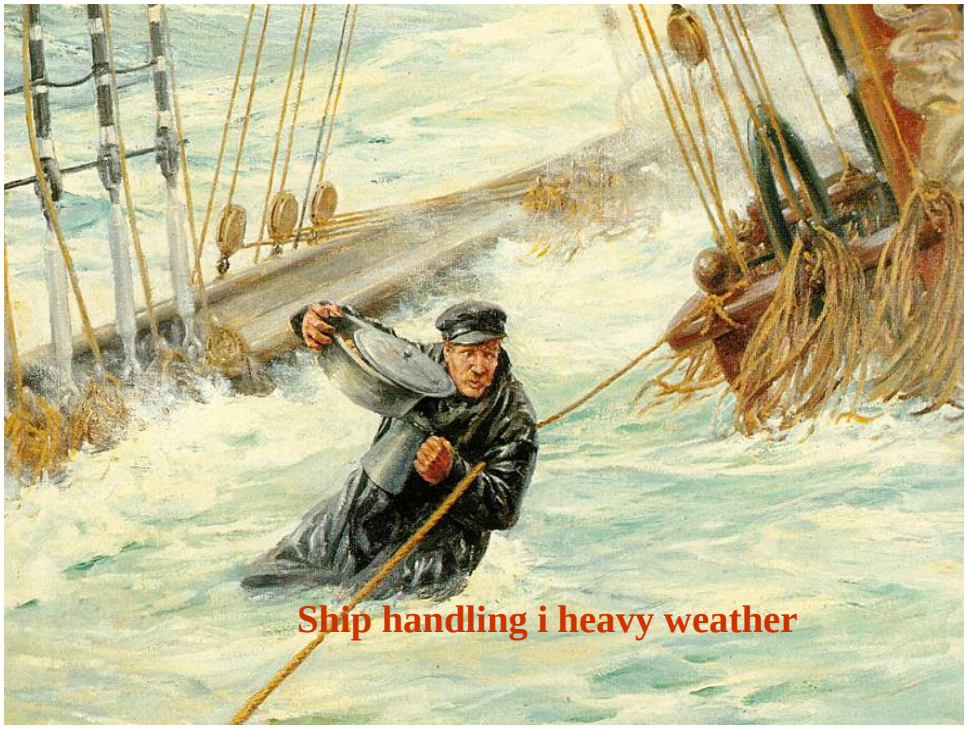


Ship handling i heavy weather

- **Why is it important today**
  - **Lack of experience, in handling ships in extreme weather conditions would seem to be a contributory factor**
  - **Cargo is expected to be delivered on schedule and this can also lead to higher speeds than appropriate in poor weather**
  - **Large ships have never before sailed in waters with weather conditions dangerous to the ship and its crew**
  - **Ships bigger – more power**
  - **Ships bigger – watch keeping officer far away from the scene**

- **Damages could be**
  - **Loss of an anchor unnoticed by personnel on the bridge**
  - **Damage to the hull and to equipment in the forepart of the vessel**
  - **Holes in the bow and sides of vessels**
  - **Damage to hatch covers – cargo**

Rough Weather Damage on Supertankers and other Large Ships
(Meddeleser fra Sjöfartsdirektoratet nr 332 1 april 1991

REKOMMENDATIONER

- *SHK rekommenderar Sjöfartsverket att*
- • **se över dagens utbildning för sjöbefäl rörande hantering av fartyg i grov sjö, av olika fenomen som kan uppkomma, och hur dessa kan undvikas eller effekterna minimeras *(RS 2008:03 R2),***

Ship handling i heavy weather Recommended action

Rough Weather Damage on Supertankers and other Large Ships (Meddeleser fra Sjöfartsdirektoratet nr 332 1 april 1991

