Chapter 6

Effect of Steel Fiber Content on Properties of Concrete

6.1 Background

The effect of the steel fiber content on workability, compressive strength, modulus of rupture, modulus of elasticity and toughness characteristics is studied.

6.2 Results

Table 6-1 shows the results of the slump test, compressive strength test on standard cubes to measure the failure load after 7 and 28 days, standard third-point loading test, third-point loading and standard E- value test (compression test). The number of fibers at the crack section of the beams are counted and presented for the different fiber dosages. The equivalent flexural strength ratio at a deflection of 1.5 mm is also calculated using the JSCE-SF4.

Table 6-1: Effect of Steel Fiber Dosage on Properties of Concrete

Content	Steel Fibers Dosage (kg/m^3)					
Property	0	10	15	20	25	30
Slump (mm)	135	135	145	100	80	90
Cube 7 days (MPa)	29.4	35.9	31.4	31.1	32	32.1
Cube 28days (MPa)	43.8	48.5	47.2	44.3	44.7	46.4
MOR (MPa)	4.1	4.9	4.8	5	5.3	5
Fibers counted Nr.	0	40	66	83	86	98
E-value (GPa)	25.3	24.2	26.7	26.6	27.3	24.4
First Crack (MPa)	4.1	5.2	5.2	5.4	4.9	5.2
Equivalent Strength (MPa)	0	2.0	1.9	2.4	2.7	3.8
Re 1.5	0	38.5	36.5	44.4	55.1	73.1
(80/60) Hook-ended steel fibers / 150x150x150 mm cubes / 150x150x500mm beams						

6.3 Discussion

6.3.1 Workability

Figure 6-1 shows the effect of the steel fibers dosage on workability of the concrete mixtures. The dotted line shows the general trend for the effect of steel fiber content on workability. It shows that addition of steel fiber has a minimum effect for low dosage while it has a significant effect for higher dosages.

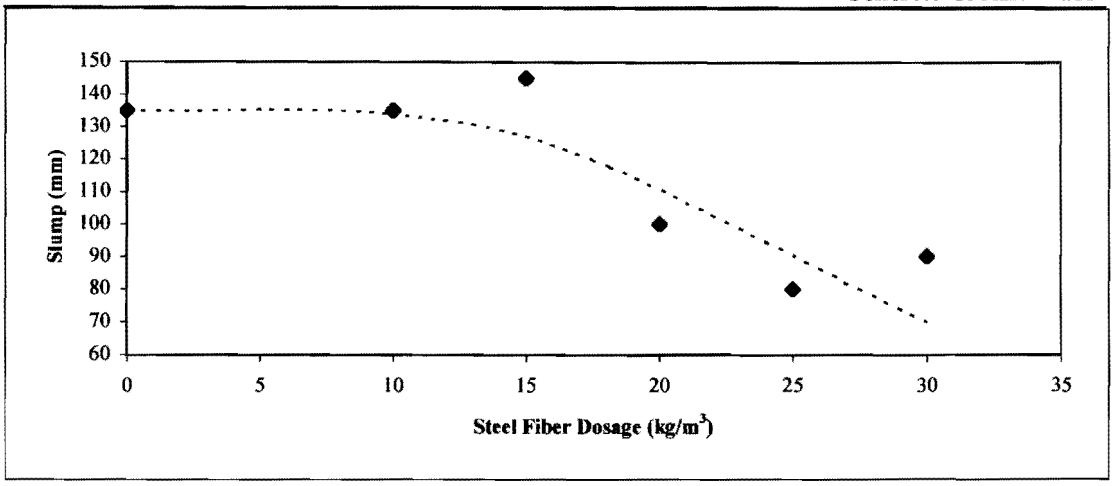

Figure 6-1: Effect of Steel Fibers Dosage on Workability

6.3.2 Compressive Strength

Figure 6-2 and figure 6-3 show that the steel fiber has a minimum effect on the compressive strength of the concrete mixture. An increase of minimum 1% to a maximum of 10% for different dosages is gained. It should also be noticeable that, the 7 days and the 28 days curves are approximately following the same patterns, which in turn means that some sort of consistency is normally associated with the strength growth characteristics of the SFRC.

