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ABSTRACT

- Hyperelastic characterisation requires multiaxial test data – uniaxial tension, pure shear and equibiaxial tension
- To increase the efficiency of material characterisation, a novel, inhomogeneous experiment is introduced utilising finite element optimisation
- No-slip compression test data is compared to an equivalent finite element model to optimise the coefficients of several material models
- Autonomous investigation of method through Finite Element Analysis (FEA)
- To increase the efficiency of material characterisation, a novel, autonomous investigation of method through Finite Element Analysis (FEA)

SIMULATED EXPERIMENT

- No-slip uniaxial compression (NsC) test
  - Standard ASTM D575 specimen: 28.6mm diameter, 12mm thickness
  - Compressed with full friction – sticking once in contact
  - Strain field is inhomogeneous – simultaneous tensile, compression and shear modes
- Finite Element (FE) modelling in Abaqus
  - Investigate test & optimisation parameters using axisymmetric FE model
  - Ogden N=3 constants fitted to Treloar’s data [1] (uniaxial, planar and equibiaxial tension)
  - Generate pseudo-test data for use in Isight optimisation
  - Requires accurate and converged solution before simplification
- FE optimised model requirements:
  - Minimise solution time while maintaining accuracy
  - Symmetry applied and mesh partitioned – significant element reduction
  - “Rough” friction formulation further reduces solution time to 26 seconds
  - Free from volumetric locking and hourglassing

RESULTS

- Observations
  - Higher compression reveals more accurate multiaxial constants but results in more convergence failures
  - Ogden-3 model is by far the least efficient method and fails most often
- Assessment criteria
  - Homogeneous test data plotted using fitted constants
  - Relative error calculated for each and compared to optimal fit from Abaqus
- Optimisation with NsC test only
  - All models fit the NsC test accurately
  - 8-chain and Ogden models do not reveal multiaxial parameters
- Optimisation with NsC and Uniaxial Tension tests
  - 8-chain and Ogden are significantly improved
  - Yeoh model gives a better average fit

CONCLUSIONS & FUTURE WORK

- Novel characterisation method can reduce required testing
  - Yeoh and 8-chain may use one and two tests, respectively
  - The Ogden model is too inefficient to be considered as viable
- Further investigation: parametric study of specimen geometry
- Improvements to method
  - Previous study by Le Saux [2] revealed that indentation may be used to reveal the constants of the Edwards-Vilgis model – requires UMAT implementation
  - The extended-tube model [3] is similar to the Edwards-Vilgis and will also be implemented for comparison
- Experimental validation: assess method for unfilled and filled rubbers

REFERENCES


ACKNOWLEDGEMENTS

This project was supported in full by an EPSRC Studentship grant, project reference (1811648), related to (EP/N059760/1). Acknowledgement also goes to Mr T. Dalrymple of Dassault Systèmes Simulia Corp, who originally conceived the inhomogeneous test method within “Isight Calibration of a Bonded Rubber Puck".