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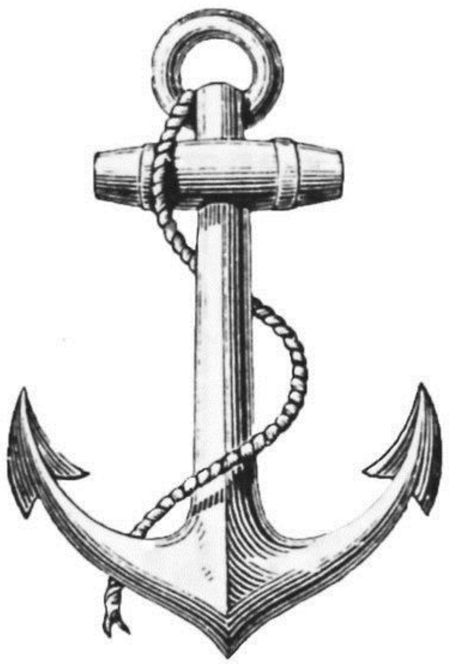

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ΑΚΑΔΗΜΙΑ ΕΜΠΟΡΙΚΟΥ ΝΑΥΤΙΚΟΥ

Α.Ε.Ν ΜΑΚΕΔΟΝΙΑΣ

ΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ

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Ο ΔΙΕΥΘΥΝΤΗΣ ΣΧΟΛΗΣ :

Contents

Abstract

The basic purpose of this dissertation is to collect and evaluate the appropriate data concerned with the use of achors and anchoring methods on merchant ships and recreation vessels. The dissertation is divided in two main parts. The first one deals with the operation of ships within the shipping industry as well as the technical characteristics of ships and anchors. The second part analyzes anchoring methods and appropriate preparations.

Introduction

Shipping is considered to be a private and very competitive industry all around the world. The activities that take place industry are divided into various categories, such as liner service, tramp shipping, industrial service or tanker operation where all operate on specific established routes. According to Belberdos, (2001), the prosperity of Greek shipping is however very much dependent on a healthy world economy and a stable situation in the hinterland of the Greek ports. The actual number of the shipping companies which exist and operate worldwide, can not be calculated.

This actually happens due to the existence of Greek law regulation, where according to it is very easy for someone to set up and operate a shipping company. This can also lead to the establishment of inactive companies. In advance, the large number of shipping companies is due to the fact that each ship is considered as company by itself.

Most of shipowners have chosen to operate their vessels in liner trade, as this could offer them good profits and keep their vessels busy for long periods. Therefore, the major objective for each shipowner is to build a ship so as to enter the liner trade and make profit. Liner services provide transport for cargoes that are too small to fill a single ship and need to be grouped with others for transportation (Stopord, 2000).

Ships operate a regular advertised service between ports, carrying cargo at fixed prices for each commodity, though discounts may be offered to regular customers. The shipowner in order to have a shipping investment and build a ship so as to operate in a liner trade, are focused on the following aspects (Blackwell, 2011):

- Offer a regular service for many small cargo consignments and process the associated mass of paperwork

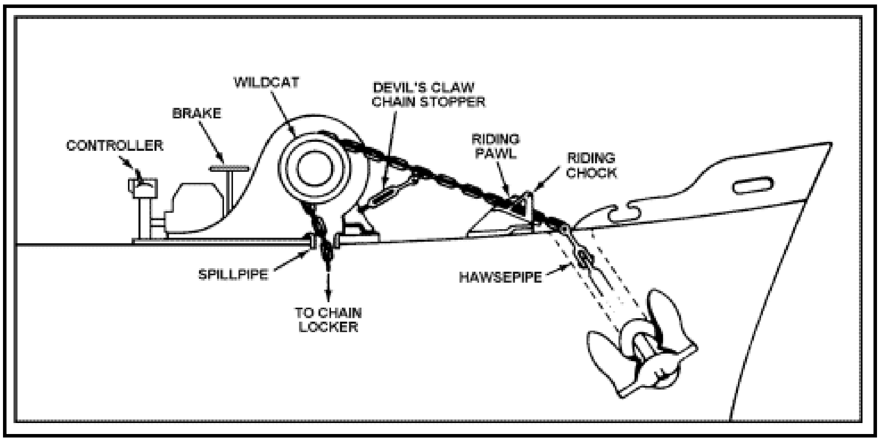
- Change individual consignments on a fixed tariff basis that yields an overall profit – not an easy task when many thousands of consignments
- Load the cargo / container into the ship in a way that ensures that is accessible for discharge (bearing in mind that the ship will call in many ports) and that the ship is “stable” and “in trim”,
- Run the service to a fixed schedule while allowing for all the normal delays – arising from adverse weather, breakdowns, strikes, etc
- Plan tonnage availability to service the trades, including the repair and maintenance of existing vessels, the construction of new vessels and the chartering in of additional vessels to meet cyclical requirements, and to supplement the company’s fleet of owned vessels.

The Anchor Gear

The *anchor gear* (or ground tackle) is located on the forecastle and consists of all the equipment used in anchoring. This includes the anchors, the anchor windlass, anchor cables or chain, chain stoppers and the connecting devices (shackles, swivels), etc. When the ship is underway, the anchor is stowed in the hawse-pipe (Smith, 1992).

It is attached to the anchor chain or cable by means of an anchor shackle and a swivel shackle. The chain then goes through the hawse-pipe onto the windlass (anchor winch) fitted on the forecastle deck. A ship is normally fitted with ten shackles (shots in US) of cable, each shackle about 25 metres in length, and connected to another shackle (length of chain) by an accessory fitting called center joining- shackle.

The cable is lifted and lowered by the cable lifter (‘gipsy’ or ‘wildcat’) from where it falls down through the spurling gate and spurling pipe into the chain locker. The cable is secured on the forecastle deck by stoppers, devil-claws and anchor lashings. The windlass brake holds the chain. The windlass also consists of one or two drums on the sides of it for warping and heaving on the mooring lines (Smith, 1992).



Picture No.1 – The mechanical way that Anchor operates on ships

An anchor windlass is a machine that restrains and manipulates the anchor chain, allowing the anchor to be raised and lowered. The cable lifter (a notched wheel) engages the links of the chain. A brake is provided for control and an electric or hydraulic motor operating via a gear train usually powers the windlass (Blackwell, 2011).

Technically speaking, the term "windlass" refers only to horizontal winches. Vertical designs are correctly called capstans. Horizontal windlasses make use of an integral gearbox and motor assembly, all typically located above-deck, with a horizontal shaft through the unit and wheels for chain and/or rope on either side. Vertical capstans use a vertical shaft, with the motor and gearbox situated below the winch unit (usually below decks) (Smith, 1992).

Wildcats (gipsies, technically referred to as cable lifters) are used in windlasses to haul in and pay out anchor chain on board ships. An associated chain stopper is used to secure the chain while the ship is anchored, or the anchor is housed. The wheels on either a vertical or horizontal windlass provide for either chain or rope to be engaged. The wheel for rope is termed a warping head, while the chain-handling wheel is variously referred to as the gypsy (in the UK) or wildcat (in US), though due to the influence of the offshore oil industry the latter usage is now more common. For clarity in communication the generic term chain wheel is often used.

Nowadays, especially on large tankers and cruise ships, the windlass may be split into independent Port & Starboard units. In these cases they are frequently coupled with Warping Drums (as distinct from Warping Heads). In some of these the warping drums are of the self-tensioning or constant tension type (Smith, 1992).

