PRELIMINARY STUDY OF MOORED POWER CABLES

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Abstract. New green energy sources deployed at sea, in mobile platforms, will use power cables in order to transport the energy generated at sea surface to the bottom. Theses power cables will be exposed to the dynamic behaviour of the platform movements, due to waves, currents and wind. A preliminary study of the static behaviour of these cables in function of parameters like mass, bending stiffness, length, water density or seabed friction is presented in this article. Simulations are been done with Orcaflex 9.4 environment. Three different cables have been simulated to observe their deformation and forces.

1. Introduction
Simulation of the static and dynamic behaviour of the cables due to marine conditions has to be done before the actual cable became manufactured, in order to identify critical parameters, like forces or curves that the cable will suffer. Parameters that will be studied and shown on this paper, at different graphs, will be: tension on superior-end (End A), maximum curvature radius, X coordinate of seabed contact, and per cent of cable with seabed contact.

2. Cable and Environment Parameters Definition
Static simulation has been done for different environmental densities in order to be able to compare results. For the subsequent static studies, 2 environments: have been defined: sea water and air with densities shown at Table 1. Two different frictions values were defined, for low and high friction (Table 2), and two cable lengths (Table 3). Finally three bending stiffness were defined as are shown in Table 4. At this paper, only the Sea Water environment results are shown.

Environment	Density	Units
Sea water	1025	kg/m³
Air	1,3	

Table 1. Environment data study table

Friction	Value
Low	0,005
High	0,25

Table 2. Seabed friction data table

Cable type	Length [m]
Cable 1	25
Cable 2	40

Table 3. Table of cable type data

Cable study	Diameter [m]	Bending stiffness [kN·m²]	Mass·Length [kg·m]
1	0,1	0,1	22
2	0,1	0,7	22
3	0,1	7	22

Table 4. Analysed cables properties Table

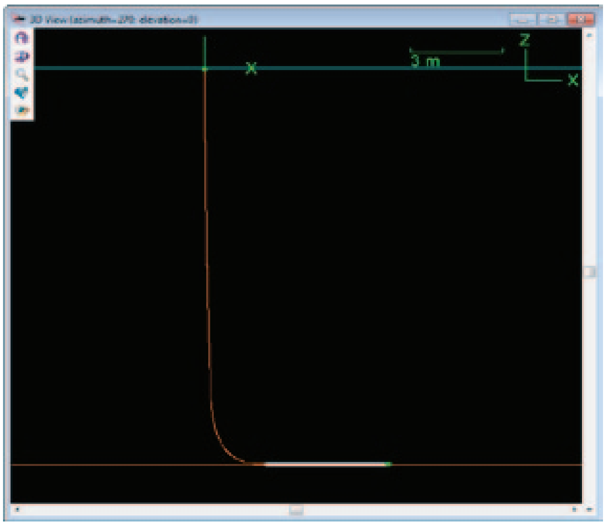

Figure 1. Hang down cable

In order to evaluate the relation between different parameters a static simulation has been done with OrcaFlex software. A hang down cable was defined, as shown in Figure 1.

3. Static Simulation Results
Different parameters were studied and its relations with other parameters. The upper cable part is defined as the point "EndA", and the lower part of the cable, which has contact with the seabed, is defined as point "EndB". Forces at EndA are a key point, and it is very important to know how theses forces change in relation with the cable length, cable bending stiffness, and seabed friction. These results are shown in Figure 2, where it can be seeing the incidence of cable friction with the seabed, and also the cable bending stiffness. For this simulation, point EndA is fixed at sea surface, and point EndB is free, and can be move in function of cable movements. In this first graph, it can is possible to see the tension that the first end cables suffers, for each different cable, and having different seabed friction between cable and seabed.

It can be seeing how EndA cable tension changes for taken into account cable length and its seabed friction. For EndB free, we can see that tensions are quite constant in function of bending stiffness.

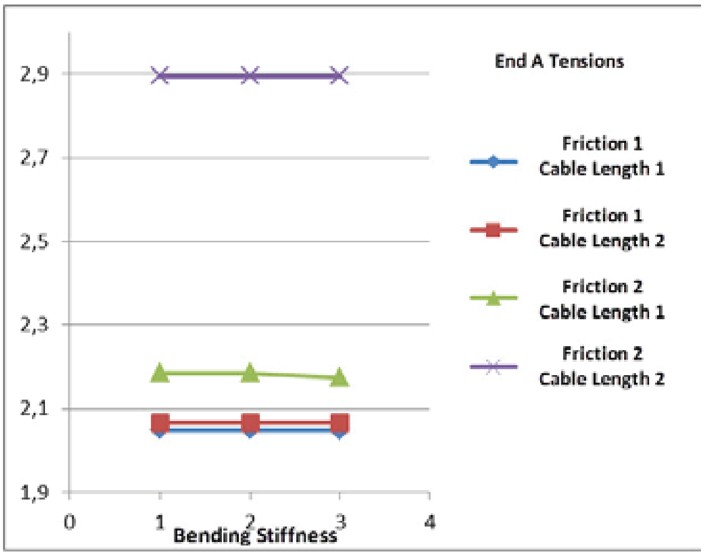

Figure 2. Cable Tensions at EndA in kN

At Ffigure 2, the X coordinate contact point with the seabed is shown. At this case, the bending stiffness parameter is quite important in order to define the cable curvature and the seabed contact point.

