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Flexural Behaviour of Beam using Manufactured Sand and Replacement of Cement with Tile Powder

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Abstract : The concrete was conceptualized by Prof.Okamura at Ouchi University, Japan in 1986.This project explores the strength and durability studies of concrete using Manufactured sand and tile powder. The parameters like protection of natural resources, environmental consciousness are the present construction field requirements. Environmental pollution a major problem faced by mankind, mainly in the construction industry the production of Portland cement causes the emission of pollutants that causes serious threat to the environment. The pollution effects on environment due to cement production can be reduced by increasing the usage of waste products in our construction industry. Usage of Manufactured sand and tile powder is such a remedial measure and in the present study, sand is being replaced with Manufactured sand and Tile powder is choosen as powder in binder (cement + powder).The replacement of Manufactured sand with the sand. The binder is 70% of cement and 30% of tile powder. The Mix design was arrived as per the guidelines of IS 10262:2009. The mix design and the tests to be conducted like material testing ,strength tests and durability tests are being discussed in this project.

1.0 Introduction

Over the years, concrete has established itself as a study building material used for different applications[1]. The inherent benefits of using concrete as a construction material is durability, fire-resistance, low maintenance, energy efficiency and environmental friendliness. Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together[2,3].Concrete is widely used for making architectural structures, foundations, brick walls, pavements, bridges, highways, runways, parking structures, dams, reservoirs, pipes, footing for gates, fences and poles and even boats. Concrete is a brittle material that is strong in compression and weak in tension. The weakness in tension can be overcome by the use of conventional rod reinforcement and to some extent by the inclusion of a sufficient volume of certain fibres[4,7].It is interesting to note that over six billion tons of concrete is produced each year, and is the second most widely used substance. Concrete is a friend of the environment in all stages of its life span, from raw material production to demolition, making it a natural choice for sustainable home construction[9,10].

1.1 Objective

To perform the durability and strength studies of concrete by **reusing** some discarded materials and **reducing** its adverse effects to the environment.

2.0 Materials Used

2.1 Manufactured Sand

Manufactured sand consists of clean, uniformly sized, high quality silica sand that is bonded to form molds of both ferrous and non ferrous metal castings. The physical and chemical characteristics of Manufactured sand will depend in great part on the type of casting process and industry sector from which it originates. It is basically a fine aggregate that can be used in many ways as natural and manufactured sands. They can be made use of in many civil engineering applications like

- Embankments
- Flowable fill
- Hot mix Asphalt
- Portland cement concrete

Table 1: Properties of M Sand

Physical Properties	**Range**
Specific Gravity	2.63
Bulk Relative Density (kg/m$^{3)}$	15.1
Absorption (%)	0.45
Ph	10.1

1.2 Tile Powder

Wall and floor tiles used for interior and exterior decoration belongs to the class of ceramics known as white wares[5]. The raw materials used to form tile consist of clay minerals mined from the earth's crust, natural minerals such as feldspar that are used to lower the firing temperature, and chemical additives required for the shaping process. The minerals are often refined or beneficiated near the mine before shipment to the ceramic plant[6] .The raw materials must be pulverized and classified according to particle size. Primary crushers are used to reduce large lumps of material.

The composition of tiles are illustrated below,

a. SiO_2 : 56-64 %
b. Al_2O_3 : 15-17 %
c. K_2O :2-3 %
d. Na_2O :0.5-1.5 %
e. CaO : 5-5.7 %
f. MgO :0.5-0.6 %
g. L.O.I. : 6-7 %

The values are given in weight percent, based on the total weight of composition. L.O.I is the loss of Ignition.

2.3 Powdered Tile

There are certain undesirable conditions were the tiles are being wasted or considered a waste and is being disposed off. The conditions are,

- Manufacture defect
- Order taken in excess than necessary
- Broken tiles
- Change of flooring tiles when becomes old-fashioned
- Tiles removed during demolishing stage

These tiles instead of being wasted can be collected and can be crushed into a powdered form and can be used as an replacement for cement or any of the aggregates. The choice of aggregates made is decided and

corresponding crushing and sieve is done. In this study tiles are crushed very fine and used as a part of binder along with cement.

