



Independent laboratory
for material testing

Laboratory report

Testing Jotaguard RB 4003 according to ASTM A775/A775M-2022 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars. Tested on steel reinforcing bars produced by Qatar steel (Q-Coat).

Conclusion

The tested samples with M2LAB ID 240167 meet the requirements of ASTM A775/A775M-2022 Annex A1

Customer:
Contact:
Report no.:
Drafted by:
Date report:

Jotun A/S
Terje Aamodt
R240167-R01 Jotun A/S-Jotaguard RB 4003 Qatar Steel
R. Brakenhoff
30-10-2024



Contents

1	Introduction.....	3
2	Application data	3
3	Tested samples	3
4	Performed tests.....	6
4.1	Dry film thickness	6
4.2	Infrared Spectroscopy of powder.....	6
4.3	Chemical Resistance	6
4.1	Cathodic disbondment	7
4.2	Neutral salt spray test	7
4.3	Chloride permeability.....	7
4.4	Coating Flexibility.....	8
4.5	Relative Bond Strength in Concrete	9
4.6	Abrasion resistance	9
4.7	Impact test	10
5	Results.....	11
5.1	Dry film thickness	11
5.2	Reference Infrared	11
5.3	Chemical Resistance	12
5.4	Cathodic disbondment	15
5.5	Neutral salt spray test	16
5.6	Chloride permeability.....	17
5.7	Coating Flexibility.....	17
5.8	Relative Bond Strength in Concrete	18
5.9	Abrasion resistance	18
5.10	Impact test.....	19
6	Summary	20
7	Conclusion	20
8	Liability	23

1 Introduction

By order of Jotun A/S, M2LAB B.V., has performed laboratory testing under M2LAB ID 240167 as mentioned in OFM2192

2 Application data

Information received from the client. See Annex 1

3 Tested samples

M2LAB ID	Customer ID		Sample description	Performed test	Date received
		Sample #			
K240167-1	Steel reinforcing bars Produced by Qatar Steel (Charge: 2018C00214 -02) D19.1, L0.25 MTR Coated with Jotaguard RB 4003	1	Green coated steel rebar Ø19,1 mm, 25 cm long	Cathodic Disbondment (A1.3.3)	21-07-2024
K240167-2		2			
K240167-3		3			
K240167-4		4		Salt Spray Resistance (A1.3.4)	
K240167-5		5			
K240167-6		6			
K240167-7		7		Impact Test (A1.3.9)	
K240167-8		8			
K240167-9		9			
K240167-10		10		Chemical Resistance (A1.3.2)	
K240167-11		11			
K240167-12		12			
K240167-13		13			
K240167-14		14			
K240167-15		15			
K240167-16		16			
K240167-17		17			
K240167-18	Taber abrasion panels Coated with Jotaguard RB 4003		Green coated steel samples 100 x 100 mm	Abrasion Resistance (A1.3.8)	
K240167-19					
K240167-20					
K240167-21	Free Film Jotaguard RB 4003		Free Film 6x 100 x 100 mm	Chloride Permeability (A1.3.5)	
K240167-22	Jotaguard RB 4003, ID:1002693 Batch No. 3397456		Container with green powder	Infrared Spectroscopy (A1.3.1)	

Application data: see annex 1

M2LAB ID	Customer ID	Sample #	Sample description	Performed test
K240167-23	Steel reinforcing bars coated with Jotaguard RB 4003 The steel reinforcing bars: Produced by Qatar Steel (Charge: 2018C00214 -02)	1	Green coated steel rebar Ø19,1 mm, 1,2 m long	Coating Flexibility A1.3.6
K240167-24		2		
K240167-25		3		Coating Flexibility A1.3.6
K240167-26		4		
K240167-27		5		
K240167-28		6		
K240167-29		7		Coating Flexibility A1.3.6
K240167-30		8		Relative Bond Strength in Concrete A1.3.7
K240167-31		9		Relative Bond Strength in Concrete A1.3.7
K240167-32		10		
K240167-33		11		
K240167-34		12		
K240167-35		13		
K240167-36		14		
K240167-37		15		
K240167-38		16		
K240167-39		17		
K240167-40		18		Relative Bond Strength in Concrete A1.3.7
K240167-41	Steel reinforcing bars: Produced by Qatar Steel (Charge: 2018C00214 -02) D19.1, L1.2 MTR Uncoated	1	Uncoated steel rebar Ø19,1 mm, 1,2 m long	
K240167-42		2		
K240167-43		3		
K240167-44		4		
K240167-45		5		Relative Bond Strength in Concrete A1.3.7
K240167-46		6		
K240167-47		7		
K240167-48		8		
K240167-57		9		

