Dark Canyon Culvert Repair
Supplemental Specifications

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PREFACE

Delete all but the first paragraph and add the following:

The Forest Service, US Department of Agriculture has adopted FP-24 for construction of National Forest System Roads. The Forest Service Supplemental Specifications (FSSS) shall be incorporated in the FP-24. The applicable specifications for the project will be the FP-24 as modified by the FSSS.

Section 101. – TERMS, FORMAT, AND DEFINITIONS

Add the following paragraph to Subsection 101.01 Meaning of Terms:

Delete all references to the TAR (Transportation Acquisition Regulations) in the specifications.

Section 101. – TERMS, FORMAT, AND DEFINITIONS

Add the following to Subsection 101.03 Abbreviations:

(a) Acronyms.

AGAR — Agriculture Acquisition Regulations

AFPA — American Forest and Paper Association

FSSS – Forest Service Supplemental Specifications

MSHA — Mine Safety and Health Administration

NESC — National Electrical Safety Code

WCLIB — West Coast Lumber Inspection Bureau

(d) Miscellaneous unit abbreviations.

MP - milepost	location
ppm - parts per million	volume

STA – station	location
MFBM - thousand feet board measure	volume

Section 101. – TERMS, FORMAT, AND DEFINITIONS

Make the following changes to Subsection 101.04 Definitions:

Delete these definitions and replace with the following:

Bid Schedule — The Schedule of Items.

Bridge — A structure, including supports, erected over a depression or an obstruction such as water along a road, a trail, or a railway and having a deck for carrying traffic or other loads.

Contractor — The individual or legal entity contracting with the Government for performance of prescribed work. In a timber sale contract, the contractor is the "Purchaser".

Culvert — Any structure with a bottom, regardless of fill depth, depth of invert burial, or presence of horizontal driving surface, or any bottomless (natural channel) structure with footings that will not have wheel loads in direct contact with the top of the structure.

Drawings —Design sheets or fabrication, erection, or construction details submitted to the CO by the Contractor.

Neat Line — A line defining the proposed or specified limits of an excavation or structure.

Notice to Proceed — (Public Works Contracts) Written notice to the Contractor to begin the contract work. (Timber Contracts) does not apply, replace NTP with Contract Award.

Right-of-Way — A general term denoting (1) the privilege to pass over land in some particular line (including easement, lease, permit, or license to occupy, use, or traverse public or private lands), or (2) Real property necessary for the project, including roadway, buffer areas, access, and drainage areas.

Add the following definitions:

Adjustment in Contract Price — "Equitable adjustment," as used in the Federal Acquisition Regulations, or "construction cost adjustment," as used in the Timber Sale Contract, as applicable.

Change — "Change" means "change order" as used in the Federal Acquisition Regulations, or "design change" as used in the Timber Sale Contract.

Forest Service — The United States of America, acting through the Forest Service, U.S. Department of Agriculture.

Forest Service Supplemental Specifications – The Forest Service uses supplemental specifications to modify the FP-24 to meet the agency needs and intents. FSSS revise the FP-24 by adding, deleting, replacing, revising, replacing part of entire sections or subsections or adding new sections to the FP..

Pioneer Road — Temporary construction access built along the route of the project.

Purchaser — The individual, partnership, joint venture, or corporation contracting with the Government under the terms of a Timber Sale Contract and acting independently or through agents, employees, or subcontractors.

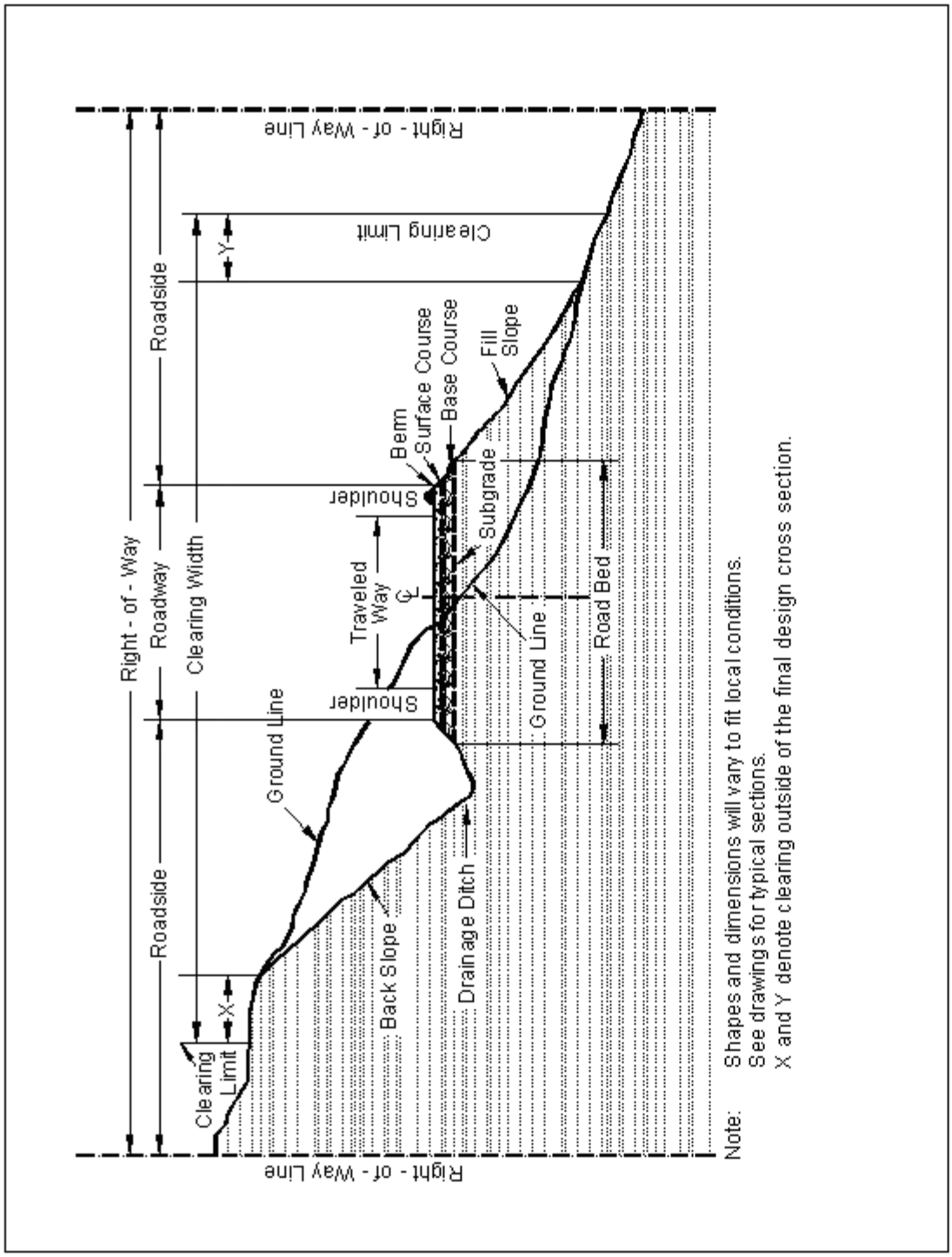
Protected Streamcourse — A drainage shown on the plans or timber sale area map that requires designated mitigation measures.

Road Order — An order affecting and controlling traffic on roads under Forest Service jurisdiction. Road Orders are issued by a designated Forest Officer under the authorities of 36 CFR, part 260.

Utilization Standards — The minimum size and percent soundness of trees described in Public Works contract specifications or Timber Sale and stewardship contract provisions to determine merchantable timber.

Add Figure 101-1—Illustration of road structure terms:

Figure 101-1—Illustration of road structure terms



Section 102. - BID, AWARD, AND EXECUTION OF CONTRACT

Delete Section 102 Bid, Award, and Execution of Contract in its entirety.

Section 103. – SCOPE OF WORK

Delete all of Section 103 Scope of Work except Subsection 103.01 Intent of Contract.

Section 104. – CONTROL OF WORK

Delete Subsection 104.07 Coordination of Contract Documents.

Section 104. – CONTROL OF WORK

Add the following Subsection 104.12 Use of Roads by Contractor:

The Contractor is authorized to use roads under the jurisdiction of the Forest Service for all activities necessary to complete this contract, subject to the limitations and authorizations designated in the Road Order(s) or described in the contract, when such use will not damage the roads or national forest resources, and when traffic can be accommodated safely.

Section 105. – CONTROL OF MATERIAL

Delete second paragraph and subparagraphs (a) and (b) in Subsection 105.05 Use of Material Found in the Work and replace it with the following:

The right to use and process material found in the work excludes the use and processing of material for nongovernment contract work, except for the disposal of waste material. Materials produced or processed from Government lands in excess of the quantities required for performance of this contract are the property of the Government. Place excess material at government-approved agreed to location(s), at no additional cost to government.

Section 106. – ACCEPTANCE OF WORK

Delete the 3rd and 4th paragraphs in Subsection 106.01 Conformity with Contract Requirements.

Section 108. - PROSECUTION AND PROGRESS

Delete Section 108 Prosecution and Progress in its entirety.

Section 109. - MEASUREMENT AND PAYMENT

Delete Subsections 109.06 Pricing and Adjustments, 109.07 Estimated Work, 109.08 Progress Payments, and 109.09 Final Payment.

Section 109. - MEASUREMENT AND PAYMENT

Delete Table 109-1 of Subsection 109.01 Measurement of Work and replace with the following:

Table 109-1

Decimal Accuracy of Quantities for Payment

Pay Item	**Level of Precision**
Acre	0.01
Cubic Foot	1
Cubic Yard	1
Cubic Yard Exception - Structure Excavation; Sheathing; Materials; Bedding, Bed Course, and Backfill, Materials; Gabions;	0.1
Cubic Yard Exception – Concrete; Masonry	0.01
Day	1
Each	1
Gallon	1
Hour	0.1
Linear Foot	1
Linear Foot Exception - Timber, Steel, and Concrete Piles	0.1
M-Gallon	0.1
Mile	0.01
Month	0.1
Pound	1
Square Foot	0.1
Square Yard	0.1
Station	0.1
Thousand Board Feet Measure	0.01
Ton	0.1
Ton Exception - Calcium Chloride; Sodium Chloride; Hydrated Lime; Bituminous Materials; Pavements; Bed Course Materials	0.01
Week	0.1

Section 109. - MEASUREMENT AND PAYMENT

Delete Subsection 109.02(c) Measurement Terms and Definitions, Contract quantity and replace with:

(c) Contract quantity. The quantity to be paid is the quantity listed in the bid schedule. The contract quantity will be adjusted for authorized changes that affect the quantity or for errors

made in computing this quantity when that error exceeds 15% or more. If there is evidence that a quantity specific as a contract quantity is incorrect by 15% or more, submit calculations, drawings, or other evidence indicating why the quantity is in error and request in writing that the quantity be adjusted.

