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What is an Epoxy Grout?

Epoxy grouts are a 3 component system, comprising a resin, hardner and specially graded aggregate. When mixed at a specified ratio the resin, hardener and aggregate react to form a cured, chemically resistant grout. Epoxy grouts have superior compressive, tensile, and flexural strengths as well as greater chemical resistance and impact resistance than a cementitious grout.

a. **Typical Physical Properties:**

Compressive Strength (ASTM C 579):	12,000 psi minimum at 7 days
Tensile Strength (ASTM C 307):	2,000 psi minimum
Coefficient of Thermal Expansion (ASTM C 531):	22 x 10^{-6} in/in/^{o}F maximum
Creep (ASTM C 1181; 400 psi; 140 ^{o}F):	5.0 x 10^{-3} in/in maximum
Effective Bearing Area (ASTM C 1339):	85% minimum
Bond Strength (ASTM C 882):	3,000 –3,500 psi average

Advantages of Epoxy Grout versus Cementitious Grout

Epoxy grouts are more costly than cementitious grouts. However, there are definite advantages of epoxy versus cementitious grouts.

High early strength	Tenacious adhesion to concrete & steel
Long working time	High impact resistance
Very low Exotherm	Excellent chemical resistance

a. **Physical characteristics:** Epoxy grouts have a much higher compressive strength, bonding strength combined with much greater energy absorption than cementitious grouts.

b. **Cure Time:** ProPoxy 2000 NS can achieve 10,000 psi within 24 hours, allowing the anchor bolts to be tightened early in the curing process." On high strength applications it is best to wait 48-72 hrs before tensioning the anchor bolts.

Unitex Epoxy Grouts

Unitex has three epoxy grout products that are effective in all types of grouting installations. Unitex epoxy grouts are pumpable, and provide the flexibility for use in most situations.

a. **Pro-Poxy 2000 NS/DP** can be used for anchor bolts & sleeves, supporting pumps, pump skids, wind towers, mill tables, crushers, crane rails, engines, compressors, rotary equipment and other heavy machinery requiring a stable energy absorbing base to maintain precision alignment.

b. **ProPoxy 2000 NS:** When the 2000 NS is mixed, the result is a non-shrink grout that can be placed from ¾ to 8 inches neat.

c. **ProPoxy 2000 DP:** When the 2000 DP is mixed, the result is a non-shrink grout that can be placed from ¾ to18 inches neat. 2000 DP can also be used where a very long working time is desired to allow time for self-leveling into large forms. This also allows more time for equipment cleanup before the material gel time is reached.

b. **Pro-Poxy Chock:** Designed for excellent flowability, low thermal conductivity and permanent alignment of machinery and equipment. Product cure time is fast, achieving compressive strength (19,000 psi) in less than 6 hours. Pro-Poxy Chock can also be "extended" with Pro Poxy™ aggregate to maximize the volume of each unit and slow down the cure time. The trade off is reduced flow-ability.

Types of Placements

a. **Rotating Machinery:** Large pumps and Gas compressors are examples of rotating machinery that would benefit by using epoxy grout on their foundations. Typical industrial installations include power plants, chemical plants, refineries and pipeline stations. These installations require rigid alignment tolerances and vibration dampening to achieve a long service life.

b. **Heavy Load Support:** Any installation where high compressive strength is required, and where a long service life is desired, will benefit from the use of epoxy grout. Examples include but not limited to wind tower bases, gantry crane rails, bridge bearing pads, industrial engines and gearboxes.

c. **Foundation Caps and Crowns:** Foundation caps consist of a layer of epoxy grout placed on top of a reinforced concrete foundation base. It is intended to provide a full base support of machinery and is typically placed in forms which match the full length and width of the underlying concrete. This installation provides the required load support and energy absorption for the machinery. It also provides an impermeable, chemical resistant surface underneath the machine in case of oil, fuel, or other chemical leaks which could degrade a concrete foundation.

