



Engineering

TS 0465

# Mortar Repair Systems

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**Government of  
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Only the current revision of this Standard should be used which is available for download from the SA Water website.

## Significant/Major Changes Incorporated in This Edition

Nil as this is the first issue of this Technical Standard.

## Document Controls

### Revision History

Revision	Date	Author	Comments
1	1/02/2019	D London	Change to 'approved products' list

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## Contents

<b>1</b>	<b>Introduction .....</b>	<b>6</b>
1.1	Purpose .....	6
1.2	Glossary.....	6
1.3	References .....	6
1.3.1	Australian and International.....	6
1.3.2	SA Water Documents.....	7
1.4	Definitions.....	7
<b>2</b>	<b>Scope.....</b>	<b>8</b>
	<b>Approved Products.....</b>	<b>9</b>
<b>3</b>	<b>Mortar Application .....</b>	<b>10</b>
3.1	Applicator Certification.....	10
3.2	Edge Preparation .....	10
3.3	Surface Preparation .....	10
3.4	Primer Application .....	11
3.5	Mortar Mixing.....	11
3.6	Mortar Curing .....	11
<b>4</b>	<b>QA &amp; QC .....</b>	<b>12</b>
4.1	QA .....	12
4.2	QC Inspection.....	12
<b>5</b>	<b>Mortar System Testing.....</b>	<b>13</b>
5.1	Adhesion Test .....	13
5.1.1	Panel Preparation .....	13
5.1.2	Sample Coring.....	14
5.1.3	Dolly and Spacer Attachment .....	14
5.1.4	Pull Testing.....	14
5.2	Failure Mode.....	15
5.2.1	Mortar – Steel Testing .....	15

5.2.2	Preferred Modes of Failure .....	16
5.3	Pipe Application Testing .....	16
5.4	Compressive Strength Testing .....	16
<b>6</b>	<b>Test Report .....</b>	<b>17</b>
	<b>Mortar Repair System Test Report.....</b>	<b>18</b>

## List of figures

Figure 1 - Pipe undergoing mortar repair with back bevelled edges and surface preparation via abrasive blasting. ....	11
Figure 2 – Pull test apparatus and set-up. ....	15
Figure 3 – This figure shows a layout of 6 pull tests per test plate. It also shows the steel spacer and Ø50mm dolly that attaches to the pull test machine.....	15

# 1 Introduction

This standard has been developed to assist in the design, construction, maintenance, and management of SA Water infrastructure.

This standard draws on recent research and development undertaken in conjunction with the University of South Australia to determine the most effective repair mortar systems for mild steel cement lined (MSCL) pipework. In-service inspections of MSCL pipework inside pump stations suggest a large number of MSCL pipe failures are attributable to poorly lined or unlined welded joints. This standard therefore aims to improve the durability of the mortar lining at welded joints within MSCL pipework and therefore the durability of SA Waters assets.

## 1.1 Purpose

The purpose of this standard is to detail minimum requirements to ensure that assets covered by the scope of this standard are constructed and maintained to consistent standards and attain the required asset life.

## 1.2 Glossary

The following glossary items are used in this document:

Term	Description
SA Water	South Australian Water Corporation
TG	SA Water Technical Guideline
TS	SA Water Technical Standard
MSCL	Mild Steel Cement Lined (Pipe)
DICL	Ductile Iron Cement Lined (Pipe)
ITP	Inspection Test Plan
TDS	Technical Data Sheet
QA/QC	Quality Assurance / Quality Control
NATA	National Association of Testing Authorities

## 1.3 References

### 1.3.1 Australian and International

The following table identifies Australian and International standards and other similar documents referenced in this document:

Number	Title
AS 1281	Cement mortar lining of steel pipes and fittings
AS 4020	Testing of products for use in contact with drinking water
AS 1012.9	Methods of testing concrete Compressive strength tests - Concrete, mortar and grout specimens AS 1478.2
AS 1627.4	Metal finishing—Preparation and pre-treatment of surfaces. Part 4: Abrasive blast cleaning of steel

### 1.3.2 SA Water Documents

The following table identifies the SA Water standards and other similar documents referenced in this document:

Number	Title
TS 0420	Welding Requirements (Metal)

### 1.4 Definitions

The following definitions are applicable to this document:

Term	Description
SA Water's Representative	<p>The SA Water representative with delegated authority under a Contract or engagement, including (as applicable):</p> <ul style="list-style-type: none"> <li>• Superintendent's Representative (e.g. AS 4300 &amp; AS 2124 etc.)</li> <li>• SA Water Project Manager</li> </ul> <p>SA Water nominated contact person</p>
Responsible Discipline Lead	The engineering discipline expert responsible for TS 0465 defined on page 3 (via SA Water's Representative)
Repair Mortar System	A repair mortar and its associated primer

## 2 Scope

This Technical Standard (TS) covers the application of repair mortar systems to:

- mild steel cement lined (MSCL) pipes for potable and raw water services
- ductile iron cement lined (DICL) pipes for potable and raw water services

Approved products currently listed are suitable for shop manufactured fittings, new pipe field joints and repairs to old cement mortar lining where fast cure is required due to limited shut down periods.

In the future this standard will include approved mortar systems for use in waste water pipework and approved products and application requirements for repair of concrete structures.

## Approved Products

To ensure consistent, high quality mortar repairs the following repair mortars are approved by SA Water for use on MSCL and DI/CL pipes. Selection of a following mortar requires the suppliers provide training, certification, and technical support for applicators. Where the supplier is unable, or unwilling to provide this, an alternate supplier shall be chosen.

Approved products are as listed:

- Fosroc® Renderoc HB40 with Nitobond EP primer
- Fosroc® Renderoc HB70 (higher build thickness than HB40) with Nitobond EP primer
- BASF MasterEmaco® 5200CI with MasterEmaco 2525 epoxy primer

To ensure proper adhesion and longevity of the mortar the appropriate primer should always be used with the selected repair mortar.

Other products can be selected and used with the approval of SA Water engineering that pass the testing criteria listed in section 5 and a report be created in accordance with section 6.

Products to be used in contact with potable water must comply with the requirements of AS 4020.

Maximum product chloride content 0.05% as tested in accordance with BS EN 1015-17 or AS 1012.20.

## 3 Mortar Application

The following must be adhered to when applying repair mortar to any MSCL or DICL pipe.

The selected mortar repair system must pass the testing outlined in section 5, and a report be created in accordance with section 6 for acceptance into this standard, or is on the list of approved products.

### 3.1 Applicator Certification

The following applies for each job lot of manufactured fittings and for each pipe chainage number where mortar repairs/replacement has occurred:

- Each applicator requires certification from the material supplier on the competent application of their product.
- A pipe sample must be produced by each applicator during certification which simulates overhead application. This can be an offcut length of pipe representative of the pipe used for the job with a minimum repair joint width of 100mm.
- The supplier shall provide product application training to any uncertified applicators.
- Certificates shall be issued to all successful applicators.

### 3.2 Edge Preparation

When applying a repair mortar in the field all damaged and/or non-adhered mortar shall be removed from the affected area and the healthy mortar shall have its edge back bevelled.

When applying a repair mortar system to shop fittings or spools made from MSCL or DICL pipe the cast in mortar shall be back bevelled prior to applying the repair mortar system, refer figure 1 below.

### 3.3 Surface Preparation

The surface on which the repair mortar system is to be applied shall be sand blasted to a minimum cleanliness of Sa 2  $\frac{1}{2}$  in accordance with AS 1627.4 and a surface profile of 50-75 $\mu$ m (refer figure 1 below) or otherwise prepared as directed by suppliers instructions and training.

For in-service pipework that is corroded, removal of corrosion product using a 'needle gun' is permitted.

