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Elastomeros cells as sinks seismic joints for contraction in floors expansion and sliding

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ABSTRACT

Through the implementation of a predictor-corrector algorithm, it was possible to determine the maximum energy to be dissipated caused by an earthquake, using dissipative cubic cells. These cells, made of elastomers, form together with the tile floor, a coordinated system of elements that resist the effect of the energy causing seismicity in residential flooring. Inside these cells, a spring bolt absorbs the energy of the seismic movement, becoming a mini-sink. The final equation of energy balance considers the dynamic energy of the earthquake is equal to the sum of the energy of deformation of the bolt, the more power dissipation multiplied by a constant "α "as a factor representing the probable events torsion. The fluid elastomer, poured into the cells, it is attached to the tiles. Succeeding a seismic event, the elastomer vibrates with the same frequency vibration system, regulated by the spring bolt into the cured elastomer. If the frequency of vibration absorber system attached to coincide with the excitation frequency produced by the earthquake, then the mass of the main system remains still, and generates the absorber at all times on the structure forces equal and opposite excitation.

1. INTRODUCTION

A constitutive pre-model to predetermine or describe the behavior will have a system of springs elastomer networked within another system of tiles that make concrete pavement, the study focused primarily on the linear stress-strain relationship is proposed and then its relationship with own material hardness, the elastomer comprises polymeric materials, pozzolanic and ground vitreous, "solid and elastic". As elastomers have excellent performance as dissipating energy, especially during cyclic loading. Our model aims to predict the amount of energy absorbed by the mini-sink deformations after stretching. As discussed in the present state of the art, and like other similar devices developed so far, the model considers both properties viscoelasticity like elastoplasticity. The numerical solution using the finite element method. In this study only this analyzing the mechanical properties of the seismic dissipators, l obtained silicon rubber. It is not considered analysis of the properties of mechanical resistance of concrete tiles that define.

2. MATERIALS AND METHODS.

2.1.-Materials

This study has experimented with compounds of improved silicone, ie pulp which led to the cubic cell and the spring elastomer must meet or make dissipative properties to the earthquake when they operate at pavements, which, after review the state of the art, very little has been studied before presenting these results (Mietta). It was used silicone rubber F-20 PLUS and model has been developed taking into account the effects of an earthquake that transmits an average seismic lateral force of 14,000 kg-f / cm2 so that for each joint seismic cubes are 5NW applies a total surface of each of the side faces.

TABLE 01: Detail dosifications volume percent for pasta elastomer spring and the cubic cell.

INPUT	Silicone rubber	Ground ceramic waste	Pozzolana	Reduced iron	Synthetic pigment	Total
PERCENTAGE	**70%**	**twenty%**	**5%**	**3%**	**2%**	**100%**

In Table 02 we can see the dosages used for both the standard sample and the test samples are to be subjected to the tensile test, a total of 10 samples, of which 01 corresponds to the sample pattern is performed, and the other 09 studies for traction.

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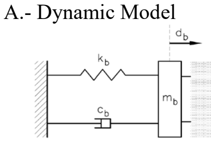
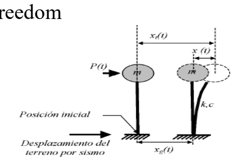
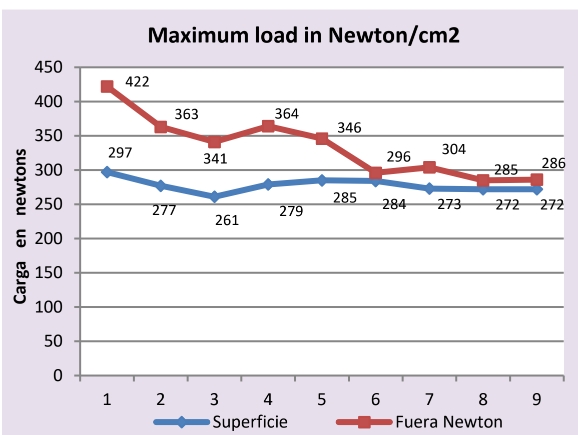
TABLE 02: Inputs used for preparing the elastomer spring both the standard sample and the samples and their improved mechanical properties of tensile strength

