New UHPFRC for Bridge Overlays

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May 2016, 12th

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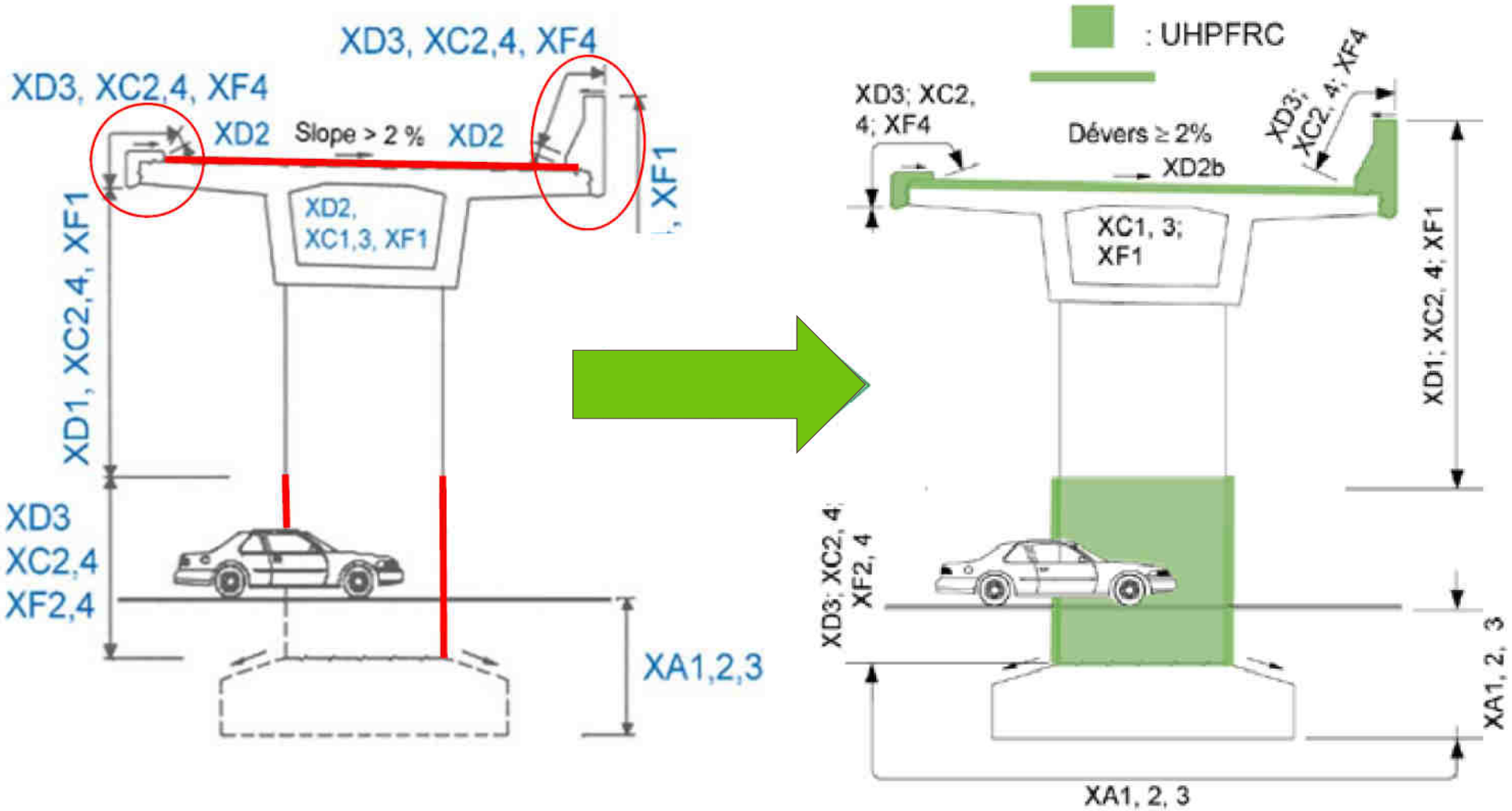
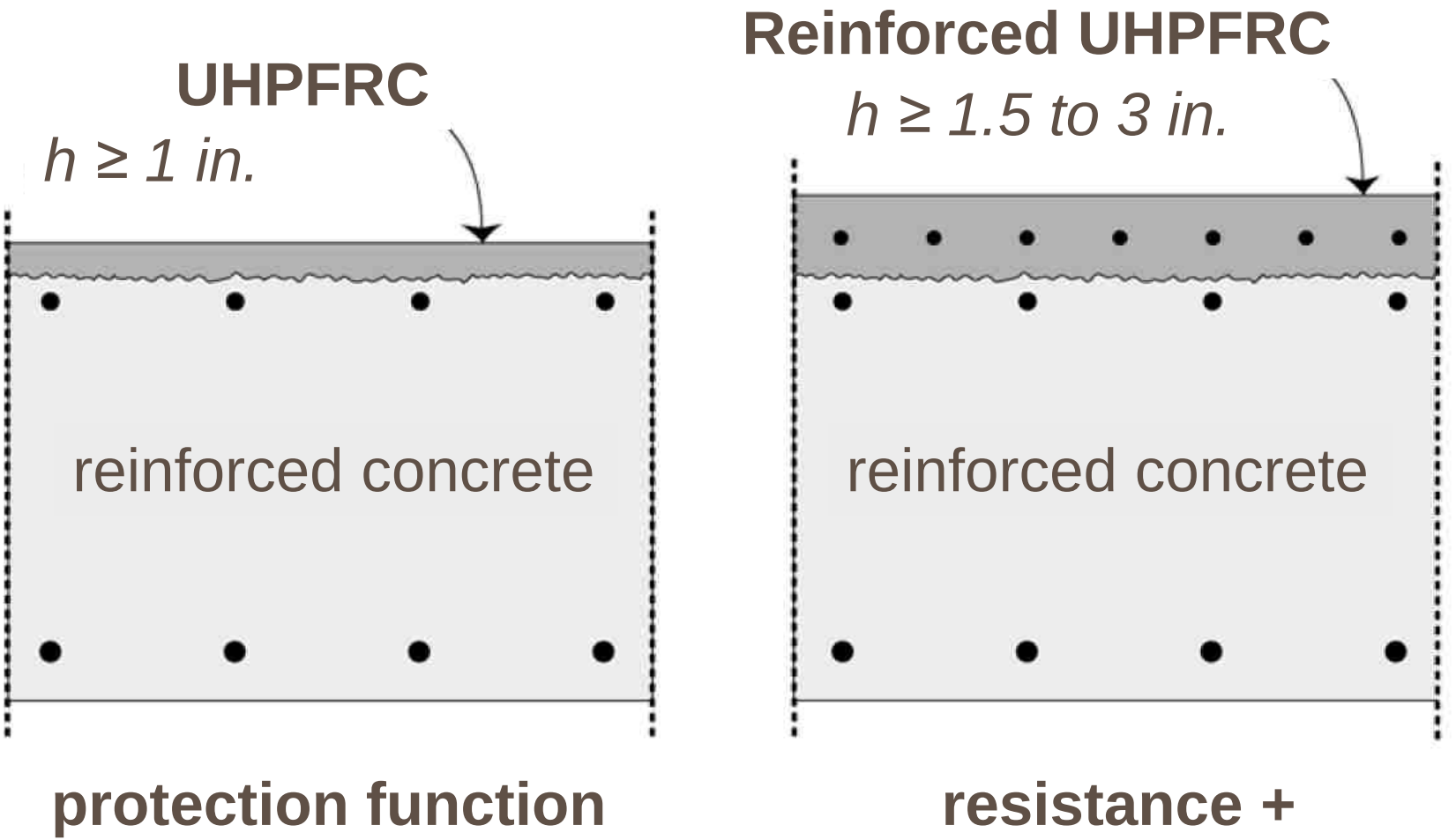
LafargeHolcim

