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SEISMIC ISOLATION CASE – NEW IMBANACO CLINIC

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Abstract: This article describes the implementation of the isolation system in the new Imbanaco clinic in the city of Santiago de Cali, which has an approximate area of 83,000 m2. The isolation system was designed under the guidelines of ASCE7-10, with a damping of 25%, and a design displacement of 30 cm. The reduction in accelerations with the isolation system of the earthquake that occurred on the coast of Ecuador in April 2016 was between 40% and 86%. The cost of implementing the insulators in the project was 32,275 pesos/m2. When comparing the cost of the insulation system per m2 of insulation proposals made for projects in the city of Cali, it is observed that the larger the area of the building, the lower the cost of the insulation system, and by increasing the number of floors, the cost of the insulation system increases. In this specific case, the final cost of the structure was not increased by using the insulators.
Keywords: Seismic Isolation, Essential Building, isolators, spectrum, acceleration, construction

INTRODUCTION

The vital aspects of a hospital, are those that are directly related to its purpose and function, are those that are most easily affected or destroyed by seismic movements (Pan American Health Organization, 2000); Like what happened in Los Angeles in 1994 due to the Northridge earthquake, where 10 hospitals were affected in the earthquake, only the University of Southern California Teaching Hospital continued in service because it had passive base isolation control systems, (Gómez, D., Marulanda, J., & Thomson, P., 2008).

The cost of non-structural elements in most buildings is greater than that of structural elements, especially in hospitals, where between 85% and 90% of the value of the installation is not in the support columns, floors and beams, but in architectural finishes, mechanical and electrical systems and equipment (Pan American Health Organization, 2000). For this reason, it is necessary to implement passive control devices in special-use buildings such as hospitals in the city in order to mitigate damage, repair costs and guarantee operation after seismic events, Chilean and Peruvian codes require it.

Santiago de Cali is a city located in the Colombian territory in a high seismic threat zone, within the city is the 4C Abanico de Cañaveralejo microzone, which is characterized by the predominant presence of clay and silty materials, the fundamental vibration periods of the stratigraphic profile are between 1.5 s and 2 s. It is an area where several buildings have constantly been damaged by seismic events, such as what happened with the Pizarro earthquake in 2004, which affected the Farallones clinic in the city, where repair costs amounted to 17.2 billion pesos (El Tiempo, 2007) and was out of service for 4 years.

The new Imbanaco clinic is located in microzone 4C, given the complexity of the project and the level of threat in which it is located, it is proposed to implement a passive control system. This article evaluates the incorporation of base seismic isolators in the new Imbanaco clinic; The design of the structure and the insulation system were carried out under the guidelines of NSR-10 and ASCE7-10.

BUILDING WITH BASE SEISMIC ISOLATION

The new Imbanaco clinic is a building of approximately 83,000 m2, it is made up of 4 basements and 10 floors, the insulation system was located when the structure exited the basements,Figure 1. The isolation period was set at 3.5 s for the permanent system load estimated with the D+0.5L combination,

appropriate for the height and characteristics of the building.

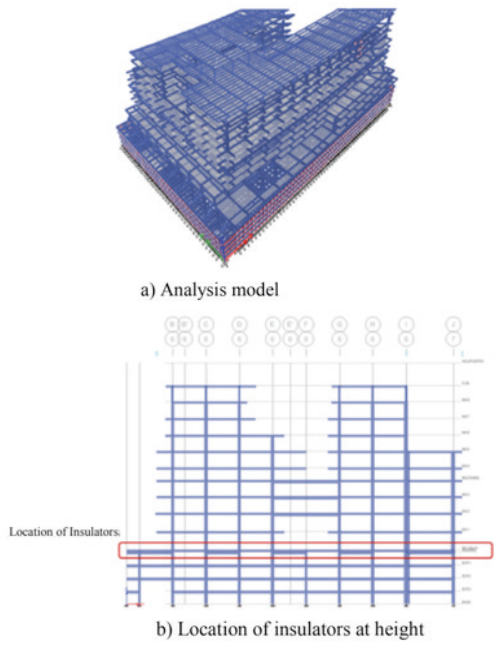

Figure 1: New Imbanaco clinic building, a) Analysis model, b) location of insulators at height.

