Evaluation of Coupled- Shear Walls Subjected to Near-Field Earthquakes

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1-Introduction

Resistance, high lateral stiffness and energy dissipation capabilities of shear walls makes them the most widely lateral resistant system in the high and medium rise reinforced concrete buildings. The need to provide large spaces in tall buildings for different applications and architectural considerations such as the location of doors, windows and doorways causes problems in locating walls with suitable dimensions in favorable positions. One of the structural forms to overcome this problem is the use of coupled shear walls.

The lateral structural response exactly depends on the shear walls behavior. Therefore, these elements should respond well when subjected to different load conditions. The structures located in near-source region behave differently compared to those in near-source sites when subjected to earthquake. Therefore, it is very important to study the behavior of these walls under near-field seismic loads.

2- Finite Element Analysis

Three 10 and three 20-story concrete buildings have been used as medium and high rise buildings. In all these buildings the concrete shear wall and coupled shear walls have been utilized as lateral resistant systems in X and Y directions, respectively.

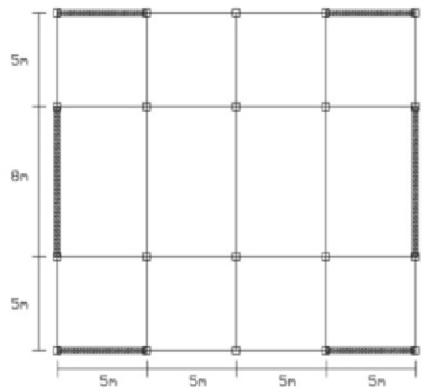

Fig.1 plan of buildings

The building has been designed for areas with a high seismic risk. The length of the coupled shear walls is assumed to be 2 meters and $\frac{l}{h}$ ratio (l=span length and h =beam height) is assumed to be $\frac{2}{1.75}$, $\frac{2}{1}$ and $\frac{2}{0.7}$ .To evaluate and compare the effects of near field and far field earthquakes, two coupled records have been selected.

The ABAQUS software has been used for analytical investigation of the coupled shear walls. Due to cyclic properties of loading, the damaged plasticity model was used in this software for modeling concrete. The concrete damaged plasticity model assumes that two main failure mechanisms of concrete are tensile cracking and compressive crushing of the concrete material. In the analysis, the stress-strain relationship for concrete is assumed by Eq. 1 as follows:

$$\frac{f_c}{f'_c} = \frac{\varepsilon_c}{\varepsilon'_c} \frac{n}{n - 1 + \left(\frac{\varepsilon_c}{\varepsilon'_c}\right)^{nk}} \qquad (1)$$

The stress-strain diagram of steel assumed to consist of a linear elastic zone and a linear plastic zone and steel has the same behavior in tension and compression. The analytical four node elements CPS4R and two nodal truss elements T2D2 were used to model concrete and rebar's of the walls.

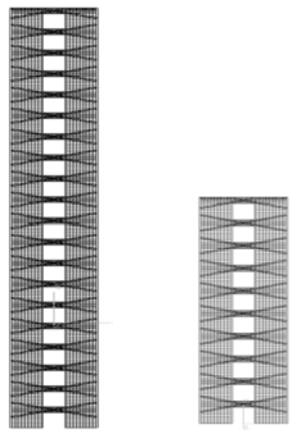

Fig2. Coupled shear walls simulated in ABAQUS

To verify the modeling method, a laboratory specimen that was tested by previous researchers has been used and the results are compared in Fig 3.

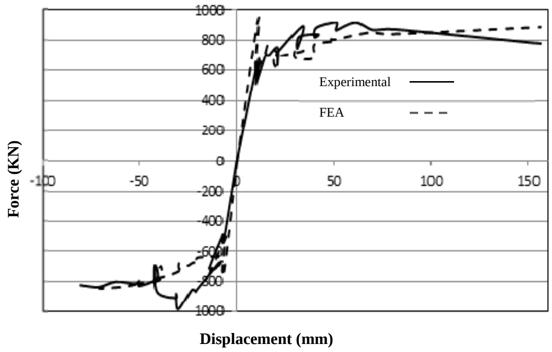

Fig3. Plan of buildings

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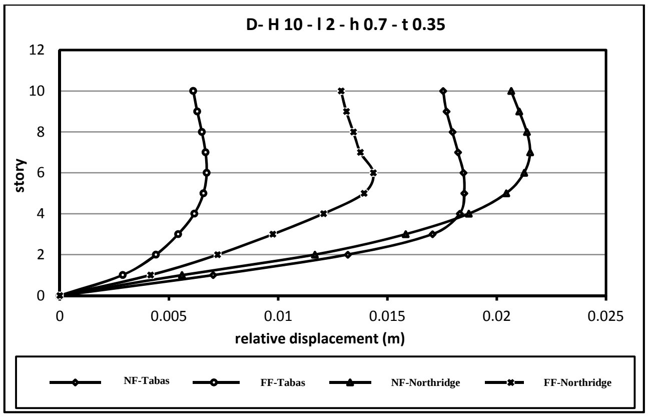

Fig4. relative displacement of wall (m)

Table1. Maximum acceleration of roof (m/s^2)

Wall	*Tabas*		*Northridge*	
	Near	**far**	**near**	**Far**
D-H10-l2-h0.7-t0.35	2.76	2.70	3.21	3.05
D-H10-l2-h1-t0.35	2.75	2.77	3.62	3.52
D-H10-l2-h1.75-t0.35	3.20	2.46	4.24	4.38
D-H20-l2-h0.7-t0.5	1.49	0.769	2.41	2.15
D-H20-l2-h1-t0.5	1.75	0.94	2.54	2.36
D-H20-l2-h1.75-t0.5	1.95	1.35	2.70	2.65

Table2. Maximum base shear (KN)

Wall	*Tabas*			*Northridge*		
	near	**far**	**near/far**	**near**	**far**	**near/far**
D-H10-l2-h0.7-t0.35	2300	1472	1.56	3215	2086	1.54
D-H10-l2-h1-t0.35	2348	1597	1.47	3344	2595	1.29
D-H10-l2-h1.75-t0.35	2986	2220	1.35	3681	2922	1.26
D-H20-l2-h0.7-t0.5	3314	2593	1.28	5367	4845	1.11
D-H20-l2-h1-t0.5	3553	3063	1.16	5531	5140	1.1
D-H20-l2-h1.75-t0.5	3555	3125	1.14	5571	5478	1.02

3- Numerical results

Twenty-four non-linear time history analyses were performed and seismic behavior, structural demands, the maximum base shear, the maximum relative displacement of wall, maximum acceleration of roofs and stress distribution in the beams were compared. For example Fig. 4 shows maximum displacement of a 10 story coupled shear wall and Tables 1 and 2 show the maximum base shear and acceleration of roof.

4- Conclusions

The results of this research illustrate that due to the specific characteristics of near-fault records, coupled shear walls show different behavior under near-field seismic loads. According to the analysis the most important results are as follows:

1- The maximum relative displacement of coupled shear walls under near-fault records occurred in the middle stories for 10- story walls and in the upper story for 20- story walls.
2- The base shear for near-fault records is more than that of far-fault records.
3- The amplification factor of base shear increases with the increase in the period of the structure.
4- Hysteresis loops according to near-field records show that energy is higher in comparison with the far-field records.
5- Wider area of reinforcement in the beams and walls are yielding under near field records.