

# **BULK CARRIER SAFETY**

**Operational measures for avoiding dangerous situations in extreme weather conditions**  
Submitted by Greece

## ***SUMMARY***

**Executive summary:** This document gives a summary on the conclusions of a recent systematic study carried out by the National Technical University of Athens - Ship Design Laboratory on the seakeeping behaviour of four standardized bulk carriers, comments on MSC 69/2/1/Add.5, MSC 70/4, and offers an alternative approach to the bulk carriers issue.

**Action to be taken:** Paragraph 4.

**Related documents:** MSC 69/2/1/Add.5, MSC 70/4.

## ***1. Introduction***

This document is submitted in accordance with paragraph 45.4 of MSC/Circ.816 and MEPC/Circ.331, concerning the Guidelines on the organization and methods of work of the MSC and MEPC and their subsidiary bodies. In earlier discussions leading to the adoption of the new SOLAS XII, Greece identified inadequate design, high loadings in seaway and lack of prudent seamanship as main factors contributing to ship losses. The findings of the UK/EC Assessors' report on the loss of MV Derbyshire actually confirm or imply the same. The United Kingdom submission MSC 69/2/1/Add.5 asserts that "...unfortunately there are formal and informal pressures on the ship's master to choose the shortest route to port which would make regulatory use of weather routing..." to avoid typhoons difficult to impose with any confidence of actual compliance. Greece does not share this pessimistic approach, but likes to reiterate the importance of the following IMO regulations and recommendations as a basis for safe and effective ship operation:

- \* Resolution A.443(XI) "Decisions of the shipmaster with regard to maritime safety and marine environment protection".
- \* Rule 6 of COLREGs on "Safe Speed".

- \* Resolution A.741(18) on ISM Code (paragraph 5.2).
- \* SOLAS regulation V/10-1 "Master's discretion for safe navigation".
- \* MSC/Circ. 707 of 19.10.95 on "Guidance to the Master for avoiding dangerous situations in following and quartering seas".

For the purpose of confirming the contribution of operational factors, the National Technical University of Athens (NTUA) carried out a systematic study.

## *2. The NTUA study*

The study carried out by the National Technical University of Athens - Ship Design Laboratory on the seakeeping behaviour of four standardized bulk carriers (Handy Size, Handymax, Panamax and Capesize) has found, as could be expected, that the various types of ships behave significantly differently in the same seaway conditions and for different operational conditions (change of speed and of wave heading). In particular, small changes of speed and/or of heading can cause large differences in the wave excited ship motions, particularly in the heave, pitch and roll motion responses, in the probability of deck wetness as a result of the ship's deck relative motion (particularly wetness of fore deck and of No. 1 hatch), as well as in the wave induced dynamic loads and related stresses on the ship's structure. In addition, it proves that stem quartering seas are most dangerous with respect to the ship's stability and might lead to the ship's capsize, as has been already pointed out in MSC/Circ.707 of 19.10.95 ("Guidance to the master for avoiding dangerous situations in following and quartering seas").

Finally, considering the above four standard bulk carrier designs under the same environmental conditions, the effect of ship's size on the overall seakeeping behaviour (wave induced motions and loads) is, as could be expected, tremendously different. A sample of results of the Greek study, showing typical ship responses (absolute and relative motion responses, wave induced forces and moments and probabilities of No. 1 hatch wetness) for a Handymax and a Capesize bulk carrier operating in typical North Atlantic and China Sea seaways is given below. Greece is preparing a detailed summary of the findings of this study, as annex to this paper, to be made available during the forthcoming MSC meeting. Results so far for the first two studied ships (Handymax and Capesize) suggest the importance of the following parameters:

### *.1 Influence of seastate*

.1.1 Position of sea spectral peak period and relation to the ship's natural periods in heave-pitch and roll. Results so far for the Handymax bulk carrier, with natural periods in heave and pitch in the range of 7 sec., suggest that maximum nondimensional motions and wave-induced loads (Response Amplitude Operators) can be expected in seaways with a peak spectral period in the range of 7 sec (e.g., CHINA SEA).

.1.2 Value of significant wave height. It is clear that maximum values of motions and wave induced loads clearly increase directly proportional to the significant wave height of the operational seastate. Insofar, absolute motion and wave induced load values were largest in the North Atlantic region (assumed significant height: 6.2 m).

## ***.2 Influence of ship's speed and wave heading***

.2.1 Ship's speed. The influence of forward speed is significant for all wave headings, except for beam seas. Depending on the incident seaway direction and the relevant ship size. Handymax heave and pitch motions clearly increase with increasing speed in head and head-bow North Atlantic sea spectra, whereas tendency reverses for following and stern-quartering seas. Roll motions clearly peak-up for a Handymax at an intermediate speed of 10 knots in 45 deg stern quartering seas.

.2.2 Wave heading. Results so far suggest that maximum heave motions occur for beam seas, roll motions for stern quartering seas and pitch motions for head-bow seas, deck-wetting most probable to occur for head-bow waves. Small changes of routing significantly change overall performance of the vessel.

## ***.3 Influence of ship's type and size***

Ship's type and size. Results so far for the Capesize bulk carrier, suggest, as could be expected, that in view of much larger size and the shift of the respective natural periods in heave and pitch, besides roll, to higher values, that the peaks of the Response Amplitude Operators are shifted to higher values of the sea spectral peak periods. The probability of deck wetness and freeboard exceedence at hatch No. 1 clearly decreases for the much larger Capesize compared to the Handymax size.

## ***3 Recommendation***

The findings of the above study and common sense prudent seamanship suggest, that it is in the best interest of ships safety to promote and implement sound operational measures. These measures could be understood in the issuance of a ship specific "Sea-

keeping Information Booklet", describing the ship's safe operational envelopes with respect to the governing seaway and seastate, the ship's speed and wave heading, and enabling the master to avoid or mitigate adverse seaway effects.

Operational measures (use of weather routing, change of speed and of heading) are more effective than raising the freeboard to a certain percentage above present margins and/or including forecastle. For example, one metre's reduction in the height of on-coming water on deck can be more effectively achieved by a change of course by abt. 20deg. - or a speed reduction, or a combination of both - than by changes in forecastle or bow designs. Awareness should be made of the above safe-ship operational measures to charterers and other ship users so they do not attempt by legal or economic means to force ship operators and masters to operate their ships in unsafe operational regimes.