Application data: see annex 1



4 Performed tests

4.1 Dry film thickness

Standard	ASTM A775 A1.2.3.4 and SSPC-PA-2
Device	M2LAB-032
Adjusting the device	Before the test
Intermediate adjustments	None
Conditioning	7 days at 23 ± 2 °C and 50 ± 5 %
Number of measurements per sample (n)	1 single recorded measurement consists of 3 measurements between 4 consecutive deformations. 5 recorded measurements have to be taken on the front and 5 recorded measurements on the back of each bar
Deviations to the standard	None
Unusual features	None
Requirements	The average of all measurements shall be higher than the minimum required thickness and lower than the maximum required thickness. No recorded value shall be less than 80% of the minimum thickness requirement or higher than 120% of the maximum requirement.
Test date	2-7-2024
Laboratory technician	YR

4.2 Infrared Spectroscopy of powder

Standard	ASTM A775 A1.3.1
Device	FT-IR with ATR
Material	Powder
Measured	On 1 location
Runs per Spectrum	16
Range	4000 till 400 cm^{-1}
compared to	Library
Test date	05-08-2024
Laboratory technician	VC

4.3 Chemical Resistance

Standard	ASTM A775 A1.3.2 and G20
Device	Sealed jar
Type of Chemical	-Demineralised water (< 20 mS/m) -3M CaCl_2 solution in water -3M NaOH solution in water -Saturated $\text{Ca}(\text{OH})_2$
Temperature	$24^\circ\text{C} \pm 2^\circ\text{C}$
Positioning of product	vertical
Immersion dept	half
Number of test panels	2
Damage	2x 6 mm holidays, one immersed and one in the damp phase
Test duration	45 days
Cleaning after test	Rinsing with tap water
Requirement	The coating shall not blister, soften, lose bond, nor develop holidays during this period. There shall be no undercutting surrounding the intentionally holidays.
Test date	2-8-2024 till 16-9-2024
Laboratory technician	RB

4.4 Cathodic disbondment

Standard	ASTM A775 A1.3.3 and ASTM G8
Device	M2LAB
Anode	Platinized wire
Electrolyte	3% NaCl solution in demineralised water (< 20 mS/m)
Temperature	24°C ± 2°C
Intentional holiday (defect)	3 mm
Test duration	168 hours
Number of test panels	Three
Evaluation	4 measurements at 0°, 90°, 180° and 270°
Requirement	The average disbondment radius of the three coated bars shall not exceed 4 mm when measured from the edge of the defect
Cleaning after test	Rinsing with tap water
Test date	18-7-2024 till 25-7-2024
Laboratory technician	RB/SV

4.5 Neutral salt spray test

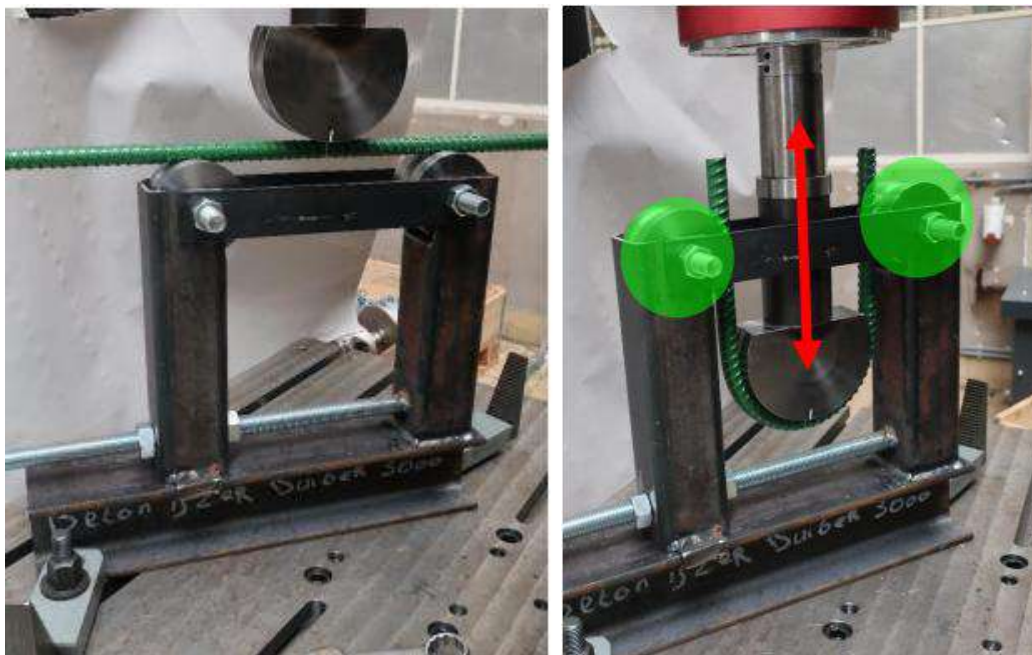
Standard	ASTM B117 and ASTM A775 A1.3.4
Device	M2LAB 005
pH	6,5 – 7,2
Type of water	Demineralised water (< 20 mS/m)
Concentration NaCL	50 g/l ± 5 g/l
Temperature	35°C ± 2°C
Collected fluid	1.0 – 2.0 ml/hour/80 cm ²
Corrosivity	70±20 g/m ²
Positioning of product	Horizontal with the intentional damage up.
Number of Bars	Three
Intentional damage	Three 3 mm holes evenly spaced along 1 side of the bar
Test duration	800 hours
Cleaning after test	Rinsing with tap water
Laboratory technician	SV
Assessment After 1 hour conditioning	4 disbondment measurements at 0°, 90°, 180° and 270°
Requirement	Average coating disbondment radius of nine sites will not exceed 3 mm measured from the edge of the defect.
Test date	23-7-2024 till 26-8-2024
Laboratory technician	RB/SV

