KRUPPSMETAL®

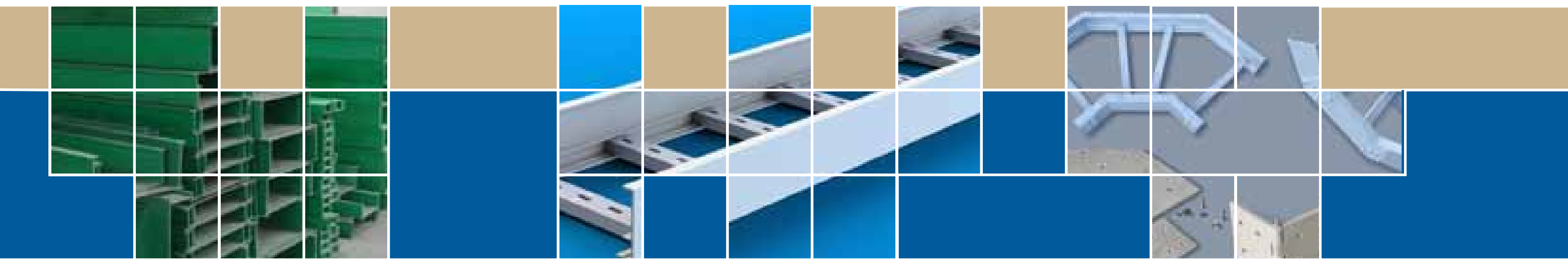
Cable Management System

Metal Raceway Product Range

FRP/GRP Product Advantages:

Fibre-reinforced plastic (FRP) (also fibre-reinforced polymer) is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, or aramid, although other fibres such as paper or wood or asbestos have been sometimes used. The polymer is usually an epoxy, vinylester or polyester thermosetting plastic, and phenol formaldehyde resins are still in use. FRPs are commonly used in the aerospace, automotive, marine, and construction industries.

A polymer is generally manufactured by Step-growth polymerization or addition polymerization. When combined with various agents to enhance or in any way alter the material properties of polymers the result is referred to as a plastic. Composite plastics refer to those types of plastics that result from bonding two or more homogeneous materials with different material properties to derive a final product with certain desired material and mechanical properties. Fibre reinforced plastics are a category of composite plastics that specifically use fibre materials to mechanically enhance the strength and elasticity of plastics. The original plastic material without fibre reinforcement is known as the matrix. The matrix is a tough but relatively weak plastic that is reinforced by stronger stiffer reinforcing filaments or fibres. The extent that strength and elasticity are enhanced in a fibre reinforced plastic depends on the mechanical properties of both the fibre and matrix, their volume relative to one another, and the fibre length and orientation within the matrix. Reinforcement of the matrix occurs by definition when the FRP material exhibits increased strength or elasticity relative to the strength and elasticity of the matrix alone.



Fibre process

The manufacture of fibre fabric

Reinforcing Fibre is manufactured in both two dimensional and three dimensional orientations

Two Dimensional Fibre Reinforced Polymer are characterized by a laminated structure in which the fibres are only aligned along the plane in x-direction and y-direction of the material. This means that no fibres are aligned in the through thickness or the z-direction, this lack of alignment in the through thickness can create a disadvantage in cost and processing. Costs and labour increase because conventional processing techniques used to fabricate composites, such as wet hand lay-up, autoclave and resin transfer moulding, require a high amount of skilled labour to cut, stack and consolidate into a preformed component.

Three-dimensional Fibre Reinforced Polymer composites are materials with three dimensional fibre structures that incorporate fibres in the x-direction, y-direction and z-direction. The development of three-dimensional orientations arose from industry's need to reduce fabrication costs, to increase through-thickness mechanical properties, and to improve impact damage tolerance; all were problems associated with two dimensional fibre reinforced polymers.
The manufacture of fibre preforms

Fibre preforms are how the fibres are manufactured before being bonded to the matrix. Fibre preforms are often manufactured in sheets, continuous mats, or as continuous filaments for spray applications. The four major ways to manufacture the fibre preform is though the textile processing techniques of Weaving, knitting, braiding and stitching.

Weaving can be done in a conventional manner to produce two-dimensional fibres as well in a multilayer weaving that can create three-dimensional fibres. However, multilayer weaving is required to have multiple layers of warp yarns to create fibres in the z- direction creating a few disadvantages in manufacturing,namely the time to set up all the warp yarns on the loom. Therefore most multilayer weaving is currently used to produce relatively narrow width products, or high value products where the cost of the preform production is acceptable. Another one of the main problems facing the use of multilayer woven fabrics is the difficulty in producing a fabric that contains fibres oriented with angles other than 0" and 90" to each other respectively.

The second major way of manufacturing fibre preforms is Braiding. Braiding is suited to the manufacture of narrow width flat or tubular fabric and is not as capable as weaving in the production of large volumes of wide fabrics. Braiding is done over top of mandrels that vary in cross-sectional shape or dimension along their length. Braiding is limited to objects about a brick in size. Unlike the standard weaving process, braiding can produce fabric that contains fibres at 45 degrees angles to one another. Braiding three-dimensional fibres can be done using four step, two-step or Multilayer Interlock Braiding.Four step or row and column braiding utilizes a flat bed containing rows and columns of yarn carriers that form the shape of the desired preform. Additional carriers are added to the outside of the array, the precise location and quantity of which depends upon the exact preform shape and structure required. There are four separate sequences of row and column motion, which act to interlock the yarns and produce the braided preform. The yarns are mechanically forced into the structure between each step to consolidate the structure in a similar process to the use of a reed in weaving.Two-step braiding is unlike the four step process because the two-step includes a large number of yarns fixed in the axial direction and a fewer number of braiding yarns. The process consists of two steps in which the braiding carriers move completely through the structure between the axial carriers. This relatively simple sequence of motions is capable of forming preforms of essentially any shape, including circular and hollow shapes. Unlike the four step process the two step process does not require mechanical compaction the motions involved in the process allows the braid to be pulled tight by yarn tension alone. The last type of braiding is multi-layer interlocking braiding that consists of a number of standard circular braiders being joined together to form a cylindrical braiding frame. This frame has a number of parallel braiding tracks around the circumference of the cylinder but the mechanism allows the transfer of yarn carriers between adjacent tracks forming a multilayer braided fabric with yarns interlocking to adjacent layers. The multilayer interlock braid differs from both the four step and two-step braids in that the interlocking yarns are primarily in the plane of the structure and thus do not significantly reduce the in-plane properties of the preform. The four step and two step processes produce a greater degree of interlinking as the braiding yarns travel through the thickness of the preform, but therefore contribute less to the in-plane performance of the preform. A disadvantage of the multilayer interlock equipment is that due to the conventional sinusoidal movement of the yarn carriers to form the preform, the equipment is not able to have the density of yarn carriers that is possible with the two step and four step machines.

Knitting fibre preforms can be done with the traditional methods of Warp and [Weft] Knitting, and the fabric produced is often regarded by many as two-dimensional fabric, but machines with two or more needle beds are capable of producing multilayer fabrics with yams that traverse between the layers. Developments in electronic controls for needle selection and knit loop transfer, and in the sophisticated mechanisms that allow specific areas of the fabric to be held and their movement controlled. This has allowed the fabric to form itself into the required three-dimensional preform shape with a minimum of material wastage.

Stitching is arguably the simplest of the four main textile manufacturing techniques and one that can be performed with the smallest investment in specialized machinery. Basically the stitching process consists of inserting a needle, carrying the stitch thread, through a stack of fabric layers to form a 3D structure. The advantages of stitching are that it is possible to stitch both dry and prepreg fabric, although the tackiness of the prepreg makes the process difficult and generally creates more damage within the prepreg material than in the dry fabric. Stitching also utilizes the standard two-dimensional fabrics that are commonly in use within the composite industry therefore there is a sense of familiarity concerning the material systems. The use of standard fabric also allows a greater degree of flexibility in the fabric lay-up of the component than is possible with the other textile processes, which have restrictions on the fibre orientations that can be produced.

Moulding processes

There are two distinct categories of moulding processes using FRP plastics; this includes composite moulding and wet moulding. Composite moulding uses Prepreg FRP, meaning the plastics are fibre reinforced before being put through further moulding processes. Sheets of Prepreg FRP are heated or compressed in different ways to create geometric shapes. Wet moulding combines fibre reinforcement and the matrix or resist during the moulding process. The different forms of composite and wet moulding, are listed below.

Composite moulding

Bladder moulding

Individual sheets of prepreg material are laid -up and placed in a female-style mould along with a balloon-like bladder. The mould is closed and placed in a heated press. Finally, the bladder is pressurized forcing the layers of material against the mould walls. The part is cured and removed from the hot mould. Bladder moulding is a closed moulding process with a relatively short cure cycle between 15 and 60 minutes making it ideal for making complex hollow geometric shapes at competitive costs.

Compression moulding

A "preform" or "charge", of SMC, BMC or sometimes prepreg fabric, is placed into mould cavity. The mould is closed and the material is compacted & cured inside by pressure and heat. Compression moulding offers excellent detailing for geometric shapes ranging from pattern and relief detailing to complex curves and creative forms, to precision engineering all within a maximum curing time of 20 minutes.

Autoclave / vacuum bag

Individual sheets of prepreg material are laid-up and placed in an open mold. The material is covered with release film, bleeder/breather material and a vacuum bag. A vacuum is pulled on part and the entire mould is placed into an autoclave (heated pressure vessel). The part is cured with a continuous vacuum to extract entrapped gasses from laminate. This is a very common process in the aerospace industry because it affords precise control over the moulding process due to a long slow cure cycle that is anywhere from one to two hours. This precise control creates the exact laminate geometric forms needed to ensure strength and safety in the aerospace industry, but it is also slow and labour intensive, meaning costs often confine it to the aerospace industry.

Mandrel wrapping

Sheets of prepreg material are wrapped around a steel or aluminium mandrel. The prepreg material is compacted by nylon or polypropylene cello tape. Parts are typically batch cured by hanging in an oven. After cure the cello and mandrel are removed leaving a hollow carbon tube. This process creates strong and robust hollow carbon tubes.

Wet layup

Fibre reinforcing fabric is placed in an open mould and then saturated with a wet [resin] by pouring it over the fabric and working it into the fabric and mould. The mould is then left so that the resin will cure, usually at room temperature, though heat is sometimes used to ensure a proper curing process. Glass fibres are most commonly used for this process, the results are widely known as fibreglass, and is used to make common products like skis, canoes, kayaks and surf boards.

Chopper gun

Continuous strand of fibreglass are pushed through a hand-held gun that both chops the strands and combines them with a catalysed resin such as polyester. The impregnated chopped glass is shot onto the mould surface in whatever thickness the design and human operator think is appropriate. This process is good for large production runs at economical cost, but produces geometric shapes with less strength than other moulding processes and has poor dimensional tolerance.

Filament winding

Machines pull fibre bundles through a wet bath of resin and wound over a rotating steel mandrel in specific orientations Parts are cured either room temperature or elevated temperatures. Mandrel is extracted, leaving a final geometric shape but can be left in some cases.

Pultrusion

Fibre bundles and slit fabrics are pulled through a wet bath of resin and formed into the rough part shape. Saturated material is extruded from a heated closed die curing while being continuously pulled through die. Some of the end products of the pultrusion process are structural shapes, i.e. I beam, angle, channel and flat sheet. These materials can be used to create all sorts of fibreglass structures such as ladders, platforms, handrail systems tank, pipe and pump supports.

RTM & VARTM

Also called resin infusion. Fabrics are placed into a mould which wet resin is then injected into. Resin is typically pressurized and forced into a cavity which is under vacuum in the RTM (Resin Transfer Molding) process. Resin is entirely pulled into cavity under vacuum in the VARTM (Vacuum Assisted Resin Transfer Molding) process. This moulding process allows precise tolerances and detailed shaping but can sometimes fail to fully saturate the fabric leading to weak spots in the final shape.

Advantages and limitations

FRP allows the alignment of the glass fibres of thermoplastics to suit specific design programs. Specifying the orientation of reinforcing fibres can increase the strength and resistance to deformation of the polymer. Glass reinforced polymers are strongest and most resistive to deforming forces when the polymers fibres are parallel to the force being exerted, and are weakest when the fibres are perpendicular. Thus this ability is at once both an advantage or a limitation depending on the context of use. Weak spots of perpendicular fibres can be used for natural hinges and connections, but can also lead to material failure when production processes fail to properly orient the fibres parallel to expected forces. When forces are exerted perpendicular to the orientation of fibres the strength and elasticity of the polymer is less than the matrix alone. In cast resin components made of glass reinforced polymers such as UP and EP, the orientation of fibres can be oriented in two-dimensional and three-dimensional weaves. This means that when forces are possibly perpendicular to one orientation, they are parallel to another orientation; this eliminates the potential for weak spots in the polymer.

Failure modes

Structural failure can occur in FRP materials when:

Tensile forces stretch the matrix more than the fibres, causing the material to shear at the interface between matrix and fibres. Tensile forces near the end of the fibres exceed the tolerances of the matrix, separating the fibres from the matrix. Tensile forces can also exceed the tolerances of the fibres causing the fibres themselves to fracture leading to material failure.

Material requirements

The matrix must also meet certain requirements in order to first be suitable for the FRP process and ensure a successful reinforcement of itself. The matrix must be able to properly saturate, and bond with the fibres within a suitable curing period. The matrix should preferably bond chemically with the fibre reinforcement for maximum adhesion. The matrix must also completely envelope the fibres to protect them from cuts and notches that would reduce their strength, and to transfer forces to the fibres. The fibres must also be kept separate from each other so that if failure occurs it is localized as much as possible, and if failure occurs the matrix must also debond from the fibre for similar reasons. Finally the matrix should be of a plastic that remains chemically and physically stable during and after reinforcement and moulding processes. To be suitable for reinforcement material fibre additives must increase the tensile strength and modulus of elasticity of the matrix and meet the following conditions; fibres must exceed critical fibre content; the strength and rigidity of fibres itself must exceed the strength and rigidity of the matrix alone; and there must be optimum bonding between fibres and matrix

Glass fibre material

Further information: Glass-reinforced plastic glam resinforced polyester FRPs use textile glass fibres; textile fibres are different from other forms of glass fibres used for insulating applications. Textile glass fibres begin as varying combinations of SiO_2, Al_2O_3, B_2O_3, CaO, or MgO in powder form. These mixtures are then heated through a direct melt process to temperatures around 1300 degrees Celsius, after which dies are used to extrude filaments of glass fibre in diameter ranging from 9 to 17 µm. These filaments are then wound into larger threads and spun onto bobbins for transportation and further processing. Glass fibre is by far the most popular means to reinforce plastic and thus enjoys a wealth of production processes, some of which are applicable to aramid and carbon fibres as well owing to their shared fibrous qualities.

Roving is a process where filaments are spun into larger diameter threads. These threads are then commonly used for woven reinforcing glass fabrics and mats, and in spray applications. Fibre fabrics are web-form fabric reinforcing material that has both warp and weft directions. Fibre mats are web-form non-woven mats of glass fibres. Mats are manufactured in cut dimensions with chopped fibres, or in continuous mats using continuous fibres. Chopped fibre glass is used in processes where lengths of glass threads are cut between 3 and 26 mm, threads are then used in plastics most commonly intended for moulding processes. Glass fibre short strands are short 0.2–0.3 mm strands of glass fibres that are used to reinforce thermoplastics most commonly for injection moulding.

Unlike glass fibers used for insulation, for the final structure to be strong, the fiber's surfaces must be almost entirely free of defects, as this permits the fibers to reach gigapascal tensile strengths. If a bulk piece of glass were to be defect free, then it would be equally as strong as glass fibers; however, it is generally impractical to produce bulk material in a defect-free state outside of laboratory conditions.

Production

The manufacturing process for glass fibers suitable for reinforcement uses large furnaces to gradually melt the silica sand, limestone, kaolin clay, fluorspar, colemanite, dolomite and other minerals to liquid form. Then it is extruded through bushings, which are bundles of very small orifices (typically 5–25 micrometres in diameter for E-Glass, 9 micrometres for S-Glass). These filaments are then sized (coated) with a chemical solution. The individual filaments are now bundled together in large numbers to provide a roving. The diameter of the filaments, as well as the number of filaments in the roving determine its weight. This is typically expressed in yield-yards per pound (how many yards of fiber in one pound of material, thus a smaller number means a heavier roving, example of standard yields are 225yield, 450yield, 675yield) or in tex-grams per km (how many grams 1 km of roving weighs, this is inverted from yield, thus a smaller number means a lighter roving, examples of standard tex are 750 tex, 1100 tex, 2200 tex).

