Manufacturing for Planetary Construction using Polymeric Concrete. T.S. Lee[1], B.C. Chang[2,*], J. Lee[3], S. J. Kang[4], D.U. Seol[5], J.Y. Lee[6], S. Xiemenes[7] and Y. Lee[8] [1]Korea Institute of Civil Engineering and Building Technology (283, Goyang-daero, Ilsanseo-gu, Goyang-si, Gyeonggi-do, 10223, Korea, tslee@kict.re.kr), [2,*corresponding author]International Space Exploration Research Institute (ISERI), Hanyang University, Korea (#515, 2nd Eng. Building, Hanyang Univ., 55 Hanyangdaehak-ro, Sangrok-gu, Ansan, Gyeonggi-do, 426-791, Korea, bcc@hanyang.ac.kr), [3]ISERI, Hanyang University (engine@hanyang.ac.kr), [4]ISERI, Hanyang University (kangsj@hanyang.ac.kr), [5]ISERI, Hanyang University (galations@hanyang.ac.kr). [6]ISERI, Hanyang University (rhee0908@hanyang.ac.kr), [7]ISERI, Hanyang University (ximsam@protonmail.com) [8]ISERI, Hanyang University (yoonsunlee@hanyang.ac.kr)

Introduction: Film "the Martian", worldwide hit of last year, pointed out the importance of planetary habitat and described manned surface mission on Mars, which draw public attention to planetary manned missions.

Early this year, European Space Agency announced plans to build a 'Moon village' by 2030. Not only ESA but also other countries have a plan of human exploration to the moon and Mars.

However, human have not built an structure on other planet surface yet, may due to lack of construction technologies for new and harsh environment and astronomical cost of construction equipment and material transporation.

Recently, 3D Printing technology became a promising alternative of planetary habitat construction as it may be proper to use in-situ materials in an efficient way.

Additive Manufacturing: Additive Manufacturing is defined by ASTM as the "process of joining materials to make objects from 3D model data usually layer upon layer, as opposed to subtractive manufacturing technologies such as traditional machining" [1].

At the beginning the aim of the new technology developed was to build prototypes quickly. The technology advanced quickly and applications have widened into medical, sculpture, architecture, industrial and many others domains. Different names were given to this technology, for example free form fabrication, digital manufacturing, layer manufacturing, 3D printing, additive fabrication, additive layer manufacturing following their purpose [2].

3D Printing for Lunar Base: Past studies of planetary base construction materials were aimed at the production of pre-fabricated parts. Producing a prefabricated product requires form-work which depends on the method and material. To use the form-work in the moon it must be hermetically sealed and may have to protect from the harsh environment during the curing. Moreover, new form-work is needed for each geometry which is a disadvantage for planetary construction which has limited resource [3].

Therefore 3D printing with different materials for the moon and mars is a rising alternative for planetary construction. These technologies have advantage of free-form, building complex shapes and geometries by layered fabrication, and it is suitable for automated construction.

NASA is operating a project named the Additive Construction with Mobile Emplacement (ACME) by Marshall Space Flight Center, Kennedy Space Center, Contour Crafting Inc., and the US Army Corps of Engineers. The project focus on the development of technologies to support automated development of in-situ materials-based, planetary surface structures [4].

ESA teamed up with building companies to start testing out various Moon base-building technologies. They mixed lunar simulant with magnesium oxide and used salt for binder and build up a 1500kg block [5].

New mechanism for polymer binded concrete additive construction: Hanyang University is developing a new mechanism for polymer binded concrete additive construction. The study focus on mixing, extruding of material, and continuos construction method of the layers. By this new mechanism, increase of productivity and increase of material quality are expected.

References:

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