N/Ref: FEM-2017-376

Object: Internship- ***Cable stability and sea floor hydrodynamics***

Context:

Tidal current kinetic energy is harnessed by means of tidal turbines. This energy is then converted into electrical energy and exported to the grid onshore by medium to high voltage export cables.

Since tidal energy sites are dominated by strong current velocities, little sediment is observed on the seabed which is generally rocky. Consequently, the sea floor is stiff enough to prevent any cable embedding.

In this case, the cable is highly exposed to hydrodynamic loads and may have unstable behavior following fluid/structure interactions.

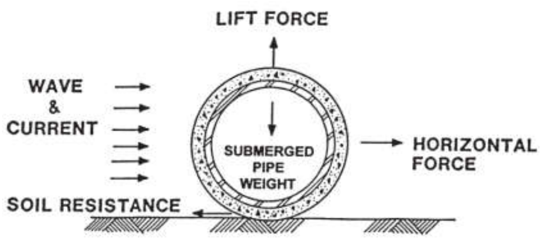
This topic has been extensively investigated in the framework of the offshore oil & gas industry's use of rigid underwater pipelines, thus providing a solid reference basis.

Nevertheless, the fluid dynamics of tidal sites are significantly different and highly turbulent while the electrical cables are more flexible than steel pipe- both of which induce new physical couplings.

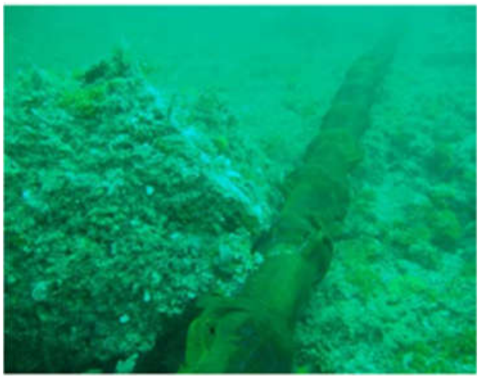
The numerical model of fluid/structure interactions needs to be improved accordingly in order to predict the occurrence of instabilities. If predicted, a related need is to assess the cable's ability to withstand the associated loads and displacements.

These developments require validation through experimental testing in current/wave flumes.

The proposed scope of work for this internship is addressed in the STHYF project coordinated by France Energies Marines (FEM). This project has been awarded funding dedicated to Marine Renewable Energy research in 2016 by the French national research agency (ANR) and is currently undergoing.



Source: I.R Soedigdo & al "Prediction of hydrodynamics forces on submarine pipelines using an improved Wake II Model"



Source: EDF – Paimpol-Bréhat

Internship Objectives:

The fluid dynamics of tidal sites are very specific for the following reasons:

- Typically shallow water depths;
- Chaotic local bathymetry is encountered by the fluid (macro-rugosity) thereby inducing a relatively thick turbulent boundary layer;

- These areas are defined as convergence zones of several current flows thereby inducing a strong turbulent intensity;
- The wave kinematic is still significant near the seabed due to the shallow water depths.

Combined, these cumulative parameters render the fluid dynamics highly complex and illustrate the need for a better understanding of the system.

The first stage of this new internship is to consolidate a proposed bibliography and methodology, and investigate a non-linear wave-current model against real data. Flume experiments will be undertaken in 2018 and will be used to validate the models developed in the project. Some CFD computation could also be performed in collaboration with the academic partner (ENPC) for the characterization of the free-stream turbulent flow and the evaluation of the flow-cable interaction.

Following this, the intern will participate in the definition and implementation of an innovative numerical model for the cable loads evaluation addressing these flow dynamics.

Finally, the intern will participate in the adaptation of the methodology and associated analytical models into an engineering software (Principias' Deeplines) and perform a cable stability study based on realistic test cases provided by the industrial partners.

References:

Guillaume Damblans worked as project engineer and manager in the hydrodynamics/mechanics engineering company PRINCIPIA and covered a wide range of technical issues encountered in offshore, MRE and naval domains. He developed an expertise in fluid/structure interactions in managing technically three collaborative research projects on the VIV and Galloping phenomena.

He is now the manager of the research program "Tools for technologies design for MRE applications in France Energies Marines".

G.Damblans, C.Berhault, C.LeCunff, B.Molin, P Wiet, A.Cinello, T.Deglaire; JL. Legras "Investigations on galloping of non-circular cross sections" OMAE 2013.

M.Z.Shiraz, S.Etienne, B.Molin, G.Damblans, D.Pelletier "Rotational Galloping of Square and Bundle Cylinders in Cross-flow at Low Reynolds Numbers" ISOPE 2014.

Nicolas Relun is an expert in structural and fluid mechanics, especially in the realm of catenary line vibrations in air. He also developed the aero/elastic models used by EDF to design its own floating wind turbine solutions. He is now the project manager of the Paimpol-Bréhat and Normandy tidal turbine deployments.

Nicolas Germain has worked over 10 years in Oil and Gas and shipping industry worldwide. He specialized in wave-current interaction in physical oceanography (MSc) and in multi-physics approaches for maritime applications. He coordinates the STHYF project on FEM-side.

Internship supervision:

This internship will be supervised Nicolas Germain (MRE array layout and network integration program manager at FEM) and Nicolas Relun (EDF R&D), Scientific Manager of the STHYF project. Guillaume Damblans will also provide scientific and technical support.

Duration and location:

The internship duration is approximately 6 months and the starting date is as soon as possible (ideally beginning of 2018).

The intern will be hosted at France Energies Marines, located at:

15 rue Johannes Kepler
Site du Vernis
Technopôle Brest-Iroise
29200 Brest

Application process: send your CV and a cover letter to the following electronic account:

contact@ite-fem.org