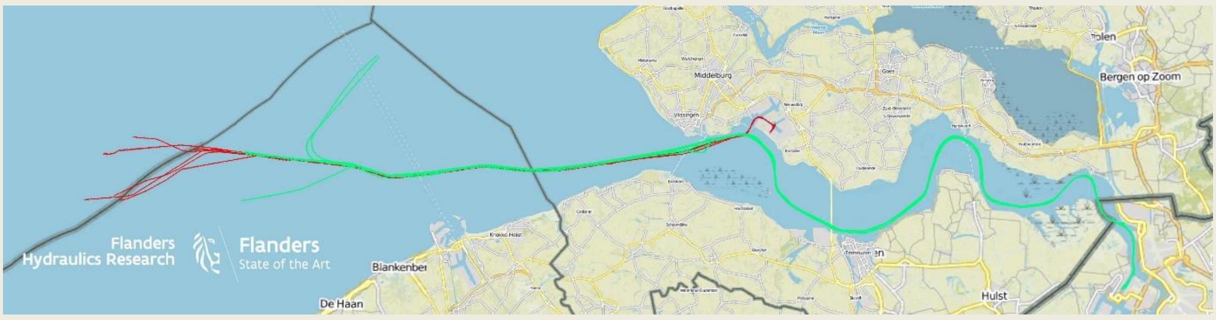
This is the 44th newsletter of the *Knowledge Centre Manoeuvring in Shallow and Confined Water*, which aims to consolidate, extend and disseminate knowledge on the behaviour of ships in shallow and confined water. In this newsletter, we bring an item on a series of full scale measurements that were carried out on Ultra Large Container Ships sailing to the port of Antwerp.

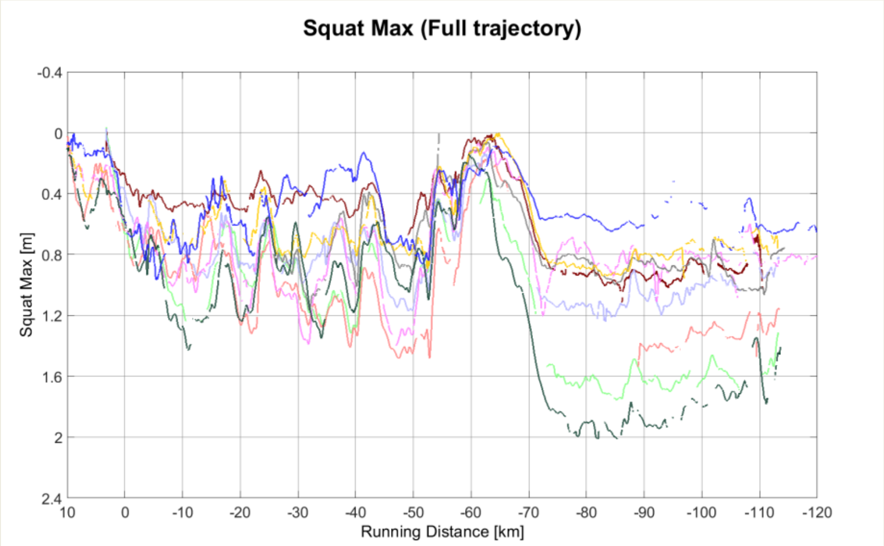


Shipping traffic to the Belgian and Dutch ports located at the Western Scheldt estuary and on the river Scheldt follows an access channel of which the depth is restricted. As a result, deep-drafted vessels, or so-called marginal ships, cannot always sail 24 hours a day. The period in which these vessels may proceed inbound or outbound is called the tidal window. The Common Nautical Authority (CNA) calculates these tidal windows and gives permission for the vessels to proceed. As mentioned in our 17th newsletter and in our 27th newsletter, the CNA is in the process of adopting a probabilistic access policy to determine the tidal windows. In a probabilistic calculation, the assessment whether or not it is safe to sail a given trajectory is mainly based on the probability that the vessel will touch the bottom, which requires an accurate prediction of the ship motions.

In order to gain information on the vertical motions of marginal ships, a measurement campaign was conducted in 2015-2016 on 8 inbound Capesize bulk carriers to the Port of Flushing. In 2018-2020 a second measurement campaign was organised, which focused on outbound Ultra Large Container Ships (ULCS) from the Port of Antwerp. Unlike the Port of Flushing, which is located at the mouth of the Western Scheldt, the Port of Antwerp is located upstream of the Western Scheldt. The shipping routes to Antwerp combine a wide and exposed coastal trajectory with straight fairways and a confined riverine trajectory presenting important curvatures.

