DURABILITY OF RC PIPES MADE OF DIFFERENT ENHANCED CONCRETE MATERIALS SUBJECTED TO AGGRESSIVE CORROSIVE MEDIA

By

Lamiaa Mohamed Omar Ali

A Thesis Submitted in Partial Fulfillment

Of

The Requirements for the Degree of

Doctor of Philosophy of Science

In

Civil Engineering

(Structures)

Department of Civil Engineering

Faculty of engineering

FAYOUM UNIVERSITY

2022

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ABSTRACT

Infrastructure deterioration is one of the major problems. Subsequently, it is necessary to minimize element corrosion in order to avoid many problems such as maintenance of reinforced concreted elements, substitution of parts of system and serious damages in water collection system or waste-water collection system.

Geopolymer material is a new binding material to use in concrete as alternative to ordinary portland cement. Geopolymer concrete is characterized by being environmentally friendly, low cost, high durability under harsh environments and high strength compared to ordinary Portland cement. Geopolymer binder can be used in concrete as a construction material or in mortar as a rehabilitation material in waste water and water pipes.

This research aims to study different mixes of geopolymer paste, mortar and concrete in order to reach optimized mixes for pipes. The effect of aggressive media (magnesium sulfate and chloride) on the corrosion rate and flexural capacity of Reinforced Concrete (RC) pipes was studied. Also, the effect of accelerated corrosion periods on the corrosion rate and flexural capacity of RC pipes was considered.

Two different geopolymer mixes; geopolymer mix binder contains 90% slag and 10% red mud (GPCB), geopolymer mix binder contains 63% slag, 27% fly ash, and 10% red mud (GPCC) in addition to Ordinary Portland Cement concrete (OPC) concrete were used to study the effect on the corrosion rate, mechanical properties of concrete and flexural capacity for RC pipes.

In this research, an experimental program of four different groups were investigated, these four groups are geopolymer paste mixes, geopolymer mortar mixes, geopolymer concrete mixes and RC pipes. Forty-three geopolymer paste mixes containing sodium based activators combinations were studied under the effect of different parameters. Three geopolymer mortar mixes containing sodium based activators combinations were exposed to different curing methods (air and water curing). Twenty-three geopolymer concrete mixes containing sodium based activators combinations were studied under the effect of different binder compositions. Twenty-one RC pipes with different thickness of pipes (50mm and 100mm), concentration of aggressive media, accelerated corrosion setup period, mix compositions of concrete and reinforcement details were studied.

Compressive strength of all groups was recorded in order to determine the effect of different mix compositions and curing method. Loading frame test was performed on group four to find the flexural capacity of pipes and the corresponding deflection under the effect of different (magnesium sulfate and chloride) aggressive media concentrations, mix compositions of concrete and reinforcement details and variable accelerated corrosion setup periods.

The compressive strength and the flexural test results of RC pipes group showed that the increase in peak load occured in cases of GPCB and GPCC pipes in spite of its exposure to accelerated corrosion setup and aggressive media. This increase is due to noticeable increase in compressive strength of mixes of GPCB and GPCC pipes.

From results of Fourier Transform InfraRed (FTIR) spectroscopy test, it was found that Geopolymer structure of (GPCB and GPCC) samples has more stable behavior than the OPC structure.

This research clarified the importance of geopolymer concrete in aggressive media existing in water and waste water. The most important features of geopolymer concrete is the increase in compressive strength in water and aggressive media clearly.