Chapter One – The Operation of Ships Inside the Shipping Industry as Also the Technical Characteristics of Ships and Anchors

1.1 Introduction to Operation of the Shipping Industry

Shipping is considered to be one of the most interest aspects worldwide. All those years of shipping operations, people have realized that this concerns a variety of duties and responsibilities that should take in order to effect accordingly the various operations included (Hiscock, 2009). As there are different types of ships that are being used so people each time to transport various cargoes they need, it should be said that there are also different modes of operation that need to be effected (Blackwell, 2011).

In ourdays, the most common ships, which are used for the transport of goods from port to port, are those of bulk carriers and tankers. Of course there are also some ships that are characterised as special one, and those might include Ro-Ro passenger ships, liquefied natural gas carriers, liquefied petroleum gas, reefer, containerships, etc (Hiscock, 2009). Each of those ships demand for different operations of management and types of charter contracts, as they carry various commodities and their shipowners need to employ experienced crew and managers ashore (Smith, 1992).

Of course the days that entrepreneurial people and especially shipowners going through, there are not considered being the most efficient on respect of shipping investments. More specifically, it could be said that the world of shipping and the market of bulk carriers, are coming through a difficult financial situation that has made most of shipowners who operate their ships in such market to sell or even stop their shipping transports. Their major purpose on present moment is to find appropriate solutions, so as to overcome this crisis upon the most efficient way (Hiscock, 2009).

Shipping is considered to be a private and very competitive industry all around the world. The activities that incur in subject industry are divided into various categories, such as liner service, tramp shipping, industrial service or tanker operation where all operate on specific established routes. According to scholars, the prosperity of shipping is however very much dependent on a healthy world economy and a stable situation in the hinterland of the world ports and the overall financial situation (Hiscock, 2009).

The actual number of the shipping companies, which exist and operate worldwide, there cannot actually be calculated. This actually happens due to the existence of law regulations in various countries, where according to this is very easy for someone to set up and operate a shipping company. This can also lead to the establishment of inactive companies. In advance, the large number of shipping companies is due to the fact that each ship is considered as company by itself (Smith, 1992).

1.2 Operation of International Shipping Industry Nowadays

All those years of shipping operations, vessels operate under a regular advertised service between ports, carrying cargo at fixed prices for each commodity, though discounts may be offered to regular customers. The transport of a mass of small items on a regular service faces the liner operator with a more complex administrative task than the one facing the shipowner.

It has also been estimated that in shipping there are four shipping markets trading in different commodities. The freight market trades sea transport, the sale and purchase market trades second hand vessels, the new building market trades new ships and the demolition market deals in scrap ships. If for example, containers could only be carried in container ships, all the shipping economist what would have to do is to predict the trade in containers, and the demand for containerships would be determined. Additionally in the bulk trade market, there are factors, which have guided shipowners to invest on subject market and operate their vessels under different offered advantages (Alderton, 2004).

Shipping is considered to be one of the most interest aspects worldwide. All those years of shipping operations, people have realized that this concerns a variety of duties and responsibilities that should take in order to effect accordingly the various operations included. As there are different types of ships that are used so people each time to transport various cargoes they need, it should be said that there are also different modes of operation that need to be effected and therefore different kind of strategies for each shipping line which operates either bulk, liner - containerships.

In ourdays the most common ships which are used for the transport of goods from port to port, are those of bulk carriers and liners -containerships. Of course there are also some ships that are characterised as special one, and those might include Ro-Ro passenger ships, liquefied natural gas carriers, liquefied petroleum gas, reefer, containerships, etc (Smith, 1992). Each of those ships demand for different operations of management and types of charter contracts, as they carry various commodities and their shipowners need to employ experienced crew and managers ashore.

Moreover the days that entrepreneurial people and especially shipowners are going through are not considered to be the most efficient on respect of shipping investments especially in the field of containerships. For such purpose, shipowners know that according to the type of ships that operate, they need to adopt and apply an appropriate type of strategy by fitting those with the most competent machinery installations like mechanical or electrical propulsions so as to be competitive in matters of transit time.

That strategy that was mentioned above, is considered to be closely concerned with the decisions that managers of shipping company will make as to whether a containership accordingly and estimate the steps that have to be followed each time and for any kind of investment in that type of ships.

Shipowners and generally all those shipping companies which operate containerships in ourdays, they need to consider that they have to concentrate their focus on cargo where the fluctuation of freight rates in this segment firming up significantly in the last few years.

Economic growth and globalization in promising markets, especially in North Europe have been pushing up freight rates in this type of cargo segment. Industry analysis that has been conducted, it has pointed out that increasing voyage length as container ships are now travelling longer distances and this is one of the factors shoring up freight rates in this field of shipping operations.

From shippers' point of view, containerships appear to have numerous advantages. Cargo in containers can be loaded and unloaded far more quickly than one cargo which is unitized, thereby leading to great savings in time and money. However, there are a number of dangers in the carriage of container cargoes and the cargo handling operations which take place should be as much safer as this is possible. This is something that has to be taken under serious consideration by shipping companies that operate containerships (Metaxas, 1998).

According to it Alderton (1995), it has also been stated that more than 50% of packaged goods and bulk cargoes transported by sea today can be regarded as dangerous or hazardous from safety stand point or harmful to the environment, relevant to the criteria set by the International Maritime Organization (IMO). (Alderton, 1995). Cargoes such as dangerous substances or even some small units loaded in containerships have been mentioned to include commodities such as solid or liquid chemicals and other materials, gases and products for and of the oil refinery industry and various wastes. Container shipping is considered to be a wholesale operation.

It sells its services in large quantities, by contract to a much smaller number of industrial customers at individually negotiated prices. In both cases the pricing system is central to the supply of transport. In the short run supply responds to prices as ships change their operation speed and move to and from debilitating, while liner operators adjust their services. In the longer term freight rates contribute to the investment decisions, which result in scrapping and ordering of ships (Metaxas, 1998).

Shipowners who operate their ships inside the container sector, they need to be aware of the various statistical aspects that exist in such sector and appraise appropriately all the involved issues that can affect it accordingly. What shipowners have to consider is about is the world demand for cargoes loaded in containers which are carried from one country to another.

Therefore by taking into serious considerations all those aspects involved in containerships' operation, they proceed each time accordingly so as to apply that kind of strategy which will allow those to dominate their position inside the shipping market of those ships and will be in accordance with the economies of scale and advantages that such sector offers.

1.3 Anchoring in General

All vessels approaching anchorages must be aware of the potential incidents and take all appropriate precautions. All Masters should take the opportunity to manoeuvre their vessels whenever possible - approaching anchorages is a good opportunity to practice their ship handling skills and familiarize themselves with the characteristics of their vessels (Smith, 1992).

Masters are reminded to exercise caution when navigating in channels with strong currents either across or with the intended track. The control of the vessel and their ability to maintain their intended track can be affected. The safety of the crew and vessel comes first - proceed at a safe speed - slow down to a minimum steering speed before you enter the channel - check the response of engine movements if you are at unusual draft or trim - if you experience difficulties steering, use the engine with large rudder movements for short periods, if in doubt or if the situation is getting worse, stop the vessel and be prepared to anchor (Hiscock, 2009).

