

DUCON® – an innovative combination of

Strength and Durability



Technical Information Overlay

DUCON Europe GmbH & Co. KG

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Ultimate performance – Beyond Concrete

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Introduction

The DUCON®-Technology combines a self-compacting and high-strength concrete with a spatial micro-reinforcement (MicroMat®) into an innovative high-performance concrete with outstanding properties.

DUCON®-Concrete is characterized by extreme strength and loading capacity simultaneous with a very high ductility. In combination with a very good durability and resistance to different impacts exceptionally thin and free-form building components are possible. The material properties can be adjusted by different variations of the material set-up to a requirements specification.

Due to the excellent material properties DUCON® is used as security-concrete against dynamic impacts such as explosions, direct fire, brunt or earthquake. In addition, DUCON® has a general building inspectorate approval as WHG (Water Resources Act)-impervious overlay and can be installed jointless over large areas, e.g. industrial floors. Last but not least the thin building components and the formability enable particular architectural and technical design components such as concrete facades, staircases and furniture. DucoGlass® and DucoStone® combine the loading capacity and protective effect of DUCON®-Concrete with the look of glass and natural stone.

Due to the simple material structure and low production costs DUCON® is a significantly more economical solution than other high-performance building materials. The production is handled by laying out the micro-reinforcement (MicroMat®) followed by mortar infiltration. DUCON® is both horizontally and vertically processible and can be produced as an in-situ or precast concrete. The high flowability and a modern formwork technology make a shaking of the concrete and a surface treatment afterwards obsolete. Executed areas can be loaded quickly again due to a high initial strength.

The patented DUCON®-Technology is unique and contributes now for more than ten years to the success of new construction and renovation projects and meets special challenges in the areas of security, industrial overlay/coating, architecture and design.



Figure 1: DUCON Fields of application

DUCON® Overlay

Strength and durability – two key features that modern building materials have to bring with them to be used as an overlay system. But the known materials for overlays and coatings usually have one major disadvantage, which makes an application problematic. The DUCON®-Technology combines the characteristics economy, functionality and material-technical efficiency in one building material. An innovative building material with strength and durability.

The aforementioned material properties enable extremely thin and tight together with strength and flexible overlays and strengthenings for use in both the automotive and chemical industry as well as in the security industry. Usual layer thicknesses are between 2.5 and 6 cm and due to the special composition of the self-compacting concrete smooth and durable surfaces with high abrasion resistance (hardness class 1) are possible. Spallings, especially in the joint and border areas can be avoided by the spatial micro-reinforcement. Furthermore DUCON® can be performed jointless over extremely large areas. The crack widths are constrained to less than 0.1 mm and thus it is proven that the DUCON®-Technology is in the microcrack region.

Particularly in case of a refurbishment of damaged concrete surfaces a costly demolition and reconstruction of the area can be avoided by the application of a DUCON® layer on the existing concrete surface. This prevents long downtimes of production, because in addition to the saved time by eliminating demolition and reconstruction, the DUCON® layer can be re-charged early because of a high initial strength. One of the products is DucoPlan®.

DUCON® possesses a flexural strength of more than 25 N/mm² and shear strength of more than 4 N/mm². Because of this DUCON® layer above the damaged / cracked subsoil ensure the loading capacity of even highly stressed industrial areas with high Point loads (for example, by driving with forklifts). The thickness of the applied DUCON® layer depends on the load situation, and in particular on the high point loads.

DUCON® Overlay is the synergy of strength and durability to a high-performance and durable overlay for ambitious industrial applications.

Impervious overlay according Federal Water Act (Wasserhaushaltsgesetz, WHG)

Production halls, logistic properties, warehousing and handling centers, airfields or parking areas need highly stressable, robust and increasingly liquid-tight industrial floor surfaces about their lifecycle. Therefore, special demands are made to the bottom surfaces in new or existing constructions.

The DUCON®-Technology meets the requirements in terms of time, economy and function. DUCON® has a general building inspectorate approval as WHG-impervious overlay for LAU systems (Z-74.1-89). The component thickness amounts to only 5.5 cm and runs largely jointless in interior and exterior. The building material is used for sealing against ground water hazardous mediums in accordance with the requirements of the Wasserhaushaltsgesetz as tank farms, catch basins, gutter systems, container storage spaces for warehousing, filling and handling (LAU). Comparable building materials such as FD- and FDE-concrete require component thicknesses of at least 20 cm.

