

» Master Builders Solutions Technical Bulletin Grouting on an industrial scale – The Does and Don'ts



Grout (Webster): A thin mortar used in filling joints and voids fluid enough to be poured.

Grout (ASTM): A material [...] intended to be used under applied load where changes in height below the initial placement height are to be avoided (Non-Shrink).

Basically, a liquid that turns into a structurally sound solid.

Basically, grouts are high strength materials that are placed as a liquid and solidify (rapidly in the case of Epoxies) to effectively carry the load imposed upon them by the equipment that they are placed under. Being in a liquid state they are far easier to place than the more traditional dry-pack grouts of old that were rammed into place making grouting of large or complicated equipment very difficult.

Fluid or flowable cementitious grouts have been around since the early 60's in various forms with both natural (Siliceous) and metallic aggregates and have been extensively used ever since. Epoxy Resin based grouts appeared in the early to mid - 70's due to the advances in chemistry and opened up an entirely new field of application where very high early and ultimate compressive strengths were achievable along with better chemical resistance.

The Master Builders Solutions Technical Bulletins are informative documents that present application recommendations and other technical details to better understand the use of construction chemicals products, often from BASF's portfolio.

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Cementitious vs Epoxy Grouts How do you decide?

Choosing the “right” grout material for the job should be an easy task. Since there are two main options – Cementitious or Epoxy. Unfortunately it’s not that simple and various factors come into play that can and should influence the final material decision, and not all of them are under the control of the grout supplier. The obvious one is “price” and in this instance there is a big difference in cost between a cubic meter of epoxy grout versus cementitious grouts (excluding the new super cementitious grouts).

Strength development is another clearly defining factor (again excluding the new super cementitious grouts) that may or may not be relevant, (*do you really need > 60Mpa in 24 hours or will 20Mpa do?*). In the vast majority of cases the contractor cannot tell you and simply goes by what is written in the specification. Epoxy grouts are well known for their rapid strength development and are typically selected on this basis for emergency re-grouting and foundation failure repairs where vital equipment has to be put back into service quickly, and more importantly are always readily available.

As mentioned earlier there is a new breed of cementitious grouts that perform as well if not better than most epoxy grouts but are only stocked in a relatively small number of countries and are not currently readily available in the Middle East (6-8 week lead time).

Service temperature of the placed grout is one thing that has to be considered seriously as epoxy grouts lose compressive strength very fast when gaining temperature. Any risk of raised service temperatures above 65°C would typically rule out the use of epoxy grouts, loss of strength and increased creep becoming a major concern that can result in severe equipment failure.

Size of the equipment has to a certain degree an influence on the grout choice although this can often be overcome with some forward planning at the time of installing the equipment. The usual point of concern is the actual gap (provided by the designer / contractor) between the top of the concrete foundation and the underside of the equipment (steel baseplate, etc.). The narrower the gap the less grout is needed therefore it has a lower cost – which is always good for the contractor. However placing thin sections of grout (especially epoxies) under very large baseplates can be very difficult and create all sorts of problems for the installation team. The recognised way is to split the large surface area up into smaller more manageable sections by using temporary or permanent shuttering beneath the equipment. However these typically should be placed before the equipment is installed, as doing so afterwards is far more difficult.

Epoxy grouts tend to be less fluid than cementitious ones and therefore require a little more effort in placing correctly.



This “fact” is often overlooked and can result in problems and delays for grouting teams when trying to install a viscous epoxy grout where in reality a highly fluid cementitious grout would be perfectly acceptable.

Another critical difference between the two types of grout is their *Coefficient of Thermal Expansion* and in the case of epoxy grouts it is a huge difference when compared to that of the underlying concrete – typically around 4 times higher. Cementitious grouts on the other hand are basically identical to the underlying concrete and therefore do not suffer from thermal expansion “issues” as much as epoxy grouts do.

If there are to be wide and or long unrestrained “shoulders” or large areas of un-restrained grout required for a typical grouting application great care should be taken to avoid “grout” failure in terms of de-bonding / cracking when using epoxy resin based grouts. Their massive rate of expansion and contraction compared to that of the concrete onto which they are bonded typically results in “bond loss”, shoulders curling up and cracking and basically chunks of grout breaking off.

This can of course happen when using cementitious grouts (incorrectly), but tends to be less dramatic.

Natural aggregate cementitious grouts tend to be brittle and therefore have historically only been used for grouting applications where there is very little or no dynamic loading such as steel columns, bases of tanks, etc., – basically heavy things that don’t vibrate, rotate or shake ! Metallic aggregate cementitious grouts originally solved this problem providing high strength with a small degree of ductility making them suitable for heavy industrial processes such as steel mills and presses, etc. These continue to be used in areas of high temperature as epoxies simply cannot / should not be used under such conditions. Metallic aggregate grouts although still available and used lost some of their market share to epoxies which as already mentioned, set much faster and offer a greater degree of chemical resistance along with the ability to absorb impact and vibration making them in the long-term more durable than the cementitious grouts of old.

Basically, despite the higher cost of the epoxy grouts their long-term durability benefits have made them far more acceptable and are now typically used in places previously associated with cementitious grouts.

General points to consider when choosing a grout:

- What is the Maximum Service Temperature?
- Is it subject to wetting and drying cycles?
- Is it subject to aggressive chemicals?
- Is it exposed to direct sunlight or large variances in day / night-time temperatures?
- Do you really need >50MPa in 24 hours or >90MPa as an ultimate compressive strength?
- How far will it need to flow and what is the expected / designed gap – Maximum expected thickness.



