SELF-EVALUATION REPORT FOR MODULE 3

THE NAME OF THE UNIT BEING EVALUATED: KLOKNER INSTITUTE, CZECH TECHNICAL UNIVERSITY IN PRAGUE

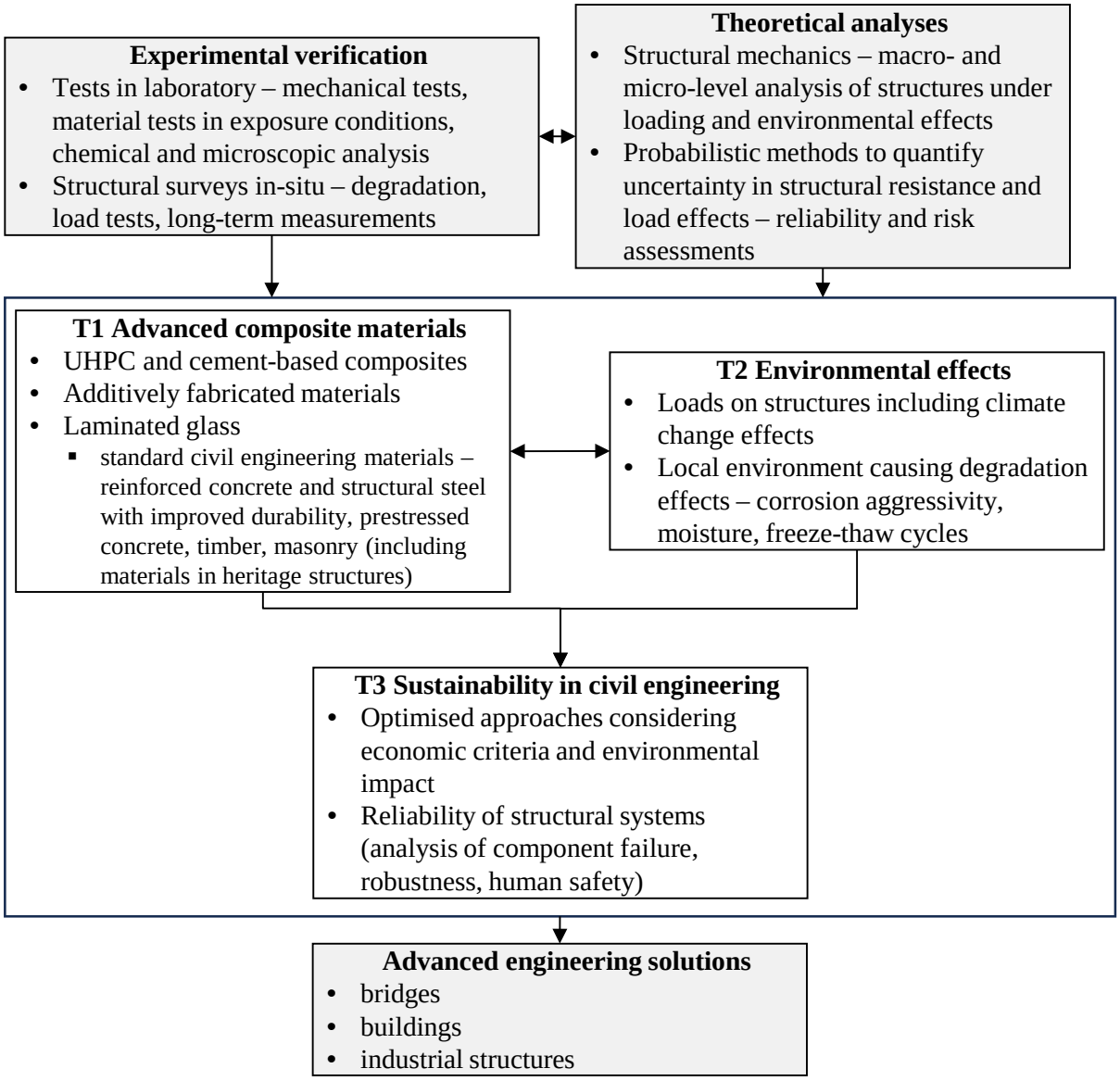
FORD: 2 - Engineering and technology

SOCIAL CONTRIBUTION OF THE EVALUATED UNIT

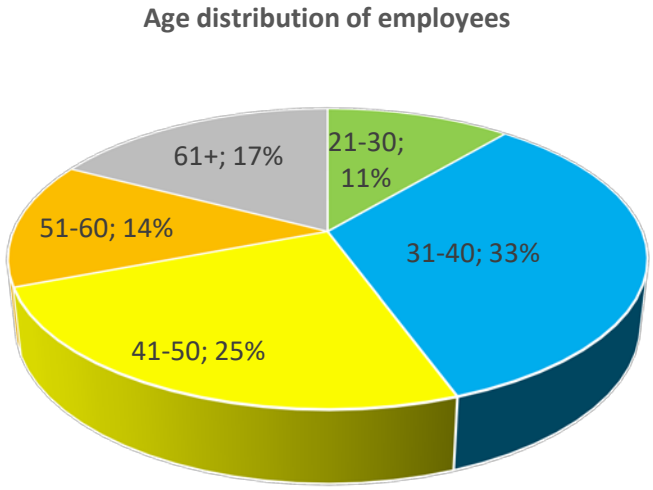
3.1 Introductory information about the unit under evaluation

Since 1921, the Klokner Institute (KI) has continuously become a Czech leader and internationally recognised institute in experimental and theoretical research of building materials and structural systems. The mission of KI consists of a variety of research activities complemented by dissemination activities and lecturing in university and lifelong education. The KI is intensely focused on transferring research results into practice, also significantly contributing to national and international standardisation.

KI has four specialised departments – Experimental Investigations, including in-situ structural surveys, Materials Engineering, Structural Mechanics, and Structural Reliability, as well as accredited laboratory and forensic engineers. Basic and applied research is balanced in the KI's activities; the fields of technology cover mainly civil engineering, with strong contributions from materials and chemical engineering, and applications to military and mechanical engineering. Basic research fields include primarily mathematics (statistics and probabilistic methods, numerical methods), physics (primarily mechanics), and chemical sciences. The main KI topics are summarized in the chart below.

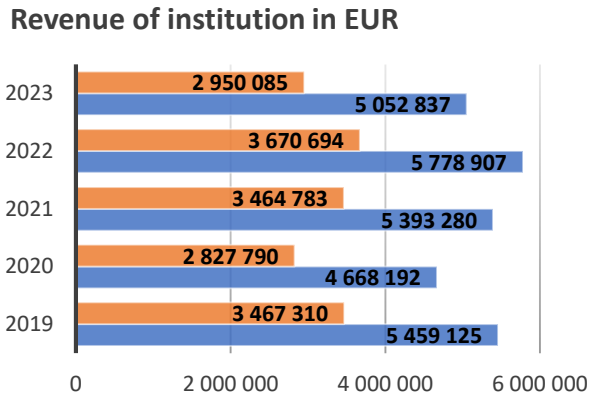


To indicate the size of the KI, FTEs varied between 66-72 in 2019-2023, with more than 62% of the researchers including professors and associated professors (app. 12% of researchers); for details, see Table 3.1.1 below. The long-term total share of women is 1/3; regarding the age distribution, a significant proportion of early-career researchers is considered positive.



The KI recognises the importance of transferring research results into practice. Therefore, it continues to promote active collaboration with national and international industrial partners. Primarily under contract research, these activities have resulted in several novel industrial applications (design and technologies for innovative materials, numerical procedures for structural design, structural health monitoring systems) and applied research results (patents, prototypes, verified technologies). The industry recognizes the strong position of KI - according to the CTU annual reports for 2019-2023, KI and FEE are CTU's leaders in contract research.

Year	Total revenue EUR	Total revenue CZK	Contract research and expert activities revenue EUR	FTE	Revenue per FTE EUR	Revenue per FTE CZK
2019	5 459 125	140 146 657	3 467 310	66,5	82092	2107469
2020	4 668 192	123 445 682	2 827 790	69,2	67459	1783897
2021	5 393 280	138 310 656	3 464 783	70,6	76392	1959074
2022	5 778 907	141 958 843	3 670 694	71,1	81279	1996608
2023	5 052 837	121 303 460	2 950 085	71,8	70374	1689463



	2019	2020	2021	2022	2023
Contract research and exper activities revenue EUR	3 467 310	2 827 790	3 464 783	3 670 694	2 950 085
Total revenue EUR	5 459 125	4 668 192	5 393 280	5 778 907	5 052 837

The KI established research cooperation with all the leading Czech institutions in civil engineering (Faculties of Civil Engineering in Prague, Brno, and Ostrava, Institute of Theoretical and Applied Mechanics of Academy of Sciences, TU Liberec, University of Defence). Its outstanding position in research is evidenced by a citation impact – one of the CTU's leaders in citation rate per FTE.
The average citation rate of articles in impacted journals authored or co-authored by KI staff according to the internal database of CTU (V3S) is ~19 citations per article in the evaluated period. The average number of citations per publication in an impacted journal authored or co-authored by KTU is almost double compared to the CTU's average, exceeding it by approximately 80%.
An important part of the KI strategy is international collaboration in research and standardisation. The Institute cooperates with leading foreign universities and research centres such as the Politecnico di Torino a Torroja Institute, Madrid (reliability of concrete structures), TNO and TU Delft (reliability of structures and risk assessment, construction glass), TU Ghent (reliability of concrete and glass construction), de Coimbra – Polo II (glass structures), University of Stellenbosch, South Africa (principles of structural design), JRC Ispra (reliability of structures, climatic changes and their influence on building structures) or LafargeHolcim Research & Development (R&D), France (advanced static and dynamic testing UHPC). KI experts are often leaders in standardisation – Czech standards CSN, European EN, and international ISO.
For more than 30 years, the KI has been running a PhD programme focusing on structural materials, testing, and reliability in construction, which approximately 30 students attend. As part of lifelong learning, it offers courses focused on structural materials, design, and surveys, mainly in cooperation with the Czech Chamber of Authorized Engineers and Technicians in Construction CKAIT and the Czech Concrete Society CBS.
The KI has established itself as a leading forensic engineering institute in the fields of civil and chemical engineering. Between 2019 and 2023, its reports covered cases involving bridges, tunnels, monuments, and other significant structures. The institute actively engages with the public through television and radio broadcasts, print media, and social media platforms, maintaining a strong reputation while handling high-profile cases within the construction industry.

