

CONCRETE WITH MARBLE WASTE AS COARSE AGGREGATE

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CERTIFICATE

This is to be certify that the Report entitled

CONCRETE WITH MARBLE WASTE AS COARSE AGGREGATE

has been submitted by

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during the academic year 1997-98

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Head of the Department

Certified that the candidate was examined by us in the project work viva-voce Examination held on

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SYNOPSIS

Rapid increase in the construction activities leads to acute shortage of conventional construction materials. In the production of concrete granite stones and river sand are used as coarse aggregate, respectively. Attempts have been made to replace coarse aggregate (granite stones) by various locally available materials to increase strength.

It is reported that around 50% of the marble is left as waste while cutting and sizing process in the marble industry.

In order to use these marble wastes effectively in the construction industry, an experimental study is carried out on concrete with marble waste as coarse aggregate.

Results of this experimental study showed that concrete with mix proportion 1:2:4 and 1:3:6 with marble waste as coarse aggregates shows a compressive strength of 51.11 N/mm² and 32 N/mm² respectively.

Hence this concrete can be used in building construction at places where marble pieces are available as a waste product.

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INTRODUCTION

Concrete is most widely used construction material today. The constituents of the concrete are coarse, aggregate, fine aggregate and the binding material. Enentthough the aggregate materials are locally available , at some place it will be economical to substitute these by more cheaply and abundantly available ones without sacrificing the strength.

Attempts are made to replace the crushed granite which are used as the coarse aggregate in conventional concrete by locally available materials such as pellitised blast fornace slag, sintered domestic refuse, laterite, recycled concrete,brick bats & marble waste.

It is reported from the marble factories of Rajasthan & Madhya pradesh that about 50% of the marble is left as a waste material while cutting ,sizing etc. An experimental investigation was carried out to examine the feasibility of using these broken marble wastes effectively as a coarse aggregate in concrete.

This was achieved by comparing the results of tests carried out on concrete with broken marble waste as coarse aggregate with that obtained on conventional concrete.

CHAPTER 2

OBJECTIVES AND SCOPE OF THE PRESENT INVESTIGATION

2.1 OBJECTIVES :

The objectives of this investigation are to find the following

- 1) *Compressive strength(cube) of marble waste concrete by varying W/C ratio*
- 2) *Compressive strength of marble waste concrete by varying mix proportion*
- 3) *Strength by total replacement of ordinary coarse aggregated by marble waste in the concrete*
- 4) *Effective utilisation of marble waste towards environmental protection*

2.2 SCOPES OF THE PRESENT INVESTIGATION :

The present investigation is aimed in making studies on strength character concrete by totally replacing coarse agg(granite) with marble waste.

In this study the compressive strength of cubes 150mm X 150mm X 150mm size of concrete studied by totally replacing coarse agg(granite) with marble waste. For cube strength, average of 3 cubes were taken.

For concrete, the water cement ratios are 0.4 , 0.5 and 0.6 and various mix proportions 1:2:4 and 1:3:6 were investigated for cube compressive strength.

CHAPTER 3

DETAILS OF MATERIALS USED

3.1 CEMENT :

Cement in its broadcast term means any substance which acts as a binding agent for materials cement applied in construction and engineering is produced by calcining at high temperature an intimate mixture of calcareous, siliceous and aluminous substances and crushing the resulting clinkers to a fine power .cement is the most expensive ingredient in concrete and it is available in a variety of different forms. The properties of cement depend upon the chemical composition the process of manufacture and the degree of fineness to which they are ground. when cement is mixed with water a chemical reaction take place as a result of which the paste first sets and then hardens to a stone like mass.

According to the code is 2185 : part II 1983 cement complying with any of the following Indian standards may be used at the discretion of the manufacture.

- IS : 455 - 1976 Specification for portland slag cement*
- IS : 1489 - 1976 Specificaton for portland pozzolana cement*
- IS : 6909 - 1976 Specification for super sulphated cement*
- IS : 8041 - 1978 Specificaton for rapid hardening portland cement*
- IS : 8042 - 1978 Specification for portland cement*
- IS : 8043 - 1978 Specification for hydrophobic portland cement*

Now the 33 grade cement is rarely available in the market. so, we used 43 grade cement for our entier experiment works.

3.2 FINE AGGREGATE :

Normally sand is used as a fine aggregate for making concrete. The sand to be used for making concrete should show less shrinkage. In our project we have used river sand of having less moisture content passing through is sieve 4.75mm and retained on IS sieve 0.15mm. For the sieve analysis of fine aggregates refer the table No :3 in Chapter 4 .

3.3 COARSE AGGREGATE :

In this project marble waste is used as a coarse agg. The coarse aggregate used for making concrete is having less content of moisture, Generally marble waste are having less moisture comparatively than that of the other stones. Gradation influences the strength of concrete. It means that the coarse aggregate to be used for making concrete should be well graded. For the sieve analysis of coarse aggregates refer the table No : 4 in Chapter 4.

The marble waste used in our project is well graded according to IS 383 - 1970 for coarse aggregate.

3.4 WATER :

Water is a most important constituent of concrete. Hence the water used should be free from harmful matters which decrease the quality of concrete. The main function of water is to react with cement to form a binding matrix, which binds with the aggregate to form a hardened mass.

Water used in the manufacture of blocks should conform to IS 456 - 1978. The water cement ratio used in this project is 0.4, 0.5 and 0.6. The exact amount of water to be used depends upon the grade of concrete, nature and type of aggregate, the compressive strength, required workability etc.

