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STRUCTURAL BEHAVIOR OF REINFORCED CONCRETE COLUMN USING DIAMOND TIE CONFIGURATION UNDER ELEVATED TEMPERATURES FOR SUSTAINABLE PERFORMANCE

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Abstract: This An total of 2,500 citizens in India die per year as a result of fire-building occurrences. Fire causes thousands of deaths and loss of property. The fire incidents across the world have been seen which results in the large amount of damage to reinforced cement concrete framed structures. Column being one of the most important loads bearing member, the whole structure fails due to the failure of the columns.RCC short c/s column 300mmX300mm with 3760mm in height, enhanced by 4 HYSD500 bars with links in diameter 25mm with 8mm ties The HYSD500 should be checked in the ANSYS programme for four leg straps and diamond strands with a load of 1700 KN and the thermal analysis should also be performed to verify the impact of columns after temperature stresses. There have been worldwide fire accidents that are causing considerable harm to buildings framed in RCC. The column is one of the largest load bearing members with fire power losses. Owing to the column collapse, the whole system is failing. In this study, the steel reinforcement of the RCC columns using diamond bonds is increased. The buildings should be built with fire prevention and post fire maintenance in mind. Many buildings suffer harm that cannot be repaired because of inadequate fire laws. ANSYS analyses the thermal analytical reaction and geometry load on columns that have four stem and diamond stem. In this study the findings with the analysis suggest that the column''s fire resistance capabilities are better than four leg stirrup columns with diamond stirrups similarly the columns can be analysed by using SFRC. Both SFRC designs increase fire-resistance capability than those without SFRC models, but all findings are concluded by the right conclusion in those models which have too little effects for diamond strips.

Keywords: Reinforced Concrete Column, Diamond Tie Configuration, Fire Performance, Fire Resistance, Stirrups.

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I INTRODUCTION

General:

This An total of 2,500 citizens in India die per year as a result of fire-building occurrences [31]. Fire causes thousands of deaths and loss of property. The fire incidents across the world have been seen which results in the large amount of damage to reinforced cement concrete framed structures. Column being one of the most important loads bearing member, the whole structure fails due to the failure of the columns.

1.1 Factors Affecting Fire Resistance Of Rcc Columns

RCC Column Energy Performance is based on content, hydraulic, mechanical, charging and construction parameters. Strength The restricting activity due to degeneration plays a vital role in RC columns' fire resistance.

- Aggregate form
- Power of concrete
- Content of concrete moisture
- Rate of fire
- Intensity and kind of loading
- Cover of cement
- Side strengthening
- Restricted
- lengthy bars
- Dimensions of the column
- Strengthening fibre
- Density of concrete

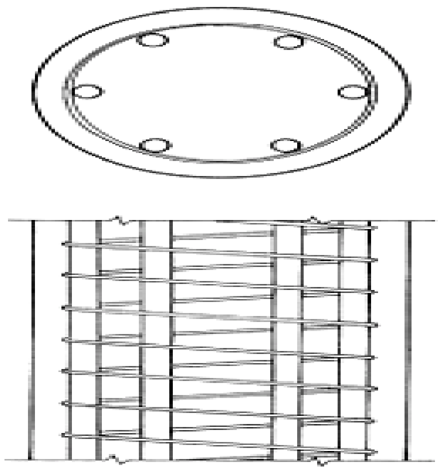
1.2 The Stirrups Commonly Found In Column Design

- Different considerations such as changeable transverse parts, the amount of longitudinal strengthening rods and the massive amount power are used to build the straps for the column. Stirrums are usually called vertical links or cross-reinforcement in the column construction.

The column construction contains the following forms of stirrups or links –

1) Helical strengthening

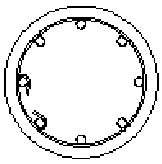
The helical reinforcement differs from the longitudinal links because the longitudinal links are separated between single links. The quantified meaning is pitches instead of just distance in helical reinforcement.



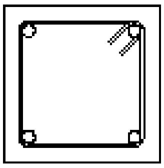
Helical Reinforcement

i) **Lateral Ties**

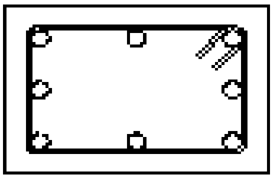
The lateral bands are used to create an independent ring within a defined distance between each bond. The side stirrings range between two-legged stirrings to four-legged or six-legged stirrups including diamond bands respectively, depending on the spine representative sample and the amount of vertical and longitudinal support bars.



