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# Non-Linear Dynamic Analysis of Offshore Blast wall

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**Abstract -** *Stainless steel profiled blast walls have been used increasingly in the oil and gas industry to protect people and personnel against hydrocarbon explosions. Understanding the safety of these blast walls greatly assists in improving safety of offshore plant facilities. However, the presence of various uncertainties combined with a complex loading scenario make the assessment process very challenging. In this study the effect of important variables such as thickness and height to optimize the design of profiled blast walls. Here analysis of blast wall with three different profiles namely S1, S2, S3 were done. Analysis is done by applying pressure load on the structure. Analysis is made to consider the influence of geometric uncertainties on the transient dynamic response of these structures. It is seen that the height is the parameter affecting the variation of deformation in S1 and S2 profile and thickness is the parameter influencing the deformation in S3 profile.*

***Key Words*: Blast wall, Offshore, Sensitivity, Pressure ,Sampling .**

## 1.INTRODUCTION

In modern structural engineering design, it is always recommended to assess performance of complex structures, such as blast walls, under the effects of material, loading and geometric uncertainties. The existence of the uncertainties cannot be avoided in many stages of structural integrity assessments. In the real world, most design variables have inherent uncertainties and it is required to consider them properly in assessing structural performance, either in terms of random variables or random processes (Hedayati et al. 2013). Stainless steel profiled walls are widely used in offshore facilities for protection against hydrocarbon explosions. Understanding the safety of these blast walls greatly assists in improving the safety of offshore facilities. However, with recent developments in computing technology, performing FEA is easier and faster than it was in the past. The Design Guide for stainless steel blast walls, known as the Technical Note 5 (TN5), prepared by the Fire and Blast Information Group (FABIG). A typical blast wall is shown in figure 1.

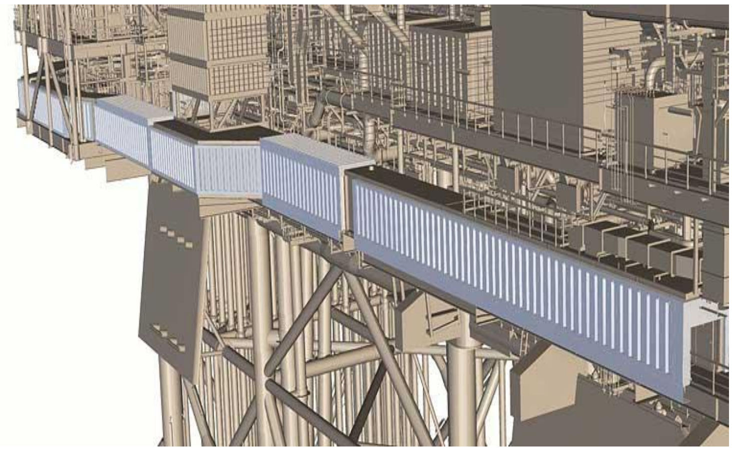


**Fig -1** Blast wall

## 2. METHODOLOGY

In the present study, in accordance with the design guidance from TN5, a profiled wall section that satisfies the geometric limits to be an appropriate structural element is considered. The geometry of the considered profiled barrier section is shown in Figure 2. The geometric properties of the considered section with total span X are given in Table 1. The considered stainless steel section is assumed to have a Young's modulus of 210 GPa, Poisson's ratio of 0.3 and material density of 7,850 kg/m3.

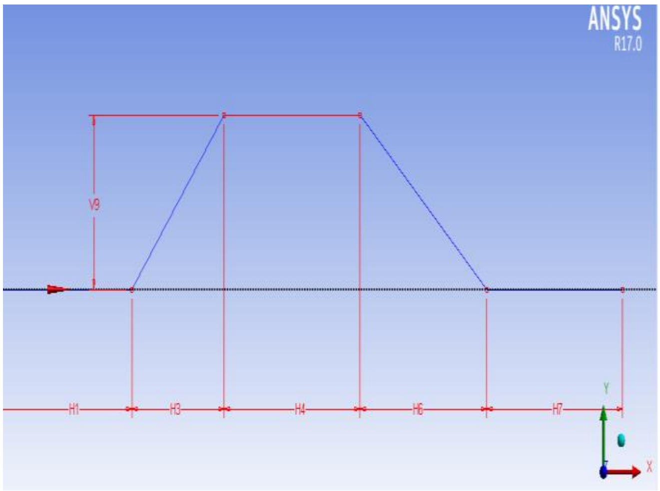


**Fig -2** Geometry of corrugated profile

**Table -1** Dimensional details of corrugated profile

| Section | T (mm) | V9 (mm) | H1(mm) | H3(mm) | H4(mm) | X(mm) |
|---|---|---|---|---|---|---|
| S1 | 11 | 554 | 200 | 320 | 240 | 6000 |
| S2 | 9 | 200 | 160 | 160 | 160 | 4000 |
| S3 | 2.5 | 45 | 62.5 | 40 | 45 | 2322 |

