Fishing gears
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Foreword

Dear young fisherman,

Put bait on the hook, tie a line to the hook, throw the hook into the water and wait. If you are lucky, you will catch a fish. But if you want to make a living from fishing, it is not enough to catch one fish at a time – more effective fishing methods are needed.

In “Fishing tools” you can read about different fishing methods: trawl, Danish seine, purse seine and netting. You will learn more about which materials are used for which tools and how you maintain your tools and use them safely.

It is not enough to read “Fishing tools” and then think you are qualified and can call yourself an expert and a specialist. You only really learn to tie a knot and a hitch, for example, when you are sitting with the rope in your hands and repeat the same thing again and again… and again.

Throughout the book you will find fact boxes which explain unfamiliar words, provide additional information and sum up the individual sections. There are also interesting stories from real fishermen who have been around a bit themselves – some offer useful advice, while others will tell you how not to do it.

Welcome to the subject Fishing tools and happy reading!

Kind regards,

[Signature]
Fishing methods

The simplest way to catch a fish is to bait a hook, tie a line to it, throw the hook into the water and wait. However, it is rarely possible to make living from that kind of fishing. If you want to make fishing your full-time profession, you have to use other methods – and many of these will involve the use of nets in one way or another.

In Western Europe we distinguish between four fishing methods that involve the use of nets:

- Trawl
- Danish seine
- Purse seine
- Mono net

These four methods and their most important variants will be explained briefly in the following. If you want to know more about, for example, the historical development of the nets or their more detailed structure, you can find information in the teaching material for the subject Fishing.

**Word Definitions**

**Common terms**

When talking about different types of net, it is useful to know the most common terms for the individual parts of the net:

- **Bell**: the net itself in which the fish are caught.
- **Lines**: the horizontal edgings of the bag, often reinforced with a rope. There is a headline to which floats are often attached and a bottom line to which weights may be attached.
- **Lining**: the reinforcement of strong netting which in some fishing tools are inserted between the bag and the lines.
- **Breasts**: the vertical edgings of the bag, also reinforced by a rope.
- **Seam**: a joint between two net sections to be placed next to each other.
- **Bridles** (also called crowfeet): the lines which are attached to the head and bottom lines and which keep the fishing tool stretched out.
Trawl
A trawl can briefly be described as a large cone-shaped net which is towed behind one or two vessels. Trawling is an active fishing method (because the net is actively moved through the water), and it works by chasing the fish into the tool and keeping them there. Trawls vary considerably in size, and unlike many other fishing methods trawling is not restricted to vessels of a certain size: Trawling can be carried out from very small boats to the largest fishing vessels.

Trawl types
Virtually no two trawls are the same. Their structure is determined by the size required by the fisherman and the fish he wants to catch. The trawls were originally made up of two panels, a top panel and a bottom panel, which were joined at the sides by lacing. Later the demand for higher trawls has led to some trawls being fitted with two side panels, resulting in four-panel trawls. Generally, trawls are classified according to whether they are towed along the sea bed, bottom trawls, or whether they are towed in mid-water, mid-water trawls.

Bottom trawls are towed along the sea bed. The top panel is usually longer than the bottom panel so it functions as a “roof” which prevents the fish from escaping upwards. At the sides the fish are retained by the net’s arms and wings. It is important that the bottom trawl maintains good contact with the sea bed itself, which is usually achieved with the right trawl design, but in some cases it will be necessary to use different types of weights to keep the bottom line down. The trawl is kept open horizontally either by mounting so-called trawl doors made from large steel plates in front of the trawl. These are placed askew in the water, thus pulling the towing wires away from each other. The horizontal opening can also be maintained by having two vessels with a certain distance between them tow the trawl. Vertically the trawl is kept open by attaching some sort of buoyant unit to the head line, usually so-called floats. Bottom trawls are used to catch, for example, Norway lobster, shrimp, plaice, cod, pollack, haddock and industrial fish such as Norway pout and sand eel, i.e. any animal that lives on or immediately above the sea bed.
**Mid-water trawls** are towed in mid-water—away from the sea bed. They have a slightly different structure than bottom trawl as they have no “roof”, among other things. Many mid-water trawls have a square cross section, while others have a more rectangular opening. It depends on where they are used and the type of fish you want to catch. The vertical opening is created by an upward draw in the upper tails, while heavy weights are attached to the bottom tails. As with bottom trawls, the horizontal opening is created by trawl doors or by having two vessels tow the trawl between them. Mid-water trawls are used to catch shoal fish such as herring, sprat, mackerel and blue whiting. There are all kinds of intermediate types between bottom trawls and mid-water trawls. Certain types of bottom trawl can be used in mid-water and are therefore similar to mid-water trawls. However, these trawls are still constructed as bottom trawls and are sometimes referred to as semi-pelagic trawls. In the same way, some types of mid-water trawl will be set on the sea bed during the towing. This can happen in cases where shoals of, for example, herring or blue whiting swim close to the sea bed.

**FACT BOX**

**Trawl/trawler** This type of net is towed through the water and/or along the sea bed. A trawler is a vessel that uses a trawl to catch fish.

**FACT BOX**

**Mid-water trawls** are also called pelagic trawls. Pelagic is the term used to describe the way most shoal fish live and means that they live in the open sea, independently of the sea bed.

**Beam trawls** are kept open by the beam to which the top panel is attached. The bottom panel with the bottom line is similar to that attached to an ordinary bottom trawl. Beam trawls are used to catch flatfish, shrimp etc.
**Towing methods with trawl**

Today, there are many different trawling techniques. Different terms are used depending on the way the trawl(s) is/are towed:

**Single trawling** means that the trawl is towed behind a single vessel.

**Pair trawling** means that the trawl is towed behind two vessels – the opening in the trawl is created by the distance between the two ships.

**Twin trawling** means that one vessel tows two trawls at once. In some cases, a vessel can tow even more trawls: three, four or as many as eight trawls.

**Danish seine**

Danish seine fishing is an active fishing method (because the net/seine net is actively moved through the water), and it works in that the ropes which are placed on the sea bed in a large triangle chase the fish towards the path of the fishing tool when it is hauled in.

In order to achieve a good result with Danish seine fishing, relatively large areas with an even sandy or gravelly bottom are generally required. Danish seines are traditionally used in areas with a moderate water depth, but Danish seines have actually been developed for larger depths, for example for catching flatfish in the Skagerrak and elsewhere. As the name indicates, the Danish seine is a Danish invention and is currently being used in different variants all around the world.

**How it works**

The Danish seine consists of the actual seine net and two seine netropes called arms, which can each be up to 3,500 m long.

When the ship arrives at the fishing ground, a large anchor is dropped and the first seine rope is fastened to it. The ship sails out with the seine rope, turns 90°, sails on, lays out the actual seine net, turns 90° again and sails back towards the anchorage. In principle, the two seine net ropes and the seine net now demarcate a triangular area. The seine net winch on board the ship is used to pull at both “arms”. Initially, this is done carefully so the ropes are moved along the sea bed – the movement and the resulting cloud of sand cause the fish to swim towards the centre of the demarcated area. Soon the seine net itself starts to move towards the cutter and the fish which find themselves within the ropes are caught in the seine net.

Danish seines are used to catch plaice, cod and haddock. A number of other species are caught as a bycatch.

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**FACT BOX**

**The Scottish method – fly shooting**

The Scottish have developed a variant of Danish seinning. It differs from the traditional method in that it does not use an anchor but merely a large buoy to secure the first section of the seine rope, and in that the cutter, when it is back at the beginning of the first arm, does not haul in right away but slowly moves forward while the ropes and the seine net are pulled in.

It can therefore be described as a cross between traditional Danish seinning and trawling.
Purse seine

Purse seines are very large tools which most of all resemble a giant curtain of netting which is laid out in a large circle around a shoal of fish, which the vessel has located in advance with its advanced electronic equipment for locating fish shoals. Purse seining is an active fishing method (because the net is actively moved through the water), and it works by surrounding the fish with the tool and trapping them inside it.

The purse seine is laid out in a circle around a shoal of fish. A wire running alongside the entire lower edge of the purse seine is pulled in, thus drawing together the opening downwards. The entire bottom part of the purse seine is lifted up to the side of the ship, and most of the net is pulled on board until the fish are accumulated such that they can be pumped up into the vessel.

Purse seines are used to catch shoal fish such as herring, mackerel, sprat and capelin. Purse seines are widely used elsewhere in the world to catch many different species of tuna, horse mackerel, sardines and anchovies.

As mentioned earlier, purse seines are usually very large fishing tools. In the North Atlantic, the net is approx. three to four times as long as it is deep, and the largest nets are 600-800 m long and have a stretched depth of 180-200 m. This means that such a purse seine can cover 18-20 football fields. It is made from vertical net sections, which are called fishing lines in a purse seine. At the top, the headline is fitted with floats intended to keep the purse seine at the surface; at the bottom the bottom line is rigged with 6-8 tons of lead intended to make the purse seine sink rapidly around the shoal of fish.

Mono nets

A net can simply be described as a wall of netting which is set on the sea bed or hangs in the water. The net is made from a thin, transparent material which the fish cannot see when they swim around searching for food or migrating from one area to another. When the fish swim into the net, they are caught in its mesh.

Net fishing is a passive fishing method (because the fishing tool stands stationary in the water while it catches the fish) – i.e. the fisherman does not “do” anything once the net has been set.

