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A Review of the Concrete Performance at Elevated Temperature Mixed with Rice Husk and Polypropylene Fibre

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Abstract: This paper deals with the effect of addition of various proportion of polypropylene (PP) fibre and rice husk on the properties of concrete. A lot of experiments were conducted by different authors to explore the effect of raw rice husk and PP fibre and rice husk on tensile, compressive, flexural strength under different temperature condition. The objective of these experiments was to study the effect of polypropylene fibre and raw rice husk at different varying content and to find the optimum content of such admixtures. Concrete specimens were tested at different curing level to check mechanical properties of concrete. A detailed study was carried out at different high temperature conditions. Result shows polypropylene fibre provide a scape matrix to scape excess vapour pressure developed at higher temperature along with reinforcing properties. Rice husk works as a great insulating agent and also enhances the inert properties of concrete. With the various advantages and disadvantages of PP fibre and RRH, this paper is focusing on how there can be an establishment of a certain proportion which makes concrete thermally insulated maintaining higher strength.
Keywords: Raw Rice Husk, Thermal insulation, mechanical properties, polypropylene fibre, elevated temperature.

I. INTRODUCTION

Infrastructure are gigantic structures that helps mankind to overcome some ferocious natural hazards. It is very easy to understand that any infrastructure requires a number of materials for its construction. Humankind is witnessing a revolution in the field of chemical technology. The knowledge of chemicals and their proper usage are necessary to use them as tools at various works related to infrastructures.

Common materials required to develop any infrastructure are various forms of iron i.e. (like steel, cast iron, manganese steel etc.) and cement (in concrete mix form). It is evident that scientists have developed the methodologies for appropriate use of Iron and its by-products, but still lacking the knowledge to develop the concrete which will be durable in case of extreme environment like fire hazards, chemical reactions etc. so there is a necessity to develop the concrete so as to make the concrete durable to sustain the extreme environments like fire.

To make the concrete durable against fire it is required to develop such condition inside concrete where extreme heat produced by fire doesn't affect the concrete structure. As it is not possible to control the heat generated because of fire, the concern will be to provide thermal insulation to the concrete structure from the various methods of thermal insulation. One is the use of admixtures (like Poly Propylene Fibres, Raw Rice Husk etc.) in concrete mix. These adulterants are believed to impart insulation properties in concrete against fire hazard.

Numerous examinations have indicated that utilizing polymer strands, for example, polypropylene (PP) as an added substance in cement is an effective strategy to forestall disintegration in cement. Numerous examinations have indicated that utilizing polymer filaments, for example, polypropylene (PP) as an added substance in cement is an effective strategy to forestall spalling in cement. Polypropylene strands liquefy at about 160°C and give micropores that permit emptying the fume, easing the inward weight inside cement and forestall unstable spalling and loss of cross area [2].

This paper is focused to study the previous research and experiments conducted by researchers to understand behaviour and effect of raw rice husk and polypropylene fibre.

II. LITERATURE REVIEW

Many research work and experiments have been done to study the physical, mechanical and thermomechanical properties of concrete. some of the research works summarized below:

A. Literature Review on Raw Rice Husk

1) *Nabi Yuzer, Zekiye Cinar, Fevziye Akoz, Hasan Biricik, Yelda Yalcin Gurkan, Nihat Kabay, Ahmet B. Kizilkanat (2013)* Polypropylene (PP) fibre is added in concrete to prevent spalling of concrete when it is subjected to elevated temperature. But PP fibre is very harmful to human health because when it burnt it generate harmful gases. In this study, raw rice husk is added in normal strength concrete instead of PP fibre.RRH reduce vapour pressure as well as release a smaller number of harmful gases. Four different RRH containing specimens were exposed to 300^{o}C,600^{o}C and 900^{o}C. The result shows RRH decrease the density of concrete and porosity has increased and this results in a small decrease in compressive strength. Due to the heating of concrete large amount glassy and amorphous phase generated o the surface of RRH and it retard transfer of oxygen to the inner layer of RRH.crystallinity of RRH decreases and structures seems to be more amorphous. Due to this phenomenon, there is no decrease in the surface area of RRH in concrete with the increase in concrete temperature. Use of RRH help to increase durability but also decrease some amount of strength and also generate a smaller number of hazardous gases [3].
2) *Morgan Chabannes, Jean-Charles Bénézet, Laurent Clerc, Eric Garcia-Diaz (2014) in* this paper author said: "Since the building sector affect the natural environment too much, so the development of eco-friendly concrete materials using plant-based aggregates should emerge as high as a priority". In this paper, hemp concrete has made out of hemp Hurds mixed with a lime-based binder material. Hemp concrete can replace usual systems based on concrete blocks and mineral wool. In this way, this material qualifies as a multifunctional material which is an efficient way related the energy conservation and the building envelope optimization. In this study, the author carried out some test for the development of an insulating concrete having use of rice husk. Experiments are performed to check the physical and structural properties of plant-based aggregates, specimens made out of whole rice husks and a lime-based binder which is manufactured by mixing and mechanical tamping. Thermal as well as mechanical properties of the final concrete materials have studied and compared with the hemp concrete designed with the same process. The author found that for the same binder on aggregates mass ratio, the target dry density of rice husk concrete is inevitably higher than those of hemp concrete due to the different physical as well as morphological properties of rice husk. Thermal characteristic test results show that rice husk concrete can easily alter hemp concrete in terms of thermal insulation. its dry thermal conductivity ranging from about 0.10 W/mK to 0.14 W/mK but it depends on the mix proportion. Compression test results on a defined mixture found that mechanical performances for rice husk concrete with an average compressive strength of 0.33 ± 0.03 MPa at 60 days which is little less than hemp concrete (0.48 ± 0.02 MPa for hemp concrete). finally, the author reached the context this composite material is a new eco-friendly building material which has been developed by using local rice husk as a vegetable aggregate and a lime-based binder. Moreover, the use of rice husk as a lightweight insulating material like hemp is an innovative idea. the investigations have also been laid on hemp concrete from the characterization of the plant aggregates to the final properties of the concrete materials with the purpose to compare newly developed concrete composite based on rice husk with hemp concrete. As compare to rice husk and hemp Hurd the characterization of the natural particles has shown completely different. Rice husk concrete has a greater density than hemp concrete. Since the rice husk has less porous than hemp herd, however, rice husk concrete shows good thermal properties. There is a strong link between millimetric porosity and thermal characteristic like conductivity. Millimetric porosity generated in concrete material manufactured with low B/A mass ratio. Since the carbonation process plays an essential role in the plant-based aggregates concretes, further work are in process to monitor the mechanical strength in a longer-term. The evolution of mechanical characteristics of LRC and LHC were compared time to time, the author saw that it is possible to evaluate and situate the influence of the carbonation process (linked to the initial degree of porosity within the concrete) with other parameters which may affect the mechanical strength. In this respect, to improve the mechanical properties of this new material by intervening on lime carbonation should be continued.
3) *Busra Akturk, Nabi Yuzer, and Nihat Kabay(2015)* In this study, to prevent spalling, improve mechanical, physical, and thermophysical properties of concrete the usability of raw rice husk (RRH) instead of polypropylene fibres (PP) in high-strength concrete after the exposer of high temperature was studied. Carbon dioxide (CO2) and carbon monoxide (CO) emissions of the concrete specimen were also observed at different high temperatures. After the test Author concludes that when RRH is used at 3% of cement by weight can make concrete safe from sudden spalling and can be an alternative option to polypropylene. RRH has better thermal conductivity than PP fibre so it can easily replace PP fibre. But the main drawback of the addition of RRH that is slightly decreased the mechanical properties of the concrete. RRH improve concrete thermophysical properties by decreasing thermal conductivity and the vapour diffusion resistance factor. Up to 300°C, RRH and PP fibre emit

the same amount of CO & CO_2 in some cases lower than those of the PP mixes. At 600°C, the CO_2 and CO emissions of the RRH mixes were higher than those of the PP mixes.

