

# Experimental Investigation of Fly ash, Marble dust and Wollastonite powder based Paver block

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**Abstract:** - paver block are used as a pavement which can be maintained easily and if any problem occurs can be replaced easily. It gives us variety in quality i.e. size, shape, colour and thickness with rates cheaper than concrete pavement. It carries load generally greater than identical sized reinforced blocks. Paver blocks can be classified accordingly loading (traffic condition) non traffic, light traffic, medium traffic, heavy traffic, very heavy traffic. In this paper we will study the effects on paver block by replacing cement with fly ash, marble dust and wollastonite powder. In this thesis we will study the amount of cement which can be replaced without affecting the strength of concrete. The aim of the project is to produce environment friendly paver block which solves disposal problem of fly ash marble dust and increasing strength of concrete. Test results obtained suggests that no three materials at a time can be used to replace cement but 10% and 15% replacement with marble dust and wollastonite powder respectively gives good results than normal cement concrete so this proportion can be adopted as it costs cheaper than normal concrete for paver block.

**Key Words:** Concrete paver block, fly ash, marble dust, wollastonite powder.

## 1. INTRODUCTION

Now a days as India is developing country and to be a developed nation infrastructural development plays vital role in overall development of country.

So on the basis of my topic I have designed paver blocks by taking different combinations of marble dust, fly ash and wollastonite powder. As I have replaced cement with three materials at a time so it has designed for light weight or non-traffic types of paver block having 60 mm thickness, Emission of the carbon di-oxide from the manufacturing industries of cement have 7% of the total emission of carbon dioxide. Hence, by using substitute material for cement such as fly ash, marble dust and wollastonite powder decreases utilization of cement. This project strictly follows Is 15658:2006 for paver blocks. Concrete used is M30 grade of concrete having proportion ratio 1:2.04:3.33. In this proportion 40% of 10 mm aggregate and 60% of 20 mm aggregate is used. Instead of river sand dust is used as it gives more compaction when kept on vibration. Water cement ratio used is 0.4. Superplastisizer used is 2% by weight of cement.

**Table 1: Proportions used**

Comb. No.	Proportions
C1	100% C
C2	85% C+15% FA
C3	75% C+25% FA
C4	90% C+10% MD
C5	85% C+15% MD
C6	85% C+15% WP
C7	75% C+25% WP
C8	75% C+15% FA+10% MD
C9	65% C+25% FA+10% MD
C10	70% C+15% FA+15% MD
C11	60% C+25% FA+15% MD
C12	70% C+15% FA+15% WP
C13	60% C+25% FA+15% WP
C14	60% C+15% FA+25% WP
C15	50% C+25% FA+25% WP
C16	60% C+15% FA+10% MD+15% WP
C17	50% C+15% FA+10% MD+25% WP
C18	50% C+25% FA+10% MD+15% WP
C19	40% C+25% FA+10% MD+25% WP
C20	55% C+15% FA+15% MD+15% WP
C21	45% C+15% FA+15% MD+25% WP
C22	45% C+25% FA+15% MD+15% WP
C23	35% C+25% FA+15% MD+25% WP
C24	75% C+10% MD+15% WP
C25	65% C+10% MD+25% WP
C26	70% C+15% MD+15% WP
C27	60% C+15% MD+25% WP

## 2. TESTS

Tests shall be made at the 7<sup>th</sup> & 28<sup>th</sup> day's ages of the specimen. At least three specimens shall be made for testing at each selected age. Paver block of triangular curvature shape is casted for testing which has cross sectional area 58400 mm<sup>2</sup>.

### 2.1 Compression testing

Compression testing is done using compression testing machine which is having capacity of 2000 kN/mm<sup>2</sup>.

$$\text{Compression strength} = P/A$$

Where, P = load and A = surface area

### 2.2 Flexural test

For this test loading applied on paver block is one point loading having effective length as 240 mm and clear cover is of 30 mm for each side.

$$F_b = 3Pl/(2bd^2)$$

Where, F<sub>b</sub> = flexural strength in N/mm<sup>2</sup>

P = maximum load in N

l = distance between end supports in mm

b = width of paver block in mm

d = thickness of paver block in mm

The maximum load shall be noted as breaking load.