The overlay concept (1999)



- **higher durability by a layer of waterproof UHPFRC**
- **higher resistance (rigidity, bending & shear, fatigue)**

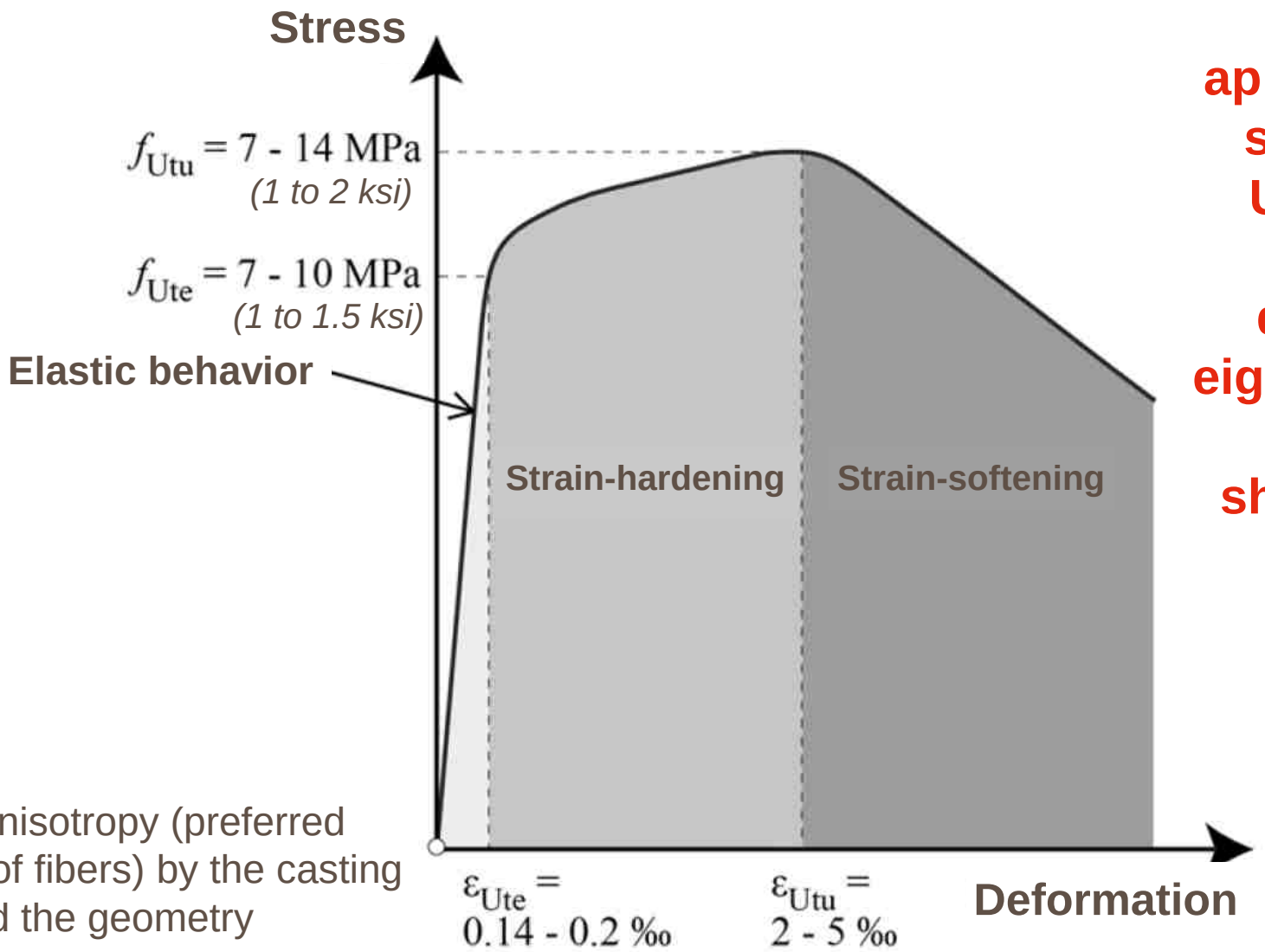
The overlay concept (1999)



protection function (durability)