A total of 120 insulators were used, which were located according to the vertical load and ensuring that the center of mass and rigidity of the system coincide, to avoid torsion effects; The insulators are located according to the proposal of the manufacturer of the DIS devices (Dynamic Isolation Systems),Figure 2.

INSULATION SYSTEM

The insulation system was designed under the ASCE7-10 guidelines. The Devices were supplied by isolator manufacturer Dynamic Isolatios Systems Inc, based in Reno Nevada USA. The properties of the insulation system are (Table 1):

For the analysis of the structure, a dynamic spectral model was carried out, the design spectrum of the seismic microzonation of the city, zone 4C, Cañaveralejo fan, was used. If a building with a fixed base and height similar to the Imbanaco Clinic is proposed, it would have a vibration period of the order of 1.05 sec, with a spectral acceleration of 0.65g, which means that the seismic loads applied correspond to 65% of the permanent load; If we decouple the structure and guarantee a fundamental vibration period of 3.5 sec by incorporating seismic isolators, we find that the spectral acceleration is 0.167g, which implies a reduction of approximately 4 times the seismic loads. In theFigure 3, the spectrum of the maximum design earthquake (MCE) is observed, equivalent to 1.5 times the design earthquake, used in the system stability review, and the design earthquake (DBE).

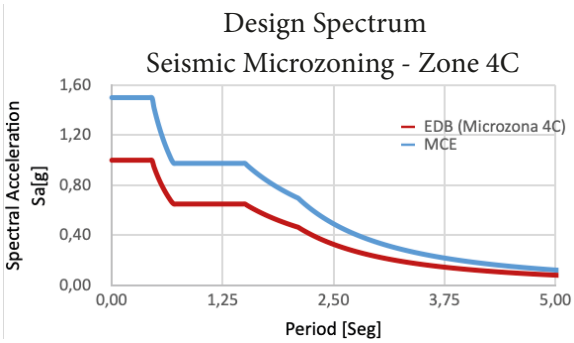

Figure 3: Design Spectrums

ISOLATION SYSTEM RESULTS

By comparing the basal shear force in theTable 2, it is observed that by implementing seismic isolation, the shear force in the structure is reduced by 74%.

Forces	Structure		Reduction
	Isolated (tonf)	Fixed base (tonf)	
vb	11344	44157	74%

Table 2: Design elastic shear forces

As a result of the implementation of the isolation system, it is observed that the structure will experience maximum accelerations of 0.2 g, and the maximum drifts will be of the order of 0.5%,Figure 4.

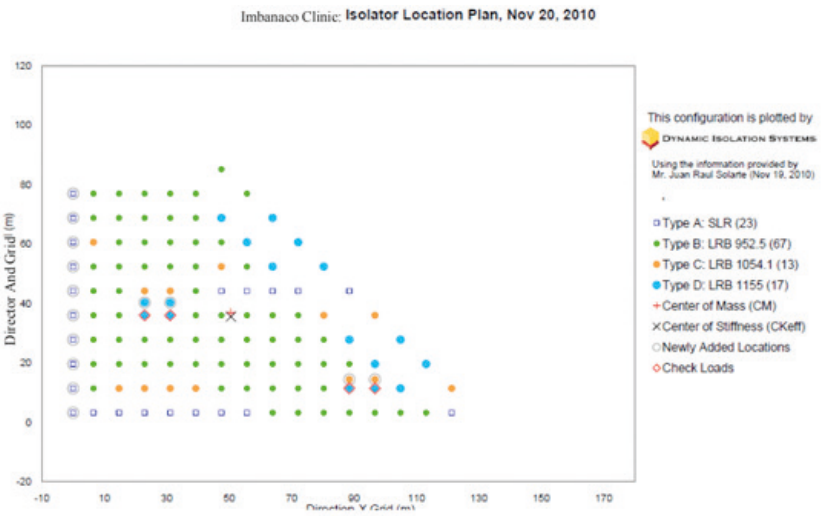

Figure 2: Location in the Insulator Plant

	DESIGN EARTHQUAKE (DBE)				MAXIMUM EARTHQUAKE (MCE)			
PROPERTIES	**T**	**Desp.**	**Keff-(DBE)**	**β**	**T**	**Desp.**	**Keff-(MCE)**	**β**
	yes	**cm**	**t/m**	**%**	**yes**	**cm**	**t/m**	**%**
Nominal	3.50	30	21582	25	3.97	4	17265.6	20

