durcrete GmbH
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www.durcrete.de

Product description:

The product **durfill** is a complete system for filling hybrid constructions made of welded sheet metal or cast iron with cast. This ready-mix dry powder, to which only water is added for mixing, results in a pumpable, self-compacting, and self-venting casting compound. In this way, machine components are stiffened, vibrations dampened, and thermal deformation is reduced. The basis of the technology is a special cement of the Dyckerhoff GmbH.

Material parameters

Characteristics	[ ]	Value	Test specifications, notes
Amount of mixing water for 1 ton of dry concrete (depends on the mixer)		110-115 l/ton 250–260l/m³ 2.8 ltr. per 25kg bag	Flow Table Test acc. to EN 1015-3 without shocks spread > 240 mm Contact us for a mixing demonstration.
Density	ρ_c	2,300 kg/m³	
Compressive strength 28 d	f_{cm}	90 Mpa	on prism, storage acc. to code
Flexible tensile strength 28 d	f_{ctm}	10 Mpa	three-point test, on prism 40 x 40 x 160 mm, wet
Static modulus of elasticity	E_c	32,000 Mpa	DIN 1048 cylinder Ø 150 x 300 mm
Dyn. modulus of elasticity	E_c	40,000 Mpa	
Poisson's ratio	μ	0.20	In accordance with EC-2
Logarithmic decrement Damping ratio	Λ	0.035 [-] ξ = 0.56 %	Test specimen 400 x 100 x 100 mm
Thermal expansion	α_T	$12.4 \cdot 10^{-6}$ K^{-1}	at 20°C
Thermal conductivity	λ	2.7 W/mK	at 20°C / 65 %
Specific thermal capacity	c_p	1.05 J/gK	at 20°C
Temperature resistance		until 90°C	
Formwork pressure on enclosing members/form		25 kN/m³ x h h=height in m	Fluid pressure
Transportable after		12 to 16 h	Depending on ambient temperature
Recommended setting time prior to further processing		> 2 weeks	Depending on temperature and the required quality of precision.
Maximum particle size		4.5 mm	Flow inlet in member > Ø 100 mm
Fibers		fiber-free	
Coating, bonding		possible	e.g. with epoxy or PU-materials
Casting performance, casting height		[-]	Depending on mixer and pump; no concrete-specific limitation
Processing time		circa 60 min	Depending on ambient temperature
Storage		for 12 months	Dry, in original packaging
Hazard rating			See Safety Data Sheet

Yield

1 metric ton of dry concrete results in 440 liter liquid casting compound and about 440 liter hardened material.

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Processing

Mix the **durfill** ready-mix casting compound with the amount of water specified. The compound can be cast, poured, shoveled, or pumped – or can be cast via inclined chutes. Vibration leads to segregation; light poking or knocking is permitted. All equipment used can be cleaned with water and a brush, or alternatively with a steam-jet cleaner.

Durfill can be mixed with any drill whisk, free-fall mixer, laboratory mixer or compulsory mixer. The most economical way is to use continuous mixers.

Mixer	Source of supply
Equipement for liquid or self levelling floor screed, maximum grain size 4 mm to 5 mm:	
Continous mixer for bags	
PFT HM 2006 or Lotus XXL bag	www.pft.eu
m-tec D30 site mixer	www.m-tec.com
WETMIX Bags mortar mixer	www.wamgroup.de
Conveying pump, stand alone	
PFT ZP 3L	www.pft.eu
m-tec P20	www.m-tec.com
WM Variojet FU	www.wernermader.de
Mixer and pump in one aggregate (Mixing pump)	
PFT ZP 3 L Multimix vario	www.pft.eu
m-tec duo-mix	www.m-tec.com
UMP 1 Standard plus	www.deutsche-foerdertechnik.com
Putzmeister MP25	www.putzmeister.com
Small and flexible silos for paper pags or BigBags	www.m-tec.com
Material Container PFT Minitainer	www.pft.eu
FIBC Discharger	www.wamgroup.de
Mortar pressure hose min. Ø 35mm, better Ø 50mm	local dealers for the equipment

The material must be filled in fresh into fresh. If a machine failure occurs, the stiffening surface should be roughened and steel rods should be inserted for a pin-connection (mechanical interlock). Depending on the thickness of the following, later casted layer, cracks in the hardened concrete of the second layer are unavoidable.

