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EVALUATION OF SEISMIC PERFORMANCE OF BUILDINGS WITH CONCRETE FRAMES REINFORCED WITH HELPING OF VISCOUS DAMPERS

MOJTABA KHARI *

*Corresponding Author, M.S. Student, Azadshahr Branch, Islamic Azad University, Azadshahr, IRAN

khari.mojtaba@gmail.com

ABSTRACT

In the event of a strong earthquake, often is designed in such a way that the building permit to enter in non-elastic range of deformation. The non-elastic deformation of the plastic hinges to form locally in some parts of the structure that increases the ductility and energy dissipation is also increasing. As a result, a lot of earthquake's energy due to the destruction of local earthquake resistant system components will be amortized structures. This damage reduces the hardness and strength. The failure of structural members, even if it is not the complete destruction of the structure due to expensive and sometimes impossible to repair or replace the damaged part is undesirable phenomenon. Using suitable absorbing system energy in structures whose members have not a good performance is important. Because the seismic energy is absorbed by the system structural members remain elastic during earthquake. In fact, these systems act like a fuse in the building and with self-sacrifice will cause do not damage to other parts of the structure. One type of passive energy dissipation systems is a viscous damper. Viscous dampers are part of waste equipment which considered the new seismic design methods.Due to the fact that although the rules have changed load normally existing structures and need not meet the provisions of new laws strengthening, that the idea of using a damper on this kind of structure is become more important,. Single dissipate earthquake energy at the time of such severe earthquakes The proper functioning leads to delays in the arrival of some state structures created to improve the performance of the structure is very impressive. The study used

covers 5-storey concrete moment frame two-dimensional arrangement as a short-order structure. Structures design with help of the old regulations (first edition 2800) and then to help dynamic pushover analysis proved that they will not work in the new regulations. The frames have already been designed with viscous damper is strengthening. To nonlinear dynamic analysis of seven Acceleration used and the results compared with this analysis. According to the results we can see that the damper in the model analysis is to reduce the response.

INTRODUCTION

Based on the available evidence, we can say that the first use of fluid viscous damper on a large scale to reduce Rejection (kicking) large artillery in military affairs. And then to a waste of energy used in buildings due to the favorable performance of the dynamic loads that are taken into consideration. Until recently, most researchers thought and civil engineers to develop robust systems for coping with the earthquake energy and memorials of various methods such as shear walls, bracing types and try to read (. Despite the fact that these systems play a role in resistance the structure against lateral forces researchers to think more modern ways energy forces (lateral) fell to the idea of seismic dampers and isolators as a means of insertion and attachment accessories was introduced in resisting systems [1]. Over the years, companies and research institutions - executive teams in many different forms of energy damping structure review and on the basis of their studies, various devices have been designed and implemented in different forms. When a structure is faced with severe dynamic stimulation structural stiffness and energy dissipation mechanisms cause to resistance dynamic stimulation. Add to lateral stiffness and economic structures in many cases are difficult, therefore, to control damping vibrations in structures with different techniques have focused increasing attention. The level of risky or structural failures like extreme natural events such as earthquakes and tornadoes can be reduced using methods to increase damping structures. The damping properties of the structure that is part of the injected energy will dissipate during dynamic loading [2]. Common structure, the seismic energy is absorbed through surrender or failure of building materials. For example, when the earthquake energy beam column joints of steel to make plastic is absorbed, or when concrete structures crack up or masonry structures unarmed its contents to defeat the ends of the energy absorption takes place. Failure to provide a solution to surrender or viscous dampers that absorb earthquake energy method is considered. Viscous dampers can absorb almost all the energy of the earthquake and flawless structure intact and ready for immediate use after an accident hold [3]. One structure during its operational life must in addition to static loads and the dynamic loads which have to be imported. Dynamic loads were not permanent and come suddenly to the structures. This is often caused by environmental factors such as wind and earthquake loads and their nature is such that calculate and estimate the magnitude and how to incorporate them or do not arrive or was not possible or is associated with high approximation. As a result, to obtain the forces caused by the need to simplify them and simplifying assumptions, which are designed to problem of resistant and has high approximation. On the other hand, under the stimulation of dynamic loads such as earthquake or wind speed, the structure suffered severe vibrations that not only may damage the structural system, but may be non-structural damage, the damage or lack of comfort of the users of the building. So today, in addition to taking into account the criteria for building design resistance must also be considered a measure of the operating structure resulting in structural vibration control that is effective in both cases and highly regarded. The traditional method for seismic design, for example in this case is meant to provide a combination of strength, and ductility to withstand the loads imposed on the structure. Large earthquakes structural design engineer in buildings with separate applications on their inherent plasticity relies to prevent catastrophic failures, but by accepting a certain amount of structural and non-structural damage. In many ways the traditional methods of seismic excitations fleeting look like a static load equivalent components that must be resisted by the structure. However, coming out of this thinking and consider the real dynamic characteristics of environmental stimuli, significant improvements can be seen. In fact, as a result of this dynamically, so the concept of new innovative protection structures have progressed and developed in different places, with an energy dissipation, one of whom is disabled. The fundamental role of passive energy dissipation devices when joined to a structure or use a section of the energy absorption, which thereby reduces the demand for energy dissipation on the primary structural members and structural damage, is possible, at least. In recent years serious efforts is considered to develop the concept of passive energy dissipation or additional attenuation as a practical technical knowledge. And many of these devices have been installed on structures around the world [4]. In improving seismic lateral One of the way of decreasing the force caused by the earthquake is using the dampers. During the earthquake, a large energy is applied to the structure. This is both kinetic and potential energy (strain) is applied on the structure that is to absorb or dissipate. If the structure is free of vibration damping will be joined, but because of damping materials, vibration is reduced. Earthquake input energy is converted into the structures presented in forms:

$$E = E_K + E_S + E_h + E_d$$

In the above equation E earthquake energy input,

EK: kinetic energy

ES: reversible strain energy within

Eh: elastic,

Ed: the amount of energy wasted due to inelastic deformation and the amount of dissipated energy by the damper [11].

The seismic isolation systems, use of energy dissipation system, have a special place. Damping using various methods such as yielding a soft metal, the metal friction on the movement of a piston inside a slimy substance or viscoelastic behavior of rubber-like material is possible.

The concept of attenuation

2.3.1 Damping effect on the structural response

Increased damping causes to reduce the structural response (acceleration and displacement). Increased attenuation at low frequencies (close to zero) has no effect on the amount of spectrum and the high frequencies has little effect on the acceleration response [8] Figure 1 and Figure 2 show most of the increase attenuation at frequencies 3.0 to 5.2 second.

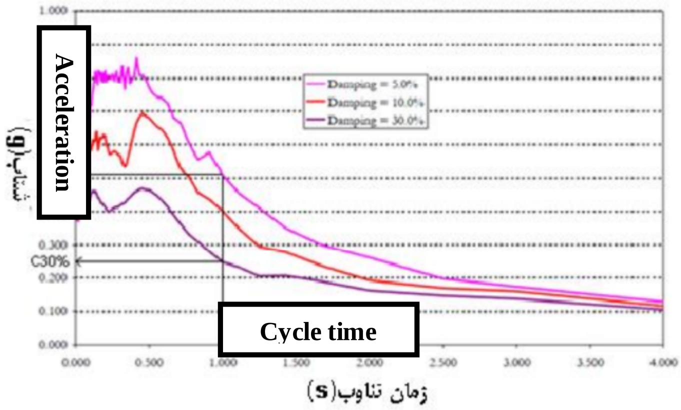


Figure 1: Effect of damping on the whole acceleration response

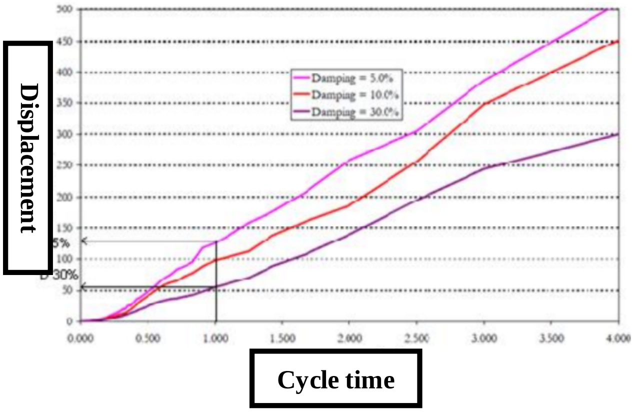


Figure 2: Effect of damping on displacement response spectrum.

The seismic design codes and optimizing damping effect by defining the damping coefficient (B) which is a function of the percentage of time BS critical damping (β) is determined. The ratio) is defined for both the short frequencies (BI) frequencies close to a second on the whole response curve between (BS. T0 0.2 scope and frequency of the time period of the transition from fixed to fixed speed acceleration BI spectrum is T0. Coefficient (T0) is also used to reduce the range at higher frequencies. Attenuation coefficient values based on the percentage of critical damping is provided. Linear static method depends on the displacement of critical damping effective means beff [4] structure is calculated by the formula:

$$\beta_{eff} = \beta + \frac{\sum_j W_j}{4\pi W_K}$$

The parameters of the above equations as follows:

β = Damping building framing system that should be deemed equal to 5% unless additional attenuation is required.

Wj = the means of displacement is dependent on the work done by my j- through a full cycle under changing place.

Di= floor by floor, the operation is performed on all j.

WK = maximum strain energy frame that is obtained from the following equation.

$$W_K = \frac{1}{2}\sum_i F_i \delta_i$$

I was on the floor i- Fi = inertial force and the operation of all i do is pan.

Viscous dampers

The dampers using viscous liquid movement inside a cylinder, the energy dissipated. Viscous dampers because of the simplicity of installation, compatibility and coordination with other member states as well as diversity in their size, have found great use in the design and retrofit. In the past, many applications of viscous fluid to control the vibrations caused by the impact of space systems and defense have been observed over time it has been shown that these systems can have a significant effect on the vibration control. In fact, the production of fluid viscous damper with high capacity dates back to around 1890. Viscous dampers for the first time in military aerospace engineering and have been used production to absorb the impact of landing an aircraft or missile launchers. When the dampers are first produced for civil uses technology developed over 35 years and they were perfect, but at that time, in fact, to protect missile silos dampers and shock waves hit was a blast. Sticky fluid depreciates a solution for increasing the energy loss in the ancillary systems in the structure. A viscous fluid damper the energy adjustment by pushing into the pores of a damper pressure creates a force that will be generated. The damping occurs to force up 90% out of phase displacement caused by the driving forces [3].

