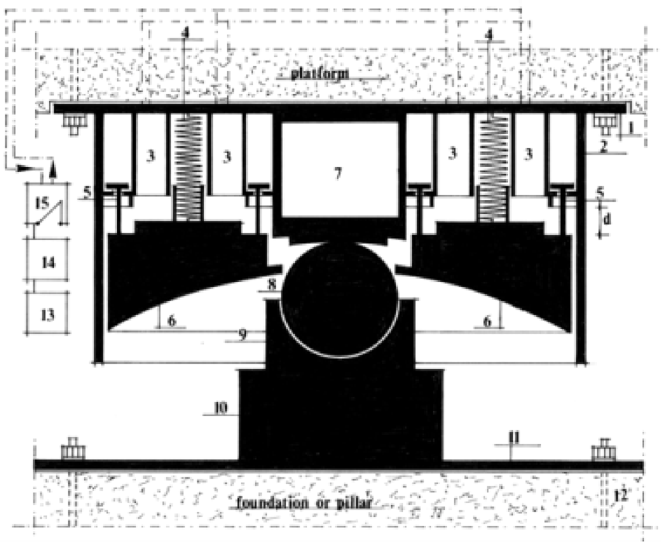
Centering and Locking Bearing for Earthquake Isolation

Figure



Constitution

The bearing consists of:

- steel plate (1), attached to the platform above with anchoring bolts;
- circular perimetrical spandrel (2);
- two or more electromagnets with rotor (3);
- pre-stressed springs (4);
- movable steel vertical spacers (5);
- movable sliding spherical bowl (6);
- fixed sliding spherical bowl (7);
- actual bearing (8). It may be a fixed steel ball with the upper part covered in Teflon (bearing with sliding friction) or a movable steel ball (bearing with rolling friction);
- chamber (9) containing the actual bearing (8);
- base support (10);
- steel plate (11) connected to the foundation or pillar;
- foundation or pillar (12);
- sensor (13) for registering the seismic phenomenon;
- electronic station (14);
- current generator (15).

Operating principle

The sensor (13), firmly attached to the platform, records the earthquake when it starts. The electronic station (14) closes the electric circuit of the current generator (15) and the electromagnets (3), overcoming the elastic reaction of the pre-stressed springs (4), attract the movable sliding spherical bowl (6), thus achieving continuity with the fixed sliding spherical bowl (7).

In this situation the building is released from the bearing, which, becoming movable, may move with respect to the building due to the horizontal displacement of the foundation-soil complex.

When the earthquake stops, the electronic station (14) opens the electric circuit of the generator (15), which stops supplying current.

At the same time, the magnetic field of the electromagnets (3) stops, and the elastic reaction of the pre-stressed springs (4) pushes down the movable sliding spherical bowl (6), thus locking the bearing, after that the building centres spontaneously because of the sliding surface curvature.

The horizontal inertial force in the building is:

$$F_{i,c} = P_c \cos^2 \Psi \mathrm{arcsin} (S_o / R) \beta c_a \qquad 1)$$

where:

P_c total weight of the building
S_o horizontal displacement of the foundation-soil complex
R curvature radius of the sliding spherical bowl
c_a friction coefficient between the building and the bearing.

The attraction force of the single electromagnet is:

$$F^* = \sigma \, d \, k + (N_{c,s} / n) \qquad 2)$$

where:

$\sigma > 1$ pre-compression coefficient of the spring
d stroke of the sliding movable spherical bowl
k elastic constant of the spring
$N_{c,a}$ weight of sliding movable spherical bowl
n number of the electromagnets in each bearing.

The vertical displacement of the building during an earthquake is obtained from the following correlation:

$$\iota^2 + 2 R \iota - S_o^2 = 0 \qquad 3)$$

where: ι is the vertical displacement of the building.

N.B. The bearing needs accurate experimental tests