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Sensing and Understanding Fatigue Lifetime of New and Converted FPSOs

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Abstract

From the very beginning of offshore exploration it has been well-known that permanently moored offshore installations are continuously subjected to sea actions. However, this has not prevented many FPSOs suffering from fatigue damage and costly repairs. Often operators are surprised by such failures because hull integrity monitoring systems are not installed. In addition, industry records show that many structural monitoring projects have floundered because they did not have effective data processing and interpretation tools. The paper describes how to change this situation.

Introduction

Traditionally ships were designed without explicit requirements with respect to fatigue failure. The Class Societies (CSs) took care of that by demonstrating that ships are implicitly safe against fatigue failure when stresses are lower than allowable stresses associated with the Ultimate Limit States (ULS). In author's opinion this historical fact explains still continuing lack of awareness in the maritime community with respect to fatigue. With growing variety of ships, their operational conditions and application of new materials it became more and more difficult to keep fatigue requirements implicit. Therefore, CSs issued explicit requirements with respect to fatigue. However, most of them are still non mandatory.

In the same time when explicit fatigue requirements were being introduced, the offshore industry started to convert tankers to FPSOs and later started to design new built FPSOs. A higher awareness of the offshore industry with respect to fatigue made these fatigue requirements for FPSOs mandatory. This was supported by the fact that FPSOs are continuously subjected to sea actions without possibility of dry docking for inspections and repair. However, the industry record shows many FPSOs suffering from fatigue damage and costly repairs (e.g. Hoogeland *et al*, 2002, Newport *et al*, 2004 and Hoppe *et al*, 2004). A key to understand this lies in uncertainties associated with the fatigue design practice and used safety factors. Unfortunately one has to wait to see how the application of the most recent codes (e.g. DNV, 2004 and 2005) will change the industry record.

Fatigue design practice

The fatigue design practice involves multiple calculations and requires different input data as shown in Figure 1. This complexity itself can already be used as an argument to treat the present design practice as *qualitative* rather than as *quantitative* process to predict fatigue lifetime. Hence, one should not be surprised with the industry record showing many FPSOs suffering from fatigue damage. In the author's opinion this premature explanation is certainly a valid explanation but not the complete one.

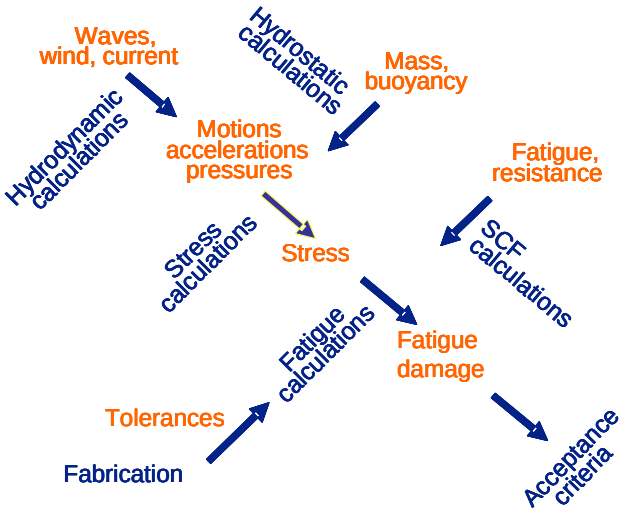

Figure 1. Elements of fatigue design

The fatigue design starts with a structure which is designed based on satisfaction of CSs rules based on ULS and offshore yard's practice. This means that fatigue design is actually a check which aims to demonstrate that FPSO's structural details show sufficient lifetime. How to do this is described