An Ultrasonic Global Inspection Technique for an Offshore K-Joint

J.L. Rose, Drexel U.
M.C. Fuller, Drexel U.
J.B. Nestleroth, Drexel U.
Y.H. Jeong, Drexel U.

Abstract

The catastrophic collapse of several offshore platforms has spurred the development of nondestructive inspection techniques for offshore structures. Presented here are the concepts of an ultrasonic global inspection technique. Also presented are the results of feasibility studies conducted on $\frac{1}{19}$-, $\frac{1}{10}$-, and $\frac{1}{3}$-scale model K-joint models using this technique for early detection of damage. The technique takes advantage of the geometry of tubular joints to give global ultrasonic coverage of a joint while employing a similarity-coefficient-based algorithm for actual damage detection. The data from the scaled models indicate a correlation between the value of the similarity coefficient and the extent of induced damage. The results are encouraging for further development of the technique for field use.

Introduction

The integrity of the supporting steel structure of offshore platforms is of universal concern, both to industry and to associated regulatory administrations.[1,2] Failure of support structures is extremely costly in money and in lives. The U.S. Minerals Management Service, charged with ensuring safe oil and gas operation on the outer continental shelf, has actively supported the research and development of means to ensure the integrity of such offshore structures. As part of these funded activities, Drexel U. has pursued the research and development of a new ultrasonic inspection technique for the early detection of damage to large tubular K-joints. Because of its generic nature, this technique also is applicable to other structural joints often found in tubular casings.

The goal is to develop an inspection technique that will successfully monitor the health of an entire joint and that will provide an indication of accumulated damage. Thus, it is desirable to develop a global inspection technique that will monitor a large area of a structure, in preference to a traditional ultrasonic technique that can address itself only to very localized areas of a structure. Therefore, the problem is simply to develop a procedure that will consistently reflect the onset and accumulation of damage, regardless of its location in the joint, using a minimum amount of equipment and inspection time.

To ensure global coverage and to ensure the proper design and selection of equipment, it was necessary to study the propagational behavior of sound energy in tubular sections. This was effected in part by studying three scaled models ($\frac{1}{19}$, $\frac{1}{10}$, $\frac{1}{3}$) of a K-joint structure. Side-drilled holes were introduced in the $\frac{1}{19}$-scale model and saw cuts in the $\frac{1}{10}$-scale model. Actual cracks were introduced in the $\frac{1}{3}$-scale model. Consideration of the effects of this damage on the propagation of ultrasonic energy, along with other physically constraining factors, led to the development of a suitable inspection technique.

As a result of these studies, a microprocessor-based inspection system has been developed[3-5] (Fig. 1) using a low-frequency through-transmission technique and a damage-detection algorithm based on a similarity-coefficient concept (a statistical correlation). The factors affecting the global inspection technique (using the

0197-7520/83/0041-0354$00.25