TIME DEPENDENT BEHAVIOUR OF A STEEL REINFORCED THERMOPLASTIC PIPE

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Introduction

Steel Reinforced Thermoplastic Pipe (s-RTP) is a new class of pipe that offers the benefits of Polyethylene (PE) at pressures up to 120 bar, whereas PE is limited to pressures below 16 bar. Such advantages include corrosion resistance, continuous lengths and damage tolerance.

Figure 1: s-RTP lay-up

s-RTP is manufactured by overwrapping a thermo-plastic liner (i.e. plain HDPE pipe) with two layers of a high- strength steel reinforced tape. The reinforced tapes consist of high strength steel cords embedded in a HDPE matrix. During production of s-RTP, the liner with the tapes are heated to weld them together.

Experimental pre-study indicated considerable time dependent mechanical behaviour, which needs to be analysed and described.

Objectives

The main objective is to prepare a theoretical model for s-RTP to derive the long-term deformation behaviour and time to failure for a set of frequently arising s-RTP configurations and load-cases.

Modelling

The s-RTP is modelled as a multi-layer thick cylinder, with the reinforcing cords positioned between the layers. A geometrically non-linear system is derived, taking into account the increasing inner diameter of the s-RTP and the changing angles of the reinforcement layers during deformation. The steel cords and the HDPE are modelled in a linear elastic and a linear viscoelastic way respectively.

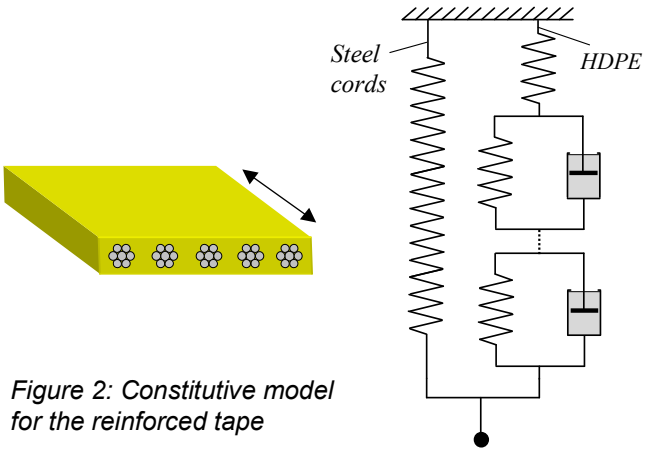

Figure 2: Constitutive model for the reinforced tape

Experiments

Experiments were performed with a 125 mm inner diameter prototype s-RTP, to validate the model. The s-RTP was subjected to 100 bar inner pressure, which was applied in a certain time. Then the pressure was held constant for 3 hours. The resulting axial (length) and tangential (diameter) strains were measured.

Results

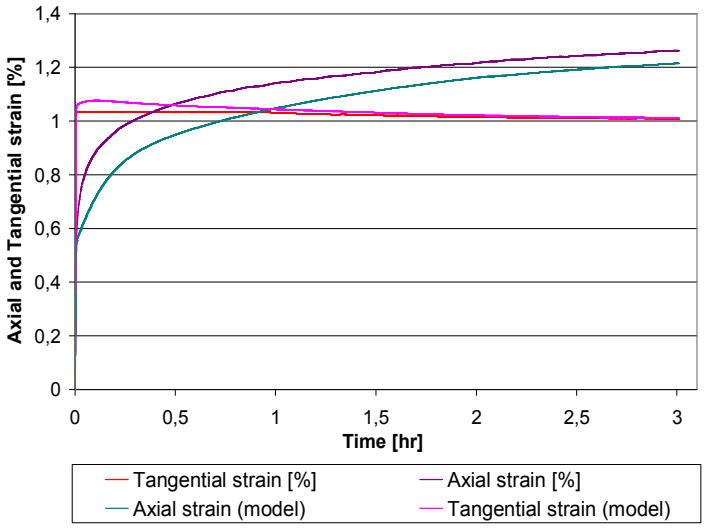

Figure 3: Deformations at constant pressure (100 bar)

Conclusion

A model was developed to predict the time dependent behaviour of a s-RTP under combined loading. The results from the model are in good agreement with the experimental results.

References

M.P.Kruijer. 'Analysis of the properties of a Reinforced Thermoplastic Pipe', *Composites Part A*, to be published December 2004.