

Recycled concrete with coarse recycled concrete aggregates (CRCA)



New design method for C30 recycled concrete using mixed source concrete coarse aggregates

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Outline of the report

- **Introduction**
- **Enlightenment of research significance**
- **Experimental investigation**
- **Results and discussion**

New design method for C30 recycled concrete

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Introduction

Studies on recycled concrete with CRCA from different SC

Author , Year (Reference no)	Type of SC	Properties of CRCA					Factors considered and properties of recycled concrete				
		Psr (mm)	Mc (%)	Wa (%)	Sg (kg/m ³)	Cv (%)	Ts (MPa)	Sr (%)	W/C	Mechanical property	Durability property
Pedro et al. (2017) [8]	L (73.2MPa); D (74.5MPa)	-	-	√	√	√	-	25, 50, 100	-	↓ (relative to Sr)	↓
Andreu & Miren (2014) [12]	L (60MPa); P (40, 100MPa)	10 (N)	-	↓	↑	√		20, 50, 100		↑ (relative to SC strength); ↓ (relative to Sr)	Same to the left
Padmini et al (2009) [21]	L (35, 45, 55)	10, 20, 40	-	↑	↓	↓	21, 34, 45	100	√	↑ (relative to SC strength/Psr)	-
Pedro et al. (2014) [27]	R and L (20, 45, 65MPa)	22.4 (M)	-	↓	↓	-	20, 45, 65	100	-	↑ (relative to SC strength)	↑
Tabsh & Abdelfatah (2009) [28]	L (30 and 50MPa); D (unknown strength)	25 (M)	-	Abrasion and soundness tests conducted; ↓ (relative to SC strength)			30, 50	100	-	↑ (relative to SC strength)	-
Tavakoli & Soroushian (1996) [29]	R (44, 55 MPa)	19 and 25.4 (M)	-	-	√	√	-	100	√	↑ (relative to SC strength)	-
Duan & Poon (2014) [30]	R and L	5-10 10-20	√	↑	↓	↑	30, 45, 60, 80	100	√	↓ (relative to Mc)	↓
McGinnis et al. (2017) [31]	13 sources around U.S.	25 (M)	-	√	√	√	48.3-68.9	50, 100	-	↓ (relative to Sr)	-
Kou & Poon (2015) [32]	L (30, 45, 60, 80 and 100MPa)	20 (M)	-	↓	No evident law	-	45, 65	100	-	↑ (relative to SC strength)	↑
Gonzalezcorominas & Etxeberria (2016) [33]	L (40, 60, 100MPa)	-	-	↓	-	↓	-	20, 50, 100	-	↑ (relative to SC strength); ↓ (relative to Sr)	Same to the left
Liu, K et al (2016) [34]	L (from 35 to 57MPa)	4.75-26.5	-	↓	-	↓	-	100	-	-	↑ (relative to SC strength);

Studies on recycled concrete with CRCA from different SC

Factors of SC defined as follow:

- Collecting site, including laboratory and precast concrete company with controlled origin as well as recycling plant and dump site with unknown information;
- Compressive strength of source concrete.

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Research significance

Research significance

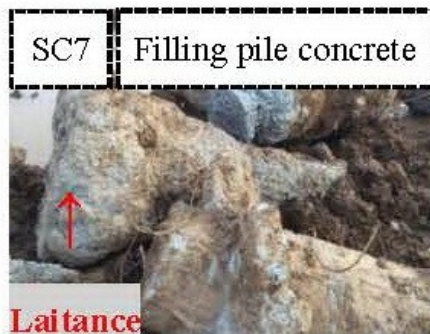
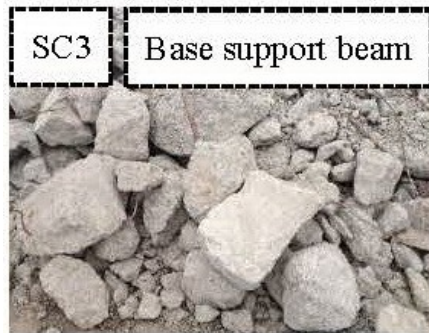
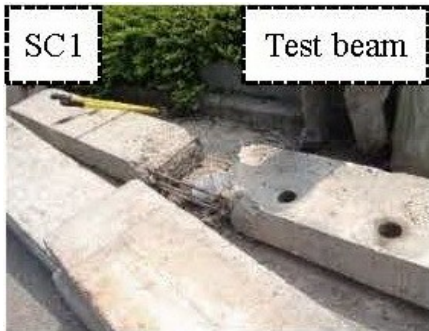
- Single strength SC & **mixed strengths SC**;
- **Mix design method**: more water; low water-cement ratio; making middle-high strength concrete with high strength SC; limiting incorporation ratio of CRCA
- **Parameters** in current study: strength grade of different SC, strength difference between two mixed SCs and proportion of mixed CRCA

