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Enhancing the Properties of R.C.C. Structures against Fire

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INTRODUCTION

General

With the escalating frequency of central hearth incidents and fire-related calamities in edifices, the assessment, restoration, and rehabilitation of fire-damaged structures have emerged as a subject of significant concern. This specialized domain necessitates a profound understanding of concrete technology, material science, and testing, structural engineering, as well as repair materials and methodologies. Analytical and developmental initiatives are being pursued across these interconnected fields. Every structure is susceptible to a catastrophic event; however, it cannot simply be dismissed or abandoned as a consequence. The challenge for the technological community lies in reconstructing a functionally viable edifice following the damage inflicted by such an incident. It is imperative that we endeavor to create buildings and structures that safeguard individuals and property with utmost efficacy. The financial repercussions stemming from fires in commercial and workplace environments amount to substantial losses annually. The magnitude of such damage is contingent upon various factors, including architectural design and usage, structural integrity, fire suppression mechanisms, and evacuation protocols.

OBJECTIVE AND SCOPE OF PROJECT

To investigate the effects of fireside exposure on reinforcement bars subjected to various temperatures, followed by rapid cooling through immersion in water, and subsequently normalized by exposure to atmospheric conditions, as well as to examine the microstructural characteristics of the bars utilizing Scanning Electron Microscopy.

Effect Of Fire On Concrete:

Concrete is arguably the foremost necessary artifact, taking part in a district all told building structures. Its virtue is its skillfulness, i.e. its ability to be wrought to require up the shapes needed for the assorted structural forms. It's additionally terribly sturdy and hearth resistant once specification and construction procedures are correct. Concrete is used for all customary buildings each single construction and multistorey and for containment and retentive structures and bridges.

Concrete's thermal properties are additional advanced than for many materials as a result not solely is that the concrete a material whose constituents have completely different properties, however its properties additionally betting on wet and consistence. Exposure of concrete to elevated temperature affects its mechanical and physical properties. Parts might distort and displace, and, below sure conditions, the concrete surfaces might fragment attributable to the buildup of steam pressure. as a result of thermally induced dimensional changes, loss of structural integrity, and un harness of wet and gases ensuing from the migration of free water might adversely have an effect on plant operations and safety, an entire below standing of the behavior of concrete under semi permanent elevated- temperature exposure further as each throughout and when a thermal excursion ensuing from a postulated style-basis accident condition is important for reliable design evaluations and assessments. As a result of the properties of concrete modification with relevancy time and also the surroundings to that it's exposed, associate degree assessment of the results of concrete aging is additionally necessary inactivity safety evaluations.

Performance Of Reinforcement In Hearth:

The performance of steel throughout a hearth is known to the next degree than the performance of concrete, and also the strength of steel at a given temperature is foretold with affordable confidence. It's usually command that steel reinforcement bars have to be compelled to be protected against exposure to temperatures in more than 250-300 C^{o}. This is often thanks to the actual fact that steels with low carbon contents are known to exhibit "blue brittleness"

between two hundred and three hundred Cº . Concrete and steel exhibit similar thermal enlargement at temperatures up to four hundred Cº; but, higher temperatures can end in vital enlargement of the steel compared to the concrete and, if temperatures of the order of 700 Cº are earned, the bearing capability of the steel reinforcement are reduced to concerning 2 hundredth of its American state sign worth. Bond failure is also vital at high temperatures, as mentioned in section Physical and chemical response to fireplace. Reinforcement may also have a big impact on the transport of water among a heated concrete member, making water-repellent regions wherever wet could become unfreeze.

Effect Of Fire On Fiber Reinforced Polymers (FRP) Columns:
Koduretal. [25] conferred the results of a complete hearth resistance experiments on 3 insulated FRP-strengthened ferroconcrete columns. A comparison was created between the fireplace performances of FRP-strengthened RC columns and traditional unstrengthened ferroconcrete columns.

Data obtained throughout the experiments is employed to indicate that the hearth behavior of FRP-wrapped concrete columns incorporating applicable fire protection systems was applicable hearth protection measures into the general FRP-strengthened structural systems. Hearth endurance criteria and preliminary style recommendations for hearth safety of FRP-strengthened RC columns were additionally in brief mentioned. The performance of protected FRP-strengthened sq. RC columns at high temperatures is kind of like, or higher than, that of typical RC columns.

The results show that, though FRP systems are sensitive to high temperatures, satisfactory hearth endurance ratings might be achieved for ferroconcrete columns that were strong with FRP systems by providing adequate supplemental hearth protection. Particularly, the insulated FRP- strengthened column was ready to resist elevated temperatures throughout the fireplace tests for a minimum of ninety minutes longer than the equivalent uninsulated FRP-strengthened column.

SUMMARY

The behavior of ferroconcrete columns below extreme temperature is especially tormented by the strength of the concrete, the changes of fabric property and explosive spalling. Concrete could be a material that consists primarily of mineral aggregates certain by a matrix of hydrous cement paste. It is straightforward to repair when a fire occur and therefore helps residents and businesses recover sooner. The performance of steel throughout a hearthis known to the next degree than the performance of concrete, and also the strength of steel at a given temperature is foretold with affordable confidenc.

