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Investigation into the performance of ABILITY'S 'abil-WELD Mark 2' adhesive

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Introduction

At the request of Ability Building Chemicals Co, manufacturer of “abil-WELD”, this laboratory has carried out a testing program to measure certain performance parameters of “abil-WELD Mark 2” powder. This adhesive has been tested for bond strength, compressive strength, flexural strength, drying shrinkage, salt attack resistance, chemical resistance, abrasion resistance and water absorption.

Details of specimen preparation and testing

Abil-WELD powder was mixed in a Hobart mortar mixer in batches of between 1 and 6 kg of powder. Water was put in the mixer first, at a ratio of 1 L per 2.46 kg of powder (approximately 1:3 by volume). Powder was added slowly during mixing, and mixing continued until the mixture was smooth.

Bond strength

Bond strength with bricks was tested using brick couplets (two bricks bonded with abil-WELD). Clay and concrete bricks were used separately. Beams made from 50 mm squares of 6 mm thick fibro-cement sheeting were also made by bonding 19 squares in a stack. In each case the specimens were wrapped in plastic sheeting and allowed to cure for 7 days before the force required to break the bond was measured. The test method used is that of AS 3700-2001 Appendix D (photos 1 & 8).

Compressive strength

Moulds were used to cast 50 x 25 x 25 mm prisms, which were allowed to set in the moulds for 24 h, then demoulded and immersed in water until strength testing at 3, 7 and 28 days. The test method is that of AS 2701.4-1984 (photo 2).

Flexural strength

Beams were cast in 350 x 100 x 100 mm moulds, demoulded after 2 days, and cured in water until testing at 28 days by the method of AS 1012.11-1985 (photo 3).

Drying shrinkage

Prisms of 280 x 25 x 25 mm were cast, with stainless steel studs incorporated in the ends of each prism to enable accurate length measurements to be made. The prisms were demoulded at 2 days, measured, then cured under water until 7 days and measured again. The specimens were then dried in an air oven at 115°C and remeasured at 1 to 3 day intervals until shrinkage had virtually stopped. The method follows that of AS 2701.9-1984 (photo 4).

Salt attack resistance

50 x 25 x 25 mm prisms were cast (the same size as for compressive strength), then demoulded and cured in water for 14 days. After 5 days of air drying at ambient

temperature, they were trimmed on one face to 50 x 25 x 20 mm to meet the requirements of the test method AS/NZS 4456.10-2003 (photo 5).

Chemical resistance

More 50 x 25 x 25 mm prisms were cast and cured for 28 days, then air dried for 5 days. The prisms were divided into 5 sets; one set was kept aside in air as a control while the other 4 sets were soaked in one each of the following liquids: toluene, xylene, acetone and blended vegetable oil (a 50/50 blend of canola and soyabean oils) (photo 6). After 1, 7 or 28 days of soaking, prisms were tested for compressive strength and compared with the strength of the control prisms at the same time.

Abrasion resistance

Slabs of 400 x 300 x 40 mm were cast, cured for 28 days, then cut into 200 x 100 x 40 mm segments to be tested for abrasion resistance according to AS/NZS 4456.9-2003 (photo 7).

Water absorption

Some of the above segments were oven-dried, then soaked in water for 24 h, following the method of AS/NZS 4456.14-2003.

Test results and discussion

Bond strength

Each strength result is the mean of six couplets or beams.

Material bonded	Pressed clay bricks	Concrete bricks	Fibro-cement sheet
Bond strength, MPa	0.50	0.94	0.25

The strength of the bond appears to be strongly influenced by the surface roughness of the material. Abil-WELD moulds itself into and around the larger-scale surface irregularities but seems not to penetrate significantly into the finer pores.

As a comparison, most cementitious mortars binding similar bricks would develop bond strengths of between 0.15 and 0.50 MPa.

Compressive strength

Each strength result is the mean of four individual prisms.

Curing time, days	3	7	28
Compressive strength, MPa	10.4	13.3	14.5

According to these data, strength development has dropped to a low rate by 28 days in water. However, similar prisms tested during the chemical resistance tests (see later) show much higher strengths after 28 days in water followed by a period of air drying.

Flexural strength

Three beams were cast; after 28 days curing they had an average flexural strength of 1.0 MPa.

Drying shrinkage

Three prisms were cast. On average, they expanded during the last 5 days of water curing by 0.05%, then shrank while drying in the oven over 14 days by 6.4%. The vast majority of the shrinkage happened in the first 24 hours.

Salt attack resistance

None of the prisms lost more than 0.04g of particles off the surface during the 40 cycles of soaking in salt solution and oven-drying. This easily qualifies abil-WELD as an exposure-grade building material (the threshold is 0.4g), meaning that it would not be expected to suffer significantly when exposed to salt (from ground water, sea spray, swimming pool chemicals etc).