These rovings are then either used directly in a composite application such as pultrusion, filament winding (pipe), gun roving (automated gun chops the glass into short lengths and drops it into a jet of resin, projected onto the surface of a mold), or used in an intermediary step, to manufacture fabrics such as chopped strand mat (CSM) (made of randomly oriented small cut lengths of fiber all bonded together), woven fabrics, knit fabrics or uni-directional fabrics.

Sizing

A sort of coating, or primer, is used which both helps protect the glass filaments for processing/manipulation as well as ensure proper bonding to the resin matrix, thus allowing for transfer of shear loads from the glass fibers to the thermoset plastic. Without this bonding, the fibers can 'slip' in the matrix and localised failure would ensue.

Properties

An individual structural glass fiber is both stiff and strong in tension and compression—that is, along its axis. Although it might be assumed that the fiber is weak in compression, it is actually only the long aspect ratio of the fiber which makes it seem so; i.e., because a typical fiber is long and narrow, it buckles easily. On the other hand, the glass fiber is weak in shear—that is, across its axis. Therefore if a collection of fibers can be arranged permanently in a preferred direction within a material, and if the fibers can be prevented from buckling in compression, then that material will become preferentially strong in that direction.

Furthermore, by laying multiple layers of fiber on top of one another, with each layer oriented in various preferred directions, the stiffness and strength properties of the overall material can be controlled in an efficient manner. In the case of fiberglass, it is the plastic matrix which permanently constrains the structural glass fibers to directions chosen by the designer. With chopped strand mat, this directionality is essentially an entire two dimensional plane; with woven fabrics or unidirectional layers, directionality of stiffness and strength can be more precisely controlled within the plane.

A fiberglass component is typically of a thin "shell" construction, sometimes filled on the inside with structural foam, as in the case of surfboards. The component may be of nearly arbitrary shape, limited only by the complexity and tolerances of the mold used for manufacturing the shell.

Material	Specific gravity	Tensile strength MPa (ksi)	Compressive strength MPa (ksi)
Polyester resin (Not reinforced)[4]	1.28	55 (7.98)	140 (20.3)
Polyester and Chopped Strand Mat Laminate 30% E-glass[4]	1.4	100 (14.5)	150 (21.8)
Polyester and Woven Rovings Laminate 45% E-glass[4]	1.6	250 (36.3)	150 (21.8)
Polyester and Satin Weave Cloth Laminate 55% E-glass[4]	1.7	300 (43.5)	250 (36.3)
Polyester and Continuous Rovings Laminate 70% E-glass[4]	1.9	800 (116)	350 (50.8)
E-Glass Epoxy composite[5]	1.99	1,770 (257)	
S-Glass Epoxy composite[5]	1.95	2,358 (342)	

Applications

Fiberglass is an immensely versatile material which combines its light weight with an inherent strength to provide a weather resistant finish, with a variety of surface textures.

The development of fiber reinforced plastic for commercial use was being extensively researched in the 1930s. It was particularly of interest to the aviation industry. Mass production of glass strands was accidentally discovered in 1932 when a researcher at the Owens-Illinois accidentally directed a jet of compressed air at a stream of molten glass and produced fibers. Owens joined up with the Corning company in 1935 and the method was adapted by Owens Corning to produce its patented "Fiberglas" (one "s"). A suitable resin for combining the "Fiberglas" with a plastic was developed in 1936 by du Pont. The first ancestor of modern polyester resins is Cyanamid's of 1942. Peroxide curing systems were used by then.

During World War II it was developed as a replacement for the molded plywood used in aircraft radomes (fiberglass being transparent to microwaves). Its first main civilian application was for building of boats and sports car bodies, where it gained acceptance in the 1950s. Its use has broadened to the automotive and sport equipment sectors as well as aircraft, although its use there is now partly being taken over by carbon fiber which weighs less per given volume and is stronger both by volume and by weight. Fiberglass uses also include hot tubs, pipes for drinking water and sewers, office plant display containers and flat roof systems.

Advanced manufacturing techniques such as pre-pregs and fiber rovings extend the applications and the tensile strength possible with fiber-reinforced plastics.

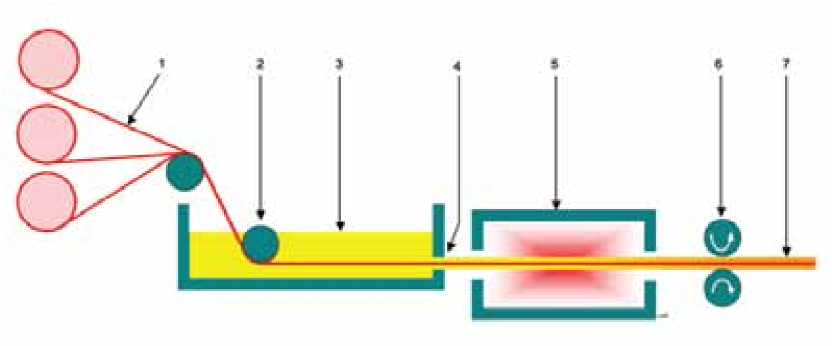
Fiberglass is also used in the telecommunications industry for shrouding the visual appearance of antennas, due to its RF permeability and low signal attenuation properties. It may also be used to shroud the visual appearance of other equipment where no signal permeability is required, such as equipment cabinets and steel support structures, due to the ease with which it can be molded, manufactured and painted to custom designs, to blend in with existing structures or brickwork. Other uses include sheet form made electrical insulators and other structural components commonly found in the power industries.

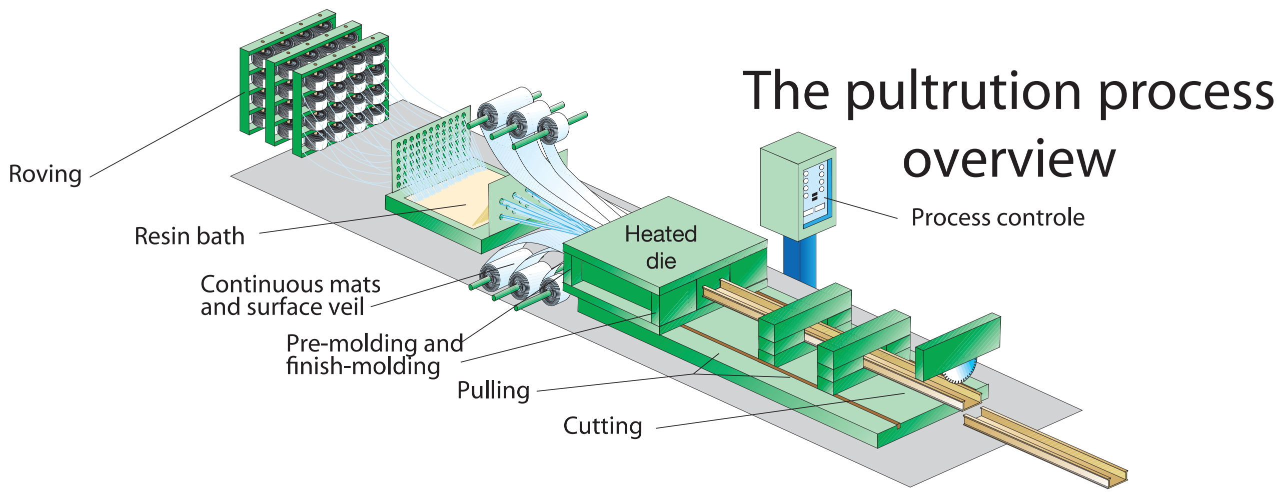
Because of fiberglass' light weight and durability, it is often used in protective equipment, such as helmets. Many sports utilize fiberglass protective gear, such as modern goaltender masks and newer baseball catcher's masks.

Pultrusion operation

Diagram of the pultrusion process.

Pultrusion is a manufacturing method used to make strong light weight composite materials, in this case fiberglass. Fibers (the glass material) are pulled from spools through a device that coats them with a resin. They are then typically heat treated and cut to length. Pultrusions can be made in a variety of shapes or cross-sections such as a W or S cross-section. The word pultrusion describes the method of moving the fibers through the machinery. It is pulled through using either a hand over hand method or a continuous roller method. This is opposed to an extrusion, which would push the material through dies.





Chopped strand mat

Chopped strand mat or CSM is a form of reinforcement used in fiberglass. It consists of glass-fibers laid randomly across each other and held together by a binder.

It is typically processed using the hand lay-up technique, where sheets of material are placed in a mold and brushed with resin. Because the binder dissolves in resin, the material easily conforms to different shapes when wetted out. After the resin cures, the hardened product can be taken from the mold and finished.

Using chopped strand mat gives a fiberglass with isotropic in-plane material properties

Typical Properties of Structural FRP

Longitudinal Direction

Mechanical (coupon)	FR-P	FR-VE
Ultimate Tensile Strength, PSI (ASTM D638)	30,000	35,000
Ultimate Compressive Strength, PSI (ASTM D695)	30,000	35,000
Ultimate Flexural Strength, PSI (ASTM D790)	30,000	35,000
Tensile Modulus, PSI x 10^6	2.5	3.0
Compressive Modulus, PSI x 10^6	2.5	2.5
Flexural Modulus, PSI x 10^6	1.6	2.0
Ultimate Shear Strength, PSI	5,500	7,000
Ultimate Bearing Stress, PSI	30,000	35,000
Izod Impact Strength, Ft.-Lbs. per inch of notch (ASTM D256) (sample thickness 1/8" except 1/4" for rod)	25	30

Transverse Direction

Mechanical (coupon)	FR-P	FR-VE
Ultimate Tensile Strength, PSI	7,000	10,000
Ultimate Compressive Strength, PSI	15,000	20,000
Ultimate Flexural Strength, PSI	10,000	14,000
Tensile Modulus, PSI x 10^6	0.8	1.0
Compressive Modulus, PSI x 10^6	1.0	1.2
Flexural Modulus, PSI x 10^6	0.8	1.0
Ultimate Shear Strength, PSI	5,500	6,000
Ultimate Bearing Stress, PSI	30,000	35,000
Izod Impact Strength, Ft.-Lbs. per inch of notch (ASTM D256)	4	5
Barcol Hardness (ASTM D2583-75	50	50

Electrical

Mechanical (coupon)	FR-P	FR-VE
Electric Strength, short term in oil, 1 8", vpm (ASTM D149)*	200	200
Electric Strength, short term in oil, KV per inch	35	35
Dissipation Factor, 60 Hz. (ASTM D150)*	0.03	0.03
Dielectric Constant, 60 Hz.(ASTM D150)*	5.6	5.2
Arc Resistance, seconds (ASTM D495)**	120	20

Full Section in Bending

Mechanical (coupon)	FR-P	FR-VE
Modulus of Elasticity, PSI x 10^6	2.5	3.0
Tensile Strength, PSI	20,000	25,000
Compressive Strength, PSI	20,000	25,000

Thermal

Mechanical (coupon)	FR-P	FR-VE
Thermal Coefficient of Expansion Inches/Inch/°F (ASTM D696)**	5 x 10^{-6}	5 x 10^{-6}
Thermal Conductivity, BTU per Sq. Ft./Ht./°F/In. (ASTM C-177-76)	4	4
Specific Heat, BTU/Lb./°F	0.28	0.28

Fire Retardant Properties

Mechanical (coupon)	FR-P	FR-VE
Flame Resistance, ign/burn, seconds (FTMS 406-2023)	75/75	75/75
Intermittent Flame Test, rating (HLT-15)	100	100
Flammability Test average time of burning 5 seconds, average extent of burning 15mm (ASTM D635)		
Surface Burning Characteristics, maximum (ASTM E84)	15	15

Other

Mechanical (coupon)	FR-P	FR-VE
Density, Lbs./In.3 (ASTM D792	0.065	0.065
Specific Gravity (ASTM D792)	1.80	1.80
Water Absorption, Max. % by weight (24 hour immersion) (ASTM D570)	.50	.50

*Note: 1 PSI = 6.894 K Pa; 1 Ft.-Lb./In. = 5.443 kg-m/m; * Specimen tested perpendicular to laminate face ** Indicates reported value measured in logitudinal direction; Depending on the specific glass content and resin, the strength and stiffness properties may be significantly higher. Contact us for specific values on Halogen-Free Low Smoke Plus resin properties.*

Concentric Static Load (if required)

A concentrated static load is not included in the table on page 9. Some user applications may require that a given concentrated static load be imposed over and above the working load. Such concentrated static load represents a static weight applied between the side rail at midspan. When so speci ed, the concentrated static load may be converted to an equivalent load (We) in pounds per linear foot (kg/m) using the formula to the below right and added to the static weight of cable in the tray. This combined load may be used to select a suitable load/span designation).

If the combined load exceeds the working load shown, please cont us.
This data was obtained from the NEMA Standards Publication and other sources to assist in the proper selection of the most appropriate cable tray type offered by Enduor.

$$W_e = \frac{2 \times (\text{Concentrated Static Load})}{\text{span length (ft or m)}}$$

Thermal Contraction & Expansion

The table to the right compares the thermal contraction and expansion based on various temperature differentials for berglass, steel and aluminum cable trays. The values shown represent the length of cable tray that will produce a 5 8" movement between expansion connectors for the indicated temperature differential. Fiberglass has the least movement. Enduro has expansion connectors to provide for total movement of 5 8".

Fiberglass vs Steel vs Aluminum

Temp. Differential	Fiberglass Ft. (m)	Steel Ft. (m)	Aluminum Ft. (m)
25°F (-4°C)	417 (126)	320 (97)	162 (49)
50°F (10°C)	208 (63)	160 (48)	81 (25)
75°F (24°C)	138 (42)	106 (32)	54 (16)
100°F (38°C)	104 (32)	80 (24)	40 (12)
125°F (52°C)	83 (25)	63 (19)	32 (10)
150°F (66°C)	69 (21)	53 (16)	26 (8)
175°F (79°C)	59 (17)	45 (13)	23 (6)

Effect fo Temperature - FRP

Strength properties of reinforced plastics are reduced when continuously exposed to elevated temperatures. Working loads shall be reduced when based on the table to the right. Percentages shown are approximate. If unusual temperature conditions exist, please contact us for consultation. Below freezing temperatures do not adversely affect the load rating capability of the tray. Fiberglass does not become brittle at below freezing temperatures. Careful review should be made of applications involving service temperatures over 200°F.

Temp.	Polyester Stength %	Vinyl Easter Strength %
75°F (24°C)	100%	100%
100˚F (38˚C)	90%	100%
125°F (52°C)	78%	100%
150°F (66°C)	68%	90%
175°F (79°C)	60%	90%
200°F (93°C)	52%	75%

Test Temp. ˚F (˚C)	-100˚ (-73˚)	-50˚ (-46˚)	-0˚ (-18˚)	-50˚ (-10˚)	-77˚ (25˚)	100˚ (38˚)	150˚ (66˚)	200˚ (93˚)	250˚ (121˚)	300˚ (149˚)
Flex. St., PSI, ASTM D790	101,500	86,400	79,500	72,300	68,100	66,300	58,700	27,400	13,200	9,200
Flex. Mod., PSI x 106, ASTM D790	3.36	3.32	3.42	3.38	3.24	3.29	3.07	1.98	0.98	0.83
Tensile St., PSI, ASTM D638	84,100	70,400	63,900	58,000	56,100	54,600	49,900	41,800	29,600	22,000

Corrosion Resistance of Resin Systems

Hdmann has two standard resin systems available. For most applications, isophthalic polyester fire-retardant (FR-P) is the more widely used. A vinyl ester composite re-retardant resin system (FR-VE) is recommended where strong acids (such as hydrochloric acid), strong alkalies (such as caustic soda), organic solvents and halogenated organic conditions exist. An abbreviated guide is provided below to assist in the selection of the proper resin system for individual application.

Polyester and vinyl ester resin systems are available in conductive formulation. Contact us for corrosion resistance information for halogen-free and halogen-free low smoke plus resins.

All composite materials have an ultra-violet light inhibiting chemical additive and has a maximum ame spread of 25 or less, per ASTM E-84 (Class 1 ame spread). All pultruded products have complete Nexus Veil Coverage (outer surfacing fabric) to provide maximum chemical and UV protection.

