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DAMAGE STABILITY REGULATIONS FOR RO-RO PASSENGER SHIPS

Study on the impact of the damage stability requirements of the SOLAS 2009 amendments on ro-ro passenger ships

Submitted by Japan

SUMMARY

Executive summary:	This document provides a summary of a study on the impact of damage stability requirements of the SOLAS 2009 amendments on ro-ro passenger ships.
Strategic direction:	5
High-level action:	5.1.1
Planned output:	5.1.1.1
Action to be taken:	Paragraph 14
Related documents:	SLF 51/17; MSC 84/22/12, MSC 84/22/23 and SLF 52/11/1

Introduction

1 The Sub-Committee, at its fifty-first session, established the correspondence group and instructed it to examine the impact of the damage stability requirements of the SOLAS 2009 amendments on ro-ro passenger ships, in comparison with the SOLAS 1990 regulations in association with the Stockholm Agreement (SA).

2 The correspondence group had comprehensive discussion on whether or not the safety levels of SOLAS 2009 and SOLAS 90 + SA for RoPax ships are generally equivalent, and "the majority of correspondents consider that some amendments to SOLAS 2009 may be necessary and most believe that these should be based on further research work, in particular on smaller ships with fewer passengers and on ships with LLH, especially those fitted with B/10 longitudinal bulkheads" (document SLF 52/11, paragraph 21.1).

3 Taking into account the discussion in the correspondence group, Japan conducted calculations and model experiments to facilitate further examination on this issue. This document provides the summary of the study and the obtained observations.

Scope of the study

4 The main purpose of the study is to investigate the following points:

.1 comparison of the safety levels between SOLAS 2009 and SOLAS 90 with SA; and

.2 the accumulated water on deck stipulated in SA may be overestimated in numeric standards and therefore it may often need to be adjusted by a model test to satisfy SA.

Calculation of the required GM by applying SOLAS 2009 and SOLAS 90 + SA

5 For the study, a model ship of RoPax ferry was prepared based on typical existing ones complying with damage stability requirements of SOLAS 2009. Principle particulars of this ship are shown in table 1. Attained and required indices for all loading cases defined in SOLAS 2009, namely deepest, partial and light service subdivisions, are shown in table 2. The subdivision of the RoPax ferry is shown in figure 1.

6 For all the loading cases, the required GM is calculated based on SOLAS 2009, SOLAS 90 only, and SOLAS 90 with SA. Table 3 shows the calculated required GM, which indicates that, in the partial and light service cases, the required GM is larger in the SOLAS 2009 than in the SOLAS 90 with SA. Table 3 also shows that, in the case of the deepest subdivision, the required GM in SOLAS 2009 is almost the same as that in SOLAS 90 with SA. Thus, it is clarified that the required GM of the present calculated ship in SOLAS 2009 is larger than, or at least equivalent to, in SOLAS 90 with SA. Findings drawn from the calculation are similar with that drawn from the study by the EMSA (SLF 52/11/1).

Table 1 – Principle particulars of the RoPax ferry

Subdivision length (Ls) (m)	199.2
Breadth(B) (m)	27.0
Number of persons on board (persons)	850

Table 2 – Attained and required indices of RoPax ferry

	Light service dl	Partial dp	Deepest subdivision ds
Draught (m)	5.7	6.39	6.85
Partial index	0.843	0.659	0.738
Attained index	0.169	0.264	0.295
Attained index(total)			0.727
Required index			0.715

7 Such difference of the required GM can be attributed to the difference of the philosophy of each regulation, in particular to the definition of damage extent. As the number of passengers increases, the required index in SOLAS 2009 increases and the required GM of every loading condition increases. For the compliance with such a severe required index, flooding of more than two compartments is required to be taken into account in SOLAS 2009. On the other hand, in the SOLAS 90, although the number of passengers has impact on the subdivision coefficient (Cs)

which defines the number of damage compartment, most of the damage case results in two compartment damage. This implies that it becomes relatively easy for larger ships to comply with SOLAS 90. Consequently, the number of passengers has little effect on the required GM in SOLAS 90.

8 Because of such difference in philosophy of both regulations, it is clarified that safety level of the SOLAS 2009 of a relatively large ship becomes higher than that of SOLAS 90 with SA. This is the conclusion for this RoPax ferry regarding the point in paragraph 4.1.

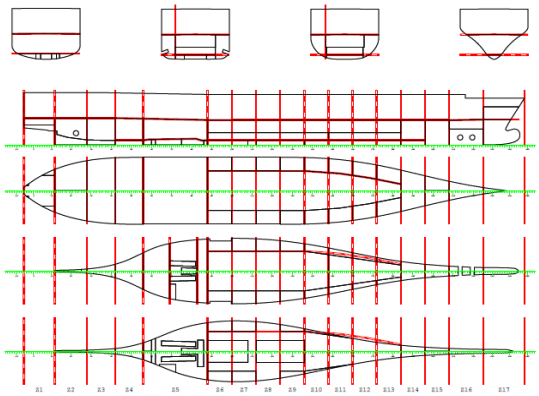

Figure 1 – The Subdivision of RoPax ferry

Table 3 – Required GM for SOLAS 2009, SOLAS 90 and SOLAS 90 + S.A.

