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DECLARATION OF PERFORMANCE No. 0484

1. Unique identification code of the product-type: **GeoSteel FRM**

   (Rinforzo ARV100 and Geocalce F Antisismico)

2. Intended use/es: **The FRM kit is suitable for strengthening and seismic upgrade of clay, tuff and natural stone masonry elements and structures.**

3. Manufacturer: **Kerakoll S.p.A Via dell'Artigianato, 9 - 41049 Sassuolo (MO) Italia**

4. System/s of AVCP: **System 2+**

5. European Assessment Document: **EAD 340275-00-0104, January 2018**

   European Technical Assessment **: ETA-19/0326 of 13/07/2022**

   Technical Assessment Body: **ITC CNR**

   Notified body/ies: **ITC n°0970**

6. Declared performance/s:

   - Characteristic value for tensile streght and tensile strain
   - Average value for modulus of elasticity

Essential characteristics	**Performance**
Reaction to fire	Class A1
Rinforzo ARV100 – Geocalce F Antisismico	See Annex A

The performance of the product identified above is in conformity with the set of declared performance/s. This declaration of performance is issued, in accordance with Regulation (EU) No 305/2011, under the sole responsibility of the manufacturer identified above.

Signed for and on behalf of the manufacturer by: **Romano Sghedoni (legal representative)**

At Sassuolo, on 29/07/2022

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Annex A – Rinforzo ARV100-Geocalce F Antisismico

Essential characteristics				Performance	
				Average value	Characteristic value
Tensile strength (σ_u)	WEFT			1021 MPa	865 MPa
	WARP			1132 MPa	936 MPa
Strain (ε_u)	WEFT			1,11 %	0,49 %
	WARP			0,77 %	0,08 %
Stress-strain curve (E)	WEFT	Elastic modulus of stage A		3782 GPa	2752 GPa
		Stiffness modulus in stage C		75 GPa	47 GPa
	WARP	Elastic modulus of stage A		5548 GPa	4194 GPa
		Stiffness modulus in stage C		115 GPa	78 GPa
Interlaminar shear strength (τ)	WEFT			0.85 MPa	0.62 MPa
	WARP			0.83 MPa	0.70 MPa
Lap tensile strength (σ_{lap})	Tested Overlap length l_{lap} =300 mm		WEFT	934 MPa	826 MPa
			WARP	1069 MPa	974 MPa
Bond strength on substrate CLAY: pull-off test	Ambient			1.45 MPa	-
	Water	1000 h		1.63 MPa	-
		3000 h		1.43 MPa	-
	saltwater	1000 h		1.30 MPa	-
		3000 h		1.44 MPa	-
	alkali	1000 h		1.50 MPa	-
		3000 h		1.50 MPa	-
Bond strength on substrate TUFF: pull-off test	Ambient			0.32 MPa	-
	Water	1000 h		0.49 MPa	-
		3000 h		0.40 MPa	-
	saltwater	1000 h		0.37 MPa	-
		3000 h		0.38 MPa	-
	alkali	1000 h		0.40 MPa	-
		3000 h		0.43 MPa	-

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Essential characteristics			Performance	
			Average value	Characteristic value
Bond strength on substrate CLAY: single-lap shear test (failure mode FR)	ambient WARP		P_{max} 2154 N P_{deb} - (1) $\sigma_{lim,conv}$ 1158 MPa	P_{max} 1809 N P_{deb} - (1) $\sigma_{lim,conv}$ 972 MPa
	Water	1000 h	2187 N	-
		3000 h	1725 N	-
	saltwater	1000 h	1828 N	-
		3000 h	1907 N	-
	alkali	1000 h	1824 N	-
		3000 h	2080 N	-
Bond strength on substrate TUFF: single-lap shear test (failure mode FR)	ambient WARP		P_{max} 2098 N P_{deb} - (1) $\sigma_{lim,conv}$ 1128 MPa	P_{max} 1923 N P_{deb} - (1) $\sigma_{lim,conv}$ 1034 MPa
	Water	1000 h	1865 N	-
		3000 h	1834 N	-
	saltwater	1000 h	1951 N	-
		3000 h	1918 N	-
	alkali	1000 h	2263 N	-
		3000 h	1950 N	-
Bond strength on substrate NATURAL STONE: single-lap shear test (failure mode FR)	Ambient WARP		P_{max} 2372 N P_{deb} - (1) $\sigma_{lim,conv}$ 1275 MPa	P_{max} 1956 N P_{deb} - (1) $\sigma_{lim,conv}$ 1051 MPa
	Water,saltwater and alkali conditioning		NPA	-
Pull out from substrate			NPA	-

