

**DUCON Overlay**

**Ceiling strengthening**

**Surface upgrading**

**WHG sealing layer**

**[www.ducon.eu](http://www.ducon.eu)**

## Product innovation

### DUCON Overlay

#### MULTIFUNCTIONAL DUCON®-UPGRADED LAYER AS "ALL-IN-ONE" SOLUTION

DUCON Overlay fulfills several functions simultaneously with a single material structure. The additional concrete layer with a usual thickness of 30–60 mm simultaneously works as:

- **Strengthening of heavily loaded industrial floors**
- **Static ceiling strengthening**
- **WHG sealing layer (WHG = Water Resources Act)**
- **Explosion protection + debris protection (anti-terrorism)**
- **Energy generation as concrete collector (optional)**

#### TAGS:

„all-in-one“ • multifunctional • sustainable • energy efficient • economical

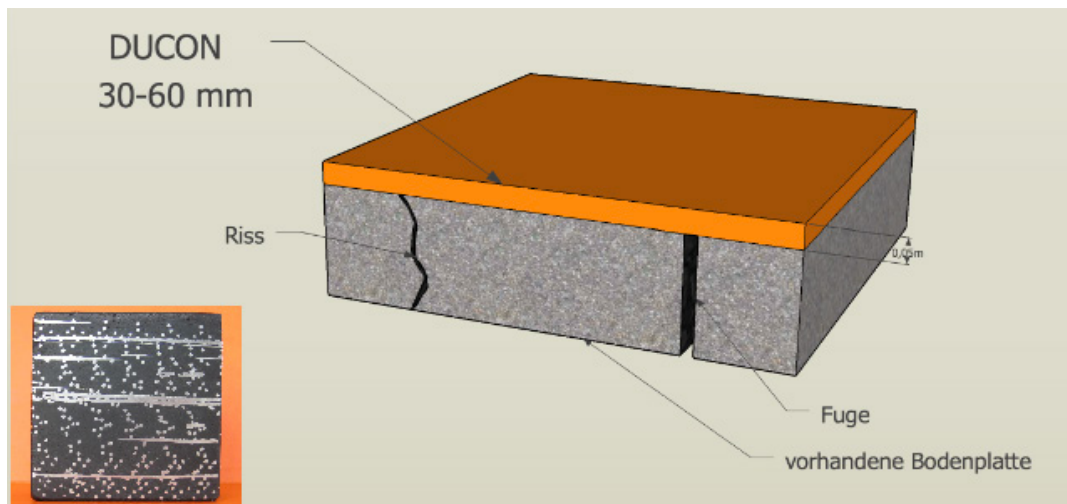


Figure: DUCON Overlay as thin multifunctional additional concrete layer

## Content

<b>1. DUCON-Technology</b>	<b>4</b>
<b>2. DUCON Overlay – multifunctional concrete layer</b>	<b>5</b>
<b>2.1 System DUCON55</b>	<b>5</b>
<b>2.2 Strengthening of heavily loaded floors</b>	<b>7</b>
<b>2.3 Static ceiling strengthening</b>	<b>8</b>
<b>2.4 WHG sealing layer</b>	<b>9</b>
<b>2.5 Explosion protection + debris protection</b>	<b>10</b>
<b>2.6 Energy efficiency „concrete collector“</b>	<b>11</b>
<b>3. Technical specifications</b>	<b>12</b>

## Introduction

DUCON®	The combination of ultra high-strength concrete and spatial micro-reinforcement to a <b>high-performance concrete (HPC)</b> with outstanding properties.
Company	Founded in 2004 by the inventor of the DUCON-technology, Dr.-Ing. Stephan Hauser, <b>internationally active company</b> based in Darmstadt.
Areas of application	The fields of activity <b>Security, Overlay and Architectural &amp; Design</b> describe the range of applications: from security concrete for endangered facilities to high performance industrial floors for automotive and chemical industries to filigree special components for architects and designers.
Decisive advantages	Compared to the state of regular concrete, DUCON is <b>thinner, lighter and more ductile</b> , while at the same time having the <b>highest load capacity</b> .
Reference projects	For dthe Architects' Darling 2018, DUCON applies with the product innovation DUCON Overlay as multifunctional and economical "all-in-one" solution. The reference projects range from chemical and automotive industries to endangered facilities. The product descriptions provide a very good insight into the vdiverse application areas of DUCON Overlay.
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## 1. DUCON-Technology

### DUCON – (DUctile CONcrete)

DUCON® is an innovative, patented high-performance material that, in addition to its high strength, is characterized by a high energy absorption (ductility) and durability, while at the same time enabling the realisation of low component thicknesses (from 15 mm). Due to its high resistance against explosions, impact, shelling and earthquakes, DUCON is primarily used to protect endangered facilities and critical infrastructures.