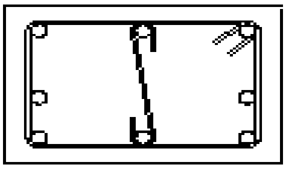
(a) Circular shaped Stirrup



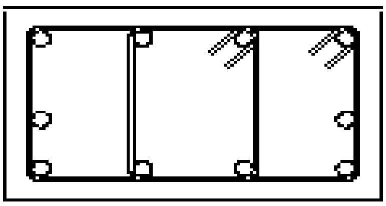
(b) Two legged Square Stirrup



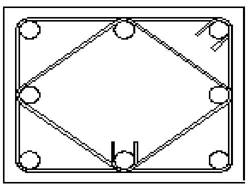
(c) Two legged Rectangular Stirrup



(d) Three legged Stirrup



(e) Four legged Stirrup



(f) Diamond tie Stirrup

1.3 Fire Performance Of Rc Columns

Different enhancement information, geometrical sections and cover specifications located in various structural construction codes for RC columns. The fire tolerance of all column configurations has been shown to be based on the dimensional, structural and loading scenarios. The reduction in transversal reinforcement spacing has also been shown to increase the fire tolerance of RC columns. The reduction in transversal strengthening of less than 100 mm does not, however, contribute to the enhancement of RC columns fire resistance.

This paper focuses on the action of RC columns with changes in the pattern of rectangular and diamond reinforcement with changes in the tie diameter. Better fire tolerance of high-fast reinforced concrete would be of economic benefit since it would hold the building intact for an extended timeframe during a fire.

1.4 PROBLEM STATEMENT

RCC short c/s column 300mmX300mm with 3760mm in height, enhanced by 4 HYSD500 bars with links in diameter 25mm with 8mm ties The HYSD500 should be checked in the ANSYS programme for four leg straps and diamond strands with a load of 1700 KN and the thermal analysis should also be performed to verify the impact of columns after temperature stresses. The models have been developed as follows.

MODEL 1	COLUMN WITH NSC
MODEL 2	COLUMN WITH HSC
MODEL 3	COLUMN WITH SFRC
MODEL 4	COLUMN WITH DIAMOND STIRRUP NSC
MODEL 5	COLUMN WITH DIAMOND STIRRUP HSC
MODEL 6	COLUMN WITH DIAMOND STIRRUP SFRC

II NEED AND SCOPE OF THE STUDY

There have been worldwide fire accidents that are causing considerable harm to buildings framed in RCC. The column is one of the largest load bearing members with fire power losses. Owing to the column collapse, the whole system is failing.

In this study, the steel reinforcement of the RCC columns using diamond bonds is increased. The buildings should be built with fire prevention and post fire maintenance in mind. Many buildings suffer harm that cannot be repaired because of inadequate fire laws.

III PROPOSED OBJECTIVES

- To determine the stress-strain relationship for RC columns at high temperature.

- To study the Reinforced concrete column and fibre steel prestressed concrete columns throughout conditions of fire.
- To research the reaction of standard hard reinforced concrete, and evaluate their structural behaviour.
- To research the impact on the structural actions of a column using a finite element model technique of the usage of a diamond connection as production support in columns in comparison with a lateral tie arrangement.

IV RESEARCH METHODOLOGY

This section describes the process process in which the planned research is carried out to determine the specified research targets. It contains the methodological information to be employed for the analysis suggested. The following measures will be taken to carry out the work:

- A 3D Finite Element (FE) dependent computational model is developed using FEM package ANSYS.
- The ANSYS component is designed to follow the reaction of the RC Columns through static elástic to fire failure phase.
- The study is conducted in small gradual times utilising a thermal-mechanical analysis technique sequentially coupled.
- Thermal load (fire exposed) is added to the column in thermal analysis with the help of a given fire scenario (duration ratios), whereby transversal temperature are calculated through solar air heater.
- The calculated pass heats are given for mechanical analysis inputs whereby, in relation to the thermal stresses, there are mechanical loading and constraints added and column axial and side displacements and axial potential are calculated.
- The analysis specifically takes into consideration the physical and chemical thermally properties of the composite material as well as due to the insulating deformations.
- The column's reaction to all potential failure limiting states is compared at each point, and the period at which a fault limiting condition is violated is taken by means of a steel reinforcement (i.e., column failure time).
- The analysis is carried until the column collapse or the completion of fire exposure.

