Recycling Turbine Blade Composites: Concrete Aggregate and Reinforcement

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Introduction

Making wind energy economically feasible will require a process that addresses the end-of-life plan for the large amount of composite blade materials being used to support the rapid build-out of wind energy expected by 2030.

Waste fiberglass in landfills presents a solid waste/environmental concern and does not take advantage of new product creation through recycling.

Previous studies have shown that fiber reinforced plastic (FRP) materials added to concrete in low quantities can improve energy absorption and decrease crack propagation. [1]

Methods

In this research project, FRP materials are added to concrete mix in different quantities, cast as cylinders, and are cured for seven days. Materials were cut to size from waste fiberglass and glass fabric.

Concrete cylinders containing a different test material will undergo compression tests and strain vs. stress analysis. Two casts are tested for each material.

FRP Materials included:

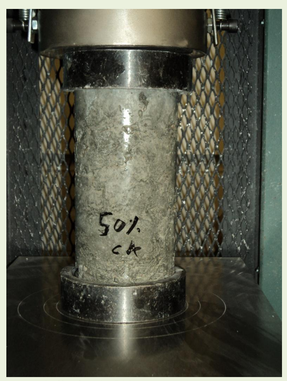
-Fiberglass cubes (½") as a 50% and 100% coarse aggregate component substitution.
-Glass fibers from glass fabric (1% and 2% vol.)
-Fibers from pyrolyzed fiberglass (1% vol.)
-Fiberglass strips (1% glass volume)
(Fibers and strips were between 1" and 1.25" long)

Current Results

Percent of Control Group Compression Strength			
50% aggr.	100% aggr.	1% fiber	2% fiber
62.3%	32.2%	61.2%	48.5%

FRP Coarse Aggregate

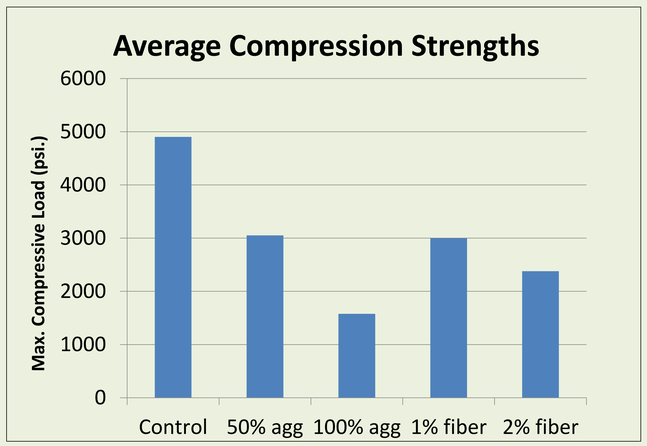
Glass Fiber



Test Cylinder (50% coarse Aggregate)

Exposed FRP aggregate cubes

2% fiber test cylinder with fiber clump.



Discussion and Conclusions

-In this experiment, lower volumes of FRP materials yielded higher compression strengths.

-Clumps of fibers due to inadequate mixing increased number internal weaknesses. Fractures usually occurred near large clumps of fibers.
Effective mixing will be crucial to effective testing and utilization of fibers in concrete.

- Poor cement bonding to flat resin surface on aggregate may mean that the material acted more as a foreign object than a reinforcement.

-The high surface area of FRP coarse aggregate was not sufficiently covered in cement paste. Surface and internal voids and irregularities may have led to lower compression strength

- Adding fibers increased observed ductility. Slower and smaller breaks were noticed with glass fiber samples. Fibers improved energy absorption and prevented the usual sudden break observed with the control groups.

Future Work

-New aggregate mix design to increase cement coverage.
-Improve uniform mixing with fibers
-Analysis with stress vs. strain, force vs. displacement, and energy absorption.

References

[1] Y. Wang, H. C. Wu, V.C. Li, "Concrete reinforcement with recycled fibers," *Journal of Materials in Civil Engineering*, 314-319, 2000.

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