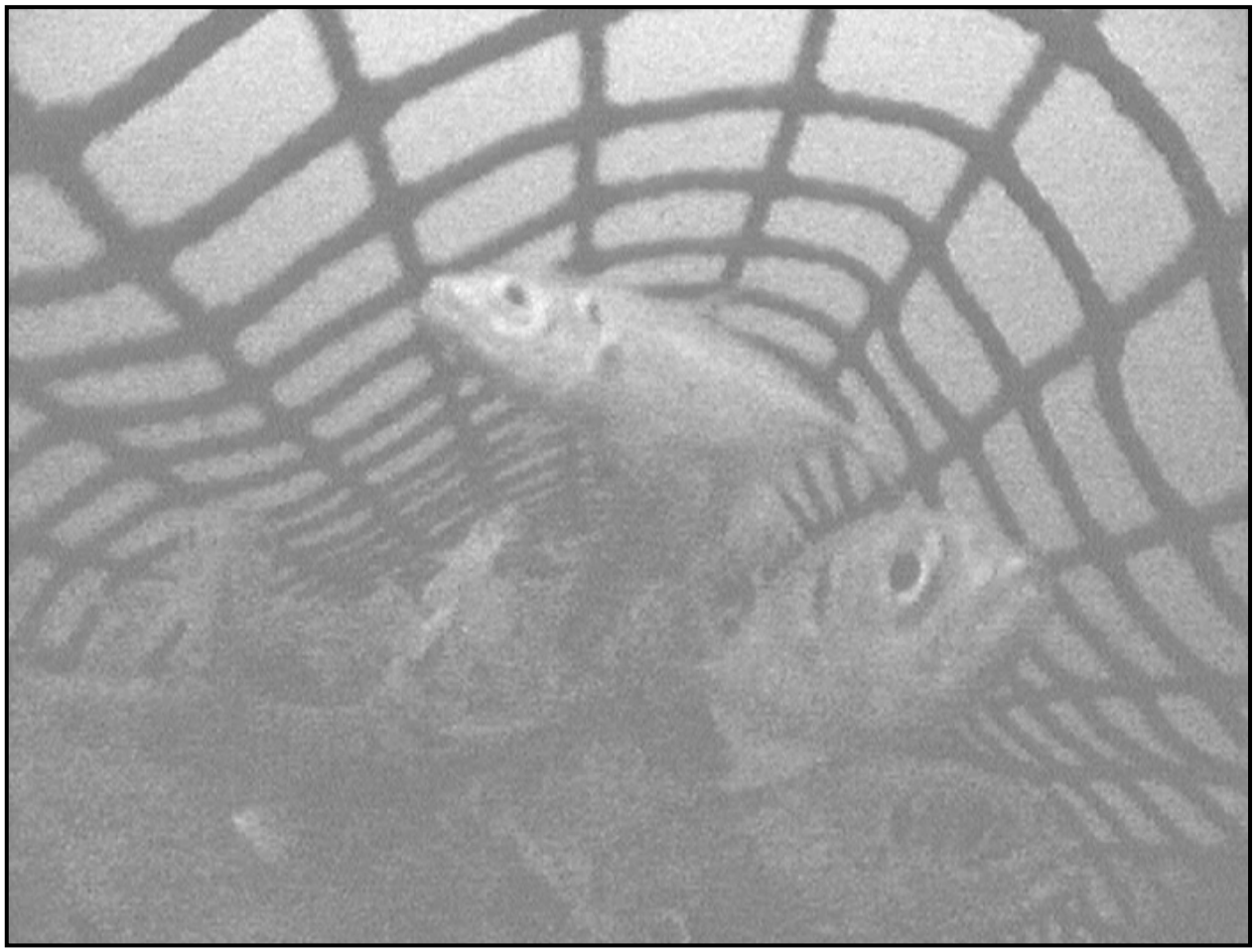
Improving Selectivity in
Towed Fishing Gears

Guidelines on the Rigging of Square Mesh Panels



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1. PURPOSE AND SCOPE

These guidelines are intended to assist fishermen with the rigging and use of square-mesh panels in compliance with current fisheries regulations *(Square-Mesh Panel Council Reg. (EC) No 850/98. The Sea Fish (Specified Sea Areas) (Regulation of Nets and Other Fishing Gear) (Scotland) Order 2000 No.227) and The Sea Fish (Specified Sea Areas) (Regulation of Nets and Other Fishing Gear) Order 2001 No.649)*.

Recent changes to fisheries regulations (August 2000 and April 2001) have introduced the mandatory requirement to fit square-mesh panels to all demersal towed gears except beam trawls. The following notes will hopefully assist fishermen and net makers with this process and provide practical recommendations to enable them to optimise panel performance whilst remaining within the scope of the regulations.

It is recommended that these guidelines be read in conjunction with the current regulations. These can be obtained from the relevant Government Departments or their Sea Fisheries Inspectorate or Protection Agency regional offices, details of which are contained in Appendix I.

These guidelines update a previous Seafish Technical Information Sheet (No.1991/1/FG), entitled: *Selectivity in Towed Fishing Gears – The Design and Fitting of Square-Mesh Selector Panels or "Windows".* The document, which is appended to these guidelines (Appendix II), was produced to provide fishermen with advice and recommendations on the use of square mesh panels as a *new* technical conservation measure. Subsequently, it has served as a guidance note for fishermen engaged in trawling for *Nephrops,* the first fishery in which this technology was introduced as a mandatory requirement.

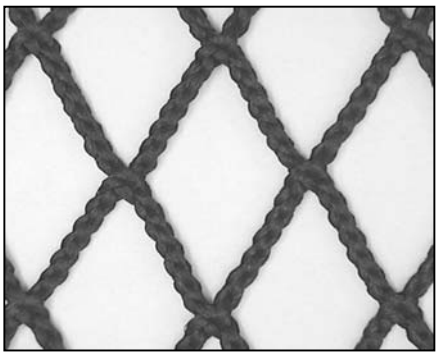
These new guidelines aim to complement some of the more basic information on panel construction included in the first information sheet. Additionally, they aim to help fishermen to apply this technology to targeted finfish fisheries in order to get the best conservation benefits from this relatively simple technical measure. This is done by examining the options available with regard to panel size and position.

The information produced in these guidelines results from a considerable number of years of Seafish R&D experience in the design and operation of square mesh panels. This work is presented in the Seafish reports, which are listed in Appendix I.

All the guidance and recommendations produced in this document take account of the legal requirements as laid down by the relevant Statutory Instruments and EC Council Regulations in force at the time of publication. The information presented here is intended to assist in the practical application of those legal requirements. Every effort will be made to update the guidelines so that they reflect current provisions, but it is the reader's responsibility to seek confirmation on this point.

2. PANEL MATERIAL

The regulations stipulate that square-mesh panels must be made from either knotless or other netting constructed with non-slip knots. In practice it is extremely difficult to guarantee mesh stability with anything other than knotless netting.



In Seafish's experience, Ultracross™, polyethylene (PE) knotless netting is the most suitable for the job. This material produces a much more regular and consistent mesh shape.

