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An experimental investigation of broken tiles and nano silica as a partial replacement of coarse aggregate and cement

Mitali Kirtania[1], Ms. D.Shakthi Priya Alias Sumitra[2]
[1]PG Student, Department of Civil Engineering, Prathyusha Engineering College
[2]Assistant Professor, Department of Civil Engineering, Prathyusha Engineering College
E – Mail: mitalirimpi@gmail.com

***Abstract*— Concrete has several appealing characteristics that have made it as a widely construction material. Due to the day by day innovations and developments in construction field, the global consumption of natural aggregates is very high at the same time production of solid wastes from the demolitions and manufacturing units are also very high increase in the industrial and urbanization, the use of buildings also increased which results in continuous usage of construction material leads to scarcity of the concrete materials. Therefore, utilization of waste materials in concrete production is very much helpful to reach the goal of the substantial construction. The tile wastes can be added in concrete preparation due to high price of coarse aggregate in the industry.**

The research focuses on tile waste as partial coarse aggregate replacement for concrete production but the partial replacement alone cannot give sufficient strength to the structure. Hence, partial replacement of Nano Silica is also done along with the Broken Tiles. Nano Silica has proven to be an excellent admixture for cement to improve strength and durability and decrease permeability. Nano Silica reduces the setting time and increases the strength (compressive, tensile) of resulting cement in relation with other silica components that were tested. Thus, the combination of Broken Tiles and Nano Silica as partial replacement of Coarse Aggregate and Cement improves the quality of concrete and reduces the environmental issues and also it reduces the production cost in construction projects.

***Index Terms*— Nano Silica, Broken Tiles, Compressive Strength**

I. INTRODUCTION

General

The materials used in this investigation are as follows:

a) Cement
b) Fine Aggregate
c) Coarse Aggregate
d) Water
e) Broken Tiles
f) Nano Silica

Broken Tiles

A tile is a manufactured piece of hard-wearing material such as ceramic, stone, metal, or even glass, generally used for covering roofs, floors, walls, showers, or other objects such as table tops. In order to reduce CO2 emissions, the construction

industry is focusing on increasing the use of coarse aggregate substitutes in concrete. These tiles when wasted or unused can be recycled or reused as the partial replacement of coarse aggregate. The size of the tiles is 20mm and the polished part of the tiles is made rough for such use.

Nano Silica

Nano Silica is typically a highly effective pozzolanic material. It normally consists of very fine vitreous particles approximately 1000 times smaller than the average cement particles. It has proven to be an excellent admixture for cement to improve strength and durability and decrease permeability. Nano Silica reduces the setting time and increases the strength (compressive, tensile) of resulting cement in relation with other silica components that were tested. Nano-silica is obtained by direct synthesis of silica sol or by crystallization of Nano-sized crystals of quartz.

Physical Properties of Materials

Cement

Properties of OPC cement (53 grade)

S.NO	DESCRIPTION	RESULT
1	Specific gravity	3.3
2	Initial setting time	32
3	Final setting time	420

Fine Aggregate

Properties of Fine aggregate

Coarse Aggregate
Properties of Coarse Aggregate

S.NO	DESCRIPTION	RESULT
1	Fineness Modulus	3.9
2	Specific Gravity	2.55
3	Bulk Density	1736.67 kg/m3

Broken Tiles
Properties of Broken Tiles

S.NO	DESCRIPTION	RESULT
1	Fineness Modulus	3.18
2	Specific gravity	2.71
3	Bulk Density	1612.67 kg/m3

Nano Silica
Properties of Nano Silica

S.NO	DESCRIPTION	RESULT
1	Specific gravity	1.31

Mix Proportion
Mix Proportion of M_{25} grade of concrete

Cement : FA : CA
1 : 1.80 : 2.06

Casting and Testing of Cube

Compressive Strength of Concrete Cubes
The cubes of different proportions of Nano Silica and Broken Tiles are casted and kept for curing for 28 days. The grade of concrete used is M_{25}.

Concrete mixtures can be designed to provide a wide range of mechanical and durable properties to meet the design requirements of the structure. The compressive strength of the concrete is the most common performance measured used by the engineer in designing buildings and other structures.

The compressive strength is measured by breaking cube/cylinder concrete specimens in a compression-testing machine. The compressive strength is calculated from the failure load divided by the cross-sectional area resisting the load and reported in units of Mega Pascal (MPa) in SI units.

Compressive Strength Of Concrete Cube

Specimen Details	Test Results		
	Weight of the specimen (kg)	Ultimate Load (kN)	Compressive Strength (N/mm^2)
NS-9% BT-15%	7.086	645	28.67
NS-10% BT-20%	6.259	674	29.96
NS-11% BT-25%	6.825	634	28.18

Note: NS- Nano Silica, BT- Broken Tiles

Casting of Beam

The beams of different proportions of Nano Silica and Broken Tiles are casted using mix proportion of M_{25} grade. The size of the beam is 1000x150x150 mm and the reinforcement used are of 4 nos.

II. CONCLUSION

S.NO	DESCRIPTION	RESULT
1	Fineness Modulus	3.42
2	Specific gravity	2.30
3	Bulk Density	1601.11 kg/m3

The Nano Silica has an excellent binding property which binds with the cement and reduces the pores in them and also it does not allow the water absorption in the structure. The waste tiles can be used in construction for reducing the environmental issues as well as to reduce the cost of coarse aggregate.

Therefore, it is concluded that the partial replacement of Broken Tiles and Nano Silica in Coarse Aggregate and Cement is yet to be studied and compared with the normal concrete.

The beam is already kept for curing of 28 days. The flexural test of the beams with different proportions of Nano Silica and Broken Tiles is yet to be done.

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