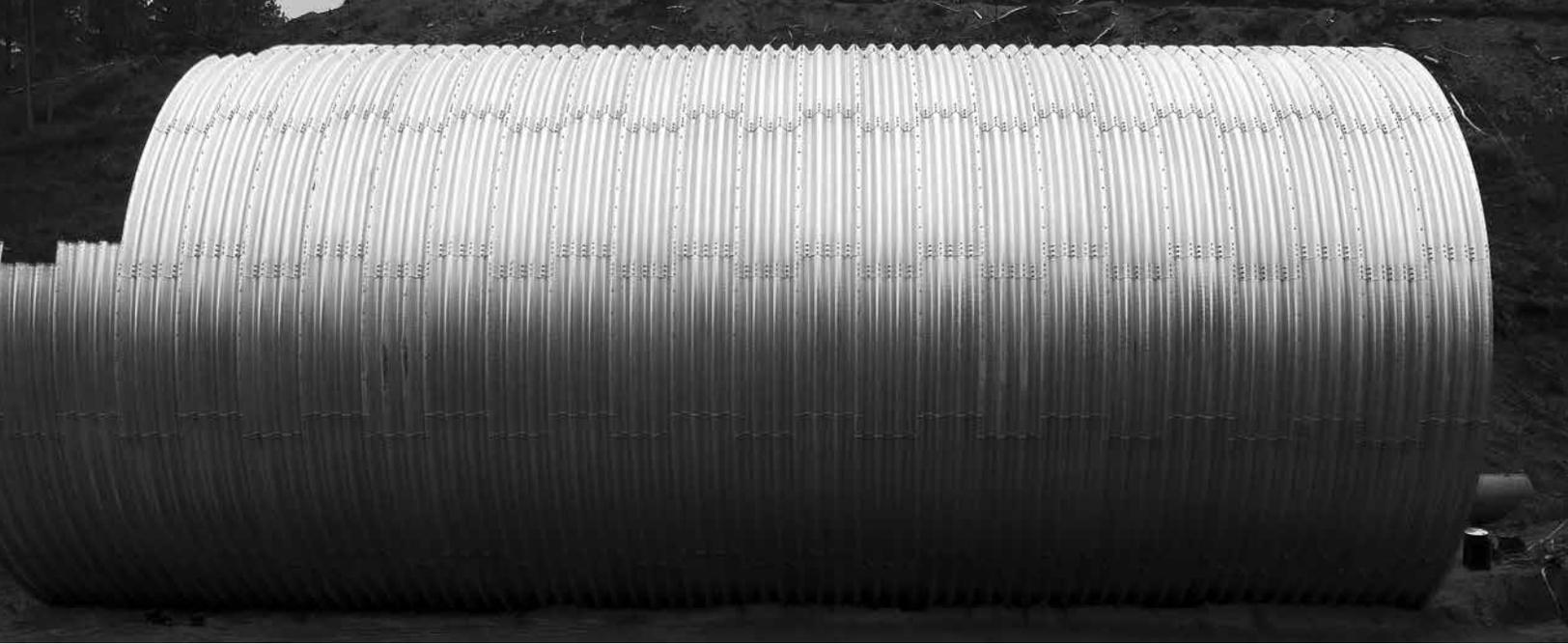


BridgeCor[®] Round and Ellipse Assembly & Installation Guide





BridgeCor® Round and Ellipse Assembly & Installation Guide

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Note to Contractor:

If at any time you have any questions, please don't hesitate to call the Winchester Plant Technical Services Team at 859-744-3339 for assistance.

Introduction

AS WITH ANY INSTRUCTIONS, PLEASE READ THROUGH THIS INFORMATION COMPLETELY BEFORE ATTEMPTING ANY FIELD WORK OR ASSEMBLY.

The following is a guideline for the assembly and installation of a Contech BridgeCor® structure. Prior to assembly, reference any assembly drawings provided, these guidelines, the Structural Plate Design Guide and the engineer's plans and specifications.

For each different structure shipped to the job site, a copy of the assembly drawings, the bill of materials (BOM) and these instructions are enclosed in a keg with a color coded lid. If the order calls for two or more identical structures, only one drawing will be furnished. The drawings provide the specific plate layout for each structure and must be used to guide assembly.

Safety Instructions

Review these instructions with your supervisors and crews. It is our intent you have a safe and successful project for you and your customer. Anytime a question or problem arises, contact your Contech representative before you proceed.

NOTICE: PRIOR TO ASSEMBLY, REFERENCE THE ENGINEER'S PROJECT PLANS AND SPECIFICATIONS. DURING ASSEMBLY AND INSTALLATION, ALL OSHA SAFETY REGULATIONS SHALL BE OBSERVED.

 **This safety alert symbol indicates important safety messages. When you see this symbol, be alert to the possibility of personal injury, and be sure you understand the message that follows.**

Terms you should know

 **WARNING** Alerts you to hazards or unsafe practices that **CAN** result in severe personal injury or property damage.

 **SAFETY INSTRUCTIONS** Messages about procedures or actions that must be followed for safe handling of BridgeCor.

  **WARNING** Falling plates and accessories can cause severe personal injury or death. Read and follow all safety instructions before unloading BridgeCor® and accessories.

UNLOADING AND HANDLING

Plates and fasteners are typically shipped in bundles which may weigh up to 10,000 lbs. See the Bill of Materials for individual plate weights. The following equipment is recommended for unloading BridgeCor and accessories:

- Forklift
- Front-end loader with fork adapters
- Backhoe with fork adapters
- Cranes
- Non-metallic slings

Other unloading methods such as chains, wire rope, cinching, or hooks in the end of the bundles should not be used.

Failure to follow these instructions can result in serious injury, death and /or damage to BridgeCor and accessories.

1. Only trained and authorized equipment operators are to be permitted to unload the BridgeCor and accessories.
2. Wear approved safety hat and shoes, gloves, and eye protection.
3. Park the truck and trailer on level ground before unloading.
4. Keep all unauthorized persons clear of the area when the driver releases the binders from the trailer and during unloading.
5. Do not cut the steel strapping around the bundles until the bundles have been placed on level ground or secured, and will not be moved again as a unit. It is recommended that the steel strapping be cut with appropriate sized cutting tools. Stand to the side when cutting a strap. Always be aware that BridgeCor and accessories may move, roll, or fall when a strap is cut.

6. Do not lift bundles by the steel strapping around the bundles. 

7. Know the capabilities and rated load capacities of your lifting equipment. Never exceed them.

8. Do not stand or ride on the load of BridgeCor and accessories while it is being unloaded. Do not stand near the BridgeCor and accessories while they are being unloaded. 

9. If unloading at multiple site locations, make sure the truck driver secures the remaining load before proceeding to the next location.

10. The contractor shall be responsible for the safety of his/her employees and agents. Adequate safety indoctrination is his responsibility.
11. Safe practices on construction work as outlined in the latest edition of the "Manual of Accident Prevention in Construction," published by The Associated General Contractors, shall be used as a guide and observed.
12. The contractor shall comply with all applicable city, state, and federal safety codes in effect in the area where he is performing the work. This conformance shall include the provision of the current issue of the "OSHA Safety and Health Standards (29 CFR 1926/1910)" as published by the U.S. Department of Labor.

ASSEMBLY AND INSTALLATION

1. Contech recommends using non-metallic slings for lifting assembled BridgeCor structures.
2. Chains with clevises may be used to handle the plates and accessories, being careful to not cause damage.
3. Do not push bundles off the trailers or permit plates and accessories to drop to the ground.
4. Prior to assembly, review and understand the engineer's project plans and specifications. Quality control is the responsibility of the contractor unless otherwise provided for in the contract documents.
5. Thoroughly review and study the product catalog, assembly instructions, assembly drawings, and bill of material prepared for your order and enclosed by Contech with the shipment.
6. Observe all OSHA safety regulations and guidelines during assembly and installation.

7. During and prior to the construction of permanent erosion control and end treatment protection, special precautions may be necessary to avoid damage.

8. The maximum allowable live loads and dead loads are those specified by the project engineer. The structure must be protected from unbalanced loads and from any structural loads or hydraulic forces that might bend or distort the structure. Flotation of the structure must be prevented.

 **Notwithstanding the instructions contained in this guide, it is the responsibility of the consignee or consignee's agent to devise safe unloading and handling procedures.**

STORAGE

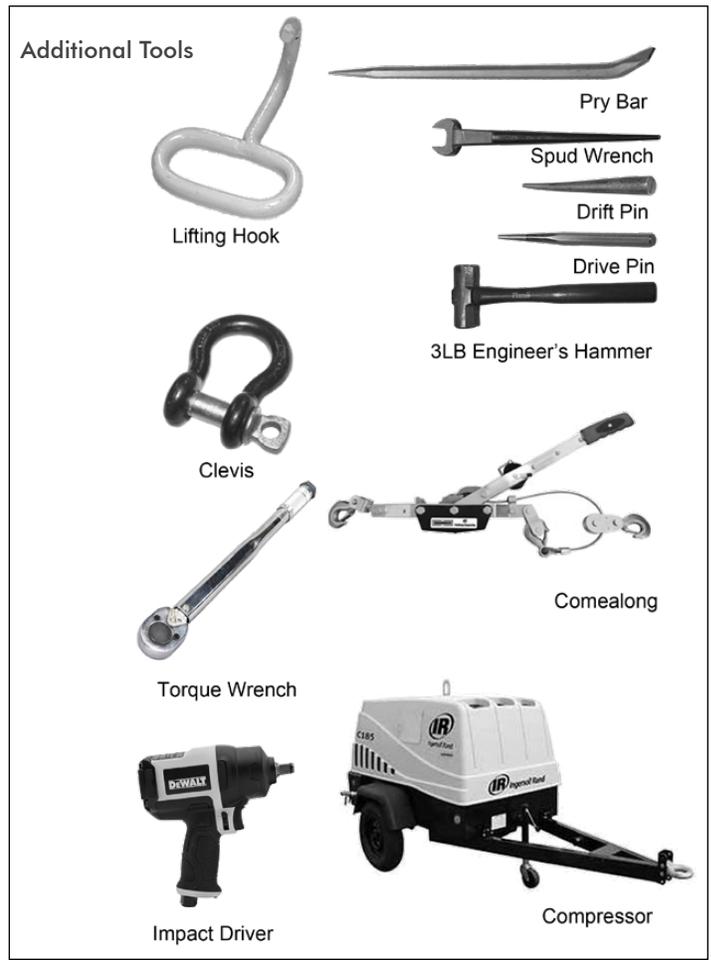
When steel bundles are exposed to moisture for extended time periods, a wet storage stain may occur. The purchaser should use reasonable handling and storage procedures for the materials to assure that a stain-free product is installed. See page 7 for more information.

