ABSTRACT

Bomb threats and attacks are common in many parts of the world today. One of the significant effects of a blast is damage to the glass windows in nearby buildings. The debris produced from the damaged windows, especially the sharp glass fragments produced, can lead to severe injuries and even casualties. One way to mitigate the damage is to use blast-resistant laminated glass, which is conventionally made of one or more polyvinyl butyral (PVB) interlayer sandwiched between two or more glass sheets, for windows. Although the PVB interlayer is widely used in the world, it still has some disadvantages, such as low strength to weight ratio which results in large thickness and increased weight of the laminated glass. The low strength to weight ratio problem can be solved by replacing the PVB interlayer with a transparent glass fiber-reinforced polymer composite interlayer, because glass fiber-reinforced composites have high strength to weight ratio and potentially higher fracture toughness. By using the glass fiber-reinforced composite interlayer, the thickness and weight of the laminated glass can be potentially reduced.

A laminated glass panel utilizing a newly developed transparent glass fiber-reinforced composite interlayer has been fabricated in this study. The transparent composite interlayer was obtained by matching the refractive index of the polyester resin matrix with that of E-glass fibers. The light transmittance of the fabricated laminated glass is above 60% over the light wavelength range of 482 nm to 700 nm with the highest transmittance is 84.4% when the light wavelength is 577 nm. The composite interlayer's mechanical properties under both quasi-static and dynamic loading conditions have been characterized. In addition, the fabricated glass panels were tested under various blast loading conditions. The panels perform well under U.S. General Services Administration (GSA) specified C, D and E blast loading levels.

In this research, the dynamic response, in terms of the midpoint deflection, of the fabricated laminated glass under blast loading has been analytically investigated using model-based method and finite element method. Failure analysis of the laminated glass was performed using the stress analysis approach.