North of England Evening Meeting: Marine Renewables, Challenges & Opportunities

Evening Meeting, Newcastle

Department of Marine Technology, Armstrong Building, Newcastle University

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SUT North of England's Third evening meeting of 2017 was held at Newcastle University on a lovely summers evening in May. The event focused on the challenges and opportunities involved in designing, servicing and operating marine renewables in the harsh North Sea environment.

The audience was welcomed by the SUT branch chair, Michael Williams, Managing Director of PDL Solutions. He was followed by the chair for the evening, Michael van Zwanenberg, Principle Engineer at SMD who provided an overview of the evening proceedings and introduced us to the first speaker of the evening; Beth Dickens, Senior Engineer at Quoceant. Beth joined Pelamis Wave Power in 2001 as a graduate engineer; after 13 years developing the Pelamis device through design, testing and implementation, Beth joined Quoceant as a Senior Engineering Consultant. Beth's presentation focused on the challenges of developing, installing and operating wave technology for the offshore environment, with a specific focus on the innovative systems developed to connect and disconnect the Pelamis device in offshore conditions.

Beth's presentation was titled "Opportunities & Challenges of Wave Power: If I could tell you one thing". After a brief introduction, Beth jumped straight into an overview of the considerations when designing for the harsh offshore environment. Inspection and monitoring of the machine was pointed out to be of high importance as the majority of these services have to be carried out remotely in order to reduce the cost and response time. Beth also highlighted that, unlike wind energy, the Pelamis machine could not be turned off during violent storms, which results in a large range of operating design loads.

Beth began her narrative of the Pelamis design process by describing the initial installation and testing process. The first installation was conducted using a Dynamic Positioning (DP) vessel and took 56 hours to complete the process. Due to these installation times the install could only be completed in large windows of calm waters; this resulted in significant delays in deployment as the team waited for their window of opportunity. After the initial installation, the Pelamis and its connecting umbilical's were then monitored 24/7 by a team of 3 consultants. Beth explained that the initial testing of the design was conducted at low Hs (significant wave height) until the team was happy with the operation. The Pelamis device was then subjected to increasing Hs, addressing issues as they arose.

The monitoring team was subsequently replaced by sensors, Beth explained, this allowed the device to be monitored remotely from the shore. The remote monitoring system significantly reduced the operating costs of the project. The sensors were rigorously tested. So when rough seas caused a hydraulic ram failure the system picked up the failure and a replacement ram was deployed within 3 hours.

Beth then went on to describe that tethering the Pelamis was easier than it may appear; the design of the Pelamis means that the structure reacts off itself, which simplified the design of the mechanical connection.

The team's next aim was to reduce the installation time. This would allow installation in smaller windows of calm seas, which would significantly reduce the average time and cost spent waiting in the dock. A 30 minute electrical and mechanical connection time was targeted to minimise the cost of waiting; the design solution that made this aim achievable was to combine the mechanical and electrical connection into a single attachment mechanism. Beth described that as a result of achieving this target, the cost of energy at the socket was reduced by 20%.

Beth then went on to discuss her thoughts on the future of offshore renewables. The main targets are to further reduce the connection and maintenance times while increasing remote monitoring and sensors. Another concept Beth discussed was an active yaw system that could potentially provide 15% more energy over the year.

Beth's conclusion linked back to her presentation title, "If I could tell you one thing", by giving one piece of advice from each of the team leaders on the Pelamis project. The commercial advice; "Develop your strategy early". The design advice; "You think you know your load data, you don't!" The hydraulics advice, "Hydraulics leak, monitor them". The final piece of advice came from the finance team, "At the beginning you don't know, so you can be optimistic."

After a round of questions and a round of applause Beth then made way for Michael, who proceeded to introduce the second speaker of the evening, Andrew Hunt. Andrew is the Engineering Manager at Sustainable Marine Energy (SME) Ltd having previously worked as a Principle Engineer at Soil Machine Dynamics (SMD) Ltd for 16 years. Andrew's presentation focused on one of the key challenges facing installation of tidal energy converters- anchoring to the seabed.

Andrew's presentation was titled "Anchoring – Getting the foundations right!" Andrew began by discussing the inspiration for his anchoring solutions- PLAT-O. The PLAT-O device is a subsea turbine that was designed to operate in "the Goldilocks zone"- a sufficient height off the sea bed for the current to be significant but below the unpredictable surface waves. As such it needed to be tethered securely and cheaply. The traditional method, of using large concrete blocks to weigh the device down, is very costly due to the mass of concrete required (approximately 860t).

Andrew's team looked for a cheaper and less time consuming solution; eventually taking inspiration from an idea first used in the 1800s; a screw anchor pile. This method is used to secure a pile in soft sand/clay sea beds. Andrew found that the traditional screw anchor method is very good at taking vertical loads due to the large activation zone engaged by the screw thread; the main design issue was improving on the poor lateral strength of the traditional design. The team's solution to this problem was to add a taper

to the shaft, resulting in a larger shaft cross-section at the sea bed; increasing the lateral load resistance sufficiently.

Andrew then gave an insight into the installation process; the installation team were experienced geotechnical drillers, however installing piles via an ROV on the sea bed is a completely different challenge to installing them above ground. Traditionally, the installation team relied on the sound and tone of the engine to monitor the drilling process; this is obviously not possible on the sea bed. Andrew then explained how the team had to adapt their skill set to monitor the process using only the sensors installed on the ROV. The design concept was first installed and tested above ground, achieving around a 20t pull out force for a 3m pile. When installation was achieved with consistency above ground and only using sensor data, the team began to install test piles subsea.

The first PLAT-O device was installed off the coast of Yarmouth using screw anchor piles in 2015. Andrew's team then moved their focus to a new project; having designed a solution for a sand/clay seabed the team began work on a rock anchor pile. The development of the Raptor rock anchor solution was aided by the teams experience in developing the Screw anchor pile. Having already trained and developed a subsea drilling team, the first rock anchors were installed off EMEC in 2016.

Andrew explained that, in addition to being a more cost effective solution, the rock anchor pile is much more environmentally friendly; for every tonne of CO2 the screw pile creates, the traditional concrete solution would produce around 7000 tonnes of CO2. The cost of marine operations is also reduced from around £20K per day to £5K per day as less expensive vessels are required. A brief explanation of the advantages of using a grout free, fully removable solution was then given.

Finally, Andrew discussed some of his trepidations in moving from the R&D world into the commercial world. He concluded by informing the audience that as of 2017 the project had acquired their first commercial anchoring job and that the future looked bright.

Audience members were then invited to ask questions about Andrews's presentation. The interesting suggestion of a cartridge system was raised and the relative merits and challenges of such a system were discussed. As the discussions died down the evening was concluded.

Thanks to the speakers for their time and effort in delivering the presentations, and to SME and Quoceant for their kind sponsorship.