A FLAW IN THE MATRIX

GRADE 8

Table of contents

Abstract

The matrix is the bond between plaster particles. I did this experiment to see what functional filler added the most strength to plaster. The control was able to withstand 78 pounds of pressure. Pyrophylite and Talc were both able to withstand 114 pounds of pressure. Wollastonite was able to withstand 166 pounds of pressure. Wollastonite was the strongest. I mixed up the plaster molds. Then I placed a metal girder on a scale. Then put the molds one at a time placed a pole on top of the molds and then used a fork truck's fork to place pressure onto the mold and measured how much it took to break the mold. Because wollastonite has acicular particles that provides better bonding than Pyrophylite and Talc's platy shape. So Wollastonite adds more strength to plaster than Pyrophylite and Talc.

Purpose

The purpose of my experiment is to prove that if I add functional fillers to plaster than the plaster will become stronger.

Research

Plaster was found to be first used by the ancient peoples in Jerico. Those same people made molds of plaster of a deceased person's head. The mold made would then be placed over the person's grave, not to be buried with the person.

The next recorded use of plaster was by the ancient Egyptians. They would put plaster up on the walls of tombs so scribes could etch hieroglyphics.

In 1912 when an archeologist dug into an ancient workshop of Thutmose they found one of the most important finds in archeological history. These sculptors were very rich -- they were not rolling twenty-ton rocks up the pyramids. So take note: The head sculptor Thutmose in circa 1350 BC had an expansive walled compound which contained four granaries, numerous gardens, pools, living quarters for apprentices, and, of course, a studio for the production of the highest quality artwork.

When archeologists broke through the mud brick wall, it showed a working Egyptian sculpture studio. In the workshop, over 20 plaster casts were discovered which had been made over clay models. Many sculptures lay about in various degrees of completion. Plaster sculptures were found as well as carved stone heads of notable Egyptians.

In mixing plaster, water must be as pure as possible. Drinking water is good enough. Gypsum has maximum solubility between 70 and 100 degrees farenheit. In my research I found out that the optimum water temperature to setting time is 100 degrees farhrenheit. Water-to-plaster ratio is the term that describes how much plaster there is in the slurry or the mixture of the gypsum and the water. Alpha Gypsum requires 22 to 45 pounds of water per 100 pounds of gypsum cement. Alpha gypsum is the type of plaster mix used in this project.

Wollastonite is used as a scrubber. It is used for this because of its particles' acicular shape that scrapes away the material being cleaned. Wollastonite is a functional filler that has the property of acicular particles. These particles are important in the added strength of the plaster. Acicular

describes the shape of the particles. They are shaped like needles. This adds to their abrasiveness, and to why they add strength to plaster.

Pyrophylite is a functional filler primarily used in wallboard, in joint cements, and in mastics, to control rheology and provide reinforcement. Rheology is the ability to flow or to be deformed. Pyrophylite's particles have a platy shape. These particles add more strength but not as much as wollastonite. Pyrophylite's high quartz content contributes to greater wear resistance. Pyrophylite is used in mud cracking resistance to texture paints and latex paints. Pyrophylite is used in pesticides because it takes the poison onto the plant then an electric charge keeps the powder in place, making it perfect for coating the plants.

Talc is a functional filler. Its particles have both an acicular and a platy particle shape. I used this because the particles in the other functional fillers I used were both in this material. Tremolitic talc is able to absorb oil at a lower amount than platy talc. I am using tremolitic talc in this experiment because it will dissolve in water while platy talc does not. Talc's main use is in ceramics.

Talc products are described as platy talc, containing predominately (>90%) the mineral talc; or tremolitic talc, most often a natural blend of talc, tremolite, and serpentine.

Platy talcs can be classified as microcrystalline or macrocrystalline. Microcrystalline varieties are naturally small in plate size and generally consist of dense ores. Macrocrystalline varieties contain relatively large plates. The term fibrous talc has in the past been used to describe tremolitic talc, but this is a complete misunderstanding.

Talc products are also categorized by geographic origin, which shows characteristic type. The so-called western platy talcs, from Montana and Texas, are microcrystalline, with chlorite as a characteristic added mineral. Eastern platy talcs, from Vermont and Canada, are macrocrystalline, with carbonates as characteristic extra minerals, as is the Chinese talc that is readily available in North America. Tremolitic talcs utilize the properties given by the large amount of added minerals that occur together with the talc.

Hypothesis

If I add wollastonite to plaster then the plaster will become stronger.

