

Finite Element Analysis of Built-Up T Stub under Blast Loading

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Introduction

T-stub connection with hot rolled T stub is popularly used in steel structures because of its high flexural resistance. Recently, an alternative approach, built up T stub has gained attention owing to its freedom of sizing and material use. The behaviour of built up T stub under monotonic [1, 2] and cyclic loading [3] have already been studied but response under blast loading is yet to be explored. Accordingly, Present study aims to evaluate the performance of built up T stub under blast load through finite element analysis.

Methodology

The 3D finite element model presented in this study is developed using ABAQUS 6.14 [4]. Numerical model proposed in the references [1, 2] has adequately reproduced the experimental findings conducted on monotonic and cyclic loading respectively. For the model developed herein, same types of element, contact effect, bolt and bolt holes model, welding specification are used as mentioned in [1, 2]. The peak pressures produced by the blast is calculated as per TM5-1300 [5] where the connection is considered as part of a hypothetical room. SHOCK and FRANG algorithm are used to determine the amount of TNT to produce this pressure and corresponding time-pressure curve developed are applied as uniform pressure to the room side walls. The nominal yield stresses of plate and bolt materials are increased using dynamic increase factors as required by TM5-1300 to account for the influence of high strain rates from the blast loads. The elasto-plastic isotropic model is used in defining material properties.

Results

The current study focuses on evaluating the criteria of TM 5-1300 by comparing it with the outcome of finite element analyses. Structural response is determined in terms of Von Misses stress, stem deformation, uplift of the T flange and overall deformation. For detailed parametric study, experimental specimens from [2] are modelled. Results are determined for a room behaviour where under blast pressure [6] one sidewall collapses. The thinner stem specimen failed due to tensile fracture in net section of stem where maximum stress is higher compared to the dynamic yield stress 357 MPa. For specimens with thicker stems, maximum stress formed in tension bolt which is higher than bolt dynamic yield stress (697 MPa) indicating failure by bolt fracture. In all specimen stem and flange deflection values are within the theoretical max limit 15.7 mm and 30.9 mm respectively. Similarly for all specimen the overall deformation of T stub is lower than the max limit of 50.8 mm defined by TM5-1300. No specimen has initiated failure by weld fracture.

Discussion

As per the guideline of TM5-1300, built up T-stub is over-designed for blast load as the displacement from the finite element model are lower than the limiting criteria by TM5-1300. In current analytic model, high stress concentration is observed in tension bolt and net section of stem which matches with the test result of built up T stub under cyclic load [3]. For further investigation experimental study is recommended on built up T stub under blast load.

References

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