

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.*

Keywords: Offshore, Blast wall, Sensitivity, 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.

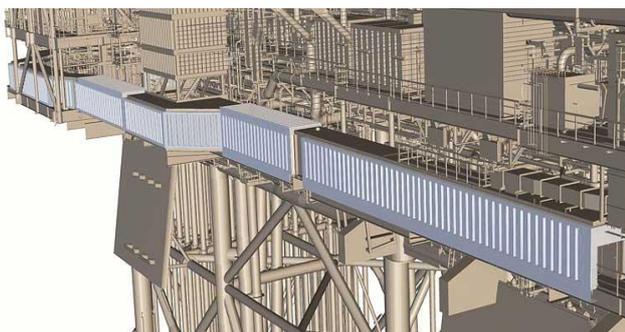


Figure 1: Blast wall

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.

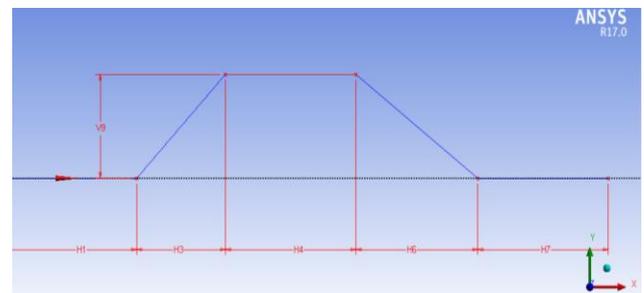


Figure 2: Geometry of corrugated profile

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.

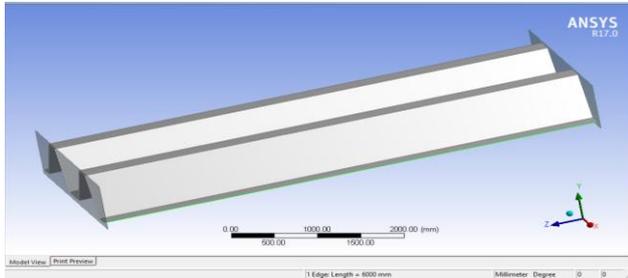


Figure 3: Geometry model of S1 profile Prepared in ANSYS

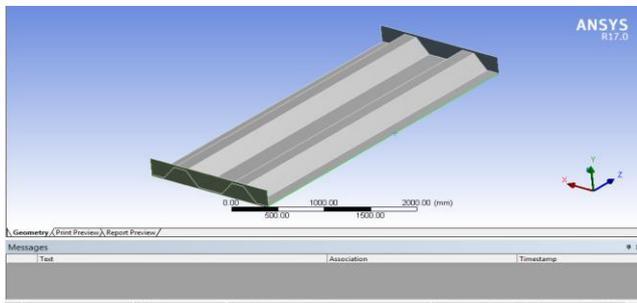


Figure 4: Geometry model of S2 profile Prepared in ANSYS

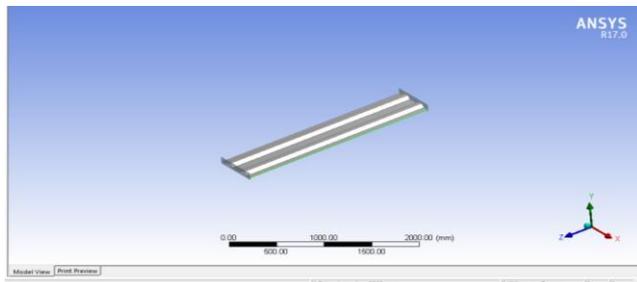


Figure 5: Geometry model of S3 profile Prepared in ANSYS

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.

