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Affordable Earthquake Building

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Abstract: Nowadays springs are the main component in the structures. A new low-cost seismic isolation system which is related on spring tube bracings has been proposed and studied, and according to that study when springs are performed their designated jobs there is very little reason to spare them much thought. One area that you might not have considered the worth of springs within is the science of architecture, but actually springs are being used in buildings all around the world.
As per the study, multiple compression-type springs are positioned in a special cylindrical tube to obtain a symmetrical response in tension and compression-type axial loading.
An isolation floor, which consists of pin-ended steel columns and spring tube bracings, is constructed at the foundation level or any intermediate level of the building. An experimental campaign with three stages was completed to evaluate the capability of the system. First, the behavior of the spring tubes subjected to axial displacement reversals with varying frequencies was determined. In the second phase, the isolation floor was assessed in the quasi-static tests.
Finally, a ¼ scaled 3D steel frame was tested on the shake table using actual acceleration records. The transmitted acceleration to the floor levels is greatly diminished because of the isolation story, which effects longer period and higher damping. There are no stability and self-centering problems in the isolation floor.

I. INTRODUCTION

Natural disasters can be devastating for communities and infrastructure. In the past, buildings have been ill-equipped to face earthquakes, hurricanes, and floods, but as technology advances so too does the possibility for greater resilience.
In areas that frequently experience these sorts of conditions, designers are coming up with new and innovative ways to create structures that can withstand such disasters to a certain extent.
The Canterbury earthquakes sequence in 2010–2011 has represented a tough reality check for the international community of seismic engineering, highlighting the severe mismatch between societal expectations over the reality of seismic performance of modern buildings. In general, albeit with some unfortunate exceptions, modern multi-storey buildings performed as expected from a technical point of view, in particular when considering the intensity of the shaking they were subjected to. As per capacity design principles, plastic hinges formed in discrete predetermined regions, e.g. beam-to-column interface, column-to-foundation and wall-to foundation connections, allowing the buildings to sway and stand and people to evacuate. In many cases, these buildings were deemed too expensive to be repaired and were consequently demolished leading to the controlled demolition of large portion of the Central Building District of the second largest city in New Zealand and to an economic impact evaluated in the range of 40 Billion NZ$, corresponding to approximately 20 % of the GDP (Gross Domestic Product).Targeting life-safety is arguably not enough for our modern society, at least when dealing with new building construction. A paradigm shift in performance-based design criteria and objective towards damage-control design philosophy and technologies is clearly and urgently required .In general, the next steps in performance-based seismic design should more explicitly focus towards the development of an integrated approach, involving all aspects of design framework, design procedures and tools and technological solutions for engineers and stakeholders to control the performance/damage of the building system as a whole, thus including superstructure, non-structural element sand soil/foundation system. In the aftermath of the Canterbury Earthquake sequence, the increased public awareness of seismic risk and better understanding on the concept of building performance, has resulted into a renewed appetite for cost-efficient technological solutions to meet the higher public expectations, i.e. sustaining low-level of damage and thus limited business interruption after a design level earthquake .In additional to more “traditional” damage-control technology as base isolation and supplemental dissipative braces, which are experiencing a resurgence in New Zealand, particular interest is being received by alternative and more recently developed “low-damage” systems, based on post-tensioned rocking mechanisms, combining self-centering and dissipating capabilities, for either concrete, timber and steel. In such a context, the first and core part of the paper will provide an overview of recent advances and on-going research carried out at the University of Canterburyin the past decade towards the development of a low-damage building system as a whole, within an integrated performance-based framework, including the skeleton of the superstructure, the non-structural components and the interaction with the soil/foundation system.

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In the second and conclusive part, examples of real on site-applications of such technology in New Zealand, using concrete, timber (engineered wood), steel or a combination of these materials, and featuring some of the latest innovative technical solutions developed in the laboratory, are presented, as examples of successful transfer of performance-based seismic design approach and advanced technology from theory to practice.

