Research Paper Engineering

Fiber Reinforced Selfcompacting Concrete

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ABSTRACT

Fibers bridge cracks, retard their propagation and improve the properties of SCC. The present study aims to develop an SCC mix with different amount of fiber content .cylinder and beam were cast with fiber volume fraction (Vf) 0.25,0.5,0.75) and with aspect ratio 50. The combining of fibers, often called hybridization, is investigated in this paper for a cementations matrix. Control, single, two fibers hybrid composites were cast using different fiber type steel and polypropylene with different sizes. To find out flow test , slump flow, v-funnel, L-box test.

Keywords : SCC,STEE FIBER,POLY PROPYLINE FIBER.

Introduction

Creation of durable concrete structure requires adequate compaction by skilled laborers. The gradual reduction of skilled workers in construction industry has led to a similar reduction in the quality of construction work. One solution for the achievement of durable concrete structures independent of the quality of construction is the employment of Self Compacting Concrete (SCC). SCC can be considered as a concrete that is able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of vibration. It is now widely used for highly congested reinforced concrete structures in seismic region. Heavy reinforcement restricts the access of vibrators that are required for adequate consolidation of Normal Concrete (NC). Moreover, excessive vibration can cause undesirable segregation and bleeding.

The invention of Super plasticizers (SP), Viscosity Modifying Agents and mineral admixtures made it possible to cast concrete of high fluidity and good cohesiveness. SCC has little resistance to flow and possesses enough viscosity to be handled without segregation or bleeding. The hardened SCC is dense, homogeneous and has the same engineering properties and durability as traditionally vibrated concrete. SCC is more brittle than NC under loading . Concentration of tensile stresses occurs at the interface between aggregates and matrix under externally imposed structural loads and environmental effects. Brittle nature of SCC causes growth of micro-cracks in size and number. Propagation of interface micro-cracks into matrix occurs and eventual joining of micro-cracks yield macro-cracks. This will lead to reduction in load carrying capacity and failure of the structure even within the life span.

The use of fiber-reinforced concrete or cement composites to enhance the performance of structural elements has been the subject of many research projects during the past few decades. Numerous types of fiber-reinforced concrete or cement composites reinforced with steel, polymeric, glass, and carbon fibers have been evaluated for structural applications. As one might suspect, not all fiber-reinforced concrete or cement composites behave in a similar manner, and thus proper material selection is critical to achieve the desired structural performance.

It is well known that fibers reduce the workability of concrete and this seems a handicap for on-site applications. There is not enough study carried out on fiber reinforced concrete produced with FA and combination of them together. In this respect, the combination of fiber-reinforced concrete and SCC and FA together and performance of new composite was investigated in order to elucidate the situation and possibly develop materials with improved properties.

FRSCC in the fresh state

The effect of fibers on workability

Fibers affect the characteristics of SCC in the fresh state. They are needle-like particles that increase the resistance to flow and contribute to an internal structure in the fresh state. Steel fiber reinforced concrete is stiffer than conventional concrete. In order to optimize the performance of the single fibers, fibers need to be homogeneously distributed; clustering of fibers has to be avoided. The effect of fibers on workability is mainly due to four reasons: First, the shape of the fibers is more elongated than the aggregates; the surface area at the same volume is higher. Second, stiff fibers change the structure of the granular skeleton, whereas flexible fibers fill the space between them.

Stiff fibers push apart particles that are relatively large compared to the fiber length, which increases the porosity of the granular skeleton. Third, the surface characteristics of fibers differ from that of cement and aggregates, e.g. plastic fibers might be hydrophilic or hydrophobic. Finally, steel fibers often are deformed (i.e. have hooked ends or are wave-shaped) to improve the anchorage between them and the surrounding matrix. The size of the fibers relative to the aggregates determines their distribution. To be effective in the hardened state it is recommended to choose fibers not shorter than the maximum aggregate size . Usually, the fiber length is 2-4 times that of the maximum aggregate size.

Types of fibers and properties

1 Steel fibers

2 Glass fibers

3 Plastic fibers

4 Carbon fibers

5 Mineral fibers

Fiber type	Specific gravity	Tensile strength(mpa)	E GN/ma	Elongation of failure (%)	common Vf(%)
Poly propylene	0.91	550-700	3.5-6.8	21	<2
steel	7.86	400-1200	200	3.5	<2
glass	2.70	1200-1700	73	3.5	4-6
polyester	1.40	400-600	8.4-16	11-13	~0.065
Concret (for comparision)	2.40	2-6	20-50	-	0

II LITERATURE REVIEW

Osman Gencel, Witold Brostow,∗, Tea Datashvili and Michael Thedford they had discussed the topic" Workability and Mechanical Performance of Steel Fiber-Reinforced Self-Compacting Concrete with Fly Ash" Steel fibers change the properties of hardened concrete significantly. However, addition of fibers to fresh concrete results in a loss of workability. Self-compacting concrete (SCC) is an innovative concrete that is able to flow under its own weight, completely filling formwork and achieving full compaction without vibration. they have studied composites of SCC with steel fibers for further property enhancement. Water/cement ratio and cement, fly ash and super plasticizer contents were kept constant at 0.40, 400, 120 and 6 kg/m3, respectively. The fiber amounts were 15, 30, 45 and 60 kg/m3. Slump flow, J-ring and V-funnel tests were conducted for evaluating the fluidity, filling ability and segregation risk of the fresh concretes. There were no problems with mixing or workability while the fiber distribution was uniform. Steel fibers can significantly enhance toughness of SCC and inhibit the initiation and growth of cracks.