This means that the damping effect on the structural deformation does not lead to increased seismic forces. Add fluid damped structure to a structure more than 30% depreciation of the property and its critical limit the amount of lead that is in some cases more. This significant decrease is 10 percent fluid dynamics, seismic dampers to a class horizontal and lateral deformation of the structure can be reduced to 50% and is sometimes even more.

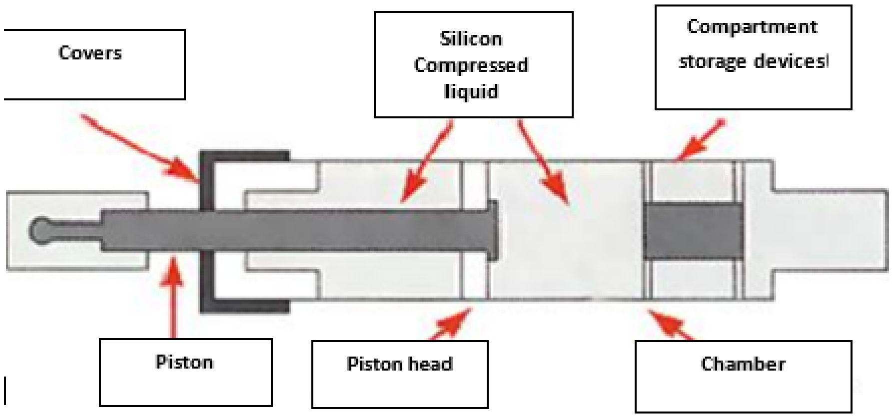


Figure 3: Detail type viscous damper system

These dampers are attached to the structure below:

- Install dampers to the floor or foundation (base isolation method).
- Connecting the wishbone damper braces.
- Installation of dampers in diagonal braces.

Figure 4: Connecting viscous dampers on the floor and foundation structures

In connection dampers on the floor or foundation structures dampers can be combined with the separation.

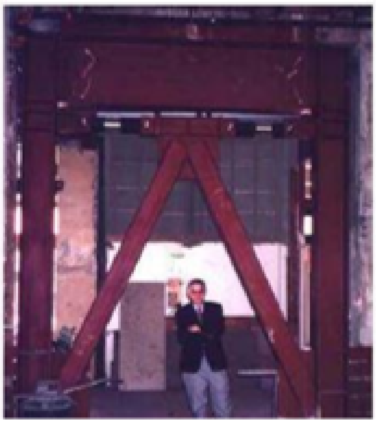


Figure 5: The use of viscous dampers in braces wishbone

Figure 6: The use of viscous dampers in diagonal braces

Modeling, structural design and evaluate the performance of its old

Model study,

The model in this study is as follows.

- Of a 5-storey model used.
- Model 2800 are designed on the basis of the first edition.
- Strengthening the model with viscous damper.
- In total there are 2 models

Due to the large number of models and the use of many of their names in tables and figures, is required to be labeled in a manner that also as being brief model best represents the model. As a result of the following general form is used in naming models.

Xst-(M or D)

In the name of:

X; is used to determine the number of classes.

St; Abbreviation for class, meaning Story

M; Abbreviation for Moment means moment frame

D: Abbreviation of damper means damper

Table 1: profile name used investments models

Model
5st-M
5st-D

Assumptions and models used geometric profile

The following assumptions were used in the modeling structure.

- SAP2000-14.2.4 software is used to model [9]
- Two-dimensional structures can be modeled.
- Building system using conventional concrete moment frame.

. - Strengthening the model with viscous damper.

. - Distance between the openings is 5 meters.

- Equal to 3 meters height classes.

In buildings with roof crossbars, composite or duplex indicating the high rigidity of the page under certain conditions can be assumed to be rigid or diaphragm. In this case, the ends of the beams do not move relative to each other and axial force should not get on in their existence. So all the nodes have the same height with each other and become aperture and bound.

- According to the terms of the beam or column length of a beam or column in theory run is different, the software SAP option End Offset to all active members and a factor of 5.0 to Area rigid allocated to be conservative.

Used Concrete materials

Profile of concrete materials used for the analysis and design is presented in Table 2.

