

KLOKNER INSTITUTE CTU IN PRAGUE

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INSTITUTE IN SHORT

- Founded in 1921
- Close to building industry since beginning
- Recently becoming more multidisciplinary

MISSION:

- Research, teaching, standardization
- R&D popularisation
- Industry cooperation
- Forensic expert institute

STRUCTURE:

- 4 technical departments + 1 eco. + admin.
- Accredited Testing Laboratory
- Forensic institute in construction since 1986



INSTITUTE IN SHORT

DEPARTMENTS:

- **Structural Reliability**
- **Mechanics**
- **Building Materials and Chemistry**
- **Experimental Methods**

STAFF:

- **72 FTEs (66 – 72 at period 2019–2023)**
- **2 : 1 gender ratio**
- **35% early-career researchers**
- **45 % up to 40 years, 70 % up to 50 year**
- **12% professors/assoc. professors**



MAIN RESEARCH FIELDS

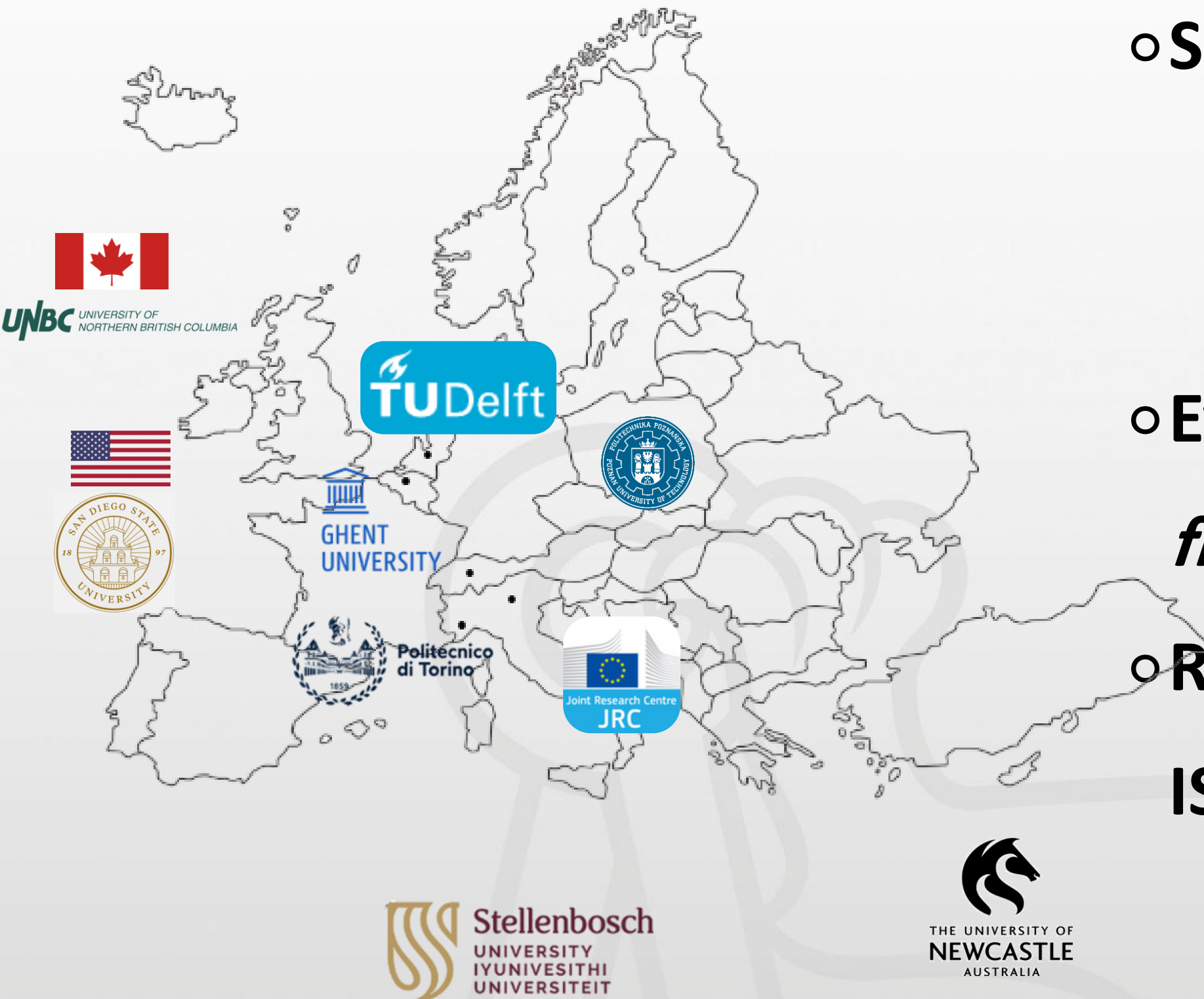
- 1) Structural reliability and risk assessment including diagnostics (new and existing structures)**
- 2) Technology of special cementitious materials
 - UHPC**
 - 3D printing****
- 3) Design guidelines for structures made from UHPC and 3D Printing**
- 4) Corrosion of metals and their protection - testing, evaluation**

EDUCATIONAL AND SOCIETAL ENGAGEMENT

- **Accredited PhD programme**
 - **over 30 students**
 - **lifelong learning courses**
- **Forensic engineering:**
 - **More than 40 reports / year**
- **Contributions in media and expert consultancy**



INTERNATIONAL COLLABORATION AND RECOGNITION



- **Strategic partners:**

- **TU Delft, Ghent, Stellenbosch, Torino, JRC Ispra, Poznan**

- **Events: IPW 2022 (jointly with Stellenbosch),**

***fib*, IABSE, ICASP, ESREL**

- **Roles: authors of *fib* Model Code 2020, ISO/CEN project team leaders/ members**

EXCHANGE STAYS

◦ Outgoing:

- students
- lecturers

KI co-financing

individually – grant projects

◦ Incoming:

- postdoctoral fellows, Ph.D.
- students
- lecturers

CTU Postdoc programme



International collaboration with industry

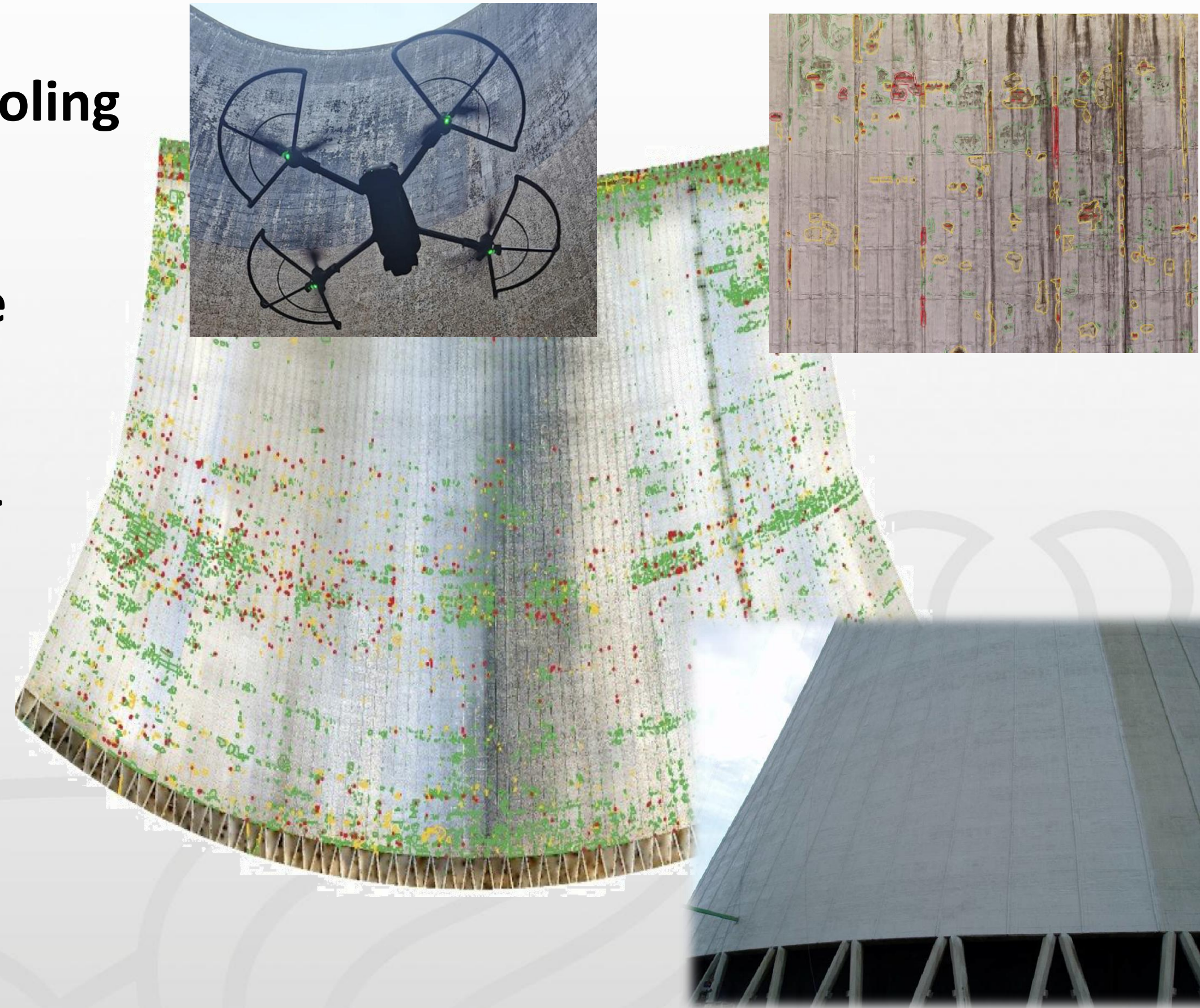
- **Testing components of high voltage systems**

- **ceramic and polymer insulators**
- **metal fittings**
- **conductors - steel or aluminium alloys**



- Existing structures – example of cooling towers in nuclear power plants

- costly surveys and maintenance
- large variability
- designed for ~40 years, 20-40y+ required
- new technologies and methods



Service life estimation

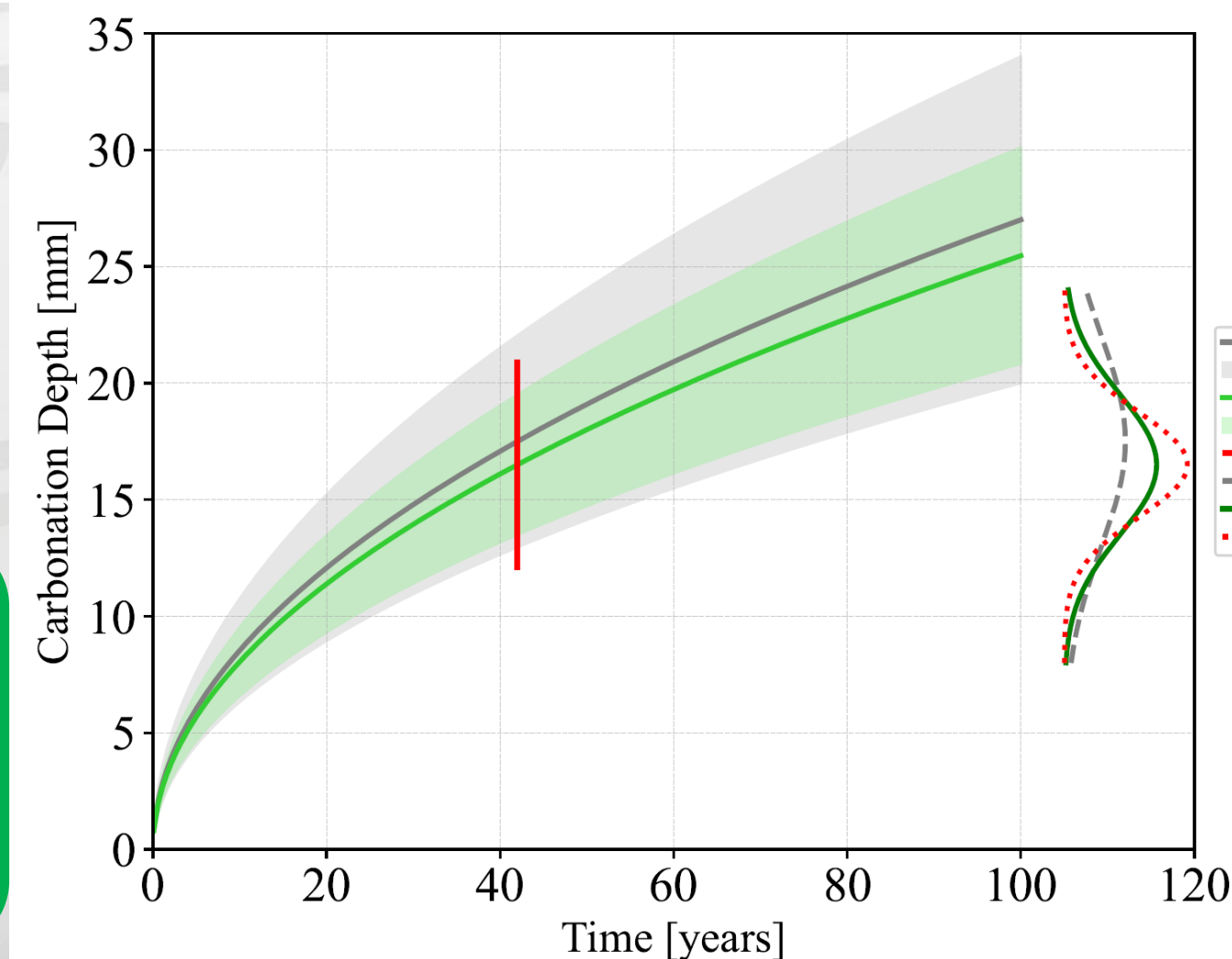
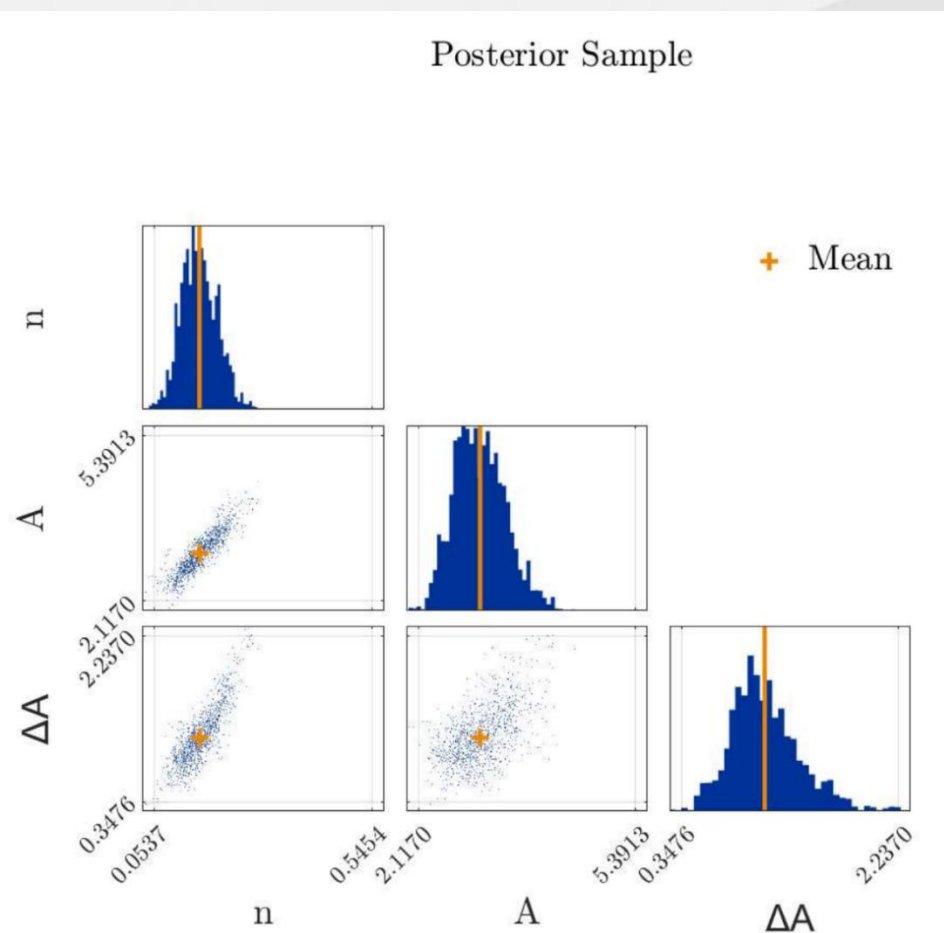
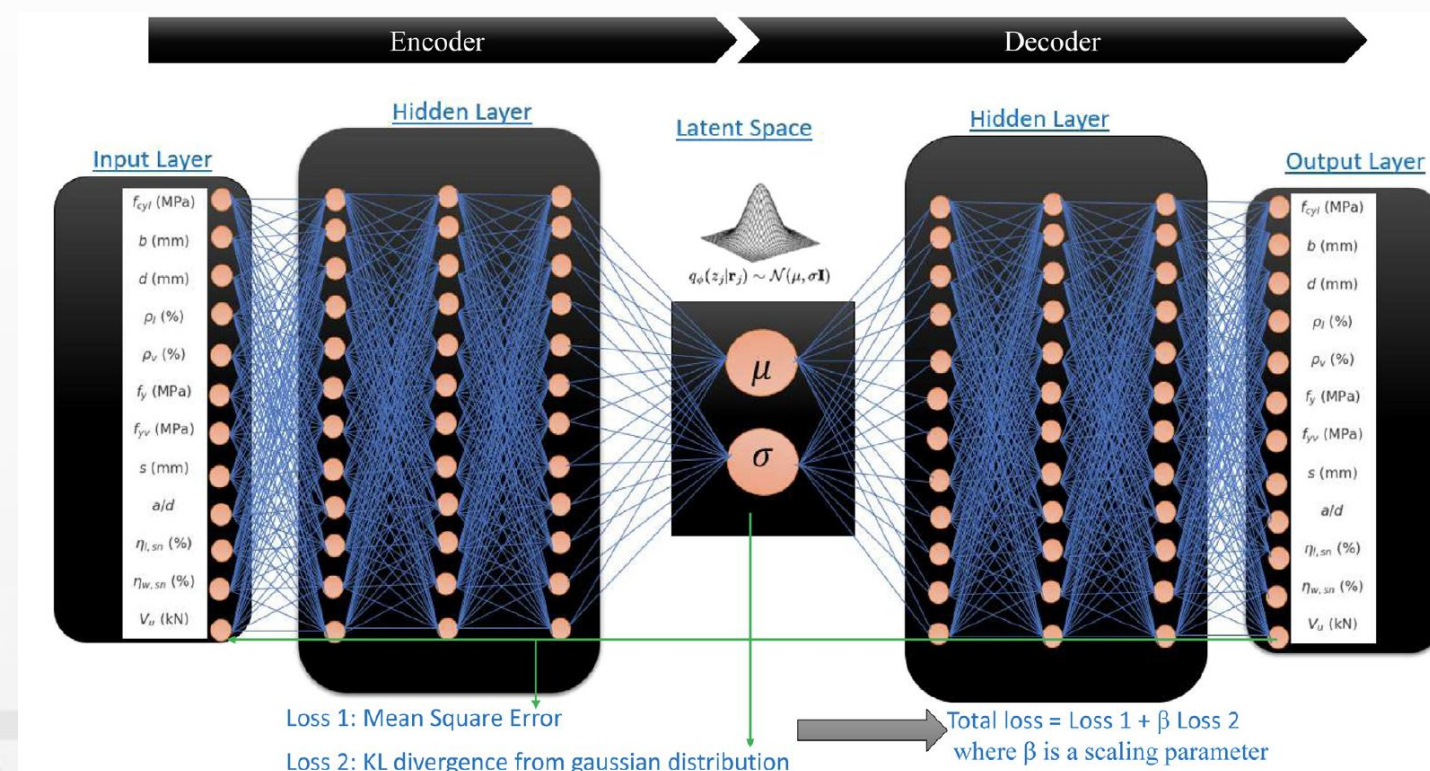
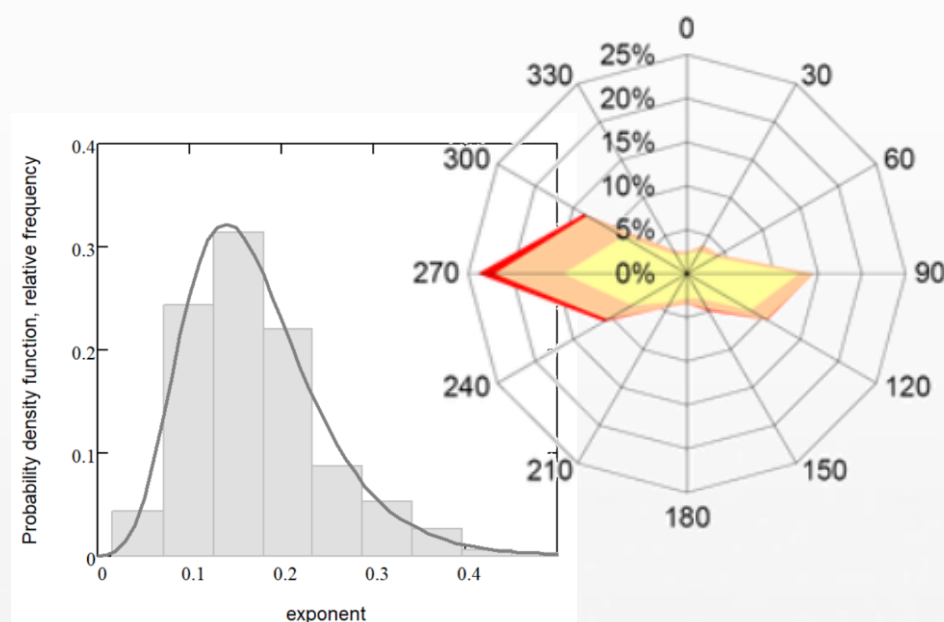
Carbonation

