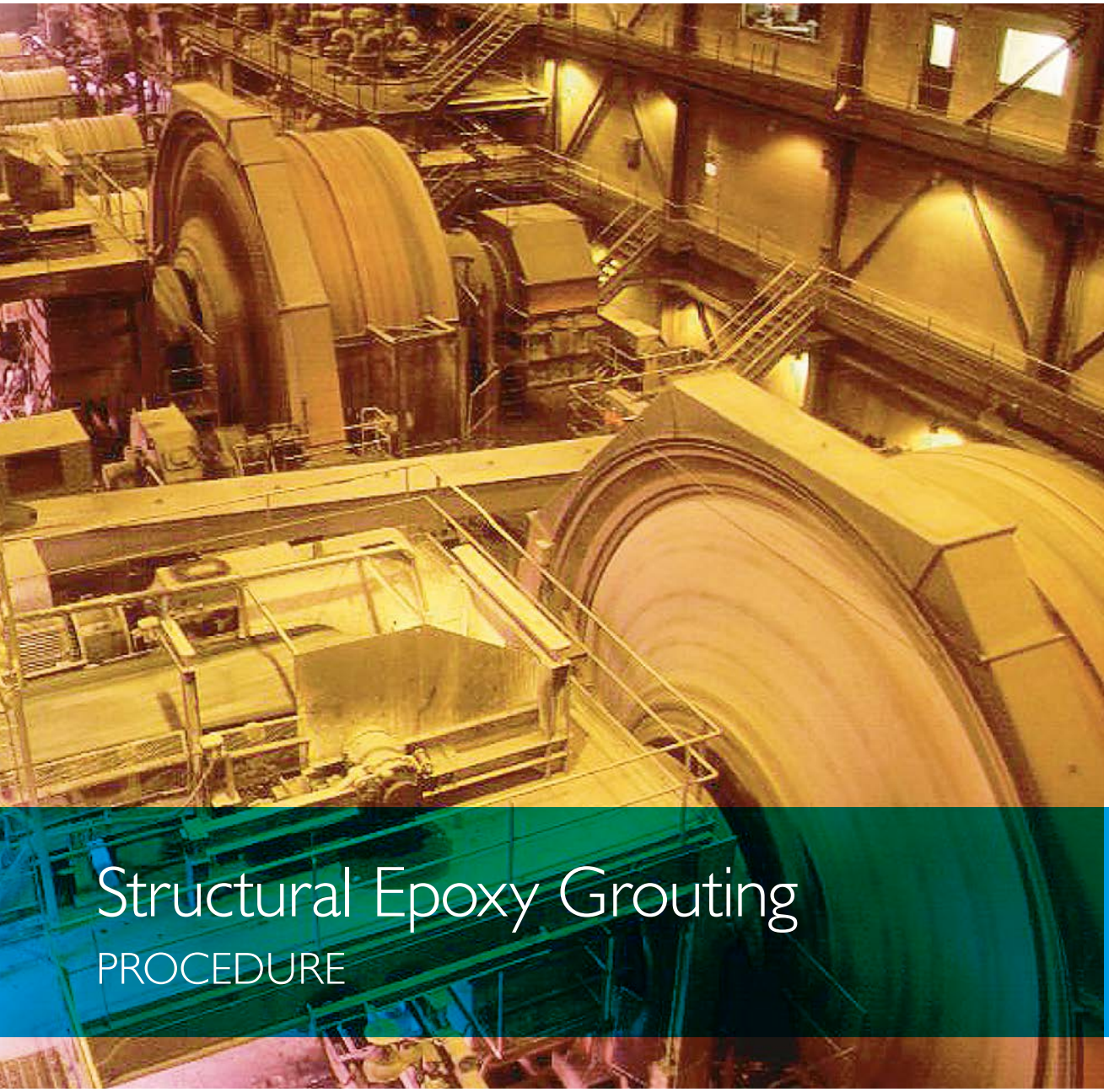
MASTER® BUILDERS SOLUTIONS

bluey



Structural Epoxy Grouting

PROCEDURE

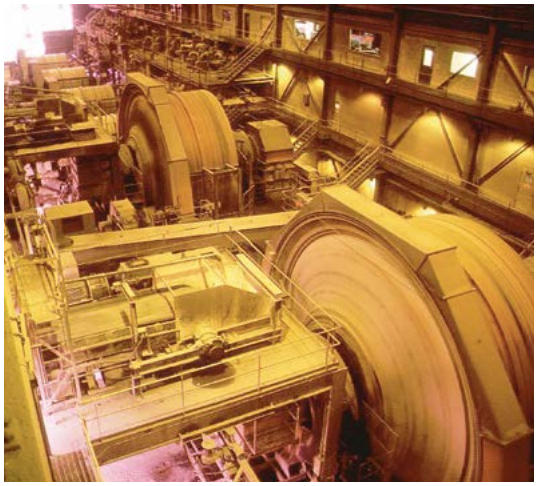
Structural Epoxy Grouting
INTRODUCTION

The preparation and installation of high strength nonshrink grouts has become a specialist operation, mainly carried out by specialist applicators and tradesmen.

This guide offers a step-by-step approach to industrial grouting from surface preparation to finishing. The guide highlights the need for good supervision and attention to detail, essential for the completion of a successful project.

The appropriateness of this guide will depend on each particular project.

Bluey is always available to support your project in the design office or on-site.

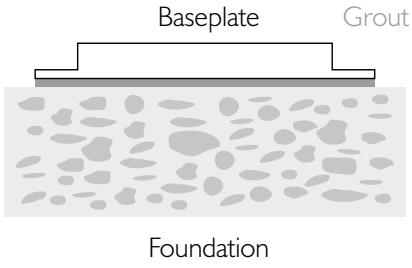


Structural Epoxy Grouting
INTRODUCTION

WHAT IS A GROUT?

A grout is a flowable mixture of materials used to fill void areas when installing machinery. After a given period of time the material hardens and helps the machinery retain its position.

A key aspect of grout performance is dimensional stability (non shrinking). The grout provides complete contact for the base plate to the foundation itself.



WHAT IS A CHOCK?

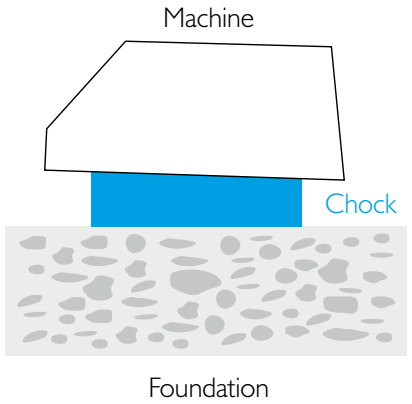
