REFOR-tec®
Reactive Forces Technologies

From Project to Jobsite

Certified Quality System since **FEBRUARY 1993**

REFOR-tec® GF 5 / ST - HS three-component

Micro-concrete UHPFRCC
Ultra High Performance Fibre Reinforced Cementitious Composite
CE approved – Certificate n. 1305 - CPD - 0808
EN 1504-3 Classe R4

R4 EN 1504-3 NORMA EUROPEA

Description It is a specially formulated cement-based material, fibre-reinforced with FIB-energy®, enriched with reactive micro-silica with very high pozzolanic activity, three-component of REFOR-tec® range, it combines the self-levelling rheology together with exceptional physical-mechanical values and ductility properties. The product is composed by three components : **A** powder, **B** liquid, **C** fibres.

Advantages There are many advantages using the **REFOR-tec®** technology for strengthening :

- benefit in structural calculations from the exceptional ductility, from the highly hardening behaviour at flexural-tensile strength and therefore from the ultimate deformations of the material ;
- exceptional tensile strengths and exceptional values of shear bond strength of the strengthening jacketing to the reinforced concrete substrate ;
- minimum thickness of application ensures more adequate strengthening conditions compared to other interventions with traditional reinforced concrete (see pages 14-15) with very considerable reduction of masses ;
- minimizing additional loads resting on the structure up to almost zero values in case the thickness of jacketing corresponds to the depth of scarification (see pages 14-15) ;
- exceptional effectiveness of **REFOR-tec®** as anti-carbonation barrier (almost zero CO_2 penetration - see page 4) and anti-corrosion barrier (see page 5) ;
- very high fire resistance of **REFOR-tec®** formulations also in direct contact at 1000°C on underload structures (systems n°1 and n° 2 – see pages 6-7) ;
- LEED® CREDITS: VOC Emissions almost no-existent – Project Innovation - Durability - Environmental sustainability - 100% recyclable at end of life.
- The Engineers of our U.A.P.P. Office assist "*from Project to Jobsite*".

REFOR-tec® GF 5 / ST-HS combines a sufficient workability time (about 1 hour at 20°C) with an exceptional progression in hardening (compressive strength after 24 hours = 48 MPa), very high Fracture Energy (32.500 N/m) and final mechanical strengths (compr. strength at 28 days = 130 MPa), hygrometric shrinkage zero, no cracking, excellent durability and resistance to frost/thaw and to sulphate attacks, absolutely waterproofing, very high wear resistance. Thickness from 5 to 200 mm.

Application

- Engineering of Shapes – Special Structures, Construction & Strengthening - Very High Durability & Sustainability - LEED® Credits.
- for Strengthening and Precision Anchoring of Heavy and Highly Stressed Machineries : i.e. Wind Turbines, Giant Carousels for the Rolling of Giants Cables, Precision Machineries, etc.
- for the seismic retrofitting of constructions with absorption and transfer of shear and tensile stresses in case of events with high dynamic stress.
- structural strengthening and seismic retrofitting through jacketing of beams, columns, nodes, walls.
- for structural and seismic retrofitting by collaborating cover at low thickness of slabs in reinforced concrete, brick/cement, corrugated sheets, wood.
- for structural strengthening with jacketing of pillars and beams, with highly resistance to fire: system n° 1 and system n° 2.
- for the manufacture of lightweight structural elements in thin section
- for the repair of floors with the need for resistance to high static and dynamic stresses, together with exceptional values of resilience and shock resistance.
- for the faithful reproduction of reliefs in plaster, sculptural creations, with colour versions "ad hoc".

Method of use The substrate must be sound, cleaned sufficiently rough, without loose parts, washed with water under pressure and saturated with water before application.

In the structural strengthening jacketing of beams, columns, nodes etc, strong pressure is exerted by the product on the formwork. Use efficient vertical axis mixer (or efficient drill with mixing device for mixer of one bag in a bucket). See mixing instructions below for "large projects", or "small applications".
Follow the instructions given for each individual jobsite by our Office for Assistance Promotion Projects.

Remarks Information regarding senses D.M. 10 May 2004:
Storage : 12 months in original packaging, unopened, maintained in a dry and protected area, at temperature between +5°C and +35°C.

Technical characteristics (typical values)

• Temperature of application	+5°C ÷ +35°C
• Workability time	≥ 1 h
• Foot traffic	12 h at 20 °C
• Accepting light traffic	24 h at 20 °C
• Trafficable with full load	3 days at 20 °C
• Density	2.450 Kg/m^3
• Compressive strength after 1 day**	48 MPa
• Compressive strength after 28 days **	130 MPa
• Tensile strength after 28 days***	8,5 MPa
• Flexural strength after 28 days**	32 MPa
• Shear strength	16 MPa
• Modulus of Elasticity	38 GPa
• Fracture energy	32.500 N/m
• Endogen shrinkage	< 0,05 %
• Depth of carbonation	0
Water permeability EN 12390-8 5 bar x 3 days.	< 2 mm
Resistance to frost/thaw cycling in presence of salts, according the Suisse standard SIA 162 : (weight loss after 28 cycles ≤ 600 gr/m^2 corresponding to the optimal resistance for applications on motorways.	≅ 0
Permeability to chlorides - Coulomb FHWA/RD/81 (100÷1000 Coulomb = very low)	< 100 Coulomb
Free Shrinkage/expansion (T = 20° R.H. = 50%) (UNI EN 1217-4 / UNI 6687-73)	± 10 µ/m at 90 days
Specific heat	= 2700 $\frac{KJoule}{(m^3 \times K)}$
Adhesion to substrate (EN 1504 – 3)	>3 MPa at 28 days (substrate failure)
Impact resistance (CSTB 3232)	No crack after 25 impacts
Surface hardness (EN 13892-6)	≥ 150 N/mm^2
Shore hardness (IS 868)	D ≥ 75
Penetration test (EN 12697-21)	I < 0,1 mm
Wear resistance roller (XP P 11-101)	$\Delta v_r \leq 2$ cm^3
Resistance to abrasion (EN 102)	15 mm^3
Resistance to sulphates UNI EN 196/1 and ASTM C 88 (sequence of 15 immersions in magnesium sulphate solution)	No degradation Weight loss < 0,10%
Resistance to chemicals (contact time 24 hours)	No change of the surface with caustic soda, amine, methanol, trichloroethylene, gasoil, engine oil, brake fluid

Note : values obtained with liquid demand 11% on samples 4x4x16 cm (according to UNI EN 1504-3).**

Note* : values obtained by tests executed on samples 10x10x50 cm "Indirect Tensile Strength"**

Safety indications Read carefully the safety indications on the packaging, or consult the relevant safety datasheet of this product.

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Packaging, proportions, method of use

PACKAGING FOR BIG VOLUME JOBS

Comp. **A** **POWDER** (bags of 25 Kg. on pallet) : **1.300 Kg.**

Comp. **B** **LIQUID** (in drums) **162,5* Kg.**

Comp. **C**** **FIBRE FIB-energy ® ST / HS** (in boxes of 20 Kg.) : **60 Kg.**

TOT: 1.522,5 Kg.

The components are dosed on the jobsite according each to individual mix. Mix during about 9 minutes with a highly efficient vertical axes mixer in following sequence:

ex. : with a mixer of 250 lt use 10 bags powder =
250 Kg. comp. A powder +
31,25* Kg. comp. B liquid (12,5*% referred on powder A) +
11,50 Kg. comp.C fibres (4,6% referred on powder comp A) :

Add 5 bags powder (comp. A) in the mixer.
+ comp. B liquid during mixing, till a fluid consistency is obtained (about half of the total liquid~ 13-14 Kg.).
+ 5 bags comp. A, adding 1 bag of powder, mixing with a small amount of liquid B till the paste is homogenous again, repeating this operation till all powder A and Liquid B has been added in the correct amounts.
+ at the end add comp. C fibres, gradually, always during mixing, till a homogeneous paste is obtained.

Total mixing time not less than 8 minutes !!!

Note* : depending on the operative conditions and fluidity of the mixing required, the ratio B (12,5% on the powder) can be reduced to a minimum of 11% referred on the powder A.

PACKAGING FOR SMALLER JOBSITES OR IN RESELLING

Comp. **A** **POWDER** (1 bag of 25 Kg.) — 1 pail of Kg. 26,15

Comp. **C**** **FIBRE FIB-energy ® ST / HS** (1 box of 1,15 Kg.) — 1 can of Kg. 3,125*

Comp. **B** **LIQUID** (in 1 can of 3,125 Kg.)

TOT. Kg. 29,275

It is always recommended the use of proper mixing equipment with vertical axis.

Note*: depending on the operative conditions and on the fluidity of the mixing required, the ratio B can be reduced up to a minimum of 2,75 kg.

PLEASE NOTE: The fibre FIB-energy® ST / HS must be handled with thick gloves in order to avoid pricks to the skin !

NOTE * : Component **C** FIBRE : the specification on the percentage to be used can vary according to the dimensions (diameter, length) and performances (tensile strength, elasticity modulus). In that case the specification will be written on the particular order. For any further information please contact our Technical Office U.A.P.P.

This information is based on our experiences and latest laboratory testing. The above information may be subject to modifications, which will be announced in the updated technical datasheets. Eventual changes to the information on top will be announced on www.tecnochem.it in which the technical datasheets are updated regularly and always the most updated can be found. Tecnochem Italiana cannot held responsible for poor results that are due to causes unconnected to the quality if the product or for defects deriving from factors different than the quality of the product including the wrong storage.