Fig 1 Crushed Tile

Fig 2 Powdered Tile

2.4 Fine Aggregate (MSAND):

Sand is a naturally occuring granular material composed of finely divided rock and mineral particles. It is defined by size being finer than gravel and coarse than silt. Sand can also refer to a textural class of soil or soil type. The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz. The second most common type of sand is calcium carbonate. The most common constituents of sand is silica usually in the form of quartz which because of its chemical inertness and hardness. They are common mineral resistant to weathering[8,10]. The influence of fine aggregates on the fresh properties of the is significantly greater than that of coarse aggregate. Particles size fractions of less than 0.125should be include the fines content of the paste and should also be taken into account in calculating the water powder ratio. The high volume of paste in mixes helps to reduce the internal friction between the sand particles but a good grain size distribution is still very important.

2.5 Coarse Aggregate

The coarse aggregate chosen for the concrete is typically round in shape, is well graded, and smaller in maximum size than that used for conventional concrete typical conventional concrete could have a maximum aggregate size of 40 mm or more. In general, a rounded aggregate and smaller aggregate particles aid in the flow ability and deformability of the concrete as well as aiding in the prevention of segregation and deformability of the concrete as well as aiding in the prevention of segregation[3].The more spherical the aggregate particles the less they are likely to cause blocking and the greater the flow because of reduced internal friction. Gradation is an important factor in choosing a coarse aggregate, especially in typical uses of SCC where reinforcement may be highly congested or the formwork has small dimensions. As with conventional concrete construction, the maximum size of the coarse aggregate for depends upon the type of construction. Typically, the maximum size of coarse aggregate used in the ranges from approximately 10 mm to 20 mm. The

coarse aggregate should have a maximum of 12mm. It is to be confirmed as per the BIS specifications. Using lesser size aggregates improves the flowability of the concrete better.

2.6 Cement

The correct choice of cement type is normally dictated by the specific requirements of each application or what is currently used. The most common cement currently used in construction is Portland cement. This cement conforms to the strength requirement and the C_3A content restriction I. This type of cement is typically used in construction and is readily available from a variety of sources. The Blaine fineness is used to quantify the surface area of cement. The surface area provides a direct indication of the cement fineness. The typical fineness of cement ranges from 350 to 500m^2/kg respectively. More than 500Kg/m^3 cement can be dangerous and increase the shrinkage. Less than 350 Kg/m^3 may only be suitable with the inclusion of other fine filler, such as fly ash, pozzolona. It was developed from other types of hydraulic lime in England in the mid 19th century and usually originates from limestone. It is a fine powder produced by heating materials in a kiln to form what is called clinker, grinding the clinker, and adding small amounts of other materials. Several types of Portland cement are available with the most common being called ordinary Portland cement (OPC) which is grey in color, but a white Portland cement is also available. The low cost and widespread availability of the limestone, shales, and other naturally occurring materials used in Portland cement make it one of the lowest-cost materials widely used over the last century throughout the world. Concrete produced from Portland cement is one of the most versatile construction materials available in the world.

2.7 Water

Potable water is used for mixing and curing. Drinking water, also known as potable water or improved drinking water, is water that is safe to drink or to use for food preparation, without risk of health problems. Globally, in 2012, 89% of people had access to water suitable for drinking.

3.0 Results and Discussions

3.1 Compressive Strength Test

For the determination of compressive strength test of concrete cube specimens of 150 mm were casted. The cylinders were casted for 30%, 40% and 50%. The tests were conducted on cylinders at an age of 7 and 28 days. The results are tabulated below.

Table 2: Compressive Strength Results

% Replacement	Compressive Strength			
	7 Days		28 Days	
	Load (kN)	Compressive Strength (N/mm^2)	Load (kN)	Compressive Strength (N/mm^2)
10	640	28.44	800	35.55
20	700	31.11	730	32.44
30	650	28.88	750	33.33
50	630	28	690	30.66

