



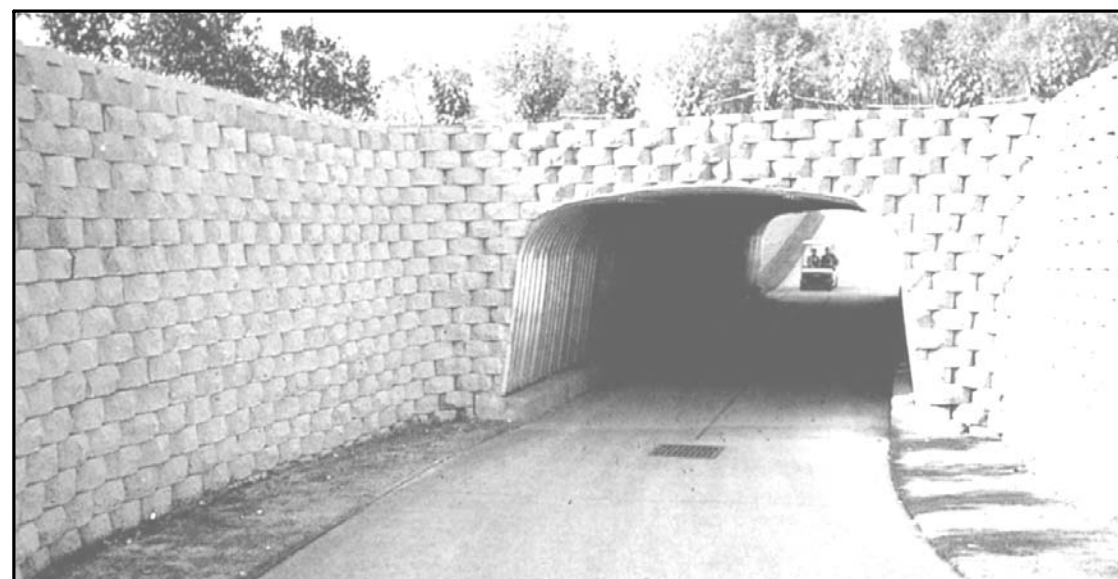
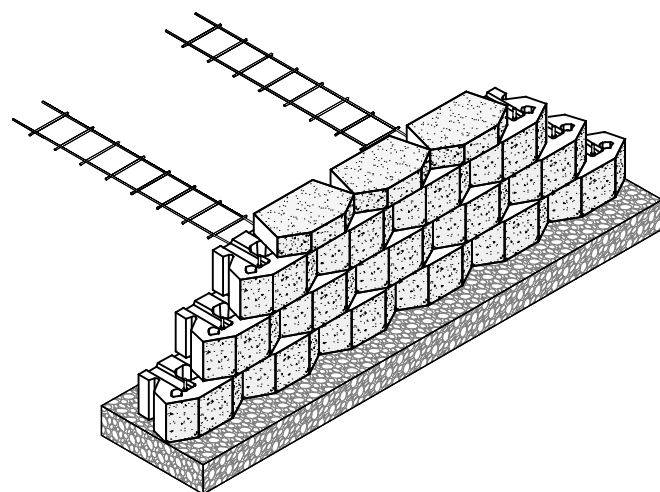
Retaining Excellence

Keystone Retaining Wall Keysteel System



Designed For

Contech Aluminum Box Culverts & Structural Plate Arches



Drawing Index

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952-897-1040

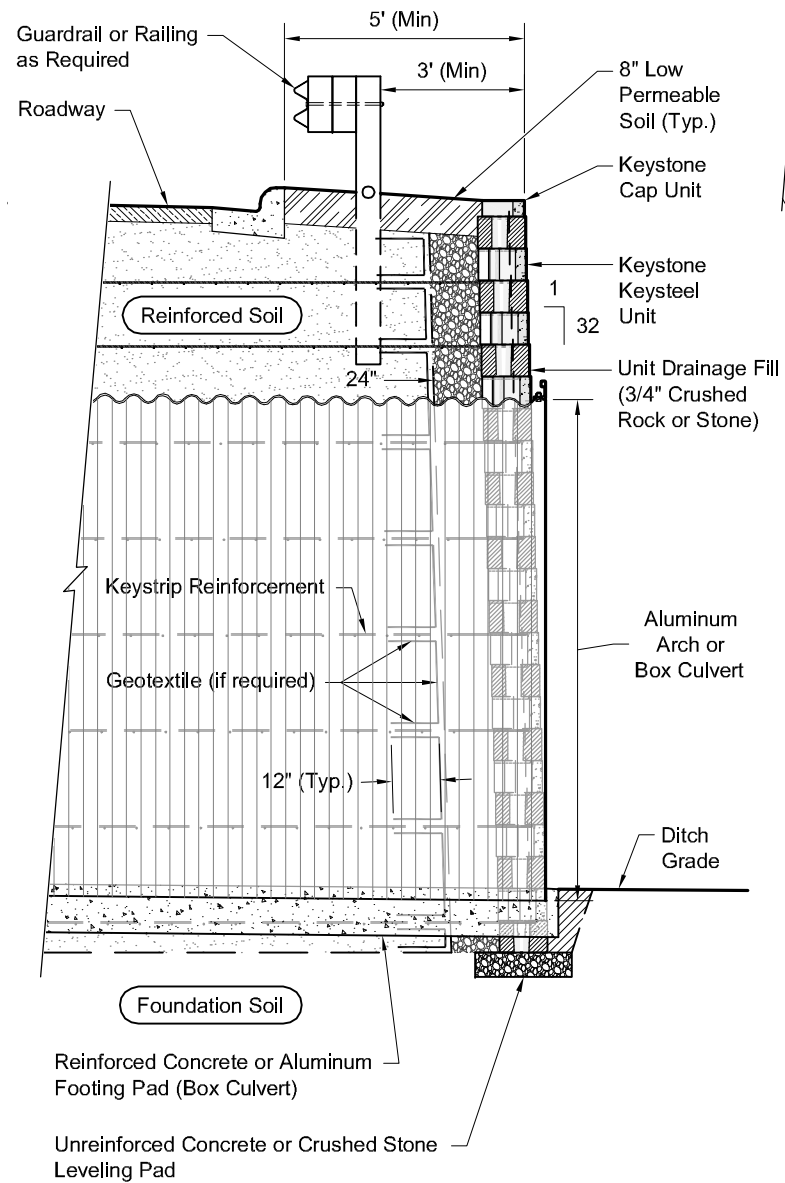
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Wall Systems
Details**

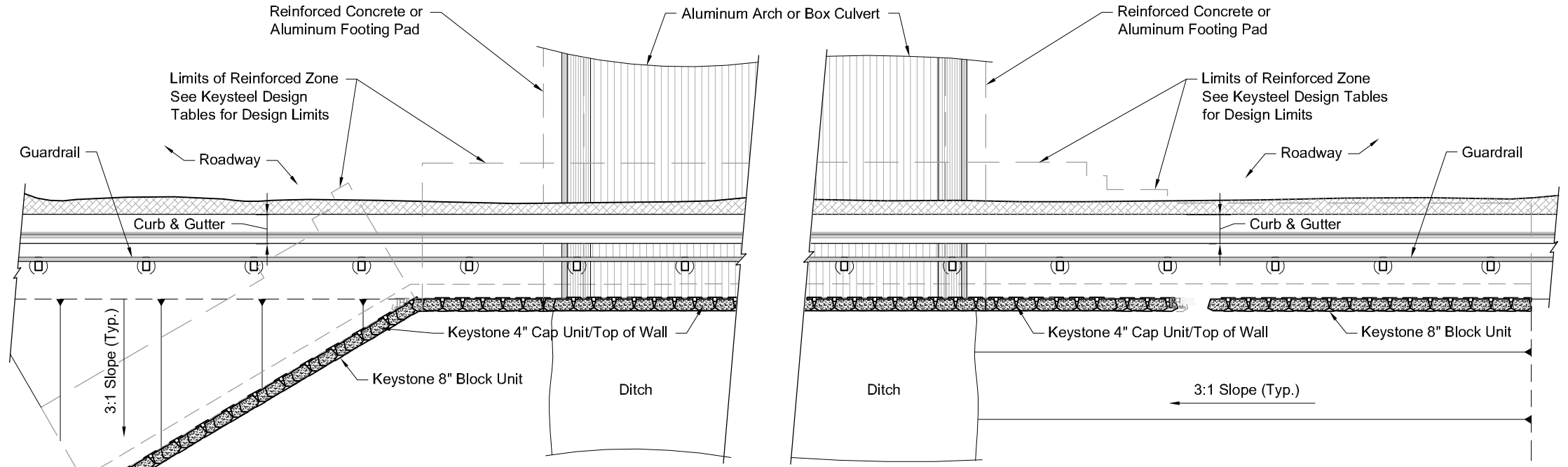
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Designed By: RKM	Title: Title Sheet	Date: 02/2011
Checked By: JMF	Client: Contech Construction Products Inc.	Project No:
Scale: No Scale		Drawing No: 1

