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The Best Location of Belt Truss System in Tall Buildings Using Multiple Criteria Subjected to Blast Loading

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Abstract

The main goal of this paper is to investigate the effect of blast phenomenon on structures to determine the best location of belt truss system in tall buildings. For this purpose, one of the exterior frames of a tall steel building, in which the belt truss is located, is considered. The steel frame model is subjected to two different charges of equivalent weight which are applied in two different standoff distances. In this research, the best location of the belt truss system is determined using OpenSees software based on the nonlinear dynamic analysis. The best location of the belt truss system for different types of loading is investigated both with and without considering the post-buckling effect for all members of the belt truss system. The results show that when blast charges are located in a 5-meter range from the building (R=5), post buckling effect of truss elements are more obvious than the case in which blast charges are located in a 10-meter range (R=10); this, in turn, causes the amount of base moment to be completely different when the belt truss is located in the first storey in comparison to the cases where the belt truss is located in any other stories. In addition, if the explosion occurs near the building when the base moment is considered as a criterion, the post buckling effect has a significant role.

Keywords: Blast Loading; Nonlinear Dynamic Analysis; Tall Building; Belt Truss System; OpenSees.

1. Introduction

In past decades, blast issues and earthquakes have received considerable emphasis. In comparison to blast loading, problems related to earthquake are older and this is because the former has been paid attention to only in the past 60 years. Generally, conventional structures are not designed for blast load due to complexity in analyzing the dynamic response of blast-loaded structures; this complexity might be due to issues such as the effect of high strain rates, nonlinear inelastic material behavior, uncertainties of blast load calculations, time-dependent deformations or high costs of design and construction. On the other hand, terrorist attacks on facility structures are increasing more and more. These factors reveal the importance of blast phenomena and examination of its effects on structures. Therefore blast issue and its effects have been studied and investigated from many different point of views and many researchers have investigated different parameters and problems in this domain such as progressive collapse issue, effects of adjacent structures on blast load, response of structure's member due to blast loading, etc. [1-6]. In 1959, Department of the Army of America published a manual titled "structures to resist the effects of accidental explosions" [7], which is the best known source in the literature for designing structures. The revised version is widely used by both military forces and civilian organizations to provide protection for the personnel and valuable equipment. Ngo et al. [8] presented an overview on the analysis and design of structures subjected to the blast load for understanding the nature of explosions and the

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