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Capstone Report

Algae Brick Making Capstone Project

Concept/Abstract:

The University of Maryland is participating in a study using controlled algal growth using Algal Turf Scrubber (ATS) technology to remove nutrients from our waterways. This process results in large amounts of algal biomass growth, requiring harvest. This biomass currently has little use, and is landfilled. Given the high ash content of algae one such use is potentially as a filler material within a concrete mixture. The purpose of this research is to determine the suitability of this usage, as well as optimal ratios of concrete to algae that uses the most algal biomass while still maintaining the structural integrity of concrete. The properties tested being compression strength, as well as weathering resistance. Successful findings will enable ATS technology to scale operations to treat larger bodies of water more effectively.

Methods

Dried algae from the Port of Baltimore algal turf scrubber was processed into dry powder. The powdered algae was mixed into the concrete based on percent dry volume. The concrete was made in accordance with ASTM C31, the standard practice for making and curing concrete specimens. The concrete was placed in cylinders that were 4” by 8”. The concrete was packed in using a ¾” diameter tamping rod. 6 replicated were poured for each mixture, with 3 samples cured for 7 day strength testing and 3 for 21 day testing. Additional samples were poured for select mixtures to submerge in water for weathering testing. These samples would be weighed weekly. Finally the cylinders were taken to the civil engineering laboratory at the University of Maryland, College Park to test the strength, pounds per square inch, using a

hydraulic press that would calculate the force based on when the press was able to crack the concrete.

Results

After curing our first set of cylinder for 28 days we recorded the weight using a digital scale. The mass of each cylinder in grams, and mean values for each mixture can be found in Table 1. The mass of each cylinder is graphed on Figure 1. The graph showing mass indicates that mass is increased as the percentage of concrete is increased. The mean values of mass are also included with a line of best fit. During the first round of testing we used the hydraulic press to find the strength of different mixtures with up to 35 percent algae. The pound per square inch strength of each cylinder is recorded in Table 1 along with the mean values for each mixture. The cylinder strength is graphed in Figure 2. Figure 2 show that strength is increasing as the percentage of concrete increases

Table A: Algae Concrete Cylinder Data 28 Day Cure

Percentage of Concrete	Mass of cylinder, grams				Strength of cylinder, psi			
	Sample A	Sample B	Sample C	Mean	Sample A	Sample B	Sample C	Mean
100%	3861.72	3802.32	3847.32	3837.12	1531.4	1525.1	1645.3	1567.3
99%	3763.22	3788.12	3827.32	3792.89	1506.1	1392.2	2025.0	1641.1
98%	3784.52	3782.92	3806.52	3791.32	1518.8	1328.9	1645.3	1497.7
97%	3774.32	3761.62	3828.72	3788.22	1202.3	1518.8	1107.4	1276.2
96%	3678.92	3749.22	3746.72	3724.95	1265.6	1278.3	1278.3	1274.1
95%	3724.22	3648.32	3763.52	3712.02	1518.8	1139.1	N/A	1328.9
93%	3563.02	3749.42	3676.42	3662.95	759.4	822.7	822.7	801.6
91%	3637.72	3671.02	3670.32	3659.69	885.9	1012.5	1012.5	970.3
89%	3660.12	3569.92	3638.32	3622.79	822.7	632.8	791.0	748.8
87%	3537.02	3450.42	3445.12	3477.52	759.4	506.3	759.4	675.0
85%	3422.02	3489.42	3502.22	3471.22	727.7	594.8	759.4	694.0
75%	3435.32	3310.62	3385.52	3377.15	253.1	278.4	N/A	265.8
65%	3074.82	3131.62	3145.82	3117.42	Not tested, material did not cure			N/A

Figure 1: Cylinder Mass

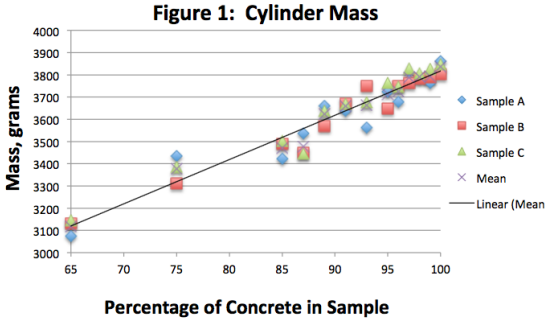
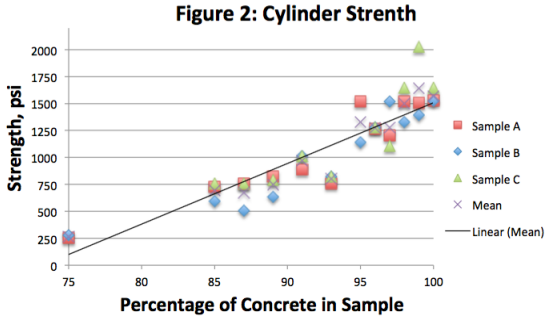


Figure 2: Cylinder Strenth



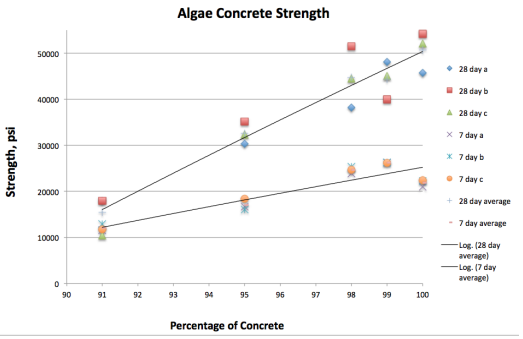
The second round of testing was completed in the civil engineering lab with more precise equipment. We created cylinders with up to nine percent algal biomass volume which were cured for either seven or twenty-eight days before testing. The pounds per square inch strength

of each cylinder and average strength of each mixture is recorded in Table 2. The results from these cylinders are graphed in Figure 3. In Figure 3 we can see two data groups with an increasing trend. The upper group represents the cylinders cured for twenty-eight days and the lower group represents the cylinders cured for 7 days. In both cases we can see that the strength is increasing as the percentage of concrete increases.

Table 2

Algae Concrete Cylinder Strength Testing					
		Strength, psi			
Days Cured	% Concrete	Sample A	Sample B	Sample C	Average
28	100	45740	54190	52090	50673
28	99	48100	39970	45060	44377
28	98	38200	51500	44470	44723
28	95	30300	35150	32330	32593
28	91	17950	17930	10420	15433
7	100	20970	22240	22400	21870
7	99	26210	26260	26170	26213
7	98	23910	25330	24660	24633
7	95	16670	16050	18370	17030
7	91	11560	12880	11750	12063

Figure 3



Discussion

We learned with our two strength tests the viability of dried algae as a filler material for concrete. We aimed to find the ideal mixture that gives the most environmental benefit (larges amount of algae) while having an adequate amount of strength. We found that the amount of algae which is be added is limited by a loss of strength. At this time we would not recommend load bearing usage of this material, further testing will be required. The material is suitable for non-load bearing items such as the turtle stepping stones. In order to use this building material in load bearing applications many more tests need to be run. The material must be tested in wet conditions, with different strength tests, and durability test to name a few. The material has a potential to become an green business. These items could be marketed as an eco-friendly product in addition to the decorative and functional use.