EXPERIMENTAL STUDY ON CONCRETE BY USING MARBLE DUST AND DISMANTLED CONCRETE AS AGGREGATES

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ABSTRACT : Concrete is a heart material for any construction in the world. Based on the usage of materials in globe the water gets first place. And the concrete gets second place. The materials used for preparation of concrete is cement, fine aggregate (Sand), coarse aggregates (HBG metal) and water. Normally fine river sand is used for fine aggregates. The scarcity of sand due to more usage in entire global. This scarcity leads to increase the cost and reduce natural sources. Therefore we should use alternative material in the replacing of natural sand. That selected alternative material should satisfy the properties of concrete and should not cause decreases the strength of concrete. Normally Hard broken granite metal is used for coarse aggregates. The scarcity of HBG metal is also occurs due to more usage in global. Out of total volume of concrete more volume occupied by coarse aggregates. Air pollution also occurs due to crushing of granite stones. Therefore the alternative selected materials should not cause environmental pollution. The present experimental study is done on concrete by using marble dust is an alternative material for fine aggregates and demolished concrete as aggregates are alternative materials for coarse aggregates. The concrete main parameters are Characteristic compressive strength, Cylindrical spilt tensile strength and Beam flexural strengths are investigated. In this work M25 grade concrete mix was designed as per IS code mix design. The dimensions of specimens are 150*150*150mm cubes are casted for checking Characteristic compressive strengt. The dimensions of cylinder 300mm length and 150mm diameter cylinders are casted for checking spilt tensile strength. The dimensions of beam 700mm length and 150*150mm cross section beams are casted for checking flexural beam strength. The concrete is prepared by partial replacement of fine sand with marble powder at various percentages are 0%,25%,50%, 75%. And Partial replacement of HBG metal with demolished concrete as aggregates at various percentages are 0%,05%,10%,15%. And evolution of strength parameters of each grade of concrete for each proportion in the form of cubes, cylinders and beams for testing at 7days,14days and 28days periods. The strength parameters of concrete increases with replacement of sand with marble powder and replacement of HBG metal with demolished concrete as aggregates up to 50% and 10% only. Otherwise decreases the strength parameters of concrete. Demolished concrete are used as aggregates which are having irregularities with hardened cement paste. The usage of these aggregates in concrete is effective in good bonding. The usage of marble dust in concrete with size between 75 to 90 microns is effective in filling the pores in concrete.

Keywords: marble powder,demolished concrete as aggreagates,concrete,characteristic compressive strength,spilt tensile strength, and flexural beam strength.

I. INTRODUCTION

River sand is most commonly used as a fine aggregate in the production of concrete and its continuous usage poses the problem of acute shortage in many areas ,serious problems with respect to its availability, cost and environmental impact. The basic objective of the study was to identify alternative source of good quality aggregates. The present investigation is to study about the effect of marble dust and demolished concrete on the mechanical properties of concrete, when replaced with fine aggregates and coarse aggregates in different percentages. Demolished concrete as aggregates are having irregularities with hardened cement paste. The usage of these aggregates in concrete is effective in good bonding. The usage of marble dust in concrete with size between 75 to 90 microns is effective in filling the pores in concrete.Using alternative materials place of natural material. concrete production makes concrete as sustainable and environment friendly construction material. Now a days most of the researchers have focus on use of the waste materials in concrete according of their properties. Wastes generated by industrial and agricultural processes have created disposal and management problems which pose serious challenges to efforts towards environmental conservation their use contributes to resource conservation, environmental protection and the reduction of construction costs.

1.1 Concrete:

Concrete is a artificial rock when it hardened. Concrete is a composite material, which is made froma mixture of cement, aggregates (sand and gravel), water and sometimes admixtures in required proportions. It is one of the most important and useful materials for construction work. When all the ingredients (cement,aggregate,water) are mixed in the required proportions , the cement and water start at a reaction with each other to blind themselves into a harden mass. This hardens rock-like mass is known as concrete.

1. 2 Materials used for Concrete Preparation:

- cement
- sand and waste marble dust
- fine aggregates and coarse aggregates
- demolished concrete
- potable water

1. 3 Cement:

Generally, selection criteria for cement is depend on requirement of strength and durability of concrete. The cement used in this experimental works is "53 Grade Ordinary Portland Cement". Grade-53 cement has the good quality and high durability. It is generally used for concreting of residential buildings.

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Cement is the most widely used material in existence and is only behind water as the planet's most-consumed rresource.

