Stochastic Simulation of the Head Impact on Windscreens

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In accidents involving cars with pedestrians, the impact of the head on structural parts of the vehicle takes a significant risk of injury. If the head hits the windshield, the injury is highly influenced by glass fracture.
In pedestrian protection tests, a head impactor is shot at different points on the windshield at up to 40 km/h while the resultant acceleration at the COG of the head is measured. To assess the risk of fatal or serious injury, a head injury criterion (HIC) as an explicit function of the measured acceleration can be determined. The braking strength of glass which has a major impact on the head acceleration, however, is not deterministic but depends on production-related micro-cracks on the glass surface as well as on the loading rate.
The aim of the present work is to show a pragmatic method, how to include the stochastic failure of glass in numerical simulations.
The methodology includes

- the experimental determination of the glass strength for the different areas of a windshield: surface, edge, and screen-printing area [1],
- the statistical evaluation of the experimental data for numerical simulation [2,3],
- a fracture mechanical model for the strain rate-dependent failure of glass [4]
- and the stochastic simulation and evaluation of a HIC probability distribution.

The method presented is not limited to head impact on the windshield, but can also be used, for example, in the case of blast loads on glass panes in building façades.

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