Example: mixing pump with minisilo from m-tec

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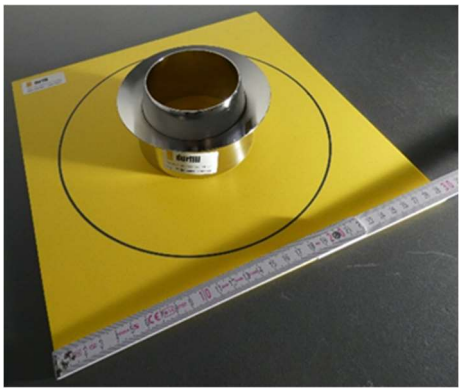
Regulation of consistency

The correct consistency can be set via the water dosage (see also https://youtu.be/9WS49CBzNnE or "durfill mixing instructions" on durcrete's YouTube channel. The mixing time depends on the mixing technique used. A creamy, cohesive, pourable, self-levelling and self-venting compound without water separation must be achieved.



The correct consistency can be checked with the setting gauge (without vibrating) using the Hägerman funnel. An instructional video from the company Knauf can be found at https://youtu.be/cFBhyxiXhH0. The following is a source of supply for the measuring funnel Ø 70/100 mm, height 60 mm.

Testing equipment	Source of supply
Set for mortar spread: funnel acc. EN 1015-3, Art.Nr. B2904 and plexiglasplate 325mm/320mm Art.Nr. B29041	Form+Test Seidner, Riedlingen Web: www.formtest.de Recommended spread: 240 bis 300mm

Curing

At temperatures below 5 ° C there is no chemical reaction between cement and water and the waiting time is extended. In frost the fresh concrete will freeze and will be destroyed.

The material is not suitable for use on fair-faced concrete surfaces. Cracks on open areas cannot be avoided, even with careful curing. The machine component can be transported on the next day and, for example, placed in the storage yard. Standard equipment can be further processed 3 or 4 days afterwards, when the compound has almost completely hardened and the concrete has cooled. High-precision equipment requires a waiting time of two weeks so that deformations and restraints that accompany the hardening process of the cement are largely completed.

Waste disposal

Dispose hardened product according to your local regulations for concrete.

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Design

During the filling process heavily strained areas like the linear guide rails should be positioned down below or on the side. The casting compound will be filled from the top. However, after turning the construction this will be the floor of the finished element. Due to the self-compacting properties the air rises upwards and needs to escape. Boreholes from Ø 8mm up to Ø 16mm are operating as vents at high points or horizontal surfaces. Moreover the filling might be controlled as well. In the case that these holes are provided with a thread, a screw may be inserted during filling in order to prevent the flow out of the material. Alternativly a riser may be used. Using a square timber, the construction may be arranged with a slope, so the ventilation openings are situated on the top areas. If threaded holes are provided for injection nipples, air bubbles at critical points can also be filled by grout injection easily.

Conduits inside the machine must be watertight. We recommend HT or KG pipes (sleeves with rubber seals) from a specialist construction-materials dealer. Please note for all other embedded parts that the casting compound reaches a temperature of up to approx. 60 °C during hardening. Aluminum reacts with the fresh casting compound and cannot be used.

A swelling agent is part of the casting compound. A closed cross-section is needed in order to build up a three-dimensional state of stress. Meanwhile, the pouring of open boxes should be avoided. If open boxes are filled, cracks will occur on the top surface of concrete which is in contact with the ambient air. For the in-filling, openings with a minimum size of Ø 100 mm must be provided. The common distance between the filling openings is 2 m.