### 2.3 Abrasion resistance test

The abrasive wear of the specimen after 16 cycles of testing shall be calculated as the mean loss in specimen volume

$$\text{Loss in volume}(V_b) = (\text{Loss in mass}(M_b))/(\text{Density of block})$$

Where, V<sub>b</sub> = loss in volume after 16 cycle, in mm<sup>3</sup>;

M<sub>b</sub> = loss in mass after 16 cycles, in g; and

P<sub>R</sub> = density of the specimen, or in the case of two-layer specimens, the density of the wearing layer, in g/mm<sup>3</sup>.

### 2.4 Water absorption test

Water absorption test is carried out to calculate amount of water material absorbs.

$$\text{W percent} = ((W_w - W_d))/W_d \times 100$$

Where, W<sub>w</sub> = Weight of wet (saturated) block.

W<sub>d</sub> = weight of block after complete drying.

### 2.5 Rapid Chloride Permeability Test

The total charge passed is determined and this is used to rate the concrete according to the criteria

Table -2: Criteria for RCPT test

Coulombs passed	Chloride ion permeability
>4000	High
2000-4000	Moderate
1000-2000	Low
100	Very low
>100	Negligible

Average current flowing through one cell is calculated by,

$$I = 900 * 2 * I \text{ Cumulative coulombs.}$$

$$I_{\text{CUMMULATIVE}} = I_0 + I_{30} + I_{60} + I_{90} + I_{120} + I_{150} + I_{180} + I_{210} + I_{240} + I_{270} + I_{300} + I_{330} + I_{360}$$

Where

I<sub>0</sub> = Initial current reading in mA at 0 min. and so on

### 2.6 Ultrasonic pulse velocity Test

In this test, the strength and quality of concrete or rock is assessed by measuring the velocity of an ultrasonic pulse passing through a concrete structure or natural rock formation.

$$\text{Pulse velocity} = (\text{thickness of structure})/(\text{time taken by pulse to go through}).$$

Table 3: Velocity criteria for concrete quality grading

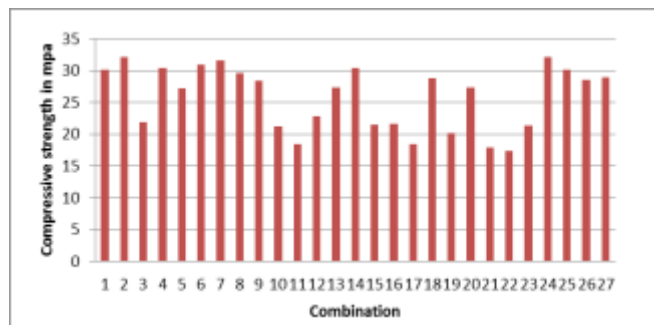
Pulse velocity in m/s	Concrete quality
Above 4.5	Excellent
3.5-4.5	Good
3.0-3.5	Medium
Below 3.0	Doubtful

## 3. Results and Discussion

Following are the results obtained when various tests conducted on paver block.

**Table 4: Test results for paver block**

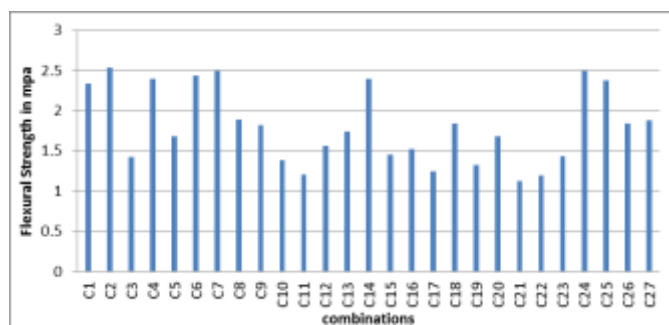
Test	Compressive Strength N/mm <sup>2</sup>		Flexural strength N/mm <sup>2</sup>	Abrasion value mm <sup>3</sup>
	7 day	28 day	28 day	28 day
Combination	7 day	28 day	28 day	28 day
1	21.57	30.13	2.34	833.33
2	21.92	32.19	2.53	833.33
3	14.72	21.91	1.42	1250
4	20.71	30.41	2.40	416.67
5	18.49	27.15	1.68	416.67
6	19.69	30.91	2.44	0
7	20.54	31.60	2.50	416.67
8	18.32	29.60	1.89	833.33
9	17.46	28.43	1.82	833.33
10	10.10	21.20	1.38	416.67
11	9.24	18.49	1.2	1250
12	15.75	22.80	1.56	833.33
13	16.43	27.40	1.74	1250
14	19.86	30.43	2.40	833.33
15	14.21	21.48	1.45	1250
16	14.89	21.62	1.52	833.33
17	11.98	18.49	1.24	1250
18	17.29	28.85	1.84	1666.67
19	10.27	20.2	1.32	2083.34
20	16.78	27.40	1.68	1667.67
21	11.98	17.89	1.13	2500
22	12.15	17.34	1.19	2500
23	8.21	21.4	1.43	3333.34
24	21.40	32.13	2.50	416.67
25	17.97	30.13	2.38	416.67
26	17.29	28.52	1.84	833.33
27	17.63	28.90	1.88	833.3



