HLE

ISSUE: 01

SUMMER 2019

THE HEAVY LIFT ENGINEER

...managing & delivering heavy lift projects

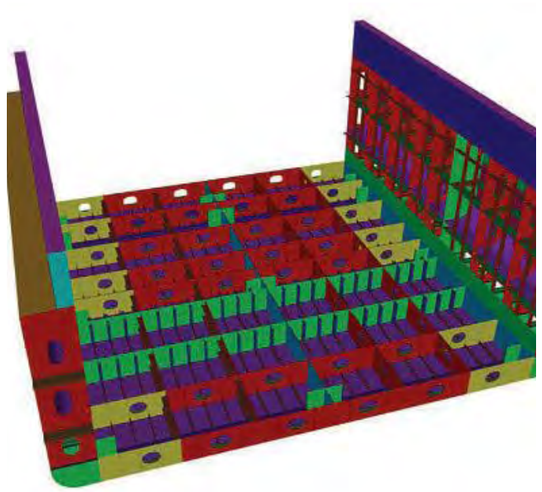
FEATURING

7 POINTERS FOR CHARTERING A BARGE

WHISKY TASTING AT BREAKBULK!
and a chance to win a premium Scotch malt

WHAT TYPE OF HEAVY LIFT PARTNER DO YOU NEED?

A Malin Group PUBLICATION



CONTENTS

EDITORIAL PAGE 5

WHAT TYPE OF HEAVY LIFT PARTNER DO YOU NEED? PAGE 6

HEAVY LIFT TIP - VESSEL MOTIONS *PAGE 10*

CHALLENGES OF A LARGE TURNKEY TRANSPORT PROJECT PAGE 12

HEAVY LIFT TIP - LINKSPANS *PAGE 16*

BOOK RECOMMENDATIONS *PAGE 18*

7 POINTERS FOR CHARTERING A BARGE PAGE 20

HEAVY LIFT TIP - TOOLBOX TALK *PAGE 22*

...IT'S THE BEST PLAYERS WITH THE BEST TEAM PAGE 24

HEAVY LIFT TIP - HEIGHT CLEARANCES AND ROAD SLOPES *PAGE 28*

SPREADSHEETS... THE QUALITY ASSURANCE POISON OF ENGINEERING PAGE 30

HEAVY LIFT TIP - CRANE HIRE AND CONTRACT LIFT *PAGE 34*

EDITORIAL

JOHN MACSWEEN

MANAGING DIRECTOR, MALIN GROUP

On reading the front cover, two questions may come to mind. First "what exactly is a heavylift engineer?" and second, "why another heavylift magazine?"

"Heavylift Engineer" has such broad meaning and application. One engineer may be expert in the nuances of lifting in general or more specifically in a niche field such as the use of strand jacks or winches. Another may be an expert in the use of hydraulic gantries. Others may have perfected their trade in the use of hydraulic trailers for the transport of oversize cargoes while leaving the entire branch of heavylift skills needed to master the marine aspects of the industry unexplored. Skills such as ballasting, ship stability, motion response and securing of cargo to steel decks and hatch covers.

And still we have not even scraped the surface of crane lifting, skidding, jacking and a myriad of other skills and areas of professional development let alone the project management skills needed to effectively bring all this together in a well executed project.

In our eyes a heavylift engineer is each and all of the above. An engineer who may have very narrow and deep skills in a specific area or one which has overarching broader expertise across a wide range of fields depending on the role they fill.

It is this world of engineering that we are dedicated to and find infinitely fascinating. We hope to share our enthusiasm with you in these pages.

Which leads us onto the second question, "why another heavy lift magazine?"

For the avoidance of doubt, we operate in this field. We contract services, execute and engineer heavylift projects on behalf of a global and varied client base. But we repeatedly come up against misconceptions, bad working and contracting practices as often as we encounter good ones.
You will not find our services listed, nor will you find sales efforts in this magazine. We will only present case studies where they offer something to you, the reader, that has the potential to be technically novel or interesting.

Nor do we limit ourselves to engineering itself, but we will explore other areas critical to project cargo handling such as project management techniques, some aspects of contracting and perhaps even the odd book recommendation that may be of interest to like-minded folk.

The goal is to convey our findings as we continue to develop and learn. Share best working practices and techniques in an effort to improve both, how projects are executed by suppliers, and contracted for by clients.

This is our first edition and we hope you find something of value and look forward to hearing your thoughts. Especially around areas you would like to see featured in future editions. For example, is the tone technical enough, would you like to see more anecdotal articles or more practical checklists that can be used for executing projects?

If you have any questions, or ideas please do not hesitate to send them to us at **heavyliftengineer@malingroup.com**

Finally, if you want to be kept up to date with subsequent editions, please feel free to register at **www.heavyliftengineer.com/magazine**

fig. 01/ lift ashore of module

WHAT TYPE OF HEAVY LIFT PARTNER DO YOU NEED

WRITTEN BY RICHARD S. LAWSON
SALES DIRECTOR, MALIN ABRAM

Full handover to a single contractor, a fully self-managed project or another option? There is a broad range of classes of heavylift partner to choose from, each with their own strengths and weaknesses. When deciding it pays to understand the categories of contractor available and which category will be the "best fit" for your needs. The following is a broad categorisation of contractors and of course there will be differences between each individual supplier within the same category

Global Heavylift Equipment Owners

This is perhaps the best known class due to the visibility of their equipment. These equipment owners have, in most cases, evolved from a heavy haulage or heavy crane background and have reinforced their equipment offering by added jacking, skidding, gantry systems, lifting equipment and even some marine plant over the intervening years.

The larger, global organisations tend to be very technically competent in the land based heavylift aspects of what they offer, although some do have marine experience as well. These owners normally take on the full land based scope of a project, primarily from their own equipment base, and then often subcontract marine based scopes. For very large trailer requirements, it is not unusual for these owners to cross hire equipment from each other to cover peak demands. Mobilisation of equipment between their regional operations to cover shifting demands of equipment around the world can also occur. The primary interest of these owners is hiring equipment which they own, as part of your project delivery. These owners have a very strong service offering for the large heavylift projects such as refinery or power station builds. There is less interest from these owners in FEED studies (except when there is equipment hire possibilities), marine transport led projects (again except when equipment hire is possible), cargo integrity checks, and warranty or third party reviews.

Local and Specialist Heavylift Equipment Owners

This covers smaller, local companies as opposed to regional off erings from the global operators. Th ey could be considered as versions of the global players, perhaps 40 or 50 years earlier in their evolution. They typically haveslightly more specialised equipment or manage more niche projects. They can have a wide variance in technical and operational manning capabilities and investigation will usually reveal where their strengths and weaknesses lie. They would not normally be capable of the very large projects but can off er economical solutions for discrete, smaller lift s and site moves due to typically lower overheads.

Global Freight Forwarders

This category covers large, global organisations wit a worldwide footprint including a presence in all major regions of the world. Freight forwarders usually have strong links with air freight and marine brokers as well as being very competent in

the management of customs requirements. Some freight forwarders have in-house technical capabilities and often supplement this with third party assistance when required.