4. EXPERIMENTAL ON MATERIALS :

4.1 TESTS ON CEMENT :

4.1.1 CONSISTENCY TEST :

For finding initial setting time and final setting time of the cement standard consistency test has performed. consistency is defined as that consistency which will permit a vacate plunger having 10mm dia at 50mm length to penetrate to a depth of 30mm - 35mm from top of the mould.

TEST PROCEDURE :-

- 1) *A cement sample weighing 300gms is taken. A paste is prepared by mixing 25% of water with cement .*
- 2) *Then this paste is filled in to the vicat's apparatus mould with in 3-5 min*
- 3) *The plunger of the vicat's apparatus is gently allowed to penetrate through the cement*
- 4) *This procedure is repeated for different water cement ratios. The particular percentage of water which allows the plunger to penetrate only to a depth of 33.55mm from the top is known as std consistency. The results are tabulated as shown in from the table no.1.From the table , The std consistency of cement is 26%*

TABLE NO : 1

SNO	% OF WATER	AMOUNT OF WATER ADDED (ML)	PENETRATED DISTANCE
1	25%	75	23
2	26%	78	33
3	27%	81	40

4.1.2 INITIAL SETTING TIME OF CEMENT :-

INITIAL setting time is regarded as the time elapsed between the moment that the water is added to the cements to the time that the paste starts losing its plasticity.

TEST PROCEDURE :-

- (i) *A sample of cement weighing 300gms is taken the cement paste is prepared by mixing the cement with 0.85 times of water required to give a paste of standard consistency.*
- (ii) *The paste is filled in to the mould of vicat's apparatus and then the plunger of 1mm dia having length of 50mm is allowed to penetrate the paste at a distance of 5mm from the bottom.*
- (iii) *The time between when the water is added to the cement and the needle penetrate through a distance of 5mm from bottom is noted.*

The results are tabulated in table NO : 2

From the table

The initial setting time : 30.509 min

TABLE NO : 2

SNO	TIME	TIME FOR PENETRATION min	NON PENETRATIONS DISTANCE (mm)
1	10 - 10.543	0.54	4.1
2	20 - 20.512	0.51	4.5
3	30 - 30.509	0.51	5.1

4.1.3 FINAL SETTING TIME OF CEMENT :-

TEST PROCEDURE :-

- 1) *The same procedure is followed as that of the initial setting time. Here inspite of using 1mm dia needle, 10mm dia needle is used.*

As per experiment result the setting time of 43 grade cement is 185 min.

4.2 TESTS ON FINE AGGREGATES :-

4.2.1 SIEVE ANALYSIS TEST :-

The main aim of this test is to find fineness modules of fine aggregates. The fineness modules of fine aggregates. The fineness modules is the numerical index of fineness giving some idea of the mean size of particle present in the entire body of the aggregates. The main objective of finding fineness modules is to grade the given aggregate for the most economical mix to require strength and workability with the maximum quality of cement .

TEST PROCEDURE :-

1. *Oven dry the given aggregates*
2. *Sieve the fine aggregate sample by hand and collect the sample passing through 4.75mm IS sieve and retained on 75 micron IS sieve.*
3. *Weigh the required quantity of the oven dried fine aggregate say 1000gms*
4. *Arrange the sieve 4.75mm at the top, 2.36mm, 1.18mm, 600 micron, 150 micron one by one and 75 micron at bottom. place the cover at the top and receiver below 75 micron..*
5. *Put the set of sieves to the mechanical sieve shaker, operate the sieve shaker for minimum of 10min.*
6. *Carefully collect the fraction retained on the sieve in the receiver and weigh them.*
7. *The results are tabulated as in the table NO: 3*

TABLE NO : 3

<i>IS Sieve</i>	<i>WT Retained (gm)</i>	<i>Camulative Wt Retained</i>	<i>Camulative % Re'tained</i>
4.35 mm	35	35	3.5
2.25 mm	50	85	3.5
1.18mm	205	290	29
600 micron	130	470	47
300 micron	305	775	77.5
150 micron	205	980	98
Reciever	20	1000	100.0
			----- 363.5

$$\begin{aligned}
 \text{Fineness modulus} &= \frac{\text{Sum of cumulative \% retained}}{100} \\
 &= 363.5/100 \\
 &= 3.635
 \end{aligned}$$

4.2.2 SPECIFIC GRAVITY TEST :

Specific gravity is used in the calculating of moisture content of the sand. So this test is performed.

TEST PROCEDURE

- 1) Clean and weight the pycnometer with the cap (M_1)
- 2) Take 200 - 400gms of dry sand in the pycnometer and weigh it (M_2).
- 3) Fill the pycnometer to the half of it's height with the soil and add water and stir it with glass rod. Replace the screw top and fill the pycnometer flush with hole in the conical cap. Dry the pycnometer out side and weigh it (M_3).
- 4) Fill the clean pycnometer with the distilled water upto the hole of the cap and weigh it (M_4).
- 5) Specific gravity is calculated as follows :

$$G = \frac{M_2 - M_1}{(M_2 - M_1) - (M_3 - M_4)}$$

Where,

$$M_1 = 592 \text{ gms}$$

$$M_2 = 1346 \text{ gms}$$

$$M_3 = 1890 \text{ gms}$$

$$M_4 = 1424 \text{ gms}$$

$$G = \frac{1346 - 592}{(1346 - 592) - (1890 - 1424)}$$

$$= 2.618$$

4.2.3 MOISTURE CONTENT TEST

The main objective of this test is to know the moisture content of the sand.

