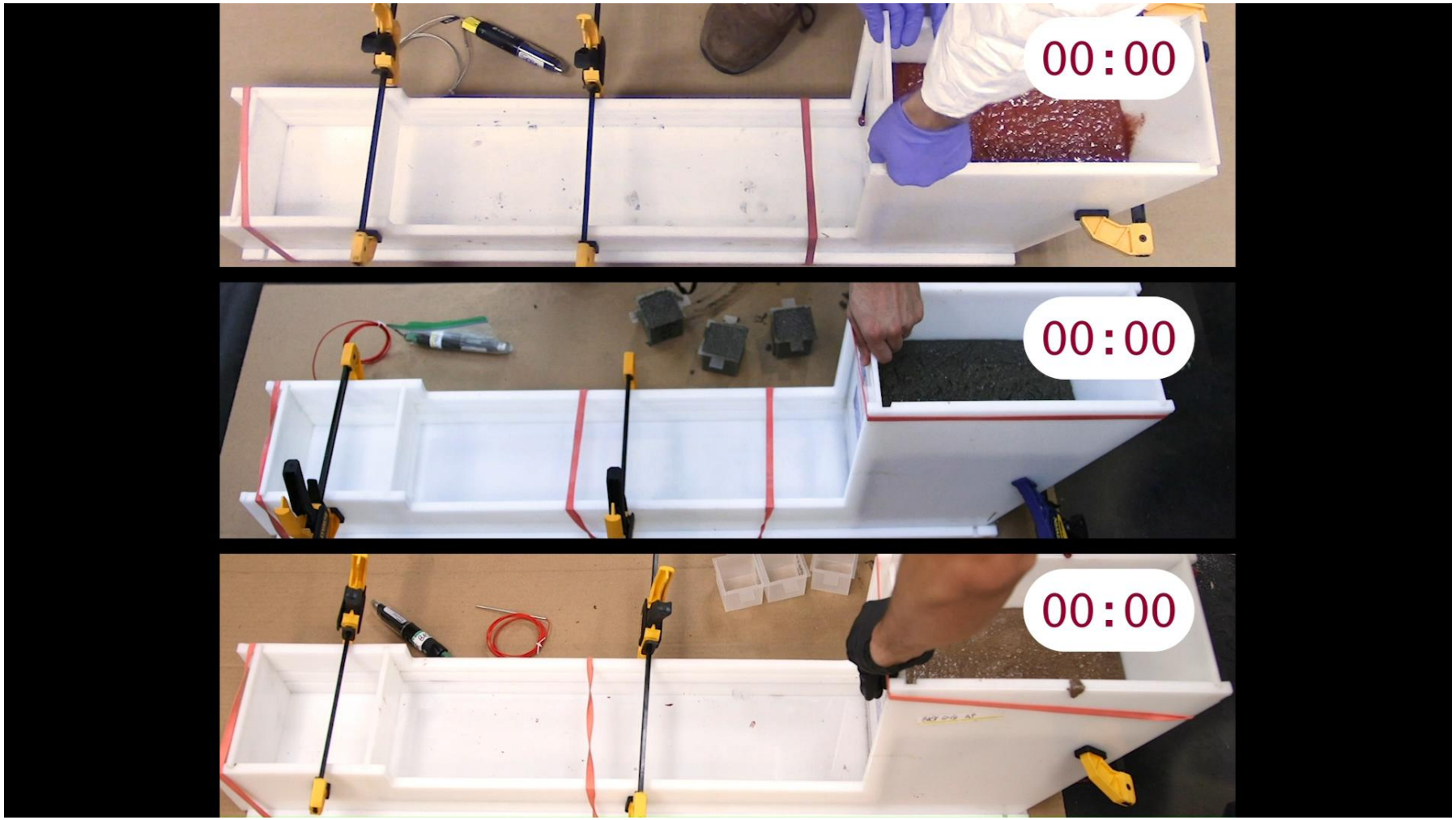
Epoxy Grout Physical Properties & Testing

- Flowability
- Strength
- Modulus of Elasticity
- Coefficient of Thermal Expansion
- Peak Exothermic Reaction

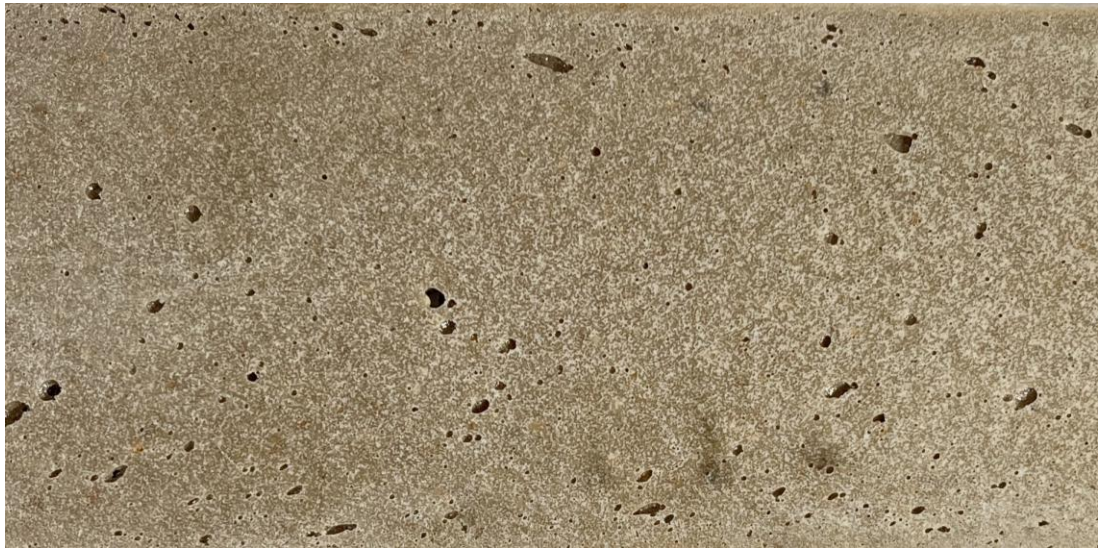
Flowability

- Epoxy Chemistry
- Temperatures
- Aggregate
- Head Pressure/ Pumping
- Resin to Aggregate Ratio

