DAKO

art of concrete

DAKO GRC

TECHNICAL MANUAL

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Introduction to This Manual

This manual specifies the technical conditions and parameters for the production, testing, storage, transport, delivery and assessment of **glassfibre reinforced concrete thin-walled parts** (hereinafter referred to as the ”parts”) under the trade name **DAKO-GRC** manufactured by DAKO Brno, spol. s r.o.

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Technical requirements

Cited or related standards

ČSN EN 1169	Precast concrete products – General rules for factory production control of glassfibre reinforced concrete.
ČSN EN 1170 (1-8)	Precast concrete products – Testing methods for glassfibre reinforced concrete.
ČSN EN 206 +A1Concrete	Part 1: Specifications, properties, production and compliance.
ČSN 72 3000	Production and inspection of concrete building components. Common provisions.
ČSN EN 15191	Classification of functional properties of glassfibre reinforced concrete.
ČSN EN 15422	Specification of glass fibres for reinforcement of mortars and concretes.
ČSN EN 14649	Precast concrete – Test method for determining strength retention of glass fibres in cement and concrete (SIC test).
ČSN EN 1170	Precast concrete products – Test method for glassfibre reinforced concrete.
ČSN EN 13501 – 1	Fire classification of construction products and building structures – Part 1: Classification according to reaction to fire test results.
GRCA techNOTE 13	GRC Tolerances.
CEN TR 15739	

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Definitions

Manufacturer – DAKO Brno s.r.o.

The buyer (also the customer or purchaser) – a natural or legal person who, on the basis of a contractual relationship, purchases façade parts.

DAKO-GRC – a trade name for a glassfibre reinforced concrete composite material, whose matrix consists of a mixture of Portland cement, special ingredients, and additives. The reinforcement is made of alkali-resistant glass fibre.

DAKO-GRC interior parts – thin-walled plate or space parts, which are usually used inside – depending on the overall dimensions, the desired shape, and the requirements for load-bearing characteristics – with a shell thickness of at least 12 mm.

DAKO-GRC façade panels – thin-walled panel or space panels, which are usually used outside – depending on the overall dimensions and the nature of the required load-bearing capacity – with a shell thickness ranging from 12 to 20 mm.

Stud frame – a steel frame that supports the DAKO-GRC panel using anchors. The whole assembly is manufactured as a finished product (part), which is then hung on the supporting structure. The stud frame system allows easy assembly and production of large format panels.

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Description of DAKO-GRC products

DAKO-GRC glassfibre reinforced concrete is a structural material which, due to its excellent physical-mechanical properties, is widely used in architecture and construction. The great advantage of this material consists in its high strength and durability thanks to the use of glass fibres, while maintaining a relatively low weight of the individual elements.

DAKO-GRC products comply with the requirements of EN 1170, EN 1169 and the Glassfibre Reinforced Concrete Association (GRCA), whose members meet the requirements for high quality GRC production from raw materials, production, curing, and storage, to quality assurance and testing.

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Characteristic features

Basic parameters

The table shows the results of testing DAKO-GRC glassfibre reinforced concrete panels, measured according to European standards and the GRCA (Glassfibre Reinforced Concrete Association) specifications. Thanks to the in-house development aimed at achieving the densest possible microstructure of the cement matrix, it is possible to produce highly resistant and durable DAKO-GRC glassfibre reinforced concrete façade panels.

Parametr	Standard | Limit value	DAKO-GRC Grade 18/18 P
Tensile strength at bending	EN 1170-5 | 18 MPa	MOR > 18 MPa LOP > 7 MPa
Volume weight	EN 1170-6 | > 1,850 $kg \cdot^{m-3}$	1,950 $kg \cdot m^{-3}$
Absorption	EN 1170-6 | < 11 %	< 11 %
Frost resistance coefficient	EN 492+A1 | > 0.75	> 0.9
Durability – climatic cycles	EN 1170-8 | > 0.8	> 0.8
Linear change in dimension due to humidity	EN 12467+A1	0.018 %
Linear change in dimension due to temperature	EN 14581:2005	$10 \cdot 10^{-6}$ °C^{-1}
Reaction to fire	EN 13501-1+A1	A1

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GRC Manufacturing Tolerances

In general, manufacturing tolerances should be within the following limits and as illustrated in the annex 1 to this.

