

# DYNLAB-Seismic Shaking Table

## General

Future development of earthquake engineering as a scientific discipline and its practical application in the aseismic design of structures and equipment is closely related to the possibilities for a reliable experimental verification of the existing analytical models. The technical characteristics of the earthquake simulation system installed in the Dynamic Testing Laboratory of the Institute of Earthquake Engineering and Engineering Seismology, Skopje, provide possibilities for performance of very complex scientific investigations and practical testings necessary in the process of the design and construction. Besides, the system is suitable for performance of various tests for investigation of operational conditions of the mechanical equipment subjected to earthquake or other dynamic effect

## Technical Performances

The table on which structural models are installed in order to be subjected to a biaxial earthquake motion, is a prestressed reinforced concrete plate, 5.0 x 5.0 m in plan.



The table is supported by four vertical hydraulic actuators located at four corners at a distance of 3.5 m in both orthogonal directions. The table is controlled in horizontal direction by two hydraulic actuators at a distance of 3.5 m with a total force capacity of 850 kN. The four vertical actuators have a total force capacity of 888 kN.



In order to provide the required power of the actuators, three inter-connected hydraulic pumps, with a maximum flow of 1,250l/min and a maximum pressure of  $350 \times 10^5$  Pa are used. The required electric power to feed the three pumps is 1,020 A. In order to increase the working flow of the system, four additional pressured accumulators with capacity of 60 litres of hydraulic fluid are used.



The gravity load due to table and the model mass is sustained by a special system with static supports which utilizes nitrogen. The total bearing capacity for static loads is 720 kN. This system is located in the lower part of each of the four vertical actuators.

In testing of tall and slender models, the horizontal acceleration of models might initiate rocking of the table. This freedom is controlled by introducing an automatic additional

motion of the vertical actuators which are capable of controlling the overturning moment of the table amounting to 460 kNm.

The horizontal and vertical actuators of the table are supported by reinforced concrete rigid structure. The total mass of the supporting structure is 12,000 kN. This structure is separated from the rest of the laboratory structure by an expansion joint.

The shaking system controls five degrees of freedom of the table, two translations and three rotations. Motion of the table along the third axis of translation is prevented by special hydraulic supports so that one of them controls the force and the other - the displacement. The analog control system controls displacement, velocity, differential pressure and acceleration of the six actuators. Reverse control is provided by three-variable servo control system which is capable of controlling displacements, velocities and acceleration, simultaneously. This three-variable control system is a new technological solution which has many advantages. One is that under low frequencies, the system provides control in respect to displacements, while for higher frequencies - in respect to acceleration.

For earthquake generation and data acquisition [modular PXI system is used](#).

## **System Application**

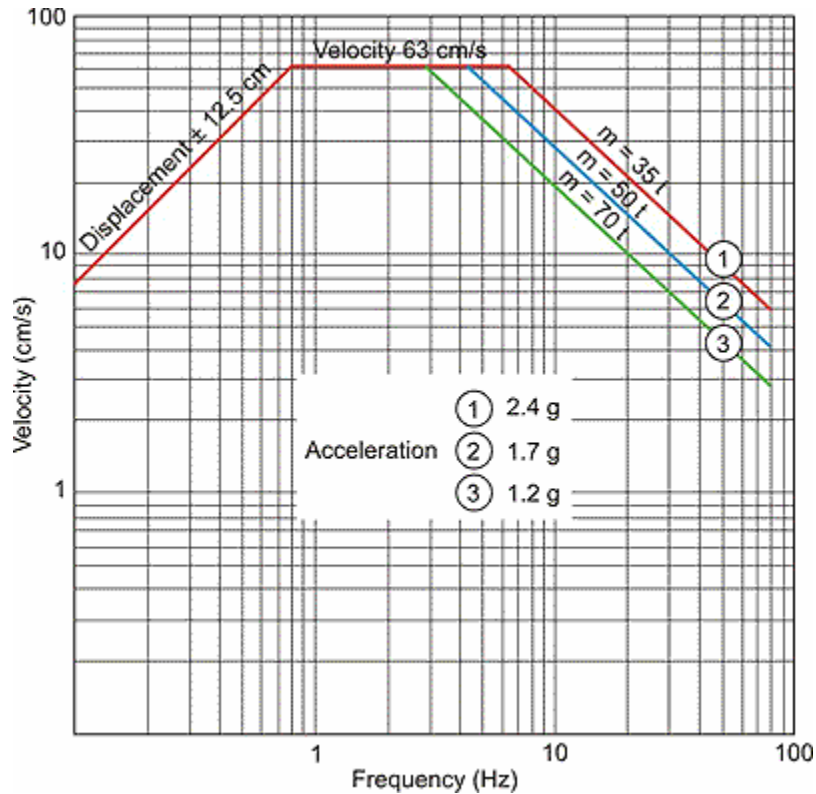
This simulator of earthquakes or other dynamic loads has a wide range of applications in testing of models of civil engineering structures, mechanical and electrical equipment. Its high technical characteristics enable testing of:

- Models of buildings or structural assemblages in given scale, subjected to actual earthquakes.
- Models of bridges and dams made of different materials.
- Models of power supply and industrial buildings under specific dynamic loading conditions.
- Models of nuclear power plants.
- Models of special structures such as: water towers, tanks for storing of different gas or liquid materials, cooling towers, stacks, etc.
- Models with base control systems and other types of structural control systems
- Mechanical testing and development of dampers for power transmission lines.
- Electrical equipment subjected to different dynamic effects such as: transformers, electromotors, switches, PTT systems, etc..
- Mechanical equipment and transportation facilities.
- Mechanical and electrical equipment as consumer goods.
- verification of operational safety of equipment components in nuclear power plants subjected to earthquakes.
- Proof testing of different products subjected to dynamic or earthquake effects, as required by standards.

## **Technical Parameters**

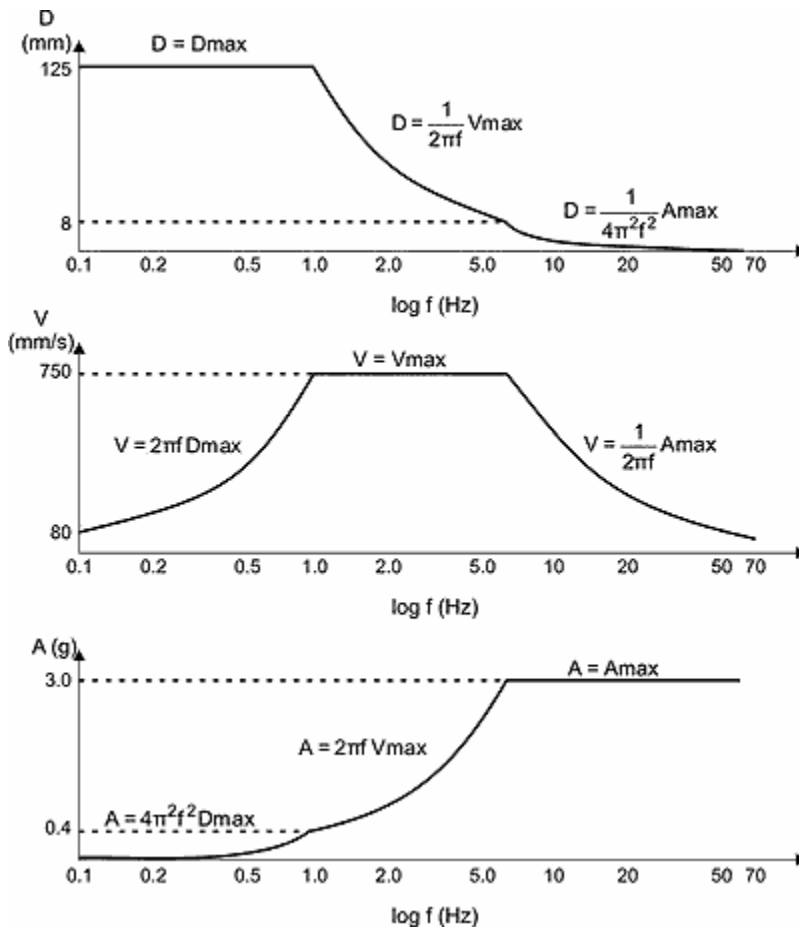
Size	5.0 x 5.0 m
Mass	330 kN
Natural Frequency	48 Hz for maximum loading mass placed in the center of the table
Material	Pre-stressed Concrete
Actuators	Vertical: 4 x 222 kN Horizontal: 2 x 425 kN
Maximum Model Mass	400 kN with a height of 6.0 m
Maximum Acceleration	Vertical: 0.50 g Horizontal: 0.70 g
Maximum Displacement	Vertical: $\pm 0.050$ m Horizontal: $\pm 0.125$ m
Frequency Range	0 - 80Hz
Maximum Overturning Moment	460 kNm
Capacity of the Hydraulic System	Static: 35 MPa Operating: 21 MPa
Analog Control	Servo Controlling Closed Loop System

