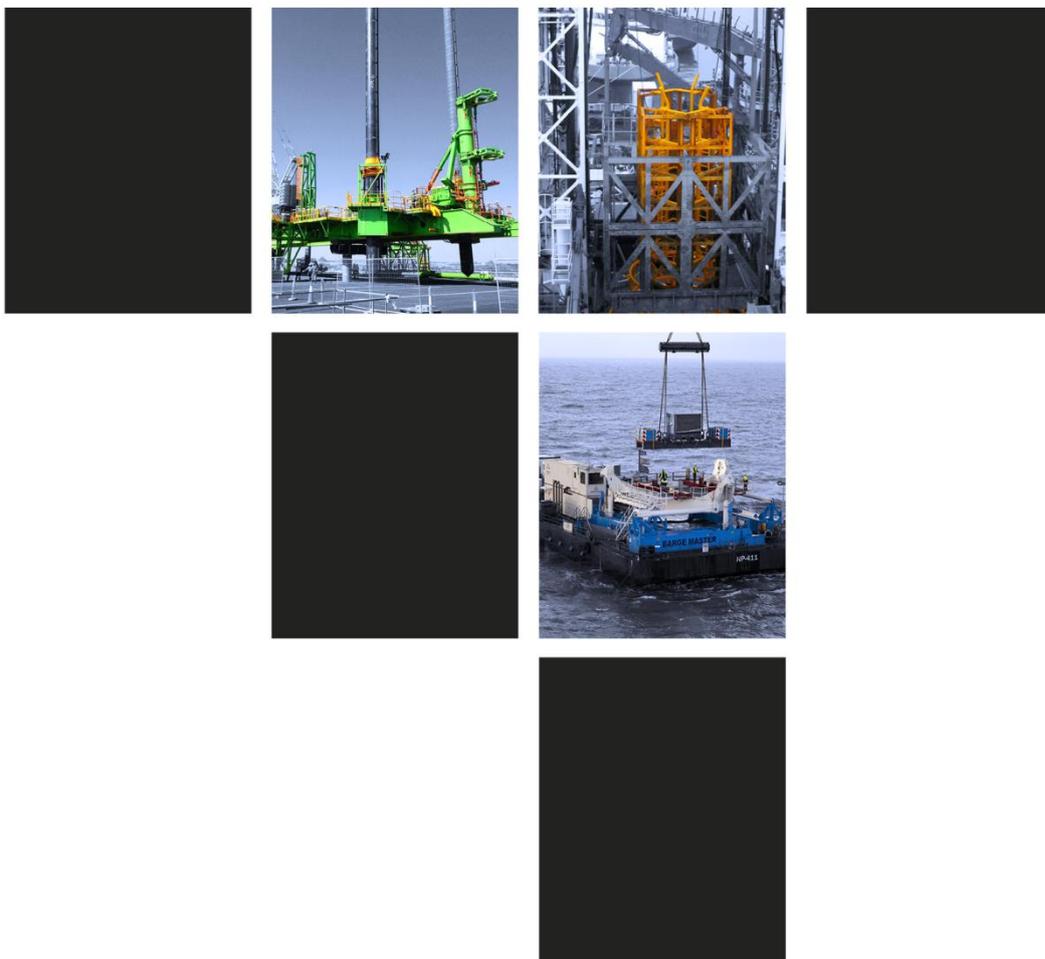




TEMPORARY WORKS DESIGN BV
YOUR PARTNER IN OFFSHORE DESIGN



Track Record Offshore Piling.

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 piling template for installation of wind turbine foundations

2 Overview of offshore piling services

TWD has performed tendering studies and designed a variety of tools for pile driving projects in collaboration with established international clients like GeoSea, Hochtief, BAM and Van Oord. TWD has experience with piling tools for piles up to 8m in diameter suitable for jack-up barges as well as floating vessels. Project examples include:

- Combi-wall piling frame
- Cell wall template
- Trestle and berth piling and drilling templates
- Pre-piling four legged jacket
- Pre-piling tripod foundation
- Monopile gripper frame

In the sub-paragraphs below, the abovementioned offshore piling projects are described in more detail. References can be provided upon request.

