MDA2020

3RD INTERNATIONAL CONFERENCE ON MATERIALS DESIGN AND APPLICATIONS

Numerical Simulation of Impact Behaviour of Multi-Cell Thin-Walled Structures with Configurable Thermal Trigger Design

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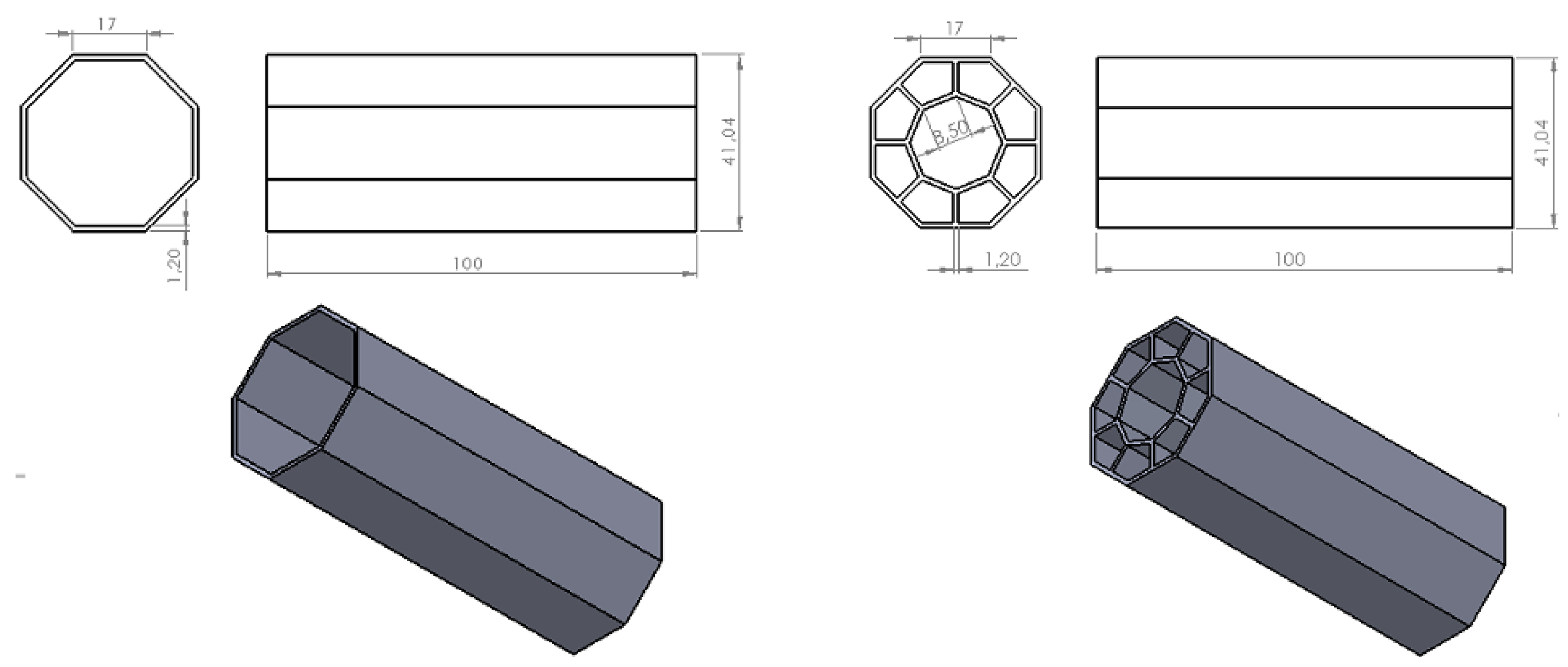
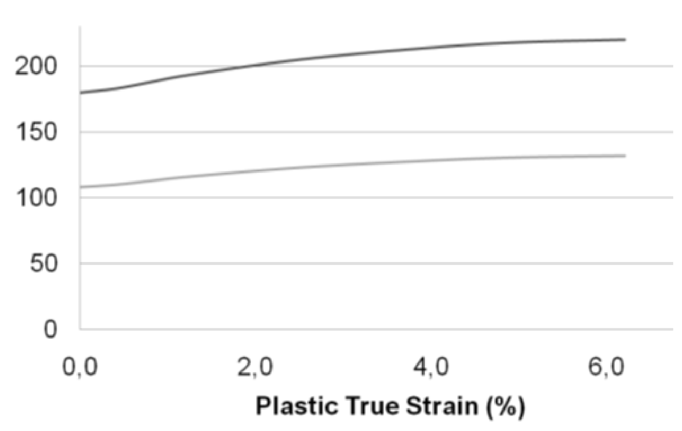
Base Reference Design Concepts

