SECTION 13

SAFRAIL™ FIBERGLASS RAILING AND LADDER AND CAGE SYSTEMS

Look for this blue line in the left margin of the Design Manual documents. This line shows you where the latest update has been made.

SAFRAIL™ INDUSTRIAL RAILING SYSTEMS

INTRODUCTION TO SAFRAIL™ INDUSTRIAL RAILING SYSTEMS

SAFRAIL™ industrial fiberglass handrails are commercial railing systems for stair rails, platform/walkway handrails and guardrails. **SAFRAIL™** systems are fabricated from pultruded fiberglass components produced by Strongwell and molded thermoplastic connectors. The railing systems are particularly well-suited to corrosive environments like those found in industrial, chemical and wastewater treatment plants as well as commercial structures with urban and salt air corrosion.

SAFRAIL™ fiberglass handrail systems are:

- Corrosion Resistant
- Structurally Strong
- Impact Resistant
- Easy to Field Fabricate
- Low Thermal and Electrical Conductivity
- Lightweight

SAFRAIL™ systems are the result of more than 40 years of experience in the manufacture, design and fabrication of fiberglass handrail systems. The systems offer the following advantages:

- **Ease of Assembly** — **SAFRAIL™** systems are produced in lightweight standard sections that include both post and rail. Systems can be prefabricated in large sections and shipped to the site or they can also be fabricated and installed on site with simple carpenter tools.
- **Internal Connection System** — All connections fit flush, resulting in a pleasing, streamlined appearance. The internal connections allow the construction of continuous handrail systems around circular tanks without special fittings.
- **Safety Features** — **SAFRAIL™** systems come in a “safety yellow color”, feature low electrical conductivity for worker safety and exhibit high strength. Systems meet federal OSHA standards with a 2:1 factor of safety with an 1830mm maximum post spacing. **SAFRAIL™** systems also comply with international standard AFNOR NF E 85-101.
- **Low Maintenance** — Corrosion resistant fiberglass with molded-in color will outlast aluminum or steel systems with virtually no maintenance.
- **Cost Effective** — Fiberglass components and easy-to-assemble design provide savings on labor and maintenance, resulting in long-term savings and elimination of the cost and inconvenience of “downtime for repairs” in plant operations.

Guardrail

SAFRAIL™ industrial systems can be used in guardrail applications where railing is needed to protect the open side of an elevated walkway. SAFRAIL™ systems meet OSHA requirements for a height of 1067mm from the top of walkway to the top of the guardrail.

The OSHA loading requirement for both guardrail and handrail is a 91 kg concentrated load at any point or direction on the top rail. Other building codes may require different loading conditions.

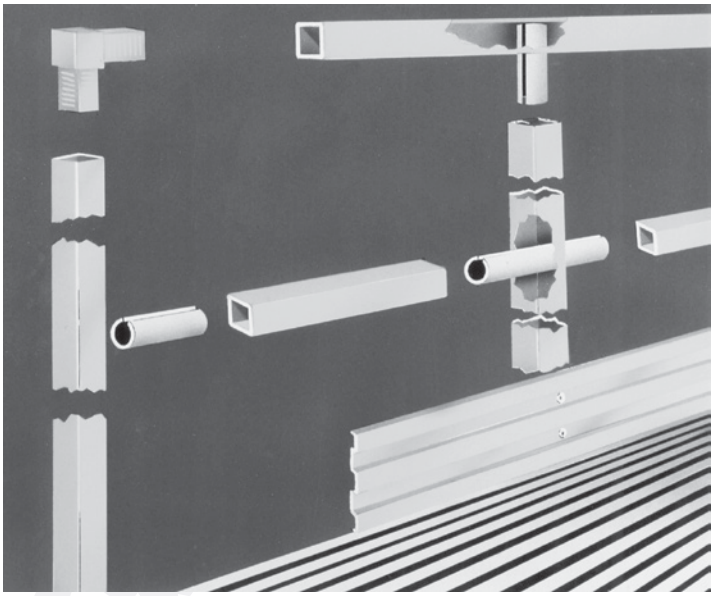
Custom Handrail Systems

SAFRAIL™ is designed to fit a wide variety of applications and because it is a standard system, to be cost effective. However, custom handrail systems are available from Strongwell to suit special needs. Contact Strongwell for special requirements.

BASIC SAFRAIL™ SQUARE HANDRAIL COMPONENTS

FABRICATION

The fiberglass handrail system can be fabricated into finished sections by fabricating and joining together the pultruded square tube using molded and pultruded components epoxy bonded and connected as shown in the fabrication details. Where required by OSHA, fiberglass kickplate shall be attached to the handrail posts with nylon rivets. Handrail sections shall be fabricated to the size shown on the approved fabrication drawings and shall be piece marked with a waterproof tag.

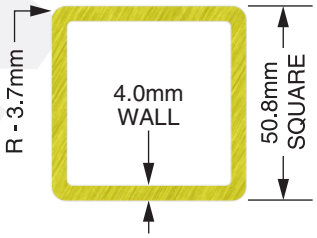


INSTALLATION AND MOUNTING

The post is constructed with a square pultruded bottom plug. The length must extend a minimum of one inch beyond the uppermost bolt hole to prevent crushing of post tubing. Bolt holes must provide clearance of 1.6mm for 12.7mm diameter bolts/studs. The holes should be on the longitudinal center line of the post 25.4mm from bottom of post (minimum) and not less than 76.2mm apart on center. The posts are fastened with stainless steel anchor bolts or studs 12.7mm diameter, extending no less than 82.6mm into the concrete, or into a minimum thickness of 6.4mm structural steel or pultruded fiberglass.

Post locations must be no greater than 457mm, nor less than 228.6mm from horizontal or vertical change in handrail direction. Posts are centered no greater than 1830mm apart on any straight run of rail, or 1219mm apart on any inclined rail section.

Post or Rail Section Properties



A	=	742.5mm²
S	=	1.077 x 10^4 mm³
I	=	2.735 x 10^5 mm⁴
*E	=	25,500 N/mm²
WT	=	1.41 kg/lin. m

*E = Flexural modulus full strength

Base mount, embedded, and removable are also types of mounting procedures for handrail. Contact approved fabricator for detailed information on these connection types.

The fabricated handrail systems are supplied complete with fittings by Strongwell. The components used to join fabricated sections together may be shaped loose, to be epoxied and tension pinned together in the field by the contractor, per Strongwell's recommendations.