#### 4 Action requested of the Committee

The Committee is requested to note the above and take action as appropriate.

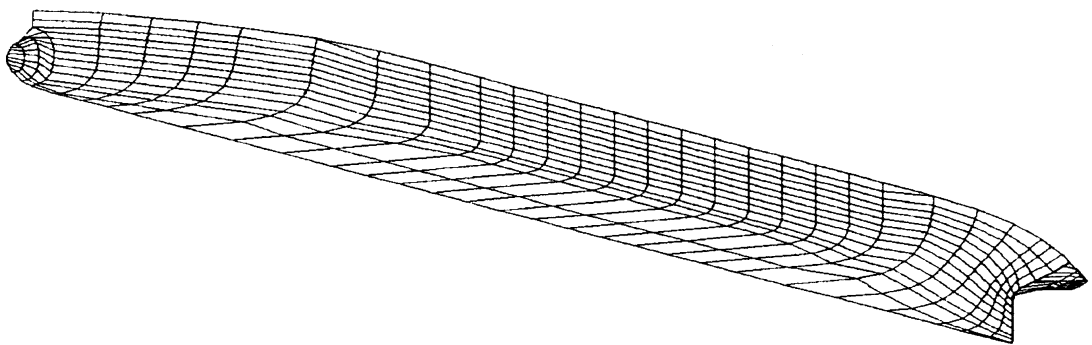


Fig 1. 3D Panel Discretization by 2x447 elements

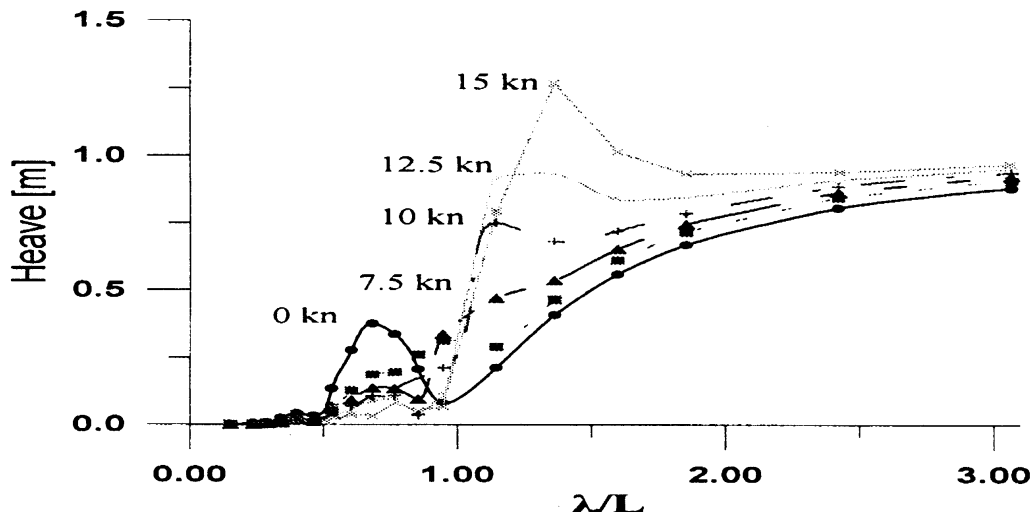


