



PAGEL®

PAGEL-TEXTILE CONCRETE for the Constructive Repair of the Sugar Silo 9 at the Nordzucker GmbH in Uelzen, Germany

Textile concrete

Textile concrete is an alternative to reinforced concrete and for the constructive repair of engineering works, which has been researched for more than 20 years at German universities and research facilities.

Important participants in the fundamental research are

TU Dresden

RWTH Aachen

and as an executing partner

PAGEL Spezial-Beton GmbH & Co.KG

At the TU Dresden, it was soon realised that carbon as reinforcing layer is significantly superior to glass fibres in the constructive engineering sector. Carbon is alkali and corrosion resistant as well as highly tensile. Thus, carbon can be utilised as a reinforcement for the concrete technically very efficient. As in comparison to steel the tensile strength of carbon is approximately seven times higher, the layer thickness can be significantly reduced with textile concrete respectively for constructive repairs. Therefore, the high cover of a carbon reinforcement compared to the steel reinforcement in steel concrete regarding the exposition of a reinforced concrete construction is not necessary. From the standpoint of the concrete technology, the covering of the carbon reinforcement can be reduced to a minimum (Textile Reinforced Concrete = TRC). For example, with the **TF10 PAGEL® / TUDALIT® - FINE CONCRETE** to e.g. 3 mm.

Research activities at the TU Dresden

Textile fibres can be produced from glass, carbon or basalt. In the construction sector, carbon fibres are employed, where high loads have to be absorbed and carried (carbon does not fatigue). High-tenacity carbon fibres are especially suitable for the carrying of high loads in thin layers of concrete or mortar. The carbon fabrics defined in the course of the research at the TU Dresden, has a checked out mesh width, through which a layer of fine concrete (**TF10 PAGEL® / TUDALIT® - FINE CONCRETE**) will be sprayed (applied) and injected. The sealing of the carbon fabrics with the **TF10 PAGEL® / TUDALIT® - TEXTILE FINE CONCRETE** is particularly important for the load transmission.

The force-locking adhesion of the **TF10 PAGEL® / TUDALIT® - TEXTILE FINE CONCRETE** - mortar matrix at the profile of the old concrete to be strengthened is particularly important for the constructive consideration of the overall profile of e.g. the construction of the ceiling (bending tensile strengthening).

With the **TF10 PAGEL® / TUDALIT® - FE**, **PAGEL Spezial-Beton GmbH & Co. KG** developed for the "spraying" and "laminating" of the carbon fabrics a textile fine concrete matrix, that - in a very soft plastic manner with a consistency liked "whipped cream" - meets all critical requirements for the spraying (spray-application) as well as the laminating by hand from the concrete technology's point of view.

TUDALIT brand consortium (www.tudalit.de)

The combination of carbon fabrics with **TF10 PAGEL® / TUDALIT® - FINE CONCRETE** is trendsetting in terms of ecology, environmental protection and sustainability as the constructive layer thicknesses of building constructions bearing high loads can be reduced significantly compared to reinforced concrete while achieving a freedom from corrosion at the same time.





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The **TUDALIT brand consortium** was founded at the location in Dresden by the companies and research institutions initially participating in the research project. Other members joined the consortium in the meantime. The members of the TUDALIT brand consortium have financed the approval tests for obtaining the first building inspection approval for the structural reinforcement.

Starting with approvals on a case-by-case basis ("Zustimmungen im Einzelfall"- ZiE) for the application of the **"TUDALIT - TEXTILE CONCRETE"** and leading to the general building inspections approval ("allgemeine bauaufsichtliche Zulassung" - abZ) of the DIBt several constructive repairs were successfully performed by the certified application companies.

Subsequently, in 2015, the sugar silo 9 at the Nordzucker GmbH in Uelzen, Germany was repaired with the **TUDALIT-TEXTILE CONCRETE**.