2.1 Combi-wall piling frame

BAM International has constructed quay walls for a new container terminal in Aqaba, Jordan. Rows of piles needed to be driven into the seabed to construct the combi-wall. TWD designed a piling frame to construct the combi-wall modules. The template was lifted with a crane on two supporting piles and allowed for the installation of five piles in one cycle.



The combi-wall piling frame

2.2 Cell wall template

TWD designed a cell wall template pontoon position frame for the Ichthys MOF project in Australia. For the cell wall construction, a template with spud legs was used, which is positioned by a “W”-shaped pontoon. Since the center to center distance of the cell walls must stay the same after installation and settling, TWD designed a positioning frame to ensure that the manual distance stayed within the allowed range.



Cell wall construction at Ichthys project

2.3 Trestle and berth piling template

TWD designed a piling and drilling template applicable to four different jack-up barges, used to install piles for the Hay Point jetty construction. The two layer piling templates were capable of installing piles at various inclination angles and could also be used to support drilling equipment when the two outriggers function as a movable support frame for the oscillator.



Piling template at Hay Point during pile driving

2.4 Pre-piling four legged jacket

GeoSea requested TWD to design a piling template for the installation of foundation piles for the Thornton Bank Offshore Wind Farm project, off the Belgian coast. The project involved the installation of 196 piles at 48 wind turbine locations and 1 substation location. Four winches on the JUB Buzzard controlled the height of the piling template. Guiding constructions on the template and around the JUB spud legs fix the template in the horizontal plane during piling and lifting. During transit the template is pulled against the bottom of the JUB and fixed in the horizontal plane by several docking facilities.



Road transportation of the Thornton Bank piling template to the DEME JUB Buzzard

2.5 Pre-piling tripod foundation

TWD designed a piling template for installation works at the EnBW Baltic II Offshore Wind Farm. The project involved the supply and installation of monopiles, jacket foundations, and 80 wind turbine generators. During the jacket pre-piling phase, 123 piles were driven, acting as foundation for 2 different types of pin pile tripod jackets. During pile driving, the template was fully suspended by winch wires.