Fig 3. Heave RAO for HANDYMAX Bulkcarrier in head seas

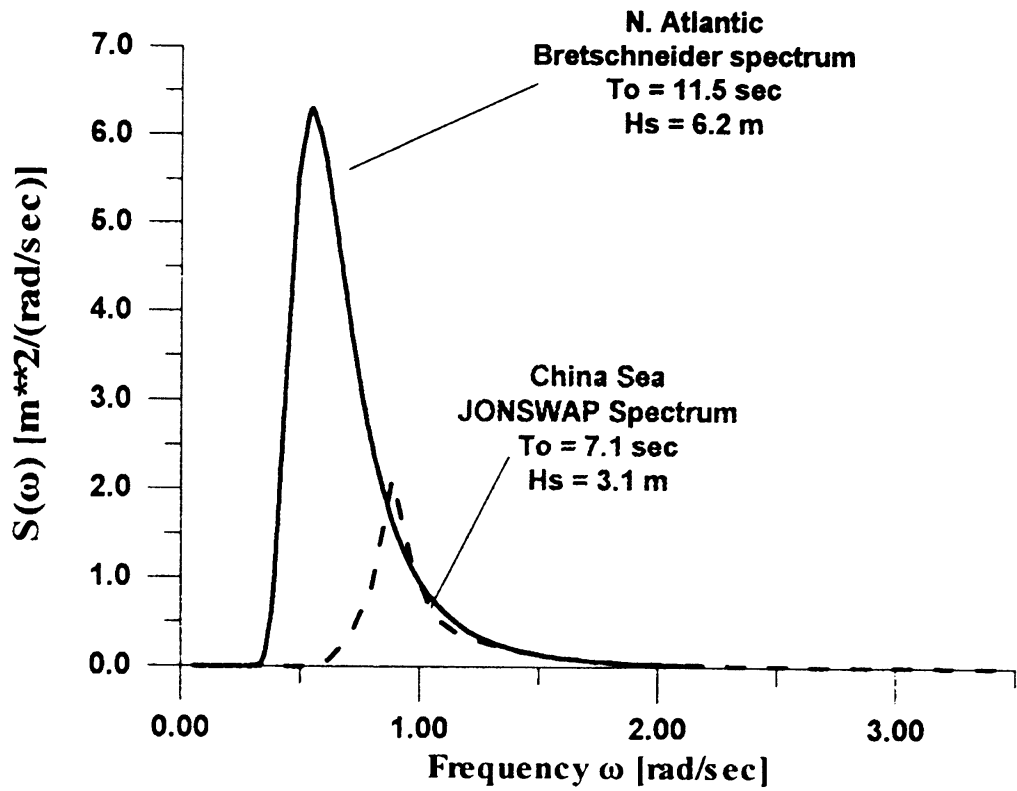


Fig 2. Considered Sea Spectra

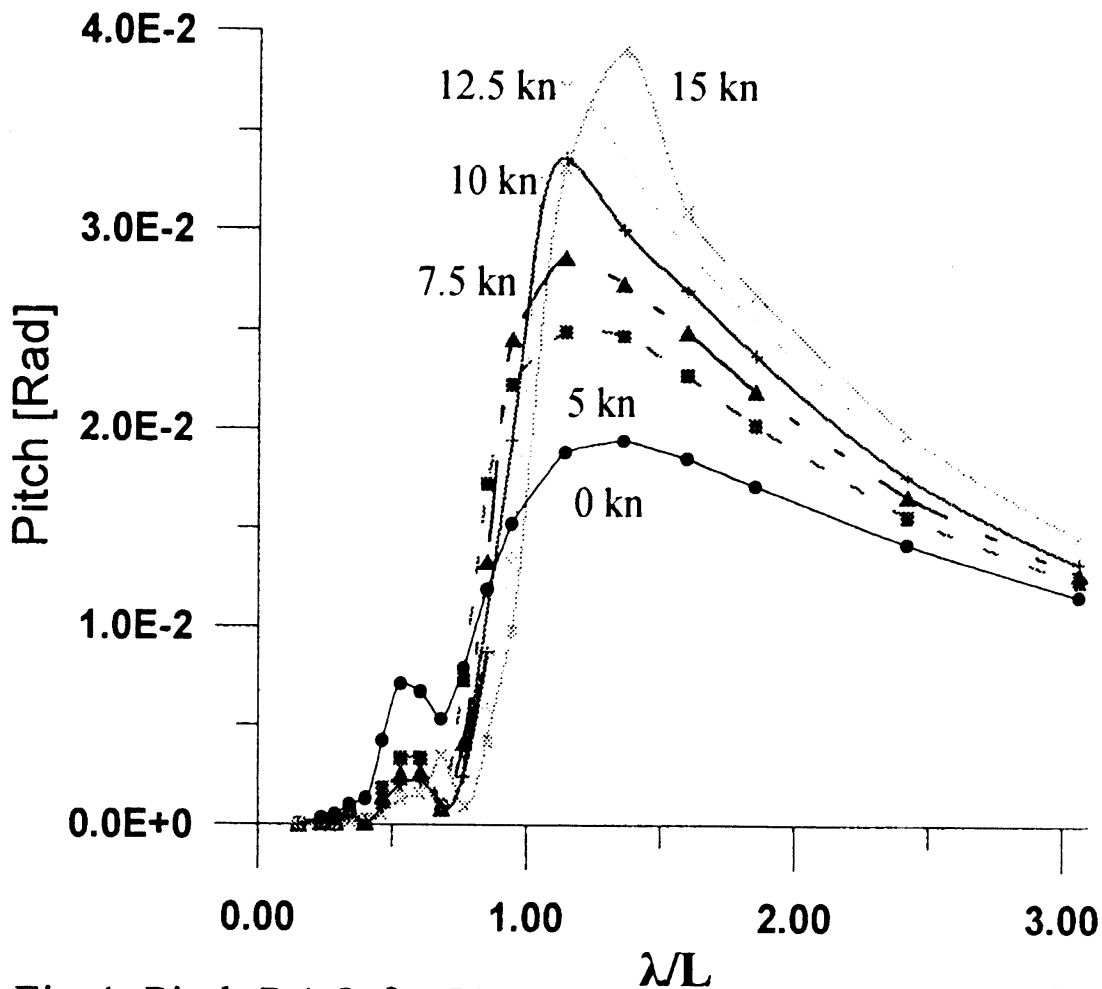
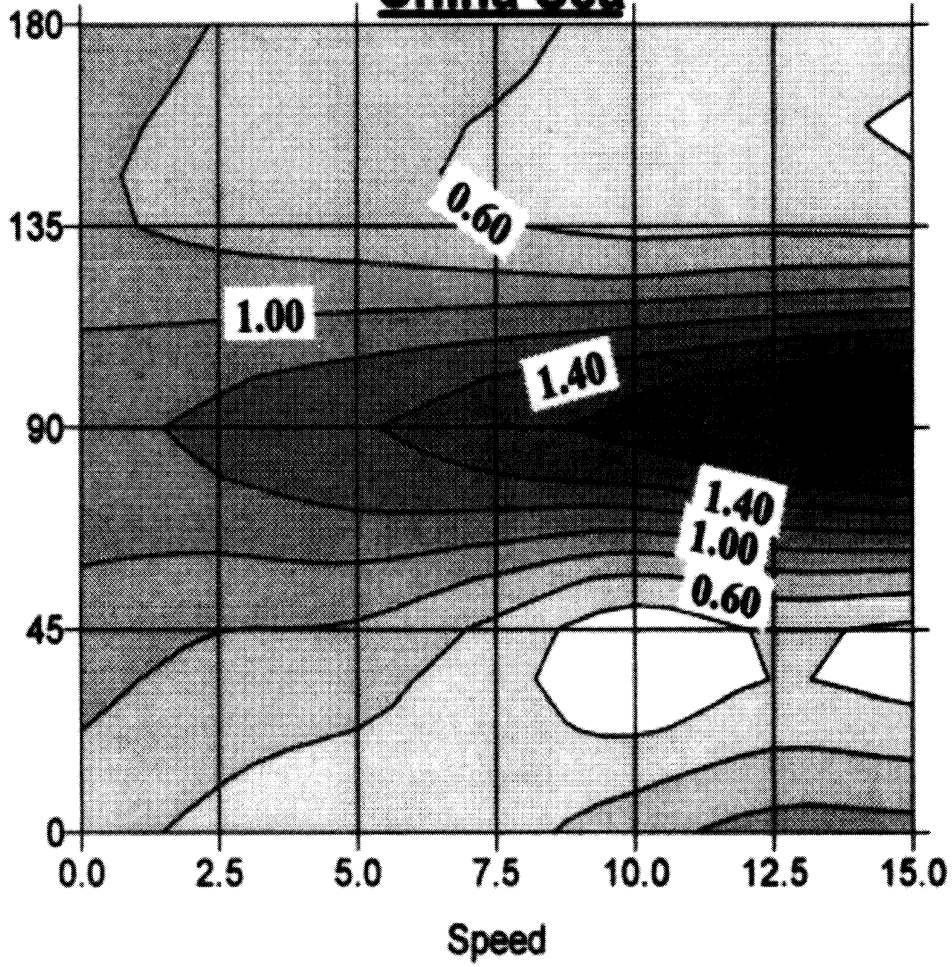


