Installation analysis of reinforced thermoplastic pipe in existing underground piping

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ABSTRACT – For internally corroded pipes, the use of Reinforced Thermoplastic Pipe (RTP) as rehabilitation is an option to extend the lifetime of the piping and reduce maintenance cost. The RTP is pulled-through the existing carbon steel piping at site which then acts as a passive conduit for the protection of the pressure capable composite pipe. One of the most important design challenges for engineers is the RTP installation analysis. A design underestimation of loads could result in serious damage, while overestimation would result in high operation costs. An accurate or improved analysis method is definitely required for the RTP installation. This works presents the analytical method and strategies employed in the trenchless piping rehabilitation using RTP. The quality of the analytical analysis method is assessed where the results are compared with actual RTP installation.

1. INTRODUCTION

Piping systems are continuously required to satisfy physical, chemical, biochemical and biological demands. These demands depend on planning, material, construction, type and period of use. When piping systems become operational, proper system management has to be put in place. In addition to inspection and cleaning, rehabilitation of the piping can be required. Rehabilitation is carried out when there is need for restoration or upgrading of the piping system in terms of its performance. Rehabilitation can consist of repair, renovation or replacement [1].

Carbon steel piping replacement is a conventional repair method to repair corroded piping including underground. This method causes massive civil work such as trenching and backfilling activity, disruption to existing asset aboveground and involving hotwork activity such as field weld joint. Furthermore, replacing the corroded piping with new carbon steel pipe does not eliminate the continuation of internal corrosion threat as there is a high possibility that the piping replacement required to be performed again [2-5]. Hence, a rehabilitation solution for a corroded carbon steel piping using a viable and cost-effective method i.e. Reinforced Thermoplastic Pipe (RTP) trenchless installation in existing underground piping is vital, see Figure 1 for the schematic of RTP lined pipe.

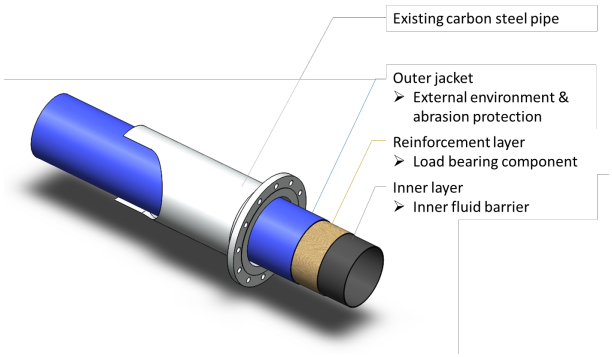

Figure 1 One-column illustration

2. METHODOLOGY

2.1 Analytical approach

Analytical approach of analysing the RTP installation by employing pulling tension formula [7]. The pulling load of RTP installation was anticipated using analytical approach with friction coefficient, μ of 0.3 by using MATHCAD. The position of the inner pipe at various points inside the outer pipe (inner pipe configuration) is defined as per Figure 2.

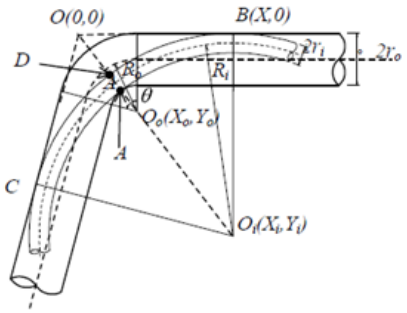

Figure 2 Configuration of Inner Pipe

2.2 Case Study

A rehabilitation work was conducted by installing RTP in DN300 underground piping in Bintulu, Sarawak. 160m length of underground piping consists of two (2) 45 deg. vertical bends and one (1) 60 deg. horizontal bend to be lined by RTP as illustrated in Figure 3.

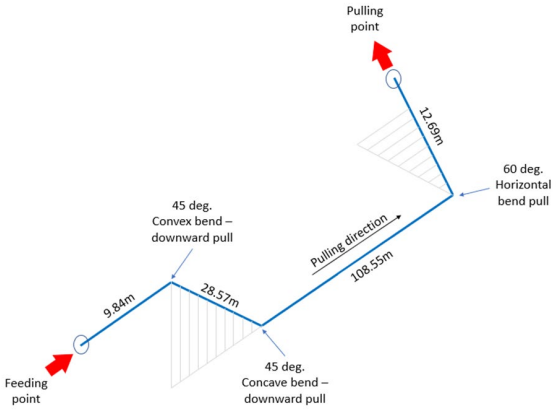

Figure 3 Schematic of RTP installation analysis

3. RESULT AND DISCUSSION

As observed in the Figure 4, the pulling-in tension jumps at distance of 6m, 15m and 151m due to bend section where it encounters bend resistant force. Meanwhile, average pulling-in tension increase gradually in relation to the pulling-in distance from distance 41m to 150m as it is a straight pipe section where it only subjected to friction effect. Furthermore, the pulling-in tension increases as the friction coefficient increases where friction coefficient of 0.4 has the greatest pulling-in tension followed by 0.3 and 0.2, respectively. Friction resists the relative motion of RTP surface and pipe wall sliding against each other which increases the pulling-in tension [6].

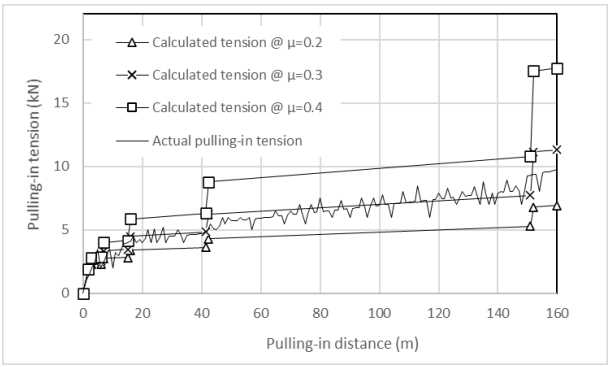

Figure 4 Comparison between calculated pulling-in tension in varied friction coefficients (μ=0.2-0.4) and actual values

Actual pulling-in tension value is in between friction coefficient of 0.2 and 0.3 where the max. pulling-in tension is 9.76 kN meanwhile, the max. pulling-in tension of friction coefficient of 0.2 and 0.3 is 7.92 kN and 11.32 kN. The data shows that pulling-in tension using friction coefficient of 0.3 is the optimal value to be used for the particular RTP installation analysis. Figure 5 shows the RTP insertion at feeding point (left) and arrived RTP at pulling point (right) at site.

Figure 5 RTP insertion at feeding point (left) and arrived RTP at pulling point (right)

4. CONCLUSIONS

From the above consideration on the analytical and experimental approach of the pipe-in-pipe technology, the following conclusions can be drawn:

a. The effect of the friction coefficient between RTP surface and pipe wall on the pulling-in tension could be understood. The larger the friction coefficient, the larger the pulling-in tension.
b. The pulling-in tension equation considering the piping configuration and RTP bending stiffness could be established. The equation that can good estimate the pulling-in tension at the bend section could be established by assuming the RTP configuration inside the pipe taking into account the RTP diameter and by assessing the bending stiffness of the RTP according to the beam theory.
c. In comparison with the measured pulling-in tension and the calculated results, it could be concluded that the proposed calculation equation can estimate the actual pulling-in tension for the RTP installation in pipe.

ACKNOWLEDGEMENT

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