Carbon-Negative Foundation Materials for Wind Energy Generation

Michael Supple, Dr. Richard E. Riman, Noemie Denis, Paul Antonick

RUTGERS

THE STATE UNIVERSITY OF NEW JERSEY

INTRO

Many wind turbines rely on concrete for their foundations and towers. Concrete is the most used material by volume globally and accounts for 8% of global CO_2 emissions. By utilizing carbon-neutral or carbon-negative materials, we can reduce these emissions. To address this, a wollastonite-based cementitious material was investigated in this study. This material sequesters CO_2 during its curing process and is believed to be a competitive alternative to concrete. The objective of this project was to create a sustainable material with comparable compressive strength performance to concrete.

METHODS

A cast process was designed to create high density wollastonite-based composite pieces with comparable compressive strengths to concrete. To achieve this, a higher packing fraction was targeted by using multiple particle size modes and using a densifying curing step. During curing, wollastonite permanently sequesters CO_2. Throughout this process, the density and the compressive strength of the cast and cured pieces will be recorded.

RESULTS

The most dense pieces were the cured 70% Wollastonite by volume, as expected, and the density was found to be 2.088g/cm^3. Generally, more dense pieces had higher compressive strengths. Although 70% wollastonite by volume had the highest density, 80% wollastonite by volume had the highest compressive strength by 48.8%. These pieces were able to reach the compressive strength goals set of 15-30 MPa. The average compressive strength of the 80% wollastonite by volume pieces was 30 MPa.

DISCUSSION

Although these pieces were able to achieve the set goals, they may be able to further exceed them. There are many variables in the casting and curing processes that may be adjusted such as water content, drying, times and temperatures. Also, the uniformity of the slurries should be evaluated to verify proper mixing of the powders and calcimetry, to quantify the CO_2 sequestration of these pieces.

AUTHOR AFFILIATIONS: Rutgers University

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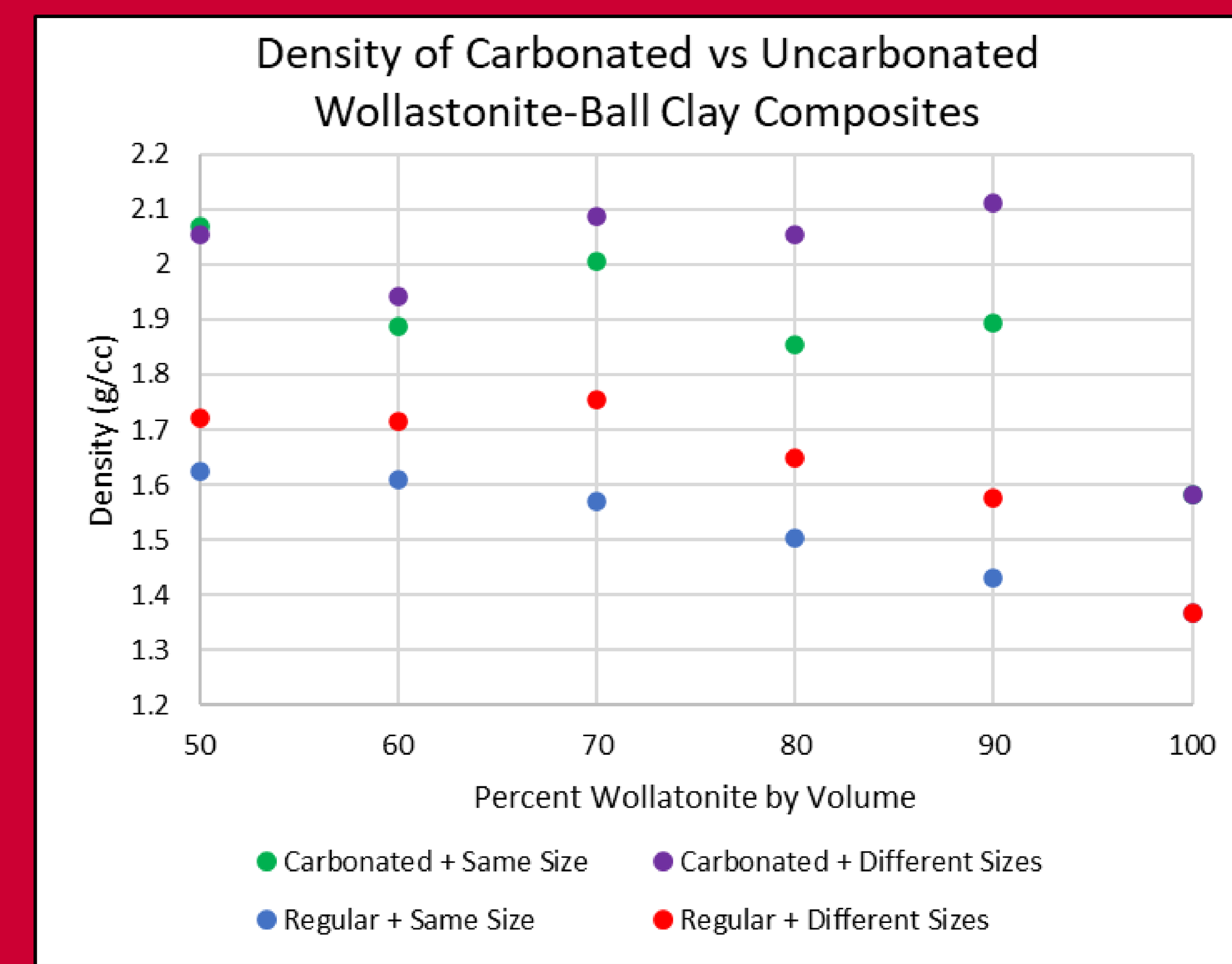

