A Review Paper on Evaluation and Performance of Concrete by Partial Replacement of Fine Aggregate by Stone Dust and Coarse Aggregate by Construction Waste for Rigid Pavement in Rural Areas

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Abstract –*India produce a large amount of waste materials from different sectors like industrial, construction, agriculture etc. which are just dumped on the land. This may lead to large areas of land which becomes difficult to find. And also now a day's fine aggregate(sand) is very expensive. So, that by adding alternative materials as partial replacement in fine aggregate & coarse aggregate would give better saving and environmental free. Therefore, it is enhanced alternative material to use in a rigid payment construction in civil engineering and also cost of construction may also reduce to the cost of conventional concrete. In this project I have added two types of alternative material named as stone dust and construction waste in concrete mix with a percentage variation of 10%,20%,30%,40%, &50% for fine aggregate and 5%,10%,15%,20%, &25% for coarse aggregate. In the present investigation our experiment will be carried out to study the compressive strength of concrete in standard mould cube cast is to ready in 7 & 28 days curing. M30 grade of concrete is designed using PPC for this experiment. Compressive strength will be determined at different replacement level of fine aggregate & coarse aggregate with respect to conventional concrete and optimum replacement level will be determined based on compressive strength.*

Keywords— *Fine Aggregate, Coarse Aggregate, Stone dust, Construction waste (crushed concrete waste), PPC, Rigid Pavement.*

I. INTRODUCTION

Concrete is an artificial conglomerate stone made up of cement, water, sand and coarse aggregates. Concrete as found to be used in different field of civil engineering, in highway engineering it is used in the production of slabs used as rigid payment. The high cost of concrete used in rigid payment construction rises from the cost of constituent materials. Such cost can be reduced through the use of locally available alternative materials to the conventional ones normally used in concrete production, of interest to this research in an alternative to fine aggregate and coarse aggregate. The worldwide consumption of sand as fine aggregate in concrete work is very high, and several developing countries have faces some stress in the supply of natural sand in order to meet the increasing needs of infrastructure development in recent years. Such a situation that is responsible for increase in the price of sand and the cost of concrete. Expensive and scarcity of river sand was reported in India today. To overcome the pressure and demand for river sand, research and practitioners in the construction industries have identified some alternative materials which are locally available can be recycled and reuse for the purpose of fine aggregate as well as coarse aggregate too. Such as crushed rock powder, stone dust, construction and demolition waste, clay brick bats, brick dust, limestone dust etc. As a result of this, the quantities of these waste materials are accumulating throughout the world are causing disposal problems that are both financially and environmentally expensive, landfilling is becoming more expensive and sustainable management of resources is becoming a goal for many countries. To deal with the growing disposal problem of these waste materials is an issue that require coordination of all parties involved such as government agencies, construction companies, the public and professionals. So, one of the best method to the construction of highways and roads. However, such a use should not compromise the quality of the highway and road infrastructure nor create environmental problems. Nominal research has been done in India to determine the availability of possible waste materials and the suitability of these materials for Indian roads. Moreover, the use of waste materials would benefit the road sector by providing it with a cheap source of material.

II. LITERATURE SURVEY

V. Gokulnath, R. Anandhan (2017) have conduct experimental investigations to judge the impact

of the partial replacement of coarse aggregate by dismantled waste with 10%,20%&30% replacement level on compressive strength and workability of DAC (Demolished mixture Concrete). For the study seven, fourteen and twenty-eight day's compressive strengths were recorded. and also the concrete cubes of M30 grade were cast by that dismantled concrete mixture than any tests conducted like workability, compressive strength for that DAC and also the result obtained are found to be comparable to the traditional concrete.

Vijay Venkatesh Chandrasekaran (2016) Describes about the project reuse waste crushed concrete maters (WCC) from the lath wastage of crushed concrete replacing from coarse aggregate 20%, 30%, 40% (WCC) of crushed coarse aggregate (lathe waste) to reduce the generation of demolition wastes. (The analysis of demolished crushed concrete aggregate (DCCA) concrete in regular mold cast is to be ready in (7, 14, 28) days hydration and examination to be conduct lying on concrete. Such as compressive strength, split tensile strength, & flexural strength.) The replacing of coarse aggregate uses of waste mater and required strength attain in the conventional M20 grade concrete.

Prakash Somani (2016) have been carried out experimental investigations to evaluate the effect of partial replacement of coarse aggregate by demolished waste on compressive strength and workability of DAC (Demolished Aggregate Concrete). For the study 3, 7 and 28 days compressive strengths were recorded. The previous study on this project shows that the compressive strength of the DAC (Demolished Aggregate Concrete) is somehow resembles with the conventional concrete if used in a proper amount up to 30%. So in this study we have taken the demolished concrete aggregate 10%, 20%, 30% by weight of the conventional coarse aggregate and the concrete cubes of M20 grade were casted by that demolished concrete aggregate then further tests conducted such as workability, compressive strength for that DAC and the result obtained are found to be comparable with the conventional concrete.

