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An Experimental Investigation on Strength of Paver Block Using Dolomite as Partial Replacement of Cement and Addition of Polyester Fiber in Different Proportions

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***Abstract*: In this exploration through experimentation partially replacement of cement with dolomite powder and addition of polyester fiber in few percentages on concrete paver block. It is called fiber reinforced concrete paver block. Cement is a grinded material with adhesive and cohesive property that performs as a binder for distinct ingredients. Dolomite powder obtained by the sedimentary rock forming minerals dolostone and some similar features of cement. When dolomite powder used in concrete it lower the price of concrete paver block and enhance the strength of paver block by adding various percentages of polyester fiber. Polyester fiber is a man-made fiber produced from any long-chain synthetic polymer as the fiber producing ingredient. Water cement ratio 0.36 is used. In this experiment using Cement is partially replaced with dolomite powder in various percentages like 0%, 10%, 20% and 30% respectively and also adding polyester fiber in various percentages like 0%, 0.1%, 0.2%, and 0.3% respectively. Mix design M_{30} concrete grade is used. For concrete mix design paver block using IS 15658:2006 and IRC: SP: 63-2004. Size of coarse aggregate 10mm is used. To implement different test like compressive strength test at the end of 7days, 14days and 28days, split tensile strength test and flexural strength test at the end of 28 days.**

Key words: Paver Block, Dolomite powder, Polyester fiber, Portland pozzolana cement.

I INTRODUCTION

Paver blocks which is also termed as brick paving. It is generally used for decorating purpose for pavements. The idea of utilizing paver block for interlocking is old. In 5000 B.C. first road was constructed using paver block. In the year 1924 Nether land first manufacturing for concrete paving blocks was started. Paver block are easy to adjust and are used in rigid pavement. Paver block absorbs stress such as earth quakes, Freezes thaws cycle and erosion by flexing. Paver blocks introduced to increase strength, durability, reduction in shrinkage and cracks. In concrete paver block addition of fiber it is called fiber reinforced concrete paver block. It is the secondary reinforcement. They improve the strength, resistance against abrasion and quality of construction. Fiber used in paver blocks do not easily crack, break and buckle. Now a day materials use for paving blocks are replaced by waste materials and used materials to reduce the impact on environment pollution and this can increase mechanical properties and strength of paving blocks. There are different wastes materials which can be used construction of paver block, this material are cheap or free of cost available. Paver blocks are firm prefabricated cement concrete blocks that are utilized in the pavement's surface course. It is available in various shapes, sizes and colours. It is not absorb water.

II LITERATURE REVIEW

Sabir Ali, Aneel Kumar, Samar Hussain Rizvi, Mohsin Ali and Israr Ahmed (July-Dec 2020) "The Compressive Strength of Concrete with Sugarcane Bagasse Ash as a Partial Replacement for cement" In this investigation they partially replaced cement by sugarcane bagasse with various percentages like 0%, 5%, 10% and 15%. The better result obtained for compressive strength at 10% replacement level for 7days and 28days and for water absorption test at 15% replacement level for 28days strength.

Abdul Rachman Djamaluddin, Muhammad Akbar Caronge, M.w. Tjaronge, Asiyanthi T. Lando and Rita Irmawaty (December 2019) "Concrete paved block made with recycled tea ash that are durable and environmentally friendly" is the title of a study." In this case study the partially replaced cement with processed waste tea ash at different percentages like 10%, 20%, 30%, 40% and 60% by weight of cement in different grade M10, M20, M30, M40, M60. The better result obtained for compressive strength test on mix design M10, for flexural strength test on mix design M0 and for water absorption test on mix design M60.

Lavanya Ganesan and Chippymol James (September 2019) "Determination of concrete paver block using PET fiber" In this experiment fine aggregates fully replaced by quarry dust and plastic fiber added from waste water bottle with various percentages like (0.4%, 0.5% and 0.6%) in concrete paver block. They used zigzag shape paver block with 240mm×120mm×80mm mould size and used M30 grade. They performed compressive strength test, flexural strength test and density test. The best result achieved at 0.4% of plastic fiber in all three test.

Nor Baizura Hamid, Siti Noraiza Ab Razak, Mardiha Mokhtar, Mohd Erwan Sanik, Masiri Kaamin, Ahmad Hakimi Mat Nor, Mohd Zakwan Ramli (JULY 2019) "Incorporation of Waste materials in Develoment of Paving blocks" In this study the coarse aggregates 40% replaced by tin and plastic and fine aggregates fully replaced by quarry dust. they made ecofriendly paving block It consist of (cement, quarry dust, coarse aggregate, tin and plastic). They used rectangular shape paver block with 50mm×200mm×100mm mould size. For compressive strength test the result of control paving block and ecofriendly paver block was same on 7 days curing periods and for 14 days curing period the result for C.P.B. was good as compared to the E.F.P.B. The density test result was better for C.P.B as compared to the E.F.P.B. for both 7 days and 14 days curing period.

