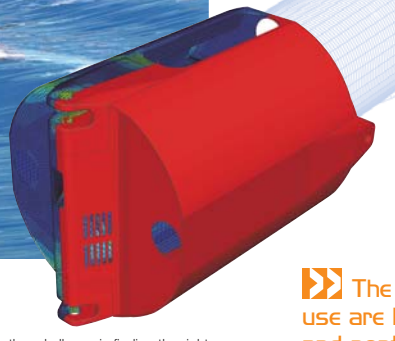
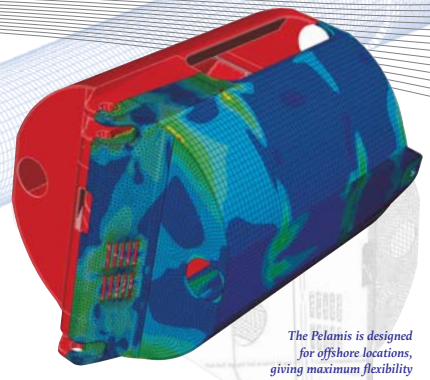
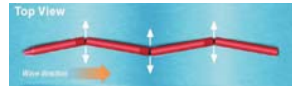


The Pelamis is a semi-submerged floating structure, composed of cylindrical steel sections linked by hinged joints.



The Pelamis is designed for offshore locations, giving maximum flexibility and scalability.



Harvesting the Power of the Ocean

Pelamis Wave Power Ltd chose Abaqus from SIMULIA to perform complex, nonlinear, finite element analyses (FEA) of its products and soon adopted it for all its design analysis needs.

Pelamis Wave Power Ltd (formerly known as Ocean Power Delivery Ltd) is an Edinburgh-based company founded in 1998 to develop a novel offshore wave energy converter called Pelamis. The Pelamis is a semi-submerged, articulated structure composed of cylindrical sections linked by hinged joints. The wave-induced motion of these joints is resisted by hydraulic rams, which pump high-pressure oil through hydraulic motors via smoothing accumulators. The hydraulic motors drive electrical generators to produce electricity.

Pelamis Wave Power has 75 employees with expertise in areas such as mechanical, structural, off-shore and hydraulics engineering as well as control systems and naval architecture. It positions itself as manufacturer and assembler of the Pelamis technology supplying machines to utilities and energy companies such as EDF or Scottish Power. Power projects consist of arrays of interlinked Pelamis machines known as 'wave farms'.

COST EFFECTIVE ENERGY OF CONSIDERABLE POTENTIAL

The World Energy Council estimates a large global market potential for wave energy of 2000TWh/year - similar in scale to the existing nuclear or hydroelectricity sectors. With one of the lowest 'opening costs' of any preceding technology PWP states that wave energy has the potential to be one of the most cost effective options over time - provided that there is volume deployment into the market. A key challenge that has faced the company is not just the technical challenge of producing a good quality reliable product but the need for political support to create the 'feeder markets' necessary for first projects. Another challenge is finding the right place to install a wave farm. PWP works with project developers to select sites which meet certain criteria such as the availability of grid capacity, wave energy levels that produce the highest yield of electricity, and sites that do not interfere with other water users such as merchant shippers, fishing fleets and recreational users. Also important are environmental concerns, which is why environmental impact studies are normally required in order to obtain a permit to install and operate a project at a site. "We believe our technology has the potential to be one of the most environmentally benign forms of electricity generation", said Max Carcas, Business Development Director at PWP. "We make sure that we have no greases or fluids in direct contact with the seawater. This is why everything is sealed and the fluids we do use are biodegradable and nontoxic", he adds.

To develop a Pelamis machine, PWP begins with an initial concept which comes from either information received from prototype testing or from existing designs to which performance improvements for certain climatic conditions need to be added. The initial design is then tested both computationally and with scaled prototypes during tank tests where large waves are simulated and nonlinear behavior is observed. Once the global machine is defined, PWP engineers design the key machine components. This is where most of the finite element analysis is done and where they incorporate input from the different departments such as hydraulic systems, electrical layouts and production assembly requirements. Since the lifespan of a machine can reach 20 years, PWP performs a considerable number of design iterations on some components that are put to the test with respect to fatigue performance and stress analyses. Once the global design is complete, PWP creates the detailed design, which to date has been independently verified by third party consulting firm, WS Atkins. The Pelamis is then assembled and installed by PWP's offshore and installation team who also perform all maintenance activities.

> The fluids we do use are biodegradable and nontoxic.

DIGITAL MODELING AND SIMULATION WITH ABAQUS

PWP's modeling program combines advanced numerical work with computer simulations with extensive use of experimental models. Numerical modeling is a vital part of the program as it allows rapid design evaluations and optimizations to be made. Much of the testing PWP performs revolves around nonlinear analyses which is why it turned to SIMULIA. "We needed to extend our finite element capabilities and Abaqus from SIMULIA was, by far, the best solution available", said Jon Benzie, Senior Engineer at PWP.

"It allows us to analyze "what-if" scenarios of nonlinear behavior that we cannot test for such as a ship driving into a farm of machines. Even though this is highly improbable, it is nevertheless a remote possibility and for safety reasons, we need to be able to design our machines to resist this type of impact", he adds.

PWP also selected Abaqus because of its sub-modeling capabilities, which allows it to perform extensive and highly focused studies on the different sub-parts of a machine thereby increasing the precision and reliability of the data. The software's extensive material modeling capabilities are also important to PWP since they need to experiment with different materials for machine design to understand the behavior of new materials as they seek to make machines as efficient, cost effective and environmentally sound as possible. Finally, PWP was impressed with the technical support provided by SIMULIA, a deciding factor in its choice for the solutions from the Dassault Systèmes brand.

"Abaqus has become the global finite element package at PWP, which we now use for practically all our analysis needs", said Jon Benzie "We use it for initial concept analysis, general design work, detailed design work and what-if scenarios. We are also looking to expand the types of analyses we can do by tying it into our dedicated in-house analysis program to directly model machine behavior in the waves. By coupling this with Abaqus, we should get direct results of the machine's structural component-level behavior hence providing additional stress and fatigue analyses", he concludes •

For more information:
www.pelamiswave.com