Prafulla Kumar triwari (2016) have studied in which replaced natural aggregates with recycled aggregates in concrete cubes. This is the first part of the study we have to do. Here we are trying to see a pattern of how the strength decrease once we replace natural coarse aggregate (NCA) with recycled coarse aggregates (RCA). The percentages of replacement will be 0%, 50% and 100%. The test and design is as per Indian standard codes. The concrete cubes are designed for M30 as per Indian standard codes.

Ch.Ganga Bhavani, G.Navya (2015) this project consists of a partial replacement of fine aggregate with stone dust in cement concrete for rigid pavement. In this project she has added stone dust in cement concrete mix. Here stone dust is added in cement concrete mix with a percentage variation of 5%, 10%, 15%, 20% and 25%. By adding stone dust there was a variation in test results of compressive strength, flexural strength and tensile strength. The strength increased when the admixtures content increased up to 20% replacement in cement concrete. Now a day's fine aggregate(sand) is very expensive; so that by adding admixtures stone dust as partial replacement in fine aggregate would give better saving and environment free. Therefore, it is enhanced admixture to use in a rigid pavement construction in civil engineering and also overall cost may also reduce to 14.64% cost of cement concrete.

Vikas Srivastava, Raushan Ranjan (2015) have been carried out experimental investigations to evaluate the effect of partial replacement of fine aggregate and coarse aggregate by different parts of demolished wastes on strength and workability of concrete made. For the study, design mix concrete of grade M25 (Referral concrete) was prepared using IS: 10262-2009. Thereafter, the replacement of different constituents of concrete, one at a time was carried out by replacing these with the different sieved fractions of crushed demolition waste. The compressive strength at 7 and 28 days, and workability in terms of slump value were measured. The compressive strength of these mixes was measured on 100mm cubes. Test results show the compressive strength of recycled concrete (FAR concrete) with 10% fine aggregate replacement by demolition waste fine aggregate at 28 days is comparable to that of referral concrete. The compressive strength of recycled concrete (CAR concrete) made using 10% of demolition waste coarse aggregate is almost similar to referral concrete. Further, the results indicate that still higher replacement of the constituent materials is possible without much compromising the 28 days strength and workability.

Anoop Chabbara (2015) have studied properties of concrete using Recycled aggregate, and Glass Powder and Crumb rubber. This project is divided into two parts i.e. Research Program 1: This Program consists concrete containing glass powder and Recycle Aggregate. Here coarse Aggregate is partially replaced by 40% Recycled Concrete aggregate and Glass Powder partially replaced Fine aggregate with varying percentage from 15%, 20%, 25% and Research Program 2: This Program consists concrete containing crumb rubber and Recycle Aggregate. Here coarse Aggregate is partially Replaced by 40% Recycled Concrete and crumb rubber partially replaced Fine aggregate with varying percentage from 5% to 10% at interval of 2-3%.

Franklin Eric kujur, Eshan Ali (2014) have conduct an experimental programmed using 30%, 40%, 50%, 60% and 70% partial replacement of fine aggregate with stone dust has been taken for concrete of M25 grade with 0.46 water cement ratio. In this study, set of cubes and beams were cast for compressive and split tensile strength respectively. Concrete specimens

were tested after 7 and 28 d moist curing. It has been observed that 40% replacement of fine aggregate with stone dust is adaptable.

Mohd Monish, Rakesh Kumar(2013) have studied a part of comprehensive program wherein experimental investigations have been carried out to assess the effect of partial replacement of coarse aggregate by demolished waste on workability and compressive strength of recycled concrete for the study at 7 and 28 d. The compressive strength thus, observed was compared with strength of conventional concrete. Test results showed that the compressive strength of recycled concrete up to 30% coarse aggregate replacement (C. A. R.) by demolished waste at the end of 28 d has been found to be comparable to the conventional concrete.

Lohani (2012) have studied the property of the quarry dust and the suitability to use it as partial replacement material for sand in concrete. Design mix of M20 grade concrete was used with replacement of 0%, 20%, 30%, 40% and 50% of sand by quarry dust. They conducted slump test, compaction factor test, compressive strength (cube, cylindrical sample), split tensile strength, flexural strength, modulus of elasticity and water absorption test. From the test results it was observed that the concrete does not give adequate workability with increase of quarry dust. It was due to the extra fineness of quarry dust. Increased finer requires greater amount of water for the mix ingredients to get closer packing results in decreased workability. Increase in dust content up to 30% increases compressive strength of concrete and if the dust content was more than 30% the compressive strength decreases gradually. But the compressive strength of quarry dust concrete continues to increase with age for all the percentage of quarry dust contents. Flexural and tensile strength was maximum at 20% sand replacement. From the above test results it was concluded that quarry dust can be utilized at 20% replacement.

