Concrete Pipe Association of Australasia

Engineering Assessment and Acceptance Guideline

Circumferential Cracking

Last updated November 2008

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.

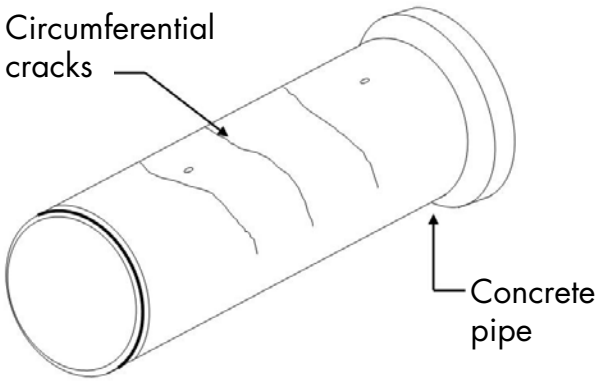
This document provides industry with the information required to make sound engineering decisions on the assessment and acceptance of reinforced concrete pipe with respect to circumferential cracking. Prevention is better than cure, and this document will give designers and installers a checklist of 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.

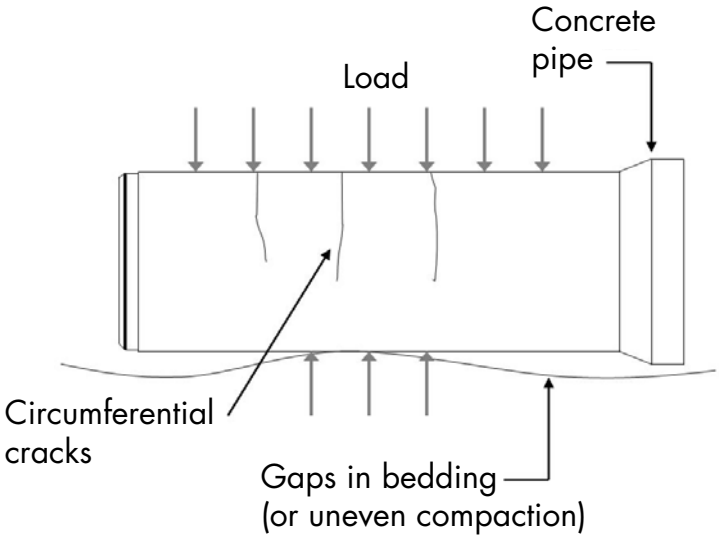
Description

This document covers cracks that develop at right angles to the axis of the pipeline. Known as circumferential cracks, they generally occur when the pipe is loaded like a beam (which it is not designed for). They do not affect the load carrying capacity of the pipe. If this type of cracking occurs it is usually evident in the middle third of the pipe, and is only likely to occur in concrete pipes ranging from DN225 to DN450.

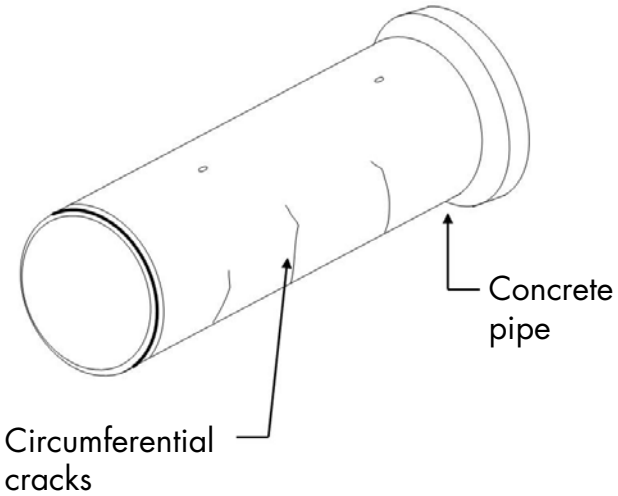
Circumferential cracking can occur at the:

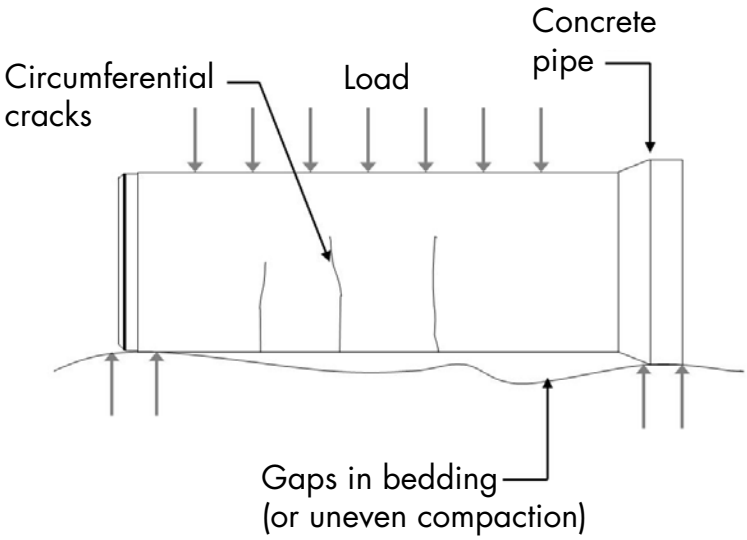
- bottom section of the pipe (CC-B)
- top section of the pipe (CC-T)
- full circumference of the pipe (CC-F)





Pipes can crack circumferentially at the top where support is not uniform and it is forced to act like a cantilever beam.

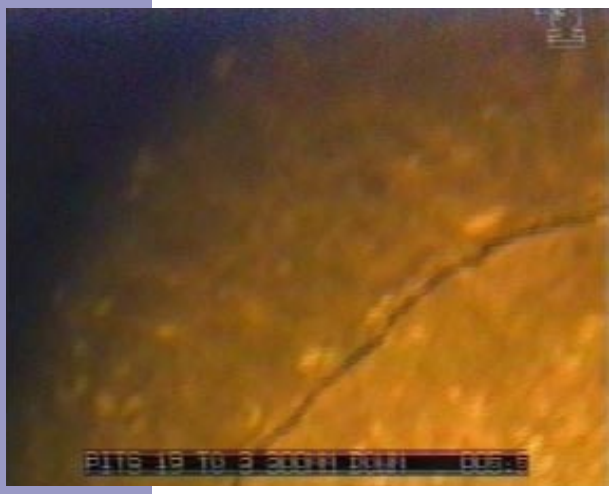




Pipes can crack circumferentially at the bottom where uniform support is not achieved. Pipes are not designed to act as beams.

A 6mm crack at the bottom of a DN300 pipe due to stresses resulting from poor bedding.

A 6mm crack at the top of a DN300 pipe due to stresses that have resulted from poor bedding



An internal circumeferntial crack of a DN300 concrete pipe, less than 0.5mm wide.

An internal circumeferntial crack of a DN300 concrete pipe, greater than 0.5mm wide.

An internal circumeferntial crack of a DN375 concrete pipe, less than 0.5mm wide.

An internal circumeferntial crack of a DN375 concrete pipe, greater than 0.5mm wide.

Checklist

The table below provides a number of scenarios, in sequence of events, that can cause reinforced concrete pipe to crack circumferentially, and in which part of the pipe it can be found. The table also explains how manufacturers, designers and contractors can avoid these issues occuring when confronted by expected or unexpected situations.