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Experimental investigation

Experimental investigation



- Impurities
- Compressive strength

Experimental investigation

- Mechanical property test of CRCA: grading analysis, water absorption, apparent density, bulk density and crushing index.
- Mechanical property test of recycled concrete: compression strength and splitting tensile strength tests.

Experimental investigation

Details of concrete mixes

Specimen	Incorporation of RA1, RA3, RA5, RA6 and RA7	Strength difference between two mixed SCs
NC	-	-
RC1	RA1	0
RC3	RA3	0
RC5	RA5	0
RC6	RA6	0
RC7	RA7	0
RC1-3a	RA1: RA3=3: 1	Less than 5MPa
RC1-3b	RA1: RA3=1:1	Less than 5MPa
RC1-3c	RA1: RA3=1: 3	Less than 5MPa
RC3-5a	RA3: RA5=3: 1	10MPa with lower strength
RC3-5b	RA3: RA5=1: 1	10MPa with lower strength
RC3-5c	RA3: RA5=1: 3	10MPa with lower strength
RC5-6a	RA5: RA6=3: 1	10MPa with higher strength
RC5-6b	RA5: RA6=1: 1	10MPa with higher strength
RC5-6c	RA5: RA6=1: 3	10MPa with higher strength
RC3-7a	RA3: RA7=3: 1	15MPa
RC3-7b	RA3: RA7=1: 1	15MPa
RC3-7c	RA3: RA7=1:3	15MPa
RC1-6a	RA1: RA6=3: 1	20MPa
RC1-6b	RA1: RA6=1: 1	20MPa
RC1-6c	RA1: RA6=1: 3	20MPa