Divakar (2012) have conducted experiments to study the behavior of concrete with the use of granite fines as fine aggregate. The percentage of replacement of sand by granite fines were 5%, 15%, 25%, 35%and 50%. Specimens were cast in M20 concrete using 53 grade OPC. Tests were conducted on compressive, flexural and split tensile strength at the age of 28 days. From the test results it was observed that the maximum compressive and split tensile strength were obtained at 35% sand replacement. The flexural strength was maximum at 25% sand replacement. Workability of concrete mixes decreased with the increase in granite fine percentage. For RCC beams the flexural strength was increased with increase of granite percentage. It was concluded that overall 35% of replacement as optimum to satisfy all properties.

Rajendra Prasad (2011) have conducted experimental works to study the effect of crushed rock powder (CRP) as fine aggregate with admixtures subjected to different curing methods. Sand was replaced by CRP in 0%, 10%, 20%, 30%,40%, 60%, 80% and 100% . 53 grade OPC was used to prepare M30 concrete with water cement ratio 0.45. From the test results that 20% quarry dust replacement gave better compressive strength. Other than 20% replacement obtained lesser compressive strength compared with control concrete. This was due to the voids present in the concrete mixes with higher amount of CRP. It was concluded that quarry dust can be utilized in concrete replacing sand.

Nagabhushana and Sharada bai (2011) have conducted experiments on concrete using crushed rock powder as a partial replacement material for natural sand. The percentage of replacement was 20%, 30%and 40%. Three grades of concrete of M20, M30 and M40 were taken for study using 53 grade OPC. Tests were conducted on compressive, flexural and split tensile strength at the age of 7 and 28 days. The w/c ratio was fixed as 0.5, 0.39 and 0.31 for M20, M30 and M40 mixes respectively. For M40 mix in addition to the water quantity as per w/c ratio a super plasticizer was added to keep slump of 70mm. From the test results it was observed that the compressive, flexural and split tensile strength was increased and maximum at 40% sand replacement. The percentage of increase will be inversely proportional to the mix ratio. It was concluded that the compressive, flexural and split tensile strength of concrete were not affected with the replacement of sand by crushed rock powder as fine aggregate up to 40%.

Mirjana Malesev, Vlastimir Radonjanin (2010) A comparative analysis of the experimental results of the properties of fresh and hardened concrete with different replacement ratios of natural with recycled coarse aggregate is presented in the paper. Recycled aggregate was made by crushing the waste concrete of laboratory test cubes and precast concrete columns. Three types of concrete mixtures were tested: concrete made entirely with natural aggregate (NAC) as a control concrete and two types of concrete made with natural fine and recycled coarse aggregate (50% and 100% replacement of coarse recycled aggregate). Ninetynine specimens were made for the testing of the basic properties of hardened concrete. Load testing of reinforced concrete beams made of the investigated concrete types is also presented in the paper. Regardless of the replacement ratio, recycled aggregate concrete (RAC) had a satisfactory performance, which did not differ significantly from the performance of control concrete in this experimental research. However, for this to be fulfilled, it is necessary to use quality recycled concrete coarse aggregate and to follow the specific rules for design and production of this new concrete type.

Manasseh Joel (2010) have studied the suitability of using the crushed granite fine(CGF) to replace river sand in concrete. Slump, compressive and indirect tensile strength tests were performed on fresh and

hardened concrete using M35 grade mix with replacement of sand from 0%,10%,20%,30%,40%,50%,60%,70%,80%,90% & 100%. The cubes were tested at the age of 7, 14 and 28 days whereas cylinder specimens tested at 28 days. From the test results it was observed that w/c ratio and slump value increased with the replacement of sand with crushed granite fine. Maximum compressive and tensile strength was obtained at 20% sand replacement. Based on economic analysis and results of tests, he recommended that river sand replaced with 20% CGF can be used in the production of concrete for use in the rigid pavement.

Radhikesh Nanda (2010) have conducted experiments on cement concrete paving block replacing sand by stone crusher dust as fine aggregate. Paving block of size 0.25x0.20x0.05 m was cast with mix M20 by weight with water cement ratio 0.6. Compressive, flexural and split tensile tests were conducted by replacing sand by crusher dust from 0%, 25%, 50%, 75% &100%. From the test results it was observed that the compressive strength was decreased if the addition of crusher dust increases. Similarly flexural and tensile strength also decreases due to increase in crusher dust percentage. Slump value decreases if the crusher dust percentage increases. It was concluded that crusher dust may be used instead of sand up to 50% in the place where sand availability was less and crusher dust is in plenty.

