Recycled Concrete Testing

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Introduction

The manufacturing of concrete is fundamental to the construction industry since its relatively accessible and possesses favorable features. Even though the structural integrity of concrete remains constant over time, discarding unwanted material is a major problem for the industry[1]. Environmentalists and industrialists have suggested the incorporation of former concrete material in new batches, promoting sustainability measures and decreasing costs for manufacturers[2].

Project Objective

The primary objective of the project is to explore the possible effects and applications of recycled concrete aggregate (RCA). This entails the analysis of compressive strength data of concrete cylinders.

Design Breakdown

Aggregate and mix design specifications were provided by Upstone Material of Northern NY. Batch developments are intended to have a compressive strength of 4,000-psi and a 0.45 water: cement ratio.

Table 1: Concrete Batch Preparations			
Concrete Components	Batch 1 (Control)	Batch 2 (25% RCA)	Batch 3 (50% RCA)
Coarse Aggregate (lb)	96.04	72.03	48.02
Fine Aggregate (lb)	74.23	74.23	74.23
Recycled Aggregate (lb)	0.00	24.01	48.02
Type I/II Cement (lb)	33.25	33.25	33.25
Water (lb)	16.57	16.57	16.57
Water Reducer (mL)	29.47	29.47	29.47
Air-Entrainment (mL)	5.03	5.03	5.03

Table 1: Batch 2 and 3 depict percent replacements of CA with RCA

*** Absorption and Moisture Content are Adjusted for Coarse Agg. Only***

Figure 1: Aggregate Materials

Aggregate Comparisons

Coarse Aggregate (Left)

- Obtained from localized quarries
- SG_{Bulk} = 2.70 , Absorption = 0.89%
- Dry Unit Weight = 104.60 lb / ft^3

Recycled Concrete Material (Right)

- Excess or surplus concrete (crushed)
- SG_{Bulk} = 2.34 , Absorption = 5.79%
- Dry Unit Weight = 89.4 lb/ ft^3

Quality Assurance Tests

Air-Content (ASTM C231)[3]

- Effects the age-hardening of concrete
- Impacts concrete abilities to withstand freeze-thaw

Slump (ASTM C143)[3]

- Indicates the consistency or workability of concrete
- Superplasticizers may require the need for spread diameters

Unit Weight (ASTM C138)[3]

- Used to calculate the volume of concrete produced

Figure 2: Air-content and Slump Tests

Table 2: Fresh Concrete Measurements			
	Batch 1	Batch 2	Batch 3
Air-Content (%)	2.5	2.4	4.5
Average Slump (in)	3.08	1.08	0.25
Unit Weight (lb/ft^3)	156.52	158.6	153.84

Table 2: Fresh Concrete Measurements

Compressive Strength Procedures

Compressive Strength Testing Dates

- Performance dates proceed initial batch preparations
- Dates include 7, 21, and 28 days

Concrete Cylinders

- 9, **four-inch diameter cylinders** were prepared for each batch
- 3 cylinders from each batch were tested on the specified dates

Figure 3: Avg Diameter Measurement

Figure 4: Concrete Loading Test

Compressive Strength Analysis

Compressive Strength = (Load Development) / (Area Subjected to Load)

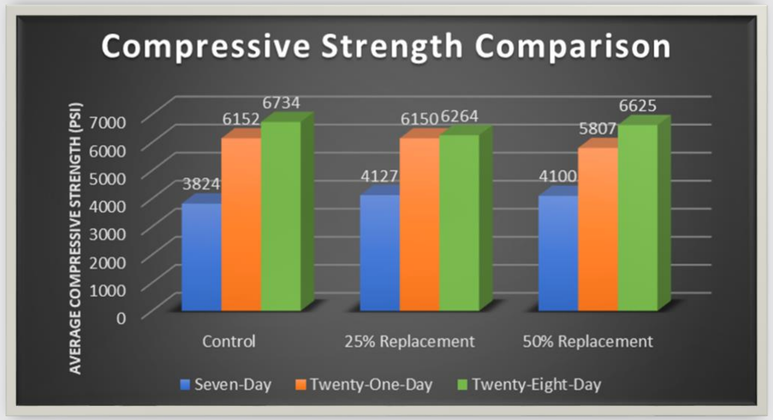

Figure 5: Compressive Strengths of Concrete Batches

Batch Three Break Patterns (Example)

- 7 Day (Left) ~ Localized Shearing
- 21 Day (Middle) ~ Localized Shearing
- 28 Day (Right) ~ Columnar Break

Figure 6: Batch 3 Break Patterns

Conclusion

Average compressive strengths were used to evaluate the effects of RCA implementations. Measurements indicated that batches two and three resulted in similar strength outputs as the control, per standard deviation considerations. The preliminary assessment does not factor in water adjustments when incorporating RCA, therefore, initial findings should not be the sole basis for determining whether RCA impacts the current structural characteristics of manufactured mixes.

References

1. *Reclaimed Concrete Material*. (n.d). USDOT. Retrieved on March 11, 2022, from www.fhwa.dot.gov/publications/research/infrastructure/structures/97148/rcc1.cfm#:~:text=Reclaimed%20concrete%20material%20(RCM)%20is,by%20a%20hardened%20cementitious%20paste

2. *Recycled Aggregate*. (n.d.). PCA - American Cement Manufacturers. Retrieved on March 11, 2022 from www.cement.org/learn/concrete-technology/concrete-design-production/recycled-aggregates

3. Rygel, Adrienne. (2018). *CONS 280 Civil Engineering Material Laboratory Manual*. SUNY Canton