4.6 Chloride permeability

Standard	ASTM A775 A1.3.6
Device	M2LAB-156
Test temperature	24°C ± 2°C
Type of water	Demineralised water (< 20 mS/m) and 3M aquas salt solution
Test duration	45 days
Assessment	Mol/L Chloride ions in the demineralized water
requirement	<1x10 ⁻⁴ M
Test date	22-07-2024 till 03-09-2024 03-09-2024 till 18-10-2024
Laboratory technician	RB

4.7 Coating Flexibility

Standard	ASTM A775 A1.3.6
Device	Instron 5738 300 kN
Test conditions	23 ± 2 °C
Test speed	5 mm/s (testduration < 15 s)
Mandrel	150 mm
Endpoint	180° bend
Assessment	The samples have been assed for cracking around the bend area
requirement	No cracking visible with normal corrected vision
Test date	19-09-2024
Laboratory technician	outsourced



Rollers marked in green provide a frictionless transmission so no strain is accomplished in area's outside the mandrel

4.8 Relative Bond Strength in Concrete

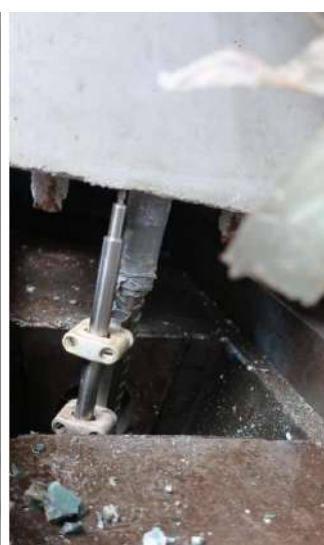
Standard	ASTM A775 A1.3.7 and ASTM A944
Device	MTS loadcel 500 kN, HBN signal amplifier Quantum X
Test conditions	23 ± 2 °C
Testduration	>180 s
Assessment	Bond strength
Requirement	The mean bond strength of the coated bars shall not be less than 85% of the mean bond strength of the uncoated bars
Test date	19-09-2024
Laboratory technician	outsourced



Overview test setup



Attachment LVDT topside



Attachment LVDT bottom

4.9 Abrasion resistance

Standard	ASTM A775 A1.3.8 and ASTM D4060
Device	5135 Abraser
Test conditions	23 ± 2 °C
Abrasive wheel	CS 10
Load at the wheel	1000 g
Hight vacuum nozzle	3 mm
Vacuum level	100%
Refacing	every 500 cycles
Number of wear cycles	1000
Assessment	Weight loss/1000 cycles
requirement	<100 mg/1000 cycles
Test date	20-8-2024
Laboratory technician	MvdV

4.10 Impact test

Standard	ASTM G14 and ASTM A775 A1.3.9
Device	M2LAB-0132
Temperature	23°C ± 2°C
Mass of the weight	1000 g
Diameter of the head	16 mm
Use of penetration limit	No
Magnification	10x
Assessment	Results at a 9 Nm impact
Requirement	No cracking or bond loss except at the area permanently deformed by the head
Test date	27-8-2024
Laboratory technician	RB