To indicate the KI strategy for the subsequent years, the main topics should include the following:

- Development of advanced engineered materials (ultra-high-performance concretes UHPC, glass),
- 3D printing of structural materials including the development of materials, technologies, and the reliability basis for structural design,
- Machine learning: processing of structural health monitoring data, reliability analysis, design optimisation,
- Risk optimisation of technological systems in hazard situations (civil and military applications),
- Development of corrosion protection based on concept of 'green chemistry': coatings for sustainability in construction.

Table 3.1.1 - Staffing per FTE[1]

Academic/ Professional position	Total / Of which women					
	year 1	year 2	year 3	year 4	year 5	Total
Professor	1,10/ 0,00	1,10/ 0,00	1,10/ 0,00	2,00/ 0,00	2,00/ 0,00	7,30/ 0,00

[1] The average number of hours worked is calculated as the ratio of the total number of hours actually worked during the reference period, from 1 January to 31 December, by all staff (including agreement on work activity, excluding agreement on work performance) to the total annual working time pool per full-time employee. The full- time status of the worker in the

Associate Professor	4,20/ 1,00	4,20/ 1,00	4,20/ 1,00	3,20/ 1,00	3,20/ 1,00	19,00/ 5,00
Assistant Professor	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00
Assistant	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00	0,00/ 0,00
R&D Personnel[2]	25,3/ 13,1	24,4/ 11,9	25,2/ 11,8	25,9/ 12,4	26,5/ 12,4	127,2/ 61,4
Researchers in other categories[3]	34,90/ 9,90	38,6/ 10,70	39,2/ 10,70	39,1/ 11,20	39,2/ 11,70	190,8/ 54,20
Technical and economic staff[4]	1,00/ 0,00	1,00/ 0,00	1,00/ 0,00	1,00/ 0,00	1,00/ 0,00	5,00/ 0,00
Scientific, research and development staff involved in teaching activities	5,30/ 1,00	5,30/ 1,00	5,30/ 1,00	5,20/ 1,00	5,20/ 1,00	26,30/ 5,00
Early career researchers[5]	28,5/ 7,9	27,9/ 6,60	27,4/ 6,2	26,3/6,7	24,9/ 6,4	134,8/ 33,7
Total[6]	66,5/ 24,0	69,2/ 23,6	70,6/ 23,5	71,1/ 24,6	71,8/ 25,1	349,3/ 120,6

Note: The categories professor, associate professor, assistant professor, assistant, other scientific, R&D personnel, researchers in other categories and technical and economic staff are mutually exclusive, i.e. one staff member is reported under one category only. Scientific, research and development staff involved in teaching activities, as well as early career researchers are reported collectively for all the above-mentioned categories.

evaluated unit is always reported. If an employee holds more than one type of full-time job within the evaluated unit, the total sum of the two shall be reported.

[2] The category "R&D Personnel" includes technical and professional personnel who are not directly involved in R&D&I but are indispensable for the research activity (e.g. operators of research facilities).

[3] The category "Researchers in other categories" includes all other staff who cannot be classified under any of the above categories (e.g. independent researcher/scientist).

[4] Who participates in the management and support of R&D&I in the institution.

[5] See Definition of Terms in Methodology HEI2025+.

[6] Total is the sum of the categories: professor, associate professor, assistant professor, assistant, R&I personnel, researchers in other categories and technical and economic staff.

3.1.2 Age structure of R&D&I personnel of the evaluated unit and their structure by job title and gender in the first year of the evaluation period (numbers of physical employees and personnel)[7]

Academic/ professional position	Under 29 years		30-39 years old		40-49 years old		50-59 years old		60-69 years old		70 years and older	
	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women
Professor	0	0	0	0	0	0	0	0	1	0	2	0
Associate Professor	0	0	0	0	1	0	0	0	1	1	2	0
Assistant Professor	0	0	0	0	0	0	0	0	0	0	0	0
Assistant	0	0	0	0	0	0	0	0	0	0	0	0
R&D Personnel[8]	0	0	1	1	9	2	7	4	11	7	2	2
Researchers in other categories[9]	0	0	22	4	14	6	3	1	2	1	1	0
Technical and economic staff[10]	0	0	0	0	0	0	0	0	0	0	0	0
Scientific, research and development staff involved in teaching activities	0	0	0	0	1	0	0	0	2	1	4	0
Early career researcher[11]	0	0	22	4	0	0	0	0	0	0	0	0
Total[12]	0	0	23	5	24	8	10	5	15	9	7	2

Note: The categories professor, associate professor, assistant professor, assistant, other scientific, R&D Personnel, Researchers in other categories and Technical and economic staff are mutually exclusive, i.e. one staff member is reported in only one category. The categories of scientific, research and development staff involved in teaching activities and early career researchers are reported collectively for all the above-mentioned categories.

[7] The total number of employees/workers as of 31st December of the calendar year in question is to be entered, irrespective of the level of time worked, but only in an employment relationship (including agreement on work activity, excluding agreement on work performance). Other types of contractual relationships under the Civil Code that involve purchase of services are not included.

[8] The category "R&D Personnel" includes technical and professional personnel who are not directly involved in R&D&I but are indispensable for the research activity (e.g. operators of research facilities).

[9] The category "Researchers in other categories" includes all other staff who cannot be classified under any of the above categories (e.g. independent researcher/scientist).

[10] Who participates in the management and support of R&D&I in the institution.

[11] See Definition of Terms in Methodology HEI2025+.

[12] Total is the sum of the categories: professor, associate professor, assistant professor, assistant, R&I Personnel, Researchers in other categories and technical and economic staff.

3.1.3 Age structure of R&D&I personnel of the evaluated unit and their structure by job title and gender in the last year of the evaluation period (numbers of physical employees and personnel)[13]

Academic/ professional position	Under 29 years		30-39 years old		40-49 years old		50-59 years old		60-69 years old		70 years and older	
	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women
Professor	0	0	0	0	0	0	0	0	1	0	1	0
Associate Professor	0	0	0	0	1	0	0	0	1	1	2	0
Assistant Professor	0	0	0	0	0	0	0	0	0	0	0	0
Assistant	0	0	0	0	0	0	0	0	0	0	0	0
R&D Personnel[14]	3	0	3	2	6	2	7	3	9	5	2	2
Researchers in other categories[15]	3	0	24	6	12	7	3	1	3	1	0	0
Technical and economic staff[16]	0	0	0	0	0	0	0	0	0	0	0	0
Scientific, research and development staff involved in teaching activities	0	0	0	0	1	0	0	0	2	1	3	0
Early career researcher[17]	3	0	24	6	0	0	0	0	0	0	0	0
Total[18]	6	0	27	8	19	9	10	4	14	7	5	2

Note: The categories professor, associate professor, assistant professor, assistant, other scientific, R&D personnel, researchers in other categories and technical and economic staff are mutually exclusive, i.e. one staff member is reported under one category only. Scientific, research and development staff involved in teaching activities, as well as early career researchers are reported collectively for all the above-mentioned categories.

[13] The total number of employees/workers as at 31.12. of the calendar year in question is to be entered, irrespective of the level of time worked, but only in an employment relationship (including agreement on work activity, excluding agreement on work performance). Other types of contractual relationships under the Civil Code that involve purchase of services are not included.

[14] The category "R&D Personnel" includes technical and professional personnel who are not directly involved in R&D&I but are indispensable for the research activity (e.g. operators of research facilities).

[15] The category "Researchers in other categories" includes all other staff who cannot be classified under any of the above categories (e.g. independent researcher/scientist).

[16] Who participates in the management and support of R&D&I in the institution.

[17] See Definition of Terms in Methodology HEI2025+.

[18] Total is the sum of the categories: professor, associate professor, assistant professor, assistant, R&I personnel, researchers in other categories and technical and economic staff.

Table 3.1.4 – Students

Type of study	year 1		year 2		year 3		year 4		year 5		Total	
	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women	Total	Women
Undergraduate	0	0	0	0	0	0	0	0	0	0	0	0
Master's[19]	0	0	0	0	0	0	0	0	0	0	0	0
Doctoral	39	9	41	9	30	4	20	3	21	3	39	9
Lifelong Learning Courses	37	10	27	3	32	2	42	8	38	7	176	30
Total	76	19	68	12	62	6	62	11	59	10	215	39

Table 3.1.5 - Study programmes in Czech/English

Type of study programme	Total[20] / Of which professional study programmes											
	year 1		year 2		year 3		year 4		year 5		Total	
Undergraduate	0	0	0	0	0	0	0	0	0	0	0	0
Master's	0	0	0	0	0	0	0	0	0	0	0	0
Doctoral	4/0	4/0	6/0	6/0	6/0	6/0	4/0	4/0	5/1	5/1	25/1	25/1
Lifelong Learning courses	4/0*	4/0*	3/0*	3/0*	3/0*	3/0*	4/0*	4/0*	5/0*	5/0*	19/0*	19/0*
Total	8/0	8/0	9/0	9/0	9/0	9/0	8/0	8/0	10/1	10/1	44/1	44/1

Note: For each SP type, enter the number of SPs in Czech language in the first cell and insert the number of SPs in English language after the slash in the same cell (e.g. 15/3), enter the number of professional SPs in Czech language in the second cell and insert the number of professional SPs in English language after the slash. Follow a similar procedure in the last column of the table (Total).

