Amirkabir University of Technology
(Tehran Polytechnic)
Vol. 45, No.1, Summer 2013, pp. 17-19

Amirkabir Journal of Science & Research (Civil & Environmental Engineering)
(AJSR - CEE)

Dynamic Analysis of Steel Shear Walls Using Different Spectrums in Near and Far Fields

M. Gholhaki[1*], M. Gerami[2] and H. Asghari Takdam[3]

1 [i]Assistant professor, Semnan University, member of academic staff Civil Engineering School, [ii] Member of research center of new technologies in civil engineering, Semnan, Iran
2 [i]Assistant professor, Semnan University, member of academic staff Civil Engineering School,[ii] Member of research center of new technologies in civil engineering, , Semnan, Iran
3 M.Sc. of Earthquake engineering, Semnan University, School of civil engineering, Semnan, Iran

(Received 6 Oct 2011; Accepted 14 Jan 2013)

ABSTRACT

Recently steel shear walls have been considered as a resistant system against lateral loads. Also researchers have seen different effects of earthquakes of near and far from the fault. These researches shows that mappings of near fault have less effective time than mappings of far from the fault and have one or more special pulse, large domain and medium to large frequency which causes to increase the domain of response spectrum in large period zones. In this article four moment resisting steel frames each of which has four spans 3, 7, 15 and 25 stories that only their mid span has steel shear wall with thin plate (strip model) have been analyzed under near or far from the fault and Iranian Earthquake 2800 Code spectrums. By the assumption of well acting of strip model, results showed that base shearing and relative roof displacements of 3 and 7 stories under the near fault spectrum was 2 to 32 percent less than the cases under far from the fault and Iranian Earthquake 2800 Code spectrums and at 15 and 25 stories the consequence was vice versa and averagely 22 and 52 percent more than the amounts of far from the fault and Iranian Earthquake 2800 Code spectrums.

KEYWORDS

Steel Shear Wall, Thin Plate, Near and Far from the Fault Spectrums, Iranian Earthquake Code

* Corresponding Author, Email: mgholhaki@semnan.ac.ir

1. INTRODUCTION

In steel shear walls with thin plates having a slenderness ratio of more than 400, the critical loud for buckling is very low and the main strength of the plate depends on post buckling strength that appears as diametrical tension square. According to the hypothesis of Torburan et al. (1983), Tromposch, E. W.; Kulak, G. L and Timler, P. A.; Kulak, presented an analytical pattern to calculate the ultimate capacity of steel shear walls with thin plates [2]. In this pattern, a thin steel plate was replaced by some diagonal tension strips with the same width and slope. Each strip is only capable of undergoing tensile axial load and its section is equal to the width of the strip in the thickness of the plate.

2. METHODOLOGY

In Canadian and American codes for designing shear walls with thin plates, the preliminary design of sections of beams, columns and a thin plate of walls are initially being done similar to a vertical truss with braces that function as tensile members. On this basis, instead of a thin steel plate, an equivalent bracing will be considered [3]. After determining the section of each bracing, the thickness of the steel plate can be calculated with equation 1:

$$t = \frac{2A_b \Omega \sin\theta}{L \sin 2\alpha} \qquad (1)$$

Ω is the ratio of extra strength and for steel shear walls and is equal to 1.2. θ is the angle between bracing and column and L width of frame span, A_b section of equivalent bracing and alpha is the angle of diametrical tension square in the steel plate that comes from equation 2:

$$\tan^4\alpha = \frac{1+\frac{t.L}{2A_c}}{1+th\left(\frac{1}{A_g}+\frac{h^3}{360 I_c L}\right)} \qquad (2)$$

