

PRACTICAL REALIZATION OF COVERING LUNAR BUILDINGS FOR ENSURE LEVELLED TEMPERATURE ENVIRONMENT. *B. Boldoghy¹, J. Kummert¹, T. Varga², I. Szilágyi², Sz. Bérczi³*, ¹ Ferroelektric Engineering Pan Konceptum Ltd., H-1116 Budapest, Vasvirág sor 72., Hungary, (konceptum@vipmail.hu), ² VTPatent Agency, H-1111 Budapest, Bertalan L. u. 20., Hungary (info@vtpatent.hu), ³ Eötvös Loránd University, Institute of Physics, H-1117 Budapest, Pázmány P. s. 1/a., Hungary (bercziszani@ludens.elte.hu).

Summary: Lunar regolith packed in bags is used for covering buildings of levelled temperature to be created in lunar ditches, valleys or craters. Pre-packed regolith in uniform size and controllable quality can be applied for covering the buildings.

Joining to previous publications: Our previous publications refer to creating levelled temperature environment under lunar conditions.

We described in our previous publications [1,2], that if pre-fabricated modules are placed in the suitable Lunar surface formations (ditch, valley, crater) in such a way, that they are covered with Lunar regolith in a thickness of abt. 10-15 m, then an environment of balanced temperature is created for the module.

We described in another of our previous publications, [3] that if "brick" elements are produced from Lunar regolith, and these elements are used for creating of load bearing structures, primarily arches from Lunar inside Lunar surface formations (valley, ditch, crater) of suitable size, and covering of this load bearing structure from above in a proper thickness (10-15 m or more) by Lunar regolith for insulating purposes, so a thermally protected and insulated interior space of great size is created, with an interior temperature free from fluctuations of exterior irradiation and due to the inner heat flow the interior temperature is balanced, respectively fluctuates to a small extent around an average temperature of abt. -20°C .

The interior space of great size formed this way is suitable to house industrial technology and/or dwelling modules and it is protected from external cosmic radiation and meteorite impacts as well.

Practical issues: One of the important practical issues of the concept is covering buildings to be created in lunar ditches, valleys or craters with lunar dust, with regolith, ensuring proper thermal insulation.

For the purpose of covering drag-line or lunar excavator or bulldozer have already been mentioned in our previous proposals. Both methods can be easily applied at preliminary creation of the lunar buildings, but the moving of lunar regolith of big quantities raised numerous issues making application difficult.

A joining problem is the floating of the lunar dust. It is to be realized, that during the moving and dragging of lunar regolith dust of nanometric size starts floating electrostatically, influencing, worsening the function of equipment as well as the working conditions.

A problem is the irregular quality of the lunar soil. Composition and structure of lunar regolith is not everywhere the same, so it can not be granted that a suitable quality regolith cover can be produced by dragging or by using bulldozers.

Conditions for dragging or using bulldozers are not everywhere suitable, there are places where the environment of the lunar valley or ditch is rocky, can not be dragged, this case the lunar regolith to be used as cover must be transported from a longer distance. Moving and transportation of lunar regolith in bulk raises additional issues. Continuous removal of the covering layer from the building at a later date, an uncovering is difficult.

Our aim: It is therefore necessary to elaborate a method which ensures uniform quality of the covering layer and in given case also a later partial or full removal of the covering layer, the uncovering of the building.

During SRR 8 Conference G. A. Smithers et al. [4] presented a method for filling bags with lunar regolith and its relevant practical problems. The lunar regolith filled in bags is used for producing a one-piece lunar regolith-bag garage. Various materials were examined for the material of bags and a method was made known for filling the bags as well.

The essence of our proposal: Lunar regolith packed in bags is used for covering buildings of levelled temperature to be created in lunar ditches, valleys or craters.

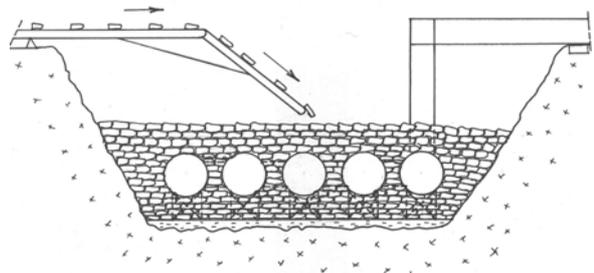


Fig 1. Application lunar regolith bags for covering ISS type modules in a lunar valley

Feasibility study: The course of covering with bagged regolith.

- The building is made in the lunar valley, ditch or crater,
- In a bagging plant located in a proper site the bags are filled with the proper quality and parameter lunar regolith,

- It can take place near the building, but in a more distant place as well, and it can happen at the same time with making the building, or afterwards, or before,
- The bagged lunar regolith is gradually placed on the building with the help of vehicles, conveyor belt,
- during the covering it is important to load the building evenly, distribute the loads evenly, which is important in order to maintain the proper conditions of the building, as well as in order to distribute tension resulting from loading,
- filling stops when the required width of the covering layer is achieved, or the ground level is reached,
- after having reached the required height the surface can be covered by additional layers, landscaping can follow according to the known aspects.

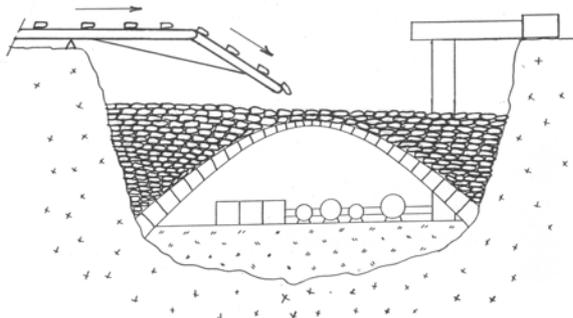


Fig 2. Application lunar regolith bags for covering an arched load bearing structure in a Lunar valley

Issues of practical realization: Bag measurements: What size bag should be used?

The bags are exposed to big mechanical heavy duty use, so it is not practical to use bags of big size, so as to avoid big stress during dropping or tossing. A practical earth size: concrete bag, about 40 liters.

Taking into consideration the density 2.9 g/cm^3 of regolith from the lunar surface so abundant in basalt, the corresponding lunar simulant density is 3.1 g/cm^3 . (Minnesota Lunar simulant)

Taking into consideration an average density of 3 g/cm^3 the weight of a bag of 40 liters (dm^3) is:

- under Earth conditions abt. 1200 N, 120 Kp.
- on the Moon it would be 1/6, 200 N, 20 Kp.

It is suitable in case of automated transportation and handling.

Shape of the bag: prism of rectangular shape, width 30-40 cm, length 50-70 cm, thickness: 15-20 cm in given case 35x70x16 cm.

The material of the bag: preferably Kevlar [4] or other plastic yarn of closed material, or densely woven plastic yarn, or combination of these.

Filling level of the bag: It is not practical to fill the bag full, it should be filled loose, 80-90% filling up is practical, because the covering of the bag does not

become tense and bags put on each other can nestle well. Filling up can be made fully automatically or it can be posterior manual handling, which is justified by smaller bag size and mass.

After filling sealing of the bag can be made by micro-wave welding.

Advantages of our proposal: Lunar regolith filled into bags can be made standard bags, the parameters of which can be calculated, among others

- size,
- mechanical stability,
- load bearing
- thermal insulation characteristics
- During placing the building it can be loaded evenly, the load can be calculated,
- The application is dust-free, except for the site where the bags are filled,
- easy to handle,
- can be automated, filling, transportation, placing can be carried out by robots,
- covering with the help of bags can be partially or fully undone,
- it can be installed again for covering of the building,
- can be recycled.

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