Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 55(1) (2023) 47-50
DOI: 10.22060/ceej.2022.19141.7086

Energy demands in reinforced concrete coupled walls under near and far field earthquakes with different approaches to the occurrence of wall plasticity

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ABSTRACT: The use of reinforced concrete wall of the coupling causes better control of lateral displacement and also more energy dissipation due to the earthquake. This paper examines the types of energy demands in coupling walls in which two reinforced concrete walls are coupled by reinforced concrete beams. First, the structures are designed using the spectral analysis method according to valid regulations and then by preparing a nonlinear model of the wall with fiber elements in PERFORM-3D software and performing time history analysis due to near and near earthquakes faults, input energy, kinetic energy, energy Damping and inelastic energy are investigated and the contribution of reinforced concrete beam and wall to energy dissipation is studied. Two approaches, single plastic hinge (SPH) and extended plastic hinge (EPH), are considered for reinforced concrete walls. In the SPH approach, the plastic joint is traditionally allowed only at the foot of the reinforced concrete wall, and the rest of the wall is modeled elastically. In the EPH approach, the entire wall has the ability to expand plasticity. The results showed that in all structures, the share of coupling beams in inelastic energy dissipation is higher than the share of reinforced concrete walls. On average, in the EPH approach, the share of beam beams is about 60% and the share of reinforced concrete walls is about 40% of inelastic energy, and these numbers in the SPH approach are about 77% and 23%, respectively. The reason for the increase in the share of coupling beams from inelastic energy in the SPH model is that the wall is elastic at 90% of its height and the share of the wall decreases, and therefore the share of coupling beams in inelastic energy will increase.

Review History:

Received: Oct, 20, 2020
Revised: Jan, 16, 2021
Accepted: Aug, 25, 2021
Available Online: Dec, 20, 2022

Keywords:

Walls
Reinforced concrete
Beams
Nonlinear time history analysis

1- Introduction

In previous researches, less attention has been paid to the contribution of beam beams and reinforced concrete shear walls in the types of structural energies. Come on. Therefore, this article examines the types of energy needs in 10 and 20-story reinforced concrete coupe wall structures. The length of the coupling beam is such that it is necessary to use a diagonal rebar. In nonlinear analysis, two approaches were investigated, which included the single joint approach and the wide joint approach for reinforced concrete walls. In the single joint approach (SPH), the common idea is followed in that the location of the plastic joint of the wall is known at its foot, and therefore in this approach only the plastic joint is allowed at the foot of the reinforced concrete wall and the rest of the wall is modeled elastically.

2- Models

The studied models including two structures of 10 and 20 floors were designed according to ASCE and ACI regulations [1, 2].

3- Nonlinear model

The nonlinear model of the structures was prepared in PERFORM-3D software. Fiber elements were used for the walls. The shear wall was made of fibrous elements; In this type of elements, each concrete and steel material is modeled with several vertical strands. Performance verification of the performance of this type of elements has been performed by various researchers and the adequacy of their response accuracy has been confirmed [3, 4].

4- Results

After performing a nonlinear time history analysis, the required energy requirements for the coupling walls can be obtained. Figure 1 shows the values of Eine / Ei, Eel / Ei, Ek / Ei, Ed / Ei, on a case-by-case basis during the vibration of the 10-story structures SPH and EPH under the influence of a near-field earthquake and a selected far-field field earthquake. In fact, each of the curves represents the share of one type of energy in the total energy input to the structure. The figure shows that the time history of E k / Ei and Eel / Ei ratios has