Anchoring large vessels has many dangers. It is strongly recommended that large vessels only walk out the anchor. All vessels should walk out the anchor when anchoring in deep water. An anchoring operation involves the following stages (Blackwell, 2011): The selection of the Anchorage Criteria, are mentioned s follows

- Sheltered

- Bottom Conditions (no rocks or reefs)
- Water Depth (not too shallow or too deep)
- Hazard Free for Anchor (buoys, traps)
- Hazard free for Navigation (shoals, sand bars)
- Fixes Available (Day & Night)
- • Boat Launch (close proximity to landing)   Plotting the Anchorage
- Letting-go Circle: radius = distance from hawse pipe to pelorus
- Letting-go Bearing
- “Drop” Bearing: 900R or 2700R preferred
- Range Circles: 100 yd. arcs to 1,000 yds. 1,200 & 1,500 & 2,000 yd. arcs
- Length of Chain: 5 to 7 times the depth:
- Drag Circle: r = chain + dist. (hawse pipe to pelorus) • Anchor holding?
- Swing Circle: r = chain + ship
- Collision threats

1.3.1 Executing the Anchorage

When executing the anchorage, the navigator’s objectives are to keep the ship as close to the approach track as possible, and to have all of the headway off the ship when the hawse pipe is directly over the center of the anchorage. The navigator will take constant fixes and make course and speed recommendations throughout the evolution (Blackwell, 2011).

- Step One: With 1,000 yards to go, most ships are usually slowed to a speed of five to seven kts.

- Step Two: Depending upon wind and current, the engines should be stopped when 300 yards from the letting-go circle, and the anchor detail should be instructed to “stand by”. As the vessel draws near the drop circle, engines are normally reversed so as to have all remaining headway off the ship as it passes over the letting-go circle.

- Step Three: When the pelorus is at the letting-go bearing, the word “Let go the anchor” is passed to the anchor detail, and the anchor is dropped.

- Step Four: As the anchor is let go, the navigator calls for an immediate round of bearings and marks the ship’s head.

After the resulting fix is plotted, a line is extended from it in the direction of the ship’s head, and the hawse pipe to pelorus distance is laid off along the line, thus plotting the position of the anchor at the moment it was let go. If all goes well, the anchor will be placed within 50 yards of the center of the anchorage.

1.3.2 Anchor ad Cable Work

After being instructed from the bridge by the officer, the ship’s Boatswain releases the brake on the windlass and, with a clanging roar, the port anchor drops and the cable chain runs out through the hawse pipe. Six shackles of cable, attaching the anchor to the ship, have been run out. The vessel, drifting astern with the tide, pulls on the cable (Smith, 1992).

The Chief Officer is leaning over the bows, directing a torch on the part of the cable that he can see. Slowly, it is lifting ahead, becomes taut, and is slackening again. The vessel is being brought up. When the Master orders “Dead slow ahead”, the vessel is inching towards the lying ground of her port anchor. Then the Chief Officer on the forecastle head says “Slack away starboard cable, heave in port cable easy”. Three shackles of the starboard cable are being paid out and three of the port cable hove in, and the vessel, her engines stopped, comes to rest mid-way between her two anchors.

This manoeuvre is known as making a standing moor. It means that the ship is put in a position between two anchors. To be moored indicates that a ship has been put in position by two or more anchors and cables. To be moored also implies that a vessel is attached to a buoy or two buoys. A vessel is also moored when she is made fast alongside (i.e. port or starboard side to) or bow/stem on. A ship may be moored to a single buoy (SBM) or to a number of buoys (Multiple-Buoy Mooring).

When the ship is under way, the anchors are stowed in the hawse pipes, on either side of the ship's bow (bower anchors). The cable runs through the hawse pipe and is stored in the cable locker below the forecastle head. An anchor is also carried on the afterdeck and is called the spare anchor. The anchor is carried out by boat some distance from the ship and the vessel is then pulled up to it by means of the windlass or a winch. Buoys and beacons are fixed into place by means of mooring anchors. Cable is supplied in lengths of ninety feet, fifteen fathoms, and these lengths are called shackles of cable. Our ship has ten shackles of cable attached to each bower anchor. In order to distinguish one shackle from another, the lugless shackle is painted white. (Each length of cable is joined to the next by a link, which can be dismantled, and is called a lugless shackle.)

Neighboring links are also painted white. The windlass is used to heave in or veer out the cable. It has two drums called gypsies. It is driven by electricity and equipped with powerful brakes. From the gypsies the cable drops vertically through openings called the spiraling gates into the chain lockers. Various stoppers are used so that the pull of the anchor will not come on to the winch alone and that the anchor can be firmly secured when not in use. They are devices fixed on to the inboard end of the hawse pipes and are known as compressors (Smith, 1992).

"Anchor clear of the hawse pipe" means that the anchor has been eased out of the hawse pipe and is hinging by its ring. The cable "grows" in the direction it leads outside the hawse pipe. "Wind-rode" means that a ship, when she is at anchor, is with her head to the wind; "tide-rode" means that her head is to the tide; "riding weather tide" is when a ship is at anchor and the wind is against the tide; "riding lee tide" means that the wind and tide are in the same direction.

When a cable is at short stay, it is taut and leads down to the anchor vertically and when it is at long stay it reaches out and makes an acute angle with the level of the water. To veer cable is to let it run out under control; To surge cable is to let it run out under its own weight; To snub or check cable is to stop it running out by putting on the brake.

When the anchor is weighed-broken from the ground and hove up clear of the water the officer in charge will report whether it is clear or foul. Clear means that it is free from obstructions such as a chain picked up from the bottom, and foul means that the cable has its own cable twisted around it. If a ship is moored in a good holding ground and the weather is fair, there is little to worry about. There are, however, a number of rules to bear in mind about anchor work generally, and managing/handling vessels at anchor in bad weather in particular (Hiscock, 2009).

1.4 Technical Characteristics of Ships – The Use of Anchors

1.4.1 Types of Anchors

Anchors achieve holding power either by "hooking" into the seabed, via sheer mass, or a combination of the two. Permanent moorings use large masses (commonly a block or slab of concrete) resting on the seabed. Semi-permanent mooring anchors (such as mushroom anchors) and large ship's anchors derive a significant portion of their holding power from their mass, while also hooking or embedding in the bottom. Modern anchors for smaller vessels have metal flukes, which hook on to rocks on the bottom or bury themselves in soft seabed (Blackwell, 2011).

The vessel is attached to the anchor by the rode (commonly called the anchor cable or anchor chain in larger vessels), which is made of chain, cable, rope, or a combination of these. The ratio of the length of rode to the water depth is known as the scope; generally, the rode should be between 5 and 10 times the depth of the seabed, giving a scope of 5:1 or 10:1; the larger the number, the shallower the angle is between the cable and the seafloor, and the less upwards force is acting on the anchor.

A 10:1 scope gives the greatest holding power, but also allows for much more drifting due to the longer amount of cable paid out. Anchoring with sufficient scope and/or heavy chain rode brings the direction of strain close to parallel with the seabed. This is particularly important for light, modern anchors designed to bury in the bottom, where scopes of 5– to 7-to-1 are common, whereas heavy anchors and moorings can use a scope of 3-to-1, or less (Smith, 1992).

Since all anchors that embed themselves in the bottom require the strain to be along the seabed, anchors can be broken out of the bottom by shortening the rope until the vessel is directly above the anchor; at this point the anchor chain is "up and down", in naval parlance. If necessary, motoring slowly around the location of the anchor also helps dislodge it. Anchors are sometimes fitted with a tripping line attached to the crown, by which they can be unhooked from rocks or coral.