COMPOSITION / ***SAMPLES***		Silicone rubber F20 PLUS	Mármol molido 0.02 mm	Mármol molido 0.05 mm	Puzolana: Zeolita 0-1mm	Pigment Synthetic yellow	Pigment Synthetic red	Pigment Synthetic blue	reduced iron	Temperature	Tensile strength	A.- Dynamic Model 
M. Pattern	**01**	*	*	*	*	-	-	-	*	25°C	100Nw/cm2	
samples improved	**01**	*	*	*	*	*	-	-	*	25°C	144Nw/cm2	B.- System a degree of freedom  Figura 1. Sistema de un grado de libertad
	02	*	*	*	*	*	-	-	*	30°C	131Nw/cm2	
	03	*	*	*	*	*	-	-	*	35°C	131Nw/cm2	
	04	*	*	*	*	*	-	-	*	40°C	130Nw/cm2	
	05	*	*	*	*	*	-	-	*	45°C	110Nw/cm2	
	06	*	*	*	*	*	-	-	*	50°C	105Nw/cm2	
	07	*	*	*	*	*	-	-	*	55°C	103Nw/cm2	
	08	*	*	*	*	*	-	-	*	60°C	103Nw/cm2	
	09	*	*	*	*	*	-	-	*	65°C	102Nw/cm2	

2.2. - Tensile tests and hardness.

A total of 18 tensile tests were done, 09 for tensile strength tests and 09 for the hardness tests, the independent variable is the same for both tests, which are represented for a single type of elastomeric compound (Table 01). In the tensile strength tests, the "temperature" was considered as a second variable dependent, using values that oscillate between 25 and 65 degrees Celsius, (Table 02) and figure 01, left side), meeting various values of tensile strength being the highest 144N, by making the appropriate conversions, then determine your resistance is 1.44Newton / cm2, this data is very important and meets the requirements of ASTM D-638. Table 01). In the hardness test, 03 variables were considered, the two first ones represented by elastomer spring and the thickness of the specimen , and the third one, is the hardness as response variable, (See figure 01, right side), in this test's group, an statistical model of rotatable hexagonal experimental designs was used , which has allowed us to obtain, after modeling, a response surface in which it is predicted that the hardness values of the elastomer will reach a value of 102 Shore, which is compatible with what is required by ASTM D-2240-15 and ASTM Standard D-1418. In conclusion we can say that the data are favorable because for seismic testing we need a value of tensile strength exceeding 0.15Newton / cm2 in each of the side faces of the boards cubic and a minimum hardness of 50 Shore, and both requirements are have more than enough value. (Gatica)



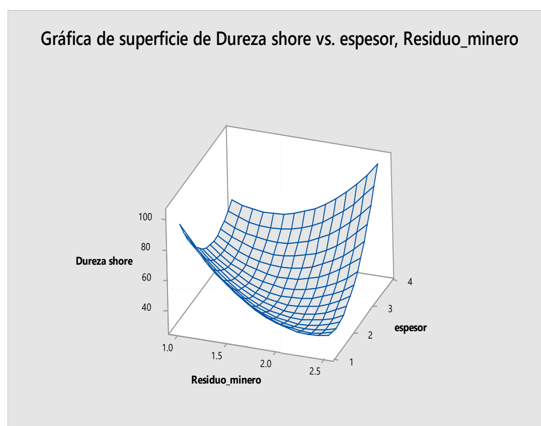


FIGURE 1. Test results of tensile strength tests *(left) and test results of hardness (right)*

3. DISCUSSION AND RESULTS

As can be seen, it has been found that the samples made from improved polymer showed greater resistance to yield stresses, this result was very important to continue the investigation. We can also observe that the weight of the standard samples was slightly higher than the standard sample, this result we also is useful to relate the mechanical properties being made. As for the hardness tests, no major difference was between responses to shore hardness of both the standard sample and the hardness of the others were tested.

