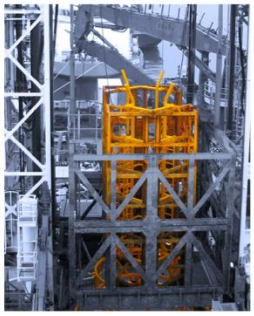
TWD

TEMPORARY WORKS DESIGN BV

YOUR PARTNER IN OFFSHORE DESIGN



Track Record Seafastening.

www.twd.nl

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1 Company

TWD is a dynamic engineering firm specialized in the design of temporary works, structures which facilitate the construction of permanent works. Our thorough knowledge of structural and mechanical engineering, finite element methods, and design for offshore conditions, enables us to develop creative solutions to meet the wide variety of client demands.

Projects range from the design of a piling template used to drive foundation piles for offshore wind turbines, a motion study for an offshore lifting operation, to a parbuckle tool for a salvage project. Flexibility, practicality, and creativity are the driving forces behind each of our designs and our enterprising work ethic.

We offer cost-efficient solutions for the heavy civil, offshore, and salvage industries, specializing in the custom design of:

- Pile handling tools
- Lifting tools
- Seafastening
- Cable handling equipment
- Support structures
- Vessel motion analyses

We are able to assist in each stage of a project's execution, whether it be drafting, engineering, commissioning, or fabrication management. Our talented, international team of mechanical, civil, and maritime engineers is available for your requests.

For more information please visit our website: http://www.twd.nl

Jack-up barge with TWD designed seafastening and upending system

2 Overview of seafastening design services

TWD has performed hundreds of seafastening design projects, including:

- Foundation (mono)piles weighing up to 800mT
- Transition pieces
- Pile driving hammers and cone followers
- Topsides and offshore modules
- Grouting spreads
- Crawler- and ringer cranes with capacities in excess of 1000mT
- A-frames and ROV's for launch and recovery systems
- Cable carousels weighing up to 5000mT and various other cable lay equipment
- Jackets (suction bucket and three-leg pre-piled jacket)
- Wind turbine components (blades, towers and nacelles)
- Salvaged marine vessel

In the sub-paragraphs below, a few of TWD's Seafastening projects are described in more detail. References can be provided upon request.

2.1 Design assistance and site engineering of TLWP installation

TWD assisted Jumbo Offshore with transporting and handing over Tension Leg Wellhead Platform (TLWP) anchoring equipment consisting of 8 foundation piles, 134 tendon segments, and 8 tendon buoyancy modules (TBM). TWD designed and calculated the pile grillage for the 320mT, 103m long piles and assisted Jumbo Offshore in designing the entire installation sequence. This included loading, upending, and offshore hand-over to the client vessel. Furthermore, designs and calculations for the seafastening of the 130mT TBM's were provided.

