

CERTIFICATE OF TEST

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Test for: Resistance of cementitious mortar to acidic medium

Test Material: OPTEK HBT (Cementitious Mortar)

Findings: OPTEK HBT Cementitious Mortar is an effective 'sacrificial layer' for protection of concrete against sulfuric acid solutions.

Over a 36 month period the acidic resistance of OPTEK HBT Cementitious Mortar being 2.5-2.8 times higher than control (plain) mortar at pH 4 and 2.8-2.9 times higher than at pH 3.

Acid resistance of concrete:

A limiting factor in hydraulic concrete structures is their resistance to acid attack. It is usually recommended the pH of the aqueous medium must not be lower than 6 as concrete starts to corrode at pH 5.5 the rate of corrosion increasing as the pH becomes lower.

In sewerage work this limitation is not completely objective as at an aqueous medium (effluent) pH of 6 the acid condensate above the effluent line can have a pH as low as 3 or 4.

At pH lower than 3 the use of protective cementitious layer is ineffective due to their high corrosion rate.

Test Standard: **Determination of concrete resistance in corrosive working mediums**

As no Australian standard exists for determining the acid resisting properties of concrete the method described in Russian Articles (references 1 and 2) was used.

This method is as follows:

Concrete specimens (sealed on all but 1 face against acid attack), of known weight are placed in a solution of known pH. After a predetermined period of time they are removed, washed under a tap, wiped to remove surface water and weighed.

From the difference in weight and determined specific gravity the depth of the corrosion layer is determined.

The solution is renewed every 2 weeks during the time of the test.

OPTEK HBT has been tested in comparison with a cementitious mortar (control) having approx the same compressive strength.

Specimens: 30 specimens of control mortar and 30 specimens of OPTEK HBT mortar with dimensions of 70 x 70 x 70 mm (cubes).

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Control mortar design and properties:

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Concrete mix design (cubic metre):

- GP cement (Blue Circle Southern) was used for making the cement mortar.
- Coarse and fine river sand in ratio 1:1 was used in the test.
- Ratio cement:sand:water was 1:3:0.45.

Concrete properties:

Fluidity of cement mortar 130mm (determined with Flow Table).
Air entrainment: 2.0% (determined with volumetric method).
Compressive strength (28 days) – 53.1 Mpa

Curing of specimens: Water cured 28 days at 22°C.

Testing of specimens: After curing all specimens were oven dried at 70°C for 3 days. The bottom and side faces of all 60 specimens were then sealed with methylmethacrylate. All specimens were then placed in a water bath to completely saturate with water (achievement of constant mass).

The specimens were then measured and weighed to determine:

(a) Volume from the formula

$$V = (W_1 - W_w) / SGW \quad (1)$$

where V = Volume

W₁ = Weight in air

W_w = Weight in water

SGW = Specific gravity of water (taken as 1)

(b) Specific gravity of water saturated specimens (SG_s)

$$SG_s = W_1 / V \quad (2)$$

(c) The area (S) of the uncoated face

Following this, 15 control specimens and 15 OPTEK HBT specimens were placed in a bath containing sulphuric acid solution of pH 4, and 15 control specimens and 15 OPTEK HBT specimens placed in a bath containing sulphuric acid solution of pH 3.

After a predetermined period of time, in this test 6, 12, 18, 24 and 30 months, 3 specimens were removed from the solution and washed and weighed as earlier described.

The depth of the corroded layer (L) was then determined from the formula.

$$L = (W_1 - W_2) / SG_s \times S$$

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The test results are shown in Table 1.

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Table 1. Average corrosion test results of the control and OPTEK HBT mortars in acidic medium

Action time of acid environment, months	Thickness of the corroded control mortar (mm) in acidic medium (sulphuric acid solution)		Thickness of corroded OPTEK HBT mortar (mm) in acidic medium (sulphuric acid solution)	
	pH-4 (0.005g/l)	pH-3 (0.05g/l)	pH-4 (0.005g/l)	pH-3 (0.05g/l)
6	1.1	1.7	0.4 (> 2.75 times)	0.6 (> 2.84 times)
12	1.9	2.8	0.7 (> 2.72 times)	0.9 (> 3.12 times)
18	2.5	3.2	0.9 (> 2.78 times)	1.1 (> 2.91 times)
24	3.0	3.8	1.1 (> 2.73 times)	1.3 (> 2.93 times)
30	3.3	4.1	1.3 (> 2.54 times)	1.4 (> 2.93 times)

Comments:

The corrosion rate of the OPTEK HBT mortar is 2.5-2.9 times lower than the corrosion rate of the control (plain) mortar.

Reference:

1. Concrete corrosion in corrosive medium. Collected articles. The All-Soviet Union Research Institute of Reinforced Concrete, 201 p., Moscow, 1971.
2. Leschinsky M.J. Tests of concrete (Reference manual). Publishing House "Strojizdat", 361 p., Moscow, 1980.

