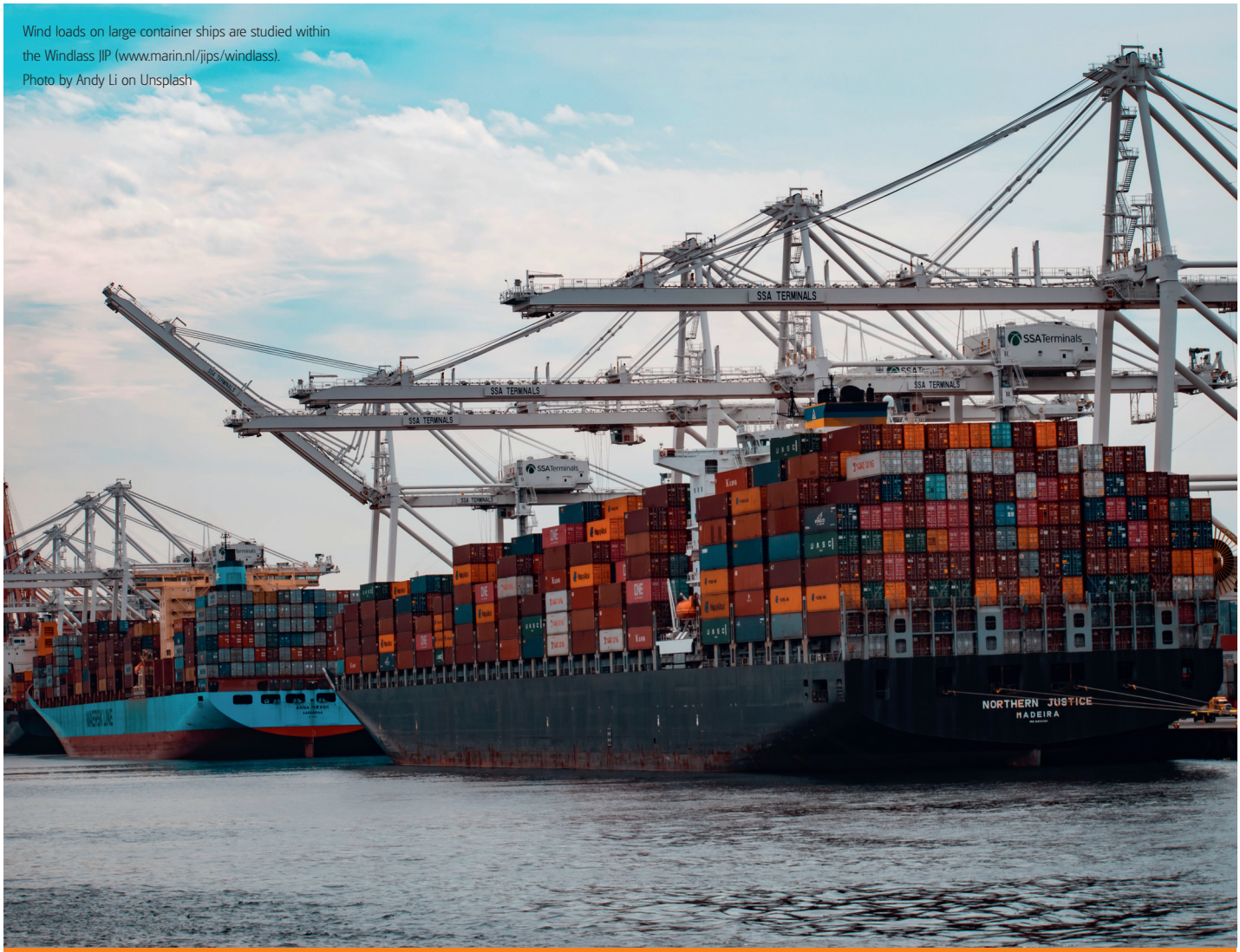

Wind loads on large container ships are studied within the Windlass JIP (www.marin.nl/jips/windlass). Photo by Andy Li on Unsplash

Examining the importance of hydrodynamic interaction

When a ship enters a lock or passes under a narrow bridge, the hydrodynamic effect is obvious, but hydrodynamic interaction also plays a role in canals, fairways and port areas. The increase in ship sizes stretches the safe use of existing infrastructure.

When large vessels and a restricted fairway are combined with a fast sailing speed, for instance due to high winds, this can lead to dangerous situations. An official report into the grounding of the Ever Given in the Suez Canal hasn't been published yet, but experts suggest that hydrodynamic interaction effects between the ship and canal banks have played a major role.

