Influence of Thermal and Water Treatment on Strength Recovery of Soda Lime Silica Glass

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Abstract

Glass is highly sensitive to damage accumulation during its service life, leading to a significant reduction in strength. Annealed glass used in glazing units of low-rise buildings can experience a 71-85% strength reduction after 20-30 years of natural weathering, which can be detrimental in structural applications. Despite these considerable reductions in strength, there are currently no well-established methods for repairing glass components, with hypothetical repair methods primarily limited to resin injection and little evidence on their durability or their efficiency in preventing water diffusion and subcritical crack growth. As glass panels increase in size, complexity and cost, the standard approach of replacing damaged components with new glass becomes unsustainable. This paper develops effective and durable thermal healing methods for damaged glass components. A systematic experimental investigation is undertaken involving controlled artificial aging of annealed glass, followed by thermal healing, microscopy and destructive flexural tests to assess the effectiveness of the repairs. Different thermal and hydrothermal profiles are explored showing that thermal treatment has potential for strength recovery. In fact, thermal healing for the flaws in this study, at high temperatures in the order of 300-500°C, can fully restore and even increase the design strength of glass beyond new as-received strength. This suggests that thermal healing can support and promote repair and reuse of end-of-life glass, enhancing circularity in the architectural glass industry.

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Keywords

glass, flaws, scratch, repair, thermal treatment, water soaking, healing, strength recovery

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