HITEXBAU GmbH

Innovative Carbon Grid Reinforcement

Sugar Silo Rehabilitation – CARBOrefit®

Uelzen, Germany

Executive Summary:

The rehabilitation of a 35-meter-high double-chamber sugar silo in Uelzen represents a benchmark industrial application of the CARBOrefit® carbon concrete strengthening method.

Due to long-term dynamic loading from filling and discharge cycles, the existing inner shell of the silo exhibited cracking and concrete spalling. Detached fragments posed a direct contamination risk to stored food products and compromised structural reliability.

Instead of demolition and reconstruction, the structure was strengthened using Hitexbau carbon meshes embedded in PAGEL TF10 high-performance fine concrete, forming a 20 mm thin-layer carbon concrete reinforcement system applied to approximately 3,100 m² of surface.

The intervention restored structural integrity, ensured hygienic safety, eliminated corrosion risk, and reduced rehabilitation costs to approximately 50% of a new construction

Project Background

Context

The silo, operated by Nordzucker AG, has:

- Capacity: approx. 20,000 t of sugar
- Height: approx. 35 m
- Diameter: approx. 30 m
- Configuration: double-chamber “silo-in-silo” system

A previous 7 cm conventional concrete repair with steel reinforcement had been applied in the 1990s using slipform technology .

However, under operational conditions typical for bulk storage silos – including:

- Cyclic filling and discharge
- Internal pressure variations
- Arching effects in granular material
- Vibration during unloading

– the repair layer deteriorated. Concrete delamination and fragment detachment occurred, creating contamination risks and threatening serviceability.

An inspection revealed extensive cracking and surface degradation within the interior shell . A durable and hygienically compliant strengthening solution was required.

Location

Client: Nordzucker AG, An der Zuckerfabrik 1, 29525 Uelzen, Germany
General Contractor: Torkret Substanzbau AG
Execution period: July – September 2012

Scope and Objectives

Scope:

- Rehabilitation of approx. 3,100 m² interior shell surface
- Crack injection and structural surface preparation
- Application of multi-layer carbon textile reinforcement
- Installation of thin-layer carbon concrete strengthening system
- Application of food-approved epoxy coating

Total material consumption:

- Approx. 14,000 m² carbon mesh
- Approx. 150 t PAGEL TF10 fine concrete

Objectives:

- Preserve the existing silo structure
- Restore structural load-bearing capacity
- Prevent further spalling
- Reduce crack widths and control crack propagation
- Ensure hygienic suitability for food storage
- Minimize downtime and avoid reconstruction

Methods and Materials

1. Structural Strengthening Concept

The rehabilitation was executed using the CARBOrefit® method, consisting of thin-layer, textile-reinforced carbon concrete applied directly onto the prepared substrate.

The 20 mm carbon concrete layer acts as a bonded tensile reinforcement shell. The embedded carbon meshes provide high tensile capacity and crack-bridging performance, redistributing stresses generated by dynamic operational loads.

Unlike conventional shotcrete solutions, the system:

- Requires no mechanical anchoring
- Adds minimal dead load
- Eliminates corrosion risk
- Achieves structural strengthening with reduced thickness

2. Materials

Carbon Reinforcement

- Approx. 14,000 m² carbon mesh installed : HTC 21/21-40
- Mesh width approx. 2.46 m
- Installed vertically over approx. 33 m

Four mesh layers were incorporated, each spaced approx. 4 mm within the mortar matrix .
The textile reinforcement provides high tensile performance and corrosion-free durability.

Fine Concrete Matrix

Product: PAGEL TF10 CARBOrefit® Fine Concrete

Characteristics include:

- High compressive strength
- High adhesion to substrate
- Low capillarity
- Excellent workability for thin-layer application

Total strengthening layer thickness: 20 mm
The final surface was ground and coated with a food-approved epoxy system .

Execution

Surface Preparation

- Full circular scaffolding installed
- Sandblasting to granular substrate
- Approx. 2,000 m of cracks injected
- Approx. 200 kg injection resin used

Application Procedure

- Four-layer build-up of carbon mesh and TF10 mortar
- Fresh-on-fresh application
- Vertical deployment of textile rolls from top to bottom
- Final smoothing of last layer

Work organization:

- Two 12-hour shifts
- Maximum 2-hour waiting time between layers

Environmental conditions recorded during application:

- 25°C temperature
- 60% relative humidity

A project-specific approval (ZiE equivalent) was obtained prior to execution .

Challenges and Solutions

Hygienic Requirements

Challenge: Direct contact environment for food storage.
Solution: Smooth surface finishing and certified EP coating combined with hygienically tested carbon concrete system.

Dynamic Loading

Challenge: Cyclic tensile stresses leading to crack propagation and spalling.
Solution: Multi-layer textile reinforcement providing crack control and tensile redistribution.

Vertical Application

Challenge: Installation across 35 m interior height in circular geometry.
Solution: Continuous vertical mesh installation and controlled mortar projection.

Structural Preservation

Challenge: Avoid full reconstruction.
Solution: 20 mm thin-layer strengthening achieving structural restoration with minimal added mass.

Outcomes

Structural

- Full restoration of load-bearing capacity
- Effective crack control
- Elimination of spalling risk
- Corrosion-free reinforcement

Economic

- Rehabilitation cost approx. 50% of new construction
- Reduced downtime
- Avoided demolition

Material Efficiency

Compared to a conventional 70 mm steel-reinforced shotcrete solution, the 20 mm CARBOrefit® system reduced additional concrete volume by approx. 70% while eliminating steel reinforcement.

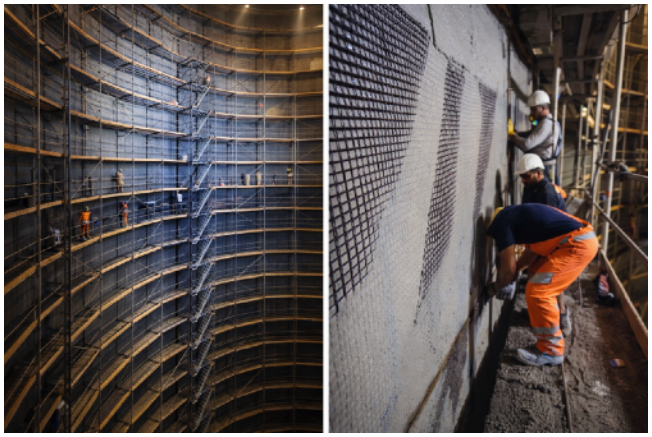
Durability

The corrosion-free reinforcement and reduced crack widths significantly improve long-term performance under cyclic loading.

Conclusion

The rehabilitation of the Nordzucker sugar silo in Uelzen demonstrates the structural, hygienic and economic advantages of carbon concrete strengthening in industrial storage infrastructure.

By combining **Hitexbau** carbon meshes with PAGEL TF10 CARBOrefit® fine concrete, the project achieved:



- High-performance structural strengthening
- Thin-layer application (20 mm)
- Corrosion-free long-term durability
- Compliance with food storage requirements
- Significant cost savings compared to reconstruction

This project represents an early large-scale industrial application of the CARBOrefit® system and establishes a reference case for vertical carbon concrete rehabilitation in silos and bulk storage facilities subjected to dynamic operational loading.