Cracking

Spalling

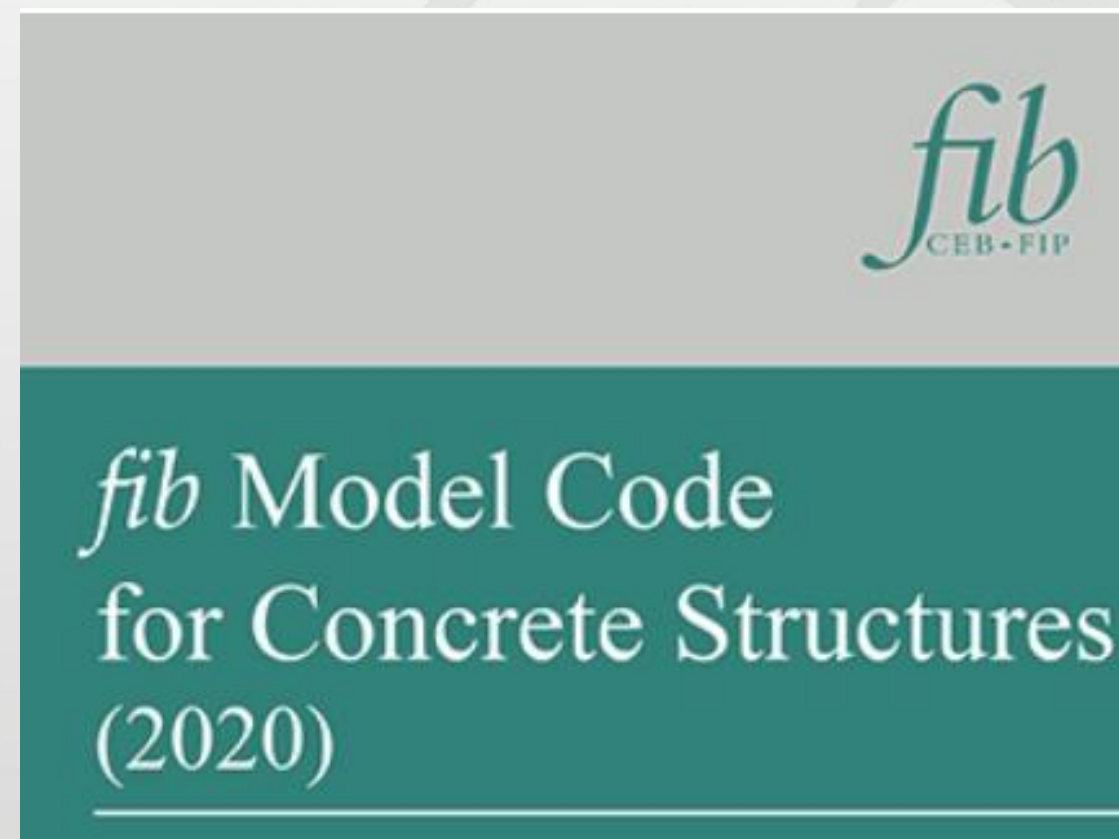
Corrosion development

→ probabilistic risk-informed
decision making –
MAINTENANCE OPTIMIZATION



◦ Large infrastructures:

- cooling towers, industrial chimneys, wind turbines
- road and railway bridges
- storage of hazardous materials



Contents lists available at [ScienceDirect](#)

International Journal of Hydrogen Energy

journal homepage: www.elsevier.com/locate/he

Predicting the hydrogen storage capacity of alumina pillared interlayer clays using interpretable ensemble machine learning



Contents lists available at [ScienceDirect](#)

Structural Safety

journal homepage: www.elsevier.com/locate/strusafe

On reliability assessment of existing structures



Contents lists available at [ScienceDirect](#)

Journal of Constructional Steel Research

journal homepage: www.elsevier.com/locate/jcsr

Epistemic uncertainties in torque capacity prediction models for circular CFDST members



Contents lists available at [ScienceDirect](#)

Engineering Applications of Artificial Intelligence

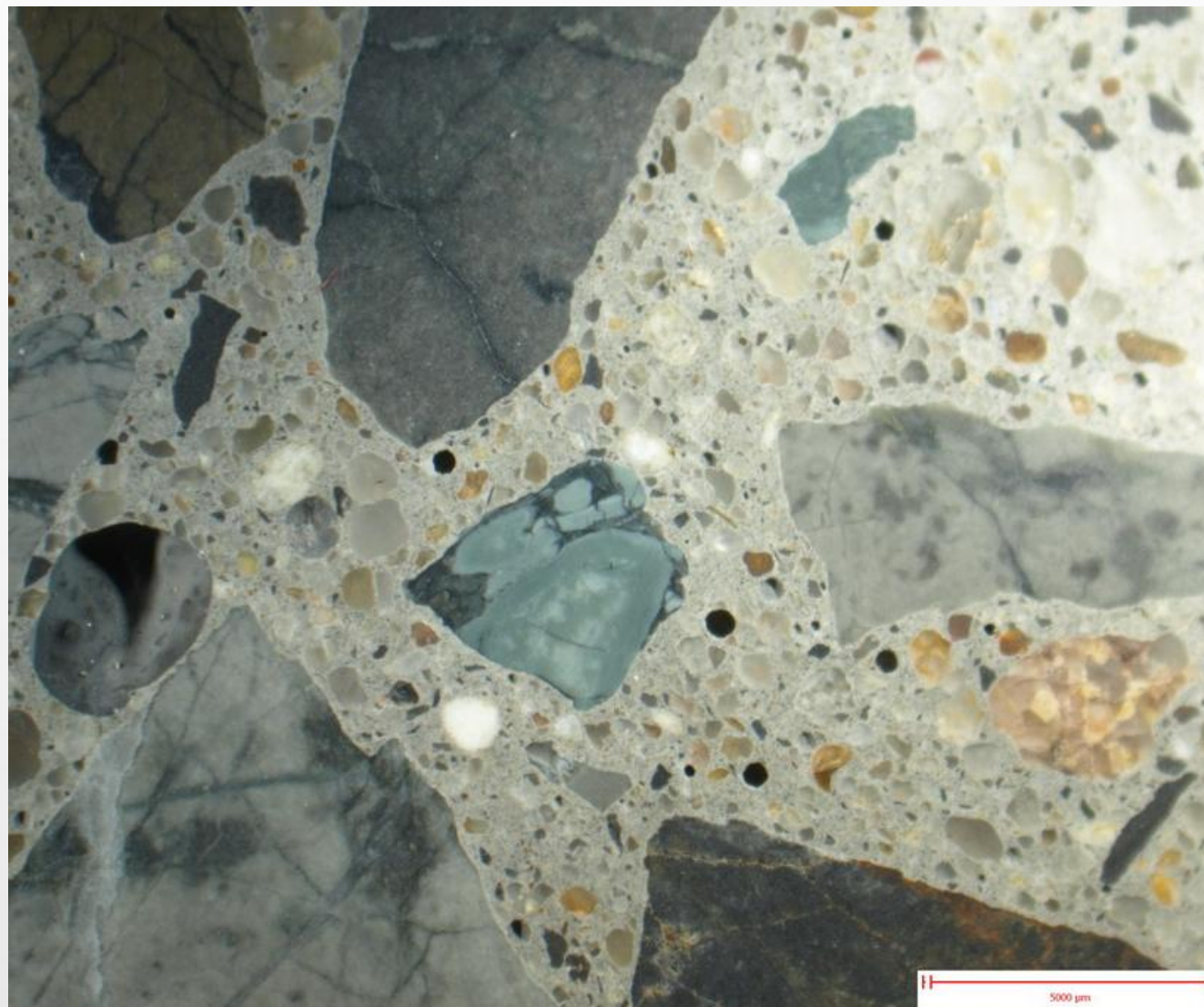
journal homepage: www.elsevier.com/locate/engappai

Research paper

Shear capacity prediction and reliability analysis of corroded reinforced concrete beams using deep generative modeling and ensemble learning

UHPC - R&D

Different composition of normal concrete and UHPC



Compressive strength: **30–50 MPa**

Brittle failure

Moderate durability, porous

Design tensile strength = 0



Compressive strength: **110–170 MPa**

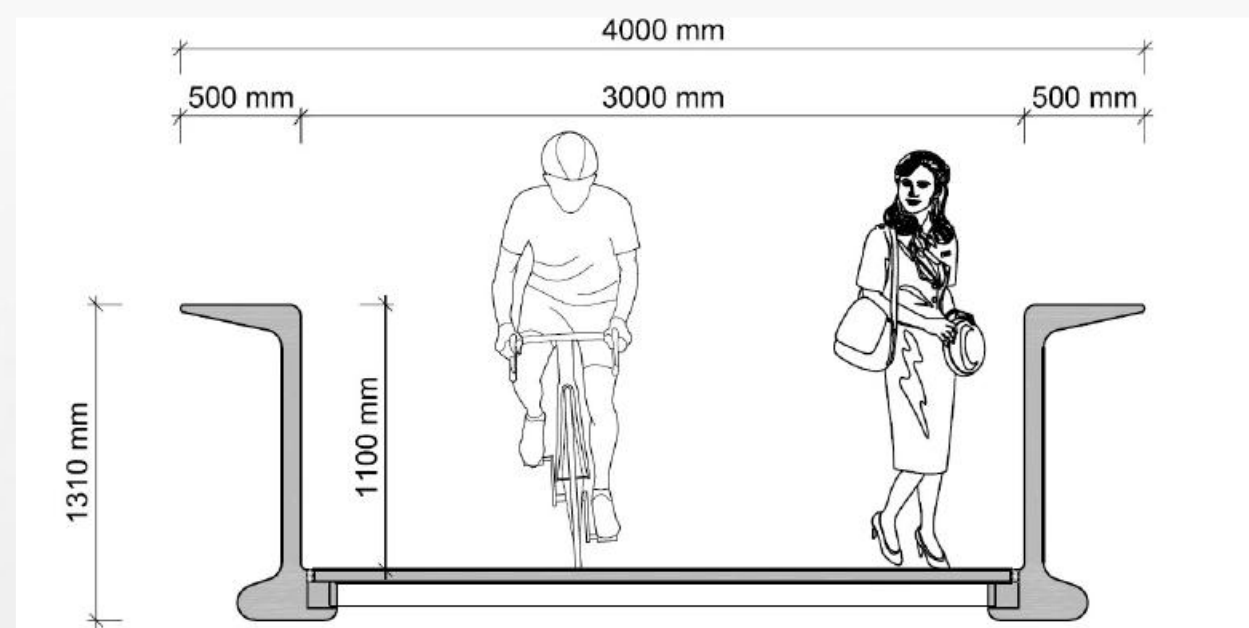
Ductile behaviour

Extremely durable, very low porosity

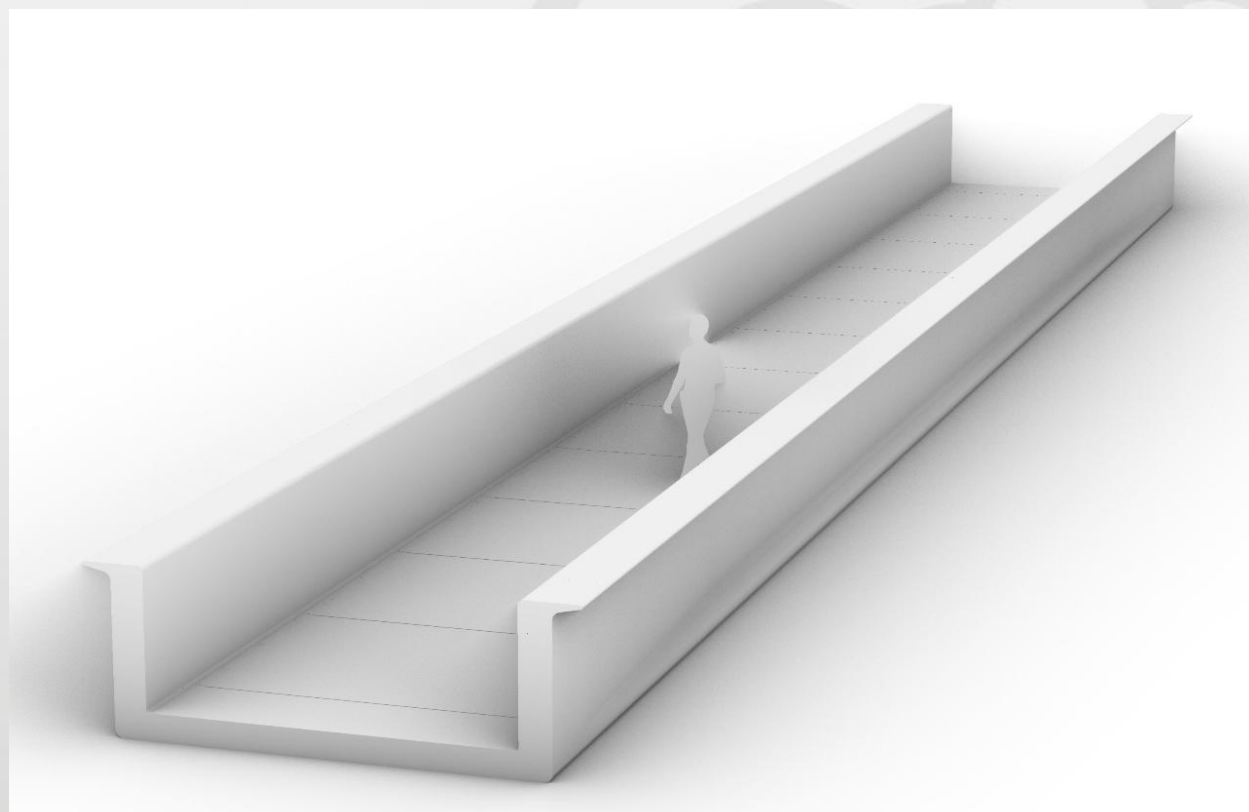
Design tensile strength = 4–10 MPa

UHPC - R&D

Collaboration with industrial partner – development of 26m prestressed footbridge



