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Introduction: Concrete has long been proposed for the use of lunar mission habitations due to its strength and temperature variation and abrasive resistance. [1] It is a versatile material that is capable of withstanding radiation and micrometeorites. The data is based on the findings from the Apollo 16 lunar soil sample findings from Construction Technology Laboratories (CTL). [2]

In 1986, the National Aeronautics and Space Administration (NASA) awarded 40g of lunar soil to CTL to investigate using native mare soil in the construction of concrete. Using a scanning electron microscope (SEM) equipped with a Tracer Northern Energy Dispersive X-Ray (EDX) spectrometer system, they have found that the major elemental composition included Calcium (Ca), Aluminum (Al), and Silicon (Si). Further investigation into other available data on Apollo lunar samples show that lunar regolith have a typical calcium oxide (CaO) content of nearly 12% by weight, highland soil of 17%, basalt rocks of 14% and calcium-rich plagioclase of 19%. [3] The composition can be compared to the typical Portland cement that is currently the most frequent used cement in concrete in the world. Portland cement contains 65% CaO, 23% silica (SiO_2) and 4& Alumina (Al_2O_3). [4] It can be derived that lunar regolith has the high potential for being used in concrete. The crystalline structure observed show a high level of angularity in particles. This characteristic will increase the bonding between aggregate and cement paste increasing the strength, durability, abrasive and temperature variation resistances. Lin concludes that the investigation from data obtained from the scientific experiment that lunar regolith can produce high quality concrete for lunar construction. [5]

Lin's study however did not take into account the effect of vaccum present on the moon. This posed as a potential problem as little investigations have been made into the behavior of concrete in vacuum. The Novel Testing Program initiated at the Los Amalos National Laboratory compared test (under vacuum) and control cylinders (with atmospheric pressure) to analyze the effects of vacuum on the water content changes within the structure of concrete. A vacuum of 3.99 x 10 .4 Pa was used during the experience.

In concrete, water is found in the in the hydration product, the absorbed water in particulars and condensed within capillary pores. Under vacuum treatment, Cullingford and Keller found that this produced an increased of free water loss. This evaporation is found to be 0.92 x 10^{-8}g/sec•cm^2 in the test specimen. Theoretically, the value of evaporation under vacuum is 3.97 x 10^{-8}g/sec•cm^2 calculated from the formula derived from the kinetic theory of gases equation:

$$W = 5.83 \cdot 10^{-2}\ \alpha\ P_v\ (M/T)^{-0.5}$$

where

W = rate of evaporation (g/sec•cm^2)
α = rate of evaporation
P_v = saturation vapour pressure (torr)
M = molecular weight
T = temperature (K)

The discrepancy is within a reasonable change and along with reasonable constant temperatures allow for the conclusion that concrete is relatively stable in a vacuum environment. [7] The internal structure of concrete was not compromised in terms of compressive strength as shown in the chart below.

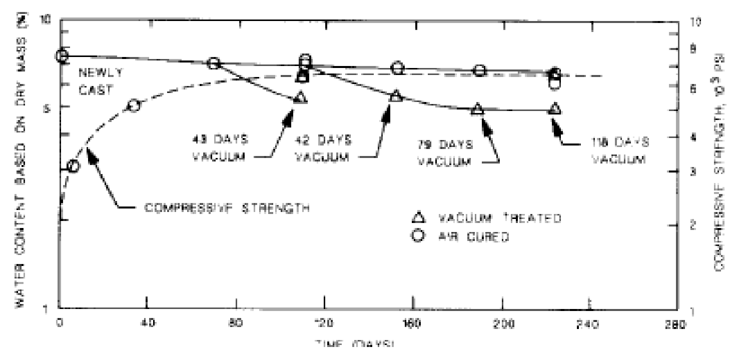

Figure 1: Water Content based on Dry Mass vs Time (days) [8]

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