resistance + protection function

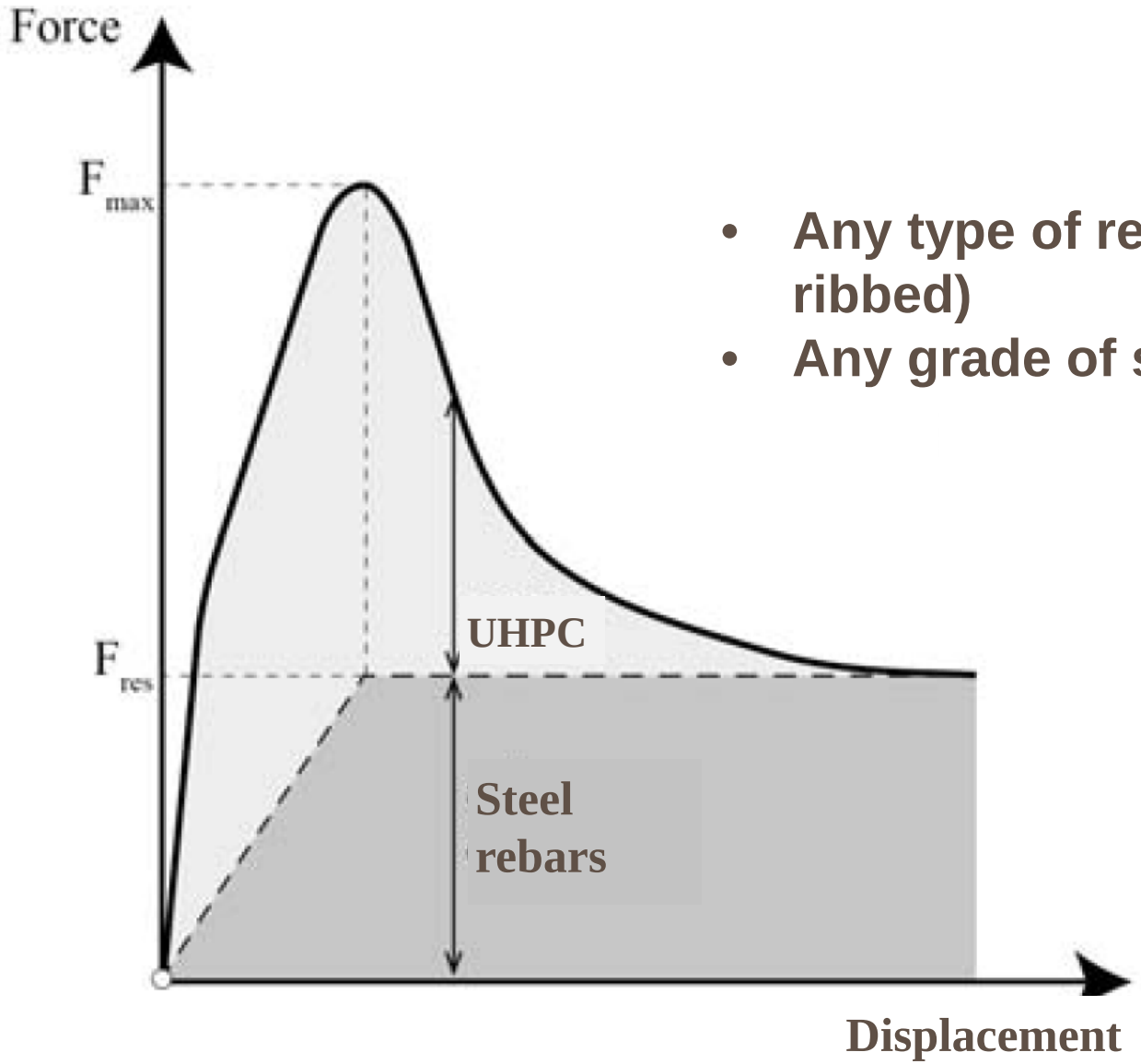
UHPFRC behavior: strain-hardening in tension



Cast-on site applications require strain-hardening UHPFRC able to withstand the development of eigenstresses due to restrained shrinkage, without cracking.

Warning: anisotropy (preferred orientation of fibers) by the casting process and the geometry

Reinforced UHPC behavior



- Any type of rebars (smooth, ribbed)
- Any grade of steel

UHPC: other requirements

- ✓ **fresh mix with the ability to be cast on inclined substrates (slope up to 10%)**

  → The rheology must be adjusted from self-compacting to rheo-thinning behavior (thixotropic)