Table 2: Specification of materials used in the analysis and design of concrete

Weight (kg/m3)	E (kg/cm2)	Poission 's ratio	Fc (Kg/cm2)
2500	273860	0.15	300

The first edition in 2800 to help design concrete moment frame

Side Loading

The importance of building assumes 1. Given the location of this research model in Tehran with an area of very high risk and accelerate project basis (A) 0.35 It is a premise to similar land use in Tehran conditions, soil type 3 is used in this study, soil. In accordance with paragraph 8 Third Edition 3.2 2800 standard for ordinary moment frame ratio is 7 and for the first edition is 6. The experimental period is calculated from the relationship T = 0.07H. For single degree structure freedom to structure the criminalization of various difficulties can be identified under a variety constructed. 2800 with a series of works by combining probabilistic range of different accelerograms, the whole regulation is achieved. Reflection coefficient is calculated as follows:

$$B = 1 + S(\frac{T}{T_o}) \qquad T < T_o$$

$$B = S + 1 \qquad T_o < T < T_S$$

$$B = (S+1)(\frac{T}{T_S})^{\frac{2}{3}} \qquad T > T_S$$

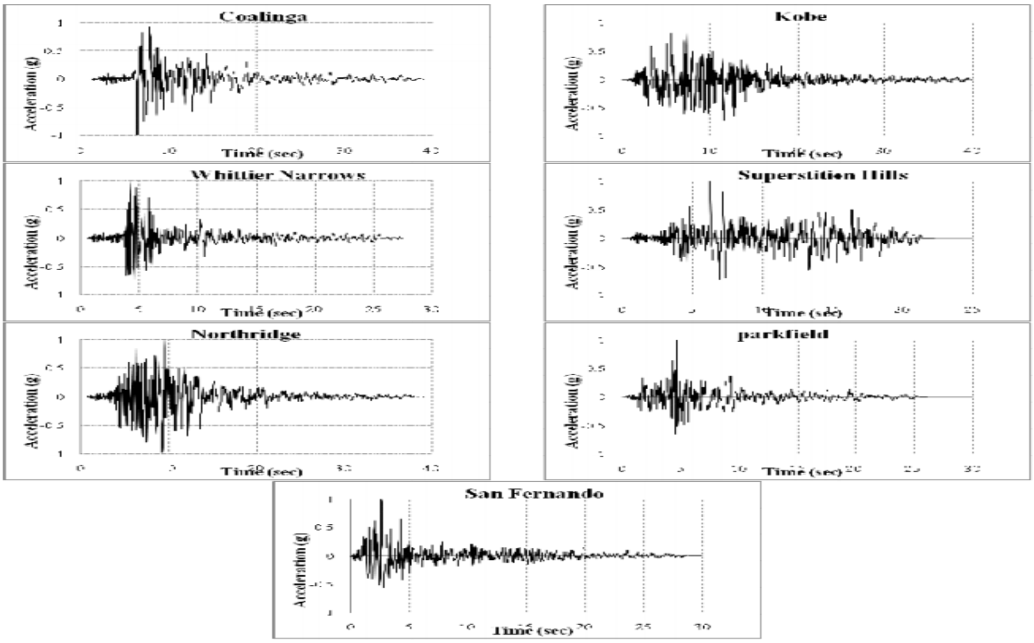
TS, to and S are parameters that depend on the terrain and the risk seismic zone. Third Edition 2800 in the amount of land Type 3 and zone with very high risk, respectively, is 0.15, 0.7 and 1.57 and in the first edition, respectively 0, 0.7 and 1.5.

Strengthening RC frame with viscous damper

Nonlinear Dynamic Analysis Structural analysis is the strictest NDA. Because the real effect of the earthquake in accelerogram at the foot of the structure and behavior of materials considered to be non-cyclic. In this type of analysis it is important Accelerogram conditions. Other methods of nonlinear analysis of structures are all trying to do a good estimation of nonlinear time history. The other methods are trying to be a good alternative for this method. Roofing and basic cutting parameters, such as history, drift, movement classes, accelerated classes, etc., can be discussed. In this study acceleration records that have been selected from a database of earthquakes Berkeley [4]. This study, 7 pair used Accelerogram. To obtain the answer, the answer is averaging seven Accelerogram. In Table 3 and Figure 7 shows the records used in the study.

Table 3: Records used in research

Record 1	Record 2	Record 3	Record 4	Record 5	Record 6	Record 7
Coalinga	Kobe	Whittier Narrows	Superstition Hills	Northridge	parkfield	San Fernando



Accelerogram response spectra using the square root of the sum of squares of each pair together and a composite whole unit to be built for each pair.

$$S_a = \sqrt{S_{ax}^{\ 2} + S_{ay}^{\ 2}}$$

Combined response spectra Accelerograms pair, as shown in Figure 7 and relationship decisions are below average.

$$S_{a\,average} = \frac{S_{a1} + S_{a1} + \ldots.. + S_{an}}{n}$$

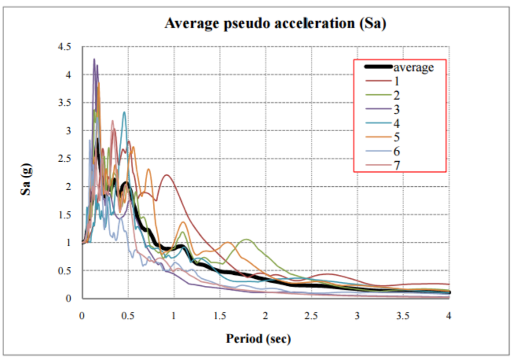


Figure 7: The pair combined response spectra Accelerograms

Average achieved within the time period T5.1 and T2.0 standard compared with the whole project. Given T experimental period construct models with different height difference, the figure should the rate be calculated separately for each model. Summarized of this operation is show in Table 4 and Figure 8.

