

Bending fatigue testing of large diameter steel wire rope for subsea deployment applications

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ABSTRACT

Steel wire rope together with active heave compensation has been used for subsea deployment applications for many years. This results in cyclic bending over sheave loading being a major influence on the lifetime of the rope. As the requirement to install heavy subsea hardware in deeper and deeper water increase, there is a need to use large diameter steel wire rope as part of the deployment system. Many of the new fleet of construction ships are equipped with steel wire ropes in excess of 100 mm in diameter. Assessment of the fatigue life of such large diameter wire rope is uncertain due to the lack of suitable bend over sheave test data. This paper presents the results from a full scale bending fatigue investigation with 109 mm steel wire rope at tensions up to 330 tons, including the details of the fatigue testing system it was necessary to construct to perform the testing. One of the main findings from the testing was the significant influence of heat build up in the rope. This led to an extensive investigation into the thermal behaviour of the rope, which will also be presented in the paper. In addition the paper will also draw conclusions relating to the life time assessment of large diameter wire rope for subsea deployment applications.

KEY WORDS: Large Diameter Wire Rope Bending Fatigue Tests

NOMENCLATURE

A&R	Abandonment and Recovery (of pipelines)
BoS	Bending over Sheave
CBoS	Cyclic Bending over Sheave
D/d	ratio of sheave diameter over rope diameter
HC	Heave Compensator
ISO	International Standards Organisation
MBL	Minimum Breaking Load
NDT	Non-Destructive Tests
SF	Safety Factor
t	Tonnes (metric)
WL	Working Load.

INTRODUCTION

Large diameter wire ropes up to 125 mm diameter are used for deepwater construction and A&R activities on deepwater construction vessels. Often low-rotating multi-strand ropes (see Fig. 1) are used in a single-fall arrangement.

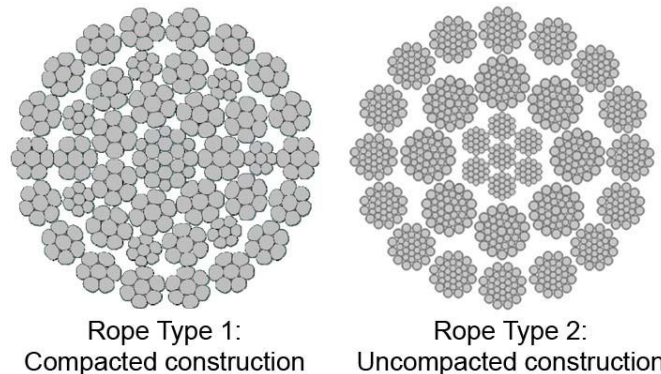


Fig. 1: Multi-Strand Rope Constructions

There are a number of new offshore construction vessels, such as the Polar Queen shown in Fig. 2, which are equipped with single fall deployment systems capable of deploying structures in the range of 300T to 400T to the seabed. In many cases the deployment system incorporates a heave compensation system. The configuration of HC systems involves routing the wire around a system of sheaves. The magnitude of the loads to be deployed results in the requirement for large diameter steel wire rope. This in turn results in the practical limitation of the size of the sheaves which in general is restricted to a factor of 20 times the rope diameter. The D/d ratio of the sheaves has been found to be a significant parameter in the bend over sheave behaviour of steel wire rope. A literature search indicated that very little data is available on bending fatigue performance of ropes with such large diameters. Several sources were found presenting bending fatigue results of smaller diameters (Gibson 1980, Potts 1990, Müller 1961, Feyrer 1985) however very little experience was documented on ropes over 90 mm diameter. As a result it was concluded that it was necessary to obtain fatigue data for large diameter steel wire ropes. Further investigations showed that no such test facility was available to