MASTER® BUILDERS SOLUTIONS

Technical Note

Using MasterSuna® RCT 323 Treated Recycled Concrete Aggregates (RCA) in Fresh Concrete Mixtures

C1. What are typical applications where we can use RCA in concrete?

Answer: Recommended applications: Slurry mixes, flowable fill (batch RCA on top of a flowable fill mix to reduce the amount of cementitious materials required), footers, pervious concrete, roller-compacted concrete, driveways, patios, temporary pavements, dunnage blocks, culverts, decorative concrete products (e.g., faux stone), planters, privacy screens and others.

C2. What verification do we need before putting RCA in concrete?

Answer: This will depend on the application and the job specifications. For example, a project may require a maximum drying shrinkage of 0.035% and a 28-day compressive strength of 4000 psi (27.6 MPa). In this case, it would be advisable to perform third-party validation for the proposed concrete mixture with and without a shrinkage-reducing admixture.

C3. What is the maximum aggregate replacement percentage that can be used?

Answer: Generally, replacement of 20% or less has shown minimal impact on concrete performance. With additional testing and mixture design adjustments, higher levels of replacement are possible.

C4. Are there any concerns using RCA in concrete?

Answer: Due to the increased absorption and porosity of RCA one should expect a shrinkage increase of 15-20% using a 20% total aggregate replacement. (See the article in the below link for additional information.)

https://ppms.trec.pdx.edu/media/project_files/Recycled_Concrete_Aggregates_pdf.pdf

Other concerns are, higher potential for alkali-silica reaction (ASR), residual chloride content, and potential for sulfate attack. RCA is not recommended for use in concrete in severe exposure environments. If these are concerns for your project, it is advisable to conduct testing before putting concrete into field applications.

C5. Do concrete trucks need to be rinsed with water or cleaned with an aggregate scrub?

Answer: It is always preferable to start with a clean drum, but in most cases, it is probably not necessary. If the subsequent batch is a short load, it may be advisable to take additional care in cleaning the drum.

C6. Does concrete containing RCA need to be chemically reactivated to get the desired performance?

Answer: No. Generally, performance shouldn't drop off dramatically with reasonable replacement levels.

C7. How do I adjust concrete mixtures to add RCA into the operation? Do I have to screen the RCA before using them?

Answer: It is not necessary to screen RCA before use in concrete. For design purposes, the specific gravity (SpG) of the recycled aggregate should be calculated as a weighted average based on the volumes of cement, supplementary cementitious materials, and coarse and fine aggregates (see examples below). To use RCA in concrete, the replacement should occur with both the coarse and fine aggregates. As a starting point, it is recommended to replace equal percentages of coarse and fine aggregates. It should be noted that for some applications, it may be desirable to replace different percentages of the different aggregates.

C8. Do you have data showing the concrete performance with different amounts of RCA?

Answer: Below you'll find some examples of straight cement mixtures and some with supplementary cementitious materials.

Example 1

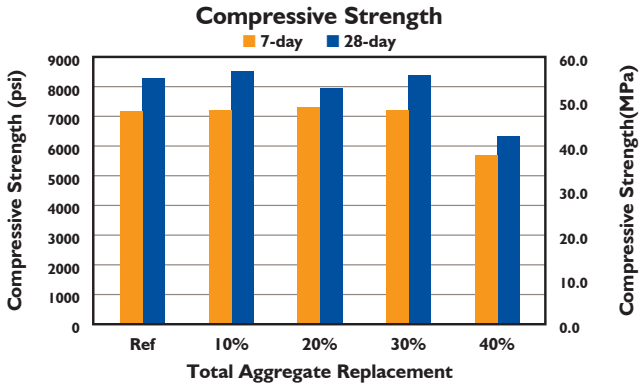
Mixture Proportions and Plastic Properties