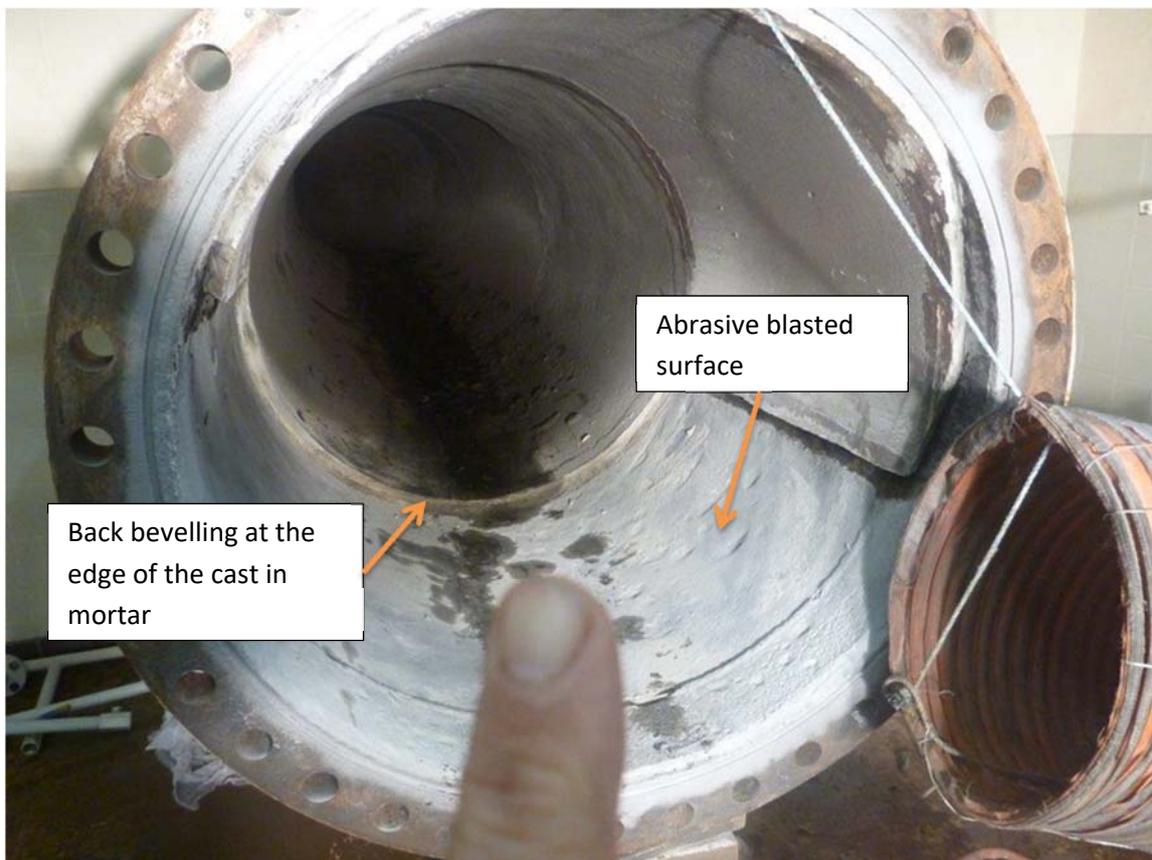


Figure 1 - Pipe undergoing mortar repair with back bevelled edges and surface preparation via abrasive blasting.

### 3.4 Primer Application

At the repair area the primer shall be applied to the exposed steel and the mortar to mortar interfaces.

Applied primer shall be allowed to go tacky to the touch, or as per manufacturer's TDS, before mortar is applied.

Primers shall be mixed strictly in accordance with the manufacturer's TDS.

### 3.5 Mortar Mixing

When applying the mortar for any size job the mixture shall be made up with whole bags to ensure correct mixing ratios and minimize variation. Part mixes are not to be undertaken. It is critical to stay within the manufacturer's recommendations for the amount of water added to optimise the strength of the cured mortar therefore the manufacturer's TDS must be strictly adhered to.

### 3.6 Mortar Curing

To optimise the curing process and therefore mortar strength shop fittings shall be end capped for as long as possible prior to installation up to the full cure time of 28 days.

## 4 QA & QC

To ensure consistent high quality mortar application the following QA and QC measures shall be applied to all MSCL pipe works.

### 4.1 QA

All MSCL repair mortar system applicators shall be certified by the material supplier in the application of their repair mortar system. This requirement shall be included as a sign off in the ITP as hold points for each job.

