
RIWAL

Laying the foundations for improved soil management

Speaking with PES, Arran Armstrong, Technical Manager at 2H, addresses the challenges associated with soil conditions in offshore renewable energy projects. 2H is the independent advanced systems engineering brand within the marine energy and infrastructure group, Acteon. The unexplored locations of these projects require new geotechnical frameworks, making foundation installation risky and costly, meaning that early planning and thorough data acquisition to mitigate risks are important. How can innovative methodologies and close cooperation with its customers enable the company to handle challenging soil conditions effectively?

PES: Good to talk to you Arran. Perhaps I should start by asking, what challenges are developers seeing in relation to soil conditions in offshore renewables?

Arran Armstrong: There are a couple of challenges here, the first being many of the offshore renewable developments are outside of the traditional oil and gas energy basins, where many of the offshore geotechnical frameworks and methodologies were originally developed. Therefore, unexplored soil conditions are becoming more of the norm, meaning that new geotechnical frameworks must be developed, and industry-standard methodologies may need to be modified.

The other is the availability of vessels to acquire offshore geotechnical data, along with the capacity of the onshore soil testing laboratories. We have seen the availability of resources significantly influence the design of offshore site investigations, rather than the engineering requirements.

PES: In terms of cost and time, how do challenging soil conditions impact offshore renewable projects, and how does Acteon manage these factors?

AA: One of, if not the biggest, risk to a development is the installation of the foundations. As mentioned, many of the soil conditions that we encounter within offshore renewables have previously not been explored for foundation installation. This is where blindly employing traditional installation methodologies can increase the overall development risk considerably. In some cases, the selected foundation design, based on in-place performance may become unfeasible or significantly more costly and/or risky to install.

Acteon, through its independent advanced systems engineering brand, 2H, and marine foundations brands, MENCK and LDD, works with customers at the earliest possible stage, looking at installation performance/ feasibility of concept foundation designs alongside the in-place design.

We see in many cases the installation performance being the key driver for the selection of the foundation type, so this approach is crucial to the project success and schedule.

PES: How important is data collection and analysis in understanding and mitigating soil challenges offshore, and what role does Acteon play in this process?

AA: The data acquisition stage is critical for the engineering challenges we face in offshore renewables. Unless the site or region is well understood from previous campaigns, the scope of the offshore data acquisition should be fluid to some degree.

This is where we support our customers during the data acquisition stage, whilst the vessel is still in the field, to identify any potential in-place or installation risk to the foundations and recommend adjustments to the offshore scope to mitigate those unknowns or concerns, before the vessel departs the site. This approach is proven to significantly reduce project and design risk while minimising the impact on survey costs.

PES: Is there anything that can be done through data acquisition to minimise risk?

AA: Having a clear understanding of the complexity of the ground conditions, in direct relation to the engineering challenges is key here. The data acquisition, as well as subsequent onshore laboratory testing, should directly address the engineering requirements for in-place design as well as installation design. The specific requirements of the latter are often overlooked.

For example, during the installation analysis, we are generally more interested in the post-peak behaviour of the soil, rather than the peak behaviour used for the in-place analysis.

Basically, ensuring that design engineers with the right experience are involved with the data acquisition is fundamental.

PES: What approach does Acteon take to this?

AA: At Acteon, we see prior planning and strategy development as a critical endeavour. We perform preliminary desk studies to understand the complexity of the site conditions and undertake preliminary in-place and installation engineering assessments to define a clear strategy for the site investigation campaign. This strategy will be based on clearly defined engineering challenges and risks, via a foundation hazard register (FHR), rather than a generic data acquisition programme.

