Guidelines for the Engineer and Designer

FRP Grating, Handrail, Ladders & Structural Shapes

Corrosion Resistant

Fire Retardant

Low Maintenance

Long Service Life

Fibergrate
Composite Structures

High Performance Composite Solutions

1.0 GENERAL

1.1 The purpose of this guideline is to assist the engineer/designer in designing FRP (Fiber - Reinforced Plastic) pedestrian walkways utilizing molded and pultruded gratings, handrail systems, ladder systems, and structural members. The guideline includes recommended sizes and configurations, recommended design criteria, and referenced standards, where applicable.

1.2 Drawing details of the FRP systems described in this guideline are also available in electronic form (AutoCAD V14) on diskette.

2.0 FRP GRATINGS AS PEDESTRIAN WALKWAYS

2.1 Gratings

2.1.1 Fibergrate Composite Structures, Inc. FRP gratings are manufactured by open molding or pultrusion processes. Molded gratings are available in a variety of stock panel sizes (i.e. 3' x 10', 4' x 8', 5' x 10', and 4' x 12' for 1-1/2" deep, 1-1/2" square mesh gratings). The designer should consider these sizes at the early stages of structure layout to efficiently utilize the material and minimize installation costs.

Molded gratings are available in a variety of resin systems and colors to meet specific project requirements. Detailed descriptions of the resin systems available are included in the Fibergrate Molded Product brochures.

RIGIDEX® Moltruded® gratings are manufactured with the molding process but have improved stiffness characteristics similar to pultruded gratings. RIGIDEX Moltruded grating is available in one general purpose resin system and several configurations and panel sizes. See the *RIGIDEX® Moltruded® Grating* brochure for detailed information.

Pultruded gratings are available in two resin systems and two colors. Detailed descriptions of these are given in the *Safe-T-Span® Fiberglass Pultruded Grating* brochure.

2.2 Minimum Grating Design Criteria

PEDESTRIAN LOADS*	
Uniform Live Load	50 lb/ft^2 - 65 lb/ft^2
Concentrated Load	250 lb
Dead Load	3.75 lb/ft^2
Maximum Deflection	SPAN L/120 or 3/8" (whichever is less)

* Note that these design criteria are minimums, but exceed general building code requirements for office space. Other criteria are commonly used in specifications. For pedestrian walkways in industrial applications, the above are sufficient and are recommended to prevent excessive cost.

2.3 Application Notes: Molded FRP Gratings

2.3.1 Molded grating spans should be kept to 36" or 48" from center to center of supporting members to most efficiently utilize grating panels. Typically, 1" deep molded gratings have acceptable deflections at spans up to 3'-0". 1-1/2" deep molded gratings are acceptable for spans from 3'-0" to 3'-6", and 2" deep molded gratings are acceptable for spans from 4'-0" to 4'-6".

2.3.2 Grating panels installed over multiple spans will further reduce deflections. The deflection of the grating can be determined using standard AISC beam formulas and grating properties provided in the Fibergrate Molded Product brochures.

2.3.3 Molded gratings may be cantilevered as required to a maximum distance of 6" (for 1" deep gratings) and up to 12" (for 2"deep gratings) from the centerline of the last supporting member. Gratings used in this way must be held down to a minimum of two supports and have a minimum of three hold downs clips at each interior support to prevent overturning of the grating panel.

2.3.4 Hold Down Clips: Gratings must be mechanically fastened in place to prevent sliding. Each grating panel should be fastened to each supporting structure using a minimum of four "M" style hold down clips. For larger panels, 6 to 8 hold down clips are recommended. Gratings installed in trenches where they are captive in an embedment angle do not require hold down clips unless bearing surfaces are uneven and the grating panels would tend to rock.

2.3.5 Covered Gratings: Due to the nature of the manufacturing process, covered gratings are often slightly warped. As a result of this, covered gratings will rock and pose a trip hazard if they are not secured with the appropriate hold down clips. It is Fibergrate policy to recommend hold down clips for all covered grating applications. In fact, Fibergrate includes “W” type hold down clips with each covered grating stock panel order.

2.3.6 Abutting edges of molded grating panels should be supported by structural members or fastened together using “F” style clips at a maximum spacing of 24” on center. This will prevent differential deflection when one of the abutting gratings is loaded.

2.3.7 Due to the bi-directional nature of square mesh molded gratings, unsupported holes of limited size may be cut into the edges or interior of the panels without the use of additional supports. This is very useful for applications which involve pipe penetrations. As a rule of thumb, as long as no more than 1/3 of the individual grating panel width is removed by such a hole, no additional support will be required.

2.3.8 Edge Banding: Unlike steel and aluminum gratings it is not necessary to edge band molded gratings for structural reasons. As FRP cannot be welded, edge banding will not transmit load to the grating. Fibergrate only recommends edge banding where personnel may be passing through the grating to prevent injury from stub bars.

2.3.9 Molded Grating Details: The attached drawings (A and B) give details of the “M” style hold down clip and the “F” style abutment clip.

2.4 Application Notes: Pultruded and Rigidex® Gratings

2.4.1 Since pultruded and Rigidex® gratings are available in large panel sizes, the support spacing is not as critical to the utilization of the panels. Typically, it is most economical to design these installations based on maximum allowable span. Due to the wide range of span capabilities of these gratings, it is recommended that the designer refer to the appropriate design tables for determining support member spacing.

Two types of hold down clips are available for pultruded gratings. The “M” style clip is configured in the same way as the similar clip for molded gratings. The “RI” type clip is a plate-style clip which grips the lower flange of the load bars. Typically, the clip type specified is based on customer preferences or application requirements. Rigidex® gratings also utilize an “M” style hold down clip.

2.4.2 As with molded gratings, pultruded gratings may also be used on multiple spans to reduce deflections. AISC beam formulas and grating design procedures apply.

2.4.3 The use of cantilever conditions for pultruded and Rigidex® gratings is typically not recommended. Due to the uni-directional span capability of these panels, cantilevers of the tie bars are dangerous and could lead to failure. For cantilevers of the load bars, it is possible to apply load to only a few of the load bars, potentially overloading the panel locally. Gratings used in this way must be held down to a minimum of two supports and have a minimum of three hold downs clips at each interior support to prevent overturning of the grating panel.

2.4.4 Abutting edges of pultruded and Rigidex® do not normally require additional support or abutment clips. Due to the high rigidity of these gratings, the differential deflection produced by locally applied loads are minimal.

2.4.5 Openings in pultruded and Rigidex® gratings must have additional support. In cutting the opening, the load bars are made discontinuous and unable to support load. Support attached to the bottom of the grating which ‘bridge’ the opening back to continuous load bars is commonly used.

2.4.6 Like molded gratings, edge banding is not required for pultruded gratings. Due to the construction of this type of grating it is very difficult to install banding.

2.4.7 Pultruded Grating Details: The attached drawings (G and H) give details of the “RI” and “M” style hold down clip.

3.0 DYNARAIL® FRP HANDRAIL SYSTEM

3.1 Handrail Arrangement & Dimensions

3.1.1 The Fibergrate Composite Structures' Dynarail® handrail system consists of a 2-1/8" x 3/16" thick square tube post with two 1-3/4" x 1/8" thick square tube rails. The midrail passes through the post at a routed square hole and is riveted and bonded in place. The top rail is fitted into a u-shaped routed slot in the top of the post and is riveted and bonded in place. The system includes a 4" FRP toe-plate mounted at each post using a self-tapping screw. The height of the top rail is 42" above the walking surface. Handrail is available in vinyl ester and polyester fire-retardant resin formulations in a safety yellow color.

3.2 Design Criteria

3.2.1 This handrail system is designed to meet the loading requirements of OSHA 1910.23, a 200 lb force applied to the top rail in any direction at any point. The system also meets the other design criteria of this standard. In addition to OSHA, this system also meets the structural guidelines of UBC, SBC, and BOCA.

3.3 UV Protective Coatings

3.3.1 For applications where the handrail is to be used outdoors, a polyurethane based UV protective coating of 1 mil thickness is recommended to preserve the long-term appearance of the handrail.

3.4 Layout Guidelines

3.4.1 The following guidelines should be used in handrail layout to most economically utilize this system and to maximize performance.

3.4.2 Posting Spacing: Post spacing for this system must not exceed 6'-0" to meet the OSHA loading requirements.

3.4.3 Inside or Outside Corners: Posts cannot be placed at corners. At interior or exterior corners, two posts should be placed within 12" of the corner, on both sides.

3.4.4 Post Location With Respect to Structure: For side-mounted posts attaching to fiberglass structures, the post should be placed within 6” of an element which torsionally fixes the element to which the post is attached. This will prevent excessive rotation of the structural element when the posts are under load.

3.4.5 Number of Posts Per Section: A minimum of two posts per straight handrail section are recommended to improve durability in shipping and erection.

3.5 Handrail System Details

3.5.1 Refer to the attached drawings for details of handrail system assembly, splicing, and post base mountings.

4.0 DYNARAIL® FRP LADDER SYSTEM

4.1 Ladder Arrangement & Dimensions

4.1.1 The Fibergrate Composite Structures Dynarail® ladder system consists of 1-3/4” x 1/4” thick square tube rails and 1-1/4” diameter x 1/4” thick fluted rungs. There is a clear horizontal distance of 18” between the inside of the rails and a center to center distance between rungs of 12”. Ladders are available in vinyl ester and polyester fire-retardant resin formulations in a safety yellow color. The designer is referred to the brochure *Dynarail® Fiberglass Safety Ladders* for further description of this system.

4.2 Loading Requirements

4.2.1 This ladder system is designed to meet the loading requirements of OSHA 1910.27, “Fixed Ladders.” The ladders are designed to meet the OSHA minimum live load requirement of a 200 lb concentrated load at the mid-point of the rung with a safety factor of 4.0.

4.3 Support Requirements

4.3.1 Ladders will require support back to a wall or solid structure at intervals not to exceed 6'-0". Exceeding this spacing will result in a ladder installation that is too flexible for comfort or safety. Ladders are required to be base supported to structure or back to a wall or solid structure. All ladders are to include a minimum of one base support. The standard ladder wall mount bracket is not capable of supporting a vertical load. Ladders that cannot be base supported should include one pair of bottom wall brackets engineered to support design loads.

