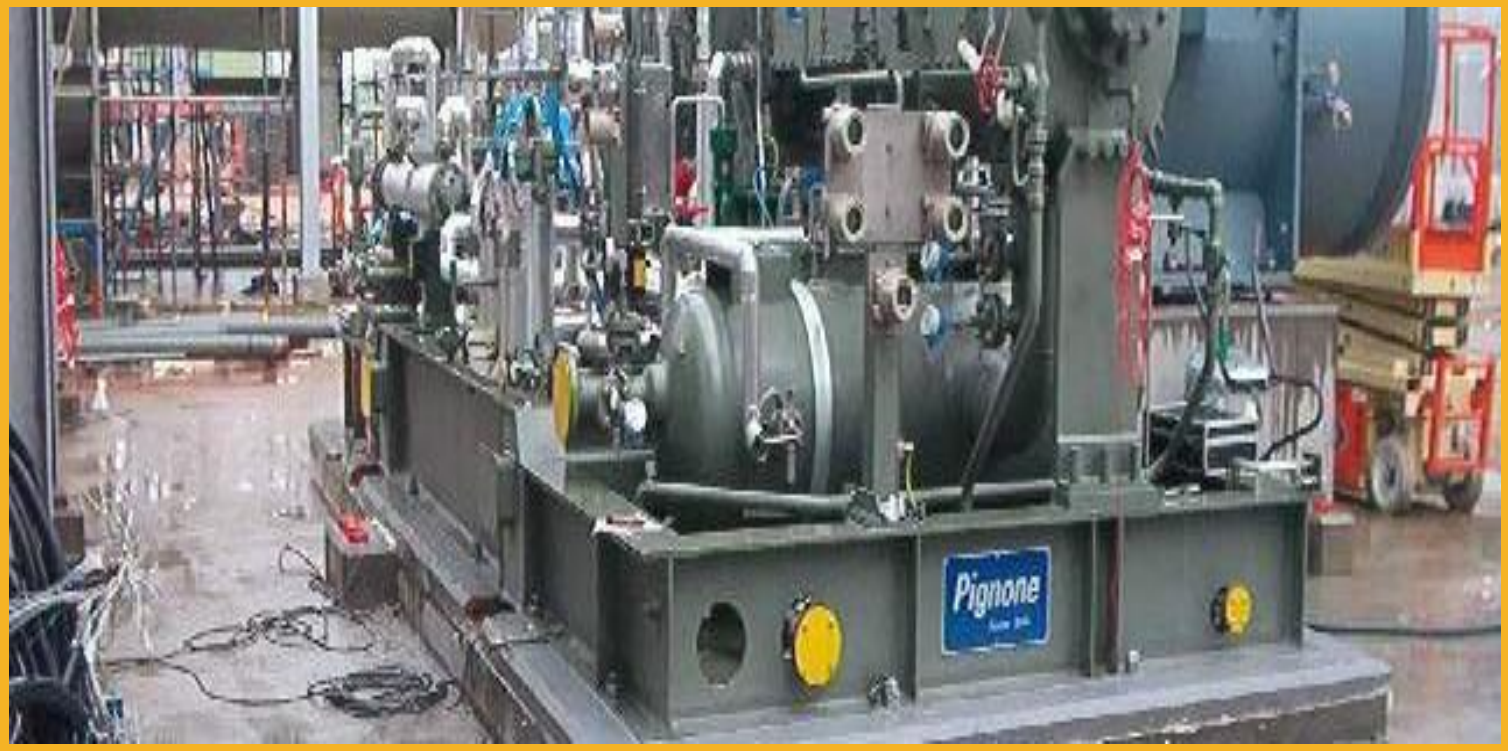

SIKA SOLUTIONS FOR RESIN GROUTING

AYDIN KHAJEPUR
SIKA PARSIAN

BUILDING TRUST

SIKA SOLUTION FOR GROUTING

1. **GROUTING OVERVIEW**
2. **PRODUCT BEHAVIOUR**
3. **APPLICATION**
4. **DESIGN & DETAILING**
5. **GROUT PROBLEMS**

SIKA GROUTING SOLUTIONS

GROUTING OVERVIEW

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SIKA SOLUTIONS FOR GROUTING
GROUTING OVERVIEW

WHAT ARE GROUTS ?

Machinery and equipment which have precise tolerances for alignment or require uniform support cannot be placed directly on finished concrete surfaces. Both the concrete surface and the machine base have irregularities which result in alignment difficulties and bearing load concentrations

A Grout is a ***load transfer material*** which fills the space between the machine base and the foundation

SIKA SOLUTIONS FOR GROUTING
GROUTING OVERVIEW

TYPE OF GROUTS

- Cement grouts
- Epoxy grouts
- PU Grouts
- PMMA Grouts

SIKA SOLUTIONS FOR GROUTING
GROUTING OVERVIEW

TYPE OF GROUTS

- PMMA Grouts

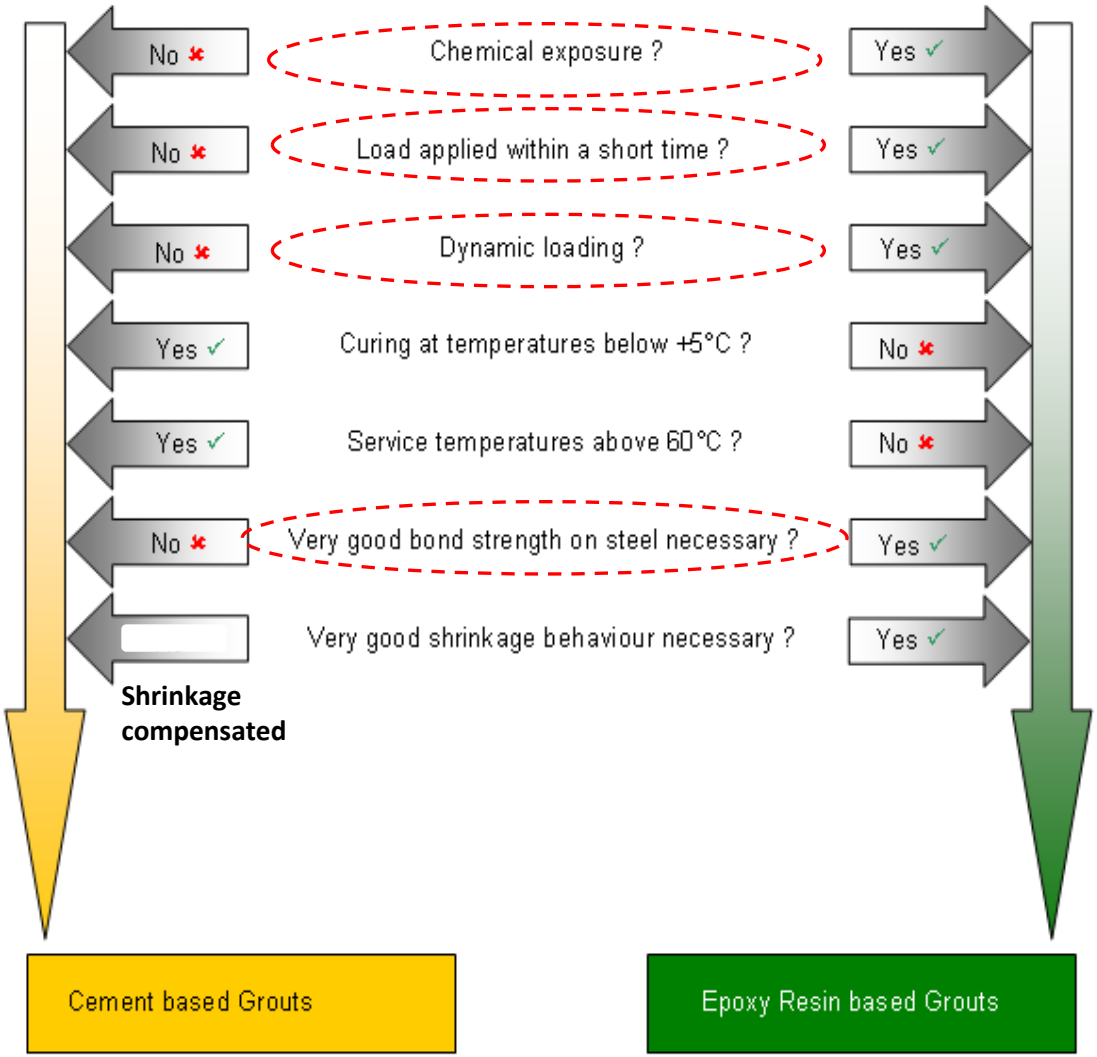
Demands to System
Concrete Repair within 7hours
Start: 11.00 PM
Latest Application 4.00 AM
Ready for first Landing at 6.00 AM

Airport Runway Repair with: Sikadur-12 Pronto

SIKA SOLUTIONS FOR GROUTING

GROUTING OVERVIEW

Decision Making Tree for Grouts :



SIKA SOLUTIONS FOR GROUTING
GROUTING OVERVIEW

Use of Epoxy Grouts:

When type of grout is not specified by the equipment Manufacturer ***epoxy grout*** shall be used for any of the following situations: .

