FISHERIES DIVERSIFICATION PROGRAM

Emerging Fisheries Development

Project Summary: FDP 398

High Strength Shrimp Beam Trawl Design

Introduction

Beam trawling for pink shrimp (Pandalus borealis) has been established as a viable fishing method for vessels in the 35 to 45-foot fleet sector. For a relatively low investment and minor deck modifications, this fleet, which has limited opportunities to diversify into other fisheries, can participate in the shrimp fishery by means of this energy-efficient, low horsepower method of trawling.

Beams used in the shrimp trawl fishery are fabricated from 6061-T6 aluminum, 40 or 50 feet long depending on the head line length of the trawl. The desired length is accomplished by welding together sections of Schedule 40 pipe ranging in diameter from three to five inches. Sometimes angled aluminum is welded to the front and back as a means of increasing the strength. The beam is positioned horizontally in the mouth of the trawl to maintain the opening.
Background

The beam trawl fishery off the coasts of Newfoundland and Labrador is carried out by larger vessels fishing in deeper water, in rougher sea conditions, and on harder bottom types than the British Columbia fishery from which the method was adopted. As a consequence, the stress loads on the fishing gear, and in particular, the beam, are considerably higher. Therefore, beams that were fabricated from designs used in the British Columbia fishery were quite often damaged or broken causing considerable repair costs and loss of productive fishing time. Fishermen experimented with various innovations aimed at improving the strength of the beam but met with only limited success.

In view of this situation, the Department of Fisheries and Aquaculture (DFA), with funding from the Fisheries Diversification Program (DFA), initiated an engineering study with the objective of creating a beam better designed to meet the conditions that exist in the fishery. The study was designed to be completed in two phases, the first phase of which consisted of analyzing the current fabrication methods and materials, and determining the loads to which the beams are subject during trawling operations. Phase two involved identifying materials and fabrication techniques that could be used to construct a beam that would exceed current standards, developing a specification for a new design, and conducting a series of trials to confirm its suitability to the fishery.

Methodology

The 45-foot shrimp beam trawler "Grandy's Pride" was chartered to assist in completing a study of how beams are deployed as part of the shrimp beam's trawling method. This included identifying the points at which the beam comes under load and quantifying the magnitude of these loads under actual fishing operations. Tensions in the main warp were recorded at bollard within the range of engine revolutions required for normal towing speeds. A series of on-land breaking load tests were conducted on four beams of different designs that are commonly used, and observations were made regarding the way in which they broke. In addition, consultations were carried out with both fishermen and fabricators to record their experiences and opinions in this area. Materials such as stainless steel, titanium, carbon fibre, and high-grade aluminum were assessed for their strength, flexibility, weight and cost.

Results

The "Grandy's Pride" normally tows the 50-foot head line length trawl at 1.5/1.6 knots which requires 1,000 rpm. In that condition, the average tension in the towing warp is 3,100 lbs.

Tensions required to permanently deform or break the sample beams in the on-land tests ranged from1,000 to 2,000 lbs., depending on the design.

An examination of the damaged beams reveals that, in a significant number of cases, the breakage occurred at, or close to, welded joints. Under common fabrication practices, aluminum alloys can lose up to 50% of their strength when welded as compared to the unwelded base metal.

When factors such as strength/weight ratio, availability and cost are taken into consideration, it appears that Schedule 80, 6061-T6 aluminum pipe is the most practical material for use in the construction of beams.
In order to maintain the strength of the aluminum, the required beam length should be continuous and not fabricated from welded sections. If welding is required, it should comply with CWB 47.2 standards for 6061-T6 aluminum pipe.
Conclusion

The forces acting on the beam are proportional to the weight (displacement) of the vessel and the speed while trawling. When the gear hooks up on the bottom, the beam must be of sufficient strength without permanently bending out of shape to withstand the momentum load created by the forward motion and the weight of the vessel until it comes to a stop. When the vessel stops, the load on the beam is then equal to the bollard pull until the power to the propeller is disengaged. Since trawling is done at a constant speed, the most significant factor in determining the required strength of the beam is the weight of the vessel.

The project vessel, "Grandy's Pride" is considered to be one of the larger beam trawlers in the fleet, displacing approximately 60 tons, and trawling at speeds of 1.5 knots (2.53 ft/sec.) using a 50-foot beam. By applying these values to several formulas that describe the various conditions that occur when the gear "comes fast", we determine that for vessels in this category, a six-inch diameter Schedule 80 6061-T6 aluminum beam is required. Figure 1 is a suggested relationship that can be used to determine the beam diameter for vessels of different tonnages.

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