Normally freight forwarders do not own their own heavylift equipment, however some of the larger organisations may have separate asset owning divisions which provide access to vessels and road haulage equipment.

Shipbrokers

Shipbrokers can assist when it comes to sourcing the most suitable ship, tug or barge for your heavylift project. To source the vessel, they may use the open spot market or utilise existing relationships or partnerships with specific shipowners. They, typically, have good connections with various ship owners and know where their vessels are and what space they have onboard at any given time.

Brokers have a very good understanding of maritime contracts and will be able to advise on appropriate terms to utilise when booking a vessel, if they are acting on your behalf rather than the ship owner's. It is important to understand this point at the outset of a project as you may need a broker acting on your behalf during any negotiations.

Shipbrokers normally do not work on fixed price contracts nor do brokers offer any technical assistance, other than technical support off ered by a shipowner as part of their freight rate, wich can vary dramatically between owners.

Technical Authorities

Technical authorities are support contractors offering engineering and operational services within the heavylift industry.

Technical authorities can usually be split into two groups:

1) Marine Warranty Surveyors
This group normally act on behalf of underwriters who carry responsibility for insuring cargo. The marine warranty surveyors ensure that, to the best of their abilities, the operation is executed in a safe and controlled manner. This includes ensuring that sea fastenings and stability of the vessel is acceptable. In addition, the

surveyors ensure that trailer arrangements and crane lifts are carefully managed and technically sound. Marine warranty surveyors can also off er these services to clients directly and can act as a third party reviewer that off ers assurance on technical and operational proposals. Marine warranty surveyors would not normally execute any heavy lift operations. Their responsibility would normally be limited to third party design checks and on site oversight only.

2) Independent Technical Design Houses
This group covers a wide range of boutique consultancies that offer heavy lift design and support services. These houses tend to have specialities in certain fields such as craneage, marine operations, or trailer operations but in some cases have a strong offering across all fields. Independent technical design houses can also offer on site support and oversight of the actual execution of the operation in question. These houses tend not to offer actual prime contracting services and instead rely on the client to take control of the commercial aspects of sourcing and hiring of all required equipment.

Project Management Consultants

Project management consultants, as the name suggests, offer project management services and draw together the various aspects of a project, usually on a fee based structure (either hourly paid or fixed price fee). Contracts for execution of the project would be placed (by the client) with each of the contractors direct. Responsibility for management of the procurement process would either rest with the client, or in a more limited capacity, with the project management team.

Using a project management team that does not have considerable experience of heavy lift projects can result in several operational challenges. There are instances where the responsibilities demonstrated by the project management team do not appear to align with the requirements of the client. This is usually due to a lack of management of the interface between the various contractors. This interface control is critical in the execution of a safe and well managed project.

Prime Heavylift Contractor/Technical Authority Hybrid

This is a hybrid merging the key offerings of all of the above categories into one. A prime heavy lift contractor may not be an equipment owner, however this contractor takes responsibility for all aspects of the project and offers a single fixed price for the work that they are responsible for managing and delivering against. It is imperative that the prime contractor has the following key features for the successful delivery of a heavy lift project:

1) a solid tendering and procurement process.
2) experienced project management staff with robust controls.
3) experienced operational and site teams including trailer experts, qualified crane/ lift engineers, naval architects and marine superintendents.
4) in-house chartering experience.
5) a broad technical capability that can cope with a wide variety of heavy lift challenges from mooring studies, FEA, vessel and trailer stability and crane studies.
6) a well connected and diverse equipment supply chain that can be brought to bear on any challenge the heavy lift project faces.

Hopefully this article has offered an insight into the different types of heavy lift partner available. Understanding what services & equipment are available is the first step to a good heavy lift partnership.

fig. 02/ arrival of floating crane to quay for lifting heavy reels

HEAVY LIFT TIP
VESSEL MOTIONS

When we transport cargo at sea, the forces it experiences are typically the highest the cargo will ever have to withstand (extreme earthquakes aside). It is therefore crucial to the designer that these loads are well defined.

In an ideal world, we can carry out a motions response analysis (or even model tank testing). This will provide the engineers with the most accurate vessel motion predictions possible, from which the relevant loads can be derived. However, for these results to be applicable, the following details are required:

- Vessel hull form and load condition (including structural weights, tank loads and stowage plan)
- Sea state and weather data for the planned route (for example, wave heights and periods, applicable wind and wave spectrum)
- Accurate cargo design information (such as weights and dimensions)

If the above data has been collected accurately, the information can then be used within a suitable soft ware program. It is important to note, however, that the results will only be valid for this specific case. This puts us in a bind; to design the cargo we need to know the vessel motion, but to correctly predict the vessel motion, we need to understand the cargo.

In order to solve this problem, several simplified/default motion calculations have been developed by the industry. These calculations use assumed limits and empirical formulae to estimate a conservative set of vessel accelerations. Vessel particulars and operational constraints limit the applicability of each method, but the results do vary, with some producing more conservative results than others.

Significant savings in steel weight can be obtained, but this would not matter if your cargo fails en route to the client. Deciding which route to take can be a complicated process, and therefore, it is always best to speak with a qualified professional that understands the ins and outs of each approach.

fig. 03/ model testing of barge roll motion

CHALLENGES OF A LARGE TURNKEY TRANSPORT PROJECT

PART 1

WRITTEN BY LINDSAY MCDOUGALL
TECHNICAL DIRECTOR, MALIN ABRAM

Transporting the blocks for something as large as the Queen Elizabeth class of aircraft carriers from build yard to integration yard is always going to be technically challenging. The same applies for any large transportation project where cargo is split into diff erent types, sizes and weights. If there is more than one load out location across the project then the level of complexity increases further.

Carrying out these types of turnkey transport projects requires the incumbent heavylift engineer to carry a whole range of skill sets encompassing hydrodynamics, stability analysis, FE analysis (see page 15), lifting plans, stow plans, 3D draughting, float off studies, towage analysis and mooring design in order to meet that challenge.

Getting the required information flow into a project of this size can also be challenging. The ability to source, collate and understand the technical details of the cargo, carrying vessels, ports, yards and handling equipment is an essential skill that a heavylift engineer also requires. Using the Queen Elizabeth class details as an example, which can be repeated for other complex transport projects, we have a typical range of:

- Lightest Cargo – 10 Te
- Heaviest Cargo – 11,337 Te
- Smallest Cargo - 8 x 4 x 5m
- Largest Cargo - 85 x 40 x 23m

Therefore the level of checks and engineering required across such a diverse range, varies from standard empirical seagoing force checks and lashing calculations to full motion response studies and FE analysis.

An example of the type of FE analysis a heavylift engineer might be asked to undertake is one that contains both cargo and carrying vessel. Once cargo reaches a certain size in relation to the carrying vessel, understanding the interaction between the two starts to become critical. Simplifi ed assumptions such as making the deck supports fi xed or springs start to become harder to justify. Th e clearest way to check this interaction is to build a detailed FE model of both the cargo and the barge, along with the supports and seafastening, to ensure that the load paths and reactions are fully captured with minimum assumptions. This can result in models of hundreds of thousands of elements. Even with the computers and software currently at the disposal of a heavylift engineer, these models can still take a long time to solve, especially if there are non-linear elements involved.