Set gillnets and drift nets

Mono nets can be set near the sea bed or anywhere between the sea bed and the surface. It is the relationship between the weight on the bottom line and the purse float on the headline that determines whether the net is near the sea bed, near the surface or in the middle of the water column. A single net is usually 50-70 m long. During fishing, several nets will be joined to form what is referred to as a fleet. In ordinary bottom fishing...
15-20 nets can form a fleet. If fishing is being carried out more locally, for example around shipwrecks, the fleets are shorter and may only consist of five nets. Set gillnets are prevented from drifting with the current by means of an anchor (also referred to as a grapnel) at either side of the fleet. An anchor and a buoy will also be placed on some sections of the long fleets. This also makes it easier to retrieve and collect a fleet where a buoy has been hit by another vessel and disappeared. Sometimes a trawler may accidentally tow its trawls through a fleet and destroy a small or large portion of it. Drift nets are not fastened with anchors but drift (as the name indicates) around in the water with the current. Drift nets have floats attached to them, and by using short or long straps on the floats, the net can be made to hang vertically anywhere between the surface and the sea bed – depending on the type of fish you want to catch.

**FACT BOX**

Many believe that pound nets are the same as set gill nets. They are not! A pound net is a fishing tool that consists of a net attached to poles which have been driven into the sea bed. Pound nets almost work like a large trap where a long row of nets lead the fish away from the coast and into a fish trap or a yard of netting which is constructed in such a way that the fish cannot find their way out again. From here the fish are hauled on board the cutter. Pound nets can be used along the coast in the Danish coastal waters but are today only used to a lesser extent and along more sheltered coasts and in inlets.
Three ways to get caught
The fish can in principle get caught in the mesh of the net in three different ways:

• The fish gets caught by its gills which act as barbs when it tries to withdraw.
• The fish squeezes its body into a mesh and is unable to move backwards or forwards.
• The fish hits the net with its mouth or, for example, a fin, and in attempting to free itself becomes even more entangled in the net. Typically, its tail gets caught between the meshes.

Set gillnets are used to catch cod, plaice, Dover sole, turbot, pollack, hake, herring etc. Driftnets are used to catch salmon, and to a lesser degree, herring.

FACT BOX
A trammel net is a special type of net. It consists of three layers of netting: a small-meshed net in the middle sandwiched between two large-meshed nets. When the fish swims into the trammel net, it swims through the first layer of large meshes and then pulls a pocket of the small-meshed net through the last layer of large meshes, thereby catching it in a pocket. Trammel nets are highly effective and good at retaining many different sizes and types of fish. However, it also makes it more difficult to clear the nets, because it takes a long time to remove each fish.

FACT BOX
Exploratory fishing
New nets are continuously being developed for the fishing industry for a variety of reasons. A new net can provide the following benefits, for example:
• Improved fishing quality
• Less waste
• Reduced fuel consumption
• Fewer repairs and longer useful life
• Improved environmental friendliness

Part of the development in fishing tools follows from new rules on the conservation of the resources of the sea – the so-called “technical conservation measures”. When you want to develop a new net, you can apply for funding from the EU and the Danish government for exploratory fishing. You might also want to contact a net maker. Net makers have years of experience in how different nets work, and they can also test new nets in a test tank.

Read more about exploratory fishing at www.dffe.dk.

Note that you can also apply for funding for exploratory fishing with other rigging, applications, areas and species.

Other fishing tools
There are many other fishing tools than those described here. Fishermen all around the world have always showed great ingenuity in their efforts to catch fish for food. However, very few fishing tools other than those mentioned here have found use in the highly efficient commercial fishing industry. Most of the other tools are passive such as lines, basket traps, fish traps and hooks. Some operate by capturing the fish in a trap from which it cannot escape (for example fish traps), while others use some sort of bait (for example a hook with bait and basket traps).
Materials science

The materials used for fishing nets are all made of synthetic fibres. When selecting which material to use to make a net, the fisherman or seine maker bases his choice on his knowledge of the properties and price of the given material. Also in connection with maintenance and repair it is important to know the properties of the materials to avoid making a weak link out of poor materials.

The introduction of synthetic fibres after World War II was somewhat of a revolution, not least within fishing. The reason for this is primarily that synthetic fibres do not rot as did the natural fibres of hemp, cotton, sisal, etc. used until then. Over time, the plastics industry has benefitted the world with a vast number of different plastics materials. They may soon replace any material, as plastics can be designed with almost any kind of properties.

Raw materials

Even though the manufacture of synthetic materials is relatively simple, we will not go into detail here. The raw materials used in the manufacture are various natural products: oil, carbon, lime and various salts. Molecules (monomers) are manufactured from these products, having the ability in further chemical and physical processes to combine to form long chains (i.e. they polymerise). The result is a mass of synthetic materials that contain only very long molecules. The mass is cut into small pieces (pearls), which are then ready for the final manufacture of the fibres. These are formed in a so-called extrusion process. In this process the pearls are melted and pressed out through small pipes. Finally, the extruded fibres are stretched 4-5 times whereby they achieve their final diameter, strength and elasticity.
During the 1980s and 1990s, a limited number of high-strength materials emerged, enabling the manufacture of stronger lines. These materials have made it possible to reduce the diameter of the net used and replace wire and steel wire ropes made of iron. Firstly, the increase in line strength is very significant as the towed tools offer less towing resistance and thus reduced expenses for the fisherman. Secondly, the reduced net diameter and the replacement of iron wires and wire ropes facilitate tool manufacture and handling and reduce the tool weight. The new materials are partly manufactured from new raw materials, partly from materials that have been treated in a new way, and finally from composite products made of two or more known raw materials.

The new materials are sold under names such as Kevlar, which is a new carbon fibre, Danline, which is a composite product, and Karat, which is a polypropylene fibre that is stretched beyond what is normal. The same applies to Dynema and Spektra, which are manufactured on the basis of polyethylene. The biggest problem with the new materials is the price.

**From synthetic material to lines and ropes**

The basic material in any net or rope is the filaments that are joined in large or small numbers and spun into a so-called yarn. These thin yarns are further spun and braided – one or more times – to increasingly thicker lines and ropes.

**Fibre types**

There are several different fibre types that have either been produced from the actual extrusion or in the different processing of the extruded fibres.

*Continuous filaments* are very thin threads of virtually infinite lengths. They are similar to silk, and a yarn manufactured from continuous filaments will typically contain filaments that are up to 1 km long. They will have a shiny appearance, at least as long as they are untreated.
Staple fibres are made of continuous filaments that have been cut into 5-10 cm pieces. Lines spun from staple fibres are “hairy”, so called due to the many loose ends sticking out. This makes them easier to hold onto and keeps the knots better in place. These lines thus have a cotton- or wool-like appearance.

Monofilaments is the name used for single filaments that are strong enough to be used alone. They are known from fishing lines, but they are also used in a spun form in the manufacture of other forms of nets and ropes.

Split fibres are manufactured by stretching plastic strips to the extent that they split down the middle. Lines manufactured from split fibres are somewhat similar to bast in that they contain fibres of irregular length and thickness. Split fibre rope can also be manufactured from plastic strips which have been cut mechanically immediately after extrusion.

Twisting and braiding
The fibres of the finished yarn or rope can be joined in many different ways. The method used is based on whether a particular property in the finished product is desired. The lines that form part of the actual net manufacture (called net mending twine by net makers) can either be twisted or braided.

Twisted lines
A finished rope often contains several “levels” of twistings. A normal line for manufacturing trawl nets is thus normally manufactured from a number of single fibres that pre-twisted. Three of these fibre bundles – confusingly called nets – are subsequently joined by post-twisting them into the finished line. In ropes it is common to have twistings at even more levels. The direction of the twistings is important for the properties of the finished rope. You talk about twistings in the S or Z-direction, or in an S or Z-lay. The letters refer to the direction of the yarn in the thread. Normally, the direction will vary from spinning to spinning, so that the pre-twisting is S-laid, and the post-twisting is Z-laid. A subsequent lay will then again be S-laid. This change is designed to make the rope “neutral”, i.e. to prevent it from untwisting when subjected to load. It is difficult to make a twisted line neutral, which can be seen if you hang a weight at the end of a line. Normally, it will start to rotate and untwist the line.

2.3 Braided lines
In the braiding of a line the yarns are placed in such a way that they cross each other in the diagonal direction of the net. Braided lines are actually tube-shaped with the size of the hollow cavity depending on the way in which the braiding is performed. The fibre bundles may have been pre-twisted, and one or more fibre bundles may accompany each other.

In the cases where you want a finished product with a round cross-section, a core must be placed in the yarn to fill the hollow cavity. A core consists of fibre bundles with different sizes of twistings.

A braided line without a core will be flattened and have an oval cross-section. Braided lines and ropes are basically neutral and are often preferred for that reason.

Braided trawl nets often have no core. There are several reasons for this; it will merely increase the weight without providing increased strength, and the knots are stronger.
From lines to nets

Knotted nets
Machines for net manufacturing have existed for more than 100 years. The first had very limited capacity because they tied the nets in the same way as a net maker would make a net by hand. The modern machines of today have a much greater capacity, i.e. because they tie many knots at once. The spools with the yarns are set up in a number corresponding to the number of rows in the finished net. And here lies one of the most significant limitations in the production.
The machines tie the net with weaver’s knots, i.e. with the same knot as is used in joints and hand-made nets, but the net exits the machine upside-down, so to speak. The rows are oriented in the same direction as the production direction, and you therefore have to cross-stretch the net when it exits the machine. In this way the width of the machine limits how long the pieces of netting become, while the width of the piece of netting is in principle limitless. Where extra strength is required in the tools, e.g. in the bag of a trawl, the net must be knotted using extra thick lines. This can be difficult if the meshes are small. In such cases the net is usually made of a double or a triple thread. The net will thus be sufficiently strong and retain some of its flexibility. It also makes the net much easier to handle.