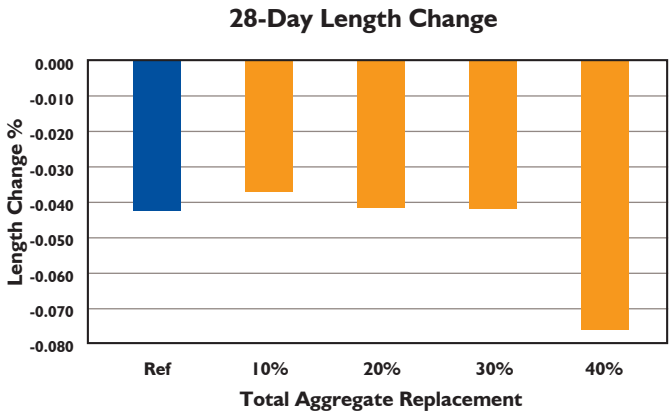
	Total Aggregate Replacement				
	Reference	**10%**	**20%**	**30%**	**40%**
Cement, lb/yd³ (kg/m³)	611 (360)	611 (360)	611 (360)	611 (360)	611 (360)
w/cm	0.42	0.42	0.42	0.42	0.42
Admixture Dosage					
MasterAir® AE 90, fl oz/cwt (mL/100 kg)	2.6 (170)	3.0 (195)	5.5 (360)	9.0 (585)	12.0 (780)
MasterGlenium® 7500, fl oz/cwt (mL/100 kg)	12.5 (815)	13.1 (855)	13.8 (900)	14.5 (945)	15.2 (990)
Plastic Properties					
Slump, inches (mm)	8.50 (215)	8.50 (215)	8.25 (210)	8.75 (220)	8.00 (205)
Air, %	5.9	5.5	5.2	5.9	5.6
Density, lb/ft³ (kg/m³)	148.6 (2380)	148.8 (2385)	146.8 (2350)	145.8 (2335)	144.9 (2320)

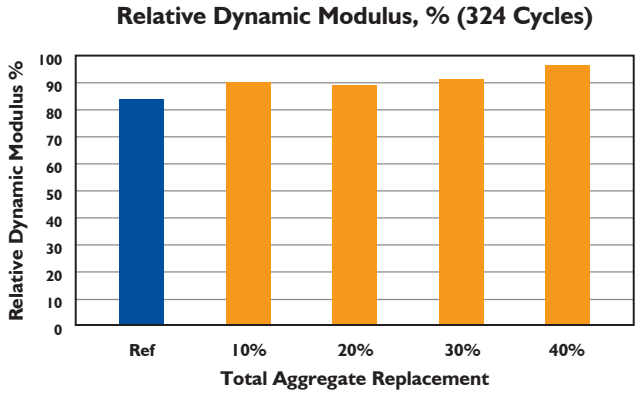
Reference concrete had a coarse aggregate content of 1750 lb/yd³ (1040 kg/m³)

Note: MasterAir® 90 is comparable to MasterAir® 200/210 which is sold in Canada.

The following graphs provide the comparison between the properties of reference concrete mixture versus mixtures with different aggregate replacement percentages.







Example 2

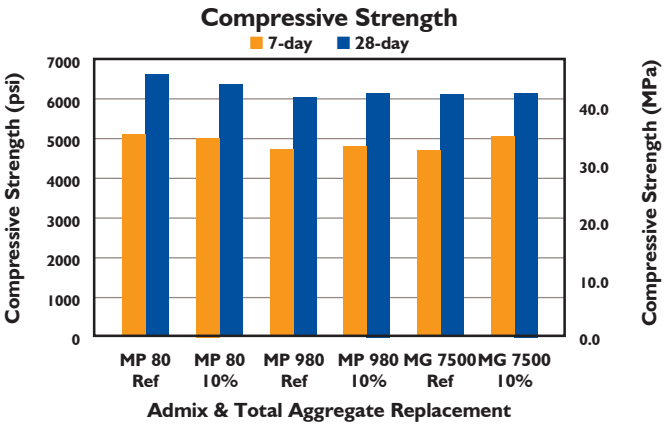
Mixture Proportions and Plastic Properties

	Total Aggregate Replacement					
	Reference	**10%**	**Reference**	**10%**	**Reference**	**10%**
Cement, lb/yd^3 (kg/m^3)	564 (335)	564 (335)	564 (335)	564 (335)	564 (335)	564 (335)
w/cm	0.55	0.55	0.55	0.55	0.55	0.55
Admixture Dosage						
MasterPozzolith® 80, fl oz/cwt (mL/100 kg)	4.0 (260)	4.0 (260)				
MasterPolyheed® 980, fl oz/cwt (mL/100 kg)			4.0 (260)	4.0 (260)		
MasterGlenium 7500, fl oz/cwt (mL/100 kg)					3.0 (195)	3.0 (195)
Plastic Properties						
Slump, inches (mm)	4.25 (110)	4.00 (100)	5.00 (125)	5.00 (125)	4.75 (120)	5.00 (125)
Air, %	2.8	2.7	2.6	2.8	2.7	3.6
Density, lb/ft^3 (kg/m^3)	147.0 (2355)	146.6 (2350)	147.2 (2360)	146.2 (2340)	148.0 (2370)	146.7 (2350)

