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PARTIAL REPLACEMENT OF FINE AGGREGATES WITH MARBLE POWDER

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ABSTRACT - The global warming is caused by the emission of green house gases, such as CO2, to the atmosphere. Between the greenhouse gases, CO2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. Therefore efforts have been made in the concrete industry to use waste materials as partial replacement of coarse or fine aggregates and cement. Waste glass is one materials when ground to a very fine powder shows pozzolanic properties which can be used as a partial replacement for cement in concrete. In this paper, an attempt has been made to find out the strength of concrete containing waste glass powder as a partial replacement of cement for concrete. Glass is used in many forms in day-to-day life. It has limited life span and after use it is either stock piled or sent to landfills. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize waste glasses.

Many efforts have been made to use waste glass in concrete industry as a replacement of coarse aggregate, fine aggregate and cement. Its performance as a coarse aggregate replacement has been found to be non-satisfactory because of strength regression and expansion due to alkali-silica reaction. The research shows that there is strength loss due to fine aggregate substitution also.

The aim of the present work was to use glass powder as a replacement of fine aggregates to assess the pozzolanic activity of fine glass powder in concrete.

A series of tests were conducted to study the effect of 10%, 15%, 20%, 30% replacement of fine aggregates with waste glaas powder.

The present study shows that waste glass if used as a fine aggregates can increase the strength of concrete if used upto some percentage.

1. INTRODUCTION

The concrete is a composite material which is mostly used all over the world. The strength characteristics of concrete depend upon the properties of component material and their collective action. Fine aggregate is one of the important constituent materials as far as strength characteristics of concrete are concerned. Increase in demand and decrease in natural sources of fine aggregate for the production of concrete has resulted in the need to identify news sources of fine aggregate. River and which is most commonly used as fine aggregate in the production of concrete and mortar poses the problem of acute shortage in many areas. Due to industrialization, infrastructure development and soft housing policy of Government of India, the construction industry is in full bloom due to which within short span of time there is a tremendous increase in the utilization of cement and concrete for various construction activities. It is expected that the same rate will continued in the next decade and this may invite the threat to the environment. Availability of raw material required for manufacturing of cement and production of concrete are limited in nature. This increased demand will lead to fast depletion of natural resources and will cause big threat to environment.

So as to overcome this problem it is very much essential to utilize the industrial waste materials and by-products generated in manufacturing of cement and in concrete construction.

2. OBJECTIVE OF THIS STUDY

1) To investigate the utilization of waste glass powder as supplementary cementitious material and influence of this Red mud on the compressive strength of cement mortar.
2) To study the effect of waste glass powder on partial replacement of fine aggreagtes.
3) The development of alternate low-cost and environment suitable building materials from industrial wastes is an economic way.

3. LITERATURE REVIEW

Manufacturing processes, service industries and municipal solid wastes are the sources of production of numerous waste materials. Concerns related with disposal of the generated wastes have tremendously increased with the increasing awareness about the environment. Solid waste management is one of the major environmental concerns in the world. Waste utilization has become an attractive alternative to disposal because of the scarcity of space for land filling and due to its ever increasing cost. The use of

waste products in concrete not only makes it economical, but also helps in reducing disposal problems. Reuse of bulky wastes is considered the best environmental alternative for solving the problem of disposal. One such waste is plastic, which could be used in various applications. According to the World Commission on Environment and Development: sustainability means "Meeting the needs of the present without compromising the ability of the future generations to meet their own needs". Sustainability is an idea for concern for the well being of our planet with continued growth and human development [McDonough 1992]. For example, if we run out of limestone, as it is predicted to happen in some places, then we cannot produce portland cement and, therefore, we cannot produce concrete; and, all the employers associated with the concrete industry go out-of-business, along with their employees [Naik and Moriconi, 2005].

SLUMP TEST

Vasudevan Gunalaan and Kanapathy pillay Seri Ganis [2013] studied slump property in his research and resulted that compared to control mix, by using waste glass powder will give another benefit which is the workability of concrete which is much higher.

R.Vandhiyan et al[2013] investigated that the workability was reduced due to the replacement and it reduced with increase in replacement, this is due to the increase in the surface area of the glass powder and also the angular shape of the glass particles.

