PIPELINE REHABILITATION WORLDWIDE

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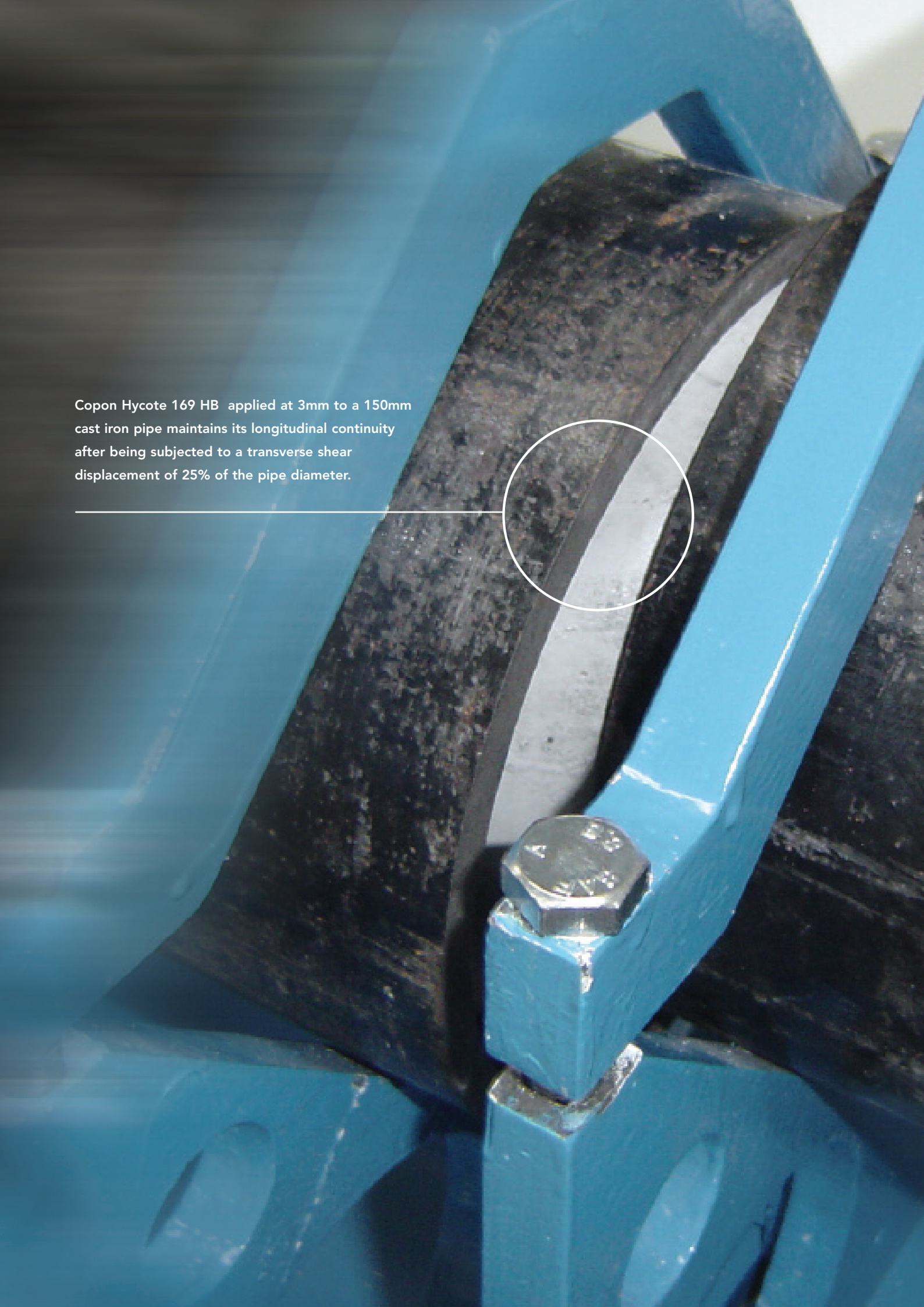
TECHNICAL GUIDANCE NOTE
COPON HYCOTE 169HB

SEMI-STRUCTURAL POLYMERIC LINING SYSTEM

PIPELINE REHABILITATION WORLDWIDE



Copon Hycote 169 HB applied at 3mm to a 150mm cast iron pipe maintains its longitudinal continuity after being subjected to a transverse shear displacement of 25% of the pipe diameter.