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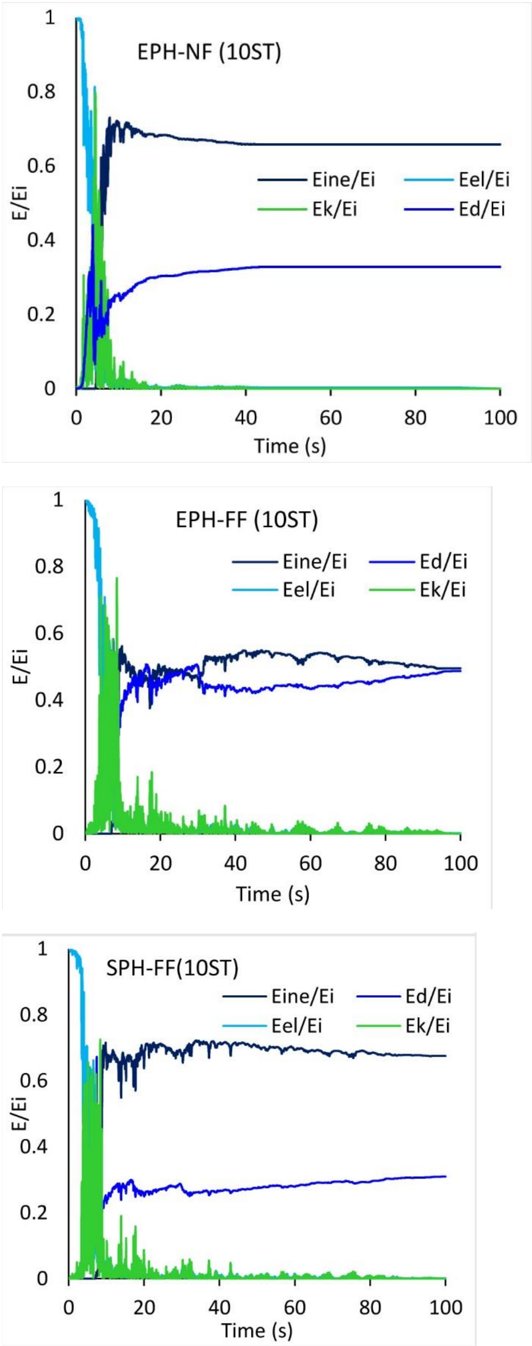

Fig. 1. Relative energy demands subjected to sample NF and FF records

different values and relatively large alternating changes, and in general, this issue is more acute in the linear responses of the structure (before the occurrence of plasticity). Relatively large amounts of Ek / Ei and Eel / Ei decrease after the structure enters the nonlinear region and plasticity occurs.

It is observed that during the first vibrations of the structure, the total input energy (Ei) is related to the elastic energy, which is then alternately converted to kinetic energy (Ek) and vice versa; But after the structure enters the plastic range, the share of these two energies decreases because two other types of energy, namely inelastic energy (Eine) and damping energy (Ed) also contribute, and significant amounts of energy input to the energy. Inelastic and damping energy is allocated. In fact, kinetic energy and elastic energy are converted into two types of damping energy and inelastic energy, and therefore their participation in the input energy is reduced.