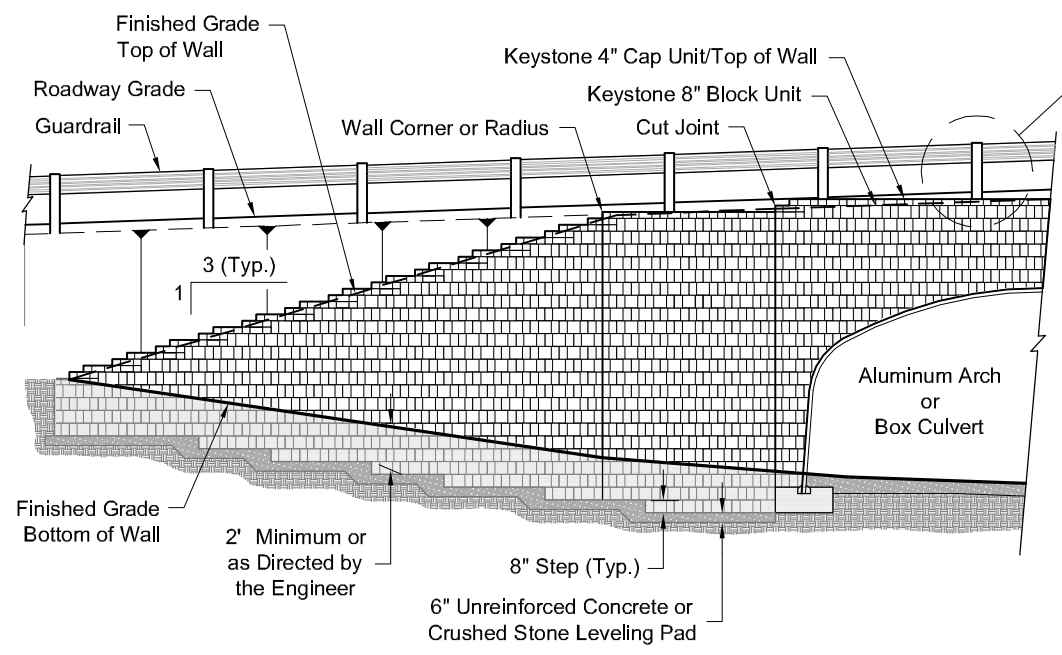
Note:
See sheet 5 for guardrail / post detail over aluminum box culvert



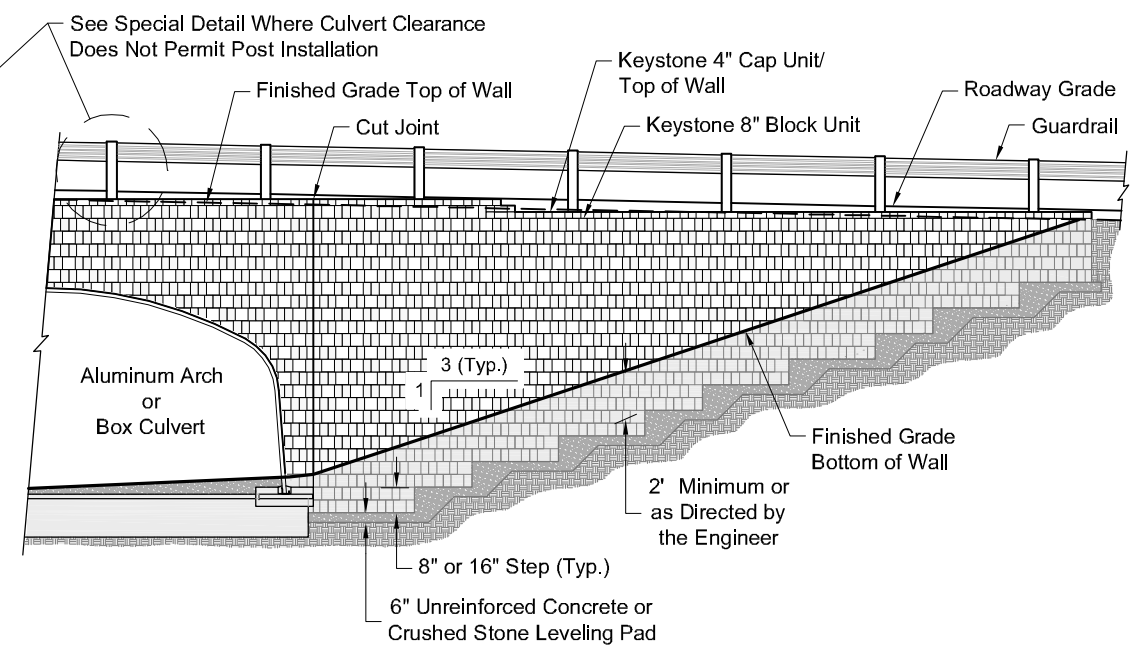
Typical Reinforced Wall Section at Culvert
Keysteel Unit - Near Vertical Setback Shown



Keysteel Wall / Culvert Plan View
Keysteel Unit - Near Vertical Setback Shown



Type "A" Modular Block Wall
(Wing Wall with Corner or Radius)



Type "B" Modular Block Wall
(Straight Wing Wall)

Keysteel Wall / Culvert Elevation View
Keysteel Unit - Near Vertical Setback Shown

