Nederland Maritiem Land

Format eindrapportage MIIP		
Datum	:	24 December 2021
Projectcode	:	MIIP014
Projectnaam	:	MarcolXMF tool for collisions between ships and offshore wind farms
Thema Innovatiecontract	:	Winnen op zee, Slim en veilig varen of effectieve infrastructuur
Betrokken partijen	:	Ministry I&W, Rijkswaterstaat, Port of Rotterdam, RH Marine

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Project

Doelstelling project (beknopte omschrijving):

Developments in MARIN MarcolXMF tool in order to perform the collision assessment between ships and offshore wind turbines.

De volgende activiteiten zijn binnen het project uitgevoerd (omschrijving):

MarcolXMF is a simplified tool that uses super-element method to rapidly calculate the dynamic interaction between ship to ship collisions. A new super element developments have been performed in order to extend the capabilities of the tool to be able to perform collision simulations between monopile wind turbines and ship structures.

Theoretical research activities include;

- A new contact algorithm between ship and monopile wind turbine body surfaces has been developed.
- A new super-element for the ship structure that has collision capability with cylindrical surfaces has been investigated and required formulas are developed.

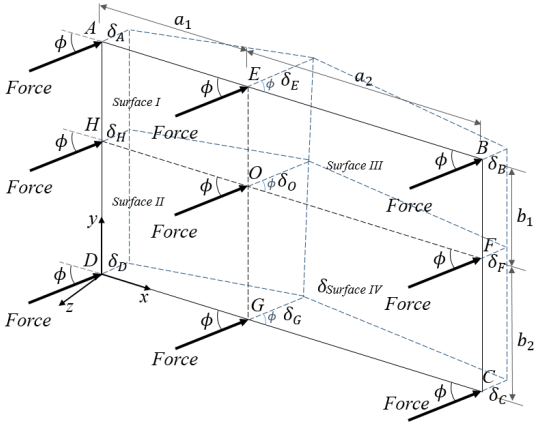


Figure 1 – Description of multi node collision super element

The new super element has now 9 nodes penetration capability and can have higher order plastic response deformations. Element has also oblique collision capability.

Ondervonden knelpunten en daarop ondernomen acties (omschrijving):

During the implementation stage of the multi node super element, some problems have occurred at the old contact algorithm. Therefore existing ship to ship contact algorithm has also been updated to be able to detect the multi node contact between the monopile bodies and ship structures.

Current ship to monopile collision feature has been developed for right angle 90 degree collisions. Although the new multi node super element has the oblique collision capability, contact algorithm have only be checked for right angle collisions so far.

Resultaten (projectinhoudelijk, maar ook m.b.t. rapporten, video's, presentaties, vervolgprojecten e.d.):

After super element implementations and contact algorithm updates have been completed, some verifications have been done.

- Single element verification: One big steel panel which has 8 m to 6 m dimensions and 25 mm thickness value have been modelled and it's collision to a monopile body with 6 m dimension simulated within MarcolXMF. Same simulation has also been modelled and solved in generic non-linear finite element package Abaqus. After required material fine tunings it seen that the results are in good agreement.

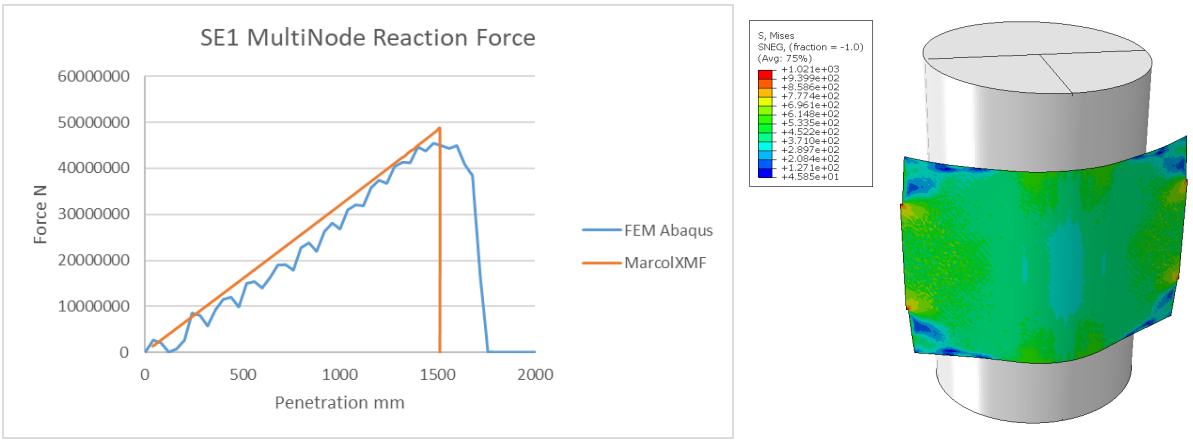


Figure 2 – Super element reaction comparison between MarcolXMF and non-linear FEM analysis

