Case Study

D J Goode

Blast Vent Panel Explicit Dynamics Analysis

Company Profile

D J Goode & Associates Ltd (DGA) is a leading firm of consulting engineers, specialising in Blast and Ballistic effects on buildings and other structures. The company was formed in 1993 and has worked in over 30 countries around the world.

DGA provide a structural dynamic design service covering Blast & Ballistic engineering, from concept right through to detailed design. They are also able to provide site based specialist engineers to work on projects during the construction phase.

DGA provides an extensive range of testing facilities, such as blast testing in association with GL Noble Denton and ballistic trials at their tubular firing range in Suffolk. DGA regularly host training courses on a variety of related subjects such as blast and ballistic design, explosive (storage and manufacture) licensing, and structural dynamics.

Background

In recent times the need to protect ourselves from the hazards of explosive or ballistic attacks, either as a result of an accident or terrorist activity, has increased. This has led to the development of a number of products to help resist blast pressures, which often require analysis using advanced finite element modelling techniques.

One such example is the assessment of a blast panel which is designed to help vent blast pressures following an event within a structure. The blast panel is designed to deform plastically under blast loading, to enable the blast pressures to vent out into the atmosphere. The design of the panel is specific to the building and the threat, and would be fitted internally to the wall at risk. Generally the blast panels would be lightweight so that they fail quickly to enable adequate venting.

Moreover, because the buildings are often located in close proximity to other explosive facilities it is important that the external face of the blast wall is capable of resisting the applied blast load generated from a neighbouring facility and thereby avoiding sympathetic detonation and protecting personnel within the building.

In many cases the blast panels are made of stainless steel, with corrugations running top to bottom. They would be connected to the supporting structure with the use of steel sub-frame and mechanical fixings. A blast panel would be 'rated' to fail at a certain pressure, and designed by the manufacturer to resist an external dynamic pressure with some permanent deformation.

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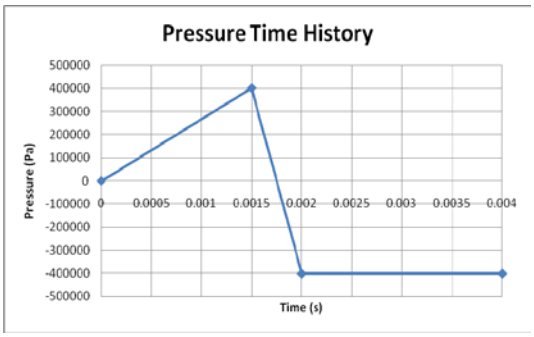
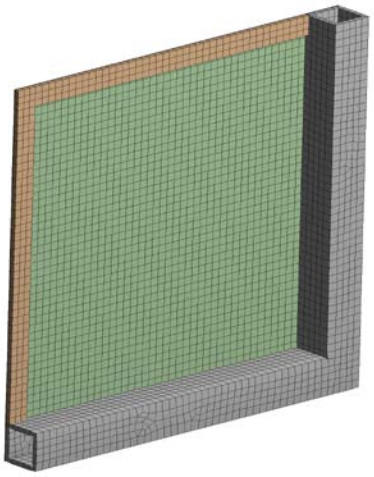
The blast panels considered in this case study were used in a variety of situations such as in explosive storage manufacturing compounds.

Analysis

IDAC were required to demonstrate how an explicit dynamic analysis could be carried out on a model of a steel vent panel made using pressed steel sections, and being subjected to an internal blast load. ANSYS Explicit STR was used for this purpose. The ANSYS Explicit STR program is based on the solver of the ANSYS AUTODYN analysis program and it is fully integrated into the ANSYS Workbench environment. The Explicit STR program requires a pressure time history load (an example of which is shown in the graphic to the right) to be supplied by the user. For more complex analyses, where the location and the weight of the explosive needs to be supplied, ANSYS AUTODYN can be used and the pressure wave can then be calculated by the software itself.





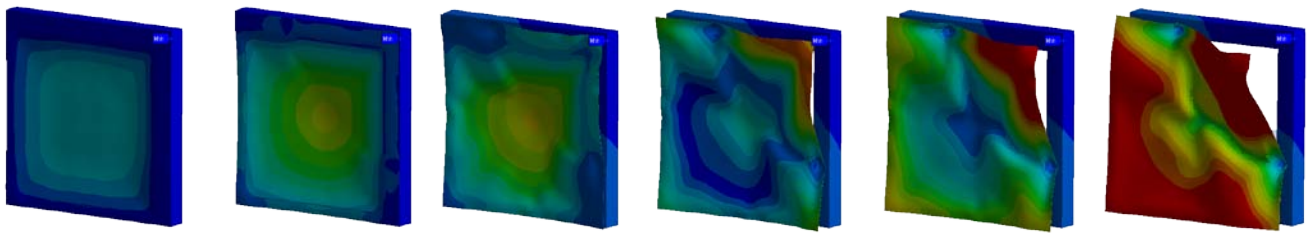
The geometry for this analysis was created within ANSYS and the quarter symmetry Finite Element (FE) model can be seen in the graphic to the left. The blast vent panel was made up of a single skin of steel plate which was spanning on to a supporting steel structure. The model was meshed entirely with membrane elements.

The vent panel material properties, loading conditions and constraints were provided by DGA, with the loading being supplied in the form of a pressure time history. The load was applied as a pressure on one face of the panel.

The results showed that the panel was capable of resisting the externally applied blast pressure but enabled venting in the event of an internal detonation. On inspection of the results it could be seen that the analysis had been successful in modelling the membrane action of the steel plate under dynamic loading.

The contour plots obtained from the analysis were used to indentify parts of the plate which were over stressed. The plots indicated in red where the stress within the vent panel had exceeded the material yield strength.

The graphics below show the total deformation contour plots of a quarter symmetry model at key intervals throughout the dynamic analysis.



Benefit

Having proven to DGA that ANSYS Explicit STR was capable of solving the blast vent panel, IDAC have carried out further analyses for DGA for other blast resistant elements such as blast door panels.

Patrick Goudkil of DGA says “We find it extremely useful to have access to IDAC’s FEA team as they have a vast amount of experience in using the software. It is very reassuring knowing that they are there if we need help in developing a model. Often it is just useful to speak to someone before we embark on a design because by talking it through with the IDAC team we are able to avoid potential problems and often we are able to provide a more efficient analysis.”

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