Chemicals	75˚F (24˚C)	160F˚ (71˚C)	Chemicals	75˚F (24˚C)	160F˚ (71˚C)
Acetic Acid 5%	FR-P	FR-P	Magnesium Chloride	FR-P	FR-P
Acetic Acid 25%	FR-P	FR-VE-210° (*)	Methyl Alcohol 10%	FR-P	FR-VE-150° (*)
Aluminum Potassium Sulfate 5%	FR-P	FR-P	Naphtha	FR-P	FR-P
Ammonium Hydroxide 10%	FR-P	FR-VE-150°	Nitric Acid 5%	FR-P	FR-P
Ammonium Nitrate	FR-P	FR-P	Nitric Acid 20%	FR-VE	FR-VE-120° (*)
Benzenesulfonic Acid 5%	FR-P	FR-P	Phosphoric Acid 10%	FR-P	FR-P
Ethylene Glycol	FR-P	FR-P	Sodium Hypochlorite 5%	FR-P	FR-VE-120° (*)
Carbon Tetrachloride	FR-VE	FR-VE-100° (*)	Phosphoric Acid 85%	FR-P	FR-P
Chlorine Dioxide 15%	FR-P	FR-VE-150° (*)	Sodium Bicarbonate 10%	FR-P	FR-P
Chromic Acid 5%	FR-P	FR-VE-150° (*call)	Sodium Bisulfate	FR-P	FR-P
Copper Sulfate	FR-P	FR-P	Sodium Carbonate	FR-P	FR-VE
Diesel Fuel No. 1	FR-P	FR-P	Sodium Chloride	FR-P	FR-P
Diesel Fuel No. 2	FR-P	FR-P	Sodium Hydroxide 1-50%	FR-VE	FR-VE-120° (*)
Ferrous Sulfate	FR-P	FR-P	Sodium Silicate	FR-P	FR-VE-210° (*)
Fatty Acids 100%	FR-P	FR-P	Sodium Nitrate	FR-P	FR-P
Fluosilicic Acid 0-20%	FR-VE	FR-VE (call)	Sodium Sulfate	FR-P	FR-P
Hydrochloric Acid 1%	FR-P	FR-P	Sulfuric Acid 0-30%	FR-P	FR-P
Hydrochloric Acid 15%	FR-P	FR-VE-180° (*)	Sulfuric Acid 30-50%	FR-VE	FR-VE
Hydrochloric Acid 37%	FR-P	FR-VE-150° (*)	Sulfuric Acid 50-70%	FR-VE	FR-VE-180° (*)
Hydrogen Sulfide	FR-P-140°	FR-VE-210°	Trisodium Phosphate 25%	FR-P	FR-VE-210° (*)
Kerosene	FR-P	FR-P	Trisodium Phosphate - All	FR-VE	FR-VE-210° (*)
			Water, Distilled	FR-P	FR-P

FR = Fire-Retardant; P = Polyester Resin; VE = Vinyl Ester Resin; (*) = Not recommended to exceed this temperature; call = Call for recommendations Information contained in this chart is based on data from raw material suppliers and collected from several years of actual industrial applications. Temperaturers are not the minimum nor the maximum (except where speci cally stated) but represent standard test conditions. The products may be suitable at higher temperatures, but individual test data should be required to establish such suitability. The recommendations or suggestions contained in this chart are made without guarantee or representation as to results. We suggest that you evaluate these recommendations and suggestions in your own laboratory or by actual eld trial prior to use

Resin Systems

Below is an overview of the common resin systems we offer. When choosing a resin type for your application, we highly recommend consulting with us regarding the application to be sure the proper resin is specif i ed. Considerations include corrosion environment, temperature, f ire resistance, smoke and smoke toxicity requirements and conductivity / resistivity requirements. Regarding the corrosion environment, certain chemical concentrations and temperatures will dictate whether a polyester or epoxy vinyl ester system is preferred for optimum durability.

Isophthalic Polyester **(P)** This industrial-grade polyester resin system offers very good weathering performance (resistance to UV) and corrosion resistance. This system is especially suitable for seawater environments.

Vinyl Ester **(V)** This resin system also delivers good weathering performance, but is superior to a polyester with respect to corrosion resistance and high heat environments. Epoxy vinyl ester resins provide greater toughness and considerably higher strength at elevated temperatures. They also provide superior resistance to chemical attack in corrosive chemical service.

Conductive **(C)** This Isophthalic Polyester-based resin is formulated to comply with ABS requirements for conductivity. To provide superior resistance to chemical attack, the conductive formulation is also available in a Vinyl Ester base.

Halogen-Free Polyester **(HP)** This system offers similar performance attributes as our standard Isophthalic Polyester, but without the use of halogens.

Halogen-Free Vinyl Ester **(HV)** This system offers similar performance attributes as our Vinyl Ester, but without the use of halogens.

Halogen-Free Low Smoke Plus **(HS)** This modified-acrylic based resin is suitable for applications which require extremely low-smoke development in the case of fre. This resin system is commonly used in tunnel applications.

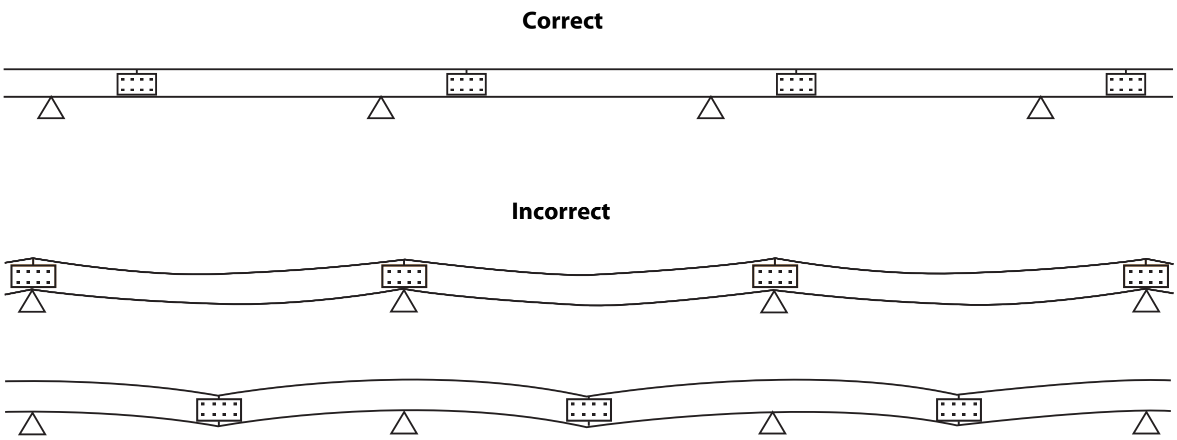
Installation

The installation of Kruppsmetal Cable Tray / Ladder / Trunking- should be made in compliance with the standards set forth by the National Electric Code and NEMA Publications FG-1 (current issue). Enduro supplies made to order, pre-fabricated cable ladder tray and fittings as specified by the purchaser.

Always observe common safety practices when assembling tray and fittings in the field. Assemble in wellventilated areas as dust from field cuts can accumulate. This presents no serious health hazard but can cause skin irritation and, if allowed to accumulate with grease and other machining lubricants, can become abrasive. Personnel should wear safety goggles, dust mask, coveralls or a shop coat when sawing, machining and/or sanding. Caution should also be noted when cutting as dust from carbon fiber is also electrically conductive and additional considerations apply.

Avoid generating excessive heat in any machining operation, as heat softens the bonding resin in the fiberglass, resulting in a ragged rather than a clean-cut edge.
Avoid excessive pressure when sawing, drilling, routing, etc. Use carbide-tipped drill bits and saw blades for extended tool life. The use of lubricant during machining is not recommended.
To avoid chipping of material at cut edges, secure cable tray and fittings properly during field cut operations. We recommend the use of Enduro sealant for sealing surfaces and cut edges after field cuts are made. When using adhesives, be sure to prepare the surface properly before applying. Follow label instructions carefully. A combination of mechanical fasteners and adhesives make the strongest most reliable connections.

Support Location Guidelines*

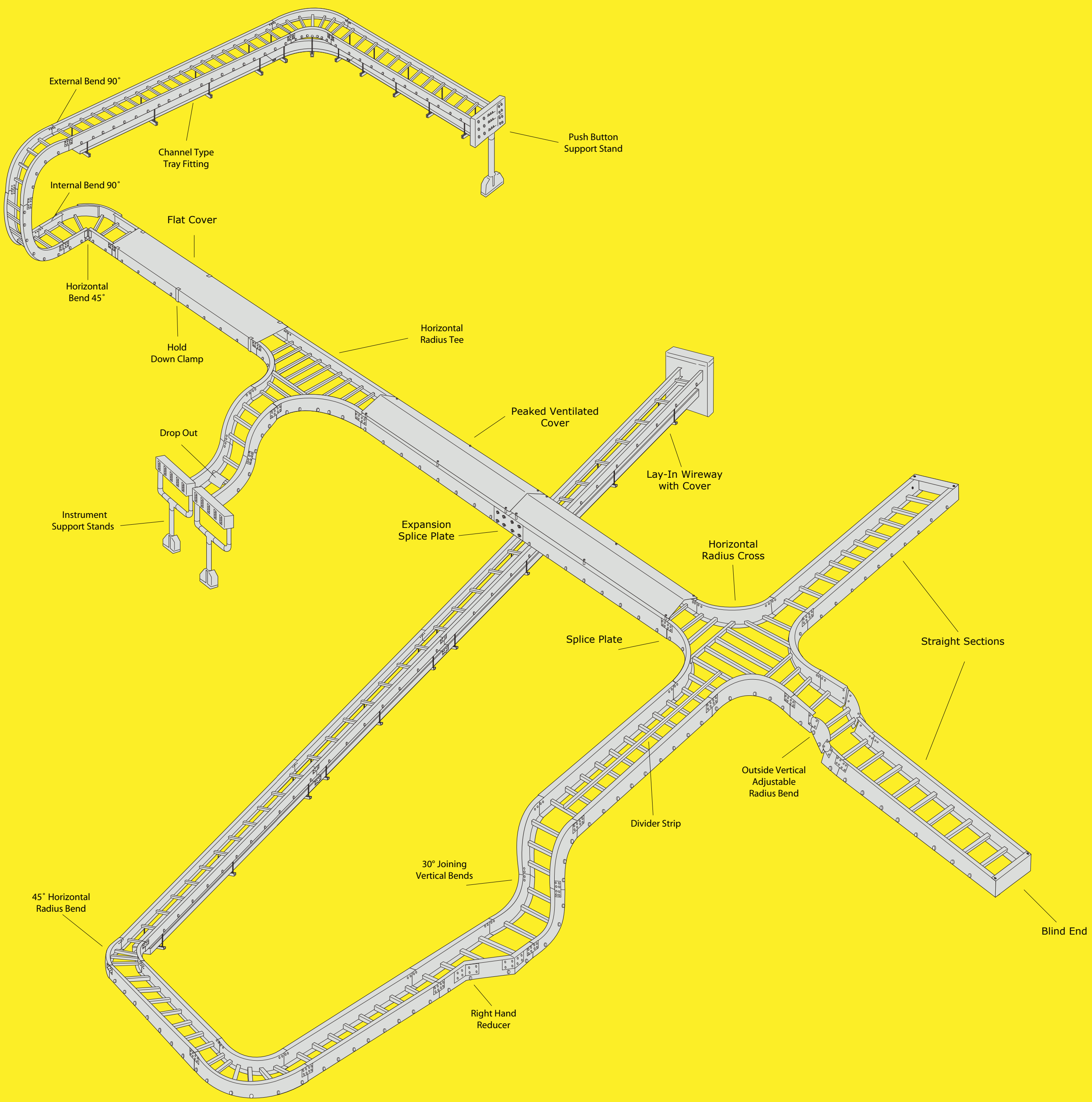


** These guidelines apply when using standard splice plates. For location flexibility, heavy duty splice plates allow for support location anywhere in the span.*

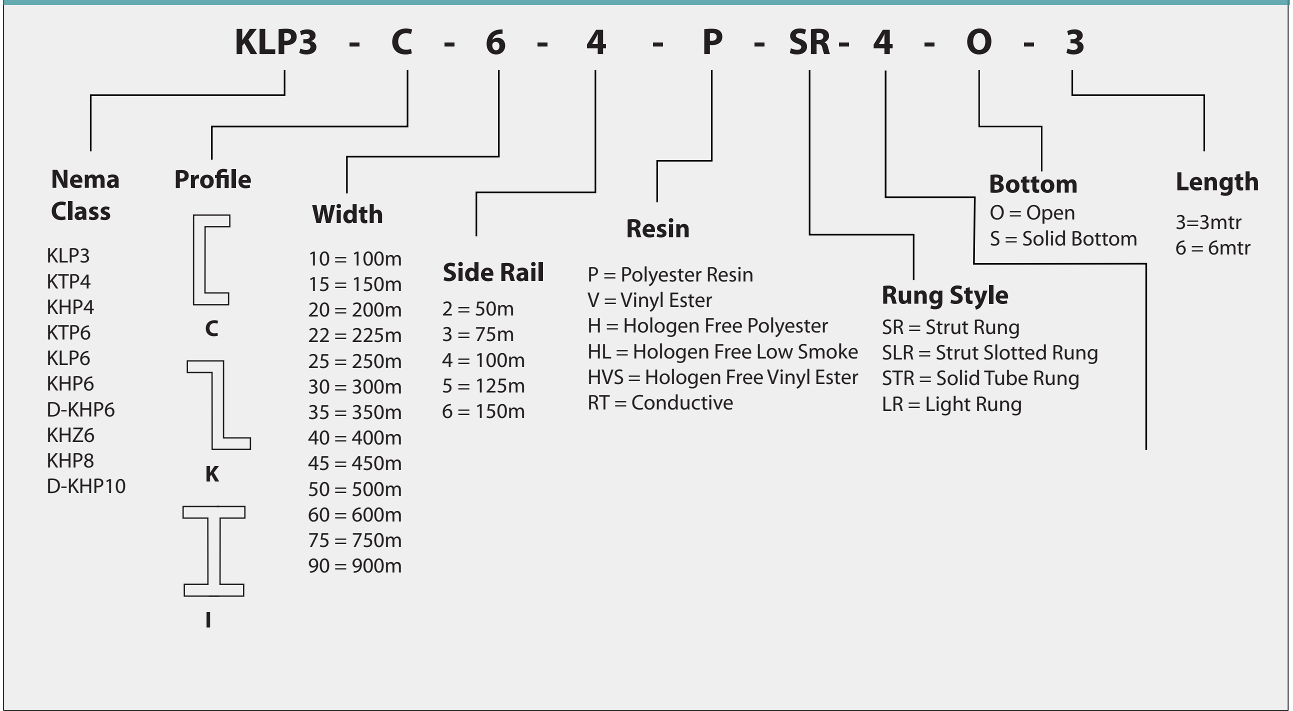
WARNING! CABLE TRAYS ARE NOT DESIGNED FOR USE AS WALKWAYS

Reference NEMA FG-1 (current issue)
In as much as fiberglass cable tray is designed as a support for power or control cables, or both; it is not intended or designed to be a walkway for personnel. The user is urged to display appropriate warning cautioning against the use of this support as a walkway.