Chemical resistance

The table below shows the compressive strengths of prisms soaked for up to 28 days in each of four organic liquids. The strengths are expressed in MPa and as a percentage of that of control prisms which were not soaked. Each result is the mean of three prisms (four in the case of the controls).

Soaking time, days	Control	Toluene		Xylene		Acetone		Vegetable oil	
		MPa	% of control	MPa	% of control	MPa	% of control	MPa	% of control
1	25.3	19.0	75	20.8	82	18.9	75	23.6	93
7	27.5	17.6	64	16.3	59	17.3	63	16.2	59
28	30.8	19.3	63	17.6	57	22.2	72	18.8	61

Each liquid causes a broadly similar degree of reduction in compressive strength, although the speed of the reduction varies. This is probably related at least in part to the rate of penetration, which may be slower with vegetable oil, and to a lesser extent xylene, because of viscosity and molecular size effects.

No colour, surface texture or other visible changes were noticeable during the soaking. The vegetable oil could be seen to have soaked about half way in towards the centre of the prisms at 28 days, but the lack of colour in the other liquids made a similar assessment difficult.

Abrasion resistance

The mean abrasion index of 16 slab segments tested was 5.5 with a standard deviation of 0.5. The abrasion index is a measure of the volume lost from the sample surface during the abrasion test, so the smaller the number the better. A value of 5.5 falls within the recommended range of pavers suitable for low volume pedestrian traffic in a public area. This has relevance for the potential use of abil-WELD as a floor tile grout or concrete repair mortar.

Water absorption

The 24-hour cold water absorption was found to be 5.9% (an average of 10 of the abrasion resistance slab segments).

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Photo 1: Clay brick couplet in bond strength test

