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Strength Properties of Concrete by the Partial Replacement of China Clay as Fine Aggregate and Glass Powder As Cement

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Abstract - *Glass is commonly used in construction industries and large amount of glass is powdered daily. The disposal of waste glass is an environmental issue, as waste glass causes disposal problem. The case is similar for waste material from china clay industries. Today the construction industry is in need of finding cost effective materials for increasing the strength of concrete structures. Glass powder finer than 600 micron is reported to have pozzolanic behavior. This work tries to investigate the possibility of using the waste glass powder as the replacement of cement in concrete and waste material from china clay industries as fine aggregate. Cement is replaced by waste glass powder at 2%,3%.4%,5%,10%,15% and 20% and fine aggregate by waste material from china clay at 2%,5%,10% and 15% and the properties are compared with normal mix concrete. Cube specimens of certain numbers will be casted, cured and tested for 7 day and 28 days strength. Compression test will be conducted and the results compared. This work aimed at determining the optimum percentage of these materials to be used for concrete. A greater percentage of china clay by product and glass powder does not conform to the required compressive strength. This may be because of the clay content in the china clay by product and impurities in glass powder. For 2% china clay by product with 2%, 3% and 4% gives better results and the maximum value of compressive strength is 30.8MPa for 2% china clay by product and 3% glass powder for 7 days strength and 35.5 for 28 days strength*

Key Words: **Glass powder, china clay by product, concrete, compression test**

1. INTRODUCTION

The interest of construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction. Presently the waste glass and china clay by products packed as a waste and disposed as landfill. This project deals with partial replacement of fine aggregate with the industrial waste from China Clay industries and partial replacement of cement by glass powder Waste glass contain high silica (SiO_2)i.e. 72%. Waste glass when ground to very fine powder (600 micron) reacts with alkalis in cement (pozzolanic reaction) and cementitious product that help contribute to the strength development.

The problem arising from continuous technological and industrial development is the disposal of waste material. If some of the waste materials are found suitable in concrete making not only cost of construction can be cut down, but also safe disposal of waste material can be achieved. The cement of high strength concrete is generally high which often leads to higher shrinkage and greater evaluation of heat of hydration besides increase in cost. A partial substitution of cement by an industrial waste is not only economical but also improves the properties of fresh and hardened concrete and enhance the durability characteristics besides the safe disposal of waste material thereby protecting the environment form pollution. In this work fine aggregate is replaced with the industrial waste from China Clay industries. The compressive strength is compared and the results are tabulated.

2 EXPERIMENTAL PROGRAMME

2.1 Materials Used

Portland slag cement was used throughout, M sand and crushed stone aggregate are used as fine and coarse aggregate respectively. The specific gravity of both coarse and fine aggregate was 3.03 and 2.89 respectively. Glass powder of size 90 micron and china clay by product are used Superplasticizer was used as the water reducing agent

2.2 Test Programme

To evaluate the compressive strength a total of 10 mixes were tried with different percentages of e-waste fibers (0%, 0.6%, 0.8% and 1% of cement) and different lengths of fiber (2cm, 3cm and 4cm). In all mixes the same type of aggregate i.e. crushed granite aggregate; M sand and the same proportion of fine aggregate to total aggregate are used. The relative proportions of cement, coarse aggregate, sand and water are obtained by IS - Code method. M30 is considered as the reference mix. Table 1 shows M30 mix proportion that was used to cast the e-waste fiber reinforced concrete.

Table -1: Concrete Mix Proportion

Material	Quantity(kg/m^3)	Mix proportion
Cement	469	1
Fine aggregate	640.239	1.35
Coarse aggregate	1267.392	2.7
Water	197	0.42

Fig -1: Test setup for cube compressive strength

3. RESULTS AND DISCUSSION

Compressive strength test was conducted at 7 days and 28 days. The results obtained from the experimental procedures were tabulated and presented below

Table -2: Compressive strength data at the age of 7 days in N/mm^2

Sl. No	Percentage of china clay by product (%)	Percentage of Glass powder (%)	7 day compressive strength(N/mm^2)
1	0	0	27.11
2	2	2	25.77
3	2	3	30.8
4	2	4	29.3
5	5	5	24.44
6	5	10	24
7	5	15	23.55
8	10	5	23.1
9	10	10	22
10	10	15	21.7
11	15	5	20
12	15	10	19.11
13	15	15	18.66

