

Performance Comparison between Shotpatch 20 and Hi-Shot Shotcrete Mixes

TSE Report 242

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1. Introduction

This report describes a laboratory trial undertaken to investigate the strength development characteristics of cast shotcrete comprised of “Shotpatch 20”, as supplied by BASF, and “Hi-Shot” supplied by SI Powders Pty Ltd. Both these products are intended to be used either as dry-mix or wet-mix shotcrete mixtures that can be prepared on-site in a small mixer. The trials were intended to compare the rate of strength gain, and ultimate strength development, for these two products when mixed with water to produce a mixture of constant slump. The principal properties of interest were strength development with age, slump, and surface finish. The present investigation was restricted to casting specimens and therefore did not include a set accelerator introduced at the nozzle and did not examine spraying characteristics, stickiness, or pumpability.

2. Experimental Programme

The investigation consisted of a pair of concrete production trials using a 20 L Hobart mixer to produce about 20 L of concrete for ASTM C116 beamlets [1], and four $\varnothing 100 \times 200$ mm cylinders [2]. Surface finish was determined subjectively using the residue materials left in the mixing bowl. The ingredients in each mix comprised all the constituents of the 20 kg bags acquired from each producer. The ingredients were determined to be dry at the start of the trial, and they were weighed to confirm the quantity listed on the bags, and then mixed with sufficient water to produce a mix with a slump of 50 mm. The mixing of the ingredients and production of specimens was completed in a period of about one half hour, and all were completed during the morning so that tests could be undertaken during the remainder of the day. Specimens were stored inside a climate-controlled room at 23°C and 50% RH. Cast cylinders were transferred to a curing tank at 23°C after two days of hardening.

2.1 Laboratory Trial 1

The first trial examined the performance of Shotpatch 20 when mixed with water to produce a mixture with a slump of 50 mm. The wet characteristics of the mixtures were consistent with a mix design that comprised primarily cementitious powder and sand, this being smooth and quite sticky. The ingredients of each 20 kg bag required 2.25 L of water to be added to produce a slump of 60 mm. The mixture consolidated well in response to external vibration during casting, and the surface finish was textured under a wooden float and very smooth under a steel float. There did not appear to be any particles larger than 3 mm contained in this product.

The Shotpatch 20 mixture was left to cure under plastic sheeting with regular inspections to determine whether set had occurred. Set occurred more than 8 hours after casting, which took place after the close of business in the lab.

Table 1. Water content, slump, and strength development for the Shotpatch 20 and Hi-Shot examined in this investigation.

Mixture	Water (mL/20 kg)	Slump	Unconfined Compressive Strength (MPa)				
			4 hr	8 hr	24 hr	2 d	28d
Shotpatch 20	2250	60 mm	0	0	15.0	25.0	60.5
Hi-Shot	2400	60 mm	1.1	4.7	12.0	25.5	53.7

2.2 Laboratory Trial 2

The second trial involved mixing 40 kg of Hi-Shot with water to produce a wet mixture which was then subject to an identical series of tests as was applied to the Shotpatch 20. In this trial water was progressively added to the mixture until the slump was equal to 60 mm. The closest that could be achieved was 60 mm using 2.40 L water per 20 kg bag. This mixture was then used to cast ASTM C-116 beamlets and four cylinders. The remainder was trowelled with a wooden float, and then a steel float, and found to be very similar to the Shotpatch 20 but for the inclusion of somewhat coarser particles in the mixture.

3. Results

The development of compressive strength for the two mixes in this investigation is shown in Table 1. It is clear that the Hi-Shot mixture set much earlier than the Shotpatch 20 mixture, and had gained almost 5 MPa of compressive strength by the time the Shotpatch had even started to set. However, by the age of 1-2 days, the two mixtures exhibited comparable performance in terms of compressive strength. At 28 days, the Shotpatch 20 exhibited somewhat higher strength than the Hi Shot mixture but both were well above the normal requirements for shotcrete sprayed by either the wet or dry process.

4. References

- [1] ASTM C 116 – 68 (Reapproved 1980) “Standard Test Method for Compressive Strength of Concrete Using Portions of Beams Broken in Flexure”, American Society for Testing and Materials.
- [2] Australian Standard AS1012 *Testing Concrete*, Standards Australia, Sydney.