Performance Evaluation Of Polypropylene Fiber Reinforced Concrete With Quarry Dust: An Overview

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Abstract- *In Indian scenario, fine aggregate is obtained from the river bed. But due to huge time gap between formation of natural sand and its rate of consumption, the ecological balance of the rivers has been disturbed and huge crises and scarcity of natural sand is observed. Now a day's District Administrator is facing the serious problem from 'sand mafia' due to large storage of illegal sand. In the present study, emphasis is made to investigate the utilization of quarry dust in Polypropylene Fiber reinforce concrete.The outcomes of this research work will promote the optimum application of quarry dust& Polypropylene Fiber and to conserve the natural resources for sustainable development of concrete industry.*

Keywords- fine aggregate, polypropylene fibre, quarry dust, natural sand.

I. INTRODUCTION

Concrete is a miraculous and most widely utilized man made material for civil engineering construction. Concrete is a backbone of infrastructural development in the whole world due to strength, structural stability, high mold ability and low cost. India has taken major initiative in developing infrastructures such as Airports, Power Projects, Express Highways, Bridges, Dams, Commercial and Residential housing projects, Sky Scrapers, and industrial structures etc. to meet the requirement of globalization.

As compared to other construction material such as structural steel, aluminium and glass, the production of concrete involves least amount of energy consumption. Also concrete saves energy during the entire service life of a building due to its excellent thermal capacity, which enables it to absorb, store and radiate heat, stabilizing the internal temperature in a building. Concrete is a recyclable material and aggregates extracted after recycling can be reused. The admirable environmental and the profile of concrete is enhanced further due to its ability to use waste product from other industries such as fly ash, granulated blast furnace slag, silica fume, ferrosilicon and stone crusher dust from stone crusher etc.

This paper is parted as optimum percentage replacement of quarry dust with natural sand and addition of polypropylene fiber as replacement of cement in concrete for optimum replacement of sand. The conclusion has summarized key results in the end of the paper.

II. LITERATURE REVIEW

- **Iswarya N (2017)** have carried out "Experimental study on polypropylene reinforced concrete pavement" The capability of durable structure to resist weathering action, chemical attack, abrasion and other degradation processes during its service life with the minimal maintenance is equally important as the capacity of a structure to resist the loads applied on it. Although concrete offers many advantages regarding mechanical characteristics and economic aspects of the construction, the brittle behavior of the material remains a larger handicap for the seismic and other applications where flexible behavior is essentially required. The interest in the use of fibers for the reinforcement of composites has increased during the last several years. Recently, however the development of polypropylene fiber-reinforced concrete (PFRC) has provided a technical basis for improving these deficiencies. A combination of high strength, stiffness and thermal resistance favorably characterizes the fibers. In this study, the results of the Strength properties of Polypropylene fiber reinforced concrete have been presented. This study shows the effect of mechanical properties of concrete in which the compressive strength, split tensile strength, flexural strength and sulphate attack of concrete samples made with different fibers amounts varies from 0%,0.5%,1% 1.5% and 2.0% were studied.[1]

- **Sayyed Mahdi Abtahiet. al. (2017**), have selected two lengths of PP fibres including 6 and 12 mm and each used separately at four different percentages of 0.1%, 0.2%, 0.3% and 0.5%, by total weight of the asphalt concrete. The mixture of fibres and aggregates was blended with 3.5%, 4.0%, 4.5%,