Figure 1a: Ultracross™ netting in diamond mesh configuration

The lack of bulky knots provides a wider open mesh area, allowing fish to escape easily when compared mesh size for mesh size with knotted netting.

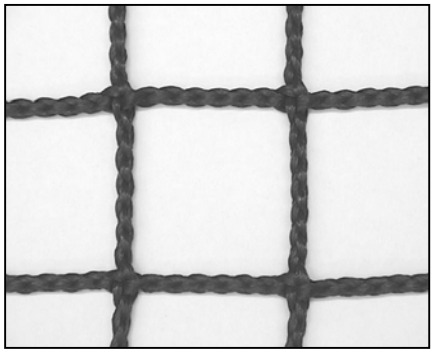


Figure 1b: Ultracross™ netting in square mesh configuration

2.1 Twine Diameter

Except for nets used for the purpose of fishing for *Nephrops,* the Regulations currently allow the use of multiple twine for the construction of square mesh panels as long as the sum of the multiple twine does not exceed 10mm. Considering the requirement for knotless or other non-slip netting, it is questionable as to whether this is an achievable option.

The regulations applying to *Nephrops* trawls stipulate a single twine diameter not exceeding 4mm for codend, extension and square mesh panel construction.

Seafish recommend that only single twine materials are used for the construction of square mesh panels and that the diameter be kept to the minimum that is practicable. In other words, the strength and overall integrity of the net should not be compromised.

For a given length of square mesh panel, the number of meshes and hence potential escape area, increases with the reduction in twine diameter. The difference is even more marked when comparing single and double twine netting. For example, comparing 4.5mm double braid knotted PE, with single braid, knotless Ultracross™ PE in the same mesh size there can be a difference in open mesh area in excess of

20% in favour of the single twine, knotless material. By using low diameter, single twine, knotless netting, the effectiveness of the square mesh panel can therefore be significantly increased.

Where there are concerns regarding strength of low diameter twines, the use of high tenacity materials can provide much higher strength to weight ratios. This can be as much as double that of standard PE twines. This effectively means that twine diameters can be reduced by as much as 50% without loss of strength.

These relatively new materials are considerably more expensive. However, as they are much lighter than standard PE, the cost per kilo of square mesh panel makes the overall cost difference less significant.

3. PANEL CONSTRUCTION

Seafish recommendations from previous guidelines regarding the fitting of square mesh panels as complete sections comprising the panel laced onto the corresponding conventional diamond mesh lower section, still apply. The only exception being where the option of fitting the panel into a tapered section is taken up. Here the panel is best retrofitted into the existing netting section.

More care is required to establish the best joining rates of the square to diamond mesh in these situations. The diamond meshes in the forward panels of the net are wider open and therefore panel measurements are more difficult to judge. In order to avoid distortion of the net, both the horizontal and vertical dimensions of the panel must be matched carefully to the lengths determined by the opening of the meshes in the surrounding netting.

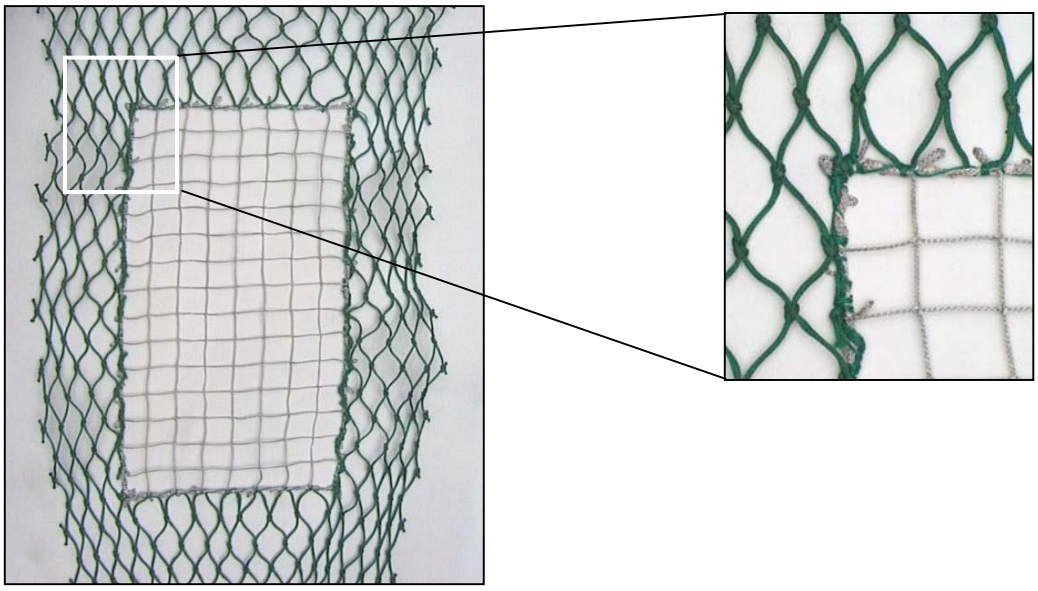


Figure 2: Square mesh panel fitted into a more open panel of netting

This is best described by example: fitting a 90mm square mesh panel into 100mm baiting section (nominal measurements), where the horizontal opening of the meshes is estimated to be 45% of the stretched mesh length.

Across the width of the panel, each diamond mesh will open to approximately 45mm (45% of 100mm). This equates to the width (bar length) of one 90mm square mesh, therefore the horizontal joining rate is one diamond mesh to one square mesh (1:1).

The vertical mesh opening corresponding to a horizontal opening of 45% is 89% (Table 1). Each diamond mesh will open to approximately 90mm or two square meshes, (89% of 100mm). The vertical-joining rate is therefore one diamond to two square meshes (1:2). See Figure 2 for details.

Table 1 - Horizontal and vertical mesh openings

	Horizontal mesh opening (% of stretched mesh length)							
	15	20	25	30	35	40	45	50
Corresponding vertical mesh opening (% of stretched mesh length)	98.8	98	97.3	95.8	93.8	92.5	89.8	86.5

To avoid rigging problems, it is important to ensure that the diamond mesh section, to which the square mesh panel is to be laced, has been adequately stretched prior to putting the two sections together.

Square and diamond mesh will stretch to different degrees, particularly if different materials are being used, e.g. standard PE and high performance PE (HPPE). For similar reasons, it is worth considering the drawbacks of fitting new square mesh netting in to old diamond mesh nets and *vice versa.*

Square meshes can be joined to diamond meshes in a number of ways. The following figures describe some of the recommended alternatives:

