PERFORMANCE OF RECYCLED CONCRETE AGGREGATES-CONTAINING CONCRETE EXPOSED TO HEATING-COOLING CYCLES

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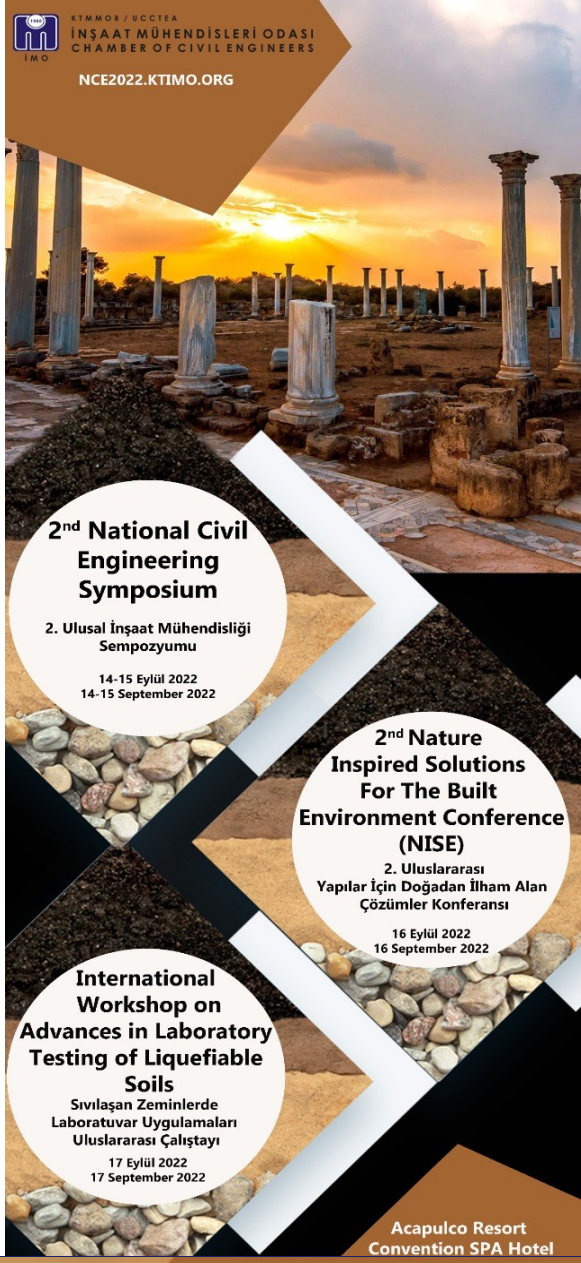

Outline:

- Introduction
  - Problem Statement
  - Objectives and Scope of the Study
- Methodology
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- Conclusions

Introduction

- Aggregates used for concrete are generally quarried and natural resources are continuously consumed.
- Structures could be demolished due to completion of their service lives; due to performance failures; for being replaced with more modern buildings, etc.
- Demolition wastes are moved into landfills
- *Quarrying and landfilling pose threats for the environment...*

Aggregate Quarry

Demolished Concrete landfill

Introduction

Using demolished concrete wastes as:

«Recycled Concrete Aggregates» (RCA) in the manufacture of new concretes is a promising solution…

Problem Statement:

- Regular concrete elements might experience up to 63° C and -33° C day-and-night temperature difference in countries like Kuwait. Also, certain concrete elements having special functions and exposed to heat conditions such as parking lots might experience up to 140° C temperature difference.

- Expansion-contracting due to being exposed to heating-cooling cycles are known to cause internal cracks in concrete. As RCA-containing new concretes will include both new and old mortars, their thermal expansions under changing temperatures cycles can be different.

- Knowledge on the performance change of RCA-containing concrete under thermal cycles is essential to ensure an improved concrete mix design practice in the real applications

- There is a lack of information in the related literature on the performance change of RCA-containing concretes exposed to heating-cooling cycles.

