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Study the Influence of Waste Glass Powder on the Properties of Concrete

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Abstract: *The amount of waste glass has gradually increased over the recent years due to an ever-growing use of glass products. Most of the waste glasses are being dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. There is huge potential for using waste glass in the concrete construction sector. When waste glasses are reused in making concrete products, the production cost of concrete will come down. Crushed glass or cullet, if properly sized and processed, can exhibit characteristics similar to that of gravel or sand.*

In this report we are going to discuss how the waste glass will have its significant effect on concrete and its properties. Fine aggregate replacement levels by waste glass powder 10, 20, and 30 %. The compressive strength of concrete cubes is tested for 3, 7, 28, days were found. The highest replacement level is 20% by WGP. The results are presented in tables and graphs. The performance of design mixes is good and results are reported in this report.

Key Words: *Compressive strength, Flexural strength, Split tensile strength, Ordinary Portland cement (OPC), Waste glass powder (WGP).*

I. Introduction

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. Here is a quick review for some of the previous research studies concerned with the waste glass as an aggregate material, but from different point of view and perspectives.

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 slots, as raw materials to produce glass pellets or beads used in reflective paint for highways, to produce fiberglass, and as fractionators for lighting matches and firing ammunition. 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 14 pieces that resemble the sizes of gravels and sands. Therefore - as an alternative - there is a potential to partially replace the concrete mix aggregate with waste glass due to the lack of natural recourses in Gaza Strip. 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. The glass recycling process produces a crushed glass product called "cullet", which is often mixed with virgin glass materials to produce new end products.

SCOPE OF WORK:

The work presented in this paper reports an investigation to determine the strength characteristic of concrete by adding the waste glass powder as a partial replacement in fine aggregate.

II. Preparation Of Test Specimens

Concrete mixture proportioning was carried out according to the mix design method. The water to binder ratio was kept constant as 0.5.The total mixing time was 20 minutes then the samples were casted and left for 24 hours. After that, samples were demoulded and placed in the curing tank until the testing time at the age of 3, 7, 28 days.

Table 2.1 Specimens Details

Properties studied	Specimen shape	No of specimens	Sizes of specimens
Compressive strength	Cube	39	150×150×150
Flexural strength	Beams	12	500×100×100
Split tensile strength	Cylinders	12	300×100

III. Experimental Programme Introduction

The experimental work starts by cast cubes for trial mix of without replacing of WGP in the ratio of 0%. WGP for partial replacement of cement in the range of 10%, 20%, 30% with constant w/c ratio of 0.5.All cubes are of same size, 150 x 150 x 150mm^3. Cylinders are casted of size 300 x100 mm^2 and beams of size 500 x100 x100mm^3.

PARAMETERS STUDIED

The following properties were studied for M20 grade of concrete.

Mechanical properties

Compressive strength of concrete – cubes
Flexural strength of concrete – beams
Split tensile strength of concrete – Cylinders

IV. Experimental Setup

The cube specimens tested in the compressive testing machine of 3000KN.All the cubes tested up to the failure. The beams are tested in UTM of load 60tons and cylinders are tested under compressive testing machine under a load of 3000KN.

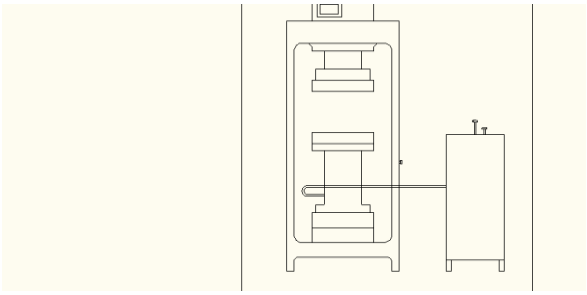


Fig1: compressive test machine

V. Test Results

COMPRESSIVE STRENGTH OF CUBE:

The average compressive strength of 150 x 150 x 150mm^3 size of cube is obtained during test after a curing period 3, 7, 28 days and the results as shown in table 5.1.

