EFRC Training Workshop

Foundation Design for Reciprocating Compressors

Epoxy Grouting & Chocking

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ITW Polymers Coatings North America

Grouting & Chocking

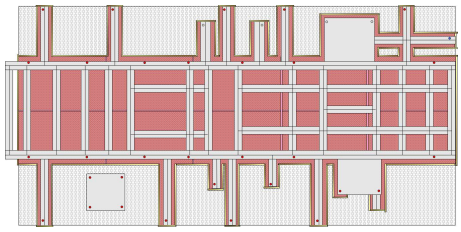
- Goals of Grouting & Chocking
  - **Accurately support** compressor for its life
  - To **firmly secure** the compressor to the foundation so that all vibration created in the compressor travel downward and go into the soil below.
  - **Protect** the foundation
- Only epoxy grout can do all three for reciprocating compressors.

Types of Compressor Installs

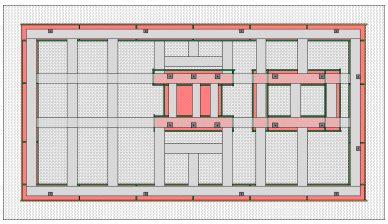
- Skid
  - Full Bed Grout
  - Grout the Beam / Rail Only
- Sole Plates
  - Sole Plates & Skids
  - Sole Plates & Compressors
- Direct Mount
  - Grout / Chocks to Engine / Compressor
  - Chocks / Grout to Sole Plates/Engine/Comp.