The author found that the combination of a lower amount of RRH and PP might help produce a more sustainable green concrete with a lower amount of harmful gas released when it exposed to fire and with improved thermal characteristics (lower thermal conductivity and VDRF). Based on the test results, mainly following conclusions can be drawn:

a) As the temperature increased, explosive spalling occurred in the reference concrete specimen at 425°C and in the concrete containing 0.5% and 1.5% it was 455°C.However, in all of the PP fibre mixed specimens, explosive spalling was completely prevented.

b) Due to increasing in the temperature a significant decrease in the mechanical properties of all of the concrete series. Also, when it compared with the PP fibre containing mixes, the addition of RRH slightly decreased the mechanical properties of the concrete.

c) Increase in temperature also modified the void content and water absorption of the concrete. They increase due to increase in temperature.

d) The use of RRH improve the thermal and physical properties of concrete. Since the RRH had a lower thermal conductivity, the mixes with RRH possessed a lower thermal conductivity at a higher temperature compared with the PP fibre mixed concrete.

e) At 300°C, the specimen containing RRH 0.5% and 1.5% (%by weight of cement) showed better thermal and physical characteristics when compared with the PP fibres mixes. But At 600°C, the emission of CO_2 and CO of the 3% RRH containing mix were higher than those of the mixes that contained PP fibre. At 900°C, the CO_2 emission values of all of the mixes found the same [5].

4) *Ling Qin, Xiaojian Gao, Tiefeng Chen (2018) production* of Portland cement induce alot of environmental pollution. Hence to reduce this pollution and eliminate the solid wastes from the agriculture industry, the author developed lightweight building material based on incorporating raw rice husk and foam bubbles in magnesium oxysulfide cement paste. Bulk density, mechanical strength, thermal conductivity and drying shrinkage of this material tested and phase composition, air bubble distribution and microstructure have also studied on typical specimens by using XRD (X-ray diffraction), FTIR (Fourier transform infrared spectroscopy), OM (Opto-digital microscope) and SEM (scanning electron microscope) facilities. from the test result author concludes that compressive strength, thermal conductivity and bulk density has decreased. Compressive strength of this composite material at 28 days decreases from 70.4 MPa to 1.1 MPa when the bulk density ranges from 1722 kg/m3 to 450 kg/m3, being superior to traditional lightweight aggregate concretes. Drying shrinkage decreases with the inclusiveness of the foam bubble and with the addition of raw rice husk it increased. As an observation of test results author recognized that Magnesium oxysulfide cement has a lower tendency to impact on the environment than OPC because OPC manufactured at very high temperature (1400-1600oC). And also, the amount of CO_2 generated during the manufacturing of MgO has successfully reabsorbed by magnesium hydroxide (the hydration product of the magnesia cement). So according to author MOS cement has an efficient eco-friendly alternative in the building industry. In the residential building lightweight material has been used very extensively and as a result, a significant reduction in self-weight occurs and thermal and acoustic insulation also improved. In this research, raw rice husk foam bubble is inclusive to manufacture magnesium oxysulfide cement-based building material. According to the experimental results, the author has succeeded to make a good exponential relationship between compressive strength and bulk density linear relationship between bulk density and thermal conductivity. Foam bubble can easily decrease Drying shrinkage and is increased by raw rice husk. For mixtures containing both foam bubbles and rice husk, drying shrinkage increased due to the dosage of foam bubbles exceeds a threshold level. drying shrinkage exponentially increases with the more mass loss due to the addition foam bubble and rice husk. Foam bubbles and rice hush has also influenced the hydration products of MOS cement. The interfacial transition zone between rice husk and MOS cement matrix has also improved by conical protrusion morphological feature of rice husk surface. This developed material fulfils all the trend of sustainability, low-carbon emission and energy conservation by making green building materials in the construction industry. It can very easily replace conventional inner partition walls and thermal insulating components of buildings [6].

