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BEAMS TORSION BEHAVIOUR OF GEOPOLYMER CONCRETE USING SILICA FUME

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ABSTRACT:

The usage of Ordinary Portland Cement (OPC) creates a risk because to CO_2 emissions. Construction time can be reduced due to the high strength of GPC at an early age and the ambient curing of GPC. In addition to having improved strength and durability properties, GPC has a wide range of advantages as well. To avoid this, pozzolanic material is used as a replacement for OPC. Alkaline activates them to generate alumino silicate gel that functions as an adhesive in masonry. Silica fume (SF) is used as an alternative to cement in this investigation. With increasing percentages of lengthwise reinforcement, the torsion response of regular concrete along with SF-based geopolymer concrete is studied. Torque, twist, stiffness, degradation, curving ductility, torsion and fracture width was all compared.

Keywords: Geo polymer Concrete; silica-fume (SF); Torsion;

1. INTRODUCTION:

Ordinary Portland Cement, often known as OPC, is a chemical that is made in the area and is used to bind aggregates together. It is an essential component in the manufacturing of concrete. A significant quantity of fuel is required for the breakdown of limestone, which is necessary for the production of OPC. As a result, emissions of carbon dioxide are produced. Atoms of silica and alumina react with one another to build formations that, chemically and physically speaking, are very comparable to the qualities that natural rocks have. It offers improved bonding capabilities, increased abrasion resistance, increased impact resistance, and reduced sensitivity, all of which contribute to its overall durability.The usage of geopolymer also lowers CO2 emissions, which helps to lessen the impact that the building sector has on the environment. After doing research on geopolymer concrete, also known as GPC, utilising a combination of fly ash and ground granular blast-furnace slag, it was discovered that this type of concrete possessed the same level of strength as Portland Cement Concrete but had a significantly longer lifespan. The mechanical qualities of geopolymer concrete can be preserved even when the material is subjected to high temperatures. Over the course of the last several decades, a series of studies designed to investigate the behaviour of RC components when subjected to pure torsion have been carried out. On the other hand, there is no published information concerning the torsional resistance of the geopolymer beam. Because of this, examining the torsional behaviour of the geopolymer beam is something that absolutely must be done. In the beginning, cement is partially substituted by silica fumes, often known as SF. The purpose of this study is to examine how a geopolymer concrete performs in comparison to a conventional concrete when both are subjected to torsional loading caused by varying the area of longitudinal reinforcement. The crack width, curvature ductility, torsion stiffness, torsion durability, as well as pre- and post-cracking activity were all factors that were taken into consideration.

2. EXPERIMENTAL OVERVIEW

2.1 Overview

The project compares the performance of green geopolymer concrete (GPC) compared to traditional concrete (CC) under torsion. The proper % substitution in silica fumes (SF) for geopolymer concrete beams was identified using the compression and split tensile tests. The specimens were examined under torsional loading and constructed using multiple reinforcements in the longitudinal regions.

2.2 Compression and Split tensile Test

A common concrete grade of M20 mix is prepared according to Indian regulations to determine the best replacement of silica fumes. The geopolymer based on silica fumes is designed for a strength of 20 N/mm 2 with constant values of Na2SiO3/NaOH=0.5 and SFAL=0.20. Table 1 provides the mix ratios. Following a curing period of 28 days, both the cube compression strength and the cylinder split tensile strength were evaluated. A Compression Testing Machine (CTM) with a capacity of 2000 kN is utilised in the performance of the test. The results of the tests are presented in Table 2.

Table 1. Proportion of mixture Details

Materials(kg/m^3)	Normal	20% replacement of SF	40% Replacement of SF	60% Replacement of SF
Cement	436	346	236	178
Silica fume	-	87	174	258
Fine aggregate	664	664	664	664
Coarse aggregate	1094	1094	1094	1094
Solution	193	193	193	193

Table 2. Compressive Test on Specimen

Description	Compression Strength	Split Tensile Strength
Conventional	32.8	4.5
20 % replacement of Silicafume	24.7	3.6
40 % replacement of Silicafume	32.2	2.6
60 % replacement of Silicafume	22.5	3.8

2.3 Detailing of Beam Specimen

The cross-sectional size of the beam is 150 millimetres by 200 millimetres, and the length of the beam is 1200 millimetres cross-sectional to cross-sectional. This applies to both conventional and geopolymer concrete specimens. Concrete of the grade M25 mix is utilised in the production of CC beams.

In this experiment, a GPC beam with an optimal amount of mix (40 percent SF) is being utilised. In the course of this investigation, the minimum recommended longitudinal reinforcement has been taken into consideration.