INTRODUCTION

Company Profile 2

Industry Background 3

PROCESS DESCRIPTION 4

THE COPON HYCOTE 169HB SYSTEM

Overview 5

What is a semi-structural lining 5

Failure Modes for Iron Mains 5

Performance Requirements 6

Physical Properties 6

Features and Benefits 7

LINING DESIGN

General 8

Design Procedure 8

Lining Design - Examples 10

Material Consumption 11

INTRODUCTION

Company Profile

E.Wood Ltd has been in existence as a surface coating manufacturer for over 120 years, producing high performance products for a diverse range of industrial applications.

Over the course of the last forty years, through its COPON brand name, E Wood Ltd has become internationally recognised as the market leader in the protection of pipelines in the water, gas, and oil distribution industries currently exporting its products to over 80 countries worldwide.

The head offices of E.Wood Ltd are located in Northallerton North Yorkshire and include 100,000 square feet of manufacturing and laboratory facilities. E.Wood Ltd is a wholly owned subsidiary of Torday and Carlisle Plc.

Industry Background

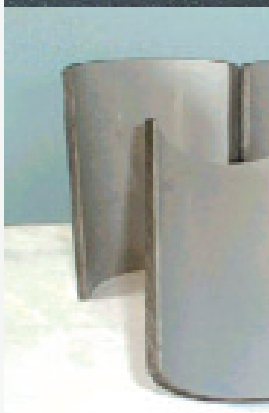
The rehabilitation technologies available to water undertakers have historically been limited to mains renewal techniques such as open- cut excavation or inserted polyethylene technologies (directional drilling, slip lining, pipebursting). In situations where water quality issues, rather than structural concerns have been the driver, non-structural spray lining has offered a minimum cost alternative to renewal.

The in-situ application of liquid epoxy resin (the so called "scrape and line" process) was adopted by many water utilities during the 1990's, providing a non structural solution to water quality problems. However this process is disadvantaged by the slow setting characteristics of epoxy resin which necessitates minimally a 16 hour cure period before commencement of return to service procedures, resulting in a 36 hour shut down period during which consumers are without water supplies.

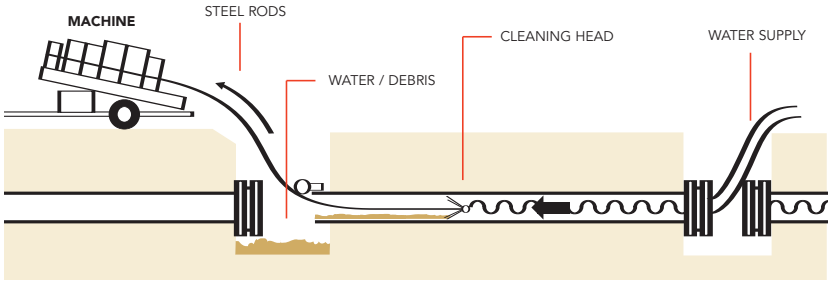
Acknowledging the inherent drawbacks associated with the use of epoxy resin, E.Wood Ltd developed a revolutionary Rapid Setting Polymeric Lining COPON HYCOTE 169, which from its inception in 1999 has transformed the non structural rehabilitation strategies of the majority of UK water utilities. By virtue of the rapid setting characteristics the shut down periods for consumers are dramatically reduced, resulting in same day return to service.

Recognising the gulf that exists between non-structural spray lining and renewal techniques, E.Wood Ltd has now developed **COPON HYCOTE 169HB**.

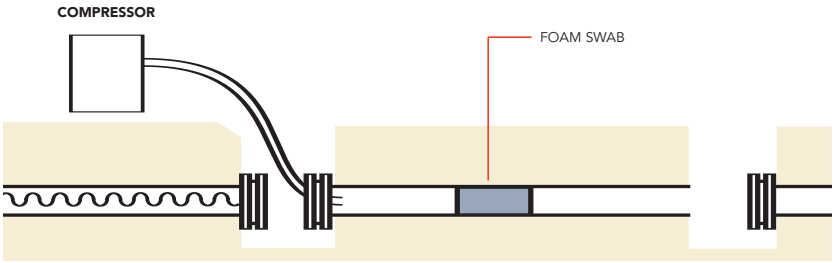
This next generation Rapid Setting Polymeric Lining now offers water undertakers a semi-structural spray lining alternative to conventional polyethylene replacement technologies.