TEST PROCEDURE

- i) A clean dry pycnometer is taken and weighed (W_1) Then about 200 - 400 gms of sand sample is taken in the pycnometer and weighed (W_2)
- ii) Water is taken filled in the pycnometer about half of it's height and it is thoroughly mixed with glass rod. The water is filled upto the hole of the conical cap and weighed (W_3)
- iii) Pycnometer is cleaned and fully filled with water upto the cap hole weighed (W_4).
- iv) The moisture content is calculated as follows

$$W_1 = 623 \text{ gms}$$

$$W_2 = 1123 \text{ gms}$$

$$W_3 = 1717 \text{ gms}$$

$$W_4 = 1448 \text{ gms}$$

$$G = 2.62$$

$$\text{Therefore Moisture content } W = \left(\frac{(W_2 - W_1)}{(W_3 - W_4)} \times \frac{(G - 1)}{G} - 1 \right) \times 100$$

$$W = \left(\frac{(1123 - 623)}{(1717 - 1448)} \times \frac{(2.62 - 1)}{2.62} - 1 \right) \times 100$$

$$W = 15.00\%$$

The moisture content of the fine aggregate = 15%

4.3. TESTS OF MARBLE WASTE AGGREGATES

4.3.1 SPECIFIC GRAVITY TEST

The main aim of the specific gravity test is to find whether the marble waste coarse aggregates taken are the light weight aggregates (or) heavy weight aggregates.

TEST PROCEDURE

- i) A sample of marble waste aggregate of 3Kg is taken. It is thoroughly washed to removed, the finer and dust particles.
- ii) It is placed in the wire basket and immersed in distilled water between 22°C to 32°C for 24 hours.
- iii) The trapped air is removed from the wire basket by jolting it at 25 times. Then the basket and aggregates are weighed (A_1) in water at room temperature.
- iv) The empty basket is weighed in water (A_2)
- v) The marble waste aggregates are then dried in atmosphere for 10 min away from the direct sunlight and further dried by clothes and weighed in air (B)
- vi) Then the aggregates are kept in the oven at a temperature of 100° - 110°c for 24 hours. It is then cooled in the air tight container and weighed (C).

The specific gravity of the marble waste aggregate is calculated using the below formula,

$$\text{Specific Gravity} = C / B - A$$

Where, weight of aggregates taken = 3 Kg

$$A = A_1 - A_2 = 2.15 \text{ Kg}$$

$$B = 3.012 \text{ Kg}$$

$$C = 2.3 \text{ Kg}$$

$$\begin{aligned} \text{Therefore Specific gravity} &= 2.3 / (3.012 - 2.15) \\ &= 2.6 \end{aligned}$$

$$\text{Specific gravity of marble waste aggregates} = 2.6$$

The above value is normal value so the marble waste aggregates are neither heavy weight aggregates nor light weight aggregates.

4.3.2 MOISTURE CONTENT TEST

Moisture content test is performed to determine the water content present in the marble waste coarse aggregates.

TEST PROCEDURE

- i) A Sample of marble waste aggregate of weight 500 gms is taken. Let the weight be A.
- ii) Then the aggregates are oven dried at the temperature of 100° - 100°c for 24 hours and cooled in the atmosphere and weighed (B)

Moisture content of the aggregates is found out as follows.

Here $A = 500$ gms

$B = 498$ gms

$$\begin{aligned} \% \text{ of moisture} &= \frac{A - B}{A} \times 100 \\ &= \frac{500 - 498}{500} \times 100 \\ &= 0.4\% \end{aligned}$$

This value satisfies the IS recommendations that the coarse aggregates used in concrete making should be in between 0.4% - 0.8%.

4.3.3 WATER ABSORPTION TEST

This test is performed to find out the % of water absorbed by the coarse aggregates.

TEST PROCEDURE

- i) Marble waste coarse aggregates sample of 500 gms is taken. Let the weight be A.
- ii) Then the aggregates are immersed in distilled water for 24 hrs.
- iii) After that they are taken away from the water and dried in the atmosphere thoroughly.

Water absorption of the aggregates is found as follows.

Weight of aggregate taken (A) = 500 gms

Weight of aggregate after taken 24 hrs = 502 gms

Immersed in water (B)

$$\begin{aligned} \text{Water absorption of marble waste aggregates} &= \frac{B - A}{A} \times 100 \\ &= \frac{502 - 500}{500} \times 100 \end{aligned}$$

Value of water absorption is less by comparing

the ordinary concrete = 0.40%

4.3.4 SIEVE ANALYSIS TEST

The main aim of this test is to find out the fineness modulus of marble waste coarse aggregates, and to achieve proper gradation.

TESTING PROCEDURE

- i) A known weight of coarse aggregate (5 Kg) is taken.
- ii) The sieves are arranged in such a way that 80mm Sieve is at the top and 10mm is at the bottom. Below the 10mm Sieve the receiver is kept.
- iii) The arrangement is such that 80mm, 40mm, 20mm, 10mm and receiver from the top.
- iv) The coarse aggregates are placed in the top Sieve and the whole set is vibrated using vibrator for 10 min.
- v) The retained Sieves are weighed.