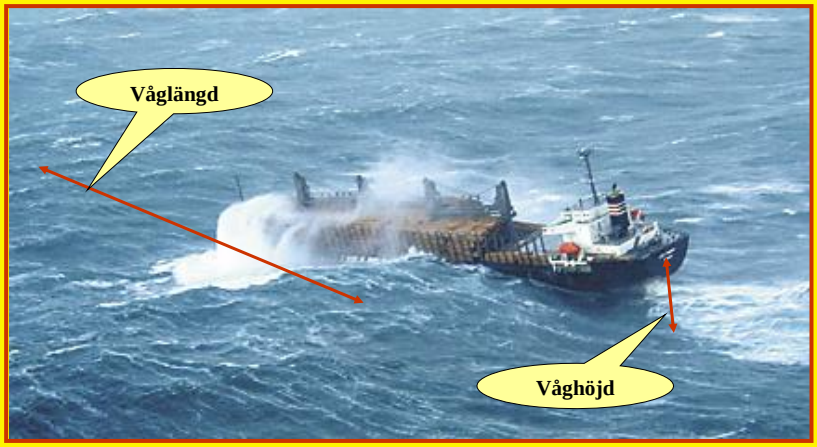
The Norwegian Maritime Directorate has received reports of a certain extent of major rough weather damage on large ships sailing in poor weather conditions. This could be due to a combination of the size of the ship, extreme weather conditions and, consequently, greatly reduced opportunities for inspection en route.

The Norwegian Maritime Directorate would therefore point out to owners to remind their captains that ships must at all times be handled in accordance with good seamanship. This means that ships should, not be pushed, in. extreme weather to the extent that major damage ensues.

Ship handling i heavy weather Recommended action

- **To prevent damage and to facilitate control on board, the following measures may be of assistance:**
  - **reduce pitch level or engine power in rough weather,**
  - **if possible. change course to minimize strain on the vessel**
  - **if necessary, reduce speed considerably or heave to,**
  - **use the fixed decklights or floodlight arrangement, when this can be done without inconveniencing other shipping in the area, for remote inspection of the most exposed areas of the ship**
  - **keep check of the condition of the ship by conducting inspections, when safe to do so, of the most. exposed areas.**

Ship handling i heavy weather

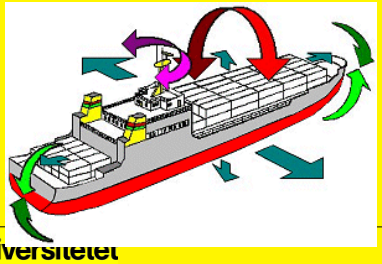


Ship handling i heavy weather

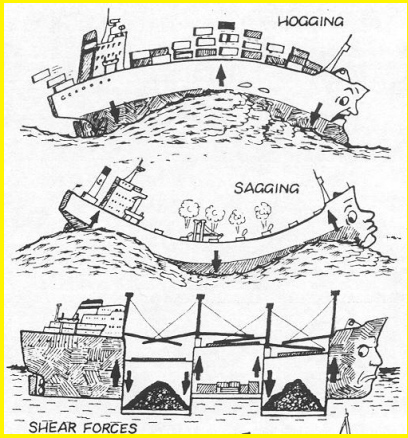
- **Dangerous conditions**
  - **Poor stability**
  - **Wave midships**
  - **Synchronous rolling**
  - **Broaching**
  - **Breakers from side**
  - **Icing down**
  - **Freak waves**

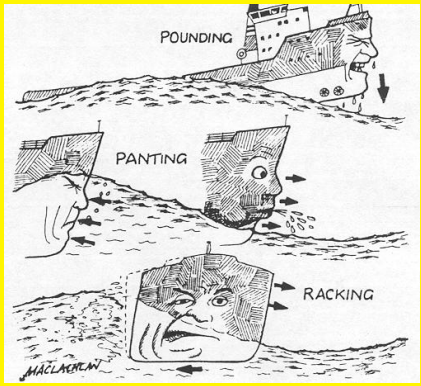
Six degrees of motion in irregular sea

Linear motion	Rotational motion
Surging is motion along the longitudinal axis.	**Rolling** is motion around the longitudinal axis
Swaying is motion along the transverse axis	**Pitching** is motion around the transverse axis
Heaving is motion along the vertical axis	**Yawing** is motion around the vertical axis

