International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

An Experimental Study on Marble waste used in Paver Blocks

Khushboo Tiwari[1]

Abstract: ***The first forms of road transport involved animals, such as horses (domesticated in the 4th or the 3rd millennium BCE), oxen (from about 8000 BCE) [1] or humans carrying goods over dirt tracks that often followed game trails. Many early civilizations, including Mesopotamia and the Indus Valley Civilization, constructed paved roads. In classical antiquity, the Persian and Roman empires built stone-paved roads to allow armies to travel quickly. Deep roadbeds of crushed stone underneath kept such roads dry. The medieval Caliphate later built tar-paved roads. A paver is a paving stone, tile, [6] brick [7] or brick-like piece of concrete commonly used as exterior flooring. They are applied by pouring a standard concrete foundation, spreading sand on top, and then laying the pavers in the desired pattern. No actual adhesive or retaining method is used other than the weight of the paver itself except edging. Pavers can be used to make roads, driveways, patios, walkways and other outdoor platforms. This study investigates the possible way for constructing the pavement blocks by using wastes. The experiment were conducted with the of proper utilization of the solid waste in construction of paver blocks without affecting the various mechanical properties such as compressive strength, flexure strength and split tensile strength. The waste which we are going to select is the waste generated by marble stone quarrying or at the time of its dressing. The paver blocks were constructed by using the waste marble products after replacing the coarse aggregate by some defined percentage. These blocks were tested by different tests like compressive strength test, flexural strength test, and split tensile strength test. The compressive strength found to be in between 47.35 N/mm^2 to 44.98N/mm^2. But we observed that up to 40% replacement of coarse aggregate with marble stone generally does not show any major difference. The replacement of coarse aggregate with the marble stone generally does not affect the flexural strength of the paver blocks. In the same manner the split tensile strength of the paver blocks does not shows any effect by the replacement of coarse aggregate with marble stones. The approximate value is found to be 46.5 N/mm^2. Based on these experiment we concluded that the waste generated by the marble stone can be used as an alternative for the natural crushed stone used in paver blocks as the compressive strength, flexural strength and the split tensile strength of the testing blocks does not shown any major difference with its original standard mix paver blocks.***

Keywords: Marble Waste, Paver Blocks, Coarse Aggregate, M40, Rigid Pavements

1. Introduction

Transport or transportation is the movement of humans, animals and goods from one location to another. Modes of transport include air, land (rail and road), water, cable, pipeline and space. The field can be divided into infrastructure, vehicles and operations. Transport is important because it enables trade between people, which is essential for the development of civilizations. Transport infrastructure consists of the fixed installations, including roads, railways, airways, waterways, canals and pipelines and terminals such as airports, railway stations, bus stations, warehouses, trucking terminals, refuelling depots (including fuelling docks and fuel stations) and seaports. Terminals may be used both for interchange of passengers and cargo and for maintenance. Vehicles travelling on these networks may include automobiles, bicycles, buses, trains, trucks, people, helicopters, watercraft, spacecraft and aircraft. Transport plays an important part in economic growth and globalization, but most types cause air pollution and use large amounts of land. While it is heavily subsidized by governments, good planning of transport is essential to make traffic flow and restrain urban sprawl. During the study we are going to discuss a possible way for constructing the pavement blocks by using wastes. The experiment will be conducted with the proper utilization of the solid waste in construction of paver blocks without affecting the various mechanical properties such as compressive strength, flexure strength and split tensile strength. The waste which we are going to select is the waste generated by marble stone quarrying or at the time of its dressing. This waste marble product will be used for replacing the coarse aggregates by some defined percentage and tested. After testing we will be concluding our results and explaining their behavior

2. Literature Review

In an experiment performed by **Yole, R.C. and Dr. Varma, M.B. (October 2014),** they used rounded steel aggregate as a partial replacement of aggregate and used rubber pad at bottom for testing. They designed a nominal m ix i.e., by weight having ration of 1:1.84:2.76 of cement aggregate and water respectively. They prepared 5 different type of paving block by percentage replacing of aggregate with 0%, 10%, 20%, 30% and 40%. The rubber pad used at bottom was of a thickness of 10 mm. They performed impact test on these blocks with and without rubber pads. They noticed that as there is an increase in percentage of steel ball bearings or rounded steel aggregate the average impact value increases from 4.33 for 0% replacement to 6.33 for 30% replacement when tested without using rubber pad below the paving block. On further increasing the replacement of ball bearing to 40% the average impact value decreases to 5. By using the rubber pad at the bottom of thickness 10mm at bottom impact value shows a drastic increase of 500 % to 600 %. The value of impact test changes to 23.33 to 35 for 10% to 40% replacement with steel ball bearings respectively. For the increasing impact value they justified that it was due to increase in the density of paver block. They also concluded that the use of rubber pad at the bottom will increase the impact value very drastic and the reason for this is the shock absorbance by the rubber pad. The various results of their experiment was shown in the following