FABRICATION METHODS

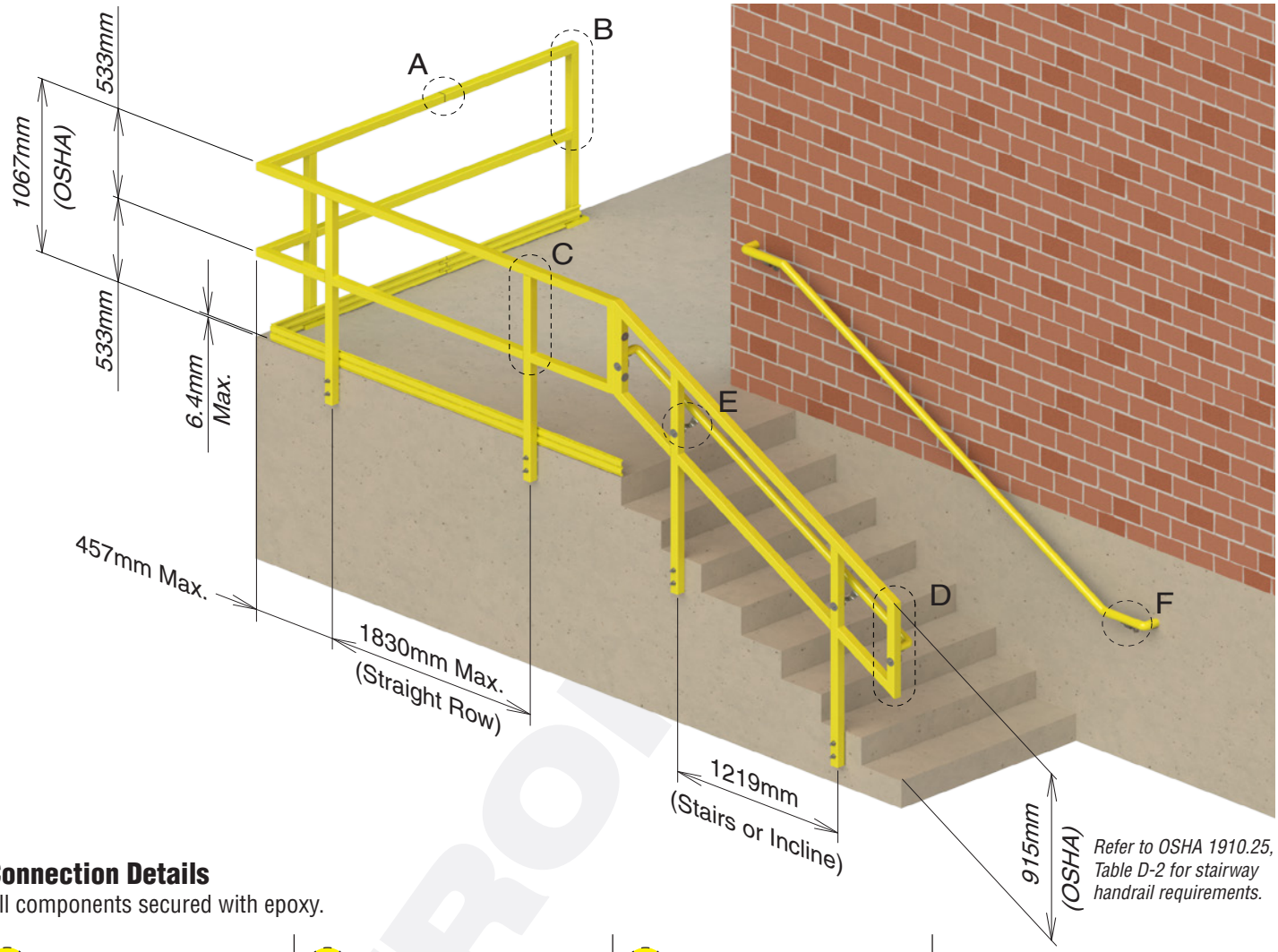
Cut components to length and miter where necessary. Locate and drill holes for split tube connector with a 42.7mm diameter core drill. Apply recommended epoxy adhesive (available from Strongwell) to connectors and inside tube. Press sections together and wipe off excess adhesive. 3.175mm tension pin is recommended at connections for field fabrication.

Joints must be immobilized until cured. The recommended temperature for epoxy cure is 15.6° C or above. Failure to use these installation and fabrication methods, including recommended epoxy adhesive and 42.7mm diameter core drill, may cause failure.

MATERIAL PROPERTIES (TYPICAL) FOR STANDARD RAILING FIBERGLASS PULTRUDED SQUARE RAILS AND POSTS

PROPERTY	TEST METHOD	UNITS	SQUARE RAIL
Ultimate Flexural Stess (Full Section)	N/A	N/mm²	248
Full Section Modulus (non-phenolic)	N/A	N/mm²	25,500
Full Section Modulus (phenolic)	N/A	N/mm²	41,400
Density	ASTM D792	g/cc	1.80 - 2.08
24 hr. Water Absorption (non-phenolic)	ASTM D570	% max by wt.	0.6
24 hr. Water Absorption (phenolic)	ASTM D570	% max by wt.	2.0
Coefficient of Thermal Expansion, lengthwise	ASTM D696	mm/mm/°C	1.2 x 10^{-5}

TYPICAL SAFRAIL™ SQUARE HANDRAIL CONSTRUCTION



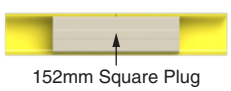
Refer to OSHA 1910.25, Table D-2 for stairway handrail requirements.

Connection Details

All components secured with epoxy.