The Baltic II pre-piling template

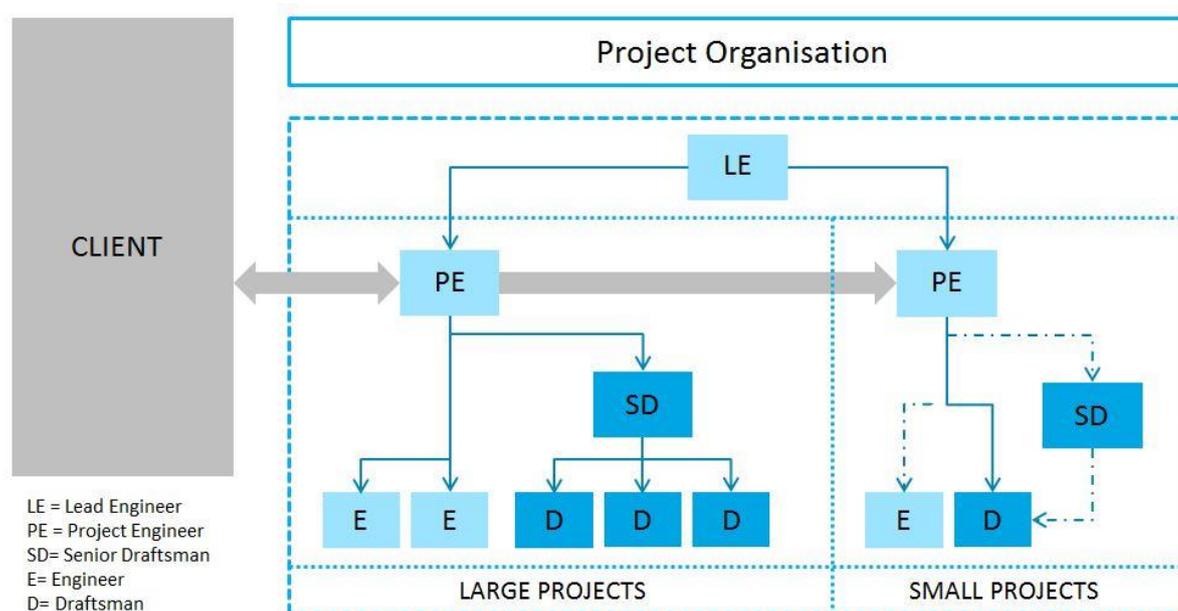
2.6 Monopile gripper frame

TWD provided the complete design of a pile gripper frame for Van Oord's new heavy lift jack-up vessel, Aeolus. The gripper frame can be lowered below the hull, allowing piles of all lengths to be driven. It is also fully retractable for transit, greatly reducing the drag and footprint of the vessel. The hydraulically operated gripper arms with rollers ensure that the monopiles of different sizes can be safely caught in the gripper to hold the monopile in the correct position during hammering. This makes the design suitable for a large range of projects. The comprehensive design addressed all related parts, including designs of the interfaces for the hydraulics and bearing systems.



Monopile gripper frame onboard of the Aeolus

3 Organisation



TWD basic project organization 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 Quality system).

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 Quality system).

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

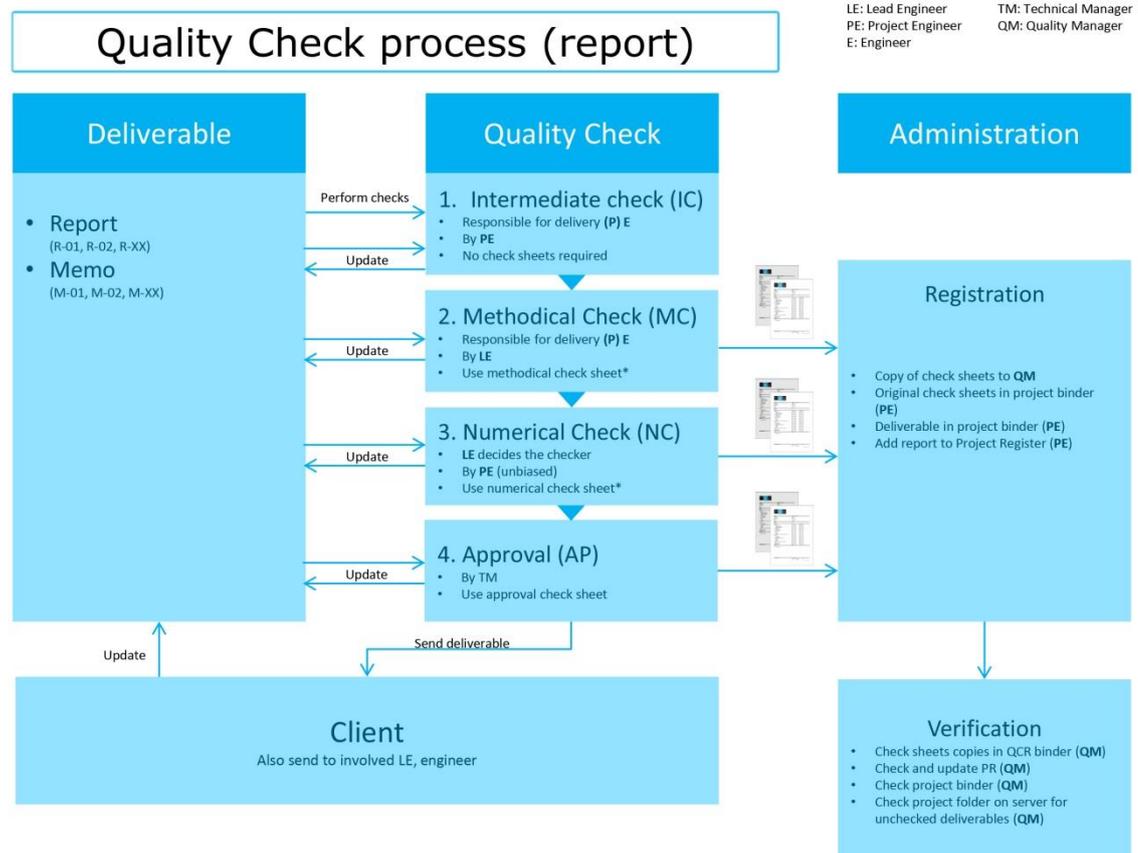
TWD is dedicated to achieve client satisfaction by delivering high quality designs that are practical, safe, and economical. We do this by using a quality management system that provides a framework for our complete design and engineering process.

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.

