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State-Of-The-Art Review on Fibre Reinforced Concrete

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Abstract

The main purpose of this review paper is to outline the various research works carried out in the field of fiber reinforced concrete in real time applications and understanding its behavior. This paper summarizes a wide range of literature carried out in the field of fiber reinforced concrete along with replacement of river sand as fine aggregate with any other option like foundry sand by keeping in view the current trends in research industry and highlighting the future cope in this area.

Keywords*: - Fibre reinforced concrete, Mortar, Cement, State-of-the-art*

INTRODUCTION

Fiber Reinforced concrete is a composite material which consists of cement, mortar or concrete and discontinuous or discrete, uniformly dispersed suitable fibers. They are of many types and variable properties with many advantages.

It is piece of reinforcing material possessing certain characteristics properties. They can be circular or flat. The fiber is often represented by a parameter called "aspect ratio" which is the ratio of its length to its diameter ranging from 30 to 150.Use of fibrous material increases its structural integrity as it contains short discrete fibers which are uniformly distributed and are randomly oriented.

LITERATURE REVIEW

NattMakul (2019) studied about the Combined use of untreated-waste rice husk ash and foundry sand waste in high-

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performance self-consolidating concrete. The aim of this study is the combined effects of using foundry sand waste (FDW) obtained from the process of casting automobile engine parts as a fine aggregate replacement for efficient results and waste reduction, material production etc., The tests are conducted compressive and splitting tensile strengths of all the specimens for compare conventional SCC also durability. That means concrete was able to bear loads for longer time as the failure was not suddenly. The research works are conducted for determining the fresh and hardened properties on concrete. The optimum level replacement with foundry sand and rice husk ash produced the positive results. FDW achieved the highest compressive strength, splitting tensile strength, and static modulus of elasticity. Fine aggregate replaced with FDW at 10 or 20 weight percentage the water permeability coefficient k values decreased and further, the FDW decreased the chloride permeability of these specimens. SCC is decreased the chloride attack and sodium sulfate (Na2SO4) attack compare conventional of concrete.

Amitkumar D.Raval et al.(2015) studied about the effect of foundry sand as fine aggregate replacement on the compressive strength of concrete with a M25mix proportion investigated at different limited curing periods (7 days, 14 days and 2 days). The percentage of foundry sand used for replacement were 10%, 20%, 30%, 40% and 50% by weight of fine aggregate. Test showed impressive results, showing capability of foundry sand for being a component in concrete for imparting strength, compressive strength, splitting tensile strength, and flexural strength of concrete specimen increased, with increase in fine aggregate replacement by foundry sand content(%) compressive strength 7 days (N/mm2), 14 days (N/mm2), and 2 days (N/mm2) foundry sand, providing the maximum strength at 30% replacement, and beyond that the strength parameters showed a decline in their respective values. The increase in strength parameters may be due to fineness of the foundry sand. The foundry sand fineness is thehigher than the fine aggregate and reduces porous nature in concrete thereby increasing density and strength. But reduction in compressive strength of specimen with replacement percentage beyond 30% is attributed to binders present in foundry sand, composed of very fine powder of clay and carbon, which used foundry sand up to 30% is desirable, as it is cost effective, reduces the

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amount of fine aggregate, reduce land fill problems and preserves nature. Making concrete using recycled materials(foundry sand) saves energy and conserve primary resources and it is concluded that the more material was reused, the fewer resources were consumed which leads to a safe, sustainable environment.

