SEISMIC PROTECTION OF AN OVERGROUND PARKING OVER THE DAMBOVITA RIVER BY USING THE BASIC CONTAINMENT METHOD. THE ANTI-SEISMIC PROTECTION SYSTEM.

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ABSTRACT The ideal solution to protect the buildings from earthquakes is to control and limit the transfer of the seismic energy to a construction by the maximum dissipation of the seismic energy transferred to the building, which is achieved by the use of mechanical devices with which the seismic behavior of buildings is controlled. The protection of the structures exposed to the risk of earthquake is based on the three fundamental operational modes: insulation, connection, dissipation of energy. The centrically braced metallic frames provide resilience, rigidity and ductility, being thus ideal for the bracing of the seismic systems. Seismic insulation systems are designed to reduce the impact of earthquakes on buildings by means of special devices. Seismic protection of an overground parking over the Dambovita river by using the basic containment method. The anti-seismic protection system.

Key words: The seismic energy. The anti-seismic protection system

1. INTRODUCTION

The concept of insulation of the base is the fundamental principle of the insulation of the base is to change the building's response so that the terrain moves under the building without transmitting its movement.

The principle of these isolators is the modification of the connection between structure and its basis so as to produce a reduction of the lateral rigidity and an increase of its fundamental period. [1]

2. SEISMIC PROTECTION OF AN OVERGROUND PARKING OVER THE DAMBOVITA RIVER BY USING THE BASIC CONTAINMENT METHOD.

The ideal system would consist of a total separation, but in reality it is necessary to have several areas of contact between structure and land [2]

The Design/consolidation method by isolating the base "(fig 1) consists in increasing the fundamental vibration period, decreases displacement. This method can be applied in case of the overground parking. This consolidation was also applied to Bucharest City Hall and consists of cutting the base of the capital city Hall building and its location on 260 seismic isolators and the use of 36 seismic shock absorbers. [3]

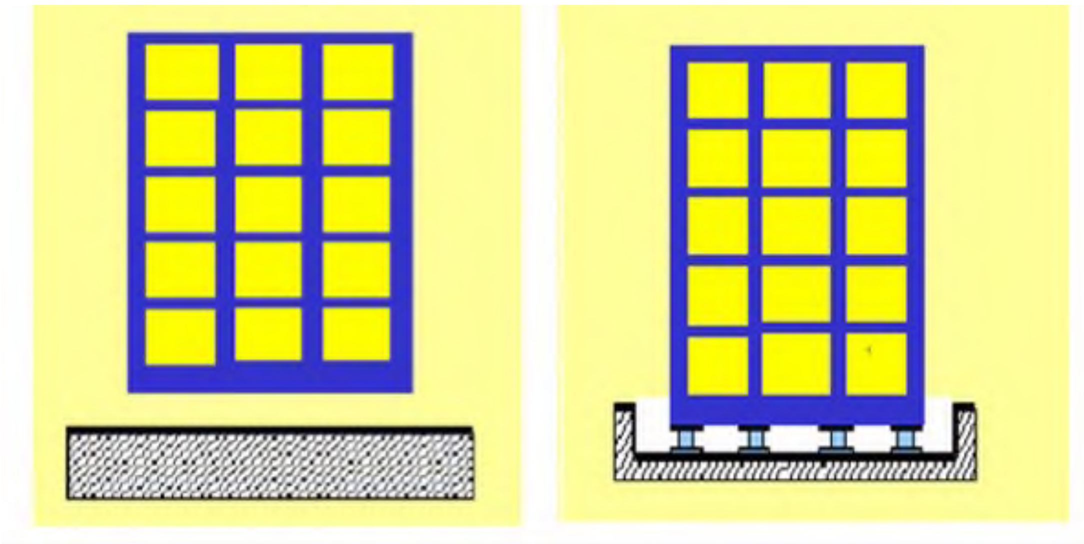


Fig.1 "The Design/consolidation method by isolating the base "

3. SEISMIC INSULATION SYSTEMS

The structure of the systems with viscous dampers is a relatively simple one: the main damping element is the hydraulic piston (s) with viscous liquid; the lever or balancing arms are meant to increase the dissipative capacity of the pistons; the end followers are meant to allow the calibration of the damping cables and the prestressing degree of the main hydraulic piston (these are additional elements that are not part of the basic damping system); the distribution plates allow the piston ends to be attached to the structural elements [4]

1= piston rod
2= damping cylinder
3= silicone fluid
4= piston rod cover
5 = piston cover
6 = resin-based insulator
7 = liquid chamber
8= hole disc
9 = valve
10= pressure chamber

The structure of a hydraulic damper with viscous liquid is presented in fig.2 [5]

