

Studies of Tensile and Compressive Strengths of SFRC on the Structural Beam

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Abstract:- Applications for steel-added supported built up concrete (SFRC) have spread to regions, for example, upper layers, burrow shells, sewer lines, and sections of enormous modern structures. Use of SFRC to individuals accountable for building structures with supported concrete (RC) and is acquiring ubiquity as of late because of its phenomenal job in both energy assimilation limit and substantial strength. This paper presents an examination of the trial and restricted part of the three SFRC points of support. For this reason, Three SFRC radiates with a width of 250 350 2000 mm are fabricated utilizing a C20 substantial class with a proportion of radiates are dependent upon adaptability with the four-point transfer setting of the surefire stacking outline, not long after dampness relieved for 28 days. Testing have some control over loads. The pillars are stacked until they break and the stacking is halted when the strong metal is broken into two pieces. The heaps involved and the deviations in the segment are painstakingly recorded for each of the 5 kN load increments from the start to the last disappointment. Eight strong block components with eight hubs are utilized to make a substantial model. Inside support utilizing 3D fight components. A fourth of the full pillar is considered in the demonstrating framework. The outcomes got from the standard component and test investigation were contrasted with one another. It is clear from the outcomes that the disappointment conduct of the moderate element shows a decent concurrence with disappointment test conduct.

1. INTRODUCTION

It's obviously true that, aside from minerals and synthetic compounds combinations, pressure Expanding the assortment of fixings, such as carbon strands, silicon filaments, and steel filaments, improves the strength and other mechanical properties of Portland concrete.. All things considered, SFC and SFRC are being used in increasing numbers of frameworks. Standard size and steel filaments of substantial construction work on breaking conduct, making the cement bendable, expanding its solidity and strengthening it fundamentally. Both the SFC and the SFRC have become standard operating procedures across a wide range of environments as a result of these clearly defined realities. Because of its high malleability, SFC's primary benefit is its high retention limit and sturdiness [1]. In order to blend this standard steel fiber (SF) into new cement during the blending process, the composite doesn't need to be radically altered in appearance.

As an example, SFC can be found in a wide range of applications, including the construction of mine shafts and passageways; large modern sections and open squares; the support of rock inclinations; shell houses; recalcitrant linings; dam construction; composite steel floors; channel fixes; and tremors. Large-scale design restoration, repairs and remodels of marine structures (fire protection, large sewer pipes), as well as the restoration of standard RC layouts. SFs RC radiation breaks were studied by Dupont and Vandewalle [2], who came up with a limit of 30-40 kg/m³ for an ideal turn of events in the breaks. Gopalaratnam et al. [3] focused on portion results, synthesis, SF surface, and the effects of stacking, layout size, and SFRC setup on SFs. To test this, Paine et al. [4] focused on SF commitment to the shear opposition of RC radiates, and found that an all-out volume of SF of 1-2 percent was correct. SFRC bars with SF dosages of 0.5 percent, 1 percent, and 1.5 percent for all out volume were examined by Ganesan and Shivananda [5] in the wake of leading analyses of the variable section in the SF volume. Shockingly, Alavizadeh-Farhang [6] demonstrated that the SFRC radiates were able to hold more weight when they were stacking at 60 kg/m³ with 30-mm-long, 0.25-mm-wide SFs at a rate of 60 kg/m³ for 30 minutes. Dramix RC-65/35-BN steel filaments were used in two unique portions of 60 kg/m³ and ne-100 kg/m³ for a total of 12 SFRC radiates created by Hartman [7] after 28 days of repairs. According to Hartman, the typical last burden load for SFRC firearms was 60 kg/m³. A major focus of Bangash's [8] work was mathematical visualization and the application of complex designs. Shear forces between breaks in built-up and fiber-supported large designs were demonstrated by Hemmaty [9] using the ANSYS [10] standard component framework. The ANSYS framework was used by Huyse et al. [11] to focus on the fiber-built up cement footer's secluded component. When Wolanski [12] used ANSYS to support cement footers, he focused on the disappointment of losing all the previously gained adaptability.

