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VIBRATING PLATFORMS WITH HYDRAULIC ACTUATION

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Abstract: *The article refers to the need to train the population for rational behavior in the case of earthquakes with a high degree of danger. An efficient training can be performed with the help of vibrating platforms to model the oscillations of the bark that occur in the case of an earthquake with a magnitude of 5-7 degrees on the Richter scale. A large part of the population did not experience an earthquake of more than 5.5 degrees during life and as a result, in such cases, panic will develop, which will easily lead to an increase in the destructive effects. Within the article some schematic solutions of mobile vibrating platforms, hydraulically operated and a solution completed with a patent application will be presented.*

Keywords: *Mobile vibrating platform, servo cylinder, earthquake, oscillatory movements*

1. Introduction

The earthquake represents an oscillatory movement, usually abrupt and of internal origin, of the tectonic plates in the earth's bark, which releases a large amount of kinetic energy. This energy creates seismic waves, thus producing extremely strong oscillations at ground level resulting in significant material damage and loss of human life. The situation at national level is quite disappointing, if in the case of the buildings there were improvements of design, execution and consolidation of the old buildings, in the case of the population nothing was implemented in the field of population preparation in case of earthquake. During the great earthquakes, such as those of 1681, 1738, 1802, 1838, 1940 and 1977, there were a high number of victims, which could have been reduced if mass training of the population had been carried out previously, thus managing to be saved numerous lives. And now this danger persists especially in crowded areas or with intense traffic. Although the earthquakes last several seconds, their effects are catastrophic.
Following the analysis of the usual earthquakes that take place in our country, the following phases of a seismic movement result: - the initial phase with oscillations of the order a = 0.001 g - 0.002 g (0.5 g) with a duration of 2-18 s (g = gravity acceleration); - the main phase, with major oscillations of over 0.05 g, but especially with accelerations a = 0.1 - 0.2 g and a duration of 10 - 50 s (for magnitudes M = 5.5 - 8); - the final phase of gradual amortization of the oscillations, up to the limit of perception, with a duration of 17 - 30s.

2. Simplified solutions of hydraulic vibrating platforms

Figure 1 shows a simple variant of vibrating platform consisting of:

- Servo cylinder 1
- The point of support and articulation
- Pulse attenuator 3.

By actuating the servo cylinder 1 with a frequency of up to 30 Hz, a vibrational movement occurs on the vertical axis around the point of articulation 2. The role of cylinder 3 in this scheme is to dampen the oscillation or to induce a load by drilling it, so it will oppose the movement generated by the cylinder 1 and will decrease the amplitude of the vibrations.

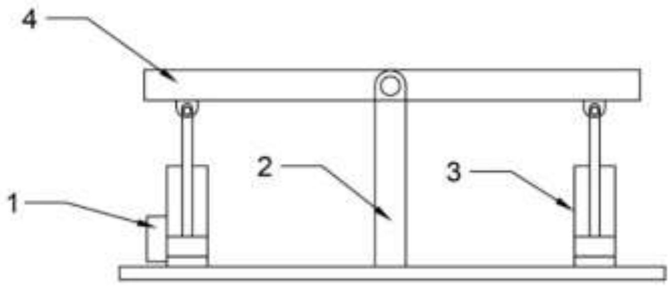

Fig. 1.

In Figure 2 is represented another variant of the vibrating platform, but this time without a pulse attenuator.
The platform consists of:
- Servo cylinder 1
- The support point and joints 2
- The platform itself 3.

Unlike the previous figure, the cylinder with the role of pulsation damper was replaced with a hinged point and we reset, so that the movements performed by the servo cylinder 1 are directly transmitted to the platform 3.

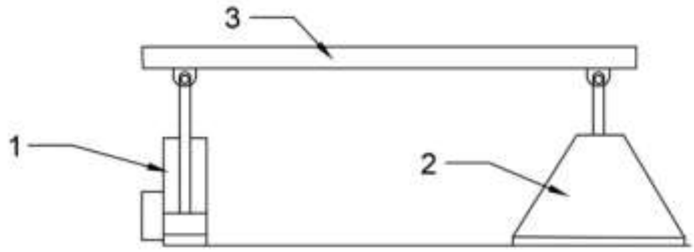

Fig. 2.

Figure 3 shows a simple variant of a horizontal vibrating platform consisting of:
- Servo cylinder 1
- Plate 2
- And the point of articulation 3.

Unlike the platforms in Figures 2 and 3, which generate an oscillatory movement along the z axis, the platform shown in Figure 3 produces an oscillatory movement in the horizontal plane x, y. By actuating the cylinder 1, there is an oscillation movement around the joint point 3. The movement transmitted by the cylinder to the platform 3 is an unamortized one.

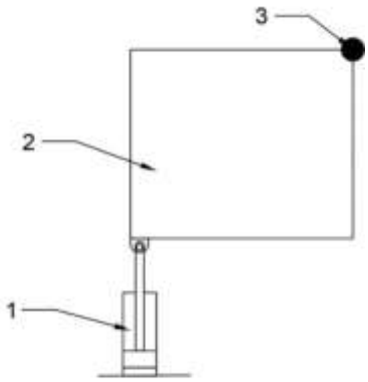

Fig. 3.

