

# Numerical investigation of low-velocity impacts on monolithic and laminated safety glass

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## Aims and Objectives

In general, free falling objects are one of the most common incidents to impact on glass floors or stairs during day to day operations and maintenance. This research aims to study the impact resistance and damage behaviour experienced during hard body impacts on monolithic and laminated safety glass, mainly of structural use. The impact process is analysed using three dimensional finite element methods by ABAQUS software. Numerical results will be validated and further explored to construct models to predict impact resistance and to assess glass damages under a range of conditions.

Key objectives include:

- To study the hard body impacts on glass panels, taking into account a number of parameters such as the glass panel size, thickness, type, interlayer material type and properties (PVB or resin), geometric properties of projectile, impact velocity, surface and boundary conditions. This will be achieved through numerical impact analysis.
- To identify the failure modes in structural safety glass under low-velocity hard body impact damage.

- To characterize the influences of design parameters and study how they can be used to improve the performance of structural safety glass impact resistance.
- Numerical results can be validated by comparing with published experimental, analytical and numerical data.
- To develop the engineering oriented model for design and assess the structural glass subjected to low-velocity hard body impacts.

## **Background**

Monolithic glass is inherently a brittle material and can fail without warning under tension. Glass experiences different fracture mechanisms when subjected to static and impact loading. It has been traditionally accepted that there are two different impact incidents on structural glass, i.e.

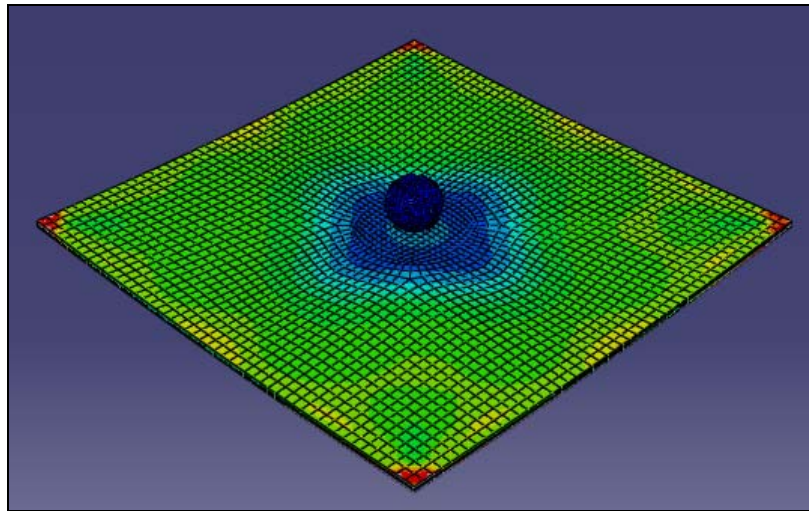
- Hard body impact (dropped object, hard wind born debris)
- Soft body impact (human bodies, soft wind born debris)

The impact response and resultant damage caused by these two incidents are different and therefore require study separately.

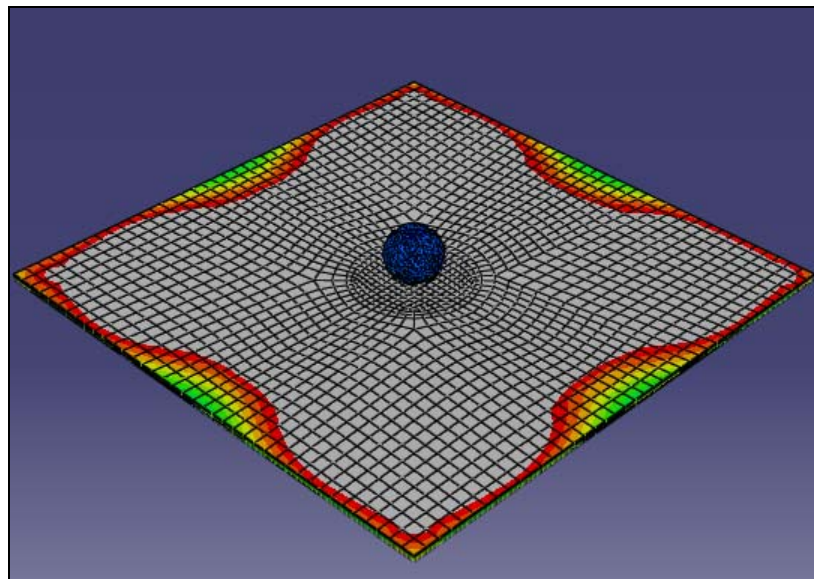
## **Methodology**

ABAQUS is a general purpose finite element method based programme. It will be used to analyse the non-linear impact behaviour of structural safety glass in this project. The model can be presented by a free dropping steel ball hit onto a glass panel. Different design parameters will be studied, which include, among others, support conditions, thickness, interlayer materials and glass types. An elastic impact analysis for point and

frame supported monolithic glass panels have been performed and results have been validated by comparing with available analytical and experimental data. Figures 1 and 2 illustrate the first principal stress contour plots induced by impact in point and frame supported glass panels respectively.



**Fig.1.** Point supported glass panel



**Fig .2.** Frame supported glass panel

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