4.4 Cages and Rest Platforms

4.4.1 The designer is referred to OSHA 1910.27, "Fixed Ladders" for ladders requiring cages and rest platforms. These units are available in FRP as part of the ladder system. Generally, cages are required for ladders of more than 20' in length to a maximum unbroken length of 30'. Ladders with a length of more than 20' will require a cage and an intermediate rest platform at 30' and for every 30' thereafter. Cages are required to start at a minimum of 7' and a maximum of 8' above the platform. They are required to extend 42" above the landing at the top of the ladder.

4.5 Ladder System Details

4.5.1 Refer to the attached drawings for ladder system splicing, and mounting details.

5.0 DYNAFORM® FRP STRUCTURAL MEMBERS

5.1 Availability

5.1.1 Dynaform® structural shapes are available in FRP in the common structural shapes: angle, channel, square and round tubes, I-sections and W-sections. These are available in fire retardant vinyl ester (beige), fire retardant polyester (slate gray) and non-fire retardant polyester (green).

5.2 Design Criteria

5.2.1 The following design criteria are recommended for use in FRP structural members used as beams for supporting live loads plus the dead load of the FRP structure. Higher safety factors and deflection ratios may be needed for other conditions.

FRP STRUCTURAL SHAPES*	
Maximum Deflection	L/180
Allowable Bending Stress	*10,000 psi (F.S. = 3)
Allowable Shear Stress	1,500 psi (F.S. = 3)
Allowable Bearing Stress	10,000 psi (F.S. = 3)

*Assumes adequate lateral bracing of compression flange, see 5.6 and a b/t [12 (flange with-to-flange thickness ration). Using a column failure analogy, we refer you to the *Dynaform® Fiberglass Structural Shapes Design Guide*.

5.3 Preferred Sizes

5.3.1 The table below gives a list of preferred sizes for FRP structural members. These sizes are available from stock without the added cost and delay of a mill run. Members are stocked in 20'-0" lengths.

FRP STRUCTURAL SHAPES	
SHAPE NAME	**SHAPE SIZE**
EQUAL LEG ANGLES	2" x 1/4", 3" x 1/4", 3" x 3/8", 4" x 1/2", 6" x 1/2"
CHANNELS	6" x1-5/8" x 1/4", 8" x 2-3/16" x 3/8", 10" x 2-3/4"x 1/2"
I - SECTIONS	4" x 2" x 1/4", 8" x 4"x 1/8"
WIDE FLANGE SECTIONS	4" x 4" x 1/4", 6" x 6" x 1/4", 6" x 6" x 3/8", 8" x 8" x 3/8"

5.4 Beam and Column Selection Tables

5.4.1 The *Dynaform® Fiberglass Structural Shapes Design Guide* provides tables for selecting the common sizes of FRP structural members used as columns and beams. Note that these tables are based on adequate lateral support of the compression flange of bending members (see Section 5.6, Lateral Support Requirements). The Design Guide also provides information on corrosion resistance, section dimensions and properties, mechanical and physical properties, and thermal effects.

5.5 Availability of Other Shapes and Mill Run Quantities

5.5.1 Non-stock shapes can be obtained in mill run quantities. Consult Customer Service for availability. These members may be used economically if they are ordered in these quantities.

5.6 Lateral Support Requirements

5.6.1 The table below gives the maximum lateral support spacing required to produce the full bending capacity of these members.

LATERAL SUPPORT REQUIREMENTS - FRP STRUCTURAL SHAPES			
MEMBER	LATERAL SUPPORT SPACING	MEMBER	LATERAL SUPPORT SPACING
C6” x 1/4”	48”	W4” x 1/4”	60”
C8 x 3/8”	60”	W6 x 1/4”	84”
C10” x 1/2”	60”	W6” x 3/8”	96”
I4” x 1/4”	24”	W8” x 3/8”	108”
I6” x 1/4”	36”	W10” x 3/8”	156”
I8” x 3/8”	48”	W12” x 1/2”	168”
I10” x 3/8”	60”		
I12” x 1/2”	84”		

5.7 Connection Details

5.7.1 The attached drawings include example connection details for use with fiberglass structural shapes used as beams and columns. Note that these details are examples only and that Fibergrate Composite Structures will perform the detailed design needed to meet the loading requirements. Fibergrate Composite Structures can provide standard connection details designed to exceed the ultimate capacity of all standard FRP beams available.

5.72 The following tables outline allowables and requirements that should be considered when designing and detailing connections.

STRUCTURAL CONNECTIONS

BEARING ON FRP

Bolt Allowable for Given FRP Plate Thickness (1)

MATERIAL THICKNESS	BOLT DIAMETER 3/8”	1/2”	5/8”	3/4”	1”
1/8”	469	625	781	938	1250
1/4”	938	1250	1563	1875	2500
3/8”	1406	1875	2344	2813	3750
1/2”	1875	2500	3125	3750	5000
3/4”	2813	3750	4688	5625	7500
1”	3750	5000	6250	7500	10000

(1) BEARING on FRP plate or web controls (Factor of Safety = 3.0; Fp=10,000 psi)
The designer must confirm that no other component of connection controls.

BOLT SHEAR

Bolt Allowable for Given Bolt Diameter (2)

BOLT TYPE & APPLICATION	BOLT DIAMETER 3/8”	1/2”	5/8”	3/4”	1”
316SS- single shear (3)	1408	2503	3912	5633	10014
316SS- double shear	2816	5007	7823	11265	20027
FRP threaded rod (4) single shear	300	600	900	1000	2050
FRP threaded rod - double shear	600	1200	1800	2000	4100

(2) The designer must confirm that no other component of connection controls.
*(3) SHEAR of bolt controls. Fv=0.17*FU = 0.17*75,000 psi = 12,750 psi*
(4) SHEAR of FRP threaded rod controls (Factor of Safety = 4.0).
Ultimate values from Dynaform® Fiberglass Structural Shapes Design Guide

RATIO OF EDGE DISTANCE TO FASTENER DIAMETER

	RANGE	RECOMMENDED
Edge Distance - cl* bolt to END	2.0-4.0	3.0
Edge Distance - cl* bolt to SIDE	1.5-3.5	2.5
Bolt Pitch - cl* to cl*	4.0-5.0	5.0

** - “cl” is centerline*

6.0 FRP STAIR SYSTEMS

6.1 Stair System Components

6.1.1 FRP structural shapes and special FRP gratings can be used in combination to create FRP stairs. The stair treads are typically made using a 1-1/2" deep, 1-1/2" x 6" mesh molded Fibertred® grating panels with an integral reinforced, gritted nosing. These stair treads are available in the same resin systems and colors as molded grating. Fibertred® panels are manufactured in a 22-1/2" wide x 120" long panel with solid nosings along both 120" sides. These panels can be best utilized if stair tread widths are kept to 24", 30" 36" or 42" with depths of 11-1/4" or less. Pultruded grating stair treads are also available in the Safe-T-Span® product line. These are manufactured using standard pultruded gratings with a stiffened nosing. The nosing bars are painted a contrasting color.

6.2 Design Criteria

6.2.1 The designer is referred to OSHA 1910.24, "Fixed Industrial Stairs" for guidelines in the design of stair systems in general. The stair should be designed for a moving live load of 1,000 lb (500 lb/stair stringer).

6.3 Tread Deflections

6.3.1 Tread deflections are typically limited to L/150 or less. The table below gives the load-deflection performance of Fibertred® for spans up to 42". Spans greater than 42" will require a stiffened nosing or intermediate support to reduce deflections. The deflections are based on 250 lb and 500 lb point loads over a 4" wide x 6" deep at the nosing to stimulate the landing of a foot.

LOAD / DEFLECTION TABLE: 1-1/2" DEEP FIBERTRED®					
	SPAN (IN)				
LOAD (LB)	18	24	30	36	42
250	0.03"	0.05"	0.09"	0.16"	0.25"
500	0.06"	0.10"	0.19"	0.32"	0.50"

*Load deflection tables for pultruded stair treads are available in the *Safe-T-Span® Fiberglass Pultruded Grating* brochure.

6.4 FRP Stair Design Notes

6.4.1 Most stairs can be satisfactorily designed using up to 8” or 10” channels as stringers with the flanges outward. The stringer must be designed to meet the loading requirements given in section 6.3.1. The individual stair treads are supported by 2” x 2” x 1/4” angles bolted to the stringers with two 3/8” diameter bolts.

6.4.2 The stair railings are manufactured using a system identical to the one described in section 3.0 for FRP Handrails. These are typically side-mounted to the channel stringers using the detail given in that section. Note that the height of handrails at stairs is 2’ - 6 1/2 “ to 2’ - 8” above the nosing, depending on the slope of the stairs. (Per OSHA)

6.4.3 Long stair runs may require intermediate support using columns and may require bracing to prevent excessive sidesway. (See Charts)

Stringer Design Table - OSHA Design Criteria

Notes:
1. Slope range is 30 to 50 degrees
2. OSHA does not limit the maximum rise
3. Design is for a 1000 lb point load, L/D ≥ 180
4. C8 = C 8” x 2-3/16” x 3/8”; C10 = C10” x 2-3/4” x 1/2”

Vertical Rise in Feet	Horizontal Run in Feet																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	C8																				
2		C8	C8																		
3			C8	C8	C8																
4				C8	C8	C8															
5					C8	C8	C8	C8													
6						C8	C8	C8	C8	C8											
7						C8	C8	C8	C8	C8	C8	C8									
8							C8	C8	C8	C8	C8	C8	C8								
9								C8	C8	C8	C8	C8	C8	C8	C8						
10									C8	C8	C8	C8	C8	C8	C8	C8					
11										C8	C8	C8	C8	C8	C8	C8	C8	C8	C8		
12											C8	C8	C8	C8	C8	C8	C8	C8	C8	C8	
13											C8	C8	C8	C8	C8	C8	C8	C8	C10	C10	C10
14												C8	C8	C8	C8	C10	C10	C10	C10	C10	C10
15													C10	C10	C10	C10	C10	C10	C10	C10	C10
16														C10	C10	C10	C10	C10	C10	C10	C10
17															C10	C10	C10	C10	C10	C10	C10
18																C10	C10	C10	C10	C10	C10

Rise/Run combinations without stringer size fall outside of 30 - 50 degree limits set by OSHA.