			Average value	Characteristic value
Freezing and Thawing (WARP)	Direct tension	Tensile strength $\sigma_{u,FT}$	1137 MPa	952 MPa
		Strain $\varepsilon_{u,FT}$	0.77 %	0,15 %
		Stiffness moduli E_{1FT}	NPA	NPA
		Stiffness moduli E_{3FT}	117 GPa	68 GPa
		Inter. shear strength (τ_{FT})	0.89 MPa	0.61 MPa
	Retained properties	Tensile strength $\sigma_{u,FT,ret}$	100 %	-
		Stiffness moduli $E_{1FT,ret;}$	NPA	
		Stiffness moduli $E_{3\ FT,ret}$	102 %	
		Inter. shear strength ($\tau_{FT\ ret}$)	107 %	

(1) **Rupture of fibres was observed outside the bonded length, therefore no value for the bond capacity is indicated**

Essential characteristics		Performance	Average value	Characteristic value
Water resistance (WARP)	Direct tension (1000 h)	Tensile strength $\sigma_{u,w}$ Strain $\varepsilon_{u,w}$ Stiffness modulus E_{1w} Stiffness modulus $E_{3\,w}$ Inter. shear strength (τ_w) Lap tensile ($\sigma_{lap\,w}$)	1069 MPa 0,73 % NPA 132 GPa 1.04 MPa NPA	884 MPa - (2) NPA 54 GPa 0.79 MPa NPA
	Direct tension (3000 h)	Tensile strength $\sigma_{u,w}$ Strain $\varepsilon_{u,w}$ Stiffness modulus E_{1w} Stiffness modulus $E_{3\,w}$ Inter. shear strength (τ_w) Lap tensile ($\sigma_{lap\,w}$)	1049 MPa 0,71 % NPA 160 GPa 1.81 MPa NPA	841 MPa - (2) NPA 93 GPa 1.25 MPa NPA
	Retained properties (1000 h)	Tensile strength $\sigma_{u,\,w,ret}$ Stiffness moduli $E_{1\,w,ret;}$ Stiffness moduli $E_{3\,w,ret}$ Inter. shear strength ($\tau_{w\,ret}$) Lap tensile ($\sigma_{lap\,w\,ret}$)	94% NPA 115 % 126 % NPA	-
	Retained properties (3000 h)	Tensile strength $\sigma_{u,\,w,ret}$ Stiffness moduli $E_{1\,w,ret;}$ Stiffness moduli $E_{3\,w,ret}$ Inter. shear strength ($\tau_{w\,ret}$) Lap tensile ($\sigma_{lap\,w\,ret}$)	93 % NPA 139 % 218 % NPA	-
Saltwater resistance (WARP)	Direct tension (1000 h)	Tensile strength $\sigma_{u,sw}$ Strain $\varepsilon_{u,\,sw}$ Stiffness moduli $E_{1\,sw}$ Stiffness moduli $E_{3\,sw}$ Inter. shear strength (τ_{sw})	1492 MPa 0,79 % NPA 147 GPa 0.96 MPa	899 MPa - (2) NPA 46 GPa 0.82 MPa
	Direct tension (3000 h)	Tensile strength $\sigma_{u,sw}$ Strain $\varepsilon_{u,\,sw}$ Stiffness moduli $E_{1\,sw}$ Stiffness moduli $E_{3\,sw}$ Inter. shear strength (τ_{sw})	1029 MPa 0,83 % NPA 116 GPa 1.04 MPa	887 MPa - (2) NPA 72 GPa 0.79 MPa
	Retained properties (1000 h)	Tensile strength $\sigma_{u,\,w,ret}$ Stiffness moduli $E_{1\,w,ret}$ Stiffness moduli $E_{3\,w,ret}$ Inter. shear strength ($\tau_{sw\,ret}$)	132 % NPA 128 % 116 %	-
	Retained properties (3000 h)	Tensile strength $\sigma_{u,\,sw,ret}$ Stiffness moduli $E_{1\,sw,ret}$ Stiffness moduli $E_{3\,sw,ret}$ Inter. shear strength ($\tau_{sw\,ret}$)	91 % NPA 102 % 125 %	-

