Reducing Drag in Towed fishing Gears-

Flume Tank Testing of a 1:10 Scale Model of the Fjardanet/Jackson T90 Trawl

Supplementary Report to SR595 - Fishing Trials to Evaluate the Performance of a Trawl Constructed from T90 (‘*turned mesh’*) Netting

Date: April 2008

Author: Ken Arkley

Introduction

As part of the fishing gear development process for the project reported in SR595, the trawl design resulting from the collaboration between SEAFISH, Fjardanet and Jackson Trawls was modelled at 1:10 scale. This model was scaled and built by SINTEF staff at the Flume Tank in Hirtshals, Denmark.

This report covers the first stage of Flume Tank observations to compare the gear parameters observed during the full-scale sea trials with those obtained at model scale. The aim was to evaluate the trawl design, and its behaviour over a range of conditions that the gear would be expected to encounter during commercial operations.

Over a period of two days in March 2008, the model was tested over a range of conditions.

Model set-up

The scale-model rig was set up to simulate the full-scale arrangements used during the commercial fishing trials onboard MFV *Mizpah* conducted in January 08 (Figure 1).

Unfortunately, scale models of the type of trawl doors used during the fishing trials (NETS Systems 5m^2) were not available and so a substitute equivalent door size/design was selected (Thyboron Type 11). For the model tests the trawl door spread was set to match the average spread achieved during the fishing trials.

The main gear parameters measured were; wingend spread, headline height (centre) and overall gear tension. General observations were made and recorded (photographed) of the shape, netting tensions, distortion etc.

Tank Tests

A total of nine test runs were carried out with various changes made to the trawl and its rigging.

In the initial test the model was set up to try to simulate the gear parameters as measured during the full scale fishing trials carried out with this net design:

Door spread:	~93m
Wingend spread:	~22m
Headline height:	~ 6 – 6.5m
Towing speed:	~3.0k
Towing load:	~4.0t/side

Observations were made of the general shape and tensions and strain lines within the model.

The initial test indicated that the model was achieving less headline height (~5.0m) at the centre of the net than had been measured with the full scale version (~6.0m). On closer examination of this it was realised that the model floatation was not matched to the full scale due to discrepancies in the buoyancy between the model and full scale floats. This was corrected for the remainder of the tests.

Once the model parameters had been matched to those observed at sea it was possible to examine the detail of the model trawl with respect to how it was assumed that the full scale version would have performed.

As general observations of the trawl design, the excessive length of the tapered extension and codend indicated much room for improvement from the point of view of reducing netting drag/resistance in the trawl.