Having the right soft ware at your disposal can aid this process dramatically. If the software has a visual indicator of convergence it allows engineers to tell at a glance if modelling is going to solve or not (see page 14). With run times stretching into 12 hours or more this can be indispensable as it allows the engineer to cancel runs early if trends show the model is unlikely to converge.

Heavier loads will often push the cargo and the marine plant to its limits. So normal design input and assumptions can oft en be too limiting. A pragmatic client and/or warranty surveyor will recognise this and will be willing to accept reductions where justification is given. For example, trying to justify the cargo and barge for accelerations associated with a maximum forward speed in a "worse case" design wave is overly conservative. The tug and barge would not be capable of making forward progress in such a sea state, nor would you want it to, so a more pragmatic approach is to use zero speed accelerations for input into the FE analysis.

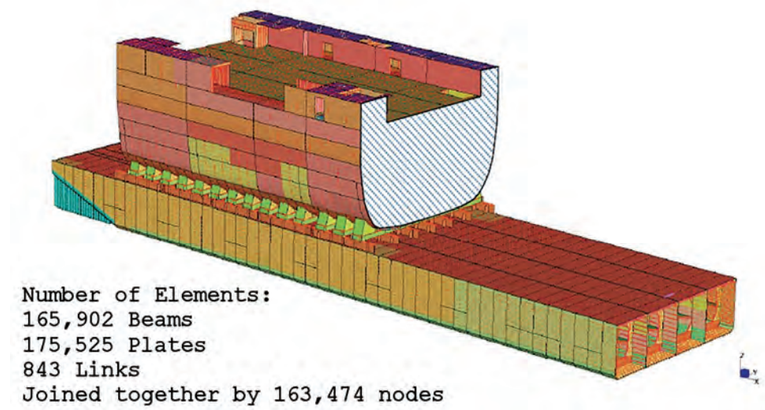


fig. 04/ FE model plot showing full model

It is not always the size or weight of the cargo that represents a challenge. If the cargo is to be floated on or off then the geometry is an important factor as well. Floating cargo will lend its stability to the barge during float offs but if the cargo has an unusual geometry, as in the case for ship sections, this may not happen at the stage you want it to, leading to issues with the stability overall. To ensure stability it may be required to fit additional buoyancy. This can come in the form of temporary buoyancy boxes, either on the cargo or the barge. Float offs have to be designed in a very systematic manner and time steps between calculated stages must be sufficiently fi ne to ensure stability is acceptable during the whole float off operation. If the stages are not sufficiently granular then a minimum stability condition may be missed.

Smaller cargo is also not without its trials. The challenges can be different but no less interesting. Often it would not justify the

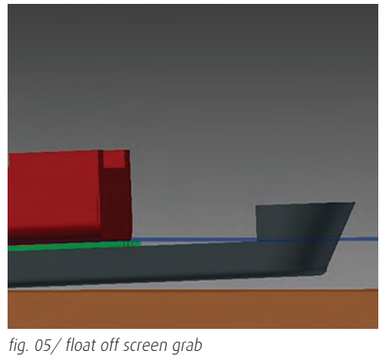


fig. 05/ float off screen grab

WHAT IS **CONVERGENCE?**

Where an FE model has non-linear elements or the engineer expects large deflections, the solution will require a large number of iterative steps to accurately predict the structural response. This is because, as load is applied, the response of the model may change significantly. To accurately model this, a single load case is broken down into a series of sub steps where the final load is "stepped" into the structure. Th eend result of each individual load case then forms the starting point of the next, slightly greater one. Convergence occurs where the model deflects or reacts only marginally between one load case and the next and the model "settles" into a final solution. If there are large changes in displacement or force then the solver will insert additional, finer load steps until the model displacement and force is within the specified tolerance (convergence) or remains out with the tolerance (no convergence).

fig. 06/ 12000 Te mid-body section of Aircraft Carrier towing under Forth Rail Bridge

WHAT IS **FINITE ELEMENT ANALYSIS (FEA)**

Finite Element Analysis (FEA) is a computer modelling tool that allows engineers to determine the stress and strain on different materials. The software works by breaking a structure down into smaller elements and determining the displacement on each one based on the input forces and boundary conditions. Once the displacement is known the stress can be determined from that. There are several diff erent types of elements available in computer analysis ranging from beams to plates and bricks. Some software offers advanced analysis such as non-linear material properties. One example of this is timber cribbing, which has a couple of non-linear properties. It only works in one direction and the stress vs strain curve is not a straight line. Therefore the model has to run several iterations until it reaches a balanced solution.

level of engineering analysis discussed above so the use of default motion criteria is standard practice. However, the default criteria, by its nature, is fairly conservative. Sea fastening design and deck strength justification starts to become problematic as the cargo weight increases. Diligent engineering is required and on site checks need to be robust to ensure technical requirements are put into practice. For example, if a design assumption is that the cargo needs to be supported across 5 transverse frames then the stowage on the day needs to be surveyed to ensure the cargo is bearing on all 5 frames. Small barges can often present more difficulties than large ones especially in terms of load outs and load ins. To minimise project cost and availability pressures it is normal to try and use the smallest barge feasible, resulting in coming alongside quays that are not really designed with small barges in mind. The challenge here is to ensure that there are lots of reserve to account for cut in tide, weight discrepancies and slack water and to have ready-made back-up plans as a contingency.

With respect to quaysides it is not only the quay height that sometimes presents a challenge to a heavy lift engineer. Load outs will often happen at quays that were not designed for RoRo operations or, if they were, then for loads perhaps much smaller than you are now planning. Th is, coupled with ageing infrastructure, oft en raises greatest issues with site services, ground capacities and in particular, the mooring points themselves. Oft en mooring points will not have SWL or MBL marked on them and the heavylift engineer needs to be fore-armed with this information so that they can arrange testing and adjust their designs to suit. Snatch-blocks can be used to reduce loading into an individual mooring point, if others are available to take a share of the load. Counterweights can be used as an alternative if bollards are unsuitable or not present. The Heavy Lift Engineer knows that "Everyday is a school day" on big transport projects and only by facing challenging problems and solving them can an engineer develop.

HEAVY LIFT TIP
LINKSPANS

A linkspan is a method of spanning between a barge and a quayside, effectively a bridge which connects one to the other for the purpose of loading or unloading. This load transfer – or "Load-out/Loadin"– can be via wheels or skid system. To provide a smooth and safe transfer
between the ship and shore, the linkspan is commonly formed from steel sections.

Linkspans are formed of I beams, or column sections, welded toe to toe and come in various widths and lengths. As a method of securing the link-span, these beams typically feature a hinge at one or both ends. These hinges are either fully pinned through eyes, or are the "pin in a U-shaped socket" type. When used with
trailers, linkspans usually require wedges or slopes to allow the wheels to transition onto the linkspan and off onto the quay or barge. Occasionally, either the quay or barge might have a recess which will eliminate one set of wedges.