Building structures that are resilient to earthquakes is of utmost importance in some regions, as collapse of structures causes most earthquake-related deaths. As the seismic waves cause the ground to shake, buildings can partially or completely collapse.

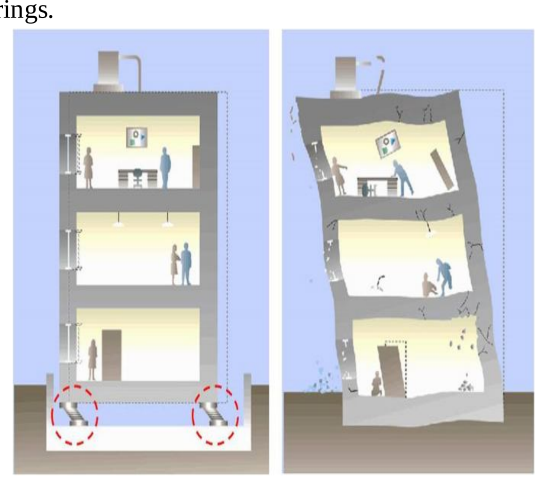
There have been a number of solutions suggested or put into practice by architects. One of these methods is known as base isolation and involves using a system of springs or bearings which effectively float the building above its foundations. As the building is attached to the foundations by a flexible yet strong material, when an earthquake hits, the structure is able to move slightly without being disconnected from its foundations.

This method has been used in practice, and a house in Santa Monica, California benefited during the Northridge earthquake of 1994.

II. METHEODOLOGY

After collecting the data regarding earthquake isolation system we have studied the following points in detailed and then likewise we have tried to make one model by spring provisions in foundation of a house to give a clear objective of our project and to explain our study in detailed

1) Step 1: The seismic isolation system consists of steel columns with pinned connections at both ends and spring tube braces. Each spring tube has a steel cylindrical web and two end pistons. Four identical linear elastic helical compression springs with stiffness (k) are positioned in the springs.



2) *Step 2:* The seismic isolation story, which is implemented on the foundation level or any intermediate level of the pins of the tube are denoted by a and b, respectively the changes in diagonal lengths and vertical settlement are determined in the distinct lines of for pulling- and pushing-type loading

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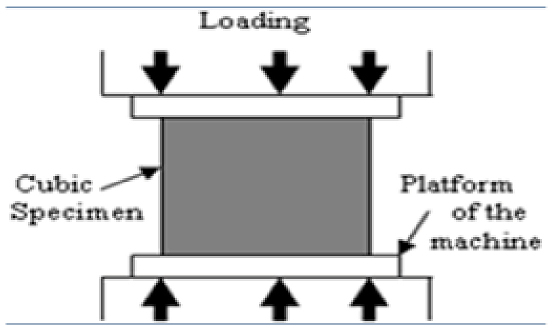
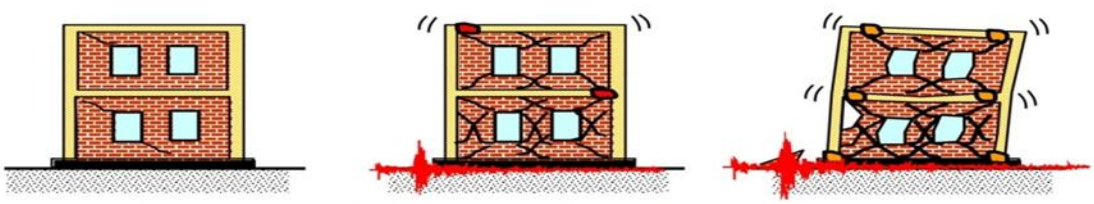
3) *Step 3:* Experimental works were performed in three successive stages to determine the competence of the spring tube braces for the seismic isolation of low-rise buildings: uniaxial loading tests of the spring tubes, quasi-static tests of the seismic isolation story and shake table tests of a 3-story ¼ scale model structure with a seismic isolation story



4) *Step 4:* The test aims to determine the axial stiffness of the spring tube and evaluates the success of the analytical equation. The spring tube is connected to the testing setup by simple hinges at both ends. Reverse displacement cycles were applied to the specimen using a servo controlled MTS actuator present in the Structural and Earthquake Engineering Laboratory of Istanbul Technical University.