Finalizing licensing process – 16 kEUR /year



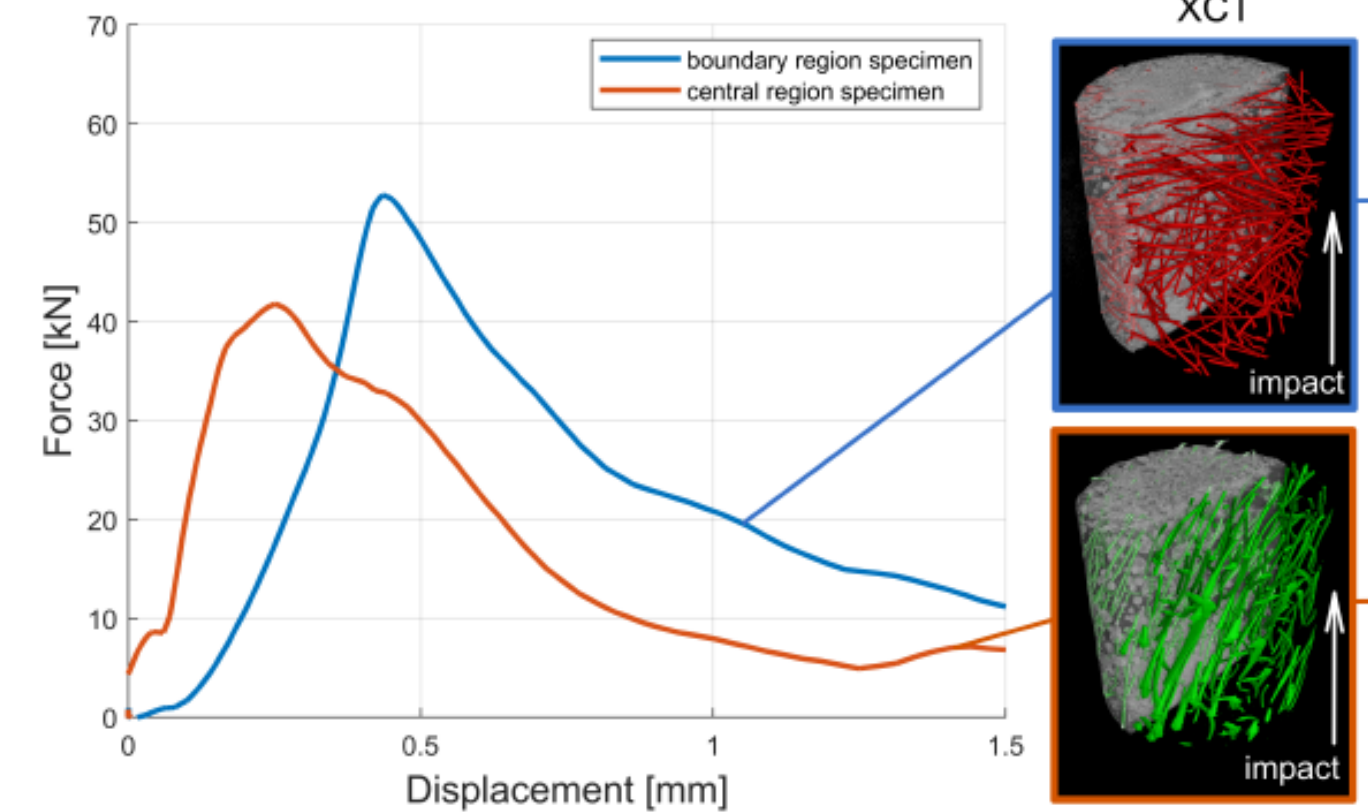
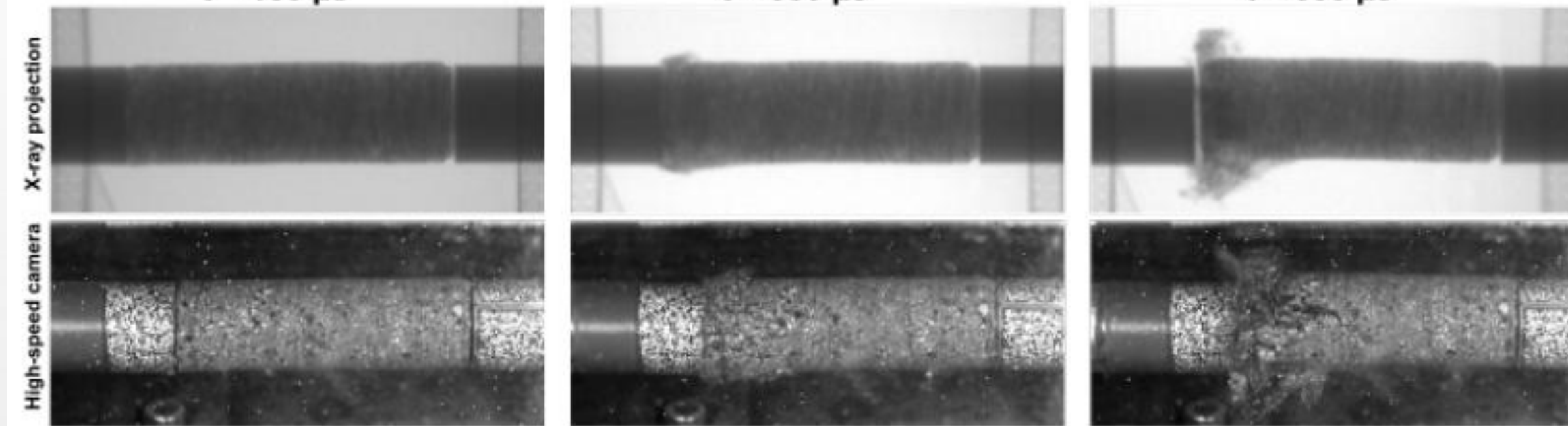
Collaboration with Faculty of Transportation - dynamic mechanical properties

Sample 4

$t = 150 \mu s$

$t = 350 \mu s$

$t = 550 \mu s$



- High strain rate experiments
 - flash X-ray system (top) and high speed camera (bottom)
 - coupled with SHPB experiments in compression
- Flashes of X-ray facilitate ultrafast RTG imaging of high velocity impacts
 - influence of fibre orientation on mechanical properties

Collaboration with Faculty of Civil Engineering blast tests and analysis NSC and UHPC

NSC

Front
side

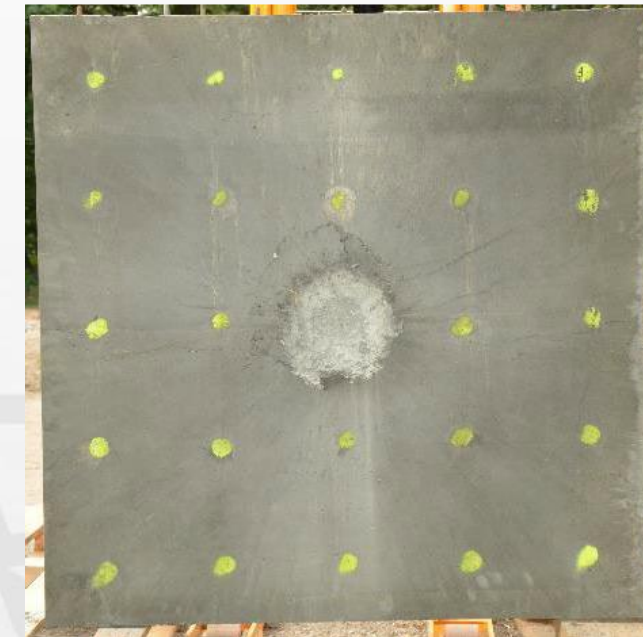


Back
side



UHPC

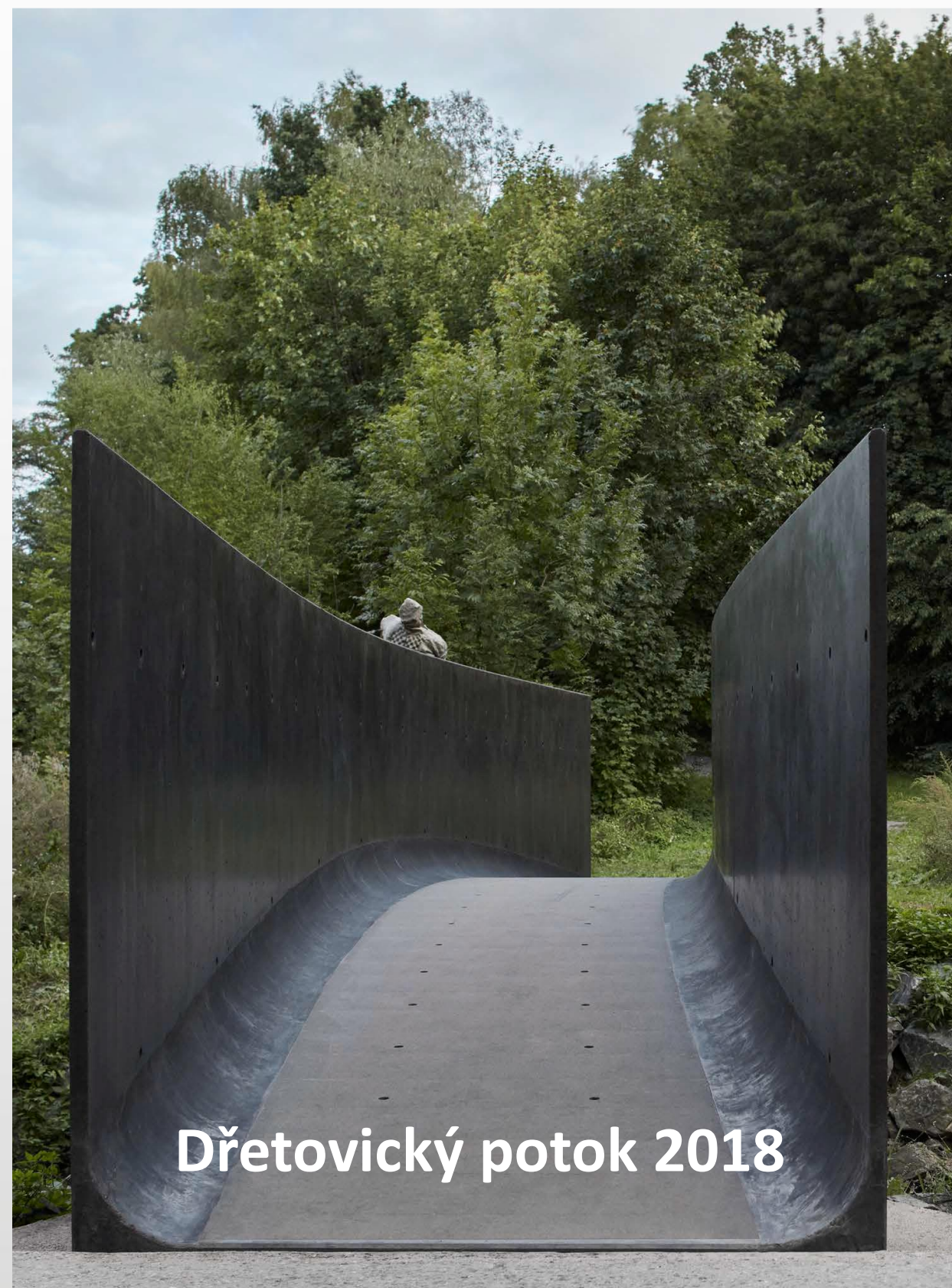
Front
side



Back
side



UHPC - KI's applications (20+)



UHPC - KI's applications

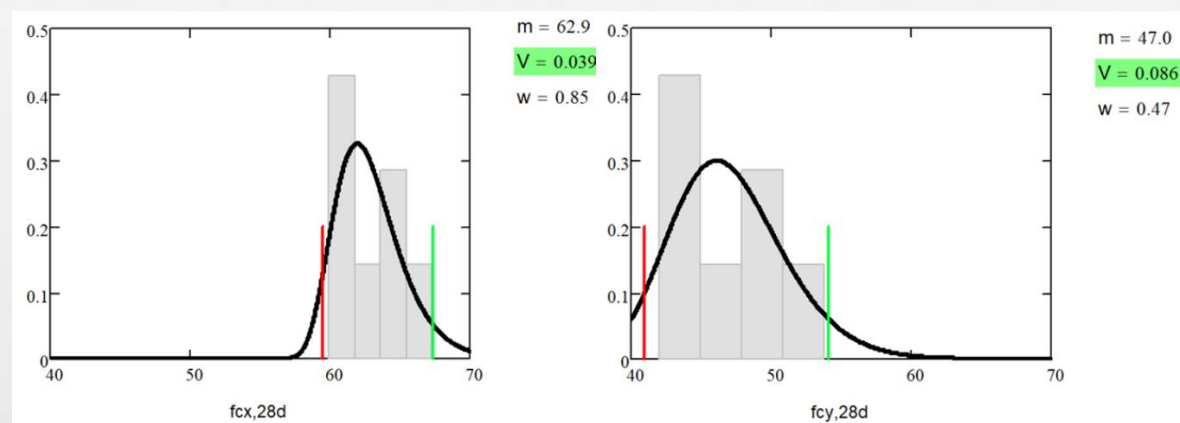


**Retrofitting
of concrete
Structures -
2022**

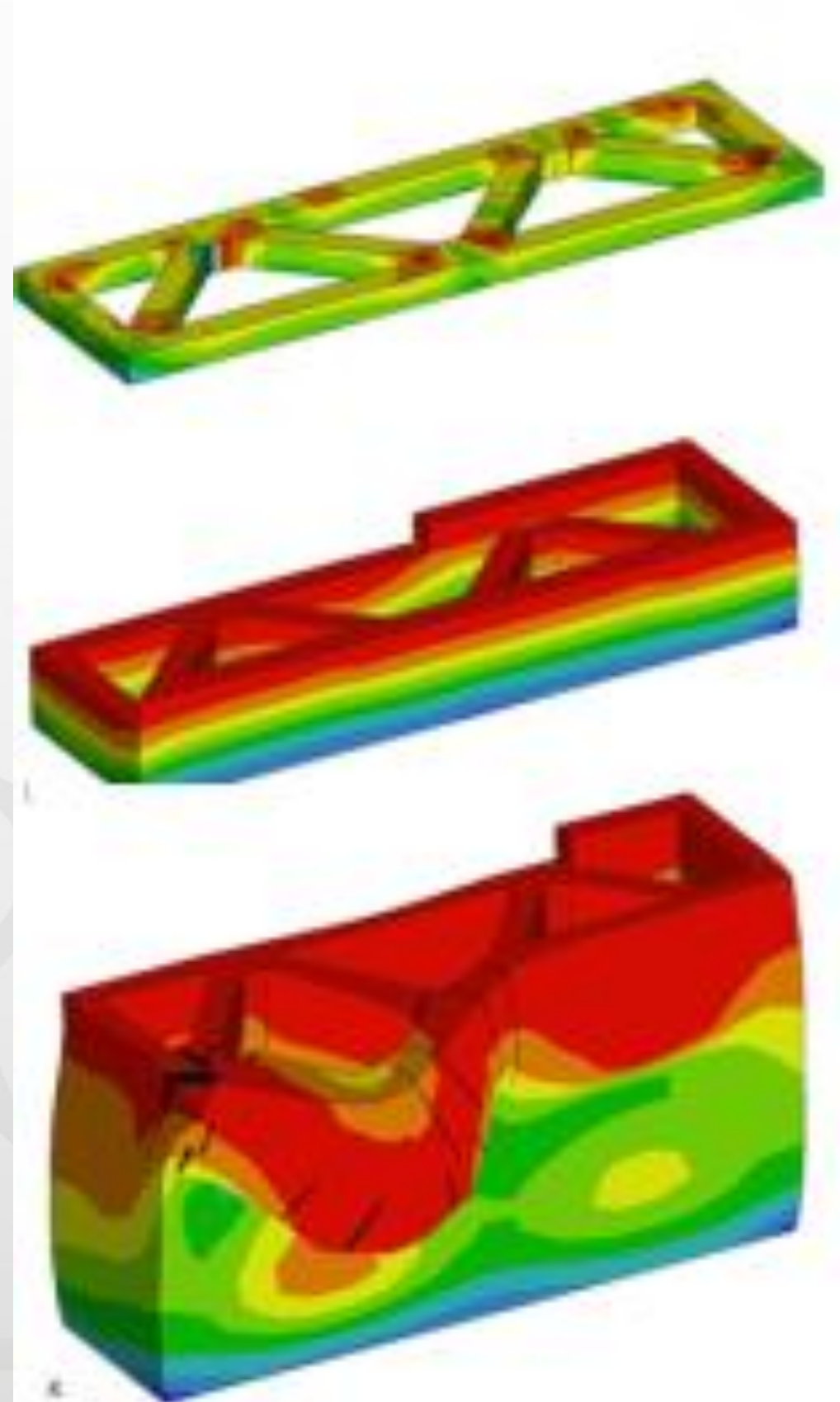
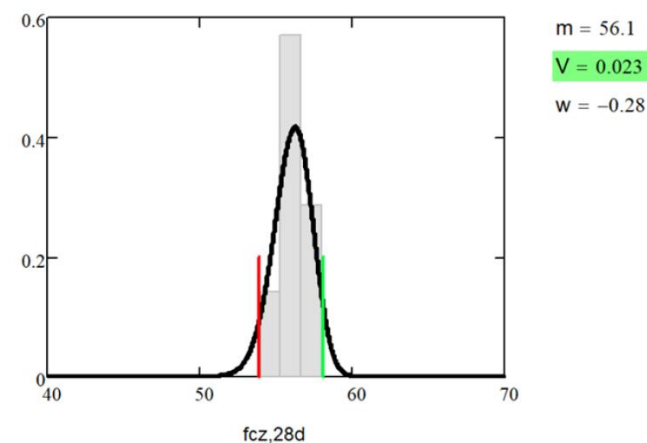


3D printed cement-based composites

- Material development
 - characterization
 - rheological properties
 - variability



