Current Status of Simulation Study of Large Midwater Trawl

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Research Object

In the long-term practice of marine fishing production, mankind has created many fruitful fishing gear fishing methods, among which trawl is one of the more efficient fishing gears in fishery production. Trawl fishing gear in the water movement by the action of the current and show great flexibility deformation, this deformation will also change the hydrodynamic force on the gear, so it is generally believed that the trawl fishing gear in the water movement is a kind of hydrodynamic behaviour. The shape of the flexible body varies with the external force, which makes it difficult to establish an accurate mathematical model for it. A common approximate modelling method is to discretise the flexible body unit, and mathematically model the discrete units separately, and then ultimately link these equations to obtain the dynamic characteristics of the whole flexible unit. The large mid-water trawl is even more different from the small and medium-sized trawl or bottom trawl because of its long mesh foot length (more than 20 metres). Therefore, this study focuses on investigating the forces and morphological changes of the mesh foot in the mouth part of large trawl nets through the concentrated mass method, which provides a theoretical basis for the design and improvement of large mid-water trawl nets in the future.

Research Target

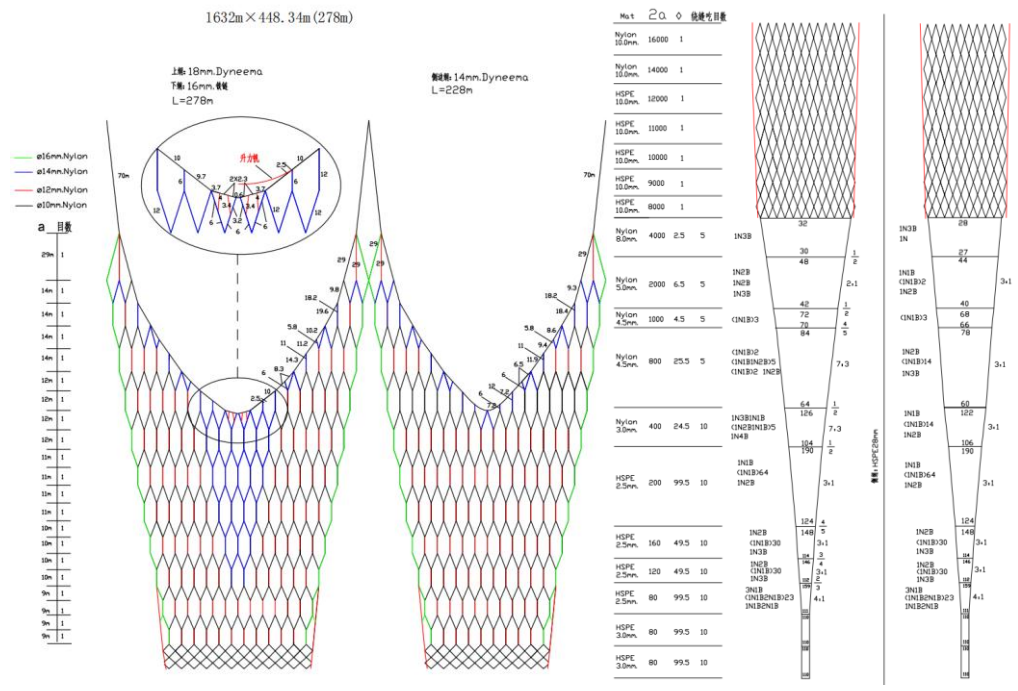

Fig. 1Four-piece mackerel midwater trawl 1632 x 448.34m (278m) type trawl

Methods

· Mathematical Modeling of Large Midwater Trawl Systems

The numerical simulation methodology for large midwater trawls is fundamentally predicated on the design principles of large-scale fishing gear, extensively employing finite element theory-based approaches such as the lumped mass method and mass-spring models for mathematical modeling and dynamic simulation of fishing gear systems. Such investigations typically utilize flexible finite element methods for modeling [1]. This theoretical framework discretizes flexible structures into finite elements, wherein the structure comprises a finite number of mass points interconnected through elastic linkages, thereby enabling precise modeling of the complete physical system.