### 4.2 QC Inspection

The following applies for each job lot of manufactured fittings and for each pipe chainage number where mortar repairs/replacement has occurred:

- A visual inspection shall be undertaken on shop fittings to ensure there is no mortar loss or cracking greater than 0.5mm wide present after curing is complete. This shall be witnessed and signed off on the ITP for each spool and/or fitting.
- A CCTV inspection shall be undertaken for in service pipelines to ensure there is no mortar loss or significant cracking present after installation of shop fittings and curing of internal field joints. This shall be witnessed and signed off on the ITP for each chainage number where mortar repairs have occurred.
- A certificate of conformance by the applicator shall be completed ensuring the mixing and application of the repair mortar is in accordance with the manufacturer's instructions.
- These requirements shall be included in the ITP as hold points for each job lot or for each pipe chainage number where mortar repairs/replacement have occurred.
- If the applicator fails these inspection criteria then the testing in section 5 must be undertaken at the cost of the applicator to help determine the cause of failure and correct for future orders.

## 5 Mortar System Testing

Successful completion of the three tests below is required prior to inclusion of a repair mortar system in this standard:

1. Adhesion
2. Pipe application
3. Compressive strength

### 5.1 Adhesion Test

The following procedure shall be followed to prepare and conduct the adhesion test.

#### 5.1.1 Panel Preparation

Three flat mild steel panels of size 500mm x 300mm made from 6mm 250 or 300 grade plate.

All steel test panels shall be uniquely numbered and tagged, stamped or engraved with the designation of the repair mortar system to be tested. Panels to be tested shall be prepared in the following manner:

##### 5.1.1.1 Panel Cleaning

All steel panels shall be abrasive blasted to a minimum surface cleanliness of  $2\frac{1}{2}$  and a surface profile of 50-75µm in accordance with AS 1627.4, before application of the repair mortar system.

##### 5.1.1.2 Mortar Mixing

Mortar mixing shall be strictly as per the manufacturer's instructions (in particular the amount of water added). Mix whole bags only do not part mix unless authorised by the mortar manufacturer.

##### 5.1.1.3 Primer

Apply the associated primer as per the manufactures instructions. For epoxy primers the use of scales may be required to correctly weigh the proportions of hardener and resin.

##### 5.1.1.4 Flat Plate Tests

Place the prepared steel plate inside a wooden frame that has 16mm high sides such that there is a 10mm clearance above the surface of the panel to the top of the frame.

Apply the repair mortar system to a thickness of 10mm such that the mortar is level with the wooden frame once the primer has been allowed to become tacky to touch, or as otherwise specified by the manufacturer.

##### 5.1.1.5 Curing

Cure as per manufacturer's TDS. As a minimum the specimens should be plastic wrapped for the full cure period.

### 5.1.2 Sample Coring

Coring shall be undertaken using a rigid stationary drill press with minimal radial run out. Samples shall be cored using a diamond tipped drill bit with an internal cutting diameter of 50mm. Six equi-spaced cores should be achievable per panel and each core should be approximately 50mm inboard of the plate edges.

Coring shall occur until the steel is just contacted and no further.

Note panels to be tested by SA Water shall be cored before being supplied for pull testing.

### 5.1.3 Dolly and Spacer Attachment

Ø50mm pull test dollies are required for adhesion testing of cementitious materials. Spacers are also required to provide a reaction force for the pull tester out past the coring cut line.

Glue each Ø50mm spacer onto the cored sample using high strength araldite or similar taking care to ensure that the edge of the spacer lines up with the edge of the cored section. Allow the glue to set fully and then glue the dolly on in the same manner. Again ensure that the dolly and spacer are concentrically aligned or the pull tester will not fit over the dolly and spacer assembly. Take care to prevent excess adhesive running into the cored section as this could influence the results of the pull testing.

### 5.1.4 Pull Testing

Pull testing shall be based on the process as described in British Standard EN 1542:1999.

For inclusion of a mortar repair system in this standard a mean adhesive strength of at least 0.8 MPa shall be obtained per panel with a minimum single pull adhesive strength of 0.4-0.5 MPa. The 0.8MPa mean adhesive strength is double the minimum adhesive strength of cured cast in mortar to steel as outlined in AS 1281-2001. This reflects the hand application method at pipe joints which will be less dense and homogeneous than the cast-in mortar and it also reflects an expectation that the repair mortar at the joint needs to be more durable than the cast-in mortar as joints often occur in areas of high speed and highly turbulent flows.