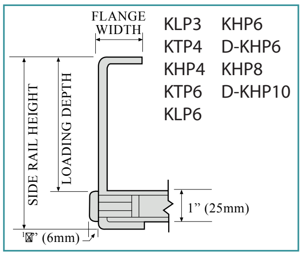
Actual Size Label

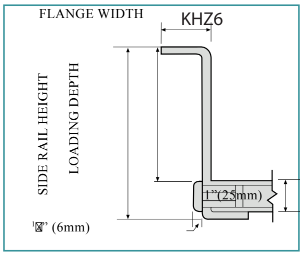

External Bend 90˚
Channel Type
Tray Fitting
Push Button
Support Stand
Internal Bend 90˚
Flat Cover
Horizontal
Bend 45˚
Hold
Down Clamp
Horizontal
Radius Tee
Peaked Ventilated
Cover
Drop Out
Lay-In Wireway
with Cover
Instrument
Support Stands
Expansion
Splice Plate
Horizontal
Radius Cross
Splice Plate
Straight Sections
Outside Vertical
Adjustable
Radius Bend
Divider Strip
30° Joining
Vertical Bends
45˚ Horizontal
Radius Bend
Blind End
Right Hand
Reducer

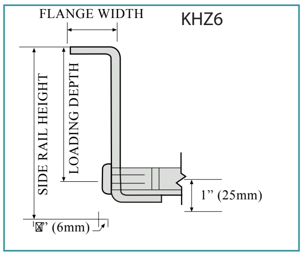
CABLE LADDER SELECTION CHART

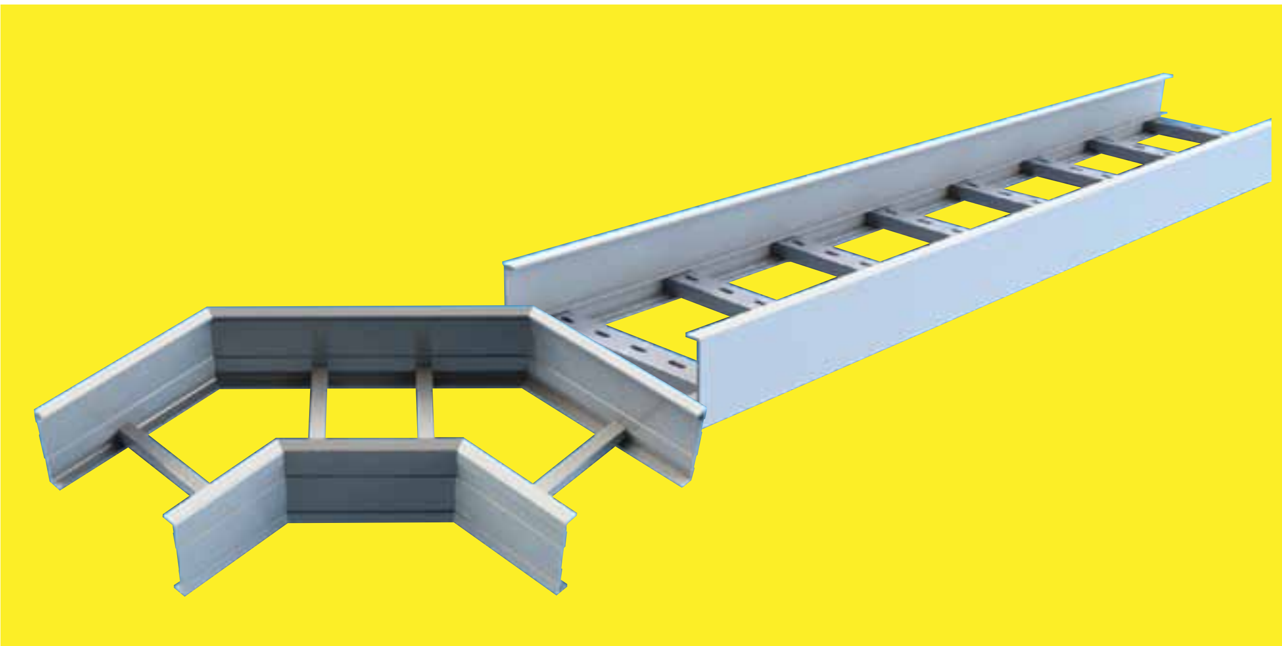


Side Rail









Ladder Cable Tray Selection Guide

NEMA Class (Polyester resin)	**Optional System No.** (Δ) = insert code; see bottom of pg.	**Side Rail** Height In. (mm)	**Loading** Depth In. (mm)	**Flange** Width In. (mm)	**Min. Channel** Thickness In. (mm)	**NEMA** Class FG-1	**Safety** Factor	
KLP3	KL(Δ)3	3″ (75)	1-13/16″ (46)	1″ (25)	3/16″ (4.8)	8A	1.5	-
KTP4	KT(Δ)4	4″ (100)	2-7/8″ (73)	1-3/8″ (35)	1/4″ (6.4)	8A	1.5	-
KHP4	KH(Δ)4	4″ (100)	2-3/4″ (70)	1-1/8″ (28)	1/4″ (6.4)	12A	1.5	Class A
KTP6	KT(Δ)6	6″ (150)	4-13/16″ (122)	1-5/8″ (41)	5/32″ (4.0)	18A	1.5	-
KLP6	**K**L(Δ)6	6″ (150)	4-13/16″ (122)	1-5/8″ (41)	3/16″ (4.8)	20A	2.0	Class A
KHP6	**K**H(Δ)6	6″ (150)	4-3/4 (121)	1-5/8″ (41)	1/4″ (6.4)	20B 20A	2.0 2.0	Class C
D-KHP6	**D-K**H(Δ)6	6″ (150)	4-11/16″ (119)	1-5/8″ (41)	5/16″ (8.0)	20C	2.0	Class C
KHZ6	**K**HZ(Δ)6	6″ (150)	4-11/16″ (119)	2″ (51)	5/16″ (8.0)	20C	2.0	-
KHP8	**K**H(Δ)8	8″ (200)	6-11/16″ (170)	1-3/4″ (44)	5/16″ (8.0)	20C	1.5	Class C
D-KHP10	**D-K**H(Δ)10	10″ (250)	8-5/8″ (219)	2-3/4″ (70)	3/8″ (9.5)	30C	2.0	-

(Δ) = Insert one of the following letters for resign designation
V = Vinyl Ester; H = Halogen-Free Polyester; HVS = Halogen-Free Vinyl Ester;
HL = Halogen - Free Low Smoke, RT = Conductive

* (mm) Value is nominal
Contact us for lead times on all Halogen-Free Systems.

Tray Weight Lbs/Ft. (kg/m) 2 side rails, 12″ rung spacing	Working (Allowable) Load Lbs./Ft. (kg/m)							
	8′ (2.4m)	10′ (3m)	12′ (3.7m)	14′ (4.3m)	16′ (4.9m)	18′ (5.5m)	20′ (6.1m)	30′ (9.1m)
1.97 (2.93)	50 (74)							
2.56 (3.81)	50 (74)							
3.06 (4.55)		224 (333)	176 (262)	134 (199)	103 (153)	76 (113)	50 (74)	
2.94 (4.37)		243 (261)	168 (251)	124 (184)	94 (141)	50 (74)		
2.94 (4.37)		200 (298)	139 (207)	100 (149)	78 (116)	61 (90)	50 (74)	
4.47 (6.66)				200 (298)	156 (232)	123 (183)	100 (148)	
4.94 (7.34)				200 (298)	156 (232)	123 (183)	100 (148)	
4.79 (7.13)				200 (298)	156 (232)	123 (183)	100 (148)	
6.45 (9.60)					156 (232)	123 (183)	100 (148)	
9.39 (13.98)						277 (412)	225 (335)	100 (148)

The Kruppsmetal straight sections listed above that are UL Listed are for 10 Ft. and 20 Ft. lengths. All molded and mitered fittings associated with these tray types are also UL listed. NEMA classes and UL listings in this table are for polyester and vinyl ester resin systems only. Values in Working (Allowable) Load are applicable to all resin systems, where possible. For more tray weight values, please contact us. For CSA class, please contact us.

1.0 Scope

1.1 The cable tray system shall conform to the material and fabrication requirements as per this specification.

2.0 Standards

2.1 The cable tray system shall conform to applicable sections of:

2.1.1 NEMA Standard FG-1 (latest edition)

2.1.2 National Electric Code (NEC)

2.1.3 ASTM E-84 (Class 1 Rating)

2.1.4 UL (Underwriters Laboratories, Inc.) Standards for Non-Metallic Cable Trays.

2.1.5 CSA INTERNATIONAL (National Standard of Canada) CAN/CSA-C22.2 No. 126 Cable Tray Systems

3.0 General

3.1 Tray Requirements

3.1.1 Tray widths 6″ (152mm), 9″ (229mm), 12″(305mm), 18″ (457mm), 24″ (610mm), 30″ (762mm), and 36″ (914mm)

3.1.2 Lengths (as required): 10 ft, 20 ft, 3m, and 6m

3.1.3 Rung spacing (as required):
6″ (152mm), 9.25″ (235mm), 12″ (305mm), and 18.5″ (470mm)
Rung Type (as required):
Standard Rung, Marine Rung or Strut Rung

3.1.4 Radius of fittings (as required):
12″ (305mm), 24″ (610mm), and 36″ (914mm)

3.1.5 Resin Systems (as required):
Isophthalic Polyester, Vinyl Ester, Halogen-Free Polyester, Halogen-Free Vinyl Ester, Phenolic, or Halogen-Free Low Smoke Plus

3.2 Loading Requirements

3.2.1 There shall be three working load classifications of fiberglass cable tray based on 20 Ft. (6m) support span:

Class	Working Load	FOS
A	50 Lbs./Lineal Ft.	1.5
B	75 Lbs./Lineal Ft.	1.5
C	100 Lbs./Lineal Ft.	1.5

3.2.2 Span support criteria shall be as specified (Reference the following table)

Support Span (Ft.)	Working Load in Lbs./Lineal Ft. Class A	Class B	Class C
30	-	-	100
20	50	75	100
18	61	92	123
16	78	117	156
14	100	150	200
12	139	208	-
10	200	-	-

• Independent test reports in conformance to NEMA FG-1 are required.

3.2.3 Nominal loading depth (as required):
2″ (51mm), 3″ (76mm), 5″ (127mm), 7″ (178mm) and 9″ (229mm)

4.0 Materials

4.1 The glass fiber to resin content shall be maintained between 45 to 55 percent by weight in all pultruded components except fiat sheet which shall be 35 to 45 percent; and, 25 to 45 percent by weight in all molded components.

4.2 All composite material shall have an ultraviolet light inhibiting chemical additive to resist UV degradation.

4.3 All composite material shall be fire retardant and have a fiame spread rating of 25 or less (Class 1 Rating) when tested in accordance with ASTM E-84.

4.4 All pultruded products shall have a complete surfacing veil to provide maximum chemical and UV protection.

5.0 Construction

5.1 Straight section tray shall be fiberglass reinforced meeting all the requirements herein described.

5.1.1 The side rail members must turn in.

5.1.2 All rung to side member connections shall have both a mechanical and a chemical (adhesive) lock. The tray shall be assembled by the use of a locking pin made of fiberglass reinforced thermoplastic. The locking pin shall be inserted under pressure with a high strength, chemical resistant adhesive.

5.1.3 All bonded connections must be sanded to maximize adhesion and structural integrity.

5.1.4 The tray interior shall be clear of all projections or sharp objects.

5.1.5 All straight section lengths shall be pre-drilled to accept connector plates.

5.1.6 All cut ends and drilled holes (factory and field) shall be resin coated.

5.2 Fittings are to be pre-fabricated and shall meet all the requirements herein described.

5.2.1 All fittings shall have a nominal 9.25″ rung spacing.

5.2.2 All fittings shall be pre-drilled to accept connector plates.

5.2.3 All fittings shall be designed and installed so as to have the same load carrying capacity as the straight sections.

5.2.4 Rung to side member connections shall have both a mechanical and/or chemical (adhesive) lock. Fittings shall be assembled by use of a locking pin made of fiberglass reinforced thermoplastic and/or a stainless steel rivet. The locking pin shall be inserted under pressure with a high strength chemical resistant adhesive.

• All radius 90° and 45° horizontal and vertical bends, all tees and crosses for tray types using 6″ (152mm), and most 4″ (101mm) and 8″ (202mm), C-channel members shall be of concentric curved molded design and made by resin transfer molding.

5.3 Connector Plates and Fasteners:

5.3.1 Connector plates shall be fiberglass and designed with sufficient strength so they may be installed between 0.2 and 0.3 of the length of the span from the support without derating the load carrying capacity of the tray.

5.3.2 Fasteners for connector plates shall be 3/8″ (9.5mm) diameter Type 316 Stainless Steel, Monel, Silicon, Bronze, or FRP studs & hex nuts as required.

5.4 Accessories

5.4.1 The manufacturer shall be capable of providing all necessary parts (i.e. clamps, support assemblies, etc.) for the installation of a complete fiberglass tray system.

Kruppsmetal offers a full line of f i berglass splice plates designed to provide a structural transition between straight sections and f i ttings. Enduro splice plates and hardware are sold separately and are not provided as standard with straight sections or f i ttings due to the many hardware options. All plates have 7/16" pre-drilled bolt holes.

NEMA FG-1
Pleae refer to NEMA FG-1 regarding proper tray installation as it pertains to support and splice plate locations for straight sections and fittngs. Refer to page 11 for recommmended support locations. NEMA

Splice and Hardware Options

Tray Resin	Splice Material			Hardware Sets			
	Polyester	Vinyl Ester	316 Stainless Steel	316 Stainless Steel	Monel	Silicon Bronze	Isoplast
Polyester	Standard	Optional	Optional	Standard	Optional	Optional	Optional
Vinyl Ester		Standard	Optional	Standard	Optional	Optional	Optional
Halogen-Free			Standard	Standard	Optional	Optional	Optional
Halogen-Free Low Smoke Plus			Standard	Standard	Optional	Optional	Optional
Conductive			Standard	Standard	Optional	Optional	Optional

Hardware

Type	Set Includes	Size	For Use With Tray Types	Part No.
316 Stainless Steel Bolt Set	Bolt, nut, 2 flat washers, 1 lock washer	3/8”-16 x 1 1/4”	All tray types (except 10” Channel**)	
316 Stainless Steel Bolt Set	Bolt, nut, 2 flat washers, 1 lock washer	3/8”-16 x 1 1/2”	All tray types (except 10” Channel**)	
Monel Bolt Set	Bolt, nut, 2 flat washers, 1 lock washer	3/8”-16 x 1 1/4”	All tray types (except 10” Channel**)	
FRP Studs & Nuts	Stud and 2 nuts	3/8”-16 x 2”	ELL3, ELL4, ELL6, EIL6, EMZ6	
FRP Studs & Nuts	Stud and 2 nuts	3/8”-16 x 2 1/2”	EHL6, EHL8, EHV6	
Silicon Bronze Bolt Set	Bolt, nut, 2 flat washers, 1 lock washer	3/8”-16 x 1 1/4”	All tray types (except 10” Channel**)	

** Contact us for hardware; It is recommended that expansion splice plates and 1[illegible]” long assembly fasteners be used when connecting mitered fittings to molded fittings or straight lengths.

Typical Dimensions for FRP Splice Plates

Typical Dimensions Inches (mm)

Channel Depth Inches (mm)	A	B	C
3 (76)	1 3/4 (44)	1 (25)	-0-
4 (102)	2 (51)	1 (25)	-0-
6 (152)	4 5/8 (117)	1 (25)	2 5/8 (67)
8 (203)	6 (152)	1 11/16 (43)	2 5/8 (67)

Typical Dimensions for Stainless Splice Plates

Typical Dimensions Inches (mm)

Channel Depth Inches (mm)	A	B	C
3 (76)	1 1/4 (32)	5/8 (16)	-0-
4 (102)	1 1/4 (32)	5/8 (16)	-0-
6 (152)	4 1/8 (105)	3/4 (19)	2 5/8 (67)
8 (203)	4 1/8 (105)	3/4 (19)	2 5/8 (67)

Specification Data GRP Cable Systems

1. International Standards
Cable ladder and tray system should comply with the materials and fabrication requirements detailed below.

2. FRP Ladder and Tray System
Shall conform to:

- BS 476 part 7 class I
- BS 476 part 7 class II
- ASTM E84 class I
- BS 476 part 6
- ASTM D635
- Nema standard-FG-1 (latest edition)
- IEC 60754-1

3. Ladder Sizes

- Ladder Heights: 50, 75, 100, 150mm.
- Ladder widths: 100 through to 900mm.
- Ladder lengths: 3m & 6m.
- Rung spacing is 300mm (other sizes available)
- Radius of Fittings: 300mm is standard.
- 600 & 900 on request. Fittings shall be mitred type.
- No moulded or pressed fitting are acceptable as they would not comply with specification.
- All ladder rungs are perforated as standard.

4. Resis System

- ISO Polyester class II Halogen free code (PGF)
- ISo Polyester class I code (PCI)
- Vinyl ester code (VE)
- Our standard resin system is our (PHF)

Cable Tray Sizes

- Widths: 50, 100, 200, 300, 450, 600, 900 mm.
- Depths: 50 and 80mm respectively
- Tray covers are self locking and clip on type.
- All trays will be perforated at 300mm centres.
- Radius of Fittings: 250mm is standard.

