TATRAN

Structural reinforcement by the composite materials in the constructions - samples of projects and applications

Jarosław Małek civil engineer, Kompozyt Expo Workshop - Cracow 29th September 2022

Dear Meers,

When we talking about structural reinforcement always we standing in the front of the challange.

When we talking about structural reinforcement by the composite materials we standing in the front of the huge challange.

When we talking about structural reinforcement by the composite materials in the historical buildings we standing in the front of the extremly taff challange.

KOMPOZYT EXPO®

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KRAJOWY KLASTER KLUCZOWY

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think green

reduce

reuse

recycle

3R

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FRP

passive frame wood houses made of certified wood
natural insulation by healthy sheep's wool
recovery, renovation & cultural heritage

composite materials center
construction design office
structural reinforcement by composite materials

Based on the composite materials, it is possible to create safe and durable construction, rationally manage natural resources with positive environment effect and what is rather important reduce the energy demand for heating or cooling of the buldings.

Composite materials are in line with sustainable development standards and already constitute an alternative to replacing steel and aluminium in many industries, not only construction.

Of course is possible to apply composite materials, but not always, not everywhere and not anytime.

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KRAJOWY KLASTER KLUCZOWY

DESIGN → PRODUCTION → DISTRIBUTION

GFRP PRODUCTS:

COMPOSITIES BARS

COMPOSITIES MESH

COMPOSITIES PROFILES

In the constructions every day we meet the problems like: corrosion, thermal bridges, vertical deviation, decreasing of load bearing or many other weakness what can follow to damage.

To solve it there is no sense to increase the load of the reinforcement by increase the their weight, because this may no any sense. That’s why the light weight of composites is so practicall.

There are some engineering solution for structural or seismic strengthening by the composite materials to build, recovery and restoration of buildings, bridges, tunnels and cultural heritage.

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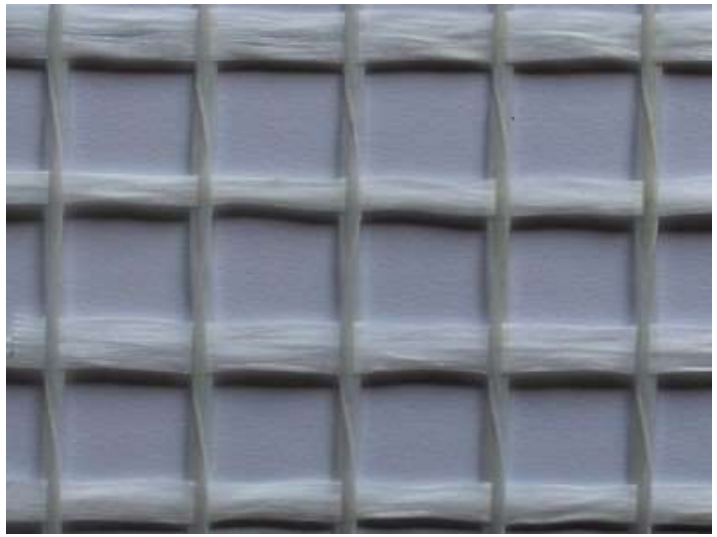
GFRP PRODUCTS:



Generally there are 2 groups of the reinforcement system:

FRP – Fiber Reinforced Polymer system what means polymer reinforced, continuous, high resistance fibers with the organic resins

and

FRCM – SRG system what means Fiber Reinforced Cementous Matrix or Steel Reinforced Grouts with inorganic matrix for example cement mortar.

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BFRP PRODUCTS:

We offer glass and basalt fibre rods and meshes, as well as shape sections of various geometries made of fibreglass and other: fabric, mats and lamellas of carbon fibre, together with proper mortars and resins for their assembly.

Reinforcement refers to the strengthening of concrete components to increase their load-bearing capacity. Reinforcement primarily increases the resistance of the composite material to tensile stresses, since concrete can only absorb a few tensile forces. Other component properties, such as flexural and compressive strength or deformation capacity, can also be improved by combining the materials.

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BFRP PRODUCTS:

Our Structural reinforcement is designed, manufactured and qualified especially for the needs of static load transmission and crack safety.

With this reinforcement you will much find more than just a substitute for conventional steel reinforcement.

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AFRP PRODUCTS:

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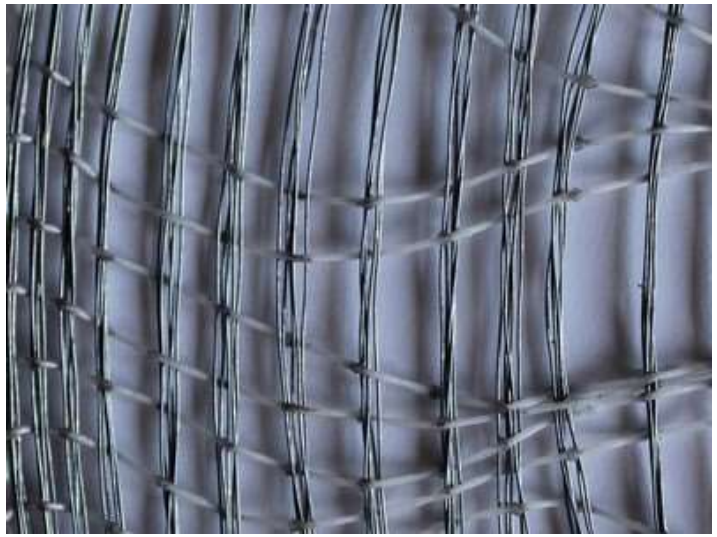
SRG PRODUCTS:



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CFRP PRODUCTS:

