Assessment and Rehabilitation of Central European Highway Structures

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FEHRL

Strengthening with FRP glued materials

Marek Łagoda
Tomasz Wierzbicki

27-28 August 2009
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CERTAIN

- ***Task 4.6: The use of prestressed externally glued FRP. Stress distribution in contact strip-element layer upon the experiments and finite elements modeling.***
- ***Task 4.7: Bonding of FRP under static and dynamic load. Formulate and control the concrete strength changes in different types (cross-section) of supporting columns.***

Main participants

Poland

Road and Bridge Research Institute -Warsaw

- ***Marek Łagoda, Tomasz Wierzbicki***

Road and Bridge Research Institute - Kielce

- ***Mirosław Biskup***

Slovakia

University of Zilina

- ***Patrik Kotula***

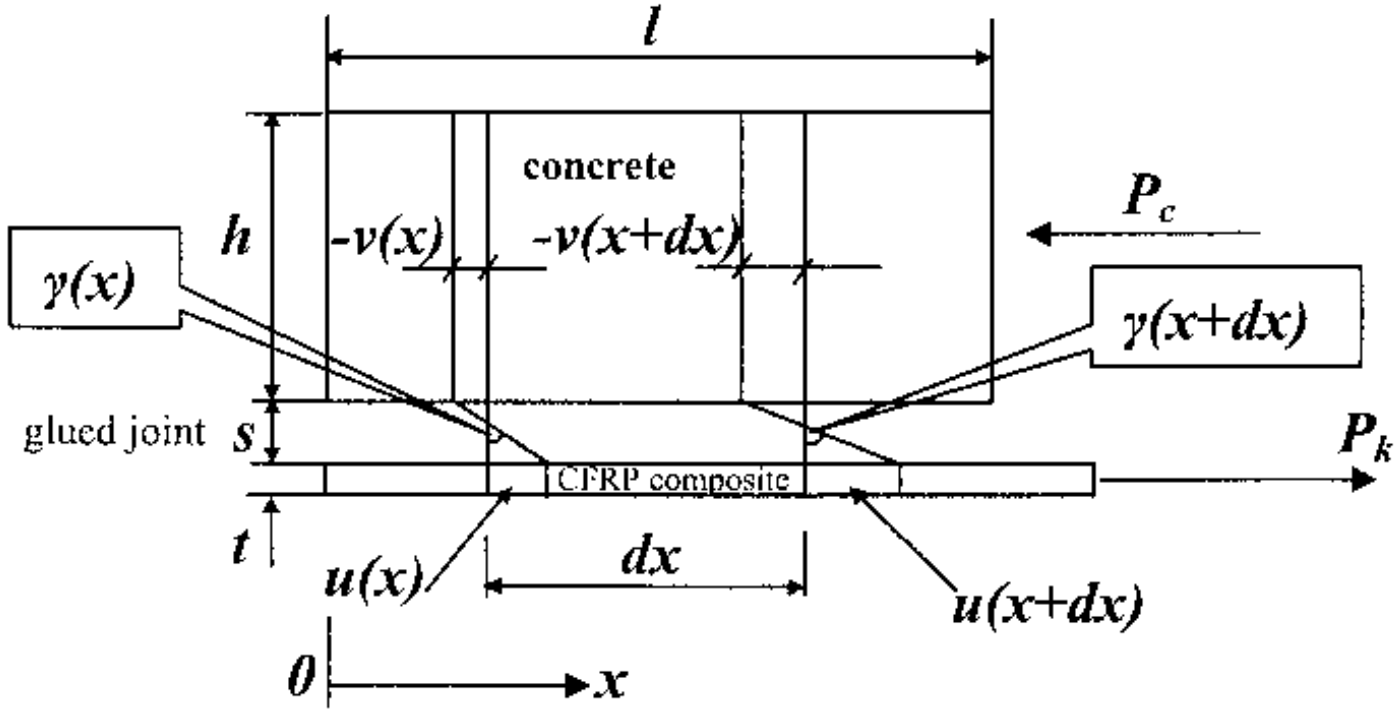
Deliverable

Guidelines for prestressed externally glued CFRP strips

Milestone

Stress-strain models of FRP-confined concrete columns

Analisis of equilibrium in the joint of the glued, tensioned element



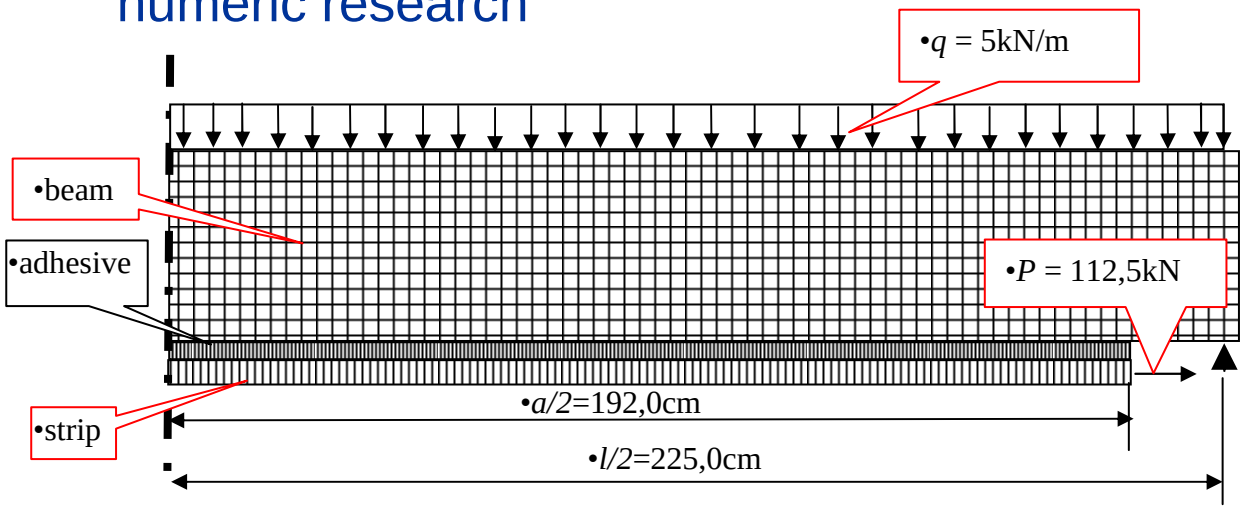
Theoretical model of glued joint transmiting pure shear