The Fairplayer jack-up vessel mobilised for TLWP installation

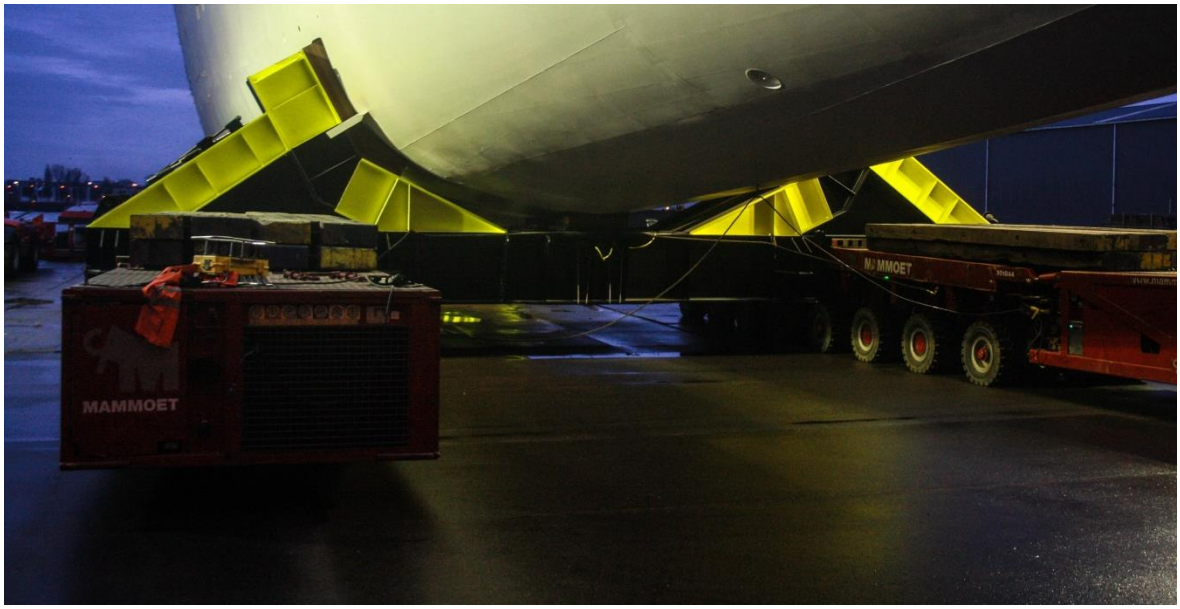
2.2 Metmast seafastening & structural analysis of equipment

TWD was requested by Hochtief AG to design the seafastening of equipment on the JB-114 jack-up barge and the Smitbarge 14 transport barge. TWD was responsible for the motion analysis, structural analysis, and seafastening design of items including the hammer, sleeve, upper and lower metmast, piling frame, teleloader, and various containers. TWD also assisted by drafting the upending and installation sequences.

Metmast installation on the JB-114 jack-up barge

2.3 Cradle support for exclusive yacht

TWD designed and constructed support cradles for Oceanco's large luxury custom yacht. A practical design met the clients design requirements: to enable transportation on self-propelled modular transporters, to support the yacht hull throughout the construction process, and to allow finishing works on the outside of the hull. A hydraulic support was integrated into the 100mT steel construction, ensuring correct distribution of the load and protection of the hull. Wooden CNC milled blocks were placed between the cradle and hull to ensure good shape agreement and even pressure distribution.



Cradle supporting the yacht

2.4 Windturbine seafastening designs

TWD executed seafastening designs for monopiles, transition pieces, anode cages, hydro-hammers and the NMS gripper for GeaSea NV. Two versions of the relatively slim monopile cradles were designed: a small version, suitable for one monopile, and a large version, for four monopiles. The large cradles consist of two levels in which the upper level can be lifted and rotated in order to aid the installation process of the monopiles. Seafastening for the transition pieces was designed with a quick release system for an extra smooth fastening and uncoupling on deck.

Seafastening cradles for monopiles

2.5 Topside seafastening

TWD was requested by Scaldis Salvage and Marine Contractors NV to deliver the seafastening designs for the decommissioned topside and the conductor pipes of the Camelot field, onboard the Ospey Trader barge. Part of the design scope was stability and motion analysis and a bollard-pull calculation. The seafastening designs were carried out in such a way that minimal offshore welding was necessary.

Lifting the topside onto the Osprey Trader barge

2.6 Versatile crane seafastening

TWD designed for Stemat BV a versatile crane seafastening system which is fully reusable and applicable to multiple types of crawler cranes in combination with various barges and ships. It can be installed with little welding to the deck, resulting in a relatively short mobilization phase. Another great advantage is the limited amount of deck space needed for the seafastening; no turnbuckles are required for horizontal seafastening.

