Title	RESEARCH REPORT: 404. Pulse pressure testing of 1/4 scale blast wall panels with connections
Publisher/Author	HSE
Publication Date	2006
Executive Summary	A study was carried out at the University of Liverpool on the response of a ¼ scale stainless steel blast wall panel under pulse pressure loading 1999-2002). The project was funded by EPSRC, Mobil North Sea Ltd and HSE (Offshore Division) with technical support from Mech-Tool Engineering Ltd who designed and manufactured the test specimens. The aim was to investigate the influence of the connection detail on the overall performance of the panel/connection system under pulse pressure loading and to develop appropriate analytical and numerical models of the blast wall/connection system for correlation with the test results. This was the first time that a detailed experimental study of the behaviour of blast walls made from profiled stainless steel sheet had considered the modes of failure and end effects of the support construction. The experimental and modelling work at Liverpool has enabled a more appropriate assessment of the ultimate capacity of the blast wall panel based on the influence of the connection detail [1]. The HSE funded a second phase (2003-2005), to extend the work through further experiments, numerical simulations and simplified modelling to provide more comprehensive response data in the quasi-static, dynamic and impulsive loading range [2]. One of the objectives of this project was to provide design guidance on the influence of connection behaviour on the overall response of the blast wall system. This has largely been achieved through the experimental data and numerical simulations that engineers can use at an early stage for assessing the adequacy of numerical and analytical models for use in design and assessment of profiled blast walls. Furthermore, most of the tests were performed at loads in excess of the design conditions and therefore represent an upper bound extreme load case. In none of the cases where buckling occurred (high strain regions) was there signs of tearing in the profile or at the connection even though some high strains were recorded. FE studies [3] have shown that strains can exceed 15%, which under current design guidance would imply tearing. The methodology developed in this work may be used to predict large plastic deformations in blast walls under explosion loading. Adequacy of the connection may need to be checked against standards to ensure integrity. Three different angle connections were studied, which are characterised by a flexible leg length. Results for both the design direction where the leg is placed in tension and the opposite direction placing the leg in compression are given. The static resistance curves given in this note show that as much as a 25% (approx.) increase in capacity before buckling occurs can be achieved by using a shorter leg length. The methods are based on an idealised SDOF structural system. The main advantages of these methods as proposed are that they take account of connection behaviour. Some of the methods rely on additional input and may be reserved for a few critical cases, while the approach that is recommended as a simplified design or assessment tool can be used independently of other analyses. It is particularly suited to large plastic deformation in the quasi-static loading domain. It can be used to demonstrate that a blast wall system has adequate capacity in the large

plastic deformation range up to a ductility value of 30 or more provided there is adequate restraint at the supports. Normally, this type of design calculation would be beyond the scope of a standard Biggs type calculation.

A simple welded angle connection was adopted in this study as it represented the most common type of connection. The results and conclusions of this study have recognised the importance of the flexibility of the angle connection. For very large deformations, the angle connection could transmit high reaction forces into the primary structure and may experience comparatively large rotations. These need to be assessed. The methodology proposed can provide estimates of the reaction forces and rotations at large deformations.

This Technical Note contains experimental and numerical data from phase 2 of the project that can be used at an early stage towards the design or assessment of profiled blast walls. This data was used to validate analytical methods for predicting large deformations of ¼ scale blast wall panels under pulse pressure loading well into the plastic range and in excess of the original design conditions. A proposed simplified approach to assessing the influence of the blast wall connection is given in detail together with a worked example to demonstrate the use of the method in practice to assess a full-scale blast wall. This is also compared with the standard Biggs method. The purpose of this note is to provide a guide to using the new method and to highlight the benefits of including the connection behaviour in the design of the blast wall system.

Table of Contents