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Capillary Porosity – Speed of Carbonation

FORMULA OF POWERS (the capillary porosity depends Of the w/r ratio and of the hydration grade of the cement α)

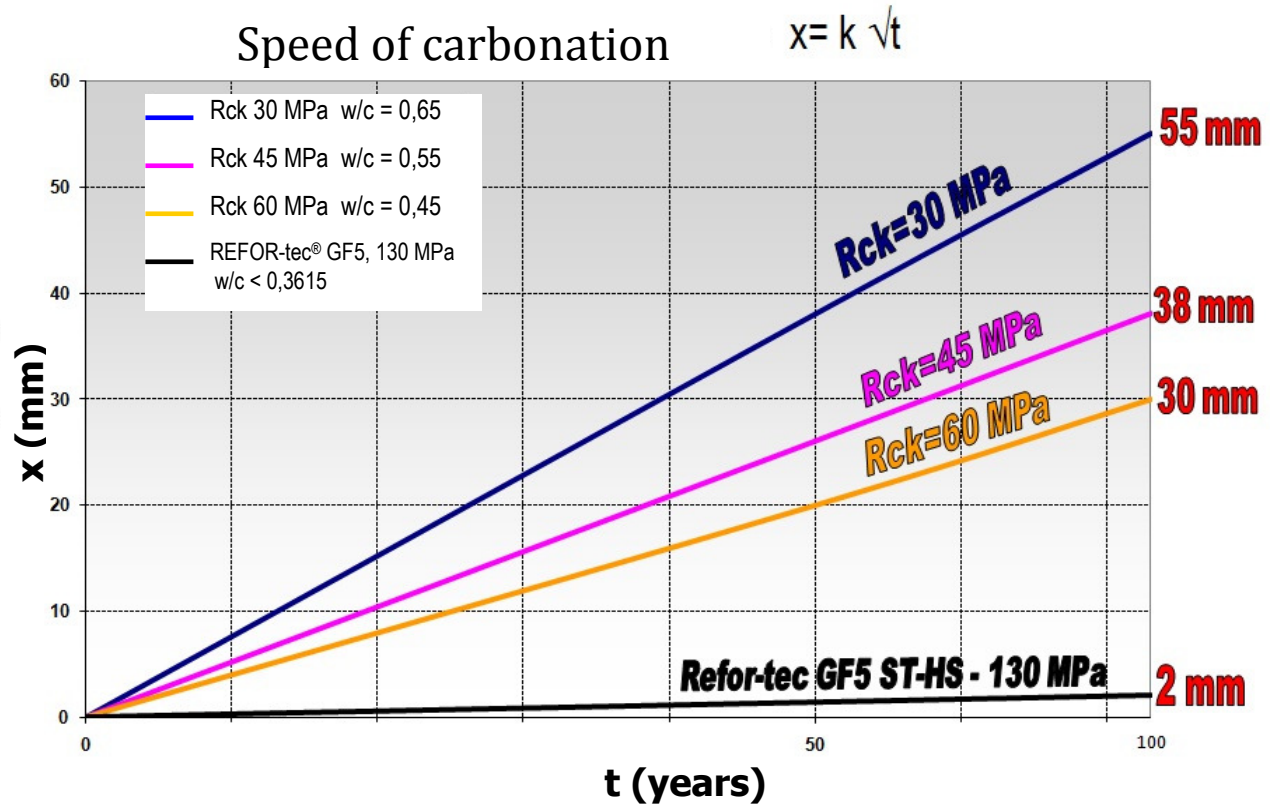
$$Vp = 100\,\frac{a}{c} - 36{,}15\,\alpha$$

in which:

- **Vp** volume of the capillary pores in litre for 100 kg of cement
- α grade of saturation (fraction of cement hydrated)

The capillary porosity is null with w/c = 0,3615 and α=1(complete hydration)

In case of REFOR-tec® GF5 ST-HS with w/c<0,3615 results in practice :



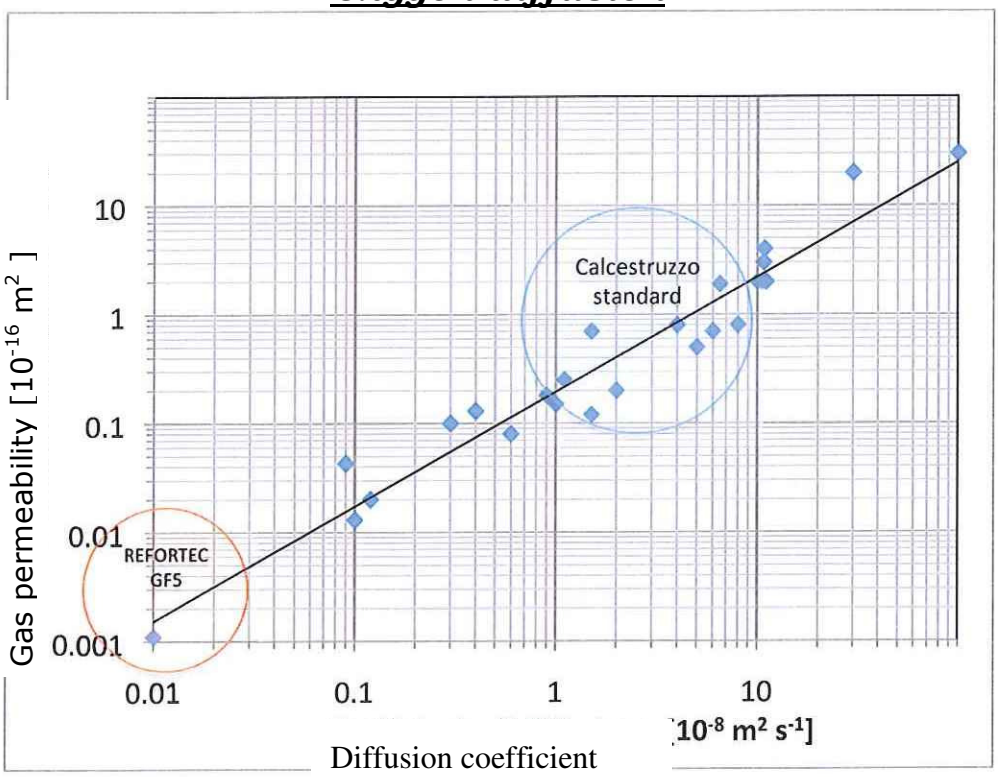
The accelerated carbonation simulations in the laboratory in atmosphere to 80% CO_2 (1 week = approx. 8 years in the environment) confirm the significance of the values shown in the diagram.

Oxygen diffusion and resistivity

The speed of corrosion is **negligible** even when there is only one of following conditions:
- The anodic process is slow because the reinforcement is (kinetic control of the passivity)
- The cathodic process takes place slowly because the rate at which oxygen can be received on the surface of the reinforcement is low (control of diffusion of oxygen)
- The electrical resistivity of the concrete is high (ohmic control)

→ Corrosion rate : **negligible** =
< 1 µm /year =
< 1 mm/ 1000 years

Oxygen diffusion



	Diffusion coefficient 10^{-8} m² s⁻¹	Gas permeability gas 10^{-16} m²
Standard concrete (w/c 0,50)	approx. **5**	approx. **1**
REFOR-tec® GF5	**0,01** (2‰)	**0,001** (1‰)

→ Corrosion rate : **negligible** =
< 1 µm /year =
< 1 mm/ 1000 years

Resistivity

REFOR-tec® GF5 > 100.000 Ω/cm (U.R. ≤ 70%) →

Speed of corrosion **negligible** =
< 1 µm /year =
< 1 mm/ 1000 years

REFOR-tec® GF5/ST-HS (contains polymer fibres)

Fire resistance

Structural reinforcement with very high efficiency and low thickness

➔Very high fire resistance to 1000°C :
system nº 1 – REFOR-tec® GF5/ST-HS
➔Thermal Shield "insensitive " to direct fire 1000°C:
system nº 2 - REFOR-tec® GF5/ST-HS +TECNOLITE

MNEMA PROJECT -LIÈGE (Belgium)

Structural reinforcement of beams and pillars with
REFOR-tec® GF 5/ ST-HS nº 2
REFOR-tec® GF 5 / ST-HS nº 1
Fire resistance tests

Pre-qualification by the University of Liege
Certificates EF/FH/1229 – 1231
"concrete beam L=5 meters -25 MPa with strengthening jacket :
• EF/FH/1229: REFOR-tec® GF 5 / ST-HS + TECNOLITE
Beam subjected to load 300 KN at 1000°C for 120 minutes - nº 2
•EF/FH/1231: REFOR-tec® GF 5/ ST-HS (after removal of TECNOLITE)
beam loaded 300 KN at 1000°C for 90 minutes" - nº 1

Perfect shape and adhesion of the structural reinforcment with
REFOR-tec® GF 5/ST-HS nº1 and nº2 after the cycle at 1000°C

Beam cross section after the double test at 1000 ° C: perfect integrity and adhesion of 'jacket'
REFOR-tec® GF 5/ ST- HS