In order for a piece of rotating machinery to operate correctly it needs to be properly positioned and supported on its foundation. After the machine has been aligned there is always a gap between the bottom mounting surface and the top of the foundation.

A chock is used to fill this space.

Note that the machine supporting foot is not parallel to the foundation. The chock must still fit as close as possible to both surfaces.

If the chocks were made of steel, each chock would have to be fitted by hand.

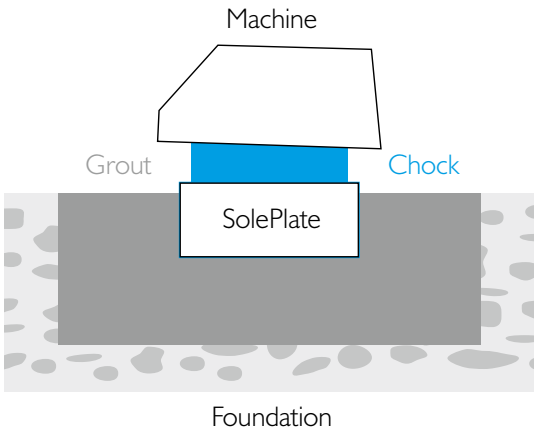
Epoxy can be poured into the gap and create a 100% non shrinking, fit.



WHAT IS A SOLEPLATE?

When machinery is installed on sole plates, the soleplates are grouted into the concrete foundation, and then the machinery is chocked to the soleplate.

In many cases the grout application can be very deep. Many grouts get too hot when they cure and therefore contract too much when they cool, causing cracks and poor bonds. The solution for these grouts is to pour in layers.



Structural Epoxy Grouting
SELECTION CRITERIA

CEMENTITIOUS AND EPOXY GROUTS - WHY CHOOSE WHICH?

Traditionally, cementitious grouts have been chosen for applications requiring good mechanical properties and economy.

