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Study on Strength & Durability of Concrete by Partial Replacement of Fine & Coarse Aggregates using Marble, Granite & Spent Fire Brick Waste

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ABSTRACT

Concrete is the most undisputable and indispensable material being used in infrastructure development throughout the world. The objective of this paper is to utilize marble, granite and Spent Fire Brick waste of different sizes in the manufacturing of concrete bricks, with partial replacement of conventional coarse and fine aggregates with Marble, Granite and Spent Fire Brick waste content up to 20%.The produced bricks are tested for physical and mechanical properties according to the requirements of the American Standards for Testing Materials (ASTM) and the INDIAN Code. The test results revealed that the recycled products have physical and mechanical properties that qualify them for use in the building sector.
Keywords: Undisputable, Indispensable, Conventional, Spent Fire Brick Waste

I. INTRODUCTION

There is an era of industrial explosion. So, it may lead to increasing demand of natural resources. The cost of natural resources is also increased. They have forced to focus on recovery, reuse of natural resources and find other alternatives. Stone waste/Granite has been commonly used as a building material. Today industry's disposal of the stone waste/Granite powder material is one of the environmental problems around the world. Stone waste/Granite blocks are cut into smaller blocks in order to give them the desired shape and size. During the process of cutting, in that original stone waste/Granite mass is lost by 30% in the form of dust.

Every year 250-400 tons of stone waste/Granite waste is generated at site. The stone waste/Granite cutting plants are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. This leads to serious environmental and dust pollution and occupation of vast area of land especially after the powder dries up .so it is necessary to dispose the stone waste/Granite waste quickly & use in construction industry.

The brick which are near the fire in the kiln subjected to high heat more than 1000 degree centigrade and ultimately shrink and loose its shape, colour becomes reddish and its appearance like reddish to blackish gradient stone. This over burnt brick serves as waste in the construction industry and has to accumulate somewhere in the process of recycling. Concrete is a solid, hard material produced by combining Portland cement, coarse and fine aggregate (sand & stone), water and sometimes admixtures in proper proportions. It is one of the most widely used construction material and has a long history of use. Its constituent ingredients derive from a wide variety of naturally occurring materials that are readily available in the most parts of the world.

Approximately 60 to 80 percent of concrete is made up of aggregates. The cost of concrete and its properties are directly related to the aggregates used. In aggregates, the major portion is of coarse aggregate i.e. stone or gravel which are obtained naturally either from river bed or by crushing rocks mechanically up to the required size.

II. PROPERTIES OF MATERIALS

A. Cement

The cement type used in this research was Maple leaf OPC cement manufactured In India. The main reason for using Ordinary Portland Cement (Type I) in this study is that, this is by far the most common cement in use and is highly suitable for use in general concrete construction when there is no exposure to sulphates in the soil or ground water. The choice of OPC from PPC also avoids any uncertainties in the results of the test.

S.no.	Parameter	Test results
1	Normal Consistency	28%
2	Fineness of cement (%)	5
3	Specific Gravity	3.12
4	Initial setting time	60mins
	Final setting time	300mins
5	Compressive strength of cement at	
	7days -28days -	17N/mm^2 22.8N/mm^2

B. Aggregates

The relevant tests are to identify the properties of the aggregates that were intended to be used in this research were carried out. After that, corrective measures were taken in advance before proceeding to the mix proportioning. In general, aggregates should be hard and strong, free of undesirable impurities, and chemically stable. If these materials coat the surfaces of the aggregate, they will isolate the aggregate particles from the surrounding concrete, causing a reduction in strength. The fine aggregate sample used in this experiment was purchased from local sand suppliers at Bhimavaram area.

1) Fine aggregate

Fine aggregate normally consists of natural, crushed, or manufactured sand. Natural sand is the usual component for normal weight concrete. In some cases, manufactured light weight particles used for lightweight concrete and mortar. The maximum grain size and size distribution of the fine aggregate depends on the type of product being made.

S.no.	Parameter	Test results
1	Specific gravity	2.61
2	Fineness modulus	2.475
3	Bulk density(Kg/ ^{3})	
	Loose	1489.89
	Compacted	1600

2) Coarse aggregate

As coarse aggregates in concrete occupy 35 to 70% of the volume of the concrete. It may be proper to categories the properties into two groups: exterior features (maximum size, particle shape, textures) and interior quality (strength, density, porosity, hardness, elastic modulus,chemical mineral composition etc.). Smaller sized aggregates produce higher concrete strength.