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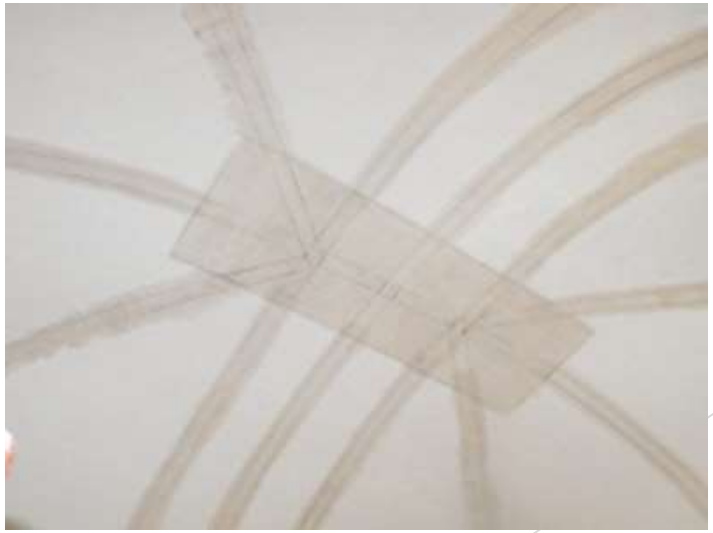
CFRP PRODUCTS:



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CFRP PRODUCTS:

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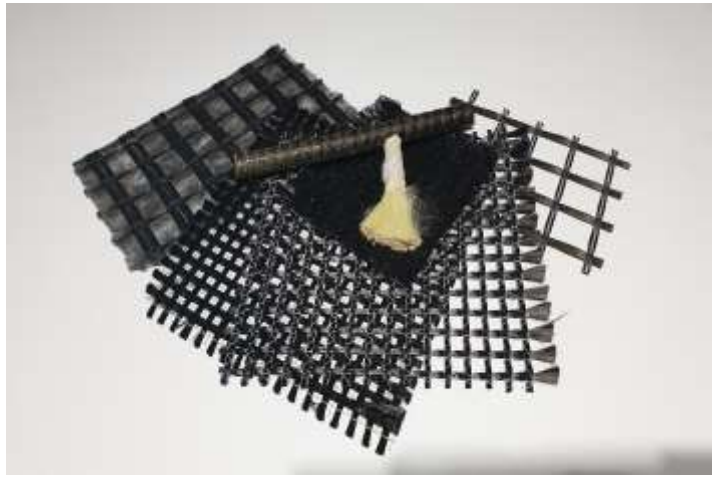
RESINS AND MORTARS:



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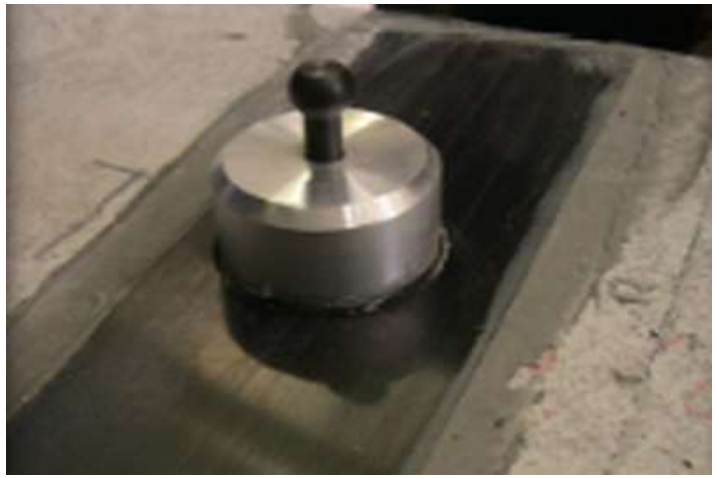
INSPECTION & CONTROL TOOLS:



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Bending | **Shear** | **Confinement**

○ RC ◉ FRP U - Wrap

Design Parameters

Comments

Geometry

T-section

w_i [mm]	h_i [mm]
1 000	770
250	180

r_c [mm]	0

Steel Reinforcement

Layers of rebar 1

n_k	ϕ_k [mm]	d_k [mm]	A_k [mm^2]
5	16	736	1 005

A_{sw} [mm^2]	57
α [°]	90
s [mm]	200
f_{yk} [MPa]	400
E_s [MPa]	200000
γ_s	1.15

Strengthening

C-Sheet 240/300 info

Continuum sheet

n_f	2
β [°]	90
t_f [mm]	0.165
E_f [MPa]	240000.0
ε_{fk}	0.0158
$\gamma_{f,d}$	1.35
γ_f	1.10
γ_{Rd}	1.20
η_a	0.95
FC	1.00

Distributed load

Concrete

f_{ck} [MPa]	25
γ_c	1.50
θ_c [°]	45

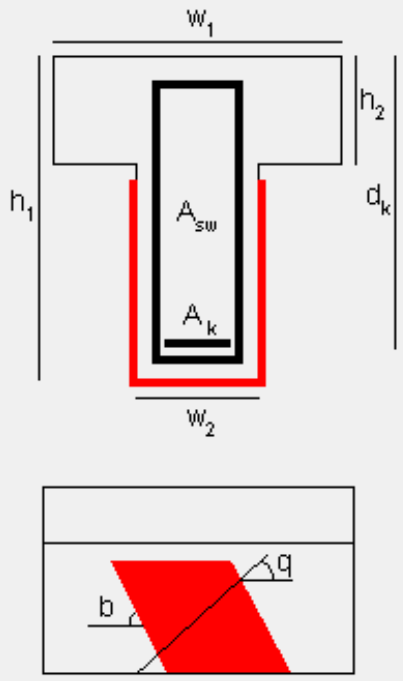
CNR-DT 200 R1/2013

k_b	1.000
Γ_{Fk} [N/mm]	0.340
l_e [mm]	107.2
f_{fdd} [MPa]	737.13
$f_{fdd,2}$ [MPa]	1071.12
ε_{fd}	0.00446

Results

f_{fed} [MPa]	697.38
$V_{Rd,u}$ [kN]	65.66
$V_{Rd,f}$ [kN]	254.07
V_{Rd} [kN]	319.73
$V_{Rd}/V_{Rd,u}$	386.92%

Cross-Section



Applied Normal Force

N_{ed} [kN]	0

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Bending | Shear | Confinement