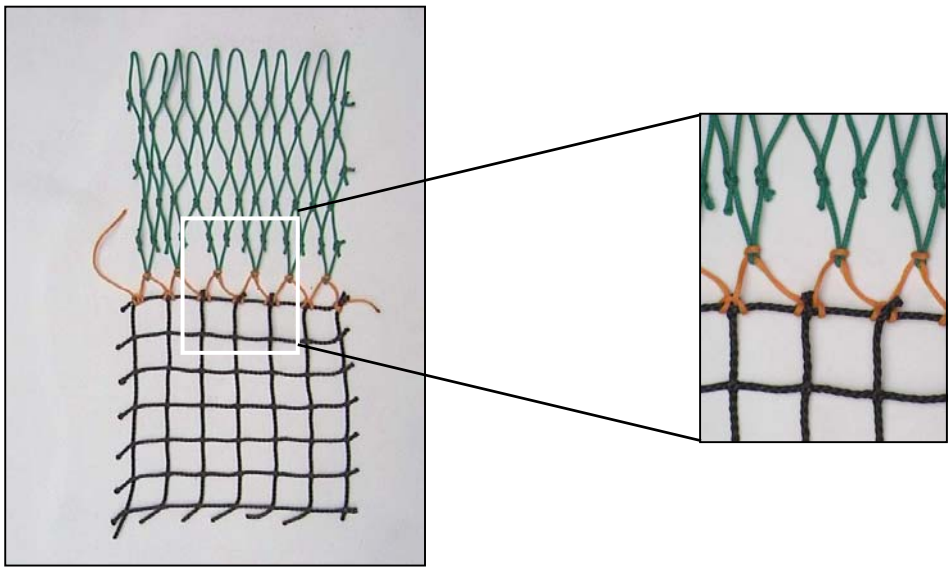


Figure 3: This shows a joining rate of 2 diamond to 1 square mesh

The join described in Figure 3 shows alternate diamond meshes cut out with the remainder joined to the square meshes by a row, clove-hitched to the bars of each square mesh.

Figure 4 overleaf shows a straight forward 2:1 diamond to square join in which the diamond meshes are baited and 'mended' onto a row of diamond meshes previously braided onto the edge of the square mesh panel.

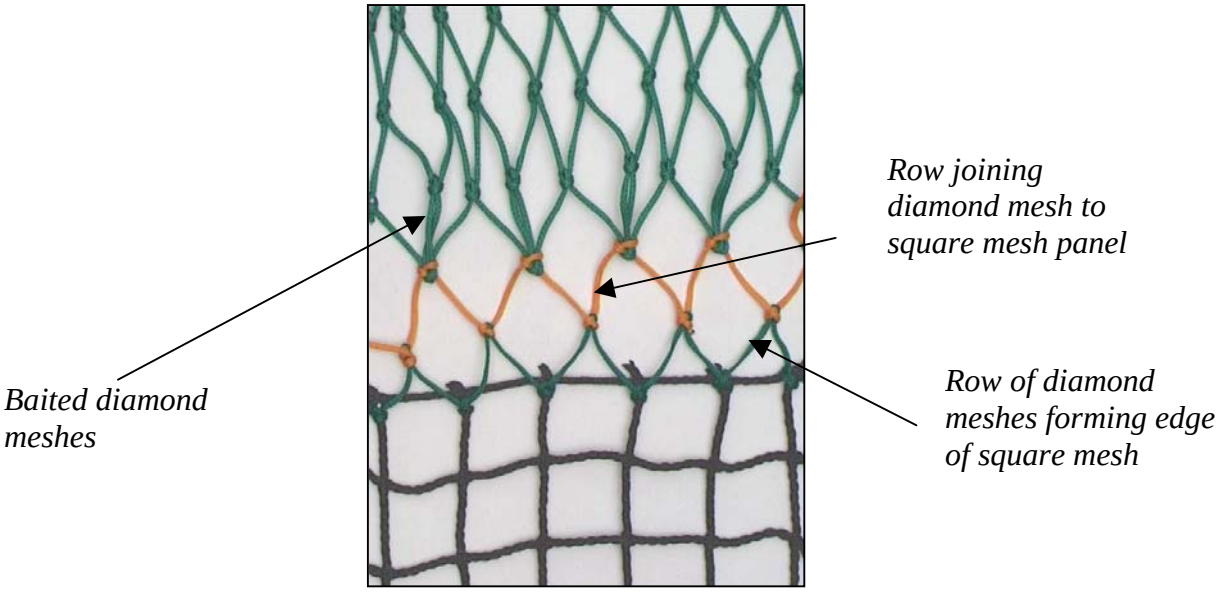


Figure 4: A traditional baited joining rate of 2 diamond to 1 square mesh

Another alternative is to lace the diamond meshes directly on to the bars of the square meshes. Figure 5 shows a 2:1 joining rate and Figure (6) a 3:1 joining rate.