S.no.	Parameter	Test results
1	Specific gravity	2.76
2	Fineness modulus	8.635
3	Water absorption (%)	0.15
4	Bulk density(Kg/M^3)	
	Loose	1546.92
	Compacted	1660.25

C. Properties of marble, granite and spent fire brick aggregate

If coarse grained marble is heated to around 600°C the anisotropy of thermal expansion of calcite causes almost complete separation at grain boundaries. The resulting material retains its shape and consists of a mass of crystals in contact, with a porosity of about 4%, very small direct tensile strength and the mechanical analysis and permeability to water of sand. This Paper examines the mechanical properties of the heated marble and shows that they different from those of soils. Granite aggregates are crushed hard rock of granular structure, being the most common on Earth. Granite rock comes from magma that erupted on the ground surface and then hardened. Good properties of granite make it the most popular building material.

When it comes to fire-bricks and dense refractory products composition content often Alumina (AL) ingredient is looked at which ranges ordinarily between 18% to 40% of alumina in modern product's body.

D. Water

The quality of water plays a significant role in concrete production. Impurities in water may interfere with the setting of the cement, may adversely affect the strength of the concrete or cause staining of its surface, and may also lead to corrosion of the reinforcement. For this research, tap water supplied by D.N.R. Engineering College at room temperature was used in all mixes.

III. METHODS AND MATERIAL

In this study, mix of concrete grade (M_{25}) were produced with partial replacements of the coarse aggregate by 5, 10, 20% of the Marble, Granite and Spent fire brick aggregate. Moreover, a control mix with no replacement of the coarse aggregate was produced to make a comparative analysis. The mix design process adopted was the Indian Standard Method. The mixture proportions of the basic ingredients i.e., cement, water, and fine aggregate were the same for the control concrete and Marble, Granite and Spent fire brick concrete. However, a certain amount of the coarse aggregate was replaced by an equal volume of Marble, Granite and Spent fire brick aggregate to form Marble, Granite and Spent fire brick concrete. Mix design for M25 (The mix design proportion is **1:0.5:1.267:3.368)** as per IS-10262-2009. The main reason for selecting this concrete grades is that these are by far the most commonly used concrete grades for most of the concrete construction works and hence application of the research can be more feasible .

IV. RESULTS AND DISCUSSION

The compressive strengths of concrete specimens were determined after 7, 14, 28, 60 and 90 days of standard curing. For Marble, Granite and Spent fire brick concrete, the results show that the addition of these aggregates resulted in a significant increase in concrete compressive strength compared with normal concrete mix. This increment increased with increasing percentage of Marble, Granite and Spent fire brick aggregate.

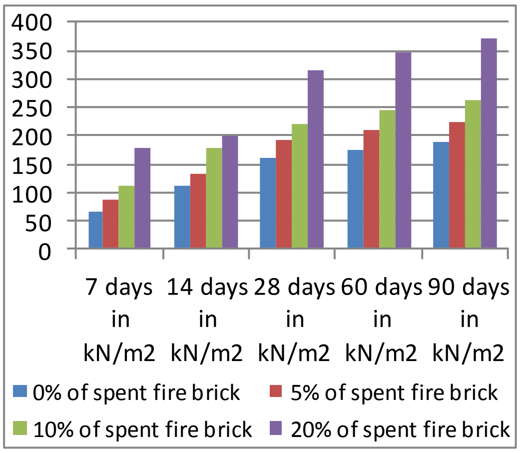

Figure 1 : Analysis of Marble (10mm)

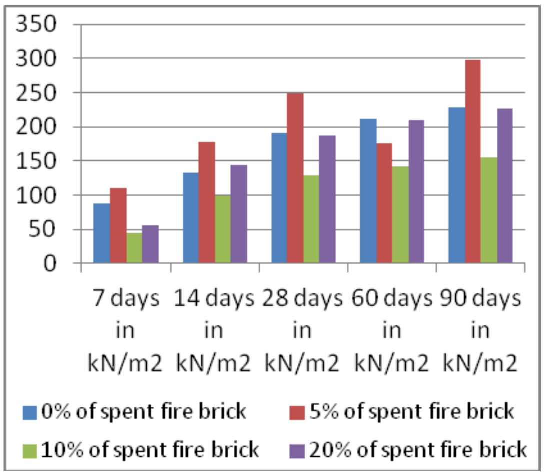

Figure 2 : Analysis of Marble (20mm)

