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STUDY ON STRENGTH & DURABILITY OF CONCRETE BY PARTIAL REPLACEMENT OF FINE & COARSE AGGREGATES USING MARBLE, GRANITE & SPENT FIRE BRICK WASTE

PARTIAL REPLACEMENT OF FINE & COARSE AGGREGATES

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***Abstract*: Concrete is the most undisputable and indispensable material being used in infrastructure development throughout the world. Umpteen varieties of concretes (FAC, HVFAC, FRC, HPC, HSC, and others) were researched in several laboratories and brought to the field to suit the specific needs. Marble, granite and Spent Fire Brick industry has grown significantly in the last decades with the privatization trend in the early 1990s, and the flourishing construction industry. Accordingly, the amount of mining and processing waste has increased. Stone waste is generally a highly polluting waste due to both its highly alkaline nature, and its manufacturing and processing techniques, which impose a health threat to the surroundings. 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 IDIAN Code. The test results revealed that the recycled products have physical and mechanical properties that qualify them for use in the building sector.**

***Index Terms*: granite, marble**

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 buildingmaterial.Todayindustry‟sdisposalofthestonewaste/Granitepowdermaterialisoneof 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.

 

OBJECTIVES, SCOPE AND METHODOLOGY OF THE STUDY

Objective of the study

II. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. concrete bricks can be the best application to utilize marble, granite and spent firebrick waste in large quantities to replace the conventional sand and aggregates.

Normally, aggregates in concrete bricks are dolomite as the coarse aggregate, and sand as the fine component. these can be replaced by marble, granite and spent firebrick waste. actual figures about the quantity of waste produced in india from the marble, granite and spent firebrick industry are inaccessible since it is not calculated or monitored by the government or any other party.

However, the waste produced during the processing stage only ranges from 20-50% as indicated based on the lowest estimates of waste percentage. so, by using this waste in replacement of aggregates will lower the waste.

This project describes the feasibility of using the marble, granite and firebrick waste in concrete production as partial replacement of aggregates.

Scope of the study

III. This study is concentrated on the performance of a multiple gradation of marble, granite and spent firebrick waste. the waste materials are collected from local sources and manually broke into pieces to achieve a uniform size of 10 mm and 20 mm, which is the aggregate size of the mix design.

IV. the influence of different gradations of the marble, granite and spent firebrick aggregate on concrete properties was not evaluated in this study but it should be considered in future researches.

V. the influence of using recycled marble, granite and spent firebrick in high strength concrete wasnotcoveredinthepresentstudy.thepercentagereplacementswerelimitedtofourcategories i.e. 0%, 5%, 10% and 20%replacement of natural aggregates. the different effects, which can be observed in different percentages of replacements, were not included in the present study.

4. MATERIAL PROPERTIES

VII.CHARACTERISTICS OFCONCRETE

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 between the aggregate particles and glues them together. In its simplest form, concrete is a mixture of paste and aggregates. The paste, composed of Portland cement and water, coats the surface of the fine and coarse aggregates.

Concrete is the world"s most important construction material. The quality and performance of concrete plays a key role for most of the infrastructures including commercial, industrial, residential and military structures, dams, power plants and transportation systems The worldwide use of concrete materials accounts for nearly 780 billion dollars in annual spending. The ability of concrete to be cast to any desired shape and configuration is an important characteristic that can offset other shortcomings. Good quality concrete is a very durable material and should remain maintenance free for many years when it has been properly designed for the service conditions and properly placed. Of course, proper use of the structure for the intended function can have a significant role. Through choice of aggregate or control of paste chemistry and microstructure, concrete can be made inherently resistant to physical attack, such as from cycles of freezing and thawing or from abrasion and from chemical attack such as from dissolved sulfates or acids attacking the paste matrix or from highly alkaline pore solutions attacking the aggregates.

Judicious use of mineral admixtures greatly enhances the durability of concrete. The main advantages of concrete as a construction material are the ability to be cast, being economical, durability, fire resistance, energy efficiency, on-site fabrication and its aesthetic properties. Whereas the disadvantages are low tensile strength, low ductility, volume instability and low strength to weight ratio.

SPENT FIRE BRICK (20MM)				
GRADE OF CONCRETE	M 25			
% OF SPENT FIRE BRICK	0%	5%	10%	20%
7 DAYS KN/M2	88.8	133.3	111.1	166.6
14 DAYS KN/M2	133.3	177.7	155.5	200
28 DAYS KN/M2	191.1	253.3	222.2	300
60 DAYS KN/M2	210.2	278.6	244.4	329.7
90 DAYS KN/M2	206.6	273.7	240.4	324.4

VIII.PROPERTIES OF MARBLE, GRANITE AND SPENT FIRE BRICK AGGREGATE:

If coarse grained marble is heated to around 6OO°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. It may be regarded as a laboratory model of randomly jointed rock and perhaps of bad and broken rock in general. It has frequently been suggested that soil mechanics theory may be applied to suchrock.