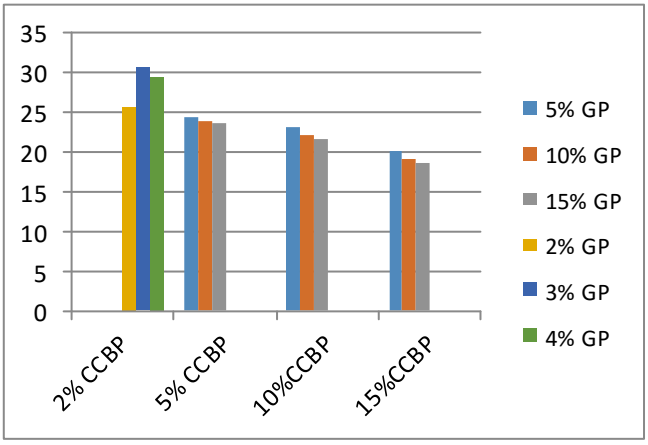

Chart -1: Compressive strength for 7 days

The experimental results suggest that at 2% china clay by product, the compressive strength increases as glass powder increases from 2% to 3% and then decreases as glass powder increases from 3% to 4%. The maximum value of compressive strength obtained is 30.8N/mm^2 that is for 2% china clay by product and 3% glass powder. For 5% china clay by product compressive strength decreases as glass powder increases from 5% to 10 % and 10 to 15 %. The values obtained are greater than the 60% of target mean strength. For 10% china clay by product compressive strength decreases as glass powder increases from 5% to

10% and 10 to 15 %. The value for the mix 10% china clay by product and 5% glass powder obtained is greater than the 60% of target mean strength. Other mixes are getting lower than the 60% of target mean strength. For 15% china clay by product compressive strength decreases as glass powder increases from 5% to 10 % and 10 to 15 %. The values obtained are lower than the 60% of target mean strength.

Table -3: Compressive strength data at the age of 28 days in N/mm²

Sl. No	Percentage of china clay by product (%)	Percentage of Glass powder (%)	28 day compressive strength(N/mm²)
1	0	0	36.88
2	2	2	30.00
3	2	3	35.5
4	2	4	33.33
5	5	5	33.7
6	5	10	33.32
7	5	15	28.44
8	10	5	30.66
9	10	10	31.35
10	10	15	27.11
11	15	5	33.77
12	15	10	32.44
13	15	15	26.22

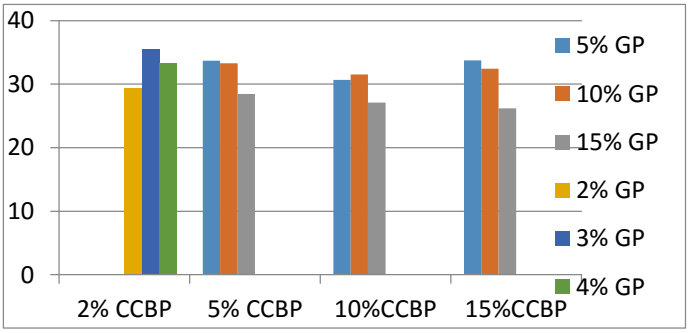

Chart -2: Compressive strength for 28 days

The experimental results suggest that at 2% china clay by product, the compressive strength increases as glass powder increases from 2% to 3% and then decreases as glass powder increases from 3% to 4%. The maximum value of compressive strength obtained is 35.5 N/mm² that is for 2% china clay by product and 3% glass powder. For 5% china clay by product compressive strength decreases as glass powder increases from 5% to 10 % and 10 to 15 %. The values obtained are greater than the 30N/mm² except for the mix with 5% china clay by product and 15% glass powder. For 10% china clay by product compressive strength increases as glass powder increases from 5% to 10 % and decreases from 10 to 15 %. The values obtained are greater than the 30N/mm² except for the mix with 10% china clay by product and 15% glass powder. For 15% china clay by product compressive strength decreases as glass powder increases from 5% to 10 % and 10 to 15 %. The values obtained are greater than the 30N/mm² except 10% china clay by product and 15% glass powder.

4. CONCLUSIONS

There is no doubt that the increasing industrial waste creates environmental concerns. Finding a way to dispose it in concrete would enhance the understanding on how to incorporate these wastes in greater engineering usage. This study represents the effect of china clay by product and glass powder obtained from industrial waste used in concrete on compressive strength. From the results obtained during investigation and based on literatures review following conclusions can be drawn:

- The percentages of glass powder and china clay by product was chosen as 5 %, 10% and 15% based on the previous researches carried out using these materials in concrete. But a decreasing trend in the compressive strength of concrete was observed for increasing china clay by product and glass powder.
- The minimum required compressive strength for 7 days is 60% of target mean strength and that is

22.95MPa. Some of the percentages of china clay by product and glass powder such as 5 %, 10 % and 15% glass powder for 5% china clay by product and 10% china clay by product for 5%glass powder satisfy this criterion.

- A greater percentage of china clay by product and glass powder does not conform to the required compressive strength. This may be because of the clay content in the china clay by product and impurities in glass powder.
- For 2% china clay by product with 2%, 3% and 4% gives better results and the maximum value of compressive strength is 30.8MPa for 2% china clay by product and 3% glass powder for 7 days strength and 35.5 for 28 days strength

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