- Machinery and pumps with driver power ≥ greater than 370 kW

GASCO	SABIC	ARAMCO
750 kW	373 kW	373 kW

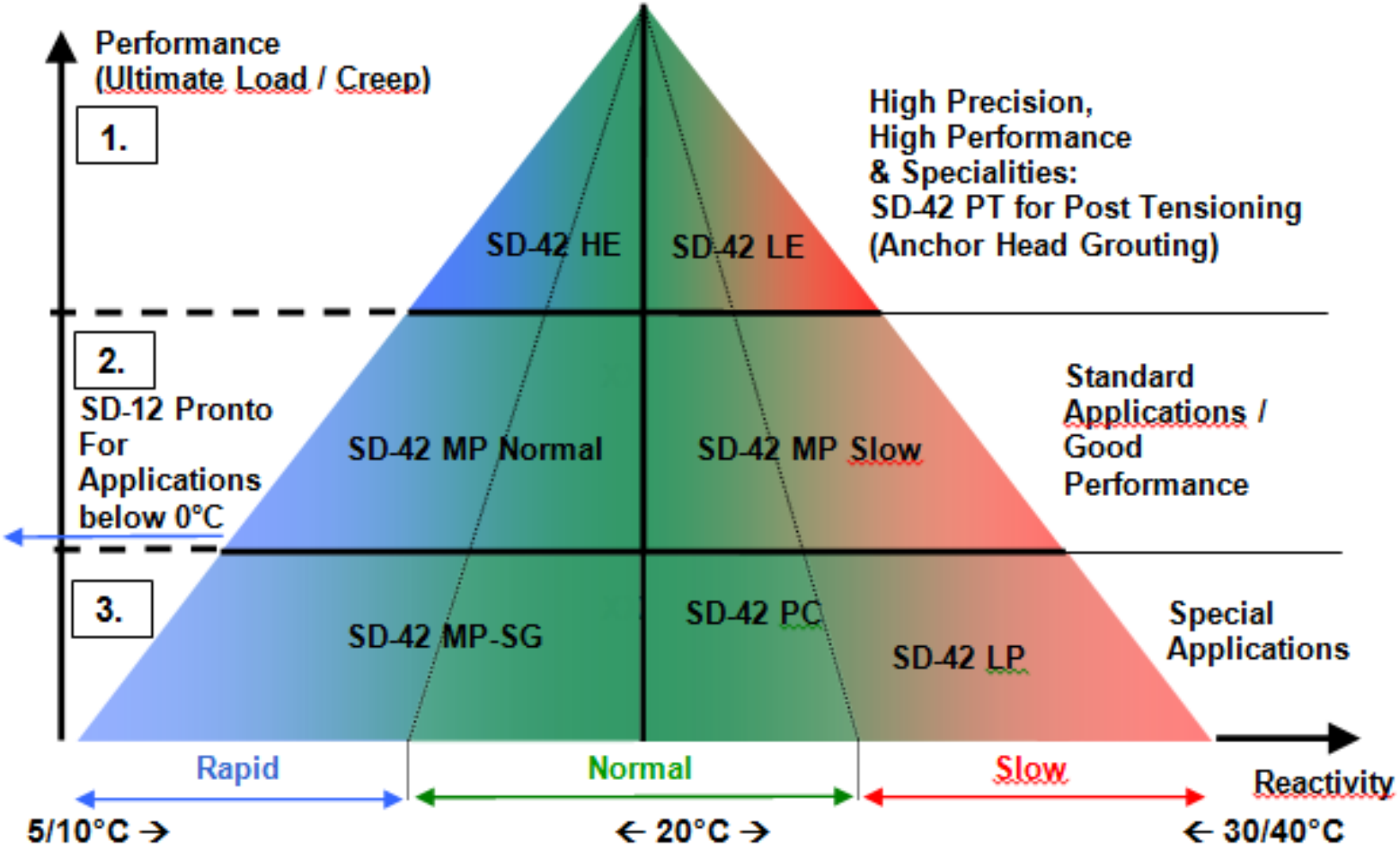
- Rotating Equipment with speed greater than 3600 RPM.
- Equipment that has a combined weight (machine, driver, and baseplate) of greater than 2,270 kg (5,000 lbs).
- All reciprocating machinery

SABIC	ARAMCO
37 kW	37 kW

Sikadur®-42

Epoxy Grouts:

GCC Range



SIKA GROUTING SOLUTIONS

PRODUCT BEHAVIOUR

BUILDING TRUST

SIKADUR®-42
PRODUCT BEHAVIOUR

Physical Properties of Epoxy Grouts:

- Very complex products
- Most properties give excellent values
- CTE is the one property that we must deal with in the grouting of equipment that presents the most problems

SIKADUR®-42
PRODUCT BEHAVIOUR

API 686 – Chapter 5:

- This document is now becoming the standard epoxy grout specification for major construction sites along with the engineers specifications.
- Most Manufactures of epoxy grout support this specification as it currently is the most positive method of installing epoxy grout under equipment to provide the best physical properties of the epoxy grout.

American Petroleum Institute

API
American Petroleum Institute

ACI 351.1R-12:

Grouting between Foundations and Bases for Support of Equipment and Machinery.

SIKADUR®-42
PRODUCT BEHAVIOR

Compressive Strength:

- The compressive strength is the maximum compressive force that can be sustained by a specimen during a static compressive load test.

- The compressive strength is often the first property examined by specifiers though not always the most important for successful performance.

- <u>This strength usually exceeds the concrete compressive strength</u>

Compressive strength N/mm2		GASCO	API
ASTM C579	Method B		
	1 day	65	
	7 days	95	> 83

SIKADUR®-42
PRODUCT BEHAVIOR

Exotherm Reaction:

- Heat is a natural by product of the epoxy/hardener reaction: When the curing reactions take place, they give off some heat (i.e. it is an exothermic reaction).
- The importance of this for grouts is: If the material is mixed completely (A+B+C) there is no problem, but if only A + B are mixed without adding C, then a considerable amount of heat is generated within the material, which can be very dangerous!
- The level of exothermic reaction in a grout limits its layer thickness. A highly reactive system also cures at low temperatures, but the layer thickness applied has to be thinner than for a lower reactive system
- Grouting above the products thickness limit can cause cracks to occur in the grout.
- *The larger the quantity of aggregate filling, generally the lower the peak exothermic heat generation*.

