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Experimental study of the slow motions related to deformation localization in granular medium.

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An effect of deformation localization in geomaterials (granular medium in that number) was studied previously both theoretically and experimentally and results were described in numerous papers. Nevertheless, the dynamics of the disturbance propagation, which leads to forming localized deformation bands in dilatant materials, was not fully researched yet. In the presented paper, the results of experimental study of deformation localization band appearance and propagation in sand are presented. The measurements of the sand strains were made with the help of original resistance sensors made of graphite powder. Two types of sensors were used. First type ("linear" sensors) was a strip of graphite powder, which was poured through a template in needed place inside sand. The strip resistance variation was registered with the help of two contacts inserted in the ends of the strip. Those linear sensors were sensitive not only to their deformations but also to variation of the powder density under stress variations in the surrounding medium. To distinct "linear" deformation from density variation, the second type of sensors was made which were sensitive only to stress variations. Thin cooper plates were glued on the both sides of insulator plate, the plate was placed in a cavity filled with graphite powder.

In the first series of experiments we filled up the box (dimensions $100\times50\times30$ cm) with the sand. The bottom of the box consisted of two thin metal plates; the box was placed on the table. One of the box walls was moved aside together with the half of the bottom, so that the sand was subjected to localized tension. Velocity of this motion was varied in experiments from 0.005 mm/sec to 0.5 mm/sec. In the second series of experiments the sand was poured on a rubber plate. The sand layer dimensions were 6-15 cm in height and 50x30 cm in bottom. The rubber plate was extended uniaxially, so that the sand layer was under uniform bottom tension. The sensors were placed on several levels along tension axis inside the sand.

In the first type of the experiments the deformations were localizing in a system of near parallel shear bands, which were appearing consecutively. In the second series of experiments the localized deformations appeared on the surface of the sand simultaneously.

An analysis of obtained data showed that localized shearing was preceded by localized decrease of the sand density. The strain localization started when the sand deformation reaches 10%. During uniform bottom tension the number of localization bands decreased from the sand upper side to bottom. The deformation localization bands rose from the area of disturbance upward with velocity 4 ± 2 mm/sec. The most remarkable is that this velocity occurred to be independent from the sand deformation rate in the studied range. It is interesting that this velocity corresponds to 100 km/year, that falls in the range of so-called deformation waves, which were detected in the upper layers of Earth crust by indirect indications (for example, by the velocity of earthquakes' epicenter migration).