THE USING OF DIFFERENT FORMS OF DEPENDENCE OF PROJECTIL ENERGY TO CRATER SIZE FOR PRODICTION OF PARAMETERS OF ARTIFICAL CRATER ON COMET 9P/TEMPEL 1.

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Introduction. The copper impactor spacecraft of the Deep Impact Mission which has mass of 372 kg, and velocity of 10.2 km/s on July 4, 2005 collided the 6 km in size nuclei of short -periodic comet 9P/Tempel 1 at velocity of 10.2 km/s on July 4, 2005. This at first gave the possibility to compare the calculated parameters of the crater on Small low-density cosmic body with experimental data. Using two theoretical models of collision of the impactor with the comet nucleus we calculated that the possible crater diameter on the nucleus of comet Tempel 1, formed by the artificial impactor Two models were used. First one – the Opik's model [1-3] This theory is based on transfer of quantity of impulse, instead of energy as many researchers accepted. .

The estimation of the crater sizes by the methods of the impact-explosive analogy which was developed in a plenty of works and appreciably generalized in [4,5]. was also done.

The calculations by the Opik's model. According this model The impacting body some time continues to move inside of a target (thus the significant part of energy is carried away outside) and for calculation of such movement it is necessary to use the law of conservation of an impulse, instead of conservation energy.

In a bowl of a crater where there is destruction, coupling between various elements of volume are small and the radial moment of a shock wave is remained. Tangential moving of substance are insignificant and radial velocity of impact is equal to the radial moment on a mass unit, belonging wave front. Destruction and rock outburst from a crater is consequence of the action of radial shock wave. In considered model the basis for the analsis and calculations is hydro dynamical pressure, which defines a value of resistance or braking.

Efficiency of hydro dynamical pressure of moving shock front is defined by expression $C\rho V^2$. The coefficient C depends on the form of a body; compressibility of medium, a Mach number and for the continuous medium is equal approximately to unit, and on the average close to 0.5. Confirmation of that $C \approx 0.5$ follows from calculations jf Gilvary and Hill,1956/ We accept, that a meteoroid striking in a target has the cylindrical form. The initial radius of the cylinder (and radius of a frontal surface) is equal R_o, its height $2R_o$. During the moment of contact the powerful shock wave extends both in an impactor and in a target. Its velocity of propagation has the order of velocity of impact. It will make essential destructions (mechanical cracking on fragments) in that area where the crater will be generated.

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However in an impactor no destructions will occur. While the shock wave will pass through it (time of passage will come to $h/V \approx 10^3$ cm/$3\cdot10^6$ cm/s $\approx 3\cdot10^{-4}$ s, where h - height of an impactor) compression and deformation of an impactor, caused by action of powerful mass forces of inertia, will not allow any mechanical destruction. The value of mass forces of the inertia, carried to acceleration of free falling at resulted above velocity, will come to $(3\ldots8)\cdot10^8$, i.e. the weight of a body in own system of coordinates will increase in hundred millions times. In these conditions right after the first contact an impactor with a target intensive melting of impactor and targets will begin. Therefore it is necessary to consider movement of a liquid body in liquid one. We shall consider the simple scheme of such process.

Accepting, that a formed liquid of impactor and target is incompressible and neglecting minor alteration of mass of a meteoroid, that, undoubtedly, rightly at the first stage, we shall receive equality:

$$R^2 h = 2R_0^3 \qquad (1)$$

Where R and h - value of radius and heights of the cylinder during the subsequent moments of time.

Data about compressibility of iron under hydro dynamical pressure P in the interval from $7.7\cdot10^{11}$ N/m^2 up to $2.9\cdot10^{12}$ N/m^2 and of silicon under pressure from $2.1\cdot10^{11}$ N/m^2 up to $2.9\cdot10^{12}$ N/m^2 are made in the paper (Gilvarry and Hill, 1956). They show, that change of density, as functions of pressure ($\rho \sim P^{1/\gamma}$), for iron and silicon is insignificant as return value of an exponent of an adiabatic curve $1/\gamma$ = 0.28 and 0.30 accordingly. For gases this value more: for one-nuclear gases it is equal 0.60, for two-nuclear one - 0.71.

A velocity V concerns to the center of the impactor mass, V_1 - a velocity of motion of a frontal surface. Accepting, that the value of velocity of different parts of an impact or increases linearly from the frontal surface to the back one, the velocity of the back surface, obviously, will be equal $2V - V_1$.. Then velocity of change (reduction) of height of the cylinder in the course of time $dh/dt = -2(V - V_1)$. Let $V_2 = dR/dt$ - a velocity of increase in radius of a cylindrical body. Change of quantity of movement on unit of cross-section of an impactor is represented in the form of(**2),**

Where σ_p - small (in comparison with the first member) an additional member which can play a role only for velocities smaller 1 km/s. Pressure upon a lateral surface of the cylinder

$$P_2 = \frac{\rho V_2^2}{2} + \sigma_p \quad \textbf{(3)}$$

Using a known hydro dynamical principle, we shall write down an equation

$$P_1 - P_2 = \frac{\delta V_2^2}{2} \quad \textbf{(4)}$$

The analysis of the numerical decision of the equation (4) testifies that the maximal braking is reached on the depth equal (0.4 – 0.5) *h*, i.e. it gives a result close to conclusion of Öpik.

Ommiting some intermediate considerations the result for the diameter D of a crater jne can give as

$$D/d^{3/2} = 1{,}20(kV\delta/h)^{1/2}(\rho\delta_p)^{-1/4}$$

From this dependences follows, that depth of the formed crater will make 4.8…5.6 m, and the size of diameter which will be equal 22…57 m, the volume of the destroyed substance (volume of a crater). will make 810…7080 m^3.

Model of impact-explosion analogy

From this analogy follows, that the craters which have formed at meteoritic impacts with space velocities are equivalent to the craters made by explosions of little buried charges. Processing of a big number of observed data, and also explosive and impact experiments [Mellosh, 1994] leads for the big range of the sizes to following dependence for diameter of a crater: $D = LE^{1/N}$, where E - energy of its formation, in this case kinetic energy of an impactor, L - constant coefficient, N = 3.4. If D is expressed in meters, and E in joules L = 0.02 For large events can appear dependence [Mellosh, 1994] more preferably:

$$D = 0.773\left(\frac{g_0}{g}\right)^{0.118} E^{0.294} \quad , (18)$$

Where D in km, E in Mт, g_o - acceleration of free falling on the Earth, g = 0.07 sm/c2 - on a nucleus of a comet. Calculation using the formula (18) leads to value D = 65 m.

Depth of craters of such size is accepted [Dence,1973] as $h = D/2\sqrt{2}$, that is h =23 m.

It seems to be that this estimation will be the closest to experimental result.

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