Flowability & Bearing Area



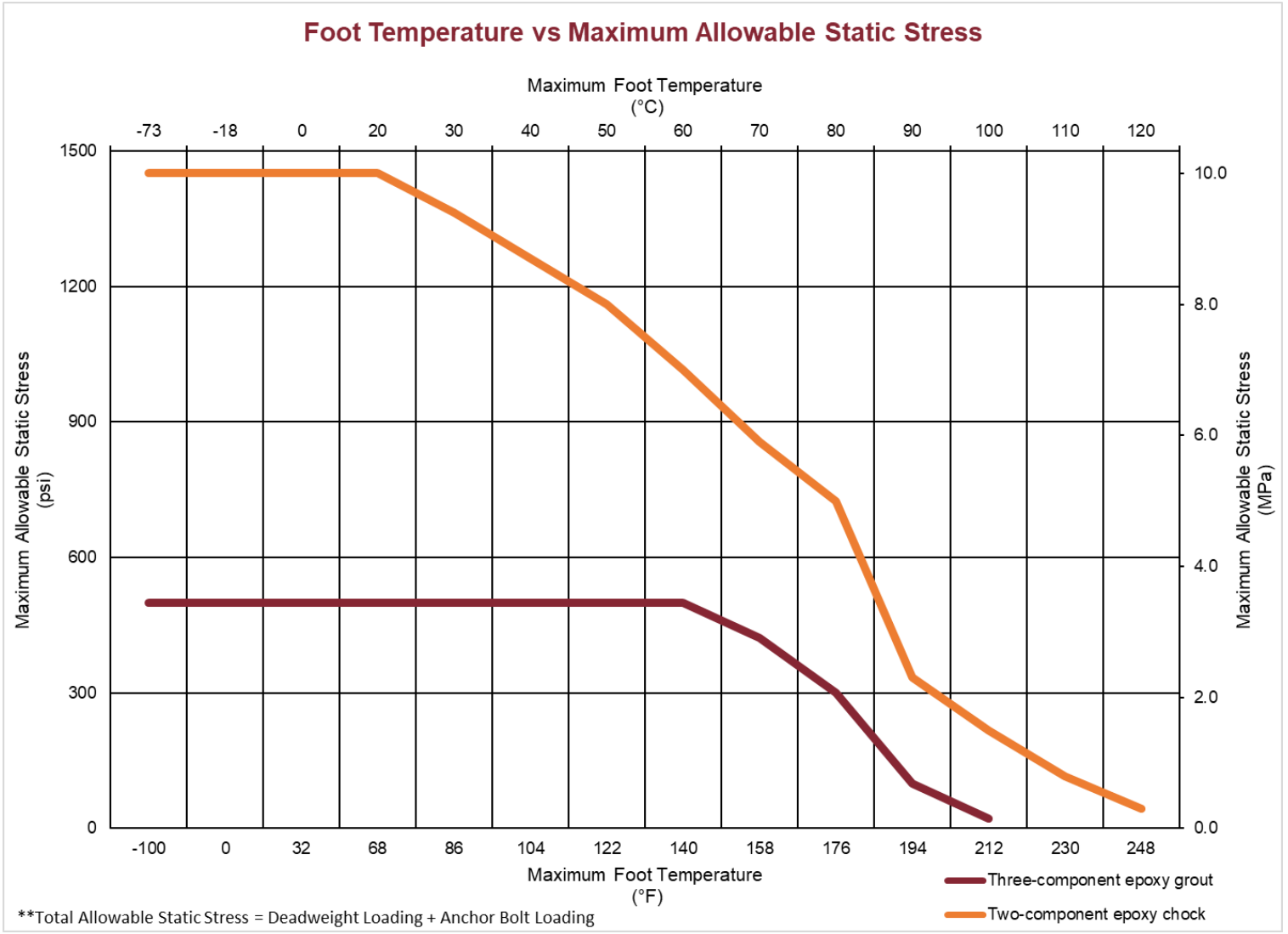
Flowability & Bearing Area



Strength

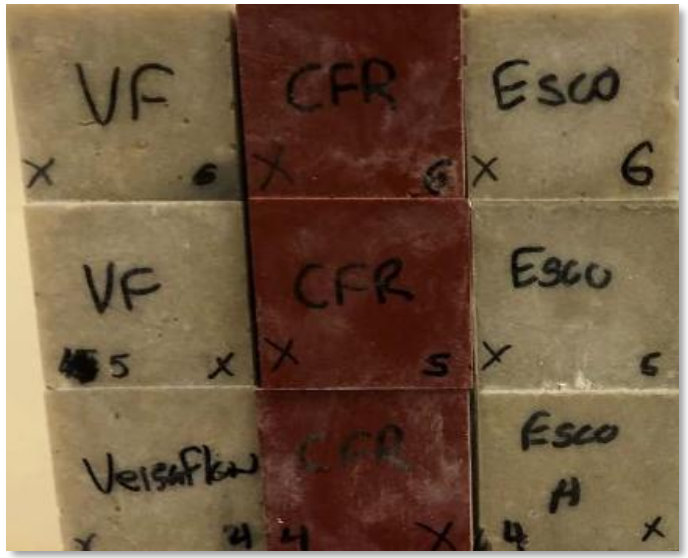
- Compressive
- Tensile
- Bond
- In-service Temperatures

In-Service Temperature Impact



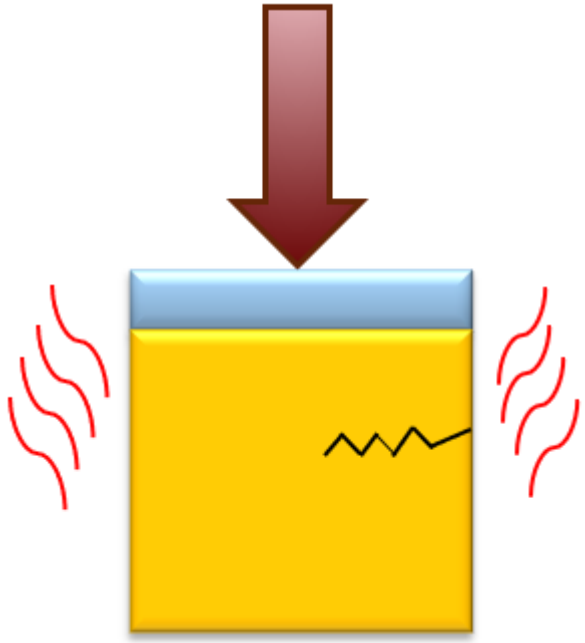
Compressive Strength

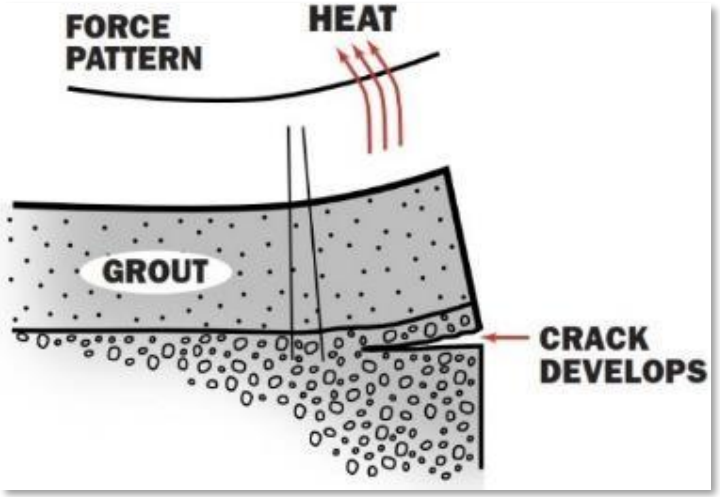
- ASTM C 579
- Method B
- Load Rate II



Peak Exothermic Reaction

- Measures Highest Internal Material Temperature During Curing
- Time to Reach Peak Exotherm
- High Internal Thermal Stress:
  - Cause Cracking
  - Reduction in Modulus
  - ↑ Potential for Edgelifting
  - Base Plate Warping





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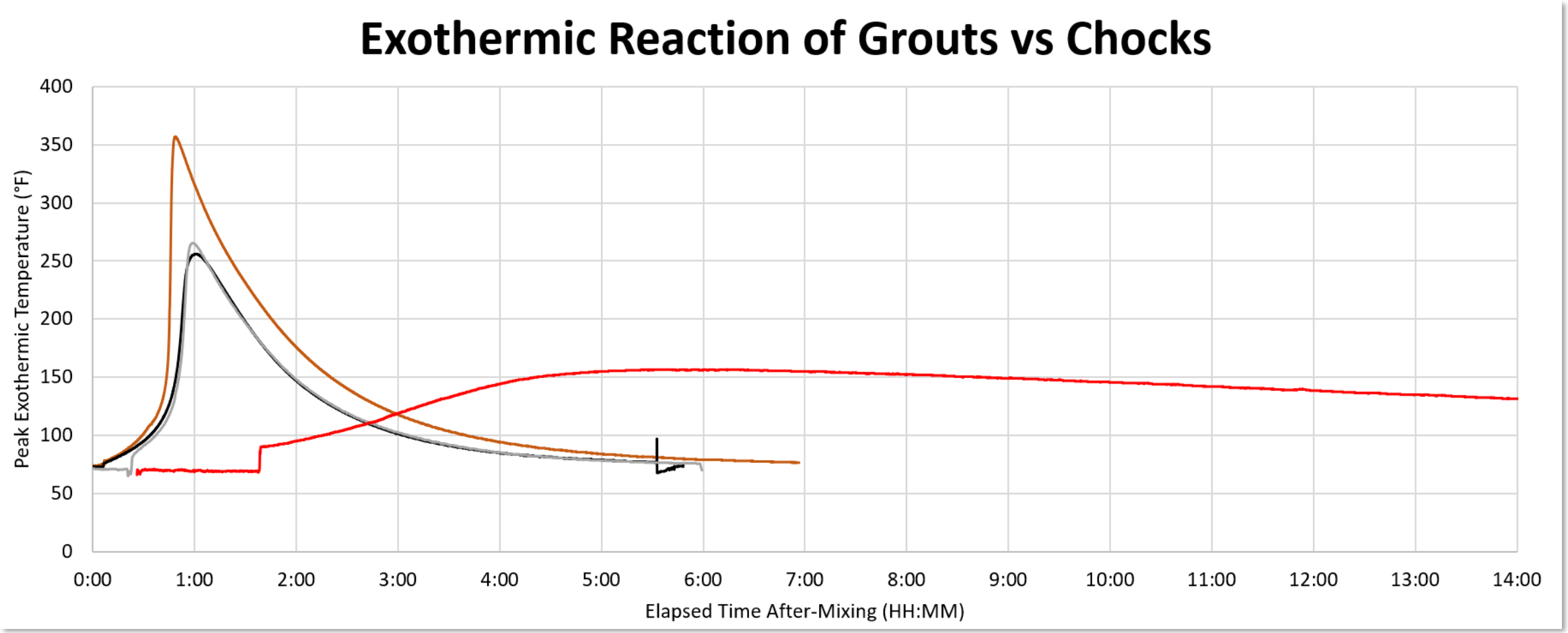