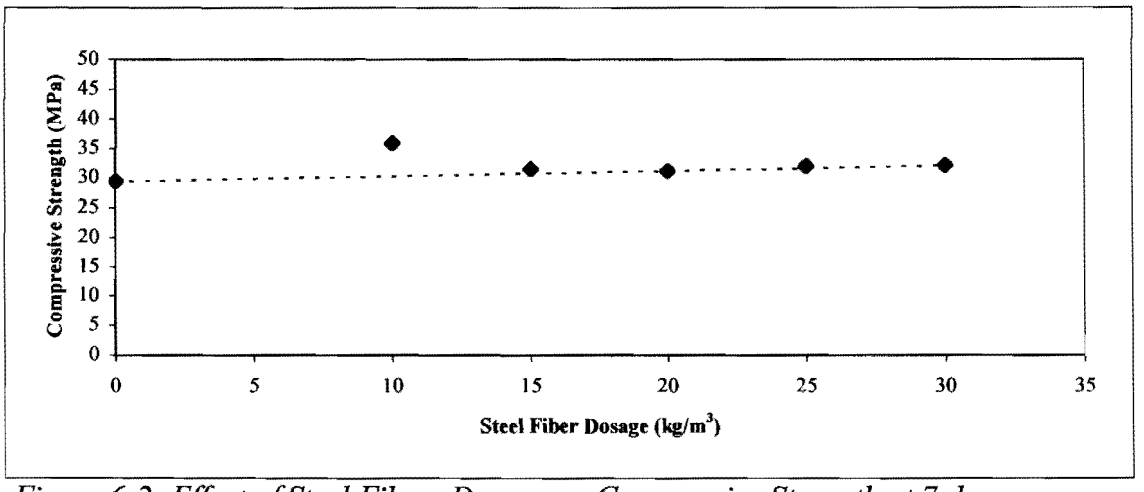

Figure 6-2: Effect of Steel Fibers Dosage on Compressive Strength at 7 days

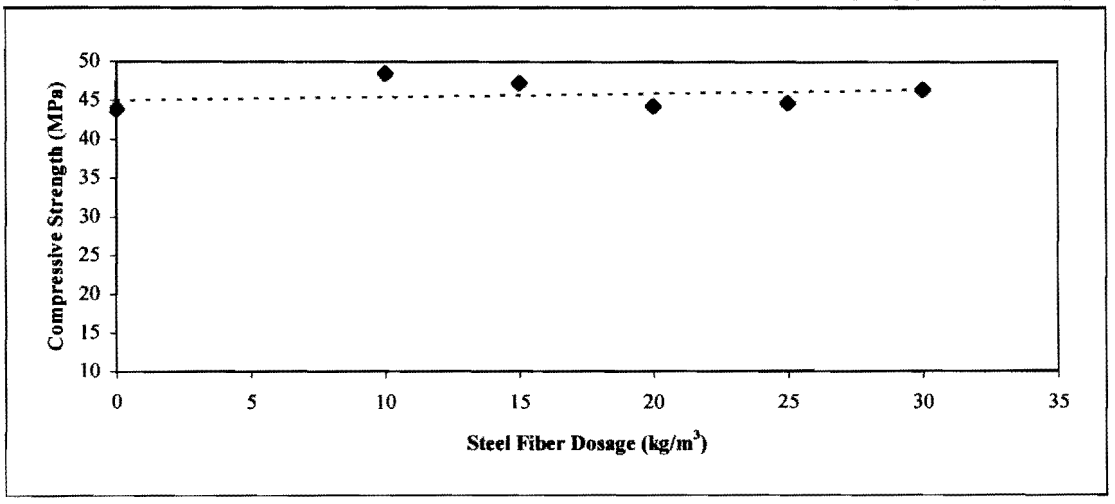

Figure 6-3: Effect of Steel Fibers Dosage on Compressive Strength at 28 days

6.3.3 Modulus of Rupture

Figure 6-4 shows the effect of the steel fiber dosage on modulus of rupture (MOR). It shows that about 19% increase is found for concrete containing steel fibers of 25kg/m^3. The orientation of the individual steel fibers might profoundly affect the measured strength using beam specimens. This is obvious from the strength reading at steel fiber dosage 30 kg/m^3 at which the MOR drops instead of increasing.

