THIRD

INTERNATIONAL

CONFERENCE

ON

STABILITY OF SHIPS AND OCEAN VEHICLES

VOLUME II

ADDENDUM 2

INSTYTUT OKRĘTOWY POLITECHNIKI GDAŃSKIEJ

STAB'86

22–26

September 1986

GDAŃSK–POLAND

STAB '86

Third
International
Conference
on

Stability of Ships and Ocean Vehicles

22-26
September 1986
Gdańsk-Poland

Volume II
Addendum 2

C O N T E N T S

An ATTEMPT of SUMMARY

This is the last volume of the Proceedings connected with the STAB '86 Conference. Previously vol. I and vol. II and the supplement to the vol. II were already issued.
Now, the report from the conference discussion is presented together with all contributions and remarks submitted by the participants in writing. From formal point of view it is also an intention of the organizers to summarize the Conference by this volume. The essential achievement of the Conference - that is a contribution to the improvement of research and projects connected with stability - will be rather estimated in future discussions in various circles, mainly at the IMO Subcommittee SLF and at the next STAB '90 Conference in Naples.
The importance of the Conference will also be reflected in the initiation of some research works and in the application of their results into practice. Thus the full appreciation of the STAB '86 is a long process in which the contributions in this volume are merely the beginning of it.

The STAB '86, held in Gdańsk, gathered 99 representatives from Universities, Research Centres, Shipyards, Maritime Administrations, Shipowners and Classification Societies from 15 countries particularly from: Australia /1/, Bulgaria /2/, Denmark /2/, Federal Republic of Germany /10/, United Kingdom and IMO /9/, German Democratic Republic /1/, Italy /4/, Japan /12/, Netherlands /1/, Norway /6/, Poland /34/, Sweden /4/, Turkey /1/, United States of America /9/ and USSR /3/.

The meetings during the Conference consisted of 12 plenary sessions and 2 discussion panels.
The plenary sessions were divided, as follows:

- Theoretical Studies,
- Stability Criteria,

- Stability and Design,
- Stability of Special Ships Types,
- Stability of Semi-submersibles,
- Experiments with Models,
- Stability in Operatiom,
- Other Problems - mainly Damaged Stability.

During these sessions 62 papers of 72 accepted and published in vol. I and II were presented and discussed.

The discussion panels were connected with:

- Outline of Research Programme Aimed at Stability Criteria
- Relationship between Stability Requirements and Design

The Conference reveals some progress in theoretical works.
In the submitted papers some new solutions of nonlinear mathematical expressions of ship motions as well as a probabilistic concept of the safety of ships against capsizing are presented. In few papers some experimental results where the model tests were directed for checking computer results are presented. In some papers the experimental procedure is the fundamental basis employed for solving the problem of ship stability.
Among the latter papers it seems that the most important are these, which enable some stability criteria for modern cargo ships to be drawn to make them more safe at sea. These new criteria would supplement the IMO criteria, originally set up for cargo ships under 100 metres in length.

The problems of stability criteria still remains open. In this field the Conference has shown again unsatisfactory progress.
It seems that this is mainly due to the lack of the possibility for applying the very sofisticated mathematical ideas into practice.
Very complicated problems associated with ship service and particulary the so called Human factor are the main obstacles here.
The Conference emphasized the view that in spite of the refirement of pure stability from technical point of view it is also necessery to improve the information provided to the ship

master and concerning dynamical properties of his ship. It seems that such information is the most effective way for increasing the safety of a ship at sea, where the ship can be treated in terms of technical and economic cybernetic system.

The above mentioned remarks express the views of the Organizers. Many contributions of interest to the reader can be found in this volume. Others, not recorded here will remain only in memory of the participants. But it is believed that all of them will be reflected somehow in future works on stability of ships and ocean vehicles. This is the only way to value properly the actual meaning of the STAB '86 Conference.

WELCOME

by: Prof. L. Kobyliński

Distinguished Guests, Ladies and Gentelmen,

On the opening of the Third International Conference on Stability of Ships and Ocean Vehicles on behalf of the Programme Committee and Organizing Committee I would like to welcome all of You in Gdańsk, in the Ship Research Institute of Gdańsk Technical University.

In particular I would like to welcome cordially

- Minister of Shipping captain Ryszard Pospieszyński
- Rektor of the University Professor Eugeniusz Dembicki

and the Director of the Association of the Polish Shipyards, Mr Marian Kotlewski
who represent the Institutions under auspices of which this Conference is being held.

I would also like to welcome prominent representatives of Naval and Merchant Marine Academies, Shipbuilding Research and Design Organizations, Ship Research Institute of Gdańsk and Szczecin, Polish Register of Shipping, Shipping Companies and Shipbuilding Press.

This a rare occasion to assembly from all over the world so many prominent scientists who are working on stability problems from the theoretical as well practical point of view.

We feel honoured that this meeting is being held in Gdańsk, in the Ship Research Institute, which has its own small contribution to solving stability problems.

I can assure You that during this week our staff will make utmost effort to ensure the Conference to be most effective and we will do our best that You feel as comfortable as at your own home.

Introductory address at the OPENING SESSION OF STAB '86

by: Prof. Ch. Kuo
University of Strathclyde
Dept. of Ship and Marine
Technology

Professor Kobyliński, Minister Pospieszyński, Rector Dembicki, Director Burzyński, Gentelmen: I think I speak for all the delegates from outside Poland when I say how delighted we are to be in Gdańsk and how much we appreciate the work done to organise this important event. I know what this has meant in terms of preparation, for my own association with the First International Conference on the Stability of Ships and Ocean Vehicles in Glasgow in 1975, and my involvement with Professor Motora on the second one in Tokyo in 1982. Our Polish colleagues have devoted considerable time and effort to ensuring that the conference will be a success in technical terms and also memorable for those making their first visit to this wonderful country. I am sure all of us are hoping to see something of Gdańsk and get to know a little of its history, culture and commercial activities, and also to meet its people.

The conference, however is about "Stability". As everyone here will know, it was a subject of major interest in the late nineteenth century and then there was very little apparent progress for some seventy years.
Many people were, in fact surprised that a conference devoted solely to the Stability of Ships and Ocean Vehicles could attract as many as twenty-four papers in 1975! Yet the 1982 conference attracted even wider interest and support. STAB '86 has maintained the impetus and enjoyed an even greater response, with papers on topics ranging from "theoretical studies" to "experiments with models", and "practical criteria" to "stability and design", not to mention the attention paid to new types of vehicle such as the semisubmersible. In fact, the subject is a popular one, as is evident from the number of distinguished naval architects, engineers and scientists who

have come to this conference from all over the world, some of whom have already established their reputation in other fields such as theoretical hydrodynamics and ship motions.

There are plenty of convincing reasons for doing research on stability - so many in fact, that the dedicated researcher may feel its justification is self-evident. Capsizing, after all, must be prevented; the safety of those who work with the sea must be guaranted; investments must be protected; knowledge is of value in itself; and so on. But can all these factors provide the basis of a "carte -blanche" for continued and increased stability research?

Bearing in mind the fact that acceptable stability is only one of around fifteen key parameters in the process whereby an initial concept is converted into a ship working to specification in the seaways, perhaps we should pause and ask ourselves whether all the effort now being devoted to stability can really be justified.

Does capsizing take place often enough to justify the amount of time and effort now being expended on its causes and cure? Are we indulging in a luxury, researching an area that we know is extremely complicated and offers few prospects of cost reduction?

Let us examine some recent statistics. In 1975, the year of the First Conference, the number of ships completed worldwide was 2730. The annual figure had dropped to 2312 by the time of the Second Conference.
Information is not yet available for 1986, but the total number of ships completed in 1985 had again dropped, to 1962.

Significant sums of money have been spent on ship stability studies in several countries, particularly Germany, Canada and the UK. In the UK at least, questions are being raised about the value of stability research, and attempts are being made to quantify the cost against actual loss of life. In Canada a Royal Commission was set up to investigate the marine disaster associated with the capsize of the semisubmersible "Ocean Ranger" off the eastern coast of Canada in February 1982, with the loss of eighty-four crew members. One outcome of this last study is a set of 134 recommendations on ways of preventing another such tragedy, but the number of these recommendations requiring increased knowledge is actually quite small!

These developments could discourage efforts to improve the stability of ships and ocean vehicles and conferences and seminars of interested parties to discuss problems and issues. In the light of this, how can we define a justifiable role for STAB'86?

Certain points do spring to mind at once. In the first place, it provides an opportunity for theoretical experts and practitioners to meet together. In the second place it is of benefit to participants from the host country, because it is such an opportunity to establish new contacts. Thirdly, it allows us to update ourselves on progress since 1982, and to compile a comprehensive set of papers on recent work in the area, in no more than two volumes. Other similar reasons can be added to this list, but I do not think they are sufficient, nor fully satisfying.

No one needs remainding that the shipping industry is in the midst of one of the longest economic recessions ever known, and shipyards are being forced to lay off staff and even closed through lack of demand. This state of affairs is not helped by the fact that one of the biggest users of ships, the oil industry, has itself temporarily slowed down because of a sharp drop in the price of oil. In the fact of these difficulties it is essential that we should be positive and resourceful. However, a closer analysis of the statistics I gave earlier does yield some encouraging trends. For example, in the fishing vessel category - where stability is highly relevant - the number of trawlers constructed did decrease from 717 in 1975 to 390 in 1982 but this number has remained steady since then, and there appears to be an upward swing in the demand for passenger ferries. However, for the industry as a whole to continue to play a key role into the twenty-first century, it is essential for its products to achieve a high degree of cost-effectiveness in design, production and operation. One critical contribution to this would be improving the performance of ships and ocean vehicles but this has to be done without impairing the stability characteristics of the vessels. Here is an opportunity for stability research, but the emphasis must be on the application of the findings for the benefit of the practitioners. The progress of our work can no longer be measured by the solving of increasingly complex theoretical formulations. Instead it should be judged by the extent to which the users, whether designers or operators, can readily employ the sound knowledge and relevant information that we have acquired over the years. Furthermore, we need to lay down a time scale for establishing the applicability of research advances.

May I suggest, therefore, that STAB '86 should be remembered as the international conference at which the emphasis of stability studies was placed firmly on improving the practical application of research findings, along with the warmth of the reception delegates received from our generous hosts.

THE CONFERENCE FINAL PROGRAMME

Monday - 22 September, 1986

- Programme Committee Meeting
- Reception at the City Town Hall

Day 1 - Tuesday - 23 September, 1986

- Opening Session

Welcome and introductory address by representatives of Polish Maritime Administration, Shipping Industry as well as Science and Education
Introductory address by Prof. Ch. Kuo

- Session 1 - General

Chairman: Prof. O. Krappinger

1. W.A. Cleary, R.M. Letourneau
Design - Regulations vol. II /3.8/

2. H. Hormann, D. Wagner
Stability Criteria for Present Day Ships Design vol. I /3.1/

- Session 2 - Theoretical Studies

Chairman: Prof. T. Ozalp

3. E. Deakins, N.R. Cheesley, G.R. Crocker, C.T.Stockel
Capsize Prediction Using a Test-Track Concept vol. II add. 1 /1.21/

4. A. Cardo, A. Francescutto, R. Nabergoj, G. Trincas
Assymetric Nonlinear Rolling: Influence on Stability vol. II add. 1 /1.20/

5. F. Caldeira - Saraiva
The Boundedness of Rolling Motion of a Ship by Lyapunov's Method vol. I /1.11/

6. S.R. Philips
Applying Lyapunov Methods to Investigate Roll Stability vol. I /1.10/
presented by K. Brook

- Session 3 - Theoretical Studies

Chairman: Prof. R. Bhattacharyya

7. J. Wiśniewski
Floation instead of Statical Stability Proposal for Changes in Basic Definitions
vol. II /1.17/

8. H. Bötcher
Ship Motion Simulation in Seaway Using Detailed Hydrodynamic Force Coefficients
vol. II /1.13/

9. P. Kröger
Ship Motion Calculation in Seaway by Means of a Combination of Strip Theory with Simulation
vol. II add. 1 /1.24/

10. Numerical Calculation of Forces and Moments due to Fluid Motions in Tanks and Damaged Compartments
vol. I /1.12/

11. H. Söding, E. Tonguc
Computing Capsizing Frequencies of Ships in a Seaway vol. II add. 1 /1.23/

- Session 4 - Theoretical Studies

Chairman: Prof. N.N. Rakhmanin

12. J.B. Roberts, R.G. Standing
A Probabilistic Model of Ship Roll Motions for Stability Assessment vol. II /1.15/
presented by K. Brook

13. W. Blocki
Probability of Non-Capsizing of a Ship as a Measure of her Safety vol. II /1.18/

14. J.T. Dillingham, J.M. Falzarano
Three Dimensional Numerical Simulation of Green Water on Deck vol. I /1.9/

15. C. Shin, M. Ohkusu
The Effects of Deck Wetting on the Stability of Ships in Beam Seas vol. II /1.19/

Day 2 - Wednesday - 24 September, 1986

- Session 5 - Theoretical Studies

Chairman: Prof. S. Motora

16. M. Hamamoto
Transverse Stability of Ships in Quartering Sea
vol. I /1.2/

17. I.K. Boroday, V.A. Morenschildt
Stability and Parametric Roll of Ships in Waves
vol. I /1.4/
presented by Prof.N.Rakhmanin

18. V. Shestopal, Yu. Pashchenko
Approximate Design Procedure of Nonlinear Rolling in Rough Seas vol. I /1.5/
presented by Prof.A.Kholodilin