The range of applications of this modern high-performance material ranges from safety concrete (anti terrorism), industrial surfaces, filigree stairways, façades and architectural special components to thin tabletops.

Rule of thumb for explosion protection and loading capacity:

DUCON is at least four times as powerful as conventional reinforced concrete and can be executed with half the component thickness and thus half the weight.

**DUCON currently represents the thinnest construction with a high load-bearing capacity in concrete.**

#### Highlights DUCON:

- Thinnest self-supporting concrete staircase in the world (folding staircase, 80 mm thin)
- Thinnest roof shell in the world („Parapluie“, 25 – 30 mm, Tsuboi Award 2013)
- Thinnest energy-efficient building shell, 11 m high, 55 mm thin, thermally activated (ETA factory, TU Darmstadt)
- Thinnest concrete house, 3 cm thin walls and roof („House in the vineyards“, TU Kaiserslautern, Innovation Award Rhineland Palatinate 2012)
- Thinnest solution for explosion protection (new World Trade Center New York, German embassy Kabul = intact after terrorist attack on May 31, 2017)
- Jointless industrial floors and sealing layers

#### Application areas:

- Structural protection of endangered facilities and critical infrastructures
- Restoration of buildings and surfaces
- Sealing of structures (WHG areas)
- Façades, architectural concrete



Figure: "Parapluie" d= 25-30 mm  
= thinnest roof shell



Figure: Self-supporting folding staircase,  
t=80mm

## 2. DUCON® Overlay (additional concrete layer)

### 2.1 System DUCON55

One structure for multiple purposes („all-in-one“ solution)

DUCON Overlay as multifunctional retrofitting of ceilings and surfaces for:

- A) Heavily loaded industrial floors**
- B) Static ceiling strengthening**
- C) WHG sealing layers**
- D) Explosion protection (anti terrorism)**
- E) Energy production (concrete collector)**

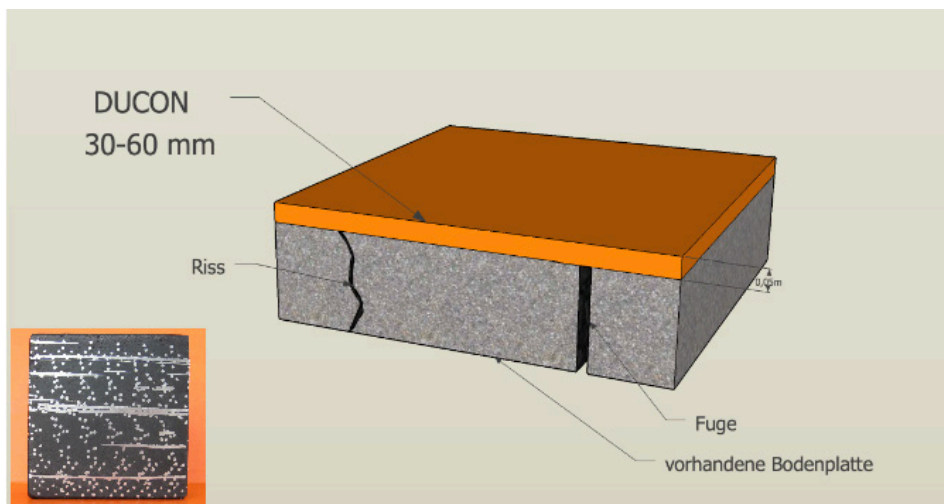


Figure: DUCON Overlay crack-bridging and seamless

#### Characteristics DUCON Overlay:

- Layer thickness: 30 – 60 mm
- Compressive strength: > 120 N/mm<sup>2</sup>
- Flexural strength: 25 – 75 N/mm<sup>2</sup>
- Degree of ductility: > 8
- Watertight: from 2 cm

#### Properties:

- High load-capacity
- High abrasion resistance
- High durability
- High energy absorption

#### Advantages:

- Seamless execution, no maintenance, crack-bridging
- Strengthening without interrupting the production
- Short usage-related downtime
- No removal of existing surface required
- No additional loads on the existing structure

Numerous damaged surfaces in the automotive and chemical industries have been repaired with the micro-reinforced high-performance concrete DUCON®. The damage to the existing areas in the interior and exterior have very different causes. The DUCON product range has always offered a solution to avoid expensive demolition and replacement of the area. As a result, both downtime and production costs were minimized.

