

## Rehabilitating Aging Structures



Get In, Get Out, Stay Out™

## The New Infrastructure

## The New Infrastructure

When drainage infrastructure reaches the end of a useful service life, the decision to excavate and replace is commonplace. Rehabilitation or relining of culverts, storm sewers and small bridges can be a faster and less expensive option that imparts little to no impact on traffic maintenance.

### Rehabilitation — Get In, Get Out, Stay Out™

Contech<sup>®</sup> offers a variety of products and systems, combined with more than 100 years of experience, to facilitate rehabilitation of storm and sanitary sewers, culverts and bridges.

### Design Considerations for Rehabilitation versus Replacement

Rehabilitating or relining a drainage structure requires a site-specific analysis. There is no one-size-fits-all approach. Every reline project needs to be examined closely by qualified professionals.

From an engineering perspective, the design approach must take into account the usual design parameters for a drainage structure, with a few additional considerations. The primary areas where an engineer should be concerned are:

Condition of existing structures

Optimum shape, size and materials

- Hydraulic requirements and limitations
- Constructability
- Design service life
- Structural analysis and design
- Specification goals

# Variety of Products for More Efficient Rehabilitation

	SPAN RANGE	PRODUCT	DESCRIPTION		
	12″ – 36″	A2™ Liner Pipe	PVC corrugated pipe with smooth interior wall		
	18″ – 102″	ULTRA FLO®	Spiral rib aluminum, aluminized and polymer-coated steel pipe		
RAINAG	12″ — 144″	Corrugated Metal Pipe	Corrugated aluminized and polymer-coated steel and aluminum alloy helical pipe		
0	30″ – 120″	DuroMaxx®	Steel reinforced polyethylene pipe		
	30″-120″ +	SPR™ PE	Spiral-wound steel reinforced PE pipe		
	12″ – 36″	A2™ Liner Pipe	PVC corrugated pipe with smooth interior wall		
SEWER	30″ – 120″	DuroMaxx®	Steel reinforced polyethylene pipe		
01	30″-120″ +	SPR™ PE	Spiral-wound steel reinforced PE pipe		
	4'-20'+	Tunnel Liner Plate	Steel and aluminum 2- flanged plate		
S	5'-23'+	ALSP MULTI-PLATE®	Aluminum structural plate Galvanized steel structural plate		
CTURE	8'-9" — 35'-5"	ALBC	Aluminum box culvert		
STRU	19′-5″ — 65′	SUPER SPAN ™ SUPER-PLATE® BridgeCor®	Galvanized steel structural plate long spans Aluminum structural plate long spans Deep corrugation galvanized steel structural plate		
	12′ – 102′	CON/SPAN $^{\ensuremath{\mathbb{R}}}$ and BEBO $^{\ensuremath{\mathbb{R}}}$	Precast concrete arches		

Ask your Contech representative about SPR™ PE liner — the in-situ wound steel reinforced PE pipe.



## Segmental Sliplining Process for Plastic Pipe

These include DuroMaxx and A2 Liner Products. Consult your local Contech representative for more detail.

Gasket bell and spigot or fusion weld joints.	Optional skids shown.
Pull or push pipe "train" from trailing end.	
When longer pushes are required, repeat and join "trains".	arta afartana adar aternaria arta afartante, arta aternaria
Install bracing or use othe anti-flotation methods as required prior to grouting.	anna amitandia. Anna amitandia amita amitana amitana

## Segmental Sliplining Process for CMP

Consult your local Contech representative for more detail.

Insert first section.	Existing structure
Block the first section and place the next section.	
Block the tail end and place internal expanding band and gasket.	
Repeat until all sections are installed. Place bracing to prevent flotation and displacement during grouting.	← Vertical bracing

## Relining with Pipe

### $PVC - A2^{TM}$ Liner Pipe

### Cost-Effective Rehabilitation with Proven Trenchless Installation Methods

The increasing rate of sanitary and storm sewer deterioration requires an efficient and cost-effective rehabilitation solution. Contech A2 Liner Pipe uses proven trenchless installation methods to slipline existing sewer lines without the disruptions associated with open trenching — while increasing productivity and lowering costs.