Obr. 2-15: Výsledky pevnosti v tlaku - směr X vlevo, směr Y pravo





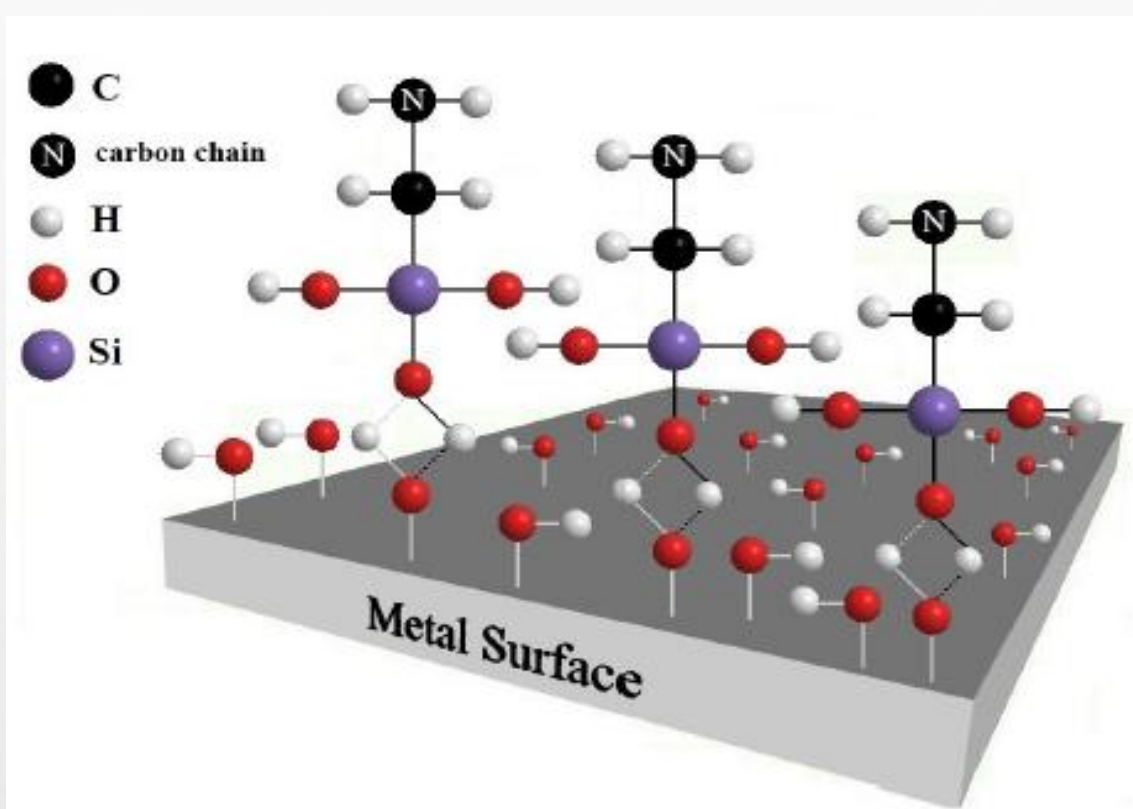
KLOKNERUV

ÚSTAV HMOT A KONSTRUKCÍ
A ZKUŠEBNÍ



New generation of ecological anti-corrosion coatings

- for conventional concrete reinforcement
- corrosion causes large losses (civil, automotive, mechanical...)



ecological organosilane coating

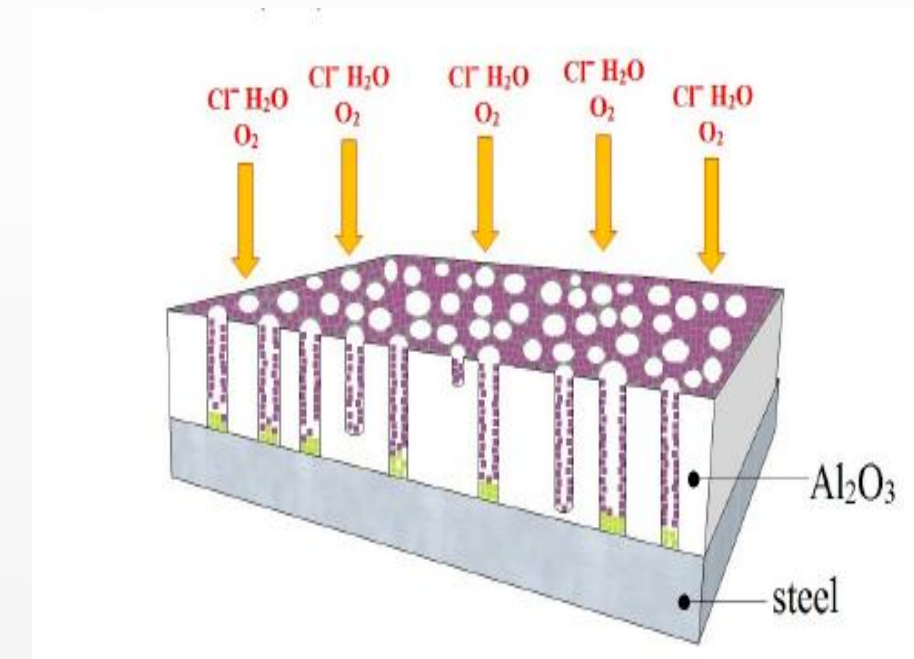
poor mechanical properties

+



resistant plasma-sprayed
corundum coating

poor barrier corrosion
protection - open porosity



excellent corrosion
protection and mechanical
properties

EcoAnti project – Novel concept of environmental friendly coating

phosphate conversion
coatings for industry

conventional way



with toxic heavy metal
 Co^{2+} a Ni^{2+}

1st approach

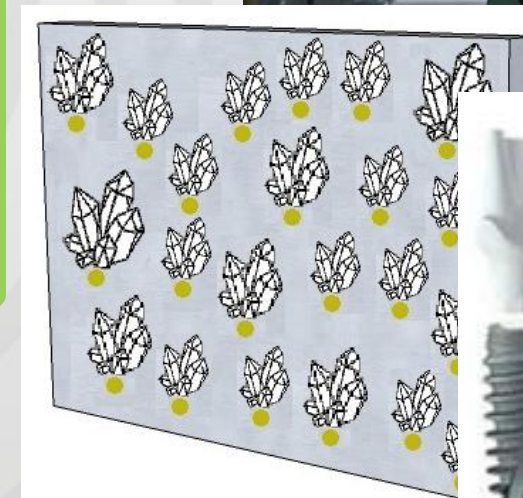
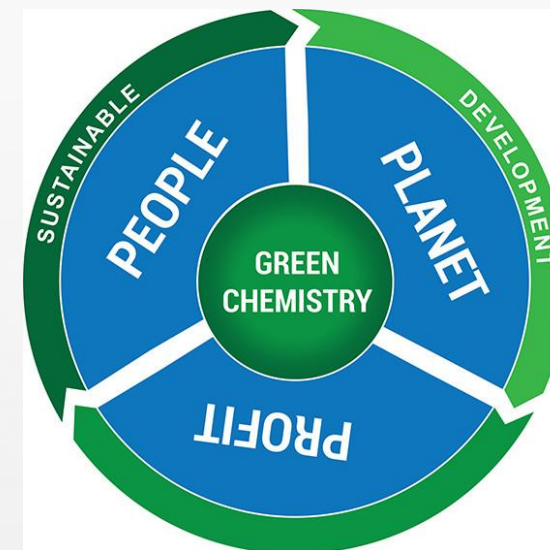
EU patent application (10/2022):
Activation based on micronized
zinc phosphates



Europäisches
Patentamt
European
Patent Office
Office européen
des brevets

2nd approach

stroncium phosphate – SrHPO_4
(inspired by bioimplant coatings)



VISION AND FUTURE OUTLOOK

**European centre of
excellence for
reliability of
structures**

**Green chemistry,
protection and durability
of materials**

**Research leader in
3D printing of
cement-based
composites**

**Transfer of AI-aided
diagnostics into
practice**

Thank you for your attention!



R&D PROJECTS



- Over 40 competitive projects (GAČR, TAČR, EU, ministries)
- Flagship Projects:
 - UHPC in bridges and prefabricates
 - Ecological nanocoatings
 - Structural glass adhesives
 - Structural reliability under climate change
 - Historic masonry – surveys, reliability, heritage preservation

Implementation of recommendations

MEP 2020

- Efforts should be made to **reduce number of small tasks** in favor of larger ones of presumably greater scientific value...
- ... more **cooperation with foreign entities** would open up new research topics...



- R&D scope narrowed
- Contract research: major framework contracts
 - road and railway managers
- Major design and consultancy offices
- National Centre for Industrial 3D Printing

Experimental
verification

Theoretical
analyses

Advanced
composites

Environmental
effects

Sustainability

Advanced engineering



ŘSD ČR
ŘEDITELSTVÍ SILNIC A DÁLNIC ČR

**SPRÁVA
ŽELEZNIC**

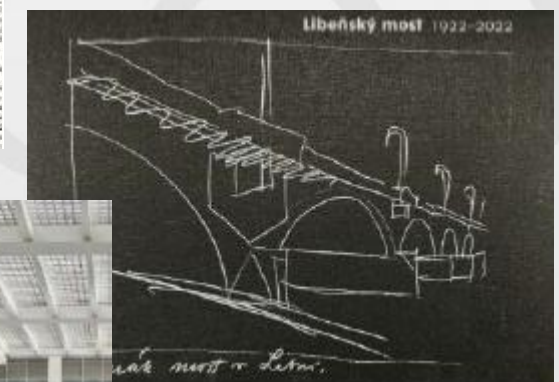
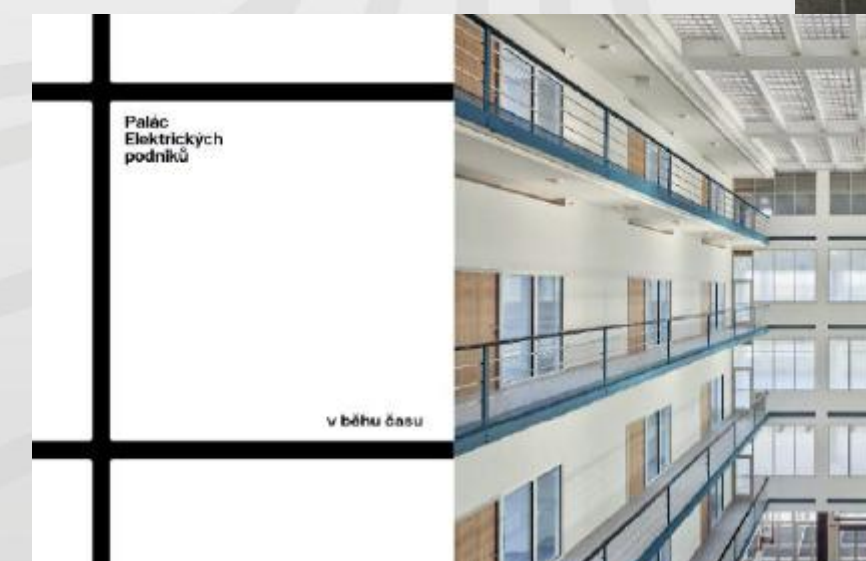


HOLCIM

- ... apart from striving for scientific excellence, efforts to **enhance the scientific visibility** should be made.
- KI should **improve public relations**... in popularization of R&D&I and communication with the public.

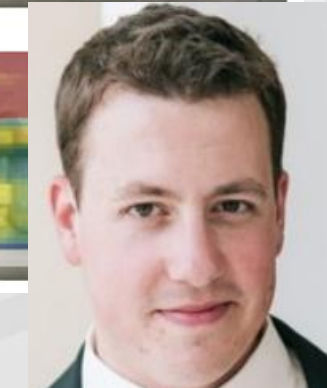
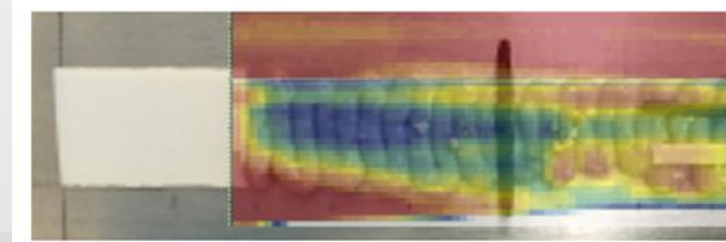
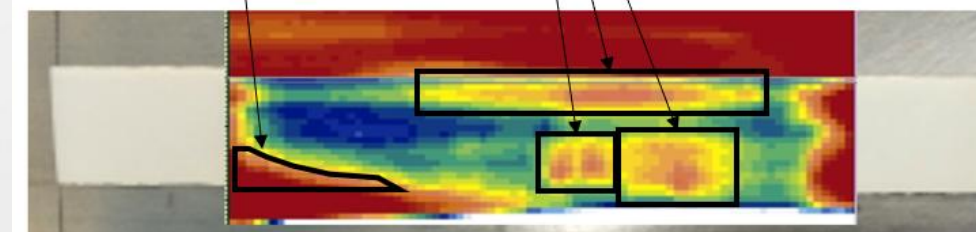
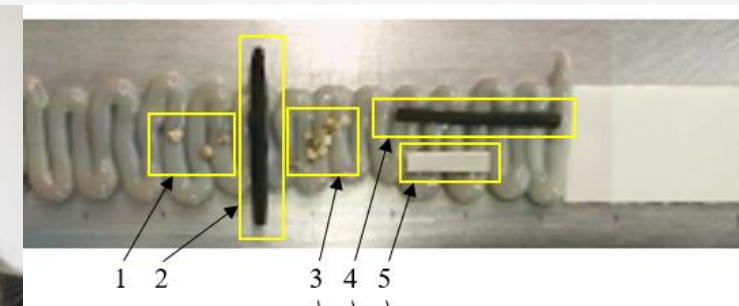


- Integration into international research networks
- Internationalization of KI's research through standardization
- Popularization and communication with public significantly improved
 - TV and radio, print media, social networks
 - exhibitions, monographs



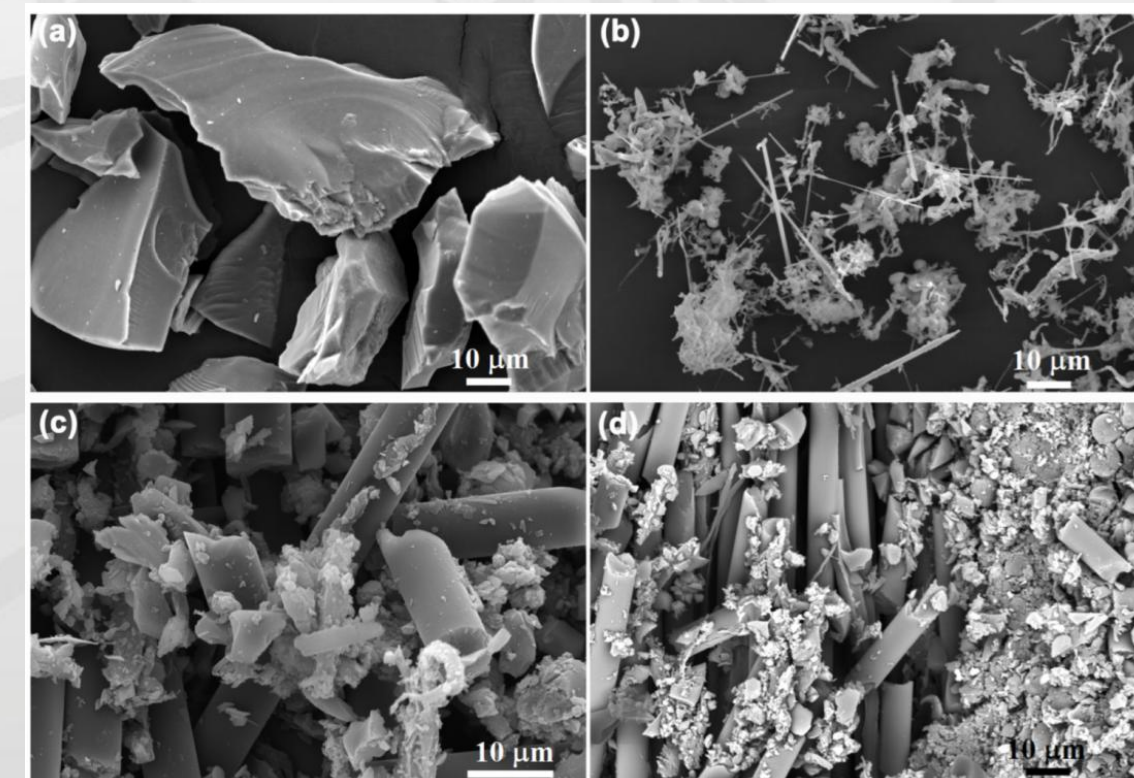
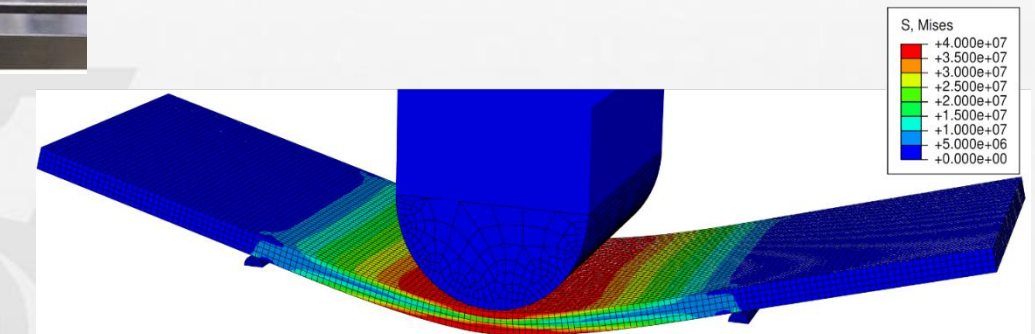
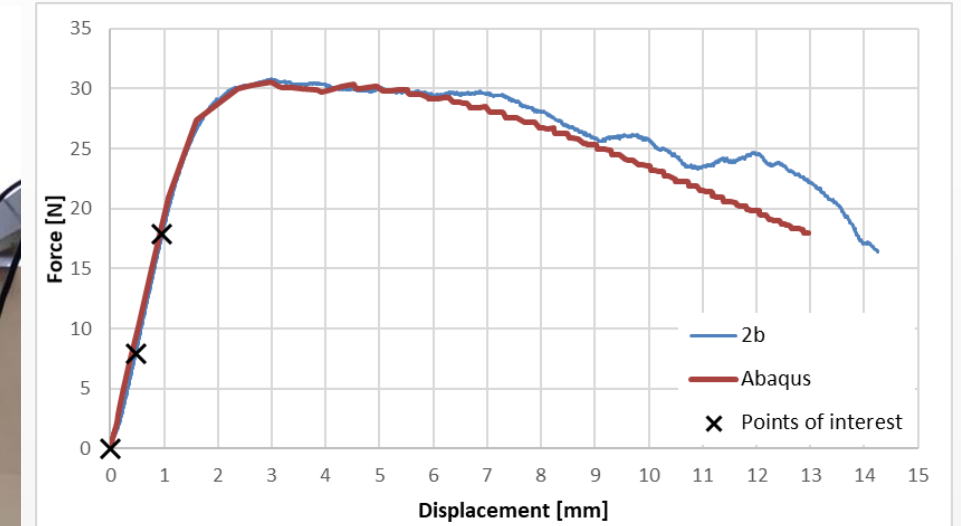
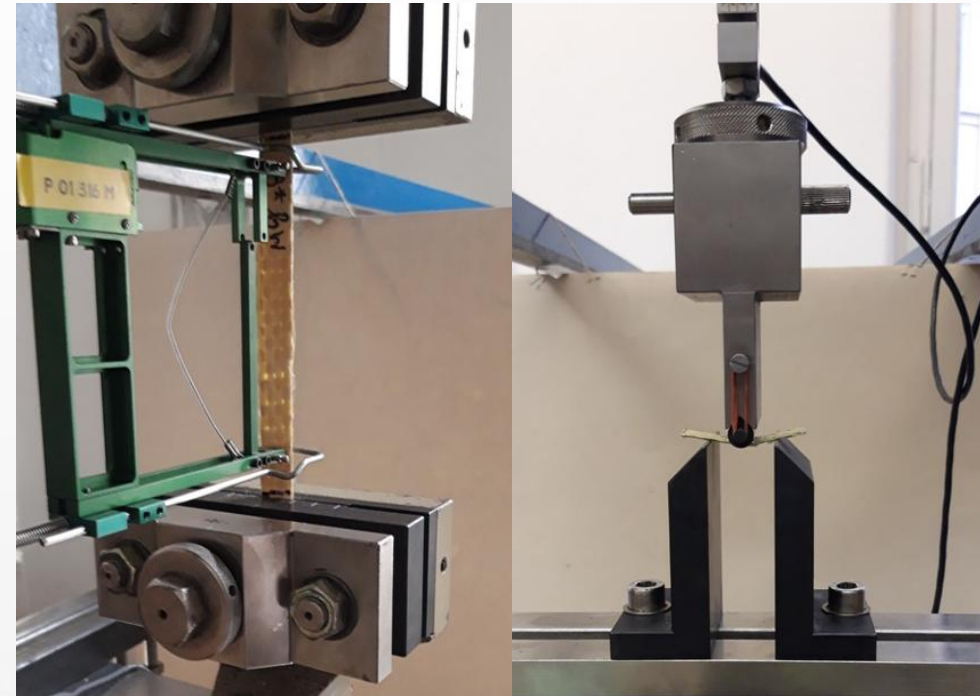
KI's annual Ph.D. seminars