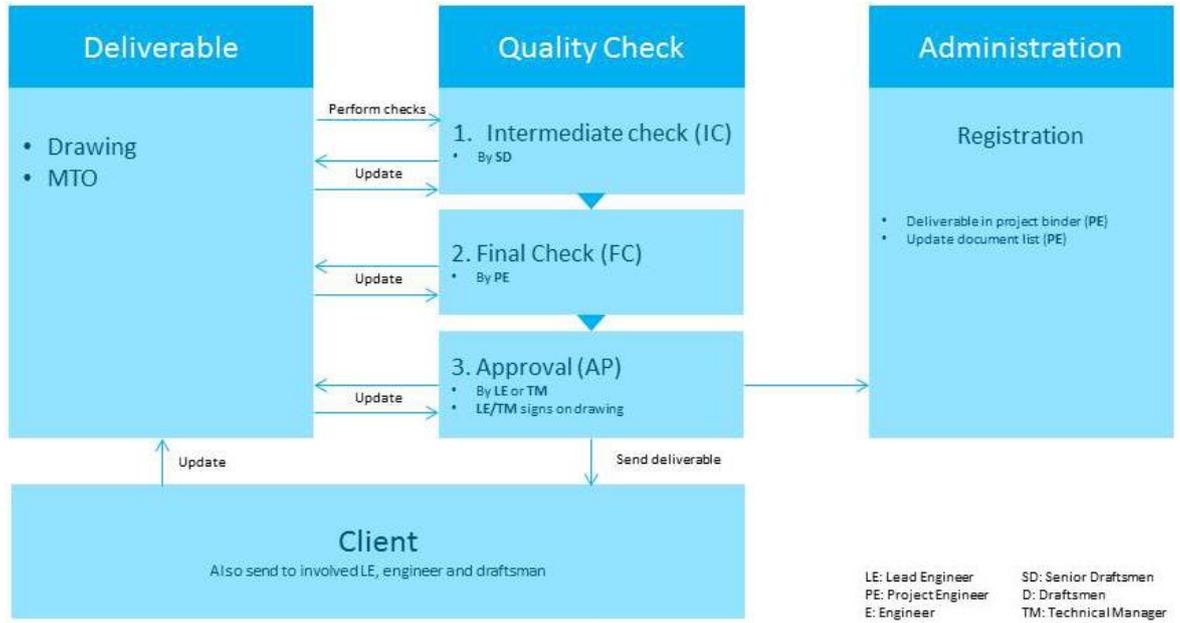
4.2 Quality accreditation

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

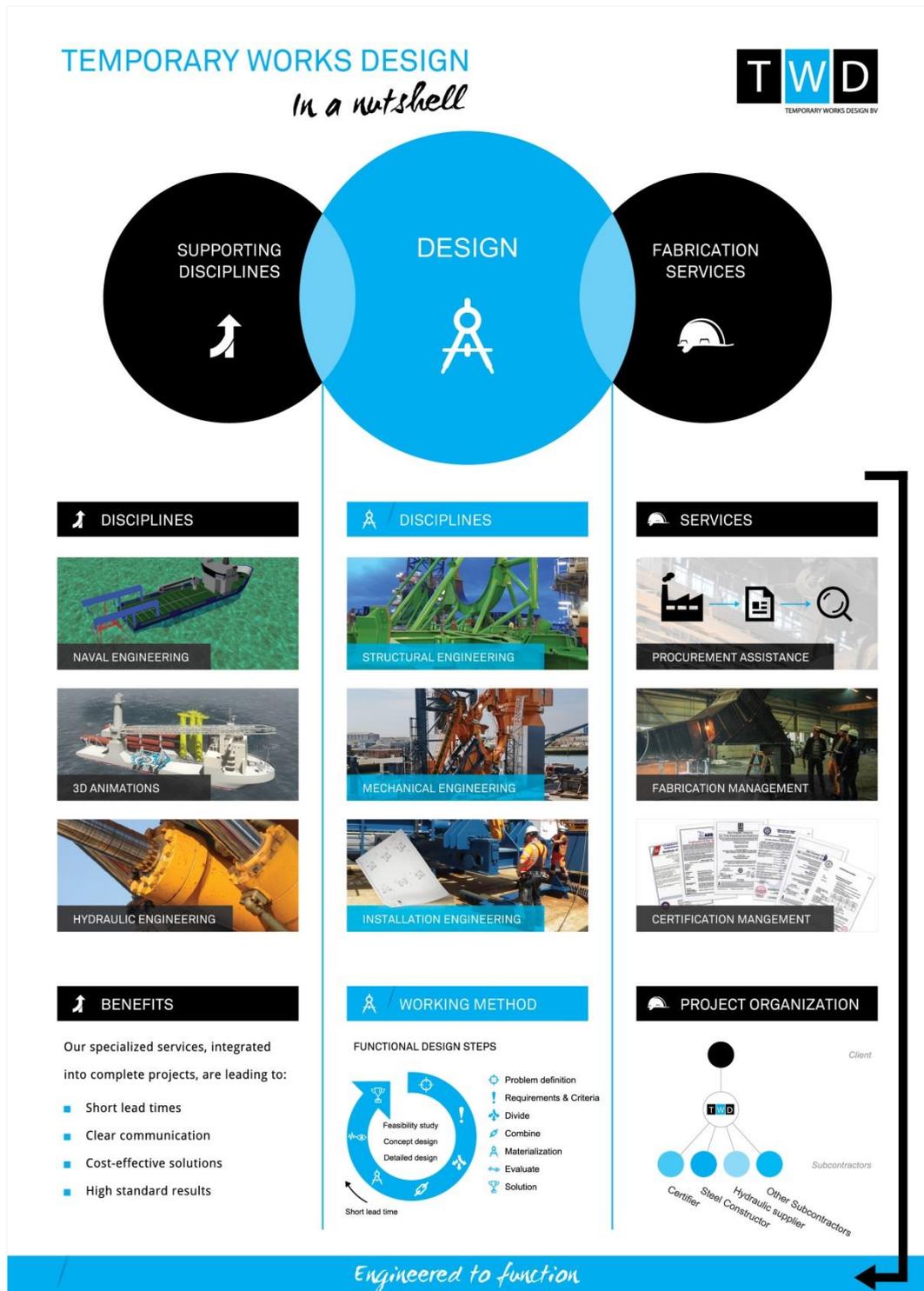
Quality check process (drawing + MTO)



TWD quality check process diagram

5 Services overview

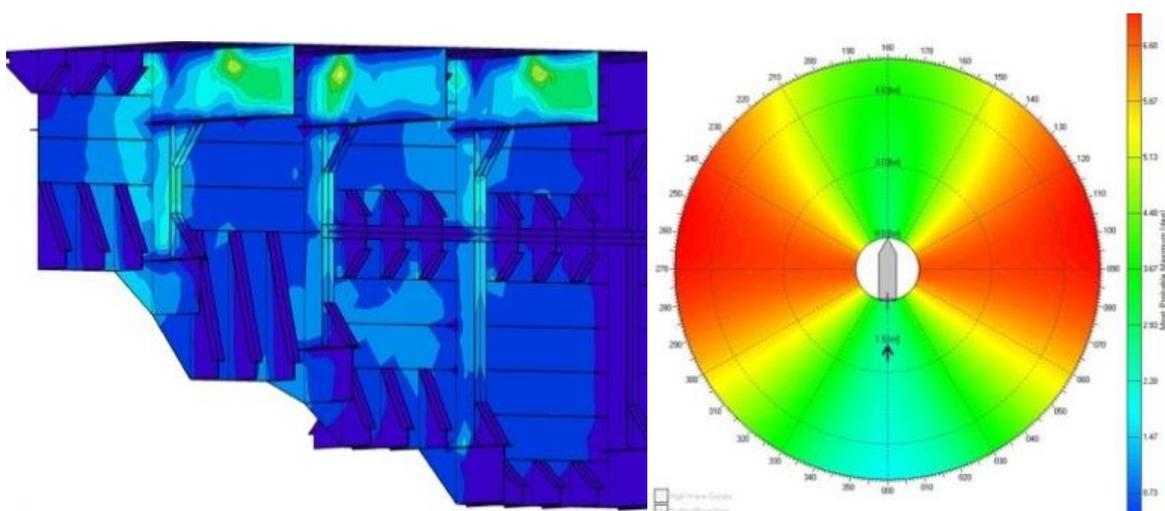
The overview below shows the different services that are offered by TWD. Allowing TWD to manage the entire design process, from support disciplines to fabrication services, will result in short communication lines, a solid project overview, and savings in time and costs.