Objective and Scope of the Study

- Two types of concrete mixtures:
  - With 0%RCA (100%Natural* Aggregates) ; as control set
  - With 50%RCA & 50%NA *
- Temperature cycles between ambient-160°C.
- Three different numbers of heating-cooling cycles
- Compressive & split-tensile strength performance of two concrete mixtures were investigated at 28 days.

*"Natural" meaning: «not recycled» NA used in this study are crushed, quarry aggregates.

Methodology

	No of Heating-Cooling Cycles Applied:		
	0 Cycles	**3 Cycles**	**6 Cycles**
Mix-1 (100%NA)	3 cubes for compresion 3 cylinders for split-tensile	3 cubes for compresion 3 cylinders for split-tensile	3 cubes for compresion 3 cylinders for split-tensile
Mix-2 (50%RCA& 50%NA)	3 cubes for compresion 3 cylinders for split-tensile	3 cubes for compresion 3 cylinders for split-tensile	3 cubes for compresion 3 cylinders for split-tensile

Methodology

- Recycled concrete aggregates were produced from 3-years old concrete cubes:

- Both concrete mixes are prepared with natural fine aggregates. RCA replacement is done only for coarse aggregates (50% replacement in Mix 2).

Methodology

- Targetted design strength for the concrete mixes: 30MPa
- 3-years old laboratory concrete samples (C25) were used to provide RCA

Methodology

Mix design for both types was prepared according to **ACI 211.1**

Constituents	Proportions (Kg/m³)	
	Mix 1	Mix 2
Cement	363	363
Natural Fine Aggregates	711	711
Natural coarse aggregates (12.5-19 mm)	549	274.5
Natural coarse aggregates (4.75-12.5mm)	549	274.5
Recycled coarse aggregates (12.5-19 mm)	-	274.5
Recycled coarse aggregates (4.75-12.5 mm)	-	274.5
Water	200	200
Water Cement ratio W/C	0.55	0.55

Methodology

- Heating-cooling cycles were decided considering similar studies in literature.
- 160°C was used as a severe case in order to accelerate the effect of temperature changes on concrete.
- 0, 3, and 6 cycles are applied on both concretes samples