- Presentations of 15-20 student
 - Ph.D. topic, achieved results, research strategy, info about studies
- Evaluation by scientific committee (including Profs from FCE CTU and BUT)
 - general suggestions for all students, specific recommendations for individual students
- Director's Award:
 - best presentation
 - recognition of committee
 - jumper of year



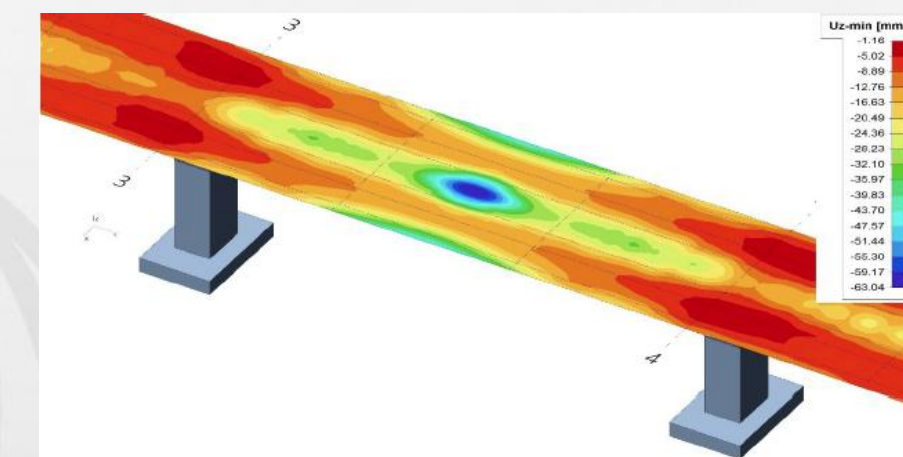
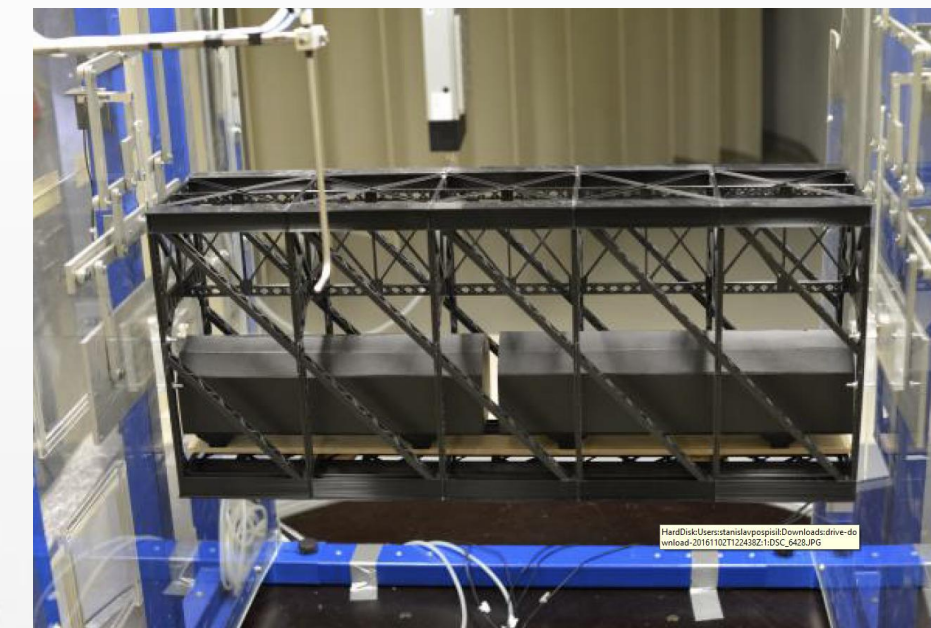
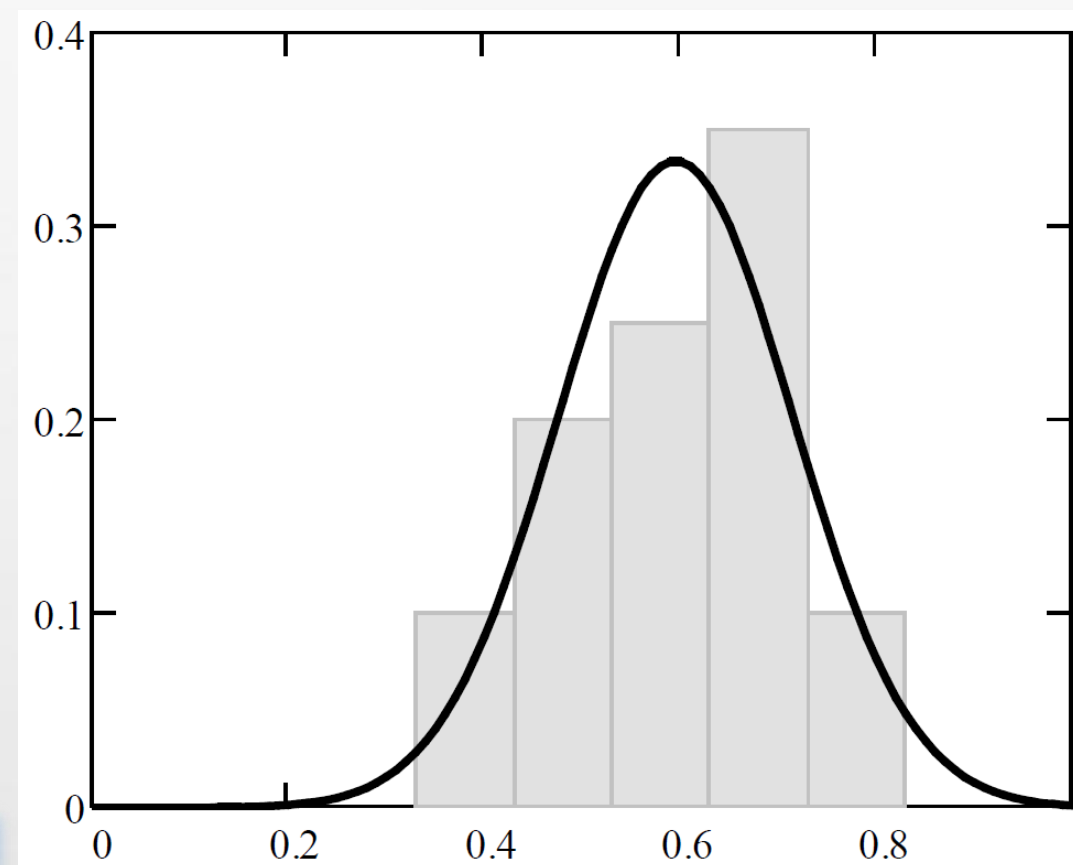
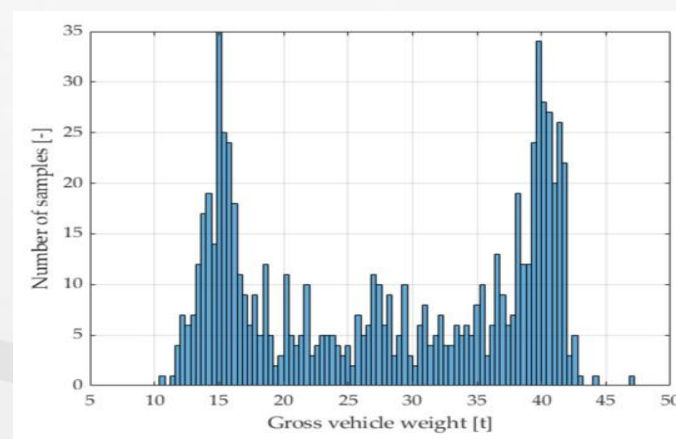
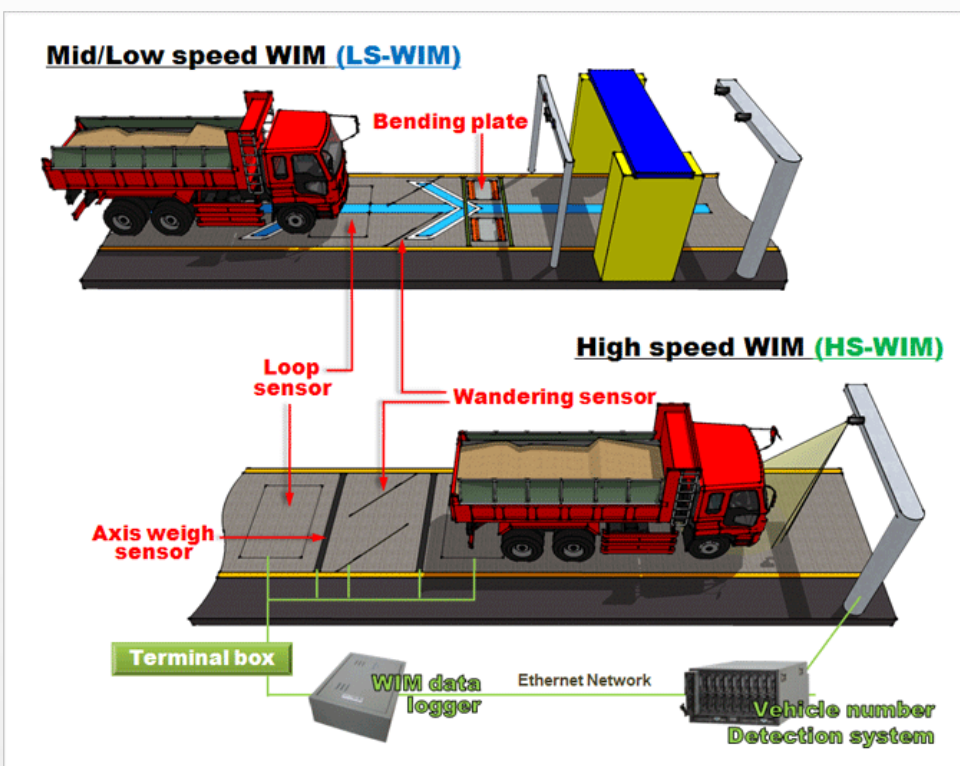
Postdoctoral fellowship

- Vera Obradovic (2023-2024)
- Innovation Center of Faculty of Technology and Metallurgy in Belgrade, Serbia
- Research focused on polymers-based composites with applications in:
 - automotive
 - aerospace
 - military industry
- Prestigious publications (3x Jimp, 3x int. conference)
- Cooperation continues after end of stay

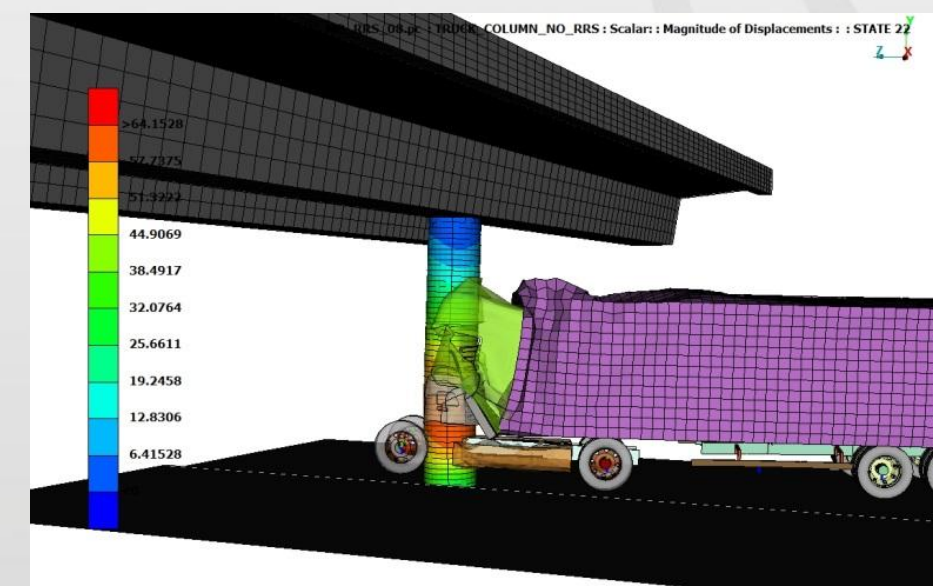
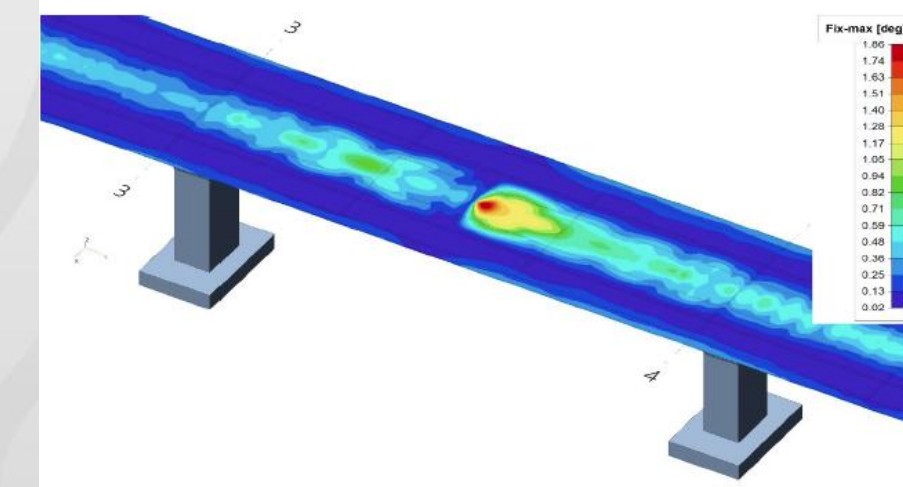


Cooperation with other CTU units

Faculty of Civil Engineering

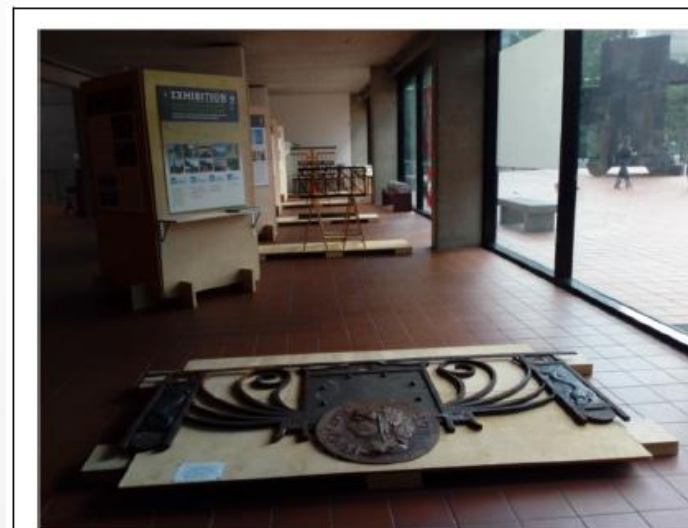


Obr. 4.8. Izolinie svislých výchylek mostovky



Cooperation with other CTU units

Faculty of Architecture



a) instalace výstavy



b) úvodní poster s poděkováním projektu a katalogem



c) největší a nejtěžší exponát – fragment zábradlí Žďákovského mostu



d) prof. Ryjáček informuje o projektu

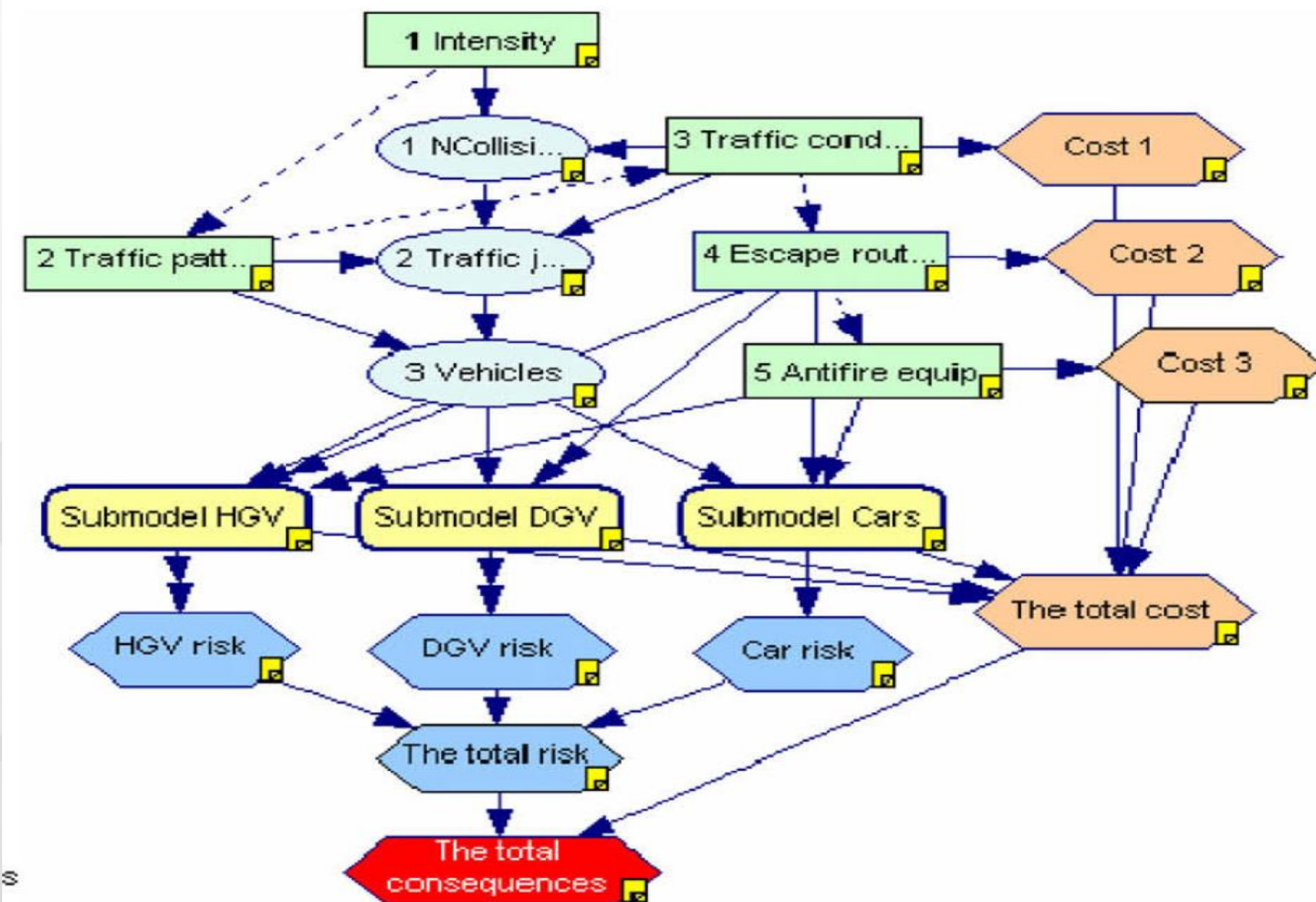


e) hosté při zahájení



f) diskuze nad exponáty

Cooperation with other CTU units (Faculty of Transportation Sciences)