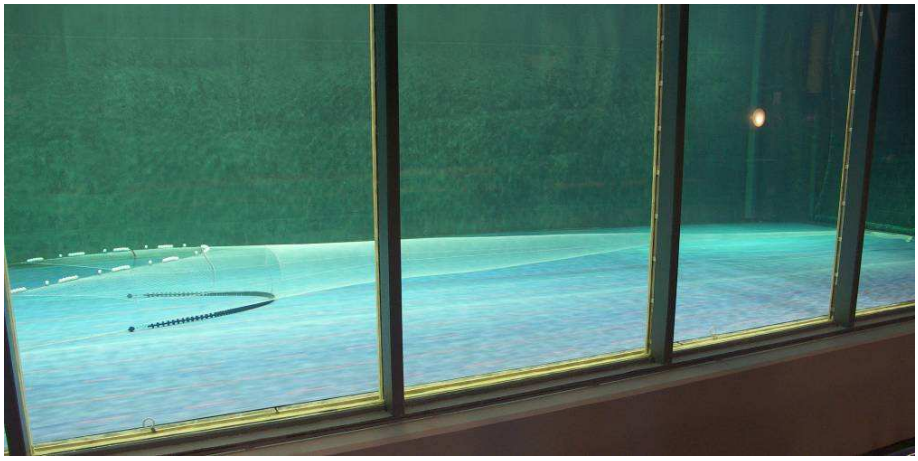
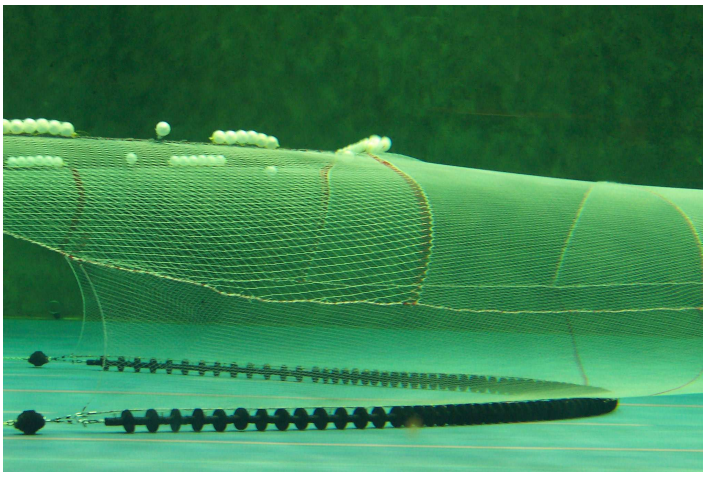
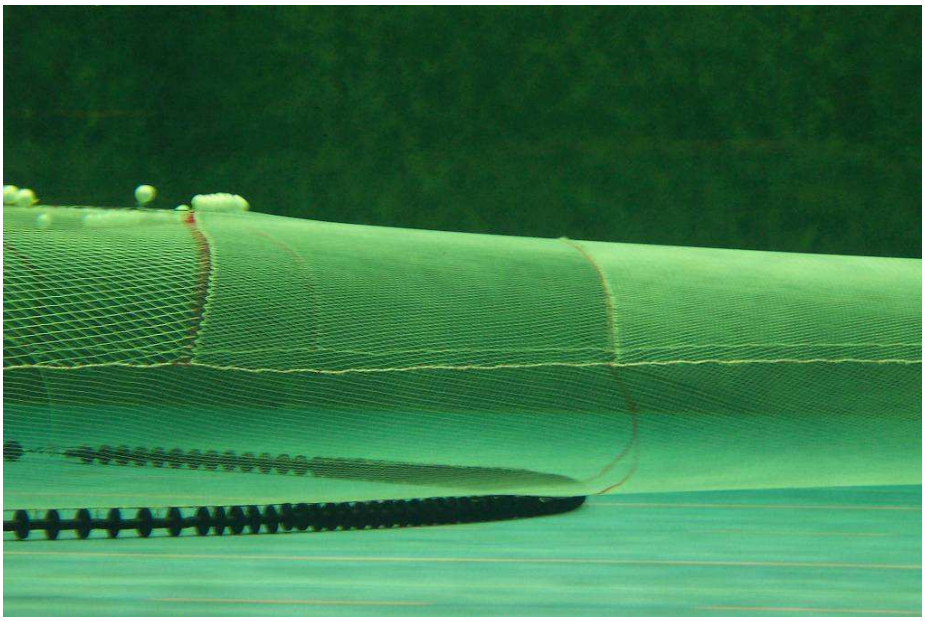


Image of the model trawl showing the excessive relative length of the tapered extension/codend

The end of the bunt section in the lower wing was almost at full stretch with very open meshes.

