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Research Article

PERFORMANCE OF BLACK MARBLE STONE WASTE AGGREGATE IN PERVIOUS CONCRETE

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A B S T R A C T

Pervious concrete can be noticed as no-fine concrete. This type of concrete has been increasingly used to reduce the amount of runoff water. It is most widely used in vehicular access pathways such as parking in residential areas, service driveways, and roadway shoulders. The objective of the present investigation is to evaluate the properties of pervious concrete and compare it with normal concrete. On the other hand, the requirement of aggregate to produce concrete is high while natural resources are reduced. An attempt was made to use Black Marble Stone Waste Aggregate in concrete in the ratios of 0, 50, and 100% to replace natural aggregate. To obtain the behavior of pervious concrete compressive, split and flexural strengths are evaluated. A total of 54 specimens were casted and tested in this experimental work to study the behavior of concrete. A regression model has been developed to assess the split tensile strength and flexural strengths.

INTRODUCTION

Normal or conventional concrete, which is a combination of cement, sand and coarse aggregate, forms a hard surface. The fast urbanization and infrastructure developments cause compactly constructed buildings. Depletion of ground water is a major problem today due to the lack of percolation of rain water into the soil. The impermeable nature of conventional concrete restricts the flow of rainwater into the ground. Pervious concrete is one solution to this problem. Pervious concrete is also called enhanced porosity concrete, which is used widely nowadays due to its higher infiltrating ability. Pervious concrete is made up of cement paste, coarse aggregate with little or no fine aggregate. The paste binds the aggregate particles together to develop a system of interconnected and highly permeable voids that encourage the quick drainage of water. Generally, it is used in parking areas, areas with light traffic, residential streets, pedestrian roads, and houses, swimming pool edge. The proper utilization of pervious concrete is a recognized Best Management Practice by the U.S. Environmental Protection Agency (EPA) for providing storm water management.

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On the other hand, the demand for production of concrete is increased and many new methods and also new materials are being introduced for production of concrete. The cost of production of aggregate is increasing at a shocking rate and there is a running down of the natural resources which give the raw material for its manufacture. The use of waste material as a replacement of coarse aggregate in concrete has become the thrust area for construction materials. These days, the focus is on utilization of waste materials or a bi-product from several manufacturing industries. It can be used as partial replacement of aggregate in concrete, without compromising on its desired strength. The scope of this research is focused on the replacement of aggregate with Black Marble Stone Waste Aggregate with different proportions. Black stone marble waste is one of the materials to be used in concrete because it has the required properties.

LITERATURE SURVEY

In this section, past literature works have been presented to know the status in the area of pervious concrete. Jing *et al*. [6] used smaller sized aggregate, silica fume (SF) and super plasticizer (SP) in the previous concrete can enhance the strength of pervious concrete greatly. Jigar J. Anghan *et al*. [5] conducted concrete experiments to estimate the pervious. Baoshan Huang *et al*. [2] evaluated the effects of latex, natural sand and fiber on the pervious concrete. Different tests such as permeability test, compressive strength test, split tensile strength test were conducted. Nader *et al*. [9] discussed thickness design of no-fines concrete parking lot pavements. Schaefer VR *et al* [10], developed the mix designs for pervious concrete for cold weather conditions. Kamel *et al* [7], studied the effects of using stone cutting waste on the compressive strength and slump characteristics and concluded that the slurry sludge generated from stone cutting may be used for concrete up to 25% of the total volume of water required for producing the concrete.

From the literature, a little work has been done on pervious concrete by using alternate materials. As a result, it is intended to learn about the performance of Black Marble Stone Waste Aggregate in pervious concrete.

Objectives of the Experimental Work

The main aim of the present work is to evaluate the strength characteristics of pervious concrete. Pervious concrete is prepared with cement and coarse aggregate. In the concrete mix, the natural aggregate is replaced by the Black Marble Stone Waste Aggregate in the proportions of 0, 50 and 100%. The mix design was done for normal concrete. The following objectives are set for the experimental work.

- To study the strength characteristics of compression, split tensile and flexural strengths of pervious concrete.
- The obtain results are compared with normal concrete.

Materials and Experimental Module

For the present experimental work the following materialswere used.