d. **Chocks:** Chocks are small placements of epoxy located at anchor bolt locations under equipment and machinery feet. This grout design provides adequate machinery support and vibration dampening with a minimum of epoxy grout required. By using chocks, the majority of a machine base is left open with a maximum clearance height, thereby optimizing equipment base cooling. However, this application does not provide the same protection to the underlying concrete as a full epoxy foundation cap or crown does.

e. **Skids/Rails, Sole Plates, Pedestals:** These installations are used for machine bases that have skids, rails or sole plates, where the epoxy grout is placed to support the skid/rail or sole plate areas only. These are long and narrow placements.

f. **Other:** Epoxy grouts may be used for many different applications, and therefore, the details of placement are greatly varied. For example, a wind generator foundation is a circular placement which forms a ring around the entire perimeter of the base. Another unique application is a bridge bearing pad, which is similar to a chock mount.

Preparations

a. **Storage Conditions** - ProPoxy 2000 NS/DP, Pro-Poxy Chock components should be stored in a dry temperature controlled environment between 50° to 90°F (10° to 32°C). Resin (Part A) may crystallize if stored below 50°F (10°C).

b. **Surface Conditions** - All surfaces that will come into contact with the grout should be maintained at a temperature of at least 55°F (13°C) during placement and for at least 48 hours after placement.

c. **Temperature Effects:** Epoxy grout viscosity increases with decreased temperature. Also, gel time and cure time significantly increase with reduced temperature, and decrease at high temperatures. These factors must be carefully considered for large foundation pours. Any reduction in aggregate must be avoided to increase flow at lower temperatures. Rather, the epoxy grout material should be preconditioned to warm temperatures prior to mixing and placement. Regarding gel time and cure time, allowances must be made in cold temperatures to extend the time to torque anchor bolts until adequate grout strength is achieved. In very hot conditions 95°F *(32°C)* and above, the material must have an adequately long gel time to allow placement prior to gelling.

d. **Metal surfaces:** Metal surfaces should be dry and free of oil, grease, paint and rust for optimum bonding. A white bright metal surface can be obtained by sandblasting or grinding. In high humidity areas, equipment should be grouted immediately after sandblasting or grinding.

VI. Pro-Poxy 2000 NS & Pro-Poxy 2000 DP ***Mixing:*** *Part A-resin, B-hardener & C-aggregate should be pre-conditioned for at least 24 hours to at least 75°F (24°C) for ease of mixing and maximum flow. First premix components A & B separately then pour part B-hardener into Part A-resin and mix for a minimum of 3 minutes with a low speed mixer. Keep mixer below material line to avoid entrapping air in the mix. A Jiffy mixer is the preferred mixing paddle. Pour mixed liquids into a mortar mixer and add component C while mixer is running. Mix for a minimum of two minutes to thoroughly wet all aggregate. Do not over mix; do not thin or add any solvents or thinners. Working time after mixing is approximately 1.5 hours at 72°F (22°C). Do not mix partial units; mix only full units.* Heating and or cooling the grout components may be necessary. Temperatures below 75°F *(24°C)* will increase the epoxy resin viscosity, inhibiting its flowability and increasing the cure time. Temperatures above 90°F *(32°C)* will decrease the viscosity; speed up the cure time considerably thus reducing the working time of the grout.

Note: High temperatures will accelerate the setting time and low, cool temperatures will slow the setting time. As a general rule, the pot life of epoxy will be cut in half for each 10° to 15° increase in temperature above 75°F (24°C), the pot life will double for each 10° to 15° drop below 75°F (24°C).

a. **Pro- Poxy 2000 NS** can be placed from ¾” (1.9 cm) to 8 inches (20.3 cm) in a single pour.

b. **Pro-Poxy 2000 DP** can be placed from ¾ (1.9 cm) to 18 inches (45.7 cm) in a single pour.

c. **Pro Poxy 2000 DP** can be “extended” with 3/8” pea gravel, for deep pours from 18 to 48 inches. Using the extended grout option also reduces the flow and exothermic temperature of a deep high volume pour. The 3/8” Pea Gravel, available from Unitex in 50 lbs bags, is a quartz based material to help maintain the physical strength of the PP-2000 DP. It comes washed and kiln dried, ready to use. In the case of low ambient air temperatures (less than 65°F, 18°C) caution must be used in “holding back” any of the Part “C” aggregate to enhance the flowability of the epoxy grout. Unitex does not recommend that any Part “C” be held out of the epoxy grout mixture to improve the flowability of our epoxy grouts. Instead, the substrate and equipment skid should be heated and brought up to an acceptable surface temperature 70°-80°F (21°-27°C) in order to use the epoxy grout as it was designed.

