On Modelling Alternatives of Non-critical Components in Dynamic Offshore Power Cables

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ABSTRACT

Modelling alternatives for non-critical components in dynamic offshore power cables are systematically investigated with the aim to clarify the extent to which these components in finite element modelling (FEM) should be considered depending on the purpose of the analysis. Level of simplification, choice of element type and determination of contact stiffness are among the key parameters when modelling such components. Mesh sensitivity on sheath layers, filled bodies and tensile armor wires is carried as well. Their effects on physical properties of the cross section, stick and slip characteristics of helical components are investigated. Axial stress in the tensile armor wires is particularly studied. Software program UFLEX is used for the investigation.

KEY WORDS: dynamic; offshore; power cable; filler; finite element modelling

INTRODUCTION

Offshore power cable in this paper refers to the power transmission lines in offshore oil and gas and offshore wind industry. It represents a critical component for power transmission between either the floating unit, such as FPSO or floating wind turbine on ocean surface to subsea facilities, such as wellhead or subsea power grid, or the onshore power supply plant to offshore power distribution system. The power cable is also often used to transmit the power over a long distance on the seabed. A typical power cable consists of a power core, strengthening components such as tensile armor wires, insulation elements and protection sheath. The power core usually consists of three conductor bundles and each bundle may be formed by another three conductor units. The conductor unit consists of several layers of helically stranded copper wires, manufacturing tapes, insulation layers, screening tapes and protection sheath, as illustrated in Fig. 1.

Fig. 1 Schematic illustration of a typical power cable

Due to the complexity of the power cable cross section, structural analysis of cross-sectional components is often difficult to be performed by analytical solution. Instead numerical tools are usually used for the analysis, particularly finite element (FE) programs including general purpose FE programs and special purpose FE program such as UFLEX (SINTEF Ocean, 2018).

FEM SOFTWARE PROGRAM UFLEX

UFLEX is an FEM software developed by SINTEF Ocean during 2000s serving as a numerical tool for estimation of stresses of functional components for stress and fatigue assessment of complicate cross section umbilicals and cables (SINTEF Ocean, 2018). Stress calculations by UFLEX has been validated by comparing the analysis results with full scale laboratory tests (Saevik and Bruaseth, 2005). The software provides different alternatives to model the cross-sectional components within an umbilical with arbitrary geometry. In addition, interactions between components are properly handled when the cross section is loaded by combination of loads like actual condition. One key feature