○ RC ◉ FRP M_{Ed}+ ◉ END ANCHORAGE

Design Parameters

Comments

Geometry

T-section

w_i [mm]	h_i [mm]
1 000	770
250	180

a [mm]	10
l [mm]	4800

Steel Reinforcement

Layers of rebar 1

n_k	ϕ_k [mm]	d_k [mm]	A_k [mm^2]
5	16	736	1 005

f_{yk} [MPa]	400
E_s [MPa]	200000
γ_s	1.15

Strengthening

Sheet | info

C-Sheet 240/300

w_f [mm]	250
n_f	1
t_f [mm]	0.165
E_f [MPa]	240000.0
ε_{fk}	0.0158
$\gamma_{f,d}$	1.35
γ_f	1.10
η_a	0.95
FC	1.00

Distributed load

Concrete

f_{ck} [MPa]	25
γ_c	1.50

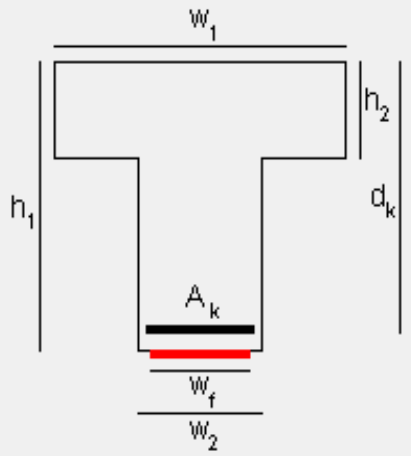
CNR-DT 200 R1/2013

k_b	1.183
Γ_{Fk} [N/mm]	0.250
l_e [mm]	88.3
f_{fdd} [MPa]	632.17
$f_{fdd,2}$ [MPa]	1647.72
ε_{fdd} [MPa]	0.00687
ε_{fd}	0.00687

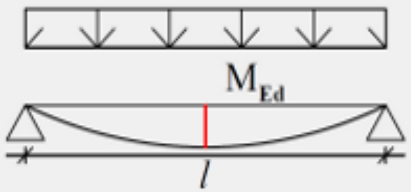
Results

x [mm]	82.7
σ_c [MPa]	-9.29
σ_s [MPa]	347.83
ε_f	0.00687
M_{Rd} [kNm]	252.85
$M_{Rd,s}$ [kNm]	297.65
$M_{Rd,s}/M_{Rd}$	17.72%

Cross-Section



Applied Load



Previous Applied Moment

M_0 [kNm]	0
M_{Ed} [kNm]	93

Lets see some samples what we have realized:

Almost 2 years ago in Józefów close to the Warsaw we have used a composite materials to strengthen the ceiling in the single-family house.

The goal was to enlarge area of the living room by removing the staircase and one concrete column that has been supporting the ceiling. That concrete beam supported 7,5kN.

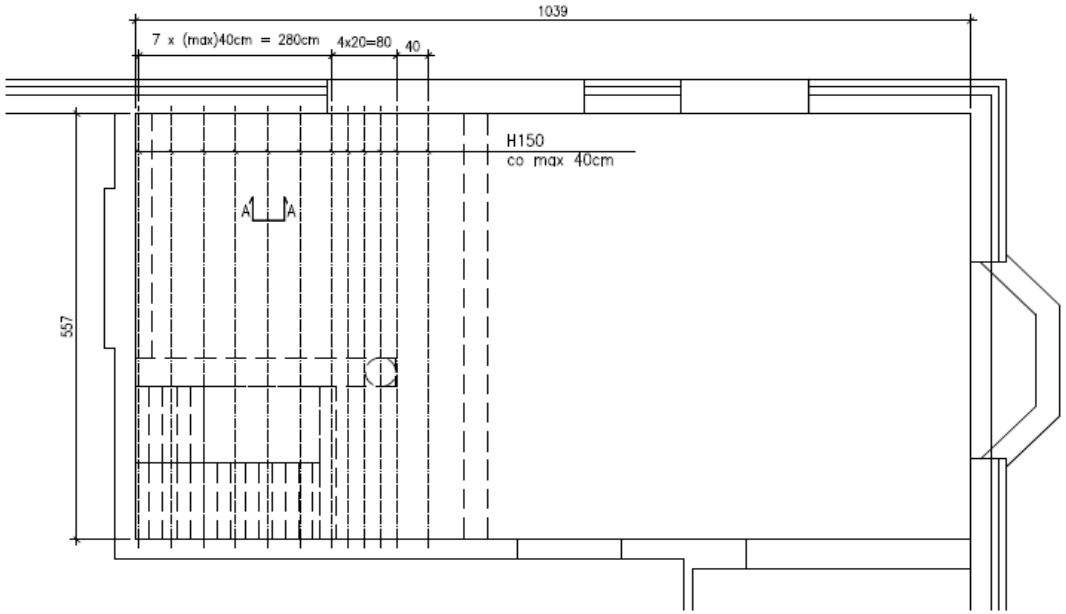
The construction of the ceiling was done by FERT system with beams spaced at 60cm and with max span about 5,5m.

On the floor above that ceiling was the bathroom with big bathtub and we had to avoid the cracking of the ceiling finish layer.

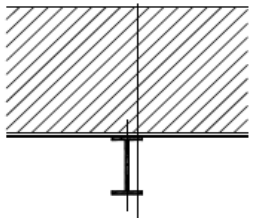
Project was realized as follows: all ceiling covers were removed to uncover and clean up the construction, surface of the ceiling was covered by the primer, the ceiling surface was align using two-component cement mortar (its high strength mortar for concrete renovation: Concrete Rock V2), under the mortar there was immersed the two directions carbon fiber fabric (C-net destiny 220 BL),

further the second layer of the Concrete Rock V2 mortar was applied, next there were pasted by epoxy resin carbon lamellas CFPR (CFK width 100mm and thickness 1,4mm) in a cross-directions and spaced at 80cm, then everything was additionally supported by the GFRP beams H 150mm spaced at 40cm, and post-stressed up as much as possible,after 28 days we removed concrete column.

