An Experimental View on Impact of Fire Steel Reinforcement of Concrete

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Abstract

The experimentation has been done to find out the impact of the fire on reinforcement steel bars by heating the bars to 100°,300°,600°,900° centigrade of 6 samples each. The heated samples are rapidly cooled by quenching in water and normally by air cooling. The change in the mechanical properties are studied using universal testing machine (UTM) and the microscopic study of grain size and grain structure is studied by scanning electron microscope (SEM). The general conclusion is that majority of fire damaged RCC structures are repairable. But the impact of elevated temperature above 900°C on the reinforcement bars was observed that there is significant reduction in ductility when rapidly cooled by quenching. In the same case when cooled in normal atmospheric conditions the impact of temperature on ductility is not high. By heating the reinforcement bars, the mechanical properties can be changed without varying the chemical composition.

Keywords *– Steel reinforcement, Impact study, concrete.*

I. INTRODUCTION

The specimens for testing were Sri TMT bar of 12mm diameter. 54 bars were cut to 40 cm size. 6 Specimens were tested for the mechanical properties using UTM before heating at normal temperature and the properties were tabulated. 12 specimens each were heated in the electrical furnace at 100°, 300°, 600° and 900°C for an hour without any disturbance. After heating, out of 12 specimens for each temperature 6 samples were quenched in water for rapid cooling and the other 6 were kept aside for normal cooling at atmospheric temperature. These specimens later were tested for mechanical properties with UTM and microstructure study using SEM.

II. MATERIAL AND METHODOLOGY

Following material and methodology adopted in these research work

EQUIPMENT
Universal Testing Machine
Scanning Electron Microscope
Electrical Furnace

UTM TESTING:
The 12mm steel bar is cut to a length of 40 cm and gave a gauge length of 60mm. The specimen is fixed on the machine and the required data on the computer is given. Test is conducted at a load rate of 300 kg/min for all the specimens. An extensometer is fixed to the specimen during the test to read the elongation. The data of the test is noted in computer during the test by default s it is setup. The graph of load versus deformation and load versus elongation is drawn on the computer. After the test all the other parameters like ultimate load, maximum extension in mm, area in mm^2, ultimate stress, elongation in percent, reduction in in area, young's modulus, yield stress, .1% and .2% proff stress and many other parameters can be observed.

Tensile testing
Tensile testing is performed in accordance with ASTM D-638 as well as ISO 527 combined tensile and flexural procedure. Tensile properties are the most important single indication of strength in a material. The force needed to pull the specimen apart is determined, along with how much the material stretches before it breaks. The tensile modulus is the ratio of stress to strain below the proportional limit of the material. This is the most useful tensile data as parts should be designed to accommodate stresses to a degree well below it.

2.5: SEM

Scanning Electron Microscopy has done by JSM- 6480LV at magnification of 5 microns (x5000) and 10 microns (x1000). The specimens are made in a size of 12mm diameter and 10mm length. Before testing the specimens are to be finely polished in all the edges and neatly cleaned with acetone for the clear view of the gain size and grain structure.

.2.6 Electric furnace:

The electric furnace is used to heat the specimens. The maximum temperature attained in this furnace is 1000°C. The inner depth of the furnace is 45mm. initially the furnace is heated to the required temperature by switching on it and when the required temperature is attained then 6 specimens put inside with the doo closing tightly so that no air enter inside. The specimens are kept for duration of 1 hour inside the furnace and later 3 specimens are quenched in water for rapid cooling and the other 3 are kept aside for atmospheric time. The 3 specimens which are quenched in water are removed after 15 minutes. Each time 6 bars are kept at temperatures of 100°C, 300°C, 600°C, 900°C and the same is repeated.

Results from computerized UTM are as following

Table 3.1: Properties for rapid cooing conditions

s.no	Temperature in ° C	Ultimate load (KN)	Ultimate stress (kN/mm2)	Yield stress (kN/mm2)	Max. extension (mm)	Elongation (%)	0.2% proof stress
1	Room temp 27	67.1	0.583	0.466	1.63	28.3	0.465
2	100	66.1	0.584	0.469	1.66	15	0.461
3	300	65.5	0.582	0.451	1.422	30	0.44
4	600	68.4	0.606	0.453	0.972	23.3	0.456
5	900	78.3	0.692	0.469	0.206	11.6	0.534

Table 3.2: Properties for ordinary cooing conditions

s.no	Temperature in ° C	Ultimate load (KN)	Ultimate stress (kN/mm2)	Yield stress (kN/mm2)	Max. extension (mm)	Elongation (%)	0.2% proof stress
1	27	67.1	0.593	0.466	1.63	28.3	0.465
2	100	66.5	0.588	0.448	1.139	30.2	0.455
3	300	63.7	0.571	0.436	1.12	28.3	0.429
4	600	64.3	0.574	0.484	0.76	27.45	0.449
5	900	65.5	0.585	0.465	0.62	26.6	0.437

III. CONCLUSION

Following conclusion are made

- The impact of fire on the reinforcement bars heated at various temperatures of 100° C, 300° C, 600° C, 900° C, cooled rapidly by quenching in water and normally cooled in the atmospheric temperature were studied and it is observed that the ductility of rapidly cooled bars after heating to high temperature to 900 ° C.
- Study of micro structure of the bars using Scanning Electron Microscope (SEM) also shows that the microstructure of highly heated specimens varies without varying the chemical composition which would have negative impact on the structure.

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