4. - PROPOSED MODEL DESCRIPTION

Elastomers under seismic loading deformations respond in elastic form and from a macroscopic point of view as homogeneous and isotropic solid. .By submitting the elastomer sheets to cyclic loads in the laboratory, reveal nonelastic components, this is probably due to the use of other materials as pozzolans and marbles, which they are added to raise dissipative properties Spring. Based on the latter a phenomenological model, which are not considered micro-mechanical aspects it is proposed, therefore volumetric and deviatoric deformation parts are treated independently. And considering that the magnitude of damping depends on the components of the material, different models are considered for each substance, viscoleasticity for silicone rubber and to elastoplasticity pozzolanic and glass components. The proposal has been inspired by the basic constitutive expressions of each component in a multiphase solid.

The overall performance of the compound is influenced by the mechanical characteristics of each single component according to the volume ratio. As constraint equation or closing kinematic model perfect compatibility is supported at all time points analyzed process. Finally by not including variable temperature as functions of strain energy, the proposed model is limited to stable thermal conditions.

In our model the total energy is absorbed, bone dissipated energy is equal to the seismic energy. As for the breaking strain by constant effort, we are considering percentages varying between 180% and one 200%, the horizontal forces are nearby monotonic breakage No to reach the vertical loads are being considered.

4.1.-Development Model.

In order to study the system response "elastic bolts" within bilaminar tiles displaceable against earthquakes, the numerical model was based essentially Newtonian mechanics (Oller). Every structure responds dynamically to the action of loads or deformations, generating inertial forces equal to its mass times acceleration (Newton's second law, dynamic equilibrium equation). As the structure is subjected to dynamic loads, impact or rapid deformation as caused by earthquake, they are considered inertial forces making necessary a dynamic analysis. Considering an idealized structural system in a model of a degree of freedom and a simple and basic dynamic model (Table 02).

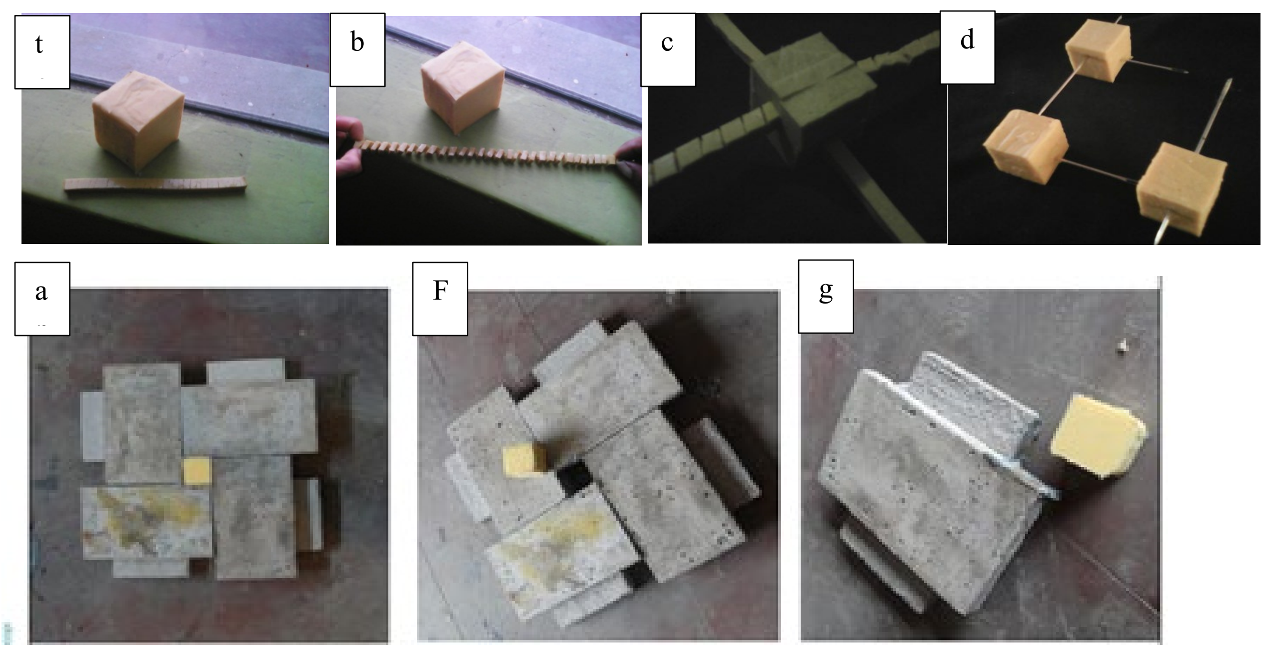


Figure 2. Different stages of the development process model.First the cubic cell (a) is obtained, then the spring (b) is designed, then 02 holes is inserted into the cell, within which are placed crosswise the two springs (c) and these springs must be related each with the other cells forming a network (d) .Abajo, concrete tiles with cell elastomer (e) view of the tiles without the cubic yield (f) and bilaminar tile and separated cubic cell (g).

