Key Engineering Materials
ISSN: 1662-9795, Vol. 912, pp 171-184
doi:10.4028/p-ha2dxu

Submitted: 2021-09-20
Revised: 2021-10-25
Accepted: 2021-10-26
Online: 2022-03-04

The Influence of Cowper-Symonds Coefficients on the Response of Stiffened Steel Plates Subjected to Close-In Blast Loads

Nurul Syafiqah Abdul Razak[1,a], Aizat Alias[1,b*], Nor Maslina Mohsan[2,c] and Siti Aliyyah Masjuki[3,d]

[1]Faculty of Civil Engineering Technology, Universiti Malaysia Pahang, Gambang Campus, Lebuhraya Tun Razak, 26300 Gambang, Pahang, Malaysia.

[2]Faculty of Civil Engineering, Universiti Teknologi MARA Pahang, Jengka Campus, 26400 Bandar Tun Razak, Jengka, Pahang, Malaysia.

[3]Deparment of Civil Engineering, Kuliyyah of Engineering, International Islamic University Malaysia, P.O. Box 10, 50728 Kuala Lumpur, Malaysia.

[a]syafiqahar@gmail.com, [b]aizat@ump.edu.my, [c]maslina252@uitm.edu.my, [d]aliyyah@iium.edu.my

Keywords: cowper-symonds, steel plate, finite element, abaqus, blast load

Abstract. The Cowper-Symonds relationship is the most common empirical equation used to model the influence of strain rates in steel structures subjected to blast loads. The simplicity of this relationship makes it as the preferred choice due to the minimum number of coefficients used in the equation. However, different coefficients were reported from experimental results where it was found that the coefficients could be influenced by the thickness of the specimens, types of materials and method of testing. Even so, the actual coefficients even for the same type of material such as for mild steel could be differ. It is known that strain rates effect increases the yield strength of steel, and this could reduce the maximum displacement of steel structures such as steel plates subjected to blast loads. This influence could be more significant if the steel plate was stiffened. Therefore, this study investigated the influence of Cowper-Symonds coefficients for steel plates with stiffeners subjected to close-in blast loads. The numerical investigations were performed using finite element software, Abaqus. The target plate was a 0.4 m x 0.4 m plate with 0.002 m of thickness subjected to a 0.012 kg of Plastic Explosive No. 4 (PE4) at 0.04 m stand-off distance. The influenced of stiffeners were investigate first where five stiffeners' configurations were used and, in each configuration, the stiffeners come with different geometry ratios. Two best stiffened steel plates have been chosen to study the influence of different Cowper-Symonds coefficients. Different coefficient values of dominator, D and hardening coefficients, q was used. The results shows that any possible coefficient combinations of Cowper-Symonds relation are possible to use in predicting response of steel plates subjected to blast loads. From this study, the most ideal stiffened square steel plates for offshore platform could be identified.

Introduction

The response of structures when subjected to blast loading has been ongoing research. Due to the many occurrences of blast related incidents that have happened around the globe such as the 9/11 incidents and the explosion of offshore platforms like the Alpha Piper and the Deepwater Horizon, the public awareness on the danger of explosions have exponentially increase. Therefore, a lot of research have been carried out experimentally and numerically on the response of steel plates when subjected to blast loads to gain more understanding on the behaviour of steel plates under blast condition and thus further improve its blast resistance to protects the civilians.

One of the earliest studies on stiffened plate was by Louca et al. [1] where they studied the response of a 8 mm thick, 2.5 m square steel plate subjected to triangular loads with different boundary conditions. The studied proposed a simple analytical approach and validated against numerical models. Moving forward, various studies on plates were conducted to study the response of steel plate for various influences such as far-field [2] and close-in blast loads [3–6] in unconfined