III MATERIALS & METHODOLOGY

A. Materials used

1) Cement: One of the most essential components of concrete is cement. It is a binding material and they are used in construction work. Various types of cement usable in market but in this experiment used Portland pozzolana cement. The density of cement is 1440 kg/m^3.

Table-3.1 Physical Properties of Cement

Characteristic	Value
Specific gravity	3.15
Initial Setting Time	30 minute
Final Setting Time	600 minutes

2) Fine Aggregate: The material which passes through the 4.75mm IS sieve, it is called fine aggregate. The main function of FA (fine aggregate) is to cover the vacant packets between CA (coarse aggregate) and reduce the shrinkage and cracking. The fine aggregate decided as per IS: 383-1970.
3) Coarse Aggregate: The material which retain on 4.75mm IS sieve, it is called coarse aggregate. The approximate greatest dimension of coarse aggregates utilized in production of paver blocks will be 12mm as per IS 15658:2006 but in this experiment 10mm size were used.
4) Dolomite powder: The dolomite powder is generated from sedimentary rock which is dolostone which is sedimentary stone. The key constituents of dolomite are magnesium carbonates (MgCo3) and calcium carbonate (CaCo3).

Table-3.2 Physical Properties of Dolomite Powder

Characteristic	Value
Formula	$CaMg(Co_3)_2$
Colour	White Powder
Fineness modulus	2.46
Specific Gravity	2.85

Tenacity	Brittle
Crystal System	Trigonal

5) Polyester Fiber: Polyester fiber refers from polymer bunch. In this experiment, a polyester triangular synthetic fiber is 12mm length and diameter 0.4mm. It increases the life of paver blocks and improves the quality.

Table-3.3 Physical Properties of Polyester Fiber

Characteristic	Value
Material	100% Synthetic Fiber
Shape of Fiber	Specially improve for holding aggregate
Specific Gravity	1.36
Colour	White
U.V.Stability	Very Good
Young Modulus	17.5×10^3MPa
Ult. Elongation%	50-70
Aspect Ratio	340

6) Water: The most important component is water, which when added with cement, makes a paste that holds the aggregate together. Through a process is known as hydration. Water is also used for curing purpose.

B. MIX DESIGN

M-30 Mix design as per IRC:SP:63-2004 & IS15658:2006

1) Grade Designation: M30
2) Type of Cement: PPC (Portland-pozzolana Cement)
3) Size of Aggregate: 10mm
4) Minimum Cement Content: 380kg/m3
5) Maximum Cement Content: 425kg/m3
6) Maximum Water Cement Ratio: 0.38
7) Workability: 25-50 mm (Slump)
8) Specific gravity of cement: 3.15
9) Specific gravity of Water: 1.00
10) Specific gravity of Aggregate: 2.64
11) Specific gravity of sand: 2.62
12) Water Absorption of sand: 0.80%
13) Water Absorption of Aggregate: 0.81%

Table-3.4 Mix Proportion for M30 Grade

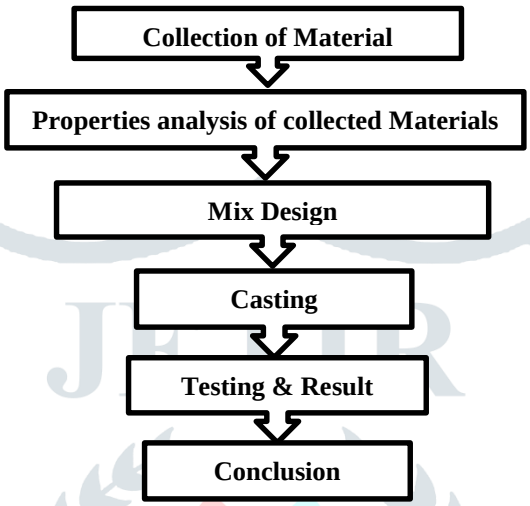
Sr. No.	Material	Quantity	Proportion
1.	Cement	400	1
2.	Fine aggregate	1116.12	2.7
3.	Coarse aggregate	749.76	1.8
4.	Water	144	0.36

C. Methodology

1) To determine the physical properties and chemical properties of materials.
2) Concrete Mix are taken as M30 grade of concrete and the design of mix are done as per IRC:SP:63-2004 and IS: 15658:2006 for replacing cement by dolomite powder with various percentages and addition of polyester fiber with different percentages, using sand as fine aggregate and 10mm size coarse aggregate.
3) The concrete mix was develop using different compositions, the cement is replace partially by dolomite powder for 0%, 10%, 20% and 30% by the mass of cement and addition of polyester fiber 0%, 0.1%, 0.2% and 0.3% by weight of cement.
4) Test on hardened concrete, the use of Compressive strength test, Flexural strength test and Split tensile strength test.

