

FATIGUE LIFE ASSESSMENT OF A DRILLING RISER CONTAINING CORROSION DEFECTS: PITS, PATCHES AND GROOVES

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ABSTRACT

Due to the lack of acceptance criterion in the international codes for thickness losses caused by corrosion in drilling risers, the practices and solutions usually applied during the drilling operations are, in general, conservatives. The code API RP 16Q just mentions that an acceptance criterion is required, but does not establish limits.

This paper presents a fatigue study of a drilling riser having corrosion defects, by evaluating the influence of the defect size in the fatigue life. The results show the possibility of extending the operational life of the riser joints, which would have to be otherwise replaced.

KEY WORDS: Drilling Risers, Fatigue Life, Corroded Risers, Stress Concentration Factor.

NOMENCLATURE

CG	- circumferential groove
d	- defect depth
D	- annual damage
kips	- 1000 lbs
OD	- outside diameter
RP	- rectangular patch
SCF	- Stress Concentration Factor
t	- wall thickness
σ_L	- longitudinal stress
σ_R	- radial stress
σ_H	- hoop stress

INTRODUCTION

During its service life, drilling risers are almost inevitably subjected to corrosion attacks. Corrosion represents a threat to the riser strength because it produces a reduction in the riser joint wall thickness. At Petrobras, the structural assessment of corroded drilling risers is getting an increased importance due to the frequent occurrence in drilling risers in Campos Basin of corrosion defects with depth above 20% of the nominal wall thickness.

Due to the lack of an acceptance criterion for wall thickness reduction caused by corrosion in the international codes, some riser manufacturers recommend the substitution of the joints with wall thickness reduction above 12.5% of the nominal thickness. This

criterion is excessively conservative because applies to a corroded riser joint in operation the same wall thickness tolerance that is applied to a new pipe, manufactured in accordance with the API Specification 5L. Furthermore, the API RP 16Q does mention that an acceptance criterion should be agreed upon between operator and drilling contractor, but such criterion is not defined.

In this context, the authors have been studying fatigue of drilling risers having defects caused by corrosion in the base metal. This paper presents the fatigue life assessment of a drilling riser presenting corrosion patches. Stress Concentration Factors (SCF) are calculated using solid Finite Element models and the fatigue analyses are performed considering wave loads and Vortex Induced Vibrations (VIV) caused by current velocities along the water column.

This study was developed for Petrobras owned semi-submersible drilling rig. The results show the possibility of operational life extension of riser joints that would have to be replaced by the usual acceptance criteria.

METHODOLOGY FOR FATIGUE LIFE ASSESSMENT

The methodology used is not new. It has already used to assess corrosion in pipelines. However, no application to drilling riser was found in the technical literature.

In the fatigue process, the geometry of the analysed region is very important due to the stress concentration effect. In drilling riser joints, the geometry of the connectors and welds should be considered. The defects caused by corrosion also induce stress concentration and need to be taken into account in the fatigue analyses as well. The defects can be depicted by finite elements models (FEM), and the SCF are calculated using these models. Another approach would be to consider the defect as a crack initiated within the corrosion area and then to analyse through fracture mechanics (Ávila, 2005).

The fatigue analysis of a tensioned riser is performed considering the damage due to wave loads and VIV. In general, these two analyses are calculated separately and, by simplification, the damages are added.

The procedure for fatigue life assessment of corroded drilling risers involves many disciplines because it deals with global analysis for calculation of wave fatigue, modal and VIV fatigue analysis, besides finite element analysis.

This multiplicity and its interactions can be observed at the flow chart that summarizes the utilized methodology (Figure 1).