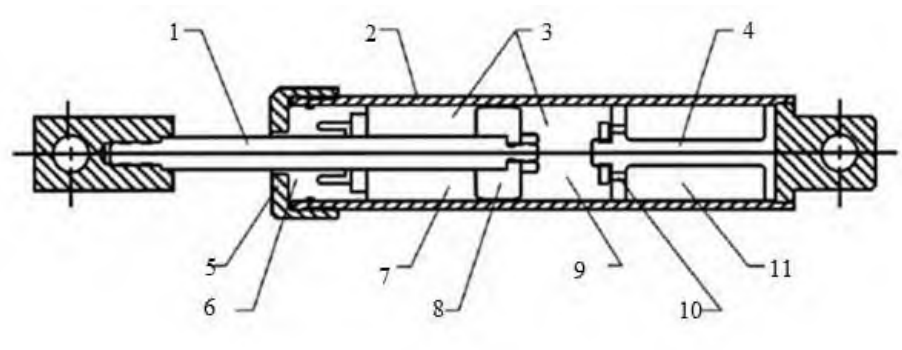


Fig. 2 The structure of a hydraulic damper with viscous liquid

4. THE CONSTRUCTIVE SOLUTIONS FOR SEISMIC INSULATORS

Seismic isolators LASTO-LRB (fig.3)

Lead rubber bearings isolate a structure from the movements of the ground during an earthquake, thus limiting the seismic energy acting on the structure.

- for structures with reduced space availability

- also applicable for modernization

Seismic isolators LASTO-LRB are similar to regular reinforced elastomeric bearings with steel connection plates, but featuring a lead core. This core will undergo plastic deformations during an earthquake, generating heat and dissipating seismic energy.

Are constituted of a series of layers of rubber and steel, with a lightweight execution technology. As disadvantage, they must be used in conjunction with additional energy dissipation systems.

Bearings with lead core (fig.4)

Components:

- Rubber layers: provide lateral flexibility

Steel metal plates: provide vertical rigidity in order to take over the building's weight and limiting in the same time the rubber's inflation.

Metallic central core: is provided as an energy dissipating source

Fig. 3 Seismic isolators LASTO-LRB

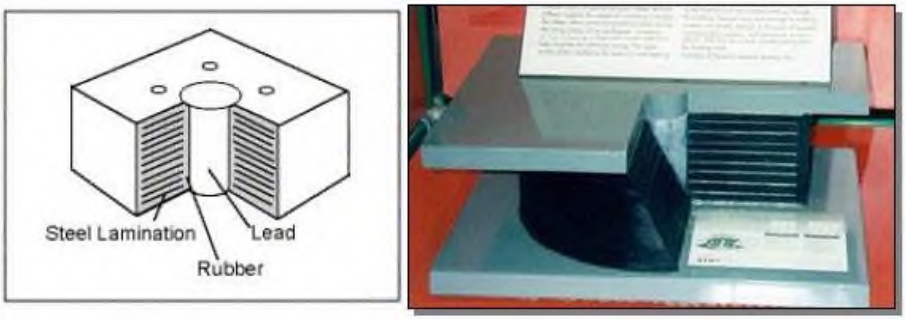


Fig 4. Rubber bearing with lead core
(D. Verdeș - Fundamentals of seismic engineering)

5. STRUCTURES ISOLATED FROM THE SEISMIC ACTION. STRUCTURES WITH ADDITIONAL DAMPING

The dimensioning methods for structures located in seismic areas may lead to two different concepts, leading to the following types of structure design:

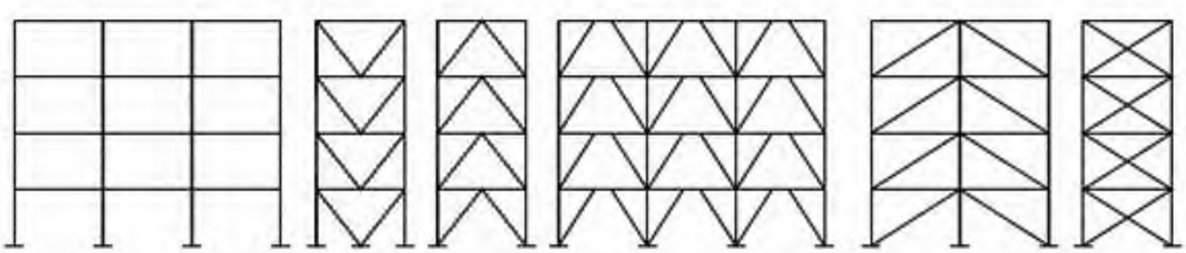
- Dissipative structures
- Structures isolated from the seismic action.
- Structures with additional damping

For structures isolated from the seismic action and those with additional damping, the structure is made so as to avoid the penetration into the plastic area by placing devices that can absorb seismic energy and can change the own vibration period of the structure up to favourable values of the global behaviour.