**Chart 2: compressive strength at 28 day of testing**

**Discussion**

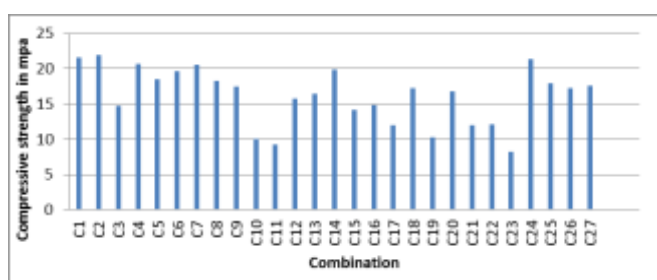
1. When fly ash added to cement up to 15% strength of concrete increases.
2. Strength of concrete increases up to 10% addition of marble dust and 25% addition of wollastonite powder.
3. Maximum replacement of cement which can be done to achieve considerable compressive strength is 55%



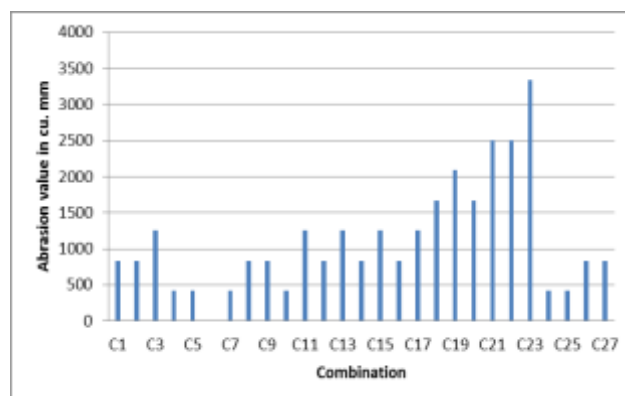
**Chart -3: flexural strength at 28 day**

**Discussion:**

1. When fly ash added to cement up to 15% flexural strength of concrete increases.
2. When 10 % marble dust and 15 % wollastonite powder is used in paver block it gives flexural strength greater than normal concrete.
3. Combination 23 gives poor result in which three materials are used at a time to replace cement up to 55 %.



**Chart 1: compressive strength at 7 day of testing**



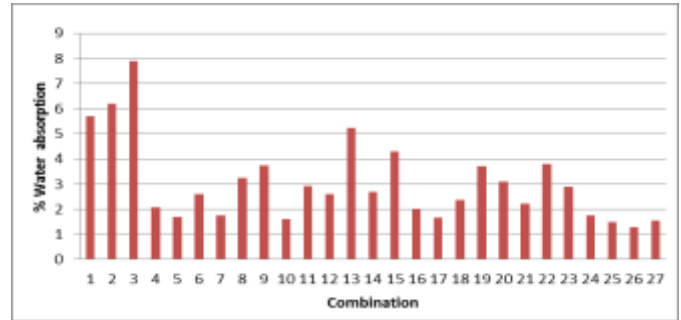
**Chart -4: abrasion loss of paver block**

**Discussion:**

1. Abrasion resistance reduces as percentage increase in fly ash. Marble dust and wollastonite powder have more abrasion resistance than fly ash.
2. Cement when replaced up to 65% cannot sustain against frictional resistance.
3. Marble dust has greater abrasion resistance than wollastonite and fly ash respectively.

