Comparison of Compression Strength of Ordinary and Carbonaceous Chondrite Simulants

H. B. Willman[1], A. R. Rolling[1], C. L. Loftus[1], M. J. Molesky[1], E. B. Patmore[1], M. M. Strait[1], G. J. Flynn[2], and D. D. Durda[3]
[1]Alma College (willman1hb@alma.edu), [2]SUNY-Plattsburgh, [3]Southwest Research Institute

Introduction

Asteroid impact studies allow us to gain a greater understanding of our solar system and the interactions within it. There is currently not a lot of data on the physical properties of meteorites and this data is essential to understanding our solar system, including impacts within it. An understanding of the physical properties of various types of meteorites, like wet carbonaceous chondrites, can be applied to larger scale solar system processes. Compression strength is a common method used to test the physical properties of rock or rock-like materials. Wet carbonaceous chondrites do not often fall to Earth which makes them rare and hard to obtain for our studies. Using a carbonaceous chondrite meteorite simulant created in our lab (Hydrated Northwest Africa 4502 and Hydrated Northwest Africa 869) as well as commercially produced materials (Exolith CC) allows us to make first order approximations of the compression strength of these materials [1,3]. Data from previous studies done in this lab allow us to expand the knowledge about compression strength that we have for different types of meteorites and terrestrial samples [1,2,4].

Figure 1. Close up images of the bottle method used to crush this sample of H-NWA 4502. The image on the left shows the first crack that occurred within the sample and the image on the right shows complete failure of the sample.

Experimental

Unhydrated NWA 869, unhydrated NWA 4502, and basalt compression strength tests were performed by previous researchers in our lab using a hydraulic press (Figure 2). A series of new experiments were performed to test the compression strength of Exolith CC, Hydrated Northwest Africa 4502, and Hydrated Northwest Africa 869 samples. Each of these samples were created in our lab using previously established hydration methods [2]. After the hydration process is compete, the sample is placed into a 2 cm cube mold and put on a hot plate overnight. The sample comes out of the mold as a firm cube and the dimensions and mass of the sample are measured. It is then placed in a plastic dish to catch the debris created when it fails during testing (Figure 1). Testing is performed using a bottle that is secured on top of the sample and incrementally filled with water until it fails (Figure 2). The amount of water and the bottle is then weighed in order to find the weight needed to crush the sample [2].

Compression strength is calculated as:

Pressure (S)=Force (F)/Area (A)

Figure 2. Bottle method used to conduct compression strength tests on H-NWA 4502, H-NWA 869, and Exolith. Bottles are placed in contact with the sample at the cap and water is added until the sample fails. If the sample has not failed after one bottle another is added to the top and we begin incrementally filling it. The scale of the bottle can be determined using my hand within the image. The right image shows the hydraulic press used to perform compression strength tests on Unhydrated NWA 4502, Unhydrated NWA 869, Basalt, and Pumice. The samples were placed on the top of the hydraulic press and when risen were crushed against the grey metal casing on the top. On the left of the press is a pressure gauge used to determine at what pressure failure occurred.

Results

We hypothesized that the compression strength of the Unhydrated Northwest Africa 4502 and 869 would be much stronger than the Hydrated Northwest Africa 4502 samples. As shown in Figure 3, these samples did indeed have a very different compression strength, and this is due to the structure of each sample [1]. While the Exolith CC and Hydrated Northwest Africa 869 samples were close to one another, the commercially created Exolith CC sample is stronger than the Hydrated Northwest Africa 869 and 4502 samples. We expected the Hydrated Northwest Africa 869 and Exolith CC samples to be very different from one another because the Exolith CC is a carbonaceous chondrite and the Hydrated Northwest Africa 869 is a converted ordinary chondrite. The samples had a difference of 0.167 MPa. Basalt and Pumice are terrestrial samples used to compare because they have a known compression strength.

