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Partial Replacement of Fine Aggregate with Quary Dust & Red Soil in Concrete

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Abstract— In India, construction industries are the fastest expanding industry. The river sand is being extensively used in the construction industry and this has lead to the acute shortage of the sand, which is used as fine aggregate. The cost of producing concrete has been steadily rising for some years, and fine aggregates have become increasingly scarce, exacerbating the problem. The negative consequences of indiscriminately extracting fine aggregate from river bottoms have been repeatedly mentioned as a source of concern. To address this problem, utilization of alternative materials should be done. In this review a thorough assessment is done on the alternatives available for the replacement of fine aggregate. The paper has reviewed the use of red soil and quarry dust as a fine aggregate replacement (partially and completely). Quarry dust is a waste by-product of aggregate processing plants. Red soil is naturally and easily available in Tamil Nadu, parts of Karnataka, south eastern Maharashtra, eastern Andhra Pradesh and Madhya Pradesh, Orissa. Different physical, chemical and mechanical properties of red soil and quarry dust as well as the concrete, containing these materials, were reviewed and comparisons were done between them. A comparative study is also done with the currently used material in the industry which is M-sand (Manufactured sand). It can be observed that in concrete where the sand was replaced by red soil soil and quarry dust exhibits improved strength and durability properties, but the water absorption is also increased significantly. It is deemed that further detailed investigations are needed for the proposed alternatives, and a structure for future research has been proposed in order to achieve reliable, robust, environmentally friendly, and economically viable concrete as the end product.

Keywords: Concrete, Red Soil, Partial Replacement, Fine Aggregate, Coarse Aggregate.

Introduction

The urbanization in India is growing at an unprecedented level due to migration of people from smaller towns and villages to bigger cities in search of jobs and a better life. As more people move to urban areas the demand for housing and infrastructure will go up eventually driving the demand for construction material. In India the construction boom has increased the demand of sand by many folds in the last 2-3 decades which is putting a lot of pressure on the traditional source of sand supplies i.e. our rivers and causing harm to aquifers, fisheries and protected areas. This has led to a shortage of sand and making it a scarce commodity in some parts of India and there were times when the construction industry almost came to a standstill or moved at a snail pace due to the shortage of sand, affecting the construction quality, timely completion of projects, and above all, affecting the livelihood of hundreds of people across related sectors. This led to a temporary disruption in the realty market which impacted the overall ecosystem in terms of cost of construction and meeting timeline. With the growing scarcity, rising costs, illegal mining, and steep royalty costs, many developers and construction companies are switching over to an alternative source. Karnataka was forced to seek an alternative source of supply and imported river sand from Malaysia and Tamil Nadu floated tenders to import sand to overcome the sand shortage.
Sand, the backbone of the construction industry, has become a problematic resource to procure in India. Availability and inferior quality have both contributed to the price volatility in this mineral resource – classified as a minor mineral under the National Mineral Policy instituted in 1993. With the problems associated with sand, namely illegal mining by the sand mafia, heavy price volatility, inferior quality and non-grade material, high demand to spurt growth, sand is nothing less than a critical mineral of very high value. The industry needs an answer to the underlying supply side problems.

LITERATURE REVIEW

Banj A. Akinyemi a, Alhassan Elijaha , Aladegboye Oluwasegunb , Denen T. Akpenpuunc , Owolaja Glory in “The use of red earth, lateritic soils and quarry dust as an alternative building material in sandcrete block” (2020) showed that quarry dust and lateritic soil performed relatively better in comparison with the traditional river sand used in sandcrete blocks production. Also there was progressive improvement of the compressive strength of the tested materials over the period of curing regime adopted for the study. Red earth and quarry dusts showed good prospect as alternative to the use of river sand in sandcrete block production for developing nations.

Felekoglu et al (2017) observed that the incorporation of quarry waste at the same cement content generally reduced the super plasticizer requirement and improved the 28 days' compressive strength of SCC. Normal strength SCC mixtures that contain approximately 300–310 Kg of cement per cubic meter can be successfully prepared by employing high amount of quarry waste.

Kiran Kumar M S, Raghavendra Naik in "Experimental Study on Utilization of Red Mud and Quarry Dust in Cement Mortar and Concrete" International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 06 | June -2017. The optimum use of red mud is 20% as a partial replacement of cement by Red Mud. Thecompressive strength for 7 days 10.22% & 28 days 10.24%more than that of conventional concrete after 28-days curing period for 20% Red Mud + 40% UsedFoundry Sand.

Sachin S Fale, Sathish S. in their paper "Study of compressive strength of concrete by partial replacement of fine aggregate by natural sand with red soil" International Journal of Research In Science & Engineering, Volume: 3 Issue: 2 March-April 2017 concluded that The partial replacement of sand in concrete has been done using in a mix proportion M20 of 1:1.94:3.17 which gives the significant improvement in strength.

James Alexander. , Prof. Antony Godwin, Dr. S. Alexander in their paper "Study on Partial Replacement of Fine Aggregate with Red Soil in Concrete" International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 4 Issue V, May 2016 found that The optimum use of red mud is 20% as a partial replacement of cement by Red Mud. The compressive strength for 7 days 10.22% & 28 days 10.24% more than that of conventional concrete after 28-days curing period for 20%Red Mud + 40% Used Foundry Sand.