Fig 4. Pitch RAO for HANDYMAX Bulkcarrier in head seas

# China Sea

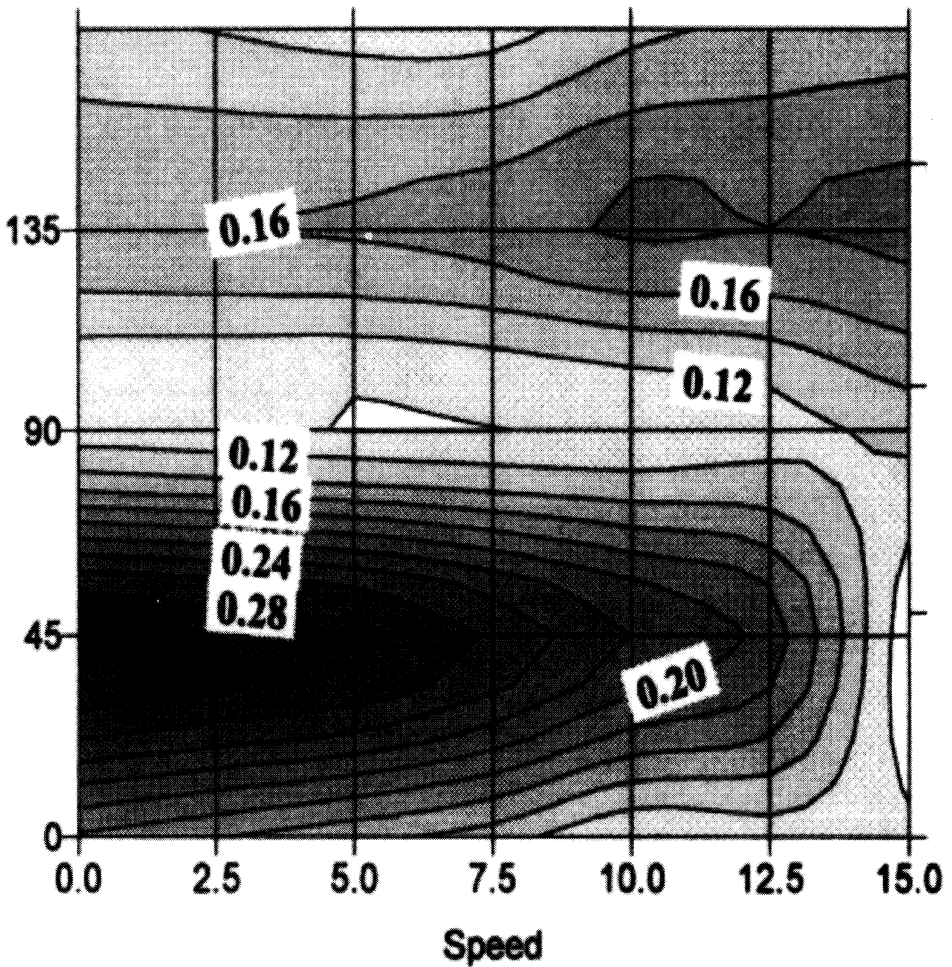
