EPOXY GROUT

Foundation Preparation

For structural elements such as soleplates or equipment supports, the areas of the foundation which will be in contact with the grout, including anchor bolt holes, must be properly prepared. The concrete foundation surface must be fully cured and laitance removed by scabbling. For the removal of concrete and or laitance large breaking equipment should not be used to avoid micro cracks in the concrete. Surfaces should be clean and dry before grouting. Ensure that the anchor bolt holes are free of water.

Forming / Shuttering

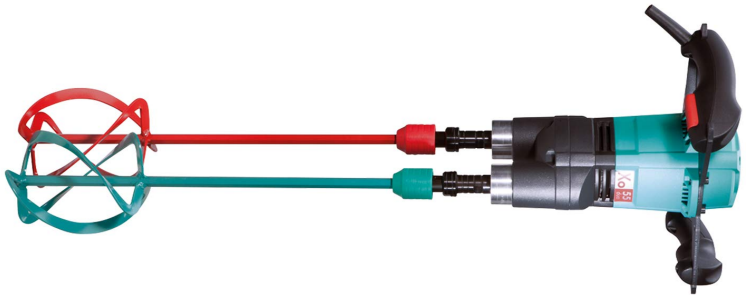
The forms should be compatible with the placement method to be used, taking into account the consistency at which the grout is to be placed, and the distance the grout must travel. Forms should be built to facilitate continuous, quick and complete filling of the cavity. The forms must be leak proof and strong enough to withstand the hydraulic pressure of the grout.

Header Box

The grout pouring position and direction must always be considered by assessing the path length which the grout has to travel between the substrate and equipment or support. The longer the path is, the more pressure is going to be required to move the grout through the gap. The higher the grout is placed into the header box, the more pressure will be achieved. The pressure requires the careful sealing of all form joints and the form work must be fixed in location. For long foundations the header box has to movable along the length of the same.

Mixing the Grout

Mix in the smallest batches possible which still affords productive grouting progress. Rather than mixing a larger batch and having trouble with the flowability at the end of the pour, mix smaller batches still provide a continuous flow of newly mixed material to the pouring process. Keeping the flow speed going, after the initial pouring helps the flow tremendously. The correct mixing paddles are an essential part of the equipment to avoid air entrapment into the mix. The container for mixing the grout should be chosen so that the level of the grout being mixed exceeds the height of the mixing paddle. Keep the mixing paddle submerged in the grout avoids mixing air into the grout. This should also be kept in mind when initially mixing the resin and hardener. In both instances the mixer should not exceed 400 RPM.



Reduction of the aggregate, to improve the epoxy flow. But is it a good idea ?

Reducing the aggregate should first be discussed with the manufacturer. Test samples should be made and lab tests completed. A new method statement approved, before proceeding with the aggregate reduction. This might sound a little over the top, but in most projects the client has approved a material and procedure in the inspection test plan.

Reducing the aggregate quantity in epoxy grout, the following effects need to be considered.

With the reduction of aggregate in epoxy grout mix, to achieve a more freely flowing material for thin layer pours (25 mm or less) and or under hot climatic conditions, we should consider the following effects. For almost all support structures we are not able to see or inspect the grouted

area. We can only rely on previous experience to a certain extent. When using a new product in an unfamiliar environment, tests should be done to evaluate how the reduction of aggregate will affect the performance of the grout.

There are commercial implications of course. A 25 % reduction in aggregate will increase the material costs by nearly the same percentage. The extra effort needed with a grout material that does not flow easily can be partially offset against the cost of volumetric grout losses.

Technically, we should test the grout material that we think is suitable for the project needs, before the project starts. That test should consist of a test pour for larger quantities. Post pouring, stripping of the formwork and supported equipment (for test purposes a plate) should be considered. The compressive strength test (ASTM 579 B) has to be carried out after 24 hours and 7 days.

Quoting the ASTM :

> "Compression tests provide a standard method of obtaining data for research and development, quality control, acceptance or rejection under specifications, and special purposes. The tests cannot be considered significant for engineering design in applications differing widely from the load-time scale of the standard test."