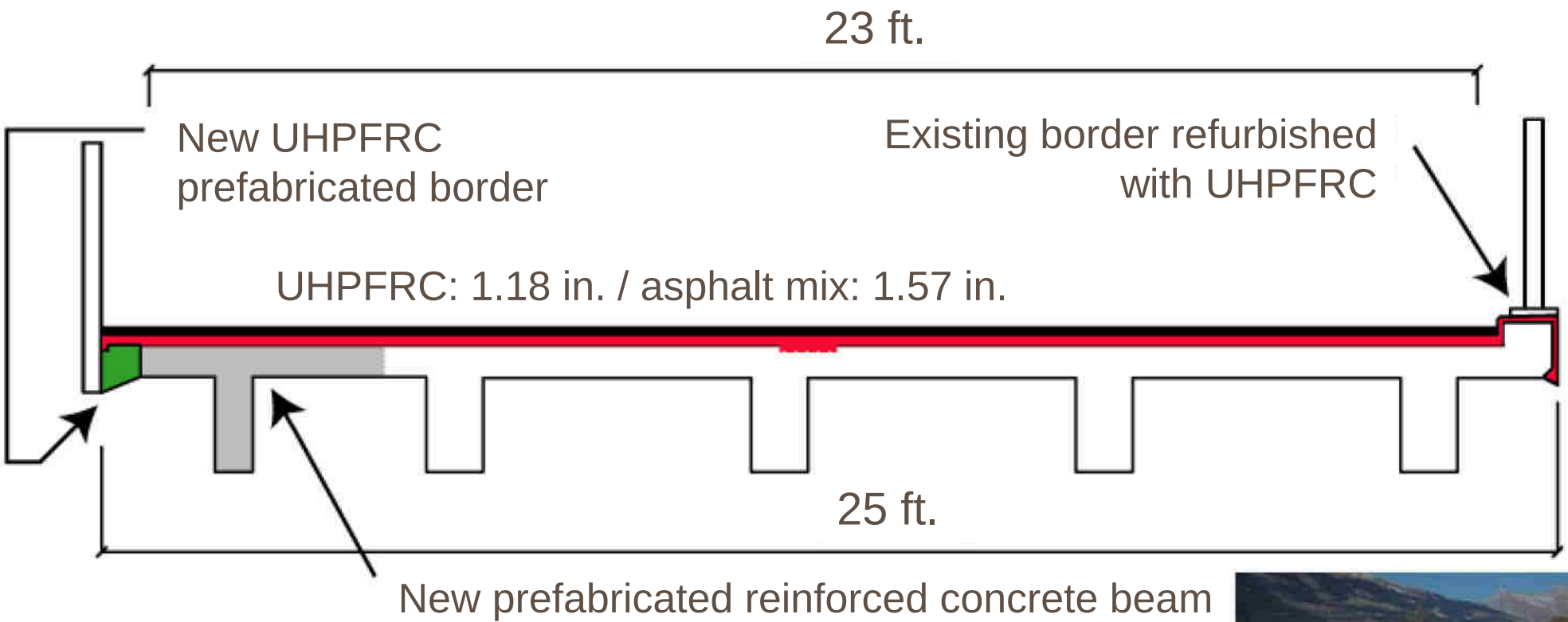
- ✓ **very low permeability → very high durability (waterproofing layer)**
- ✓ **bond stress ≥ 1.5 MPa → existing concrete should have a saturated surface dry (SSD)**
- ✓ **compatibility with the process (either manual or mechanical)**
- ✓ **robustness with T° (in-situ projects)**

Ductal® range for bridges overlay

Properties	Ductal NaG3 TX	Ductal G2 TX
Uniaxial tensile behavior: type	UA	UB
Characteristic value of the elastic tensile strength	1.13 ksi	1.5 ksi
Characteristic value of the tensile strength	1.3 ksi	1.8 ksi
Strain when the tensile strength is reached (hardening)	0.35 %	0.25 %
Characteristic value of the cube compressive strength	18 ksi	22 ksi
Mean value of the modulus of elasticity	7200 ksi	8000 ksi
Total shrinkage at 90 days	700 µm/m	800 µm/m
Water porosity at 90 days	6%	4%
Apparent gas permeability at 90 days	$\leq 0.5.10^{-19}$ m^2	$\leq 0.5.10^{-19}$ m^2
Diffusion coefficient of chloride ions at 90 days	$\leq 0.5.10^{-12}$ $m^2.s^{-1}$	$\leq 0.5.10^{-12}$ $m^2.s^{-1}$

mix used for the pilot yesterday

First application in 2004: rehabilitation and enlargement of a small road bridge (Switzerland)



First application in 2004: rehabilitation and enlargement of a small road bridge (Switzerland)

Largest application in 2014/2015: rehabilitation of Chillon Viaduct (Switzerland)

(prestressed box girder segments)

Key figures

1969
opening year to traffic

Twin viaducts

1.4 mile
long

2 x 39 ft.
width

341 ft.
maximum span

302 ft.
maximum height

571000 ft.²
deck suface

50 000
vehicles / day

Largest application in 2014/2015: rehabilitation of Chillon Viaduct (Switzerland)

