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SR612_Testing Materials used in Queen Scallop dredge Construction_C100

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Seafish Research and Development

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Summary:

The project began in April 2008 and was 50% funded through the Seafish Industry Project Fund.

The work aims to improve the durability, reduce the weight and environmental effects and minimize costs of Queen Scallop dredges by finding more durable and or cheaper materials for use in dredge component construction.

The main output of the project was to obtain the services of a consultant from Lancaster University Product Development Unit. The remit was to review the characteristics of present dredge construction and to provide a report on possible replacement materials, their characteristics and construction and to provide a list of possible suppliers.

This report describes some of the alternatives recommended by the Lancaster University report and those selected to be tested by skipper Douglas White and his crew aboard the West Coast Sea Products Ltd vessel King Challenger BA87.

Table of Contents:

Scallop boats in Kirkcudbright (March 09)

1. Introduction

Kirkcudbright based shellfish processor West Coast Sea Products Ltd (John King MD) have been undertaking innovative developments in Queen Scallop (*Aequipecten opercularis*) dredge design and construction aboard their own vessels fishing the Isle of Man and Eastern Irish sea grounds.

Gear developments tested have included the use of rollers, skids and flexible rubber flappers to replace steel teeth normally used. This has been observed to reduce King Scallop *(pecten maximus)* by catch and stone retention in the dredges and also greatly reduces seabed impact compared with standard tooth dredges.

They have also been testing the use of a grid section in the bellies of the dredges that has the potential to reduce overall weight and improve the flow of sand through the dredges whilst potentially reducing manufacturing costs.

This project gave WCSP the opportunity to trial some of their own ideas and those put forward in the Lancaster University report. Feedback came from the skipper in the form of a verbal report on each alteration tested at sea.

1.1. Project Rationale

The project rationale was to address the main themes of cost reduction, responsible sourcing and sustainability by focusing attention on the materials used in scallop dredge construction. The factors below were identified as points that needed to be addressed.

- Reduce operational costs through savings in gear manufacture
- Reduce negative environmental effects by adopting less sea bed intrusive gear modifications.
- Improved dredge durability by ensuring that the materials used are of suitable quality and fit for purpose.

- Improve catch quality by improving flow through the dredges and a reduction in stone retention.
- Improve fuel efficiency with a reduction in overall weight of the dredges by utilizing lighter alternative component parts

1.2. Benefits

Manufacturing Queen Scallop dredges and component parts is labour intensive and as a result expensive, this along with the high cost of steel forms 20% of WCSP operating costs (2008).Innovative gear designs and use of alternative materials has the potential to reduce these costs and provide positive benefits for the environment. The information provided by Tom Abram and his team from the Lancaster Product Development Unit, Engineering Department, Lancaster University and the work done aboard King Challenger BA 87 skippered by D White has highlighted areas where possible changes could be made.
The findings may also be transferable to the King Scallop industry where gear cost is equally as high and environmental impact also a major issue.

2. Methodology

The services of a materials engineer from Lancaster University were obtained, and following a meeting in Kirkcudbright with all project partners was tasked to produce a report that covered the characteristics of materials currently being used in Queen Dredges. The report also looked at alternative materials, their characteristics and their suitability for use on dredges. A list of relevant material suppliers was also included in the appendix of the report.
It was then up to WCSP to choose the gear changes they deemed practicable and worthy of testing at sea.
The alterations were observed and monitored by the skipper and crew and at this stage a simple comparison made against the standard dredges.

3. West Coast Sea Products Limited (company overview)

Based in Kirkcudbright, Dumfries and Galloway, Scotland, WCSP as it is today began in 1971 supplying the French and American markets. They currently have approx 150 full and part time employees and own and operate three scallop fishing vessels. The company takes landings from all over the UK from other vessels and accounts for around 75% of UK production. www.westcoastseaproducts.co.uk.

3.1. The West Coast Sea Products Ltd Fishing Fleet

3.1.1. King Challenger BA 87

Designed by Macduff Ship Design Ltd and built at Macduff Shipyards Ltd.. Completed and launched in June 2006. This vessel measures 21.3 metre overall. With a 7.81 metre beam and 4.20 metre depth moulded giving her maximum stability. The other main difference from WCSP other vessels is the towing derricks as a pose to the aft outriggers.