Materials

400 grams Plaster

280 grams water

10 grams Wollastonite

10 grams Pyrophyllite

10 grams talc

Weight

One large bucket

Four small cooking trays

Heat source

One pot

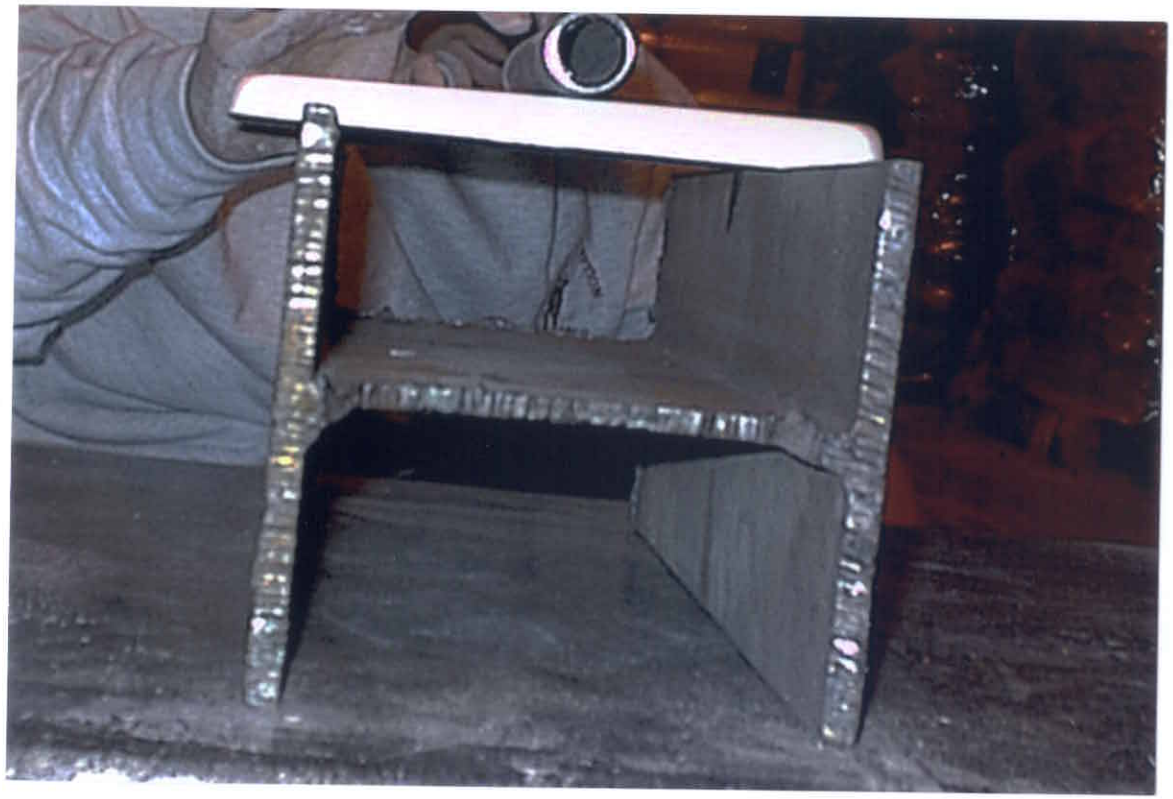
Procedure

Gather your materials. Retrieve the large bucket that will be used for mixing the plaster. Heat 70 grams of water to 90 degrees F. Pour the water into the bucket. Add a total of 100 grams of plaster into the water at a slow rate. While slowly adding the plaster mix, continue to mix the slurry. After all the plaster is added, continue to mix for eight more minutes. Pour this mixture into a small cooking tray. Let it dry over night.

Repeat the above steps with the additional step of add 10 grams of wollastonite to the mixture. Repeat this step using Pyrophyllite. Then after you have done this, instead use Talc.

Remove plaster blocks from cooking trays.

Apply pressure to plaster blocks and measure results.