ASSEMBLY

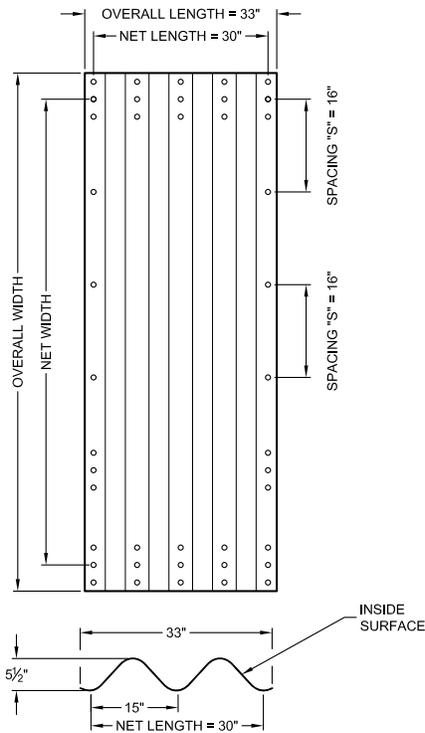
Suggested Tool List

- ☑ Band Cutters to cut packaging bands around bundled material.
- ☑ Lifting devices, such as cables/chains with safety hooks or Clevis for moving individual plates.
- ☑ 3 lb. Engineer's Hammer, Lifting Hook, and Pry bar.
- ☑ Tapered Drive Pin or Drift Pins for use in positioning plates, sheets, components or sections of material. The preferred material is tempered steel bar stock.
- ☑ Spud Wrench and/or Socket Wrench with appropriate sockets.
- ☑ Metered Torque Wrench. Many projects require verification of the bolt torque.
- ☑ Come-along for use in pulling the plates, sheets, components, or sections together (if required).
- ☑ 7/8" reamer bit and 1 1/4" socket.
- ☑ Generator or air compressor for fasteners.
- ☑ Power source (air or electric).
- ☑ Air hose. Universal quick-fit fittings are found on most compressors.
- ☑ Electric extension cords with proper ground provisions and adequate wire gage.
- ☑ Air/electric impact wrench with adequate capacity for the torque ranges as noted. Torque levels are for installation, not residual, in-service requirements.
- ☑ Scaffolding and/or Ladders for larger structures as needed.

Note: Cordless tools are not recommended.

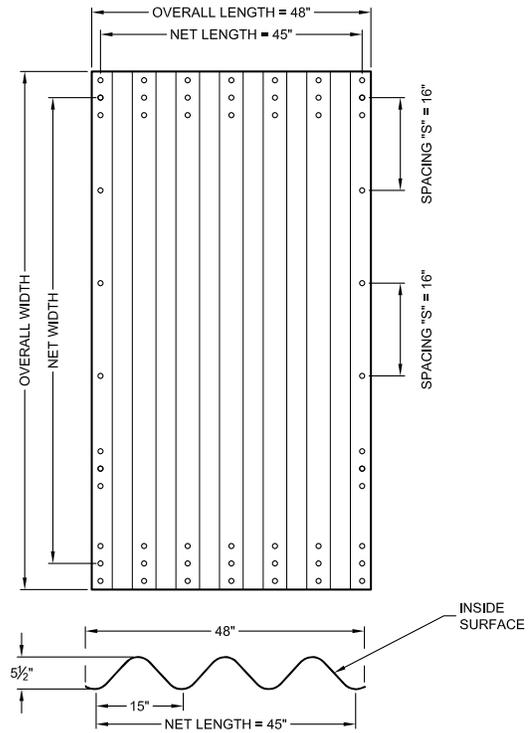


Standard Plate Detail



15" x 5.5" Corrugation, 30" Long Detail

- Notes:
1. The plate length is subject to manufacturing capabilities.
 2. All bolts are per ASTM A449 (with suitable nuts) and are 3/4" diameter for all thicknesses except 5/16" and 3/8", which are 7/8" diameter.



15" x 5.5" Corrugation, 45" Long Detail

Plate Width S	Overall Width (Feet)	8 (0.170)	7 (0.188)	5 (0.218)	3 (0.249)	1 (0.280)
4 S	6.1	219	242	280	321	361
5 S	7.4	267	295	342	391	440
6 S	8.8	315	348	404	461	519
7 S	10.1	363	401	465	531	598
8 S	11.4	411	454	527	602	677
9 S	12.8	459	507	588	672	756

Nominal	Net Width (Inches)	Overall Width (Inches)	Spaces (16 inches)	Number of Circumferential Bolt Holes
4 S	64	73	4	5
5 S	80	89	5	6
6 S	96	105	6	7
7 S	112	121	7	8
8 S	128	137	8	9
9 S	144	153	9	10
10 S	160	169	10	11
11 S	176	185	11	12
12 S	192	201	12	13
13 S	208	217	13	14
14 S	224	233	14	15

For BridgeCor, S = 16 inches.

Plate Width S	Overall Width (Feet)	8 (0.170)	7 (0.188)	5 (0.218)	3 (0.249)	1 (0.280)	5/16* (0.318)	3/8* (0.380)
4 S	6.1	152	165	192	218	250	285	339
5 S	7.4	185	201	234	267	305	347	414
6 S	8.8	218	248	276	315	360	409	489
7 S	10.1	251	286	318	362	414	471	563
8 S	11.4	284	323	360	410	469	534	638
9 S	12.8	317	361	402	458	524	596	712
10 S	14.1	350	381	444	506	578	637	n/a
11 S	15.4	384	436	486	554	633	704	n/a
12 S	16.8	417	474	528	601	688	765	n/a
13 S	18.1	450	512	570	649	742	826	n/a
14 S	19.4	483	549	612	697	797	878	n/a

1. Weights are based on a zinc coating of 3 oz./sq. ft. of double-exposed surface.
2. All weights are subject to manufacturing tolerances.
3. Specified thickness is a nominal galvanized thickness. Reference AASHTO M 167.
4. S = 16 inches
5. Weight of plates are without fasteners.



BridgeCor® Bolts and Nuts

Hot-dipped galvanized steel (specially heat-treated) bolts meeting ASTM A449 specification with suitable nuts are used to assemble structural plate structures.

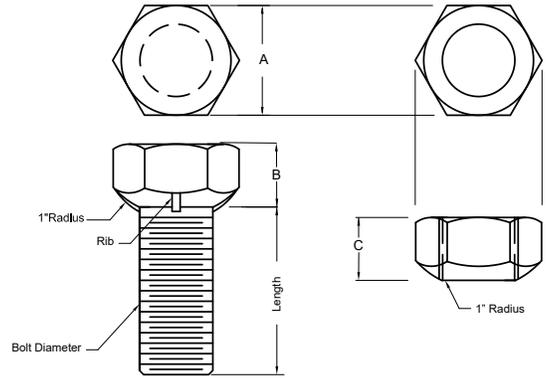
The underside of the bolt head is uniformly rounded and ribbed to prevent bolt head rotation while tightening. Unlike conventional bolts, once the nut is finger tight, final tightening can typically be accomplished by one worker with an air driven impact wrench to 150-300 ft.-lbs. of torque for 3/4" bolts and 200-350 ft.-lbs. of torque for 7/8" bolts.

In addition, one side of the nut is spherically formed to help align and center the fastener into the punched holes. The rounded side shall be placed against the structure.

TABLE 4. TYPICAL BOLT AND NUT			
Diameter (Inches)	A (Inches)	B (Inches)	C (Inches)
3/4	1 1/4	9/16	13/16
7/8	1 7/16	3/4	7/8

Notes:

1. The longer bolts are used in 3 plate lap seams.
2. In some cases 3" bolts can be used as a service type bolt.



Sample Drawing

DETAIL "A"
SCALE: N.T.S.

LEGEND: (TYPICAL FOR ALL LOCATIONS)

- LONGITUDINAL INTERNAL 1 1/2" LONG BOLT
- = 3-PLATE LAP JOINT 2" LONG

MOVEMENT CONTROL HOOKS LOCATED 1 HOLE RIGHT OF THE CENTERLINE (LOOKING DOWNSTREAM)

MOVEMENT CONTROL HOOKS (11 TH HOLE FROM TOP CENTERLINE)

MOVEMENT CONTROL HOOK - SECTION VIEW
SCALE: N.T.S.