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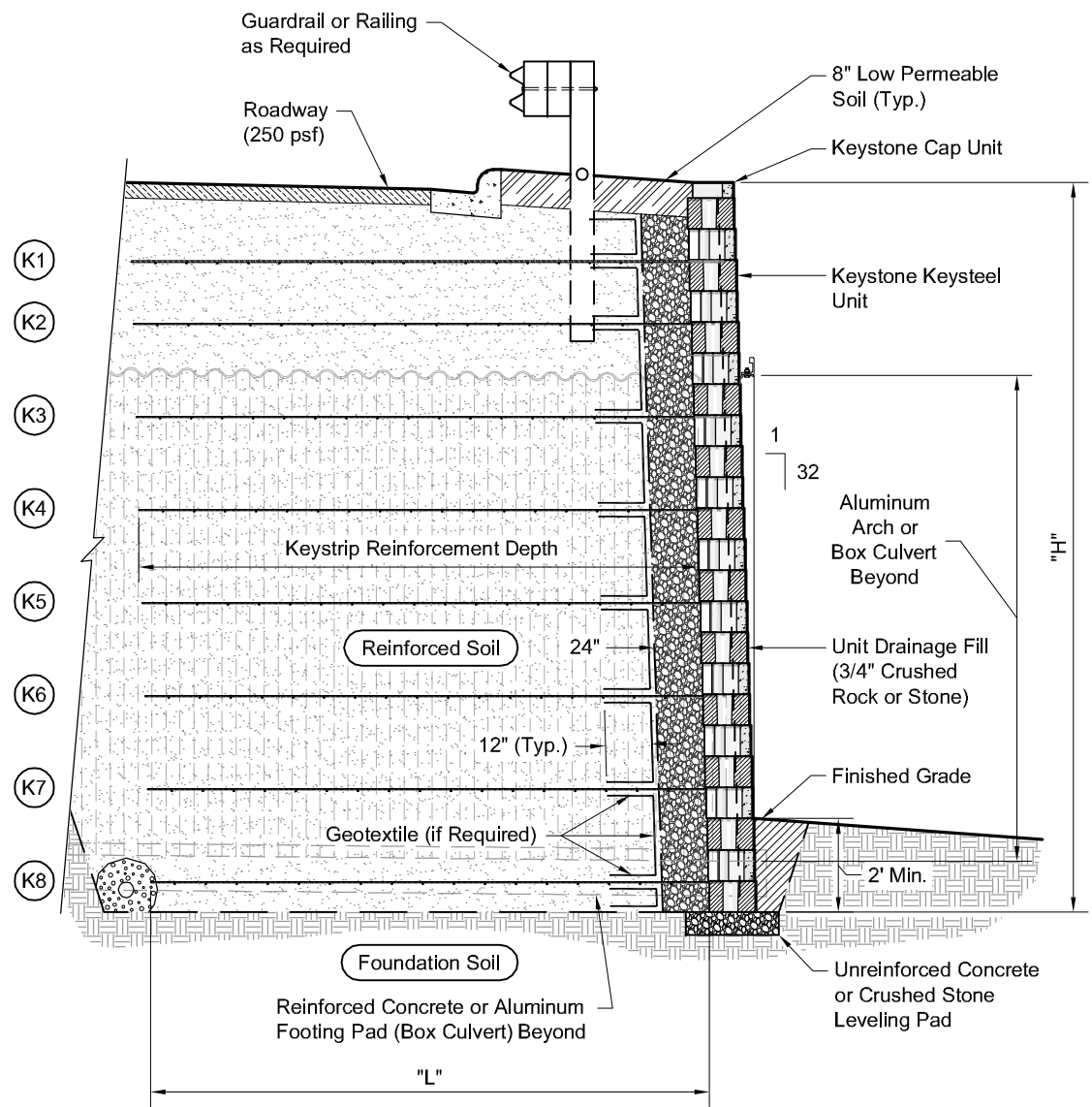
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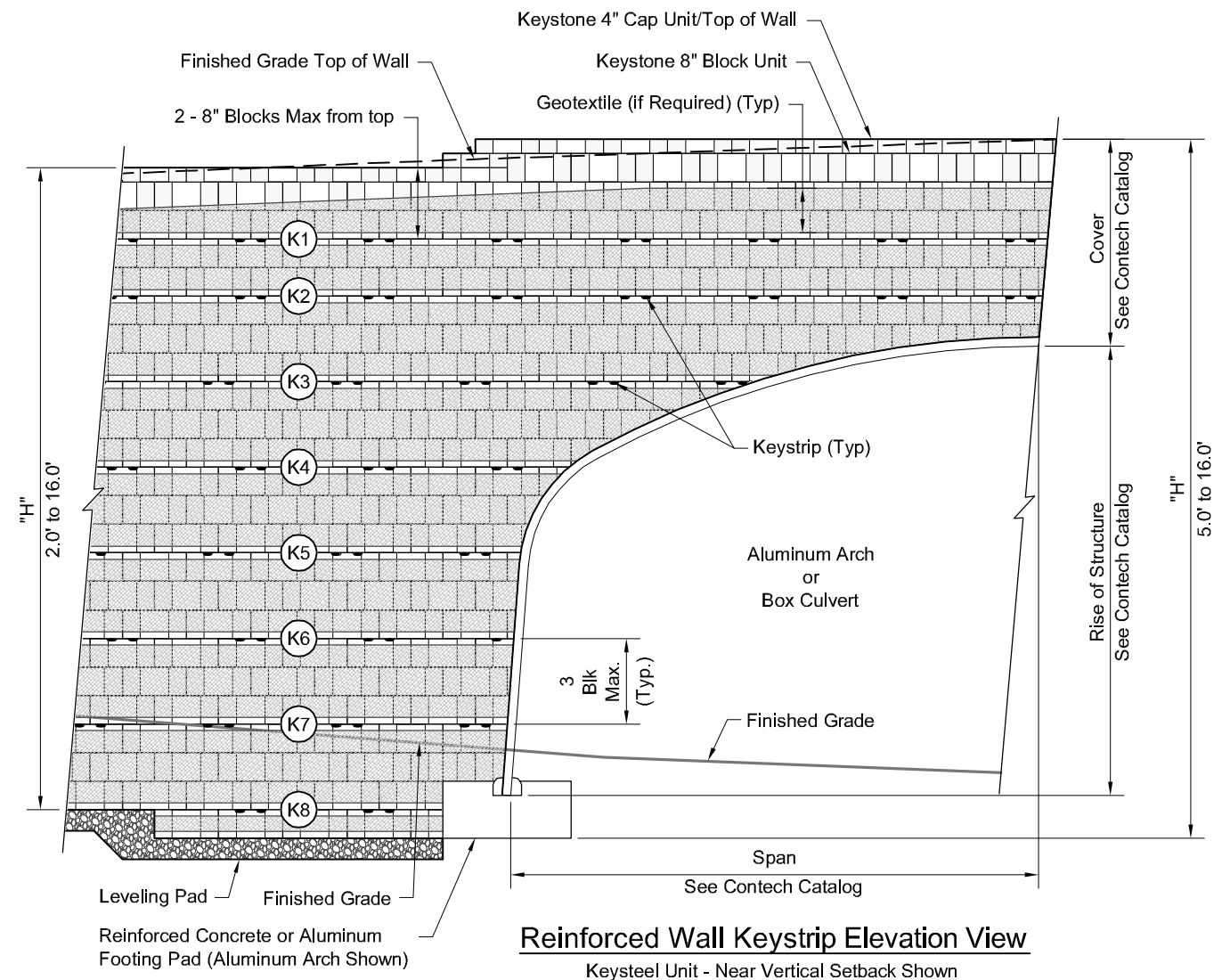
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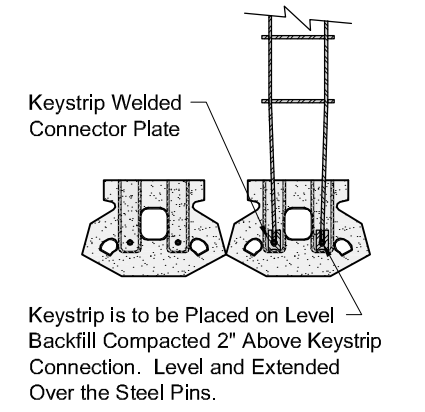
Designed By: RKM	Title: Keystone Wall Type Details	Date: 02/2011
Checked By: JMF	Client: Contech Construction Products Inc.	Project No:
Scale: No Scale		Drawing No: 2



Typical Reinforced Wall Section
Keysteel Unit - Near Vertical Setback Shown



Reinforced Wall Keystrip Elevation View
Keysteel Unit - Near Vertical Setback Shown



Keystrip & Pin Connection
Keysteel Unit - Near Vertical Setback Shown

Keystrip Table		
Keystrip Type	Reinforcing Parameters (lbs/strip)	
	TD	* TAL
W7.5	6535	3137
W11	10323	4956
W14	13676	6565

Internal Stability									
	Key strip Row	Wall Height (ft.)							
		16.33	14.33	12.33	10.33	8.33	6.33	4.33	2.33
Keystrip Strength	K1	W11	W11	W11	W7.5	W7.5	W7.5	W7.5	W7.5
	K2	W11	W11	W11	W7.5	W7.5	W7.5	W7.5	
	K3	W11	W11	W11	W7.5	W7.5	W7.5		
	K4	W11	W11	W11	W11	W11			
	K5	W11	W11	W11	W11				
	K6	W14	W14	W11					
	K7	W14	W14						
	K8	W14							

External Stability		
Wall Height "H" (ft.)	Keystrip Length "L" (FT.)	Applied Bearing Pressure (PSF)
2.33	8	300
4.33	8	600
6.33	8	1200
8.33	8	1600
10.33	8	2000
12.33	10	2500
14.33	12	3000
16.33	12	3200

* 8' AASHTO Minimum

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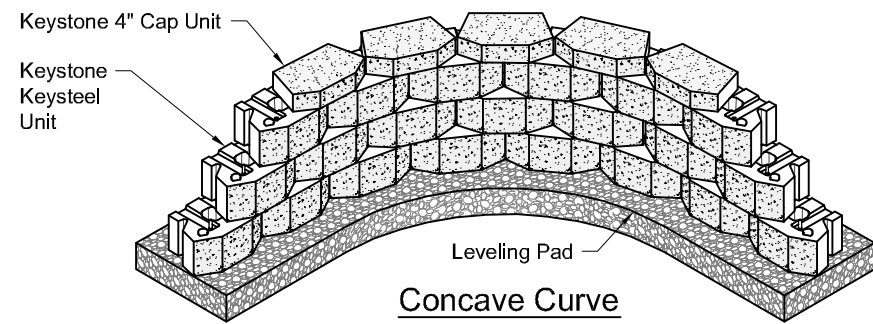
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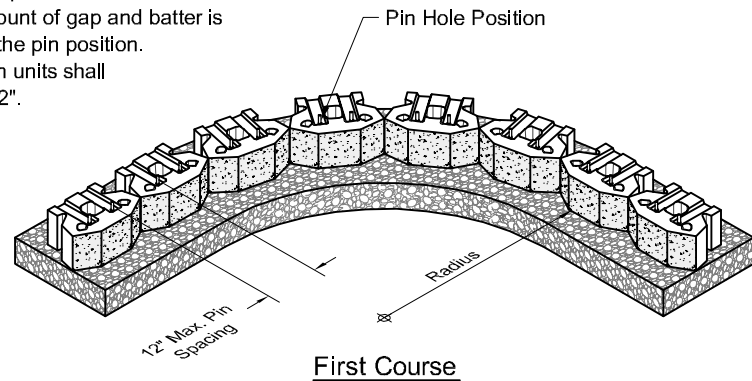
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Designed By: RKM	Title: Keystone Keysteel Design	Date: 02/2011
Checked By: JMF	Client: Contech Construction Products Inc.	Project No:
Scale: No Scale		Drawing No: 3