Peak Exotherm Temperature	API
ASTM D 2471	< 45 C

SIKADUR®-42
PRODUCT BEHAVIOR

Curing Speed / Potlife:

- The curing speed and the potlife are important topics for grouting and this is therefore also very often critical for a successful application.
- For larger volume grouting jobs, it is essential to ensure, that the potlife is not too short and that the grout can still continue to flow, for as long as is necessary.
- If there is a large mass of epoxy grout, the exothermic reaction also accelerates the curing process. It is therefore essential for applications with higher layer thickness / large volume application requirements, to use a product with a sufficiently long potlife / curing time.

working time/ Potlife	GASCO
ASTM D 2471	> 45 min

SIKADUR®-42
PRODUCT BEHAVIOR

Creep:

- Since epoxy resins in their cured or hardened state are essentially plastics, creep resistance is of obvious concern for epoxy applications
- Creep is the amount that a material deforms (changes in dimension) under constant load over a sustained period of time.
- All materials experience some creep and concrete is often looked to for its excellent creep resistance (low change of dimension) when used to support heavy loads.
- Compressive creep is therefore another important consideration for most high performance grouting applications.

SIKADUR®-42
PRODUCT BEHAVIOR

Effective Bearing Area:

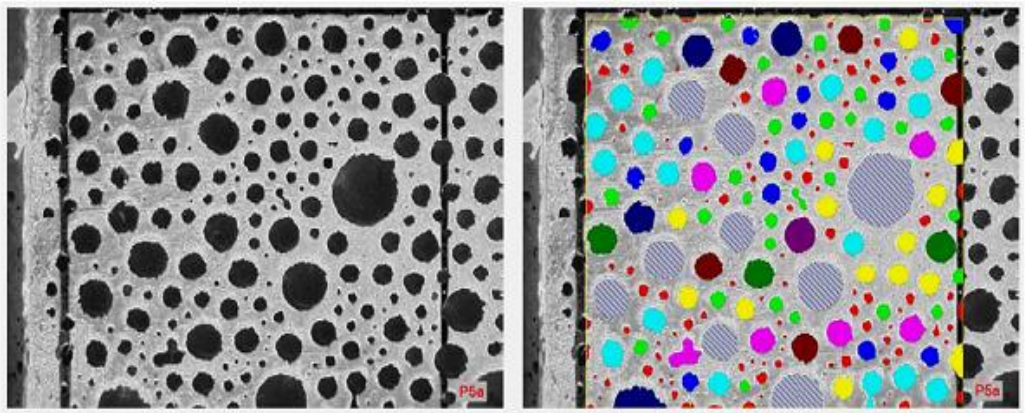
- One of the most important performance characteristics behaviour of an epoxy grout is its effective bearing area this is the area of the grouts top surface / plate contact area.
- This value (in percentage) describes the area of contact of the grout with the underside of the equipment or a baseplate, etc. In other words the contact surface with no voids.
- Additionally the higher the flowability and the larger the flow distance required, the more critical is this characteristic!
- This characteristic is essential, as through the top surface contact area all of the load and forces are transmitted.
- Voids under base plates, due to a low percentage effective bearing area, could obviously cause huge failures - and claims!

ASTM -C 1339

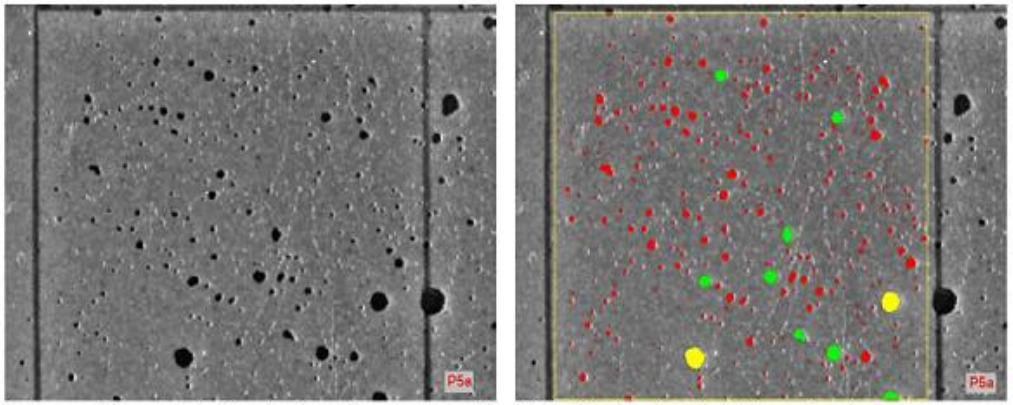
SIKADUR®-42
PRODUCT BEHAVIOR

Effective Bearing Area:

Examples of some bearing area photographs:



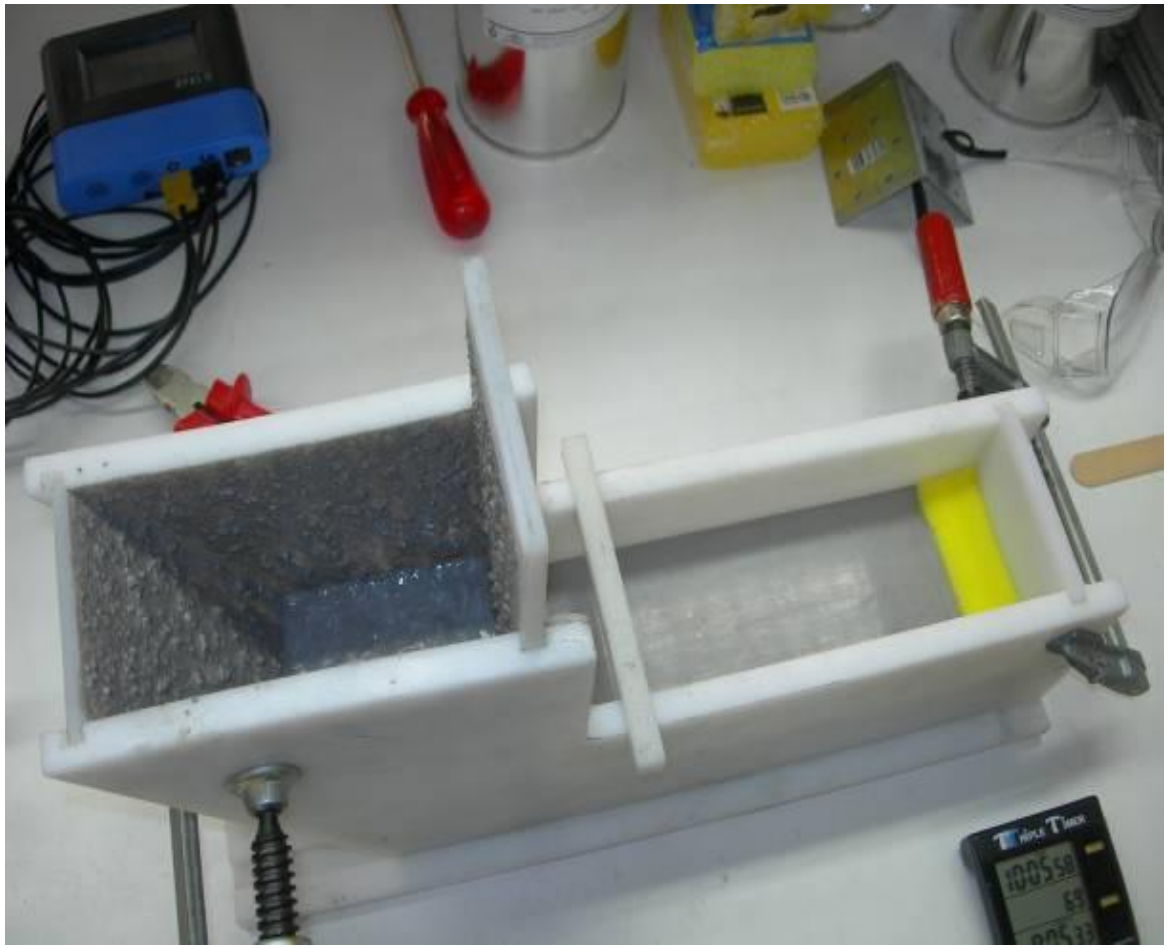
Surface with a low effect bearing area due to grout "bubbling" behaviour (~50% surface)



Surface with a good effective bearing area and "bubbling" behaviour (~90% surface)

SIKADUR®-42
PRODUCT BEHAVIOR

Effective Bearing Area:



Effective bearing area according to ASTM C 1339 :

SIKADUR®-42
PRODUCT BEHAVIOR

Fillers (Component C):

