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Central Laboratory – Testing Department Brno
Hněvkovského 77, 617 00 Brno
tel.: +420 734 432 093, e-mail: zadelak@tzus.cz, www.tzus.eu
L 1018.3

TEST REPORT

issued by Testing Laboratory No. 1018.3
accredited pursuant to ČSN EN ISO/IEC 17025:2018 by Czech Accreditation Institute

č. 060-050374

On test of tensile strength, elastic modulus, elongation, alkali resistance, determination of nominal diameter, fibre content, shear strength, tensile fatigue and bond strength by pull-out testing

Ordering Party:	GALEN LLC
Address:	52 K. Marks street, Cheboksary, Chuvash Republic, Russia 428 000
Company ID:	212 731 8197
Manufacturer:	GALEN LLC 52 K. Marks street, Cheboksary, Chuvash Republic, Russia 428 000
Test sample:	ROCKBAR- Reinforcement bars based on glass fibre bonded by epoxy resin of declared diameter 6 mm
Order No.:	Z060190228

Number of pages incl. title page: 9 Pages of annexes: -

Prepared by:

Adéla Válková
Test Technician - Specialist

Approved by:

Ing. Martin Zadělák
Head of the Testing Department

Print No.:
Number of prints: 2

Brno, 24 April 2020

Declaration: 1) The test results in this Report relate only to the tested article and they do not substitute any other documents
2) The Test Report must be copied as a whole only otherwise a written consent of the testing laboratory is needed.

1. Samples data

Sample No.:	VZ060200013
Sample:	ROCKBAR- Reinforcement bars based on glass fibre bonded by epoxy resin of declared diameter 6 mm
Date of delivery:	14.1.2020
Taken over by:	Ing. Marek Sopko

The test results relate to the sample as received.

2. Test methods

Determination of the tensile strength	ISO 10406-1:2015 cl. 6	Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids
Determination of alkali resistance	ISO 10406-1:2015 cl. 11	Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids
Determination of tensile fatigue	ISO 10406-1:2015 cl. 10	Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids
Determination of nominal diameter	ISO 10406-1:2015 cl. 5	Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids
Determination of the glass fibre content	ČSN EN ISO 1172: 1999	Textile-glass-reinforced plastics - Prepregs, moulding compounds and laminates - Determination of the textile-glass and mineral-filler content - Calcination methods
Determination of shear strength	ISO 10406-1:2015 cl. 13	Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids
Determination of elongation	ČSN EN ISO 6259-1:2015	Thermoplastic pipes: Determination of tensile properties - Part 1: General test method [+])
Determination of compressive strength	ČSN EN 12390-3: 2020	Testing hardened concrete – Part 3: Compressive strength of test specimens
Determination of bond strength by pull-out testing	ISO 10406-1:2015 cl. 7	Fibre-reinforced polymer (FRP) reinforcement of concrete - Test methods - Part 1: FRP bars and grids

Deviations from a standard procedure or the use of non-standardized methods: were not applied.
[+]) Not subject of accreditation according to EN ISO/IEC 17025

3. Test results

Tests were carried out on:	20.1.2020 – 24.4.2020
Tests were carried out by:	Adéla Válková
Place:	Test laboratory Brno

Data on the person who performed the test, test conditions and equipment used are listed in the Test Minutes. Apparatuses and measuring instruments that used have been certified pursuant to a valid plan of the Testing.

3.1. Determination of nominal diameter according to ISO 10406-1:2015, cl. 5

Sample No.	Length [mm]	Volume [mm^3]	D [mm]
1	99,07	3500	6,71
2	101,90	3500	6,61
3	100,79	3500	6,65
Average	**100,59**	**3500**	**6,66**

3.2. Determination of glass fibre content according to ČSN EN ISO 1172:1999

Determination at 625 °C	1.	2.	3.	Average
Glass fibre content [% hm.]	85,75	85,54	85,62	**85,64**

