

# Cost estimation study on concrete paver block by partially replacing cement with granite powder

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**Abstract:** The marble and granite industries have grown tremendously in recent decades. The granite industry in India produces over 3500 cubic meters of granite powder slag all day as waste material. Granite tiles producers often create granite particulate matter tones although during the production process. The exclusion of granite fines from the polishing industry is a major concern. The polished granite powder is reactive, but not disposable on the floor. Stone waste is commonly a heavily polluting waste due to its high alkaline origin, which poses a health hazard to the environment. Downstream waste affects soil quality due to reduced porosity, water retention, water percolation etc. As it is dumped on land. They cause severe waste and pollution of the atmosphere and need large areas of land for disposal. The polishing process obtained the granite powder and is held at 12% and 88% respectively, by 150 microns. Due to its fineness and size, the granite powder can be used effectively. This study describes the viability of partial cement replacement with granite powder in paver block construction. Furthermore, this study urges engineers, contractors, and the government to consider substitute materials for a better future.

**Keywords:** Marble powder, Granite powder, Cement, Paver block, Compressive strength

## 1) INTRODUCTION

The idea that the paver block is connected is very ancient. The Minoans first built the road in 5,000 B.C. with a paver block. About 2000 years ago, Roman pavement roads were first built with the assistance of labour and military groups. The Netherlands adopted concrete block paving (CBP) as a substitute for baked clay bricks roads in the early 1950s.

Concrete is the single most widely used construction material in the world today. It is used in buildings, bridges, sidewalks, highway pavements, house construction, dams, and many other applications. The key to strong and durable concrete is the mix proportions between the various components. Less cement paste can lead to more voids, thus less strength and durability while more cement paste can lead to more shrinkage and less durability. The gradation and the ratio of fine aggregates to coarse aggregates can affect strength and porosity. The mix design should also achieve the desired workability of concrete to prevent segregation and allow for ease of placement. Concrete should have enough compressive strength and flexural strength to support applied loads. At the same time, it should have good durability to increase its design life and reduce maintenance costs. In general, durable concrete will have good resistance to freeze and thaw abrasion and alkali-silica reaction.

The design of the paver block is based according to Indian standards IS15658:2006. Our design concern for paving paver block for light traffic condition(M-35) and strength will be checked out after 28 days.

## 2) SCOPE

- The motive of the utilization of granite powder in paver block concrete is to make it economical in such a way that it helps for sustainable development.
- To encourage the waste product as eco-friendly material.

## 3) OBJECTIVES

- To check the changes of different properties (compressive strength, durability, hardness etc.) of paver block by adding different percentages of granite powder.
- To reduce the cement content.
- To utilize the waste material available in the granite quarries.
- To promote sustainable development.

## 4) LITERATURE REVIEW ON PAVER BLOCK

The research found that paver blocks can be quickly maintained and modified as pavement. The project aims to create environmentally sustainable paver blocks to address fly ash, marble dust, and accelerate concrete strength removal. Paver blocks may be classified as needed for loading [4].

The intensity of the granite powder paver block as the cement replacement was investigated. The research indicates that granite dust in paver blocks can be used effectively and is resistant [5].

The cement and soil mix of the concrete paving block is a mixture of water and cement. Several test cubes were cast and measured by regulation of the water content at various soil-cement ratios. The wet compressive strength of soil-cement blocks is 1.32 N/mm<sup>2</sup> [6].

A research investigation studied the probability of partially interchanging sand with waste glass. The study showed that discarded glass can effectually be replaced with sand up to 45% [7].

[8] Described in their research that marble powder is marble waste that is readily accessible and causes environmental contamination. In civil works, using marble waste not only protects the atmosphere from contamination but also produces environmentally friendly buildings.

## 5) MATERIAL AND METHOD

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Granite powder
- Superplasticizer

### 5.1-Cement

Cement used shall be any of the following as per IS CODE 15658:2006

- a) 33 Grade ordinary Portland cement conforming to IS 269,
- b) 43 Grade ordinary Portland cement conforming to IS8112,
- c) 53 Grade ordinary Portland cement conforming to IS 12269,

Cement act as binding material in concrete, the specific gravity of cement (OPC43) would be 3.15 which is being used.

