Modelling the Structural Behaviour of Netting with Beam Finite Elements

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ABSTRACT

Industrial fishing is mostly carried out by trawls or similar gears that produce a high proportion of discards. One of the methods to increase the selectivity of trawls is to modify the shape, size, orientation and stiffness of its meshes [1]. To assess the performance of new designs, fishing trials are required. Since the late 1990s, computational simulation methods have been proposed to predict the structural behaviour of fishing gears and hence reduce the need of fishing trials in the preliminary stages of the design process.

Several numerical models for netting have been proposed. Many of them discretize the twines using spring or bar elements. The effect of mesh resistance to opening, which is quite important in trawls and has a high impact on the selectivity, can be modelled by introducing rotational springs [2]. While these models can accurately predict the planar deformation of netting, preliminary experiments show that they cannot predict the interaction between in-plane and out-of-plane bending that happens in areas of high curvature like cod-ends.

This paper aims to develop numerical models to accurately predict the deformation of net panels with mesh resistance to opening and out-of-plane bending. The proposed approach consists of discretizing the net twines with 3D beam finite elements. The complexity of these elements is notably higher than springs and bars in terms of element formulation and degrees of freedom of the model.

Two different models have been proposed. In the first one, both twines and knots are discretized with beam elements, where knots are represented as a beam cross. By contrast, in the second model, knots are represented with rigid bodies, requiring to use constrains to join bodies and beams. Regarding to the beam element formulations, Euler, Isogeometric Analysis (IGA) and Absolute Nodal Coordinate Formulation (ANFC) have been evaluated. Several simple test problems have been used to assess each model, and the most promising results correspond to Euler beams, combined with a non-linear static solver. However, solving an entire cod-end with this approach is a challenging task due to the remarkable number of degrees of freedom and the non-linearities in the model.

REFERENCES

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