The distribution of shear stress in the glue joint was determined on the basis of theoretical analysis of equilibrium state.

This knowledge allowed the system of stressing CFRP strip and strengthening the prestressed girder to be designed. The girder was tested under static and dynamic loads.

Prestressed Beam

numeric research



Detailed description of material properties:

Beam: l_t = *420,0 cm;* *h=22,0 cm;* b_c=*27,0 cm*

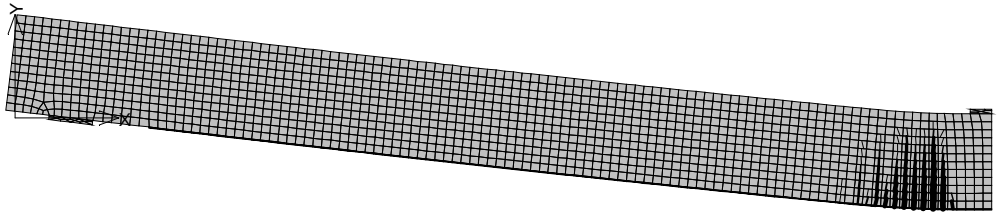
Concrete: *C40;* E_{cm} = *34 GPa; G = 13,08 GPa* ν = *0,3*

Adhesive: thickness s_{max} =*1,0 mm; E = 10 GPa; G = 4 GPa,* ν = *0,35*

Strip: *width* b_k = *75 mm; thickness* t_k = *1,2 mm; E = 210 GPa, G = 87 GPa,* ν = *0,2*

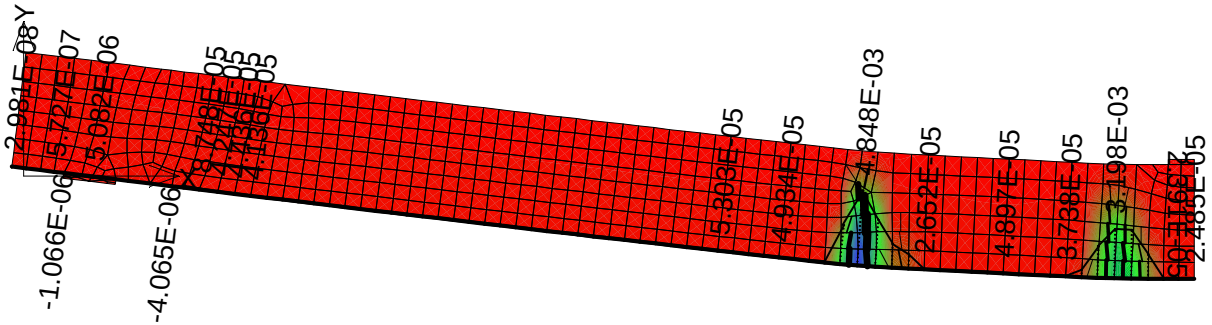
Selected results (FEM)