A linkspan is a vital piece of port equipment, where if not constructed correctly, can result in serious accident. Some issues to be aware of are:

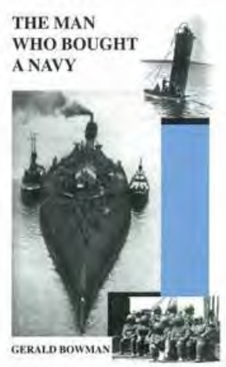
- The longer the linkspan, the deeper the section required (relative to the axle/ skid load). The deeper the section, the more of the effective trailer stroke that is lost whilst crossing the linkspan.
- Shorter boards can be a problem on berths with a large or rapid swell.
- Depending on the location of the linkspan hinge, the barge may have to be always above or below the quay level during load out.
- Transporter clearances and low grillage height can be a problem if the grillages are within a half trailer length of the linkspan.
- Use of loose plates, instead of an engineered linkspan system, is a high risk alternative, because the plates can easily move, or be moved (even by SPMT drive axles), potentially falling between the barge and quay. Plates can also deflect, causing the plate edges to rise, in turn catching pipes and cables under a trailer, especially if the plate is shorter than the axle pitch, causing potential damage and delays.

For efficient loading and unloading, and to minimise turnaround time of ship to shore transfers, it is imperative to speak with a specialist about the function, limits, and types of linkspans available.

fig. 07/ typical linkspan from a barge to a quayside

BOOK RECOMMENDATIONS...

THE MAN WHO BOUGHT A NAVY
BY GERALD BOWMAN



This was a great recommendation from a colleague who was a diver in a previous life and himself worked on numerous salvage projects. It tells the story of an electrical engineer turned marine salvage expert who gambled his entire personal fortune to raise a significant portion of the scuttled German fleet in Scapa Flow, 35 in total, including 24,700 te displacement SMS Kaiser and SMS Prinzregent Luitpol.

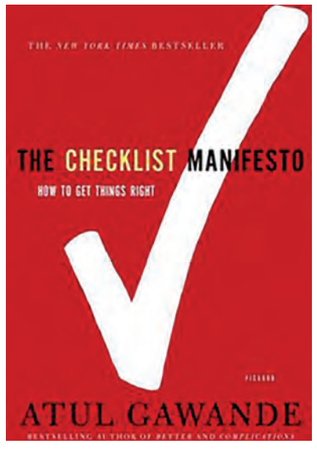
The book takes you on a fantastic journey of abandoned attempts, towage of inverted hulls to dry docks with tents full of men on their back, weather set backs, compressed air and caissons for gaining access to submerged hulls and the tumultuous changes in the viability of the whole venture from one month to the next as scrap metal prices fluctuated and miner strikes cut off essential supplies of coal.

It is a sobering reminder that anything attempted on the high seas is, on occasion, subject to forces beyond the control of any Project Manager or Engineer. At times, the success of a project relies as much on how a team reacts to changing circumstance as it does to any plan made at the outset.

The book is a real gem and there are even some YouTube clips online showing footage of the operation.

It has been out of print for many years but a recent re-print can be found online. Search for the "Orcadian Bookshop" if you want to order a copy.

THE CHECKLIST MANIFESTO
BY ATUL GAWANDE



A book advocating greater use of checlists... not immediately obvious as a thrilling read.

It opens by making an argument that failures in major human endeavours have moved over time from failures of ignorance to failures of ineptitude.

From historical failures due to a partial understanding of how to do the task in hand, where science has not yet progressed far enough, to present day failures of ineptitude, where the knowledge exists but we fail to apply it correctly.

This is true of most issues in modern heavy lift projects. Whether it is technical or operational, failures predominantly occur due to poor application of existing knowledge rather than failing to manage something that is genuinely new.

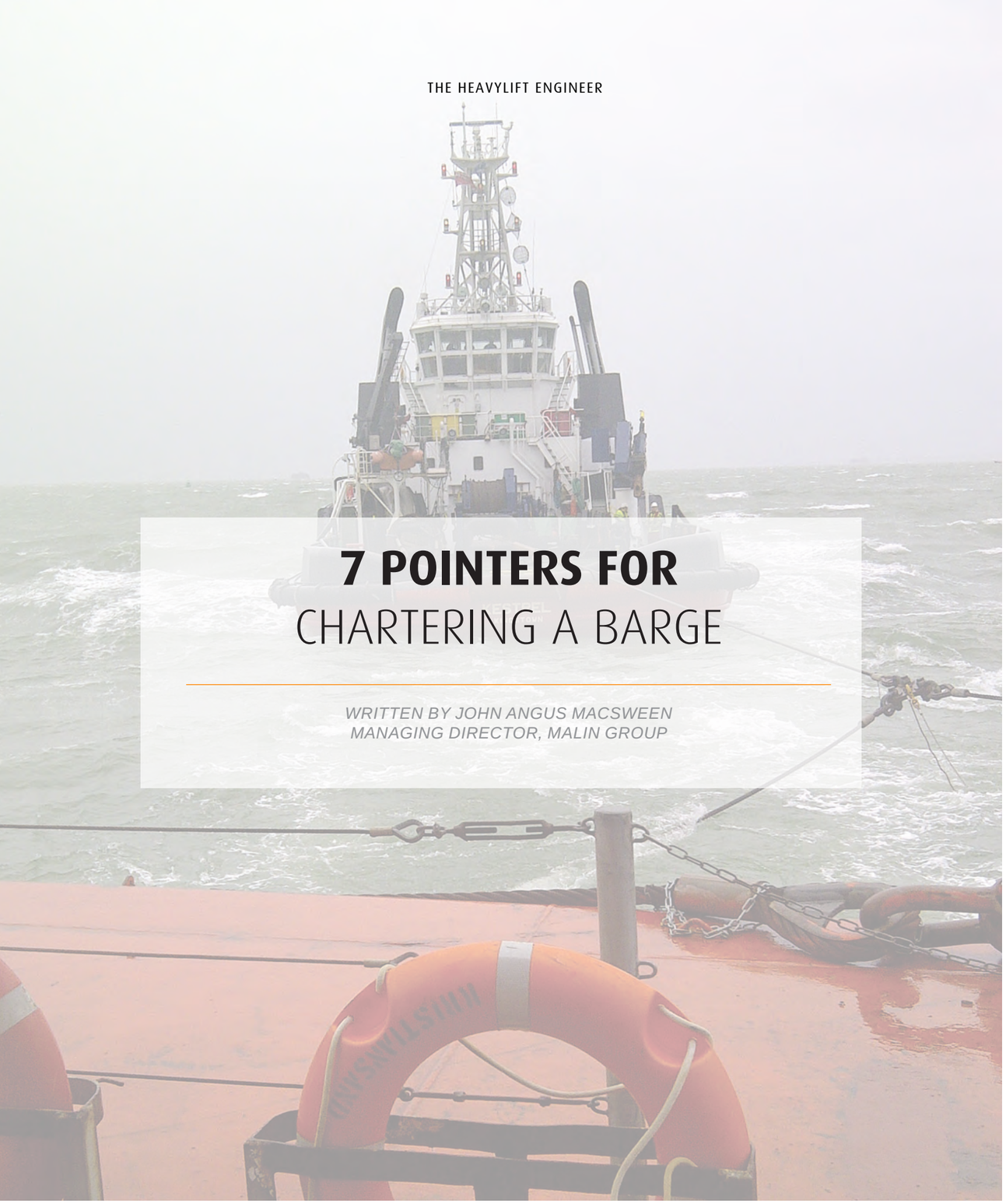
In fact when something truly novel in heavylift is being tackled for the fi rst time, the additional focus it receives tends to ensure its success.

