

Fatigue, Internal Stresses and Deformations of Electrical Umbilicals: Analytical Work

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ABSTRACT

This paper reports the analytical part of a development project into the design and fatigue performance of composite umbilicals. A computer model of an all-electrical, symmetrical umbilical subjected to various axial loads and bent around sheaves of different diameters has been developed. Relative sliding between the cores and stresses due to bending and friction is calculated.

INTRODUCTION

Over recent years, umbilicals have been increasingly used in many offshore applications worldwide for subsea control, chemical injection, etc. The failure of these components in a remote subsea installation can be extremely expensive both in lost production and rectification.

Unfortunately, insufficient knowledge of the complex behaviour of umbilicals has often led to defective design, manufacture, installation and operation. A report from the Engineering Research Centre, dated July 1990, states a high percentage of failures for umbilicals (Knight et al., 1990). With these failures, investigations were of course carried out. However, it became obvious that some form of planned R & D was necessary.

Since 1985, BP Norway Ltd, ABB Norsk Kabel and EFI, which is a part of the SINTEF Group, Norway, have run a project in order to achieve a better understanding of the behaviour of umbilicals and to try to reveal factors having a great influence on the life of umbilicals.

It was decided, as a start, to concentrate on electrical umbilicals, both unarmoured and armoured, and to try to determine the stresses and the fatigue life of an axially loaded umbilical running back and forth over a sheave. If this problem could be solved, it was expected that more complex umbilicals and other types of bending problems could be included in later phases.

The problems were attacked both analytically and experimentally simultaneously. This parallel running of investigations

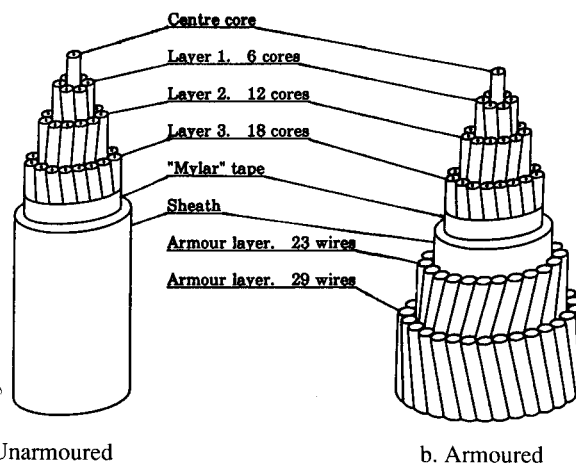
turned out to be very successful.

The analytical work, which will be presented in this paper, had to be based on several assumptions and unknown parameters. Some of these could be tested directly; others could only be tested indirectly by observing which assumptions and parameter values gave correspondence between calculation and test results.

UMBILICAL DATA

Fig. 1 shows the investigated umbilicals. The centre core and the three inner layers consist of polyethylene insulated copper conductors with a copper section area of 1.5 mm^2 . The conductor was solid, 7-stranded or multistranded. The number of cores in each of these inner layers was 6, 12 and 18, and the lay lengths

2. UMBILICAL DATA



a. Unarmoured

b. Armoured

Fig. 1 Investigated umbilicals

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