The goal of this paper is to conduct an experimental investigation of the ultimate behavior of SFRC (steel fibers reinforced concrete) beams. SFRC beams were put through their paces in the lab to see if they could accomplish this. A numerical and graphical comparison of the findings is made. Experimentation on the ultimate behavior of steel fiber reinforced concrete (SFRC) beams is the goal of this paper. For this, SFRC beams were put through their paces in the labs. The numerical and graphical results of the experiments are compared.

2. EXPERIMENTAL STUDY

- The Dramix-RC-80 / 0.60-BN steel fibers (SFs) are available in four different doses of 30, 40, 50, and 60 kg / m³, and the fifth non-SF produced cylindrical specimens six of 15 30 cm measurements from each group. Compressometers are used for the standard crushing test on all models, and the movement and transport and stress of these models are accurately measured in a certified pressure machine. So, the difficulty, the final compression strength, and the module flexibility of all models have been established.... With 30 kg/m³ steel fiber added (SFA) to C20 reference concrete, the compressive strength and expandable module decreased by 9% and 7% respectively, while the area under load-removal curve more than doubled. SFA concrete in high SF volumes has a 10% increase in these values and a similar increase in strength. SFA concrete with a steel fiber content of 30 kg/m³ is preferred for economic reasons because it has similar strength and elasticity to the previous modulus and even better than the last. For SFA-reinforced concrete, this recipe should work (SFARC). SFA concrete with an SF capacity of 30 kg / m³ is used in the production of six rigid reinforced concrete (RC) beams of equal size and rigidity. This beam's final failure load is approximately 18% higher in SFARC planks than conventional RC beams when tested in the standard four-point loading risk. The load-to-failure curves for SFARC beams are not noticeably longer than those for conventional RC ones, despite the fact that the load-to-failure curves for both types of beams are higher.
- One phase was followed by another in the experimental research. Tests were carried out on five different concrete clusters, the first of which was C20 class without SFs, while the other four contained SFs of different dose and concentration in the same concrete (Fig. 1). Second, load-removal tests on SFRC radiation were carried out to better understand the effects of SFC addition to reinforced concrete on the total volume of machinery structures investigated.
- **Experiment on SFCs**
Concrete clusters in the C20 category have been processed because the building's common concrete class was determined.

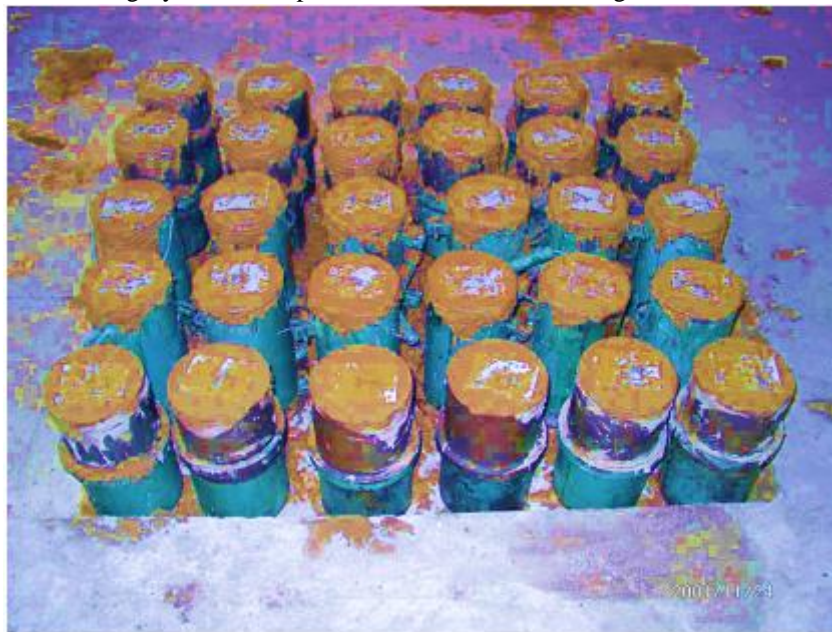


Fig. 1 Five different concrete batches, the first one being an ordinary C20 class without any SFs, and the other four containing SFs of varying dosages again in the same C20 class concrete.