5 Results

5.1 Dry film thickness

M2LAB ID	Customer ID	Sample #	Dry Film Thickness (µm)			
			min	max	Average	std
K240167-1	Lot # 2018C00214 D19.1, L0.25 MTR Coated	1	375	477	404	31
K240167-2		2	307	440	392	35
K240167-3		3	260	443	363	58
K240167-4		4	313	433	365	35
K240167-5		5	240	387	328	42
K240167-6		6	273	410	343	41
K240167-7		7	283	427	368	42
K240167-8		8	300	393	353	30
K240167-9		9	300	447	368	41
K240167-10		10	197	467	288	86
K240167-11		11	207	350	264	51
K240167-12		12	183	393	302	75
K240167-13		13	180	467	370	88
K240167-14		14	253	400	319	49
K240167-15		15	327	419	379	26
K240167-16		16	283	390	323	37
K240167-17		17	230	380	291	48
K240167-18	Coated panels 100 x 100 mm	18	259	318	292	27
K240167-19		19	249	329	292	29
K240167-20		20	262	344	299	31
K240167-21	Free Film	1-1	211	229	217	7
		1-2	224	237	229	5
K240167-23	Lot # 2018C00214 D19.1, L1.2 MTR Coated	1	373	440	399	20
K240167-25		3	307	440	392	35
K240167-29		7	260	443	361	56
K240167-30		8	313	433	365	35
K240167-31		9	240	387	328	42
K240167-40		18	273	410	343	41

Remark: Due to the shape of the substrate the measurements on the rebar show large variations