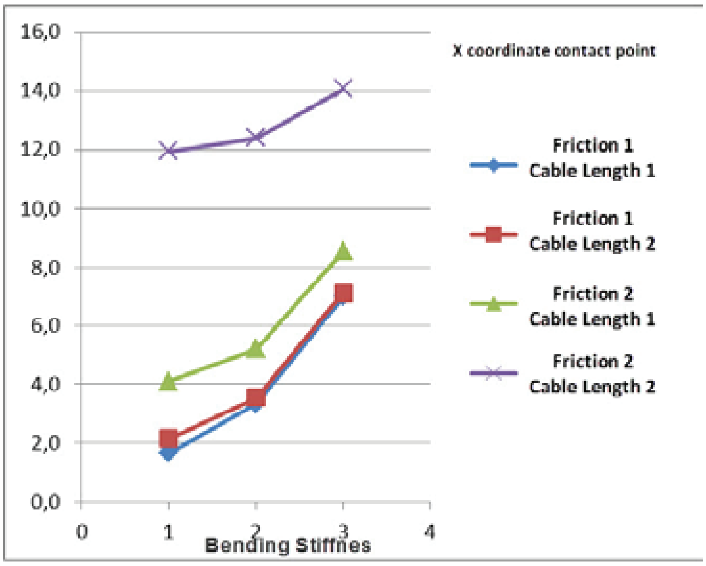

Figure 3. X-coordinate with seabed contact

Another important parameter is the cable curvature and to know how it changes. Figure 4 shows the curvature radius of each cable and as the same way as the before cases, it has to be considered how important is the bending stiffness, the seabed friction and the cable length.
As can be seen, for the bending stiffness lower values, the curvature radius is higher. From this graph can also explain the fact that a higher curvature, the curvature radius is lower and this fact also happens is the relation is changed.
In order to conclude the preliminary results, percentage of cable that has a seabed contact is shown in figure 5. In the same way of previous cases, it shows the difference between the studied frictions, bending stiffness and the cable length.

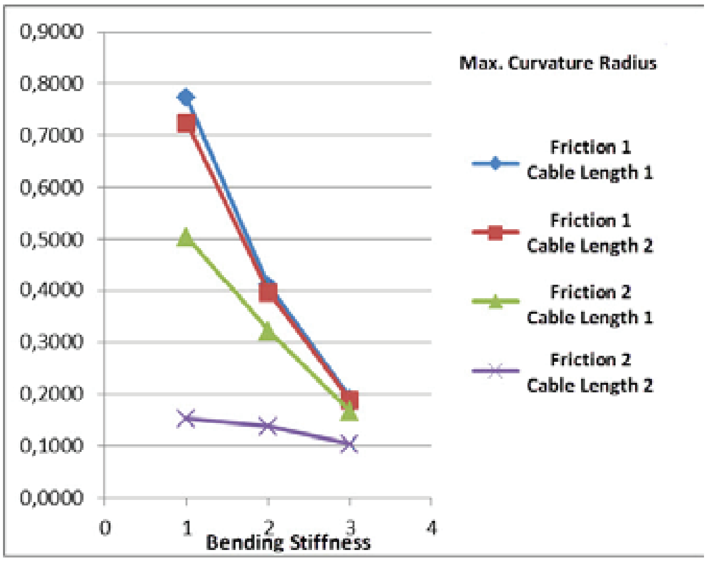

Figure 4. Maximum curvature radius graph

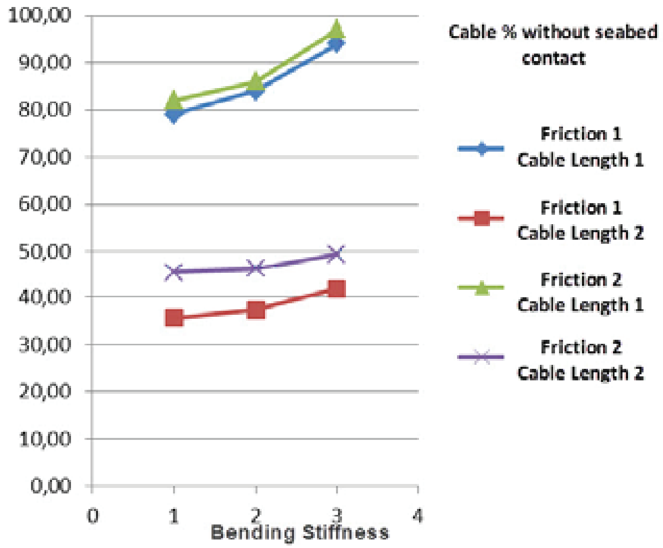

Figure 5. Cable percentage without seabed contact

4. Conclusions

After the preliminary simulations, some conclusions about power cable parameters and its relations are presented for this specific test situation with EndB point free.
EndA forces are function of seabed frictions and for this reason have to be considered. About cable curvature radius, the maximum value is always produced with higher bending stiffness. The seabed contact point for the static situation varies with different seabed frictions and cable length.
These results give us valuable information in order to define the next simulation phase, where EndB point will be fixed to seabed and the decision about where will be the EndB point position fixed.

References

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