Table-1: PROPERTIES OF OPC 53 GRADE CEMENT

S .no.	Characteristics	Value obtained Experimentally
1	Specific Gravity	3.16
2	Normal Consistency	32%
3	Initial Setting Time	27 minutes
4	Final Setting Time	600 minutes
5	Fineness	3.2%
6	Soundness of Cement	0.2

1. 4 Marble powder:

The present study is aimed at utilizing waste marble powderconstruction industry itself as fine aggregate in concrete, replacing natural sand. Normally the size of marble powder is between 90 microns to 75 microns. The replacement of sand with marble dust at 0%,25%,and 75%. The mechanical properties (compressive,spilt tensile,and flexural beam strength) are increases with the increase in percentage of marble dust up to 50%. Marble dust can be replaced without affecting the target strength.

Chemical properties of marble powder

Ferric oxide +Aluminium oxide +Silicon dioxide.	72 to 82%
Magnesium oxide.	1.3 to 2%
Sulphur trioxide.	1.1%
Sodium oxide.	1.3%
Calcium oxide.	0.6
Potassium oxide.	0.08
Loss on ignition.	2.8 to 3%

Physical properties of marble powder

Specific gravity.	2. 65
Water absorption (%)	0.85
Particles retained on 75 microns sieve(%)	1.5

1.5 Necessity for use of marble powder

Marble stone industry jenerates both solid waste and stone slurry. Whereas the solid waste results from the rejects at mine sites or at the processing units, stone slurry is a semi liquid sunstance consists particles originating from the sawing and polishing process and water used for cool and lubricate the cutting and sawing tools. The slurry form substance about 20% formed due to polishing and sawing precess. Therefore reuse and recycle of those waste marble powder should be done.

1.6 Applications of marble powder

An additive for thermoplastic and as a hardening agent for rubber industry are as follows:-

- Power coating, paints and ceramic industry
- Reinforced polyester glass fibre
- Leather cloth and flooring applications
- Detergent applications
- Glass industry (in manufacturing sheet & optical glasses)

1.7Fine aggreagate:

Fine aggregate is the natural material. The fine aggregate effectively fills all the open spaces in the middle of coarse aggregates. Therefore, it diminishes the porosity of the last mass and significantly builds its quality. The fine aggregate means the stones which are passing through the 4.57 mm sieve with specific gravity of 2.79 and water absorption is 3.5%.

Sand is naturally occurring material from rock and minerals by weathering and composed of majorly SiO_2, and calcium carbonate. The sand used throughout the experimental work was obtained from the Godavari River i.e., locally available.

Table-2: PROPERTIES OF FINE AGGREGATE

S .no.	Characteristics	Value obtained Experimentally
1	Fineness Modulus of fine aggregate	2.72
2	Specific gravity of fine aggregate	2.61

1.8 Coarse aggregate:

Those particles that are predominantly retained on the 4.75 mm (No. 4) sieve are called coarse aggregate. The coarser the aggregate, more economical the mix. Larger pieces offer less surface area of the particles than an equivalent volume of small pieces. Use of the largest permissible maximum size of coarse aggregate permits a reduction in cement and water requirements. Using aggregates larger than the maximum size of coarse aggregates permitted can result in interlock and form arches or obstructions within a concrete form. That allows the area below to become a void, or at best, to become filled with finer particles of sand and cement only and results in a weakened area.

Coarse Aggregates are a main material of concrete. The role of aggregate is to give reinforcement in concrete. The 10mm and 20mm sized coarse aggregates are used. The water absorption capacity of it is 2%.

Table-3: PROPERTIES OF COARSE AGGREGATE

S .no.	Characteristics	Value obtained Experimentally
1	Fineness modulus of coarse aggregate	6.15
2	Flakiness index	39.18%
3	Elongation index	42.27%
4	Specific gravity of coarse aggregate	2.631
5	Impact test	19.3%

1.9 Demolished concrete:

When demolished concrete is crushed, a certain amount of mortar and cement paste from the original concrete remains attached to stone particles in recycled aggregate. This attached mortar is the main reason for the low quality of recycled coarse aggregates compared to natural aggregate. The replacement of normal coarse aggregate with demolished concrete at 0%,5%,10%,and15%. The mechanical properties of concrete increases with replacement of demolished concrete up to 10% only.