5.0% and 5.5% of butmen by weight of the total mix. Asphalt specimens were made by Superpave Gyratory Compactor (SGC), analysed by both Marshall and Superpave methods and tested by Marshall Stability apparatus. Addition of PP fibres showed an increase in Marshall Stability (26.3%), and the percent of air void (67.5%) while decreases in flow property (38.0%). As a result, the data show that PP modified asphalt-concrete samples can be considered as high-performance asphalt-concrete mixtures. Increasing the percent of air void, in modified treatments, they are useful for hot regions where bleeding and flushing are critical distresses. The composite "law of mixture" was used to explain the experimental results. Since the density of PP fibres is low compared to AC density, the specific gravity of the modified samples is decreased. The fitness of the unit weight experimental results with the values obtained through the "law of mixtures" was investigated. Therefore, it was found that the fitness of the real results with the theoretically calculated values is considerable, especially at low percentages of fibre contents. It was due to the existence of voids in all modified and/or neat AC treatments which leads samples to not fitting completely with the "law of mixtures", the concept that is well-known in compos-ite science. Another interesting outcome is that by increasing the PP dosage in the AC mixture, air voids in the FRAC composite is increased. Accordingly, the unfitness of the experimental results with the theoretical calculated values is enhanced. Finally, we concluded that 0.3% of polypropylene of 12 mm length is better than other percentages and lengths used in the experiment, because the air void increased to 6.7% at this percentage. The high amount of void is disadvantageous and also there is no significant difference in stability (3.6% difference) at this percentage, which is approved by LSD and Dunnett tests. The study was carried out only on the continuous gradation, with one type of asphalt cement. The dry method with 6 and 12 mm polypropylene fibres was tested. Hence, Superpave wet modification as a useful procedure is recommended for the future studies. Moreover, modifications with other polypropylene fibre lengths, e.g., 3 mm are also recommended for the future study. [2]

- **VasconcelosRaimundo E. (2016),** have determined and presented the results of an "Experimental study of Synthetic (Polypropylene) Fibers Reinforced Concrete (SFRC)", in levels of 0.33% - 3kg/m3, 0.50% - 4.5 kg/m3, and 0.66% - 6 kg/m3, at ages 28 and 88 days after specimens moulding. The specimens were exposed for 60 days in aggressive environment (in solution of water and 3% of sodium chloride), after 28 days. The bending toughness tests were performed in prismatic specimens of 150x150x500mm. The toughness factor values of the specimens in aggressive environment were the same to those obtained in normal environment (in air).[3]

- **Khan Samanet. al. (2016)**have carried out comparative "Experimental study on mechanical performance of Polypropylene Fiber Reinforced Concrete (PFRC) under compression and split tensile loading". The cube compressive strength and cylinder split tensile strength of conventional concrete and polypropylene fiber reinforced concrete were determined in the laboratory. The M25 and M30 grades of concrete mixes and polypropylene mono-filament macro-fibres of length 35 mm at volume fractions of 0.0%, 0.5%. 1.0%, 1.5%, 2.0%, 2.5% and 3.0% were used in the research. All specimens were tested at curing age of 28 days. In this paper the relationship between cube compressive strength and cylinder split tensile strength for conventional and polypropylene fiber reinforced concrete were established and compared with standards. The study suggested the significant improvement in compressive and tensile strength for concrete mixes reinforced with polypropylene fibers. The samples with added polypropylene fibers of 1% and 1.5% showed better results in comparison with the others.[4]

- **Ezeokonkwo, J. C and Nwoji, C. U (2015),** have examined "The use of polypropylene fibres to improve the compressive strength of sand Crete blocks". This involved the reinforcement of sand Crete blocks with twisted polypropylene fibres of length 50mm, 75mm and 100mm respectively at 5 different volume fractions of 1 per cent, 2 per cent, 3 per cent, 4 per cent and 5 per cent, and 5 different water/cement ratios of 0.4, 0.5, 0.6, 0.7 and 0.8. Analyses of the results showed that, addition of fibre increased the compressive strength from 2.236 per cent to 35.783 per cent and it is dependent on the length, volume fraction of fibre and water/cement ratio. The optimum compressive strength is dependent on the water/cement ratio, volume fraction of fibre and fibre length. Water/cement ratio of 0.6 produced strength above 3.0 N/mm2 than any other

water/cement ratio in all the length and volume fraction of fibre examined. [5]