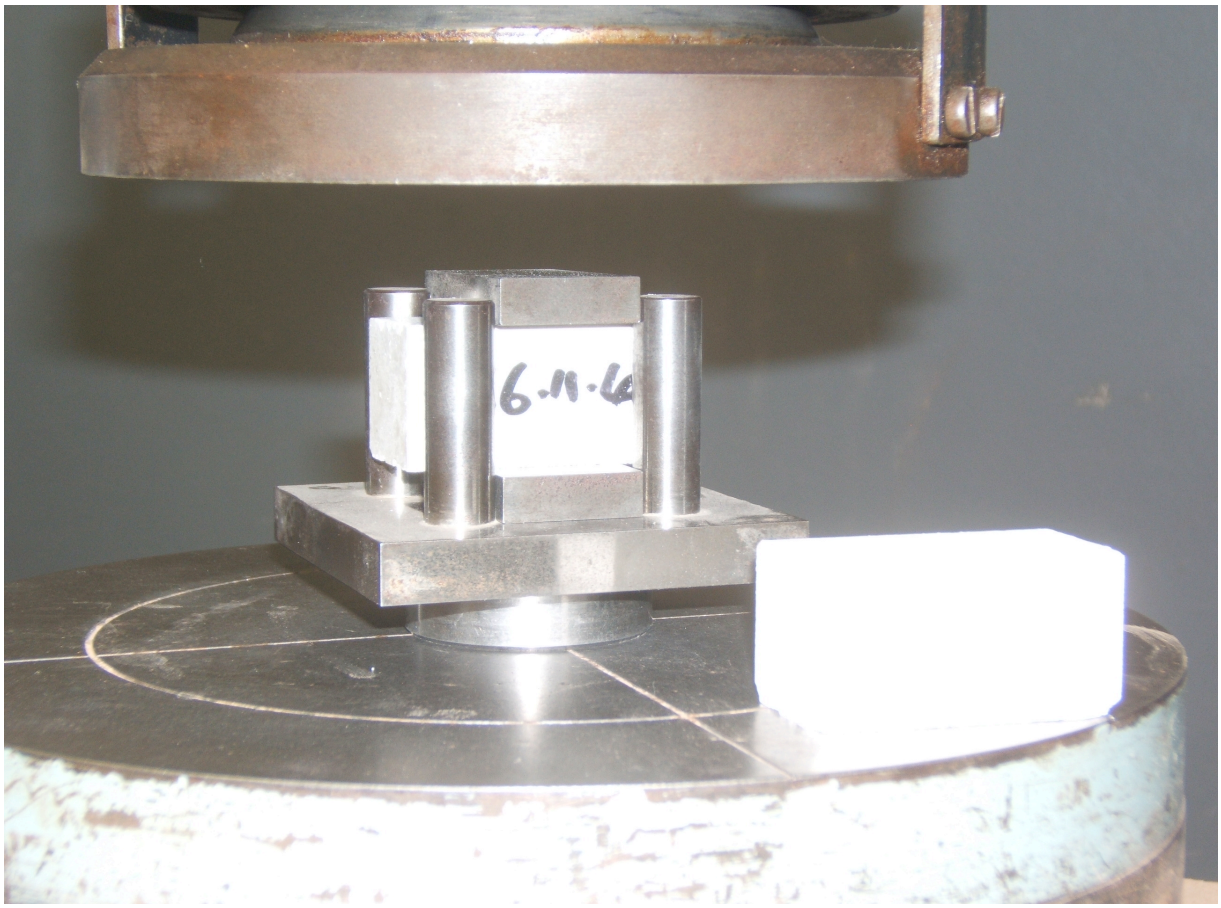

Photo 2: Prisms in compressive strength test

Photo 3: Beam in flexural strength test

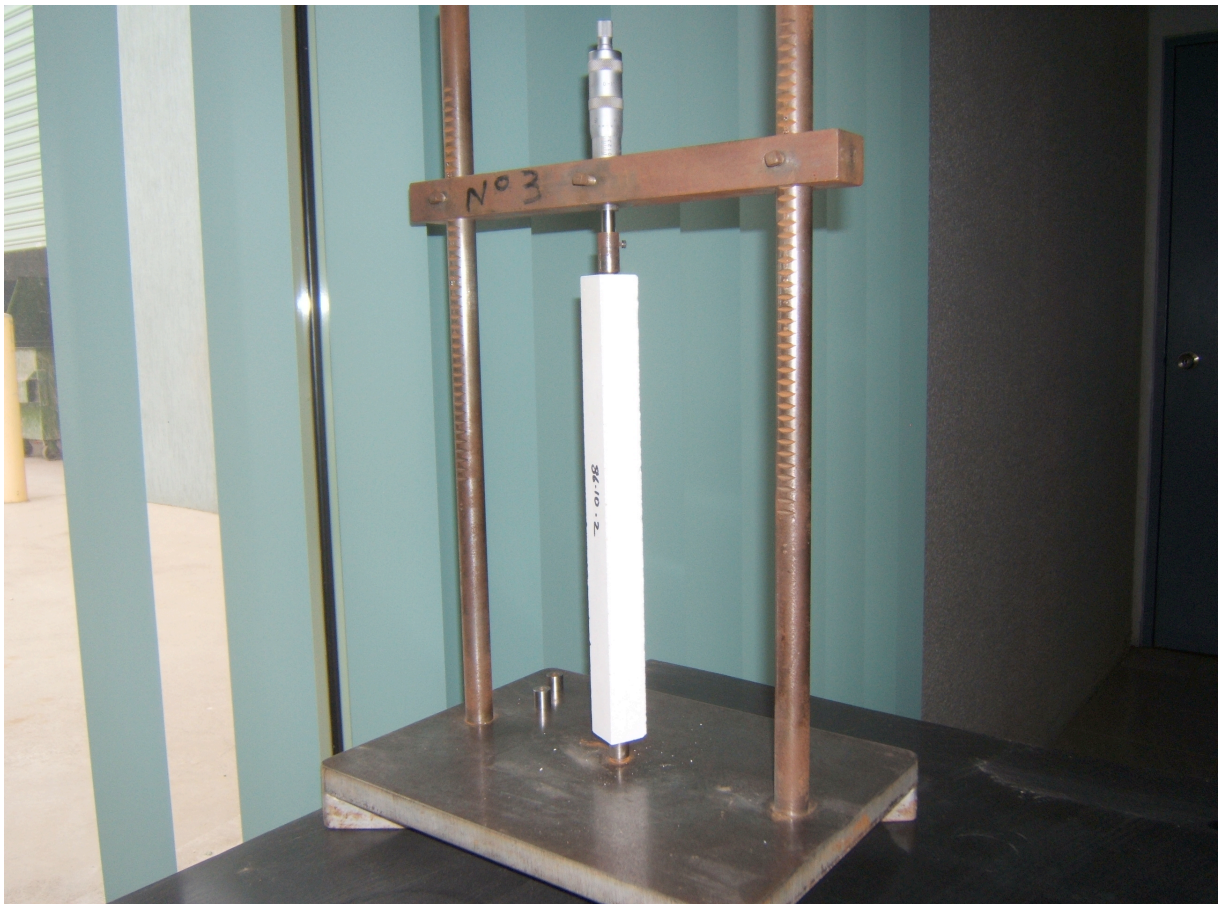

Photo 4: Prism being measured for length change

Photo 5: Prisms soaking in salt solution

Photo 6: Prisms soaking in organic liquids

Photo 7: Slab segments after abrasion resistance test

Photo 8: Beam made from fibro-cement sheet squares, after bond strength test