

Technical Data

Mechanical Performance

Ductal's innovative characteristics provides exceptional mechanical performance, in particular its resistance to compression and bending, creep and shrinkage behavior, and fire-resistance. The table below indicates the material's general performance values which are obtained in the test procedures specified in the UHPC recommendations.

	Ductal® with metallic fibres or Ductal®-AF with heat treatment (90°C at 90% relative humidity for 48 hours.)	Ductal® with organic fibres, without heat treatment
Density	2500 kg/m ³	2350 kg/m ³
Compressive strength on cylinder (75 x 150 cm)	150-180 MPa	100-140 MPa
Flexural strength on 4x4x16cm test cylinders	30-40 MPa	15-40 MPa
Direct tensile strength	8 MPa	5 MPa
Residual tensile strength (0.3mm)	8 MPa	3 MPa
Young's Modulus	50 GPa	35 GPa
Poisson Ratio	0.2	0.2
Shrinkage	< 10 µm/m	550 µm/m
Creep Coefficient	0.3	0.8
Thermal expansion coefficient	11.8 µm/m/°C	11.8 µm/m/°C

Durability

The table below compares the durability of Ductal vs normal concrete and HPC; providing four indicators including porosity to water, permeability to oxygen, diffusion coefficient of chloride ions and portland content of heat-treated Ductal® with metallic fibres.

	Normal concrete	HPC	Ductal®
Water-accessible porosity (%)	12-16	9-12	1.5-6
oxygen permeability (m ²)	10 ⁻¹⁵ - 10 ⁻¹⁶	10 ⁻¹⁷	10 ⁻¹⁹
Tritium(*) diffusion coefficient (m ² /s)	2.10 ⁻¹¹	2.10 ⁻¹²	2.10 ⁻¹⁴
Portlandite content (kg/m ³)	76	86	0

(*)Mineral ions have less mobility than tritium, which means they have a lower diffusion coefficient.

Accelerated Ageing Tests

The table below presents the results of classic accelerated tests - carbonation, freeze/thaw, resistance to sulfates and various aggressive solutions, resistance to abrasion and impact - performed on heat-treated Ductal® FM, together with a comparison with other concretes.

	Normal concrete	HPC	Ductal®
Depth of carbonation (mm) after 1 month of accelerated carbonation	10	2	< 0.1
Freeze/thaw ASTM C666 Residual Young module at 300 cycles (% of control part) without air-entraining agent with air-entraining agent	10% 50%	15% 90%	100% 100%
Freeze+Salt AFNOR P 18 420 Flaking at 60 cycles (g/m ²)	> 1000	<900	< 60
Immersion cycles 15°C - drying 60°C EN 494 50 cycles 100 cycles			Δl/l 80 µm/m No variation in performance
Damp abrasion CNR I = V/V _{glass}	4	2.8	1.3-1.7
CNR impact - indication volume (2700 shocks)	250-400		60

Chemical stability, resistance to leaching

Research clearly shows the absence of endogenous deterioration processes (DEF, thaumasite, Alkali-reaction, swelling of residual anhydrous clinker, etc.) including in intentionally mechanically pre-fissured Ductal® materials. Recently obtained, simplified models dealing with resistance to leaching in various aggressive mediums show the extremely long service lifetimes possible under extreme conditions.

Resistance to acid attack

Ductal® demonstrates high resistance even under extremely harsh conditions where ordinary concretes would suffer serious damage. Tests carried out on Ductal® samples show that the material is highly resistant to exposure to various aggressive elements (calcium sulfate, sodium sulfate, acetic acid, ammonium sulfide, nitrates, sea water and distilled water).

Impermeability

Tests of impermeability to water were carried out on slabs measuring 600 x 500 x 10 mm. These were placed in test cylinders filled with water over several days. After 24 hours, no drops of water had formed and no humidity was observed on the underside of the slabs.

Please note: The values given are for guidance only and cannot be used as technical design specifications. They depend on the product characteristics, experimentation method, raw materials, formulae, manufacturing procedures and equipment used; all of which may vary. This data provides no guarantee or commitment that the values will be achieved in any particular application of Ductal®.

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