3. Solutions of mobile vibrating platforms worldwide

Figure 4 shows a mobile platform called Big Shaker, made by the company QUAKEHOLD from America and is able to simulate earthquakes up to 8 degrees on the Richter scale.

Fig. 4.

Figure 5 [1] shows a mobile earthquake simulation platform in Alaska, which is included in a governmental population training program on the state of seismic production in that state.

Fig. 5.

Figure 6 shows a mobile earthquake simulation platform "called Quake Cottage" [2] and can simulate earthquakes up to 9.5 degrees on a Richter scale. The platform is equipped with various elements of furniture and equipment to be able to observe what happens to them during the production of a large earthquake and the importance of securing some of them.

Fig. 6.

Figure 7 shows another type of mobile earthquake simulation platform used in Japan. As can be seen from the pictures near adults, children are also trained to acquire appropriate behavior in the event of an earthquake.

Fig. 7.

4. Presentation of the vibration platform solution placed on a car trailer

The mobile vibrating platform presented in figure 8, is placed on a car trailer, which gives us the possibility to tow it where it is needed and has been the subject of a patent application, requested by specialists from the National Institute for Research and Development INOE 2000-IHP .
The vibrating mobile platform according to the invention, is made up of a trailer platform (2) which is equipped with a folding hydraulic servo cylinder (fig. 8 pos. 6), located on the small rear side, mounted on the ground in the working position and two folding classic hydraulic cylinders (figs 8, 4 and 5), with a patina on the head of the rod which in the working position have a distance of 50-100 mm from the ground. They are fed from a hydraulic station (fig. 8 pos. 3) through distribution devices and are commanded to execute movements with the help of a controller that allows manual control or after preset programs. The servo cylinder exerts on the platform vibrational movements controlled in vertical direction in the range 0-50 mm and 1-30 Hz. Cylinders located on the side periodically crash into the ground and print to the platform a lateral swing movement in both directions. From this combination of movements you can obtain oscillatory movements of the platform similar to the real situations created by the production of an earthquake.
During the simulation, the wheels are tightened and the trailer is mounted in the front (fig. 8, picture 1) or remains fixed on the tractor head. The amplitude of the movement is taken up by the platform springs and the deformation of the tires which during the simulation remain permanently in contact with the ground.
The hydraulic station (fig. 8 pose 3), is located under the platform, and the three cylinders are foldable with clamping and fastening under the platform so that it can be transported safely on the roads. Depending on the consumption and location, the power supply can be done from the network or from a power generator.

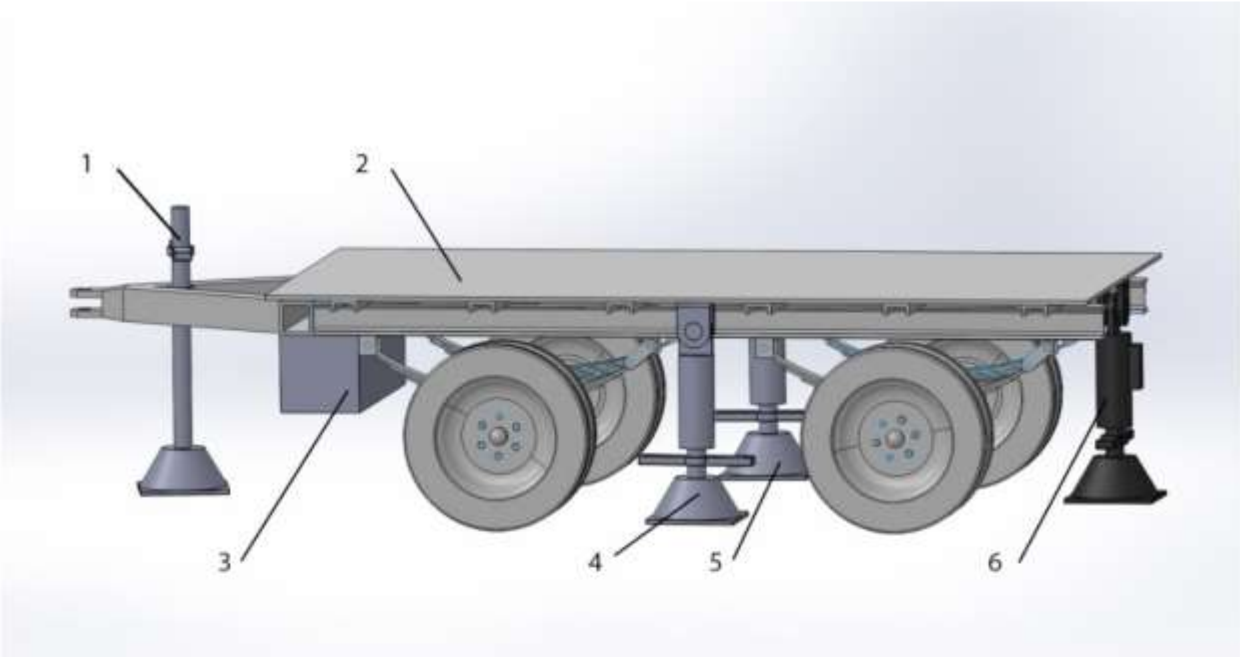

Fig. 8.