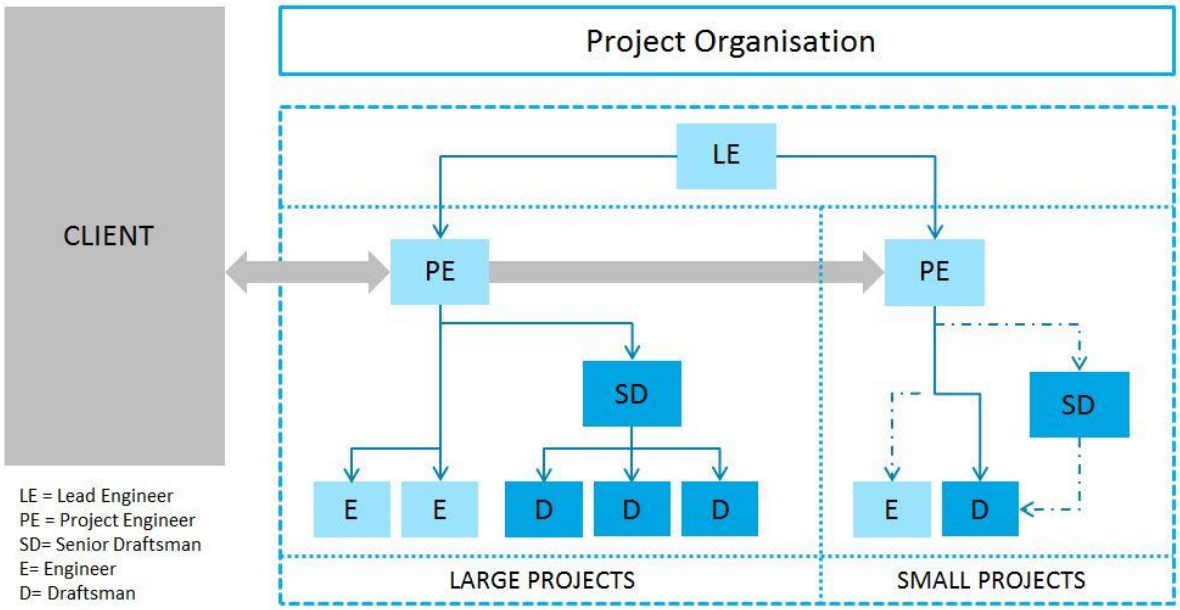
Versatile crane seafastening for Stemat

2.7 Jacket seafastening

TWD delivered a detailed design of jacket seafastening structures for three different barges for transportation from Denmark to Sweden for Royal Boskalis Westminister NV. The load spreading grillage had to be adjusted to the frame spacing. Three jackets were transported per barge, seafastened on custom made T-sections, which reinforced the deck, and a 3.7 m high “table structure” with an opening in the top. The design features easy operatable uplift clamps and a smart decoupled constraining principle to minimize influence on global vessel strength.

Jacket seafastening frame at construction site

3 Organisation



TWD basic project organisation diagram

3.1 Design team

The project engineer (PE) in the TWD project organisation plays the central role and is the primary point of contact for the client. The PE focuses on one single project and guides the complete process from kick-off to detailed design. In this role, the PE translates client wishes into practical, safe, and economical designs. The PE is responsible for budget and planning and supervises the design team of engineers and draftsmen.

The lead engineer (LE) supervises the project team and plays an active role in the design process. The LE oversees the design process, suggests concepts, and performs quality checks on every deliverable. (see chapter 4).

The senior draftsman (SD) is responsible for timely delivery of drawings, revision status, work distribution and planning of the draftsmen. The SD is in charge of the master model and analyzes the sub-assemblies provided by the draftsmen regarding overall function, clashes, and consistency.

3.2 Project documentation

The design team members work in close cooperation and constant communication with each other. For cases in which the basis of design report (BoD) is not sufficient or specific enough, a so called ‘mini-BoD’ will be created stating all requirements, functions, loads, and points of attention for a sub-design.

Decisions made throughout the design process are tracked by the design decision sheet, a to-the-point BoD, easy to update and maintain.

All deliverables (drawings, calculations, and reports) are listed in a document list, including revision and status, and will run through the quality system (see chapter 4).

