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MECHANICAL PROPERTIES OF CONCRETE INCORPORATING USED FOUNDRY SAND AND WASTE CERAMIC TILES

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ABSTRACT - This paper presents an attempt for the best suitability methods to use the foundry sand and waste ceramic tiles for making concrete having desired properties. From the last few years, the use of metal and concrete and their components increasing continuously with the growth of different types of metal industries and construction companies. Today, the current area of research in concrete was introducing used foundry sand and also wastes ceramic tiles. Used foundry sand is by product of metal casting industries which causes mainly the environmental pollution and environmental problems because of their improper disposal and bad effects on the environment. The construction industries also require huge amount of ceramic tiles and other types of tiles for good appearance and aesthetic look, due to which production rate of tiles are increasing day by day and the amount of waste, is also increasing fastly during manufacturing, handling and at the construction time. The experimental study was carried out on concrete containing waste foundry sand in the range of 0%, 10%, 20%, 30% and waste ceramic tiles in the range of 0%, 10%, 20% and 30% by weight for M-25 grade concrete. Cubes and Cylinders were cast from that concrete and tests were performed for compressive strength, split tensile strength and modulus of elasticity for different curing periods of 7 days, 28-days and 56-days. The experimental results showed that there is some increase in compressive strength, split tensile strength and modulus of elasticity after replacing the fine aggregates with some percentage of foundry sand so that foundry sand can be safely used in concrete for durability and strength purposes.

Key Words: concrete, used foundry sand, waste ceramic tiles, coarse aggregates, fine sand, compressive strength, split tensile strength, modulus of elasticity.

1. INTRODUCTION

Foundry sand is a sand that when moistened and compressed or oiled or heated tends to pack well and hold its shape. It is also known as moulding sand. It is used in the process of sand casting for preparing the mould cavity. The foundry sand is high quality sand with uniform physical characteristics. It is a byproduct of ferrous and non-ferrous metal casting industries where sand has been used for centuries as a molding material because of its thermal conductivity and its unique engineering properties. In modern foundry practice, sand is typically recycled and reused through many production cycles. Industry estimates are that approximately 100 million tons of sand is used in production annually. The main ingredients for manufacturing of concrete are cement, course aggregates, fine aggregates, waste ceramic tiles and waste foundry sand. Foundries successfully recycle and reuse the sand many times in a foundry. When the sand can no longer be reused in the foundry, it is removed from the foundry and is termed as waste foundry sand. The sand is used in two different ways in metal casting: as a molding material, which forms the external shape of the cast part, and as cores, which form internal void spaces in products such as engine blocks. Since sand grains do not naturally adhere to each other, the binders must be introduced to cause the sand to stick together and hold its shape during the introduction of the molten metal into the mold and the cooling of the casting. Two general types of binder systems are used in metal casting depending upon which the foundry sands are classified as: clay bonded systems (Green sand) and chemically- bonded systems. Both types of sands are suitable for beneficial use but they have different physical and environmental characteristics.

2. LITERATURE REVIEW

Many authors have submitted the report for the use of foundry sand and waste ceramic tiles in different civil engineering applications and different engineering structures like dams, bridges, high rise buildings and other type of structures**.** Tarun R. Naik, Viral M. Patel, 1994 conducted a project to evaluate performance and leaching of CLSM in which both clean and used foundry sands were incorporated. The clean sand was obtained from a sand mining company in Wisconsin and the used foundry sand was obtained from a steel company in Milwaukee, Wisconsin. For purposes of comparison, properties of regular concrete sand (meeting ASTM C 33 requirements for use in making concrete) were also measured. Physical properties of these three foundry sands were determined using the appropriate ASTM standard .However a modified ASTM C 88 was used to measure soundness of foundry sands. The properties of used foundry sand vary due to the type of foundry processing equipments used, the type of additive for mold making, the number of times the sand is reused, and the type and amount of binder used. Han-young also investigated two types of foundry sands like silicate bonded sand as a fine aggregate and clay bonded sand also as a fine aggregate for the concrete and also performed the test for the basic and important properties of concrete like slump test, workability test, initial setting time of concrete, final setting time of concrete with the use of waste foundry sand and then, compared the results of tests with another concrete without mixed with waste foundry sand. Also measured the compressive strength, tensile strength and split tensile strength of that concrete for 7 days and 28 days.