Table 2.1 and 2.2 as below:

Table 2.1: Properties of the cements used [21]

Sr. No.	Properties	Results
1	Grade of OPC	53
2	Standard Consistency	33%
3	Initial Setting Time	2 Hrs and 20 Minutes
4	Final Setting Time	5 Hrs and 10 Minutes
5	Specific Gravity	2.85
6	Strength of Cement	38.32 N/ mm2 (For 28 Days)

3. Methodology

During this experimental study we are going to perform various test on fine aggregate, coarse aggregate, Marble Stone , Fly ash and various strength test on Interlocking Tiles Designed by decided mixes of M40.

We are going to perform following tests on materials:

a) On Coarse Aggregate
Specific Gravity, Fineness Module and, Water Absorption Test

b) On Fine Aggregate
Specific Gravity, Fineness Module, bulk density and Water Absorption Test

c) On Fly Ash
Specific Gravity, Fineness Module, bulk density and Water Absorption Test

d) On Cement

Specific Gravity, Finesse Test, Consistency, Initial and Final Setting Time, Compressive Strength and Soundness Test.
We are going to perform following tests on modified mixed concrete Paver Block:
Compressive Strength test

4. Result and Discussion

4.1 General

All the methodology and test adopted were discussed in the previous chapter. As per our experiment analysis, we used:
- Coarse aggregate of size 10-20 mm.
- Electronic waste chips of size 10-20 mm
- Fine Aggregate
- Ordinary Portland Cement of Grade 43

The process and experimental result analysis will be discussed further.

4.1.1 Preparation of Marble Stone

The marble stone brought from the market were varying in size, they are required to be broken further into smaller pieces and sieved as per the selection required for replacing the coarse aggregate. For breaking these we asked the worker of that market to break it into smaller pieces of about 10-20 mm. after that we sieved them from 10-20mm size sieve and the retained stoned were taken further for experiment.

4.2 Test on Coarse Aggregate

4.2.1 Results of various test

The summarized results are shown in table 4.1 and plotted in graph no 4.1 for better and easy understanding.

4.2.2 Discussion

The results of our test various test shows that the specific values which we are calculated are within the limits as per ISO 9001:2008 with approximately. The minor deviations may be results of temperature and human errors. Specification for the coarse aggregate required for concrete is followed by IS383:1970.Method of testing of coarse aggregate are done as per IS2386:1963 (PART III & PART IV)

Table 4.1: Properties of Coarse Aggregates.

Sr. No.	Properties	Observed Value
1	Avg Specific Gravity	2.6567
2	Water Absorption Test	0.70%
3	Fineness Modulus	6.86

4.2.3 Test on Marble Stone used as Coarse Aggregate

<u>Results of various test:</u>
The summarized results are shown in table 4.2.

Table 4.2: Properties of Marble Stone

Sr. No.	Properties	Observed Value
1	Avg Specific Gravity	3.2867
2	Water Absorption Test	0.63%
3	Fineness Modulus	7.25

4.2.4 Discussion

As the marble stone used are not as per any standards although the values obtained during experiments are quiet similar to those values which were obtained by Khandave. P .v. and Rathi, A. S.[22]. The cause of deviations from their results is that as they used a standard specific type of marble stones for their experiment but in our experiment we used a various mixture of marble stone. The various properties of marble stone is shown as below in table 4.2.

4.3 Test on fine Aggregate

4.3.1 Result

The summarized results are shown in table 4.3

Table 4.3

Sr. No.	Properties	Observed Value
1	Avg Specific Gravity	2.71
2	Water Absorption Test	1.21%
3	Fineness Modulus	3.18
4	Bulk Density	1577 kg/m3

4.3.2 Discussion

The test result shows good physical properties of fine aggregates. The sand used in our experiment seems to a natural river sand as its properties are similar to those used in experiment counted by Revathi, S. et al (2015) [29] and also as per other references which we have explained in chapter 2.

4.4 Test for Cement

4.4.1 Discussion

The test result shows properties of Cement as per ISO 9001:2008 standards. The minor deviations may be results of temperature and human errors. Results of our experiment are shown in following table 4.4.