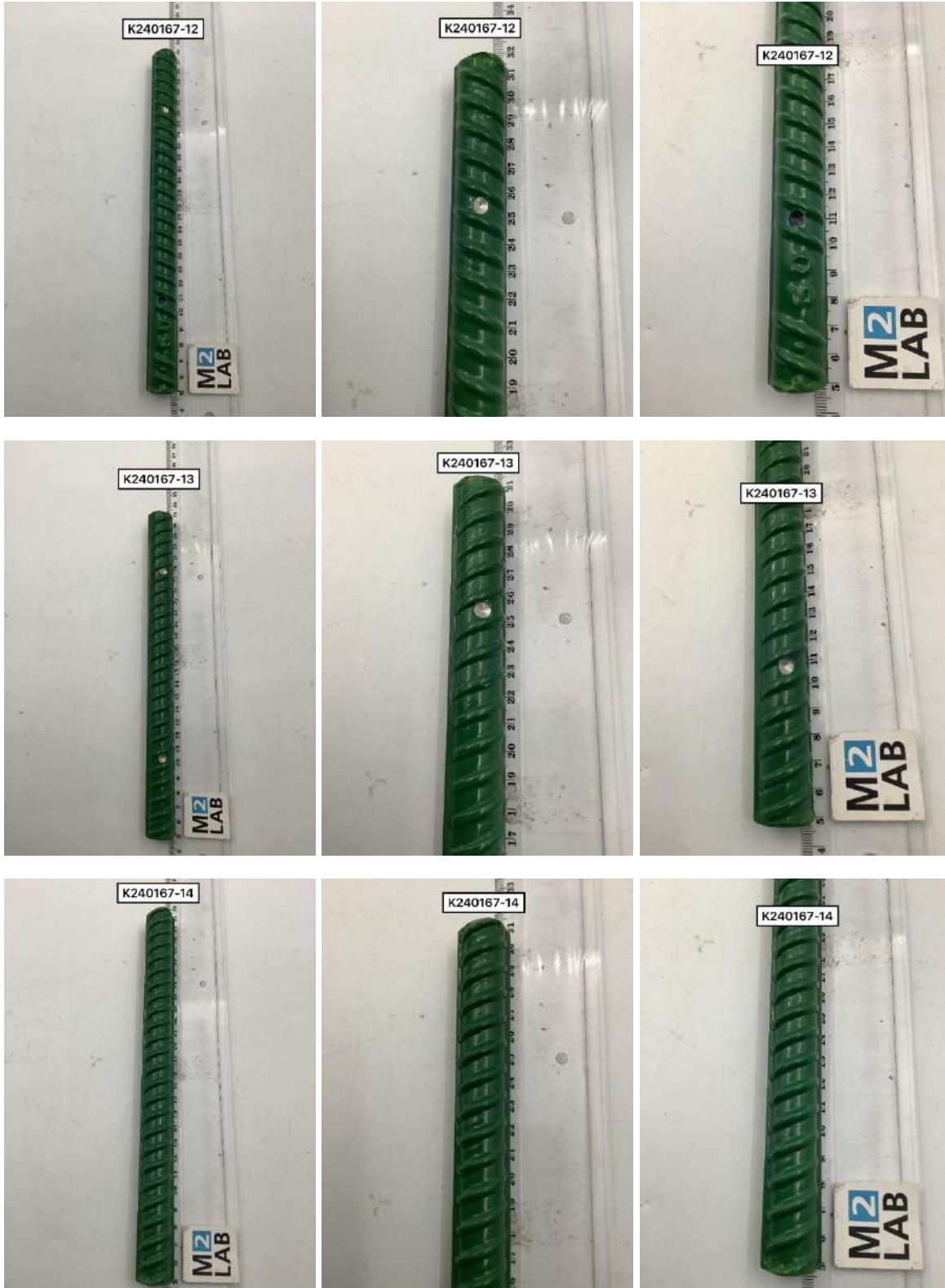
5.2 Reference Infrared

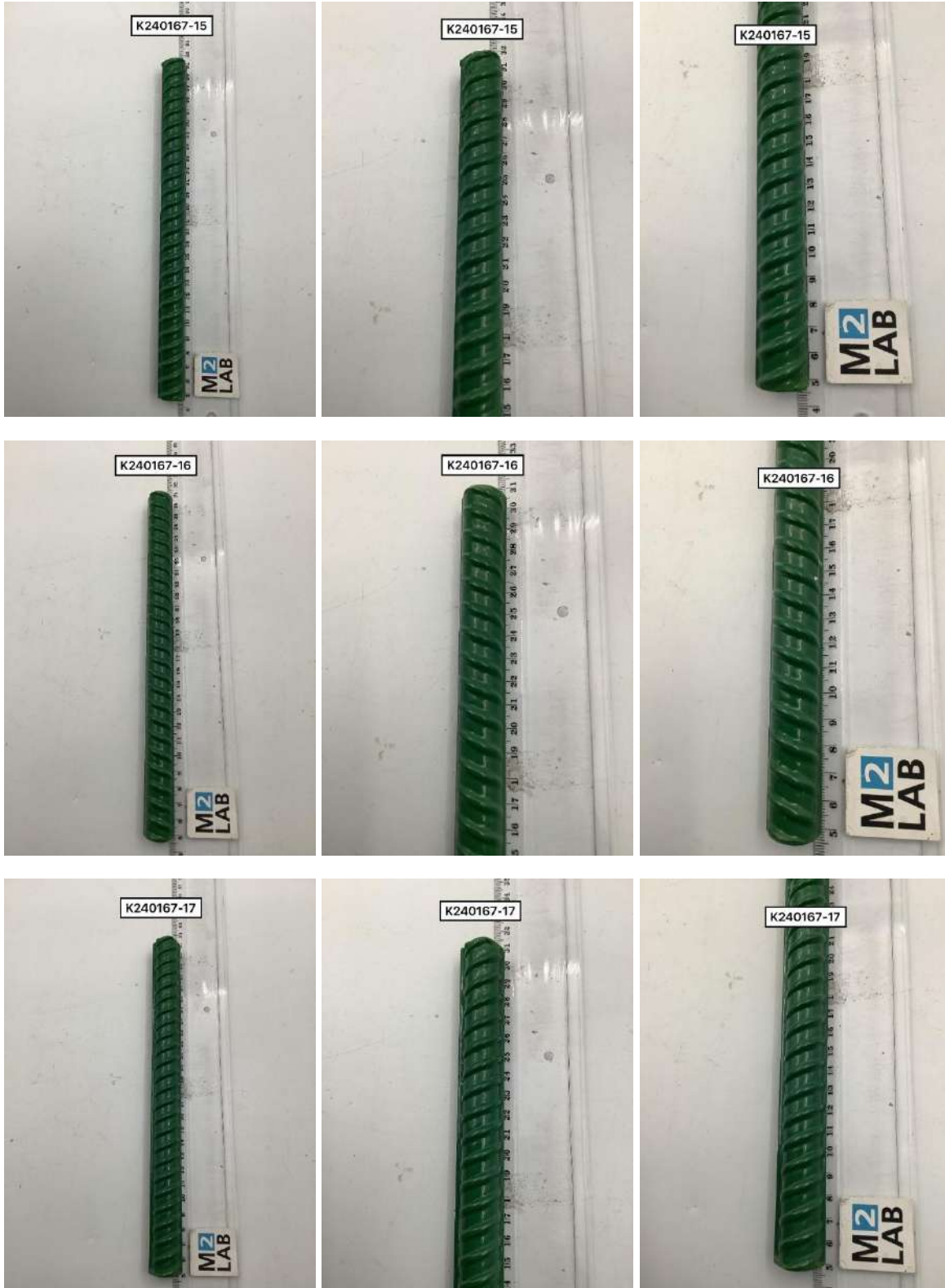
See Annex 2

5.3 Chemical Resistance

M2LAB-ID	Solution	Blistering	Softening	Loosening	Unintentional holidays	Undercutting of intentional holiday
K240167-10	Deionized water	None	None	None	None	None
K240167-11	Calcium Chloride 3M	None	None	None	None	None
K240167-12	Sodium Hydroxide 3M	None	None	None	None	None
K240167-13	Calcium Hydroxide saturated	None	None	None	None	None
K240167-14	Deionized water	None	None	None	None	N.a.
K240167-15	Calcium Chloride 3M	None	None	None	None	N.a.
K240167-16	Sodium Hydroxide 3M	None	None	None	None	N.a.
K240167-17	Calcium Hydroxide saturated	None	None	None	None	N.a.







5.4 Cathodic disbondment

M2LAB ID	Measured angle in degrees				avg. Sample (mm)	avg. all samples (mm)
	0	90	180	270		
K240167-1	2,7	5,9	2,5	5,9	4,3	4
K240167-2	2,3	4,4	1,7	5,9	3,6	
K240167-3	4,9	6,4	2,4	5,4	4,8	



