The Effects of Recycled Additives in Concrete

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Abstract

This research reviews the benefits of varying environmentally friendly, recycled additives to concrete cylinders for the purpose of performing standard compression and tensile tests. Because of the harmful greenhouse gases released upon concrete creation, the use of recycled aggregates and additives lessens potential negative environmental impacts. By combining cement, fine aggregate, coarse aggregate, and water, six concrete cylinders were created. Such cylinders are listed as follows, with names deriving from the recycled additive: Control, Nails, PVC, Brush Fibers, Fibers. Before testing, cylinders were cured in a water bath. Results from testing indicate that the control group performed the worst under compression testing with a value of 1211.2 psi, while the brush fibers performed the best with a value of 2097.7 psi. Results from split tensile testing indicates the control group performed the worst, with a strength of 125.3 Pa, while the brush fibers performed the best, with a value of 238.7 Pa. For future concrete mixtures seeking high compression and tensile strength values, it is suggested to use recycled brush fibers as an additive.

Introduction

As one of the most common construction materials in the world, concrete has made a significant impact on both engineering and the environment. This extreme usage introduces thousands of tons of greenhouse gases into the atmosphere (Naik). As recent research is focusing on the harmful impacts of greenhouse gases on the Earth's climate, evidence shows the dire need for sustainable concrete development. If recycled materials can be utilized in the production of concrete, overall energy consumption and release will significantly lessen. The use of cementitious materials and "green" aggregates can decrease undesired air pollution and health concerns associated with creating basic Portland cement. Aggregate additives, such as bristles, fibers, nails, and rubber, are all materials that can easily be recycled. Through the increased use of recycled aggregates, sustainable mix development, and resource preservation, concrete production can aim to decrease the stunning yearly 8 billion tons of required natural materials.

Procedure

In order to test the effect of using recycled materials, PVC, nails, nylon fibers, and brush bristles were used as environmentally-friendly additives. To begin, a standard mix of concrete was prepared with a cement mixer, using 57 lbs. cement, 157 lbs. coarse aggregate, 60 lbs. fine aggregate, and 28 lbs. water. The mix was then separated into five smaller batches, where recycled additives were hand-mixed in. One batch contained no new additives, acting as the control group, while the other four groups had additives included. Due to similar densities, fibers, bristles, and PVC were added in equal amounts to the according batches. Steel nails were added in with a smaller amount, due to the high density of the material. After all of the proper batches were prepared, cylinders were created in accordance with ASTM C31. After curing cylinders were properly tested in accordance with ASTM standards. To understand the relationship between strength and the various additives, compression and tensile testing was performed. Through testing, the compressive and split tensile strengths were measured.

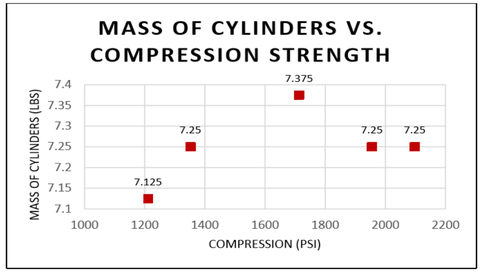
Testing Pictures

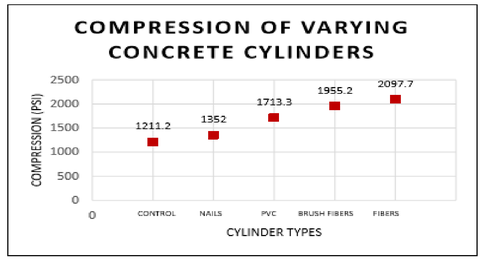
Control Testing

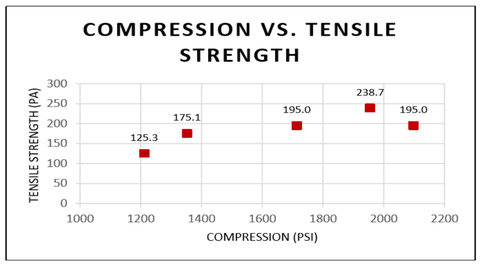
Brush Fiber Testing

Results

Using ASTM C39 Standards for Concrete Cylinder Compression Testing, the various compression pounds per square inch values were determined for the six concrete cylinders. It can be noted that after testing, the concrete cylinders can be ranked, with increasing compression values, in the following order: Control, Nails, PVC, Brush Fibers, Fibers. Following ASTM C496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens, the various tensile values were recorded in pounds. After calculating tensile strength, the concrete cylinders can be ranked, with increasing tensile strength values, in the following order: Control, Nails, PVC/Fibers, Brush Fibers. When comparing 10% compression values with calculated tensile strengths, values are similar with a 15% averaged difference. As a result, concrete cylinder creation methods and testing standards are verified for validity.







Conclusions

Prior to testing, it was hypothesized that the concrete cylinder with nails would perform the best under compression and tensile testing, as the nails would act similar to reinforcing rebar. However, after testing it can be observed that the nails did not perform well in both compression and tensile tests, ranking as the second weakest cylinder out of the six total cylinders. It is possible that this poor performance may be due to the shape and weight of the nails. Rather than being deformed like typical rebar, the nails were kept in unused condition, potentially making it difficult for the concrete to bond well to the metal nails. It is also possible that segregation occurred due to the heaviness and thickness of the nails, causing localized stress. It was not anticipated that the brush fibers would perform as well as data indicates, making them useful for concrete mixtures seeking strong tensile values.

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