HIGHER ORDER FINITE ELEMENTS FOR THE SIMULATION OF ULTRASONIC WAVES FOR STRUCTURAL HEALTH MONITORING

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Ultrasonic waves offer a great potential for structural health monitoring (SHM) in many applications. At distinguished discontinuities high frequency waves are transmitted, reflected and mode conversions may also occur, which can be used to identify even small structural failures and damages (Fig. 1). For a suitable design and analysis of SHM systems the finite method (FEM) is commonly applied. Due to the required increasing number of elements per wave length for increasing frequencies, the application of standard finite elements is limited due to the computational costs.

In the presentation it is shown that for wave analysis higher order finite elements with non-uniform ansatz spaces are much more efficient with respect to computational costs and accuracy than standard lower order finite elements available in commercial FEM software tools.

Even more complex finite element models are required if traveling waves in heterogeneous materials have to be investigated.

In the presentation it is shown, that a higher order finite cell approach is of great advantage for such materials, because the mesh has not to be body fitted. A regular cubic or tetrahedral mesh is sufficient. The real structure is taken into account only during the integration of the finite element/cell matrices (see Fig. 2). It is also possible to use a microstructure available from CT measurements. The accuracy of the cell approach is shown for different wave propagation examples.

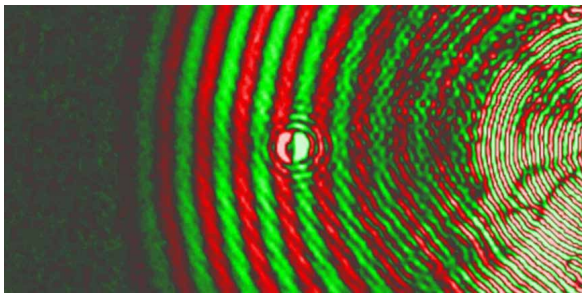

Fig. 1: Mode conversion at a circular damage

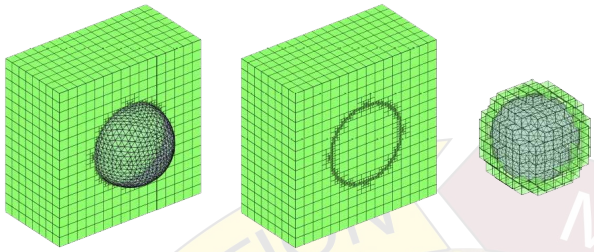

Fig. 2: A hollow sphere embedded in a cell mesh

Guests are welcome!