### 5.2-Fine aggregate

Aggregate which is passed through 4.75 mm IS sieve and retained on 75 microns IS sieve is termed as fine aggregate. Locally accessible M-sand & Zone2 (table number 4 IS383code) has been used to cast all the paver blocks and specific gravity was 2.60.

### 5.3-Coarse aggregate

Coarse aggregates shall comply with the requirements of IS 383. As far as possible crushed/semi-crushed aggregates shall be used. For ensuring adequate durability, the aggregate used for the production of blocks shall be sound and free of soft or honeycombed particles. The specific gravity of aggregate is 2.69 & the nominal maximum size of coarse aggregate shall be 12mm

### 5.4-Water

Portable waters are generally considered satisfactory for mixing and curing concrete. The value of PH should not be less than 6 & less than 8% of silt is permissible.

### 5.5-Granite powder

Granite is a coarse intrusive igneous rock composed mostly of quartz, alkali feldspar and plagioclase. It is from magma with high content of silica.

Physical properties

The average density of granite is between 2.65 and 2.75 g/cm<sup>3</sup>

Compressive strength lies between 200mpa

Melting temperature 1215-1260 degrees Celsius

Granite is poor primary permeability

(Table 1. Chemical configuration of granite powder)

Chemical Constitute	Percentage
Silica	72.04
Alumina	14.42
Potassium oxide	4.12
Sodium oxide	3.69
Calcium oxide	1.82
Iron oxide	1.22
Magnesium Oxide	.71

### 5.6-Plasticizer

The plasticizer is a mixture of organic & inorganic substance which permits the reduction in w/c ratio at the same workability or ensure higher workability at the same w/c cement ratio.in either case, it provides a strong mix or a workable mix.

These plasticizers act as deflocculating Reagents hence gets adsorb over the cement particles. Thereby making the interactive free water free which modifies the properties of the mix.

The dose of the plasticizer varies in the range of .1%to.4% by the weight of cement at which they permit the reduction in the water to content by 5% to 15% or increase slump value by 30 to 150mm. commonly used plasticizers include ligno sulphate, polyglycol esters, carbohydrates & hydroxylated carboxylic acid.

**6. MIX PROPORTION**

The design mix for M35-grade concrete was developed based on IS 10262:2009. The mixture ratio of 1:1.6:2.22:0.4 has been adopted. The required compressive strength of characteristic was 35MPa for 28 days in the test.



(Fig1 ingredient by weight)



(fig2 Dry homogenous concrete )



(fig3 wet homogenous concrete )



(fig4 compaction through a vibrating table)



(fig5 placed for final setting )

Coarse aggregate maximum tailing of the 6 mm to 12 mm. Quality assurance degree is acceptable. In this experiment with paver block, the granite powder was substituted with 5% 10%, 15%, 20% and 25%. Compression strength and flexural strength were taken into account in the effects of cement substitution with granite powder in different percentages [7,8].

(Table 2 showed a proportion of a trial mix for cement substituted with different percentages of granite stone.)

S. No	Cement in percentage	Granite powder in percentage
1	100	0
2	95	5
3	90	10
5	85	15
6	80	20
7	75	25

Mixing of concrete such that it should be homogenous, in picture1 according to mix proportion ration all the ingredient taken by weight. Now all the ingredients will be put on a clean surface then homogenous mixing will be done by hand. After adding the required amount of water and admixture again hand mixing is done.

**7) TEST ON HARDENED CONCRETE**

**7.1-Compressive strength test**

The cube with size 250 x 123 x 80 mm was cast using grade M-35 for compressive strength. The mould of the paver is made of concrete. The samples were dismantled and stored in the tank for 28 days after 24 hours. This sample has been tested in machines for compression testing. The load is carried out by IS 15658:2006.