The term aweigh describes an anchor when it is hanging on the rope and is not resting on the bottom. This is linked to the term to weigh anchor, meaning to lift the anchor from the sea bed, allowing the ship or boat to move. An anchor is described as aweigh when it has been broken out of the bottom and is being hauled up to be stowed. Aweigh should not be confused with under way, which describes a vessel which is not moored to a dock or anchored, whether or not the vessel is moving through the water (Smith, 1992).

The earliest anchors were probably rocks, and many rock anchors have been found dating from at least the Bronze Age. Pre-European Maori waka (canoes) used one or more hollowed stones, tied with flax ropes, as anchors. Many modern moorings still rely on a large rock as the primary element of their design. However, using pure mass to resist the forces of a storm only works well as a permanent mooring; a large enough rock would be nearly impossible to move to a new location.

The ancient Greeks used baskets of stones, large sacks filled with sand, and wooden logs filled with lead. According to Apollonius Rhodius and Stephen of Byzantium, anchors were formed of stone, and Athenaeus states that they were also sometimes made of wood. Such anchors held the vessel merely by their weight and by their friction along the bottom. Iron was afterwards introduced for the construction of anchors, and forming them with teeth, or “flukes” made an improvement, to fasten them into the bottom (Blackwell, 2011).

1.4.2 Recent Designs and Types in Ships' Anchors

Picture No.2 Rocna anchor

In recent years there has been something of a spurt in anchor design. Primarily designed to set very quickly, and then generate high holding power, these anchors (mostly proprietary inventions still under patent) are finding homes with users of small to medium-sized vessels (Smith, 1992).

- The German-designed bow anchor, Bügelanker (or Wasi), has a sharp tip for penetrating weed, and features a roll-bar which allows the correct setting attitude to be achieved without the need for extra weight to be inserted into the tip.
- The Bulwagga is a unique design featuring three flukes instead of the usual two. It has performed well in tests by independent sources such as American

boating magazine Practical Sailor.

- The Spade is a French design, which has proved successful since 1996. It features a demountable shank (hollow in some instances) and the choice of galvanized steel, stainless steel, or aluminium construction, which means a lighter and more easily stowable anchor.
- The New Zealand–designed Rocna has been produced since 2004. It too features a sharp toe like the Bügel for penetrating weed and grass, sets quickly, and has a large fluke area. Its roll-bar is also similar to that of the Bügel.
- Mud weight: Consists of a blunt heavy weight, usually cast iron or cast lead, that will sink into the mud and resist lateral movement. Suitable only for very soft silt bottoms and in mild conditions. Sizes range between 5 and 20 kg for small craft. Various designs exist and many are home produced from lead or improvised with heavy objects. This is a very commonly used method on the Norfolk Broads in England.

1.4.3 Permanent Ships' Anchors

These are used where the vessel is permanently or semi-permanently sited, for example in the case of lightvessels or channel marker buoys. The anchor needs to hold the vessel in all weathers, including the most severe storm, but needs to be lifted only occasionally, at most – for example, only if the vessel is to be towed into port for maintenance. An alternative to using an anchor under these circumstances, especially if the anchor need never be lifted at all, may be to use a pile driven into the seabed (Blackwell, 2011). Permanent anchors come in a wide range of types and have no standard form. A slab of rock with an iron staple in it to attach a chain to would serve the purpose, as would any dense object of appropriate weight (for instance, an engine block).

Modern moorings may be anchored by sand screws, which look and act very much like oversized screws drilled into the seabed, or by barbed metal beams pounded in (or even driven in with explosives) like pilings, or by a variety of other non-mass means of getting a grip on the bottom. One method of building a mooring is to use three or more conventional anchors laid out with short lengths of chain attached to a swivel, so no matter which direction the vessel moves, one or more anchors will be aligned to resist the force (Smith, 1992).

1.4.4 Mushroom Anchor

Picture No.3 - Mushroom anchor on the lightship Portsmouth in Virginia.

The mushroom anchor is suitable where the seabed is composed of silt or fine sand. Robert Stevenson, invented it for use by an 82-ton converted fishing boat, Pharos, which was used as a lightvessel between 1807 and 1810 near to Bell Rock whilst the lighthouse was being constructed. It was equipped with a 1.5-ton example. It is shaped like an inverted mushroom, the head becoming buried in the silt. A counterweight is often provided at the other end of the shank to lay it down before it becomes buried (Smith, 1992).

A mushroom anchor will normally sink in the silt to the point where it has displaced its own weight in bottom material, thus greatly increasing its holding power. These anchors are only suitable for a silt or mud bottom, since they rely upon suction and cohesion of the bottom material, which rocky or coarse sand bottoms lack. The holding power of this anchor is at best about twice its weight until it becomes buried, when it can be as much as ten times its weight. They are available in sizes from about 10 lb up to several tons (Blackwell, 2011).

1.4.5 Deadweight Anchor

This is an anchor, which relies solely on being a heavy weight. It is usually just a large block of concrete or stone at the end of the chain. Its holding power is defined by its weight underwater (i.e. taking its buoyancy into account) regardless of the type of seabed, although suction can increase this if it becomes buried.

Consequently, deadweight anchors are used where mushroom anchors are unsuitable, for example in rock, gravel or coarse sand. An advantage of a deadweight anchor over a mushroom is that if it does become dragged, then it continues to provide its original holding force. The disadvantage of using deadweight anchors in conditions where a mushroom anchor could be used is that it needs to be around ten times the weight of the equivalent mushroom anchor (Smith, 1992).

1.4.6 Screw Anchor

Screw anchors can be used to anchor permanent moorings, floating docks, fish farms, etc. These anchors must be screwed into the seabed with the use of a tool, so require access to the bottom, either at low tide or by use of a diver. Hence they can be difficult to install in deep water without special equipment. Weight for weight, screw anchors have a higher holding than other permanent designs, and so can be cheap and relatively easily installed, although may not be ideal in extremely soft mud (Hiscock, 2009).

1.4.7 High-holding-power Anchors

There is a need in the oil-and-gas industry to resist large anchoring forces when laying pipelines and for drilling vessels. These anchors are installed and removed using a support tug and pennant/pendant wire. Some examples are the Stevin range supplied by Vrijhof Ankers. Large plate anchors such as the Stevmanta are used for permanent moorings (Blackwell, 2011).

1.5 Anchoring Gear

The elements of anchoring gear include the anchor, the cable (also called a rode), the method of attaching the two together, the method of attaching the cable to the ship, charts, and a method of learning the depth of the water. Vessels may carry a number of anchors: bower anchors (formerly known as sheet anchors) are the main anchors used by a vessel and normally carried at the bow of the vessel. A kedge anchor is a light anchor used for warping an anchor, also known as kedging, or more commonly on yachts for mooring quickly or in benign conditions (Hiscock, 2009).

A stream anchor, which is usually heavier than a kedge anchor, can be used for kedging or warping in addition to temporary mooring and restraining stern movement in tidal conditions or in waters where vessel movement needs to be restricted, such as rivers and channels (Blackwell, 2011).

A Killick anchor is a small, possibly improvised, anchor. Charts are vital to good anchoring. Knowing the location of potential dangers, as well as being useful in estimating the effects of weather and tide in the anchorage, is essential in choosing a good place to drop the hook. One can get by without referring to charts, but they are an important tool and a part of good anchoring gear, and a skilled mariner would not choose to anchor without them.