5) *Step 5:* Low Cost Earthquake Resistant Design In seismic building design, whether a certain type of construction material can withstand an earthquake is a function not only of the material's resilience and strength, but also how it is incorporated into the structure. A long, straight stone wall, for example, using only friction and geometry to keep stones in place, will almost certainly topple in an earthquake.

A. Spring tube Braces

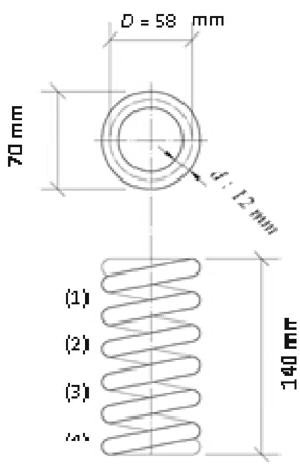
The seismic isolation system consists of steel columns with pinned connections at both ends and spring tube braces. Each spring tube has a steel cylindrical web and two end pistons. Four identical linear elastic helical compression springs with stiffness (k) are positioned in the spring tube. When the spring tube is subjected to tension force, the external helical springs are compressed. When the spring tube is subjected to compression forces,the internal springs are compressed.

The main physical properties of the helical compression springs in this study, i.e., the wire diameter, outer and mean diameter of the coil, free length and number of active coils, are shown in Figure. The ground-type ends of the springs enable continuous touching to the flat surface of the pistons.

The axial stiffness of the spring tube **(*K*)** is equivalentto half of the stiffness **(*k*)** of an identical helical compression spring

$$\mathbf{P = K \times 2\Delta}$$
$$\mathbf{k = P/\Delta}$$

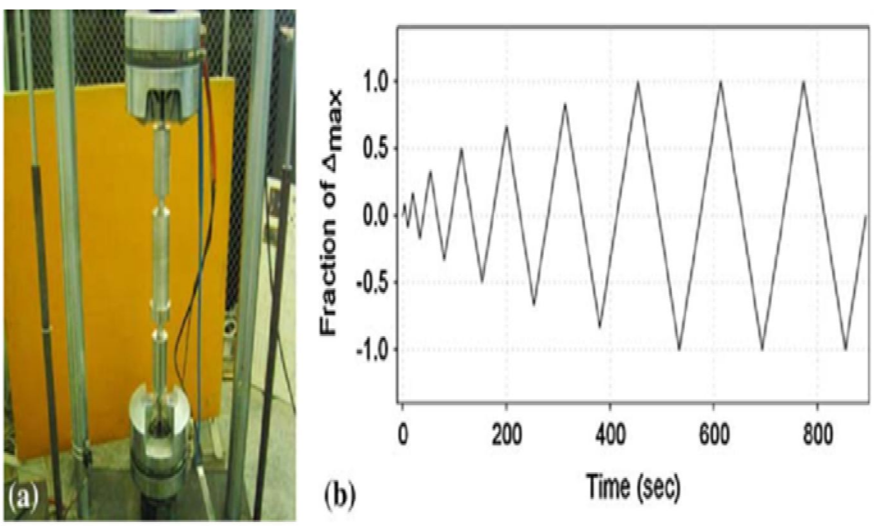
$$\mathbf{K = k/2}$$



Properties of the compression spring

III.RESULTS

The results mostly shows the goal of decreasing the amount of shear force by its cone angle coming to the structure is well achieved by base isolation involving system of springs or bearings which effectively float the building above its foundations.