Duration of heating period: 2 hours

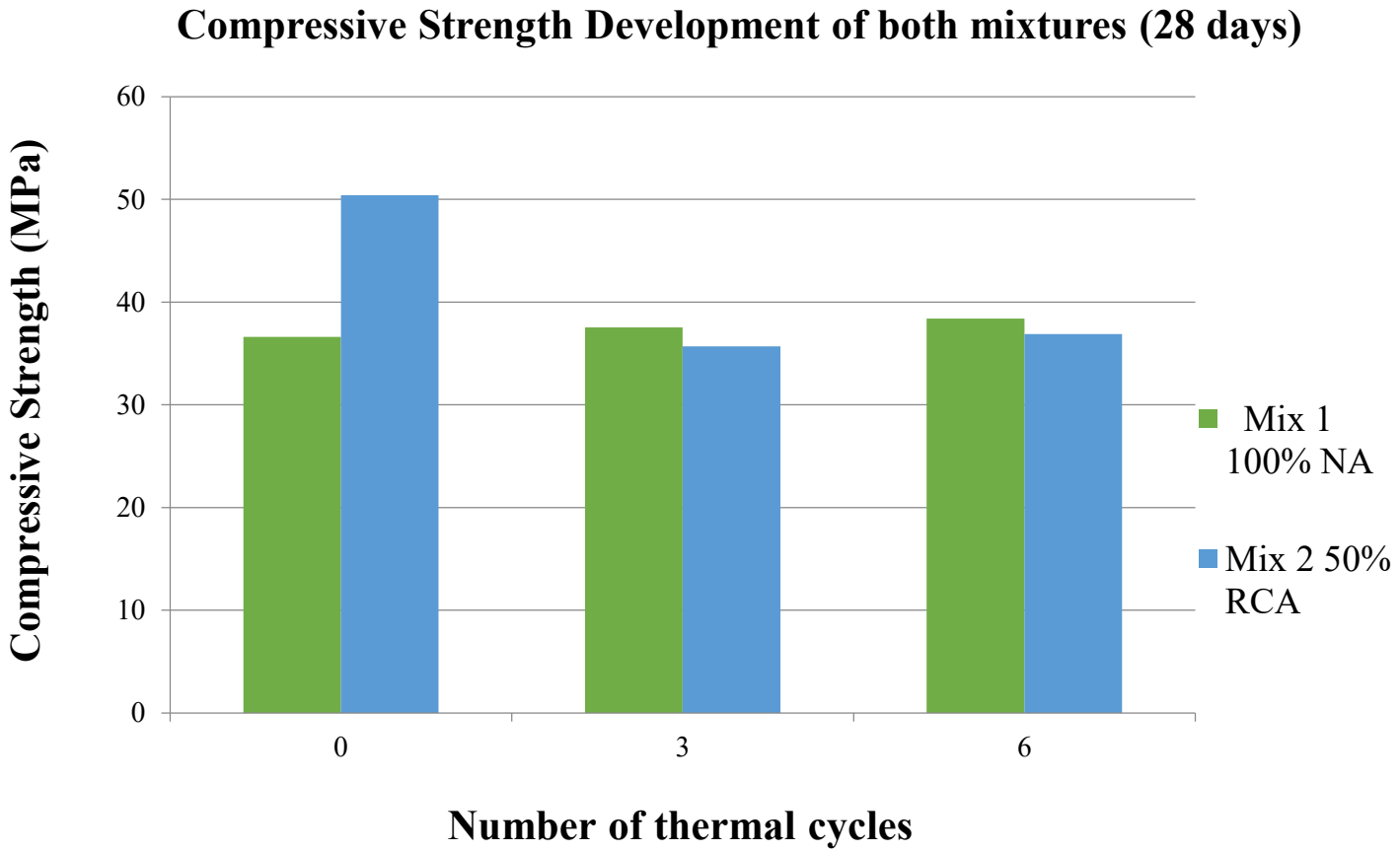
Duration of cooling period: 1 hour

Results and Discussion

Mechanical properties of aggregates:

	Los Angeles abrasion value (%)	Absorption Capacity (%) (5-12) mm	Absorption Capacity (%) (12-19) mm
RCA	41.2	4.8	3.7
NA	34	0.7	0.5