Fig. 1: Densities of pieces of different conditions at multiple stages of the process

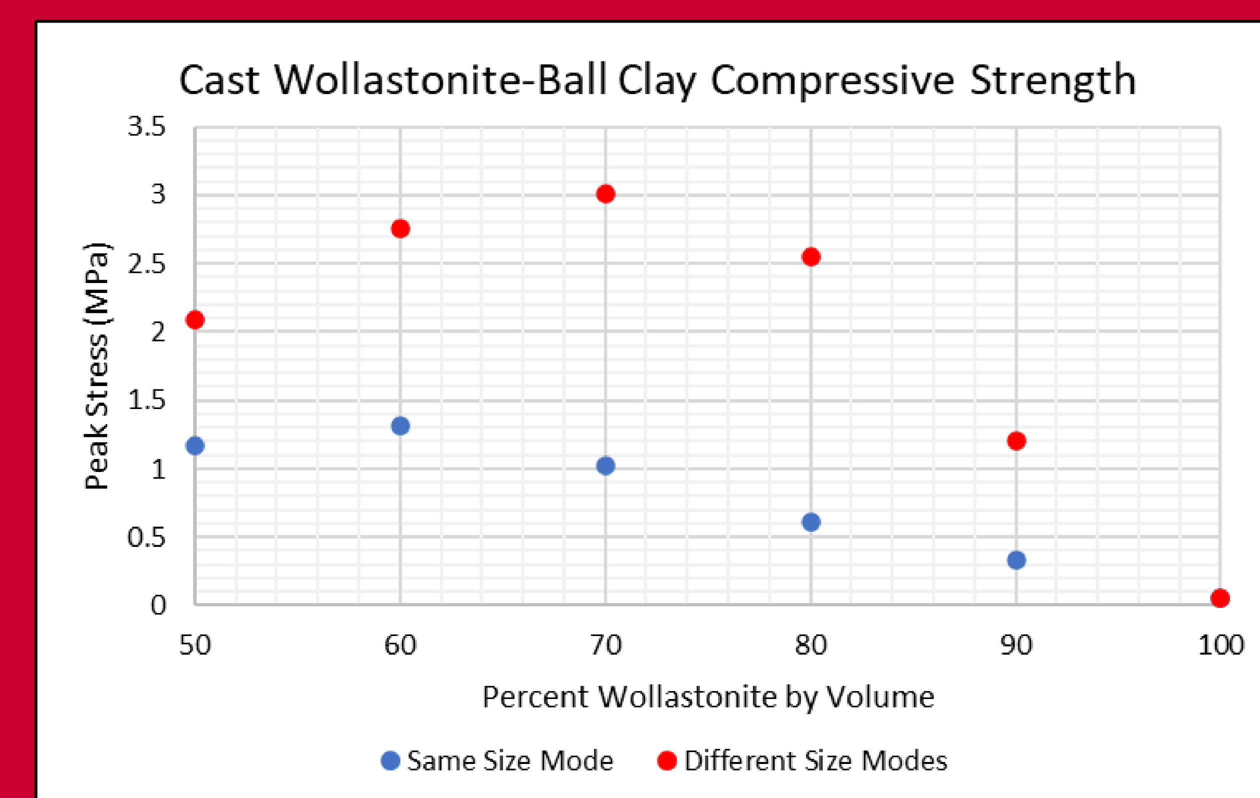

Fig. 2: Compressive Strength of Uncured Pieces