*Short-term courses (1-2 days), mostly organised with the Czech Chamber of Civil Engineers and Technicians Active in Construction CKAIT and/ or with the Czech Concrete Society CBS.

3.1.6 – R&D&I capacities

R&D&I field	FORD	FORD share [%]	Predominant type of research	Total share of industry group [%]
1. Natural Sciences	1.1 Mathematics		Zvolte položku.	0,4
	1.2 Computer and information sciences		Zvolte položku.	
	1.3 Physical sciences		Zvolte položku.	
	1.4 Chemical sciences	0,4	Balanced basic and applied research	
	1.5 Earth and related environmental sciences		Zvolte položku.	
	1.6 Biological sciences		Zvolte položku.	

[19] All master's degree students are listed, regardless of the length of their programme of study.
[20] The total number of study programmes for which admissions have been announced in a given academic year.

	1.7 Other natural sciences		Zvolte položku.	
2. Engineering and Technology	2.1 Civil engineering	76,97	Balanced basic and applied research	99,24
	2.2 Electrical engineering, Electronic engineering, Information engineering	0	Zvolte položku.	
	2.3 Mechanical engineering	3,05	Balanced basic and applied research	
	2.4 Chemical engineering	2,74	Balanced basic and applied research	
	2.5 Materials engineering	16,48	Balanced basic and applied research	
	2.6 Medical engineering		Zvolte položku.	
	2.7 Environmental engineering		Zvolte položku.	
	2.8 Environmental biotechnology		Zvolte položku.	
	2.9 Industrial biotechnology		Zvolte položku.	
	2.10 Nanotechnology		Zvolte položku.	
	2.11 Other engineering and technologies		Zvolte položku.	
3. Medical and Health Sciences	3.1 Basic medicine		Zvolte položku.	
	3.2 Clinical medicine		Zvolte položku.	
	3.3 Health sciences		Zvolte položku.	
4. Agricultural and veterinary sciences	4.1 Agriculture, Forestry, and Fisheries		Zvolte položku.	
	4.2 Animal and Dairy science		Zvolte položku.	
	4.3 Veterinary science		Zvolte položku.	
	4.4 Other agricultural sciences		Zvolte položku.	
5. Social Sciences	5.1 Psychology and cognitive sciences		Zvolte položku.	
	5.2 Economics and Business		Zvolte položku.	
	5.3 Education		Zvolte položku.	
	5.4 Sociology		Zvolte položku.	
	5.5 Law		Zvolte položku.	
	5.6 Political science		Zvolte položku.	
	5.7 Social and economic geography		Zvolte položku.	
	5.8 Media and communications		Zvolte položku.	
	5.9 Other social sciences		Zvolte položku.	
6. Humanities and the Arts	6.1 History and Archaeology		Zvolte položku.	0,37
	6.2 Languages and Literature		Zvolte položku.	
	6.3 Philosophy, Ethics and Religion		Zvolte položku.	
	6.4 Arts (arts, history of arts, performing arts, music)	0,37	Applied Research	
	6.5 Other Humanities and the Arts		Zvolte položku.	
	Total	100 %	-	100 %

RECOGNITION BY THE RESEARCH COMMUNITY

3.2 Recognition by the research community

Despite the adverse impact of COVID-19 pandemic, the KI continued international and national research collaborations and many of its results were highly recognised by the scientific community:

- Innovations related to ultra-high-performance concrete (UHPC) resulted in global pioneering bridge applications that received awards from research and professional organisations in architecture and civil engineering; an overview of the KI's UHPC applications is attached, *KI_3.2_UHPC footbridges_monograph*.
- Participation in international research resulted in the study on structural design and climate change that received the IABSE Outstanding Paper Award 2023.
- The KI's PhD students are actively involved in basic and applied research projects. Therefore, their dissertations regularly win awards, primarily for applications in concrete and cement composites, but also for their contributions to the protection of cultural heritage or corrosion protection.
- Memberships in Editorial Boards of prestigious journals provide evidence of recognition of the experts of the KI in various fields of technology (structural concrete and glass, reliability and safety, heritage preservation). In these fields, the KI's experts have been regularly invited to review applications on national and international grant calls. Strong international collaboration is also documented by memberships in scientific committees of prestigious international conferences (fib and IABSE conferences, ICASP, ICOSSAR, ESREL, etc.). The KI organised the International Probabilistic Workshop IPW 2022 jointly with the University of Stellenbosch, South Africa, with speakers from 11 countries from three continents – Africa, Australia and Europe. The KI, jointly with the Brno University of Technology, organises annual WTA conferences on the rehabilitation of buildings (WTA Days and CRRB); see also 3.5 Transfer of results.

KI researchers contribute significantly to international research under the following organisations:

- Réunion internationale des Laboratoires d´Essai et de Recherches sur Matériaux et les Constructions (RILEM) – KI being a founding member (*KI represented by its director*)
- International Council for Building Research Studies and Documentation (CIB)
- International Association for Bridge and Structural Engineering (IABSE – *Assoc. Prof. Sykora and Dr. Tej*)
- International Federation for Structural Concrete (*fib – Prof. Kolisko – Technical Council, assembly of leaders of national groups, Dr. Citek* - Youth Group of fib, *Assoc. Prof. M. Sykora* is a member of the management board of *fib* COM3 Existing concrete structures and chair of TG3.1 Reliability and safety evaluation, lead author of *fib* Model Code 2020, Chapters 11 Structural performance evaluation framework, 12 Principles of structural design and assessment, and 13 Actions on structures)
- Scientific and Technical Association for Building Rehabilitation and Monument Preservation (WTA – *Dr. Pernicova and Prof. Kolisko – members of the national committee*)
- Joint Committee on Structural Safety (JCSS – *Prof. Holicky, Assoc. Prof. Markova and Assoc. Prof. Sykora – Czech representatives in* WP1 Probabilistic Model Code; WP2 Risk-Informed Decision Support for Systems Involving Structures; WP3 JCSS Continuing Education and Advanced School; TG1 JCSS Special Task Force on Resilience and Sustainability in the Built Environment)
- Joint Research Centre of the European Commission (JRC), Safety & Security of Buildings, TG Numerical simulation for hostile vehicle mitigation (*Assoc. Prof. Sykora*)

They are active in international standardisation through ISO and the European Committee for Standardisation CEN. In the field of load modelling, structural reliability, and risk assessment, the KI experts are recognised as leading European experts. They were selected and continue to be involved in the CEN and ISO teams for revisions of structural design codes. They were/ are leaders of the CEN project teams on assessing existing structures, thermal loads, and reliability assessment of towers and masts; they were leaders of subtasks within teams on snow loads and climate change. They are Czech national representatives for CEN/ TC 250 Eurocodes, TC 250/ SC1 and SC10 for loads on structures and basis of structural design, and WGs on assessment and retrofitting of existing structures, climatic loads, traffic loads on bridges, and in the Horizontal Group - Bridges of CEN.
Furthermore, the KI's experts serve as:

- reviewers of fib bulletins, international journals and dissertations at foreign universities (strong cooperation particularly with University of Stellenbosch, South Africa) – mainly in civil and chemical engineering,
- members of editorial boards of national professional journals,
- lecturers at CTU and within lifelong education courses.

Table 3.2.1 - Prestigious R&D&I awards granted during the evaluation period (see the attachment *KI_3.2_awards UPHC footbridges_OTHERS*)

Name, surname and title(s) of the evaluated unit's staff member	Name of the award	Awarding institution
Dr. Petr Tej et al.	UHPC long-span footbridge between Holesovice and Karlin in Prague (put into operation in 2023): 1. IABSE International Award 2024 (finalist) 2. Iconic Award for Innovative Architecture and Materials in Munich 3. Best Czech Civil Engineering Work 2023 4. Opera Pragensia 2023 - Prague City Council Award for the best quality and most beneficial public buildings 5. National Architecture Award – Grand Prix of Architects 2024 6. Vit Branda's Award for Improvement of Public Space 2024 See Section 3.4 for technical details.	1. International Association for Bridge and Structural Engineering (IABSE) 2. German Design Council 3. Czech Chamber of Authorised Engineers and Technicians in Civil Engineering 4. Prague City Council 5. Czech Chamber of Architects 6. Obec architektu (Community of Czech Architects)
Dr. Petr Tej et al.	UHPC footbridge over the Dretovicky stream in Vrapice (in cooperation with FA CTU): 1. Footbridge awards 2020 2. Czech Award for Architecture 2019: *The footbridge is an elegant masterpiece made possible by using state-of-the-art UHPC material. The footbridge is an example of cutting-edge bridge engineering. It is an outstanding piece of architecture; it appears to float due to its extremely thin form*. Facebook post reached 1,2M followers.	1. Journal Bridge Design & Engineering 2. Czech Chamber of Architects
Dr. Petr Tej et al.	UHPC footbridge over the Lubina River in Pribor - Czech Award for Architecture 2019	Czech Chamber of Architects

Name, surname and title(s) of the evaluated unit's staff member	Name of the award	Awarding institution
Dr. Petr Tej et al.	UHPC footbridge over the Vltava River in Luzec nad Vltavou - Award of the Czech Concrete Society for Civil Engineering Works Built between 2017-2020	Czech Concrete Society (CBS)
Assoc. Prof. Miroslav Sykora	A 2022 paper "Investigating the Effects of Climate Change on Structural Actions" by Orcesi, Sykora et al. received the IABSE Outstanding Paper Award 2023, category: Scientific paper	Association for Bridge and Structural Engineering (IABSE)
Dr. David Citek (2022 winner) Dr. Tomas Bittner (2019, 2nd place)	CBS Outstanding Dissertation in the technology of concrete	CBS (Czech Concrete Society)
Dr. Milan Rydval (winner) Dr. Sarka Nenadalova , Ph.D. (honourable mention)	WTA Best Dissertation 2019 in rehabilitation of buildings	WTA (Scientific and Technical Association for Building Rehabilitation and Monument Preservation)
Ing. Tomas Chobotsky	HYTEP Prize competition for an excellent diploma thesis in the field of hydrogen and hydrogen technologies (2nd place, 2023)	HYTEP (Czech Hydrogen Technology Platform)

Note: Provide up to 10 examples.

