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Deepwater Moorings with High Stiffness Polyester and PEN Fiber Ropes

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Abstract

The benefits of synthetic fiber ropes for deepwater station keeping are now well established and their use is expanding. Nearly all current applications use a single grade of polyester fiber, but for different supports and environments this may not be the optimal choice. Properties of polyester fibers can be modified by adjusting processing parameters and there are other fibers available such as PEN, which offer higher stiffness. This study examines the benefits of intermediate stiffness fibres, stiffer than standard polyester but less stiff than the high performance fibers. The results indicate that there is scope for improving mooring line performance and reducing line weight by careful evaluation of material options.

Introduction

Polyester fiber ropes are finding increasing applications in offshore mooring systems as production moves to deeper water. Following successful installations offshore Brazil in the late 1990's [Pellegrin 1999] the first Gulf of Mexico mooring was for the *Mad Dog* spar [Bugg 2004] in 2004, which employed 1200 tons of polyester down to 1670 meters water depth. The recently installed *Independence Hub* platform also used polyester moorings, in 2440 meters water depth [Paganie 2007]. Different rope constructions have been used but these mooring lines were all composed of similar high tenacity polyester fibers. The *Red Hawk* spar [Haslum 2005], also installed in 2004, used a modified polyester fiber with a higher initial stiffness to facilitate installation, and this raised the question of whether a higher fiber stiffness might be beneficial for other supports and allow rope diameter to be reduced. Previous work within the French Mooring line project [Davies et al 2002] studied high performance fibres such as aramids and HMPE and concluded that their very high stiffness, while allowing much smaller rope diameter and weight, did not improve durability as it would result in high fatigue loading of the metallic components of the mooring line. However, there is an intermediate stiffness region, shown in Figure 1, situated between the currently used fibres, with initial tensile modulus around 10-15 GPa, and the high performance fibers (> 60 GPa) which has not been explored previously for deepwater mooring applications.

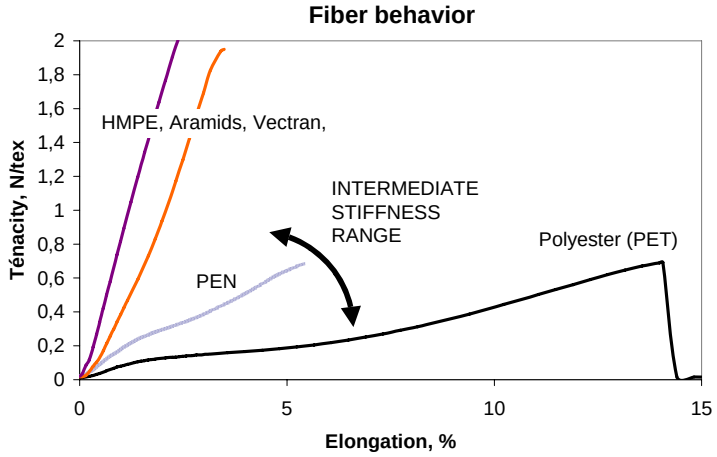

Figure 1. Available fiber properties and unexplored intermediate stiffness region