

Fibres in Concrete

Dramix steel fibres for SFRS and SFRC

About two decades back, steel fibre reinforced shotcrete (SFRS) and steel fibre reinforced concrete (SFRC) were considered a new technology for the construction industry. However today this technology has found wider acceptance among the construction industry. Currently, steel fibres are used in varied segments in many application areas across different segments in the construction industry, especially in tunneling, airports, warehouses, etc.



Typical *Dramix* fibres

Time and safety are the main factors among the various advantages which renders steel fibres superior to the competing product

History

Initially, shotcrete was applied either plain or reinforced with conventional reinforcing steel, welded mesh or even in some occasions chain link mesh. It was, however, not until the early 70s that the first experimental work was undertaken with the steel fibre reinforced shotcrete (SFRS).

Since then SFRS has been used extensively in most of the world's industrialised nations, for a wide variety of applications. Uses of SFRS have varied from rock slope stabilisation and underground support to industrial flooring, road pavements, structural rehabilitation and construction of air-inflated dome form structures.

Definition

Steel fibre reinforced shotcrete (SFRS) is defined as a mortar or concrete, containing discontinuous discrete steel fibres, which are pneumatically projected at high velocity onto a surface. Steel fibres are incorporated in the shotcrete to improve its crack resistance, ductility, energy absorption and impact resistance characteristics. Properly designed, SFRS, can reduce, or even elimi-

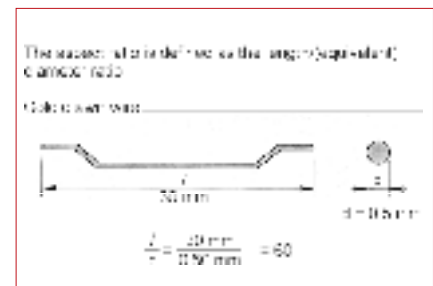
nate cracking, a common cause for concern in plain shotcrete.

Performance

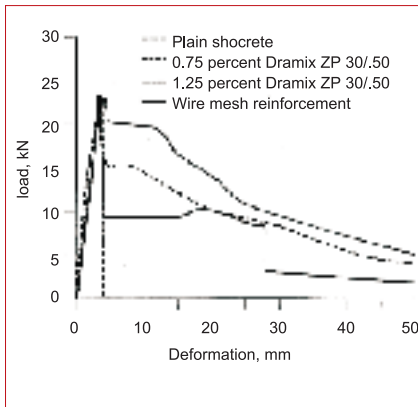
The most important aspects controlling the performance of steel fibres in shotcrete (and concrete) are the:

- aspect ratio
- volume concentration
- geometrical shape.

The higher the aspect ratio and volume concentration of the fibre — provided the tensile strength is high — the better the performance of the SFRS with respect to



The aspect ratio



Comparison of load-carrying capacity of plain, mesh and *Dramix* steel fibre reinforced shotcretes

flexural strength, impact resistance, toughness, ductility, crack resistance.

Unfortunately, the higher the aspect ratio and volume concentration of the fibre, the more difficult the shotcrete becomes to mix, convey and shoot. Thus there are practical limits to the amount of single fibres, which can be added to SFRS, with the amount varying with the different geometrical characteristics of the several fibre types. Loose steel fibres with a high l/d aspect ratio, which is essential for good reinforcement, are difficult to add to the concrete and to spread evenly in the mixture.

Bekaert, Belgium, has glued the loose fibres together with a water-soluble glue into bundles of 30-50 fibres to facilitate handling of the *Dramix* steel fibres. The individual *Dramix* steel fibres have the necessary high l/d aspect ratio, but as they are glued together in compact bundles,

they have approximately the same size as the other aggregates. Glued *Dramix* steel fibres present no difficulty in mixing. They are added as an extra aggregate and require no special equipment to be added to the mix, whether dry mix or wet mix.

The hooked ends improve the bond and anchorage of the *Dramix* steel fibres in the concrete/shotcrete and increase the reinforcing efficiency and ductility. Hooked ends are proved to be best as compared to any other shape of fibres.

