A Review on Waste Materials based Geo-Polymer Concrete

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ABSTRACT
India is a developing country concentrated to develop the infrastructure and implement new construction techniques. Concrete is a main source of developing structure. It makes a great demand second only after water. So need an alternative to prevent this demand. Concrete is the mixture of cement, river sand and coarse aggregate. Cement manufacture produce carbon-di oxide and make ozone layer depletion cause global warming. Scarcity of river sand makes a demand in construction. So need an alternative for cement and river sand to prevent environmental effect and also increase the compressive and tensile strength of the concrete.

Geo-polymer is a good alternative material. It prevents the environmental effects and increases compressive and tensile strength of the concrete. The combination of sodium hydroxide and sodium silicate is called geo-polymer. Using geo-polymer in concretes called geo-polymer concretes. Due to great demand occurred in the construction materials need to take research by replacement, partial replacement and admixture by use waste materials in geo-polymer concrete and find which composition will give strength and durability of the concrete.

Keywords--- Geo-polymer, Concrete, GGBFS

I. INTRODUCTION

Geo-polymer was researched by a French professor Davidovits in 1978. To found out the alternatives of construction material by used waste materials. In Geo-polymer fly ash is used as a binder material with sodium hydroxide and sodium silicate ratio as 2.5. The schematic formation of geo-polymer material can be shown as described by equation (A) and (B).

\[
n(Si_2O_5, Al_2O_3) + 2nSiO_2 + 4nH_2O + NaOH \text{ or } KoH \rightarrow Na^+ , K^+ + n(OH)_3 – Si – O – Al’ – O – Si-(OH)_3
\]

(OH)2

(Geo-polymer Precursor)

O O O

n(OH)3 – Si – O – Al’ – O – Si – ( OH3) + NaOH or KoH \rightarrow (Na+, K+) – (- Si – O – Al’ – O – Si – O –) + 4n H2O

O O O

Major need in geo-polymer concrete
Fly ash
Sodium hydroxide
Sodium silicate
Super plasticizer

Replacement and admixtures
GGBFS
Bottom ash
Glass fiber

APPLICATION
Geo-polymer was used in bridges, structural members, roads and can also use for repair and rehabilitation work.
It used for pre-cast construction work.
It used in building material such as brick and block made by fly ash with used Indian standards
It process is the 100 percent utilization of waste materials.

ADVANTAGES
Recycling waste materials By used this can able to prevented 80 percentage of carbon-dioxide emission. It increases strength and durability of the concrete. It is cheap in cost and available material.

**DISADVANTAGES**

Tough to mix the concrete due to low workability. Carefully handled the sodium hydroxide and sodium silicate while prepare the alkali solution.

Need ambient curing. It reduced the weight of cube and decreased the early strength of concrete.

Room temperature taken long days to give high stability.

**II. LITRATURE REVIEW**

Abhishek Bisarya et al., [1] said that geo-polymer reduces 80 percentages of carbon-dioxide emissions. By used this increased the strength and durability of the concrete. It can used in many field like construction materials, transportations, road buildings, aerospace materials, metallurgy mining etc. It used this fields and achieved high strength and durability compared to cement concrete. Beyond 70°C of ambient cured decreased the strength of concrete.

Bennet Jose Mathew et al., [2] analyzed that Bottom-ash, GGBS based binder material decreased strength due to large particle size. Fly -ash, GGBS based binder material increased the strength of concrete. Fly-ash cost was low compared to ordinary Portland cement.

Bapugouda patil et al., [3] proved that used GGBS in geo-polymer can increased the compressive strength of concrete. It need ambient cured to increased strength. Increased the molarity of NaOH can increased the compressive strength. In durability test, deterioration occurred minutely in geo-polymer concrete.

Chandan Kumar et al., [4] investigated that increased with increased the ambient cured, the strength was decreased. The temperature was beyond 200°C makes deterioration in concrete. Sulphuric acid attacks lead minutely reduced the weight of geo-polymer concrete.

Carlos Montes and Erez N.Allouche [5] recommended that the sodium silicate solution was added 2 litters in 1 litter of NaOH solution given good results instead for used 3.22 and 2.5. Higher the sodium hydroxide and the sodium silicate ratio the strength of the concrete decreased.

