NAFEMS UK Regional Conference 2018 - Abstract Submission

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Please identify the event for which your submitting?	NAFEMS UK Conference 2018
Will you be the presenting author?	Yes
Presentation Title	3D beam elements abstracted from 3D solids FE models with shear correction
Relevant Themes / Keywords	Beam, abstraction, shear correction, system analysis, accuracy, Timoshenko, Cowper

Abstract (plain text)	When carrying out system analysis of complex machines and structures it would be advantageous to simulate the whole 3D solid system. However this would mean we would need a computer or a cloud the size of a planet for real systems like engines coupled to motors, gearboxes and drive lines coupled to vehicles, without us considering buildings and even whole factories. One major objective of this work was to reduce the calculation time it takes for a 3D solid FE mesh to run (in tets or hexs) compared to a 3D FE beam representation, and secondly to improve the accuracy of the current 3D beam model as originally defined by the work of Timoshenko and Cowper. In this respect our methods solve 10, 20 or 100 times quicker. But the most important thing is to produce a 3D beam model that closely represents the accuracy of the 3D solid that is derived from, and that is currently available to the CAE analyst and design engineer. Currently we see a 20 - 60 times improvement in solution time and a 2-5 % error in modal frequencies. This means that design iterations and what if scenarios can be carried out much quicker and sooner in the design process and we have developed a more accurate method of representing the 3D beam for all its L/D ratios. Not just for limited short beams, (L/D = 1) which is what the Timoshenko and Cowper beams represent. We have derived two ways of defining a beam as an abstraction of the real 3D beam (3D solid FE mesh/model), and not as an approximation like the Timoshenko beam. Our work also shows that as the L/D ratio approaches ten (10), the Euler-Bernouli beam is similar to the Timoshenko beam behaviour. Our work derives a beam theory that takes into account shear deformation and warping, and is applicable for all L/D ratios, and is smarter so it can include kt features at holes, fillets and notches.
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