Optimisation of Blast Door Structures

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Blast protection of structures is an increasing concern worldwide. This issue is particularly relevant in Singapore, where specific legislation mandates that certain structures incorporate built-in protective measures. Blast doors are often critical components of such security strategies, as they must ensure an adequate level of protection while maintaining accessibility to facilities.

The objective of this project is to optimize the performance of blast door systems subjected to blast loads from bare charges. These doors typically consist of two metal plate skins connected by steel spacers, often in the form of C-sections or I-beams. However, this design could be improved by incorporating honeycomb cores, which may be fabricated using conventional methods or, in the future, advanced 3D printing techniques. Honeycomb cores have the potential to enhance protection while reducing overall structural weight.

In this study, a finite element analysis (FEA) model was developed using OpenRadioss and validated to evaluate various core designs. Validation was achieved using data from existing literature tests on panels constructed with traditional I-beam spacers, with the model accurately replicating peak deflections.

Subsequently, several innovative core configurations were modelled and compared, including square, hexagonal, and re-entrant honeycomb structures. Parametric studies were conducted to assess the influence of honeycomb cell size and wall thickness, while maintaining a consistent panel mass across all designs.

The results demonstrated that honeycomb panels outperformed traditional panels with C-section spacers under blast loading, achieving reduced peak and permanent deflections for equivalent panel weights. Optimized configurations were identified for each type of honeycomb core.

This study highlights the potential of honeycomb-structured blast door designs. Future work will involve experimental validation through small-scale drop tower tests and, ultimately, full-scale blast tests to confirm the findings. These advancements aim to produce safer and more efficient blast door structures for projects in Singapore and beyond.