REVIEW AND ASSESS THE OPTIMAL ARRANGEMENT OF VISCOUS DAMPERS IN ORDER TO REDUCE THE SEISMIC RESPONSE OF TALL REINFORCED CONCRETE STRUCTURES

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ABSTRACT

In recent years, the call control structures in earthquake using energy dissipating devices such as dampers have been of particular importance. Research has shown that the use of viscous dampers can play an effective role in monitoring the response of structures against the wind, explosion and earthquake. The optimal arrangement is very effective damper efficiency of their performance. In this study, design is ideal viscous damper damping operation for 100 percent and put it in different modes in structures using software ETABS2015 try to determine whether the optimal model can be offered to install dampers in plan and elevation classes, to be answered. The model used in this study is a 20-storey reinforced concrete three-dimensional structure of the records used for non-linear time history analysis of earthquake KOBE and SMART1 and are LANDERS. The results show the effect of the optimal arrangement of viscous damper in reducing the seismic response of structures. However, the optimal location for a viscous damper structure under different earthquake quake because of different characteristics vary. Therefore, it can be a hundred percent for the optimal location pattern presented viscous dampers. LANDERS structures under earthquake model in this study will have the seismic response of the maximum amount of 43.02 percent compared to non-damper. However, in most cases, the best structural response is the time when the dampers in building frames with each other in adjacent springs are installed.

Keywords: *Viscous Damper, Seismic Response, ETABS 2015, Time History Analysis, Records.*

VISCOUS DAMPER

Fluid viscous damper is one of the energy absorbing systems is compared to the physical size of the ability to absorb high energy. So this type of energy dissipation caused by the earthquake dampers can be used in structures. In the past, many applications of fluid viscous dampers to control the vibrations caused by blasting in space systems and defense have been observed. As time has shown that this system can have a significant impact on vibration control. In fact, the production of fluid viscous dampers with high capacity to about 1980 returns. Including its dependence on temperature and frequency characteristics of the damper depending on the severity and frequency of load and load a certain amount of energy wasted [3]. Building a damper includes a cylinder and a piston made of stainless steel with a bronze cap is perforated. Should damper cylinder pressure load on the cylinder, which is made of stainless steel to withstand, because of fatigue or residual stress, welding is not possible damper cylinder. Cylinders are usually designed to handle 1.5 earthquake. Meanwhile, according to the cylinder compressive forces should not leak. The cylinder of liquid silicone oil is non-toxic and non-flammable and is stable for a long time. It damper on energy dissipation by fluid pressure from within Aperture is built into the plunger cap. When the damper pressure, high pressure liquid flows from the chamber 2 to chamber 1 and vice versa when the damper is in tension, fluid flows from chamber 1 to chamber 2. High-pressure fluid outlet of

Ron pistons, piston causes a pressure difference on either side of the cap and thus the damping force is generated. Fluid compressibility may cause elastic return force after the piston stroke to prevent this from happening a control valve, the liquid passes through the third compartment provides the Accumulator or storage enclosure.

Viscous damper is analytically dependent on the speed and the force-velocity relationship for viscous damper shown in Equation 1:

$$F = C.sgn(v).|v|^{\alpha}$$

Where the damper, the relative velocity of the piston, damping, and speed is an exponential function of speed and function symbols. Damping constant, which is determined by the diameter of the damper and opening areas. Fixed number is between 0.3 to 1.95. Viscous damper behavior is linear with $\alpha = 1$ for the relationship between the damping forces is linear with relative speed. Damper with $\alpha < 1$ nonlinear behavior is often not useful utility. Damper $\alpha > 1$ also has a non-linear behavior is extremely effective in minimizing initial shock with relative speed. In this study, linear viscous damper is used. Details viscous damper is shown in Figure 1.

Figure 1: viscous damper detail [4]

GENERAL MODEL SPECIFICATIONS

It is a model of building of 20 floors with concrete slab roof. General specifications of the model are as follows:

1. Building is assumed in the city of Urmia.
- 2 User building is assumed in a residential floors.
3. System X and Y axis for dual-system structures to concrete moment frame with shear walls is considered.
4. Plasticity of concrete moment frame, medium and shear walls are particularly intended.

AGGREGATES SPECIFICATIONS

Due to the lack of steel materials, concrete material properties defined in this research is presented in the table below.

