EXPERIMENTAL ANALYSIS ON COMPRESSIVE AND SPLIT TENSILE STRENGTH OF GEOGRID REINFORCED CONCRETE BY USING GLASS WASTE

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Abstract Concrete has been the primary and most important construction material in the modern world. What makes it vastly used for construction is its economy, durability, strength, resistance to fire and versatility. The most important property of the concrete is the way in which it can be developed as per the needs of the project by just changing the proportions and constituents of the materials used in the concrete. It is this versatility in the preparation of concrete which lead to continuous innovations and developments in the Concrete Technology. The aim of this project is to analyze the compressive and split tensile strength of M-15 grade concrete by using glass waste and geogrids. Cement is partially replaced with glass powder in 10, 20 and 30 percent by weight of cementin view of economy. Geogrids are used as reinforcement material in concrete. Indian Standard codes are used to design the mix proportions of concrete and tests are carried out on samples accordingly. A control specimen is used to compare the results obtained.

Keywords: Concrete, Glass waste powder, Geogrids, Compressive strength, Split Tensile Strength.

I. INTRODUCTION

Modern day Concrete used in construction industry is a complex and composite material. It contains various admixtures and replacements in cement, various reinforcing materials which enhance the properties of concrete as per the needs of the project along with coarse and fine aggregates. The development in concrete technology lead to various waste materials from different industries being used as replacements for constituents in conventional concrete. Previous studies have been made on partial replacement of cement by glass powder for high grade concrete and conventional concrete specimens. In this project an attempt has been made to study optimum percentage of glass powder to be replaced in cement for low grade concrete (M15).

Low grade concrete is often used to enhance strength properties of earthworks in retaining walls and lean base of pavements. Recent developments in concrete technology makes Geogrids as most popular reinforcements used in concrete related to retaining walls and pavements to enhance tensile strength of members. Geogrids are geosynthetic polymer based mesh like materials with large voids between bands. When used in earthworks geogrids capture and interlock the aggregates thus creating mechanically stabilized earthwork. Also geogrids provide lateral resistance, tensile strength and improved bearing capacity. Thus in this project low grade concrete with geogrid reinforcement is considered for studying strength properties. The samples prepared are tested for Compressive strength and Split tensile strength as per the Indian Standards.

2. MATERIALS

2.1 Cement

In this project 53 Grade Ordinary Portland Cement (OPC 53) was used.

2.2 Water

The portable water is used in the preparation of concrete Water was used in three parts of preparing specimen in this study, which were

- mixing concrete for the production of LFC
- curing purpose
- agent for absorption testing

2.3 Fine Aggregate

Fine aggregate with specific gravity of 2.46, Bulk density of 1526.88 kg/m^3, Fineness modulus of 2.2 is used.

2.4 Course aggregate

Coarse aggregate of nominal size 20mm, specific gravity of 2.68, and Bulk density of 1483.66 kg/m^3 is used.

2.5 GEOGRIDS

Geo-grids of open structure woven and coated with poly vinyl chloride are used.

2.6 GLASS PODWER:

Glass Powder of fineness 150 micron with specific gravity of 2.7 is used.

3. CONCRETE MIX DESIGN AND EXPERIMENTAL PLAN

3.1 MIX DESIGN FOR M15 GRADE CONCRETE

W/C ratio = 0.45

Cement quantity = 413.33 Kg = 414 kg

Fine aggregate quantity = 824 kg

Coarse aggregate quantity = 1620 kg

Mix proportion = cement : F.A : C.A = 1 : 2 : 4

Proportions of volume of coarse aggregate and fine aggregate

Volume of coarse aggregate = 0.92

Volume of fine aggregate = 0.4709

3.2 MIX CALCULATIONS FOR CUBES AND CYLINDERS AS PER 10262 : 2009

a) Volume of concrete =1m^3

b) Volume of cement = [mass of cement]/[specific gravity of cement] ×1000

= 413.33/2.92 ×1000

= 0.1415 m^3

c) Volume of water = [mass of water]/[specific gravity of water] ×1000

=186/[1×1000]

