Certificate no.:
TAK00002KR

TYPE APPROVAL CERTIFICATE

This is to certify:

that the Structural Cementitious Grout

with type designation(s)
S5R+

issued to
ITW DENSIT ApS
Aalborg Øst, Nordjylland, **Denmark**

is found to comply with

DNV standard DNV-ST-C502 – Offshore concrete structures

Application:

Load carrying, vertically and diagonally oriented cylindrical-shaped grouted connections, filled with displacement grouting
and
Load carrying, vertically oriented cylindrical-shaped rock-socket grouted connections, filled with an extracted stinger placement method or displacement grouting.

Further details, including properties, operational limitations and approved production facility, are given overleaf. Please refer to last page of this TAC for important information related to the validity of the TAC

Issued at **Høvik** on **2025-10-28**
This Certificate is valid until **2030-10-28**.
DNV local unit: **Oslo Marine Structures Verification**

for **DNV**

Approval Engineer: **Andrew McVey**

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to USD 300 000.

This Type Approval Certificate (TAC) has been issued in accordance with the DNV Type Approval scheme described in DNV-SE-0295, December 2018 (amended September 2021). Reference is made to the technical requirements specified in DNV-ST-C502, February, 2018 (amended October 2021).

This Type Approval Certificate should be read in conjunction with DNV Summary Report - 2025-3183 – Rev 0 providing references and background data for all presented information. This Type Approval Certificate does not act as an approval for design of any particular grouted connection.

Product description

Table 1 outlines general product information and validity range of the Certificate for Ducorit S5R+.

Table 1 Validity for Type Approval Certificate for Ducorit S5R+

Details of Manufacturer / Owner of Certificate	ITW Densit ApS
Maximum aggregate size	≤ 5 mm
Water Demand (fresh water)	78 to 81 litres of water per 1000 kg of dry powder, depending on grouting temperature
Approved Production Facility	ITW Densit, Rørdalsvej 44, 9220 Aalborg, Denmark

Responsibility

The owner, stated as that to which the Certificate has been "issued to" on page 1, takes responsibility that both the design and production are in compliance with the standards listed on page 1 of this Certificate.

Marking of product

The delivered product shall be clearly marked with the manufacturer’s name and production facility. Furthermore, the Production Batch Id., production date, shelf life, storage/handling instructions, weight and water demand shall be clearly identified by the label. The current TAC is applicable for production of Ducorit S5R+ for big bag storage/transportation. Reference to the TAC shall be included on the product label.

Application

The application limitations for the Ducorit S5R+ material have been established during the Certification Scheme based on laboratory and mock-up tests independently witnessed by DNV. The general application and operational limitations for Ducorit S5R+ are presented in Table 2.

Table 2 Main Operational Limitations for Application of Ducorit S5R+

Description	Unit	Limitations
Nominal Bore (NB) for grout hoses/lines[1)]	inch	NB ≥ 3
Grout annulus thickness[2)3)]	mm	40 ≤ t ≤ 1000
Pumping length through 3” NB flexible hoses[1)]	m	L ≤ 250
Pumping elevation head using 3” NB hoses	m	H ≤ 25
Minimum application temperature ($t_{app,min}$)[4)5)6)8)]	°C	5
Maximum application temperature ($t_{app,max}$)[7)8)]	°C	40
Verified free-fall height through water[9)]	mm	500

