Post Fracture Design of the NGI Sculpture Court Structural Glass Roof

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Abstract

The Sculpture Court glass roof is the central feature of the recent extensive refurbishment of the National Gallery of Ireland in Dublin, completed in 2017. Its principal structure is composed of 23 structural glass fins that span the 7m to 9m meter gap between two historic wings of the building. These triple laminated toughened glass beams minimise the visual impact of the structure and achieve a more "external" and open feel to the space below. The principal challenge for the structure was to ensure that its post fracture behaviour remained satisfactory, minimizing the risk of progressive collapse.

The paper sets out the design process for the development of the glazed structure and focuses on the research for robust alternative load paths, and its interaction with the historical existing structure. It explores the balance required between the transparency of the roof, the reliability of the system, and the capacity of an existing masonry.

Keywords: Structural glass, post-fracture behaviour, redundancy, robustness, accidental damage, glass.

1 Introduction

The C19th National Gallery of Ireland has undergone a major refurbishment from 2011 to 2017. One of the principal elements of this project is the transformation of an existing courtyard, situated between two wings of the building, into a breakout space accessible to the public and used for the display of art objects and sculpture.

The proportions of the courtyard are relatively narrow - between 7m to 9m wide - for its height of around 20m, and it was critical to the architectural concept that its roof should be as light and visually simple as possible.

To achieve this design intent, an all glass structure was developed, composed of 23 structural glass fins spanning between the two wings (see Figure 1).

The essential quality that differentiates structural glass elements from almost any other construction material is their fragility – they are prone to breakage under impact or contact loads and may even spontaneously rupture at stresses well below their expected resistance.

This characteristic must be incorporated into the development of any structural glass system. The designer must ensure that, in case of breakage, the integrity of the structural system is not compromised or susceptible to progressive collapse. Strategies to achieve this are set out in Eurocode 0 [1] and Eurocode 1-7 [2] and expanded on in Guidance for European Structural Design of Glass Components [3] and various specialised literature [4], [5]. Recommendations on limiting the consequences of component failure of structural glass elements are given in [3], such as:

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