The results are tabulated as shown in the Table No.4

TABLE NO : 4

IS Sieve	WT Retained (gm)	Camulative Wt Retained	Camulative % Retained
80 mm	0	0	0
20 mm	120	120	4
10 mm	1080	1200	40
4.75 mm	1800	3000	100
2.36 mm	0	3000	100
1.18 mm	0	3000	100
600 micron	0	3000	100
300 micron	0	3000	100
150 micron	0	3000	100
			644

$$\begin{aligned}\text{Fineness modules} &= 644/100 \\ &= 6.44\end{aligned}$$

For 24 hours and weighed (B)

Then the % of water absorption is determined as follows :

$$\text{Here } A = 500 \text{ gms}$$

$$B = 502 \text{ gms}$$

$$\begin{aligned}\% \text{ of moisture} &= \frac{B - A}{A} \times 100 \\ &= \frac{502 - 500}{500} \times 100 \\ &= 0.4\%\end{aligned}$$

This value is less than that of the water absorption required for coarse aggregates as per. IS code recommendations.

4.3.5 CRUSHING TEST

The main aim of this test is to find out the crushing value of the given coarse aggregates.

TEST PROCEDURE

- i) The material used for this test consisting of aggregate passing through IS sieve 12.5 mm and retained on 10mm IS Sieve. From this some known quantity of aggregates is taken.
- ii) Then this aggregates are filled into the cylindrical measure there layers. Each layer is tamped with 16mm dia rod at 25 times. The weight of the sample in the container is taken (A)
- iii) The cylinder of the test apparatus with the aggregates is put in position on the base plate of the compression testing machine.
- iv) Then plunger is placed on the surface of the aggregates in the container and the load of 40KN is applied gradually on the aggregates through the plunger for 10min.
- v) After that the crushed aggregates are sieved through 2.36mm. IS sieve. The fraction passing the sieve is weighed (B)

The crushing value is calculated as follows % of crushing value = $B/A \times 100$

Here $A = 419 \text{ gms}$

$B = 224 \text{ gms}$

$$\begin{aligned} \text{\% of crusing Value of aggregates} &= \frac{224}{419} \times 100 \\ &= 53.46 \% \end{aligned}$$

This value satisfies IS code recommendations for coarse aggregates

CHAPTER - 5

DETAILS OF EXPERIMENTAL WORK

5.1 MATERIALS

Marble waste is used as a coarse aggregate in making of concrete by replacing conventional coarse aggregate of granite with 43 grade cement.

5.2 FINE AGGREGATE

River sand passing through 4.75mm I.S Sieve and retained on IS sieve 0.15mm was used.

5.3 COARSE AGGREGATE

Marble waste passing through IS Sieve 20mm and retained on IS Sieve 4.75 mm is used as coarse aggregate.

5.4 WATER

Portable water available in the Kumaraguru College of technology premises was used.

5.5 PREPARATION OF MARBLE WASTE CONCRETE

Marble concrete mix using cement (43 grade), sand and coarse aggregate (marble waste) in different proportions of 1:2:4 and 1:3:6 by weight were prepared. The water ratio of 0.4, 0.5 and 0.6 were followed. The cube size adopted for concrete was 150mm X 150mm X 150mm

5.6 CASTING PROCEDURE

The required mix with required water was taken and was compacted in three layers in respective cube moulds. Table vibrator incated in photograph No : 3 was used for better result. For each mix proportion 27 cubes were casted for the above mentioned various water cement ratios. For each water cement ratio 9 cubes were casted and out of which three were tested on 3rd day and remaining were tested on 7th day and 28th day taking 3 cubes every time. Similar procedure was carried out for the other mix proportions also. The casting procedure is indicated in photograph No : 1

5.7 CURING

The cubes were demoulded after 24 hrs of casting. Then the specimens were submerged in water till the test dates. The curing procedure for marble waste concrete is indicaced in photograph No : 2

5.8 TESTING PROCEDURE

After the completion of proper curing the testing of cubes were carried out. Three cubes from each mix proposed for a particular water-cement ratio was taken on the testing date and the cubes were tested as per IS 516 - 1959 to determine the cube compressive strength.

CHAPTER - 6

MIX PROPORTIONS

In building constructions commonly 1:2:4 concrete mix is used for the construction of slabs, beams, columns, footings etc. The other concrete mixers like 1:3:6, & 1 : 4 : 8 & 1:5:10 are rarely used.

In this project, two different mix proportions were chosen.

- i) 1:2:4 mix (one part of cement, 2 part of sand & 4 part of marble waste aggregates)*
- ii) 1:3:6 mix (one part of cement, 3 part of sand & 6 part of marble waste aggregates)*

The water cement ratio used for above mixes are 0.4, 0.5 and 0.6.

7. TESTS ON CONCRETE

7.1 WORKABILITY TESTS

7.1.1 COMPACTION FACTOR TEST

The compaction factor test is performed to find workability of concrete.

TEST PROCEDURE

- i) *The given concrete mix is placed in the top hopper of the compaction factor test machine with out any compaction. The door at the bottom of top hopper is opened and allowed the concrete to fall with the middle hopper. Then the concrete is allowed to bottom hopper and finally it is allowed in the cylinder placed under the bottom hopper.*
- ii) *Then the contents of the cylinder are weighed (W_1).*
- iii) *After that the same concrete mix is poured in to cylinder as three layers and each layer is well compacted with 16mm dia rod at 25 times. Then the contents are weighed W_2 .*
- iv) *The compaction factor is calculated as follows*

$$\text{Compaction factor} = W_1 / W_2$$

The results are tabulated as shown below

COMPACTION FACTOR FROM 1:2:4 MIX & 1:3:6MIX

S.No	Mix	W/C ratio	Wt of partially compacted concrete (W_1)	Wt of fully compacted concrete (W_2)	Compaction factor W_1/W_2
1	1:2:4	0.4	9,450	12,250	0.77
		0.5	10,650	13,450	0.79
		0.6	11,250	14,150	0.8
2	1:3:6	0.4	10,100	13,800	0.73
		0.5	9,850	14,100	0.70
		0.6	11,480	15,050	0.76

According to the above results the degree of workability of concrete is very low when comparing to the IS recommended slump values.