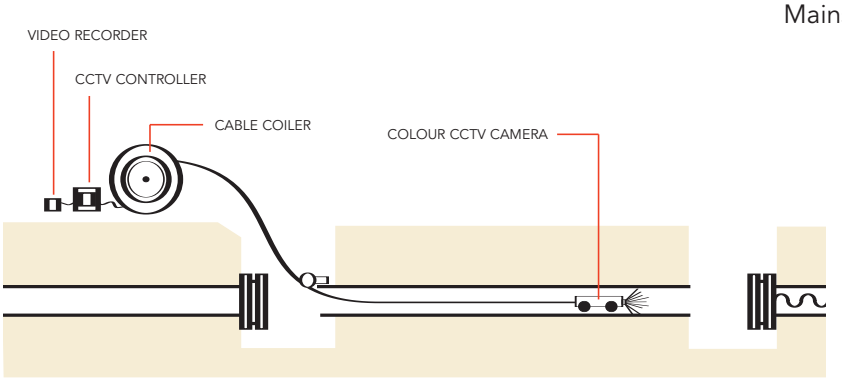
PROCESS DESCRIPTION



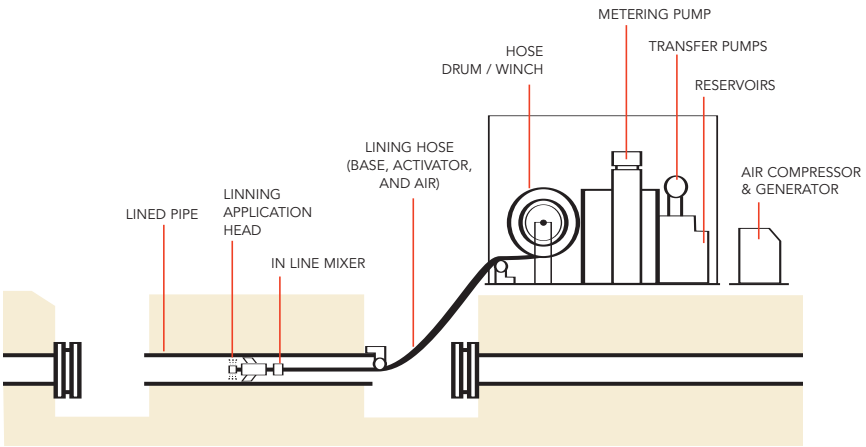
Cleaning



Mains Drying



Pre lining CCTV Inspection / Post cure CCTV inspection



Rapid –Setting Polymeric Lining

THE COPON HYCOTE 169HB SYSTEM

Overview

The decision making process for determining a rehabilitation strategy is generally driven by a condition assessment of the pipeline to be renovated. Internal and external corrosion pit depth measurements made on pipe samples, allied to a simple corrosion model, enable predictions to be made regarding the residual asset life.

If the predicted residual asset life is less than 30 years, non structural lining is not considered viable and renewal is preferred. However adherence to the 30 year rule on the basis of the pit depth measurements may result in renewal of mains which are likely to sustain only local, rather than global damage during their lifetime.

Thus there is considerable scope for a semi-structural spray lining which has the capability to accommodate local damage to the host pipe during the desired asset life.

What is a Semi-Structural Lining ?

A semi-structural lining requires support from the host pipe in order that general operating pressures and external loads are withstood by composite action, except where the lining is required to span any local damage zones which may manifest themselves after application of the lining.

Local host pipe damage can be considered as that which is sufficiently limited in extent to enable the lining to be designed for bridging capability rather than as a full thickness pressure pipe.

A semi-structural lining is designed to maintain longitudinal continuity in the event of local host pipe damage, and to provide long term spanning of the resultant discontinuities.

Failure Modes for Iron Mains

The failure modes for iron drinking water mains can be broadly categorised as follows:

Ductile iron	(all diameters)	-	corrosion voids in all sizes
Cast iron	(large diameters)	-	longitudinal fracture, corrosion voids
Cast iron	(small diameters)	-	transverse fracture (“back break”) corrosion voids

In most distribution networks there is a considerably greater proportion of cast iron pipe in comparison to ductile, and the predominant problem with small diameter cast iron mains is transverse fracture arising from imposed bending stresses (ground loading) and thermal stresses. The fracture is invariably clean and the lining is essentially left spanning a gap of negligible width.