Yogesh Aggarwal et al. (2014) studied about the Mechanical and durability properties of concrete using industrial by-products (waste foundry sand, bottom ash) and use of industrial byproducts. Also research includes the microstructure analysis of concrete using XRD and SEM. The study investigated the effect of waste foundry sand and bottom ash in equal quantities as partial replacement of fine aggregates in various percentages (0–60%) on concrete properties such as mechanical (compressive strength, splitting tensile strength and flexural strength) compared to that of conventional concrete and durability characteristics (rapid chloride penetration and deicing salt surface scaling) of the concrete along with micro structural analysis with XRD and SEM. The strength was observed to be in the range of 29–32 MPa, splitting tensile strength in the range of 1.8–2.46 MPa, and flexural strength in the range of 3.95–4.10 MPa on the replacement of fine aggregates from 10% to 50% at the interval of 10%. Furthermore, it was observed that the greatest increase in compressive, splitting tensile strength, and flexural strength compared to that of the conventional concrete was achieved by replacing 30% of the natural fine aggregates with industrial by-product aggregates. The focus of the research was 60% of waste foundry sand replaced by weight of fine aggregate and compared the strength and microstructure activities that of conventional concrete. This study is economic and environmental advantages which are of great importance in the present context of sustainability in the construction sector. The results are produced positively but the maximum replacement could be taken as 50% in foundry sand and increase in strength from 28 to 90 days was observed.

Archana sugumaran et al.(2016) has carried out research on the effect of waste foundry sand and phosphogypsum on structural beams. Phosphogypsum is a byproducts of phosphate based fertilizers. Foundry is a by- products from the metal alloys casting industry with high silica content. This project is relevant as cost of the building material is increasing and

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availability of the material is decreasing, which leads to many environmental issues. M25 mix concrete was used in the study. The fine aggregate was replaced by foundry sand and cement with phosphogypsum in different proportions. Quarry sand was replaced at 10, 20, 30, 40 and 50% by foundry sand while cement replaced at 4, 6, 8, 10 and 12% with phosphogypsum. The strength properties of the mixes were compared with that of conventional concrete mix. Strength tests were conducted. The result said that the maximum strength was obtained at an optimum replacement of 30% foundry sand and 10%phosphogypsum. The beam tests results showed good characteristics with respect to the load deflection. The workability of the mix on adding foundry sand reduces. The experiment is very economical and materials are easily available. The RC beam load deflection gives satisfactory results in terms of strength. The load deflection curve values showed the beam with combination mix to yield under load greater than that of reference beam.

Mohammedrafi et al.(2019) has carried out research on Concrete Using recron fiber as reinforcement. In this investigation, recron fiber is added to concrete in the proportion of 0%, 0.25%, 0.50%, and 1% by the weight of cement. This investigation is done in 4 different grades of concrete such as M20, M25, M30 andM35. For strength parameters, each grade of concrete for each proportion, cubes are casted for 7 days, 14 days and 28 days and prisms and cylinders are casted for 28 days. The compressive strength, flexural strength and split tensile strength are compared to that of conventional. The experimental results, it is clear that the strength of concrete increases when recron fibre is added to it. Itis found that the strength of concrete increases gradually from 0.25% and then decreases in 1% of recron fibre in concrete. M20, M25, M30, M35 grades of concrete showed positive results for 0.75% of recron in concrete. The strength of all the four grades of concrete decreased when recron was increased to 1% in concrete. Better flexural strength was obtained when the recron fibre was increased to 0.75% by weight of cement in concrete. Split tensile strength increased from 0.25% to 0.75% of recron in concrete and decreased when 1% of recron was added to concrete. So, in order to get maximum strength, 0.75% of recron fibre by weight of cement can be added to concrete.