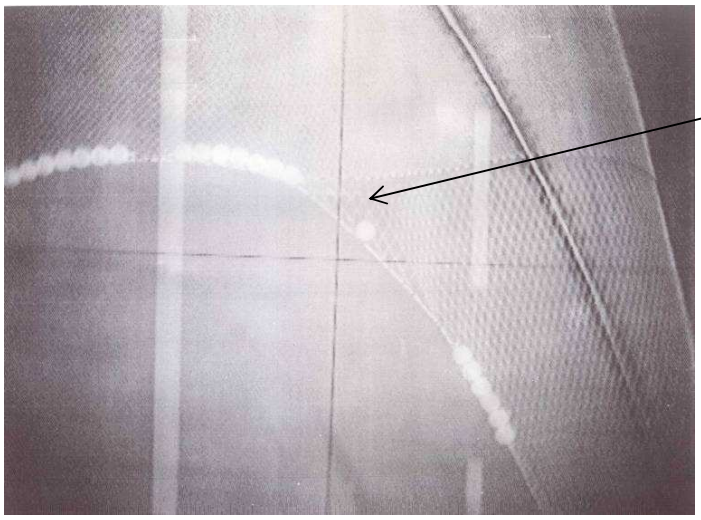


It was noticeable that the fishingline was positioned well on the rockhoppers and that the belly sheet was lying clear of the ground immediately at the back of the ground gear with a good rising angle maintaining the ground clearance.



Shortening of the tapered extension would require a change in taper rate that would also help to improve this clearance of the belly sheet, further protecting the netting in this region from potential seabed damage.

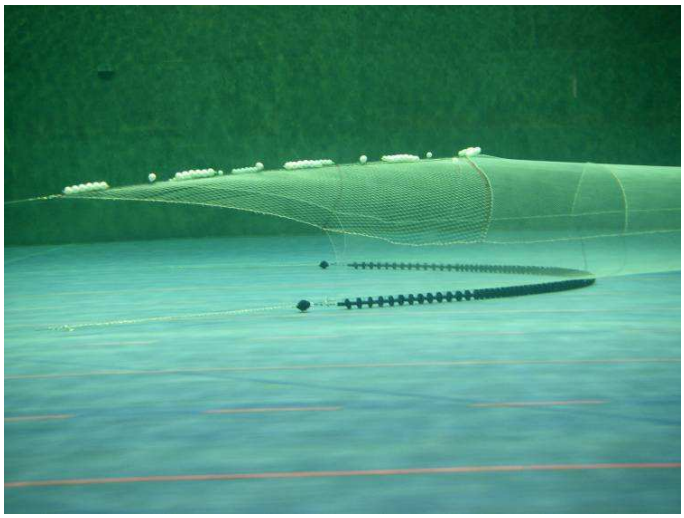
Observations using an overhead mounted underwater camera showed that the net had a good shape to the headline and that the ‘drop meshes’ in the quarters of the headline helped to achieve this shape. The images indicated that there was still scope for further improvement by increasing the number of ‘drop meshes’. This would help to reduce the strain lines running through from the all bar cut on the top wing which were observed.



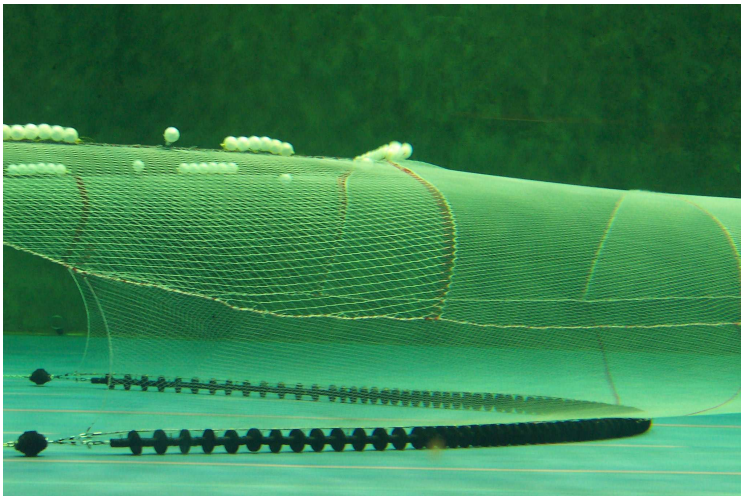
Subsequent model test runs achieved comparable parameters with the full scale gear:

Door spread:	~95m
Wingend spread:	~21.7m
Headline height:	~ 5.6m
Towing speed:	~3.0k
Towing load:	~4.1t/side

The model indicated that there was further scope to attain additional headline height whilst maintaining the wingend spread. As a result adjustments were made to the extension chains to achieve this. Initially, the lower extension chain was shortened by ~150mm/side. This additional strain on the footrope increased the headline height to 5.8m. Further shortening to ~300mm/side increased height to 5.9m. Good ground contact was maintained with some indications of slack netting in the bunt and lower wing sections and some loss of tension in the selvedge. This was deemed to be about the maximum shortening that could be made without creating net distortion.

