Fatigue and monitoring of SPM

Michele Rizzo
DICEA University of Florence, Florence, Italy

Ostilio Spadaccini
DICEA University of Florence, Florence, Italy

Paolo Castelli
EDISON SpA, Siracusa, Italy

ABSTRACT
Near the offshore production platform Vega A, the tanker FSO Leonis is moored to a steel column with circular section, 130 meters high and 10 meters in diameter, installed in 1988 in the Sicilian Channel, the connection is via a bridge structure with welded steel sections that make up the system SPM (Single Point Mooring). The structural system in steel box girders and column, with its cylindrical hinges, is subjected to the actions of the sea that induce cyclic stresses and fatigue. The paper presents the monitoring system of the structure connecting the ship to the column, installed in October 2009. The system is composed of fiber optic strain gauges sensors and biaxial inclinometers that detect rotations of the column and the bridge. The research concerns the method of collecting and interpreting statistical data, to determine the structural behavior under the action of the wind and sea. Through the processing/interpretation of the data it was possible to identify the dynamic response of the system SPM, count the number of fatigue cycles and conduct the structural verification in welded sections of the column and the hinge joints.

The results allowed us to evaluate the conditions assumed in the project and made it possible to define a program of inspection and maintenance of steel structures.

KEY WORDS: Offshore; dynamic identification; fatigue; damage.

INTRODUCTION

The VEGA field is located approximately 12 miles south of the southern coast of Sicily, off the coast of Pozzallo. It includes a platform called VEGA-A for the exploitation of the oil field and a 110,000 ton floating deposit obtained from the transformation of the former oil tanker Leonis in FSO (Floating - Storage - Offloading). The float is moored at SPM (single point mooring) located about 1.5 miles from the platform and connected to it via pipelines.

In Fig. 1 the ship Leonis and the SPM (column and yoke) are shown. The SPM is constituted by a column that is bound to the seabed by means of a universal joint which allows rotations in two orthogonal vertical planes, and a reticular arm (Yoke) that is bound to the column via coupling tri-axial joint allowing rotations around all three axes, and to the ship by two aligned cylindrical hinges.

Figure 1. Ship Leonis and the mooring system.

THE MONITORING SYSTEM

Together VEGA-A platform and the tanker ship Leonis are monitored. VEGA-A platform is monitored by means of 9 linear accelerometers, an underwater current meter, an underwater pressure gauge and sensors for detecting speed and direction of wind; therefore the monitoring system installed is able to reconstruct the actions of the sea states and the wind. The data acquisition of the SPM monitoring system is running from October '09 in order to monitor and collect the structural data of yoke. The system performs the structural monitoring through a series of optical strain gauges and installed on the ship (# 25 strain gauge sensors, Fiber Bragg Gratings (FBG)) and on the Yoke (# 12 strain gauge sensors, Fiber Bragg Gratings (FBG)).