## FORCES

$F/[(GE) \cdot (\text{Disp.}/L)]$   
Heading

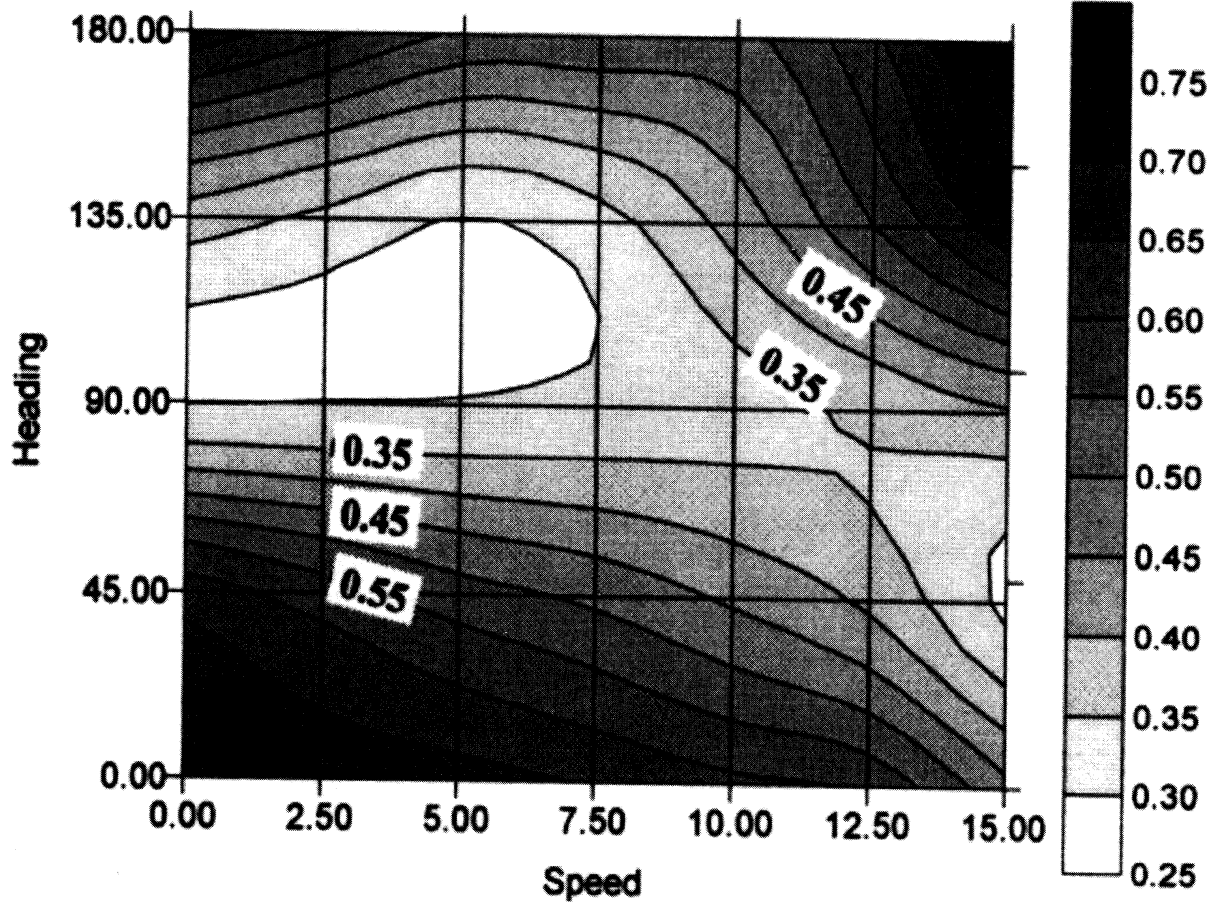
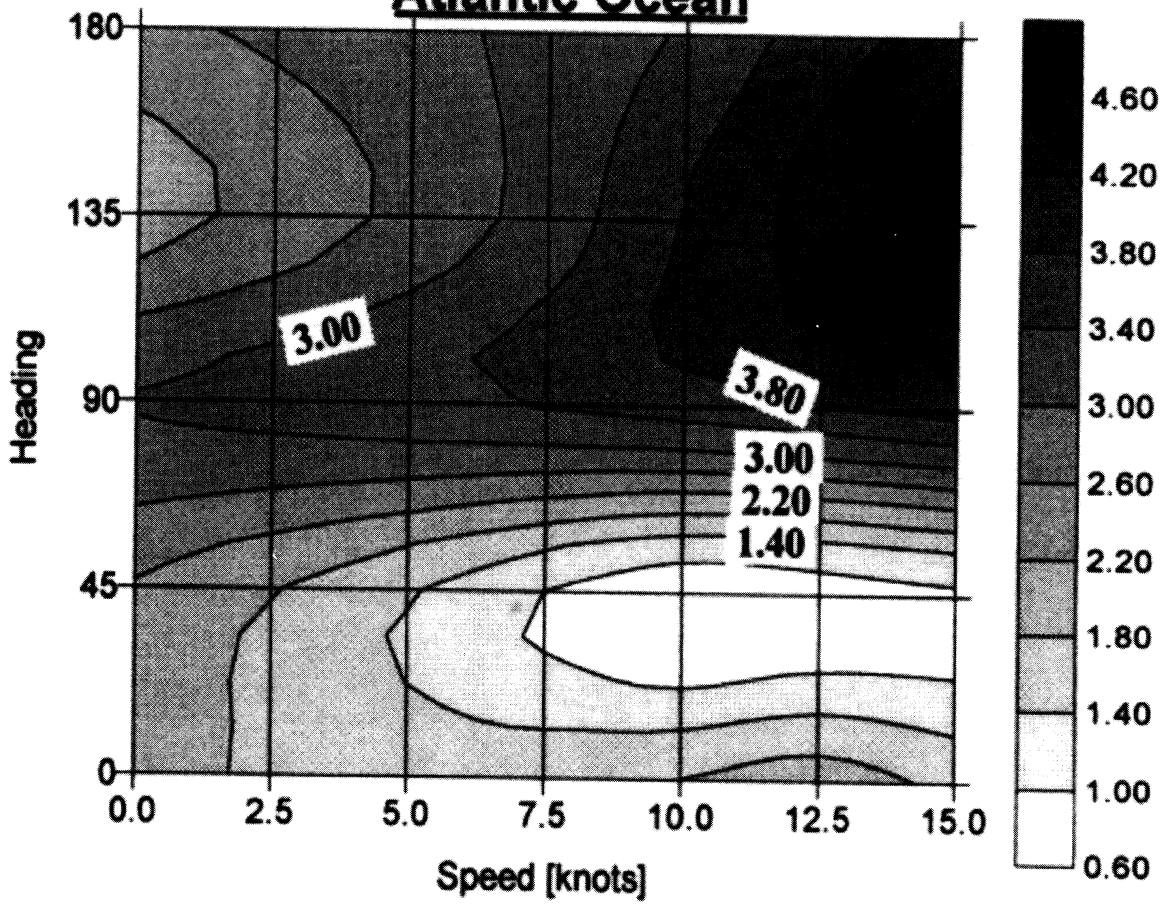


