# Numerical simulation of I-section steel beams under blast loading

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ABSTRACT

There is significant interest amongst computational mechanics researchers in the area of investigating structures under blast loading since many recent collapses of buildings were due to accidental or intentional explosion. Blast loads can result in partial collapse of the buildings and significant loss of life and property. Numerical methods can be used to simulate the explosion and so as to study the interaction between them. Recent advances in numerical methods and developments in high-performance computer facilities have enabled engineers to simulate complicated blast scenarios and subsequently to provide useful reference data for safeguarding design of critical infrastructure in the future. Therefore, the blast response of a simply supported W150×24 steel beams under two different shots was studied using LS-DYNA FE code. Two different explosion modelling methods were used to apply the blast pressure on the steel beams. The maximum and residual deflection of beam then compared with the experiments available in literature. Since dynamic loads are much more complicated than static loads, all the parameters which could possibly affect the results should be assigned carefully. Hence, a comprehensive review on modelling techniques is explained in this paper. Results indicated that the blast response of the steel beams can be predicted effectively in LS-DYNA when using LBE method to apply blast pressure on beams. Strain rate has significant effect on the response and Cowper-Symonds constants, C=3200 $s^{-1}$ and p=5, provides more accurate results.

**Keywords:** Numerical, I-section, Beam, Blast, Cowper-Symonds, LS-DYNA

## 1. INTRODUCTION

There is significant interest amongst computational mechanics researchers in the area of investigating structures under extreme loads since many recent collapses of buildings were due to accidental or intentional explosion. Blast loads can result in partial collapse of the buildings and significant loss of life and property. Over the past couple of decades, significant efforts have been devoted to capturing the response and to assess the performance of important or critical buildings under blast load, and in developing guidelines to increase the resistance of buildings against such possible blast loads [1-6]. However, more studies still required to reach to a better understand of the blast response for different members in a building structures. The results of such studies can assist design engineers to more accurately assess the blast response of the existing buildings and so develop more effective blast response mitigation strategies.

To design blast-resistant buildings, an understanding of the blast wave propagation and its effects on the building structures are required. Although much information can be collect from experimental testing, relying only on such an approach would be too costly and not very efficient particularly when considering the entire structure. Numerical methods, as the best and sometimes the only available option, can be used to simulate the explosion and so capture the interaction between the blast wave and structure, as well as the dynamic response of the structure itself. Recent advances in numerical methods and developments in high-performance computer facilities have enabled engineers to simulate complicated blast scenarios in a viable, efficient and cost-effective way and subsequently to provide useful reference data for safeguarding design of critical infrastructure in the future.

The models investigating the effects of blast loads present a highly complex problem and require a significant attention to produce models, analyze models and post process results. Therefore, LS-DYNA [7] which is frequently used among researchers for predicting the response of structures subjected to blast loading, has been used in this study to simulate the response of a simply supported W150×24 steel beams under two different blast shots. Two different explosion modelling methods in LS-DYNA; i) LBE and ii) the coupled LBE and ALE method (CPL) were used to apply the blast pressure on the steel beam. The maximum and residual deflection of beam then compared with the expriments availabe in literature. In order to evaluate the explosive wave propagation precisely in the model, including the incident and reflected pressure waves, mesh sensitivity has been carried out on Eulerian elements and validated with empirical methods at the first stage. Since dynamic loads are much more complicated than static loads, all the parameters which could possibly affect the results and their further interpretation should be assigned carefully. Hence, a comprehensive review on modelling techniques is explained in this paper. In particular, the strain rate effect is investigated in this study with a variant Cowper-Symonds constants. To distinguish between different models, an error