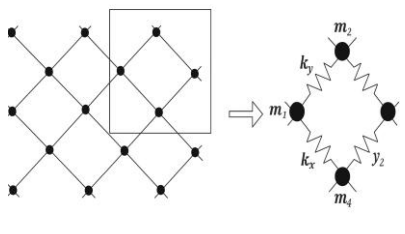

Fig. 2 Mass-Spring Model[1]

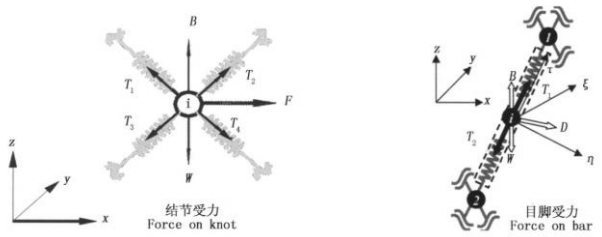

Fig. 3 Force Diagram of Mass Point[2-3]
Note:W:gravity; B:buoyancy; T:netting twine tension; F:hydrodynamic force

· Simulation Analysis

Chen Yinglong [4] employed the lumped mass method to conduct simulation studies on large midwater trawl systems, analyzing the force distribution in the 1632-type trawl gear. The study investigated the trawl position and net mouth geometry under varying warp lengths and towing speeds, with sea trial results validating the accuracy of the simulation model.

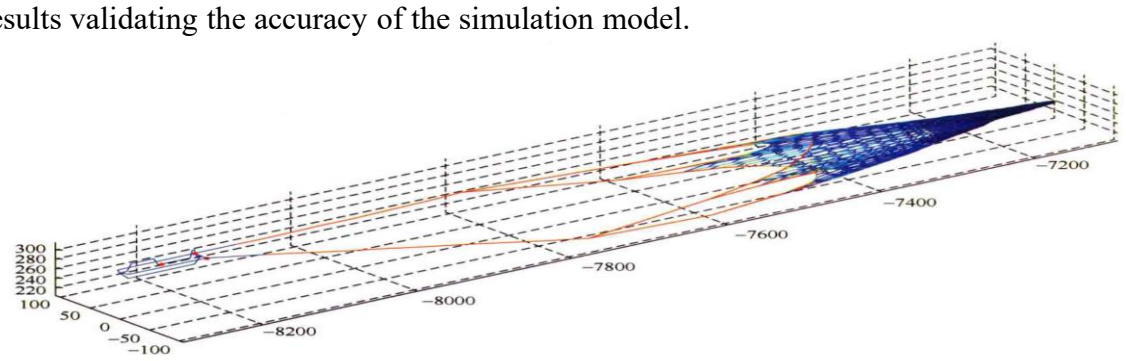

Fig.4 Simulation results of mid-trawl system[4]

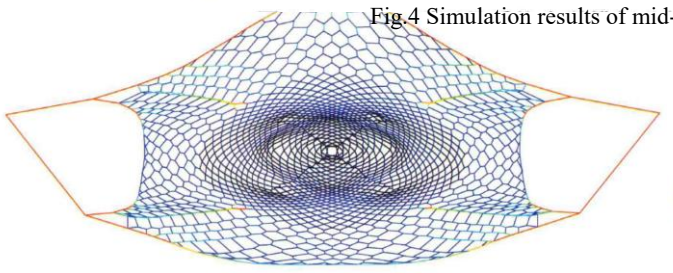

Fig.5 Tension distributed simulation results of trawlsystem[4]

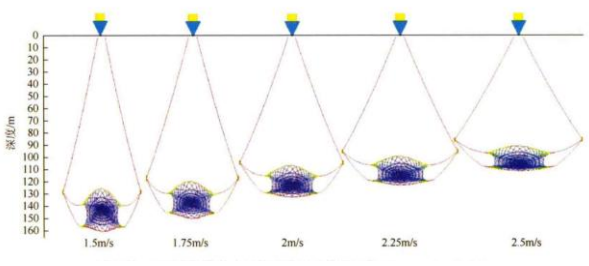

Fig.6 Simulation results of mid-trawl system with towing speed[4]

Discussion

Based on prior research accumulated by our group, a numerical model for large midwater trawl gear was derived using the lumped mass method, with stable numerical solutions obtained through the fully implicit Euler method, accompanied by visualization studies. The present study aims to employ numerical simulation software to investigate and analyze the hydrodynamic performance of large midwater trawls under various operational conditions, achievable through modifying flow velocities and configuring different hydrodynamic states. Furthermore, computational data from numerical simulations will be compared with field measurements and flume tank model test data to examine the accuracy and applicability of finite element analysis software in the design research of large midwater trawls. This research provides critical parameters for advancing numerical simulation studies of large midwater trawls and offers references for the matching of warp systems in large trawl configurations.

Reference

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[2] TAKAGI T,SHIMIZU,K.SUZUKI. Performance of "NaLA":a Fishing Net Shape Simulator [J]. Fisheries Research,2003,40:125-134.
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[4]陈英龙,赵勇刚,周华,等.大型中层拖网网具系统的仿真研究[J].浙江大学学报：工学版, 2014(4):8.DOI:10.3785/j.issn.1008-973X.2014.04.010.