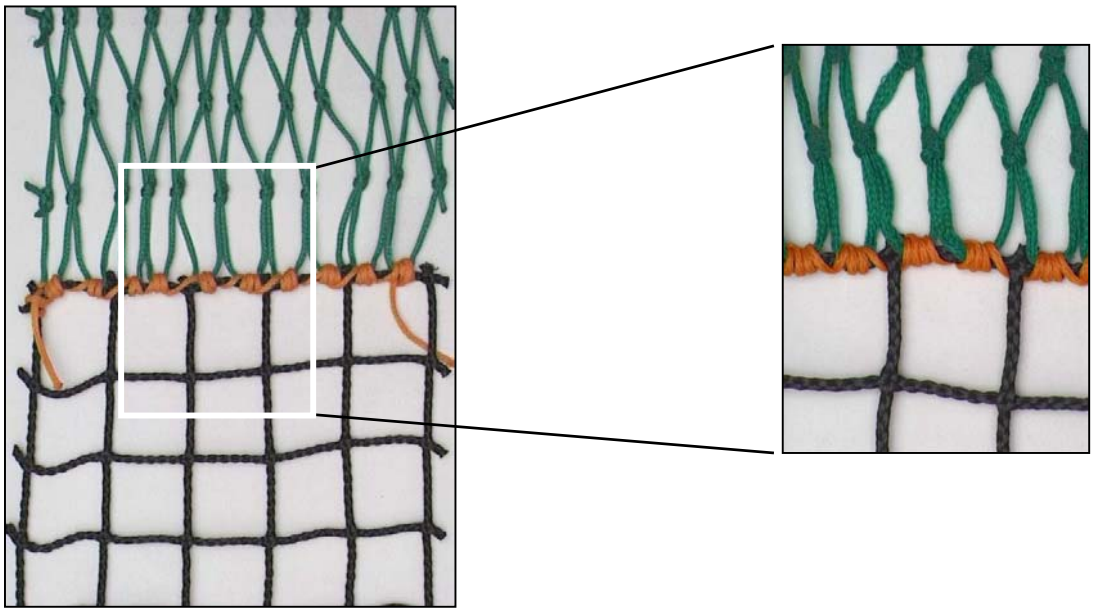


Figure 5: Joining rate of 2 diamond to 1 square mesh using the lacing method

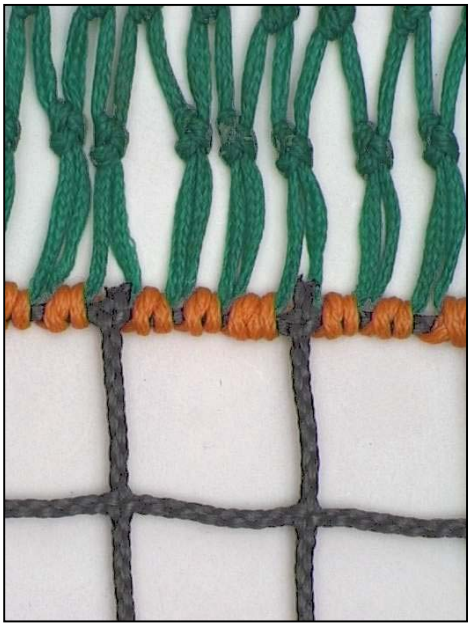


Figure 6: Joining rate of 3 diamond to 1 square mesh using the lacing method

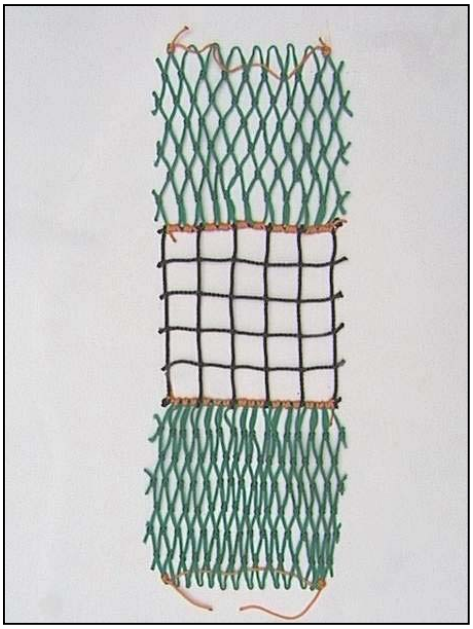


Figure 7: Comparing the 2:1 and 3:1 joining rates

The affect that the different joining rate has on the opening of the diamond meshes in the adjoining panel can be clearly seen in Figure 7.

3.1 Selvedging

When using knotless, Ultracross™ netting to construct square mesh panels, the material produces more consistent shaped panels if the netting is selvedged on all four edges before insertion, or joining to the corresponding diamond mesh sections. Ideally, the braided material should be cut out using a 'hot knife', which seals the cut ends of the meshes. As this is not always a practical option, selvedging the edge of the panel helps to strengthen the cut edges.

These figures show some ways in which knotless netting can be selvedged to aid the fitting and final shape of the panel.

By simply lacing together opposite edges of the same mesh a strengthened edge can be formed. This applies to both horizontal and longitudinal panel edges and helps the meshes to hold a square shape.

Figure 8a: Panel edge formed by lacing adjacent bars together

Cut mesh 'tails' can be incorporated into the lacing as an additional measure against fraying if the twine has not been heat-sealed.

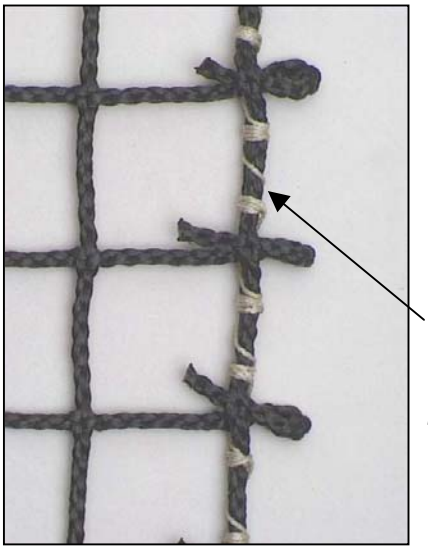


Figure 8b: Detail of selvedge

Another method is to overlap the outer mesh and lace it onto the inside bar of the adjoining mesh as shown in Figures 9a and 9b. This type of selvedge tends to be better for horizontal edges (Figure 11) overleaf.

9a

9b

Figure 9: Panel edge formed by overlapping and lacing two adjacent meshes together

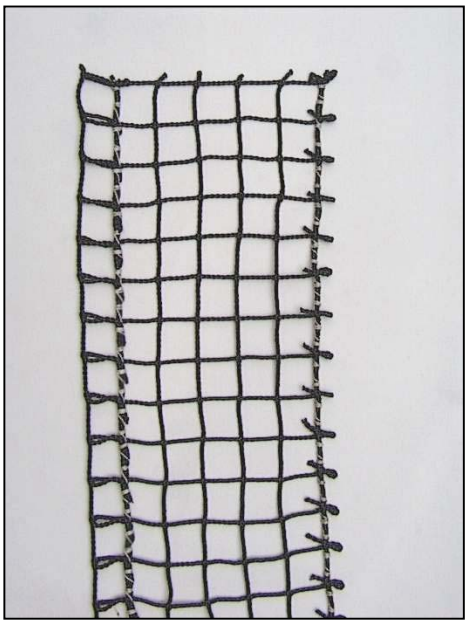


Figure 10: A finished section of square mesh netting comparing the two methods

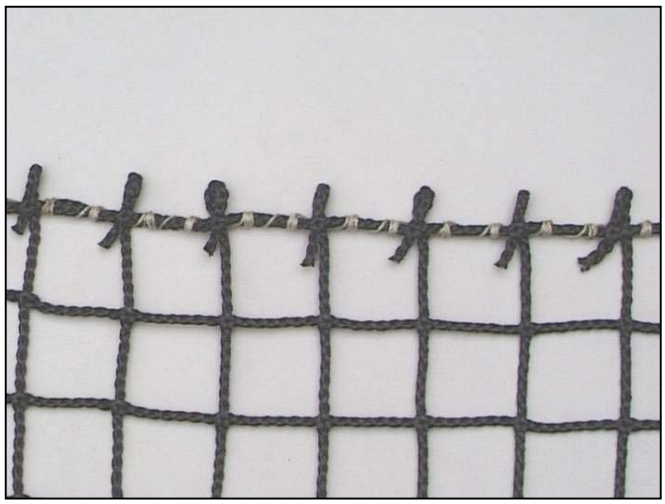


Figure 11: Selvedging on a horizontal edge

3.2 Panel Dimensions

3.2.1 Panel width

The width of the square mesh panel is governed by the width of the adjoining netting sections to which it is being fitted, namely the extension and/or the codend. This corresponds to the width that the net section takes up under tension as it is being towed through the water.

The other factor to be considered is the number of meshes in the circumference of the net at the point of attachment. Once these have been determined, the most practical joining rate is selected.

It is recommended that for mesh sizes up to 110mm, with up to 100 meshes in circumference, the joining rate of diamond to square mesh should be 2:1.

For mesh sizes between 70 and 80mm (*Nephrops* trawls), with up to 120 meshes in circumference, a joining rate of 3:1 provides the best match of panel widths. However, it is suggested that a joining rate of 2:1 may be more practical considering the nature of *Nephrops* fisheries. This additional width of square mesh panel may be required to avoid a 'bottle neck' and prevent build up of catch causing a blockage in the extension. There is an additional allowance in the regulations that can be used where there are such concerns.

In any net in which a square mesh panel is inserted in an un-tapered portion of the net, the regulations allow up to five open diamond meshes between each panel side and the adjacent selvedges of the net. These diamond meshes can open and effectively expand the width of the extension as required. It is expected that this requirement would apply mainly to *Nephrops* trawls or situations where the panel is sited in close proximity to the codend and/or instances of high catch rates where the catch extends back into the extension. This would be more relevant to stern ramp trawlers where the catch is hauled up the deck, as opposed to being lifted onboard.