This Paper examines the mechanical properties of the heated marble and shows that they different from those of soils. A small amount of confining pressure varies the tri-axial strength rapidly, the initial slope of the Mohr envelope being of the order of 65° and the

strength finally increasing to over 80% of that of the original rock. Young's modulus also increases with confining pressure but only to about 30% of that of original rock.
Even if one principal stress is tensile, a perpendicular compressive stress greatly increases the strength. Model „plate bearing" tests give the same value of Young's modulus as compression ofcylinders, suggesting that this may be true for full scale tests on bad rock.

Permeability is found to decrease rapidly with confining pressure and slightly with un-axial stress. Pronounced effects of size on strength are observed which appear to deviate from the usual power or Proto-dyakonov laws at smallsizes.
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.

Fig 4.1 Compression Testing Machine

IX 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 coarseaggregates.

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 grades.

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 fineaggregate.

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 theproportion.

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STUDY ON M60 GRADE STEEL FIBRE REINFORCED SELF COMPACTING CONCRETE

Self-concrete

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***Abstract*: Self compacting concrete has been described as "the most revolutionary development in concrete construction for several decades". A self-compacting concrete, which has excellent deformability and resistance to segregation and can be filled in heavily reinforced form work without vibrators was developed 20 years ago. SCC is defined as a concrete, which can be placed and compacted into every corner of formwork, purely by means of its self-weight by eliminating the need of either external input from vibrators or any other type of effort. Due to its specific properties, SCC may contribute a significant improvement in the quality of concrete structures and open up new fields for the application of concrete. The use of self-compacting concrete is spreading worldwide because of its very attractive properties in the fresh state as well as after hardening. SCC improves the quality, durability and reliability of concrete structures and eliminates some of the potential for human error. It will replace manual compaction of fresh concrete with a modern semi-automatic placing technology and in that way improve health and safety on and around the construction site.As the main feature of SCC is the behavior in the fresh state, the mix design is especially focused in this point. SCC is designed to be able to flow under its own weight without external vibration and with sufficient viscosity. The flow behavior can be roughly evaluated by the slump flow test. For SCC we will need a high final spread and a maximum limit to the slumping time T 50cm. A concrete mix can only be classified as self-compacting concrete if the requirements for all three characteristics i.e. filling ability, passing ability, segregation resistance, are fulfilled. Superpasticizers are an essential component of SCC to provide the necessary workability. Other types may be incorporated as necessary, such as viscosity modifying admixtures (VMA) for stability; air-entraining admixtures to improve freeze thaw resistance, retarders for control of setting etc. Fly ash is a fine inorganic material with pozzolanic properties, which can be added to SCC to improve its properties.**

Index Terms*: *self-concrete

I. INTRODUCTION

1.1 General

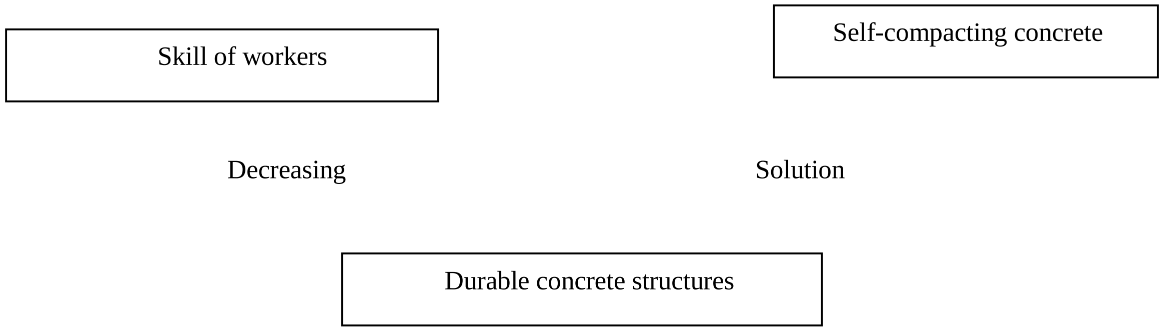
At present world is witnessing the construction of very challenging and difficult Civil Engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concrete with special characteristics. Researchers all over the world are attempting to develop high performance concrete by using various admixtures in concrete up to certain proportions. One of the most outstanding advances in the concrete technology for the last decade is "**Self Compacting Concrete (SCC)**".
The main characteristics of SCC are the properties in the fresh state. The mix design is focused on the ability to flow under its own weight without vibration, the ability to flow through heavily congested reinforcement under its own weight, and the ability to retain homogeneity without segregation. Due to its specific properties, SCC may contribute a significant improvement of the quality of concrete structures and open up new fields for the application of concrete.

Self-Compacting Concrete (SCC) is defined as: "A Category of high- performance concrete that has excellent deformability in the fresh state and high resistance to segregation and can be placed and compacted under its self-weight without applying vibration". SCC is also referred as self-leveling concrete, super workable concrete, self-consolidating concrete, highly flowable concrete, non-vibrating concrete etc.

I. Application of SCC

The use of self compacting concrete is recommended for all applications, where the mentioned advantages are necessary to assure a good concrete quality.