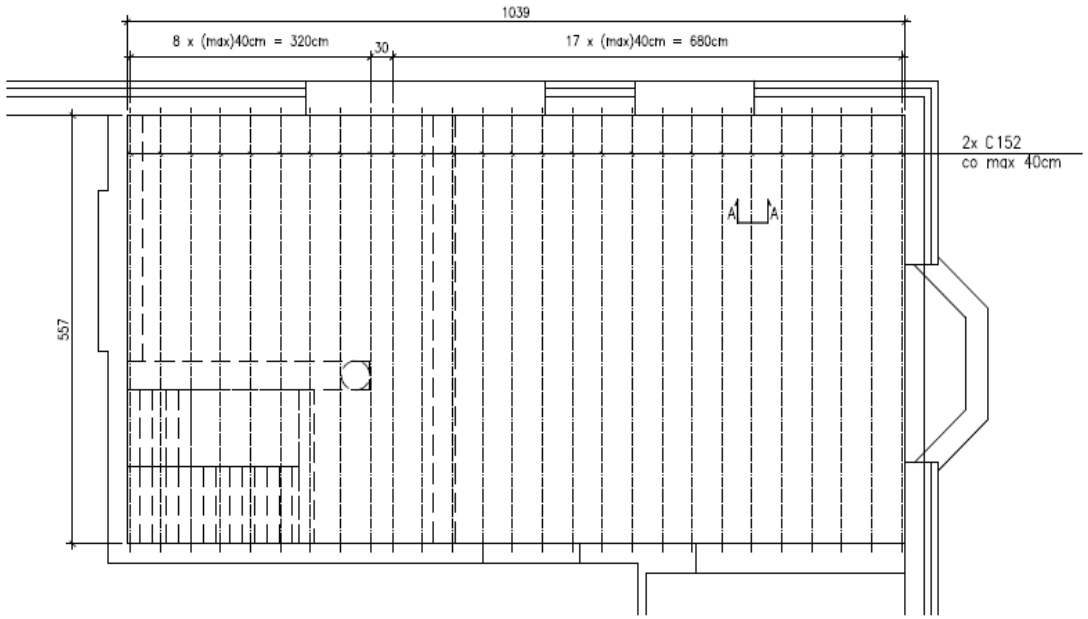
Before reinforcement the client mark the revision eye to check the eventually cracks, but in the upper bathroom was no any cracks



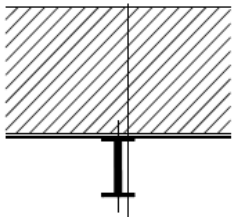
Przekrój A–A
skala 1:10



1. Strop FERT 24
2. Siatka węglowa dwukierunkowa 15x15mm
3. Lamele węglowe co 80cm
4. H150



Przekrój A–A
skala 1:10



1. Strop FERT 24
2. Siatka węglowa dwukierunkowa 15x15mm
3. Lamele węglowe co 80cm
4. 2x C152 wzmocnione lamelami węglowymi w układzie pionowym

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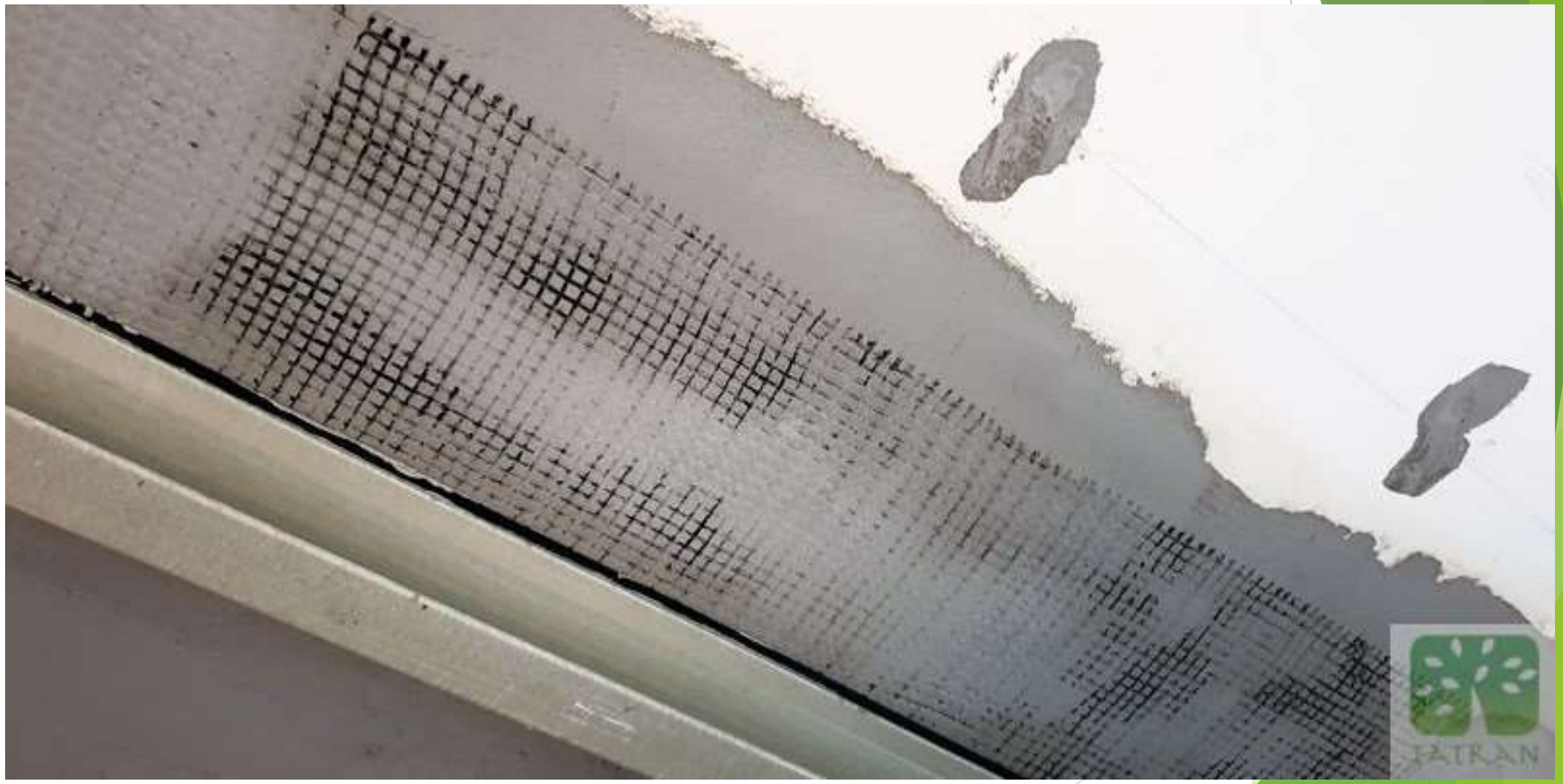

