XI International Conference on Computational Methods in Marine Engineering

Comparison study of elements used in FEA of aquaculture nets

Marin Palaversa[1,*], Zhaolong Yu[1] and Svein Sævik[1]

[1] Department of Marine Technology, NTNU, Jonsvannsveien 82, 7050 Trondheim, Norway.

[*] marin.palaversa@ntnu.no

ABSTRACT

As aquaculture facilities move into deeper sea, they get exposed to much stronger loads leading, potentially, to break of twines in their nets and to occurrence of holes with loss of the fish stock as a consequence. Thus, it is important to be able to accurately assess deformation of the nets.

Most research in this field has been concerned with hydrodynamical aspects of the net hydroelastic behaviour focusing on accurately assessing loads on the structures, H. Cheng et al. (2020). A structural designer, on the other hand, must demonstrate that the maximum force in net twines does not exceed a limit force prescribed regulatory bodies, Standards Norway (2022), and, typically, needs more accurate FEA results. There are, however, relatively few studies concerned with characteristics of finite elements (FEs) used in analysis of aquaculture nets. These are usually conducted when a new FE is proposed, but they then investigate properties of the proposed FE without a rigorous comparison with other available FEs (see papers referenced in the following paragraph).

This study is, thus, concerned with analysing and comparing properties of FEs used in structural analysis of aquaculture nets. The following FEs are considered: a truss FE, the consistent net element of Tsukrov et al. (2003), a rectangular membrane element of Tronstad and Larsen (1997) and a triangular membrane element of Priour (1999). They are implemented in an open-source program called OOFEM together with two relevant hydrodynamic models to obtain loads. The elements are compared in terms of their underlying assumptions regarding structural behaviour of the net, accuracy, convergence rate, ease of use and computational effort. The results are verified by means of comparison with simple theoretical models as well as two physical experiments with nets of various complexity.

References

H. Cheng, L. Li, K. G. Aarsæther, and M. C. Ong. Typical hydrodynamic models for aquaculture nets: A comparative study under pure current conditions. Aquacultural Engineering, 90:102070, 2020. doi: 10.1016/j.aquaeng.2020.102070.

Standards Norway. NS 9415:2021 Floating aquaculture farms - Site survey, design, execution and use. Lysaker, Standards Norway, 2022.

I. Tsukrov, O. Eroshkin, D. Fredriksson, M. R. Swift, and B. Celikkol, Finite element modeling of net panels using a consistent net element, Ocean Engineering, vol. 30, no. 2, pp. 251–270, 2003, doi: 10.1016/S0029-8018(02)00021-5.

H. Tronstad and C. Larsen. NFEM Approaches for Calculating Fishing gear as a System of Flexible Lines. In Proceedings of the 16th International Conference on Offshore Mechanics and Arctic Engineering, 1997.

D. Priour, Calculation of net shapes by the finite element method with triangular elements, Commun. Numer. Meth. Engng., vol. 15, no. 10, pp. 755–763, 1999. doi: 10.1002/(SICI)1099-0887(199910)15:10<755::AID-CNM299>3.0.CO;2-M.