7.2 COMRESSIVE STRENGTH TEST

Concrete is very strong in compression. It is this property which is made use of in modern construction. The compressive strength of concrete is regarded as a primary quality of good concrete. Since it is seen that all properties such as durability bond, resistance to abrasion, improve with improvement of compressive strength.

TESTING PROCEDURE

Concrete blocks were surface dried before testing and loose materials projecting out were removed. They are placed on compression testing machine centrally over bottom plate. Upper plate was lowered down to come in contact with top surface and proper contact was established, loading was done uniformly and loading continued upto failure of the block. These values are obtained by dividing ultimate load by cross sectional area.

$$\text{Compressive strength} = \frac{\text{Load at failure}}{\text{Area under compression}}$$

The compressive strength for the different mix proportions are tabulated as follows :

1. MIX PROPORTION

1:2:4 : Cement : Sand : Coarse Aggregate.

Size of Block = 150mm X 150mm X 150mm

Net cross sectional area = 22500 mm²

No. of days of curing = 3 days

$$\text{Compressive strength} = \frac{\text{Load at failure}}{\text{Cross sectional area}}$$

B.No	W/C Ratio	Block Name	Load at Failure in KN	Compressive strength in N/mm ²	Average compressive strength in N/mm ²
1	0.4	PP1	330	14.67	13.48
2		PP2	300	13.33	
3		PP3	280	12.44	
1	0.5	PQ1	450	20.00	19.70
2		PQ2	400	17.78	
3		PQ3	480	21.33	
1	0.6	PR1	200	8.89	9.78
2		PR2	180	8.00	
3		PR3	220	9.78	

2. MIX PROPORTION

1:2:4: cement : sand : coarse Aggregate

Size of Block = 150mm X 150mm X 150mm

Net cross sectional area = 22500 mm²

No. of days of curing = 7 days

$$\text{Compressive strength} = \frac{\text{Load at failure}}{\text{Cross sectional area}}$$

B.No	W/C Ratio	Block Name	Load at Failure in KN	Compressive strength in N/mm ²	Average Compressive in Strength N/mm ²
1	0.4	PS1	600	26.67	25.19
2		PS2	520	23.11	
3		PS3	580	25.78	
1	0.5	PT1	800	35.56	32.89
2		PT2	750	33.33	
3		PT3	670	29.78	
1	0.6	PU1	300	13.33	12.44
2		PU2	280	12.44	
3		PU3	260	11.56	

3. MIX PROPORTION

1:2:4: cement : sand : coarse Aggregate

Size of Block = 150mm X 150mm X 150mm

Net cross sectional area = 22500 mm²

No. of days of curing = 28 days

$$\text{Compressive strength} = \frac{\text{Load at failure}}{\text{Cross sectional area}}$$

B.No	W/C Ratio	Block Name	Load at Failure in KN	Compressive strength in N/mm ²	Average Compressive Strength in N/mm ²
1	0.4	PU1	930	41.33	41.18
2		PU2	950	42.22	
3		PU3	900	40.00	
1	0.5	PV1	1150	51.11	48.74
2		PV2	1000	44.44	
3		PV3	1140	50.67	
1	0.6	PW1	680	30.22	31.11
2		PW2	720	32.00	
3		PW3	700	31.11	

4. MIX PROPORTION

1:3:6 : : cement : sand : coarse Aggregate

Size of Block = 150mm X 150mm X 150mm

Net cross sectional area = 22500 mm²

No. of days of curing = 3 days

$$\text{Compressive strength} = \frac{\text{Load at failure}}{\text{Cross sectional area}}$$

B.No	W/C Ratio	Block Name	Load at Failure in KN	Compressive strength in N/mm ²	Average Compressive Strength in N/mm ²
1	0.4	X1	180	8.00	7.26
2		X2	150	6.67	
3		X3	160	7.11	
1	0.5	X4	210	9.33	8.89
2		X5	190	8.44	
3		X6	200	8.89	
1	0.6	X7	120	5.33	5.48
2		X8	130	5.78	
3		X9	120	5.33	

5 MIX PROPORTION

1:3:6 : cement : sand : coarse Aggregate

Size of Block = 150mm X 150mm X 150mm

Net cross sectional area = 22500 mm²

No. of days of curing = 7 days

$$\text{Compressive strength} = \frac{\text{Load at failure}}{\text{Cross sectional area}}$$

B.No	W/C Ratio	Block Name	Load at Failure in KN	Compressive strength in N/mm ²	Average Compressive Strength in N/mm ²
1	0.4	Y1	370	16.44	16.00
2		Y2	350	15.56	
3		Y3	360	16.00	
1	0.5	Y4	400	17.78	18.08
2		Y5	420	18.67	
3		Y6	400	17.78	
1	0.6	Y7	240	10.67	10.22
2		Y8	220	9.78	
3		Y9	230	10.22	

6. MIX PROPORTION

1:3:6 : cement : sand : coarse Aggregate

Size of Block = 150mm X 150mm X 150mm

Net cross sectional area = 22500 mm²

No. of days of curing = 28 days

$$\text{Compressive strength} = \frac{\text{Load at failure}}{\text{Cross sectional area}}$$

B.No	W/C Ratio	Block Name	Load at Failure in KN	Compressive strength in N/mm ²	Average Compressive Strength in N/mm ²
1	0.4	Z1	630	28.00	27.85
2		Z2	620	27.56	
3		Z3	630	28.00	
1	0.5	Z4	720	32.00	31.56
2		Z5	700	31.11	
3		Z6	710	31.56	
1	0.6	Z7	450	20.00	20.74
2		Z8	480	21.33	
3		Z9	470	20.89	

7. TESTS ON CONCRETE

7.3 DENSITY TEST

This test is performed to predict the whether the concrete is light weight concrete (or) high density concrete. According to density of concrete, the purpose of concrete varies.