Chemical properties of demolished concrete

Calcium oxide.	23 to 28%
Silicon dioxide.	55 to 60 %
Aluminium oxide.	13 to 18%
Iron oxide.	3 to 5%
Sodium oxide	3 to 4%
Calcium oxide	1.8%
Potassium oxide	1.5%
Titanium dioxide.	0.8%

Physical properties of demolished concrete

Finesse modules.	8%
Specific gravity	2.5
Water absorption (%)	0.6

Aggregate Crushing value(%)	29.58
Aggregate impact value(%)	18.36
Moisture content(%)	4.2

2. LITERATURE REVIEW

Bahar Demirel (2010) investigated four different series of concrete-mixtures by replacing the fine sand with dust from marble waste (WMD) at different proportions of 0, 25, 50 and 100% by weight. It was discovered that the mixing of WMD in different proportions has shown an improving influence on compressive strength.

H. Hebhoub et.al (2011) display the likelihood of using wastes from marble as an alternative of natural aggregates in cement production. Experimental research was allotted on three groups of concrete mixtures, fine sand substitution, gravel substitution and a combo of every aggregate. The outcomes show that the mechanical properties of concrete samples were good and victimization the marble wastes were found to adapt to the concrete production standards.

Baboo Rai et.al (2011) studied the effect of exploitation marble powder and granules as constituents of fines in mortar or concrete by partly reducing quantities of cement additionally as different typical fines has been studied in terms of the relative workability, compressive strength as additionally as flexural strengths. Partial replacement of cement and usual fine aggregates by varied proportion of marble powder and marble grains reveals that lifted waste marble powder (WMP) or waste marble granule (WMG) ratio has positive effect on workability as well as compressive strength of the mortar and cement concrete.

Ali Ergun (2011) studied about Diatomite and test outcomes mentioned that the cement samples containing ten % diatomite & 5% WMP and 5% WMP +10% diatomite had the better compressive & bending strength. The replacement of concrete with diatomite & WMP independently as well as along having a very plasticizing admixture may be used to enhance the mechanical properties of the typical concrete combination of mixtures.

P.A. Shirule et. al (2012) investigated physical, chemical and mechanical properties of the waste and concluded that with 10% inclusion of marble dust the initial strength gain in concrete is high. Hassan A. Mohamadien (2012) investigated the replacement and addition quantitative relation of each marble powder and silicon oxide fume with cement content independently 0%, 5%, 10%, 15%, 20%, 30% and 50% by weight and ascertained that the strength developments at seven, and twenty eight days and therefore the highest development rate of compressive strength was ascertained at 15% replacement proportion of each the marble powder and silica fume independently.

Ramamurthy(1997) study on properties of concrete making with demolished concrete as aggregates at various percentages. At 10%of demolished concrete, Compressive strength and spilt tensile strength are moderate. Otherwise decreases.

Omar M. Omar et. al (2012) has done study by experiment undertaken to research the influence of partial replacement of fine aggregate with waste from limestone (LSW), with marble powder (M.P) as an additive on all the concrete properties. The replacement proportion of sand with rock waste, 25%, 50%, and 75% were practiced within the concrete combines except within the concrete mix. It had been found that rock waste as fine combination increased the slump take a look at of the contemporary concretes. However the unit weight concretes weren't affected.

Satish Chandra and Rajan Choudhary (2013) explored the attainable use of those three industrial wastes, in conjunction with lime hydrate & standard stone from quartzite used as filler in construction with bitumen. Completely different take a look at procedures area unit accustomed examine the void and clay content material in the 5 fillers. Mixes of Bituminous concrete (BC) have been designed constant with the Marshall technique at 4 absolutely specific possibilities of the five styles of fillers. Many of the three commercial wastes and marble dirt is the good filler and could prove to be very cost-effective

3. METHODOLOGY

3.1 CHARACTERISTIC COMPRESSIVE STRENGTH

Compressive strength test on concrete is done by casting and curing of an standard cube mould of size 150mm x 150mm x 150mm. After curing, specimens were allowed to dry in air. The dried specimens were centered on a compression testing machine and testing were conducted as per IS 516-1959. To determine the compressive strength, cubes were casted with different percentage of Marble Dust Powder, Demolished concrete as aggregates. After that, the casted specimen are tested at 7, 14 and 28 days. The optimum percentage of Marble Dust Powder, Demolished concrete as aggregates were again casted and tested at 7, 14 and 28 days.

It is determined from the expression given below.

