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TEST EFFECTIVENESS OF DEFECTED PIPES' COMPOSITE REPAIR

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ABSTRACT

Every year the petroleum industry has to deal with defects in pipes, mainly due to corrosion, which results in metal losses. The defects appear in different forms and shapes, depending on the corrosion pattern. These metal losses defects change the way the pipes interact under a given operational environment. One way of repairing defected pipelines is to use the so-called Epoxy Grout Sleeve (EGS). However, the pressure holding capacity for this kind of repair is known to be low and, in many cases, it does not meet the required operational pressure. Moreover, the EGS repair is used only on buried pipelines, and there is a need for an alternative form of repair for non-buried pipelines. The aim of this study is to qualify the suitability of composite repair for high-pressure pipelines. This can be achieved through conducting a series of pressure tests on artificially defected pipes.

Keywords: composite repair, defected pipes, pressure test.

INTRODUCTION

The pipelines used to transfer oil generally operate at high pressure. Metal loss due to corrosion affects the pressure holding capacity of those pipelines. Replacing the defected pipeline can interrupt the oil transfer, resulting into great financial losses. One way of avoiding such losses is to repair the defected pipe using composite materials. A number of analytical and numerical studies have been carried out to examine the effectiveness of such repairs. Kopple MF *et al.*, (2013) presented an analytical and numerical approach for composite repair qualification of through-wall defected pipes. Finite Element Modelling of a damaged pipeline repaired by a composite material and subjected to internal pressure was investigated by Lyapin AA *et al.*, (2015). In this study the effect of the number of composite wrap layers is estimated. To predict the ultimate failure pressure of corroded pipelines reinforced with composite repair systems, Chen R *et al.* (2019) presented a numerical model describing a defected pipeline subjected to internal pressure. This study shades light on an experimental investigation of a defected pipe reinforced with a composite repair. Two types of defects are investigated: wall-thickness reduction and through-wall defects.

PRESSURE TEST PROCEDURE

To investigate the effectiveness of the composite repair on defected pipelines, a pressure test is performed on a defected pipe specimen reinforced with a composite repair. Each test specimen consists of a 2-meter-long pipe that has a diameter of 42 inch. A rectangular shaped defect is machined on the outer surface of the pipe with curved corners, to avoid stress concentration. The depth of the defect is based upon the practice in the field. Two carbon-steel blind flanges

are welded to the pipe ends, as shown in Figure 1, for the schematic diagram of the test specimen and a fully fabricated specimen). The appropriate thickness of the flanges is calculated using an empirical formula to satisfy the intended test pressure. Holes are drilled on one of the flanges to provide the fittings for the pump hose and other instruments necessary for the pressure control unit. The machined defect is then filled with epoxy filler and the composite repair is applied to make a sleeve in the pipe. Once the repair is cured, the following pressure test procedure is applied. The pipe is pressurized at a rate of 5 bar per minute and is raised gradually to the calculated test pressure, P_{test} .

$$P_{test} = \frac{2S_Y t}{D} \quad (1)$$

Where S_Y is the yield stress. A tensile stress is carried out to determine the yield stress of the pipe material. D and t are respectively the pipe outer diameter and the pipe wall thickness. It should be noted that the calculated test pressure is based on the hoop stress equal to the yield stress. The P_{test} is held for 24 hours followed by a pressure cyclic testing at 10 cycles per hour. For each cycle the applied pressure is alternated between $0.2 P_{test}$ and P_{test} . This pressure cyclic is applied for another 24 hours. The repair is observed during the test for any failure and changes.

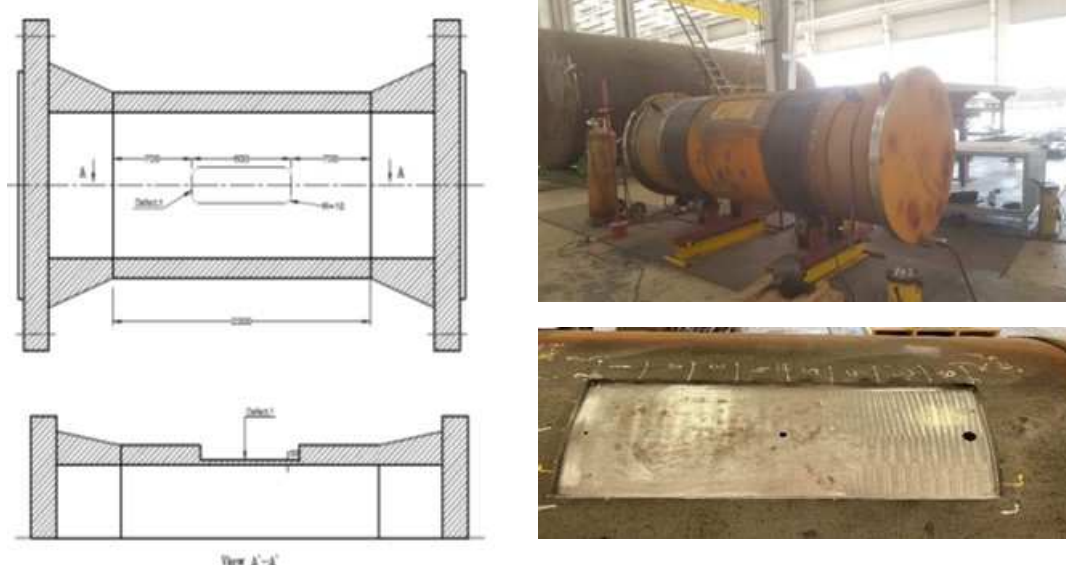


Fig. 1 - Defected pipe test specimen

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