After initial design and production, the initial C20 concrete set was modified to be 150 by 20 mm deep. Also included in the internal C20 batch of concrete are SFs, which have a weight capacity of 30 kg/m³ and can store the same amount as other ingredients, such as 40 kg/m³, 50 kg/m³, and 60 kg/m³. In each group, six 15-30 cm diameter cylindrical specimens were collected using standard methods. Cement Type I is used in all five collections: PC-32.5 equivalent ASTM Portland Cement Type I.

The stream bed's natural element, sand, had a gravitational density of 2.72, 2.65, and 2.60 when crushed into medium-sized aggregate aggregates.

In order to obtain a composite combination order near the lower and upper bounds, the ratings of these three merged groups were adjusted following standard screening tests. Table 1 provides the C20 concrete mix recipe used here.

Ingredient	Amount (kg/m ³)
Water	150
Portland cement	300
Filler (SSD ⁴)	386
Sand (SSD)	472
Fine coarse (SSD)	467
Medium coarse (SSD)	559

Table 1 Recipe for concrete mix of class C20

Dramix RC 80/0.60BN metal fibers, 60 millimeters long and 0.75 millimeters wide, were used in the experiment. One of these SFs is depicted in Fig. 2.

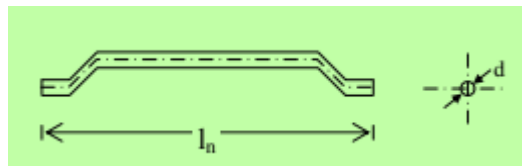


Fig. 2 Shape of one of the steel fibers used

In order to guarantee consistency, these SFs are added to manufactured batches at a rate of 20 kg/min and then blended at high speed for 5 minutes. concrete depictions of science fiction Figure 3 depicts the SFC cluster's appearance.

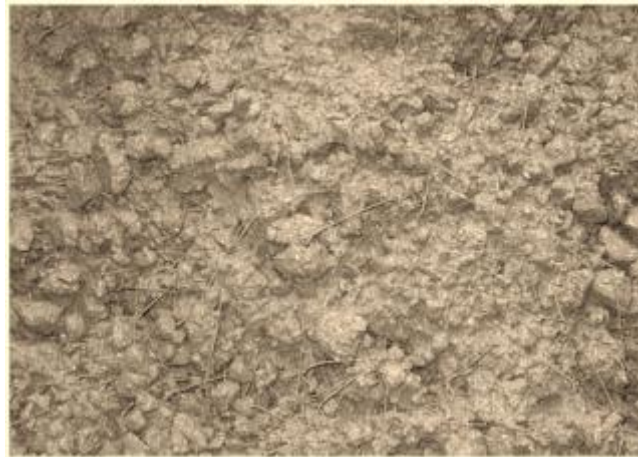


Fig. 3 Appearance of one of the batches of SFCs mixed in this study while fresh.

Sulfuric acid was applied to the upper surface of each cylindrical sample after it had been treated for a period of 28 days. Standard compressometers were used to press samples for two hours, after which time the samples were examined. At each of the 20 kN load increases up to the final failure, short-term deviations due to compressive pressures were accurately recorded.

Table 2 summarizes the recorded data and calculates the central pressures, the module's average flexibility, and the stiffness of each of the five different compounds. From the results in Table 2, it can be seen that the SFC appears to be very tight, very flexible, leading to a decrease in modulus elasticity of about 10%, which is consistent with the compression strength of SFCs decreasing by 10%.

Concrete batch	Dosage of SFs (kg/m ³)	Ultimate load (N)	Ultimate strength (N/mm ²)	Percent loss in strength (%)	Elasticity modulus (N/mm ²)	Toughness (kN mm)
No. SFs	0	432,000	24.46	—	29,500	202
SFC-30	30	397,000	22.48	8.80	27,500	446
SFC-40	40	385,000	21.80	12.20	26,500	522
SFC-50	50	377,000	21.34	14.60	26,500	415
SFC-60	60	399,000	22.59	8.30	26,000	474

Table 2 Averages of the measured mechanical peculiarities of the concrete batches tested

- A 120 percent increase in SFC hardness was found when the minimum SF volume was 30 kg/m³, as compared to plain concrete. Stiffness did not increase as SF volume increased, as shown in Table 2 again. To keep costs down and because some structures haven't changed much, the SFRC chose the lowest dose of 30 kg/m³, which turned out to be

sufficient in terms of total SF capacity. The beams that were to be designed by the SFRC used S20 class CFA SFA concrete with an SF rating of 30 kg/m³.

