

# APPLYING CUTTING EDGE GEOSCIENCES (SLIPPERY FOUNDATIONS AND OTHER INNOVATIONS)



Report on SUT Perth Branch Evening Technical Meeting

Wednesday, 26<sup>th</sup> February 2014

*By Dr Ian Finnie, Perth Branch Committee Member*

To a packed house at the Hilton, Dr Ian Finnie from AG-Fugro chaired a whirlwind tour of innovations in geosciences at the first SUT technical event of the year. Ian was delighted to be able to thank the audience for turning up in their droves and introduced the 4 renowned speakers that they had come to hear. They were in for a treat.

The scene was ably set by Paul Brunning, the Geotechnical Discipline Manager for Subsea 7, drawing on more than 30 years of experience. Paul led with the fundamental question to the industry of who actually "owns" the risk of geohazards and seabed uncertainty, and how this is linked to the need for thorough site investigation. The scale of the problem was graphically illustrated when Paul showed a manifold foundation that needed to be bigger than an Airbus A320, all because the seabed surface had the strength of butter. This then ran onto the next challenge of how to install such a large foundation using conventional installation vessels. Much to the amusement of the audience, Paul then showed videos of some very badly behaved foundations that slid off uncontrollably into the distance when they touched mudline, like a pat of butter on a hot frying pan. As a segue onto the next speaker Paul introduced some of the cutting edge innovations that Subsea 7 is involved in with the University of Western Australia (UWA).

Professor Susan Gourvenec from UWA, co-author of the definitive book on offshore geotechnics, presented a toolbox of methods to optimise subsea foundation design. She dived into the complex theory behind shallow foundation response, and, without wishing to butter her up, showed-off her exquisite skills as a lecturer taking the audience through 6-degrees of freedom and the world of yield envelopes. In particular, Susan showed how the shape of these yield envelopes can be captured in elegant equations and then captured in engineer-friendly analyses, and how these types of methods should be bread and butter to practicing geotechnical engineers. Susan demonstrated how careful incorporation of internal foundation skirts or corner pinpiles can effectively bypass the soft and slippery layers that more often than not occur at mudline, and how relying on strength increases through consolidation between set down and operation can improve the engineering properties of soft seabed soils in situ and lead to stable and well-behaved foundations.

With a touch of irony, the next speaker, Dr Andrew Deeks, a principal engineer and technical authority from Advanced Geomechanics, challenged the convention of ensuring foundation stability, and how foundations could be designed to be slippery, using the weakness of the soft sediments spread across the seabed to your advantage. Andrew described how many subsea structures were connected to a wriggling network of pipelines, flowlines and spools; and that trying to rigidly interconnect these at discrete foundation locations was not always the smartest thing to try and do. Andrew first described the conventional mechanical fix to this problem by having sliding carriages on a fixed foundation and then the innovative technique of having a saucer shaped foundation with a base that is designed to slip across the mudline that can be as slippery as butter. Andrew then described the robust design methodology that has been adopted to prove-up these foundations, using corroboration with centrifuge model tests.

The final presentation of the evening was given by Steve Thomas of Fugro Geoconsulting who, with more than 30 years of experience in some of the most challenging seabeds around the world, painted the picture of how quantitative geohazard risk assessments could be rigorously performed. This drew us full circle to where Paul had started, with his question about who owns the risk. Ultimately whether or not a foundation is allowed to move on the seabed or not is immaterial if the seabed itself is unstable and, for instance, a debris slide could sever a pipeline like a hot knife through butter. Using a fascinating example, Steve illustrated how terrain mapping is used to understand geohazards and the ground model is populated through consideration of data from the widest range of scales and types, from geophysical data to microscopic core logging. Steve then gave several good-news stories of how experienced interrogation of data morphed a known-unknown risk that threatened project viability into an understandable and tolerable exposure. The closing technical comment of the evening was that assessment of active geohazards needs to be aforesought not an afterthought, and certainly before you get too carried away with detailed foundation designs.

The speakers all ran perfectly to time, despite being crammed into overly tight slots, and their thought provoking presentations yielded more questions from the audience than there was time for them to field. In the customary fashion Ray Farrier, Perth Branch Chairman, then called on the audience to thank the presenters for their contributions to what turned out to be a most excellent and enlightening evening, and setting the bar so high for the technical evenings to follow in 2014. He then invited the dialogue to continue in a more convivial setting, over drinks and nibbles provided by the generous sponsors of the evening, Advanced Geomechanics, Subsea 7 and the Energy and Minerals Institute (at the University of Western Australia).