The density is calculated by dividing the mass of the concrete block by the over all volume, including holes (or) cavities and cores.

TEST PROCEDURE

- i) Three blocks are taken and they are dried in the oven to approximately 100°C. After cooling the blocks to room temperature, the dimensions of each concrete block is measured in centi meters and the over all volume is computed in cubic centi meters.
- ii) The blocks then be weighed in kg and the density of each block is calculated as follows :

$$\text{Density} = \frac{\text{mass of concrete block in kg}}{\text{Volume of specimen in cm}^3} \times 10^6 \text{ kg/m}^3$$

The average of the three blocks shall be taken as the av.density.

1. MIX PROPORTION 1:2:4

Size of Marble waste concrete block = 15cm X 15cm X 15cm

Volume in cm^3 = 3375 cm^3

S.No	WEIGHT IN KG	DENSITY (kg/m^3)
1.	8.25	2444.4
2.	8.40	2488.9
3.	8.50	2518.52

AV.density = 2483.94 kg/m^3

2. MIX PROPORTION 1:3:6

Size of Murble concrete block = 15cm X 15cm X 15cm

Volume in cm^3 = 3375 cm^3

S.No	WEIGHT IN KG	DENSITY (kg/m^3)
1.	9.00	2666.7
2.	8.60	2548.5
3.	9.00	2666.7

AV.density = 2627.2 kg/m^3

The value of density of concrete is in between light weight concrete density and the heavy weight concrete density. So the murble concrete is the medium weight concrete.

CHAPTER - 8

DISCUSSION OF TEST RESULTS

Concrete cubes with marble waste as a coarse aggrements were prepared with different water cement ratios. These cubes were cured 7 days and tested for there compressive strength. Results obtained are presented in graph no : 1. A study of this graph shows that there is an optimum water cement ratio for each mix, which gives the maximum compressive strength. The optimum watercement ratio for 1 : 2 : 4 and 1 : 3 : 6 mix is 0.5.

A study of the table shows that irrespective of mix ratios and gradations of marble waste pieces (coarse aggregate) , the compressive strength increases with increasing curing age. It can also be seen from the table in that the compressive strength of cubes increases with increase in cement content of the concreate, irrespective of gradation of marble waste piece and curing age.

Concreate with mix proportions 1 : 2 : 4 and 1 : 3 : 6 with marble waste as a coarse aggregates shows the compressive strength of 48.74 N/mm² and 31.56 N/mm² respectively which fairly satisfies the requirements of a buildings stone. Concreate cube with 1 : 2 : 4 mix and marble waste piece as coarse aggregate shows the compressive strength of 48.74 N/mm² in comparision to 31.56 N/mm² for conventional concreate of same mix. Similar comparision for compressive strength of cubes of other mixes also shows only 65 % to 75% strength of that of conventional concreate.

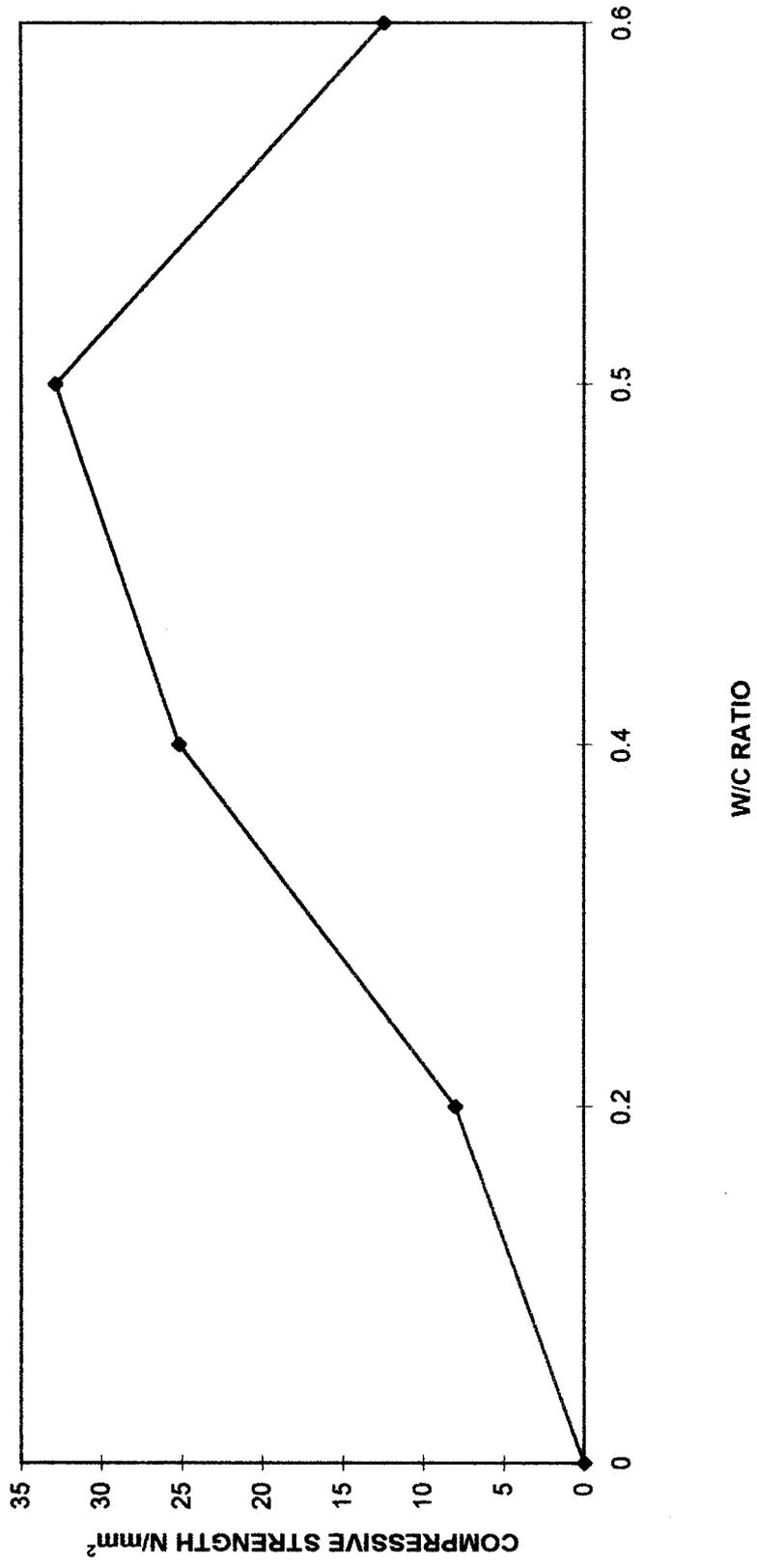
In order to study water absorption characteristics water absorption tests were carried out on concrete cubes prepared using different mix ratio and results are tabulated below