Experimental Work For Testing The Mechanical Properties:
The specimens for testing were Sri TMT bar of 12mm diameter. Fifty four bars were move fourty cm size. Six Specimens were tested for the mechanical properties victimisation UTM before heating at traditional temperature and also the properties were tabulated. Twelve specimens every were heated within the electrical chamber at 100°, 300°, 600° associate degreed 900°C for an hour with none disturbance. once heating, out of twelve specimens for every temperature six samples were quenched in water for speedy cooling and also the different six were unbroken aside for traditional cooling at atmospherical temperature. These specimens later were tested for mechanical properties with UTM and microstructure study victimisation SEM.

A. Universal Testing Machine
B. Scanning Electron Microscope
C. Electrical Furnace

Tensile Testing:
Understanding the fracture point is also critical, as it indicates the material's failure under stress. The point at which a material can no longer withstand tension is known as the ultimate tensile strength (UTS). This property is essential for predicting how materials behave in real-world applications. Fatigue tests may accompany tensile tests to evaluate how repeated loading affects the material over time. Furthermore, environmental factors such as temperature and humidity can significantly impact tensile and flexural properties, necessitating careful consideration when selecting materials for specific applications. Documenting all test conditions and results is imperative to ensure reliability and reproducibility in engineering design.

CONCLUSIONS AND RECOMMENDATIOS

Conclusions:

i. The impact of fireside on the reinforcement bars heated at temperature of 100°C, 300° C, 600° C & 900° C cooled quickly and it’s ascertained that plasticity of quickly cooled bars once heated at extreme temperature 900° C.

ii. Find out the changes in the mechanical properties of the bars by UTM shows that the rise in final load and reduce in proportion elongation of the specimen that means there is decrease in plasticity of the specimen.

SUGGESTIONS FOR FUTURE WORK

- The thickness of concrete cover has a useful effect in resisting elevated temperatures and makes a useful protection for steel reinforcement. So, concrete covers should not be less than 30mm.
- The building which uses to store flammable materials "gas, fuel, wood...etc" must be designed to resist loads caused by elevated temperatures.
- More research is needed in the area of " STRENGTHENING OF R.C.C. STRUCTURES AGAINST FIRE ", due to its importance and seriousness in protecting properties and lives.
- It's recommended to use pp fibers in concrete columns because of it's good contribution to axial load capacity of reinforced concrete columns under fluctuate temperature.

REFERENCES

[1] Alia F, Nadjai A, Silcock G, Abu-TairA, Outcomes of a major research on fire resistance of concrete columns, Fire Safety Journal 39 (2004) 433-445.
[2] AriozO, Effects of elevated temperatures on properties of concrete, Fire Safety Journal 42 (2007) 516-522.
[3] Balázs L.G , Lublóy É, Mezei S , Potentials in concrete mix design to improve fire resistance, Concrete Structures, 2010.
[4] Bilow D.N., Kamara M.E., Fire and Concrete Structures, Structures 2008.
[5] Chen Y.H , ChangY.F , Yao G.C , Sheu M.S , Experimental research on post-fire behaviour of reinforced concrete columns, Fire Safety Journal 44 (2009) 741-748.
[6] Chen .B , Li.C, Chen .L, Experimental study of mechanical properties of normal-strength concrete exposed to high temperatures atan early age, Fire Safety Journal 44 (2009) 997-1002.
[7] Chowdhurya E.U, Bisbya L.A, Greena M.F, Kodur V.K.R, Investigation of insulated FRP-wrapped reinforced concrete columns in fire, Fire Safety Journal 42 (2007) 452- 460.
[8] Chi-Sun poon, Salman Azhar, Mike Anson, Yuk-Lung Wong. Strength and sturdiness recovery of fire-damaged concrete once post-fire-curing. Honkong engineering school university-2000.
[9] Cooke, R.A. and Rodger, H., Principles of fireplace Investigation. 1985. Principles of fireside Investigation. Kent: Institute of fireside Engineers.
[10] Chung, J.H., Consolazio, G.R. and Mc Vay, M.C., Finite component stress analysis of astrengthened high-strength concrete column in severe fires. Computers and Structures.
[11] Concrete and Fire: victimisation concrete to deliver the good safe, economical buildings and structures. The Concrete Centre, 2004.
[12] Dr.A.Kumar, V.Kumar, Behaviour of RCC Beams once Exposure to Elevated Temperatures.
[13] Dorsch, David F. Assessment and repair of fire-damaged concrete structures Source: Innovation in Repair Techniques of Concrete Structures, p 16-26, 1993.
[14] Fletcher,I.A., Borg,A., Hitchen, N. and Welch, S., Performance of concrete in fire: A review of the state of the art, with a case study of the Windsor Tower fireplace.
[15] Fletcher I.A., Welch S, Torero J.L, Carvel R.O, UsmaniA , behavior of concrete structures in fire, THERMAL SCIENCE: Vol. 11 (2007), No. 2, 37-52.