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VALIDATION OF A NON-LINEAR CONTACT MECHANICS PROBLEM

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The modelling of progressive contact between ridge bodies and soft materials either analytically or numerically is challenging due to the non-linear behaviour and the evolving nature of the contact conditions. Tan et al. [1] have demonstrated the limits of validity of analytical modelling of a rigid wedge in progressive deeper contact with a rubber block representing a half-space. Here this earlier work is extended to consider the validity or confirmation of a finite element model of the same contact situation.

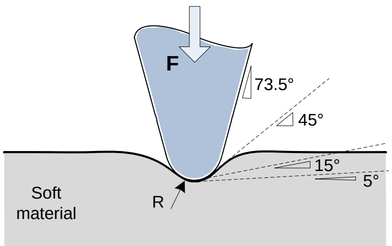

Figure 1: Geometry of the case studied.

The geometry considered consisted of a rectangular rubber block [106RTV from ACC Silicones, UK) with dimensions 60mm x 60mm x 25mm which was contacted by a symmetrical aluminium wedge-shaped indenter with an included angle of 33 degrees and a rounded end of radius 1.68mm. The wedge was 25mm thick, i.e. the same as the rubber block. The finite element model was created using the Abaqus 6.11 software package. The rubber block was modelled using 13,500 C3D8RH elements, which are 8-node linear hybrid elements. The rubber was assumed to be a hyperelastic material that could be described in terms of a strain energy potential, $U(\varepsilon)$. The Ogden stress-deformation function [2] in the form of the Yeoh potential [3] was found to provide the optimum strain energy potential based on typical experimental stress-strain data [4, 5]. The Yeoh potential was implemented in Abaqus using the following coefficients: N=3, D_1=9.90, D_2=-1.36, D_3=4.78, α_1=1.54,

α_2=5.84, α_3=-1.83, μ_1=0.37, μ_2=6.56 and μ_3=1.70. The wedge was modelled as a discrete rigid part using 25,935 R3D4 elements, which are 4-node 3-D bilinear rigid quadrilateral elements.

The experiment was conducted using a electric-drive loading machine [Electropuls E1000, Instron, High Wycombe, Buckinghamshire] to push the indenter into the block while using stereoscopic digital image correlation [Q-400, Dantec Dynamics GmbH, Germany] to evaluate the resultant strain fields. A pair of cameras [FireWire, 1/8", 1624x1234 pixel] fitted with lenses of focal length 50mm were used and gave a magnification of 35pixels/mm. The in-plane calibrations procedures described by Patterson et al. [6] were employed to establish an experimental uncertainty of 1.49%.

The results from the experiments and simulations (see Figure 2) were compared using the approach proposed by Sebastian et al. [7]. It was concluded that the model was valid for displacement loads upto 2 mm.

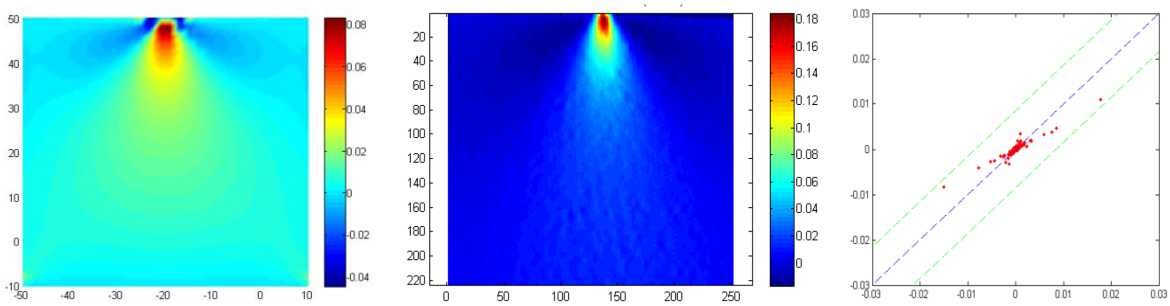

Figure 2: Typical predicted in-plane strain, ε_{xx} (*left*), the corresponding field obtained using digital image correlation (*middle*), and the comparison (*right*) for the rubber block subject to an indentation of 2 mm.

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