ABSTRACT

In 2002, several mooring chains of a deepwater offloading buoy failed prematurely within a very small time frame. These chains were designed according to conventional offshore fatigue assessment using API recommendations. With this first deepwater buoy application, a new mooring chain fatigue mechanism was discovered. High pretension levels combined with significant mooring chain motions caused interlink rotations that generated significant Out of Plane Bending (OPB) fatigue loading. Traditionally, interlink rotations are relatively harmless and generate low bending stresses in the chain links. The intimate mating contact that occurs due to the plastic deformation during the proof loading and the high pretension of the more contemporary mooring designs have been identified as aggravating factors for this phenomenon.

A Joint Industry Project (JIP), gathering 26 different companies, was started in 2007 to better understand the Out of Plane Bending (OPB) mooring chain fatigue mechanism and to propose mooring chain fatigue design recommendations.

This paper summarizes the quasi static OPB stiffness measurement campaign and the post processing work to derive the OPB interlink stiffness.

INTRODUCTION

Out of Plane Bending (OPB) of a chain link refers hereafter to the bending of a chain link out of its “main plane” (the plane containing the oval shape, see Figures 1 and 4). It is caused by the application of transverse forces and OPB moments which are resisted by frictional forces at the contact between links.

In Plane Bending of a chain link (IPB) is related to the bending of a chain link inside its “main plane”. This type of loading was also considered within the frame of the project. This loading is however less severe for fatigue because the nominal stress related to IPB is approximately seven times smaller than the nominal stress related to OPB loading (in line with the bending inertia ratio). Both OPB and IPB fatigue loadings are experienced in addition to the conventional chain tension fatigue mechanism.