   Note: Caution must be used when reducing aggregate in order to improve flow. To improve flow it is best practice to use head pressure to push the grout into place or increase the surface and grout temperature rather than aggregate reduction.

d. **Pro-Poxy Chock:** Condition the temperature of the Poxy™-Chock to 65°F–85°F (18°C–29°C) for at least 12 hours prior to the time of mixing. Pour Part B into Part A container and mix for 4 minutes with a low speed drill motor (200 rpm max) keeping the mixer completely submerged at all times to avoid air entrainment. Carefully scrape and remove all material from the bucket sides during mixing to insure both components are completely mixed.

VII. Epoxy Grout Procedures

a. **Foundation caps or crowns**: Foundation caps or crowns perform best when the epoxy grout coefficient of thermal expansion (CTE) closely matches the CTE of the underlying concrete foundation. This will minimize any stress or thermal cracking to the epoxy grout as it cures.

b. **Forming:** Foundation caps must incorporate specific requirements to reduce the chances of cracking and edge lifting. All epoxy grout edges within the forms must be chamfered to a minimum of 1" x 1". Always include expansion joints in the form design as this will greatly reduce any stress cracking.

c. **Base plate forming** must minimize the distance of grouted surface outside the equipment base. A good rule of thumb is to limit the epoxy pour to 4" outside of the machinery or skid edge on all sides. (6" is considered the maximum edge distance of the epoxy grout to the equipment being grouted.) This reduces the possibility of edge lifting by keeping the equipment load near the edge of the epoxy grout placement. If the installation does not allow this method, forming must incorporate an edge lifting limitation design, such as using dowel pins, or exposed vertical reinforcing steel embedded in the concrete substrate between the edge of the equipment and the edge of the forms. Be sure the height of the forms is above the epoxy grout pour depth by about 1". The epoxy pour should also "wrap" up the side of the equipment foot or skid beam edge by about ½". This improves lateral stability of the equipment in the grout and seals the support area from moisture being wicked up under the foot and causing corrosion. Reinforcing steel is not required unless very deep pours are made, or to tie together multiple pours. Be particularly careful about any sharp corners or edges on steel skids or jacking pads. All sharp steel corners that will contact the epoxy grout need to be radiused to minimize any stress cracking. Use the bottom of a soft drink can as a radius pattern. All "Jacking Pads" must be round with all edges beveled to eliminate stress cracks during the epoxy grout cure. If you do not remove all of the sharp corners you can expect to see hairline stress cracks out to the edge of the foundation. All forms must be water tight to contain the epoxy grout. Use high density foam insulation tape (double sided adhesive) on the wood forms where it touches the concrete to seal the pores and seams in the concrete foundation. Use ONLY new lumber for the forms. Used lumber has a rough texture that will bond to the epoxy grout and not release very well. After the forms are built, cover all surfaces that will contact the epoxy grout with 2 coats of Johnson's Paste Wax. It's kind of like waxing a car. Be generous with the paste was when you apply it. Be VERY careful not to touch any concrete or the steel skid with the Paste Wax as it will prevent the epoxy grout from bonding to the concrete foundation or steel skid. Do NOT use Car wax as it has almost no wax in it mainly comprised of polymers which will not release the forms from the epoxy.

d. **Expansion joints** Expansion joints for epoxy grout should be installed in advance, if possible, when a crane is used to lower the equipment in place. If jacks and rollers are used, then the joints should be added prior to lowering the equipment with the jacks. When expansion joints are required, the following procedures are suggested: Expansion joints are normally placed in the non-load bearing shoulders. It is very important that the expansion joint material bonds to the grout so that it does not

provide a path to the concrete for oil, water and other contaminants. The top of the expansion joint should be above the finished surface by at least ½".
Note: Expansion joints should be placed every 4-6 Feet.