Kumarappan N. [2013] presented that there is a systematic increases in the slump as the glass powder in the mix increases. The slump ranged from around 40mm for the reference mix (i.e. 0% glass powder) to 160mm at 40% glass powder.

COMPRESSIVE STRENGTH TEST

Many works have been done to explore the benefits of using waste glass powder in making and enhancing the properties of concrete.

Vasudevan Gunalaan and Kanapathy pillay Seri Ganis [2013] investigated the test results at 7, 14, 28 days of curing of specimens containing waste glass powder as partial replacement of cement and his results showed that the 20% glass powder mix amount shows a positive value of compressive strength at 28 days compare to other ratio which 10% and 15% is not achievable even though have slight increment from 14 days results.

Vandhiyan R. et al[2013] studied the replacement of cement by waste glass powder and concluded that the considerable increase in the early strength gain particularly at Specimen 15% GP gave a 29% increase in the strength at 7th day more than control specimen. At 28th day this difference in strength reduces to 23 %. The strength increment is optimal at 10% replacement.

Kumarappan N. [2013] partially replaced cement by glass powder and stated that upto 10% it is feasible to replace cement as it showed higher compressive strength than the control mix. Vijayakumar G. et al [2013] proposed that cement replaced upto 40% by glass powder showed increment in compressive strength at both 28 days and 60 days age of curing as compared to conventional concrete.

FLEXURAL STRENGTH TEST

Vandhiyan R. et al [2013] experimented on replacement of cement by waste glass powder and concluded that a considerable improvement in the flexural strength was seen at 10% replacement of cement.

Vijayakumar. G et al [2013] showed that flexural strength increment is achieved upto 40% replacement of cement by waste glass powder.

Jangid Jitendra B. and Saoji A.C. [2012] in their work proposed that flexural strength increases upto 35% replacement of cement by waste glass powder as compared to control mix and the peak % increment is at 20%, beyond which it decreases.

Chikhalikar S.M. and.Tande S.N. [2012] tested flexural strength parameter in his study and resulted that 20% dosage of waste glass powder is optimal for replacing cement.

SPLIT TENSILE TEST

Vijayakumar G. et al [2013] studied that the glass powder concrete increases the tensile strength effectively when compared with conventional concrete.

Vandhiyan R. et al [2013] showed that there was a marginal improvement in the tensile strength.

Chikhalikar S.M. and Tande S.N. [2012] in their study on Steel Fibre Reinforced Concrete (SFRC) presented that the tensile strength attains a peak value at 20% replacement of cement by waste glass powder.

4. WASTE GLASS POWDER

Glass is one of the oldest man-made materials. It is formed in many forms such as packaging or container glass, flat glass, and bulb glass, all of which have a limited life in their manufactured forms and therefore need to be recycled so as to be reusable in order to avoid environmental problems that would be produced if they were to be stockpiled or sent to landfills. Quantities of waste glass have been rising rapidly during the recent decades due to

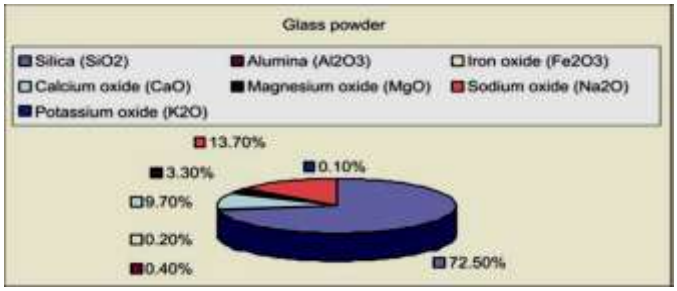
the high increase in industrialization and the considerable improvement in the standards of living, but unfortunately, the majority of these waste quantities are not being recycled but rather abandoned causing certain serious problems such as the waste of natural resources and environmental pollution. Recycling of this waste by converting it to aggregate components could save landfill space and also reduce the demand for extraction of natural raw material for construction activities. Theoretically, glass is a fully recyclable material; it can be recycled without any loss of quality. There are many examples of successful recycling of waste glass: as a cullet in glass production, as raw material for the production of abrasives, in sand-blasting, as a pozzolanic additive, in road beds, pavement and parking lots, as raw materials to produce glass pellets or beads used in reflective paint for highways, to produce fiberglass. Waste glass can also be produced from empty glass bottles and pots, and come in several distinct colors containing common liquids and other substances. This waste glass is usually crushed into small pieces that resemble the sizes of gravels and sands. In its original form, glass comes as a balanced combination from three main raw natural materials: sand, silica, and limestone, in addition to a certain percentage of recycled waste glass utilized in the manufacturing process. Table below lists some of approximate compositions and the corresponding uses of various common forms of glass.