The A2 Liner Pipe has a unique STAB-JOINT coupler that fits flush with the outer wall surface for easy installation while ensuring proper load transfer across the joint during installation.

### A2 Liner Pipe Increases Hydraulic Capacity

When reinforced concrete and vitrified clay pipe have offset joints, cracks, spalling or protrusions, there is greater resistance to flow, reducing hydraulic capacity. Significant hydraulic improvements are achieved when these deteriorated pipes are sliplined with A2 Liner. A Manning's "n" value of .009 can actually result in increased flow capacity and higher flow velocities for improved self-cleaning.

The Manning equation can be used to determine the flow capacities for circular pipes before and after rehabilitation:



The hydraulic comparisons chart, below, compares the flow of existing concrete pipe after it is relined with A2 Liner Pipe, where:

- n = Manning's coefficient
- A2 Liner "n" = .009
- Existing RCP "n" = 0.015
- D = inside diameter

This analysis is based upon closed-system flow for sewers or outlet-controlled flow for culverts.

### Hydraulic Comparisons

Existing Diameter (in)	A2 Liner Diameter (in)	Percent Existing Flow*				
15	12	92				
18	15	103				
21	18	111				
24	21	117				
27	24	122				
36	30	103				
42	36	111				



\* Sliplining with A2 Liner actually can **increase** the hydraulic capacity of existing RCP drainage systems.

## Rehabilitating Aging Structures

## A2 Liner Pipe Jacking Loads and Pushing Distances

Pipe Diameter (in)	Safe Compressive Jacking Loads (Ib)	Allowable Jacking Distance <sup>1</sup> (ft)	Allowable Jacking Distance <sup>2</sup> (ft)	Recommended Grout Pressure <sup>+3</sup> (psi)
12	3,200	3,000	7,000	5
15	9,100	5,000	12,000	5
18	14,000	5,000	12,000	5
21	19,000	5,000	12,000	5
24	23,830	5,000	12,000	5
27	27,760	5,000	12,000	5
30	30,900	5,000	12,000	5
36	37,000	4,000	10,000	5

<sup>1</sup> Based on Sliding Coefficient of 0.25

<sup>2</sup> Based on Sliding Coefficient of 0.10

<sup>3</sup> Contact your local Contech representative for more information about recommended grout pressure and grout procedures

\* Includes a Factor of Safety (FS) = 3.0 for A2 Liner pipe that is installed perfectly round or a FS = 2.0 for liner pipe with 5% deflection

### A2 Liner Pipe Dimensions

Nominal Diameter (in)	Average O.D. (in)	Average I.D. (in)	
12	12.8	11.7	
15	15.7	14.3	
18	19.2	17.6	
21	22.6	20.7	
24	25.6	23.5	
27	28.9	26.4	
30	32.2	29.5	
36	38.7	35.5	

### Lightweight for Easy Handling and Installation

The lightweight design of the A2 Liner, coupled with a unique gasketed STAB-JOINT, makes joining easy. Lubricant, two chains and one or two come-alongs are usually all that is required to join sections. The light, easy-to-handle sections allow for maneuvering in tight workspaces. For more information, please contact your Contech representative.











## Relining with Pipe

### Steel Reinforced Polyethylene Pipe (SRPE) — DuroMaxx®

DuroMaxx is designed with a smooth inner wall for outstanding hydraulic capacity, and provides the properties you can count on for long-term service and performance in the most demanding environments. By providing the strength of steel and the durability of plastic, DuroMaxx is an optimal reline solution in many situations.

### Features

- 80 ksi steel reinforced ribbed profile walls. •
- Pressure-rated Polyethylene (PE) Resin.
- Diameters from 30 to 120 inches.
- Standard lengths of 14 or 24 feet with bell and spigot joints. Custom lengths available.
- Watertight bell and spigot joints.
- Leak-free ElectroFusion (EF) joints available.