19. Yu. Remez, I. Kogan
Inclinations of a Ship due to Arising Seas
vol. I /1.6/
presented by Prof.N.Rakhmanin

20. A.N. Kholodilin, V.K. Trounin, B.N. Oushakov
Some Aspects of Seakeeping for Small Ships
vol. II /1.16/

21. Yu. Bilyansky, L. Dykhta, V. Kozlyakov
On the Floating Dock a Dynamical Behaviour under Wind Squall in Seaway vol. I /1.7/
presented by Prof.N.Rakhmanin

22. R.E. Bishop, W.G. Price, P. Temarel
The Influence of Load Condition in the Capsizing of Ships vol. II add. 1 /1.22/
presented by Dr A. Morrall

23. A. Campanile, A. Cassella
BSRA Trawler Series Stability in Longitudinal Waves
vol. I /4.3/

- Session 6 - Stability Criteria

Chairman: Prof. M.St. Denis

24. F. Plaza, A.A. Petrov
Further IMO Activities in the Development of International Requirements for the Stability of Ships
vol. II /3.5/

25. H. Bird, A. Morrall
The Safeship Project - a Basis for Better Design and Stability Regulations
vol. II /3.6/

26. K.A. Brook
A Comparison of Vessel Safety Assessment Based on Statical Stability Criteria and an Simulated Roll Response Characteristics in Extreme Sea States
vol. II add. 1 /3.10/

27. H. Sadakane
A Criterion for Ship Capsize in Beam Seas
vol. I /3.1/

28. Ch. Kuo, D. Vassalos, J.G. Alexander, D. Barrie
The Application of Ship Stability Criteria Based on Energy Balance vol. I /3.3/

29. T. Nedrelid, E. Jullumstrø
The Norwegian Research Project
Stability and Safety for Vessels in Rough Weather
vol. I /3.4/

- PANEL DISCUSSION I - OUTLINE of RESEARCH PROGRAMME AIMED at STABILITY CRITERIA

Chairman: Dr A. Morrall + Prof. O. Krappinger,
Prof. S. Motora, Dr T. Nedrelid

Day

Day 3 - Thursday - 25 September, 1986

- Session 7 - Stability and Design, Stability of Special Ship Types

Chairman: Prof. A. Kholodilin

30. E.A. Dahle, D. Myrhaug
Probability of Capsizing in Steep Waves from the Side in Deep Water
vol. I /4.1/

31. H.E. Guldhammer
Analysis of a Self Righting Test of a Rescue Boat
vol. I /4.2/

32. M. Frąckowiak, M. Pawłowski
The Safety of Small Open Deck Fishing Boats
vol. II /3.9/

33. L. Dykhta, E. Klimenko, Yu. Remez
Determination of Heeling Moment due to Bulk Cargo Movement under Harmonic Compartment's Oscillations
vol. I /4.4/
presented by Prof.N.Rakhmanin

34. E. Kogan
Computer Aided Stability Calculations
vol. I /4.5/
presented by Prof.N.Rakhmanin

- Session 8 - Stability of Semisubmersibles

Chairman: Dr E. Dahle

35. E.C. Haciski, N.T. Tsai
Stability Assessment of VISCG Barque Eagle
vol. I /4.6/
presented by W.A. Cleary

36. R. Latorre, A. Suda, C. Mugnier
Utilization of Photogrammetry in Obtaining Hull Offsets for Intact Stability Calculations
vol. II /4.8/
presented by W.A. Cleary

37. N. Takarada, T. Nakajima, R. Inoue
A Phenomenon of Large Steady Tilt of a Semi-Submersible Platform in Combined Environmental Loadings vol. I /6.1/

38. S. Takezawa, T. Hirayama
On the Dangerous Complex Environmental Conditions to the Safety of a Moored Semi-Submersible
vol. I /6.3/

39. K. Ikegami, Y. Watanabe, M. Matsuura
Study on Dynamic Response of Semisubmersible Platform under Fluctuating Wind
vol. II /6.6/

40. H.H. Chen, Y.S. Shin, J.L. Wilson
Towards Rational Stability Criteria for Semisubmersibles - a Pilot Study
vol. II /6.5/

- Session 9 - Stability and Design, Stability of Special Ship Types

Chairman: Dr J. Dudziak

41. M. Jagiełka
Stability Parameters of Ships Investigated by means of Discriminant Analysis
vol. II /3.7/

42. Y. Masuyama
Stability of Hydrofoil Sailing Boat in Calm Water and Regular Wave Condition
vol. I /4.7/

43. B.C. Nehrling, N.T. Tsai
Stability and Extraction of Grounded Icebreakers
vol. II /4.9/

44. P. Bogdanov, R.Z. Kishev
Dynamical Stability of Support Ship-Diving Bell Complex vol. II /4.10/

45. M.R. Renilson
The Seabreake - A Device for Assisting in Prevention of Broaching - too
vol. II /2.6/

- PANEL DISCUSSION II - RELATIONSHIP BETWEEN STABILITY REQUIREMENTS and DESIGN

Chairman: W.A. Cleary + Dr J. Dudziak, H. Vermeer

- Session 10 - Experiments with Models

Chairman: Prof. W. Abicht

- Session 11 - Stability in Operation

Chairman: Prof. A. Cardo

54. S. Kastner
Operational Stability of Ships and Safe Transport of Cargo vol. I /5.1/

55. E.A. Dahle, T. Nedrelid
Operational Manuals for Improved Safety in a Seaway vol. I /5.2/

56. M. Gerigk
The Human Factor Effect on the Safety of Ship Stability at Sea vol. II /5.3/

57. J. Stasiak
Lashing of Ship Cargo as an Essential Factor Determining Stability Safety and Economics of Vessels vol. II /5.4/ .

- Session 12 - Other Problems

Chairman: Mr A. Vermeer

58. N. Hogben, J.A.B.Wills
Environmental Data for High Risk Areas Relating to Ship Stability vol. I /7.2/
presented by Dr A. Morrall

59. D. Myrhaug, S.P. Kjeldsen
On the Occurence of Steep Asymmetric Wave in Deep Water vol. I /7.1/

60. E.A. Dahle, G. Nisja
Improved Safety by Application of Subdivision of Means of Flotation for small Vessels
vol. II /7.3/

61. M. Sigurdsson, S. Rusas
Subdivision Standard for Dry Cargo Ships Based on the Probabilistic Concept of Survival
vol. II add. 1 /7.7/

62. Y. Terao, K. Minohara
On a Micro Computer Based Passive Controled Antiroll Tank System /System Simulation and Full Scale Measurements/ vol. II /7.4/
presented by Prof. S. Motora.

THE CLOSING SPEACH

by: Prof. L. Kobyliński

Ladies and Gentelmen,

The Conference STAB '86 is approaching the end.

Perhaps it is not the place to sum up the results and achievements of the Conference. This almost certainly will come later, as participants will have enough time to quietly assess all the papers presented and thoughts expressed during the discussions.

Therefore I restrict myself to formal results only. To the Conference 72 papers were submitted and majority of them were presented by the authors or by participants acting on their behalf. 99 participants were present during the Conference from 15 countries.

Papers were divided under 7 headings:

- Theoretical Studies,
- Stability Criteria,
- Stability and Design, Stability of Special Ship Types
- Stability of Semi-submersibles,
- Experiments with Models,
- Stability in Operation, and
- Other problems /mainly damage stability/.

Valuable contributions were made during the panel discussions and in order they were not forgotten we kindly request all contributors to submit those contributions by December, 1st this year.

Other contributors are also invited to send their comments by this deadline. All this contributions will be printed in the Addendum 2 to vol. II and distributed amongst the participants. All four parts of the proceedings will be then submitted to the Subcommittee on Stability, Load Lines and Fishing Vessels Safety of IMO for information. All participants and in particular members of the Programme Committee are invited to convey their

observations in writting regarding possible organization of the next conference. Comments will be passed to the members of Programme Committee.
Yesterday there was a meeting of the members of the Programme Committee. This meeting proposed that in the future conference be maintained as the open conference and that no separate organization or permanent secretariat is necessary. Simply, the host organization of the next conference will create the secretariat and will undertake the task of preparatory work for the next conference. New Programme Committee will be composed and this Committee will help the organizers to formulate the programme of the conference.

I already spoke about the next conference. Yesterday, during the dinner I announced that prof. Cassella from the University of Naples kindly offered the next, fourth conference to be held in Naples. But I would like to ask you if this proposal may be accepted by the Conference. So may I ask if anybody has other proposal? If no, then by applause we may unanimously accept the proposal and I will send a letter on behalf of the Conference informing Prof. Cassella about your decission.

I must draw your attention to the certain coincidence. Today is the World Maritime Day declared by IMO under the heading - - International Cooperation for Safety at Sea and Pollution Prevention. So we have another reason to celebrate - succesful closing of the Conference and the World Maritime Day.
I take that this is of a good omen for our future work.

Finally I would like to express deep gratitude to the members of the Programme Committee for their effort towards the success of the Conference, all Chairmen for their help to conduct the sessions, for the authors for their achievements and to all participants for their coming and for their patience for all our faults. I wish all of You happy return journey home. I wish to thank whole heartedly to all members of the Organizing Committee composed of the staff of our Institute for their tremendous effort before and during the Conference. I want to thank also to all those members of staff of the Institute and others who worked behind the Conference but without whose the Conference could not be held.

Panel Discussion I

- Outline of Research Programme Aimed at Stability Criteria

Open discussions: The Open Discussions on Wednesday afternoon Sept., 24, was chaired by:

Dr A. Morrall
British Maritime Technology Ltd

assisted by:

Prof. O. Krappinger
Hamburgische Schiffbau-Versuchsanstalt GmbH

Mr T. Nedrelid
MARINTEK A/S
Trondheim, Norway

Prof. S. Motora
Foundation for Shipbuilding Advancement, Tokyo

Contribution for Panel Discussion I:
"RESEARCH AND DEVELOPMENT NEEDS FOR STABILITY CRITERIA"

by A. Morrall

INTRODUCTION

In his introductory address Professor Kuo raised the question as to whether the number of actual capsizings justify the research. Should, for example, a cost benefit analysis be carried out based on the number of lives and vessels lost, to justify the research?

In my view this is not the best way to proceed, but it has to be recognised that research is expensive and safety related research must be cost effective in terms of the benefit it provides. What Professor Kuo also said was that the sensible role for Stab '86 was to provide a key strategy for taking stability criteria into the 21st century. One such role could be in the application of findings of research for the benefit of practitioners. Another important aspect is to put a time-scale on the application of findings.

A possible framework for stability research

A number of papers have been written on the philosophical aspects of intact stability criteria and possible solutions for the means of achieving the end result. However, the desired result has so far proved unobtainable and this needs to be examined in the experience of the last 10 years of stability research.

In the author's opinion, several factors have emerged that have meant that apart from the IMO Weather Criterion, no new stability criterion has received international support since the introduction of the IMO criterion A167 introduced in 1968. Several factors have conspired to make progress in this area particulary slow, and some of the reasons why new stability criteria have proved elusive are as follows:

1/ The absence of an adequate theoretical model to model capsize. It should be appreciated by now that if existing theoretical models are used it is not possible to "predict" capsize or even estimate the probability of capsize, because the problem is too poorly defined.

2/ The extremely complex nature of the problem and the number of different modes of capsize, i.e. pure loss of stability and broaching etc. has tended to direct effort into long-term research programmes.

3/ The difficulty of defining the problem to be solved, i.e. what is the real problem and how can it be solved.

4/ The absence of any clear objective as to what end result is required, i.e. what level and for what application.

Although the problem of intact stability is worthy of research on several fronts, it has lacked realism and has left the case for "capsize" research overstated. For example, if no adequate theory exists to predict capsize, why no simplify the problem to large amplitude roll motion whithin the limitations of the theory?

The most important aspect must be the overall objective; whether to improve the state of knowledge in several areas of interest or to strive for obtainable results whithin a reasonable timescale.

Research for Stability Criteria

There are several ways that research into stability criteria has been conducted in recent years which are worthy of consideration and each have their own contribution to make to this complex subject.

The three main approaches may be described as pragmatic, ad-hoc, mainly theoretical and model experiments.

Pragmatic

Stability research in this category includes studies related to the problem area of roll stability and includes topics such as the Rahola-type of stability criteria where every effort is made to produce practical and usable criteria. Although the results of this approach to stability has provided the most widely used methods to date, they usually have severe limitations such as smallness of sample of casualty data used or in the absence of external forces etc.

Ad-hoc

In this category stability criteria research is often centred on investigations of a particularly casualty such as the loss of a fishing vessel or loss of an oil rig from which general indications are sought on how stability criteria might be modified or improved.

Mainly theoretical

The last two International Conferences on stability have seen a great number of papers in this category; they are usually based on complex mathematic theories to describe roll motion and capsize but rarely conclude with a practical stability criteria that could be used by regulatory bodies.

Model Experiments:

Model tests have been used extensively world wide to help bring an understanding of the physics of the capsizing mechanism. The most notable examples in this area are the identification of pure loss of stability and of parametric resonance by Professor Paulling for example and extensive physical modelling of the complex and non-linear problem of broaching by Profs. Motora and Fujino.
Although much research has combined theory with experimental measurement, the purely experimental approach is limited by the type of ship model and the range of experiment. In view of this situation, stability assessment could be considered as an aspect of seakeeping performance in which motion and acceleration limits could be set for safe operation in a seaway.

In this context it is the seakeeping qualities of a ship that are of vital concern in assessing adequate levels of intact stability.

The question remains - what is sufficient stability?