Stringers below double line require lateral bracing, see detail.

Stringers below heavy black line are longer than 20’-0”. These require a splice or pull to length.

Stringer Design Table - UBC Design Criteria
3'-0" Wide Stair Only

Notes:
1. Slope range is 19.5 to 41.6 degrees
2. Landings are required every 12' of rise
3. Design is for a 100 psf point load, L/D ≥ 180
4. C8 = C 8" x 2-3/16" x 3/8"; C10 = C10" x 2-3/4" x 1/2"

Vertical Rise in Feet	Horizontal Run in Feet																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		C8																	
2			C8	C8	C8														
3				C8	C8	C8	C8	C8											
4					C8	C8	C8	C8	C8	C8	C8								
5						C8	C8	C8	C8	C8	C8	C10	C10						
6							C8	C8	C8	C8	C8	C10	C10	C10	C10	C10			
7								C8	C8	C8	C8	C10	C10	C10	C10	C10	C8*	C8*	C8*
8									C8	C8	C10	C10	C10	C10	C10	C8*	C8*	C8*	C8*
9											C10	C10	C10	C10	C10	C8*	C8*	C8*	C8*
10												C10	C10	C8*	C8*	C8*	C8*	C8*	C8*
11													C10	C8*	C8*	C8*	C8*	C8*	C8*
12														C10	C8*	C8*	C8*	C8*	C8*

Rise/Run combinations without stringer size fall outside of slope limits set by UBC.

Stringers below heavy black line are longer than 20'-0".

Stringers below double line require lateral bracing, see detail.

*Indicates that C8 stringers can be used if columns are installed at midspan of stringer. C10 will not work.

Stringer Design Table - UBC Design Criteria
4'-0" Wide Stair Only

Notes:
1. Slope range is 19.5 to 41.6 degrees
2. Landings are required every 12' of rise
3. Design is for a 100 psf point load, L/D ≥ 180
4. C8 = C 8" x 2-3/16" x 3/8"; C10 = C10" x 2-3/4" x 1/2"

Vertical Rise in Feet	Horizontal Run in Feet																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		C8																	
2			C8	C8	C8														
3				C8	C8	C8	C8	C8											
4					C8	C8	C8	C8	C8	C8	C10								
5						C8	C8	C8	C8	C8	C10	C10	C10						
6							C8	C8	C8	C8	C10	C10	C10	C10	C8*	C8*			
7								C8	C8	C8	C8	C10	C10	C10	C8*	C8*	C8*	C8*	C8*
8									C8	C8	C10	C10	C10	C10	C8*	C8*	C8*	C8*	C8*
9											C10	C10	C10	C8*	C8*	C8*	C8*	C8*	C8*
10												C10	C10	C8*	C8*	C8*	C8*	C8*	C8*
11													C10	C8*	C8*	C8*	C8*	C8*	C8*
12														C8*	C8*	C8*	C8*	C8*	C8*

Rise/Run combinations without stringer size fall outside of slope limits set by UBC.

Stringers below heavy black line are longer than 20'-0".

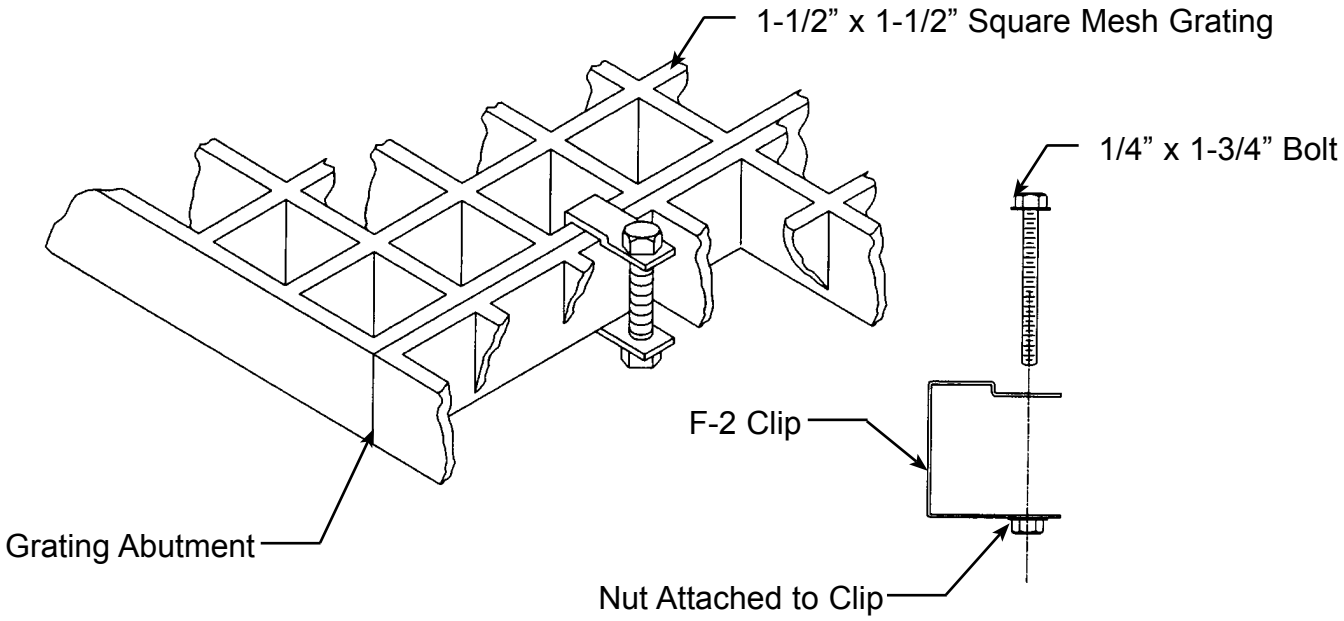
Stringers below double line require lateral bracing, see detail.

*Indicates that C8 stringers can be used if columns are installed at midspan of stringer. C10 will not work.