- Intensive cooperation with industry - contract and applied research projects
- Contacts established and strengthened by:
 - cooperation in professional associations and standardization committees, memberships in expert committees supporting decision-makers
 - meetings at conferences
- Industry leaders - members of KI Scientific Board and Ph.D. Programme Management Board
- Lifelong education courses, dissemination

Year	Contract research and expert activities Total revenue in thousands €	Revenue from foreign entities k€	Share of income from foreign entities %	FTE	Revenue per FTE k€	Revenue per FTE thousands CZK
2019	3 467	399	11,5	66,5	52,1	1 339
2020	2 828	298	10,5	69,2	40,9	1 081
2021	3 465	351	10,1	70,6	49,1	1 259
2022	3 671	350	9,5	71,1	51,6	1 268
2023	2 950	530	18,0	71,8	41,1	986

Main users

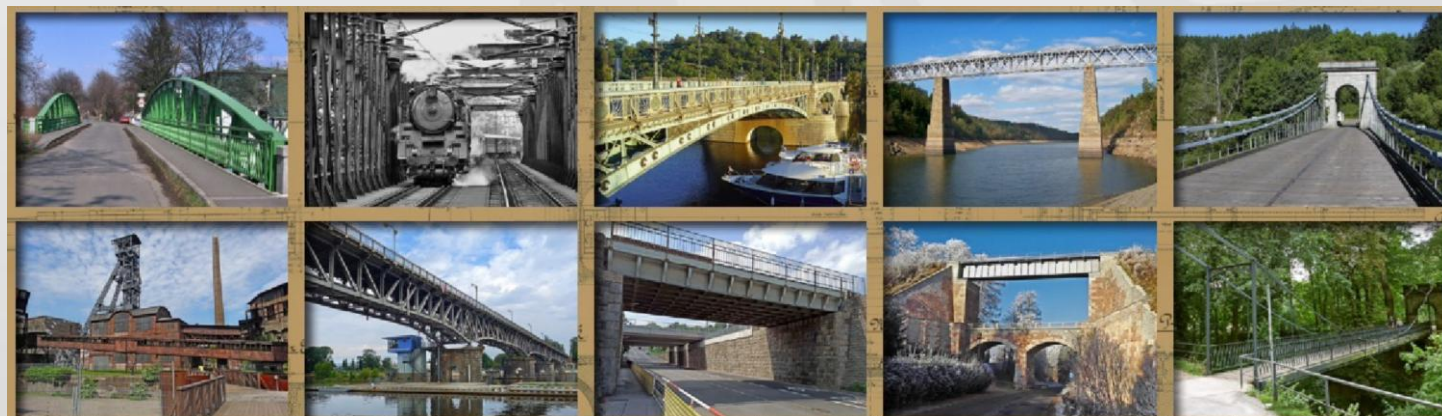
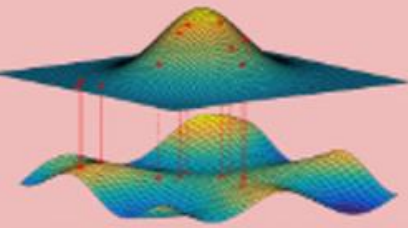
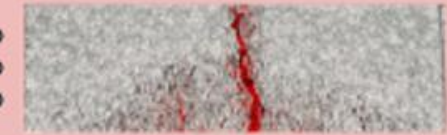
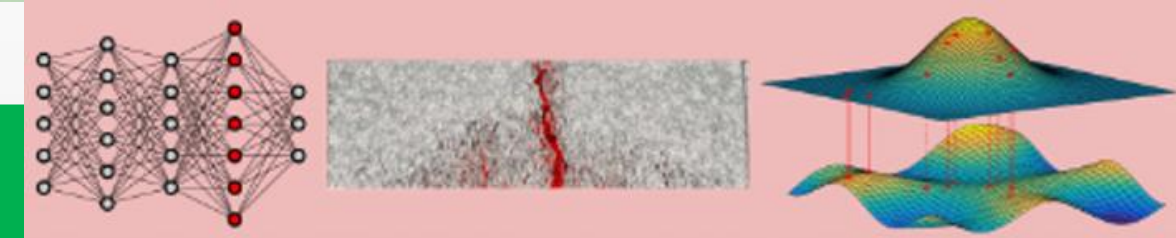
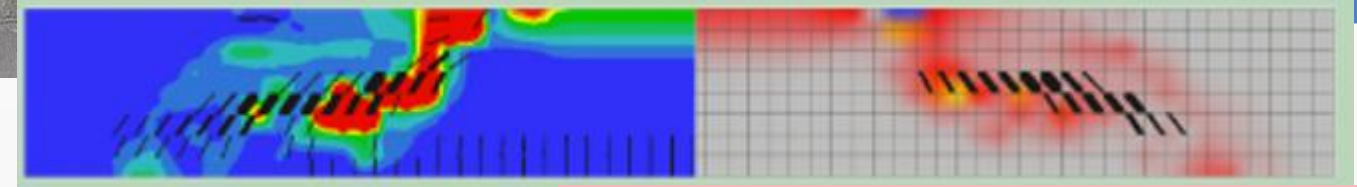
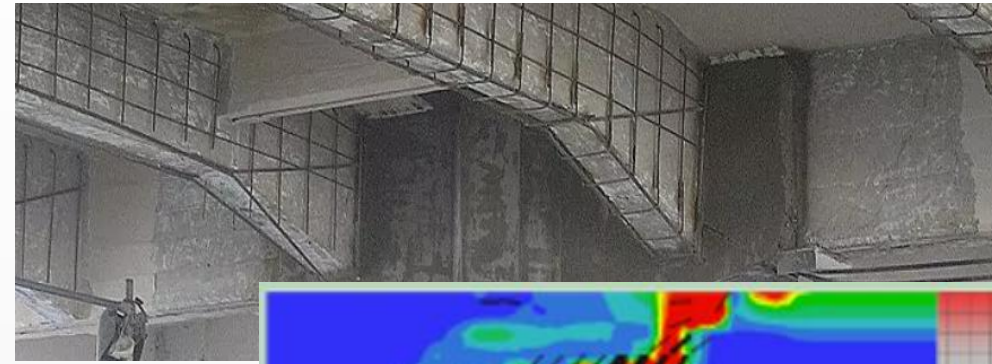
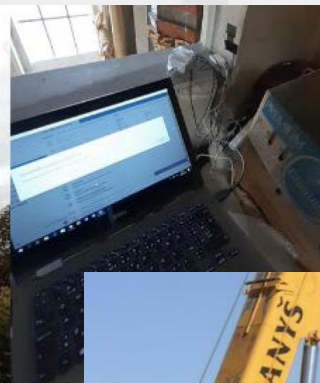
Management of
transportation
networks

Heritage
monuments

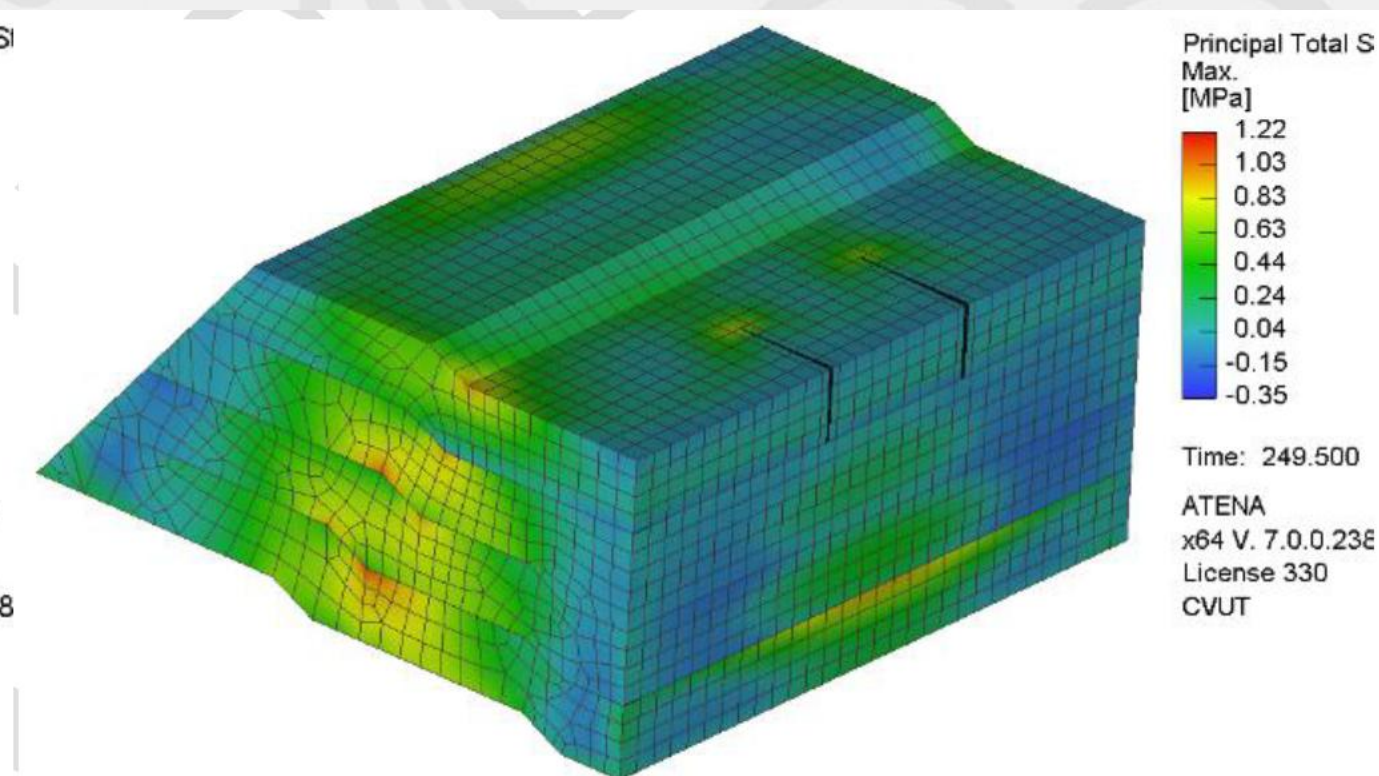
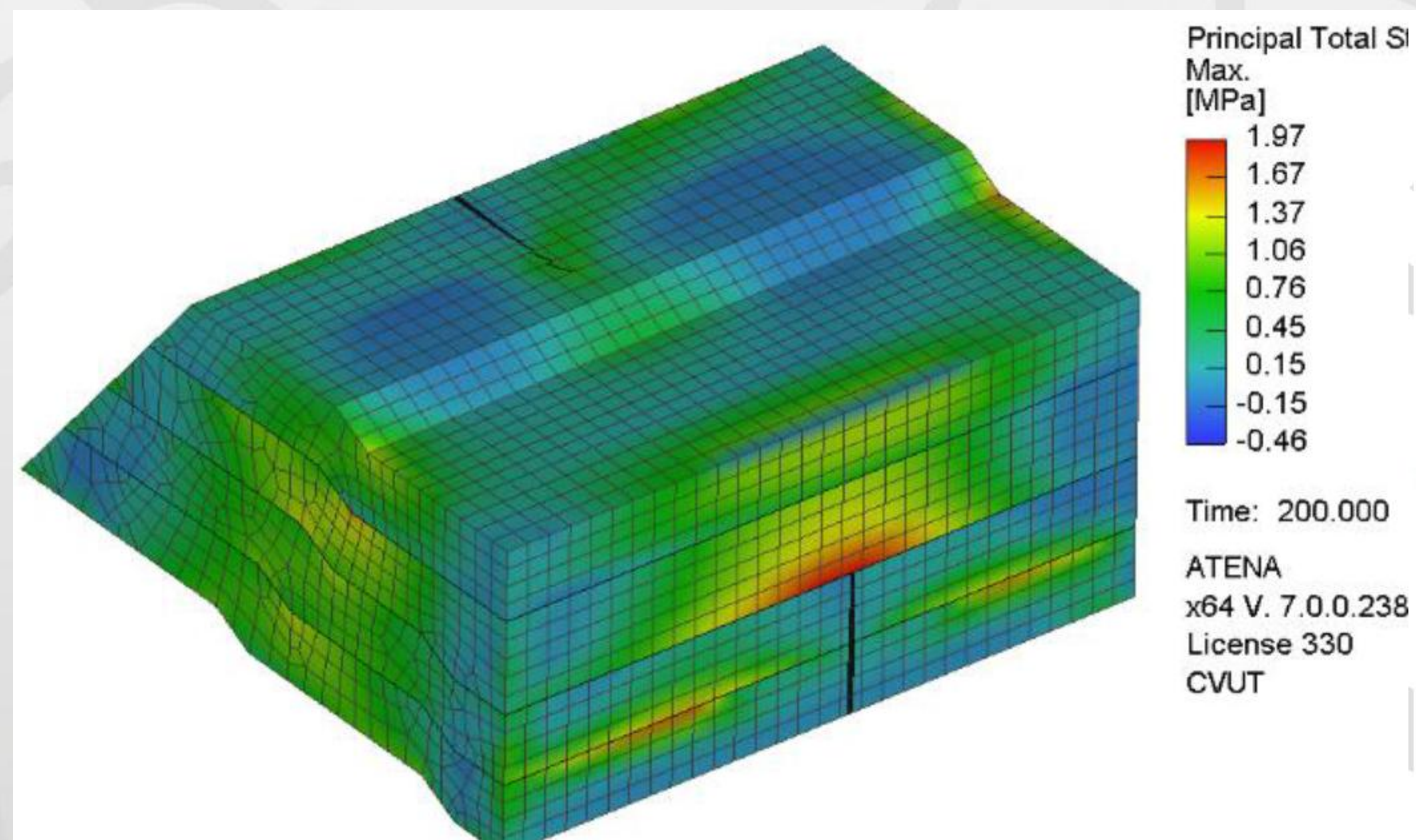
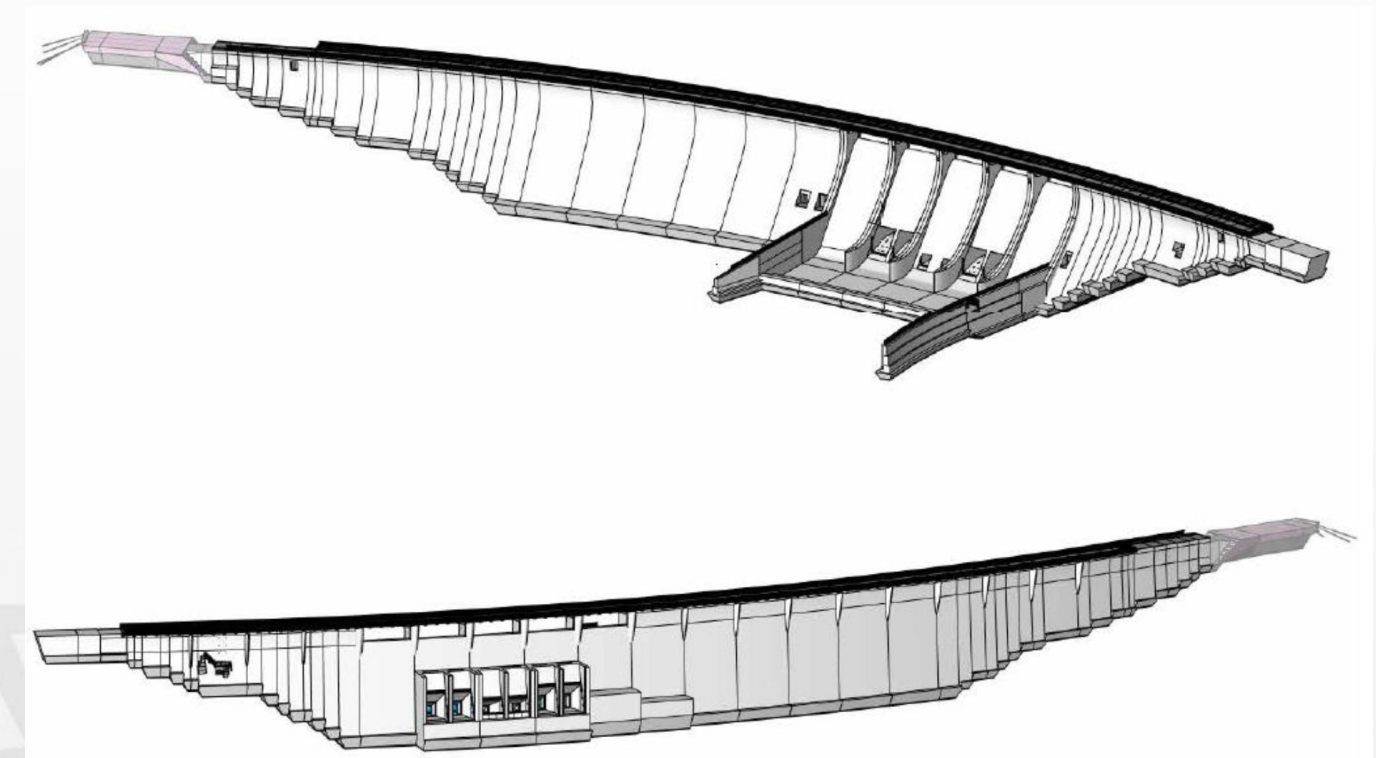
Concrete
producers