The depth of water is necessary for determining scope, which is the ratio of length of cable to the depth measured from the highest point (usually the anchor roller or bow chock) to the seabed. For example, if the water is 8 metres (26 ft) deep, and the anchor roller is 1 m (3 ft) above the water, the scope is the ratio between the amount of cable let out and 9 m (30 ft). For this reason it is important to have a reliable and accurate method of measuring the depth of water.

A cable or rode is the rope, chain, or combination thereof used to connect the anchor to the vessel. Chain rode is relatively heavy but resists abrasion from coral sharp rocks or shellfish beds, which may abrade a pure rope warp. Fibre rope is more susceptible to abrasion on the seabed or obstructions, and is more likely to fail without warning. Combinations of a length of chain shackled to the anchor, with rope added to the other end of the chain are a common compromise on small craft (Smith, 1992).

1.6 Anchor Warps

The best rope for warps is nylon, which is strong and flexible. Terylene (polyester) is stronger but has less flex. Both ropes sink, so they avoid fouling other craft in crowded anchorages and do not absorb much water. Neither breaks down quickly in sunlight. Polypropylene or polythene are not suited to warps as they float and are much weaker than nylon and only slightly stronger than natural fibres. They break down in sunlight.

Natural fibres such as manila or hemp are still used in developing nations but absorb much water, are relatively weak and rot. They do give good grip and are often very cheap. All anchors should have chain at least equal to the boat's length. Some skippers prefer an all chain warp for added security in coral waters. Boats less than 8 m typically use 6 mm galvanized chain. 8–14 m craft use 9 mm chain and over 14 m use 12 mm chain. The chain should be shackled to the warp through a steel eye or spliced to the chain using a chain splice. The shackle pin should be securely wired. Either galvanized or stainless steel is suitable for eyes and shackles.

In moderate conditions the ratio of warp to water depth should be 4:1. In rough conditions it should be twice this with the extra length giving more stretch to resist the anchor breaking out. This means that small craft less than 5 m should carry at least 50 m of 8 mm warp. 5–8 m craft 75–100 m of 10 mm warp. 8–14 m should carry 100–125 m of 12 mm warp and over 16 m the same length but 16 mm warp (Hiscock, 2009).

1.7 Anchoring Techniques

Colored plastic inserts on a modern anchor chain show the operator how much chain has been paid out. This knowledge is very important in all anchoring methods. The basic anchoring consists of determining the location, dropping the anchor, laying out the scope, setting the hook, and assessing where the vessel ends up. The ship will seek a location, which is sufficiently protected; has suitable holding ground, enough depth at low tide and enough room for the boat to swing.

The location to drop the anchor should be approached from down wind or down current, whichever is stronger. As the chosen spot is approached, the vessel should be stopped or even beginning to drift back. The anchor should be lowered quickly but under control until it is on the bottom. The vessel should continue to drift back, and the cable should be veered out under control so it will be relatively straight.

Once the desired scope is laid out, the vessel should be gently forced astern, usually using the auxiliary motor but possibly by backing a sail. A hand on the anchor line may telegraph a series of jerks and jolts, indicating the anchor is dragging, or a smooth tension indicative of digging in. As the anchor begins to dig in and resist backward force, the engine may be throttled up to get a thorough set. If the anchor continues to drag, or sets after having dragged too far, it should be retrieved and moved back to the desired position (or another location chosen.) There are techniques of anchoring to limit the swing of a vessel if the anchorage has limited room (Blackwell, 2011):

Chapter Two – Analysis of Anchoring Methods and Appropriate Preparation

2.1 Chapter Introduction

Anchoring is as frequent operation on board as loading and unloading a cargo. But in spite of being frequent operation, the number of incidents related to anchoring never seems to reduce. That is when many minor incidents never come in light to wider audience (Hiscock, 2009).

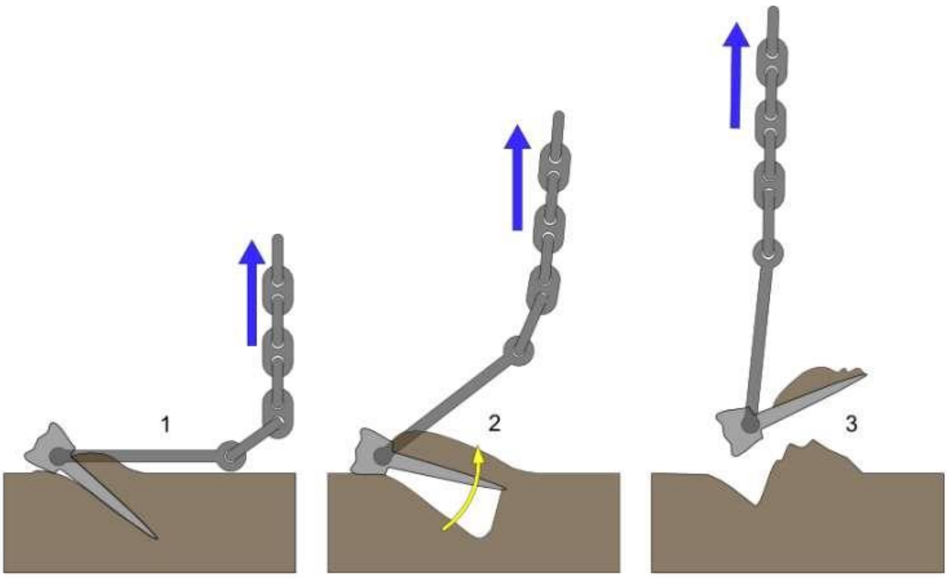
The truth is even after being a routine operation; effective way of anchoring is not a child's play. Sure one can just somehow arrive at anchoring position and open the brake to anchor a ship. But before we do that, we need to discuss two things. First how an anchor holds the ship. And second what guarantees more holding power of anchor (Smith, 1992).

2.1.1 How an anchor holds the ship

When an anchor is dropped, the crown of the anchor is the first to hit the sea bottom. As the ship moves back, the flukes take its position and embed itself into the seabed. It does not matter from what height the anchor is dropped; the crown will always hit the bottom first. The flukes will only dig into the seabed once the ship moves aft and flukes are facing downwards in to the sea bottom (Hiscock, 2009).

Picture No.5 Anchor in the sand

Opposite happens when we pick up the anchor. When the chain is all picked up, the flukes face upwards and gets uprooted from the bottom.



Picture No.6 – The way that anchor in the sand should return back on ship

2.1.2 Holding Power of anchors

All other factors being common, there are three things that affect holding power of anchors. First is the construction of anchor, second nature of seabed and third the scope of the cable (Blackwell, 2011).

a) Holding power due to anchor construction

A ship's Equipment number decides the weight of the anchor and length of the chain . The fluke area determines the holding power of the anchor. International association of classification societies (IACS) governs the rules for anchors.

IACS enlist three types of anchors. Normal holding power, high holding power and super high holding power anchors. Because of the high and super high holding powers, these anchors can have lesser weight than the normal anchors. This is because the high holding design (Larger fluke area) compensate for the loss of holding power due to lesser weight.

