Heat Treatment of Pre-damaged Soda-lime silicate Glass and its Influence on Glass Strength

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Abstract

The ongoing energy crisis has brought consideration of the circular economy in structural glass construction to the forefront. Although glass is theoretically a material that can be recycled an infinite number of times, virtually no glass that has been dismantled has been added back to flat glass production due to high quality requirements of the cullet to prevent contamination. The high energy consumption required to produce flat glass makes the re-use of glass without re-melting interesting. Since the strength of glass is determined by its surface defects, this prompts the questions of what the strength of deconstructed glass is, whether it can be restored, and what processes are suitable for that endeavour. Literature reports, that heat treatment of pre-damaged annealed soda–lime silicate glass can increase its fracture strength. This serves as the methodical starting point of this research. In order to study this phenomenon in more detail, this paper investigates seven temperature programs (temperature levels: 350°, 540°C and 640°C; and treatment durations between 1h – 8h) on pre-damaged soda-lime glass samples, whereby the samples are pre-damaged with a defined crack depth using an universal surface tester (figure 1, left). The samples are slowly cooled down after the heat treatment, so that they remain annealed. Double-ring bending tests are performed to determine the strength of the heat-treated samples (figure 1, right). In addition, the critical crack depths are evaluated using a microscope. The results are compared with a reference series (pre-damaged, but without further treatment) to show the potential of this method and the possibility of healing cracks as restoring strength. For all temperature programs, an increase in the mean fracture stress was observed together with a decrease in the mean critical crack depth.

The full paper will be published in the Glass Performance collection of the Glass Structures & Engineering journal (Springer).

Keywords

Reuse, strength, heat-treatment, glass, circularity, crack-healing

Article Information

- Published by Glass Performance Days, on behalf of the author(s)
- Published as part of the Glass Performance Conference Proceedings, June 2025
- Editors: Jan Belis, Christian Louter & Marko Mökkönen