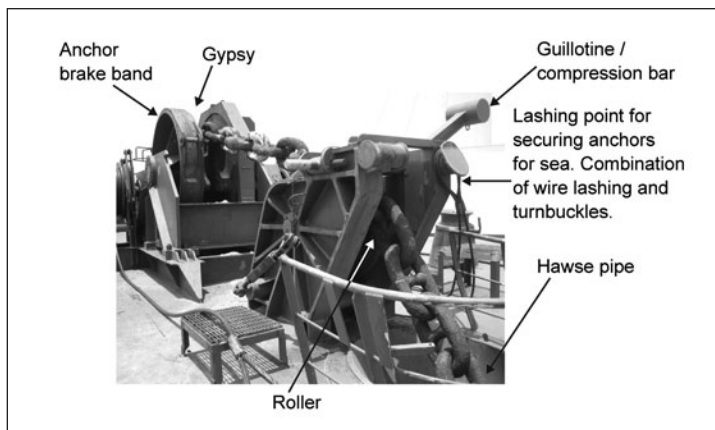


### 3 The Windlass



**Figure 14 – Anchor Windlass Arrangement**

The performance criteria for a windlass, quoted by Lloyd's, shows that it must operate under the following conditions:

- A steady pull for 20 minutes
- a peak pull for 2 minutes
- a heaving speed
- a brake proof load
- a design that will not collapse under a load equivalent to the breaking load of the cable.

The equation used to determine the pulling power is:

The continuous pulling power (Z)Kg = Constant x (the chain diam mm)<sup>2</sup>

*The constant is based on the chain grade. For grade 2 and 3 it is 4.25.*

This could be worrying if you are the Master of a very large vessel. For example, assuming the following conditions, which would not be considered excessive:

- Wind Force 6
- current 3 knots
- anchor depth 100 metres
- lifting rate 9 metres/min.

On a vessel of 250,000 dwt fitted with grade 2,120 mm cable:

$$Z = 4.25 \times 120^2 \text{ Kg} = 61.2 \text{ tons}$$

If the vessel was fitted with an HHP anchor, such as the AC14, with a weight of 16 tons, and knowing that the cable weighs 0.6008 tons per fathom, then this vessel could only lift a maximum of 5 shackles of cable in a vertical lift. Therefore, the ship would be limited to anchoring in a depth of 137 metres.

However, this is purely academic as the length of chain required to be carried on ships, under the IACS rules, is 742 metres. Therefore, based on a recommended ratio of cable to depth of 6–10 times, the maximum effective anchoring depth is limited to a depth of 74–123 metres.

Maritime Pusnes AS Norway, which was established in 1875, is a world leader in the design of deck machinery and mooring systems. With their kind permission I follow with their comments regarding windlass operation.

*Acceptance criteria (not specifically stated in Class Rules, but based on experience) are that the anchor with chain can be stopped in any position during the payout of 3 shackles (82.5 m) of chain. DNV rules for ships quote "The capacity of the windlass brake is to be sufficient for safe dropping of anchor and chain cable when paying out"*

*The design criteria set up by the Classification Societies are mainly based on a water depth of 100 m (DNV) ABS, Lloyd's, NKK are 82.5 m. Anchoring in deeper water requires an extension of the general specification for the anchor windlass, particularly for windlass pull. Design criteria for an anchor windlass is the Class requirement. For the windlass band brake, the design criteria is 45% of the chain's minimum breaking load (MBL). If a chain stopper is not installed, the design criteria for the band brake is 80% of chain MBL. In practice, all VLCCs have a chain stopper installed.*

*A band brake is difficult to operate as a dynamic brake, especially when dropping the anchor. This is because of the special behaviour of a band brake. However, compared to other brake designs, the band brake has a very high static capacity compared to weight and cost. Manual operation is the standard design of the band brake. Hydraulic operated fail-safe brakes are optional, ie spring applied, hydraulically released. For VLCCs we recommend a hydraulically operated brake of the fail-safe type. A hydraulically operated brake is simpler and safer in operation than a manually operated brake. To obtain and keep a full brake holding load it is very important to maintain the brake properly and regularly (and not have asbestos lining.)*

*Most brake failures reported by our service engineers are based on lack of adjustment and maintenance of the brake system. Due to the disadvantage of the band brake, we have developed a disc brake as an additional brake for dynamic operation of the windlass. This brake is hydraulically operated and has excellent performance during payout of the anchor chain. A disc brake is always used in combination with a band brake, and both brake systems are hydraulically operated. The disc brake is used when lowering the anchor, ie dynamic operation, while the band brake is used as a static brake only. Regarding the different opinions in lowering the anchor, this is based on some bad experiences in the past. Many vessels lost anchor and chain due to failure in windlass brake system. That failure was a combination of badly maintained windlasses and the asbestos brake lining. Asbestos brake lining was extremely sensitive to humidity and lost most of its friction in wet condition. The new*

*asbestos-free brake linings used today keeps a constant friction coefficient even in wet condition.*

*As a result of this, many ship owners refused to allow the crew to drop the anchor by means of the windlass brake. The anchor had to be walked out by means of the windlass motor to keep control over the operation. This procedure is acceptable but certain precautions have to be taken. The vessel must not be drifting with a higher speed over the ground than the payout speed of the motor of the windlass. (This speed is 5 cms/sec = 0.1 knot, VLCC) Due to the big gear ratio in the anchor windlass a drifting speed higher than the payout speed will easily cause an over-speeding overload of the windlass motor and damage the motor, ie the vessel is pulling the chain out. The chain stopper has to be engaged before the chain is tensioned. The chain stopper is the only element which is designed for arresting the vessel's movements. The anchor windlass motor must never be connected when the chain is under tension. If the chain is under tension, the main engine has to be used to slacken the chain before connection to the winch. A golden rule for all anchor and mooring equipment is that both the cable lifter unit and the mooring drums must always be kept disconnected from the motor whilst under tension. Before connecting a tensioned chain or a mooring line, the tension must be reduced below nominal pull of the unit.*

The above commentary can be summarised as follows:

It is impossible to control a ship to a speed of 0.1 knot for periods of up to one hour, so walking back the anchor the whole way is not an option unless in very calm waters with little or no current.

The windlass brake must be well maintained and should not be asbestos lined.

When the chain is paid out it must not be held on the brake as the brake is not designed for this. Instead, the stoppers must be put on and the cable slacked back until the weight of the cable is held on them as they are designed for this purpose.

When heaving anchor again, the cable should not be straining against the windlass. Instead, the engines should be used to take the strain off the cable while heaving.

What the manufacturer is saying is eminently sensible. Look after your windlass and it will look after you!

## 4 The Wind and Current Effect

On most vessels current, affects the holding pull far more than wind, particularly in shallow waters.

Forming a definitive list of sea bed types and their associated holding power is difficult because of the differing compositions of each bottom type. For example, while clay would normally be considered a good holding ground, if it is soft this would not be the case.

### 4.1 Wind/Current Forces and Holding Powers

In the presence of increasing wind/current:

- To safely hold the ship in position, both anchors must be used
- to safely anchor with both anchors, the draught/depth ratio must be at least 2
- the larger the ship, the greater the effect of current over wind.

Under IACS rules, the holding pull required for anchors is as follows:

Vessel DWT	Max holding power both SS anchors	Max holding power both HHP anchors
50,000	60 tons	130 tons
100,000	90 tons	190 tons
150,000	110 tons	230 tons
200,000	130 tons	270 tons
250,000	150 tons	315 tons
300,000	170 tons	350 tons

**Table 2 – Holding Pull Comparisons**