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CIRCULAR

To the Members

Beware of　Parametric Rolling in Following Seas－Top Tier report

The International Group (IG) recently became a member of the Maritime Research Institute of the Netherlands (MARIN) Top Tier project. The project has been established to examine and assess the causes of container losses arising from at-sea incidents onboard various sizes of container ships with a particular focus on ultra large ships. The project has been approved by a cross section of industry, academic and government interests and MARIN will produce a report of its findings including recommendations in due course. It is envisaged that the recommendations will eventually lead to operational and technical improvements that should mitigate the risk and underlying causes of container losses at sea.

In the meantime, the IG has received the annexed interim note on parametric rolling which all clubs assess to be of crucial importance to container ship operators, masters and crew. The note is technical and intended for use by seafarers and company operational staff. This circular is not intended to assess or critique the note. It merely draws attention to the phenomenon of parametric rolling.

All clubs in the International Group have issued a similarly worded circular.

Yours faithfully,

The Japan Ship Owners' Mutual Protection & Indemnity Association

Attachment: TopTier_N2M_ParamatricRollFollowingSeas_V1.1

Notice to Mariners

Beware of parametric rolling in following seas

A series of incidents with exceptional container losses occurred during the winter season 2020-2021. The TopTier project was put in place by industry to find ways to avoid similar incidents in the future, and initial results show that parametric rolling in following seas was especially hazardous. This notice describes how container vessel crew and operational staff can plan, recognize and act to prevent parametric rolling in following seas.

Hazard & rationale

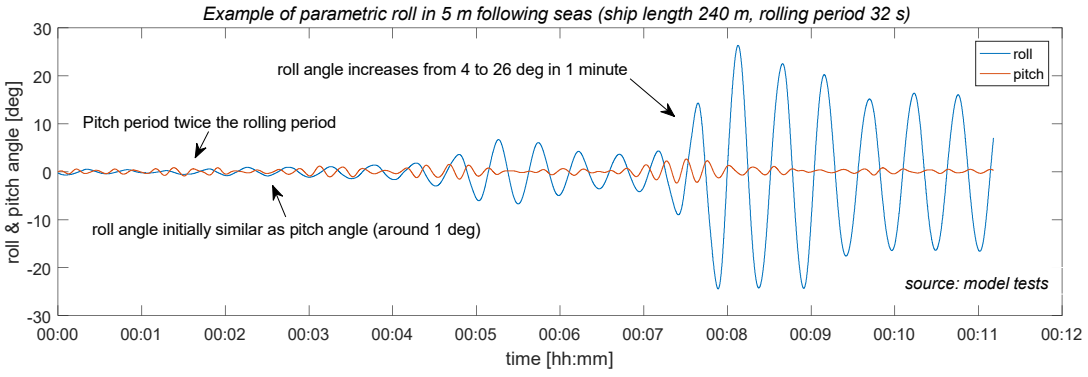
Container ships are also vulnerable to parametric rolling in following sea conditions. Unfavourable combinations of rolling period, vessel speed, heading, and wave conditions, can trigger sudden and extremely rapid increase of roll motions to hazardous levels, threatening the safety of vessel, crew and cargo. This can happen in relatively mild wave heights.

What is parametric rolling?

Parametric rolling can occur when:

- The rolling period is twice the wave encounter period
- Wave lengths are in the range of the vessel length

In these conditions the passing waves cause a variation in waterplane area that can trigger vessel instability in roll. This is most common in heavy head seas, but can occur also in following seas, when the rolling period is long. Even a few high waves after each other may trigger unexpected large roll motions, as shown by the measured time traces of roll and pitch motions in the figure below. In the example, the ship is 240m long with a natural roll period of 32s and is sailing in a 5m following sea.



When to be alert?

Ships at low GM are vulnerable to parametric rolling in following seas, especially when there are waves with a long length from the stern quarter. Long term routing and short term vessel handling should consider the risk of parametric rolling in following seas when:

- Vessel rolling period is long because of low GM (rolling periods in excess of 20s for ships with length above 250m). The rolling period should be measured after departure, as rules of thumb based on GM are not always accurate.
- Following sea conditions (or close to) are expected or experienced.
- The rolling period is twice the wave encounter period. The wave encounter period is equal to the pitching period and can be measured with a stopwatch.
- Wave lengths are longer than two-thirds of the ship length.

The combination of above conditions should be avoided already in route planning by calculating the wave encounter period and wave length using the vessel speed, the forecasted wind and swell wave periods and direction (see next page for details).

How to recognize the first signs or increasing risk?