The solution? A checklist.

The author argues this case via a tour of scenarios where checklists have revolutionised industries and safety.

Such as the story of how they came to play a central role in airline safety as a result of taking Boeing's newest bomber from a plane that was "too much for one pilot to fly" to one that the US Airforce bought 13,000 of.

Not the poolside page turner you might normally be looking for in the run up to summer but thanks to the interesting insights and industry anecdotes, a great read nonetheless.



7 POINTERS FOR CHARTERING A BARGE

WRITTEN BY JOHN ANGUS MACSWEEN
MANAGING DIRECTOR, MALIN GROUP

Chartering a barge is often thought of as a fairly straightforward task and it can be, if you know what you are doing and understand the pitfalls or employ a broker on your behalf who does.

Barges are the workhorses of the project cargo shipping industry and thousands are under charter round the world every day.

The charter of these assets employs very specific contracts that have evolved over many years with each owner having their own preferred modifications in the form of custom clauses.

The following represents some very simple pointers for anyone looking to charter a barge for the first time, whether through a broker or direct with an owner.

1. Understand how the mechanism of narrowing notification windows work and what the implications are should you miss a notification.
2. Understand the difference between an "on-hire" survey, which specifies the condition of the barge before you take over responsibility for it, and a "suitability survey" which dictates whether or not the surveyor acting on behalf of your client or the underwriter accepts that your barge is fit for purpose.
3. Be aware of the delivery and re-delivery options for the barge.
4. Understand the differing conditions and balance of benefits that the different charter party options offer, principally the differences between a **PROJECTCON** and **BARGE HIRE**.
5. Make sure that, technically, the barge is fit for your required purpose. This means more than simply checking that the cargo fits on the plan area of the barge, but also whether or not there are restrictions in the load or discharge port. Can the barge deck reach the quay level at the required tides planned for load-out and are there any local strength issues with point loads from your cargo that may need expensive loadspreading or strengthening. Is the combined barge and cargo stable at sea and can they meet any required damage stability requirements set by international or local regulations.
6. For long-term charters: who is responsible for the maintenance, insurance and upkeep of the barge including dry-docking and replacement of spare parts?
7. Do you have visibility of the risk associated with delays of other charters that could run over into yours and what scope for substitution does the owner have and what effect this would have on any detailed plans and arrangements you may have made.

The above list is, of course, by no means exhaustive but should give some good early pointers to get started on negotiations.

HEAVY LIFT TIP
TOOLBOX TALKS

Toolbox talks are an essential part of any operation where multiple parties are involved. When engaged in activities that require simultaneous operations, such as cargo loading/securing, toolbox talks are key to ensuring everyone knows what the others are doing and what hazards are present due to other operations.

You may be party to toolbox talks at all levels, from being an observer during a third party review, to holding the talk yourself as the lead contractor on a turnkey project. Therefore you should have a thorough understanding of what makes a successful toolbox talk.

- What is the purpose of the toolbox talk?
- Who needs to be involved?
- What does it need to cover?

The purpose of a toolbox talk, in general, is to brief the team doing the work. A toolbox talk may be a pre-operational brief to all hands, or a local start of shift briefing for a team. It can also serve as a good way to re-inforce changes to a methodology after a safety incident or other site change.

Toolbox talks will typically involve all parties who are directly involved in the operation. Those who are not directly involved can also be included if there is a safety concern regarding their presence, however, this should not impact on the need for briefing the essential persons.

Regardless of the overall purpose of a toolbox talk the contents will typically cover the 5 key topics below as a minimum.

1) Identify key personnel and who is in charge / responsible?
2) What the lines and means of communication are
3) Give a brief overview of the operation / task
4) Highlight key hazards everyone needs to be aware of, including those caused by simultaneous operations (e.g. overhead lifting, proximity to unprotected edges, slips/trips/falls, climate and environment, and traffic)
5) Personal Protective Equipment (PPE) requirements for the operation

A toolbox talk can also be used to remind all parties that they have an obligation and the right to stop any job if they see something they feel is unsafe.

The secret to a good toolbox talk is to cover the key points of the operation but be as concise as possible to ensure interest is maintained. It is a balancing act that is not always easy. In larger, more complex operations, it may be beneficial to have several toolbox talks, held at key points to reinforce the next stage of the process.

fig. 08/ typical toolbox talk in progress for heavy lift operation
© Wan Fahmy Redzuan / Shutterstock.com

"IT'S THE PLAYERS WITH THE BEST TEAM"

WRITTEN BY STEVEN THORNLEY
DIRECTOR, MALIN ABRAM

Earlier in this edition we discussed the engineering complexity of delivering a major multimodal heavylift project. This got me thinking about a series of shipments we undertook from Appledore, in the UK. The berth itself dried out at low water and a sand bar, navigable on certain tides only, also blocked access, further complicating matters.

This meant a tight turnaround to complete a three-day loading otherwise the ship would be trapped on the mud for weeks. To accomplish this, it needed a strong and unified team. As a football fan, I think of the teamwork needed to complete assignments such as this to a football team in the tried and trusted 4-4-2 formation.

The goalkeeper of this particular project was the ship-owner. It needed a safe pair of hands and the ship-owner never dropped the ball (pun intended). Due to the narrow loading window, the ship-owner had to have their vessels delivered on time at the start of each available window, something which, thankfully, was achieved.

In this same vein, I saw the local Pilot and Harbour Master like the trusted defender, whose knowledge of the port was second-to-none, alongside Babcock Appledore's Rigging Foreman who laid down the cargo on the quay exactly to our plans. These men were truly the core of the back line. In football, the defender's expert judgement allows them to prevent an attack from the opposing team. These men were able to do just that by bringing their knowledge and experience to bear and carrying out their duties with absolute precision. The full backs of the team were the Babcock Riggers and the Crane Company's Appointed Person; both working in unison to load the cargo safely to the vessel.

The Welding and MPI Team were the mighty Midfield Four. Midfielders are the runners, the 'engine' behind every team, physically working the hardest on the playing field these group of men did not disappoint. They consistently over achieved and worked long hours to ensure the securing plan was actioned exactly as laid down. The tight deadlines and difficult conditions did not affect their can-do attitude and willingness to help the team fulfil our ultimate goal.