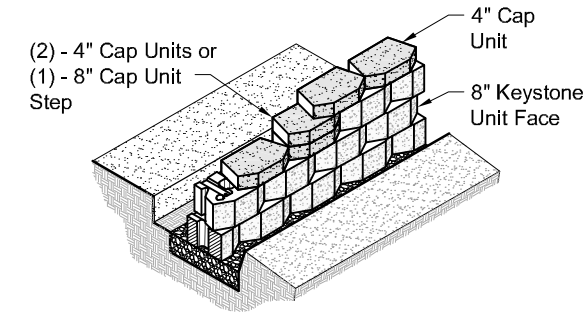


Concave Curve
Keysteel Unit - Near Vertical Setback Shown

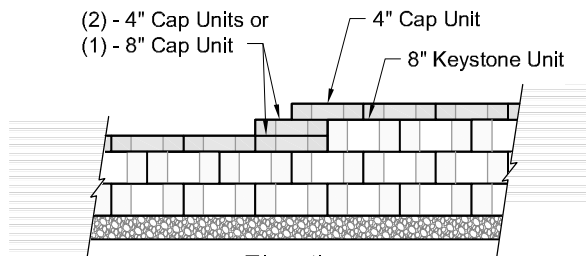
Note:
All units batter or step back away from the point of radius. Units will gap. The amount of gap and batter is controlled by the pin position. Gaps between units shall not exceed 1/2".



First Course



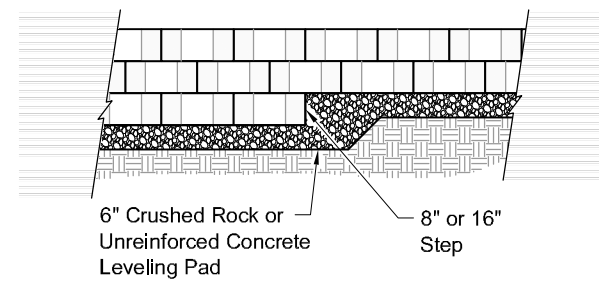
Isometric



Elevation

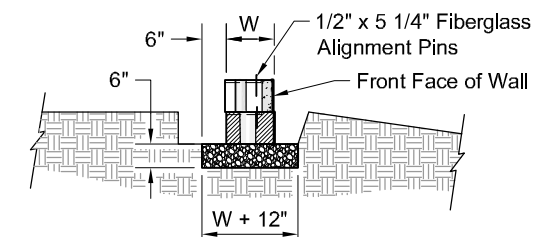
Note:
1. Secure all cap units with Keystone Kapseal or equal.
2. Cap unit options vary, common 3 plane split face option shown

Top of Wall Steps



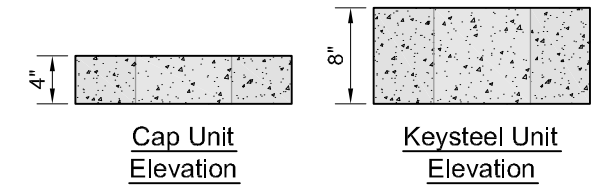
Elevation

Note:
1. The leveling pad is to be constructed of crushed stone or 2000 psi ± unreinforced concrete.
2. Use 9/16" x 8" Steel Connector Pins with keystrips



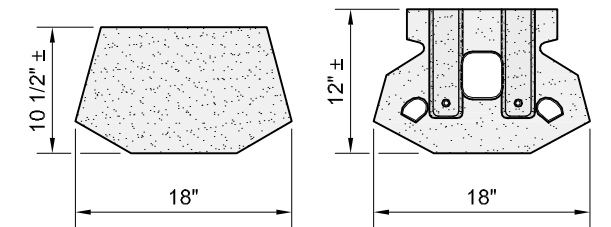
Section

Leveling Pad Detail



Cap Unit Elevation

Keysteel Unit Elevation

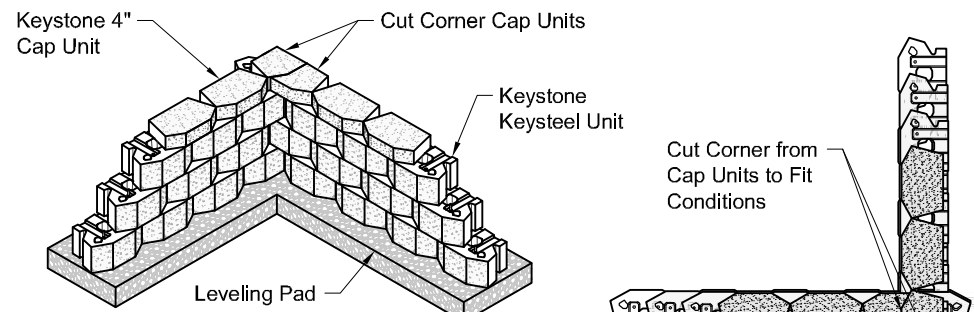


Cap Unit Plan

Keysteel Unit Plan

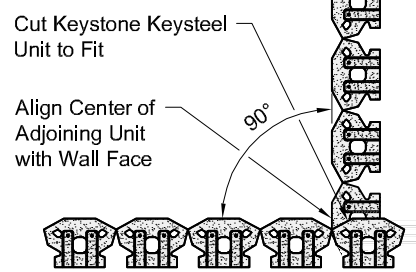
Keystone Units

* Dimensions May Vary by Region



90° Inside Corner - Squared
Keysteel Unit - Near Vertical Setback Shown

Cap Course



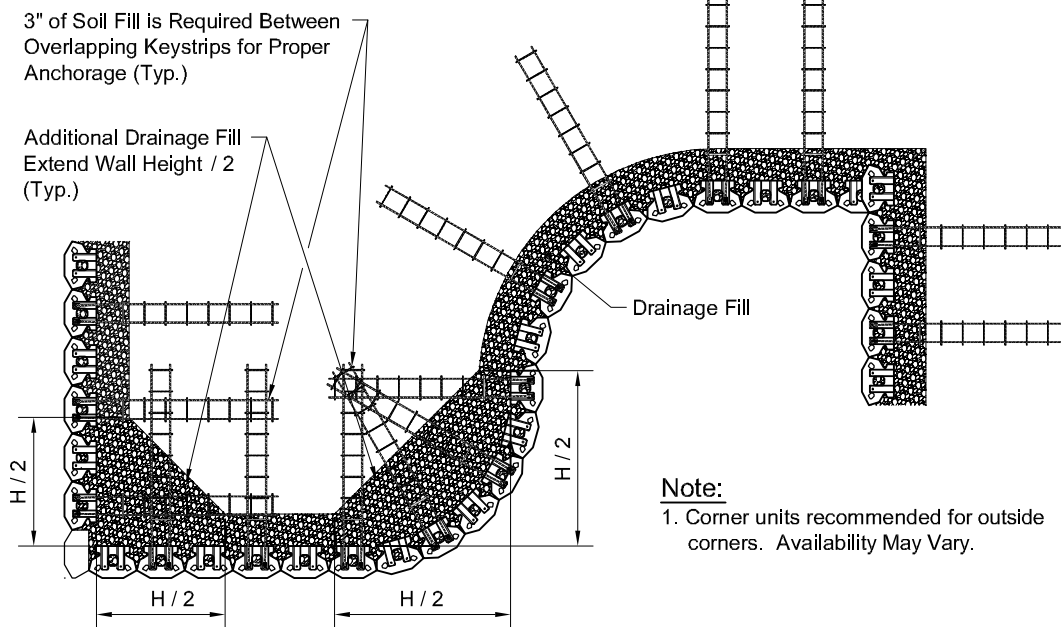
First Course

Note:
All units shown with the 3-plane split face finish

No Pinning Needed in Overlapping Unit

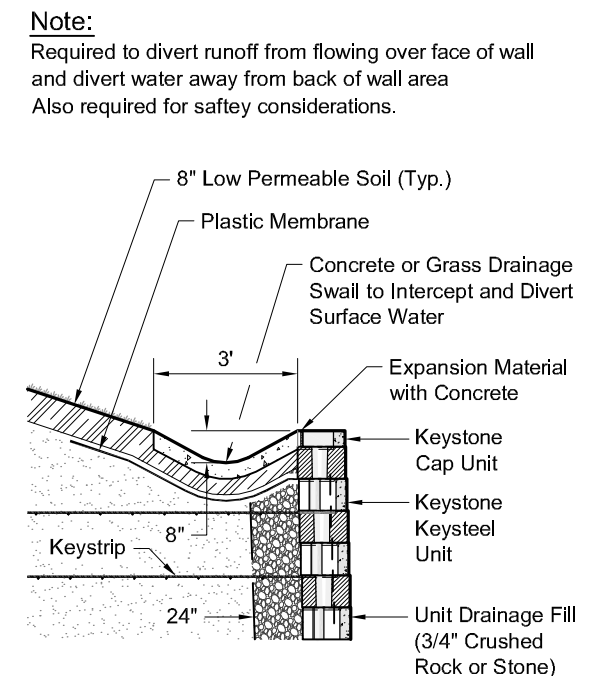


Second Course



Keystrip Installation on Corners and Curves

Note:
1. Corner units recommended for outside corners. Availability May Vary.