3. MATERIALS AND METHODS USED.

3.1 MARTERIALS.

Used foundry sand and waste ceramic tiles are the main materials used to get the desired properties of concrete. Foundry sand is high quality silica sand with uniform physical characteristics. It is a byproduct of ferrous and nonferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. The physical and chemical characteristics of foundry sand will depend in great part on the type of casting process and the industry sector from which it In India, the huge amount of different types of ceramic tiles are not recycled , but these tiles are mostly used as landfill, foundation work or as a pavement material. In worldwide, India is the third largest country in terms of the production of different types of ceramic tiles. The aggregates formed by the ceramic tiles are very hard having considerable value of specific gravity, rough surface on one side and smooth surface on another side, less thickness, and light in weight as compared to other normal aggregates used in the construction work. Construction industries requires large amount of ceramic tiles and other ceramic tiles for architecture appearance. Due to these major reasons, the production of the ceramic tiles drastically increased, due to this large amount of waste is also produced during handling and usage of tiles. As 25% to 35% of total production from manufacturing units considered as solid waste. That's the main reason to select these waste tiles as a replacement material to the basic natural aggregates.

Used foundry sand

Waste ceramic tiles

PHYSICAL PROPERTIES OF USED FOUNDRY SAND

Property	Results	Test Method
Specific Gravity	2.39-2.55	ASTM D854
Bulk Relative Density, kg/m³ (lb/ft³)	2589(160)	ASTMC48/AASTHO T84
Absorption, %	0.45	ASTM C128
Moisture content, %	0.1-10.1	ASTM D2216
Clay Lumps and Friable Particles	1- 44	ASTM C142/AASTHO T112
Coefficient of Permeability (cm/sec)	10.3-10.6	AASTHO T215/ASTM D2434
Plastic Limit/Plastic Index	Non-plastic	AASTHO T90/ASTM D4318

3.2. METHODS

For testing purpose, cubical mould of size 150mm*150mm were used to prepare the concrete specimens for the determination of compressive strength of foundry sand concrete at various replacement levels. Care was taken during casting and vibrator was used for proper compaction of concrete. Also Cylindrical mould of size 150 mm*300 mm were used to prepare the concrete specimens for the determinations of split tensile strength and modulus of elasticity of foundry sand concrete. The moulds for the specimens must be made of cast iron or cast steel and the inside faces must be machined plane. The given cube mould is normally made in two halves to facilitate the removal of concrete cube without damage. Each mould has a base, which is a separate metal plate, preferably fastened to the mould by clamps .when the cubes are assemble, all the internal angles of mould should be right angles.

Cylinderical mould

Cubical mould

4. RESULT AND DISCUSSION.

Various properties of concrete like compressive strength, split tensile strength and modulus of elasticity incorporating used foundry sand and waste ceramic tiles at various replacement levels with fine aggregate were studied, the results were compared and checked for compressive strength, split tensile strength and modulus of elasticity of foundry sand mix with ordinary mix.

COMPRESSIVE STRENGTH OF CONCRETE

Foundry Sand Content, %	Designation	Compressive Strength, MPa	
		28 days	56 days
0	M-1	28.47	32.74
10	M-2	29.68	33.23
20	M-3	30.05	34.52
30	M-4	31.36	37.58

Test set up of cube specimen

SPLIT TENSILE STRENGTH OF CONCRETE

Foundry Sand Content, %	Designation	Split Tensile Strength, MPa	
		28 days	56 days
0	M-1	2.52	3.01
10	M-2	2.78	3.25
20	M-3	2.83	3.28
30	M-4	3.02	3.59

Test set up for cylindrical sample

MODULUS OF ELASTICITY OF CONCRETE

Foundry Sand Content, %	Designation	Split tensile strength, MPa	
		28 days	56 days
0	M-1	2.52	3.01
10	M-2	2.78	3.25
20	M-3	2.83	3.28
30	M-4	3.02	3.59

5. CONCLUSIONS

Depending upon the above experimental results and methods adopted the following conclusions are made regarding various properties of concrete incorporating the used foundry sand and waste ceramic tiles:

1. Compressive strength of concrete increased with increase in sand replacement with different replacement levels of foundry sand. However, at each replacement level of fine aggregate with foundry sand, an increase in strength was observed with the increase in age.
2. The compressive strength increased by 4.1%, 5.3%, & 9.7% when compared to ordinary mix without foundry sand at 28-days.

3. Compressive strength at 56 days increased by 1.1 %, 5.17 %, & 14.2% compared to ordinary mix.
4. Split Tensile Strength also showed an increase with increase in replacement levels of foundry Sand with fine aggregate.

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