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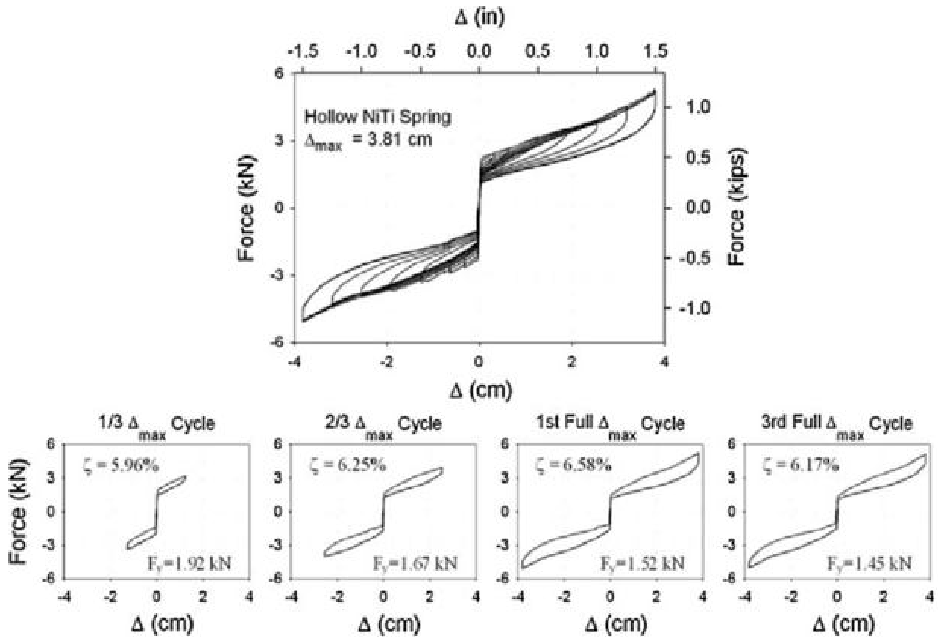

The tests are ongoing to evaluate the effectiveness of the proposed base isolation system. The analytical study is also progressing on a two story RC building. In a succeeding project, it is planned to perform tests for a bearing and springs for different earthquake frequencies having some proper engineering details. It is clear that all of these stages should be accomplished and satisfactory results obtained prior to engineering implementation.

IV. CONCLUSIONS

Concerning the purpose of this project, designed homes are suitable for building and house the less favored society of these countries. It is to clarify that for affordable housing is not essential the details or finishes, but essential be resistant and keeps the comfort of its owners, which normally call decent housing.
This study investigates the effectiveness of the new seismic isolation system based on spring tube bracings.

The general conclusions are:

1) The uniaxial loading tests performed on the spring tubes show that the analytical and experimental axial stiffness values of the spring tube are consistent.
2) The seismic isolation story are consistent with the analytical results in terms of the first- and second-order lateral stiffness, lateral and vertical displacements and internal forces on the spring tube.
3) In the isolated structure, the floor accelerations and their differences are small compared to the ordinary fixed-based structures, which moves the structure away from the destructive range.
4) The maximum observed drift of the seismic isolation story is approximately 16%, which is sufficiently large to withstand the demands of the design earthquake.
5) Relatively high damping ratio of 18%–20% is obtained because of the friction in the partially fixed 'HINGED' CONNECTIONS of the base isolation story columns.
6) The self-centering capability was experienced during the shake table tests.

The greatest difficulty of this project has been to unify an antiseismic house and turn it affordable, as the connections of the elements are often reinforced by expensive items such as plates, sheet metal, bolts, etc. In order to solve this problem we have concentrated into two parts: the structure to withstand the earthquake; and the other part that the constructive and materials are low cost and fast construction. Although sometimes it is inevitable for materials or means in the area, at least ensure that the structure cannot collapse without prior notice.

