

**EXPERIMENTAL INVESTIGATION ON GEOPOLYMERIC
NATURAL AND RECYCLED AGGREGATE CONCRETE**

A Thesis submitted to

GURU GHASIDAS VISHWAVIDYALAYA

For the award of the degree of

DOCTOR OF PHILOSOPHY

in

CIVIL ENGINEERING

by

Tanuja Gupta

Roll No: 18924001

Enrollment No: GGV/18/1360

Under the Supervision of

Professor. M. Chakradhara Rao



RESEARCH CENTER

DEPARTMENT OF CIVIL ENGINEERING

SCHOOL OF STUDIES OF ENGINEERING AND TECHNOLOGY

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)

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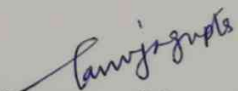
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I, **Tanuja Gupta**, certify that the work embodied in this Ph.D. thesis is my own bonafide work carried out by me under the supervision of **Professor. M. Chakradhara Rao**, Department of Civil Engineering from August-2020 to June-2024 in the Department of **Civil Engineering** of Guru Ghasidas Vishwavidyalaya, Bilaspur (C. G.). The matter embodied in this Ph. D. thesis has not been submitted for the award of any other degree/diploma.

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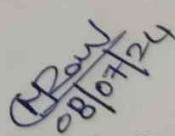
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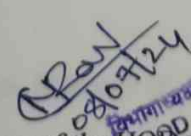

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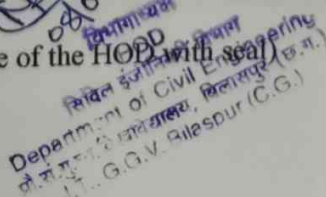
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This is to certify that the above statement made by the candidate is correct to the best of my knowledge. The research work embodied in the thesis was carried out under my supervision and that the candidate has worked under me for the period required under the regulations.


Professor. M. Chakradhara Rao
Civil Engineering Department
Guru Ghasidas Vishwavidyalaya
Bilaspur (CG)


(Signature of the HOD with seal)


Department of Civil Engineering
Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.)

PREFACE

Concrete is the most consumable building material after water in the world. Cement is one of the major ingredients of concrete. But it has many disadvantages such as emission of CO₂, high consumption of energy during the production of cement leading to decrease of availability of fossil fuels, which are major sustainability issues. To overcome this many alternative solutions such as the capturing of CO₂ and storing it away into soil or ocean, use of industrial wastes, reduction in clinker-cement ratio, use of alternative fuels in place of fossil fuels, use of blended cements. The use of industrial waste is one such alternative adopted in the present study. Geopolymer concrete (GPC) is one such promising product, where conventional cement is fully replaced by silica and alumina rich materials such as fly ash (FA), ground granulated blast furnace slag (GGBS) etc. Geopolymer concrete (GPC) has a number of advantages over conventional concrete due to its unique composition. Its remarkable qualities include improved resistance to chemical corrosion, less shrinkage over time, and greater compressive and flexural strengths. Still, geopolymers are facing setbacks due to various parameters such as curing regime, molarity of sodium hydroxide (SH) solution, alkaline activator binder ratio which play an important role in mechanical strength development and durability. Another concern is regarding the usage of construction and demolition waste which generally turns into landfills and causes environmental pollution.

So, in the present research work a systematic experimental investigation has been carried out on M25 grade low calcium fly ash based GPC containing various types and amount of recycled aggregates (100% natural aggregates, 100% untreated recycled aggregate, 50% untreated recycled, 100% treated recycled, and 50% treated recycled). The various parameters considered in this investigation which affect the properties of GPC are molarity of SH (10M, 12M, and 14M), curing temperature (60 °C and 90 °C), curing period (24, 48, and 72 hrs). As literature available on use of recycled aggregates in GPC is very scarce, this investigation will help in utilising the recycled aggregates in GPC by which we can attain sustainability to some extent. The above parametric study has been conducted to identify the most influencing parameters to attain the maximum compressive strength, split tensile and flexural strength of GPC.

Based on the experimental results, GPC (with highest strength) with different amount of recycled aggregate is found to be produced from 12M SH, cured at 90 °C for 72