Note: Unitex has a flexible expansion joint that is available in 5 foot and 10 ft lengths. It is impervious to petroleum products.

e. Head Pressure: ProPoxy 2000 NS/DP epoxy grouts have excellent placement consistency, but flow is enhanced using hydraulic head pressure. Construct a head box or funnel 1-2 feet deep to place the grout in hard to reach places. Grout flow is somewhat slow (slightly thicker than pancake batter), so working time must be considered as compared to the distance through which the material must move to fill the forms. Epoxy grout can be placed through grouting access holes in the machine base. If possible ventilation holes should be present in the corners and top surface of the deck plate being grouted. All skid compartments (between I-beams supports) will need vent holes to allow the epoxy grout to rise and bond to the under surface of the plate. The epoxy grout will self-level into the forms leaving a solid, level support under the machine. Do not allow the level of grout to fall beneath the base plate as this will result in trapped air and voids under the deck plate.

VIII. Chocks

a. **Forming:** Forming for chocks is relatively simple. It will determine the final surface height of the chock. The dimensions of the chock will determine the surface area to which load is applied and thus, the pressure applied to the epoxy grout after torquing the anchors. Therefore, the compressive strength of the grout must be compared to the loaded surface area. It is recommended that the compressive strength of the grout exceed the anchor compression by a factor of at least 2. The anchor compression is influenced by the machine weight, and also by the bolt loading value [due to the torquing or tensioning of the anchor]. Thus, all of these factors must be carefully considered as part of the overall design.

IX. Skids/Rails:

a. Epoxy grout for skid or rail installations may require the use of a head box to "push" the epoxy grout under the skid or rail. Often this grout design borders on the minimum grout thickness of the product (PP-2000 NS/DP has a minimum of ¾").Forming for these long, narrow installations may not require chamfering and jointing like foundation cap pours. Sometimes, the user is simply filling a trough, so no forms are necessary. Jointing at approximate distances of 4-6 feet will help avoid cracks across anchor bolt locations, but is left to the discretion of the user. As with chocks, the width dimension of the epoxy grout must provide adequate strength to avoid crushing at the anchor locations.

X. Pro-Poxy Chock Physical Properties

Pro-Poxy Chock	
ASTM Laboratory Tests	
Compressive Strength (ASTM C 579)	19,000 psi (131 MPa)
Tensile Strength: (ASTM C 307)	5,000 psi (34.4 MPa)
Flexural Strength: (ASTM C 580)	6,300 psi (43.4 MPa)
Modulus of Elasticity: (ASTM C 580)	2, 800,000 psi (19,305 MPa)
Bond Strength: (ASTM C 882)	3,000 psi (20.6 MPa)
Liner Shrinkage on Cure: (ASTM C 531)	0.02%
Density: (ASTM C 905)	110 lb/cu ft (1,800 kg/cu m)
Coefficient of Thermal Expansion: (ASTM C 531)	17 X 10-6 in/in°F.
Hardness Shore: (ASTM D 2240) D Scale = 90	D Scale = 90
Fire Resistance: (ASTM D 635)	Self Extinguishing
Gel Time: (60g mass) 45 minutes @ 73°F (23°C)	
Final Cure: @ 60°F (16˚C) = 48 hrs; 65°F (18˚C) = 36 hrs;	
70°F (21˚C) = 24 hrs; 75°F (24˚C) = 18 hrs	
Maximum Placement Depth: 2.5 inches (6.35 cm)	

XI. Pro-Poxy™ 2000 NS/DP Physical Properties

ASTM Laboratory Tests	Pro-Poxy™ 2000 Normal Set	Pro-Poxy™ 2000 Deep Pour
Compressive Strength_ C 579		
1 day cure @ 75°F	10,000 psi (68.9 MPa)	6,500 psi (44.8 MPa)
7 day cure @ 75°F	14,500 psi (99.9 MPa)	12,000 psi (82.7 MPa)
Compressive Modulus_ C 579	2,130,000 psi (14,685.8 MPa)	2,000,000 psi (13,789.5MPa)
Tensile Strength_ C 307:	2,400 psi (16.5 MPa)	2,000 psi (13.8 MPa)

