The Royal Institution of Naval Architects

# Damaged Ship IV

International Conference on

## Damaged Ship IV

## 16-17 May 2018, London, UK

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## DAY 1 PAPERS:

**09.00-09.30** **COFFEE & REGISTRATION**

**09.30-10.00** **SOLAS 2020 PASSENGER AND CARGO SHIP DAMAGE STABILITY REGULATION,** *Keith W Hutchinson, Babcock International Group - Energy and Marine Technology, UK, Andrew L Scott, Maritime and Coastguard Agency (MCA), UK*

The degree to which ships designed to comply with the newly amended regulations may be economically compromised in comparison with the current SOLAS 2009 Regulations is yet to be fully understood. Understandably, within the industry there are currently significant concerns over the forthcoming regulatory changes particularly the substantial increase in the Required Subdivision Index R for passenger ships carrying up to 1,200 persons and, specifically for the operators and designers of Roll-On / Roll-Off (RO-RO) passenger ships for service in European Union (EU) waters, the future of the Stockholm Agreement namely EC Directive 2003/25/EC as amended, to mention just two.Hence, the paper will discuss the concerns of ship owners, operators and designers and how the upcoming international damage stability regulations may influence the economics of the dry cargo or passenger ship fleet constructed on or after 1st January 2020. The question as to how these new design and operational regulations, some potentially conflicting and diverse in nature, can be applied as a coherent whole for practical application within the design process will be addressed. As part of this, current issues surrounding regulations will be discussed along with a critique of recent research and the needs of the shipping industry. The impact of these will be investigated considering the practicing ship designer, regulators assessing and ensuring the inherent and operational safety of new designs and major conversions and also those involved in the education of naval architects and seafarers.

**10.00-10.30** **DESIGNED ACCORDING TO - OR FAR BEYOND, THE REGULATIONS?,** *Rolf Catol, Western Norway University of Applied Sciences, Norway*

The burnouts of Norman Atlantic and Sorrento proves that their designs does not protect these ships in case of fire at their open ro-ro deck. The naval architectural consensus is, however, that they are according to the rules. Careful studies of SOLAS indicate on the other hand that the most relevant regulations seem dishonored with gross margin.The flooding of Emma Mærsk and Rocknes indicates these ships did not comply with the double bottom requirement. They may, nevertheless, have been designed according to common practice. Documents disclosed for Al Salam Boccaccio 98 and her sister vessels reveals that no damage stability calculations was approved when she was redesigned in Italy. Presumably this was also the case when she later were reflagged. Studies of above mentioned accidents indicate that Due Diligence seems not to be taken into account at time of design.

**10.30-11.00** **CALCULATING RAKING DAMAGE EXTENT FROM DECELERATIONS MEASURED DURING A GROUNDING INCIDENT,** *Alex W. Vredeveldt, Martijn G. Hoogeland, TNO, Netherland, Liza C. van Kempen, TU-Delft, Netherland*

When a grounding accident occurs, the officer of the watch is usually unable to assess the severity of the actual damage. Most ships do have damage response procedures in place. In case of military ships these are well developed, while a well-trained crew is available to respond adequately. But even for these vessels underwater damage is hard to assess because of accessibility issues of flooded compartments. Being unable to assess grounding damage is undesirable because the extent of damage needs to be known in order to decide whether to evacuate or to stay on board and control the loss of buoyancy and hydrostatic stability. There exists good literature on the topic of ship grounding, including results from full scale tests conducted in the nineties of the previous century. The reported research shows that calculating structural damage can be done in a satisfactory way. Moreover, when using the calculated contact forces as input, the motions of the ship during the grounding accident can be predicted satisfactorily as well. This paper reports on a reversal of the prediction process. When the ship motions, caused by the grounding event are known from deceleration measurements during the incident, it possible to calculate the damage through a reverse engineering process. Measured data from full scale collision experiments, carried out by a Dutch, German, Japanese consortium, has been used to test the validity and usefulness of the reverse engineering approach. Preliminary results are very encouraging.

**11.00-11.30** **COFFEE**

**11.30-12.00** **A RISK PROFILE FOR ESCORTED TANKERS AND THEIR RESISTANCE TO COLLISION DAMAGE,** *Robert G Allan, Robert Allan Ltd, Canada, Iain Braidwood, Ian Braidwood Consulting Ltd, Canada*

