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Experimental Comparison between the Plain Reinforced Concrete Beam and High Performance Reinforced Concrete Beam

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***Abstract*—** *The development of engineering materials as High Performance concrete (HPC) has got significant role in the filed of the construction of Buildings, Industrial Structures, Hydraulic Structures, Gravity dam, spillway, tunneling, power house, surge shaft, culvert, Bridges and Highways etc.. This paper presents a comprehensive coverage of High Performance concrete developments in civil engineering field. It highlights the High Performance concrete features and requirements over Normal concrete with the help of beam. Furthermore, recent trends with regard to High Performance Concrete development in this area are explored. This paper also includes effect of Mineral and Chemical Admixtures used to improve performance of concrete. An investigation on the flexural behavior of reinforced high performance concrete (HPC) has been conducted. Crushed sandstone known as reactive aggregate was used for both fine and coarse aggregates. In addition, mineral admixtures such as silica fume and fly ash combined with super plasticizer was used. The beams were made with concrete having compressive strength in the range of 56 - 60 N/mm2 and tensile reinforcement in the range of 1.34 to 3.14 %. The experimental ultimate moment was found to be about 14 - 34 % and 3 - 15 % higher than the predicted ultimate moment based on BS 8110 and ACI 318 respectively. Due to lower stiffness of reactive sandstone aggregates, the actual deflections of the beams were found to be slightly above allowable values under service loads. The observed crack widths under service loads were within acceptable limits. It was found that HPC made with crushed sandstone coarse and fine aggregate had better structural integrity. Hence, there is a high potential to produce high strength HPC using sandstone aggregates with silica fume and fly ash. Further development of self compaction concrete (SCC) and ultra high strength concrete (UHPC) is also the part of the research paper.*

***Keywords*—** *Chemical admixtures, conventional concrete, high performance concrete, mineral admixtures, self compaction concrete (SCC), ultra high strength concrete (UHPC).*

I. Introduction of the Technical Papers and Problem Identification of the Papers

The consideration of using composite beam in the construction field is becoming more important in civil engineering studies. This study is concerned with a new type of composite configuration of concrete beam where the different materials are used as per required capacity to improve in terms of constructability and material optimization. This study is focused on fabrication of the High performance reinforced Concrete (HPRC) beam. A normal reinforced concrete (RC) beam and HPRC beam with lightweight concrete enveloping arch shape high performance concrete are fabricated and tested. It observed that the HPRC beam was subjected to less displacement of 24.96% compared to RC beam in equal applied load. The further study is self-compacting concrete, the powder type SCC and the stabilizer type SCC, will be presented. Differences in the mix design and composition as well as the properties in the fresh and in the hardened state will be indicated. It is expected that of the properties of SCC are roughly similar to normal concrete (NC) – apart from the self-compacting property – this holds by far not true for UHPC. Not only the mechanical properties but also the durability of UHPC deviates significantly from normal concrete. In addition, it is expected that HPC is more sustainable than normal concrete if the ecological impact is considered in relation to the performance of the concrete.

II. Problem Identification and Preparation of Normal Reinforced Concrete Beam

(a) Problem identification: The beam dimension of 170x15x12.5 in cm were casted in lab with the mix proportion of 1 part of cement, 1.5 part of fine aggregate, and 3 part of coarse aggregate. The weight of beam was weighted as 47.28 kg which include cement, fine aggregate and coarse aggregate excluding reinforcement. The weight of the cement was taken as 8.6kg, 12.9kg as fine aggregate and 25.8 kg as coarse aggregate as well as water cement ratio was taken as 0.5, then quantity of water was added to 4.3lit. The main steel bar of 6 numbers of dia 10mm were provided with 10 stirrups of dia 8mm. The distance between each stirrups was provided as 7 cm. The Clear cover of 2.5cm was provided on sides and top and bottom of each beam. The casted reinforced concrete beams were kept for 28 days.

(b) Preparation of normal reinforced concrete beam: The materials for mixing and casting of beam were kept in dry place before placing it to the mixing plant. The reinforcement were suitably arranged from the bar binding schedule and cutting were made appropriate with the bar binders. The concrete had been prepared then bottom and sides of the frames for casting the beams were properly greased. Bottom part of the frames were filled with concrete by giving the cover of 2.5cm. Then the reinforcement were placed into the frame with the provision of the cover of 2.5cm.Concrete was filled into the reinforcement and tamping was done properly so that there should not be any voids or space created in between the reinforcement and frame. When each and every part of the reinforcement were properly filled with concrete

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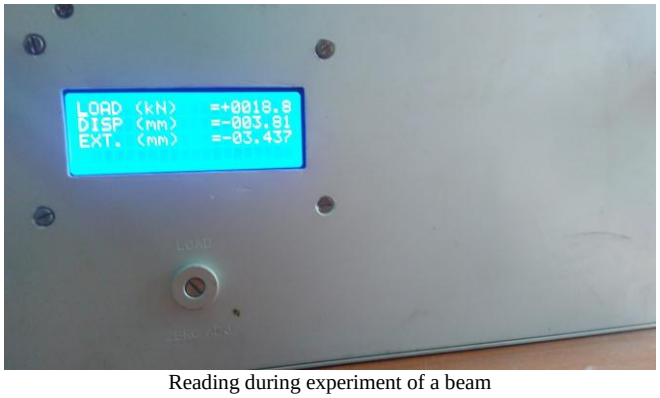
then again the top surface was given with the clear cover of 2.5cm. Top surface of the beam was kept smooth and kept it for 24hrs. After 24hrs beam had been taken out from the frame carefully without causing any disruption to the beam. Then the beam was kept into the water for curing for 28 days.

