



Utilization of Polycrrete in Manufacturing Manhole Covers: A Comparative Study

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Sultanate of Oman focuses on its infrastructure development in the most sophisticated planning manner by preserving its precious landscape and terrains. Cities like Muscat, Al-Amerat, Sohar, etc. are now in high priority in its infrastructure development. Drainage and sewerage network play a vital role for cities and country's infrastructure development. The ETP (Enlarged Treatment Plant) or STP (Sewerage Treatment Plant) is very important to treat the industrial and domestic waste water and the conveyance of waste water flows through network of pipes, manholes and chambers. Portland or sulfur resistant cement concrete products were used to convey the waste water. But, the durability is a question for long term development plan due to corrosive effect on the product and give way for more renovation or rehabilitation program for the entire network which needs a re-budgeting plan. While an alternative and high corrosive resistant and durable product, polymer concrete products offer the best solution to avoid or eliminate renovation process for the network. As a result of its development over time, polymerized monomer can substitute Portland cement as a binder in concrete. Polymer concrete holds multiple effective properties to traditional concrete using Portland cement, such as high compressive strength, low permeability, resistance to corrosive agents as well as chemicals, and rapid curing. These properties provided polymer concrete with many uses in extremely specific sectors around the globe. This research is discussing the various types of Polycrrete, assessing polycrrete's rheological properties and the properties of the normal cement used instead of Polycrrete, comparing normal and Polycrrete cement as well as analyze the environmental issues and the price of using Polycrrete instead of normal cement

Introduction

This research aims to assess polycrrete's rheological properties and find various types of Polycrrete and the properties of the normal cement used instead of Polycrrete. The study assesses by comparing normal and Polycrrete cement. It analyses the environmental issues as well as the price of using Polycrrete instead of normal cement. In the methodology, the objectives will be discussed by collecting data from various sources. Polymer concrete is a compound material where the binder is completely made of synthetic organic polymer. Since replacing polymers with Portland cement increases the price, polymers must only be used when the increase in the price can be explained by significant properties, low energy requirements, or low labor cost throughout handling and processing. There are three main categories of Polymer Concrete materials: Polymer Portland Cement Concrete (PPCC), Polymer Impregnated Concrete, and Polymer Concrete

History of Polymer Concrete

Polymer concrete is a composite material that is produced from a monomer-aggregate mixture polymerization. It is a compound which utilizes organic synthetic polymer as a binder and is



produced by mixing an aggregate mixture with polymeric resin. The use of polymer concrete is expected to grow worldwide over time. Sooner or later, it will help to make the polymer concrete market larger throughout the world by having to replace existing concrete as its ages and by raising awareness about the use of polymers in concrete and the development of modern and less costs products.

Advantages of Polymer Concrete

- Numerous utilizations due to their diverse properties.
- Higher compressive quality (Getrevising.co.uk, 2019)
- Higher strength (European-science.com, 2019)
- Resistance to solidifying, defrosting and corrosive assaults

Disadvantages of Polymer Concrete

- Greater expenses (Getrevising.co.uk, 2019)
- Complex run (European-science.com, 2019)
- Produced using oil, a non-inexhaustible asset.
- Landfill locales are appalling

Comparison Between Polymer and Regular Concrete

First, by design Polymer concrete is dense; mix design eliminates reinforcement and connective pores structure with low environmental impact. But, in Portland concrete reinforcement is required. Second, the production and curing in Polymer concrete is only 24 hours; whereas, in Portland concrete is the duration of production and Curing is minimum of 10 days duration. Third, the corrosion resistance in Polymer concrete is very strong. Corrosive resistance effluents ranging from Ph-1 to Ph-10. It withstands any aggressive media, However, in Portland concrete is not corrosive resistant. It requires lining, or coating while installation. Fourth, the compressive strength in Polymer concrete is as high as 80 N/mm². But, in Portland concrete, it is 45 to 60 N/mm². Fifth, the tensile strength in Polymer concrete is high with minimum of 16N/mm². But, in Portland concrete it's 10 N/mm². Sixth, the water absorption in Polymer concrete is below 0.5mm; however, in Portland concrete, it is 4mm. Seventh, the thermal expansion is only found in Polymer concrete between 10 and 20 x 10⁻⁶ /°C. Eight, the dimensional accuracy is only found in Polymer concrete with high dimensional accuracy preventing field fabrication or correction works. Ninth, the wall roughness in Polymer concrete is 25 μm smooth without pores, but in Portland concrete it's 175μm. Lastly, the jointing system in Polymer concrete is efficient with perfect water tightness using polymer mortar/putty adhesive system. It's ready after 24 hrs.