## MOMENTS

$M/[(GE) \cdot (\text{Disp.})]$   
Heading



# Atlantic Ocean



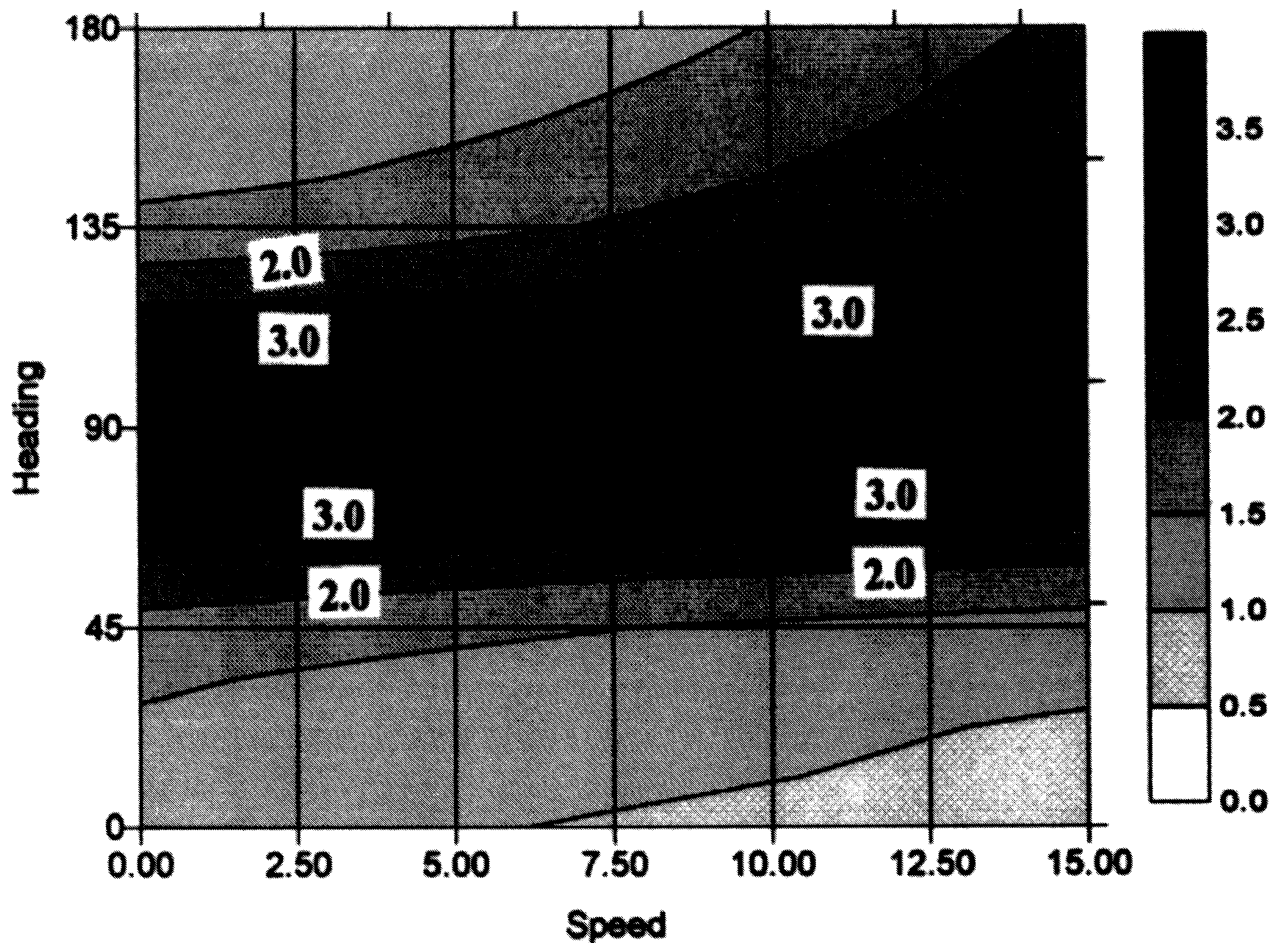


Fig 9. Heave Motion Significant Amplitudes