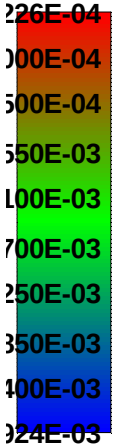
Crack development



grid size 20 mm, q=5kN/m; P=122,5kN

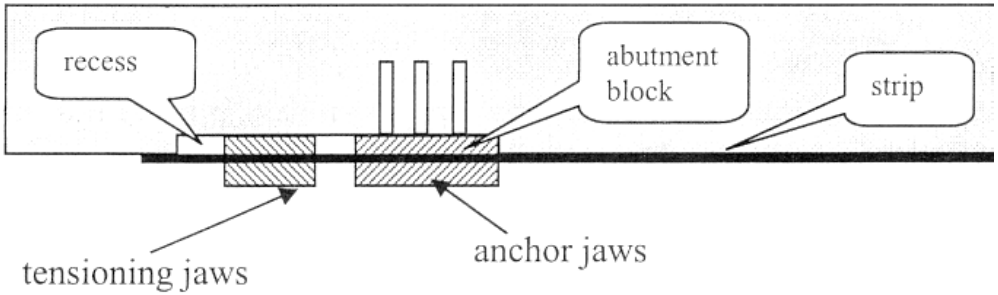
Distribution of strain



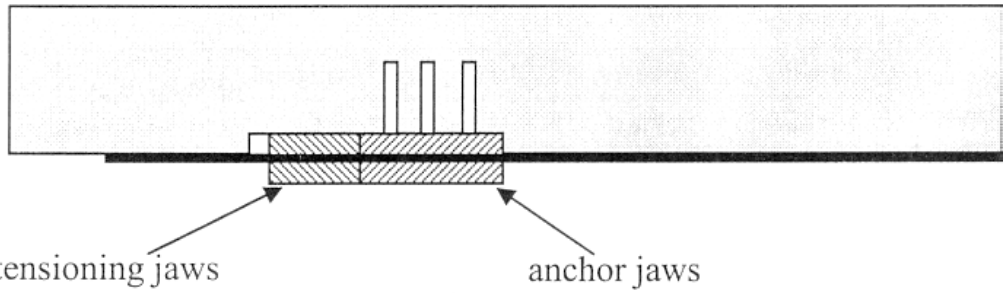


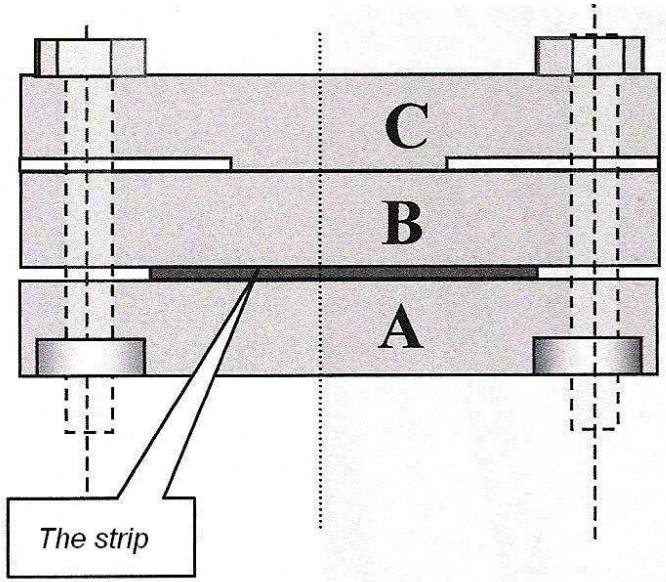
The stressing system description

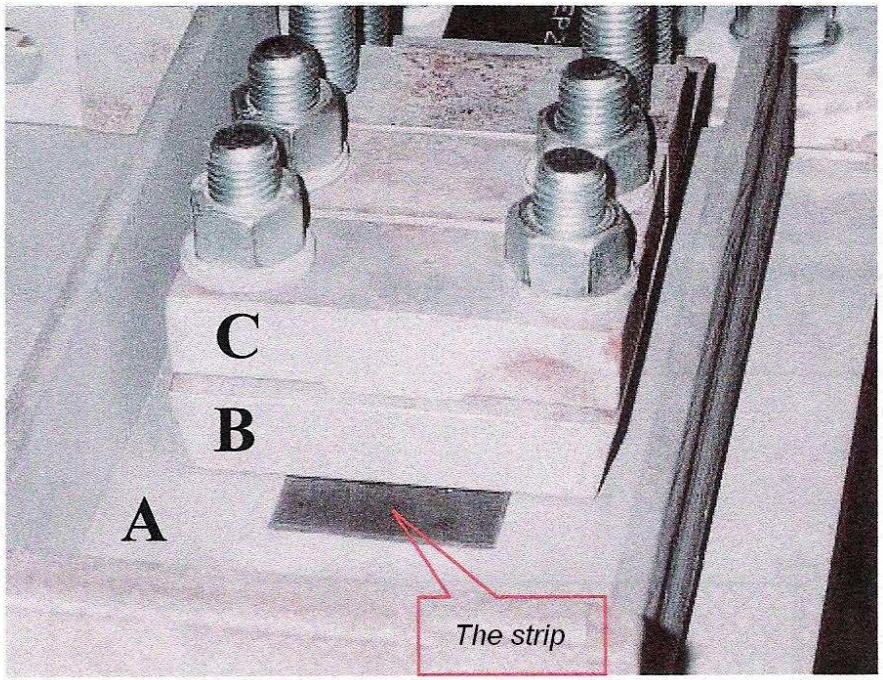
a) active part



b) passive part



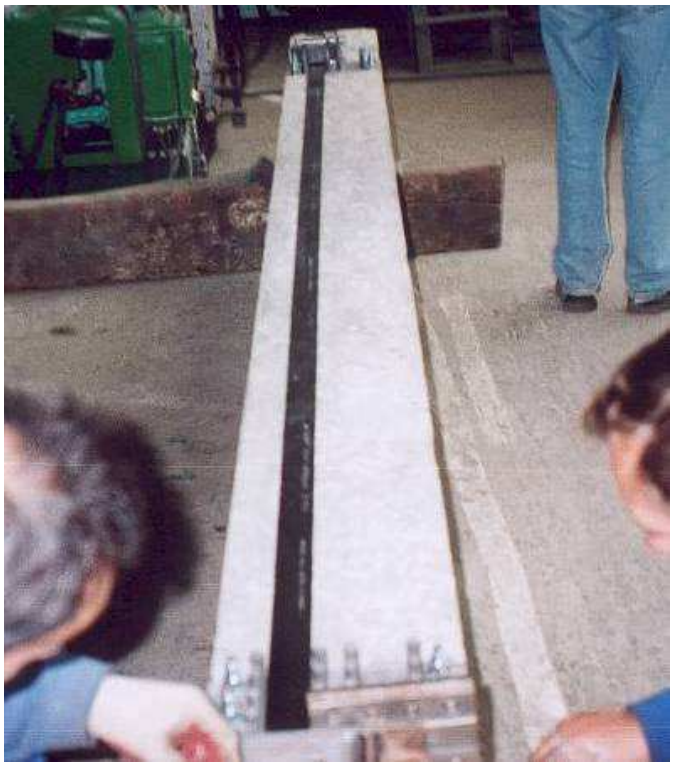