If the longitudinal edges of the square mesh panel are incorporated into the main selvedges, there should be no requirement for any additional strengthening. However, for the larger, more powerful vessels, (particularly those using stern ramp arrangements), where excessive loads/strains may be encountered during catch handling operations, it may be prudent to strengthen the panel edges with selvedge ropes. In particular, the arrangement utilising the five-mesh diamond edge strip may benefit from additional strengthening.

The allowance of up to five diamond meshes between the panel edge and the main selvedge can influence the effectiveness of the panel. This arrangement can substantially reduce the area of the square mesh netting and hence the potential for escape of fish through the panel.

For a given length of panel, the use of the maximum five-diamond mesh allowance between each longitudinal panel edge and the main selvedge can reduce the square mesh area by 20% (Figure 5). Even using only 3 meshes per side, produces a significant reduction of 12% in panel area.

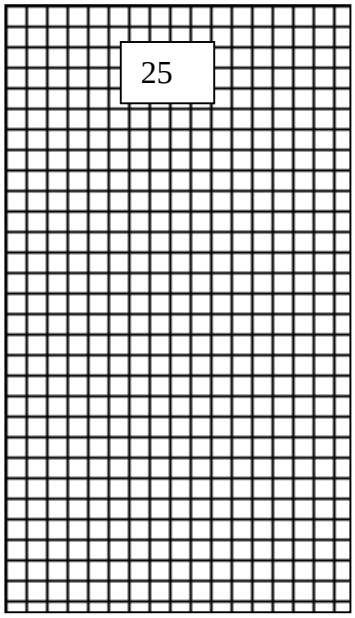


Figure 12a: Full width square mesh panel

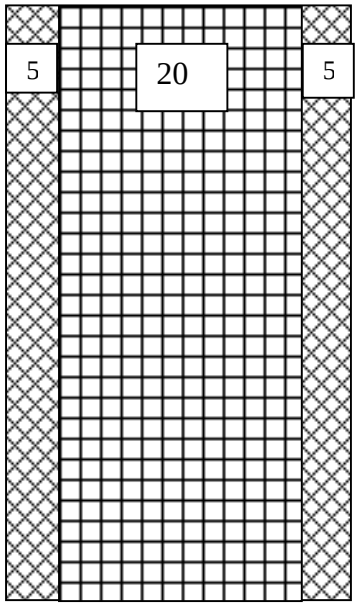


Figure 12b: Square mesh panel with diamond mesh edge

In situations where the option to use a number of diamond meshes between the panel and the edge of the net is taken up, it is recommended that the panel is lengthened to compensate for this loss in potential escape area.

3.2.2 Panel length and position

Square mesh panels in their current form were originally developed as a measure to reduce the by catch of round fish species such as haddock and whiting in targeted *Nephrops* fisheries. In this situation, the panel's primary function is that of a species selection device. In most instances the panel only has to deal with a relatively small proportion of the total catch entering the net, i.e. the by catch.

The recent mandatory requirement for square mesh panels to be fitted into whitefish nets means that the panel's principal role is now one of size selection. The panel is now required to deal with a much greater proportion of the total catch entering the gear. With this in mind, Seafish recommend that fishermen carefully consider the length of panel to suit their gear and the prevailing fishing conditions.

When considering panel length and/or position, it is worth first thinking about how square mesh panels work. Their performance is linked closely to fish behaviour. Unfortunately, from the point of view of trying to optimise selectivity, this behaviour is strongly influenced by numerous, highly variable factors. Fish condition, environmental conditions, time of year, etc, can all affect fish behaviour and hence the performance of the gear. As with most problems relating to selectivity in mixed species fisheries, the answer lies in finding the best compromise.

The aim of the panel is to provide an improved avenue of escape for unwanted fish, from areas of the net that would otherwise present difficulties. The emphasis is on the word *escape*. It is obviously preferable to encourage active escape from the gear as opposed to passive release at a stage when the fish have little or no control over their movement. In other words, the aim is to promote escape before the fish become exhausted and collect in the codend. After all, release of juvenile fish will be of little benefit to the fishery if they are unable to survive once they have been released from the net.

Conventional diamond mesh netting in the extension of a net remains closed due to the tension created under normal towing conditions. Fish passing down the net towards the codend are confined in this narrow, dark 'tunnel' formed by the closed meshes of the extension. Inserting a square mesh panel in the extension provides a 'window' of escape in a region of the net that fish would otherwise find it almost impossible to escape from. Dependent on towing speed and stamina, the fish effectively have only one direction of movement – back towards the codend. The fitting of a square mesh panel now provides a second option. This however, does not guarantee escape.

The inclusion of the panel alters the physical conditions within the 'tunnel' in a way that encourages an active escape response. This activity is not fully understood but appears to be related to changes in water flow and light conditions at the junction of the panel and extension. The level of response to these 'windows' is highly variable, for the same reasons as previously mentioned.

By design, the extension is the last section of net before the codend. Positioning the panel here may therefore appear contradictive to what has previously been stated. However, the extension is also the point within the gear where the fish become channelled and more concentrated. This provides greater opportunity for directing the fish towards the escape area. In this situation the fish *must* pass the escape route.

There are arguments for positioning the panel in the tapered, front sections of the net to take advantage of natural behavioural responses of species like haddock and whiting. Their natural tendency to rise in the mouth of the net brings them into contact with these sections at a point in the capture process when they would have more energy to attempt an escape when compared with the extension arrangement. However, size for size, there would be less chance of fish encountering a panel in this position due to the overall size and shape of the net in this area.

Generally, most trawls designed to catch white fish have their front sections built in larger mesh sizes as a matter of design. Additionally, under normal towing conditions, the meshes in these sections will be wider open. These factors combine to aid the general inherent selectivity of the net.

This is not to dismiss the possible benefits of such positioning of panels. The incorporation of panels additional to the mandatory requirements is wholeheartedly encouraged. What is emphasised is that the benefits of siting panels in the main body of the net will improve with the increase in panel area.

For gear technologists and fishermen, the task is to find the best compromise with respect to reduction in discards, loss of marketable catch and practicability.

When considering the extension arrangement, the effectiveness of the square mesh panel comes down to one or more of the following: mesh size, panel size (area), and position. All of these parameters are controlled through regulation by imposing minimum allowable cases. There is however, flexibility to improve on these options as and when conditions dictate.

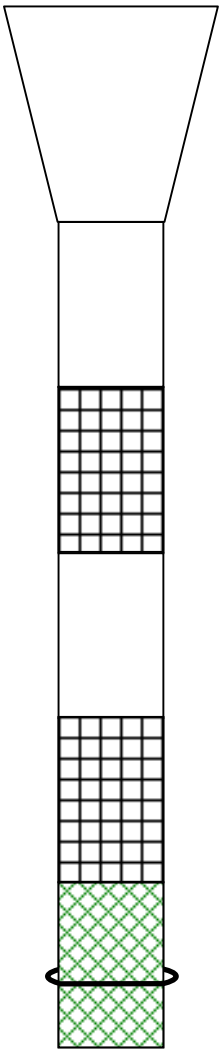
The option to increase the size of the meshes in the panel is probably the least favourable to fishermen, due to the potential loss of marketable fish. This is particularly relevant in highly mixed species fisheries. Panel size and position however, offer more scope for change.