6. Loading Requirements
There are three workding load classifications for FRP Cable ladder based on (20') support spans with a minimum safety factor of 1.5

Class Working Load		
A	50 Lbs./Lineal Ft or	74 Kgs/mt
B	75 Lbs./Lineal Ft or	111 kgs/mt
C	100 Lbs./Lineal Ft or	148 Kgs/mt

b. Span support criterial shall be as specified (reference the following table)

Support Span (Ft.)	Working Load in Lbs./Lineal Ft.		
	Class A	Class B	Class C
20	50	75	100
18	61	92	123
16	78	117	156
14	100	150	200
12	139	208	-
10	200	-	-

* Independent test reports are required to substaintiates NEMA FG 1 load criteria.

7. Material Content

- Glassfibre to resin ratio shall be maintained between 45-65% by weight in all pultruded components.
- Flat sheet shall be 4-50%

8. Ultraviolet (UV)
Pultruded products shall have an integral chemical additive to help to mitigate discoloration and a surface veil will help to prevent glass fiber exposure, thus maximizing total UV protection.

9. Flame Spread
All composite materials shall be fire retardant and have a flame spread rating in accordance with ASTM E-84 class I or BS476 part 7 class I and II.

Chemical Exposure Guide

The information compiled in this exposure chart is related to data collected from actual projects installed in the field. Temperatures used are neither minimum nor maximum but represents a cross section of test conditions. Some products may be suitable for higher temperatures but individual testing should be carried out prior to installation. Please make contract with CCS for any special applications you may have.

Resin Selection

Isophthalic ISOFR uses modifield premium grade isophthalic polyester resins.
Fire retardant and complies with ASTM E 84 and ASTM D635
Vinyl ester VEFR uses vinyl ester fire retardant resin and complies with ASTM E 84 and ASTM D635

CHEMICAL EXPOSURE CHART

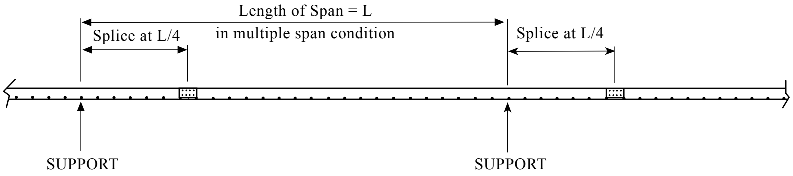
CHEMICAL ENVIRONMENT	ISO POLYESTER Wt %	ISO POLYESTER Temp °F	VINYL ESTER Wt %	VINYL ESTER Temp °F
Acetic Acid	10	190	10	210
Acetic Acid	50	125	50	180
Aluminium Chlorine	SAT	170	SAT	200
Aluminium Hydroxide	SAT	160	SAT	170
Aluminium Nitrate	SAT	150	SAT	170
Aluminium Sulfate	SAT	180	SAT	200
Ammonium Chloride	SAT	170	SAT	190
Ammonium Hydroxide	1	100	10	150
Ammonium Hydroxide	28	■	28	100
Ammonium Carbonate	■	■	SAT	150
Ammonium Bicarbonate	15	125	SAT	130
Ammonium Nitrate	SAT	160	SAT	190
Ammonium Persulfate	SAT	■	SAT	150
Ammonium Sulfate	SAT	170	SAT	200
Amyl Alcohol	ALL	■	ALL	90
Amyl Alcohol Vapor	▲	140	▲	120
Benzene Sulfonic Acid	25	110	SAT	200
Benzoic Acid	SAT	150	SAT	200
Benzoly Alcohol	100	■	100	■
Borax	SAT	170	SAT	200
Calcium Carbonate	SAT	170	SAT	200
Calcium Chloride	SAT	170	SAT	200
Calcium Hydroxide	25	70	25	165
Calcium Nitrate	SAT	180	SAT	200
Calcium Sulfate	SAT	180	SAT	200
Carbon Disulfide	■	■	■	■
Carbonic Acid	SAT	130	SAT	180
Carbon Dioxide Gas	▲	200	▲	200
Carbon Monoxide Gas	▲	200	▲	200
Carton Tetrachloride	■	■	100	75
Chlorine, Dry Gas	▲	140	▲	170
Chlorine, Wet Gas	▲	■	▲	■
Chlorine Water	SAT	■	SAT	90
Chromic Acid	5	70	10	120
Citric Acid	SAT	170	SAT	200
Copper Chloride	SAT	170	SAT	200
Copper Cyanide	SAT	170	SAT	200
Copper Nitrate	SAT	170	SAT	200
Crude Oil, Sour	100	170	100	200
Cyclohexane, Vapor	ALL	100	ALL	130
Diesel Fuel	100	160	100	180
Diethyl Ether	■	■	■	■
Dimethyl Phthalate	■	■	100	80
Ethanol	50	75	50	90
Ethyl Acetate	■	■	■	■
Ethylene Chloride	■	■	■	■
Ethylene Glycol	100	90	100	200
Fatty Acids	SAT	180	SAT	200
Ferric Chloride	SAT	170	SAT	200
Ferric Nitrate	SAT	170	SAT	200
Ferric Sulfate	SAT	170	SAT	200
Ferrous Chloride	SAT	170	SAT	200
Fluoboric Acid	■	■	SAT	165
Fluosilicic Acid	■	■	SAT	75
Formaldehyde	50	75	50	100
Formic Acid	■	■	50	100
Gasoline	100	80	100	150
Glucose	100	170	100	200
Glycerine	100	150	100	200
Heptane	100	110	100	120
Hexane	100	90	100	130
Hydrobromic Acid	50	120	50	120
Hydrobromic Acid	10	150	10	200
Hydrobromic Acid	20	140	20	190
Hydrobromic Acid	37	75	37	95
Hydrobromic Acid	■	■	15	80
Hydrogen Bromide, Dry	100	190	100	200
Hydrogen Bromide, Wet	100	75	100	130
Hydrogen Chloride	▲	120	▲	200
Hydrogen Peroxide	30	■	30	80
Hydrogen Sulfide, Dry	■	140	ALL	180
Hydrogen Sulfide, Wet	V	140	V	180
Hypochlorous Acid	10	70	20	100
Isopropyl Alcohol	■	■	15	80
Kerosene	100	140	100	180

CHEMICAL ENVIRONMENT	ISO POLYESTER Wt %	ISO POLYESTER Temp °F	VINYL ESTER Wt %	VINYL ESTER Temp °F
Lactic Acid	SAT	170	SAT	200
Lead Acetate	SAT	170	SAT	200
Lead Chloride	SAT	140	SAT	200
Lead Nitrate	SAT	▲	SAT	200
Linseed Oil	100	150	100	190
Lithium Chloride	SAT	150	SAT	190
Magnesium Carbonate	SAT	140	SAT	170
Magnesium Chloride	SAT	170	SAT	200
Magnesium Hydroxide	SAT	150	SAT	190
Magnesium Nitrate	SAT	140	SAT	180
Magnesium Sulfate	SAT	170	SAT	190
Mercuric Chloride	SAT	150	SAT	190
Mercurous Chloride	SAT	140	SAT	180
Mineral Oils	100	170	100	200
Naptha	100	140	100	170
Nickel Chloride	SAT	170	SAT	200
Nickel Nitrate	SAT	170	SAT	200
Nickel Sulfate	SAT	170	SAT	200
Nitric Acid	5	140	5	150
Nitric Acid	20	70	20	100
Oleic Acid	100	170	100	190
Oxalic Acid	ALL	75	ALL	200
Paper Mill Liquors	▲	100	▲	120
Perchlorethylene	100	■	100	80
Perchloric Acid	■	■	10	150
Perchloric Acid	■	■	30	80
Phosphoric Acid	10	160	10	200
Phosphoric Acid	100	120	100	200
Potassium Aluminium Sulfate	SAT	170	SAT	200
Potassium Bicarbonate	50	80	50	140
Potassium Carbonate	10		10	120
Potassium Chloride	SAT	170	SAT	200
Potassium Dichromate	SAT	170	SAT	200
Potassium Hydroxide	■	■	25	150
Potassium Nitrate	SAT	170	SAT	200
Potassium Permangante	SAT	75	SAT	200
Potassium Sulfate	SAT	170	SAT	200
Propylene Glycol	ALL	170	ALL	200
Phthalic Acid	▲	▲	SAT	200
Sodium Acetate	SAT	160	SAT	200
Sodium Benzoate	SAT	170	SAT	200
Sodium Bicarbonate	SAT	160	SAT	175
Sodium Bisulfate	ALL	170	ALL	200
Sodium Bromide	ALL	170	ALL	200
Sodium Carbonate	10	80	35	160
Sodium Chloride	SAT	170	SAT	200
Sodium Cyanide	SAT	170	SAT	200
Sodium Hydroxide	■	■	10	150
Sodium Hydroxide	■	■	25	80
Sodium Hypochlorite	■	■	10	150
Sodium Monophosphate	SAT	170	SAT	200
Sodium Nitrate	SAT	170	SAT	200
Sodium Sulfate	SAT	170	SAT	200
Sodium Thiosulfate	ALL	100	ALL	120
Stannic Chloride	SAT	160	SAT	190
Sulfated Detergent	0/50	170	0/50	200
Sulfur Dioxide	100	80	100	200
Sulfur Trioxide	100	80	100	200
Sulfuric Acid	93	■	93	N/R
Sulfuric Acid	50	■	50	175
Sulfuric Acid	25	75	25	190
Sulfurous Acid		80	■	
Tartaric Acid		170		200
Tetrachloroethylene	■	■	■	■
Toluene	■	■	■	■
Trisodium Phosphate			SAT	175
Urea	SAT	130	SAT	140
Vinegar	100	170	100	200
Water, Distilled	100	170	100	190
Water, Tap	100	170	100	190
Water, Salt	SAT	170	SAT	190
Zinc Chloride	SAT	170	SAT	200
Zinc Nitrate	SAT	170	SAT	200
Zinc Sulfate	SAT	170	SAT	200

LEGEND: SAT - SATURATED, ▲ - NOT AVALIABLE, ■ - NOT RECOMMENDED, V - VAPOURS

Straight Section

Supports must be located so that connector (splice joints) between horizontal runs fall between the support point and the quarter point of the span.

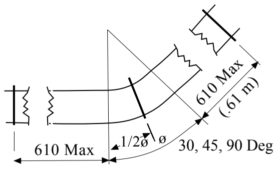


Standard engineering practice requires that the splice joints be located where they will resist little or no bending moment. This allows the cable tray system to act as a continuous member with spans working in conjunction with one another to resist loading. When a cable tray system is installed with the splice joints located directly over the support, the previous continuous span condition is changed to one of a number of simple spans.

These spans act independently of each other and excessive stress will occur at substantially less loading. Vertical straight lengths should be supported at intervals dictated by the building structure not exceeding 24 Ft. on centers. A support should be located 2 Ft. on each side of an expansion connection.

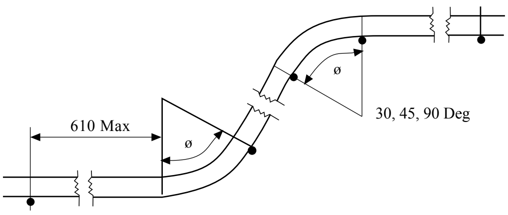
Horizontal Fitting Support Sectors

Supports should should be placed within 610mm of each fitting and as follows: 90 degree supports at the 45 degree point of the arc, 45 degree supports at the 22.5 degree point of the arc (except for the 12" radii), 30 degree supports at the 15 degree point of the arc (except for the 12" radii).



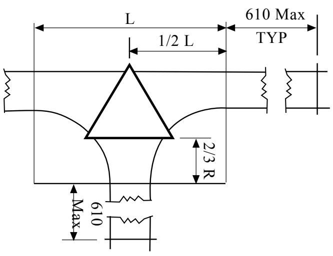
Vertical Fitting

Vertical fittings at the top runs should be supported at each end. Fittings at the bottom of runs should be supported at the top of the fitting, and within 610mm of the lower extremity of the fitting.



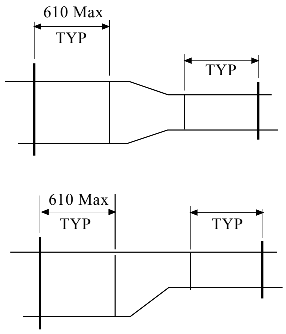
Horizontal Tee

Supports should be placed within 610mm of each of the three openings connected to other cable tray items for 12" (305mm) radius. On all other radii, at least one support should also be placed under each side rail of the tee.



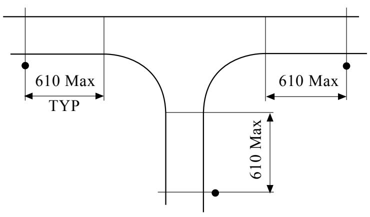
Reducer Fitting

Straight reducer and right/left hand reducer fittings should be supported within 2 Ft. (.61mm) of each fitting extremity.



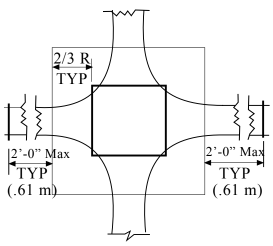
Vertical Tee

Vertical tee fittings should be supported within 610mm of each fitting extremity.



Horizontal Cross

Supports should be placed within 610mm of the four openings connected to other cable tray items for the 12" (305mm) radius. On all other radii, at least one support should also be placed under each side rail of the cross.



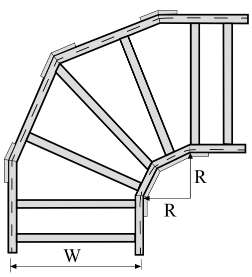
CABLE LADDER ACCESSORIES SELECTION CHART

KLP3 - C - 4 - HL - SR - HB90 - 12

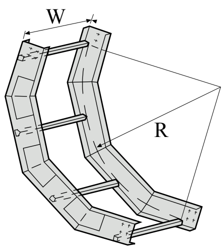
NEM Class	Width	Side Rail	Resin	Style Rung	Radius
KLP3	4 = 100	2 = 50	P = Polyester Resin	SR = Strut Rung	12 = 300mm
KTP4	6 = 150	3 = 75	V = Vinyl Ester	SLR = Strut Slotted Rung	16 = 450mm
KHP4	8 = 200	4 = 100	H = Helogen Free Polyster	STR = Solid Tube Rung	24 = 600mm
KTP4	9 = 225	5 = 125	HL = Halogen Free Low Smoke	LR = Light Rung	36 = 900mm
KTP6	10 = 250	6 = 150	HVS = Hologen Free Vinyl Ester		
KLP6	12 = 300		RT = Conductor		
KHP6	14 = 350				
D-KHP6	14 = 350				
KHZ6	16 = 400				
KHP6	18 = 450				
KHP8	20 = 500				
D-KHP10	24 = 600				
	30 = 350				
	36 = 900				

Type of Fittings

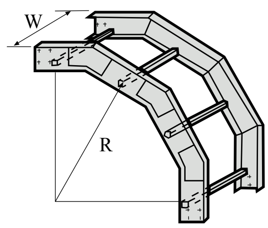
HB90 - Horizontal Bend 90 Deg	FB90 - Flat Bend 90 Deg
HB45 - Horizontal Bend 45 Deg	FB45 - Flat Bend 45 Deg
HB30 - Horizontal Bend 30 Deg	FB30 -Flat Bend 30 Deg
HB660 - Horizontal Bend 60 Deg	FB60 - Flat Bend 60 Deg
VIB90 - Verticle Internal Bend 90 Deg	HT - Horizontal Equal Tee
VIB45 - Verticle Internal Bend 45 Deg	HUT - Horizontal Un Equal Tee
VIB30 - Verticle Internal Bend 30 Deg	HEC - Horizontal Cross
VIB60 - Verticle Internal Bend 60 Deg	HUC - Horizontal Un Equal Cross
VOB90 - Verticle External Bend 90 Deg	SR - Straight Reducer
VOB45 - Verticle External Bend 90 Deg	RSR - Right Offset Reducer
VOB30 - Verticle External Bend 90 Deg	LSR - Left Offset Reducer
VOB60 - Verticle External Bend 90 Deg	



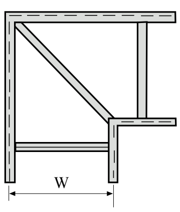
Horizontal 90˚ Bend (HB90)



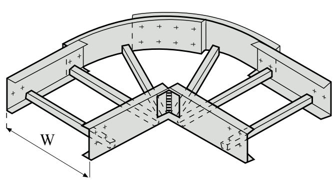
Verticle 90˚ Internal Bend (VIB90)