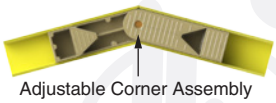
A RAIL SPLICE

STRAIGHT



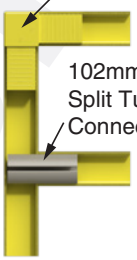
152mm Square Plug

ANGLE

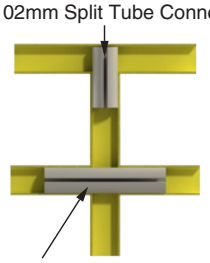


Adjustable Corner Assembly

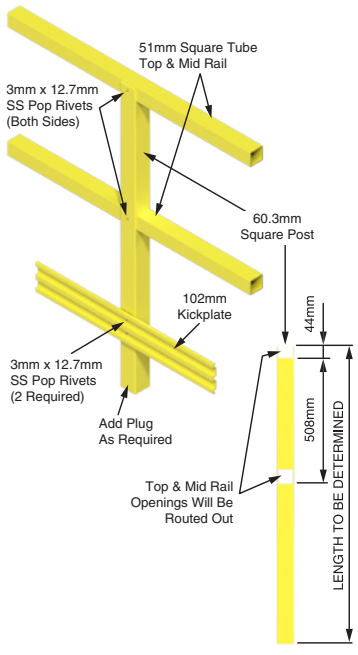
B END POST TO RAIL



C LINE POST TO RAIL

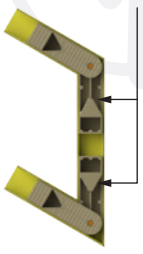


ALTERNATIVE POST DESIGN

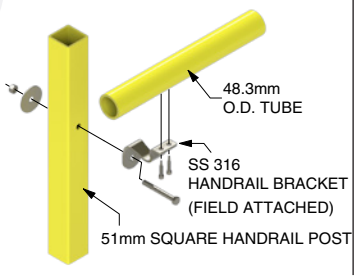


D STAIR RAIL RETURN

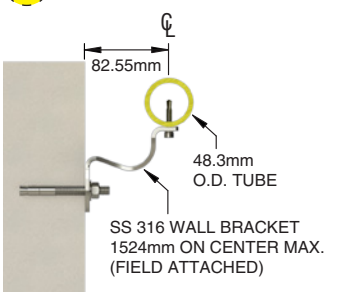
(2) Adjustable Corner Assemblies



E POST MOUNTED RAIL



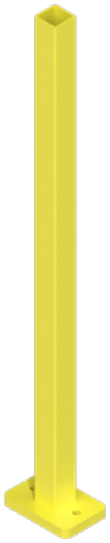
F WALL MOUNTED RAIL



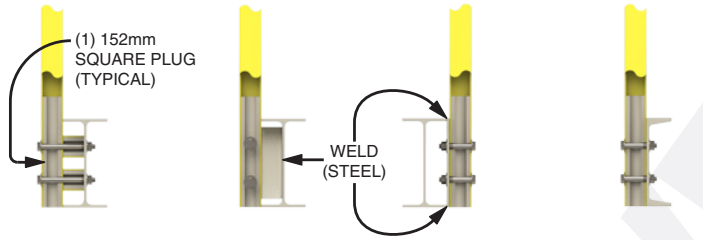
SAFRAIL™ SQUARE HANDRAIL FABRICATION AND INSTALLATION

RECOMMENDED SQUARE POST AND KICK PLATE INSTALLATION

Posts with FRP Base Plate

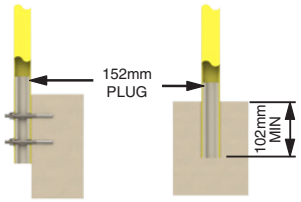


Fastening to Structural Steel or Fiberglass



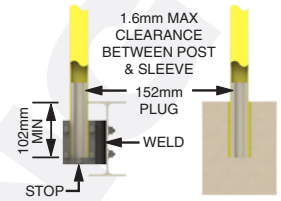
I BEAM WITH SPACERS | PERPENDICULAR PLATE | PARALLEL PLATE | CHANNEL

Fastening to Concrete



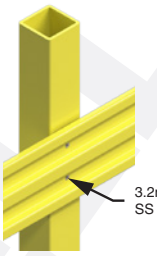
ANCHORED TO CONCRETE | EMBEDDED IN CONCRETE

Removable Posts

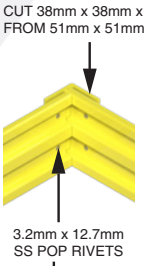


SLEEVE ON STRUCTURAL STEEL | SLEEVE IN CONCRETE

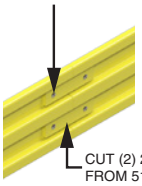
Kickplate to Post



Kickplate Corner

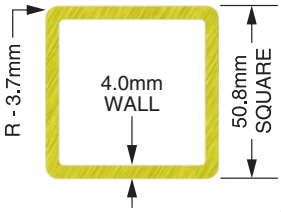


Kickplate Splice

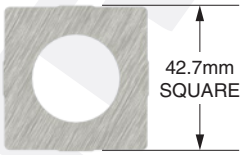


SQUARE HANDRAIL COMPONENTS

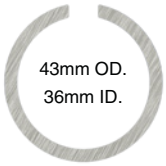
Post or Rail



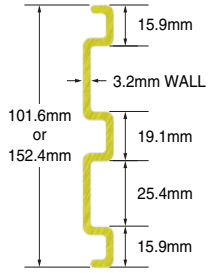
Square Plug



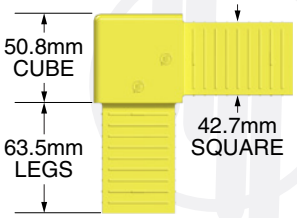
Split Tube Connector



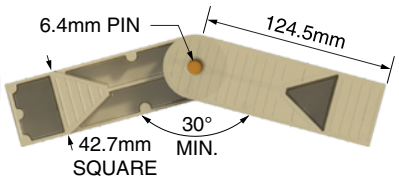
Kickplate



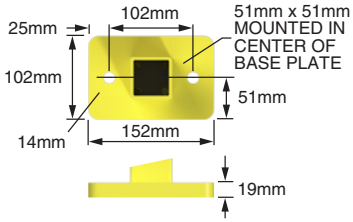
90° Corner



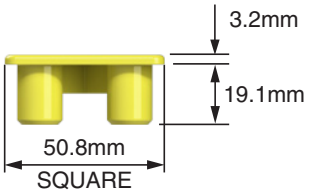
Adjustable Corner Assembly



Post Base (Mounted To Post)



End Cap



Note: For Capping Tubes (Special Construction)

Supplementary Components:

- Nylon Rivets
- 3.175mm x 38.1mm Tension Pins
- Two-Part Epoxy Kits
- Mounting Bolts
- Kickplate Splice and Corner Connectors

SAFRAIL™ ROUND HANDRAIL SYSTEM

INTRODUCTION

The **SAFRAIL™** round handrail system is a round fiberglass system that is ideal for any high traffic area where handrail is needed. The round rails are easy to grip and 90° molded corners eliminate sharp edges.

The handrail system meets OSHA strength requirements with a 2:1 factor of safety with a 1524mm maximum post spacing. The handrail system can be made to comply with ADA standards upon request.

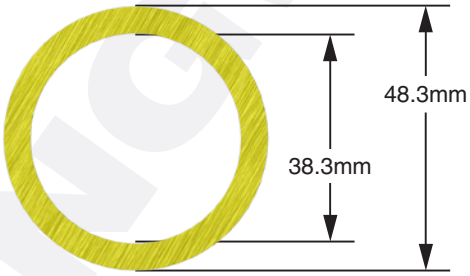
Internally bonded fiberglass connectors result in no visible rivets or metal parts. Rail and posts are 48.3mm O.D. x 38.3mm I.D. This is the same outside dimension as typical metal rails for ease of adapting to common metal brackets. Kickplates are available upon request.

The **SAFRAIL™** round handrail system is pultruded using either a vinyl ester or a polyester resin system. The handrail system includes a UV inhibitor for additional resistance to ultraviolet degradation and corrosion.