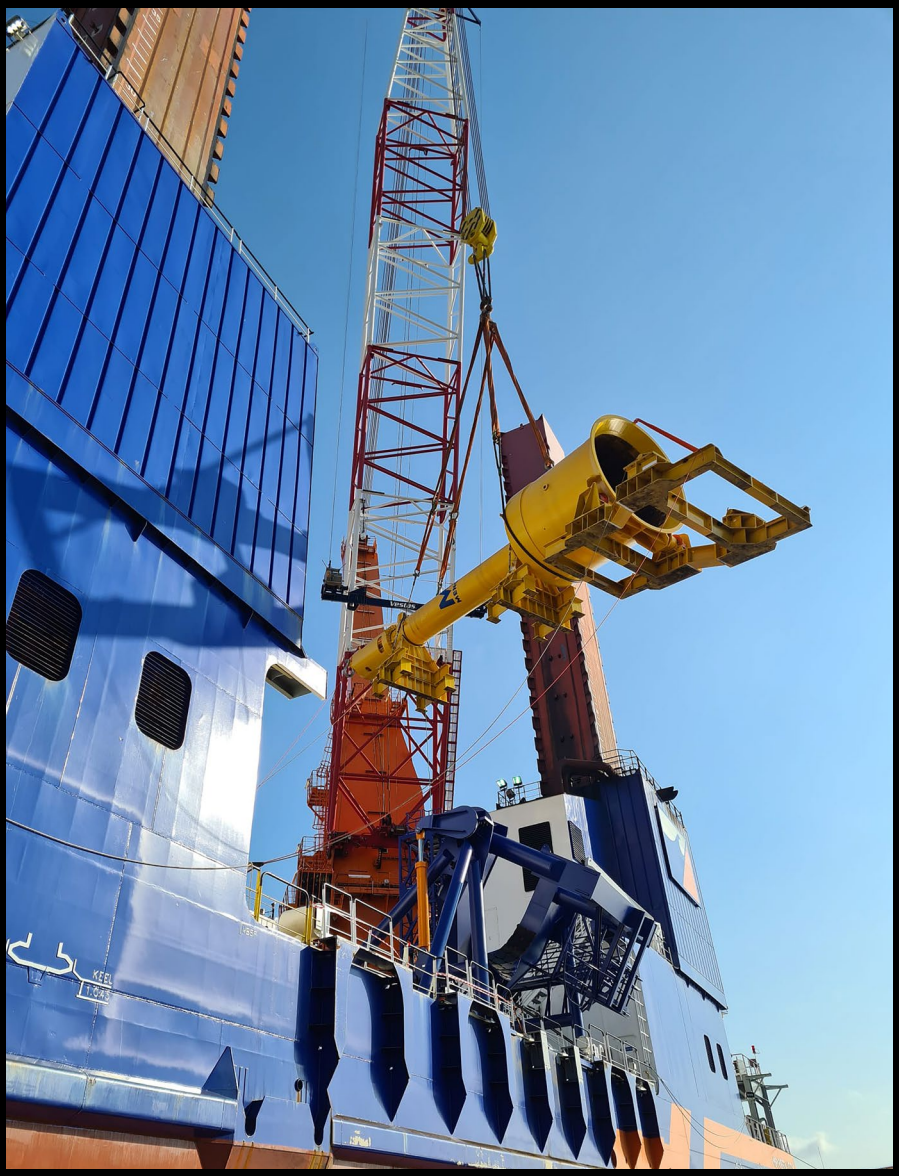
By reviewing the acquired in data real-time, updating the preliminary engineering assessments and FHR allows us to re-focus the site investigation objectives, if necessary, whilst the acquisition vessel is still in the field.

PES: To ensure the optimal selection of installation methodology and equipment, are there measures that can be taken?

AA: This is where the combined installation and engineering knowledge of 2H's experts provides our customers with the information they need to make informed decisions. But once again, this comes down to early planning during the development lifecycle, with consideration of what methodologies and equipment are likely to be suitable along with the limitations, challenges and risks associated with each. This includes the structural performance of the foundation solution.

As the project knowledge base increases regarding the soil conditions, the foundation type and size, fabrication and transport, installation method and performance and the installation vessel size can be better defined and the most efficient solution for the development can be selected. The installation performance and the associated risk profile may drive the foundation solution type.

Arran Armstrong



PES: Can you give us an idea of some key technologies or methodologies you employ?

AA: The renewables industry is advancing quickly with larger turbines, meaning larger foundations for fixed wind as well as the acceleration of the floating offshore wind industry requiring multiple anchors per turbine.

Monopiles for fixed wind are getting larger, and in some cases, it may not be possible to install them using traditional impact hammers. Depending on the soil conditions there may be requirements to use an impact hammer from MENCK in combination with a pile top drill, that LDD can develop and operate, to pass hard ground or initially use a vibrohammer to mitigate the risk of pile run.

We see floating wind anchors as most critically driven by efficiency, and most of this efficiency needs to be incorporated within the installation methodology phase. Although the geotechnical foundation size is reduced, the scale is still huge as floating wind turbines can have around three to six anchors each.

PES: Acteon offers specialist equipment, doesn't it?

