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Editorial

The last two decades have seen significant advances in fibre reinforced cement composites (FRC) due, primarily, to two reasons. Firstly, the technology of FRC has improved tremendously because of the use of chemical admixtures and supplementary cementing materials such as fly ash, slag and silica fume, and the availability of new and more efficient types of fibres. Equally importantly, extensive research has clarified many of the fundamental mechanisms controlling the behaviour and properties of FRC materials. These advances have led to a new family of materials such as slurry infiltrated fibre concrete, SIFCON, which is often referred to as one of the new class of High Performance Fibre Reinforced Cement Composites.

High performance is often confused with high strength, although there is no guarantee that high strength materials are automatically highly durable. High performance has necessarily to be related to the environment to which a structural element is exposed throughout its life, and in which the structure has to live, breathe and fulfil its load-bearing activities, and at the same time perform this act without losing its safety, functionality or appearance. Looked at this way, a High Performance Concrete Material can be viewed as a material that is designed to give optimised performance characteristics for a given set of load, usage and exposure conditions, consistent with cost, service life and durability. Thus, high performance materials need not be costly either!

In the context of high performance, particularly with FRC materials, the presence of quasi strain hardening or pseudo-strain hardening behaviour in tension is often taken as tantamount to high performance. SIFCON thus, for example, is often termed as high performance FRC whereas conventional FRC which can give equally high performance, is often not considered as a High Performance Material.

SIFCON is generally produced by first sprinkling steel fibres into a mould, and then impregnating the fibre array with a cement slurry. There are thus two distinctly different operations in the production of SIFCON. Fibre placement can be carried out manually or by mechanical means. The properties of the fibres as well as the geometry of the mould would then dictate the extent of fibre alignment, and the volume of fibres consolidated.

The infiltration of the fibre bed with a cement slurry is a much more complex process. Here many parameters influence the efficiency of the infiltration process — the packing density of the fibres, or their interstitial spacing, the fibre geometry and surface characteristics, the flow characteristics of the slurry, and of course, the use of external pressures or vibration. External vibration can significantly affect the arrangement of fibres — both their orientation and alignment. Since there is no effective means of applying controlled amounts of vibration as homogenerously as possible, there is always the danger — and the unacceptable situation — where the method of compaction has a pronounced influence on the engineering properties of the resulting material. In practice, it is inevitable that the compaction process has to be externally controlled, and that the level of compaction has to vary throughout the structural member.

SIFCON is thus faced with an engineering problem. How can a slurry infiltrate the fibre array without implicitly altering the placement geometry? Vibration will inevitably change the rheological properties of the slurry — so what are the qualities required of the slurry which would enable it to behave in a fashion similar to a cement slurry subjected to vibration? Further, what is the application process of the slurry which will ensure that all entrapped air is removed, and which will induce flow characteristics similar to external vibration, without corrupting the fibre array.

Much work has now been carried out, during the last decade, to fundamentally alter the rheology of concrete and cement paste. Self-compacting concrete, requiring no consolidation work, was first proposed in 1986 as a means of achieving durable concrete in construction. After the successful development of the material in 1988, intense research on the material has been carried out to make it a practical reality. The Akashi Kaikyo Bridge, for example, the world's longest suspension bridge with a main span of 1991 m and opened in April 1998, has utilized self-compacting concrete for its two anchorages.

The concept of self-compaction opens out a new era of construction, and the application of a new materials technology not only to concrete construction in general, but also to specialist applications such as SIFCON, prestressing ducts, and rock fissures.