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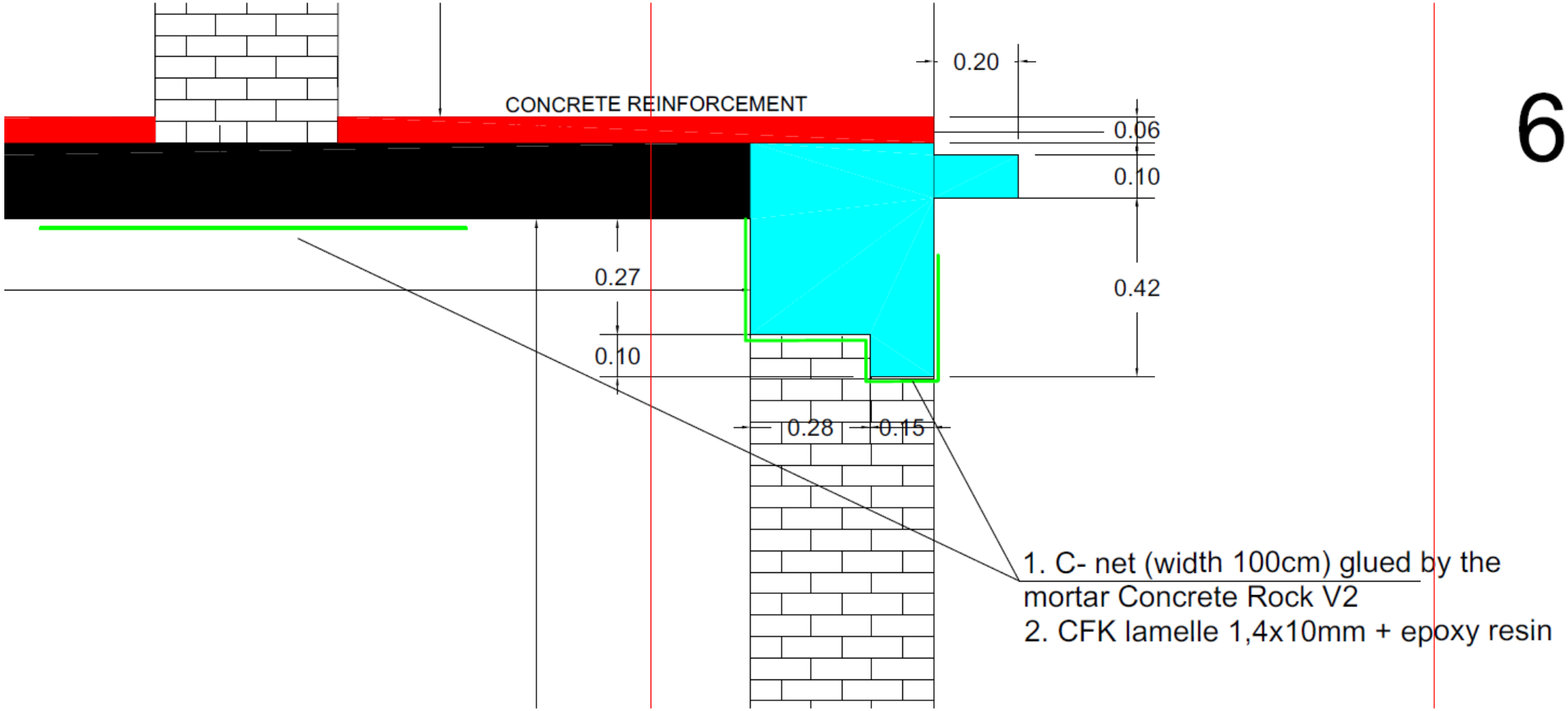
Other realizations:

- Lintel Racibórz
- Lintel Olkusz


CONCRETE REINFORCEMENT
0.20
0.06
0.10
0.42
0.27
0.10
0.28
0.15
1. C- net (width 100cm) glued by the mortar Concrete Rock V2
2. CFK lamelle 1,4x10mm + epoxy resin