3.3. Determination of shear strength according to ISO 10406-1:2015, cl. 13

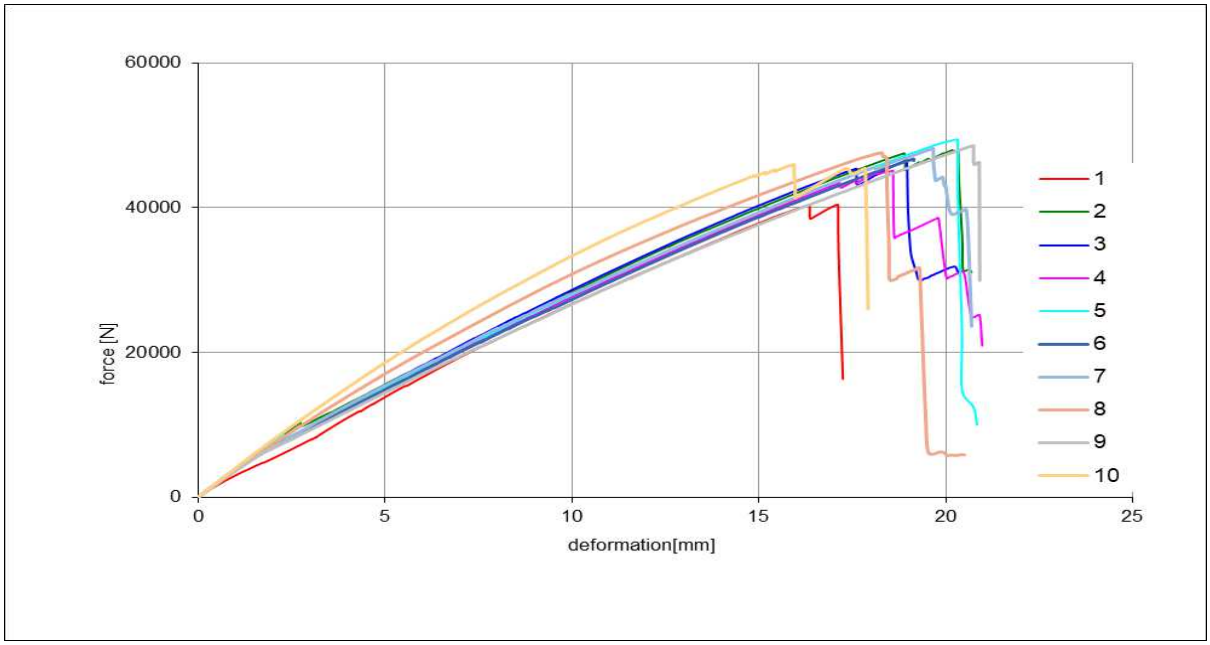
The test was performed at temperature 20 °C.
Nominal diameter 6,66 mm, nominal cross-sectional area of the test specimens is 34,82 mm²

Sample No.	Shear strength at rupture [N]	Shear strength [N/mm^2]
1	19 487	279,82
2	21 254	305,20
3	22 565	324,03
4	20 288	291,32
5	22 995	330,19
Average	**21 318**	**306,11**

3.4. Determination of tensile strength according to ISO 10406-1:2015, cl. 6

Nominal diameter 6,66 mm, nominal cross-sectional area of the test specimens is 34,82 mm²

Sample No.	Maximum force F_u [kN]	Tensile strength f_u [MPa]	Average tensile strength $f_{u\,m}$ [MPa]	Standard deviation S [MPa]	Characteristic value of the tensile strength $f_{u\,c}$ [MPa]
1	40,4	1160	1339	69,3	1205
2	48,0	1378			
3	46,5	1335			
4	45,1	1295			
5	49,4	1418			
6	46,7	1341			
7	48,2	1384			
8	47,6	1366			
9	48,6	1395			
10	46,0	1320			



Graph of sample deformation versus force

3.5. Determination of tensile rigidity according to ISO 10406-1:2015, cl. 6.4.4

Nominal diameter 6,66 mm, nominal cross-sectional area of the test specimens is 34,82 mm²

Sample No.	Tensile rigidity E_A [kN]	Average value of tensile rigidity $E_{A\,m}$ [kN]	Standard deviation S [kN]
1	1582	1551	64,0
2	1640		
3	1506		
4	1577		
5	1577		
6	1520		
7	1593		
8	1549		
9	1562		
10	1404		