- **Experiments on RC and SFRC beams**

The actual edge's dead heap was left out of the estimate. An alternative non-supported conduct would be to use $q =$ still in the air. Figure 4 shows the three SFRC 2 m long bars that were used in the testing. Figures 5 and 6 show cross-area, shaft stacking, and support. Steel bars 12 mm and 8 mm wide are inserted into the strain zone, and two 8 mm steel bars are used as tension gauges. Twenty 8mm steel bar shear connectors are inserted into the shaving material at 100 mm intervals to strengthen the shear. A simple twist of the stirrps causes steel bars to break, which is why they are electronic and mounted on a tabletop.

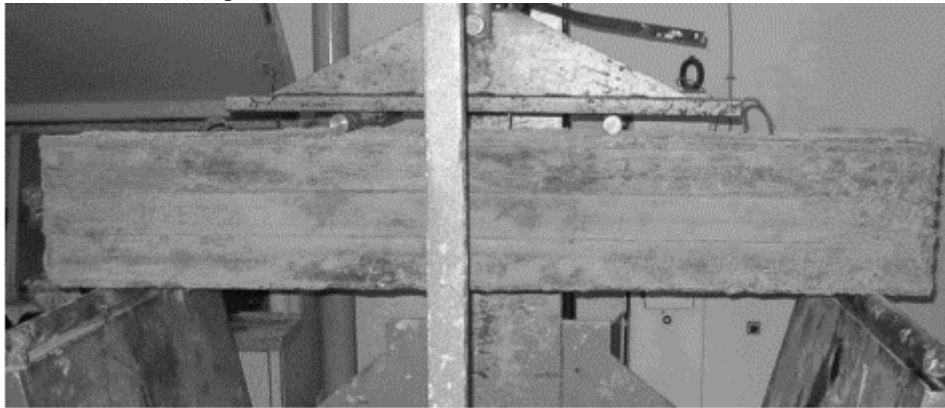


Fig. 4 The test model of the SFRC beam.

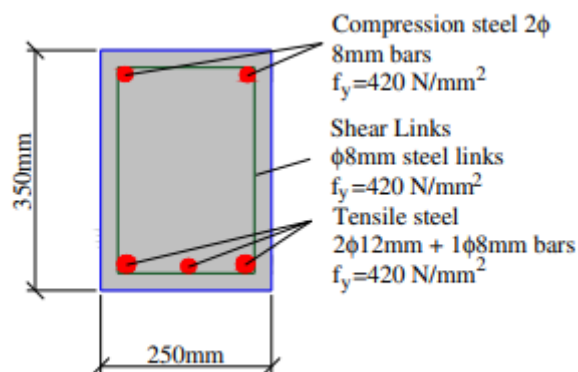


Fig. 5 Cross-section details of SFRC beam

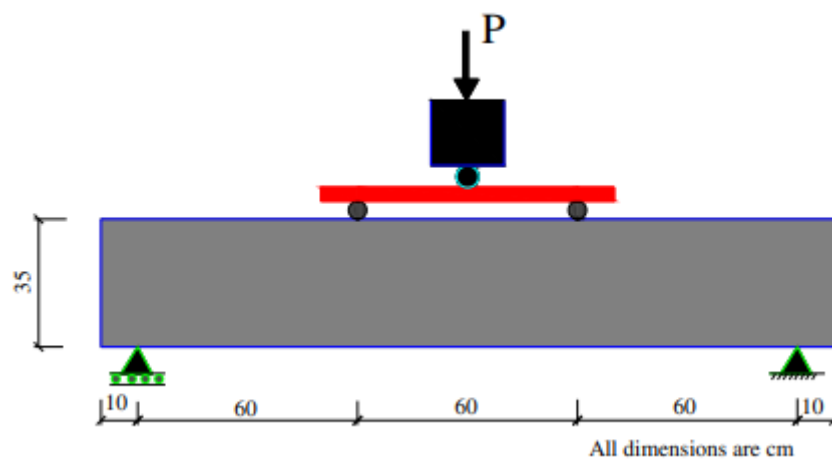


Fig. 6 Loading and supporting arrangement of SFRC beam

The RILEM TC162-TDF [14] compressive strength and maturing properties of C20 concrete were used in these estimations. Three C20 RC radiates and three SFRC RC radiates, both of which have 30 kg/m³-measurements SF, were delivered [15].