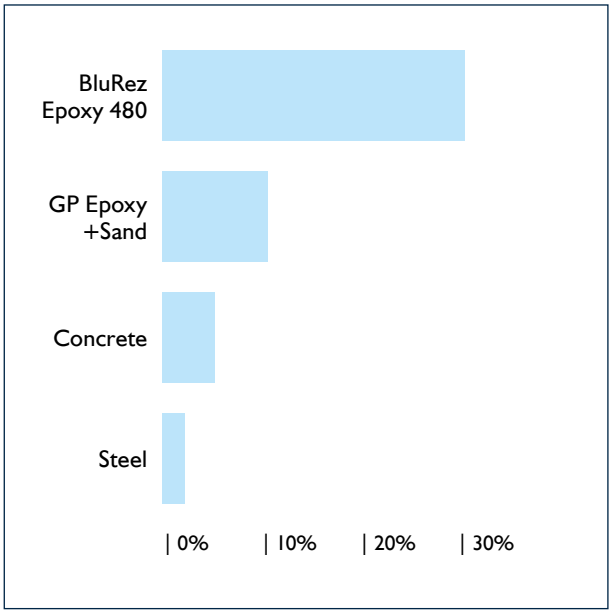
Cementitious grouts generally offer:

- Slower rates of strength development
- Lower chemical (especially acid resistance)
- Formulation to compensate shrinkage
- Greater economy

Epoxy grouts generally offer:

- Faster rate of strength development
- Higher chemical resistance
- Greater vibration damping capability
- Good dynamic load response to rotating machinery inherently non-shrink performance
- Higher tensile strength

CHARACTERISTIC VIBRATION DAMPENING CAPABILITY



Structural Epoxy Grouting
APPLICATION

GENERAL APPLICATION

TEMPERATURE ISSUES

In order to follow standard grouting procedures, temperatures of foundations, plates, and grout components should be as follows:

CORRECT CSP

	Min	Preferred	Max
Foundation and Plates	10°C	15 - 25°C	30°C
Grout Components	10°C	15 - 25°C	30°C
Grout at Mixed and Placed Temperature	10°C	15 - 25°C	30°C

Special epoxy grouts have been developed to be installed at temperatures outside this range.

If temperature extremes are anticipated, or if special placement procedures are planned, see comments below or contact Bluey Technical Services for specific advice. When grouting at minimum temperatures, care must be taken to see that foundation, plate and grout is protected from freezing (0°C) until it has reached 30MPa compressive strength.

EPOXY GROUTING

Installation procedures described here are as specific as possible but cannot cover all variations in applications and field conditions. Contact Bluey Technical Services for specific advice.

SYSTEM SELECTION

Before starting any epoxy grouting project, a review of the available systems and their features and benefits should be made.

Epoxy grouts can be formulated for a variety of applications, flow rates, cure rates, mechanical strengths, creep resistance, chemical resistance, and thermal resistance. Refer to the Generic Review included in this document for a summary of the features.

FOUNDATION GROUTING - SUB-BASE PREPARATION

- Epoxy grouts should only be placed on properly cured foundations
- The concrete sub-base should be scabbled so sound aggregate is exposed and laitance and weak float is removed
- The concrete sub-base shall be clean, dry, and free of oil, wax, and other contaminants
- Ensure all surfaces are dry. Double check anchor bolt sleeves
- If an anchor bolt sleeve is to be left un-grouted, seal the bolt hole with felt, foam, rubber, or other means
- Cover all shims, anchor bolts and levelling screws with suitable putty to keep the grout from adhering. Epoxy grouts exhibit good adhesion
- Shade the foundation from summer sunlight for at least 24 hours before and 48 hours after grouting

PLATE AND EQUIPMENT PREPARATION

- The bonding surfaces of the base or plate to be grouted should be free of coatings, wax, grease or scale
- Since the grout may come up at least 12mm to 18mm onto the equipment, it may be advisable to mask above this area with masking tape
- To permit easy clean up, wax or cover all surfaces where the grout may splash.

Structural Epoxy Grouting
APPLICATION

FORMING

- Moderately sized equipment should utilise a head form sloped at 45 deg to enhance the grout placement
- A movable head box may be a way to help the flow of the grout and minimise forming costs

NOTE:100mm-125mmclearanceisrecommended at the area where the grout is placed.