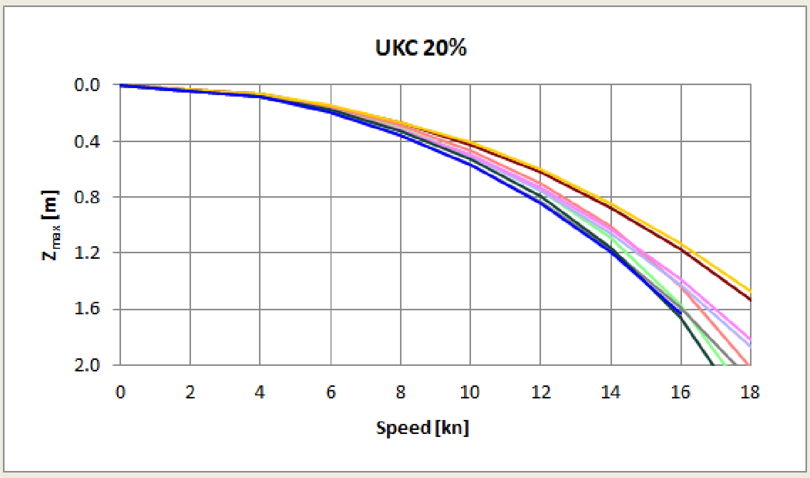
A total number of 9 full-scale measurements on ULCS to the Port of Antwerp were performed. 8 of the vessels were sailing outbound. The dimensions of the ULCS varied between 366 m and 400 m in length and between 51 m and 59 m in breadth. The mean draft of the vessels was ranging between 10.0 m and 15.1 m. During the full-scale measurements, the motions of the vessel were measured in 6 degrees of freedom and the application of rudder and propeller was monitored using synchronised photo-cameras. The full-scale measurements were performed by the Flemish Pilotage and the data were provided to Flanders Hydraulics Research (FHR).

FHR together with Ghent University analysed the measurement data and combined the ship measurements with a full reproduction of the environment including bathymetry, tide, current, waves, density and AIS. A thorough analysis was performed in order to rely the different vertical motions to the determining parameters. The research focused on the analysis of squat and roll motion as these motions proved to present the most important vertical motions.

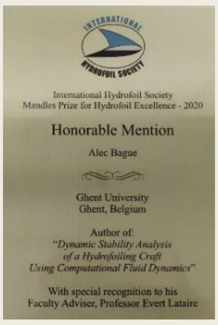


Squat motions were obtained by subtracting the steady heave and pitch motion of the vessel from the reproduced water levels and by performing a correction for draft variations due to changing water density. The squat motions of the ULCS revealed large variations which was partially related to the different operational conditions, such as speed and water depth, but also to the different designs and loading conditions of the vessels.

In order to distinguish the squat behaviour of the different ULCS, a formula for maximum squat was derived for each of the vessels.



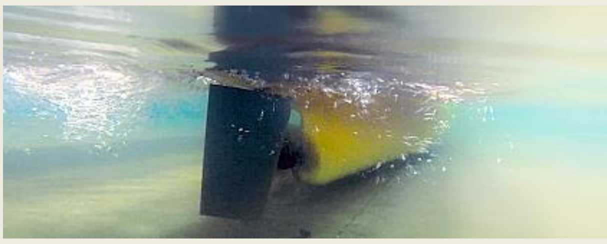
Roll motions on the Western Scheldt revealed to be a very dynamic phenomenon, mainly depending on the transverse stability of the vessel on the one hand and the roll moments induced by turning, rudder actions and wind on the other hand. The dynamic roll motion due to rudder actions in particular revealed to be a very significant effect. For some vessels the roll angles on straight trajectories due to rudder applications (with rudder variations close to the natural roll period of the vessel), were larger than the roll angles in bends. A dynamic roll formula was derived for each of the vessels, simulating the effects of rudder angle, turning (and wind). The formula was applied to a standard manoeuvre corresponding to two consecutive bends with an intermediate straight trajectory and the motion characteristics were evaluated. An example is shown on the website. Large variations in unsteady roll motions are believed to be related to differences in both the roll stability and damping and the design of rudder, propeller and hull of the vessels.



Researchers associated will present a paper entitled “Typhoon: a vortex-lattice code for assessing dynamic stability characteristics of hydrofoil crafts” at the 26th International Virtual HISWA Symposium, which takes place on 16-17 November 2020.

In addition, Alec Bagué has been awarded Honorable Mention in the 2020 Mandles Prize for Hydrofoil Excellence for his paper “Dynamic Stability Analysis of a Hydrofoiling Craft Using Computational Fluid Dynamics”.

The 6th MASHCON conference will be held in Glasgow from 22 to 26 May 2022 and will have a non-exclusive focus on port manoeuvres, where several shallow and confined water challenges are present. A lot of these manoeuvres occur in the vicinity of moored ships, leading to passing ship effects on moored ships.



As mentioned in our previous newsletter, we released a new set of benchmark data containing selected model test data which were obtained during the PESCA (Passing Effects in Shallow and Confined Areas) captive model test program, which was executed in the Towing Tank for Manoeuvres in Confined Water at Flanders Hydraulics Research. The captive model tests present results with the

KCS as passing ship and a Neo-Panamax container carrier and an Aframax tanker as moored ships. The benchmark data and accompanying explanatory paper have been updated to include the ship models in numerical form and are available upon simple request.
The 6th MASHCON conference is organized jointly by the University of Strathclyde, Ghent University and Flanders Hydraulics Research.

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