In recent years, fishermen have started to use trawl nets in a whole new way. They turn the nets 90° compared to a normal net. This is called T90 and is used mostly in trawl bags and at part of the trawl belly or as intermediate section. When the net is turned in this way it acquires a number of advantages. It is stronger when stressed in this direction, and the meshes are more open. This means that in some trawls the amount of dirt gathered in the trawl bag is reduced and that more small fry are able to escape. In certain trawls the use of T90 nets also benefits the quality of the catch.

Knotless nets
Even though machines for making knotless nets have existed since the 1920s and these types of nets have many immediate benefits, they have only been used in commercial fishing to a limited extent. There are three types of knotless nets: a twisted type, a “crochet” type and a braid-ed type. The twisted type cannot be made with firm knots, and nets of this type are therefore unable to maintain their mesh size. This type is therefore not used in fishing. The crochet net, the so-called Ultra Cross net, is very elastic and is used for fine-meshed
trawl bags and for sea cages for offshore fish farming. The braided type of knotless nets is patented and is only manufactured two places in the world. It is marketed under the name Ultracross. This type of net is strong because it has no knots and it may offer great savings in trawls as the knots normally contribute significantly to the towing resistance. Unfortunately, it is quite expensive and its use is often limited to small pieces of net inserted as square-meshes in normal trawl nets. Here they act as “windows”, allowing small fry to escape.

**Mesh sizes**

There is some confusion as to how to specify different mesh sizes. There are local traditions, from country to country and from port to port, and there are differences as to what net makers, fishermen and fisheries inspectors “use” the net size for. For example, the net maker uses the mesh size to calculate the length of a piece of netting while the fisheries inspector uses the mesh size to check whether fish of the correct sizes are caught in the net.

You therefore talk about:

*The mesh size in half mesh*: which is the distance from the middle of one knot to the middle of the next. This is the measurement a net maker would use mostly in Denmark i.e. it is the length of a bar or a half mesh. *The mesh size in full mesh*: which is the distance between the middle of two opposite knots in a mesh. This is the internationally adopted way of specifying mesh sizes, and it is used in several of our neighbouring countries, e.g. in Norway and the UK.

*Inside measure or the mesh opening*: which is the inside opening between two opposite knots. This is the measurement referred to in the Danish fishing legislation as it says something about the size of fish that are either allowed to escape or are caught.

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**Fact Box**

**Legal mesh sizes**

There are a number of legal provisions governing mesh sizes which fishermen must observe. The rules have been introduced as it is deemed inappropriate to catch small fish. Small fish must be allowed to escape through the fishing tools until they are big enough and have had the chance to spawn at least once. In an attempt to take into consideration the different sizes and shapes of fish and crustaceans, different mesh sizes have been introduced in the various fishing tools. In addition to this, the restoration schemes initiated for a number of fish populations in recent years have resulted in further restrictions being imposed. This has resulted in an extensive set of laws that compel fishermen to use different mesh sizes in different trawls and in different waters.

Most net manufacturers produce nets with meshes that are a little larger than the threshold limits set out by the applicable legislation. This provides the fisherman with a small margin which takes into consideration any shrinkage in the net. However, it should be emphasised that the owner of the vessel is responsible to the fisheries inspectors – not the net maker or the net manufacturer.
Rope

The manufacture of rope is based on the same twistings of fibres and yarns used in the manufacture of lines and nets, only with more levels of lays. By varying the number and thickness of the yarns and strands and how hard they are laid, you can make ropes of various dimensions, types and qualities. If the rope is laid from three strands or four strands it is called three-strand or four-strand rope, respectively. An insert (known as the “core”) is always placed in the middle of a four-strand rope to keep the four strands correctly placed in relation to each other.

Most three or four-strand ropes are right-laid. If you twist three hawsers together you get a so-called cable which is normally left-laid.

FACT BOX

Rope maintenance

It is important to handle and look after rope well. Poorly maintained rope can pose a safety risk and does not last very long. In other words, it pays to take care of your lines and ropes. Some good advice:

- Untie knots as soon as possible after using it – leaving knots on the rope will weaken the rope. The breaking strength is reduced by approx. 40 per cent when tying a knot on a line or a rope!
- Do not leave rope and lines exposed to strong sunlight without good reason.
- Some synthetic ropes (polypropylene) will deteriorate from exposure to sunlight.
- Never haul thick ropes and wires over blocks and discs of a small diameter. When bent excessively, most fibres will be stretched so much that they break.
- Avoid contaminating the rope with acids, alkalis, oils and organic solvents.
- Protect synthetic rope against heat and sparks.
- Remove sand, gravel and oil from rope by washing it in hot water with a detergent.
- Before storing rope, it may be a good idea to wash out the salt water using fresh water.
- Rope is best stored in a cold, dark and dry building which is well-ventilated.
- Examine ropes regularly – look for wear and damage.
- Never step on rope.
- Never leave rope lying loose on the floor. It may be damaged and may cause an accident!
The hardness of the lay determines whether the rope is soft or hard. A lightly laid rope becomes soft and is easy to splice and it does not kink easily, but it does not have the wearing resistance of a hard-laid rope. Braided rope will often consist of several layers of braiding so that the core is also braided. Braided ropes can also be made with several yarns lying next to each other, accompanying each other throughout the braiding. Square-braided rope is solely made of eight strands that accompany each other in pairs. There are four right-laid and four left-laid strands. This type of rope has a natural balance, does not kink and is flexible and easy to handle even when wet. It is therefore one of the preferred types for mooring ropes.

Today, rope – mostly braided – is used in many cases where wire or steel wire rope was previously used. This is often the case in tails and lines in many trawls.

**Fact Box**

**Dangerous ropes**

When using ropes with a high elasticity for hauling, you put yourself at risk. If the rope breaks, the contraction will fling the rope back against the winch and the object being hauled. At worst, this many result in fatality if there are people in the area. On winches, elastic ropes will build up a contractive force with each turn of the winch. This force may become excessive to the point that the shaft breaks or the flanges are forced out at the sides.

**Wire and combination rope**

Wire is made of iron or steel wires. Iron wires undergo a galvanising process which protects the wire against corrosion while a steel wire is protected in itself. Over time however, both types will be subject to corrosive deterioration. During the manufacture of the wire, mineral fat is added which greases and protects the inner wires.

Wires can be structured in a very complex way. There may be a varying number of strands, but for fishing purposes wire types with six strands are mostly used. The number of wires in each strand may be 6, 7, 12, 19, 24, 26 or 37. The threads in the strands can even be of different thicknesses. Generally you could say that the more threads in a wire, the more flexible it is. Most wires have a core of synthetic fibres. This also adds to their flexibility. In thick wires the strands may have a fibre core.

In Denmark, combination rope is better known as Taifun. This also consists of a combination of steel wire and textile fibres – usually polypropylene – but here the fibres are on the outside. Taifun rope is usually composed with a fibre core on the inside and six strands, all with cores of iron or steel wires.

Wires are to a large extent used as tow wires in trawl fishing and in many other applications where a winch is used for hauling. These applications do not place special requirements on the flexibility, but where the elasticity of the wire must be low. Similarly, combination rope is
used as tails and lines in trawls. Here too, the elasticity of the wire must be low. Wire and combination rope with threads of steel are more expensive than galvanised iron and is therefore only used where special conditions make it necessary. For example, Taifun with steel wires is used in small trawls which are only used for a short season and which are therefore expected to last for many years.

**Trawl drawings, specification of net types**

The net maker’s drawing should specify how the tool is made and the materials used. The drawing must therefore include the following information:

- The raw material used to make the net
- Type and dimension of the yarn
- The mesh size
- Width and length of each net section

Unfortunately, no international agreements have been made to determine these specifications. The subsequent overview is, however, based on the Danish standard terms, and only in cases where is has been deemed absolutely necessary have other terms been included.

The synthetic material is only specified directly in a few cases. Normally, this is only stated as some form of number code in connection with the specification of the yarn type and thickness.

**Polyamide**: twisted net is only specified by its yarn number which expresses the net thickness. Braided net is specified by the line diameter. The international term is “210/yarn number”. The international yarn number is three times the Danish number as we specify the number of yarns in a strand, while the international yarn number specifies the number of yarns in the entire line.

**Polyester**: twisted net is specified by the yarn number followed by the number 3, and braided net again by its diameter. Internationally by a “250/yarn number” (three times higher than the Danish number).

**Polyethylene**: twisted net is specified by a “3/yarn number”, braided net by its diameter and internationally by a “500/yarn number” (three the Danish number).

Braided lines are normally just specified by their diameter and you therefore have to specify the material in more detail. Furthermore, the diameter is not a measurement in itself, as these lines are often flattened, it is how the lines used to be measured.

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**Fact Box**

**Examples of terms for nets as specified on the net maker’s drawings**

**Twisted materials**

<table>
<thead>
<tr>
<th>Material</th>
<th>No. 20 or 210/60</th>
<th>203 or 250/60</th>
<th>3/20 or 500/60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyamide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyester</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyethylene</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Braided materials**

- 4 mm braided nylon
- PES br. 4.0 mm
- br. PES 4.0 mm
- br. PET 4 mm
- br. nylon 4.0 DB

**Rope-laid**

- 240 TS

**Net turned 90°**

- T90

**Double thread**

- DB 4mm
A different number of letters may be added to these number specifications, specifying that the net is made from a double thread: DB, or that the thread is rope-laid: TS. This means that each yarn includes three lays. This is only used in very thick yarns. Tgo specifies that the net must be turned 90°. As mentioned above, Danish net makers specify the mesh size as the half mesh size while the numbers used by the fishing legislation are the inside measure or the mesh opening. In most cases, net manufacturers try to adapt their products to the applicable legislation so that there is a certain margin, allowing the net to shrink.

The number of meshes in the depth of a piece of netting is determined by the width of the machine making the net. In many cases the mesh depth will be a half mesh from a round number, e.g. 49.5 or 99.5 meshes. This way the finished net section in the tool will be 50 or 100 meshes with the lacing.