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Essential characteristics			Performance		
				Average value	Characteristic value
Alkali resistance (WARP)	Direct tension (1000 h)		Tensile strength $\sigma_{u, alk}$	1114 MPa	888 MPa
			Strain $\varepsilon_{u, alk}$	0.72 %	0,26 %
			Stiffness moduli $E_{1\ alk}$	NPA	NPA
			Stiffness moduli $E_{3\ alk}$	131 GPa	81 GPa
			Inter. shear strength (τ_{alk})	0.97 MPa	0.75 MPa
	Direct tension (3000 h)		Tensile strength $\sigma_{u, alk}$	981 MPa	828 MPa
			Strain $\varepsilon_{u, alk}$	0.68 %	0,16 %
			Stiffness moduli $E_{1\ alk}$	NPA	NPA
			Stiffness moduli $E_{3\ alk}$	112 GPa	57 GPa
			Inter. shear strength (τ_{alk})	1.05 MPa	0.73 MPa
	Retained properties (1000 h)		Tensile strength $\sigma_{u, alk,ret}$	98 %	-
			Stiffness moduli $E_{1\ alk,ret}$	NPA	
			Stiffness moduli $E_{3\ alk,ret}$	114 %	
			Inter. shear strength ($\tau_{alk\ ret}$)	117 %	
	Retained properties (3000 h)		Tensile strength $\sigma_{u, alk,ret}$	87 %	-
			Stiffness moduli $E_{1\ alk,ret;}$	NPA	
			Stiffness moduli $E_{3\ alk,ret}$	98 %	
			Inter. shear strength ($\tau_{alk\ ret}$)	127 %	
	Lap Tensile		NPA		
Alkali soil resistance	WARP	Direct tension (1000 h)	Tensile strength $\sigma_{u, soil}$	1089 MPa	899 MPa
			Strain $\varepsilon_{u, soil}$	0.85 %	0.25 %
			Stiffness moduli $E_{1\ soil}$	5423 GPa	3779 GPa
			Stiffness moduli $E_{3\ soil}$	90 GPa;	69 GPa;
		Retained properties (1000 h)	Tensile strength $\sigma_{u, soil,ret}$	96 %	-
			Stiffness moduli $E_{1\ soil,ret;}$	98 %	
			Stiffness moduli $E_{3\ soil,ret}$	79 %	
	WEFT	Direct tension (1000 h)	Tensile strength $\sigma_{u, soil}$	1030 MPa	926 MPa
			Strain $\varepsilon_{u, soil}$	1.22 %	0.92 %
			Stiffness moduli $E_{1\ soil}$	3664 GPa;	2930 GPa;
			Stiffness moduli $E_{3\ soil}$	63 GPa;	48 GPa;
		Retained properties (1000 h)	Tensile strength $\sigma_{u, soil,ret}$	101 %	-
			Stiffness moduli $E_{1\ soil,ret;}$	97 %	
			Stiffness moduli $E_{3\ soil,ret}$	85 %	