- In an Epoxy Grout, 80 to 90 % of the material consists of the fillers.
- This is a complex filler composition, the influence of this 80 to 90% of the product volume is huge on the whole grouting system. Especially on the most important product properties and performance criteria listed below.
- A strong C-Component includes filler aggregates of good quality according to a grading curve, as well as other ingredients and additives to produce the product properties

The filler (Component C) has a great influence on the most important product properties including:

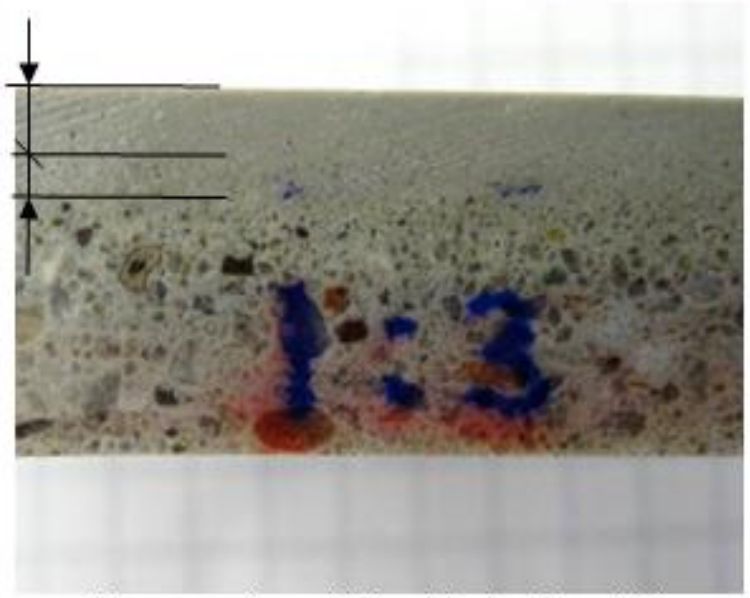
- Sedimentation / settlement within the grout layer
- Flowability
- Creep
- Compressive Strength
- Coefficient of Thermal Expansion
- Shrinkage
- Exothermic Reaction
- Effective Bearing Area

SIKADUR®-42
PRODUCT BEHAVIOR

Fillers (Component C):

- A good C-Component with an optimized grading curve has very good sedimentation behaviour, even at high temperatures there is effectively no sedimentation.

Cross-section with **good behaviour** low sedimentation



Cross-section with **bad behaviour** high sedimentation

SIKADUR®-42
PRODUCT BEHAVIOR

Fillers (Component C):

- The high sedimentation is bad. On the top the mixture of resin/hardener followed by some finer fillers while the large aggregates are on the bottom.
- This concentration of the resin content at the surface has the effect of creating an excessively high exothermic reaction.
- Cracks can also occur because of the differential curing and shrinkage! Creep is also very critical!
- A further negative outcome of the bad sedimentation behaviour and therefore of the surface composition is a very low effective bearing area with high bubbling and voids under the plate!
- High sedimentation also causes a decrease in the compressive strength and poor creep behaviour.

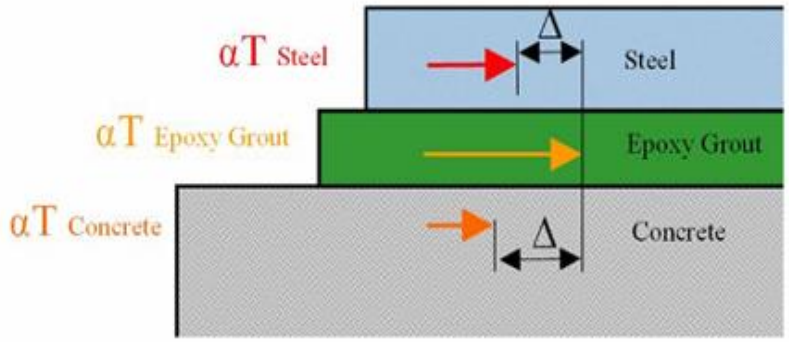
SIKADUR®-42
PRODUCT BEHAVIOR

Fillers (Component C):

COEFFICIENT OF THERMAL EXPANSION (CTE)

This can obviously cause some problems due to the stresses imparted during changing temperatures between the steel base plate, the epoxy grout and the concrete base. Cracks can be a result of this behaviour.

Stress occurs through different αT's:



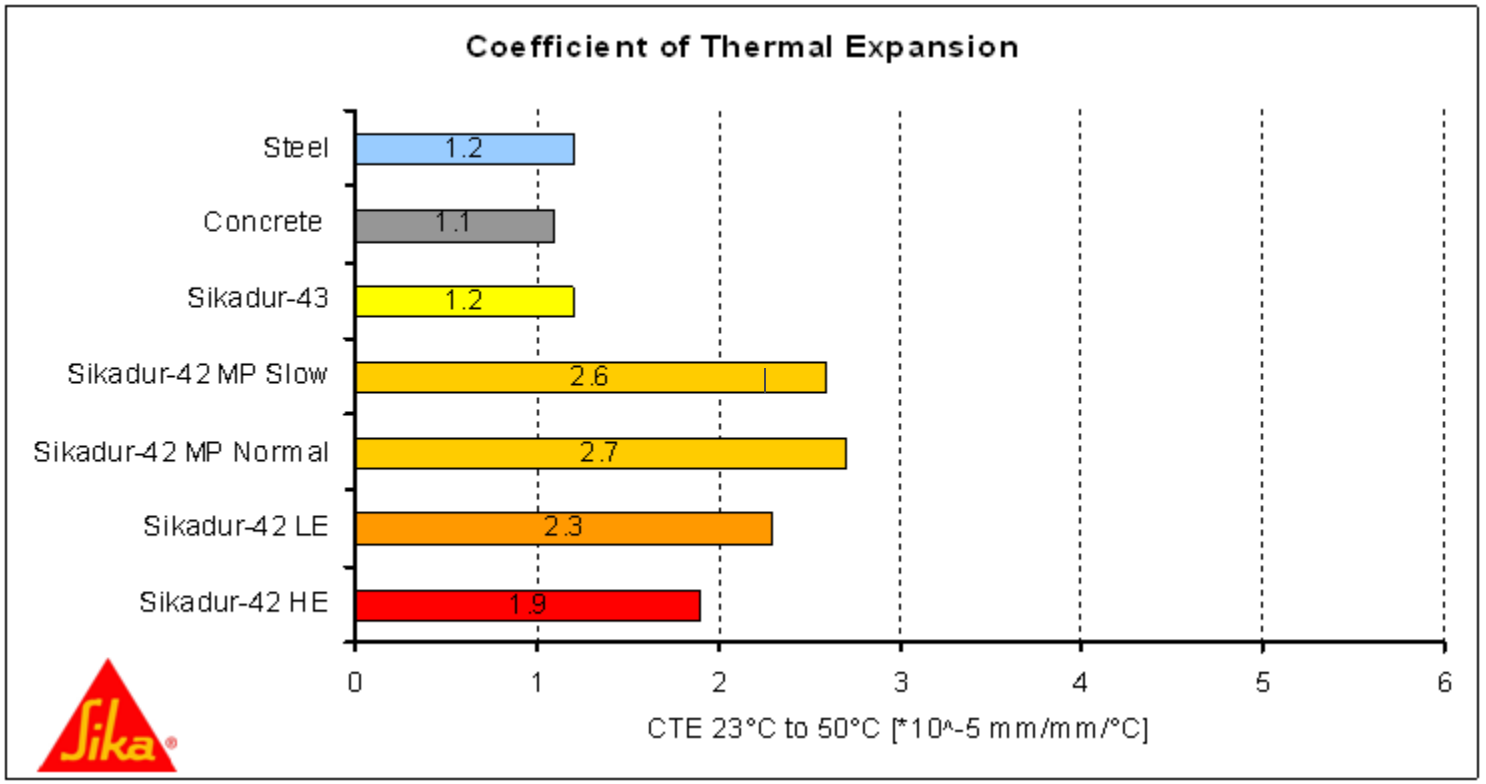
To avoid this problem, all Sikadur®-42 grouts from the new Corporate range are especially designed to keep this CTE as close as possible to the CTE of concrete and steel. The filler as well as the epoxy resin and the hardener all have an influence on this

SIKADUR®-42
PRODUCT BEHAVIOR

Fillers (Component C):

COEFFICIENT OF THERMAL EXPANSION (CTE)

Please see the graph below for the special CTE's of Epoxy Grouts from the Corporate Range:



SIKADUR®-42
PRODUCT BEHAVIOR

Fillers (Component C):

COEFFICIENT OF THERMAL EXPANSION (CTE)

The influence of the epoxy grout filler content and its quality,

as well as the quality of the resin and hardener systems gives us ***excellent low coefficients*** which are relatively closer to the CTE of concrete and steel.