B. Literature Review on Polypropylene Fibre

1) *Albert N. Noumowe, Rafat Siddique,G. Debicki (2009)* to check durability of high performance concrete permeability is one of the main parameter. Permeability is directly related to spalling of concrete at higher temperature. So generally, permeability is not tested at elevated temperature condition and also not measured on thermally damaged test sample. In this paper experiments are carried out to and result explain effect of elevated temperature on the permeability of high-performance concrete. To conduct this experiment three difference proportion of concrete has prepared, 1. Controlled high-performance concrete,2. HPC containing polypropylene fibres,3. HPC mixed with light weight aggregates. Heating and cooling process on a cyclic manner was applied on different cylindrical specimens. Author tried to kept test temperature either 200 or 600^{o}C. After the exposure of heat 65 mm thick slices has cut from each cylinder and after daring and cooling specimens are put to permeability test. In this paper result obtained from thermal gradient in concrete specimen during thermal exposure, compressive strength test and splitting tensile tests are shown. Author also represent a relationship between thermal destruction and permeability [7].
2) *M. Mastali, and A. Dalvand (2017)* In this paper author have done a lot of tests on fresh and hardened properties of self-compacting concrete reinforced with hybrid polypropylene (PP) fibre and recycled steel fibre (RSF) in various fibres volume mixes. For the experiment steel fibre recovered from useless tyres of vehicles. The mix combination has reinforced with different fraction of hybrid recycled-steel fibre (0.35, 0.7, and1.05%) and polypropylene fibre (0.35and0.7%). The fresh concrete mix compositions have assessed by using a lump flow diameter, T500, and Tv. Also, the hardened properties of test samples have defined by using flexural strength, compressive strength and impact resistance. Regression analysis was attempted on the relatively large amount of collated experimental data to correlate characteristic of fresh and hardened phase of self-compacting concrete reinforced with hybrid steel–PP fibres. The results showed that by the addition hybrid recycled steel–PP fibre enhanced the impact resistance and mechanical characteristic. Adding recycled steel fibre led to higher improvement in the compressive strength compared to PP fibre. Moreover, increasing the proportion of PP fibre mitigate the effect of recycled steel fibre in improvement of flexural strength. Increased flexural strength is due to addition of recycled steel fibres is reduced when pp fibres content is increased. Flexural strength and impact resistance can correlate linearly to compressive strength with a coefficient of determination higher than 0.86. addition of PP fibre increases rate of impact resistance. Its highest value was noted in sample reinforced with 0.7% recycled steel fibre moreover, due to addition of PP fibre, the maximum rate of increase in bending and compressive strengths was noted in test sample that did not contain recycled steel fibre [8].
3) *M. A. Dalhat, Ph.D. and H. I. Al-Abdul Wahhab (2017)* in this paper author formulate polyproline fibre and Thermoplastic recycled polystyrene to and make a composite concrete by thermal curing. Physical characteristics mechanical properties thermal susceptibility, healing efficiency of cracks due to thermal destruction have evaluated with respect to Portland cement and asphalt concretes (ACs). The polystyrene mixed samples show better compressive strength which is higher than that of ACs polyproline fibre mixed concrete, approximately three times better that of the ACs, which is similar to the strong PCC. Experimental studies shows Thermoplastic recycled polystyrene concrete shows the highest bending strenght,more than the ACs and twice as rigid as the PCCs, while recycled PP fibre bounded concrete has stiffer than the ACs. The recycled polystyrene concrete shows flexural strength greater than both the PCCs and the ACs, and the recycled PP fibre mixed concrete exhibits approximately three times and five times flexural strength of the PCC and ACs respectively. A assessment test was proposed to test crack-healing efficiency. Results exhibits that crack are successfully repaired by in thermoplastic recycled plastic concretes (TRPC). The recycled PP fibre mixed concrete and polystyrene based concrete shows better moisture resistance and very less thermal sensitivity than the ACs. Appropriate aggregate gradation, standardized method of determining optimal content in mix design, and performance tests like fatigue and rutting tendencies, these are some test which are also recommended for study on the TRPCs [9].
4) *Wasim Khaliq and Venkatesh Kodur (2018)* in construction industry Fire-induced spalling is one of the major concerns so author tried to use of high-strength concrete (HSC) in structural applications. To overcome such spalling previous studies, suggest use addition of polypropylene and or steel. In paper author present various test results from fire resistance tests on HSC columns with and without FRP. Four test specimens were made of HSC with standard mix (without fibres), polypropylene fibres, steel fibres. Along with these test samples a conventional normal strength concrete (NSC) has also tested on fire condition. Test result from these samples is helped to analyse comparative behaviour of RC columns made of plain and fibres mixed concrete. In addition, to check out relative change void percentage and temperature induced pore pressure in NSC and HSC and its consequences on spalling effect due to fire in HSC column. Experimental result shows that hybrid-fibre-reinforced HSC column shows better performance compared to polypropylene steel fibres and standard HSC column. Author recognised that due to addition of polypropylene fibre in HSC fire induced spalling mitigates, it happened because of polypropylene fibre