MATERIAL USED

Red Soil

Red soil **helps plants to grow better**. The red colour of the soil comes from the iron oxide in the rocks.Red soil is naturally available resources in plenty of quantity. It is like sand but mostly red in color and in addition it is mineral particles. It can be reduced significantly by mixing with red soil.

Figure 1- Red soil

Quarry Dust

Quarry Dust is made when huge rocks are broken down into small particles to construction in quarries. It is like sand but mostly grey in color and in addition it is mineral particles. Quarries and aggregate crushers are basic requisites for construction industry and quarry dust is a by-product of rubble crusher units. Geotechnical and mineralogical characterization of quarry dust and its interaction behavior with soils can lead to viable solutions for its large-scale utilization.

Figure 2- Quarry Dust

Fine Aggregate

Fine aggregates are essentially **any natural sand particles won from the land through the mining process**. Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. This product is often referred to as 1/4"' minus as it refers to the size, or grading, of this particular aggregate.

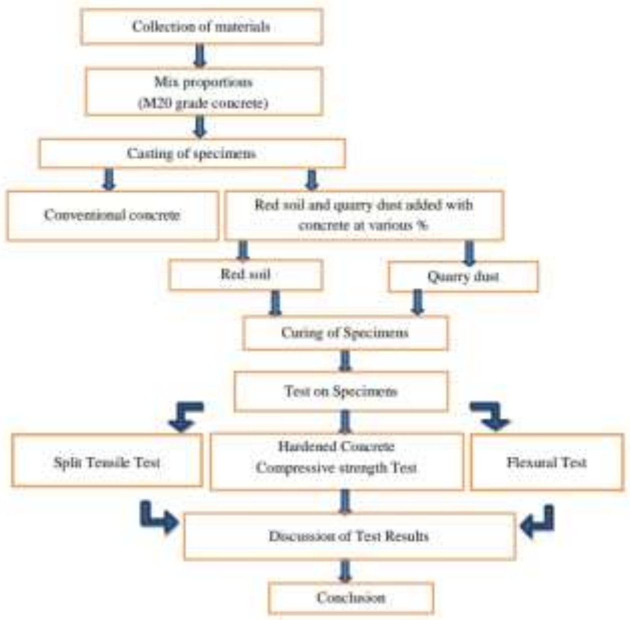
Figure 3- Fine aggregate

Coarse aggregates

Coarse aggregates are **any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter**. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

Figure 4 - Coarse Aggregate

MEDHODOLOGY



MATERIAL USED

1. Cement:- The cement used in this study was Portland pozzolona cement .
2. Fine Aggregate:- Fine aggregate of 10mm fine m-sand is used.
3. Coarse Aggregate:- Coarse aggregate used in this are size of 15cm.
4. Red Soil:- 10 mm fine red soil is been used.

MIX DESIGN AND SAMPLE PREPARTION

The concrete mixture have been made with 100 % replacement of fine aggregate with quary dust and red soil in concrete as 0%, 20% and 30%. First the constituents are weight according to the M20 mix ratio in separate bucket. Over all time take for mixing the concrete was about 5 min. The mix was been completely tamped in specimen and filled with tamping rod. The specimen were remolded after 24 hrs cured in water and then tested in room temperature at required ages. Mix design is known as the selection of mix ingredients and their proportions required in a concrete mix.

The mix design involves calculations of the amount of cement, fine aggregate and coarse aggregate in addition to other related parameters. The mix design calculations are dependent on the properties of the constituent materials.

DESIGN STIPULATIONS: M 20

1. For M20 grade of concrete characteristic strength at 28 days:20Mpa
2. Maximum nominal size of aggregate:20mm
3. Degree of quality control: Good
4. Type of exposure: Moderat

MATERIAL USED

1. Type of Cement: OPC (53 grade)
2. Specific Gravity of Cement: 3.15
3. Specific Gravity of Fine Aggregate: 2.61
4. Specific Gravity of Coarse Aggregate: 2.76

COMPRESSIVE STRENGTH TEST

The hardened concrete sample were tested for strength determination as per IS 516-1959 "METHODS FOR TEST FOR STRENGTH OF CONCRETE". Concrete cubes of size 150 mm × 150 mm × 150 mm were cast with and without granite dust and steel slag. After 24 hours, the specimens were demoulded and subjected to curing for 7, 28 days in portable water. Aftercuring, the specimens were tested for compressive strength using universal testing machine. The maximum load at failure was taken. The average compressive strength of concrete specimens was calculated by using the following equation.

