Glass Panels under Concentrated Static and Impulsive Actions

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Abstract:
The conventional approach of determining the strength of glass by repetitive test is obscured by cost and paucity of data. In addition, most previous research focused on uniformly distributed loads representative of the wind pressure, and the understanding to point load scenarios is poor. This research aims to developing a methodology to address the point load problem based on the first principles of surface defects distribution and fracture mechanics. So far the research focused on static loading, but transient and impulsive actions will be addressed in subsequent efforts.

Methodology

Experimental study on the competing failure modes induced by concentrated transverse loads on thin glass panels is carried out. The specimens been tested are annealed soda-lime glass panels simply supported at all edges and are loaded with quasi-static ramp loads. Failure loads and deflection are measured, and the locations of individual crack origins are recorded by high-speed photography (as shown below). Data was analysed by the means of ANOVA and probability plot.
The probability density distribution of surface flaws are assumed to take a functional form of

$$f(c) = \frac{c_0^{n-1}}{\Gamma(n-1)} c^{-n} e^{-(\frac{c_0}{c})}$$

Combined with numerical stress analysis carried out using FEM and the established Mode I fracture criterion, the probability of fracture at load *p* in the given point-load scenario takes the following form:

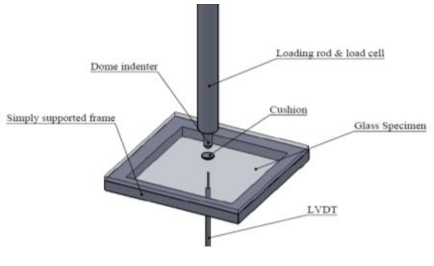
$$P(p) = 1 - \exp[-N \frac{2c_0^{n-1}}{\pi\Gamma(n-1)} \times \int_0^{u_p} u^{n-2} e^{-u0} cos^{-1}(\frac{u}{u_p})^{1/4} du]$$

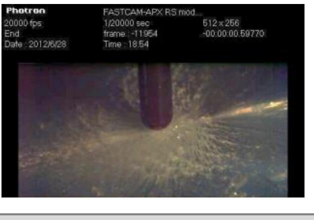
Which is overdetermined, hence parameters *N, n* and c_0 can be calculated from an array of experimental failure loads.

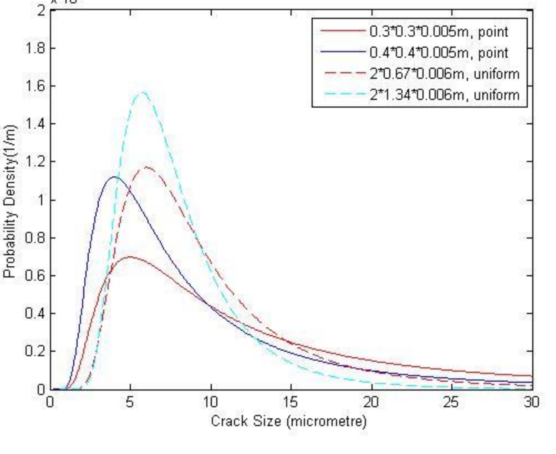
Discussion

It is found that under quasi-static loading conditions, localised fracture mechanisms including Hertzian cone cracks and quasi-plastic deformation do not have significance contribution to the collapse of the plate. This leaves the most likely failure mode being bending failure.

The numerical analysis method deduced surface flaw parameters from the test-fracture load distribution, established a procedure to estimate the strength distribution. It could potentially reduce the number of repetitive test required for systematic strength analysis dramatically.







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