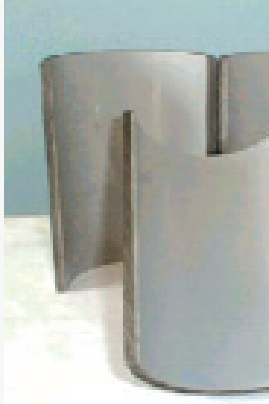
Performance Requirements

A lining which is to remain viable after a transverse host pipe fracture must have the following properties:

Sufficient toughness to survive the dynamic loading at fracture
Sufficient ductility to accommodate any joint rotation that may occur after fracture
Sufficient shear strength to maintain longitudinal continuity in the presence of unrestrained ground movements
Sufficient flexural strength to provide long term corrosion void spanning capability

Copon Hycote 169 HB - Summary of Physical Properties

Tensile Stress @ Yield	14.2 MPa
Ultimate Tensile Stress	19.2 MPa
Ultimate Tensile Strain	30%
Tensile Modulus	600 MPa
Ultimate Flexural Stress	25.0 MPa
Flexural Modulus	770 MPa
Joint Rotation Capability	> 12%
Transverse Shear Resistance	> 25% of pipe diameter
Resistance to Imposed Axial Stress (bending and thermal)	Maximum 100 MPa



Features and Benefits

- Approved under Regulation 31(4)(a) of the Water Supply (Water Quality) Regulations
- Rapid setting polymeric lining, 1 hour cure period before commencement of return to service procedure
- High build capability –linings of up to 5mm thickness in a single application
- Obviates reinstatement of service connections
- Corrosion void spanning capability
- Maintains longitudinal continuity in the event of transverse fracture
- Minimum 50 year design life
- High abrasion resistance
- Semi structural properties
- Can be applied to cast or ductile iron , asbestos cement, and previously coated pipes
- Restores hydraulic capacity
- Enhances original pipe structure
- Cost effective environmental alternative to conventional renewal techniques

LINING DESIGN

General

COPON HYCOTE 169HB is suitable for application to a variety of pipeline substrates including cast iron, ductile iron, previously coated cast or ductile iron, and asbestos cement. The product should not be applied to pvc on account of the failure mode of pvc pipes (full length longitudinal cracking) which may result in the lining effectively having to function as an unsupported pressure pipe.

Design Procedure

Step 1 Carry out condition assessement and pit depth analysis on pipe samples.

Step 2 From the pit depth measurments, determine the projected residual asset life.

Step 3 By reference to Table 1 below, establish the appropriate rehabilitation method.

TABLE 1

Pipe Condition	Rehabilitation Method
Global Damage - full wall corrosion or longitudinal cracking	Renewal
Residual life >30 years, no history of bursts	Non - structural lining
Residual life >30 years, known burst history	Semi - structural lining
Residual life 0-30 years, no global damage	Semi - structural lining

Step 4 If suitable for non-structral lining, determine the minimum lining thickness by reference to Figure 1.

Step 5 If suitable for semi-structural lining, determine the minimum lining thickness by reference to Figure 2.

NB: It is assumed that the lining should have the capability to span corrosion voids which form as a result of external corrosion after application of the lining up to a maximum diameter of 15mm