DISCUSSIONS:

FOR 3, 7, and 28 days:

From the following results it is observed that the strength increases with the age of curing and strength increases with increase in the WGP content up to 20% replacement and then after increase in WGP reduced the compressive strength when compared with control mix.

Fig:5.1 Variation of compressive strength at 3,7,28 days age

Table 5.1 cube compressive strength:

WGP%	3 days	7 days	28 days
0	15.06	21.56	28.5
10	30.99	37.49	43.99
20	41.32	47.82	54.32
30	34.56	41.06	47.36

Split Tensile Strength of concrete cylinders:

From the following results it is observed that the strength increases with increase in the WGP content up to 20% replacement and then after increase in WGP reduced the compressive strength.

Fig 5.2 : variation of split tensile strength at 28 days curing

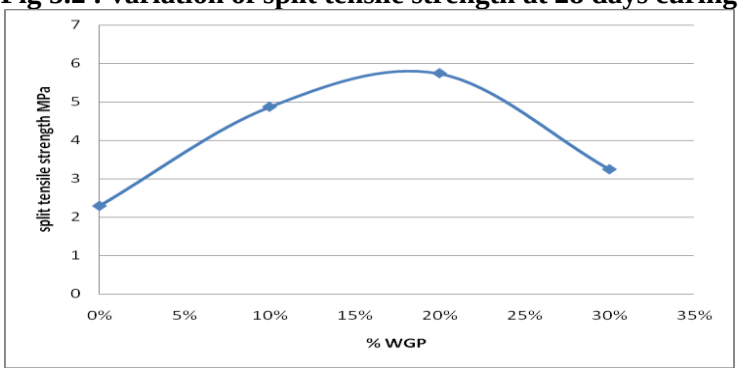


Table 5.2 split tensile strength:

% WGP	Split Tensile Strength
0%	2.3
10%	4.87
20%	5.74
30%	3.25

Flexural Strength of concrete beams:

From the following results it is observed that the strength increases with increase in the WGP content up to 20% replacement and then after increase in WGP reduced the compressive strength similar to concrete cubes and cylinders.

Fig 5.3 Flexural strength variation at 28 days curing

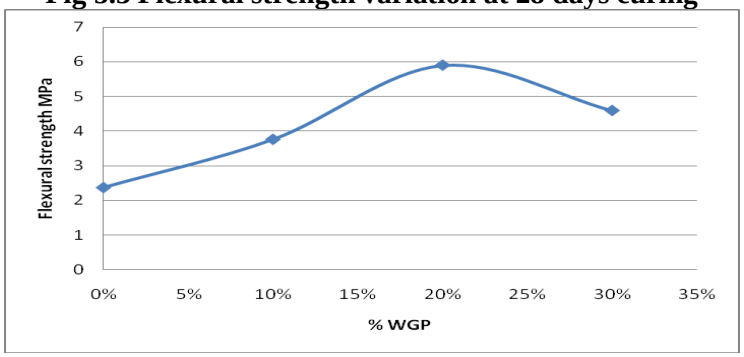


Table 5.3 Flexural strength:

% WGP	Flexural strength
0%	2.37
10%	3.76
20%	5.895
30%	4.59

LITERATURE COMPARISIONS:

Extensive research papers on partial replacement of WGP with cement both at National and International level are collected. Among these, a paper had been selected based on the results which is very close to this paper is