Linear Dimensions (i.e. Lenght and Height, Fig. 1)	≤ 3 m: ± 3 mm > 3 m: ± 6 mm	
Edge returns (Fig. 1)	+ 12 mm / – 0 mm	
Thicknesses - shaped panels (see Detail A, Fig. 1)	Architectural facing thickness (min. 3 mm)*	+ 2 mm / – 0 mm
	Backing mix	+ 5 mm / – 0 mm
	Depths of integral ribs	+ 10 mm / – 5 mm
Thicknesses - flat panels (see Detail A, Fig. 1)	Tolerances for the flat panels	– 0 % / + 15 %
Angular variation of side moulds (see Detail B, Fig. 1)	≤ 75 mm depth	± 1 mm
	> 75 mm depth	± 1,5 mm
Variations from square (see Fig. 1)	Difference in lengths of diagonals or other similar criteria: • 3 mm for 2 m or below • or 6 mm for above 2 m	
Bowing (see Fig. 2)	≤ L / 250	
Openings within panel face (see Fig. 1)	± 5 mm	
Location of opening within panel (see Fig. 1)	± 3 mm	

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Stud Frames (see Fig. 3), should be fabricated within the following tolerances	Vertical and horizontal lengths alignments	6 mm per 3 m or part thereof (i.e. for 5 m length frame tolerance would be 12 mm)
	Spacing of framing members	± 10 mm
	Squareness of frame, (difference in diagonals)	10 mm
	Overall lengths of frame	± 10 mm**
Warping (see Fig. 4)	Maximum permissible warp of one corner out of the other three should be not be more than 5 mm/m distance from the nearest adjacent corner.***	

** This may not be possible for heavier aggregate/textured finishes. In such instances indicative samples may be referenced to establish acceptable variances.*
*** It may be necessary to adjust the jigs used to fabricate the stud frames, prior to the frames being galvanised, to offset some of the distortions due to the galvanising process.*
**** However, it may be possible to erect the panel within installation tolerances via connection adjustments.*

Source: GRCA techNOTE 13, November 2020

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Anchor Tolerances

Lifting points:	±13 mm
Bighead anchors:	±5 mm (left-right), ±2 mm (front-back)
Fischer anchors:	±3 mm (left-right), +2 mm / -0 mm (front-back)
Embedded anchor (e.g., Kings Road Park):	±10 mm (left-right), ±3 mm (front-back) – this refers specifically to the stainless steel anchor itself, not the aluminum bracket mounted onto it.
Mounted anchors:	±2 mm (all directions)

Rib Tolerances

Fire barriers:	±5 mm (height)
Reinforcement sprayed ribs:	±75 mm
Ribs for mounted anchoring:	±5 mm (height), ±3 mm (thickness)

Anchor Strengths

Load bearing capacity of anchoring elements		
Fischer FZP II 11x8 M6/T/12 PA Hidden hole depth 8 mm	EAD 090062-01-0404	Tension 1.020 kN Shear 3.637 kN
Fischer FZP II 13x15 M8/15 Carbon Hidden hole depth 15 mm	EAD 090062-01-0404	Tension 3.045 kN Shear 9.693 kN

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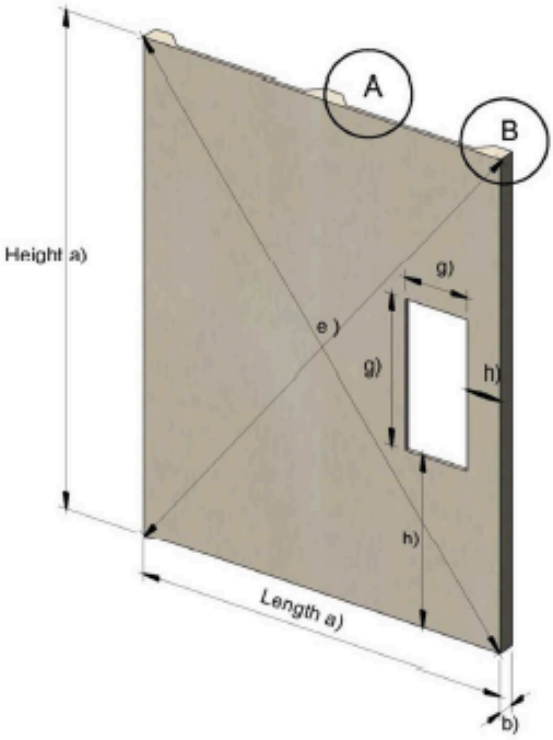
Tolerances - Annex