D B Raijiwala et al., [6] said that split tension strength in geo-polymer concrete was increased 1.45 times compared to ordinary Portland cement concrete. Flexural strength in geo-polymer concrete was increased 1.6 times compared to ordinary Portland cement concrete. Pull out test in geo-polymer concrete was increased 1.5 times compared to ordinary Portland cement concrete. In durability test in geo-polymer concrete was decreased 10 times compared to ordinary Portland cement concrete.

Deepa Balakrishnan S et al., [7] analyzed that the strength reached more than 60 percentages at 90 days test compared to 28 days test. The ambient cured for 72 hours given better strength. The ambient cured of 90 days test increased two times compared to 28 days test strength.

Nagajothi.S and Sayieda.R.Zedane [9] proved that 10 percentage of phosphogypsum given maximum strength. Increased with increased the phosphogypsum in geo-polymer concrete reduced with reduced the strength of concrete. The ambient cured up to 800-1200°C given better strength. Fully-replacement of fly-ash by used phosphogypsum reduced 70 percentage of the strength in concrete.

Herbert Sinduja et al., [10] recommended that ambient cured 120°C given maximum compressive strength and up to 800°C given better compressive strength and up to 800°C given better compressive strength of the geo-polymer concrete. In fly-ash based geo-polymer concrete increased with increased the sodium hydroxide increased with increased strength of concrete. Addition of 6 percentage Nano silica in geo-polymer concrete given better compressive, tensile and flexural strength of the concrete need ambient cured for 28 days.

J.S.Jayalaxshmi et al., [11] investigated that slump value increased with increased by increased with increased the demolished concrete. It water absorption capacity also increased. Added more amount of demolished concrete decreased the compressive and tensile strength of geo-polymer concrete. By used the demolished aggregate in geo-polymer concrete 6 molarity of sodium hydroxide given same strength compared to ordinary Portland cement. Remain 3, 4, 5 molarity of NaOH reduced the strength of concrete compared to ordinary Portland cement.

Joseph Davidovits [12] said that geo-polymer based binder material widely reached in structural concrete. It can prevent the environmental effects. The Portland cements standards are not adapted to geo-polymer cements.

Kamlesh Patidar and H.S.Goliya [13] proved that the initial settled time was 45 min and the final settled time was 120 min in GPC. In durability test the 5% of sulphuric acid solution was added and it given 8.43% of strength increased in 30 days test and it strength increased 10.69% in 60 days test compared to OPC. 5% of phosphoric acid solution given 7.39% of strength increased in 30 days test and it strength increased 12.42% of strength increased in 60 days test compared to OPC. In sulphate solution the 5% of Na₂SO₄ given 10.65% of strength increased in 30 days test and the strength increased 11.26% in 60 days test.
polymerization process was the 100 percentage utilization increased while increased with increased of NaOH. Geostandards. The compressive strength was increased with such as brick and blocks made by fly ash with used Indian S.D.Muduli et al., [21] proved that building material sodium hydroxide and sodium silicate was 3.5.

reduced the compressive strength of concrete. Likewise the compressive strength of concrete and 3 -12% in GPC Magnesium sulphate 5-25% in PPCC reduced the compressive strength of concrete. The range of 800°C. Further studied are need to investigate the fracture resistance of this brittle composition. K.Srinivasan and A.Sivakumar [14] analyzed that the addition of NaOH in initiation of geopolymserisation reaction at ordinary temperature was not effective by improved the stability see ambient cured at 100°C. Finally concluded the geo-polymer material was superior binder material due to strength and faster setting.

L.Krishnan et al., [17] proved that 24 hours ambient cured without water cured given high strength in geo-polymer concrete. The strength of geo-polymer increased with increased the percentage of GGBS increased in fly ash. F_{60} G_{40} given maximum compressive strength compared to F_{60}G_{10}, F_{60}G_{20}, F_{70}G_{30}.