3.6. Determination of Young's modulus of elasticity according to ISO 10406-1:2015, cl. 6.4.4

Nominal diameter 6,66 mm, nominal cross-sectional area of the test specimens is 34,82 mm²

Sample No.	The modulus of elasticity E [GPa]	Average value of the modulus of elasticity E_m [GPa]	Standard deviation S [GPa]
1	45,4	44,5	1,7
2	47,1		
3	43,2		
4	45,3		
5	45,3		
6	43,6		
7	45,7		
8	44,5		
9	44,8		
10	40,3		

3.7. Determination of elongation according to ČSN EN ISO 6259-1:2015, cl. 10.2

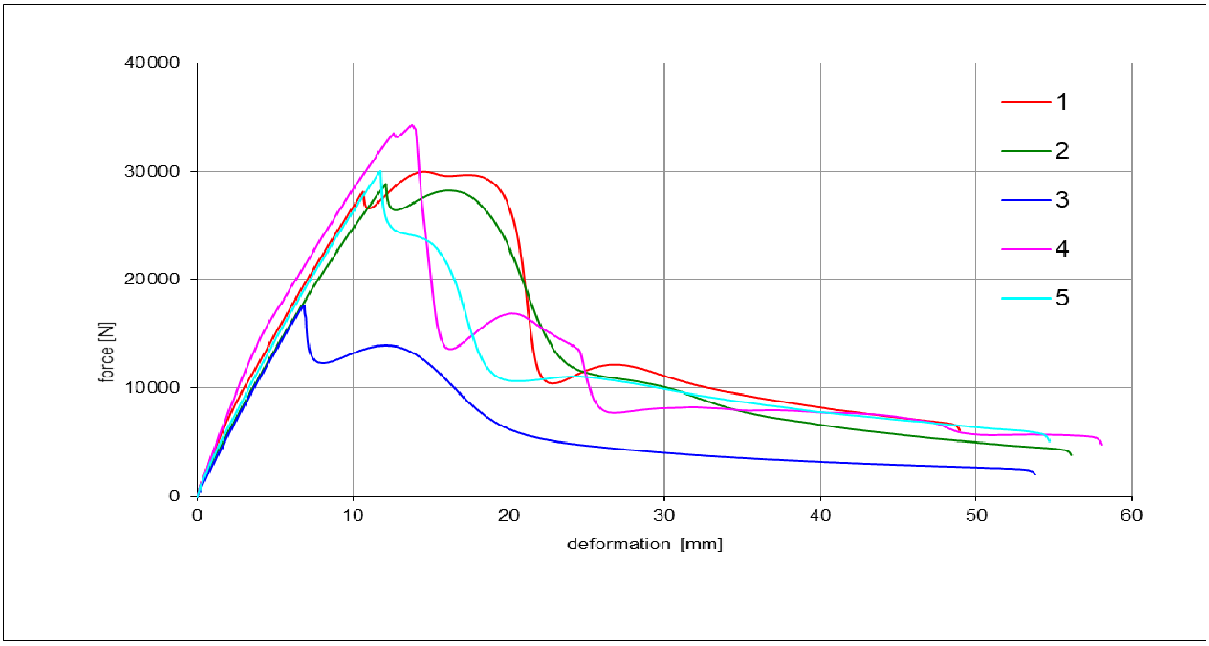
The elongation εb was determined at maximum force was reached.

