AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

RUBBERIZED HIGH STRENGTH CONCRETE MADE WITH MINERAL ADMIXTURES WITH HIGH FIRE RESISTANCE

By

Eng. Yasmin Hefni Abd El-Aziz

B.Sc. Civil Engineering

Cairo University, 1999

A Thesis

Submitted in Partial Fulfillment for Requirements of the Degree
of Master of Science in Structural Engineering

Supervisors

Dr. Hany Mohamed El-Shafie

Associate Professor

Structural Engineering Department

Faculty of Engineering - Ain Shams University

Dr. Yehia Abd El-Zaher Ali

Associate Professor

Structural Engineering Department

Faculty of Engineering - Ain Shams University

Dr. Mona Mostafa Abd El-Wahab

Associate Professor

Structural Engineering Department

Faculty of Engineering - Ain Shams University

2010

TO MY PARENTS,
HUSBAND AND SISTER

Ain Shams University

Faculty of Engineering

Thesis Title: Rubberized High Strength Concrete Made With Mineral Admixtures with High Fire Resistance

Researcher Name: Eng. Yasmin Hefni Abd El-Aziz

Refrress Committee

Prof. Dr. Ahmed Hasanen Ahmed Abd El-Rehem

Professor of Properties and Testing of Materials

Structural Engineering Department - Faculty of Engineering - Mansoura University

Prof. Dr. Samir Hasan Okba

Professor of Properties and Testing of Materials

Structural Engineering Department - Faculty of Engineering - Ain Shams University

Dr. Yehia Abd El-Zaher Ali

Associate Professor

Structural Engineering Department - Faculty of Engineering - Ain Shams University

Dr. Mona Mostafa Abd El-Wahab

Associate Professor

Structural Engineering Department - Faculty of Engineering - Ain Shams University

ACKNOWLEDGMENT

I wish to express my deep gratitude to Dr. Hany Mohamed El-Shafie Associate Professor of Structural Engineering Department, Faculty of Engineering - Ain Shams University for his kind supervision.

Also, all words can not express how deep I am grateful to Dr. Yehia Abd El-Zaher Ali Associate Professor, Structural Engineering Department - Faculty of Engineering - Ain Shams University for his continuous advice, precious remarks and good discussion throughout the work presented in this master.

I am also wish to thank Dr. Mona Mostafa Abd El-Wahab Associate Professor, Structural Engineering Department - Faculty of Engineering - Ain Shams University for her good interest, encouragements and hard support all the time to complete this research.

Many thanks for Eng. Tag El Sahly the chairman and Eng. Husien El Sawy the vice president of Technical Consultation Bureau (EL-SAHLY-EL-SAWY) for their good help and encouragements all the time.

Statement

This thesis is submitted to Ain Shams University for the degree of Master of Science in Structural Engineering.

No part of this thesis has been previously submitted for obtaining a degree or a qualification before.

Name : Yasmin Hefni Abd El-Aziz
Date :
Signature :

Ain Shams University
Faculty of Engineering
Structural Engineering Department

Master of Science, 2010
Eng. Yasmin Hefni Abd El-Aziz

ABSTRACT

As high strength concrete has many benefits when used in structural applications, it was essential to study its behavior at elevated temperature and also investigate the admixtures that can improve this behavior to ensure safety of structural design.

High strength concrete has high stiffness and low permeability which is reasonable for the occurrence of explosive spalling when exposed to fire. Rubber is used to reduce the risk of explosive spalling of high strength concrete, as water vapor escape from the concrete matrix in small passes obtained by burnt rubber. Using recycled rubber tires into concrete will improve some concrete properties such as concrete fire resistance, toughness, ductility, impact resistance, and also will gain an environmental benefit as it will reduce accumulation of used rubber tires in land fills and its contamination.

Pozzolans are siliceous or aluminous material which is not a cementitious material itself but if it is ground to be in fine form and in presence of water it will react with calcium hydroxides at ordinary temperature to form compounds processing cementitious materials. Metakaoline is a type of natural pozzolans; its mineral form is hydrated aluminum disilicate

$Al_2Si_2O_5(OH)_4$ which reacts aggressively with calcium hydroxide to form compounds with cementitious value which increase concrete strength.

This study was conducted to develop a high strength concrete made with mineral admixture as silica fume and metakaoline using recycled rubber particles to improve its fire resistance. Several mixes were used to investigate the effect of adding rubber latex and mineral admixures on concrete strength at normal and elevated temperature.

Three shapes of recycled rubber particles were used in the experimental investigation; fine, coarse and shredded. In order to increase rubber surface adhesion to cement paste, the rubber particles were surface treated using NaOH saturated aqueous solution.

Test results of this study indicated that using NaOH rubber surface treatment enhances the concrete performance, regardless the shape of rubber particles, due to good adhesion between rubber and concrete as a result of removal of oils and lubricants accumulated on rubber surface. Also adding rubber by 3% slightly reduces concrete compressive strength at normal temperature but improve its strength at elevated temperature.

Four types of kaolin clay were obtained from Aswan in this study. The four kaolin clay types were Pullclay, Kalabsha, Abusbera and Essela. After thermal and mechanical activation of these kaolin clays, it was found that Essela clay exhibited the highest compressive and tensile strengths of cement mixes compared to other types.

Adding metakaoline or silica fume to concrete mixes improved concrete strength at normal temperature when compared with control mix but metakaoline posses better improvement than silica fume. It is concluded that strength was increased as the ratio of mineral admixtures increased. Metakaoline or silica fume consumes Ca $(OH)_2$ in concrete which is responsible for vapor pressure when concrete is exposed to fire, it reduces concrete permeability which causes spalling at elevated temperature. As a result, metakaoline and silica fume cause limited increase in concrete fire resistance and the addition of rubber helps in this aspect.

TABLE OF CONTENTS

LIST OF TABLES