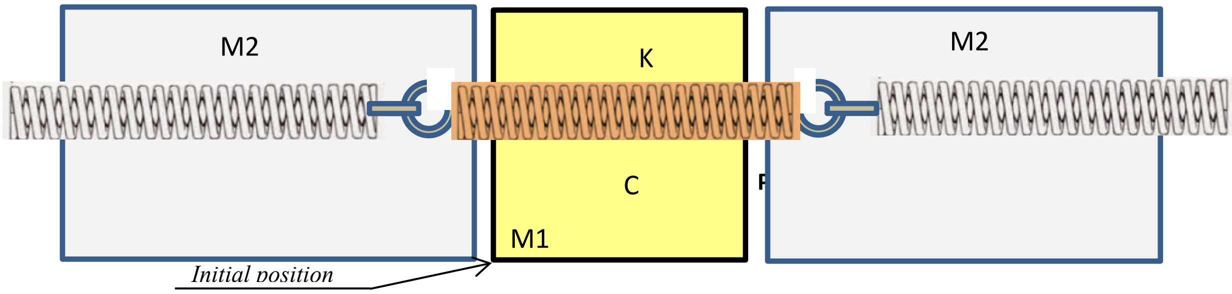


FIGURE 3. System under static conditions, frontal view of cubic cell and tiles

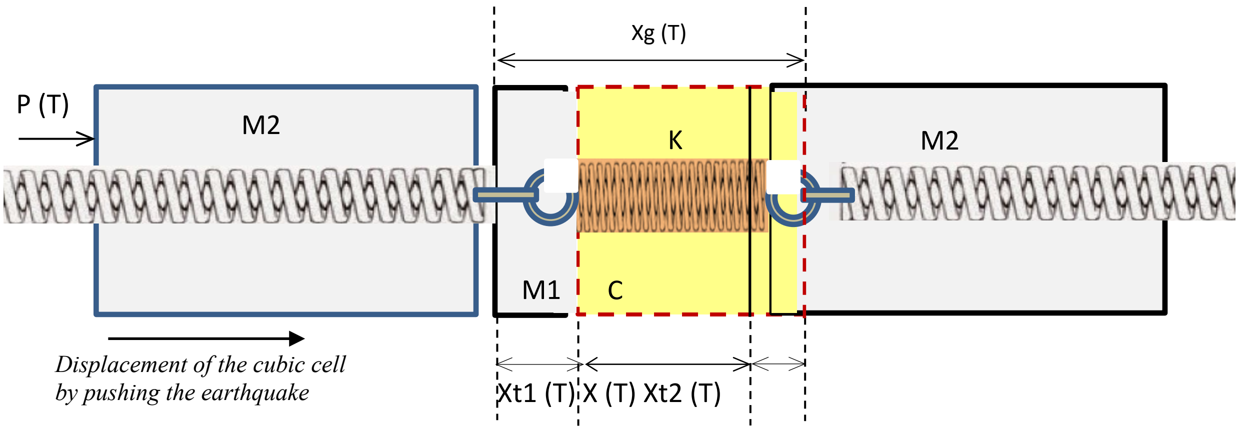


FIGURE 4.-System in circumstances of contraction, the cubic cell and spring contracts