REVISED: 6/9/2015

8 PLATE STRUCTURE

FLOW →

ANCHOR BOLTS PLACED 9\" FROM PLATE EDGE IN NEAREST CREST OR VALLEY AS SHOWN (QTY OF 188x (94x EACH SIDE))

47 RINGS = 174'-2\" (TOP) (OUT TO OUT)

MOVEMENT CONTROL HOOKS (QTY OF 42) FOR SHAPE MONITORING. PLACED AT EVERY FOURTH SEAM

TOP CENTERLINE

BRIDGECOR INSIDE CREST

USE 3/4\" x 3\" LONG M.P. BOLT AT MOVEMENT CONTROL HOOKS AT EVERY FOURTH SEAM (SEE PLATE LAYOUT FOR LOCATIONS)

MOVEMENT CONTROL HOOK

BridgeCor Bill of Material

Order #: OR00263579

Length: ft. 210.00	Region: Southwest	Merlin: 447.263
Shape: ROUND	Sales #: 735-JESSWMT	Date: 4/21/2015
Structure "S": 72	Project: LA PATA AVENUE GAP	
Gage: 8 gage	Samples: none required	

1 Structure, Dip-Galvanized, Each Containing:

Item	Qty	Gage	ϕ	Radius	Piece Wgt. lbs	Item Wgt	Max Lift	Notes
The following are fully curved single radius plates (Unmodified)								
1/101	362	8	9	180.5	459	166,158	13	
1/102	2	8	9	180.5	316	632	18	V2,V3,V24
1/103	8	8	9	180.5	305	305	19	30\" RING
The following are fully curved single radius plates (w/ 1\" AB Holes)								
1/104	31	8	9	180.5	263	10,540	22	Marks T1-T23, V1,V3,V4,V6-V23
Total Plate Wgt =						177,635	pounds	
Fastener Requirements								
1/105	9,050	3/4\" x 1-1/2\" bolt (Code 320)		Piece Wgt. Ea.	0.370	Item Wgt.	3,349	
1/106	2,475	3/4\" x 2\" bolt (Code 322)		Piece Wgt. Ea.	0.395	Item Wgt.	978	
1/107	92	3/4\" x 3\" bolt (Code 323)		Piece Wgt. Ea.	0.525	Item Wgt.	216	
1/108	188	3/4\"x19\"x5\" Hook Bolt (Code 301)		Piece Wgt. Ea.	0.610	Item Wgt.	26	
1/109	42	3/4\" Movement Control Hooks (Code 353)		Piece Wgt. Ea.	0.200	Item Wgt.	2,399	
1/110	11,983	3/4\" nut (Code 302)		Piece Wgt. Ea.	0.200	Item Wgt.	2,399	
Total Fastener Weight =						7,015	pounds	
Total Order Wgt =						184,650	pounds	

Example Plate Layout Drawing from Contract Set

Example Bill of Material (BOM)

BridgeCor® General Assembly Instructions

PLANNING BEFORE ASSEMBLY

It is important for you to know the jobsite conditions, be familiar with the materials, and understand the plans and specifications. Necessary arrangements and preparations including those suggested below should be made before the assembly crew moves onto the project. This should save time and expedite assembly.

STORAGE

The rapid corrosion of zinc surfaces under certain adverse conditions, generally referred to as wet storage stain and sometimes as “white rust” is a condition familiar to users of galvanized materials. When wet storage staining is found on galvanized materials, it is not usually sufficient to be detrimental to the protection of the steel. Normally, the stain disappears with weathering.

Because the wet storage stain may be unsightly, any attack may seem more serious than it is in actuality. The thick zinc coating provided by hot dip galvanizing of the plates after fabrication usually results in wet storage stain being of little or no significance to the durability of the coating in its intended service.

The purchaser should use reasonable handling and storage procedures for the materials at the construction site to assure that a stain-free product is installed.

When relatively long outdoor storage is necessary, plates should be raised from the ground and separated with strip spacers to provide free access of air to all parts of the surface. They also should be inclined in a manner which will give maximum drainage. The material should also be stored under cover whenever possible. Bolts and nuts should be stored inside and periodically checked to ensure that the containers are free from moisture or condensation.

ASSEMBLY CONSIDERATIONS

1. The staging area needed must be fairly flat, free of large brush, stumps, or trees and as close to the installation site as possible. In those cases where there are no level places to assemble the structure, make arrangements to level an area for staging. The staging area required is generally: a width of $[2x (\text{Span}) + 15']$ by the length of the structure.
2. Depending on the size and weight of the BridgeCor, a preassembled structure can often be lifted and set into place. For example, removing the existing bridge while the structure is being assembled may be the most effective approach to the project. (Reference the section on Lifting.) See the Bill of Materials, the Structural Plate Design Guide or a Contech representative for the handling weight of the structure.

CREW SIZE

Crew size can vary depending on several factors such as allowable time, structure size, site conditions, etc. Generally, an even numbered crew is most efficient since the work is done in pairs. A crew of four workers, one material organizer, and one crane operator is ideal with manpower increased as the individual project requires.

TOOLS REQUIRED

Reference the “Suggested Tool List” on page 4.

DESCRIPTION OF MATERIAL

BridgeCor plates are field assembled into round, arch, and box culvert structures. Corrugations of 15-inch pitch and 5.5-inch depth are perpendicular to the length of each plate.

The various lengths of cut (e.g. T1, V1, T2, etc.) and uncut plates are assembled or placed in the structure in accordance with the assembly drawing (plate layout drawing furnished by Contech).

Normally, all of the plates in the barrel of the structure are not shown on the assembly drawing. However, enough of the plates are shown to establish the proper seam stagger and a repetitive pattern in the barrel. This pattern establishes the correct location for all of the plates. Since the plates are not symmetric, they must be oriented such that their location matches that shown on the assembly drawing. Reference the detail “A” in the sample plate layout drawing on the previous page for proper orientation of the plate bolt hole pattern. Should it prove difficult to match the plate and the assembly drawing, a Contech representative should be notified for assistance.

Thickness. Standard specified thickness of the galvanized plates vary from 0.170 (8 gage) to 0.380 inches (3/8”).

Please reference the standard plate details shown on page 5 of this document.

PLATE LENGTH (LONGITUDINAL)

BridgeCor plates are furnished in either 2.50 foot net lengths or 3.75 foot net lengths. Please refer to the assembly drawings for the specific plate sizes. Actual length of a square-ended structure is three inches longer than its net length because a 1 1/2-inch lip protrudes beyond each end of every plate for lapping purposes.

PLATE WIDTH (CIRCUMFERENTIAL)

Standard plates come in multiples of 16 inches ($S=16$ inches or $5 * \pi$) and are fabricated in six net covering widths. The “S” nomenclature translates circumference directly into nominal diameter in inches. Each plate is identified by a stamped number in the corner of the plate located in the first inside crest at one end. The number consists of digits which identify the plate (see the table and image below).

Plate gage and plate radius can be determined from the stamp number that is embossed in the end corrugation on the inside of the structure. For custom cut or welded plates, the mark number is shown on the third line of the stencil (MK 2 in this case). See page 8.

Plate Stamped Number Identification

Order	Item	Heat	Gage
9786176	1\101	330704	8GA



Gage	Mark
8	8
7	7
5	5
3	3
1	1
5/16"	F
3/8"	T

Note: Only a single digit is included for the gage mark. The gage marks shown in the are used on the plate stamp.

BOLTS

BridgeCor plates are punched with 1 inch holes for 8 gage through 1 gage plates to accommodate a 3/4 inch bolt. Circumferential holes are punched on 16 inch (1 S) centers. All BridgeCor requires a staggered longitudinal seam. These seams have a three-hole bolt pattern in the crest and valley of the corrugations along the length of structure to help provide additional seam strength. For heavier plate structures (0.318" and 0.380"), the holes are punched to 1.125 inch diameter along the seams to accommodate a 7/8 inch bolt. Bolt lengths will vary depending on the location of the bolt and the number of plates in a given location.

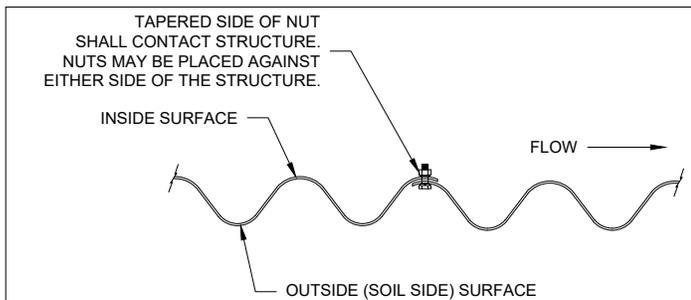
To determine the specific number of bolts for a structure, check the BOM. All containers are stenciled with the individual bolt size.

BOLTING

Bolting procedures may vary depending on the size and gage of the structure. Generally speaking, on smaller diameter lighter gage structures, a loose bolting procedure works best. On larger heavier gage structures, a tight bolting procedure, ring to ring may provide better results. The assembly contractor should use the procedure best suited for his particular project based on his experience.

To facilitate alignment, initial assembly should be done by inserting the bolts and finger tightening them, thus leaving the plate free to move slightly to help in matching the remaining bolt holes. Bolting the circumferential seam is best done by first placing bolts near the middle of the plate. Pins and pry bars will be needed to align the holes. Note, aligning of bolt holes is done easier when bolts are loose while drifting of holes is best done with adjacent bolts tight.

Sometimes it is desirable to insert and tighten all of the bottom plate bolts as the bottom is assembled. If this is done, be certain that the plates are properly aligned before tightening the bolts.