- **Aly T. et. al., (2016)** have presented "The effects of admixed polypropylene (PP) fibers on the drying shrinkage of hardened concrete." Concrete mixtures made with Ordinary Portland cement (OPC) and OPC/slag blended cements containing various volume fractions of PP fibers were tested and reported. The results showed small but consistently higher drying shrinkages in concretes incorporating PP fibers than that without fibers. The effect is more pronounced in slag concretes and in concretes cured for only 1 day. An attempt to explain this phenomenon was made by water loss, nitrogen adsorption, sorptivity and scanning electron microscopy tests on the same concretes. Additional moisture loss and porosity are proposed as possible reasons. The results of early-age restrained shrinkage tests on slag concretes show that PP fiber concrete had higher cracking tendency than the concrete without fiber. This was found to be due to higher shrinkage and elastic modulus of PP fiber concrete. Their study suggested that more research work needs to take a place to study the effects of various types of PP fibers on the permeability, porosity and the potential of restrained shrinkage on the cracking tendency of concrete made with different binders.[6]

- **Singh S.P. et. al., (2015)** has "Evaluated the strength and flexure toughness of Hybrid Fibre Reinforced Concrete (HyFRC) containing different combinations of steel and polypropylene fibres." The specimens incorporated steel and polypropylene fibres in the mix proportions of 100-0%, 75-25%, 50-50%, 25-75% and 0-100% by volume at a total volume fraction of 1.0%. The results indicate that concrete containing a fibre combination of 75% steel fibres + 25% polypropylene fibres can be adjudged as the most appropriate combination to be employed in HyFRC for compressive strength, flexural strength and flexural toughness. A maximum increase in compressive strength of the order of 18% over plain concrete was observed in case of concrete containing 75% steel fibres + 25% polypropylene fibres. In case of static flexural strength tests, a maximum increase in flexural strength of the order of 80%, centre point deflection corresponding to peak load of the order of 84% was observed for HyFRC with 75% steel fibres + 25% polypropylene fibres. The results obtained in this investigation indicate that, in terms of flexural toughness, concrete with fibre combination of 75% steel fibres + 25% polypropylene fibres gives the best performance. Increase of fibre availability in the hybrid fibre system due to low density non-metallic fibres in combination of steel fibres could be the reason for the enhanced flexural toughness of the HyFRC mix.[7]

- **HorbanovaĽuba et.al. (2015),** have focused on the properties of polypropylene concentrates and fibers modified by inorganic additive. Polypropylene staple fibers are assigned as reinforcement of concrete to transform and absorb deformation energy. Modification of polypropylene fibers is necessary to ensure more intense anchoring of fibers in cement matrix. In this work the impact of inorganic additive on the rheological properties of polypropylene and polypropylene concentrate as well as on thermal, thermo mechanical and mechanical properties of composite polypropylene fibers is investigated. At rheological properties the index pseudo plasticity of polypropylene and polypropylene concentrates were comparable. Thermo mechanical analysis shows, that temperature of fiber deformation was higher at higher drawing ratio of composite polypropylene fibers containing inorganic additives. Mechanical properties of modified fibers without stabilization and stabilized at 95°C for 1 minute achieved higher values at drawing ratio 4.0. Surface modification of fibers containing inorganic additives was noticeable.[8]

- **Devi (2014)** performed the studies to know the influence of polypropylene fiber in enhancing the strength and durability properties of fly ash blended concrete containing quarry dust as fine aggregate. The mechanical properties were studied in addition to water absorption. From the results, it has been found that fly ash blended quarry dust concrete along with polypropylene fiber can be effectively and economically utilized in the construction industry.[9]

- **Deshpande N.K. et. al. (2014),** have attempted to utilize recycled concrete aggregates and artificial sand (machine made sand) in concrete, using IS10262:2009 as guideline for designing the concrete with grade M25. Use of machine made sand will allow replacement to conventional sand. The fresh and hardened properties of new concrete were studied and compared with concrete made using conventional materials. A comparison with control mix mainly their compressive strength, split tensile strength and flexural strength, would allow assessing the suitability of using recycled aggregate in concrete

with replacement to sand with conventional or artificial sand. Target strength of 31.6 N/mm2 could be achieved for M25 grade of concrete by 100% replacement of recycled coarse aggregates.100% replacement of recycled coarse aggregate with river sand exhibited a increase of 3.82% in compressive strength and concrete with RCA-20mm and RCA-10mm and AS showed a increase of 4.20% as compared to target strength. A mix grading of 20mm and 10mm of aggregates could be done for economic perspective and also higher strength. Thus use of river sand and artificial sand with 100% replacement of recycled coarse aggregate can be used for low strength applications. Use of artificial sand in concrete can be a viable option due to the scarcity of river sand. [10]