Five mixtures, one control and five fiber-reinforced, were prepared. Cement content and aggregate grading were kept constant in all mixtures. Mixture proportions were presented in Table 8. Water cement ratio, cement content and fly ash content were kept constant. Cement content was 400 kg/m3 and w/c ratio was 0.40. For the mixtures with steel fibers, the fiber ratios were 15, 30, 45 and 60 kg/m3. These ratios correspond to fiber volume fractions Vf of 0.2%, 0.4%, 0.6% and 0.8%, respectively. The SP and FA content were 1.5% and 30% of the cement content by weight, respectively. The coarse aggregate (crushed limestone) had a 15 mm maximum size. The maximum aggregate size was selected 15 mm in order to avoid subsequent blocking effects.

They have evaluated deformability with the slump test. The V-funnel flow test evaluates the ability to achieve smooth flow through restricted spacing without blockage. We had no problems in mixing and the fiber distribution was uniform for all mixtures tested. Although all mixes had good fluidity and exhibited self-compacting characteristics, the flow behavior of steel fiber-reinforced concrete differs from that of plain self-compacting concrete. The fiber inclusion reduced the fluidity, which is the ability of fresh concrete to flow and fill the mold. However, all of the high volume fiber-reinforced mixes exceeded the minimum limits suggested for t500 and slump flow required by EFNARC (European Federation for Specialist Construction Chemicals and Concrete Systems). In order to retain high level workability or fluidity with fiber reinforcement, the amount of paste in the mix should be increased to provide better dispersion of fibers. Increasing cement content, increasing fine aggregate content or using pozzolanic and chemical admixtures constitute other options available. Mechanical properties of concrete can be improved by the addition of steel fibers. However, the improvement in compressive strength does not always increase with a larger content of fibers. In the present study, although concretes including higher fiber content did not have the highest compressive strength, they demonstrated the best ductility under flexural, splitting tensile and compressive loads. Mix 2 has the highest compressive strength value of 58.6 MPa. Especially the effect of steel fiber inclusion in flexural strength was remarkably high at 51.7%. Fibers prevent concrete from a sudden failure since randomly distributed steel fibers bridge internal micro cracks and transfer the load by stitching the cracks in the concrete. Thus, concretes with fibers also exhibit better resistance to crack formation. Splitting tensile strength results show an increase of 23.3% for mix 3. The modulus of elasticity was improved only slightly with increasing fiber content. A significant improvement in the energy absorption and ductility in compression is achieved by adding fibers to concrete. The higher is the fiber content, the greater is the toughness.

Chih-Ta Tsai, Lung-Sheng Li, Chien-Chih Chang, and Chao-Lung Hwang they had discussed the topic" DURABILITY DESIGN AND APPLICATION OF STEELFIBER REINFORCED CONCRETE IN TAIWAN"

This paper presents the way durability has been introduced to steel fiber reinforced concrete in Taiwan. It is generally acknowledged that steel fibers are added to improve the toughness, abrasion resistance, and impact strength of concrete. However, a locally developed mixture design method, the densified mixture design algorithm (DMDA), was applied to solve not only the entanglement or balling problem of steel fibers in concrete or to produce steel fiber reinforced self-compacting concrete (SFRSCC) with excellent flow-ability, but also to increase the durability by reduction in the cement paste content. By dense packing of the aggregates and with the aid of pozzolanic material and super plasticizer (SP), concrete can flow honey-like with less entanglement of steel fibers. Such SFRSCC has already been successfully applied in several projects, such as construction of a low radiation waste container, bus station pavement, road deck panel, and two art statues. So it is recommended that the SFRSCC can be used for improving the performance of ordinary steel fiber reinforced concrete in many ways and should be considered for increasing the lifecycle of a concrete structure.

According to the results in this study, a number of conclusions such as the following can be drawn.

1. The SFRSCC designed by the DMDA method reduces the entanglement or balling problem of fibers. To attain high flowing capability, the content of steel fiber should not be greater than 0.5% for normal weight SFRSCC made with crushed coarse aggregate.

2. Test results reveal that higher fiber content has brought about increased compressive strength, flexural strength, abrasion resistance, and fiber crack-control effect. Hence the addition of steel fiber within SFRSCC is more helpful for the flexural strength than the compressive strength.