Chaturanga Lakshmi Kapugamage (2008) have reported about the use of fly ash and quarry dust as partially replacement materials for sand in concrete. Sand was replaced by quarry dust from 0%,15%,30% & 45%. Using M30 mix with OPC the strength was determined at the age of 3, 7 and 28 days. From the test results it was observed that the effect was eliminated by addition of 30% quarry dust. Using of quarry dust leads to the reduction in the workability of concrete. Therefore, the concurrent use of crushed rock material in concrete will lead to the benefits.

Prachoom Khamput (2006) has conducted experiments to study the compressive strength of concrete using quarry dust as fine aggregate instead of sand. The mix used was 1: 2: 4 (by weight) with water-cement ratio 0.45. In addition to normal concrete(0% quarry dust) 70%, 90% and 100% sand replaced concrete was prepared , specimen were cast to conduct compressive strength test at an age of 7, 14, 21 and 28 days with and without admixture. From the test results it was observed that maximum compressive strength of concrete was obtained at 70% sand replacement both at 7 and 28days. Concrete with admixture was more workable than concrete without admixture. However, the compressive strength of concrete with admixture was higher than without admixture concrete in every mix ratio of quarry dust and sand. He concluded that quarry dust could be used to replace sand in general concrete structures.

Chandrasekhara Reddy (2003) has conducted experiments to study the performance of concrete using stone dust as a replacement to sand. Sand was replaced by quarry dust from 0%,25%,50%,75% & 100%. Compressive strength and tensile strength tests were conducted using 43 grade OPC in M20 concrete. Compressive strength was computed at the age of 7 days, 28 days and 60 days. From the test results he observed that all the mixes except 50% replacement achieved the target strength. The stone dust decreases workability of concrete due to the larger portions of fine particles. At 75% of sand replacement, the percentage of increase in compressive and tensile strength were 40 and 28 compared with reference mix respectively. The unit weight increases with increase in percentage of replacement of sand. He concluded that sand can be replaced by stone dust available locally without affecting strength of concrete.

Patagundi, Patil (2002) have conducted experiments to investigate the properties of concrete when natural sand was partially replaced by crusher stone powder. The compressive strength and flexural strength were studied. The replacement of sand was from 0%, 10%, 20%, 30% & 40%. Using OPC the design mix 1:1.2:2.4 was prepared with water cement ratio 0.30. To facilitate the flow of concrete a super plasticizer was used. From test results it was observed that 28 day compressive strength was maximum at 30% sand replacement and this was due to the fact that crusher powder fills up the maximum voids to get dense concrete and liberates strength during later periods. Similarly, flexural strength was also maximum at 30% replacement itself.

Selvakoodalingam, Palanikumar (2002) have analyzed through experimental study the use of quarry dust as fine aggregate in cement concrete. M15 mix was considered with three proportions say 100% sand, 50% sand and 100% quarry dust. Workability and compressive strength tests were conducted. From the test results it was observed that the 28-day compressive strength was maximum at 50% sand replacement. Compared with sand, quarry dust was more workable. It was concluded that quarry dust can be utilized as replacement material in place of sand with higher strength at 50% replacement.

III. INFERENCES

The following inferences can be drawn from reviews of above mentioned studies are as:-

(i) From the above studies, the Stone dust and construction waste may be alternative to the conventional concrete. When usage of Stone dust as fine aggregate replacement showed that it can be replaced fully depend on the availability but optimum replacement ranges from 30-40% replacement is suggested and when the replacement of coarse aggregate by construction waste, the optimum replacement ranges of 10-20% is recommended.

(ii) Availability of Stone dust and construction waste is easier and hence it can save time and cost of

transportation too. It can also be utilizing for the construction of precast & cast in-situ.
(iii) Stone dust can be used as partial replacement for fine aggregate in the case of non-availability of nature sand at reasonable cost.
(iv) From the above investigation, the compressive strength of non-conventional concrete is mainly depending on the quality of non-conventional material.
(v) It is cleared from the past studies that 10% extra water and 3-5% extra cement should be preferred to produce a rich mix by using construction waste materials.
(vi) The use of Stone dust and construction waste material in pavement construction helps in reducing cost of materials and environmental disposal issues and there by leading to developing of sustainable construction.

IV. CONCLUSION

Most of the researchers listed above considered alternative material such that stone dust and construction waste for fine aggregate and coarse aggregate replacement in the production of concrete for other purposes, not for use in rigid pavement. This research is needed to determining the suitability of such an alternative material that are eco-friendly, inexpensive and better for strength and durability performance to replace river sand and conventional stone in the production of concrete for use in rigid pavement for rural areas, using compressive strength tests as basis for assessment.

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