Drainage Swale Section Detail

Note:
Required to divert runoff from flowing over face of wall and divert water away from back of wall area Also required for safety considerations.

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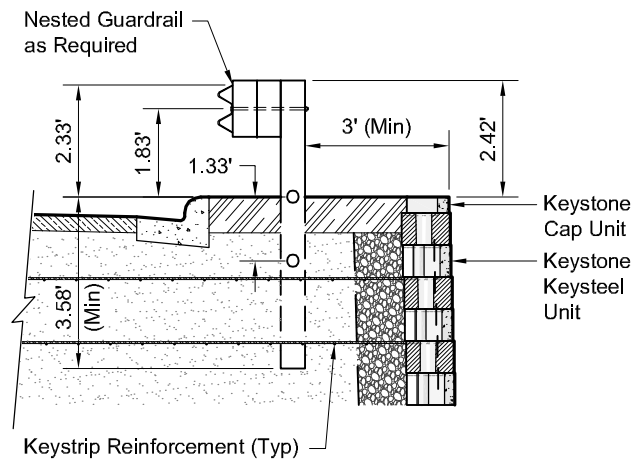
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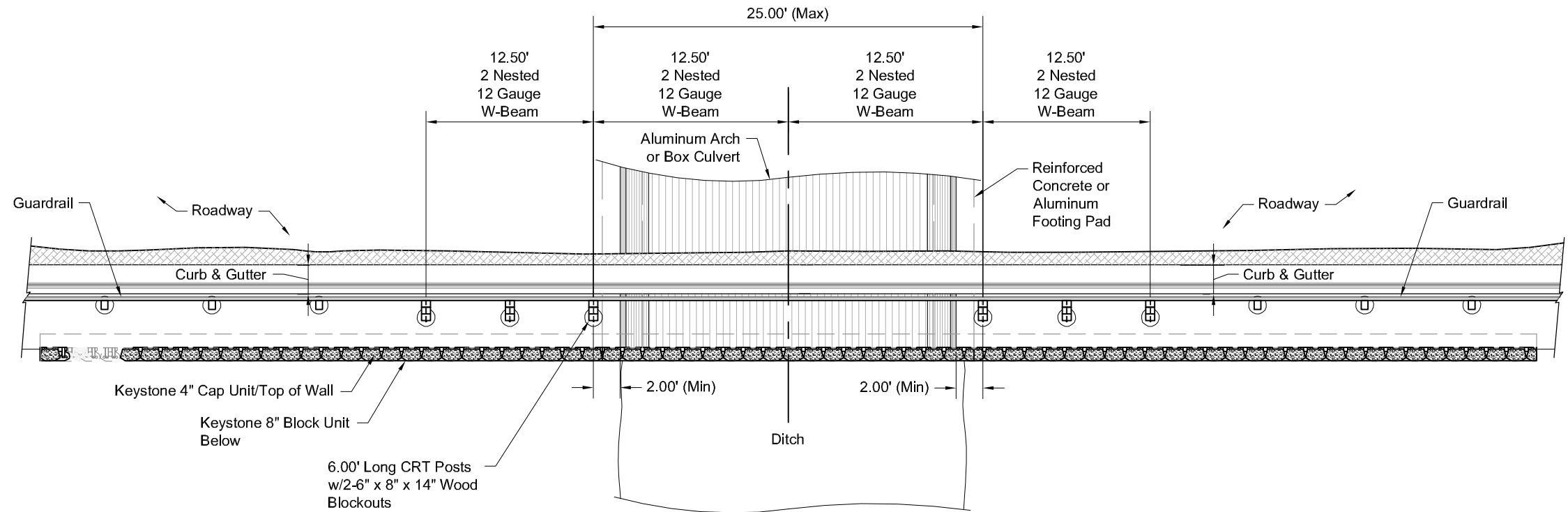
No.	Date	Revision	By



Designed By: RKM	Title: Keystone Wall Keysteel Unit Details	Date: 02/2011
Checked By: JMF	Client: Contech Construction Products Inc.	Project No:
Scale: No Scale		Drawing No: 4



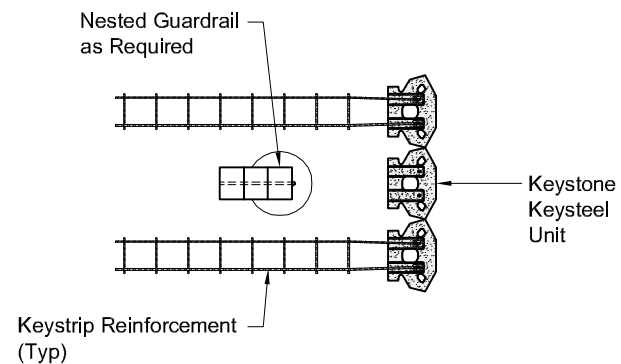
Section View



Plan View

Long Span Guardrail System for Aluminum Box Culverts

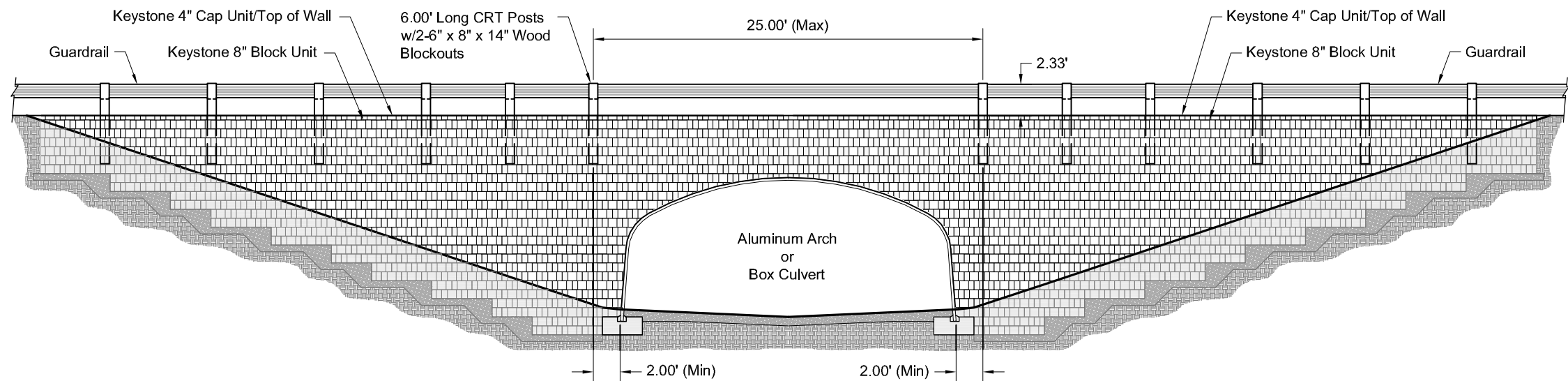
Keysteel Unit - Near Vertical Setback Shown