The type of failure (failure mode) will also be considered when determining the acceptability of a repair mortar system. Generally cohesive failures (within the repair mortar) are preferred over adhesive failures (failure between mortar and steel or at mortar interfaces) as cohesive failures will continue to give partial corrosion protection to the inside of pipe surfaces.

Final approval for alternate mortar repair systems will be given at SA Water engineering's discretion.

Using an automated adhesion pull tester (see figure 1 below), set at the lowest continuous pull rate; test the strength of all cored test panels. Record the failure loads in the test report and on the test panel alongside each coupon using permanent paint marker. Take a photo of the panels for reference of failure loads and modes as per figure 3 below. Note SA Water can undertake pull testing on pre-cored plates as required.



Figure 2 – Pull test apparatus and set-up.

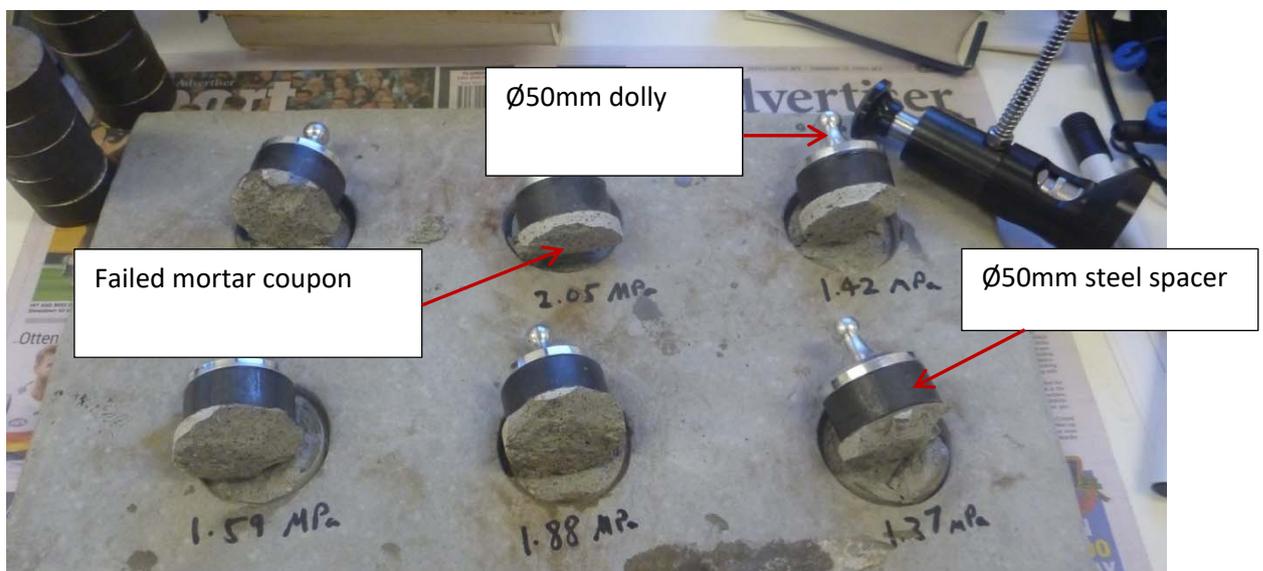


Figure 3 – This figure shows a layout of 6 pull tests per test panel. It also shows the steel spacer and Ø50mm dolly that attaches to the pull test machine.

## 5.2 Failure Mode

There must be at least 5 successful, non-abnormal failure tests per panel for that panel to be accepted as an appropriate test. If there is more than one abnormal failure per panel then that panel must be remade and retested.