Perhaps no vessel poses a greater potential risk for causing environmental damage than a laden tanker. However since the Exxon Valdez incident in 1989, significant changes have been made making tankers inherently safer, most notably the adoption of mandatory double-hull construction. Major advances in the field of escort towing have created a new generation of purpose-designed, powerful tugs in this service. One can state with confidence today that an escorted tanker subject to a well-managed set of escort procedures has an absolutely minimal risk of a cargo oil spill. Regardless of these safeguards, many political and environmental spokespersons cite the Exxon Valdez and similar incidents as reasons today for not permitting the passage of tankers through coastal waters. Much has been written about the resistance of double hull structures to collision, nevertheless there is a need to present this material in a way which is accessible to an interested public so as to help debate proceed on the basis of fact. This paper distils some of that data to a level which will contribute to informed debate. This includes an analysis of the speed and direction of impacts involving tankers which would be required to breach the inner cargo tanks. Work from Estonia, the United States, and Korea is examined demonstrating the worldwide interest in this topic. Using the example of the Port of Vancouver (Canada), the authors present the scenarios used locally for escorting tankers, and identify the potential risks and the associated potential for a cargo oil spill.

**12.00-12.30** **DAMAGE CONTROL SURVIVABILITY & CONTAINMENT OF FIRE AND FLOODING. ONLY AS STRONG AS THE WEAKEST LINK: MULTI CABLE TRANSITS (GLANDS) & PIPE PENETRATIONS CRITICAL ROLE IN ACHIEVING WATERTIGHT INTEGRITY,** *Peter Litchfield, CSD Sealing Systems, UK*

This “containment” is only as strong as the weakest link; the cable transits and pipe penetrations play a critical role but are often overlooked. For ship stability calculations there is a general assumption that the watertight bulkheads will remain tight and contain the flood and progressive flooding is often not considered. Through-life performance of cable and pipe penetrations is key to survivability during fire or flooding. Following Investigation of several engine room flooding incidents CEFOR-(The Nordic Association of Marine Insurers) published a report in May 2016 highlighting the failings of incorrectly installed and maintained boundary cable penetration sealing arrangements contributing to the development and seriousness of accidents. In the design process, focus is on the steel construction of the watertight bulkhead entailing quality control of the design and testing of the welding and thickness measurements of the steel. The cable penetrations are viewed from a component viewpoint without quality control and with separate approval procedures that often do not involve testing and therefore performance depends on the individual craftsman assembling the system. There is often no readily available testing method for assuring the quality of the fitted cable penetration system. The classification survey process is not always performed by a person with detailed knowledge of t cable penetration system. Therefore, survey process rests on the type approval certificate. Explore the contributory factors and preventive measures including ultrasound watertight integrity surveys.

**12.30-13.30** **LUNCH**

**13.30-14.00** **SENSOR-BASED BREACH DETECTION AND DAMAGE CONTROL IN PASSENGER SHIPS,** *Kristian Bertheussen, Dracos Vassalos, University of Strathclyde, UK*

Complex subdivision in large passenger vessels increases uncertainty in flooding incidents, that impose challenges on the crew to obtain a complete overview in making fully-informed decisions. The introduction of flooding sensors in passenger vessels as required by SOLAS (2009) Reg. II-1/22-1 aims at reducing uncertainty and assist the crew, particularly in emergencies. On this basis, onboard decision support systems predicting breach size and the ensuing flooding process by utilising flooding sensors to assist numerical simulation tools have recently been developed. Research shows that predicting breach size and the ensuing flooding process purely by using flooding sensors is possible, but this is highly dependent on sensor position and density. Flooding sensors have further limitations in detecting breaches located above the waterline, as only the submerged breach will be detected from measured flood-rate. This may result in underestimation of the breach and overestimation of the time available for evacuation and hence predicting false safety. This paper will present a methodology whereby numerical simulations and sensors are combined to limit uncertainty and facilitate informed decision-making in emergencies.

**14.00-14.30** **INVESTIGATING HULL GIRDER LOADING OF DAMAGE SHIPS BY HYDRODINAMIC ANALYSIS,** *Yongwon Lee, Stefano Persico, Lloyd's Register, UK*

Lloyd’s Register’s has investigated the application of its latest hydrodynamic modelling tools, widely used in design offices and in design appraisal, to intact and damaged ships. The computational tools are based on a three dimensional linear method to predict the hydrodynamic loads acting on intact and damaged ships. Motions and hull girder loads; such as vertical and horizontal shear forces, bending and torsion moments; have been calculated and validated against experimental results. Sensitivity of the hydrodynamic component of vertical shear force and bending moment to different damage configurations has been explored for vessels of full and fine form. The ability to make rapid calculations of this type and the significance of the results are of interest to Lloyd’s Register’s Ship Emergency Response Service in assessing vessel strength at the time of a casualty. They would also be useful when evaluating routing options for repair voyages. This work is a preliminary investigation. Its limitations and the possibilities for development, extension, application and implications for different ship types are considered. Finally, this paper summarises results and discusses design assessments of damaged ships in hydrodynamic aspects.