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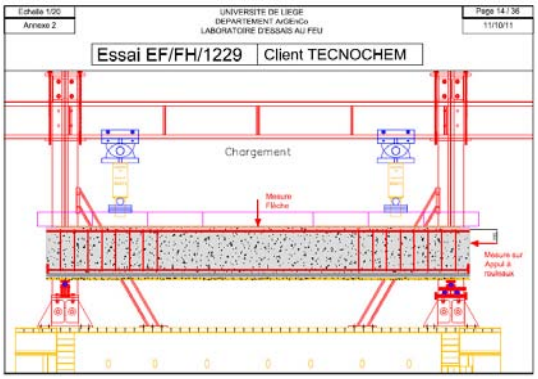
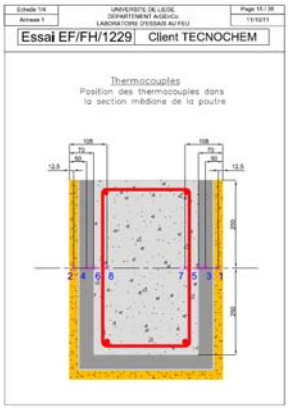
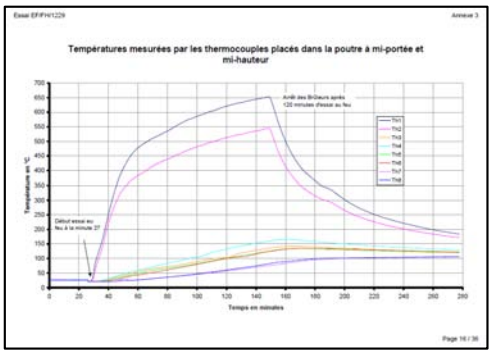
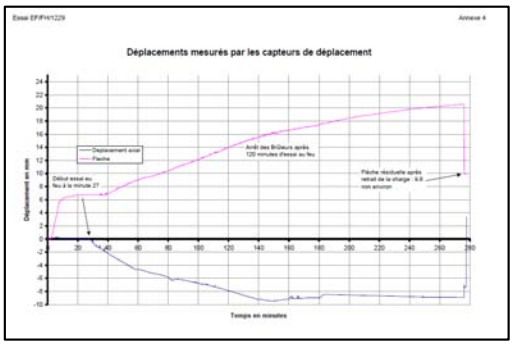
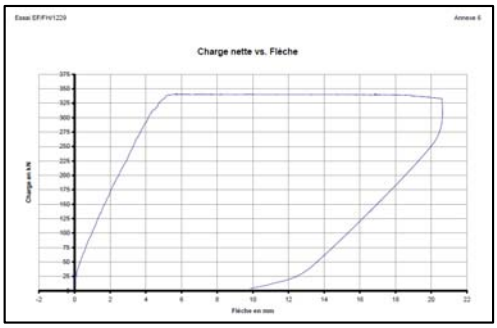


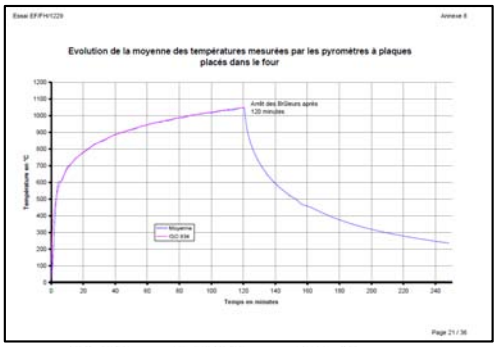


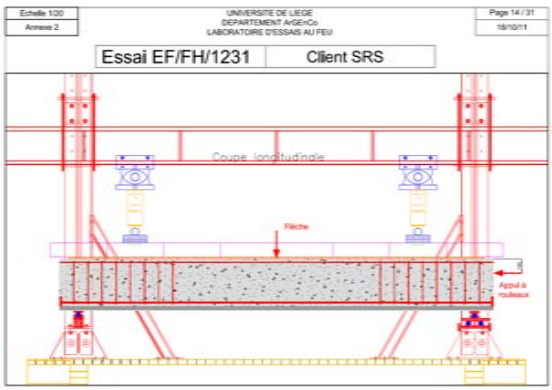
system nº 2

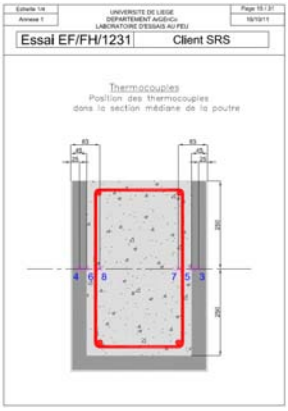




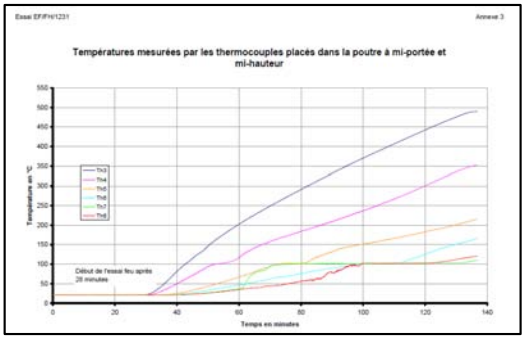


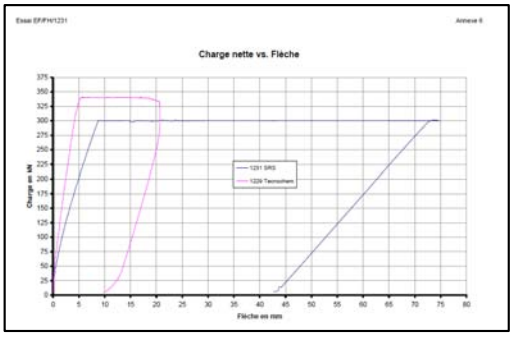


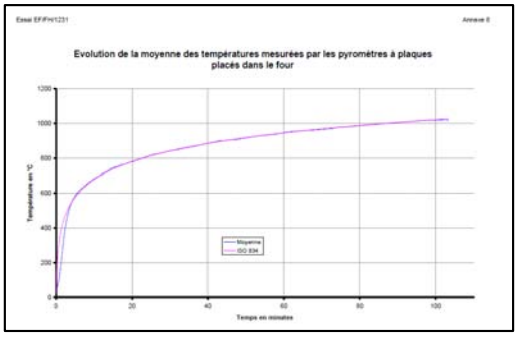




system nº 1

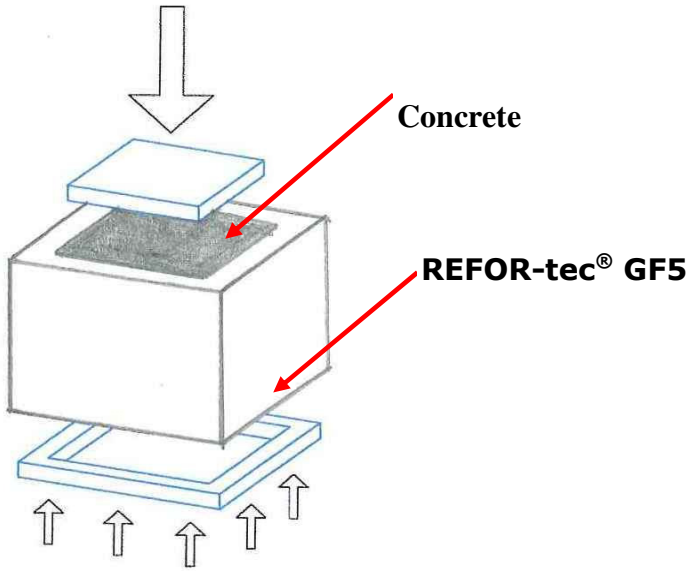






Shear adhesion test

The specimen to be tested consists of a cube of concrete C20/25 MPa dimensions of 150x150x150 mm. The lateral surfaces of the specimen are coated by a jacket of 30 mm thick of REFOR-tec® GF5. Prior to the application of the reinforcement sandblasting has been applied of the side surfaces or by hydro-scarifying (roughness 1-1,5 mm).
The test is performed by placing the specimen on the jacket REFOR-tec® GF5 by a metal frame and compressing the substrate formed by the cube of concrete.



Result of the test :

	Specimen Sand-blasted	Specimen Hydro-jetting
Load at break average*:	347,1 kN	535,5 kN
Medium shear strength :	3,86 MPa	5,95 MPa

* mean value obtained from an experimental campaign on a sample of 50 specimens

Preparation of the specimen: : casting of REFOR-tec® as a jacket of 30 mm around the concrete prism in the formwork

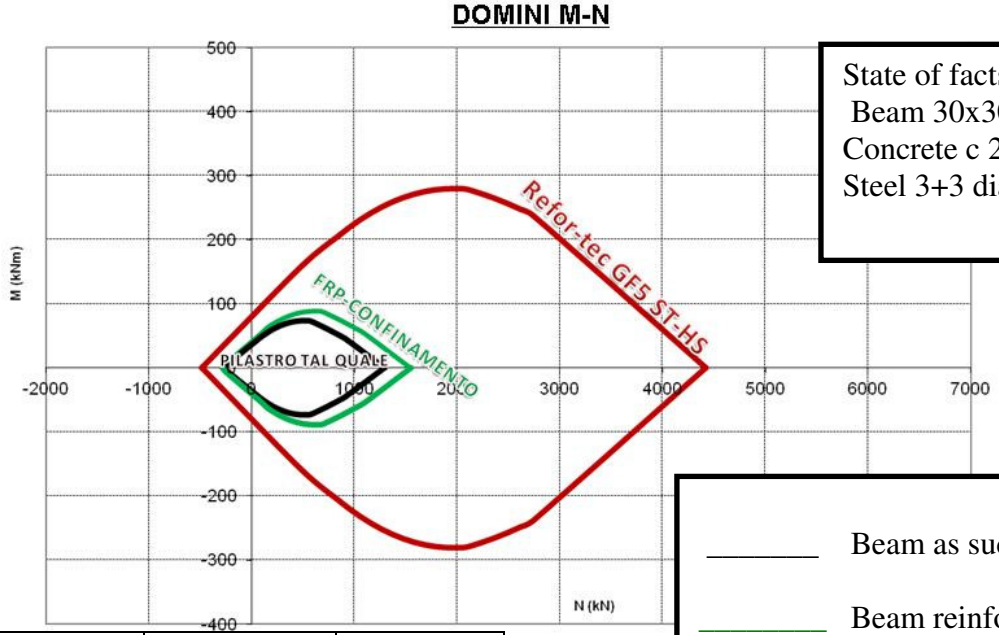
Method of testing : compression on the concrete prism with a metal plate, which is smaller than jacket of REFOR-tec®