Table 3.2.2 Participation of academic staff of the evaluated unit in editorial boards of international scientific journals during the evaluation period

Name, surname and title(s) of the evaluated unit's staff member	Name of scientific journal, ISSN
Prof. Milan Holicky	International Journal of Safety and Security Engineering, ISSN: 2041-9031 (Print); 2041-904X (Online)
Prof. Milan Holicky, Assoc. Prof. Miroslav Sykora	International Journal of Heritage Architecture, Print ISSN: 2058-8321, Electronic ISSN: 2058-833X
Assoc. Prof. Miroslav Sykora	• Structural Safety (ISSN 0167-4730, D1-Q1) • Structural Concrete (ISSN 1464-4177, Q2) • Acta Polytechnica (EISSN 1805-2363, Q3)
Dr. Klara Vokac Machalicka	International Journal of Structural Glass and Advanced Materials Research, ISSN: 2616-4507 (Print), ISSN: 2616-4515 (Online)

Note: Please provide up to 10 examples of academic staff participation in editorial boards of international scientific journals (e.g. editor, editorial board member, etc.).

Table 3.2.3 The most important invited lectures delivered by the academic staff of the evaluated unit at foreign institutions during the evaluation period

Name, surname and title(s) of the evaluated unit's staff member	Invited lecture title	Name of host institution, or name of conference or event	Year
Dimitris Diamantidis, Miroslav Sykora	Reliability differentiation and uniform risk in standards: a critical review and a practical appraisal	Scientific Symposium FUTURE TRENDS IN CIVIL ENGINEERING Zagreb, Croatia, 17 October 2019	2019
Miroslav Sykora, Katerina Kreislova, Petr Pokorny	Corrosion of Historic Grey Cast Irons: Indicative Rates, Significance, and Protection	STREMAH 2019 – 16th International Conference on	2019

		Studies, Repairs and Maintenance of Heritage Architecture Conference, 7-9 October 2019, Seville, Spain	
Sophie Eberhardt, Martin Pospisil, Pavel Ryjacek, Miroslav Sykora	Heritage Value Assessment Method – Application to Historic Steel Bridge in Prague	STREMAH 2021 – 17th International Conference on Studies, Repairs and Maintenance of Heritage Architecture Conference, 26–28 May 2021	2021
Miroslav Sykora	Reliability Assessment of Existing Bridges according to *fib* Model Code 2020	Assessment of Existing Bridges based on Recent Guidelines and Standards, IABSE webinar, 26 May 2023	2023

Note: Provide up to 10 examples.

Table 3.2.4 - The most important lectures by foreign scientists and other guests relevant to R&D&I at the evaluated unit during the evaluation period

Name, surname and title(s) of the lecturer	Lecturer's employer at the time of the lecture	Invited lecture title	Year
Prof. Dimitris Diamantidis	OTH Regensburg, Germany	1. Probabilistic assessment of existing buildings and bridges including structures with heritage value; 2. Semi-probabilistic method for reliability verification; 3. Target reliability levels for existing structures; 4. Partial factors for assessment; 5. Case studies, practical applications, numerical examples	2019-2022
Prof. Johan Retief	Stellenbosch University, South Africa	Assessment of model uncertainties for structural resistance	2019

Note: Provide up to 10 examples.

Table 3.2.5 - Involvement in the evaluation of national/European research project/programme calls relevant to the R&D&I area at the unit during the evaluation period

Name, surname and title(s) of the evaluated unit's staff member	Name of the research project/programme call	Name of the contracting authority/guarantor of the project/programme call	Year
Prof. Jiri Kolisko, Dr. Miroslav Vokac	National evaluation of research institutions	Government of the Czech Republic	2019-2023
Prof. Jiri Kolisko, Assoc. Prof. Jana Markova, MSc. Adam Zabloudil	Various programmes including Transportation 2020+/ 2030+	Technology Agency of the Czech Republic	2019-2023
Prof. Milan Holicky, Assoc. Prof. Miroslav Sykora	Research and Innovation Support and Advancement	National Research Foundation, South Africa	2023
Prof. Milan Holicky, Prof. Jiri Kolisko, Dr. Miroslav Vokac	Memberships in the Evaluation Panels P104 Building materials, architecture	Czech Science Foundation	2019-2023

	and civil engineering, and P105 Structural mechanics and structures, fluid mechanics and geotechnics		

Note: Provide up to 10 examples.

RESEARCH PROJECTS

3.3 Research projects

In this section, 10 projects are briefly presented. More details are provided in the attached document (see the list of attachments at the end of this report).

GA20-24234S New generation of ecological anti-corrosion coatings for conventional concrete reinforcement based on functional nanodisperse organosilanes (2020-2022)

Objective:

Develop innovative, sustainable coatings for protecting conventional (carbon steel) reinforcement in concrete structures, providing superior corrosion resistance compared to traditional epoxy coatings.

Innovations:

- Development of nanodisperse organosilane coatings optimized for enhanced durability and adhesion
- Elimination of hazardous components typically found in epoxy coatings, improving environmental sustainability
- Improved bond strength with concrete surfaces, allowing application even on slightly corroded reinforcement

Research Approach:

- Laboratory testing under simulated corrosive conditions
- Evaluation of mechanical performance and adhesion properties
- Field testing in real-world infrastructure applications

Key Results:

- Innovative organosilane-based coating with superior performance
- Improved corrosion resistance and longer service life demonstrated by a prototype
- Published research findings and patents for innovative formulations

Impact on Industry:

- Potential for large-scale use in reinforced concrete structures in harsh environments, such as coastal areas, tunnels, and bridges
- Collaboration with construction companies to implement coatings in pilot projects
- Reduced environmental impact through sustainable material alternatives

Interdisciplinarity: Chemistry, Materials Science, Civil Engineering.

TH02020690 Concrete with excellent resistance in aggressive environments (2017-2020)

Objective:

Develop high-performance concrete mixtures with exceptional resistance to chemically aggressive environments, such as agricultural and industrial applications.

Innovations:

- Identification of organomeric agents resistant to silage solutions, petroleum products, and strong acids
- Optimization of concrete formulations to maximize durability and chemical resistance
- Validation of new concrete mixes through rigorous testing

Research Approach:

- Experimental testing of resistance to organic acids and aggressive chemicals
- Structural validation of reinforced elements
- Collaboration with industry partners for prototype development

Key Results:

- Development of three utility models and two prototypes
- Demonstrated a 50% increase in resistance to aggressive chemicals
- Published research findings in peer-reviewed journals

Impact on Industry:

- Extended service life of concrete structures in high-exposure environments
- Reduced maintenance costs for agricultural and industrial facilities
- Commercial application of optimized concrete formulations

Interdisciplinarity: Materials Engineering, Chemical Engineering, Structural Design.

GA22-14105S Adhesive joints in structural glass applications - combined effect of long-term static loading and humidity (2022-2026)

Objective:

Investigate the long-term mechanical performance of adhesive joints in structural glass applications, considering the combined effects of static loading and humidity.

Innovations:

- Advanced analysis of polymer degradation under environmental stressors
- Development of predictive models for adhesive joint performance
- Establishment of best practices to increase safety and durability

Research Approach:

- Controlled environmental testing on adhesive joints
- Finite element modelling to simulate real-world stress conditions
- Collaboration with industry partners to refine practical guidelines

Key Results:

- New predictive models for the evaluation of the durability of adhesive joints
- Contribution to international standards for bonded glass applications

- Improved understanding of humidity-induced degradation mechanisms

Impact on Industry:

- Strengthened use of adhesive joints in glass structures
- Development of reliable bonding techniques for architectural applications
- Cost reductions in glass construction through improved material efficiency

Interdisciplinarity: Civil Engineering, Materials Science, Experimental Mechanics.

GA23-06222S Stochastic interaction of climatic actions in structural reliability (2023-2025)

Objective:

Develop advanced probabilistic models to assess the reliability of structures exposed to stochastic climatic interactions.

Innovations:

- Development of statistical methods for spatial and temporal analysis of climatic parameters
- Improved stochastic modelling techniques to predict extreme weather effects on structures
- Integration of meteorological and structural engineering data for optimized design

Research Approach:

- Statistical analysis of climatic variability
- Predictions through computational modelling, probabilistic analyses, and demonstrations by case studies
- Close collaboration with meteorologists and reliability engineers

Key Results:

- Improved prediction models for climate-induced structural failures
- Enhanced reliability assessment techniques for critical infrastructure
- Contributions to international research on climate adaptation strategies

Impact on Industry:

- Increased resilience of bridges, towers, and large-span structures
- Practical applications in regulatory frameworks for climate adaptation
- Improved safety protocols for structures in regions prone to extreme climatic events

Interdisciplinarity: Civil Engineering, Climatology, Statistics, Machine Learning.

TH02020373 Service life enhancement and construction speed-up of elements of traffic infrastructure using UHPC (2017-2020)

Objective:

Develop innovative structural elements using Ultra-High-Performance Concrete (UHPC) to improve construction efficiency and durability.