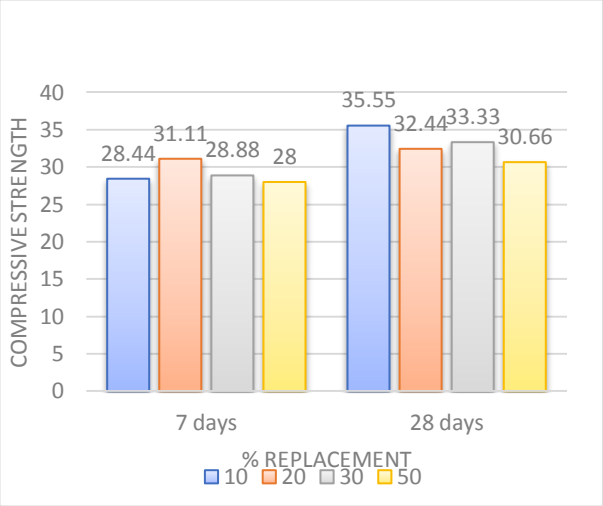

Fig 3 Graph Showing Compressive Strength Results

Table 3: Compressive Strength Results

% Replacement	Compressive Strength			
	7 Days		7 Days	
	Load (kN)	Compressive Strength (N/mm^2)	Load (kN)	Compressive Strength (N/mm^2)
10	640	28.8	800	35.55
20	680	32.88	1150	51.11
30	740	30.52	930	41.33
50	690	30.66	880	39.11

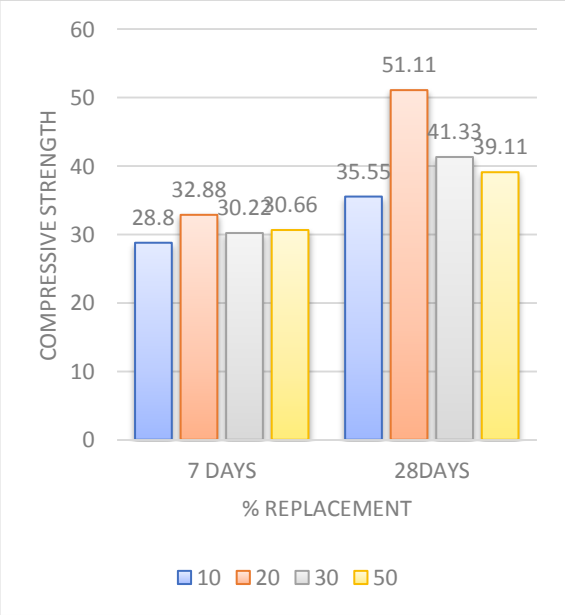

Fig 4 Graph Showing Compressive Strength Results

3.2 Split Tensile Strength Test:

For the determination of split tensile strength test of concrete cylinder specimens of diameter 150 mm and height 300 mm were casted. The cylinders were casted for 30%, 40% and 50%. The tests were conducted on cylinders at an age of 7 and 28 days. The results are tabulated below.

Table 4: Split Tensile Strength Results

% Replacement	Compressive Strength			
	7 Days		7 Days	
	Load (kN)	Split Tensile Strength (N/mm^2)	Load (kN)	Split Tensile Strength (N/mm^2)
10	240	3.39	280	3.96
20	230	3.25	270	3.81
30	220	3.11	250	3.53
50	180	2.54	210	2.97

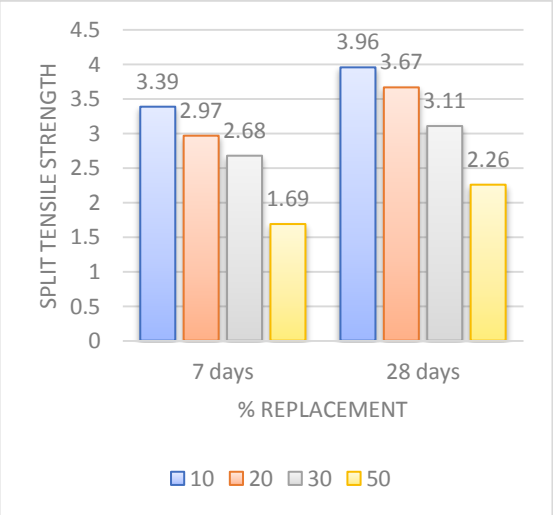

Fig 5 Graph Showing Split Tensile Strength Results

4.0 Conclusion

- The concrete with the use of Manufactured sand and tile powder is found to be economical and environment friendly.
- From the study carried out it is clear that the implementation of concrete is easier and a better option.
- The use of M sand as a replacement for sand is environment friendly.
- Tile powder instead of being discarded can be used in its complete powdered form can be used for the powder content in the binder.
- They are expected to show better results.
- Due to the reuse of materials considered as waste the economy is being stabilized.
- Concrete which uses aggregates of size 12.5 mm can even fill up congested reinforced areas.
- The main aspect follow in this project is to reduce the waste disposal and save the earth from environmental hazards.

5.0 References

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