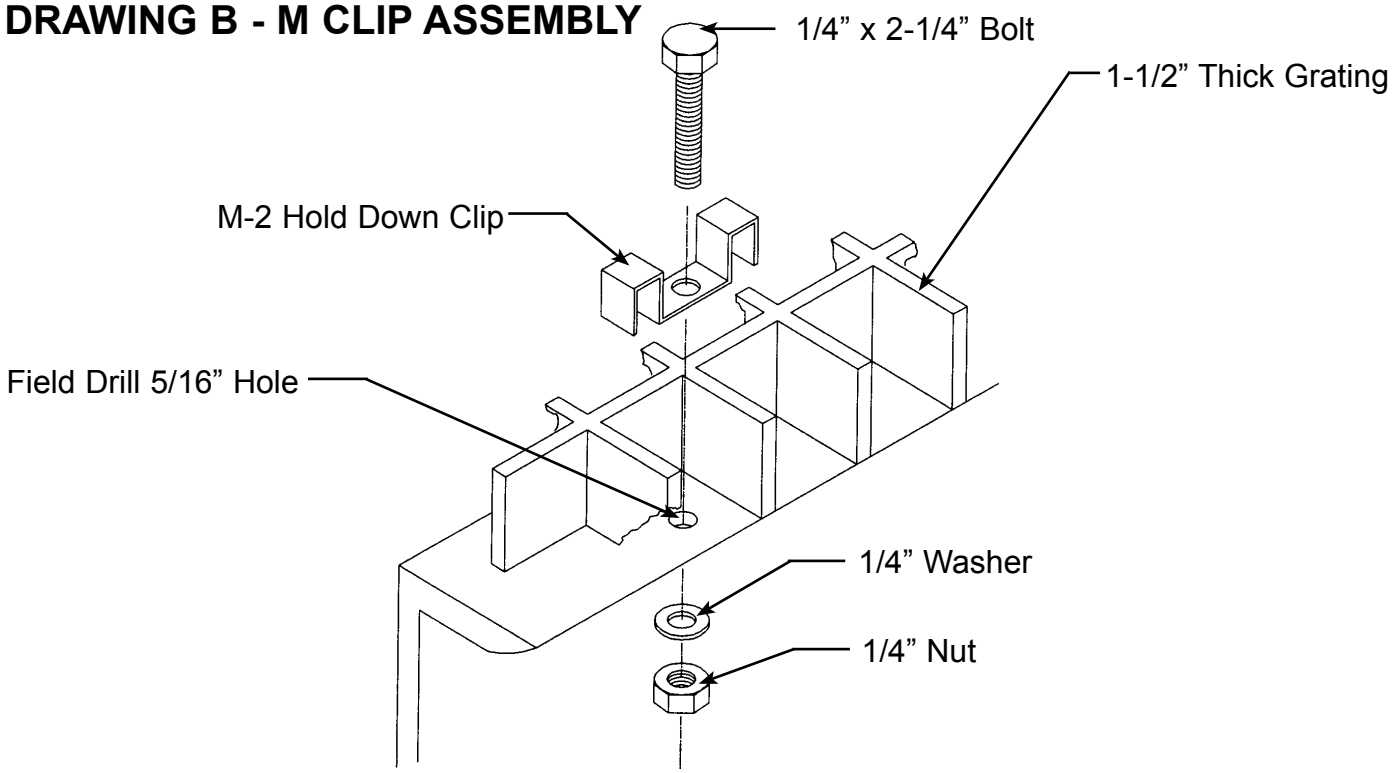
6.5 FRP Stair Details

6.5.1 The attached drawings provide typical details of stair systems using channel stringers.

DRAWING A - F CLIP ASSEMBLY



DRAWING B - M CLIP ASSEMBLY



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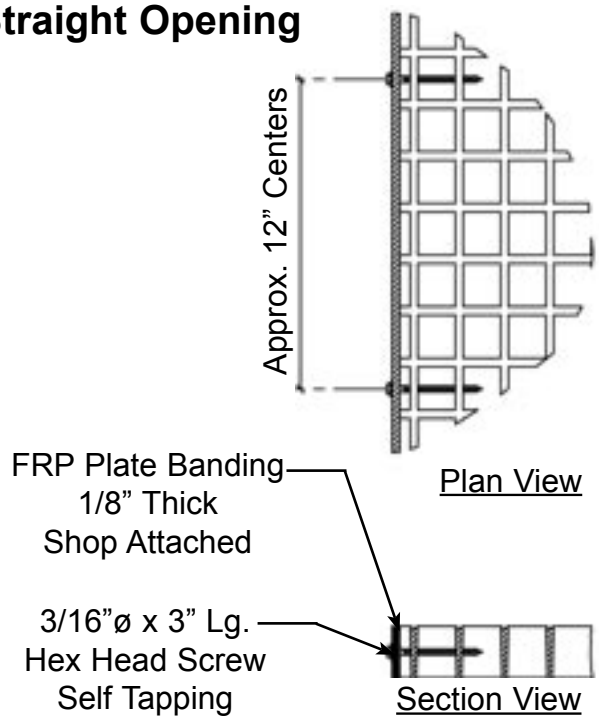
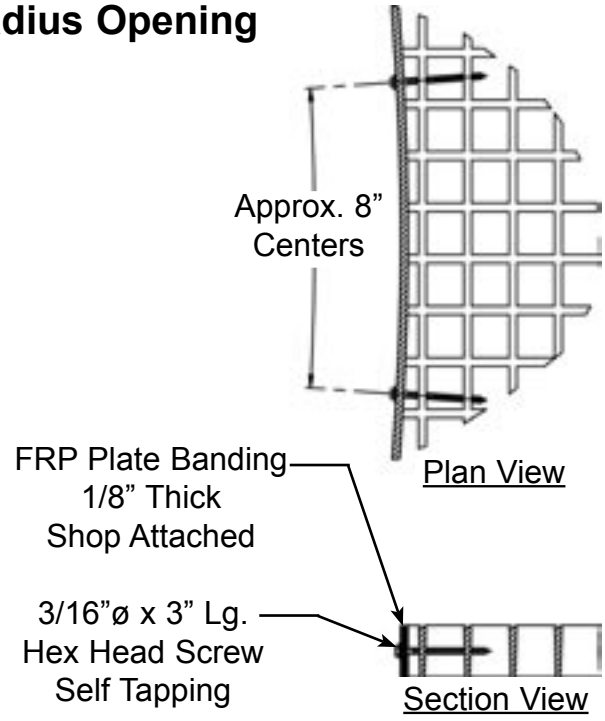
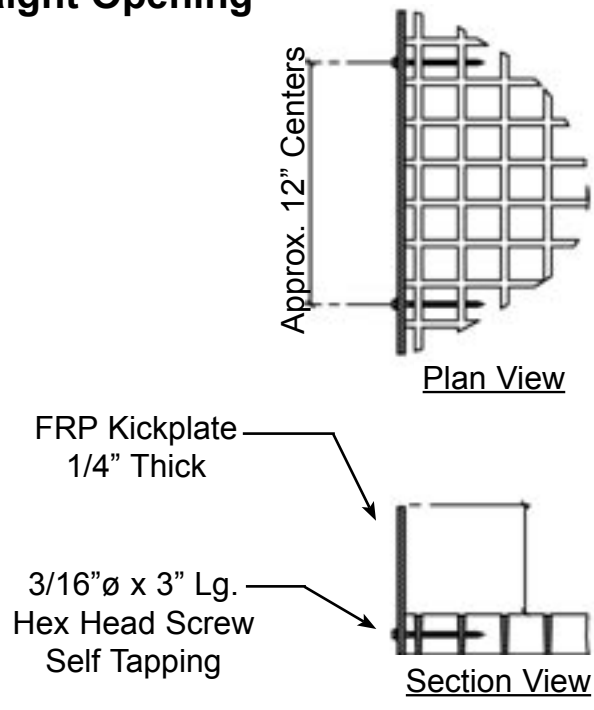
DRAWING C - FRP EDGEBANDING Straight Opening



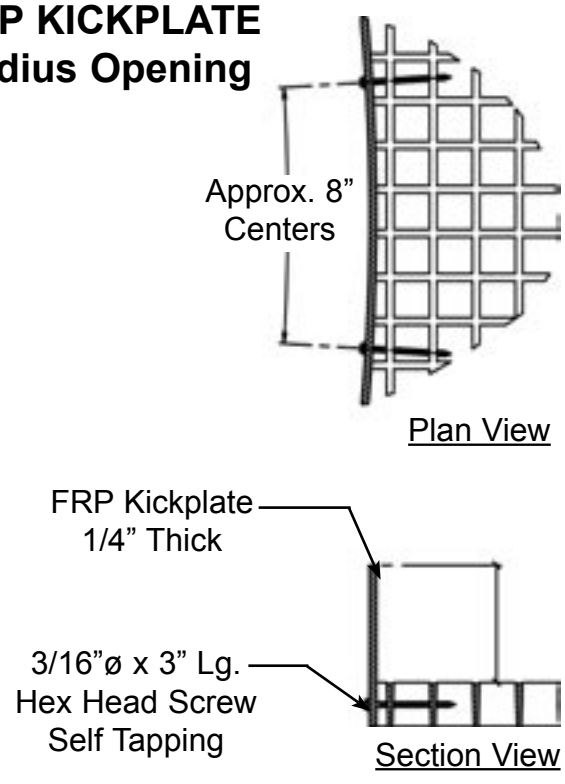
DRAWING D - FRP EDGEBANDING Radius Opening



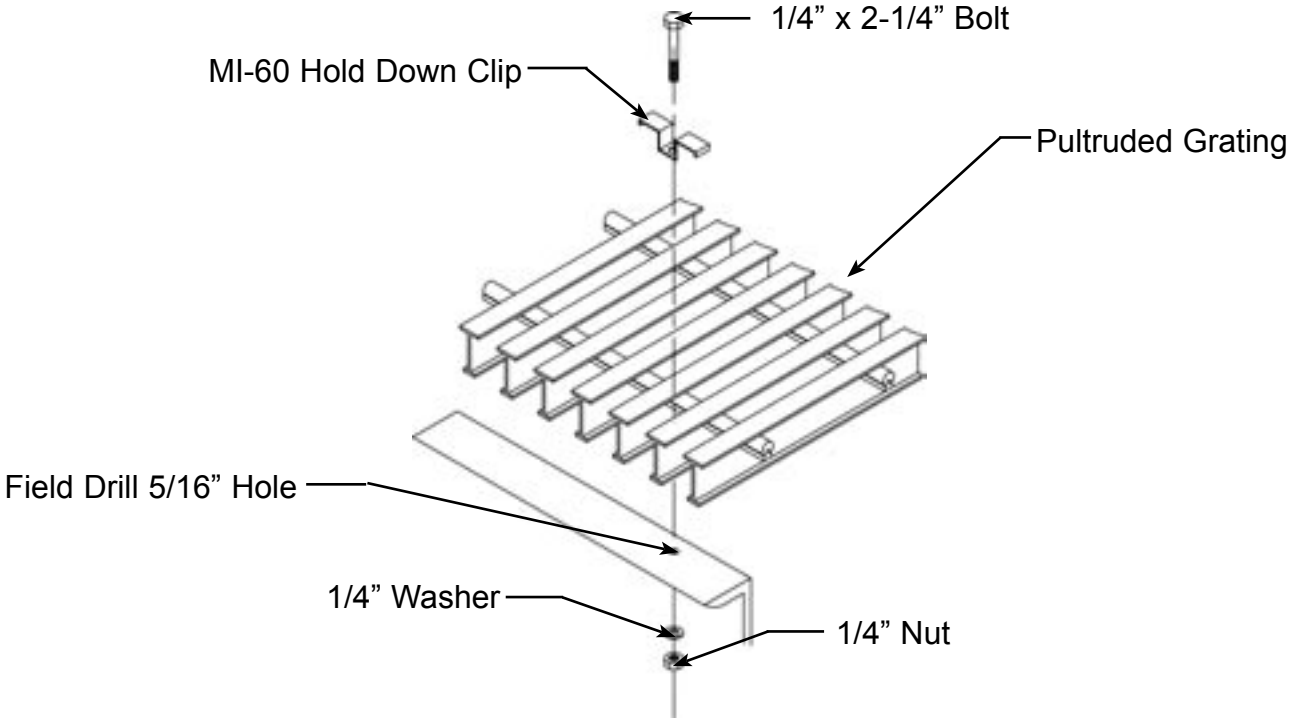
DRAWING E - FRP KICKPLATE Straight Opening



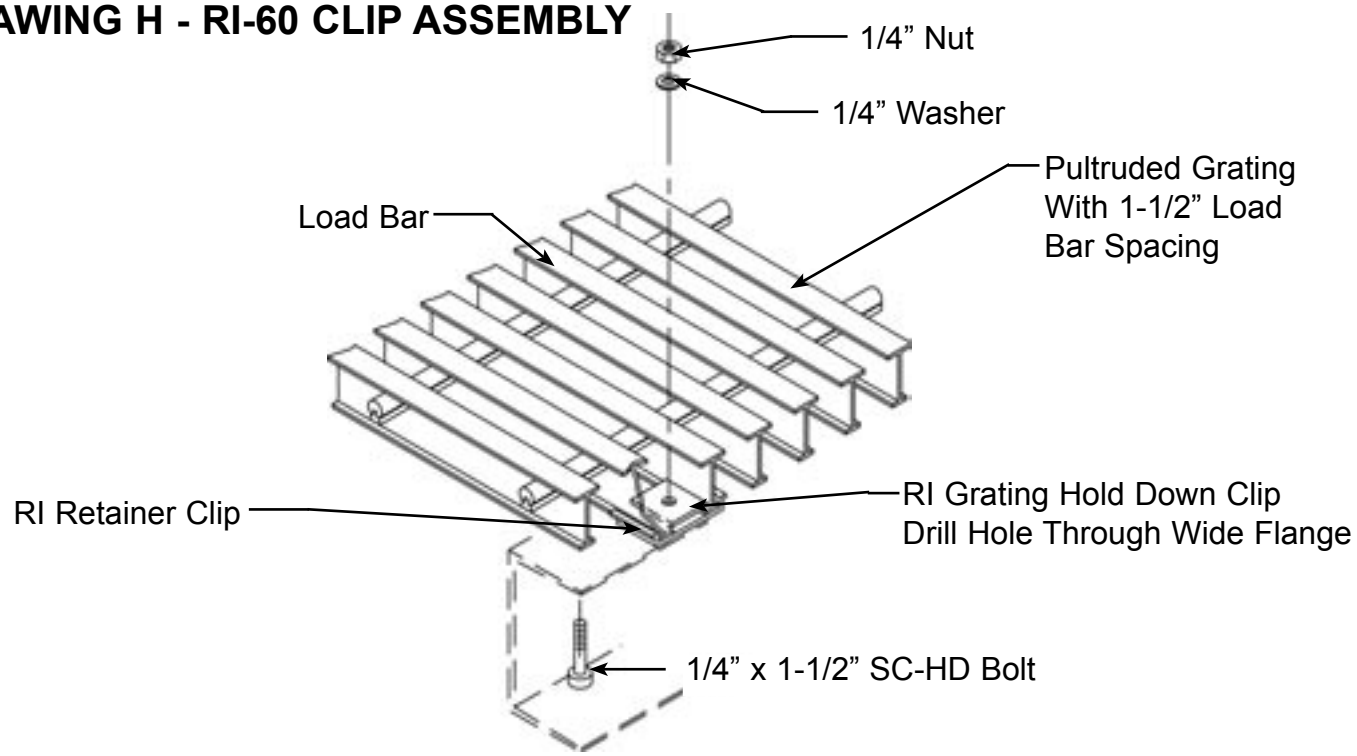
DRAWING F - FRP KICKPLATE Radius Opening