Even though anchor weight has nothing to do with holding power per se, it contributes to some extent in holding a ship in its position. More weight of the anchor would need more force to push the ship from its position. For this reason, anchor weight is more often used as a function of holding power (Smith, 1992).

b) Holding power due to nature of Seabed

Another factor that affects the holding power of the anchors is nature of seabed. Sand is considered to be the strongest holding ground. Soft mud is the least holding ground. This is because of obvious reasons. Anchor embedded into soft mud would leave the bottom easily compared to harder surface like sand. Mariners must consider nature of sea bed to determine possibility of dragging of anchor (Hiscock, 2009).

c) Holding power due to scope of the anchor cable

Correct scope is essential for safe anchoring and better holding of the anchor.

Scope is the ratio of depth of the water to the length of the cable deployed. More the scope, better an anchor will hold the ship. The idea of having more scope is that the angle of chain with respect to sea bottom should be minimum. More the angle, lesser the holding power. OCIMF has published a graphical relation between this angle and holding power of anchor (Hiscock, 2009).

As a thumb rule, Scope of 6 is advisable for anchoring. That is when anchoring into a depth of 20 meters; we should pay at least 120 meters of cable. When anchoring in areas of strong wind or current, we should have scope of more than 6, up to 10 sometimes (Smith, 1992). There are two situations where scope of 6 may not be always possible. In congested anchorages like in Singapore and in deep-water anchorages like Fujairah. In congested anchorages, this is due to insufficient sea room and In deep water anchorage due to insufficient cable length. In calm weather, the lesser scope in these areas should not be a problem. But if you expect wind force to increase, increased possibility of anchor dragging should be part of the risk assessment (Blackwell, 2011).

2.2 Preparing for Anchoring

Preparing the vessel for anchoring can start days before arrival. This is when a Master checks the charts for marked anchorage areas days before arrival. Anchorage area for the vessel could also be suggested in the agent’s pre-arrival message. In any case, the anchorage area must be physically checked in the chart to ensure that (Blackwell, 2011)

- It is designated for the type of ship,
- The depths complies with the UKC requirement of the company
- Depths are less than the maximum depth ship can anchor
- It is clear of any cables, pipeline, wrecks or other obstructions. and

- The nature of sea bed is appropriate for anchoring

When checking the charts for underwater obstructions, attention should be paid to the chart symbol '#'. This symbol means there is a foul ground and shall be avoided for anchoring. I am particularly mentioning this chart symbol because you may not miss a wreck but it is easier to miss this (Hiscock, 2009). It is important to be aware of the ship's windlass lifting capacity. In any case most of the ship's windlass are able to lift the weight of the anchor and about 3 shackles. Vessels could easily anchor in depths of about 80 meters. If anchoring in depths more than that, you might need to first check the windlass capacity for the particular ship (Hiscock, 2009).

2.3 Anchor Stations

Anchor stations should be ready forward well in advance. The anchor party should make the inspection of anchor windlass. They should also ensure that the drive (Hydraulic power packs or electric power) is running. The lashing of both the anchors should be removed even if it is pre-decided about which anchor will be used. It is a good practice to brief anchor party well in advance of some information about anchoring such as (Smith, 1992)

- The depth of water at the anchoring position
- Which anchor to use
- Anchoring method (Let go or walk back)
- Number of shackles the vessel will be brought upto.

2.4 Approaching the Anchorage Position

The most critical factor while approaching anchoring position is the speed of the vessel. Engines must be ready and tested well in advance and the speed of the vessel should be under control. If Master feels the ship’s speed is much more than what it should be, he should exercise zigzag manoeuver to reduce the speed. Zigzag manoeuver (also called rudder cycling) is the most effective way to reduce the ship’s speed over a shorter distance. While doing rudder cycling, master must give due consideration to the near by ships and not run over other ships in vicinity (Blackwell, 2011).

Apart from speed, the direction from which to approach the anchoring position is important. The best approach heading is of heading into the wind and tide. The heading of similar sized anchored vessels can give quite accurate sense of the approach heading. If the traffic density, water depth and sea room permits, it is better to bring the vessel to this heading at least 1 mile from the anchoring position.

Anchoring is as frequent operation on board as loading and unloading a cargo. But in spite of being frequent operation, the number of incidents related to anchoring never seems to reduce. That is when many minor incidents never come in light to wider audience. The truth is even after being a routine operation; effective way of anchoring is not a child’s play. Sure one can just somehow arrive at anchoring position and open the brake to anchor a ship. I am sure you would agree that it is not effective way of anchoring.

2.5 Letting go an anchor

Would you agree that anchoring by letting go is easier of the two methods. It is most used method of anchoring too. As we know, in this method, we open the windlass brake to let the anchor go under gravity. Before opening the brake, we must consider the height from which we plan to drop anchor. Depending upon the height, the damage may not be visible in same operation but will be visible in longer run

(Smith, 1992).

There is another obvious risk of dropping the anchor from a height. The anchor under its weight will continue to gain momentum until it touches bottom. This momentum will increase with the height. If the momentum increases so much that the windlass break can't hold it, the anchoring will turn into a dangerous operation. The anchor's momentum will only stop when the anchor along with entire chain is in the bottom after it has been uprooted from the bitter end (Blackwell, 2011).

2.6 What is the referencing height then

As a thumb rule, you should never allow anchor to drop from a height of 20 meters. That is, one must lower anchor to a level when distance between bottom and the anchor is not more than 20 meters. But that is a maximum figure. One must lower the anchor to as close to bottom as possible, before it is let go. But no one can judge accurately to lower anchor say one meter from the bottom. Here is another rule of thumb. We should aim for lowering the anchor to around half shackle from the bottom before we let go. To summarize, here is how we should anchor by let go (Smith, 1992)

- Approach the anchor position heading into wind and tide with speed around 2 knots at 0.5NM from the position.

- Lower the anchor with gear to around half shackle off the bottom and then hold the anchor on brake

- Give stern movement to stop the vessel over ground once vessel is in anchoring position. if using starboard anchor, check the starboard swing (for Right hand fixed pitch propellers) because of stern movement.

- When in position, drop the anchor by opening the brake

- Maintain around 0.5 knots stern speed to allow the cable not to pile up.

- Hold the break once required cable length is paid out.

2.7 Anchoring by walking back

Walking back means lowering the anchor with gear. The principle difference between walks back and let go methods are that in walk back we lower the anchor under power. The advantage of this method is that cable would not run on its own. So the risk of damaging the anchor or windlass by dropping from a height is absent. But there is another risk involved with this method (Blackwell, 2011).

But even if we exceed this speed to 1.0 knots, only the anchor will pay off. There will not be any load on the windlass. Even when brake is on, and the chain stresses, windlass brake will be the first thing to render. But that is not the case with walk back method. In walk back method, since we are lowering the anchor with windlass in gear, excessive speed would surely damage the windlass. We must not exceed the stern speed to more than the design speed of the windlass. Typically the design speed of windlass is 9 mtrs/minute. That is 540 mtrs/hour (0.3 knots). So we must not exceed the stern speed to more than 0.3 knots while walking back the anchor. Other things are same as in let go method (Smith, 1992).

2.8 Anchor brought up

Once we have lowered the required anchor length, and we have disengaged the gear (in case of walk back), we then wait for the anchor to brought up. We know that anchor is brought up when it leads to long stay and then gradually comes back to short to medium stay (Hiscock, 2009).