Table 4: Accelerograms scale factor in different models

Model	5st
Scale Factor	0.963

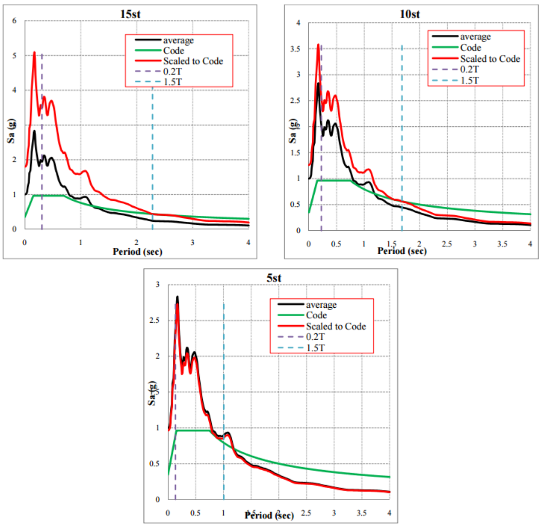


Figure 8: Scale model Accelerograms.

Modeling viscous damper according to a presentation last season that was discussed in detail the type of viscous damper and damper choose placed between two adjacent structures. The following parameters were used in the selective damper. In structures with few degrees of freedom (MDOF) used an analytical model of Maxwell that the stiffness and damping damper is in series with each model is used (Figure 9), which is hardly representative of the Cd of the spring Kb its hardness and the amount of the patrimony.

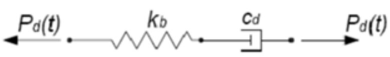


Figure 9: analytical model of viscous damper

Kb: hardness bracing

Cd: attenuation value

Pd: (t) damper force

$$F = C.V^N$$

F: is the damping force.

C: an arbitrary constant

C) Remains constant throughout the speed range

V is speed.

N: power that can change between 3.0 and 95.1 (N remains constant rate during the period). In this study, the coefficient: K linear and nonlinear mode 10200 ton / m, coefficient of C = 5 and N = 1 is used.

Below the viscous damper structure is displayed in SAP software.

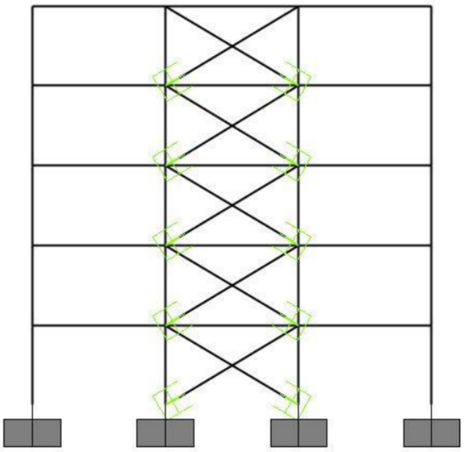


Figure 9: A viscous damper structures in Software SAP

Validated modeling viscous damper on SAP software

In the manual for the software example 6-007 laboratory test sample from the University of Buffalo as shown below is done when the sap software testing model and its accuracy is controlled.

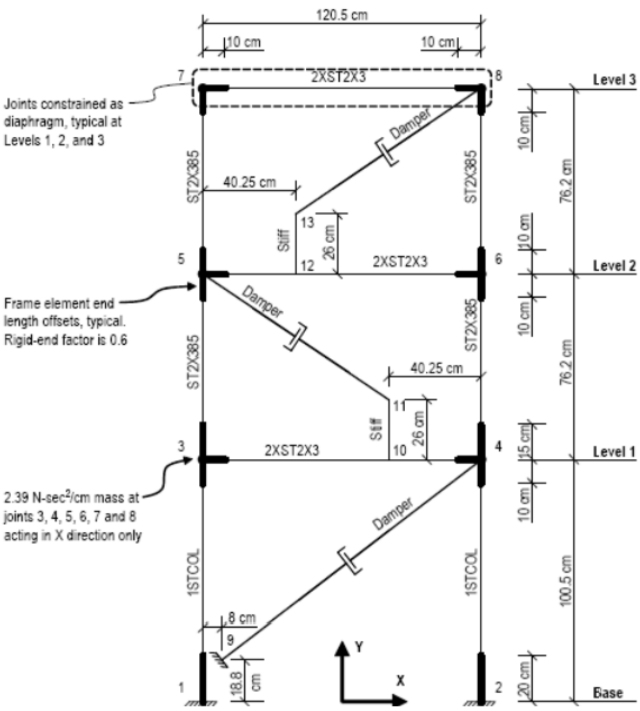


Figure 10: Model validation of the University at Buffalo

The model with all the details is shown below in software simulation sap.