Compressive strength $\sigma b = P/A$, in Mpa

Where, P = Maximum applied load in KN

A = Area of mould

AS per (IS 516-1959) Compressive Strength The compressive strength of concrete is given in terms of the characteristic compressive strength of 150 mm size cubes tested at 28 days (fck). The characteristic strength is defined as the strength of the concrete below which not more than 5% of the test results are expected to fall.

Table 4 : Characteristic compressive strength results

% of marble dust and dismantled concrete	Characteristic compressive strength (mega Pascal's)		
	7 Days	14 Days	28 Days
0%	16	22	24
25% and 5%	17. 4	25. 6	26. 5
50% and 10%	19. 7	26. 3	27. 75
75% and 15%	12. 7	15.70	19. 2

3.2 SPILT TENSILE STRENGTH:

Spilt tensile strength on concrete cylinder is a method to determine tensile strength of concrete. The standard dimensions of cylinder as per IS 5816- 1999 is 300mm length and 150mm diameter. Moreover the concrete having less tensile strength due to its brittle nature. It is not expected to resist the direct tension. So concrete developed crakes when tensile forces exceeds its tensile strength.Spilt tensile strength test on concrete cylinder is a method to determine the tensile strength of concre. The procedure based on the ASTM C496 (Standard Test Method of Cylindrical Concrete Specimen) which similar to other codes like IS 5816 1999.

It is determined from the expression given below.
Where, F_t = Split tensile strength in N/mm2
p = Compressive load on the cylinder
L = Length of the cylinder

Table 5 : spilt tensile strength results

% of marble dust and dismantled concrete	Spilt tensile strength		
	7 Days	14 Days	28 Days
0%	2.1	2.369	3.17
25% and 5%	2.33	2.78	3.38
50% and 10%	2.68	3.25	4.3
75% and 15%	2.49	2.9	3.5

3.3FLEXURAL BEAM STRENGTH:

Flexural beam strength on concrete is method to determine bending strength of concrete. The standard dimensions of beam as per IS 516-1959 is 700mm length and 150mm cross section. It is a measure of un reinforced beam or slab to resist failure in bending.

It is determined from the expression given below.
F_{cr} = when a = 11.0 cm to 13.3 cm for cross section 10 cm × 10 cm
WhereP is maximum load at failure.
L is length of the span on which the specimen is ssupported.
b is measured width of the specimen.
d is measured depth of the specimen at the point of failure.

table 6 : flexural beam strength results

% of marble dust and dismantled concrete	Flexural beam strength		
	7 Days	14 Days	28 Days
0%	2.95	3.8	4.2
25% and 5%	3.14	4.28	5.1
50% and 10%	3.28	4.31	5.39
75% and 15%	3.20	4.25	4.90

4. RESULTS AND DISCUSSIONS:

4.1 Characteristic compressive strength

The results of compressive strength are represented in table 4 and graphical representation in figure 1. The compressive strength of concrete increases up to 50% and 10% replacement of marble powder and dismantled concrete as aggregates. Compressive strength of concrete cubes increases from 24 to 27.75 MPa with replacement of marble dust at 0%, 25%, 50% with partially replacement with sand at 7 days, 14 days and 28 days curing. And at 75% marble dust replacement decreases the compressive strength (19.2MPa) of concrete. So above 50% replacement decreases the compressive strength.