1) Limitation for nominal bore is also valid for valves/couplings between each segment of grouting lines/hoses. I.e. the valves/couplings shall not have a reduced nominal bore compared to the grouting lines/hoses.
2) Limitations for grout thickness are valid for annuluses in tubular/conical grouted connections.
3) Temperature gradients over the grouted section should be considered for the application in question
4) The minimum application temperature is defined based on the limitation in DNV-ST-C502 for normal temperature testing.
5) The minimum application temperature reflects the temperature limit where the material is Certified to develop strength during low temperature grouting.
6) The minimum application temperature shall be taken as the temperature limit of the structure, immediately adjacent to the grouted part, for not less than 72 hours after grouting, or after the grout has attained sufficient strength to resist early frost damage. In lieu of specified requirements related to resistance of early frost damage in DNV-ST-C502, this value may be taken conservatively as 35 MPa. In addition the minimum application temperature shall be taken as the minimum temperature the material will be exposed to during mixing, pumping, placement.
7) Maximum application temperature shall be taken as the maximum temperature the material will be exposed to during mixing, pumping, placement and during the first 24hours after placement. This includes the temperature of ambient air, surfaces the grout will be in contact with, the structure immediately adjacent to the grouted part, and / or water temperature. Note that for application above 30°C mixing water of 10°C shall be used.
8) Due consideration shall be given to special measures, pre-conditioning of materials and equipment, as well as mixing of the grout, when performing grouting close to the extremes of the qualified temperature range. Reference is made to the Generic Method Statement (Table 15). Temperature effects/gradients for the application in question need to be considered specifically for each project.
9) The maximum stated free fall height is based on successful mock-up testing representative of a typical MP-TP connection. For large volume/wide annuli connections project specific testing may be required to confirm good quality grout is present throughout the entire effective length of the connection.

Fresh Properties

The tests of fresh properties of Ducorit S5R+ grout witnessed by DNV as part of the Certification Scheme are listed in Table 3 and Table 4. Properties are based on tests undertaken after mixing with laboratory equipment.

Table 3 Summary of fresh properties for Ducorit S5R+ for testing at 20°C

Test Id.	Type of Test	Test Method	Test Temperature	Test Values
				Mean
FG1[2)]	Flow spread test (2 min)	ASTM C230 /C1437	20°C	290 mm
	Flow spread test (30 min)			275 mm
	Flow spread test (60 min)			263 mm
	Flow spread test (90 min)			240 mm
	Flow spread test (120 min)			230 mm
	Flow spread test (180 min)			198 mm
FG2[2)]	Fresh density	EN 12350-6	20°C	2377 kg/m3
FG3[2)]	Bleeding	ASTM C940	20°C	No observed bleeding
FG4[2)]	Air content	EN 12350-7	20°C	2.1 %
FG5[2)]	Initial setting time	EN 196-3[1)]	20°C	06:23 hh:mm
FG5[2)]	Final setting time	EN 196-3[1)]	20°C	09:08 hh:mm

1) Weight of moving parts 1000 grams instead of 300 grams as specified in EN 196-3
2) All test results are from material testing at MPA (250538).

Table 4 Summary of fresh properties for Ducorit S5R+ for testing at $t_{test,\ min}$ (40°C)

Test Id.	Type of Test	Test Method	Test Temperature	Test Values
				Mean
FG1a[4)]	Flow spread test (2 min)	ASTM C230 /C1437	40°C	288 mm
	Flow spread test (30 min)			207 mm
	Flow spread test (60 min)			126 mm [2)]
	Flow spread test (90 min)			-
	Flow spread test (120 min)			-
	Flow spread test (180 min)			-
FG2[3)]	Fresh density	EN 12350-6	40°C	2350 kg/m3
FG3[3)]	Bleeding	ASTM C940	40°C	No observed bleeding
FG4[3)]	Air content	EN 12350-7	40°C	3.1 %
FG5[3)]	Initial setting time	EN 196-3[1)]	40°C	02:05 hh:mm
FG5[3)]	Final setting time	EN 196-3[1)]	40°C	04:50 hh:mm

1) Weight of moving parts 1000 grams instead of 300 grams as specified in EN 196-3
2) Presented flow data is based on average of three test occurrences where one or more values are 100mm, i.e. no flow measurable after removal of cone.
3) All test results are from material testing at MPA (250538)
4) Flow results for 40°C are from material testing at MPA (250538) and (253136).