melts at high temperature and then interconnected path were created to expel excess vapour pressure. Steel fibre increase tensile strength of HSC and in case of elevated temperature it slow down the degradation of of concrete, it is helpful to mitigate pore pressure related tensile stresses in reinforced concrete column. According to author this numerical approach capable of predicting temperature generated excess pore pressure and fire induced spalling in reinforced concrete columns made of different types of concrete and fibre combinations [10].

5) *José D. Ríos1,Héctor Cifuentes, Carlos Leiva, Celia García and María D. Alba (2018)* In this study analysis has done to use of high-performance structural concrete reinforced with polypropylene fibres in applications requiring long exposure times to high temperatures, such as thermal energy storage systems. We analysed the behaviour of the concrete at different temperatures (hot tests: 100°C, 300°C, 500°C and 700°C), cooled-down states (cold tests) and exposure times (6, 24, and 48 h). We also experimentally determined the thermogravimetric analysis, fracture behaviour, compressive strength, young's modulus, and tensile strength of concrete. Subsequently, we performed a comprehensive analysis of the thermal and mechanical behaviour of high-performance concrete under different thermal conditions. We applied longer exposure times to broaden the available results on the behaviour of high-performance fibre-reinforced concrete when subjected to high temperatures. Results show that, once thermal and moisture equilibriums are reached, exposure time does not have any influence on mechanical properties. They also provide useful information about the influence of high temperatures on the different parameters of fibre-reinforced concrete and its application for thermal energy storage structure. In this study, author explored the effects of temperature on the fracture behaviour and other mechanical properties of high-strength polypropylene fibre-reinforced self-compacting concrete, at a range of temperatures up to 700°C and after cooling at three different exposure times. The conclusions drawn from the results that the irreversible process of weight loss increases with higher temperatures. This process involves dehydration of residual moisture at low temperatures, dehydration of chemically bound water at medium-high temperatures, and decarbonation of calcium carbonate at higher temperatures. The addition of fibres creates a network of channels in the matrix that reduces internal pressure damage and spalling effects. However, it also reduces material strength at room temperature due to the increased number of pores created by the trapped air. As long as fibres are not degraded, the they have a bridge effect on the crack front that stitches any eventual microcracking. This improves the strength properties and ductility of the concrete in both hot and cold conditions. Longer fibres reduce the effects of spalling and create a greater network of channels for the evaporation of internal pressure. Yet, they also increase the number of voids in the matrix, which in turn reduces its mechanical properties and causes a softening of the material. The cooling process generates microcracking due to the thermal gradient that is more noticeable from medium-high temperatures, where this thermal gradient is more abrupt, and the fibres are partially melted. These harmful effects add to those sustained during the heating process. When the thermal gradient is more gradual, the cooling process does not cause significant damage, and the fibres help to stitch any microcracking. This leads to higher mechanical properties. Exposure time has no effect when the temperature is uniformly reached in the entire matrix. From that point, the behaviour of concrete is the same regardless of the length of time the specimens are exposed to the temperature [11].