- Ship to wind turbine collision simulations (mid ship collision): 8 MW monopile offshore wind turbine has been modelled as a rigid structure in the tool. A generic passenger vessel with approximately 210 meters overall length has also been modelled as the striking ship. The deformable part of the striking ship consist of 30 meters parallel block which is placed at the mid ship. Deformable ship structure contains 120 new multi node super elements and 140 in plane deck super elements. Deformable body and geometries can be seen in Figure 3 below.

  According to the MARIN report '32091.600-Analysis of ships drifting behaviour at NCP (2017 – 2019)' average drifting velocity from the drifting incidents occurred between 2017 to 2019 is given as 1.7 knots. Therefore ship drifting speed have been taken as 1.7 knots and simulations performed.

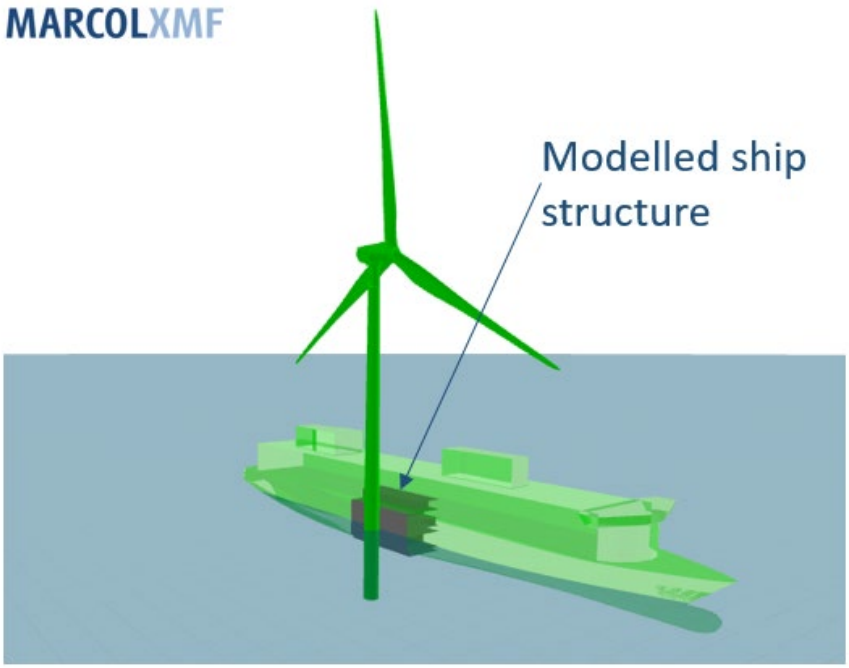


Figure 3 – Collision setup within MarcolXMF

Simulation results can be seen in below graphs. All of the ship's kinetic energy has been absorbed by the deformable structure and therefore 3m of penetration observed. Some of the outer plates have also been ruptured and the ship structure damaged.

