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Impact of Kota Stone Refractory Waste and Crusher Sand on Properties of M-20 Cement Concrete

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Abstract: ***For any developing country, construction industry plays a key role. Construction industries require raw materials such as cement, sand and aggregates etc. Processing of raw materials have great impact on environment. Aggregates processing alone causes severe environmental issues such as erosion and loss of habitat. Stone processing produces 20 to 25 percent stone mass as waste. Stone waste can be utilized as alternative of aggregate and sand. Requirements of aggregate and sand can be reduced by the utilization of waste produced from stone processing industries. In the present study, a cement mix of M-20 grade has been made and tests have been performed to analyse the impact on various properties of M-20 cement concrete. This study presents the proper utilization of the waste in construction industry by testing the changes observed in the properties of M-20 cement concrete on mixing with stone waste to utilize the stone waste and to decrease the adverse effect on environment.***
Keywords: Stone industry, Mix design, Environment, Aggregate, Sand zone

I. INTRODUCTION

India is one of the fastest economically growing country in the world [1]. For the development of any country, construction industry plays a vital role. Indian construction industries consist of nearly 200 firms in corporate sector and additionally one lakh twenty thousand A-Class contractor have registered. Indian construction industries have been growing compound 20 percent per annum for the last five years. Indian construction industry contributes 8 percentages to GDP [2]. Increase in the development due to construction work has adverse effect on environment. Extraction of aggregates used in construction work produces acidic mine drainage. Mining of aggregate converts land use from agricultural land to non-cultivable land, moreover mining of aggregate generates noise, produces dust, causes erosion, sedimentation accompanied by loss of habitat [3]. The average production of admissible quality of Kota stone/Hectare land area is nearly 100000 Metric Ton yearly and ongoing trend of production level per year ranges 55 to 60 hectares' land brought under stone mining. In the process of stone cutting, nearly 20 to 25 percentage of stone mass comes out as waste [4]. Waste stone mass consists of small fragments of stone chips and very fine stone particles of size similar to sand. The present study gives emphasis on utilization of stone waste in construction industry as aggregate and sand and identifying impact on properties of cement concrete thereby reducing the environmental impact by utilization of stone waste in construction industry.

II. EXPERIMENTAL STUDY

This section presents details of tests performed required for the study.

A. Sieve analysis for gradation of aggregates: To obtain the size distribution curve for Kota stone aggregate, various sieves were arranged in decreasing order of their size from top to bottom. The total weight of the Kota stone aggregate is taken prior to testing. Aggregated was placed in the top sieve and covered by a lid. Then by using a shaking table, aggregates are sieved for 10-15 minutes. Weight of aggregate retained in each sieve was taken and it results in grain size distribution was concluded.

B. Sieve analysis for obtaining zone of sand: Sieve analysis is performed to obtain the zone of crusher sand. For this test sieves of size 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, and 150µ were arranged in descending order from top to bottom. The sample of 500gm sand was sieved and retained sand on each sieve has been weighted. Cumulative percentage of the weight of sand retained on each sieve calculated, then percentage finer than these sieves is calculated by subtracting the cumulative percentage of sand retained from 100.

C. Compressive strength test: This test is performed to obtain the compressive strength of cubes casted. As per Indian standards 9 samples were cast and were tested in CTM. In order to obtain compressive strength at various ages of concrete, the testing of three cubes was required at the interval of 3 days, 7 days, and 28 days after casting and continuous curing. A compressive load was applied on the faces of cubes that were in touch with mould at the time of casting. Loading was done till the first crack appeared in the cube. This load at which crack forms divided by area of a cube and compressive strength was calculated, which follows the concrete acceptance criteria given in clauses 16.1 and 16.3 of IS 456:2000[5].

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III. RESULTS AND DISCUSSIONS

This section presents the results obtained from the above mentioned tests.

1) *Sieve Analysis of Aggregate:* This when initially performed, resulted in about 50% of particles finer than 20 mm and retained on 4.75 mm. Though with a little hammering this percentage significantly rose to about 80% by weight.
2) *Sieve analysis for the Zone of sand*

Table 1: Sand Zone and Finer Percentage

Size of sieve (mm)	Weight Retained (g)	Cumulative Weight Retained (g)	Cumulative Percentage Retained (%)	Percentage Finer
10	0	0	0	100
4.75	15.6	15.6	3.12	96.88
2.36	172.4	188.0	37.6	62.4
1.18	171.4	359.4	71.86	28.14
0.6	42.4	401.8	80.36	19.64
0.3	49.8	451.6	90.32	9.68
0.15	19.2	470.8	94.16	5.84
Pan	15.6	486.4	97.28	-

On comparing the results with the Zone tables it can be interpreted that the obtained M-sand falls in the Zone-1.

3) *Mix-Design:* Based on the obtained properties in along with the shape of aggregate, mix design was calculated as per Indian Standards [5] for which the following ratio was obtained:

Table 2: Proportion of Mix Design

Water	Cement	Sand	Coarse Aggregate.
186	318	665	1172

4) *Compressive Strength under CTM:* The compressive testing was done at 3 days, 7 days, and 28 days for 3 cubes at each turn.

