

Product Data Sheet 27

Ductal®

1 Product Description

Ductal® is an Ultra-High Performance Concrete (UHPC). This concrete is characterized by a compressive strength in excess of 120MPa, a ductile tensile failure mode and very low porosity. This is achieved by high binder content, very low water/cement ratio ($W/C \leq 0.26$), incorporation of organic PVA (poly-vinyl alcohol) fibres and an optimized particle size distribution.

Developed by Lafarge, Ductal® has been designed to serve contemporary architectural creativity and can be used in a highly diverse range of applications. Ductal® is a registered trademark held by Lafarge, and is used with permission.

Armourcoat hold the first sublicense to manufacture Ductal® precast elements in the UK.

2 Properties

- Superior flexural strength (up to 40 MPa) and compressive strength (up to 200 MPa).
- Outstanding durability (100-1000 times greater than conventional concrete).
- Ideal for structures built in harsh settings such as marine or industrial environments and buildings open to the public, with demanding maintenance and safety requirements.
- Self-consolidating material, Ductal® can replicate fine formwork detail or dry cast.
- This enables the construction of large-scale, highly complex, ultra thin precast structures.
- Applications including building envelopes, acoustic sound panels, facing walls, cornice outlines and flooring.

3 Test Data

This technical evaluation by the Centre Scientifique et Technique du Bâtiment (CSTB) was carried out on Ductal®-FO, variant suitable for architectural applications. Two formulas were tested; Ductal®-FO BS1000 and Ductal®-FO AB1000.

3.1 Compressive strength

The compressive tested were performed at CSTB on non heat-treated cylinders $\varnothing 7 \times H 14$ cm.

Type	AB1000	BS1000
28 days	151MPa	129MPa
90 days	132MPa	116.5MPa

3.2 Flexural behaviour

Four-point bending tests were performed at CSTB using NF EN 1170-5 on non heat-treated specimens produced at the Lafarge laboratory.

Type	AB1000	BS1000
Strain PL*	0.5mm/m	0.4mm/m
Stress PL*	16MPa	13.3MPa
Strain failure	0.5mm/m	0.4mm/m
Stress failure	16.0MPa	13.3MPa
E	40,000MPa	39,000MPa

*PL = Proportionality Limit

3.3 Impact behaviour

Impact punching tests were performed by CSTB on a large plate of heat-treated specimen measuring 186cmx156cm. Three 400J and three 900J tests were performed, no disorders observed in each case.

3.4 Impact punching test (CNR)

Compagnie Nationale du Rhône's (CNR) laboratory performed impact punching tests on heat-treated blocks measuring 25x25x10cm³. The test involves subjecting the surface of the block to 2,700 impacts caused by dropping a metal ball onto it. The volume in cm³ of the depression created is measured, and used to calculate the index (I) expressed in cm³. The studied material was determined to have an index I of 60.

3.5 Insert pull out test

CSTB performed tests involving pulling away metal inserts anchored in 33mm thick plates of heat-treated specimens, in accordance with NF B10-514. The mean result after 22 tests was 351daN, with a standard deviation of 37daN.

3.6 Durability

3.6.1 Water porosity

Specimens placed in a container and subjected to a 25mbar vacuum for 24 hours. Then covered with water for a further 24 hours with the vacuum maintained.

	Water	Air
AB1000	11.2%	10.9%
BS1000	11.6%	10.2%

3.6.2 Chloride migration

A non-stationary chloride migration test was performed with 60 V applied (20V is standard). Despite the high voltage, the test did not reveal any evidence of chloride migration.

3.6.3 Freeze-thaw resistance

Specimens (352mm x 50mm x 15mm) were subjected to 100 freeze-thaw cycles (3hrs at 20 °C, 3hrs at -20 °C). Results indicate that the subjected material did not decrease its mechanical bending performance.

Type	AB1000	BS1000
Strain PL*	0.5mm/m	0.5mm/m
Stress PL*	15.8MPa	13.4MPa
Strain failure	0.9mm/m	2.4mm/m
Stress failure	15.9MPa	13.5MPa
E	42,000MPa	39,500MPa

*PL = Proportionality Limit

3.6.4 Accelerated ageing tests

Non-precracked Ductal®-FO

CSTB performed accelerated ageing tests (HRT cycles) on heat-treated specimens. The specimens were first subjected to 100 hot+cold cycles (3 hours at 80°C, 3 hours at -20°C) in a ventilated chamber, followed by 100 immersion+drying cycles (6 hours in water at 15° C, 6 hours in air at 60°C).

	Flexural Strength	Elastic modulus
Reference	14.1 ± 1.5	50.7 ± 0.7
100 hot+cold	14.9 ± 2.7	49.9 ± 1.0
100 hot+cold+ 50 imm+drying	14.4 ± 2.5	50.6 ± 1.1
100 hot+cold+ 100 imm+drying	14.3 ± 2.2	50.4 ± 0.5

Precracked Ductal®-FO

CSTB performed accelerated ageing tests on heat-treated specimens. Precracking was achieved by tensile bending until cracks with a total width of 300µm opened. The specimens were then subjected to two types of accelerated ageing:

Immersion+drying cycles (18 hours in water at ambient temperature followed by 6 hours drying at 60°C and 20% RH) for 90 days,
 Immersion in water at 60°C for 90 days

Ageing type	max load	deflection
Reference	30.5daN	12.2mm
Water 60°C	36.0daN	11.0mm
Imm+drying	35.5daN	8.6mm

3.7 Fire resistance

Non-flammable (Classified MO-AI). Tests were performed on heat-treated panels and slabs – in accordance with ISO 834.

Panels

Test on 20mm thick vertical panel (2.4m x 2m), with four insulating panels 50-75mm thick bonded to the unexposed side, halted after 132 minutes. The panel remained sealed against flames and hot gases throughout the test. Thermal insulation ranged from 55-112 minutes, depending on the area.

Slabs

Test on 25mm slab (400mm x 300mm, with a 42kg load. Maximum deflection of 4mm occurred after 30 minutes. Slab was breached by inflammable gases after 44 minutes, thermal insulation ceased after 13 minutes. The slab continued to bear the load with no further significant evolution until the end of the test.

All data reproduced from the original CSTB technical evaluation (September 2005) with kind permission of Lafarge. Translated from the original document in French.

Whilst every attempt has been made to ensure the accuracy and reliability of the information contained in this document, the information should not be relied upon as a substitute for formal advice. Armourcoat Ltd, its employees and agents will not be liable for any loss or damage, of any kind, arising out of or in connection with the use of this document. Please refer to the company disclaimer for further details.

DMM PDS27 0111

Armourcoat Limited

Morewood Close London Road
 Sevenoaks Kent TN13 2HU United Kingdom
 Tel: +44 (0)1732 460 668 Fax +44 (0)1732 450 930
 Email: technical@armourcoat.co.uk

web: www.armourcoat.com