Table-3.5 Descriptive proportion of dolomite with cement and additional % of polyester fiber

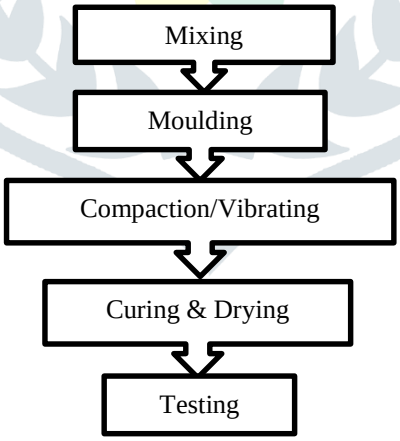
Mix design	Description
M_0	Standard composition of M-30 grade
M_1	Composition with 10% of dolomite powder by cement weight and 0.1%addition of polyester fiber
M_2	Composition with 20% of dolomite powder by cement weight and 0.2%addition of polyester fiber
M_3	Composition with 30% of dolomite powder by cement weight and 0.3%addition of polyester fiber



Flow chart-3.1 Flow chart of methodology

D. MANUFACTURING OF PAVER BLOCKS

Following procedure to be adopted for the manufacturing of Paver block and testing.



Flow chart-3.2 Flow chart of manufacturing

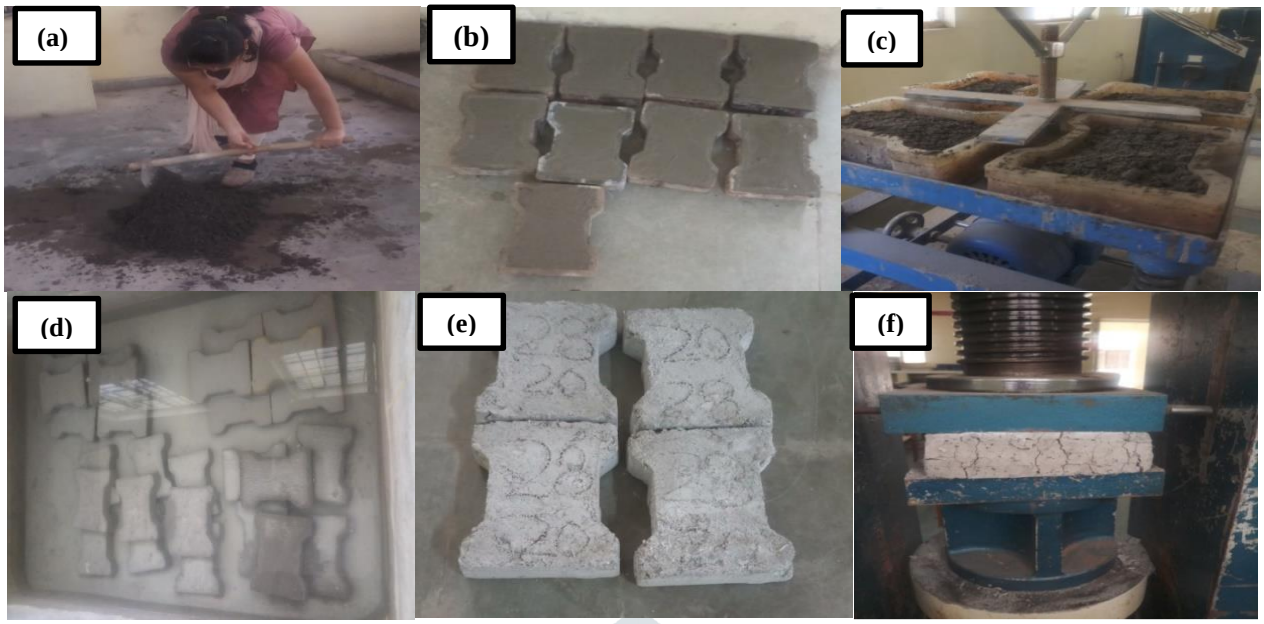


Fig-1, Experimental procedure for manufacturing of paver block (a)Mixing, (b)Moulding, (c)Vibrating, (d)Curing, (e)Drying, (f)Testing (Source:Author)

IV TESTING AND RESULT

First, both fine and coarse aggregates are tested to a water absorption test and a specific gravity test. Concrete in its fresh state were tested both slump test and compaction factor test. After 7 days, 14days, and 28 days, a compressive strength test was done, and their average values obtained were recorded. After 28 days, to determine the flexural strength test and split tensile strength test were tested.

