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# VALLE DEL LILI CLINIC, BUILDING 2 WITH SEISMIC ISOLATION

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**Abstract:** This document describes the effects of implementing a base seismic isolation system in building 2 of the Valle del Lili Clinic, in the city of Santiago de Cali. This article evaluates the structural response effects and implementation costs.
**Keywords:** Base seismic isolation, design earthquake, maximum design earthquake.

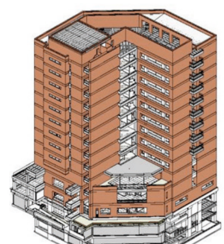
## INTRODUCTION

Santiago de Cali is the third most important city in the country, and of the main ones it is the only one located in a high seismic threat zone, so its hospital infrastructure must be capable of mitigating the impacts of a severe earthquake. Currently, the conventional technique to mitigate the response of a building to an earthquake is carried out by combining the resistance and rigidity of the elements in the inelastic range. Another way to mitigate the response is to implement additional control devices to the structure, which modify the dynamic characteristics, dissipating part of the energy imposed by the earthquake, thereby reducing damage to structural and non-structural elements, demonstrating efficient performance. and offering a higher level of security for buildings.

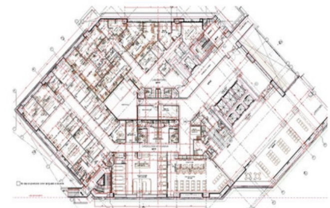
This article evaluates the incorporation of a passive control system with base seismic isolators, in an essential building; The design was carried out under the guidelines of NSR-10 and ASCE7-16.

## BUILDING WITH BASE ISOLATION

Building 2 of the Valle del Lili clinic is a built project, located south of the city of Santiago de Cali, in the 4D micro zone of the Meléndez and Lili fan. The project has an area of 21,900 m2, which is distributed over 12 floors and 3 basements (Figure 1). The use of the basements corresponds to parking, and the upper floors are used for hospitalization and vascular intervention; The plan configuration is hexagonal on the lower floors, and with setbacks on the upper floors (Figure 1). It is the third building for clinical use designed with base isolators in the city of Cali.



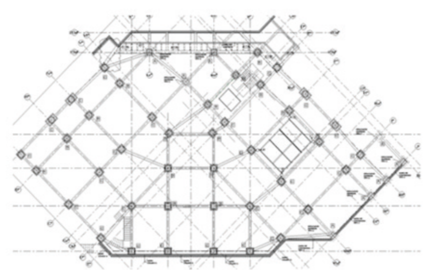
a) Isometry



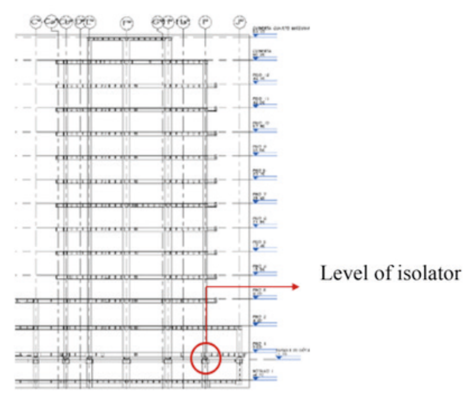
b) Distribution in the plant

Figure 1. Building 2: Clinic: Valle del Lili, a) Isometry, b) Distribution in the plant.

The isolation system is located on the first floor, decoupling 12 floors. 25 rubber insulators with lead core (LRB), 16 rubber insulators (RB) and 8 sliders were used, the distribution in plan and height are shown in Figure 2. The maximum compression load on the insulators is 1183 tonf .



a) Location of isolators in the plant




b) Location of isolators at height

Figure 2. Distribution of isolators in plan and height.

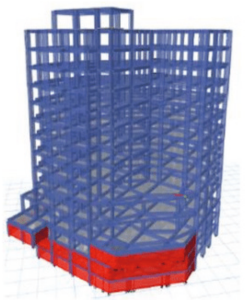
## ISOLATION SYSTEM

The isolation system was designed under the guidelines of ASCE7-16, with a design damping of 13.6%, for the maximum design earthquake (MCE), the design displacements are 41.1 cm for the MCE earthquake and 47.6 cm for the displacement maximum total (Table 1).

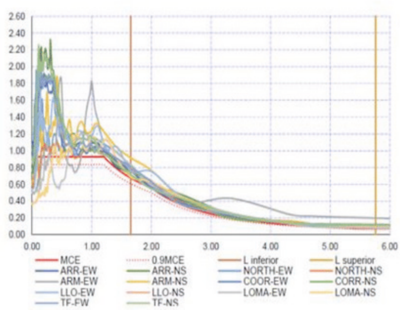
| PROPERTIES | MAXIMUM EARTHQUAKE (MCE) | | | |
|---|---|---|---|---|
| | T | Desp. | Keff | β |
| | s | cm | t/m | % |
| **Lower** | 4.31 | 41.1 | 5553.3 | 13.6 |
| **Nominal** | 3.86 | 41.1 | 6941.6 | 13.6 |
| **Upper** | 3.31 | 39.6 | 9447.7 | 15.4 |

Table 1: Seismic isolation properties.

For the analysis of the structure, a linear elastic model was carried out, and for the design of the isolation system, the non-linear properties of the devices were considered, so non-linear dynamic analyzes were carried out, using seven pairs of compactible seismic records with the spectrum of the area (Figure 3).