In general a high filler load reduces the CTE. A very high filler content (1:12) no longer a grout, it is a mortar and is therefore no longer flowable. But with this high filler content it has the same CTE as steel.

The more aggregate in the epoxy grout, the lower the CTE will be.

Other benefits of a low CTE:

- Less tendency to cracking
- More distance between expansion joints
- Less linear shrinkage during temperature variations
- Less differential movement between the steel and the concrete elements when in operation
- Less tendency for plate voids to occur

SIKADUR®-42
PRODUCT BEHAVIOR

E-Modulus:

- The modulus of elasticity of a material relates to its overall stiffness (rigid or flexible). It is measured as the ratio of stress (force applied) to strain (change in length).
- An ***elastic modulus*** that is ***too high, can result in a brittle resin*** that easily cracks or shatters. As with mechanical strengths, a higher E-modulus is not always ‘better’. Follow the specifying engineer’s requirements for the specific project.
- For the Sikadur®-42 grout range, ***our target is to have an E-Modulus which is close to that of the concrete***.

SIKA GROUTING SOLUTIONS

APPLICATION

BUILDING TRUST

SIKADUR®-42
APPLICATION

Construction

N°: 850 42 01
Author: Marco Poltéra
Date: XX/2013

Method Statement
Sikadur®-42
Epoxy Resin based Grout
Corporate Construction

Storage Place:
Key Words: Sikadur®-42, Grouting, Epoxy Resin Grout, Reactive Resin Grout

Scope:

Method statement for the application of:
Sikadur®-42, a range of 3-part, Epoxy Resin based Grouts

Sika Services AG / Speckstrasse 22 / CH-8330 Pfaeffikon / Switzerland
Tel: +41 58 436 23 73 / Fax: +41 58 436 23 77
E-Mail: poltera.marco@ch.sika.com / www.sika.com

SIKADUR®-42
APPLICATION

Personal Protection:

The following protective equipment is essential for anyone working with any epoxy resin based products and these instructions must be strictly adhered to:


Wear protective overalls


Wear safety goggles


Wear protective gloves


Professional eyewash kit available

Dependent on local regulations respiratory masks may be required. Please observe all relevant local regulations.


Breathing protection required

The following equipment is also generally recommended on construction sites:


Wear hard hats


Wear safety shoes with steel toe caps


Wear ear protection. For use of mixing equipment → please refer to the manufacturers advice

Please refer to the local country regulations and the specific construction site requirements.

SIKADUR®-42
APPLICATION

3.1. Surface Preparation

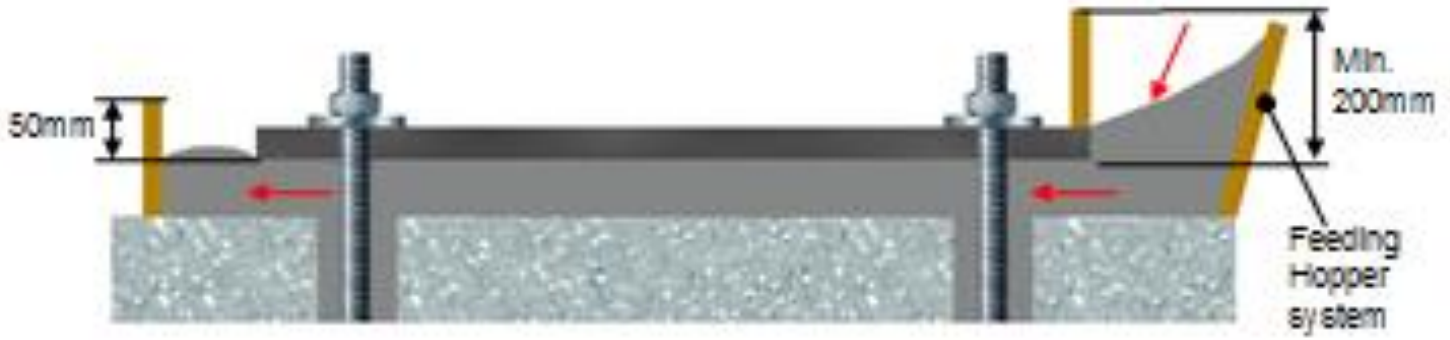
Requirements for the substrate:

- Weak concrete must be removed and surface defects such as blowholes and voids must be fully exposed.
- Mortar and concrete must be older than 28 days (dependent on minimum strength requirements).
- The max. substrate moisture content is ≤ 4 % pbw; if in doubt check with an equipment described below.
- Confirm the substrate strength (concrete, masonry, natural stone etc). If in doubt, make a test area first.
- The substrate surfaces must all be sound, clean and free from contaminants such as dirt, oil, grease, rust, existing surface treatments and coatings etc.
- All loose particles must be removed.
- Substrate must be dry or mat damp and free from any standing water, ice etc.

If in doubt, make a test area first and confirm with bond strength testing equipment, as shown on the left.
(Proceq or similar)

Cleaning:

SIKADUR®-42
APPLICATION



Opposite the filling side

Pouring side

Wooden triangle slats which are installed in the formwork

During placement

After removing the formwork, all flanges are chamfered

SIKADUR®-42
APPLICATION

Mixing Tools:

For optimum mixing results use a mixing paddle similar to the ones shown below:

With this design of mixing paddle, you can obtain the best results
to mix Resin and Hardener (A+B Component)

With this design of mixing paddle, you can obtain the best results
To mix (A+B) and C-Component (Fillers)

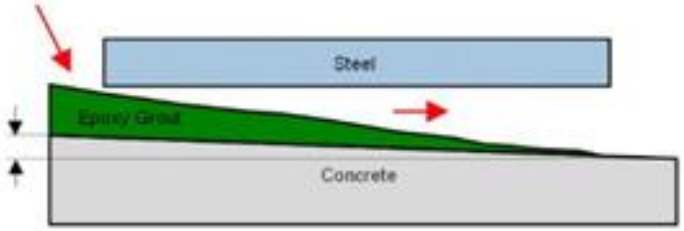
For additional information on high performance mixing tools and equipment:
See chapter 6.

Mixing of larger quantities:

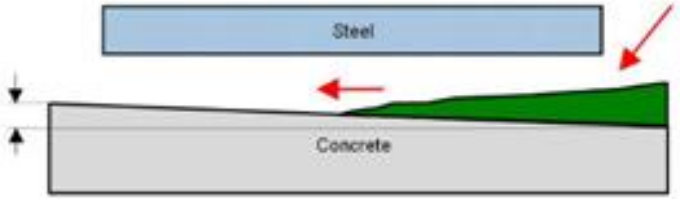
For big job sites and mixing of larger quantities, mixing equipment with more capacity is needed; such as for classic mortar mixing:

SIKADUR®-42
APPLICATION

Grouting down / with any slope or decline:



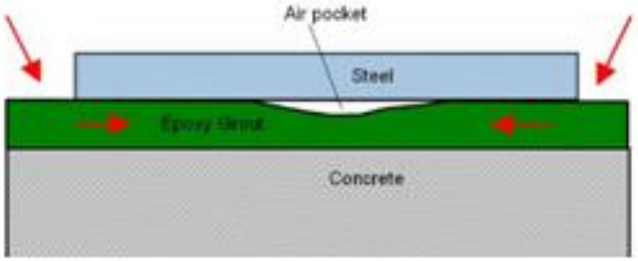
Grouting down along the slope



Do not grout against/up the slope

Grout from one side only:

Grouting from one side



Do not grout from both sides

SIKADUR®-42
APPLICATION

Working at high temperatures: 

It is recommended when working with Sikadur®-42 at temperatures above 35°C, that the following guidelines should be observed:

- Prior to use store the unmixed materials in a cool, preferably temperature controlled environment, avoiding exposure to direct sunlight or other heat sources.
- Refer to the data sheet of the specific product and closely follow the instructions in the section "storage conditions".
- Keep all equipment cool, arranging shade and protection where necessary. It is especially important to keep cool all surfaces that will come into direct contact with the material.
- Try to avoid application during the hottest times of the day.
- Provide sufficient material, plant and labour to ensure that the application is a continuous process and that the grout does not stop moving during flow application process.