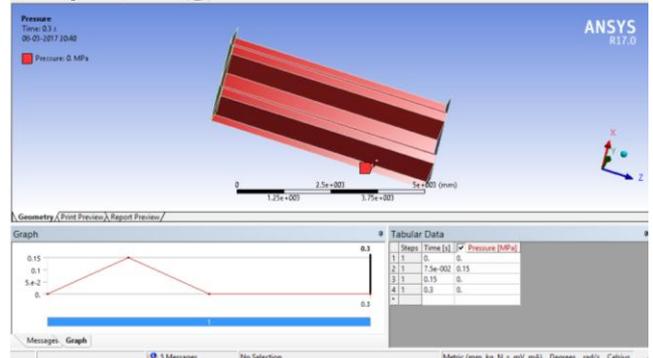


Figure 6: Loading

3. Results and Discussions

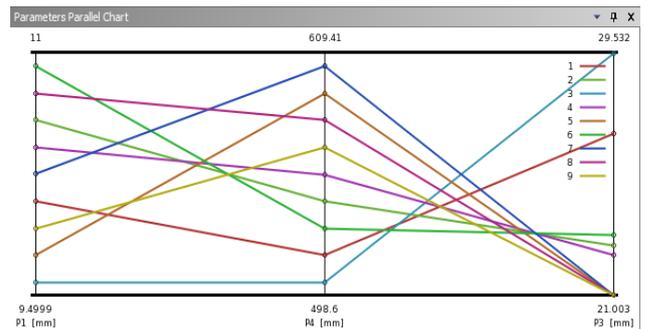


Figure 7: Parameters parallel chart of S1 profile

The value of deformation for different combinations of thickness and height of S1 profile is as shown in figure 7.

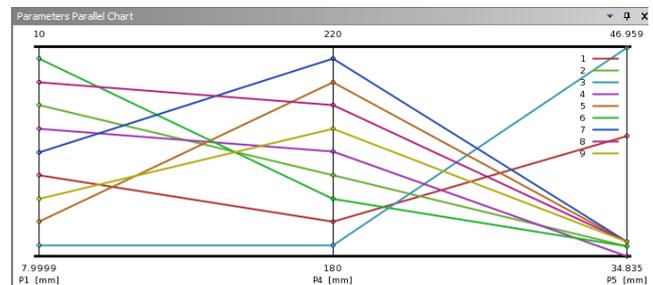


Figure 8: Parameters parallel chart of S2 profile

The value of deformation for different combinations of thickness and height of S2 profile is as shown in figure 8.

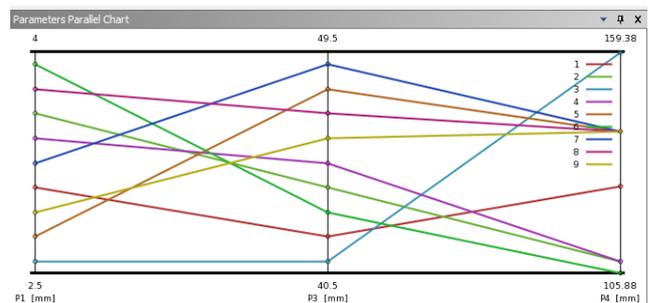


Figure 9: Parameters parallel chart of S3 profile

The value of deformation for different combinations of thickness and height of S1 profile is as shown in figure 9.

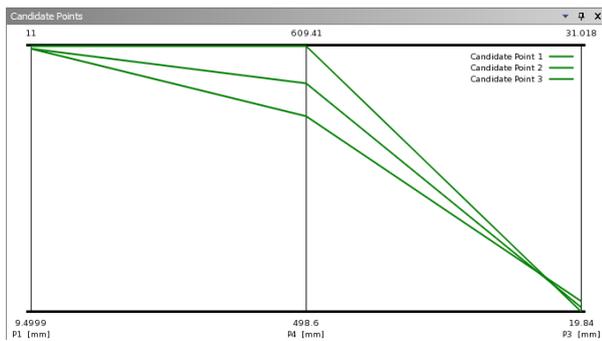


Figure 10: Optimisation chart of S1 profile

Figure 10 shows the optimization result of S3 profile. In which three best combinations for thickness and height corresponding to least deformation is represented.

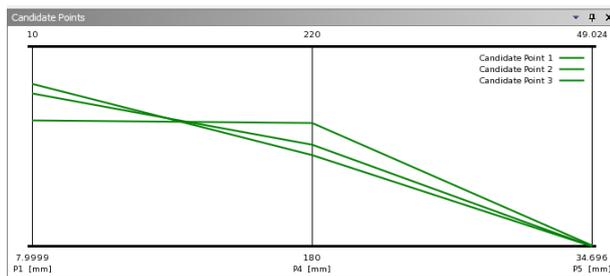


Figure 11: Optimisation chart of S2 profile

Figure 11 shows the optimization result of S3 profile. In which three best combinations for thickness and height corresponding to least deformation is represented.