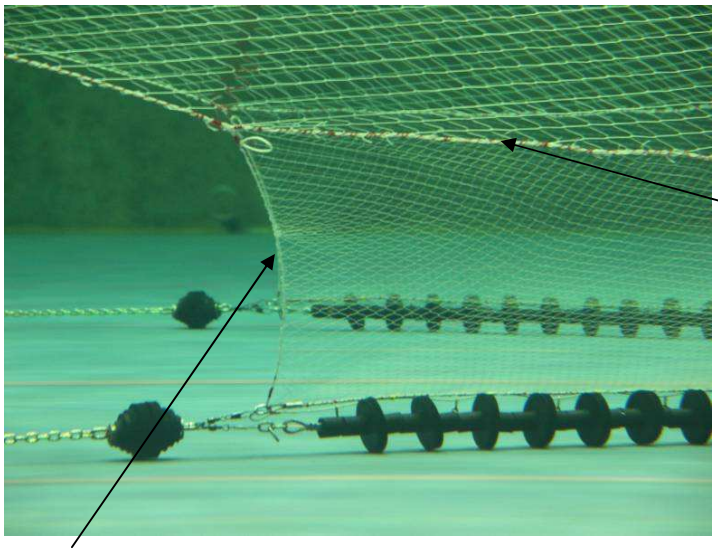


For the next test runs a further 150mm/side was taken in on the lower extension chain, (total 450mm/side) to confirm the suspicion that further tightening would result in distortion of the netting. No improvement in headline height was achieved. Strain developed at the junction of the bunt end gable rope (vertical breast line) and the top wing with tension lines also showing within the bunt end netting. It was estimated that the meshes were open to an extent of ~55% with the gable rope set at 3.0m. This indicated that the gable rope could be shortened to around 2.5m which would result in a mesh opening of ~40% in this region.



For test run 6 the extension length was put back to 300mm tight per side and an attempt to increase headline height by adding floatation was tried. Adding the equivalent of 16 x 280mm full scale floats marginally increased the headline height to 6.2m. This was not deemed to be cost effective for the additional expense of the floatation and increased drag to the gear.

For the next run the gable rope was reduced to ~2.5m. This was a very positive rigging change improving the appearance of the lower wing section of the trawl. The tension was more evenly distributed with the selvedge line taking more of the strain. The gable rope was standing almost vertical and all slack netting in this area was eliminated. This was achieved without lifting the ground gear at the wingend.

