Experimental Investigation on Concrete with Partial Replacement of Fine Aggregate by Marble Dust Powder

T Naga Sai Sree Saran, T Venkat Das

Abstract:. The construction buildings which are present in and around coastal area re severely facing lot of problems. This to is due to penetration of sea salts. This leads to damage of structure fast. The average NACL Concentration of sea water is about 3.5%. In this study , Marble Dust powder as been taken to analyze the chemical and physical properties of the concrete which is partial replaced with marble dust powder as fine aggregate by 10%,20%,30%,40% and 50%by weight of fine Aggregate. After replacing this marble dust powder as fine aggregate, cylinders and cubes are casted. After casting this cubes and cylinders, they are using to know its both compressive as well as tensile strength by using compression test and split tensile strength for 7 days and 28 days.

Index terms: Compressive strength, Marble dust powder, Sodium chloride, Split tensile strength.

I. INTRODUCTION

Blended cement based on the partial replacement of Portland cement clinker by means of subjected more Investigations. Materials Participate in the hydraulic reaction contributing the composition in micro structure Hydrated product. Marble has been commonly used for various purposes like flooring cladding etc .Marble is Metaphornic rock material industry disposal of the Marble powder material consisting of every line powder today constitutes environmental problems around the world. The project work intended to analyze the feasibilities of using Marble waste powder as Replacement with fine aggregate the test result shows that use of the Marble dust powder have the capability of improving performance of hardened concrete[1]. The compressive strength of concrete is increased with addition of waste marble powder up to 50% by weight of fine aggregate and further any addition of waste Marble powder the Compressive strength decreases[2]. Strength results showed consistent Behavior at lower ratio and higher ratio the Permeability increased with decrease in the Compressive strength and decreased with w/b ratio[3]. The test results on the compactor factor increased with increased the level of replacement by 15% further high level replacement.

1.1 SCOPE AND OBJECTIVE

The main objective of the present study is to determine the mechanical properties of the concrete which is replaced with marble dust powder.

II. METHODOLOGY

Conventional concrete with a water cement proportion 0.42 was produced. The cement used was ordinary Portland cement of 53 grade using Marble Dust powder was 10%.20%,30%,40% &50% of the weight of Fine Aggregate . Sieve aggregates with sizes of 20 mm and 10mm fine sand is fine modulus obtained sufficient workability the relative ratio of coarse aggregate and sand was determine by standard weight concrete as reference .

III. MATERIALS

A.GENERAL

In the experimental program, the first step is selecting of the raw materials. Number of conventional trails is prepared and the mix proportion M30grade is selected by changing different water cement ratios. By replacing the fine aggregate with Marble dust powder in the range of (10-50%) for M30 grade. The strength and durability properties are studied in this work by comparing both grades.

B. CEMENT

Cement is the main ingredient in manufacturing of concrete. The characteristics of concrete will be greatly affected by changing the Cement content. The cement used in this project is Ordinary Portland cement 53 grade confirming to IS 12269- 1987.

C. MARBLE DUST POWDER

Marble chips that have been crushed to form a powder. Marble dust powder is used as an inert pigment and filler in paints. Even as a fine powder , some of the crystalline surfaces reflect light adding a sparkle to regions in which was been added to the plaster used in a fresco support.

Table-I : Properties of Marble dust powder

S No	Property	Value
1.	Density	575 kg/m^3
2 .	Specific gravity	2.4
3.	Mean particle size	0.1µm
4.	Min surface area	2500m^2/kg
5.	Particle shape	Spherical

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Table -II: Chemical Properties of MDP

S No	Component	Symbol	Percentage
1.	Silica	SiO_2	28.35
2.	Alumina	A_2lO_3	0.42
3.	Ferric oxide	Fe_2O_3	9.70
4.	Manganese oxide	MnO	0.004
5.	Calcium	$C_a O$	40.5
6.	Magnesium	$M_g O$	16.5
7.	Loss of Ignition	LOI	2.08

D. FINE AGGREGATE

The river sand which obtained from Zone-II and which is passed through 4.75mm sieve is used as a fine aggregate.

E. COARSE AGGREGATE

Aggregate of size more than 4.75mm are generally considered as Coarse aggregate used in this experiment work is 20mm and 12mm. A good quality of Coarse Aggregate is obtained from nearest crusher unit. The Coarse aggregate is selected as per IS : 383 specifications.

