# Waste Marble Chips As Concrete Aggregate

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***Abstract* - The study is based on the use of waste marble chips as concrete aggregate. The high consumption of raw material like coarse aggregate will result in shortage of such aggregate in future. This will result in environmental damage because of the associated mining and disposal work. Presently large amount of marble waste is generated in marble stone processing in marble industries. Therefore, by this study it is intended to investigate the possibility of using these waste marble as aggregate for concrete. Further, with the help of this study we intend to make economical concrete.**

***Index Terms* - waste marble chips, coarse aggregate, environmental damage, economical concrete.**

## I. INTRODUCTION

By virtue of its size, construction is one of the largest users of energy, material resources and water, and it is a formidable polluter [1]. There is increasing concern now that the choice of construction materials must also be governed by ecological considerations. Today, concrete is the widely used man made material in construction industries which consumes considerable amount of coarse aggregate. Globally, for concrete making, we are consuming sand, gravel, and Crushed rock at the rate of 10 to 11 billion tons every year [12].

Marble waste produced from marble industries as a result of production. More production equals more waste, more waste creates environmental contamination. A high volume of marble production has generated a considerable amount of waste materials; almost 70% of the minerals gets wasted in the mining, processing and polishing stages which have a serious impact on the environment [6]. An economically viable solution to this problem should include utilization of these waste materials for new products especially in construction applications which in turn minimizes the heavy burden on the nation's landfills, saves natural resources, energy and reduces environmental pollution.

If the waste product of one industry is recycled as a substitute for the raw material of another industry, it will thereby reduce the environmental impact of both. Use of recycled aggregate in concrete can be useful for environment protection. Recycled aggregates are the materials for the future. Many countries are giving infrastructural laws relaxation for increasing the use of recycled aggregate [7]. The advancement of concrete technology can reduce the consumption of natural resources and energy sources which in turn further lessen the burden of pollutants on the environment [8].

Marble chips is an industrial waste produced from cutting of marble stone for usage in various construction applications in India. The amount of marble 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 use of marble chips as coarse aggregate in concrete reduces the amount of natural aggregate required. This displaces mining process of natural aggregate, an energetically expensive and environmentally problematic process, while reducing both the need for land area for extracting resources and amount of industrial waste that must be disposed of.

Now-a-days waste marble chips has found to be more useful and research has been conducted to examine their application. Waste marble is well usable instead of the usual aggregate in the concrete paving block production[10]. Use of waste marble in concrete as aggregate can save about 5% and 4 % the cost of concrete per meter cube with O.P.C and P.P.C respectively, thus it can be say as economical concrete and for sustainable development this material can be used in concrete[11].

More research is still needed to see its wider application in concrete especially as fully replacement of natural coarse aggregate. The objective of this study is to provide a more scientific evidence to support the reuse of accumulated marbles waste in India; by investigating into the following hardened properties of concrete with waste marble chips, compressive strength, split tensile strength and flexure strength. If this is successful there will be less demand on natural aggregate, thus providing possible solutions to environmental contamination by mining and depletion of natural resources.

## II. MATERIALS & METHODOLOGY

### CEMENT[5]

Ordinary Portland cement conforming to IS:383-1967 up to date.

### MARBLE CHIPS[9]

Marble chips used is of the size of inbetween 16mm retain and 20mm passing from IS Sieve. Sampling of waste marble is done through hand sampling.

TABLE-1: Various physical properties of marble chips

| | |
|---|---|
| Fineness modulus | 6.598 |
| Water absorption | 0.5% |
| Specific gravity | 2.78 |
| Impact value | 22.68 |
| Crushing value | 30.10 |
| Abrasion value | 10.46 |

**SIZE OF SPECIMEN**

Size of specimen used for various testing are as below:-

TABLE-2: Size of Specimen

| Type of Mould | Size(mm) |
|---|---|
| Beam | 150*150*700 |
| Cube | 150*150*150 |
| Cylinder | 150*300 |

**SPECIMEN PREPARATION**

The batching of concrete was done by weighing the different constituent materials based on the adopted mix proportion of M25(1:1:2). Waste marble chips are fully replaced with natural coarse aggregate.

The water cement ratio used was 0.45% by weight. The freshly mixed concrete was then filled in various size of mould shown in TABLE-2 with each layer given 25 strokes of the tamping rod. Samples were held in the room temperature for curing. The tastings were conducted at the age of 7$^{th}$ day, 21$^{st}$ day and 28$^{th}$ day.

**TEST PROCEDURE**

1) Compressive strength test

We were used cubical specimen for this testing purpose. We collect the result for compressive strength at the age of 7$^{th}$ day, 21$^{st}$ day and 28$^{th}$ day until the specimen fails in compressive testing machine. The results are shown in the form of graph.

2) Split cylinder test

We were used Cylindrical specimen for this testing purpose. We collect the result at the age of 7$^{th}$ day, 21$^{st}$ day and 28$^{th}$ day until the specimen fails in the compressive testing machine. The results are shown in the form of graph.

3) Flexural strength test

We were used beam specimen for this testing purpose. We collect result at the age of 7$^{th}$ day, 21$^{st}$ day and 28$^{th}$ day until the specimen fail in universal testing machine. The results are shown in the form of graph.

## III. Results And Discussion

**Compressive strength result[2]**

Compressive strength test were conducted with reference to IS 516:1959. Compressive strength test results are shown in Table-3 and Graph-1. Waste Marble concrete showed increase in compressive strength upto 81.32% compared to the plain concrete at the age of 28$^{th}$ day. On the observation of result of compressive strength test it is clearly seen that result of 28$^{th}$ day is decrease by 5.56% than 21$^{st}$ day result, the reason behind it could be the poor curing conditions of mould as compared to other mould specimen.