Table 4.4: Properties of Cement

Sr. No.	*Properties*	*Observed Value*
1	Average Specific Gravity	3.15
2	Fineness	3%
3	Normal Consistency	35%
4	Initial Setting Time	29 mins
5	Final Setting Time	625 minute
6	Compressive Strength	
	At 3 days N/mm2	18.33
	At 7 days N/mm2	27.3
	At 28 days N/mm2	42.33
7	Soundness Test	3.33 mm

4.5 Preparation of concrete

4.5.1 Quantity estimation by IS10262:2009

Target Mean Strength = 48.25n/mm2
Water Cement Ratio = 0.4 (from IS 456:2000 table no 5)
Water Content = 180 kg
Estimated Air Entrapped = 2%
Cement Content = 450 kg
Fine Aggregate = 623.63 kg/m3
Coarse Aggregate = 1084095 kg/m3

4.5.2 Quantity after replacement with marble stone:

Table 4.5: Quantity of Components.

Designated Mix	Weight kg/m3				
	Cement	Water	Fine Aggregate	Coarse Aggregate	Marble
CA100M0	450	180	623.63	1084.95	0
CA90M10	450	180	623.63	976.455	108.495
CA80M20	450	180	623.63	867.96	216.99
CA70M30	450	1800	623.63	759.465	325.485
CA60M40	450	180	623.63	650.97	433.98
CA50M50	450	180	623.63	542.475	542.475
CA40M60	450	180	623.63	433.98	650.97

The concrete is prepared by mixing in the mix proportion of M40 and 0%, 10%, 20%, 30%, 40%, 50% and 60% of the coarse aggregate proportion and quantities of each components are given in following table 4.5

4.6 Test on Paving Bricks

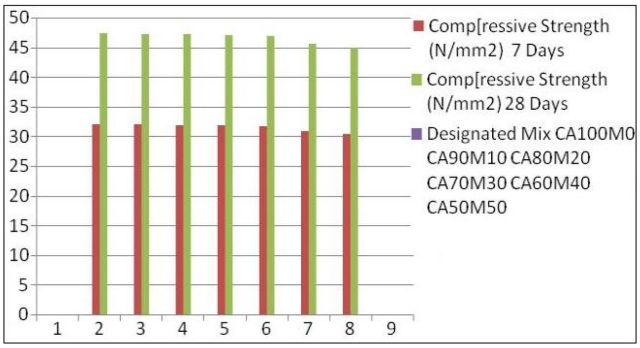
4.6.1 Test of Compressive strength

As discussed above we prepared the paver bricks and designated them as CA100M0, CA90M10, CA80M20, CA70M30, CA60M40, CA50M50 and CA40M60. The test for compressive strength is conducted as discussed in chapter 3. The maximum compressive strength found out of three paver bricks of each mix is plotted on graph. The maximum value observed is 47.35 N/mm2 for CA100M0 mix. The lowest value is observed at CA40M60 is 44.98 N/mm2. The different value observed during the experiment is given in the following given table 4.6 and the plotted graph in graph no 4.1.

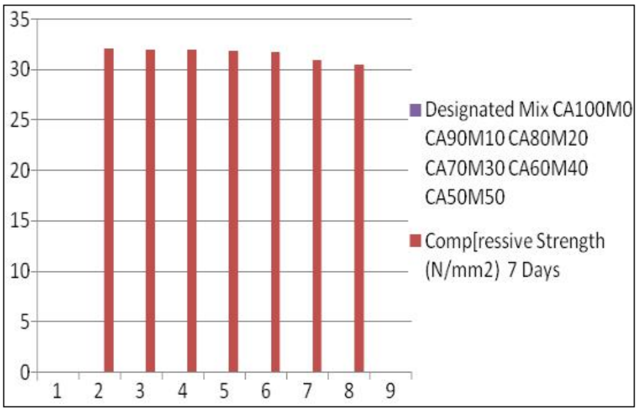
Table 4.6: Test result of compressive strength of paver brick

Designated Mix	Weight kg/m3					Compressive Strength 7 days	Compressive Strength 28 days
	Cement	Water	Fine Aggregate	Coarse Aggregate	Marble		
CA100M0	450	180	623.63	1084.95	0	32.01	47.35
CA90M10	450	180	623.63	976.455	108.495	31.95	47.26
CA80M20	450	180	623.63	867.96	216.99	31.89	47.18
CA70M30	450	180	623.63	759.465	325.485	31.79	47.02
CA60M40	450	180	623.63	650.97	433.98	**31.7**	46.89
CA50M50	450	180	623.63	542.475	542.475	30.83	45.6
CA40M60	450	180	623.63	433.98	650.97	30.41	44.98