Innovations:

- Design of UHPC-based prefabricated structural elements

- Reduction of material consumption and carbon footprint through optimized mix formulations
- Enhancement of mechanical properties to increase service life

Research Approach:

- Laboratory testing of mechanical performance and durability
- Field implementation of prototypes in infrastructure applications
- Life-cycle analysis of UHPC-based components

Key Results:

- Four utility models and one prototype bridge girder developed
- 50% reduction in raw material consumption
- Demonstrated lower CO_2 emissions in UHPC applications

Impact on Industry:

- Faster and more efficient bridge and road construction
- Reduction in maintenance and material costs for transport infrastructure
- Increased adoption of UHPC as a sustainable construction material

Interdisciplinarity: Structural Engineering, Materials Science, Sustainability Research.

DH23P03OVV024 Technologies and procedures for the protection of historic masonry bridges of the 19th and early 20th centuries (2023-2027)

Objective:

Develop advanced methods for the protection, survey, and continuous structural health monitoring of historic masonry bridges, ensuring compliance with heritage preservation requirements while maintaining safety standards for modern traffic loads.

Innovations:

- Integration of high-strength cement-based composites for minimal intervention reinforcement
- Implementation of UAV-based structural health monitoring and IoT technologies
- Development of new non-invasive survey techniques to assess the condition of historic bridges

Research Approach:

- Field studies on selected heritage bridges to validate rehabilitation techniques
- Laboratory testing of novel composite materials with minimal impact on historic structures
- Collaboration with heritage preservation authorities to balance technical and conservation requirements

Key Results:

- Development of preservation guidelines aligned with UNESCO heritage conservation standards
- Pilot applications for bridges with significant historical and technical value

- Improved assessment methodologies using digital modelling and remote sensing technologies

Impact on Industry:

- Direct application of developed technologies in heritage conservation projects
- Enhanced knowledge base for engineers, architects, and preservationists
- Long-term cost savings by reducing maintenance needs through advanced monitoring

Interdisciplinarity: Civil Engineering, Materials Science, Digital Monitoring Technologies.

TH02020730 Progressive bridge structures based on novel timber-high strength concrete composites (2016-2019)

Objective:

Develop innovative bridge structures by combining ultra-high-performance concrete (UHPC) with timber, optimizing structural performance while minimizing environmental impact

Innovations:

- Combination of UHPC with timber for durable and sustainable composite structures
- Development of prefabricated bridge elements to accelerate construction and reduce material waste
- Reduction of overall CO2 emissions through optimized material utilization

Research Approach:

- Experimental validation of composite timber-UHPC structural behaviour
- Finite element modelling to optimize structural efficiency
- Prototype implementation in a pilot project

Key Results:

- Development of an innovative timber-concrete composite (TCC) bridge system
- Completion of a pilot application: footbridge in Pilsen
- Significant contributions to sustainable construction practices and material efficiency

Impact on Industry:

- Increased use of renewable materials in bridge construction
- Expansion of timber-concrete applications in both infrastructure and residential buildings
- Reduction in lifecycle costs and environmental footprint of bridges

Interdisciplinarity: Civil Engineering, Structural Mechanics, Experimental Research, Materials Engineering.

TN02000033 NCC for industrial 3D printing (2023-2028)

Objective:

Advance additive manufacturing technologies through efficient and sustainable use of raw materials, enabling the development of innovative products and materials with enhanced mechanical and functional properties.

Innovations:

- Optimization of digital fabrication techniques for precision and material efficiency
- Interdisciplinary networking of research institutions and industry leaders to accelerate innovation
- Application of AI-driven optimization for 3D printing processes

Research Approach:

- Development of new composite materials specifically designed for additive manufacturing
- Collaboration between leading universities and industrial partners to improve production techniques
- Experimental validation of printed components for various industries, including automotive and healthcare

Key Results:

- Several utility models and patents related to new 3D printing materials
- Synergies established among research institutions and global industry leaders
- Implementation of additive manufacturing solutions in medical, automotive, and construction applications

Impact on Industry:

- Expansion of 3D printing in various industrial sectors, including architecture and engineering
- Reduction of raw material waste and energy consumption in manufacturing processes
- Strengthened competitiveness of Czech industry in advanced manufacturing technologies

Interdisciplinarity: Additive Manufacturing, Materials Science, Industrial Engineering, Digital Technologies.

Contract research – TSK (roadway authority for Prague) – Optimisation of structural surveys and maintenance of road bridges (2019-2023)

Objective:

Develop optimized strategies for the structural assessment and maintenance of road bridges in Prague, focusing on long-term durability and cost-effective maintenance.

Innovations:

- Development of a comprehensive strategy for bridge surveys based on advanced diagnostic techniques
- Implementation of non-destructive testing methods tailored to various bridge types
- Pilot studies of AI-assisted structural reliability assessments
- Recommendations for updating bridge management systems.

Research Approach:

- Data collection and processing using advanced monitoring tools
- Development of risk assessment models to prioritize maintenance activities
- Close cooperation with municipal authorities and infrastructure managers

Key Results:

- Improved maintenance planning strategies for more than 700 bridges in Prague
- Development of an AI-based predictive maintenance model for bridge infrastructure
- Increased efficiency in bridge maintenance, reducing long-term costs

Impact on Industry:

- Enhanced decision-making processes for road bridge management
- Implementation of new non-destructive testing techniques in practical applications
- Cost-effective solutions for municipalities responsible for critical infrastructure

Interdisciplinarity: Civil Engineering, AI-based Diagnostics, Infrastructure Management.

Contract research – CEZ, a.s. (central European leader in power generation) – Implementation of new technologies in monitoring and reliability assessments of concrete structures in power plants (2019-2023)

Objective:

Develop advanced methods to optimise survey strategies, reliability, and risk assessments of concrete structures in nuclear, thermal, and fossil power plants.

Innovations:

- Integration of UAV-based monitoring and machine learning for predictive maintenance
- Development of probabilistic risk models for improved reliability assessments
- Implementation of new materials and maintenance strategies for extended service life

Research Approach:

- Use of UAVs for large-scale infrastructure monitoring
- Application of AI in processing data on structural health monitoring
- Collaboration with leading industrial partners to apply research in real-world scenarios

Key Results:

- New methodologies for predicting degradation and optimizing maintenance planning
- Reduced operational risks and maintenance costs for power plants
- Enhanced structural safety and extended service life of critical energy infrastructure

Impact on Industry:

- Strengthened reliability and efficiency of power plant infrastructure
- Adoption of innovative monitoring technologies by CEZ and other energy companies
- Improved safety protocols and decision-making based on predictive analytics

Interdisciplinarity: Civil Engineering, Climatology, Machine Learning.

Table 3.3.1 Projects supported by public funds

In the role of beneficiary						
Provider[21]	Project name	Support (in thousands CZK/EUR)[22]				
		year 1 2019	year 2 2020	year 3 2021	year 4 2022	year 5 2023
Ministry of Culture of the Czech Republic	DG16P02M050 Optimisation of Observations and Assessment of Heritage Structures (2016-19, total fund 14836/567)	3 862 / 152 347				
Ministry of Culture of the Czech Republic	DG20P02OVV005 Technologies and Procedures for the Protection of Historic Concrete Bridges		3 374 / 133 097	4 068 / 160 473	3 700 / 145 957	
Ministry of Culture of the Czech Republic	DH23P03OVV024 Technologies and Procedures for the Protection of Historic Masonry Bridges of the 19th and Early 20th Centuries (2023-27, total fund 15160 / 609)					3820 / 150 690
GACR (Czech Science Foundation)	GA17-22796S Experimental and Numerical Analysis of Bond Behaviour Between Steel Reinforcement and Ultra High Performance Concrete (UHPC) at Elevated Temperatures (2017-21, total fund 5874/227)	1910 / 75 345				
GACR	GA20-01781S Uncertainty Modelling in Safety Formats of Concrete Structures		2343 / 92 426	2481 / 97 870	2481 / 97 870	
GACR	GA20-24234S New Generation of Ecological Anti-Corrosion Coatings Conventional Concrete Reinforcement Based on Functional Nanodisperse Organosilanes		1159 / 45 720	1206 / 47 574	1206 / 47 574	
GACR	GA22-14105S Adhesive Joints in Structural Glass Applications - Combined Effect of Long-Term Static Loading and Humidity (2022-26, total fund 3659/147)				1263 / 49 822	
GACR	GA23-06222S Stochastic Interaction of Climatic Actions in Structural Reliability (2023-25, total fund 6633/268)					2167 / 85 483
GACR	GA23-08038S Optimized Detailing of Reinforcement in Cementitious Composites (2023-25, total fund 4854/197)					1578 / 62 249

[21] If the provider is from abroad, please indicate the provider's country of origin in brackets. For the determination of the country of origin of the provider, the place of residence of the provider is decisive.
[22] Indicate the total amount expressed in thousands of CZK and the conversion of the total amount into Euro.