C
B
A
The strip

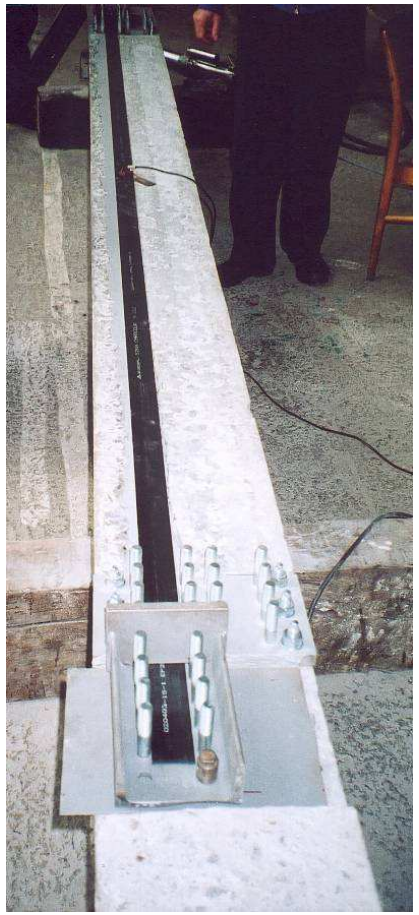

C
B
A
The strip

Recess forming and resin placing

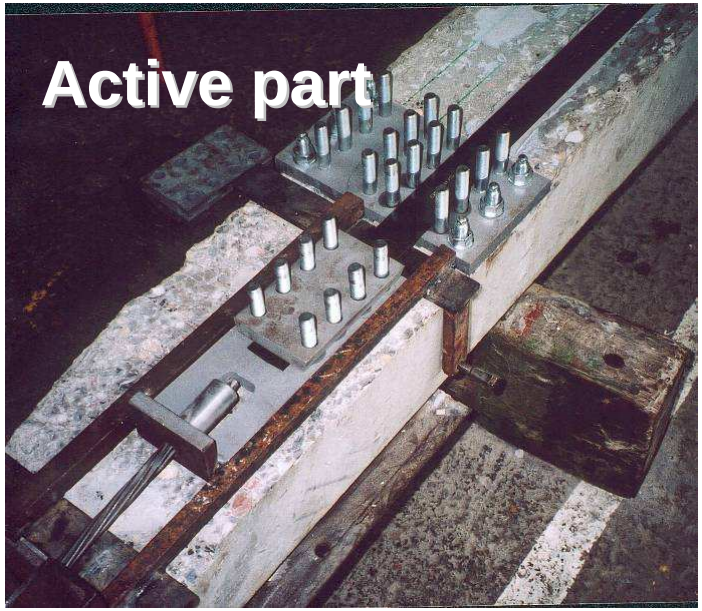
Preparation of the strip

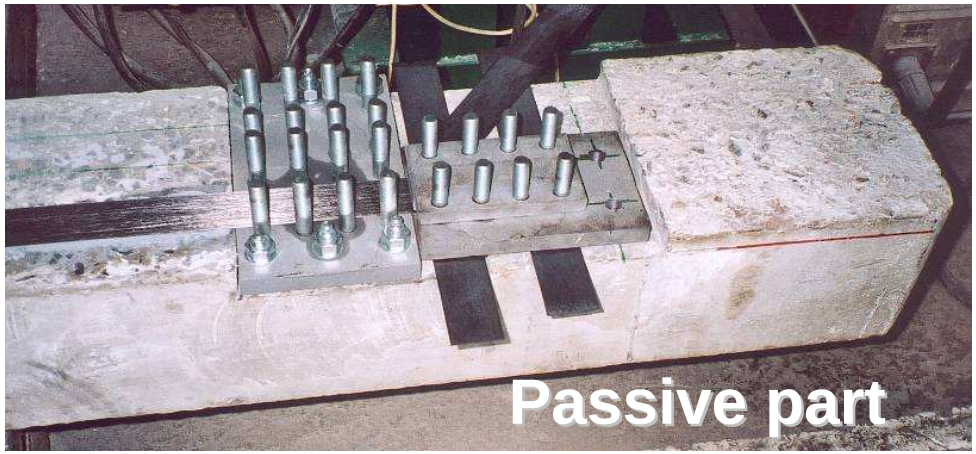
Adjustment and sticking of the strips



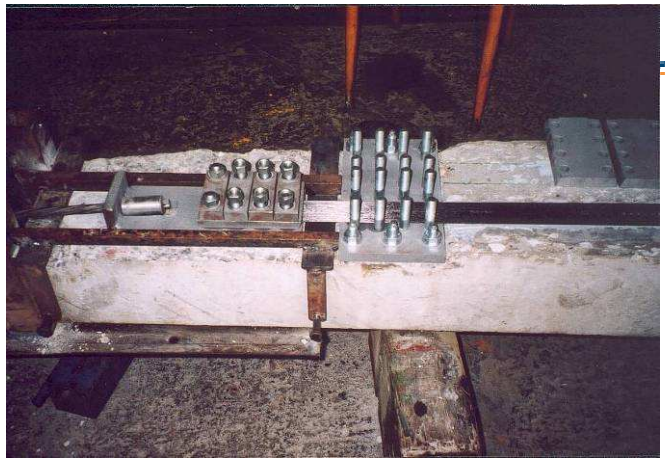


Assembly jaws



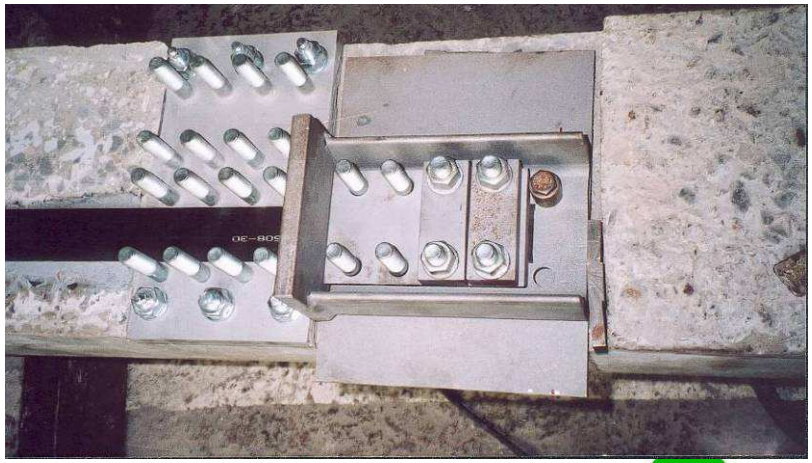


The strips prestressing



