Diatomaceous earth is naturally occurring siliceous rock, which consists of fossilized remains of hard-shelled microalgae- diatoms. One of the locations of such diatomaceous earth mining is Georgia, Akhaltsikhe, Kisatibi Ore. Because of its low thermal conductivity, Diatomaceous earth is well-known for being a supplementary cementing material in concrete mixes for improving concrete properties, including- Improved resistance to freeze.

The Kisatibi Mining

The diatomaceous earth

The Kisatibi Mining

The diatomaceous earth

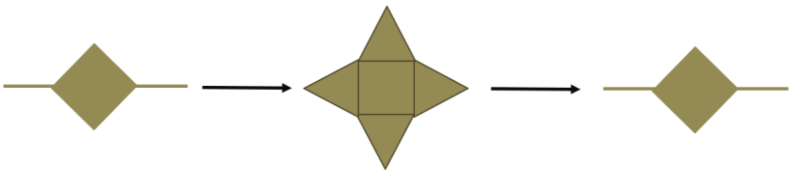
In the Georgian Technical University, during the observation process of such diatomaceous earth's characteristics, it was found that a chemical reaction, between the siliceous rock and different chemical bases, gave the Non-Newtonian clay as the product. From that day, our team started the observation of this Non-Newtonian clay's characteristics and applications of it.

It's known, that for Newtonian fluids, the viscosity is not affected by share rate, but that's not the case for Non-Newtonian fluids; their viscosity is dependent on the stress. There are vast kinds of such materials, and one of them is Thixotropic fluids, which tend to change their viscosity under stress by becoming less viscous. Diatomaceous clay was thixotropic, as in an inertial environment it tended to be solid, and after bringing it into the oscillating conditions, its viscosity tended to decrease.

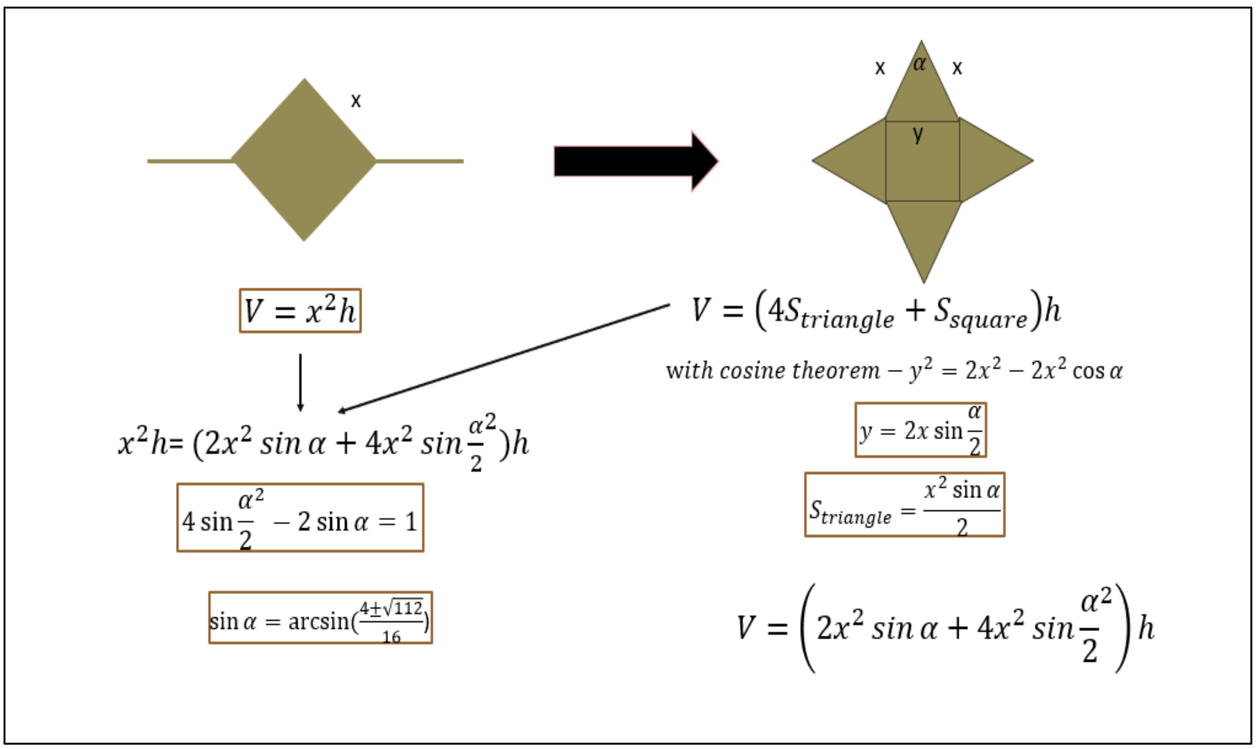
Our team started to find the optimal ratio of chemical base and diatomaceous earth. Initially, we started to clean the provided material from natural pollution by leaving the rocks in the 1.5 liters of water for one week. For the chemical base, we chose to use the best chemical sanitizer – NaOH. The tried ratios by our team of NaOH and diatomic earth, respectively, were: 50 g/350 g, 25 g/350 g, and 100 g/350 g. After 2-3 weeks, we compared all non-Newtonian fluids with the parameter- the difference between viscosities before and after applying the shared stress. To investigate them, we used Pasco's Rotary Motion Sensor, which measured the number of rotations per minute; We put this sensor on the top of the cup and placed it into a larger cup, full of our clay, which was connected to the rotational motor. With various experiments, we determined that the optimal ratio, when initially highly viscous clay's viscosity noticeably decreased after applying the shared stress, was 50g/350g.