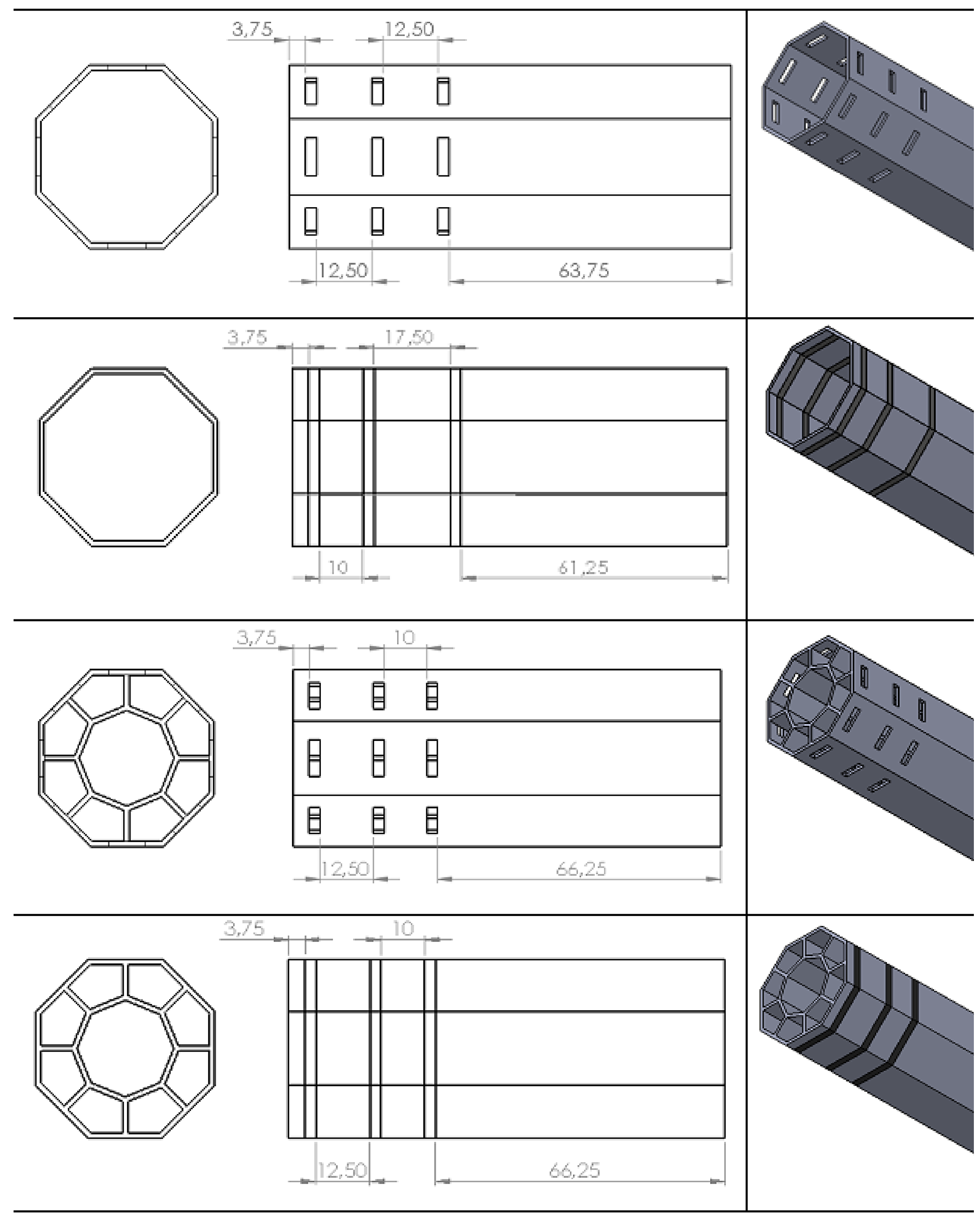


Base reference geometries. Left: Ref. A; Right: Ref. B (multicell)



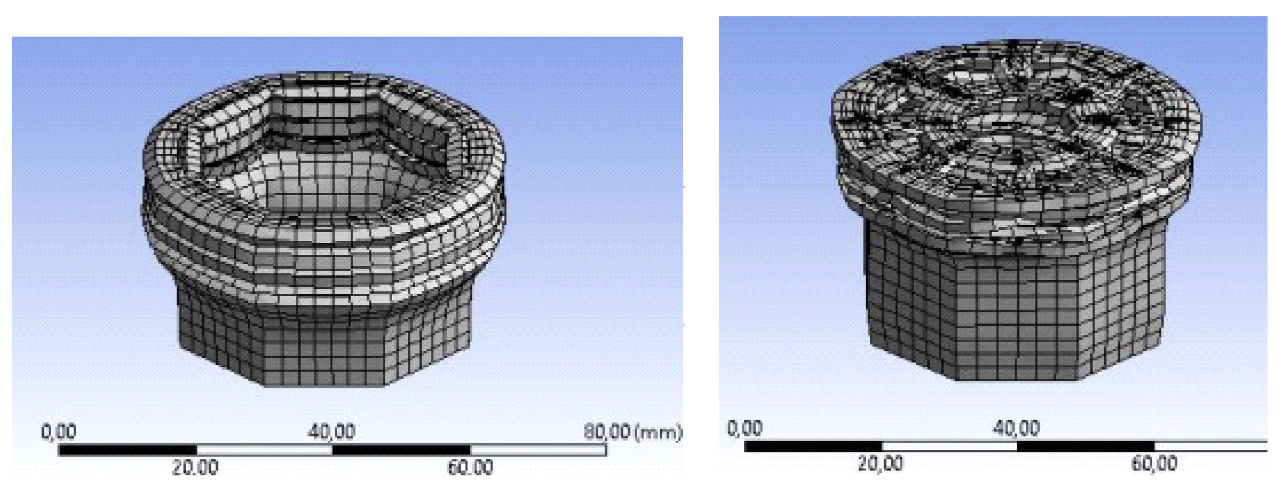
Material and thermal trigger concept: Local softening of 6061-T4 aluminium alloy to induce trigger regions. Concept analysed in numerical simulation through base and softened true stress true strain curves.

