Stress distribution analysis of composite repair with carbon nanotubes reinforced putty for damaged steel pipeline

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ABSTRACT

Composite pipeline repair systems involving infill material and composite wrapper are a common method of enhancing the integrity of damaged oil and gas pipelines. Composite wrappers can be theoretically optimised by minimising the layers of wrapper whilst reinforcing the infill material; i.e., putty. Integrating nanomaterial into putty to enhance its strength is a novel approach to provide secondary layer protection of damaged pipelines. A finite element model simulating a composite repaired pipe was developed to investigate the influence of reinforced Carbon Nanotubes putty on the system's overall repair performance and behaviour. The result was verified with a previous experimental hydrostatic burst pressure test and industrial standard resulting in less than a 15% error margin. The result shows the damaged artificial pipe segment filled with two different putties, namely Grout A and Grout B, ruptured at 32.22 MPa and 32.93 MPa, respectively. The reinforced putty improved the load-bearing capacity of the repaired pipe by a marginal increment of 2.2%. It demonstrated a better load-transfer and load-sharing mechanism than the common composite repair system. The recorded burst failure of the repaired pipe was less abrupt, thus minimising the sudden rupture of the pipeline by acting as a secondary layer of protection in the event of a composite wrapper failure.

KEYWORDS

Load-transfer mechanism; Reinforced putty; Carbon nanotubes; Finite element analysis; Repaired pipeline; Burst failure

ACKNOWLEDGMENTS

The work was supported by Universiti Teknologi Malaysia and the Ministry of Higher Education of Malaysia (MOHE) under Fundamental Research Grant Scheme [grant number FRGS/1/2019/TK03/UTM/02/7] and some of the equipment were provided by Orbiting Scientific & Technology Sdn. Bhd.