Review paper on Comparison of Experimental and Analytical Study of RC structural element Subjected to Elevated Temperature

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Abstract - *The present paper represents the current postulates on the behaviour of RC member subjected to elevated temperature. The selected research articles summarizes the significance of FEM analysis to predict RC beam behavior such as spalling, crack width etc. Several attempts has been done with respect RC behavior at elevated temperature. But there is a close need to evaluate the results with experimental values. It shows that spalling is mostly due to the increase in crack width and it has been occurred beyond 600^{0}C. The micro level study is required in between 600 ^{0}C and 800^{0}C, because the variation in mechanical parameters is observed. The non-linear analytical work required to validate the experimental results.*

Key Words: **Finite element analysis, Flexural response, Elevated temperature, Crack width.**

1.INTRODUCTION

Concrete structural elements come in a variety of shapes and sizes in buildings and bridges. Understanding how those elements respond during loading is critical to the success of an overall economical and safe structure. The response of structural elements is tested in a variety of ways. Experiment-based testing has been widely used to investigate individual components as well as the effects of concrete strength under loading. While this is a technique that produces real-world responses, it is time-consuming and material-intensive. Finite element analysis has also been used to test these elements. Unfortunately, early attempts to achieve this were also extremely time consuming and unfeasible due to the use of existing code and hardware. However, due to advances in information and the capabilities of design software applications, the use of Structural Analysis has increased in recent years. It is now the preferred methodology for investigating concrete structural elements. To fully comprehend the capabilities of Structural Analysis, one should remember experimental knowledge and straightforward analysis when using design software. Knowledge obtained from a Structural Analysis package isn't useful unless the necessary steps square measure taken to understand what's going on at intervals the model that's been created victimisation the code. Also, performing the required checks on the means is critical to ensuring that the software's output is valid. By comprehending the application of Structural Analysis, additional economical and higher analysis will be created to completely comprehend the response of individual structural elements and their contribution to a structure as a whole. This paper could be a study of Reinforced Beams Victimized by Finite element Analysis to learn about the response of concrete beams to cross loading. The purpose of this study is to analyse and evaluate the use of flexural and shear failure analysis and comparison to experimental results.

1.1 Literature Review

Dia Eddin Nassani et al [2020] It focuses primarily on beam deformation and stress at an equivalent size of 1500x150 x200 mm. Using software, a nonlinear FE model was developed to analyze the two hybrid RC beams. The experimentally and analytically obtained findings were compared and close associations between them were found. In addition to initial and progressive cracking of FE and experimental analyses, deflection and stress at the centreline were compared and strong associations between them were found. [1]

Chittaranjan B. Nayak et al [2020] Using software to authenticate the experimental results and numerical results such as deflection and overall load carrying capacity for the various reinforcement patterns, the beam was modeled in order to authenticate the experimental results. Finally, this analysis concluded that different modes of experimental failure were seen and the numerical results were compared. The outcome of this research is expected to be of great help to improve the structure. [2]

Sougata Chattopadhyay, et al., [2018] In this analytical study, twenty-four concrete beams of dimensions, 150 mm in width, 200 mm in depth and 1200 mm in length, reinforced with steel and GFRP, were modelled and analysed until failure under the four point bending test using the Software. Solid65 is used as a concrete model and LINK180 as a steel and GFRP reinforcement test. They were analysed using software tunder four point loading. Mid-span deflection, stress, strain and concrete failure patterns were studied for six different levels of reinforcement ratio and four different grades of concrete. [3]

Kiran Kumar Poloju et.al [2018] An elevated temperature test was performed on concrete grade cubes M20, M40 and M60, respectively. The specimens were held inside the oven and reached the necessary temperatures of 200°C, 400°C, 600°C and 800°C for constant 1-hour exposure to temperature. Specimens cooled under air-cooling and it is noted that concrete of the M20 grade had a slight increase in strength at 200 to 400°C, a drastic decrease in almost 50 percent of strength after 600°C-800°C is observed. Concrete spalling is mostly due to crack width expansion and it is observed that when concrete is exposed to 800°C, spalling begins. The color of the surface of the concrete was found to be light pink at 600°C and red-hot. At 800°C, color. Even after the concrete surface was cooled, it was found to be a faint pink colour. The magnitude of cracks reaches to 400°C and it contributes to concrete spalling at high temperatures. [4]

Tomasz Drzymała et al [2018] The test was performed on three high-strength concrete types: air-trained concrete, fiber-reinforced polypropylene concrete and reference concrete with a constant w/c ratio of 0.3. The ISO 834 standard fire curve was followed by the heat treatment process in the furnace Compressive Reference concrete strength 21 percent gain at 300°C at elevated temperature, 12.5 percent gain at 450°C and 18 percent loss at 600°C, with reference to ambient temperature strength. With increasing temperature, the flexural strength decreased and showed a 6 percent loss at 300°C. Tensile intensity increased to 300°C by 5.2 percent, with terms starting to decrease by around 8.5 percent and 57 percent at 450°C and 600°C respectively. The young high-strength concrete module decreased at a rate of 34 percent, 58 percent and 83.5 percent at a temperature of 300°C, 450°C and 600°C, respectively. [5]