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Results and discussion

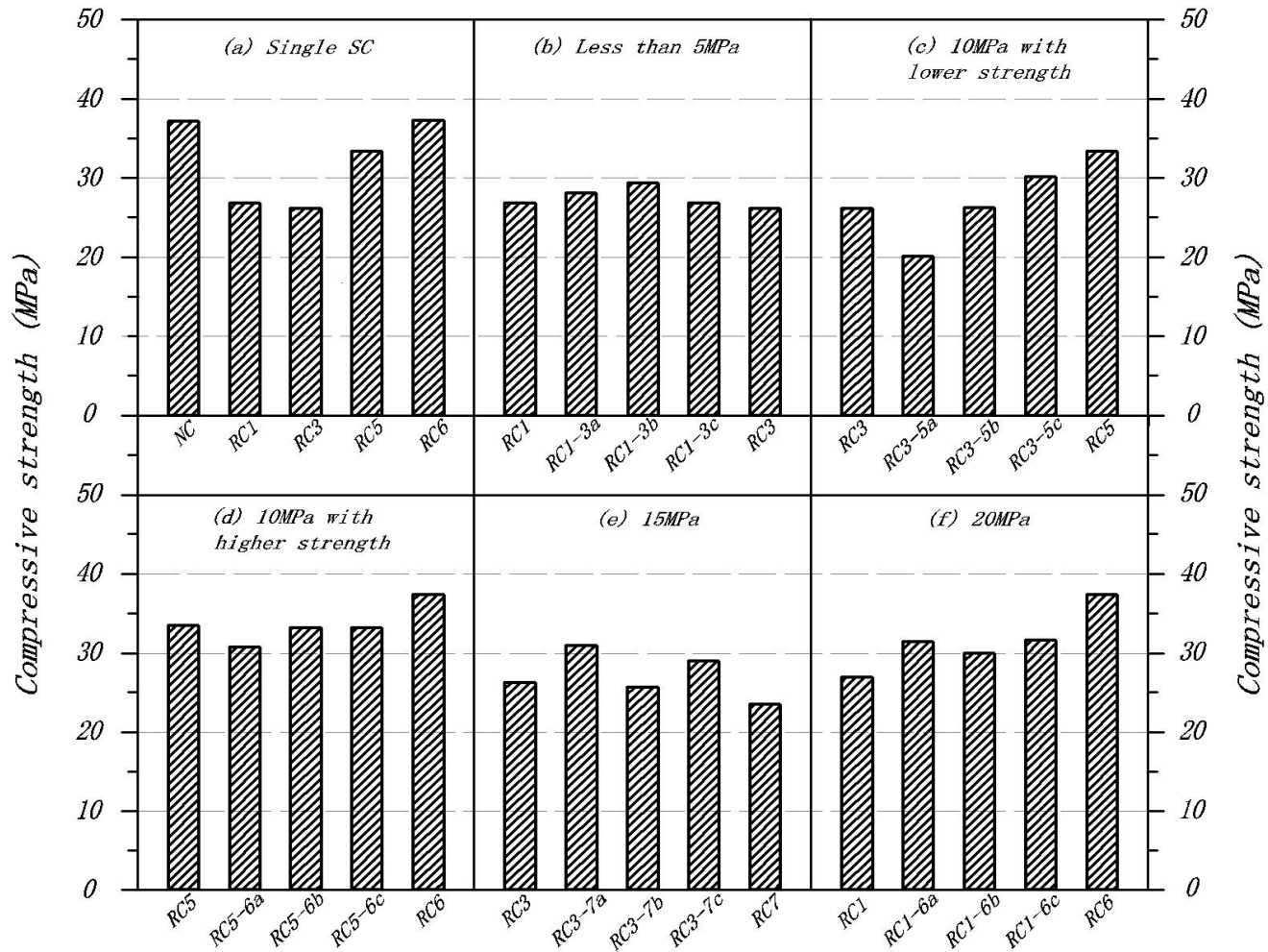
Results and discussion

Mechanical property of CRCA

- Higher water absorption, crushing index and bulk densities.
- CRCA crushed from higher strength SC could possess better quality, e.g., lower water absorption and crushing index and higher apparent density.