ROUND POST OR RAIL SECTION PROPERTIES

A = 677.4mm^2
S = 6.637 x 10^3 mm^3
I = 1.602 x 10^5 mm^4
*E = 31,000 N/mm^2
WT = 1.28 kg/lin. m

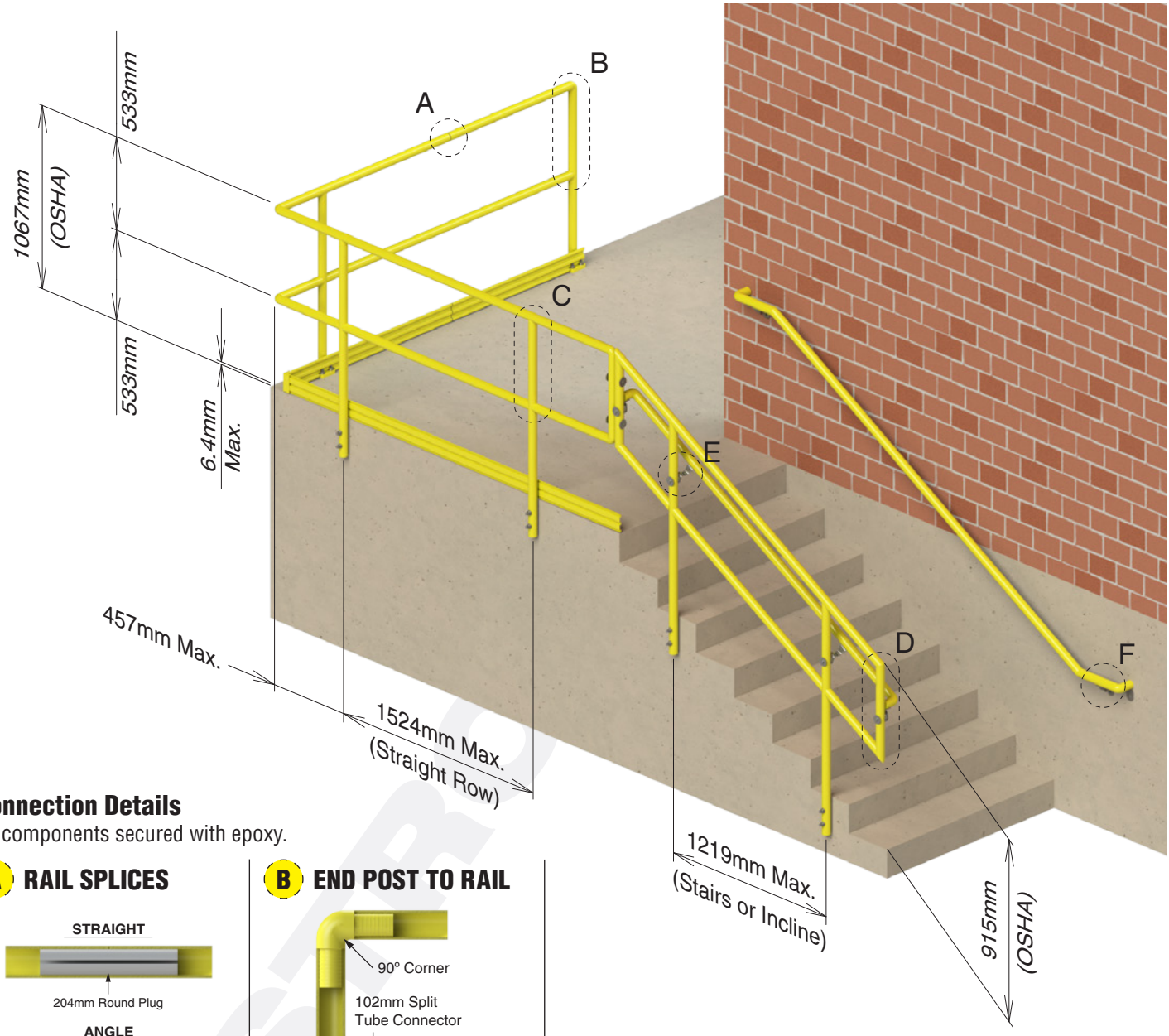
*E = Flexural modulus full strength



MATERIAL PROPERTIES (TYPICAL) FOR STANDARD RAILING FIBERGLASS PULTRUDED ROUND RAILS AND POSTS

PROPERTY	TEST METHOD	UNITS	VALUES
Ultimate Flexural Stess (Full Section)	N/A	N/mm^2	414
Full Section Modulus (non-phenolic)	N/A	N/mm^2	31,000
Full Section Modulus (phenolic)	N/A	N/mm^2	41,400
Density	ASTM D792	g/cc	1.80 - 2.08
24 hr. Water Absorption (non-phenolic)	ASTM D570	% max by wt.	0.6
24 hr. Water Absorption (phenolic)	ASTM D570	% max by wt.	2.0
Coefficient of Thermal Expansion, lengthwise	ASTM D696	mm/mm/°C	1.2 x 10^{-5}

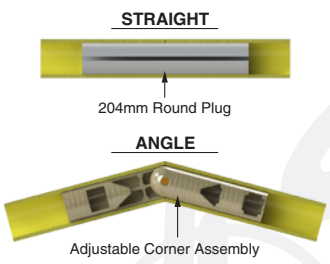
TYPICAL SAFRAIL™ ROUND HANDRAIL CONSTRUCTION



Connection Details

All components secured with epoxy.

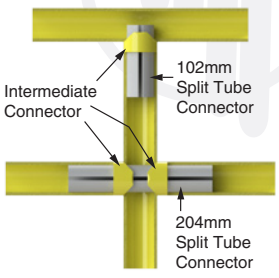
A RAIL SPLICES



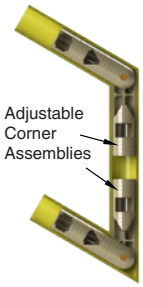
B END POST TO RAIL

Refer to OSHA 1910.25, Table D-2 for stairway handrail requirements.