The predominant mode of failure shall be visually determined and classed as one of the following:

### 5.2.1 Mortar – Steel Testing

- Mortar failure (C)
  - o Cohesive failure within the mortar layer
  - o Indicated via a 'rough' or broken surface on the fracture face of the pulled mortar coupon
- Adhesion failure (A)
  - o Adhesive failure between the mortar coupon and the steel panel
  - o Indicated by the exposure of any amount of steel under the pulled coupon

- Abnormal failure (X)
  - o Adhesive failure between spacer and mortar coupon or between the dolly and spacer
  - o Adhesive or cohesive failure without application of a pulling force
  - o Any failure otherwise not listed above

### 5.2.2 Preferred Modes of Failure

The preferred failure mode for the flat panels is a cohesive failure as this will leave some mortar cover on the steel which in practice will continue to provide a high pH at the surface of the steel pipe thereby preventing corrosion. In contrast an adhesive failure will directly expose some of the steel pipe and allow the initiation of corrosion.

## 5.3 Pipe Application Testing

The aim of this test is to qualitatively assess the application of the repair mortar system into an offcut length of MSCL or DICL pipe to simulate overhead application.

An internal joint shall be simulated inside the pipe offcut by removing a 100mm wide section of the cast in mortar all the way around the inside of the pipe. Abrasive blasting is not required for the internal pipe surface at the joint however all loose mill scale and corrosion product should be removed by sanding or finishing with a power tool and solvent wiped to remove organic contaminants such as oils. The edges of the cast in mortar at the internal joint should be back bevelled and the manufacturer's TDS followed for primer and mortar mixing and application requirements. During application the pipe shall be fixed in position to ensure overhead application and any failure of the mortar to adhere to the internal pipe surface shall be cause for rejection.

## 5.4 Compressive Strength Testing

A compressive strength test shall be undertaken in accordance with AS 1012.9 to validate the mixing and preparation of the mortar and that the produced sample matches the manufacturer's TDS.

The material supplier is to complete the required compressive tests in accordance with AS 1012.9 and supply SA Water engineering with results for review. Testing must be undertaken in a NATA endorsed laboratory. The material supplier must be satisfied that the sample is an accurate reflection of their product.

## 6 Test Report

A test report for the tensile strength of a mortar/primer system shall include the following information:

- 1) The test date and the name of the person undertaking the test
- 2) The type and manufacturer of the repair mortar system
- 3) The method of surface preparation for the steel panels
- 4) Attach the method used for primer and mortar mixing, for example manufacture's TDS
- 5) The method and duration of cure
- 6) The thickness of the repair mortar applied
- 7) The test panel number as identified in section 5.1.1 above
- 8) The failure load applied to each coupon and the mode of failure as specified in 5.2
- 9) The mean failure load for the six coupons on each steel panel
- 10) The compressive strength of the mortar and test certificate attached from the testing laboratory
- 11) Comments relating to any anomalies or things of note for each test
- 12) A photograph of each panel/coupon with the pull strength values written alongside each test coupon in permanent paint marker as per figure 3 above

# Mortar Repair System Test Report

Test Date:	
Test Conducted by:	

*Note: Inspection protocols and acceptance criteria are outlined in SA Water Technical Standard 0465 – Mortar Repair Systems.*

Repair Product/System Specifications	
Mortar Type	
Primer Type	
Manufacturer	

Application Methodology	
Surface Preparation (cleanliness class and surface profile height)	
Duration of Cure	
Thickness of Mortar Applied	

Panel Number 1			
Coupon Number	Failure Load (MPa)	Failure Mode	Comments
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
<b>MEAN FAILURE LOAD (MPa)</b>			

Panel Number 2			
Coupon Number	Failure Load (MPa)	Failure Mode	Comments
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
<b>MEAN FAILURE LOAD (MPa)</b>			

Panel Number 3			
Coupon Number	Failure Load (MPa)	Failure Mode	Comments
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
		<input type="checkbox"/> Mortar (cohesive) <input type="checkbox"/> Adhesion <input type="checkbox"/> Abnormal	
<b>MEAN FAILURE LOAD (MPa)</b>			

<b>Compressive Strength of Mortar (MPa)</b>	
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Adhesion test criteria as outlined in SA Water TS 0465 satisfied? Yes  No

Was the pipe application testing considered to be successful? Yes  No

Did the compressive strength meet the manufacture’s specification? Yes  No

***Additional Comments/Observations:***