Framework for Stability Criteria Research:

The objectives for stability research should clearly be defined at the outset and consideration given to the particular area of application and the duration of the research. These aspects are as outlined below:

1. State objective:

a/ design criteria

b/ regulatory criteria:

i/ modification of Res. A167
ii/ new criteria
iii/ guidelines

c/ short-term /5 years/

d/ long-term /10-20 years/

2. Realistic assessment:

Any new stability criteria should be based on a realistic assessment of what can be achieved and whether it will be accepted nationally or internationally.

a/ limited objective:

i/ beam sea criteria
ii/ following sea criteria

b/ international/national acceptability

c/ credibility:

i/ based on physics and theory
ii/ validated by simulation/full scale trials
iii/ appropriate for different ship types.

Stability Criteria

Stability criteria in the future could be based on the following considerations:

i/ design wave

ii/ operational limits of roll motion

iii/ probability that maximum roll will not exceed say 40° in 10^{-4} in short-term sea state

iv/ roll angle in a specified wave steepness has probability of occurence of 10^{-4} to 10^{-6}.

Design Criteria:

a/ bulk mineral cargoes

b/ lashings for ro-ro ships

c/ angle of heel in turn/crowding of passengers

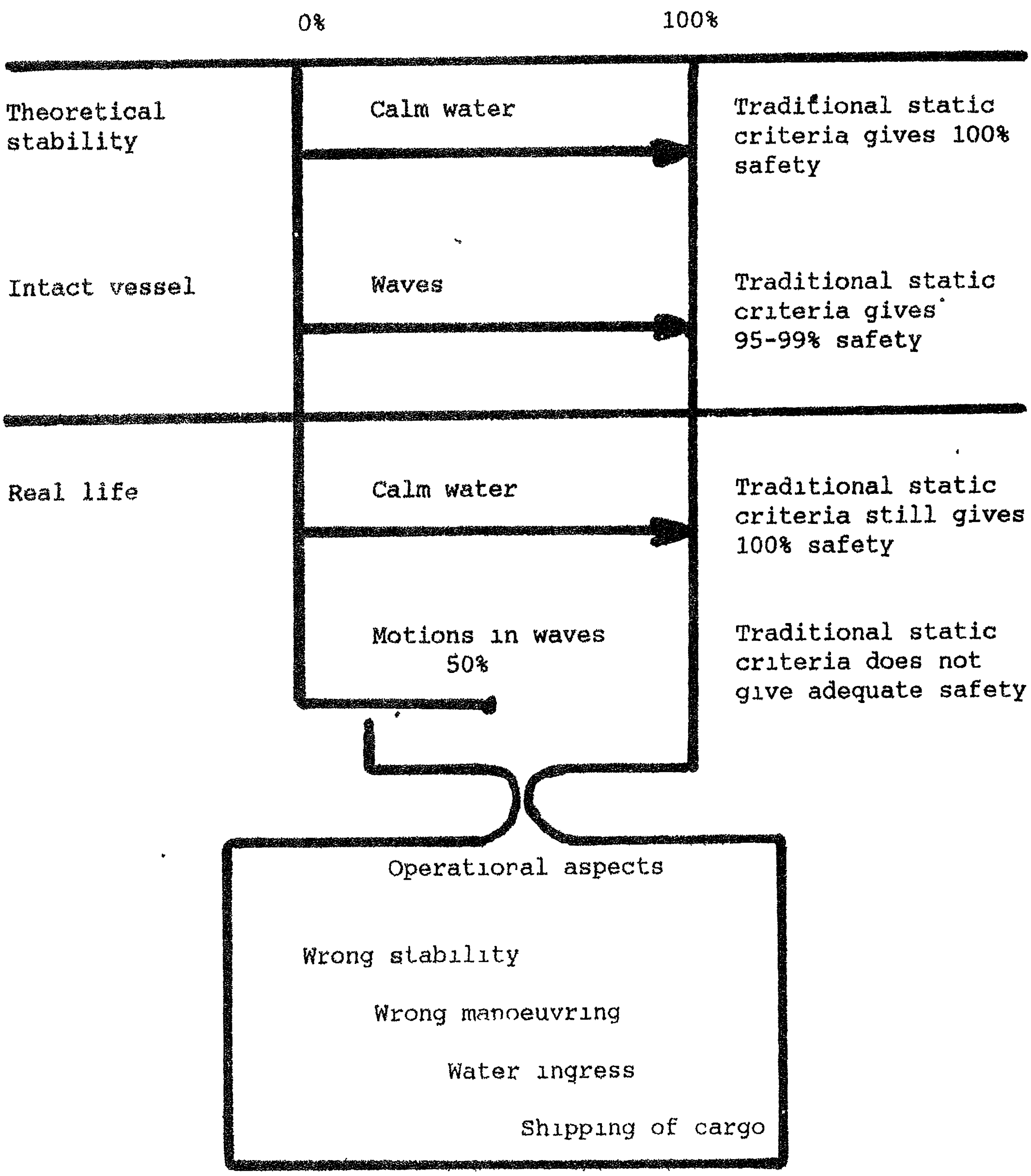
d/ operational limits of roll motion /angle, rate, etc./

Finally, in my opinion, intact stability research for the future should have limited objectives and more importantly it is essential for a consolidation of the research on stability that has taken place since the first international conference on stability in 1975. This consolidation should provide the designer and "practitioner" with practical means of assessing stability in the short-term and for the development of improved design and stability criteria in the long-term.

Contribution for Panel Discussion I:
"RESEARCH AND DEVELOPMENT FOR STABILITY CRITERIA - STABILITY RESEARCH DISCUSSION ON STABILITY CRITERIA"

by T. Nedrelid
MARINTEK A/S
Trondheim, Norway

STABILITY CRITERIA
SAFETY OF A VESSEL



- Ships very seldom capsize as an intact vessel. Even in waves it is difficult to capsize an intact vessel. Only in certain breaking waves or in some following wave situations is an intact vessel likely to capsize.

- The intact vessel situation, and how it responds to waves is therefore very theoretical when talking about safety.

- The inquiry records from casualties always refer to non-intact vessels. The capsize is caused due to mal-operation, damage, cargo shipping, etc. These events are influenced by the waves and the motions of the vessel.

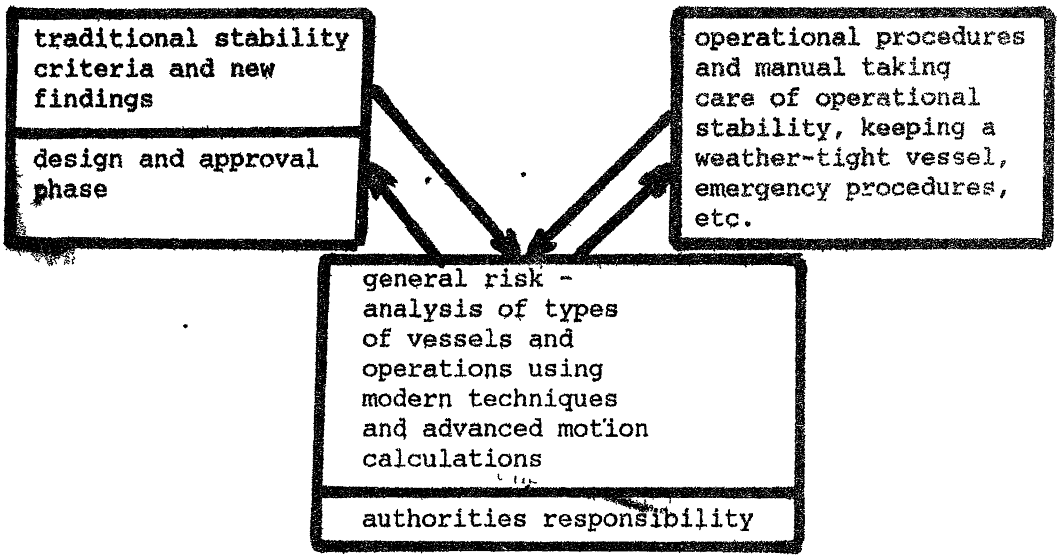
- Future criteria should reflect this, and future research should be considered around ship motions and how abrupt events occur. In this way we define critical physical situations - vessel description, vessel condition, waves - motions, operational failure.

The results of findings from casualty investigations and research should then be included in a total stability criteria concept.

A warning should be given to the people involved in stability research.

- don't be too academic or theoretical when defining or simplifying the actual situation that is being considered.
- don't believe that it is possible to simplify the knowledge into static thinking or simple formulae.

Further stability criteria concept should involve a total capsizing safety, and be built up of:



Contribution to the Group Discussion:
"RESEARCH PROGRAMME AIMED AT STABILITY CRITERIA"

by O. Krappinger
Institut für Schiffbau
der Universität Hamburg

At the first and second International Conference on Stability of Ships and Ocean Vehicles a wealth of valuable papers was presented. The same holds true for this, the third Conference. In spite of this fact not much progress has been achieved regarding an agreement on how to prescribe safety against capsizing or how to make stability rules.

What are the reasons for this frustrating situation? It appears to me that there are two main reasons which prevent progress:

The first is to ask for too much: Scientific concepts which are basically sound but which cannot be realized at the time being are of little use to improve the present situation. Of course we should go on to develop these concepts, but these efforts are an investment into the future. They cannot help to solve the problems of today.

The second reason which prevents progress is to pretend that the problem can be solved by methods which are too primitive and physically unsound.

What we need is an approach which is somewhere in betweeen the two extremes just mentioned.

I do not think it wise at the time being to aim at a general solution of the problem of safety against capsizing which holds for all kinds of ships. In order to make progress we should try to find solutions for distinct groups of ships. -

Therefore in the following I shall restrict myself to ships the type of which has been defined yesterday by Mr Hormann and Mr Wagner, namely container vessels or Ro-Ro-vessels etc. In order to develop stability criteria for this group of ships it seems proper to start with the physics of capsizing. I shall not go much into details here.
In principle either experiments or theoretical models can be used. If sufficiently developed mathematical models would be available, the outcome would be the same from both methods:

We would find for a given ship with a certain draft in a given seaway that the safety varies with KG or with GM. It is possible to determine a limiting value GM_L with which the ship is just safe. This can be done for different ships, each on different drafts. For each case we would find a value for the limiting GM_L /Fig. 1./.

But this is not yet the solution of our problem for two reasons:

1. I cannot think of stability regulations prescribing model tests or equivalent theoretical simulations. For regulations the outcome of such research has to be stipulated in a simple and practicable manner.
2. All physical investigations do not give any information which level of safety should be required. Testing ships /physically or by simulation/ in the most severe which are still realistic /although not very likely to occur/ would lead to requirements which are not reasonably acceptable.

In order to get a practically applicable representation of the results of experimental or theoretical investigations we may try to find a function of ship characteristics such that it assumes the same value for any ship when it has the limiting GM_L . Such a function may be considered as a stability criterium. While there is no straight forward method to find such a function the usefulness of heuristically found functions can easily be checked:

For different ships the values of GM_L vary in a wide range /Fig. 2./. If we try e.g. the GZ_{max} - values which correspond to the GM_L - values the variation would be much smaller, but it would still be too big. If we use the product $C \cdot GZ_{max}$ /as defined in the paper presented yesterday by Mr Hormann and Mr Wagner/ corresponding to the GM_L - values we find that it is very much the same for all the different ships in spite of the wide scatter of their particular GM_L. Therefore this product can be used as a criterion.

What we need next is a calibration of this criterion so that it provides a proper standard of safety. It is not yet possible to base such a calibration on the probability that a ship will not capsize during its lifetime. But we can find an /implicitly/ accepted standard of safety by determining the values of the criterion for existing ships which are considered just sufficiently safe.

Finally I would like to summarize the steps which I think are necessary in order to end up with a criterion which can be practically used for stability regulations for a particular group of ships:

1. Systematic investigation of the physics of capsizing / by model tests or theoretical methods validated by tests/.
2. Representation of the results of the systematic investigation in a form suited for stability regulations. The suitability of such forms /or criteria/ has to be proved by demonstrating that it reflects the boundary between safe and unsafe /as determined by the systematic investigation/ for all ships of the considered group.
3. Calibration of the criterion. An indication of the presently accepted safety level can be derived by determining the values which the criterion assumes for existing ships are considered just sufficiently safe.

safe | just safe | capsize

$$KG_S < KG_L < KG_C$$

$$GM_S > GM_L > GM_C$$

Fig. 1

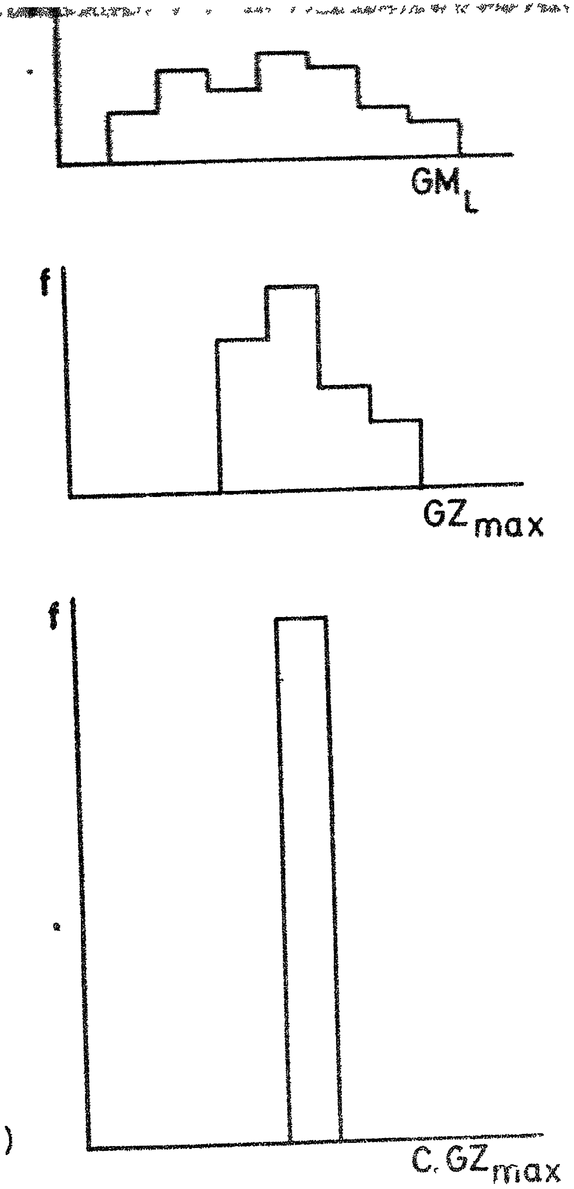


Fig. 2

(f = frequency)

Comments to the "FLOATATION INSTEAD OF STATICAL STABILITY, PROPOSAL OF CHANGES IN BASIC DEFINITION"

by J. Wiśniewski - presented on discussion session by the Author

J. Wiśniewski
Ship Research Institute
Technical University of
Gdańsk

Mr Chairman, Gentelmen,

You know the main idea of my proposal from the title of my paper. I would like to give you now short comments, explaining this idea and its supporting arguments.