FIGURE 1



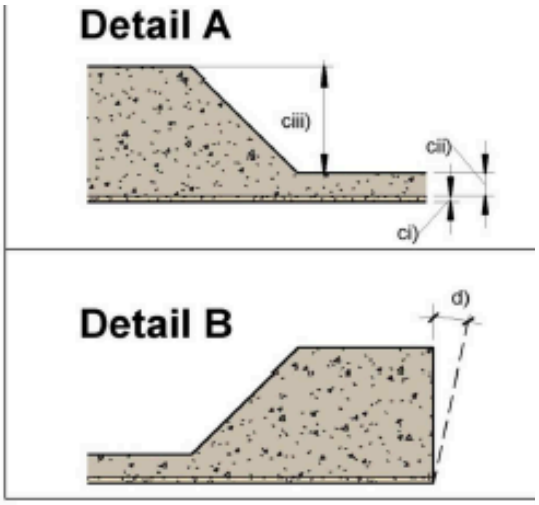


FIGURE 2 Bowing

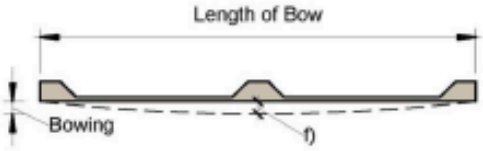


FIGURE 3 Stud Frame

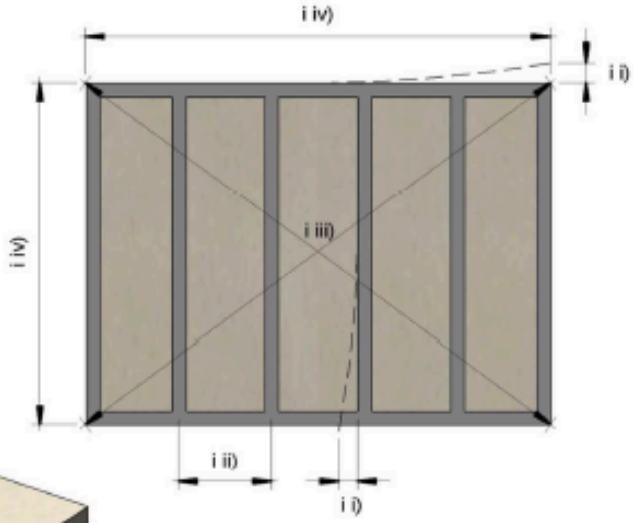
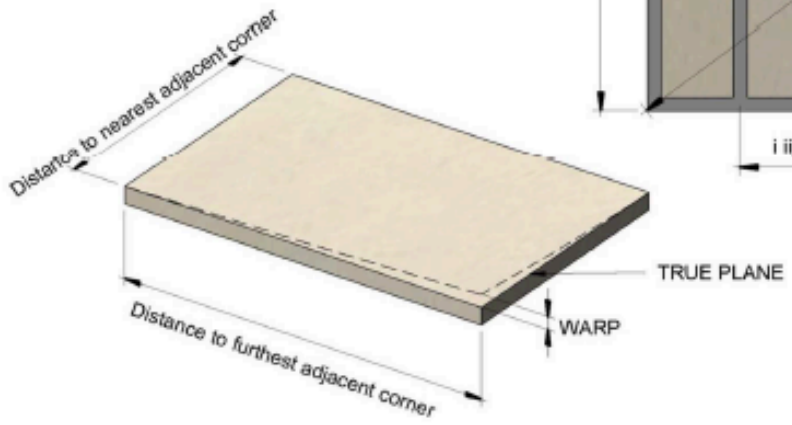


FIGURE 4 Warping



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Colour and surface finish

The surface of glassfibre reinforced concrete parts is not homogeneous even after curing, as it is a silicate composite made of natural raw materials. The colour of the individual parts is created (at the client's request) by colouring the cement component. However, due to the overall natural character, the resulting colour of the parts may vary due to the colour difference of both silica sands and white cement. The resulting saturation and hue is also influenced by the dosage of individual raw materials, especially the amount of mixing water, which can affect the appearance even if the dosage varies within the limits allowed by ČSN EN 206. The colour variation of glassfibre reinforced concrete façade panels is therefore dependent on many factors that cannot be completely influenced. For the reasons stated above, this material should therefore be seen as a material made of natural components, the appearance of which cannot be fully consistent, with more significant differences in shades always being noticeable in the case of darker shades and colours. Any potential surface or local colour therefore does not represent a defect and cannot be the subject of a complaint.

The appearance of micro-caverns up to 1 mm in diameter and hairline cracks up to 0.2 mm in thickness are possible on the visible surfaces.

The glassfibre reinforced concrete façade should be assessed as a whole under the circumstances as close as possible to future viewing conditions, i.e. from a distance (minimum 5 metres) and from routes that would be used normally by the public under the conditions of diffused daylight rather than under direct sunlight.

The color evaluation is conducted in accordance with **CEN TR 15739** standards.