6 Software

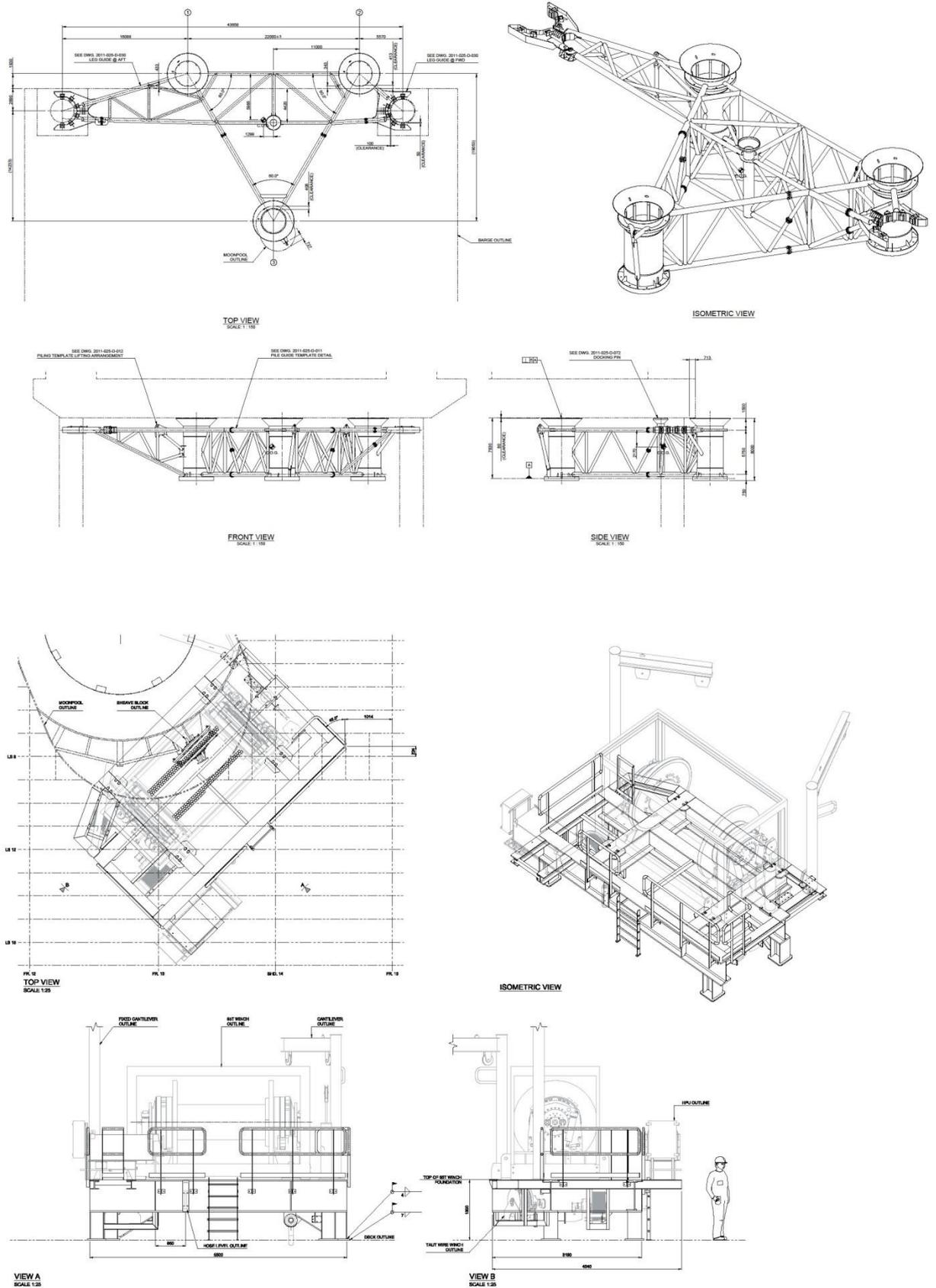
TWD has developed several calculation tools for reliable and efficient calculation of pad- and lashing eyes, kicker plates, current and wave loading, loading capacity of deck constructions, and forces acting on cargo due to vessel motion. Furthermore, the following several widely recognized software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



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