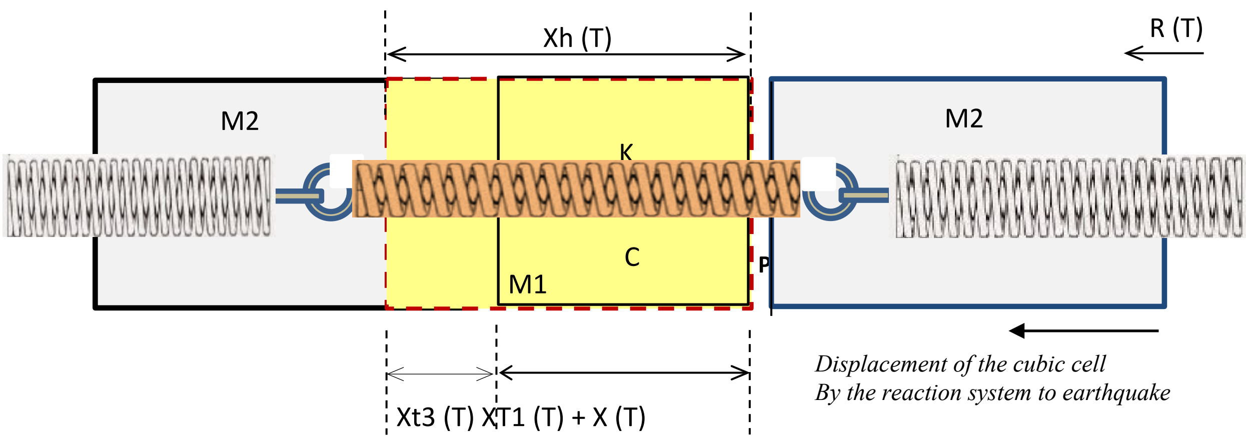


FIGURE 5. System in circumstances of expansion, the cubic cell and expand the spring

4.2.-Design-phase algorithm-Start Phase.-

In this part we show the initial part of the development model, which is to culminate with the computational implementation using Charpy methodology ASTM D 256.(Medalla)

The model consists of a concentrated mass M1 which surrounds the spring stiffness k elastomer with a viscous damping coefficient c own system. The system is subjected to a seismic load characterized by a soil displacement xg (t) and a load P (t) or may not be time dependent. The system response is to determine the value of the dissipated energy and the displacement of the mass at any time with respect to its general original position xt (t). This parameter is calculated depending on the displacement of the mass of the cubic cell (M1), the displacement of the mass M2 of the tile concrete and final displacement of the mass of "elastomer spring" with respect to its base (Gonzales). There are 2 Newtonian equations to predict this behavior, the time compression.

Balance equation in a moment of maximum contraction elastomer spring:

Xt1 (T) = Xg (T) - [(X (T) + Xt2 (T)] **(1)**

For these conditions the dynamic equilibrium equation is:

XT1 M1 (T) + C Xg (t) + K [Xt (t) + Xt2 (T)] = P - [M1 XT1 (T) + M2 Xt2 (T)] (2)

Where:

Maximum energy dissipated = P - [M1 XT1 (T) + M2 Xt2 (T)]

Where:
M1Xg (T) It represents the inertial force of the mass of polymer of the cubic cell.
M2Xt2 (T) It represents the inertial force of the mass of the concrete tile next.
Xg C (T) It is the inherent damping of the system.
K [Xt (t) + Xt2 (T)] It is the elastic force of the retracting spring.

Balance equation in a moment of maximum expansion of the elastomer spring:

Xt3 (T) = Xh (t) - [XT1 (T) + X (T)] (3)

For these conditions the dynamic equilibrium equation is:

M2Xt3 (T) + CXH (T) + K [Xt3 (T) + XT1 (T) + X (T)] = R + M1Xt3 (T) (4)

Where:

Maximum energy dissipated = R + M1Xt3 (T)

Where:
M1Xt3 (T) It represents the inertial force of the mass of polymer of the cubic cell
M2Xt2 (T) It represents the inertial force of the mass of the concrete tile next.
C Xh (T) It is the inherent damping of the system.
K [Xt3 (T) + Xt (T) + Xt2 (T)] It is the elastic force of the retracting spring.

5. CONCLUSIONS

a.-The results of the values obtained from the tensile and hardness tests applied to the same type of elastomer compound exceeded the values that were required for it to be used as a seismic dissipater.
b. The inputs used are reduced iron, pozzolans and ground marble if they contribute to elevate the properties of seismic dissipation.
c. The temperature causes changes in the coloration of the specimens, but does not reduce the values in the mechanical properties.
d. The temperature value of 25 ° C is what allows the maximum values of tensile strength and hardness of the polymer compound.

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