999469802 - 08/2022 en-GB

The Formwork Experts.

REPOXAL two component adhesive with Fibre concrete tube 22mm

Art. n° 581991000

Test Report

water impermeability

WATERTIGHTNESS TEST

of the system

FRANK Distance Tube with "Repoxal glue, solvent-free"

of the Max Frank GmbH & Co. KG, Leiblfing

Professor Dr.-Ing. Harald Sipple

Officially appointed and sworn expert on concrete technology, damage and faults of buildings and components made of concrete, commissioned and sworn in by the IHK (Chamber of Commerce) of Regensburg;

October 1997

01030/1 - 11/97

1. PRELIMINARY REMARKS

The system of FRANK distance tubes with double stoppers made of fibre concrete, which are glued in place, according to the instructions of the manufacturer, with a reaction resin glue to form a watertight seal, has proven in practice.

The composition of the reaction resin glue used to cement the stoppers into the tubes, has been re-developed - it is now solvent-free. This is why the watertightness of the system is to be tested anew.

The examinations were carried out by order of the M. Frank GmbH & Co. KG. The parts to be incorporated in the concrete - fibre-concrete tube, fibre-concrete stopper and the "Repoxal glue, solvent-free" - were supplied by the Frank company.

2. CONTENTS OF ORDER

The watertightness of the complete system, installed according to the instructions of the manufacturer in concrete impermeable to water, is to be proved.

This requires two testing criteria:

- Water penetration depth on the outside, i.e. along the contact surface between the concrete and the outside wall of the tube.

- Water penetration depth on the inside, i.e. into the fibre-concrete tube, the fibre-concrete stoppers and the glue.

The tested specimens were cube-shaped blocks with edges of 20 cm in length, with the sealing system installed horizontally in the centre. The water pressure was 5 bar[1] over three days altogether, according to DIN 1048, part 5.

Compared to the standard conditions within a building structure, the test conditions for the specimens were worse because of the almost completely missing load of the green concrete.

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[1] *... This corresponds to a water column of 50 m.*

3. TESTING METHOD AND RESULTS

3.1 Production of the test samples

The samples (cubes with edges of 20 cm in length) were produced according to DIN 1048, part 1. The concrete used in the laboratory was to correspond to the concrete as it is used at site with a strength class of B 25 and an impermeability to water according to DIN 1045, section 6.5.7.2. The following technological data of the concrete was given:

- B 25, impermeable to water, for exterior components,
- 350 kg/m³ CEM II/A-L 32.5 R (PKZ),
- water-cement ratio = 0.58,
- liquefier (BV), 0.2 weight percentage, referred to the cement weight,
- maximum grain size: 32 mm Ø,
- consistency KR, upper range.

The sealing system was installed horizontally in the centre and clamped between the shuttering. The green concrete was compacted with an internal vibrator and re-compacted after 30 minutes.

After 24 hours of storage at 20°C the formwork was dismantled and the samples were then kept under water according to DIN 1048, part 5. Contrary to the instructions in section 6.4 of the above-named standard, the surface to be exposed to the water pressure was not roughened. When the samples were 14 days old, the fibre-concrete stoppers were glued in[2] on one side and on the following day on the other side according to the instructions of the manufacturer.

When the samples were 28 old, water pressure of 5 bar was applied and kept constant for 3 days by an air cushion (a large-sized air vessel).

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[2] *... The immersion in water was intermitted briefly for the stoppers to be glued in place.*

3.2 Test results

The dissemination rate in the green concrete was 47 cm and 48 cm respectively (2 measured values).

The compression strength of the concrete used for the test samples was ascertained with three separately produced test cubes with edges of 15 cm in length according to DIN 1048, part 5, to be 38 N/mm² (mean value).

The test results for the water penetration depth are represented graphically in appendix 1 and are summarized as follows:

Test sample no.	**Water penetration depth on distance tube outside**[1)] e_{w1}	**Water penetration depth in tube / stopper / glue** e_{w2}
1	15 mm, 19 mm	≈0
2	27 mm, 31 mm	≈0
3	11 mm, 16 mm	≈0
4	22 mm, 20 mm	≈0
5	16 mm, 22 mm	≈0
6	20 mm, 24 mm[2)]	≈0

[1)] *The samples were split in the centre plane of the tube; the water penetration depth of each sample was measured at the left and at the right side at the contact surface between the tube and the concrete.*

[2)] *The maximum value of the water penetration depth was 40 mm in the range of an aggregate grain surrounded by water (sandstone). The penetration depth at the tube itself was lower, as indicated.*

Chart 1: *Water penetration depths after compression test*

4. ASSESSMENT

The measured values of the water penetration depth along the distance tube - along the contact surface of the concrete and the fibre concrete (tube) - are not higher than that of the adjacent concrete.

The fibre-concrete parts - fibre-concrete tube and stopper - and the glue do not show any visible water penetration.

According to the results, the complete system of FRANK distance tubes with double stoppers of fibre concrete is to be described as "tight". The water penetration depth is not increased by the incorporation of the distance tubes in the test samples.