The Ship Riggers were, without doubt, Striker No.1. These two men knew how to work the ship. They prepared the hold to receive the units and timber layout. They landed the cargo in the hold and completed ship carpentry and lashings. These guys were first on the vessel in morning and last to leave in the evening. As we had worked together for years, they were always going to be a great fit for the team.

With the duties of the Marine Superintendent being so critical, there can be no other comparison than that of Striker No 2 (the Captain). After weeks of planning, preparing the lay down plan of each unit at the quayside prior to vessel arrival to suit both ship and crane, all documentation, calculations, design of seafastening, drawings, co-ordinating all above trades and

fig. 09/ vessel safe aground at low water

fig. 10/ view of quay, full of units and crane in position prior to operation commencement

fig. 11/ loading of unit to lower hold of vessel

> "
>
> *...WE'RE ULTIMATELY A TEAM THERE TO MAKE THE DREAMS OF OUR CLIENTS COME TRUE AND, WITHOUT THEM, OUR OCCUPATION WOULD BE NON EXISTENT...*
>
> "

running the operations on site, the Marine Superintendent ensured all our painstaking plans were delivered on time.

As for me, well I was more of the sheepskin-coat-wearing manager; directing from the side lines, making sure the duties of each individual member were being met and, fundamentally, resulting in a clean and smooth process overall.

Finally, and most importantly, the clients are like the football fans. We are ultimately a team there to make the dreams of our clients come true and, without them, our occupation would be non-existent. Football fans have certain expectations and, like the dedication of a football team, the project cargo team should consistently strive to achieve the best they can.

In total there was 14 shipments, roughly three months apart, and thanks to the 4-4-2 above, all cargo was loaded, secured on time and safely discharged at Rosyth. The teamwork used in a 4-4-2 formation is outstanding; the communication between players, their telepathic signals to one another, the individual talents and responsibilities, all contribute to a winning result.

It may not be the same physical end-goal as a football team, but the hope is the same: to achieve great things with the knowledge and skill that the team holds, to make our clients happy with our performance and make them want to return to us time and time again, and finally, that teamwork and unity makes for an extraordinary outcome.

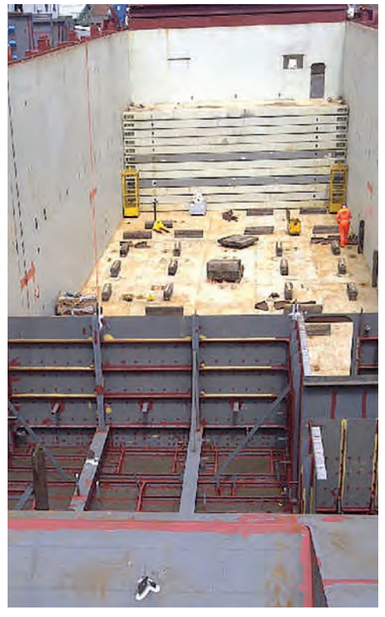


fig. 12/ view of hold during loading operations

HEAVY LIFT TIP
HEIGHT CLEARANCES AND ROAD SLOPES

Self-propelled modular transporters (SPMTs) can carry some of the heaviest loads in the world and are widely used to transport bridge sections. In order for a successful and smooth operation involving SPMTs and bridge installations, it is essential to identify any height limitations that could impact the process.

Heights that must be considered during a SPMT bridge installation are:

- Nominal road level.
- Actual bridge underside height. The lowest point usually occurs at a crash protection beam or something similar, and not typically the main bridge itself. Check at any rivet or bolt head locations on the bridge underside.
- Overall height of the transporter and packing. This figure needs to include any timber, plywood shims or packs. Additionally, check for actual physical section sizes, not just nominal dimensions, as well as any bolt heads or lifting eyes.
- Transporter stroke. Make sure to check on any limits imposed by the PPU (Power Pack Unit) location.

In addition to considerations above, it is important to recognise that roads under bridges are rarely flat. In most cases, the road level is lowered as it approaches a bridge and quite often dips in the middle, as well as the sides (to allow for drainage). Height adjustments will therefore need to be made to accommodate an uneven ground. The slope of the road needs to be considered as every millimetre difference in road level is a millimetre removed from the available transporter stroke. If the dip is too great underneath for the available trailer stroke, then look at filling the dip to return the road level back to within the trailer stroke.

fig. 13/ image showing limited space between the steelwork and the build support

SPREADSHEETS... THE QUALITY ASSURANCE POISION OF ENGINEERING

WRITTEN BY JOHN ANGUS MACSWEEN
MANAGING DIRECTOR, MALIN GROUP

This is a controversial topic, I suspect everywhere, never mind in our office. Spreadsheets are widely used and the current form that we are all familiar with can be traced back to VisiCalc, created in 1979 for the Apple II. This one program had no small part to play in the success of Apple because it was so useful that, for businesses, it was worth owning a computer just to be able to run it.

Spreadsheets are ideal for adding up rows and columns of data. They are ideal for summarising large tables of information and they give you access to some great tools for simple data manipulation, in short an accountant's dream.

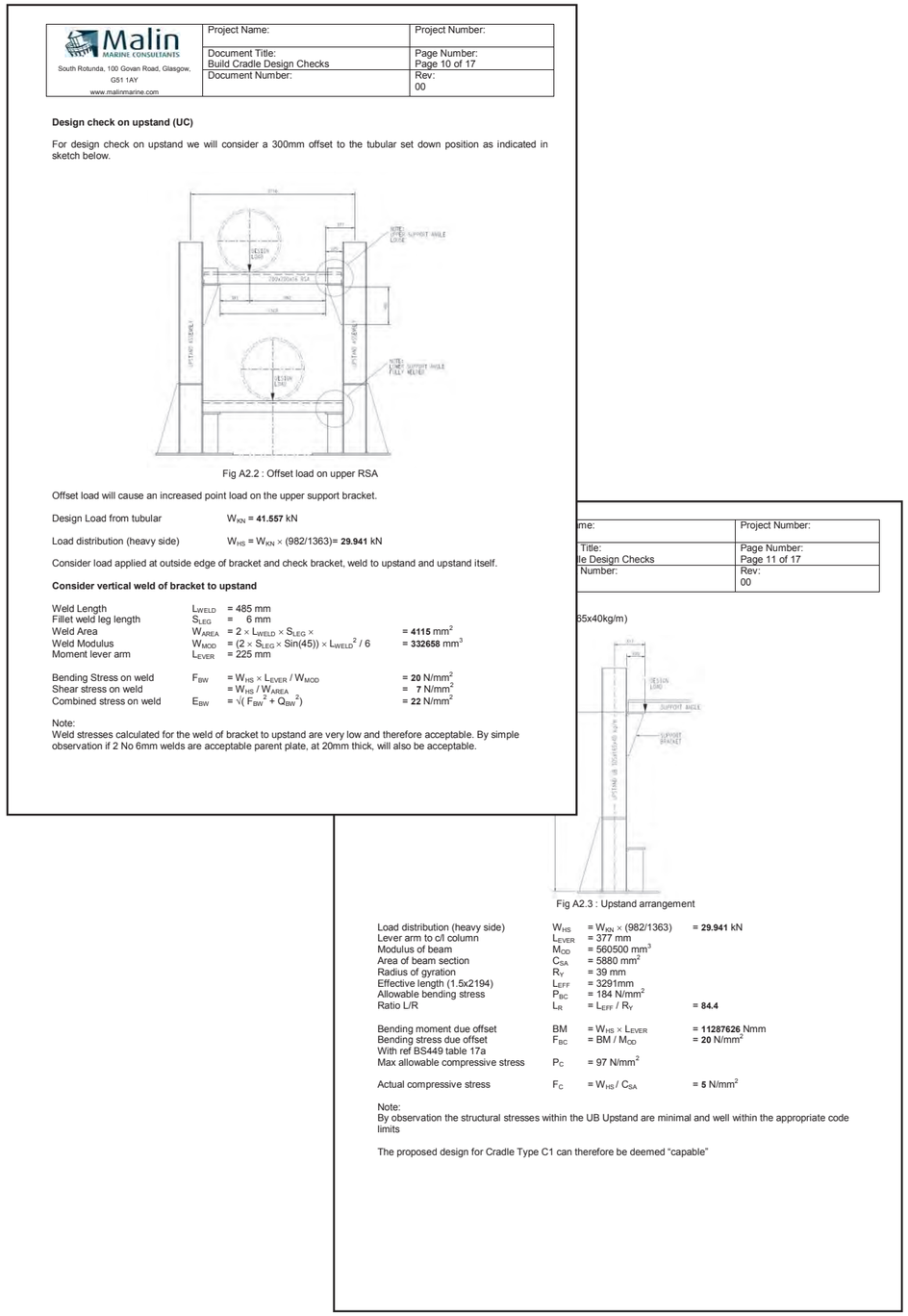
However they are not the panacea for engineering that many think them to be. They hide the algorithms and back end analysis behind closed 'cell' doors. To audit or investigate them closer, one must open the sheet and trawl through the logic of another engineer (the closest one can get to the horror of peering inside your colleague's mind) and try and figure out what on earth they were thinking when they created it.