- Forms should extend a minimum of 18mm higher than the bottom of the equipment being grouted
- Large non-supporting grout areas should be eliminated wherever possible
- Protect the foundation and equipment from rain or moisture
- Areas not to be grouted must be sealed off
- Forms must be liquid tight. They may be sealed with suitable putty or sealant. Seal wood forms to vertical concrete surfaces by applying sealant below top of concrete, then press form into place
- It is desirable to place forms within a maximum of 150mm and a minimum of 25 mm from the edge of each individual base, rail, or sole plate being grouted
- Expansion joints will reduce the possibility of cracking
- On multiple sole plate installations each sole plate may be isolated.

DEEP POUR RECOMMENDATIONS

Contact Bluey Technical Services to select appropriate deep pour grouts.

EPOXY GROUT EQUIPMENT CHECKLIST

- Suitable low speed power tool (400 rpm) and mixers (Festo)
- Clean and dry wheelbarrow and buckets or shovels for transporting the grout
- Rags for wiping hands and tools
- Cleanup Solvent for tools
- Hand Cleanser for personnel
- Rubber gloves
- Extension cords
- Required amount of Bluey grout. Add 10% material for certainty factor
- Sufficient number of labourers to mix, transport and place grout
- Pallets for elevating material and mixer operator
- Pails for pouring grout
- Caulk and duct tape to stop leaks in forms
- Extra forming material and tools, wood, saws, hammer, nails

Structural Epoxy Grouting
APPLICATION

MIXING COMMENTS

To achieve optimum cured properties, proper proportioning and mixing are crucial. Rather than using a drum mixer, some mix small amounts of polymer grouts by hand. The process seems simple, the results appear acceptable.

However, proportioning and mixing greatly affects the hardened properties of the cured system. Poor adhesion and mechanical strength is the result of poor mixing.

The chemical reaction that occurs when an epoxy compound, for example, is mixed with a hardener, changes the liquid to a solid.

To accomplish this reaction effectively, the hardener must be dispersed thoroughly in the epoxy grout. Casual mixing isn't enough. Every molecule of hardener must connect with a compound molecule.

A good mix hardens into a solid with hardener and compound molecules interconnected like a chain link fence. Poor mixing results in weak spots where the hardener and compound aren't firmly connected. The result: a chain link fence with some of the links cut. The cut or incomplete links are weaknesses where failure can begin.

Correct mixing ensures a complete chain link fence. The hardened (cured) epoxy has high bond strength, low shrinkage, and excellent chemical resistance.

TEMPERATURE CONDITIONING

Components sometimes are stored in the field at ambient temperatures above 30°C. Wherever possible, cool the components before mixing. Cooler components will give longer work times and less chance of exotherm.

Components sometimes are stored in the field at ambient temperatures below 15°C. Whenever possible, warm the components before mixing. Heated components have a lower viscosity, making mixing easier and faster. A lower viscosity reduces the tendency to whip air in during mixing.

HOT WEATHER EPOXY GROUTING

Avoid high temperatures while grouting in summer.

In hot weather, store in relatively cool shaded areas below 30°C.

If grout components are above 30°C, the resulting mix will have a shortened work time. In these cases, pre-chill the materials to extend work time.

Pre-chill the sealed pails of hardener and compound in tub of ice.

Ideally cool the grout below 20°C. Provide shade from summer sunlight for at least 24 hours before and 48 hours after grouting.

COLD WEATHER GROUTING

Temperatures below 15°C can make epoxy grouts stiff and hard to handle and the cure time is significantly increased.

Contact Bluey Technical Services for minimum grouting temperatures.

In general epoxy grouting is not recommended below 10°C unless special systems are employed.

If heating is required, an enclosure (typical materials are polyethylene or canvas) should be erected around the equipment and foundation to be grouted. Forced air or infrared heaters may be used to provide the necessary heat to increase the base plate and foundation temperatures above 15°C.

In cold weather, condition for at least 24 hours at 20°C.

TEMPERATURE CONDITIONING OF AGGREGATES

If aggregates are used, they also may need to be temperature-conditioned. Hot aggregate will reduce work time and cold aggregate will reduce flow. Aggregates should always be kiln dry.

Check the recommendations for storage temperatures, temperature conditioning, and pot life at temperature extremes.

Structural Epoxy Grouting
APPLICATION

PROPORTIONING

It is sometimes incorrectly thought that altering the specified mix ratio of the components will cause faster or slower curing. When incorrect amounts of components are blended, the chemical reaction will be incomplete and the resulting product will not perform as expected.