- **Veera Reddy M. (2014),** has attempted to assess " the suitability of stone dust and ceramic scrap in concrete making." In the laboratory stone dust has been tried as fine aggregate in place of sand and ceramic scrap has been used as partial/full substitute to conventional coarse aggregate in concrete making. The cubes, cylinders and prisms were cast and tested for compressive strength, split tensile strength and modulus of rupture after a curing period of 28 days. The results indicated effectiveness of stone dust as fine aggregate and partial replacement of conventional coarse aggregate by ceramic scrap up to 20 percent, without affecting the design strength.[11]

- **KapgateSudhir S. and Satone S.R. (2013),** have designed mixes of M25 grade concrete with replacement of 0%, 20%, 25%, 30%, and 35% of quarry dust organized as M1, M2, M3, M4 and M5 respectively have been considered for laboratory analysis for slump test, compaction factor test, compressive strength, split tensile strength and flexural strength of hardened concrete. It was observed that the slump value increases with increase in percentage replacement of sand with quarry dust. The concrete gave adequate workability with the increase of quarry dust as fine aggregate. The compressive strength of cubes at 28 days curing for control mix increases for 53 grade concrete but strength reduces with the control mixture (M1) . The increase in dust content up to 30% increases compressive strength of concrete, if the dust content is more than 30% the compressive strength decreases gradually. The split tensile strength at 28 days curing showed reduction in strength in comparison with control mix M1. [12]

- **A.P. Sathe and A.V. Patil** Compare The Properties Polypropylene Fiber Reinforced Concrete With Conventional M40 Grade Of Concrete Mix and Polypropylene Fibers Of Length 20 mm Is Used. The Paper Shows The Experimental Results Of Compressive Strength And Flexural Strength With The Addition Of 0, 0.5%, 1%, 1.5%, and 2% Of PPF By Replacement Of Cement By Weight. It Is Seen that The Samples With Added Polypropylene Fiber Of 1% and 1.5% Showed Better Results In Comparison with The others. In this investigation program we conclude that there was increase in compressive strength, split tensile strength, and flexural strength up-to 1.5% of fiber content and thereafter there was decrease in strength on further increase in fiber content. On using polypropylene fiber in M40 mix there was low shrinkage, creep cracks also reduce in comparison with conventional concrete. [13]

- **K.Anbuvelan** studied "strength and behavior of polypropylene fibers in impact characteristic in impact characteristic of concrete" The impact resistance of concrete is poor which shows low tensile strength and fracture energy the behavior of concrete under impact load is far from adequate and there is significant variability in the publish literature . Three grades of concretes namely M1,M2 ,M3 are considered in this study with 0.1% , 0.2% , 0.3% dosage of polypropylene fiber . Those results that the fiber concretes are compared with plan concrete and conclusions are arrived .this attempt is made to study the impact resistance of fiber concrete using ACI drop weight impact tester.

For M1 grade of concrete Addition of 0% , 0.1% , 0.2% &0.3% of dosage polypropylene fiber in plan concrete improves the characteristic no. of blows to the maximum extent of 15.38% to 45.85% for1 st crack and 14.95% to 48.98% for ultimate strength.

For M2 grade of concrete Addition of 0% , 0.1% , 0.2% &0.3% of dosage polypropylene fiber in plan concreteimproves the characteristic no. of blows to the maximum extent of 9.61% to 25.17 % for1 st crack and 8.21% to 22.44 % for ultimate strength

For M3 grade of concrete Addition of 0% , 0.1% , 0.2% &0.3% of dosage polypropylene fiber in plan concreteimproves the characteristic no. of blows to the maximum extent of 1.30% to 97.06% for1 st crack and 4.51% to 103.79% for ultimate strength.[14]

- **SalahaldeinAlsadey, Muhsen Salem,** "Influence Of Polypropylene Fibre on Strength Of Concrete", This paper describes the enhancement in the strength of the M35 grade concrete mix by the addition of Polypropylene fibres (recron 3S) in the proportion of 0.0%,0.1%, 0.2%, 0.3%, 0.4%, and 0.5% by volume of concrete were used in the. The tests were carried out to determine the mechanical properties of concrete upto 7, 14 and 28 days for compressive strength, split tensile strength and flexural strength.

