

FIBRE REINFORCED GEOPOLYMER CEMENT BASED COMPOSITE MATERIALS

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INTRODUCTION

1. Name : DR. NRIPATI RANJAN BOSE
2. Qualifications : B. Sc. ; B. Tech. (Chemical) ; M.Tech. (Chemical) ; Ph.D.(Tech.) in Polymer Science & Technology
3. Nationality : Indian
4. Past position : Principal Scientist at Central Glass & Ceramic Research Institute under Council of Scientific & Industrial Research (C.S.I.R.), Govt. of India
5. Work Experience : (a) 8 years in Plastics, Paints, Fibreglass Reinforced Plastics (FRP) and Plywood Industries
(b) 24 years as Scientist for R & D work having following output :
 - * Publications in International Journals : 25
 - * Patents : 1 International ; 5 Indian
 - * Presented Papers in International Conferences : 15
 - * Technical Know-How Transferred to Industries : 2
 - * -Guided Ph.D. students : 2
6. Present Activities : (a) Director of New Era Polysat Engineering Pvt. Ltd., Kolkata, India
(b) Consultant of Sols 4 All Consultants , Kolkata, India
(c) Expert for the project “Development of Bullet Resistant Armour Panels “ at Central glass & Ceramic research Institute, Kolkata under CSIR, Govt. of India
(d) Contract research, Product Development and commercial utilisation
7. Author of two Chapters : Books published by Woodhead Publications, U.K.
8. Membership with Professional Scientific bodies : (a) Institute of Materials, U.K. , (b) Indian Concrete institute
(c) Indian Plastics institute , (d) Indian Science Congress Association

Essential Phases For Composite

- *Fibres

- *Matrix

- *Fillers

- *Additives (Fire resistant, Impact resistant, Wear resistant etc.)

Presently Used Composite/ Concrete

- * Fiber (Glass, Carbon, Natural) Reinforced Plastics (FRP) Composites
- * Steel Rebar Reinforced Portland / Prozzolana Cement Concrete
- * FRP Rebar Reinforced Advanced Plastics Composites
- * Metal Reinforced Ceramic Composites
- * Ceramic-Ceramic Composites
- * Nano Fibre (SiC, Al₂O₃, Single Walled Carbon Nano Tube etc.)
Reinforced Ceramic composites
- * Nano-Nano Ceramic Composites

New Avenues For The Development of High Value Composite Materials

Fibre Reinforced Geopolymer Cement Based Composite Materials

1. Fire Resistant Structural Panels
2. Insulated Foamed Roof Panels
3. Chemical Resistant Panels
4. Door Panels
5. Bricks
6. Tiles

Present Scenario

1. One ton cement production require 2 tons of shale and limestone ---- releases 0.87 ton CO_2 , 3 Kg. NO and airborne particulate matter that is harmful to the respiratory tract when inhaled.
2. Aluminium, and Thermal Power Stations are using coal and creating environmental pollution by their by-products (a) Fly Ash (FA), and (b) Ground Granulated Blast Furnace Slag (GGBS)

Importance of Geopolymer

PART-1

Geopolymer has great potential to reduce the environmental pollution in two ways :

- 1 Fulfillment of the demand of portland cement by using Geopolymer cement without going for new cement industries
2. Fruitful utilisation of waste materials such as FA and GGBS for the production of good quality Geopolymer cement by chemical transformation of Al and Si

Importance of Geopolymer

PART-2

Geopolymer Cement Concrete (GPCC) materials are inorganic polymer composites using Geopolymer Cement prepared by alkali activation of industrial aluminosilicate waste materials such as FA & GGBS

Importance of Geopolymer

PART-3

Properties of GPCC mixes :

1. Compressive strength in 24 hours : 25-35 Mpa
2. Compressive strength in 28 days : 60-70 Mpa
3. Modulus of Elasticity : Marginally lower than cement concrete
4. High stiffness
5. Acid, Alkali, Heat and Fire Resistant
6. Bond Strength with Steel is higher than cement concrete (IS : 456-2000)
7. Durability as per ASTM 1202 C : Better protection of steel as compared to cement concrete

Proposed Design of Fire Resistant Composite Panels

1. Impregnation of Ceramic Blanket with Geopolymer Cement Slurry Blended with Water Settable Polyester Resin + Redox Catalyst + SBR Latex + Fillers + Water as required : Formed into Prepreg Layers
2. Assembly of Multiple Prepreg Layers as per desired thickness in between two Aluminium Metal Sheets
- 3, Pressing in Cold Hydraulic Press

The above design is based on ESTERCRETE

USES :

- * Blast Resistant Structural Panels for Defense Sector
- * Bridge Decks, Industrial Flooring

Compressive Strength : More than Ordinary Concrete

Proposed Design of Insulated Foamed Roof Panels

1. Geopolymer Cement Slurry + Water Settable Phenolic Resole Resin + SBR Latex + PTSA Catalyst + Sand + Stone aggregates + Superplasticizer + Polypropylene Fibre + Water as required
2. Polyurethane Foam System (Part A & Part B)
3. Silicone Rubber Mould
4. Anti Sticking Silicone Spray
5. Compacting Box System to Hold Silicone Rubber Mould

Production Process :

After Mixing Part A & Part B of item No. 2 then add Item No. 1
-----After mixing -----pour into the closed Mould properly coated with anti sticking Silicone Spray

Proposed Design of Chemical Resistant Floor

1. Water Settable Isophthalic Polyester Resin
2. Geopolymer Slurry
3. Redox Catalyst System
4. SBR Latex
5. Sand
6. Stone (6-8 mm) Aggregates
7. Polypropylene Fibre
8. Water as required

Application : After Mixing item Nos. 1-8 in a Gear Mixer it is to be pumped through Hose Pipe inside the Framed workplace. Curing for 12 hours will develop high compressive strength.

Proposed Design For Doors and Windows

1. Fibre Reinforced Plastics (FRP) Casings as per size of the doors and windows
2. Geopolymer Slurry + PU Foam System + Water Settable Polyester Resin + Redox Catalyst + SBR Latex + Polypropylene Fibre + Superplasticizer + Water as required

Production :

1. Mixing all ingredients of item No. 2 and then injection into individual FRP casings
2. Curing time : 12 hours

PROPER SOLUTION

1. Production of Geopolymer for gainful utilisation of FA and GGBS and to save the environment by reducing stockpiles
2. Use of Geopolymer cement as a right substitute of Portland Cement for the production of value added composite products

Possibilities for New Research Projects

1. Nano fibre development from Geopolymer Gel by using Electrospinning Equipment
2. Anti Rust and High Heat Resistant Inorganic Waterbase Geopolymer-Zinc Rich Coating for Cathodic Protection of Steel
3. Development of Advanced Nano Ceramic Composites Based on Geopolymer Gel

Conclusion

- * To learn more about Geopolymer Chemistry
- * To Know the Specifications and Standards for Geopolymer Based Products
- * To involve myself in collaborative Research Project between Geopolymer Institute, France and Central Glass & Ceramic Research Institute, India
- * To work jointly with any Institute for the development of new products

----- Thank you all -----