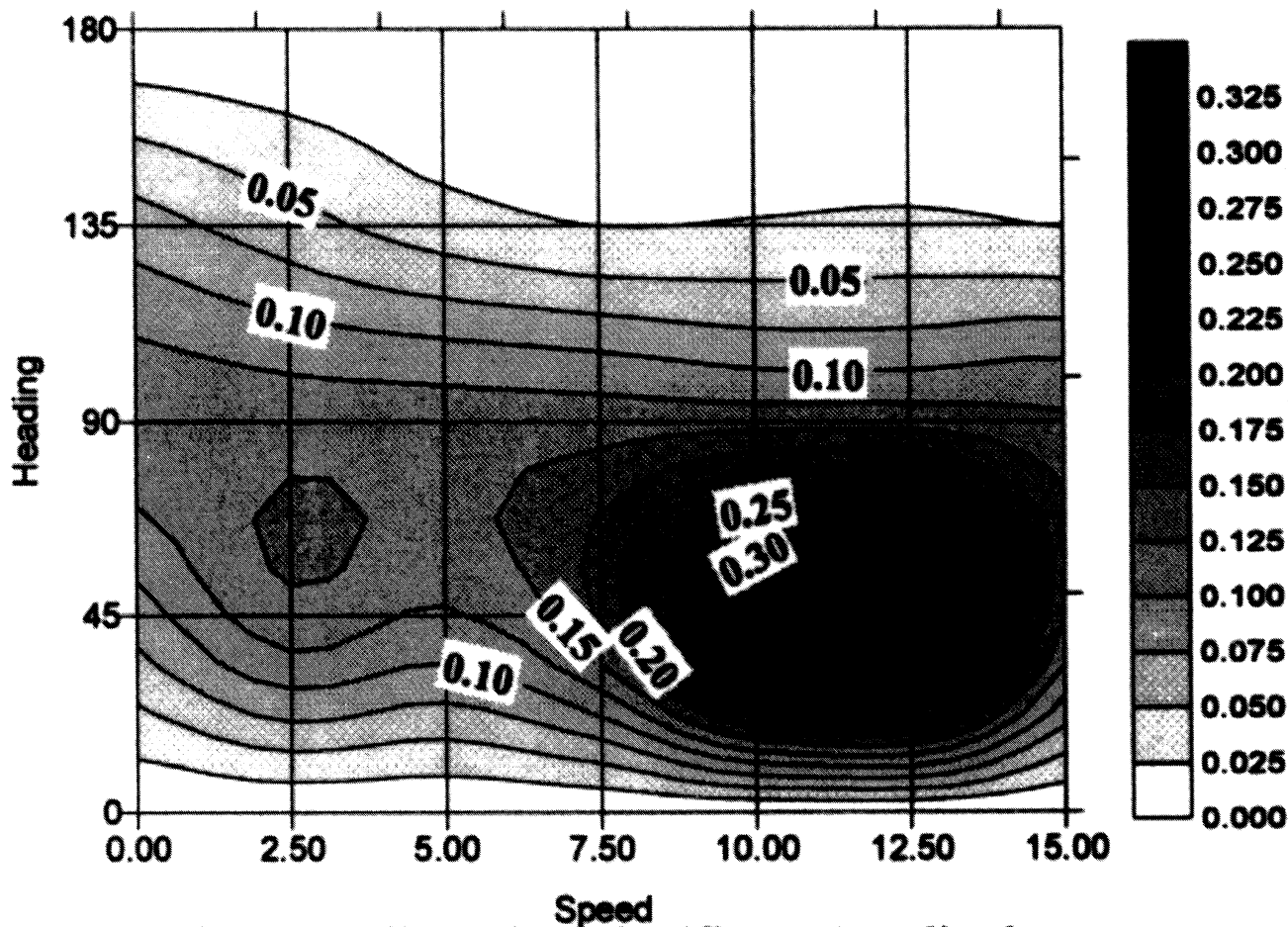


Fig 11. Roll Motion Significant Amplitudes

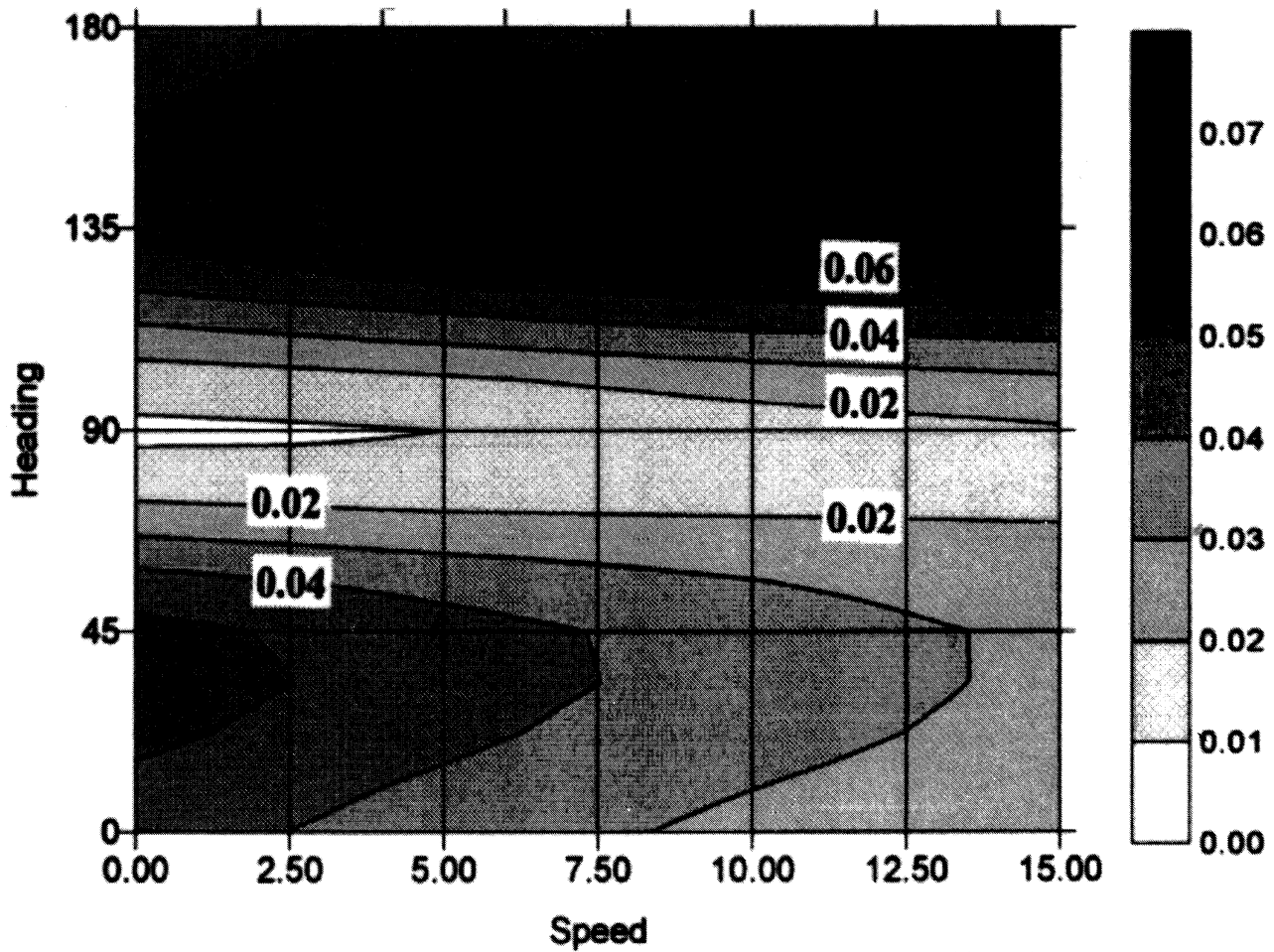


Fig 10. Pitch Motion Significant Amplitudes

