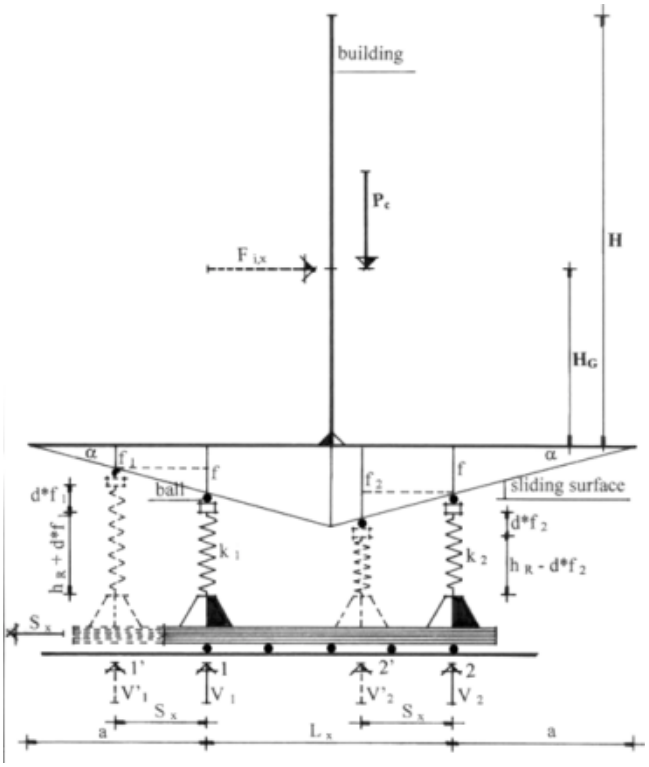
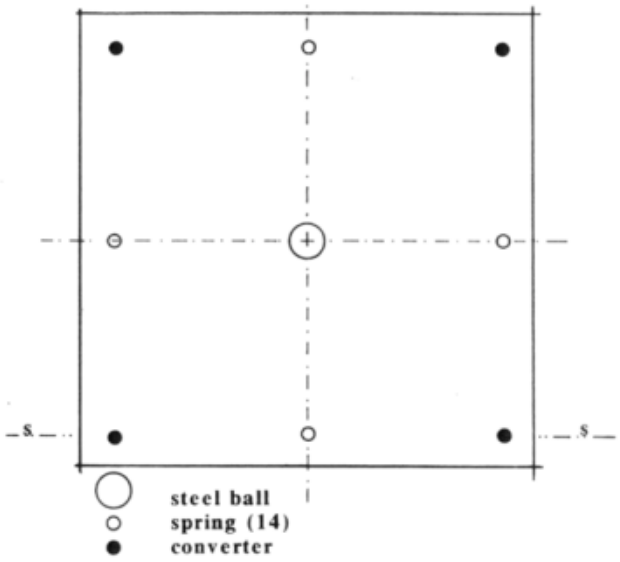
Elastic Bearing with Frequency Converters