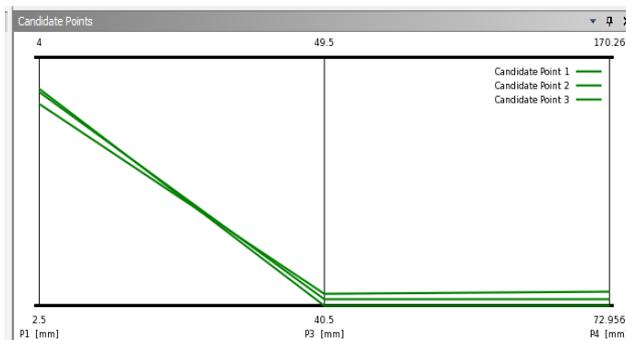


Figure 12: Optimisation chart of S3 profile

Figure 12 shows the optimization result of S3 profile. In which three best combinations for thickness and height corresponding to least deformation is represented.

4. Conclusions

Out of the 3 profiles S1 profile is having the least deformation. Further studies are to be done on different profiles of blast walls by considering the pressure load and explosive loads that are supposed to act on the blast wall. The effect of different loads acting on blast wall can be studied by varying the parameters. Understanding the different elements of a corrugated blast wall can help the engineer be informed of the compromises that must be made to meet specific project requirements.

References

- [1] Akhila Ramanujan and Sreedevi Lekshmi (2016) Comparative Study on the Analysis of Blast Wall with and without GFRP Using ANSYS, *International Journal of Science and Research*, 5, 864–70.
- [2] Anuj Kumar and Gaurav Kumar (2016) Effect of Blast Wave on Structures, *IJSR*, 5, 2013–16.
- [3] Ashish Kumar Tiwari, Aditya Kumar Tiwary, and Anil Dhiman (2016) Analysis of Concrete Wall under Blast Loading, *ICAET*, 0975 – 8887.
- [4] Atikur Rahman, Zubair Imam Syed, Kurian V. John and M. S Liew (2014) Structural Response of Offshore Blast Walls under Accidental Explosion, *Advanced Materials Research*, 1043, 278–82.
- [5] Jung Min Sohn, Sang Jin Kim, Byoung Hoon Kim, and Jeom Kee Paik (2013) Nonlinear Structural Consequence Analysis of FPSO Topside Blast Walls, *Ocean Engineering*, 60, 149–62.
- [6] L A Louca, J W Boh, and Y S Choo (2004): Design and Analysis of Stainless Steel Profiled Blast Barriers, *Journal of Constructional Steel Research*, 60, 1699–1723,
- [7] Mazlan Abu Seman, Feng Yun Tian, Zainorizuan Mohd Jaini, and Nasly Mohammed Ali (2004): Transformer Explosion and Impact on the Reinforced Blast Wall, *International Journal of Civil Engineering and Geo-Environmental*, 3, 29-33.
- [8] Qu Haifu and Li Xueguang (2009) “Approach to Blast Wall Structure Computing in Ocean Engineering, *International Conference on Industrial and Information Systems*, 76, 354–57.
- [9] Rafika, Mohammed Alias Yusof, Norazman Mohamad Nor, Ariffin Ismail, Muhammad Azani Yahya and Ng Choy Peng (2014) Simulation of reinforced concrete blast wall subjected to air blast loading, *Journal of Asian Scientific Research*, 4, 522–33.
- [10] J W Boh, L A Louca, and Y S Choo (2004) Strain Rate Effects on the Response of Stainless Steel Corrugated Firewalls Subjected to Hydrocarbon Explosions, *Journal of Constructional Steel Research*, 60, 1–29.
- [11] M A Faruqi, J. Grisel, A. Salem and J. Sai (2010) “A parametric study for the efficient design of corrugated blast wall panels used in” *ARNP Journal of Engineering and Applied Sciences*, 5, 89–96.
- [12] S Sriramula, M.H Hedayati and R D Neilson (2014) Linear Dynamic Reliability Analysis of Profiled Blast Walls, *ASCE*, 2574–85.
- [13] S Sriramula, M.H Hedayati and R D Neilson (2013) “Non-Linear Dynamic Reliability Analysis of Profiled Blast Walls, *Safety, Reliability, Risk and Life-Cycle Performance of Structures & Infrastructures*, 5257–64.
- [14] Umesh Jamakhandi and S B Vanakudre (2015) Design and analysis of blast load on structures, *IRJET*, 2, 745–47.
- [15] Zubair Imam, Osama Ahmed, and Shaikh Atikur (2016): Non-Linear Finite Element Analysis of Offshore Stainless Steel Blast Wall under High Impulsive Pressure Loads, *Procedia Engineering*, 145, 1275–82