Hardened Properties

Characteristic 28-days strengths of relevant hardened material properties for Ducorit S5R+ are given in Table 5. The 5 % characteristic values are determined in accordance with Appendix D of EN 1990 on the basis of each individual test result from all production batches being tested as part of the laboratory test program.

Table 5 Characteristic 28-days strengths for Ducorit S5R+ acc. to EN 1990

Material Property	Test Specimen	Curing/Testing Temperature [°C]	Notation	Characteristic Value [MPa]
Compressive Strength[1)]	150 x 300 mm cylinders	20	f_{cck}	116.3
	75 mm cubes	20	f_{ck}	123.7
	40 x 40 x 160 mm prisms	20	$f_{ck.prisms}$	119.4
Flexural Strength[1)]	40 x 40 x 160 mm prisms	20	$f_{ctk,fl}$	15.4

1) The characteristic strength of the material at different temperatures may be found from data presented in DNV Summary Report 2025-3183 Rev. A.
2) Values achieved during laboratory testing, using laboratory mixing equipment.

Mean values of hardened material properties of Ducorit S5R+ documented during the laboratory test programs are presented in Table 6 and Table 7.

Table 6 Summary of hardened properties for Ducorit S5R+ for testing at 20°C

Test Id.	Type of Test	Test Method	Testing / Curing Temperature	Test Values	Unit
				Mean	
HG1[1)]	Hardened density	EN 12390-7	20°C	2388	kg/m³
HG2[1)]	3 days compressive strength (150 x 300 mm cyl)	EN 12390-3	20°C	86.4	MPa
	7 days compressive strength (150 x 300 mm cyl)			98.9	MPa
	28 days compressive strength (150 x 300 mm cyl)			121.6	MPa
	90 days compressive strength (150 x 300 mm cyl)			136.3	MPa
HG3[1)]	28 days compressive strength (75 mm cubes)	EN 12390-3	20°C	130.6	MPa
HG4[1)]	28 days flexural strength (40 x 40 x 160 mm prisms)	EN 196-1	20°C	16.8	MPa
HG5[1)]	Creep coefficient after 1 day loading	ASTM C512	20°C	0.551	-
	Creep coefficient after 28 days loading			0.993	-
	Creep coefficient after 58 days loading			1.098	-
	Creep coefficient after 90 days loading			1.154	-
HG6A[1)]	Autogenous shrinkage strain after 28 days curing	ASTM C1698	20°C	0.465	mm/m
	Autogenous shrinkage strain after 56 days curing			0.432	mm/m
HG6B[1)]	Restrained shrinkage strain after 14 days curing	Modified ASTM C1581	20°C	-0.052	mm/m
	Restrained shrinkage strain after 28 days curing			-0.079	mm/m
HG7[1)]	Static Young's modulus	ASTM C469	20°C	44.8	GPa
	Poisson's ratio	ASTM C469	20°C	0.17	-

1) All test results are from material testing at MPA (250538), except creep which is from MPA report 250539.

Table 7 Summary of hardened properties for Ducorit S5R+ for testing at $t_{test, min}$ (40°C)

Test Id.	Type of Test	Test Method	Testing / Curing Temperature	Test Values	Unit
				Mean	
HG1[1)]	Hardened density	EN 12390-7	40°C	2324	kg/m³
HG2[1)]	3 days compressive strength (150 x 300 mm cyl)	EN 12390-3	40°C	106.1	MPa
	7 days compressive strength (150 x 300 mm cyl)			116.3	MPa
	28 days compressive strength (150 x 300 mm cyl)			122.3	MPa
	90 days compressive strength (150 x 300 mm cyl)			127.4	MPa
HG3[1)]	28 days compressive strength (75mm cubes)	EN 12390-3	40°C	138.5	MPa
HG4[1)]	28 days flexural strength (40 x 40 x 160 mm prisms)	EN 196-1	40°C	18.1	MPa

1) All test results are from material testing at MPA (250538).