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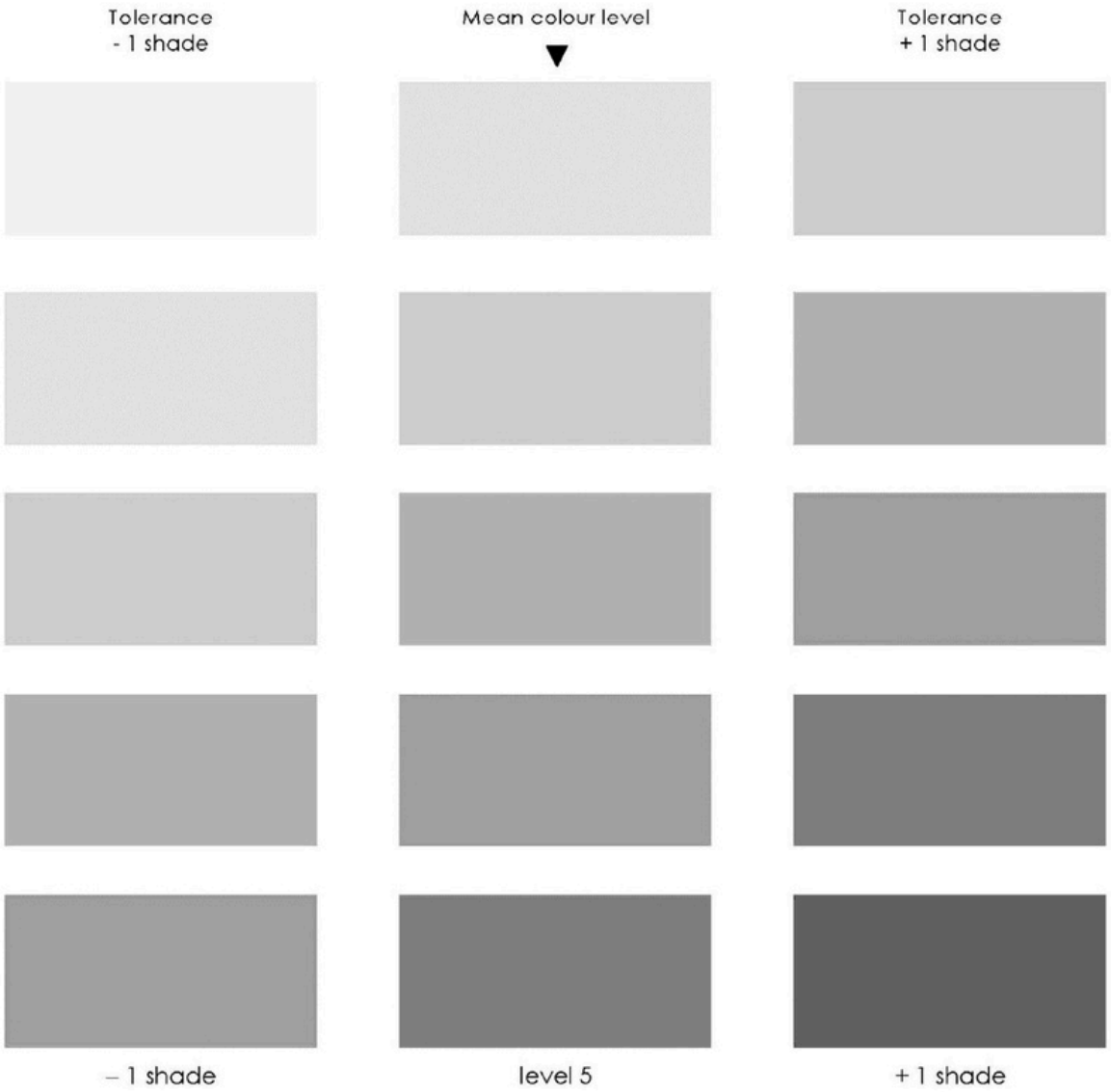
Viewing Distance and Conditions

The façade's appearance must be assessed as a whole, under conditions that simulate real-world use:

- From a minimum distance of 5 meters,
- From normal public viewing angles,
- Under diffused daylight, not under direct artificial or solar lighting.

Colour evaluation should follow the guidelines of CEN/TR 15739.



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Inspection of façade components

A visual inspection shall be carried out on the completed and finally cleaned handed over part of the façade, only on the visible parts of the structure and places normally accessible. The inspection of the dimensions and shape shall be carried out by appropriate means and with regard to the "visibility" of details.

