TB-1901 - CLARENA® RC40 Technical Bulletin

Additive to treat and reuse returned concrete as aggregate

CLARENA®RC40 is a patent pending bagged solid additive that converts returned (unused) plastic concrete into a hardened granular state that can be broken up and reused in fresh concrete as a partial replacement for fine and coarse aggregate. This granular material can also be used as a high quality compacted fill material for end uses including road base. CLARENA®RC40 is a single component environmentally friendly additive that is non corrosive, non-reactive, biodegradable and is fully compatible with all concreting materials. CLARENA®RC40 is packaged in bales, and is typically dispensed by hand or with a commercially available blower into a slowly revolving concrete drum containing returned concrete, at a dosage rate of 30-50 pcy. The drum is then charged for a minimum of 3 minutes (or 1 minute per cubic yard) at 10-15 rpm, after which the recycled material is discharged onto the ground, ideally at 8-10 rpm. A front end loader (or other suitable equipment) is used to break up and recombine the piles of recycled material typically within 24 hours after it was made (preferably around or just prior to initial time of set). The recycled granular material can now be loaded into bins, conveyed through the plant and reused as a partial replacement for fine and coarse aggregate in fresh concrete. This Technical Bulletin details results from two CLARENA®RC40 field tests and includes physical property comparison of recycled fine and coarse granular material compared to reference fine and coarse aggregate.

CLARENA® RC40 Northeast Region Field Test

Three 4 yd^3 batches of 4000 psi design (611 pcy cement factor) concrete were batched, mixed and tested at a Northeast Region ready mix concrete producer. Plastic and hardened concrete test results showed the 3 mixes were similar with approximate 5" slump, 2.5% plastic air, and 5000 psi 28 day compressive strength. Next, CLARENA®RC40 was dispensed using a blower into slowly revolving mixer drums at 3 dosage rates- 40, 56 and 72 pcy. The material was then mixed at charge speed for 3 minutes and discharged onto the ground. The following morning, a front end loader was used to break up and recombine the piles of recycled material. The returned concrete was now converted into a recycled granular material that can be reused as coarse and fine aggregate in fresh concrete. Referring to the right hand column of Table 1 below, as CLARENA®RC40 dosage rates increased from 40-72 pcy, the time and effort it took the front end loader to break up the recycled material into usable recycled granular material decreased.

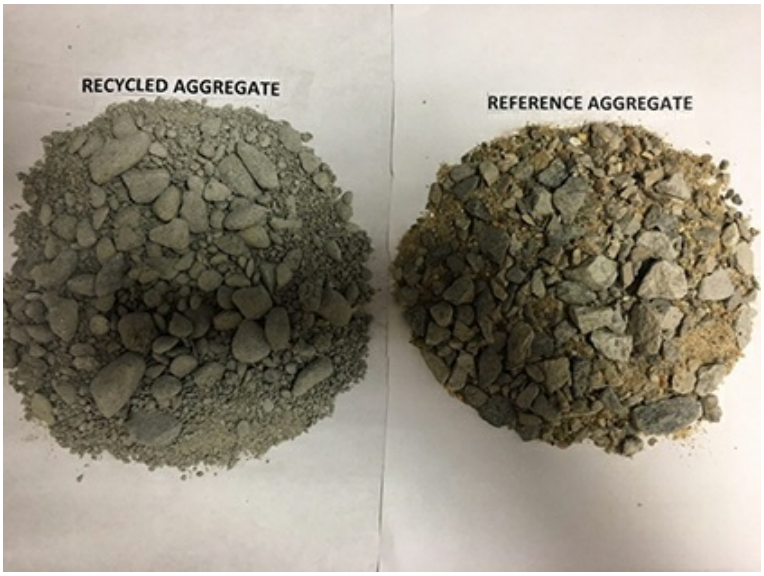
Table 1- Reference and recycled granular material properties