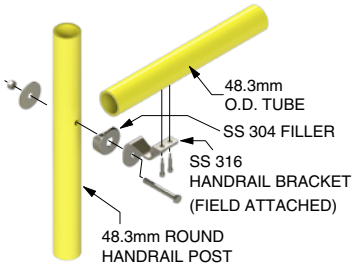
C LINE POST TO RAIL



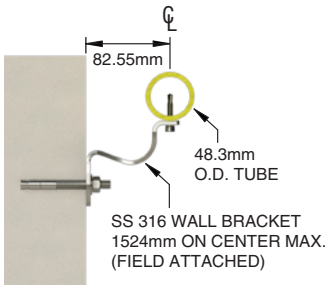
D STAIR RAIL RETURN



E POST MOUNTED RAIL



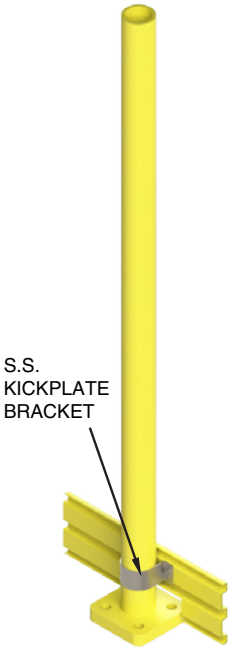
F WALL MOUNTED RAIL



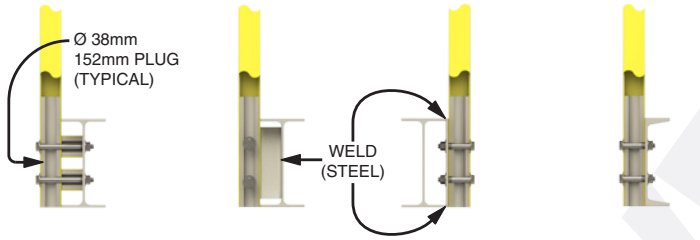
SAFRAIL™ ROUND HANDRAIL SYSTEM

RECOMMENDED ROUND POST AND KICK PLATE INSTALLATION

Posts with FRP Base Plate

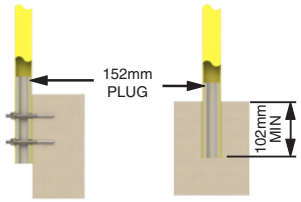


Fastening to Structural Steel or Fiberglass



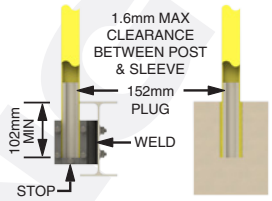
I BEAM WITH SPACERS | PERPENDICULAR PLATE | PARALLEL PLATE | CHANNEL

Fastening to Concrete



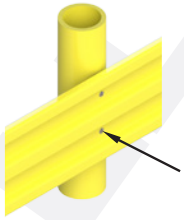
ANCHORED TO CONCRETE | EMBEDDED IN CONCRETE

Removable Posts

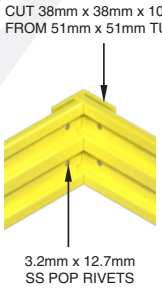


SLEEVE ON STRUCTURAL STEEL | SLEEVE IN CONCRETE

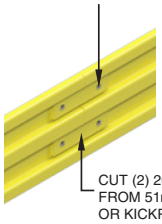
Kickplate to Post



Kickplate Corner



Kickplate Splice

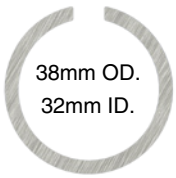


ROUND HANDRAIL COMPONENTS

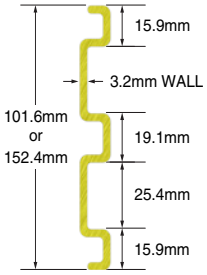
Intermediate Connector

Round Plug

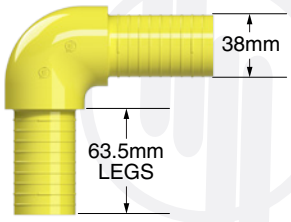
Split Tube Connector



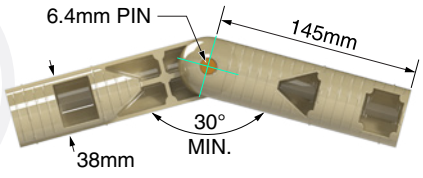
Kickplate



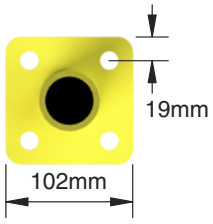
90° Corner



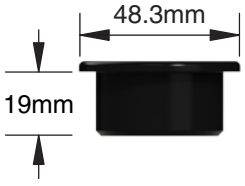
Adjustable Corner Assembly



Post Base (Mounted To Post)



End Cap



Note:
For Capping Tubes
(Special Construction)

Supplementary Components:

- Nylon Rivets
- 3.175mm x 38.1mm Tension Pins
- Two-Part Epoxy Kits
- Mounting Bolts
- Kickplate Splice and Corner Connectors

SAFRAIL™ ECONOMY CHANNEL TOP HANDRAIL SYSTEM

INTRODUCTION

The **SAFRAIL™** channel top industrial fiberglass handrail is an economical commercial railing system designed for long runs on platforms and walkways. The railing system is designed for fabrication efficiency and is not particularly well-suited for stair rails with twists and turns. SAFRAIL™ channel top can be used in combination with round and square SAFRAIL™.

The handrail system meets OSHA strength requirements with a 2:1 factor of safety with a 1500mm maximum post spacing. The handrail system can be made to comply with ADA standards upon request.

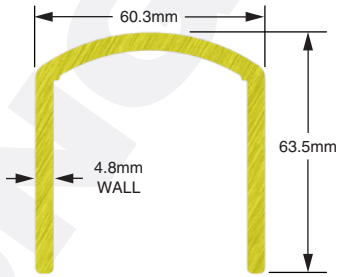
Internally bonded fiberglass connectors result in no visible rivets or metal parts. Rails are 60.3mm wide x 63.5mm tall. This is the same outside dimension as typical metal rails for ease of adapting to common metal brackets. Kickplates are available upon request.

The **SAFRAIL™** channel top handrail system is pultruded using either a vinyl ester or a polyester resin system. The handrail system includes a UV inhibitor for additional resistance to ultraviolet degradation and corrosion.

TOP RAIL SECTION PROPERTIES

$A = 780.6mm^2$
$S_x = 1.576 \times 10^4\ mm^3$
$S_y = 1.535 \times 10^4\ mm^3$
$I_x = 2.984 \times 10^5\ mm^4$
$I_y = 4.620 \times 10^5\ mm^4$
$*E = 20{,}700\ N/mm^2$
$WT = 1.47\ kg/lin.\ m$

