DYNAMIC BEHAVIOURS OF SOILS AND ROCKS IN A WIDE PRESSURE RANGE

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Summary Investigations of dynamic compressibility of soils were performed by two various experimental methods: the modified Kolsky method was used at strain rates about $10^3 s^{-1}$ and pressure up to 300 MPa, and the plane-wave shock testing was at higher strain rates and pressure up to 2GPa. As in these above methods deformation state is the same, then it is able to construct total stress-strain curves of dynamic deformation of soft soils in uniaxial strain condition in a wide range of pressure. Besides above testing, there are presented experimental analysis for two rocks' materials, i. e. the gabbro-diabas granite and two kinds of marble tested in compression as well as in tension (splitting tests) by SHPB at high strain rate about 10^3 s^{-1}.

EXPERIMENTAL SET-UPS

Modified SHPB set-ups

Investigation of dynamic compressibility of non-cohesive building soils was performed by two various experimental techniques. The first of them was modified split Hopkinson pressure bar, where soils' specimens were placed in a rigid steel jacket, equipped by strain gauges (Fig. 1) to measure circumferential strain ε_θ. This method was used at high strain rate $\dot{\varepsilon}$ up to 10^3 s^{-1} and pressure P_i up to 300 MPa. In the modified Kolsky method by measuring signals from strain

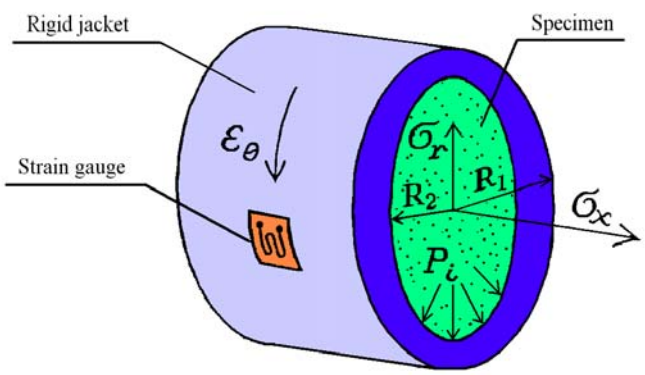

Fig. 1. Soil specimen confined in steel jacket, which was equipped by strain gauges; R_1, R_2 are external and internal jacket's radiuses

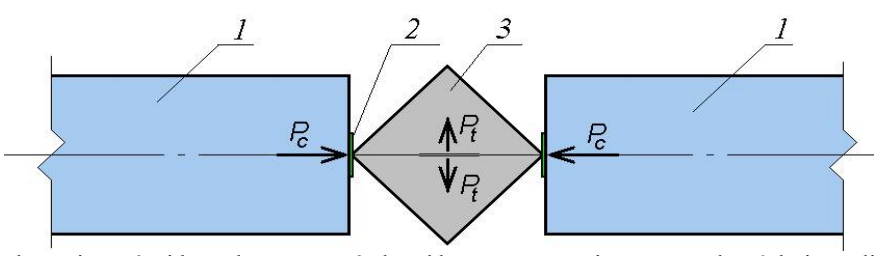

Fig. 2. Rock specimen *3* with steel separators *2* placed between measuring pressure bar *1* during splitting tests

gauges mounted on measuring bars and the jacket, it is possible to determine axial σ_x and radial σ_r components of stress and further to calculate dependence: pressure P_i – volumetric strain θ. The SHPB set-up was also used to determine dynamic behaviors of two rocks' specimens *3*, i. e. the gabbro-diabase granite and two kinds of marble placed between measuring bars *1*, and tested in compression (compressive forces P_c) as well as in tension (splitting forces P_t – see Fig. 2) at high strain rate about 10^3 s^{-1}.

Shock wave tests

Plane-shock wave testing of following soft soils: sand of various grain structures and humidity, loams (dry and at humidity 25 %) and clay of natural humidity and original structure, was used to study their compressibility at higher strain rates and pressure up to 2GPa. Soils' specimens confined in steel jackets and placed between screening and thrust plates, were impacted by a plate-striker – Fig. 3.

EXPERIMENTAL RESULTS

The first example of strain rate effects on tensile strength of rocks from Koelga and PervoUralsy Regions in Russia obtained from static and dynamic splitting tests is showed in Fig. 4. Next examples of dynamic compressibility of a dry and wet sand in ranges of small stresses, determined with the help of the SHPB technique, and in ranges of high stresses - by the

plane-wave experiments, are also presented in Fig. 5. Between these results, there is a small site, experimentally uncertain. It is visible, that the results obtained with the help of various methods satisfactorily correlate.