Sample No.	Elongation ε_b [%]	Average value of elongation $\varepsilon_{b\,m}$ [%]	Standard deviation S [%]
1	3,22	3,21	0,13
2	3,16		
3	3,39		
4	3,21		
5	3,16		
6	3,11		
7	3,12		
8	3,08		
9	3,18		
10	3,48		

3.8. Determination of alkali resistance, ISO 10406-1:2015 cl.11

Nominal diameter 6,66 mm, nominal cross-sectional area of the test specimens is 34,82 mm²

Sample No.	Maximum force F_u [kN]	Tensile strength f_u [MPa]	Average tensile strength $f_{u\,m}$ [MPa]	Standard deviation S [MPa]	Characteristic value of the tensile strength $f_{u\,c}$ [MPa]
1	30,0	861	808	178,4	389
2	28,8	827			
3	17,7	508			
4	34,3	985			
5	30,0	861			



Graph of sample deformation versus force

3.9. Determination of tensile rigidity according to ISO 10406-1:2015, cl. 6.4.4 after alkali

Nominal diameter 6,66 mm, nominal cross-sectional area of the test specimens is 34,82 mm²

Sample No.	Tensile rigidity E_A [kN]	Average value of tensile rigidity $E_{A\,m}$ [kN]	Standard deviation S [kN]
1	1453	1571	195
2	1599		
3	1834		
4	1320		
5	1647		

3.10. Determination of Young's modulus of elasticity according to ISO 10406-1:2015, cl. 6.4.4 after alkali

Nominal diameter 6,66 mm, nominal cross-sectional area of the test specimens is 34,82 mm²

Sample No.	The modulus of elasticity E [GPa]	Average value of the modulus of elasticity E_m [GPa]	Standard deviation S [GPa]
1	41,7	45,1	5,6
2	45,9		
3	52,7		
4	37,9		
5	47,3		

3.11. Determination of elongation according to ČSN EN ISO 6259-1:2015, cl. 10.2 after alkali

The elongation εb was determined at maximum force was reached.

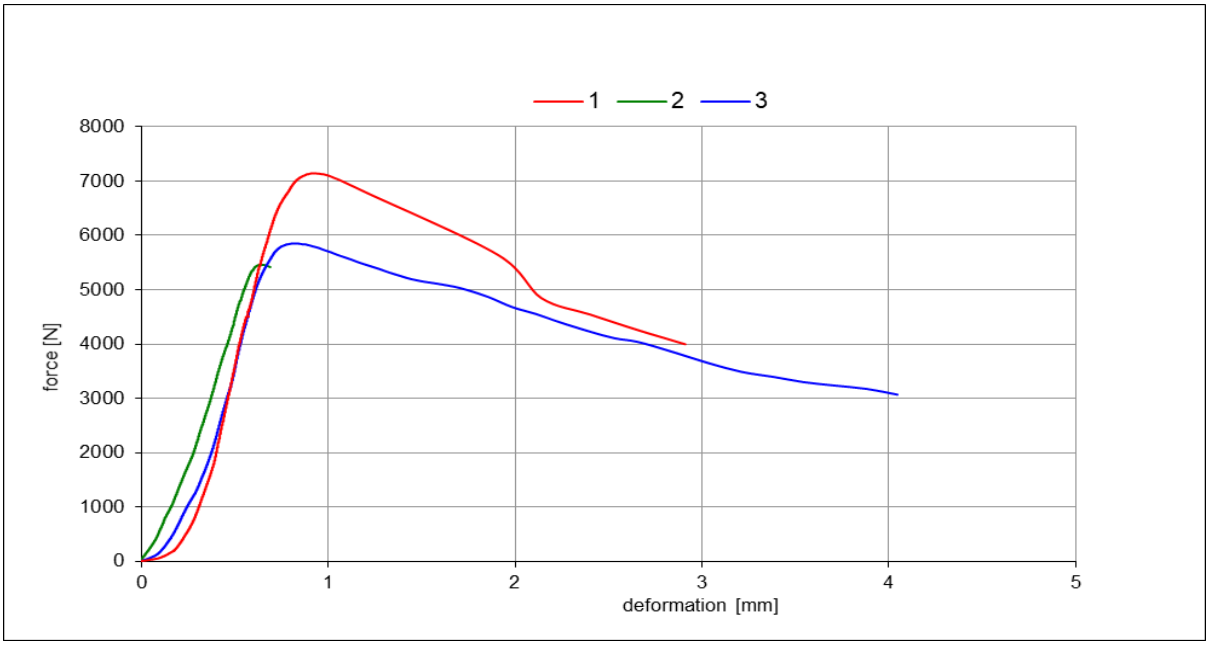
Sample No.	Elongation ε_b [%]	Average value of elongation $\varepsilon_{b\,m}$ [%]	Standard deviation S [%]
1	2,10	1,72	0,58
2	1,75		
3	0,96		
4	2,53		
5	1,77		