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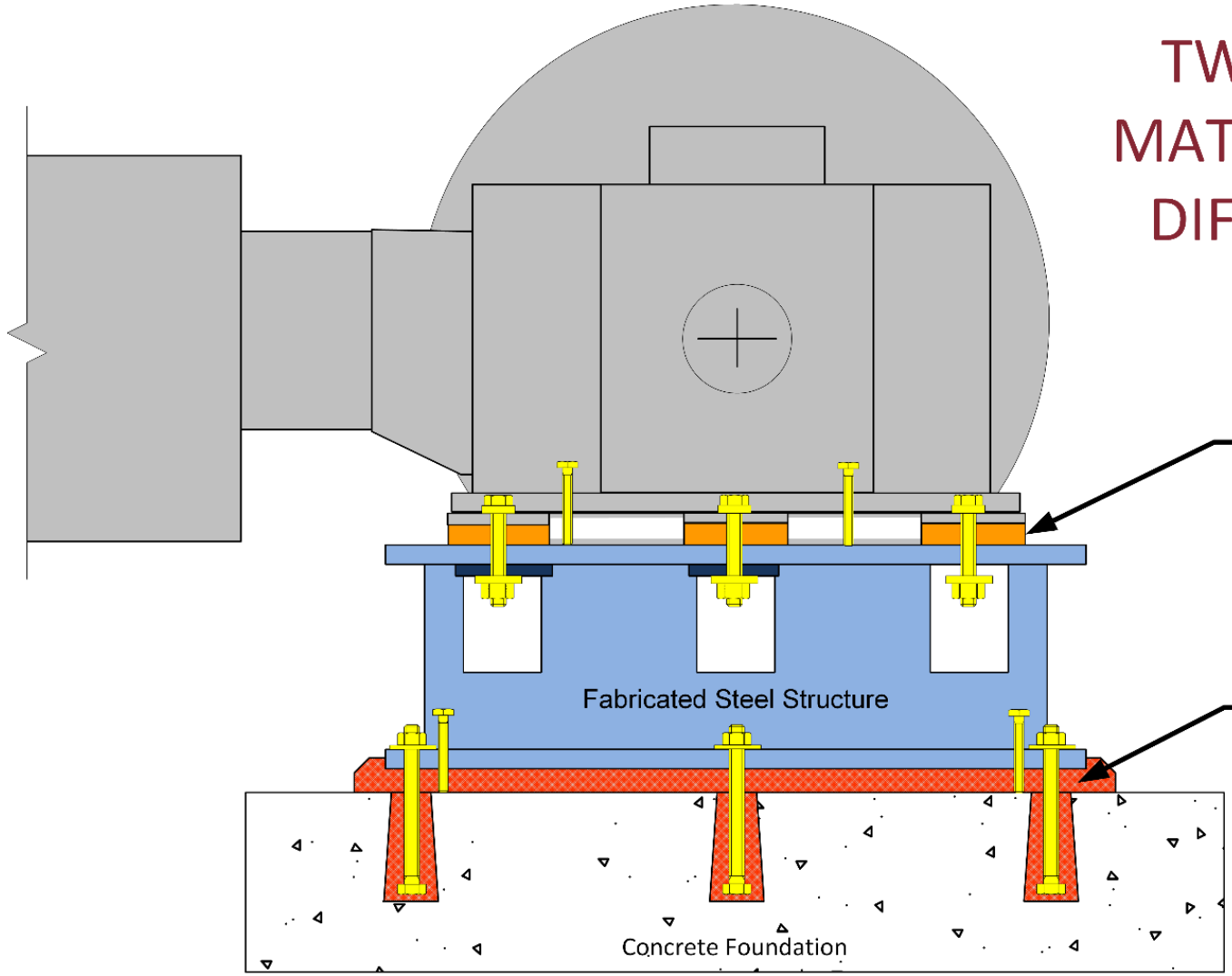


TWO DIFFERENT MATERIALS USED IN DIFFERENT WAYS

CHOCKS

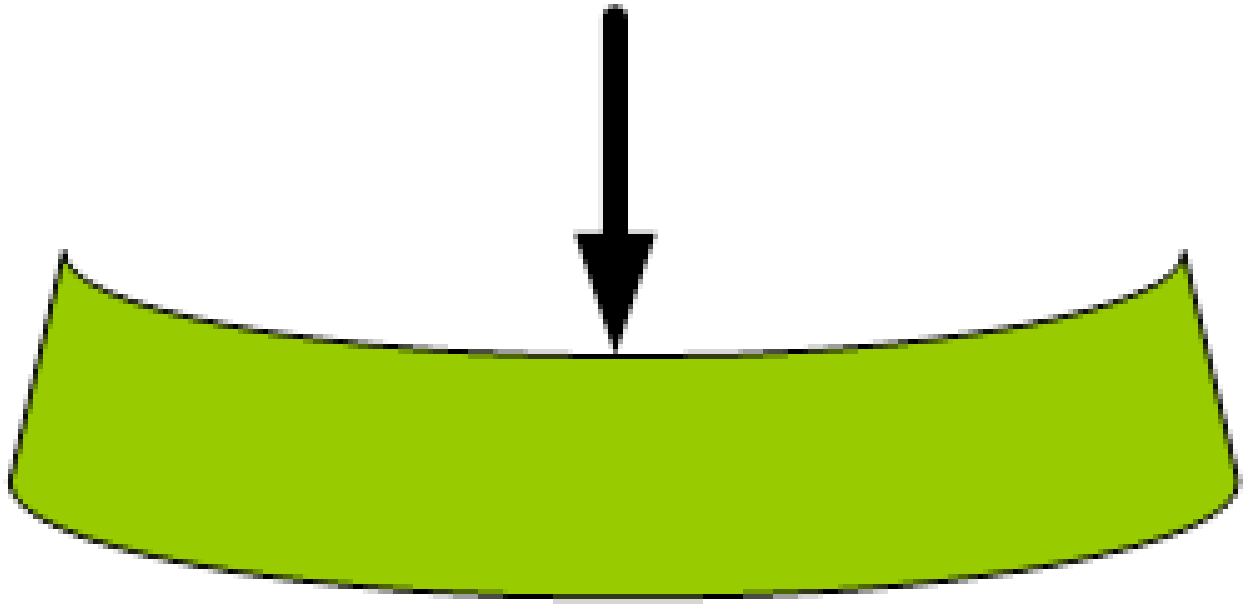
- SMALL CONTACT AREA
- AROUND ANCHOR BOLTS
- USUALLY SMALLER HEIGHTS

GROUTS

- LARGE CONTACT AREA
- OVER ENTIRE FOUNDATION
- FILL ANCHOR BOLTS POCKETS
- ALSO FILL SKID
- USUALLY LARGER HEIGHTS

Chocking Compound Used as Grout

Modulus of Elasticity



Rigid

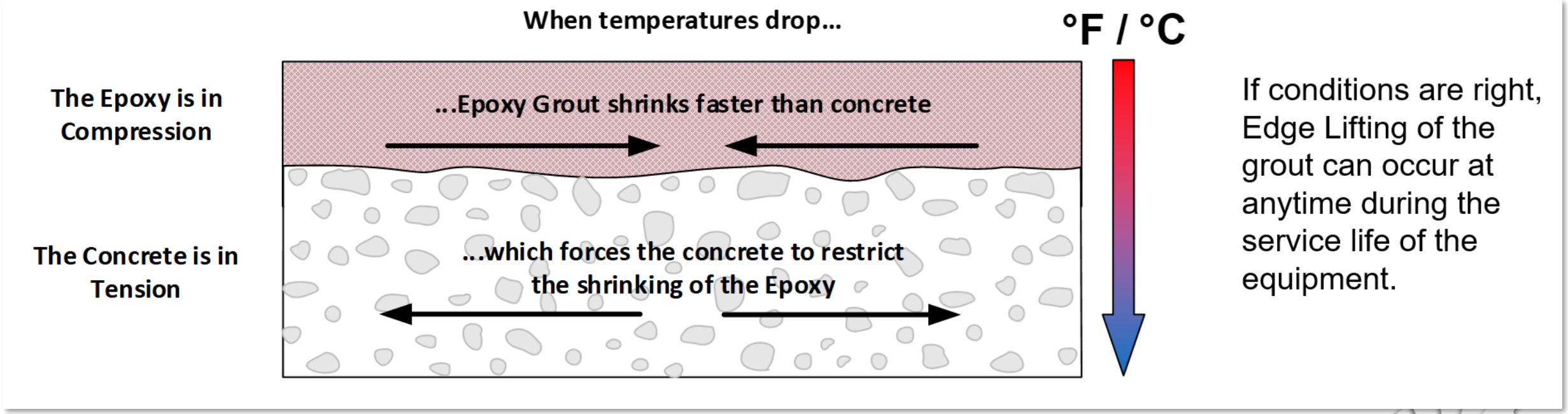
Cementitious Grouts ~3.5 x 10^6 per ASTM C 469

Flexible

Epoxy Grouts ~1.8 x 10^6 per ASTM C 580

Coefficient of Linear Thermal Expansion

- As external temperatures increase and decrease, materials expand and contract at different rates