There were three standard-size 150 150 750-mm molds filled with SFC 30 kg/m³ SF ability to be tested on an exceptional testing machine to measure the strength of these small posts created by this SFC. Fig 7 shows this process in action It took 28 days for the researchers to conduct a four-point straightforward twisting test on these three SFRC particles and three RC particles, each of which underwent a constant, wet burlap-encased twisting test at 350 kN. Using a well-fitting check measure, the deviation of the center area is accurately estimated in each of the 5 kN load increments.. Tests for the final disappointment are depicted in Figure 8. A demonstrated stroke-controlled set extraordinarily intended to quantify the firmness of those SFC radiates in accordance with ASTM C1018-92 [16] was used to stack each of the three small SFC radiates by 1 mm at a time.



Fig. 7 Concreting of the SFRC beams.



Fig. 8 One of the four-point loading beam-loading experiments

When the pillar model revolved, the external substantial region's gravity information was used to stack it to break it. As depicted in Fig. 6, the evenly circulated load is applied first, with the point P being applied at each rising until the last bar load is reached. Figure 9 depicts the behavior of the Pillar during this test in which it was disappointed. Just where breaks are found in a substantial chunk, the substantial fails to withstand the unbending strain, as shown in Fig. 9. It grinds the substantial between the breaks because of the overall pressure of the bond. This reduces the steel's tensile strength.

3. RESULTS

Fig. 9's restricted component is thought to have caused the following reactions to radiation burden deviations from the test. There are 227.1 kN of final loads for each standard element and test model, respectively. This is as close as possible to the normal deviation from the last SFRC stacking of the kept metal in the test, as shown in Fig. 9. Distinction between normal component testing and shaft load testing is usually quite stable. well-equipped with test data. Load factor is restricted - the bend is slightly different from the test break. There are a few possible side effects that could occur. First, microcracks in the shaft concrete have been tested and can be delivered by repairing breaks in the substantial and/or control radiates of the shaft. Restricted variant models, on the other hand, do not include microcracks. In addition, the investigation of limit components provides an immediate connection between cement and steel support, but this assumption cannot be valid for the tried structure.