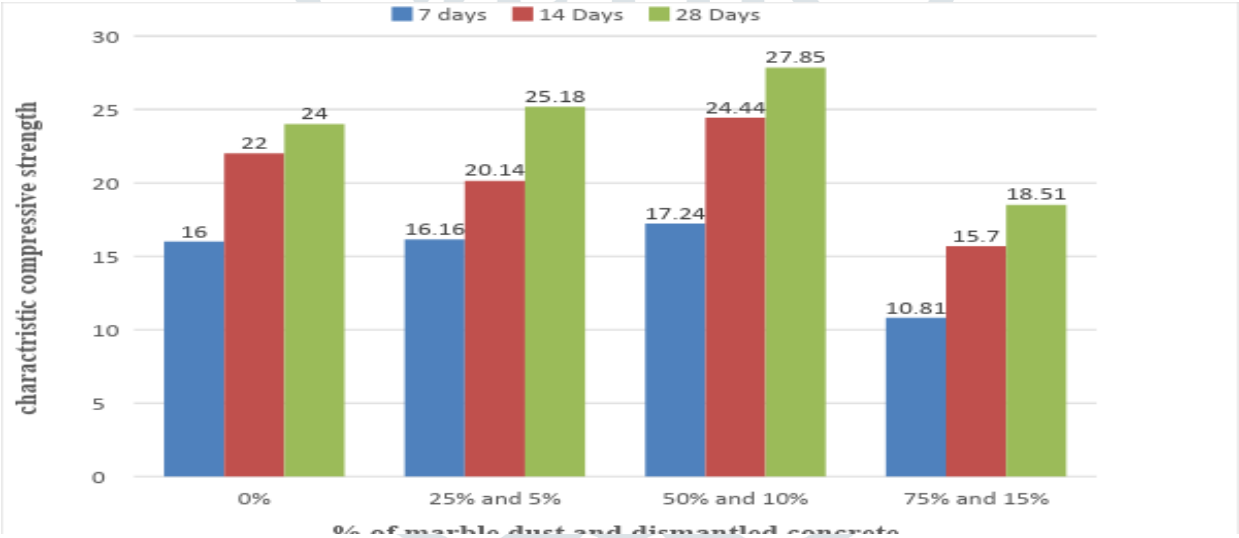

Fig 1: Compressive strength results

4.2 Spilt tensile strength

The results of spilt tensile strength are represented in table 5 and graphical representation in figure 2. The spilt tensile strength of cylinders increases from 3.17 to 4.3 MPa with replacement of marble dust with sand up to 50%only. The replacement of marble dust is more than 50% causes decreases the tensile strength (3.5MPa).

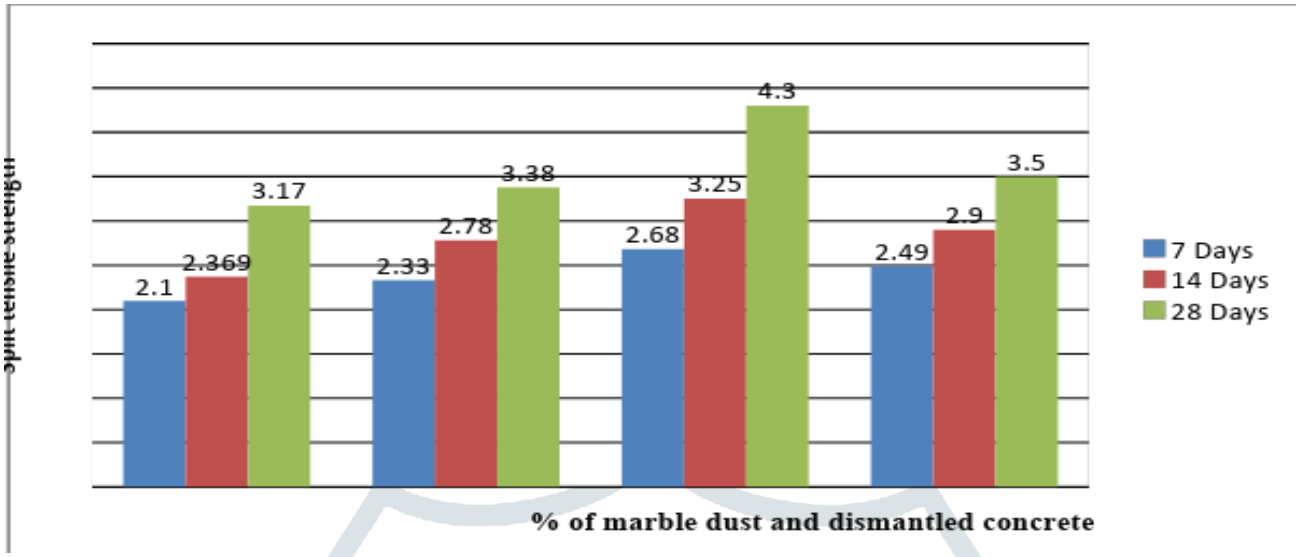

Fig 2 : spilt tensile strength results

4.3Flexural beam strength

The results of flexural beam strength are represented in table 3 and graphical representation in figure 3. The flexural strength of beam also increases from 4.2 to 5.39 MPa with replacement of sand with marble dust up to 50%. The replacement of marble dust is more than 50% causes decreases the flexural strength (4.90MPa)