Table 1: Insulation system properties

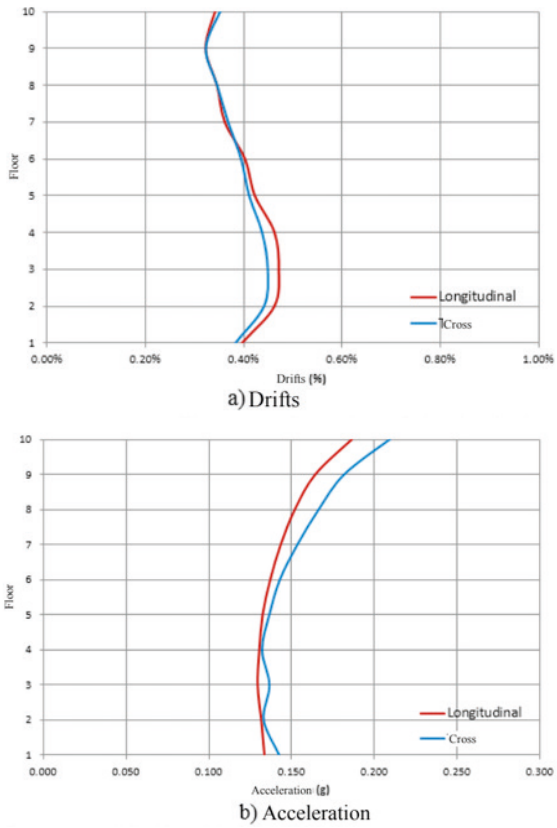

Figure 4: Results of the Isolation System, a) Drifts, b) Accelerations

CONSTRUCTIVE PROCESS

A complex part of the project due to the type of terrain and situation of the building was the construction process of the basements, which was proposed as follows:Figure 5 and figure 6:

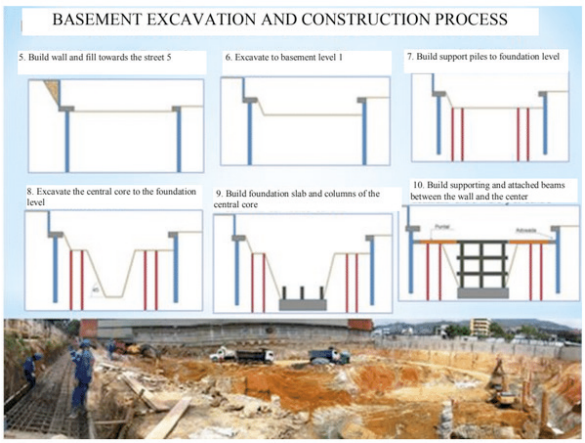

Figure 5: General view of the entire area at basement level 1

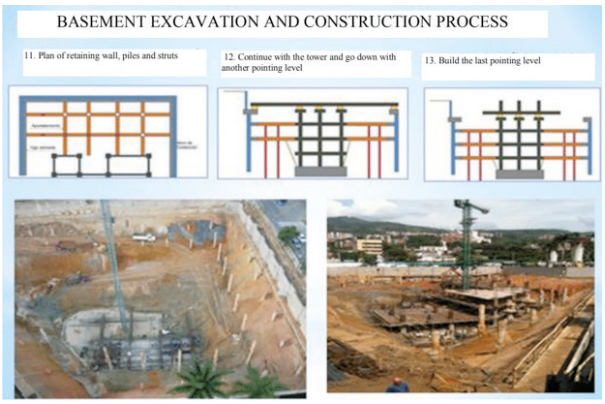

Figure 6: Excavation seen at the foundation level and the structure of the central core.

Under the first floor slab the insulators are located which allow the advancement of the upper floors; As this slab must be fully supported on the insulators, 2 construction details are presented, on race 38 and on street 5a,Figure 7.