Panel length

As previously described, fish passing down the extension are presented with an escape opportunity as they are forced past the panel. Their opportunity to escape is influenced by the time they spend in the region of the panel and competition for available escape gaps, i.e. open square meshes. This is dictated to a certain degree by the speed at which they are pushed back down the net as a result of the towing speed and the catch rates that are encountered. In general terms the panel will provide more opportunity for escape at lower towing speeds and lower catch rates. Similarly, for a given towing speed, the opportunity for escape should increase with an increase in panel area.

This would suggest that square mesh covering the whole of the extension would be the answer to the discard problem. As previously mentioned, simply presenting an escape opportunity to fish does not always guarantee escape. An escape response is required.

Observations suggest that fish respond more actively to a sudden change in conditions, as experienced by the fish passing from within the diamond mesh section to the region of the panel. Any prolonged exposure may result in the fish becoming 'acclimatised' to the panel and hence lessening the response. For this reason, multiple square mesh panels can be more effective if separated by similar lengths of diamond mesh.



Within limits, increased panel areas should be given serious consideration as a potential solution in circumstances where minimum panel lengths are not reaching discard reduction expectations. For example, trawl nets having long extensions, used to target haddock and/or whiting, may benefit from increasing panel lengths to double the minimum regulation requirement. Another option would be to incorporate a second panel, preferably separated from the first by a panel length.

The positioning of the second panel is best selected after closely observing fish responses to the gear, such as looking for areas in the net where fish are tending to make escape attempts, indicated by meshed fish ('stickers'). More often than not experience and/or trial and error best determine this.

Ideally, panel position should be tailored to suit the vessel's working arrangement, the species to be selected and the prevailing conditions in the fishery.

Panel lengths are defined in legislation, however it is important to stress that these are *minimum* panel lengths. Fishermen are encouraged to tailor panel length to suit their operation, (single trawl, pair trawl seine net etc), gear design, requirements of their handling operations, and the conditions encountered in their target fisheries, i.e. catch profiles and quantities of fish encountered.

The Regulations state a minimum panel length of 3m for all nets except those towed by vessels with a power rating of below 112kw, in which case the minimum is 2m.

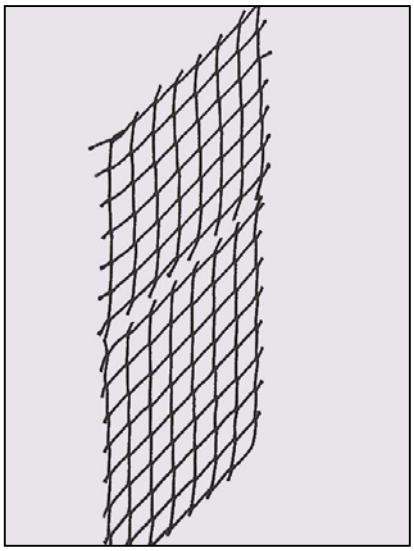
Figure 13: A double panel arrangement

If minimum panel lengths are not producing the desired results, it is a relatively simple task to increase the panel length by simply joining on an additional section. In such situations, as a general 'rule of thumb', Seafish recommend that one square mesh panel for every 100 meshes of parallel extension should be incorporated into whitefish nets. Additionally, the panel length should be increased to be equivalent to 50 corresponding diamond meshes and an equivalent length of diamond mesh extension should separate multiple panels (Figure 13). It should also be remembered that at least one of the panels *must* conform to the regulation.

The task of extending panels is even easier if the square mesh section is made up and added as a complete unit as described in the earlier section on panel construction.

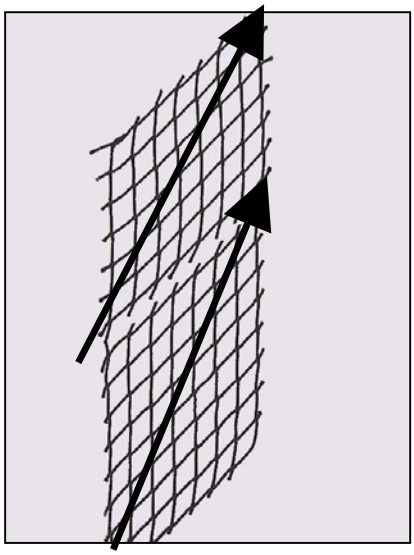
When joining two sections of square mesh netting together, maintaining the overall 'squareness' of the resultant enlarged panel can sometimes be a problem. This is due to the tendency of the netting to try and return to its original diamond mesh shape.

The following simple procedure can reduce this effect.



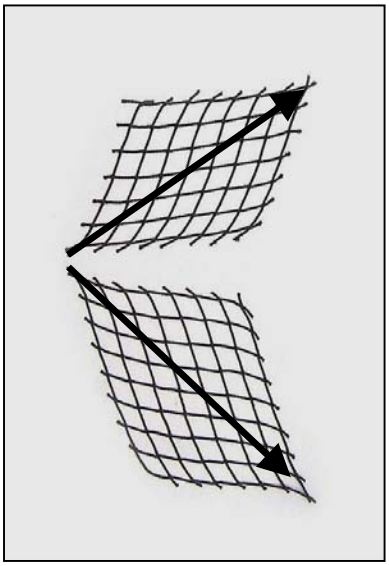
14a

When the netting has been cut out 'on the square', the meshes will have a tendency to revert to their original diamond mesh shape following a line diagonally across the panel. This effect is shown in Figures 14a and 14b.



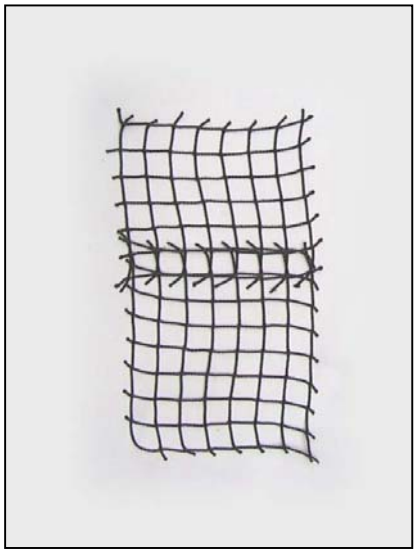
14b

Figure 14: Shows netting cut 'on the square' with the tendency to revert back to its diamond shape



15a

This effect can be used to advantage in determining the final shape of the panel. If one of the two pieces of netting is turned-over so that the direction of the netting panels are opposing each other, the natural tendency of the netting now works to cancel out the distortion.



15b

Figure 15: Shows two halves of netting running in opposing direction prior to joining

The two halves of the panel are joined together by overlapping a row of meshes and lacing across the horizontal bars. This is the same technique used in making a general repair in square mesh, knotless netting.

16a 16b 16c

Figure 16: Sequence of steps for joining two halves of netting

Panel position

The other factor influencing performance, which has scope for change, is that of panel position within the length of the extension. The factors for consideration here are primarily performance versus practicality. Wherever the panel is sited, it should not compromise the strength/integrity of the net.

The position of the panel is defined by regulation relative to the codline of the net. This distance can be no more than 12m, or in the case of nets used for the purpose of fishing for *Nephrops*, 18m.