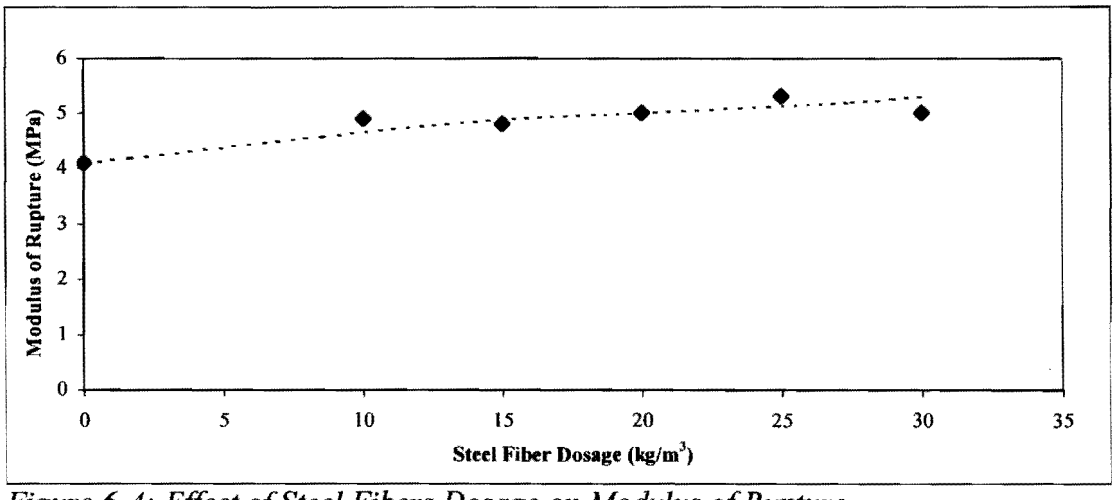

Figure 6-4: Effect of Steel Fibers Dosage on Modulus of Rupture

6.3.4 Modulus of Elasticity

Figure 6-5 shows the effect of steel fibers on the modulus of elasticity. Although the general trend of the curve shows a slight increase in its value with the increasing of the steel fiber dosage, this increase is insignificant.

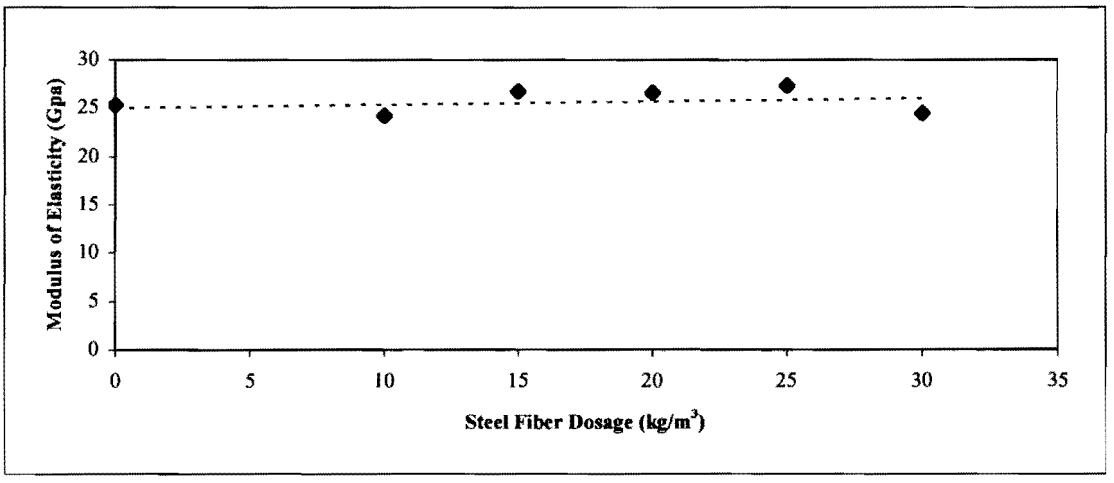

Figure 6-5: Effect of Modulus Steel Fibers Dosage on Modulus of Elasticity

6.3.5 Toughness

Figure 6-6 shows the effect of steel fiber dosage on first crack strength. The highest increase found was 25% with dosage 20kg/m^3. The general trend shows that the steel fiber dosage has an insignificant effect on first crack strength at 28 days.