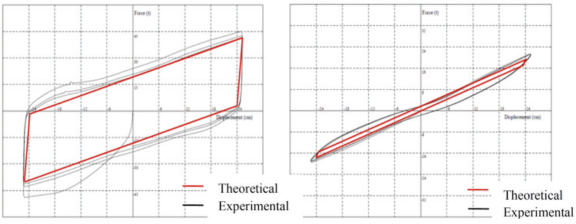
a) Analysis model




b) Comparison of spectrum and seismic records

Figure 3. Model with isolation system and comparison of design spectrum and seismic records.

The properties of the isolators, considered in the design, were validated with the tests carried out in compression and shear for the different displacements of the isolation system (Figure 4). The isolation system was supplied by isolator manufacturer Dynamic Isolatios Systems Inc, based in Reno Nevada USA.




a) LBR isolator b) RB isolator

Figure 4. Hysteresis behavior of isolators (LBR, RB), theoretical and experimental.

## ISOLATION SYSTEM RESULTS

As a result of the implementation of the isolation system, the dynamic properties of the structure with isolators and the fixed base proposal are summarized in Table 2, which highlights the increase in the participation of the first vibration modes of the structure. reducing the participation of higher modes.

When comparing the average basal shear force of the seven pairs of seismic records in Table 3, it is observed that by implementing seismic isolation, the shear force in the structure is reduced by 78%.

| Powers | Structure | | Reduction |
|---|---|---|---|
| | Isolated (tonf) | Fixed base (tonf) | |
| **Vb** | 3366 | 15750 | 78% |

Table 3. Design shear forces.

On the other hand, when comparing the distribution of floor drifts and acceleration, due to the average of the seven pairs of seismic records, Figure 5 and Figure 6, it is observed that using seismic isolation floor accelerations are reduced by 82%, and the drifts, are reduced by 40%.

| Mode | Isolated Structure | | | Conventional Structure | | |
|---|---|---|---|---|---|---|
| | Period (s) | Mass Direction: X | Participant Direction: Y | Period (s) | Mass Direction: X | Participant Direction: Y |
| 1 | 4.04 | 5.04% | 76.67% | 1.18 | 20.0% | 30.5% |
| 2 | 3.98 | 74.87% | 5.44% | 0.89 | 30.9% | 26.1% |
| 3 | 3.65 | 2.34% | 0.10% | 0.7 | 6.3% | 2.6% |

Table 2: Dynamic properties, isolated structure and fixed base.

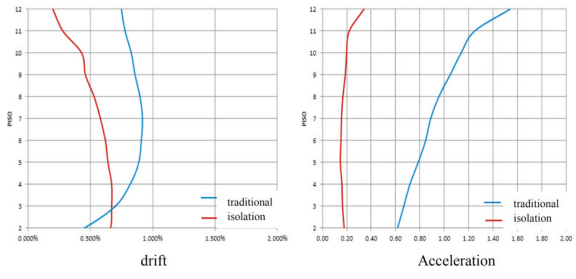



Figure 5. Comparison of response in drifts and acceleration in transverse direction.

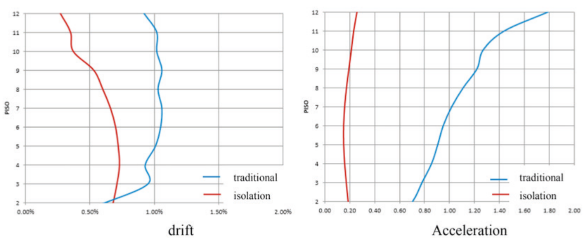



Figure 6. Comparison of response in drifts and acceleration, longitudinal direction.

Regarding concrete and reinforcing steel construction materials, Figure 7 shows that when implementing seismic isolation, the amount of concrete materials is reduced by 6.7%, and reinforcing steel by 7.1%. regarding the fixed base proposal.

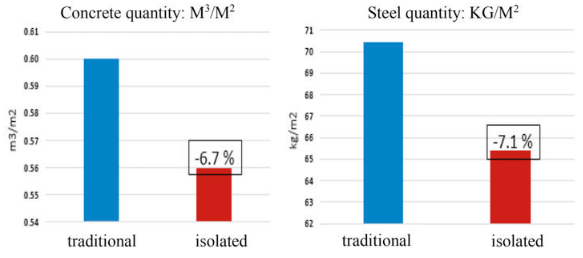



Figure 7. Quantity of concrete materials (m3/m2) and steel (kg/m2).

## ISOLATION SYSTEM COSTS

The cost of the devices in the project is USD 562,890, this value increases the cost of the structure by 7% (Table 4). This increase is low, considering the advantages from a safety point of view, which allows reducing seismic risk in the structure, since it lowers the demand for forces and deformations on the elements, allowing the structure to work in the elastic range, guaranteeing continuous operation in the building. On the other hand, from an architectural point of view, it is possible to reduce the number of structural elements that affect operation.

| AREA 21900 m2 $1.000.000 m2; structure | Isolated | Traditional |
|---|---|---|
| Structure | $ 21,234,739,320 | $ 21,900,000,000 |
| Isolators (USD 562,890) | $ 1,782,773,950 | - |
| Freight and Insurance | $ 47,000,033 | - |
| National Taxes | $ 445,642,000 | - |
| Transportations | $ 50,000,000 | - |
| Total | $ 23,560,155,303 | $21,900,000,000 |
| | + 7.05% | |

Table 4: Seismic isolator implementation costs.

## CONCLUSIONS

Building 2 of the Valle del Lili Clinic demonstrates that the implementation of a seismic isolation system is totally feasible to use in our country, in essential buildings, since, in addition to the numerous advantages that the use of these devices has in the structural part, by allowing the response in accelerations and displacements to be reduced. Investment costs can be offset by the reduction of structural elements and the reduction of seismic risk, which is reflected in possible over repair costs due to the design earthquake, so the cost of a structure with seismic isolation is very competitive. compared to that of a conventional structure in an essential building.

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