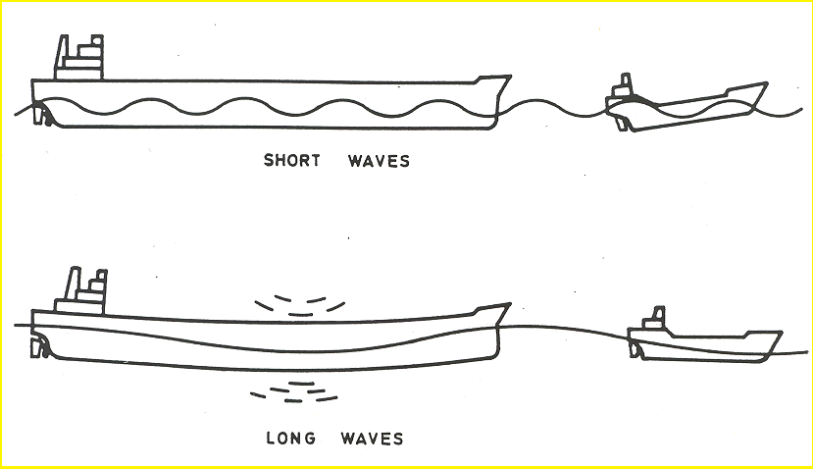


Influence of a ship in rough weather

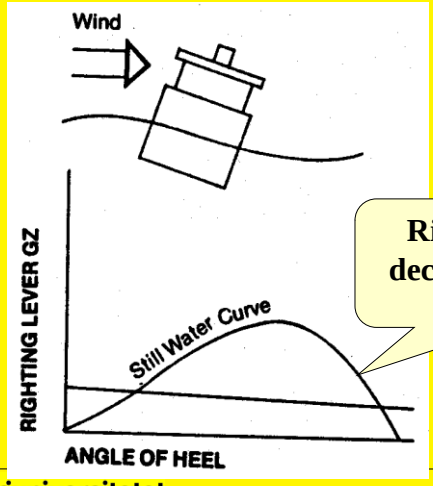




Influence of the wave length on different ship sizes



Ship handling i heavy weather
Bad stability



Righting lever will decrease and also the stability width

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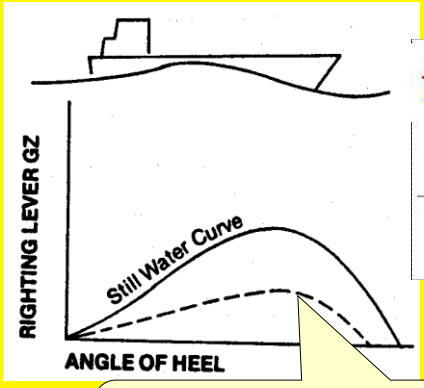
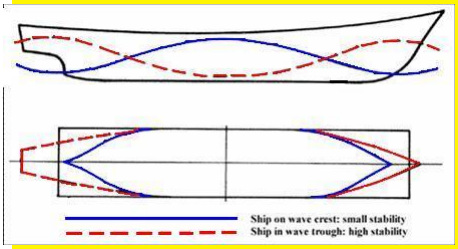
Ship handling i heavy weather
Wave midships





Righting lever will decrease and also the stability width

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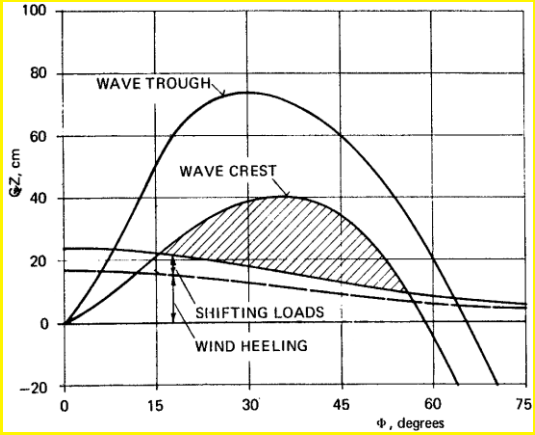
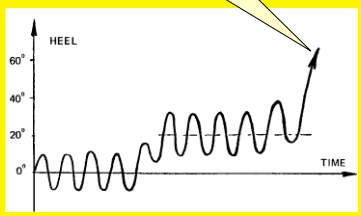
Ship handling i heavy weather
Wave midships and cargo shifting



Ship capsizes



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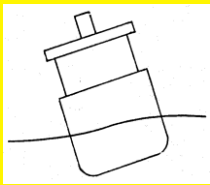
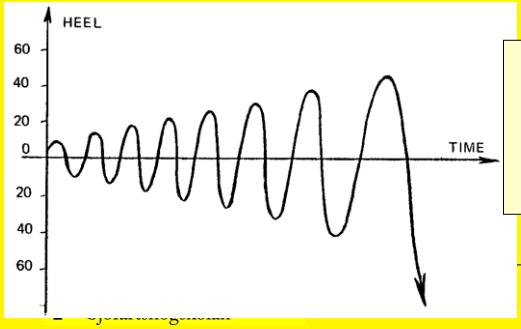
Ship handling i heavy weather
Synchronous rolling



$$T_{Roll} = 2\pi \frac{B/3}{\sqrt{gGM}}$$

$$T_{Roll} = \frac{c \times B}{\sqrt{GM}}$$



If a ship roll period is in resonance with the wave period the roll amplitude
Increases – ship capsizes