**14.30-15.00** **COFFEE**

**15.00-15.30** **EVALUATION OF RESIDUAL SHIP STRUCTURAL INTEGRITY FOLLOWING DAMAGE USING WHOLE SHIP FINITE ELEMENT ANALYSIS,** *Kevin F. Stone, Stone Naval Consulting, USA, Tobin R. McNatt, MAESTRO Marine, USA, Nick Danese, NDAR, France*

Global finite element analysis (FEA) of ships during design and construction is now becoming more common and the models are often used for life-cycle engineering support. This paper presents a method using full ship FEA to conduct damaged ship residual structural evaluation, and to compute operational limits to preserve structural integrity of the damaged ship in a seaway. Immediately following major damage to a ship from collision, grounding or weapons effects, the first concern is quite properly containing the fires and/or flooding and ensuring that the ship remains afloat, upright and stable. It is now routine practice to use onboard damage control and stability software to aid in these efforts. But what about the ship’s residual structural integrity, including hull girder strength, and proximity to further buckling or progressive collapse? The answers to these questions are not routinely available to either the ship operators or the support organization ashore following a casualty at sea. The MAESTRO whole ship finite element analysis aevaluation code, in use by many naval design authorities, allows the rapid modification of an existing model of any ship type to reflect current cargo and tank loadings, structural damage, flooding conditions, and to accurately calculate the hydrodynamic loads, i.e. pressures and accelerations, resulting from the seaway. The analysis provides structural deflections and stresses, and comprehensively evaluates the entire structure against failure modes such as local panel buckling and hull girder buckling. This paper will demonstrate the method and capabilities using a finite element model of a notional frigate that has suffered damage to its hull from a collision and will also describe how this technical capability can be implemented to support operating ships.

**15.30-16.00** **THE COSTA CONCORDIA WRECK REMOVAL: HOW COMMERCIALLY AVAILABLE SOFTWARE WAS CUSTOMIZED TO MAKE MISSION IMPOSIBLE A SUCCESS,** *Phil Reed, Reed Maritime LLC, USA*

The wreck removal of the COSTA CONCORDIA was the biggest wreck removal project ever undertaken. Refloating the casualty was executed using only external buoyancy comprised of 30 sponsons and a pair of blister tanks custom fit to the bow. A bespoke Control & Monitoring System was developed to remotely operate 264 valves in order to ballast 66 separate tanks. The system also measured tank loads, waterplane data and hull deflections, all of which were input into the Load Monitoring Program for real-time evaluation of the casualty's stability and residual structural strength. This paper discusses the challenges involved with integrating the General HydroStatics (GHS) software into the Control & Monitoring System and how it was used to plan the dewatering sequence and monitor the casualty during the refloating operations and subsequent tow.

**16.00-** **GENERAL DISCUSSION**

**DAY 2**

**09.00-09.30** **COFFEE & REGISTRATION**

**09.30-10.00** **THE DAMAGE STABILITY CALCULATIONS EVOLUTION FROM THE CAD POINT OF VIEW,** *Rodrigo Perez, SENER, Ingeniería y Sistemas, Spain*

Damage stability, as part of naval architecture calculations, has existed for many years, probably since Pierre Bouguer published in 1746 the first treatise of naval architecture, Traité du navire. Historically, damage stability calculations for ships relied on manual calculations, often tied to a specific system of measurement. Some of these very old equations continue to be used in naval architecture books today. However, the advent of the towing tank and CAD Systems allows much more complex analysis.Damage stability calculations are much more complicated than other naval architecture calculations, as for example, intact stability, launching or power estimation. Software utilizing numerical methods are typically employed because the areas and volumes can quickly become tedious and long to compute using other methods. Stability tests in damage conditions, as in shipyards, technical offices or universities, are performed with software packages that starting from conceptual design information are able to quickly compute the required data. This paper focuses on evaluating old and new methods of damaged stability calculations in the shipbuilding CAD tools.

**10.00-10.30** **CHALLENGE IN HYDROSTATIC MODELLING OF A CASUALTY SINKING SEQUENCE,** *Baiqian Jiang, Paris Mangriotis, Simon Pollard, London Offshore Consultants, UK*

The investigation of a ship casualty usually involves creating a hydrostatic model and simulating a sequence of events in an attempt to best replicate the actual sinking scenario. However in most cases, there is little evidence on which to base such hydrostatic analyses. There may only be photographs or videos to identify the floatation, trim and heel. The main challenges lie in the accurate assumptions of the progressive flooding sequence and the internal cargo/fluid movement at each intermediate step along the capsizing timeline. Sequences are influenced by the down-flooding / progressive flooding angle, the presence of slack tanks and the identification of where flooding may have occurred, for example which cargo hold may have flooded on a bulk carrier in a certain static condition. Hydrostatic modelling is a tool for creating snapshots of the sinking sequence and therefore has certain limitations when compared to a dynamic flooding analysis which accounts for real time flooding rates and wave response. The dynamic analysis, however, poses far more complexities. In addition to an accurate model, it is essential to have an experienced investigator who is able to determine the most appropriate analytical approach and to distil the many permutations of tank filling / flooding into a few simple cases which, whilst approximations, may be considered accurate enough to determine the causative events of the incident.