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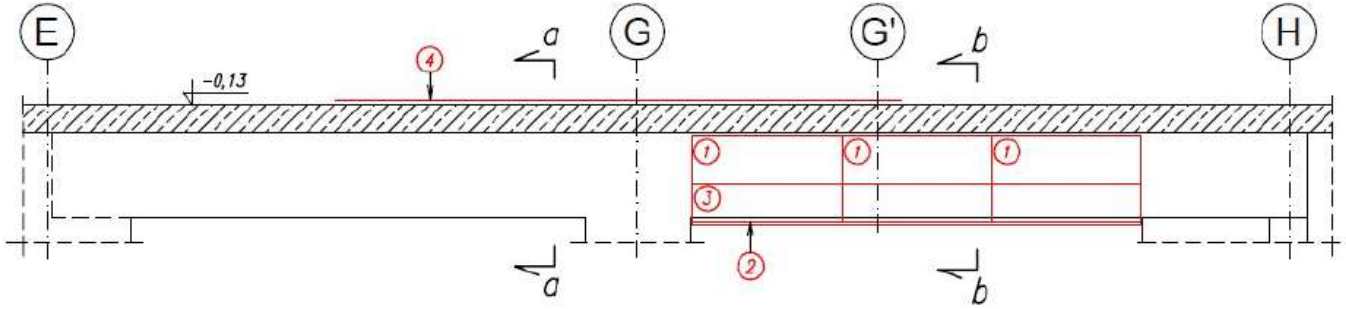
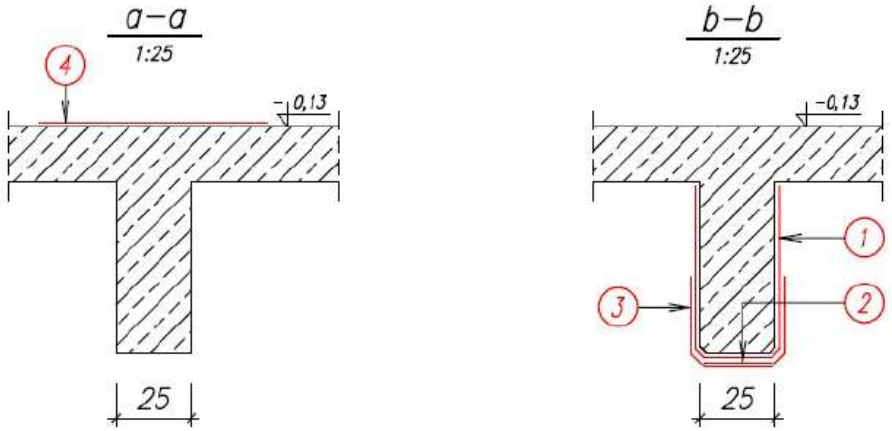
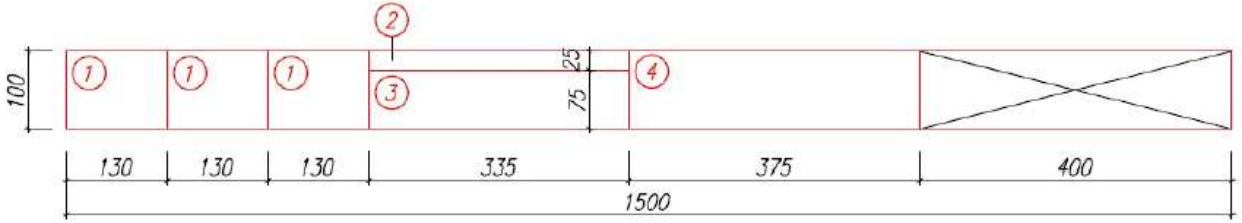
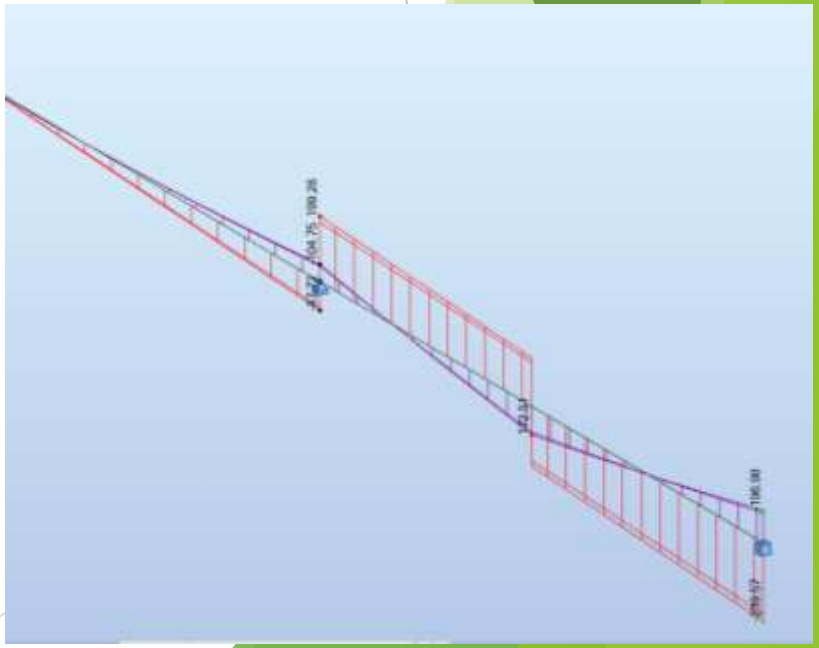
Belka Poz. B-B.2









