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A SOLUTION FOR PORTS AROUND THE WORLD: FORECASTING THE MOTION OF MOORED SHIPS

A vessel motion forecast tool

Addressing a problem and fulfilling a market demand

Winds and waves cause vessel motion that affects port operations

Some 13 000 ships enter South Africa's eight ports annually. These ports process some 10 000 containerised loads per day. Many industries rely on imports and exports via the country's ports, where a safe port environment, with minimal disruptions while loading or offloading cargo, is critical.

Delays at ports, caused by weather events and uncontrollable environmental factors such as wind and waves, are common and have far-reaching impacts. Ports around the world face these factors, which impact their operability and interrupt operations. The motion of moored vessels can contribute to operational hindrances and downtime of the port. It can also result in the breaking of mooring lines during larger environmental events.

One of the main contributing factors to mooring problems is long-period waves. These waves result in varying ship motions at the berths inside a port, making it difficult for port operators to predict the impact of the resulting ship motions. Solutions to manage the impact of long-period waves on moored vessel motion can be very costly and often involve making structural changes to the ports or adopting specialised mooring systems.

Downtime at ports can be reduced with proper port planning and strategies such as where, when and what size vessels can be moored safely for optimal operational conditions.

The technology on offer

A vessel motion forecast tool

A new CSIR-developed tool can predict the motion of moored ships in a port, for both current wave conditions and forecasted wave events, contributing to operational efficiency and port safety. First tested in the Port of Ngqura, northeast of Gqeberha in the Eastern Cape, South Africa, the tool can be set up to be port specific and can be integrated into most existing infrastructure.

The vessel motion forecast tool helps with the management of mooring and long-period wave problems at ports. Predicting the effects of long wave events on moored ships can be challenging for port operators, but the CSIR-developed tool allows them to readily assess the impact of long-period waves on particular vessels at specific berth locations inside the port, removing any guesswork. This is achieved by linking numerous state-of-the-art numerical models, enabling the modelling of complete long-period wave climates and the resulting moored ship motions.

The CSIR has been providing long wave forecasts to the ports of Ngqura, Cape Town and Saldanha Bay for many years, and although this system has been proven to work well, the impact of these long-period waves on moored vessels at the respective ports has not been quantified. Recent experience has highlighted the fact that port operators are unable to readily assess and quantify the impact of long-period waves on a particular vessel based on the forecast alone. Although the port operators might be aware of a long-period wave event on the horizon, they are unable to determine what, if any, effect this will have on port operations. From the prevalence of adverse wave activities experienced at ports, a clear international opportunity for the creation of this tool has been developed from mature capabilities.

Value proposition and competitive advantage

Beating the variables to minimise wave disturbance at berths

The interaction between long-period waves, port geometry and moored ships is complex and to accurately predict or forecast long-period waves, numerical models are implemented. The downside to only having a long-period wave forecast is that it only gives the wave height at specific locations, and it does not provide an indication of moored vessel impact. The wave patterns are generally different for all berth locations, and ship motions are also impacted by factors such as ship size and the loaded state of the ship, resulting in only experienced port operators being able to determine the impact of the long-period wave forecast.

The system is innovative in the way it links various numerical models to perform in unison in an automated process to transform available offshore swell wave data to accurate long-period wave-induced moored vessel data. This is enhanced by a unique user-interface display that identifies potential problems per berth and vessel size at a glance.

The tool consists of a long-period wave and moored ship motions forecast. Different port clients will be able to access the application via a user interface without having to understand the underlying computational model and CSIR-developed algorithms. The tool predicts moored ship motions for various class ships at certain berth locations and a prediction is given for the current wave condition, including any detected forecast wave event that could be of concern. The predicted vessel motions are linked

A moored ship at the Container Terminal in the Port of Cape Town.

Ship-to-shore cranes in service at the Container Terminal in the Port of Cape Town, used to load and unload containers from ships.

to international guideline parameters to determine operability efficiency percentages. The tool also gives an indication of the safety of the moored ship based on mooring force limiting criteria. This allows port operators to establish whether a ship can be safely moored for the current wave conditions, or for any of the detected wave events in the future. Since each ship size reacts differently at each berth location, the port operators can use the tool to do berth planning in the most efficient way for the expected wave conditions.

For system development, info such as port bathymetry, berth layout and ship particulars are required. Measured and forecast wave data are used as input to the system, but this is automated. Measured data is not a requirement, but it does improve the tool's performance. No user input is required once the system is set up.

Market opportunity

Vessel motion: A universal port problem

The system can be implemented at any port where operations and safety are impacted by severe vessel motions.

End users such as the Harbour Master or Port Captain are responsible for the safe operation of vessels entering, berthing and departing ports. The environment is challenging, and weather and human error are the main contributors to incidents in ports.

When used correctly, the tool will indicate impending events and the effect of these events at particular berths to the port authorities.

The new technology demonstrator was first developed for use by the Transnet National Ports Authority in South Africa but is relevant to any port impacted by severe vessel motions. Entities that make use of ports, most notably cargo owners, ship owners, import and export associations, the insurance industry and underwriters, could all benefit from the tool.

Business opportunity

Better manage berth mooring in a specific port

The vessel motion forecast tool can be licensed via CSIR C^3 and will include:

- Upfront cost to customise the tool for each port, entailing modelling and integration with hardware; and
- Monthly/annual usage fee to be negotiated based on port complexity, number of vessel types and sizes and environmental factors considered.

Investment and return on investment

Reap the benefits from getting an advanced vessel motion forecast tool on the market

The investment amount of R6 million is relatively modest as the tool has been developed from mature capabilities. The investment is required for the tool to become a standalone tool; additional modelling to cover other port features; and environmental factors; and marketing activities to secure uptake of the tool.

Milestones and timelines

Additional modelling, and changes to the algorithm and user interface of the tool to incorporate the effect of other environmental forces on vessels, such as wind and swell waves that penetrate a port, are estimated to be completed in the first year. Development of a platform that makes it possible for the tool to independently run from other systems is estimated to be completed in year two.

A team of experts in numerical modelling and port infrastructure

CSIR scientific, engineering and technical staff in coastal engineering and port infrastructure are suitably equipped to cover the specialist fields directly pertinent to vessel response, ocean monitoring and forecasting. These staff members have over 60 years of combined experience in the sectors of ports and shipping as well as marine and coastal, both locally and internationally.

ENQUIRIES:

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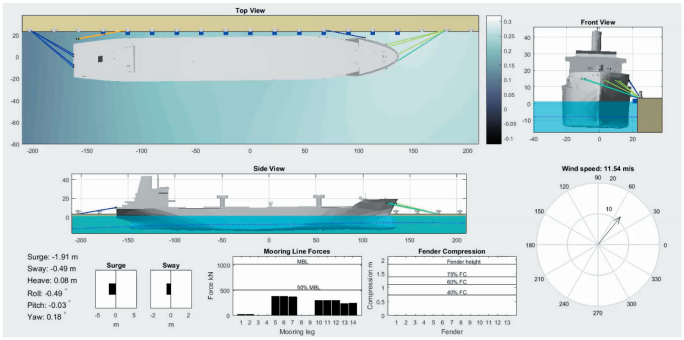

Verifying moored ship motions along the Container Terminal for the implementation of the CSIR-developed vessel motion forecast tool, in the Port of Cape Town, South Africa.