Reference concrete had a coarse aggregate content of 1795 lb/yd^3 (1065 kg/m^3)

Note: MasterPozzolith® 80 is comparable to MasterPozzolith® 210 which is sold in Canada.

The following graph provides the comparison between the properties of reference concrete mixture versus mixtures with 10% total aggregate replacement and containing different admixtures.



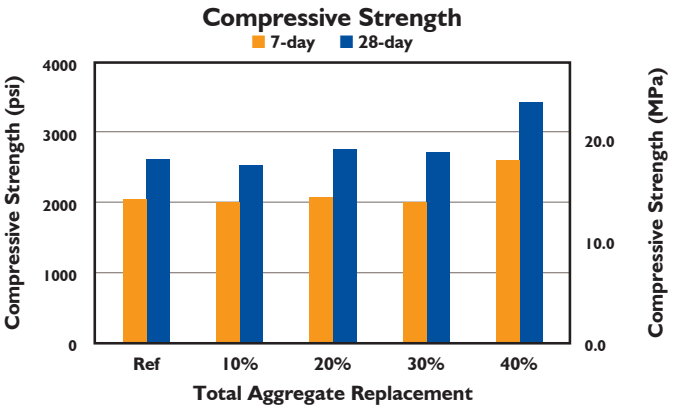
Example 3

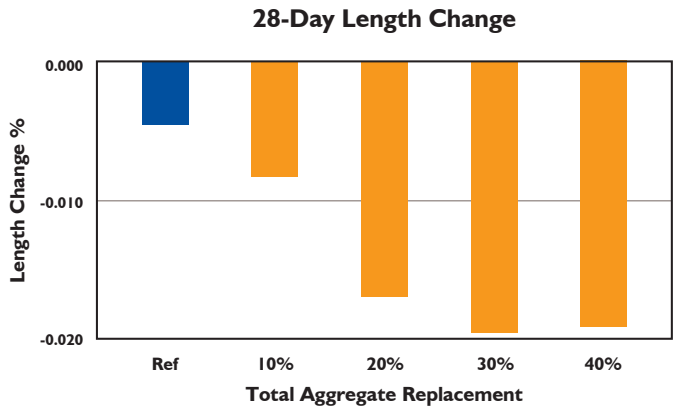
Mixture Proportions and Plastic Properties

	Total Aggregate Replacement				
	Reference	**10%**	**20%**	**30%**	**40%**
Cement Factor, lb/yd^3 (kg/m^3)	450 (265)	450 (265)	450 (265)	450 (265)	450 (265)
Class F Fly Ash, %	15	15	15	15	15
w/cm	0.57	0.57	0.57	0.57	0.57
Admixture Dosage					
MasterAir® AE 90, fl oz/cwt (mL/100 kg)	0.25 (15)	0.25 (15)	0.30 (20)	0.30 (20)	0.25 (15)
MasterPozzolith 80, fl oz/cwt (mL/100 kg)	2.8 (180)	2.9 (190)	3.0 (200)	3.2 (210)	3.2 (210)
Plastic Properties					
Slump, inches (mm)	8.50 (215)	8.50 (215)	7.25 (185)	6.50 (165)	1.75 (45)
Air, %	5.1	5.1	7.2	7.8	7.6
Density, lb/ft^3 (kg/m^3)	146.0 (2340)	143.6 (2300)	140.0 (2240)	137.9 (2210)	142.3 (2280)

Reference concrete had a coarse aggregate content of 1730 lb/yd^3 (1025 kg/m^3)

The following graphs provide the comparison between the properties of reference concrete mixture versus mixtures with different total aggregate replacement percentages.