All inspections of completed portions of the façade shall take place under prior agreed conditions floor by floor or in otherwise agreed units prior to the removal of the scaffolding.

After the inspection and acceptance of the inspection report, the buyer is responsible for any further defects and damage and must ensure that the structures cannot be damaged by other entities carrying out work in adjacent areas or on adjacent structures.

The originator of the damage is liable for damage proven to have been caused by a third party after the inspection. The manufacturer is entitled to claim the repair costs from the purchaser, who in turn claims them from the originator of the damage.

Once the complete part of the façade has been handed over and the scaffolding has been removed, no further defects or backlogs can be claimed.

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Packaging and shipping

Packaging

The glassfibre reinforced concrete façade panels are stored horizontally on rigid and custom-made wooden pallets. **Pallets are not stackable (they cannot be laid on top of one another)!**


Photo: Examples of palletisation of parts

- The base of the pallet is made of wooden stringers, usually with a square cross-section of 100 x 100 mm.
- Bracing of the pallets and the individual levels or other auxiliary structures are then made of wooden slats, usually with a cross section of 60 x 40 mm.
- The individual wooden elements are joined with nails (steel construction nails) or with screws, the type and length of which is determined by the dimensions of the pallet elements to be joined.
- The individual parts, when placed face to face with the pallet structure, are protected/separated from the wooden pallet structure with PE foam sheeting (Mirelon).
- The parts are bound and secured against movement on the pallet.
- The pallets are protected against weather effects with a film around the sides.
- Ingress of moisture from the top is prevented by using film stretched over the sides of the pallet.

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- A loading sheet, which contains the pallet number and a list of the elements stored on it, is attached to each panel.
- The size of each pallet is determined by the maximum dimensions of the loaded elements, so each pallet can have different dimensions.
- Loading in the production plant takes place in a standard way from the side using a forklift truck.

Transport

The parts are transported on pallets by covered trucks with sides. They are loaded symmetrically on the truck.


Photo: Example of shipping pallets and their loading on the transport vehicle

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Material inspection

Each part undergoes a quality check by an expert employee of the manufacturer before packaging. Subsequently, an inspection and standard photo documentation of the parts prepared on the pallet is carried out before wrapping with film.

The buyer shall inspect the pallets for damage before unloading them at the place of delivery. Pallets are visually inspected from all accessible sides. This inspection involves checking that there has been no significant damage to the pallets during transport (e.g. breakage of stringers, slats, etc.), e.g. due to an impact, collapse, or overturning of the pallets, damage to the packaging, etc., resulting in damage to the glassfibre reinforced concrete façade panels for which the forwarder is responsible. After unloading, any visual damage to the pallets with parts can no longer be considered.

The buyer is obliged to inspect the parts on the pallet immediately after unpacking. In the event of a damaged part, the buyer must take immediate photographic documentation of the damaged part while it is still on the pallet (if the damage is on an accessible side) or after it has been turned over, so that the manufacturer can assess the claim. At the same time, the manufacturer's representative (the employee designated by the contractual relationship) must be contacted in writing within 48 hours at the latest. Any damaged parts must not be further handled or hung on the façade in any way, otherwise the damage cannot be claimed as a complaint.

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Storage on site

If unloading on site is to be carried out by crane using fabric straps, it is necessary to position individual slings so that the parts cannot be damaged during lifting. It is essential that the pallets are stored on a level and sufficiently firm base. When storing them, it is also necessary to keep the boards wrapped in protective material (original packaging, waterproof tarpaulin, sheeting, etc.).

Photo: Example of a violation of the storage conditions for parts on shipping pallets on site. The original packaging of the shipping pallets is damaged and insufficiently replaced. There is no complete waterproof covering of the pallet to prevent standing water, snow accumulation, etc., and potential water leakage into the pallet. Parts on partially dismantled pallets are not protected at all. In both cases, irreversible damage to the components may occur due to climatic conditions.

Failure to follow these procedures may result in damage to the boards due to leakage or degradation of the covering film and adhesive, or cracks and deformations in the boards caused by uneven pallet settlement in the case of insufficient load bearing capacity of the storage area.

The period of storage of the covered and wrapped shipping pallets shall not exceed 1 month. After unpacking the pallet, the glassfibre reinforced concrete parts should be mounted on the façade as soon as possible to prevent weathering of the uncovered, stacked parts. The buyer shall take photographs of all the glassfibre reinforced concrete façade parts during unpacking and send the photo documentation to the manufacturer. If the Buyer finds damage to the parts, they shall file a claim with the Seller.

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Material handling

During transport and handling, it is necessary to secure the pallets and individual parts against spontaneous movement, possible impact, and subsequent mechanical damage. It is forbidden to stack pallets with parts.