Plan View

Long Span Guardrail System for Aluminum Box Culverts

Keysteel Unit - Near Vertical Setback Shown



Elevation View

Long Span Guardrail System for Aluminum Box Culverts

Keysteel Unit - Near Vertical Setback Shown

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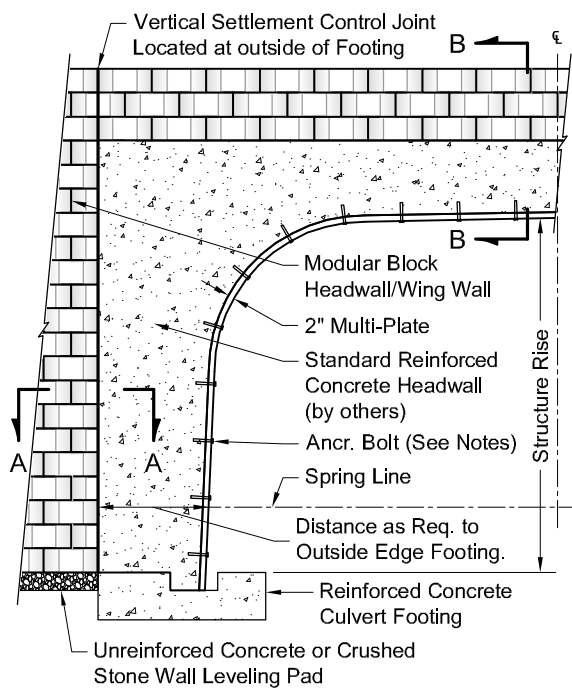
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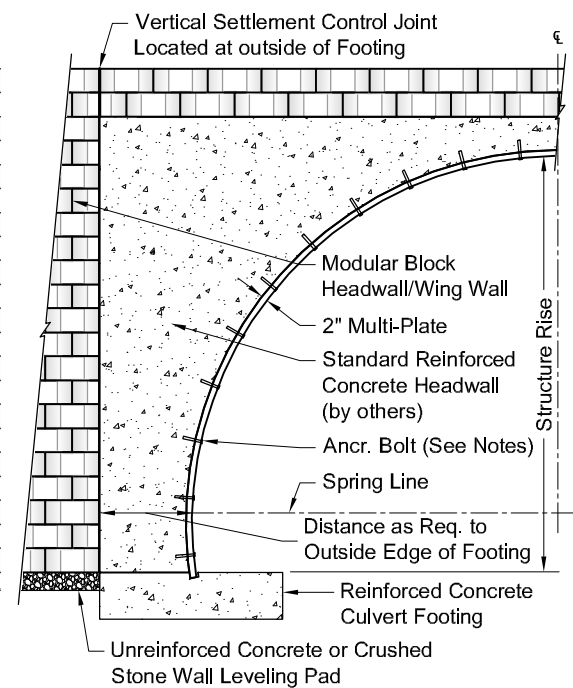
Designed By: RKM	Title: Keystone Wall Guardrail Details	Date: 02/2011
Checked By: JMF	Client: Contech Construction Products Inc.	Project No:
Scale: No Scale		Drawing No: 5

CAST IN PLACE HEADWALL DETAILS FOR CULVERTS AT AN ANGLE TO KEYSTONE WALL

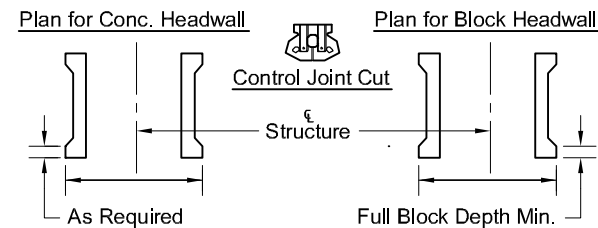
KEYSTONE HEADWALL OPTION FOR CULVERTS PERPENDICULAR TO KEYSTONE WALL



**Aluminum Box Culvert
Modular Block/Conc. Headwall Detail**
No Scale



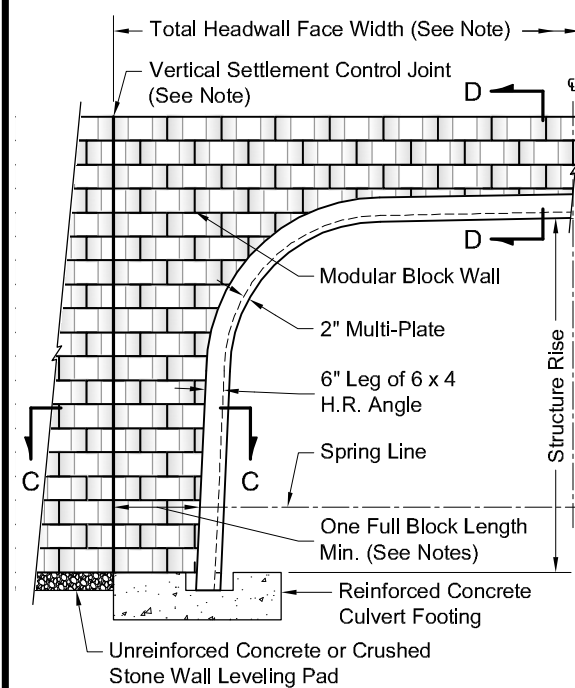
**Aluminum Structural Plate
Modular Block/Conc. Headwall Detail**
No Scale



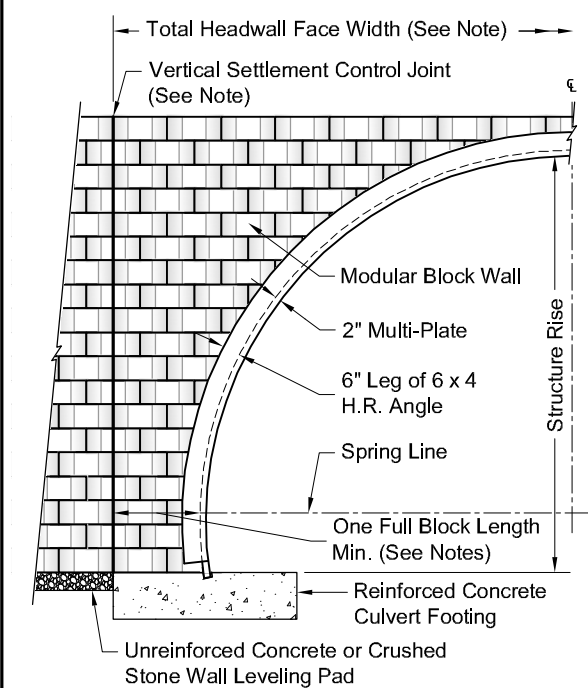
Footing Notes:
As designed by the Engineer. The reinforced concrete footings may be widened at the ends of the structure to:
-Achieve an adequate headwall width.
-Maintain settlement joint at footing/leveling pad intersection
-Combine the above with a wingwall/leveling pad intersection as required.
Note: out to out of footing is a critical dimension, see plan view. Modular block wingwalls may start at the outer edge of an arch footing. Adjacent modular block wing or other walls must be separated by a vertical settlement joint as required. For structural plates with inverts, a modular block headwall must be integrated with the cutoff wall design so that the headwall and structure end are a unit.

Vertical Settlement Notes:
Place settlement joint one full block length min. from structure extending to outside edge of footing. Place 1/2" black insulation board joint filler backed with geotextile at the transition from the footing to the leveling pad.

Headwall Notes:
Total width of modular block headwall face must be a full increment of the modular block laying length. For concrete headwalls place 3/4" x 6" anchor bolts as required with 19"± as the maximum spacing

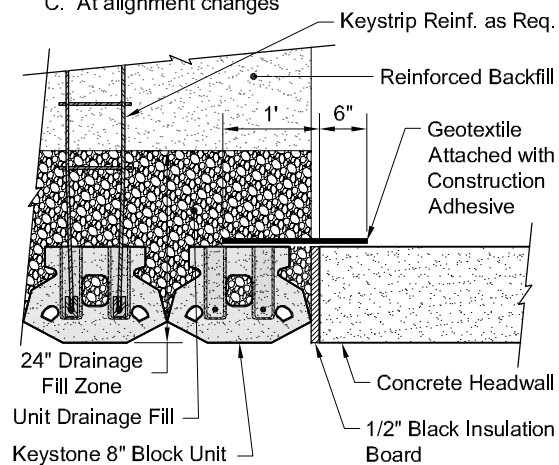


**Aluminum Box Culvert
Modular Block Headwall Detail**
No Scale



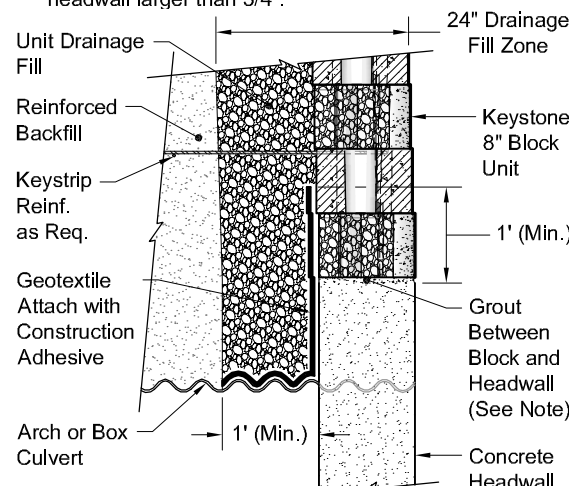
**Aluminum Structural Plate
Modular Block Headwall Detail**
No Scale