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Essential characteristics		Performance			
				Average value	Characteristic value
Dry heat resistance	WARP	Direct tension (1000 h)	Tensile strength $\sigma_{u,\,heat}$ Strain $\varepsilon_{u,\,heat}$ Stiffness moduli $E_{1\,heat}$ Stiffness moduli $E_{3\,heat}$	1277 MPa 1.13 % 4989 GPa; 110 GPa;	869 MPa - (2) 4397 GPa; 39 GPa;
		Retained properties (1000 h)	Tensile strength $\sigma_{u,\,heat,ret}$ Stiffness moduli $E_{1\,heat,ret;}$ Stiffness moduli $E_{3\,heat,ret}$	113 % 90 % 95 %	-
		Direct tension (3000 h)	Tensile strength $\sigma_{u,\,heat}$ Strain $\varepsilon_{u,\,heat}$ Stiffness moduli $E_{1\,heat}$ Stiffness moduli $E_{3\,heat}$	1111 MPa 0.47 % 6069 GPa; 145 GPa;	921 MPa 0.22 % 4477 GPa; 124 GPa;
		Retained properties (3000 h)	Tensile strength $\sigma_{u,\,heat,ret}$ Stiffness moduli $E_{1\,heat,ret;}$ Stiffness moduli $E_{3\,heat,ret}$	98 % 109 % 126 %	-
	WEFT	Direct tension (1000 h)	Tensile strength $\sigma_{u,\,heat}$ Strain $\varepsilon_{u,\,heat}$ Stiffness moduli $E_{1\,heat}$ Stiffness moduli $E_{3\,heat}$	1060 MPa 1.24 % 4120 GPa; 72 GPa;	969 MPa 0.70 % 2579 GPa; 43 GPa;
		Retained properties (1000 h)	Tensile strength $\sigma_{u,\,heat,ret}$ Stiffness moduli $E_{1\,heat,ret;}$ Stiffness moduli $E_{3\,heat,ret}$	104 % 109 % 96 %	-
		Direct tension (3000 h)	Tensile strength $\sigma_{u,\,heat}$ Strain $\varepsilon_{u,\,heat}$ Stiffness moduli $E_{1\,heat}$ Stiffness moduli $E_{3\,heat}$	931 MPa 0.78 % 4123 GPa; 89 GPa;	845 MPa 0.35 % 3552 GPa; 39 GPa;
		Retained properties (3000 h)	Tensile strength $\sigma_{u,\,heat,ret}$ Stiffness moduli $E_{1\,heat,ret;}$ Stiffness moduli $E_{3\,heat,ret}$	91 % 109 % 119 %	-
Fuel resistance - WARP	Direct tension		Tensile strength $\sigma_{u,\,fuel}$ Strain $\varepsilon_{u,\,fuel}$ Stiffness moduli $E_{1\,fuel}$ Stiffness moduli $E_{3\,fuel}$	NPA	NPA
	Retained properties		Tensile strength $\sigma_{u,\,fuel,ret}$ Stiffness moduli $E_{1\,fuel,ret;}$ Stiffness moduli $E_{3\,fuel,ret}$	NPA	NPA

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Essential characteristics			Performance		
				Average value	Characteristic value
Creep behaviour related to the adhesion on substrate - WARP	Substrate: clay		Displacement vs time (tab) Maximum load $P_{max, creep}$ Bond capacity $P_{deb, creep}$	0.007 mm 1639 N - (1)	- 934 N -
	Substrate: tuff		Displacement vs time (tab) Maximum load $P_{max, creep}$ Bond capacity $P_{deb, creep}$	0.013 mm 1812 N - (1)	- 1406 N -
Tensile strength after long term actions (creep) - WARP	100 h	Direct tension	Tensile strength $\sigma_{u, creep}$ Strain $\varepsilon_{u, creep}$ Stiffness moduli $E_{3\ creep}$	1364 MPa 1.36 % 99 GPa	-
		Retained properties	Tensile strength $\sigma_{u, creep,ret}$ Stiffness moduli $E_{3\ creep,ret;}$	121 % 86 %	-
	500 h	Direct tension	Tensile strength $\sigma_{u, creep}$ Strain $\varepsilon_{u, creep}$ Stiffness moduli $E_{3\ creep}$	1557 MPa 1.50 % 102 GPa	-
		Retained properties	Tensile strength $\sigma_{u, creep,ret}$ Stiffness moduli $E_{3\ creep,ret}$	138 % 89 %	-
	1000 h	Direct tension	Tensile strength $\sigma_{u, creep}$ Strain $\varepsilon_{u, creep}$ Stiffness moduli $E_{3\ creep}$	1346 MPa 1.36 % 96 GPa	-
		Retained properties	Tensile strength $\sigma_{u, creep,ret}$ Stiffness moduli $E_{3\ creep,ret;}$	119 % 83 %	-
	4000 h	Direct tension	Tensile strength $\sigma_{u, creep} \geq$ Strain $\varepsilon_{u, creep}$ Stiffness moduli $E_{3\ creep}$	1335 MPa 1.35 % 102 GPa	-
		Retained properties	Tensile strength $\sigma_{u, creep,ret}$ Stiffness moduli $E_{3\ creep,ret;}$	118 % 89 %	-

