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STRUCTURAL OPTIMISATION AS A MOVING BOUNDARY PROBLEM USING LEVEL SET FUNCTIONS

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This paper will present two structural optimisation formulations which use level set functions representing the moving boundaries. The first of these is topology optimisation. The level set function based approach to topology optimisation has gained much popularity in the recent years due to its numerical stabilities and clear boundary representation of the solution. One advantage of the level set representation is its inherent capability to handle topological changes such as merging and splitting boundaries. We have developed a stable hole nucleation algorithm which makes the level set formulation completely suitable for topology optimisation. We demonstrate that our level set topology optimisation, both in 2D and 3D, have good convergence properties and less dependent on the initial design. We apply this to typical structural optimisation problems as well as coupled aero-structural problems. As coupled multidisciplinary optimisation problems have multiple optima, we find that the solutions 3D level set topology optimisation produce can be quite different from the solutions from the previous element-based approaches and simplified 2D solutions, suggesting interesting alternatives. The second structural optimisation using level set functions in composite fibre angle optimisation. We are the first to take this approach in this domain and the paper will introduce and show the feasibility. The advantages of the level set approach is better convergence properties compared to the existing functional approaches and we can improve the continuity of fibres compared to the discrete element approaches, particularly in a complex loading scenario. The paper will introduce the methodologies with emphasis on how the level set functions are utilised in the optimisation formulation. It will then show some numerical results for both types of problems and benchmarked against the existing known solutions, thus demonstrating how level set functions work in the context of structural optimisation.