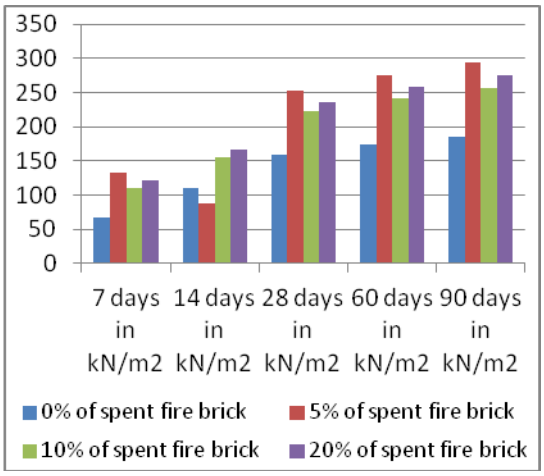

Figure 3 : Analysis of Granite (10mm)

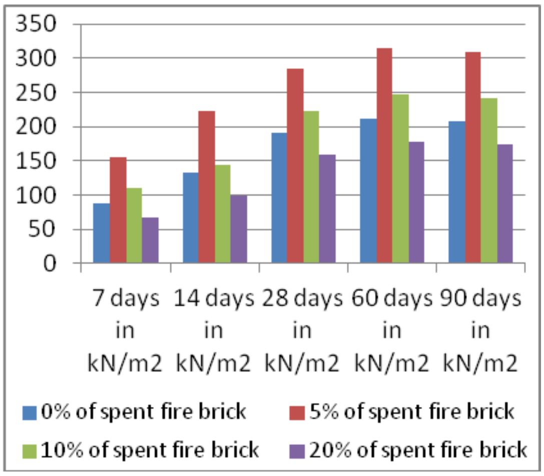

Figure 4 : Analysis of Granite (20mm)

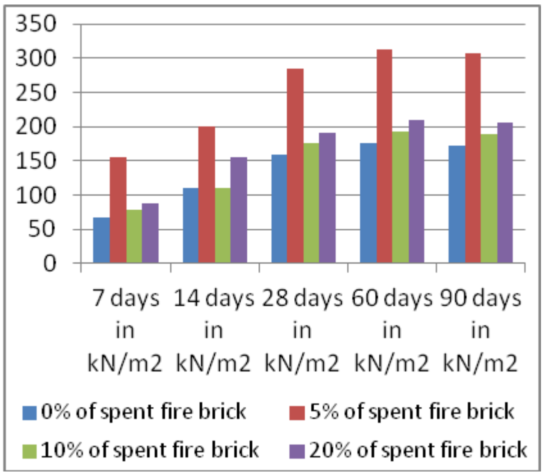

Figure 5 : Analysis of Spent fire brick (10mm)

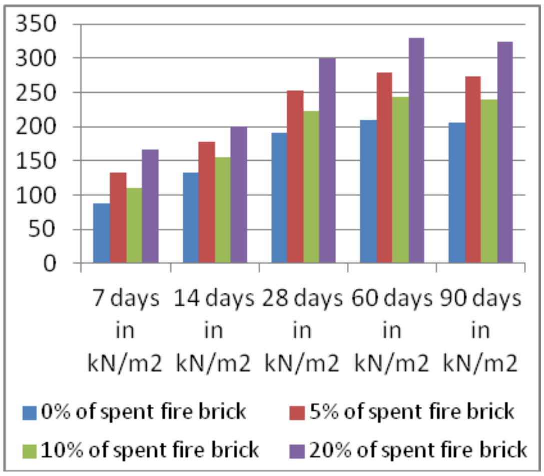

Figure 6 : Analysis of Spent fire brick (20mm)

V. CONCLUSIONS

Based on limited experimental investigation concerning the compressive and split tensile strength of concrete, the following observations are made regarding the resistance of partially replaced fine and coarse aggregates.

1. Marble and granite waste cement bricks yield similar mechanical, in terms of compressive strength, and physical, in terms of density and absorption, properties. There is a positive effect of granite waste on cement brick samples that reach its optimum at 20% granite waste incorporation.