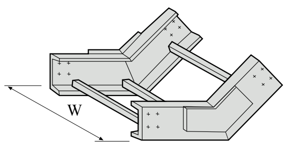
Verticle 90˚ External Bend (VIB90)



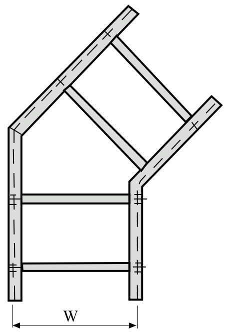
Flat 90˚ Bend (FB90)

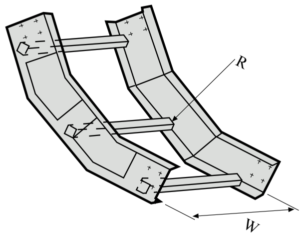


Horizontal 45˚ Bend (HB45)

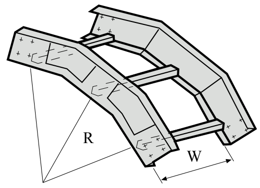


Verticle 30˚Internal Bend (VIB45)

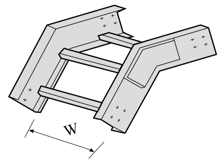




Flat 45° Internal Bend (VIB45)

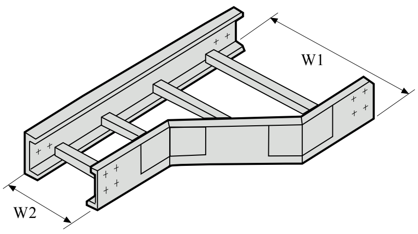


Verticle 45° External Bend (VOB45)

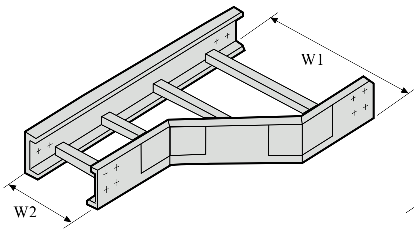


Verticle 30°
External Bend (VIB45)

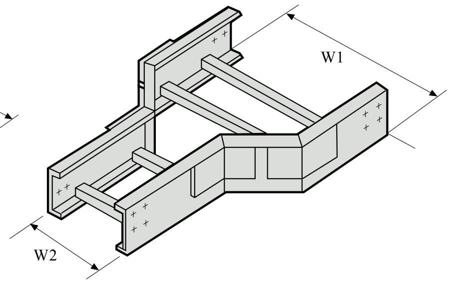
Flat 45° Bend (FB45)



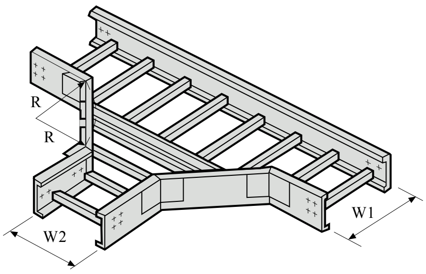
Right Offset Reducer (RSR)



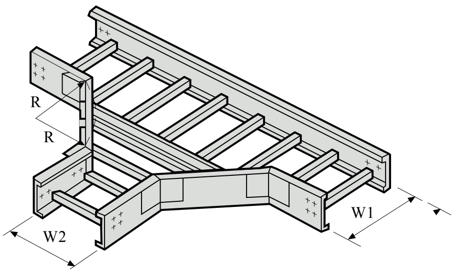
Left Offset Reducer (LSR)



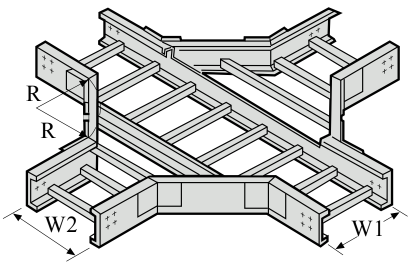
Straight Reducer (SR)



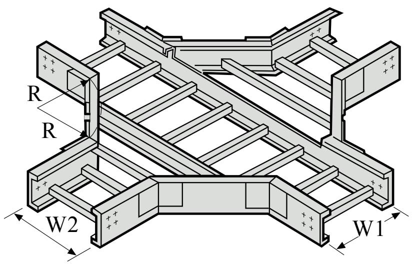
Horizontal Tee (HT)



Horizontal Un Equal Tee (HUT)

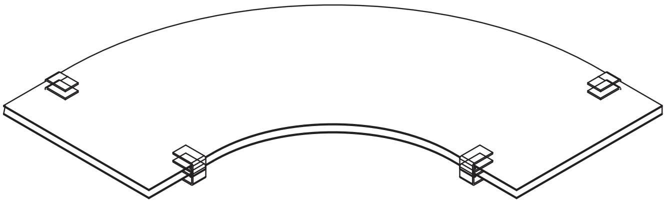


Horizontal Equal Cross (HEC)



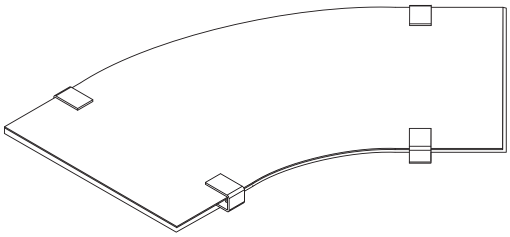
Horizontal Un Equal Cross (HUC)

Cable Ladder Accessories Style



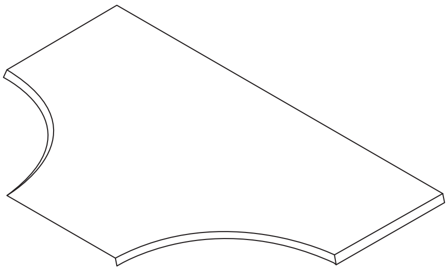
90 ˚ Bend Cover

Accessory Cover Suitable for Ladder	Accessory Cover Suitable for Tray	Size mm	Height mm
KLCF10-90B	KLCFT10-90B	100	15
KLCF15-90B	KLCFT15-90B	150	15
KLCF20-90B	KLCFT20-90B	200	15
KLCF22-90B	KLCFT22-90B	225	15
KLCF25-90B	KLCFT25-90B	250	15
KLCF30-90B	KLCFT30-90B	300	15
KLCF40-90B	KLCFT40-90B	400	15
KLCF45-90B	KLCFT45-90B	450	15
KLCF50-90B	KLCFT50-90B	500	15
KLCF60-90B	KLCFT60-90B	600	15
KLCF70-90B	KLCFT70-90B	700	15
KLCF75-90B	KLCFT75-90B	750	15
KLCF90-90B	KLCFT90-90B	900	15
KLCF100-90B	KLCFT100-90B	1000	15



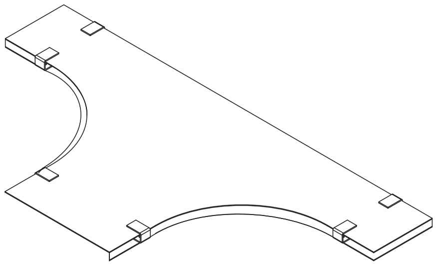
45 ˚ Bend Cover

Accessory Cover Suitable for Ladder	Accessory Cover Suitable for Tray	Size mm	Height mm
KLCF10-45B	KLCFT10-45B	100	15
KLCF15-45B	KLCFT15-45B	150	15
KLCF20-45B	KLCFT20-45B	200	15
KLCF22-45B	KLCFT22-45B	225	15
KLCF25-45B	KLCFT25-45B	250	15
KLCF30-45B	KLCFT30-45B	300	15
KLCF40-45B	KLCFT40-45B	400	15
KLCF45-45B	KLCFT45-45B	450	15
KLCF50-45B	KLCFT50-45B	500	15
KLCF60-45B	KLCFT60-45B	600	15
KLCF70-45B	KLCFT70-45B	700	15
KLCF75-45B	KLCFT75-45B	750	15
KLCF90-45B	KLCFT90-45B	900	15
KLCF100-45B	KLCFT100-45B	1000	15



Tee Cover

Accessory Cover Suitable for Ladder	Accessory Cover Suitable for Tray	Size mm	Height mm
KLCF10-TE	KLCFT10-TE	100	15
KLCF15-TE	KLCFT15-TE	150	15
KLCF20-TE	KLCFT20-TE	200	15
KLCF22-TE	KLCFT22-TE	225	15
KLCF25-TE	KLCFT25-TE	250	15
KLCF30-TE	KLCFT30-TE	300	15
KLCF40-TE	KLCFT40-TE	400	15
KLCF45-TE	KLCFT45-TE	450	15
KLCF50-TE	KLCFT50-TE	500	15
KLCF60-TE	KLCFT60-TE	600	15
KLCF70-TE	KLCFT70-TE	700	15
KLCF75-TE	KLCFT75-TE	750	15
KLCF90-TE	KLCFT90-TE	900	15
KLCF100-TE	KLCFT100-TE	1000	15



Tee Cover - Un Equal

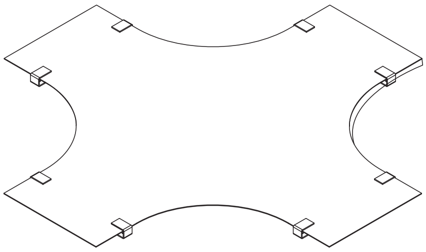
Accessory Cover Suitable for Ladder	Accessory Cover Suitable for Tray	Size mm	Height mm
KLCF10-TU	KLCFT10-TU	100	15
KLCF15-TU	KLCFT15-TU	150	15
KLCF20-TU	KLCFT20-TU	200	15
KLCF22-TU	KLCFT22-TU	225	15
KLCF25-TU	KLCFT25-TU	250	15
KLCF30-TU	KLCFT30-TU	300	15
KLCF40-TU	KLCFT40-TU	400	15
KLCF45-TU	KLCFT45-TU	450	15
KLCF50-TU	KLCFT50-TU	500	15
KLCF60-TU	KLCFT60-TU	600	15
KLCF70-TU	KLCFT70-TU	700	15
KLCF75-TU	KLCFT75-TU	750	15
KLCF90-TU	KLCFT90-TU	900	15
KLCF100-TU	KLCFT100-TU	1000	15

Note:

Please add suffix

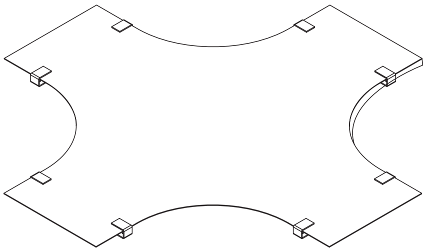
P= Peak cover 25 Deg, B = Peak Cover 10 Deg, V = Ventilated Cover, F = Flat Cover at the end of the Part No.

Standard Cover will here 15mm Height



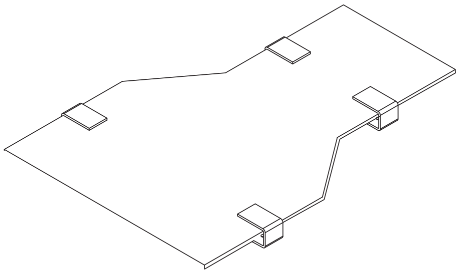
Equal Cross Cover

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-EC	KLCFT10-EC	100	15
KLCF15-EC	KLCFT15-EC	150	15
KLCF20-EC	KLCFT20-EC	200	15
KLCF22-EC	KLCFT22-EC	225	15
KLCF25-EC	KLCFT25-EC	250	15
KLCF30-EC	KLCFT30-EC	300	15
KLCF40-EC	KLCFT40-EC	400	15
KLCF45-EC	KLCFT45-EC	450	15
KLCF50-EC	KLCFT50-EC	500	15
KLCF60-EC	KLCFT60-EC	600	15
KLCF70-EC	KLCFT70-EC	700	15
KLCF75-EC	KLCFT75-EC	750	15
KLCF90-EC	KLCFT90-EC	900	15
KLCF100-EC	KLCFT100-EC	1000	15



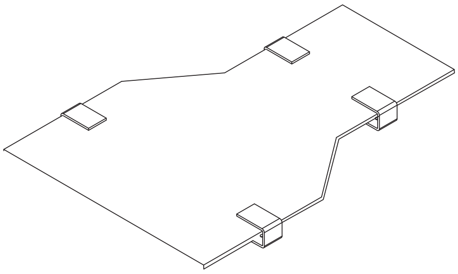
Un Equal Cross Cover

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-UC	KLCFT10-UC	100	15
KLCF15-UC	KLCFT15-UC	150	15
KLCF20-UC	KLCFT20-UC	200	15
KLCF22-UC	KLCFT22-UC	225	15
KLCF25-UC	KLCFT25-UC	250	15
KLCF30-UC	KLCFT30-UC	300	15
KLCF40-UC	KLCFT40-UC	400	15
KLCF45-UC	KLCFT45-UC	450	15
KLCF50-UC	KLCFT50-UC	500	15
KLCF60-UC	KLCFT60-UC	600	15
KLCF70-UC	KLCFT70-UC	700	15
KLCF75-UC	KLCFT75-UC	750	15
KLCF90-UC	KLCFT90-UC	900	15
KLCF100-UC	KLCFT100-UC	1000	15



Straight Reducer Cover

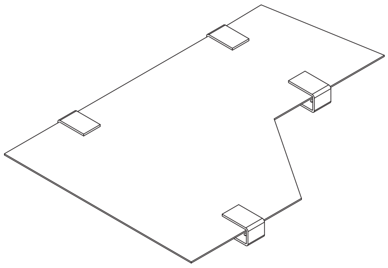
Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-R	KLCFT10-R	100	15
KLCF15-R	KLCFT15-R	150	15
KLCF20-R	KLCFT20-R	200	15
KLCF22-R	KLCFT22-R	225	15
KLCF25-R	KLCFT25-R	250	15
KLCF30-R	KLCFT30-R	300	15
KLCF40-R	KLCFT40-R	400	15
KLCF45-R	KLCFT45-R	450	15
KLCF50-R	KLCFT50-R	500	15
KLCF60-R	KLCFT60-R	600	15
KLCF70-R	KLCFT70-R	700	15
KLCF75-R	KLCFT75-R	750	15
KLCF90-R	KLCFT90-R	900	15
KLCF100-R	KLCFT100-R	1000	15



Left Reducer Cover

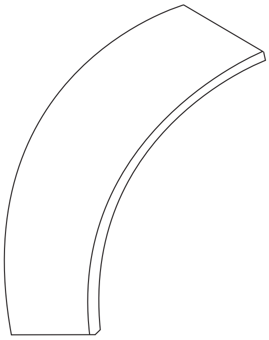
Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-LR	KLCFT10-LR	100	15
KLCF15-LR	KLCFT15-LR	150	15
KLCF20-LR	KLCFT20-LR	200	15
KLCF22-LR	KLCFT22-LR	225	15
KLCF25-LR	KLCFT25-LR	250	15
KLCF30-LR	KLCFT30-LR	300	15
KLCF40-LR	KLCFT40-LR	400	15
KLCF45-LR	KLCFT45-LR	450	15
KLCF50-LR	KLCFT50-LR	500	15
KLCF60-LR	KLCFT60-LR	600	15
KLCF70-LR	KLCFT70-LR	700	15
KLCF75-LR	KLCFT75-LR	750	15
KLCF90-LR	KLCFT90-LR	900	15
KLCF100-LR	KLCFT100-LR	1000	15

Note:
Please add suffix
P= Peak cover 25 Deg, B = Peak Cover 10 Deg, V = Ventilated Cover, F = Flat Cover at the end of the Part No.
Standard Cover will here 15mm Height



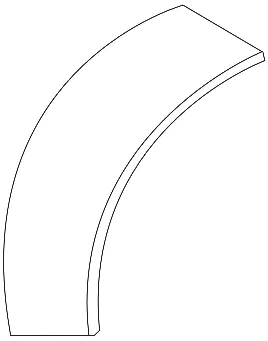
Right Offset Reducer Cover

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-RR	KLCFT10-RR	100	15
KLCF15-RR	KLCFT15-RR	150	15
KLCF20-RR	KLCFT20-RR	200	15
KLCF22-RR	KLCFT22-RR	225	15
KLCF25-RR	KLCFT25-RR	250	15
KLCF30-RR	KLCFT30-RR	300	15
KLCF40-RR	KLCFT40-RR	400	15
KLCF45-RR	KLCFT45-RR	450	15
KLCF50-RR	KLCFT50-RR	500	15
KLCF60-RR	KLCFT60-RR	600	15
KLCF70-RR	KLCFT70-RR	700	15
KLCF75-RR	KLCFT75-RR	750	15
KLCF90-RR	KLCFT90-RR	900	15
KLCF100-RR	KLCFT100-RR	1000	15



