

- Flexural reinforcement
- High tensile modulus
- High tensile strength
- Excellent adhesion to concrete
- Excellent weather resistance

SOLUTION FOREVA® LFC : EXTERNALLY BONDED CARBON FIBER LAMINATES (Eurocodes)

Foreva® LFC 50, 80, 100, 120 and 150 tensile reinforcements are implemented by bonding a pultruded carbon fibre strip onto the tensioned surface of a reinforced or prestressed concrete structural element using an adhesive.

### Characteristics of products

- **Foreva® LFC** laminates: pultruded carbon fibres-epoxy resin flat and black composites. Two types of laminates are available:
  - Type 1 : Modulus of elasticity: **160 GPa**
    - ✓ Nominal dimensions (mm x mm)
    - ✓ 50x1.2 ; 80x1.2 ; 100x1.2 and 150x1.2
    - ✓ 50x1.4 ; 80x1.4 ; 100x1.4 and 120x1.4
  - Type 2: Modulus of elasticity: **200 GPa**
    - ✓ Nominal dimensions (mm x mm)
    - ✓ 50x1.4 ; 100x1.4 and 120x1.4 and 150x1.4
- Structural adhesive : two-component epoxy resin for structural bonding of carbon reinforcement to concrete substrates:
  - ✓ **Foreva® Epx LFC/I**
  - ✓ Eponal 380 (BOSTIK)
  - ✓ or equivalent

### Field of application

Foreva® LFC laminates are effective provided that the concrete surface is sound and cohesive.

- Apply to bridges, buildings, and all civil engineering structures in general.
- Increase the resistance of the structural element against tensile and bending stresses.

### Specified properties

|                             |                      |
|-----------------------------|----------------------|
| Nominal values of thickness | 1,2-1,4 mm           |
| Nominal values of width     | 50-80-100-120-150 mm |
| Max operating temperature   | 60°C                 |

**Design values (for factored load combinations according to Eurocode 2), with reference to the AFGC guide of February 2011 (Repair and reinforcement of concrete structures using composite materials)**

#### Type 1: E-modulus 160 GPa

|  |                              |
|--|------------------------------|
| Average tensile strength of the composite                | $f_{tu} = 2800 \text{ MPa}$  |
| Average elongation at break of the composite             | $\epsilon_{fu} = 1,65$       |
| Reduction coefficient for long-term effects              | 0,65                         |
| Partial safety coefficient at Ultimate Limit State       | 1,25                         |
| Design tensile strength at ULS of the composite          | $f_{tud} = 1456 \text{ MPa}$ |
| Partial safety coefficient at Serviceability Limit State | 1,40                         |
| Design tensile strength at SLS of the composite          | $f_{td} = 1300 \text{ MPa}$  |

#### Type 2: E-modulus 200 GPa

|  |                              |
|--|------------------------------|
| Average tensile strength of the composite                | $f_{tu} = 2900 \text{ MPa}$  |
| Reduction coefficient for long-term effects              | 0,65                         |
| Partial safety coefficient at Ultimate Limit State       | 1,25                         |
| Design tensile strength at ULS of the composite          | $f_{tud} = 1508 \text{ MPa}$ |
| Partial safety coefficient at Serviceability Limit State | 1,40                         |
| Design tensile strength at SLS of the composite          | $f_{td} = 1346 \text{ MPa}$  |

### Surface repair

- All surfaces must be structurally sound, clean and free of laitance or other surface deposits, dirt, dust, oil, grease or any contaminant that would adversely affect the bond.
- **Foreva® LFC** laminates are as rigid as steel; the substrate evenness tolerances are approximately the same as for installing bonded steel sheets.
  - ✓ Global planeity :  $\leq 5 \text{ mm} / 2\text{m}$  ruler
  - ✓ Local planeity:  $\leq 2 \text{ mm} / 0,2 \text{ m}$  ruler
  - ✓ Height of formwork fins :  $\leq 1 \text{ mm}$



- ✓ Blowhole diameter  $\leq 2$  mm
- ✓ Blowhole depth  $\leq 4$  mm
- ✓ Blowhole area :  $\leq 10\%$  of the total laminate surface
- ✓ Rugosity height :  $\leq 1,5$  mm
- Adhesion of repairs (mortars and concretes) on the substrate must exceed the concrete surface cohesive strength.

## Surface preparation

- Mark the positions of the specified locations of the laminates.
- Concrete surface must be prepared by mechanical means such as grinding or sandblasting.
- Test the substrate cohesive strength by direct pull-off tests (mean value of three valid tests). The measured stress shall be greater than or equal to 2,0 MPa unless otherwise specified by the Project's Engineer.

## Conditions of application

- Do not apply without precautions for temperatures  $< +5^{\circ}\text{C}$  or  $> +35^{\circ}\text{C}$ .
- Surfaces may be dry or damp, but free of standing water. The substrate temperature must exceed the one of the dew point of at least  $3^{\circ}\text{F}$  ( $3^{\circ}\text{C}$ ).
- Keep surfaces free from dust.

## Laminate preparation

- Refer to Project's drawings and cut the laminates to the specified length.
- Grind lightly the laminate surface to be bonded with sandpaper (optional).
- Clean the surface to be bonded with MEK or equivalent.

## Resin Mixing

- Use the relevant structural adhesive.
- Refer to information provided resin product data sheet.

## Application on the concrete

- Apply one layer of structural adhesive (**1 mm mini**) to the prepared concrete surface.
- Apply one layer of structural adhesive (**1 mm mini**) to the prepared laminate (using a special box to control the amount of adhesive is recommended).
- Install and align the laminate.



- Roller-press the laminate with a rigid roller: the aim of roller-pressing is to squeeze the layer of adhesive to expel any excess and remove air bubbles trapped on the bonding interface.

## Packaging

- **Foreva® LFC** laminates:
  - ✓ standard reels of 50 to 100m.
  - ✓ inner diameter : 900 mm.

## Storage

- **Foreva® LFC** laminates:
  - ✓ Avoid shocks and twisting

## Safety

- Make certain the most current versions of SDS of the products are being used.
- Never cut the straps around a reel unless it is inside a dispenser.
- A dust mask, gloves and protective goggles must be worn when cutting the laminate to length or grinding the laminate surface.

## Resin consumption

- Average yield: 3,0 - 4,0 Kg/m<sup>2</sup>