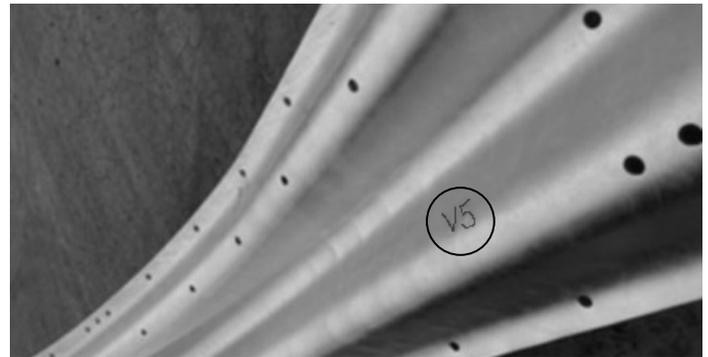
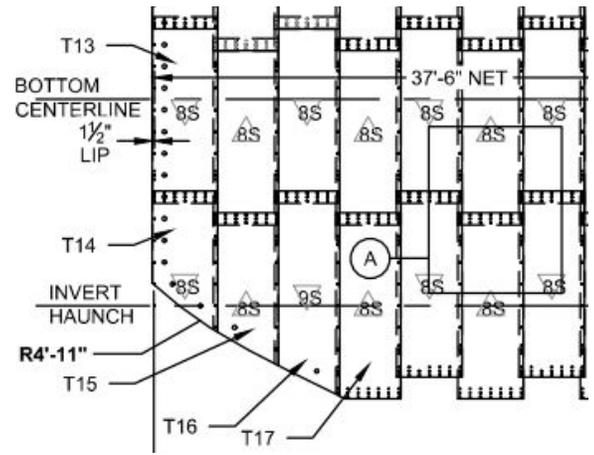
Note: The nut may be placed on either side of the plate.

BridgeCor® Assembly Instructions for Round and Ellipse Shapes

PLATE ASSEMBLY

The various widths of plates are positioned in accordance with the plate layout drawings furnished with the structure. The numbers shown on the drawings, inside the plates, indicate the plate "S" value (refer to Standard Plate Details on page 5). The beginning and end rings are shown for square end structures to obtain the proper plate stagger.

Special plates in cut end structures are shown on the plate layout together with the standard plates required to obtain proper seam stagger in the barrel. For cut plates, elbow cut and welded plates, numbers appear on the plate layout corresponding to the embossed numbers on the plates themselves (e.g. T1,V1,T2,MK1,MK2 ...). Reference the plate layout drawings furnished with the order.



One option for the initial assembly is to build the first two rings of the outlet end, on the ground, then lift it into its final position. Choose an area as flat as possible for assembly on the ground to avoid plate alignment issues. Have dunnage on hand to support the structure where required. Loose bolt the structure on the ground until both rings are complete and the structure shape is established at proper span and rise. Completely torque all bolts prior to lifting the structure into place. Add successive plates to these rings starting at the invert plates and adding plates up each side to the crown plate, following the layouts on page 9.

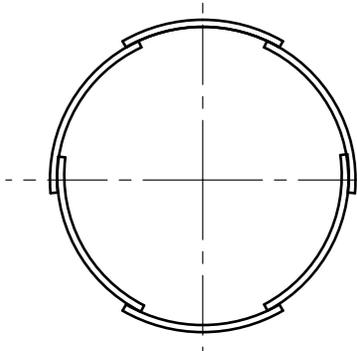
Another option would be to assemble the structure in three stages: 1) bottom/invert; 2) sides; and 3) top/crown. Please refer to page 9 for proper end view orientations.

For even number of plates per ring structures please use the following guidelines. The bottom invert plates are assembled by laying the first bottom plate at the outlet end, then placing each succeeding plate in the adjacent ring, so it laps one (1) corrugation of the preceding plate. Position the invert plates accurately with a stringline. When beginning construction, the bolt hole pattern must match the pattern shown on the plate layout drawing. Assemble two plates at the invert, then add side plates to the invert plate of the first ring until you can close the ring with the crown plate. Next, add a third invert plate and add side plates to the invert plate of the second ring until you can close the ring with the crown plate. Check the structure dimensions to ensure that they are within tolerance.

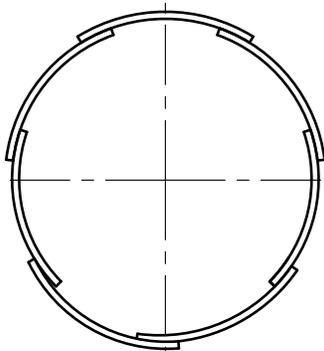
Continue this assembly sequence until you reach the inlet end of the structure. Pay close attention to the plate layout drawings to ensure that any cut plates are installed in the correct position.

For odd number of plates per ring structures please use the following guidelines. The bottom invert plates are assembled by laying the first bottom plate at the outlet end, then align the second invert plate of the same ring on top of the first plate, as detailed on the end views of page 9 of this booklet. Then place each succeeding plates in the adjacent rings so that it laps one (1) corrugation of the preceding plates. Position the invert plates accurately with a stringline. Then follow the same procedure that was outlined in the previous paragraph for the even number plates per ring structures.

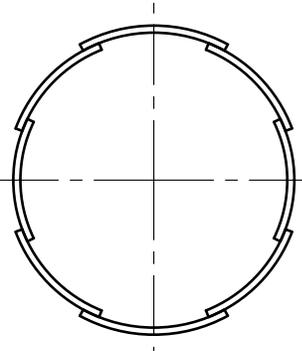
BridgeCor® Round and Ellipse Shape Orientation



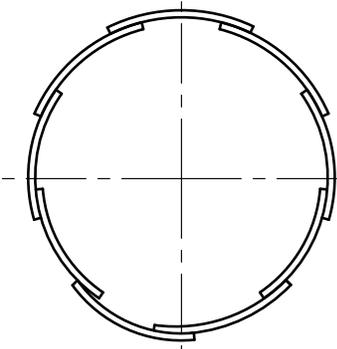
6 PLATE
STRUCTURE



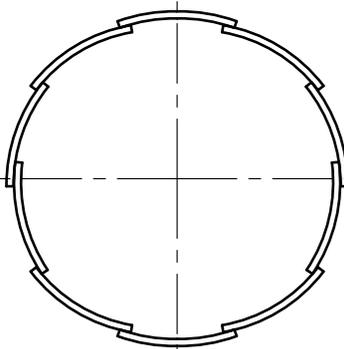
7 PLATE
STRUCTURE



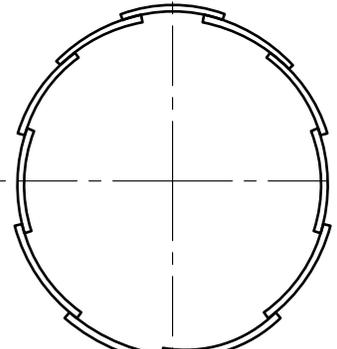
8 PLATE
STRUCTURE



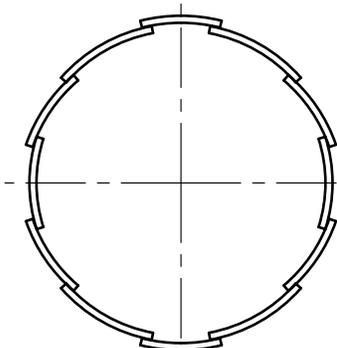
9 PLATE
STRUCTURE



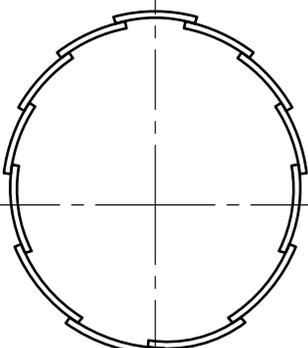
10 PLATE
STRUCTURE



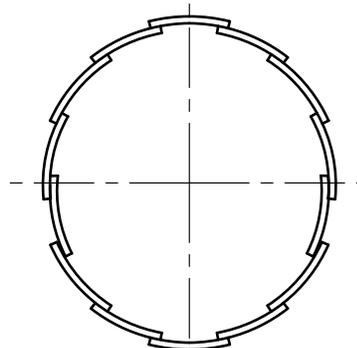
11 PLATE
STRUCTURE



12 PLATE
STRUCTURE



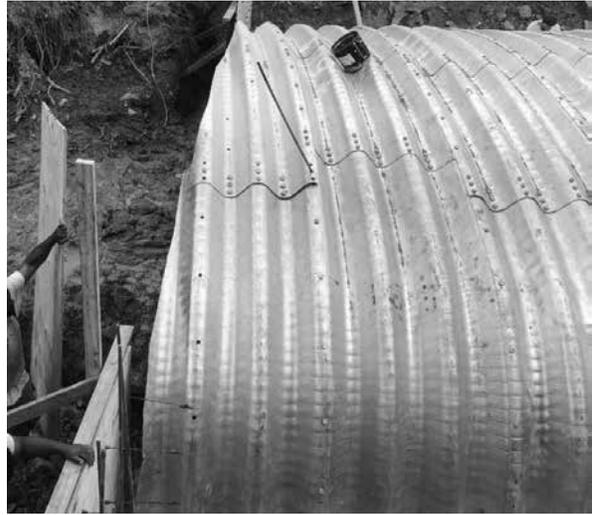
13 PLATE
STRUCTURE



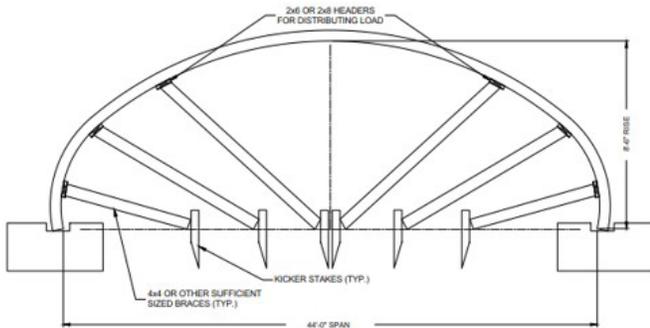
14 PLATE
STRUCTURE

ADDITIONAL ASSEMBLY CONSIDERATIONS

1. Due to plate length and bolt hole diameter tolerances, periodic checks should be made to ensure that the structure length is not deviating from the nominal length. Standard structure length tolerance is $\pm 1/2"$ per 10 LF.
2. If the structure includes a skew or bevel those plates should be installed after the main barrel of the structure has been completed. The completed rings support the skewed or bevel plates and help prevent them from distorting the design shape of the structure. When cast-in-place concrete collars are to be installed, the Installer will need to allow for formwork to be erected on the end of the structure.