The project planning is made in Microsoft Project, depicting an overview of deadlines, relations between processes, and capacity planning.

Project hours are electronically registered and can be split per project part. The weekly hour sheet will give a detailed overview of the hours spent per topic, providing a clear detailed overview of the budget status. The project parts to be monitored can be agreed upon.

4 Quality system

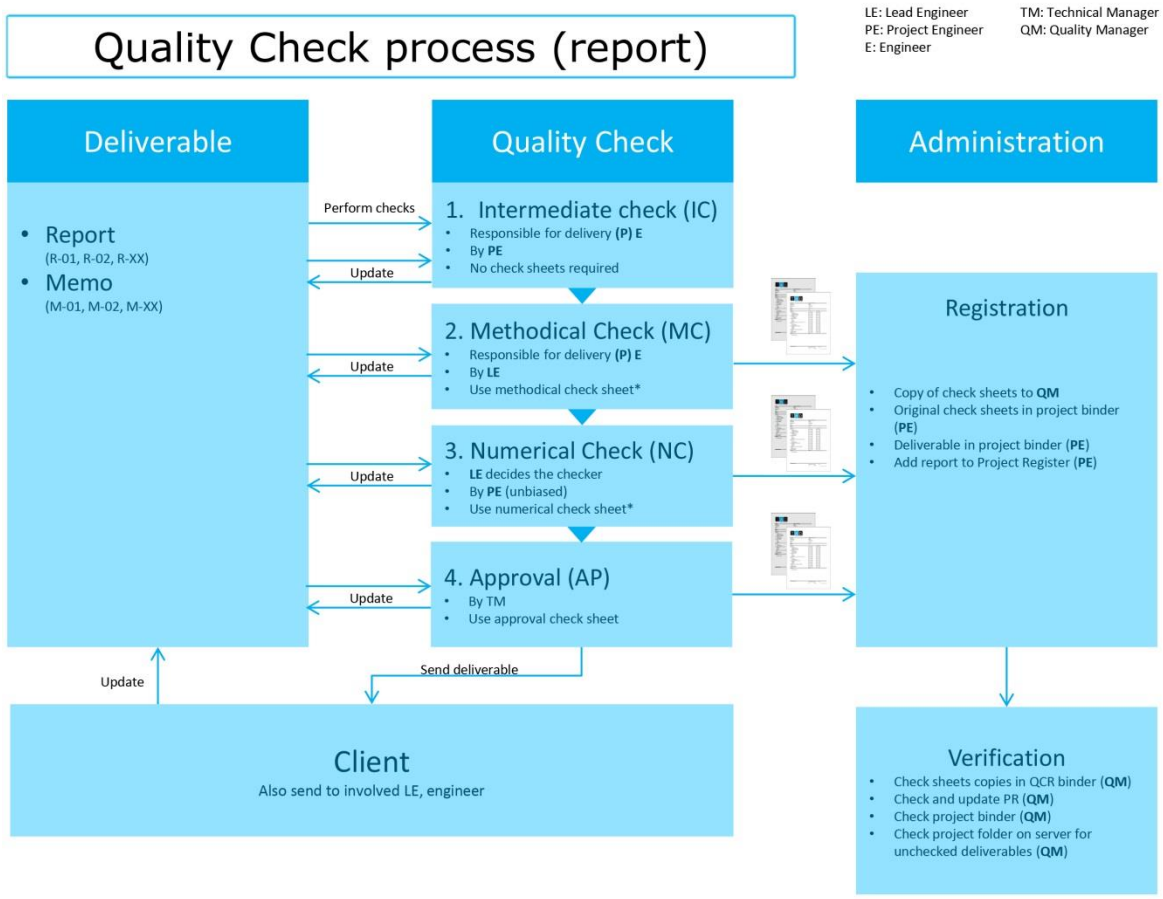
TWD is dedicated to achieve client satisfaction by delivering high quality designs that are practical, safe, and economical. We do this by using a quality management system that provides a framework for our complete design and engineering process.