Specimen at end of testing of the shear adhesion

Performance comparison between the structural reinforcement on pillars:

- **FRP – carbon fibre fabric - Modulus of elasticity 240 GPa - Weight 300/400 g/m²**
- **Micro-concrete UHPFRCC - REFOR-tec® GF5/ST-HS – jacketing thickness 3 cm**

Performance comparison between the structural reinforcemet on concrete pillars



State of facts :
Beam 30x30 cm
Concrete c 20/25
Steel 3+3 diam 16 FeB 44k

	Axial load	Moment of Resistance
Beam	1300 KN	80 KNm
+ FRP	1500 KN	90 KNm
+ REFOR-tec®	4400 KN	285 KNm

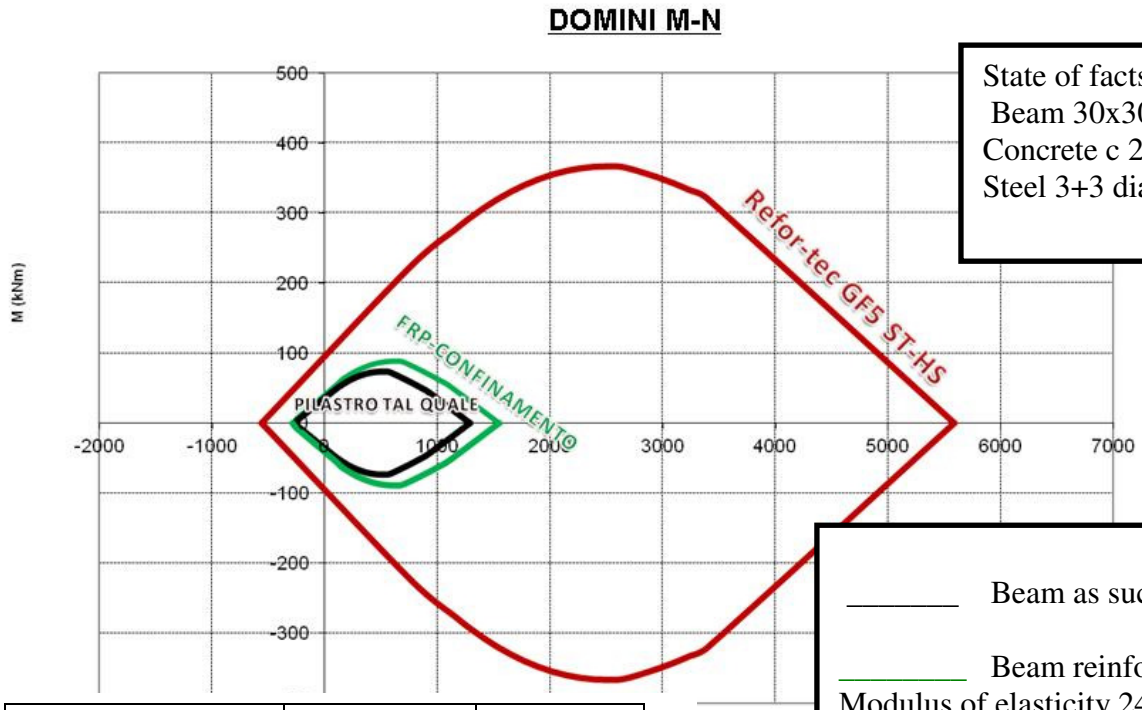
_____ Beam as such

_____ Beam reinforced with FRP – carbon fibre fabric - Modulus of elasticity 240 GPa - Weight 400 g/m²

_____ Beam reinforced with Micro-concrete UHPFRCC - REFOR-tec® GF5/ST-HS – jacketing thickness 3 cm, no reinforcement

- **FRP – carbon fibre fabric - Modulus of elasticity 240 GPa - Weight 300/400 g/m^2**
- **Micro-concrete UHPFRCC - REFOR-tec® GF5/ST-HS – jacketing thickness 4 cm**

Performance comparison between the structural reinforcemet on concrete pillars



State of facts:
Beam 30x30 cm
Concrete c 20/25
Steel 3+3 diam 16 FeB 44k

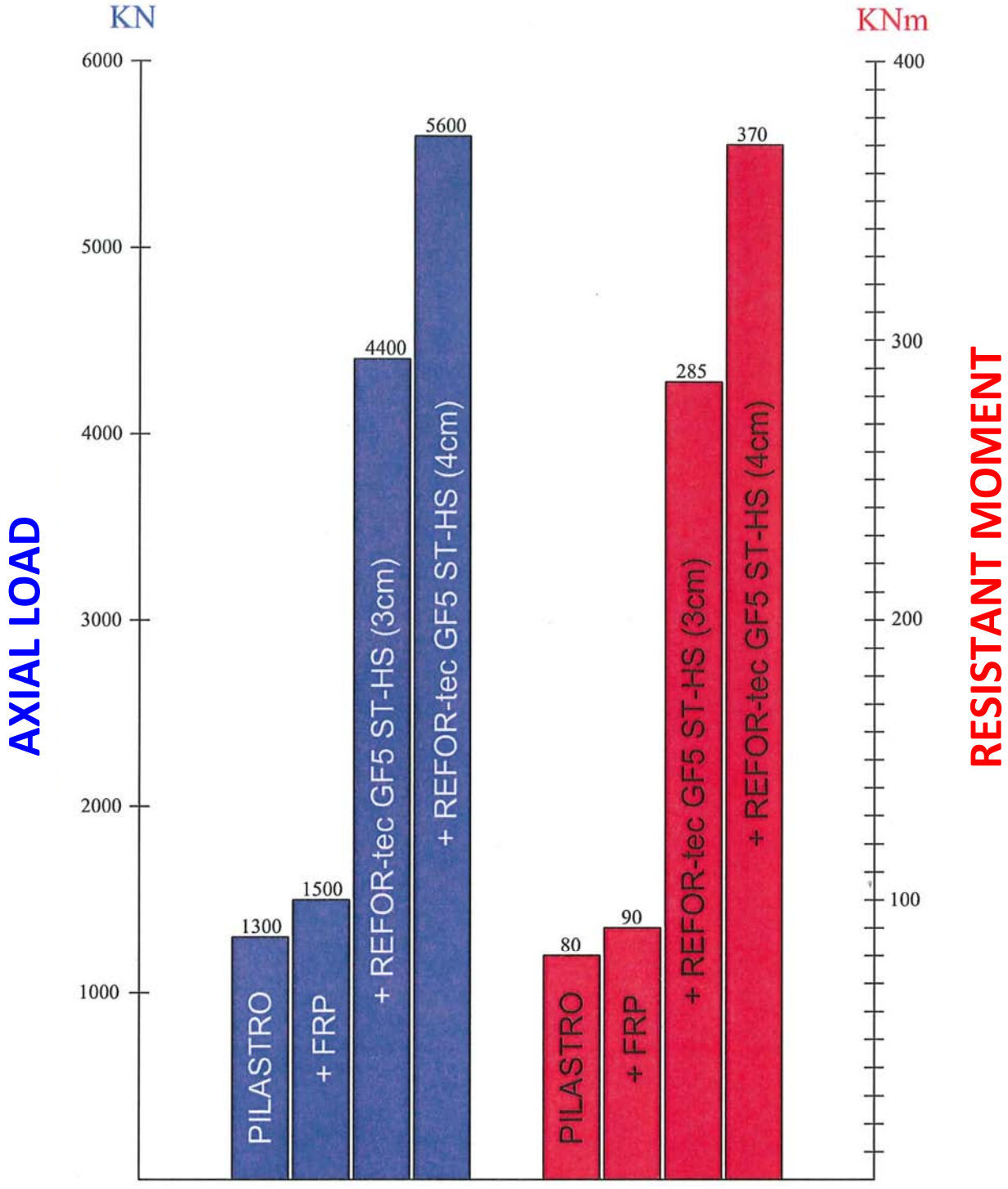
	Axial Load	Moment of Resistance
Beam	1300 KN	80 KNm
+ FRP	1500 KN	90 KNm
+ REFOR-tec®	5600 KN	370 KNm

_____ Beam as such

_____ Beam reinforced with FRP – carbon fibre fabric - Modulus of elasticity 240 GPa - Weight 400 g/m^2

_____ Beam reinforced with Micro-concrete UHPFRCC - REFOR-tec® GF5/ST-HS – jacketing thickness 4 cm- no reinforcement

Comparison between M-N DOMAINS



→ **PILLAR***

→ pillar * + **FRP** (240 GPa, 300-400 g/m^2)

→ pillar * + **REFOR-tec® GF5** / **ST-HS** thickness 3 cm (un-reinforced jacketing)

→ pillar * + **REFOR-tec® GF5** / **ST-HS** thickness 4 cm (un-reinforced jacketing)

Note*: C 20/25 reinforced 3+3 ø16FeB 44 K

Summary of testing and performance comparison of structural reinforcements of pillars

(see also the complete report in attachment)

