Investigation on compressive strength of concrete utilizing broken marble tiles as coarse aggregate

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Abstract - *In general, all the mines affect their surrounding environment to a little or more extent, but open cast mining i.e. in case of marble, granite, lime stone, sandstone and other type of building stone quarries leads to complex nature of environmental problems such as Choking of drains in rainy season , Dust nuisance , Fine particles of slurry (with size less than 363 micron) become air borne and cause air pollution , Slurry affects productivity of land due to decreased porosity, water absorption and percolation Slurry dumped areas cannot support vegetation and remain degraded , Due to long-term deposition of slurry on land and the finer particles block the flow regime of aquifers. Thus, seriously affecting underground water availability so these waste materials needs to be utilized meaningfully in an economic way. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. Marble stone industry generates both solid waste and stone slurry. The concrete industry is constantly looking for supplementary material with the objective of reducing the solid waste disposal problem. In that paper Broken marble is replace by Coarse aggregates the project is carried out by using M20 grade concrete with replacementof0%,5%,10%,15%,20%,25%,30%,35%,40%,45%,50% broken marble pieces by coarse aggregates and is carried out to determine the optimum percentage of replacement at which maximum compressive strength is achieved .There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled.*

KeyWords: Broken Marble Tiles, Cube Mould, Compressive Strength, Mix Design, Compaction

1. INTRODUCTION:

The basic requirements of all mankind are shelter. Hence the shelter is basic on the building construction in which cement concrete is aessential requirement.From the materials of varying properties to make concrete of stipulated qualities an intimate of the interaction of various ingredient that go in to the making of the concrete is required to be known, both in plastic condition. The strength of concrete depends upon the components such as aggregate water ratio, workability and consistency of mix, proportion and age of concrete. In this project broken marble tiles have been utilized which are obtained after the flooring work in FOREST VIEW APPARTMENT, HSR layout, Sector-2.In this project experimental studies were conducted to determine compressive strength of concrete mix on replacement of coarse aggregate by different proportions of broken marble tiles.The greenhouse gas emission associated with both the processing of the raw material and from the fuel burned to produce the expansion of the raw material pales in comparison to the environmental rewards derived from its use.

2. LITERATURE SURVEY

In Dr. T.Shekar at al/international journal of engineering science and technology (IJEST). As per this project studies on strength characteristics on utilization of waste material as coarse aggregate in concrete based on the studies conducted on strength characteristics of concrete made with utilizing waste materials, it was found that the concrete made with of waste broken marble tiles as coarse aggregate produced similar strength in compression. The compressive strength of concrete cubes made with broken marble tiles as coarse aggregate in concrete were found to be 16% and 26.34% lesser respectively than that of conventional concrete. Hence, it can be seen that waste broken marble tiles can be used an alternate reconstruction material to coarse aggregate in concrete. Besides economical strength criteria, concrete, concrete made from waste materials (broken marble tiles) as coarse aggregate, solves the disposal problem of these waste materials.Mineral Industry Research Organization (MIRO) by Scott Wilson in UK. It was financially supported by the aggregate levy sustainability fund (ALSF). As per this report focused on quarry fines produced from aggregates and sand gravel production. Quarry fines and dust are generated from various activities such as extraction (for example drilling and blasting) and rock preparation/beneficiation.

2. CONCRETE

Concrete is man-made material. The concrete is most commonly employed construction material. It consist of hard in organic material called aggregate such as gravel, sand and crushed stone, etc. mixing the material undergo chemical reaction and from the product of hydrated calcium silicate which binds the composition and act the mixture monolithic one after the solidification. The concrete attains great strength and it possess high compressive strength with age.

The ingredients of concrete are:

- Cement
- Aggregates
- Water
- Marble

2.1 Cement

The cement used was ordinary Portland cement 53 (OPC 53).All properties of cement were determined by referring IS 12269 - 1987. Cement is the most important constitution in that it forms the building medium for the discrete ingredients. It is made out of naturally occurring raw materials and sometimes blended or inter ground with industrial waste content come in type and chemical composition for general concrete construction.

The raw materials used for the manufacture of lime, silica, alumina and iron oxide. These oxides interact with one another in the kiln to form are complex compound. The relative proportion of these oxides composition is responsible for influencing the various properties of cement. Cement is the important building material in today's construction world. 53 grade Ordinary Portland Cement (OPC) conforming to IS: 8112-1989. Table 3.1 gives the properties of cement used.

