Load Spreading and Seafastening

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Circa 1760, the rise of the Industrial Age in Great Britain was primarily characterized by power driven technology that replaced hand operated tools. These technologies included the steam engine which gave rise to locomotives, steamboats, and by 1815, the golden age of massive ocean transportation vessels. In turn, these advancements enabled the worldwide transportation of the proliferation of manufactured goods via global waterways.

As manufactured goods became larger, heavier, and more complex, the multipurpose fleets became more diversified. Crane capacities and deck strengths increased and we witnessed the introduction of ro-ro and semisubmersible vessels. As recently as four decades ago, a unit of a mere 60mt was considered a heavy lift for a marine vessel. At Intermarine, LLC, we are geared for a maximum lift of 1,400mt, however, some vessels in the world’s fleet have a capacity approaching 3,000mt.

In today’s developing world, large infrastructure projects are becoming more and more prevalent. Large power stations, oil refineries, and LNG plants were initially “stick built”. This system involved shipping small components which were assembled at the site.

Inevitably, lack of resources, skilled labor and complicated supply chains resulted in significant delays and cost overruns. Today we see a significant increase in modularization whereby large components are fabricated at an industrial facility, shipped to the final destination, and then rolled into position. This process typically requires vessels with large crane capacities or ro-ro capabilities. At Intermarine, LLC we have moved transformers, reactors, and turbine packages weighing in excess of 800mt. In addition, large wind turbines and blades are also carried on a regular basis. The carriage of all these commodities presents specific load spreading and securing challenges.

Regulatory Agencies

Various international regulatory organizations, such as International Maritime Organization, GL/DNV and Noble Denton have been instrumental in drafting and enforcing rules and guidelines specific to this industry.

These organizations have developed recommendations unifying procedures and calculation methods to ensure safe ocean transportation and to keep up with the tremendous increase in offshore projects. There is an obvious need to follow these guidelines very closely when handling heavier, over-dimensional cargo.

Engineering Calculations

Significant planning, analysis and documentation are all required before executing a project loadout. Advanced heavylift shipping companies prepare a detailed method statement that will include a stowage plan, lifting arrangement, materials list, load spreading arrangement, securing plan, and risk assessment. The document will also include all the required supporting documentation and certification for the loadout.

In the past, these types of calculations were performed mostly by hand and were based on the accepted engineering principles of the time. Today sophisticated engineering software and various spreadsheet-based modeling techniques are utilized for complex equations and formulas for securing, accelerations, strength, and other dynamic factors. In addition, commercially available software has reached the Marine Industry. A few examples of these are Visual Cargo Care for securing calculations, MACS3 for stability calculations, and AutoCAD, SolidWorks, and ANSYS for 3D modeling and stress analysis [Figure 1].

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Lifting and Spreader Beams

A spreader bar is a lifting device which is

connected to a vessels crane hook or hooks. A single

longitudinal beam may be fixed or adjustable in length

and may consist of one set of lift/drop points or multiple

lift/drop points to offer flexibility during lifting

operations (Figure 2). A single longitudinal bar can be

used to perform a tandem lift, whereby, two cranes are

used to lift a unit whose weight exceeds the capacity of

one crane.

As cargo weights and dimensions have

increased, so has the need for more complex spreader

bar configurations. Combinations of longitudinal and

transverse bars are becoming more common for larger

units such as turbines and locomotives. In some cases,
cargoes such as process modules may require a

combination of eight bars to minimize the possibility of

structural damage. Detailed lifting plans are prepared to

show the spreader bar configuration and rigging

arrangement that are planned to handle the cargo.

(Figure 2)

Load Spreading

As unit loads have increased, so has the need for
detailed load spreading calculations. The permissible
tons/m2 allowance is normally readily available and is
commonly sufficient for most loads. A comparison to the
cargo footprint will indicate whether the limit is
exceeded. Container stack weights and line loads are
also provided by the hatch cover manufacturers.

When planning for heavier cargo more detailed
calculations are required that consider the various
forces that are experienced in a seaway and additional
materials that may be required to distribute the weight
over an acceptable area. Materials such as timber, crane
mats, I-beams, or steel load spreading mats (Figure 3)
may be utilized to achieve adequate load spreading.

(Figure 3)

Cargo Securing

After the load spreading materials have been
installed, and the cargo is safely loaded using the
approved lifting device, the cargo must be secured for

ocean transportation (Figure 4). All ocean going vessels
have a cargo securing manual on board that is normally
drafted by the hatch cover manufacturer. It defines how
containers should be secured and also includes basic
information on forces and accelerations that may be
expected. Simple formulas are included that can be used
to calculate the required securing for non-standardized
cargo.

Heavier, larger units require more detailed
calculations. As with engineering calculations, load
spreading calculations were initially calculated by hand.
However, maritime cargo securing software and
programs such as Visual Cargo Care are now readily
available for commercial use. These programs
accurately calculate acceleration forces, lashing and
securing requirements, and create the necessary
reports for inclusion in the method statements.

The materials used for sea fastening vary
according to the cargo specifics, but generally include
welded stoppers and clips, chains, wires and
turnbuckles, and nylon belts.
The project was completed safely, efficiently and economically because all the work was managed through Intermarine’s Quality and HSE Management systems. The company ensured that all policies, standard operating procedures and risk assessments were followed. Intermarine’s Quality Manager and HSE Director was consulted when there was any doubt about which method or equipment was to be used.

The Future

All indications are that we will see more modularization, with corresponding increases in unit weights and dimensions. Project Managers will have to ensure construction is completed on time, with minimal damages, and within budget. Ocean transportation is a vital part of achieving this. In recent years we have seen considerable advancements in training and technology. Ships staff are trained on crane simulators prior to joining the vessel and schooled on the procedures for loading and discharging heavylifts. Modern vessels are fitted with sophisticated ballast systems to ensure all stability requirements are satisfied and cranes that can be operated from the main deck level. Advanced Dynamic Positioning Systems ensure a vessel can maintain its position and heading offshore by using its own propellers and thrusters.

At Intermarine, we have fully staffed Technical offices throughout the world with qualified personnel to ensure the clients and their warranty surveyors that detailed planning is our top priority. As the market and technology continue to evolve, so will the capabilities of our technical staff.

Case Study

Intermarine recently loaded a ship loader (Figure 5) in Porto Marghera (Venice, Italy) and safely delivered it to Corpus Christi, Texas. The loadout presented many diverse challenges due the nature of the cargo. The main unit had overall dimensions of 22.8m x 24.4m x 36.9m and a gross weight of 320mt. The extreme height resulted in a hook height problem that was resolved by designing a custom made lifting arrangement. The cargo height also contributed to the excessive forces that were overcome by an intricate securing web of lashing wires and turnbuckles (Figure 6).

The main body and the boom section were shipped separately and the client requested that they be reassembled on the dock. This was successfully achieved by utilizing the ship’s cranes in a tandem lift operation.

Intermarine was able to offer the right ship at the right price along with the personal attention of our professional Port Captain. Our vessel, the MV Ocean Globe, was nominated for the project as she had sufficient crane capacity, outreach, and hook height to handle the main body. A tremendous amount of planning is involved in a project of this magnitude, which requires the participation of the Technical, Operations, and Commercial Departments. Roughly 300 man hours went in to planning this particular project, while 40 man hours were involved in both the loading and discharge. Adequate planning reduces the possibility of accidents, loss of life or injury, material damage, and time lost on the vessel. Projects such as this typically have long lead times. As such, damages or delays will inevitably result in liquidated damages with a tremendous financial impact.