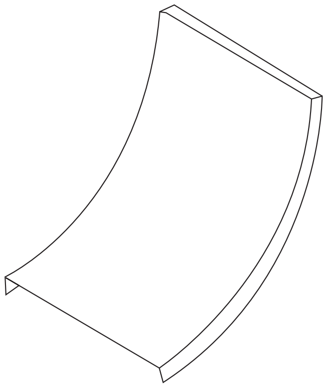
External Riser Cover 90˚

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-ER90	KLCFT10-ER90	100	15
KLCF15-ER90	KLCFT15-ER90	150	15
KLCF20-ER90	KLCFT20-ER90	200	15
KLCF22-ER90	KLCFT22-ER90	225	15
KLCF25-ER90	KLCFT25-ER90	250	15
KLCF30-ER90	KLCFT30-ER90	300	15
KLCF40-ER90	KLCFT40-ER90	400	15
KLCF45-ER90	KLCFT45-ER90	450	15
KLCF50-ER90	KLCFT50-ER90	500	15
KLCF60-ER90	KLCFT60-ER90	600	15
KLCF70-ER90	KLCFT70-ER90	700	15
KLCF75-ER90	KLCFT75-ER90	750	15
KLCF90-ER90	KLCFT90-ER90	900	15
KLCF100-ER90	KLCFT100-ER90	1000	15



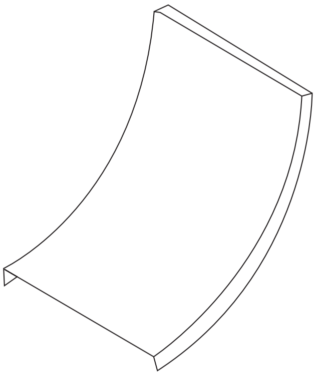
External Riser Cover 45˚

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-ER45	KLCFT10-ER45	100	15
KLCF15-ER45	KLCFT15-ER45	150	15
KLCF20-ER45	KLCFT20-ER45	200	15
KLCF22-ER45	KLCFT22-ER45	225	15
KLCF25-ER45	KLCFT25-ER45	250	15
KLCF30-ER45	KLCFT30-ER45	300	15
KLCF40-ER45	KLCFT40-ER45	400	15
KLCF45-ER45	KLCFT45-ER45	450	15
KLCF50-ER45	KLCFT50-ER45	500	15
KLCF60-ER45	KLCFT60-ER45	600	15
KLCF70-ER45	KLCFT70-ER45	700	15
KLCF75-ER45	KLCFT75-ER45	750	15
KLCF90-ER45	KLCFT90-ER45	900	15
KLCF100-ER45	KLCFT100-ER45	1000	15



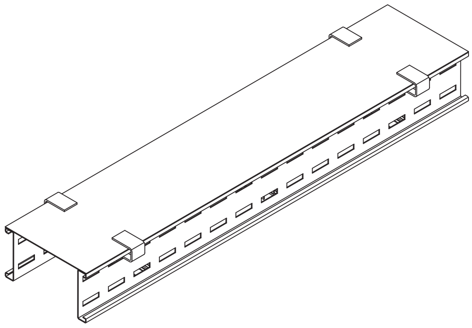
Internal Riser Cover 90˚

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-IR90	KLCFT10-IR90	100	15
KLCF15-IR90	KLCFT15-IR90	150	15
KLCF20-IR90	KLCFT20-IR90	200	15
KLCF22-IR90	KLCFT22-IR90	225	15
KLCF25-IR90	KLCFT25-IR90	250	15
KLCF30-IR90	KLCFT30-IR90	300	15
KLCF40-IR90	KLCFT40-IR90	400	15
KLCF45-IR90	KLCFT45-IR90	450	15
KLCF50-IR90	KLCFT50-IR90	500	15
KLCF60-IR90	KLCFT60-IR90	600	15
KLCF70-IR90	KLCFT70-IR90	700	15
KLCF75-IR90	KLCFT75-IR90	750	15
KLCF90-IR90	KLCFT90-IR90	900	15
KLCF100-IR90	KLCFT100-IR90	1000	15



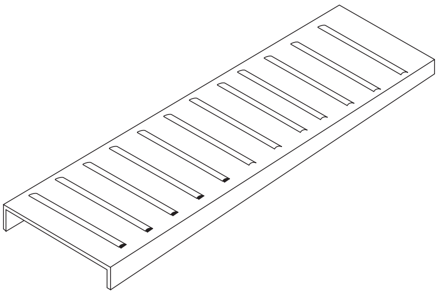
Internal Riser Cover 45˚

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10-IR45	KLCFT10-IR45	100	15
KLCF15-IR45	KLCFT15-IR45	150	15
KLCF20-IR45	KLCFT20-IR45	200	15
KLCF22-IR45	KLCFT22-IR45	225	15
KLCF25-IR45	KLCFT25-IR45	250	15
KLCF30-IR45	KLCFT30-IR45	300	15
KLCF40-IR45	KLCFT40-IR45	400	15
KLCF45-IR45	KLCFT45-IR45	450	15
KLCF50-IR45	KLCFT50-IR45	500	15
KLCF60-IR45	KLCFT60-IR45	600	15
KLCF70-IR45	KLCFT70-IR45	700	15
KLCF75-IR45	KLCFT75-IR45	750	15
KLCF90-IR45	KLCFT90-IR45	900	15
KLCF100-IR45	KLCFT100-IR45	1000	15



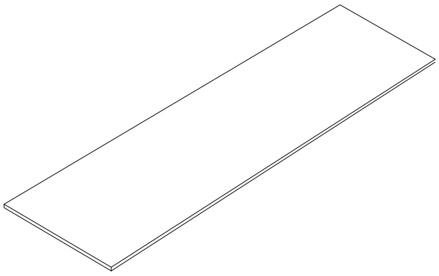
Ladder Cover

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCF10	KLCFT10	100	15
KLCF15	KLCFT15	150	15
KLCF20	KLCFT20	200	15
KLCF22	KLCFT22	225	15
KLCF25	KLCFT25	250	15
KLCF30	KLCFT30	300	15
KLCF40	KLCFT40	400	15
KLCF45	KLCFT45	450	15
KLCF50	KLCFT50	500	15
KLCF60	KLCFT60	600	15
KLCF70	KLCFT70	700	15
KLCF75	KLCFT75	750	15
KLCF90	KLCFT90	900	15
KLCF100	KLCFT100	1000	15



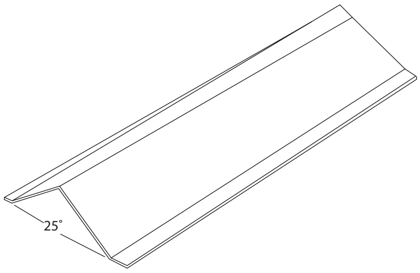
Ventilated Cover

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLVCF10	KLVCFT10	100	15
KLVCF15	KLVCFT15	150	15
KLVCF20	KLVCFT20	200	15
KLVCF22	KLVCFT22	225	15
KLVCF25	KLVCFT25	250	15
KLVCF30	KLVCFT30	300	15
KLVCF40	KLVCFT40	400	15
KLVCF45	KLVCFT45	450	15
KLVCF50	KLVCFT50	500	15
KLVCF60	KLVCFT60	600	15
KLVCF70	KLVCFT70	700	15
KLVCF75	KLVCFT75	750	15
KLVCF90	KLVCFT90	900	15
KLVCF100	KLVCFT100	1000	15

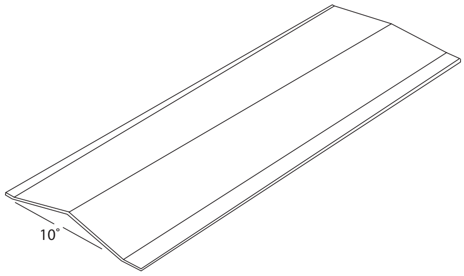


Flat Cover

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLCFF10	KLCFTT10	100	-
KLCFF15	KLCFTT15	150	-
KLCFF20	KLCFTT20	200	-
KLCFF22	KLCFTT22	225	-
KLCFF25	KLCFTT25	250	-
KLCFF30	KLCFTT30	300	-
KLCFF40	KLCFTT40	400	-
KLCFF45	KLCFTT45	450	-
KLCFF50	KLCFTT50	500	-
KLCFF60	KLCFTT60	600	-
KLCFF70	KLCFTT70	700	-
KLCFF75	KLCFT75	750	-
KLCFF90	KLCFFT90	900	-
KLCFF100	KLCFFT100	1000	-



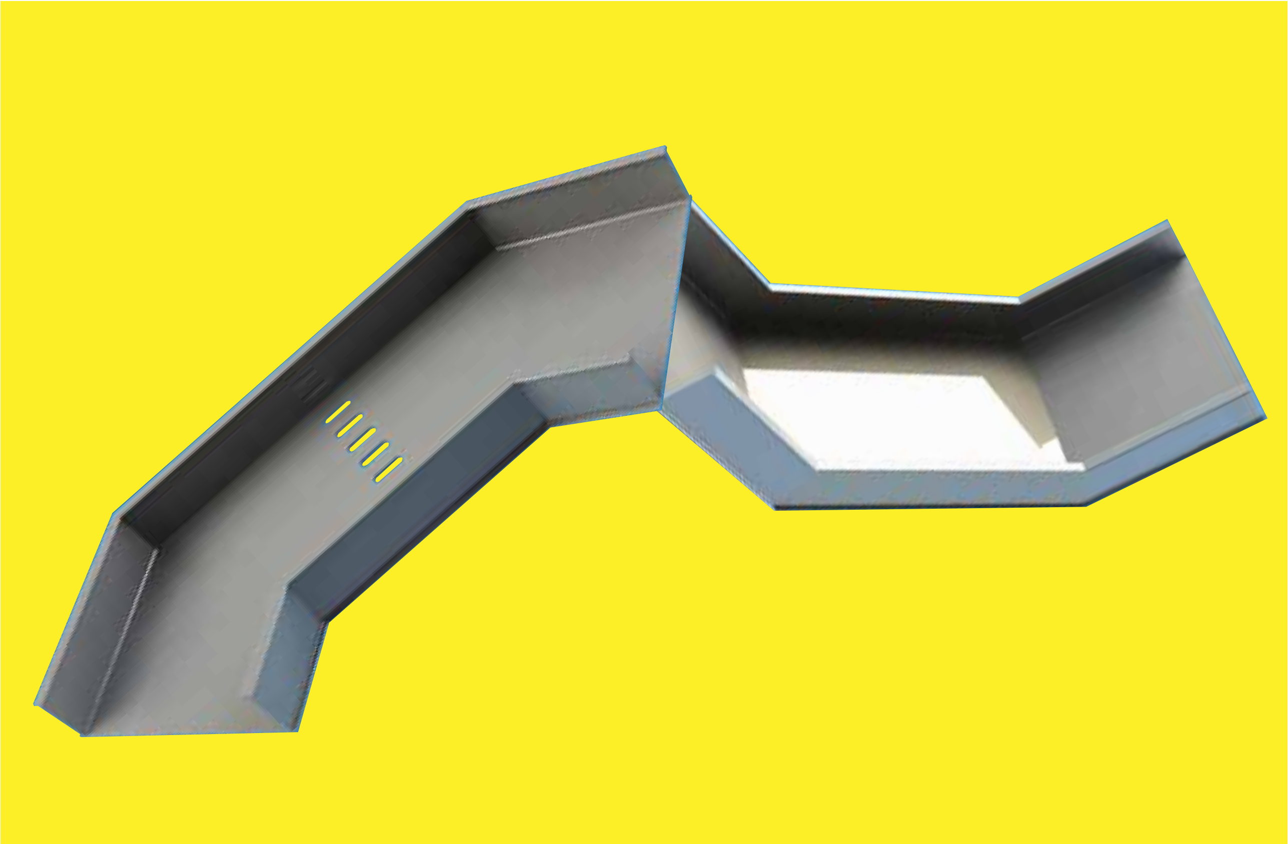
Peak Cover 25˚



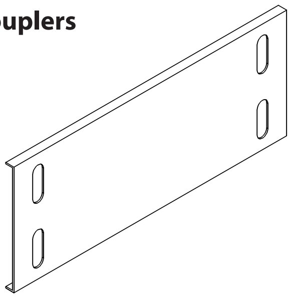
Peak Cover 10˚

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLPLF10	KLPLFT10	100	-
KLPLF15	KLPLFT15	150	-
KLPLF20	KLPLFT20	200	-
KLPLF22	KLPLFT22	225	-
KLPLF25	KLPLFT25	250	-
KLPLF30	KLPLFT30	300	-
KLPLF40	KLPLFT40	400	-
KLPLF45	KLPLFT45	450	-
KLPLF50	KLPLFT50	500	-
KLPLF60	KLPLFT60	600	-
KLPLF70	KLPLFT70	700	-
KLPLF75	KLPLFT75	750	-
KLPLF90	KLPLFT90	900	-
KLCFF100	KLPLFT100	1000	-

Accessory Cover Suitable for		Size mm	Height mm
Ladder	Tray		
KLBCF10	KLBCFT10	100	-
KLBCF15	KLBCFT15	150	-
KLBCF20	KLBCFT20	200	-
KLBCF22	KLBCFT22	225	-
KLBCF25	KLBCFT25	250	-
KLBCF30	KLBCFT30	300	-
KLBCF40	KLBCFT40	400	-
KLBCF45	KLBCFT45	450	-
KLBCF50	KLBCFT50	500	-
KLBCF60	KLBCFT60	600	-
KLBCF70	KLBCFT70	700	-
KLBCF75	KLBCFT75	750	-
KLBCF90	KLBCFT90	900	-
KLBCF100	KLBCFT100	1000	-

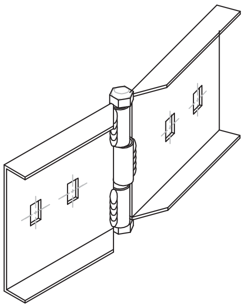


Couplers



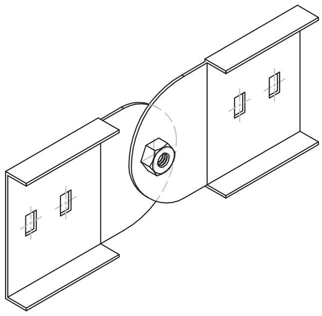
Straight Coupler

Model	Height
KSLF-50	50m
KSLF-75	75m
KSLF-100	100m
KSLF-125	125m
KSLF-150	150m
KSLF-175	175m



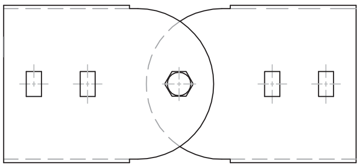
Horizantal Coupler

Model	Height
KHCF-50	50m
KHCF-75	75m
KHCF-100	100m
KHCF-125	125m
KHCF-150	150m
KHCF-175	175m



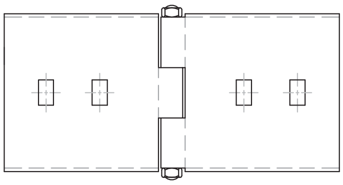
Vertical Coupler

Model	Height
KVCF-50	50m
KVCF-75	75m
KVCF-100	100m
KVCF-125	125m
KVCF-150	150m
KVCF-175	175m



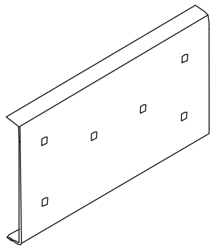
Verticle Straight Coupler

Model	Height
KVSCF-50	50m
KVSCF-75	75m
KVSCF-100	100m
KVSCF-125	125m
KVSCF-150	150m
KVSCF-175	175m



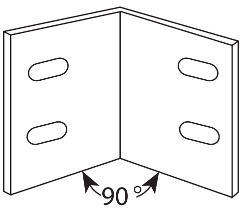
Horizantal Straight Coupler

Model	Height
KHSCF-50	50m
KHSCF-75	75m
KHSCF-100	100m
KHSCF-125	125m
KHSCF-150	150m
KHSCF-175	175m