Coarse aggregate specific gravity (SG)	Fine aggregate specific gravity (SG)	Coarse aggregate absorption (%)	Fine aggregate absorption (%)	Combined gradation fineness modulus (FM)	Coarse aggregate fineness modulus (FM)	Fine aggregate fineness modulus (FM)	Ease of breakup with loader next day (scale 1-10, 1- easiest to 10- hardest)

Reference aggregate (3/4", 3/8", FA)	2.6	2.6	<1.0	<1.0	4.53	3/4"- 6.62, 3/8" -5.51	2.07	N/A
40 pcy CLARENA RC40	2.67	2.58	4.96	10.07	5.43	6.66	3.48	5
56 pcy CLARENA RC40	2.69	2.58	3.6	10.86	4.6	6.65	3.08	3
72 pcy CLARENA RC40	2.69	2.54	3.47	10.74	4.84	6.67	3.14	1

Table 1 above details specific gravity (SG), fineness modulus (FM) and absorption test results for reference 3/4"coarse , 3/8" coarse and fine aggregates and the 3 samples of 40, 56 and 72 pcy CLARENA®RC40 recycled granular material. Note that the recycled material was split into two samples representative of typical coarse and fine aggregate. Test results revealed all reference and recycled granular material fine and coarse aggregate specific gravities were in the same range (2.6 +-0.1%). Absorption values (%) for recycled granular coarse aggregate averaged 4%, absorption values for recycled granular fine aggregate averaged slightly >10%, while reference fine and coarse aggregate absorptions were < 1%. Recycled granular coarse aggregate fineness modulus (FM) was similar compared to reference coarse aggregate FM, while recycled granular fine aggregate FM was coarser (>3.0) compared to reference fine aggregate FM (2.07). Figure 1 below depicts representative combined gradation samples of the tested reference and recycled granular aggregates.

Figure 1- Recycled granular material and Reference aggregate



Referring to mixes 1-3 of Table 2 below, the same mix design that was used in the testing detailed above was used to test modified mixes containing recycled granular material. Mix 2 replaced 200 pcy (100 pcy FA, 75 pcy 3/4" CA, 25 pcy 3/8" CA) reference aggregate with 200 pcy recycled granular material while Mix 3 replaced 400 pcy (200 pcy FA, 150 pcy 3/4" CA, 50 pcy 3/8" CA) reference aggregate with 400 pcy recycled granular material. W/C ratios were kept constant at 0.47 for the 3 mixes. As detailed in Table 2 below, plastic and hardened concrete property test results show similar performance when comparing reference mix 1 to 200 pcy and 400 pcy recycled granular material mixes 2 and 3. It was noted plastic airs slightly increased and water demand (as reflected by lower slumps) slightly increased as recycled granular material quantities increased. Also, air entrained 200 pcy recycled granular material mix 4 showed stable air over 60 minutes and excellent air void quality. After testing was completed, all the mixes were placed and finished as slab on grade concrete in the ready mix plant's yard. It was noted the finishing contractor did not observe any significant differences in placeability or finishability between any of the mixes.

Table 2- Reference vs 200 pcy and 400 pcy replacement with recycled granular material

	Mix 1- Reference	Mix 2- 200 pcy recycled material	Mix 3- 400 pcy recycled material	Mix 4- 200 pcy recycled material (air entrained)
Cement (pcy)	595	607	598	553
ADVA 140M (oz/cwt)	3	3	3	3
Darex II AEA (oz/yd)				2
3/4" Coarse Agg. (pcy)	1263	1191	1100	1084
3/8" Coarse Agg. (pcy)	450	425	394	392
Fine Aggregate (pcy)	1355	1259	1131	1147
Recycled Material (pcy)	0	200	390	229
Total aggregate weight (pcy)	3068	3075	3015	2852