Microcalcestruzzo UHPFRCC

REFOR-tec® GF5 /ST-HS

not reinforced jacketing

40 mm thickness

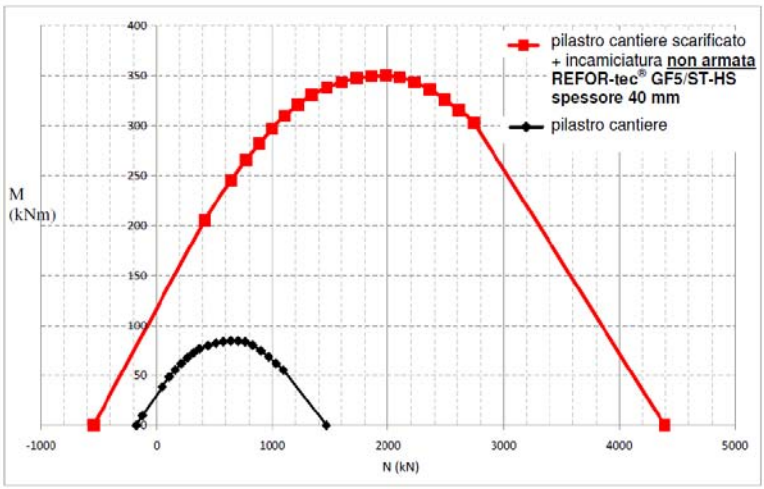
Flowable grout 80 MPa

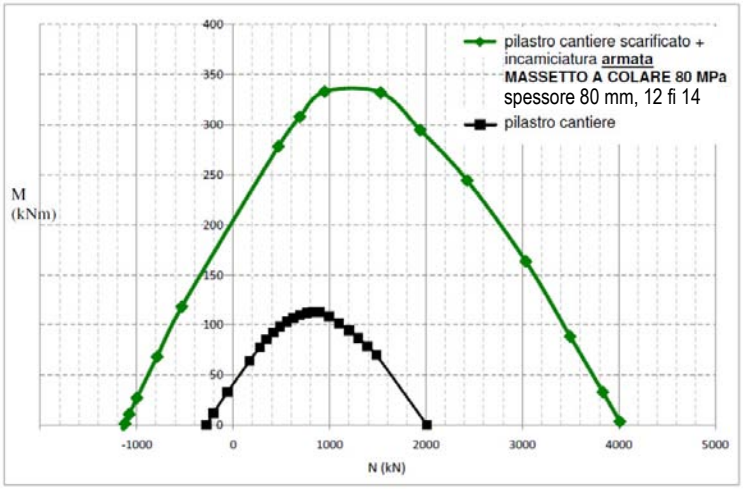
reinforced jacketing

(12 fi 14 in section + brackets fi 8/10 in the lower till 1 metre)

80 mm thickness

Numerical calculation of interaction domains :





"Simulating Seismic Stresses" Performance evidence of 40 mm REFOR-tec® Jacket (no steel bar reinforcement) compared to 80 mm Reinforced Concrete Jacket

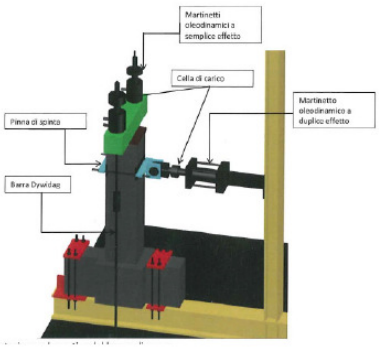
Performance comparison after test "hinge" with axial load 60 KN :

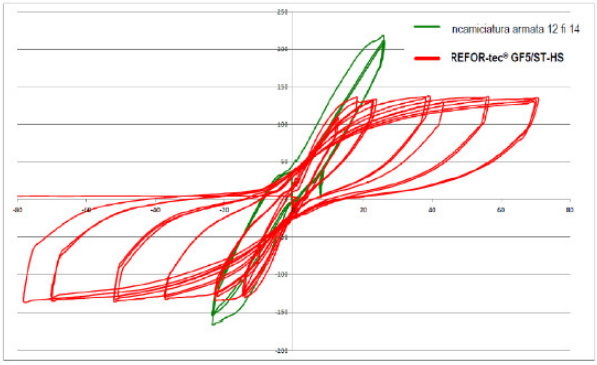
DISPLACEMENT	8 mm	16 mm	32 mm	48 mm	64 mm
DRIFT	0,5%	1%	2%	3%	4%

PILLAR Nr. 1
40 mm REFOR-tec® GF5 /ST-HS Jacket

PILLAR Nr. 2
80 mm Reinforced Concrete Jacket

Performance comparison between PILLAR Nr.1 and PILLAR Nr.2





On the pillar no. 1 the program has been completed with all the displacement involved: 8-16-32-48-64 mm. Pillar perfectly intact, it maintains its structural capacity*, only some micro-crack.

Note*: 93% of final resistance remains in respect to the initial maximal resistance.

Integral beam after the "hinge" test, with displacement up to 64 mm

The pillar no. 2 shows the beginning of spalling of the concrete already with displacement of 16 mm and with 1% of drift. With 32 mm displacement and 2% of drift, with probable load of 170 KN, the concrete shows widespread cracking, crushing and spalling, tensile failure of some bars with loss of its structural capabilities*.

Pillar disintegration

Note*: 53% of final resistance remains, with displacement of only 32 mm, in respect to the initial maximal resistance.

Certificate from Milan Polytechnic

"Cyclic tests of bending beam specimens in reinforced concrete pillar Comparison of two different structural strengthening systems through experimental tests "

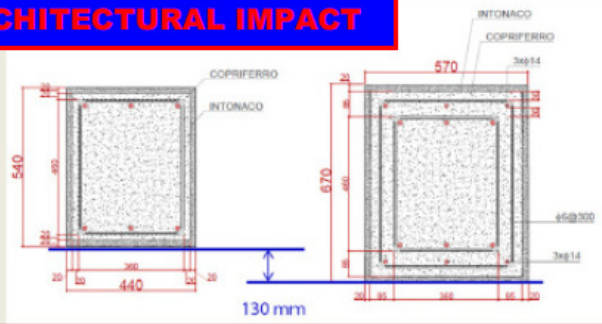
Comparison of the architectural and performance impact of:

Pillar in R.C.
Pillar reinforced with steel jacket
Pillar reinforced with jacket with R.C. concrete
Pillar reinforced with REFOR-tec® 40 mm jacket

Courtesy of Eng. Oreste Mammana- Consultant for the Design of Structural Works of Seismic Improvement of the Castel di Sangro Hospital (L'Aquila)

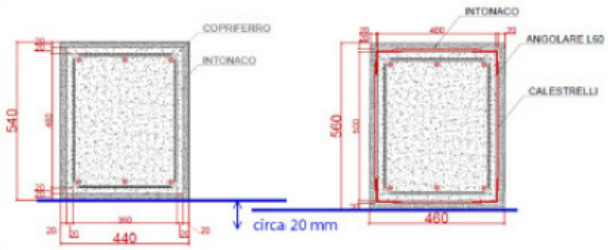
ARCHITECTURAL IMPACT

Jacket in R.C.



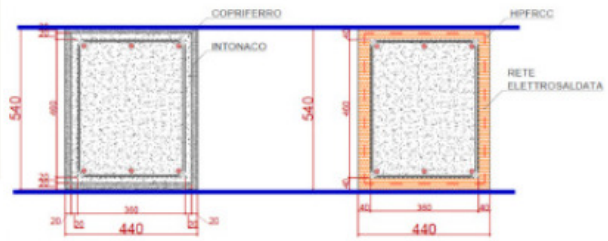
- Significant increase in the geometry
- Necessary to plaster

Jacket in steel

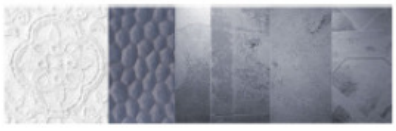


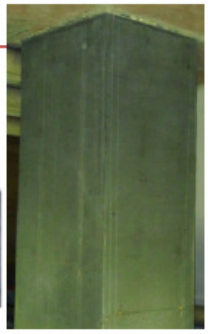
- Light increase in the geometry
- Necessary to apply fire protection
- Necessary to plaster