**10.30-11.00** **HAVE THE BENEFITS OF EMERGENCY RESPONSE SERVICES BEEN OVERLOOKED FOR DRY CARGO SHIP?,** *David Prentice, Lloyd's Register, UK*

Perhaps it is perceived that enrolment with a recognised emergency response service (ERS) providing prompt access to damage stability and strength assessment is primarily to satisfy legislative requirements of the USA and IMO, aimed at reducing pollution risk from oil tankers. Indeed, legislative needs are wider, e.g. to satisfy the response time requirements of US legislation for Non-Tank vessels. And also for decision support of passenger ships. However, nowadays the greater part of most ERS fleets is not enrolled for legislative reasons. Owners, operators and managers increasingly recognise the safety, environmental and financial benefits of ERS. The ERS fleets are growing rapidly with enrolment of other vessel types. We look at key sectors that are increasingly realising the benefits of ERS, including bulk-carrier, container, Ro-Ro, general cargo and yachts and the targets of client's focus in commercial risk-reduction. A variety of scenarios relevant to the key types is described, demonstrating the naval architecture challenges and the benefits of rapid assessment to stabilising an emergency. And beyond that, the potentially very significant value of post-emergency assistance in supporting efforts to reach a best place of repair and to have the vessel back in service as quickly and as inexpensively as possible. Typical scenarios include grounding, collision, fire/explosion, hull failure and general benefits are reasonably understood, however, almost every case is different in its own way. We draw upon Lloyd's Register's SERS' 35 years of experience, including 400 emergencies and 1600 exercise scenarios, in presenting various scenarios and the interesting challenges that they offer.

**11.00-11.30** **COFFEE**

**11.30-12.00** **PRACTICAL CHALLENGES FOS SALVORS, DEALING WITH DAMAGED SHIPS,** *Alexander Gorter, SMIT Salvage BV, Netherlands*

The paper is about the practical challenges salvors face during an emergency - and/or wreck removal job and gives some insight in the way we work and the technical issues we meet. Get the ship's information from the shipowner, Class-ERS, etc (drawings, departure condition, current condition, stability booklet, …).
After that we need draft surveys; due to the weather conditions, could be challenging to read the correct draft readings and get onboard the casualty (weather conditions, transportation, ...). Analyse tank soundings, correction tables and what is onboard. Damaged cargo; water in containers, water in bulk cargo, fire damaged cargo (what is left?). Preparing a 3D computer model in our salvage software, with the data available and make a solid salvage plan with the available resources, with a few uncertainties (deteriorating condition, doubtful tide tables, operational capacity of assisting tugs, lightering vessels, …). On the other hand for wreck removals we need engineering of lifting operations, where the weight of the section needs to be calculated with margins due to no availability of a lightship weight distribution, and additional weight due to trapped water, sediment etc. Examples will be shown of recent cases where the above was put in practice.

**12.00-12.30** **DOCKING SUPPORT SYSTEM,** *Ahmed Samir, Kuwait Oil Company, Kuwait*

Accidents happen, thereafter salvage takes place. On the other hand, ship's owner decision is either going for scrapping or repairing based on the coming feedback. On the other side, the shipyard is still as it is, in a fixed site, waiting for the damaged ship to arrive. Wasted time can be partially saved by sending drawings to the shipyard for pre-fabrication. But will be subject to martial availability and the shipyard production planning. But by thinking even without the box, the author with his docking background, believes that the shipyard can be reconstructed by self-propelled docking and integrated facilitates that will be named hereafter F-Yard [Floating Shipyard], to serve in such an emergency case. Based on the received data, different production process and material requesting would start. And by the time F-Yard arrives to the incident location, it will be ready for docking and repairing the damaged ship. For vessels up to 5000 DWT, the F-Yard main function, is to be utilized in case of emergency. However it will be capable for covering class survey, in order to cover the market needs for it. The arising problems such as lay-offs, restructuring and environment legislation …etc. require, a balanced solution which enables adaptation of: talent management and competitive production tools, during the huge undergoing changes in its backbone structure. Proposed approach and solutions will be illustrated as a whole docking support system. In addition a case study of a real accident for a tug boat with a tanker in Ahamdi Port

**12.30-13.30** **LUNCH**

International Conference

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