International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 12 Issue 3 ǁ March 2024 ǁ PP. 460-462

Developments of Sustainable Materials For Concrete Technology

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ABSTRACT-
It is a known fact that the main construction material for any structure is none other than concrete. Moreover due to urbanization, the infrastructural needs of individuals and organisations keep on growing day by day which also suggests that the use of concrete technology in the above field is already on its peak. So this phase of urbanization not only takes the world to a new upgraded version but also puts the same into an endangered position of being surrounded by the problem of global warming. So the development and implementation of concrete technology must be in a sustainable way. There are some essential principles that need to be followed in sustainable development of concrete technology. So this paper aims at knowing these principles and implementing them so as to find out some newer elements that can suppress this hazardous side of concrete technology.
Keywords: *Portland Cement, Geopolymer, Magnesium Phosphate Cement, High Performance Concrete*

I. INTRODUCTION

Concrete is the base construction material for almost all infrastructures. And there has been a large increase in infrastructure construction over the last two decades. So the concrete technology has a good chance of being developed quickly and also ensuring the development by following the principles of a sustainable environment. Now follows some essential principles that need to be followed in any process that aims at sustainable development of concrete technology.

II. RAW MATERIAL CONSERVATION OF CONCRETE

Portland cement (PC) concrete is the most popular and widely used buildingmaterials. This is possible because of its availability of the raw materials over the world i.e. rock and clay, its ease forpreparing and fabricating in all sorts of conceivable shapes. The applications ofconcrete in infrastructure, habitation, and transportation have greatlyacquired the development of civilization, economic progress, stability and alsoquality of life [1,2]. Nowadays, with the occurrence of high performance concrete(HPC), the durability and strength of concrete have been improved largely. HPC is defined as a specially engineered concrete, having one or more specific characteristics those have been enhanced through the selection of component. However, due to the restriction of the manufacturing process and the raw materials, some inherent disadvantages of portland cement are still difficult to overcome. Moreover Fly ash which is a primary supplementary material used for concrete also has been sighted large urban areas in scarcity. So, this signifies the requirement of conservation of concrete making materials[4].

III. ENHANCEMENT OF DURABILITY OF CONCRETE STRUCTURES

Now here comes a key fact on which all engineers and developers should equally focus i.e., not only should they focus on quick construction but also on durable construction. This emphasizes on the fact of premature deterioration. This means that enhancement of durability of concrete structures also plays a great role in sustainable development. Because there would be no use of developing a structure that deteriorates within 10-20 years of existence. So one should also follow the above said principle in order to maintain a step towards sustainable environment[6,4].

IV. HOLISTIC APPROACH TO CONCRETE TECHNOLOGY

Researchers and scientists suggest an holistic approach for studying concrete technology which means that in such a way that both graduates and undergraduates should understand the concept, and could work together

in the direction of sustainable concrete development. And this can be gained by providing the right education, implementing it with the correct technologies and also providing future scope for further research [1, 2,5].

V. DEVELOPMENT OF SUSTAINABLE CEMENTITIOUS MATERIALS

This paper is about two types of sustainable cementitious composites, geopolymer and magnesium phosphate cement. The geopolymer is a type ofamorphous alumino-silicate products and magnesium cement is MgO basedcementitious material. Geopolymer can be synthesized by polycondensation reaction of geopolymeric precursor, and alkali polysilicates. The MgO cement can beobtained by properly mixing MgO particles, fly ash, and phosphate. Comparing to portland cement, geopolymers and magnesium phosphate cement are energy efficient and environment friendly. Thus they are sustainable cementitious materials[3].

Portland cement (PC) concrete is the most popular and widely used buildingmaterials, Further with the occurrence of high performance concrete (HPC), the durability and strength of concrete have been improved largely. However, there are two major drawbacks with respect to sustainability[3]. About 1.5 tones of raw materials is needed in the production of every ton of PC, at the same time, about one ton of carbon dioxide (CO2) is released into the environment during the production. Therefore, the production of PC is extremely resource and energy intensive process. Concrete made of PC deteriorates when exposed to the severe environments, either under the normal or severe conditions. Cracking and corrosion have significant influence on its service behavior, design life and safety [2,3].

VI. CHARACTERISTICS OF GEOPOLYMER

In comparison with the portland cement, geopolymers possess the following characteristics:

Abundant raw materials resources: any pozzolanic compound or source of silicates or almino-silcates that is readily dissolved in alkaline solution will suffice as a source of the production of geopolymer.

Energy saving and environment protection: geopolymers do not require large energy consumption. Thermal processing of natural alumino-silicates at relative low temperature (600° to 800°) provides suitable geopolymeric raw materials, resulting in 3/5 less energy assumption than portland cement. In addition, a little CO2 is emitted.
Simple preparation technique: Geopolymer can be synthesized simply by mixing alumino-silicate reactive materials and strongly alkaline solutions, then curing at room temperature. In a short period, a reasonable strength will be gained. It is very similar to the preparation of portland cement concrete.