Industrial
plants

Academia

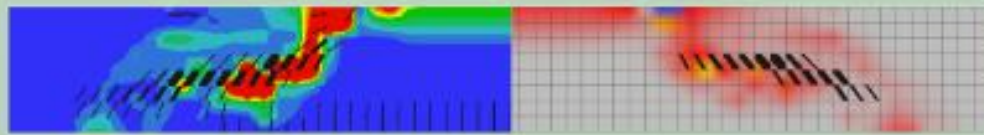


- design of dam in Nove Herminovy
- analysis of stepwise concrete casting
- effects of hydration heat and shrinkage during casting and in-service
- crack width control



Service life estimation

WP1 Macroscopic fracture



Upscaling of fracture parameters

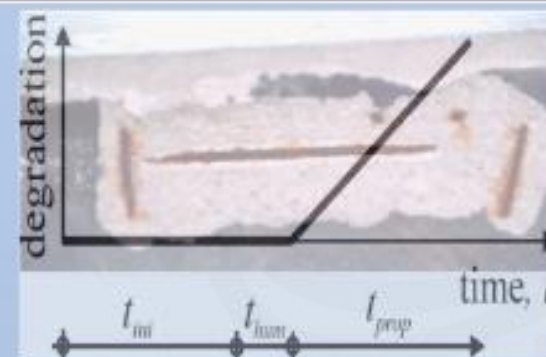
WP2 Mesoscale of RC



Discrete mesoscale models
Machine learning surrogates

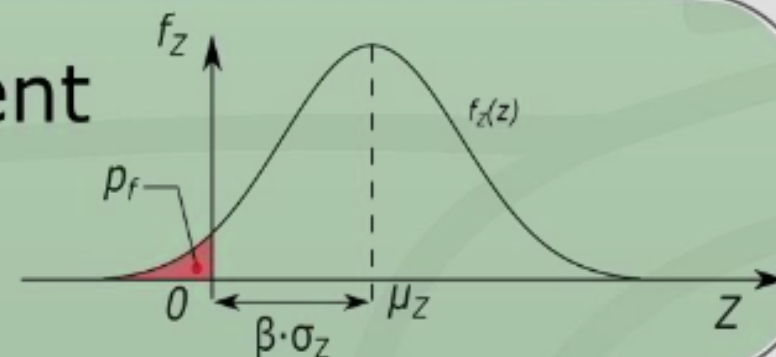
WP3 Durability and corrosion

Cracking and Corrosion
Time-variant reliability



WP4 Probabilistic assessment

Uncertainty quantification
Life-cycle optimisation



Structural
mechanics,
experimental data,
AI/ML

Materials
engineering –
degradation
processes

Probabilistic risk-
informed decision
making

RESEARCH PROFILE AND CAPACITY



- **FORD field: Engineering and Technology**
 - **Civil Engineering: 76.97%**
 - **Materials Engineering: 16.48%**
 - **Mechanical and Chemical: ~6%**

- **Key facilities:**
 - **Mechanical and chemistry labs**
 - **structural diagnostics**
 - **SHM instrumentation.**

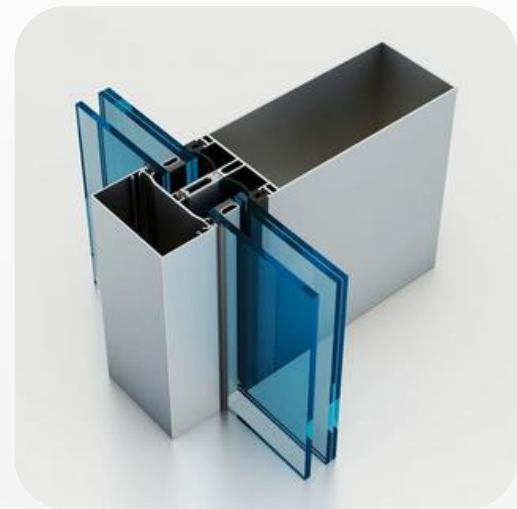
RESEARCH OUTPUTS AND SOCIETAL IMPACT



- **80 publications in WoS: 19 citations per article**
- **Applied results:**
 - **5 patents**
 - **over 20 certified methods**
 - **over 10 industrial prototypes**
- **Impact cases:**
 - **Hol-Ka footbridge (UHPC) – iconic award-winning structure**
 - **ISO/CEN leadership: Eurocode committees**

STRATEGIC RESEARCH DIRECTIONS (2025–2030)

- **Advanced Engineered Materials**
- **Digitalisation and 3D Printing**
- **SHM and Machine Learning**
- **Risk Assessment and Optimisation**
- **Green Chemistry and Sustainability**



EDUCATIONAL AND SOCIETAL ENGAGEMENT

Organizing an exhibition of 3D printing at NTK 07-08/2025 NTK

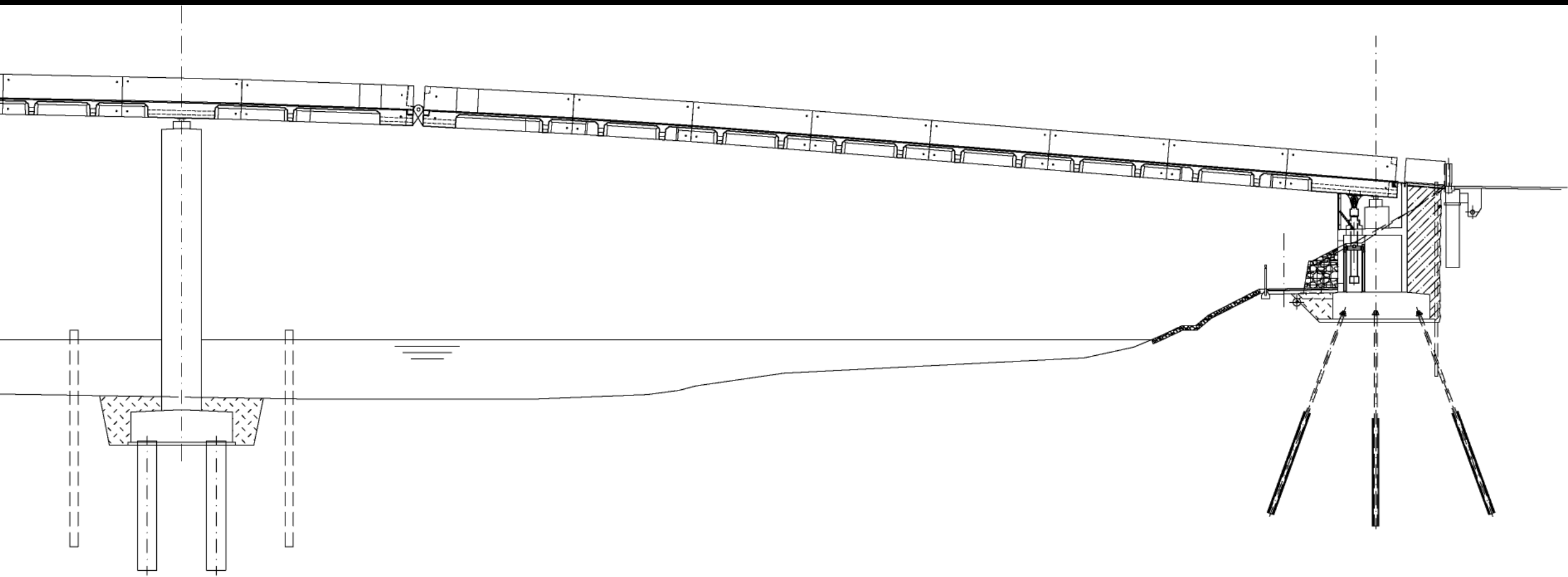


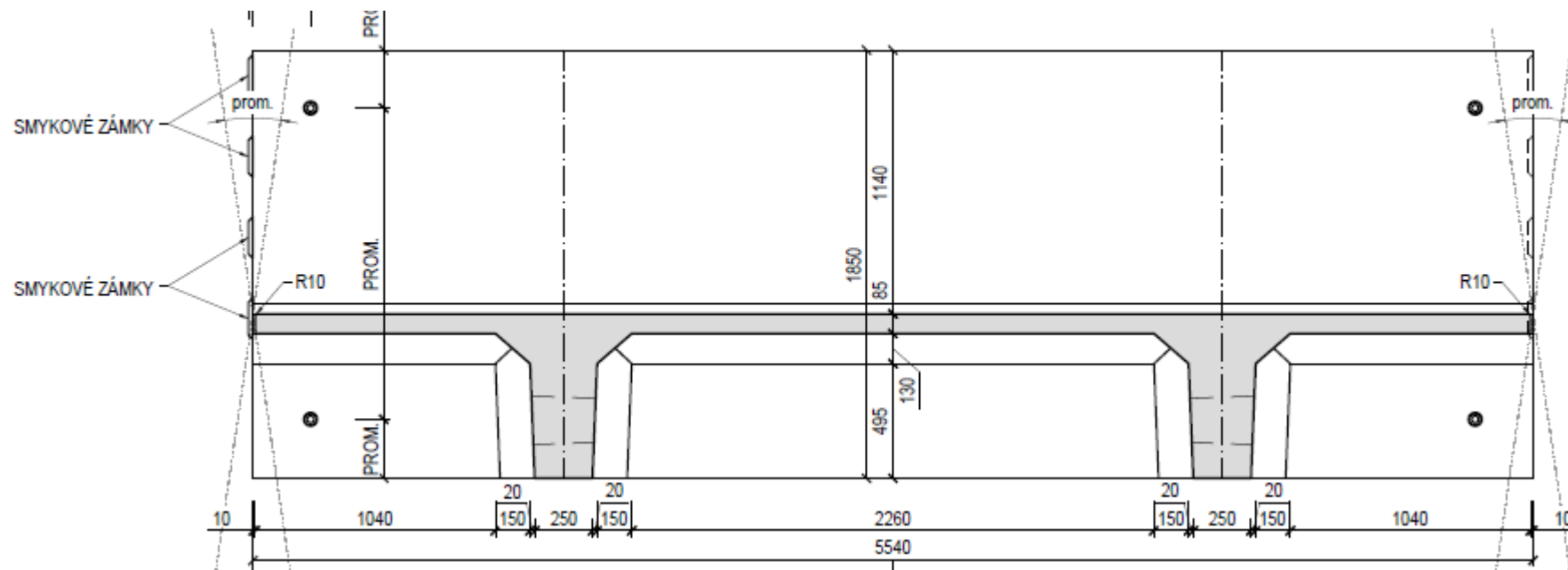
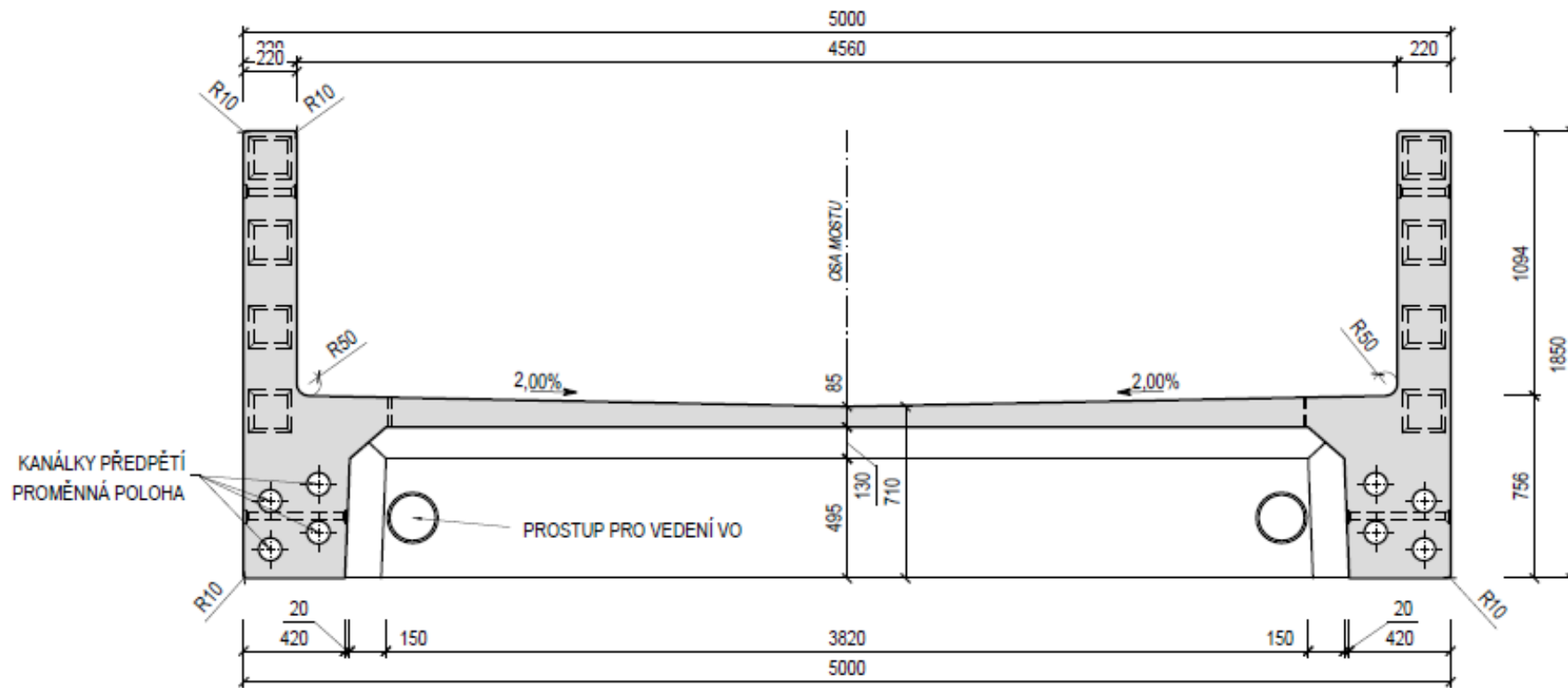