Materials properties

Table. presents the features of the "A3" column and the actual properties of the material. It should be noted that this analysis also considered the quantity, height and diameter in other setups for the adapters. Composite Column's material properties is the following

Sr.No.	Material	Property	Value
1	Structural steel	Yield stress f_{sy} (MPa)	265
		Ultimate strength f_{su}(MPa)	410
		Young's modulus E_s(MPa)	205×10^3
		Poisson's ratio µ	0.3
		Ultimate tensile strain e_t	0.25
2	Reinforcing bar	Yield stress f_{sy} (MPa)	250
		Ultimate strength f_{su} (MPa)	350
		Young's modulus Es(MPa)	200×10^3
		Poisson's ratio µ	0.3
		Ultimate tensile strain e_t	0.25
3	Concrete	Compressive strength f_{sc}(MPa)	42.5
		Tensile strength f_{sy}(MPa)	3.553
		Young's modulus E_c(MPa)	32920
		Poisson's ratio µ	0.15
		Ultimate compressive strain e_s	0.045
4	Stud shear connector	Spacing (mm)	110
		Number of rows	2
		Numbers of connectors	68
		Yield stress f_{sy} (MPa)	435
		Ultimate strength f_{su} (MPa)	565
		Young's modulus E_s(MPa)	200×10^3
		Poisson's ratio µ	0.15
		Ultimate strain e	0.045

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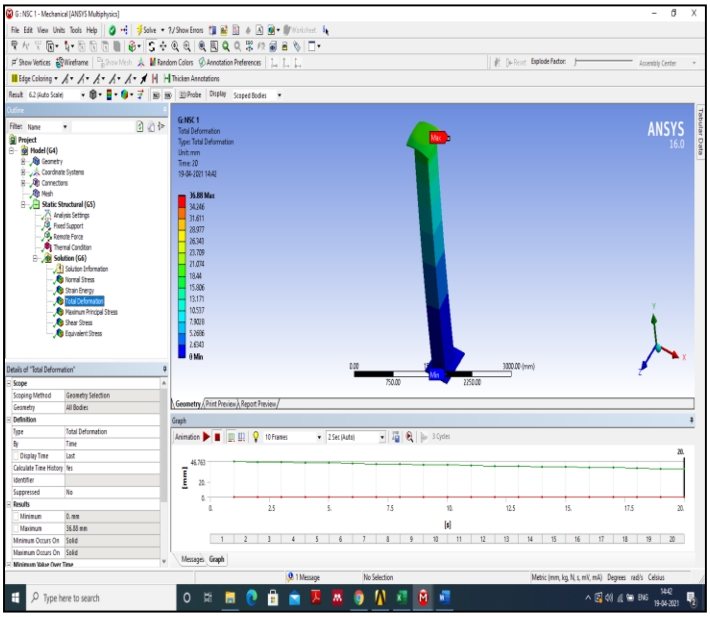
V RESULT AND DISCUSSION

Prepare Model In Ansys

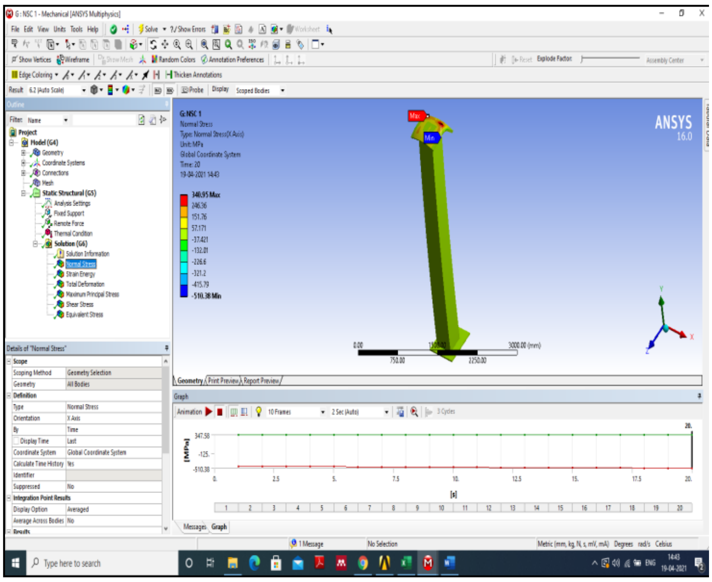
MODEL 1	COLUMN WITH NSC
MODEL 2	COLUMN WITH HSC
MODEL 3	COLUMN WITH SFRC
MODEL 4	COLUMN WITH DIAMOND STIRRUP NSC
MODEL 5	COLUMN WITH DIAMOND STIRRUP HSC
MODEL 6	COLUMN WITH DIAMOND STIRRUP SFRC

MODEL 1: COLUMN WITH NSC:

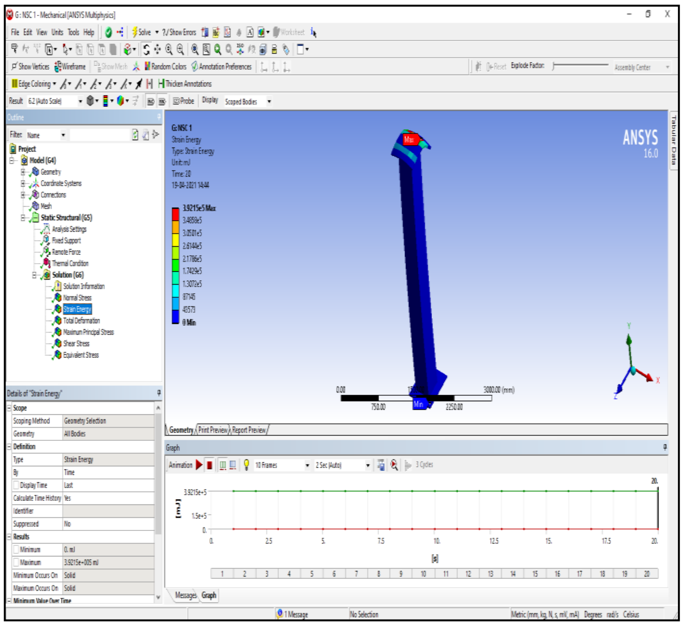
Total Deformation:



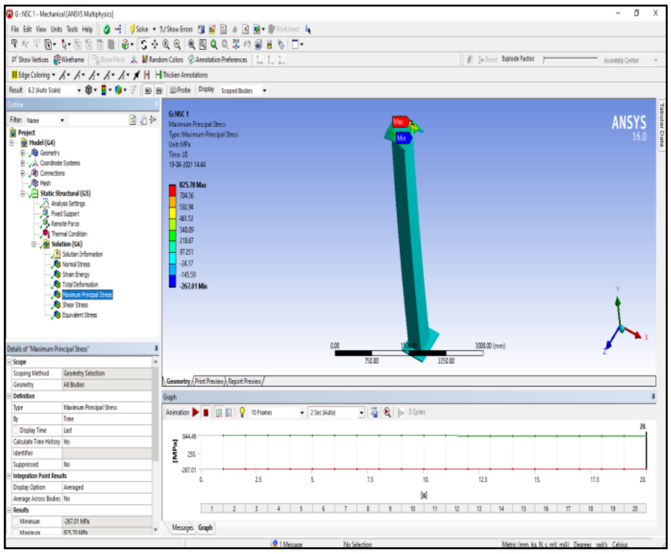
Normal Stress:



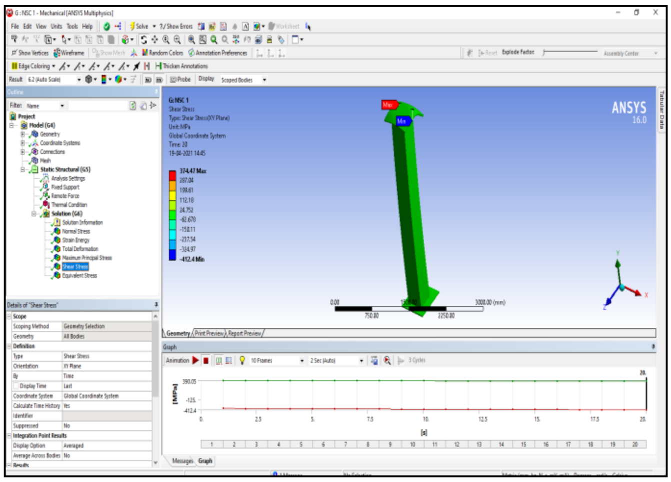
Strain Energy:



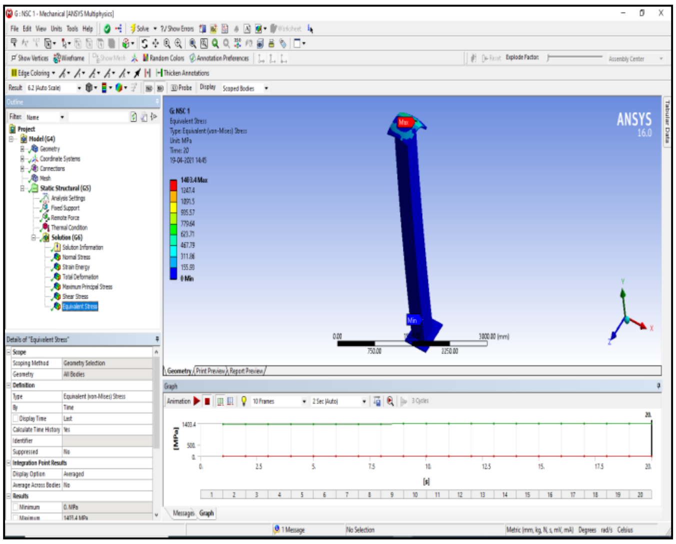
Maximum Principal Stress:



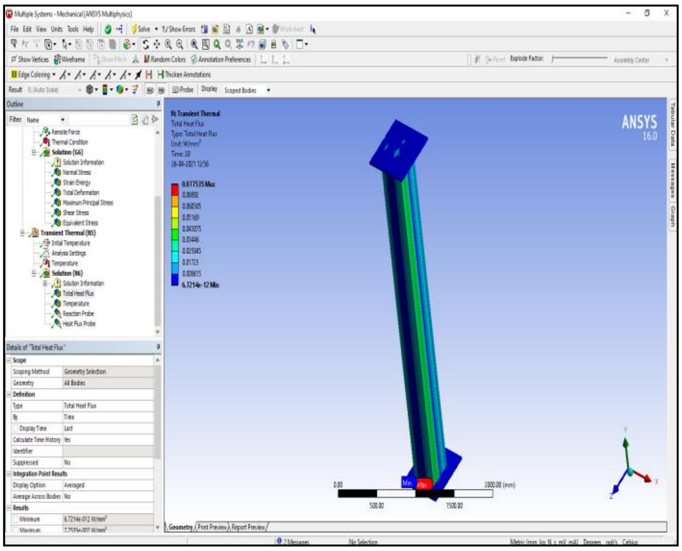
Shear Stress:



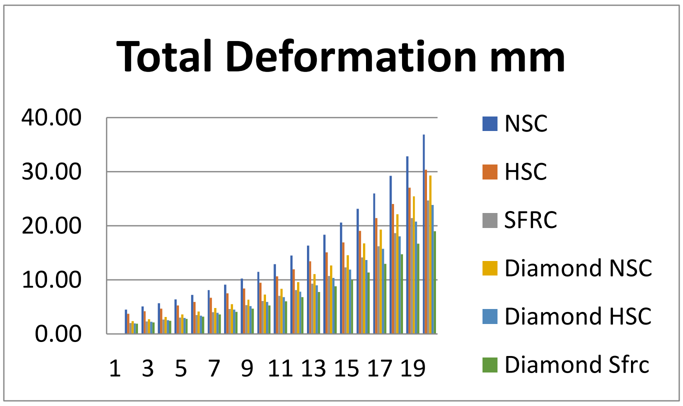
Equivalent Stress:



Total Heat Flux

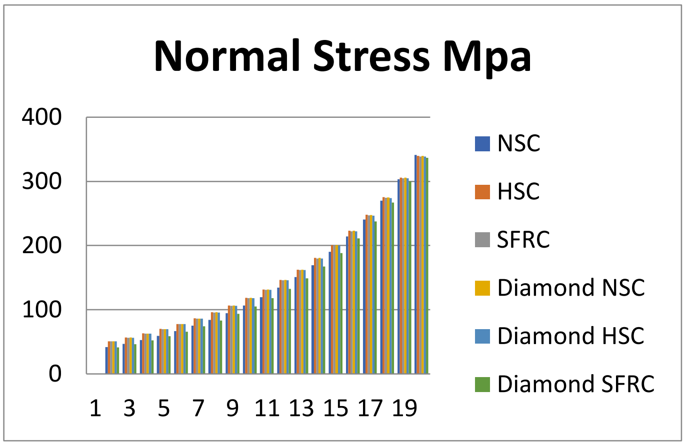


VI RESULT ANALYSIS IN ANSYS



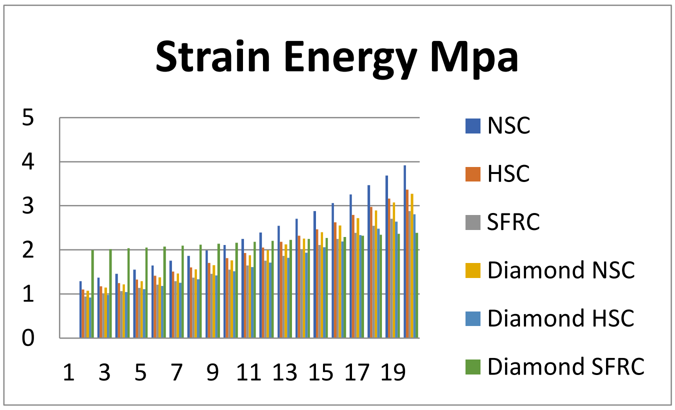
Graph.1. Total Deformation(mm)

Above graph shows the result for Total Deformation for column with four leg stirrups and diamond stirrups and it compare with SFRC results of both, from the results it conclude that Total Deformation for diamond stirrups in both condition are less than four leg stirrups than around 20-30% in both conditions.