Complete sample after Cathodic disbondment



Details disbonded area

5.5 Neutral salt spray test

M2LAB ID	Measured angle in degrees				avg. Sample (mm)	avg. all samples (mm)
	0	90	180	270		
K240167-4	2,6	3,2	1,8	2,1	2,4	3
	1,7	4,6	2,6	2,7	2,9	
	2,7	2,7	1,4	2,8	2,4	
K240167-5	2,4	2,8	1,4	2,7	2,3	
	2,7	3,5	2,3	5,3	3,5	
	0,6	2,3	1,3	1,9	1,5	
K240167-6	1,9	2,4	4,2	5,2	3,4	
	2,3	1,0	2,2	4,6	2,5	
	0,3	3,9	3,4	4,2	2,9	



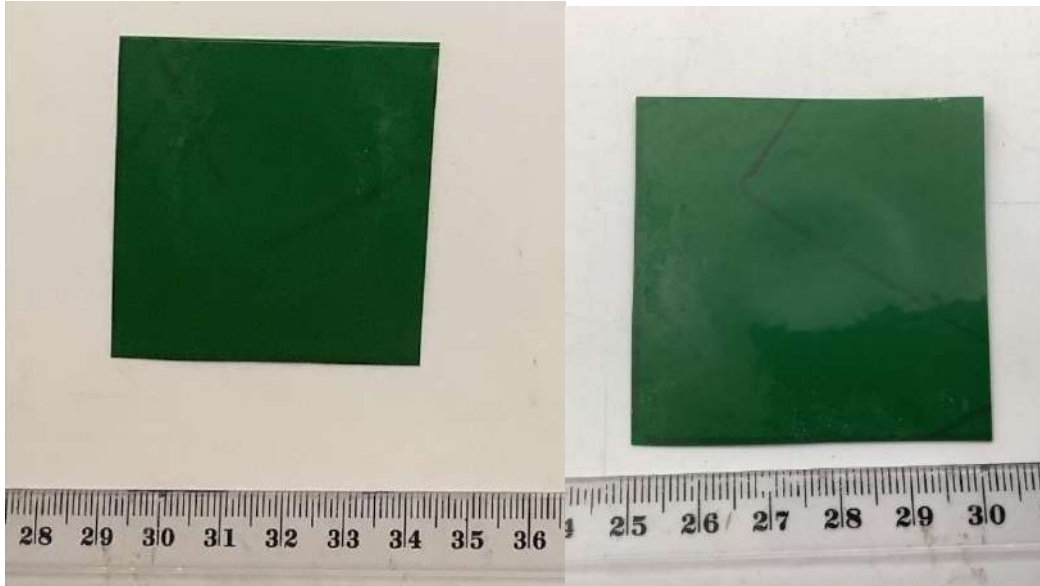
Samples direct from the test



Samples after evaluation

5.6 Chloride permeability

M2LAB ID	Run	Dry film thickness (μm)	Result (Mol/L)	Average (Mol/L)
K240167-22	1	217±7	$2,53 \cdot 10^{-6}$	$2,96 \cdot 10^{-6}$
	2	232±4	$3,38 \cdot 10^{-6}$	



Free Film Run 1

5.7 Coating Flexibility

M2LAB ID	Customer ID	Results after 180° bend
K240167-23	Sample # 1	No defects
K240167-25	Sample # 3	No defects
K240167-29	Sample # 7	No defects



