

AN INVESTIGATION ON THE EFFECT OF INFILL WALLS ON THE FUNDAMENTAL PERIOD OF MOMENT-RESISTING AND ECCENTRICALLY BRACED STEEL FRAMES STRUCTURES WITH CONSIDERATION OF SOIL-STRUCTURE INTERACTION

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One of the most critical parameters in process of analysis and design of structures is determination of the fundamental period of vibration. The fundamental period of vibration depends on the distribution of the mass and the stiffness of the structure. However, the building codes provide empirical equations based on the observed period of real buildings during an earthquake. These equations are usually a function of type and height of building. Differences in the fundamental period of buildings determined by the code equation and analytical methods are due to elimination of the effects of non-structural elements in the analytical methods. For this reason, the presence of non-structural elements such as infill panels, which may produce a variation in these properties, should be carefully considered. The most probable cause for such predictive discrepancies can be attributed to the complex interaction arising between primary structures and masonry infill panels. The equivalent diagonal compression strut method has become the most popular approach for analyzing infilled frame systems. A bracing action, affecting both the strength and stiffness, originates by this mechanism, as demonstrated by a large number of experimental investigations. From the comparison of experimental and numerical results, it was shown that the double-strut model proposed by Crisafulli (1997) provided a very good fit to the experimental results, while the single-strut model could not adequately represent the experimental behaviour.

In this study, masonry is modelled using an equivalent strut nonlinear cyclic model proposed by Crisafulli (1997) for the modelling of the nonlinear response of infill panels in moment-resisting and eccentrically braced steel (EBF) frames structures from 3 to 18 stories. Each panel is represented by six strut members. Each diagonal direction features two parallel struts to carry axial loads across two opposite diagonal corners and a third one to carry the shear from the top to the bottom of the panel (Figure 1). The struts act only across the diagonal that is on compression; hence, its 'activation' depends on the deformation of the panel.

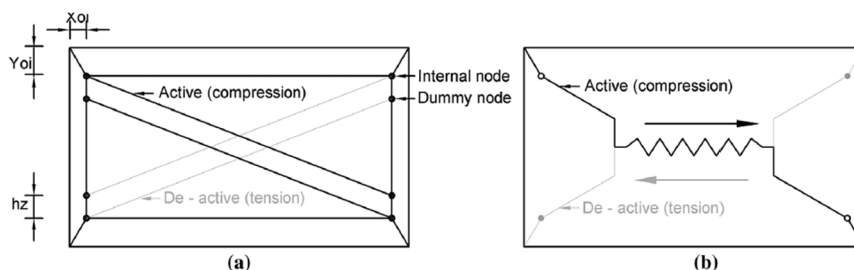


Figure 1. Infill panel element proposed by Crisafulli (1997): (a) compression/tension struts, (b) shear strut.

Another effective parameter on the fundamental period is the influence of Soil-Structure Interaction (SSI). It is well known that soil flexibility increases the fundamental period of the structure. In the most seismic building codes, the role

of the SSI is usually considered beneficial to the structural system under seismic loading since it increases the fundamental period and leads to higher damping of the system. This conclusion could be misleading in the design process. Recent case studies and post-seismic observations suggest that the SSI can be detrimental and neglecting its influence could lead to unsafe design for both the superstructure and the foundation especially for the structures founded on soft soil.

So in this research, the influence of building height, the infill wall panel stiffness, the configuration of infill walls and percentage of openings within the infill panel on the fundamental period of moment-resisting and eccentrically braced steel frames structures with consideration of soil-structure interaction in 3, 6, 9, 12, 15 and 18 floors have been investigated.

RESULTS

- The height of a structure significantly influences its fundamental period
- In the absence of infill walls, numerical fundamental periods were approximately 50% higher than values obtained from the empirical formula provided in such building codes as Iranian Standard No. 2800 and FEMA450. This was also the case for the other codes.
- Fundamental periods obtained from Standard No. 2800, for the case with considering the effect of infill walls (with a coefficient of 0.80 to consider the effect of infill walls), were almost equal to the values obtained from the precise numerical method, when infill wall percentage were 30–60%.
- As the opening increases from full infill to 80% opening, the fundamental period of the structure increases almost linearly.
- The soil-structure interaction strongly affects the fundamental period. The fundamental period is higher for more flexible soil. Furthermore, the influence of soil-structure interaction is higher when the infill wall stiffness is higher.
- It seems necessary to revise the empirical fundamental period formula provided in building codes, so as to account for the effect of infill walls.

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