Results and Discussion
Compressive Strength Performance

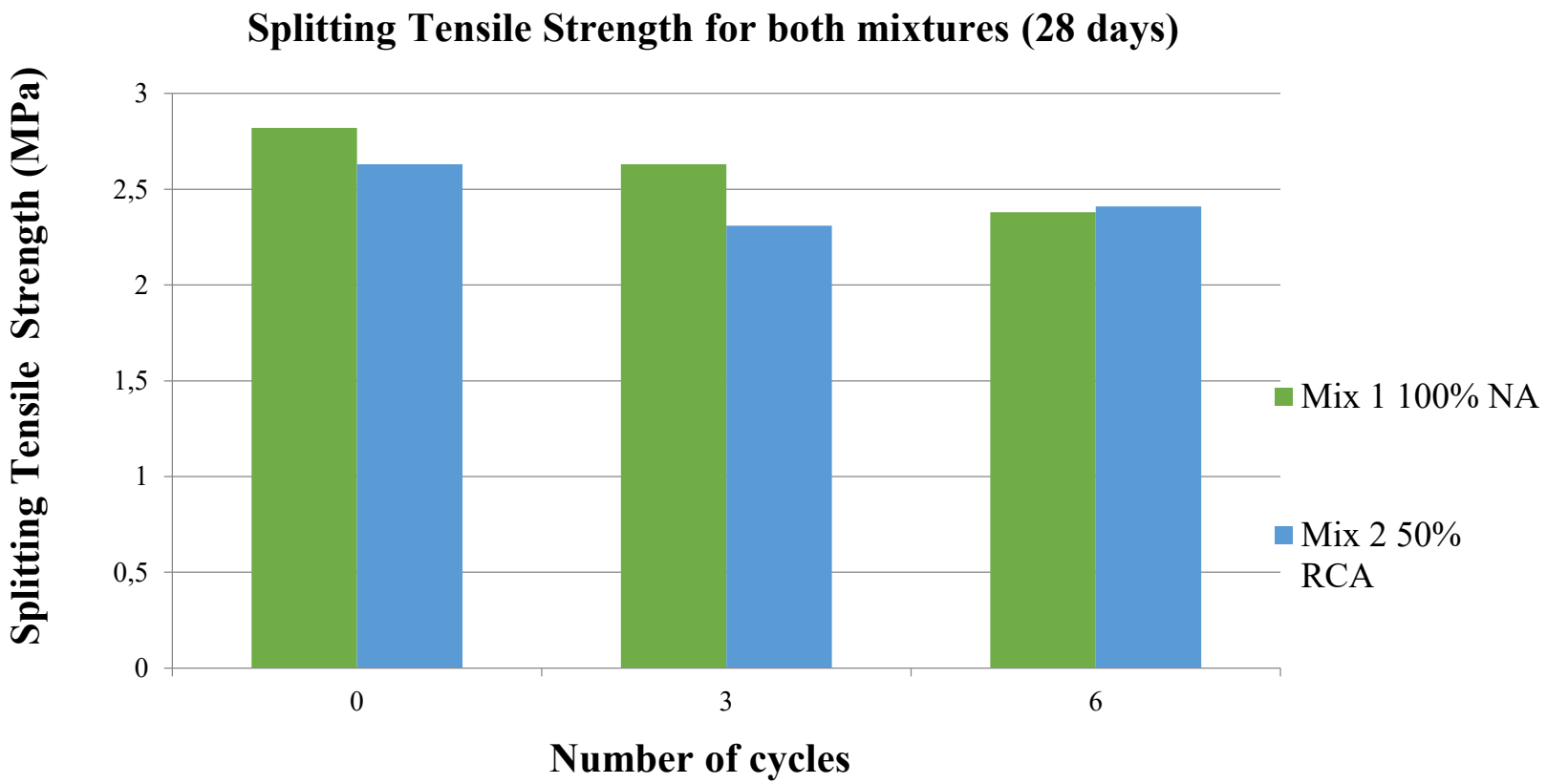


3 Heating –Cooling cycles caused the RCA-containg concrete to yield 3.5% strength drop (compared to Mix-1-control set)

6 Heating –Cooling cycles caused the RCA-containg concrete to yield 3.9% strength drop (compared to Mix-1-control set)

In total; exposure to 6 cycles made the RCA-concrete to yield 26.8% strength drop within itself (compared to 0 cycles).

Results and Discussions
Split Tensile Strength



3 Heating –Cooling cycles caused the RCA-containg concrete to yield 12.2% strength drop (compared to Mix-1-control set)

6 Heating –Cooling cycles caused the RCA-containg concrete to yield no strength drop (compared to Mix-1-control set)

In total; exposure to 6 cycles made the RCA-concrete to yield 8.4% strength drop within itself (compared to 0 cycles).

Conclusions

- RCA yielded higher absorption capacity than natural aggregates
- RCA yielded lower abrasion resistance than NA
- RCA mixture showed a noticeable drop (~27%) of compressive strength performance

Conclusions

- Both mixtures yielded a drop in splitting tensile strength performance after exposure to thermal cycles.
- NA mixture yielded higher splitting tensile strength performance than RCA mixture when no thermal cycles and when 3 cycles were applied.
- 6 cycles was observed to yield similar splitting tensile strength performance both in NA and RCA samples.
- It is observed that split tensile strength testing could be more reliable for reflecting the performance decrease due to RCA inclusion when sumples are exposed to heating-cooling cycles, than compressive strength testing; which might have a closing effect on the cracks during testing

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