REDUCING COMPUTATIONAL COSTS – PRACTICAL INSIGHTS INTO A LOWER ORDER (MACRO-ELEMENT) APPROACH FOR AUTOMOTIVE CRASH

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The Macro Element Method (MEM) was developed to investigate the dynamic collapse of thin-walled components, commonly used in vehicle structures. Its main advantage over traditional finite element modelling is a significant reduction in computational cost, as MEM models run in the order of seconds / minutes vs. several hours using parallelised, non-linear explicit finite element analysis codes. This presentation reviews and compares the Macro Element Method (MEM) against high fidelity finite element modelling (FEM) for typical automotive frontal crash structures. Good agreement with experimental results for a crush can assembly were obtained, providing a reliable (numerical) FE baseline response to assess the accuracy of the Macro-element method by extending the modelling to a full-frontal crash structure.

The frontal crash structure was represented by a 10 component MEM model, requiring 4secs (1CPU), versus ~1.5hours (8CPUs) for a 67 component (104.4k element), mass-scaled FE model. MEM predicted the time sequence of collapse, but overestimated mean crush and peak collapse force by up to 15% (and deemed acceptable). The two methods diverged in the latter stages of post longitudinal rail collapse, which was not unexpected, as the failure mode is complex and the role of contact friction (not implemented in MEM) will effect subsequent collapse. Despite this difference, good agreement for the time to absorb the impact energy was obtained (MEM=62.5ms; FEM=64.0ms). MEM is an extremely powerful tool to support the early design process where detailed FEA may not be appropriate, but requires an a-priori understanding of the collapse sequence.