Fig 5:- Compressive Strenght Testing

COMPRESSIVE STRENGTH FOR CONVENTIONAL CONCRETE

TABLE 1

S.No.	Days	Load (P) KN	Compressive strength (N/mm2)
1	7	450	20
2	7	455.4	20.24
3	7	448.2	19.92

Average compressive strength for 7 days – 20.05 N/mm2

TABLE 2

S.No.	Days	Load (P) KN	Compressive strength **(N/mm2)**
1	28	630	28
2	28	620	27.55
3	28	628	27.91

Average compressive strength for 28 days – 27.82 N/mm2

COMPRESSIVE STRENGTH OF RED SOIL (12%) AND QUARRY DUST (8%) CONCRETE FOR 7 DAYS AND 28DAYS.

TABLE 3

S.No.	Days	Load (P) KN	Compressive strength (N/mm2)
1	7	447.8	19.90
2	7	451.2	20.05
3	7	444.7	19.76

Average compressive strength for 7 days –19.90 N/mm2

TABLE 4

S.No.	Days	Load (P) KN	Compressive strength (N/mm2)
1	28	743.23	33.03
2	28	741.47	32.95
3	28	731.50	32.51

Average compressive strength for 28 days– 32.83 N/mm2

SPLIT TENSILE STRENGTH TEST

The hardened concrete sample were tested for strength determination as per IS 516-1959 "METHODS FOR TEST FOR STRENGTH OF CONCRETE".

Concrete cylinders of size 150 mm diameter and 300mm length were cast with incorporating copper slag as partial replacement of sand and cement. During casting, the cylinders were mechanically vibrated using a table vibrator. After 24 hours, the specimens were demoulded and subjected to curing for 28 days in portable water. After curing, the cylindrical specimens were tested for split tensile strength using compression testing machine of 2000 kN capacity. The ultimate load was taken and the average split tensile strength was calculated using the equation.

Split tensile strength (N/mm^2) = $2P/(\pi LD)$ Where, P=Ultimate load at failure (N) L=Length of cylindrical specimen (mm), D=Diameter of cylindrical specimen (mm).

Fig 6. Split tensil strength testing

SPLIT TENSILE STRENGTH FOR CONVENTIONAL CONCRETE

TABLE 5

S.No.	Days	Load (P) KN	Split Tensile strength (N/mm2)
1	7	197.92	2.80
2	7	189.43	2.68

Average split tensil strength for 7 days – 2.74 N/mm2

TABLE 6

S.No.	Days	Load (P) KN	Split Tensile strength (N/mm2)
1	28	258	3.65
2	28	243.86	3.45

Average split tensil strength for 28 days – 3.55 N/mm2

SPLIT TENSILE STRENGTH OF RED SOIL (12%) AND QUARRY DUST (8%) CONCRETE FOR 7 DAYS AND 28DAYS.

TABLE 7

S.No.	Days	Load (P) KN	Split Tensile strength (N/mm2)
1	7	155.5	2.20
2	7	166.8	2.35

Average Split Tensile strength for 7 days – 2.275 N/mm2

TABLE 8

S.No.	Days	Load (P) KN	Split Tensile strength (N/mm2)
1	28	226.19	3.20
2	28	231.14	3.27

Average Split Tensile strength for 28 days – 2.35 N/mm2

FLEXURAL STRENGTH TEST

The ultimate load was taken and the average flexural strength was calculated using the equation.

Flexural strength (N/mm2) = 3PL/ (4BD2)
Where, P=Ultimate load at failure (N)
L=Length of the beam specimen (mm),
D=Depth of the beam specimen (mm).
B=Breadth of the beam specimen (mm).

Fig 7. Flexural Strenth Testing

FLEXURAL STRENGTH FOR CONVENTIONAL CONCRETE

TABLE 9

S.No.	Days	Load (P) KN	Flexural strength (N/mm2)
1	7	7.73	2.32
2	7	8.20	2.46

Average flexural strength for 7 days – 2.39 N/mm2

TABLE 10

S.No.	Days	Load (P) KN	Flexural strength (N/mm2)
1	28	11.93	3.58
2	28	11.73	3.52

Average flexural strength for 28 days – 3.55 N/mm2

FLEXURAL STRENGTH OF RED SOIL (12%) AND QUARRY DUST (8%) CONCRETE FOR 7 DAYS AND 28DAYS.

TABLE 11

S.No.	Days	Load (P) KN	Flexural strength (N/mm2)
1	7	6.26	2.35
2	7	5.89	2.31

Average flexural strength for 7 days – 2.28 N/mm2

TABLE 12

S.No.	Days	Load (P) KN	Flexural strength (N/mm2)
1	28	8.80	3.03
2	28	8.53	3.20

Average flexural strength for 28 days – 3.115 N/mm2

CONCLUSION

As a part of preliminary work,the various material needed to be used for the further study,were obtained and their physical properties were determined.

A study on qurry dust and red soil was done which is proposed to be used in this experimental work.

A review of literature was done which was done which was helpful in getting a better idea on the topic.

The various per percentage of partial replacement of qurry dust+ red soil concrete has been discussed in this my project.

Compressive strength increases about compared to conventional concrete while adding 12% red soil and 8% quarry dust.

The annual sand demand for the construction industry in India is nearly 8 million cubic meters and all is obtained from major rivers. This present demand is expected to be 10 million cubic meters within next three years.

A review of literature was done which was helpful in getting a better idea on the topic.

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