ASSESSING THE DURABILITY OF CONCRETE MADE OF LIMESTONE PORTLAND CEMENT WITH ADDITIVES (SILICA FUME –METAKAOLIN)

By

MOHAMED AHMED MOHAMED IBRAHIM

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
IN
Structural Engineering

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Under the Supervision of

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Title of Thesis: **Assessing the durability of concrete made of limestone Portland cement with additives (silica fume –metakaolin)**

Key Words:
Limestone cement; silica fume; metakaolin; accelerated corrosion; permeability.

Summary:

The Portland limestone cement with the Mineral Admixtures (metakaolin and silica fume) were used in this research to study their impact on the durability of concrete and the corrosion of steel in reinforcement concrete .the corrosion of reinforcement steel in concrete is the main factor which decrease the durability of concrete and therefore decrease the age of the Buildings. The research aimed to increase durability of concrete by decreasing the concrete permeability. The results showed that the samples contains (CEM II,CEM II(SF5),CEM II(SF15)and CEM II(MK5)) improved the compressive strength when compared with (CEM I), the results of the corrosion test showed that the samples contains (CEM II(SF15),CEM II(SF15 + MK5)and CEM II(MK5)) improve resistance of the Reinforced concrete against the corrosion when compared with (CEM I) and for the permeability test the samples contains (CEM II.L, CEM II(SF15 +MK5), CEM II(SF15+MK5),CEM II(MK5) and CEM II(SF15) decrease the permeability of concrete when compared with (CEM I). It was concluded that the sample contains (CEM II (SF15)(gave the highest results in the)compressive strength test , resistance of corrosion of steel in the reinforced concrete and also reduced concrete permeability) by percentages (16%, 35% and31%) respectively when compared with the ordinary Portland cement (CEM I).

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Mohamed Ahmed Mohamed Ibrahim Date: / / 2019

Signature:

Dedication

I can't forget to mention **my father** and **my mother** for their contentious Doaa for me to success in my work, I also would like to thank **all my family** specially **Eng .Alaa Marouf.**

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In the Name of Allah, the Most Gracious, the Most Merciful

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Abstract

Concrete is the main material used in construction. The manufacturing of cement all over the world is increasing; the increasing in the production of ordinary Portland cement caused to increase of CO2 gas emission. The emission of CO2 leads to an increase in the environmental pollution. The Portland limestone cement with the Mineral Admixtures (metakaolin and silica fume) were used in this research to study their impact on the durability of concrete and the corrosion of steel in reinforcement concrete .the corrosion of reinforcement steel in concrete is the main factor which decrease the durability of concrete and therefore decrease the age of the Buildings. The research aimed to increase durability of concrete by decreasing the concrete permeability. The experimental program Consists of three groups of samples to test, The first group prepared for the compressive strength test as cubes with dimensions (150x150x150) mm, the second group is for the corrosion test as cylinder with dimensions (150) mm long and (50) mm diameter with Reinforcing steel Φ10, and the third group is for permeability test as cubes with dimensions (150x150x150) mm. the maximum rebars weight loss due to corrosion test and the maximum rebar's diameter loss due to corrosion test were calculated .The results showed that the samples contains (CEM II,CEM II(SF5),CEM II(SF15)and CEM II(MK5)) improved the compressive strength when compared with (CEM I), the results of the corrosion test showed that the samples contains (CEM II(SF15),CEM II(SF15 + MK5)and CEM II(MK5)) improve resistance of the Reinforced concrete against the corrosion when compared with (CEM I) and for the permeability test the samples contains (CEM II.L, CEM II(SF15 +MK5), CEM II(SF15+MK5),CEM II(MK5) and CEM II(SF15) decrease the permeability of concrete when compared with (CEM I). It was concluded that the sample contains (CEM II (SF15)) gave the highest results in the (compressive strength test , resistance of corrosion of steel in the reinforced concrete and also reduced concrete permeability) by percentages (16%, 35% and31%) respectively when compared with the ordinary Portland cement (CEM I).

Chapter 1: Introduction

1.1. General

Concrete is the most utilized construction material in today's world .this is mainly due to its superior compressive strength .however, it is classified as brittle material. Steel is used in reinforced concrete to overcome the brittle nature of concrete.
Manufacturing of cement, the binding agent in concrete, is a serious environmental problem because it causes the release of large amount of CO2 which is a major contributor to greenhouse effects. Cement dust causes serious health problems to inhabitants of neighboring areas.

Durability of concrete is the ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration" .That's what The American Concrete Institute (ACI) said to define the durability of concrete there are a number of factors that affect the durability of concrete such as compressive strength, (w/c) ratio, thermal cracking and permeability. The Most effective factor is concrete permeability. Permeability of concrete is a result of rising of capillary water. External solutions percolate through concrete pores to reach steel reinforcement. If enough chlorides, moistures oxygen reach steel, corrosion will start. The permeability passes the chemical to the entire of concrete this cause's chemical reaction in the reinforcement concrete. From this we conclude that permeability is a factor in the reducing the service life of buildings. [1]

Corrosion of steel is the most serious problem facing the reinforced concrete. Steel corrosion causes a decrease of the RC section capacity .Corrosion of reinforced concrete causes loss of bond between steel bars and surrounding concrete leading to the removal of concrete cover. The corrosion of reinforced concrete will decrease the service life of the structures. To effectively, reduce the adverse effect of reinforcement corrosion on structural safety and economy; concrete permeability must be enhanced. Assessment of concrete performance in aggressive media can be done using different ways. In this research, impressed current is utilized to induce reinforcement corrosion. This accelerated corrosion method has proven to give reliable results.