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### **The Behaviour of Jacked Concrete Pipes During Site Installation**

#### **Summary**

While much money and effort has been spent by manufacturers and users of pipe jacking equipment to develop suitable techniques, this work appears to be the first to study the method at full scale, in a scientific research programme. It has involved monitoring a series of five pipe jacks during construction. In each case a heavily instrumented pipe was incorporated into the pipe string to measure pipe joint stresses, pipe and joint compressions and contact stresses between pipe and ground. Total jacking loads and movements of the pipe string were also measured and all results correlated with a detailed site log, full tunnel alignment surveys, and observed ground conditions. The success of the site monitoring has been highly dependent upon the development of a suitable instrumentation and data acquisition system in conjunction with appropriate site procedures for working in the restricted and physically demanding pipe jack environment without undue disruption to normal site operations.

The build up of total jacking force is the result of highly complex soil-pipe interaction. The local interface stresses are essentially frictional in most ground conditions, and can be related to the shear strength of the ground. The problem is in determining the effective radial stresses which are affected by soil insitu stresses, stiffness and strength; groundwater conditions; rate of progress; pipeline misalignment and use of lubricants.

Relations between pressure distributions at pipe joints and measured tunnel alignments are presented. That small angular deviations between successive pipes cause severe localisation of stresses on their ends is clearly demonstrated. Careful back analysis shows that the linear stress approach of the Concrete Pipe Association of Australia can adequately match the measured stresses and could be used by pipe manufacturers to provide design data on allowable jacking forces for pipes on the basis of pipe size, packer properties, concrete strength and angular alignment. It is also clear from the small pipe barrel stresses that improved packing materials would allow more of the potential strength of pipes to be achieved.

Since relative angular than absolute deviations control transfer mechanisms between pipes, uncritical adherence to specifications based on absolute line and level is counter-productive.