In order to avoid penetration into the plastic field, devices will be installed that can absorb seismic energy and modify the own vibration period of the structure. Dissipative structures are calculated and designed so as to allow the plasticization of certain areas, also called dissipative areas.

The kinetic energy induced by the seismic motion will be dissipated by a hysteretic behaviour in the plastic field. The structural parts designed as non-dissipative must be dimensioned so as to remain in the elastic field. There may be:

- Centric wind bracing frames Fig.: 5 a, 5 b, 5 d
- Eccentric wind bracing frames Fig.: 5 c
- Frames without wind bracing Fig.: 5 e



a b c d e

Fig. 5

The parking lot's foundation has a double role:

- To ensure an allowable value of the force which is transmitted to the structure and soil by the parking lot's building, elevator, loaded cars;

- To perform anti-vibration isolation and seismic protection

The foundations' system will be checked according to the provisions of the applicable technical regulations in force on the design of surface foundations.

At the foundations' dimensioning, the effects of the superstructure's action in the combination of loads that include the seismic action must correspond to the plasticization mechanism associated with the type of structure. Buckling occurs for centric wind bracing frames_ Dissipative areas are located in the wind bracing frames subject to extension, those subject to compression undergo the buckling phenomenon. The dissipative performance of this wind bracing system is limited due to repeated buckling.

The metallic structure consists in centric wind bracing frames.

The modelling of the non-linear properties of metallic structures is similar to that of reinforced concrete structures. As for the structure's wind bracings, they are modelled with axially deformable bar-type elements with a steel material that captures the buckling characteristics of the bracing

The considered constructive systems are centric wind bracing frames in case of metallic structures. The introduction of a homogeneous distribution of dampers was intended for each of these structures, capable to develop forces strong enough to reach an equivalent damping of about 25%.

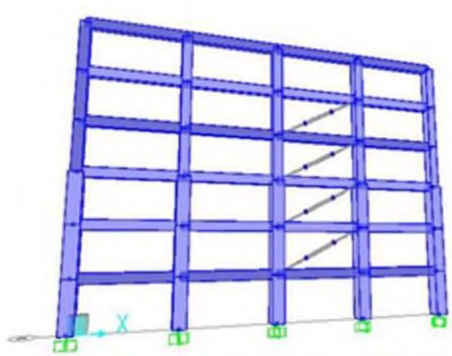


Fig. 6

6. CONCLUSIONS

1. In all cases, the introduction of dampers improves the structure's response in average with 40%.
2. In all the studied cases, the optimum distribution produces superior results in terms of displacements (1-8%) using a smaller number of dampers, with approximately 30%.
3. In all cases the forces developed in dampers are higher than in case of the optimum distribution.
4. Differences between the homogeneous distribution and the optimum one decrease with the increase of the height level. This is most likely due to the condensed

model used in the algorithm for optimum placement

5. The introduction of viscous dampers in structure is beneficial on the reduction of the seismic response. The mounting of dampers produced decreases of the response in drifts and rotations of the structural elements for all the studied structures.
6. The more rigid the buildings are, the shorter the length of the fundamental periods of vibration by the use of seismic insulators.
7. In case of using seismic isolators, the more floors the buildings have (they are more flexible), the more the drifts decrease, the more rigid the buildings are (fewer floors) drifts increase. HDRB seismic isolators are found to be more effective in terms of drifts.At the base it is found that on average the displacements increase more for the buildings that use seismic insulators of LRB type compared to HDRB.

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References

[1] **Mihali A.C**., *Seismic Insulation System Using Air Pillows And Eew* - Earthquake Early Warning

[2] Seismic Design Code - Part III - Provisions for Seismic Assessment of Existing Buildings - Technical University of Civil Engineering, Bucharest 2018

[3] **Miyamoto H.K., Gilani, A.,** *Design of New Steel-Framed Building Using ASCE 7 Damper Provisions*, Proceedings of ASCE Structures Congress, Vancouver, Canada, 11 March 2010

[4] **Iordachescu A., Iordachescu E.,** *Seismic Rehabilitation Of Bucharest City Hall Building Through Base Insulation Method,* Proceedings of the 15th World Conference on Earthquake, Lisbon, Portugal, 2012

[5] **Rășchitor E., Radu C.E., Tempea I.,** *Anti-Vibration Insulation Possibilities Of Theoverground Parking Over The Dambovita River Antiseismic Protection Systems***,** Publishing House "Academica Brancusi" ISSN 1842-4856 , Engineering series no. 2/2019, ISSUE 2/2019, pg. 47-53