Production rate: 60 to 100 m^3 per day → mobile ready-mix plant installed on the bridge

- *2 Teka mixers 1.2 m^3, 75kW operating in parallel*
- *production rate: 9 m^3/ h*
- *batch size: 1.2 m^3*
- *Mixing time: 10 min/batch*

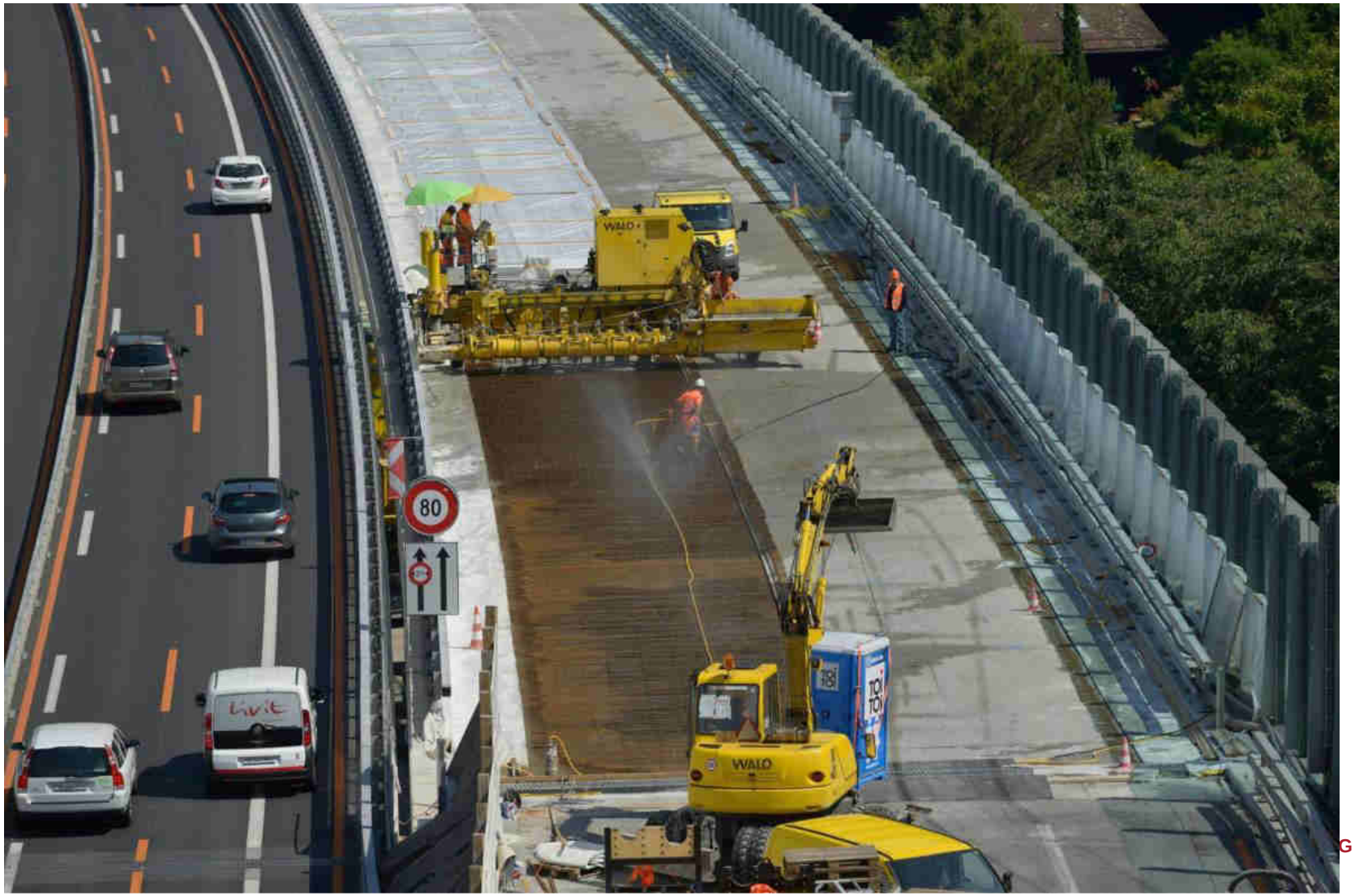
- *automatic weighing for all the components (premix, sand, fibers, water, admixtures)*