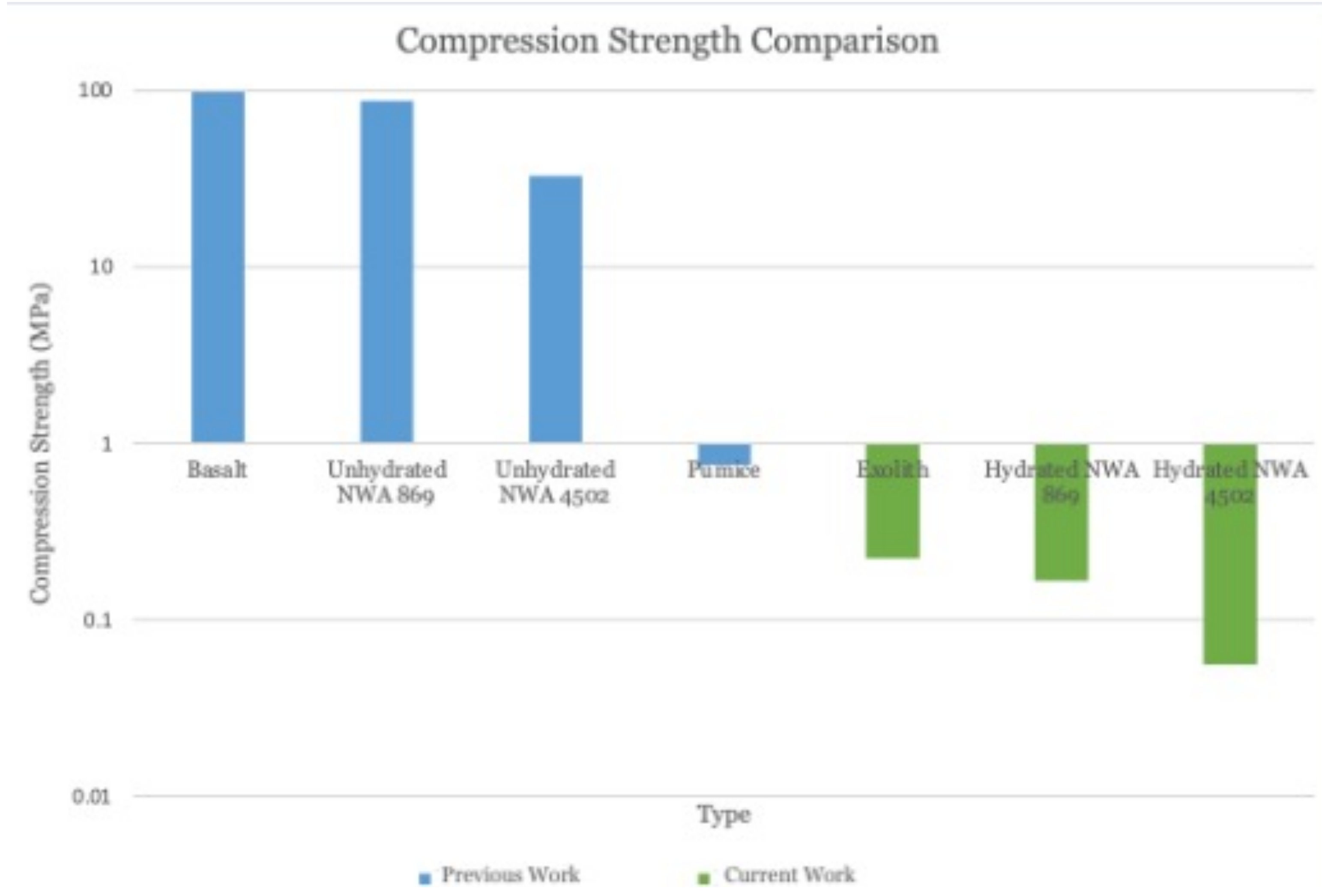

Figure 3. New compression strength tests on Exolith CC, Hydrated Northwest Africa 869, Hydrated Northwest Africa 4502, are compared with Pumice, Unhydrated Northwest Africa 869 [2], Basalt [4], and Unhydrated Northwest Africa 4502 [1] as performed previously in this lab.

Discussion

We found that the unhydrated samples (performed earlier) had a much higher compression strength compared to the hydrated samples of NWA 869 and NWA 4502. In this work we found that the Exolith carbonaceous chondrite material was found to have a higher compression strength than the hydrated ordinary chondrite NWA 869 and the hydrated dry carbonaceous chondrite NWA 4502, both of which we have manufactured. Future work on this project will include a comparison between compression strength and density to see if they correlate with one another. As well as trying to increase the density of our samples to more closely match actual carbonaceous chondrites.

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