Façade parts are preferably stored horizontally on rigid pallets. When handling and installing the façade panels, suitable and clean protective gloves must be used that do not leave marks on the parts. The panels can be handled using suitable lifting straps. When handling manually, the panels must first be lifted. They should not be shifted or pulled over the edges, which could irreversibly damage their surface.

The handling of the parts is similar to other board material – i.e. glassfibre reinforced concrete must not be allowed to sag horizontally, as cracking or breakage of the part may occur. The parts must therefore be turned 90° to vertical when carried.

The use of mounting points (anchoring components) for handling is prohibited.

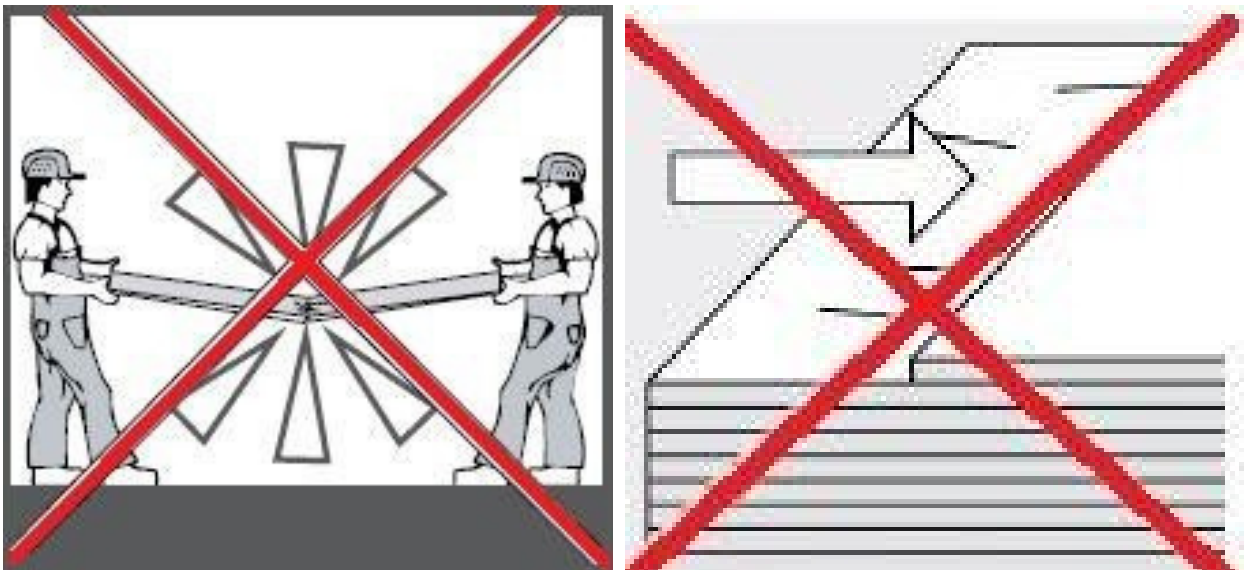

Image: Examples of improper handling components

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Making additional holes

Additional holes in the panel are made by means of a diamond bit of the appropriate size for an M14 thread, attached to an angle grinder. Drilling of smaller holes up to 12 mm diameter can be made using an electric drill with a concrete drill bit. The distance of the perimeter of the hole must be at least 100 mm from the outer edge of the component. **All holes must be made without impact!**

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Maintenance of the façade

Glassfibre reinforced concrete façade panels are maintained by cleaning and recovery of the surface protection according to the instructions below.

In the event that workers are to carry out cleaning by moving on the façade using climbing equipment, it is absolutely necessary to avoid using climbing shoes that could leave marks due to surface abrasion (e.g. abrasion of dark soles), scratch or otherwise damage the parts.

Cleaning of DAKO-GRC parts

The following principles must be observed when using and additionally modifying composite parts:

- The parts must not come into contact with oils, petroleum products, solvents, or aggressive chemicals as this would damage the water repellent coating and cause difficult to remove grease stains. In the case of acids, the entire surface will also be etched.
- The removal of dust and usual dirt build-up should always be carried out with the awareness that it is a cement-based material and the choice of cleaning agents should be made accordingly.
- Interior parts are normally maintained with a duster or vacuum cleaner.
- The surfaces of glassfibre reinforced concrete parts outside are normally cleaned with water using a hose or high-pressure equipment, cleaning machines with suction, or a steam cleaner (minimum steam pressure – 3 bar). In some cases, subsequent restoration of the hydrophobic surface is necessary.
- In the case of contamination with substances leaving stains (oil, grease, etc.), these substances must be removed as soon as possible. After a certain period of time, these materials leave stains that are usually difficult to remove and can only be removed with special cleaning agents.
- It is recommended to use washing tools with soft to medium hard bristles.
- The use of steel brushes and brushes with sharp and hard bristles should be avoided – their use can leave circular (dull) marks on the surface and cause irreparable

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defects (from loss of gloss, discolouration, a coarser surface, to removal of the cement bonding agent) with prolonged use or higher pressure.