As far as effectiveness of the panel is concerned, there is no '*ideal'* position. Assuming that the fish entering the net are provided with sufficient opportunity, (time and panel area), and that they have the physical capability, (they have not been exhausted), then theoretically escape should not be affected by panel position. In practice however, this is not generally the case. There are many factors that can influence the performance of the panel and as such it is difficult to determine what is the *best position*.

The overall extension length can influence effectiveness. Excessive lengths can dramatically reduce panel performance and selectivity in general. The main reason for this is thought to be linked to the exhaustion of fish, particularly the juveniles at which the measure is aimed.

It is often reported that panel performance improves the closer it is to the codend. This can probably be explained by the fact that in this position the panel provides greater exposure of the fish to the release area. The fish come up against, either the end of the net, or the catch as it builds up in the codend. The turbulent flow ahead of the catch can allow fish some forward movement, albeit limited. It may be sufficient to allow the fish additional escape opportunities i.e., a second attempt at escape through the panel. Observations of panels in this position indicate that there is also passive release of fish through the panel when it is sited close to the codend.

In situations of high catch rates, the catch can build up in the codend relatively quickly. This can often 'mask off' the square mesh panel if it is positioned too close to the codend. The panel can then be redundant for most of the duration of the tow.

It is important for fishermen to use their judgement and experience to try and optimise the effectiveness of this technology, within the scope of the current regulations.

Appendix I

Further Sources of Information and Advice

Further information on the current regulations appertaining to square mesh panels can be obtained from the following sources:

Sea Fisheries Inspectorate:

England and Wales:
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All these Departments have regional offices, details of which can be obtained from these main centres.

Details of the research and development work on square mesh panels conducted by Seafish are contained in the following reports:

SR378 May 90 - The use of square mesh selection panels as a means of improving selectivity of demersal towed fishing gear. K. Arkley.

SR379 June 90 - Selectivity trials of seine net cod ends - MFV *Kestrel*. K. Arkley.

SR383 Dec 90 - Fishing trials to evaluate the use of square mesh selector panels fitted to *Nephrops* trawls – MFV *Heather Sprig.* K. Arkley.

SR384 Jan 91 - Square mesh selector panels as a means of improving selectivity of demersal towed fishing gears. K. Arkley.

SR401 Jan 92 - Selectivity trials with the Looe pair trawling team *Budding Rose* and *Levan Mor.* K. Arkley.

SR406 April 92 – ICES VIIf - Selectivity trials of single boat demersal trawl, MFV *Ocean Harveste*r. K. Arkley.

SR422 May93 - Improved selectivity in demersal trawl gear. J. Swarbrick

SR445 Aug 94 - Further evaluations of square mesh panels to improve selectivity for cod in demersal trawls. G. Dunlin.

These reports are available from the Librarian at Seafish. Any further technical advice on square mesh panels or other fishing gear related matters can be obtained by contacting:

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Appendix II

Technical Information Sheet

Improving Selectivity in Towed Fishing Gears
The Design and Rigging of Square Mesh Selector Panels or 'Windows'

TECHNICAL INFORMATION SERVICE

SEAFISH TECHNOLOGY

Improving Selectivity in Towed Fishing Gears

The Design and Fitting of Square Mesh Selector Panels or "Windows"

Technical Information Sheet No: 2000/01/FT
Revised July 2001

The information contained in this data sheet is based on work carried out by Seafish to evaluate the use of square mesh selector panels as a means of releasing juvenile round fish from demersal towed fishing gears in an attempt to reduce levels of discarded fish.

To understand how the panels work, it is necessary to study the behaviour of fish as they pass from the trawl mouth to the codend. This has been done by underwater observations using divers and more recently remote controlled video cameras.

Round fish tend to swim ahead of the trawl at the same speed as it is being towed. Some flip over the headline or wings of the net whilst others eventually tire and gradually fall back into the trawl, through the extension and finally the codend. Once in the codend they have tired and are probably no longer able to take effective escape action themselves. Thus, it is vital that escape routes are offered to them before this. The square mesh panel offers this escape route but fish are also encouraged by the water flow through the panel and during daylight they are also aware of the light change, which draws them towards the panel.

Over a number of trials, the results obtained using the panels have shown consistent reductions in discard levels of species like haddock and whiting from nets fitted with square mesh panels when compared with conventional nets made from diamond mesh. The results with cod have been less successful.

As a technical conservation measure, the use of square mesh panels is simple, effective, practical and relatively inexpensive to undertake.

The Use of Square Mesh Netting

With conventional diamond mesh netting, the meshes have a natural tendency to close-up once the netting comes under tension applied along the direction of tow.

In components of the trawl, such as the extension and codends, the increased tension caused by the build-up of catch tends to cause a closing of the meshes in these areas, resulting in a reduced area of escape for undersized fish. Since size selection is dependent on the mesh opening, the process is vulnerable to changes in the shape of the netting within the codend and extension. One way of improving the selection is to use square mesh netting panels incorporated into the extension. In this way, the meshes can be kept open over a larger area and the positioning of these panels can be varied to optimise the escape of juvenile fish.

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To produce this square mesh effect with conventional diamond mesh, the netting is turned so that half of the mesh bars are parallel and half at right angles to the direction of tow of the net. This is achieved by cutting the panels out of conventional sheet netting "on the bar" (as shown in the diagram).

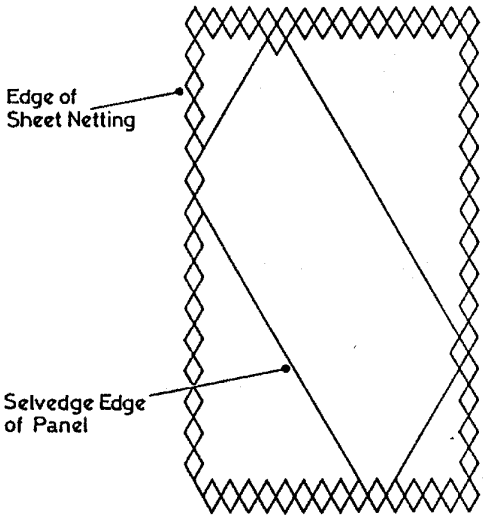

Figure 1 - "On the bar" cut

Hung in this way, the netting is not stretched or constricted by water pressure or affected by any other tensions. All the meshes maintain their square shape, thus increasing the potential escape area for juvenile fish.

Conventional knotted diamond mesh netting can be used for these panels, but the use of knotless material is preferred. This material has a number of advantages over knotted netting, amongst which are: it maintains a regular 'square' mesh shape, the absence of knots presents an improved escape area and abrasion damage to the fish is minimised as they pass through the meshes. Finally, panel distortion is reduced as the possibility of knot slippage is eliminated.

It should be noted that although it is described as square mesh knotless netting, it is produced as "diamond" knotless netting and cut on the square.

If knotless netting is damaged it is repaired by cutting out the damaged area and replacing it with a 'patch' which is 'laced in' along the four sides of the resulting hole. If this is done well it is not a disadvantage and for the less skilled fisherman is probably easier than a traditional diamond mesh repair.

The fact that the selector panels are positioned in the top sheets of the net in areas of the extension limits the probability of damage.

