FRP Grating, Handrail, Ladders & Structural Shapes

Guidelines for the Engineer and Designer

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

<table>
<thead>
<tr>
<th>PEDESTRIAN LOADS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform Live Load</td>
</tr>
<tr>
<td>Concentrated Load</td>
</tr>
<tr>
<td>Dead Load</td>
</tr>
<tr>
<td>Maximum Deflection</td>
</tr>
</tbody>
</table>

* 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.

<table>
<thead>
<tr>
<th>FRP STRUCTURAL SHAPES*</th>
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<tbody>
<tr>
<td>Maximum Deflection</td>
</tr>
<tr>
<td>Allowable Bending Stress</td>
</tr>
<tr>
<td>Allowable Shear Stress</td>
</tr>
<tr>
<td>Allowable Bearing Stress</td>
</tr>
</tbody>
</table>

*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.

<table>
<thead>
<tr>
<th>FRP STRUCTURAL SHAPES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHAPE NAME</td>
</tr>
<tr>
<td>EQUAL LEG ANGLES</td>
</tr>
<tr>
<td>CHANNELS</td>
</tr>
<tr>
<td>I - SECTIONS</td>
</tr>
<tr>
<td>WIDE FLANGE SECTIONS</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>MEMBER</th>
<th>LATERAL SUPPORT SPACING</th>
<th>MEMBER</th>
<th>LATERAL SUPPORT SPACING</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6” x 1/4”</td>
<td>48”</td>
<td>W4” x 1/4”</td>
<td>60”</td>
</tr>
<tr>
<td>C8 x 3/8”</td>
<td>60”</td>
<td>W6 x 1/4”</td>
<td>84”</td>
</tr>
<tr>
<td>C10” x 1/2”</td>
<td>60”</td>
<td>W6” x 3/8”</td>
<td>96”</td>
</tr>
<tr>
<td>I4” x 1/4”</td>
<td>24”</td>
<td>W8” x 3/8”</td>
<td>108”</td>
</tr>
<tr>
<td>I6” x 1/4”</td>
<td>36”</td>
<td>W10” x 3/8”</td>
<td>156”</td>
</tr>
<tr>
<td>I8” x 3/8”</td>
<td>48”</td>
<td>W12” x 1/2”</td>
<td>168”</td>
</tr>
<tr>
<td>I10” x 3/8”</td>
<td>60”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I12” x 1/2”</td>
<td>84”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

5.7.2 The following tables outline allowables and requirements that should be considered when designing and detailing connections.
GUIDELINES FOR THE ENGINEER AND DESIGNER

STRUCTURAL CONNECTIONS

BEARING ON FRP

Bolt Allowable for Given FRP Plate Thickness (1)

<table>
<thead>
<tr>
<th>MATERIAL THICKNESS</th>
<th>3/8&quot;</th>
<th>1/2&quot;</th>
<th>5/8&quot;</th>
<th>3/4&quot;</th>
<th>1&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8&quot;</td>
<td>469</td>
<td>625</td>
<td>781</td>
<td>938</td>
<td>1250</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>938</td>
<td>1250</td>
<td>1563</td>
<td>1875</td>
<td>2500</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>1406</td>
<td>1875</td>
<td>2344</td>
<td>2813</td>
<td>3750</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>1875</td>
<td>2500</td>
<td>3125</td>
<td>3750</td>
<td>5000</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>2813</td>
<td>3750</td>
<td>4688</td>
<td>5625</td>
<td>7500</td>
</tr>
<tr>
<td>1&quot;</td>
<td>3750</td>
<td>5000</td>
<td>6250</td>
<td>7500</td>
<td>10000</td>
</tr>
</tbody>
</table>

(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)

<table>
<thead>
<tr>
<th>BOLT TYPE &amp; APPLICATION</th>
<th>3/8&quot;</th>
<th>1/2&quot;</th>
<th>5/8&quot;</th>
<th>3/4&quot;</th>
<th>1&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>316SS- single shear (3)</td>
<td>1408</td>
<td>2503</td>
<td>3912</td>
<td>5633</td>
<td>10014</td>
</tr>
<tr>
<td>316SS- double shear</td>
<td>2816</td>
<td>5007</td>
<td>7823</td>
<td>11265</td>
<td>20027</td>
</tr>
<tr>
<td>FRP threaded rod</td>
<td>300</td>
<td>600</td>
<td>900</td>
<td>1000</td>
<td>2050</td>
</tr>
<tr>
<td>single shear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRP threaded rod -</td>
<td>600</td>
<td>1200</td>
<td>1800</td>
<td>2000</td>
<td>4100</td>
</tr>
<tr>
<td>double shear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(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