Effective auditing of a technical assessment requires comprehensive peer review which, for a spreadsheet based calculation, means painstaking cell by cell checking of each formula. However research has shown that a deep review such as this will only catch 80% of errors (https://arxiv.org/abs/0802.3457)!

And when they start to sprawl across multiple tabs, or even worse, external referenced sheets that may or may not have moved, spreadsheets produced even by yourself no more than a month or two ago can seem a complete mystery when you revisit them.
For simple section modulus calculations, weight control and summarising small amounts of data in tabular form, they are ideal. But for more complex tasks such as post processing RAO data, detailed stress analysis or quasi static representations of time domain problems, they should be avoided like the plague they are.

I am not sure why they came to such proliferation, and recall in University, overhearing our lecturers citing them as the bane of their existence. I also recall scoffing at their elitist views, but with the benefit of a couple of decades of experience, I humbly admit they were on to something.

Research has shown, unsurprisingly, that error rates in spreadsheets are comparable with any other human cognitive endeavour, i.e. you are no more likely to make an error when doing an engineering calculation in a spreadsheet than if you were hand writing your calculations. But, tracking and spotting these errors are significantly more difficult to do in a spreadsheet as the code and algorithms behind the results are more opaque than in say a series of hand calculations or regular computer code. In short the errors are there, but a nightmare to find. In addition, research has also shown that users of spreadsheets, more so than other forms of computation, seem to be particularly susceptible to



Malin MARINE CONSULTANTS South Rotunda, 100 Govan Road, Glasgow, G51 1AY www.malinmarine.com	Project Name:	Project Number:
	Document Title: Build Cradle Design Checks	Page Number: Page 10 of 17
	Document Number:	Rev: 00

Design check on upstand (UC)

For design check on upstand we will consider a 300mm offset to the tubular set down position as indicated in sketch below.

Fig A2.2 : Offset load on upper RSA

Offset load will cause an increased point load on the upper support bracket.

Design Load from tubular W_{KN} = **41.557** kN

Load distribution (heavy side) $W_{HS} = W_{KN} \times (982/1363)$= **29.941** kN

Consider load applied at outside edge of bracket and check bracket, weld to upstand and upstand itself.

Consider vertical weld of bracket to upstand

Weld Length	L_{WELD}	= 485 mm	
Fillet weld leg length	S_{LEG}	= 6 mm	
Weld Area	W_{AREA}	$= 2 \times L_{WELD} \times S_{LEG} \times$	= **4115** mm^2
Weld Modulus	W_{MOD}	$= (2 \times S_{LEG} \times \sin(45)) \times L_{WELD}^2 / 6$	= **332658** mm^3
Moment lever arm	L_{EVER}	= 225 mm	
Bending Stress on weld	F_{BW}	$= W_{HS} \times L_{EVER} / W_{MOD}$	= **20** N/mm^2
Shear stress on weld		$= W_{HS} / W_{AREA}$	= **7** N/mm^2
Combined stress on weld	E_{BW}	$= \sqrt{(F_{BW}^2 + Q_{BW}^2)}$	= **22** N/mm^2

Note:
Weld stresses calculated for the weld of bracket to upstand are very low and therefore acceptable. By simple observation if 2 No 6mm welds are acceptable parent plate, at 20mm thick, will also be acceptable.

me:	Project Number:
Title: le Design Checks	Page Number: Page 11 of 17
Number:	Rev: 00

65x40kg/m)

Fig A2.3 : Upstand arrangement

Load distribution (heavy side)	W_{HS}	$= W_{KN} \times (982/1363)$	= **29.941** kN
Lever arm to c/l column	L_{EVER}	= 377 mm	
Modulus of beam	M_{OD}	= 560500 mm^3	
Area of beam section	C_{SA}	= 5880 mm^2	
Radius of gyration	R_Y	= 39 mm	
Effective length (1.5x2194)	L_{EFF}	= 3291mm	
Allowable bending stress	P_{BC}	= 184 N/mm^2	
Ratio L/R	L_R	$= L_{EFF} / R_Y$	= **84.4**
Bending moment due offset	BM	$= W_{HS} \times L_{EVER}$	= **11287626** Nmm
Bending stress due offset	F_{BC}	$= BM / M_{OD}$	= **20** N/mm^2
With ref BS449 table 17a			
Max allowable compressive stress	P_C	= 97 N/mm^2	
Actual compressive stress	F_C	$= W_{HS} / C_{SA}$	= **5** N/mm^2

Note:
By observation the structural stresses within the UB Upstand are minimal and well within the appropriate code limits