DuroMaxx Jacking Loads, Pushing Distances and Grouting Pressure						
Diameter (in)	Safe Jacking Load (Ibs)	Allowable Jacking Distance <sup>1</sup> (ft)	Allowable Jacking Distance <sup>2</sup> (ft)	Recommended Grout Pressure*3 (psi)		
30	2,000	426	1,064	3.0		
36	2,400	407	1,017	2.4		
42	2,800	415	1,037	2.2		
48	3,750	487	1,218	2.0		
54	4,240	470	1,175	1.7		
60	4,710	439	1,098	1.5		
66	5,260	370	924	1.5		
72	5,810	354	886	1.3		
84	6,910	362	906	1.2		
96	8,010	368	921	1.0		
120	10,220	375	938	0.9		

<sup>1</sup> Based on Sliding Coefficient of 0.25

<sup>2</sup> Based on Sliding Coefficient of 0.10

<sup>3</sup> Contact your local Contech representative for more information about recommended grout pressure and grout procedures \* Includes a Factor of Safety (FS) = 3.0 for DuroMaxx liner pipe that is installed perfectly round

or a FS = 2.0 for liner pipe with 5% deflection.

A proven trenchless installation method providing cost-effective rehabilitation and easy installation with a joint tightness on which you can depend.

- Manning's "n" of .012 restores hydraulic capacity to your sewer.
- Eliminates costly bypass operations as normal flow is maintained.
- Provides excellent durability and resistance to abrasion.
- Meets the joint tightness test requirements of ASTM D3212.







### Grout Plug and Coupling Detail

74.1

85.9

97.8

121.9

70.9

82.7

94.5

118.1

\*A variety of joint options are available for large diameter DuroMaxx. Contact your local Contech representative for more information about available joint options and dimensions.

77.6

\*

65.6

76.3

87.0

109.0

72

84

96

120



## Relining with Pipe

## Corrugated Metal Pipe — ULTRA FLO<sup>®</sup> and SmoothCor<sup>m</sup>

Restoration of failed or deteriorating pipe can be accomplished by relining with ULTRA FLO or SmoothCor. Their low-wall profile can yield an inside diameter that approaches the original pipe, while the hydraulic capacity is improved. Contech's corrugated metal pipe is light weight and can be provided in custom lengths to meet individual site conditions, making the lining process easier.

#### Features

- Predictable service life of up to 100+ years.
- A variety of premium coatings available.
- Lengths of up to 40 feet.
- Diameters from 18 to 144 inches.
- Custom lengths and diameters available.
- Smooth interior Manning's "n" of 0.012

	Steel ULIKA FLU						
Diameter (in)	Safe Jacking Load (Ibs)	Allowable Jacking Distance <sup>1</sup> (ft)	Allowable Jacking Distance <sup>2</sup> (ft)	Safe Jacking Load (Ibs)	Allowable Jacking Distance <sup>1</sup> (ft)	Allowable Jacking Distance <sup>2</sup> (ft)	
18	3,220	860	2,140	1,610	640	1,610	
21	3,660	820	2,030	1,830	610	1,520	
24	4,070	810	2,030	2,940	650	1,630	
30	4,950	790	1,970	4,380	580	1,460	
36	5,090	550	1,370	7,800	670	1,690	
42	4,950	330	830	8,510	650	1,630	
48	4,750	280	700	9,050	600	1,500	
54	5,090	270	670	9,540	560	1,400	
60	5,510	260	660	10,040	540	1,350	
66	10,260	440	1,110	10,110	490	1,230	
72	10,180	400	1,010	10,520	460	1,160	
78	10,290	380	950	11,030	450	1,120	
84	14,650	500	1,260	11,480	440	1,100	
90	14,840	470	1,180				
96	14,020	420	1,050				
102	14,420	410	1,030				

### ILTRA FLO and SmoothCor Jacking Loads and Pushing Distances

<sup>1</sup> Based on Sliding Coefficient of 0.25 <sup>2</sup> Based on Sliding Coefficient of 0.10

### Alignment Rod and Grout Coupling Detail









ULTRA FLO Pipe Dimensions*						
Pipe Diameter (in)	Max O.D. (in)	Steel Approx. Weight (lbs/ft)	Aluminum Approx. Weight (Ibs/ft)			
18	20.28	15	5			
21	23.28	18	6			
24	26.28	20	9			
30	32.28	25	15			
36	38.28	37	23			
42	44.28	59	26			
48	50.28	67	30			
54	56.32	75	34			
60	62.38	83	37			
66	68.44	92	41			
72	74.50	100	45			
78	80.56	108	49			
84	86.62	116	52			
90	92.68	125				
96	98.74	133				
102	104.80	140				

\* Based on AASHTO M36 Specifications. Custom diameters available upon request.