Good volume stability: geopolymers have 4/5 lower shrinkage than Portland cement.
Reasonable strength gain in a short time: geopolymer can obtain 70% of the final compressive strength in the first 4 hours of setting. Ultra-excellent durability: geopolymer concrete or mortar can withdraw thousands of years weathering attack without too much function loss.

Advantages of Geopolymer

Toxic waste treatment: Immobilization of toxic waste may be one of the major areas where geopolymer can impact significantly on the statues quo. The molecular structure of geopolymer is similar to those of zeolites or feldspathoids, which are known for their excellent abilities to adsorb and solidify toxic chemical wastes such as heavy metal ions and nuclear residues

Civil engineering: Geopolymer binders behave similarly to portland cement. It can set and harden at room temperature, and can gain reasonable strength in a short period. Some proportions of geopolymer binders have been tested and proved to be successful in the fields of construction, transportation and infrastructure applications. Global warming and energy saving: Studies have shown that one ton of carbon dioxide gas is released into the atmosphere for every ton of portland cement which is made anywhere in the world. In contrast, geopolymer cement is manufactured in a different way than that of portland cement. It does not require extreme high temperature treatment of limestone. Only low temperature processing of naturally occurring or directly man-made alumino-silicates (kaoline or fly ash) provides suitable geopolymeric raw materials. These lead to the significant reduce in the energy consumption and the CO2 emission..

High temperature and fire resistance: Geopolymer cement possesses excellenthigh temperature resistance up to 1200° and endures 50kW/m2 fire exposure withoutsudden properties degradation. In addition, no smoke is released after extended heatflux. The merits make geopolymer show great advantages in automotive andaerospace industries. At present, some geopolymer products have been used inaircraft to eliminate cabin fire in aircraft accidents.

Archaeological analogues: It is proved that the micro-structure of hardenedgeopolymer materials is quite similar to that of ancient constructs such as Egyptian yramid, Roman amphitheater. Consequently, many experts suspended that these ancient constructs might be cast in place through geopolymerization, rather than made of natural stones[3].

Magnesium Phosphate Cement (MPC)

MPCs are artificial stone made from acid-base reaction of magnesia and phosphates. They possess some properties that portland cements do not possess according to the previous studies. Therefore, they can be utilized in the field in which Portland cements are not suitable [7,5].

ADVANTAGES:

Very quick setting, high early strength.
Recycling lot of non-contaminated industrial waste to building material.
Recycling organic waste to building materials.
Stabilization of toxic and radioactive waste.
Very good durability, including chemical attack resistance, deicer scaling resistance, permeation resistance.

VII. APPLICATIONS

Due to its rapid setting and high early strength, magnesium phosphate cement (MPC) has been utilized in raped repair of concrete structure, such as highway, airport runway, and bridge decks for many years. It can save a lot of waiting timeand cost caused by long disrupting time by use other materials. By using MPC materials, the interrupt time of transportation canbe greatly shortened. Therefore, the valuable time and resource can be saved[1, 3]. MPC can incorporate with lot of non toxic industrial waste, such as Class F flyash (FA) and translate it into useful construction materials. The addition I'A in MPCcan be over 40% by mass of MPC, about two times comparing with PC.

Due to the high alkali environment of PC (pH over 12.5), when they are use asreinforcement, some components natural fibers, notably lignin, and hemicelluosewill be susceptible to degradation. However, the lower alkalinity of MPC matrices (pH value 10 to 11) makes them potentially better suited to vegetable fiberreinforcement. Very suitable for repairing of the deteriorated concrete pavements in the coldareas. MPC can develop strength at low temperature due to its exothermic hydrationand low water to binder ratio. The raw material of MPC is hard burnt magnesia. In fact, it is a refractorymaterial. Therefore, MPC can be designed to be fire proof and/or as cold settingrefractory according to the practical need [1,3].

VIII. CONCLUSION

This phase of urbanization not only takes the world to a new upgraded version but also puts the same into an endangered position of being surrounded by the problem of global warming. So the development and implementation of concrete technology must be in a sustainable way. There are some essential principles that need to be followed in sustainable development of concrete technology. So this paper aims at knowing these principles and implementing them so as to find out some newer elements that can suppress this hazardous side of concrete technology.

From the above paper we conclude that the development of cementitious material by other sustainable material are possible which is beneficial for civil engineering for many infrastructural purpose.Geopolymer& MPC are a type of amorphous alumino-silicate cementitious material. Geopolymer can be synthesized by polycondensation reaction of geopolymeric precursor, and alkali polysilicates. Comparing to portland cement, the production ofgeopolymers consume less energy and almost no CO2 emission. Geopolymers are not only energy efficient and environment friendly, but also have a relative higher strength, excellent volume stability, better durability, good fire resistance, and easymanufacture process. Thus geopolymer& MPC will become one of the perspective sustainable cementitious materials in 21st century.

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