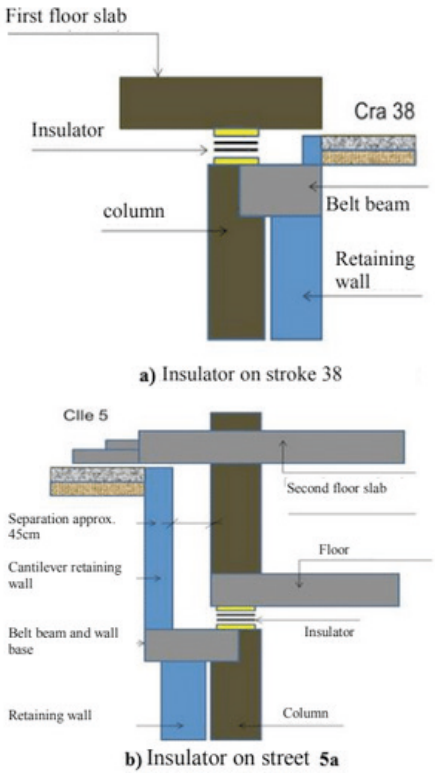

Figure 7: Location of insulators. a) On Carrera 38, b) on Calle 5a.

After the construction of the first floor slab, the construction of the tower continues to complete the basement slabs along with the demolition of the support piles, which are temporary.

CHECKING THE OPERATION OF THE INSULATION SYSTEM

In April 2016, an earthquake occurred on the coast of Ecuador and it was the opportunity to test the operation of the seismographs installed in the building at the foundation level, on the first floor.Figure 8.

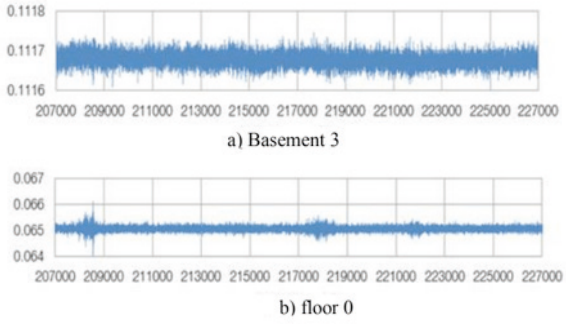

Figure 8: North direction seismograph records. a) Basement 3, b) Floor 0.

The accelerations recorded in the foundation were 1% of g, even so the response on floor 0, where the insulation system is located, recorded a significant decrease in accelerations between 40% and 86%.Table 3.

weight	direction		reduction	
	east	north	east	north
Basement floor, number 3	0.0082	0.0661	86.90%	40.83%
	0.0628	0.1117		

Table 3: Reduction of seismic accelerations

COSTS OF IMPLEMENTING THE INSULATION SYSTEM

The cost of implementing the insulators in the project was 32,275 pesos/m2, in theFigure 9, isolation system implementation costs are identified with some of the projects in the city of Santiago de Cali that have been carried out in the company, some have only been proposals, others are in the process of coordination or construction, and two are already built.

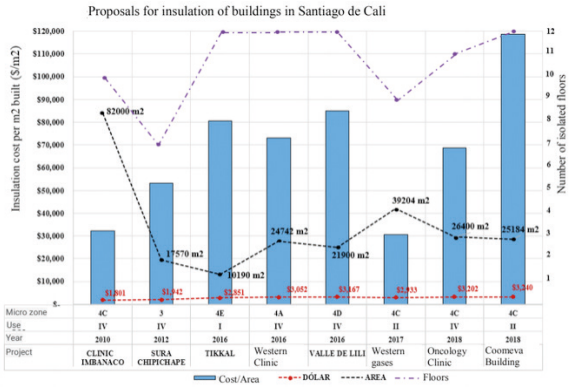

Figure 9: Costs of insulation system in buildings in Cali

Of theFigure 9, it can be identified that the larger the area of the building, the lower the cost of the insulation system, and the greater the number of floors, the value of the cost of the insulators increases.

CONCLUSIONS

The New Imbanaco Clinic is a project that shows the enormous structural advantages of the implementation of the seismic isolation system. The final cost of the project is competitive compared to that of a conventional structure, and its effectiveness has also been verified with the earthquakes that occur. have been presented, allowing the clinic to continue with normal operations.

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