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## A New Method of Testing for Change-in-Length Properties of Large Fiber-Rope Deepwater Mooring Lines

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### Abstract

A spring-dashpot model is proposed to represent the change-in-length properties of polyester fiber rope. The model comprises four units arranged in series – a dashpot representing long-term creep, a spring-ratchet unit representing construction stretch, a spring-dashpot unit representing response to slow loading, and a spring representing response to fast loading. The change-in-length characteristics of the rope under any sequence of loading can be described using the model.

The spring-dashpot model is not intended to be used directly for design analysis of mooring systems. Instead, the model is intended to represent fundamental change-in-length characteristics of the rope. These characteristics can be presented in tables, graphs or equations which can then be used in calculations or computer simulations of mooring system response.

The characteristics of the model's four units and thus the fundamental change-in-length properties of the rope can be determined by a series of short tests which need only be performed once for a particular rope design. Once these fundamental properties are determined, they can then be used without further testing to calculate the change-in-length performance of that rope in response to various installation, operational, and extreme-event (e.g. loop current or hurricane) sequences.

These fundamental properties can be used in preliminary design, final design, and in-service analyses. If deemed necessary, the properties can be confirmed after the rope design has been selected by conducting additional tests on a prototype rope using the actual (expected) loading sequence. This approach will avoid time-consuming and costly testing of alternate rope designs during preliminary design.

The model concept, the test method, and the calculation procedure are now being developed and verified as part of a JIP. The model is being tested on components of large polyester ropes typically used in deepwater mooring lines. The test method and calculation procedure will be documented as a DNV Offshore Standard.

This paper will be of interest to mooring system designers, platform operators, rope manufactures and users, and regulatory agencies.

### Introduction

This paper describes a spring and dashpot model which represents the change-in-length characteristics of large polyester ropes.

This model does not represent the actual components of a polyester rope. But it does perform much like the change-in-length characteristics observed in actual polyester rope. Thus it is a useful tool to represent, describe and understand these characteristics.

The change-in-length characteristics represented by the model can be determined by rope testing. They can be represented by tables, graphs, or equations. They can then be used in calculations for designing and analyzing fiber rope systems, particularly deepwater mooring systems.

The model is comprised of four units, arranged in series, as shown in Figure 1. These are :

- \* a separate dashpot unit representing creep
- \* a parallel spring and ratchet unit representing construction stretch,
- \* a parallel spring and dashpot unit representing slow response to tension
- \* a separate spring unit representing fast response to tension.

The creep dashpot represents the creep characteristic of the rope. This creep is a property of the polymer fibers which make up the rope. Polymer creep takes place whenever tension is applied and maintained on the rope. The rate of creep of polyester fiber decreases over time and is essentially negligible after a short time. This dashpot is called the creep dashpot unit.

The ratchet arranged in parallel with the construction spring allows that spring to stretch in response to the highest tension applied to the system. But the ratchet