3. The usefulness of combined steel fiber and pozzolanic material improves the bonding strength as a result of which a modified equation for determining the cylinder splitting strength from the compressive strength has been derived for the SFRSCC.

III PRELIMINARY EXPERIMENTAL INVESTIGATION

The preliminary experimental investigation consists of tests on constituent materials, development of a SCC mix with 100% MSand, influence of volume fraction of steel fibers on fresh and hardened properties of SCC.

A. Tests on Constituent Material

Cement: Cement used in all mixes were Ordinary Portland Cement (53 grade), which conforms to IS specification

Fine Aggregate: Commercially available MSand passing through 4.75mm IS sieve and conforming to zone II of IS 383- 1970 was used. All physical properties as per IS recommendation [9] were determined. Specific gravity and fineness modulus of MSand were 2.48

Coarse Aggregate: For proper gradation, combination of 6mm and 12mm aggregates was used. The properties of coarse aggregate conformed to the IS specification [9, 10]. Specific gravity and fineness modulus were 2.81

Superplasticizer (SP): A poly carboxylic ether based S.P was

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used. The normal dosage suggested by the manufacturer was 1 to 1.2% of powder content.

Steel fibers: Locally available steel fiber of diameter 0.5mm was used. To obtain the required aspect ratio, fiber was cut to a length of 25mm.

Poly propylene;- locally available poly propylene fiber. Fiber was cut to a length 12 mm.

S.C.C DESGN MIX

PARTICLES	QUANTITY(KN/M3)
CEMENT	350
FLY ASH	250
SAND	813.9
COARSE AGGREGATE	748.50
WATER	219.80
SUPER PLASTICIZER	0.8%
VISCOSITY MODIFED AGENT	0.31%

FRESH PROPERTIES OF DESIGN MIX

Tial mix	Cement Content Kg/m3	Fly ash Content Kg/m3	%vf (volume of fiber)	Slump test T-50 t5 In Sec 2-5	in sec 650-800	V funnel test T0 IN SEC <5	T5 IN SEC 5-12	L box test H2/h1	time in sec	remark
A1	350	250	-	2.2	740	2.95	7.2	1	4.7	s.c.c
A2	350	250	-	2.52	750	3.01	7.4	1	4.1	s.c.c
B1	350	250	0.25	3.05	710	4.2	9.3	1	3.48	s.c.c
B2	350	250	0.50	3.8	685	4.9	10.5	1	4.9	s.c.c
B3	350	250	0.75	4.2	690	-	14.5	.96	-	n.a
C1	350	250	0.25	3.08	675	4.5	8.7	1	5.1	s.c.c
C2	350	250	0.50	4.2	667	4.89	13	1	6	s.c.c
C3	350	250	0.75	6.2	590	-	22	-	-	n.a
D1	350	250	0.25+0.25	3.22	660	5.1	13.5	.98	5.5	s.c.c
D2	350	250	0.50+0.25	5.6	640	-	19	-	-	n.a

INFLUENCE OF FIBRES ON HARDENED PROPERTIES OF SCC

specimen		a1	a2	b1	b2	b3
Split tensile strength	7days	1.69	1.86	2.54	2.26	2.77
	28days	1.89	2	2..66	2.32	3.05
Modulus of elasticity	7days	y=11774x	Y=9650x	y=14175x	y=13200x	y=12050x
	28days	y=11950x	y=13150x	y=16200x	y=15500x	y=13000x
Impact energy	7 days	19.62	19.62	39.24	58.86	117.72
	28 days	19.64	19.62	58.86	78.48	137.34

A1=nominal concrete;;A2=nominal concrete

B1=0.25% steel fiber;;B2=0.5% steel fiber

B3=0.75% steel fiber;;C1=0.25% p.p fiber

C2=0.5% p.p fiber;;;C3=0.75% p.p fiber

D1=0.25% steel fiber+0.25% p.p fiber;

D2=0.5% steel fiber+0.25% p.p fiber.

specimen		c1	c2	c3	d1	d2
Split tensile strength	7days	2.66	2.85	2.74	2.71	3.11
	28days	2.68	3.14	3	2.94	3.25
Modulus of elasticity	7days	y=6250x	y=7900x	y=11300x	y=10033x	y=11300x
	28days	y=6334x	y=9050x	y=16533x	y=14667x	y=13900x
Impact energy	7 days	19.24	39.22	58.86	58.86	117.72
	20 days	58.06	58.06	58.06	78.40	156.96

IV . CONCLUSION:-

1 Steel fiber addition reduced the filling ability but satisfying the suggested limits for SCC up to 0.75% fiber. 2poly propylene addition reduced the filling ability but satisfying the suggested limits for SCC upto 0.50% fiber. 3steel fiber+poly propylene addition the filling ability but satisfying the suggested limit for scc upto 0.25+0.25% respectively

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