Section 204. – EXCAVATION AND EMBANKMENT

Delete Subsection 204.06 Roadway Excavation and replace with the following:

204.06 Roadway Excavation. Excavate as follows:

(a) Rock cuts. Verify the top portion of the rock cuts during pioneer access or initial excavation. Construct the final soil cut before starting drilling for rock blasting or other rock excavation methods unless approved. Blast rock according to Forest Service Supplemental Specification Section 205 if approved by the CO. Excavate rock cuts to 6 inches below subgrade within the roadbed limits. Backfill to subgrade with select borrow. Compact the material according to Subsection 204.11.

(b) Earth cuts. Scarify earth cuts to 6 inches below subgrade within the roadbed limits. Compact the scarified material according to Subsection 204.11.

(c) Drainage Feature. Drainage feature includes construction of all ditches, minor channel changes, drainage dips, catch basins, surface water deflectors, and other minor drainage structures. Compact the material according to Subsection 204.11. Excavate on a uniform grade between control points.

Remove snow or ice in advance of the work and deposit beyond the roadway limits in a manner to prevent resource damage.

Conserve 6-inch minus material from the roadway excavation to use for finishing the roadbed. Dispose of unsuitable or excess excavation material according to Subsection 204.14. Replace shortage of suitable material caused by premature disposal of roadway excavation.

At the end of each day's operations, shape to drain and compact the work area to a uniform cross-section.

Section 204. – EXCAVATION AND EMBANKMENT

Delete 204.16(a)(1)(a) Measurement, Roadway Excavation and replace with the following:

(a) Roadway prism excavation;

Add the following to Subsection 204.16(g) Measurement:

(g) Drainage features. Measurement includes all excavation, embankment, shaping, and grading necessary for a completed drainage feature

Section 208. – STRUCTURAL EXCAVATION AND BACKFILL FOR SELECTED MAJOR STRUCTURES.

Delete 208.10 Compacting and replace with the following:

Determine optimum moisture content and maximum dry density according to AASHTO T180, Method C . Adjust the moisture content of the backfill to a moisture content suitable for compaction.

Compact material placed in each lift to at least 90 percent of the maximum density. Determine the in-place density and moisture content according to AASHTO T310 or other approved test procedures.

Do not apply density requirements as measured by AASHTO T310 to material that cannot be tested or compacted to maximum values determined by AASHTO T180. For this material, fill the voids around the rocky material in each lift with structural backfill or foundation fill as appropriate. Compact each lift until there is no visible evidence of further consolidation.

Section 301. - UNTREATED AGGREGATE COURSES

Add the following to Subsection 301.03 General:

Written approval of the roadbed is required before placing aggregate.

For pit run material, furnish material smaller than the maximum size identified in the plans, no gradation will be required otherwise. After processing on the road, remove all oversize material from the road and dispose as directed by the CO.

Provide additives or binder, if required, at the proportions specified.

Develop and use Government furnished sources according to Section 105.

If the aggregate is produced and stockpiled before placement, handle and stockpile according to Section 314.

Section 601. - MINOR CONCRETE

Delete from Table 601-2 Remarks column "Deliver verification cylinders to the CO or designated laboratory for scheduled testing" in Section 601 Minor Concrete.

Section 607. - CLEANING, RELAYING, AND REPAIRING EXISTING DRAINAGE STRUCTURES

607.04a - The following list of Government Furnished Property, stored at the Hayfork Ranger Station, located at 111 Trinity Street in Hayfork, California, shall be transported by the Contractor to the Site and installed, costs incidental to pay item 60705, Repair Drainage Structure:

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WINCHESTER KY 40391
(859)744-3339
Fax (859)744-9665

SHIPPING INSTRUCTIONS

Cameron Tippin (530)262-2472
agrosch@jstatehighways.com

BOL #
28015746

ORIGINAL ORDER 09796569

SOLD TO:	SHIP TO:
684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002	684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002

DATE ORDERED	DATE REQUESTED	DATE PROMISED	DATE SHIPPED	PURCHASE ORDER #	UNIFORM SHIPPING	SHIP VIA	TRUCK
02/04/26	02/06/26	02/06/26		Dark Canyon Creek	28015746-000 SO	Prepaid	

ORDERED BY	ORDER ACCEPTED BY	DRIVER	MILES	WEIGHT	PROJECT #
A243618	\JAMES.SCH				852880

PIECES	UNITS ORDERED		UNITS SHIPPED/LINE#	ITEM NUMBER	ITEM DESCRIPTION	UNITS RECEIVED	USD PRICE PRICE	USD PRICE AMOUNT
44	44	FT	10.000	852880-010-01 WGT: TON:	MP ARCH DG PI=26 L=80' Shape:Single Radius Arch;Span/Rise/Structure Pi:26'-0" Span x 13'-1" Rise (153 Pi);Plate Gage:5/16";Bottom Centerline Length:80;Foundation:None (Grouted Keyway);Inlet End Treatment:Squar;Outlet End Treatment:Squar;CONTECH MULTI-PLATE Custom Single Radius Arch 80 LF of 26'-0 Span x 16'-7" Rise			
12	12	EA	11.000	MPBS FDG5621108 WGT: 11,604.1200 TON: 5.8021	MP SH FRMD DG 5/16 21PI 10' 8P ✓ 1/101 MK: T1;T2;T3;T4;T5;T6 V1;V2;V3;V4;V6;V8			
6	6	EA	12.000	MPBS FDG5618108 WGT: 5,030.8200 TON: 2.5154	MP SH FRMD DG 5/16 18PI 10' 8P ✓ 1/102 MK: T7;T8;T9;V5;V7;V9			
6	6	EA	13.000	MPBS FDG5621128 WGT: 6,940.6572 TON: 3.4703	MP SH FRMD DG 5/16 21PI 12' 8P 1/103			
3	3	EA	14.000	MPBS FDG5618128 WGT: 3,008.9727 TON: 1.5045	MP SH FRMD DG 5/16 18PI 12' 8P			
				PALOUT PALLETS DELIVERED OUT (CHARGE)				
				PALIN PALLETS RETURNED IN (CREDIT)				

RECEIVED BY:

Customer's signature constitutes acknowledgement of receipt of all items listed herein, up to and including the "last page" of this document, except as noted below:
(Note: Returned Merchandise Subject to 25% Restocking Charge)
* Note: Total Units Do Not Include Pallets

TOTALS ▶

UNITS ORDERED	UNITS SHIPPED	USD DOLLARS
		TAX TOTAL

ITEMS INVOICED ARE NET QUANTITIES RECEIVED

Shipping Plant: 5190

Palletized by _____ Date _____ Loaded by _____ Date _____ Trlr/Car _____

Quality Chk #1 _____ Quality Chk #2 _____ Pictures by _____

This Delivery Ticket incorporates herein by reference Buyer's previously executed Credit Application, if any, Seller's Standard Terms and Conditions (available at: https://www.conteches.com/cos/), Seller's Quotation, if any, and Seller's Acknowledgement (including limitations of warranties), as if fully set forth on this Delivery Ticket (as amended, modified, supplemented, restated and/or replaced by mutual written agreement). Seller will provide a copy of the Standard Terms and Conditions upon written request. Buyer agrees that unless otherwise noted on the front hereof, all quantities and items were delivered as indicated and further expressly agrees to pay in accordance with the Agreement.

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ORIGINAL ORDER 09796569

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684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002	684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002

DATE ORDERED	DATE REQUESTED	DATE PROMISED	DATE SHIPPED	PURCHASE ORDER #	UNIFORM SHIPPING	SHIP VIA	TRUCK
02/04/26	02/06/26	02/06/26		Dark Canyon Creek	28015746-000 SO	Prepaid	

ORDERED BY	ORDER ACCEPTED BY	DRIVER	MILES	WEIGHT	PROJECT #
A243618	\JAMES.SCH			36,763 LB	852880

PIECES	UNITS ORDERED		UNITS SHIPPED/LINE#	ITEM NUMBER	ITEM DESCRIPTION	UNITS RECEIVED	USD PRICE PRICE	USD PRICE AMOUNT
12	12	EA	15.000	MPBS FDG5615128 WGT: 10,178.8260 TON: 5.0894	1/104 MP SH FRMD DG 5/16 15PI 12' 8P 1/105			
				PALOUT	PALLETS DELIVERED OUT (CHARGE)			
				PALIN	PALLETS RETURNED IN (CREDIT)			

RECEIVED BY:

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(Note: Returned Merchandise Subject to 25% Restocking Charge)
* Note: Total Units Do Not Include Pallets

TOTALS ▶	UNITS ORDERED	UNITS SHIPPED	USD DOLLARS
			TAX
			TOTAL

ITEMS INVOICED ARE NET QUANTITIES RECEIVED

Shipping Plant: 5190

Palletized by _____ Date _____ Loaded by _____ Date _____ Trlr/Car _____

Quality Chk #1 _____ Quality Chk #2 _____ Pictures by _____

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agrosch@jstatehighways.com

SOL #
28015750

ORIGINAL ORDER 09796569

SOLD TO:	SHIP TO:
684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002	684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002

DATE ORDERED	DATE REQUESTED	DATE PROMISED	DATE SHIPPED	PURCHASE ORDER #	UNIFORM SHIPPING	SHIP VIA	TRUCK
02/04/26	02/06/26	02/06/26		Dark Canyon Creek	28015750-000 SO	Prepaid	

ORDERED BY	ORDER ACCEPTED BY	DRIVER	MILES	WEIGHT	PROJECT #
A243618	\JAMES.SCH				852880

PIECES	UNITS ORDERED		UNITS SHIPPED/LINE#	ITEM NUMBER	ITEM DESCRIPTION	UNITS RECEIVED	USD PRICE PRICE	USD PRICE AMOUNT
36	36	FT	10.000	852880-010-01 WGT: TON: 5.0894	MP ARCH DG PI=26 L=80' Shape:Single Radius Arch;Span/Rise/Structure Pi:26'-0" Span x 13'-1" Rise (153 Pi);Plate Gage:5/16";Bottom Centerline Length:80;Foundation:None (Grouted Keyway);Inlet End Treatment:Squar;Outlet End Treatment:Squar;CONTECH MULTI-PLATE Custom Single Radius Arch 80 LF of 26'-0 Span x 16'-7" Rise			
12	12	EA	13.000	MPBS FDG5621128 WGT: 13,881.3144 TON: 6.9407	MP SH FRMD DG 5/16 21PI 12' 8P 1/103			
6	6	EA	14.000	MPBS FDG5618128 WGT: 6,017.9454 TON: 3.0090	MP SH FRMD DG 5/16 18PI 12' 8P 1/104			
12	12	EA	15.000	MPBS FDG5615128 WGT: 10,178.8260 TON: 5.0894	MP SH FRMD DG 5/16 15PI 12' 8P 1/105			
62	62	EA	20.000	MPBFAGB3419 WGT: 161.2000 TON: .0806	MP GV BOLT 3/4-19x5 HOOK (301) 1/110	missing 130		
				PALOUT	PALLETS DELIVERED OUT (CHARGE)			
				PALIN	PALLETS RETURNED IN (CREDIT)			