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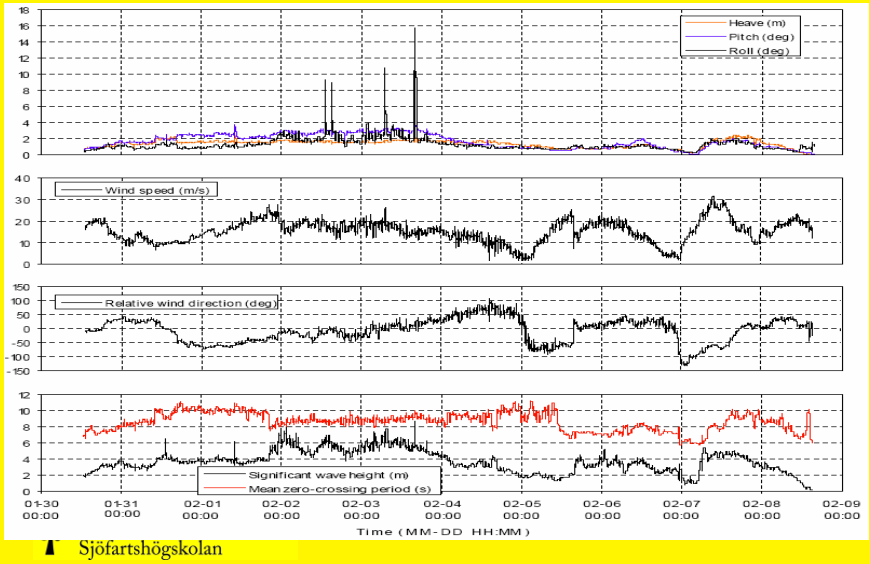
PCTC M/V Aida (February 2004)



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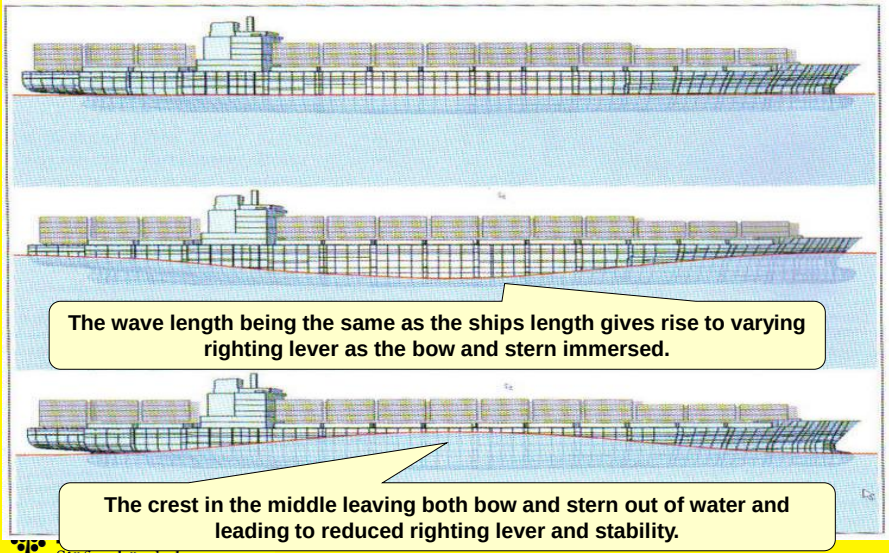
Parametric rolling



The wave length being the same as the ships length gives rise to varying righting lever as the bow and stern immersed.

The crest in the middle leaving both bow and stern out of water and leading to reduced righting lever and stability.