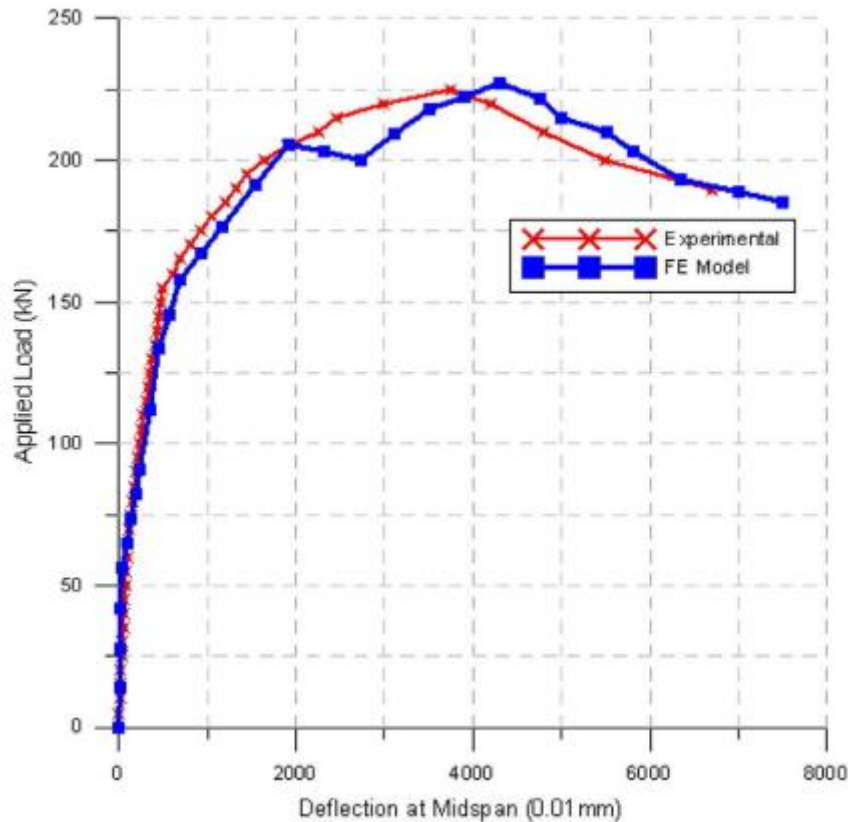


Fig. 9 Experimental and FEM load-deflection responses.

ANSYS uses joining marks on strong substantial items to determine tension and trouble. At this point, it appears that the greatest pliable strain has exceeded the last remaining strength of the substantial. It appears that the split sign is in line with the greatest tension bearing.

The investigation of the limit things in the study led to the creation of partitions.

In contrast to the images of the failed pillar, the final stacking advancements are shown. The breaks marks are shown on the quarter model's outer layer. Solid strain primarily occurs on the x side of the bar during the time period (longitudinally). Circular breaks in the markings appear to be dependent on the principal strain on the x-side whenever tension exceeds the last strength of the substantial. Because of this, cracks in the joints of heavy, sturdy objects are depicted as straight lines. In the future, these flexural breaks are referred to as such.

Since the crack is formed by the expanded pressure as a result of the Poisson impact, the break spreads essentially in accordance with the heading of the compressive burden applied to the construction. Investigations into obstructions reveal a similar pattern of behavior. The Poisson impact strengthens the pathways in y as loads move toward z. So the circles look like they're in direct opposition to tractable types, especially when it comes to y-bearing joints at large components near the stacking region. We refer to these as pressure breaks. As a result, the direction of the primary center strain gradually shifts away from its even position..... Bended circles that appear as straight lines in the joints of the material when the really tractable tensions exceed the last strength of the substantial occur when the bearing of the principle stress occurs. Slanting malleable breaks are the name given to these after that point.

Concrete fails to withstand solid tensions precisely where breaks occur in our SFRC field at sufficiently high stacking levels. During the break, a substantial opposes the middle qualities of the opposition introduced by the bond pressure related to the noticeable connector in the way As a result, steel loses some of its toughness. Before the bar test, there was no proof that the supporting metal had failed. Quantitative pressure analysis of the variable reaffirms this conclusion.

4. CONCLUSION

SRFC's exploratory disappointment conduct has been examined in this review. SFRC's shaft was engineered in a testing facility. We stacked up the shaft model to the point of failure while checking the diversion and strain data on the outer significant

surfaces. An ANSYS program was used to conduct a limited component dissatisfaction investigation (not displayed here). To demonstrate the importance, we used eight-hub solid block components (Solid65). 3D finite components were used to demonstrate inner support.

Limited component examination yielded disappointment burden and relocation estimates that were extremely close to the trial testing estimates of actual disappointment behavior, which is not surprising. For the pillar in the limited component investigation, the heap redirection bends are very similar to those in the trial. Limited component investigation's break dispersions agree with the results of trials.

Based on the results of the test and limited component analysis of the SFRC shaft, the accompanying ends can be expressed as such.

In contrast to the exploratory data obtained from a built up cement footer, the limited component model exhibits deflections and stresses at the centerline along with starting and moderate breaking.

(2) Using FEA, the disappointment instrument of an SFRC shaft can be clearly seen, and the expected disappointment load is exceptionally close to the disappointment load estimated during exploratory testing. (2)

Deflections and stresses at the zero diversion point and decompression are clearly shown with a small number of components. (3)(3)