Let us start from the definition of floatation. I hope everybody will agree that this is the ability of ship to float in the position of stable equilibrium under the action of gravity and buoyancy forces. If somebody can not accept this definition please correct me.

Now as a consequence let us deduce the conditions of floatation which must be fulfilled within the framework of this accepted definition. We may use for this purpose the commonly accepted law of mechanics that associates the minimum potential energy of an object with the state of stable equilibrium.

I have just done this in my paper, simplyfying the deduction. I have considered separately the changes of position coordinates of the ship in water, treating them as displacements with one degree of freedom. There are two reasons for doing this: firstly, to be in accordance with classical simplifications, common in naval architecture, and secondly, because the general solution in vector notation is not easy. I have never found it published anywhere.

The deducted conditions of course are known, but here all of

them are connected with one notion. The ship in order to be floating at rest must have both forces equal and colinear, and the area of equilibrium waterplane and the smallest metacentric hight must be positive;
Then we have conditions of floatation and the set of parameters connected with them. In my paper /including the appendix/ examples are given of the range of practical problems which are to be solved when examining ship floatation. Floatation is to be understood in accordance with the proposed definition. This range of problems is large. It includes practically the whole of ship hydrostatics.

And now to the subject of stability. Its definition may be quoted from contemporary approaches in mechanics as: the ability to retain an acceptable magnitude and character of response under existations of predetermined magnitude and character. This definition involves both the statical and dynamical stability of the ship. But there are practically no other statical exitations on a ship, other than changes in magnitude and position of her gravity force /changed with zero velocity/. And these problems are involved in our definition of floatation. Hence the title of my paper.

Somebody may ask me what all this is for?
My response would be:

Firstly - to be in accordance with general mechanics, one must be precise when talking about equilibrium of a system of forces.
Secondly - to clean the platform of understanding in stability research.
Thirdly - to rationalise the use of computers. In my paper together with problems concerning floatation I have briefly described the state of the art of their solution. These solutions are included in contemporary software. In my opinion some changes are possible and advisable.
And forthly - the personal reason - I see as a teacher some elegance in this proposal, and I like its results.

That is all I would like to present.

Panel Discussion II

- Relationship between Stability, Requirements and Design

Open discussions: In the Open Discussions period on Thursday afternoon Sept., 25, chaired by Mr Cleary assisted by Dr Dudziak and Mr Vermeer, the subject was DESIGN AND REGULATIONS

Mr A. Cleary
U.S. Coast Guard
Washington
USA

Dr J. Dudziak
CTO-OHO
Gdańsk, Poland

Mr H. Vermeer
Directorate General of Shipping
and Maritime Affairs
Netherlands

Mr Cleary presented thoughts on the practical reasons for stability research and the regulatory review cycle.

He also presented a figure comparing the amounted of total safety in design of very large ships versus very small ships in a full ocean storm. It was suggested that total safety is composed of design safety, operator safety and always there is some safety left to chance. Absolute safety is never possible in advance. In the smaller ship which is more affected by large seaways in a major storms, it was recognized that a larger percentage of safety must be left to the operator or required of the operator.

He felt the most difficult area in application of regulatory standards occurs when it is realized that there is not sufficient information to decide immediately whether an existing standard is adequate or not. The many maritime nations of the world ought to be active in research because the existing stability standards have not been well defined as to limits of applicability.

Dr Dudziak emphasized that the form of each stability criteria is not necessarily the most important problem before us. Rather, attention should be paid to which items of stability evaluation should be included in the evaluation.

He recommended that the criterion can be effective if it succeeded in preventing a sudden capsize. He also mentioned weight growth and gyradius changes which should be kept below a 10% change. Finally he recommended stability evaluations of ships using cross curves on waves and in various seaways.

Dr Vermeer completed the comments from the panel by emphasizing that stability criteria ought to be coupled with consideration of the Type of Ship Hull; that operational limits may be necessary for new ship types such as offshore Crane vessels and submersible vessels; and finally that on-board Computers for maintaining current stability information should be examined and utilized using new high speed electronic memory capabilities.

The voluntary speakers at this session were Mr Zychski of the Gdynia Shipyard, Professor Kholodilin of Leningrad Shipbuilding Institute, Professor S. Kastner of Bremen University. Dr Dahle of Det Norske Veritas and Professor Kobyliński.

Mr Zychski spoke particularly of the need for subdivision flooding protections in dry cargo ships. He pointed out the error committed by designers who calculate damage stability only to the margin line because international rules do not necessarily require the designer to view all the aspects of design weakness. This error he referred to as "margin line sickness".

Professor Kholodilin spoke of the need to utilize the probability approach to stability accidents and the need to solve the dynamics of seaway motion in an accurate representation of the actual ship motions.

Professor Kastner recalled Professor Krappinger's comment that stability criteria should be simple in application. He noted that ship Masters are eager to obtain information from ship researchers, that Masters can effectively increase the safety level, if they know what to do. He also mentioned as an item of concern the relatively new development of cargo related casualties, whether from inadequate lashings or stowage, or from extreme ship motions.

Dr Dahle supported Dr Dudziak's comments on proper design especially with regard to large ships and that a sudden capsize is not acceptable and should cause administrations to develop more conservative criteria. He noted that speed is an ignored but important factor in most stability criteria. Finally be spoken of the use of warnings to MASTERS as often not generally applicable to all situations.

Professor Kobyliński reminded the delegates that there is much more to the selection of design standards than a hydrodynamic examination. Criteria must include the broader problems such as Environment, Construction features and skills, and Operation. He recalled that 70% of all casualties have an element of human error as part of the cause or as the reason why a small accident became a major disater.

Contribution for Panel Discussion II:
"RELATIONSHIP BETWEEN STABILITY REQUIREMENTS AND DESIGN"

by S. kastner
Bremen Polytechnic

I am going to deal with, in my view, three basic problems.
First on deriving practical stability criteria now:
Defining and calibrating a measure from comparison with a set of experiments, as Prof. Krappinger pointed out yesterday, is certainly the most practical way. It is important to agree internationally on some formulation of that measure to allow for sound criteria and regulations on stability.

More than 20 years ago, we pursued basically the same approach in Wendel's group in Hamburg. We had evaluated free water model tests and capsizing runs and compared the results with simple wave crest and through calculations as a practical procedure. Then, a moment balancing method for regulations was developed, which included the wave crest reduction.

A main difference of the new criterion devised by Dr Blume based on HSVA tests is to relate experiments on capsizing in irregular seas with the still water righting arm solely, and to derive a formula - his C-factor - to make things even easier to apply.

Any of those measures are just comparative simplified measures, based on the need to cover a very complex and complicated behaviour of the ship in a most simple way.
We may call criteria of this kind to be a suitable replacement for the real thing, quite ficticious in a way.

This leads me to my second point, which has been clearly reflected in Mr Nedrelid's remarks in the Panel discussion.
Ship masters tend to apply regulatory stability criteria as

some measure and guidance how to operate a ship. However, any criterion of the above kind does not show the specific events covered. Thus, there is a need to develop information to the master on his ship behaviour in severe environment.
What happens, if a ship in the future capsizes after fulfilling the newest develop international criterion, due to improper operation? There is always some probability for capsizing left, and it is up to the operator of the ship to operate safely. Naval architecture is now at a stage, where we know enough on motion behaviour, and we must convey our knowledge in an efficient and simplified way.

Finally, do not let us forget on the dangers from the feedback of the cargo, as cargo constitutes the most part of the total ship mass. This relates with questions of lashing and securing of cargo in order to prevent shifting. Shifting of cargo has been the cause of many recent capsizes and ship losses.

Contribution for Panel Discussion II: "RELATIONSHIP BETWEEN STABILITY REQUIREMENTS AND DESIGN"

by J. Stasiak
Ship Research Institute
Technical University of
Gdańsk

Whenever we talk about stability criteria we are nearly always thinking about the ship safety against capsizing. However these two problems are not identity as have been remarked today both by Prof. Kastner and Mr Nedrelid. For this reason the stability criteria themselves, even if the best, are never univocally of the solution of the safety problem because:

- they do not comply with structure and operation of the man-ship-environment system,
- they are solutions of long-term prediction character prescinding from the constantly changing conditions of the ship's exploitation,
- they do not take into consideration such phenomena as flooding and shift of cargo for example,
- they do not take into consideration the economical aspects of shipping,
- they ignore the subjective rôle of a man as the operator of the system.

In my opinion the real problem of safety against capsizing is a system subject, a cybernetic one and such also should be its solutions.
A good measure of the safety is a space of condition in which this safety have been kept /see Fig.1/.

A magnitude of space conditions of potential ship's safety /P.S./ is specified by the inherent ship's stability only, whereas the real safety /R.S./ conditions resulted from inherent stability as well as from the operational decisions of ship's master.

From this appears that R.S. may be greater than space of P.S. conditions.

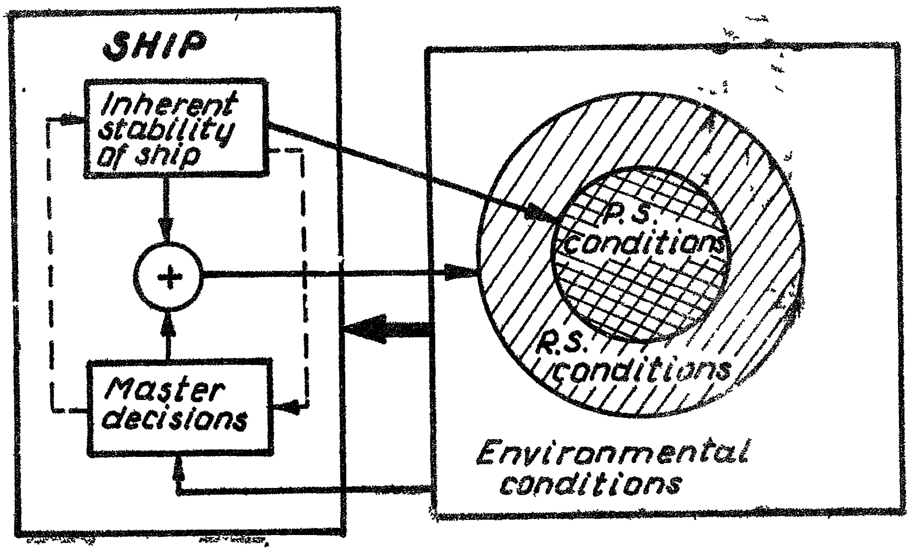


Fig. 1. The conditions spaces of safety

The proper decisions and the reasonable control of safety are conditioned by the quality and quantity of some appropriate information about the ship's roll properties in the wave conditions.

With regards for above is proposed as follow:

- an identification of the ship's safety against capsizing problem with the roll motion stability and
- a new formula of a manual titled: "Information Regarding the Ship's Stability and Safety for the Master".

In this way, a lot of difficulties that the identification of a mathematical safety faces can be avoided.
In particular, there is no need for a model of man but, at the same time, his rôle in safety controlling is properly shown.

In this way, the already known solutions in the field of sea-keeping can be effectively used, and the problem of safety could be expanded and might include such problems as cargo stability and grain loading, which in the theoretical safety model cannot be taken into account.

This way makes it possible to control the safety reasonably and constantly in time of the ship's operation and simultaneously to take into account the commercial aspects of the shipping.

- Above mentioned document should be prepared by the shipyard and approved by classification society.
  The dependences of the ship's roll motion on the wave conditions and on the loading conditions of a ship should take into consideration all the dangerous phenomena that is resonance, parametric resonance, the pure loss of the stability, a lurching and so on.
  Those phenomena are mainly due to non-linear characteristics of a ship and research work must take them into account.

  Such a research programme is being worked at the Ship Research Institute by the way of a systematic numerical experiment for simulation of ships' motions on the basis of the adequate numerical program.
  This program taking into account the coupling of the toll motion with heave and pitch and non-linear both damping and righting arms as well.

Contribution for Panel Discussion II:
"RELATIONSHIP BETWEEN STABILITY REQUIREMENTS, DESIGN AND OPERATION"

by J. Dudziak
CTO-OHO
Gdańsk, Poland

1. Introduction

The design of ships and other floating structures is undoubtly a more complicated procedure than of any other similar structures. This, what constitutos the greatest difference between ships and other designs, is the fact, that the loads affecting her safety are functions of the ship behaviour herself.