3. Skewed structure ends will include a variable corrugation profile through the plane of the skew. As a result, when forming cast-in-place collars or headwalls, this "roughness" will be present and should be factored into construction of formwork. Based on manufacturing tolerances for the plate and depending on project aesthetic requirements or the level of precision required with headwall or collar layout, field trimming may be required to provide a straight edge along the plane of the skew or bevel. Skewed and beveled plates may be cut in the shop prior to delivery to the site. However, many contractors will prefer to cut skewed plates in the field when the formwork for the concrete headwall or collar is constructed to ensure the plane of the cut is at the desired location. Some contractors may also prefer to cut the plates in the field after the concrete headwall or collar is placed. This provides additional space for setting formwork at the face of the concrete headwall or collar and will allow for a clean, straight cut after the formwork is removed.
4. The skewed ends will not support the weight of the cast-in-place headwalls during placement and will need to be supported until the headwall reaches an adequate compressive strength as determined by the wall designer. Special bracing and/or scaffolding is required. The shape (arch is shown as a concept below) must be completely supported to proper span and rise during headwall construction. Design of temporary shoring to support the structure during construction is not provided by Contech and typically not provided by the wall designer. Temporary shoring is the responsibility of the wall contractor and/or a qualified construction engineer or formwork specialist.



5. Water forces, including unexpected flooding, may bend assembled plates or cause flotation of the structure. The contractor should secure the upstream end by backfilling and constructing final end treatment as soon as possible.

LIFTING

The lifting of preassembled sections of structures or entire structures is a proven and fairly common method of installation. However, attention must be given to proper techniques and safety measures. Structures must be lifted carefully in a controlled and balanced fashion.

The use of slings and/or full perimeter cables is recommended. Many structures, depending on the size, have been lifted into place using eyebolts with plate assemblies. The type, number and location of lifting devices will be dependent upon the size, length and weight of the structure. Lifting devices are normally located at a seam with appropriate reinforcement, washers, etc. used to distribute the load.

Rigging a structure to be lifted into place should be done by proportioning the weight between the lifting points to achieve balanced loading and control. The rigging plan must be approved by the Engineer of Record; for additional guidance contact your Contech representative.

The use of a spreader beam with multiple lifting points is desirable and serves to better distribute lift loads. Additionally, the lift loads should be transmitted vertically to the structure, minimizing eccentric forces on lift assemblies and excessive bending.

WARNING

THE CONTRACTOR MUST REVIEW ANY LIFTING PROCEDURE TO ENSURE THAT AN ADEQUATE SAFETY FACTOR HAS BEEN PROVIDED. THE CONTRACTOR MUST LIFT THE STRUCTURE INTO PLACE IN SUCH A MANNER AS TO NOT DAMAGE THE STRUCTURE. REVIEW ALL SAFETY GUIDELINES. ONCE THE ASSEMBLED STRUCTURE HAS BEEN LIFTED AND PLACED, CHECK THE BOLT TORQUE AND RE-TIGHTEN AS NECESSARY.

CAUTION

DO NOT ATTEMPT ANY LOADING OF A STRUCTURE (INCLUDING LIFTING A PREASSEMBLED STRUCTURE INTO PLACE) PRIOR TO THE TORQUING OF ALL NUTS. COME-A-LONGS AND/OR STRUTS MAY BE REQUIRED TO MAINTAIN STRUCTURE SPAN DIMENSION FOR OUT OF TRENCH ASSEMBLY AND INSTALLATION.



INSTALLATION

Basic Principles for BridgeCor® Round and Ellipse Shapes

Project plans and specifications provide the basic requirements for construction and installation. However, site conditions may vary from those anticipated during design. The contractor and construction engineer must recognize these variations. Often, alternate or additional construction considerations are necessary. The following guidelines provide specific considerations and details for various conditions in a step-by-step construction sequence. (This summary is listed at the end of this manual.)

1. Check alignment in relation to the plans as well as the actual site conditions.
2. Excavate to the correct width, line and grade.
3. Provide a uniform, stable foundation—correct site conditions as necessary.
4. Unload, handle and store the plates and fasteners correctly and safely.
5. Assemble the structure properly—check alignment, follow special procedures for any items detailed on the plate layout drawings. Make sure to achieve properly aligned plate laps, bolt torque, and assembled dimensions.
6. Use a suitable (granular) backfill material as required in the plans and specifications.
7. Maintain proper backfill width.
8. Haunch the structure properly.
9. Place the backfill in 8-inch thick uncompacted lifts and thoroughly compact each lift to a minimum 90% density (AASHTO T-180).
10. Maintain balanced fill placement and loading during all phases of installation, keeping fill height differential side to side to a 2' maximum amount.
11. Provide shape control monitoring as required.
12. Install the necessary end treatment quickly to protect the structure from erosion and uplift.
13. Protect the structure from heavy construction equipment loads, other heavy loads and hydraulic forces.

LOCATION

Before installing any structure, it is best to first recheck the planned alignment and grade (position and percent of slope) of the structure in relation to the topography of the site. Even when complete construction plans are supplied, a careful examination of the site must be completed.

EXCAVATION

Embankment Condition

Typically, the excavation required for an embankment condition is to remove the topsoil, muck, organic matter and other fill deemed unsuitable by the project engineer and prepare a stable foundation at the proper elevation and grade.

Trench Condition

When structural plate is installed in a trench, there are some general guidelines that should be followed.

All trench excavation should proceed only after OSHA and other safety requirements are met. Trench excavation normally proceeds in the upstream direction. Most trenching equipment is more efficiently operated in this manner, and plate sections are also more easily joined when progressing in this direction. If an acceptable in-situ material is to be used as backfill, it should be stockpiled at a safe distance from the edge of the trench. As a general rule, when trench walls are unsupported, the distance from the trench edge to the toe of the stockpiled material should not be less than one-half the depth of the trench. When trench walls are protected by some form of sheeting or shoring, a safe minimum distance between the trench edge and stockpiled material must still be maintained, but will vary with soil and bracing types.

Care should always be exercised in the operation of equipment in the vicinity of an open trench. Operated too close to the trench, equipment weight and vibration may collapse the trench walls. The three phases of construction in a trench (excavation, structure installation, and backfilling) should be scheduled in close sequence with each other. An open trench is dangerous and vulnerable to accidents. An open excavation can result in damage to the project under construction. The two main hazards that must always be considered in trenching work are:

- Stability of trench walls; and
- Water that may accumulate in the trench resulting from seepage and surface runoff.

To minimize accidents and losses resulting from trenching operations the following procedures should be followed:

- Begin excavation only when installation of structural plate can immediately follow.
- Protect trench walls to insure their stability throughout the construction period.
- Follow procedures that will keep the trench free of seepage and surface waters.
- Excavate the trench at the same rate as structure installation with a minimum distance, as dictated by safety, separating the two operations.
- Backfill the trench as soon as practicable after structural plate installation.

Trench Width and Shape

The absolute minimum trench width on each side of the structure is 8' according to AASHTO specifications. The actual width and shape of the trench depends on the size and shape of the structure. Refer to backfilling details on the plans for specific dimensions. The trench width must be wide enough to allow the critical lower quadrants of a structure with an invert to be properly backfilled (haunched).

Figure 10 (on page 18) provides guidelines about minimum spacing between multiple structures. These same guidelines can be used to provide the necessary width between the structural plate and trench wall to adequately place and compact typical backfill. Lesser spacing may be used with slurries and other backfill materials that do not require mechanical compaction.

PREPARING FOUNDATIONS

The structure foundation requirements should be detailed on the plan sheets. However, field conditions may vary requiring special attention and alterations that are discovered only during excavation. Any alterations should first be approved by the project engineer. The critical factor is to achieve uniformity along the structure. The foundation has a tendency to yield under the structure in relation to the embankments alongside the structure.

Bedding is the material located between the prepared foundation soils and the invert (or bottom) of the structure. Bedding is an important part of the installation, because it provides the interface between the rigid or unyielding foundation and the flexible soil - steel structure. Structures with inverts require proper bedding preparation. The bedding layer consists of loose granular soil that will fill in the structure corrugations as the structure is assembled and backfilled to ensure the structure is fully supported.

Although corrugated steel drainage structures can experience some uneven settlement without distorting, they should be placed on a firm yet yielding, uniform foundation for best performance and long service life.

