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Techno Economical Analysis for Sand Stone Chips as a Coarse Aggregate in Concrete

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Abstract: ***Sand Stone Chips is a waste material found from stone crusher industries. It has properties for use as partial substitute of Coarse Aggregates in concrete. Use of stone chips in concrete no longer only improves the quality of concrete however also preserve the coarse aggregates for future. In the experimental investigation, an experimental program changed into achieved to optimize the workability and compressive strength of concrete produce using stone chips as partial substitute of Coarse mixture. Stone industry generates both strong waste and stone slurry. The concrete enterprise is continuously looking for supplementary material with the objective of decreasing the strong waste disposal issue. In this investigation Sand stone chips is replaced with C.A., The investigation performed for M20 grade concrete with replacement of 0%, 10%, 20%, 30%, 40%, 50% stone chips by coarse aggregates to determine the most reliable percentage of substitution for maximum compressive strength.***
Keywords: Concrete, compressive strength, M 20 Grade, replacement, stone chips, workability.

I. INTRODUCTION

Aggregates are most important element in concrete that are usually present in natural form. Concrete is a combination of cement, fine aggregate, coarse aggregate and water. At present construction industry is growing exponentially due to several other factors besides increasing developmental activities. This results in huge demand of construction materials. Concrete is generally used for structural construction. Aggregates are most important element in concrete that are usually present in natural form. The naturally available source of coarse aggregate is limited as such conservation of the same is unevitable. Going for alternative and supplementary material which can be utilized as partial or full replacement of conventional material can play a vital role in conservation of natural resources. The requirement for Coarse aggregate in the building industry has therefore augmented because of the extensive use of concrete resulting in the decrease of aggregates sources. The depletion of natural aggregates generates also the environmental difficulty for example erosion and breakdown of river banks, lowering of river beds into the land. Thus an experimental investigation is required to recognize appropriate replacement that is environmental friendly, economical and superior for strength and durability performance. Stone chips are an industrial waste formed from stone industries for utilization in numerous construction applications in India. The amount of Stone chips waste generated due to the cutting is increasing every day; this put pressure on the limited number of land fill and suggests more sustainable use of such in construction development and in production of new products like concrete.
The utilization of Stone chips as coarse aggregate in concrete manufacturing the quantity of natural aggregate essential. This shifts mining method of natural aggregate, an actively costly and environmentally difficult procedure, while decreasing both the requirement for land area for extracting resources and amount of industrial waste that must be disposed of. [5]. Use of Stone chips in concrete as combination can save approximately 5% and 4 % the cost of concrete in step with meter cube with O.P.C, for that reason it may be say as low cost concrete and for sustainable development this material can be used in concrete [12]. More research is still needed to see its wider application in concrete especially as fully replacement of natural coarse aggregate. [2].

II. MATERIALS AND METHODS

A. Materials

The materials used in the projects for making concrete mixture are cement, Fine aggregate, coarse aggregate, Sand Stone chips, are detailed describe below

1) *Cement:* The cement used in this experimental investigation was OPC 43 grade and Properties of OPC Cement are as listed below in table 1.

Table 1: Testing on Cement

S. No.	Properties	Result values
1.	Standard consistency %	33%
2.	Initial setting time	45 min
3.	Final setting time	300 min
4.	Specific gravity	3.15
5.	Fineness	2%

2) *Fine aggregates:* Fine aggregate (FA) used in this investigation was the natural river sand, passing completely through 4.75 mm aperture size sieve and conforming to zone II as stated by IS:383-1970 specification. Properties of Fine aggregates are listed below in table 2.

Table 2: Properties of Fine Aggregates

S. No.	Test	Result
1.	Zone	II
2.	Specific gravity	2.5
3.	Fineness Modulus	3.76
4.	Water Absorption	0.59%

3) *Coarse Aggregate:* Coarse aggregate is a substitute of concrete mixture used for building concrete material. They can be within the variety of unequal broken stone or naturally occurring gravel. Materials that are large to be maintained on 4.75mm sieve size are named coarse aggregates. Its highest size shall be up to 20 mm. Properties of coarse aggregates are explained in table 3.

Table 3: Test of Coarse Aggregates

S. No.	Test	Result
1.	Water absorption	0.40%
2.	Specific gravity	2.94
3.	Fineness Modulus	7.07

4) *Water:* Potable water was used for mixing the concrete mix in entire investigation and for curing the concrete in the determination of the optimal percentage of stone chips as coarse aggregate replacement.

5) *Sand Stone Chips:* Stone Chips aggregates are created from stone cutting waste via crushing via machine or hammering and separation of most important length by using IS sieve. Stone waste which includes byproducts of cutting process of the sand stone from the various stone industries etc. Properties of sand stone chips are defined in table 4.