Jacket in REFOR-tec®

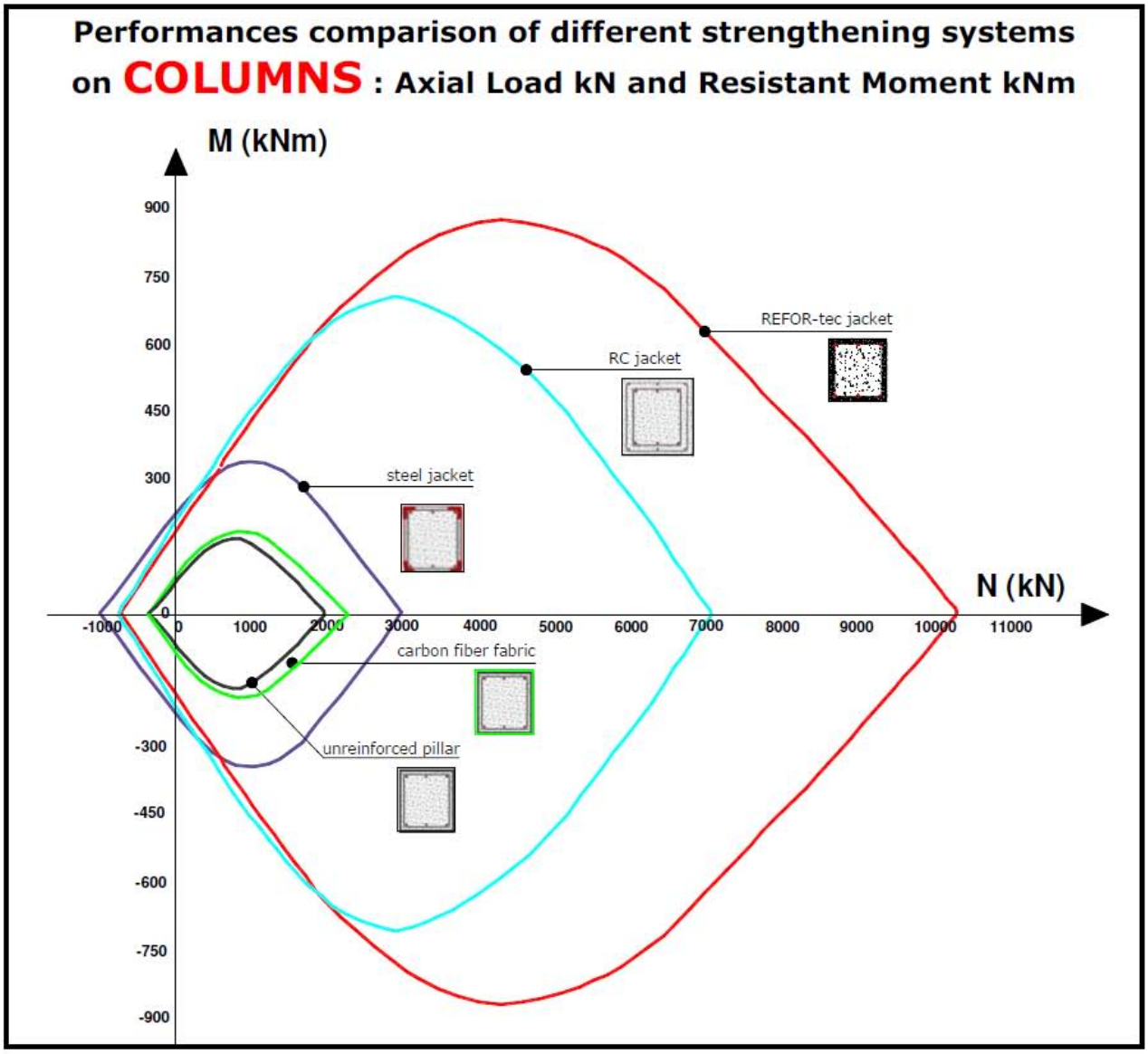


- No increase in the geometry of the element
- Only need for finishing layer (paint)
- Texture





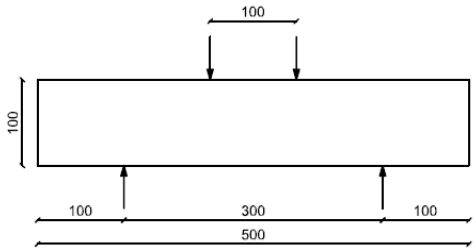
Extract from the thesis: "The use of fiber-reinforced concretes for the seismic retrofitting of existing buioldings" - Supervisor Prof. Eng. Raffaele Landolfo – Teachers co-: Arch. Ornella Iuorio; Eng. Oreste Mammana - Candidate Arch. Silvia Costanzo - University of Naples Federico II



Interaction M-N Domain for various types of reinforcement	Axial load	Resistance Moment
Pillar	2000 KN	170 KNm
With thin mortar + FRP Carbon Fiber - extra thickness 5 mm	2200 KN	185 KNm
With steel jacket - extra thickness 10 mm	3000 KN	350 KNm
With jacket in R.C. - extra thickness 80 mm	7000 KN	700 KNm
with REFOR-tec® jacket - no extra thickness ! (40 mm thickness equal to what is removed by scarification)	10.300 KN	870 KNm

Determination of the mechanical parameters according to CNR DT 204/2006

The four point bending tests were performed on specimens of dimensions 100 x 100 x 500 mm.
The equipment consists of a load cell and two LVDT transducers for the measurement of the displacement in mid-air on front and back of the specimen. The tests were performed under displacement control at a constant speed of 0.01 mm/s. The geometry and the load diagram of the specimens is shown in the following figure.



REFOR-tec® GF5/ST-HS after 28 days	Maximum load	Load at first cracking	Peak Flexural Strength	Flexural Strength at first cracking	Tensile strength peak	Tensile strength at first cracking	Compressive strength
	P_{max}	P_{If}	f_{max}	f_{If}	$f_{t,max}$	$f_{t,If}$	
	[kN]	[kN]	[N/mm^2]	[N/mm^2]	[N/mm^2]	[N/mm^2]	[MPa]
1	48.26	23.84	14.48	7.15	9.67	4.81	128.0
2	52.79	20.17	15.84	6.05	10.57	4.04	132.3
3	41.75	21.65	12.53	6.50	8.36	4.34	129.5
4	41.92	24.09	12.57	7.23	8.4	4.83	136.0
5	43.37	23.67	13.03	7.10	8.70	4.74	133
6	56.29	29.24	16.89	8.77	11.28	5.86	145.0

P_{max} Maximum Load

P_{If} Load at first cracking

f_{max} Peak Flexural Strength $f_p = \frac{P_{\max} \cdot l_{fp}}{b_{fp} \cdot h_{fp}^2}$

f_{If} Flexural Strength at first cracking $f_{If} = \frac{P_{If} \cdot l_{fp}}{b_{fp} \cdot h_{fp}^2}$

l_{fp} Distance between supports (300 mm)

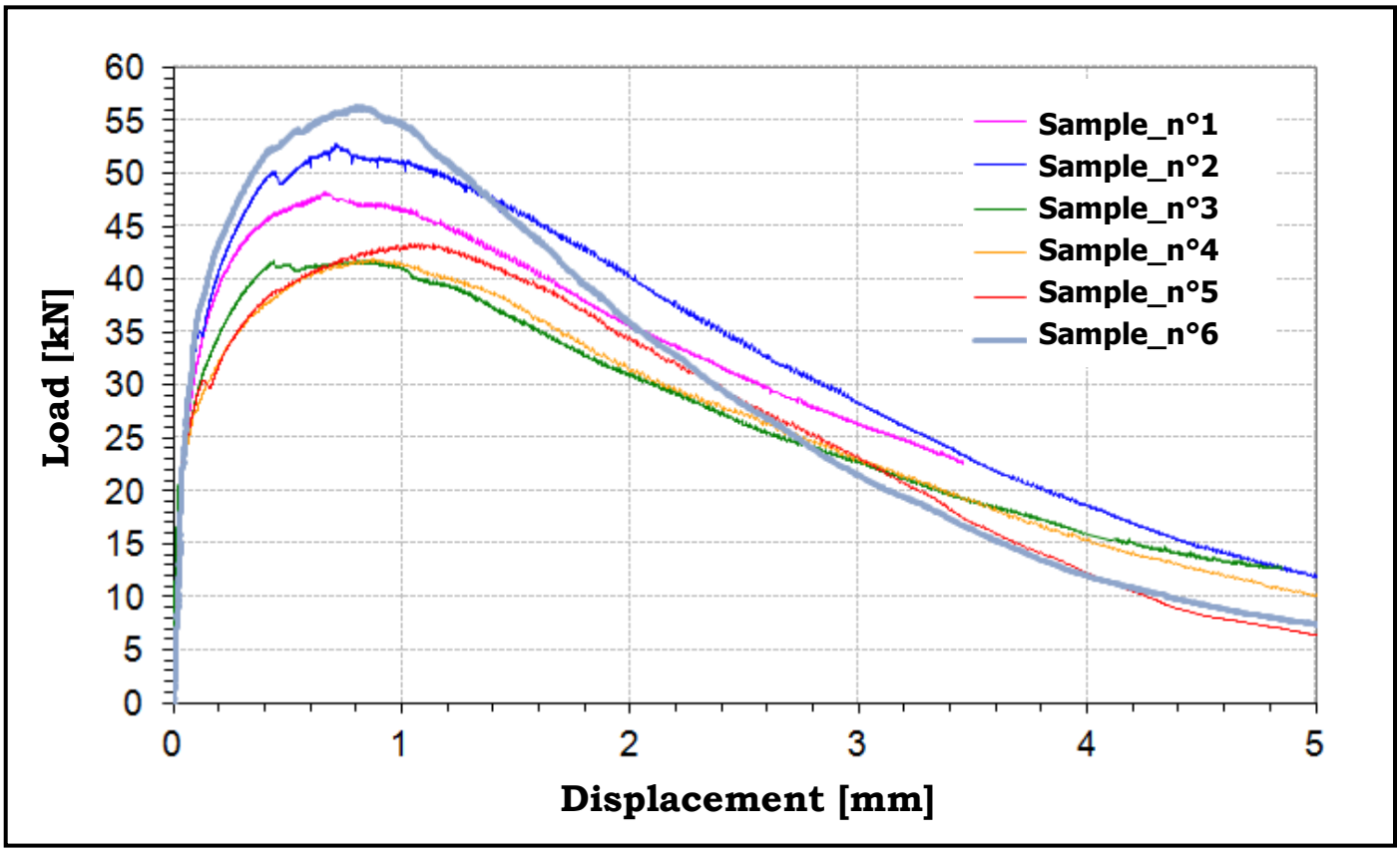
b_{fp}, h_{fp} Lateral dimensions of the sample (100 mm)