All structures with an invert must be installed with the area under the haunches well compacted and all voids filled. The most popular method of preparing the foundation is by excavating to a flat surface and then carefully tamping the fill under the haunches of the structure. See Figure 1 for guidance.

All structural plate must be placed on stable earth or fine granular foundation. Never install them on sod, frozen earth or on a bed that contains large boulders or rock. When poor foundations with low bearing strength are encountered, it may be necessary to stabilize the poor foundation by a method described in the next section.

Care must be taken to prevent water leaking through the fill or along the length of the structure. When granular materials have been used for structure bedding and select backfill, the exposed ends of the fill slopes should be sealed against infiltration. This can be done by utilizing slope paving, cut-off walls, construction of slope faces utilizing impermeable fill or some similar type of end treatment that guards against water infiltration and migration through the structure select fill and bedding zones.

UNEVEN FOUNDATIONS

When the excavated grade line reveals both soft and hard spots, the foundation must be changed to make it as uniform as possible. Sometimes hard spots can be excavated below grade and replaced with softer material. Alternatively, it may be more economical to excavate the entire foundation slightly below grade line and replace it with suitable, uniform material. In any event, any abrupt changes from hard to soft foundation must be avoided.

SOFT FOUNDATIONS

When soft, unstable material is encountered at the foundation level, it must be excavated below the flow line grade and backfilled to grade with sand, gravel, crushed stone or other suitable material. The zone of select material must be adequate to support the structure and backfill. See Figure 2. When unexpected materials are encountered, consult the project engineer.

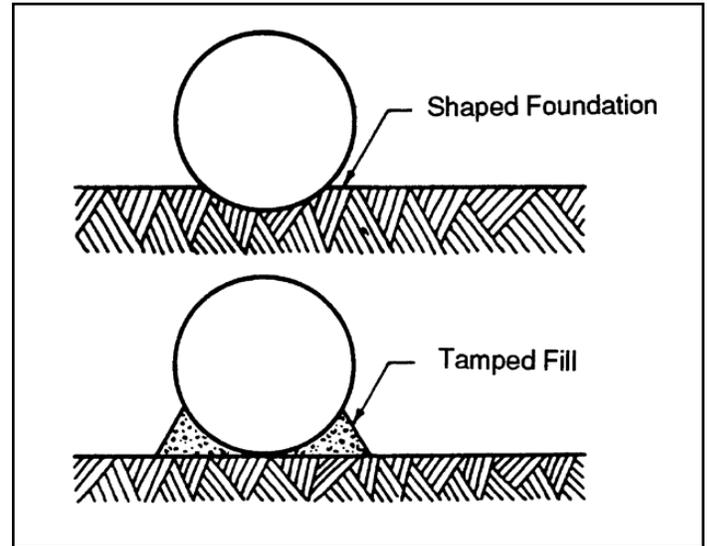


Figure 1. Methods for attaining proper compaction under haunches of structural plate round and ellipse shapes.

POCKETS OF UNSTABLE SOIL

If unstable foundation material is in small pockets, it is best to excavate all of the poor foundation and replace it with suitable backfill material. Frequently, a relatively thin mat of granular material will provide satisfactory support, but it may be necessary to replace very soft foundations to a depth great enough to support not only the structure, but also the heavier backfill placed beside it.

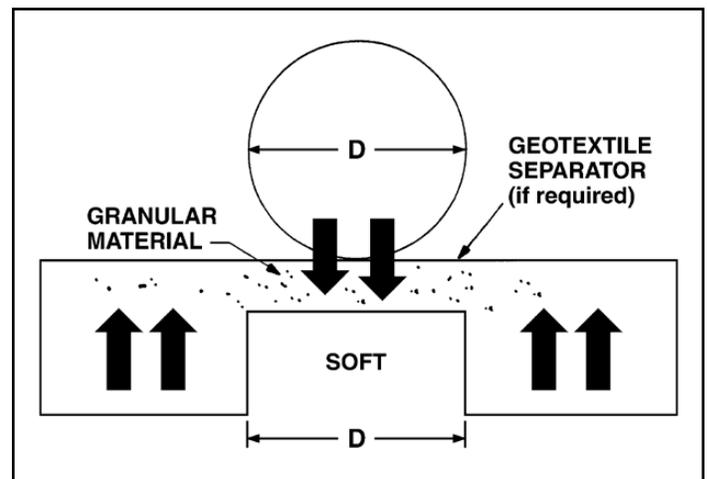


Figure 2. Soft Foundation Considerations

IMPROVED FOUNDATIONS

Whenever a foundation is stabilized by undercutting and replacing substandard, poor quality materials with a coarsely graded granular fill material, consideration of the adjacent bedding and backfill material becomes even more important. The adjacent side fill zones must also be properly supported to prevent excessive differential settlement that could lead to dragdown loads on the structure. Additionally, finer graded fill materials can migrate into the more coarsely graded fill. Use of a geotextile separator should be considered to prevent such migration of fill particles. Attempts to support structural plate structures on intermittent piles, pile bents or concrete cradles to provide support over zones of poor foundation support creates the potential risk of introducing differential settlement issues for the structure system and for the adjacent side fill and thus should be avoided.

ROCK FOUNDATIONS

Rock encountered in the foundation must be removed to provide more than the minimum bedding thickness underneath the bottom of the structure. Excavate wide enough to avoid any possibility of the structure resting on rock and provide access to adequately haunch the structure as shown in Figure 3 (on page 15). The excavated area is then backfilled with compacted, granular soil to cushion the structure.

STREAM DIVERSION

If the stream is temporarily diverted during construction, the diversion ditch or temporary drainage structure must be adequate to carry the flow. Reduced construction times are helpful in limiting this exposure. The structure installation must be protected from storm flows by a temporary dike, cofferdam, etc.

If the structure must carry the flow during the construction stage, the upstream end must be protected with the proper end treatment, etc. to ensure that the flow is not diverted around or beside the structure thereby scouring out backfill as it is placed or floating the structure. In phased construction, it is desirable to construct and backfill the upstream end first.



Structure invert placed on shaped bedding.

BACKFILLING

BridgeCor® Round and Ellipses

PLACING THE BACKFILL

It is important to emphasize the necessity of adequate backfill and proper placement. Faulty compaction has led to more trouble with structure installations, flexible and rigid, than all other factors combined!

For trench installations, backfill must follow as closely behind the excavation and assembly stages as possible. Embankment installations typically are backfilled after the entire structure, or a major portion of it, is assembled. Unless the embankment and backfill materials are placed simultaneously, one must be benched so the other can be compacted against it.

The backfill should be carefully compacted under the haunches (lower part of structure exterior, below widest part).

Continue placing the backfill equally on both sides of the structure in 8-inch uncompacted lifts, thoroughly compacting each lift(s) to a minimum 90% density per AASHTO T-180. Backfill lift(s) shall be placed symmetrically on each side, with no side to side differential exceeding 24". Such compacted lift(s) must extend to the limits shown on the plans on each side of the structure, or to the side of a trench, or to the natural ground line.

A frequent problem during backfilling is having the material dumped in piles around the structure. It is the responsibility of the contractor to ensure that these piles get evenly spread so that there is a maximum depth of 8 inches of uncompacted lift. If the filling crew works too fast, the compaction crew never has a chance to adequately compact the first material before more is placed in the trench. Please see Figure 3 on the right, and Figures 4 and 5 on the next page, for proper guidance.

Backfill must be placed and fully compacted to the minimum cover level as indicated on the plans, before the structure is subjected to highway loads. When dealing with construction equipment that may exceed legal highway loads, please refer to the section called Construction loads, page 19.