### Dynamic properties of the IZIIS' biaxial seismic shaking table

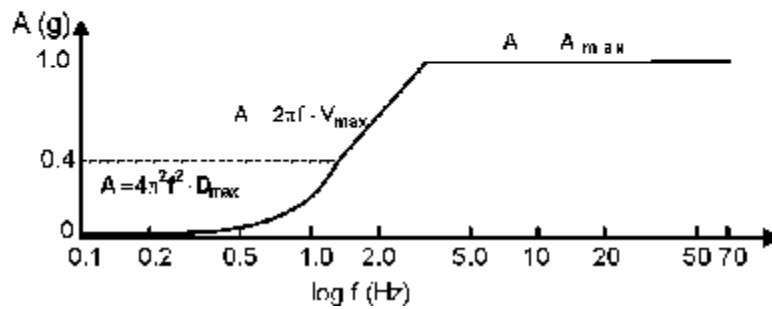
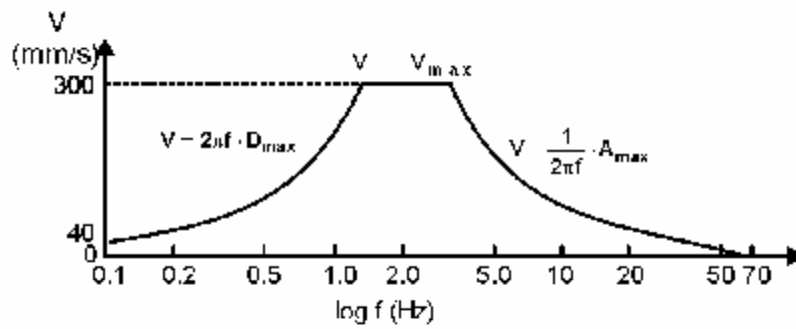
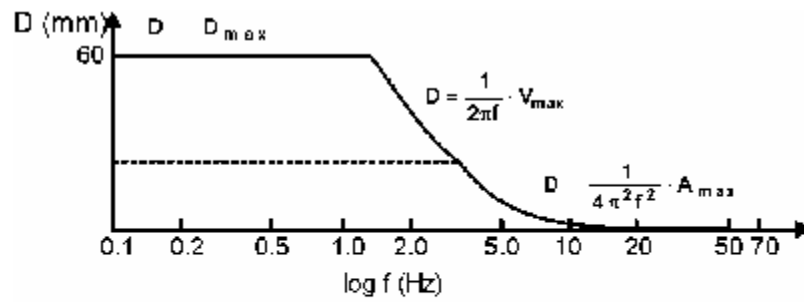


# Displacement, velocity and acceleration characteristics

horizontal direction



vertical direction



[IZIIS-Skopje, R. Macedonia](#)