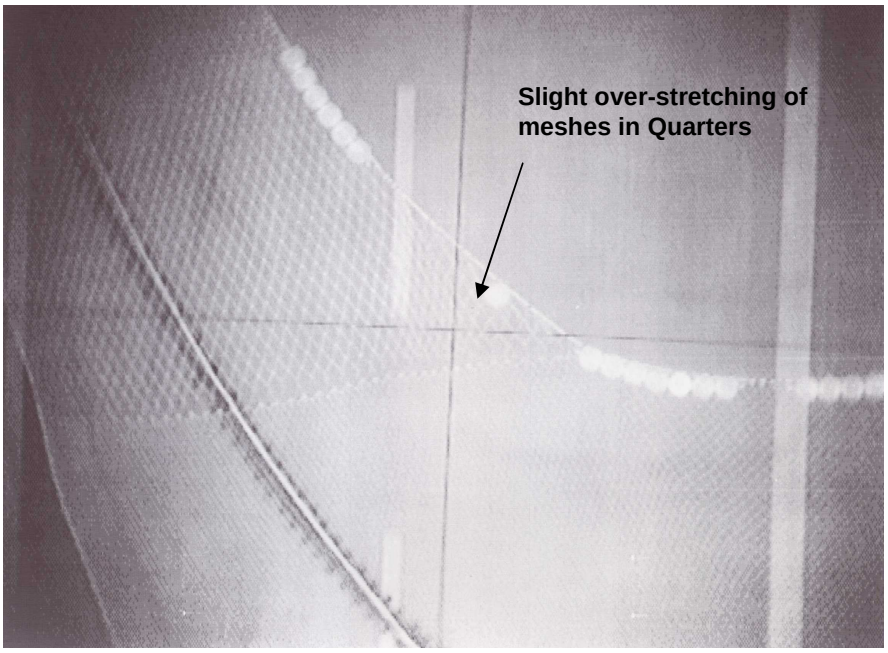


Gable rope shortened from 3.0m to 2.5m – gable rope standing vertical and showing no signs of strain

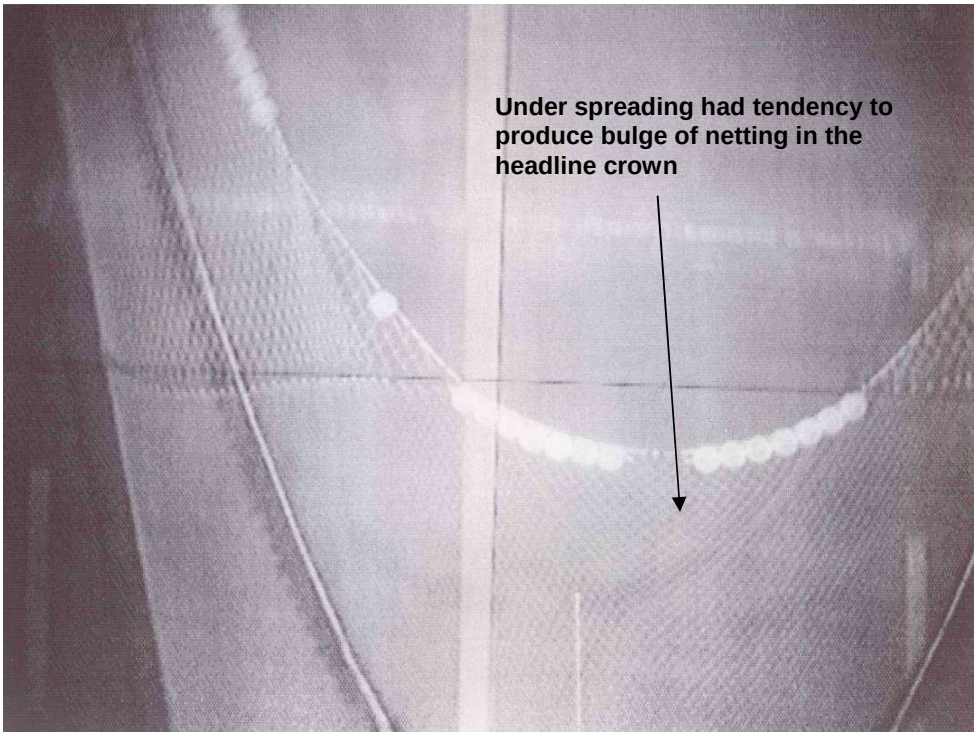
The final two test runs looked at how the trawl design coped with situations of over and under spreading. During the previous test runs the net (wingend) was spread to a length equivalent to just over 50% of the headline length (bridle angle = ~19º).

