

Effective energy absorbing unit made of natural materials in seismic isolation systems

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ABSTRACT: Energy absorbing unit consisting of loaded reinforced concrete plate and loose material of natural origin is proposed as an effective and low-cost system for seismic protection of buildings. Gravel, broken stone, sand, etc or combinations of the above mentioned materials are used as loose material. Energy absorbing unit is placed into flexible base isolation systems of different kinds. This unit can be used for different buildings. The advantages of the unit are the following: simplicity of construction; effective damping of seismic vibrations; stable and high characteristics; capability of adjusting the limit resistance to displacement; smooth switching on and off at the start of the earthquake; high reliability. Extensive experimental and theoretical studies have been done and some recommendations concerning the use of the unit have been worked out.

1 EXPERIMENTAL RESEARCH

A special plant has been designed for experimental research. Different factors were considered in designing this plant: basic period of the building on the base isolation system being 1sec-2sec; changes of the vertical forces on the reinforced concrete plate; changes of reinforced plates surfaces; the use of different kinds of loose materials; availability of moisture, etc. The plant was put into motion mechanically. The main results of the experiment are the following. Coefficients of friction of loaded reinforced plates against loose material range from 0.5 to 0.95, those of the reinforced plates with ribbed surface and metal rods against the broken stone having maximum values. This is important for the selection of damping parameters of the system. Coefficients of friction change insignificantly with the moisture, which is very important for maintenance of energy absorbing units. Analysis of experimental diagrams of deforming shows, that these diagrams have curve sections. These sections represent loading, stabilizing and unloading. The development of microplastic friction deformations in the loose material are the main cause of curve

sections. Due to this factor energy absorbing units have smooth switching on and off at the moment of the earthquake.

2 THEORETICAL RESEARCH

Analysis of effectiveness of energy absorbing unit in seismic base isolation systems is carried out on simplified models and lumped mass models. These models took into account the turn of the building about the base foundation, types of stiffness and damping of structural elements of the building, different kinds of flexible supporting elements in the base isolation system, types of the ground and the diagrams obtained in the experiment. Earthquake accelerograms were used for dynamic analyses of the models. The studies show, that the effectiveness of the proposed system of building protection depends on the character of the earthquake. This system is effective for high- and medium-frequency earthquakes, seismic forces decrease twofold and more. For low frequency earthquakes with deep center the decrease of seismic forces is not big, but the damping parameters are very significant. It is proved, that the energy absorbing unit in base isola-

tion system prevents the appearance of the highest forms of vibrations in the building. Influence of the turn deformations on seismic forces insignificant. Experimental and theoretical studies have been used for working out some recommendations for civil and industrial engineering. The cost of the proposed protection system is rather low.