2.2 Aggregates

These are inert in organic material employed in making of concrete about 75% of bulk concrete is made of aggregates. They often control the behavior of concrete.

Description of test	Test results obtained	Requirements of IS: 8112 1989
Initial setting time	65 minutes	Min. 30minutes
Final setting time	270 minutes	Max. 600minutes
Fineness (specific surface by Blaine's air permeability test)	412.92 m2 /kg	Min. 225 m2 /kg.

Aggregate are the important of concrete they can be classified as:

- Fine Aggregate
- Coarse Aggregate

2.2.1 Fine Aggregate

The sand which was locally available and passing through 4.75mm IS sieve is used. The important function of the aggregate is to increase the volume of the concrete fill up in voids between the coarse aggregate particles in suspension. This action plastically in the mixture and prevents the possible segregation of the paste and aggregate.

Locally available river sand, Clean and dry river sand available locally will be used. River sand is always preferable for making concrete. Sea sand is avoided; sand used for free from direct, organic material that deteriote with passage of time and creates voids.

2.2.2 Coarse Aggregate

The coarse aggregates with size of 20mm were tested. Aggregates were available from local sources. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability. The coarse aggregate in concrete are in greater volume, which contributes stability and durability of concrete. It forms bulk of concrete. It should be of proper shape, hard strong and well graded.

2.3 Water

Water is an important ingredient in the concrete mass, as it actively participants in the chemical reaction with cement is require for chemical reaction with cement compounds. The water should be added to require consistency. Water should be fresh and potable. Sea water and other blackish should not be used as the sculpture, aluminates present in the cement. The pH value should be between 6 to 7.

2.3.1Water-Cement Ratio

Water cement ratio has greatest influence of concrete quality of water in concrete is generally specified in terms of water cement ratio (w/c ratio).

2.4 Marble

In general there is only one type of waste named as cutting from in-site marble stone sites. During the processing of marble stone, the raw stone block is cut as demanded either into tiles or slabs of various thickness (usually 2 or

4 cm), using diamond blades. Water is showered on blades while marble stone blocks are cut into sheets of varying thickness, to cool the blades and absorb the dust produced during the cutting operation. The amount of wastewater from this operation is very large. It is not recycled as the water is so highly alkaline that, if re-used, it can dim the slabs to be polished. In large factories, where the blocks are cut into slabs, the cooling water is stored in pits until the suspended particles settle (sedimentation tanks), then the slurry is collected in trucks and disposed off on the ground and left to dry. This water carries large amounts of stone powder. The polishing operation is fully automated with the use of powdered abrasives that keep on scrubbing the surface of the stone until it becomes smooth and shiny

3. PRILIMINARY INVESTGATIONS

3.1 CEMENT

ULTRATECH 53 GRADES

Specific gravity – 2.833

Fineness modulus – 1 mm

Initial setting time – 60 min

Final setting time – 600 min

3.2AGGREGATE

3.2.1Fine Aggregate:

4.75 mm down size (zone-2 according to IS: 383 – 1970) was taken

Specific Water absorption – 1%

Specific gravity value - 2.50

Surface moisture – 2%

3.2.2Coarse Aggregate

20mm down size coarse aggregates was taken.

Specific Surface moisture - nil

Specific gravity value - 2.78

Water Absorption –0.5%

3.3. Broken marbles

Water absorption – 0.1%

Specific gravity – 2.10

4. Proportion

Broken marble chips along with the concrete mix the percentages of broken marble tiles are 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50% by the weight of the coarse aggregates.

5. METHODOLOGY

- Percentage of replacement 0% to 50%
- Maximum size of aggregates 20 mm
- Number of days for compressive strength – 7days, 28 days
- Proportion ratio – 1:1.5:3
- Grade of concrete – M20

6. CONCRETE MIX DESIGN

This mix was carried out according to IS: 10262 – 1982

Grade of concrete	M20
Maximum size of aggregates	20 mm
Shape of coarse aggregate	Angular
Degree of workability	0.85 compaction factor
Degree of the quality control	Good
Degree of exposure	Mild
Sand	Confirming zone

Table:1 Design Of Stipulation

Cement brand	Ultratech 53 grade
Specific gravity of the cement	2.833
Initial setting time of cement	60 minutes
Final setting time of cement	260 minutes
Specific gravity of coarse aggregate	2.29
Specific gravity of sand	2.50

