



### Silica Fume / Microsilica for Shotcrete

Fig 1a - President Hotel in Melbourne used silica fume spraycrete as the contractor found it the cheapest means of constructing curved architectural walls



Fig 1b - Water tanks 20m diameter and 5m tall have been constructed in one day with silica fume shotcrete. An internal shutter about 3m long and full height is moved like a horizontal jump form.



#### INTRODUCTION

Shotcrete relies on three key components which ensure the ideal performance for commercial construction, mining and tunnelling applications.

Silica fume imparts the following properties:

- High cohesion and adhesion (fig 2) makes Silica fume shotcrete a viable low cost construction method, particularly where formwork costs are high, eg basements, curved walls, water tanks. In underground construction Silica fume shotcrete linings can be shot in one pass without using toxic accelerators (fig 8).
- High durability (fig 3) and strength makes silica fume the ideal choice in severe exposure environments.

Shotcrete should incorporate fibre specifically selected for each application:-

- Synthetic fibres (fig 4) provide excellent control of early age cracking, a particular consideration in high cement contents shotcrete which is highly restrained.
- Scanfibre steel fibres impart high

#### CONCRETE BENEFITS

##### WITH SILICA FUME

##### Formwork Elimination

- shortens construction period
- reduced labour

##### Low Rebound

- reduced waste
- low clean up

##### High Build

- no cold joints
- rapid construction

##### Waterproof

- no membrane required

##### Durable

- suitable for severe exposure

##### High Quality Finish

- suitable for coating

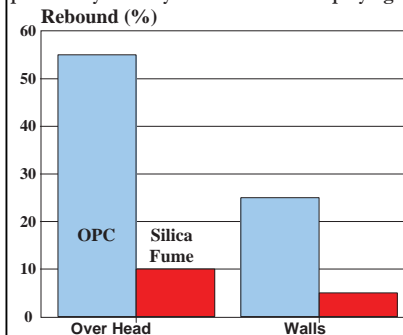
##### WITH SYNTHETIC FIBRES

- low early age cracking
- high build

##### WITH SCANFIBRE STEEL FIBRES

- eliminates mesh
- low overspray
- low preparation
- high toughness and impact resistance

Fig 2 – Silica fume shotcrete's cohesion and adhesion reduces the amount of rebound, particularly with dry mix and overhead spraying.



toughness (fig 5) enabling mesh to be excluded (fig 6).

- The high toughness of steel fibres imparts high impact resistance (fig 7).

Fig 3 – Silica fume shotcrete provides resistance to corrosion. The very low chloride permeability is indicated here (ref Morgan 1992)

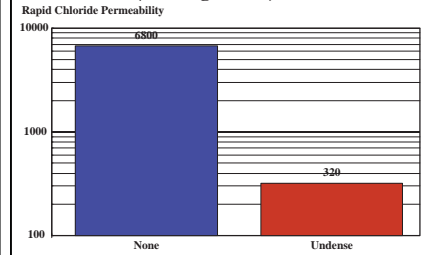


Fig 4 - The low early age cracking with Nycon synthetic fibres results from their high bond performance due to their hydrophilic nature

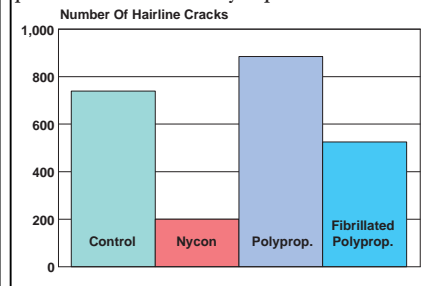


Fig 5 - Toughness Using Scanfibre

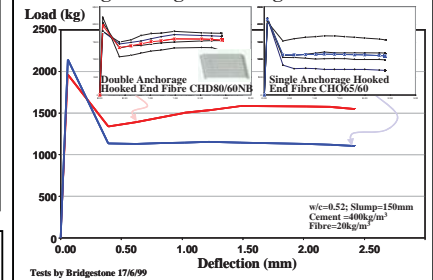


Fig 6 – Use of Scanfibre can eliminate mesh and reduce overspray.

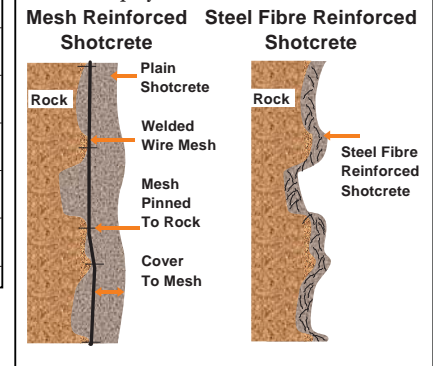


Fig 7 – Scanfibre steel fibres imparts high impact resistance not obtainable with other fibre types. Synthetic fibres only give low impact resistance.