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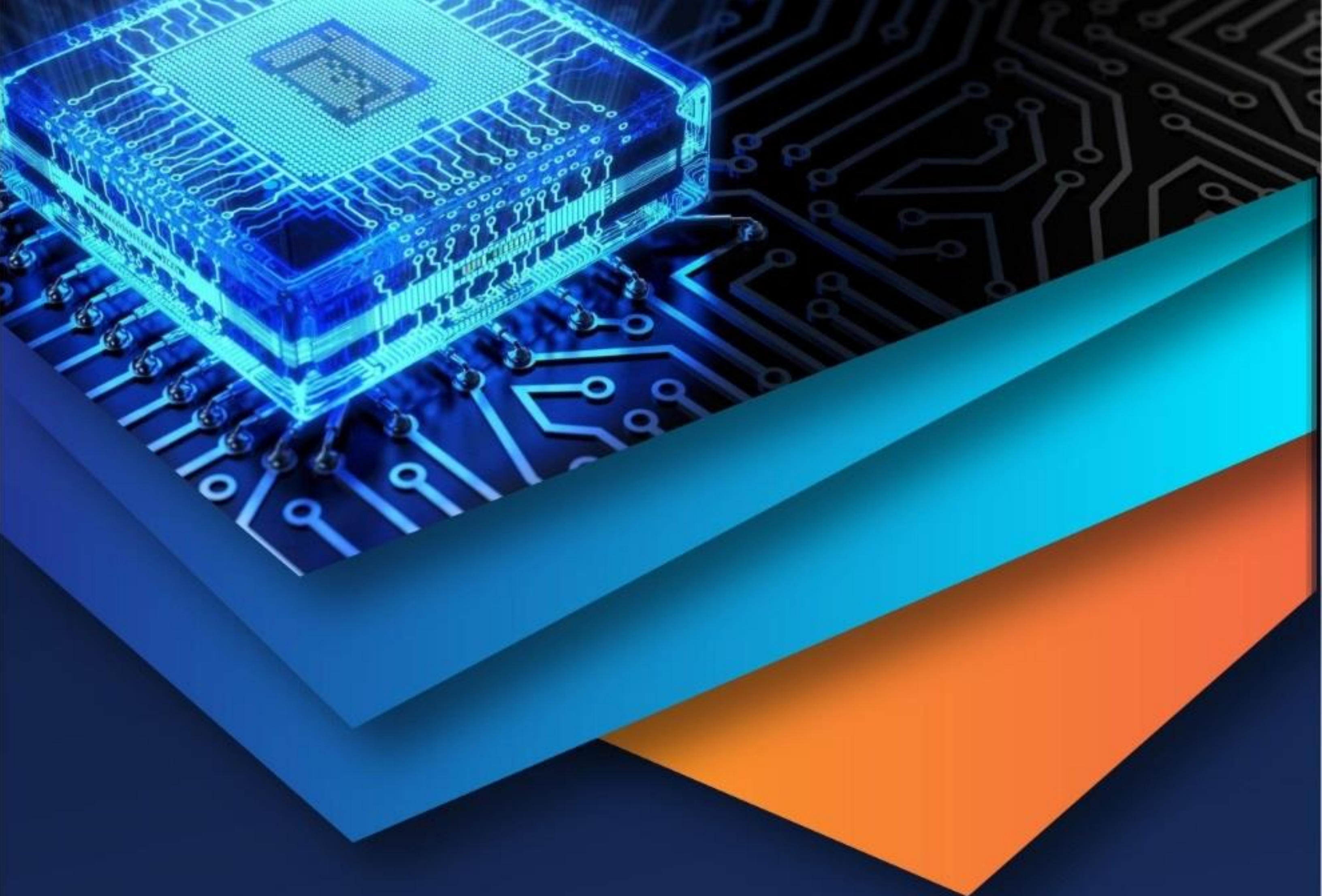

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