Abstract for talk in 2018

The Institute of Marine Engineering, Science and Technology (IMarEST)

Auxetic structures for marine safety applications

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Auxetic structures – a relatively new type of materials – have been studied greatly within the past twenty years. These studies revealed that auxetic materials possess unusual mechanical properties – most interestingly that they exhibit a Negative Poisson's Ratio (NPR). This means when the material is stretched, it expands in the lateral direction. Additional mechanical properties auxetics have been found to possess include: high energy absorption, improved shear resistance, improved indentation or impact resistance, improved crack resistance to failure and a synclastic (i.e. curved toward the same side in all directions) curvature. Studies have proven that auxetic structures can provide a stronger, lighter alternative to some conventional structural metals such as carbon steel and aluminium.

Many unique applications in various fields have been identified for auxetic materials and more recently marine or oil and gas applications have been explored. Advanced Fabric Technologies in US lead the way in auxetic solutions for oil and gas applications such as curtains (or blankets) for blast mitigation and auxetic fabric meshes (e.g. helical auxetic yarns or HAYs[1]) that can be woven into various industrial parts to extend their service life. It is important to note that in the case of HAYs, they can be woven into a textile like 3D structure capable of resisting greater loads than standard materials which has led to suggestions that they could be used to reinforce critical structures such as pressure vessels or the exterior of safety critical structures.

The presentation will include a review of current safety strategy of safety critical structures in marine environment, selection and combination of materials, and design aspects of auxetic structures. The presentation will also summarise existing auxetic structures (e.g. seal in well-pipes that is suitable for high pressure/high temperature applications, blankets for pressure vessels), and will present some new design considerations for enhanced NPR in HAYs structures.

[1] J. McAfee, **N. H. Faisal**, Parametric sensitivity analysis to maximise auxetic effect of polymeric fibre based helical yarn, **Composite Structures**, 162, 2017, p. 1–12