We can only use these tests as a guide since other approved test provide different results.

Test for the tensile strength should also be undertaken. Most importantly we need to view the grouted bearing area to establish the effective bearing area (EBA). In addition, there will be a increase in the flexural strength and a decrease in creep resistance, which is not favorable and will only show after commissioning.

With the reduction of aggregate the compressive strength is be reduced slightly, about 10%, which generally is not a problem. With the aggregate reduction, the exothermic heat energy created in the resin and hardener reaction is still the same, but the reduced aggregate in the mixture will absorb less heat in this reaction as a result heat stress cracking must be considered to occur. The surplus heat can cause bubbles in the epoxy grout which rise to the surface under the supported area. The risk of incomplete grouting due to poor flow with the grout having a low viscosity, should be considered as well. The trade off in real terms between the two problems needs to be considered carefully.

Placing the above in the installation context, we need to find agreement on how exactly we are going to proceed with grouting under hot or very hot weather conditions, which adds another layer of difficulty to the above observations. There are many additional techniques to be considered as best practice.

EBA – Effective bearing surface

Below we can observe what happens when there has been no bonding between the epoxy grout and soleplate.

Expansion Joints

In order to maintain alignment of grouted equipment, epoxy grouts are designed to be rigid and have high resistance to creep. Epoxy grouts have a dissimilar coefficient of thermal expansion compared to concrete by a factor of 5. As a result, stresses that occur during curing and temperature changes and seasonal changes can result in cracks. Expansion joints are advised when the grout exceeds ± 1.5 m in any direction to prevent excessive stress on the grout / concrete and epoxy grout / steel interface from building up, which can cause cracking, edge lifting etc.

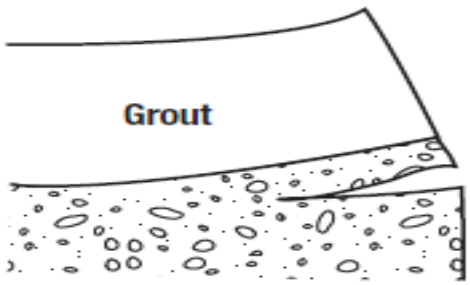
Expansion coefficient:

Steel :	10.5 -12.8 x 10^{-6} m/m ^{0}C
Concrete :	10 x 10^{-6} m/m ^{0}C
Epoxy :	45 – 65 x 10^{-6} m/m ^{0}C

Edge Lifting

Edge lifting is a term generally used to refer to horizontal cracks around the edges and corners of grouted foundations. The crack starts on the vertical concrete surface just below the grout / concrete interface and may extend back under the grout from 50–150mm. This cracking is usually accompanied by slight upward movement at the edge. This movement is called “edge lifting” or “curling.” The initial cracking occurs when the shear stress near the concrete / grout interface exceeds the strength of the concrete.

When the grout cures stresses develop, caused by the curing shrinkage and the exothermic reaction of the grout. Additional stresses occur as the grout and foundation undergo thermal cycling. Stresses created during thermal cycling are caused by uneven heating and cooling in various parts of the structure and by differences between the coefficient of thermal expansion of the grout and the concrete.



Compressive Strength & Compressive Strength Testing

Compressive strength alone doesn’t guarantee satisfactory performance, but it is critical, and an important indicator for other performance parameters. On many projects, specifications call for the testing of the epoxy grout to confirm compressive strength properties. Testing of epoxy

grouts is important, and the success of the test relies on the collection and preparation of grout samples on the site application.

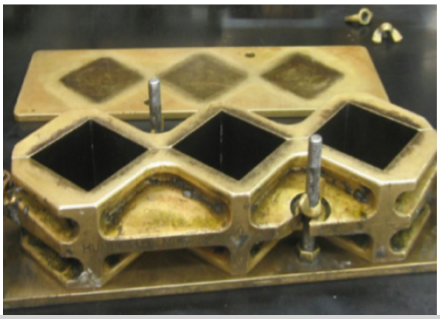
There are many ways to test for a material's compressive strength. Different test methods and protocols yield different results, it is equally important that the design documents specify the test method, and provide clear instruction on the procedure for taking samples in the field.