5.8 Relative Bond Strength in Concrete

M2LAB ID	Customer ID	Bar type	Max. pull strength (kN)	Mean pull strength (kN)	% coated pull strength of uncoated pull strength
K240167-44	Sample # 4	Uncoated	113,2	107,7**	85,5%
K240167-45	Sample # 5		86,6*		
K240167-46	Sample # 6		102,2		
K240167-30	Sample # 8	Coated	90,0	92,0	
K240167-31	Sample # 9		90,7		
K240167-40	Sample # 18		95,4		

*rupture within 180 seconds

** calculated mean without the second trial



Sample after pull test



Sample after pull test

5.9 Abrasion resistance

M2LAB ID	weight		weightloss (g)	weightloss/1000 cycles (mg)	avg weightloss/1000 cycles (mg)	std
	start	1000	1000	1000		
K240167-18	32,0619	32,0342	0,0277	28	28	1
K240167-19	32,0372	32,0108	0,0264	26		
K240167-20	31,9172	31,8880	0,0292	29		



5.10 Impact test

No cracking or bond loss except at the area permanently deformed by the head.



Tested samples after impact

Detail of impact area

6 Summary

Test method	Requirement	Result	Pass/Fail
Dry film Thickness (8.1)	Average measurement: >175 µm < 400 µm Individual recorded measurement: Min. >140 µm Max. <480 µm	All average measurements of the tested samples are >175 µm and <400 µm No Individual recorded measurement <140 and >480 µm	Pass
Infrared scan (A1.3.1)	n.a.	n.a.	n.a.
Chemical Resistance (A1.3.2)	The coating shall not blister, soften, lose bond, nor develop holidays during the test period. There shall be no undercutting surrounding the intentionally holidays.	The coating did not blister, soften, lose bond, nor develop holidays during the test period. There has been no undercutting surrounding the intentionally holidays.	Pass
Cathodic Disbondment (A1.3.3)	Average of three samples ≤ 4 mm	4 mm	Pass
Salt Spray Resistance (A1.3.4)	Average all nine sites ≤ 3 mm	3 mm	Pass
Chloride Permeability (A1.3.5)	< 1 x 10 ⁻⁴ M	2,96.10 ⁻⁶	Pass
Coating Flexibility (A1.3.6)	No cracking visible with normal corrected vision	No cracking visible with normal corrected vision	Pass
Relative Bond Strength in Concrete (A1.3.7)	Mean bond strength shall not be less than 85% of the bond strength of the uncoated bars	85,5%	Pass
Abrasion Resistance (A1.3.8)	≤ 100 mg/ 1000 cycles	28 mg/1000 cycles	Pass
Impact Test (A1.3.9)	No cracking or bond loss except at the area permanently deformed by the head.	No cracking or bond loss except at the area permanently deformed by the head.	Pass

7 Conclusion

The tested samples with M2LAB ID 240167 meet the requirements of ASTM A775/A775M-2022 Annex A1