C. Literature Review on Thermal Conductivity

1) *Venkatesh Kodur and Wasim Khaliq (2011):* The knowledge of high temperature thermal properties is critical for evaluating the fire response of concrete structures. This paper presents the effect of temperature on the thermal properties of different types of high-strength concrete (HSC). Specific heat, thermal conductivity, and thermal expansion are measured for three concrete types, namely, HSC, self-consolidating concrete (SCC), and fly ash concrete (FAC), in the temperature range from 20–800°C. The effect of steel, polypropylene, and hybrid fibres on thermal properties of HSC and SCC is also investigated. Results from experiments shows that SCC possesses higher thermal conductivity, specific heat, and thermal expansion than HSC and FAC in the 20°C–800°C temperature range. Data generated from tests is utilized to develop simplified relationships for expressing different thermal properties as a function of temperature. The proposed thermal property relationships can be used as input data for evaluating the response of concrete structures under fire conditions. Temperature has significant influence on thermal conductivity, specific heat, and thermal expansion of HSC, FAC, and SCC. The thermal conductivity generally decreases with temperature, while the thermal expansion increases with temperature up to 800°C. However, specific heat remains almost constant up to approximately 400°C, and then increases up to approximately 650°C before following a constant trend in the 650–800°C range. The addition of steel, polypropylene, and hybrid fibres to SCC or HSC does not significantly alter the thermal conductivity. However, the addition of fibres increases the specific heat of SCC and HSC in the 400–800°C temperature range. In the case of thermal expansion, the addition of fibres to SCC increases thermal expansion in the 400–800°C range, while in case of HSC, the addition of fibres decreases the thermal expansion in the 20–800°C range [12].

2) *Marcus Achenbach, Tom Lahmer, Guido Morgenthal (2017):* The fire resistance of concrete members is controlled by the temperature distribution of the considered cross section. The recalculation of laboratory tests on columns from TU Braunschweig shows, that there are deviations between the calculated and measured temperatures. Therefore, it can be assumed, that the mathematical formulation of these thermal properties could be improved. A sensitivity analysis is performed to identify the governing parameters of the temperature calculation and a nonlinear optimization method is used to enhance the formulation of the thermal properties. The proposed simplified properties are partly validated by the recalculation of measured temperatures of concrete columns. These first results show, that the scatter of the differences from the calculated to the measured temperatures can be reduced by the proposed simple model for the thermal analysis of concrete. The sensitivity analysis reveals, that calculated temperatures at the surface are highly sensitive against the uncertainty of the gas temperature and the model uncertainty. Both uncertainties can be hardly reduced. The influence of the uncertainty of the material properties increases with the distance to the surface. Hence the uncertainty of the calculated temperatures can be reduced by improved material properties. It can be shown, that it is possible to fix the density and the specific heat to constant values and to consider only the thermal conductivity λ as temperature dependent. The applied methods lead to a simple, piecewise linear function for λ. The obtained results of the calibration and validation are encouraging for further simplifications, it is not clear, if the proposed values are valid for all dimensions and types of concrete cross sections like beams and hollow core slabs. It must be pointed out that only one slab with a thickness of 10 cm has been used for optimization and that the results of the validation are limited to tests on columns from two laboratories. Therefore, the proposed methodology should be applied to a bigger number of laboratory tests. Also the effect on the fire resistance and the mechanical behaviour of the considered member needs further investigation [13].
3) Venkatesh Kodur, Srishti Banerji, and Roya Solhmirzaei (2020) Data on temperature-dependent thermal properties of concrete are critical for fire-resistance evaluation of concrete structures. This paper presents the effect of temperature on thermal properties of different types of ultrahigh-performance concrete (UHPC). A set of thermal property tests were carried out on UHPC specimens in the 20°C–800°C temperature range for measuring thermal conductivity, specific heat, mass loss, and thermal expansion. The test variables included type of UHPC [with steel, polypropylene (PP), and hybrid fibres]and temperature range. Data from the tests were used to evaluate the effect of temperature on thermal conductivity, thermal expansion, specific heat, and mass loss variations in UHPC. Furthermore, the measured test data were utilized to propose relations expressing each thermal property as a function of temperature. The proposed relations can be used as input data for evaluating fire resistance of structures fabricated with UHPC. In addition, high-temperature thermal properties of UHPC were compared with those of conventional normal-strength concrete (NSC) and high-strength concrete (HSC). Data from these tests show that temperature has a significant influence on the thermal properties of UHPC, while the presence of steel or PP fibre reinforcement has very little influence on the thermal properties of UHPC. Also, the thermal conductivity and thermal expansion of UHPC is slightly higher and mass loss and specific heat are lower than that of NSC and HSC in the 20°C–800°C temperature range. Based on the results obtained from the study presented in this paper, author conclude that temperature has a significant effect on thermal conductivity, specific heat, thermal expansion, and mass loss properties of UHPC. Moisture content and batch mix composition of UHPC, specifically volume of cement paste, aggregates, and mineral admixtures, govern the variation of thermal properties of UHPC at elevated temperatures. The thermal conductivity of UHPC generally decreases in the 20°C–400°C range and increases in the 400°C–700°C range. All three types of UHPC (plain, UHPC-S and UHPC-H) experience an overall mass loss of about 7% in the 20°C–750°C range The thermal expansion of UHPC generally increases in the 20°C–900°C range, with the exception of thermal shrinkage taking place in the 700°C–800°C range. UHPC exhibits slightly higher thermal conductivity and thermal expansion, whereas specific heat and mass loss are lower at elevated temperature as compared to those in NSC and HSC. Beyond 600°C, thermal properties of UHPC exhibit quite different trends as compared to NSC and HSC; this is because of the reduced (or non-existent) amount of coarse aggregate and the associated moisture content. The presence of steel and polypropylene fibres in UHPC does not influence the thermal properties of UHPC with temperature increase [14].
4) *Yogiraj Sargam, Kejin Wangand James E. Alleman (2020)* Thermal conductivity (k) is one of the key factors that control heat transfer in concrete. This paper presents the results of an experimental study conducted to analyse the effects of modern concrete materials, such as supplementary cementitious materials (SCMs), normal-weight, lightweight, and recycled aggregates, and steel and polypropylene (PP) fibres, on the thermal conductivity of concrete. The thermal conductivity tests were performed on cylindrical specimens of concrete mixes containing various amounts of these materials. The results indicate that k values of concrete reduced with the amount of SCM (slag and fly ash) replacement for cement. The mineralogy and absorption of normal

