Impact response of injection-moulded polypropylene parts for automotive exteriors

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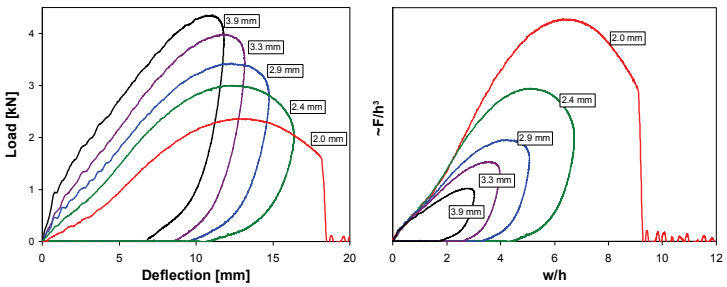
Introduction

- Automotive exterior parts such as bumper covers must fulfil several demanding specifications.
- This poster deals with the low-velocity low-energy impact response at low temperatures (-30 °C). At cold winter conditions, minor impact events on the bumpers should not result in a brittle fracture.
- One aim of this ongoing study is to identify the main factors influencing the impact response, in particular those leading to brittle fracture. Another aim is to improve material models and data for numerical simulations.

Experimental

- **Material**: A commercial 20% mineral-filled elastomer-modified polypropylene compound developed for automotive exterior parts.
- **Test specimens**: Injection-moulded plates with different thicknesses.
- **Test equipment**: Instrumented falling-weight impact tester. The plates were clamped by a ring with inner diameter 40 mm. Different strikers were used. The standard striker was hemispherical with diameter 20 mm. The strikers were lubricated.
- **Test conditions**: Velocity at impact up to 4.4 m/s, corresponding to an incident energy of 34 J (same mass in all tests). Test temperature: -30 °C.

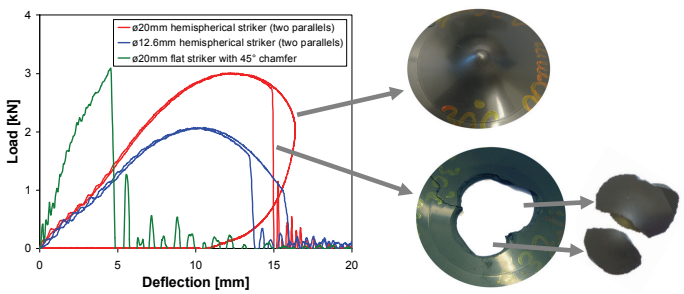
Effect of plate thickness and impact velocity



Load (F) vs. deflection (w) for different plate thicknesses (h) (4.4 m/s)

- The thinnest plate fractured in a brittle manner. The next thickness (2.4 mm) showed brittle fracture in some of the repeated tests.
- With an impact velocity of 3 m/s, brittle fracture was not observed for any of the plate thicknesses.
- Injection moulding conditions seem to have relatively small effect on the probability of brittle fracture.

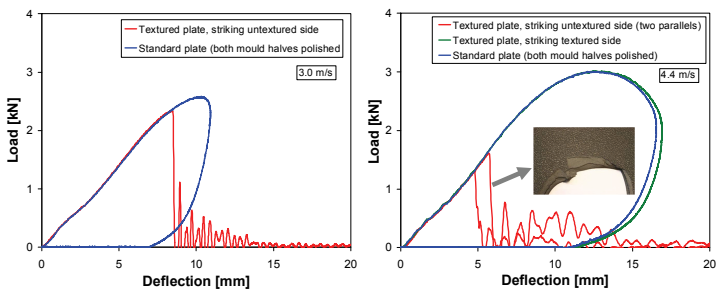
Effect of striker geometry



Results with different strikers for 2.4 mm thick plates (4.4 m/s)

- When using a smaller hemispherical striker (ø 12.6 mm) at an impact velocity of 4.4 m/s, all plates except the thickest showed brittle fracture.
- With a flat ø 20 mm striker the plates fractured at quite low deflections, before the load reached a maximum.

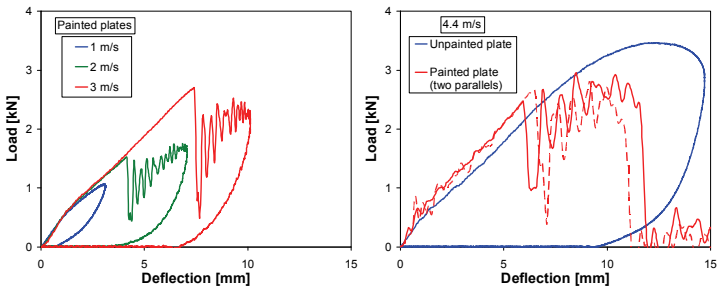
Effect of surface texture (topography as unpainted bumper cover)



Results for 2.4 mm thick plates with and without one textured side

- Plates with and without one textured side were injection moulded by using an exchangable mould insert.
- When striking at the untextured side (textured side in tension opposite the striker), the plates showed a brittle response with lowered absorbed energy, both at 3.0 and 4.4 m/s. Note that the absorbed energy was lower for 4.4 m/s than for 3.0 m/s.

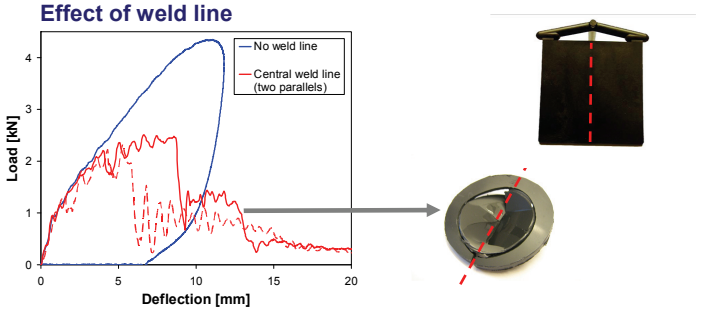
Effect of painting (primer, basecoat and clearcoat)



Results for 2.9 mm thick painted and unpainted plates

- Painted plates impacted on painted side. A circular crack formed near the clamp at the impacted side at 2 m/s and higher velocities. At 4.4 m/s the crack ran through the plate.

Effect of weld line



Results for 3.9 mm thick plates with and without a weld line

Summary

- Clamped injection-moulded polypropylene plates were impact tested at -30 °C at low velocities (≤ 4.4 m/s) and low incident energies (≤ 34 J).
- Brittle fracture was observed above a certain velocity for plate thicknesses below a certain value.
- Weld lines, surface texture, paint, and more concentrated load caused brittle fracture in more cases.

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