The correct ASTM test method for determining compressive strength of polymer grouts is ASTM C579. Method B of this standard, which requires the casting and testing 50mm cubes.

Preparing Epoxy Grout Samples in the Field for ASTM C579 Testing

Ensure proper cube molds are used.

- Use metal / brass cube molds, with 2" (50mm) sides.
- Seal the edges with wax. Apply mold release
- Place on a flat, level surface, where they can remain undisturbed until set.
- The molds must be conditioned to temperature just like the foundation and equipment.



DO NOT USE PLASTIC MOLDS FOR EPOXY

Curing

After striking off the excess grout from the mold, leave the material undisturbed for a minimum of 24 hours. Make sure it is in a temperature controlled location away from vibrating equipment. Epoxy grout samples should only be air cured and do not require any form of restraint. The molds must be allowed to reach initial set before transporting them.

Epoxy grouting in hot or very hot conditions

Hot conditions 27 – 32 C° Very hot conditions 33 C° +

STORAGE

In hot conditions the temperature at night falls sufficiently to provide a drop on the material temperature to below the 32 C° threshold temperature for epoxy grout. It is however advisable to have the 3 components covered during the day from direct sunlight to keep the temperature of the material below that threshold. For most resin compositions 32C° seems to be the point above which the pot life is reduced. For some installations that might not matter when the mixed grout batch is poured quickly. Keeping the component stored in a shaded area is therefore advisable. Bringing the material to site in smaller batches would also help against rising material temperatures. Ideally, grouting at night or early morning will provide the lowest material temperatures.

For very hot conditions we need to store the material in a shaded area. Ideally keep the resin and hardener in a cooler place. The reason for this is that the resin and hardener will already heat up during the initial mixing process before the aggregate is added. The final temperature after mixing is completed will determine the pot life. For this reason we cannot leave the aggregate standing in the sun on site because the greater mass of the aggregate will transfer heat to the cooler resin/hardener mix and the exothermic reaction will produce additional heat, all affecting the pot life of the grout.

SURFACE PREPARATION

Here we have the same requirements as for cold weather. The substrate aggregate/surface must be free of oil, grease, water or other contaminants. For concrete the laitance must be removed until a clean solid aggregate is visible. This will then provide excellent bonding.

EQUIPMENT / SUPPORT PREPARATION

The equipment / support which is to be grouted needs to be shaded in hot and very hot conditions. Metal plates in direct sunlight can get up to temperatures of 80^0 C + by lunchtime or early afternoon. The equipment or plate above the substrate provides shade for the substrate below reducing the temperature of the same. This causes a temperature gradient between grout on the top and the bottom. This cannot lead to good results. The other problem with this is during the grouting. Once the grout touches the hot surface it starts reacting even faster, reducing the flowrate. Should for any reason the level of the grout decrease (leaking out of the formworks or similar) than the grout will sticks to the underside of the plate. The new additional grout poured cannot pass this area. Even worse, the rest of the cavity will fill-up and nobody will notice this until much later.

MIXING GROUT

For hot and very hot weather conditions the same applies. Mix in the smallest batches possible which still afford productive grouting progress. Rather than mixing a larger batch and having trouble with the flowability at the end of the pour, mix smaller batches and provide a continuous flow of newly mixed material to the pouring. Keeping the flow speed going after the initial pouring helps the pouring tremendously. The correct mixing paddles are an essential part of the equipment to avoid air entrapment into the mix. The container for mixing the grout should be chosen so that the level of the grout being mixed exceeds the height of the mixing paddle. Keep the mixing paddle submerged in the grout to avoid mixing air into the grout. This should also be kept in mind when initially mixing the resin and hardener. In both instances the mixer should not exceed 400 RPM.