USE OF LUNAR SOIL AND LUNAR SURFACE ROCKY MATERIALS IN INSULATION OF BUILDINGS ON THE MOON.

Sz. Bérczi[1], B. Boldoghy[2], J. Kummert[2], T. Varga[3], I. Szilágyi[3], [1]Eötvös University, H-1117 Budapest, Pázmány P. s. 1/a., Hungary (berczi szani@ludens.elte.hu), [1] Ferroelektric Engineering Pan Konceptum Ltd., H-1116 Budapest, Vasvirág sor 72., Hungary, (konceptum@vipmail.hu) [3]VTPatent Agency, H-1111 Budapest, Bertalan L. u. 20., Hungary (info@vtpatent.hu),

Summary: The fine particle sized dust available on the surface of the Moon can be used for the thermal insulation of the lunar buildings. As location of the buildings we suggest the ditches or grooves, where lunar buildings can be buried directly into the subsurface, in the regolith for insulation.

Introduction*:* Surveyor, Luna and Apollo Missions measured the main characteristics of the lunar soil, [1], of heat flow [2], mechanics [3]. According to these data analog material consisting of glass-rich basaltic ash sample, was developed [4]. Even electrostatic characteristics and charging properties of the lunar soil were measured [5]. We used these data for the planning engineering of a permanent lunar base construction. For human beings it is necessary to create internal spaces in buildings with conditions similar to those of the Earth. Insulation plays a central role because the heat loss between the inner temperated and the outer space is determined mainly by the thermal insulation system of the building. As the lunar dust consists of fine particles, it has excellent thermal insulation characteristics. This dust has unlimited availability on most part of the lunar surface. For steady temperature of the lunar architecture this property of the lunar regolith is very useful.

The principles of the use for thermal insulation:

Lunar dust consists of fine particles. The particles are products of mainly mechanical fragmentation therefore they have large surface with less surface contacts as compared to terrestrial rounded grains. This few contact between the particles results in a loose structure. In such a grain system conduction transport of the heat is very little, heat is forwarded to the neighboring particles mainly by radiation (this form of thermal energy transport is less effective, than conduction).

Compared to the conditions on the Earth the significant difference lies there, that on the Moon the thermal conductivity of the dust is considerably lower than on the Earth due to the absence of atmosphere and liquid materials, therefore we assume, that the lunar soil can be used as thermal insulator in its original texture. Because of the small grains size, if used as building material this soil behaves as fluid, similar to riverbed sand available in some parts of the Earth.

Utilizing the lunar regolith in architectural constructions: On the Moon a lot of conditions are missing that are present on Earth and restrict or prevent the use of the fine grained dust. Due to the lack of atmosphere there is no wind, no draught and no dust blast is possible.

According to our proposal [6] the possible methods of using lunar dust as thermal insulator in constructing lunar architectures are as follows: 1) In its genuine dust form, a) by loading (with preliminary collection) as thermal insulating cover, b) its partial advantage is, that in case of a possible impact it acts as moderator as a material behaving like a liquid material, c) it gives protection against radiation.

It is suitable for surrounding the building from every direction. In block form: 1) using light binding material creating a crust on its outer surface a) as solid building material, with binding material to be produced on the spot (e.g. salt, which can be NaCl) and b) as dust, as thermal insulating filling material - to fill up hollows and certain parts of existing structural elements. For example the pre-fabricated frame structure is assembled on the Moon – creating the frame and the crust and filling up the space around the building (below, above, on the sides around) with moon dust or with thermal insulating material made of the dust. Thermal insulation is made on the spot, e.g. with building, thermal insulating materials made on moon dust. Another solution for its use is putting lunar soil or regolith gravels into bags (though it is not so useful as thermal insulator, but can be used as industrial building element. It can be used as uniform building material).

The steps of the building technology: 1) A horizontal surface is prepared of coarse particles, (it is compacted) in a ditch or in the bottom of a valley, 2) The pre-assembled building is located on the prepared surface, 3) The frame structure is fixed, 4) The pan will be filled with thermal insulating dust, which will give protection against radiation, heat and mechanical damages, 5) An appropriate thickness of dust layer will be formed from below, from the sides as well as from above. (In this technological step the behavior of the lunar dust as liquid, is used, so it envelops the whole object.) Finally the dust can entirely surround the whole thing. Thermal insulation is necessary downwards as well [7].

Further steps: transfer, exchange, extension: The building to be located is vibrated into the dust. A hollow can be created by vibration and material transport where the building can be placed. Size: the size of the valley is approximately 50-100 m, depth 20-40 m. The thickness of the dust surrounding the building – 20-30 m. (It would be preferable first to build a preassembled object, e.g. like the space station unit, and surround it with lunar dust envelope. This way the production and operational costs could be significantly lower).

The advantage of our approach*:* It requires the necessity of delivery of only very few devices while using local materials available on the Moon to a maximum extent. Human resources: min. 2, preferably 4 people. It is worth developing a 1) mobile ensuring arrangement and manipulation of both solid and dust-like materials, 2) operation of mechanical devices is possible by partial robot or remote control mode.

References: [1] Gast, P. W. et al. (1973): Preliminary Examination of the Lunar Samples. NASA SP-330, JSC; [2] Langseth, M.G. et al. (1973): Heat Flow Experiment. NASA SP-330, JSC; [3] Mitchell, J. K. et al, (1973): Soil mechanics. NASA SP-330, JSC; [4] McKay, D. S. et al (1993): JSC-1: A new lunar regolith stimulant. *24th LPSC*, Part 2. G-M p 963; [5] Horányi, M., et al (1995): Electrostatic charging properties of simulated lunar dust. *Geophys. Res. Lett*. **22**, 2079-2082; [6] Boldoghy et al (2005): Functional program of buildings for conditions on the moon. This volume, [7] Kummert et al (2005): Using the sun's radiating energy for heat-storage as energy source of buildings on the Moon. This volume. [8] Boldoghy et al (2005): Planning project for establishing buildings on the moon to be operated cost-effectively. This volume.