ULTRA FLO Grouting Pressure							
	Steel — Max PSI Recommended*1		Aluminum — Max PSI Recommended* 1				
Liner Diameter (in)	Round 5% Deflection		Round	5% Deflection			
18	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>			
21	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>			
24	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>			
30	5²	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>			
36	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>			
42	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>			
48	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>	5 <sup>2</sup>			
54	5 <sup>2</sup>	5	5 <sup>2</sup>	5			
60	5	3	5	3			
66	5	3	4	3			
72	4	3	3	2			
78	3	2	2	2			
84	4	2	2	]			
90	3	2					
96	2	2					
102	2	1					

<sup>1</sup> Contact your local Contech representative for more information about recommended grout pressure and grout procedures.

<sup>2</sup> Grout pressure limited to 5 psi maximum for practical, safe installation considerations. Higher grouting pressures may be possible and tolerable, depending upon the type of joint system used and other site-specific installation considerations.

upon the type of joint system used and other site-specific installation considerations.
Includes a Factor of Safety (FS) = 3.0 for installed ULTRA FLO liner pipe that is perfectly round or a FS = 2.0 for liner pipe with 5% deflection.









## Rehabilitation of Bridges

### Structures

With a nationwide focus on structurally-deficient and functionally-obsolete bridges, time and cost-effective bridge replacement solutions are in high demand. Contech plate and precast structures have proven records of success for:

- Emergency bridge replacements
- Fast-tracked projects
- Relining and rehabilitation
- Culvert extensions for road widening











### CON/SPAN $^{\ensuremath{\mathbb{R}}}$ and BEBO $^{\ensuremath{\mathbb{R}}}$

Buried concrete arches provide another alternative for bridge rehabilitation. Precast elements are slid easily underneath existing aging structures to ensure their long-term serviceability.

Because these structures are prefabricated and come with extensive technical support, they allow highway agencies and municipalities to dramatically reduce construction time and traffic disruptions during bridge replacements.

### Steel and Aluminum Box Culverts

Box Culverts are a practical and cost-effective solution for small bridge rehabilitation. These wide-span, low-rise shapes are lightweight, making them fast and easy to install.

## Structures

### MULTI-PLATE® and Aluminium Structural Plate

Steel and aluminum structural plate offerings from Contech have a long history of strength, durability and economy. These structures meet a wide range of site-specific challenges with a variety of sizes and shapes available. Additionally, these structures offer unique design elements that include sloped ends, beveled cuts and elbows. Many are suited specifically for rehabilitation due to fast installation accompanied by extensive technical support. These structures provide spans of up to 26 feet.

### SUPER-SPAN <sup>™</sup>, SUPER-PLATE<sup>®</sup> and BridgeCor<sup>®</sup>

- Offering larger spans
- A different family of shapes
- Spans of up to 65 feet

### Tunnel Liner Plate

Contech Tunnel Liner Plate provides optimum stability and protection when constructing new utility tunnels, relining structures under highways and railroads, and lining vertical shafts. It offers the highest continuous ring stiffness and high compression joint strength. The 2-Flange Liner Plate has effective stiffness that is more than double the stiffness of the same gage of 4-Flange Liner Plate.



Deep, full-length corrugations and lapped joints for more effective stiffness and ring compression.

### Typical Grout Fill for Tunnel Liner Plate



### Standard Shapes











## Rehabilitation in Action







## Providing Economic Alternatives

#### Installation Site

I-64 Bridge Repair Huntington, West Virginia

#### Materials

BEBO precast arch structure 54' span, 24'-4" rise and 158' length

#### **Project Details**

A buried BEBO Concrete Arch Structure C54 was selected as a value engineering proposal to replace the original I-64 three-span, steel girder bridge.

