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Long term effectiveness of life extension methodologies applied to offshore structures

P.J. Haagensen [a,*], J.E. Larsen [b], O.T. Vårdal [c]

[a] NTNU, N-7194 Trondheim, Norway
[b] Statoil, Bergen, Norway
[c] Axess, Bergen, Norway

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ABSTRACT

This paper documents developments in fatigue cracking of a floating platform that required repair and upgrading during 1999–2000. The Veslefrikk B (VFB) platform was built in 1985 for drilling exploration but was converted to a production platform in 1989. Shortly thereafter extensive fatigue cracking was discovered and several repairs were made. However, extensive fatigue cracking continued and a retrofitting program was implemented, using various types of grinding and peening techniques. In 1999 the platform was temporarily decommissioned and dry-docked for a comprehensive repair and upgrading program, following the International Institute of welding (IIW) guidelines for weld improvement methods [1], this was completed in only four months. However, after a few more years of service fatigue damage again necessitated new repairs. The majority of cracks occurred in the hull skin plates and caused water leakage. It is noteworthy that cracking this time occurred only in areas of the structure that were left untreated in the first retrofitting program due to low levels of stress from FE analyses in these areas. The paper describes the original repair and strengthening program, and the types of subsequent fatigue damage that necessitated new repairs. The recent life extension program has resulted in the safe operation of the platform for an estimated additional period of 20 years.

1. Introduction

The Veslefrikk (VFB) B platform is a conventional type of double hull floating platform structure consisting of two pontoons with four large diameter vertical columns, a deck and a bracing system (Fig. 1). Similar to a ship, this type of structure experiences different loads dependent on the heading relative to the waves. As a production platform the VFB platform was moored in a fixed direction, (Fig. 1b), and consequently exposed to higher structural loads than a free floating platform that would be positioned in the direction of the waves under severe environmental conditions.

The highest loads occur at the corners where the columns are connected to the pontoons, and the first incidents of cracking were discovered in the pontoon deck plates near the columns. Later cracking took place in various locations near the columns. In preparation for the upgrading and strengthening of Veslefrikk B extensive stress analyses were performed using finite element methods (FEM) to identify areas of high local stress. New buoyancy elements had to be added to compensate for the increased weights caused by the extra weight of supplementary production and processing equipment, the new structural configuration is shown in Fig. 2. Areas that were subjected to severe cracking are indicated in Fig. 3. FEA plots are shown in Figs. 3 and 4, indicating highly stressed areas.

* Corresponding author.
E-mail address: per.haagensen@ntnu.no (P.J. Haagensen).

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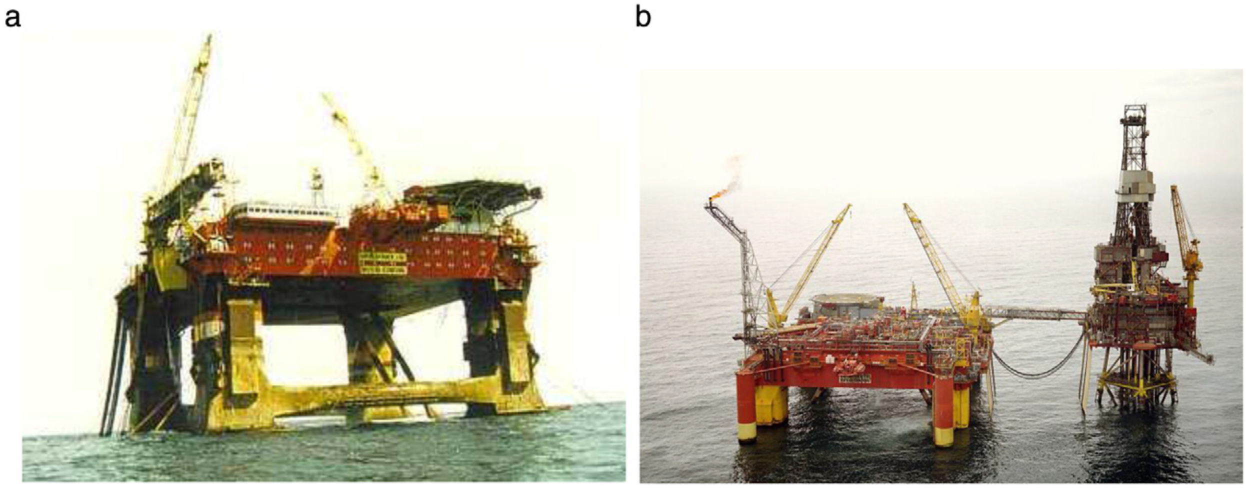

Fig. 1. The Veslefrikk B platform; a) at sea in position for maintenance work; b) after repair and upgrading, moored in place near the Veslefrikk A platform. Note extra columns added to VFB A for stability.

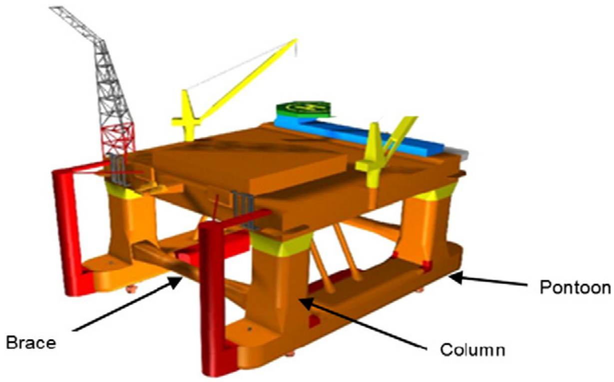

Fig. 2. Structural modifications to the Veslefrikk B platform.

To carry the higher loads in the structure cast steel inserts were introduced in the areas of highest stress in the corners of the pontoons and columns. The size and shape of the inserts were determined on the basis of finite element analyses (FEA), an example of a stress plot is shown in Fig. 4. One of the larger inserts is shown in Fig. 5. The more refined analyses also indicated higher stress levels than initially assumed in the braces and intersections between brace and column.

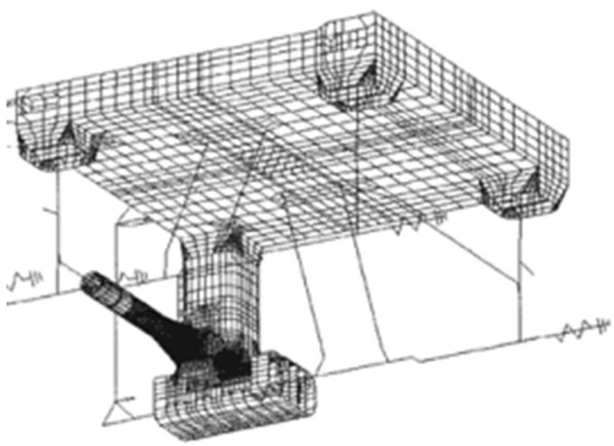

Fig. 3. Finite element analysis plot of part of the platform, indicating high stresses in brace to column and pontoon region.