= 0.186 m^3

d) Volume of all in aggregate = [a-(b+c)]

= [1-(0.1415+0.186)]

= 0.6725 m^3

e) Mass of course aggregate = d×(volume of coarse aggregate specific × gravity of course aggregate ×1000)

= 0.6725×0.92×2.65×1000

= 1620 kg/m^3

f) Mass of fine aggregate = d × (volume of fine aggregate specific × gravity of fine aggregate ×1000)

= 0.6725 × 0.47× 2.64 × 1000

= 824.95 kg/m^3

e) Mix proportion :-

- Cement = 413.3 kg\m^3
- Water = 186 lit
- Fine aggregate = 824.95kg/m^3
- Coarse aggregate (20mm) = 1620kg/m^3
- Density of concrete = 2400kg/m^3
- Water cement ratio = 0.45

- **Casting of specimens**

Number of cubes are casted by 9 for each proportion (10% 20% 30%) by replacing glass waste in cement

Volume of the cube = 0.15m×0.15m×0.15m

= 0.003375 m^3

- **Replacing by 10% glass waste in cement**

Volume of cement = 0.1415x9

= 1.27 m^3

= 1.27x10/100

= 0.127 %

Total quantity =1.27-0.127

= 1.143 kg/m^3

For fine aggregate = 0.629x9

= 5.58 m^3

For coarse aggregate = 0.92x9

= 8.28 m^3

➢ **Replacing by 20% of glass waste in cement**

Volume of cement = 0.1415x9

= 1.27 m^3

= 1.2 x20/100

= 0.254 %

Total quantity = 1.27-0.254

= 1.02 kg/m^3

Fine aggregate = 0.62x9

= 5.58 m^3

Coarse aggregate = 0.92x9

= 8.28 m^3

➢ **Replacing by 30% of glass waste in cement**

Volume of cement = 0.1414×9

= 1.27m^3

= 1.27×30/100

= 0.381%

Total quantity = 1.27-0.381

= 0.889kg/m^3

Fine aggregate = 0.62×9

= 5.58m^3

Coarse aggregate = 0.92×9

= 8.28m^3

Calculation For Cylinders

➢ **Replacing By 10% Of Glass Waste In Cement**

Volume of cylinder = 1.63×9

=14.67m^3

Percentage = 14.67× 0.1

=

1.467%

Total quantity = 13.203kg/m^3

Fine aggregate = 3.26×9

= 29.34kg/m^3

Coarse aggregate = 6.52×9

= 58.68kg/m^3

➢ **Replacing by 20% of glass waste in cement**

Volume of cylinder = 1.63×9

= 14.67m^3

Percentage = 14.67×0.2

= 2.934%

Total quantity = 11.736kg/m^3

Fine aggregate = 29.34kg/m3

Coarse aggregate = 58.68kg/m^3

➢ **Replacing of 30% of glass waste in cement**

Volume of cylinder = 1.63×9

= 14.67m^3

Percentage = 14.67× 0.3

= 4.401%

Total quantity = 10.269kg/m^3

Sand = 29.34kg/m^3

Coarse aggregate = 58.68kg/m^3

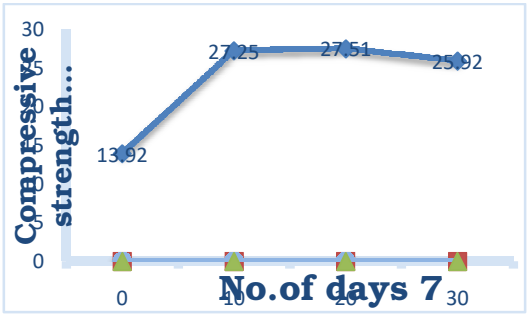


Figure 1 Variation Of Compressive Strength Of Concrete As Cement Is Replaced With Glass Waste And Geogrids For 7 Days