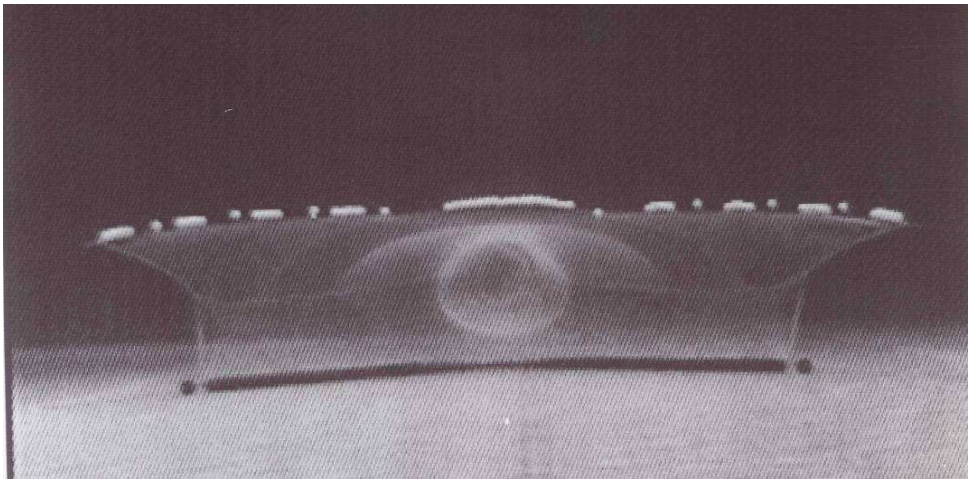
For the last tests the trawl was set to under spread to the equivalent of ~40% of the headline length and overspread to the equivalent of ~60%.

Overspreading the net surprisingly did not affect the headline height and in effect did not produce any noticeable changes to the performance of the gear. None of the expected changes were noticed. An overhead view of the trawl showed some slight tendency towards overstretching of the meshes in the quarters of the headline in the area of the 'drop meshes' but no actual problems were evident. Bridle angle was measured at ~24º.



When the model trawl was set to under spread a similar result was seen from the point of view that there were no major detrimental changes to the trawl. A slight 'bulge' of netting appeared at the back of the headline bosum which increased the headline height slightly in the centre; however this did not reflect an overall increase in height. There was a noticeable reduction in the towing load when the gear was under spread, a decrease from 4.1t to 3.69t/side.





Frontal view of T90 trawl model from underwater camera showing general shape of trawl mouth.

In both situations the netting in the belly sections maintained its ground clearance rising away from the ground gear.

The observations from the last runs showed the versatility of the net design. Whether this is just a function of the T90 construction or as a result of a number of factors associated with the Fjardanet design would require further investigations.

Figure (1): **General trawl gear rigging arrangement used during full scale sea trials**

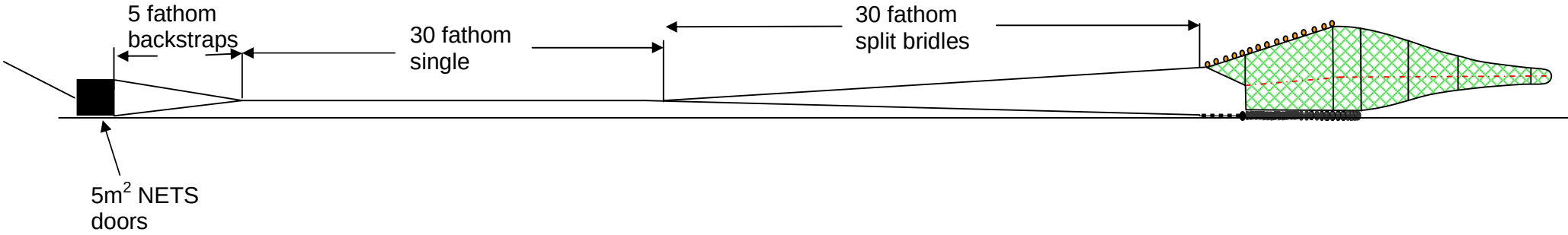


Figure (2): **Images of the trawl door types used for full-scale commercial testing (left) and Flume Tank model testing (right)**

NETS Systems 5m^2 trawl doors

Thyboron Type 11 no.1 trawl doors

Images of the T90 model trawl in the Flume Tank