Slump test were carried on fresh concrete while compressive strength, split tensile strength and flexural strength were carried on hardened concrete. The slump test results conclude that the workability of the polypropylene fibre mixes goes on decreasing as the fibre content is increased in the concrete mix.0.3% rcron3 s improved tensile strength of concrete from 2.65MPa to 3.4MPa and flexural strength from 5.13MPa to 6.83MPa after 28 days of curing. Increase in concentration of recron 3s beyond 0.3% showed decline in flexural strength from 6.83MPa to 5.7MPa.The workability of the fibre reinforced concrete has been found to decrease with an increase in the concentration of recron 3s fibre in the concrete mix .Recron 3s shows optimum readings in compressive and flexural strength with variation of 0.3% recron 3s with respect to cement in volumetric terms. Usage of recron 3s fibers will reduce the cost of maintenance by reducing the micro-cracks and permeability and hence the durability will increase. It is found that use of recron 3s fibre reduces the segregation.28 days curing recorded maximum strength irrespective of different levels of natural and artificial fibers under study.[15]

- **Anthony Nkem Ede and AbimbolaOluwabambiIge, "**Optimal Polypropylene Fibre Content for improved Compressive and Flexural Strength of Concrete" This research studies the effects of micro synthetic polypropylene fiber in improving concrete strength. The samples of 0.25% , 0.5%, 0.75 % & amp; 1% contents of polypropylene fibers were tested for destructive and non destructive compressive strength test and destructive flexural strength test and the samples were tested after 7, 14, 21, 28days of curing .The minimum percentage of polypropylene is added to concrete mix to increase the compressive strength which lies between 0.25%.The polypropylene fiber increases to 28 days which increases the compressive strength of concrete by 9%.Polypropylene fiber addition greater than the optimum percentage (0.25%) slight increase for 0.50% and then decreased for higher values.When low percentage fractions are added the flexural strength of concrete will increase by 65%.It is seen that the optimum dosage of polypropylene fiber is 0.25% and0.5% both for compressive strength and for flexural strength.[16]
- **NajilahFaroukh, I Padmanabad,** "Experimental Study of Polypropylene fibre Reinforced Self Compacting Concrete", Self compacting concrete is developed in1988 in Japan to achieve long lasting concrete structure. This paper is experimental studied on Mechanical performance of polypropylene fiberreinforced concrete (PFRC) under compression ,slit tensile and flexural Loading .the M30 grade of concrete mixes and polypropylene fibers of length30mm at volume fraction of 0.5% , 1.0%,1.5% ,2.0% was used in this experiment .Allcubes was tested at curing age of 7th and 28th day In this study specimens achieve the maximum strength at 4 days and 28days and it was casted on the basis of nan-su mix design method for M30 grade SCC.In SCC mix design procedure gives more fine aggregate content but lesser in reinforcing bars had been increased. the strength properties at 28 days improves the addition of fibers in the concrete mixture. The maximum strength of is achieved at the 0.15% of fiber. IT reduces the water permeability plastic shrinkage and settlement amp; carbonation depth. With the addition of fiber the compressive strength, split tensile strength & flexural strength get increased. The polypropylene fiber is not much good on compressive strength but it gives better result to reduce cracks and cracks propagation.[18]

III. CONCLUSION

Analysis is based on the Polypropylene fibre reinforced concrete .The replacement of natural sand with quarry dust found increase in average compressive strength and more percentage increase in flexural strength and split tensile strength found at optimum replacement 60% artificial sand and 40% natural sand .with this optimum replacement on natural sand and quarry dust in concrete polypropylene fibre were added in percentage replacement of 0.25% and 0.5% of cement content in concrete gives best strength result for compressive, flexural and split tensile strength.

It was found that with addition of polypropylenefibre the slump of concrete may decrease with increase in percentage of fibre in concrete.

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