Table 4: Properties of Sand Stone Chips

S. No.	Test	Result
1.	Type	Crushed
2.	Specific gravity	2.8
3.	Maximum size	20 mm
4.	Total water absorption	0.3 %
5.	Fineness Modulus	8

6) *Mix Proportions:* Mixture ingredients used for concrete and concluded with their relative amount with the objective of manufacturing a concrete of the desired strength, durability as reasonably as possible is termed concrete mix design. Table 5 explained the mix proportion of concrete.

Table 5: Mix Proportions of Concrete Mix

Percentage Stone chips	Weight of Cement (kg/m^3)	Weight of C.A. (kg/m^3)	Weight of Sand Stone chips (kg/m^3)	Weight of Water(kg/m^3)	Weight of F.A. (kg/m^3)
0%	362.5	1414.14	0	145	647.5
10%	362.5	1272.72	141.41	145	647.5
20%	362.5	1131.31	282.82	145	647.5
30%	362.5	989.89	424.24	145	647.5
40%	362.5	848.48	565.65	145	647.5
50%	362.5	707.07	707.07	145	647.5

III. EXPERIMENTAL PROCEDURE

The evaluation of concrete with stone chips used as replacement of coarse aggregate materials is finished all through concrete specimen testing. Concrete include cement, water, F.A., C.A. & Sand Stone chips. Concrete is replaced with alternative materials by varying percentage of replacement. The waste Chips of stone is used as partially substitution for coarse aggregates in the range of 0%, 10%, 20%, 30%, 40% and 50% as per its weight and its optimum level is to be found. For analyzing the Chips of normal and other variation mix cubes of size 150x150x150mm were casted for compression strength test. Then dimensions beam 700x100x100mm is designed for flexural strength optimization. Once 24hours finished from casting the concrete specimens are opened and allowed for continuous curing in a tank with portable water. The specimen is taken and tested at required 7thday & 28th day from curing for compression test and flexural test at 28th day from curing. Then compare the Strengths of M20 design mixes with control cubes.

IV. RESULTS AND ANALYSIS

In this analysis the casted cubes of concrete are analyzed under various examinations to estimate the strength and other properties of the casted concrete cubes. The primary intention of the investigation is to optimize the established strength achieved by the concrete at several testing days from curing. Usually appropriate production and curing of concrete cubes will enhance the strength of the concrete. For this investigation separately test is performed with 3 samples for every mix ratio and tested at required curing days. Then the average values are used for the analysis. Details of performed experiments are explained below:

A. Slump Cone Test

This experiment is executed to confirm the workability of newly casted concrete. This test independently executed on newly casted concrete and the Sand stone chips replacing with Natural coarse aggregates to find the workability. The slump is very valuable in identifying variations in the consistency of a mix of given nominal proportions; it is a measure of consistency of the fresh concrete. This test is conducted immediately after the concrete has been made.

Table 6: Slump value of Concrete Mix

% Replacement	Slump Value
0%	92 mm
10%	91 mm
20%	91 mm
30%	90 mm
40%	88 mm
50%	86 mm

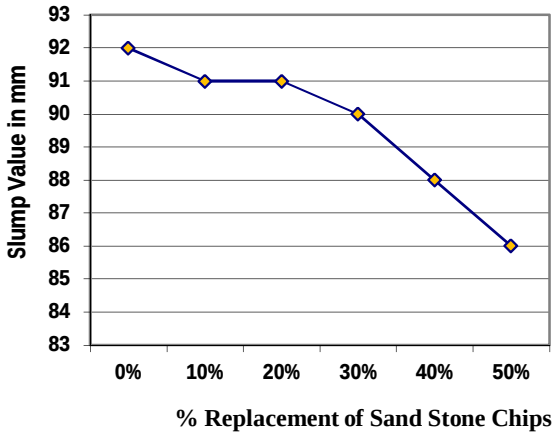

Figure 1: Slump Test values

B. Compressive Strength Test

In this Experimental investigation concrete cubes were tested and the average strength is compared with nominal mix of M20 Mix. Compressive strength investigation evaluated the heavy compressive load a material can stand below facture limit. The outcome of compressive strength at the age 7thday & 28th day are shown in Table 7 and Figure 2.

Table 7: Compressive Strength on Concrete M20 Cubes

Percentage Replacement of Stone Chips	Compressive Strength (N/mm²)	
	7 Days	28 Days
0%	17.28	27.99
10%	21.61	28.33
20%	20.66	28.88
30%	17.35	29.32
40%	16.88	24.6
50%	15.99	22.81

