COMPARATIVE STUDY REGARDING THE NON-ISOLATED CIRCULAR ABOVE-GROUND PARKING LOT AND THE PARKING LOT ISOLATED BY MEANS OF THE BASE ISOLATION METHOD

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ABSTRACT. *This paper studies the beneficial effects of the base isolation method. "The design/consolidation method by base isolation" consists in increasing the fundamental vibration period, decreasing displacement. The placement of HDRB (High Damping Rubber Bearings) and LRB (Lead Rubber Bearings) in the structure has a beneficial effect on reducing the seismic response. A study shall be performed regarding the non-isolated above-ground circular parking lot and parking lot isolated by means of the base isolation method, equipped with seismic isolators.*

KEYWORDS: Parking, base isolation, seismic isolators

1. INTRODUCTION

The concept of base isolation is the fundamental principle of base isolation, i.e. change the response of the building, so that the ground would move under the building without transmitting its displacement. The ideal system would consist in a total separation, but in reality it is necessary to have several contact areas between the structure and the ground.

2. BASE ISOLATION METHOD

"The design/consolidation method by means of base isolation" consists in increasing the fundamental vibration period, decreasing displacement. The principle of seismic isolation of structures is to modify the building's inherent vibration period (i.e. increasing it), so that it would be placed outside the area of maximum amplitude of the response spectrum for the given location. The placement of the seismic isolators leads to an increase in the flexibility of the base horizontally, in order to increase the vibration period, so that the acceleration transmitted to the structure would be considerably reduced. Comparing the variations of the displacements and of the forces acting on the structure, it is found that, with the change of the vibration period, a decrease of the forces acting on the structure corresponds to an increase of the displacements at the base level. [3]

The structure has an elastic behavior in case of small-sized displacements.

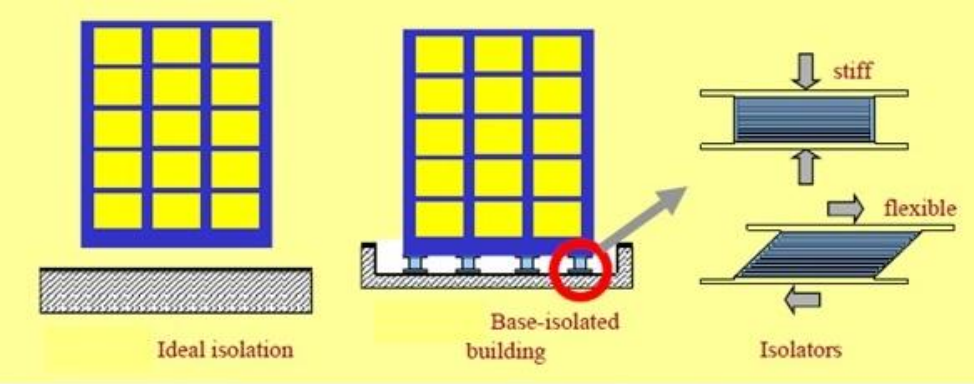

Fig. 1. "The design/consolidation method by means of base isolation".

In figure no 1. we can see the definition of the base isolation concept and implicitly the advantage of the isolated structure: lower relative level displacements, almost non-existent deformations, slightly stressed elements. Due to the low lateral rigidity of the isolation layer, the structure has a much longer fundamental period than the fundamental period of the same fixed-base structure. The increase of the fundamental period of the isolated structure leads to a significant reduction of the accelerations imposed by earthquakes to the isolated structure (implicitly, of the forces). This can be seen from the elastic accelerations spectrum.