TACR (The Technology Agency of the Czech Republic)	TJ01000156 Development of new generation of mineral plaster (2017-19, total fund 2223/87)	955 / 37 673				
TACR	TJ02000368 Development of new generation of noise barriers with extended service life	764 / 30 138	928 / 36 607	945 / 37 278		
Total		7491/ 295 503	7804 / 307 850	8700 / 343 195	8650 / 341 223	7565 / 298 422
In the role of another participant						
Provider[23]	Project name	Support (in thousands CZK/EUR)				
		year 1	year 2	year 3	year 4	year 5
TACR	CK01000108 New Approaches to Surveys of Pre-Stressed/Post-Tensioned Concrete Bridge Beams		500 / 19 724	494 / 19 487	981 / 38 698	165 / 6509
TACR	CK02000329 UHPC as the Main Load-Bearing Structure for Middle-Span Bridges (2021-24, total fund 5059/205)			614 / 24 221	1 779 / 70 178	2 004 / 79 053
TACR	CK03000125 Innovative Diagnostic Methods for Assessment of Safety and Durability of Weathering Steel Bridges (2022-25, total fund 4586/185)				1 098 / 43 314	1 164 / 45 917
Ministry of Industry and Trade of the Czech Republic	FV10295 Safety Glass with Reinforcement (2016-19, total fund 2376/91)	728 / 28 718				
Ministry of Industry and Trade of the Czech Republic	FV10509 Research and Development of New Floor Mixture with the Contents of Recycled Raw Materials with Guaranteed Qualities (2016-19, total fund 2080/80)	434 / 17 120				
Ministry of Industry and Trade of the Czech Republic	FV20585 Operational Methods of Monitoring and Prediction of Service Life for Safe Bridges (2017-20, total fund 5700/219)	1430 / 56 410	1430 / 56 410			
TACR	FW01010539 Safe Use of fly Ash from NOX Reduction Technology at CMB Concrete Plants		1251 / 49 349	1303 / 51 400	1328 / 52 387	633 / 24 970
TACR	FW06010422 Simulation and Design of Structures from Digital Concrete (2023-25, total fund 4808/193)					1603 / 63 235

[23] Ibid.

Ministry of Education, Youth and Sports of the Czech Republic	LTT18003 Probabilistic Analysis of Deteriorating Structural Systems (2018-22, total fund 1935/75)	495 / 19 527	239 / 9 428	495 / 19 527	256 / 10 099	
TACR	TH02020373 Service Life Enhancement and Construction Speed-Up of Elements of Traffic Infrastructure Using UHPC (2017-20, total fund 2880/111)	841 / 33 176	607 / 23 945			
TACR	TH02020690 Concrete with excellent resistance in aggressive environments (2017-20, total fund 2975/114)	36 / 1420	555 / 21 893			
TACR	TH02020729 Research and Development of New Generation Silicon Carbide Briquettes in Order to Improve Their Utility Properties (2017-19, total fund 2713/106)	936 / 36 923				
TACR	TH02020730 Progressive bridge structures based on novel timber-high strength concrete composites (2016-19, total fund 4780/185)	3113 / 122 801				
TACR	TN02000033 NCC for Industrial 3D Printing (2023-28, total fund 21228/853)					3900 / 153 846
TACR	TE01020068 Centre of Research and Experimental Development of Reliable Energy Production	1700 / 67 061				
TACR	CZ.02.1.01/0.0/0.0/16_025/0007424 3D Print in Civil Engineering and Architecture	4940 / 194 872	4420 / 174 359	4318 / 170 335	648 / 25 562	
Total		14653 / 578 028	9002 / 355 108	7224 / 284 970	6090 / 240 238	9981 / 373 530

In Table 3.3.2, selected contracts are presented only, to indicate the KI's main activities in the evaluated period.

Table 3.3.2 - Contract research activities

Client[24]	Activity name	Revenue (in thousands CZK/EUR)				
		year 1	year 2	year 3	year 4	year 5
TSK (technical road management of the capital city of Prague)	Optimisation of strategies for surveys and maintenance of bridges, load tests, reliability assessments of degrading bridges	37 260/ 1 451 400	11 953/ 452 027	23 043/ 898 545	20 267/ 825 040	15 830/ 659 401

[24] If the client is from abroad, indicate in brackets the country of origin of the client.

SZ (technical road management of the rail roads in CZ)	Optimisation of strategies for surveys and maintenance of bridges, load tests, reliability assessments of degrading bridges, technical support during building process of new structures)	7513/ 292 658	15 381/ 581 634	8017/ 312 597	10 296/ 419 151	10 694/ 445 443
RSD and SUS (technical road management of the highways and roads in CZ)	Optimisation of strategies for surveys and maintenance of bridges, load tests, reliability assessments of degrading bridges, technical support during building process of new structures)	2267/ 88 316	2561/ 96 846	135/ 5258	5958/ 242 520	1703/ 70 951
Dopravni podnik hl. m. Prahy (Prague Transport provider)	Surveys, maintenance and service life predictions for steel structures in various types of buildings	1113/ 43 345	2343/ 88 588	282/ 10 996	602/ 24 519	2738/ 114 060
KS Prefa leader in UHPC development and production of prefabricates	Development of UHPC, material and structure testing, structural design	108/ 4194	13/ 477	284/ 11 057	1767/ 71 940	481/ 20 036
ORLEN Unipetrol (Poland, leader in petrochemistry in CZ)	For buildings, towers, masts, and industrial bridges advanced methods of structural surveys (UAV-based, specialised chemical analyses), large concrete structures – recommendations for maintenance, predictions, support for decision-making	360/ 14 031	74/ 2805	173/ 6751	50/ 2019	269/ 11 221
SURAO (Czech Radioactive Waste Repository Authority)	Low-alkali concrete for nuclear waste disposals – development, design, experimental verification meeting the standards of the Governmental Office for Nuclear Safety	1840/ 71 673	95/ 3579			
VSL Systems (Switzerland), Freyssinet (France)	Testing of prestressing steels for common and special applications. Development of special grouting mortars.	575/ 22 386	1235/ 46 719	1247/ 48 620	664/ 27 011	1287/ 53 598
Holcim - Lafarge innovative centre (France)	Fatigue analysis of UHPC, dynamic testing	553/ 21 560		498/ 19 422	301/ 12 268	
SAINT-GOBAIN IndustrieKeramic Rodental GmbH (Netherlands)	Analysis and testing of glass elements	254/ 9895	127/ 4805	328/ 12 780	501/ 20 400	22/ 900
PPC CAB A.S. (USA), CERISOL - ISOLADORES Serzedo (Spain), GRID SOLUTIONS S.P.A (Italy), CERALEP SN (France), ARTECHE (Spain) - ceramic insulator and elements producers	Analysis and testing of ceramic elements and parts of insulators	735/ 28 630	688/ 26 010	1574/ 61 390	582/ 23 680	2159/ 89 940
LAPP INSULATORS GMBH (Germany), PFISTERER SWITZERLAND (Switzerland) - polymeric insulators producers	Analysis and testing of polymeric elements and parts of insulators	1390/ 54 135	775/ 29 320	503/ 19 600		466/ 19 430

PEIKKO GROUP CORP. (Finland)	Development, analysis and testing of special steel elements for joining concrete structural members and its parts	137/ 5355		169/ 6600		
Pontex (leading design and consultancy office of transport infrastructure)	Surveys of exposed bridge structures, material and load tests, structural analysis, measures	6104/ 237 768	1784/ 67 480	20 163/ 786 250	3517/ 143 177	1785/ 74 366
AFRY (Sweden), Mot McDonald (England), Pragoprojekt, Top Con, Sudop, Metroprojekt, Novak a partner, Nemec and Polak, AED, INSET, MDS (leading design and consultancy offices)	Surveys of exposed structures (buildings, bridges), material tests, structural analysis, measures	6439/ 250 830	15 924/ 602 188	3276/ 127 741	12 716/ 517 635	5213/ 217 153
Aquatis, part of Safichem group (Switzerland)	Design of water management structures - sewers, sewage treatment plants, water reservoirs, dams and their parts (analysis and design of special concretes for massive structures)	688/ 26 781				995/ 41 438
EGU and CEPS (engineering applications and research in energetics), cooperation with foreign clients as PCI (USA)	Experimental research and verification of components of power systems and power regulation	2441/ 95 088	812/ 30 720	1461/ 56 953	1224/ 49 824	901/ 37 545
Forensic reports for court and police	Technical assistance in solving professional problems in connection with the evaluation of buildings, structures, projects and their failures and defects. Determining the causes of problems. Preparation of forensic expert reports and expert reports.	341/ 13 281	263/ 9963	319/ 12 447	816/ 33 208	313/ 13 022
Expert activities for municipalities, public administration (cities, regions, ministries)	Technical assistance in solving professional problems in connection with the evaluation of buildings, structures, projects and their failures and defects. Determining the causes of problems. Preparation of forensic expert reports and expert reports.	1914/ 74 548	5102/ 192 952	7300/ 284 675	9076/ 369 458	6518/ 271 511
Avers, Eurovia (France), Hochtief (Germany), Chladek a Tintera, Firesta, Metrostav, PORR (Austria), Skanska (Sweden), Stavby mostu, STRABAG (Austria), Subterra, Syner, VCES, Zakladani staveb (leading construction companies in CZ)	Technological support in construction, development of new technologies, testing of materials, design of measures, surveys	2403/ 93 619	3293/ 124 526	3235/ 126 126	3044/ 123 924	5973/ 248 791
Sipral - leading company in the field of glass building cladding	Development and testing of facade elements	140/ 5434	56/ 2124	161/ 6259	153/ 6208	37/ 1550

CEZ (No.1 in power generation in central Europe, owner of nuclear and conventional power stations in CZ)	Reliability analysis of systems, structural surveys	58/ 2271	94/ 3543	371/ 14 473	445/ 18 112	180/ 7498
VUT Brno, FCE (TU Brno)	Materials research – use of waste and recycled materials in concretes, experimental verifications	393/ 15 292	354/ 13 372	237/ 9234	180/ 7335	168/ 6997
CAS (Czech Standardisation Body)	Development of Czech standards and Czech National Annexes to the Eurocodes and ISO standards (basis of structural design and assessment of existing structures, actions on structures, design and assessment of concrete structures, specifications for concrete and masonry, testing of materials and structures etc.), representation of the Czech Republic in international standardisation committees.	641/ 24 978	17/ 628	110/ 4289	24/ 995	9/ 379
All other contractors - more than 200 different companies	Consultancy - failures of structures, material and technology development etc. - testing of material and elements - in situ surveys an measurements - structural analysis	13 345/ 519 841	11 833/ 447 483	15 970/ 622 720	17 988/ 732 271	13 080/ 544 855
Total		89 013/ 3 467 309	74 778/ 2 827 789	88 854/ 3 464 783	90 171/ 3 670 695	70 823/ 2 950 085

Note: List and describe contract research activities with a revenue in a given calendar year, regardless of the amount of financial revenue.