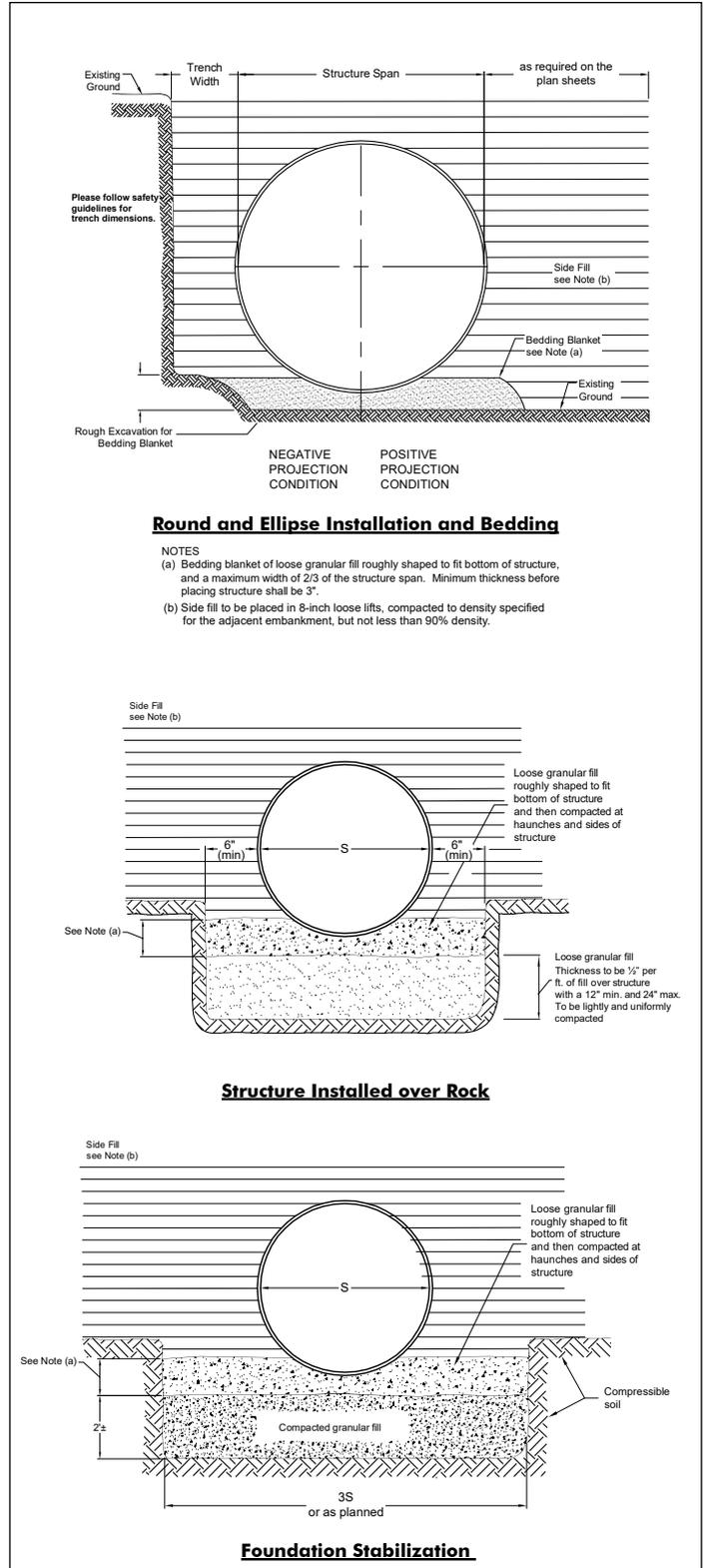


Figure 3. Bedding Details.

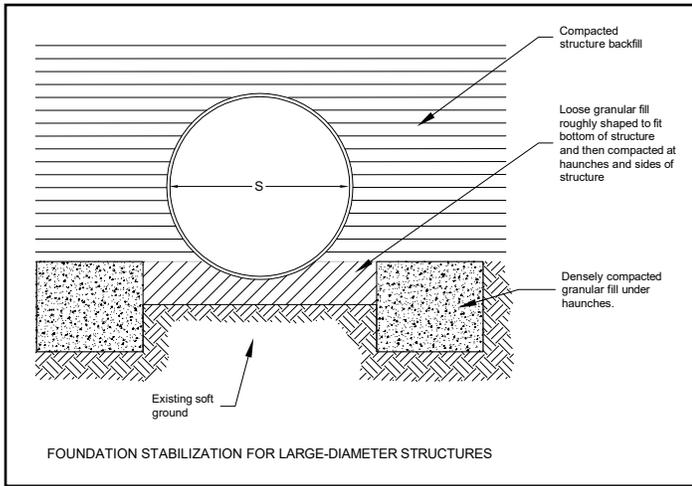


Figure 4. Bedding Details.

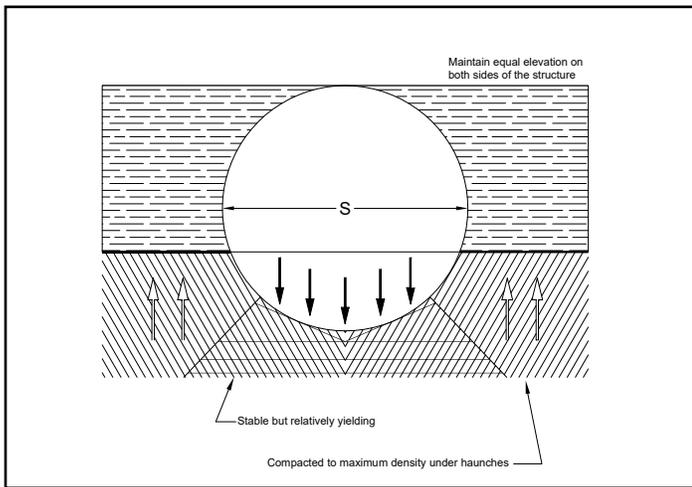


Figure 5. Recommended backfilling practice for larger round shapes, using a vee-shaped bed.

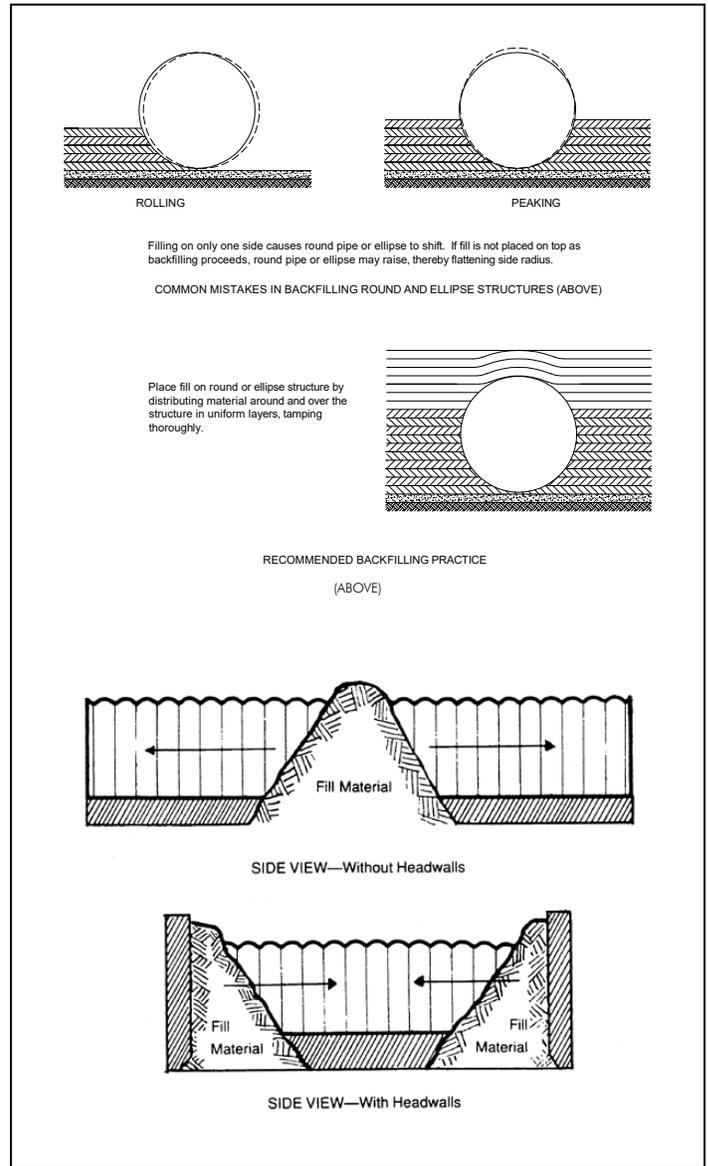


Figure 6. Recommended backfilling practice for structural plate.

If the headwalls are built before the structure, the backfill material should first be placed adjacent to each headwall. Place and compact material uniformly on both sides of the structure until the top of the structure is reached. Then backfill should proceed toward the center by extending the ramp, with care being taken to place and compact the material evenly on both sides of the structure. Top loading will help control peaking. Please see Figure 6 above.

PROPER MATERIAL PLACEMENT AND COMPACTION

The bedding and backfill operation should be entirely conducted in the dry if at all possible, but with enough moisture to meet compaction standards. There are cases where BridgeCor structures are preassembled and lifted into the stream bed "in the wet," where it is not possible to build a cofferdam and divert the stream. Such conditions make it very difficult to ensure good base preparation and proper backfill. Soil strength consideration must be made by the designer in these cases, and expert advice obtained on backfill procedures.

The areas immediately next to the structure shall be compacted by hand-operated methods. Larger compaction equipment shall be brought within no closer than 4 feet in most embankment installations. Changes in dimension or plumb of the structure warn that heavy machines must work further away or be replaced with lighter, more suitable equipment. Please see Figure 8 below.

Full compaction density levels may not be achieved in the first several inches of fill over the top of the structure due to flexing and vibration.

When required, as determined by the geotechnical engineer, a geotextile or graded soil filter may be used between the select backfill and the in-situ soil to prevent migration of fines and possible internal erosion. Spread backfill material with equipment running parallel to, not at right angles to the structure. Please see Figure 7 below.

BACKFILL PLACEMENT GUIDELINES

Compact the backfill by working parallel to, but not immediately adjacent to, the structure. Place fill evenly on both sides. Peaking or rolling of the structure must be avoided. (Note discussion of shape control, in the next column.)

For multiple barrel installations, sufficient space between the structures must be allowed for compaction equipment to operate properly.

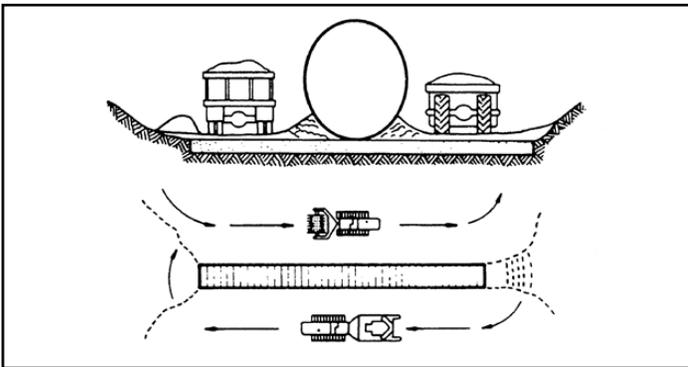


Figure 7. Proper material placement.

