ENGINEERING GUIDELINE

Longitudinal Cracking

Concrete Pipe Association of Australasia

Introduction

Reinforced concrete pipe, when designed in accordance with AS/NZS4058 and AS/NZS3725 can last for over 100 years. However, when the synergy required between manufacturers, designers, installers and asset managers is not met, the integrity of the concrete pipe may be affected.

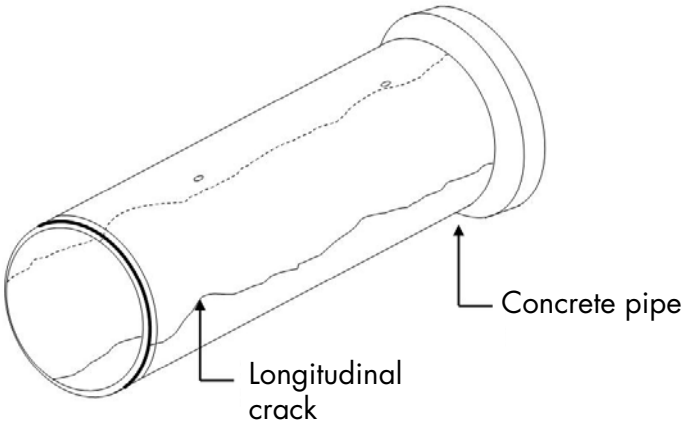
This document provides industry with the information required to make sound engineering decisions on the assessment and acceptance of reinforced concrete pipe with respect to longitudinal cracking. Prevention is better than cure, and this document will give designers and installers a checklist of what to look out for to ensure the integrity of the pipe remains as specified, and give asset managers a practical guide to assessment and any appropriate action required.

Description

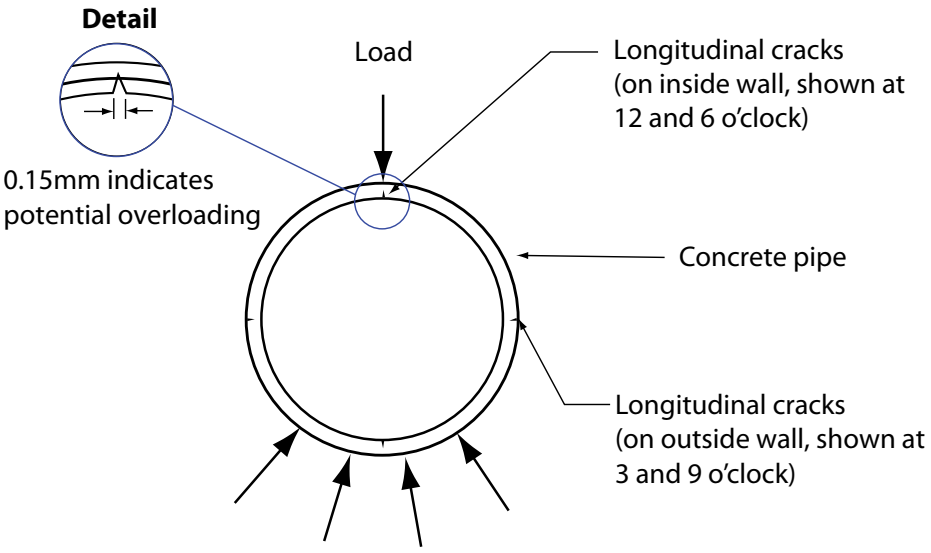
This document covers cracks that run along the axis of the pipeline. Known as longitudinal cracks, they generally occur when the pipe is over loaded. When this type of cracking occurs it is usually evident at the top or bottom (i.e at 12 o'clock or 6 o'clock) and usually does not penetrate the pipe wall. If this type of cracking occurs it is likely to be found in concrete pipes ranging from DN600 upwards.

Longitudinal cracking can occur at the:

- Top and bottom section of the pipe
- Side section of the pipe

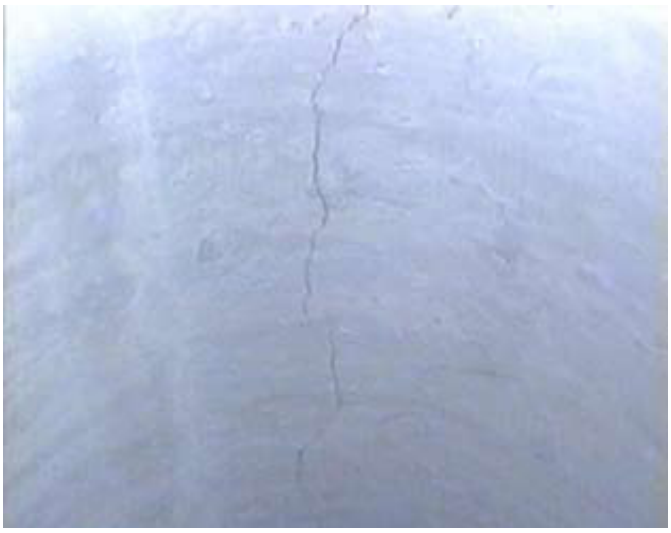


3D view of where longitudinal cracks can occur and what they look like.



Looking at a pipe in section and the effect that overloading can have on a pipe.