DRAWING G - MI-60 CLIP ASSEMBLY

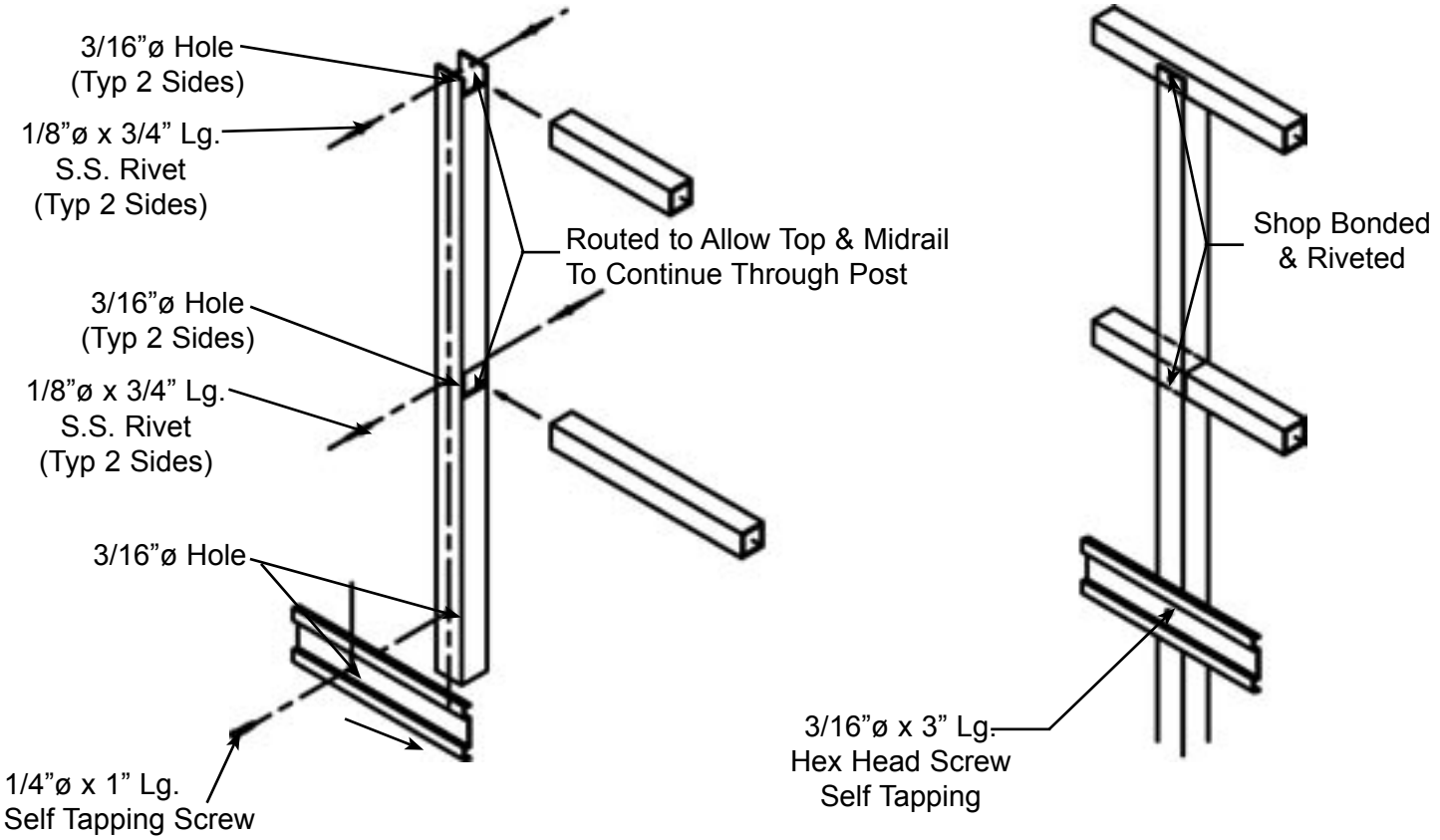


DRAWING H - RI-60 CLIP ASSEMBLY

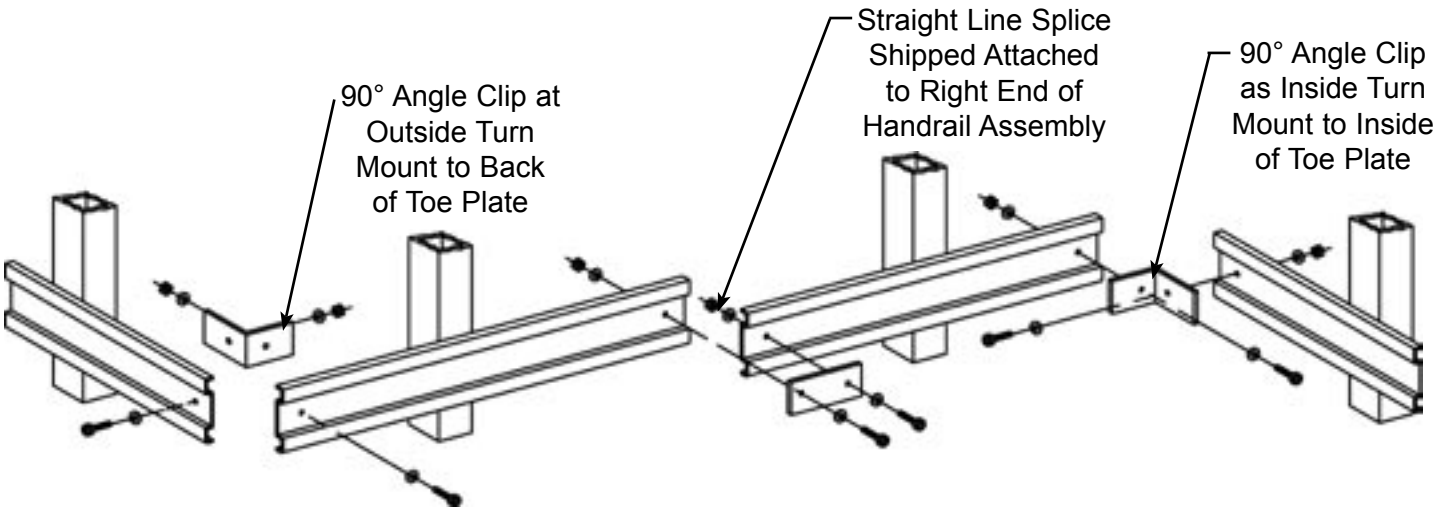


Guidelines for the Engineer and Designer

DRAWING I - FRP HANDRAIL

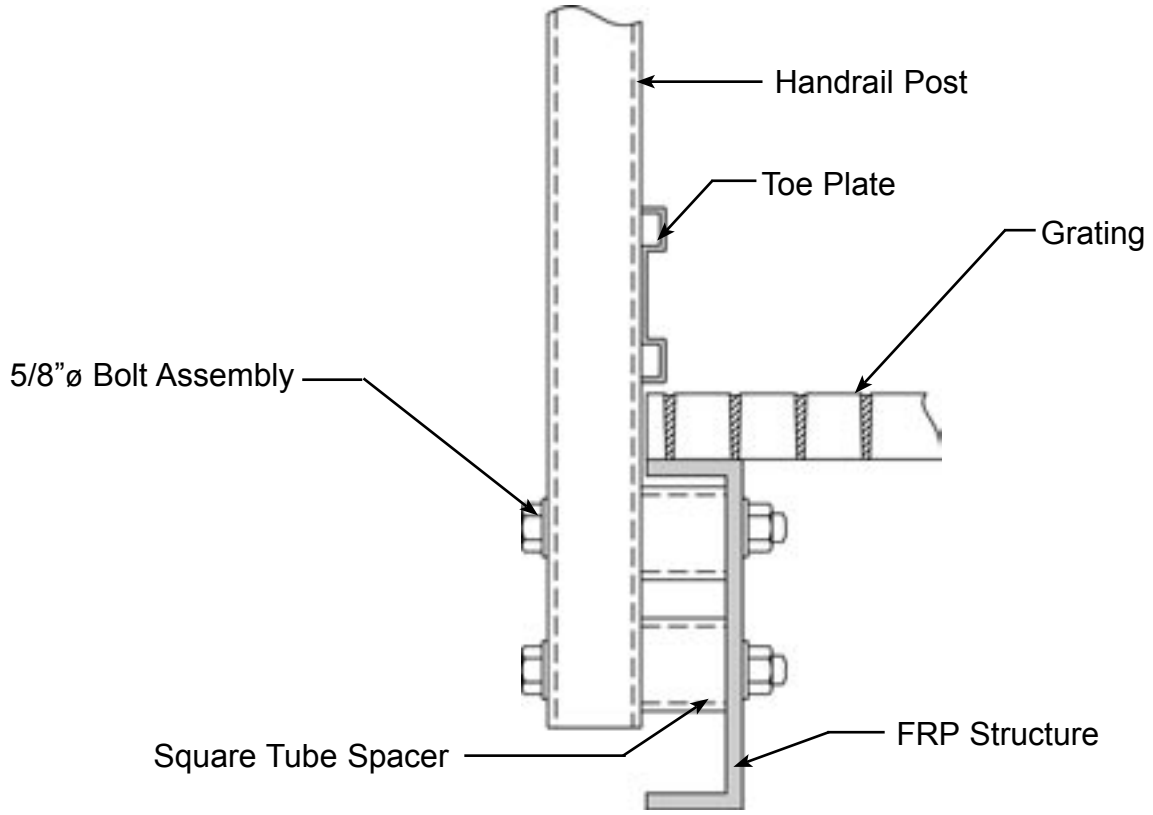


DRAWING J - TOE PLATE SPLICE CONDITIONS

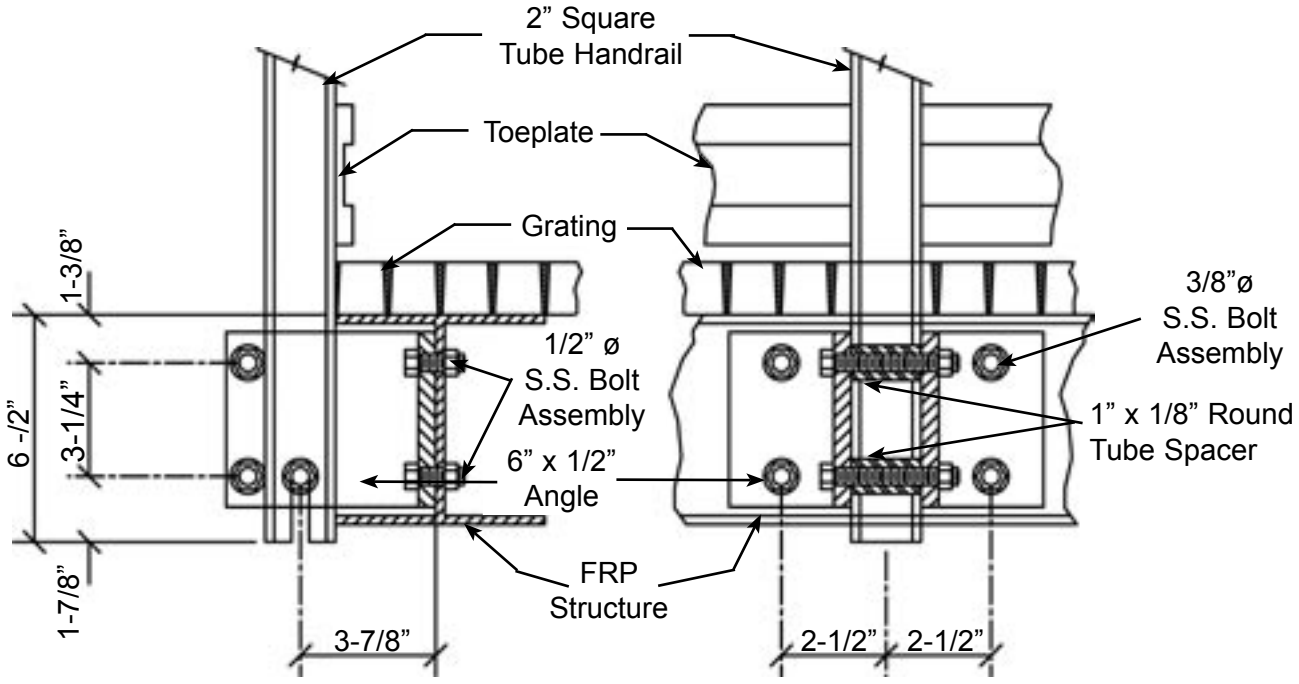


Outside Turn Straight Line Inside Turn

DRAWING K - HANDRAIL TO FRP STRUCTURE CONNECTION