Aim for a plus-or-minus tolerance of 2% when proportioning components. Do not guess or eyeball the weights or volumes. The best method of proportioning is to use the entire pre-proportioned containers

MIXING

Some components need to be pre-blended before mixing. Check with Bluey.

Add hardener to compound and blend the components with a suitable low speed power tool (about 400 rpm) equipped with a suitable mixing paddle. Mix for about 5 minutes, scrape the sides and bottom of the bucket, then mix for another 5 minutes. When mixing, move the paddle in a circular pattern with an up-and down motion.

Many polymer grouts have their components distinctly pigmented so that mixing produces a third colour. This is very helpful in determining when a complete mix has been achieved.

Continue mixing until a uniform colour develops with no streaks. This may take as little as 2 minutes or as long as 10 minutes depending on viscosity, density, and flow characteristics.

If aggregates are to be added, thoroughly blend the liquids before adding any aggregate. Then slowly add the aggregate and mix to a uniform consistency.

THE DONT'S OF MIXING POLYMER GROUTS

DON'T alter the specified mix ratio.

DON'T use a high speed drill.

DON'T try to mix components if too cold (<10°C); condition first.

DON'T try to mix components if too hot (>30°C); condition first.

DON'T try to mix aggregates if wet; always keep dry and sealed.

DON'T add solvent, water, or any other material to the system.

DON'T use product that's stuck to the mixing paddle.

DON'T use product that contains spots or streaks after mixing.

DON'T make new mixes in a buckets containing partially cured product.

DON'T forget to follow the recommendations for safe mixing.

DO:

- Read and observe MSDS
- Wear safety glasses... avoid eye contact
- Wear safety clothing and chemical resistant gloves... avoid skin contact
- Remove contaminated clothing and shoes
- Provide adequate ventilation to avoid breathing vapours
- Wear an approved organic vapour respirator

Structural Epoxy Grouting
APPLICATION

WORK TIME

Work time varies with product type and temperature.

In general, work time is halved for every 10°C temperature rise.

PLACING AND CURING

When grouting closed areas, start at one end of the form and fill the cavity completely as you advance toward the other end to prevent air entrapment.

Low foundation and ambient temperatures decrease flowability.

Strapping will assist movement of grout in low clearance applications.

Check frequently for leaks. Leaks do not self seal. If not stopped they will cause voids.

Epoxy grouts can develop high compressive strengths in as little as 12 hours and develop nearly 100% of their ultimate strength in seven days.

Curing rates are retarded at lower temperatures. Assume halving of cure rate for every 15°C drop.

Curing can be accelerated in many cases through the addition of an accelerator designed for use with the particular grout. Contact Bluey.

ANCHORING BOLTS, REBAR AND DOWELS WITH EPOXY GROUTS

Epoxy grouts may be used as grouts for anchoring bolts, reinforcing bar and dowels into portland cement concrete, rock and brickwork. In general, epoxies are most suitable for this application. The performance and durability of mechanical anchors is also greatly improved.

These adhesive grouts exhibit two to four times the compressive strengths and 10 to 15 times the tensile strength of concrete. Through uniform stress distribution, epoxy grouts function as shock absorbers, minimising the chance of catastrophic failure.

Relative to cement grouts, epoxies offer the advantages of much higher tensile strength, greater toughness and resistance to shock.

Relative to polyester resin grouts, epoxies shrink less and provide greater toughness and adhesion to concrete, rock and steel.

Conventional polyesters may also hydrolyse with time and lose bond to damp, alkaline surfaces such as concrete.

Well-designed epoxy adhesives can not only bond to wet surfaces, but will also maintain bond in damp or wet substrates over long term exposure.

HOLE DIAMETER

In general specify hole diameters 1.5 time insert diameter.

With large diameter inserts (>100 mm) this factor can be reduced. As the annular space decreases, grout placement becomes more difficult and care must be taken to avoid entrapping air, which degrades strength and creep properties.

DEPTH OF EMBEDMENT

Concrete tensile strength and the depth of bolt embedment determines the pullout load. The anchor depth should be designed to provide bolt failure when tested in tension (short-term test).

Contact Bluey Technical Services for specific advice.

HOLE SPACING

Hole spacing is important to avoid stress interaction caused by holes spaced too closely together or near the edge of the structure. A good guide for minimum spacing is 10 times the bolt diameter for bolt spacing and five times the bolt diameter for edge spacing.