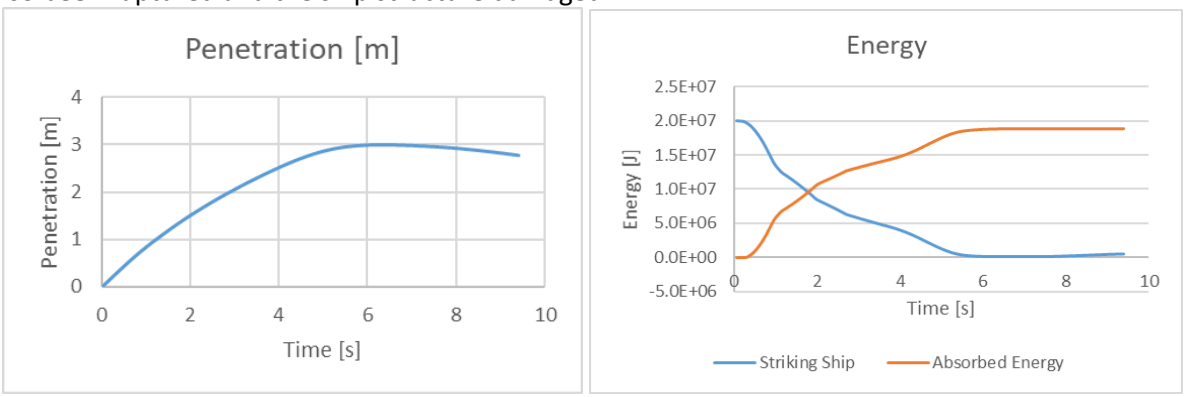
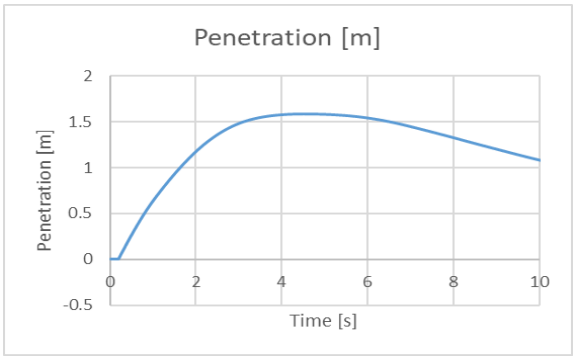


Figure 4 – Collision Simulation results mid ship collision MarcolXMF

- Ship to wind turbine collision simulations (collision at the aft ship): Same setup as above have been reconsidered with the collision point at 50 meter behind the mid ship. So both of the wind turbine and deformable structure have been moved 50 m to the aft.

  Simulation results can be seen in below graphs. Now, the lesser part of the ship's kinetic energy has been absorbed by the deformable structure. Some of the ship's kinetic energy have been preserved as the ship's rotation around the monopile. Therefore now 1.55 m of penetration have been observed. In this case none of the outer plates have been ruptured and the ship structure not damaged.

  A time dependent ship motion can also be seen in Figure 6 below.