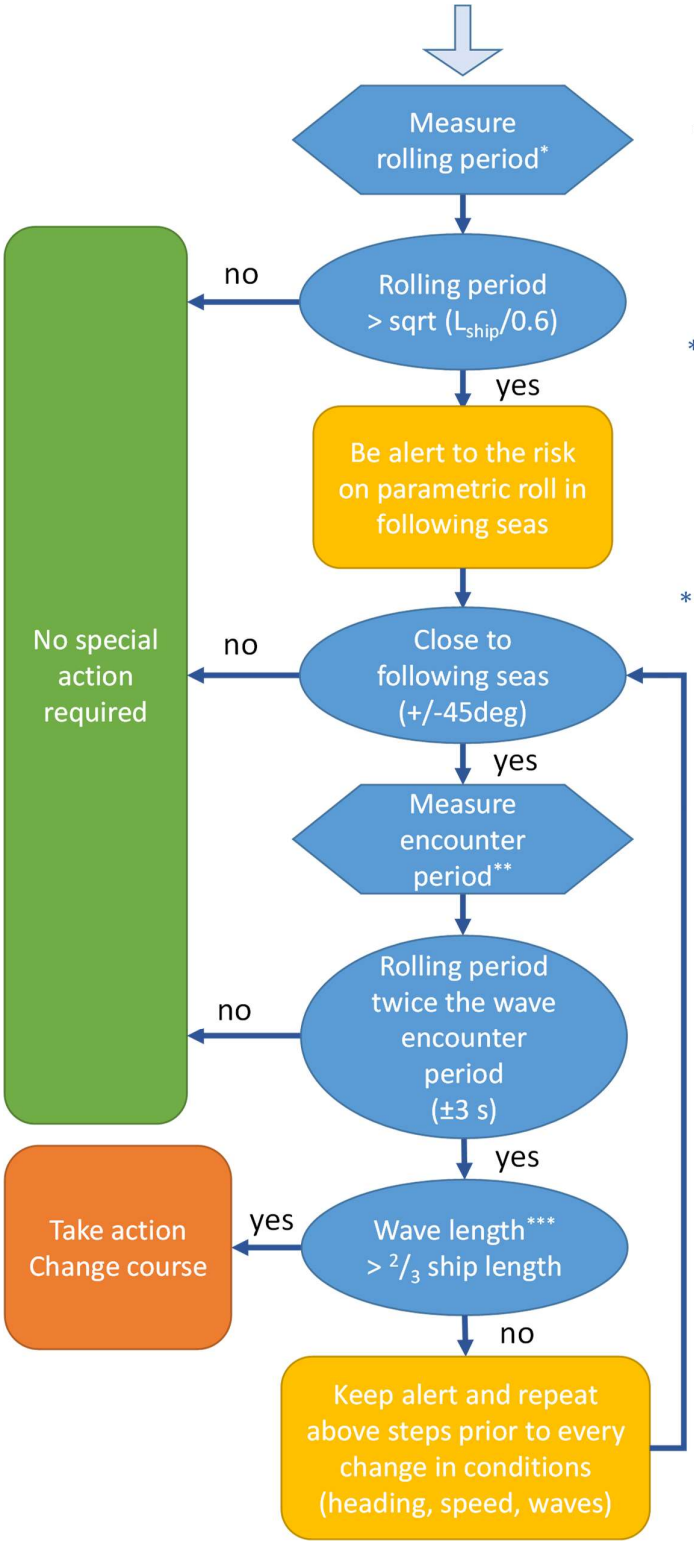
A vessel can go into parametric rolling very suddenly and unexpectedly. To prevent it, crew should therefore learn to recognize the conditions and danger signs at an early stage. Tell-tale behaviour is the synchronisation between the gentle roll and pitch motions as waves pass underneath, especially when the vessel starts rolling alternatingly from port onto starboard shoulder in perfect sync with successive pitching cycles. This indicates that wave encounter periods are close to half of the roll period and in this condition parametric rolling can happen at any time if waves are high enough.

What to do when it happens?

Break the synchronization between the roll period and the encounter period. The most direct way to do this is to change heading to beam or bow quartering seas. Avoid abrupt steering. The heading change can be combined with a speed increase but only if it does not increase the risk of other hazards. Changing course may seem counterintuitive but is the only way to reduce the risk of parametric rolling in following seas.

This notice to mariners in an initiative of the TopTier JIP. The Joint Industry Project TopTier is initiated to address the loss of containers with active participation of major stakeholders. More explicit guidance on the hazard of parametric rolling in following seas is work in progress. For more information https://www.marin.nl/en/jips/toptier

When to be alert on parametric rolling in following seas?

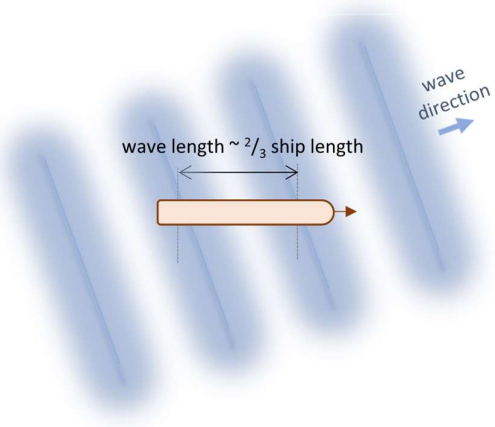


*) Measure roll period:
Use a stopwatch to measure the time of 10 complete roll motion, divide measured time by 10.

**) Measure wave encounter period:
Use a stopwatch to measure the time of 10 complete pitch motions, divide measured time by 10

***) Estimate the wavelength:

The wave length can be estimated in comparison with the ship length.



= measurement / calculation
= decision point
= notice / alert

Calculating the rolling period

An accurate assessment of the rolling period is preferred but may not yet be available during voyage preparation. In that case, you can use the formula below, adding an estimate for the encounter period and wave length.

$$T_{roll} = \frac{0.86B}{\sqrt{GM_{fluid}}} \qquad T_e = \frac{3T_w^{\,2}}{3T_w + V\cos(\alpha)} \qquad L_w = \frac{1.56T_w^{\,2}}{\mathrm{abs}(\cos(\alpha))}$$

Where:

T_{roll}	=	Estimated rolling period of ship in [seconds]
B	=	Beam of ship in [meter]
GM_{fluid}	=	Transverse stability including free surface correction in [meter]
L_w	=	Wave length in [meter]
L_{ship}	=	Ship length [meter]
T_w	=	Wave period in [seconds]
α	=	Ship fixed wave direction (α=0° means head seas) in [degrees]
T_e	=	Wave encounter period in [seconds]
V	=	Ship speed in [knots]
abs	=	Absolute value
sqrt	=	Square root