Additional Fresh Properties

The flow test with agitation and wick induced bleed test at 20°C,, results for fresh properties of Ducorit S5R+ grout for 4°C, including wick induced belled testing relevant for rock-socket connections, witnessed by DNV as part of the Certification Scheme are listed in Table 8, 9 and 10. Properties are based on tests undertaken after mixing with laboratory equipment.

Table 8 Summary of additional fresh properties for Ducorit S5R+ for testing at 20°C

Type of Test		Test Method	Testing / Curing Temperature	Test Value
				Mean
FG1b [1)2)]	2 min	ASTM C1437[1)]	20°C	282 mm
	30 min			278 mm
	60 min			272 mm
	90 min			258 mm
	120 min			243 mm
	180 min			215 mm
	240 min			188 mm
Volume change / Bleeding, vertical tube of 1.0 m[2)]	30 min	EN 445	20°C	-0.00 % / 0%
	60 min			-0.40 % / 0%
	120 min			-0.40 % / 0%
	180 min			-0.40 % / 0%
	240 min			-0.40 % / 0%
	24 h			-0.50 % / 0%

1) These tests have been undertaken to evaluate the upper bound flow performance, where agitation of the grout prior to testing has been undertaken by mechanical mixing for 30s. DNV see the standard FG1 test results as presented in Table 3 and Table 4 to be more representative of the behaviour of the grout material in the compartment during installation.
2) All test results are from material testing at MPA (250538).

Table 9 Summary of fresh properties for Ducorit S5R+ for testing at $t_{test, min}$ (4°C)

Test Id.	Type of Test	Test Method	Test Temperature	Test Values
				Mean
FG1a[2)]	Flow spread test (2 min)	ASTM C230 /C1437	4°C	270 mm
	Flow spread test (30 min)			278 mm
	Flow spread test (60 min)			272 mm
	Flow spread test (90 min)			272 mm
	Flow spread test (120 min)			267 mm
	Flow spread test (180 min)			248 mm
	Flow spread test (240 min)			233 mm
	Flow spread test (300 min)			230 mm
FG2[2)]	Fresh density	EN 12350-6	4°C	2323 kg/m3
FG3[2)]	Bleeding	ASTM C940		No observed bleeding
FG4[2)]	Air content	EN 12350-7		3.9 %
FG5[2)]	Initial setting time	EN 196-3[1)]		14:53 hh:mm
FG5[2)]	Final setting time	EN 196-3[1)]		20:00 hh:mm
Volume change / Bleeding, vertical tube of 1.0 m[2)]	30 min	EN 445	4°C	0.0 %
	60 min			-0.4 %
	120 min			-0.4 %
	180 min			-0.4 %
	240 min			-0.4 %
	24 h			-0.5 %

1) Weight of moving parts 1000 grams instead of 300 grams as specified in EN 196-3
2) All test results are from material testing at MPA (250538).

Table 10 Summary of additional fresh properties for Ducorit S5R+ for testing at 40°C

Type of Test		Test Method	Testing / Curing Temperature	Test Value
				Mean
FG1b [1), 2), 3)]	2 min	ASTM C1437[1)]	20°C	277 mm
	30 min			242 mm
	60 min			197 mm
	90 min			147 mm [4)]
	120 min			117 mm [4)]
	180 min			107 mm [4)]

1) These tests have been undertaken to evaluate the upper bound flow performance, where agitation of the grout prior to testing has been undertaken by mechanical mixing for 30s. DNV see the standard FG1 test results as presented in Table 3 and Table 4 to be more representative of the behaviour of the grout material in the compartment during installation.
2) Presented flow data is based on average of three test occurrences where one or more values are 100mm, i.e. no flow measurable after removal of cone.
3) All test results are from material testing at MPA (250538).

Additional Hardened Properties

Mean values of hardened material properties of Ducorit S5R+ documented during the laboratory test programs are presented in Table 11, Table 12 and Table 13.