2. Stability criteria

A ship should be "sufficiently safe" against capsizing. To design such a ship the designer needs some stability criteria. The form of the criteria is not very important. However, it is important that they should take into account all ships' parameters which realy affect her safety against capsizing.
So, this may be the set of critical values defining the lowest acceptable righting arms curve, as for example in the statistical criteria recommended by IMO in Resolution A.167. But it may be a statment like this one: "A model ship in each presummed load condition should not capsize when operates in a model basin in quartering two dimensional /long crested/ irregular sea corresponding to the ITTC standard sea spectrum with significant wave hight equal to 9 m and mean zero-crossing wave period equal to 10 s, in full speed, during a time of 12 hours /in ship scale/". The figures in the last statement of course are not important/.
Let us assume that the criteria are for the disposal of the designer.

Of course it would be more convenient for the designer to have as simply criteria as possible, but this does not matter at all.

3. Design procedure

The design is a process of situation. In each situation stage the stability criteria affect the design variables. In an early stage of design they will be probably the main dimension of the ship, in the further stages the shape of the hull, the distribution of the mass, the location and dimensions of superstructures and so on.

But independently of the details of the design procedure, in this procedure there always occur some routine calculations such as:

- hydrostatic curves,
- cross curves on still water,
- mass and mass distribution,
- righting arms or righting moment curves /for intact stability/.

The two latest items are calculated for different loading condition.
Sometime, additional calculations are concerning the static behaviour of the damaged ship.
The exactness of their results depends of the exactness of input data and of the approximations in methods of calculation. I am affraid our knowledge about this matter is still unsufficient.
Beside there are some uncertainties concerning the method of calculations. How to calculate the cross curves in still water: with trim fixed or trim free? Should we taken into account in this calculations the volumnes of superstructure and deck house closed in a paper way? In my opinion the last operation is very important. The IMO recommendations as well as some national rules concerning that matter say, that enclosed superstructures and deckhouses on the freeboard deck comply*

ing with some others Regulations may be taken into account. It means, that this is optional and depends only upon the designer.

As a result of this the righting arms curve, which is the basis to assess the stability of a ship and a measure of her safety in a range of large heeling angles is determined only from down i.e. one can be sure only that the righting arms are not smaller than indicated. In a normal operating mode this is probably not very important. But this becomes very important in case of casualty.

The ship should be so design that if she must capsize, she ought never capsize suddenly.

Another doubts concern the calculations of the ordinate of the mass as well as the mass of the ship itself.

It is known, that especially for small ships, the mass and its ordinate grows with the age of the ship.

In the following table some examples of the Polish ships are given.

Table 1.

The mass and the $\overline{KG}$-value for the ship empty, equipped

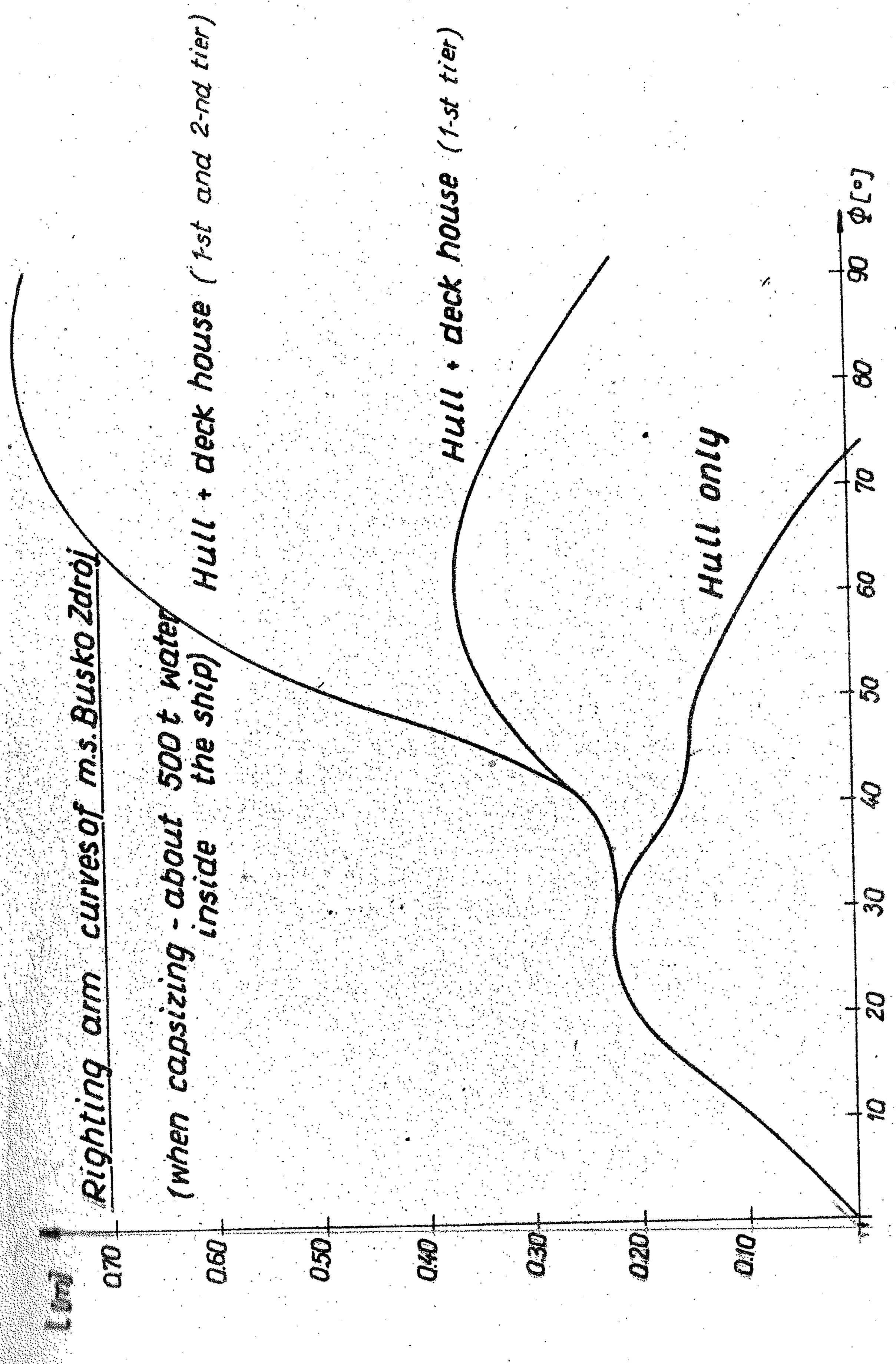
Type of ship	Age of ship years	Mass t	Ordinate of the centre of mass m
Fish cutter	0	104	2,73
	18	115	2,82
Small dry cargo ship	0	1368,0	5,90
	15	1372,2 1385,8	6,14 6,08

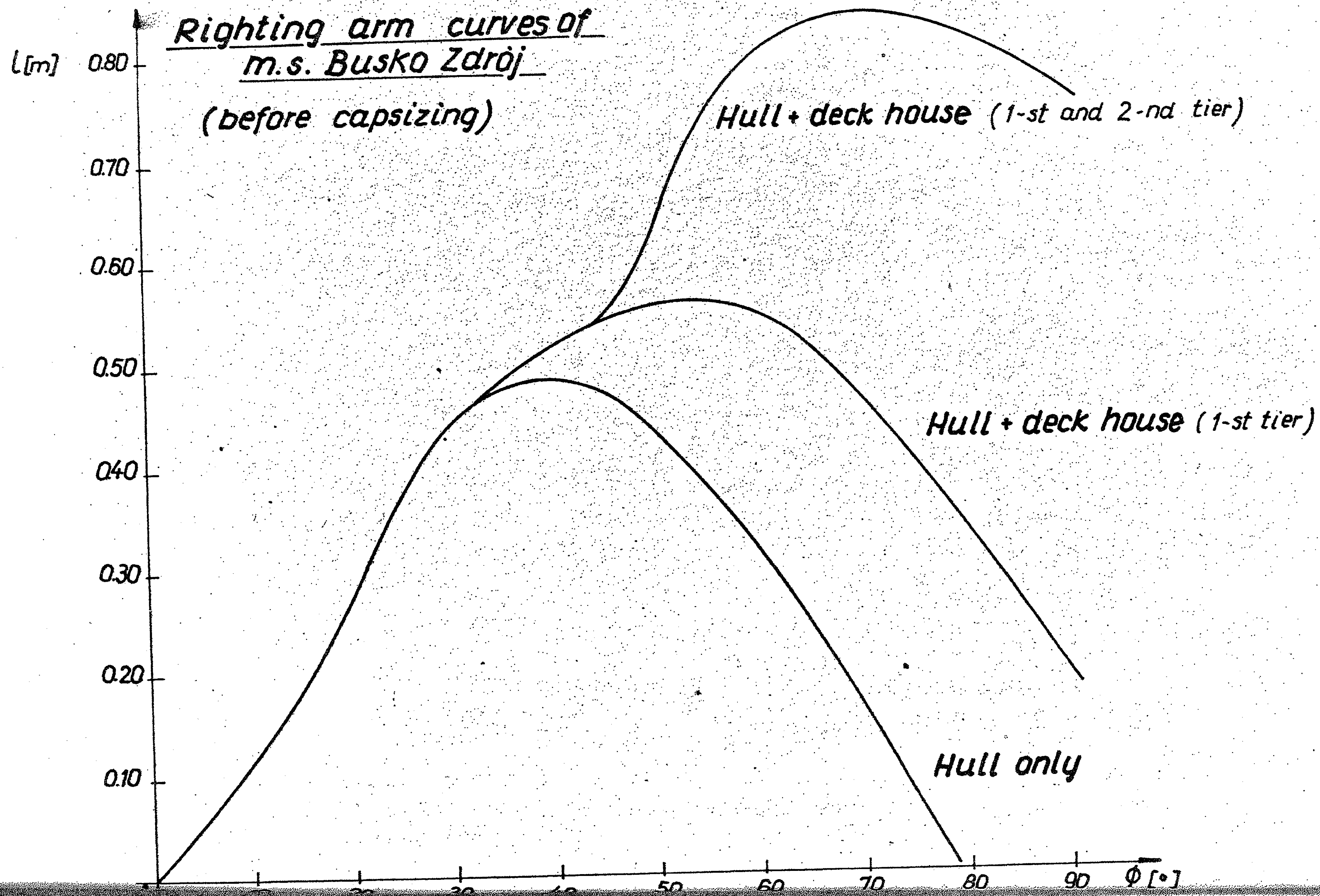
Who should take this fact into account? The designer of the ship, her owner or those who creates the stability criteria?

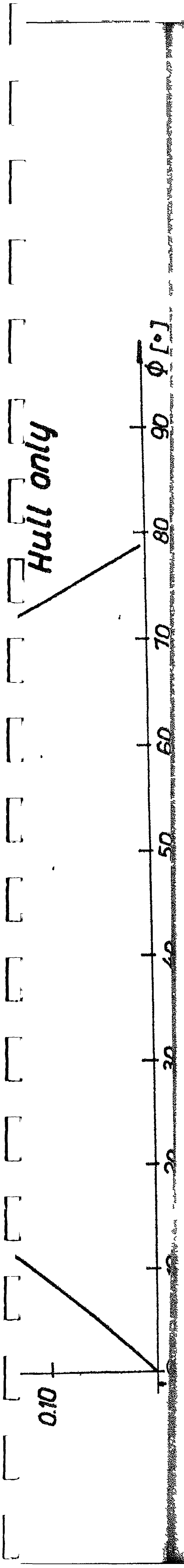
Today the possibilities to include into the design procedure some non-routine calculations, concerning the behaviour of a ship in rought sea. One of the most interesting phenomena is the altering the ships stability by waves. So, there is a need to calculate the cross curves in wave . But yesterday it was shown in the paper by Dr Nedrelid that the results of such calculations carried out for the same ship differed seriously. That means we can not yet calculate the righting arm curve in a wave crest with sufficient accuracy.

Regarding the calculations of the oscillatory ship motion in rough sea as a part of the design procedure there is still a lack of statistical data concerning the sea itself. Even the six-parameter sea spectrum assuming long-crested sea may be unsufficient to assess the ship behaviour in a real rough sea. According to Polish experience the most danger sea condition which leads often to the damage of the ship and cargo, especially in the case of modern ship-types such as ro-ro and con-ro, is the cross sea. This names the situation when the fresh, stormy waves are coming from one direction and at the same time swell is coming from another one. As far as I know our knowledge concerning the cross sea is rather small.

Today the designing process includes the prediction of the seagoing qualities of a ship by means of calculations or model tests. Results of such prediction can be a basis to enlarge the Information for the master containing only the information about the ship stability, but also information about her behaviour in bad weather condition. Changing the heading and reducing the speed in a proper time a ship can avoid the dangerous situation for the cargo or for herself.


Righting arm curves of m.s. Busko Zdrój
(when capsizing - about 500 t water inside the ship)
Hull + deck house (1-st and 2-nd tier)
Hull + deck house (1-st tier)
Hull only
Φ[°]
10
20
30
40
50
60
70
80
90
L [m]
0.70
0.60
0.50
0.40
0.30
0.20
0.10


Righting arm curves of
m.s. Busko Zdròj
(before capsizing)
l [m]
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Hull + deck house (1-st and 2-nd tier)
Hull + deck house (1-st tier)
Hull only
50
60
70
80
90
Φ [°]



Contribution for Panel Discussion II:
"RELATIONSHIP BETWEEN STABILITY REQUIREMENTS DESIGN AND OPERATION"

by M. Abicht
Institut für Schiffbau
der Universität Hamburg

I think when we discuss future intact stability requirements for cargo ships, we should know whether for these ships in future also damage stability requirements must be applied.