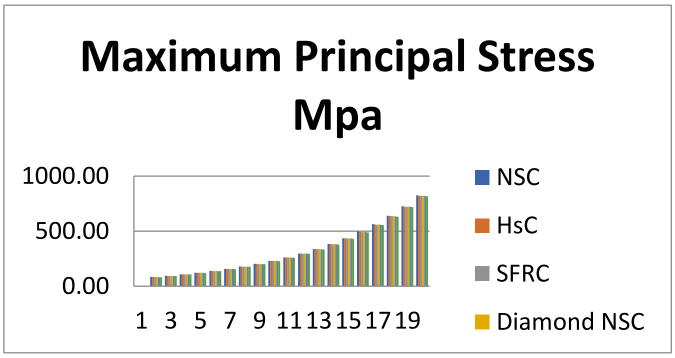
Graph.2. Normal Stress (mm)

The findings for Normal Stress for columns of four leg stirrups and diamond stiffs above diagrams demonstrate and compare them, according to the results of the two, that normal stress is less than 4 legs stiff than around 15-20% in both situations for diamond stiffs. The results show.



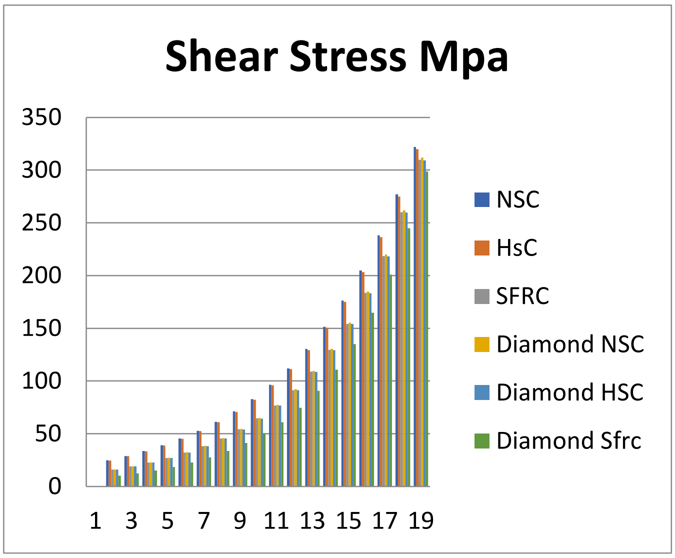
Graph.3. Strain Energy (Mpa)

Above diagram indicates the strain energy outcome of columns with four legs and diamond stirrups, and compared with SFRC findings from both columns, the conclusions infer that strain energy is less than four legs of diamond stirrups including both conditions than 15-20% in both conditions.



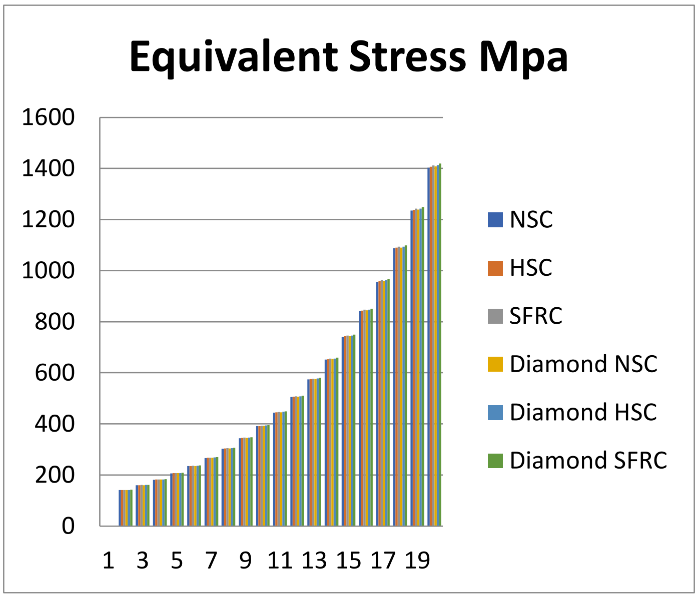
Graph.4. Maximum Principal Stress

The result for Maximum Main Stress for columns with 4 leg stirrups and diamond strains is seen below graph and it compares to SFRC results of the same, and the findings indicate that for diamond strains for both conditions the Maximum Main Stress is less than four legs stirrups than in both conditions between 10-15 p. 100.



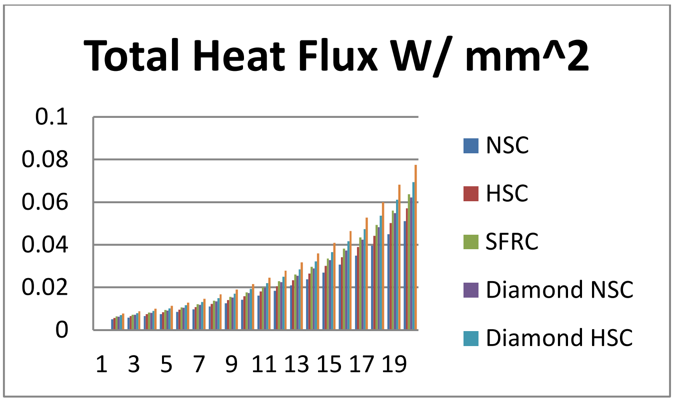
Graph.5. Shear Stress

Upon the above table, Shear Stress findings for columns with four legs and diamond strains and comparing them to SFRCs, from the results it is concluded that Shear Stress is less than four leg stems in both situations than around 10-15 percent.