M.I.Abdul Aleem and P.D.Arumairaj [18] said that geo-polymer concrete used in repairs and rehabilitation work. It was used in precast industries due to this can able to complete the work faster and it minimized breakage for transportation. It also used for infrastructure work. The government taken steps to collected the sodium hydroxide and sodium silicate in waste material of chemical industries. So the cost of alkaline solution will reduce.

More Pratap Kishanrao [19] analyzed that the partial replacement GGBFS in fly ash combination in geo-polymer concrete losses weight due to ambient cured. So used the sunlight cured at least in tropical countries for geo-polymer concrete mixes.

Mohd Mustafa Al Bakri Abdullah et al., [20] recommended that the fly ash porous geo-polymer increased the strength weather the ambient temperature exceed 1000°C. In this concrete the ratio between the sodium hydroxide and sodium silicate was 3.5.

S.D.Muduli et al., [21] proved that building material such as brick and blocks made by fly ash with used Indian standards. The compressive strength was increased with increased while increased with increased of NaOH. Geo-polymerization process was the 100 percentage utilization of waste materials.

Shankar H. Sanni et al., [22] said that the range of sulphuric acid 10-40% in PPCC reduced the compressive strength of concrete and 7-23% in GPC decreased the compressive strength of concrete. The range of Magnesium sulphate 5-25% in PPCC reduced the compressive strength of concrete and 3-12% in GPC reduced the compressive strength of concrete. Likewise the range of sulphuric acid 15-25% in PPCC reduced the split tensile strength of concrete and 8-45% in GPC reduced the split tensile strength of concrete. Then the range of magnesium sulphate 4 -15% in PPCC reduced split tensile strength of concrete and 7-30% in GPC reduced the split tensile strength of the concrete.

S.Usha [23] analyzed those raw materials such as metakaolin, GGBFS, fly ash rich in silica and alumina. So it acts as a better binder material. There was lacked in researched the area of local avail abled waste material. So the future research will take in this area.

S.Kumaravel [24] recommended that the low calcium fly ash based geo-polymer given better compressive strength and it was given better result in structural application and precast product.

S.S.Bachhav and S.K Dubey [25] proved that geo-polymer resisted both acid and salt environment compared to Portland cement concrete specimen. Increased the percentage of fine and coarse aggregate the compression strength were increased. Cured temperature in the range of 60-90°C given better strength.

Sonal P.Thakkar et al., [26] said that geo-polymer concrete with GGBS given more compressive strength. The percentage of slag increased in geo-polymer concrete the compressive strength was increased but it need ambient cured to gained strength.

Vaibhav A et al., [27] analyzed that the compressive, tensile and flexural strength increased 46, 45, 62 percentage in geo-polymer concrete compared to ordinary Portland cement concrete.

Venugopal K et al., [28] proved that geo-polymer masonry block given better performance compared to conventional blocks. It also gives better durability.

Vinod Kumar Gupta and Akhilkhare [29] recommended that geo-polymer can used for repair and rehabilitation work. Because it reached the strength faster compared to ordinary Portland cement concrete. It can also use for road construction.

Vishnu P Anirudhan and Aravind Unnithan [30] said that increased the molarity of NaOH given more compressive strength. It need ambient cured but the room temperature was convenient in practical condition. It acted as eco-friendly material.

Xueying et al., [31] analyzed that class C fly ash based geo-polymer workability was low due to low water fly ash ratio. Cured 70°C for 24 hours given better compressive strength in geo-polymer concrete.

IV. CONCLUSION

Geo-polymer was widely used in structural work, road construction, aero-space materials, transportation, metallurgy mining etc. it was given better strength and durability of the concrete. By used these can recycle the waste material. Government taken steps to collected the sodium hydroxide and sodium silicate in chemical industries waste materials. So it reduced the cost of
construction materials. Ambient cured in the range up to 1200°C given better compressive strength. Beyond 1200°C reduced the strength of concrete. The major disadvantage of ambient cured reduced the weight of concrete and it losses the early strength of the concrete. So used sunlight cured at least in tropical countries. The sunlight cured taken 90 days for gettter stability. But there is no loss in weight of concrete. The water content presented in the concrete was very low due to low water fly ash ratio. So the super-plasticizers were used mainly to make the workability in concrete.

REFERENCE