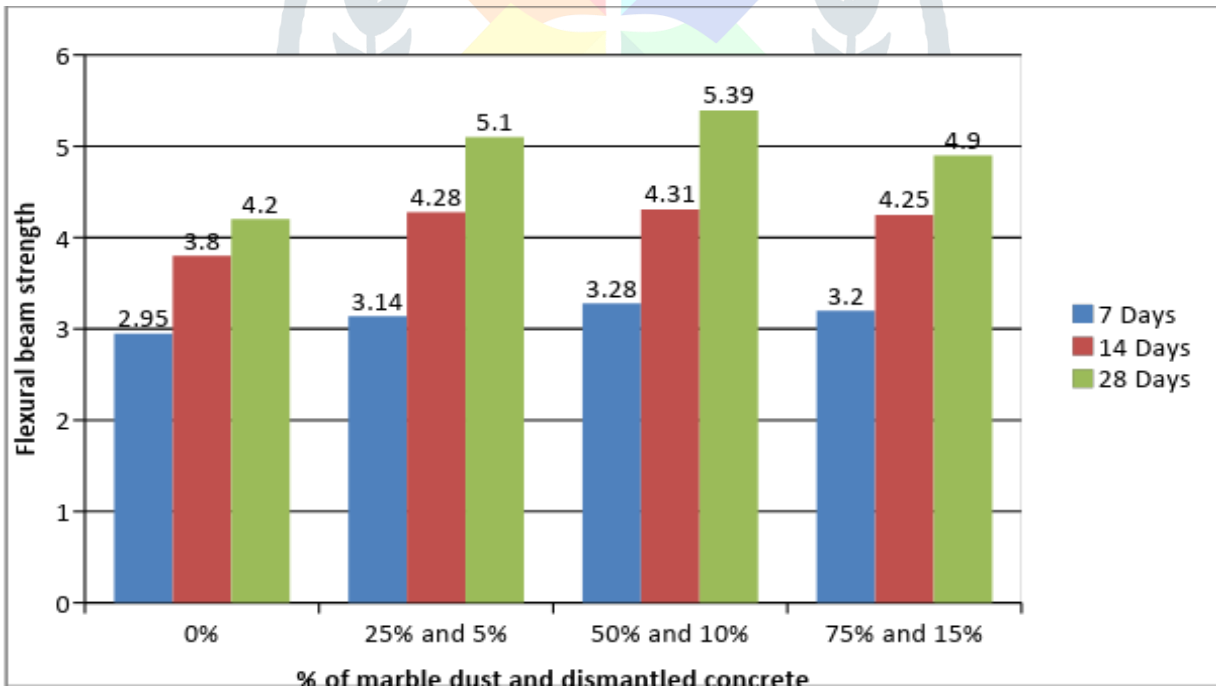

Fig 3 :flexural beam strength results

5.Conclusions

Compressive strength of concrete cubes increases from 24 to 27.75 MPa with replacement of marble dust at 0%, 25%, 50% with partially replacement with sand at 7 days, 14 days and 28 days curing. And at 75% marble dust replacement decreases the compressive strength (19.2MPa) of concrete. So above 50% replacement decreases the compressive strength. The spilt tensile strength of cylinders increases from 3.17 to 4.3 MPa with replacement of marble dust with sand up to 50%only. The replacement of marble dust is more than 50% causes decreases the tensile strength (3.5MPa). The flexural strength of beam also increases from 4.2 to 5.39 MPa with replacement of sand with marble dust up to 50%. The replacement of marble dust is more than 50% causes decreases the flexural strength (4.90MPa).The slump value for workability test is increases from 52mm to 75mm with introducing the marble powder at 0%, 25%, 50% and 75% by filling the pores in the concrete mass. Compressive strength, spilt tensile strength and flexural beam strength of concrete increases with replacement of demolished concrete up to 10% only. The silicon content in the of marble dust mostly helps in increasing the strength of concrete. The water absorption of marble dust (0.26%.) is 6 times lesser than water absorption of natural sand (1.62%).Specific gravity of marble dust (2.85) is always more than natural sand. Crushing value of demolished concrete as aggregates(29.5%) is always more than crushing value of normal coarse aggregates (18.6%).Fineness modulus of demolished concrete as aggregates(7.35%) is always more than fineness modulus of normal coarse aggregates

6. **FUTURE SCOPE OF STUDY**

- The usage of alternative materials for making of concrete is very common in United States, European etc. So study in this field could be useful in our country also.
- Further study on road construction with usage of the marble powder.
- Similar study can be apply on bricks making with marble powder.
- Study can be done on use of demolished concrete in pavement construction
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- 4 .Study can be apply on non-structural elements made with demolished concrete.

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