

Polymer Modified Steel Fibre Reinforced Concrete

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ABSTRACT-

Polymer cement concretes have high tensile strength, good ductile behavior and high impact resistance capability due to the formation of a three dimensional polymer network through the hardened cementitious matrices. Because of the void-filling effect of this network and its bridging across cracks, the porosity decreases and pore radius are refined. Furthermore, the transition zone may be improved due to the adhesion of a polymer. A styrene butadiene rubber emulsion is incorporated to improve the ductile behavior and flexural strength of steel fibre reinforced cement concretes (SFC). Silica fume and fly ash are also used to enhance the densification of cementitious matrix. The mechanical properties, microstructure, porosity and pore size distribution of polymer modified steel fibre reinforced concrete are studied.

Keywords: Polymer, cement, fibre, polymer

I. INTRODUCTION

Steel fibre reinforced concretes are structural materials that are gaining importance quite rapidly due to the increasing demand of superior structural properties. These composites exhibit attractive tensile and compressive strengths, low drying shrinkage, high toughness, high energy absorption and durability. This is due to the tendency of propagating micro-cracks in cementitious matrices to be arrested or deflected by fibres, which is guaranteed by the local bond between fibres and matrix. Studies show that fibre-matrix interfacial bond is provided by a combination of adhesion, friction and mechanical interlocking (Li, 2007). Thus fibre reinforced concrete has superior resistance to cracks and crack propagation. The net result of all these is to impart to the fibre composite pronounced post- cracking ductility which is unheard of in ordinary concrete (Nguyen Van,2006). These properties of SFC can be enhanced by the addition of a suitable polymer into it. The properties of which has been overlooked based on the studies conducted by Gengying Li and Xiaohua Zhao, Dept. of civil engg, Shantou university, China.

STEEL FIBRE REINFORCED CONCRETE

Plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. Steel fibre reinforcement is widely used as the main and unique reinforcing for industrial-concrete floor slabs, shotcrete and prefabricated concrete products. It is also considered for structural purposes in the reinforcement of slabs on piles, tunnel segments, concrete cellars, foundation slabs and shear reinforcement in prestressed elements. In tension, SFC fails only after the steel fibre breaks or is pulled out of the cement matrix. The role of randomly distributed discontinuous fibres is to bridge across the cracks that develops and provide some post- cracking ductility. The real contribution of the fibres is to increase the toughness of the concrete under any type of loading. When the fibre reinforcement is in the form of short discrete fibres, they act effectively as rigid inclusions in the concrete matrix.

MIX DESIGN OF SFC

As with any other type of concrete, the mix proportions for SFC depend upon the requirements for a particular job, in terms of strength, workability, and so on. Several procedures for proportioning SFC mixes are available, which emphasize the workability of the resulting mix. However, there are some considerations that are particular to SEC. In general, SFC mixes contain higher cement contents and higher ratios of fine to coarse aggregate than do ordinary concretes, and so the mix design procedures the apply to conventional concrete may not be entirely applicable to SFC. Commonly, to reduce the quantity of cement, up to 35% of the cement may be replaced with fly ash (Nguyen Van, 2006). In addition, to improve the workability of higher fibre volume mixes, water reducing admixtures and, in particular, superplasticizers are often used, in conjunction with air entrainment.

Compressive strength

Fibres do little to enhance the static compressive strength of concrete, with increases in strength ranging from essentially nil to perhaps 25%. Even in members which contain conventional reinforcement in addition to

the steel fibres, the fibres have little effect on compressive strength. However, the fibres do substantially increase the post-cracking ductility, or energy absorption of the material.

Fibres aligned in the direction of the tensile stress may bring about very large increases in direct tensile strength, as high as 133% for 5% of smooth, straight steel fibres. However, for more or less randomly distributed fibres, the increase in strength is much smaller, ranging from as little as no increase in some instances to perhaps 60%, with many investigations indicating intermediate values, as shown in Fig. 2.1. Splitting-tension test of SFRC show similar result. Thus, adding fibres merely to increase the direct tensile strength is probably not worthwhile. However, as in compression, steel fibres do lead to major increases in the post-cracking behavior or toughness of the composites.

Steel fibres are generally found to have aggregate much greater effect on the flexural strength of SFC than on either the compressive or tensile strength, with increases of more than 100% having been reported. The increase in flexural strength is particularly sensitive, not only to the fibre volume, but also to the aspect ratio of the fibres, with higher aspect ratio leading to larger strength increases. describes the fibre effect in terms of the combined parameter WI/d , where I/d is the aspect ratio and W is the weight percent of fibres. It should be noted that for $WI/d > 600$, the mix characteristics tended to be quite unsatisfactory. Deformed fibres show the same types of increases at lower volumes, because of their improved bond characteristics.

APPLICATIONS OF SFC

categorize them. The most common applications are pavements, tunnel linings, pavements and slabs, shotcrete and now shotcrete also containing silica fume, airport pavements, bridge deck slab repairs, and so on. There has also been some recent experimental work on roller-compacted concrete (RCC) reinforced with steel fibres. The fibres themselves are, unfortunately, relatively expensive; a 1% steel fibre addition will approximately double the material costs of the concrete, and this has tended to limit the use of SFC to special applications.

Mechanical properties and cost feasibility

The compressive strengths of concretes (SFC) reinforced with 1, 2, 3 vol.% SFs are 70.0, 79.9, 82.8 MPa, and the flexural strengths are 9.6, 12.6, 15.6 MPa, respectively. With the addition of SBR, the flexural strengths of concretes are generally higher than these of SFC. For series I (containing 1 vol.% steel fibers), the flexural strengths of concretes incorporating 3, 5, 10 wt.% SBR are 12.75, 13.05, 11.1 MPa, about 32%, 33%, 15% higher than these of SFC, respectively. For series II (containing 2 vol.% steel fibers) and III (containing 3 vol.% steel fibers), the flexural strengths of concretes incorporating 3, 5, 10 wt.% SBR are about 1%, 15%, 9%, 11%, 19%, 6% higher than these of SFC, respectively. However, the compressive strengths are generally decreased with the addition of SBR. For series I, II and III, the compressive strengths of concretes incorporating 3, 5, 10 wt.% SBR are about 1.06, 1.05, 0.88, 0.99, 0.94, 0.86, 1.01, 0.94, 0.84 times as high as these of corresponding SFC, respectively.

II. CONCLUSION

Mechanical behaviors and microstructures of the materials were analyzed. It is concluded that Addition of steel fibres to a concrete will improve both its flexural and compressive strength. The strengths increase significantly with fibre content. The flexural strength increases greatly when containing 3-10 wt.% SBR. The optimal use of SBR is 5 wt.%, which achieves the highest flexural strength. However, the compressive strength may decrease with the addition arrives 10 wt.%, a 16% reduction is observed. Polymer films are observed in concretes when incorporating 5 or 10 wt.% SBR, and act as bridges across pores and cracks. Moreover, the polymer films in concrete incorporating 10 wt.% SBR are thicker and more coherent. The pore size distribution curves specimens exhibit at least two peaks, which locate in the ranges of 5-20 nm and 50-1000 nm, respectively. Higher addition of SBR leads to a larger peak magnitude in the range of 50-1000 nm. The overall porosity increases with the increasing dosage of SBR

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