**Split Tensile test[3]**

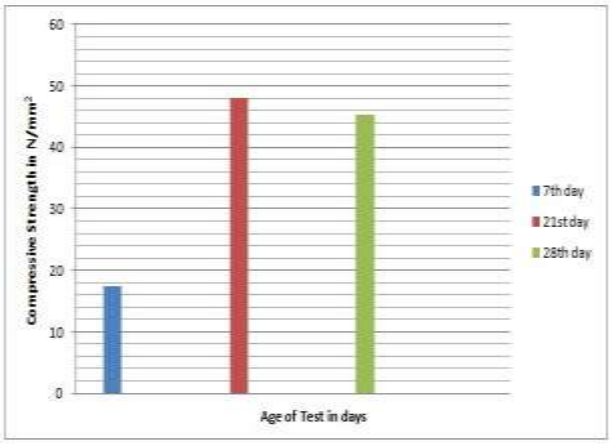
Split Tensile test were conducted with reference to IS-2386(Part-3)-1963. Split Tensile test results are shown in Table-3 and Graph-2. Waste Marble concrete showed increase in tensile strength upto 46.20% compared to the plain concrete at the age of 28$^{th}$ day.

**Flexural Strength test[3]**

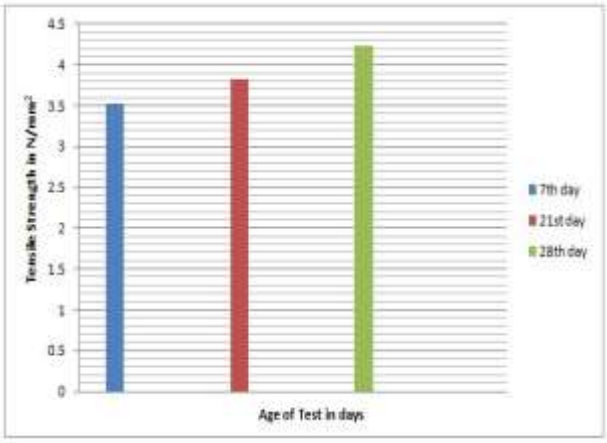
Flexural strength test were conducted with reference to IS-2386(Part-3)-1963. Flexural strength test results are shown in Table-3 and Graph-3. Waste Marble concrete showed increase in flexural strength upto 43.42% compared to the plain concrete at the age of 28$^{th}$ day.

Table-3 Results of marble concrete with comparison to plain concrete

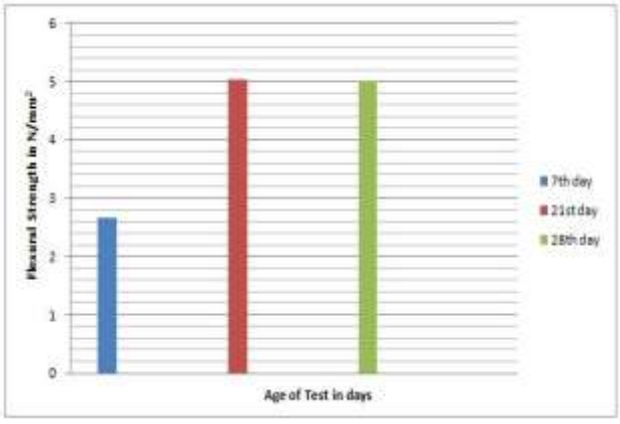
| IS Test | IS Reference No. | Marble concrete results(N/mm$^2$) | | | Plain concrete results (N/mm$^2$) |
|---|---|---|---|---|---|
| | | 7$^{th}$ day | 21$^{st}$ day | 28$^{th}$ day | 28$^{th}$ day |
| Compressive Strength of Concrete | IS-516- 1963 | 17.33 | 48 | 45.33 | |
| Split Cylinder Test | IS-2386(Part-3)- 1963 | 3.53 | 3.82 | 4.24 | 2.9[4] |
| Flexure Strength of Concrete | IS-2386(Part-3)- 1963 | 2.67 | 5.04 | 5.02 | 3.5[5] |




Graph-1 Compressive strength result




Graph-2 Tensile strength result




Graph-3 Flexural strength result

On the observation of result of compressive strength test it is clearly seen that result of 28$^{th}$ day is decrease by 5.56% than 21$^{st}$ day result, the reason behind it could be the poor curing conditions of mould as compared to other mould specimen. Thus it is highly recommended to keep all the specimen under the healthy curing condition.

Due to hand sampling of marble chips, the surface of marble remains polished which cannot be able to make good bond with cement slurry this drawback can directly affects the strength of concrete. However, marble industries generate marble waste with polished surface. Thus, it is highly recommended that the marble waste with polished surface should not be used for construction purpose.

**COST ANALYSIS**

Table-4 Cost per $1m^3$ Concrete

| Concrete Mix. (M25) | Marble concrete | Plain concrete |
|---|---|---|
| Fully replacement | 6748 INR | 7291 INR |

**(As per market survey 2014/15)**

## IV. CONCLUSION

- From the above study it can be concluded that the waste marble chips can be used in concrete production as a coarse aggregate with fully replacement with natural aggregate.
- Upon cost analysis result it is proved that the marble concrete proves more economical at rate of around 7.44% than concrete made with conventional coarse aggregate.
- As marble chips is used in concrete, it reduces use of natural aggregate which reduces mining to extract natural aggregate, which results in reduced environmental contamination.
- It reduces the depletion of conventional coarse aggregates from environment and also enables to produce Green Concrete.
- Thus, an innovative construction material is produced through this study.

## V. ACKNOWLEDGEMENT

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