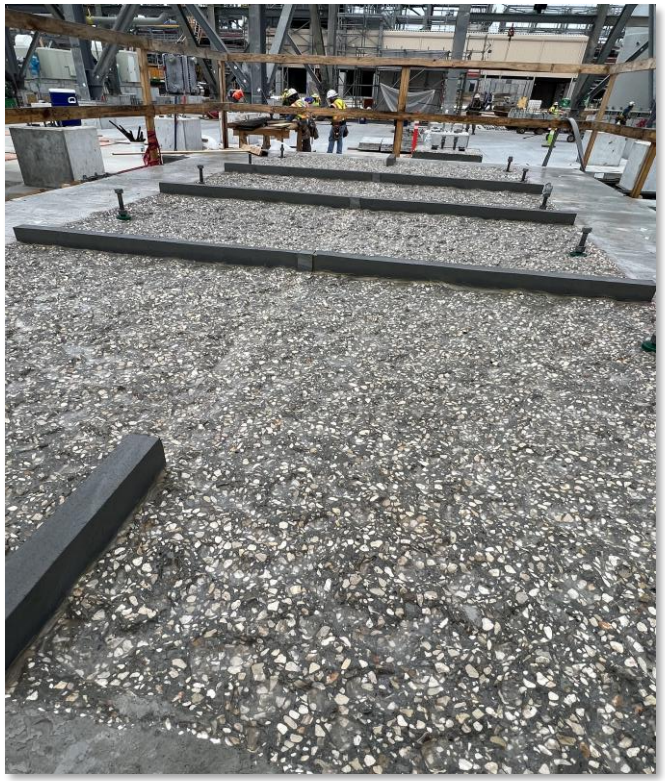


API 686 Installation Procedure

- Concrete Surface Prep
- Edge of Slab Detail
- Equipment Prep
- Anchor Bolts
- Expansion Joints
- Formwork
- Temperatures
- Mixing
- Placement
- Finishing
- Voids
- Cracking

Concrete Surface Prep

- Cured at least 7 days prior to surface prep
- Epoxy grout never place on “green” concrete
- 1” (25 mm) peak to valley Concrete Surface Profile
- No Bush Hammers
- 2” (50 mm) Minimum Clearance



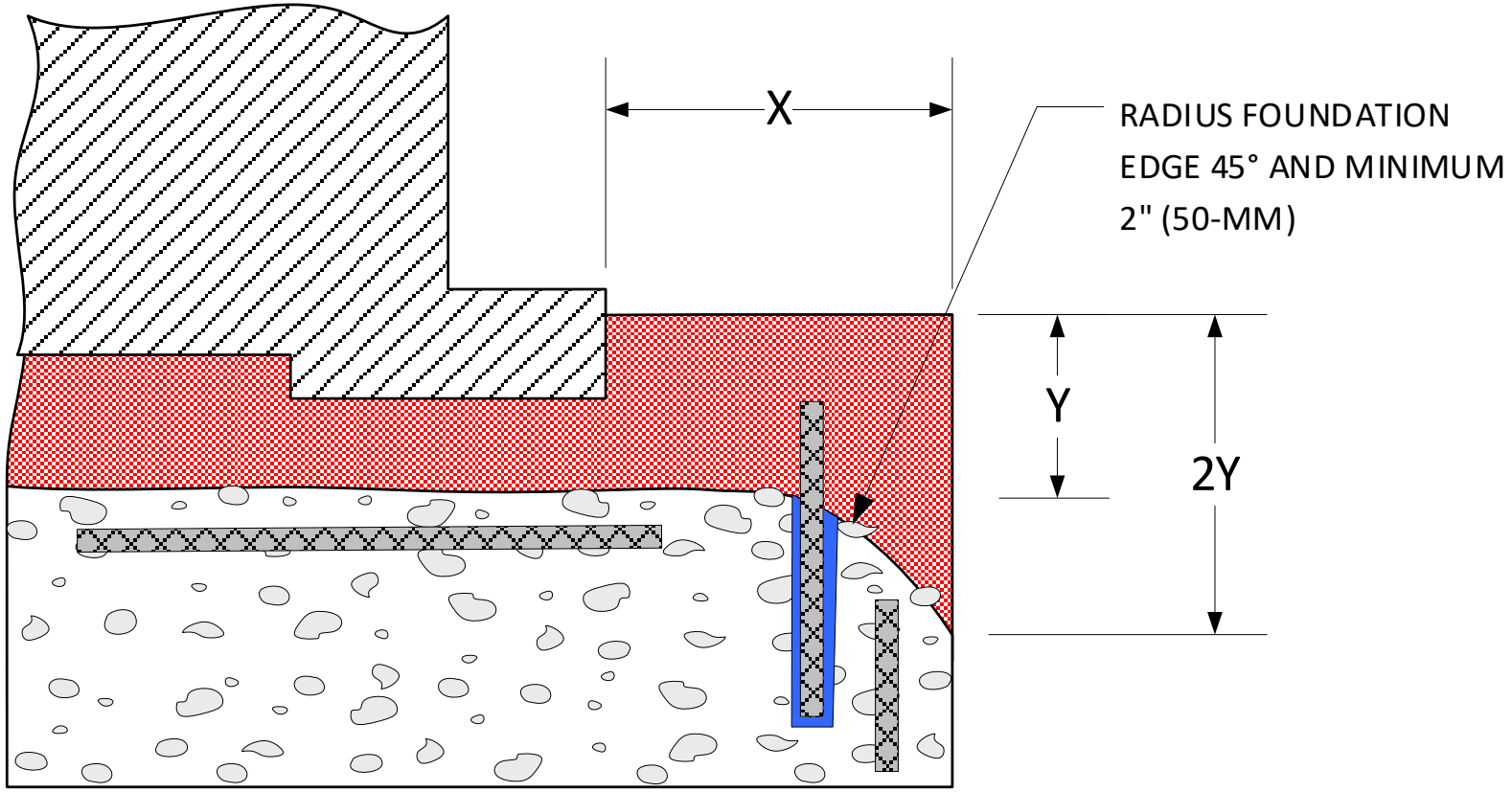
Concrete Surface Prep

Concrete Surface Prep

- **Edgelifting Occurs:**
  - Epoxy grout shoulder taken to the edge of the elevated concrete foundation
  - Forces at the epoxy grout/ foundation interface
  - Tensile strength of concrete foundation are exceeded

- **Edgelifting Causes:**
  - Thermal Stress
  - Linear Shrinkage
  - Difference if CLTE

Concrete Surface Prep

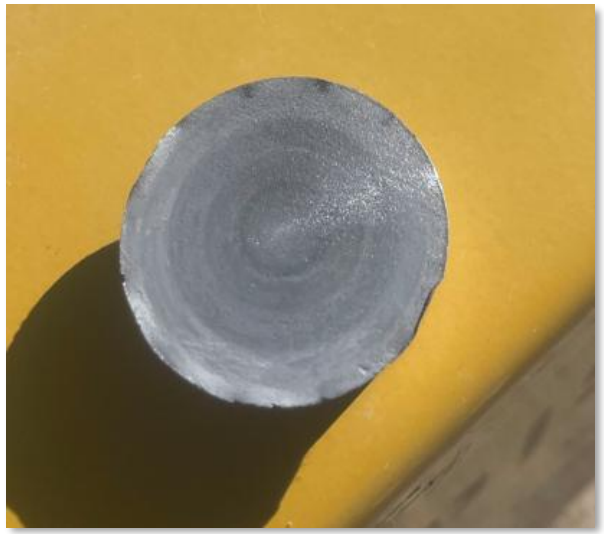


WHEN DEPTH (Y) < SHOULDER WIDTH (X)
BEST OPTION - ROUND EDGE OF CONCRETE &
ADD REBAR DOWEL PINS

Mounting Plate Prep

- Mounting plate grout surfaces should have been prepared and ready for installation by the OEM