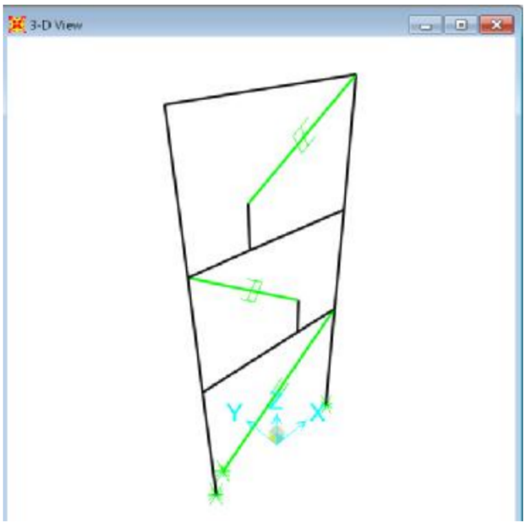


Figure 10: Create a model of software validation sap

The results of the modal analysis are based on research, the University of Buffalo in the following table.

Modal Period	Load Case	SAP2000	Independent Experimental	Percent Difference
Mode 1 sec	MODAL	0.438	0.439	0%
Mode 2 sec		0.135	0.133	+2%
Mode 3 sec		0.074	0.070	+6%

The results shown below sap software have been validated. As you can see, the results are quite consistent with the manual of sap.

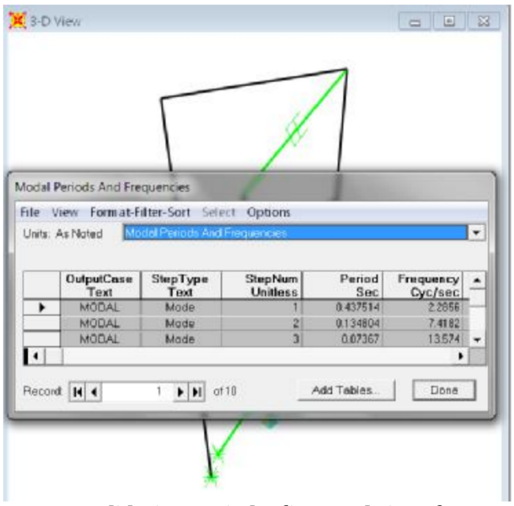


Figure 11: Validation Period 3 first mode in software sap.

History roof displacement and base shear

Including removable roof and base shear is important responses. With non-linear behavior of the structure due to plastic hinges and get your members to increase the maximum base shear resistance (strength (142 limited. On the other hand due to plastic joints and soft structure, its movement easier it happens.The earthquake may cause permanent structural deformation value. The steady movements cause earthquakes vertical axis response at the end of the number is not zero. In Fig. 12 and 13, respectively, removable roof and cut the base for the model with and without the damper and the two modes is drawn Kvalynga earthquake.

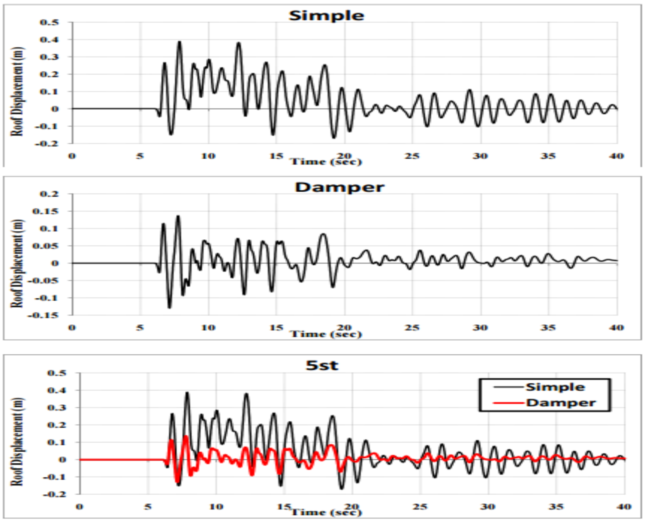


Figure 12: History removable roof Kvalynga earthquake in the st5

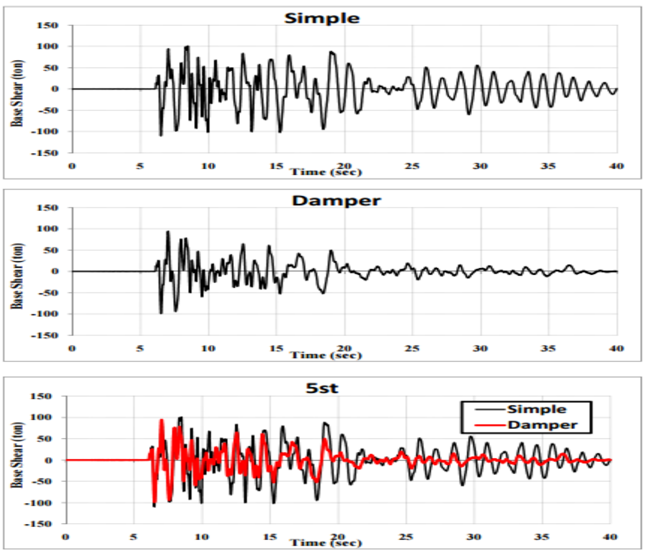


Figure 13: History of the base shear in Kvalynga earthquake st5.