The width of a net section is specified by the number of knots in a certain row across a net. The number of knots will be double the number of meshes.

**Properties**

To be able to select the correct material for a certain part of a tool you must know the properties of the materials. Their breaking strength, elasticity, pliability, density and a number of other properties which must be weighed up against each other – and, of course, against the price.

It is difficult to comment in general on the properties of a net or rope material as they vary from manufacturer to manufacturer. The actual raw material has a number of reasonably well-defined properties, but they can be strengthened or weakened by the way in which the thread is twisted, braided or knotted into a net or a rope and by the way that the manufacturers finish the nets in terms of stretching, treatment/heat treatment, etc.

In the following section we will review the various properties which the net maker must consider when selecting materials for a fishing tool.

**Durability in water**

Even though some of the material properties are altered by being submerged in water, they are not weakened. Synthetic materials can last almost infinitely in water. It is only nylon (PA) which can absorb water, and the properties of this material are thus most liable to changes depending on whether it is wet or dry.

**Weather resistance**

If is very difficult to determine the durability of a synthetic material in air. Of course, many factors come into play and make the material brittle. There is, however, no doubt that the most significant factor is the effect from the ultraviolet rays of sunlight. With untreated materials, the breaking strength is reduced by 50 per cent following long-term exposure to sunlight. Polypropylene (PP) appears to be have the lowest durability while polyester (PES) is the most durable. Polyamide (PA) and polyethylene (PET) lie in between.
## 2.12 Material properties for synthetic fibres

<table>
<thead>
<tr>
<th>Property</th>
<th>Polyethylene</th>
<th>Polypropylene</th>
<th>Polyester</th>
<th>Polyamide</th>
<th>Aramid</th>
<th>HDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shack load</td>
<td>*</td>
<td>***</td>
<td>**</td>
<td>****</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Handling</td>
<td>***</td>
<td>***</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>Durability</td>
<td>**</td>
<td>***</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>Rot, fungal rot, moisture</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>UV radiation</td>
<td>**</td>
<td>*</td>
<td>****</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Acid resistance</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>Alkaline impact</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
<td>****</td>
</tr>
<tr>
<td>Wearing resistance</td>
<td>**</td>
<td>**</td>
<td>****</td>
<td></td>
<td></td>
<td>****</td>
</tr>
<tr>
<td>Storage</td>
<td>wet/dry</td>
<td>wet/dry</td>
<td>wet/dry</td>
<td>wet/dry</td>
<td>wet/dry</td>
<td>wet/dry</td>
</tr>
<tr>
<td>Buoyancy (density)</td>
<td>barely floats (0.95)</td>
<td>floats (0.99)</td>
<td>sinks (1.12)</td>
<td>sinks (1.14)</td>
<td>sinks (1.44)</td>
<td>floats (0.97)</td>
</tr>
<tr>
<td>Melting point</td>
<td>approx. 128 °C</td>
<td>approx. 150 °C</td>
<td>approx. 245 °C</td>
<td>approx. 250 °C</td>
<td>approx. 427 °C</td>
<td>approx. 147 °C</td>
</tr>
</tbody>
</table>

*poor  **acceptable  ***good  **** excellent

Note that the material softens and weakens already at 20-30% below its melting point.

The treatment process often involves adding a substance which prevents sunlight from penetrating the material. The treated materials therefore only lose 5-10 per cent of their breaking strength, even after long-term exposure to sunlight. However, the conclusion is that you should cover your net, and as the net does not rot it will not be damaged by being wet.

### Density

Density is one of the properties which you can literally touch and feel. The density of all plastic materials is close to that of water, but it is important to know whether it is above or below, as this determines whether the material sinks or floats. Density is normally expressed in grams per cubic centimetre. The density of fresh water is 1.00 g/cm³. That of saltwater in the open sea is 1.02 g/cm³.

Polyamide and polyester are heavier than water while polyethylene and polypropylene float. These data are important for the fisherman to know when mounting weights and floats on a fishing tool. It is also very important in, e.g. purse seining, where the density helps determine how fast the purse seine sinks to surround the shoal of fish, and in net fishing when having to determine the relative weight and bouyancy of the net.

### Melting point

Only in a few cases is this important as regards the use of a specific material. If a rope rubs against a surface while being let out the frictional heat may in some cases result in materials with a low melting point starting to melt. This is particularly important when a mooring line or another rope runs around a mooring post. This may produce a significant amount of heat.

### Properties of the finished net or rope

As mentioned earlier, the post-treatment of the raw materials will affect a number of important properties. Fibre type, dyeing, twisting, knotting, treatment and stretching will all determine the applications of the finished net or rope. The quality assurance of the manufacturer is also a significant factor. It is therefore very difficult to provide specific information about the properties. In the following we will thus have to stick to certain general features, knowing that there may be net and rope types that do not fall into this category.

### Breaking strength

The breaking strength is understandably one of the most important properties that the fisherman and the net maker must consider when selecting a material for a certain job. You have to weigh both the safety of
having a material which will be sufficiently strong against the price, the weight and the towing resistance of a strong piece of netting or rope.

Most manufacturers specify the breaking strength of a dry line – also in connection with nets. But this value is useless for the fisherman as he needs to know the breaking strength of the wet, knotted net which will typically be considerably lower. The reason for this is that once a knot is tied on a line or rope, its breaking strength will be reduced by approximately 50 per cent in most materials. In nets the knot breaking strength is thus much more important to know than the breaking strength.

Generally, the breaking strength for a dry line is very high in the four most common materials, and somewhat higher for nylon and polypropylene than for polyester and polyethylene. But when comparing the knot breaking strength for the same materials, it becomes evident that polyethylene does not lose its breaking strength to the same extent as the others. Thus, the material compensates for its somewhat lower breaking strength when dry.

Knot firmness
In nets that are subjected to heavy stress, such as trawl net, it is important that the knots do not slide. Knot firmness is thus an important property in ensuring that the trawl does not lose its shape.
In net fishing it is also unfortunate if the mesh loses its shape due to knot sliding. Good knot firmness depends partly on the material, the fibre type and the twisting. It can be increased by finishing the net by hot stretching or by impregnating the material in a treatment process.

**Stretching**
The stretching of a material covers several different aspects:

- Shock resistance capability
- The stretching at a certain load, e.g. 50 per cent of the knot breaking strength
- The reaction to long-term constant load
- The ability to regain its original length following a certain amount of stress

When the material is capable of stretching when subjected to stress, it is more capable of absorbing shock effects without breaking, and it can distribute the pull more evenly in the net.

The stretching of a material depends heavily on the fibre type and the twisting of the thread, and there are therefore large variations from manufacturer to manufacturer. Thus, staple fibres not only have a lower breaking strength, they also lead to increased stretching than continuous fibres.
In general, the stretching is higher in nets made of polyamide (PA) than in other raw materials. At 50 per cent knot breaking strength, a large-scale examination of different materials showed that the stretching in polyamide (PA) was 15-30 per cent and 10-15 per cent in polyester (PES), polyethylene (PET) and polypropylene (PP).

One of the most important properties associated with stretching is the ability of a material to regain its original length. This is called elasticity. If the net has complete elasticity the net will not only retain its shape, but also its mesh width. However, a certain amount of sustained stress will often result in some degree permanent stretching.

**Flexibility**
The rigidity or the flexibility of a material for a fishing tool is usually not that significant within the normal framework. Furthermore, there are some tools, e.g. certain types of net in which a high rigidity is not desirable. A rigid net can be easier to handle, clean and repair whereas a flexible rope can be easier to coil.
A number of the treatment agents used for net protection increase the rigidity of the material.

**Wearing resistance**
Before the introduction of synthetic materials for fishing tools, the wearing resistance of the material was virtually without significance as the material always rotted away before it was worn out. Today, things are quite different in this respect. The durability of a net or a rope depends entirely on the wearing resistance of the material. The highest degree of wear appears to occur on board the vessel where the material rubs against rollers, pipes, hull etc. On stern trawlers a high degree of wear occurs when the bag is hauled up through the ramp.

The wear occurring while the tool is being used for fishing is a problem in bottom trawling and seining. Sand, gravel and rocks will result in a lot of wear, but in most cases many efforts have been made in the construction of the tool to avoid that the tool comes into contact with the sea bed. The highest degree of wear occurs in the knots of the net. Furthermore, on rope you often see wear produced by the fibres rubbing against each other.

It is difficult to compare studies of the wearing resistance of different materials. However, it seems that the coarser the material, the higher the wear. Thus, staple fibre lines will wear faster than continuous fibre lines. Similarly, it seems that the higher the strength of the individual fibres, the higher the wear resistance. The monofilaments are thus the most durable lines, particularly if they are made of nylon (PA).

**Shrinkage**
It was previously mentioned how nets made of PA in some cases shrink when exposed to water for the first time. It is very important for a net maker and a fisherman to know the extent of this phenomenon before using the material for, e.g., trawl bags, where the mesh width is stipulated in the fishing legislation.

Naturally, fishermen are not interested in using meshes with a large safety margin in relation to the legal mesh width. The choice of mesh width in a trawl bag will therefore often be a balancing act.

However, the effect of the water on the material is not the only factor which is able to change the mesh size. Sometimes a trawl bag will have absorbed a lot of sand in its bars and knots. This is particularly the case with braided nets and nets made of heavy-duty material. In addition to significantly increasing wear on the net, it will also lead to the bars getting thicker and thereby shorter. You could call this sand shrinkage.