*E = Flexural modulus full strength

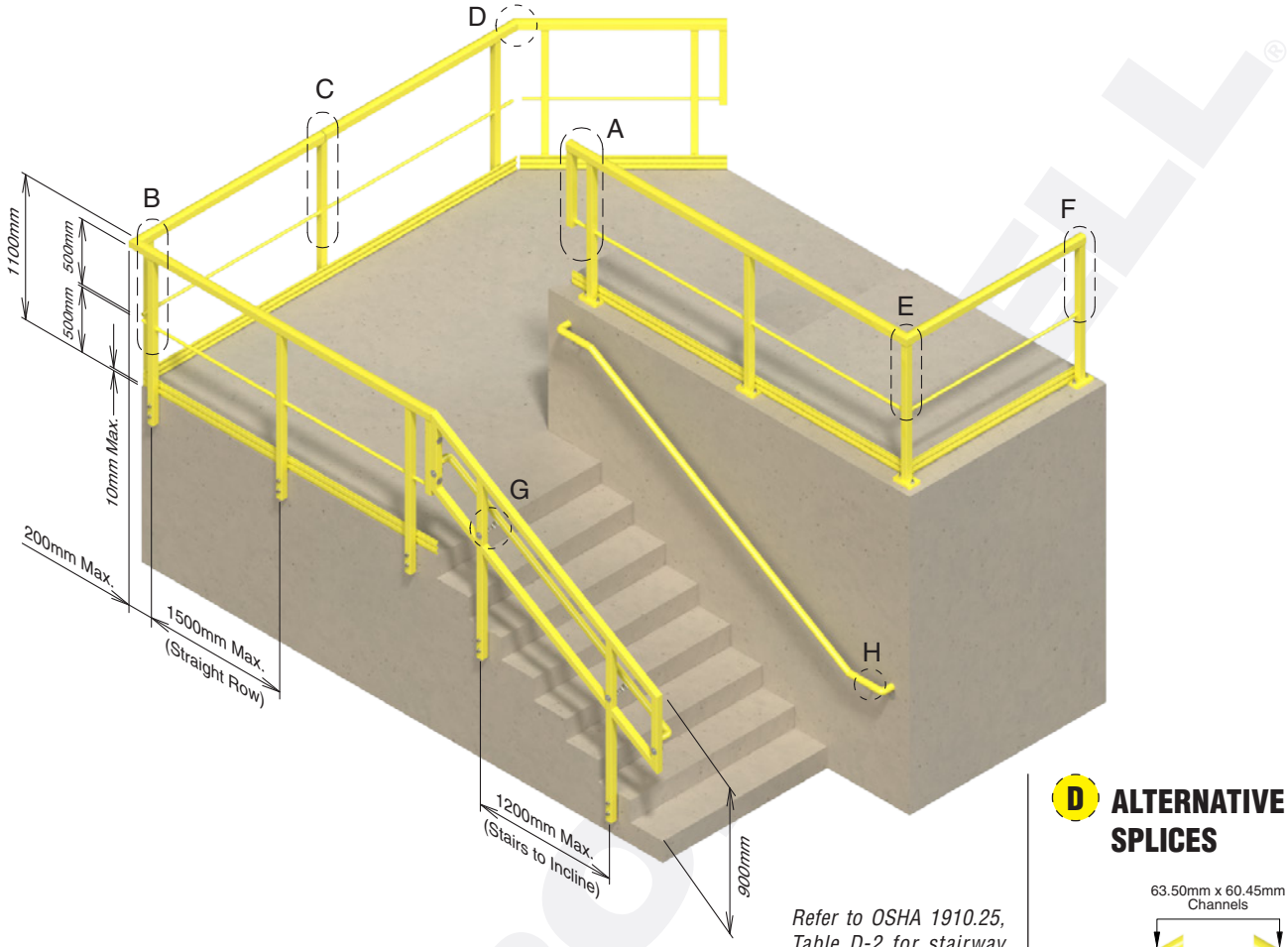


MATERIAL PROPERTIES (TYPICAL) FOR STANDARD RAILING FIBERGLASS PULTRUDED CHANNEL TOP RAILS

PROPERTY	TEST METHOD	UNITS	VALUES
Ultimate Flexural Stess (Full Section)	N/A	N/mm^2	207
Full Section Modulus (non-phenolic)	N/A	N/mm^2	20,700
Full Section Modulus (phenolic)	N/A	N/mm^2	N/A
Density	ASTM D792	g/cc	1.80 - 2.08
24 hr. Water Absorption (non-phenolic)	ASTM D570	% max by wt.	0.6
24 hr. Water Absorption (phenolic)	ASTM D570	% max by wt.	N/A
Coefficient of Thermal Expansion, lengthwise	ASTM D696	mm/mm/°C	1.2×10^{-5}

STRONGWELL

TYPICAL SAFRAIL™ ECONOMY CHANNEL TOP HANDRAIL CONSTRUCTION

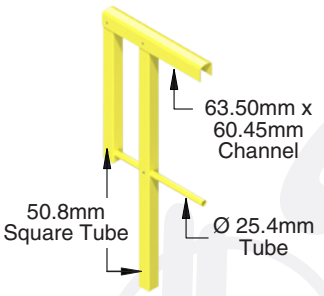


Refer to OSHA 1910.25, Table D-2 for stairway handrail requirements.

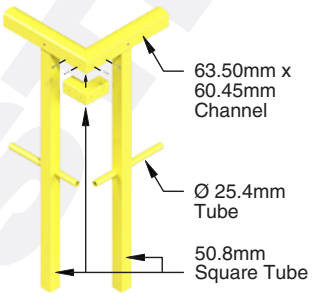
Connection Details

All components secured with rivets.

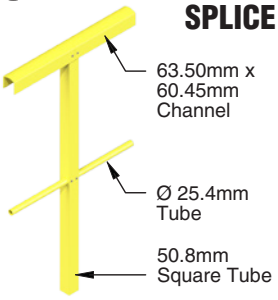
A END RETURN



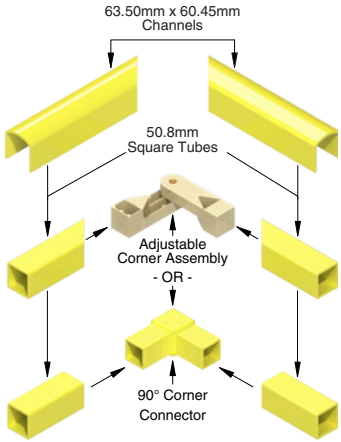
B CORNER SPLICE



C TOP & MID RAIL SPLICE

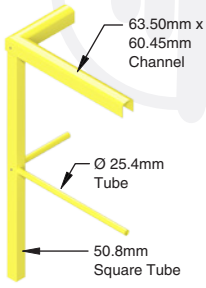


D ALTERNATIVE RAIL SPLICES

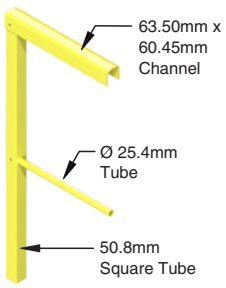


Note: Field epoxy adjustable corner inside 50.8mm tubes at angled intersections. Slip inside 63.5mm channels.