III. Problem Identification and Preparation of High Performance Reinforced Concrete Beam

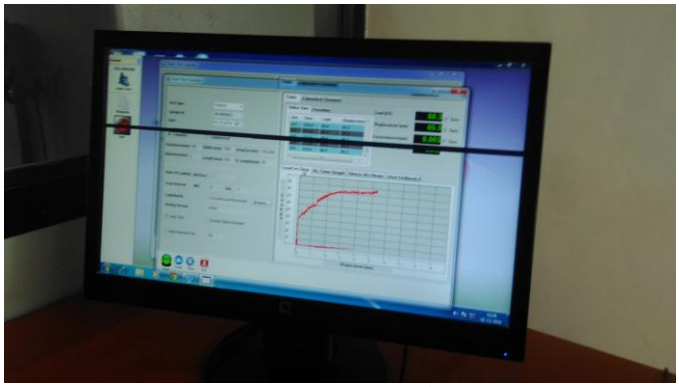
(a) Problem identification: The beam dimension of 170x15x12.5 in cm were casted in lab with the mix proportion of 1 part of cement, 2.17 part of fine aggregate, and 3.43 part of coarse aggregate. The weight of beam was weighted as 47.28kg which include cement, fine aggregate and coarse aggregate excluding reinforcement. The weight of the cement was taken as 7.16 kg, 15.5 kg as fine aggregate and 24.5kg as coarse aggregate as well as and admixtures as 400 gm of flyash, 27.5ml of HRWR, 210 gm of silica fume, water cement ratio was taken as 0.6,then quantity of water was added to 4.0lit. The main steel bar of 6 numbers of dia 10mm were provided with 10 stirrups of dia 8mm. The distance between each stirrups was provided as 7cm. The Clear cover of 2.5cm was provided on sides and top and bottom of each beam. The casted reinforced concrete beams were kept for 28 days.

(b) Preparation of normal reinforced concrete beam: The materials for mixing and casting of beam were kept in dry place before placing it to the mixing plan. The reinforcement were suitably arranged from the bar binding schedule and cutting were made appropriate with the bar binders. The concrete had been prepared then bottom and sides of the frames for casting the beams were properly greased .Bottom part of the frames were filled with concrete by giving the cover of 2.5cm. Then the Reinforcement were placed into the frame with the provision of the cover of 2.5cm.Concrete was filled into the reinforcement and tamping was done properly so that there should not be any voids or space created in between the reinforcement and frame. when each and every part of the reinforcement were properly filled with concrete then again the top surface was given with the clear cover of 2.5cm. Top surface of the beam was kept smooth and kept it for 24hrs. After 24hrs beam had been taken out from the frame carefully without causing any disruption to the beam. Then the beam was kept into the water for curing for 28 days.

IV. Experimental Set Up and Testing Methodology



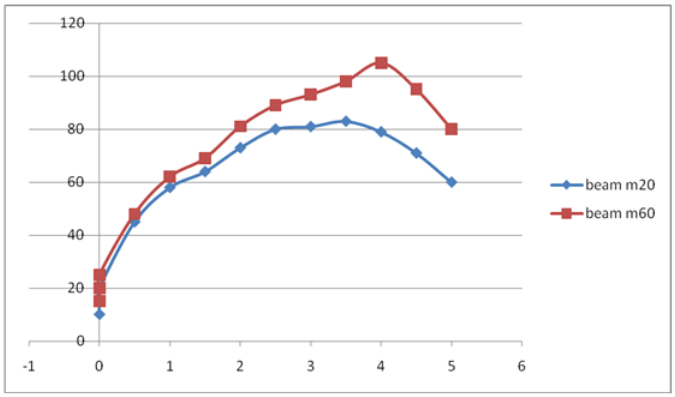
Reading during experiment of a beam



Graph between load and deflection

Cracks after applying load

V. Graphical Representation of Comparison between M20 Reinforced Concrete Beam and M60 High Performance Reinforced Concrete Beam



Load (kN) vs deflection (mm) of beam

VI. Result and Discussion

This graph was plotted between the load and deflection for M20 reinforced concrete beam and M60 high performance reinforced concrete beam.

The observations of the above graph are as under-

i. The maximum failure load for M20 reinforced concrete beam was obtained 83 KN and corresponding deflection was visualized as 3.5mm.

ii. The maximum failure load for high performance M60 reinforced concrete beam was obtained 105 KN and corresponding deflection was visualized as 4.6mm.

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iii. Thus based on above observations the high performance concrete gave higher load capacity of the beam compare to the design based on normal concrete mix. The comparison were made with normal concrete mix grade of concrete to high performance concrete mix, the deflections of the beam were obtained 4.6mm with a load carrying capacity of the beam become 1.5 times the load carrying capacity of M20 concrete beam.
iv. After using the admixture and ingredient the deflection for the M60 high performance reinforced concrete beam could resist deflection more compare to normal mix design.

VII. CONCLUSION

Comparison between M20 reinforced concrete beam and M60 high performance reinforced concrete beam
i. The maximum failure load for M20 reinforced concrete beam was obtained 83 KN and corresponding deflection was visualized as 3.5mm.
ii. The maximum failure load for high performance M60 reinforced concrete beam was obtained 105 KN and corresponding deflection was visualized as 4.6mm.
iii. Thus based on above observations the high performance concrete gave higher load capacity of the beam compare to the design based on normal concrete mix. The comparison were made with normal concrete mix grade of concrete to high performance concrete mix, the deflections of the beam were obtained 4.6mm with a load carrying capacity of the beam become 1.5 times the load carrying capacity of M20 concrete beam.
iv. After using the admixture and ingredient the deflection for the M60 high performance reinforced concrete beam could resist deflection more compare to normal mix design.

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