Technical Talk

Finite Element Analysis for the Analysis of Rotomoulded Parts

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Profile

Hashim Bhabha is a mechanical engineer and a PhD student at Manchester Metropolitan University. His work into enhanced stiffness materials for rotomoulding is sponsored by Rotomotive Limited

Computer aided engineering (CAE) technologies such as finite element analysis (FEA) offer the capability to build, optimise and validate engineering designs within a virtual environment, consequently decreasing development time and simplifying revisions.

Currently, FEA is widely used in the rotomoulding industry to ensure products will be within the dimensional tolerance specified, withstand the loads required and last the intended life cycle. When verifying the structural integrity of parts using FEA, engineers require accurate numerical materials data. Therefore, it is crucial to ascertain which material parameters are required for FEA and to understand their effect on simulation results. Rotomoulded parts often have considerable variations in wall thickness, exemplifying the necessity for accuracy during FEA modelling.

Primarily, two main analysis types are conducted within FEA software; linear and non-linear. Linear FEA simulations typically require a value for modulus, strength at yield and Poisson's ratio; the former two parameters can be determined by standard mechanical testing. However, extracting a modulus from mechanical testing is dependent upon which section of the resulting stress-strain curve is selected for calculation (leaving this open to debate). Non-linear simulations typically require a Poisson's ratio value and a tensile stress-strain curve from physical testing. Furthermore, non-linear simulations are normally more time-consuming relative to linear simulations, due to the larger amount of input data.

Initial FEA investigations conducted on a small rotomoulded safety step indicated the linear analysis results correlated better with physical test results, relative to equivalent non-linear FEA results. However, the tensile stress-strain curve used for non-linear simulations may not account for mechanical behaviour due to compression (assuming the stress-strain response of the safety step material in compression is not identical to that of an equivalent tensile response). Therefore, non-linear FEA experiments using combined tensile-compression stress-strain curves are being investigated to gauge the effect of this data combination on the outcome of results.

Moreover, variations in the values of Poisson's ratio for rotomoulded materials (according to literature and general consensus) places a question mark over the extent at which this factor affects FEA simulations. Therefore, methods to measure the Poisson's ratio of rotomoulded polymers and identify the effect of this parameter on the outcome of FEA simulations are being developed. If new materials are to be introduced to the rotomoulding industry, it is essential that reliable material data (such as modulus and stress-strain data) for these materials are available for design engineers using FEA.

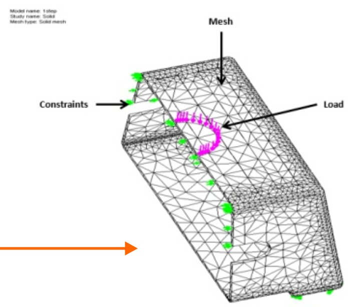

Figure 1. SolidWorks FEA test setup of rotomoulded safety step.

Figure 2. Rotomoulded safety step

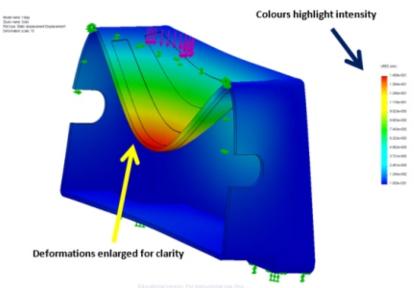

Figure 3. Cross sectional view of rotomoulded safety step within SolidWorks FEA. The colour red indicates area of highest stress.