	Light service dl	Partial dp	Deepest subdivision ds
Draught (m)	5.7	6.4	6.9
Required GM (m)			
CASE 1 SOLAS 2009	2.50	1.30	1.73
CASE 2 SOLAS 90	1.40	1.19	1.33
CASE 3 SOLAS 90+SA	1.44	1.25	1.65

Actual safety level ensured by the Stockholm Agreement

9 The summary of model tests is indicated in the annex. The result shows that the required GM exists between 1.0 m and 1.2 m, which demonstrates that the required GM based on the numeric standards in SA as described in table 3 (1.65) is larger than the required GM revealed by the model test. Therefore, it is clarified that there is a certain difference between the required GM based on the numeric standards and that based on the model test.

10 According to the model test result, accumulated water on deck stipulated in SA is overestimated in numeric standards and needs to be adjusted by a model test for compliance with SA. This confirms the statement in paragraph 4.2, at least as long as this ship concerns.

11 For the further consideration of such differences in a quantitative manner, the effect of the modification of residual stability requirement, GZmax, on the required GM is examined. Having referred to the results of HARDER project, the required GM in the case of GZmax>0.25m is evaluated. The accumulation of probability factor (Pi) of damage cases is shown in figure 2. In the case of GZmax>0.12m, it is found that about 96% of all damage cases can survive with a certain probability. In the meanwhile, about 83% of all damage cases can survive in the case of

GZmax>0.25m. Consequently, the required GM increases by 0.1m due to the change of attained index from 0.730 to 0.719.

12 It is found that the difference between the numeric standards and adjusted GM by the model test is more significant and not negligible. Therefore, it should be considered preferable to compare safety levels of SOLAS 2009 with those of SOLAS 90 with SA using model test adjustment.

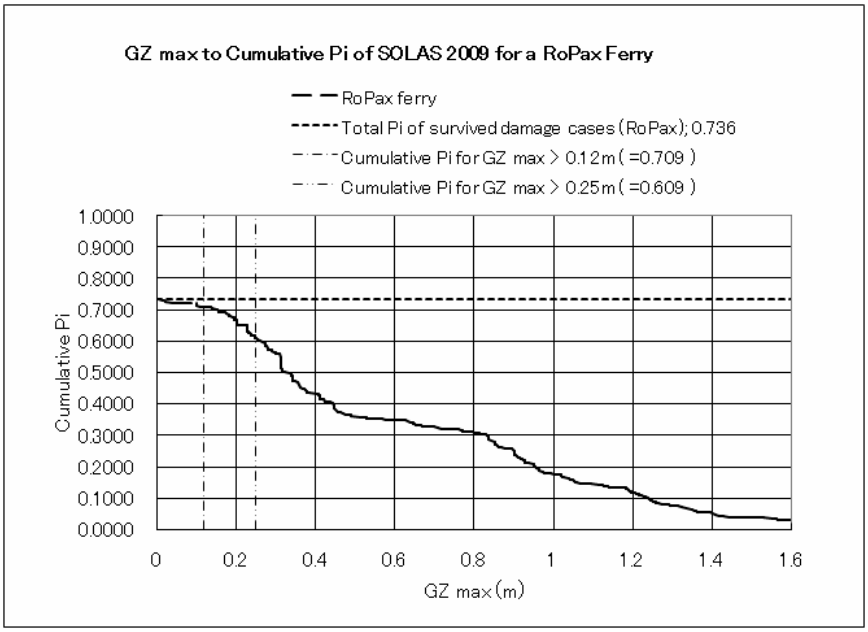

Figure 2 – The distribution of GZmax in the calculation of SOLAS 2009

Observations based on the investigation

13 As a result of the calculations and model experiments, the following observations are obtained:

.1 The required GM is larger in the SOLAS 2009 than in the SOLAS 90 with SA in all the loading cases defined in SOLAS 2009. Such difference can be attributed to the difference of philosophies between SOLAS 2009 and SOLAS 90, in particular to the difference of definition of damage extent. This indicates that safety level of SOLAS 2009 for a relatively large ship becomes higher than that of SOLAS 90 with SA. Therefore, it is important that we should take such difference of philosophy into account in the further consideration of the safety levels of SOLAS 2009.

.2 It is clarified that there are a certain differences between the safety levels of SOLAS 90 with SA obtained by the numerical standards and that obtained by model tests because accumulated water on deck stipulated in SA is overestimated in the numeric standards. Hence, it is preferable to compare safety levels of SOLAS 2009 with those of SOLAS 90 with SA adjusted by model tests.

.3 In the meanwhile, there are some small ship cases of EUROYARD results that the safety levels of SOLAS 90 with SA is higher than those of SOLAS 2009. Furthermore, based on the investigation through the model tests conducted by EMSA/HSVA, there are not significant difference between the limiting GM of test

results and the GM of numerical results on the SHIP EMSA regarding small (relatively small number of passengers) ro-ro passenger ships. Therefore, we should carry out further investigation bearing those results in mind because ro-ro passenger ships are of great variety and it is difficult to draw an absolute conclusion by limited investigation.

