BENDING STIFFNESS OF SUBMARINE CABLES.

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ABSTRACT

The development of HV large section three core power cable, to connect wind farms to the shore, requires a precise knowledge of the mechanical parameter, such as the bending stiffness. Specific test equipment has been developed and is presented here, in order to provide accurate measurement of the flexural characteristics of the cables. The measures are performed at various speeds and maximum deflections and have been applied to various types of cables. The experimental results show that bending stiffness depends on many factors such as bending amplitude, speed of the deflection (that is cycle frequency), ambient temperature and preconditioning of the sample.

KEYWORDS

Bending Stiffness – Submarine cables – High Voltage – Mechanical properties - Measurement – Cable Modelling.

INTRODUCTION

The installation of HV large section three core power cable necessitates a precise knowledge of the mechanical Bending Stiffness (BS), in order to use appropriate equipment and procedures.

The apparatus developed to measure the Bending Stiffness is an innovative implementation of the three points bending method, where the cables are bent in the horizontal plane (Fig.1).

At the extremities, the sample is pivoting on two specifically designed rolling supports: the deformation is easily modeled as a beam and the Bending Stiffness can be computed once the applied force and deflections at the center of the sample are measured.

To characterize the BS of a cable, two series of measures are performed at constant speed, with varying maximum deflection, and at constant maximum deflection, with varying maximum speed.

CHOICE OF THE BENDING METHOD

The approach of designing a bending machine based on the three point bending method is given by practical considerations and precision targets. In fact, this solution is adaptable to a broad range of cable diameters and rigidity, has pivoting fixing points that allows flowing of the core and armoring and does not introduces longitudinal forces.

Due to the broad range of cable constructions and subsequent bending stiffness values, cable samples of various lengths can be tested simply changing the separation between the pivoting supports at extremities.

For special cases and research studies, the same apparatus can be used to measure the same cable again, once the armoring has been removed or temperature is changed with air flowing into a flexible plastic pipe placed around the cable.

The most difficult challenge that this method bypasses, is to firmly block the rotation of one extremity of the sample, without affecting the sample integrity and preparing devices for doing that for all cable diameters.

CABLE ARRENGMENT

The cable sample is supported by specifically designed rollers, in order to minimize the friction and allow large deflection and precise measurement on a broad spectrum of deformations (Fig.1).

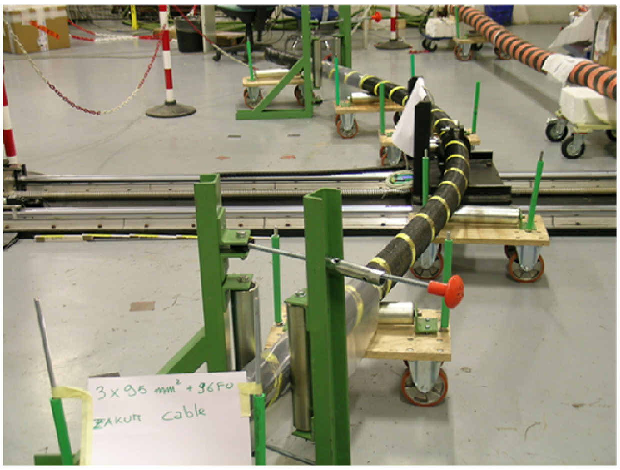

Fig.1: Arrangement of the cable sample for bending stiffness measurement

Due to specific preliminary stretching, it is supposed that the cable starts from straight configuration at no load.

The value of the separation between the supports has to be more than 20 times greater than the outside diameter of the cable: that is required for a good execution of the bending tests, in order to have a long enough cable sample.

A minimum length of at least 2 times the diameter of the cable has to emerge beyond each support, for good contact between cable and rollers.

The axis of one of the second roller can pivot around the axis of the fixed roller, thus keeping the distance between the two rollers constant (Fig.1).

This innovative solution allows also studying cables subjected to creep, where self-deformation can affect the measures if it is performed in the vertical plane.