IV. PROPERTIES OF MATERIALS

Various test are to be conducted on the Raw materials to obtain the physical and mechanical properties. The test results are given below.

A. Tests on Cement:

a) Specific Gravity of Cement:

The method used to calculate specific gravity of Cement is Le-chatlier's flask method. In this cement is tested by using Kerosene.

b) Normal Consistency of Cement:

Normal Consistency test is conducted as per IS 4031 (part -IV) -1980. The main purpose of conducting Normal consistency is to find the amount of water to be added for producing Cement paste standard consistency. Vicat apparatus generally used to confirming to IS 5513-1976

B. Fineness of Cement

The Fineness of cement is calculated by the 90 microns sieve method. In this method amount of Cement on the sieve should not be more than 10% ordinary cement.

C. Initial and Final Setting Time

Initial and Final setting test is conforming to IS 4031(part V) .In this test we use Vi-cat apparatus, gauging trowel and balance.

Observations:

Time at which the water is first added to the cement($t_{1)=}$ 5min

Time at which the needle fails to penetrate a depth of 5-7mm(t_2)=50 min

Time at which needle fails to impression the block (t_3)=>10hrs min. The above table3 mentioned test on cement values.

Table - III :Test Results on the Cement

S No	Test	Results
1.	Specific gravity	3.15
2.	Normal consistency	31.2%
3.	Fineness of cement	92%
4.	Initial and Final setting	50mins and >10hrs

D. Tests on Fine Aggregate

Test on aggregate are conforming to IS 383 specifications. The detailed test reports are tabulated as fallows.

E. Sieve Analysis of Fine Aggregate

Sieve Analysis helpful in determining the particle size distribution of the aggregates gradation of fine aggregate. It confirming to IS 2386-1963(part 1). The above table 4 mentioned the fine aggregate sieve analysis.

Table IV: Grading Limits of Fine aggregate in sieve analysis (IS 383-1970)

Sieve size	Zone I	Zone II	Zone III	Zone IV
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18mm	30-70	50-90	75-100	90-100
600µ	15-34	35-59	60-79	80-100
300µ	5-20	8-30	12-40	15-50
150µ	0-10	0-10	0-10	0-15

F. Specific gravity of Fine Aggregate

Specific Gravity is the Major Property of the aggregate Specific gravity is calculated by the cylindrical(Pycnometer Bottle) method.

The specific gravity can be calculated by the formula

Specific gravity(G)= (W2-W1)/(W_2-W1)-(W_3-W_4)

G. Bulk Density of Fine Aggregate

Bulk density of is the very important property in preparing the Mix design. Bulk density is directly proportional to the weight of the building. The table 5 mentioned the sieve analysis.

Table -V Sieve Analysis of Fine Aggregate

S NO	Sieve size	Wt retained (gm)	Cumulative wt retained (gm)	Cumulative % wt retained	% of passing
1.	4.75mm	0	0	100	0
2.	2.36mm	15	1.5	98.5	1.5

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3.	1.18mm	120	12	88	13.5
4.	600µ	605	60.5	39.5	74
5.	300µ	245	24.5	75.5	98.5
6.	150µ	15	1.5	98.5	100

Total = 2.87

H. Water Absorption of Fine Aggregate

The water absorption of Aggregates will greatly effects the workability of concrete. The ratio increase in weight of the sample to the weight dry sample is called water absorption. The above table 6 mentioned the summary results.

Table-VI: Summary of Test Results

S No	Test	Value
1.	Specific gravity	2.6
2.	Bulk density	LP=1493.2 C=1602.6
3.	Water Absorption	0.9%

Total = 6.505

I. Tests on Coarse Aggregate:

The maximum size of Coarse Aggregates used in this process is 20mm. The test reports are tabulated as fallows.

a) Sieve Analysis of Coarse Aggregate:

Sieve analysis helpful in determining the practice size distribution of the aggregate. It is Conforming to is I S 2386-1963 (Part -1).

Grading limits(as per IS 383-1970, clause 4.1 and 4.2)

b) Specific gravity of Coarse Aggregate

Specific gravity is the major property of the Coarse aggregate. Specific gravity is calculated by the Cylindrical (Pycnometer Bottle) method.