Due to the dead weight of fresh concrete, beams need additionall support in order to prevent a deflection of the element. The deformation is freezing and will cause higher processing costs during the machining. Thin side walls can bulge as a result of the liquid pressure. All openings with exposed concrete surfaces should be sealed, so that no water can penetrate to the concrete. This can be done with welded sheet metal, glued plastic lids or an epoxy or polyurethane coating.

Repairs

Foto: remmers

A local separation from steel to concrete or air bubbles at critical points can also be subsequently grouted. A hole is drilled in the steel sheet at the affected point and a thread is cut there. Then you can screw in a nipple and inject epoxy resin using a hand press.

Material	Source of supply
M6 HD taper nipple with sealing cone and thread or grease nipple	www.remmers.com www.desoi.de
Hand lever presses, injection pumps, injection hoses, low viscosity epoxy resin as injection resin	www.remmers.com e.g. Remmers ST 100 www.webac.de e.g. WEBAC 4110 www.koester.eu e.g. KB-Pox IN www.mc-bauchemie.de e.g. MC-Injekt 1264

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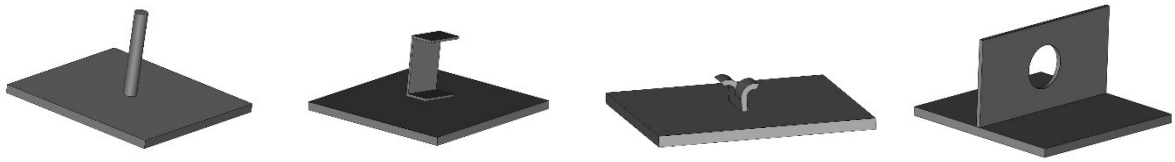
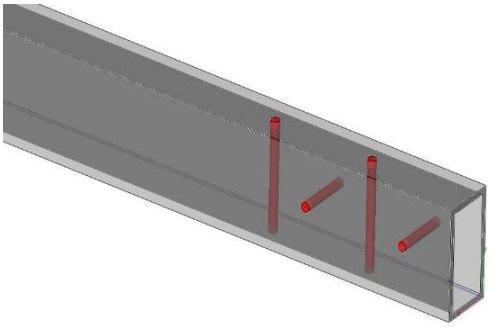
Bonding course:

For a good bond, the fresh filling compound must be pressed against the steel, so that it does not detach when the concrete shrinks during hardening. This is achieved by a swelling agent in the mixture. When the element is subjected to load, the joint between the steel and the filling compound is subjected to shear. Concrete and steel surfaces try to slide against each other. In order to ensure an optimal uniform supporting action, a perfect shear bond is necessary. Therefore, the following design measures must be taken in accunt for bending as well as tension and compression elements.

For flat steel sheets, every 200 x 200mm a shear connector is required.



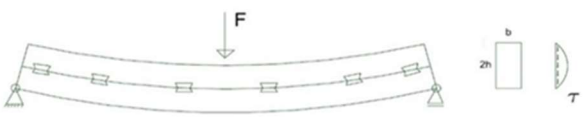
You may use welded perforated plates as stiffeners, welded shear studs Ø 16mm, welded or screwed M16 bolts, length 70mm, welded reinforcing bars Ø16mm, l = 100mm, etc. as a mechanical connection between steel sheet and concrete. Using this solution, descaling or grit blasting of the steel surface is not required, due to the mechanical bond. The rougher the surface, the better is the bond. There should be no oil or grease at the surface, which prevents the adhesion between steel and concrete. The surface can be wet.



Welding is not possible inside rectangular or circular hollow profiles. Therefore every 100 mm horizontal and vertical holes are drilled, through which threaded bolts Ø 16mm or reinforcement bars Ø 16mm are placed and fixed by welding. It is sufficient to do this at the beginning and at the end of the profiles, since in the middle third the shear forces are usually low. In stainless steel tubes, the same method can be applied using screws instead of welding.