Table 3: Result of Compressive Strength Test

No. of Days	Load(kN) Cube 1	Load(kN) Cube 2	Load(kN) Cube 3	Strength (Mpa)
3	200	220	180	8.88
7	300	340	280	13.63
28	480	460	460	20.74

The strength when compared to M20 concrete satisfies the strength gain curve with very low variance. This positive response revealed that Kota stone aggregates and M-sand can be used for making low-grade eco-friendly concrete.

IV. CONCLUSIONS

This section presents the conclusions drawn from the results of tests performed.

A. The manufactured sand tested was revealed to be of Zone-1 and hence is suitable for construction.
B. The coarse aggregates can be easily obtained from the Kota stone residual by nominal hammering.
C. Mix-designed M20 grade concrete made from the Kota stone residual and Crusher-Sand was found in substantial agreement with the compressive strength criteria specified in Indian Standards.
D. Though there are still more tests that are needed to be conducted for higher grades of concrete, the tests still conclude that Kota Stone and crusher-sand mix can be used for low-grade concrete.

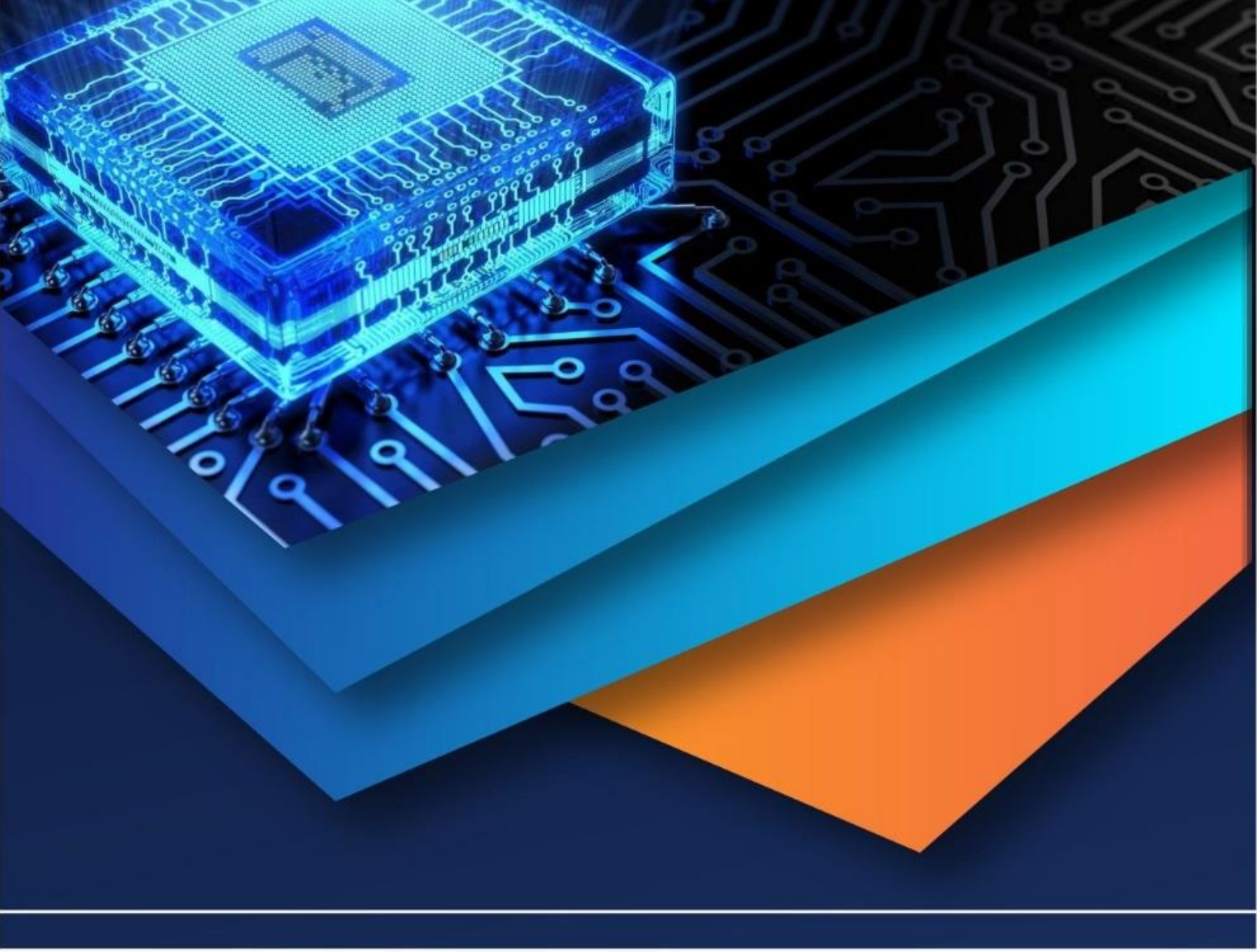
Above conclusions denotes that stone wastes can be used as aggregates and sand in the construction work which will help to minimize the environmental impact associated with aggregate mining industries and construction activity.

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