3.12. Determination of compressive strength according to ČSN EN 12390-3: 2020

Sample No.	**Date production / Date of testing**	**Sample weight [kg]**	**Dimensions [mm]**			**Density [kg·m^{-3}]**	**Force F [kN]**	**Compressive strength f_c [MPa]**
			lenght	width	height			
1	16.3.2020	7,655	149,8	150,1	150,1	2270	688,3	**30,3**
2	-	7,721	148,9	150,2	150,1	2300	691,9	**30,9**
3	13.4.2020	7,603	149,7	150,0	149,9	2290	682,0	**30,4**
Average	–					**2287**	–	**30,5**

3.13. Determination of bond strength by pull-out testing according to ISO 10406-1:2015 cl. 7

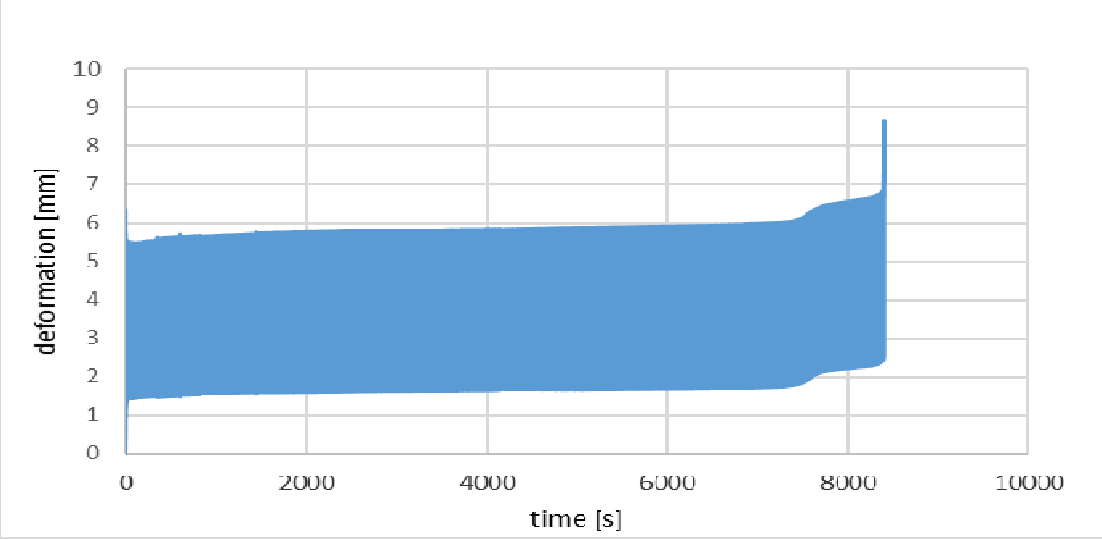
Sample No.	**Maximum force [N]**	**Bonded length [mm]**	**Nominal peripheral length [mm]**	**Pull out displacement of bar [mm]**	**Bond strength by pull-out testing [N/mm^2]**
1	7144	26,64	20,91	0,92	12,82
2	5462			0,63	9,80
3	5853			0,84	10,51
Average	6153	-	-	-	11,04



