Dynamic Analysis of Steel Confined Concrete Tubular Columns against Blast Loads

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Abstract

The use of composite construction has drawn more and more attention in recent decades. This thesis contains a number of journal articles which aim to enrich the knowledge of the performance of concrete filled tubular columns when subjected to blast loading. Experimental investigations are used in conjunction with numerical analysis to provide a thorough assessment of the blast-resistance of concrete filled tubular columns.

The first chapter mainly focuses on the experimental study on concrete filled tubular columns under blast loading. A large-scale blast experimental program is carried out on concrete filled double-skin steel tube (CFDST) columns. The blast experiment aims to examine the blast-resistance of ten CFDST specimens, including five with square cross-section and the other five with circular cross-section. The parameters that are investigated during the blast experiment include: cross-sectional geometry, explosive charge weight and magnitude of axial load. After the experiment, several damaged test specimens are then transported back to the laboratory for residual axial load-carrying capacity tests. The proposed CFDST columns are able to retain more than 60% of its axial load-carrying capacity even after being subjected to close-range explosion.

As blast experiments are often costly and associated with potential safety concerns, numerical tools have been adopted by more and more researchers. In the second chapter of the thesis, numerical approaches in modelling the dynamic behaviour of concrete filled steel tube (CFST) columns and CFDST columns under blast loading are presented. The numerical models are validated against the results of the blast experiment as described in the first chapter and good agreement is achieved. Parametric studies on the effect of column dimensions and material properties are also discussed through intensive numerical simulations.

In the last chapter, a numerical method to generate pressure-impulse diagrams for CFDST columns is proposed which uses a damage criterion involving the residual axial

load-carrying capacity. Based on the numerical method, pressure-impulse diagrams for different column configurations are derived and analytical expressions of deriving pressure-impulse diagrams for CFDST columns are also developed through regression analysis.

Statement of Originality

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I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

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Print Name	Signature	Date

List of publications

1. Zhang, F., Wu, C., Zhao, X.-L., Xiang, H., Li, Z.-X., Fang, Q., Liu, Z., Zhang, Y., Heidarpour, A. & Packer, J. A. 2016. Experimental study of CFDST columns infilled with UHPC under close-range blast loading. *International Journal of Impact Engineering*.
   Status: Published

2. Zhang, F., Wu, C., Li, Z.-X. & Zhao, X.-L. 2015. Residual axial capacity of CFDST columns infilled with UHPFRC after close-range blast loading. *Thin-Walled Structures,* 96**,** 314-327.
   Status: Published

3. Zhang, F., Wu, C., Wang, H. & Zhou, Y. 2015. Numerical simulation of concrete filled steel tube columns against BLAST loads. *Thin-Walled Structures,* 92**,** 82-92.
   Status: Published

4. Zhang, F., Wu, C., Zhao, X.-L., Li, Z.-X., Heidarpour, A. & Wang, H. 2015. Numerical modeling of concrete-filled double-skin steel square tubular columns under blast loading. *Journal of Performance of Constructed Facilities,* 29**,** B4015002.
   Status: Published

5. Zhang, F., Wu, C., Zhao, X.L., Heidarpour, A. and Li, Z., 2016. Experimental and numerical study of blast resistance of square CFDST columns with steel-fibre reinforced concrete. *Engineering Structures*.
   Status: Published

6. Numerical derivation of pressure-impulse diagrams for square UHPCFDST columns
   Status: Submitted to *Thin-walled Structures*

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