Another aspect which may reduce the effective mesh size is when the material is exposed to a pull of such a magnitude that some of the fibres break. The line will obtain a woollen appearance, and the bars will get thicker – and again shorter.
Net making

Today, nearly all fishermen buy ready-made tools from a net maker or net shop. They do not have to worry about their manufacture but can choose any type of quality or design they like. Yet it would be hard to imagine working on a ship and not having any basic knowledge of how to maintain and mend the fishing gear used on board. When you are out on the fishing grounds there is no net maker nearby, and you will need to be able to mend any damage to the net or splice a new eye on a rope.

Technical terminology

Before you can even begin to work with a line and rope, you need to know the right terminology. The technical terminology used about ropes and how to work with them was developed on board the old sailing ships where very accurate terminology was needed: The ship’s and the crew’s safety could depend on whether the right fastening was used in the right places. Basically, there are some general terms for the rope and its most simple bends.
**Net maker’s tools**

Net making is characterised by the fact that the net maker uses only a few tools in his work. Other crafts have developed a wide range of tools and aids over time, which have helped increase efficiency, but this has not happened to the same extent within net making.

This book describes the three most important net making tools: the knife, the net mending needle (also referred to as the net needle) and the marlinspike.

**Knife**

First of all, you need a good, sharp knife that can cut cleanly through ropes and lines to avoid raw edges. The knife is also used to trim the knots in the individual sections of the net. In particular, the steel needs to be of a high quality to ensure that the knife can always be sharpened to make it really sharp.

If the knife does not cut through the rope like a hot knife through butter, it requires too much effort, which may cause the knife to slip and cause injury. A knife that is not sharp is a dangerous knife!

Net making does not require the use of one specific knife. Many net makers use knives with a straight blade, either with a fixed handle or as a folding knife, but the final choice varies from person to person.

A knife is a personal tool which may not function well in the hands of others. This is due to the fact that each person has a unique way of positioning the blade, which makes it difficult for other people to sharpen the knife. It is also very difficult for left and right-handed people to swap knives.

**Net mending needle**

The net mending needle is a special type of needle with an “inner” tongue. The tongue holds thin line or thread so it is easy to pull the thread through the meshes and unwind as it is used.

Needles come in many sizes, and it takes some practice to use a needle correctly. First of all, it is important to learn how to replenish the thread or line – if it is not done correctly, the line will start twisting and turning during the work, which is both time-consuming and annoying!

Ordinary needles can be used for most tasks, but if you need to do the seizing on the lines on a purse seine, for example, you need a special purse seine or seizing needle. It is similar to a shuttle and has several advantages: It is sturdier, the tongue in the middle does not bend if force is used to tighten the line or thread, and the line or the thread is protected by the high edges.

**Marlinspike**

Marlinspikes also come in various sizes and versions. It is a round steel rod which is pointed at one end. The spike is used when splicing to open the strands of the rope/wire. Some marlinspikes are round and have to be removed from the rope before inserting the strand, while others resemble a cut pipe into which the strand can be placed when the marlinspike has been inserted. Then, when it is subsequently pulled out, it is necessary to check that the strand stays in the tuck.
Whippings
When a piece of rope is cut from a role of rope, there are two rope ends which must both be prevented from unravelling. Plant fibre rope must be properly whipped, while synthetic rope is often “whipped” most effectively by simply melting the ends with a lighter. This can be difficult if the rope is thick. If so, you need to use a hot knife that melts its way through the rope when it is cut, or you can wrap a piece of sticky tape around the rope end or the strands.

Common whipping
A common whipping is made by making a suitable number of turns around the strands towards the rope end – the width of the whipping should be just as high as the diameter of the rope. One end of the whipping twine is held secure under these turns. The other end of the whipping twine is laid towards the first one and wound around the rope four times. Everything is pulled tight and the ends of the whipping twine are cut off.

Hitches and knots
There are hundreds of recorded hitches and knots. Most hitches and knots are of unknown origin and have a history which goes back a long time, while a few have been invented in recent times such as the special Danish knot “dummepeter over”, which is used to tie on a smooth line; this knot was not recorded until 1989.

It is estimated that around 90 per cent of all recorded knots have been invented by sailors while the remaining 10 per cent originate from other professions or leisure activities. Archers, bookbinders, surgeons and mountaineers, for example, have all contributed their own ways of arranging thread, lines and ropes.

The difference between a hitch and a knot is vague. Generally, you can say that a hitch is something which forms an eye or a turn, while a knot is a type of fastening:

A hitch includes bights or turns that either circle the standing part of the rope, some other rope or an object (such as a timber head).

A knot is made directly on the rope or when two pieces of rope or line are joined together. This may involve turns or bights which are led around their own part or other rope.

The “right” knot or hitch for a particular task should meet the following criteria:

- It must be laid fast.
- It must be durable and safe.
- It should not cause any undue wear and tear on the rope or equipment.
- It should be easy to untie or almost impossible to undo (as required).

However, it will often be necessary to moderate one or several of these requirements to meet the others, depending on which requirement is most important in a given situation.

So although there are hundreds of knots and hitches, there is no need to learn all of them by heart nowadays. This book only includes the most important and most frequently used ones. Texts and illustrations are helpful to read and look at but there is only one good way to become familiar with various knots and hitches: Lay them yourself – and do it over and over again! And remember: “Learn to do it well – then you will also learn to do it fast”.

**Bowline – a loop hitch**
The bowline is a very frequently used hitch if, for example, on a large hawser you need a loop to place over a pole. The bowline enables you to pull on the rope without it tightening around the object over which it has been placed. Cross the working end of the rope over the standing part and hold it with your palm facing downwards (a). Turning your hand so your palm faces upwards while catching the one part with your thumb creates a loop on the standing part with the working end passing through the loop. Then pass the working end under the back of the standing part and back down through the loop (b), and pull (c).

![3.5-Bowline](image)

**Clove hitch – a hitch for fastening**
A clove hitch is frequently used to secure small and large ropes to, e.g. posts. However, the hitch is not completely secure unless it is subjected to an even and constant load; if not, it must be secured by an additional round turn or a half hitch around its standing part.

![3.7 Knots](image)

**Sheet bend – a knot for joining two (dissimilar) ends**
The sheet bend is also called the weaver’s knot and is the knot most frequently used by the net maker to join two pieces of netting. It is especially suitable for joining ropes of unequal thicknesses. Form a bight in the working end of the thicker rope. Pass the working end of the thinner rope around the bight, and trap it under itself. The knot is laid correctly if the two rope ends are on the same side. The knot can be strengthened by tucking in the rope end as shown below. This ensures that both rope ends are on the same side. This variant is used especially for synthetic rope and line.

![3.6-Simple sheet bend](image)
Reef knot – a knot for joining two (similar) ends
The reef knot is very easy to untie even if it has been subjected to a heavy load. It should only be used when the two ends have the same thickness and stiffness, otherwise you cannot be certain that it will hold. It is particularly suitable for relatively thin lines. Place the two ends in a turn around each other, and place the rope ends in yet another turn so that each working end is parallel to its standing part. A simple mnemonic: Left over right and under, right over left and under.

Fisherman’s knot – a knot for joining two ends
The fisherman’s knot is also known as the true lover’s knot. It is formed by two single knots which are pushed together. The fisherman’s knot is a very strong way of joining two ends but the knot is almost impossible to untie – on thin lines it has to be cut up. The net maker uses it to join seizing twine. The knot is made by tying each rope in a single knot around the other.

Figure-of-eight knot – a stopper knot
The figure-of-eight knot is also called the Flemish knot. The figure-of-eight knot is used like an ordinary knot to prevent an end from running free (i.e. running through an opening such as a block or an eye). It also effectively prevents a rope end from unravelling and can be used to secure a line to, for example, a thin ring. The figure-of-eight knot is easier to untie than an ordinary knot.

Splices on laid rope
Splices are used to form permanent joints, and when you want to create a fixed eye on a rope end. Splices can be made on ordinary rope as well as synthetic rope and wires. Hawser is usually delivered with a splice, but if you need more the fisherman may still need to splice something while at sea. There are many ways to splice a rope. Generally, there are three types of splices: eye splices, short splices and long splices. This book only describes the most common splices (four eye splices and one short splice). It takes practice to be able to do a splice well. It is often helpful to start by making a temporary whipping on the rope to prevent any further unravelling of the strands.
**Eye splice on three-strand rope**
Eye splicing is used to create an eye on a rope, for example a mooring line, and to fasten a chain or a shackle to the end of a rope. A thimble is often inserted to protect the rope from wear and tear.

**Word Definitions**

| thimble = a metal ring inserted in a rope as reinforcement, for example in connection with eye splicing |

**Eye splice on four-strand rope**
If you need to do an eye splice on a four-strand rope, you use the same procedure as for a three-strand rope. Let the first tuck of strand no. 4 go in the same spot as strand no. 3, but let strand no. 4 pass under two strands.

**Short splice on three-strand rope**
Short splicing is used to join two rope ends where a knot would be in the way. Unwind three turns on each of the two rope ends and place them together so the strands of the one rope end are interwoven with the other (a).
Splice the strands from the left rope end over one and under one opposite the direction in which the rope is laid (b). When each strand has been tucked in, turn the splice around and repeat the process with the other three strands. Pull all six strands tight and make an additional two tucks with all the strands. If you carry out a splice on a synthetic rope, you should make another 1-2 tucks with each strand. Stretch the splice well before cutting off the strands.

---

**FACT BOX**

To splice means to join two parts (for example two rope ends, but also to get married (get spliced).
Splice on braided rope
For obvious reasons, splices on braided rope are more complicated to make than on three- and four-strand ropes. It is possible to splice braided rope fitted with a sleeve according to the same principles as with laid rope but this is not done in the fishing industry. Instead an eye is made by sticking the rope end through the braiding and letting it follow the core for a certain length. It is possible to make a nicer looking splice by pulling back the sleeve and exposing the core. The eye is then made from the core which is tucked under the sleeve below the pulled back sleeve. Pull the sleeve over the core in the eye itself and adjust its length.
Square-braided rope has fewer strands, often 4, 8 or 16 and no sleeve or core. The strands often lie as pairs. If an eye splice is desired, it can be made by spreading the strands as usual (or the strand pairs) and making three or four tucks along the rope. As always, it is important to start the splice correctly to prevent the eye from reducing the strength of the rope significantly. See the example in Appendix on p. 43.

