**Design Method of an Expansive Stressed Grouted Clamp on a Joint of a Jacket Platform**

Chuan Jie Zhang¹, Hong Hui Zhang², Xiang Shi², Jian Ren Chen² and Lei Zhou¹

1. Engineering Company, Offshore Oil Engineering Co. Ltd., Tanggu, Tianjin, China;
2. Engineering College, Ocean University of China, Qingdao, Shandong, China

**ABSTRACT**

This paper introduces the design method of an expansive stressed grouted clamp on a joint of a jacket platform. The general design requirements are summarized initially. Then the four design principles are put forward. The principles including the verifications of slip capacity, bolt prying force and crushing loads help to determine the basic dimensions of clamp structure. The structural strength is checked by finite element method referring to the principle of structural strength. A design example that the clamp is used for repairing a K-joint of an offshore jacket platform located in the Bohai Sea is introduced to make a clear description of the design process.

**KEY WORDS**: underwater repair; platform joint; expansive stressed grouted clamp; design method; strength analysis

**INTRODUCTION**

The stressed grouted clamp is a kind of strengthening and repair technique for offshore structure, which has been proved to possess the advantages of a high tolerance of imperfection and high slip capacity (MSL Engineering Ltd., 2004). However, for the traditional clamp, the self-stress is established on grout by the bolts pretension, and the divers and operating vessels have to wait for slurry solidification for about 48h after clamp fitting, thus the underwater operations are complicated. For this matter, it is suggested the expansive agent is added in the cement slurry, therefore the self-stress is established automatically by expansive grout instead due to the expansion constraint. Such kind of clamp called expansive stressed grouted clamp (Yang, et al., 2010) would be convenient and reliable, helping to save the time waiting for slurry solidification and tensioning the stud bolts for a second time. Accordingly, the construction efficiency is improved and the construction cost is reduced.

Elnashai et al. (1985) conducted the earliest study on grouted connection using expansive agent. The related experimental studies were carried out at Monash University in the behavior of such connections under static loading, fatigue loading and under elevated temperatures (Zhao, et al., 2002). Jiang et al. (2011) summarized the mechanical properties of the grouted pile-to-sleeve connections under axial load, combined loads and cycling load according to the test results. Shi et al. (2010) tested the expansive pressure and the corresponding slip stress of clamp using a new expansive agent with different percentage of content. The expansive stressed grouted clamp with short bolts, possessing advantages of low steel consumption and easy installation, was found to produce relatively larger expansive pressure and obtain a larger slip stress (Yuan, et al., 2013). And the slip capacities of the short-bolt-type expansive stressed grouted clamp models were tested under different agent contents and different slenderness ratios (Shi, et al., 2015).

This paper aims to summarize the design method of an expansive stressed grouted clamp on a joint of a jacket platform. As shown in Fig. 1, the expansive stressed grouted clamp with short bolts (Yuan, et al., 2013), which is designed in this paper, is a wrapped structure based on the shape of damaged structure, split longitudinally. Bolts on the symmetric flanges connect the two halves of clamp. The space between the clamp saddle plate and the damaged inner tube is filled with cement slurry mixed with expansive agent. The radical self-stress at grout/steel interface is established automatically when the expansion of grout is constrained.

![Expansive stressed grouted clamp with short bolts](image)

**Fig. 1 Expansive stressed grouted clamp with short bolts**

**GENERAL DESIGN REQUIREMENTS**

**General rules of design**

It follows the general rule that the clamp is designed to be able to sustain the full set of loads extracted from the undamaged structure on the ultimate working state instead of having the original structural component share the loads together.

The rule is put forward conservatively by taking account of different