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Bavita Bhardwaj et al. (2017) has focused his research on the material properties of Waste Foundry Sand (WFS), WFS shows enhanced mechanical performance of concrete and durability of concrete enhanced with incorporation of WFS up to an optimum level. Foundry sand is high quality silica sand that is a by-product from the production of both ferrous and non-ferrous metal casting. Several foundries still use binders such as clay, sawdust and wood floor for moulding. The presence of these particles reduces the specific density of the material, and also decreases the density of the concrete by creating air voids in the concrete. A number of studies have been carried out on utilization of WFS in concrete, wherein, optimum replacement level is obtained as 30% for most of the properties. In general, increase in substitution leads to decrease in workability of concrete attributed to presence of finer particles of sand and additives. The trend was same in case of special concretes like SCC and GPC beyond 50% replacement. There was drastic increase in water demand of concrete. Self compacting concretes with 100% replacement with WFS have also been produced with workability satisfying the requirement as per European Guidelines for SCC. With increase in WFS content demand of superplasticizer also increased. The addition of WFS generally decreases its mechanical strength Poor workability lead to pores in concrete and less paste available for binding which lead to decrease in strength. Sand from ferrous foundries performed better than non-ferrous foundries. Up to 20% replacement level, results comparable to control concrete have been obtained. Some studies have shown 30% as optimum replacement ratio. Fungal treatment of WFS also resulted in better compact matrix due to formation of bio-mineral, which plugs the pores and increases strength. Some studies have shown improvement in microstructure of concrete up to 50% WFS level. Large C-S-H gel formation was found up to 30% substitution. Beyond that C-S-H formation was low but number of pores was reduced, which increased the strength. Concrete with 100% substitution have shown strength as nearly 50% of control concrete. Shrinkage rate of WFS mixes was found higher at initial age of concrete but leveled out to other concretes after 28 days.

Bavita Bhardwaj et al. (2019) investigated the Comparative study of geopolymer concrete and alkali activated

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slag concrete comprising waste foundry sand. This research use of WFS as partial to full replacement to normal sand in GPC and AAS concrete. Because WFS addition beyond 40% significantly affected workability. Strength and sorptivity enhanced up to certain WFS levels. The natural sand was replaced by WFS in the range of 0% to 100% at an interval of 20%. Tests on hardened concretes, to study, compressive strength, split tensile strength, capillary suction, SEM and EDS analysis, were conducted to assess the strength, permeability and microstructure of both types of concretes. Addition of WFS lowered the workability of GPC and AAS concretes and the effect was abrupt beyond 40% WFS replacement level. Strength and sorptivity of both concretes improved upto 60% WFS replacement in GPC, whereas, upto 20% replacement in AAS concrete mixes, besides more than 45% of strength of reference concretes (0% WFS) was achievable at 100% replacement by WFS. The following conclusions from this investigation wider cracks were found in case of concretes with higher WFS percentages, leading to increase in porosity at higher replacement levels. There was a visible surface micro-cracking as well as micro crack, inside the concrete matrix attributable to shrinkage strains in case of AAS concretes. Wider cracks were found in of concretes with higher WFS percentages, leading to increase in porosity at higher replacement levels.

Gustavo J.L. Coppio (2019) studied about the Surface electrical resistivity and compressive strength of concrete with the use of waste foundry sand as aggregate. The steel industry generates large amounts of waste foundry sand (WFS) in landfills. Studies on the viability of using this residue as a fine aggregate have been carried out for asphalt mixtures. However, studies are still scarce in relation to their use in concrete. In this sense, the present work analyzed the effects of the use of WFS as fine aggregate in Portland cement concrete, in the electrical resistivity and compressive strength. The results showed that the behavior of the electrical resistivity varies according to the characteristic of the WFS, whereas the compressive strength tends to be smaller. It is necessary to further study the effects of the use of waste foundry sand in relation to the durability and performance of the concrete, in addition to the effects on the phenomenon of steel corrosion. The compressive According to the composition and content of residues and fine materials

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of the waste foundry sand used as a small aggregate, the surface electrical resistivity of the concrete may be larger, smaller, or even equal to that of concrete molded with natural sand.