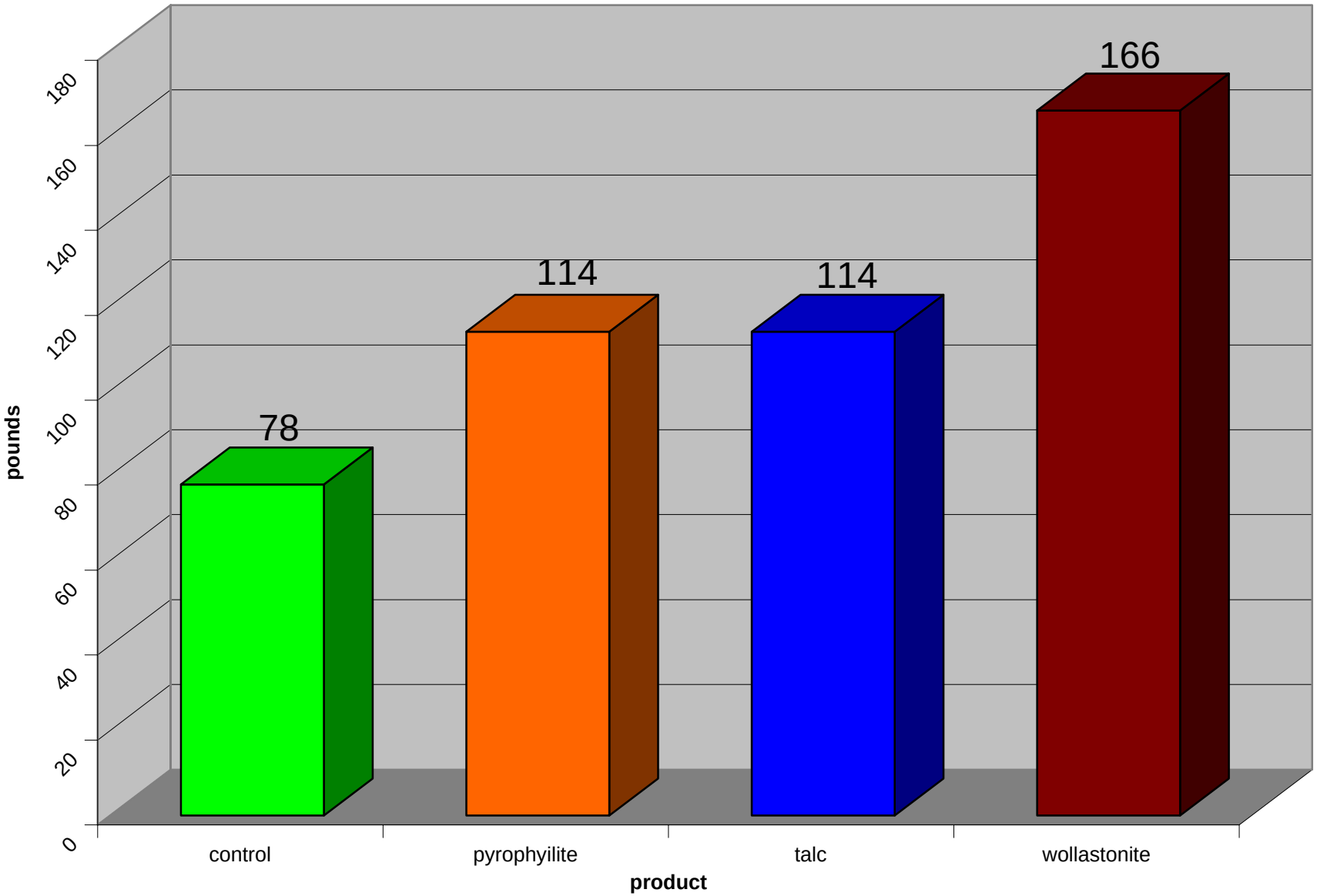

TOLEDO

Data

To do this experiment we placed the mold on a piece of a metal girder that had two points so that we could have three points of pressure. We placed a metal pole on top of the mold. We use a fork truck's fork to put pressure onto the pipe, and recorded the pressure it took to break the mold. We tried to use the most accurate testing method possible so we used the three-point method. The three-point method is used in a modulus of rupture machine, which we tried to duplicate.

Product	**Break point**
Control	78 pounds
Pyrophylite	114 pounds
Talc	114 pounds
Wollastonite	166 pounds

While doing my experiment I learned that wollastonite added the most strength to plaster. The next strongest was talc and Pyrophylite that added the same amount of strength as each other. The control was obviously the weakest.


pounds
0
20
40
60
80
100
120
140
160
180
78
114
114
166
control
pyrophyilite
talc
wollastonite
product

Analysis

In my experiment I learned that a plaster bar with no additives could withstand 78 pounds of pressure. A plaster mold with Pyrophylite added or Talc added could both withstand 114 pounds of pressure. A plaster mold with Wollastonite added could withstand 166 pounds of pressure.

I believe that since talc's platy and irregular particles are somewhat similar to Pyrophylite's platy particles that that is the reason that they have the same breaking point.

I think that because wollastonite has acicular particles that provides better bonding than Pyrophylite and Talc's platy shape. So Wollastonite adds more strength to plaster than Pyrophylite and Talc.

I could improve the testing method by finding a more accurate machine. I could also find a more even mixing procedure. Also I could test the difference in strength to amount of functional filler.

Conclusion

From this experiment I can conclude that my hypothesis was correct: wollastonite added the most strength to plaster.

Acknowledgments

I would like to thank R.T.Vanderbilt for supplying me with materials and research. I would also like to thank my parents for pushing me to do my work.