Geometric and Thermal Trigger Design Concepts



Trigger design and references. From top: Ref. A with Geometric Triggers (GT) (A_GT); Ref. A with Thermal Triggers (TT) (A_TT); Ref. B with geometric triggers (B_GT) and geometry B with thermal triggers (B_TT)

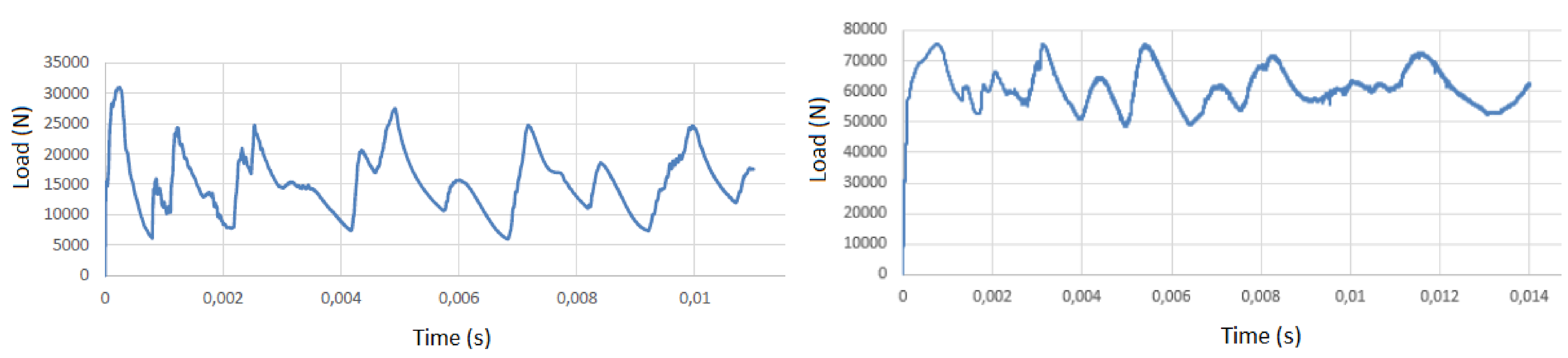
Numerical simulation results



Final deformed shapes of base reference designs: Ref. A (left) and Ref. B

Crashworthiness parameters. Comparison of A and B reference geometries

Structure Ref.	Mass [kg]	E_A [J]	$P_{máx}$ [N]	SEA [kJ/kg]	CFE
A	0.0452	1109	30905	24.56	0.497
B	0.0928	4125	75527 (+144.4%)	44.47 (+81%)	0.807 (+62.4%)



Load-time curves of base reference designs: Ref. A (left) and Ref. B

- The study presents numerical results for thin-walled octagonal structures subjected to impact loading and analyzed for different section and trigger solutions. Two different alternatives for section design complimented with thermal or geometrical trigger solutions were proposed. The multi-cell design, as a base reference geometry, demonstrated higher specific energy absorption than the original octagonal section.

Crashworthiness parameters. Comparison of Ref. A and trigger designs

Structure Ref.	Mass [kg]	E_A [J]	$P_{máx}$ [N]	SEA [kJ/kg]	CFE
A	0.0452	1109	30905	24.56	0.497
A_GT	0.0435	1146 (+3.3%)	24445 (-20.9%)	26.36 (+7.3%)	0.646 (+30.0%)
A_TT	0.0452	1165 (+5.0%)	24671 (-20.2%)	25.80 (+5.0%)	0.656 (+32%)

Crashworthiness parameters. Comparison of Ref. B and trigger designs

Structure Ref.	Mass [kg]	E_A [J]	$P_{máx}$ [N]	SEA [kJ/kg]	CFE
B	0.0928	4125	75527	44.47	0.807
B_GT	0.0911	4244 (+2.9%)	71744 (-5%)	46.60 (+4.8%)	0.857 (+6.2%)
B_TT	0.0928	4229 (+2.5%)	73472 (-2.7%)	45.59 (+2.5%)	0.839 (+4.0%)

- The ability to tailor peak loads through both thermal and geometrical trigger design was validated in numerical simulations. The obtained results are indicative of a high effectiveness of the thermal and geometrical triggers in the original octagonal thin-walled section with improvements in specific absorbed energy and crush force efficiency while allowing for a significant reduction of peak loads. For the multi-cell design the thermal triggers were less effective regarding peak load reduction and crashworthiness parameters.

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