Project data:
Fire damage restoration

Sugar silo 9
Nordzucker AG Uelzen, Germany

Fire damage repair of the inner surface of the silo after a blaze in June 2014

Planning office:

IPRO Industrieprojekt GmbH, Brunswick, Germany

Performance of the works:

Pursuant to the general building inspections approval Z-31.10-182, in connection with a ZiE of the responsible construction inspection and a performance by a specialist company with a **TUDALIT - CERTIFICATION**

Contractor:

Implenia Instandsetzung GmbH

Textile Concrete:

Carbon fibre-strengthened textile reinforced concrete with **TF10 PAGEL® / TUDALIT® - TEXTILE FINE CONCRETE**
Carbon textile: TUDALIT-BZT2-V.FRAAS

Aim of the repair:

Restoring the suitability for use of the inner shell of the silo
- the concrete surfaces of the inner shell of the silo were damaged by a fire

Old concrete:

Profile of the old concrete overcompressed by prestress

Requirements for the repair:
spreading
with

Carrying of tensile stresses in the re-profiling layer, covering and of cracks, that are occurring. Reinforcement close to the surface

a covering as minimal as possible

Silo, figures and facts:

Sugar silo 9

| | |
|-----------------------------|------------|
| Wall height: | about 60 m |
| Height of repair: | 57 m |
| Repair surface: | 4,500 m² |
| Carbon fibre reinforcement: | 14,000 m² |

TUDALIT® TEXTILE CONCRETE with

TF10 PAGEL® /

TUDALIT® FINE CONCRETE:

340,000 kg

Execution time:

from May until July 2015





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Textile fine concrete:

Upper silo area:

2 layers carbon fibre reinforced

TUDALIT - textile concrete

TF10 PAGEL® / TUDALIT® FINE CONCRETE

Overall thickness of layer: 18 mm

Lower silo area:

2 layers carbon fibre reinforced **TUDALIT®** - textile concrete

TF10 PAGEL® / TUDALIT® FINE CONCRETE

Overall thickness of layer: 24 mm

Overlap lengths: 2.20 m

Horizontal execution of the carbon textile:

A length of 36 m at a width of 1.50 m,

corresponding to $\frac{1}{4}$ of the internal elevation of the inner silo wall

Preparation of the surface:

Mechanical engineering:

Water jet with maximum pressure of 2800 bar

Compulsory mixer for the mixing of the **TF10**

Mono feeding pumps for the delivery of the material

Delivery of the mortar:

up to a height of approx. 60 m from the ground,

then approx. 40 m along to the installation site

Spraying nozzle system:

MAWO PAGEL® Dense phase wet spray technique

The employees from the company Imlenia with their practical experience were able to finish the work some days prior to the scheduled completion date. There was even enough time to renovate the screed floor coating and to apply onto the textile concrete coating a speciality coating approved for the food industry.

Future perspectives:

As contrary to reinforced and pre-stressed concrete, carbon concrete / textile concrete shows no material fatigue, textile concrete is a good choice in particular for future repairs of especially stressed and already fatigued engineering works. This could for example be fatigued bridge constructions, that can be reinforced again (shear force reinforcement) with the **TUDALIT® TEXTILE CONCRETE**. Also the replacement of reinforced steel concrete with carbon concrete is possible and is pursued. The chances of success are high. Even after 20 years, bridge constructions from everywhere in the world - where carbon reinforcements or strands were built into the carrying parts of the construction - show no signs of fatigue whatsoever. With carbon concrete / TUDALIT textile concrete, the financial burden of the national economy of the Federal Republic of Germany could be eased by billions spent for regular repairs and new construction works to maintain the infrastructure in the field of road construction and bridge engineering.

Let's do it! In this context, another 10 research projects at the TU Dresden are supported by Federal Ministry of Education and Research (BMBF) with a subsidiary amount of € 50 million. In the medium-term, reinforced concrete could actually be replaced by carbon concrete and TUDALIT textile concrete.

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August 2015