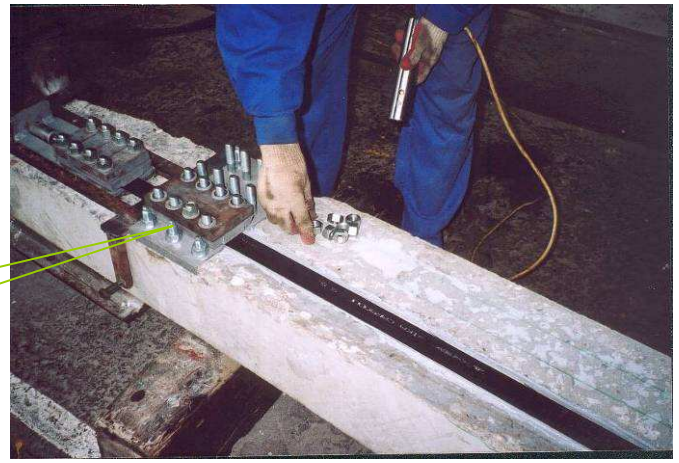
The first step

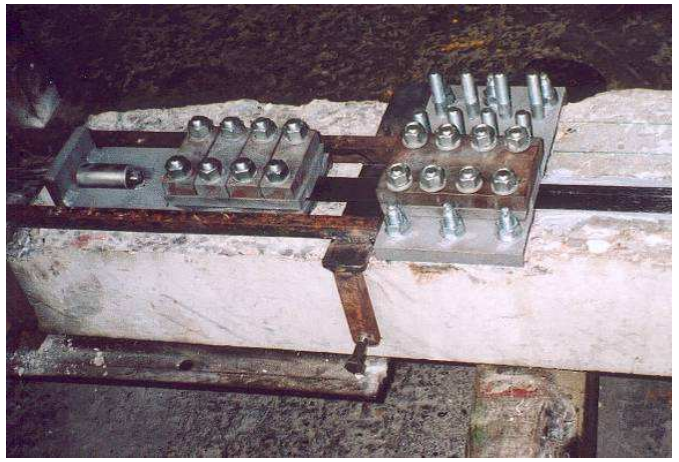
The second step



The prestressed strips anchoring

The anchor jaws bolting





The final action

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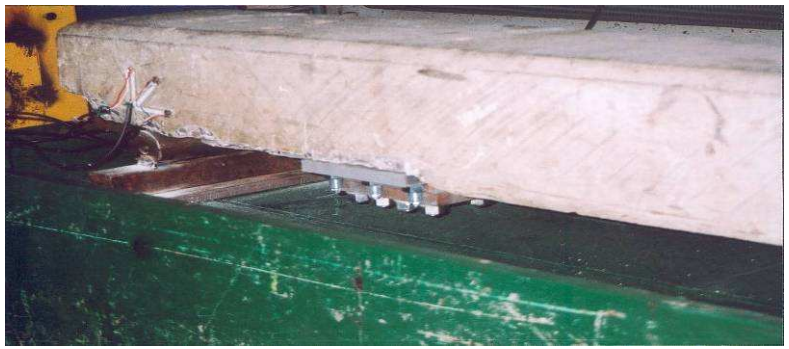
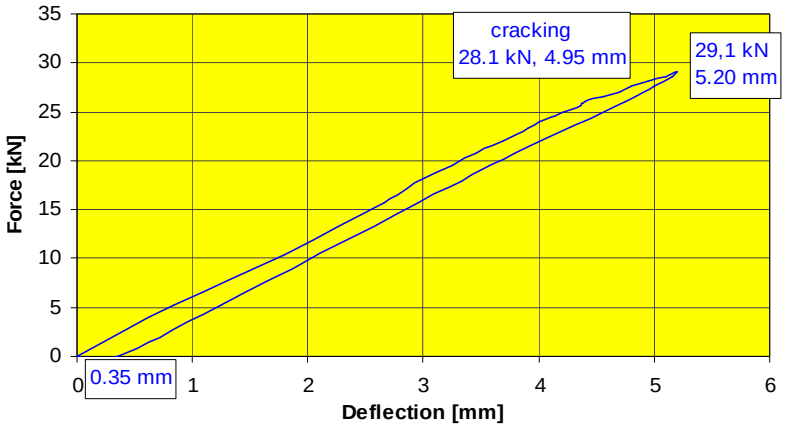
Girder testing and situation of measuring points