In accordance with the design guidance from Technical note 5 the range for thickness and height that satisfies the geometric limits were selected. Monte Carlo methods (Monte Carlo experiments) are a broad class of computational algorithms that rely on repeated sampling to obtain numerical results. They are often used in physical and mathematical problems are most useful when it is impossible to use other mathematical methods. The Latin Hypercube Sampling technique was first introduced by McKay et al. (1979). Later on, further developments were explained by other researchers

- The range of each variable is divided into **n** non overlapping intervals on basis of equal probability.

- One value from each interval is selected at random with respect to probability density in the interval.

- The **n** values thus obtained for **X**1 are paired in a random manner (equally likely combinations) with the **n** values of **X**2. These **n** pairs are combined in a random manner with **n** values of **X**3 to form **n** triplets, and so on, until **n k**-tuplets are formed these **n k**-tuplets are the same as the **n k**-dimensional input vectors.

A parametric model was developed in ANSYS design modeller 17. The corrugated profile is as shown in Figure 3 and the connecting end plates were modelled. Figure 3 gives an overall view of the model of the profiled barrier. It can be seen that two corrugation bays were modelled for the analysis.

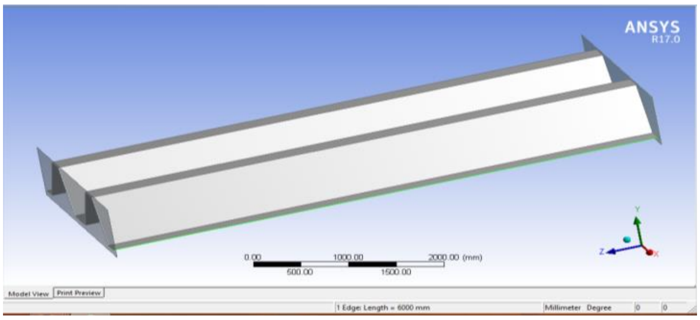


**Fig -3** Geometry model of S1 profile Prepared in ANSYS

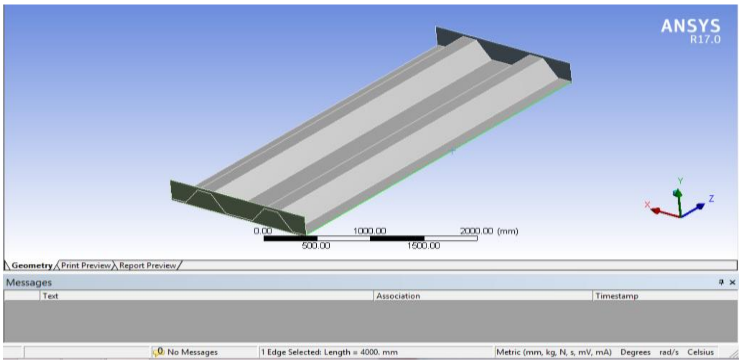


**Fig -4** Geometry model of S2 profile Prepared in ANSYS

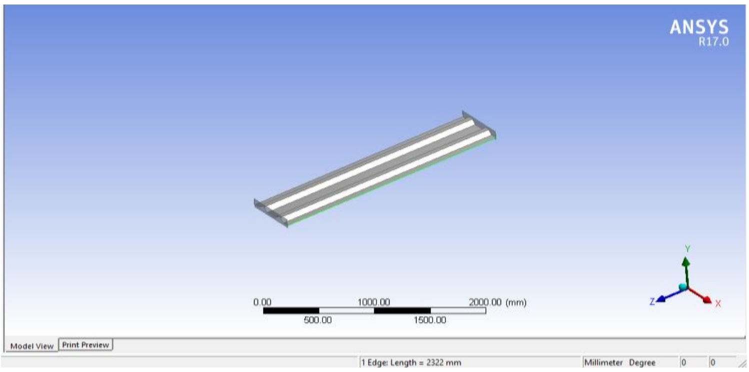
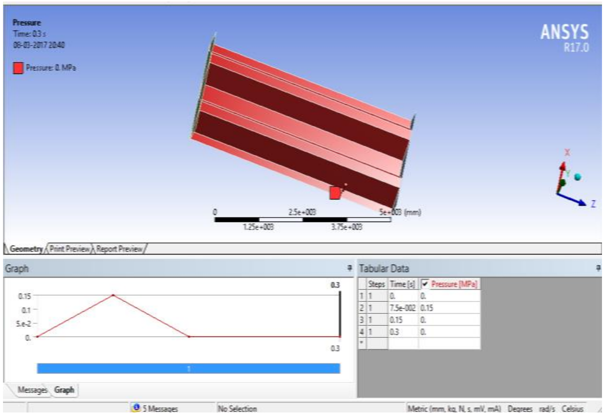