Table 1. Class C25 concrete materials

250 Kg/ M ²	Mass Per Unit Volume, M
2500 Kg/ M ²	Weight Per Unit Volume, W
2.4 * 10 Kg/M ²	Elasticity Modulus, E
0.2	Poisson Coefficient
10 ⁵ 25 Kg/M ²	Compressive Strength, Fc
400 * 10 ⁵ Kg/M ²	Longitudinal And Transverse Reinforcement Yield Stress, Fy, Fys

Modulus of elasticity of concrete in accordance with Section IX is calculated as the following equation:

$$E = 15100\sqrt{f_c} = 15100 \times \sqrt{250} \times 10^4 = 2.4 \times 10^9 \text{ kg} / \text{m}^2$$

RULES USED

In this study, the following Rules is used to load and building design:

- Gravity and lateral loading on the basis of "national building regulations - Section VI: loads on buildings (2013)"
- Concrete frame design and concrete shear walls based on the "Regulations ACI318-99 and national regulations ninth topic"
- Building Rules Earthquake 2800 (Edition 4)

The use of moment frames with shear walls a very good system for dealing with lateral forces. Since the shear walls, the bulk of lateral forces exerted on the structure and absorb its cut, according to 6-11-8-4 sixth issue, should be 25% of that moment frame alone can withstand earthquakes. Given that the building has a dual system in both directions X and Y, the above paragraph should be considered in the design.

Situations of columns, shear walls, stairs and beam position in class are in the following figure. In this way, positioning is to determine the shear walls in the plan view.

Figure 2: Plan view and shear walls

DETERMINATION OF DAMPING RATIO TARGET AT THE DESIGN LEVEL

According to paragraph A.2.4.113 Rules NEHRP, structures that are supposed to use the damper, absorb the energy induced by the earthquake, should be able to withstand earthquake forces alone 0.75. This means that the reduction in base shear coefficient of the damper (B), the maximum would be 1.35 times the equivalent damping coefficient of 15%. Due to the robust design of structures for comparing arrangement, damping is considered to be the ideal 100%.

Therefore:

1. The initial structure should be cut to 75 percent of Regulation NEHRP to be designed base.
2. Damper system should be designed so that the viscous damping is able to supply 100 percent, this means that your damper damping does the duty ideally.

DETERMINING THE DAMPING COEFFICIENT OF DAMPER:

Structural damping ratio created by the damper (ζd) is calculated using the following equation.

$$\zeta d = T \sum C_j \varphi_{ij}^2 \cos^2 \theta_j / 4\pi \sum m_i \varphi_i^2$$

T in the above period, the main mode of structure, C_j floor damping coefficient j, ϕ_{rj} horizontal displacement of both ends of the damper due to structural deformation in the first mode of deformation, θ_j damper angle with the horizon line on the floor j, m_i seismic mass, class i and ϕ_i shift class i in the first mode shift is structural deformation. The above relation for linear dampers, and then sung and Konstantino 1 (1994) and Selma and Konstantino 2 (1997) equation for non-linear dampers provided.

$$\xi = \frac{T^{2-\alpha} \sum_j C_j \lambda \cos^{1+\alpha} \theta_j \phi_{rj}^{1+\alpha}}{(2\pi)^{3-\alpha} A^{1-\alpha} \sum_i m_i \phi_i^2}$$

The parameter λ is equal to the following formula:

$$\lambda = 2^{2+\alpha} \frac{\Gamma^2(1 + \alpha/2)}{\Gamma(2 + \alpha)}$$

If instead of diagonal layout used in high regard Chevron instead $\cos \theta_j$ we will be number one.

DETERMINING THE DAMPER ANGLE WITH THE HORIZON

According to the project dampers diagonally (Diagonal) are installed in the structure. Therefore:

$$\cos \theta = \frac{5}{\sqrt{3.2^2 + 5^2}} = 0.8422714$$

DAMPER MAKE-UP IN STRUCTURE

According to previous research that has been made in the ordering dampers, the most appropriate arrangement on the following consideration:

is assumed to be a damper in each direction 2 and 4 are located between floors. Ie B-C and C-D openings and D-E in frames 2 and 5 in the direction of X and at the mouth of 2-3 V3-4 and 4-5 in frame B and E in the Y damper is located.

Figure 3: damper arrangement structure

CALCULATING THE DAMPING COEFFICIENT OF DAMPER

STORY	Displacement	Drift	Siesmic Mass	Cos θ	$M \times \phi^2$	$(\phi r_j \times \cos \theta)^2$
1	0.006974	0.3197	103214	0.8422714	5.019985877	0.072508577
2	0.020289	0.013315	103214	0.8422714	42.48737438	0.000125773
3	0.037712	0.017423	103214	0.8422714	146.790429	0.000215353
4	0.058101	0.020389	99901.96	0.8422714	337.2416639	0.000294914
5	0.081287	0.023186	96888.19	0.8422714	640.1961147	0.000381378
6	0.106038	0.024751	96888.19	0.8422714	1089.416374	0.0004346
7	0.131579	0.025541	96888.19	0.8422714	1677.428454	0.000462786
8	0.157555	0.025976	93869.83	0.8422714	2330.185049	0.000478684
9	0.184532	0.026977	91149.74	0.8422714	3103.836327	0.000516287
10	0.211313	0.026781	92465.17	0.8422714	4128.864247	0.000508812
11	0.239038	0.027725	89659.97	0.8422714	5123.09586	0.000545315
12	0.268018	0.02898	86013.43	0.8422714	6178.658482	0.000595801
13	0.296487	0.028469	83643.1	0.8422714	7352.608327	0.000574974
14	0.323301	0.026814	83643.1	0.8422714	8742.672624	0.000510067
15	0.347805	0.024504	83530.93	0.8422714	10104.59611	0.000425969
16	0.369535	0.02173	80651.25	0.8422714	11013.42147	0.000334984
17	0.389153	0.019618	78452.23	0.8422714	11880.81022	0.000273032
18	0.41201	0.022857	78452.23	0.8422714	13317.44178	0.000370632
19	0.441417	0.029407	78452.23	0.8422714	15286.33604	0.000613487
Roof	0.471079	0.029662	78695.69	0.8422714	17463.78743	0.000624173
ST Room	0.48191	0.010831	2804.22	0.8422714	651.2443359	8.32226E-05
				Σ	120616.1387	0.080878819