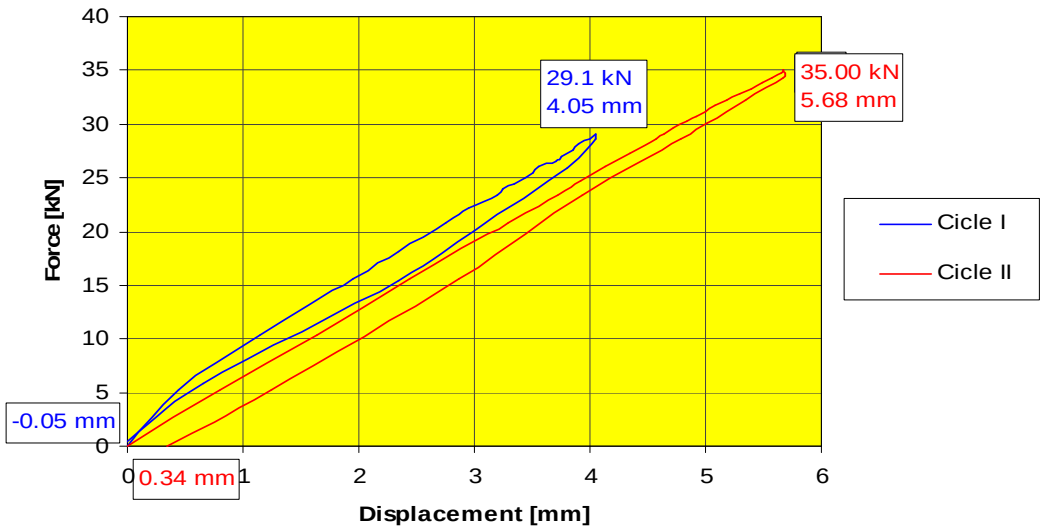


Selected investigation results

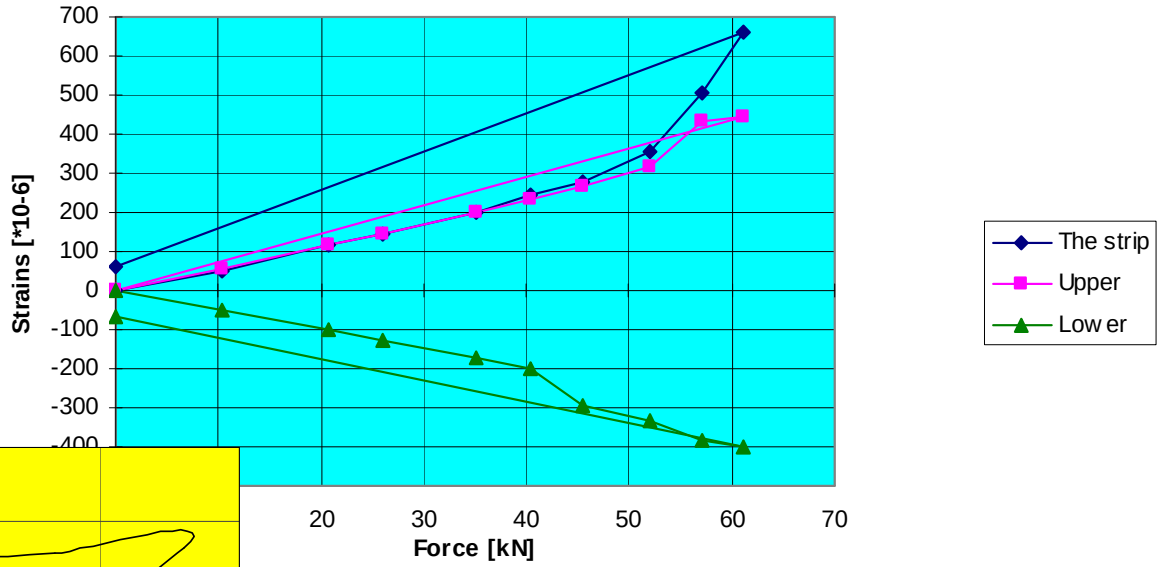


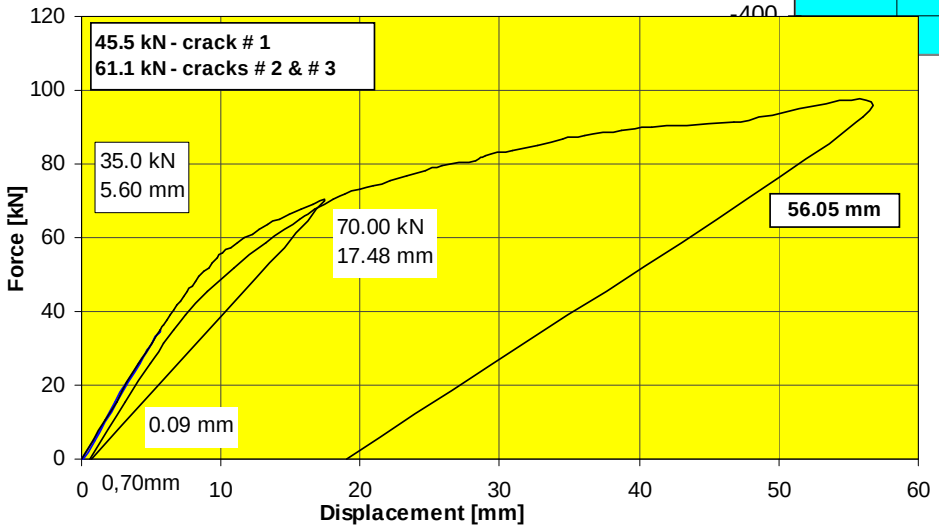
Deflections at mid-span of not strengthened beam