- The cleaning of parts using conventional chemical agents (such as washing-up liquid) represents a certain type of chemical stress to which cement surfaces are not infinitely resistant in its ultimate effect.

- Cleaning agents must not contain organic solvents or alkalis in high concentrations. It is not permissible to clean parts with strong organic solvents (such as acetone, toluene, xylene, trichlorethylene, etc.). Acidic chemicals such as hydrochloric acid or acetic acid are generally unsuitable for cleaning, even diluted.

- We would like to remind you that the surface is based on a cement binder and therefore acids and other substances aggressive to the individual components of concrete leave irremovable defects in the surface of the panel (such as loss of gloss, change of colour shade, roughening, depressions, pits, holes, etc.) at higher concentrations or longer exposure.

- We generally recommend cleaning the façade once a year with high-pressure water to maintain its original appearance as much as possible.

Removal of lime efflorescence, impregnation

The formation of efflorescence can occur if the minimum curing period is not observed, when the parts must not be exposed to draughts and water for at least 7 days after boarding removal. However, the recommended curing time is 4 weeks. Efflorescence occurs especially on cold rainy days, when the cement components dissolve and leach out insufficiently cured and microstructurally unsealed concrete products. It follows from the above that the manufacturer is responsible for the formation of efflorescence and is therefore also responsible for removal before delivery to the buyer. This assumption applies provided that the buyer gives the manufacturer sufficient time to produce and cure the glassfibre reinforced concrete parts. If the buyer requests delivery of the parts before the recommended curing time, the buyer is solely responsible for any efflorescence formation and removal.

To clean the surface, we recommend first using a standard brush with water, with added kitchen detergent where necessary. It is also possible to use pressurised water or vinegar (up to 5% acetic acid concentration) for already crystallised efflorescence. If the lime efflorescence is of a more intense form and none of these procedures is satisfactorily effective, we recommend using a concrete surface cleaner.

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After cleaning the surface, it is necessary to let the part dry thoroughly before applying the impregnating agent. A well dried surface ensures good bonding of the impregnating agent to the surface layers of the structure to be treated and thus a more lasting effect. The products can be applied with a spray, or with a brush or roller.

Concrete surface cleaner application

If the above-mentioned procedures are not sufficiently effective to clean the surface of glassfibre reinforced concrete parts from efflorescence and clay and dust impurities, it is possible to use a concrete surface cleaner. This is an aqueous solution of formic acid. It is recommended to first dilute a small amount of the product to a lower concentration and check to what extent the efflorescence has been removed, then you can use a more concentrated solution if necessary. For example, Fortesil Cleaner (manufacturer: Stachema) can be used to clean efflorescence.

It is an aggressive preparation that not only disrupts the structure of the efflorescence, but also disturbs, or ”renews and revives” the colour of the surface layers of the concrete product (”darkened” by use, carbonation, concrete curing).Therefore, it is necessary to soak the surface of the concrete product to be cleaned well with water before application (by spraying or mild pouring) to prevent it from being drawn deeper into the structure of the component, i.e. to keep it only on the surface of the structure to be cleaned.

The product is left on the surface (depending on the product and chosen concentration) to act with surface for time recommended by producer (foaming) and then the surface must be thoroughly rinsed with water and the cleaning agent should be removed completely. You can also use a brush to help you apply it.

With repeated application and prolonged exposure, the colour may ”leach” from the surface of the part – it is not the pigment itself, but leached cement stone grains that are coated with the pigment itself. For many years, stable inorganic pigments have been used to colour concrete, as they are very well bound to the alkaline concrete mass and cannot be washed out on their own.

This cleaning agent must be handled with care and caution in accordance with the instructions in the manufacturer’s manual and MSDS.

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General cleaning by Fortesil cleaner

1) Soak the surface of the GRC panel with clean water.

2) Apply the Fortesil cleaner to the brush or Scotch-Brite (Fortesil clener shouldn't be applied directly on the panel surface).

3) Clean the panel by a circular motion of the brush on the panel surface. Cleaning should take maximum 5 minutes.

4) After using the Fortesil cleaner, wash the panel with clean water to remove cleaner completely.