Comparison with plain and mesh concrete

In 1979 Morgan and Mowatt undertook a detailed comparative evaluation of plain, mesh and steel fibre reinforced shotcrete. The results of this study are illustrated (see figure). They demonstrated in load/deformation tests on large panels, that SFRS can provide superior residual load carrying capacity to wire mesh reinforced shotcrete at small deformations after first crack and equivalent performance at large deformations. These conclusions are subsequently supported by the results of similar work carried out by Little for the British Columbia Hydro and Power Authority.

Practical differences

One of the factors, which make SFRS particularly appealing to contractors, is the ability to do away with the need of installing wire mesh. Fixing mesh to any irregular surface is difficult, time consuming, costly and sometimes hazardous. On an irregular surface, the mesh is pinned mostly at spots that projects from the surface. It is pinned back inside large depressions but it is draped over most small ones.

Applications

Steel fibre reinforced concrete has gained widespread use in applications such as the following:

- Rock slope stabilisation and support of excavated foundations, often in conjunction with rock and soil anchor systems;
- Industrial floorings, road pavements, warehouses
- Channel linings, protect bridge abutments and stabilise debris-flow prone creeks;
- Rehabilitation of deteriorated marine structures such as light stations, bulkheads, piers, sea walls and dry docks;
- Rehabilitation of reinforced concrete in structures such as bridges, chemical processing and handling plants.
- Support of underground openings in tunnels, mines, drainage adits and exploratory adits,

Usage in Indian projects

Dramix has been used in various India projects successfully namely,

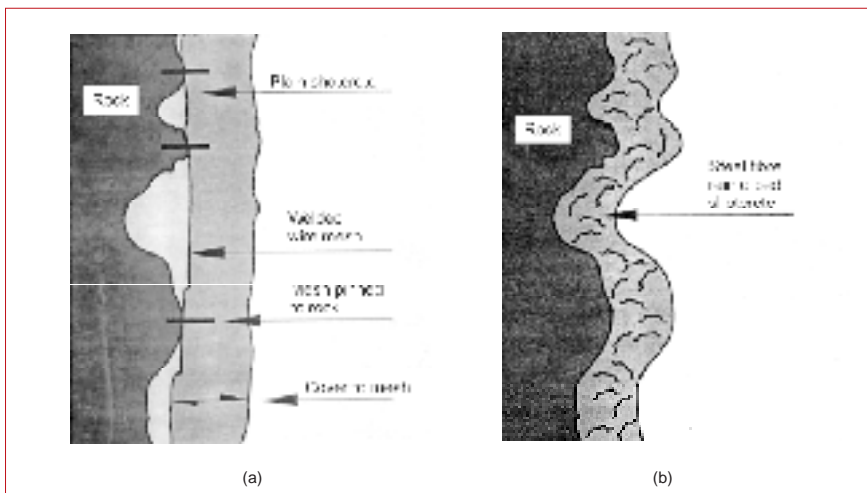
- KRCL-MSRDC tunnels
- Naftha Jakari hydro electric project
- KOL hydro electric project
- Baglihar hydro electric project
- Chamera hydro electric project
- Uri dam
- Sirsisilam project
- Tehri Dam project
- Salal Hydroelectric project
- Ranganadi Hydroelectric project, etc

Tata SSL Ltd is the sole marketing representative of *Dramix* fibres in India.

The above feature is based on the inputs given by ir. Marc Vandewalle N.V., Bekaert S.A., Belgium, and Mr Ganesh P. Chaudhari, Tata SSL Ltd, India.

For more details, please contact:

Mr Ganesh P. Chaudhari
 CAM - Infrastructure Business
 Tata SSL Limited
 Dattapara Road, Borivli (East)
 Mumbai 400 066
 Tel: (022) 28542514
 Fax: (022) 28702473/59
 Mobile: 9821037287
 E-mail: chaudhari@tatawire.com
 Website: www.bekaert.com/building



Difference in shotcrete consumption when using plain, (a) welded wire mesh shotcrete and (b) steel fibre reinforced shotcrete