A. Compressive strength test

Observations of "Apparent Average Compressive Strength" value achieved for fiber reinforced concrete paver block are given in table below:

Table-4.1 Observation of Apparent Average Compressive Strength Value

DAYS	**Apparent average compressive strength of paver block in (N/mm^2)**		
Mix Proportions	7 days	14 days	28 days
M_0	22.52	30.07	33.18
M_1	24.78	32.85	36.02
M_2	23.34	31.9	35.38
M_3	22.28	30.78	33.45

The IS: 15658-2006 clause D-5 and Table 5 provide a correcting factor to be used in the "Apparent Compressive Strength" for their corrected value. The "correction factor" for a 60mm thickness of chamfered paver block is 1.06. This correction factor multiply with the apparent average compressive strength value then obtained "Corrected average compressive strength" for fiber reinforced concrete paver block are given in table below:

Table-4.2 Observation of Corrected Average Compressive Strength Value

DAYS	**Corrected average compressive strength of paver block in (N/mm^2)**		
Mix Proportions	7 days	14 days	28 days
M_0	23.87	31.87	35.17
M_1	26.26	34.82	38.18
M_2	24.74	33.81	37.5
M_3	23.61	32.62	35.45

- The experimental values of "Corrected Average Compressive Strength Test" are represented by chart:

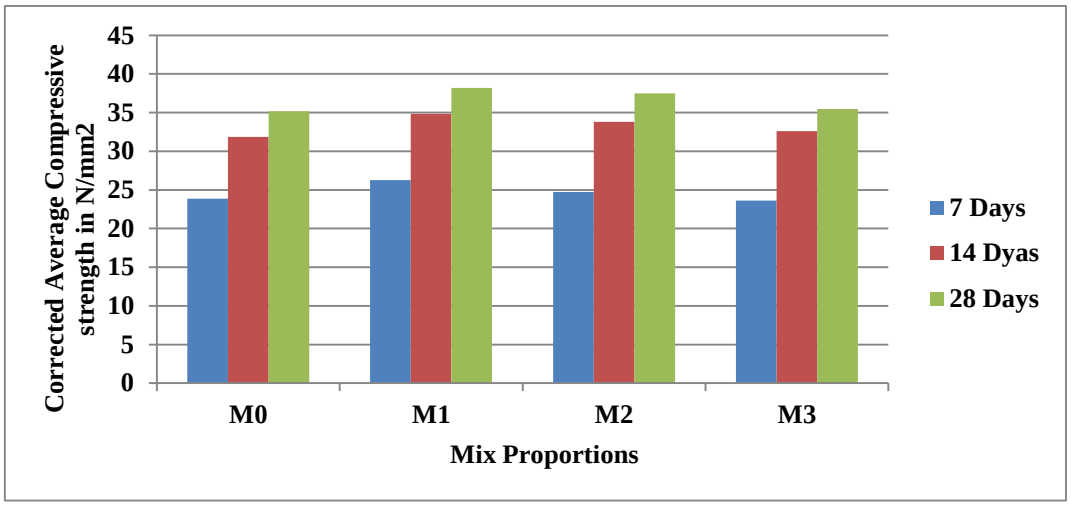


Chart 4.1 Variation in Corrected Average Compressive Strength value

B. Flexural strength test

Table-4.3 Observation of Average flexural strength value

DAYS	Average flexural strength of paver block in (N/mm^2)
Mix Proportions	28 days
M_0	2.74
M_1	3.05
M_2	2.9
M_3	2.6

- The experimental values of Flexural strength test are represented by chart:

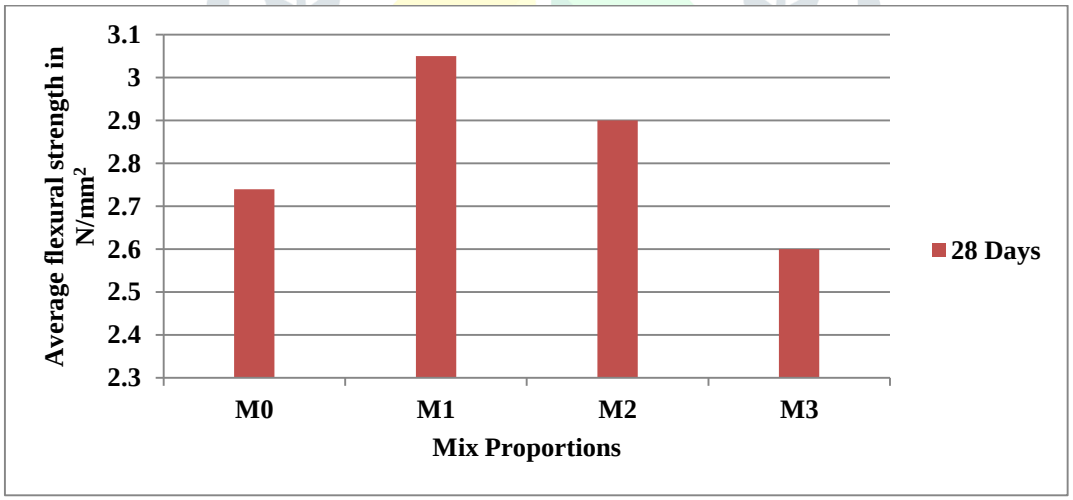


Chart-4.2 Variation in Average Flexural Strength value

C. Split tensile strength test

Table-4.4 Observation of Average Split Tensile Strength Value

DAYS	Average split tensile strength of paver block in (N/mm^2)
Mix Proportions	28 days
M_0	1.83
M_1	2.04
M_2	1.94
M_3	1.74

- The experimental values of Split tensile strength test are represented by chart:

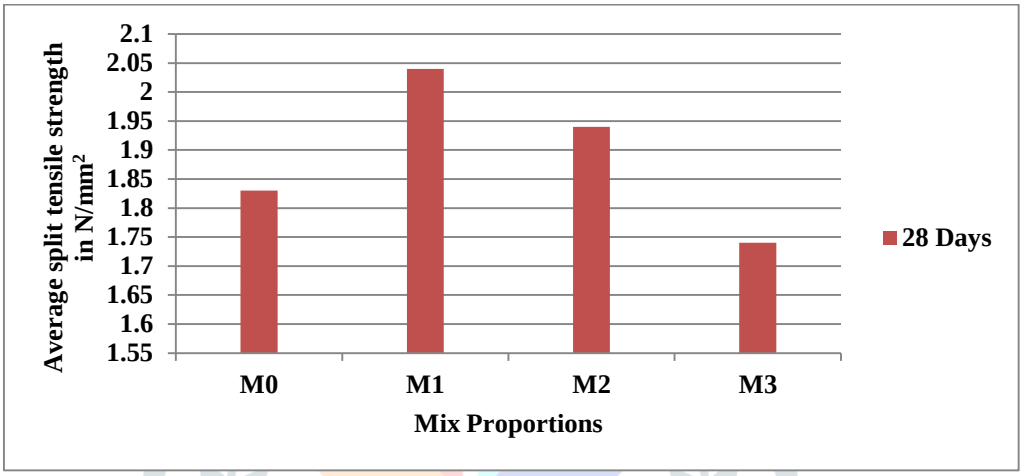


Chart-4.3 Variation in Average Split Tensile Strength value

V CONCLUSION AND FUTURE SCOPE

A. Conclusion

1) Dolomite powder can be used to partially replacement of cement up to 10% and adding polyester fiber up to 0.1 percent, the compressive strength, split tensile strength, and flexural strength of paver blocks are increased; however, as the proportion of dolomite powder and polyester fiber increases, the compressive strength, split tensile strength, and flexural strength decrease.
2) From the above mentioned analysis, we found that for 10% dosage of dolomite powder substitute by cement and addition of 0.1% of polyester fiber by cement weight at 28days we achieved maximum strength for compressive strength, flexural strength and split tensile strength. The maximum values obtained from above composition for 28 days for compressive strength, flexural strength and split tensile strength are 38.18, 3.05 and 2.04 respectively.

B. Future Scope

1) Specialists have attempted to make the concrete economical by replacing either cement, fine aggregate or coarse aggregate with other waste material.
2) Dolomite replaced with cement and addition of polyester fiber it very well may be supplanted with other waste material, to accomplish better economy.
3) Other waste material such as fly ash, silica fume, ground granulated blast furnace slag, quarry dust etc.it can also be replaced with cement.
4) Strength and durability properties of dolomite powder can be increase by adding organic fibers.

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