Cement: OPC 53 grade cement was used. The specific gravity is 3.15

Natural Aggregate: 20mm size aggregate is used as coarse aggregate.

Black Marble Stone Waste Aggregate: Crushed Black Marble stone waste aggregate with a maximum size of 20 mm is used, according per IS 383-1970. The specific gravity is 2.75.

Water: portable water was used.

Casting and Curing

Standard cubes (150x150x150mm), cylinders (150mm diax300mm height) and beams (700 x 150 x150 mm) are casted and the specimens are cured in water tank for a period of 28 days.

Fig 1 Compressive Strength Test

Total 18 cubes, 18 cylinders and 18 beams are casted. Compressive strength test is conducted on cubes. Split tensile strength test is conducted on cylinders. Flexural strength test is conducted on beams. The testing of specimens are shown in Fig. 1, Fig. 2 and Fig. 3.

Fig 2 Split Tensile Strength Test

Fig 3 Flexural Strength Test

RESULTS AND DISCUSSIONS

Compressive Strength

The cube compressive strength results are presented in Table1 and the graphical representation is shown in Fig 4. It is observed that, as the replacement of BMSWA is increased the cube compressive strengths are reduced. For 100% of natural aggregate the compressive strength of normal concrete is 28.44 Mpa. For 50% of natural aggregate the compressive strength of normal concrete is 23.11 MPa and for 100% of BMSWA the compressive strength is 18.11. The natural aggregate is replaced with BMSWA in the proportions of 50% and 100% and the compressive strengths are reduced by 18.74% and 36.32% respectively. For 100% of natural aggregate the compressive strength of Pervious concrete is 4.69Mpa. For 50% of natural aggregate the compressive strength of pervious concrete is 2.86Mpa. For 100% of BMSWA the compressive strength is 0.93Mpa. As per ACI guidelines the compressive strength of the pervious concrete should be in range of 2.8 to 28MPa. From present experimental work it noticed that upto 50% replacement of BMSWA is preferable. From the results it is also noticed that, strengths are decreased as the percentage replacement of BMSWA increased.

Table 1 Test Results

Sl.No	Replacement of Aggregate	Cube Compressive strength (MPa)		Split Tensile strength (MPa)		Flexural strength (MPa)	
		NC	PC	NC	PC	NC	PC
1	0	28.44	4.69	3.06	1.18	4.29	1.65
2	50	23.11	2.86	2.75	0.92	3.85	1.17
3	100	18.11	0.93	2.43	0.52	3.4	0.73

Split Tensile Strength

The results of split tensile strengths are presented in Table1 and the graphical representation is shown in Fig 4.. For 100% of natural aggregate the split tensile strength of normal concrete is 3.06 Mpa. For 50% of natural aggregate the split tensile strength of normal concrete is 2.75 MPa and for 100% of BMSWA the split tensile strength is 2.43 MPa. The natural aggregate is replaced with BMSWA in the proportions of 50% and 100% and the split tensile strengths are reduced by 10.13% and 20.58% respectively. In case of pervious concrete of 100% of natural aggregate, 50% of natural aggregate and100% of BMSWA the split tensile strengths are 1.18 Mpa, 0.92 Mpa and 0.52 Mpa respectively. From results, it is observed that as the replacement of BMSWA is increased the split tensile strengths are reduced. The maximum decrease in the split tensile strength is noticed for 100% BMSWA mix.

Relation between Split Tensile Strength and Cube Compressive Strength

A model between split tensile and compressive strengths for 28 days is developed. A regression model was developed by the method of least squares and presented below. The relationship equation is given as

$f_{sp28}=0.584 \sqrt{(f_{c28})}$

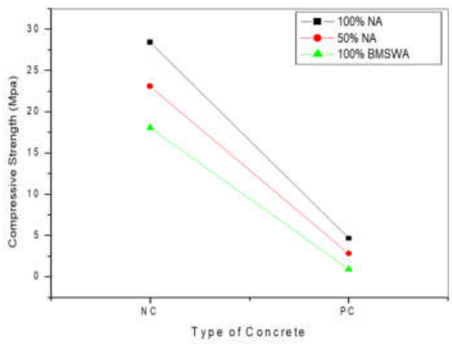
f_{sp28}= 28 days split tensile strength of concrete in MPa

