DECLARATION

I herby declare that this thesis together with work contained herein was produced entirely by myself, and contains no materials that have been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person except where due acknowledgment to others has been made.

Signature: …………………………………….

Salem A. Abukersh

ABSTRACT

Sustainable development is gaining popularity around the globe nowadays. Governments are under pressure, on many fronts, to embed sustainable development in policies, practice, and operations to secure the planet's future. Adding to this, increased populations, and the need for more infrastructures, have unfortunately led to the unacceptable depletion of raw materials, increasing amounts of construction and demolition waste (C&DW) and accelerated deterioration of the natural environment in many places worldwide.

For the conservation of natural resources, reuse and recycling of C&DW is the most obvious way to achieve sustainability in the construction sector. Currently, recycled aggregate (RA) is produced from C&DW in modern recycling facilities, under good quality control provisions which could lead to improve its performance compared with the earlier days of recycling. In addition to C&DW, large amounts of industrial and mining by-products such as fly ash, slag, limestone powders, aggregate dust, *etc*. are dumped in landfills. Fly ash has been used successfully in concrete for a long time due to its numerous advantages across a wide range of properties, including aspects of durability. A concrete produced with the combination of PFA and RA *i.e.* recycled aggregate concrete (RAC) is obviously more sustainable and economical than conventional natural aggregate concrete (NAC).

To date, statistics show that a considerable proportion of the world's RA is used for low-utility applications due to perceived risks and uncertainty over their performance formed as a result of previous history of use when RA was produced manually and low strength cement and higher water to cement ratios were used. Despite the advances in recycling, materials and concreting technologies, this impression prevails. However, to increase the use of RA, it is believed that the quality of RAC should be improved by chemical and mineral additives. For cost effectiveness, quality-improving additives should be abundant, safe, and inexpensive; PFA and new generation polymer-based superplasticizer (SP) are deemed to be a good option.

The aims of this study are to investigate the possibility of producing good quality RAC that could be used as a substitute for NAC in normal strength concrete members, and to study its fundamental properties. An attempt has been made to create superplasticized RAC concretes, in which new generation polymer-based SP and PFA produced to the latest European standards were used. PFA was used to partially replace fine aggregate and cement in ordinary and self-compacting concretes. The thesis also includes an investigation into the potential of utilising an aggregate by-product (red granite dust (RGD) in producing environmentally beneficial RAC.

The findings show that good performance RAC can be produced with the help of SP and PFA. The study also revealed that it is possible to utilise RGD to substitute up to 30% of cement without substantially influencing the performance of concrete, while also providing cost savings. Strengths and stifnesses of the ensuing RAC either with SP, PFA, or RGD were comparable, or better than, a wide range of counterpart NACs. The author's produced RAC concretes *can* replace NAC concrete used unnecessarily for many applications including structural concrete.

DEDICATION

This study has been started in September 2005 under the guidance and supervision of Dr Fouad Khalaf who sadly passed away on 26 June 2008.

During the course of the study, Dr Khalaf had given me so much invaluable advice, encouragement, and support; the author is indeed indebted to him. This work is dedicated to Dr Khalaf's spirit, meanwhile asking Allah (God) to be kind and merciful with him on the day of judgment.

The author
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CONTENTS

CHAPTER 3 LITERATURE REVIEW

CHAPTER 7 RAC PRODUCED BY CEMENT REPLACEMENT

List of Figures

CHAPTER 4

CHAPTER 5

CHAPTER 6

CHAPTER 7

CHAPTER 8

List of Tables

CHAPTER 5

CHAPTER 6

CHAPTER 7

CHAPTER 8

List of abbreviations

ASR	Alkali silica reaction
C&DW	Construction and demolition waste
C_u	Uniformity coefficient of coarse aggregate
EDXA	Energy dispersive X-ray analysis
E_s	Modulus of elasticity of concrete
FST	Final setting time of the paste
F_{cu}	Cube strength of concrete
F_{cy}	Cylindrical strength of concrete
f_{ct}	Tensile splitting strength of concrete
f_r	Flexural strength of concrete
GGBS	Ground granulated blast furnace slag (slag)
HSC	High strength concrete
IST	Initial setting time
NC	Normal consistency
NAC	Natural aggregate concrete
PA	Passing ability of SCC
RGD	Red granite dust
RD	Relative density of aggregate
PFA	Pulverised fuel ash
RAC	Recycled aggregate concrete
SCC	Self-compacting concrete
SCC-NAC	Natural aggregate self-compacting concrete
SCC-RAC	Recycled aggregate self-compacting concrete
SEM	Scanning electron microscope
T_{500}	Time taken by a concrete to spread 500 mm
T_{final}	Time taken by a concrete to cease spreading
VMA	Viscosity modifying agent
w/b	Water to binder ratio
w/c	Water to cement ratio
μ	Poisson's ratio