1 silo for the sand (63 tons)
1 silo for the premix (75 tons)

buggies (capacity 0.6 m^3)

Largest application in 2014/2015: rehabilitation of Chillon Viaduct (Switzerland)

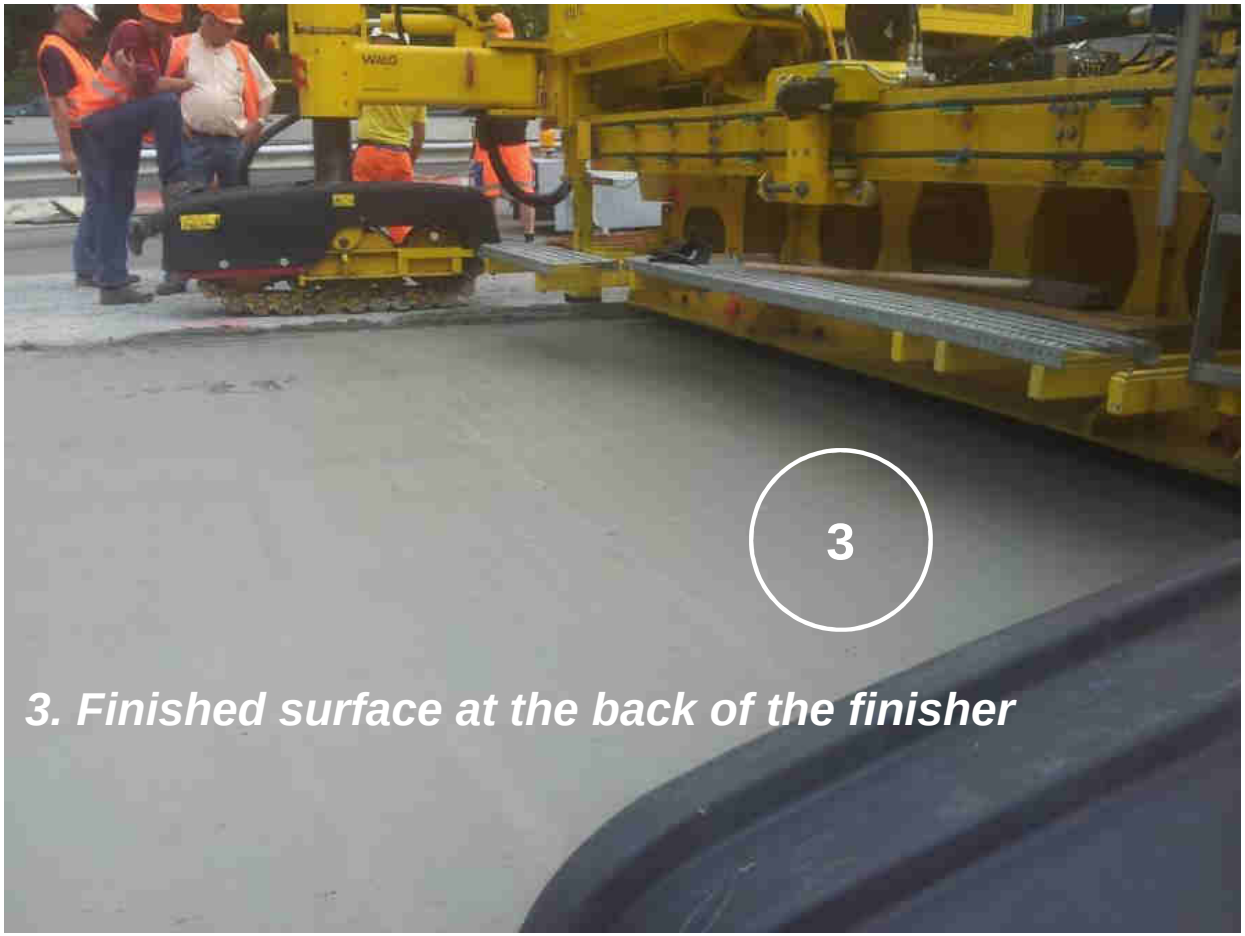
Production rate: 60 to 100 m^3 per day → UHPFRC implemented mechanically



Largest application in 2014/2015: rehabilitation of Chillon Viaduct (Switzerland)

1. Distribution of UHPFRC using a screw conveyor

2. Vibrating rules to facilitate the implementation of UHPFRC



3. Finished surface at the back of the finisher

Thank you for your attention

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