DUCON® effects in addition to fulfilling the imperviousness requirement simultaneously a load increase in the existing structure and an increased resistance to mechanical attack by impact and abrasion. The compound with an existing structure is produced by dowelling. Usual preparatory work such as shot peening, etc. are not required. Horizontal surfaces are surface-finished and already resilient the next day due to the self-compacting and self-leveling mortar. WHG-impervious overlays of DUCON® were mainly implemented in the chemical industry and automobile industry.

The exceptional properties of the DUCON®-Technology:

- High-strength & ductile WHG-impervious overlay system with general building inspectorate approval
- Low component thickness from horizontal to vertical
- Defined steel content in DUCON®-Concrete by friction-locked connection with existing structure statically chargeable
- Single-layer structure with surface-finished surface
- Widely jointless and crack-free, durable and impervious surface
- High crack-bridging- and early loading capacity
- Possibility of jointless and WHG-impervious upstands / connections by special corner elements



Figure 2: Finished impervious overlay according to Federal Water Act (WHG)



Figure 3: Mortar infiltration (left) and finished overlay (right)



Figure 4: Mortar infiltration (above) and finished overlay (inside) (below)

Slab strengthening

DUCON® can contribute as subsequent slab strengthening to increase the ceiling loading capacity and thus the live loads. For slab strengthening usually a 3–6 cm thin DUCON® layer is applied in full compound on the existing ceiling. Often the applied DUCON®-layer can carry the existing live loads entirely. This avoids a conventional demolition and reconstruction of the existing structure.

Long downtimes of production can be avoided by the simple construction and the high initial strength of the building material. The DUCON®-Technology has been successfully applied as a screed substitute to existing reinforced concrete floors and ceilings. Improvement measures at the bottom of the ceiling were often not possible.

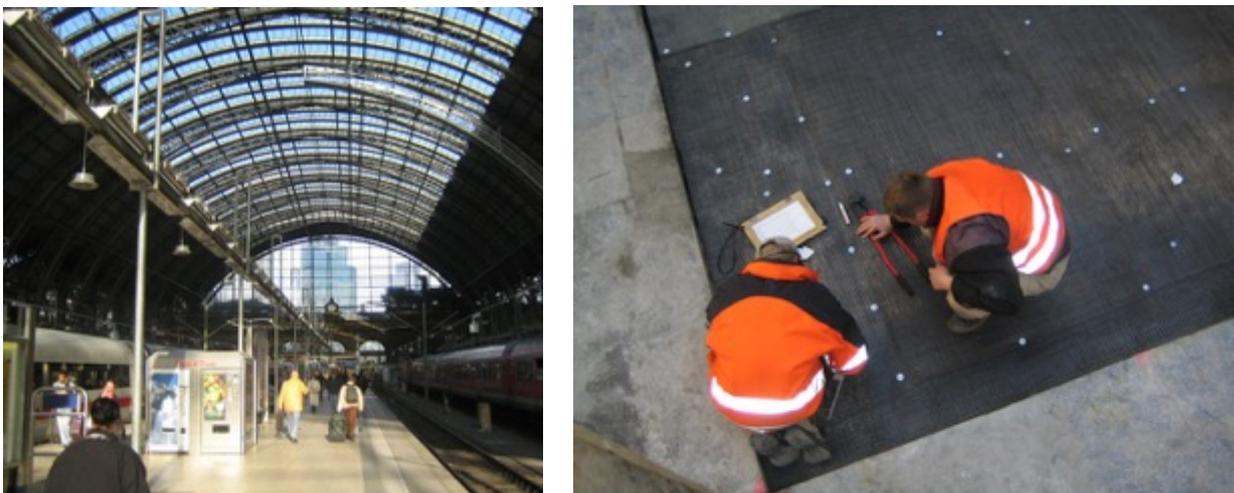


Figure 5: Slab strengthening at Frankfurt Main Station (left); Manufacturing of MicroMat® (right)



Figure 6: Manufacturing of MicroMat® and mortar infiltration (left); Burden of a DUCON surface 2 days after manufacturing by a printing machine (right)

Industrial flooring (DucoPlan®)

The patented high-performance system combines the novel micro-reinforcement with a durable cementitious coating. This coating allows the developing of a durable protective floor for indoor and outdoor areas.

