MULTI-PENDULUM SEISMOMETERS OF NEW DESIGN

by

B.K.Karapetian[I], A.S.Mouradian[II], A.K.Mouradian[III], A.G.Nazarov[IV]

SYNOPSIS

A new design of multi-pendulum seismometer is devised, made up of a system of linear oscillators with various periods of free vibrations and damping decrements, with the help of which one can obtain directly reaction spectra of buildings and structures in strong earthquakes and explosions. Gauging is made and the work of the device checked on a specially devised platform and also during blasts in quarries.

INTRODUCTION

It is commonly known that more exhaustive information on the seismic force is obtained from the accelerograms of strong earthquakes. However, at present the problem of fixing strong earthquakes with devices of simpler design remains to be an important issue, one of which is the problem of multi-pendulum seismometers [1,2] . The analysis shows that at the given period of free vibrations and damping decrements of the linear oscillator its reaction (elastic reaction attributed to the mass unit, i.e. the reduced seismic acceleration) depends by no means on the designing features of the oscillator itself. This allows the recordings obtained from multi-pendulum seismometers to be applied to the study of the vibrations of elastic systems with one degree of freedom and also make some rough estimates of the behaviour of real structures. Another advantage of the device is the fact that no maintenance is required during its operation and it is durable. The multi-pendulum seismometers are capable of recording the most powerful earthquakes (we have established a recording of seismic reaction in 16g) and can be of great use even in catastrophic earthquakes.

I Doctor of engineering sciences,Professor;Yerevan Polytechnic Institute,Institute of Geophysics and Engineering Seismology,Academy of Sciences,Armenian SSR.

II Engineer-designer;Institute of Geophysics and Engineering Seismology,Academy of Sciences,Armenian SSR.

III Engineer-designer;Institute of Geophysics and Engineering Seismology,Academy of Sciences,Armenian SSR.

IV Academician,Doctor of engineering sciences,Professor; Institute of Geophysics and Engineering Seismology, Academy of Sciences, Armenian SSR.

PARTICULARS OF THE CONSTRUCTION AND TESTING RESULTS OF THE DEVICE

The multi-pendulum seismometer IGIS-1 possesses 10 linear elastic spherical vertical pendulums with the following periods: 0.05; 0.1; 0.15; 0.2; 0.25; 0.3; 0.4; 0.6; 0.8; 1.0 sec for recording horizontal components of vibrations and four polarised horizontal pendulums with periods: 0.05; 0.1; 0.15; 0.2 sec for recording vertical components of vibrations. The damping decrements of the pendulums vary within the range 0.3-0.5, depending on the period of their free vibrations (the lesser value corresponds to the greater period). High pressure polyethylene is used as spring material;at the same time it serves as a damper which fact simplifies the construction of the device in large measure. The recording is done with a pointer on smoked glass inserted in flutes which the movable tables,common to all vertical pendulums, are provided with. Recordings of vibrations with the help of horizontal pendulums are made independently, and they somewhat differ in design. Fig.1 illustrates a cross-section of the multi-pendulum seismometer.

The reduced seismic acceleration τ is deduced from the following expression according to the maximum relative deflections of the pendulums f :

$$\tau = K f$$

where $K = \frac{g}{a}\left(\frac{T_0}{T}\right)^2$ is the coefficient which is properly marked in the certificate of the device and is determined as a result of gauging; the gauging of the device consisted in determining the vibration periods with elastic rigid fixing for each pendulum - T and the rotation freely suspended from the center-T_0 , the damping decrement - δ and also the distance from the center of the rotation to the recording pointer - a.

The tests of the two devices of the above design were made on a specially built universal gauging platform of simplified design with a range of vibration periods 0.05-4.5 sec and vibration amplitudes 0.1-200 mm as well as in field conditions during powerful blasts at pumice quarries. The results obtained are accordingly enlisted in Figs 2 and 3. The devices were also experimented at various temperatures and showed rather a high stability of mechanical characteristics when the temperature range varied from -40°C to 50°C.

REFERENCES

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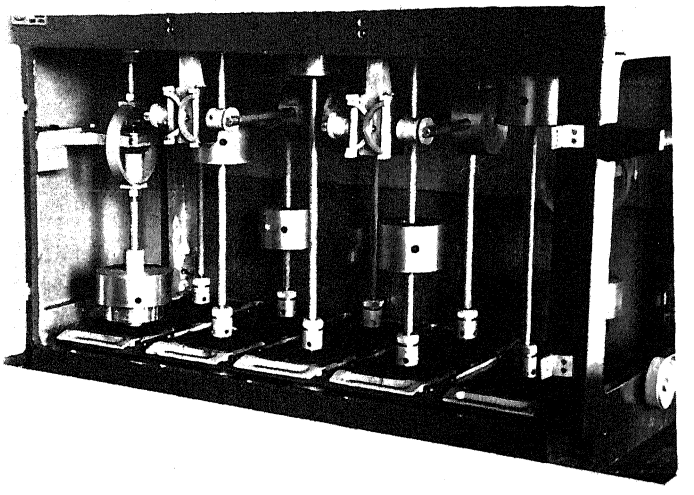

Fig.1 A cross-section of the multi-pendulum seismometer IGIS

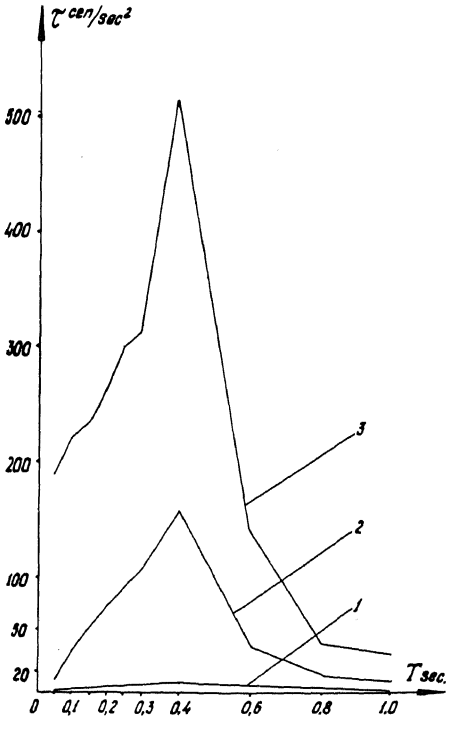

Fig.2 Curves obtained during tests on the platform

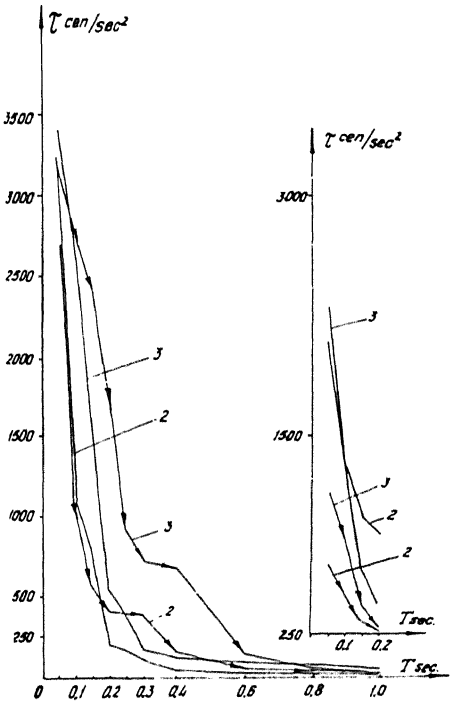

Fig.3 Curves obtained during explosions