Eye splice on wire
When splicing a wire, it is also important to whip the strands to prevent them from unravelling. Insulating tape is often used for this, as it helps to avoid “spiky” rope ends that can scratch your hands and are difficult to work with.

Insert the marlinspike so it passes under two strands and emerges where strand no. 1 goes in. Tuck strand no. 2 along the marlinspike (i.e. strand no. 2 passes under two strands).

Tuck in strand no. 3 so that it only passes under one strand. Make sure that strand nos. 1, 2 and 3 are all tucked in the same spot but pass under three, and one strands, respectively.

Turn the eye 180° (half turn). Tuck strand no. 4 in and around the strand which is opposite the spot where the three first strands go in. Wrap strand no. 5 around the next strand, and repeat the procedure with the last tuck. Make sure that all tucks go around the same strand.

When all the tucks have been made, the eye is pulled tight. Make three more tucks with each strand. Finally, cut off the strands with a chisel.

There are another two ways to create an eye on a wire. First, you can use a wire clamp consisting of two bent plates which are fixed together by two bolts. Normally, you should use three wire clamps placed in succession, which allows you to join two pieces of wire or create an eye on a loose end of a wire. However, this should only be used in absolute emergencies, because it does not hold very well and because the wire clamp will usually be in the way during regular use.

Fact Box
It is not unusual to see a type of wire clamp, consisting of a u-bolt which is threaded at both ends. Two nuts are used to push a plate over a wire join or an eye on a wire. However, it should be emphasised that it is prohibited to use such a wire clamp on board ships for hoisting and unloading gear.
**FACT BOX**

The large meshes at the front of a mid-water trawl are often made by splicing the bars. This method is easier than tying knots for the meshes which in some cases are 75 m in the bar.

Another method is to use talurits. A talurit is a piece of metal piping which is squeezed around the eye in a hydraulic press. The talurits are available in different metals depending on whether they are to be used on Taifun (combination rope) (aluminium), iron wire (steel) or steel wire (copper). A talurit press is not usually found on board fishing vessels, only at the net makers.

**FACT BOX**

**Common terms**

In order to be able to describe how to work with fishing nets, it is necessary to know some common terms.

You talk about:

**Bars:** The parts of the net which are not included in the knots.

**Row:** A horizontal row of bars. In machine-made nets a row consists of one long thread.

**Joining row:** The row which the net maker ties in the joint between two sections.

**Vertical cut:** A cut which is parallel to the longitudinal direction of the net.

**Across:** A cut which is perpendicular to the longitudinal direction of the net, i.e. in the same row.

**Bar cut:** A cut which is parallel to the bars of the stretched net.

**Joining and mending nets**

**Net mending**

As mentioned earlier, most fishing nets today are made by net makers but it is still important for a fisherman to be able to mend his own nets. Small tears and holes need to be repaired when they happen – even at sea. Net mending requires both practice and experience. You need to practice a lot, and it helps if you can ask older fishermen for advice.

The knot used in net mending is called the sheet bend (a). The drawing below shows how to make a mesh from A to B (b) using the net mending needle which is loaded with net mending twine. As the bight between A and B passes under the left side of your hand, you can use your hand to adjust the mesh size. When the mesh has the right size, squeeze point B with the index finger and thumb of your left hand, and proceed to tie the sheet bend with the net mending needle. Pull tight. If you use nylon thread for net mending, it may be necessary to make two tucks (c), thereby tying a sheet bend with round turn.

![Net mending diagram](image-url)
It is very important to ensure that the meshes in the net have the right size. If they are too small, the net becomes smaller where it has been mended. This results in an uneven pull in the net, which minimises its strength. The same thing happens if the meshes are too large. If you are mending a tear in the trawl bag and the meshes become too small, you may be in violation of the rules on mesh sizes. For more extensive repair work, mending over a so-called row can make the task of maintaining the right mesh size a little easier. The row resembles a ruler, and its width must be equal to half the mesh size. Below are some examples of how to mend torn nets. Trim the tears to make it possible to start and finish the work where the net has three parts (where three strands of thread radiate from a knot) – this is also called a three-leg. A two-leg is the spot where the net has two parts (where two strands of thread radiate from a knot).

3. A horizontal tear. Start at a three-leg, and work your way towards the right from a two-leg to a two-leg and finish at a three-leg.

4. A vertical tear. As always, start at a three-leg and work your way into the tear from two-leg to two-leg and finish at a three-leg.

5. A hole in the net. Trim the hole so you can start at a three-leg (a) and finish at a three-leg (b). Work your way from left to right and from right to left by turns until you reach point b.

See the trawl drawing in Appendix on page 44.

**Trimming**

When joining two net sections of a trawl, you need to trim the top of one section and the bottom of the other section. Two things are important when trimming a net section across:

1. That you choose the right row of knots to cut. If you look at a piece of netting, you will see that the entire net is joined using the same type of knots, but in every other row the orientation of the knots changes (try to turn the net around and you will see it!). One row can be used when trimming the top of the section while the other row is used when trimming the bottom.

2. That you avoid damaging the loops during trimming. The knife must be kept away from the loop which must remain. The trimming is therefore carried out in a very special way, such that the knife “lands” up at the end which is cut off once it has passed through the net.

**Cutting a net section**

In the body of the trawl the sides of the pieces of netting are not parallel. The cut in the side can be more or less steep, which is determined by how the bars are cut. You talk about:

- cutting a side knot which results in a “vertical cut”.
- cutting bars which results in a “bar cut”.
- cutting a knot at the top or cutting across.
See also the fact box on page 30. Normally, all sorts of combinations of these two cuts will be used to achieve the right cone shape. On the net maker’s drawing, the individual cut will be defined according to the number of plain meshes and cut bars. 2-2 thus denotes a cut with two plain meshes and two bars, while 1-4 denotes a harder cut on one plain mesh and four bars. On the drawing, a cut-out has been made for a piece of netting cut 1-3.

As mentioned earlier, the length of a piece of netting is determined by the width and number of bobbins on the machine tying the net. The length of the pieces of netting is therefore usually predetermined and a half mesh from a round number: 19½ mesh, 49½ mesh, 99½ mesh etc. Thus, the entire section is 20, 50 and 100 meshes long if you count in the joining row. This makes it easier to calculate the length.

The width is defined by the number of meshes across or as the number of knots in a specific row. The last number is double the first number.

Three examples of joining two pieces of netting. It can be seen that the cuts are a combination of both vertical cuts and bar cuts. The joining of two different numbers of mesh must be calculated in order to get a reasonable number to work with. The ratio between the number of meshes in the two pieces will normally be 0.5 to 1. The picking up of a mesh is known as a decrease.

The following ratio provides good joints:
1  the joint will be 1 to 1
0.9  the joint will be 10 meshes to 9
     – i.e. a decrease for every tenth mesh
0.8  the joint will be 5 meshes to 4
0.75 the joint will be 4 meshes to 3
0.67 the joint will be 3 meshes to 2
0.5  the joint will be 2 meshes to 1
     – i.e. a decrease for every other mesh

If the calculation of the ratio does not yield a good result, it can be improved by omitting decreases at the edge of the joint. In a the ratio is 1 and the meshes are therefore joined 1 to 1. In b the ratio is 0.58, i.e. close to 0.5, and the joint is made 2 meshes to 1 and is adjusted by letting two meshes on each side join 1 to 1. In c the ratio is 0.83. The nearest good ratio is 0.8 and again it is adjusted by letting two meshes on each side join 1 to 1.
Edging, joining and seaming
When tying a joining row it is very important that the bars have just the right length. The net can be distorted if the bars are too long or too short, and if they are not uniform, the pull between the net sections is not distributed evenly.
Make sure you are fully familiar with the knots used, not least when starting and finishing the job. Check regularly that the length of the bars of the rows made is correct and uniform.

Work sequence
There is no real reason to start in one place rather than another when you begin making a fishing tool, but traditionally you start in certain places.
When making trawls and Danish seines you start at the first section of the upper side of the body and cut the number of meshes across that the trawl should be wide. Presumably, the reason why you start here is that in earlier times a trawl would often be made without the use of a drawing – if you started elsewhere, you might not be sure how big the trawl would eventually be. The number of meshes around the opening is one of the most direct indications of the trawl’s final size and thereby its towing resistance.
Once the first section has been cut, you cut out a piece of netting for the roof and thus work your way towards the wings. Afterwards, using the same procedure, you work your way backwards towards the bag.
When making a purse seine you will often start by preparing the lines and attaching the lining. This is done for both practical and economic reasons: A purse seine takes a long time to make and is very bulky, so you do not want to take it home until it is finished to save space and storage charges.
As regards nets, some Danish fishermen have purchased their own sewing machines to fasten lines to the nets, but most nets are usually purchased ready-made from overseas suppliers in Eastern Europe or the Far East.

Tool maintenance
Trawl and Danish seine
Many fishing tools today are so large that the fishermen are unable to handle the tools on board the ship. There is not much room on deck to remove the trawl from the net drum and check it, and it can be difficult to get it onto the quay without the net maker’s lorry with the power block. Consequently, the fisherman does not carry out much maintenance of his own fishing tools.
When a trawl has been in use for some time, it is advisable to carry out a readjust-
A readjustment involves checking the entire trawl to ascertain whether the trawl has retained its original dimensions. Usually it has not, since the net, the lines and the tails often become stretched after a period of use. A readjustment involves checking:
- that the tails are of equal length,
- that the variance often built into nets and lines by the net maker, called the hanging ratio, has been maintained,
- that the difference between net sections in the top and bottom panels has been maintained.

