Safe on all seas

High-precision sensors from ASC provide important information for ship designers

The Marin research institute in Wageningen in the Netherlands tests the seaworthiness of ships using scale models. To help optimize ship design, the experiments use data from ASC accelerometers. The sensors also provide valuable services for a hyperloop project. Here, Marin is testing a system for underwater passenger transport in high-speed capsules.

Marin is the third-largest research facility of its kind in the world, after the shipbuilding test institutes in Russia and the US. Some 400 engineers and technicians work every day on making ships and other nautical vessels safer, greener and smarter. The services provided by the private institute are aimed at the likes of ship owners, shipyards and engineering design offices. Miniature versions of ships, submarines or drilling rigs up to six meters in length are tested in a variety of pools under real-life conditions to assess their seagoing behavior. "Here we can create wind and waves and find out how the models behave under these influences," states project manager, Jocco Dekker. Six different test pools are available to researchers, in which they can simulate flow conditions, for example, in shallow and coastal waters as well as on the high seas. In addition, Marin has other test facilities that can be used to test a ship's propellers or engines, among other things. Ship masters can also train on steering ships in simulators.

Sensor data bring design flaws to light

The tests in the pools can provide Marin's engineers and technicians with important information about weaknesses in ship design. These may have a significant impact on safety and efficiency. For example, the fuel consumption of container ships depends on the nature of the hull and the longitudinal position of the ship in the water. On the basis of the data obtained in the tests, Marin develops computer simulations, makes recommendations to shipbuilders to optimize their designs and thus increases the competitiveness of their products.

Maximum accuracy of measurement is essential

However, to be able to use the data for computer simulation, the measurements on the models must be made with the highest accuracy. This is why Marin uses high-precision capacitive accelerometers from ASC. The company from Pfaffenhofen-an-der-Ilm develops and manufactures customized sensor solutions for test and measurement applications. Its engineers know precisely the requirements facing sensors for these applications. They can therefore adapt their measurement technology precisely to the needs of their customers. At Marin they appreciate this kind of flexibility: "It is ideal that the sensors should be configured specifically for us," says project manager Jocco Dekker. ASC's service includes the individual adjustment of the calibration and measuring range, the adaptation of cable lengths and the installation of special connectors.

ASC GmbH | Ledererstraße 10 | 85276 Pfaffenhofen / Germany
Tel.: +49 (0) 84 41 / 78 65 47-0 | Fax: +49 (0) 84 41 / 78 65 47-9 | office@asc-sensors.de | www.asc-sensors.de
Geschäftsführung: Renate Bay | Amtsgericht Ingolstadt | HRB 4084 | Ust-IdNr. DE247900685

Jocco Dekker and his colleagues have also been won over by the short delivery times of ASC and the direct contact with the engineers: "If we have a question, we can reach the experts there quickly." Another big advantage is the possibility of repairing the ASC sensors if ever damage does occur. The risk is relatively high, because the sensors are often installed and removed for the tests and are thus exposed to high stress and strain. "We had to scrap another manufacturer's sensors as soon as their cable was damaged," recalls Jocco Dekker. "With the ASC sensors, we can easily replace the cable and continue to use the sensor."

Sensors can be used even underwater

Marin uses the ASC OS-315LN and ASC 5521MF triaxial accelerometers for its tests, which are highly sensitive and at the same time very robust. The OS sensors are used in the Dutch institute's offshore pools because they have a very good signal-to-noise ratio (7 to 400 $\mu g/\sqrt{Hz}$) and can therefore capture even low frequencies reliably and accurately. This property is important for the tests in this pool, as one of the things tested here is how the ship models behave in fairly calm waters. In these environmental conditions, the acceleration of the model only changes slowly, and the frequencies of the vibrations are rather low. "The signal-to-noise ratio of the ASC sensors is better than the sensors of the competition," states Jocco Dekker. "Not by much, maybe, but every detail matters where the measurements are concerned."

The sensors of the ASC OS-315LN (Low Noise) series were also selected for testing by the Marin engineers because they are IP68-rated, affording protection against continuous submersion and thus ensuring safe underwater use in the tanks. Other advantages include the high sensitivity of the sensors (between 2,000 and 10 mV/g), and the measurement range of between ±2g and ±400g.

IMUs track the exact orientation of the models in space

In the so-called sea-going pools, where maneuvers are simulated on the high seas, 5521-MF (Medium Frequency)-type ASC sensors measure the acceleration of the model nautical vessels. The sensors in this series have a measuring range of ±2g to ±200g, a sensitivity of 1,350 to 13.5 mV/g and a wide frequency range of 0 Hz to 7 kHz. This makes the sensors ideal for the wide spectrum of frequencies (up to 800 Hz) to be measured during the tests. In addition, Marin also uses four Inertial Measurement Units (IMUs) from ASC. They combine accelerometers and yaw rate sensors in one housing. These IMUs are 6-axis systems that measure both linear and angular motion. ASC's IMUs consist of high-precision triaxial accelerometers and yaw rate sensors. They can be used to precisely determine the position and orientation of an object in space.

Marin tests hyperloop system for underwater passenger transport

The most spectacular experimental object in the Marin pools so far has been the hyperloop system from the Dutch firm, Hardt. This is a kind of underwater tube at a depth of about 100 meters, in which passengers should in the future be able to travel from Europe to the east coast of the US. The means of transport features 30-meter-long capsules which pass through the tubes at a speed of up to 620 mph.

In tests running from January to late summer 2019, the experts from Marin wanted to find out what loads the tunnel would be exposed to. Even before the start of the trials it was clear that the tube would move slightly underwater due to the waves. The question was therefore to determine if these movements were small enough to allow the transport capsules with their passengers to pass through the tunnel comfortably and without interference.

ASC sensors provide important data for optimizing design

In order to simulate the planned tunnel realistically, a 140 m-long model was built in one of the pools. The tube was then exposed to the strongest wave movement that can be expected in the North Atlantic. The ASC OS-315 LN sensors provided valuable services in measuring the tunnel movements. Eight of them were mounted on top of the tunnel to provide measurement redundancy and determine the influence of the wave movement depending on the position along the tube model. Due to their high sensitivity, the sensors were able to record tunnel accelerations of a mere 0.1 m/s^2 – the highest value measured on the individual tube segments.

Test results to convince investors

Marin has successfully used the high-accuracy accelerometers from ASC for many years. They make the extremely detailed measurements on the ship models possible. The sensors also played a central role in the hyperloop tests: "With their help we could precisely determine the movements of a floating tunnel," says Jocco Dekker. "Now we are analyzing the data and trying to reproduce the actual experiment in computer simulations." When the evaluations are completed and the results are published, Marin will look for investors for the next stage of the project. The hyperloop system is therefore that much closer to becoming a reality.

Keywords: Marin, Transatlantic Hyperloop, Hardt Hyperloop, ASC GmbH, sensors, sensor technology, accelerometers, Inertial Measurement Units, IMU, yaw rate sensors, gyroscopes, marine tests, marine trials, flow channel, operational strength tests, measurements on ship models, tunnel simulation, acceleration of waterborne models, computer simulation of models, marine test behavior, tests on seaworthiness of marine vessels, ship design

Meta-Title: ASC accelerometers for ship testing

Meta-Description: The ASC OS-315 LN and ASC 5521MF sensors are used by the Dutch research institute, Marin, to test ships in the flow channel.

Links: https://www.asc-sensors.de/produkt/asc-5521mf-kapazitive-beschleunigungssensoren/
https://www.asc-sensors.de/produkt/asc-os315ln-kapazitive-beschleunigungssensoren/
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