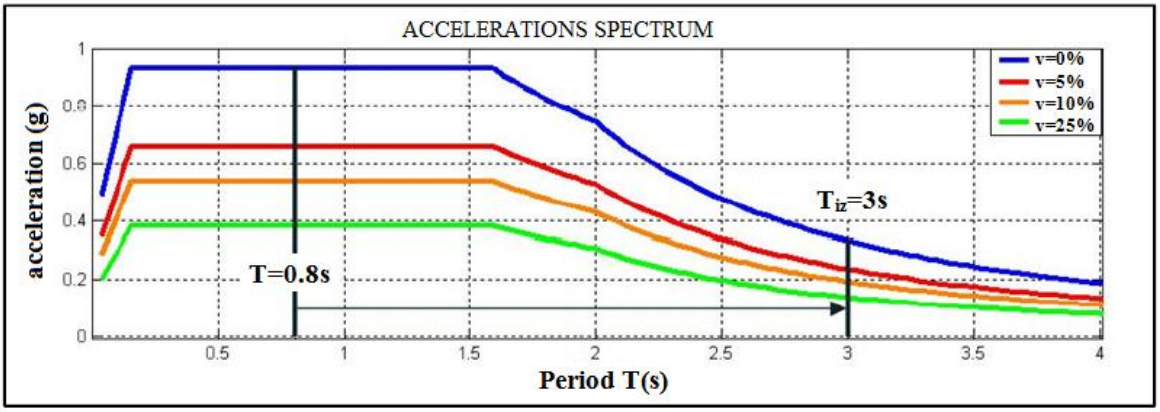

Fig. 3 Accelerations spectrum.

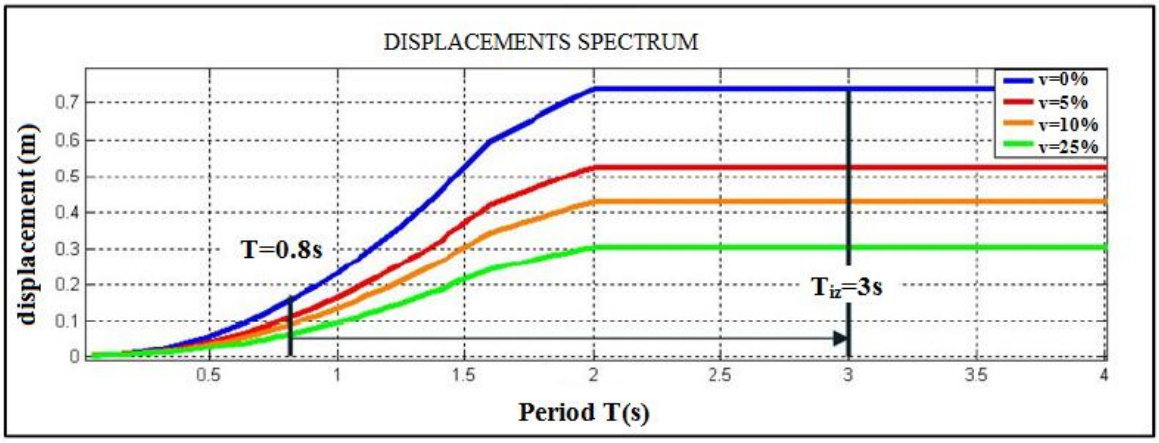

Fig. 4. Displacement Spectrum.

Analyzing the displacements spectrum, it can be seen that this "leap" of the fundamental period of the isolated structure leads to a much greater displacement requirement than in the case of the fixed-base structure. [4]

The placement of the isolators in the structure is made, so that the center of the masses would be as close as possible to the center of rigidity.

3. COMPARATIVE STUDY FOR NON-ISOLATED CIRCULAR BUILDINGS AND BUILDINGS ISOLATED ON THE PRINCIPLE OF BASE ISOLATION IN SEISMIC DESIGN

3.1 Choosing the structures for analysis

For this study, it has been intended to analyze the isolated and non-isolated circular structure. The structure was modeled using the ETABS program, as follows:

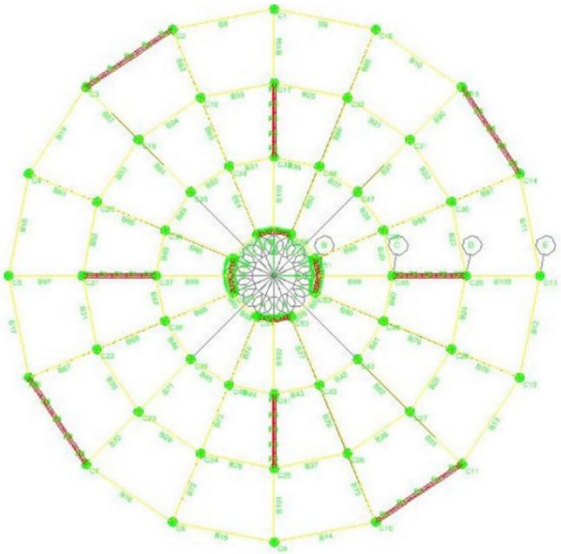

Fig. 5. "Plan of circular building"

The isolators chosen in this study are HDRB and LRB, which have dampings of 16% in the case of HDRB and 28% in the case of LRB.

3.2 Modeling the isolators

For the modeling of the base isolation system, in both variants, the structure placed on a reinforced concrete foundation frame has been considered. Two types of isolators have been used, namely HDRB (High Damping Rubber Bearings) and LRB (Lead Rubber Bearings) replaced for modeling with “link” type elements; for the calculation, they have considered a 16% HDRB damping coefficient, respectively 28% LRB of critical damping.

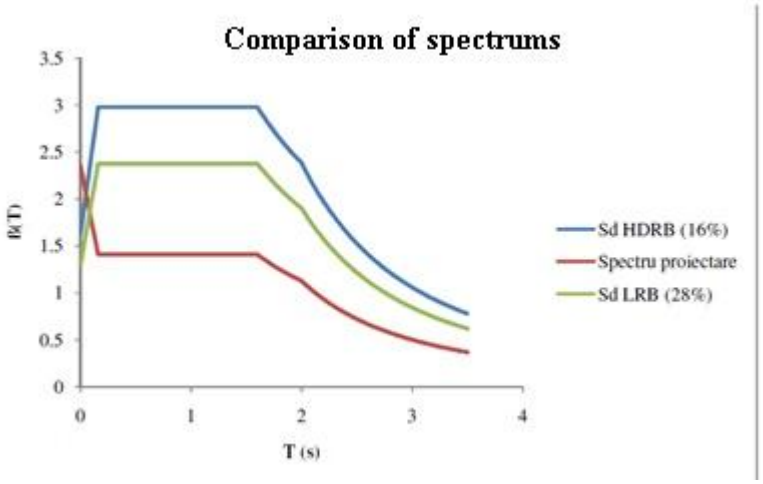

Fig. 6. Comparison of spectrums.

In order to pre-size the isolators, we must consider the following rules [5]:

- the average unit compression force in isolators must be approximately equal to 15N/mm2
- achieve damping between 20-30%
- the placement of isolators in its structure should be made in such a way, as to keep the center of masses = to the center of the rigidities, avoiding torsion
- its superstructure should remain in the elastic field (q = 1.5)

The calculation of the structural elements has been made according to the principle "weak beams and strong pillars", and the slab is considered the rigid diaphragm. The sectional efforts of the elements have been determined using ETABS calculation program.

The efforts that appear in the elements of a circular metallic structure for a non-isolated building and building isolated with LRB- or HDRB-type seismic isolators shall be studied. The results are presented in fig..7