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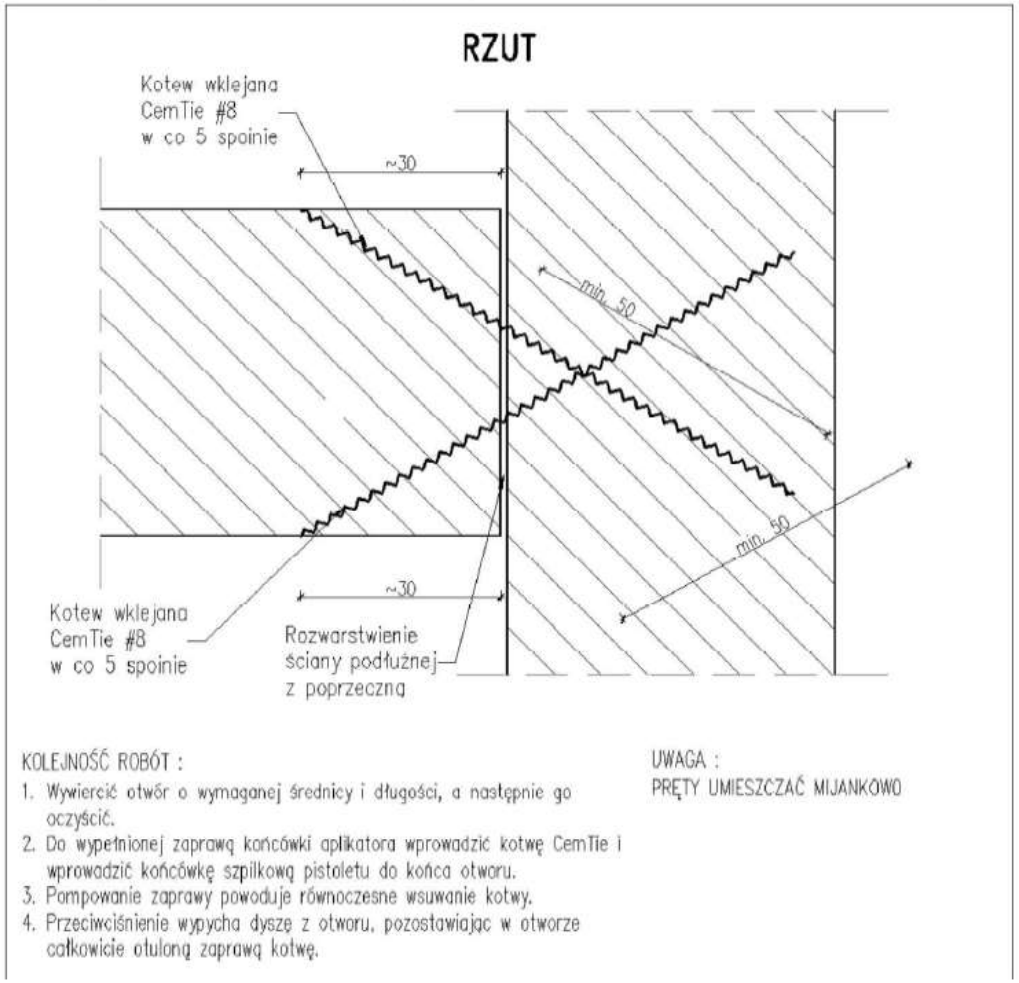
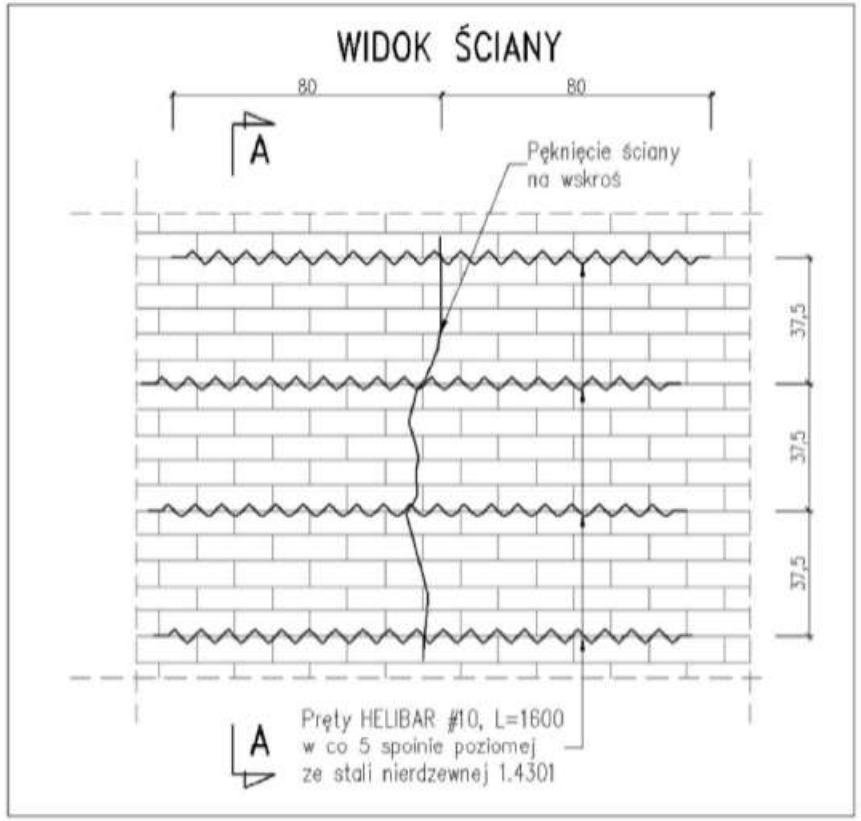
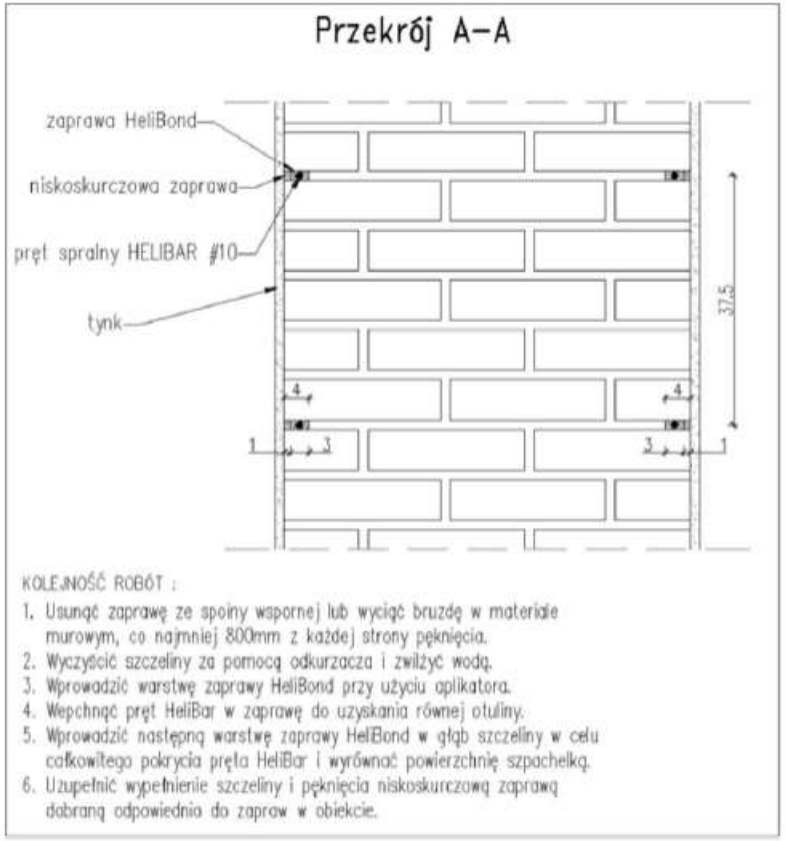
Naprawy rozwarstwień ścian poprzecznych z podłużnymi należy wykonać według poniższego schematu stosując obustronnie kotwy CemTie w układzie krzyżowym.