3.4 Research results with existing or prospective impact on society

Five publications, and five results of applied research are presented below to provide insights into the impact of basic and applied research by KI. The results marked with (*) have been evaluated as *excellent at an international level* in the national evaluation of R&D results. As the research results are closely related to the projects described in Section 3.3, their main contributions are highlighted in the short lists.

01 Physical-Based Model for Exposure Coefficient and Its Validation towards the Second Generation of Eurocode EN 1991-1-3 for Roof Snow Loads (LTT18003)*

- Snow loads dominate the reliability of many roof structures, including long-span roofs of industrial halls and halls where people gather, such as stadia or concert halls. The ground snow loads are highly variable in both temporal and spatial terms. Roof loads are then affected by climatic effects (wind drifts, ambient air temperature variability, humidity) and the properties of the roof (shape, slope, slipperiness, thermal insulation, heating regime).
- In the paper published in a Q1 journal, an international team of co-authors (Norway, Italy, and Czechia) addresses the effects of wind on conversion from ground-to-roof snow loads (exposure coefficient), considering a range of European climates. A model of the exposure factor that accounts for the main physical and local climatic effects on roof snow loads was validated and the range of its application was identified using an extensive database of roof snow load measurements along with an advanced theoretical model.
- The results obtained by the new model are critically compared with the estimates based on the JCSS Probabilistic Model Code, which is considered a reference model unless detailed numerical modelling is carried out for a particular structure. It is demonstrated that the new model reflects typical European snow and wind climates well.
- Therefore, the paper provides key background information on the revision of the model for the exposure coefficient in the Eurocode on snow loads. The new exposure coefficient model

corrects the primary Eurocode model deficiency, where no account for wind velocities expected at the site during a snow season is taken. According to prEN 1991-1-3, the exposure coefficient affects all snow load cases on all types of structures covered by the European standard; its use in the design and assessment of existing structures will thus have an enormous economic impact. Additionally, experts from the US, Canada, Japan, China, etc., are just considering the model in the ongoing revision of ISO 4355 for roof snow loads. Thus, a worldwide impact is foreseen and the paper was evaluated as outstanding.

- In the study, M. Sykora (KI) played a crucial role. In close cooperation with Prof. Thiis (NTNU) and Prof. Formichi (Univ. Pisa), he developed the study concept and drafted about 25% of the main text. He commented on the manuscript at all stages. He took the lead in all aspects of statistical uncertainty and uncertainty quantification.

02 JRC Report Thermal Design of Structures and the Changing Climate (LTT18003)*

- The JRC Technical Report presents the methodology for adapting structural design to climate change toward a method for new thermal design maps for structural design considering the changing climate. The report critically analyses the EU Strategy for adaptation to climate change. Taking into account the general probabilistic models of thermal actions applied in reliability verifications of civil engineering structures, adjustments of the models for thermal actions are discussed. Probabilistic analysis of the expected variations of climate factors that would directly affect the design values for thermal actions then provides the theoretical background for developing the thermal maps for structural design considering the influence of climate changes.
- The report presents a scientific and technical background intended to stimulate further discussions about the implications of climate change on the thermal design of key construction works, such as bridges. It is widely known that adapting design procedures to the foreseen effects of climate change is of utmost importance for society.
- J. Markova (KI) is a recognized leading European expert in modelling thermal actions. In addition to many scientific publications, she developed a chapter “Thermal actions” in the JCSS Probabilistic Model Code, which serves as a reference for developing models for thermal actions in design standards. She was a leader of the CEN project team and was responsible for revising EN 1991-1-5 for thermal actions on structures. Based on her distinguished expertise in the field, she was asked to contribute to the JRC report by drafting the key chapter “6 Potential implications of changes in thermal actions in structural design” and served as a reviewer for all other chapters of the report. By affecting structural design approaches in Eurocodes, the JRC report has enormous economic impact; the result was evaluated as outstanding.

03 Structural behavior of double-lap shear adhesive joints with metal substrates under humid conditions (GA16-17461S)*

- Adhesive bonding has become a promising technology for joints in structural systems. Durability in various environmental exposures is a key factor in the design of adhesive joints. The mechanical properties of the joints are difficult to predict due to the complicated interactions between various degradation processes. To fill the gap in existing knowledge, the study investigates the effect of water on adhesive joints with various metal substrates and their treatments in civil engineering and architectural applications.
- The original data and findings for adhesive bonding in facades are provided. The article was rated outstanding due to the importance of the topic and the complexity of applied experimental procedures and methods.
- It was published in the International Journal of Mechanics and Materials in Design, an international platform for disseminating recent advances and original works in mechanics and materials engineering and their impact on the design process.

04 Timber-UHPFRC composite connection - Analysis and experiments (TH02020730)*

- The KI researchers developed an innovative timber-concrete composite structural system. The precast ultra-high-performance fiber-reinforced concrete (UHPFRC) bridge deck is connected to timber girders. The structural system was designed and tested. A non-linear finite-element model was developed and validated to verify various geometries and combinations of materials of the joint. The complex experimental campaign accompanied by detailed numerical modelling demonstrated many advantages of the composite structure developed with respect to sustainability; the use of natural and renewable structural materials with advanced concrete, which provides the necessary stiffness, lateral load redistribution, and protection of the timber against unfavourable environmental effects.
- Both timber and UHPFRC are efficient materials characterised by a high ratio of load-bearing capacity to self-weight. The novel application of UHPFRC leads to a significantly thinner bridge deck, faster construction, and improved durability, thus reducing material consumption while maintaining the mechanical properties of the structure.
- This pioneering application of UHPFRC for timber-concrete composite structures was published in a Q1 journal. An experimental structure with a span of 9.5 m was realized, and a footbridge using this coupling system is currently being designed and should be executed (see info about project TH02020730).

05 Changes in bond strength properties of hot-dip galvanized plain bars with cement paste after 1 year of curing (GA17-22796S)*

- The article experimentally investigates the effect of the corrosion of hot-dip galvanized steel on the porosity development of cement paste in the interfacial transition zone between materials. Advanced physical-chemical analysis included unique, very long exposure times (up to 1 year).
- The results of this experimental study support the conclusions of a minority of previous studies, confirming the views on the ineffectiveness of hot hot-dip galvanizing as corrosion protection for concrete reinforcement since increasing the porosity of the cement paste can significantly reduce the bond strength of hot-dip galvanized ribbed reinforcement. Furthermore, a reduction in the thickness of the hot-dip galvanized coating on the surface of the reinforcement is observed. Corrosion of the coating in the active state in fresh cement paste is shown to significantly reduce the thickness of the layer and even cause transverse cracks permeable to corrosion stimulators.
- As hot-dip galvanized coatings are currently being considered suitable corrosion protection for conventional concrete reinforcement, the study provides essential insights – these coatings do not provide sufficient corrosion protection for service life exceeding 100 years, especially in areas with higher chloride exposures. To provide a comprehensive insight, this article emphasizes the suitability of these coatings, particularly for other environments where the ability of cathodic protection of the hot-dip galvanized coating can be fully utilized.
- The article, published in Q1 journal – Construction and Building Materials, was rated as outstanding due to its novelty, complexity of the experimental programme (design of experiments, experimental methods, and analysis and interpretation of results), and great potential for industrial applications and expected economic benefits.

Applied research results:

06 Holesovice-Karlin footbridge: a bridge that connects more than just river banks (“Hol-Ka”, in Czech “girl”)

- The Holesovice-Karlin footbridge is more than a new Prague bridge over the Vltava. It is a symbol of innovation in materials and bridge engineering. The KI’s experts are behind every

construction detail – from the choice of materials to load tests to the advanced structural health monitoring system. Thanks to their know-how, Prague has an elegant structure and an innovative, durable, and safe bridge that will serve for decades.

- One of the KI's key tasks was to ensure the structure's long service life. The footbridge was designed with an emphasis on resistance to dynamic loads, environmental effects, and scour. Experts, therefore, conducted extensive testing of the materials and optimised the composition of the concrete to give it exceptional strength and low porosity, and thus resistance to aggressive environments.
- Another crucial aspect was the stability and safety of the exceptionally slender structure during operation. The structure was subjected to static and dynamic tests that simulated a variety of loads, from standard pedestrian and cyclist movement to extreme conditions such as high winds or structural vibrations. The Klokner Institute helped to design and verify the geometry of the bridge to eliminate dynamic effects.
- To create a bridge of the future, the designers equipped it with an intelligent monitoring system. The KI designed and installed sensors to monitor structural stresses, temperature changes, and mechanical loads. This data is continuously analysed and provides an early warning system to prevent potential failures.
- The Holesovice-Karlin footbridge implements the results of the scientific work of the Klokner Institute and pushes the boundaries of modern bridge engineering. Its story shows how academic research influences the real world – creating beautiful, functional structures and also safe, durable solutions for future generations.
- In 2023 and 2024, the footbridge and the design team led by Ing. Petr Tej, Ph.D. (Head of the Department of Structural Mechanics in the KI) received the National Architecture Award–Grand Prix of Architects 2024, the IABSE International Award, the Iconic Award for Innovative Architecture and Materials in Munich, and Vit Branda's Award for Improvement of Public Space.