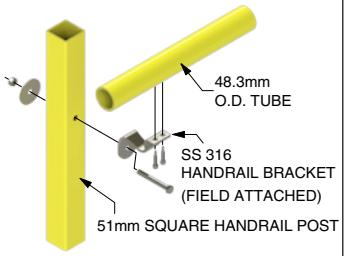
E CORNER POST



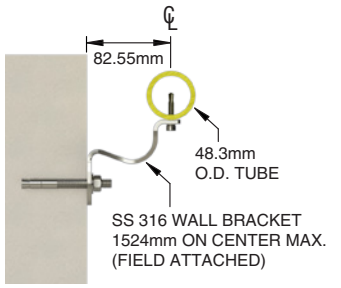
F END POST



G POST MOUNTED RAIL



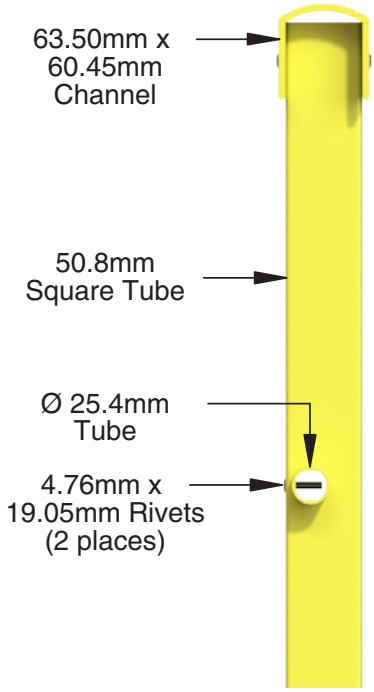
H WALL MOUNTED RAIL

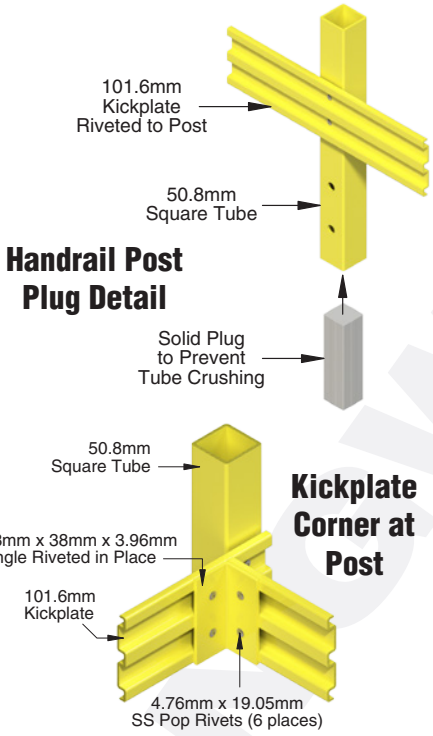


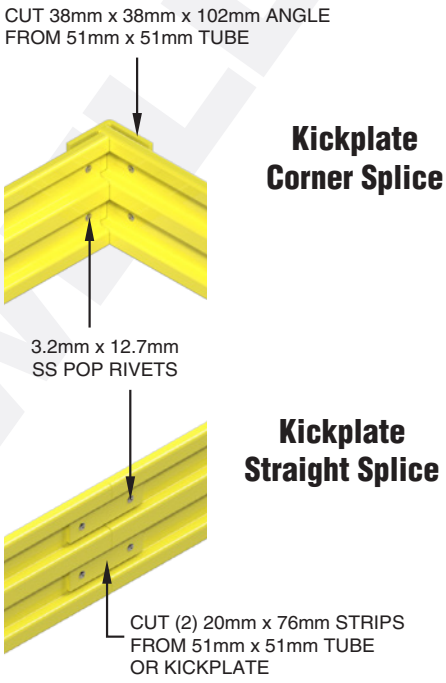
SAFRAIL™ ECONOMY CHANNEL TOP HANDRAIL SYSTEM

RECOMMENDED ROUND POST AND KICK PLATE INSTALLATION

Handrail Post, Top Rail & Mid Rail

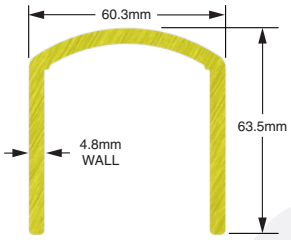




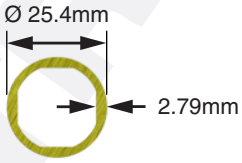


CHANNEL TOP HANDRAIL COMPONENTS

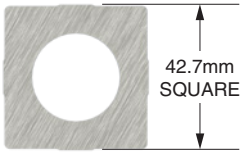
Top Rail



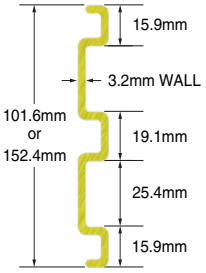
Mid Rail



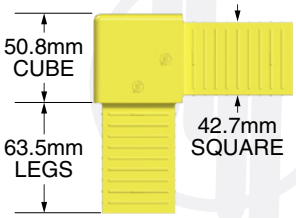
Square Plug



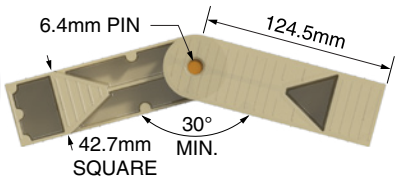
Kickplate



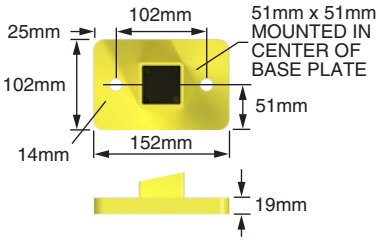
90° Corner



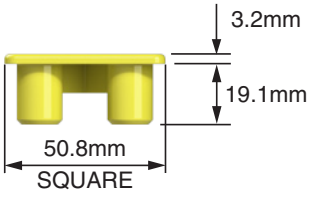
Adjustable Corner Assembly



Post Base (Mounted To Post)



End Cap



Note:
For Capping Tubes
(Special Construction)

Supplementary Components:

- Nylon Rivets
- 3.175mm x 38.1mm Tension Pins
- Two-Part Epoxy Kits
- Mounting Bolts
- Kickplate Splice and Corner Connectors

FIBERGLASS LADDER & CAGE SYSTEMS

INTRODUCTION TO SAFRAIL™ LADDERS & LADDER CAGE SYSTEMS

SAFRAIL™ fiberglass ladders and ladder cages are fabricated from pultruded fiberglass components and produced by Strongwell. **SAFRAIL™** fiberglass ladders are constructed of side rails, rungs, and cage straps produced by the pultrusion process and cage hoops produced by the open molded hand lay-up method.

SAFRAIL™ ladder and cage systems meet the requirements set forth in OSHA 1910.23 and 1926.1053.

The side rails and cage straps are fiberglass reinforced pultruded polyester with OSHA safety yellow pigment. An optional industrial grade polyurethane coating may be applied to the finished ladder and cage for outdoor application.

The side rails are 51 x 51 x 4mm or 60 x 60 x 4.76mm square tube. The rungs are pultruded 31.75mm diameter FRP fluted tube for a non-skid surface.