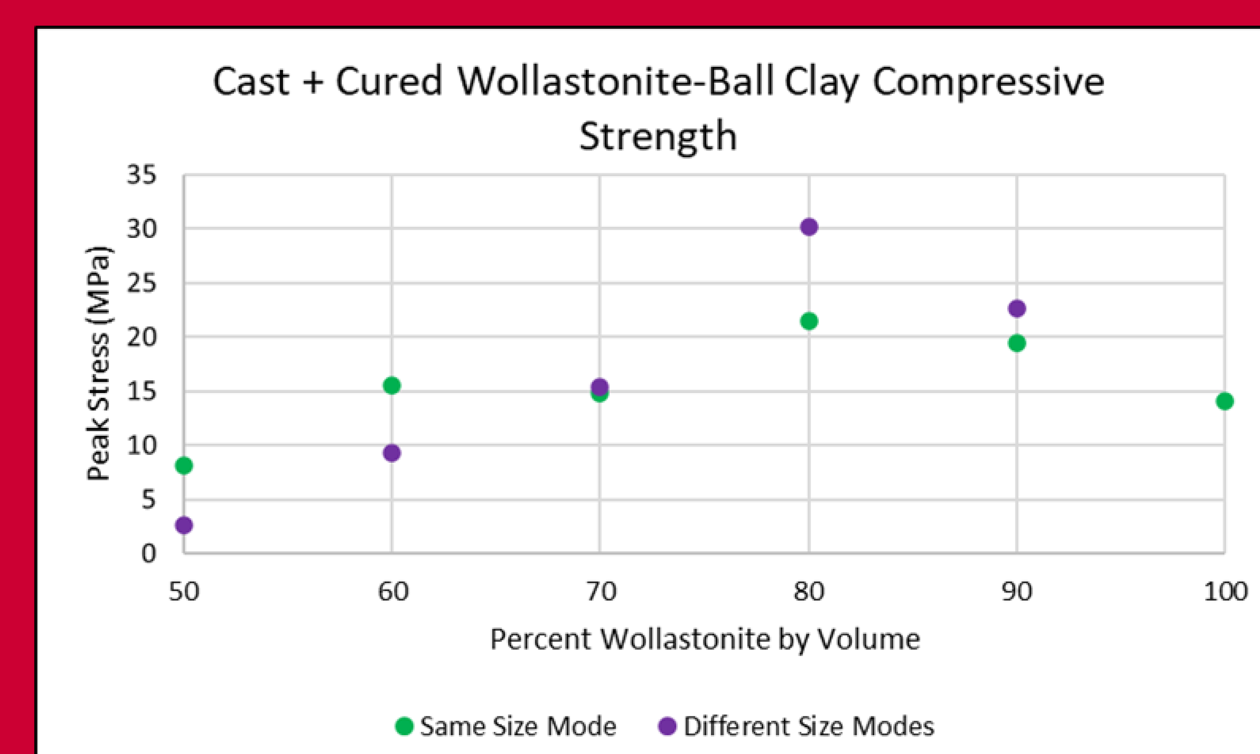

Fig. 3: Compressive Strength of Cured Pieces

Michael Supple mjs804@scarletmail.rutgers.edu