The static effect of the shear devices can be seen in the following calculation of stiffness.

$I = 2 \times b \times h^3 \times {}^1/_{12} = {}^1/_6 \times b \times h^3$



$I = b \times (2h)^3 \times {}^1/_{12} = {}^2/_3 \times b \times h^3$

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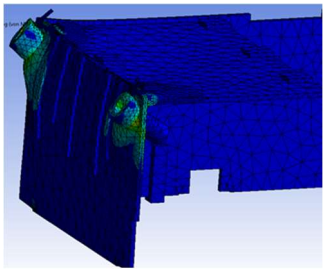
Structural Analyses

Loads are transferred by both the steel and the concrete. The load distribution depends on the stiffness of the individual components and thus essentially on the thickness of the steel plates. Deformations, stresses and natural frequencies can be determined by means of FEM calculations. The shear forces occurring can be analyzed and the shear dowelling designed accordingly.

thick-plate construction: The steel structure is regarded as a self-supporting structural component and structural calculations are performed, for example a design to resist fatigue is performed. The concrete cross-section is not taken into consideration. The concrete is used solely to add weight, for adjustments with respect to the eigen frequency, for damping vibrations and as well as reducing sound emissions.

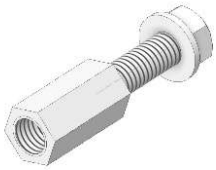
thin-plate construction: The steel structure is designed as a composite material with a thickness of 5 to 8 mm. For additional strengthening and improving the stiffness, reinforcing steel BSt 500 or a steel structure can be welded on. This design method results in fine cracking of the concrete; its stiffness should be reduced accordingly.



Lifting anchors should be designed in accordance with the EC machinery directive. When anchoring in concrete, industrial anchors are preferable. Especially for heavy components, anchoring on the steel housing with verification of force transmission to the bottom is recommended. The verifications for the transport condition are usually decisive for the maximum stresses to be absorbed by the filling material.

Threaded sleeves

In thin-plate constructions, tensile loads must be introduced deep into the casting compound. ‘Fixing Sockets’ or ‘Socket Dowels’ from construction suppliers are suitable for this purpose. For small screw diameters, ‘Spacer Studs’ with female/male thread with an additional washer and hexagon nut on the male thread offer higher thread accuracies. For large screw diameters, a hexagonal ‘Spacer Sleeve’ or ‘Hexagon Nut, High Profile’ with a screwed-in hexagon bolt incl. washer is used.



Retrofitting

Durfill is not suitable for filling existing machines, as the accuracy of the guideways will be lost.

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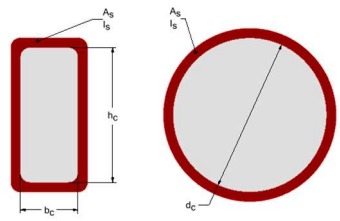
Stiffness Improvement Using Hollow Profiles

In order to compare the advantages against the additional costs of durfill, a calculation scheme for the stiffness values EA and EI is shown below. The analyses is based on double-symmetrical cross sections, elastic material properties and a perfect bond.



Young´s mod. steel: E_s = 210.000 N/mm² = 21.000 kN/cm²
Young´s mod. concrete: E_c = 32.000 N/mm² = 3.200 kN/cm²

Read from tables:

Steel area	A_s in [cm²]
Moment of inertia steel profile	I_s in [cm⁴]
Rectangular cross section: width/height concrete	b_c, h_c in [cm]
Circular cross section: diameter of concrete	d_c in [cm]