G. Ganesh Prabhu et al. (2014) investigated the effects of foundry sand as a fine aggregate in concrete production. Also studied about the physical and chemical characteristics of the FS were also addressed. The substitutions used five different proportion 10%, 20%, 30%, 40% and 50%).Substitute for fine aggregate in five different substitution rates (10%, 20%, 30%, 40% and 50%). The tests are conducted, including density, slump cone, split tensile strength, flexural strength, ultrasonic pulse velocity (UPV) and compressive strength tests and performed to understand the effects of FS on the behavior of concrete. The results are followed the fineness and high water absorption properties of the FS reduce the workability of the concrete, and the workability of the concrete also decreases with an increase in the FS substitution rate. N. Gurumoorthy et al. (2016) investigated on micro and mechanical behavior of treated used foundry sand concrete. Foundry sand consist of more iron content so the used of foundry sand was treated with acid. Because UFS without proper treatment in concrete will reduce the binding and strength properties. This paper presents the results of experimental investigation carried out to evaluate the micro structural and mechanical properties of concrete mixtures in which fine aggregate (river sand) was partially replaced with TUFS (Treated Foundry Sand). Test results indicated a marginal increase in the strength properties and good micro structural properties of plain concrete by the inclusion of TUFS as partial replacement of fine aggregate (sand). This will pave the way for making good quality concrete and disposing the Used Foundry Sand safely without disturbing the environment. Study about from this research Mechanical properties of concrete mixtures increase with increase in percentage of TUFS content. TUFS concrete mixtures show enhanced mechanical properties (compressive strength, splitting tensile strength and flexural strength) with respect to age for all the percentage of replacement. From SEM analysis, TUFS shows that there is reduced void and C–S–H gel paste is spread very finely and firmly throughout the sample leading to the reduction in porosity and hence improved strength.

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Muhammad Nawazish Husain et al. (2015) studied about the application of recron3S fiber. Recron3S is a modified polyester fiber. It is generally used as secondary reinforcing material in concrete and soil to increase their performance. Recron3S sample used in experiment was of 12mm length and manufactured by Reliance Industries Limited. Use of Recron-3S as a reinforcing material is to increase the strength in various applications like cement based precast products, filtration fabrics etc. It also provides resistance to impact, abrasion and greatly improves the quality of construction during foundation, retaining wall design etc., Testing for index properties of the soil, Modified proctor compaction, CBR and UCS were carried out as per the procedures and guidelines laid down in Indian Standards Codes of practice. A total of four samples of soil – Recron3S fiber mixture were made (0.15 %, 0.30 %, 0.45 %. 0.60 % of the total dry weight of the soil). After the determination of various index properties of soil, Modified Proctor compaction tests were conducted, followed by CBR tests and UCS tests.

Modified Proctor Compaction tests were carried out on untreated parent soil and parent soil mixed with 0.15 %, 0.30 %, 0.45 % and 0.60 % of recron3S fiber in accordance with IS: 2720 (Part VIII) 1983[14].Information from this investigation recron3S fiber helps in improving soil sub grade strength of silty soil. In case of soil – fiber mixture as the content of fiber is increasing; its dry density goes on reducing. This may be because of the reason that as fiber content increases, soil-fiber packing becomes loose and it's become difficult to make samples even.

Anusha Chowdary et al. (2017) studied about the Impact of Polypropylene (Recron 3S) Fibers on Compressive and Tensile Strength of Concrete. The experimental study of this investigation consists of design of M40 grade concrete mix. Conventional concrete mixtures with differing rates of fly ash (0, 20, 30 and 40%) as cement replacement material were examined. Simultaneously the fibers were varied from 0 - 1% for each of the fly ash replacement in the concrete mix. The compressive strength and split tensile strength test were carried out at the ages of 7, 28 and 56 days. The impact of fibers and fly ash as cement replacement material on mechanical properties were analyzed and compared with conventional cement

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concrete. This paper briefly shows the compressive strength of cubes and tensile strength of cylinders of all the concrete mixtures explored at 7, 28 and 56 days. The experimental study give information are concrete without addition of polypropylene (Recron-3s) fibers, concrete has high workability and good slump for all the mix proportions. For concrete with addition of polypropylene (Recron-3s) fibers, as the amount of fibers content increases (0.25%, 0.5%, 0.75% and 1%) the workability decreases. Recron3S fiber reducing the micro-cracks and permeability and hence the durability will increase. It also reduces the segregation. For 28 days and 56 days curing, there is no significant change in compressive and split tensile strength. Micro structural behavior of concrete influences the strength characteristics of mix and also influence the compressive strength and split tensile strength of mixes.