Tensile Modulus of Elasticity_ C 307	2,000,000 (13,789.5 MPa)	1,900,000 psi (13,100 MPa)
Flexural Strength_ C 580	3,100 psi (21.3 MPa) DSC TDS	3,000 psi (20.7 MPa)
Bond Strength_ C 882	3,500 psi (24.1 MPa)	3,000 psi (20.7 MPa)
Linear Shrinkage on Cure_ C 531	0.005%	0.005%
Coefficient of Thermal Expansion_ C531	18 X 10^{-6} in/in/°F	20 X 10^{-6} in/in/°F
Hardness Shore D Scale_ D 2240	95	93
Density on Cure_ C 905	144 lb/cu.ft. (2,300 kg/cu m)	144 lb/cu.ft. (2,300 kg/cu m)
Placement Depth @ 75°F.	8 inches (20.3 cm) maximum	18 inches (45.7 cm) maximum

Temperature	**Working Time**		**Curing Time**	
	Pro-Poxy 2000 DP	**Pro-Poxy 2000**	**Pro-Poxy 2000 DP**	**Pro-Poxy 2000**
50 ^{0}F /10 ^{0}C	8 hrs	6 hrs	84 hrs	42 hrs
55 ^{0}F /13 ^{0}C	7 hrs	5 hrs	72 hrs	36 hrs
65 ^{0}F /18 ^{0}C	5 hrs	3 hrs	60 hrs	30 hrs
75 ^{0}F /24 ^{0}C	3.5 hrs	1.5 hrs	48 hrs	24 hrs
85 ^{0}F /29 ^{0}C	2.5 hrs	45 minutes	36 hrs	18 hrs
95 ^{0}F /35 ^{0}C	1.5 hrs	20 minutes	24 hrs	12 hrs
100 ^{0}F /38 ^{0}C	1.0 hr	15 minutes	16 hrs	8 hrs

XII. Pro-Poxy 2000 (NS), Pro-Poxy 2000 Deep Pour (DP) and Pro-Poxy Chock Chemical Resistance Chart

E - Suitable for immersion, spillage and fumes

S - Suitable for spillage and fumes

NR - Not Recommended

REAGENT	Pro-Poxy 2000 NS & DP
ACIDS	
Acetic Acid, 5%	E
Acetic Acid, 20%	S
Sulfuric Acid, 10%	E
Sulfuric Acid, 96%	NR
Hydrochloric Acid, 10%	E
Hydrochloric Acid, Conc.	S
Nitric Acid, 10%	E
Nitric Acid, Conc.	NR
Butyric Acid, 10%	E
Phosphoric Acid, 10%	E
Citric Acid, 10%	E
Linseed Oil Fatty Acid	S
Phenol Acid, 90%	E
Cresylic Acid	E
Naphthenic Acid	E
Boric Acid, 5%	E
Carbolic Acid	E
Oleic Acid	S
ALKALIES	
Sodium Hydroxide, 20%	E
Sodium Hydroxide, 50%	E
Ammonium Hydroxide, 10%	E

Ammonium Hydroxide, 29%	S
SALTS	
Barium Chloride	E
Aluminum Chloride	E
Magnesium Chloride	E
Ammonium Chloride	S
Ammonium Nitrate	S
Magnesium Sulfate	S
Sodium Phosphate	E
Sodium Thiosulfate	S

REAGENT	Pro-Poxy 2000 NS & DP
Iron Chloride	E
Sodium Hypochlorite	S
Sodium Sulfite, 1%	S
Calcium Hypochlorite	S
Calcium Chloride	E
Sodium Chloride	E
Sodium Sulfate	E
Trisodium Phosphate, 10%	E
Sodium Metasilicate, 10%	E
MISCELLANEOUS	
Mineral oil	E
Gasoline	E