Water absorption/ unit weight of ordinary concrete and marble waste concrete

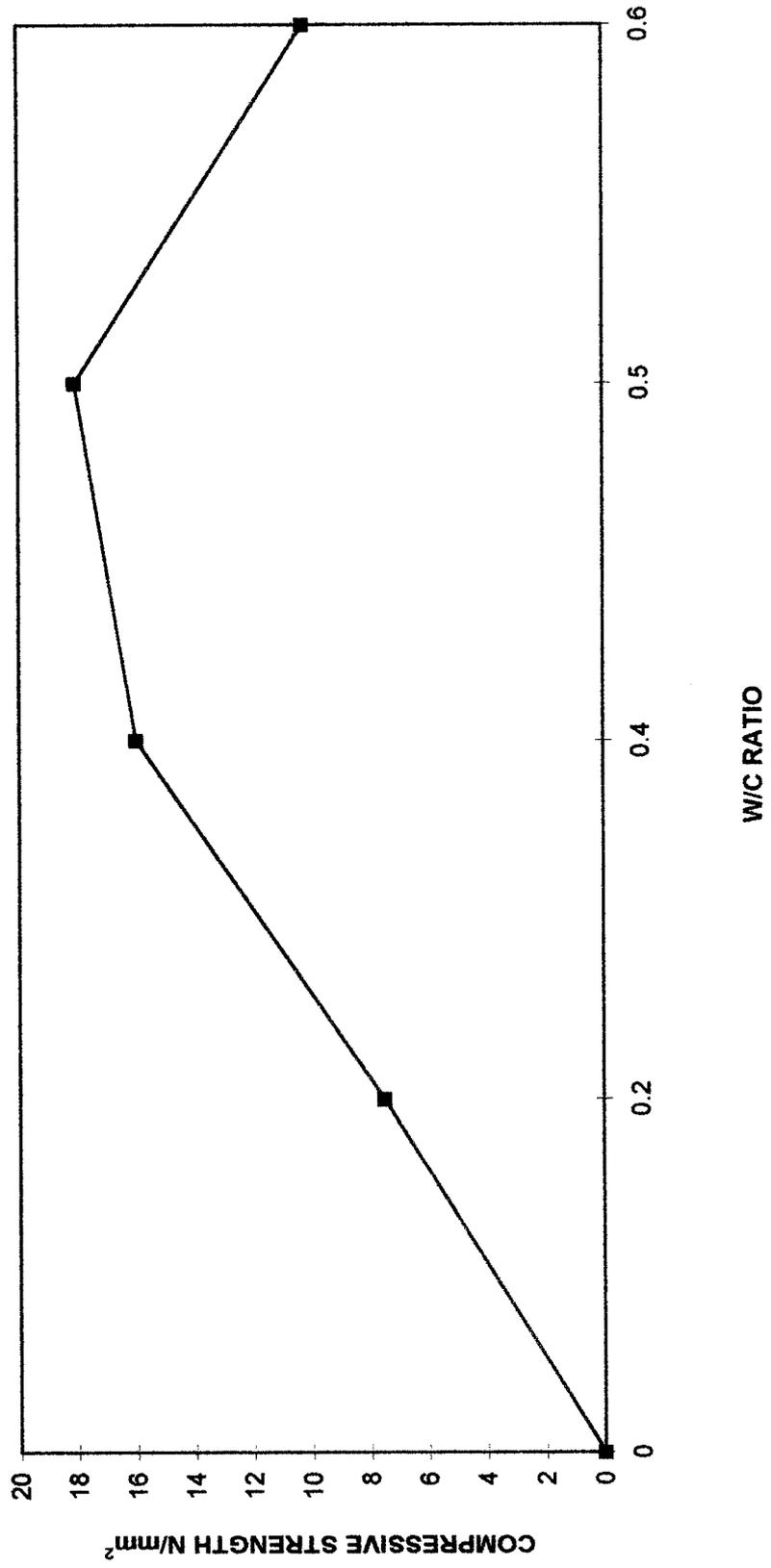
<i>Mix ratio</i>	<i>Marble waste concrete</i>	<i>Marble waste concrete</i>	<i>Ordinary concrete</i>	<i>Ordinary concrete</i>
	<i>Water absorption (%)</i>	<i>Unit weight kg/m³</i>	<i>Water absorption (%)</i>	<i>Unit weight kg/m³</i>
<i>1 : 2 : 4</i>	<i>3.5</i>	<i>43.8</i>	<i>3.8</i>	<i>44.25</i>
<i>1 : 3 : 6</i>	<i>3.9</i>	<i>40.75</i>	<i>4.0</i>	<i>41.10</i>

