ABSTRACT

The recent earthquakes in different parts of the world revealed again the importance of the design of reinforced concrete structures with high ductility. Strength and ductility of structures mainly depends on proper detailing of reinforcement. I.S.456-2000 code gives the guidelines for the design of Plain and Reinforced Concrete. I.S.: 13920-1993 code deals Ductile detailing of Reinforced Concrete Structures subject to seismic forces. However the performance of structure will differ when it is designed and detailed as I.S.: 456-2000 code and I.S.: 13920-1993 code is not quantified in the literature.

From the review of literature, the uses of fibres and mineral admixtures in concrete show great promise for improving performance with respect to ductility, stiffness, energy absorption capacity etc. To study the structural performance considering above aspects the experimental and analytical study has been taken up.

Experimental study was carried out in three phases. In the first phase the strength of partial replacement of cement by Metakaolin and addition of fibres in Plain concrete, i.e., Steel fibre as well as Polypropylene fibre was studied using the results of 108 numbers of cube size 150mm x 150mm x 150mm, 81 numbers of cylinder size 150mm diameter and 300mm height and 81 numbers of beam size 100mm x 100mm x 500mm size. Based on this, the optimum dosage of materials was found to be 10% for replacement of cement by Metakaolin, 1.5% addition of Steel fibre, 0.1% PolyPropylene fibre for fibre and mineral admixture.

Using the optimum dosage for the materials three different proportions of concrete mixes were considered to evaluate the strength characteristics of High Performance Concrete namely Mix1, Mix2 and Mix3. Mix1 represents Plain Concrete. Mix2 represents the partial replacement of cement by
metakaolin (10%) and the addition of a constant quantity of 1.5% of Steel fibre by volume to Plain Concrete, whereas the Mix3 represents the partial replacement of cement by metakaolin (10%) and the addition of a constant quantity of 0.1% of Polypropylene fibre by volume to Plain Concrete. In order to compare the performance of Mix 1, Mix 2 and Mix 3 with respect to Static Modulus of Elasticity, Static Modulus of Rupture, the results were obtained using 27 numbers cube of size 150mm x 150mm x 150mm, 27 numbers cylinder of size 150mm diameter and 300mm height and 27 numbers beam of size 100mm x 100mm x 500mm size. The above performance has been quantified using different codes such as I.S.:456, ACI-318, NZS: 3101, EC-02, BS: 8110 and Canadian Code of Practice.

In the second phase, 3 numbers of single bay two storey bare frames with IS: 456-2000 code provisions were tested using three types of mixes (i.e.,) Mix 1, Mix 2 and Mix 3. The frame was subjected to horizontal lateral force consists of cyclically applied at top storey, and beam-column joint at first floor level.

In the third phase, 3 numbers of single bay two storey bare frames with IS: 13920-1993 code provisions were tested using three types of mixes (i.e.,) Mix 1, Mix 2 and Mix 3. The frame was subjected to horizontal lateral force consists of cyclically applied at top storey, and beam-column joint at first floor level.

An analytical investigation of experimentally tested reinforced concrete bare frame as per IS: 456-2000 and IS: 13920-1993 were carried out in fourth phase of this study using Finite Element Software ANSYS and the results were discussed and compared with the experimental results. For analytical study the results of Mix 1, Mix 2, Mix 3 (Optimum dosage) were considered for input. The experimental results to that of analytical values are found to be 1.12 & 1.10 and 0.26 & 0.14 for ultimate load and initial stiffness.
for RCBF1 and RCBF2 respectively. Similarly, 1.10 & 1.14 and 0.02 & 0.11 for ultimate load and initial stiffness for SFRCBF1 and SFRCBF2 and 1.11 & 1.17 and 0.68 & 0.79 for ultimate load and initial stiffness for PPFRCBF1 and PPFRCBF2 respectively. The analytical and experimental results are correlating well.

From the present study, the addition of Steel fibre and PolyPropylene fibre along with metakaolin as per IS: 13920-1993 code detailing shows improvement in performance with respect to lateral cyclic load of bare frame when compared to I.S.: 456-2000. The improvement in performance of I.S.:13920-1993 code detailing when compared to I.S: 456-2000 code detailing was found to be 22.22% for ultimate load, 49.57% for stiffness, 7.88% for ductility factor and 12.83% for energy dissipation capacity for Mix 1, 9.09% for ultimate load, 1.14% for stiffness, 65.79% for ductility factor and 51.09% for energy dissipation capacity for Mix 2, and 22.72% for ultimate load, 55.42% for stiffness, 57.18% for ductility factor and 82.94% for energy dissipation capacity for Mix 3.

The test results of fibre models indicate better ductility and energy absorbing capacity than conventional concrete. Also, the inclusion of fibres in concrete reduces the damage against failure due to cyclic load, there by contributing better performance in structures.