Roadway closure from 8:00 p.m. to 6:00 a.m. daily during construction, kept local road closure time to a minimum. The original maintenance of traffic scheduled for two construction seasons was reduced to one construction season, providing a huge safety bonus to the traveling public and to the contractor. With lower material costs and faster installation times, BEBO provided to be an economical and successful vehicular overpass solution for the West Virginia Department of Highways.

#### Installation Site

Route 65 Reline Carroll County, Missouri

#### Materials

120" dia. of 10-gage Aluminized Steel Type 2 Corrugated Steel Pipe – 2 runs, 40' long each

#### **Project Details**

Aluminized Steel Type 2 Corrugated Steel Pipe was used to reline an existing concrete box culvert on Route 65 – a major four-lane highway in North-Central Missouri. The initial consideration was to remove and replace the existing twin 12'x12' culverts, but this relining alternative proved to be less expensive, provided the quickest turnaround time for construction and was the most convenient for traffic flow on the highway. The Route 65 Reline project was a great success and won an MODOT Practical Design Award in the Small Bridge Replacement category.

### Maintaining Our Infrastructure

#### Installation Site

CT DOT I-84 Middlebury, Connecticut

#### **Materials**

154" to 172" dia. of Galvanized Steel Tunnel Liner Plate and Aluminum Tunnel Liner Plate

#### **Project Details**

A 335' long, twin 14' ellipsed steel structural plate pipe structure installed in 1964 under 35' of fill was lined with a galvanized steel Tunnel Liner Plate, with high strength mortar lining for hydraulic efficiency, on the upstream end. On the downstream end, an aluminum Tunnel Liner Plate, without lining, was used to reduce water velocity at outlet. New structures have diameters from 154" to 172". The new structures were designed to carry the full load above. Installed in 2000, photos show this structure in 2012.

#### Installation Site

ADOT – AZ SR 95 Quartzite, Arizona

#### Materials

718 LF of 30", 36" and 42" dia. of DuroMaxx SRPE Pipe

### **Project Details**

Multiple culverts of various diameters under State Route 95 near Yuma required rehabilitation or replacement. ADOT chose to rehabilitate the culverts instead of using open trench methods to replace them. DuroMaxx and segmental sliplining methods were selected by the contractor, and a small, rubber-tired backhoe was used for liner handling and insertion.



## The Mew Infrastructure

### The Grouting Process



#### What is Involved

Grouting of the annular space fixes the position of the new liner pipe, provides uniform support and inhibits further failure of the host pipe. High slump, low-strength grout mix containing fly ash or a cellular grout additive will help ensure all voids are filled. Pre-blended, commercially available products and blown-sand methods are other strategies the contractor may consider.



Contech can provide assistance from conceptual ideas to cost estimates to final shop drawings.



NEW PRECAST STRUCTURE

GROUT IN ANNULAR SPACE



### Small Diameters (less than 48") » Grouting Technique



Pipe diameters less than 48" are best suited for a single stage grouting technique.

This is done most efficiently by constructing a bulkhead at the ends of the reline and allowing the new pipe to float to the crown of the existing pipe while grout is pumped into the annular space. Grout should flow in a controlled manner to ensure balanced filling on all sides.

Large Diameters (48" and larger) » Grouting Technique



Multiple stage grouting is normally necessary for pipe that is 48" diameter and larger. This approach allows for a large reduction in effective buoyant force of the fluid grout. The technique requires a well-thought bracing and blocking scheme and a full evaluation of shape control, grout slump and mix design and grout pumping rate. Typically, a self-leveling grout product should flow in a controlled manner to ensure balanced filling.

### Multi-Stage Grouting Procedure



Always use a screen on the pump hopper to sift out any large aggregate that can clog the grout line and potentially damage the structure. For more information, contact your Contech representative.

Contech Engineered Solutions provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, retaining walls, sanitary sewer, stormwater, erosion control, soil stabilization and wastewater products.

#### For more information, call a Contech Regional Office:

#### Ohio (Corporate Office)

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