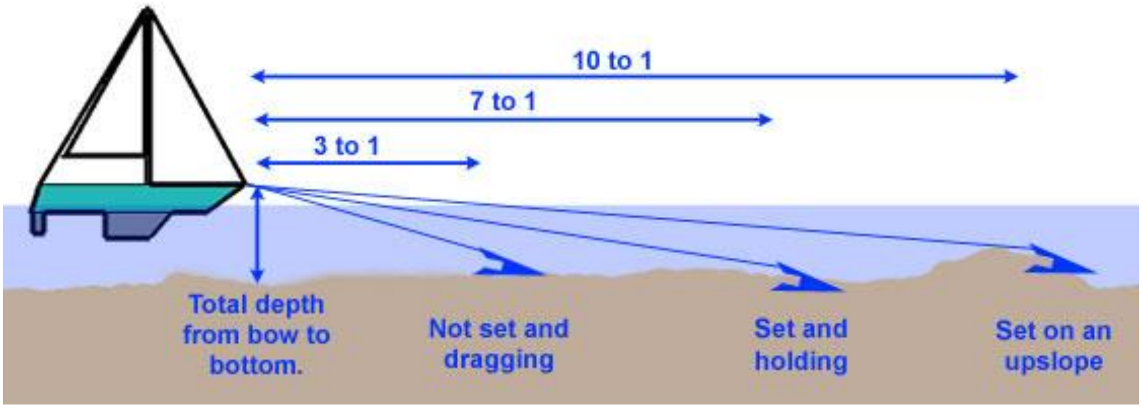
Once brought up, there is an important thing that we need to do. Put the bar (Bow stopper) on and rest the anchor chain on it. This is because; the load generated by the vessel's movement during its stay at anchor should be borne by the bow stopper, which has higher capacity than the windlass system. There is a disadvantage though. In heavy weather, there are chances that stopper may jam or deform (Hiscock, 2009).

In this case if for some reason vessel need to let go the cable in emergency, it would be difficult. The only solution to it is that Master must get underway before putting any component of anchoring at the risk of damage. Most of the companies have instructions to the masters to leave the anchorage if wind force is more than force 6. There have been incidents of total constructive loss due to master's decision to stay at anchorage in spite of adverse weather warnings (Blackwell, 2011).

Anchoring is routine job. Number of incident during anchoring or while at anchor suggest that we might not have yet mastered the art of anchoring a ship effectively. Knowing about the correct anchoring procedures and their limitations is one of the best way to avoid anchoring related fatalities and damages.

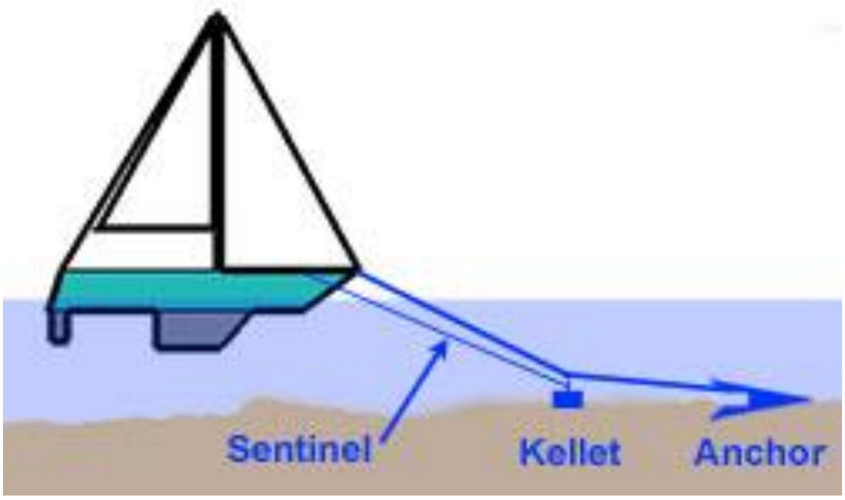
2.9 Different Ways that an Anchor Works

Scope is the ratio of the depth of the bottom from the bow to the horizontal distance the bow is from the anchor. The depth can be conveniently measured by the depth sounder then add the height of the bow above the water. In areas of large tidal range what is adequate scope at low tide may not be sufficient at high tide. Generally speaking, 7 to 1 scope is considered adequate for overnight anchoring. The more scope, the better the anchor will hold. There are many factors that come into play but, if you have the room, why not throw out more rode creating more scope? After all, it's free (Smith, 1992).



Picture No.7 Anchor in the sand and possible positions could be grabbed

Another way to increase holding power is to drop the anchor on an up slope. This might be a sand bar or an area where the depth gets shallower from a deeper area. You can also use a sentinel and kellet to increase holding power, this is a weight clipped onto the rode and lowered part way down, along the rode. The weight acts the same as more scope would because it decreases the angle of the rode to the bottom (Hiscock, 2009).

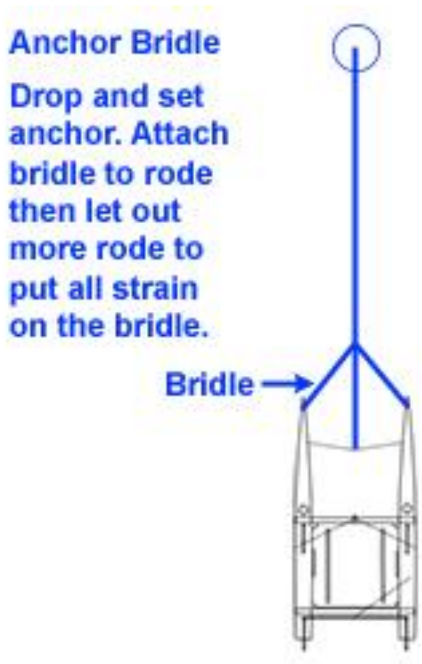


Picture No.8 Anchor in the sand and possible positions could be grabbed with the Kellet

There are anchor kellets made that will slip down over an all chain rode. If you have a combination of chain and line the eye splice and shackle at the transition would not allow for passage beyond that point. Understand, if high winds come up there is a real possibility the anchor line will straighten out and any effect provided by the kellet will disappear (Hiscock, 2009).

Snubbers are used to cushion the load, acting as a shock absorber, on an all chain anchor rode . A snubber will also move the load from the bow roller to a bow cleat which can help with any chain noise in the forward cabin. After the anchor has been deployed and set tie a length of nylon line onto the chain with a rolling hitch, let out more chain, then tie the snubber onto a bow cleat. Now, let out even more chain so that the entire load, from the anchor, goes through the snubber and to the cleat. Use nylon line because it stretches; and, 3 strand stretches more than braided. Just be sure to prevent any chafe, which might occur (Blackwell, 2011).

A variation of the basic snubber would be to have a dedicated bridle with a chain hook in the middle. This could be tied off to both bow cleats thus distributing the load. See next paragraph for a description of a bridle.