2. Absorption is the major drawback of waste incorporation in cement bricks according to the ASTM C55 where water absorption requirement is fulfilled only at Zero, 5%, 10 %, and 20% slurry samples for grade S.
3. The SFB is a locally available, low cost, and inert industrial solid waste whose disposal is a matter of concern likes construction waste. On an overall, the CSFB can be comparable to the natural river sand. The CSFB satisfies the zone II gradation for not only to partially replace the sand, but for making good concrete, Unit weight of CSFB is higher than that of river sand aggregate in dense condition which, in turn, contributes to the increase in the unit weight of concrete containing CSFB as a fine aggregate.
4. From the obtained results we observe that the maximum strength is achieved by 25% of CSFB replacement in concrete. The 30th% of CSFB replacement in concrete indicates there is no strength gaining after increasing the proportion.
5. The accelerated hydration, endued by heating, compensated the detrimental effect of volumetric changes associated with temperature variation.
6. Most cement brick samples, including the control, are of normal weight according to both the Indian specifications and ASTM C55.All cement brick samples tested in this study comply with the requirement for structural bricks.
7. This is not true when compared to ASTM C55. Instead, 10% and 20% marble and granite waste yield Grade S. Most cement brick samples which contain marble and granite waste had sufficient abrasion resistance.
8. The compressive strength of partial replacement of CSFB aggregate concrete is marginally higher than that of the river sand aggregate concrete at age of 7 days, 14 days, and 28 days, 60 days, 90 days respectively. The split tensile strength of partial replacement of CSFB aggregate concrete is higher than that of the river sand aggregate at all ages.

9. The modulus of elasticity of partial replacement of CSFB aggregate concrete is marginally higher than that of the river sand aggregate concrete. The partial replacement of GGBS can be used effectively as fine aggregate in place of conventional river sand concrete production.

VI. RECOMMENDATIONS

The outcomes of this project lead to diverse areas that still need improvements or research to help the building industry to be more sustainable. In this section there are suggestions of further studies from the life cycle point of view, of the destination of filler and the use of limestone as crushed aggregate in concrete.

1. Special attention should be paid to the fine fraction of the crushed aggregate. The rock-crushing process results in large amount of fines which can potentially impair the workability, as it was observed during the tests performed in order to find the optimum grading.
2. These fines are usually considered waste and dumped in landfills. From the life cycle point of view, this material should be applied to some other activities instead of being disposed. Some applications of this material are already known and are often used, for example mixing these fines with asphalt.
3. In this study, only the use of granitic, crushed rocks in concrete was investigated. The limestone has, in some cases, a totally different rheological behavior compared to granitic rocks. Transportation, as it was mentioned in the Life cycle section, is a very important issue.
4. In some areas, granitic rocks are not available, but there is occurrence of limestone. In these cases, to transport granitic rocks is not plausible or sustainable, thus limestone should be used. Therefore, the use of this type of crushed rock in concrete should have further investigations.
5. The crushed rock flour can be used to replace the natural sand in concrete. The crushed ceramic aggregate can be used to produce lightweight concrete, without affecting strength.
6. The stone dust can be used as alternative material in place of sand in concrete based on grain size data. Sand can replaced by rock flour upto 40% without affecting strength and workability.
7. The sand can be replaced fully with rock flour (Rao. S. Pet, 2002). However a slight loss in workability has been noticed with increase in replacement of sand by rock flour.
8. Nearly 20% of rock is converted into rock flour while crushing rock into aggregate at stone crushing plants. In ceramic insulator industry, there is a mass failure of about 30 to 50% of the total production due to improper mixing of raw materials, excess water, improper drying and too much of heating.
9. The research carried out so far is only the initial stage of this project. Durability studies have not been done on concrete containing CSFB.
10. Therefore, it is planned that durability properties like alkali–silica reaction, freeze thaw, chloride–ion permeability, interaction with air-en- training agents, fatigue strength, etc., of concrete made with CSFB concrete, will be studied.

VII. REFERENCES

[1] Celik, M., & Sabah, E. (2008). Geological and Technical Characterization of Iscehisar (Afyon-Turkey) Marble Deposits and the Impact of Marble Waste on Environment Pollution. Journal of Environmental Management, 87, 106-116. On-line. Science Direct.

[2] Ciccu R., Cosentino, R., Montani, C.C, El Kotb, A., &Hamdy, H. (2005), August. Strategic Study on the Egyptian Marble and Granite Sector (Industrial Modernization Centre Ref-PS_1).

[3] El Haggar, S. (2007). Sustainable Industrial Design and Waste Management: Cradle-to-Cradle for Sustainable Development. Elsevier Academic Press.

[4] EGITTO reference period: 2003. Retrieved May 5, 2007 from the World Wide Web: www.ice.gov.it/new_settori/main/egitto_II_03.pdf

[5] Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete. IS 383 –1970, Bureau of Indian Standards, New Delhi.

[6] IS Method of Mix Design. IS 10262 –1981, Bureau of Indian Standards, New Delhi, Methods of Tests for Strength of Concrete. IS 516 –1959, Bureau of Indian Standards, New Delhi

[7] Code of Practice for Plain and Reinforced Concrete. IS 456 –2000, Bureau of Indian Standards, New Delhi.