## Manufacturing steps:



Figure: Laying of the micro-reinforcement MicroMat®



Figure: Concreting with DUCON1 concrete



Figure: Completed area



## 2.2 Strengthening of heavily loaded industrial floors

One of the most well-known reference projects is the seamless construction of a 15.500 m<sup>2</sup> sealing and wearing layer at an automobile manufacturer. The inventory area, which was several decades old, was no longer sustainable and heavily contaminated with chloride. Instead of expensive demolition and new construction, DUCON55 has been fitted as a load-bearing and dense industrial floor, which, due to the jointlessness, also enables the installation of long production lines. The additional concrete layer was completed in just 28 weeks and 16 concreting sections. This resulted in a four months shorter downtime.



Figure: WHG sealing layer, d=55mm, 15.500m<sup>2</sup> seamless, automotive industry

**Function:** High-resilient area strengthening + liquid-proofing

**Reference projects:** Daimler AG (Stuttgart)

DUCON Overlay	Conventional renovation of bottom plate
<ul style="list-style-type: none"> <li>• Jointless design, maintenance-free</li> <li>• Short usage-related downtime</li> <li>• No need to remove the consisted area</li> <li>• <b>4 months of time saving für for production</b></li> <li>• Cost-benefit factor: 50% of construction costs + minimal temporal and local interruption of production</li> </ul>	<ul style="list-style-type: none"> <li>• Demolition + construction of new floor slab</li> <li>• Disposal costs</li> <li>• Expansion joints required -&gt; expansive maintenance</li> <li>• Long-term interruption of production</li> <li>• Lack of production income for 4 months</li> </ul>

## 2.3 Static ceiling strengthening

In the chemical industry, a 6,200 m<sup>2</sup> big structural layer of DUCON (t = 6 cm) was installed as a static ceiling reinforcement in a multi-story production building. It was a deliberate decision, as a costly demolition and new construction of the area would have been required due to increased forklift loads. With DUCON these costs could be avoided, as the jointless industrial floor as reinforcement was monolithically applied to the existing ceiling or screed was replaced and thus existing ceiling levels were maintained. In addition, the usage-related downtime was minimized by renovating during operation. Another special feature in this case is that the reinforcement made of DUCON carries the weight of the old ceiling in addition to the increased loads.



Figure: Construction of a ceiling reinforcement (t = 60 mm)

**Function:** Static strengthening of existing ceilings

**Reference projects:** BASF production building (6,000 m<sup>2</sup>)  
Deutsche Bahn Main Station Frankfurt (2,500 m<sup>2</sup>)

DUCON Overlay	Conventional reinforcement
<ul style="list-style-type: none"> <li>• No need to remove the consisted area</li> <li>• Jointless design, maintenance-free</li> <li>• Replacement of existing screed</li> <li>• No increase in dead weight + no change in door heights</li> <li>• <b>„Ceiling reinforcement you don't see or feel“</b></li> <li>• Field-wise execution during operation</li> <li>• Short usage-related downtime</li> <li>• Cost-benefit factor: 50% of construction costs + minimal temporal and local interruption of production</li> </ul>	<ul style="list-style-type: none"> <li>• Demolition of existing ceiling</li> <li>• Expansion joints required</li> <li>• Loss of use of two floors at the same time</li> <li>• Long-term interruption of the production process on two floors</li> <li>• Double construction costs</li> </ul>



## 2.4 WHG sealing layers (LAU plants, highest requirements for water protection)

The exceptional properties of the high-performance concrete also enable the formation of DUCON55 as WHG sealing layer for LAU plants (plants for storing, bottling or processing) to protect groundwater against substances hazardous to water. Due to the very fine cracking compared to conventional reinforced concrete, the crack widths of DUCON are largely below 0.1 mm and are practically impermeable to liquids. These properties give DUCON a general buildinginspectorate approval as WHG sealing layer for LAU plants (Z-74.1-89), even in cracked condition. DUCON sealing layers with a thickness of just 55 mm have already been executed several times both indoors and outdoors. A highly loaded area covering more than 6,000 m<sup>2</sup> outdoors in the chemical industry has previously been regarded as the flagship of the DUCON WHG sealing layer. The jointless sections of more than 2,000 m<sup>2</sup> represent an economic advantage over a liquid-tight reinforced concrete with the usual narrow joint grid of 4 – 5 m. In addition, the outstanding load capacity and high resistance to mechanical stress enable DUCON to withstand the burden of heavy vehicles and stacked containers. Even after years of mechanical stress and under exposure to water-polluting media, the WHG sealing layer stays in perfect condition.