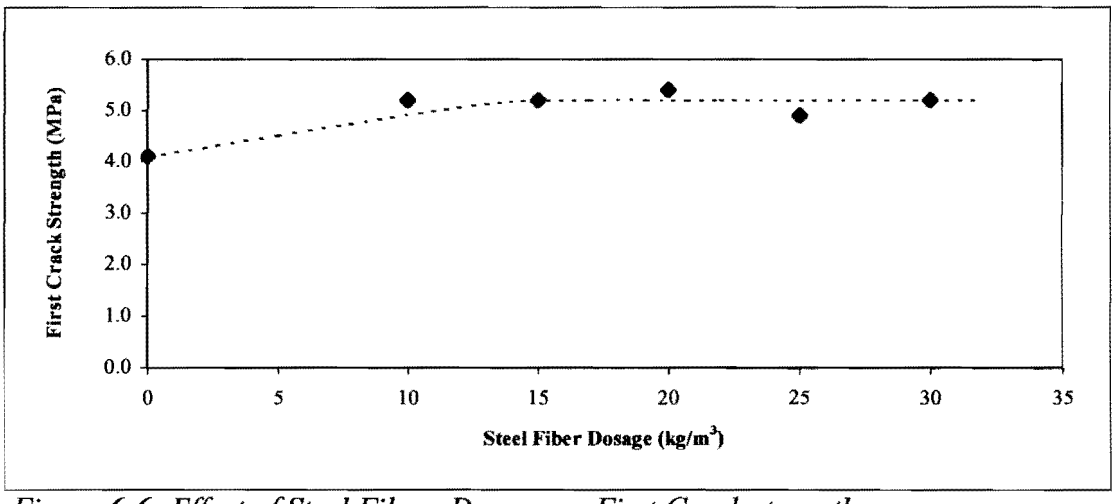

Figure 6-6: Effect of Steel Fibers Dosage on First Crack strength

Figure 6-7 shows the strength equivalent ratio (at a deflection equal to span/300) as a function of steel fiber dosage. From the graph it is noticeable that the addition of the steel fibers to concrete increases the toughness of the concrete by more than 70% at steel fiber contents such as 30 kg/m^3. The general trend shows that a significant increase in toughness is gained by adding even low steel fiber dosage.

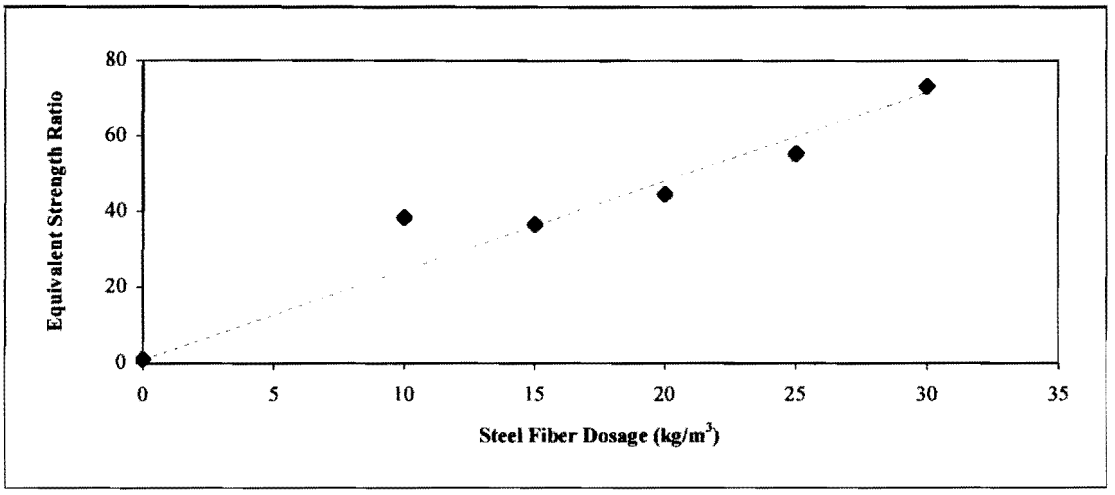

Figure 6-7: Effect of Steel Fibers Dosage on Toughness

6.4 Conclusions

The steel fiber dosage was found to influence the workability, compressive strength, MOR, modulus of elasticity, and toughness characteristics as following:

- The workability is less sensitive to low dosage and the sensitivity increases with the increase of dosage. As an indication, with steel fiber dosage of 25 kg/m^3 the workability decrease by about 40% compared to plain concrete.
- The steel fiber dosage has a negligible influence on the compressive strength at 7 and 28 days.
- At 28 days, steel fiber dosage has insignificant influence on MOR. As an indication, for steel fiber dosage of 25 kg/m^3 an increase of approximately 19% in the MOR was obtained (relevant to plain concrete).
- At 28 days the general trend is found that the steel fiber slightly increases the modulus of elasticity. This increase is considered insignificant.
- At 28 days, the addition of steel fibers with various contents increases the first crack strength by about 25 % (relative to plain concrete) and the most rapid increase occurred at low steel fiber dosage (up to 15 kg/m3).
- Steel fiber dosage has a significant influence on toughness characteristics. As an indication, it increases the after crack strength by more than 70% with steel fiber dosage of 30 kg/m^3.