3.1.2. The King Explorer BA829

Built at Hepworth Shipyard Ltd, Paull, Hull.
Completed and launched in June 2001.
A 78 foot (24 metre) scalloper with a fully automated gear and catch handling system, which considerably reduces the workload for the 6 man crew and enables the vessel to fish with maximum efficiency and safety. Constructed of welded steel, with a soft nose and bulbous bow, she features a full-length shelterdeck with the sides left open inboard. The flake ice machine is situated on the main deck and the insulated fishroom is fitted with chilling blowers to maintain optimum catch quality.

3.1.3. 3.1.3. Kingfisher BA810

In 1997 this was the largest vessel to be built at Hepworth Shipyard, Paull, Hull.
Completed and launched in May 1998.
A 75 foot (23 metre), steel hulled, fully automated scallop trawler. Purpose designed to enable fishing in a wider range of grounds. Featuring a full shelter deck, providing increased safety and protection for the crew of 8. A refrigerated hold and on board ice plant ensure maximum quality King and queen scallops

4. Lancaster University

Lancaster Product Development Unit (LPDU) is the Outreach Team of Lancaster University's Engineering Department and prides itself on being a business support service with strong links on a regional, national and international scale with key stakeholders.
The Unit - established in May 2002 - has a proven track record in delivering business support Projects to further the regional economic growth of the NW. Historically, this has been around the sectors of manufacturing, automotive and general engineering, however the range of companies and their diversity continues to grow.
www.lpdu.lancs.ac.uk

5. Trial Gear

5.1. Rubber Flappers

As a method for reducing ever increasing costs for replacing worn out gear WCSP introduced rubber belting flappers as a replacement to the conventional teeth. The flapper arrangement proved to be most effective on stonier ground when the queens are swimming and on the move.

Rubber flappers in various stages of wear and stiffness.

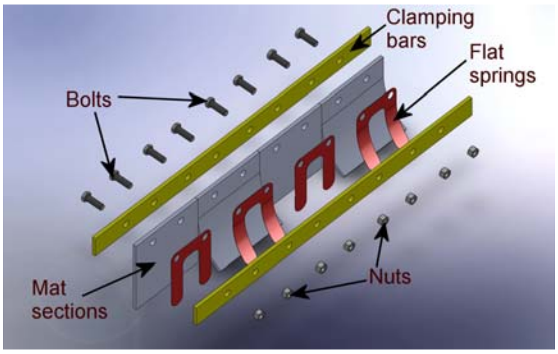
The flappers last somewhere between 24 -72 hours depending on seabed conditions and as they wear and soften they become less effective and catches are reduced. It is necessary therefore to renew them at this stage. The new replacement flapper is fitted behind the previous one, doubling up this way regains the rigidity required and also prolongs the working life of each piece enabling fishers to obtain as much use as possible from each flapper.

Double flapper

The intention was to source and use cheap second hand rubber conveyor belting. This was the case initially as WCSP had a small stock of their own, however their supply was soon used and they now source from a supplier at approximately £7 per flapper.

Other methods such as plastic stiffeners of various thickness were tried in order to maintain the rigidity of the rubber flapper and were tested by Skipper Douggie White but proved to be unsuccessful and were discarded as unworkable.

5.2. Rubber Flapper with spring stiffener



Spring stiffener arrangement

A similar arrangement to one shown in the above photograph from the Lancaster University report was tested. 3mm flat steel spring stiffeners were fitted behind the rubber flapper but proved to be too thin and did not provide enough stiffness to the flapper. A 5mm thick spring stiffener was then applied and tested. This proved to be too thick and simply remained bent backwards as force was applied during towing. The skipper did not pursue the spring stiffener option any further although more investigation into sourcing the correct spring thickness and material may yet provide some positive results providing costs are not prohibitive.

5.3. Rubber Flapper with Bolts

The image above shows a section of unused modified rubber belting 35” x 9” with M16 x 50mm bolts. The idea behind using bolts was to introduce a method of stiffening to the flapper, which becomes softer, more flexible and less effective as it wears. As the belt flexes back the end of the bolts meet and prevent any further flexing.

Testing flappers with 50mm and longer 120mm bolts was soon halted however as it was found that after a short period of working (a few tows); the bolts were gripping the seabed and simply being ripped out.