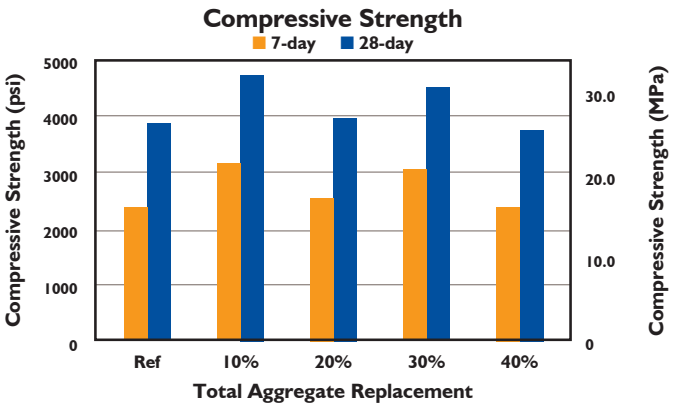
Example 4

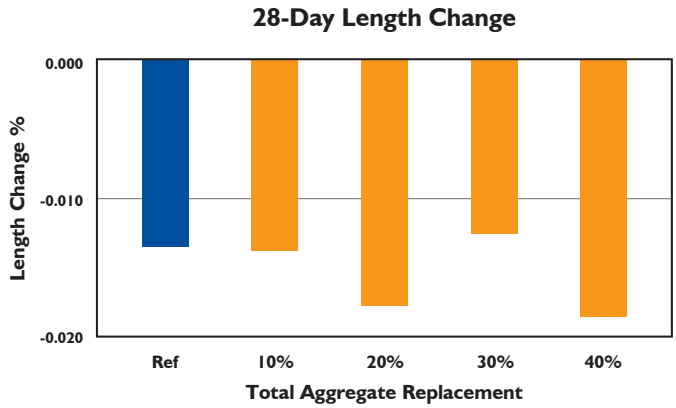
Mixture Proportions and Plastic Properties

	Total Aggregate Replacement %				
	Reference	**10%**	**20%**	**30%**	**40%**
Cement Factor, lb/yd^3 (kg/m^3)	450 (265)	450 (265)	450 (265)	450 (265)	450 (265)
Slag Cement %	15	15	15	15	15
w/cm	0.57	0.57	0.57	0.57	0.57
Admixture Dosage					
MasterAir AE 90, fl oz/cwt (mL/100 kg)	0.4 (25)	0.4 (25)	0.4 (25)	0.4 (25)	0.4 (25)
MasterPozzolith 80, fl oz/cwt (mL/100 kg)	2.2 (140)	2.2 (140)	2.50 (165)	3.5 (230)	4.8 (310)
Plastic Properties					
Slump, inches (mm)	8.00 (205)	4.75 (120)	7.00 (180)	2.50 (65)	5.25 (135)
Air, %	7.9	7.0	8.2	7.2	9.0
Density, lb/ft^3 (kg/m^3)	141.8 (2270)	144.0 (2305)	139.0 (2230)	141.8 (2270)	137.2 (2200)

Reference concrete had a coarse aggregate content of 1680 lb/yd^3 (1000 kg/m^3)

The following graphs provide the comparison between the properties of reference concrete mixture versus mixtures with different total aggregate replacement percentages.





Calculations & Recommendations

1. Developing an SSD RCA specific gravity (SpG) should be done using ASTM C127. If this isn't possible at the time, we know that RCA consists of cementitious materials, coarse aggregate, and fine aggregate. If you have the mixture proportions for the concrete used to produce the RCA, you can use the weighted volumetric average to estimate this value. If you don't have it, you can use the following approximation:

   RCA SpG = 0.85(Coarse Agg SpG) + 0.15(Fine Agg SpG)

2. Adjusted aggregate amounts are calculated by (1 – [Aggregate Replacement %/100])
3. RCA amount is calculated by (Aggregate Replacement %) x (Total mass of coarse & fine aggregates)

Example 5

Mixture Proportions and Plastic Properties

	Total Aggregate Replacement %			
	10	**20**	**30**	**40**
Compressive Strength	similar	similar	similar	similar
Drying Shrinkage	similar	similar	increased	increased

** Compared to a reference concrete*
RCA is not recommended for use in severe exposure environments.
If these are concerns for your project, it is advisable to conduct testing before putting concrete into field applications.

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