Table 3.Details of Minimum Reinforcement

Details	Lengthwise Reinforcement	Transverse Reinforcement	Volume ratio
CC1 and GPC1	Top: 2-10 mm diameter Bottom: 2-12 mm Dia.	2 legged – 8 mm Diameter	0.030
CC2 AND GPC2	Top: 2-8 mm diameter bottom: 2-10 mm diameter	2 legged – 8 mm Diameter	0.025

2.4 Specimen Preparation

For the purpose of preventing concrete from adhering to the inside surface of the mould, a very thin coating of crude oil has been applied to the surface. To guarantee uniform compaction, the machine-mixed concrete is placed in three layers and compressed with a needle vibrator. The formwork's sides were taken off after 24 hours, and it was thermally cured for six hours at a temperature of 100°C. The beams were bleached to make it easier to observe the crack pattern before testing. Before mounting the specimen on the loading frame, the effective span, centre line, and loading point were all noted.

Fig. 1 Loading frame setup

2.5 Testing of Specimen

The examination carried out at the structural laboratory. In order to lift the specimen, a hydraulic crane with a capacity of 20 kN is employed. The loading platform of the frame is where the beam is stored at all times. The specimen is positioned atop a steel saddle, which makes it possible for the beam's cross section to rotate. In order to get ready for the twist, the steel saddles had 12 mm mild steel bars placed between them. An Indian standard medium beams (ISMB175) was positioned in a diagonal fashion on the upper surface of the cantilever component of the experimental setup.In order to stimulate the load, a hydraulic jack with a capacity of 250 kN has been positioned directly above the ISMB175 section. On top of the hydraulic jack, there is a testing ring with a capacity of 20 kN placed in the middle of the structure. A plumb bob was used to modify the beams so that the centre lines of the proving ring and the beam would lay on the same line. This was done in order to provide a constant level of torsion over the cantilever area. In order to get an accurate reading of the angle of twist, two dial gauges were installed at the cantilever portion in a vertical position. Zero was the starting point for the settings on the dial gauges.A hydraulic jack applies continuous force in the form of torque. Through the use of ISMB, the weight is distributed evenly over the cantilever's edges. The load was applied at a pace that was held constant in order to get the highest torque that could be achieved. The width of the crack on the testing frame is measured with the assistance of a portable microscope that has a sensitivity of 0.01 millimetres and an optical magnification of 40 times.

3. RESULTS AND DISCUSSION

The breaking tension Tcr, shattering twist, final tension T (ult), and acute twist (ult) were all easily calculated from the curves and the pertinent variables.

Torsional behaviour prior to cracking

a. With a decrease in VRT value, GPC outperforms CC in terms of twist performance. The presence of reinforcement had no impact on the specimen's torsional behaviour before cracks appeared. The underlying explanation of this is because before the fracture begins, the torque is primarily absorbed by the concrete..

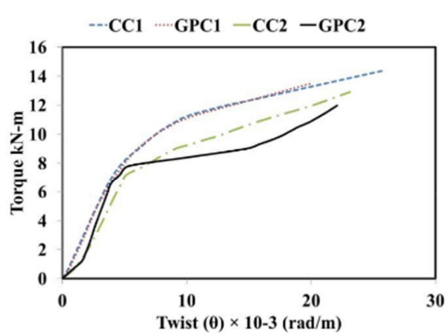

Fig.2. Relation of Torque- Twist

b. Post Cracking Torsional Behaviour

Previous talks have shown that the concrete's durability has a major impact on the specimen's pre-cracking torsion characteristic. However, reinforcement plays a significant part in the torsional movement of concrete after breaking. Under pure torsion mode, once a concrete-reinforced beam undergoes the formation of the first crack, it will act like a flexural structure under pure torsion mode. Cracking is known to disturb the tension in the uncracked concrete, causing a new equilibrium to be imposed by shifting the load to the reinforcement as a result of having disturbed the tension in the uncracked concrete.

1. The region of strengthening has little impact on the specimen's torsional behavior prior to breaking. At first, the torque is absorbed by the concrete. The ratio of change in torque value is therefore the same. The twist essentially stays unchanged with an increased VRT number. The amount of twist that the GPC can withstand, however, reduces as the VRT value increases.

2. The reinforcement is transferred to the reinforcement after a fracture is caused by pure torsion.

3. When the VRT value is increased, it is found that the ductility of the CC1 specimen, as well as the GPC1 specimen, is superior to that of the CC2 specimen, as well as that of the GPC2 specimen.

4. Due to the material's torsional behaviour prior to cracking being independently of the reinforcing region. The torsional toughness before cracking stays constant. Depending on the location of reinforcement, the specimen's post-cracking torsional behaviour changes. Greater than the similar GPC specimen, the combined torsional toughness of CC.

5. The lower performance of geopolymer concrete during both phases of breaking is suggestive of the potential damage in the bonding between aggregate due to the partial replacement of cemented with silica fumes.

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