f_{c28}= 28 days compressive strength of concrete in MPa

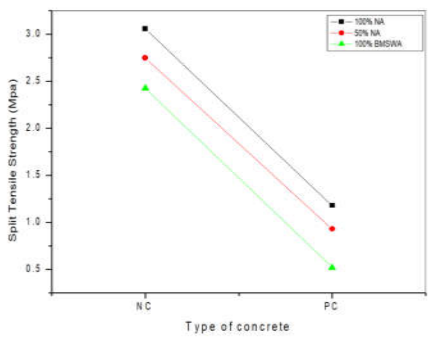
The performance of the regression model is tested for the experimental results and shown in Table 2. It is noticed that the ratio between experimental to regression model is varied from 0.92 to 0.98 and the average ratio between the strengths is observed as 0.95.

Relation between flexural Strength and Cube Compressive Strength

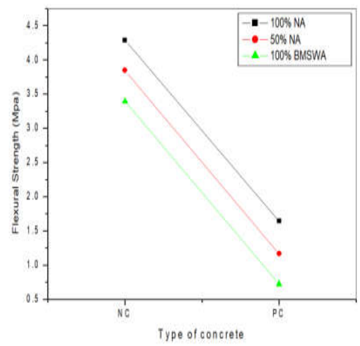
A model between flexural and compressive strengths for 28 days is developed. A regression model was developed by the method of least squares and presented below. The relationship equation is given as



Comparison of Compressive Strength between Normal and Pervious concrete



Comparison of Split tensile Strength between Normal and Pervious concrete



Comparison of Flexural Strength between Normal and Pervious concrete

Fig 4 Comparison of different strengths between Normal Concrete and Pervious Concrete

Table 2 Performance of the regression models for Split tensile and Flexural Strength for 28 days

Replacement of Aggregate	Split tensile Strength (Mpa)						Flexural Strength (Mpa)					
	Normal concrete			Pervious concrete			Normal concrete			Pervious concrete		
	Ultimate Value	Value by Regression	Ratio	Ultimate Value	Value by Regression	Ratio	Ultimate Value	Value by Regression	Ratio	Ultimate Value	Value by Regression	Ratio
0	3.06	3.11	0.98	1.18	1.27	0.93	4.29	4.42	0.96	1.65	1.8011	0.91
50	2.75	2.81	0.97	0.92	0.99	0.93	3.85	3.99	0.96	1.17	1.4027	0.83
100	2.43	2.49	0.97	0.52	0.56	0.92	3.4	3.53	0.96	0.73	0.7968	0.91

Flexural Strength

The Flexural strength results are presented in Table1 and the graphical representation is shown in Fig 4. For the normal concrete of 100% of natural aggregate, 50% of natural aggregate and100% of BMSWA the flexural strengths are 4.29 Mpa, 3.85 Mpa and 3.4 Mpa respectively. The natural aggregate is replaced with BMSWA in the proportions of 50% and 100% and the split tensile strengths are reduced by 10.25% and 20.74% respectively. In case of pervious concrete of 100% of natural aggregate, 50% of natural aggregate and100% of BMSWA the flexural strengths are 1.65 Mpa, 1.17 Mpa and 0.73 Mpa respectively. From results, it is observed that as the replacement of BMSWA is increased the split tensile strengths are reduced. The maximum decrease in the split tensile strength is noticed for 100% BMSWA mix.

$F_{fl28}=0.83 \sqrt{(f_{c28})}$

F_{fl28}= 28 days Flexural strength of concrete in MPa

f_{c28}= 28 days compressive strength of concrete in MPa

The performance of the regression model is tested for the experimental results and shown in Table 2. It is noticed that the ratio between experimental to regression model is varied from 0.83 to 0.98 and the average ratio between the strengths is observed as 0.92.

CONCLUSIONS

1. As the percentage of BMSWA increases, the compressive strength is decreased by 18.74% and 36.32% for 50 and 100 % of replacement.
2. It is also concluded that replacement of BMSWA

upto 50% is considerable.

3. The split tensile strength decreased about 10.13% to 20.58% for the 50 and100% of BMSWA replacement when compared as the natural aggregate
4. The flexural strength of concrete decreased about 10.25% and 20.74% for 50 and100% of BMSWA replacement.

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