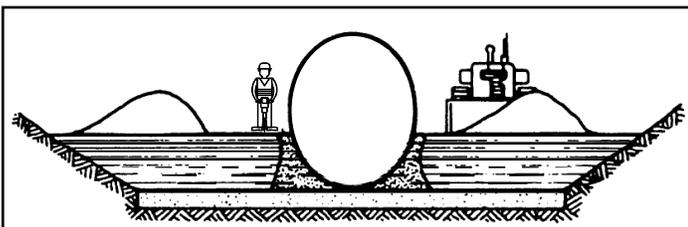


Figure 8. Hand compaction and heavy equipment procedure.

As backfill progresses, place the select material in radial lifts at approximately 75% of the rise of the structure. See Figure 9 below.

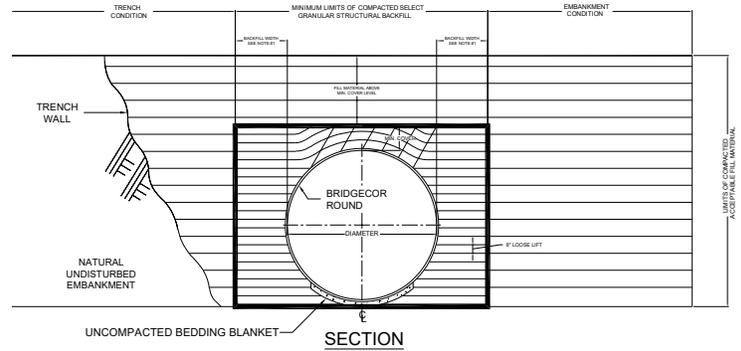


Figure 9. Backfill material placed in radial lifts.

When the fill on both sides approaches the crown of the structure (see the Recommended Backfilling Practice in Figure 6), the same techniques of spreading shallow layers and compacting thoroughly must be followed as the fill covers the structure. For the initial layers over the structure, push first lift to the crown centerline (12" min. under D4 tracks, 20,000 lbs. max operating weight). Come to a complete stop at crown. Complete the lift by working from the other side to the crown centerline.

After backfilling up to the minimum cover elevation over the top and no changes outside the allowable tolerances of the structure's dimensions have been observed, further filling to grade may continue using procedures applicable to embankment construction. See information regarding construction loading.

SHAPE CONTROL

Shape control refers to monitoring the symmetry of the structure during the backfilling process. Please check the project requirements to determine if on site monitoring is required. Two movements may occur during backfilling: "peaking," caused by the pressure of the compaction of the sidefill, and rolling or sidewall distortion-caused by generating compaction forces on one side of the structure relative to the other. See the top of Figure 6.

Shape changes are limited by using proper backfill compaction procedures and equipment as well as backfill, material quality, gradation and moisture content. Special attention should be paid to maintaining the structure's rise dimensions, symmetry and smooth, consistent curvature. The inside span and rise of the assembled structure shall be within 2% (or 5 inches, whichever is less) of the plan dimensions.

The "plumb-bob" method of deflection control is most convenient and effective for large structures. Suspend plumb bobs from the movement control hook locations as shown on the plate layout drawings, so that the points are a specific vertical distance from a marked point on the invert at start of backfill.

Peaking or deflection action can be detected when the points of the bobs move vertically or the survey results indicate movement. Corrective action is usually to keep heavy equipment further away from the structure. Placing and compacting backfill in thinner lifts and/or bringing the backfill to the proper moisture content will reduce the necessary compactive effort and help to control peaking.

Rolling action can be detected when the plumb-bobs move laterally or the survey results indicate movement. It is corrected by filling or compacting on the side towards which the plumb-bob has moved. For example, a roll to the right will be corrected by higher fill on the right.

Careful observance of the deflection and prompt remedial steps prevents peaking or rolling action from distorting the structure.

Compaction Equipment

MULTIPLE BARREL INSTALLATIONS

Backfill must be balanced across all the structures at all times. Place backfill material with a stonebucket, conveyor or other device in a balanced and symmetrical fashion to assure that even pressure is felt on both sides of all the structures. The design should have provided adequate room between the structures to operate the equipment required for proper compaction of the backfill. Flowable fills that require no compaction effort can be used with minimal spacing between the structures.

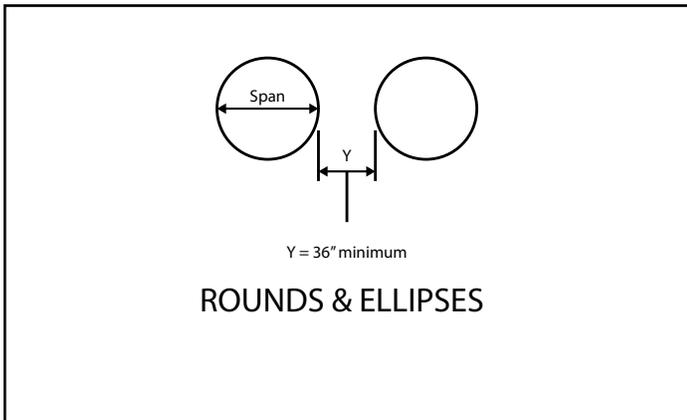


Figure 10. Minimum Barrel Spacing.

The 36" minimum spacing must be confirmed by the required finite element analysis for the project. Appropriate equipment should be considered in determining the spacing between the structures. More than the 36" minimum spacing may be needed for larger span structures. The space between structures should allow efficient operation and selection of compaction equipment. Please contact your Contech representative for assistance.

FINAL BACKFILLING

Once the envelope of select backfill material has been properly placed and compacted around and over the structure, the remainder of the fill, if any, should be placed and compacted to prevent settlement at the surface. The specified backfill material and compaction level requirements are written to prevent surface subsidence, protect the pavement, etc.

When sheeting has been used to support the trench walls be sure to fill and compact the voids left when it is withdrawn or, cut it off above the crown of the structure.

Final backfill is compacted by conventional methods.

HAND COMPACTION

For compacting the areas under the haunches of a structure, hand tampers or light vibratory equipment is needed.

MECHANICAL COMPACTORS

Most types of power tampers are satisfactory in all except the most confined areas. However, they must be used carefully and completely over the entire area of each layer to obtain the desired compaction. Avoid striking the structure with power tamping tools.

ROLLER COMPACTORS

The fill adjacent to the structure should be tamped with hand or hand-held power equipment. However, where space permits, sheepsfoot, rubber tired and other types of rollers can be used to compact backfill beyond 3' to 4' from the structure.

VIBRATING COMPACTORS

Vibrating compactors can be used effectively on all types of backfill except heavy clays or other plastic soils. Small walk behind equipment is especially suited to trench installations.

STRUCTURE PROTECTION

Often, construction loads exceed the finished design loads for the structure. Additionally, during the various phases of assembly, backfill and construction, the structure typically is more vulnerable to loadings and hydraulic forces because its backfill, end treatment, etc. are not complete. The corrugated steel structure must be properly protected.



Figure 11. Adequate, uniform compaction is critical to building soil/steel structures.

Summary

CONSTRUCTION LOADS

Frequently, it is necessary for heavy construction equipment to travel over installed corrugated steel structures during completion of grading, paving or other site work. Heavy construction equipment can impose concentrated loads far in excess of those the structure is designed to carry.

Additional analysis is required to determine if the construction vehicle is able to cross the structure. Please contact your Contech representative for guidance.

Temporary dead loads resulting from storage piles, crane placements, etc. must be evaluated as to structure capacity, loading balance, backfill support, adequate foundation strength, and other factors that may be applicable to the conditions.

HYDRAULIC PROTECTION

During installation, and prior to the completion of backfilling and the construction of permanent end treatments, slope protection, flow controls, etc., the structure is vulnerable to damage from storm and flow conditions. Hydraulic flow forces on unprotected ends, unbalanced backfill loads, loss of backfill and support due to erosion and uplift forces are examples of factors to be considered. While guidance is offered in some of the above sections, temporary protection may need to be constructed.

Hydraulic forces can float structures without adequate protection or buckle inverts (large radius inverts are especially vulnerable to buckling) if the foundation, bedding or backfill becomes saturated. Proper channeling of flow through active structures and placing end treatments and slope protection as soon as possible are advised. Structures installed between cofferdams or in trenches subject to inundation should be protected from the effects of ponded water.

Proper installation of any drainage structure will result in longer and more efficient service. This installation manual is intended to call attention to both good practice and to warn against possible pitfalls. The principles apply to most conditions. It is not a specification but an aid to your own experience.

The following items should be checked to insure proper installation:

1. Check alignment in relation to the plans as well as the actual site conditions.
2. Make certain the structure length(s), sizes and necessary fittings and appurtenances, etc. are correct.
3. Excavate to the correct width, line and grade.
4. Provide a uniform, stable foundation—correct site conditions as necessary.
5. Unload, handle and store the structure correctly and safely.
6. Assemble the structure properly—check alignment, follow special procedures for any items detailed on the plate layout drawings. Make sure to achieve properly aligned plate laps, bolt torque, and assembled dimensions.
7. Use a suitable (granular) backfill material as required in the plans and specifications.
8. Maintain proper backfill width.
9. Haunch the structure properly.
10. Place the backfill in 8-inch thick uncompacted lifts and thoroughly compact each lift to a minimum 90% density (AASHTO T-180).
11. Maintain balanced fill placement and loading during all phases of installation, keeping fill height differential side to side to a 2' maximum.
12. Provide shape control monitoring as required.
13. Install the necessary end treatment quickly to protect the structure from erosion and uplift.
14. Protect the structure from heavy construction equipment loads, other heavy loads and hydraulic forces.





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