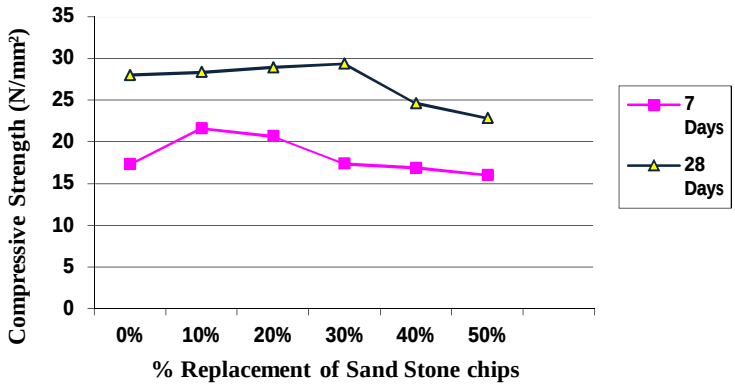

Figure.2: Compressive Strength of Concrete M20

C. Flexural strength

Flexural strength also called as modulus of rupture. In concrete flexure is the bending moment caused by the applied load, in which a concrete beam has compression at top and tensile stress at the bottom side. Beams on testing will fail in tension due to its property and shear will appear on concrete. In this experimental works totally 6-beams of size 700 x 100 x 100 mm are casted of M20 design mix concrete and other percentage of replacements as for 0%, 10%, 20%, 30%, 40% and 50% by weight of sand stone chips with coarse aggregates. Then compare the values of both design mixes. The flexural values of various mixes are displayed in Table.8 and Figure 3.

Table.8: Flexural Strength of Concrete at 28 days

Percentage Replacement of Sand Stone chips	Flexural Strength (N/mm²)
	M-20
0%	4.83
10%	4.96
20%	4
30%	3.5
40%	3
50%	2.8

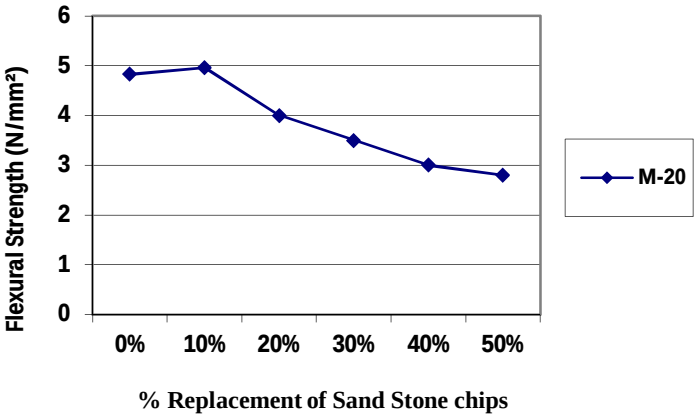

Figure.3**:** Flexural Strength at 28 Days

V. COST ANALYSIS

This Experimental analysis is based on 1m^3 M20 grade of concrete with OPC 43 grade made from conventional material and modified concrete made by substituting materials with 0 % to 50% Replacement of Coarse aggregates with sand stone chips coarse aggregates. Proportion of materials for mix 1:1.78:3.90 and the cost of production for all concrete mix are given in table 9 and Figure 4.

Table 9: Total cost of Sand Stone Chips Aggregates Concrete (Rs/m^3)

Sr. No.	Concrete Mix	Coarse Aggregates (Rs)	Sand Stone chips (Rs)	Fine aggregates (Rs)	Cement (Rs)	Total cost for 1m^3 concrete (Rs)
1.	0%	1060.60	0	1295	2320	4675.60
2.	10%	954.54	63.63	1295	2320	4633.17
3.	20%	848.48	127.26	1295	2320	4590.74
4.	30%	742.41	190.90	1295	2320	4548.31
5.	40%	636.36	254.54	1295	2320	4505.90
6.	50%	530.30	318.18	1295	2320	4463.48

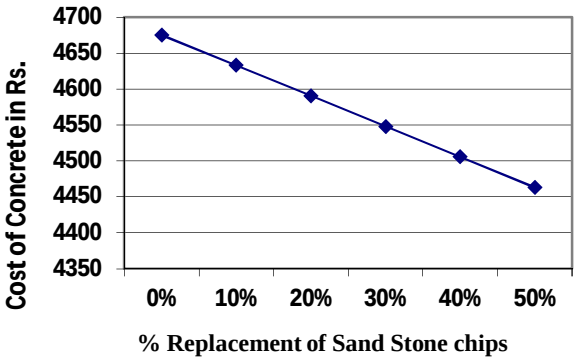

Figure 4: Cost of Concrete in Rupees per m3

VI. CONCLUSION

A. For 1m^3 M-20 grade of concrete 1414.14 Kg Coarse aggregates is required. Replacement of coarse aggregates by 10%, 20%, 30%, 40% and 50% by weight is done. As per experimental results, Maximum compressive strength is obtained for 30% sand stone chips replacement.

B. Use of sand stone chips in place of natural aggregates results in saving of rupees 127.29 per m^3 of concrete.

C. It reduces the depletion of conventional coarse aggregates and additionally allows providing green concrete.

D. As Sand stone chips are used in concrete, it reduces use of herbal combination which reduces mining to extract herbal mixture, which leads to decreased environmental contamination.

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