Annotation:

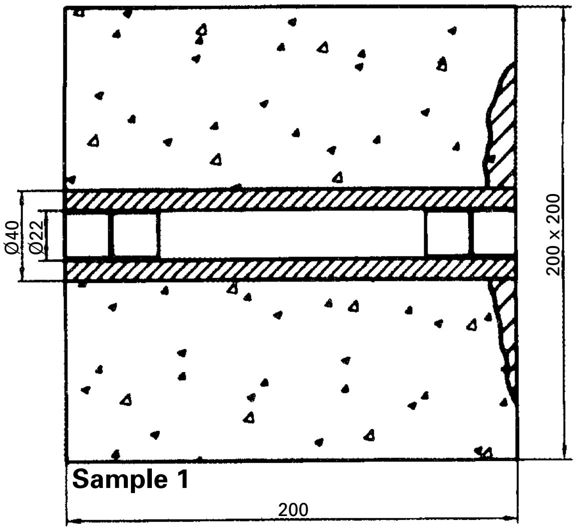
The instructions of the manufacturer must be followed. If the load from the green concrete is not sufficient (upper anchor course), the concrete must be re-compacted.

In case there is additional chemical attack from in-situ soil or water, the resistance chart of the glue must be checked.

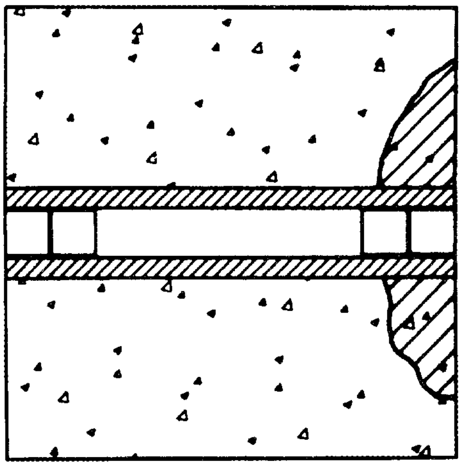
Prof. Dr.-Ing. Harald Sipple

<u>Appendix 1:</u> Water penetration courses, graphical representation

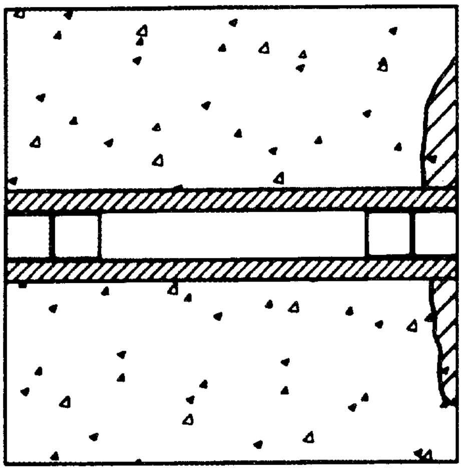
Water penetration courses of the test samples



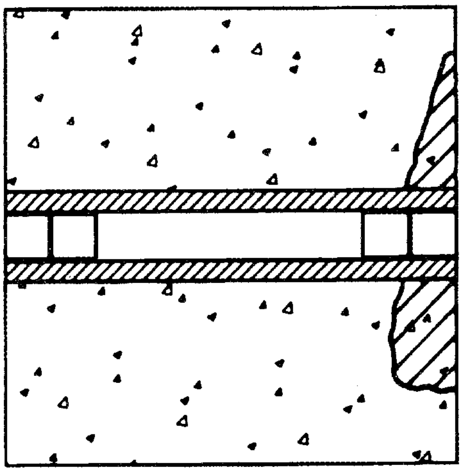
Sample 1



Sample 2



Sample 3



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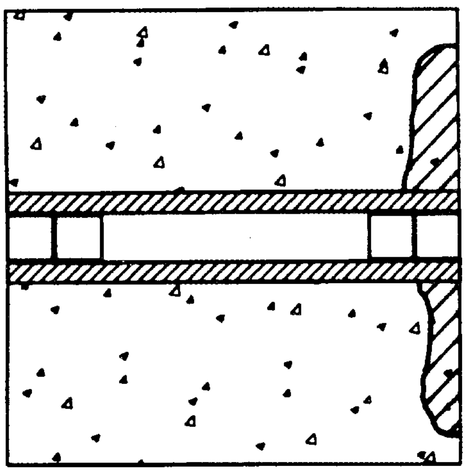
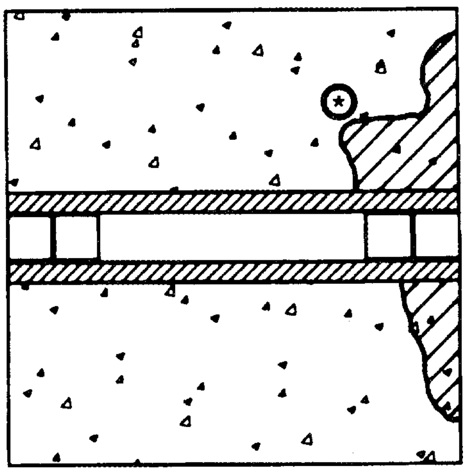


Sample 5



Sample 6

(*) ... grain surrounded by water