Designing the Panels

The details described apply to the fitting of 90mm square mesh netting panels to conventional 70mm and 80mm mesh prawn nets and to 90mm square mesh panels to conventional 100mm mesh white fish nets.

The selector panels are constructed as a complete section to allow more flexibility with their use and simplify their fitting. Each panel section is made up with the square mesh topside panel laced onto a conventional diamond mesh lower section, complete and ready for insertion into the desired position within the net's existing codend/extension configuration.

If using knotted material for the selector panel, this can be made from material of the same specification as the adjoining netting. Where knotless material is used, twine sizes slightly greater than the adjoining sections can be used to compensate for the slight reduction in strength of the knotless material compared with the knotted (twine diameter for twine diameter, knotless netting is generally not as strong as knotted).

The width of the square mesh panel is determined from the "towing width" of the netting section to which it is to be attached i.e. in most cases the parallel extension section. The towing width is in effect the diameter of the extension when it is under tension from the towing load.

The towing widths used to determine the panel sizes described here have been established from direct underwater observations of full-scale nets and Flume Tank testing of scale models. The resultant panel widths take into account the towing widths described and also the most practical joining ratio to be used.

Fitting the Panels

All the panels described use a diamond mesh to square mesh-joining ratio of 2:1 when fitted into the extension/codend section of a net. The bottom panels are joined at a normal 1:1 rate (see diagram).

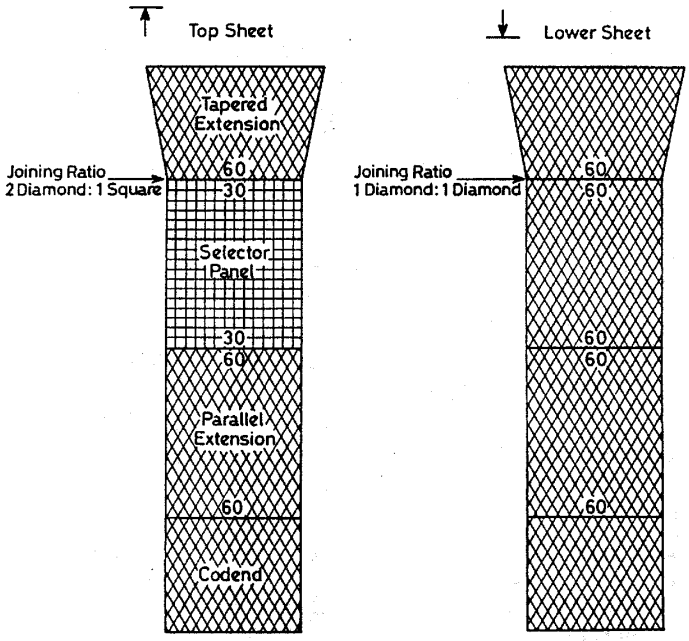

Figure 2 - Selector Panel

Once the panel width has been determined, it is cut out from sheet netting. It is an advantage to selvedge the square mesh section separately before lacing together with the corresponding lower sheet. Since it has been cut from diamond mesh sheet netting, it has a tendency to try and pull back into diamond mesh configuration. By selvedging the panel prior to lacing together, the section maintains its square mesh shape more easily.

If the netting section to which the square mesh panel is to be attached has a four-mesh selvedge, then the square mesh panel should have a two-mesh selvedge. This is achieved by lacing the first three vertical bars together over the full length of the selvedge edge of the panel.

It is also important to strengthen the horizontal joining edges of the panel to prevent the meshes parting on the first row of the panel. This is best achieved by lacing the first two horizontal bars together in a similar way to the selvedge edge.

The joining of the square mesh selector panel section to the existing net can also be simplified by braiding a row of diamond meshes onto the first row of square meshes. This facilitates a conventional diamond mesh join with a simple 2:1 baiting rate. Alternatively, the meshes of this first row can be joined directly onto the middle of the horizontal bar of the square mesh by clove hitching (see diagram).

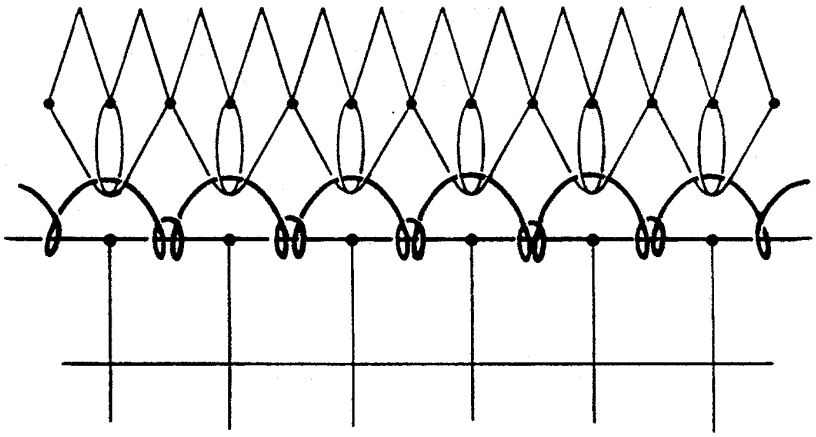

Figure 3 - Joining Square and Diamond Mesh Netting

When lacing the top square mesh panel to the lower diamond mesh panel, the length of the lower panel to correspond to the square mesh panel is determined by pulling the diamond mesh out alongside the selvedged edge of the square mesh and measuring to the nearest full diamond mesh. The two edges are then laced together length for length.

It is very important to ensure that the square meshes are level across the width of the panel when lacing the two selvedges together, otherwise the meshes will have a tendency to go back to their diamond shape, causing panel distortion.

Length and Positioning of Panels

The work carried out to date by Seafish has been concentrating on panel lengths of between 3m and 6m. A minimum of 3m is advocated but existing net design, the species to be released and the catch rates of fish encountered can all influence the length. There are also practical handling considerations to be taken into account. Further investigations into the optimum panel lengths are still being undertaken.

The actual positioning of the panel within the net can also vary depending on a number of factors.

To date, commercial fishing trials have shown that for practical handling reasons the positioning of panels should be restricted to areas foreside of the codend lifting becket.

The siting of the panel relative to the codend is influenced, for example, by the design of the gear (namely the length of the existing extension) and the species being targeted.

To a large extent, the positioning of the panels is based on experience to date and observations taken on video of fish behaviour or in the net when it is hauled alongside. Seafish recommend the following:

When fitting panels in prawn trawls to release by-catches of juvenile haddock and whiting, it is advisable to site the panel in a position between the end of the tapered extension and the start of the parallel extension. It is important to allow sufficient length of standard extension between the aft end of the panel and the codend. This helps to prevent any loss of prawns that may be washed from the codend as it is being hauled.

When fitting panels in white fish trawls, the panel may be sited anywhere within the parallel extension. Although work to establish the optimum siting of panels is still ongoing, Seafish have had some of their best results with panels situated as close as possible to the codend lifting becket. It appears that in this position, the square meshes of the panel help to open the diamond meshes of the adjoining codend.

More detailed information on the use of square mesh selector panels is contained in Seafish Reports Numbers 378, 383 and 384.

These reports and further advice are available from:

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