If the deviations from the original shape are too big, they must be remedied. Daily maintenance of the fishing tool involves repairing the holes in the net that will invariably occur and checking that rope and other equipment are not too damaged by long-term use, rendering it unsafe. If the trawl is not going to be used for some time, it should be stored in a dry place away from sunlight, preferably indoors. Some ports and net makers have so-called trawl terminals or trawl drying facilities where the trawls can be stored. If the trawl is stored outdoors, moisture from the rain will cause dirt and grime in the net to rot, including dead fish. Apart from the smell, it will attract rats which can quickly gnaw their way through an entire trawl and make an awful lot of (new) holes in the net!

**Purse seine and net**

Fishermen only maintain their purse seine and netting tools to a limited extent. The purse seine is usually too big to handle on board the ship. If a minor tear is discovered, it is possible to pull the section with the tear aside during hauling and repair it later, otherwise the purse seine is taken to the net maker if more extensive repairs are needed. Holes and tears in nets usually appear very quickly in nets but they do not significantly reduce the ability of the tool to catch fish. It just means that there are fewer meshes for the fish to get caught in. At the same time, nets are so cheap today that a worn-out net is often discarded rather than repaired.

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**REAL-LIFE STORY**

**Try again**

It can often be very difficult to see what is what with a trawl when it is piled up on the deck and even if it is lifted onto the quay, it can be tricky to carry out repairs or replacements because it is impossible to distinguish the different parts from one another. This was what the crew on a cutter found when they were asked to carry out a readjustment of a herring trawl which had been in use for some time. The fish catching ability of such a trawl depends on the pieces of netting that make up the top panel being slightly shorter than the pieces that make up the bottom panel. The top panel had become stretched during use and a readjustment was needed, i.e. removing a mesh from across several of the sections. The joining rows were cut up and the row of meshes was cut off, and the extra slack in the bottom panel was distributed by taking apart some of the side seams. The crew then started to put the trawl back together but after a while it became clear that something was not right. It looked wrong and could probably not be used as a fishing tool. It turned out that the section of the net which was to be readjusted had not been marked off properly before the work was begun, and as a result the crew had begun to make a seam between two panels which did not belong together. The moral is that it is worth making thorough preparations for a task and make sure that the trawl is well stretched out and that the work is well marked off before you start – in this case the crew’s failure to do so cost them 3-4 hours of extra work.
Loading and unloading gear

Heavy weights are constantly being moved around a fishing vessel, and only the smallest vessels have weights that can be handled without the use of cranes and other lifting gear. In order to be able to load fishing tools or provisions on board the vessel or replace a set of trawl doors, you need the help of a winch and other deck machinery. The equipment may be supplied by the shipyard or a net maker or sailmaker which guarantees that it meets the specifications for lifting capacity and breaking strength etc. However, once the fisherman is out at sea, he should have basic knowledge about the load capacity of the equipment.

Many other iron products are used in fishing than those mentioned below: rings, turning joints, P-links, G-links, hammerlocks, split links, safety hooks and many others with different shapes, properties and functions. What they all have in common is that they are used as connecting links in the fishing tools or in hoisting and unloading systems, and that it could spell disaster if they are exposed to excessive loads.

Due to the considerable safety aspects regarding the equipment, the need has arisen for a guarantee that a particular product meets the promised breaking strengths and maximum working load. As a result, manufacturers have made the classification companies check the quality of the equipment and thereby vouch for its durability. In this context, you talk about a classed chain or a classed hammerlock.

Chains

Chains are made from ship building steel of different strengths. The chains used in the unloading systems are usually chains without studs, while the chains used for the anchor are chains with studs. The studs make the chain stronger and prevent kinks from forming; this is especially important for anchor chains that must be able to run freely out of the chain locker. Unlike ropes and wires, chains are inelastic and do not stretch. On the other hand, they become worn at every link, and a chain will therefore get longer over time.
The dimension of the chain is indicated by:
• the diameter of the rod iron it is made of
• the inside width of the links
• the inside length of the links
• the estimated number of links per metre

The strength of a chain can be read from breaking strength tables.

Shackles and other hammerlocks
These are made from steel. They are used to fasten and join the individual parts of the unloading system (chains and wires). A shackle consists of an iron loop with a screw bolt. The design of both the iron loop and the shackle bolt depends on where the shackle is going to be used in the system – whether it will be unscrewed often or remain in the same position for longer periods of time.

The dimension of a shackle is indicated by the diameter of the rod iron it is made of (if the diameter of the loop and bolt differs, both are indicated).

Shackles are rarely used for the fishing tool itself, particularly trawls. When joining the foot rope or ground rope, for example, hammerlocks are often used which are two loops joined with a pin which is hammered in using a sledge hammer and removed using a sledge hammer and a punch. They are preferred to shackles where there is so much movement and shaking in the system that the shackle’s screw bolt could be unscrewed from its thread.

Hooks
Hooks are often used to hoist and move large and/or heavy objects on the ship. They are exposed to heavy loads and must therefore be designed for adequate strength. Around the opening, the hook will be affected by bending and stretching forces, and this area is often thicker than the rest of the hook. At the same time, you have to make sure that the hook does not catch on any protruding edges during lifting.

Blocks and tackles
Blocks are frequently used to reduce the force needed to lift heavy equipment. Two blocks are often used together and form a tackle. However, the direction of a pull or a lift can be changed by means of a single block.

A block consists of:
• a casing
• one or several sheaves (made from nylon or iron)
• a bolt
Blocks have many different designations depending on their design and use. Depending on the number of sheaves, a block is referred to as a single, double or treble-sheave block.

If there is one sheave in each block, the tackle is called a gun tackle. If there is a sheave in one block and two in the other, the tackle is called a luff tackle. In other words, the tackle’s total number of sheaves determines its name. If the two blocks of the tackle together have more than four sheaves, it is called a winding tackle. You therefore talk about five, six and seven-sheave winding tackle.

**Fact Box**

The subject matter of this chapter is so important for the safety on board that there are international rules prescribing how the equipment must be constructed and used. The rules state: “Hoisting equipment and unloading gear must have the required strength, a suitable design and be kept in a good state of repair. During use, they must not be exposed to loads which exceed their maximum permitted working load.” This is followed by detailed rules regarding designs, material strengths and uses. In this context you talk about:

- **Breaking strength**: The maximum load that an object can withstand before it breaks.
- **Maximum working load**: The maximum load that an object is certified to be subjected to.
- **Safety factor**: The ratio between the breaking strength and the maximum working load.

The regulations prescribe the following safety factors:

<table>
<thead>
<tr>
<th></th>
<th>Safety factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel wire rope (wire) as a general rule</td>
<td>5</td>
</tr>
<tr>
<td>Chains</td>
<td>4.5</td>
</tr>
<tr>
<td>Other unloading gear such as hooks, shackles, blocks, swivels, rings etc.</td>
<td>5</td>
</tr>
<tr>
<td>Rope</td>
<td>7</td>
</tr>
</tbody>
</table>

1. Luff tackle, running block is the standing block.
2. Luff tackle, running block is the moving block.
3. Two-fold tackle, running block is the standing block.
It is important for the durability of the wires and ropes that the width of the groove in the block is equal to the diameter of the wire – it should never be smaller. It is recommended that approx. onethird of the wire's diameter rests firmly against the bottom of the groove. In the same way, the diameter of the sheave should match the diameter of the wire or the rope. This is most important in the case of wires where it is recommended that the diameter of the sheave is 25 times the wire diameter for stiff wires (for example 6x7) and 20 times for softer wires (for example 6x19).
## Synthetic lines

<table>
<thead>
<tr>
<th>Danish yarn number</th>
<th>International yarn number</th>
<th>Running length, m per kg</th>
<th>Breaking strength, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Twisted nylon</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>210/18</td>
<td>2,114 m per kg</td>
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<tr>
<td>8</td>
<td>210/24</td>
<td>1,587 m per kg</td>
<td>37 kg</td>
</tr>
<tr>
<td>10</td>
<td>210/30</td>
<td>1,290 m per kg</td>
<td>48 kg</td>
</tr>
<tr>
<td>12</td>
<td>210/36</td>
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</tr>
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<td>16</td>
<td>210/48</td>
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<td>73 kg</td>
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<td>20</td>
<td>210/60</td>
<td>597  m per kg</td>
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<tr>
<td>24</td>
<td>210/72</td>
<td>491  m per kg</td>
<td>106 kg</td>
</tr>
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<td>124 kg</td>
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<tr>
<td>32</td>
<td>210/96</td>
<td>364  m per kg</td>
<td>135 kg</td>
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<td>40</td>
<td>210/120</td>
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<td>173 kg</td>
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<tr>
<td>60</td>
<td>210/180</td>
<td>196  m per kg</td>
<td>287 kg</td>
</tr>
<tr>
<td>96</td>
<td>210/288</td>
<td>120  m per kg</td>
<td>426 kg</td>
</tr>
<tr>
<td>160</td>
<td>210/480</td>
<td>75   m per kg</td>
<td>736 kg</td>
</tr>
<tr>
<td>240</td>
<td>210/720</td>
<td>47   m per kg</td>
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</tr>
<tr>
<td>3/6</td>
<td>500/18</td>
<td>909  m per kg</td>
<td>46 kg</td>
</tr>
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<td>3/8</td>
<td>500/24</td>
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<td>57 kg</td>
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<td>3/12</td>
<td>500/36</td>
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<td>3/20</td>
<td>500/60</td>
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<td>3/40</td>
<td>500/120</td>
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<td>279 kg</td>
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<td><strong>Braided polyethylene</strong></td>
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<td>2.5 mm</td>
<td>2.5 mm</td>
<td>373  m per kg</td>
<td>110 kg</td>
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<tr>
<td>3.0 mm</td>
<td>3.0 mm</td>
<td>258  m per kg</td>
<td>151 kg</td>
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<td>6.0 mm</td>
<td>6.0 mm</td>
<td>86   m per kg</td>
<td>471 kg</td>
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<tr>
<td><strong>Twisted polyester</strong></td>
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<td>43</td>
<td>250/12</td>
<td>2,730 m per kg</td>
<td>23 kg</td>
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<tr>
<td>63</td>
<td>250/18</td>
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<td>35 kg</td>
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<td>250/24</td>
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<td>250/30</td>
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<td>250/36</td>
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<td>68 kg</td>
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<td>163</td>
<td>250/48</td>
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<td>87 kg</td>
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<td>203</td>
<td>250/60</td>
<td>533  m per kg</td>
<td>119 kg</td>
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<tr>
<td>243</td>
<td>250/72</td>
<td>445  m per kg</td>
<td>131 kg</td>
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<tr>
<td><strong>Braided polyester</strong></td>
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<tr>
<td>4.0 mm</td>
<td>4.0 mm</td>
<td>140  m per kg</td>
<td>394 kg</td>
</tr>
<tr>
<td>6.0 mm</td>
<td>6.0 mm</td>
<td>93   m per kg</td>
<td>583 kg</td>
</tr>
<tr>
<td>7.0 mm</td>
<td>7.0 mm</td>
<td>81   m per kg</td>
<td>657 kg</td>
</tr>
<tr>
<td>9.0 mm</td>
<td>9.0 mm</td>
<td>62   m per kg</td>
<td>858 kg</td>
</tr>
</tbody>
</table>
## Technical information