AA: Yes, within Acteon we have several brands that provide specialist equipment; MENCK supplies impact hammers, LDD provide large-diameter drilling solutions and our Geo-services business line, provides construction support, geophysical and geotechnical data acquisition.

This is very useful from 2H's engineering perspective as we have all this real-world installation experience that we can draw upon to complement our in-house expertise and assist our clients during the engineering consultancy scopes.

PES: Do you collaborate with other stakeholders, such as developer

and engineers, to address soil challenges effectively?

AA: Very much so. We always work collaboratively, especially with equipment suppliers and our customers. The equipment suppliers generally have extensive practical experience that is so important in understanding and defining risk profiles, along with operational challenges that we may face.

We also work collaboratively with our customers and developers, in the first instance to enable their understanding of our expertise within geo-engineering, as well as structural engineering and help them to make informed decisions and identify potential risks within their developments. Conversely, it also helps our engineers at 2H to understand development drivers and risks, so we may better tailor our solutions and services.

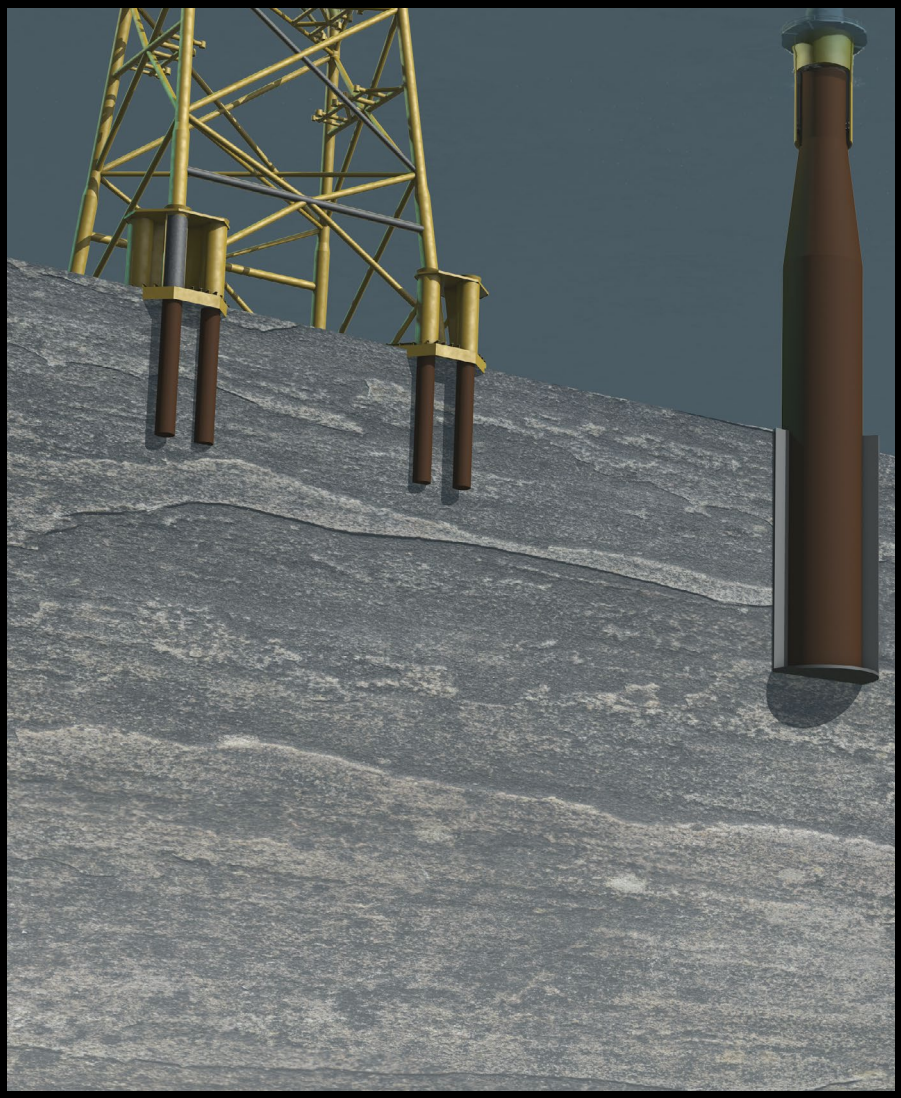
PES: It's often useful to hear about specific projects, if any come to mind, where Acteon successfully navigated challenging soil conditions in an offshore renewable project.