M2LAB BV



Stefan Vermeer
Laboratory technician

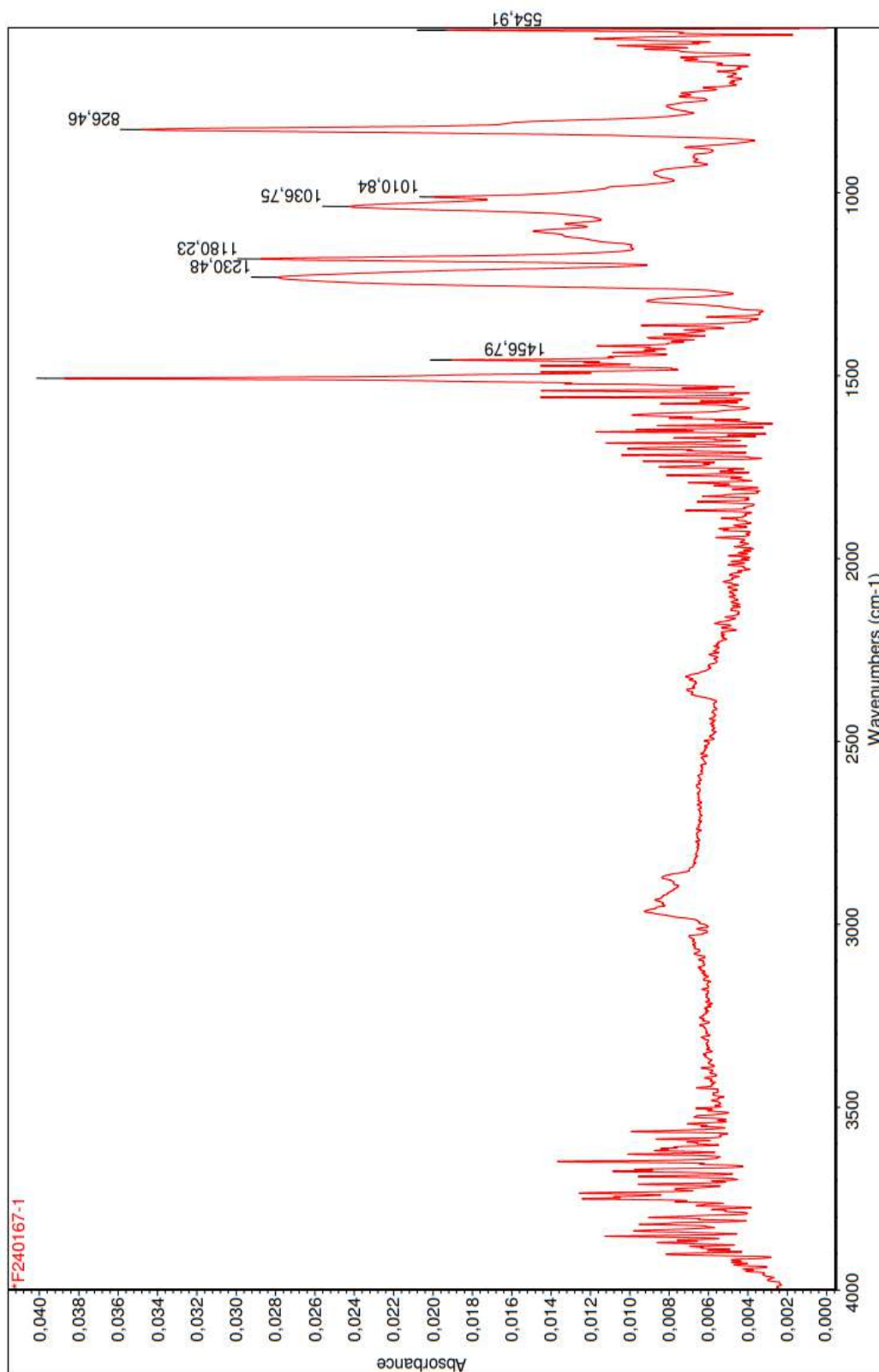


Rob Brakenhoff
Laboratory manager

Annex 1

Powder Coating Application Form		
Project name	Third party testing Jotaguard RB 4003 (Rebar) according to ASTM A775	
System number	-	
Substrate Data		
Substrate used	Reinforcement bars with different diameters	
Surface preparation	Grit blasting	
Blasting standard	Sa 2½	
Abrasive used	Steel Grit GL 25 and GL 40 @ 3:1 ratio	
Roughness	Profile up to 70 µm	
Pre-treatment	-	
Application data	1st Coat	2nd Coat
Powder product	Jotaguard RB 4003 - (1002693)	
Powder manufacturer	Jotun powder Coatings KSA	
Batch number	3397456	
Application date	08.05.2024	
Equipment used	Electrostatic spray guns	
Preheating temperature	239°C	
Preheating time	-	
Curing temperature	239°C	
Curing time	-	
Quenching media	Water	
Quenching temperature	-	
Quenching time	-	
Dry film thickness (6 points)	7.6 to 11.4 mils	
Comments: DFT (6 points) Mean average DFT = 9.5 mils		

Annex 2



8 Liability

M2LAB BV is an independent test laboratory, specialised in inspection of materials and member of NVVT (Dutch Association of Paint Technicians) and NRK (Dutch Plastics- and Rubber Industries).

M2LAB BV hereby declares to have no financial or legal interests in the outcome of the executed inspection.

The operational work has been performed with the greatest possible degree of care which also sought to maximize representativeness of the study. Observations are in many cases snapshots, making certain derogations or details might not have been noticed with the result that the conclusions of the inspection are not complete.

No part of this publication may be reproduced and/or published without written consent of M2LAB BV.

Sharing the complete report by the client for inspection to parties who have a direct interest is permitted.

M2LAB BV is not responsible for the sampling

M2LAB BV is responsible for all content in this report, except for information delivered by the client. Information from the client can influence the validity of the test results.

All results in this report are only applicable for the tested samples as received by M2LAB BV.

Amendment in report:

All amendments have been marked in the border

Rev. number

1 Amendment on request of: Customer

Amendment: added "Tested on steel reinforcing bars produced by Qatar steel (Q-Coat)." on title page