Figure: Heavily loaded base course and sealing layer (6,000 m<sup>2</sup> container storage area, t = 55 mm)

**Function:** WHG sealing layer + base layer on weak underground  
Protective layer against substances hazardous to water + against high high stress from containers and debris dumps

**Reference projects:** BASF (Ludwigshafen) + Bayer (Leverkusen)

DUCON Overlay	Conventional sealing layer
<ul style="list-style-type: none"> <li>• Jointless design, maintenance-free</li> <li>• No need to remove the consisted area</li> <li>• No soil replacement required</li> <li>• Reduced usage-related downtime</li> <li>• <b>The only material approved in cracked condition for all media</b></li> <li>• 3 months time profit for new use</li> <li>• Cost-benefit factor: 50% of construction costs + minimal temporal and local interruption of production</li> </ul>	<ul style="list-style-type: none"> <li>• Demolition of existing area + 60 cm soil replacement (contamination)</li> <li>• New construction of 25 cm floor slab</li> <li>• Expansion + sealing joints according to LAU every 5 m = 2100 m</li> <li>• Maintenance-intensive joints with short monitoring cycles</li> <li>• Disposal costs soil + concrete</li> <li>• Long-term interruption of use</li> </ul>

## 2.5 Explosion protection + debris protection

In addition to protection measures against explosions and impact such as protection walls, explosion-proof façades, column sheathing or shelter, DUCON is also used as debris protection for ceilings.

Here, DUCON is used either as a concrete layer on or below the existing ceilings as a kind of safety net and explosion protection for overlying or underlying building parts.

An exemplary scenario is a car bomb in an underground garage with a public space above the parking level.

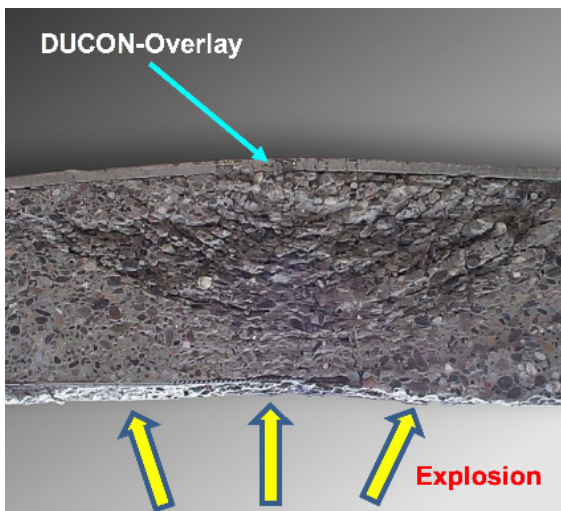


Figure: DUCON Overlay as safety net

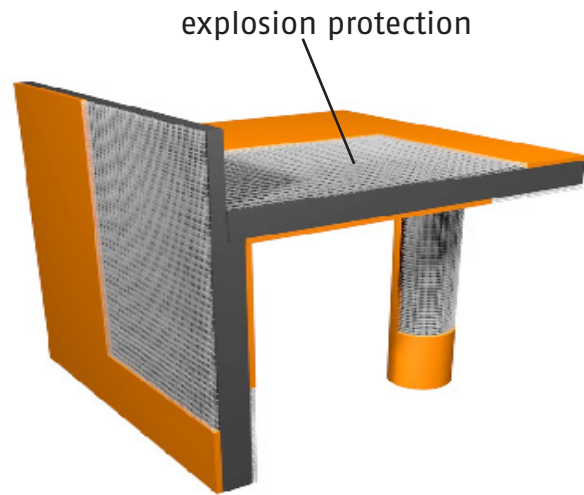


Bild: DUCON Overlay as explosion protection

**Function:** Explosion protection + debris protection against bombs  
E.g. car bomb in underground garage and protection of overlying areas

**Reference project:** European Space Agency (ESA)

DUCON-Overlay	Geplante Schutzmaßnahme
<ul style="list-style-type: none"> <li>• No need to remove the consisted area</li> <li>• Replacement of existing screed = low additional load, no change in door heights</li> <li>• Cost-benefit factor: Loss of use not decisive, <b>but effective protection (anti terrorism)</b></li> <li>• <b>Additional debris protection</b></li> </ul>	<ul style="list-style-type: none"> <li>• Removal of ceiling</li> <li>• Construction of a thicker reinforced concrete ceiling = greater weight</li> <li>• Extra weight requires additional column reinforcement</li> <li>• Possible debris throw not prevented</li> <li>• Longer loss of use</li> </ul>