If this is so, intact stability requirements for normal ships may be less complex, because damage stability requirements will contribute to more safety also in the intact condition. The remain reason for this is that in practice - different to what we have seen in capsizing tests and different to what we normally assume in rolling calculations - capsizing is mostly combined with flooding.

In many cases - this applies especially to small cargo vessels - capsizing occured after the ship got a list. In this condition, water may flow through openings into a space /for instance into a cargo hold/ and will make the ship sink. However, she would have a chance to survive, if she had to fulfil damage stability requirements.

Contribution for Panel Discussion II:
"RELATIONSHIP BETWEEN STABILITY REQUIREMENTS DESIGN AND OPERATION"

By A.N. Kholodilin
Leningrad Shipbuilding Institute
Leningrad, USSR

I would like to make four remarks.

1. It is difficult to use probability factor as a stability criterion for ship capsizing. For example, the probability of $1/10^6$ one could say as a very small. But on the other hand, say for the ship with the period of oscillations 10 seconds, in the hour it goes to 360 oscillations, a day - about 8.000, a month - about 250.000 which gives 1.000.000 oscillations in rough sea during four months only. This works as a fatigue phenomenon.
For my opinion it is better to use the dynamic region where a ship could capsize as the characteristic for a determination the effect on the safety of ship stability at sea.

2. Prof. S.N. Blagoveschensky has proposed a good system of Euler's angles in his very well known book published in English in USA in 1954. For rolling equation he proposed to use θ as well as α /see Fig. 1/. This gave a possibility to analyse a nonlinear rolling equation in ammore convenient form /see Fig. 2/ using the relative angle φ .

3. In the rough sea the action of waves and wind are the same for a big ship as well as for a small one. But a small ship has .. less .. resistance than a big one. This means that for a small ship the dangerous situation could arise more often. This is why we should study more carefully the problems of seakeeping for small ships.

4. The different antirolling systems have an influence on characteristic of the ship's stability. It will be usefull to study these phenomena.

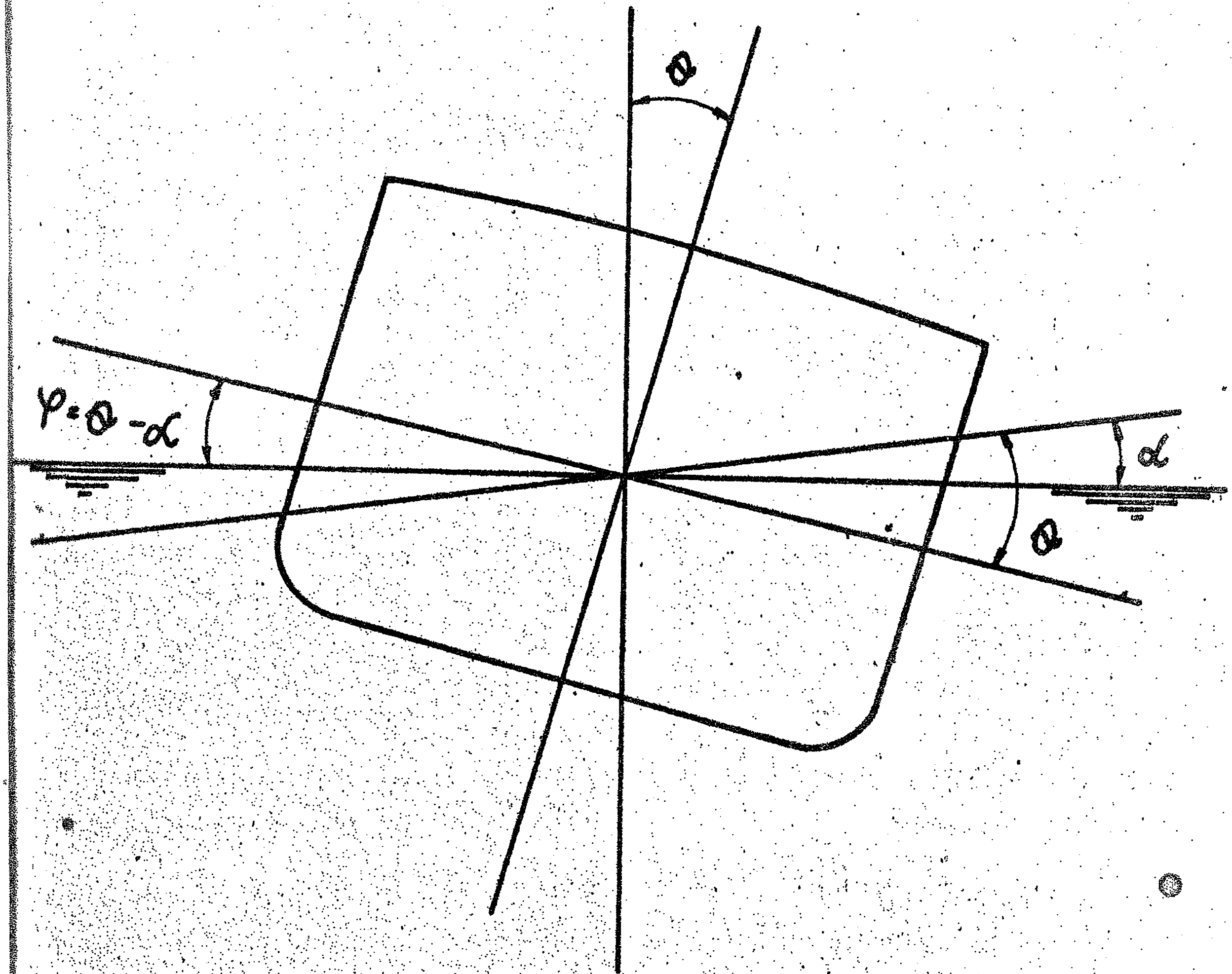


Fig. 1

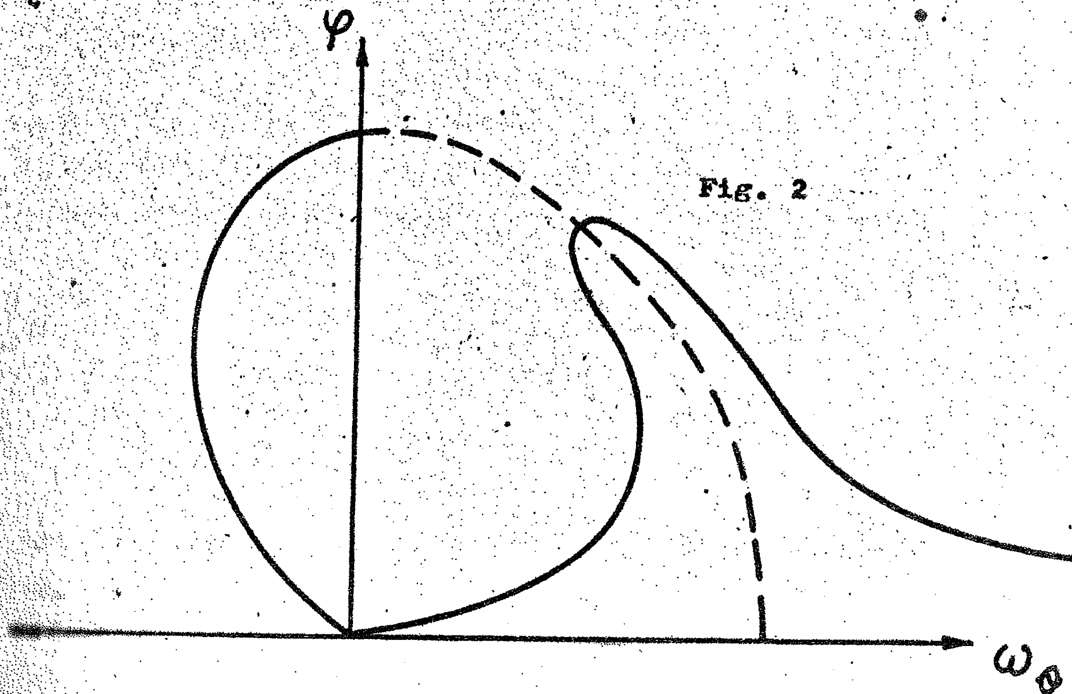


Fig. 2

Discussions on: "EXPERIMENTAL STUDY ON PURE LOSS OF STABILITY IN REGULAR AND IRREGULAR FOLLOWING SEAS"

a paper presented by N. Umeda; Y. Yamakoshi

by O. Krappinger

Hamburgische Schiffbau-
Versuchsanstalt GmbH
Hamburg

The paper presents a nice exercise of determining the GZ-variation in regular and irregular waves. From the mathematical point of view interesting results regarding the probability of capsizing have been derived. But it seems to me that the mathematical treatment of the problem is not in proper proportion to the used physical frame: The GZ-variation is just one influence on the phenomenon of capsizing and even the most sophisticated stochastic consideration cannot compensate the fact that all other physical effects are neglected.

I agree that sometimes a correlation can be obtained between a simplified approach and reality. It was this hope which encouraged me to write the paper [6] mentioned by the authors. But in the meantime I got severe doubts that approaches of this kind can solve the capsizing problem.
I fully concur with the authors when they state at the end of Section 5 that they cannot conclude that their method can be used for a practical purpose. Nevertheless I enjoyed reading the paper.

by P. Blume
Hamburg Ship Model Basin
Hamburg, FRG

At first I would like to have further explainations to your experimental technique. The heeled model becomes unsymmetrical. At captive tests with speed in general a lateral force will be included which can contribute to the measured righting moment with an unknown lever. How did you take care for this effect? Did you measure that lateral forces?

The decrease of the first order roghting lever amplitude with increasing speed is not surprising. The same trend can be obtained also at simple hydrostatic calculations if the profil of the wave system produced by the ship is superposed on the external wave. An example can be found in my STAB´82 - paper.

Beside These remarks I want to encourage the authors to prepare results /in terms of their probability of capsizing/ for different hull forms and compare these results with the experience got from experiments with free running models. Only if this simplified method neglecting important degrees of freedom - mainly surge and broaching - produces the some order as found from experience it will be of practical value. Then such a criterium could be used as an interpolator over tha range of the investigated hull forms.

by W.A. Cleary

U.S. Coast Guard
Washington, USA

I have several questions:

1/ -Section 3 - Your experiment first assumed the disturbance of the water by the ship model to be negligible and then concluded that the disturbance must be taken into account. How best to do this?

2/ -Section 2 - To reach a sufficient number of cycles, multiple but independent, tests were used. Is the mathematical principle still valid. If not perhaps open water tests are necessary.

3/ -Section 4.2 - What does "non-memory" mean?

4/ -Section 4.5 - Is it possible to use your stability variation to derive stability velocity and acceleration?

5/ -Section 4.6 - The increase in probability of capsizing with Froude number seems extreme and not covering the normal range of Fn. What does this mean?

by E.A. Dahle

Det Norske Veritas
Høvik, Norway

1/ Could you please explain why the significant wave height of only 6.55 cm was chosen, when the length of the model was 2.52 m?
Were also other significant wave height used?

2/ The ship used in the experiments has a step-like shape close to the deck. Is it possible that dynamic effects due to submergence of this part can explain the discrepancy between computed and experimental values for Fn > 0?

3/ In the Fig. 12, the threshold value of τ_c = 0.4 sec. is chosen. Could you give the reasons for this choice?

by D. Vassalos

University of Strathclyde
Dept. of Ship and Marine Technology

1/ I what way does GM represent a measure of stability in your graphs Fig. 3 to Fig. 7?

2/ What does GZw represent?

3/ How do you propose to use stochastic prediction of stability /in whatever form/ for practical purposes:

4/ How is t_c arrived at? Is not this affected by speed?

by S. Kastner
Hochschule Bremen
Bremen, FRG

1/ Because of the nonlinearities involved, certainly the seaway energy is important. Did you test just with one single wave spectrum? What was the largest wave steepness of the waves generated?

2/ Why did you restrict your studies to 10 degrees of heel? Stability with respect to capsizing is important at larger heel, and generally at least 30 degrees of heel have been considered a good value for comparison.

3/ What was the initial metacentric height of the ship model? Have you tested just one single value GM/B?

Author's reply to:

Prof. Krappinger

1/ The authors treated the capsizing inducted by only one factor, that is, pure loss of stability in following sea. Of course, another phenomena are also very important.

2/ The authors think that we must carry out model experiments in various sea states and various ship conditions. These results will make our doubts clear.

Prof. Kastner

1/ Experiments in following sea is very patient work Because, they need multiple runs to observe the sufficient number of cycles. Therefore, I only carried out experiments in one short-term random sea which is described by one single wave spectrum. The formula of the spectrum is given as follows:

$$S = A\,\omega^{-5}\exp\left(-B/\omega^{4}\right)$$

where $A = 173\,H_{1/3}^{2}\,T_1^{-4}$ $B = 691\,T_1^{-4}$

2/ We may observe the shipping water with a model ship heeled of large angle. Therefore, the phenomena are more complicated. Thus we used a model ship heeled of 10 degrees in the first stage. In the next stage the authors have a plan to carry out model experiments with a model heeled of large angle which the discusser said.

3/ This model ($GM_o/B = 0.157$) was fixed with regard to roll. Thus contribution to stability by gravity is a constant value and independent of waves. The results in Figs. 3-10 does not depend on the initial metacentric height GM_o of a model, apart from coupling effects to heave and pitch. As the results in Figs. 11-12 we can get values of a model ship with any GM values.