4.1 Document control and quality checks

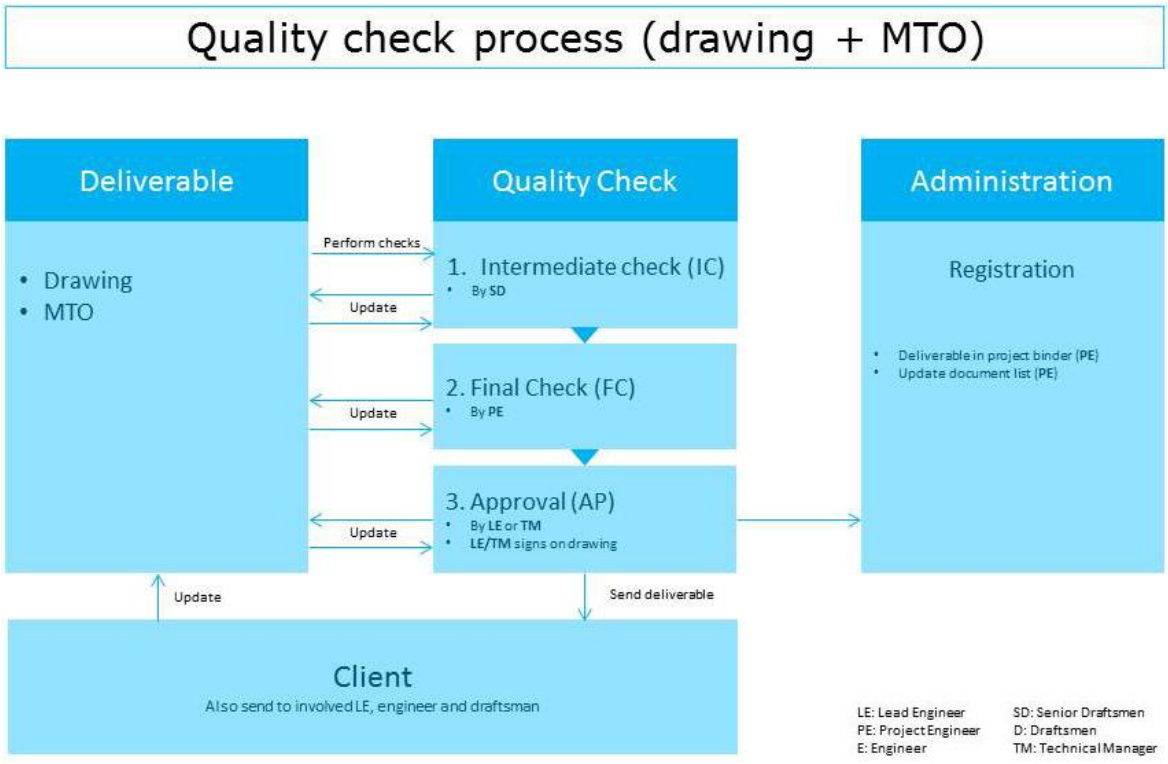
Most of TWD's clients are involved in projects where delay and/or failure is very expensive. Consequently, TWD has developed and implemented thorough quality control systems for calculations, reports, and drawings. Clear file and revision names are used and registered in document lists to avoid errors. Check sheets are used to register the checks performed for every revision of a document. An example flow diagram of the report quality check process used by TWD is shown on page 9.

4.2 Quality accreditation

TWD's designs are routinely reviewed, approved and certified by certifiers including DNV-GL, London Offshore Consultants (LOC), Lloyds Register, Bureau Veritas and ABS.