## 2.6 Energy efficient floor areas, concrete collector

DUCON Overlay can be thermally activated in addition to the functions described in 2.2 to 2.5. The patented structure of incorporating capillary tube mats into the micro-reinforcement, the following functions can be achieved due to the thermal conductivity of the thin DUCON elements:

- Concrete collector (solar heat recovery, e.g. runways))
- Heating surfaces (removal of snow and ice)
- Cooling surfaces (heat exchangers, convection cooling)



Figure: Production of thermally activated plate strips for heat recovery (glycol mixture)

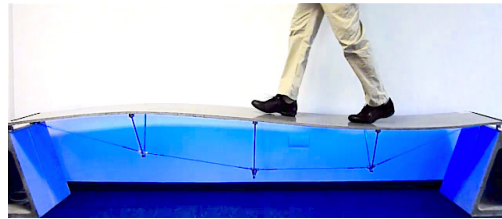
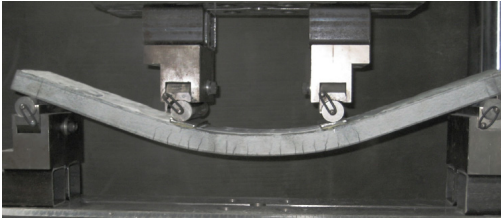
**Funktion:** Hochbelastbare Bodenfläche mit zusätzlicher „Betonkollektor“-Funktion

**Referenzprojekt:** Gebäudeaußenhülle ETA-Fabrik 1.600m<sup>2</sup>, Bodenfläche Nordhausen

DUCON Overlay	Konventionelle Lösung
<ul style="list-style-type: none"> <li>• Energy efficiency through integrated capillary tube mats in 55 mm DUCON</li> <li>• Heat output 100 – 120 W/m<sup>2</sup></li> <li>• Cooling capacity 80 – 120 W/m<sup>2</sup></li> <li>• Cost-benefit factor: <b>all advantages of applications 2.2 to 2.5 + additional energetically function</b></li> <li>• No need to remove the consisted area</li> </ul>	<ul style="list-style-type: none"> <li>• Not possible as thin additional concrete layer</li> </ul>

### 3. Technical specifications

Description: Self-compacting micro-reinforced high performance concrete



Technical Specs:	Compressive strength:	100 – 200 N/mm <sup>2</sup> (13,000 – 29,000 psi)
	Flexural strength:	20 – 75 N/mm <sup>2</sup> (2,300 – 11,000 psi)
	Tensile strength:	9 – 20 N/mm <sup>2</sup> (1,100 – 2,900 psi)
	Shear strength:	3 – 16 N/mm <sup>2</sup> (430 – 2,300 psi)
	Elastizitätsmodul:	> 40.000 N/mm <sup>2</sup> (> 5,500 ksi)
	Rohdichte:	25 KN/m <sup>3</sup> (160 pcf)
	Bauteilstärken:	> 10 mm (> 0.39 in)
	Abrasion resistance:	Class A3, Böhme-test, DIN EN 13813
	Electrostatic dissipation:	discharge resistance 1,5 < 1000, DIN 61340-4-1
	Flow spread:	> 35 cm (> 14 in) (EN 196, Haegermann)
	Shrinkage:	0,5 – 0,6 ‰ (w/o micro-reinforcement: 0,9‰)
	Fracture energy:	G <sub>f</sub> = 50 – 80 kN/m (w/o reinf.: 0,1 – 0,15 kN/m)
	Bullet proof:	FB7: FMJ PB HC at t = 8 cm (3.2 in) (DIN EN 1522)
	Break-through resistance:	RC6 at t = 7,5 cm (3.0 in) (DIN EN 1627)
	Explosion resistance:	> 1,0 bar at t = 6 cm (2.4 in) > 10 bar msec Impulse at d = 6 cm (2.4 in)

Other features:

- Extremely ductile, meaning great deformability
- High sustainability, high impact resistance, high energy absorption
- high durability, crack control
- High abrasion resistance, high resistance to freeze-thaw
- Sealed against liquids hazardous to water
- Good thermal conductivity and accumulation, electrical conductivity
- Multifunctional, adjustable material properties



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