MIX PROPORTION OF STEEL FIBER REINFORCED CONCRETE

Considering Flowable High Strength Concrete

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1. INTRODUCTION

Leaving its experimental small scale applications, steel fiber reinforced concrete has been emerging as a powerful construction material. The addition of steel fibers in concrete improves remarkably many of its mechanical properties such as – fracture resistance, resistance to impact and dynamic loads. Also they impart additional strength under all modes of loading which include tensile, shear and flexural loads. As the addition of steel fibers reduces the workability of the concrete matrix, mix proportion of steel fiber reinforced concrete should be done keeping in mind that workability is the primary design criteria. In this study, two basic mixes of flowable high strength concrete were chosen and then steel fiber of different volumes were added to those. The fresh properties of the fiber reinforced concrete are presented here.

2. MATERIALS AND METHODS

Ordinary Portland cement satisfying JIS R 5201 and fly ash conforming to JIS A 6201 were used in this investigation. The fine aggregate used was crashed sand, and the coarse aggregate was crashed stone with a maximum size of 20 mm.The fine aggregate had a water absorption of 2.14 % and a saturated surface dry specific gravity of 2.56. The corresponding values of the coarse aggregate were 1.89 and 2.63. The fineness modulus of fine and coarse aggregates were 2.56 and 6.83 respectively. Superplasticizer was used in all the mixes. The steel fiber was cut wire type and of dimensions 0.5 × 0.5 × 30 mm.

The basic mix proportions for the flowable high strength concrete are shown in Table 1. Fly ash used was 20 % of total binder in both mixes. Two series of mixes were done by adding steel fibers of 0.5, 1.0 and 1.5 % by volume of total concrete with those two basic mixes. Series 1 comprises with the basic mix 1 with W/B of 35 which corresponds to 50 MPa strength and series 2 comprises with the basic

Table.1 - Basic mix proportions

Mix	Water/Binder Ratio	Ratio of Fine to Total Aggregate	Quantities kg/m^3					Superplasticizer
			Water	Binder		Aggregate		
	W/B (%)	s/a (%)	W	Cement C	Fly ash F	Fine S	Coarse G	
1	35	58	170	389	97	985	713	2.5% of B
2	25	47	165	528	132	689	842	3.5% of B

mix 2 with W/B of 25 which corresponds to 90 MPa strength. Steel fibers were added to the basic mixes accompanying with the reduction of coarse aggregate volume corresponding to the volume of steel fibers. Mixing was done in a 0.06 m^3 pan mixer with each batch of 0.02 m^3. Cement, fly ash and fine and coarse aggregate were dry mixed for 1 min. Water along with the superplasticizer was gradually added to the mix in 1 min. Then for the basic mixes, mixing continued for another 7 min. For the mixes with fibers, after adding the water, mixing continued for 3 min. Then the fibers were gradually dispersed over the mix in 1 min. Mixing continued for another 3 min.

The freshly mixed concrete were tested for slump flow (JSCE-F 503) and air content(JIS A 1128). For the mixes with 1 % steel fiber, slump flows were measured at intervals of about 30 min to study the loss of slump flow.

3. RESULTS AND DISCUSSION

The slump flow and air content for all mixes are shown in Fig.1 and Fig.2. The variations of slump flows for concrete with 1 % steel fiber are shown in Fig.3 and Fig.4. Slump flows for the basic mixes are 72 and 83 cm which show high flowability of both concretes. For both series, slump flow

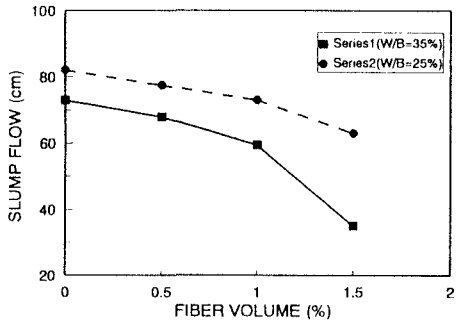

Fig.1 Slump flow for different steel fiber volume content

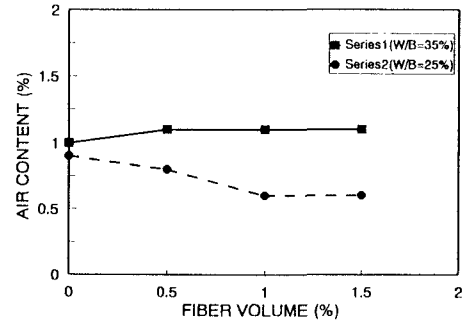

Fig.2 Air content for different steel fiber volume content

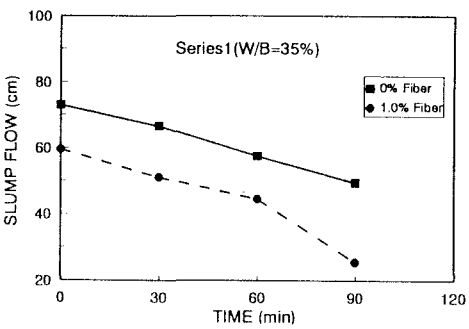

Fig.3 Comparison of slump flow loss -Series1

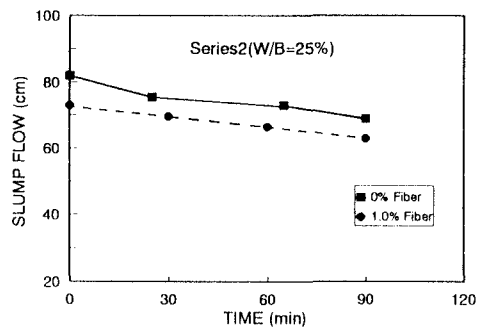

Fig.4 Comparison of slump flow loss -Series2

decreases with increase of steel fiber volume but the decrease is relatively greater in series 2. Air content for both two series are low. In series 1, air content reduces from 0.9 to 0.6 percent with the increase of fiber volume, but in series 2, it remained almost constant at 1 percent. In series 1, the rate of loss of slump flow are same for basic and 1 % steel fiber mixes up to 60 min but after that the rate of slump flow loss of steel fiber mix is greater than that of basic mix and the slump flow of the steel fiber mix reduces to a very low value of 25.5 cm, which means the flowability is almost lost. In series 2, the rate of loss of slump flow are also same for basic and 1 % steel fiber mix but the rate is lower than that of series 1. In both two series, addition of 0.5 % steel fiber has little influence on flowability. Addition of 1 % fiber also gives considerable slump flow but small heap occurs at the center with 10 cm height for series 1 and with 7 cm height for series 2. Steel fiber and coarse aggregate interlocking make the heap. For 1.5 % steel fiber addition, the central heaps are of larger height and flow characteristics are also not good.

4. CONCLUSION

For the two mix proportions of flowable high strength concrete with steel fibers, the following conclusions can be made,

a) Slump flow decreases with the increase of steel fiber volume content.
b) Up to 1 % addition of steel fiber by volume can be used without affecting the flowability appreciably but care should be taken regarding handling time for series 1.
c) Up to 60 min. the rate of loss of slump flow are same for the concrete with or without steel fiber. After that the rate of slump flow loss will be same or greater for concrete with fiber to that of concrete without fiber.