Specific gravity(G)=$(W_2-W_1)/(W_2-W_1)-(W_3-W_4)$

c) Bulk Density of Coarse Aggregate

Bulk density is defined as the ratio of weight of aggregates to its volume. Bulk density is the very important property in preparing the Mix design. Bulk density is directly proportional to the weight of the building.

d) Water Absorption of Coarse Aggregates

The water Absorption of aggregates will greatly affects the workability of concrete. The ratio increase in the weight of the sample to weight dry sample is called Water Absorption. The above table 7 mentioned the results. The above table 7 mentioned the test values.

Table -VII: Summary of Test Results

S No	Test	Value
1.	Specific gravity	2.9
2.	Bulk density	LP=1524.02kg/m^3 C=1700 Kg/m^3
3.	Water Absorption	0.1

V. CASTING OF SPECIMENS

A. GENERAL

After Completing the mix proportioning of the materials concreting is done to represent the characteristics. Three types of concrete specimens are prepared in the respective moulds in the Casting procedure. The types of the specimens are Cubes and Cylinders.

B. CASTING PROCEDURE

a) Preparation of mould:

The moulds for moulds for Concreting are need to prepare carefully before casting . All the moulds should be fitted properly. Oiling is done on the surface of the moulds for an easy removal.

b) Calculation of materials

The required materials are calculated for casting. The materials should be dry and well graded.

c) Mixing of Materials

The required materials are poured in Rotating miller and careful supervision is needed here.

d) Measuring the fresh properties

Before pouring concrete in to the moulds we need to observe the fresh properties of concrete by slump cone method.

e) Concreting the moulds

Placing the concrete into the moulds with a trowel. The concreting should be done in layers of 5cm each. For each layer proper compaction is required by tamping bar. After compacting top layer , moulds are vibrated in the vibrating table for better mixing and bonding.

f) Naming of the trails

The casted moulds are named and set for undistributed for 24hrs for setting.

g) Remolding

The specimens should be removed after proper setting concrete. The specimens are removed and processed for curing.

C. CASTING OF CUBES

For each trail 6 cubes were casted for calculating 7days and 28 days strengths. The dimensions of specimen for the each cube are 150mm × 150mm × 150mm.

D. CASTING OF CYLINDERS

For each trail 6 cylinders specimens were casted for calculating 7days and 28 days strengths. The dimensions of the cylindrical specimens are of

Height = 300mm

Diameter=150mm

E. FOR DURABILTY STUDIES

For measuring the durability of concrete, cubes of size are casted 150mm × 150mm × 150mm.

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F. CURING OF SPECIMENS

Curing is the most important process in concreting. Concrete strength increases with age of curing. The specimens should keep in curing tank for better improvement in strength. Generally curing is done by pounding curing tanks. The water used for concrete curing should free from salinity, scrap, vegetation and chemicals . We need to change the water for every 7days and 28days of curing.

VI. TESTING SPECIMENS

A. GENERAL

The properties of fresh and hardened concrete can be done using laboratory test such as compression test, split tensile strength etc., After conducting these test, the specimens are taken from curing tank. After the drying process, the specimens are processed for testing. The specimens tested for 7days and 28days strengths .

B. FRESH PROPERTIES

Observation of fresh concrete is done at the time of casting. Workability of concrete should be done . Concrete good in workability will show the better properties in its life time. Before pouring the concrete in the moulds we need to check the workability by slump cone method. The workability test for concrete conforms IS 1199-1959.

a) *SLUMP CONE METHOD*

Slump cone consists of a cone of 300mm height, 200mm bottom diameter and 100mm top diameter. For doing the slump cone test concrete poured into the cone in 3 layers and tamped at 24 times for each layer with a tamping bar. After total compaction the cone will be removed and height of the cone will measured. The difference between actual height and formed cone height will give the slump value.

C. MECHANICAL PROPERTIES

a) Compressive strength

Compressive strength or crushing strength in the main property observed in testing the cubes. Cubes are tested to calculate Compressive strength by applying gradual loading in compression Testing Machine. The reading of the failure occurred on the top of the machine in the indicator.

The compressive strength has been calculated by the formula . The above table shows the compressive strength results for consecutive days.

Compressive strength = applied load/ cross sectional area
= P/A
= load/area(N/mm^2)

Figure 1: Compressive strength testing machine

b) Split tensile strength

Split tensile strength is the most important property of concrete. Concrete generally weak in tension. So to improve tensile behavior of concrete, split tensile strength is important. It also important in reducing formation of cracks in concrete. Cylinders are casting for calculating the split tensile strength. The cylindrical specimens are also tested in compression testing machine. The cylinders are placed in axial direction by facing cylindrical face to the loading surface. Here the cylinder split into the two parts reading observed on the top of the machine

The split tensile strength as been calculated by the formula. The above table 8 mentioned the split tensile strength results for obtaining days

Split tensile strength = $2P/\pi DL$
P= failure load(applied load)
L= height of the cylinder specimen
D= diameter of mould.