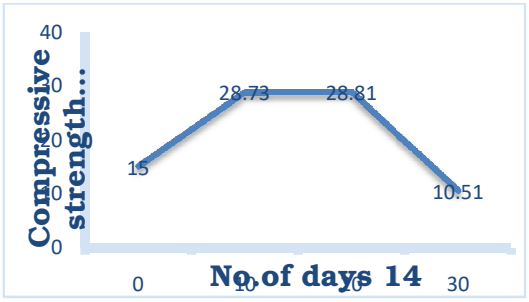


Figure 2 Variation of Compressive Strength of Concrete for 14 Days

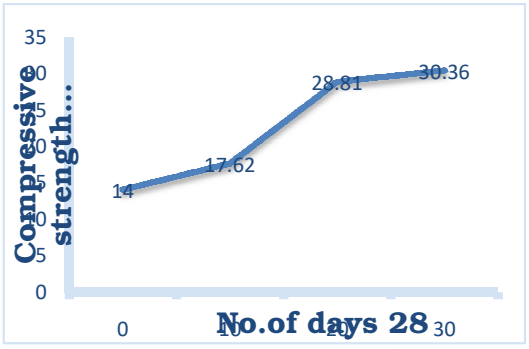
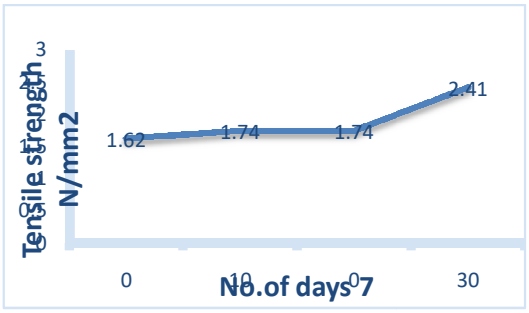


Figure 3Variation of Compressive Strength of Concrete for 28 Days



Variation of Tensile Strength of Concrete for 7 Days

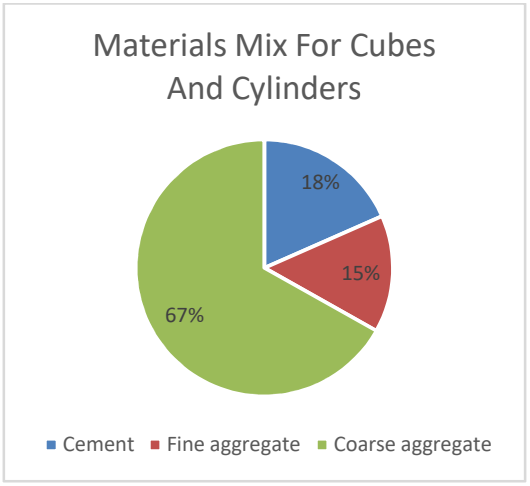


Figure 4 Materials Mix for Cubes and Cylinders

4. CONCLUSIONS

- The data shows thatcement can be partially replaced by glass waste powder and percentage of cement replacement has an effect on concrete strength parameters.
- The major conclusion drawn from this experimental investigation using glass waste and geo grids for partial replacement of cement in the concrete mix.
- Compressive strength test was conducted for various percentages of glass waste and geo grids with the replacement as cement and from the calculated design mix for 10%, 20% and 30%.
- The values observed from the test data that the compressive strength of concrete slightly decrease for 10% and 30%.
- For experimental studies, we can conclude that the compressive strength of concrete 10%, 20% and 30% replacement of cement by glass waste and geo grids for cubes of 28 days is optimum and the values is 14N\mm^2, 10N\mm^2, and 11.5N\mm^2.
- The addition of glass waste and geo grids (by weight of cement) into the concrete slightly decreased its compressive strength when compared with conventional concrete.

- The compressive strength of concrete of 20% is slightly increased in 7 days and 14 days when compared to normal concrete and 30% replacement.

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