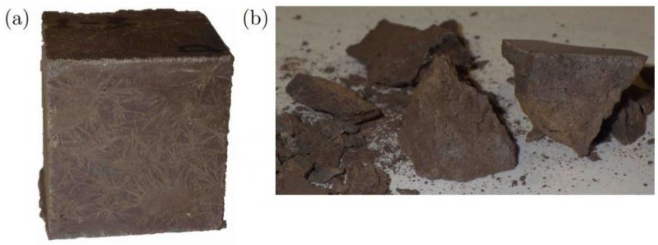
Martian concrete made from materials only on the Red planet

7 January 2016, by Bob Yirka



Cube specimen (a) before and (b) after unconfined compression test. Credit: arXiv:1512.05461 [cond-mat.mtrl-sci]

(Phys.org)—A trio of researchers with Northwestern University has created a type of concrete made only from materials found on Mars, which suggests it could be used as a building material for those who make the journey to the Red planet sometime in the distant future. The trio, Lin Wan, Roman Wendner and Gianluca Cusatis, have written a paper describing their efforts and results and have posted it on the preprint server *arXiv*.

Many countries and consortiums have been looking into the possibility of not only sending humans to Mars, but of establishing a presence there—perhaps even building a permanent colony. But there are many obstacles that must be overcome first, one of which is figuring out how to build a place to live on the planet without having to carry the materials for it—a tricky problem when noting the barren terrain. In this new effort, the research trio looked into the possibility of making concrete out of only material available on Mars, and notably, without the need for water, which is always used to make concrete here on Earth.

The researchers drew on prior knowledge of sulfur which has been studied for many years as a possible building material and is readily available on Mars. The odorous material can be melted and formed into shapes, but past efforts have shown that the results tend to be weak due to bubbles that form in it and shrinkage that makes it difficult to make blocks of desired sizes. To address these issues, the researchers added material that was very nearly the same as Martian soil—a mixture of titanium dioxide, iron oxide, silicon dioxide, aluminum oxide and other components. They also added pressure to keep bubbles from forming inside as the material cured. They team tried multiple different mixes until they found the proportions that seemed to make for the best Martian concrete—equal parts soil and sulfur. They report that the strength of the concrete is more than sufficient for making buildings on Mars, particularly in light of less stress due to gravity. Other testing has shown that it would also be able to withstand environmental conditions or Mars, such as temperature extremes and atmospheric pressure. As an added bonus, the concrete could be melted down if needed and pressed into different shapes.

More information: A Novel Material for In Situ Construction on Mars: Experiments and Numerical Simulations, arXiv:1512.05461 [cond-mat.mtrl-sci] arxiv.org/abs/1512.05461

Abstract
A significant step in space exploration during the 21st century will be human settlement on Mars. Instead of transporting all the construction materials from Earth to the red planet with incredibly high cost, using Martian soil to construct a site on Mars is a superior choice. Knowing that Mars has long been considered a "sulfur-rich planet", a new construction material composed of simulated Martian soil and molten sulfur is developed. In addition to the raw material availability for producing sulfur concrete, while its strength reaches similar levels to conventional cementitious concrete, fast curing, low temperature sustainability, acid and salt environment resistance, 100% recyclability are appealing superior characteristics of the developed Martian Concrete.

In this study, different percentages of sulfur are investigated to obtain the optimal mixing proportions. Three point bending, unconfined compression and splitting tests were conducted to determine strength development, strength variability, and failure mechanisms. The test results are compared with sulfur concrete utilizing regular sand. It is observed that the particle size distribution plays a significant role in the mixture's final strength. Furthermore, since Martian soil is metal rich, sulfates and, potentially, polysulfates are also formed during high temperature mixing, which contribute to the high strength. The optimal mix developed as Martian Concrete has an unconfined compressive strength of above 50 MPa, which corresponds to a roughly 150 MPa concrete on Mars due to the difference in gravity between Mars and Earth. The formulated Martian Concrete is then simulated by the Lattice Discrete Particle Model (LDPM), which exhibits excellent ability in modeling the material response under various loading conditions.

APA citation: Martian concrete made from materials only on the Red planet (2016, January 7) retrieved 21 September 2019 from https://phys.org/news/2016-01-martian-concrete-materials-red-planet.html