Dr Blume

1/ The authors define the righting moment to be all the hydrostatic and hydrodynamic moment acting upon the hull about the center of gravity, according to Prof. Nomoto /ref.:his answer to Dr Odabashi's discussion at STAB' 82/. We can get values of moment acting upon the hull of any other vertical position, because we measured not only righting moment but also the lateral force.

2/ Dr Blume treated the additional stability increase component by wave generated by a ship in still water /STAB '82/. This component is not time varying components, On the Other hand we observed that the amplitued of time varying components decreased with the increasing Froude number. Thus the component which the discusser said is quite different from these components.

Mr Cleary

1/ In our calculation the authors used the assumption that disturbance by a ship is negligible. However, our experimental results show that such assumption is not always accepted.

2/ We can get stochastic values by ensemble averages of many samples of random process. Therefore, we can get stochastic values of ship stability from multiple tests in irregular waves which have common stochastic properties.

3/ "Non-memory" means non-frequency dependence.

4/ Yes, it is possible.

5/ The authors expect that the probability of capsizing induced by the pure loss of stability has the maximum value for 0.4. However, our computational and experimental methods become difficult for Fn = 0.4 where a encounter period becomes infinity. Moreover, we think that another instability like broaching-to is more important than the pure loss stability in the condition where Froude number is larger than 0.4.

Prof. Dahle

1/ Our used wave is relatively moderate. In such moderate sea state heaving and pitching motions are regarded as linear phenomena. However, stability variations are completely nonlinear. This fact is still important in order to discuss ship motions in more severe sea state. Furthermore, we plan to carry out experiments in more severe sea state now.

2/ Now I am studying about stability variation in regular wave from hydrodynamic point of view. Your comment may be effective for me.

3/ τ_c chosen in Fig. 12 is only one example. τ_c must be closely related to the dynamic properties of ship. It depends on many factors, namely, the roll damping, period, inertia, environment and so on. We cannot predict τ_c by pure theory presented by now. However, Dr Helas proposed one idea from practical point of view at STAB '82.

Dr Vassalos

1/ GM in Figs. 3-7 is derived from GZ at fixed heel angle of 10 degrees. Because, we confirmed that GZ in waves is proportional to such a small heel angle. The results were expanded in Fourier series. We excluded the GM in still water from the steady component in Fig. 7.

2/ GZ_w represents the values of righting arm except for GZ in still water.

3/ If we propose stability criteria by Grim's effective wave concept, we must use some correction factors from many observed results. Dr Helas [8] proposed one example.

4/ You would be suggested to refer to an answer to Prof. Dahle's discussion No 3.

Discussion on: "AN EXPERIMENTAL TECHNIQUE FOR INVESTIGATION INTO PHYSICS OF SHIP CAPSIZING"

a paper presented by S. Grochowalski;
P. Söderberg

by P. Blume
Hamburg Ship Model Basin
Hamburg, FRG

At first I want to congratulate the authors to their large and detailed investigation. In my opinion this is one of the rare investigations which have the potential to come to more general results. I hope we can hear from such results on a later occasion and I wish the Canadian people good luck at their attempts for analysing the measured data.

Here the authors show curves of forces and moments from partly and fully captive tests. They show larger differences especially for the moments around the x-axis. I want to underline, that these results including dynamic forces cannot be compared directly with the righting moments calculated in the usual hydrostatic manner on a wave crest or in a trough, because these results depend strongly from the condition at the tests. As I understand, the authors also varied the drift angle of the ship, or in other words the mean of the transverse force.
I expect a larger influence on the moments here too, can you confirm this?

Discussion on: "PROBABILITY OF NON-CAPSIZING OF A SHIP AS A MEASURE OF HER SAFETY"

a paper presented by W. Błocki

by N. Umeda

National Research Institute
of Fisheries Engineering
Tokyo, Japan

Your prediction method to estimate probability of capsizing is very excellent one. I have a simple question.

The roll motion described by equation (3.1) depends on an initial roll angle and a roll angular velocity and phase difference between wave and roll. Do your results of critical angular velocity depend on the phase difference between wave and roll?

Author's reply to:

Mr N. Umeda

Thank you for your comment. This is true in general.

The phase angle α between wave excitation ξ and ϕ(roll) has two parts:

$$\alpha = \beta + \gamma$$

where: β - phase angle between wave excitation ξ and excitation moment m of a force

γ - phase angle between excitation moment m of a force and roll ϕ.

The solution of the differential equation (3.1) depends on phase angle γ only.

In the paper the resonance case was considered /perhaps this was not cleary said/. Only this case is really dangerous and the ship capsizing in beam sea is practically possible only in this case.

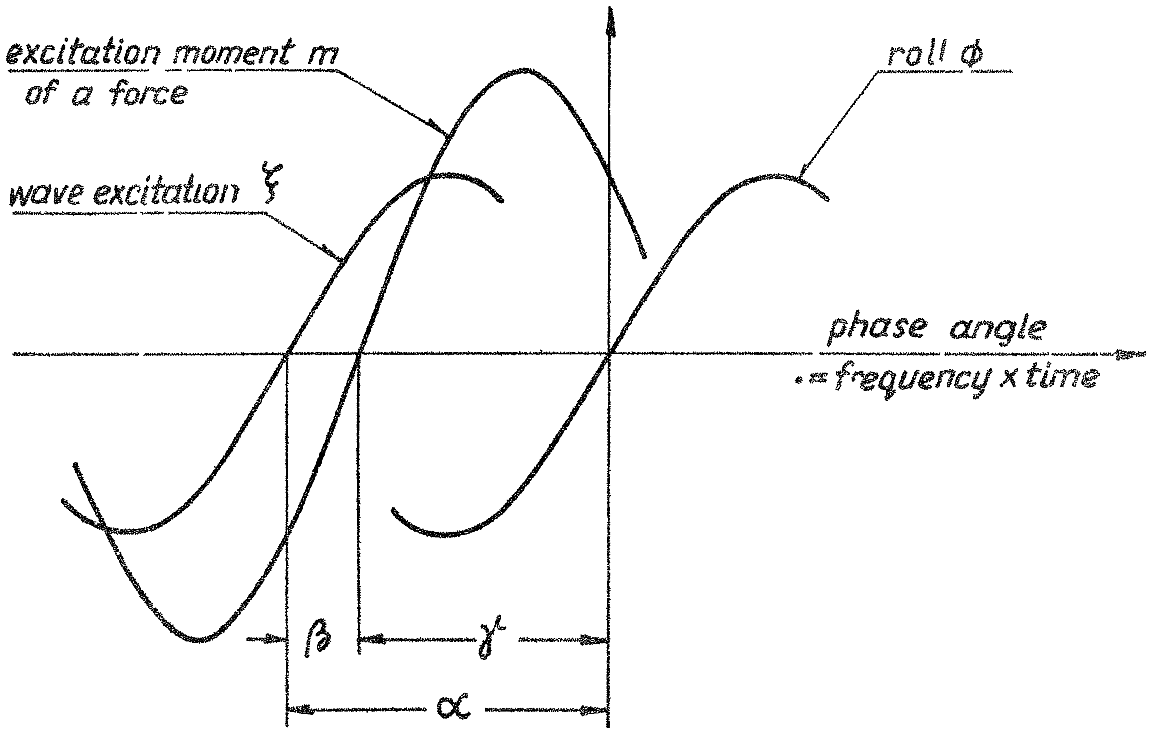


Figure : The phase angles

It is assumed that the ship motions /the roll also/ are not too large until the occurance of high wave group. Therefore, in such a case the ship may be treated as linear object. Phase angle γ has fixed value in the resonance case. It means $\gamma = \pi/2$. But, if the excitation moment m of a force may be expressed by:

$$m = m_r \cos \omega t$$

the roll ϕ is given by:

$$\phi = \phi_A \cos(\omega t - \gamma) \overset{\gamma = \pi/2}{=} \phi_A \sin \omega t$$

Therefore the roll angle ϕ has value $\phi = 0$ and the roll angular velocity $\dot{\phi}$ has positive value at the moment of occurance of high group /at the point of time t = 0/.

The above assumptions make possible independence from the phase angle.

By the way, my additional computations show that in general the influence of phase angle on the result is rather small.

Discussion on: "THREE DIMENSIONAL NUMERICAL SIMULATION OF GREEN WATER ON DECK"

a paper presented by J.T. Dillingham; J.M. Falzarano

by M.S. Pantazopoulos
University of Washington
USA

This paper is dealing with the same theoretical problem as the paper "Numerical Calculation of Forces and Moments due to Fluid Motions in Tanks and Damaged Compartments", by Mr F. Petey. The method used for the calculation of the flow of the water on deck is Glimm's method for the solution of a system of Hyperbolic equations. The authors, however, do not comment on the limitations of the numerical scheme with respect to the conservation of mass. Have they realized the difficulties the algorithm introduces for satisfaction of the conservation of mass and therefore, the incorrectness of the solutions in the proposed form?

What are their comments on the correlation of the conservation of mass of the deck water and the automatic satisfaction of the CFL condition, which prohibitively increases the computer running time?

The generalization of the 2-D numerical scheme to the 3-D problem has not yet been proved mathematically, but has been used intuitively.

It seems that the generalization of the Glimm's method to the three dimensions using the method of functional steps by Yanenko, does not solve the correct 3-D Riemann problem. The authors do not comment in their paper on the analytical solution of the general 3-D Riemann problem. I think that additional assumptions are needed for the conservation of momentum

in the x and y directions in order to apply correctly the method of operator splitting.
What is the author's opinion on the matter?

Discussion on: "NUMERICAL CALCULATION OF FORCES AND MOMENTS DUE TO FLUID MOTIONS IN TANKS AND DAMAGED COMPARTMENTS"

a paper presented by [illegible]

by M.S. Pantazopoulos

With respect to the proposed solution for the low fill depth case, I would like to make the following comments:

The last few years, the Fishing Vessel Safety Center at the University of Washington has been interested in the water on deck problem and its effect on capsizing of fishing vessels, and has contributed a number of theoretical and experimental studies on the various aspects of the subject.

1. It seems to me that the random choice method combined with operator splitting for the one-dimensional does not conserve the mass of water on deck. Especially, using Dillingham's original computer code [1] for the 1-D case, which we have extended for automatic satisfaction of the CFL condition and fixed grid, we encountered a problem trying to conserve the mass of water on deck.

   The problem consists of a large fluctuation in the total mass of the water on deck /the problem we have solved does not permit water to flow into and off the deck/, which either increases or decreases, even though the CFL condition is satisfied in all the cells. The problem of the satisfaction of conservation of mass has been underestimated, in my opinion. Several papers by Chorin [1] , Colleia [2] , have argued that the exact satisfaction of the conservation of mass is not essential to the accuracy of the method because the corrected wave depth and wave speeds have been calculated to some reasonable degree of accuracy.

Parametric studies varying the number of cells indicated that the problem of the mass fluctuation may be reduced as the number of cells on the space domain is increased. An increase in the number of cells though, decreases the time increment to prohibitively small in order to satisfy the CFL condition. This may create a timewise accounting problem with computer resources when it is compared with other conventional finite-difference methods.

For the water on deck problem, I think that good satisfaction of the problem of conservation of mass is going to produce results more satisfactory to the engineers.
Has the author encountered this problem and how does he solve it?

2. The CFL condition. I call this condition a logical condition for every finite difference problem, or space-continuum domain, if you like. What it actually means is that the finite-difference domain of dependence must at least include the continuum domain of dependence, or specifically, that a "sound" wave cannot travel more than one cell length in one time increment. It is stated:

$$\frac{\Delta t}{\Delta x} \leq S \cdot \max (C + U)$$

Δt = time increment
Δx = space increment
C = wave celerity
U = particle velocity
S = coefficient

Wigton [3] indicates that the accuracy of the bore or shock wave is more accurately approximating the exact solution if the CFL is barely satisfied /when the equal sign occurs/. From my experience, when we use variable Δt to ensure an automatic satisfaction of the CFL, the CFL is strongly satisfied in some cells and barely in others. A bare satisfaction of the CFL throughout the space domain for the same Δt is implying variable Δx, space increment, which may produce again a timewise accounting problem with computer resources.

The discusser at the present time has not investigated throughly other possibilities in the CFL condition.

How does the author approach the problem?

3. My next comment is related to the two-dimensional case of the sloshing probleme it has a qualitative nature. In particular, my comment is related to the method of operator splitting as applied to the breakdown of the solution of the two - dimensional problems.
The discontinuity conditions for the 1-D case are given in Stoker [4] . When we apply the operator splitting method, in my opinion, we could look at the possibility of making additional assumptions on the transfer of mementum among cells and impose additional restrictions for the discountinuity conditions in the numerical scheme, Pantazopoulos [5]. This will ensure a meaningful qualitative idealization of the "dam breaking" or the wave propagation in the 2-D problem. This also might improve the accuracy of the method in the 2-D case, which is not as promising as is the case of the 1-D problem.

4. The author does not present any examples where the vessel starts from an initial keel angle. The results that he presents in Figure 2 are for a roll amplitude of 2 degrees. Did he perform any experiments for larger roll amplitude, and what is the correlation of theory and experiments [6] ? I would appreciate the author's comment on this matter.

5. Finally, the flow of water in a damaged compartment is a very interesting and more complex phenomenon. Itthink that the proposed method treates an oversimplified model of the flow in a damaged compartment and more engineering disciplines should be taken into account.

REFERENCES

1. Dillingham, J.T., "Motion Studies of a Vessel with Water on Deck", Marine Technology, Vol. 18, pp. 38-50, January 1981.