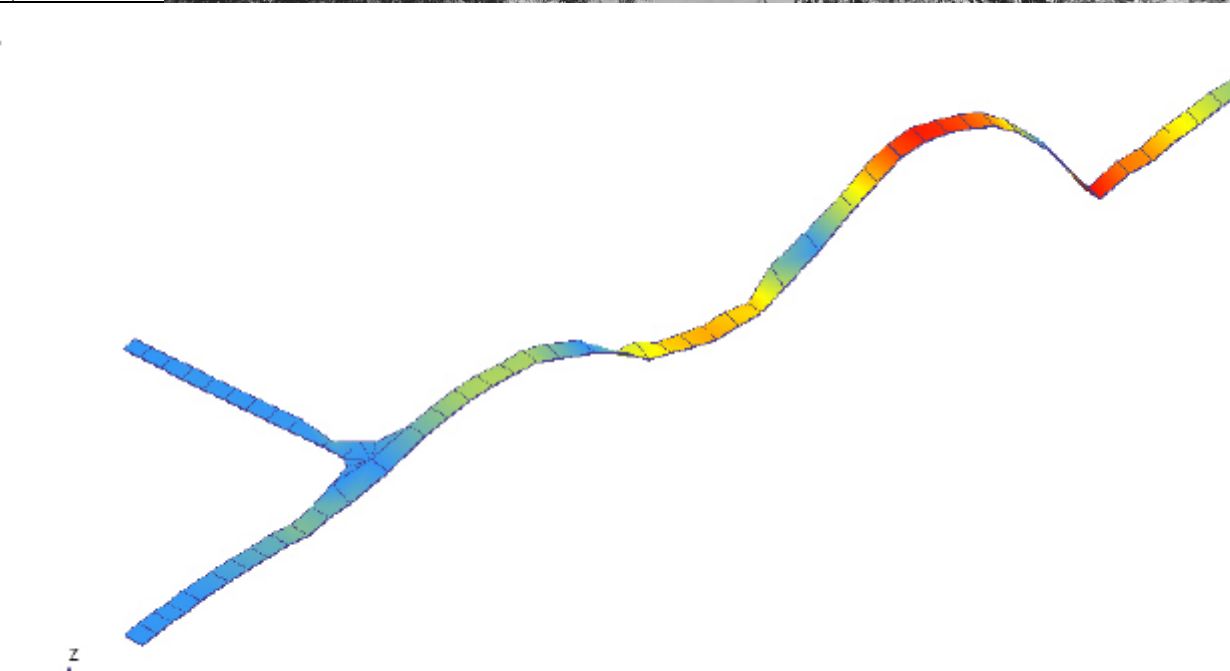
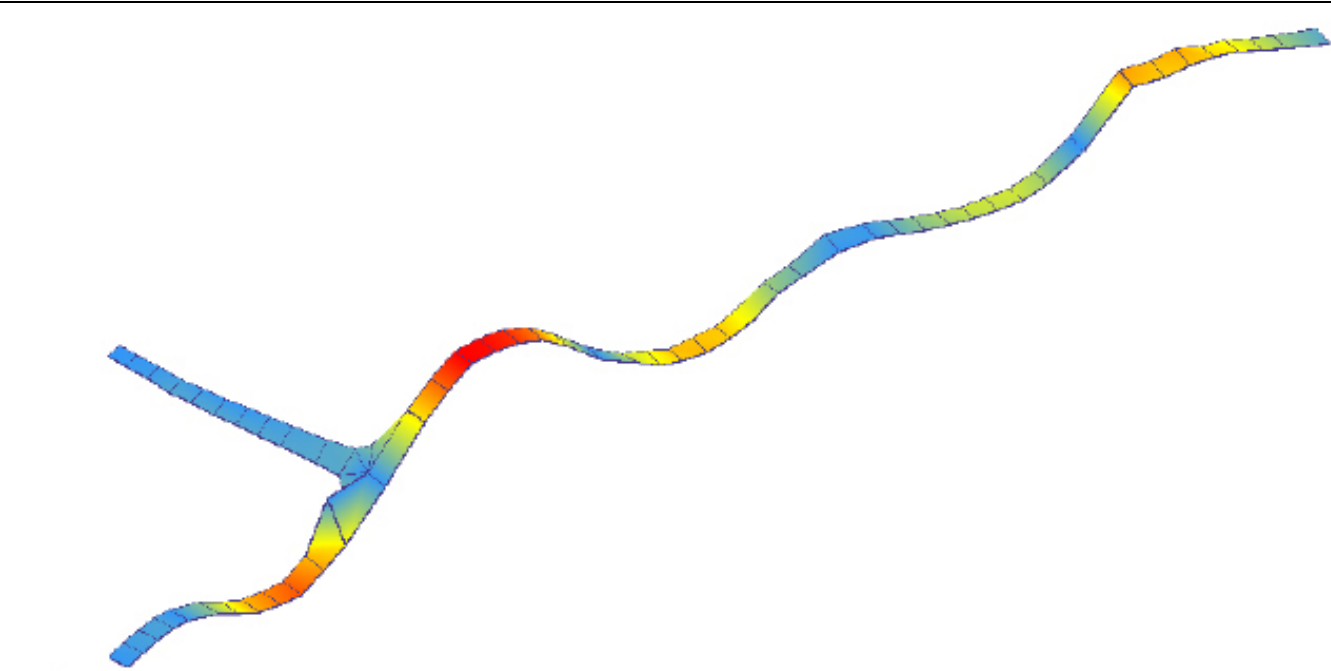
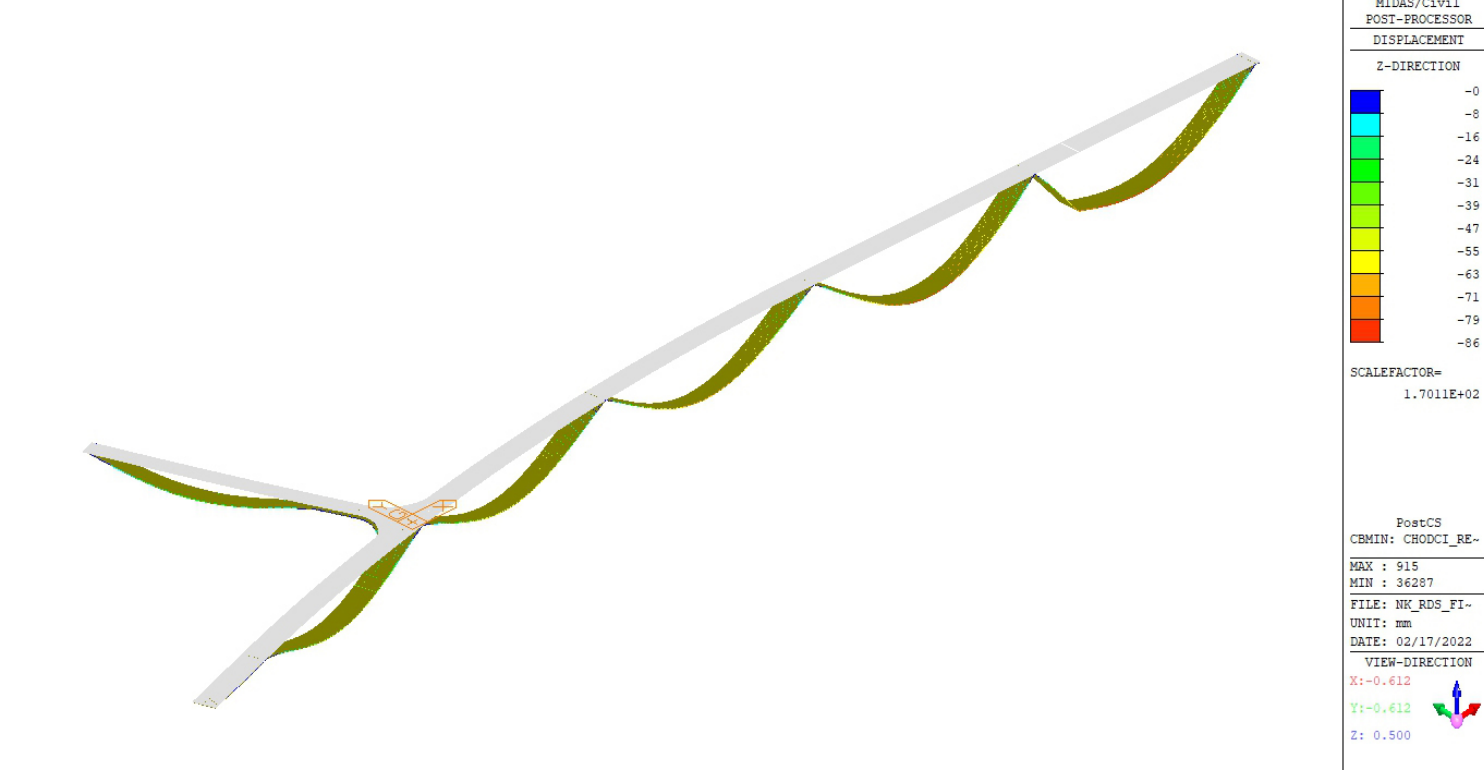








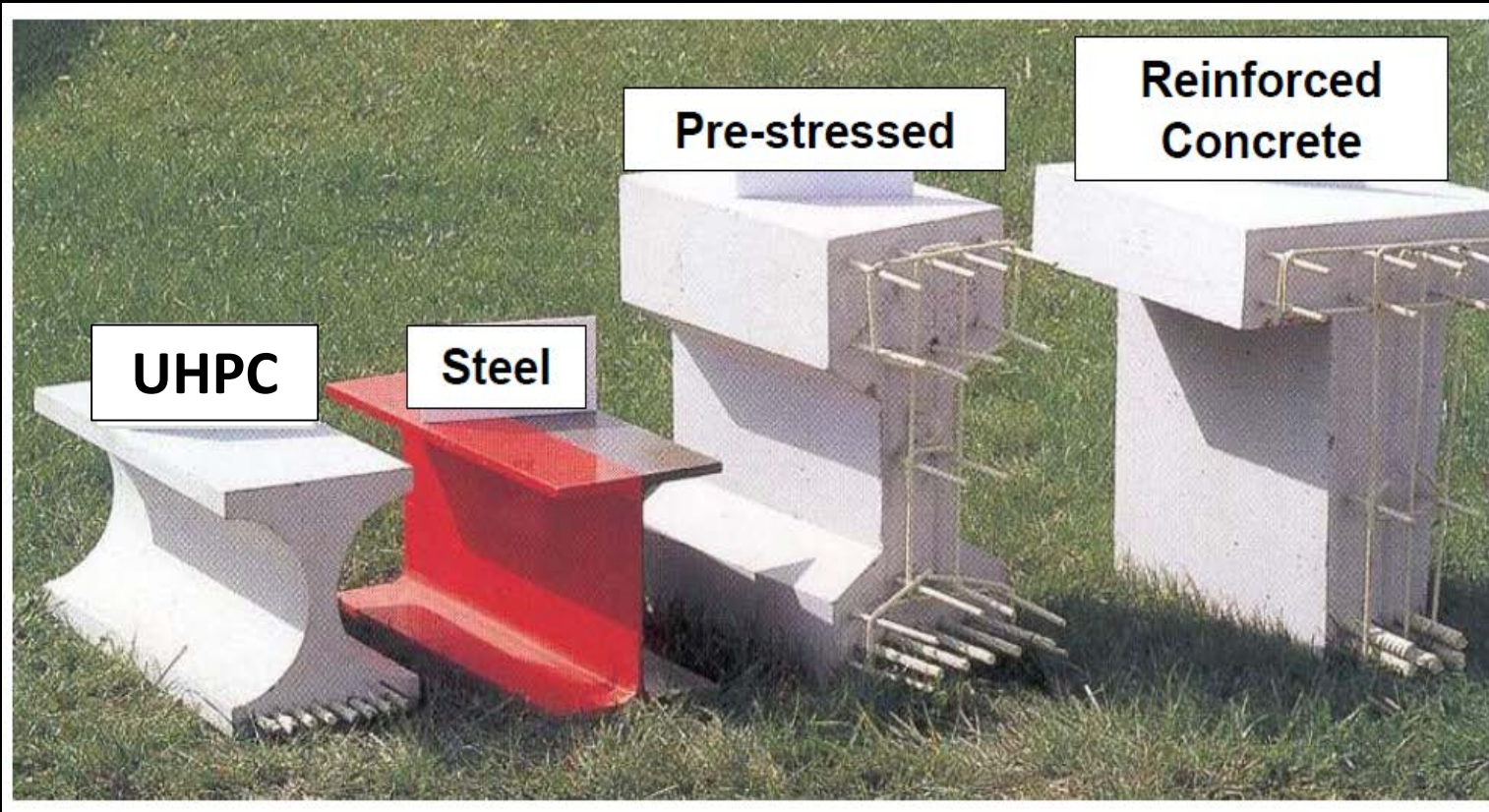








Segment	Quantity	Volume	Weight
	[pts]	[m³]	[t]
S1	21	10,4	27,0
S1-KOT-I	2	11,8	30,6
S1-KOT-II	3	13,7	35,6
S2	13	11,1	28,9
S2-KOT	1	14,4	37,5
S3	4	16,8	43,6
S4-OP00	1	17,8	46,2
S4-OP60	1	17,7	45,9
S-R1	7	10,0	26,0
S-R1-KOT	1	12,4	32,1
S-R2	1	14,8	38,5
A1	1	19,9	51,8
A2	1	18,3	47,5
TOTAL	57	679,9	1631,6















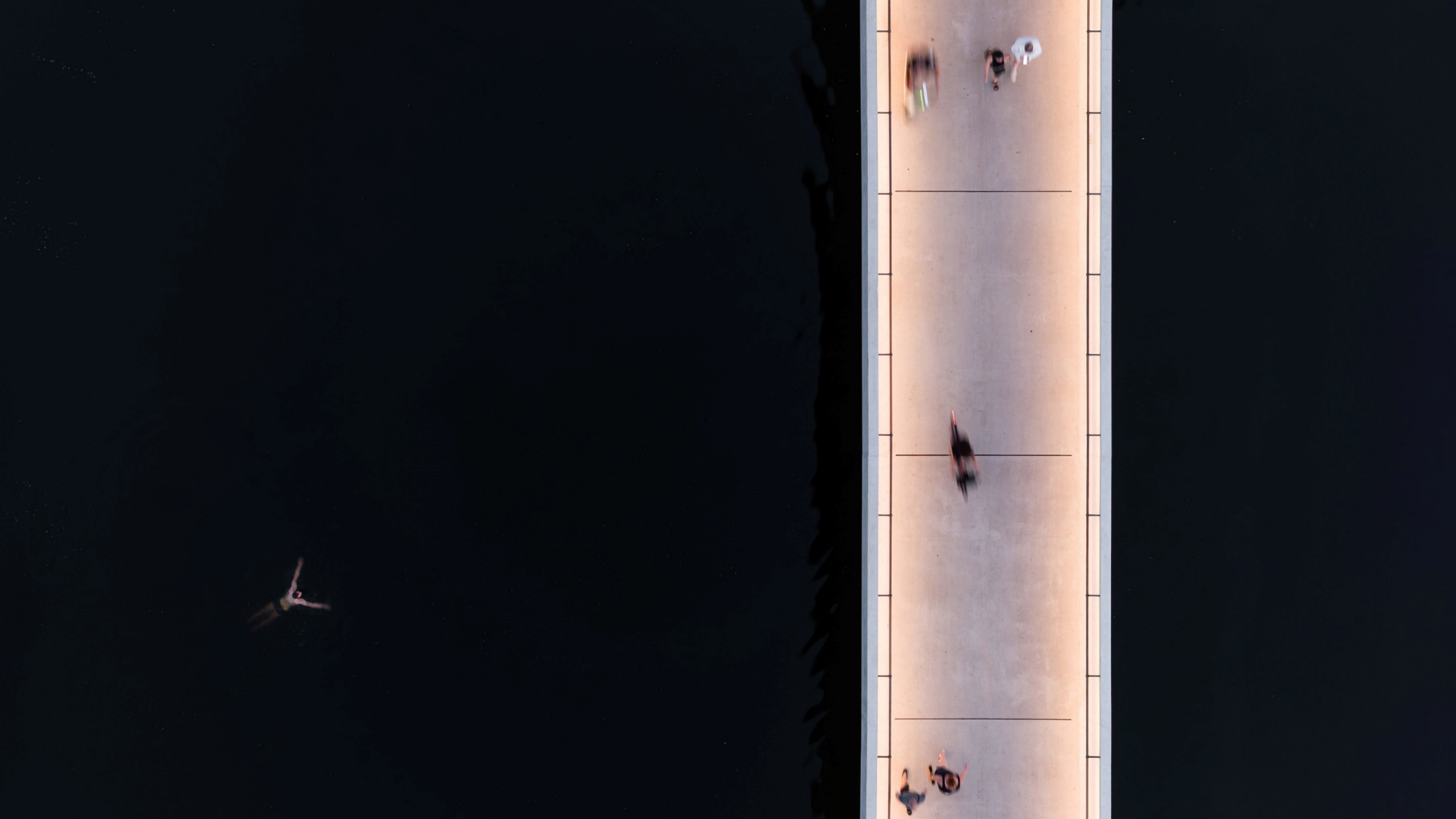














































Magistrát hlavního města Prahy | Architecture Week Praha
v rámci oslav 30. výročí vzniku České a Slovenské republiky
dne 9. 10. 2023, palác Žofín

udělují

Cenu Magistrátu hlavního města Prahy

OPERA PRAGENSIA

za nejvalitnější a nejprospěšnější soubory veřejných staveb ku prospěchu občanů
a návštěvníků hlavního města Prahy v letech 1993-2023

architektonicky konstrukčnímu týmu

Petru Tejovi, Marku Blankovi a Janu Mourkovi

za návrh lávky Holešovice-Karlín propojující ostrov Štvanice s městskými částmi
a přispívající k zvýšení atraktivity obytného prostředí hlavního města Prahy



TITUL STAVBA ROKU 2023

Štvanická lávka Praha
Hlavní město Praha

Příhlašovatel: Skanska a.s.
Investor: Hlavní město Praha
Dodavatel: Skanska a.s.
Autor: Petr Tej, Marek Blank, Jan Mourek, Al Praha s.r.o.
Projektant: Vít Najvárek, TOP CON SERVIS s.r.o.

Celá bílá, tvarově velmi lapidární, výtvarnému účinku podřízená, konstrukčně unikátní lávka. Dojmově odhmožňuje použití železobetonovou konstrukci s technickou finesou zvedací části u Holešovického břehu obnazuje unikátním způsobem pražský veřejný prostor. Chodcům i cyklistům přináší radost z pohybu a výhledy nad plynoucí řekou. Zkracuje vzdálenosti a spojuje živé městské části Karlín a Holešovice s ostrovem Štvanice.

Ing. arch. Jan Fibiger, CSc.

předseda rady programu Stavba roku 2023

Ing. arch. akad. arch. Jan Vrana

předseda poroty Stavba roku 2023

Vypisovatelé:

STAVBA
ROKU 2023



ŠTVANICE FOOTBRIDGE
IN PRAGUE

CATEGORY
Architecture - Public/Culture/Education

ARCHITECT/DESIGN
Klokner Institute CTU
Petr Tej
Marek Blank
Jan Mourek

CLIENT/MANUFACTURER
KŠ PREFA
PREMIX Servis s.r.o. Skanska a.s.
Skanska a.s.

LUTZ DIETZOLD
CEO GERMAN DESIGN COUNCIL

MAIEN 1 & OCTOBER 2024



... ocenění za dobré změny ve veřejném prostoru

CENA VITA BRANDY 2024
HLAVNÍ CENA ZA STAVBU
NEBO OPATŘENÍ

pro autorský tým
Ing. MgA. Petr Tej, Ph.D.; Ing. arch. Marek Blank;
Ing. Jan Mourek; MgA. Aleš Hvizdal; prof. Jan Hendrych
za projekt

Štvanická lávka v Praze

Investor: Hlavní město Praha

Partnerství pro městskou mobilitu, z.s.
Chomutov 388
783 35 Horka nad Mohovou
IČ: 01911996 DIČ: CZ01911996

Ing. Jaroslav Vymazal
předseda spolku
Partnerství pro městskou mobilitu, z.s.

PhDr. Věra-Karin Brázová
předsedkyně odborné poroty



PROJECT AND TECHNOLOGY
AWARDS 2024

FOR

Pedestrian and Cycle Bridges

FINALIST

PRESENTED TO

Štvanice Footbridge
Czech Republic

ON 12 NOVEMBER 2024

THE IABSE AWARDS 2024 & GALA DINNER ZURICH, SWITZERLAND

Tina Vejrum
PRESIDENT OF IABSE

IAN FIRTH
CHAIR OF IABSE AWARDS JURY



ŠTVANICE FOOTBRIDGE
IN PRAGUE

CATEGORY
Innovative Material

ARCHITECT/DESIGN
Klokner Institute CTU
Petr Tej
Marek Blank
Jan Mourek

CLIENT/MANUFACTURER
KŠ PREFA
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Skanska a.s.

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MAIEN 1 & OCTOBER 2024



NÁRODNÍ CENA
ZA ARCHITEKTURU
2024

Hlavní cena
Grand Prix Architectů
Národní cena za architekturu 2024

Štvanická lávka

Autoři
Petr Tej, Marek Blank, Jan Mourek, Aleš Hvizdal, Jan Hendrych

OLEG HAMAN
PŘEDSEDA
OBCE ARCHITEKTŮ
SOCIETY OF CZECH ARCHITECTS
UIA MEMBER
21/10/2024