Fatma Eid et.al [2017] The action of the Reinforced self-compacted Concrete Beam-Column attachment for 1 and 2 hours under standard fire was studied. 1/3rd scaled down test samples divided into three types based on the supplied reinforcement. Details of reinforcement- 4 ?? 16, 4 ?? 12, 4 ?? 12 longitudinal bars and minimum shear reinforcement for Case 1,2 and additional shear reinforcement for Case 3, respectively. The appropriate 600°C temperature is achieved in 6 minutes in the furnace and the 2018-19 Department of Civil Engineering, NIE Mysuru 9 peak temperature analysis on reinforced concrete beam subjected to elevated temperature for 1 and 2 hours was maintained. A special loading arrangement was carried out to load the specimen under fire. The temperature distribution inside the specimens was measured using a K-type thermocouple (900°C direct fire capacity), a furnace specifically designed for testing beam column connections. As the fire exposure period increased, the cracks increased and it was found that more cracks appeared on the specimen with additional stirrups than on other specimens. In case 1, the center of the specimen reached a temperature of 202°C and 428°C respectively after exposure to 1h and 2h of fire. The inside temperature of the specimens depends on the reinforcement ratio present, the temperature is high and the reinforcement is higher, and vice versa. [6]

Shamim Al Razib et al [2016] A test was performed on M15 grade concrete cubes and cylinders with and without admixture. The elevated temperatures reached in the electric furnace range from 25 to 600°C. With increased temperature, the residual compressive strength of concrete declined linearly. At 200°C, 400°C and 600°C respectively, the strength loss of normal concrete estimated 13 percent, 19 percent and 44 percent each. At 200°C, 400°C and 600°C respectively, the tensile strength loss of regular concrete was 10 percent, 15 percent and 21 percent each. There is no improvement in concrete color up to 200°C from the observation and 600°C is yellowish grey color at 400°C. [7]

Samia Hachemi et.al [2014] Test on Regular Strength Concrete (NSC) Concrete cube, High Strength Concrete (NSC) Power Concrete (HSC) and Concrete of High Value (HPC). The appropriate elevated temperatures are 150°C, 250°C, 400°C, 600°C and 900°C achieved in the oven and the maximum temperature is maintained for 60min. In NSC, there is a 15 percent loss of compressive strength between 20°C and 250°C, although only a 2.5 percent loss of strength was observed at 250°C to 400°C. 81% of strength Analysis on reinforced concrete beam subject to elevated temperature between 600°C to 900°C 2018-19 Department of Civil Engineering, NIE Mysuru 7 reduction is observed. With an increase in temperature, the residual flexural strength decreases gradually. Power decreases up to 150°C linearly, strength decrease is stable from 150°C to 250°C and decreases moderately up to 400°C. At 600°C, almost 90% loss of strength was experienced. At 900°C, a maximum of 11 percent loss of mass was observed for all specimens. The average decrease in density between 20 and 400 °C is about 8 percent for NSC and 15 percent for NSC overall at 900 °C. [8]

Chowdhury [2014] The residual compressive and tensile strength of concrete was observed after suffered for varying durations at elevated temperatures between 60-600°C. 7.42 percent of mass loss observed at 400°C under 4& 8 hours of length in concrete. 4.75 to 6.5 percent of the mass loss was observed for 4, 8 & 12 hours at 200°C. Explosive cylindrical spalling observed at 550°Cto 600°C for 8 hours for all exposure times, cylinders exploded completely beyond 600°C. [9]

Pathan et.al [2012] The residual strength of concrete grade M20 and M50 after prolonged exposure to sustained elevated temperatures ranging from 50 to 250°C for 1 hour was examined. The residual strength of concrete grade M20 increased marginally by up to 100°C and achieved 23 percent compressive strength at 150°C. From 150-250°C there was no strength loss observed. [10]

Omer Arioz [2007] The mechanical properties of concrete at elevated temperatures between 200°C and 1200°C have been studied. The four distinct concrete mixes with varying w/c ratio and coarse aggregate source source were prepared between 39 and 52 Mpa. With increases in temperature for all forms of concrete, compressive strength decreases. The decrease in strength is incremental at 600°C and a rapid decrease in strength at 600°C. The complete loss of strength is seen at 1200°C. The mass loss is about 0 to 8 percent up to 600°C and from 600°C to 1200°C; there is about 45 percent mass loss. There was no color change in the specimens exposed to 200°C. When the specimens are exposed to temperatures of 400,800 and 1000°Crespectively, straw yellow, off-white, and red appear. On samples heated to 400°C, there was no noticeable crack. The cracks are started at 600°C and up to 1000°C are increased by cracks. Excessive cracks after 1200°C exposure have been found. [11]

Fu-Ping Cheng et.al [2004] All high strength concrete losses from M75 to M85 grade concrete losses were noted. Power, with temperature rise. A 25 percent linear variance of strength loss was observed at temperatures up to 100°C. Compressive strength gain in the 100°C to 200°Crange. At 200°C, the strength loss is around 20 percent of the original strength. Temperature losses are very sharp between 400-800°C power, losses of about 55 percent and 80 percent at 600°C and 800°C, respectively. For all forms of HSC up to 400°C, the decrease in Elastic module followed the same trend, losing around 50% of its initial values. The sum does not affect the variance of the high temperature HSC elastic modulus from the experimental observation. [12]

3. SUMMARY

This study of reinforced concrete beams was conducted using finite element software applications in order to understand the response of reinforced concrete beams to transverse loading. The flexural and shear reinforcement of a reinforced concrete beam was tested to failure and the findings were compared to experimental results. The stress strain curves for Reinforced concrete of various mix proportions were developed based on the experimental results. The structural model was created with ANSYS and deformation tests were carried out. In comparison to the ANSYS software, the experimental results are more conservative.

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