2. Chorin, A.J., "Random Choice Method with Applications to Reacting Gas Flow", Journal of Computational Physics, Vol. 25, pp. 253-272, Nov. 1977.

3. Collela, P., "Glimm's Method for Gas Dynamics", SIAM, Jour. Sci. Sta. Comp., Vol. 3, No 1, March 1982.

4. Wigton, L., "Glimm's Method for Humans", Lecture Notes prepared for Course on Numerical Methods, Dept. of Mechanical Engineering, University of California, Berkeley.

5. Stoker, J.J., Pure and Applied Mathematics, Vol. IX Water Waves, the Mathematic Theory with Applications, editor by Courant, R., Bers, L., and Stoker, T.T., Interscience Publishers, Inc. New York, 1957.

6. Pantazopoulos, M.S., "Solution of the General Water Sloshing Problem", Proposal for PhD Dissertation, Mechanical Engineering, University of Washington, Seattle, Washington 98195, Oct. 1985.

7. Adee, B.H. and Caglayan, I., "The Effects of Free Water on Deck on the Motions and Stability of Vessels", 2nd International Conference on Stability of Ships and Ocean Vehicles, Tokyo, October 1982.

Discussion on: "THE APPLICATION OF SHIP STABILITY CRITERIA BASED ON ENERGY BALANCE"

a paper presented by C. Kuo; D. Vassalos; J.G. Alexander; D. Barrie

by H.E. Guldhammer
Technical University
of Denmark

During some years the staff of the Department of Ship and Marine Technology of the University of Strathclyde have presented what they call the Strathclyde Criteria.

This special form of a weather criteria intends to include timevarying factors from a ship sailing in a following sea, thereby using the so-called "butterfly-diagram", which is a graph of the variation of the stability lever during the combined roll and advance movement of the ship in a standardized following sea.

So far I have been able to understand the method, production of the butterfly-diagram assumes the roll movement to be regular sinusiodal and the advance speed to be constant.

Considering the roll movement it seems unlikely that a ship in a quartering sea would roll in the above-mentioned way. From the experiments with the "Edith Terkol" we know that the roll movements were forced by the sea. The "ultimate 1/4 period" lasted much longer than the other 1/4 periods. This observation regards quartering seas, and a pure regular following sea cannot directly induce roll movements, but only through coupling with other movements.
The rolling therefore must origing from influence of other kind /unsteady transverse winds/.

The speed of advance, however, will most probably not be constant. It will vary in a way that the time "in the trough" will be much shorter than the time "on the crest".
This is due to the rotation of the water particles in the wave, which is not considered by the proposed criteria. But this means that the situation in many respects will seem as, an may be treated as statical.

As the situation on the crest is more dangerous than any other situations, and as this situation may occupy a large part of time, it must be convenient to consider it in the calculations.

The GZ-curve with the ship on the wave crest /bogging/ will most likely not be very different from the lower branch of the butterfly-diagram, except in the outermost parts. It is therefore proposed to use this GZ-curve in the criteria, and to save the apparently formidable work which the production of the "correct" butterfly-diagram must represent.

Doing so, and keeping the remaining parts of the method more or less unchanged, we probably will get more severe requirements, thus some adjustments in coefficients etc. may be necessary.
By studying all I could find at our department about the Strathclyde Criteria I found Fig. 11 in the article of D. Vassalos in RINA-W4 /1985/. This Figure compares results from calculations of the required GM for MT "Edith Terkol". I highly wondered how the GM_{min} could be so low according to the IMO-weather criterion. My own calculation of the required GM according to the criteria give a very much higher value at the capsize displacement. The curve shown in Fig. 11, however, almost corresponds to the requirements of the IMO-criteria /A 167/, which the ship fulfilled at the capsize.

Discussion on: "THE EFFECTS OF DECK WETTING ON THE STABILITY OF SHIPS IN BEAM SEAS"

a paper presented by C. Shin, M. Ohkusu

by Duru, Stephen Chidozie
Ship Research Institute
Technical University of
Gdańsk

The paper is well worth many thanks regarding its consideration of the factors affecting assessment of relative motions of a ship in beam seas. My submission is that in considering relative motions, the amplitude of pitching motions is of significant importance due to the relatively large moment of inertia of heave-pitch coupled ship motions especially for relative motions at stations /towards the bow and stern part of the ship. Hence the equations of motion [4,11 and 12] as well as the relative motion equations (7) should reflect this fact. This points to the fact that purely beam sea condition will not expectedly result in the greatest deck wettening as could be expected from bow or stern quatering seas heave-pitch coupled motions as well as roll and sway motions are very considerably significant.

Relative motion equation has for instance been given for a point (X_p, Y_p, Z_p) on the deck at side by:

$$Z_R = \zeta_S + X_p \cos\theta + Y_p \cos\phi - \zeta_W \qquad (1)$$

where θ and ϕ are pitch and roll motions respectively, and ζ_S and ζ_W are heave and wave amplitudes measured respectively as positive upwards with respect to the mean vertical coordinate of ship origin with respect to an inertial co-ordinate system.

The above equation is yet one amongst various equations on definition of ship-seaway relative motions by various authorities.

REFERENCES

1. Seaway-Ship Interactions; 1984 - by P.N. Majumdar; H.Vu; [redacted] report No C018.

Discussion on: "SUBDIVISION STANDARD AND DAMAGE STABILITY FOR DRY CARGO SHIPS BASED ON THE PROBABILISTIC CONCEPT OF SURVIVAL"

a paper presented by M. Sigurdsen, S. Rusaas

by M. Pawłowski
Ship Research Institute
Technical University of
Gdańsk

I have two remarks:

1. I do not think it is advisable to use only two intact draughts for carrying out subdivision calculations, all the more that one of the two draughts corresponds to ballast condition. According to my opinion it would be advisable to use three draughts for this purpose. In case, however, we use only two draughts, both of them should correspond to loading conditions as ballast condition for many dry cargo ships appears to be of a very small probability in comparison to a load condition. I am aware that the authors wanted to simplify subdivision calculations making them less time consuming. Still, I think also that the application of such two draughts is an over-simplification.

2. It is apparent from your interesting paper that the required subdivision index should be dependent not only on ship size but also on ship type. The results of your systematic calculations do not support the latest IMO view in this regard but they agree with the opinion of Poland expressed in IMO document SLF 31/3/7 to employ the following formula for R, namely

$$R = 1 - \frac{c_1}{L_s + c_2}$$

where c_1 and c_2 are constants for a given ship type.

Author's reply to:

Dr M. Pawłowski

Thank you very much for your very relevant remarks.

Regarding the draughts used in the calculation of subdivision index, I agree that this may be the weakest point in our implementation of the method. The reason why we chosed this approach, was that to our knowledge there were very limited statistics for draught distribution available. We therefore found it difficult to implement a fully probabilistic concept as far as distribution of loading conditions was concerned, and a more "deterministic" approach was therefore chosen. If the goal was to arrive to the exact probability of survival, I agree with you that our approach is an over-simplification. We have, however, taken a more pragmatic attitude, and said that the method should give us a comparative measure, in the sense that the probability of survival should be proportional with the calculated subdivision index. In that respect, we think our implementation serves the purpose.
This does not mean, however, that we should not implement a more correct draught distribution as statistics become available, but some benefits should be anticipated before such a complicating factor should be implemented.

Regarding required subdivision index, I agree that the results of our systematic calculations show a significant difference in attained index between ship types, but this, in my opinion, does not support the view that the required index should be dependent of ship type. It just shows that some types are safer than others, but the only conclusion I can draw from this observation, is that the more unsafe ship types should be upgraded in order to meet a minimum safety standard.

Having said that, I wish to add that the aim of our SC Class is not mainly to achieve a more or less arbitrary "required" subdivision index, but to offer to the industry a realistic method of evaluating the ship's subdivision standard. For example, if a watertight bulkhead is required in any case, where is the optimum position of that bulkhead in terms of survival capability. This in itself has great safety implications. To give a class notation, however, we need a certain minimum standard, but it is the availability of a reasonable implementation of the method, which can be used without extensive and complicated calculations, which counts for the industry.

M. Pawłowski - two years later

Having done more research on damage survivability of ro-ro ships, now I am inclined to the opinion that the required index of subdivision R should be independent of ship type.

All new dry cargo ship types, of the same size, including ro-ro ships, can have in fact the same level of safety without impairing their presently successful design features. The previous objections in this respect were mainly due to extremely law values of the indices of subdivision for ro-ro vessels. It appears, however, that these ships, if properly designed, can be as save as the other ship types or even more safe. Horizontal subdivision within the vertical extent of damage, too many buoyancy provisions below the car deck and the lack of them above this deck are most detrimental for damage survivability of ro-ro ships.

Discussion on: "BSRA TRAWLER SERIES STABILITY IN LONGITUDINAL WAVES"

a paper presented by Campanile, Cassella

by J. Wiśniewski
Ship Research Institute
Technical University of
Gdańsk

It is very interesting for me to know, that there are more naval architects, who choosed the conception of presenting the influence of form parameters of systematical series of shiplines on stability characteristics, using the law of geometrical affinity. It seems to be very helpfull tool for preliminary design.

I have done similar work in 1964 for Todd Series 60 [1] . Fatur has been the first autor of proposal how to use the law of affinity in stability calculations [2] . It may be interesting for the Authors that there is possibility of simplyfying the stability characteristics data of affine ships.

The form stability lever /Fig. 1/ may be directly calculated for affine ships using the formula:

$$w_1 = w\,\lambda_H \frac{\sin\phi}{\sin\phi_1} + \left(z_{F_0} - \int_0^{\phi} w\,d\phi\right)\left(\lambda_H - \frac{\lambda_B^2}{\lambda_H}\right)\cos\phi\,\sin\phi_1 \qquad (1)$$

where:

$$\lambda_H = \frac{H_1}{H}\;; \quad \lambda_B = \frac{B_1}{B}\;; \quad \phi = \arctan\left(\frac{\lambda_B}{\lambda_H}\tan\phi_1\right)$$

During the time of desk calculations the use of this formula was rather labourous, but with the advent of computers it has advantage over the Fatur's proposition. In [3] one may find the example of application of formula (1) for optimisation the main ship parameters in preliminary design.

REFERENCES

1. Wiśniewski, J; Systematic Investigation of Hull Forms for the Purpose of Stability Calculations in Preliminary Ship Design. Zeszyty Naukowe, Politechniki Gdańskiej Budownictwo Okrętowe, Nr 4, 1964 /in Polish/;

2. Fatur, J.; Uber die Auftragung der Ergebnisse der Stabilitatsrechnung. "Schiffstechnik", 1958 Nr 25;

3. Wiśniewski, J.; Discussion to the paper Nr 4. Second International Marine Systems Design Conference, Theory and Practice of Marine Design. Lyngby, 1985. Proceedings Part 2, page D4-3.

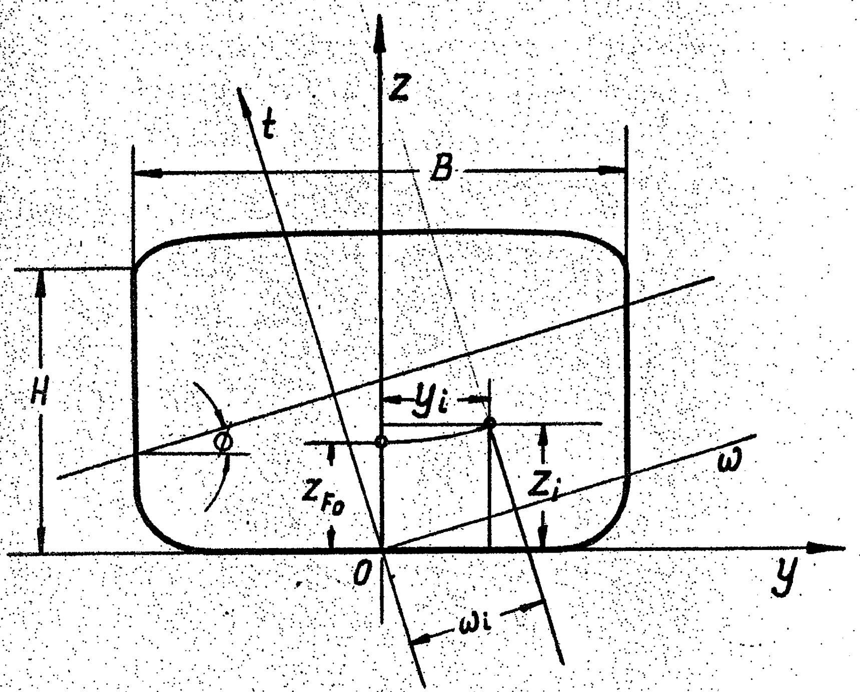


fig. 1

Discussion on: "SOME ASPECTS OF SEAKEEPING FOR SMALL SHIPS"

a paper presented by N.R. Kholodilin;
V.K. Trounin;
B.N. Oushakov

by H. Söding
Institut für Schiffbau
der Universität Hamburg

From captain's experience and model experiments I got the impression that the ship's position without forward speed in beam seas is the safest condition with respect to capsizing. There may be exceptions from this rule for the case of small ships in breaking waves, but for non-breaking waves I do not see a difference between large and small ships if wave parameters and ship details are scaled correspondingly. Therefore I wonder why you investigated just the case of beam non-breaking waves.

Author's reply to:

Mr H. Söding

As result of the influence of wind and waves the ship expects transverse drift. This phenomena leads to displacing the "transfer function" in the direction of high frequencies and as a result the amplitudes of ship's rolling are increasing. For small ships this is more dangerous than for a large one.

ZPPG/411/88/150