Graph.6. Equivalent Stress

The above graph indicates the Equivalent Stress for columns of four leg strains and diamond strains. From its findings, Equivalent Stress for diamond strains is concluded that in both conditions, the equivalent strain for diamond strains was less than four leg strains than in both circles is around 10-15 percent.



Graph.7. Total Heat Flux

The findings showed above show the Total Heat Flux resistance ability for four leg straps and diamond straps, and compare the results in both SFRC, according to the data, for diamond straps the Total Heat Flux resistance capacity in both conditions is greater than four legs than about 20-25 percent in both conditions.

VII CONCLUSIONS

ANSYS analyses the thermal analytical reaction and geometry load on columns that have four stem and diamond stem. In this study the findings with the analysis suggest that the column's fire resistance capabilities are better than four leg stirrup columns with diamond stirrups; similarly the columns can be analysed by using SFRC. Both SFRC designs increase fire-resistance capability than those without SFRC models, but all findings are concluded by the right conclusion in those models which have too little effects for diamond strips.

- Total strain findings compared to SFRCs for column with four leg straps and diamond straps, and the results showed that the normal strain of the elastic strains of the diamonds strains was less than four leg strains in both cases than approximately 20-30 percent in both situations.
- The findings for normal column stress with four leg stirrups and diamond stirrups, according to SFR C results, suggest that total diamond stirrup distortion in both cases is less than four leg stirrups than approximately 15-20% in both cases, Result for normal stress.
- The strain energy result for columns with four leg strains and diamond strains, according to SFRC findings from both columns, results shows that the equivalent stress for diamond strains was less than four leg strains in both case, compared to about 15-20% for both cases.
- Result for the Maximum Main Stress for colume, which is compared to the findings of SFRC, with four leg strains and four diamond strains, concludes from the

conclusions that in both situations Maximum Main Stress is less than four leg strains than in the case of approximately 10-15 percent.

- The data for the Shear stress column for 4 leg strands and diamond strands and the SFRC results of both, it is concluded that for diamond strands in both cases, the maximum shear stress is less than 4 leg struts than 10-15% in both situations.
- The finding for the same stress for four-legged strains and diamond stirrups, according to the data from both the SFRC, is that, for the diamond stirring in both situations, Maximum strain shear is less than four leg strains than about 10-15 percent.
- The conclusion for the Total Heat Flux column resistant ability for four leg strains and diamond strains and the performance of both compared with SFRC, is that the Total Heat Flux resistant capacity of both sides for diamond straps is strong above four legs, compared with approximately 20-25% in both cases.

REFERENCES

[1] Kodur, V.K.R. and Lie, T.T. (1998), Fire Resistance of Fiber-Reinforced Concrete. Fiber Reinforced Concrete: Present and the Future, Canadian Society of Civil Engineers, pp. 189-213.

[2] Phan, L.T. and Carino, N.J. (1998) "Review of Mechanical Properties of HSC at Elevated Temperature" Journal of Materials in Civil Engineering, Vol. 10, No. 1, pp. 4 58-64.

[3] Kodur, V. K. R. (2000). "Spalling in High Strength Concrete Exposed to Fire-Concerns, Causes, Critical Parameters and Cures." in Proceedings of the ASCE Structures Congress: Advanced Technology in Structural Engineering, Philadelphia, Pennsylvania (PA), USA. 1-9.

[4] Kodur, V.K.R. and McGrath, R. (2001) Performance of High Strength Concrete Columns under Severe Fire Conditions. Proceedings Third International Conference on Concrete under Severe Conditions, Vancouver, BC, Canada, pp. 254-268.

[5] Kodur, V. K. R and Sultan, M. A, (2003) "Effect of Temperature on Thermal Properties of High-Strength Concrete", Journal of Materials in Civil Engineering, Vol. 15, No. 2, pp. 101 20 – 107.

[6] Suhaendi, S.L. and Horiguchi, T. (2004), "Fiber-reinforced High-strength Concrete under Elevated Temperature—Effect of Fibers on Residual Properties" Proceedings of the Japan Concrete Institute, , Kochi, Japan

[7] Naus, D.J.(2005), "The Effect of Elevated Temperature on Concrete Materials and Structures-A Literature Review." U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington (DC), USA.