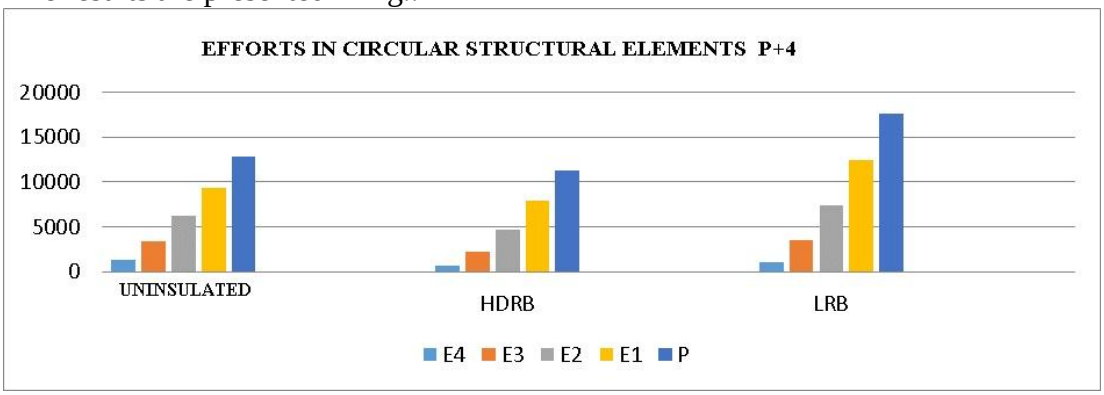

Fig 7 The diagram of the efforts in structural elements for a circular 5-storeyed building

In fig.8 one can see how fundamental vibration periods d vary for the non-isolated building and for the building isolated using the mentioned isolators.

CIRCULAR BUILDING PERIODS	
Tneiz	0,1568
T iz HDRB	3,04
Tiz LRB	2,208

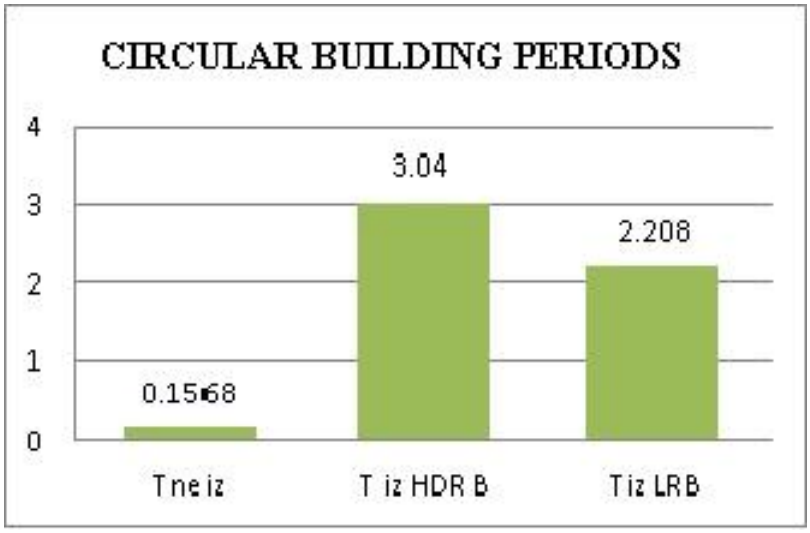

Fig. 8 The diagram of the vibration periods.

4. CONCLUSIONS:

1. In all cases, the introduction of dampers improves the response of the structure by an average of 40%.
2. The introduction of viscous dampers in the structure has a beneficial effect on reducing the seismic response. For all the studied structure, the installation of dampers has caused decreases of the response in drifts and rotations of the structural elements.

In the context of fundamental vibration periods:

3. For the 5-storeyed buildings, the fundamental vibration periods are increase by ca. 20 times in the case of using HDRB-type isolators, and 15 times in the case of using LRB-type isolators, respectively;
   Conclusion – the more rigid the buildings, the shorter the duration of the fundamental vibration periods by using seismic isolators.

In general, the fundamental vibration periods in case of using LRB-type isolators are about 80% of the fundamental vibration periods for the case of using HDRB-type seismic isolators (so, HDRB makes the structure 20% more flexible than LRB).

In the context of displacements:

4. For the 5-storeyed buildings, drifts are increased in the case of using HDRB-type seismic isolators by ca. 30% and 50% respectively in the case of using LRB-type seismic isolators;
   In the case of using seismic isolators, the more storeys the buildings have (the more flexible they are), the more drifts decrease, so the more rigid the buildings are (the fewer storeys they have), the more drifts increase. It is found that HDRB-type seismic isolators are more efficient in terms of drifts.
   At the base, it is found that, on average, displacements increase more for the buildings using seismic isolators of LRB-type as compared to HDRB.
   For the 5-storeyed buildings, displacements are on average ca. 30 cm, for the 10-

storeyed buildings, displacements are 35 cm, and for the 15-storeyed buildings with dual structure, displacements reach ca. 40 cm.

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