Profile	Steel without filling		with filling	
	E_sA_s in [kN]	E_sI_s in [kNcm²]	EA in [kN]	EI in [kNcm²]
Rectangle	21.000 x A_s	21.000 x I_s	E_sA_s + 3.200 x b_c x h_c	E_sI_s + 3.200 x b_c x h_c^3 / 12
Example rectangle profile 180x100x6,3	21.000 x 33,3 = 699.300	21.000 x 1.407 = 29.547.000	699.300 + 3.200 x 8,74 x 16,74 = 1.167.484 Improvement 50%	29.547.000 + 3.200 x 8,74 x 16,74³ / 12 = 40.480.180 Improvement 37%
Circle	21.000 x A_s	21.000 x I_s	E_sA_s + 3.200 x $(d_c/2)^2$ x π	E_sI_s + 3.200 x 0,05 x d_c^4
Example circle profile 88,9x4	21.000 x 10,7 = 224.700	21.000 x 96,3 = 2.022.300	224.700 + 3.200 x $(8,09/2)^2$ x 3,14 = 389.189 Improvement 73%	2.022.300 + 3.200 x 0,05 x $8,09^4$ = 2.707.652 Improvement 34%

Weight rectangle profile empty: 26.1 kg/m with filling: 59.8 kg/m
weight circle profile empty: 8.4 kg/m with filling: 20.2 kg/m

Trading units and source of supply

Material	Source of supply
Ready-mix ‘durfill’, including binder, aggregate and additives, ready-to-use, requiring only the addition of water. Only full palettes, no single bags	Available with worldwide delivery from: durcrete GmbH Dr.-Ing. Bernhard Sagmeister Am Huttig 4, 65549 Limburg, Germany Tel.: +49 6431 58 40 376 Mail: info@durcrete.de Web: www.durcrete.de
Bags with 5 kg or 25 kg, available as single bags for testing and protypes	Webshop: www.moertelshop.de Backstein Engineering GmbH E-mail: Sven.Backstein@moertelshop.com

durfill is designed for the use in machinery construction. Regarding the special characteristics, it doesn't fit the the regulations of EN 206 / DIN 1045 or the German Code 'DAfStb-Richtlinie zu Vergussbeton und Vergussmörtel'. So it may not be used for construction purposes within Germany.

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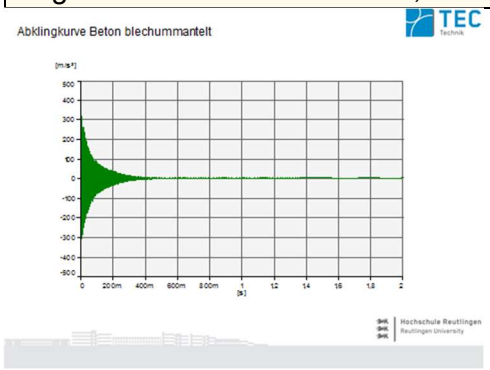
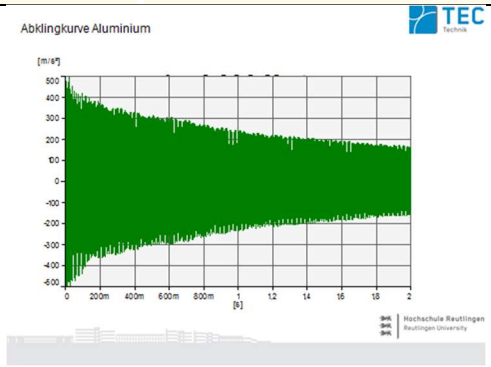
Damping

Dynamic tests performed by Prof. Nebeling, University for applied science Reutlingen, 2014

Material	
Sandwich with durfill 40 x 40 x 700 mm 1. Eigenfrequency 437 Hz Damping D in [%] 0,38 % Logarithm. Decrement Λ 0,024	
Aluminium 40 x 40 x 700 mm 1. Eigenfrequency 445 Hz Damping D in [%] 0,1 % Logarithm. Decrement Λ 0,006	





Test of Fraunhofer IWU in Chemnitz, dated 31th of Mai 2016 proofs, that the damping characteristiv of durfill is better than other products available.