Likely cause of crack	Where it occurs	How to avoid
Excessive movement during transport and handling can result in the "broken back" effect	CC-B, T, F	Do not place pipes in a position where beam loads are applied during transport or handling on site (e.g. travelling over or on uneven ground with the pipe suspended on a single strop)
Very low foundation strength	CC-B, T, F	Visually assess the conditions when unsure. Consider a special design to improve the strength such as designing a raft, using a wider and deeper bed zone, encapsulating in geotextile.
Collars not dug out in the bedding	CC-B	Ensure correct pipe installation practice is followed by excavating collar pockets to sufficient depths in the bed zone
Non-uniform support due to : • variable compaction of bed zone • low spots in bed zone • variable foundation strength	CC-B, T, F CC-B, T, F CC-B, T, F	• Construct bed zone in accordance with AS/NZS3725 • Ensure compacted surface is level and on grade • Visually assess and over excavate, re-fill and compact local soft spots where necessary
Bedding not compacted to required grade or attempted grade adjustment with pipe installed)	CC-B, T, F	Remove pipe and correct the bed zone grade before laying any further pipes
Uncontrolled de-watering (liquefaction of foundation or bedding when natural water table re-established)	CC-B, T, F	Assess potential for bed zone to liquefy at pump shutdown. Backfill trench to minimum depth to prevent liquefaction. Use granular material in the bed zone and encapsulate in geotextile if necessary.
Settlement of pipeline adjacent to entry and exits to rigid structures	CC-T, F	Provide flexible joints close to all rigid structures e.g. entry and exit stubs
High spots at mid pipe	CC-T, F	Ensure that the compacted surface is level and on grade along the pipe bedding.
Migration of fines in the bedding	CC-B, T, F	Use correctly graded material or geotextile that is suitable for the installation
Excessive and non uniform side fill compaction	CC-T, F	Ensure uniform compaction on both sides of pipe in appropriate lifts. Use appropriate well graded material and do not over compact poor materials.
Compaction lift too high for pipe being installed	CC-T, F	Ensure uniform compaction on both sides of pipe in appropriate lifts.
Construction loads without sufficient full cover	CC-B, T, F	Ensure minimum cover over pipe appropriate to construction equipment being used (refer to CPAA Pipe Class or Charts)

Acceptance and Assessment Chart

Size of crack	Action recommended
< 0.15 mm	No action required
0.15 mm to 0.5 mm	No action required, allow autogenous healing to take place
0.5 mm to 1.0 mm	Monitor and allow autogenous healing and review after 12 months
1.0 mm to 2.0 mm	Assess potential for fines to migrate through crack (which may degrade the bedding)
2.0 mm >	Crack likely to be all way around and may require repair or replacement of pipe

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. 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	Seal cracks with approved flexible PVC bandage using appropriate epoxy adhesive.	Minor cracks, 0.15mm to 0.5mm, that may remain "live" (i.e. continue to grow) or larger cracks that are not subjected to any further movement.
5	Apply shear bands, rubbers straps or 'concrete stitching" for non-structural repairs to prevent the ingress of fines.	Large cracks (> 0.5mm) that won't affect the structural capacity of the pipe but may affect the long term durability.
6	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.
7	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 persepc-tive.
8	Replace the entire pipeline. Contact your local CPAA member company for more details.	Where the entire pipeline is beyond repair from a durability perspective.

Autogenous healing has filled this 0.5mm wide circumferential crack that has occurred at the top of the pipe.

Autogenous healing has filled this 0.5mm wide circumferential crack that has occurred at the bottom of the pipe..

Further Resources

To understand and achieve the requirements of sound design and installation practice and prevent or assess circumferential cracking in concrete pipe, the following references may be useful:

- **Design**
  - o PipeClass design software
  - o AS/NZS4058:2007 "Precast concrete pipes"
  - o AS/NZS3725:2007 "Design for installation of buried concrete pipe"

- **Durability**
  - o CPAA Technical Brief "Autogenous healing"
  - o CPAA Fact Sheet "Cracking in concrete pipes"

- **Installation**
  - o CPAA "Foremans Guide to Laying Concrete Pipe"
  - o CPAA Technical Note "Improving installation of small Ø pipe"

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