[8] Shin, S., Kim, J. and Ahn, J. (2010), "Transverse Reinforcement of RC Columns Considering Effective Lateral Confining Reduction Factor" Journal of Asian Architecture and Building Engineering, 501-508.

[9] Martins, A. M. B. and Rodrigues, J. P.C. (2010), "Behavior Of Concrete Columns Subjected To Fire" University of Coimbra.

[10] Khaliq, W. (2012), "Performance Characterization of High Performance Concretes Under Fire Conditions" Michigan State University.

[11] Baolin Yu, B. (2013), "Fire Response of Reinforced Concrete Columns Strengthened With Near-Surface Mounted FRP Reinforcement" Michigan State University.

[12] Kodur, V. K. R., Khaliq, W., Raut, N. (2013). "An approach to account for tie configuration in predicting fire resistance of reinforced concrete columns" Retrieved 15 July 2020, from https://www.researchgate.net/publication/263466983

[13] Bhatt, P, Kodur, V.K.R., and Matsagar, V.(2019), "Numerical approach to evaluate elevated temperature behavior of steel fiber reinforced concrete columns." The Indian concrete journal, 8-15.

[14] Buch, S.H. and Sharma, U.K.(2019) "Improvement of fire resistance of reinforced concrete columns by using diamond tie configuration" The Indian concrete journal, 51-56.

[15] Buch, S.H. (2019) "Design of RC columns for fire resistance: Revised Guidelines" Retrieved 20 July 2020, from https://www.researchgate.net/publication/333842951

[16] ACI-216.1 (2007). "Code requirements for determining fire resistance of concrete and masonry construction assemblies" Farmington Hills, MI, American Concrete Institute

[17] Ali, F. A., N. Ali, et al. (2004). "Outcomes of a major research on fire resistance of concrete columns." Fire Safety Journal 39: 433-445

[18] Bilodeau, A., V. M. Malhotra, et al. (1998). Hydrocarbon Fire Resistance of High Strength Normal Weight and Light Weight Concrete Incorporating Polypropylene Fibres. International Symposium on High Performance and Reactive Powder Concrete. Sherbrooke, QC: 271-296

[19] Danielsen, U. (1997). Marine Concrete Structures Exposed to Hydrocarbon Fires, SINTEF – The Norwegian Fire Research Institute: 56-76.

[20] Hertz, K. (2003). "Limits of Spalling of Fire-Exposed Concrete." Fire Safety Journal 38(2): 103-116.

[21] Kodur, V. K. (1999). "Performance based fire resistance design of concrete-filled steel columns." Journal of Constructional Steel Research 51(1): 21-36.

[22] Kodur, V. K. and R. McGrath (2006). "Effect of silica fume and confinement on fire performance of high strength concrete columns." Canadian Journal of Civil Engineering 33: 93-102.

[23] Kodur, V. R. (2000). Spalling in High Strength Concrete Exposed to Fire - Concerns, Causes, Critical parameters and Cures. ASCE Structures Congress, Philadelphia, U.S.A.

[24] Kodur, V. R. (2003). Fire resistance design guidelines for high strength concrete columns, National Research Council, Canada: 1-11. 30 8

[25] Kodur, V. R. and L. Phan (2007). "Critical Factors Governing the Fire Performance of High Strength Concrete Systems." Fire Safety Journal 42: 482-488.

[26] Kodur, V. R. and M. A. Sultan (2003). "Effect of Temperature on Thermal Properties of High-Strength Concrete." Journal of Materials in Civil Engineering 15(2): 101-107.

[27] Kodur, V. R. and R. McGrath (2003). "Fire endurance of high strength concrete columns." Fire Technology- Special Issue 39(1): 73-87.

[28] Kodur, V. R., F. P. Cheng, et al. (2003). "Effect of Strength and Fiber Reinforcement on the Fire Resistance of High Strength Concrete Columns." ASCE Journal of Structural Engineering 129(2): 253-259.

[29] Tan, K.H., & Nguyen, T.T. 2013. “Structural responses of reinforced concrete columns subjected to uniaxial bending and restraint at elevated temperatures”. Fire Safety Journal 60: 1–13.

[30] Martins, A.M.B., & Rodrigues. J.P.C. 2010. “Fire resistance of reinforced concrete columns with elastically restrained thermal elongation”. Journal of Engineering Structures 32: 3330–3337.

[31] NCRB, “Technical report”, National Crime Records Bureau, Delhi, India, 2016.

[32] Buch, S.H. and Sharma, U.K.(2017) “Fire Resistance of Reinforced Concrete Columns:A Systematic Review” DOI: 10.1201/9781315107202-17. Applications of Fire Engineering – Gillie & Wang Taylor & Francis Group, London, ISBN 978-1-138-09291-4.