5. REFERENCES

- [1] Ocean Heidelberg Cement Group. Ocean concrete products, steel fibre reinforcement, working together to build our communities report, 1999.
- [2] Dupont D, Vandewalle L. Bending capacity of steel fibre reinforced concrete (SFRC) beams. In: International congress on challenges of concrete construction, Dundee, 2002. p. 81–90.
- [3] Gopalaratnam VS, Shah SP, Batson GB, Criswell ME, Ramakrishnan V, Wecharatara M. Fracture toughness of fiber reinforced concrete. *ACI Mater J* 1991;88(4):339–53.
- [4] Paine KA, Elliott KS, Peaston CH. Flexural toughness as a measure of shear strength and ductility of prestressed fibre reinforced concrete beams. In: International congress on challenges of concrete construction, Dundee, 2002. p. 200–212. Fig. 25. Maximum compressive and tensile stresses (MPa) for element solution. Fig. 26. Maximum compressive and tensile stresses (MPa) for nodal solution. 1076 D.M. Özcan et al. / *Construction and Building Materials* 23 (2009) 1064–1077
- [5] Ganesan N, Shivananda KP. Spacing and width of cracks in polymer modified steel fibre reinforced concrete flexural members. In: International congress on challenges of concrete construction, Dundee, 2002. p. 244–253.
- [6] Alavizadeh-Farhang A. Plain and steel fibre reinforced concrete beams subjected to combined mechanical and thermal loading. Master thesis, Department of Structural Engineering, Royal Institute of Technology, Bulletin No. 38, Stockholm, Sweden, 1998.
- [7] Hartman, T., Steel Fiber Reinforced Concrete, Master Thesis, Department of Structural Engineering, Royal Institute of Technology, Stockholm, Sweden, 1999.
- [8] Bangash MYH. Concrete and concrete structures: numerical modeling and applications. London, England: Elsevier Science Publishers Ltd.; 1989.
- [9] Hemmaty Y. Modelling of the shear force transferred between cracks in reinforced and fibre reinforced concrete structures. In: Proceedings of the ANSYS conference, vol. 1, Pittsburgh, Pennsylvania, 1998.
- [10] ANSYS, Swanson Analysis System, US, 2003.
- [11] Huyse L, Hemmaty Y, Vandewalle L. Finite element modeling of fiber reinforced concrete beams. In: Proceedings of the ANSYS conference, vol. 2, Pittsburgh, Pennsylvania, 1994.
- [12] Wolanski A. Flexural behavior of reinforced and prestressed concrete beams using finite element analysis. Master thesis, Marquette University, Milwaukee, Wisconsin, 2004.
- [13] RILEM TC162-TDF. Test and design methods for steel fiber reinforced concrete: bending test. *Mater Struct* 2000;33(January–February):3–5.
- [14] RILEM TC162-TDF. Test and design methods for steel fiber reinforced concrete: r–e design method. *Mater Struct* 2000;33(March):75–81.
- [15] Ozcan DM. Experimental investigation of ultimate capacity of steel fiber reinforced concrete beams. Master thesis, Erciyes University, Kayseri, Turkey, 2003 [in Turkish].
- [16] ASTM C1018-92, Standard test method for flexural toughness and first-crack strength of fibre-reinforced concrete, American Society for Testing and Materials, May 1992. 7 p.
- [17] Nilson AH. Design of concrete structures. New York (NY): McGraw-Hill, Inc.; 1997.
- [18] Willam KJ, Warnke EP. Constitutive model for triaxial behaviour of concrete. In: Seminar on concrete structures subjected to triaxial stresses, international association of bridge and structural engineering conference, Bergamo, Italy, 1974. p. 174.
- [19] MacGregor JG. Reinforced concrete mechanics and design. Englewood Cliffs, NJ: Prentice-Hall, Inc.; 1992.
- [20] TS 3114, Turkish Standard, Concrete-Determination of Compressive Strength of Test Specimens, Turkey, 1998 [in Turkish].
- [21] TS 500, Turkish Standard, Requirements for Design and Construction of Reinforced Concrete Structures, Turkey, 2000 [in Turkish].
- [22] CNR-DT 204/2006- Istruzioni per la Progettazione, l'Esecuzione ed il Controllo di Strutture di Calcestruzzo Fibrorinforzato.
- [23] Mindess S, Young JF. Concrete. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.; 1981.
- [24] Shah SP, Swartz SE, Ouyang C. Fracture mechanics of concrete. New York (NY): John Wiley & Sons, Inc.; 1995.