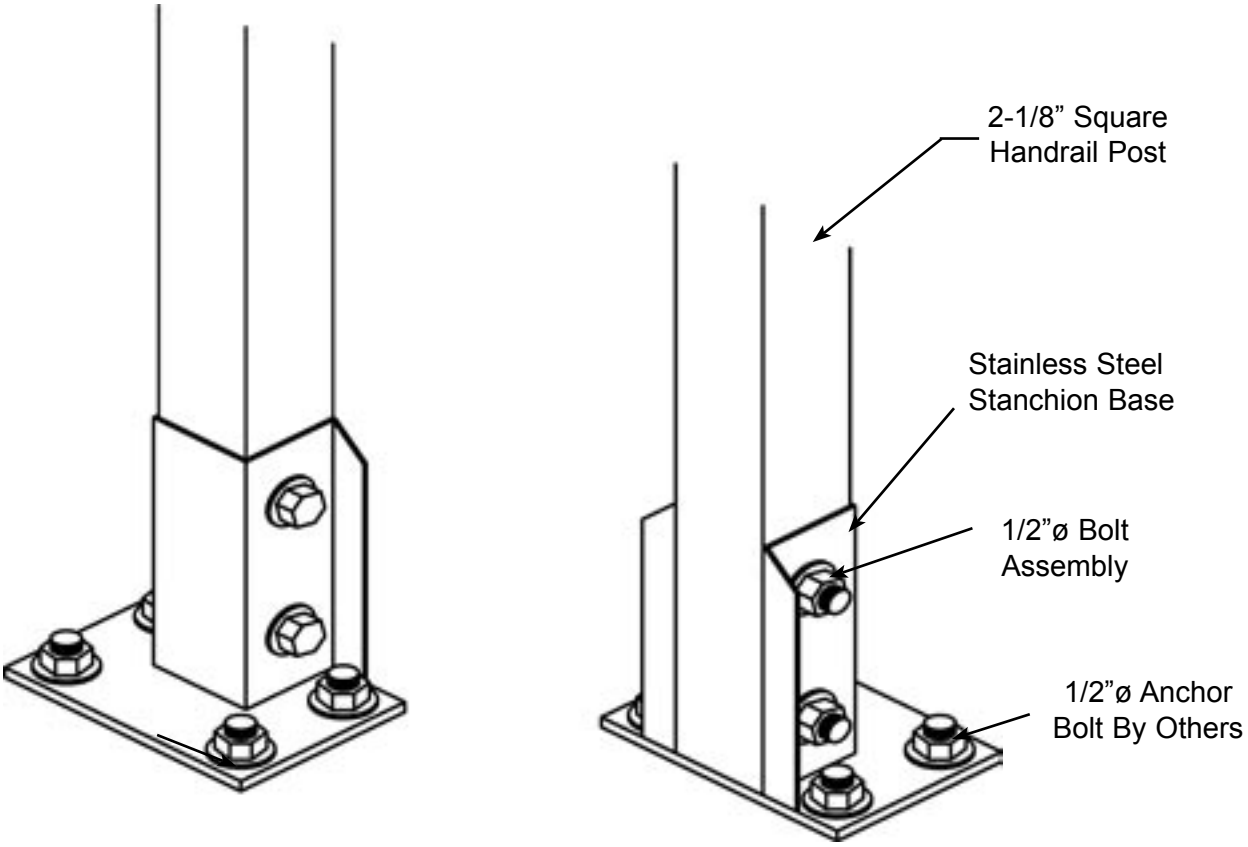


DRAWING L - REMOVEABLE HANDRAIL CONNECTION

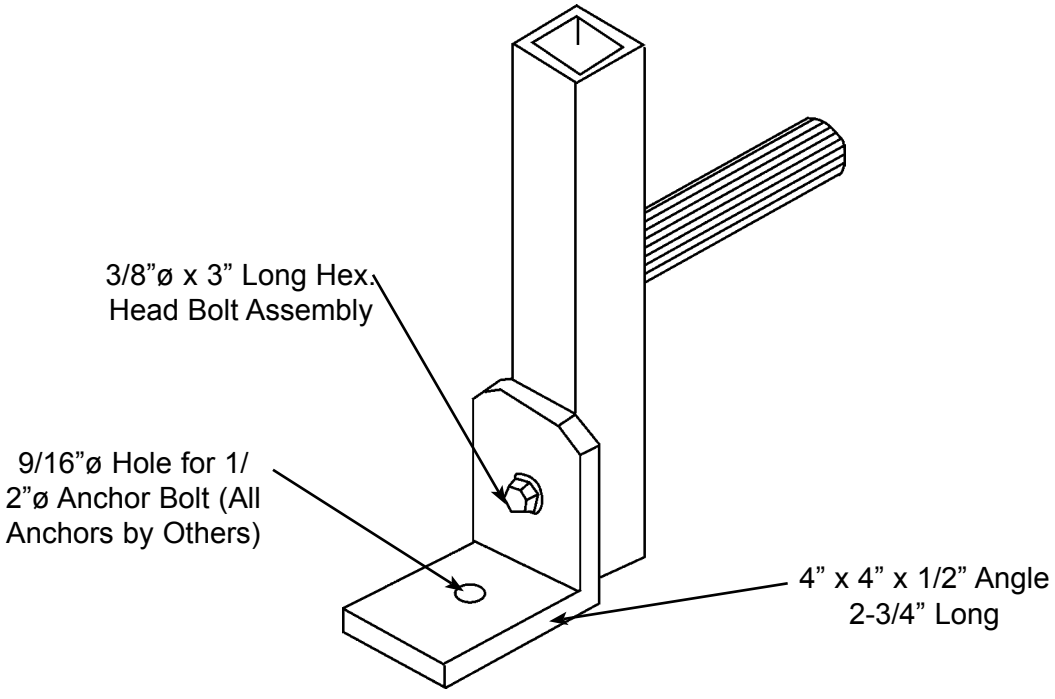


Guidelines for the Engineer and Designer

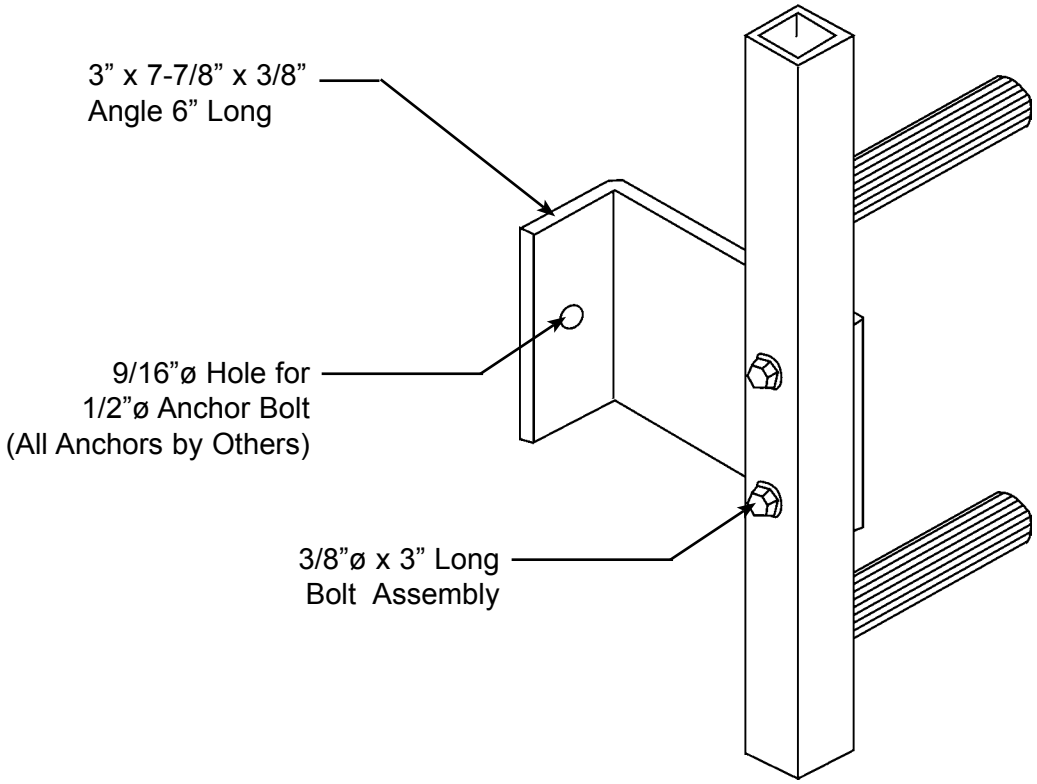
DRAWING M - STANCHION BASE



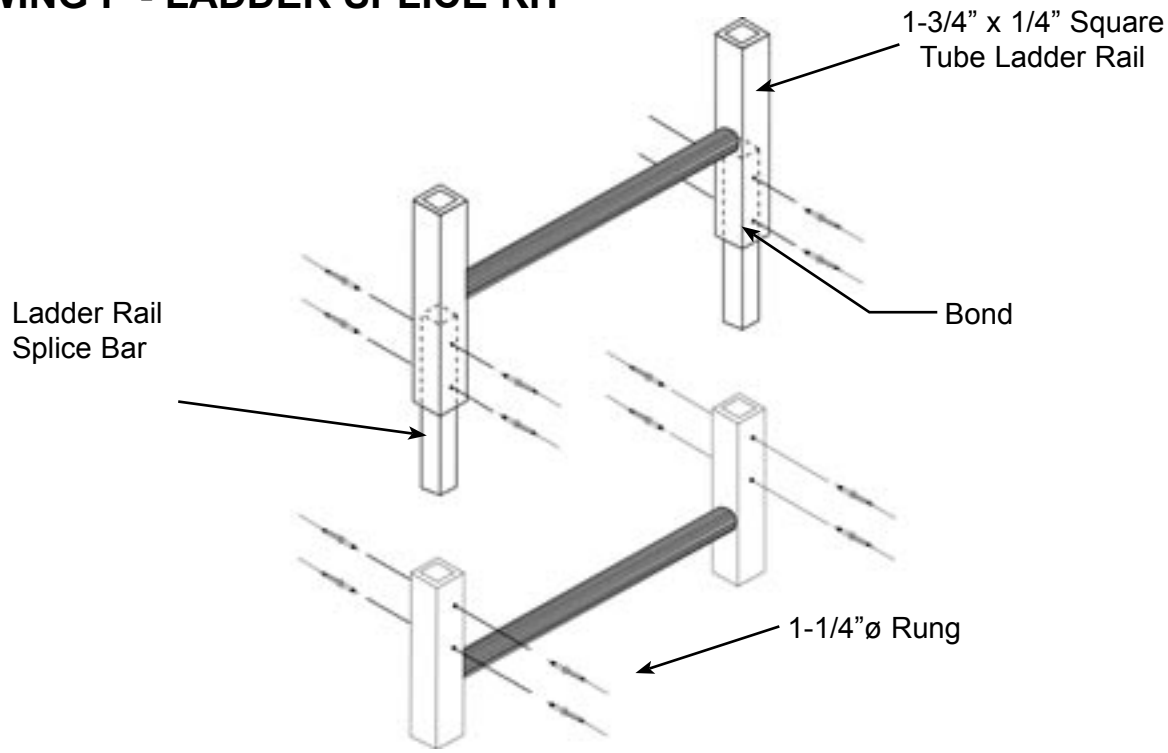
DRAWING N - LADDER FLOOR MOUNT KIT



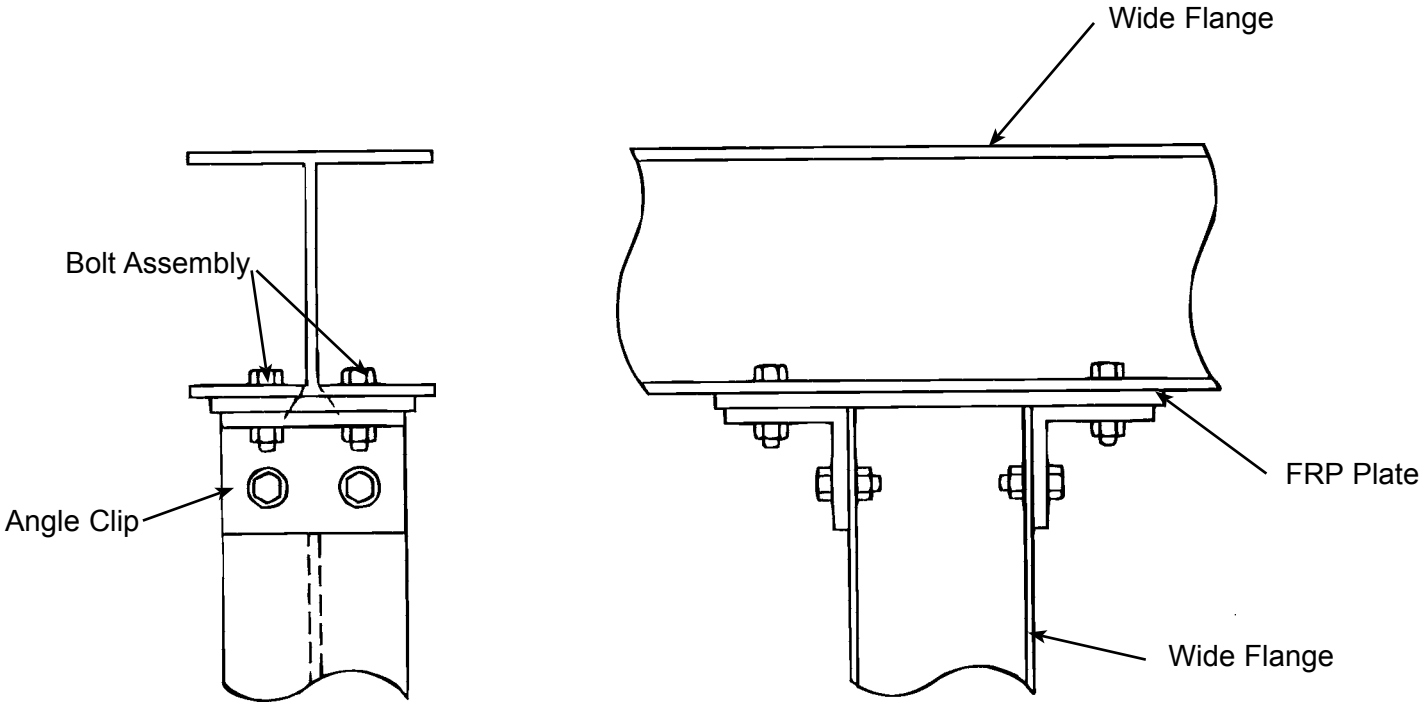
DRAWING O - LADDER WALL MOUNT KIT