**Fig -5** Geometry model of S3 profile Prepared in ANSYS

Dynamic pressure loading generated by explosions varies with time, and the resulting response of the structure is therefore also time-dependent. This loading causes the structure to vibrate at its natural period, and large intensity loading can cause plastic deformation of the structure. A triangular impulse load with a peak dynamic pressure of 1.5 bar is used. The total time duration for this impulse load is 0.15 seconds. The analysis is continued up to 0.3 seconds. The model after loading is shown in figure 6.



Tabular Data

| | Steps | Time [s] | ☑ Pressure [MPa] |
|---|---|---|---|
| 1 | 1 | 0. | 0. |
| 2 | 1 | 7.5e-002 | 0.15 |
| 3 | 1 | 0.15 | 0. |
| 4 | 1 | 0.3 | 0. |
| * | | | |

**Fig -6** Loading

## 3. RESULTS AND DISCUSSION

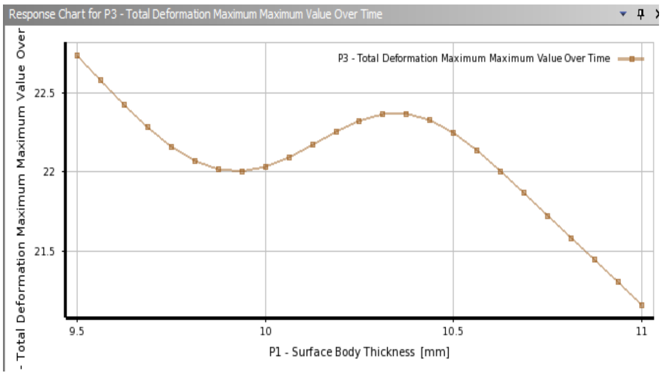


**Fig -7** Response chart for thickness of S1 profile

By increasing thickness beyond 10.5mm lower deformation can be obtained.

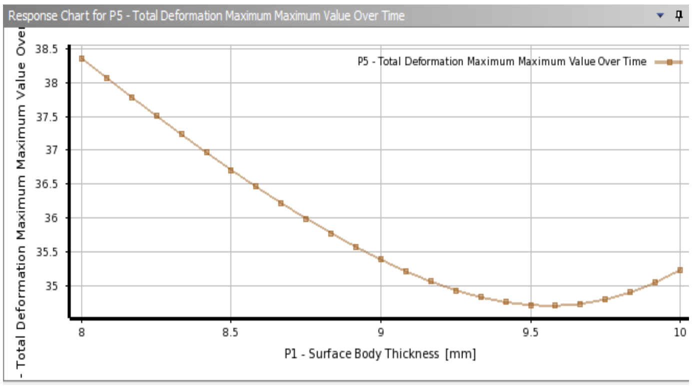


**Fig -8** Response chart for thickness of S2 profile

By increasing thickness upto 9.5mm lower deformation can be achieved.

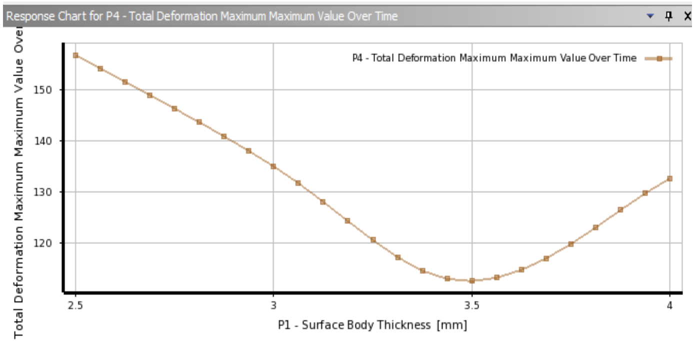


**Fig -9** Response chart for thickness of S3 profile

By increasing thickness upto 3.5mm lower deformation can be achieved.