Important Note: When both the materials and/or the substrates are too hot, the potlife will decrease dramatically!

SIKADUR®-42
APPLICATION

Working at low temperatures: 

It is recommended when working with Sikadur®-42 at temperatures below 15°C, that the following guidelines should be observed:

- Prior to use store unmixed materials in a warm environment, preferably temperature controlled and avoiding exposure to frost or temperatures below +5°C.
- Cold temperatures will decrease the flow properties of the grout.
- Refer to the data sheet of the specific product and closely follow the instructions in the section "storage conditions".
- Avoid condensation! Ambient temperature during application must be at least 3°C above dew point.
- Avoid water or ice formation on any surfaces.
- Grouting of Anchors: Heat up the steel (20-35°C) to activate the Epoxy grout.

Note: When both the materials and/or the substrates are too cold, the potlife will increase, the flow will also be restricted and curing will be delayed!

SIKADUR®-42
APPLICATION

Quality Control:

For optimal quality control grout some test specimens using the same material as used for the grouting work.

Test afterwards e.g. measure the compressive strength, or store these as retained samples for any future evaluation or requirements.

Example:
Retained samples according to ASTM C 579 as shown in the picture.
Specimen size: 2 inches or 5cm cubes

Check from every side of the grouted bearing plate (with a large nail or similar tool), that the grout level is full below the plate and not just at the shoulder before stopping the grouting flow and procedure. (See sketch below)

SIKA GROUTING SOLUTIONS

DESIGN & DETAILING

BUILDING TRUST

SIKADUR®-42
DESIGN & DETAILING

The success of a grouting operation depends on:

1. The design of the foundation and machine or equipment base,

2. The clearances provided for the grout, and

3. The provisions made for obtaining complete filling of the space

SIKADUR®-42
DESIGN & DETAILING

1. The design of the foundation and machine or equipment base

Concrete foundation:

- The concrete foundation should be designed to have sufficient stiffness to prevent flexural tension in the grout and to prevent thermal warping caused by temperature differential or change.

- If severe changes in temperature are expected, wide shoulders or long pours should have expansion joints and/or reinforcement to minimize cracks or horizontal fractures near the concrete-grout interface

SIKADUR®-42
DESIGN & DETAILING

2. The machine base should be detailed so that:

- Grout can be placed beneath the plate without trapping air in un-vented corners.
- If grout cannot be placed from one edge and flowed to the opposite edge, air vent holes must be provided through the plate to prevent air entrapment.
- A vent hole (6 to 13 mm) in diameter should be placed through the plate at the intersection of all crossing stiffeners and at each point where air may be trapped.
- Grout holes for placement of the grout should be located so that grout does not travel more than (1.2 m).
- The grout holes should be placed so that grouting can be started at one hole and continued at other holes
- Holes for pumping grout are typically (19 to 50 mm) in diam.

SIKADUR®-42
DESIGN & DETAILING

Clearances

- The clearances is often a compromise of two opposing requirements: minimum thickness of grout for optimum economy and performance versus maximum clearance under the base plate for ease and proper placement.

- *For epoxy grouts* placed by gravity, the minimum thickness should be about (25 mm) for each (30 cm) flow length. For each additional (30 cm) of flow length, the thickness should be increased about (13 mm) to the maximum layer thickness- approx. about (150-450 mm).

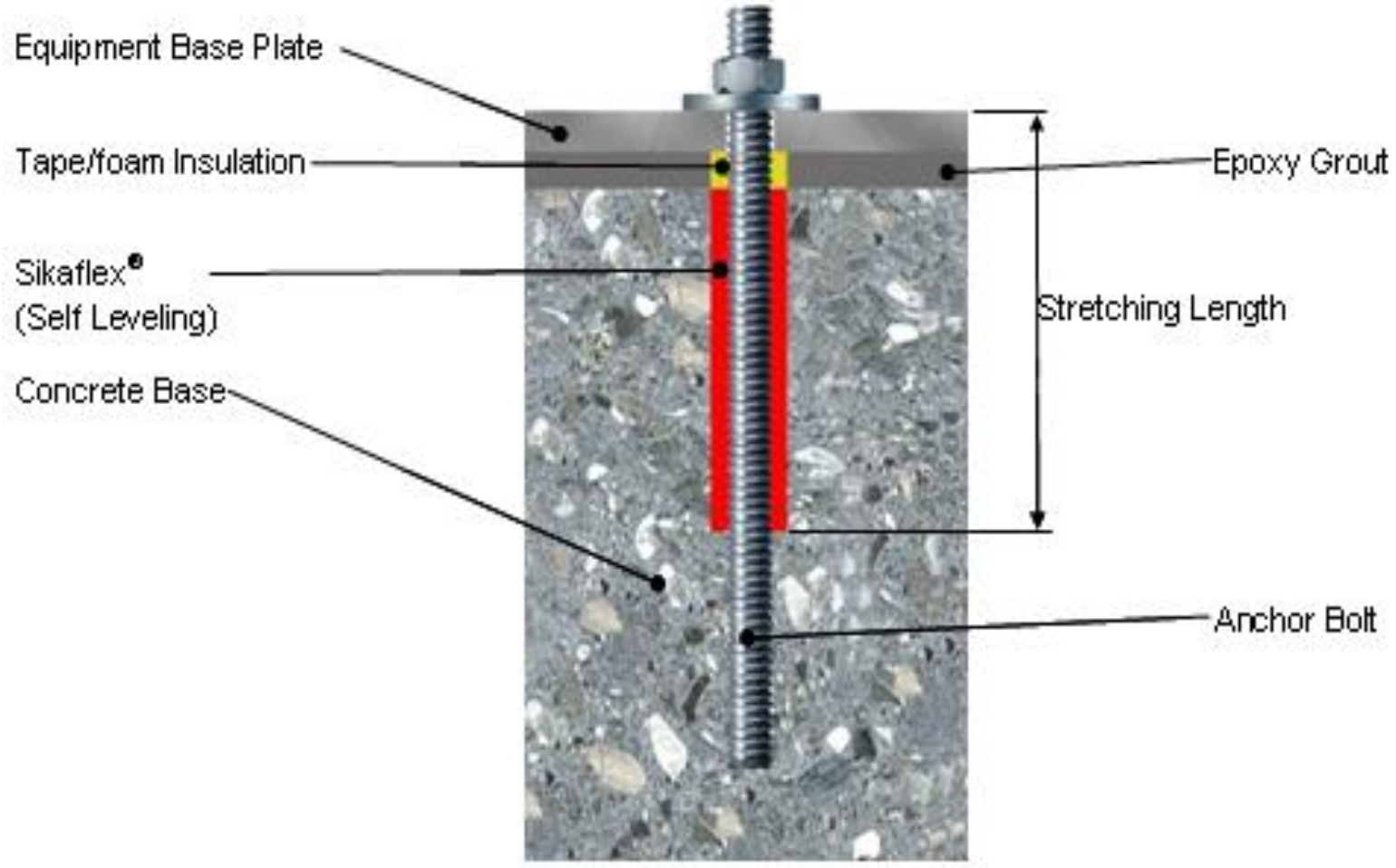
- *For pumping grout* depends on hose diameter to be placed under base plate.