Deflections at mid-span of strengthened beam



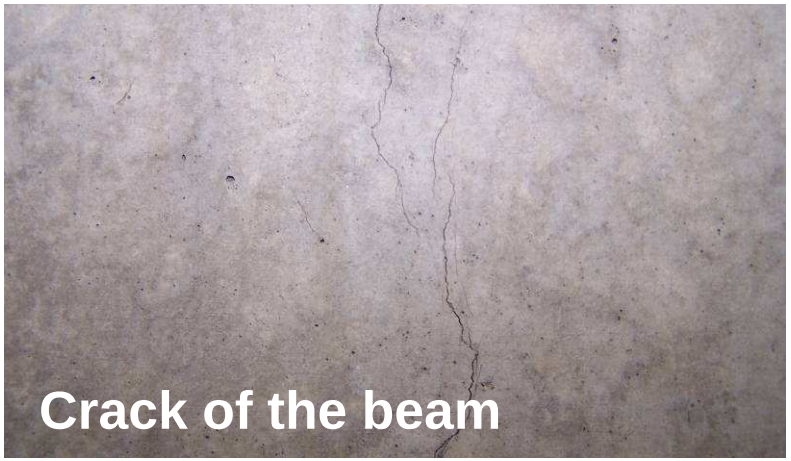
Selected investigation results





Practical use of prestressed externally glued CFRP strips

20 beams in Tychy Brewery. # 1 Application


Crack of the beam


The structure


Blocs anchor


Active part

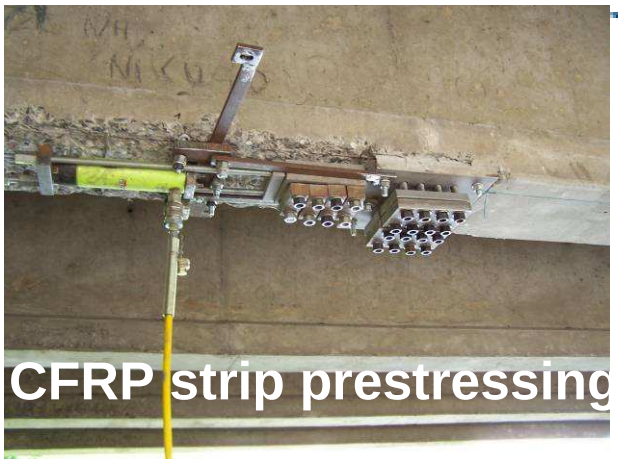

Jaws assembly


CFRP strip prestressing

Protection of the tense tape

Practical use of prestressed externally glued CFRP strips
12 beams in Seroczyn Bridge. # 2 Application


Jaws assembly


CFRP strip prestressing


Passive part

Deliverable

GUIDELINES FOR
PRESTRESSED EXTERNALLY
GLUED CFRP STRIPS

Sustainable Development, Global Change and Ecosystems
Sustainable Surface Transport

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Strategic Targeted Research Project

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Assessment and Rehabilitation of Central European Highway Structures

D13: Recommendations for prestressed externally glued FRP strips

Deliverable D13

Document number:		Version:		Date:	

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2. *Design specification*
3. *Design process overview*
4. *Practical execution and quality control*

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1.3.1. Limit states and design situations

1.3.2. Verification of the SLS

1.3.3. Verification of the ULS

1.3.4. Accidental situation

1.3.5. Special design considerations

1.3.6. Durability

2. Design specification

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2.3. Load factors
2.4. Environment
2.5. Temperature
2.6. Moisture
2.7. Chemicals
2.8. Ultraviolet radiation
2.9. Fire

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3.2. General design principles

3.3. Structural design

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Practical execution and quality control

4.1. Preparation of the surfaces

4.2. Qualification of workers

4.3. Quality control on the practical execution

4.4. Bond quality control after the practical execution

4.5. In-service inspection and maintenance

Milestone

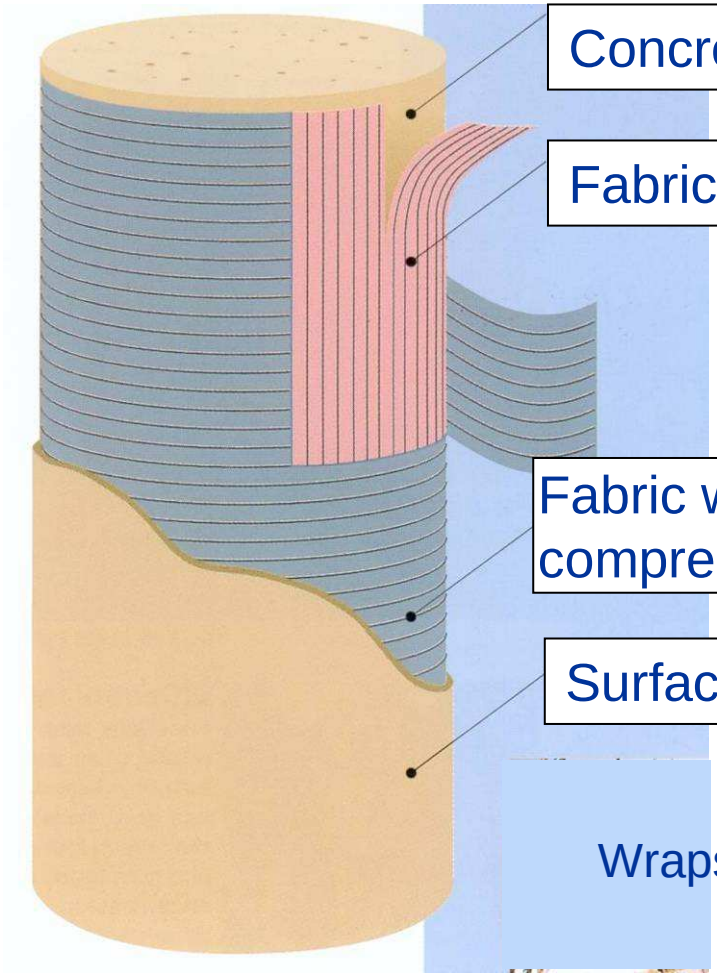
Stress-strain models of FRP-confined concrete columns