Note:
1. Total width of headwall face must be in full or half width unit increments.
2. Vertical settlement joints required at transition:
A. Between footings
B. Between wall types
C. At alignment changes



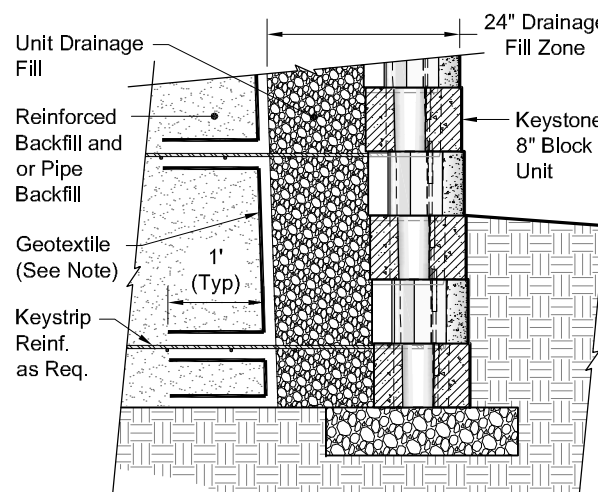
**Section A-A
Modular Block/Concrete Headwall
Vertical Settlement Joint Plan**
No Scale

Note:
1. Total width of headwall face must be in full or half width unit increments.
2. Grout using non-shrink type grout conforming to ASTM C1107. Trim blocks to leave no gap with headwall larger than 3/4".



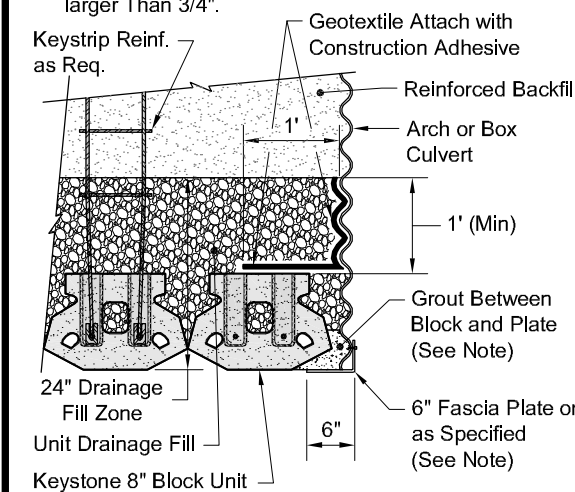
**Section B-B
Modular Block/Concrete Headwall
Horizontal Connection Joint Section**
No Scale

Note:
1. Drainage aggregate fill in the pipe zone is 3/8" to 3/4" crushed stone.
2. Geotextile must be selected so it is not blinded by the pipe backfill material.



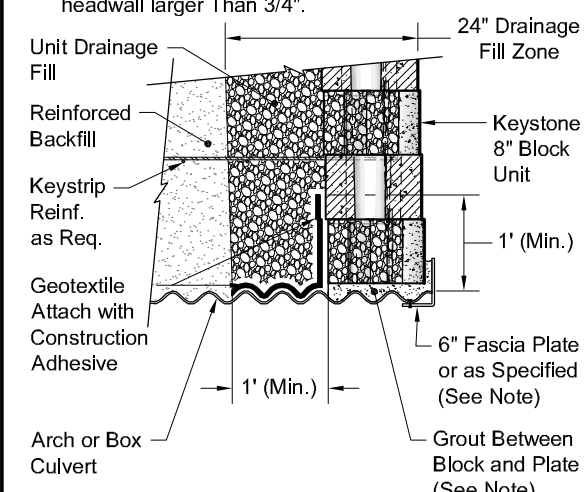
**Section C-C
Modular Block Headwall
Pipe Zone Separation Detail**
No Scale

Note:
1. FacsiFascia Plate Shown is 6"x4"x5/16" Hot Rolled Steel Angle (Galvanized Finish) or as Specified.
2. Grout using non-shrink type grout conforming to ASTM C1107. Trim blocks to leave no gap with Plate larger Than 3/4".



**Section C-C
Modular Block/Aluminum Arch or Box
Culvert Vertical Connection Joint Plan**
No Scale

Note:
1. Total width of headwall face must be in full or half width unit increments.
2. Grout using non-shrink type grout conforming to ASTM C1107. Trim blocks to leave no gap with headwall larger Than 3/4".



**Section D-D
Modular Block/Aluminum Arch or Box
Culvert Horiz. Connection Joint Section**
No Scale

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Designed By: RKM	Title: Culvert Details	Date: 02/2011
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1.0 MATERIAL SPECIFICATIONS for KEYSTEEL RETAINING WALL SYSTEM

1.1 DESCRIPTION

This work consists of furnishing and installing mechanically stabilized earth walls and abutments in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established by the Engineer.

1.2 WORKING DRAWINGS

The Contractor shall not start work on any system for which drawings are required until such drawings have been approved by the Engineer. Approval of the Contractor's working drawings shall not relieve the Contractor of any of his responsibility under the contract for the successful completion of the work.

1.2.1 Field Verification - The contractor shall verify existing ground elevations for each location involving construction wholly or partially in original ground.

1.3 MATERIALS

1.3.1 Cast-in-Place Concrete - Concrete used in the leveling pad shall conform to the requirements of AASHTO Section 8, "Concrete Structures" for class B concrete. All other Cast-in-Place concrete shall conform to AASHTO, Section 8, Class A unless otherwise indicated on the drawings.

1.3.2 Concrete Facing Units - The concrete facing units shall be manufactured and tested in accordance with ASTM C 1372.

1.3.2.1 Physical Properties - Concrete units shall have a minimum 28 day compressive strength of 4,000 psi (28 mPa). The concrete shall have a maximum moisture absorption of 5%.

1.3.2.2 Add Mixtures and Color - Add mixtures, i.e., color, silica, air entraining, reducers, etc., shall be previously established as suitable and shall conform to the applicable ASTM Specifications, or shall be demonstrated to be suitable to the concrete units.

1.3.2.3 Finish and Appearance - Units shall be free of defects that indicate imperfect molding, concrete weakening or lessened durability. The units shall be free of chips and cracks when viewed from a distance of 10 feet under diffused lighting.

1.3.2.4 Face Finish - Unless otherwise indicated on the plans or elsewhere in the specifications, the concrete surface for the front face shall have a tri-planer split rock face finish

1.3.2.5 Marking - The date of manufacture and the production lot number shall be clearly scribed on a tag affixed to each pallet of units shipped.

1.3.2.6 Handling, Storage and Shipment - The units shall be fully supported until the concrete reaches a minimum compressive strength of 1,000 psi (7 mPa). The units may be shipped after reaching a minimum compressive strength of 3,000 psi (21 mPa). All units shall be handled, stored and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses.

1.3.2.7 Unit Dimensions - Dimensions variances shall be in accordance with ASTM C 1372. Adjustments shall be made for the specified patterns on the facing surface.

1.3.2.8 Testing, Inspection, and Acceptance - Acceptance of concrete units with respect to compressive strength and absorption will be determined on the basis of ASTM Method C 1372. Full units may be used in place of coupons.

1.3.2.9 Acceptance - If any of the tests indicates non compliance then the Engineer will perform a second testing of the same lot. The results of the second test will determine the acceptability of the lot. Units shall be rejected because of failure to meet any of the requirements specified above. Minor cracks and chips incidental to the usual method of manufacture and shipments are not grounds for rejection.

1.3.3 Soil Reinforcing and Attachment Devices - All reinforcing and attachment devices shall be carefully inspected to insure they are true to size and free of defects that may impair their strength and durability.

1.3.3.1 Reinforcing Strips - Reinforcing strips shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of ASTM A 82 and shall be welded into the finished fabric strips in accordance with ASTM A 185. Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of ASTM A 123 (AASHTO M-111).