Table 2: Calculating the damping coefficient of damper

Calculating the damping coefficient of damper and damper of the classes in each direction 4 in the third floor of a damper are placed in each direction 4:

$$\zeta d = T \sum C_j \varphi_{ij}^2 \cos^2 \theta_j / 4\pi \sum m_i \varphi_i^2$$

$$1 = 1.876 \times 4 \times C \times 0.080878819 / 4\pi \times 120616.1387$$

$$C = 2497397.42 \text{ Kg-sec/m}$$

DETERMINING THE DAMPER TO MODEL IN ETABS 2015

Damper Properties for Nonlinear Analyses

If pure damping behavior of the damping is concerned, it is necessary to adopt measures to attain the effect of softness spring is removed from the model. For this purpose, it is sufficient to define spring stiffness is big enough.

$$\omega_n = 2\pi / T = 2\pi / 2.52 = 2.493$$

$$\tau = 1.1000 \omega_n = 0.0004$$

4 damper dampers determination of the classes in any direction and in the third case in stories as a damper placed in between in each direction 4:

$$\tau = C/k$$

$$2497397.42 / k_{\text{nonlinear}} = 0.0004$$

$$k_{\text{nonlinear}} = 6243493550 \text{ Kg/m}$$

COMPARING THE ARRANGEMENT AND CONCLUSION

Since the time history analysis in this study for construction of three records KOBE, SMART1, LANDERS use and maximum displacement is LANDERS earthquake. To compare the different modes in the structure of the earthquake LANDERS damper arrangement is used. The results of such displacement classes, classes drift and seismic response of structures for time history, are as follows:

Classes and seismic response of displacement and drift in the first case under LANDERS earthquake will be in accordance with the following forms of graphs where the maximum amounts shown. The maximum displacement 33.871298 cm, the maximum drift 0.006875, maximum seismic responses are 3874830 kg f.

Figure 6: ordering the movement of the oppressed classes Lenders Earthquake in the first arrangement

Figure 7: ordering the movement of the oppressed classes Lenders Earthquake in the second arrangement

Figure 8: seismic response of structures under earthquake Lenders in the first case Ordering

2. Shift and drift classes and seismic responses under earthquake LANDERS the latter will be in accordance with the charts following figures in which the maximum values are shown. The maximum displacement cm 37.709797, 0.007809 maximum drift, the maximum seismic responses are 4285287 kg f.

Figure 9: Moving floors under the latter arrangement Lenders Earthquake

Figure 11: seismic response of structures under earthquake Lenders in the second arrangement

3. Handling and drift classes and seismic response of the earthquake in the third LANDERS will be in accordance with the charts following figures in which the maximum values are shown. The maximum displacement cm 33.871298, 0.006875 maximum drift, the maximum seismic responses are 3874830 kg f.

Figure 12: Moving the oppressed classes in the third arrangement Lenders Earthquake

Figure 14: seismic response of structures under earthquake Loaders in the third Ordering

CONCLUSION

According to seeing the results of any of the conditions arrangement, it is specified that the optimal arrangement of the damper to what extent can the results of the seismic response of structures dislocation of classes and drift classes also effective. If ordering the state to reduce the maximum displacement of 30.37%, 39.35% reduction in the maximum drift, reducing the maximum seismic response of 33.28%, 21.75% decline in the second mode setting maximum displacement, 30.03% reduction in the maximum drift, reducing the maximum seismic response of 37% and in the third case ordering the reduction of the maximum displacement of 29.71%, 38.4% reduction in the maximum drift, reducing the maximum seismic response of 43.02% can be achieved. Thus it can be seen that the optimal arrangement of dampers can be achieved with a damper less acceptable results, as seen in the third case the maximum seismic responses is more percent. This arrangement than other arrangement is economically. It also reduced the length and thickness shear wall that also benefits as a result of the economic costs of a project.

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