The proposed design for Cradle Type C1 can therefore be deemed "capable"

fig. 14/ Example of software calculation sheets

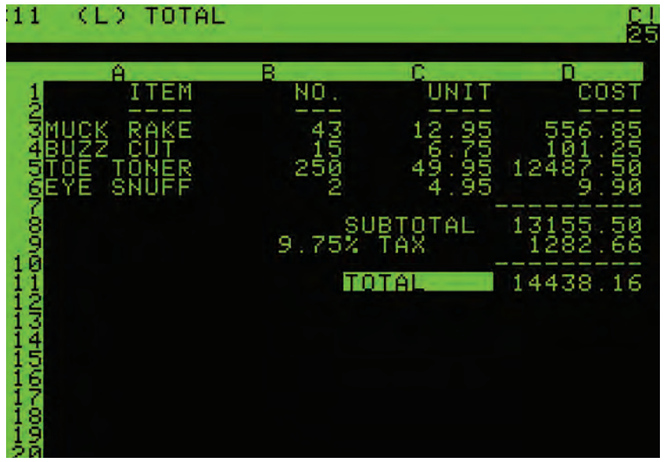
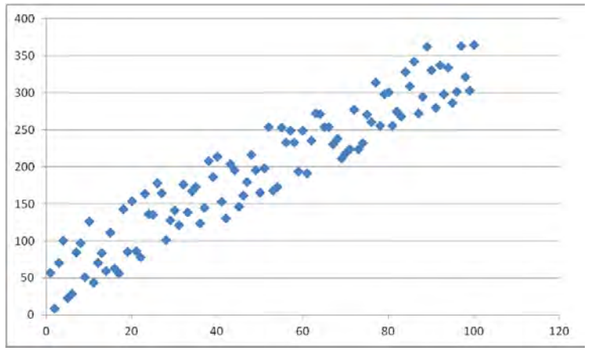
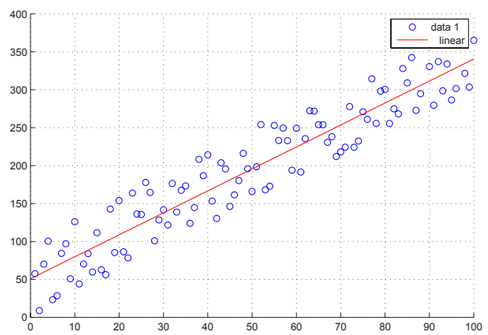


fig. 15/ Example of viscale software



EXCEL GRAPH



MATLAB GRAPH

fig. 16/ Comparison of Excel graph and Matlab graph

overconfidence in the robustness of their work (https://arxiv.org/abs/0804.0941).

The demise of the programming engineer as the norm rather than the exception is a real loss to the industry as a whole. Emphasis on programming and coding seems to have taken a back seat in many undergraduate courses where spreadsheets and GUI driven software is in the mainstream.

There is a huge variety of programming languages under offer that are exceptionally well suited to engineering applications without delving into the more esoteric offerings such as c++ or FORTRAN.

For line by line calculations, you have tools such as MathCad (www.ptc.com) which is ideally suited to replicate scientific hand calculations but in a format that is intuitive and conducive to peer review. Historically I have always found it to be troublesome for creating quality controlled documents, in that you would struggle to create templates that met any stylistic standard a company may have and left you resorting to trying to insert as a live document link, or create a pdf which was then attached to a word document. While it may have improved in recent years it is not optimal for many tasks such as batch processing large amounts of data.

Our preferred solution for writing up our technical reports is TEDDS (www.tekla.com) which replicates the engineer's traditional hand calculation in word processor form. It allows access to engineering libraries directly from within your word processor and also permits live calculation of formulas and expressions within your document. It allows you to develop a range of standard calculations and company or industry specific templates that you can error check and reuse many times over. It can be tricky to get started with, but for the right reasons (it enforces 'unit' logic for example in that if you divide a variable by another to get a force per square meter, it reports an error if the variables passed have not been defined as a force and area respectively).

For tasks such as post processing large amounts of data being spat out from a mooring study or finite element analysis to running automatically refined versions of a model through an API, I would highly recommend MatLab (www.mathworks.com).

It stands for MATrix LABoratory and, as such, excels at handling matrix manipulation, the cornerstone of many engineering calculations.

As well as allowing for data import and export in a wide variety of formats, it also has a wide range of engineering toolboxes for mapping, simulations and finite element methods. In fact there is likely a script for just about anything you could think of. The syntax is intuitive and has the ability to produce crisp and clear scientific graphs (another sore point...excel is absolutely one of the poorest choices for graphing in situations where anything other than a rough picture of what your data looks like is required).

Best of all, there is an open source program that looks to replicate MatLab functionality that you can download and try for free called Octave (www.gnu.org/software/octave). I have not used it extensively and would recommend that you take a trial license for MatLab as the documentation and coverage is that bit more complete.

I would close with this plea to engineering managers and lecturers everywhere...do us all a favour and kill Excel off for complex work. I for one am glad that I have left the days of trawling the sprawling engineering spreadsheets of others for mistakes behind me. Lets get our younger generation of engineers used to using tools that give them much more flexibility later in their careers rather than continuing to shoehorn into them tasks for which they were simply never designed.

HEAVY LIFT TIP
CRANE HIRE AND CONTRACT LIFT

If you are looking for a mobile crane to lift or move something, it is crucial that you know what your responsibilities are during the operation and the types of risk involved.

Crane hire is normally carried out under one of two sets of standard terms set down by the Construction Plant-Hire Association (CPA); namely CPA Crane Hire or CPA Contract Lift.

To determine which type of crane hire is suitable for you, you must understand the significant differences between the two:

CPA Crane Hire

Under CPA Crane Hire terms, you as the hirer are completely responsible for the hired crane once it leaves the public highway. You must handle a variety of important decisions concerning the operation of the crane, such as:

- choosing the correct crane,
- lift planning & supervision,
- arranging slinging and signalling,
- designating a trained Appointed Person to oversee the process,
- preparing Method Statements and Risk Assessments.

More so, the hirer must provide insurance for the crane, for the goods being lifted, as well as public liability.

CPA Contract Lift

Under CPA Contract Lift terms, much of the responsibilities are taken onboard and fully managed by the crane hire company. Although it can be more costly upfront than the CPA Crane Hire, it significantly reduces the risk of paying out later should something go wrong during the operation. The crane hire company will select a suitable model of crane for the goods being lifted, carry out lift planning & supervision, arrange labour for slinging & signalling, in addition to preparing Method Statements & Risk Assessments.

Finally, the crane hire company will also retain responsibility for any loss or damage to the crane, associated equipment, third party liability and (if agreed) insurance of items being lifted.

Note:
Provision of lift rigging is not normally included within terms of a Contract Lift and should be agreed between the parties.

fig. 17/ crane tandem lift of towhead subsea structure

COMING AUTUMN 2019

HEAVY LIFT MAGAZINE EDITION 2:

- HEAVY LIFT OPERATIONS - HOW INTEGRATED IS YOUR PROJECT MANAGEMENT?
- KEY HEAVY LIFT TIP - POACHER TURNED GAMEKEEPER
- CHALLENGES OF LARGE TURNKEY TRANSPORT PROJECT PART 2

To receive future exciting editions, please register at www.heavyliftengineer.com

A Malin Group PUBLICATION
SOUTH ROTUNDA
100 GOVAN ROAD
PACIFIC QUAY
GLASGOW
G51 1AY
WWW.MALINGROUP.COM