The next step of our project was to think about the applications of such kind of clay. The inspiration for creating the earthquake-resistant building was the earthquakes in Turkey, which had destroyed thousands of people's lives. The main reason, for the buildings collapsing during the earthquake, is that the wave of earthquake breaks the foundation of the building. However, if the foundation tends to "move" along the direction of the earthquake's wave. Furthermore, we decided to use our clay someway in the foundation, as during the earthquake, the diatomic clay would become more viscous, and would become a "shock absorber"

There were many ideas about how could we supply the clay in the foundation of the building, in order to also guarantee its safety. We decided to place the diatomic clay into the shape-changing container, which tends to have a constant volume. My job was to theoretically find such a container, and after mathematical observation, I found that our container during the earthquake should pass these states:



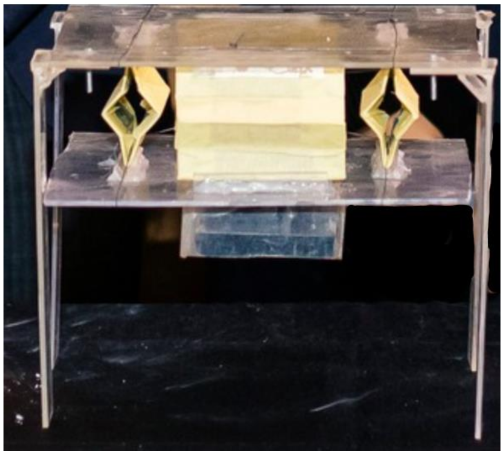
the first image is the initial state, when in the middle of the container there is a square in the middle, full of clay, and other ones show the movement states of this container. This container has to have the angle of arcsin ((4±√112)/16), in the middle state, in order to tend to have constant volume. This way, we got a shock absorber foundation, consisting dozen of such containers: in the initial state, the diatomic clay would be solid, holding the entire building, and during the shaking, caused by the earthquake, the clay would become less viscous and furthermore, a shock absorber.



Mathematical model of container

As this container had to hold the entire building, we had also to try to find such strong material. The caterpillar tracks of tanks, which can hold approximately 80 tones, are made with steel plates. Furthermore, the average mass of 5 5-story buildings is 25000 tonnes; Theoretically, the 35 of such containers in the foundation, made with steel, could hold the entire building.

P.S This project was the finalist of the USA Foundation program- Millenium Innovations Award and the second placer of the National Inventors competition-Leonardo Da Vinci



Prototype of our foundation

Our project is still in progress, and we are working to improve and investigate more carefully the advantages and disadvantages of such foundation