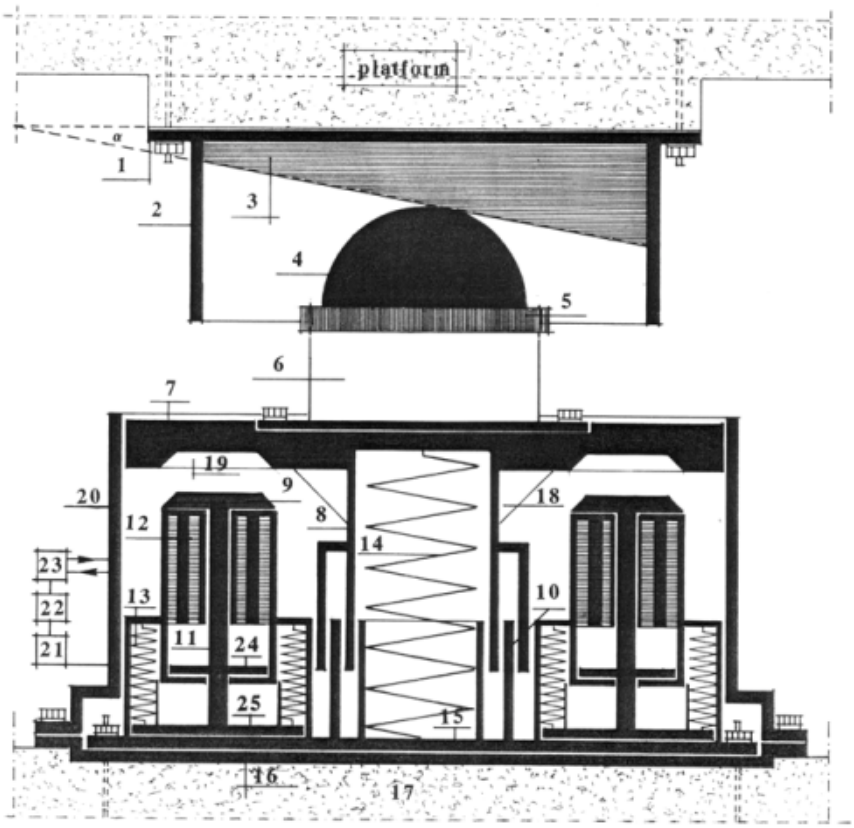
Figures



Vertical section of the system



Planimetric scheme of the bearing



The bearing – Section s-s

Constitution

The bearing consists of more devices. Some of them are fixed permanently and the others have the double function of fixed and movable devices as to the vertical translation.

Fixed devices

One of them consists of:

- steel plate (1), having a square shape, connected with anchoring bolts to the intrados of the platform;
- perimetrical steel spandrel (2), welded to the plate (1). The hollow, which it delimits, has the function of lodging the inclined sliding plane of tempered steel (3).

The other devices are the frequency converters, which may be two or four and they arranged vertically and symmetrically as to bearing axis. Their function is, as already specified, to confer the bearing the characteristic to be transformed from elastic to stiff and vice versa. Each converter is stiffly linked low-down to the steel plate (15), which is blocked to the pier or the foundation (17) by means of anchoring bolts.

The converter consists of two concentric pipes with different diameters, linked between them. In one of the pipes an electromagnet with anchor (12) and a part of the movable piston (11) lodge. The piston (11) expands in the higher terminal side with the truncated-conic mass (9) and in the lower side with the cylindrical mass (24). The other pipe lodges the lower part of the movable piston (11), which expands with the cylindrical mass (25), and the two helical springs (13).

Devices with fixed and movable springs (13)

Each of them consists of:

- two coaxial reciprocally movable pipes (8) and (10). The former is linked on the upper side to the circular steel plate (7), in the intrados of which the hollow of the truncated-conic mass (19) is made and on the extrados of which the hollow (6) of the ball (4) is connected stiffly. The pipe (10) is soldered to the plate (15) on the lower side;
- vertical spring (14), seated inside the pipes (8) and (10).

Other devices

They are:

- stiffening bracket (18);
- cylindrical hollowed container (20);
- frequency-meter (21);
- electronic control station (22);
- current generator (23).

Operating principle

In absence of an earthquake, the load transmitted from the building to the bearing compresses the spring (14), which buckles because the coaxial pipes (8) and (10) are released reciprocally. In this situation the bearing is elastic. During the motion, because of the horizontal component of the soil displacement, the foundation-soil complex moves as to the building, obliging the spring (14) to buckle further with a shrinkage and a stretch alternatively for offsetting the stiff deflection relative to bearing, caused by the inclination of the sliding surface (3).

Also the vertical component of the soil displacement, due to the sub-undulatory shock, oblige the spring (14) to buckle further. In this situation the bearing is still elastic and so it remains on condition that the frequency of the sub-undulatory shock is external to the emergency interval, defined by the formula 39). Vice versa, if the vertical component of the seismic frequency is inside the emergency interval, including the resonance frequency, the frequency-meter (21), in contact with the foundation (17) or with any other structural element stiffly linked to the foundation-soil complex, registers the emergency frequency and transmits it to the electronic control station (22).

The latter closes the electric circuit of the generator (23), which supplies the electromagnets (12) of the converters with current. The passage of the current into the solenoids makes a magnetic field, which attracts the anchors (24). The movable pistons (11) move upwards, compress the springs (13) and oblige the truncated-conic mass (9) to occupy the relative hollow (19), realising in this way, at the end of stroke, the reciprocal stillness of the pipes (8) and (10). In this situation the bearing is stiff. The spring (14), deprived of the possibility of buckling, is not able to offset the stiff deflection relative to bearing.

Therefore, the building is subject to a minor pendulous motion. As regards the other frequencies of the sub-undulatory shock, external to the emergency interval and working in phase or in phase opposition with the natural frequency of the building, the electronic control station (22) opens the electric circuit of the current generator (23) again. Because of the absence of the current, the magnetic field into the electromagnets (12) stops and the movable piston (11) returns to the initial position, thanks to the elastic reactions of the springs (13). In this situation, being the coaxial pipes (8) and (10) released reciprocally, the bearing is elastic. The elastic constant of the single spring of the converter is:

$$k^* = P^* / 2\, d^* \qquad 1)$$

where:

P* weight of the movable piston (11) and the relative masses (9), (24), & (25)

d* stroke of the movable piston

N.B. The bearing needs accurate experimental tests