Yangtzekanaal study

Hydrodynamic interaction is also an important factor for sailing vessels in encounter and overtaking manoeuvres in confined waters. Ship-ship interaction has been included in a real-time simulation study for the approach to Eemshaven/Emden where fast-sailing car carriers were overtaking slower sailing ships. More recently, encounter manoeuvres in the Yangtzekanaal in the port of Rotterdam were studied. This 570 m wide port basin is used for two-way traffic by ULCSs. Using real-time simulations, the possibilities and restrictions for such encounter manoeuvres in strong winds were investigated. The available width is significantly less than the total width as one side of the basin features a container terminal, while the opposite side is used by waiting inland barges. The two ULCSs do not have the full width available as they must keep sufficient distance at the sides to limit the forces and motions caused by hydrodynamic interaction from both the moored vessels.

CFD & Dynamic mooring analysis

The interaction forces and the motions of the moored ship are smaller when the passing ship is at a larger distance and sailing at a lower speed. Passing distances which are too close or too far would hamper port accessibility. The required distance and permissible speed of the passing ships needed to keep motions within the limits to allow safe

operations can be determined using CFD and Dynamic Mooring Analysis (DMA). CFD calculates the hydrodynamic interaction forces on the ships and DMA is used to compute the response of the moored ship. Thus including hydrodynamic interaction in both manoeuvring simulations and DMA strategies for optimal use of the existing infrastructure could be developed.

The trend to increase the size of ships means that hydrodynamic interaction is relevant in more and more situations, but all the tools are available to include this aspect when designing infrastructure or developing operational procedures.

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Clear hydrodynamic interaction: a ship entering the lock in IJmuiden. Photo by Arjan van den Berg on Unsplash.

construction vessels are also interesting. The operational profile of these kinds of vessels is very different compared to other vessels which makes optimising the hydrodynamic design sometimes challenging."

Ever-growing vessels One of the most important developments in the infrastructure market that MARIN helps its clients to address is the ever-growing size of vessels. "In container shipping especially, the size of the ships has increased considerably over the last decade. The ultra large container carriers are mainly used on the routes between East Asia and Europe, but the effect is that the slightly smaller vessels are transferred to other routes. This requires port infrastructure that is adequate to receive these larger vessels. Sometimes it is possible to receive the larger vessels within the existing infrastructure, but this may only be feasible in milder conditions."

Though an official report is not yet available, it seems that the recent incident in the Suez Canal is an interesting example of this problem of increasing ship sizes, Johan says. "I understand it happened in strong winds and though the Canal has been widened several times, it may not be adequate for the largest vessels in all conditions anymore."

Other interesting developments are autonomous ships and alternative fuels. The first is still in its early stages and it is unclear what impact this may have on port operations, but some tests have already been carried out involving controlling a tug from a desk in an office, he explains. The latter may require other bunkering infrastructure. "LNG is the forerunner in this respect: LNG bunkering vessels are being developed which require new berths for loading. There are inspiring examples of ships for wind-assisted propulsion, but when entering ports, such vessels may require more space because of the larger wind forces."

Looking over the horizon When considering what the main challenges are for the infrastructure sector, Johan laughs, adding that one of the challenges is the horizon! "When you build new infrastructure, it will be there for decades. This means that it still needs to function properly 25 – 50 years after it has been built. Therefore in the design stage you sometimes need to look over the horizon and make an educated guess of what ships may be using the port or waterway for decades later on."

"In the design stage you sometimes need to look over the horizon and make an educated guess of what ships may be using the port or waterway for decades later on."

For the design of the Maasvlakte 2 port extension project in Rotterdam, MARIN did the first simulations in 2000 with container vessels of 387x57 m, with the largest vessels at that time about 346x43 m. "However, when the first container terminals were opened, the largest vessels were already around 400x60 m. The difference is not that large, but if the increase in size continues in the next 30 years, new port basins may be required unless these larger vessels are handled at fixed or floating infrastructure in the coastal area."

Cooperation within the sector is also important for developing new technology, he says. In the Infrastructure market, examples include the ROPES and Windlass JIPs (www.marin.nl/jips). In the ROPES JIP, the forces and motions of moored ships were measured when ships were passing to improve and validate numerical tools that are used for the design of moorings. Windlass aims to better understand the 3D wind field in ports and waterways and to develop a practical tool to predict the wind loads on ships, taking into account the effects of buildings, cranes, container stacks and other obstacles. MARIN cooperates with port authorities, consulting engineers and other research institutes to improve the tools that are used in the design of port infrastructure in these JIPs.