Congested Structures



The application of SCC is limited to special cases where it is impossible to use ordinary concrete. Practical applications of SCC worldwide are

- Of the most outstanding applications of SCC in Japan, Yakoham land mark tower and Akashi-kaikyo-bridge are significant examples.
- SCC was used for the construction of wall of a large LNG tank belonging to Osaka gas Company in 1998.

II.PROPERTIES OF FRESH SCC:

SCC differs from conventional concrete in that its fresh properties are vital in determining whether or not it can be placed satisfactory. The various aspects that govern the workability of SCC are: its

- *Filling ability:*

Ability of fresh concrete to flow into and all spaces within the formwork, under its own weight.

- *Passing ability:*

Ability of fresh concrete to flow through tight openings such as spaces between steel reinforcing bars without segregation or blocking.

- *Segregation resistance:*

Ability of concrete to remain homogeneous in its form while in its fresh state. All these need to be carefully controlled to ensure that its ability to be placed remains acceptable.

- *III.Workability:*

The level of fluidity of the SCC is governed chiefly by the dosage of the super plasticizer. Overdosing of which may lead to the risk of segregation and blockage. Consequently the characteristics of the fresh SCC need to be carefully controlled using preferably two of the different types of tests.

- *IV.Segregation Resistance:*

Due to the high fluidity of SCC, the risk of segregation and blocking is very high. Preventing segregation is therefore an important feature of the control regime. The tendency to segregation can be reduced by use of sufficient amount of fines (<0.125 mm), or using a Viscosity Modifying admixture (VMAV)

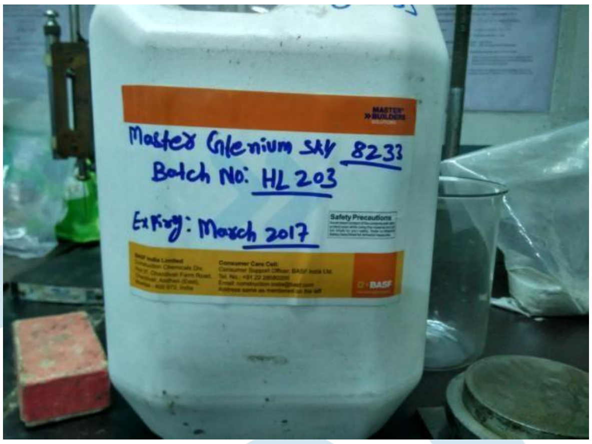
Funnel test and V funnel test at T 5minutes

(a) (b)

S.no	I.S.Sieve	Weight retained (gm)	% Wt retained (gm)	Cumulative % of wt retained	Percentage passing (By weight)
1	10 mm	-	-	-	100
2	4.75 mm	13	1.30	1.30	98.70
3	2.36 mm	24	2.40	3.70	96.70
4	1.18 mm	142	14.20	17.90	82.10
5	600µ	564	56.40	74.30	25.70
6	300 µ	230	23.00	97.30	2.70
7	150 µ	20	2.70	100.00	0
8	Lower than 150 µ	7	-	-	-
Total		1000		294.00	

V.Dosage

The normal dosage of Glenium B 233 is between 0.5 and 1.5 liters per 100 kg of cement (cementious materials). Dosage outside this range is permissible subject to trial mixes.



TEST RESULTS

S.No.	Specimen size	% of steel Fibres of aspect ratio 50.	Load In KN	AVG Split tensile Strength in N\mm^2 (2P/πld)
I	150x150mm	0.00%	130.1	3.68
II	150x150mm	0.25%	138.3	3.91
III	150x150mm	0.50%	152.8	4.32
IV	150x150mm	0.75%	162.7	4.60
V	150x150mm	1.00%	187.1	5.29
VI	150x150mm	1.25%	219.2	6.20
VII	150x150mm	1.50%	186.7	5.28

DISCUSSION ON TEST RESULTS

VI. Mix proportions

In the present investigations, the mix proportioning is done using Erntroy &Shaklok method for M-60 grade concrete. The Resulting mixes are modified after conducting trials at laboratory, duly following the EFNARC guidelines to achieve self- compacting ability of concrete. Test specimens of cubes, beams, cylinders are caste with batches of seven varieties of SCC by varying the percentage of steel fibers from 0.00%to 1.50% (by volume of concrete.)

The usage of superplasticizer increased linearly with increase in percentage of steel fibers content and maximum dosage of 1.40 lts at 1.50% of steel fibre demanded to keep the self compacting parameters within EFNARC specifications. The increase in dosage of superplasticizer with increase of steel fibre for maintaining the balance between fluidity and resistance to segregation of flow able concrete.

Fresh concrete.

The workability of test results is given in table 5.10. Fig. 5.5.3 to 5.5.9 shows the various test results of fresh SCC and EFNARC acceptance criteria limits. Conventional SCC has satisfied all the parameters according to EFNARC specifications .The T 50 cms slump flow test result value, v funnel& v funnel at T 5 mts test result value, increased as the % of steel fibers increased in SCC.

The mixes were self-compactable and any means of external vibration is not applied for compaction during casting of the specimens. This shows that steel fibre reinforced concrete can also be produced using SCC technology, without any vibration

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