Figure2: Split tensile strength testing machine

Sodium Chloride

It is also known as salt through sea salts are also contains other chemical salts is the Ionic compound with the chemical formula of NACL. Representing the 1:1 ratio in sodium and chloride ions with molar masses 22.99 and 35.45 g/mol.

The preparation of 5% NACL as 1liter of water will be added to 50g of Sodium chloride.

VII. RESULTS AND DISCUSSIONS

A. WORKABILITY OF CONCRETE

The workability of concrete is done using Slump cone method which ranges from 25-50mm. The above table mentioned the workability results and percentages of MDP for each mix and percentage.

Table -IX: Slump Obtained for M30 grade

S No	Test series	slump
1.	MDP (10%replacement)	27
2.	(20%replacement)	26
3.	(30%replacement)	26
4.	(40%replacement)	25
5.	(50%replacement)	16

Normal concrete= 28

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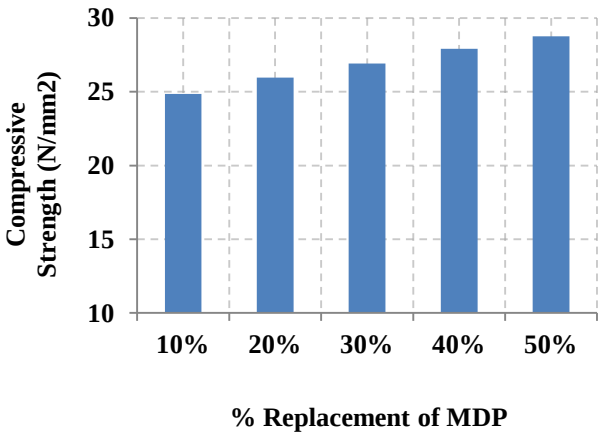
B. COMPRESSIVE STRENGTH

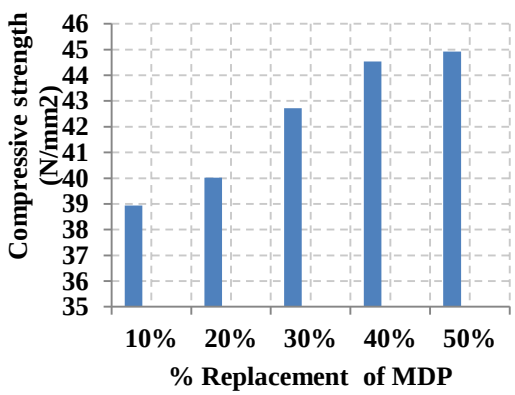
Compressive strength is obtained by applying crushing load on the cube surface load on the cube surface. So it is also called as crushing strength. Compressive strength of concrete is calculated by casting 150mm×150mm×150mm cubes. The test results are presented here for the compressive strength of 7 days and 28 days. A compressive strength test requires precise measurements, so the "squashing" process of a compressive stress test must be done under carefully controlled conditions, including the equal-and-opposing forces applied to compress the material from both top and bottom.

Table -VII Compressive strength results for M30 grade of concrete

S No	MDP Replacement (%)	Average Compressive strength (N/mm^2)	
1.	10%	7-Days	28-Days
		24.84	38.94
2.	20%	25.96	40.02
3.	30%	26.91	42.72
4.	40%	27.91	44.53
5.	50%	28.75	44.92



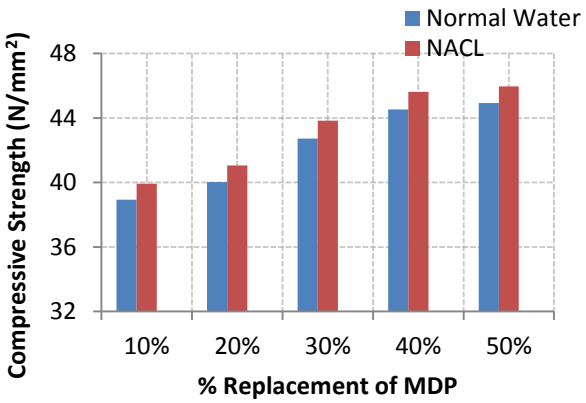
Graph 1 Compressive strength of concrete cubes cure in Water for M30 grade of concrete for 7- days