RECEIVED BY:

Customer's signature constitutes acknowledgement of receipt of all items listed herein, up to and including the "last page" of this document, except as noted below:
(Note: Returned Merchandise Subject to 25% Restocking Charge)
* Note: Total Units Do Not Include Pallets

TOTALS ▶

UNITS ORDERED	UNITS SHIPPED	USD DOLLARS
		TAX TOTAL

ITEMS INVOICED ARE NET QUANTITIES RECEIVED

Shipping Plant: 5190

Palletized by _____ Date _____ Loaded by _____ Date _____ Trlr/Car _____

Quality Chk #1 _____ Quality Chk #2 _____ Pictures by _____

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agrosch@jstatehighways.com

BOL #
28015750

ORIGINAL ORDER 09796569

SOLD TO:	SHIP TO:
684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002	684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002

DATE ORDERED	DATE REQUESTED	DATE PROMISED	DATE SHIPPED	PURCHASE ORDER #	UNIFORM SHIPPING	SHIP VIA	TRUCK
02/04/26	02/06/26	02/06/26		Dark Canyon Creek	28015750-000 SO	Prepaid	

ORDERED BY	ORDER ACCEPTED BY	DRIVER	MILES	WEIGHT	PROJECT #
A243618	\JAMES.SCH			36,203 LB	852880

PIECES	UNITS ORDERED		UNITS SHIPPED/LINE#	ITEM NUMBER	ITEM DESCRIPTION	UNITS RECEIVED	USD PRICE PRICE	USD PRICE AMOUNT
6800	6800	EA	21.000	MPBFAGB782 WGT: 4,093.6000 TON: 2.0468	MP GALV BOLT 7/8 X 2 (393)			
500	500	EA	22.000	MPBFAGB78212 WGT: 341.5000 TON: .1708	MP GALV BOLT 7/8 X 2-1/2 (394)			
48	48	EA	23.000	MPBFAGB783 WGT: 34.7520 TON: .0174	MP GALV BOLT 7/8 X 3 (395)			
124	124	EA	24.000	MPBFAGN34 N78 WGT: 24.8000 TON: .0124	MP GALV NUT 3/4 (302) (392)			
7348	7348	EA	25.000	MPBFAGN34 N78 WGT: 1,469.6000 TON: .7348	MP GALV NUT 3/4 (302) (392)			
				PALOUT PALLETS DELIVERED OUT (CHARGE)				
				PALIN PALLETS RETURNED IN (CREDIT)				

RECEIVED BY:

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(Note: Returned Merchandise Subject to 25% Restocking Charge)
* Note: Total Units Do Not Include Pallets

TOTALS ▶

UNITS ORDERED	UNITS SHIPPED	USD DOLLARS
		TAX TOTAL

ITEMS INVOICED ARE NET QUANTITIES RECEIVED

Shipping Plant: 5190

Palletized by _____ Date _____ Loaded by _____ Date _____ Trlr/Car _____

Quality Chk #1 _____ Quality Chk #2 _____ Pictures by _____

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BOL #
28387123

ORIGINAL ORDER 09796569

SOLD TO:	SHIP TO:
684605 JEFFERSON STATE HIGHWAYS 20256 SKYPARK DR REDDING CA 96002	684605 US Forest Service Hayfork District Offic 111 Trinity Ave. HAYFORK CA 96041

DATE ORDERED	DATE REQUESTED	DATE PROMISED	DATE SHIPPED	PURCHASE ORDER #	UNIFORM SHIPPING	SHIP VIA	TRUCK
04/02/26	04/02/26	04/02/26		Dark Canyon Creek	28387123-000 SO	Prepaid	

ORDERED BY	ORDER ACCEPTED BY	DRIVER	MILES	WEIGHT	PROJECT #
A243618	\JAMES.SCH			1,307 LB	852880

PIECES	UNITS ORDERED		UNITS SHIPPED/LINE#	ITEM NUMBER	ITEM DESCRIPTION	UNITS RECEIVED	USD PRICE PRICE	USD PRICE AMOUNT
130	130	EA	23.000	MPBFAGB3419 WGT: 338.0000 TON: .1690	MP GV BOLT 3/4-19x5 HOOK (301)			
4	4	EA	24.000	MPBCHFDG1000ST WGT: 242.4000 TON: .1212	MP UNBAL CHAN FRM DG 10' ST			
10	10	EA	25.000	MPBCHFDG1200ST WGT: 727.0000 TON: .3635	MP UNBAL CHAN FRM DG 12' ST			
				PALOUT	PALLETS DELIVERED OUT (CHARGE)			
				PALIN	PALLETS RETURNED IN (CREDIT)			

RECEIVED BY:

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(Note: Returned Merchandise Subject to 25% Restocking Charge)
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TOTALS ▶

UNITS ORDERED	UNITS SHIPPED	USD DOLLARS
		TAX TOTAL

ITEMS INVOICED ARE NET QUANTITIES RECEIVED

Shipping Plant: 5190

Palletized by _____ Date _____ Loaded by _____ Date _____ Trlr/Car _____

Quality Chk #1 _____ Quality Chk #2 _____ Pictures by _____

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Native Species Revegetation Seed Mixes
Shasta-Trinity National Forest
04/24/2000
Trinity River and South Fork Management Units

The species listed are taken from recommendations in *Grass Valley Creek Watershed Restoration Project: Restoration in Decomposed Granite Soils* (1998), a report prepared by Trinity County Resource Conservation District and the Natural Resources Conservation Service in Weaverville. All species were tested and showed great germination and establishment success in decomposed granite soils, which are very common throughout the Trinity River and South Fork Management Units. Refer to this publication for more specific detail on recommendations give here.

In order to insure the best revegetation success, assess the site to determine its habitat characteristics. Aspect and presence of moisture are the two key characteristics and will drive the site type selection in the table below. Specific sites and projects may require extra efforts to assure successful establishment of native species.

Seed Mix	***Species***	***Common Name***
Hot/Dry	*Hordeum brachyantherum* spp. *californicum*	California barley
	Elymus elymoides	Squirreltail
	Poa secunda	Pine bluegrass
	*Bromus carinatus**	California brome
	*Elymus glaucus**	Blue wildrye
	*Lupinus succulentus**	Arroyo lupine
	*Lotus crassifolius/L. purshianus**	Lotus
Warm/Moist	*Deschampsia elongata*	Slender hairgrass
	Poa secunda	
	*Bromus carinatus**	California brome
	*Festuca idahoensis**	Idaho fescue
	*Festuca californica**	California fescue
	*Elymus glaucus**	blue wild rye
	*Lupinus succulentus**	Arroyo lupine
	*Lotus crassifolius/L. purshianus**	Lotus
Riparian Channel	*Festuca rubra*	Red fescue
	Deschampsia elongata	Slender wheatgrass
	Deschampsia caespitosa	Tufted hairgrass
Quick Establishment	*Bromus carinatus**	California brome
	*Elymus glaucus**	Blue wildrye
Non-Persistent Non-Native		Winter barley

*Recommended in most basic mix

Apply seed mix at a *total* rate of 10-20 pounds per acre. It may be necessary to apply a heavier rate if there is a greater chance of mortality, but this would be the unusual case. Apply seed in the fall or spring, when soils are moist or expected to be moist soon after distribution. Press seed into soil if possible (use hand or "belly roller") to insure good soil contact for germination. Seeding done in the fall typically shows the greatest results, but has a greater chance of predation by birds and rodents. Applying straw mulch over seed will help reduce bird predation.

There are no good reasons anymore to use exotic grass species such as orchard grass (*Dactylis glomerata*), annual and perennial rygrasses (*Lolium* spp.), yellow or white sweetclover (*Melilotus* spp.), timothy grass (*Phleum pratense*), crested wheatgrass (*Agropyron desertorum),* or smooth brome (*Bromus inermis*). There are others; these are some of the worst. All of these species are very persistent, can spread over a much larger area under many environmental conditions, and often permanently displace native species better suited in the long run for the original seeding purpose.

There are numerous suppliers of these species in the western United States, but only a few which have stock genetically related to natives found in Trinity County. It is important to use local natives to insure best resilience to environmental events and to avoid contaminating local species, causing them to become genetically weaker. Costs may vary by supplier. I have a catalog of suppliers of native seed that lists the entirety of companies.

Mulching

Mulching may be required where slopes are steeper (less than 70% slope) and greater erosion control is desired. Mulching protects bare soil from raindrops and provides a favorable microclimate for germinating seeds. Rice straw has been used successfully within the past couple of years, but it must be used outside of riparian areas in order to minimize germination of riparian weed seeds that may be present in the straw. Use agricultural wheat straw in riparian areas to avoid this problem. Mulching is most effective when spread in the fall, so that expected rain or snow will hold it in place. Spread straw at least 2 inches thick and in a way to insure good contact with the soil.

Rice straw can be obtained from Hawes Ranch and Farm Supply in Anderson, CA (530-365-2332) at $4-$5 per bale. For very small jobs, there is still a large pile of somewhat decomposed rice straw at the boneyard in Weaverville. Rice straw will stay useful for several years if kept dry.

Fertilization

The benefit of fertilizers is debatable, as many native species, especially nitrogen fixers, have evolved under conditions of low fertility, or in soils that need no extra fertilization. Use of fertilizers in sites not needing it can promote increased shoot growth over root growth, leading to extra stress in plants and possibly mortality. It is best to restrict fertilization to the harshest sites, and use sparingly there. Nitrogen is the most limiting

nutrient in decomposed granite soils, but ammonium phosphate may also be desirable. Do not apply fertilizer in riparian areas with more favorable site conditions or other areas in proximity to water.

Apply 80-180 lbs. per acre by hand. Fall applications favor exotic non-natives and spring applications favor native species. Fertilizers can be obtained from many commercial sources.