SIKADUR®-42

DESIGN & DETAILING

Application / Installation:

Anchor Bolts for Machinery and Equipment:



SIKA GROUTING SOLUTIONS

GROUT PROBLEMS

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SIKADUR®-42
GROUT PROBLEMS

- Cracks (C&E)
- Curling/edge lifting (C&E)
- Cavities and hollow sound (C&E)
- Debonding and surface imperfections (C&E)

SIKADUR®-42
GROUT PROBLEMS

Cracks Type 1:
Top surface cracks perpendicular to base plate edge

SIKADUR®-42

GROUT PROBLEMS

Cracks Type 1:

Top surface cracks perpendicular to base plate edge

ACI 351.1R-12: **3.4—Common issues**

One of the major concerns when using a nonshrink grout is hairline cracks in the shoulder of the grout. In most cases, these hairline cracks are cosmetic in nature and do not affect the performance of the grout under the base plate unless located outdoors and subject to weather. If the grout is outside, a good fix is to seal the cracks to prevent water infiltration. A closer examination of these cracks is required to determine if they extend through the full depth of the grout. This could indicate a foundation failure that would require major repair. Cosmetic hairline cracks can be greatly reduced by requiring the grout shoulder to extend no more

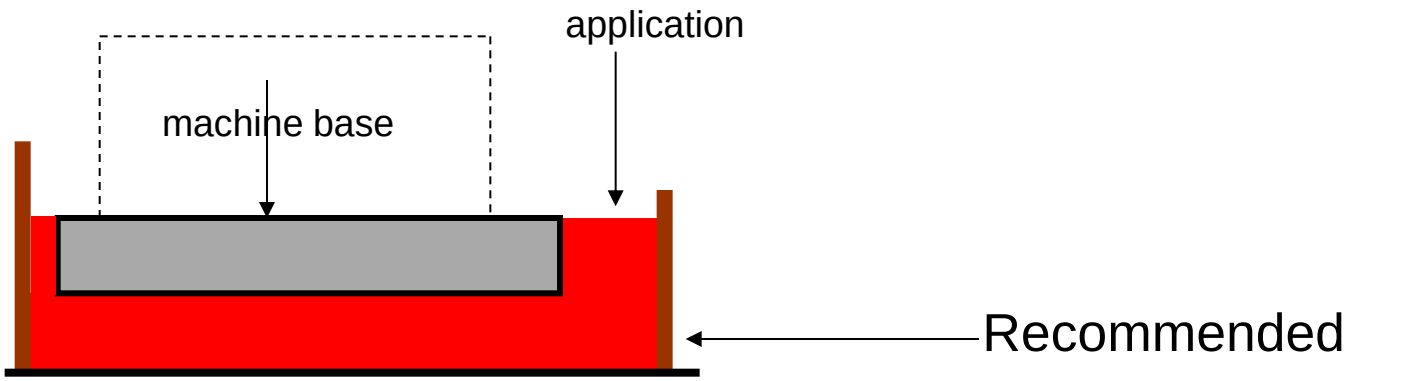
SIKADUR®-42
GROUT PROBLEMS

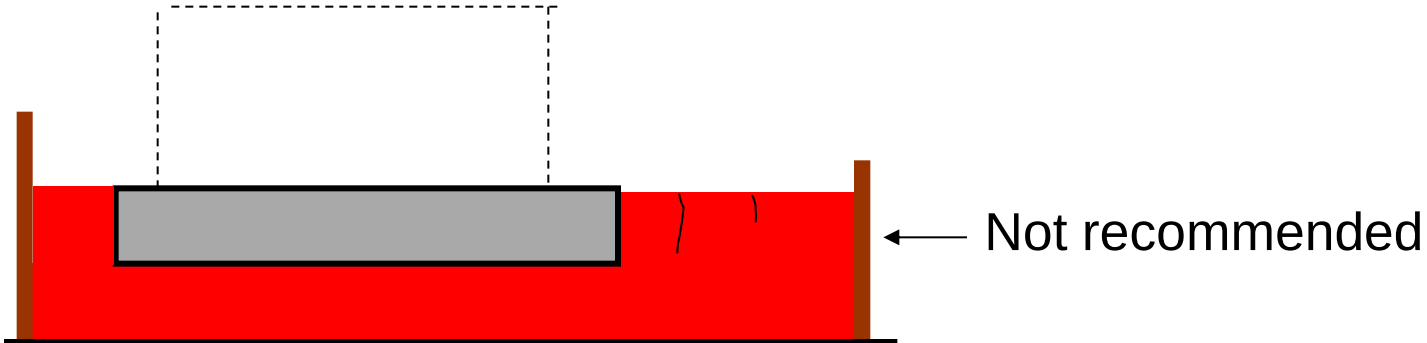
Use minimum shoulder width

ACI 351.1R-12: **3.4—Common issues**

require major repair. Cosmetic hairline cracks can be greatly reduced by requiring the grout shoulder to extend no more than 2 to 3 in. (50 to 75 mm) beyond the base plate.

API 686 – Chapter 5: **75 to 150 mm**





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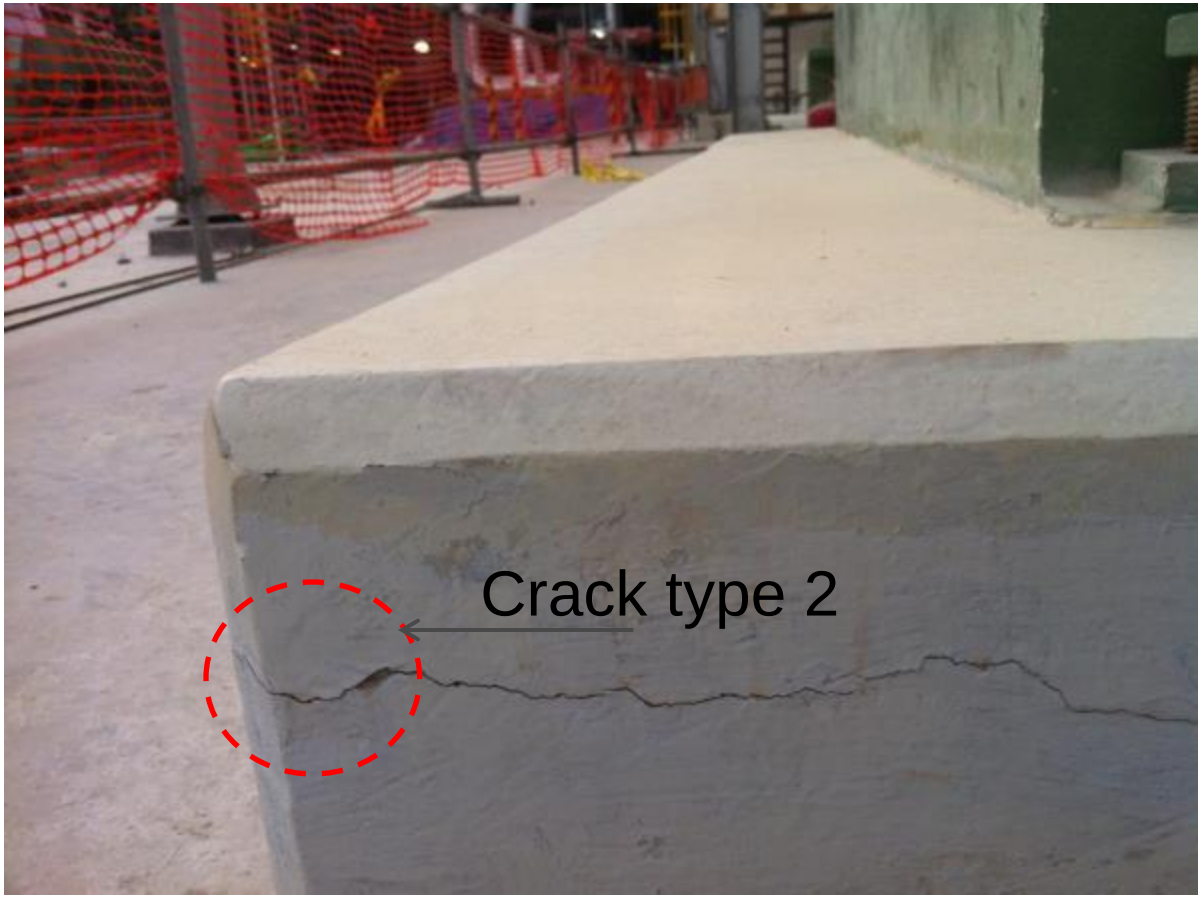
SIKADUR®-42
GROUT PROBLEMS