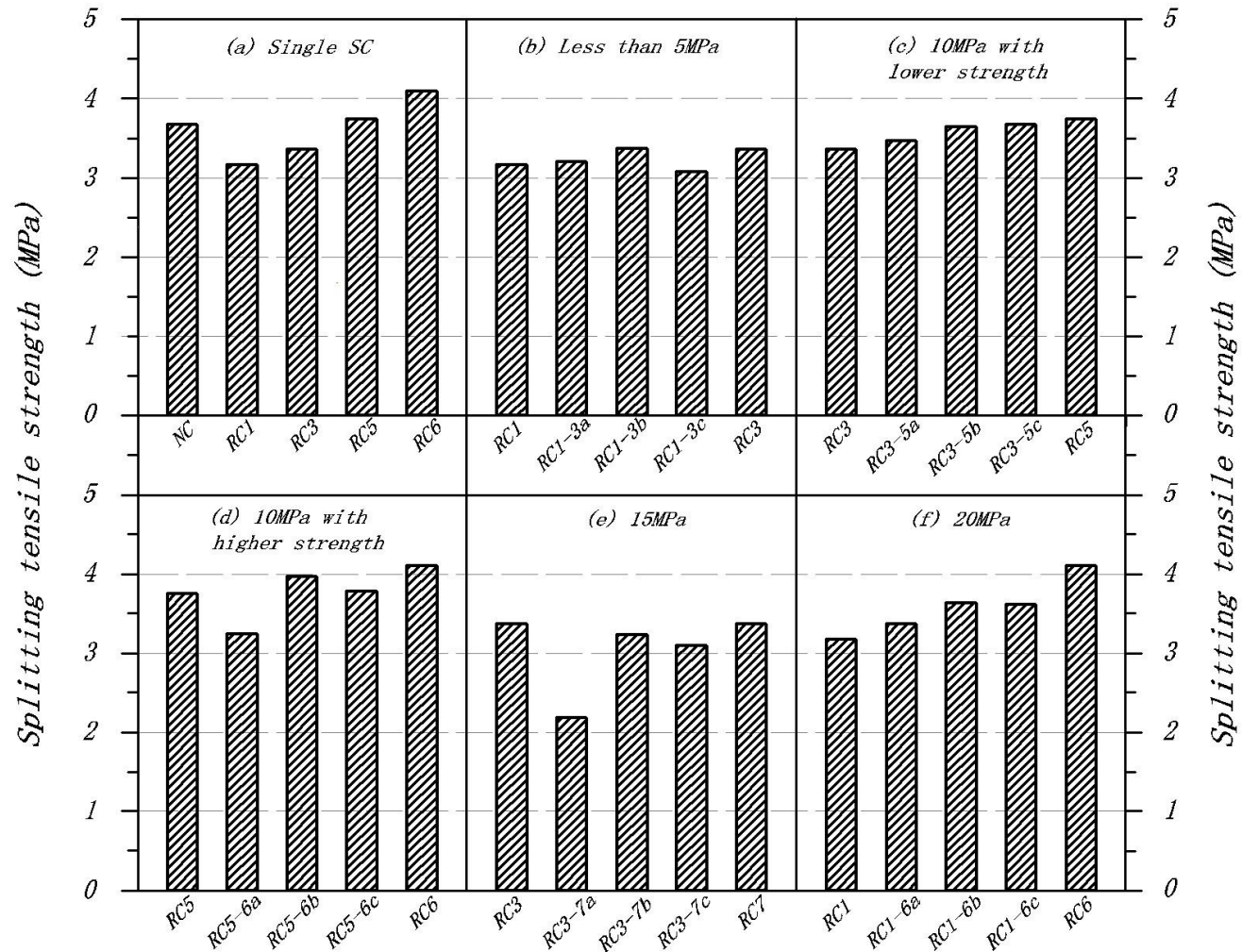
Results and discussion

Compression strength of recycled concrete



Experimental investigation

Splitting strength of recycled concrete



Experimental investigation

Law of measured strength: Single SC

- Tested strengths increase as the SCs' strength increase.
- The recycled concrete with CRCA from SC with strength 10MPa higher than the target strength, could reach the target compressive strength.

Experimental investigation

Law of measured strength: Mixed SCs

- When the two SCs' strengths are similar to target strength, the recycled concrete couldn't satisfy the strength requirement.
- When one of the SC strength is 10MPa higher than the target strength and the proportion of the higher strength SC is larger than 75%, the recycled concrete could achieve the target strength

Experimental investigation

Law of measured strength: Mixed SCs

- When the two SCs' strengths are both 10MPa higher than the target strength, no matter what the proportions of the two kinds of aggregates are, the recycled concrete could reach the target strength requirement.

Experimental investigation

Proposed mix design for C30 recycled concrete with 100% CRCA

- CRCA should be pre-wetted; dosage of all components are kept the same as those in natural concrete mix design.
- According to the strength difference and proportions of two strength SCs, the proposed weighted mean strength for a recycled concrete able to achieve the target strength is 43.1MPa.

Thanks !

Silane coupling agent KH-550

KH-550 used in recycled ceramic concrete

- The chemical bonding theory indicated that the Si-O bonds, which are generated in the process of the hydrolysis-condensation reaction, have 1 to 2 orders of magnitude's energy higher than the intermolecular attraction so that the interfacial bond strength is significantly enhanced.
- Alternative chemicals with similar properties but lower cost.

Silane coupling agent KH-550

KH-550 used in recycled ceramic concrete

- Ding X, Qi J, Fang W, Chen M, Chen Z. (2017). Improvement on properties of recycled concrete with coarse ceramic vase aggregates using KH-550 surface treating technology. *European Journal of Environmental and Civil Engineering*, DOI:10.1080/19648189.2017.1363664.
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