Shipboard Weather Routing – Operational Benefits

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Introduction

Containerships have seen an enormous growth in size in the last decade. Today, the largest containerships in service can carry up to 14,000 TEU, whereas ten years ago about half this capacity was the limit. In spite of the global financial crisis this trend due to the economy of scale effect, is assumed to continue. This rapid growth entails substantial demands on ship navigators because the feeling and visual perception for a huge and sluggish ship in heavy seas diminishes. Therefore, the common practice to steer the ship based on estimated ship responses and weather forecast information, seems to be too risky. More reliable information for the navigator on how the ship responds to wind and waves is required.

Shipboard Weather Routing

Easy-to-handle systems aiming to support the navigator's decision process are thus desirable and various Shipboard Weather Routing (SWR) type systems were developed in the last years. Principal objectives of SWR systems are to reduce the risk of crew injuries and to avoid claims caused by hull damage and cargo damage or even loss of cargo. In view of soaring fuel prices, there is an obvious demand for practical guidance to reduce fuel consumption in waves. Reduced emissions of CO_2, NO_X and SO_X are a welcome side effect.
Characteristic features of SWR systems are that they are installed onboard and that either shipboard computed or shipboard measured ship responses are monitored. So-called conventional hull response monitoring systems merely make use of shipboard measured data, whereas more advanced SWR systems process weather data comprising wind and seaway information to continuously compute the ship's response during the voyage. SWR systems provide decision support for the navigator regarding optimum speed and course based on limit values for relevant ship response. Furthermore, forecasted weather information is processed onboard to enable active planning of the route, briefly called routing. Summarising, the core motivation for merchant ship owners to invest in SWR systems is to enhance the ship's and crew's safety at sea and to gain operational benefits by reducing repair times, less cargo claims, and reduced fuel expenses. The North Atlantic wave climate according to IACS Rec. 34 contains 70 percent seaways of significant wave heights less than four meters. Operation in these milder seaways is primarily of economic interest, whereas operation in seaways of significant wave heights above four meters is considered more safety relevant.
By installing an SWR system, owners and operators of ferries and passenger ships can take advantage of increased comfort onboard in severe seaways. This can be achieved by changing course or speed, and thus reducing the ship's motions in waves.

Class notation for hull response monitoring systems

At the last Shipbuilding Machinery and Marine Technology trade fair 2008 in Hamburg Germanischer Lloyd (GL) presented new structural rules for containerships, and industry asked for a dedicated class notation for hull response monitoring systems at several occasions. Therefore, a new class notation for different system types, addressing individual technical features was drafted. In particular, the following notations are listed:

1. HRW for shipboard seaway measurement systems
2. HRM for ship motion measurement systems
3. HRS for hull stress measurement systems
4. HRSRA for advanced shipboard routing assistance system types
5. HRD for voyage data recorders (VDR)

The first four system types must be capable to record the data and display it on the bridge, whereas the primary purpose of VDR systems is to record data for later analysis. The technically most demanding notation is the HRSRA for SWR type systems, because such systems, apart from the monitoring feature, also offer a routing function for voyage planning based on selected ship responses. The seaway information is either gathered by so-called X-band radar wave sensors or by observations for the case of continuous ship response monitoring.
Routing is performed with forecasted seaway data for selected waypoints along the ship's route. Because the ship responses are calculated using the ship's mass information from the loading computer together with data from the shipboard hydrodynamic database and the wave information, independent sensors are to be installed as well to validate these computations. Suitable validation sensors for containerships are, for instance, a six-degrees-of- freedom gyro, a vertical accelerometer at the bow, or two strain gages mounted on deck stringers portside and starboard side. Examples of HRSRA type systems are the SeaScout Basic without the wave sensor and validation sensors and the SeaScout Premium from Ms Logistik Systeme.

Fuel consumption module

There is a strong tendency that today's SWR type systems are, or will be, further upgraded with fuel consumption modules to save fuel expenses. Because seagoing ships most of their time operate in waves, the largest contribution of the total resistance can be attributed to the added resistance in waves. Thus, just assessing the ship's efficiency in calm water is too short-sighted. Added resistance primarily depends on the hull form and draft, wave amplitude and wave length, the wave heading and the ship's speed. Tank test data from MARIN in the Netherlands for a postpanmax containership revealed that the added resistance is highest in head waves with a wave length about the ship's length. For a wave of one meter amplitude about 30 percent of the calm water resistance is reached in this case. If the added resistance is assumed to depend on the square of the wave amplitude, 1.2 times the calm water resistance results. This example highlights the potential saving potential that can be realized by considering effects of added resistance in waves. Therefore, SWR type systems that monitor the seaway are capable of providing profound assistance regarding optimum speed and course in waves.

Conclusion

Today's large ship dimensions call for SWR navigational aid and, therefore, respective class notations for such shipboard systems are currently under development at GL. Conventional purely sensor based systems and more advanced routing systems will shortly be classifiable. It must be emphasised that the young SWR technology still undergoes extensive development. Few systems can offer fuel consumption modules today, for instance. Because SWR type systems process hydrodynamic databases that are calculated with potential theory based seakeeping codes, a method is required to accurately calibrate roll affected ship responses. Purchasable wave sensors based on X-band radar technology still have substantial shortcomings regarding disturbed signals in either stormy weather conditions with sea spray or in heavy rain. However, the last years have shown that the SWR technology is maturing to meet the high reliability criteria regarding handling and robustness of these systems. Thus, SWR is considered an inevitable tool to enhance the ship's safety during its operational phase.

Helge Rathje is head of the Department Analysis of Hull Structures and Damages at GL. Before joining GL in 1994, he worked for MAERSK Shipping Line as a freight coordinator in Hamburg. His technical background primarily comprises seakeeping analysis and statistical evaluation of wave loads and ship motions. He is responsible for rule development of ship loads and structural strength and the assessment of rule related ship damages. He was GL's representative in the former IACS AHG on Wave Data and Sea Loads and chaired the group from June 2002 until its termination in December 2004. Currently, he represents GL in the IACS Common Structural Rules Load Harmonisation Team.