CONTECH®
ENGINEERED SOLUTIONS

MULTI-PLATE® Arch
Assembly & Installation Guide

CONTECH®
STRUCTURAL PLATE

MULTI-PLATE® Arch
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 MULTI-PLATE® (MP) 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 MULTI-PLATE.**

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

1. Only trained and authorized equipment operators are to be permitted to unload the MULTI-PLATE 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 MULTI-PLATE and accessories may move, roll, or fall when a strap is cut.
6. **Do not lift bundles by the steel strapping around the bundles.** **WARNING**
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 MULTI-PLATE and accessories while it is being unloaded. Do not stand near the MULTI-PLATE and accessories while they are being unloaded**. **WARNING**
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 all MULTI-PLATE and accessories handling requirements.
2. Chains with hooks 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

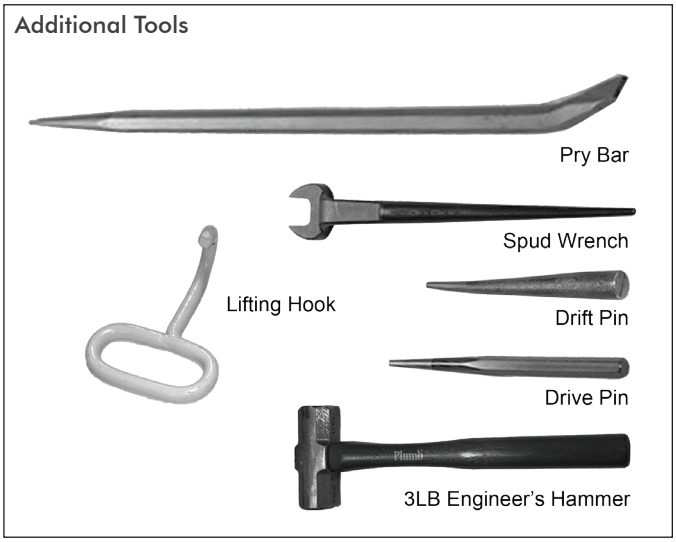
When steel bundles are exposed to moisture for extended time periods, a wet storage stain may occur. The purchaser should use reasonable handling and storage procedures for the materials to assure that a stain-free product is installed. See page 7 for more information.

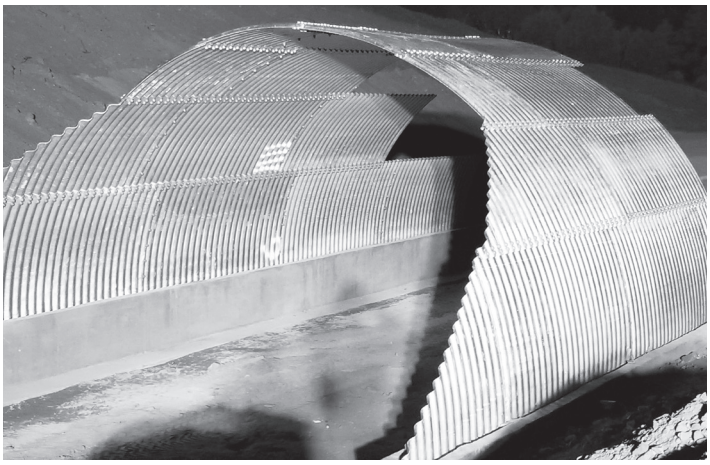
ASSEMBLY

Suggested Tool List

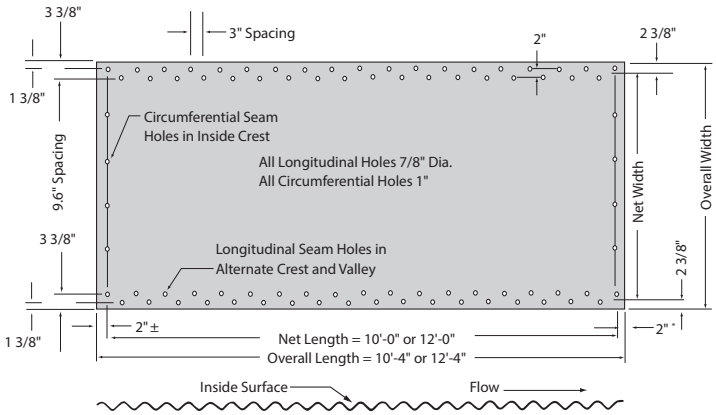
- ☑ Band Cutters to cut packaging bands around bundled material.
- ☑ Lifting devices, such as cables/chains with safety hooks or Clevis for moving individual plates.
- ☑ 3 lb. Engineer's Hammer, Lifting Hook, and Pry bar.
- ☑ Tapered Drive Pin or Drift Pins for use in positioning plates, sheets, components 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 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.
- ☑ Bolt torque shall be between 100-300 ft-lbs
- ☑ Scaffolding and/or Ladders for larger structures as needed.

Note: Cordless tools are not recommended.





Standard Plate Detail

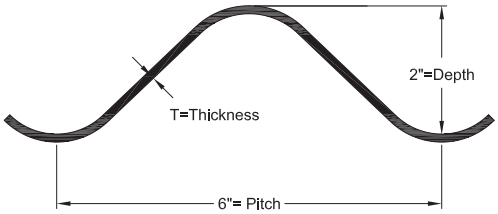


Notes:
1. For square-end structures on which headwalls are to be built, design should allow for a 2" lip at each end of the structure.
2. A 4-bolt per foot pattern is detailed above.

TABLE 1. DETAILS OF UNCURVED MULTI-PLATE® SECTIONS

Net Width (Inches) Nominal Detail			Overall Width (Inches)	Spaces (9.6 Inches)	Number of Circumferential Bolt Holes
9 Pi	28.8	28 13/16	33 9/16	3	4
15 Pi	48.0	48	52 3/4	5	6
18 Pi	57.6	57 5/8	62 3/8	6	7
21 Pi	67.2	67 3/16	71 15/16	7	8
24 Pi	76.8	76 13/16	81 9/16	8	9

For MULTI-PLATE, Pi = 3.2

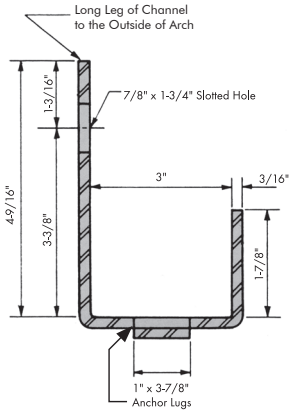


Standard 6" x 2" Corrugation

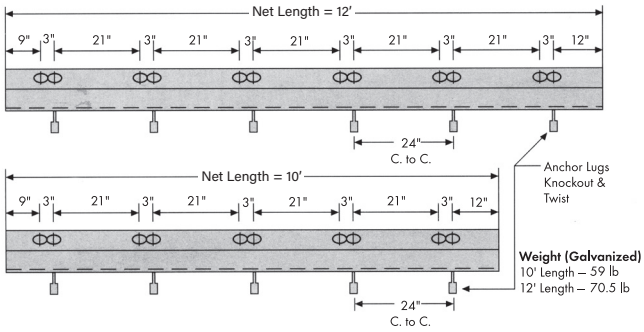
TABLE 2. APPROXIMATE WEIGHT OF MULTI-PLATE SECTIONS

Pi	Net Length (Feet)	Gage Thickness, T (Inches) Galvanized, in Pounds, without Fasteners								
		12 (0.111)	10 (0.140)	8 (0.170)	7 (0.188)	5 (0.218)	3 (0.249)	1 (0.280)	5/16 (0.318)	3/8 (0.380)
9	10	161	205	250	272	316	361	405	460	545
9	12	193	246	299	325	379	432	485	551	653
15	10	253	323	393	428	498	568	638	725	859
15	12	303	386	470	511	595	678	762	865	1026
18	10	299	382	465	506	589	671	754	856	1015
18	12	357	456	555	604	703	801	900	1022	1212
21	10	345	441	536	583	679	774	869	987	1170
21	12	412	526	640	697	810	924	1038	1179	1398
24	10	396	504	613	667	775	886	995	N/A	N/A
24	12	473	603	732	797	927	1060	1190	N/A	N/A

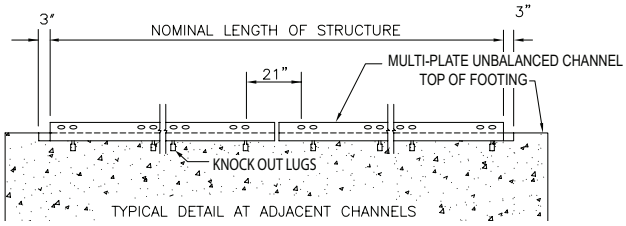
Notes:
1. Weights are based on a zinc coating of 3 oz./sq. ft., total both sides.
2. All weights are subject to manufacturing tolerances.
3. Specified thickness is a nominal galvanized thickness. Reference AASHTO M 167.
4. Gages 12 through 1 use 3/4" diameter bolts. 5/16 and 3/8 use 7/8" diameter bolts.



Unbalanced Channel Cross Section



(as measured from the inside legs of corrugation)



Unbalanced Channel for MULTI-PLATE® Arch

MULTI-PLATE® 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 100 – 300 ft.-lbs. of torque (150-300 ft.-lbs. of torque for asphalt coated or seam sealant applications).

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.