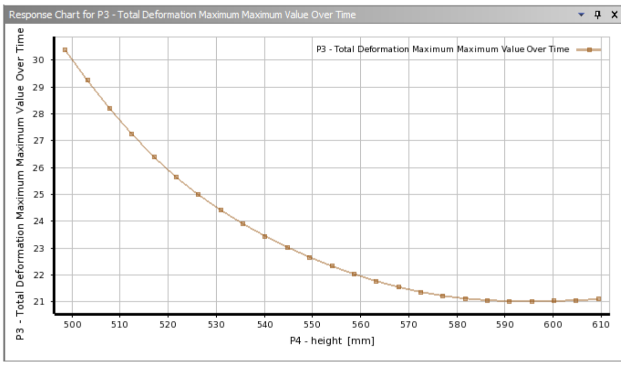


**Fig -10** Response chart for height of S1 profile

By increasing height lower deformation can be achieved.

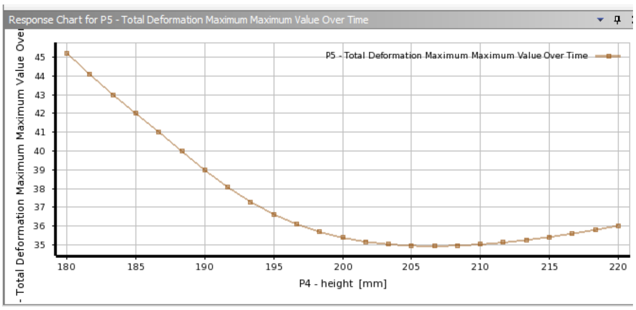


**Fig -11** Response chart for height of S2 profile

By increasing height upto 210mm lower deformation can be achieved

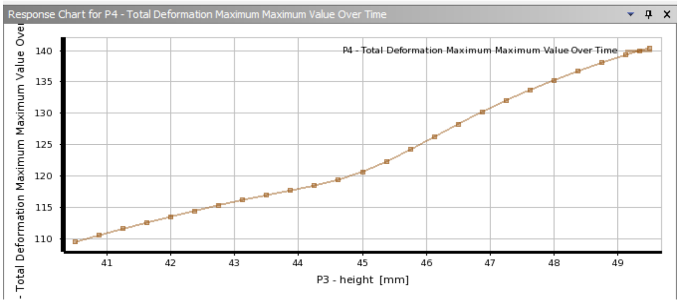


**Fig -12** Response chart for height of S3 profile

An increase in height doesn't conribute a lower distribution. The next step is to quantify the sensitivity of the output variables with respect to the variability of the input parameters. By generating plots of the output variables as a function of the most important random input variables, it is possible to determine the relation between the output and input variables. The evaluation of the sensitivities is based on the relation between all random input variables and a particular random output parameter. The sensitivity chart for the profile is shown in figure. From the figure it is seen that the height is the sensitive parameter in the case of deformation for S1 and S2 profile. For S3 profile thickness is the sensitive parameter.

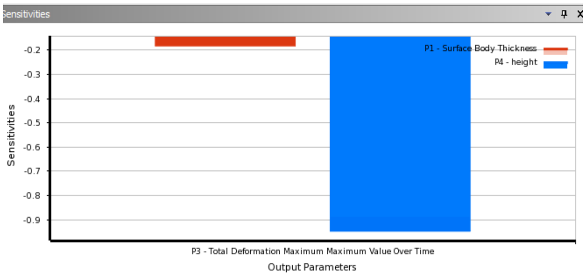


**Fig -13** Sensitivity chart of S1 profile

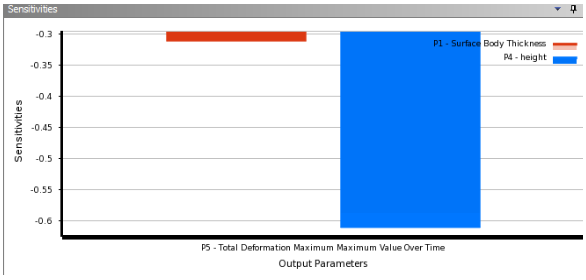


**Fig -14** Sensitivity chart of S2 profile

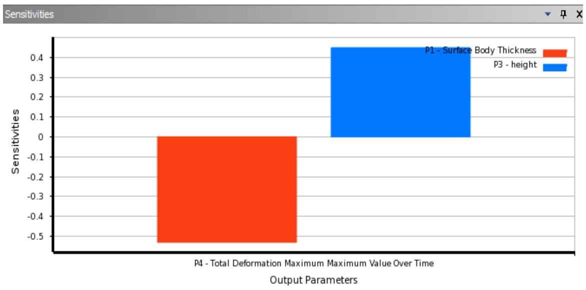


**Fig -15** Sensitivity chart of S3 profile

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