The crews also reported that preparing the belting was very labour intensive. It took considerable time to drill the holes in each flapper section and fit each nut and bolt.
Costing around 53 pence for each bolt it also proved to be too expensive.
The skipper observed that there was no benefit to the fishing operation using this alteration.

6. Grid Sections

Grid sections were introduced into the ring belly section in an attempt to find cheaper alternatives to the chain belly which is labour intensive and expensive to manufacture.

6.1. Grid Version 1

Grid versions 1 and 2 were made by R & A Fabrication, Kirkcudbright.

Size - 2mtr x 0.76mtr

Results from early tests with the grid section replacing a short section of belly rings at the rear of the chain belly offered some encouraging results with less sand and cleaner queens.
Bottom contact is made by the wear pads welded on to the grid frame work. The wear pads raised the grid off the sea bed and allowed sand, debris and undersize queens to pass through more easily.

6.2. Grid Version 2

Size - 2mtr x 1mtr

The size of the grid section has been increased to reduce the amount of chain belly in contact with the sea bed and to further reduce manufacturing costs. Each square of the grid measures 40mm diagonally. Skids were again welded on to the framework of the grid to absorb some of the ground contact and to raise the grid off the bottom to allow a better flow through of sand, undersize shells and benthic debris.

6.3. Grid Version No 3

Wheeled grid construction recently completed by Deeside Marine Ltd. Kirkcudbright.

Here the overall grid has been strengthened and rubber wheels added to replace mild steel skids. This raises the grid clear of the seabed and allows debris and benthic waste to fall through while also reducing gear drag. Each square of the grid measures 45mm diagonally this version will undergo sea trials later in 2009 on board King Challenger

The dimensions are the same as the traditional grid 30 rings x 18 rings or 2mtr x 1mtr + rings. It took an initial 23hrs to manufacture each prototype grid. However it is expected that production time and costs would be reduced if sufficient quantities were to be manufactured and assembly line techniques introduced. Other costs such as power and welding consumables are slightly less than in the production of the standard dredge design. As bottom contact is reduced it is also expected that the life span of this design would be greatly increased in contrast to the standard ring dredge. This will also offset some of the increase in manufacturing costs.

7. Examples of wear

The photos above left shows excessive wear to the tubular steel frame at the aft end of the frame construction. The right photo shows the 22mm mild steel skids (not hardened) which wore down to approx 3mm in less than 100hrs of working. The skids were fitted temporarily to assess if the grid was still as effective raised higher of the seabed, these skids would eventually be replaced by rubber wheels on grid version 3.

8. Future developments

Gear manufacturers, vessel operators and fishermen continue to investigate possible gear design developments which will offer improved environmental benefits and improve the industry reputation. This has to be balanced with sourcing more cost effective materials and maintaining catching effectiveness to enable fishers to remain viable.
Various projects are currently underway which include looking at individually hung Tines which replace the standard dredge teeth, and new belly designs with rollers to replace rings. The use of underwater cameras will also enable researchers to look at gear interaction with the seabed and aid in this future gear development.

9. Conclusions

This project was intended to highlight possible alternative material options open to scallop fishermen and allow them to test some of the recommendations suggested and to input some of their own ideas. Currently fishers are reliant on their gear manufacturer to provide materials constructed of steel of sufficiently high quality which has been treated in such a way as to enable fishermen to obtain the maximum life span possible from the gear. The Lancaster University report has identified some possible options, and it is hoped the industry will find it useful as a reference document when contemplating making changes to gear design and the materials they use.
Some of the ideas tested on board King Challenger BA87 seemed to give positive results in relation to catch quality and environmental benefits. There are also possible savings to be made in material costs. The introduction of wheels fitted to the third grid version has the possibility to reduce gear drag and therefore fuel consumption and also prolong the useful life of each dredge, these benefits could outweigh the initial manufacturing costs, which at this development stage are almost double those of the standard dredge.

Due to time constraints the limited budget and material availability the trials on some of the materials were not exhaustive and should not be dismissed at this stage. There is still scope for further testing in the future.

Future projects are needed to scientifically assess the positive anecdotal evidence obtained during these trials. Catch characteristics of the altered dredges should be compared across standard dredges to confirm initial observations made aboard the WCSP Ltd vessels.

10. Acknowledgements

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