A_c and I_c are section and inertial moment of lateral columns, respectively. H is the height of story and A_g is the section of the Beam. After determination of thickness, every plate converts to some inclined strips and the section of each strip comes from equation 3:

$$A_s = \frac{L\cos\alpha + h\sin\alpha}{n}.t \qquad (3)$$

In which n is number of strips. Many studies have been carried out regarding the determination of numbers for strips. Studies show that 10 inclined strips are adequate for analysis of a shear steel wall with thin plates. Considering the probable buckling of these columns due to diametrical tension square, stiffness of lateral columns should be calculated using equation 4:

$$I_c \geq \frac{0.00307 t h^4}{L} \qquad (4)$$

Also for prevention from bending of the beam on the top of the steel shear wall due to the nonsymmetrical a metrical tension square, Equation 5 should be controlled:

$$M_{fpb} \geq \frac{\sigma_{ty} t L^2}{8}\sin^2\alpha \qquad (5)$$

In which M_{fpb} is the plastic moment of beam section and σ_{ty} is the ultimate stress of diametrical tension square which is approximately equal to yield stress in thin steel plates. For confidence about strength of lateral columns when subjected to lateral loads and stresses due to diametrical tension square, it is necessary for columns to have the conditions in equation 6:

$$M_{fpc} \geq \frac{\sigma_{ty} t h^2}{4}\cos^2\alpha \qquad (6)$$

3. CONTRIBUTION

Considering this study, in Steel Shear Walls Thin Plates with rigid connections (strip pattern) and with a period of 0.6 s, the spectrum of the Iranian 2800 earthquake code [1] cannot be respondent for earthquakes near the fault, and it is needed to reform this spectrum. However, the Iranian 2800 earthquake code is suitable for structural needs of earthquakes far from the fault in models taller than 7 stories (with a period more than 0.6 s).

4. SIMULATION RESULTS

Investigation of base shear and relative lateral displacement of top story of steel shear walls show that the quantity of these factors in 3 and 7 story models are less than those in spectrums far from faults and also the Iranian 2800 code. However, in models with 15 and 25 stories, the quantity of base shear is more than those in spectrums near faults and also the Iranian 2800 code. Also The most difference between base shear and lateral displacement of the top story has occurred in models with 15 stories. On the other hand, base shear and lateral displacement of the top story of the spectrum far from the fault in the 15 story model shows fine equality with quantities in the 2800 code. Observations of this study include more effectiveness of base shear in zones far from the fault and considering the results it seems that this is due to more effects of upper modes in zones far from the fault compared with those near the fault.

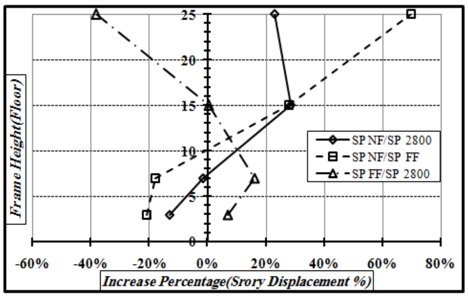

Figure 1.Variation of differential roof displacement percentage, derived from design spectrum of 2800 code of Iran and near and far fault spectrums, pertaining to variation of steel plate shear wall heights, based upon spectral dynamic analysis.

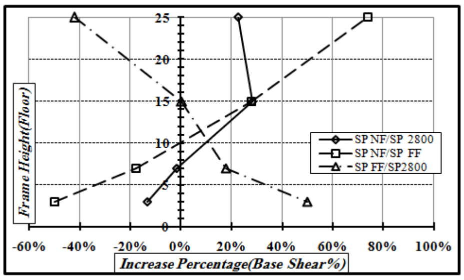

Figure 2.Variation of near fault base shear raise in accordance with fault base shear and base shear obtained from 2800 code spectrum pertaining to variation of frame height of steel plate shear walls , based upon spectral dynamic analysis.

5. References

[1] Code of building seismic design of iran, 3th edition, survey center of building and structures, 2800.
[2] S. Sabouri-Ghomi.; M. Gholhaki" Experimental Study of Two Three-Story Ductile Steel Plate Shear Walls", Journal Amirkabir ,19- 68- 29-42, 2008.
[3] American Institute of Steel Construction (AISC).Seismic Provisions for Structural Steel Building. Chicago (IL, USA): AISC; 2005.