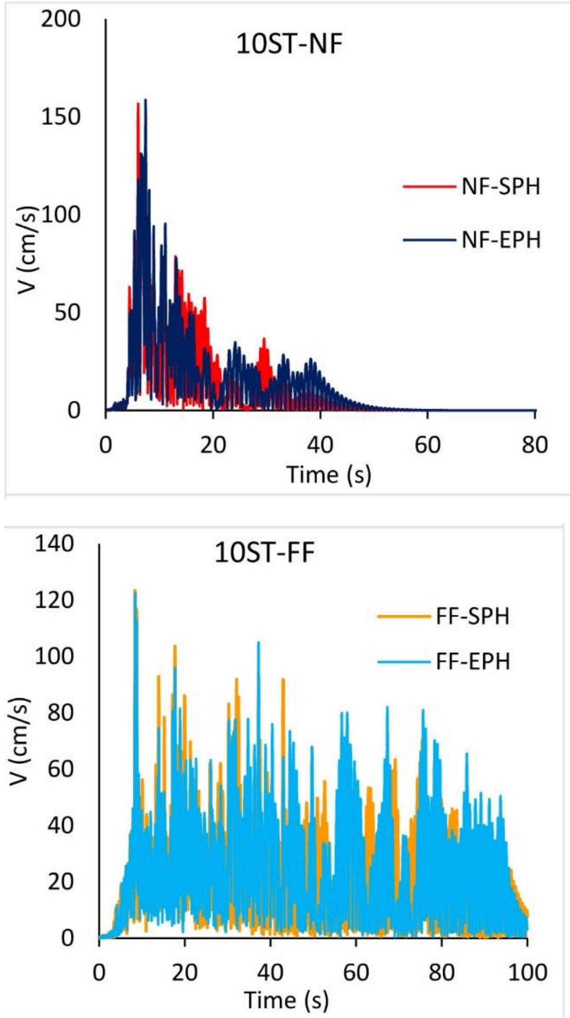

Fig. 2. Time history of kinetic energy of 10-story structures under earthquake samples of far and near basins

Figure 3 shows the average values of damping energy, inelastic energy and input energy for ten- and twenty-story structures affected by total earthquakes in the near and far basins.

Figure 2 shows that under the effect of a near-field earthquake, the structure experiences a relatively strong kinetic energy requirement in a short period of time, which is due to the directional effect in near-field maps. Due to the earthquake, the distant area of kinetic energy needs of the structure has expanded more gently during the earthquake.

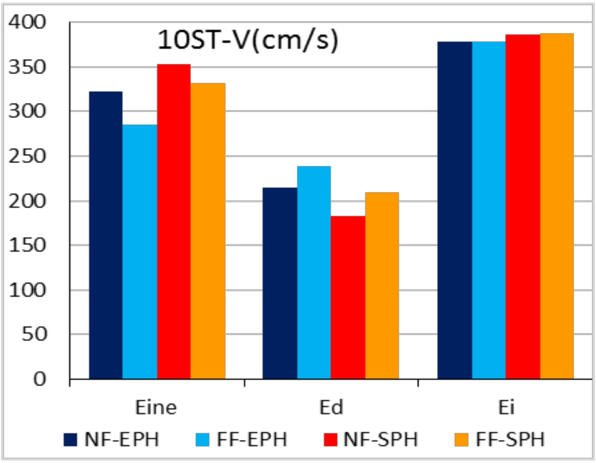

Fig. 3. Average values of damping energy, inelastic energy and input energy under the effect of total earth-quakes.

5- Conclusions

This study investigates the types of energy needs in coupling walls in which two reinforced concrete walls are connected by reinforced concrete beams. Initially, the structures were designed using the spectral analysis method according to valid regulations. Then, the nonlinear model of the structure in PERFORM-3D software was prepared using fibrous elements and nonlinear time history analysis was performed under the effect of earthquakes near and near the fault. Types of energy including input energy, kinetic energy, damping energy and inelastic energy were studied and the participation and contribution of reinforced concrete wall and beam in energy dissipation were studied. In nonlinear analysis, two approaches were investigated, which included the single joint approach and the wide joint approach for reinforced concrete walls. In the single joint (SPH) approach, the plastic joint is allowed only at the foot of the reinforced concrete wall and the rest of the wall is modeled elastically. In the wide joint (EPH) approach, plasticity can be spread throughout the wall.

References

[1] O. K, Flexural Modeling of reinforced Concrete Walls-Experimental Verification, ACI Structural Journal, 103(2) (2006) 196-206.

[2] H. Zhou, Li J, Comparison study of two criteria for identification of structural dynamic stability, Science China Technological Sciences, 62(5) (2019) 856-867.

[3] J. Li, Zhou, H., Ding, Y. Stochastic seismic collapse and reliability assessment of high-rise reinforced concrete structures, The Structural Design of Tall and Special Buildings, 27(2) (2018).

[4] C.S. Association, CSA Standard A23.3-04, in: Design of Concrete Structures, Canada 2005.

HOW TO CITE THIS ARTICLE

H. Beiraghi, E. Momen Abadi, Energy demands in reinforced concrete coupled walls under near and far field earthquakes with different approaches to the occurrence of wall plasticity , Amirkabir J. Civil Eng., 55(1) (2023) 47-50.

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