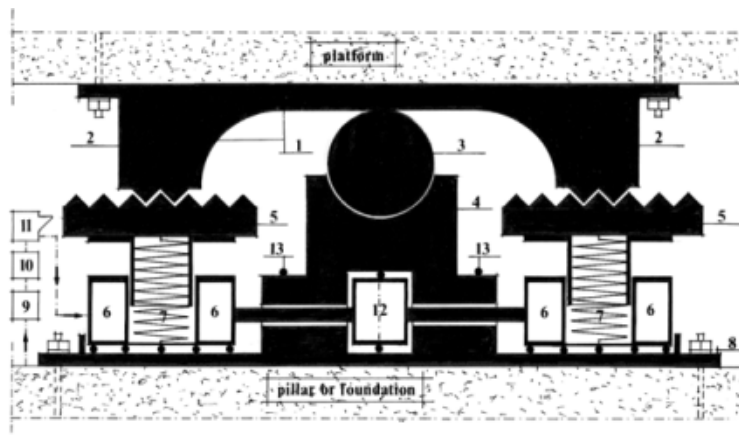
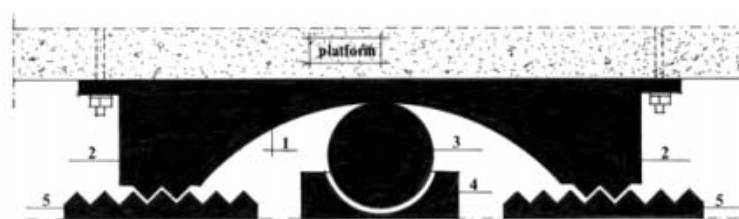


## Aseismic Bearing with Partially or Totally Curved Sliding Surface and Angular Corrector

**Figure 1**



**Figure 2**



### **Constitution**

The bearing consists of:

- a. a steel sliding surface (1), the central part of which is flat and horizontal, while the perimetric one is circular (see figure 1). Surface (1) may also have a totally circular section (see figure 2). It is connected to the intrados of the overhanging platform;
- b. four steel bodies (2), placed in accordance with the two horizontal and perpendicular diameters of the sliding surface (1) and linked to it. The lower part of each body has a steel toothed surface;
- c. real bearing (3), consisting of a movable steel ball (bearing with rolling friction) or of fixed steel ball coated with a thin layer of Teflon (bearing with sliding friction);
- d. body (4) containing the ball (3), connected below to steel plate (8);
- e. four devices placed in accordance with the vertical axes of the corresponding bodies (2), each of which consists of:
  - movable steel mass (5), surmounted by a steel toothed surface;
  - electromagnets with keeper (6);
  - pre-stressed spring (7).

These movable devices rest on the steel plate (8) and may be subjected to a circular motion. On the upper part they penetrate, through of the steel teeth of the vertically movable masses (5), into the corresponding steel toothed surfaces of the fixed bodies (2);
- f. steel plate (8), linked to the pier of foundation;
- g. sensor (9);
- h. electronic control station (10);
- i. electricity generator (11);

- j. angular corrector (12), firmly attached to each of the four devices referred to in point e.;
- k. sensors (13), able to start up the angular corrector (12) electronically.

### **Operating principle**

In absence of an earthquake, and due to the elastic reactions of the pre-stressed springs (7), bodies (2) and (5) are perfectly connected to one another by means of the mutual penetration of the respective steel toothed surfaces and the bearing is therefore fixed. When an earthquake starts, the sensor (9) registers the seismic vibration and the electronic control station (10) closes the electric circuit of the electricity generator (11).

The electromagnets (6), started up by the passing current, create a magnetic field, which attracts the masses (5) downward, winning the elastic reactions of the pre-stressed springs (7). In this situation the masses (5) and (2) are totally independent from one another and the bearing becomes movable and, therefore, free to translate horizontally with respect to the overhanging building, which remains almost motionless under the prevailing action of the weight force.

Since the horizontal inertial force in the building does not depend on the seismic shock parameters (displacement, acceleration and frequency), it is constant and negligible if the bearing is with rolling friction, and is constant and minor if, on the other hand, the bearing is with sliding friction. The total inertial force in the building is:

$$F_{i,b} = c_f P_b \quad 1)$$

where:  $c_f$  is the friction coefficient between the building and the bearings,  $P_b$  is the total weight of the building.

At the end of the earthquake, the electronic control station (10) reopens the electric circuit of the electricity generator (11) and the absence of a magnetic field in the electromagnets (6) allows to the pre-stressed springs (7) to raise the toothed masses (5), which, penetrating into the corresponding toothed masses (2), lock the building. In this situation the bearing becomes fixed. It should be noted that the centring of the building does not always occur. This is not half- very important because it does not have any negative repercussions on the general equilibrium of the building, since any eventual residual displacement of the bearing is minor.

The lock of the building is, on the other hand, always guaranteed, even if there is any slight eccentricity in the load, due to the greater size of the toothed surface of masses (5) with respect to masses (2). In addition, the curvature along the entire perimeter of the sliding surface allows the bearing to centre spontaneously and partially when a displacement of the foundation-soil complex exceeds the diameter of the central part of the sliding surface. In this situation the total inertial force in the building is:

$$F_{i,b} = \cos^2 \alpha \arcsin \left( \frac{\sqrt{2} S_h - d}{2 R} \right) c_f P_b \quad 2)$$

where:  $S_h$  is the horizontal displacement of the foundation-soil complex,  $d$  is the diameter of the central part of the sliding surface,  $R$  is the curvature radius of the perimeter part of the sliding surface,  $c_f$  is the friction coefficient between the building and the bearings.

If the sliding surface has an entirely circular vertical section, on the other hand, the self-centring of the building at the end of an earthquake is total, while, during an earthquake and due to the horizontal displacement of the foundation-soil complex, the building is subjected to a vertical

displacement according to the curvature of the entire sliding surface. The inertial force in the building is:

$$F_{i,b} = \cos^2 \Psi \mu r \sin(S_h / R) \beta c_f P_b \quad 3)$$

where the symbols are already known.

It should be pointed out that, during an earthquake, the building could be subjected to a little rotation round to its own vertical axis when the bearing has a partially curved sliding surface. In this case, the building would not be able to lock at the end of an earthquake, due to the imperfect reciprocal connection between the toothed masses (2) and (5). This drawback could be overcome using an angular corrector (12), which is integral part of each bearing. It is electronically started up by the sensors (13) and allows the circular translation of the four devices made up by (5), (6) and (7), until the building rotation has been completely compensated. In this way the toothed devices (5) are perfectly connected to the toothed masses (2) and the building locks.

**N.B. The bearing needs accurate experimental tests**