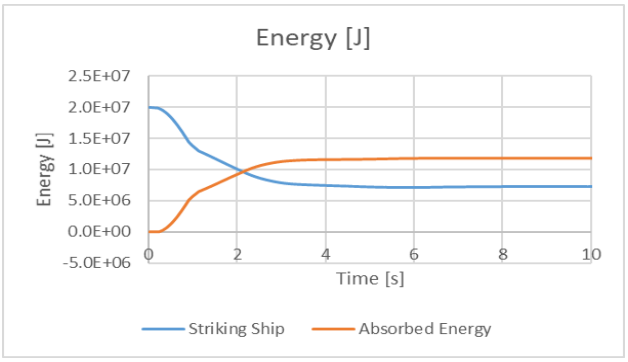


Figure 5 – Collision Simulation results aft ship collision MarcolXMF

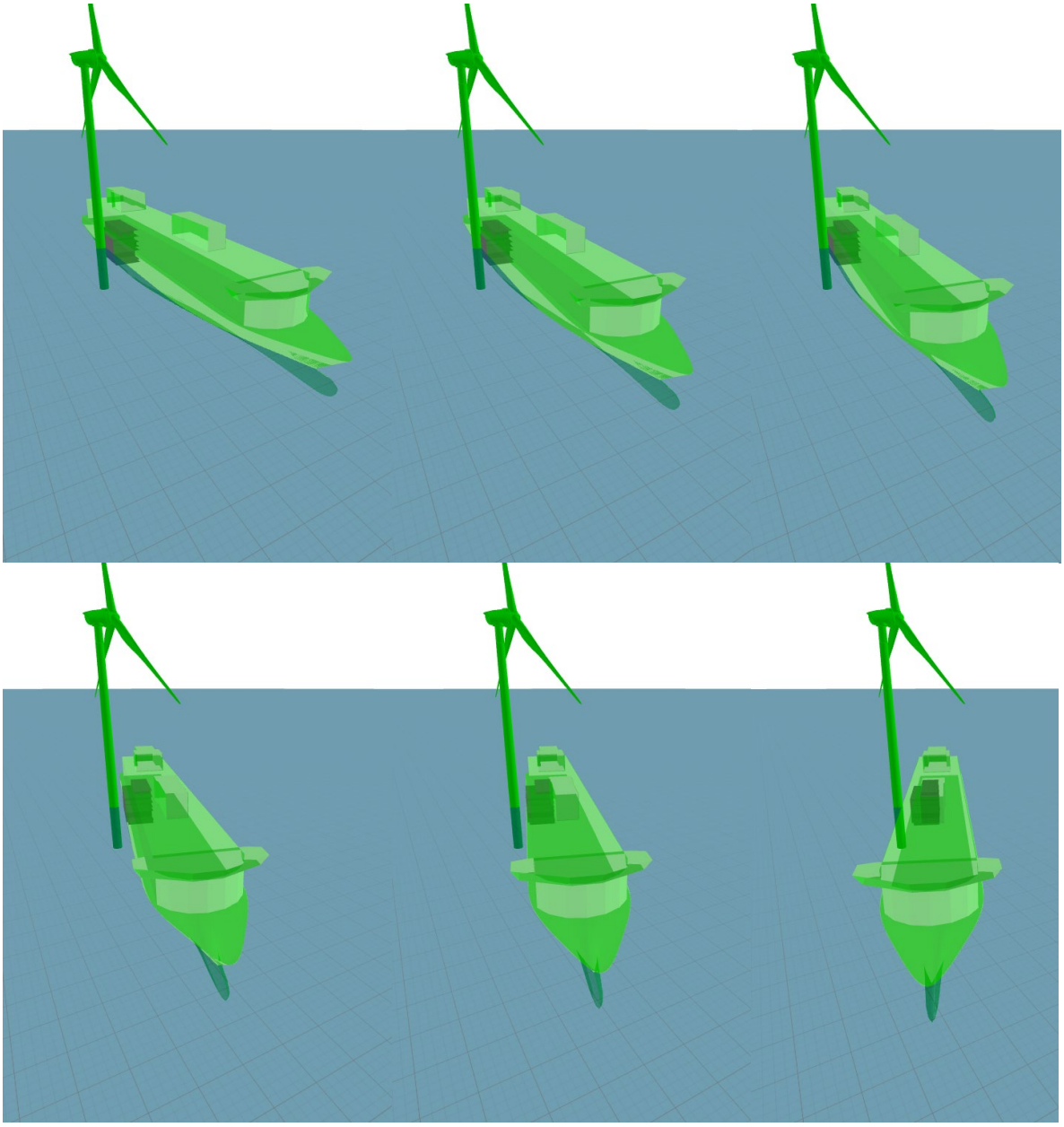


Figure 6 – Collision Simulation in time aft ship collision MarcolXMF

Follow up:

By this MIIP project, it has been shown that the ship to wind turbine collision dynamics can be simulated and damage assessment can be done by the MarcolXMF. Current implementation only consist of rigid monopile structures.

Opportunities for a follow up project have now been investigated. In the possible follow up project, new structural super elements will be implemented to enable modelling of the foundation and the tower structures, including their flexibility while maintaining fast computational time. Therefore deformable ship to deformable monopile collision simulations can be done. Different types of ships (cargo, passenger, recreational, fishing etc.) and several types of turbine foundations will be included. In addition, soil-foundation interactions and wind effects may also be modelled. The tool will be validated against high fidelity computational tools and dedicated experiments.

The next step is to develop a unified software tool by combining SAMSON and MarcolXMF and bring these tools to a new version focused on wind farm collision assessments. SAMSON is also a MARIN tool which is able to predict the number of various (nautical) incidents based on possible dangerous situations that are modelled from the real and future traffic situation and layout of the area.

Waarom was de haalbaarheidsstudie & subsidie nodig:

It was not possible to finance the development of the MarcolXMF for wind turbine collisions without a subsidy. We have now been able to demonstrate that the ship to wind turbine collision dynamics can be simulated and damage assessment can be done by the MarcolXMF. Therefore this will pave the way for new developments and possible projects .

Waar en wanneer is gepubliceerd:

The plans and results have been presented during the progress meetings. The results will also presented in the MARIN Report, a magazine distributed to our customers 3 times a year. Preparations for a scientific paper will also be continuing.

Binnen een MIIP-project moet er sprake zijn van samenwerking, bijvoorbeeld tussen een kennisinstelling en private partijen en/of daarop gericht te zijn. Hoe is dit in dit project geborgd?

The project have been carried out mainly by MARIN. Resulting report will be published and send to the supporting companies for their review and comments.

Financiële Rapportage
Zie Excel bijlage

Bijzonderheden

Geen bijzonderheden.