Methodology

Polymer concrete (PC) is a piece of gathering of cements by utilization polymers to enhance or supplant bond as a cover. (Abdul Haakim, 2018) Moreover, initial use of PC was in new scaffold construction with scaffold deck framework, new extension construction in fortifying and in fixing spans. Polymer concrete is connected to seismic segment retrofit to the recharging of common foundation and it is utilized as remotely reinforced components for reinforcing of breaking down and under strength cement, as basic segments in modern frameworks and steel segments.



Materials Used

Thermosetting resin: Thermosetting resins have used an unadulterated resin require expansion of various manufactured mixes to render them processable. For fortified plastics, the blends by and large incorporate a resin structure (with soothing experts, plasticizers, hardeners, fillers and inhibitors). The resin system gives the cover to an extensive degree coordinating the cost, dimensional strength, warmth and compound resistance, and fundamental instability.

Aggregates: Aggregates are torpid granular materials such as rock, sand and, squashed stone that close by bond and water are a basic settling in concrete.

Fiber reinforced composites (FRC): FRC have notoriety for being predominant in their solidness, quality and creep obstruction.

Resins: The polyester resin is the most typical resin used for amassing PC considering their low costs and consumption opposition such as Portland bond solid, polymer cements must be restored although the instruments fundamental the two procedures are extraordinary.

Silica sand: Silica is the name given to a gathering of minerals made out of silicon and oxygen, the two most bottomless components in the world's outside. Silica is found generally in the crystalline state and seldom in a formless state.

Epoxy resins (ER): ER are thermosetting polymers with remarkable mechanical and opposition properties. They are the consequence of a compound response called 'restoring', which includes epoxies and different synthetic substances all the more usually known as relieving operators or hardeners.

Types of Polycrrete

1. **Geopolymer concrete (GC):** GC is produced using waste materials such as fly cinder and ground granulated impact heater slag (GGBS).
2. **The polymer modified concrete (PMC):** PMC is a composite that is gotten by the consolidation of a polymeric material into the solid.

Conducted Experiments

- **Mechanical Characteristics Test:** The purpose of this test is to determine the vertical cracking and bending force for the tensile strength on sample sown from the shaft / pipes
- **Physical Characteristics Test:** The advantage for this experiment is to define the resin viscosity unit as in cps. The purpose in this test is to determine the density of liquids by conforming to the particle size of Silica Sand and Gravels.
- **Mechanical Stress & Strain Characteristics Test:** The benefit of these tests is to define the gradual decrease in the construction of the inspection rooms or the vertical crushing of the panels. The European standard of testing is applied to each type of panel and this is the required standard EN 146362:2009. These tests cover the method of determining the rigidity of the rubber adjustment ring used in the joint grounding of the pipes.

Experimental Data

Mix Design: Polymer concrete is produced by mixing an aggregate mixture with polymeric resin. Sometimes, microfillers are used to fill the voids in the aggregate mix. Moreover, polymeric resins



which are usually utilized in polymer concrete are polyester resin, vinyl ester resin, methacrylate, furan resins, and epoxy resin. The most commonly resin systems that are used for polymer concrete are unsaturated polyester. Due to their good mechanical properties, they are easily availability and cost low.

Chemical properties of polychemmer concrete: The advantages of Polymer Concrete can be found in their high corrosion resistance against aggressive waste waters or soils. Their great static load carrying capacity is with their simultaneously relative low weight, low internal wall roughness, and high abrasion resistance.

Manufacturing process: Solid polymer ducts are made in a variety of ways. For example, they can be made through the exterior, the shape of rolling and vibrating both with and without strength. In the process of vibration, as used here, the materials are controlled in a PC measuring and preparing device, and then attached to the vertical metal molds, which include the inner center and the outer shape. After compression on the vibrating table, the tubes are removed from the shell in molds and then rebuilt in the furnace.

Range of application of polymer concrete products: Polymer Concrete products are manufactured by the company which has wide range of application in the following industries: Sewer System-Urban & Industrial, Pumping Station and Tunneling Work

Quality Assurance / Quality Control: The QA/QC Department of UNFCF promises clients the quality products. The department sends to them the products to satisfy all norms according to the international standards followed by the company.