Average maximum displacement classes

As noted at any moment, any displacement is an Accelerogram on each floor. In the exercise of any Accelerogram, in an instant shift is the maximum class. The maximum displacement occurs at a different time each Accelerogram. The average of the maximum displacement of each class in different accelerograms, achieved the maximum displacement of the floor. Figure13. Average maximum displacement classes in the model both with damper and without the damper and drawn the two modes. In Figure 14, the effects of a damper on all models.

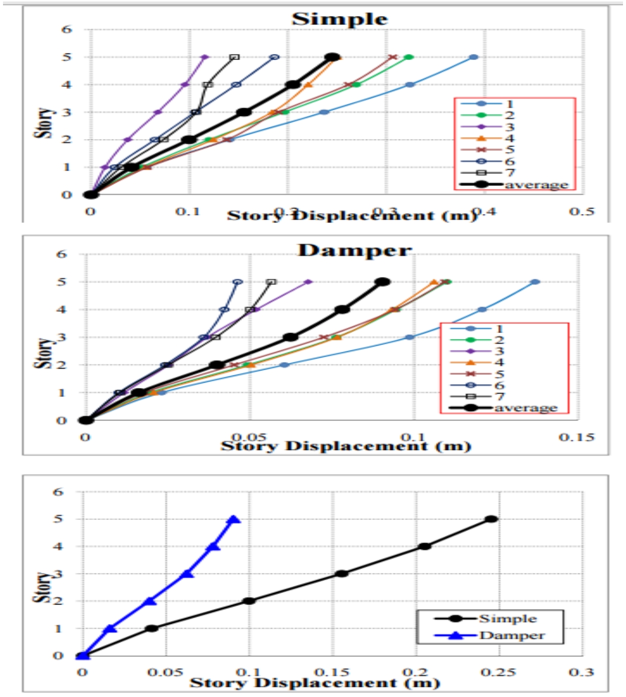


Figure 13: Average maximum displacement classes in the model st5.

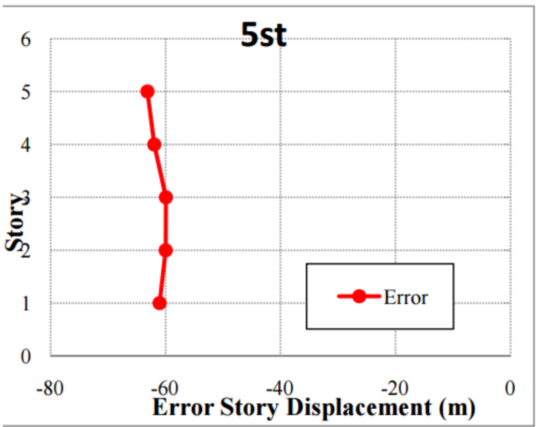


Figure 14: Impact damper on average maximum displacement classes

Average maximum drift classes

To get the drift classes, can be the difference between the maximum displacement classes. But in any Accelerogram switch classes at any time to obtain the maximum difference between the calculated differences during earthquake and to obtain the maximum drift of the average used per class. Average maximum drift of 15 classes in the model both with and without damper and comparison of these two modes is drawn. In Figure 16, the effects of a damper on the model.

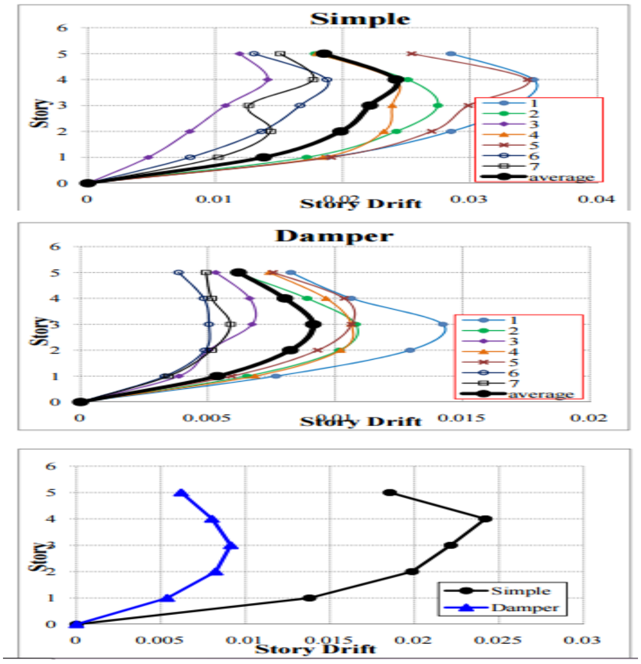


Figure 15: Average maximum drift classes in the model st5.