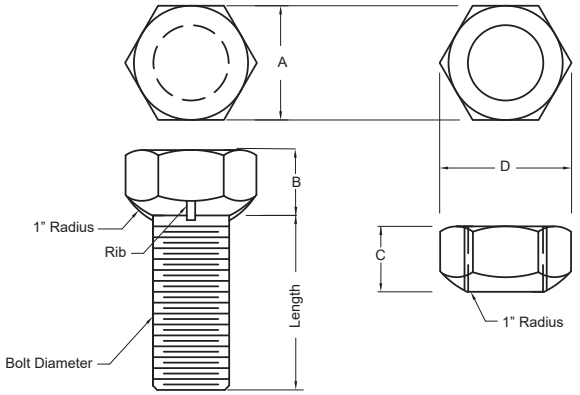


TABLE 3. BOLT LENGTH AND USAGE

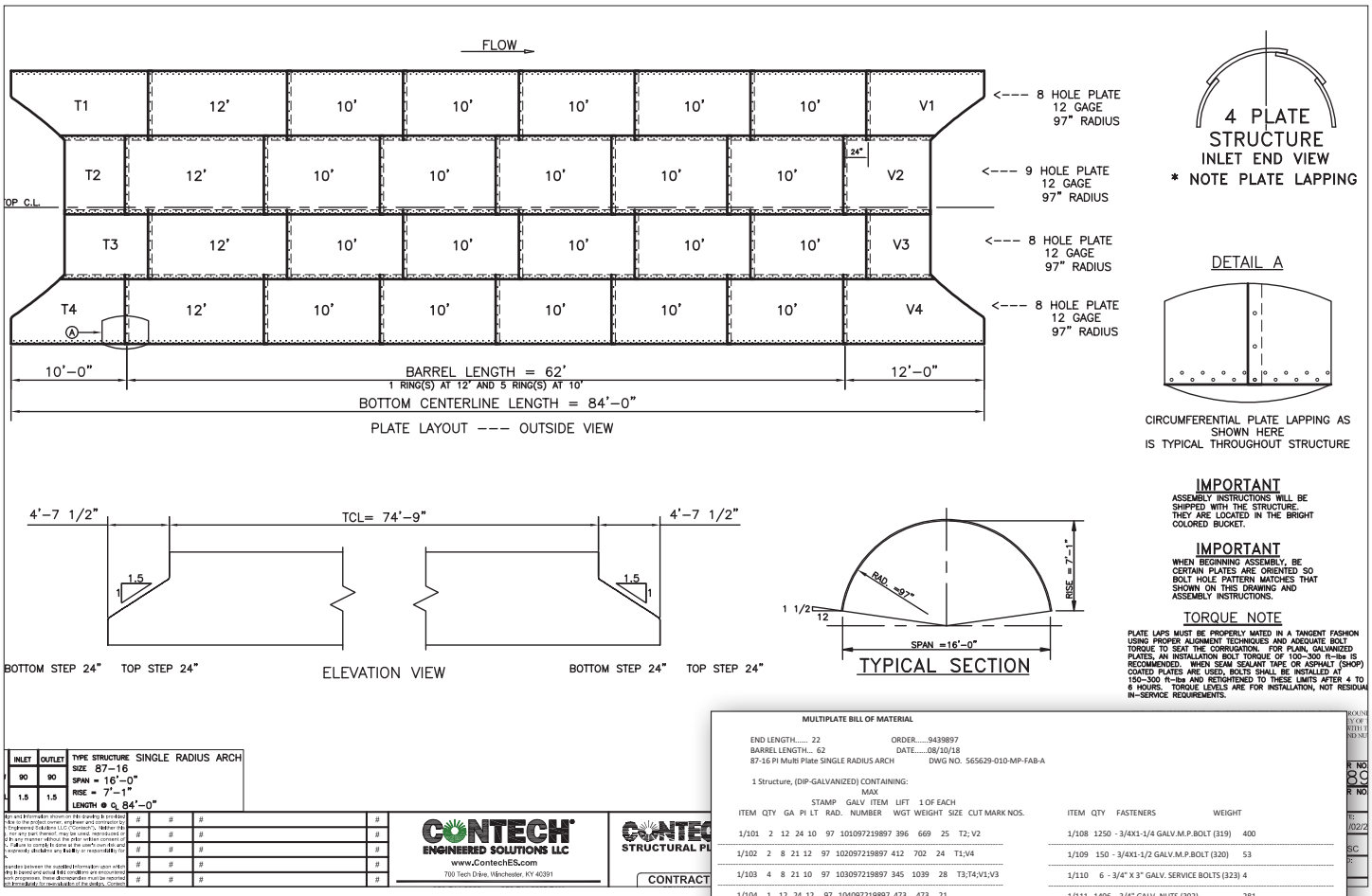
Plate Gages	Bolt Lengths	Bolt Diameter
12, 10 and 8	1¼″ and 1½″	¾″
7 and 5	1½″ and 1¾″	¾″
3 and 1	1½″ and 2″	¾″
5/16 and 3/8	2″ and 2½″	⅞″

Notes:
1. The longer bolts are used in 3 plate lap seams.
2. For asphalt coated plates, bolts are ¼″ longer.

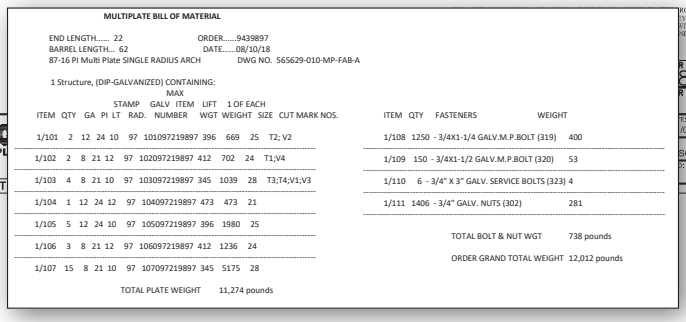
TABLE 4. TYPICAL BOLT AND NUT

Diameter (Inches)	A (Inches)	B (Inches)	C (Inches)	D (Inches)
¾	1¼	9/16	13/16	1 7/16
⅞	1 7/16	¾	⅞	1⅝

Sample Drawing



Example Plate Layout Drawing from Contract Set



MULTIPLATE BILL OF MATERIAL

END LENGTH..... 22 ORDER.....9439897
BARREL LENGTH... 62 DATE.....08/10/18
87-16 PI Multi Plate SINGLE RADIUS ARCH DWG NO. 565629-010-MP-FAB-A

1 Structure, (DIP-GALVANIZED) CONTAINING:

ITEM	QTY	GA	PI	LT	RAD.	STAMP NUMBER	GALV WGT	ITEM WEIGHT	LIFT SIZE	1 OF EACH CUT MARK NOS.
1/101	2	12	24	10	97	101097219897	396	669	25	T2; V2
1/102	2	8	21	12	97	102097219897	412	702	24	T1;V4
1/103	4	8	21	10	97	103097219897	345	1039	28	T3;T4;V1;V3
1/104	1	12	24	12	97	104097219897	473	473	21	
1/105	5	12	24	10	97	105097219897	396	1980	25	
1/106	3	8	21	12	97	106097219897	412	1236	24	
1/107	15	8	21	10	97	107097219897	345	5175	28	

TOTAL PLATE WEIGHT 11,274 pounds

ITEM	QTY	FASTENERS	WEIGHT
1/108	1250	- 3/4X1-1/4 GALV.M.P.BOLT (319)	400
1/109	150	- 3/4X1-1/2 GALV.M.P.BOLT (320)	53
1/110	6	- 3/4" X 3" GALV. SERVICE BOLTS (323)	4
1/111	1406	- 3/4" GALV. NUTS (302)	281

TOTAL BOLT & NUT WGT 738 pounds

ORDER GRAND TOTAL WEIGHT 12,012 pounds

Example Bill of Material (BOM)

MULTI-PLATE® 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 (Span) + 15′] by the length of the structure.
2. Depending on the size and weight of the MULTI-PLATE, 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

The marked bolt container will contain the bill of materials (BOM) and a drawing set which will have a plan view of the structure, showing the inside surface as if it were laid out flat.

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.

MULTI-PLATE corrugations of 6-inch pitch and 2-inch depth are perpendicular to the length of each plate. Standard specified thickness of the galvanized plates vary from 0.111 inches (12 gage) to 0.380 inches (3/8 gage). See detail on page 5.

PLATE LENGTH (LONGITUDINAL)

Plate length can be determined by counting the number of corrugations, which are on 6″ centers crest to crest. The standard plates for MULTI-PLATE are furnished in two lengths, nominally 10 feet (124″) and 12 feet (148″) long. Depending on the required length of the structure, other plate lengths (6ft, 8ft, or cut plates) may be furnished.

PLATE WIDTH (CIRCUMFERENTIAL)

There are five plate widths as detailed in Table 1 on page 5. To determine plate arc widths – count the circumferential bolt holes. The number of circumferential bolt holes in each plate will help you identify the nominal arc width for that plate. 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 12 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.

Plate Stamped Number Identification

Sub Item	Radius	Gage	Order Item	Plant Order
110	071	2	3	0442

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

Gage	Mark
12	2
10	0
8	8
7	7
5	5

Gage	Mark
3	3
1	1
5/16″	F
3/8″	T

BOLTS

Bolts will be furnished in some combination of six lengths, 1-1/4", 1-1/2", 1-3/4", 2", 2 ½" and 3" depending on specific plate lap and thickness.

For longitudinal holes, when 3/4" bolts are supplied, 7/8" diameter holes will be punched on 3" centers. When 7/8" bolts are supplied, 1"diameter holes are punched on 3" centers.

For circumferential holes, when 3/4" bolts are supplied, 1" diameter holes are punched. When 7/8" bolts are supplied, 1-1/8" diameter holes are punched. All holes are punched on 9.6" centers.

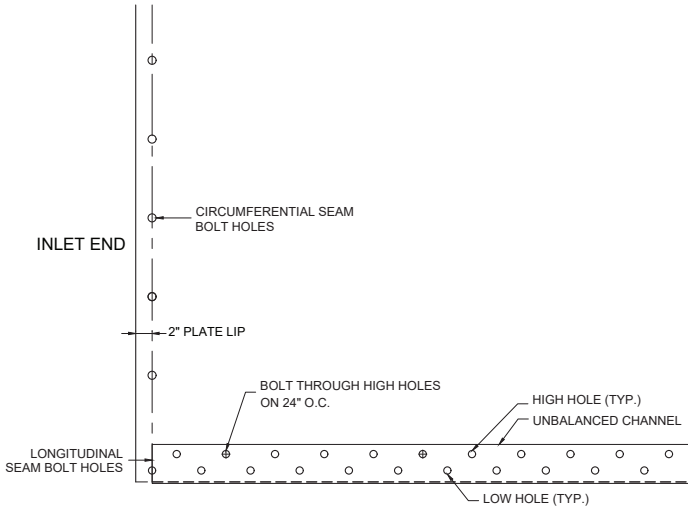
To determine the specific number of bolts for a structure, check the BOM. All containers are stenciled with the individual bolt size.

BOLTING

Bolting procedures may vary depending on the size and gage of the structure. Generally speaking, on smaller span and lighter gage structures, a loose bolting procedure works best. On larger and 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 with a minimum number of bolts. Insert sufficient bolts in each seam to hold the plates in position, but do not tighten the nuts, 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. About three rings behind plate assembly, insert the remaining bolts, using pins or a pry bar to align holes. After all the bolts are in place, tighten the nuts. Note, aligning of bolt holes is done easier when bolts are loose while drifting of holes is best done with adjacent bolts tight.

All bolts to be tightened to 100-300 ft.-lbs. of torque. A good plate fit is far more important than high bolt torque.