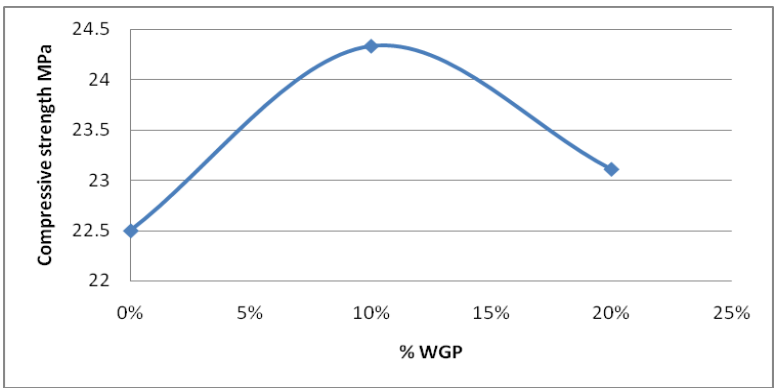
- Conducted by V.Vidivalli & M.Mageswari Department of Civil Engineering, Jabalpur Engineering College, Jabalpur, Published in International Journal of Application or Innovation in Engineering & Management (IJAIEM).

VI. View Of Their Project

Table 6.1: results of their project

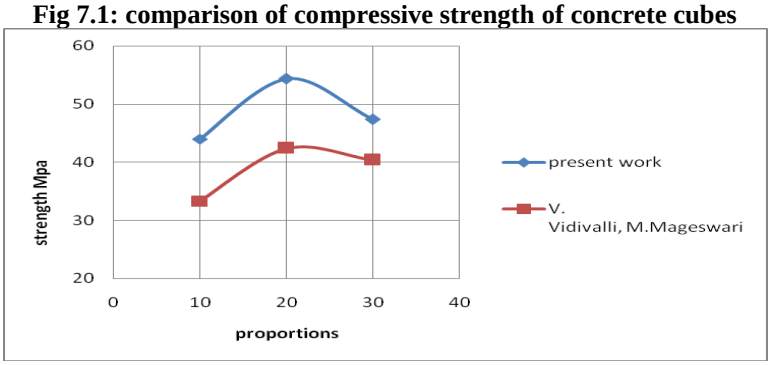
% WGP	Compressive strength for 28 days curing
0%	22.5
10%	24.33
20%	23.11

Fig 6.1: Compressive strength obtained at 28 days curing



VII. Discussion On Results

Fig 7.1: comparison of compressive strength of concrete cubes



The above graph shows the comparison between the compressive strengths of concrete cubes with different percentages of waste glass powder. The curve which is in "Blue" color shows the variation of compressive strength of concrete in which the partial replacement of the fine aggregate is done with different percentages of waste glass powder.

Whereas, the curve with the "Red" color represents the variation of compressive strength of concrete when the coarse aggregate is replaced with waste glass powder. From our experimental Investigations we have found that the partial replacement of fine aggregate with waste glass powder yields more compressive strength, when compared to the partial replacement of Coarse aggregate, because the glass powder has more tendency to fill the voids in concrete more effectively, where as in the case of coarse aggregate it doesn't happened. The maximum compressive strength of our concrete cubes was found at 20% of waste glass powder.

The compressive strength of our cubes for 10% is found to be 43.99 Mpa, whereas for 20% it is found to be 54.32 Mpa , and for 30% it is found to be 47.36 Mpa. Hence it is evident that at 10% and 20%, the compressive strength increases and decreases for 30%. So, incorporating 20% of waste glass powder to partially replace the fine aggregate in concrete yields ideal results.

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VIII. Conclusion

From our experimental investigations, the strength of traditional concrete cubes for 28 days was found to be 28.5 N/mm^2. As we further continued our investigation by adding waste glass powder to concrete by 10%, 20%, 30%, After 28 days the compressive strengths are 43.99 N/mm^2, 54.32 N/mm^2, and 47.56 N/mm^2 respectively. When we compared the strengths of traditional concrete and concrete with partially replaced fine aggregate with glass powder exhibits more strength. We have also found that the concrete cubes exhibit more strength when 20% of glass powder is added. We have also conducted the split tensile strength and flexural strength of the concrete cylinders and beams and found out that the beams exhibit maximum strength at 20%.

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