Rys. 7 *Zszycie rozwarstwionych ścian - rzut.*



Rys. 4 *Schemat wzmocnienia naprawy – rzut.*



Rys. 5 *Schemat wzmocnienia naprawy - przekrój.*

- R&D projects:

Composite tie Our R&D project consists of composite tie rods for stay-in-place formworks, which reduce the quantitative demand for concrete, increase the thermal resistance of buildings, are resistant to corrosion and are less expensive and more effective than steel.

Our R&D project: GFRP composite tie

GFRP COMPOSITIES TIE

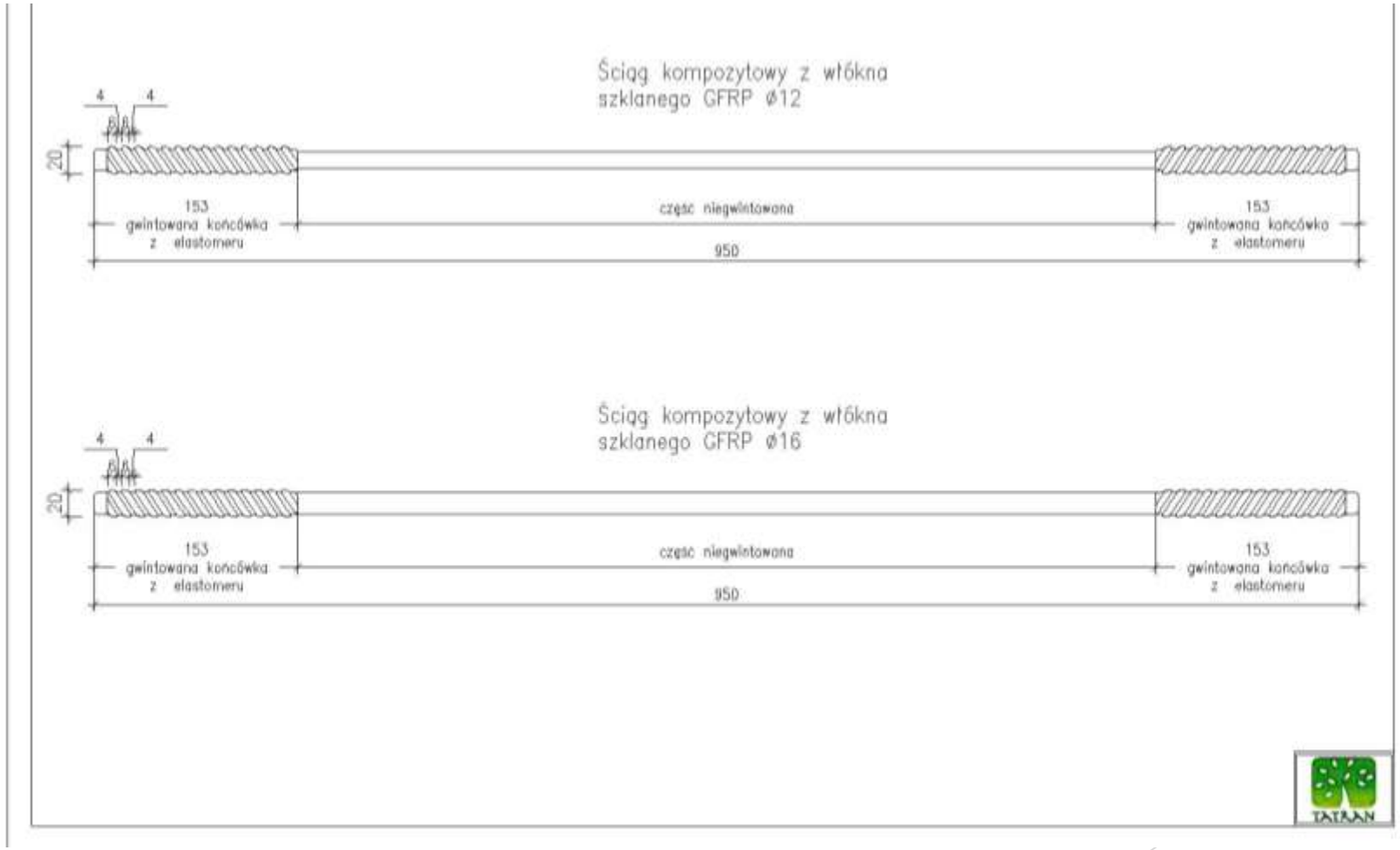
LOWER INVESTMENT COSTS

LESS CARBON FOOTPRINT

HIGHER HEAT RESISTANCE

TIME SAVING

Our R&D project: GFRP composite tie



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Our R&D project: GFRP composite tie

- R&D projects:

TimberFRP by the glue the carbon textile between lower lamelles of the wood we have a target to reduce a geometric cross-section profile of the wood, reduce the weight and increase the strength. All surface of wood is protected by the fire retardant no salt impregnation. For received the result we need to move out the compression area away of form the tension zone. After some laboratory test we have seen that this way may sense.

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Our R&D project: Timber FRP GL + C net

TATRAN FRP

POLSKI KLASTER TECHNOLOGII KOMPOZYTOWYCH

KRAJOWY KLASTER KLUCZOWY

Our R&D project: Timber FRP GL + C net

TATRAN FRP

POLSKI KLASTER TECHNOLOGII KOMPOZYTOWYCH

KRAJOWY KLASTER KLUCZOWY

Our R&D project: fire retardant GFRP rods + hybrid core CFRP+GFRP

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POLSKI KLASTER TECHNOLOGII KOMPOZYTOWYCH

KRAJOWY KLASTER KLUCZOWY

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Thank You very much for Your attention.

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