

CFRP Laminates

DESCRIPTION

CFRP laminates are factory pultruded plates consisting out of unidirectional stretched carbon fibres in an epoxy resin matrix.

Two grades of pultruded plates are available, offering modulus of elasticity values in excess of 165 kN/mm² and 205 kN/mm².

USES

The structural design and thus the production of structural elements made of reinforced concrete is based on forces and loads current in codes of the time. However, during the service life of a structure, various circumstances may require that the service loads are changed due to:

- A modification of the structure: cutting of holes in slabs or beams
- A different use of the structures: from offices to library
- Ageing of the construction materials
- Deterioration of the concrete caused by reinforcement corrosion
- Cutting of pre- or post- stressed reinforcement cables
- Fire damages
- Upgrading of building codes
- Earthquake design requirements

Fortius pultruded CFRP laminates are used for the post-strengthening of structures to increase the load bearing capacity of structural components (increase of bending tensile force). The increased flexural capacity results in reduced deflections and the reduction in crack propagation. The use of carbon fibre pultruded plate has distinct advantages over the use of conventional steel plate and provides the designer with a unique freedom of design. Carbon fibre plates can be applied to both wooden and concrete beams, columns, slabs and walls for permanent structural reinforcement. This is in both the positive as well as negative moment.

PROPERTIES

Physical Properties

Composition	Pultruded carbon fibre laminate with epoxy resin matrix
Colour	Black
V _f	70% fibre content
T _{GM}	100 – 125 °C

Mechanical Properties

	Fortius CFRP Laminate 150/2000	Fortius CFRP Laminate 200/2000
E _{ipu} (Modulus of Elasticity for Design)	>165 kN/mm ²	>205 kN/mm ²
F _{ipu} (Ultimate Tensile Strength)	>2500 N/mm ²	>2500 N/mm ²
ε _{ipu} (Ultimate Elongation)	1.6%	1.3%



SIZES

Width/Thickness (mm)	amount of Fortresin CFL needed
10/1,4	
50/1,2	300 g/m
80/1,2	450 g/m
100/1,2	550 g/m
120/1,4	700 g/m
Delivery	Coiled rolls of 150 meters

APPLICATION

In order to ensure the load transfer from the CFRP laminate system to the substrate, the surface must be roughened by sandblasting or grinding. All damaged areas (cracks, bug holes, surface defects) must be repaired prior to placing Fortius CFRP laminates. Cracks should be repaired using a structural injection resin and surface defects should be filled and levelled using appropriate materials. The adhesive strength of the concrete must be verified after surface preparation by random pull-off testing at the discretion of the engineer. Minimum tensile strength is $1,5 \text{ N/mm}^2$. Before application of the Fortresin, the surface must be clean and without dust..

The CFRP laminate will arrive on site as a coil. The uncoiling should be done carefully, preferably with a special apparatus, which can be obtained from Fortius. Care should be given to avoid splitting the ends of the laminate. Since loose carbon fibres may be present on the surface and airborne carbon dust may be generated while cutting, gloves, mask and goggles are recommended when handling the material.

Fortius CFRP laminates should be cut with tools using a shearing force (e.g. guillotine, heavy duty shears, hand held grinder). Care should be taken to support both sides of the laminate when cutting. The surface should be wiped clean using an appropriate cleaner. With a clean white cloth, wipe down the side which is to receive adhesive (this side is not labelled) with acetone until all residual

carbon dust is removed (i.e. the white cloth remains white after wiping the laminate).

Fortius pultruded CFRP laminates should be adhered to the substrate with **Fortresin CFL** gel epoxy. Mix the A and B components in a clean pail and mix thoroughly for 3 minutes using a paddle mixer at slow speed (500 rpm). Mix only that quantity, which can be used within its pot life.

Apply Fortresin CFL to the substrate as a prime coat using a spatula to form a uniform thickness of 1,5 mm and a width approximately 2 cm wider than the laminate, which is to be used.

Then apply neat Fortresin CFL to the side of the CFRP laminate opposite the labelled side using a roof-shaped spatula and this to a normal thickness of 1,5 mm. The best method to accomplish this is to fabricate a 'hopper' for the Fortresin with the spatula at one end. The CFRP laminate is then pulled through the hopper under the Fortresin and then past the roof-shaped spatula to produce uniform cross section.

After both substrate and laminate have thus been prepared, the strip is placed on the concrete (epoxy to epoxy). A rubber roller is used to remove air and to properly seat the strip using enough pressure so that the Fortresin gel is forced out on both sides of the laminate and so that the glue line does not exceed 3 mm. Excess gel should be carefully removed. Do not disturb material 24 hours following application. Fortresin CFL will reach its designed strength in 7 days.

TENSILE FORCE FOR STATIC DESIGN

Design Strain	Fortius CFRP laminate 150/2000		Fortius CFRP laminate 200/2000	
	$\epsilon = 0,6\%$	$\epsilon = 0,8\%$	$\epsilon = 0,6\%$	$\epsilon = 0,6\%$
Width/Thickness (mm)				
10/1,4			13 kN	17 kN
50/1,2	58 kN	77 kN		
50/1,4	67 kN	90 kN	84 kN	112 kN
80/1,2	92 kN	123 kN		
80/1,4	108 kN	143 kN	134 kN	179 kN
100/1,2	115 kN	154 kN		
100/1,4	134 kN	179 kN	168 kN	224 kN
120/1,4			201 kN	269 kN