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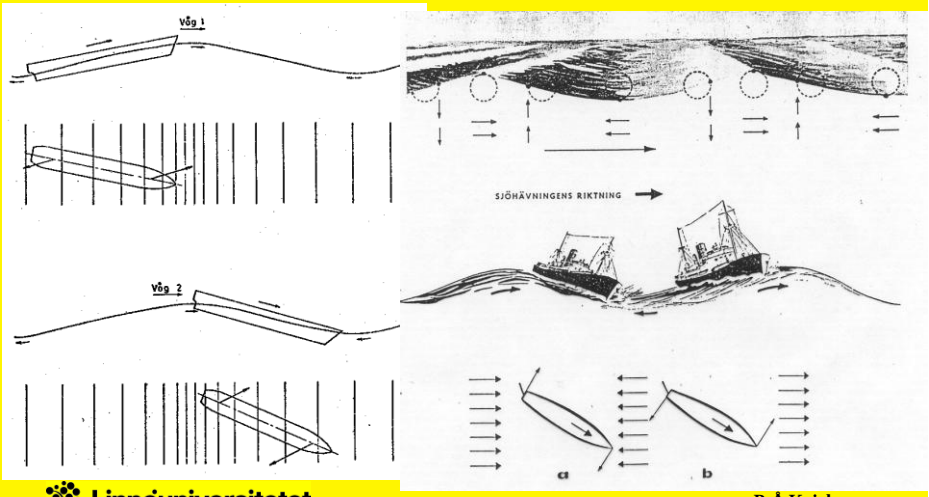
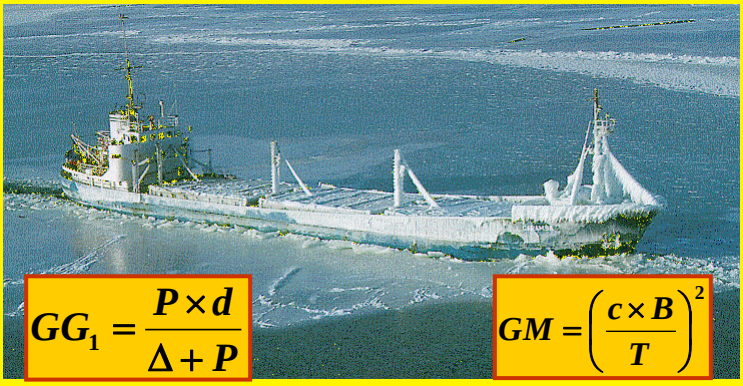
Ship handling i heavy weather
Broaching



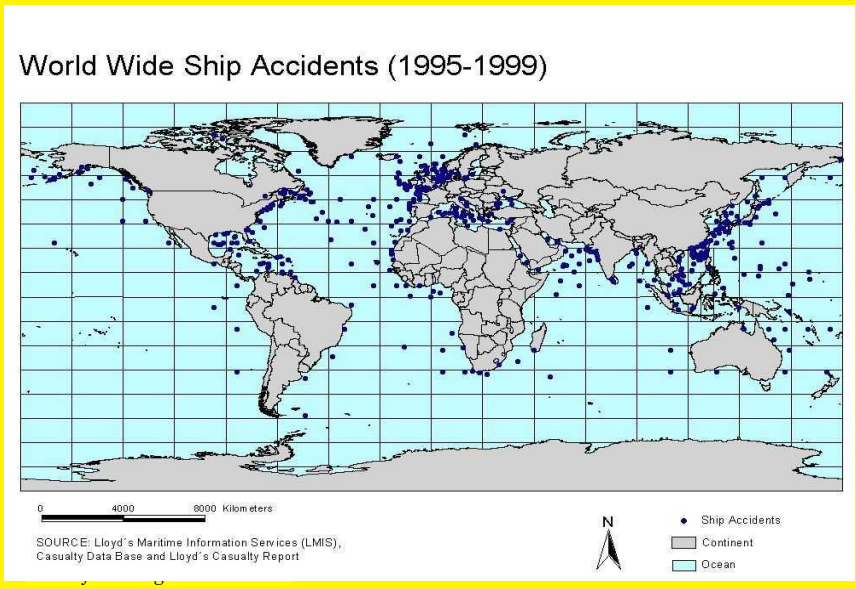
Ship handling i heavy weather
Icing down