Chemical Characteristics: This test determines the capacity of a chamber ring or a shaft ring to resist external long-term loadings perpendicular to its axis along its length, considering media attack. This procedure and the test specimen are to evaluate the corrosive resistance under long-term loading of products made of Polymer Concrete material used in the sewer system.

Apparatus: The surfaces in contact with the test pieces are hard, flat, smooth and clean. The component of the test is rigid enough to prevent any visible deformation during test.

Test Solutions: Acid test solution (1N): The acid solution is of 0.5 mol/l sulphuric acid solution Concentrated (H₂SO₄) prepared by adding 28.5 ml of concentrated sulphuric acid (1.84g/ml) to 971.5 ml of distilled water to produce 1 liter of test solution.

Test Procedure Long Term Analysis of Polymer Concrete Shaft in Acid Solution: The long-term crushing strength is determined by applying the value of initial or short-term crushing strength which is derived as per standards.

According to the study by Kumar and Gupta (2018), about the use of polymer concrete in the construction, Solid polymer (PC) is a composite material in which a completely polymeric coating is covered. It is otherwise known as a canvas solid, plastic concrete or just reinforced concrete. Because the use of polymers instead of Portland concrete increases the cost considerably, polymers should be used in applications where higher costs can be achieved with unique characteristics, low cost or critical requirements during the preparation and Care should be taken. It is imperative that designers and specialists have some information about the capabilities and limitations of computer materials to choose the most appropriate and financially relevant for explicit software. Polymers are a large class of materials, which contain many small particles (called monomers) that can be attached to long chains, and then they are known as macromolecules. Significant progress has been made as a major research related to a wide range of polymer / solid frames. There are three main floors of solid polymer materials .

Polymer Concrete was strengthened with reused tire strands to enhance the compressive and



flexural quality. Polymer solid examples were set up with 70% siliceous sand, 30% polyester gum, and various fiber concentrations (0.3, 0.6, 0.9 and 1.2 vol%). The outcomes indicate an increase in the half of the compressive and flexural quality along with the twisting of 1.2 vol% of reused filaments. Cost Comparison of Cement Concrete and Polymer Concrete Manholes in Sewer Systems, Bond solid sewer vents are commonly utilized in sewer arrangements in the United States. Be that as it may, these solid sewer vents are very powerless against substance consumption and require visit support and substitution. Polymer solid sewer vents as a substitute to the bond solid sewer vents in water and wastewater pipelines have demonstrated to have longer administration life and more protection from different compound consumptions than typical solid sewer vents. The results showed that the installation and rehabilitation costs per foot per year of the polymer concrete manholes are significantly lower than that of cement concrete manholes in the case of 48-inch and 60-inch diameters manholes, with 50 years of service life of polymer concrete manholes. The costs were not significantly different for 72-inch diameter manholes. However, the installation and rehabilitation cost of 72-inch polymer concrete manholes with 25 years of service life is determined to be significantly higher as compared to cement concrete manholes while the installation and rehabilitation cost of 65 48-inch and 60-inch polymer concrete and cement concrete manholes are not significantly different.

Conclusion

Polymers were generally identified and their effects on concrete were listed. The case study had several objectives including assessing the rheological properties of concrete, finding different properties of Polycrrete as well as the properties of normal cement, which was used instead of concrete, a comparison of the normal and Polycrrete cement and discussing the environmental issues that emerged.

In the three edge bearing test, the average result of the 6 tests was that the actual bending tensile strength of the is 18.84N/mm² which was more than the needed value. In the viscosity test (Resin), the viscosity of the fluid was 396.7cps. As for the density test (Resin), the result obtained was 1.18g/cm³ which is the best result. The sieve analysis test was carried out on a sample of 10mm gravel on various sizes of sieves. The limits of the result were 95 to 100% passing, and it was within the accepted limit. Moreover, the load test carried out on the Polycrrete manhole was also divided into two sections; applied test load, rate of load applied. The value of the result obtained was around 301.5KN per 1666N/s. Finally, the shore hardness test, the results obtained from this test was an average of 46.53 which reaches the accepted value and surpasses it.

According to the research conducted regarding polymer concrete, the characteristics and benefits of polymer concrete were discussed. The research showed that the role of the polymer increased day by day in modern building materials alongside construction industry, that was as a result to its benefits in comparison with other types. The benefits include quick hardening, high mechanical strength, chemical resistance and low cost.

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