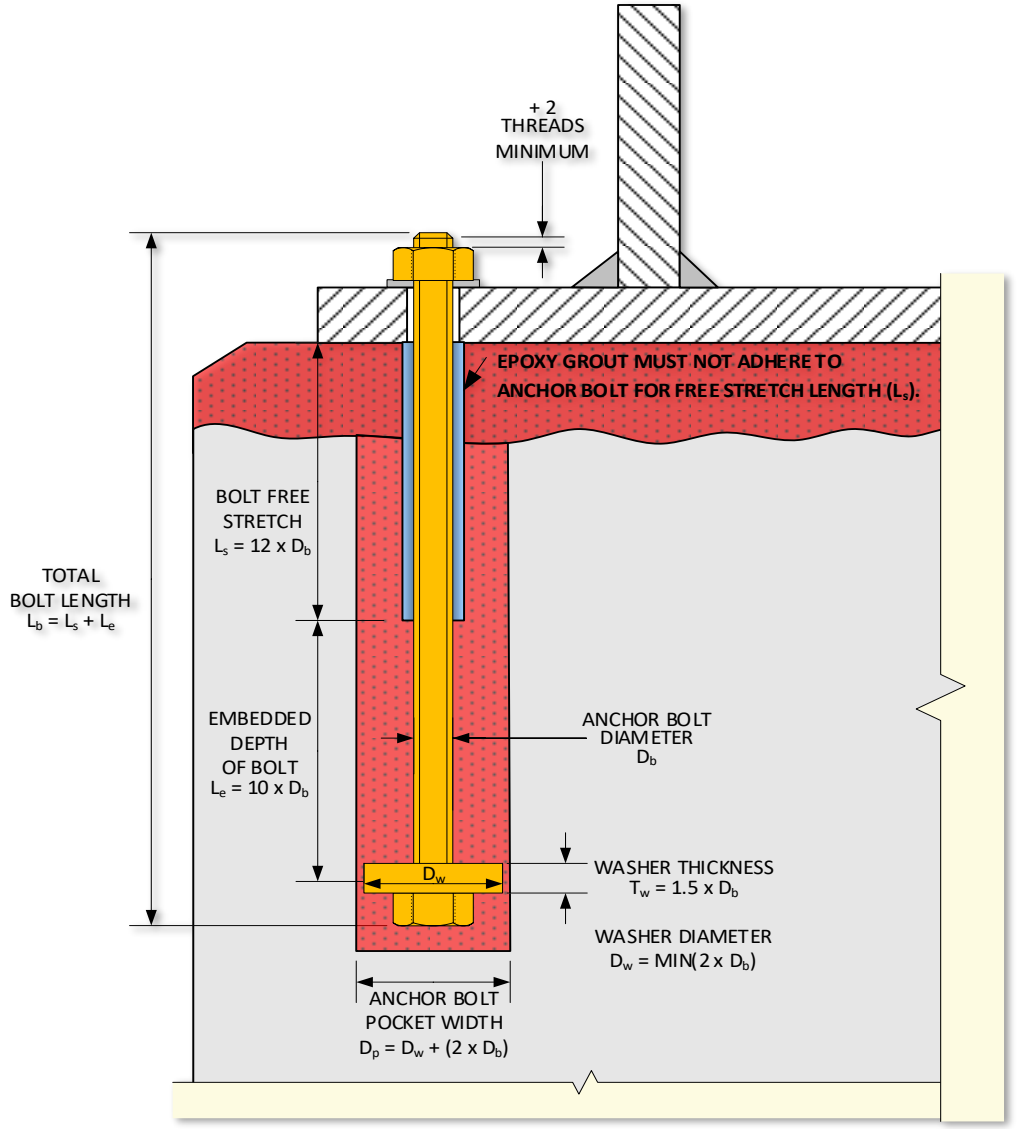
- Oil, grease, and dirt are to be removed by solvent wipe prior to grouting



Anchor Bolts

- **API Pumps:**
  - Pre-torque anchor bolts 10% of final torque value prior to grouting

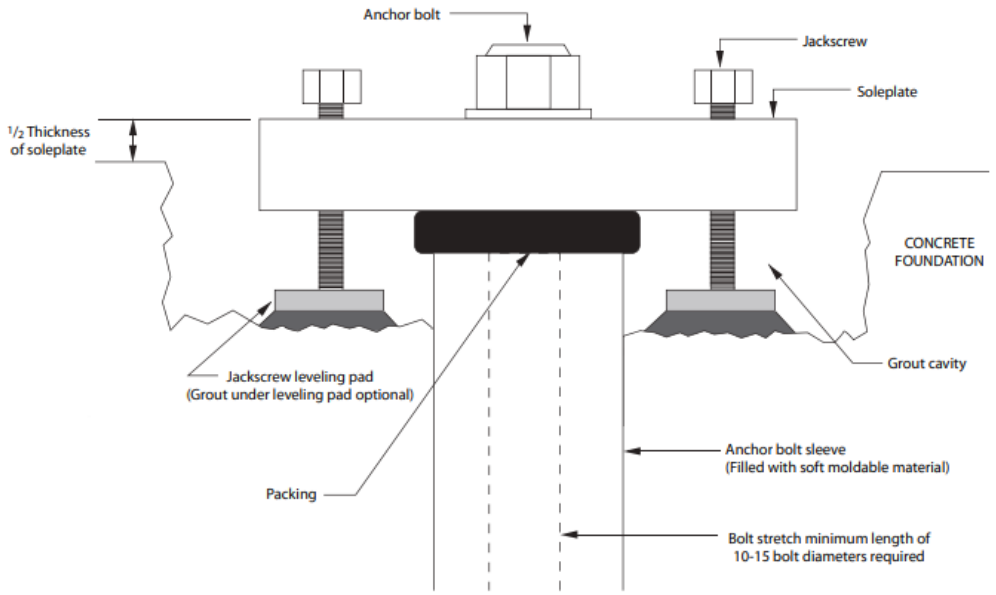
- **Compressors:**
  - Frame hold down bolts must be snugged down to hold frame into place prior to grouting
  - After frame is leveled, it must sit for 24 hours prior to grouting
  - Level and frame alignment must be check prior to grouting



Leveling Pad & Jackscrews

Annex F
(informative)

Typical Grouting Installation of Soleplates



For Special Purpose Equipment

Figure F.1—Typical Grouting Installation of Soleplates

- Shims and wedges are NOT to be used

Leveling Pad & Jackscrews

- Shims and wedges are NOT to be used
- Outside corners to have a 2” radius

Expansion Joints

- Incorporated into large epoxy grout pours
- Breaks up pour into smaller pours
  - Controls the volume of epoxy grout placed
  - Helps with constructability

Expansion Joints

- 1” wide closed-cell neoprene foam
- Placed every 4’ to 6’ intervals
  - Do not bridge internal crossmembers or mounting plate
  - Min. 3” away from anchor bolt or jackscrew
- Fixed into position with RTV silicone
- Sealed after grout is cured

Expansion Joints

Expansion Joints

Expansion Joints

Formwork

- Withstand head pressure
- Attached using drilled anchors
- Apply 3 coats of paste wax
- Seal grout forms using silicone
- 1” (25 mm) 45-degree chamfer on all vertical and horizontal corners

Formwork

Temperatures

- All **components of the grout** must be within 65°F (18 ° C) to 85 ° F (29 ° C) for 48 hours prior to grouting
- All **concrete foundations and metal surfaces** must be within 65 ° F (18 ° C) to 90 ° F (32 ° C) for 48 hours prior to grouting

Shelter

Mixing

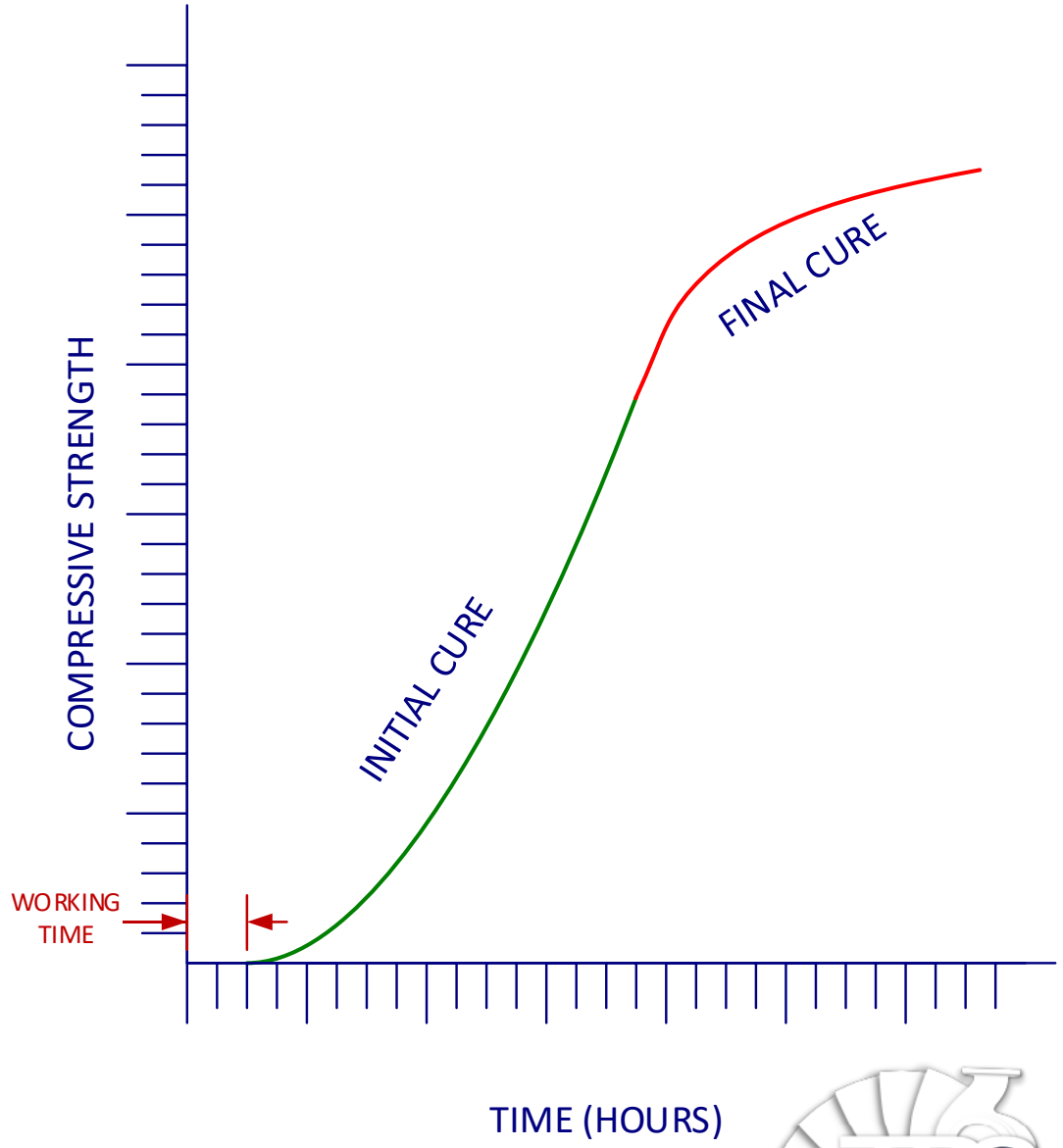
- No partial units of epoxy, resin, hardener, **or aggregate** are to be used
- Resin and hardener are to be blended with a “jiffy” mixer
  - 200 to 250 RPM
- Add blended epoxy to a horizontal shaft or vertical shaft mortar mixer
- Full bags of grout aggregate are to be added to the mixer
- Mix until the aggregate is completely “wet-out” with resin