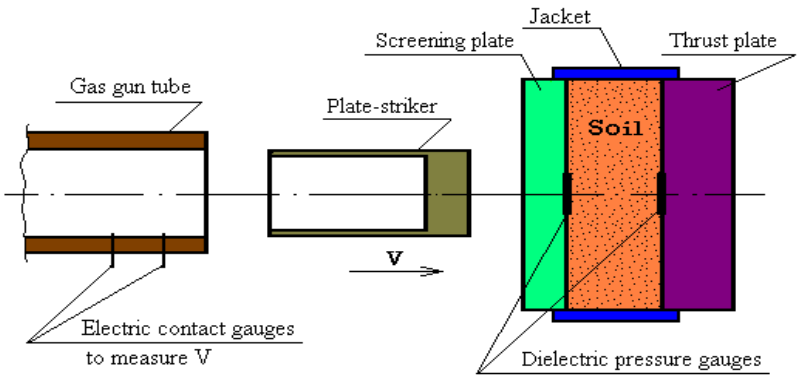

Fig. 3. Scheme of shock-wave test

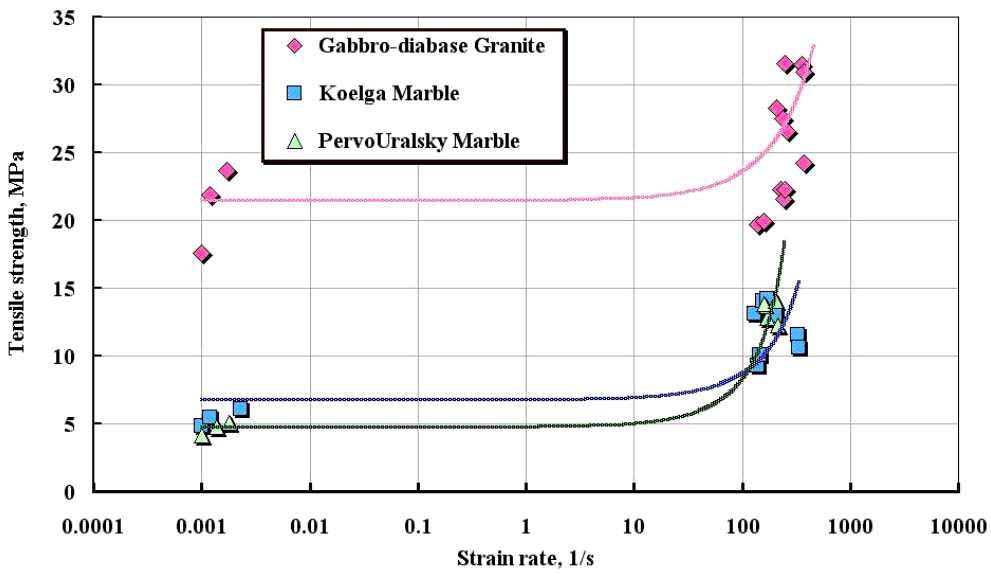

Fig. 4. Strain rate effects on tensile strength of rocks from static and dynamic splitting tests

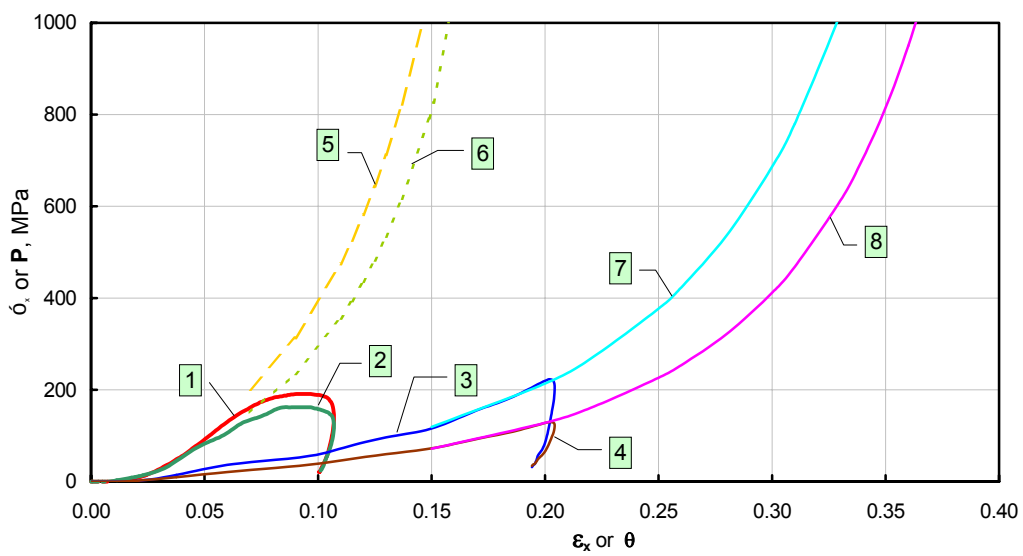

Fig. 5. Examples of "stress σ - strain ε_x" curves for wet (1 & 2) and dry (3 & 4) sand obtained from SHPB tests, and "pressure P_i - volumetric strain θ" curves for wet (5 & 6) and dry (7 & 8) sand from plane-shock wave tests

CONCLUSIONS

Thus, as a result of the carried out experiments the effect of humidity as well as grain structure on both dynamic and shock compressibility of soils is discussed. The possibility of use of complementary experimental techniques for research of a dynamic behavior of soil and rock materials, in a wide ranges of strain rates and pressures is presented.