Cage hoops are produced by the open mold hand lay-up process with a width of 76mm and thickness of 6mm minimum. The cage is interconnected with 51 x 5mm pultruded straps spaced 230mm on center around the hoop.

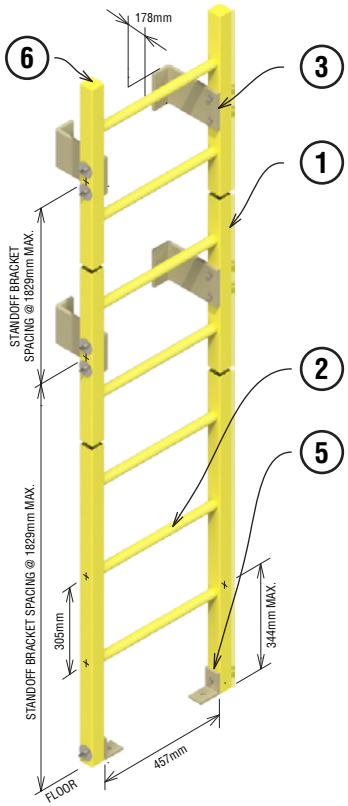
All cut or machined edges, holes and abrasions shall be sealed with a resin compatible with the resin matrix used in the structural shape.

All joints and rungs are epoxied and riveted. The hoops are attached to the rails so that hand clearance is provided throughout the length of the ladder. The cages may be shipped as kits for field assembly.

Ladders are shop assembled and may be pre-drilled and prepared for field attachment of standoff clips.

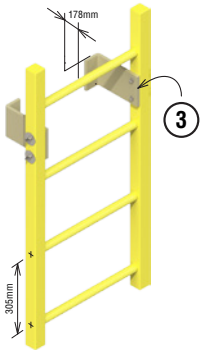
STANDARD LADDER SYSTEMS

STANDARD LADDER

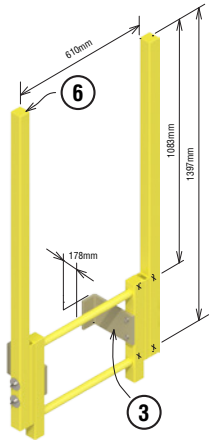


Standard Base Mount

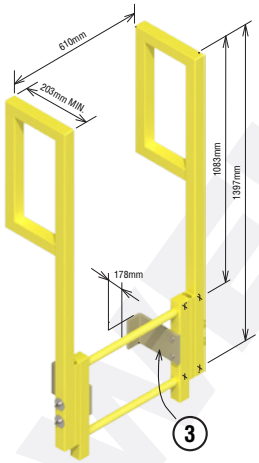
TOP OPTIONS



Standard

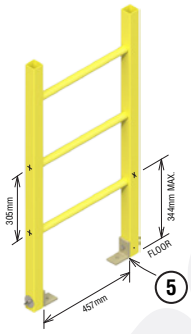


Standard
24" Walk Through

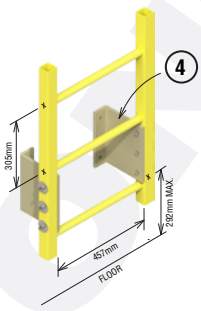


24" Walk Through
with Return

BOTTOM OPTIONS

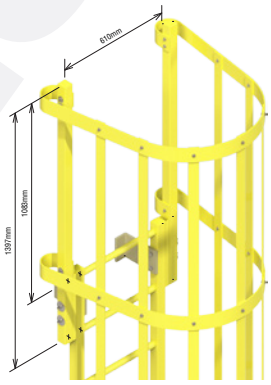


Base Mount

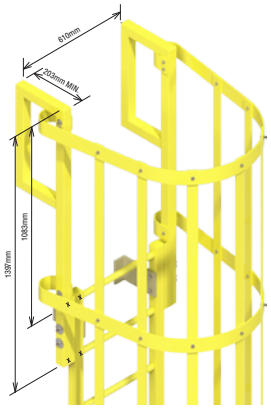


Wall Mount

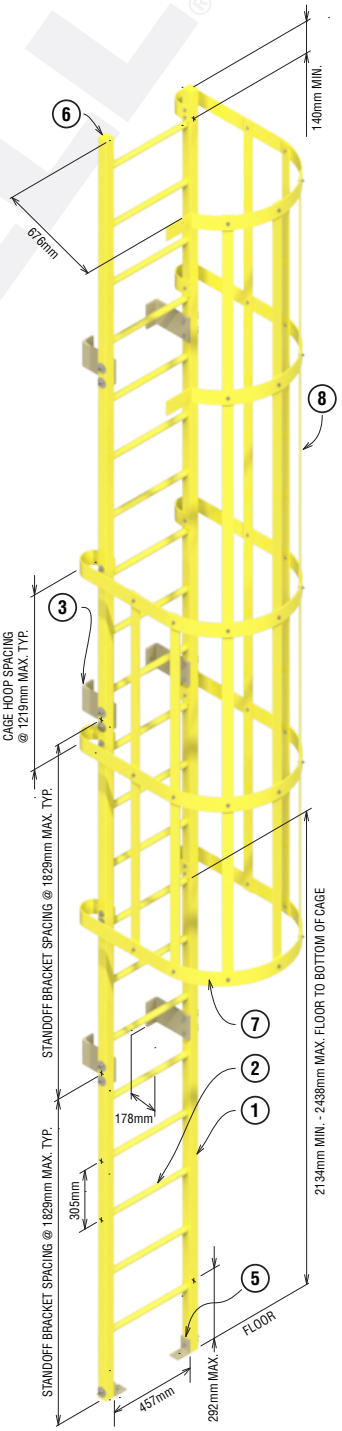
CAGE OPTIONS



Standard 24" Walk Through



24" Walk Through with Return



Side Access Base Mount

PART IDENTIFICATION

	NAME	DESCRIPTION
1	Side Rail	51 x 4mm square tube
2	Rung	31.75mm diameter fluted tube
3	Intermediate Standoff Bracket	70 x 203.2 x 9.5mm angle, 127mm long
4	Wall Standoff Bracket	70 x 203.2 x 9.5mm angle, 254mm long
5	Bottom Bracket	76 x 76 x 9.5mm angle, 50.8mm long
6	End Plug	Molded end cap
7	Cage Hoop	76 x 6mm strip
8	Cage Straps	51 x 5mm strip

Note: All FRP to FRP fasteners are SS 316.

CUSTOM OPTIONS

Custom Ladder and Cage System options include:

- Custom rung widths
- Custom rail options for unsupported ladder heights, including larger tubes, trusses, or solid bars
- Custom 25mm gritted solid rungs: round, square, diamond
- Larger stand-off brackets to avoid obstructions
- End returns and safety gates
- Cages available fully assembled or unassembled for field assembly