Examples of Grouting Methods

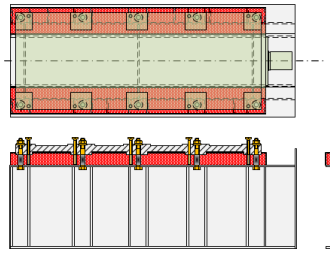
FULL BED GROUT



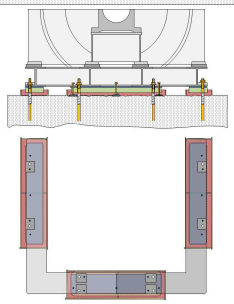
BEAM GROUTING



RAIL GROUT

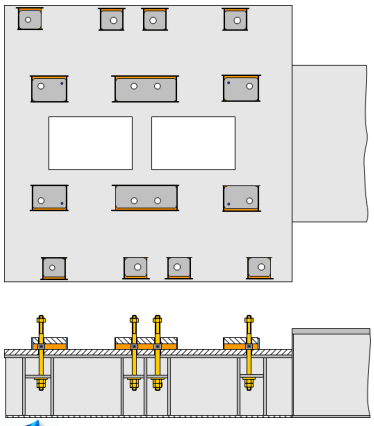


SOLE PLATE GROUT

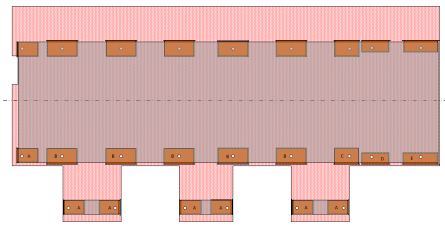


Examples of Chocking Methods

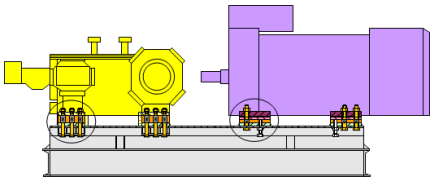
SOLE PLATES - CHOCKS



COMPRESSOR ENGINE - CHOCKS



DIRECT MOUNT - CHOCKS



There Are Many Ways to Install Epoxy Grout & Chocks

The Key to Success is a Good Understanding of the Materials

Epoxy Grout vs Chocks

Material Characteristics

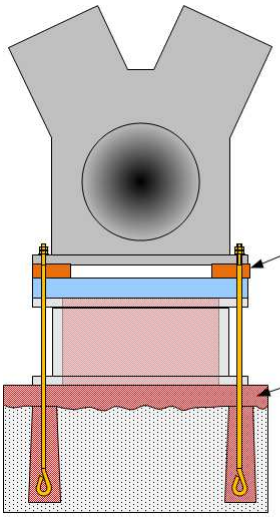
CHARACTERISTICS	EPOXY GROUT	EPOXY CHOCKS
Material Consists of…	Resin, hardener and 4 to 5 large bags of aggregate	Resin and hardener
Pour Restrictions	Up to 2 M x 2 M x 45 cm	Up to 75 cm x 45 cm x 7 cm
Exothermic Temp.	50°C	90°C
Consistency	Lumpy Oatmeal	Thick, heavy oil
Flowability	Fair to Poor	Fair to Good
Working Time	1 to 4 hours	15 to 40 minutes
Cure	Cool and slow – 24 to 48 hours	Hot and fast – 24 hours
Damming Material	Wood with 100 to 150 mm overpours on all 4 sides	Metal with 18 mm wide overpours on 2 sides only

Epoxy Grout vs Chocks

Physical Properties

CHARACTERISTICS	EPOXY GROUT	EPOXY CHOCKS
Compressive Strength	79 to 125 MPa	130 to 170 MPa
Modulus of Elasticity	12 to 20 GPa	2.5 to 6 GPa
Tensile Strength	11 to 20 MPa	34 to 46 MPa
Creep	0.004%	0.02%
Coefficient of Thermal Expansion	19 34 x 10^{-6} cm/cm/°C	30 to 48 x 10^{-6} cm/cm/°C
Shrinkage	0.0005%	0.0002%
Coefficient of Friction	0.125 to 0.5	0.5 to 0.7
Adhesion to Substrate Desirable	Yes to concrete & steel	No to steel, Yes to concrete & grout

Different Materials & Installation

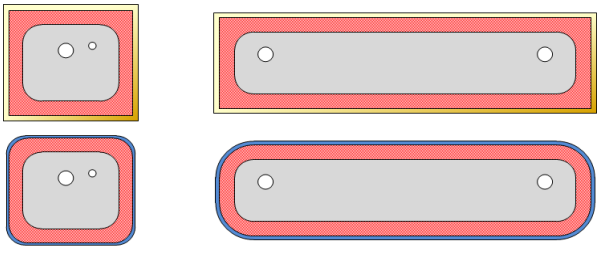


Two Different Materials Used And Installed In Two Completely Different Ways

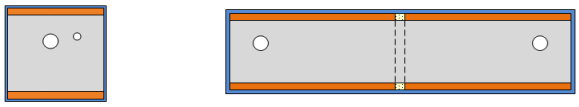
EPOXY CHOCKS
- Small, thin pour
- Around anchor bolt
- Metal dam

EPOXY GROUT
- Large, thick pour
- Over entire foundation
- Fill anchor bolt pockets
- Fill skid
- Wood dams

Different Damming



SOLE PLATES AND DAMS FOR EPOXY GROUT



SOLE PLATES AND DAMS FOR EPOXY CHOCKING COMPOUND

Grout
- Wood or steel damming
- Wide overpours
- Wax inside dams

Chocks
- Metal on front
- Metal or foam damming on sides
- Foam damming underneath
- Narrow overpour (20mm Max)
- Spray Release Agent

Prior to Grout Installation

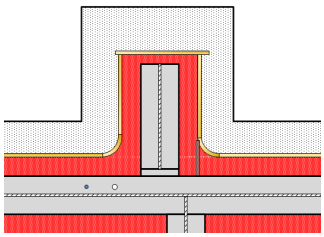
- Fully Cured Concrete – shrunk, strong & dry
- Foundation Preparation
  - Chip laitance & expose broken aggregate
  - Round edges of the foundation
  - Clean off all dust and loose stone
  - Must be oil & water free
  - Heat / Cool as required – 20 to 25^{o}C is Best
  - Bolt pockets rough & dry