<table>
<thead>
<tr>
<th>RANGE</th>
<th>RECOMMENDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge Distance - cl* bolt to END</td>
<td>2.0-4.0</td>
</tr>
<tr>
<td>Edge Distance - cl* bolt to SIDE</td>
<td>1.5-3.5</td>
</tr>
<tr>
<td>Bolt Pitch - cl* to cl*</td>
<td>4.0-5.0</td>
</tr>
</tbody>
</table>

* - “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.

<table>
<thead>
<tr>
<th>LOAD (LB)</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>42</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>0.03”</td>
<td>0.05”</td>
<td>0.09”</td>
<td>0.16”</td>
<td>0.25”</td>
</tr>
<tr>
<td>500</td>
<td>0.06”</td>
<td>0.10”</td>
<td>0.19”</td>
<td>0.32”</td>
<td>0.50”</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Vertical Rise in Feet</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>C8 C8</td>
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<td>3</td>
<td>C8 C8 C8</td>
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<tr>
<td>4</td>
<td>C8 C8 C8</td>
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<tr>
<td>5</td>
<td>C8 C8 C8 C8</td>
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<tr>
<td>6</td>
<td>C8 C8 C8 C8 C8 C8</td>
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**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 = 8” x 2-3/16” x 3/8”; C10 = 10” x 2-3/4” x 1/2”

Stringers below double line require lateral bracing, see detail.

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

Stringers below heavy black line are longer than 20'-0”. These require a splice or pull to length.
### Guidelines for the Engineer and Designer

**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"

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<tr>
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*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"

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*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**

- 1-1/2" x 1-1/2" Square Mesh Grating
- 1/4" x 1-3/4" Bolt
- F-2 Clip
- Nut Attached to Clip

**DRAWING B - M CLIP ASSEMBLY**

- 1/4" x 2-1/4" Bolt
- 1-1/2" Thick Grating
- M-2 Hold Down Clip
- Field Drill 5/16" Hole
- 1/4" Washer
- 1/4" Nut
GUIDELINES FOR THE ENGINEER AND DESIGNER

DRAWING C - FRP EDGEBANDING
Straight Opening

- FRP Plate Banding
  - 1/8" Thick
  - Shop Attached

- 3/16" Ø x 3" Lg.
  - Hex Head Screw
  - Self Tapping

DRAWING D - FRP EDGEBANDING
Radius Opening

- FRP Plate Banding
  - 1/8" Thick
  - Shop Attached

- 3/16" Ø x 3" Lg.
  - Hex Head Screw
  - Self Tapping

DRAWING E - FRP KICKPLATE
Straight Opening

- FRP Kickplate
  - 1/4" Thick

- 3/16" Ø x 3" Lg.
  - Hex Head Screw
  - Self Tapping

DRAWING F - FRP KICKPLATE
Radius Opening

- FRP Kickplate
  - 1/4" Thick

- 3/16" Ø x 3" Lg.
  - Hex Head Screw
  - Self Tapping
**DRAWING G - MI-60 CLIP ASSEMBLY**

- MI-60 Hold Down Clip
- Pultruded Grating
- Field Drill 5/16" Hole
- 1/4" Washer
- 1/4" Nut
- 1/4" x 2-1/4" Bolt

**DRAWING H - RI-60 CLIP ASSEMBLY**

- RI Retainer Clip
- Pultruded Grating With 1-1/2" Load Bar Spacing
- Load Bar
- RI Grating Hold Down Clip
- Drill Hole Through Wide Flange
- 1/4" x 1-1/2" SC-HD Bolt
Guidelines for the Engineer and Designer