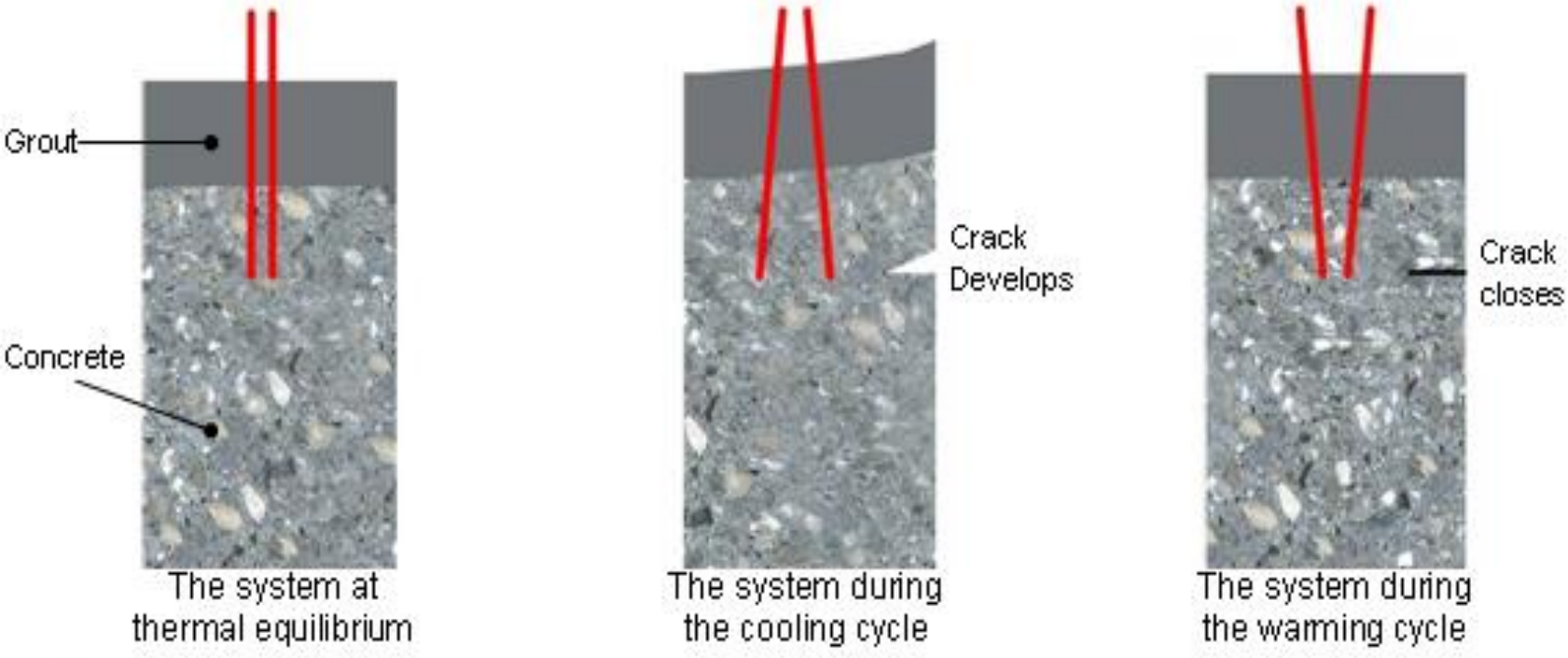
Cracks Type 2:

Grout Edge Curling/lifting problem



SIKADUR®-42
GROUT PROBLEMS

Problem of Edge curling:



The system at thermal equilibrium

The system during the cooling cycle

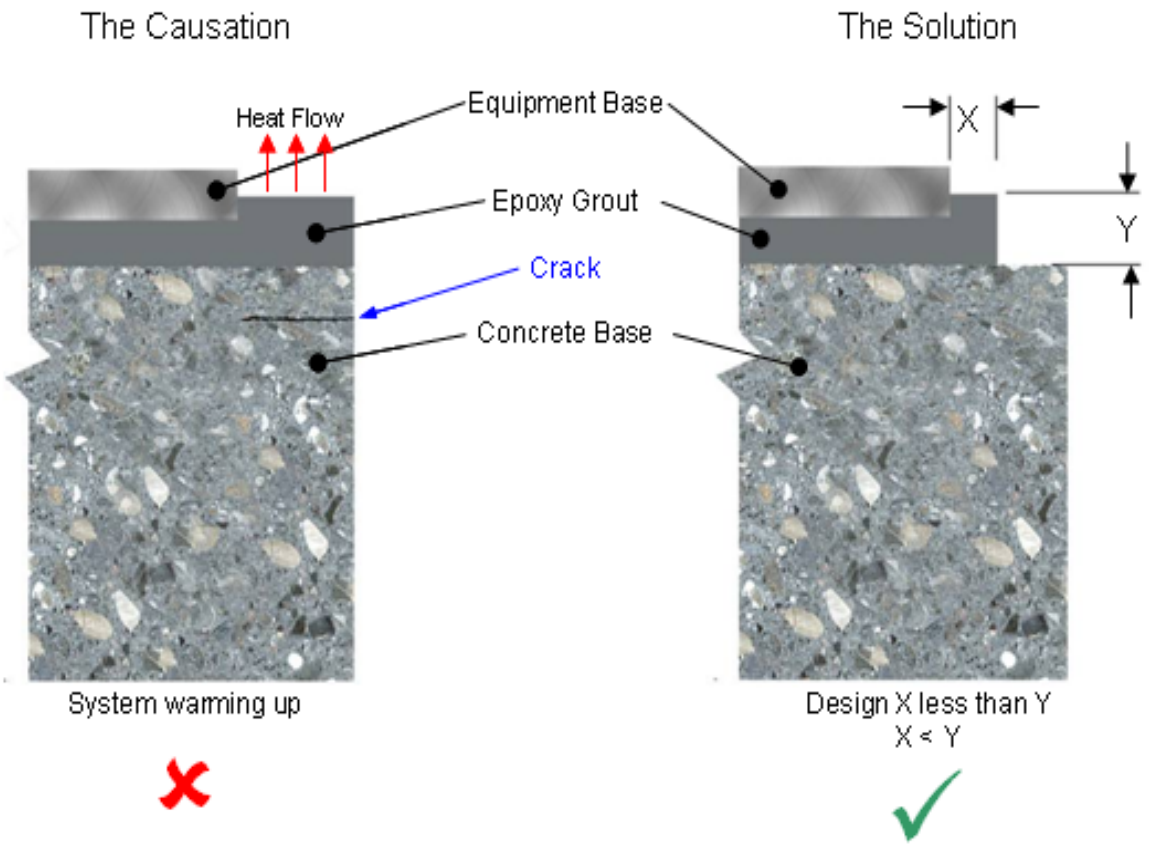
The system during the warming cycle

= tensile or compressive stress, due to thermal expansion.

SIKADUR®-42
GROUT PROBLEMS

Preventing Grout Edge Curling

The Solution for Edge curling:



It is recommended that the exposed edge distance (X) of the epoxy grout from the base plate to the formwork be kept less or equal to the thickness (Y) of the grout. This will eliminate edge curling of the grout.

QUESTIONS?

BUILDING TRUST

CONTACT DETAILS

AYDIN KHAJEPUR

TMM of Refurbishment
Mobile: 09128215684
KHAJEPUR.AYDIN@IR.sika.com

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