Physical properties

The glass as natural sand replacement in concrete trials was a crushed product with a size distribution between 3mm ~ 0.3mm. The clear and green glass was very clean with no materials passing 150 and 75 micron fractions.

Type of Glass	Composition (by weight)	Usages
Soda-Lime-Silica	73% Silica – 14% Soda – 9% Lime – 3.7% Magnesia – 0.3% Alumina	Glass Widows – Bottles – Jars
Boro-Silicate	81% Silica – 12% Boron Oxide –4% Soda – 3% Alumina	Pyrex Cookware – Laborator
Lead (Crystal)	57% Silica – 31% Lead Oxide – 12% Potassium Oxide	Lead Crystal Tableware
Alumino-Silicate	64.5% Silica – 24.5% Alumina – 10.5% Magnesia – 0.5% Soda	Fiberglass Insulation – Halogen Bulbs

Table 1.1: Composition of Glass



Advantages of Waste Glass Powder:

The advantages of adding Waste Glass Powder to concrete can be one or more of the following:

1. Reduced the cost of production.
2. Increased workability of the mix due to fineness of particles.
3. Reduced dosage of super plasticizer to achieve target workability.

5. MIX PROPORTION

MIX DESIGNATION	GLASS POWDER (%)	CEMENT (kg)	Fine Aggregates(kg)	Coarse Aggregates(kg)	Water	Glass Powder(kg)
M-0	0	1.38	2.484	4.181	0.55	0
M-1	10	1.38	2.236	4.181	0.55	0.248
M-2	15	1.38	2.1	4.181	0.55	0.384
M-3	20	1.38	1.98	4.181	0.55	0.504
M-4	25	1.38	1.73	4.181	0.55	0.754

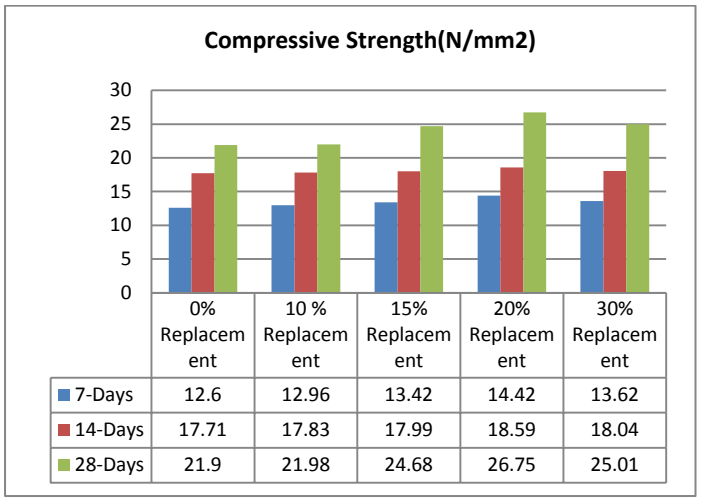
6. EXPERIMENTAL SETUP

1. In this work, 5%, 10%, 15%, 20% and 30% of fine aggregate is replaced by glass powder for M20 grade concrete.
2. Cube specimens of size 150 mm x 150 mm x 150 mm were casted for different proportions with glass powder and compared with the properties of concrete prepared without glass powder (control mix).
3. Compression test was performed on the concrete after 7, 14 and 28 days of curing.

