INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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SPECIAL ISSUE FOR
NATIONAL LEVEL CONFERENCE
"Recent Trends and Development in Civil Engineering"

ECO-FRIENDLY CONSTRUCTION OF STRUCTURE WITHOUT CEMENT AND STEEL

ABHIJITSINH PARMAR[1], KAUSHAL RAVAL[1], DHAVAL M PATEL[1], SACHIN BHAVSAR[2], DIXITKUMAR PATEL[2]

1.Assistant Professor, Department of Civil Engg., S.V.B.I.T., Gandhinagar - 382650
2.Lecturer, Department of Civil Engg., S.V.B.I.T., Gandhinagar – 382650

Accepted Date: 27/01/2018; Published Date: 01/03/2018

Abstract: Day-by-day environmental pollution increases. Manufacturing process of Cement is also one the main reason. Making one ton of cement results in the emission of roughly one ton of CO_2[1]. In this research we have tried to construct eco-friendly structure by Geo-polymer concrete, Bamboo as reinforcement and Scrap tire as a permanent column formwork to reduce solid wastes. Slab, columns and footings are constructed by Geopolymer concrete. Steel reinforcements are replaced by Bamboos to reduce cost of structure.

Keywords: Geopolymer Concrete, Eco-friendly Structure, Bamboo, Scrap tire, waste

Corresponding Author: ABHIJITSINH PARMAR

Access Online On:

www.ijpret.com

How to Cite This Article:

Abhijitsinh Parmar, IJPRET, 2018; Volume 6 (7): 217-220

PAPER-QR CODE

INTRODUCTION

Geopolymers are new materials for fire and heat-resistant coatings and adhesives, medicinal applications, high-temperature ceramics, innovative binders for fire-resistant fiber composites, toxic and radioactive waste encapsulation and novel cements for concrete [1]. The properties and uses of geopolymers are being explored in many technical and industrial disciplines: modern inorganic chemistry, physical chemistry, colloid chemistry, mineralogy, geology, and in other types of engineering process technologies. Geopolymers are part of polymer science, chemistry and technology that forms one of the major areas of materials science. Polymers are either organic material, i.e. carbon-based, or inorganic polymer, for example silicon-based. The organic polymers comprise the classes of natural polymers (rubber, cellulose), synthetic organic polymers (textile fibers, plastics, films, etc.) and natural biopolymers (biology, medicine, pharmacy) [2]. Raw materials used in the synthesis of silicon-based polymers are mainly rock-forming minerals of geological origin [3].

Figure 1 Bamboo as a Slab Reinforcement

Bamboo is a likely complex material with a high strength-to-weight ratio helpful for

Fig. 2 Scrap Tire as a Permenant Formwork for Column

structures.[4] Bamboo as a construction material is conventionally connected with the cultures of South Asia, East Asia, and the South Pacific, to some extent in Central and South America. In China and India, bamboo was used to hold up simple postponement bridges, either by making cables of split bamboo or twisting entire culms of adequately pliable bamboo as one. Bamboo has also long been used as scaffolding; the practice has been banned in China for buildings over six stories, but is still in continuous use for skyscrapers in Hong Kong.[5] In the Philippines, the nipa hut is a fairly typical example of the most fundamental sort of housing where bamboo is used; the walls are split and woven bamboo, and bamboo slats and poles may be used as its support. In architecture, bamboo is used primarily as a supplemental and/or decorative component in buildings such as fencing, fountains, grates, and gutters, mostly due to the ready abundance of quality timber.[6] A variety of structural shapes may be complete by training the bamboo to imagine them as it grows. Squared sections of bamboo are created by compressing the growing stalk within a square form. Arches may similarly be created by forcing the bamboo's growth into the desired form, costing much less than it would to obtain the same shape with regular wood timber. More traditional forming methods, such as the application of heat and pressure, may also be used to curve or flatten the cut stalks.[7]

Mix Design

The alkaline liquid used was a combination of sodium silicate solution and sodium hydroxide solution. The sodium silicate solution (Na_2O = 13.7%, SiO_2 = 29.4%, and water = 55.9% by mass) was purchased from a local supplier in bulk. The sodium hydroxide (NaOH) in flakes or pellets from with 97%-98% purity was also purchased from a local supplier in bulk. The NaOH solids were dissolved in water to make the solution.

Table – 1 Mix design off Geopolymer Concrete

Material	Weight in Kg/m^3
Fly Ash	502
Fine Aggregates	520
Coarse Aggregates	744
Alkaline Solution	
NaOH Flakes	42
Water	112
Na_2Sio_3	238

Structural specifications

Eco-friendly structure was constructed on area 3.5 X 3.5 m. Slab, 4 Columns and Foundations were constructed by Geopolymer Concrete(100% cement was replaced by Fly Ash and for Binding of materials Alkaline Solution was used). Grade of Geopolymer concrete for slab is M30 and for column and Foundation M35. Slab Thickness was 175 mm. Thickness of Slab depth increased due to bamboo as bamboo have larger diameter to resist force. Average Diameter of bamboo used in slab, column and foundation are approximately 35 – 40 mm. Spacing of

bamboo in slab were 120 mm C/C. Diameter of Circular column was 450 mm and height of Column is 3 m and rectangular columns casted backside having size 230 x 400 mm and height of column is 2.5 m. Walls of structure constructed using waste plastic bottles to improve aesthetic view and solid waste management. Total 796 plastic bottles were used to construct wall.

CONCLUSION

Structure constructed using Geopolymer concrete and bamboo as a reinforcement has reduced the cost of structure up to 23% compared to normal concrete and steel reinforcement. Geopolymer concrete is new material suitable for low rise building to replace normal concrete to reduce pollution.

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