Picture No.9 Anchor Bridle

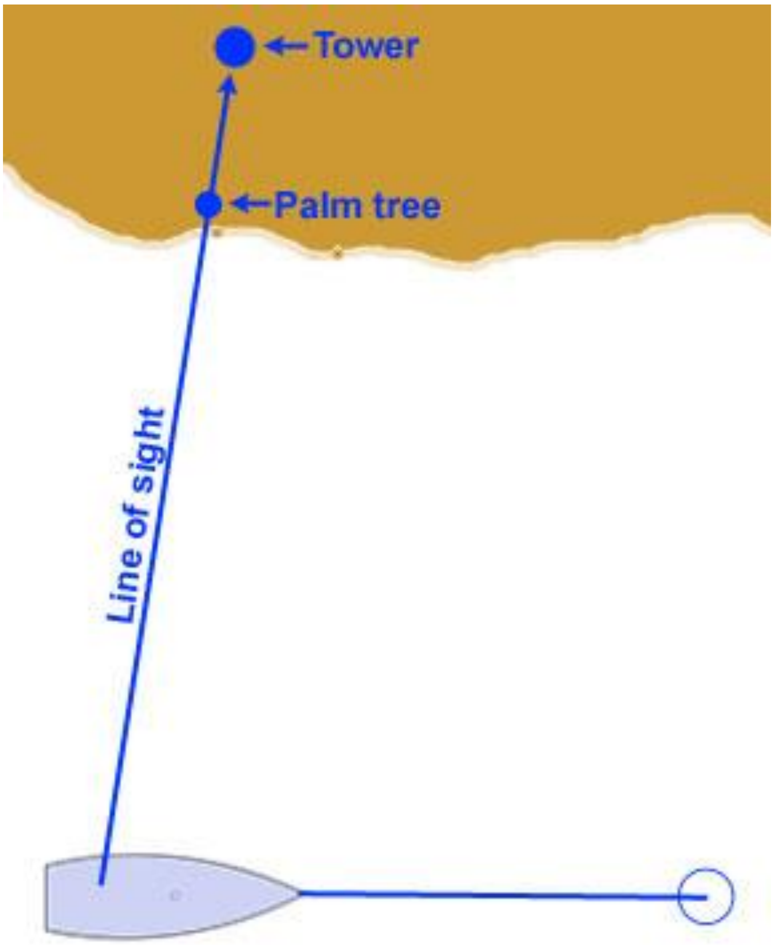
We use a bridle arrangement when anchoring a catamaran. Usually, you will have a pre-made anchor bridle all set to go when you anchor. This is made from two lengths of 3-strand nylon line with a chain hook joining them together. The two free ends attach to bow cleats after the anchor is set. Alternatively, people can make up the bridle by attaching two nylon lines to the anchor rode using rolling hitches so they won't slip. The bridle arrangement can also be used on a monohull vessel with good results (Hiscock, 2009).

2.9.1 Dropping and setting the anchor

With a basic understanding of how the anchor attaches itself to the bottom and some anchoring techniques we'll now look at the procedure of dropping, then setting the anchor. Once a spot is chosen to drop anchor approach slowly from downwind or down current, whichever is stronger (Blackwell, 2011).

When people arrive at the spot they want to drop, having made adequate accounting for scope and swing, come to a complete stop, lower the anchor. Now hey want to get the boat going backwards so the falling chain doesn't foul the anchor. You might slowly engage reverse then go back to neutral; just enough to get the boat headed backwards. She won't go straight back because the wind wants to blow the bow off first. Be patient as one or more of the crew lets out the anchor rode. When you have let out enough cleat the line or the chain. The boat will now align itself with the anchor rode as it takes out all the slack.

Set the anchor by backing down on it. Engage reverse; first at idle speed and watch for any movement. The easiest way to do this is to set up a range with two non-moving objects (not other boats) and watches to see if they come out of alignment (Smith, 1992).



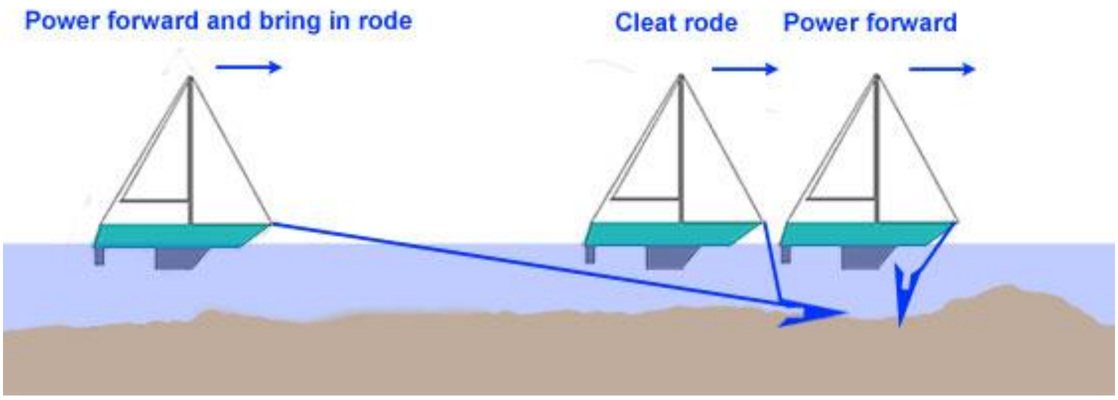
Picture No.10 – Line of Sight for the Anchor

It really doesn't matter which two non-moving objects you use. Could be a point of land with a tree beyond. Or, a navigational marker and a tree beyond. You get the picture. The slightest movement of the boat will show up when looking at the range you have set up. If the anchor holds at idle speed reverse, then increase to 1500 rpm (or one half the full cruising rpm). If the anchor holds now then increase to 2500 rpm (or full cruising rpm). Keep the engine in reverse for several seconds to see what happens. If no movement, slowly lower the rpm, shut the engine down, and relax (Smith, 1992).

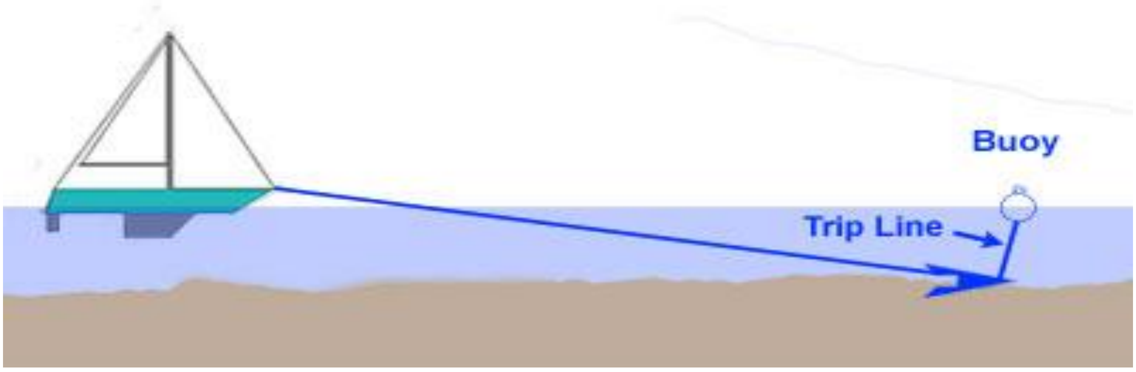
What if there is no land around or no available range to be found? In this situation do the same as above in terms of backing down on the anchor at various engine speeds but, without the range, put your hand on the rode and you will be able to feel a vibration if the anchor is skipping along the bottom (Blackwell, 2011).

2.9.2 Retrieving an anchor

Getting the anchor back onboard should be an easy matter with today's electric anchor windlasses. Start by powering the boat toward the anchor using the engine, not the windlass. We save the windlass to bring the anchor up once we are over it. Many times the anchor simply breaks itself free as we motor up to it and tension the chain.



Picture No.11 Ways that multiple ships could be anchored in same area



Picture No.12 Way that anchoring should be made in use of buoy

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