SEISMIC PERFORMANCE OF STEEL TALL BUILDINGS WITH OUTRIGGER SYSTEM IN NEAR FAULT ZONES

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This research deals with the seismic response parameters of nonlinear dynamic behavior of steel tall buildings with outrigger frameworks. When a building becomes taller in height, the demand for general increase of structural stiffness will be an important design factor. The application of outriggers and belt trusses in tall buildings provides both goals of the enough stiffness and the reduction of dynamic drift. The magnitude of reduction in dynamic drift depends on flexural rigidity of the perimeter wide columns and stiffness of the belt truss system as well as the location of all outriggers. The usage of outriggers and belt trusses in structural skeleton of tall buildings is noted as an effecient lateral resisting system, especially in zones near to active faults (Stafford Smith, 1983; Seng Kian and Torany Siahaan, 2001). Yet, It needs still to extended further studies on the seismic response parameters of these type of resistant structures. In recent destructive major earthquakes, the occurrence of the most structural damages was corresponding to the relatively short duration of impulsive motions which expose very much kinetic energy to structures (Alavi and Krawinkler, 2000). It was observed that great acceleration spikes and distinct feature of multi velocity pulse configurations are simultaneously displayed in time history of near field records, (Movahed et al., 2014).

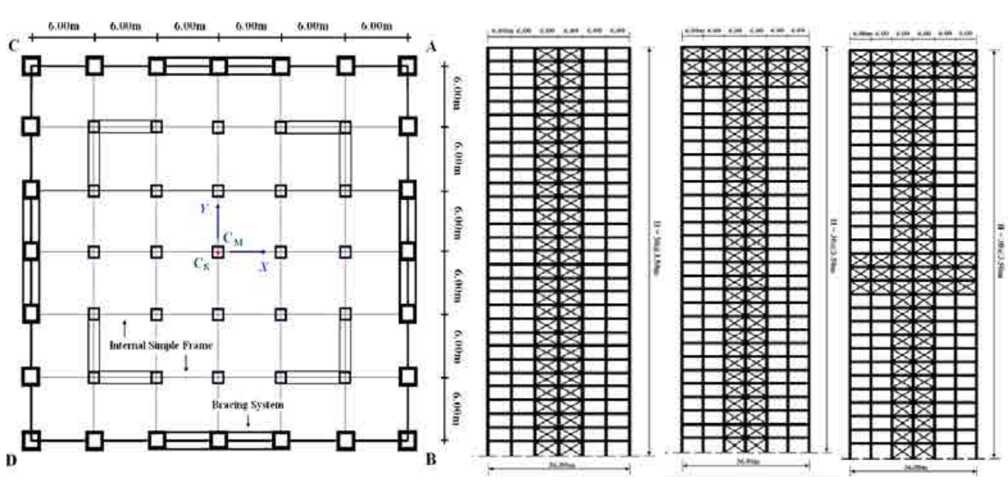
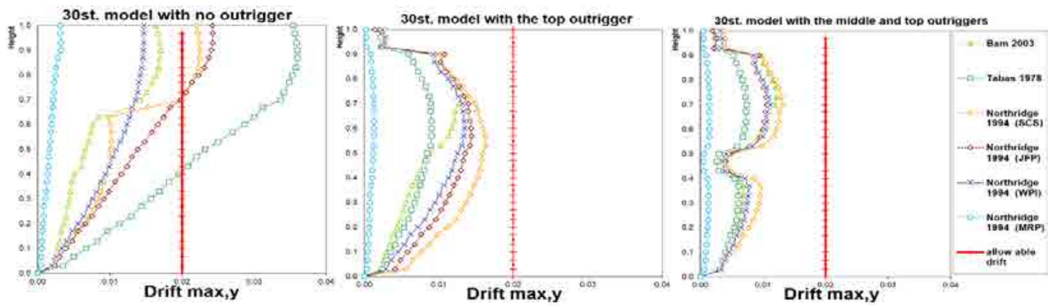


Figure 1. The plan and elevation of the studied structure, C_M: mass center, C_S: shear center

As shown in Figure 1, the studied models are three 30 story structures with different configurations of belt trusses. The outrigger panels have the height of three stories and a typical plan with six equal bays was considered for the selected studied models. The complete seismic designation process has been performed according to the Iranian seismic design code 2800. All of the sections of members and the connection zones of the studied models have been designed and controlled based on the Iranian national building code (steel structures - part 10). The consideration of the principle of strong column and weak beam in all connections as well as the assessment of strength of panel zones have been approved based on accurate design assessments. The analytical definition of the probable nonlinear hinges for all three studied models was assigned based on Fema 356. A great number of nonlinear dynamic time history analyses were conducted for the studied models subjected to an ensemble of free field recorded pulse type ground motions. The forward directivity effects in the time history of the selected earthquake records are along with the appearance of pulse type features in the velocity time history. Hence, a various types of long period and high amplitude velocity pulses as well as large acceleration spikes can be observed in the time histories of the selected records.



(a) (b) (c)

Figure 2. Maximum seismic drift in the studied model, (a) without outrigger; (b) with the top outrigger; (c) with both middle and top outriggers

One of the mostimportant response parameter which controls the design of tall building is the seismic drift which is illustrated in Figure 2. These graphs indicate that for the studied model with no outrigger, the maximum drift was happened at the top of the structure in relatively upper numerical domain respect to the allowable limit. This subject for the other two models was occurred almost in the outriggers location as well as significant decreases in the computed drift value. Yet, the computed structural response parameters due to powerful records entitled SCS and JFP related to the Northridge 1994 earthquake, would take place in the highest analytical limits. Obviously, this is because of the existence a continuous configuration of long period multiple pulses in the velocity time history record.

Having a general assessment on this research results, it is demonstrated that the use of outrigger skeletons in the total lateral load resistant structure of tall buildings causes a considerable increase in the lateral stiffness and control the drift response parameter efficiently. Furthermore, the other response parameters would remain in the acceptable performance domain.

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