

## DESIGN OF AN EQUIPMENT TO PERFORM CREEP EXPERIMENTS IN SYNTHETIC YARNS SUBMERGED IN LOW TEMPERATURE WATER

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**Summary:** *Unlike most metallic materials, some synthetic materials are known to exhibit a very prominent creep behavior. Additionally, among many other variables, this type of effect is highly dependent on the material temperature. The aim of this work is to study the creep behavior of synthetic ropes used in the anchorage of offshore platforms working in deep and ultra-deepwater. In these regions the low temperature of the water affects directly the behavior of the synthetic materials when subjected to permanent tensile loads. These results are shown in a displacement-time graph, in which the three creep phases are identified by the slope of each curve. The creep test is characterized by the application of a static load with the purpose to observe the deformation of the synthetic material over time. The loadings applied in this paper are relative to 5%, 20% and 45% MBL (medium break load of the material). To perform such test, this paper details the project of an equipment in which the specimens will be positioned vertically and submerged into water at  $4^{\circ}\text{C} \pm 1$ . The load will then be applied in a lever-type mechanism. This type of system is relatively simple and requests a minimum friction between its mechanical components. The data are recorded by a digital system during the test time.*

**Keywords:** *creep, synthetic material, low temperature*

### 1 Introduction

The Stress Analysis Laboratory POLICAB, in partnership with the Brazilian petroleum industry (Petrobras), aims the study of synthetic ropes applied as mooring lines in offshore platforms. Among the different studies carried out in the laboratory, the most important are tension tests, creep, quasi-static stiffness and fatigue of subropes and yarns.

This work aims the design of an equipment to perform creep tests in synthetic yarns submerged in cold water (typically  $4^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ). The conditions imposed to the samples must be the most similar as possible to the real applications to which the mooring ropes will be submitted in service in deep (until 2000 meter) and ultra-deepwaters (deeper than 2000).

The first prototype was designed to test the specimens in the horizontal position, as to facilitate their submersion, however, some problems regarding friction in the load applying mechanism were detected, as well as galvanic corrosion in the bearings and rollers. For that reason, it was decided to design a new prototype taking into consideration the vertical placement of the samples, with the load applying mechanism outside the tank and, thus, without any contact with the cold water.

Each set of tests will be performed in three different yarn samples, each of which submitted to 5%, 20% and 45% of the yarn break load (YBL). The YBL must be determined a priori, in virgin samples, after a total of 30 tension tests up to the rupture of these yarns.

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## 2 The apparatus

The apparatus designed will be consisted in a simple steel structure constructed as a pivoted horizontal lever of equal length arms (1 meter). At the end of one arm, the yarn sample will be positioned vertically, and the load will be applied to the end of the other arm, thus applying a 1 : 1 proportion between the load applied and the load to which the yarn will be submitted. As to facilitate the simultaneous test of three different samples, three separate structures are to be built, with all the three yarns submerged to the same water tank. Figure 1 shows the three dimensional model of the equipment, with only one lever displayed.