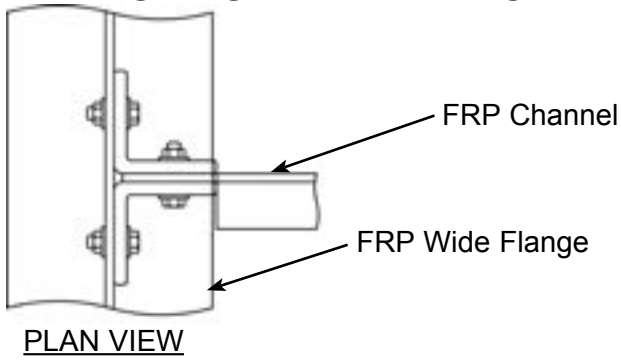
DRAWING P - LADDER SPLICE KIT



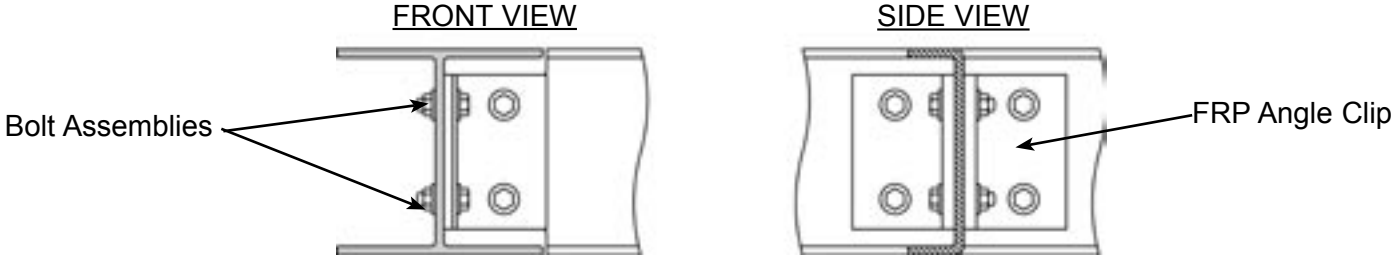
DRAWING Q - WIDE FLANGE COLUMN TOP



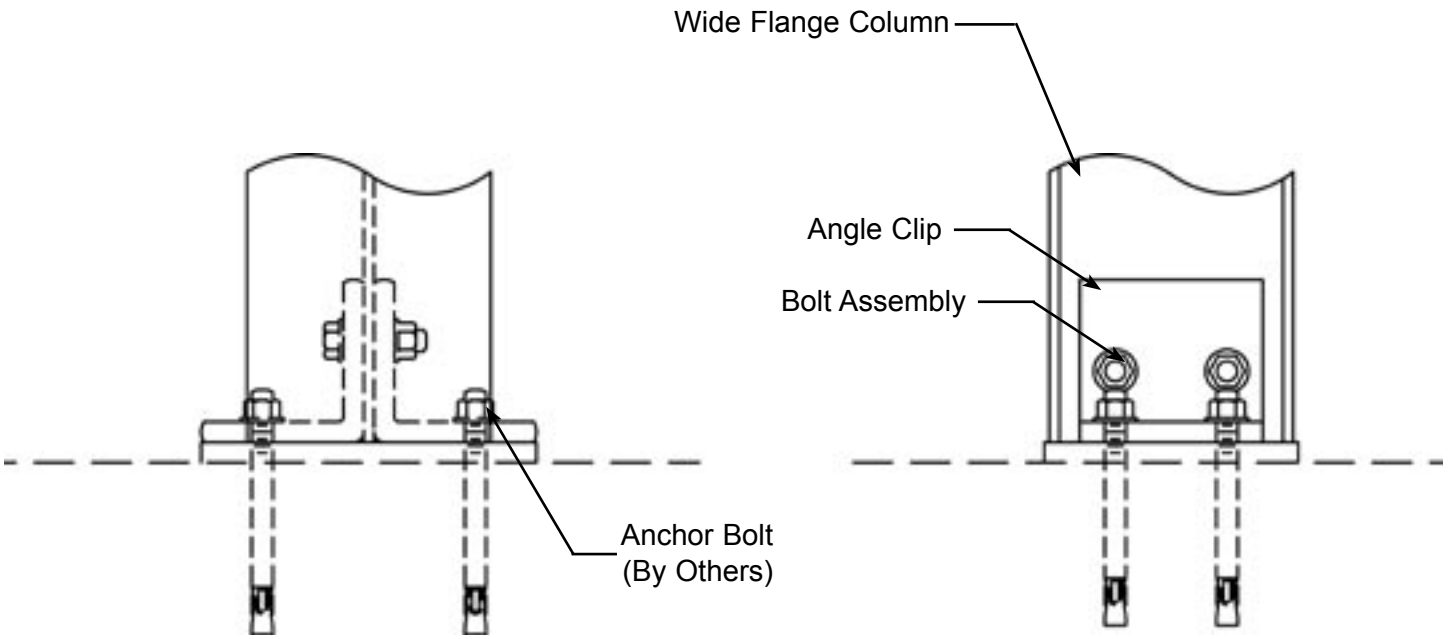
DRAWING R - WIDE FLANGE TO CHANNEL CONNECTION



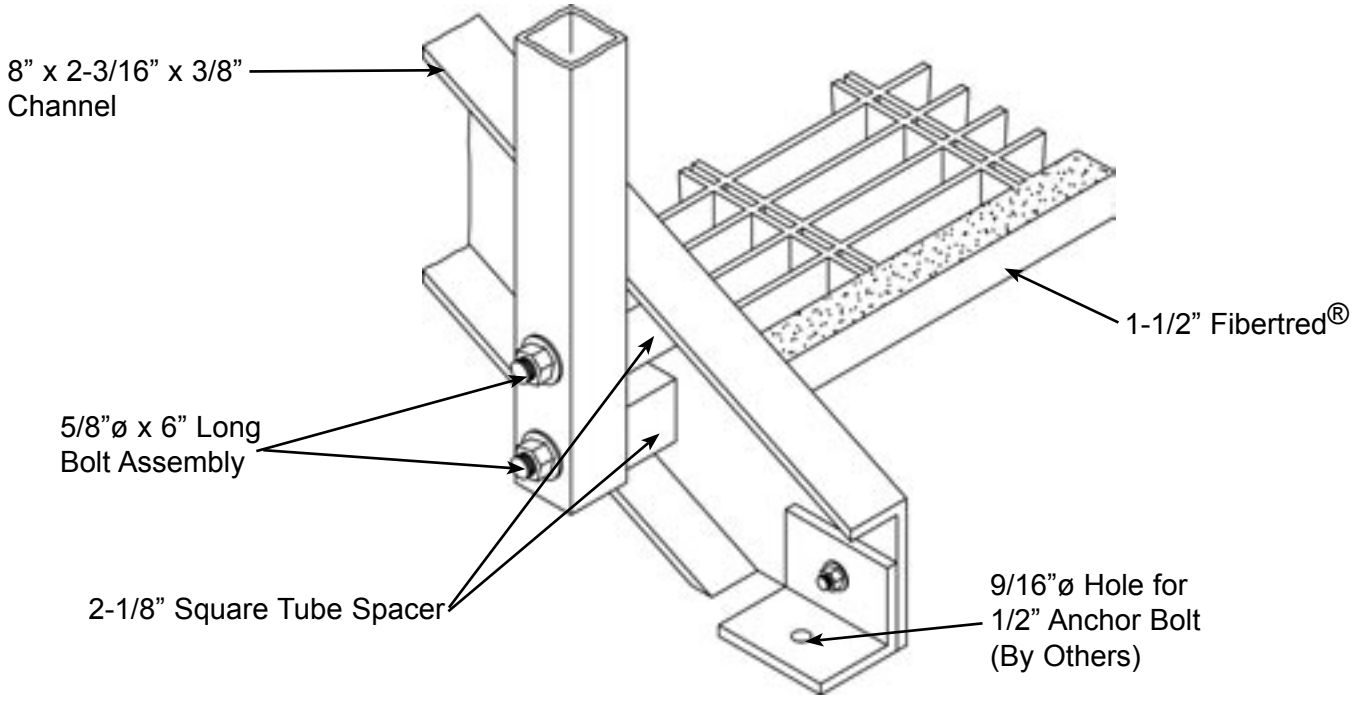
PLAN VIEW



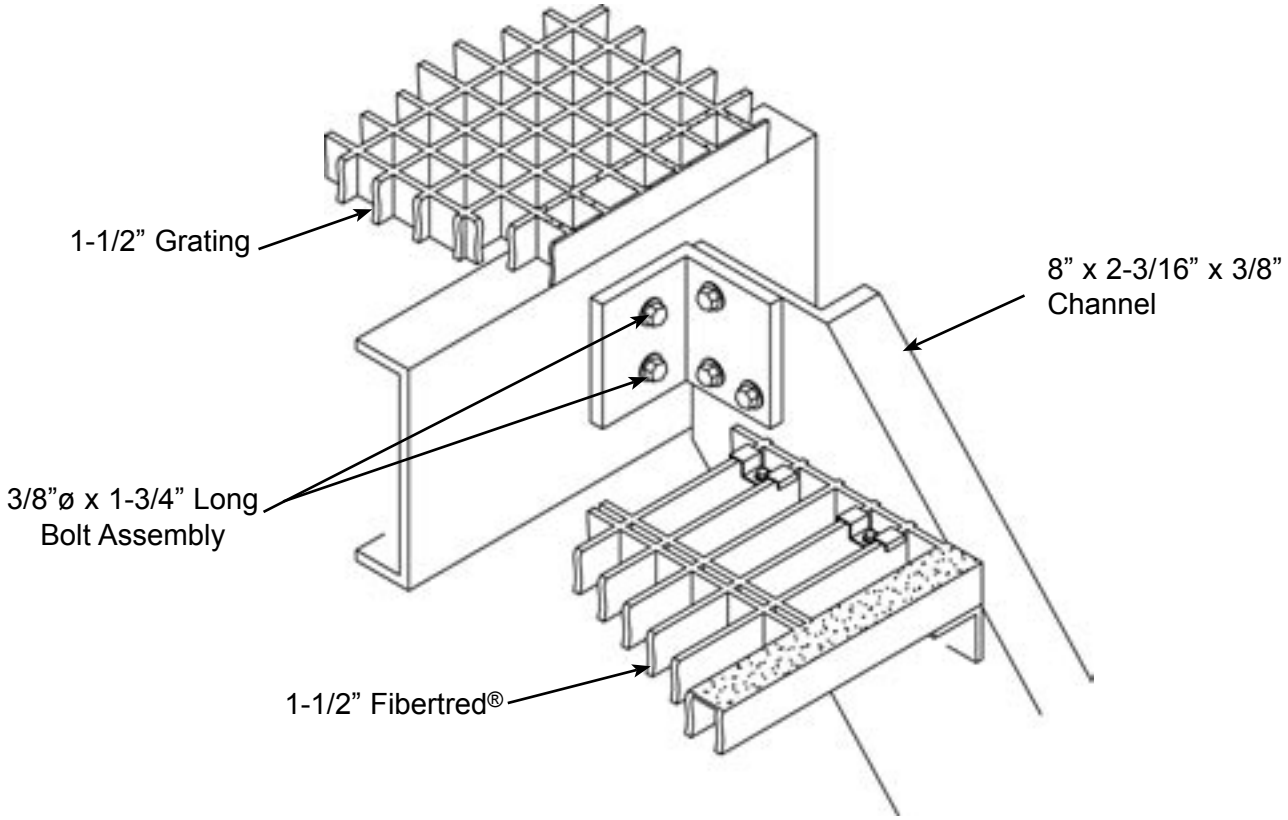
DRAWING S - WIDE FLANGE COLUMN BASE



DRAWING T - BOTTOM STAIR STRINGER MOUNT



DRAWING U - TOP STAIR STRINGER MOUNT



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Stonhard offers a complete line of engineered secondary containment systems and flooring for concrete. These systems range from reinforced coatings and linings to heavy-duty floors. For more information on Stonhard’s engineered systems, call Stonhard at 800/257-7953.

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