3.14. Determination of tensile fatigue according to ISO 10406-1:2015, cl. 10

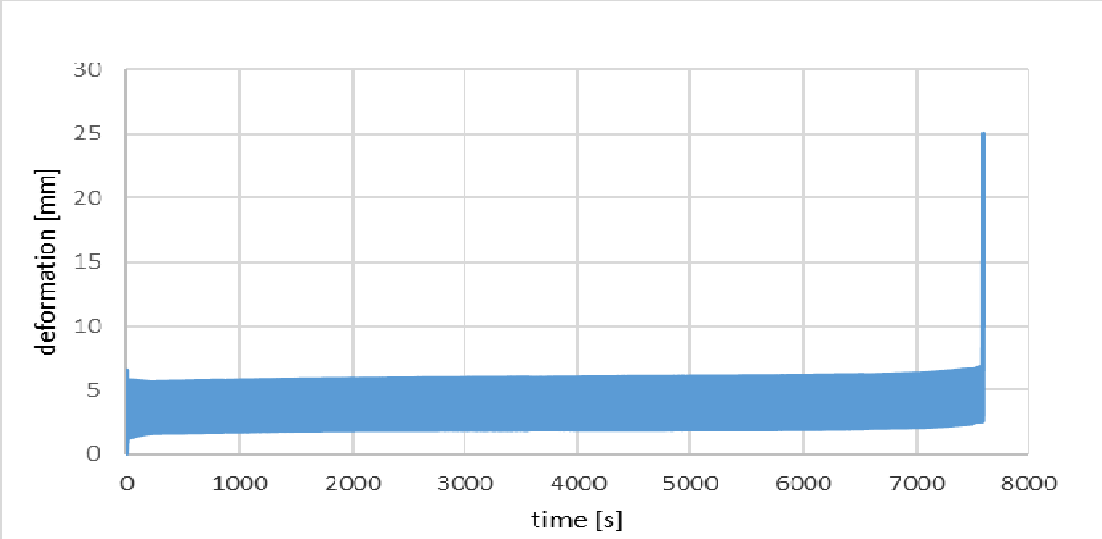
3.14.1. Sample no. 1

Range of minimum and maximum load cycle: 4-18 kN
Cycle frequency: 0,4 Hz
Maximum number of cycles: 4199
Method of failure: failure of reinforcement fibers



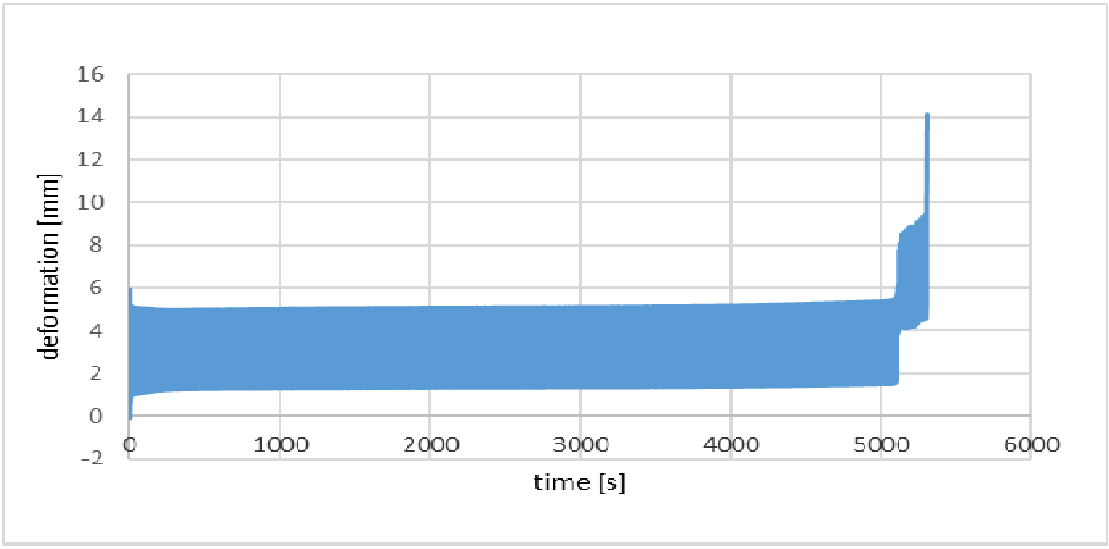
3.14.2. Sample no. 2

Range of minimum and maximum load cycle: 4-18 kN
Cycle frequency: 0,4 Hz
Maximum number of cycles: 3799
Method of failure: failure of reinforcement fibers



3.14.3. Sample no. 3

Range of minimum and maximum load cycle: 4-18 kN
Cycle frequency: 0,4 Hz
Maximum number of cycles: 2656
Method of failure: failure of reinforcement fibers



END OF THE TEST REPORT