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Essential characteristics		Performance			
				Average value	Characteristic value
Tensile strength after long term actions (creep) - WEFT	100 h	Direct tension	Tensile strength $\sigma_{u,\ creep}$ Strain $\varepsilon_{u,\ creep}$ Stiffness moduli $E_{3\ creep}$	858 MPa 1.17 % 78 GPa	-
		Retained properties	Tensile strength $\sigma_{u,\ creep,ret}$ Stiffness moduli $E_{3\ creep,ret;}$	84 % 105 %	-
	500 h	Direct tension	Tensile strength $\sigma_{u,\ creep}$ Strain $\varepsilon_{u,\ creep}$ Stiffness moduli $E_{3\ creep}$	885 MPa 0.89 % 89 GPa	-
		Retained properties	Tensile strength $\sigma_{u,\ creep,ret}$ Stiffness moduli $E_{3\ creep,ret}$	87 % 119 %	-
	1000 h	Direct tension	Tensile strength $\sigma_{u,\ creep}$ Strain $\varepsilon_{u,\ creep}$ Stiffness moduli $E_{3\ creep}$	857 MPa 0.88 % 100 GPa	-
		Retained properties	Tensile strength $\sigma_{u,\ creep,ret}$ Stiffness moduli $E_{3\ creep,ret;}$	84 % 133 %	-
	4000 h	Direct tension	Tensile strength $\sigma_{u,\ creep}$ Strain $\varepsilon_{u,\ creep}$ Stiffness moduli $E_{3\ creep}$	868 MPa 1.22 % 74 GPa	-
		Retained properties	Tensile strength $\sigma_{u,\ creep,ret}$ Stiffness moduli $E_{3\ creep,ret}$	85 % 99 %	-
Tensile strength after low number of cycles (seismic behaviour) - WARP			Tensile strength $\sigma_{u,\ seismic}$ Strain $\varepsilon_{u,\ seismic}$ Stiffness moduli $E_{1\ seismic,ret;}$ Stiffness moduli $E_{3\ seismic,ret}$	1636 MPa 1.55 % 1202 GPa 119 GPa	1488 MPa 1.35 % 826 GPa 111 GPa
Tensile strength after high number of cycles (fatigue actions)			NPA		
Mechanical properties of fabric	warp		Ultimate stress $\sigma_{u,f}$ Ultimate strain $\varepsilon_{u,f}$ Mean elastic modulus E_f	1601 MPa 2,09 % 73 GPa	1431 MPa 1,75 % 58 GPa
	weft		Ultimate stress $\sigma_{u,f}$ Ultimate strain $\varepsilon_{u,f}$ Mean elastic modulus E_f	1007 MPa 1,57 % 63 GPa	930 MPa 1,30 % 49 GPa
	Substrate: clay Substrate: tuff Substrate: Natural Stone		Conventional limit strain $\varepsilon_{lim,conv}$ Conventional limit strain $\varepsilon_{lim,conv}$ Conventional limit strain $\varepsilon_{lim,conv}$	1,57 % 1,53 % 1,73 %	1,32 % 1,40 % 1,43 %
Tensile strength on bent fabric (for steel fabrics)			Not applicable		

(2) value not determinable due to the hight dispersion of results