OUTSIDE VIEW OF PLATE

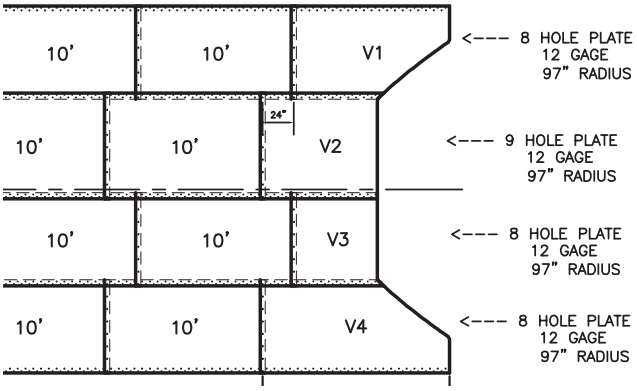
MULTI-PLATE® Assembly Instructions for Arch Shapes

UNBALANCED CHANNEL (UBC) INSTALLATION

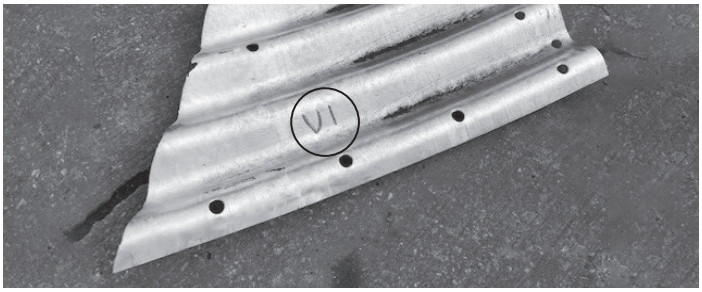
UBCs are sometimes used in arch construction. When concrete footings are poured, a unbalanced channel may be cast into the footing. Refer to "MULTI-PLATE Unbalanced Channel Details" and the assembly drawings.

PLATE ASSEMBLY

The various widths of plates are positioned in the barrel in accordance with the plate layout drawings furnished with the structure. The numbers shown on the drawing in the barrel area or on the plates indicate the number of bolt holes across the end of each plate.



The beginning and end rings are shown for square end structures and these contain combinations of 10' and 12' rings required to obtain the proper plate stagger. Special plates in cut end structures are shown on the plate layout together with the necessary 10' and 12' long plates required to obtain proper seam stagger in the barrel. Intermediate barrel rings contain plates all the same length. For cut plates and 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…) Reference the structure assembly drawings furnished with the order.



Starting at the inlet end, assemble three or four plates on one side only, referencing the plate layout drawing for plate location. Bolt the first row of plates to the stationary unbalanced channel. The attachment of the plates to the unbalanced channel is made by bolting through the highest row of holes on the outside crests of the corrugation.

After placing and bolting a few plates on one side, start at the inlet end again connecting plates on the opposite side of the structure to the unbalanced channel. The plates are bolted to the unbalanced channel through the highest row of bolt holes on the outside of the valleys of the corrugation. This will require the use of a 3" bolt on the side of the structure where the inside corrugation meets the long leg of the unbalanced channel. A short bolt is needed on the opposite side of the structure at this location. Please see details on page 11.

Continue by placing side and top plates into position as shown on the plate layout drawing (PLD) until at least two full rings are completed. Structural plate structures should be assembled with as few bolts as possible until all plates are in place. Three or four "finger tight" bolts placed near the center of each plate along the longitudinal and circumferential seams are sufficient. (As a general guideline, use approximately ¼ of the number of bolts to hold the plates into position.)

At this point, check the eccentricity of the structure.

A plumb bob dropped from the crown centerline with measurements to the bolt at the top of the unbalanced channel will determine if the structure is square to the channels. To square up the structure, loosen enough bolts so the structure can flex, remove the bolts from one unbalanced channel and drift the lower edge up stream or down stream as necessary.

Following this check to ensure a symmetrical arch, continue to move downstream placing the plates in the same sequence until all of the plates are in place. Now, insert all of the remaining bolts and tighten the nuts to the required torque.

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 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.

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.

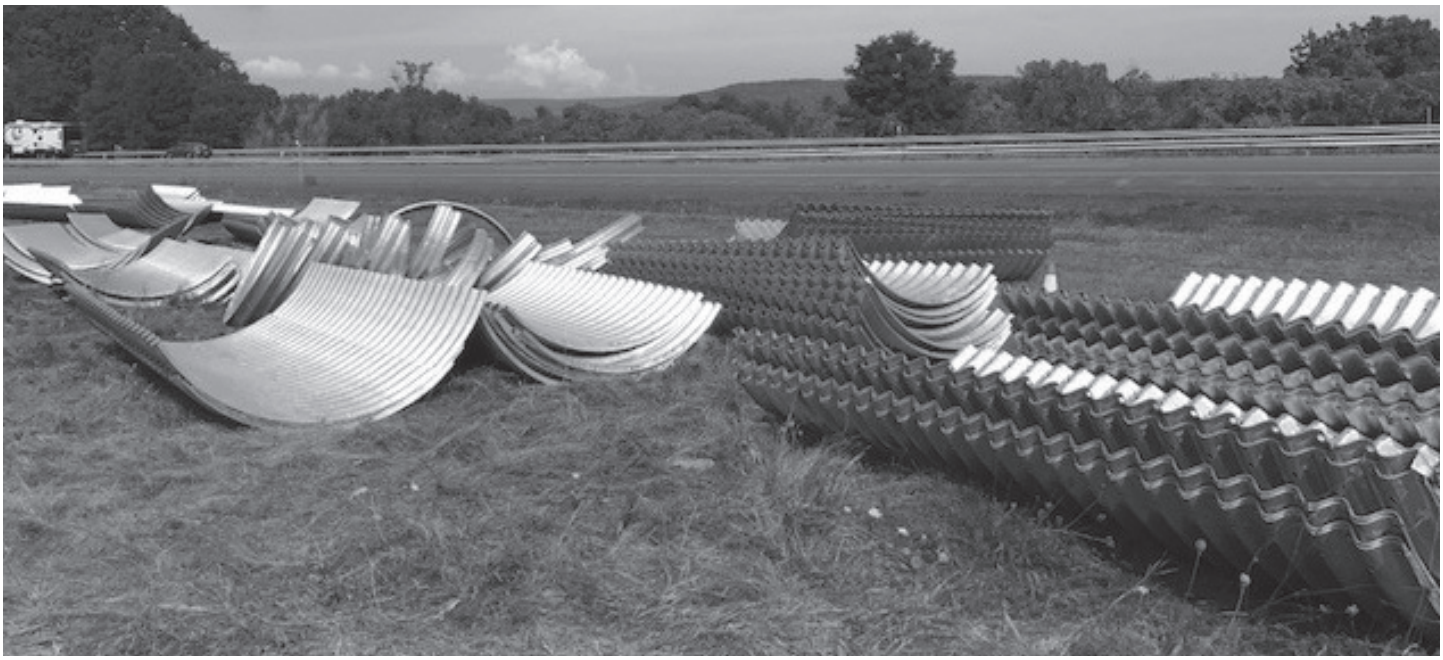
Rigging a structure to be lifted into place should be done by proportioning the weight between the lifting points to achieve balanced loading and control. The rigging plan must be approved by the Engineer of Record; for additional guidance contact you Contech representative.

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.

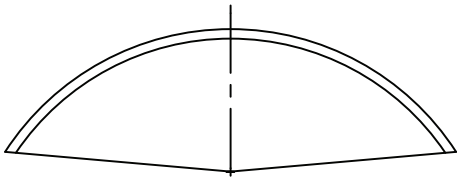
CAUTION

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.

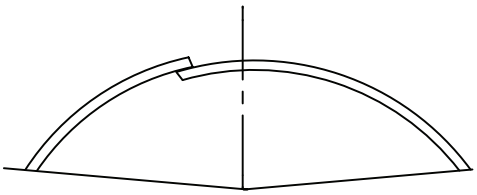


MULTI-PLATE® Arch Plate Orientation

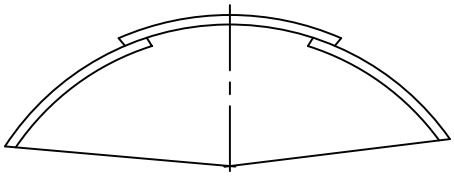
VIEW LOOKING DOWNSTREAM



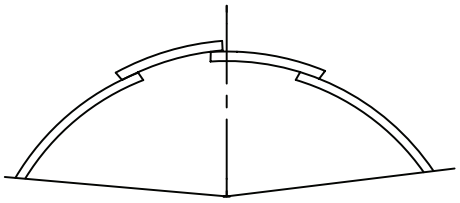
1 PLATE
STRUCTURE



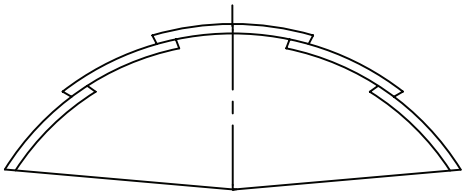
2 PLATE
STRUCTURE



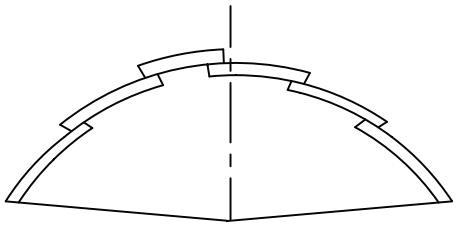
3 PLATE
STRUCTURE



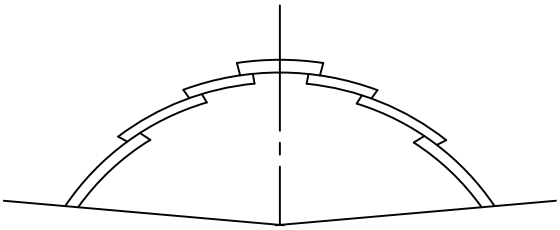
4 PLATE
STRUCTURE



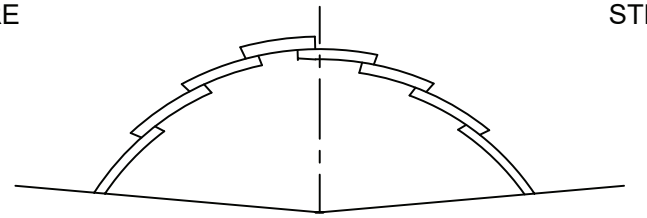
5 PLATE
STRUCTURE



6 PLATE
STRUCTURE



7 PLATE
STRUCTURE



8 PLATE
STRUCTURE

Foundations for MULTI-PLATE® Arch Shapes

General Foundation Types

- Cast-In-Place Footing
- Steel EXPRESS® Foundation
- Precast EXPRESS® Foundation
- Foundation in Existing Rock

Cast-in-Place Foundations

GENERAL INFORMATION

1. Foundation must be built in accordance to the project specifications and details.
2. Structures can be installed sitting within a keyway or within an unbalanced channel. See lower right diagram.
3. When unbalanced channels are used, they are generally set using knockout lugs built into the UBC. Knock out the steel tabs so that they are oriented at 90 degrees to the base of the UBC, then twist them with pliers prior to setting into the foundation. This helps anchor the UBC into the finished CIP foundation. If the structure is placed all at once into the unbalanced channel and spreading occurs, use come-alongs and/or struts to maintain the correct span.