weight aggregate considerably affect k value of concrete. Replacing normal weight coarse aggregate by lightweight or recycled aggregate reduced the k value of concrete. Addition of steel fibre at a dosage higher than 0.25% (by volume) increased k value of concrete noticeably, whereas the addition of up to 2% PP fibre showed little effect.

The experimental method used in this study allows the test to be performed on a frequently used cylindrical concrete specimen with minimal preparation, and therefore it is a convenient test procedure to measure the thermal conductivity of concrete. Specific findings from this research were as follows:

1) Thermal conductivity of the concrete decreases almost linearly with an increase in w/c.
2) SCMs replacement for cement reduced the thermal conductivity of concrete, and the reduction is more at the early age (≤14 days) than at the later age (after 28 days).
3) The thermal conductivity of concrete was found to decrease during the initial period of curing, from 3 to 7 days, but increased afterward as curing continued up to 28 days. After 28 days, thermal conductivity of concrete had little change.
4) Addition of steel fibre (0.25%–2% volume fraction) in concrete increased its thermal conductivity, whereas the addition of PP fibre had little effect on concrete thermal conductivity.
5) Properties of aggregate have a significant effect on concrete thermal conductivity. The conductivity of concrete reduced by approximately 20% because absorption of dolomite increased from 4.1% to 6.8%. A 100% substitution of normal weight limestone aggregates with expanded shale LWAs reduced the thermal conductivity of concrete by approximately 30%. Replacing normal coarse aggregate with recycled coarse aggregate also reduced the conductivity of concrete by approximately 33%.
6) Thermal conductivity of concrete was found to increase exponentially and linearly with an increase in its dry density and compressive strength, respectively [15].

III. CONCLUSIONS

In this paper, there is a short description on the various studies carried out previously on the usability of rice husk and advantages of using polypropylene fibre in concrete. Ratio and proportion of materials have been discussed to modify mechanical and thermal properties. And also, the latest techniques which have been experimented in various countries is focused here. With the various advantages and disadvantages of PP fibre and RRH, this paper is focusing on how there can be an establishment of a certain proportion which makes concrete thermally insulated with maintaining higher strength. On the basis of reviewing literature mentioned above author conclude that polypropylene fibre and rice husk definitely helps to improve mechanical and thermal properties of concrete at the time of higher temperature exposure. Results of previous paper show that the addition of 2kg/m^3 PP fibre can significantly promote the residual mechanical properties of concrete during heating. The lower and higher dosages of fibre generally showed worse performance due to more deteriorations and higher volume of voids, respectively. Addition of RRH decreases the density, but increases the percentage of voids in concrete samples. Also, mixing of RRH with concrete leads to some amount of reduction in compressive strength. But it significantly modifies the physical and thermophysical properties of concrete.