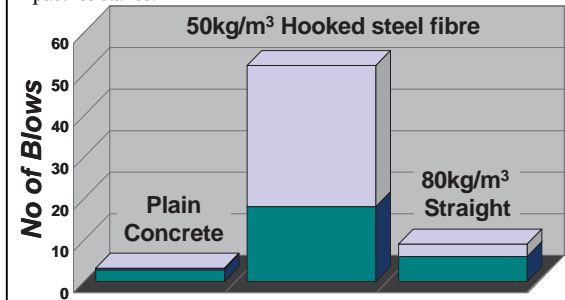
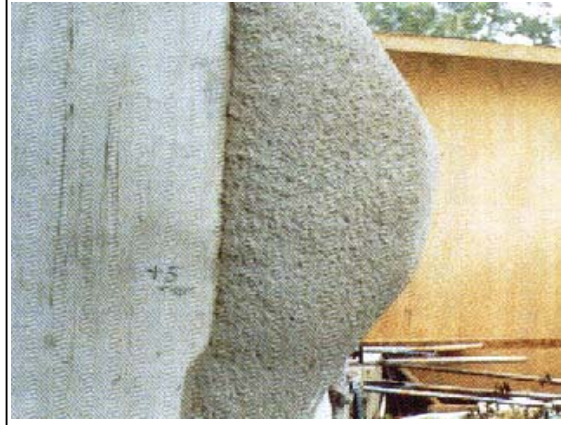


Fig 8 – Silica fume shotcrete can be built up to 10x that of normal shotcrete



### SPECIFICATION

Where silica fume is to be used the general specification clauses outlined on the “Silica Fume” data sheet shall be included in the concrete specification.

Additionally shotcrete can be specified by including the following clauses in the standard concrete specification:-

1. All shotcrete shall contain a minimum of 8% silica fume.
2. Steel fibre shotcrete shall have the following properties\*
  - $R_{e3}$  60%
  - 28Day  $f_c$  40 MPa
3. All shotcrete shall be placed in one pass to the full thickness such that there are no cold joints.
4. All rebound shall be collected and removed from the job site.

\*Consult Scancem Materials to give specific recommendations for your project.

### GENERAL

Scancem Materials and its associates are able to provide technical support related to most aspects of the use of concrete in construction. This support takes the form of:-

Fig 9 – Silica fume Shotcrete, the rapid simple way of applying concrete



- Meeting with the Owner, Architect, Engineer and/or Contractor to develop a cost effective and technically appropriate concrete option that invariably offers advantages to all parties; “the win, win, win approach”.
  - Presentation to interested parties on the mechanisms by which advanced materials in concrete provide solutions to construction problems.
  - Report preparation that details the design methods and assumptions used for any analysis undertaken and includes published papers supporting the use of these design methods.
- 2) Morgan, D.R., "Advances in Shotcrete Technology for Support of Underground Openings in Canada", Engineering Foundation Conference, Shotcrete for Underground Support V, Uppsala, Sweden, 1990.
  - 3) Burge, TA., 'Fiber Reinforced High Strength Shotcrete with Condensed Silica Fume', SP91-57. American Concrete Institute 1991.
  - 4) Wolsiefer, J., and Clear, K., 'Long Term Durability of Silica Fume Structural Concrete, Shotcrete, Grout, Slab Overlays and Patches', Fourth Canmet/ACI International Conference on Fly Ash, Silica Fume, Slag and Natural Pozzolans in Concrete, Istanbul, Turkey, 1992.
  - 5) Morgan, D.R., Neill, J., McAskill, N., and Duke, N., "Evaluation of Silica Fume Shotcrete", CANMET/CSCE International Workshop on Silica Fume in Concrete, Montreal, Quebec, 1987.
  - 6) "Structural Shotcrete Walls", International Patent Pending No. PC-F/A492/0041 1.
  - 7) Morgan, D.R., 'Wet-Mix Silica Fume Shotcrete: "Effect of Silica Fume Form", 432.

Use of computer models to calculate dosages of special materials.

### TECHNICAL SUPPORT

We can provide shotcrete matched to design requirements for durability and toughness based on exposure conditions, or select suitable combinations of silica fume and Scanfibre to give the ideal impact and abrasion resistance.

### SUGGESTED READING

- 1) Morgan, D.R., 'Use of Supplementary Cementing Materials in Shotcrete', Proceedings International Workshop on the Use of Fly Ash, Slag, Silica Fume, and Other Siliceous Materials in Concrete, Sydney, CIA, 1988 pp 403-

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