Blending the Resins

Wetting out the Aggregate

How much time do I have?

- **Working Time/Pot Life**: Time from mixing components to transition to a solid. Effective time to place material
- **Initial Cure**: Where solid epoxy grout reaches the 60% to 80% of its ultimate physical properties. (Expressed in hours)
- **Final Cure**: Additional time required for epoxy grout to reach 100% of its rated physical properties. (Expressed in days)

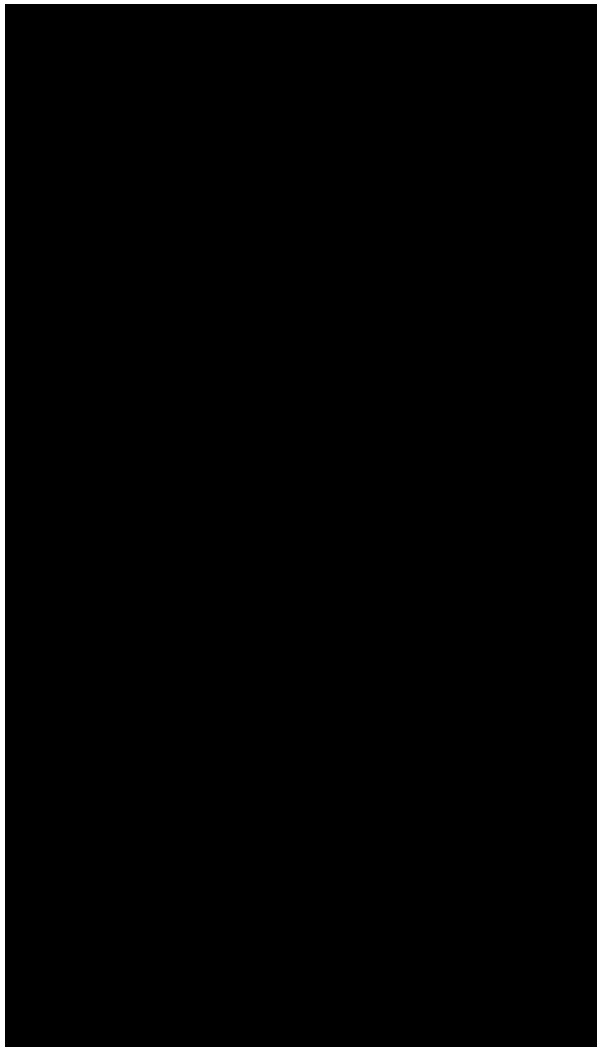


Placement

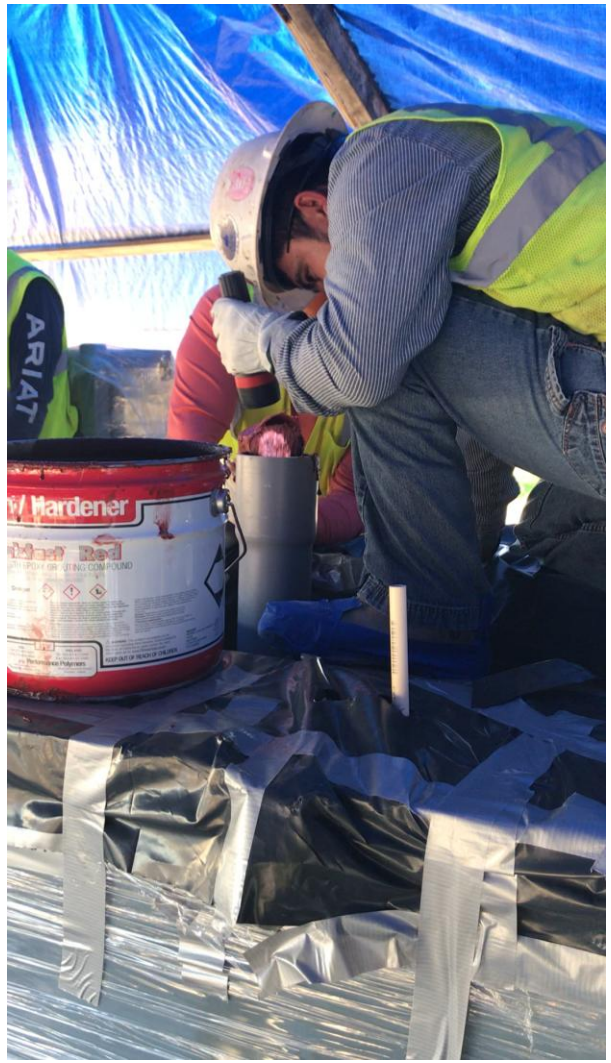
- One of two locations to place grout:
  - From one side to the other
  - From the middle out
- Key is to **build** and **maintain** head pressure
- Let the grout do the work and push the air out