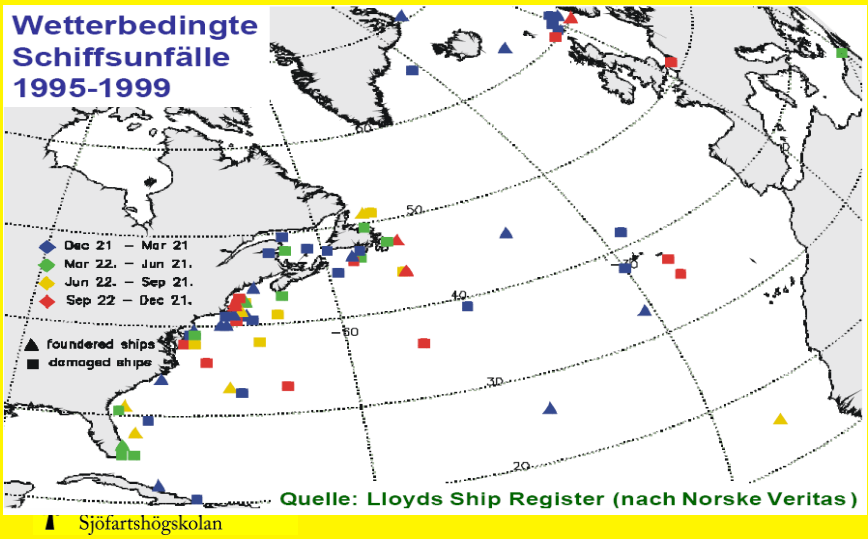
$$GG_1 = \frac{P \times d}{\Delta + P}$$

$$GM = \left(\frac{c \times B}{T}\right)^2$$

Locations of ship damages as well as losses due to severe weather conditions



Weather related ship accidents in the North Atlantic



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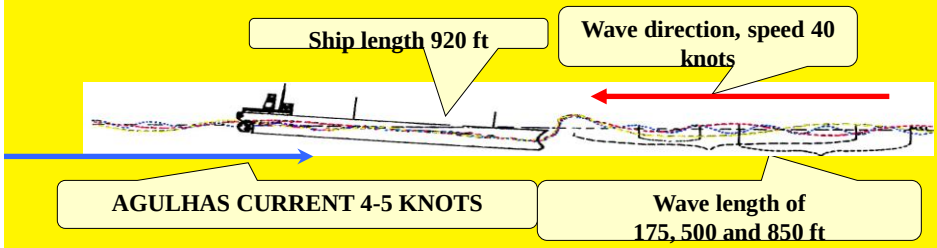
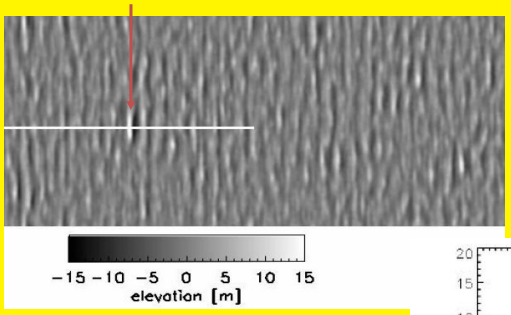
Ship handling i heavy weather
Freak wave

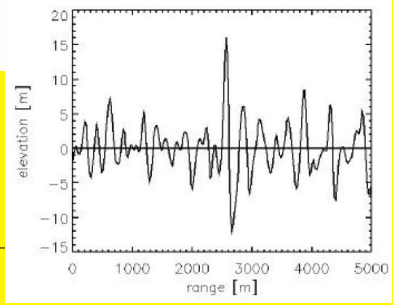


From: SA Sailing Directions Vol 1 page 43:

- ***3.9 ABNORMAL WAVES. As described in section 3.8.9, the Agulhas Current flowing off and parallel to the East coast of South Africa is about 60 miles wide and attains rates of up to 5 knots on occasions. This current is normally kept outside the continental shelf by the fact that it extends downwards to a depth of more than 200m. It attains its greatest rate along its western edge. Between Durban and Port St. Johns the average width of the continental shelf is 5 miles, and it is in this area between the shore and the western edge of the Agulhas Current that a counter current is sometimes generated when a strong wind from the SW is associated with an atmospheric depression moving to the ENE. This current, moving in a NE direction, is composed of a gradient current caused by the level of the sea being raised in the low pressure area and the surface drift caused by wind friction.***

http://coast.gkss.de/projects/maxwave/





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Ship handling i heavy weather
MSC.1/Circ.1228 11 January 2007