Korrapati Anil Kumar(2017) studied the Impact of Polypropylene (Recron3S) Fibers on Compressive and Tensile Strength of Concrete. In this present investigation workability, strength properties of concrete with Recron 3s fiber in proportions of 0%, 0.2%, 0.3% and 0.4% is studied for M25 and M40 grade concrete cubes, cylinders and prisms. Recron3S fiber used in secondary reinforcement of concrete. The present investigation is to study the workability parameters of M25 and M40 grades of concrete using slump cone test, Compaction factor test, and Vee-bee time test. For strength parameters, each grade of concrete for each proportion, cubes, cylinders, prisms were casted for 7days, 28days, 56 days and 91days strength. Results were analyzed to derive useful conclusions regarding the strength characteristics of Fiber Reinforced Concrete (FRC) for M25 and M40 concrete. The Workability of concrete measured from slump cone test, as the percentage of recron3s fiber increases in mix slump value decrease. Hence it can be concluded that with the increase in the fiber content workability decreases. The compressive strength of M25 concrete at 28 days increased with the addition of recron3s fiber up to 0.3% level when compared to that of plain concrete.

Muhammad Fajad Iqbl et al. (2020) has carried out investigations on the mechanical properties of green concrete incorporating waste foundry sand based on gene expression programming. Waste foundry sand (WFS) is a major pollutant

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generated from metal casting foundries and is classified as a hazardous material due to the presence of organic and inorganic pollutants which can cause adverse environmental impact. In this study to develop empirical models for prediction of mechanical properties of concrete made with WFS (CMWFS). The mechanical properties can be estimated by the application of proposed simplified mathematical expressions. The performance of the models is assessed by conducting parametric analysis, applying statistical checks and comparing with regression models. The findings of this study can enhance the re-usage of WFS for development of green concrete leading to environmental protection and monetary benefits. This study presented the application of gene expression programming (GEP) technique for the development of models to predict the compressive strength, elastic modulus and split tensile strength of concrete made with waste foundry sand (CMWFS). The results obtained from the predicted models are in close agreement with the experimental results. The parametric analysis shows that the proposed models efficiently incorporated the influence of input variables to predict the accurate trends of mechanical properties of CMWFS. The empirical models can provide accurate and effective basis to enhance the utilization of hazardous sand for construction purposes rather than dumping as landfill. This can contribute towards sustainable construction since green concrete is produced by incorporating waste sand and results in the reduction of energy consumption, greenhouse gases emission, and disposal and construction costs.

Dr Sunil V Desale (2015) has carried out research on the use of Industrial waste and Recron3s fiber to improve the mechanical properties of concrete. Over 400 million tons of waste materials are being produced by various industries every year. Use of industry waste like fly ash to partly replace cementing material in concrete System. The focus the study is reducing industrial waste and the various mechanical properties of concrete containing sludge and recron3s fibers. Fly ash was used as a replacement to cement. Replacement percentages used during the present study were 10%, 20%, 30%, 40%, 50%. For each replacement percentage of cement with, 0.0%, 0.2%, 0.3%, 0.4% of recron3s fibers were added and specimens were cast to determine the mechanical properties. Compressive strengths of cubes were found on the 7th day and 28th day. Usage

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of Recron3s fiber will reduce the cost of maintenance by reducing the micro cracks and permeability and hence the durability will increase. It is found that use ofRecron3s fiber reduces the segregation. Flexural strength and split tensile strength increased with increase in recron3S fiber content.

CONCLUSIONS

Based on the experimental reviews it can be concluded that the use of fibrous material of various types in concrete improves the mechanical properties of concrete when used in correct aspect ratio an proper orientation and hence it can be effectively introduced in recycled concrete effectively to improve the mechanical strength of recycled aggregate concrete thus reducing the waste disposal problems.

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