Figure 1

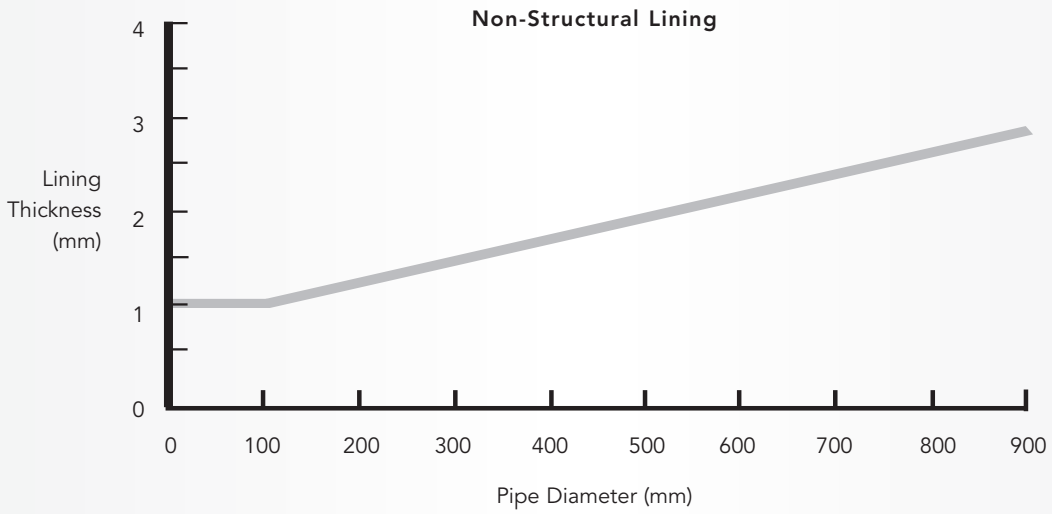
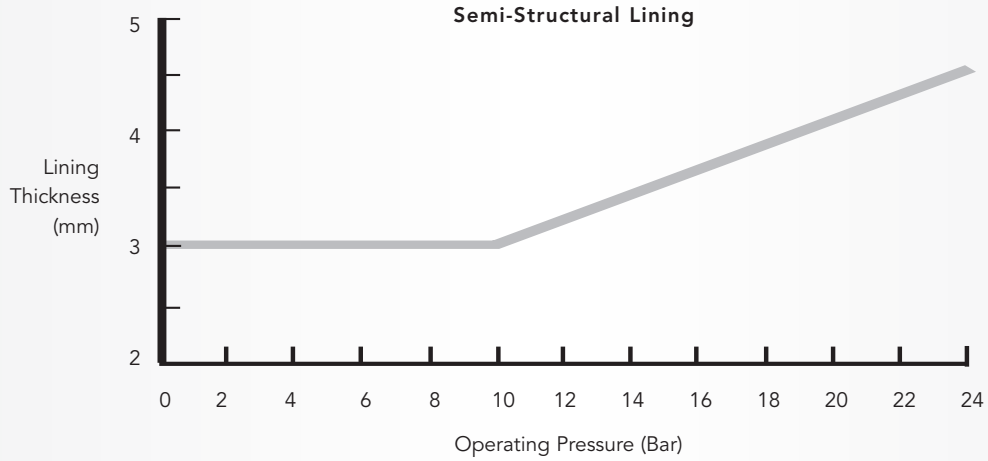


Figure 2



LINING DESIGN - Examples

Example 1

A 4 inch diameter cast iron main operates at 8 bar pressure. The pit depth analysis predicts a residual life of 40 years. However, the main has a known history of repaired bursts.

By referenace to Table 1, the main can be considered for semi-structural lining. By reference to Figure 2, the required minimum lining thickness is 3mm.

Example 2

A 6 inch diameter cast iron main operates at 14 bar pressure. The pit depth analysis predicts a residual life of 20 years. There is no evidence of full wall corosion or longitudinal cracking.

By referenace to Table 1, the main can be considered for semi-structural lining. By reference to Figure 2, the required minimum lining thickness is 3.5mm.

Material Consumption (Litres / metre)

Pipe Diameter (inches)	Lining Thickness (mm)				
	1	2	3	4	5
3	0.25	0.50	0.75	1.00	1.25
4	0.335	0.67	1.00	1.33	1.67
6	0.50	1.00	1.50	2.00	2.50
8	0.665	1.33	2.00	2.69	3.33
9	0.75	1.50	2.25	3.00	3.75
10	0.835	1.67	2.50	3.33	4.17
12	1.00	2.00	3.00	4.00	5.00
15	1.25	2.50	3.75	5.00	6.25
18	1.50	3.00	4.50	6.00	7.50
24	2.00	4.00	6.00	8.00	10.00
30	2.50	5.00	7.50	10.00	12.50
36	3.00	6.00	9.00	12.00	15.00

The decision making process for determining a rehabilitation strategy...

choose...

COPON HYCOTE 169HB

SEMI-STRUCTURAL POLYMERIC LINING SYSTEM