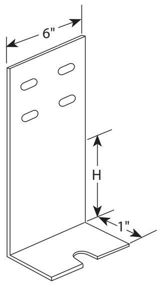
Splice Plate and Fixture

Model	Height
KSPFF-50	50m
KSPFF-75	75m
KSPFF-100	100m
KSPFF-125	125m
KSPFF-150	150m
KSPFF-175	175m



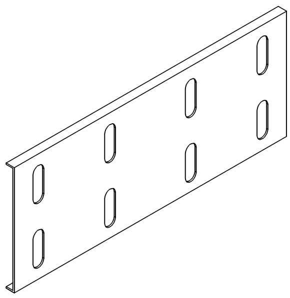
90˚ Splice Plate

Model	Height
KSPF90-50	50m
KSPF90-75	75m
KSPF90-100	100m
KSPF90-125	125m
KSPF90-150	150m
KSPF90-175	175m



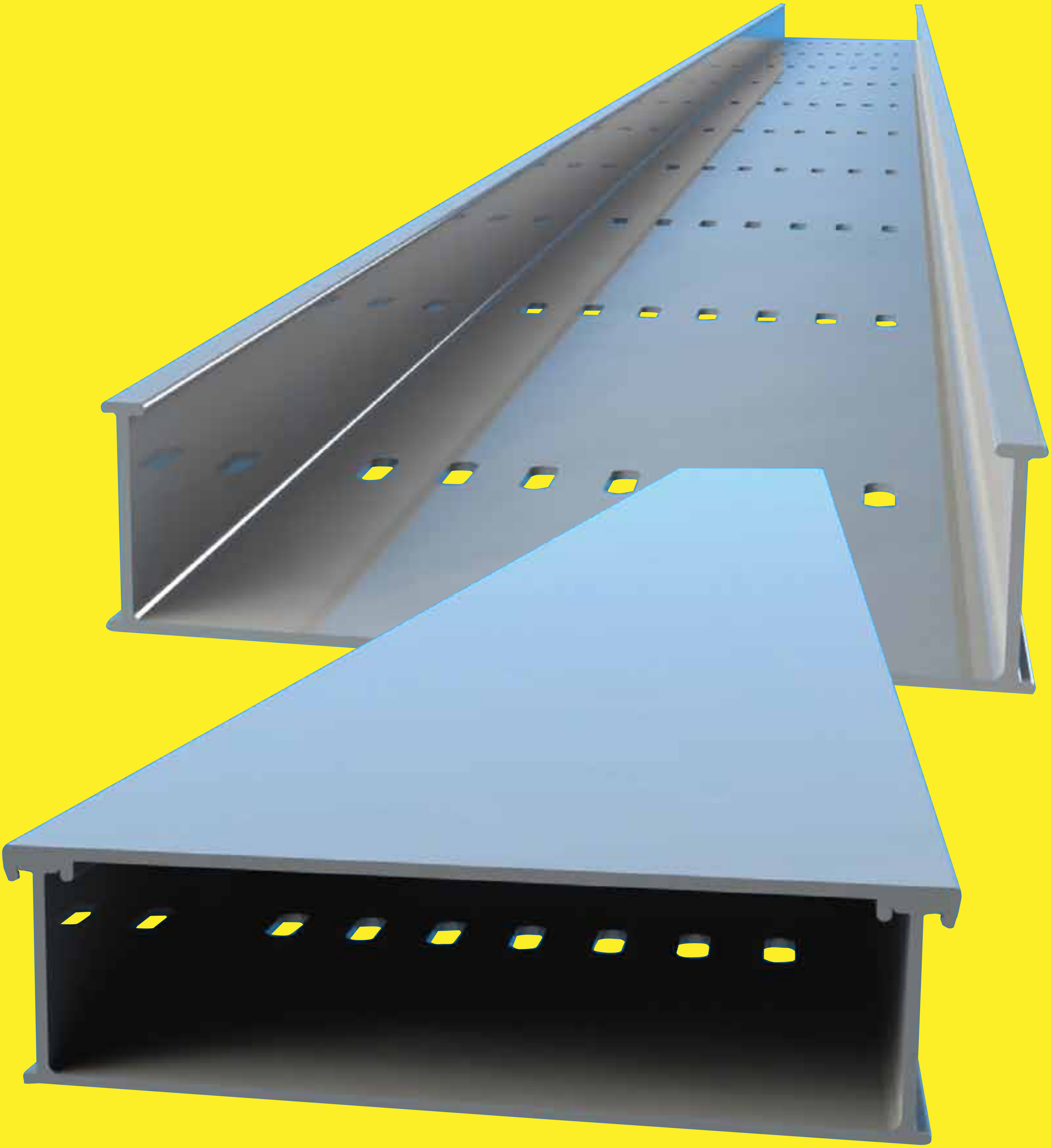
Raised Coupler

Model	Height
KRCF-50	50m
KRCF-75	75m
KRCF-100	100m
KRCF-125	125m
KRCF-150	150m
KRCF-175	175m



Straight Coupler 8 Hole

Model	Height
KSL8F-50	50m
KSL8F-75	75m
KSL8F-100	100m
KSL8F-125	125m
KSL8F-150	150m
KSL8F-175	175m



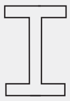
CABLE TRAY SELECTION CHART

KFT - C - 15 - 2 - P - 3

Type

KFT

Profile



I

Width

10 = 100m
15 = 150m
20 = 200m
22 = 225m
25 = 250m
30 = 300m
35 = 350m
40 = 400m
45 = 450m
50 = 500m
60 = 600m
75 = 750m
90 = 900m

Side Rail

2 = 50m
3 = 75m
4 = 100m

Resin

P = Polyester Resin
V = Vinyl Ester
H = Hologen Free Polyester
HL = Hologen Free Low Smoke
HVS = Hologen Free Vinyl Ester
RT = Conductive

Length

3=3mtr
6 = 6mtr

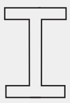
CABLE TRAY ACCESSORIES SELECTION CHART

KFTA - C - 15 - 2 - P - HB90

Type

KFTA

Profile



I

Width

10 = 100m
15 = 150m
20 = 200m
22 = 225m
25 = 250m
30 = 300m
35 = 350m
40 = 400m
45 = 450m
50 = 500m
60 = 600m
75 = 750m
90 = 900m

Side Rail

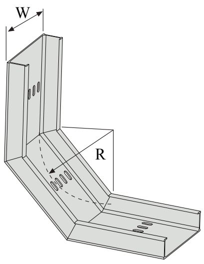
2 = 50m
3 = 75m
4 = 100m

Resin

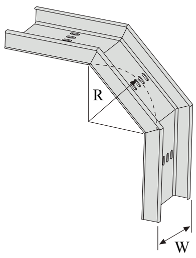
P = Polyester Resin
V = Vinyl Ester
H = Hologen Free Polyester
HL = Hologen Free Low Smoke
HVS = Hologen Free Vinyl Ester
RT = Conductive

Type

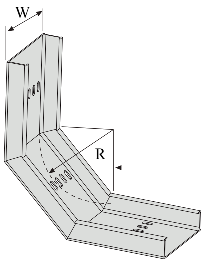
HB90- Horizontal Bend 90 ˚
HB45 - Horizontal Bend 45˚
IB90 - Internal Bend 90˚
IB45 - Internal Bend 45˚
EB90 - External Bend 90˚
EB45 - External Bend 45˚
HT - Horizontal Equal Tee -
HUC - Horizontal Un Equal Tee



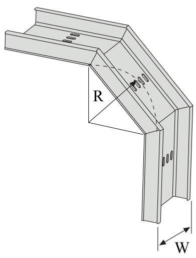
45˚ Internal Bend



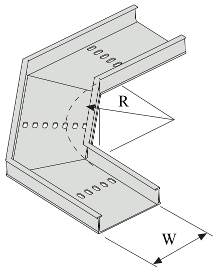
45˚ External Bend



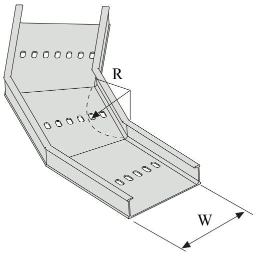
90˚ Internal Bend



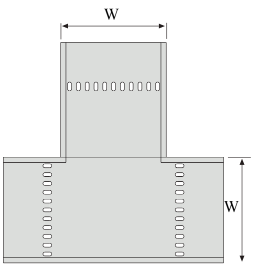
90˚ External Bend



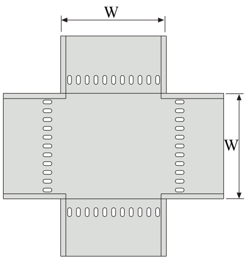
90˚ Horizontal Bend



45˚ Horizontal Bend

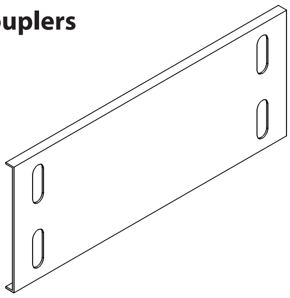


Horizontal Un Equal Tee



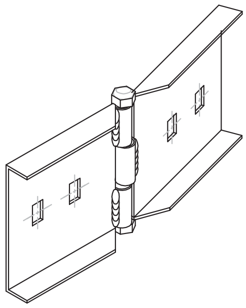
Horizontal Un Equal Cross

Couplers



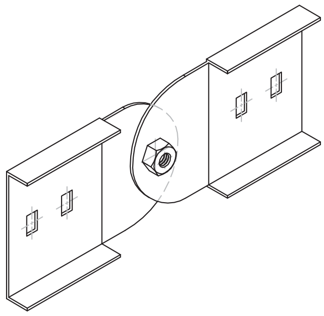
Straight Coupler

Model	Height
KSLFT-50	50m
KSLFT-75	75m
KSLFT-100	100m
KSLFT-125	125m
KSLFT-150	150m
KSLFT-175	175m



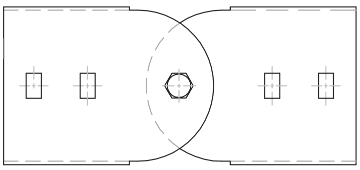
Horizantal Coupler

Model	Height
KHCFT-50	50m
KHCFT-75	75m
KHCFT-100	100m
KHCFT-125	125m
KHCFT-150	150m
KHCFT-175	175m



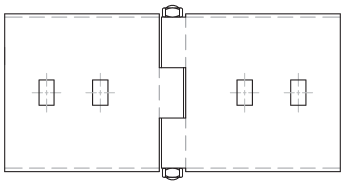
Vertical Coupler

Model	Height
KVCFT-50	50m
KVCFT-75	75m
KVCFT-100	100m
KVCFT-125	125m
KVCFT-150	150m
KVCFT-175	175m



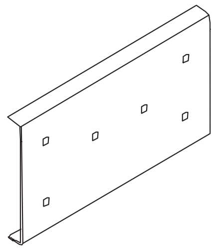
Verticle Straight Coupler

Model	Height
KVSCFT-50	50m
KVSCFT-75	75m
KVSCFT-100	100m
KVSCFT-125	125m
KVSCFT-150	150m
KVSCFT-175	175m



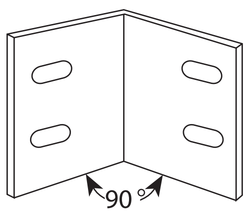
Horizantal Straight Coupler

Model	Height
KHSCFT-50	50m
KHSCFT-75	75m
KHSCFT-100	100m
KHSCFT-125	125m
KHSCFT-150	150m
KHSCFT-175	175m



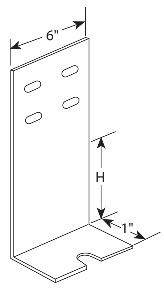
Splice Plate and Fixture

Model	Height
KSPFFT-50	50m
KSPFFT-75	75m
KSPFFT-100	100m
KSPFFT-125	125m
KSPFFT-150	150m
KSPFFT-175	175m



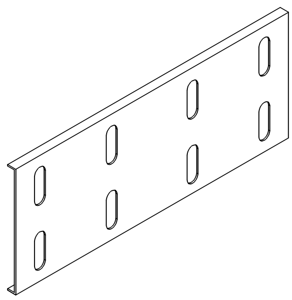
90˚ Splice Plate

Model	Height
KSPFT90-50	50m
KSPFT90-75	75m
KSPFT90-100	100m
KSPFT90-125	125m
KSPFT90-150	150m
KSPFT90-175	175m



Raised Coupler

Model	Height
KRCFT-50	50m
KRCFT-75	75m
KRCFT-100	100m
KRCFT-125	125m
KRCFT-150	150m
KRCFT-175	175m



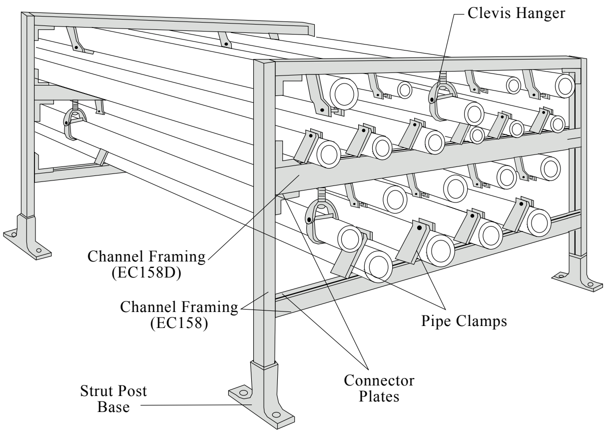
Straight Coupler 8 Hole

Model	Height
KSL8FT-50	50m
KSL8FT-75	75m
KSL8FT-100	100m
KSL8FT-125	125m
KSL8FT-150	150m
KSL8FT-175	175m

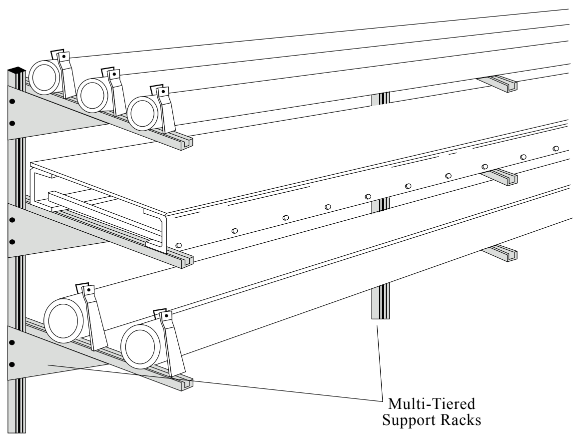
Kruppsmetal strut combined with our cable tray accessories are functional in many non-cable tray applications. Strut includes all the items nessary to field fabricate to your specifications whether wall, floor, or ceiling mounted. Krupps-metal can also assist in engineering to your requirements.

If you need a special shape or assembly, call Enduro for information on custom pultrusions and fabricatioris.

Pipe Support Racks Sample Installation



Wall Stanchion Sample Installation



Specification

1.0 Scope

1.1 This specification covers the requirements for Krupps-metal non-metallic Channel framing systems & accessories..

2.0 Standards

2.1 All channel shall have a fiame spread rating of 25 or less, and the smoke developed index shall have a density of 450 or less when tested in accordance with the provisions of ASTM E-84; therefore qualifiying as a class 1 material in the uniform building code.

3.0 Mdsaterials

3.1 All channel shall be manufactured by the pultrusion process, and contain a minimum of 50% glass by weight.

3.2 All channel shall conform, as a minimum requirement, to loads and defiections shown on the tables in the latest version of the Enduro Technical Catalogue.

4.0 Non-Metallic Pipe Clamps

4.1 All pipe clamps shall be manufactured by the injection molding process with an impact modified, 30% glass filled thermoplastic polyester resin.

4.2 All pipe clamps interlock with the channel framing described above.

4.3 All pipe clamps shall be designed for rigid PVC coated steel, Schedule 40 and 80 PVC, and filament wound fiberglass pipe or conduit. Clamps shall be adjustable to accommodate a 3/4 minimum deviation in O.D. size.

5.0 Fasteners

5.1 All fasteners shall be injected molded glass reinforced nylon, 316 stainless steel, or pulturded vinyl easter rod with ground threads and compression molded vinyl ester nuts.

Note:

For Strut Channel and its accessories please select from Kruppsstrut Catalogue.

Kruppsmetal Corporation Consists of these Products

KRUPPSSTRUT
KRUPPSFIBER
KRUPPSTRAY
KRUPPSTRUNKING
KRUPPSFLEX
KRUPPSENCLOSURE
KRUPPSLADDER
KRUPPSCONDUIT

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