7. RESULTS

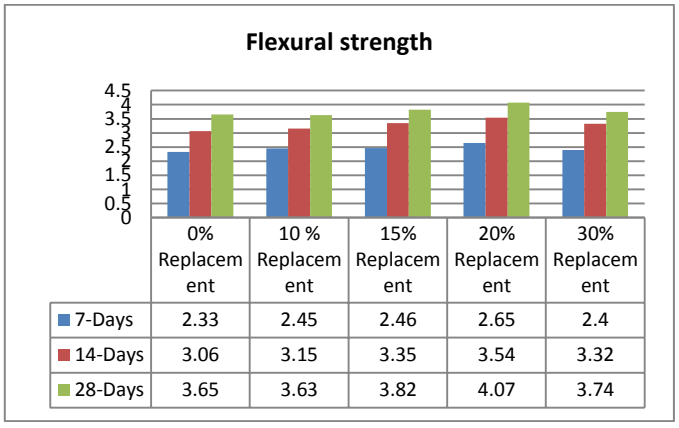
Compressive Strength Test Results

Replacement (%)	Avg. 7-days Compressive strength of concrete (N/mm²)	Avg. 14-days Compressive strength of concrete (N/mm²)	Avg.28-days Compressive strength of concrete (N/mm²)
0	12.60	17.71 76	21.90
10	12.96	17.83	21.98
15	13.42	17.99	24.68
20	14.42	18.59	26.75
30	13.62	18.04	25.01



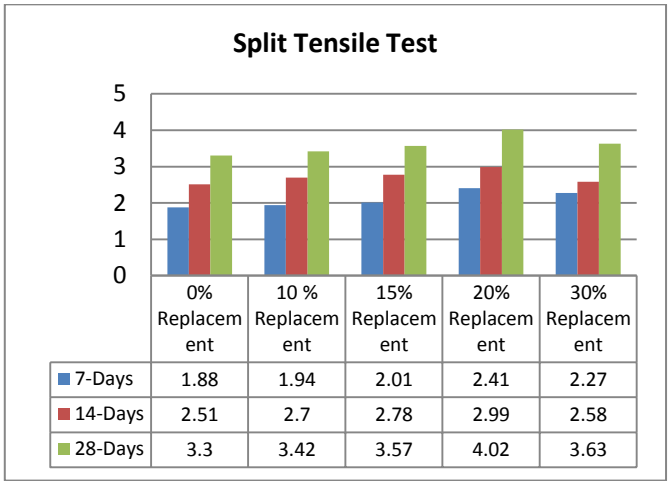
Flexural Strength Test Results

Replacement (%)	Avg. 7-days Flexural strength of concrete (N/mm²)	Avg. 14-days Flexural strength of concrete (N/mm²)	Avg.28-days Flexural strength of concrete (N/mm²)
0	2.33	3.06	3.65
10	2.45	3.15	3.63
15	2.46	3.35	3.82
20	2.65	3.54	4.07
30	2.40	3.32	3.74



Split Tensile Strength Test Results

Replacement (%)	Avg. 7-days Split Tensile strength of concrete (N/mm²)	Avg. 14-days Split Tensile strength of concrete (N/mm²)	Avg.28-days Split Tensile strength of concrete (N/mm²)
0	1.88	2.51	3.30
10	1.94	2.70	3.42
15	2.01	2.78	3.57
20	2.41	2.99	4.02
30	2.27	2.58	3.63



8. CONCLUSION

A series of laboratory experiments was conducted to find the fresh properties of concrete like Workability and also the testing on hardened concrete is also done to find compressive strength, split tensile strength, and flexural strength of concrete with several percentage of marble powder. The effects of waste glass powder on these properties are studied. The following are the conclusions that can be drawn from the experimental investigation:

1) The compressive strength of the concrete increases up to 20% replacement of glass powder and then gradually decreases with increase of glass powder content.
2) Along with compressive strength, the flexural strength of the concrete increases up to 20% replacement and then decreases with increase partial replacement of glass powder.
3) The split tensile strength of the concrete increase up to 20% replacement of glass powder and decreases with further increase in glass powder.
4) Thus waste glasses are made in to glass powder and loaded in to concrete which makes it useful. The partial replacement of glass powder as fine aggregate Makes the concrete strengthen.
5) Thus our project states that concrete can be strengthen by glass powder replacement , which makes the waste in to useful, so the waste materials made in to use.

9. SCOPE FOR FUTURE STUDIES

1) Use of admixtures to add to workability of concrete made with waste glass powder can be studied.
2) Durability aspects of concrete made with waste glass powder as fine aggregate can be investigated.
3) People approach to the glass powder dust in concrete with red mud in mortar will be more and more as it will strengthen the building at economical cost.
4) Environmental effects of wastes and disposal problems of waste can be reduced through this research and make the environment green.
5) It will reduce the wastage and solve dumping problem of the industry.

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