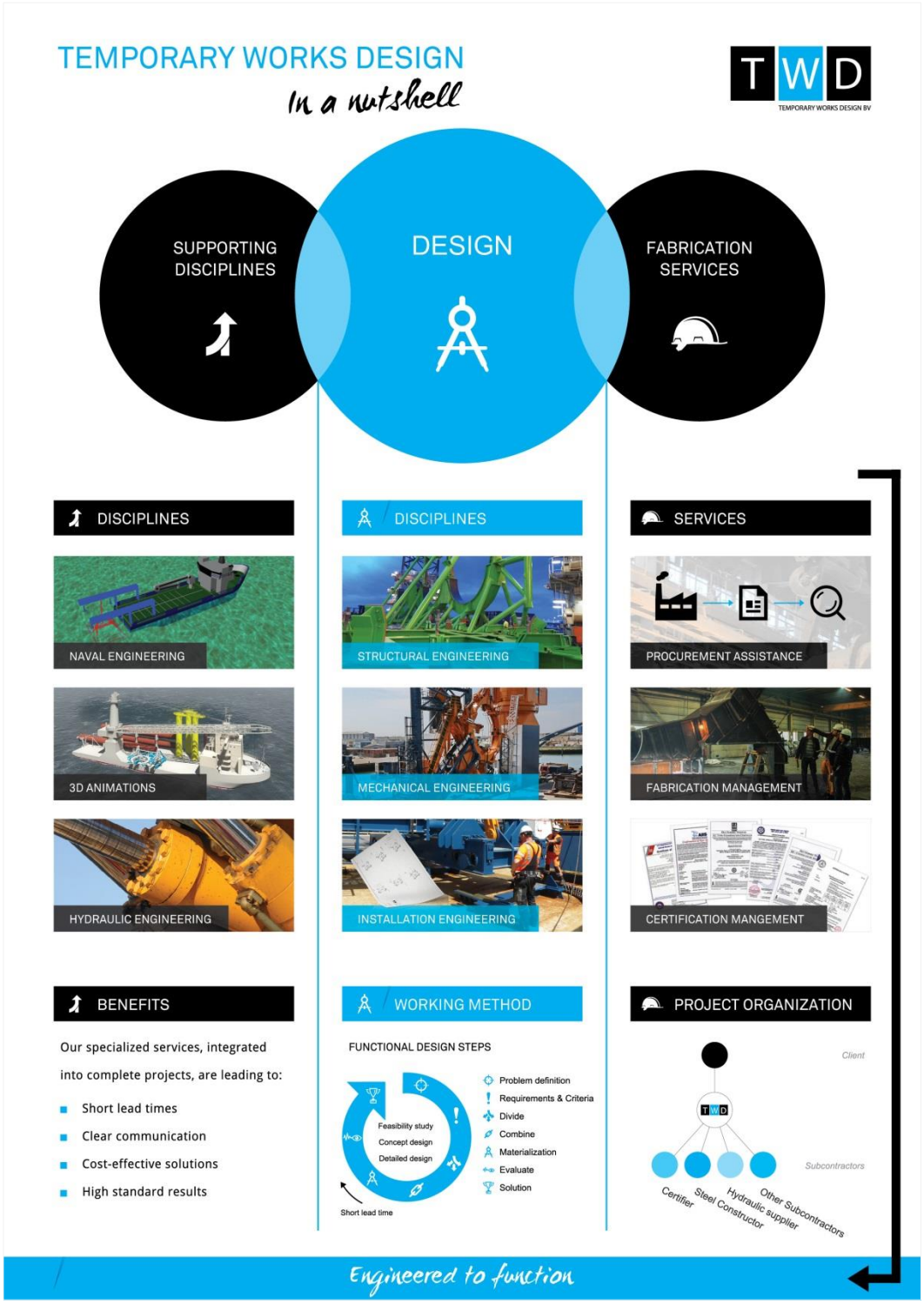
TWD quality check process diagram



TWD quality check process diagram

5 Services overview

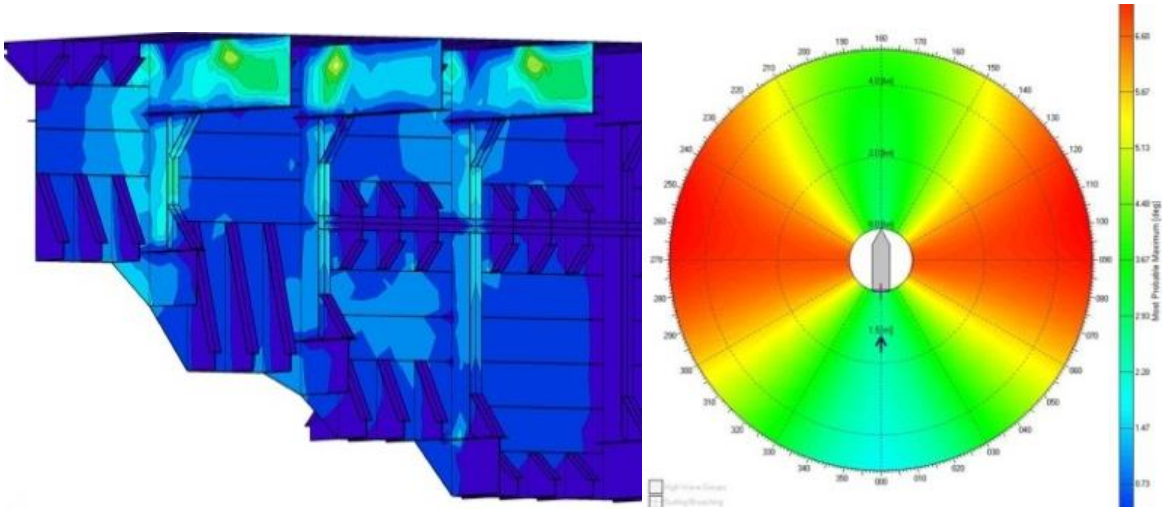
The overview below shows the different services that are offered by TWD. Allowing TWD to manage the entire design process, from drafting to commissioning, will result in short communication lines, a solid project overview, and savings in time and costs.