1.3.3.2 Connector Pins - Connector pins shall be 9/16" (14.3mm) in diameter and be fabricated from A 82 steel. Galvanization shall conform to ASTM A 123 (AASHTO M-111)

1.3.3.3 Alignment Pins - Alignment pins shall be 1/2" (12.7mm) in diameter and fabricated from pultruded fiberglass. Alignment pins may also be fabricated from ASTM A36 or A82 steel and galvanized in conformance with ASTM A 123 (AASHTO M-111) when specified on the construction drawings.

1.3.4 Crushed Stone Pad - A crushed stone leveling pad, when required on the construction drawings, shall consist of crushed stone material meeting the requirements of aggregate for subbase and base shown on the roadway plans.

1.3.5 Unit Drainage Fill - The unit drainage fill material in and for a nominal distance of 1 ft (300 mm) directly behind the facing units or as indicated on the construction drawings shall consist of a crushed stone material complying to the following gradation:

Sieve Size	Percent Passing
1 inch (25 mm)	100
3/4 inch (19 mm)	100-75
No. 4 (4.74 mm)	0-10
No. 50 (300 um)	0-5

In addition the unit drainage fill shall comply with the electrochemical properties in Section 1.3.6 of this specification.

1.3.6 Structure Backfill Material - The reinforced Structure Backfill material for mechanically stabilized earth walls shall conform to the following grading, internal friction angle, and soundness requirements. Structure Backfill material behind the Unit Drainage fill shall be reasonably free from organic or otherwise deleterious materials and shall conform to the following gradation limits as determined by AASHTO T-27 and be obtained from natural sources.

Sieve Size	Percent Passing
4 inch (100 mm)	100
No. 40 (425 um)	0 - 60
No. 200 (75 um)	0 - 15*

*The plasticity index (P.I.) as determined by AASHTO T-90 shall not exceed 6.

The material shall exhibit an effective angle of internal friction of not less than 34 degrees, as determined by the standard Direct Shear Test, AASHTO T-236 (ASTM D3080), on the portion finer than the #10 (2 mm) sieve, utilizing a sample of material compacted to 95 percent of AASHTO T-99, Methods C or D (with oversized correction as outlined in Note 7) at optimum moisture content. No testing is required for Structure Backfill material where 80% of sizes are greater than 3/4 inch (19 mm).

The materials shall be substantially free of shale or other soft, poor durability particles. The material shall have a magnesium sulfate soundness loss of less than 30 percent after four cycles or sodium sulfate soundness loss of less than 15% after five cycles as determined by AASHTO T-104.

Electrochemical Requirements	Test Methods
Resistivity > 3,000 ohm centimeters	AASHTO T288-91
pH 5 - 10	AASHTO T289-91
Chlorides < 100 parts per million	AASHTO T291-91
Sulfates < 200 parts per million	AASHTO T290-91

1.3.7 Acceptance of Material - The contractor shall furnish the Engineer a Certificate of Compliance certifying the above materials comply with the applicable contract specifications. A copy of all test results performed by the manufacturer necessary to assure contract compliance shall be furnished to the Engineer.

1.3.8 When required, drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D3034 or corrugated HDPE pipe manufactured in accordance with AASHTO M 252, unless otherwise specified.

1.3.9 When required, geotextile filter fabric shall be a 4.0 oz/sy, polypropylene, needlepunched nonwoven fabric, unless otherwise specified.

2.0 EXECUTION FOR KEYSTEEL RETAINING WALL SYSTEM

2.1 WALL EXCAVATION - Unclassified excavation shall be in accordance with the requirements of AASHTO Section 1 for Structure Excavation and Backfill and in reasonably close conformity to the limits and construction stages shown on the plans.

2.2 FOUNDATION PREPARATION - The foundation for the structure shall be graded level for a width equal to the overall length of reinforcement elements plus 1.0 ft (300 mm) or as shown on the plans. Prior to wall construction, except where constructed on rock, the foundation shall be compacted with a smooth wheel vibratory roller. Any foundation soils found to be unsuitable shall be removed and replaced with Structure Backfill per 1.3.6 Structure Backfill Material of these specifications.

At each unit foundation level, a leveling pad of the type shown on the plans shall be provided. Concrete leveling pads shall be cured a minimum of 12 hours before placement of wall units.

2.3 MODULAR UNIT AND SOIL REINFORCEMENT ERECTION - Concrete facing units shall be placed so that their final position is vertical or battered as shown on the plans.

The first course of concrete wall units shall be placed on the leveling pad and checked for elevation and alignment. They shall also be checked for full contact with the leveling pad. Install the connecting pins at the reinforcement locations and the alignment pins at all other locations. Fill all voids with Unit Drainage Fill and tamp. Place the Unit Drainage Fill and Structural Backfill material behind this course and compact. Be sure that each course is completely filled, backfilled and compacted before placing the reinforcement or proceeding to the next course. Clean all excess material from the top of units and install the next course. Ensure that connecting and alignment pins protrude into the adjoining courses. Move each unit forward, toward the exposed wall face, until it is restrained by the pins in the previous course. Repeat this procedure to the extent of the wall height.

As Structure Backfill material is placed behind the wall units, the units shall be maintained in position by means of the alignment pin. Wall facing vertical tolerances and horizontal alignment shall not exceed 3/4 in (19 mm) when measured with a 10 ft (3 m) straight edge. During construction, the maximum allowable offset in any unit joint shall be 3/4 in (19 mm). The overall vertical tolerance of the wall (top to bottom) shall not exceed 3/4 in 10 ft (19 mm/3 m) of wall height.

KeyStrip reinforcement elements of the proper wire size and length shall be placed at the locations shown on the construction drawings. The KeyStrip reinforcement shall be connected to the wall units by placing the KeyStrip connectors over the steel pins and placing the reinforcement normal to the face of the wall unless otherwise shown. Prior to placement of the reinforcing elements, Structure Backfill shall be compacted in accordance with these specifications. All soil reinforcements shall be tensioned to remove any slack in the connection.

Where cap units are the finished top of wall, apply KeyStone KapSeal to the top surface of the adjoining lower units just before placing the cap unit. Insure that all contact surfaces are dry and free from debris prior to applying adhesive.

Constant monitoring of the wall alignment during construction determines the adequacy of the construction techniques and the need for addition alignment procedures.

2.4 UNIT FILL PLACEMENT - (see section 2.5 STRUCTURE FILL PLACEMENT)

2.5 STRUCTURE FILL PLACEMENT -Unit Drainage and Structure Fill placement shall closely follow erection of each course of units. The field engineer may accept the placement of the units from one reinforcement layer to the next before placement of the fill. In this case, the contractor shall demonstrate to the field engineer's satisfaction the ability of the Unit Drainage Fill to fill the voids using this procedure. Structure Backfill shall be placed in such a manner as to avoid any damage or disturbance of the wall materials or misalignment of the facing units or reinforcing elements. At each reinforcement level, the Structure Backfill shall be placed slightly higher than level of the connection (+ 0.1 ft (30 mm)) before installing the soil reinforcement.

Structure Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T-99 or 92 percent of AASHTO T-180 maximum density. Follow Method C or D of the corresponding test (with oversized corrections as outlined in Note 7). For Structure Backfill containing more than 30 percent retained on the 3/4-inch (19 mm) sieve, a method of compaction consisting of at least 4 passes by a heavy roller shall be used. For applications where spread footings are used to support bridge or other structural loads, the top 5.0 ft (1.5 m) below the footing elevation should be compacted to 100 percent maximum density per AASHTO T-99.

The moisture content of the Structure Backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Structure Backfill material shall have a placement moisture content no less than 3% below or equal to the optimum content. Structure Backfill with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift.

The maximum lift thickness after compaction shall not exceed 8 inches (200 mm). The contractor shall decrease this lift thickness, if necessary, to obtain the specified density. Compaction within 3 ft (1m) of the back face of the wall shall be achieved by at least three passes of a lightweight mechanical tamper, roller or vibratory system.

At the end of each day's operation, the contractor shall slope the last level of backfill away from the wall facing to rapidly direct runoff away from the wall face. In addition, the contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

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Design is for internal stability of the KEYSTONE wall structure only. External stability, including but not limited to foundation and slope stability is the responsibility of the Owner. The design is based on the assumption that the materials within the retained mass, methods of construction, and quality of materials conform to KEYSTONE's specification for this project.

This drawing is being furnished for this specific project only. Any party accepting this document does so in confidence and agrees that it shall not be duplicated in whole or in part, nor disclosed to others without the consent of Keystone Retaining Wall Systems, Inc.

No.	Date	Revision	By



Designed By: RKM	Title: Keystone Installation Notes and Specifications	Date: 02/2011
Checked By: JMF	Client: Contech Construction Products Inc.	Project No:
Scale: No Scale		Drawing No: 7