$\mathbf{f_{tmax}} = \frac{f_p}{\beta(h)}$ → Tensile Strength in relation with the peak load

where $\beta(h) = \frac{25 + 2 \cdot h^{0.7}}{2 \cdot h^{0.7}}$; h= height of the sample (100 mm)

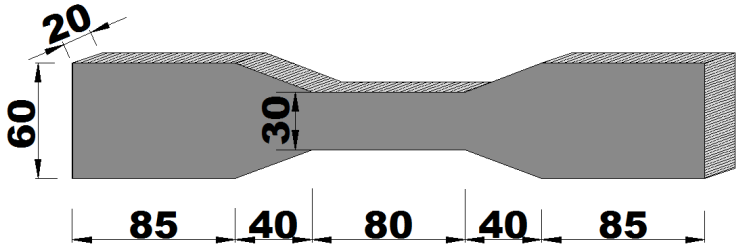
$\mathbf{f_{tIf}} = \frac{f_{If}}{\beta(h)}$ → Tensile strength in relation with the load of the first cracking

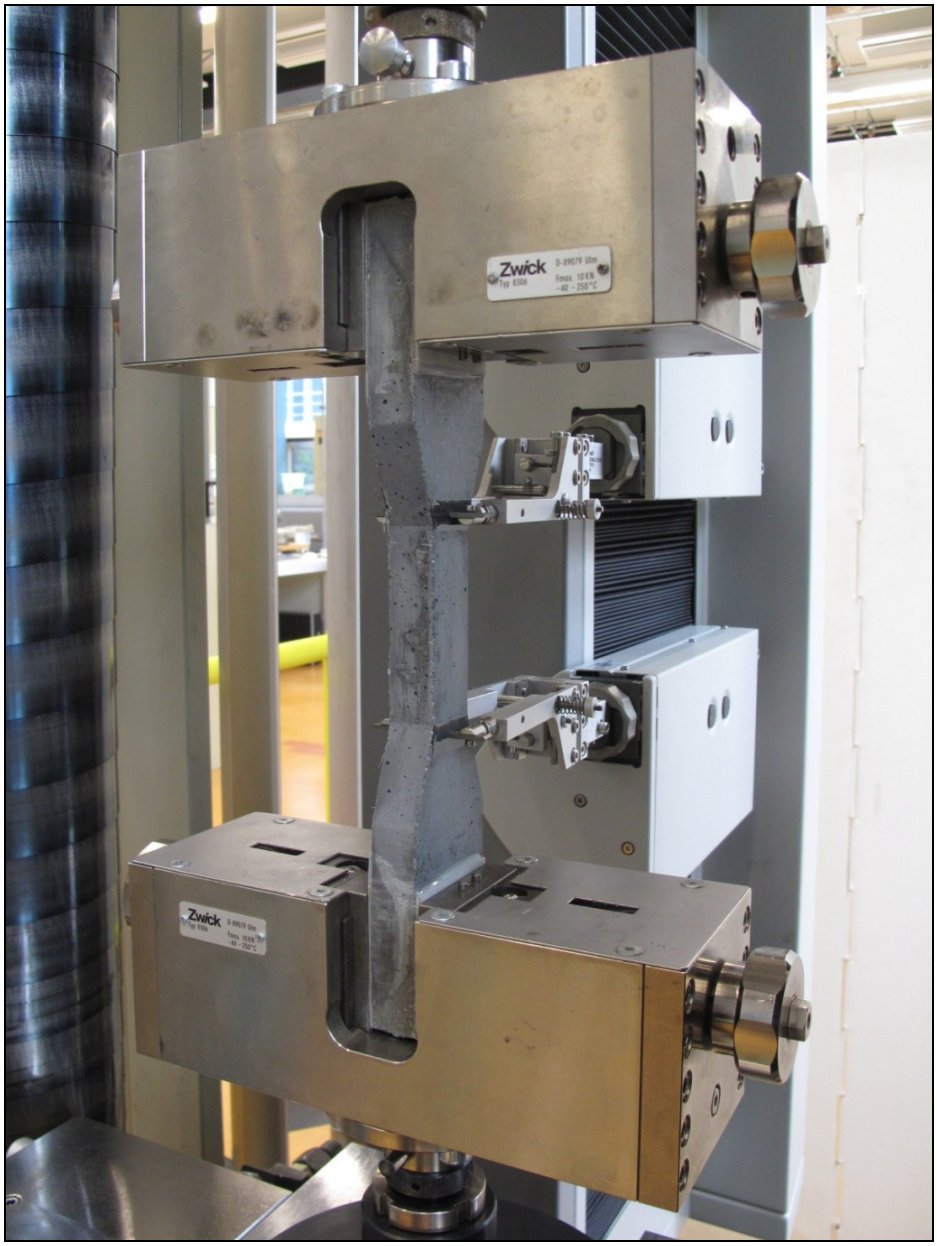
Flexural strength on four point bending on prisms 10x10x50 mm



REFOR-tec® GF5/ST-HS

tensile stress vs. strain % tests "dog bone" specimens according to CNR 204/2006 (strain stress measure)





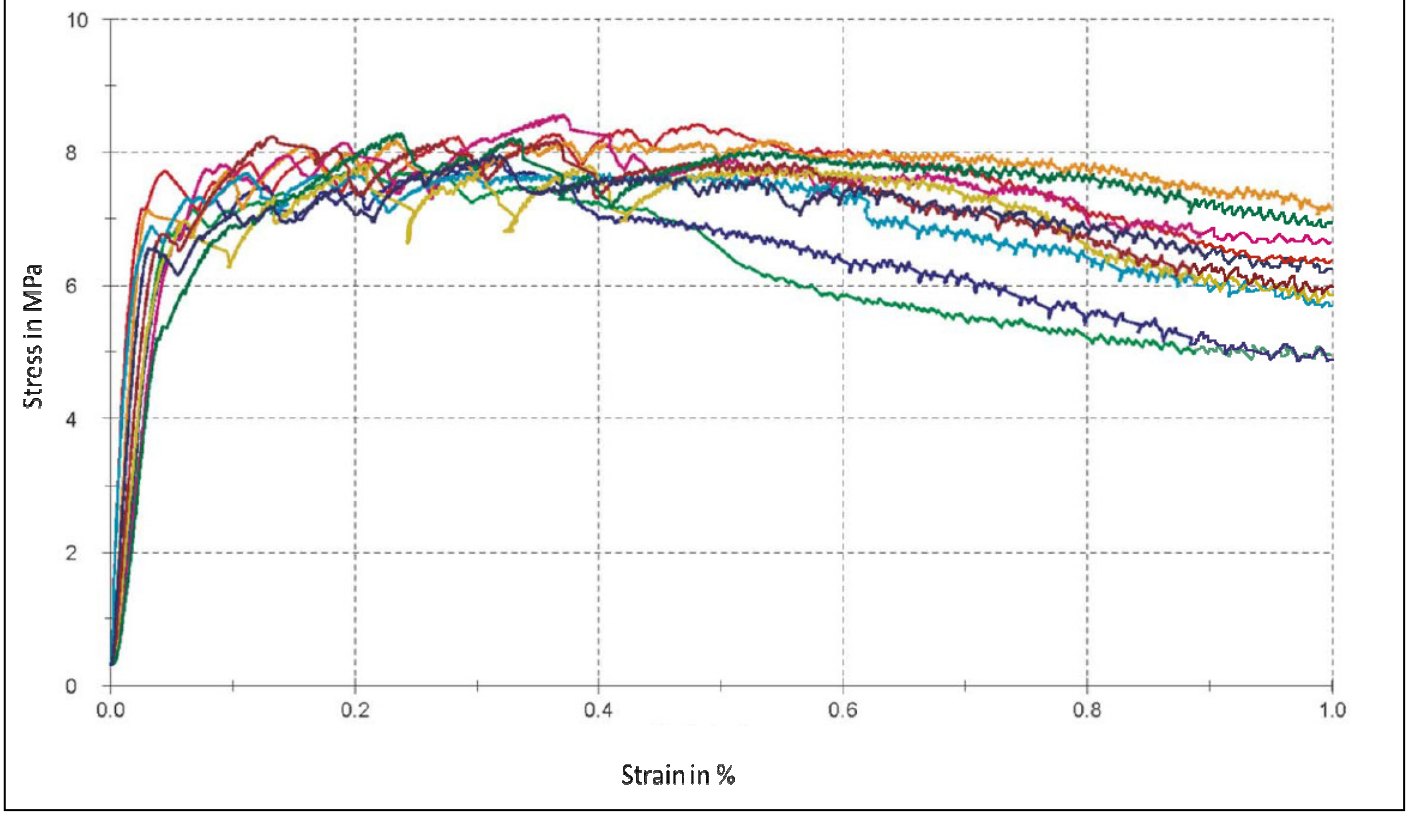
REFOR-tec® GF5/ST-HS

tensile stress vs. strain % tests

Results:

Legende	Nr	Sample name	a_0 mm	b_0 mm	S_0 mm²	L_e mm	R_{low} MPa	R_{high} MPa	m_E MPa	F_m N	R_m MPa	Remarks
	1	1A	20.87	29.65	618.80	90.0	1.8	3.8	41310	5213	8.42	Test o.K.
	2	2A	21.39	30.31	648.33	90.0	2.2	3.8	24917	5048	7.79	Test o.K.
	3	3A	21.18	30.11	637.73	90.0	2.2	3.8	20560	5006	7.85	Test o.K.
	4	4A	21.20	30.26	641.51	90.0	1.8	3.8	32341	5245	8.18	Test o.K.
	5	5A	21.42	30.04	643.46	90.0	1.8	4.0	17225	5508	8.56	Test o.K.
	6	6A	20.76	30.20	626.95	90.0	2.2	3.8	36824	4817	7.68	Test o.K.
	7	7A	20.74	30.25	627.39	90.0	1.5	3.0	20910	4901	7.81	Test o.K.
	8	8A	21.40	30.75	658.05	90.0	1.5	3.5	23122	5420	8.24	Test o.K.
	9	9A	20.69	30.03	621.32	90.0	2.2	3.8	17703	5147	8.28	Test o.K.
	10	10A	21.25	30.66	651.53	90.0	1.8	3.8	27438	5192	7.97	Test o.K.