Structural Epoxy Grouting
APPLICATION

EPOXY ADHESIVE SELECTION:

The majority of anchor applications involve structural loads, thus similarly rigorous criteria must be used in the selection of the epoxy adhesive as that used for the anchor. The ACI Committee 503 on the "Use of Epoxy Compounds with Concrete" recognises the relationship between heat deflection temperature (HDT) and creep resistance.

HDT is a measure of the temperature region in which the behaviour of plastics undergo a transition from rigid to elastomeric. ASTM C881 (Standard Specification for Epoxy- Resin-Base Bonding Systems for Concrete) recommends that epoxy adhesives used in anchoring applications have a minimum HDT of 49°C.

DRILLING AND SUBSTRATE PREPARATION:

Best results are obtained when the holes are dry cut by rotary-percussion drilling. This drilling method is preferred because it produces a rougher cut, providing a better key for the grout. After drilling, the holes should be scrubbed with a stiff, nonmetallic brush and blown out with oil free compressed air. Where holes are to be precast, they should be cast undersize and drilled to obtain the desired annular space.

SURFACE PREPARATION OF INSERTS:

Full column grouted anchors must be dry and free from contaminants, such as rust, dirt, oil, grease, protective coatings and galvanising. Rust should be removed by grit blasting or abrasive wheel.

Rust-protective storage films must be thoroughly removed with degreasing solvents. Test adhesion first. Once applied, epoxy adhesive grouts themselves provide excellent corrosion protection.

ADHESIVE GROUT PLACEMENT:

The adhesive selected for anchoring must be proportioned, mixed and placed in strict compliance with the recommendations and limitations.

Air entrapment in horizontal and overhead applications can be avoided by beginning placement of the adhesive grout at the bottom of the hole. The nozzle of the mixer or the gun should be adapted so that the outside diameter of the nozzle tip is just slightly under the diameter of the hole. This will allow the nozzle to be displaced outward as the adhesive material is extruded into the hole.

GENERAL SURFACE PREPARATION:

Proper surface preparation is a key to the successful use of epoxy adhesives.

Careful planning and execution of the cleaning and preparation procedures will lead to maximum efficiency in the application phase and greatest durability in use.

The following tests can be used to evaluate the condition of the substrate and the effectiveness of the surface preparation procedures.

STRENGTH:

The direct tensile strength of the surface may be determined by a pipe cap pullout test or a commercially available adhesion tested. Pull-off strength should be a minimum of 2 MPa.

CONTAMINANTS:

The presence of grease, wax, oil, curing compounds or other sealers may be detected by dropping a small amount of hydrochloric acid onto the surface. No reaction indicates that contaminants are present. If oil has penetrated into a concrete surface, it may be detected by raising the temperature of a small area to about 80°C with a heat lamp. Presence of the contaminant is indicated if oil appears or the area becomes "greasy" to the touch.

Structural Epoxy Grouting
APPLICATION

CLEANING CONCRETE SURFACES:

Remove grease, wax and oil contaminants by scrubbing with an industrial grade detergent or degreasing compound and follow with mechanical cleaning.

Remove weak or deteriorated concrete to sound concrete by bush hammering, shot or abrasive blasting, scarifying, hydro-demolition or other suitable mechanical means.

Remove dirt, dust, laitance and curing compounds by shot or gritblasting, water blasting or scarifying. Acid etching with 15% hydrochloric acid should only be used if there is no practical alternative. Etching often produces a fine dust which may act as a bond breaker. When employed, etching must be followed by scrubbing and flushing with copious amounts of clean water to remove residual chemicals.

Check for removal of acid with moist pH paper. Reading should be greater than 10.

Follow mechanical cleaning with vacuum cleaning.

CLEANING STEEL SURFACES:

Remove dirt, grease and oil with suitable industrial grade cleaning and degreasing compounds.

Remove rust and mill scale by blasting. Blast steel to white metal. Follow blasting with vacuuming or oil-free, dry air blast, and solvent cleaning.

STRUCTURAL CONCRETE BONDING WITH INJECTION GROUTS

Epoxy injection grouts are suitable for structural bonding of cracked concrete elements. Traditionally, these applications are best suited to specialised epoxy grouts. Please refer to the Bluey Crack Repair Procedures for more detailed information.