Action requested of the Sub-Committee

14 The Sub-Committee is invited to consider these observations and take action as appropriate.

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ANNEX

DAMAGE STABILITY TESTS WITH A RO-RO FERRY

1 Model tests were conducted with a ro-ro ferry in accordance with "Revised model test method under resolution 14 of the SOLAS conference" (resolution MSC.141(76)). The width of the damage openings and all conditions of experiments are determined based on this guideline.

2 The tests were carried out in the towing tank in National Maritime Research Institute of Japan (NMRI) on July 2009. About 5 m long model, which corresponds to a model scale of 1:40, was used. Damaged compartments and ro-ro spaces are modelled with the correct surface and volume permeability ensuring that floodwater mass and mass distribution are correctly represented. Ventilating and cross-flooding arrangements are constructed to represent the real situation of the subject RoPax ferry.

3 The irregular beam seas were generated with the JONSWAP spectrum. The 200 m long test basin provided sufficiently long measurement duration practically free of wave reflection. Figure A1 shows the overview of model ship and photo of experiments. Ship motion including roll, incident wave and water height on ro-ro deck were measured by means of gyro and wave proves.

4 The main purpose of the tests was to investigate the difference of required GM between SOLAS 90 + SA in numeric standards and that adjusted by model test and to find out whether the ship designed according to SOLAS 2009 would survive in model tests carried out according to the guidelines in the annex of the Stockholm Agreement or according to the directive 2003/25/EC, as amended. Therefore, model tests were carried out with various loading conditions (GM=1.0, 1.2 and 1.4 m).

5 Figure A2 shows the example of time histories of roll motion, water height on ro-ro deck and incident waves. In the case of GM=1.2m, it is clarified that the present RoPax ferry did not capsize in different ten 30 minutes realizations although water piled up on ro-ro deck and induced the certain heel to lee side. In the meanwhile, in the case of GM=1.0m, ship capsized because GM after damaged became almost zero. Therefore, it is clarified that the required GM exists between 1.0 m and 1.2 m.

Figure A1 – Photo of model of the RoPax ferry and experiments in beam irregular waves

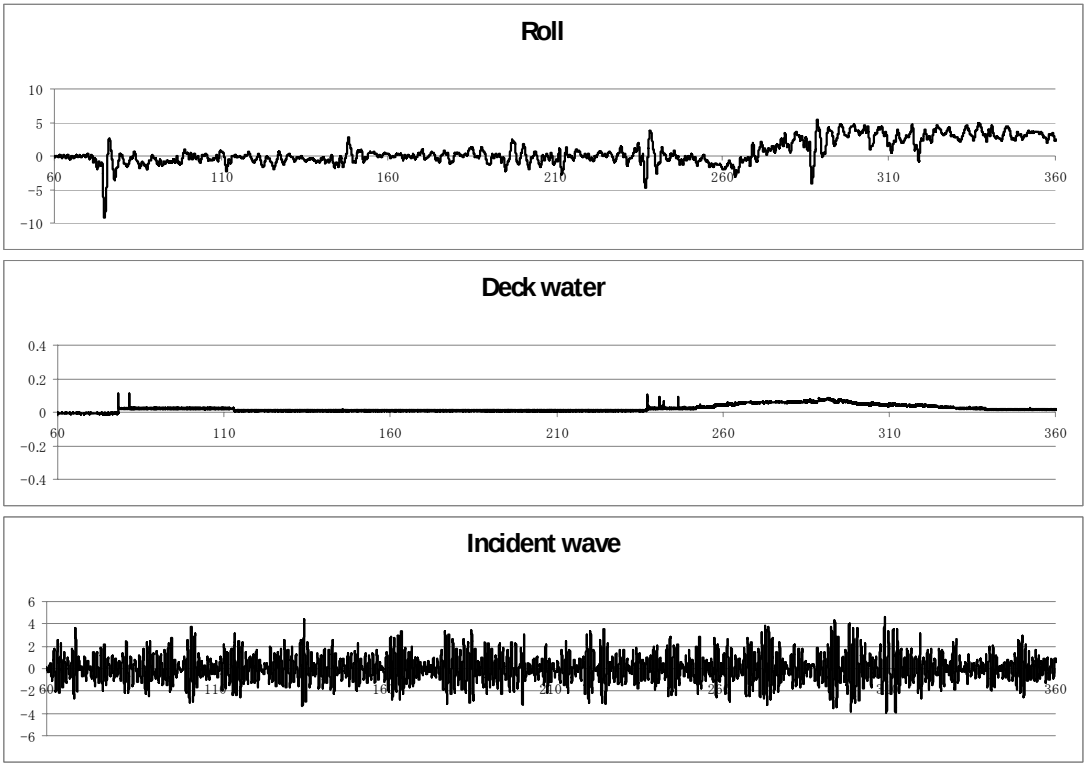

Figure A2 – Sample of time history of roll motion, water height on ro-ro deck and incident wave (GM:1.2 m, Significant wave height :4 m)