### Examples of the use of steel wire ropes

<table>
<thead>
<tr>
<th>Design</th>
<th>Description</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6 x 7 + 1 FC</strong></td>
<td>This design is made from few and therefore relatively thick threads, thus achieving a high degree of wearing resistance and resistance to corrosive deterioration.</td>
<td>Trawling, Backstays, Stays. If the steel wire rope is used as trawl wire, it can be supplied with different weave-ins and marking.</td>
</tr>
<tr>
<td><strong>6 x 24 Seale + 7 FC, purse seine line</strong></td>
<td>The sturdy outer threads give this design a high degree of wearing resistance.</td>
<td>Purse seineing.</td>
</tr>
<tr>
<td><strong>6 x 19 + WSC</strong></td>
<td>As standard, this design is only made in dimensions up to and including 10 mm. A robust and hard-wearing wire.</td>
<td>Hoisting wire for small tackles. Backstays, Stays.</td>
</tr>
<tr>
<td><strong>Thin steel lines with the design 1 x 19.6 x 7.6 x 812 + 7FC, 7 x 19</strong></td>
<td>Use: Small hand winches. Tackles. Lorry cranes. Tipping bodies. Purse seine line. Carriers etc.</td>
<td></td>
</tr>
<tr>
<td><strong>6 x 24 + 7 FC</strong></td>
<td>This design is the most frequently used within ship provisions due to its relatively high breaking strength combined with a high degree of flexibility and elasticity.</td>
<td>Moorings, Running rigging, Loading wire, Tow hawser, Straps.</td>
</tr>
<tr>
<td><strong>6 x 19 Seale + FC or IWRC</strong></td>
<td>This design with few thick threads is recommended for applications which require a high degree of resistance to wear and tear and rough treatment.</td>
<td>Trawl wire, Anchor wire, Bridles, Tow wire.</td>
</tr>
<tr>
<td><strong>Randers Compact. 6 x 19 seale and 6 x 25 seale</strong></td>
<td>The compacted outer threads offer very high wearing resistance and their useful life can sometimes be significantly longer than that of standard wires. Available with FC and IWRC.</td>
<td>Trawl wire, Purse seineing.</td>
</tr>
<tr>
<td><strong>Combined wire</strong></td>
<td>Combined wire is made from galvanised and stainless steel material covered with polypropylene split film, Danline or sisal. It is supplied with both a fibre core and a steel core, (IWRC). Galv. has white marking yarn. Stainless has red marking yarn.</td>
<td>Top and bottom lines in a trawl. Bridles, Tow lines.</td>
</tr>
</tbody>
</table>
Steel wire

<table>
<thead>
<tr>
<th>Diameter, mm</th>
<th>Area, mm²</th>
<th>Weight, kg per m</th>
<th>Min. breaking strength, kp</th>
<th>Min. breaking strength, kp</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.0</td>
<td>63.6</td>
<td>0.586</td>
<td>86.8</td>
<td>8850</td>
</tr>
<tr>
<td>18.0</td>
<td>102.1</td>
<td>0.941</td>
<td>139.3</td>
<td>14200</td>
</tr>
<tr>
<td>22.0</td>
<td>149.6</td>
<td>1.374</td>
<td>204.0</td>
<td>20800</td>
</tr>
<tr>
<td>26.0</td>
<td>221.7</td>
<td>2.033</td>
<td>303.1</td>
<td>30900</td>
</tr>
</tbody>
</table>

Taifun (combined rope)

<table>
<thead>
<tr>
<th>Diameter, mm</th>
<th>Strand design</th>
<th>Steel area, mm²</th>
<th>Weight, kg per m</th>
<th>Min. breaking strength, kp</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>6 x 8 x 0.60</td>
<td>13.6</td>
<td>0.21</td>
<td>3.600</td>
</tr>
<tr>
<td>18</td>
<td>6 x 8 x 0.80</td>
<td>24.1</td>
<td>0.35</td>
<td>5.500</td>
</tr>
<tr>
<td>22</td>
<td>6 x 8 x 1.10</td>
<td>45.6</td>
<td>0.59</td>
<td>9.700</td>
</tr>
<tr>
<td>26</td>
<td>6 x 8 x 1.30</td>
<td>63.7</td>
<td>0.83</td>
<td>12.700</td>
</tr>
<tr>
<td>32</td>
<td>6 x 8 x 1.60</td>
<td>96.5</td>
<td>1.23</td>
<td>17.200</td>
</tr>
</tbody>
</table>

Terryflex seine rope

<table>
<thead>
<tr>
<th>Diameter, mm</th>
<th>Weight, kg per m</th>
<th>Min. breaking strength, kp</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>0.234</td>
<td>4.200</td>
</tr>
<tr>
<td>20</td>
<td>0.292</td>
<td>5.100</td>
</tr>
<tr>
<td>22</td>
<td>0.353</td>
<td>6.200</td>
</tr>
</tbody>
</table>

Explanation of the abbreviations used in the tables

kp – Kilopond, the difference between force and mass
• In earlier times, force was measured in kp (kilopond), before that also in kg (kilogram force, sometimes abbreviated kgf). The weight of a 1 kg weight (with the mass 1 kg) is gravity’s pull on the mass, i.e. a force, which is calculated as the mass multiplied by the gravitational constant g (which on earth is approx. 9.81 m/s²).
• Mass (in earlier times called “weight”) is measured in kg, 1 kg = 1000 g
• Force is today measured in Newtons, abbreviated N. 1 kp is equal to 9.81 kN

WLL
The Working Load Limit is equal to payload and denotes the object's breaking strength divided by an agreed safety factor for the object and its use.

SWL
Safe Working Load – is an old term for WLL
Steel shackles
Safety factor: 5.4:1

<table>
<thead>
<tr>
<th>Diameter inches</th>
<th>Diameter mm</th>
<th>Weight, kg</th>
<th>*WLL, ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>9.65</td>
<td>0.14</td>
<td>1.00</td>
</tr>
<tr>
<td>5/8</td>
<td>16.00</td>
<td>0.63</td>
<td>3.25</td>
</tr>
<tr>
<td>3/4</td>
<td>19.10</td>
<td>1.02</td>
<td>4.75</td>
</tr>
<tr>
<td>1</td>
<td>25.40</td>
<td>2.41</td>
<td>8.50</td>
</tr>
</tbody>
</table>

*Working load limit

Steel shackles
High alloy steel
Hot-dip galvanised
Safety factor: 6

<table>
<thead>
<tr>
<th>Diameter of u-bolt, mm</th>
<th>Inside length, mm</th>
<th>Payload/*WWL, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>32</td>
<td>0.75</td>
</tr>
<tr>
<td>13.5</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>59</td>
<td>4.75</td>
</tr>
</tbody>
</table>

*Working load limit

Steel chains
Safety factor: 4

<table>
<thead>
<tr>
<th>Diameter mm</th>
<th>Inside length, mm</th>
<th>Weight, kg per m</th>
<th>Payload/*SWL, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>30</td>
<td>2.2</td>
<td>3150</td>
</tr>
<tr>
<td>13</td>
<td>39</td>
<td>3.8</td>
<td>5300</td>
</tr>
<tr>
<td>19</td>
<td>57</td>
<td>3.8</td>
<td>11200</td>
</tr>
</tbody>
</table>

*Safe working load

Hammerlocks
Safety factor: 4

<table>
<thead>
<tr>
<th>Diameter of u-bolt</th>
<th>Weight, kg</th>
<th>Payload/*SWL, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0.06</td>
<td>1120</td>
</tr>
<tr>
<td>10</td>
<td>0.18</td>
<td>2000</td>
</tr>
<tr>
<td>17</td>
<td>0.70</td>
<td>5300</td>
</tr>
<tr>
<td>25</td>
<td>2.25</td>
<td>11200</td>
</tr>
</tbody>
</table>
Eye splice on square-braided rope with eight strands
Trawl
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