The important application of FRP composites is the wrapping or jacketing for the confinement of reinforced concrete (RC) columns for enhanced strength and ductility.

In FRP-confined concrete - subject to axial compression, the FRP is principally loaded in hoop tension, while the concrete is loaded in tri-axial compression ➔ that both materials are used to their best advantages.

Both the strength and the ultimate strain of concrete can be greatly enhanced as a result of FRP confinement, while the high tensile strength of FRP can be fully utilized.

Instead of the brittle behaviour exhibited by both materials, FRP-confined concrete possesses greatly enhanced ductility.



Concrete column

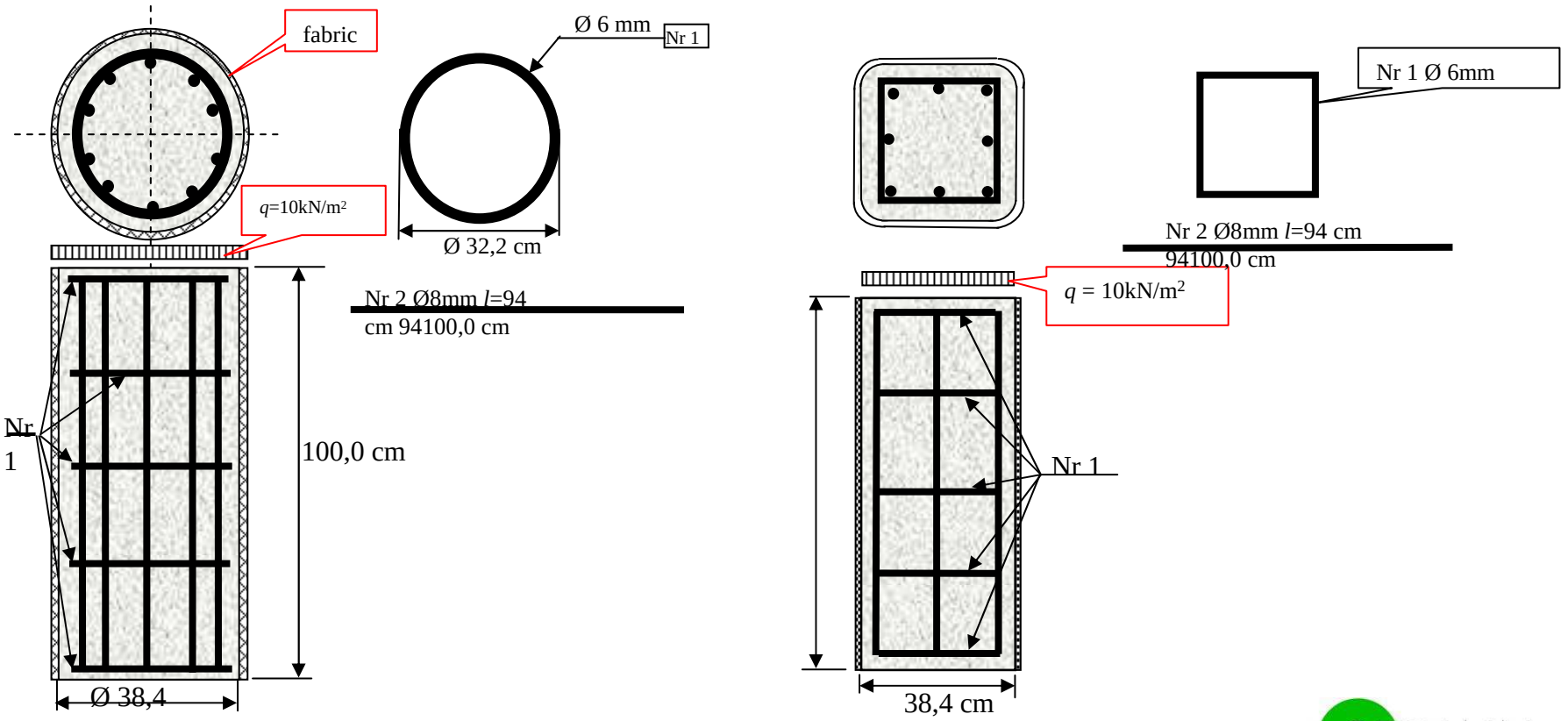
Fabric with vertical fibres (for higher bending)

Fabric with horizontal fibres (for higher shear and compressing)

Surface finish (any color)

Wraps and jackets for the confinement of RC columns

Model for FEM circular and rectangular column



Surface preparation for wrapping

CFRP fabrics gluing

Thank you for attention