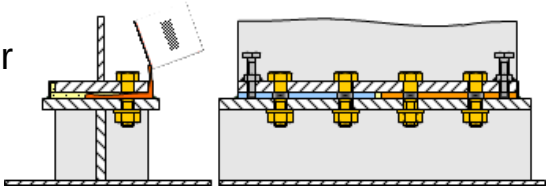
Prior to Installation

- Bolt Preparation
  - Wrap or cover bolt shank – need free stretch
- Alignment Devices
  - Install & level landing pads for jacking screws
  - Grease well
- Expansion Joints
  - 1.5 m to 2m apart
  - Under I-beams and away from anchor bolts
- Install Pins – if needed, 30 cm apart

Prior to Installation

- Forming for Grout
  - Wood forms well braced
  - Round internal corners
  - Waxed on inside
- Forming for Chocks
  - Metal and foam
  - Narrow overpour
  - Air can escape
  - Release Agent

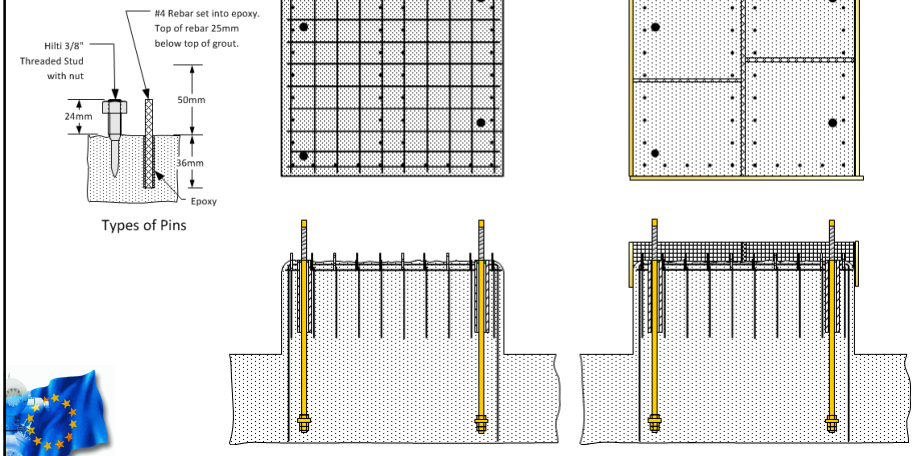




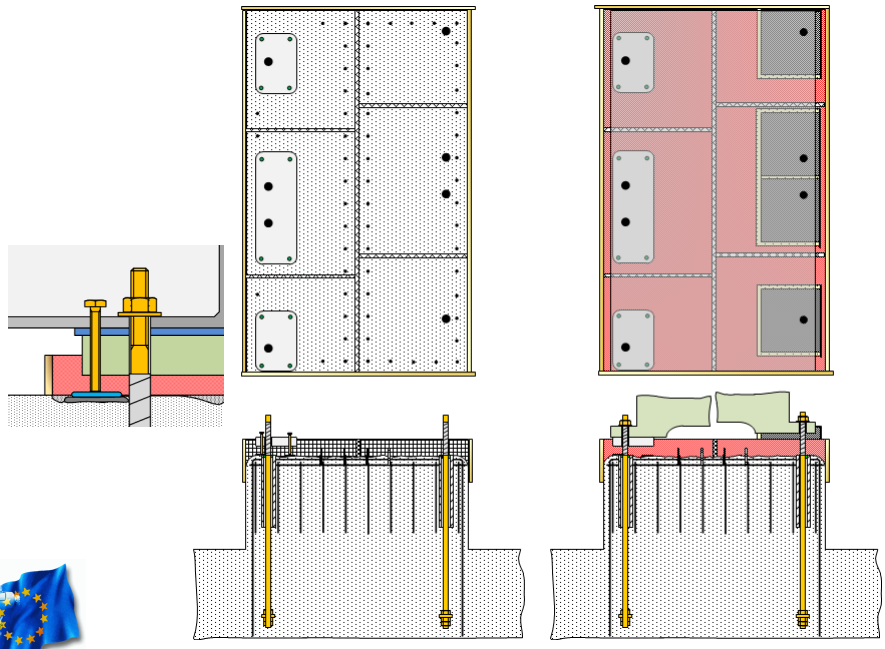
Steel Preparation

- Skid Preparation
  - Preferred – white metal blast
  - Second Choice – thin coat epoxy primer (NO ZINC)
  - Solvent wash
- Engine/Compressor/Sole Plate Preparation
  - No paint, oil, grease, slag, rust, etc.
  - Solvent wash
  - Release Agent on steel only