**Table 5: Test results for paver block**

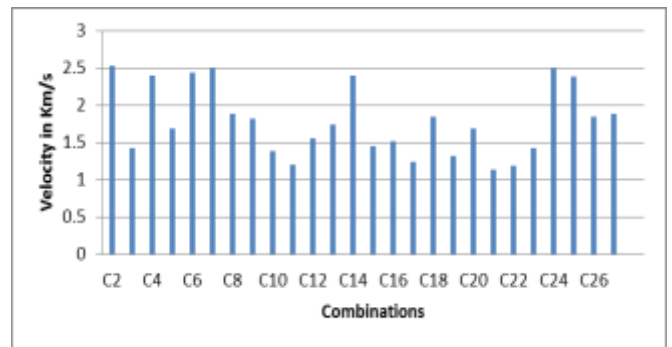
Test	%water absorption	Pulse velocity m/s
Combination		28 day
1	5.7	4.54
2	6.2	4.6
3	7.9	4.4
4	2.081	4.62
5	1.69	4.3
6	2.61	4.56
7	1.75	4.24
8	3.23	3.8
9	3.75	3.7
10	1.62	2.9
11	2.91	2.8
12	2.60	3.1
13	5.24	3.6
14	2.70	4.5
15	4.3	3.0
16	2.012	3.3
17	1.65	2.8
18	2.38	3.8
19	3.7	2.7
20	3.11	3.6
21	2.22	2.7
22	3.8	2.68
23	2.88	2.9
24	1.74	4.7
25	1.49	4.6
26	1.28	4.2
27	1.54	4.3



**Chart 5: % water absorption v/s combination**

**Discussion:**

Paver block are not impervious to water and in order to bond with mortar they must be able to absorb some water. From above results we can see that for combination no 3 i.e. 70% cement + 25% FA gives maximum % water absorption which is 7.9, which is not acceptable, Similarly combination no. 1, 14, 19 and 24 also gives 5.7, 2.70, 3.7, 1.74 respectively.



**Chart 6: UPV test results**

**Discussion:**

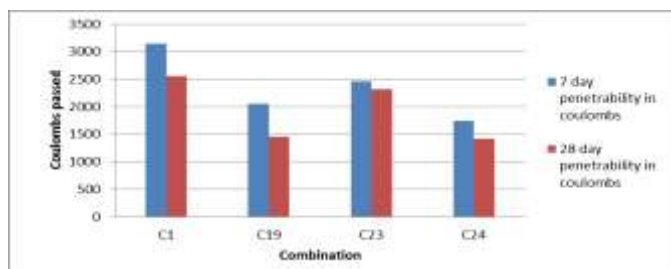
1. As UPV test is a parameter of quality of concrete, combination 1,2,4,6,14,24,25 shows excellent quality of concrete.
- 2 From the results obtained from the test we can say that when the three materials used at a time to replace cement, quality of concrete reduces. Hence 10% of marble dust and 15% of wollastonite powder is used in concrete as a replacement of cement, wave propagates at faster speed. Hence property of concrete is increased for combination number 24.
3. As we know that UPV test is used for determining the quality of concrete hence these results can be useful in future for enhancement of the property of structure.

**4.6 Rapid Chloride permeability test:**

Rapid Chloride permeability test is conducted on four combinations of paver block. Test is used for determining the durability of concrete Is code used for this test is IS: 516-1959.

**Table 6: RCP test results**

Combination	Chloride ion permeability at 7 day	Remark	Chloride ion permeability at 7 day	remark
C1	3150	moderate	2560	Moderate
C19	2052	Moderate	1450	Low
C23	2466	Moderate	2320	Moderate
C24	1746	Low	1420	Low



**Chart 7: Chloride permeability at 7 and 28 day**

**Discussion:**

1. RCPT test is a measure of performance of concrete under acid attack.
2. Test is conducted only on four combinations, if chloride permeability is less that means it has more resistance capacity to acid attack.
3. Marble dust and Wollastonite powder when used together in concrete it has less permeability than normal concrete.

**4. CONCLUSIONS**

- 1) Fly ash when used in concrete the strength of concrete increases gradually up to 15% addition. As fly ash is light in wt. it results into light wt. structures with great compressive strength. Only one major drawback of using fly ash in paver block is, it is not possible to achieve finishing of paver block as some amount of fly ash get stuck in mould.
- 2) Marble dust can be used in concrete up to 10%. Further addition causes reduction in physical properties of concrete.
- 3) Wollastonite powder can be used up to 15% it gives strength to concrete; fire resistance of concrete also increases.
- 4) From this test we can conclude that no three materials can be used at a time to replace cement.
- 5) When 10% marble dust and 15% wollastonite powder is used as a combination in concrete it gives positive results in overall six tests conducted in this thesis. Cost of construction

reduces as marble dust and wollastonite powder are cheaply available in the environment, disposal problem of marble dust can be solved and paver blocks produced can be environment friendly.

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