Table2: Test Data for Materials

i. Standard deviation – 4%
ii. Target strength = fck+1.65*sd

=20+(1.65*4)
=26.6 N/mm^2

iii. Water cement ration is 0.525
iv. Compaction factor is 0.85
v. Water content per cubic meter of concrete is 186kg required water content is
=186+(186*3)/100
=191.58 lit/m^3
vi. w/c = 0.525
water = 191.58 lit
cement = 191.58/0.525=364.91 kg/mm^3
so the absolute volume of concrete in one m^3
=1-0.02
=0.98 m^3
vii. Determine of coarse aggregate and fine aggregate:-
Fine aggregate:
V=[w+(c/sc)+1/px(fa/sfa)]*(1/1000)
0.98=[191.58+(364.916/2.83)+1/0.335*fa/2.5]*(1/1000)
Fa=554.18 kg/m^3
Coarse aggregate:
V=[w+(c/sc)+(1/1-p)*(ca/sc)]*(1/1000)
0.98=[191.58+(364.91/2.83)+(1/1-0.335)*Ca/2.5]*(1/1000)
Ca=1014.58 kg/m^3

Cement	Sand	20mm CA
364.91	554.18	1014.58

Table3.Proportion by weight

Proportion by ratio

Cement: Sand: 20mm CA

1:1.5:2.7

7. PROPORTIONS OF SPECIMEN AND TESTING

7.1 Cube Moulds

Cube moulds are the standard size blocks of steel. They are open at top and having a base plate at bottom. Steel cube moulds are made of 6mm thick and (150*150*150) mm size.

7.2 Concrete specimen

For the preparation of good concrete the following steps are adopted

- Batching
- Mixing
- Placing and Compacting
- Curing

7.2.1 Batching

In batching, there are two methods

- By volume
- By weight

In this project, weight batching is adopted.

7.2.2Mixing

Mixing should ensure that the mass becomes homogenous, uniform in color and consistency. It is done by,

- Hand mixing
- Mechanical mixing

In this project, hand mixing was adopted; mixing concrete is then placed in the moulds, which is already oiled. Compaction of the concrete is the process adopted for expelling this entrapped air from the concrete. The compaction is carried out in 3 layers of 25 blows each. Then the moulds of followed for final setting (usually a day) the blocks are removed and kept for curing.

7.2.3 Curing

Curing is the process of maintain satisfactory moisture content and a favorable temperature in the concrete. The specimen was kept for curing for 28 days in the water as per planning of project.

7.3 PREPARATION OF CONCRETE CUBE

Moulds

Table:4. Compressive Strength with % Replacement of Broken Marble Tiles

Metal moulds, preferable steel or cast iron, thick enough to prevent distortion are required. They are made in such a manner as to facilitate the removal of the molded specimen without damage and are so machined that, when it is assembled provided with a metal base plate having a

Plane surfaces. The base plate is of such dimension has to stop the during filling without leakage and it is preferably attached to the moulds by spring or screws ready for use, the dimension and internal faces are required to be accurate within the following limits.

The height of moulds and the distance between the opposite face are of the specified size+0.2mm the angle between adjacent internal faces and between internal faces and top and bottom places of moulds is required to be 90+0.5. The interior faces of the moulds. The plane surfaces with a permissible variation of 0.03mm. Each mould is (150*150*150).

Replacement of C.A by Broken Marble Tile in %	7 days Compressive Strength in N/mm2				28 days Compressive Strength in N/mm2			
	specimen 1	Specimen 2	Specimen 3	AVG	Specimen 1	Specimen 2	pecimen 3	AVG
0	20.13	21.11	20.10	**21.11**	31.11	30.00	22.22	**28.27**
5	18.77	22.88	20.62	**20.75**	27.66	28.44	26.64	**27.24**
10	19.00	21.33	22.66	**20.99**	28.00	29.77	28.44	**27.73**
15	21.30	21.12	20.33	**20.91**	28.88	26.66	30.22	**27.58**
20	19.81	21.60	21.33	**20.93**	27.77	30.11	28.88	**27.92**
25	23.11	21.33	17.77	**20.73**	32.00	30.66	22.22	**27.29**
30	23.00	18.66	20.22	**20.62**	32.00	24.00	28.00	**27.00**
35	20.88	21.98	19.88	**20.91**	24.44	26.66	33.77	**27.29**
40	19.88	21.00	21.63	**20.83**	29.77	26.66	28.88	**27.43**
45	21.33	21.44	19.52	**20.75**	28.44	27.66	28.55	**27.21**
50	20.98	21.55	20.33	**20.95**	30.66	26.66	28.66	**27.57**