Table 11 Summary of additional hardened properties for Ducorit S5R+ for testing at 20°C

Test Id.	Type of Test	Test Method	Testing / Curing Temperature	Test Values	Unit
				Mean	
HG2[1)]	1 day compressive strength (150 x 300 mm cyl)	EN 12390-7	20°C	50.2	MPa
HG3[1)]	1 day compressive strength (75mm cubes))	EN 12390-3	20°C	45.7	MPa
	3 days compressive strength (75mm cubes)			97.7	MPa
	7 days compressive strength (75mm cubes)			114.9	MPa
HG8[1)]	1 day splitting tensile strength (150 x 300 mm cyl)	EN 12390-6	20°C	4.7	MPa
	3 days splitting tensile strength (150 x 300 mm cyl)			5.7	MPa
	7 days splitting tensile strength (150 x 300 mm cyl)			6.2	MPa
	28 days splitting tensile strength (150 x 300 mm cyl)			7.83	MPa

1) All test results are from material testing at MPA (250538).

Table 12 Summary of hardened properties for Ducorit S5R+ for testing at $t_{test, min}$ (4°C)

Test Id.	Type of Test	Test Method	Testing / Curing Temperature	Test Values	Unit
				Mean	
HG1[1)]	Hardened density	EN 12390-7	4°C	2363	kg/m³
HG2[1)]	1 day compressive strength (150 x 300 mm cyl)	EN 12390-3	4°C	1.0	MPa
	3 days compressive strength (150 x 300 mm cyl)			59.6	MPa
	7 days compressive strength (150 x 300 mm cyl)			77.5	MPa
	28 days compressive strength (150 x 300 mm cyl)			88.9	MPa
	90 days compressive strength (150 x 300 mm cyl)			100.5	MPa
HG3[1)]	1 day compressive strength (75mm cubes)	EN 12390-3	4°C	1.1	MPa
	3 days compressive strength (75mm cubes)			61.0	MPa
	7 days compressive strength (75mm cubes)			93.2	MPa
	28 days compressive strength (75mm cubes)			100.5	MPa

HG4[1)]	28 days flexural strength (40 x 40 x 160 mm prisms)	EN 196-1	4°C	11.3	MPa

1) All test results are from material testing at MPA (250538).

Table 13 Summary of additional hardened properties for Ducorit S5R+ for testing at $t_{test, max}$ (40°C)

Test Id.	Type of Test	Test Method	Testing / Curing Temperature	Test Values	Unit
				Mean	
HG2[1)]	1 day compressive strength (150 x 300 mm cyl)	EN 12390-7	40°C	83.8	MPa
HG3[1)]	1 day compressive strength (75mm cubes))	EN 12390-3	40°C	90.0	MPa
	3 days compressive strength (75mm cubes)			116.8	MPa
	7 days compressive strength (75mm cubes)			132.5	MPa

1) All test results are from material testing at MPA (250538).

Conversion factors

Relevant conversion factors between strength properties obtained on different test specimens are given in Table 14. The conversion factors are based on mean values presented in Table 6.

Table 14 Conversion factors for 28-days strengths for Ducorit S5R+ at 20°C

Conversion factor	Value
f_{ccm} / f_{cm}	0.93
f_{ccm} /$f_{cm,prims}$	0.95
f_{cm} / $f_{cm,prisms}$	1.02

Approved Procedures

The approved ITW's procedural documentation for application of Ducorit S5R+ is shown in Table 15. This Type Approval Certificate is only valid when ITW is performing the grouting operation in accordance with the referenced generic method statement and offshore QC procedures.

Table 15 Approved Procedural ITW's Documentation for application of Ducorit S5R+

Description	Title of Document
Generic Method Statement	DOC - 00366 – Generic Grouting Method Statement – Scope and Procedure – Ducorit S5R+, revision 4, 17.10.2025
Qualification Scheme for 3rd Party Grouting Contractor	DOC – 00367 – Licensed Applicator Approval Program (LAAP) – Ducorit S5R+, revision 4, 10.10.2025
Offshore QC Procedures	DOC – Evaluation of Ducorit S5R+ compressive strength, revision 0, 29.08.2025

Traceability

In order to operate under a valid Type Approval Certificate for Ducorit S5R+, a comprehensive traceability system of all delivery shall be maintained on a project specific basis. This system shall allow the location of all production batches at any point along the delivery line.