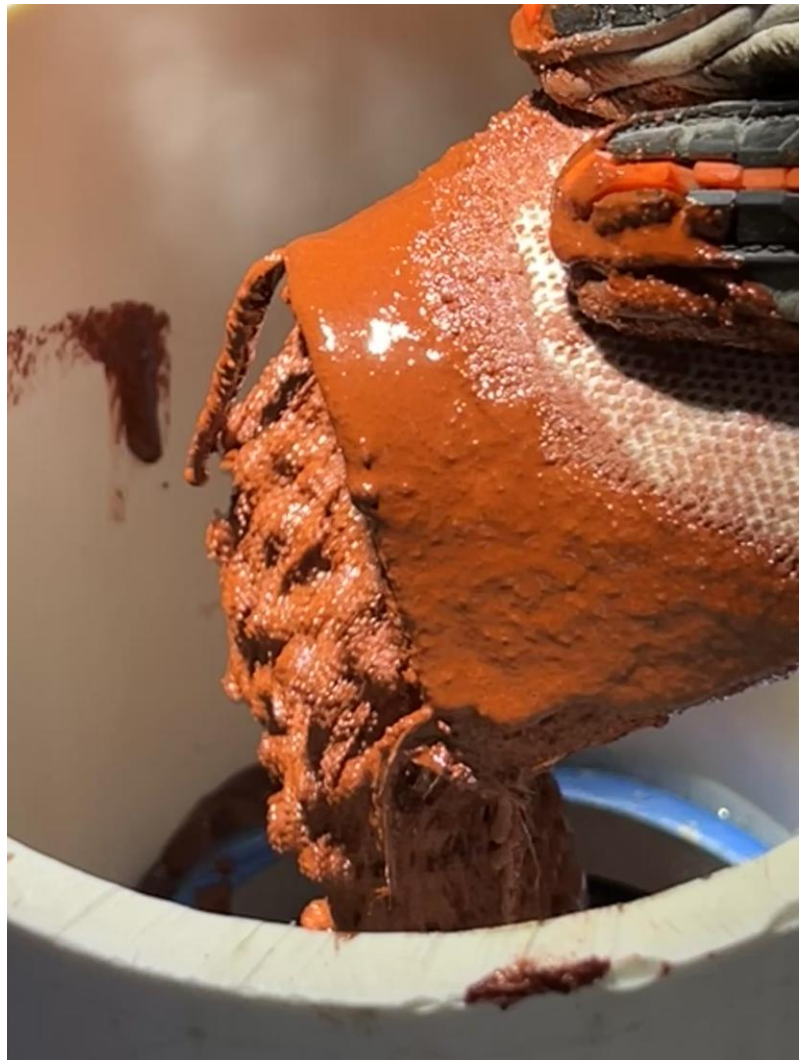
Placement

Pumping Epoxy Grout



Pumping Epoxy Grout

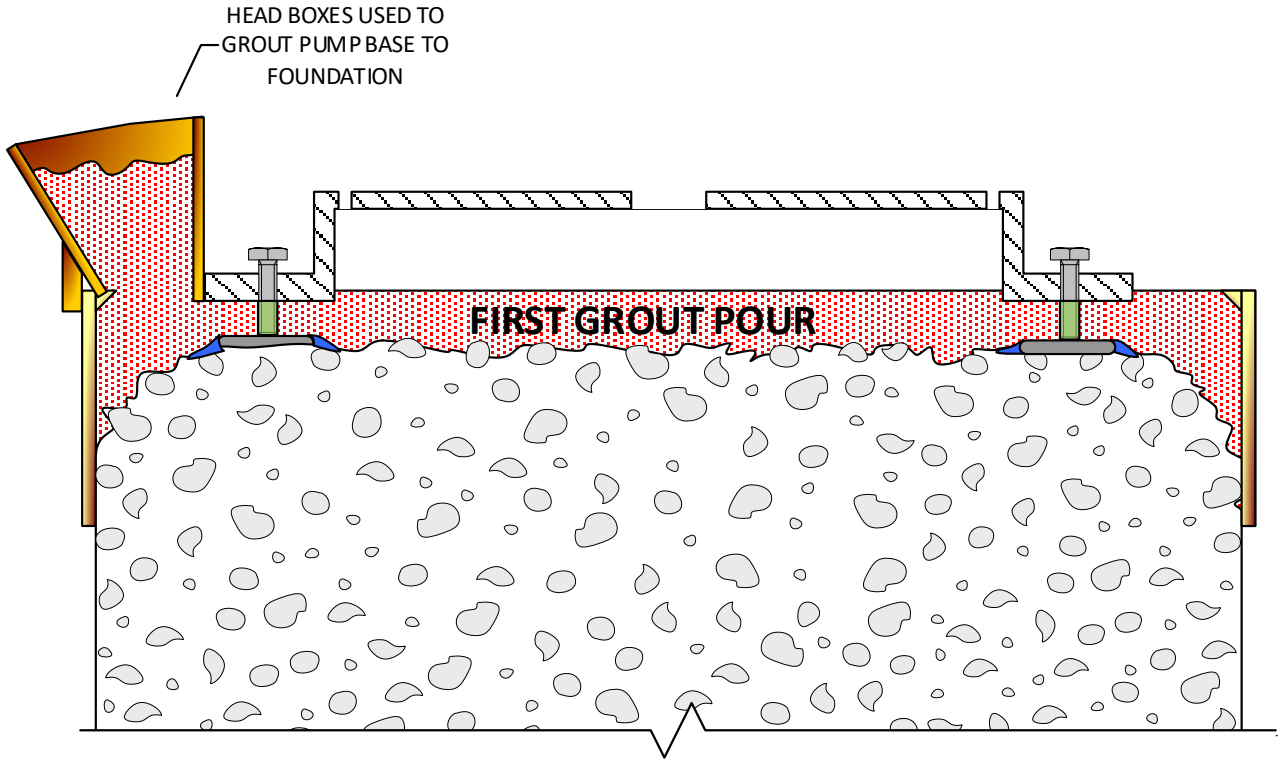




Pump Cavities

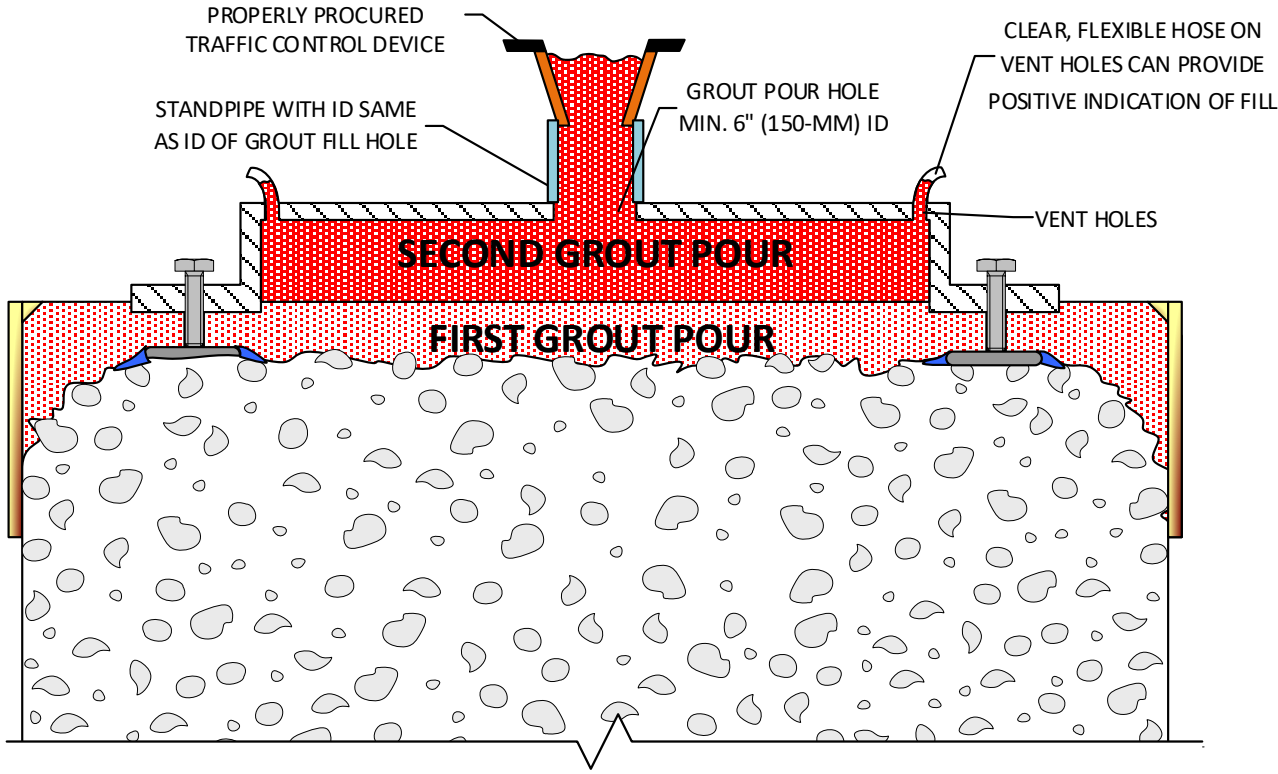
Pump Cavities

- A Two-Stage Pour first requires a base pour between the bottom flange of the baseplate and the concrete
- This pour is allowed to cure until load-bearing capacity is achieved
- Often referred to as a “seal” or “lock-in” pour



Pump Cavities

- The second stage cavity pour is then accomplished, though may be accomplished in multiple individual layers
- Second stage is used to add mass and rigidity to the pump base plate, reducing natural frequency of foundation system
- Second stage is poured after first stage has become structurally stable, usually 16-24 hours