Water (pcy)	277	283	282	258
W/C ratio	0.47	0.47	0.47	0.47
Slump (")	6	5.5	4.75	7,5,5, (0,30,60 min)
Plastic air (%)	2.5	2.4	3	8.8, 7.8, 7.5
Unit Weight (pcf)	145.9	146.9	144.3	135.6,137.8,138.8
Initial Time of Set (hrs:min)	07:05	06:50	06:35	
7 day compressive str.(psi)	4311	4442	4320	2710
28 day compressive str. (psi)	4982	5586	4822	3414

CLARENA® RC40 Midwest Region Field Test

Five 3yd^3 batches of 4000 psi design (550 pcy total cementitious) concrete were batched, mixed and tested at a Midwest Region ready mix concrete producer. Plastic and hardened concrete test results revealed the mixes were similar, all 5 had approximate 7.5" slump, 1.7% plastic air, and 5500 psi 28 day compressive strength. Referring to Table 3, CLARENA®RC40 was then dispensed using a blower into slowly revolving mixer drums using 5 dosage rates- 21, 32, 43, 53 and 64 pcy. The material was then mixed at charge speed for 3 minutes and discharged onto the ground in two distinct piles identified as "Pile 1" and "Pile 2". "Pile 1" was worked/recombined with a front end loader same day (3-6 hours after batching), while "Pile 2" was worked/recombined the next morning. Referring to the 2 right hand columns of Table 3, as CLARENA®RC40 dosage rate increased from 21-64 pcy the time and effort it took the front end loader to break up the recycled material into a usable granular aggregate type form decreased. Also, for all CLARENA®RC40 dosage rates, it was easier to break up the piles same day around initial time of set compared to breaking up the piles the next morning.

Table 3- Reference and recycled granular material properties

CLARENA RC40 dosage rate (pcy)	Time after batching pile 1 worked with loader	Pile 1- Ease of breakup with loader same day (scale 1-10, 1-easy, 10-hard)	Pile 2- Ease of breakup with loader next day (scale 1-10, 1-easy, 10-hard)
21	3 hours 15 min	8	9
32	6 hours	1	5
43	6 hours	1	4
53	5 hours 30 min	1	3
64	4 hours	1	1

The same mix design detailed above was used to test modified mixes replacing 0,400, 800 and 1600 pcy reference aggregate with recycled granular material. W/C ratios were again kept constant at 0.47. Referring to mixes 1-3 in Table 4 below, plastic and hardened concrete properties for mixes with 400 and 800 pcy recycled granular material replacement showed similar overall performance when compared to reference mix 1. However, very high 1600 pcy replacement levels of reference aggregate with recycled granular material (mix 4) resulted in higher plastic air and significantly lower 7 and 28 day compressive strength. The test mixes were placed and finished as slab on grade concrete in the Ready Mix plants yard and the finishing stated he preferred the finishing properties of the mixes containing recycled material compared to reference concrete mix 1.

Table 4- Reference vs 400, 800, 1400 pcy replacement with recycled granular material

	Mix 1- Reference	Mix 2- 400 pcy recycled material	Mix 3- 800 pcy recycled material	Mix 4- 1400 pcy recycled material
Cement (pcy)	452	471	443	413
Fly Ash (pcy)	75	85	75	70
ZYLA 640 (oz/cwt)	3	3	3	3
#57 gravel Coarse Agg. (pcy)	1708	1466	1381	934
Fine Aggregate (pcy)	1270	1229	965	727
Recycled Material (pcy)	0	400	751	1410
Total aggregate weight (pcy)	2978	3095	3097	3071
Water (pcy)	251	258	244	225
W/C ratio	0.477	0.465	0.471	0.465
Slump (")	7.5	6	5	5.75
Plastic air (%)	1.8	2.5	2.4	3.1
Unit Weight (pcf)	147.2	144.8	143	140
7 day compressive str. (psi)	3582	3403	3493	2438
28 day compressive str. (psi)	5015	5055	4936	3682

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gcpat.com/solutions/products/clarena-rc-returned-concrete-management-solutions/tb-1901-clarena-rc40-technical