REVISED GUIDANCE TO THE MASTER FOR AVOIDING DANGEROUS SITUATIONS IN ADVERSE WEATHER AND SEA CONDITIONS

IMO publicerade 1995 ett MSC-cirkulär 707 med titeln ”Guidance to the master for avoiding dangerous situations in following and quatering seas”. Denna skrift reviderades i cirkulär 1228 som utkom i januari 2007. Fenomenen brukar delas in på följande sätt (här enl. IMO MSC/Circ. 1228):

1. **Surfing och broaching (sv. skärning) är ett fenomen som medför förlust av styregenskaper och kursstabilitet i följande sjö i relativt hög fart.**
2. **Reduktion av stabilitet när fartyg rider på en våg med toppen midskepps. Kallas även ”pure loss of stability” eller ”(quasi-) static loss of stability” i litteraturen.**
3. **Successiv attack i höga vågor. Fenomenet är inte helt klart beskrivet i referensen, men kan delvis sammanfalla med övriga beskrivna fenomen. Det kännetecknas av en successivt ökande rullning och krängning.**
4. **Synkroniserad (parametrisk) rullning som kan inträffa när vågperioden som träffar fartyget (encounting period) ligger nära fartygets egenperiod i eller nära halva dess egenperiod i rullning.**

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Heavy Weather - The Ingredients for a Successful Defence

- **The qualifications and experience of the master and officer may come under review, together with the steps taken to stow and secure the cargo for the passage, and to ensure that the GM of the vessel was such as to avoid the vessel being excessively stiff.**
- **The navigation of the vessel prior to and during the heavy weather will also come under close scrutiny. Could the severe weather conditions, or at least the worst of them, have been avoided by appropriate navigational measures? Whilst encountering the heavy weather, were adequate steps taken by the master to alter course and reduce speed in order to minimise ship motions, and therefore the stresses on both hull and cargo?**
- **Some people are *weather wise*, but most are otherwise"**

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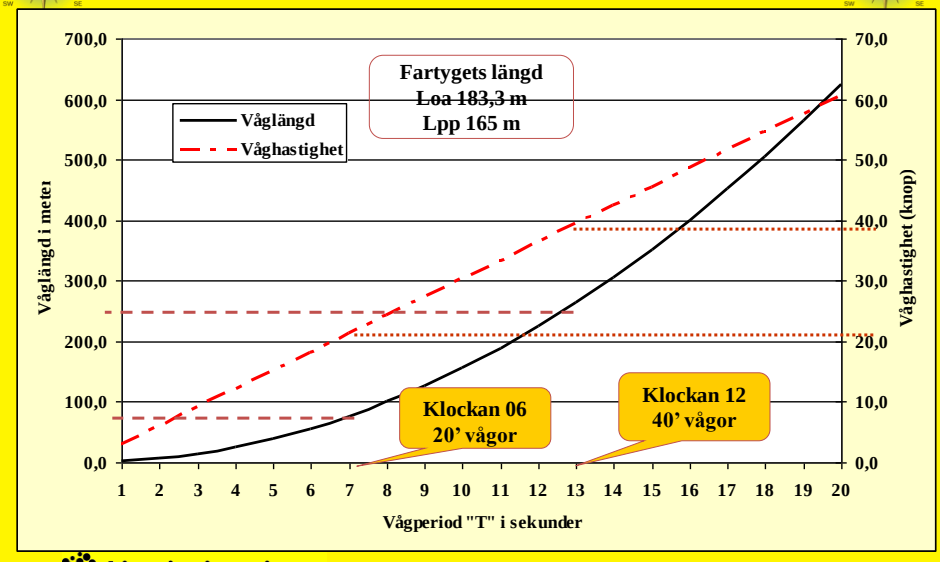

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Tid för våg att passera fartyget.

Klockan	Fartygets hastighet	Våghastighet	Våglängd	Fartygets längd (m)	Tid för våg att pasera
06	19,5 knop	22knop (11,3 m/s)	76 m	165	165/11,3 = 14,6 s
12	19,5 knop	40 knop (20,6 m/s)	263	165	165/20,5 = 8 s

Reduction of intact stability when riding a wave crest amidships

Criteria		Danger
Wave lengths 0,6L to 2,3L i.e. 99 – 380 m	Actual wave lengths 76-263 m i.e. 0,46-1,59L	Yes
Long duration of riding on wave crest		Yes

Synchronous rolling and parametric rolling

Criteria		Danger
Te nearly equal to ship rolling period	At speed 19,5 knots actual Te about 24,5 s / Vid vågperiod 13 s Actual natural period ~24 s.	Yes
Te nearly ½ of ship rolling period		No

