P31 Field Blast Testing and SDOF Analysis of Unfilled and Concrete Filled RHS Member

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Abstract:

Protective design is an increasingly common requirement for various civilian and military structures. Tubular steel sections have been cited as ideal structural members for blast-resistant structural framing because of their ability to withstand large deformations without collapse. Other blast-resistant framing techniques, such as massive concrete structures, are generally not ideal architectural solutions and concrete is subject to spalling and scabbing during blasts, thus increasing the level of hazard. There is a desire to continue to utilize traditional structural systems as well as maintain flexibility in architectural design despite the requirement for blast resistance. Tubular steel sections are ideally suited to meet this need. A research programme has been initiated to advance knowledge regarding the performance and design of full-scale tubular steel sections under blast loading.

The first stage of this programme involves full-scale blast arena testing of unfilled and concrete-filled, Rectangular Hollow Sections (RHS). Testing was performed to investigate the flexural behaviour of cold-formed, square RHS members subjected to blast loading. Unfilled and concrete-filled RHS elements with a variety of width-to-thickness ratios were tested at several scaled distances. The blast tests were heavily instrumented in order to gather detailed data on the behaviour of the RHS elements and the blast wave profile. Measurements included displacements, strains, reflected pressures, and free-field pressures. Mechanical properties were measured for the materials used and the validity of steel-concrete composite action was investigated for subsequent modeling.

The results from the blast arena testing are used to validate predictive and analytical numerical models. Modeling methods include single degree of freedom (SDOF) analysis. One common resource is the Single-degree-of-freedom Blast Effects Design Spreadsheet (SBEDS) computer program. When used in conjunction with the blast arena test results, the SBEDS methodology over-predicted the displacement of the RHS elements. While this conservative approach may be well suited to design, it is not ideal for analysis. Modifications to the RHS properties and other SDOF methodologies are explored to better understand the relationship between the field testing results and SDOF models.

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