Layer thicknesses of 2-4 cm are summarized in the brand name DucoPlan®. There were already jointless areas up to 11,000 m² implemented.

In accordance with the technical requirements of the construction project the system is adapted in the reinforcement density and thickness of the coating. In addition to an excellent chemical resistance, the resistance to mechanical attacks are unique. A high abrasion resistance while water resistance coupled with an extremely high bending tensions strength. Usual coating thicknesses are between 2 and 5 cm.

Large areas can be durably protected in a short time and with little effort through a modern laying-technology. Subsequent usage can be done without waiting times.

The surface is concrete colors, but if desired freely selectable.

This patented high-performance system offers a wide range of applications, e.g. as highly stressed industrial floors, parking areas or deflecting surfaces and represents an economical and durable alternative to sophisticated reconstructions of reinforced concrete surfaces.



Figure 7: Finished high performance industrial floor



Figure 8: Overhaul (left) and completion (right) of a cracked surface with DucoPlan (d = 3 cm)

Technical Data

Description:	Self-compacting micro-reinforced high performance concrete
Technical Data:	<p>Compressive strength: 100 – 200 N/mm² (DucoPlan: > 35 N/mm²)</p> <p>Flexural strength: > 20 N/mm²</p> <p>Centr. tensile strength: 9 – 20 N/mm²</p> <p>Shear carrying capacity: 3 – 16 N/mm²</p> <p>Tensile modulus: > 40.000 N/mm²</p> <p>Bulk density: 25 KN/m³</p> <p>Elem. thicknesses: > 10 mm</p> <p>Carbonation: 0 mm after 112 days (3 % CO₂, 50 % r.h.)</p> <p>Chloride-diffusion: 0,3 (10⁻¹² m²/s²) (EN 206-1, valid)</p> <p>Chloride-iones-content: 0,01 % Cl for DUCON® mortar</p> <p>Frost and de-icing salt resistance: 215 g/m² < 1.500 g/m² (CDF-Test, 3 % NaCl, 28 changes) Drop dynamic E-Module 2,4 % < 25 % (XF1, DIN EN 206)</p> <p>Frost resistance: Chemical defects: 26 g/m² < 1.000 g/m² (CIF-Test) Drop dynamic E-Module 2 % < 40 % (XF1 u. XF3 DIN EN 206)</p> <p>Abrasion: Standard mortar: 10 cm³/50cm² (< 15 cm³/50cm², class 1) 2,8 cm³/50cm² (< 15 cm³/50cm² = Class 1) < 3 cm³/50cm² = Class A3 (DIN EN 13813 concr. surfaces) < 4 cm³/50cm² = Class F11M (DIN EN 18560 Hartstoff)</p> <p>Slump factor: > 35 cm (EN 196, Haegermann, extreme fluid)</p> <p>Shrinkage: 0,5 – 0,6 ‰ (without micro-reinforcement: 0,9‰)</p> <p>Fracture energy: G_f = 50 – 80 kN/m (unreinf. concrete 0,1 – 0,15 kN/m)</p>
Further properties:	<p>Extreme ductile, i.e. high formability</p> <p>High loading capacity, high impact strength, high energy intake</p> <p>High durability, Crack width restriction</p> <p>High abrasion strength, high frost and de-icing salt resistance</p> <p>Imperviousness against substances hazardous to water</p> <p>Good heat transfer and –storage capacity, electric conductivity</p> <p>Spatial stiffness regulation</p> <p>Multifunctional, adjustable material properties</p>
Components:	<p>Random cross sections (e.g. circle-, box-, wave-, t-profiles)</p> <p>Impervious overlays, surfaces, container/cases, pipes, beams</p> <p>Wrapping of weak components (subsequent strengthening)</p> <p>Jointless, pre-cast components, prestress feasible</p>
Manufacturing:	<p>Placement of micro-reinforcement followed by mortar infiltration</p> <p>Modular design ensures simple, quick and economical application</p>

Research institutes / Consultants

Experiments, calculations and surveys were conducted i.a. at following institutes:

Germany / Switzerland



USA