- Is the equipment going to have exposed shoulders? Are they really necessary?
- Are the shims to be left in place, where are they to be positioned?
- What is the maximum thickness to be and are the bolt pockets to be grouted at the same time or before? How big are they?
- Are there any large sections of grouting left completely “un-restrained”.

The basic rule of thumb when discussing the grouting requirements for a particular project is “ask as many questions as possible, as early in the project as possible! – The more information you have to hand the better! Get copies of drawings showing the foundation and equipment layout with holding down bolt details, etc., don’t leave anything to chance.

Typical Grouting Issues (Both Cementitious and Epoxy Grouts)

If the above questions (and many others) have been asked, everything should go as planned and the grouting installation should be a success.

However this is rarely the case and for various reasons. The typical complaint from site regarding cracking and the contractor sends along numerous photographs clearly showing cracking of the grout at various points. All other information is either withheld or simply not known and it is left up to the supplier to figure out.

The almost standard reasons for grout cracking are as follows:

- Inadequate surface preparation or weak concrete.
- Excessive water addition to increase flow.
- Complete lack of curing or inadequate curing (cement based grouts)
- Excessively wide and thin “shoulders”
- Massive shoulders without reinforcement.
- Excessively long shoulders with no allowance for contraction jointing
- Grout level taken too far above bottom of baseplate.
- Sharp corners acting as crack inducers.
- Packers too close to the edge of the grout – very rarely taken into consideration.
- Holding Down Bolts NOT isolated from the grout
- Incompatibility of Coefficient of Thermal Expansion between grout and concrete foundation – **EPOXIES**
- Large areas of grout un-restrained – typical in skid mounted applications

There are literally dozens of reasons associated with grout cracking and most of which can be avoided with attention to detail:

- Surface preparation – confirm requirements of manufacturer and ensure it is done correctly on site.
- Correct mixing equipment for the task in hand – large volumes of grout = large mixers and more people to assist.
- Shoulder widths to be kept to minimum. Basic rule – width to be less than depth.
- Remove shoulders unless absolutely needed – can be added using a low strength screed mix if required.
- Ensure packers are at least 50 mm inside the equipment boundary so they can be fully encased in grout – or preferably boxed out and removed after grouting (never done but should be).



Ideally, packers should be round in shape – no sharp corners to create cracks

- Jacking screws, holding down bolts, etc. to be provided with an isolation collar so any lateral forces are not transferred to the grout thus inducing cracking.
- Long shoulders to be provided with expansion / contraction joints to prevent linear shrinkage cracking – relevant for both cementitious and especially epoxy grouts. Use reinforcement and anchors if necessary. Seal joints accordingly.
- Avoid large un-restrained areas or provide mechanical anchoring / light reinforcement to reduce risk of cracking.
- Finish grout off with bottom edge of baseplate.
- If grout level has to be taken well above bottom edge of baseplate, etc., provide thin compressible expansion joint around perimeter of base (self-adhesive foam strip).
- Provide wide external corners / large shoulders with mechanical anchoring to prevent curling of the grout.
- Ensure adequate and correct curing regimes are followed – Cementitious keep wet / moist for at least 72 hours as a minimum, epoxies keep protected from direct sunlight / large changes in ambient temperature (thermal expansion issues)
- **Remember – NON SHRINK GROUTS ARE NOT NON-SHRINK and some degree of cracking should be expected on larger installations – it is almost impossible to avoid completely.**

Apart from the above possibly less obvious precautions other grouting “faults” that regularly materialize are typically related to the actual shuttering of the baseplates or skids that support the equipment. These have to be carefully made, be an almost perfect fit and MUST be liquid tight.

In the case of cementitious grouting this water-tightness can be easily tested as the concrete foundation MUST be flooded and saturated with water prior to grouting. Leaks can then be seen and rectified BEFORE any grout is poured.

However when using epoxy grouts this is NOT the case and any leaks will only be found at the time of pouring the grout. Leaks once established are extremely difficult to seal and this therefore requires a greater degree of fabrication skills along with a more thorough pre-grouting inspection in an attempt to visually spot any minute gaps.

Equipment grouted with slowly leaking shutters can result in gaps appearing under the base plates once the material has cured and is NOT uncommon. Once this happens it is difficult to correct other than possible injection with a low viscosity epoxy resin (has service temperature issues if used in the wrong places).

Other typical problem areas are the Holding Down Bolt Pockets themselves. These are typically quite deep, sometimes difficult to get to once the machine / equipment is in place and notorious for collecting rubbish. Ideally and when possible the HD bolts (studs) should be accurately set using jigs and grouted in place prior to the machine / equipment being installed. This way the pockets are assured of being free of debris, water and anything else that would compromise the grout. If this cannot be done (HD Bolts rather than studs) it is imperative that ALL water used for saturation of the foundation when using a cementitious grout, be removed from deep within these pockets.

Failure to ensure this can lead to excessive water being either trapped beneath the baseplate – creating a thin void once it is absorbed by the hardened grout, or being blended into the fluid grout thus increasing its water content and possibly inducing the grout to “bleed”, shrink and have a reduced compressive strength. Deep HD Bolt pockets when using an epoxy grout can also generate issues as the volume of grout placed into them can sometime be quite large and if not very careful can lead to excessive heat generation of the grout as it chemically hardens. This can cause severe bubbling and drop in strength development, etc., and must be avoided at all costs.



Sever Grout Loss



Totally inadequate surface preparation and large are unrestrained.



All packer & bolt – no room for grout

In conclusion “Grouting” is a relatively simple process that is difficult if there is no planning and attention to the little details. It doesn’t require a highly skilled workforce to install correctly but properly trained with experience in what can go wrong.

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