6 Software

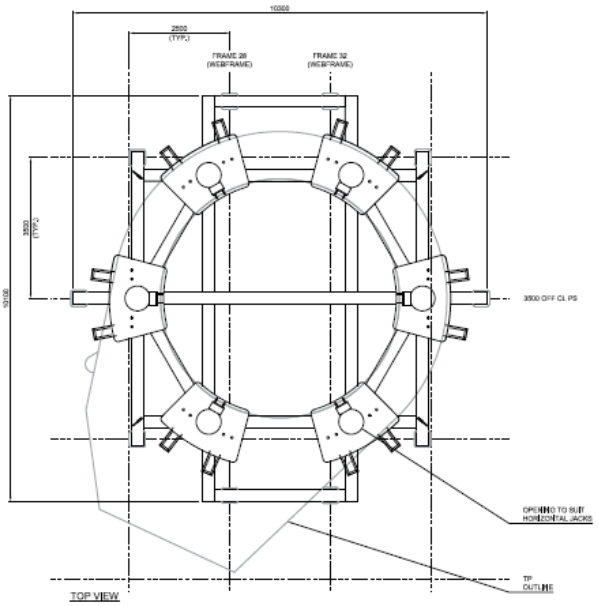
TWD has developed several calculation tools for reliable and efficient calculation of pad- and lashing eyes, kicker plates, current and wave loading, loading capacity of deck constructions, and forces acting on cargo due to vessel motion. Furthermore, the following several widely recognized software packages are used:

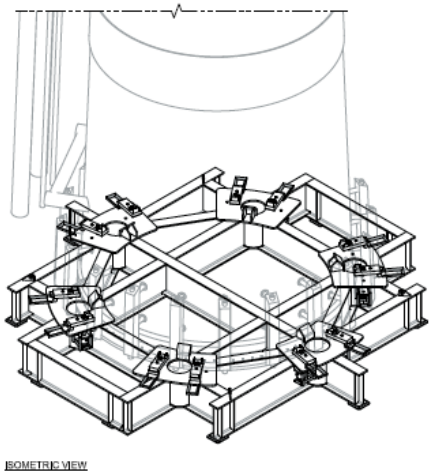
- **Amarcon Octopus**
  Accurately determining vessel motions based on strip theory. By calculating vessel and cargo motions, the resulting seafastening loads can be accurately determined.
- **Autodesk AutoCAD**
  Industry standard 2D- and 3D drafting software
- **Autodesk Inventor**
  Intelligent digital prototyping software developed for mechanical engineering design
- **Delftship**
  Software which allows for fast and accurate hull modelling and hydrostatic analysis
- **Dlubal Rfem**
  Finite element method structural analysis software with 1D, 2D, and 3D analysis capabilities
- **Global Maritime GMOOR**
  Analyses the performance of mooring systems by simulating the station keeping behavior and line tensions for catenary moored vessels
- **Mathworks MatLab**
  Mathematics / programming software with numerous tools for analysis of complex problems and processing of large amounts of data
- **Nemetschek SCIA Engineer**
  Finite element method structural analysis software for 1D and 2D elements. Capabilities include buckling and non-linear calculations. The extensive profile library ensures rapid calculation
- **OrcaFlex**
  Marine multibody dynamics program for static and dynamic analysis of a wide range of offshore systems, including all types of marine risers (rigid and flexible), moorings, offshore installations and towed systems

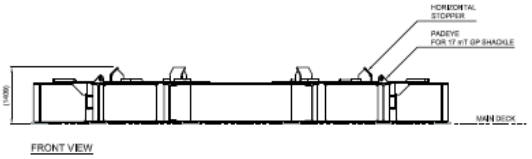


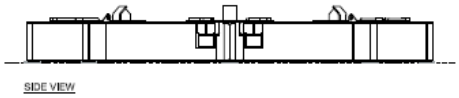
Example of 2D FEM analysis of barge construction (left) and of detailed motion analysis (right)

7 Example of general arrangements of TP seafastening









TYPICAL GRILLAGE (POSITION 3 SHOWN)
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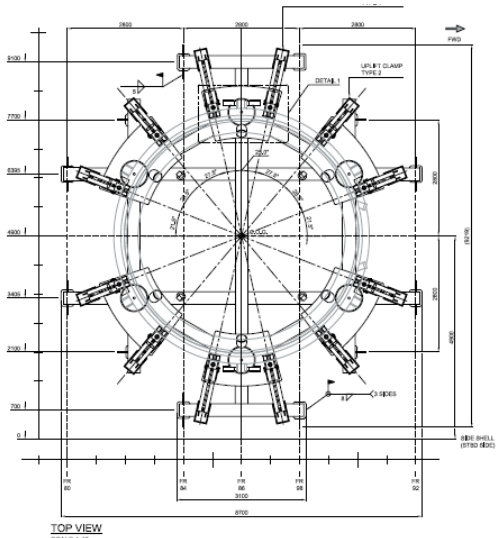

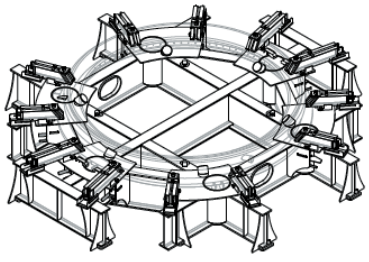

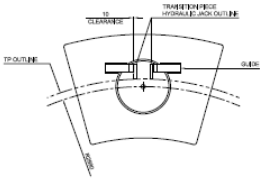

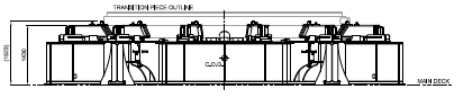

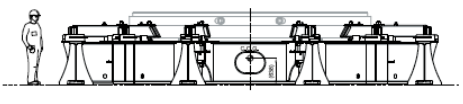

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