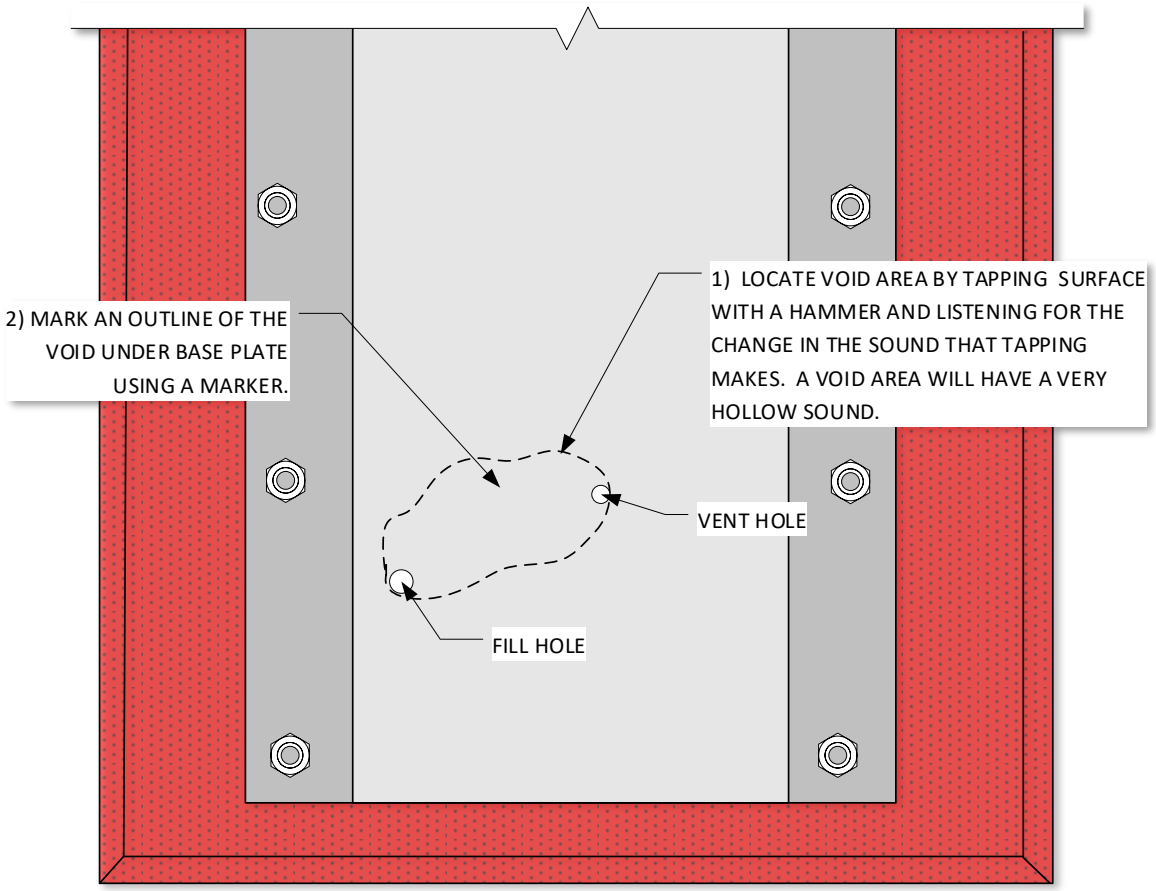


Finishing

Pinning – Level Up Pour

Sounding for Voids

- Grout voids should NOT be accepted as “**Normal**”



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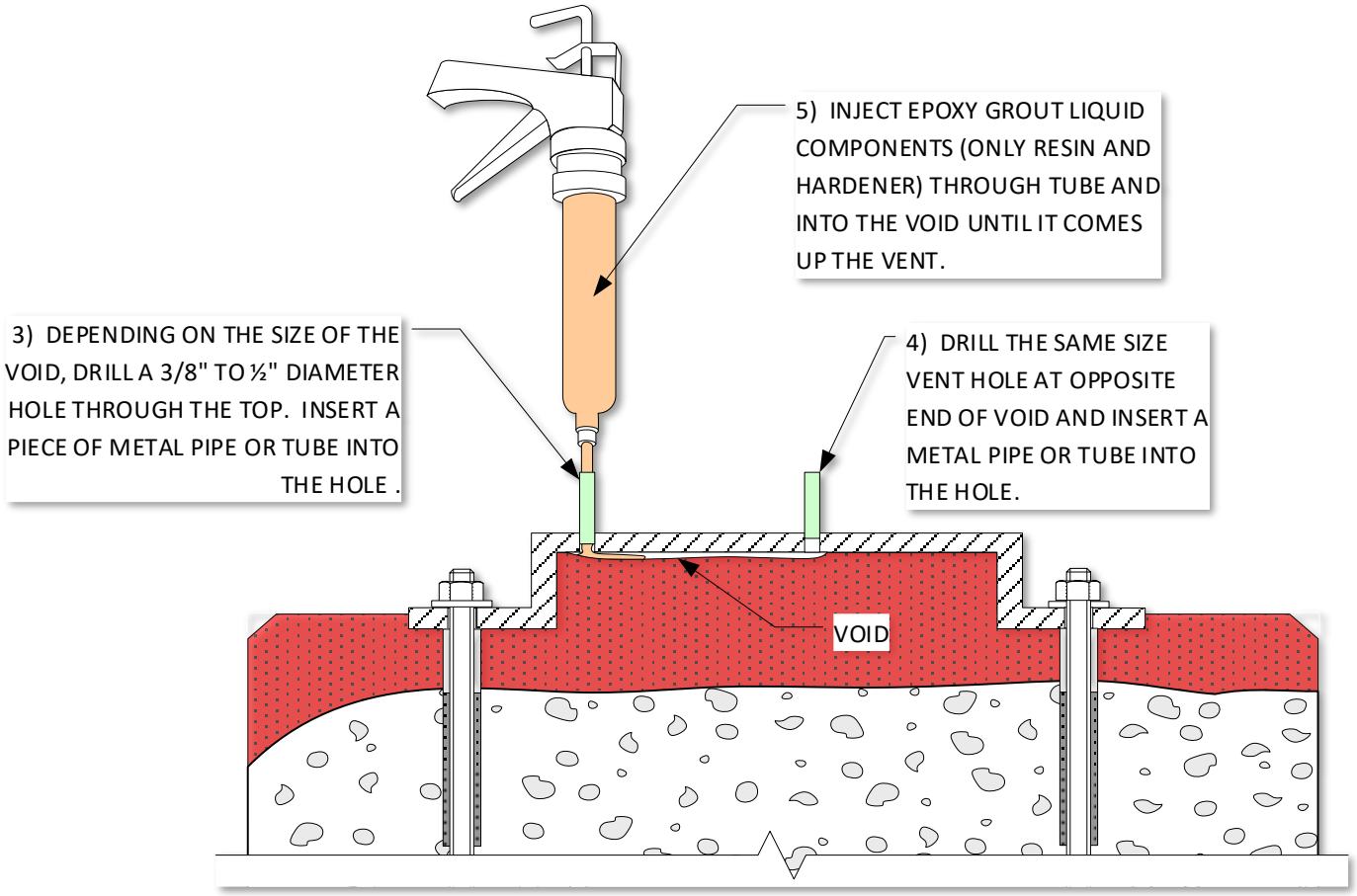


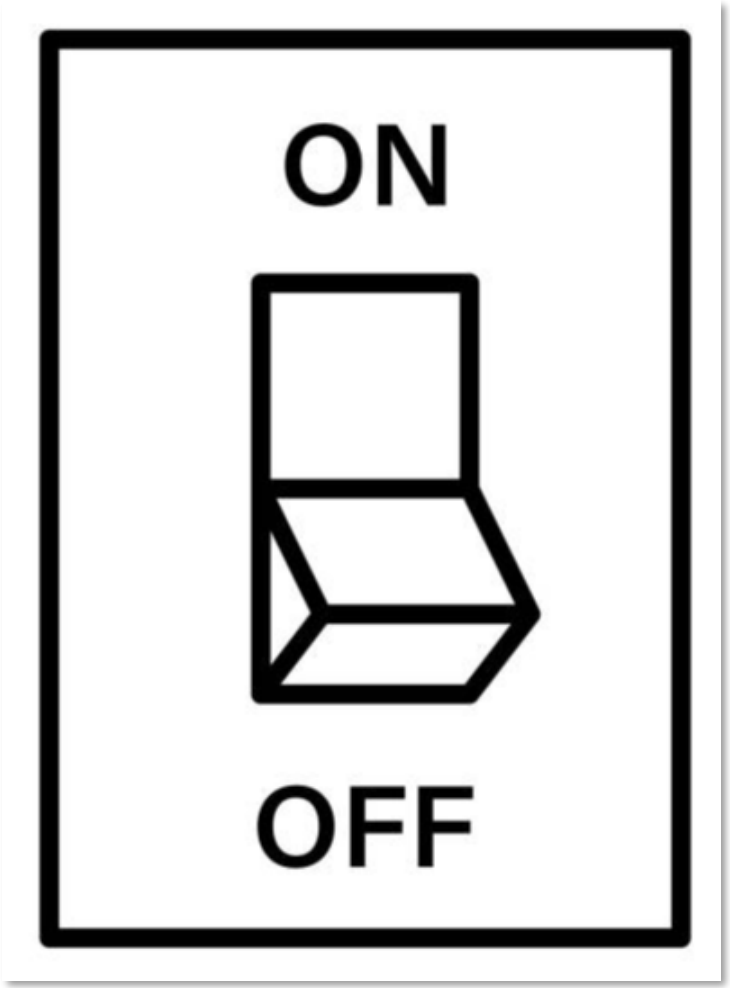
Removing the Shelter

- Critical not to thermal shock the foundation system
- Stairstep the temperature inside the shelter up/ down to assure even cure
- Work front not completed until grout is completely cured

Addressing Cracking

Keys to Success

Money Making Time



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