The Grouting / Chocking Process



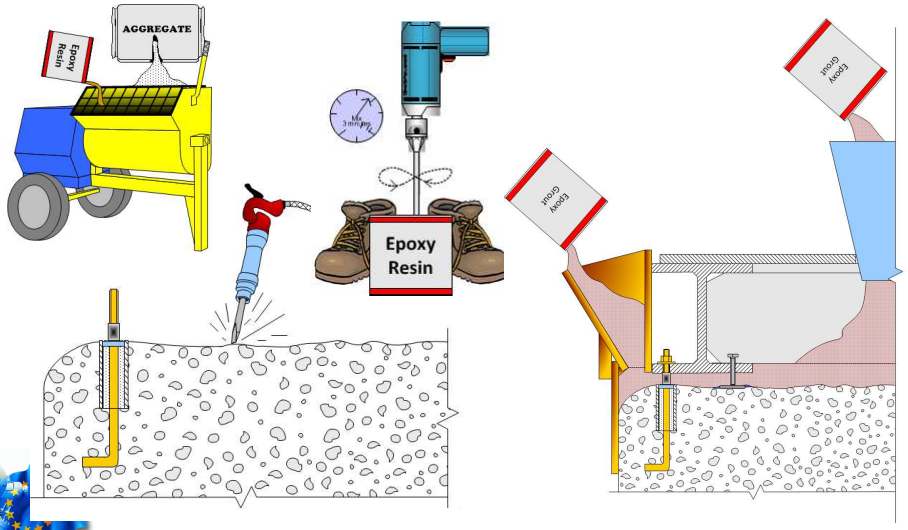
Types of Pins



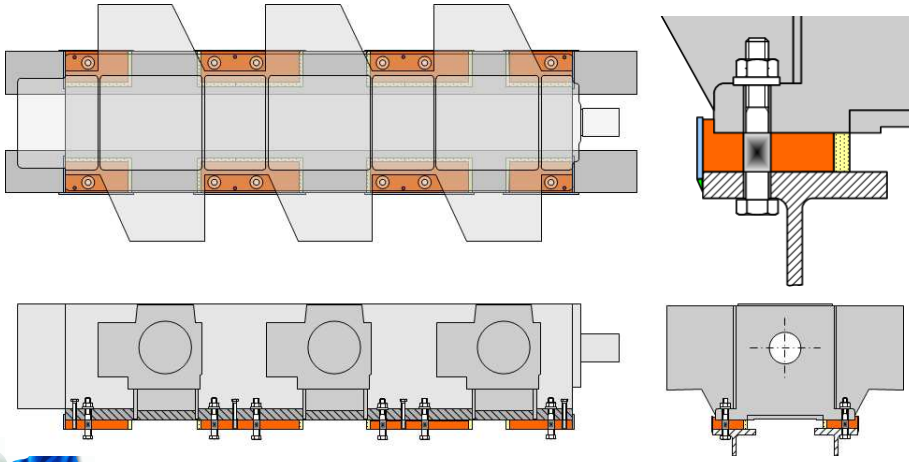
Grout / Chock Installation

- Grout Installation
  - Mix resin & hardener first then add aggregate
  - Use mortar mixer
  - Pour through grout holes or from side
- Chock Installation
  - Mix well using Jiffy mixing blade
  - Pour in thin stream from a height into one end of the chock
- Both – Fill to 24mm above bottom of steel