Graph 2 Compressive strength of concrete cubes cure in water for M30 grade of concrete for 28- days

Table -X:Compressive strength results of M30 grade curing in NACL water

S NO	MDP Replacement (%)	Average compressive strength (N/mm^2)	
1	10%	7-Days	28-Days
		25.02	39.92
2	20%	26.14	41.05
3	30%	27.82	43.83
4	40%	28.86	45.62
5	50%	29.96	45.97



Graph -3Comparison of Compressive strength for both Normal Water and NACL Water

C. SPLIT TENSILE STRENGTH

The tensile strength is evaluated using cylindrical specimens of size 300mm height and 150mm diameter. The specimens are tested for 7 days and 28 days of curing.

Table -XI Split tensile strength results M30 Grade for Normal water

S NO	MDP Replacement (%)	Split tensile strength (N/mm^2)	
1.	10%	7- Days	28- Days
		2.36	2.6
2.	20%	2.8	2.95
3.	30%	3.1	3.3
4.	40%	3.67	3.74
5.	50%	3.82	3.85

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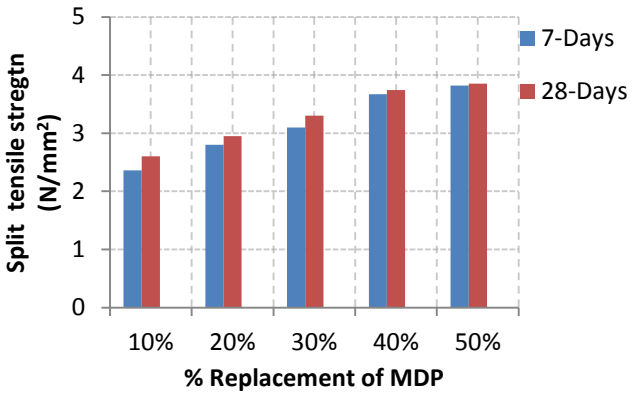
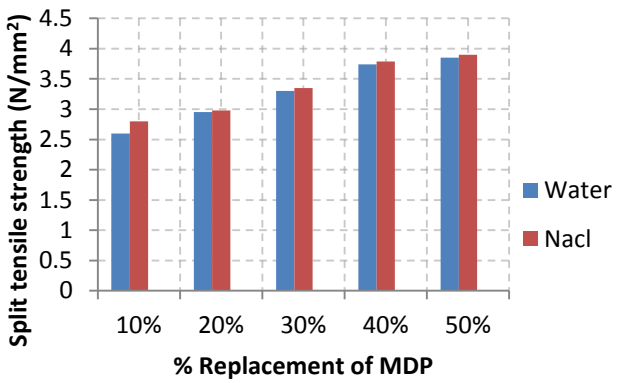


Graph -4 Comparison of Split tensile strength for 7 Days and 28 Days

Table -XII Split tensile strength for M30 grade cured in NACL water

S.No	MDP replacement %	Split tensile strength (N/mm^2	
1.	10%	7- Days	28- Days
		2.45	2.8
2.	20%	2.69	2.98
3.	30%	3.32	3.35
4.	40%	3.71	3.79
5.	50%	3.83	3.9



Graph-5 Comparison of Split tensile strength for both Normal water and NACL

VIII. CONCLUSION

The project work is intended to Analyze the feasibilities of using waste marble dust as replacement with Fine aggregate. It offers unique advantages of being abundance, easily accessible and cost efficient. The test result show that the use of these Marble dust powder have the capability of improving the performance of the hardened concrete. The compressive strength results of marble dust powder concrete showed similar behavior with control of concrete. The compressive strength of concrete is increased with addition of Marble dust powder up to 50% by the weight sand if it is used more than 50% the strength may automatically decreases. The split tensile strength of cylinders is decreased with addition of 100%, so we want replacement 50% with sand the strength may obeys up to that percentage only. By the Durability of compressive strength and split tensile strength of concrete with 10%,20%,30%,40% and 50% with replacement of fine aggregate With Marble Dust Powder in NACL solution as shown increases in strength for 7days and 28days. Now a days the scarcity of sand is more in all the areas. So by this Project I conclude that in emergency of sand needed we can use Up to 50% replacement of Fine aggregate in construction. The cost of the material per ton is very reasonable.

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