T_W = wave period (s)
T_E = encounter period with waves (s)
α = angle of encounter (α = 0° in head sea, α = 90° for sea from starboard side) degrees
V = ship's speed (knots)

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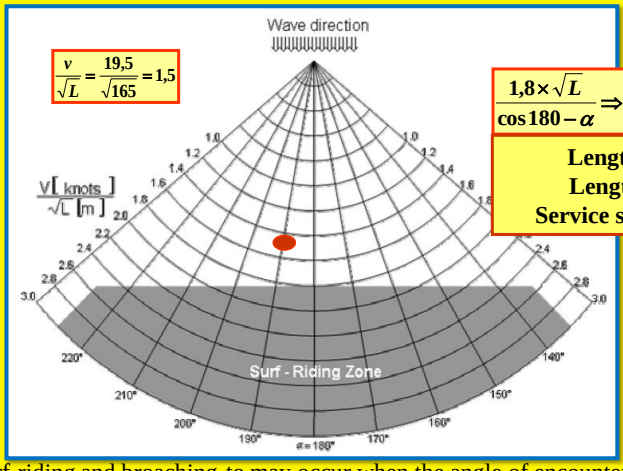
For surf-riding and broaching-to



Surf-riding and broaching-to may occur when the angle of encounter is in the range 150° – 210° and the ship speed is higher than (1.8 L)/cos(180 −α) (knots).

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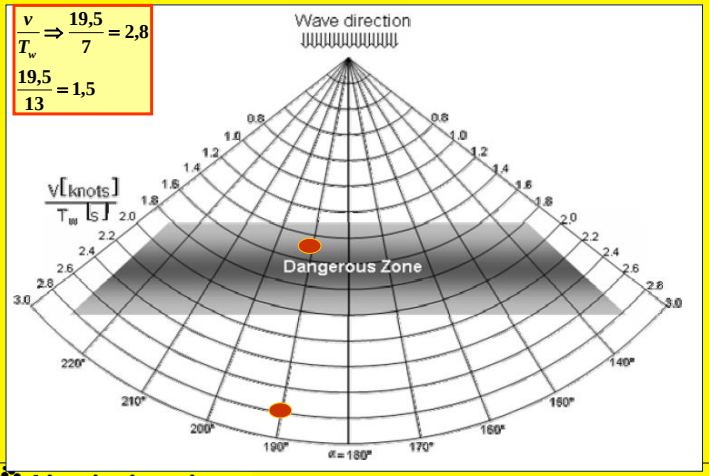
Risk of successive high wave attack in following and quartering seas

$$\frac{v}{T_w} \Rightarrow \frac{19,5}{7} = 2,8$$

$$\frac{19,5}{13} = 1,5$$



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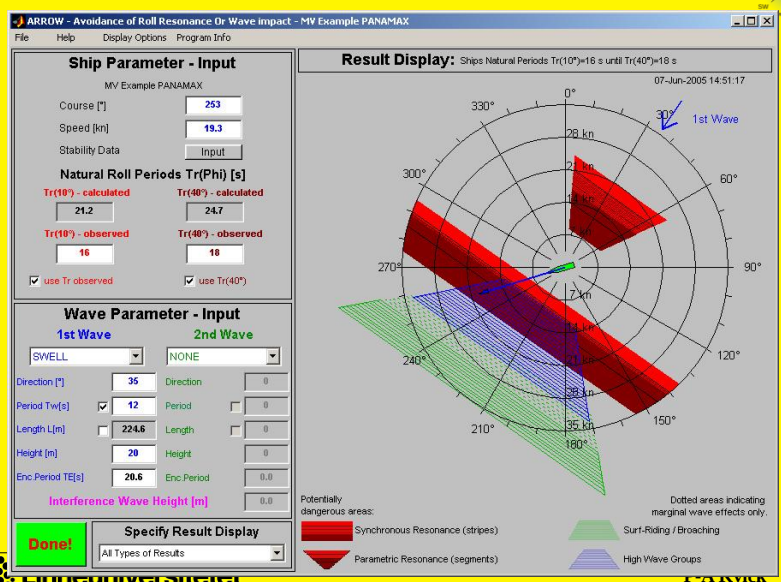
http://www.marsig.com/software_arrow.html



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