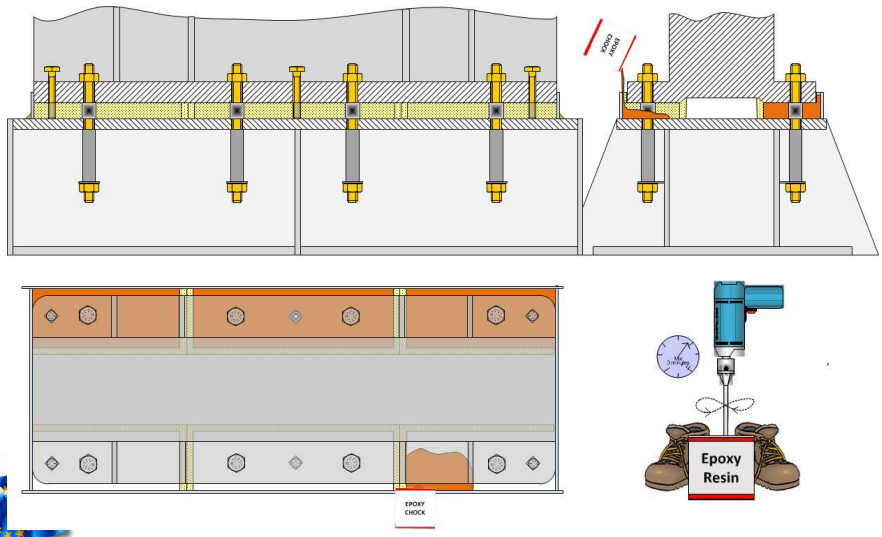
Grout Installation



Chock Installation



Chock Installation



Wrap-Up

- Finishing – Grout & Chocks
  - Remove alignment devices & tension bolts
  - Remove forms
  - Grind off sharp edges
  - Coat exposed foundation
  - Seal expansion joints with flexible compound
  - Gradual temperature change to ambient (0.5°C per hour)
- Clean up mixers and tools quickly

Design Considerations

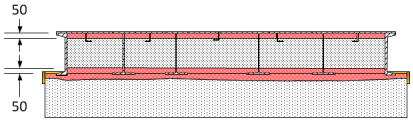
- Load Limits – Sliding scale based on mounting foot temperature (8 MPa Max)
- Calculate Grout/Chock Loading
  - DeadWtLoad (N/mm^2) = DeadWt (N) / EffChockArea (mm^2)
  - BoltChockLoad (N/mm^2) = MaxChockLoad (N/mm^2) - DeadWtLoad (N/mm^2)
  - TotBoltTension (N) = BoltChockLoad (N/mm^2) x EffChockArea (mm^2)
  - IndivBoltTension (N) = TotBoltTension (N) / Number of Anchor Bolts
  - Torque (N.m) = [IndivBoltTen (N) x LF x NomBoltDia (mm)] / 1000 m per mm

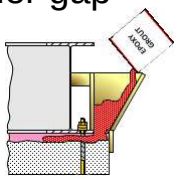
Design Considerations

- Checks
  - Deadweight Loading should be less than 20% of Total Loading
  - Keep % of Yield of anchor bolt to between 50% and 70%
  - Total Bolt Tension should be greater than 5 times the unit's mass
  - Do everything you can to raise bolt tension to maximum allowed by manufacturer

Possible Grout Issues

- Creep – Greater Area = Less Load = Less Creep
- Shrinkage – Pour grout in layers. Manage heat.
- Cracks – No stress risers. Manage heat.
- Flow - Use headbox, grout holes, wider gap
- Vibration - Add Mass to Skid





- Grout Samples – Heat to 70°C before testing & grind top and bottom flat, smooth and parallel

Conclusions

- Choose the correct material
  - Epoxy Grout and Epoxy Chocks are not the same.
  - Determine the correct size of pour & damming material required.
  - Manage the temperature.
- Plan well ahead of time
  - Do not put the machine in place until you are completely prepared.

Thank You

Please feel free to contact me if there are any questions

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