Diagram-over view:



EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 14651

June 2005

ICS 91.100.30

English version

Test method for metallic fibered concrete - Measuring the flexural tensile strength (limit of proportionality (LOP), residual)

Méthode d'essai du béton de fibres métalliques - Mesurage de la résistance à la traction par flexion (limite de proportionnalité (LOP), résistance résiduelle)

Prüfverfahren für Beton mit metallischen Fasern - Bestimmung der Biegezugfestigkeit (Proportionalitätsgrenze, residuelle Biegezugfestigkeit)

REFOR-tec® GF 5 / ST - HS tricomponent

Microconcrete UHPFRCC

Ultra High Performance Fiber Reinforced Cementitious Composite

CE approved – Certificate n. 1305 - CPD - 0808
EN 1504-3 Class R4

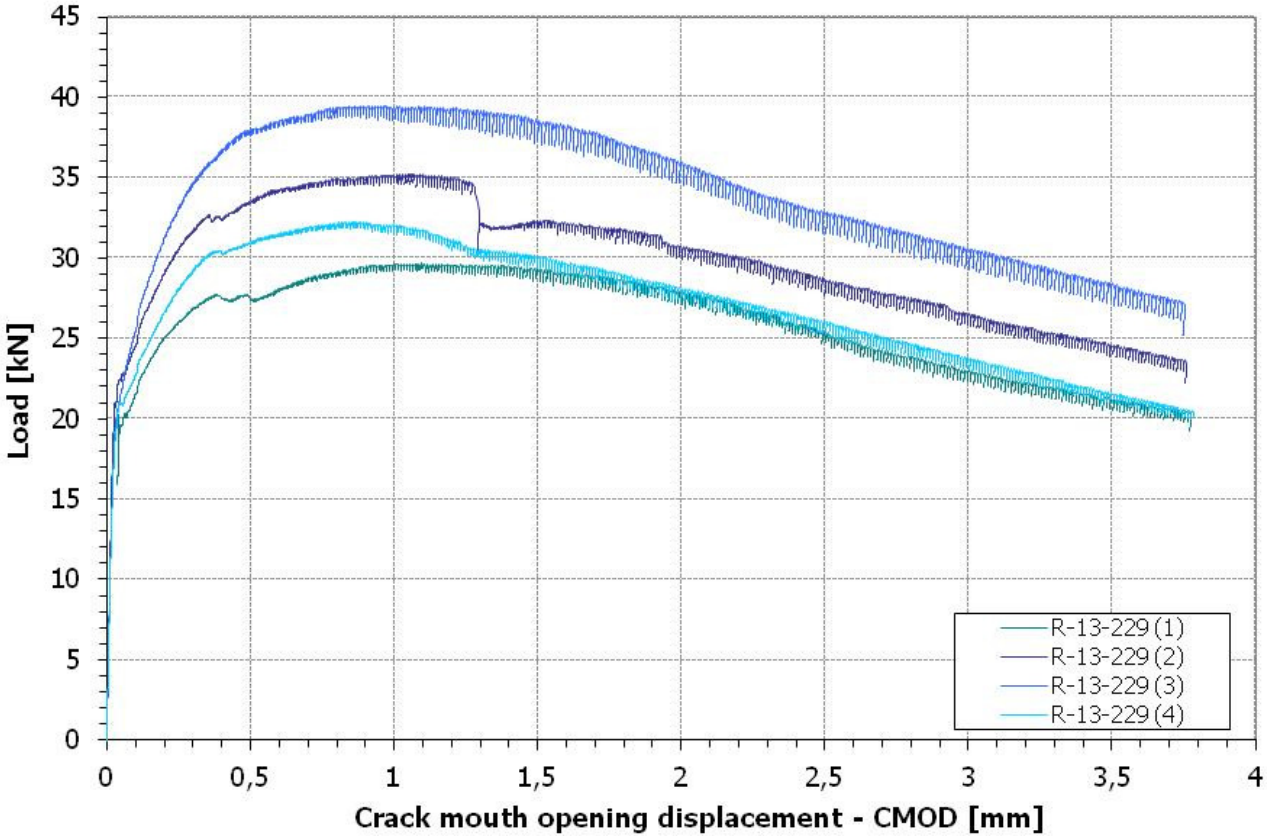
R4 EN 1504-3 NORMA EUROPEA

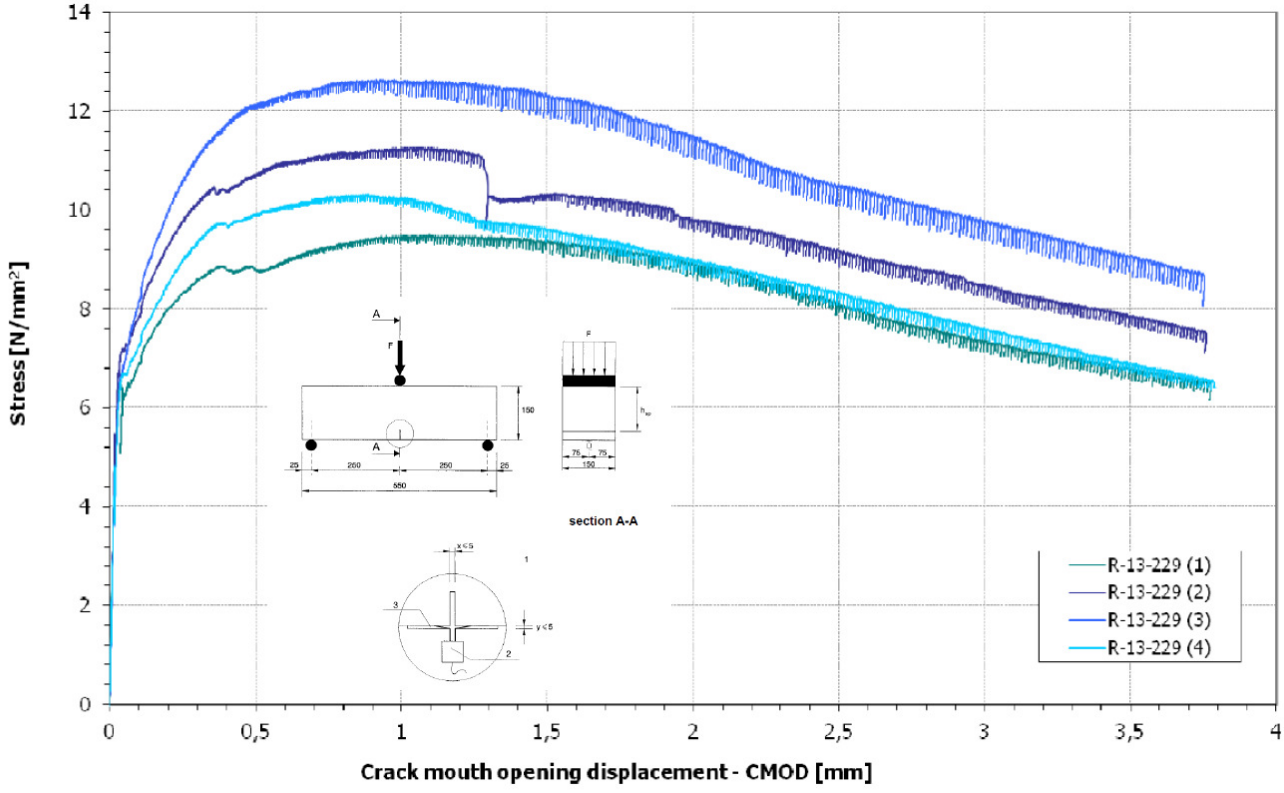
TEST REPORT – UNI EN 14651

Id. Code	Date of manufacture	Date of testing	F_L	$f_{ct,L}$	$f_{R,1}$	$f_{R,2}$	$f_{R,3}$	$f_{R,4}$
			[kN]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]
R-13-229 (1)	16/12/13	18/02/14	20.22	6.47	8.79	9.30	8.06	6.80
R-13-229 (2)	16/12/13	18/02/14	22.52	7.21	10.71	10.33	8.91	7.87
R-13-229 (3)	16/12/13	18/02/14	21.66	6.93	12.15	11.98	10.48	9.04
R-13-229 (4)	16/12/13	18/02/14	20.96	6.71	9.92	9.62	8.35	6.92

F_L	Load corresponding to the LOP
CMOD	Crack mouth opening displacement – CMOD (mm)
$F_{ct,L}$	LOP – limit of proportionality (maximum stress value in the range 0 - 0,05 mm)
$F_{R,1}$	Residual flexural tensile strength corresponding with CMOD1 (0,5 mm)
$F_{R,2}$	Residual flexural tensile strength corresponding with CMOD2 (1,5 mm)
$F_{R,3}$	Residual flexural tensile strength corresponding with CMOD3 (2,5 mm)
$F_{R,4}$	Residual flexural tensile strength corresponding with CMOD4 (3,5 mm)

Comparison of the curves load – CMOD





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