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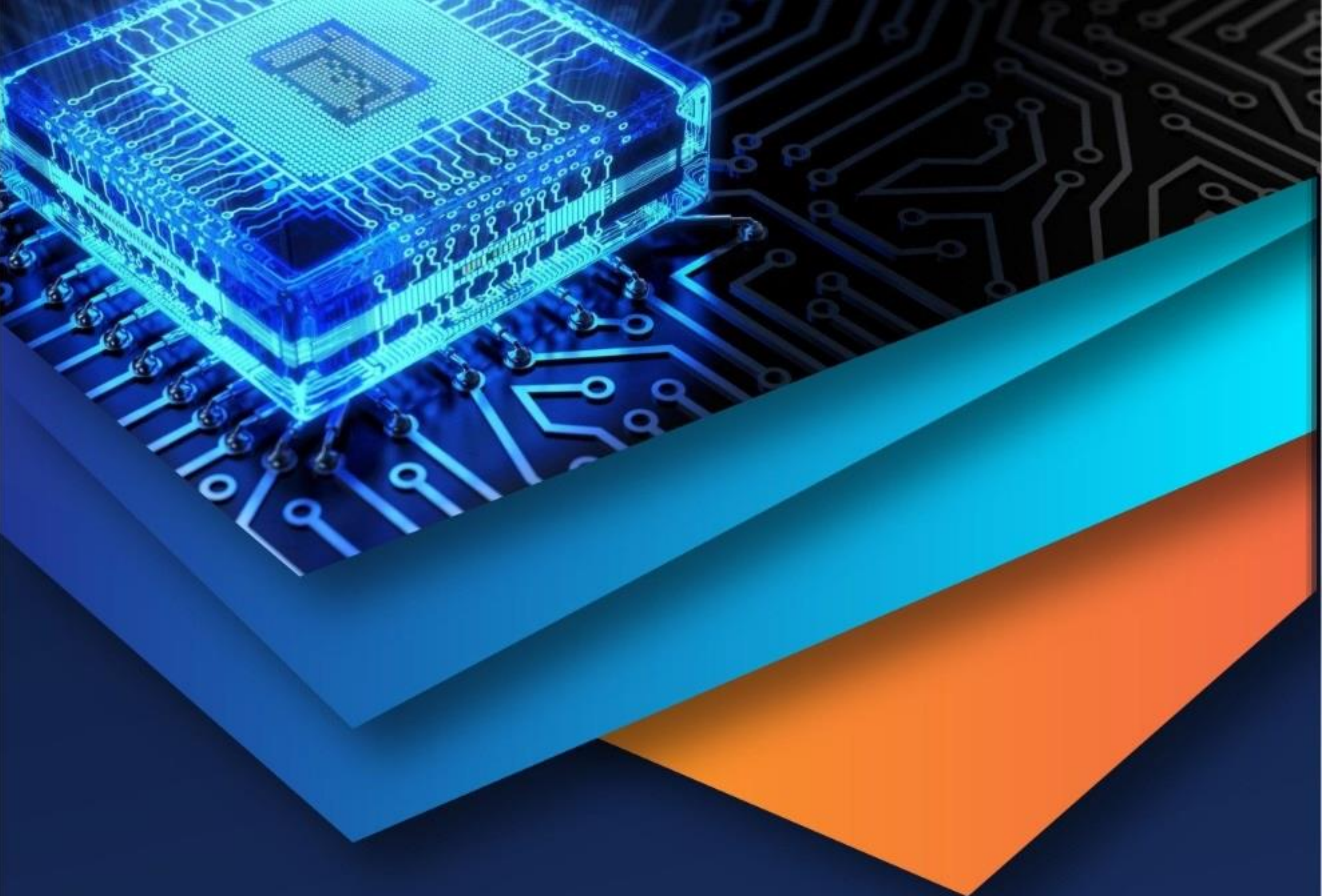

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