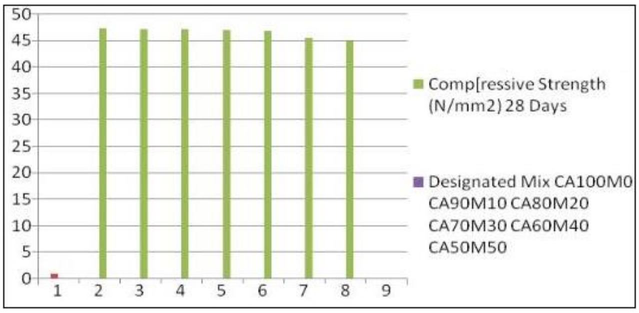
As we increase the content of the marble stones we observed that up to 40% replacement the decrease in compressive strength very slightly from 47.35 N/mm2 to 46.89 N/mm2. As we increase the marble content above 40% the compressive strength of the paver brick starts decreasing but with larger rate as compared to upto 40% replacement. The lowest value observed is at 60% replacement of marble stone with coarse aggregate is 44.98 N/mm2. This type of phenomena is observed in the experiment performed by Khandve P. V. and Rathi A.S. [29] in concrete pavement paving brick using Marble stone industry waste. The maximum value observed by them was 47.35 N/mm2.



Graph 4.1



Graph 4.2: Compressive Strength of 7 Days



Graph 4.3: Compressive Strength of 28Days

5. Conclusion

The final conclusion of our detailed analysis is as follow:

1) The Average specific gravity of the stone used as coarse aggregate is 2.66, water absorption noted is not more that 0.70% by its own weight. Also the fineness modulus for the fine aggregate is 6.86. These results shows that the fine aggregates which we buyer or used is up to standard grade.
2) For Marble stone used to replace Coarse Aggregate following point can be concluded from our detailed dissertation, the average specific gravity of the stone used is 3.2867, The water absorption noted is not more that 0.63% by its own weight. Also the fineness modulus for the fine aggregate is 7.25.
3) For Fine Aggregate following point can be concluded from our detailed dissertation are the Average specific gravity of fine aggregate is 2.71, water absorption noted is not more that 1.21% by its own weight. Also the fineness modulus for the fine aggregate is 3.18. The bulk density note is 1577 kg/m3. This results show that the fine aggregates which we used is up to standard grade.
4) For Cement grade testing the Average specific gravity is 3.15, fineness is 3%, normal consistency found is 35%, initial time and final setting time for the cement which we used are 16 mins and 625 mins, compressive strength for cement cube after 28 days found to be 42.5 N/mm2, expansion in the cement mixture is noted to be 3.33mm. These results shows that the fine aggregates which we used are up to standard grade.
5) The compressive strength found to be in between 47.35 N/mm2 to 44.98N/mm2. But we observed that upto 40% replacement of coarse aggregate with marble stone generally does not shows any major difference in the compressive strength and after that the strength decreases but up to 5%.
6) The Flexural strength found to be 4.817 N/mm2 for upto 50 % replacement of coarse aggregate with marble stone. Or we can say that the replacement of coarse aggregate with the marble stone generally does not affect the flexural strength of the paver blocks. In the same manner the split tensile strength of the paver blocks does not shows any effect by the replacement of coarse aggregate with marble stones. The approximate value is found to be 4.65 N/mm2.
7) The Split tensile strength found to be in between 4.735 N/mm2 to 4.4498N/mm2. But we observed that upto 40% replacement of coarse aggregate with marble stone generally does not shows any major difference in the Split tensile strength and after that the strength decreases but up to 5%.

References

[1] Watts, Martin (1999). *Working Oxen* (https://books.google.com/books?id=u86yjr-J-hAC). Shire Album. 342.

[2] O'Flaherty, edited by C.A. (2002). *Highways the location, design, construction and maintenance of road pavements* (4th ed.). Oxford: Butterworth-Heinemann. ISBN 978-0-7506-5090-8.

[3] Tom V. Mathew and K V Krishna Rao Introduction to Transportation Engineering nptel lectures

[4] R.C. Yeole and Dr. M. B. Varma "Comparision of mix design of paver blocks using waste rounded steel aggregates and rubber pad" International Journal of

[5] Emerging Technology and Advance Engineering, ISSN 2250-2459, ISO 9001:2008, PP-523-527.

[6] Khandave P.V. and Rathi A. S. "concrete paving block using marble stone industry waste" IJRESTS, ISSN 2395-6453(online) Vol-1, pp 86-91.

[7] Pattnaik, T, et al "Manufacturing of interlocking concrete paving blocks with fly ash and glass powder" IJERST, ISSN: 2277-9655, JAN 2018, PP- 604-612.

[8] Meena A.K. et al "a research paper on use of waste material in interlocking tiles to improve its quality", SSRG-IJCE, ISSN: 2348-8352, VOL 3 2016, PP 60-63.

[9] Kapgate, S,S, and Satone, S.R. "effect of quarry dust as partial replacement of sand in concrete" IJRESTS, ISSN 2395-6453(online) Vol-1, pp 80-85.

[10] Karthik M.P. et al "a general review on interlocking paver blocks" Technical Research Organisation India, ISSN: 2393-8374, VOL-4, 2017, PP 40-42.