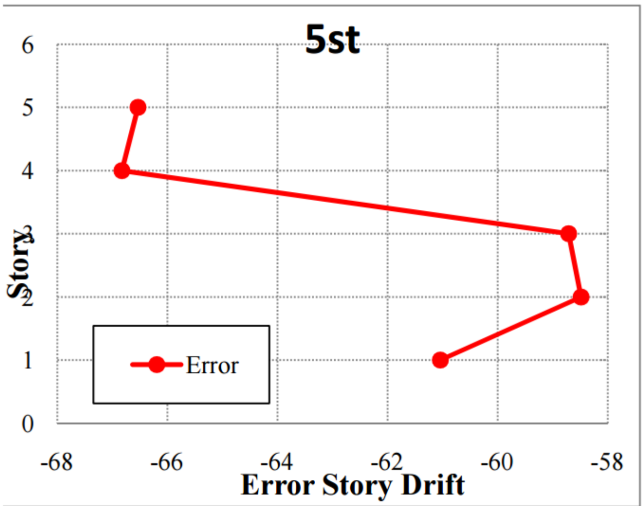


Figure 16: Impact damper on average maximum drift classes

Persistent plastic joints in the structure after the earthquake

Starting with the base excitation by earthquake, suffered structural distortions that deformation after the earthquake may be lasting. If all structural members remain linear deformation after the earthquake there will be lasting. But in the case of joint structures and the residual deformation of the structure will remain stable. Figure 17 show durable plastic joints in the model with and without the damper. Looking carefully at the figures, we can say:

There damper reduces the volume and value of plastic hinge rotation in the models.

- The performance of members in models without damper inappropriate

. - The model is the damper cause to improve the performance of the structure. But at some earthquakes even add damper structural performance is not acceptable.

. - Damper role in improving the performance of structures with less class is highlighted.

In the series of earthquakes there is a damper, causing the structure to remain in the linear range.

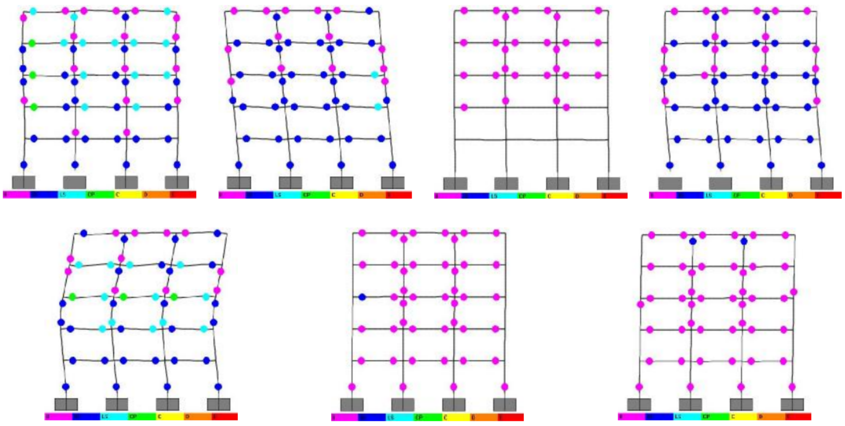


Figure 17: plastic joints lasting created after the earthquake in st5 without damper model

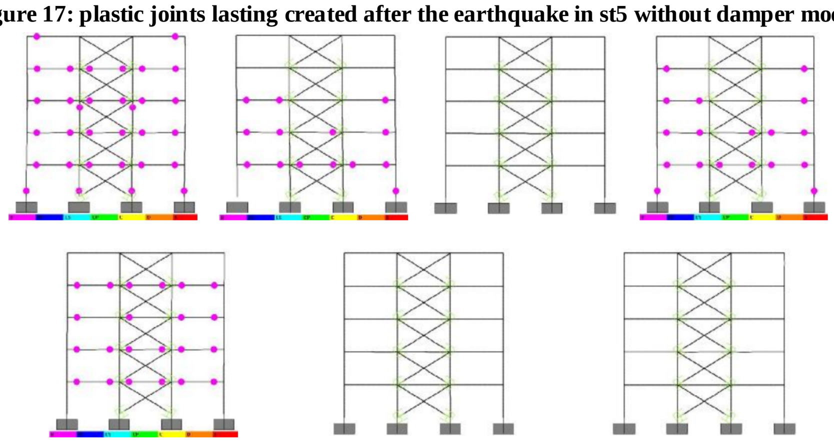


Figure 18: plastic joints lasting created after the earthquake in st5 model with damper

CONCLUSION

- In the model there damper reduces call history roof and reduce the movement of waste

. - The model is the basis for history and damper reduces the residual force.

-There Damper to reduce the base shear history has been the greatest influence on st5 model.

. - Cutting base not reduce the size of the removable roof. Because there damper makes structures harder.

-There Damper reduces the maximum displacement classes. The maximum amount of this reduction is 63%. -

. The least reduction in this model is 9 percent.

. - The damper reduces the maximum drift and drift model classes not pass damper 2.0. While the damper in models without this number reached to 0.04.

- The maximum amount of this reduction is 66% drift in the model.

- The damper reduces the maximum acceleration classes. -. The maximum amount of this reduction is 50%.

- Models without damper in terms of performance are in trouble. Do not mean the earthquakes with any member of the damper after the passing of the LS earthquake plastic hinges are not crossed.

- Damper role in improving the performance of structures with less class is highlighted. - The damper reduces the volume and value of plastic hinge rotation is in all models.

. - The number of earthquakes associated with the damper, causing the structure to remain in the linear range. - All dampers in the model have been designed to absorb energy (into the nonlinear range).

- Damper lower classes have the highest energy absorption

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