5) Cleaning by Fortesil cleaner can be done multiple times. After each cleaning the panel has to be washed with clean water.

Water repellent coating

The minimum service life of the surface protection used is 10 years. The loss of its effectiveness is demonstrated by a very rapid change of colour shade (darkening of the part) due to the effects of water. This is not a permanent change in the colour of the part. After drying, the colour shade returns to its original state. If the part does not immediately change shade after being sprayed with water, the protection is still effective.

If the coating needs to be renewed, the manufacturer of the parts will supply surface protection in the appropriate quantity under the prior agreed conditions.

Application of surface protection:

The surface of the part must be dry and clean. If the original paint is present, it is advisable to use an abrasive fleece (such as 3M Scotch-Brite – fine) to increase the adhesion of the renewal protection.

The surface and ambient temperature at the time of application and 24 hours after application must be between 5-30 °C. It is not possible to work when it is raining.

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The surface protection is applied with a foam roller. The part is painted until the product is fully saturated when excess is formed on the surface which does not penetrate further into the microstructure. This excess is wiped off with a roller. When painting vertical surfaces, the coating is applied in a top-down direction.

The coating dries for 24 h. It is fully effective after 7 days.

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Minor repairs of DAKO-GRC parts

Preparation of the substrate

The substrate must be damp, firm, free of dust, dirt and sediment.
Any residue of paint, lime splashes, and non-adhering plaster must be removed.

Equipment and working aids

The necessary equipment and tools are shown in the attached photo below.

Selection of the appropriate shade of the repair compound

Before starting the repair work on the part, it is necessary to select the closest shade of the repair compound. Please note that the colour of the repair compound may not always match the colour of the part. However, the differences are usually slight and negligible for small-scale repairs

Photo: Equipment and working aids

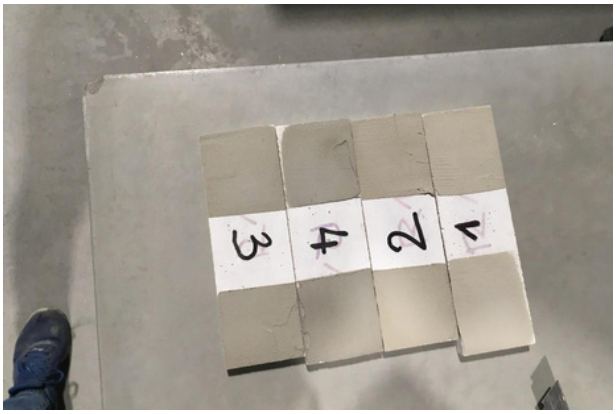

Photo: Example of selecting the shade of the repair mixture

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Preparation of the repair compound (mixture)

Pour clean water into a clean mixing bowl and stir in enough powder to obtain a smooth, paste-like, lump-free mortar. Approximately 8½ litres of water is used to mix 25 kg of powder. The mortar is workable for about 30 minutes at 18-20 °C and can be applied in a layer with thickness of up to 3 mm. An ambient temperature above +5 °C is required for sufficient hardening for further work (grinding, felting, gilding, or recoating with ARDEX F11).

Colour matching to the surrounding concrete can be achieved by mixing in cement-resistant pigment additives, which are first mixed with water into a tinting paste and then mixed into ARDEX F11 mortar. The maximum amount of pigment additive is 3 weight percent of the amount of ARDEX F11 powder (depending on the shade of the panels).

Only work with the DAKO-GRC, ARDEX, and other repair compounds at temperatures above +5 °C.

Photo: Take about 30 grams of the repair compound and add about 12 grams of water. If you don't have any means to measure the amount of water, you can determine the amount of water needed according to the correct consistency. The correct consistency is achieved when the compound does not run and can be easily shaped. Stir the paste very well to avoid "pigment lines" which occur when the pigment in the paste is not mixed well

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Application of the repair compound

The drying time depends on the thickness of the applied layer, the existing weather conditions, and the moisture content of the substrate. Insufficiently dried substrate can cause efflorescence after application.

It is necessary to follow the recommendations of the manufacturers of coatings for cement substrates, whether it is a full area or local application.

If it is possible to return to the repaired area after the repair compound has cured, an additional repair can be made to facilitate creation of the final shape and then continue with another coat. If it is not possible to return to the repaired area, the final shape must be created when the repair compound is applied.


Photo: Examples of application of the repair compound

After the repair compound has cured, it can be additionally treated by sanding. Please note that the colour of the compound will be slightly lighter after sanding.


Photo: Example of additional sanding of the repaired area and its final appearance

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