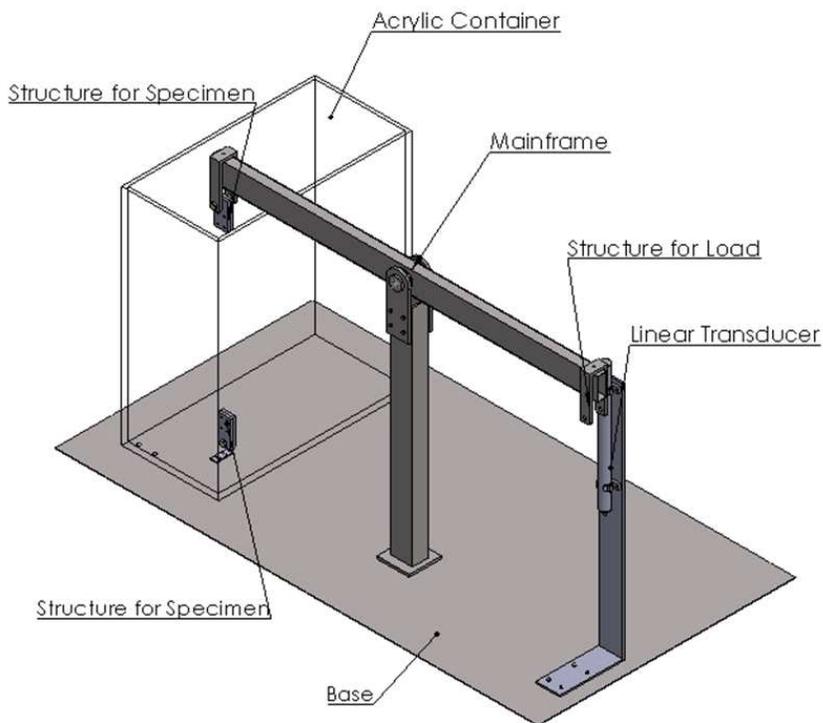


Figure 1: Overview of the equipment

Regarding galvanic corrosion, it can be avoided with the proposed configuration, since all the components in contact with the water will be built of stainless steel and the water tank will be of acrylic.

### 2.1 Refrigeration and data acquisition systems

A refrigeration system must be present in order to keep the water at test temperature ( $4^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ). That will be made with a thermopar placed inside the water tank to send the refrigeration system the signal to turn on or off. To maintain certain homogeneity of the temperature of the water in the tank, a water pump will be used to keep the water circulating between the tank and the refrigerator.

The hydrostatic pressure is not considered in the present study.

Three different data acquisition devices will be used, such as linear variable differential transformer (LVDT), electronic data register and desktop computer.

### 2.2 Samples

The yarn samples have 500 mm length with extremities made with the "sandwich" technique developed in Policab and the diameter depends on the sample material (Figure 2).

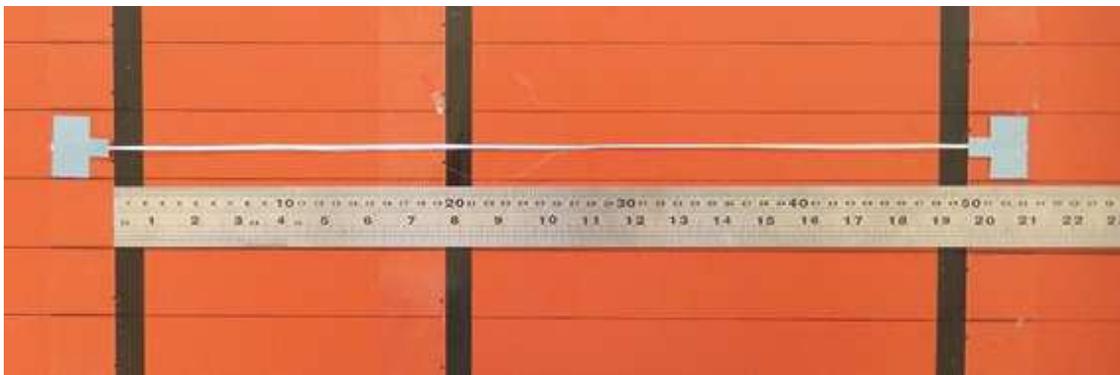


Figure 2: The yarn sample

### 3 Tests

Determination of the YBL:

- Samples tested: 30 samples;
- Controlled Environment:  $24^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ,  $55\% \pm 2\%$  relative humidity;
- Torsion: 60 torsions per meter;
- Test speed: The yarn samples have 250 mm/min;
- Distance between clamps: 500 mm.

Creep test procedure:

- Samples preparation;
- Apply the loads of 5%, 20% and 45% of the YBL to the three yarn samples;
- Turn the water cooling system on;
- Positioning of the samples in the lever structure;
- Turn data acquisition system on;

At first, the data will be acquired within one second interval, and later within one hour interval. The experiments with loads under 50% YBL, typically last approximately 23 days.

### 4 Conclusion

After the construction of the equipment and preliminary tests are approved, the Deformation versus Time curves will be plotted for each yarn. Later, these results will be compared with tests performed in yarns not submerged in water for the purpose of comparison.

### 5 Acknowledgment

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