**DRAWING I - FRP HANDRAIL**

- 3/16"Ø Hole (Typ 2 Sides)
- 1/8"Ø x 3/4" Lg.
  - S.S. Rivet (Typ 2 Sides)
- 3/16"Ø Hole (Typ 2 Sides)
- 1/8"Ø x 3/4" Lg.
  - S.S. Rivet (Typ 2 Sides)
- 3/16"Ø Hole
- 1/4"Ø x 1" Lg.
  - Self Tapping Screw
- Shop Bonded & Riveted

**DRAWING J - TOE PLATE SPLICE CONDITIONS**

- 90° Angle Clip at Outside Turn Mount to Back of Toe Plate
- Straight Line Splice Shipped Attached to Right End of Handrail Assembly
- 90° Angle Clip as Inside Turn Mount to Inside of Toe Plate

**Outside Turn**

**Straight Line**

**Inside Turn**
**Guidelines for the Engineer and Designer**

**DRAWING K - HANDRAIL TO FRP STRUCTURE CONNECTION**

![Diagram of Handrail to FRP Structure Connection]

- **Handrail Post**
- **Toe Plate**
- **Grating**
- **Square Tube Spacer**
- **FRP Structure**

**DRAWING L - REMOVEABLE HANDRAIL CONNECTION**

![Diagram of Removeable Handrail Connection]

- **2" Square Tube Handrail**
- **Toeplate**
- **Grating**
- **3/8" Ø S.S. Bolt Assembly**
- **1" x 1/8" Round Tube Spacer**
- **1/2" Ø S.S. Bolt Assembly**
- **6" x 1/2" Angle**
- **FRP Structure**

19
Guidelines for the Engineer and Designer

DRAWING M - STANCHION BASE

- 2-1/8" Square Handrail Post
- Stainless Steel Stanchion Base
- 1/2"ø Bolt Assembly
- 1/2"ø Anchor Bolt By Others

DRAWING N - LADDER FLOOR MOUNT KIT

- 3/8"ø x 3" Long Hex Head Bolt Assembly
- 9/16"ø Hole for 1/2"ø Anchor Bolt (All Anchors by Others)
- 4" x 4" x 1/2" Angle 2-3/4" Long
**DRAWING O - LADDER WALL MOUNT KIT**

- 3" x 7-7/8" x 3/8" Angle 6" Long
- 9/16"ø Hole for 1/2"ø Anchor Bolt (All Anchors by Others)
- 3/8"ø x 3" Long Bolt Assembly

**DRAWING P - LADDER SPLICE KIT**

- 1-3/4" x 1/4" Square Tube Ladder Rail
- Ladder Rail Splice Bar
- Bond
- 1-1/4"ø Rung
Guidelines for the Engineer and Designer

DRAWING Q - WIDE FLANGE COLUMN TOP

- Bolt Assembly
- Angle Clip
- Wide Flange
- FRP Plate

DRAWING R - WIDE FLANGE TO CHANNEL CONNECTION

- FRP Channel
- FRP Wide Flange
- Bolt Assemblies
- FRP Angle Clip
DRAWING S - WIDE FLANGE COLUMN BASE

Wide Flange Column

Angle Clip

Bolt Assembly

Anchor Bolt (By Others)

DRAWING T - BOTTOM STAIR STRINGER MOUNT

8" x 2-3/16" x 3/8" Channel

5/8"Ø x 6" Long Bolt Assembly

2-1/8" Square Tube Spacer

1-1/2" Fibertred®

9/16"Ø Hole for 1/2" Anchor Bolt (By Others)
Guidelines for the Engineer and Designer

DRAWING U - TOP STAIR STRINGER MOUNT

1-1/2" Grating

8" x 2-3/16" x 3/8" Channel

3/8" ø x 1-3/4" Long Bolt Assembly

1-1/2" Fibertred®

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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.

► Plasite
Plasite offers a complete line of high-quality corrosion resistant immersion and maintenance coatings for industrial applications. Plasite products include epoxies, epoxy phenolics, baked phenolics, vinyl esters, polyurethanes and acrylics. For more information on Plasite products, call 877/PLASITE.

► Carboline
The Carboline Company is a world-wide manufacturer of protective coatings, high-performance paints and fireproofing materials for industrial, commercial and OEM accounts. For more information on Carboline products, call 888/227-2654.