AA: Many of our customers approach us for our installation engineering foundation selection expertise, in many cases, their foundation design may have been selected and designed with very little consideration for the installation performance. We have worked on several projects where the soil conditions were outside of the traditional geotechnical frameworks. This is where we have gone back to the basic principles of soil mechanics and worked from there to develop a realistic installation engineering solution. However, in some cases, the installation may not be optimised as well as it could have been if the installation engineering had been assessed at an earlier stage during the foundation screening scopes.

It is also important not to view foundations as a purely geotechnical or geo-structural discipline. When all factors are considered on top of the geo-structural aspects, i.e. fabrication, transport, installation, recyclability, carbon footprint, and overall risk profile, the preferred foundation may change. We have worked on a floating wind project recently where a bespoke gravity base solution became the favourable solution to that of a drilled and grouted pile option. This was both favoured commercially and regarding risk profile when considering the factors mentioned.

PES: Are there alternatives when soil conditions prevent the straightforward installation of cost-effective foundations like monopiles?

AA: Monopiles are generally favoured for fixed wind as they are an efficient and cost-effective solution due to their ease of fabrication compared to other structures. However, the feasibility of a monopile



solution is generally driven by the soil conditions and its installation performance. When the monopile option becomes either unfeasible or unacceptably risky, jackets are usually the next favoured option. We are also working on projects where jacket structure feasibility is starting to move into deeper water past the traditional 50 to 60 m water depth for fixed wind.

PES: Has the effectiveness of 3D methodology been proven?

AA: The drive-drill-drive method, sometimes known as 3D, and/or relief drilling has been used for years offshore in the oil and gas and nearshore construction sectors. It has also been used extensively in the renewables sector for years, for both pin pile solutions for jacket structures and monopiles up to 8 m diameter, which were drilled using a pile top drill and then re-driven to target depth.

However, monopiles are getting much larger, between 12 to 15 m in diameter, so there will need to be another step change in drill design and fabrication.

PES: Do you think there are lessons that can be taken from mature markets like Europe, which can be adapted for application in emerging markets?

AA: The equipment, technologies and vessels are very much the same. However, how the engineering is applied and how that equipment is operated may have to change. This is where the danger lies, the risk profiles due to the soil conditions change, therefore the foundation selection may change, and the installation methodology may also change or require modifying.

The key here is that a blueprint of a European project would not be taken and applied to an emerging market. Ideally a blueprint of a process to assess the development risks due to soil based on their own merits would be taken. However, it should be noted that Europe has a vast range of ground conditions which are getting more complex due to the majority of 'easy sites' having already had offshore wind installed, so the engineering principles for immature markets should be considered within Europe as well.

Acteon is leading the way in many aspects, to firstly improve the efficiencies of existing technologies and methods along with advancing the next generation of installation equipment and tools.

PES: Could you elaborate on any inventive strategies or technologies being developed or employed to tackle demanding soil conditions in the future?

AA: Strategy is key. If quality soil and/or rock data across a development has been obtained, the first step is to assess what foundation solution would be feasible and which would be the most efficient for in-place and installation performance. This should be based on the technologies that will be available at the time of installation.

The key technologies that we see developing over the next few years are larger diameter pile top drills for monopile relief drilling. This would likely be for light relief drilling, as this approach may rapidly become inefficient if excessive drilling is required.

Many of the floating wind projects we have worked on will likely require the development of robust subsea drilling technology, especially in the presence of overburden and/or poor quality rock. The key to this technology will be efficiency.

The rest is down to strategy and optimisation of the foundation designs accounting for soil conditions for both in-place and probably more importantly, the installation challenges.

PES: Anticipating developments in this field, how is Acteon positioning itself to adapt to forthcoming trends and advancements?

AA: Acteon is leading the way in many aspects, to firstly improve the efficiencies of existing technologies and methods along with advancing the next generation of installation equipment and tools.

This includes combining geophysical and geotechnical campaigns to reduce delays between campaigns and improve data delivery efficiencies for clients. MENCK has developed systems to proactively identify pile run risk in the field, MENCK is also developing its next generation of monopile hammers. LDD is currently building its largest subsea drill for drilling sockets, and our 2H engineers are working with customers and suppliers to optimise designs, methodologies, and processes and build solutions with robust risk profiles.

Bruce Anchor, an Acteon Moorings and Anchors brand is undertaking various research projects to better define the performance and risk associated with using drag embedment anchors and plate anchors.

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