7.4 Compaction

The test tube specimens are made as soon as practicable after mixing and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance. The concrete is filled into the mould in layer approximately 5cm deep. In placing each scoopful of concrete. The scoop is required to be moved around the top edges of the mould as the slides from it. In order to ensure the symmetrical distribution been compacted the surface of concrete is brought to the finished level with the top of the mould, using a trowel. The top is converged with a glass or metal plate to prevent evaporation.

The cubes are de-molded after 24 hours and left for curing. After curing with the help of compression testing machine, the specimen is compressed till the failure occurs in cube as per IS: 516-1959 code of practice. In the compressive testing first the cube is placed then the load is applied on the cube. As the cube fails the load is noted and then compressive strength is calculated.

8. Hardened Concrete Properties

8.1 Compression Test:

The cube specimens of size (150mm*150mm*150mm) prepared and tested for their strength.

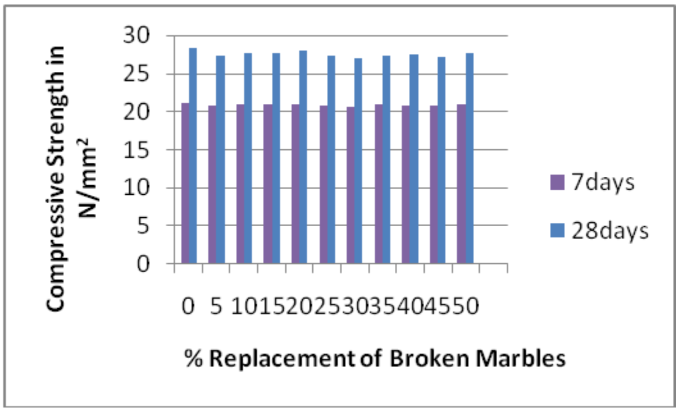

Chart -1: Compressive Strength with % Replacement of Broken Marble Tiles

9. DISCUSSION

The concrete specimens were prepared using different percentages of broken marble tiles as replacement of coarse aggregates.

9.1 Compressive Strength:

The compressive strength noticed after 7 days of curing for 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% and 50% were found to be 21.11 N/mm², 20.75 N/mm², 20.99 N/mm², 20.91 N/mm², 20.93N/mm², 20,73 N/mm², 20.62 N/mm², 20.91 N/mm², 20.83 N/mm², 20.75 N/mm², and 20.95 N/mm² respectively. It is observed that the compressive strength values are slightly higher and comparable with that of plain concrete specimen.

The compressive strength noticed after 28 days of curing for 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% and 50% were found to be 28.27 N/mm², 27.24 N/mm², 27.73 N/mm², 27.58 N/mm², 27.92 N/mm², 27.29 N/mm², 27.00 N/mm², 27.29 N/mm², 27.43 N/mm², 27.21 N/mm² and 27.57 N/mm² respectively. It is observed that the compressive strength values are slightly higher and comparable with that of plain concrete specimen.

10. CONCLUSIONS

- It is feasible to use the concrete by repacking coarse aggregate by broken marble tiles up to 50%.

- It can be concluded that broken marble tiles which are treated as waste products after flooring work can be used as a useful material for concrete.
- From the present experimental investigation it was found that the recycled aggregates will influence much in hardened properties of concrete.
- Use of such broken marbles cuts down the cost of construction.
- The compressive strength of concrete cubes made with broken marble tiles as coarse aggregate in concrete were found to be 16% and 26.34% lesser respectively than that of conventional concrete.
- Hence, it can be seen that waste broken marble tiles can be used an alternate reconstruction material to coarse aggregate in concrete.

ACKNOWLEDGEMENT: I would like to extend my most profound gratitude and deepest thanks to my students, Mohammed Favas, Ismail Abdullah & Remshed Shaher Department of Civil Engineering, NHCE, BANGALORE for their assistannce, commitment and encouragement throughout the entire period of the research project . Their Dedication and continuous assistance enabled me to remain focused on the research investigation from the beginning of the project to the very end for all the time spent on coordinating and supervising the whole thesis.

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