Steel EXPRESS® Foundations

GENERAL INFORMATION

1. Determine the proper location, orientation and grade of the structure's foundation.
2. Excavate, grade and prepare the stabilized subgrade for the foundation.
3. Unload the prefabricated steel foundation forms onto a level area.
4. Locate the proper pick points on each Steel EXPRESS section.
5. Lift and place the steel foundation sections onto the prepared subgrade.
6. Fasten adjacent foundation sections together and securely anchor the foundations into the soil.
7. Place and tie the supplemental steel splice bars between adjacent sections to provide foundation reinforcement continuity.
8. Place backfill to secure foundation prior to setting the structure.
9. Locate and set the structure onto the foundation.
10. Pour concrete into the foundation and grade concrete so water runs away from the structure.

Precast EXPRESS® Foundations

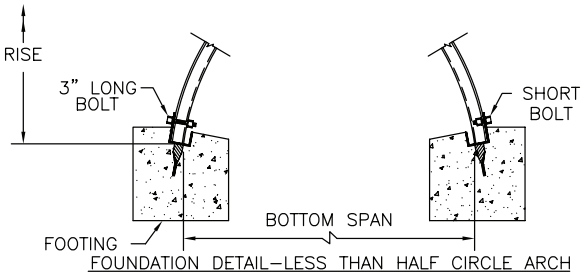
GENERAL INFORMATION

1. Structures are typically installed within a keyway. Unbalanced channels are attached to structure legs to help distribute structure dead loads to cross members prior to concrete pouring.
2. Structure can be set within the keyway prior to the footing concrete pour or after.

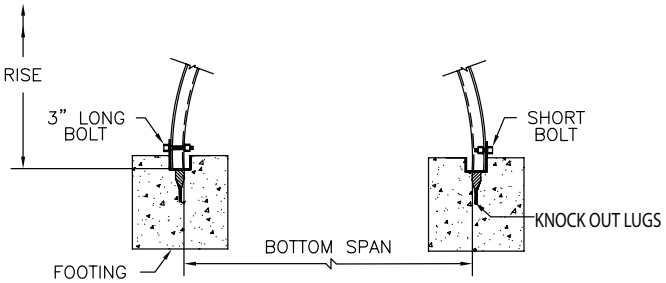
Foundation in Existing Rock

GENERAL INFORMATION

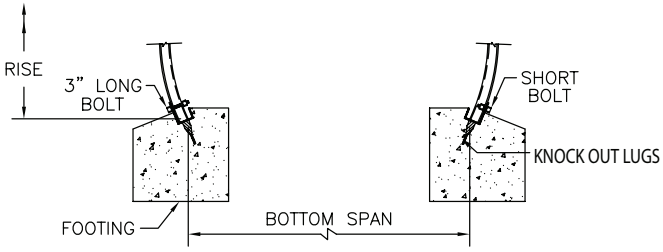
1. When installing arch structures in existing rock foundations, minimal excavation may be needed to achieve project specific grade requirements.
2. Structures are typically installed within an unbalanced channel.
3. Please contact your Contech representative for more detail.



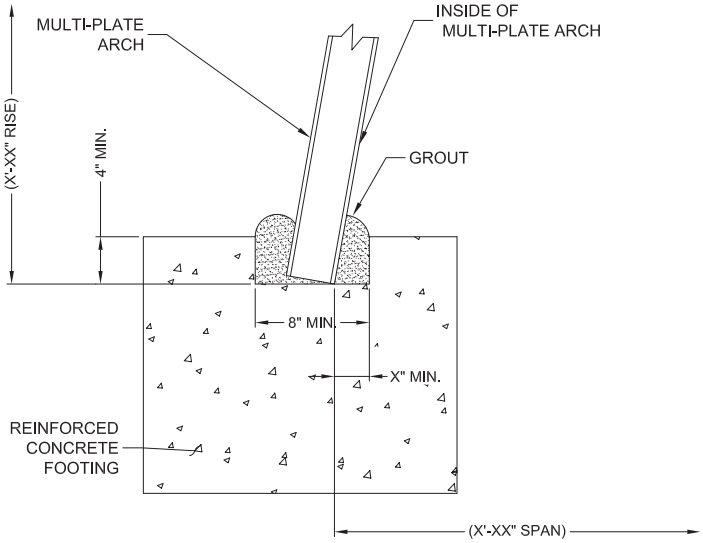
FOUNDATION DETAIL—LESS THAN HALF CIRCLE ARCH
(as measured from the inside legs of corrugation)



FOUNDATION DETAIL—HALF CIRCLE ARCH
(as measured from the inside legs of corrugation)



FOUNDATION DETAIL - ARCH > 180°
(as measured from the inside legs of corrugation)



NOTES:

1) SIZE AND REINFORCING OF FOOTING TO BE CONTROLLED BY SOIL-BEARING CAPACITY AND LOADING CONDITIONS.

2) BLOCKING OR SHIMMING SIDE PLATES TO ACHIEVE AND MAINTAIN PROPER BOTTOM SPAN AND SIDE RETURN ANGLE MAY BE REQUIRED.

3) GROUT SHOULD BE NON-METALLIC, NON-SHRINK MATERIAL, WITH A MINIMUM 4,000 PSI COMPRESSIVE STRENGTH

4) GROUT AND SHIMMING MATERIAL SHOULD NOT CONTAIN ANY CORROSION-PROMOTING AGENTS.

INSTALLATION

Basic Principles for MULTI-PLATE® Single Radius Arches

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. Place and compact the backfill in 8-inch thickness of compacted lifts at 90% modified minimum density per AASHTO T-180.
9. Maintain balanced fill placement and loading during all phases of installation, keeping fill height differential side to side to 2′ maximum.
10. Install the necessary end treatment quickly to protect the structure from erosion and uplift.
11. 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 foundations 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. For arches, plate sections should be assembled in the downstream 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 in a safe manner.
- Backfill the trench as soon as practicable after structural plate installation.

Trench Width and Shape

The width and shape of the trench should be as shown on the plans. Any change should be approved by the Engineer.

Figure 5 (on page 15) 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 SUBGRADES

The subgrade 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 strength of the subgrade must be capable of supporting the foundation, structure and the select backfill envelope. The critical factor is to achieve uniformity along the structure.

HANDLING DIFFERENT TYPES OF SUBGRADES

When the excavated grade line reveals both soft and hard spots, the subgrade 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 subgrade slightly below grade line and replace it with suitable, uniform material. In any event, any abrupt changes from hard to soft subgrade must be avoided.

When soft, unstable material is encountered at the subgrade level, it must be excavated below the bottom of footing elevation and improved as necessary. The zone of select material must be adequate to support the foundation of the structure and backfill. When unexpected materials are encountered, consult the project engineer.

Whenever a subgrade 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. The use of intermittent piles, pile bents or concrete cradles may be required due to inadequate subgrade strength. This may create the potential risk for differential settlement issues for the structural plate and for the adjacent side fill and thus should be avoided.

ARCH SUBGRADES

Arches are erected on a prepared reinforced concrete foundation. Setting a structure in a concrete foundation can be in done either a keyway slot or in an unbalanced channel.

KEYWAY SLOT

A keyway slot is formed into the concrete foundation wide and deep enough to accept the corrugated plate. After assembly, a non-shrink, non-metallic grout is placed to fill the void. This eliminates ponding of water in the formed keyway.

UNBALANCED CHANNEL (UBC)

An unbalanced channel is used as a construction tool to help secure the plate during the assembly process. This channel is cast in the concrete footing during the footing construction. It is important to have the channel square with the subgrade, parallel to the opposite footing and located properly to ensure the hole alignment in the channel matches the holes in the plates.

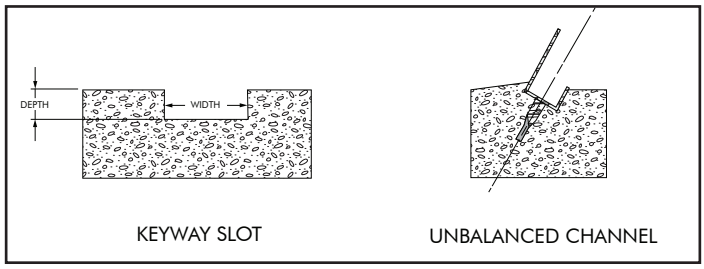


Figure 1. Arch foundation options

FIELD-APPLIED COATING FOR MULTI-PLATE

Field coated asphalt coatings shall be applied per the manufacturer's application instructions and AASHTO M243 and ASTM A-849.

The coating shall be applied to a clean surface, free of dirt, oil, grease, or other foreign matter, when the atmospheric temperature is above 40°F. and the humidity is low enough that the surface of the metal can be kept dry.

Coating may be applied by spray or brush as required by the manufacturer to attain a uniform dry thickness of 0.05 inch.

STREAM DIVERSION

If the stream is temporarily diverted during construction, the diversion ditch or temporary drainage pipe 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. This will 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.

BACKFILLING
MULTI-PLATE® Single Radius Arch

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.

Continue placing the backfill equally on both sides of the structure in 8-inch uncompacted lifts, thoroughly compacting each to a 90% density (AASHTO T180). 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 compacted lifts. 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.

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, an extra thickness of compacted fill, beyond that required for minimum cover, is required. See construction loads on page 17.

Care must be taken in backfilling arches, especially half-circle arches, because they have a tendency to shift sideways (roll) or to peak under backfilling loads. The recommended way is to place in a balanced fashion backfill on each side of the structure in 8" loose lifts and compacted to 90% modified density, with no more than a 2' differential on each side. Prevent distortion of the shape as necessary by varying compaction methods and equipment. Place the backfill material in radial lifts beginning approximately at 75% of the rise of the structure as seen on figure 2. If one side is backfilled more than the other, the arch will move away from the larger load. If both sides are backfilled equally and tamped thoroughly, the top of the arch may peak unless enough fill has been placed over it to resist the upward thrust.

When backfilling arches before headwalls are placed, the first material should be placed midway between the ends of the arch, forming as narrow a ramp as possible until the top of the arch is reached. See figure 2 (side view without headwalls). The ramps should be built evenly from both sides of the arch and the backfill material should be thoroughly compacted as it is placed. After the two ramps have been built to the depth specified to the top of the arch, the remainder of the backfill should be placed and compacted by extending the ramp both ways from the center to the ends, and as evenly as practicable on both sides of the arch.