Manufacturing Site Approval

An initial inspection audit at ITW's primary production facility in Aalborg, Denmark was successfully carried out on the 25th June 2025, according to App. I of DNV-ST-C502 (February 2018).

DNV shall at any time, upon request, be given access to all areas and facilities for production and quality control at the manufacturing facility. The frequency and timing of periodical surveys shall be confirmed in advance with the manufacturer, see Sec 5.4 of DNV–SE-0295.

Periodical inspections

2 and 3.5 year periodical inspections are required within a 5 year valid period to maintain the certificate valid. The start of the 5 year period is normally the same as the issue date. Per DNV –SE-0295: "The exact timing of the inspections shall be arranged in advance with DNV by the manufacturer."

Renewal Assessment

The scope of the Renewal Assessment is to verify that the conditions stipulated for the Type Approval are complied with and that no alterations are made to the product design or selection of materials. The renewal assessment shall be performed after five (5) years of issuance of this Certificate (Certificate Renewal).

Validity of Type Approval

The following information is provided for all structural grout TACs issued by DNV in accordance with the requirements of DNV-ST-C502, and in accordance with the Type Approval scheme set out in DNV-SE-0295.

The TAC is valid for the grouting of structural connection types for which generic grouting procedures / method statements have been approved as part of the Type Approval process. In this case vertically and diagonally oriented cylindrical-shaped grouted connections, filled with displacement grouting. Operational limitations are specified within the approved procedures. If applicable, additional precautions may be specified within the approved procedures without details explicitly stated on this TAC. The approved procedures are listed in DNV Summary Report No. 2025-3183 – Rev0, Section 3.2.

For the grouting of vertically oriented cylindrical-shaped rock-socket grouted connections, filled with an extracted stinger placement method or displacement grouting, project specific considerations may be required to supplement the validation testing undertaken as part of the TAC process. This includes but may not be limited to; maximum filling duration, evaluation of rock formation to assess potential for filtration and hole stability, interface items (manifolds, sub-sea connectors, density probes etc.), removal rates of temporary casings, flow between multiple annuli, etc.

The TAC is valid when the material is applied by the owner of the TAC, or by an approved 3rd Party contractor, when the qualification scheme has been approved as part of the Type Approval process. The approved 3rd Party contractor qualification scheme is given in DNV Summary Report No. 2025-3183 – Rev0, Section 3.3.

The TAC is valid when the material is tested, and field records are kept, in accordance with approved QC procedure. The approved QC procedures are listed in DNV Summary Report No. 2021-0201 – Rev0, Section 3.4.

The TAC is valid when the material is transported and stored, and traceability records are kept, in accordance with approved QC procedures. The approved QC procedures are listed in DNV Summary Report No. 2021-0201 – Rev0, Section 3.4.

The TAC is valid when grout is transported, mixed, pumped and installed in line with procedures documented through the Validation testing conducted as part of the Type Approval process. For primary / contingency applications significantly outside of that tested during the Type Approval process in scale, grout line arrangement, duration, or complexity, additional testing may be required on a project specific basis. This should be assessed by the designer, or specifier. If the extent, or limitations of the testing conducted during the Type Approval process is questioned, the manufacturer shall be contacted. The approved Validation test reports are listed in DNV Summary Report No. 2025-3183 – Rev0, Section 3.5.

Validation tests are based on idealised conditions and sometimes on reduced scale equivalents. While every effort has been made to capture conservatisms, some combinations of application parameters may unintentionally result in conditions which are outside of that documented through the Validation testing. The designer, or specifier, should account for project specific demands of the particular design and / or installation operation, and shall assess if additional testing is required on a project specific basis.

END OF CERTIFICATE