High Flash Naphtha	E
Formaldehyde, 37%	E
Lard	E
Cottonseed Oil	E
Crude Oil	E
Hydrogen Peroxide, 20%	S
Styrene	NR
Kerosene	E
Vegetable Oil	E
Fish Oil	E
Fuel Oil	E
Motor Oil	E
Carbon Tetrachloride	S
Transmission Oil	E
Aliphatic Hydrocarbon	E
Chlorinated Hydrocarbon	S
Ethyl Alcohol	S
Butyl Alcohol	E
Nitrobenzene	NR
Ethylene Glycol	E
Ethyl Acetate	E
MEK	S
Coal Tar	E
Soap solution	E

XIII. TOP 10 Epoxy Grout job Mistakes that are made:

1. Concrete not properly cured.
   (A minimum of 21 days or less than 1.5% moisture content.)

2. Preparation of concrete surface to a 60 grit texture all the way to the foundation edge.
   (1. When properly done one can use a chemical surface retarder to expose the aggregate surface – Dayton Superior "Top Cast" or Unitex "Top-Etch" normal depth.)
   (2. Sandblast with "Black Beauty" or "Garnet", then blow surface clean of dust/debris.)
   (3. Use a Shot Blasting or Milling machine to rough the surface evenly.)

3. Use only Round Jack pads
   (Do not use "square corner" Jacking Pads, which cause stress cracks in the epoxy after it cures.)(Use Round Jacking Pads – 2.5" – 3" OD, 1/2" thick to minimize stress cracks.)

4. Do not Hard Shim the skid
   (Hard shimming can cause Stress Cracks in the epoxy. It does not allow the epoxy to dampen the Equipment vibrations fully thru the mass of the foundation.)(Use Jack screws or soft shims – i.e. plastic)(IF there is no alternative to a hard shim, wrap "Duct tape" around the shim corners 2-3 times to "Soften" the corners.)

5. Radius all outside skid corners (Pepsi can pattern) and dress edges smooth
   (Square skid corners, [I-Beams, C-Channel, Angle iron, Steel Plate] will cause stress cracks in the epoxy. Use a cold drink can as a pattern to radius the outside corners to minimize stress cracks. Dress with a grinder to a smooth edge.)

6. Wax forms and jacking bolts with Johnson's paste wax
   (Use NEW lumber to build the water tight forms around the foundation. Using screws makes it easier to "lay back" the forms after assembly to wax them (2 coats, using a 3"x 5" damp kitchen sponge). DO NOT get any wax on the concrete as there will be no bonding of the epoxy to the concrete. Use chamfer strips to break (bevel) the edge of the epoxy. Use double stick "Camper seal" to prevent leaks in the forms and where the forms contact the concrete foundation. "Johnsons paste wax" [preferred] is available at Lowes.)

7. Install expansion joints every 48" – 60" max.
   (Under a steel skid, start with an expansion strip (joint) 2"-3" from each end, then every 48"-60" across the width of the epoxy pour. Notch the joint under any I-beam flanges. If grout pour is deeper than 2", epoxy the expansion joint on top of 1" Unitex expansion joint material using Unitex ProPoxy 300F. Be sure to add the expansion joint on both ends so the spacer (polystyrene / wood is not exposed.)

8. Use a Jiffy mixer to blend Part A + B (3 minutes min. @ 300 rpm max.)
   (Very important step to minimize foam and air in the epoxy grout pour. Use a Jiffy model "ES" to blend the Part "A" and "B" together [2 cu ft. units, for .5 cu ft. units use a Jiffy model "HS" mixer]. 3 minutes is the minimum to be sure both components are blended together. Parts A/B blends best if they are 75°F - 85°F before starting.)(Mix both components together in the 5 gal can, then pour slowly into the Mortar mixer.)

9. Use a clean mortar mixer with blades making at least 70% contact on the drum.

(*Do Not use a Cement mixer (Drum turns) use a Mortar mixer where the blades turn. Most rental mortar mixers have residual mortar/concrete in them. Plan on sandblasting the inside to get it clean before you mix any epoxy in it or you will have excess air/foam in the epoxy.*

10. Remove Jack Bolts 18-24 hrs after grout pour.
    (Stress cracks to the edge of the foundation will occur if the Jack bolts are not "Removed" or Backed off.)