In general, cracks in concrete become unacceptable if they are likely to cause one or more of the following:

- Local structural weakness
- Ingress of moisture leading to steel corrosion and concrete spalling
- Unsightly appearance

Corrosion-induced cracks normally run along the direction of steel bars, with rust stains being apparent nearby.

Even fine cracks not exceeding 0.2mm in width are an evidence of advanced stage of corrosion because the steel must be well rusted to produce the expansive force necessary to crack the concrete cover.

Frequently a simple problem which is easy to rectify develops into a serious one in a few years if left unattended to, necessitating a costly solution.

Furthermore, the conditions of the concrete, such as carbonation and chloride content, have an important bearing on the complexity of the repair scheme. It is not infrequent that the repair work involves much more than filling the cracks.

In fact, cracks observed on the concrete surface are just visible symptoms of a hidden problem which must be eradicated. The same applies to cracks due to alkaliaggregate reaction, sulphate attack or fire.

For cracks initiated by other than chemical causes, the urgency of treatment depends on their width, their direction relative to the adjacent reinforcement and the condition of exposure. Judgment in this respect is subjective.

Structural Epoxy Grouting
APPLICATION

The following may be used as a guide:

Crack Width (relative to main bars)	Crack Direction	Environment	Immediate Treatment Required?
<0.5mm	Perpendicular	Internal	No
	Perpendicular	External dry	No
	Perpendicular	External coastal	Yes
	Parallel	Anywhere	Yes
>0.5mm	Perpendicular	Internal	No
	Perpendicular	External dry	Yes
	Parallel	Anywhere	Yes

REPAIR OF CRACKS

Cracks are invariably the result of overstressing of the concrete at some stage. If the forces which caused the overstressing have not been relieved when cracking occurred, or are not substantially eliminated, a concrete member which has been "welded" may crack again in the vicinity.

Repair of cracking is only feasible if the cause of the cracks has been, or can be, removed. Besides, cracks can be filled with any certainty only if they exceed 0.1mm in width, although effective repair has been achieved with cracks as narrow as 0.05mm under favourable conditions.

Before proceeding with the repair, it is necessary to anticipate the effects that the proposed repair system would have. If the cracks caused were caused by, say settlement or other movement that is likely to continue, or by overstressing that may be repeated, then any attempt to lock the crack against further movement may cause another crack to form alongside the original one.

In some cases it would be sufficient to seal the crack against ingress of moisture, but in others it may be necessary for loads to be transmitted across the crack.

For crack repair, the product used is usually a specially developed epoxy-based adhesive. To achieve an effective and lasting repair, the product should have the following properties:

- Low viscosity and surface tension
- Low shrinkage
- High bond strength
- High stability at service temperature

To seal a crack against moisture, a simple method is to brush a suitable adhesive sealer into it. Many plastic shrinkage and plastic settlement cracks in horizontal slabs can be repaired in this way. These products penetrate freely and can often be run in by gravity.

If it is necessary to restore the structural integrity of the concrete member, a strong and permanent epoxy injection system is used. The following general properties of epoxies make them suitable for the purpose:

- The mixed system can offer low viscosity and surface tension
- After hardening they are chemically inert
- Offer excellent adhesion to most structural materials
- Show minimal shrinkage during and after curing
- Possess excellent mechanical properties
- Offer high resistance to chemical attack

Application can be made by one of the following methods:

- Gravity or capillary action, suitable for floor slabs
- Vacuum suction, suitable for walls
- Pressure injection, suitable for most situations

Injection of the epoxy system is made with specially designed equipment. The compound and hardener are fed continuously, through separate hoses, to a selfmetering mixing and injection head, in which the ingredients are automatically mixed in the correct proportions immediately before being injected into the crack.

MASTER® BUILDERS SOLUTIONS

bluey®

We deliver...

- Products developed for civil engineering
- Product technical knowledge
- Site application knowhow
- A collaborative approach
- Economical solutions for large projects

1300 0 BLUEY | qld@bluey.com.au

bluey.com.au

NSW
nsw@bluey.com

VIC
vic@bluey.com

SA
sa@bluey.com

WA
wa@bluey.com

TAS
tas@bluey.com

ACT
act@bluey.com

NT
nt@bluey.com

NZ
nz@bluey.com

Exclusive Distributors for

EpiMax JM JENNMAR AKS FiRep Anchor Technology SAMWOO

Our products have Government and Regulatory Authority approvals across Australia and New Zealand.

R01/2023