For loading, a CTM of 2000 kN was used [9]. Three samples have been evaluated in each category, and the formulation indicates the average compression value calculated by equation (1)

$$\text{Compressive strength} = \text{Load} / \text{Cross-sectional area (MPa)} \quad (1)$$

Mix ID	Mean compressive strength @28days (n/mm <sup>2</sup> )
0	48.87
5	51.27
10	55.71
15	52.78
20	44.47
25	43

### 7.2-Flexural Strength test

Based on IS 15658:2006, a flexural strength of concrete prism has been estimated. After 24 hours of the cast and uncut beam specimens, 250 x 123 x 80 mm is held for 28 days of cure [9]. The test specimens were carried out by the UTM using equation (2).

$$\text{Flexure strength} = P \times L / bd^2 \quad (2)$$

P = Load, L = Length, B = Breadth, D = Depth

Mix id	Mean flexural strength @28days (n/mm <sup>2</sup> )
0	3.67
5	3.74
10	3.98
15	3.93
20	3.86
25	3.77

### 7.3-Water absorption test

**Saturation:** The Paver block is entirely submerged in the water at 24±2 h. It is then to separate the paver block from the water. A moist cloth shall be taken out of the visible water on the paver block. The weighing block for each specimen shown by the next 0.01 N shall be instantaneously measured (WW).

**Drying:** The paver block shall be dried at 107 ± 7° C for 24 h after saturating and the loss shall not increase more than 0.2 % from the formerly defined quantity of the paver block until two consecutive weighing at the intervals of 2 h has appeared. The dry weight (Wd) is taken at N to the nearby 0.01N calculated by using equation (2).

$$\text{Water absorption percent} = W\text{percentage} = (W_a - W_d / W_d) \times 100 \quad (3)$$

Mix id	Mean % of water immersion < 6%
0	3.48
5	3.36
10	3.16
15	3.27
20	3.55
25	3.989

### 7.4-Impact test

In this test, a few blocks are dropped from 1m in height. If blocks are broken it indicates low impact value and is not acceptable for construction work. Good quality blocks do not break at all.

## 8) RESULT AND DISCUSSION

Granite powder properties were cast and measured in different concentrations. Properties such as compressive power, bending force were analysed and it has identified and exploited the optimal mix ratio. Both findings demonstrate that the properties were improved successfully. Table 4 demonstrates the results of compressive, flexural, water penetration and cost analysis.

Table 4. Results of Compressive, Flexural, Residual of Compressive strength, water absorption and Cost Analysis

Mix id	Mean compressive strength @28 days (N/mm <sup>2</sup> )	Mean flexural strength@28 days(n/mm <sup>2</sup> )	Mean %of water immersion <6%	Cost study per paver block (Rs.)
0	48.87	3.67	3.48	16.80
5	51.27	3.74	3.33	16.48
10	55.71	3.98	3.16	15.00
15	52.78	3.93	3.27	14.50
20	44.47	3.86	3.55	13.50
25	43	3.77	3.98	12.90

As per table 4, it is observed that using granite powder in the replacement of cement will change the properties of concrete. If replacement is done by the amount of 10% all results in favour and more than the actual value which also reduces the cast of paving without compromising strength.

## 9) CONCLUSION

Granite powder is formed from granite stone which is widely in use in marble industries. A large amount of granite dust is easily collected from such industries which can be used in the construction site. The characteristic strength of the concrete paver was evaluated by experimental studies to replace the cement with the granite powder by adding three mix ratios. The compressive, flexural, water immersion, residual and cost study were checked and measured for concrete paver specimens. Based on the results of the tests, the mix ratios showed better accuracy compared to the standard concrete paver for 28 days. replaced by cement in the construction field.

- The research objectives have been drawn based on experimentations carried out with substituted granite powder over cement (0%,5%,10%,15%,20% and 25%)
  - As per table 4, if we replaced cement with granite powder by 10% the compressive strength increase by 14%, flexural strength Increase by approximate 8% and water absorption capacity reduce by 9% concerning 100% cement concrete paver block.
  - As per the cost study, if 10% of cement is replaced by granite powder cost of construction is reduced by 11% which is a huge amount of reduction in the construction field.
  - In general, 10 per cent granite powder cement replacement was initiated to be suitable for compressive, bending, and resistance of residual compressive and cost concrete paver.
- in simple, the usage in the paver block of granite powder can be inferred as an important method for enhancing properties of concrete of paver block which also reduces the cost of construction.

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