If the headwalls are built before the arch is backfilled, 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 arch 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 arch. Top loading will help control peaking.

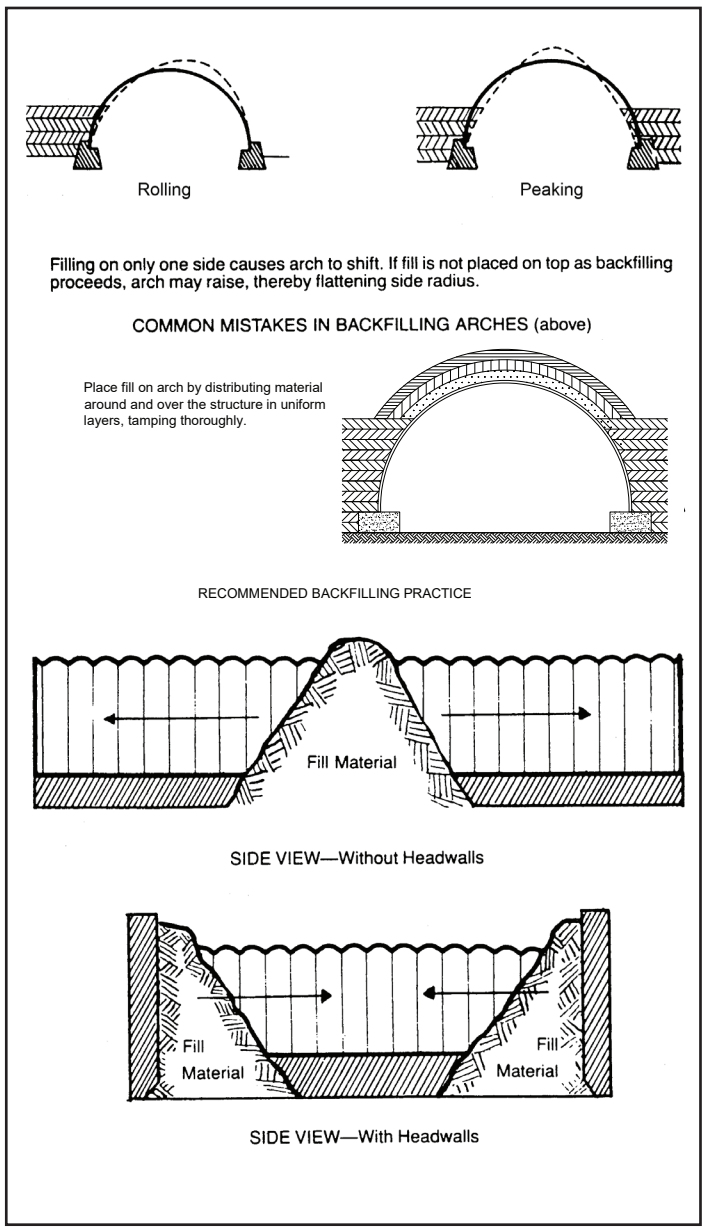


Figure 2. Recommended backfilling practice for structural plate arches.

PROPER MATERIAL PLACEMENT

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 replaced with lighter, more suitable equipment. 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. See figures 3 and 4.

EVEN PLACEMENT OF BACKFILL

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, below.)

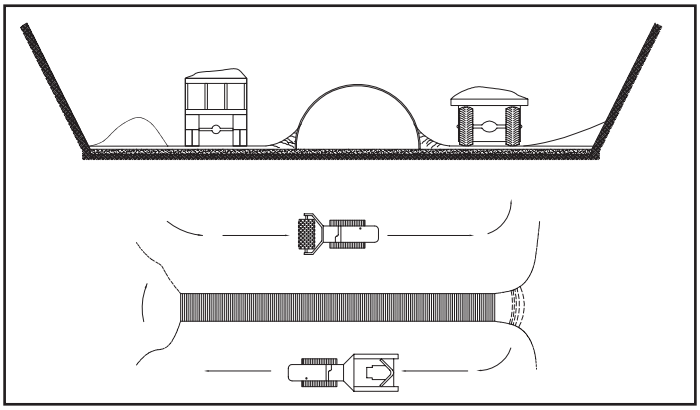


Figure 3. Proper Material Placement

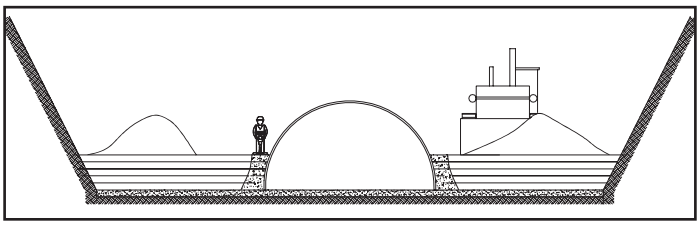


Figure 4. Hand Compaction and Heavy Equipment Procedure

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

When the fill on both sides approaches the crown of the structure (see the Recommended Backfilling Practice in Figure 2), 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, light hand or walk-behind compaction equipment is necessary.

After backfilling to the specified minimum cover, and no changes in the structure's dimensions have been observed, then further filling to grade may continue using procedures applicable to embankment construction. See information regarding construction loading.

The bedding and backfill operation should be entirely conducted in the dry if at all possible, but with enough moisture to meet compaction standards.

SHAPE CONTROL

Shape control refers to monitoring the symmetry of the structure during the backfilling process. 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 2.

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 "plumb-bob" method of deflection control is most convenient and effective for large structures. Suspend plumb bobs from the shoulder (2 and 10 o'clock) positions 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. 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. 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 control plumb-bobs and prompt remedial steps prevents peaking or rolling action from distorting the structure.

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.

Recommended minimum spacing for arches are shown below. This spacing is when using all standard backfill materials and allows for room to compact the backfill.

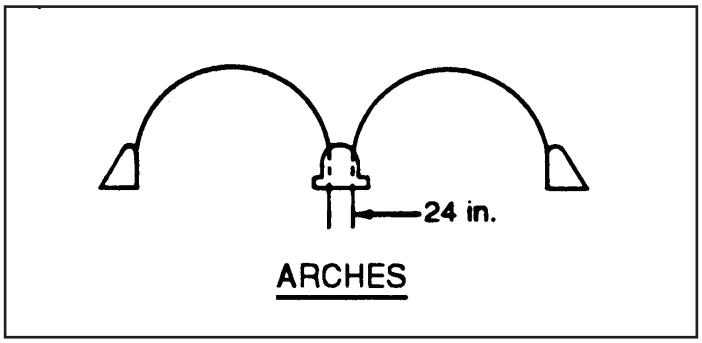


Figure 5. Minimum Barrel Spacing.

The minimum spacing shown provides adequate room between the structure and the trench wall for adequate material placement and compaction.

Appropriate equipment should be considered in determining the spacing between the structures. More than the 24" 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 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 thick sheeting, such as wood, 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. The use of water flooding or jetting should be limited to compacting soils which are sufficiently permeable to dispose of the excess water and should not be used with cohesive soils.

Figure 6. Adequate, uniform compaction is critical to building soil/steel structures.

COMPACTION EQUIPMENT

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

Where space permits, sheepsfoot (recommended for silts only), rubber tired and other types of rollers can be used to compact backfill. However, the fill adjacent to the structure should be tamped with hand or hand-held power equipment.

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.

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.

Adequate protection of the corrugated steel structure may require more than finished design fill. The amount of additional fill needed depends on the equipment axle loads.

The following table provides the minimum cover for typical structure sizes and axle loads. While providing extra cover is a simple way to protect the structure, it must be maintained so that rutting, surface grading, etc. does not reduce its effect. A minimum crossing width of 24 feet is recommended for typical equipment.

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.

Heavy Wheel Load Table Minimum Cover for Off Highway Equipment up to 450 Tons GVW							
Span (ft)	Wall Thickness (inches)						
	0.111″ (12 GA)	0.140″ (10 GA)	0.170″ (8 GA)	0.188″ (7 GA)	0.218″ (5 GA)	0.249″ (3 GA)	0.280″ (1 GA)
5-10	2.5′	2.5′	2.5′	2.5′	2.5′	2.5′	2.5′
11-12	3.0′	3.0′	3.0′	3.0′	3.0′	3.0′	3.0′
13-14	3.5′	3.5′	3.5′	3.5′	3.5′	3.5′	3.5′
15-16	4.0′	4.0′	4.0′	4.0′	4.0′	4.0′	4.0′
17-18		4.5′	4.5′	4.5′	4.5′	4.5′	4.5′
19-20			5.0′	5.0′	5.0′	5.0′	5.0′

* Follow AASHTO or AISI guidelines for spans greater than 20 feet.

* Backfill should be excellent quality, compacted to 90% density AASHTO T-180

* In unpaved situations, the surface must be maintained, level and free of ruts or add 2 feet for rutting in un-maintained areas.

* Maintaining minimum cover is important. The contractor must provide the additional cover required to avoid damage to the structure. Minimum cover is measured from the top of the maintained construction roadway surface. See Figure 8 for guidance.

Figure 7. Minimum Cover.

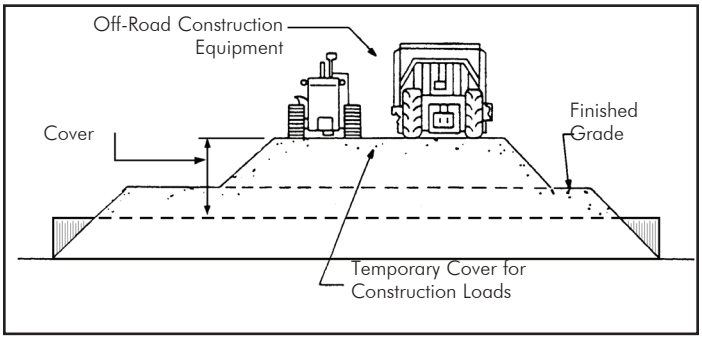


Figure 8. Minimum cover for construction loads.

HYDRAULIC PROTECTION

During installation, and prior to the completion of backfilling and the construction of permanent end treatment, 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 damage structures without adequate protection if the foundation, bedding or backfill becomes saturated. Proper channeling of flow through active structures and placing end treatment 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.

SUMMARY

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 and compact the backfill in 8 inches thickness of compacted lifts at 90% modified minimum density per AASHTO T-180.
11. Maintain balanced fill placement and loading during all phases of installation, keeping fill height differential side to side to 2′ maximum.
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.

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