Note: Controlled cracks can occur in these positions without the pipes being overloaded

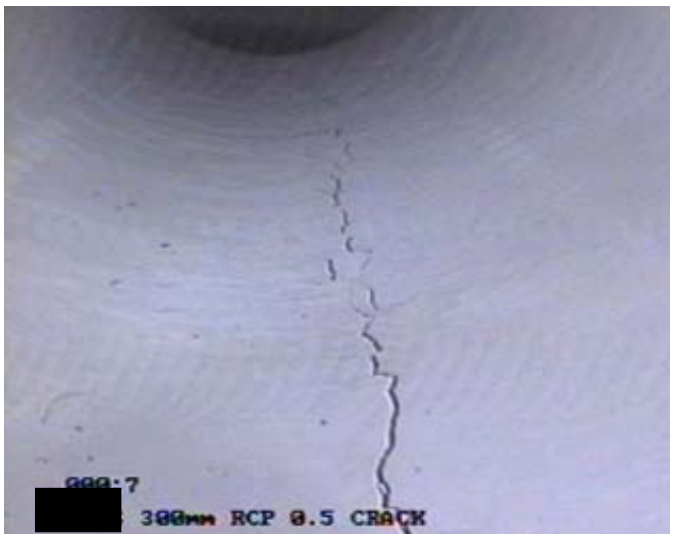


An 0.15mm crack at the invert of a DN300 pipe tested for proof load. This is acceptable in accordance with AS/NZS4058

An 0.15mm crack at the obvert of a DN375 pipe tested for proof load. This is acceptable in accordance with AS/NZS4058

An 0.15mm crack at the obvert of a DN300 pipe tested for proof load. This is acceptable in accordance with AS/NZS4058

An 0.3mm crack at the invert of a DN450 pipe.



An 0.5mm crack at the invert of a DN300 pipe, possibly caused by overloading of the pipe

A 1mm crack at the obvert of a DN375 pipe, possibly caused by overloading of the pipe.

Checklist

The table below provides a number of scenarios, in sequence of events, that can cause reinforced concrete pipe to crack longitudinally, and in which part of the pipe it can be found. The table then goes on to explain how manufacturers, designers and contractors can avoid these issues occuring when confronted by expected or unexpected situations. Use this as a checklist for risk assessment during design, installation and maintenance.

Likely Cause of Crack	Where it Occurs	How to Avoid
Incorrect class loading for long term loads	Top & Bottom	Correct design and review if construction changes
Excessive construction loads	Top & Bottom	Consider the effect of construction loads
Design bedding factor not achieved (trench too wide, inadequate compaction of haunch and side zones, incorrect haunch material)	Top & Bottom	Ensure construction specification is followed or review design if variation is introduced. Supervision of construction. Check grading of material for compliance.
Applied loads approach class proof rating	Top & Bottom	Within expected behaviour of reinforced concrete elements i.e. understand nature of reinforced concrete. Minor cracks can be expected when applied load approximates rating load. This can be expected in all medium and large diameter pipes of Class 2 and above.
Previously load tested pipe	Top & Bottom	Crack should be < 0.1 mm prior to installation. Crack is expected to open under the load.
Transport or handling damage	Top & Bottom	Check pipes before installation. Do not install pipes with excessive cracks. Minor cracks may develop under load.
Pipe installed >15° from TDC	Top & Bottom	Ensure orientation of pipe "top" is correct.
Excessive compaction of side fill	Side	Monitoring of compaction standards, particularly in high risk situations (e.g. compacting against rocky trench sides.)
High horizontal loads caused by unusual installations e.g. pipe on a skew installation under high fills, pipe installed at right angles to sleep slope	Side	Use appropriate well graded material to achieve compaction standards without pipe damage. Design recognition, specify double circular reinforcement.
Incorrect handling resulting in pipe rotating > 15° from vertical	Side	Good housekeeping QA for handling and storage of oval reinforced pipe branded "TOP" for TOP UP installation.

Acceptance and Assessment Chart

FOR PIPES WITH LONGITUDINAL CRACKS – TOP AND BOTTOM	
Size of Crack	**Action Recommended**
< 0.15mm	No action required - crack unlikely to extend through the wall and equivalent to the design serviceability load crack defined by AS/NZS4058.
0.15mm to 0.5mm	Monitor for stability of crack. Cracks up to 0.5 mm are not considered to be a durability risk. If crack is stable, no further action required.
0.5mm >	Engineering assessment required to consider effects of long term loads.
FOR PIPES WITH LONGITUDINAL CRACKS – SIDES	
< 0.15mm	No action required. If pipe is in final loaded condition, the imposed loads will close longitudinal cracks in the spring zone.
0.15mm >	Engineering assessment required. Repair may be deferred to allow autogenous healing to occur. If after agreed monitoring period autogenous healing has not occurred refer to recommended repair

Available Repair Options

Where repair work or rectification of a pipe is required to allow it to remain in service, a number of options are available to the asset manager. The repair method used is dependant on the extent of the problem and the following table offers some suggested options.

Option	Repair Description	For Rectifying
1	No rectification required	No need for repair or autogenous healing may fill any cracks.
2	Access defect via pit or manhole and grind out crack to solid concrete. Fill and seal defect zone with an approved epoxy paste or resin.	Minor cracks, 0.15mm to 0.5mm, that are not “live” and are not subjected to any further movement. Applicable where number of cracks is small.
3	Provide an internal lining with an approved non-structural patching repair mortar (epoxy based or polymer modified cement based) to cover defect.	Minor cracks, 0.15mm to 0.5mm, that are not “live” and are not subjected to any further movement. Applicable where there are multiple cracks.
4	Provide an internal structural lining that is designed in accordance with the appropriate standard (for flexible pipe, AS2566.1) to ensure it satisfies the required loading criteria.	Large cracks (> 0.5mm) where the durability of the pipe may be affected.
5	Replace the pipe using appropriate techniques such as shear bands. Contact your local CPAA member company for more details.	Where the pipe affected is an isolated problem and is beyond repair from a durability persepctive.
6	Replace the entire pipeline. Contact your local CPAA member company for more details.	Where the entire pipeline is beyond repair from a durability persepctive.
7	Provide a concrete cup to the pipe to transfer load to the side fill	Large cracks (> 0.5mm) where loading is likely to increase crack width.

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