

Pipe bending rig trial tests

Introduction

This fact sheet provides information on initial pipe bending tests performed using the Monash University full-scale pipe bending rig. The test setup and working principles are briefly explained and future tests are outlined.

Test information and methodology

Pipe bend tests can be conducted on pipes with diameters of up to 300 mm (DN300). The testing will be conducted under 4-point bending, using clamps to attach the pipe at 4 locations to the bending platform. Testing is displacement controlled (2-10 mm/sec). This test was devised to examine whether the liner will survive a bending failure (broken back). The idea of this test is to see whether the liner will detach from the host pipe when the host pipe fails and whether the liner is still intact. This test will also check whether the whole liner detaches or just a certain section of the liner. For this to occur, adhesion of the liner to the host pipe must be low enough to debond near the break (so that the liner does not experience infinite strain and crack), without affecting exposed sections of liner, such as tappings or fittings.

The results will depend upon the longitudinal strain the liner can exhibit and the bonding strength of the liner. Testing will involve unpressurised and pressurised pipe samples. Tests can also be conducted on joints if a joint is present. The failure case for CIPP and spray liners for the pipe break tests will be due to bending and tension. The bending rig setup is shown in Figure 1.

Outcomes, benefits and reasons why the tests are conducted:

- Determine bending strength of pipe liner bonded to host pipe under internal pressure
- Verification of liner debonding over a larger pipe length under internal pressure
- Previous testing conducted used shorter lengths of pipe (<1 m) and bending caused liner to detach.
- Verify for large lengths of pipes circumferential failures will not be an issue for liners with network internal pressure



Figure 1: Pipe bending rig with clamps and supports

Trial tests conducted

The following trials were conducted to evaluate the operability and planning of future tests.

- Trial 1 – 1.3 m DN150 PVC polymer pipe secured with ratchet straps
- Trial 2 – 2m DN225 jointed FRC Pipe secured with bolted metal clamps
- Trial 3 – 1.6m DN125 Cast iron pipe with joint mounted on wooden wedges and bolted with metal clamps.

Results and discussion

The PVC pipe used in the Trial 1 did not undergo significant bending, and instead the pipe deformed at the edges and lifted off the rig, due to the ratchet straps elasticity. Based on these results, it was determined that the ratchet straps used to secure the pipe onto the rig may not be suitable and therefore stiffer metal clamps were fabricated to be used subsequent tests. This test also provided useful guidelines regarding the length of the specimen to be used in bedding tests.

Trial 2 was conducted with stiffer metal clamps. The test was conducted on an FRC pipe with a joint in the

center. The pipe showed considerable bending before failing at the joint. The joint mainly moved out of the socket as the pipe rotated. Crushing at the top of the joint was the failure mechanism. Also, the platform the pipe was laid allowed the pipe to rotate more on one side, therefore it was suggested to use mounting supports for the next test. The test setup used for Trial 2 is shown in Figure 2.



Figure 2: Test setup for trial 2, showing the use of metal clamps on an FRC pipe

Trial 3 was conducted on a cast iron pipe with a joint at the end. Wooden supports were used to elevate the pipe to maintain the pipe horizontal due to its joint. Such supports would also be used to elevate pressurised pipes with end caps.

The cast iron pipe (DN 125) tested in Trial 3 failed by a broken back (circumferential failure) between the mid-point of the pipe and one of the close supports (Figure 3). Manufacturing defects were visible at the crack from post failure analysis in the old pit-cast, cast iron pipe. This test proved successful and for future tests on newer pipes lined with polymer liners artificial defects may need to be introduced. Figure 3 shows the testing setup for the cast iron pipe.



Figure 3: Test setup for trial 3 with wooden supports and metal clamps.



Figure 4: Broken back failure in Trial 3, CI/CL DN125 pipe.

Conclusions

The following information was determined from initial trial testing:

- The bending rig will be useful for testing pipes up to DN300.
- Iron pipes and FRC pipes can be tested, PVC was too flexible to fail in broken back. Therefore, metal or FRC pipes should be used.
- Pipe damage will be introduced to fail new pipe specimens with CIPP or spray liners.

Future tests will be conducted with internal water pressure and spray or CIPP liners.