The hydraulic diagram shown in Figure 9 performs all the movements necessary for the simulation in real conditions of production of an earthquake.
The hydraulic system shown in Figure 9 is an open system consisting of a basin, on which is filled the filling filter 11, the submersible pump 12 and the electric motor 13 attached to the pump and located on the tank cover, return filter 14 which contains a clogging indicator and the level indicator 15.
Considering that the pump 12 is a fixed flow pump, which is not adjustable, as a protection element against its start-up, the distributor 10 is provided, which at the time of start-up is in the open position, thus making the direct connection between the pump and tank refueling. After starting the pumps, the electromagnet of the distributor 10 is actuated and the pump delivers flow into the system. Also on the discharge route of the pump is provided the manometer 8 to be able to read the pressure in the system, as well as the safety valve 9 that protects the pump in case of overpressure in the system, releasing the pressure to the tank.
On the supply path of the solenoid valve 3 there is also a filter 7 for the protection of the solenoid valve, because it is sensitive to impurities in the system.
Hydraulic cylinders from position 4 and 5 are operated by distributors 1 and 2 to create periodic shocks on the side of the platform, in order to obtain the lateral oscillations. Distributors 1 and 2 in the closed position keep the cylinder stem retracted, remaining prepared for a new balance impulse that should be applied to the platform according to the scheduled scenario.
The vibrations of the servo cylinder - the frequency and the amplitude - are controlled by the solenoid valve 3, also according to the programmed scenario.

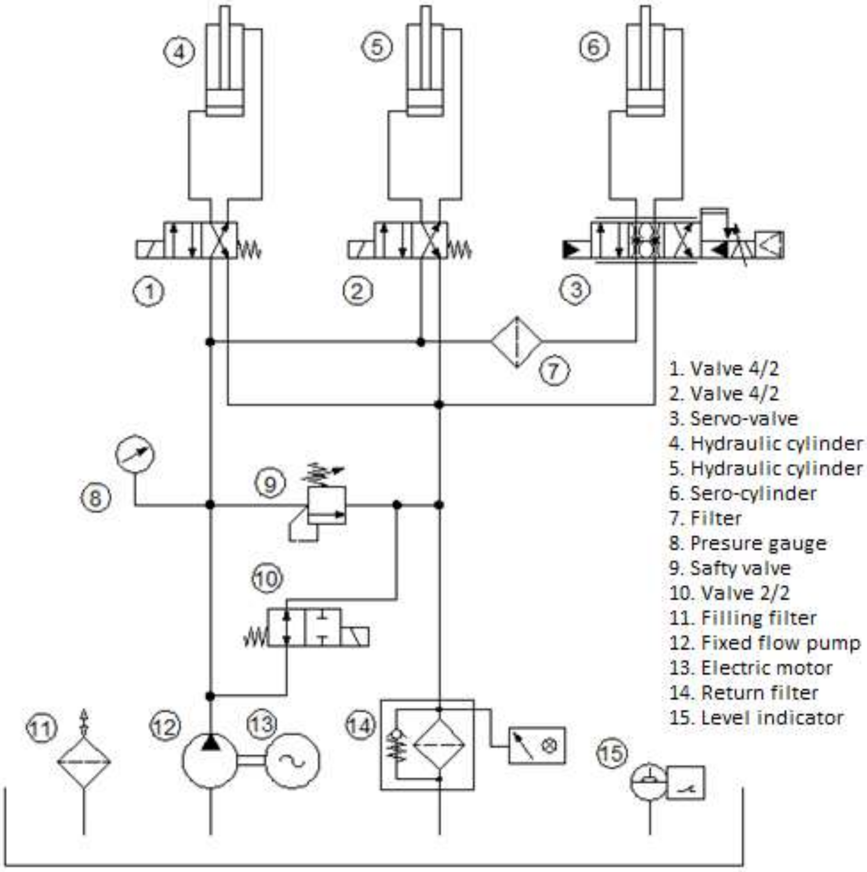

Fig. 9.

5. Conclusions

Romania is among the few countries affected by the intense seismic activity, which has not implemented a program to prepare the population for appropriate behavior in case of a large magnitude earthquake. This population preparation program should be implemented especially in areas with high population density in order to control the effects of panic among the population.
The implementation of such programs also implies the development of such indigenous platforms to support the training programs.
The authors of the article will try to develop such a mobile platform for training the population in case of earthquakes, by applying to different national and European competitions for project submission, but also by seeking beneficiaries from the state institutions that want such equipment.

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