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Comparison of Response of Building Structures to Blast Loading and Seismic Excitations

Dan (Danesh) Nourzadeh[a,*], Jagmohan Humar[b] and Abass Braimah[b]

[a]*Candu Energy Inc., a Member of SNC Lavalin Group, 2285 Speakman Dr., Mississauga, ON, Canada*
[b]*Carleton University, 1125 Colonel By Dr., Ottawa, ON, Canada*

Abstract

Blast loading and earthquake excitations can be regarded as the most destructive events a building structure can experience during its life. Response of the structures to these two types of dynamic loading can be of comparable magnitude. Therefore, in this study, response of a benchmark 10-story building to moderate blast loading is compared to that produced by several different synthetic ground motions whose spectra are compatible with the uniform hazard spectra for selected sites in the eastern and western regions of Canada. The results show that the lateral story drifts produced by blast loading are significantly larger than the corresponding seismic drifts. The study concludes that consideration of the global response of a building to blast loads is important, and response parameters, such as the lateral drifts and floor responses, should be paid attention in the design and response assessment procedures for blast loading.

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Keywords: Blast loading; dynamic analysis; seismic response; structural analysis; protective design.

1. Introduction

Two of the most destructive events that a building structure could experience are earthquake and blast. In designing a building structure to resist the forces induced by an earthquake, both the local response at the element level and the

* Corresponding author. Tel.: +1-905-823-9040 x 35908.
E-mail address: dan.nourzadeh@snclavalin.com

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global response are considered. However, despite the similarities between seismic excitation and blast loading, the global response of buildings to blast loading is usually not considered as being critical. The response of building structures to blast loading is traditionally assessed by individual analysis of its critical members [1-3]. While this type of assessment can be conservative [4,5], it does not provide an estimate of the global response of the building, particularly of the deformations in the lateral load resisting system, which can at times be critical. On the other hand, the global deformations, such as inter-story drifts, have been traditionally considered as being among the most important response parameters of the building structures subjected to earthquakes.

The importance of estimating the global deformations has been pointed out by the authors in another research [6]. To compare the magnitude of such deformations and in general, the global response of the buildings to seismic events and blast loads, a benchmark 10-story building, designed for the seismic hazard of eastern and western Canadian region [4-6], is analyzed for its response to different blast load scenarios, and such response is compared to that produced by seismic excitation.

The benchmark 10-story building structure is modeled in OpenSEES software, using nonlinear beam-column elements. The building is subjected to 10 different earthquake ground motions, representing two different hazard levels (eastern and western regions of Canada), as well as to two different moderate far-field blast load levels. The lateral deformations of the structure under earthquake forces are compared to those obtained under the selected blast loads.

2. Description of Structure

A benchmark 10-story reinforced concrete (RC) building is used for the current study. The moment frame building is designed for moderate ductility [5], based on the provisions of the National Building Code of Canada [7] and the Canadian Standard for the Design of Concrete Structures [8]. A schematic view of the building is shown in Fig. 1. The structural characteristics and design calculations of the building are presented elsewhere [5]. The structure is modeled in OpenSEES code [9] for the purpose of this study. The nodes on the base of the structure (columns) are considered as being fixed, and as shown in Fig. 1, the response of the structure in the *x*-direction (shorter direction) is studied.

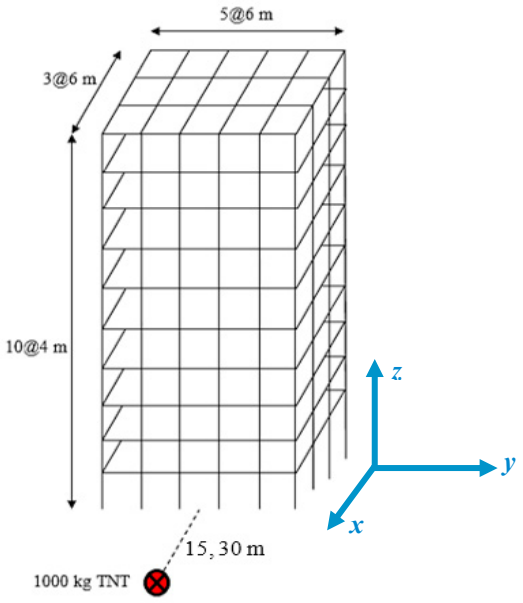

Fig. 1. Geometrical model of the building and the blast source