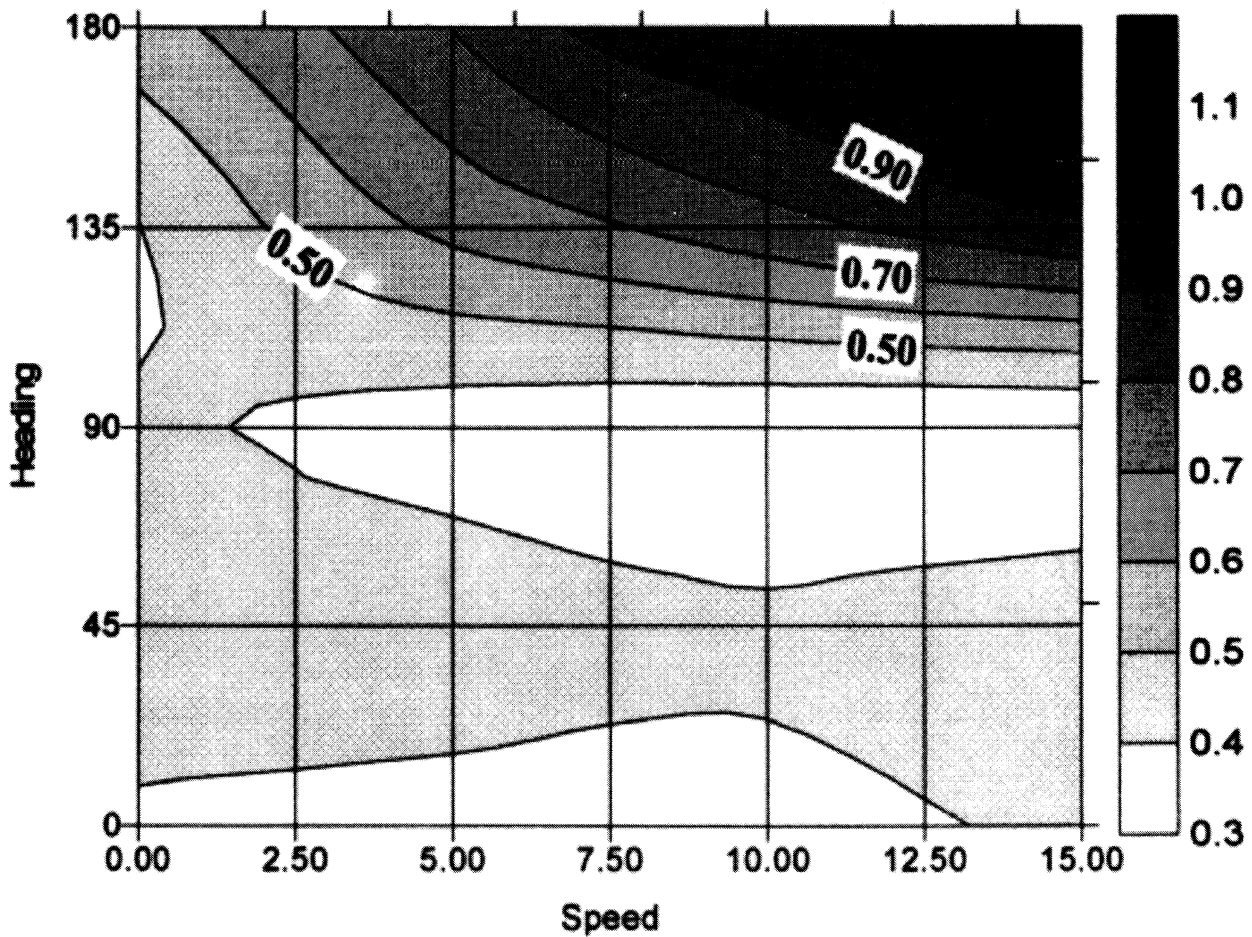


Fig 12. Significant relative motion amplitude ratio to freeboard

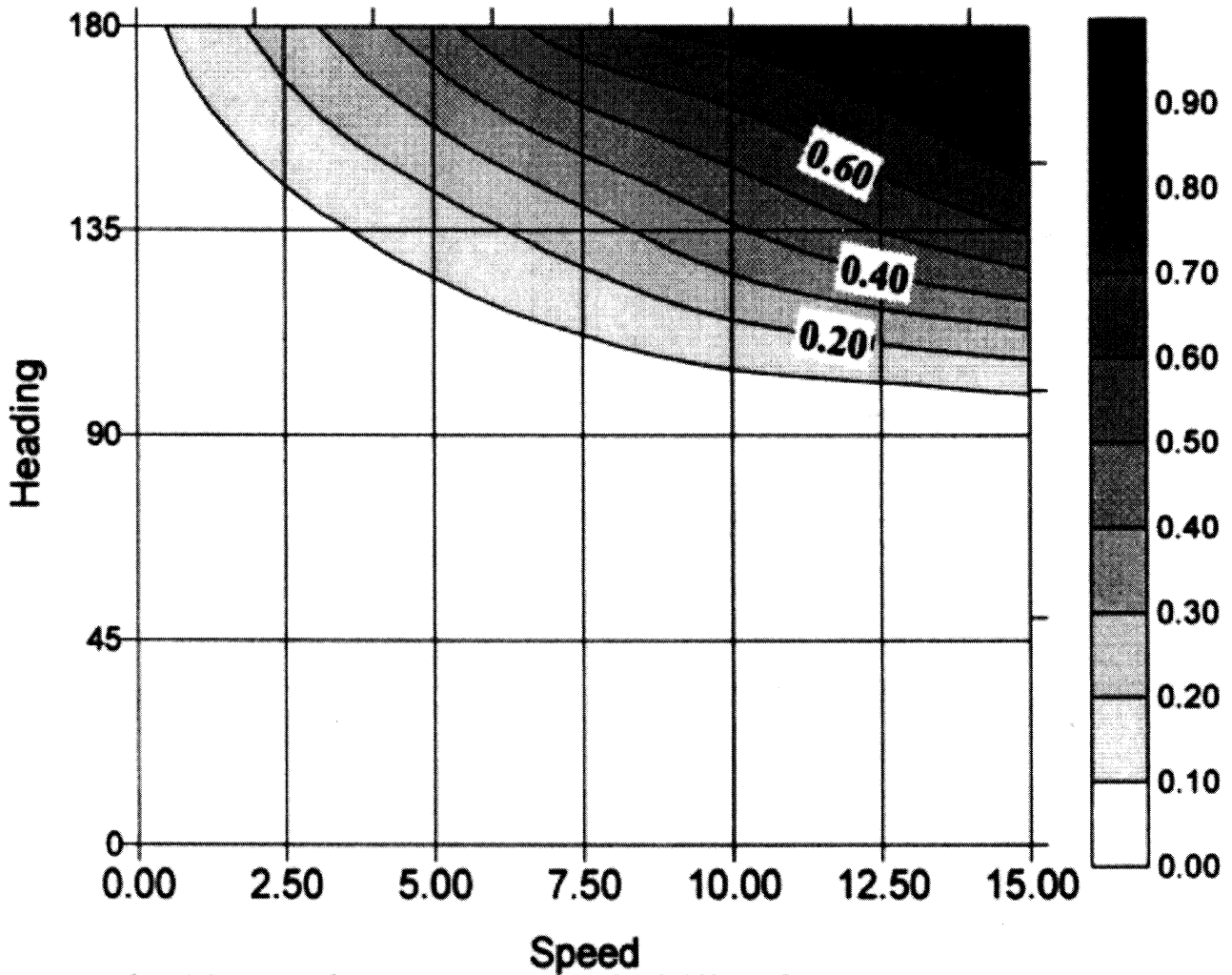


Fig 13. Deck Wetness Probability for HANDYMAX