A study of this table shows that water absorption increases when the mix becomes lean. This may be due to presence of higher percentage of marble waste as coarse aggregate in the concrete with lean mix. It can also be seen from this table that the unit weight of the rich mix concrete is higher than that of the lean mix concrete. From the table it is clear that the water absorption characteristics of concrete with marble waste satisfies the requirements of the building stone.

**COMPRESSIVE STRENGTH OF MARBLE WASTE CONCRETE AT
7 DAYS FOR 1 : 2 : 4 MIX**



**COMPRESSIVE STRENGTH OF MARBLE WASTE CONCRETE
AT 7 DAYS FOR 1 : 3 : 6 MIX**



CHAPTER - 9
STRENGTH COMPARISON OF MARBLE WASTE CONCRETE WITH THE
ORDINARY CONCRETE

The marble waste concrete shows high compressive strength with 0.5 w/c ratio in the 1:2:4 mix and as well as in 1:3:6 mix so, the comparison between ordinary concrete and marble waste concrete is taken at the 0.5 w/c ratio.

The results obtained on both the normal concrete and marble waste concrete with 0.5 w/c ratio is shown in the below table No:9.1

COMPRESSIVE STRENGTH OF CONCRETE

Mix Ratio	W/C Ratio	Compressive strength of Marble Waste Concrete in N/mm ²			Compressive strength of Ordinary Concrete in N/mm ²			
		Curing Age (Days)			Curing Age (Days)			
		3	7	28	3	7	28	
1 : 2 : 4	0.4	14.67	26.67	41.33	7.21	14.25	28.26	
		13.33	23.11	42.22	7.11	14.00	28.00	
		12.44	25.78	40.00	6.67	14.56	27.56	
	0.5	20.00	35.56	51.11	9.98	20.58	35.18	
		17.78	33.33	44.44	9.70	21.63	35.20	
		21.33	29.78	50.67	9.78	21.53	34.83	
	0.6	8.89	13.33	30.22	5.32	7.20	25.80	
		8.00	12.44	32.00	5.00	7.11	25.52	
		9.78	11.56	31.11	5.25	7.25	26.67	
	1 : 3 : 6	0.4	8.00	16.44	28.00	5.21	10.61	20.56
			6.67	15.56	27.56	5.32	10.72	20.82
			7.11	16.00	28.00	5.25	10.80	20.80
0.5		9.33	17.78	31.11	8.21	12.62	24.72	
		8.44	18.67	31.56	8.00	12.75	24.80	
		8.89	17.78	32.00	8.32	12.50	24.53	
0.6		5.33	10.67	20.00	2.78	8.58	16.72	
		5.78	9.78	20.89	2.72	8.72	16.80	
		5.33	10.22	21.33	2.80	8.90	16.53	

From the above table, the marble waste concrete shows greater strength than that of the ordinary concrete.

The only advantage of the marble waste concrete over the ordinary concrete is that it has a higher compressive strength over the ordinary concrete. So it can be used in the construction of slabs, beams, columns & foundation works.

CHAPTER - 11

CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

11.1 CONCLUSIONS

Based on various investigation carried out the following conclusions can be made.

1. Compressive strength of concrete with marble waste as a coarse aggregate is more than the ordinary concrete. Compressive strength of concrete with marble waste as a coarse aggregate is about 65% to 75% of that conventional concrete

2. Concrete with mix properties 1 : 2 : 4 and 1: 3 : 6 with marble waste as a coarse aggregate shows compressive strength of 48.74 N/mm² and 31.56 Nmm² respectively and 3.5% and 3.9%, respectively and this satisfies the requirements of load bearing building blocks. Hence, these concrete can be used to make building blocks at places, were marble waste is available.

11.2 SUGGESTION FOR FUTURE WORK

- 1) To increase strength further admixture can be used in the concrete.*
- 2) For further developing of this project the same marble waste concrete is made by using marble fine as a fine aggregate.*
- 3) The same marble waste concrete can be made by replacing part of cement with flyash.*
- 4) The same marble waste concrete can be made by replacing sand with quarry fine.*

BIBLIOGRAPHY

FOR REFERENCE :

1. M.S. SHETTY, *Concrete Technology*, Chand & Co
2. N. KRISHNA RAJU, *Design of concrete mixes* CBS publishers and distributors, Delhi.
3. KULKARNI.P.D, MITTALL.N, *Labortory manual for concrete technology*, Teachers training institute chandigarh.
4. B.C.PUNMIA, *Soil mechanics and foundation* - Lakshmi Publishers 1984.
5. IS 456 - 1978 BUREAU OF INDIAN STANDARDS DELHI.
6. IS 2185 - Part II 1983 BUREAU OF INDIAN STANDARDS DELHI.