07 Methodology of Estimation of Service Life of Industrial Chimneys and Cooling Towers

- Cooling towers and industrial chimneys are the key components of conventional and nuclear power plants, heating and chemical plants. These immense structures are exposed to adverse environmental influences, which causes degradation processes to develop, leading to

excessively costly maintenance. The degradation processes affecting these concrete and masonry structures depend on the properties of the construction materials, the performance of protective coatings, and local environmental influences, which can scarcely be described by common deterministic methods without conservative assumptions. Maintenance of these structures is then usually based on long-term experience and often unnecessarily expensive measures.

- The proposed methodology for assessing the actual conditions of cooling towers and industrial chimneys and predicting their service life was developed to optimize decision-making about their repairs. KI led the consortium with CEZ, a.s. (a leading Central European power producer) and the Institute of Applied Mechanics (UAM) Brno.
- The methodology is based on relevant standards (Eurocodes, ISO, International Atomic Energy Agency). It provides new methods for assessing the reliability of existing structures and predicting the service life of these specific structures. The methodology is largely based on the results of probabilistic analyses for which the input probabilistic models were updated based on measurements from more than 40 cooling towers and chimneys (surveys including 3D scans by UAVs and meteorological data) and the latest findings in the literature. Probabilistic modelling of the spatial variability of material properties and environmental effects partly relied on Bayesian updating, considering observations of surface cracking (significantly affected by corrosion).
- The certified methodology is continuously applied to assess the service life of industrial chimneys and cooling towers at the nuclear and conventional plants of CEZ, a.s. and ORLEN Unipetrol, a.s. The KI's benefit associated with using this methodology in assessments of cooling tower and industrial chimney service life is estimated at approximately CZK 500k (20k €) per year. Both operators (CEZ, a.s. and ORLEN Unipetrol a.s.) estimate savings related to optimizing surveys and repair costs in the order of several million CZK per year.
- The knowledge gained in developing this methodology is systematically applied in international research (JCSS – modelling of degradation of concrete structures, article in Structural Safety, Q1, 2025; fib TG 8.8 – modelling of degradation of reinforced and prestressed concrete structures, preparation of fib bulletin).

08 Patent – Method of Optimizing the Concrete Reinforcement Detailing and Orientation in Concrete

- The patent introduces a new method of reinforcing concrete structural members based on optimising the directions and dimensions of concrete reinforcement inserted into the formwork during their execution. The method is tailor-made for 3D printing and is largely applicable to all types of structural members – bar-shaped (such as beams or columns), 2D (walls and slabs), and 3D massive members such as foundation blocks.
- The method introduces an iterative process – a detailed numerical model follows preliminary structural analysis carried out by common methods. A spatial mesh system splits the volume of the geometric model of the structural member into small discrete volumes whose shapes are selected to reflect shape of the structural member. The size is tuned to meet the requirements for the fineness of the resulting spatial reinforcement mesh. Then, the magnitudes of tensile stresses and spatial vectors of their directions at individual discrete nodes of the mesh are determined, for example, by the finite element method, the boundary element method, or the finite difference method. Based on this, the directions of reinforcements in individual discrete nodes given by the resulting direction of the tensile stress and the diameters of individual reinforcement bars corresponding to the magnitudes of these tensile stresses are determined. The resulting spatial reinforcement mesh is modelled by CAD software and printed using the Direct Metal Laser Sintering 3D metal printing method. The produced spatial reinforcement mesh is inserted into the formwork, and concrete is cast.

- This multivariate computing approach provides key insights to distribute and arrange dispersed concrete reinforcement correctly. This makes it possible to design and execute structures with increased load-bearing capacity while reducing the consumption of construction materials, contributing positively to sustainability in construction.

09 ISO 10252:2020. Bases for design of structures — Accidental actions (FV20585)*

- By focusing on accidental actions due to natural causes and human activities, the ISO standard systematically applies the principles of reliability and risk-based decision in designing and assessing structures subjected to extreme actions. Based on the intensive cooperation of leading experts from Europe, North America, Australia, and Asia, ISO 10252 is based on the most recent scientific knowledge. The models for effects of impact loads (road and railway vehicles, ships, planes, helicopters, falling or sliding objects), various types of explosions (interior or exterior, dust explosions, high-energy explosions), and unidentified accidental actions (by assuming damage to parts of the structure) have been improved or newly proposed.
- The 2020 edition of ISO 10252 was rated as outstanding as it presents significant progress in the available models compared to Eurocodes, ASCE, Australian, Japanese, and other international standards. It promotes the international harmonization of structural design practice while allowing each national economy to specify its levels of structural performance and safety by its own needs and available economic sources (by specifying the target reliability level). The desired harmonization should promote compatibility, interchangeability, consistency, and comparability of structural standards developed by different economies. Accidental situations are of key importance for the reliability of critical infrastructures. Implementing the principles and models provided in ISO 10252 will benefit society significantly; this is why this research result was evaluated as outstanding.
- The KI's researchers utilized the results of their previous research supported by the Czech Ministry of Interior and Czech Science Foundation. They contributed mainly to the probabilistic modelling of impacts due to the road and railway vehicles, proposing adequate design models ensuring specified target reliability. They further contributed to modelling loads due to forklifts in industrial plants and developed the other parts of the standard.

10 3D Printed Arch Concrete Footbridge

- Prototype of an arch concrete footbridge verified novel application of UHPC material and structural design by 3D printing. The prototype has a span of 6 m and a width of 1 m. It consists of two 3m-long parts and two concrete blocks simulating supports. The weight of the prototype is 1.5t.
- The experimental research project demonstrated the current advances in additive technologies and the great possibilities of structure shaping. The prototype was subjected to load tests and measurements which confirmed theoretical assumptions. The girder was authorised for use and installed as a footbridge over the outlet of the lake (Solopisky, at the border of Prague), where its natural rough surface with its characteristic interwoven print layers blends harmoniously with the surrounding nature. The innovative footbridge was appreciated by civil engineers and architects alike.

Table 3.4.1 - Overview of research results in the period under evaluation (an overview of the KI's main results in 2019-2023 is attached, *KI_3.4.1_Overview of research results*)

Type of result[25]	Year of application	Name
01 - Paper in journal (Q1)	2022	Physical-Based Model for Exposure Coefficient and Its Validation towards the Second Generation of Eurocode EN 1991-1-3 for Roof Snow Loads
02 – Monograph	2020	Thermal Design of Structures and the Changing Climate
03 – Paper in journal (Q2)	2019	Structural behavior of double-lap shear adhesive joints with metal substrates under humid conditions
04 – Paper in journal (Q1)	2022	Timber-UHPFRC composite connection - Analysis and experiments
05 - Paper in journal (Q1)	2019	Changes in bond strength properties of hot-dip galvanized plain bars with cement paste after 1 year of curing
06 – Real-world awarded application of innovative technologies, implementation of KI's patents, prototypes, and verified technologies and methodologies in practice	2022	Holesovice-Karlin footbridge: a bridge that connects more than just river banks
07 – Certified technology	2019	Methodology of Estimation of Service Life of Industrial Chimneys and Cooling Towers
08 – Patent	2019	Method of Optimizing the Concrete Reinforcement Detailing and Orientation in Concrete
09 – International standard	2020	ISO 10252 Bases for design of structures — Accidental actions
10 – Prototype	2021	3D Printed Arch Concrete Footbridge

Note 1: Please list and describe the results already applied in practice or heading towards application in practice with existing or prospective impact on the society (e.g. domestic or foreign patents, sold licenses, spin-offs, prototypes, varieties and breeds, methodologies, significant analyses, surveys, expert outputs for policymaking or other forms of non-publication outputs, etc.). Indirect results of research, development and creative activities with documented societal impact, e.g. expert activities, services to the public/government/scientific community, may also be reported.

[25] Specify the specific type of result. Add rows as needed.

TRANSFER OF RESULTS INTO PRACTICE

3.5 Transfer of results into practice

As one of CTU leaders (according to CTU annual reports), the KI is strongly dedicated to the commercialization of its R&D&I results. Its strategy largely relies on intensive cooperation with industry through contract research and applied research projects. The contacts are established and strengthened by:

- Cooperation in professional associations (Prof. J. Kolisko chaired the Czech Concrete Society CBS in 2011-2019) and standardisation committees, joint membership in various expert committees supporting the decision-making of the Czech government and municipalities (see 3.6 on popularisation) and informal meetings at conferences.
- Leading industry experts are members of the KI Scientific Board and the Management Board of the KI Ph.D. Programme.
- New contacts are often established with participants in lifelong education courses and readers of the KI conference and journal papers – to disseminate principal outcomes of particularly applied research projects among Czech researchers and civil engineers, the KI experts keep publishing in national journals and at national conferences.

Contract research revenues have been varying in 2019-2023 as result of the covid-19 pandemic. Despite this, the total revenues from collaboration with industrial partners confirmed the leading role of KI within the university. The average income per FTE in this period was 46 kEUR, well above the CTU average. A positive aspect is that key contracts are medium or long-term. Revenues from non-public sources resulted mainly from the collaboration with partners focusing on the urgent needs of the industry, such as materials and technology research, assessment of damaged structures, strategies for structural health monitoring, surveys of large or exposed structures and risk assessments of technological systems. In the evaluated period, collaboration with more than 260 partners per annum occurred. The outcomes of this collaboration included expert reports (~300/year), forensic engineering reports (~45/y), test protocols on tests (~1000/y), patents, prototypes, and many structural applications (mainly bridges, but also buildings).

In the 2014-2018 evaluation period, the KI reported the share of revenues from foreign contractors around 4-5% and the IEP recommended increasing this share. With a strong focus on internationalisation, the KI significantly strengthened cooperation with foreign companies and the share increased to 10-11%, reaching its maximum of 18,0% in 2023.

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

KI's research findings are directly applied in forensic engineering reports. Between 2019 and 2023, the institute produced over 200 reports, primarily addressing structural and geotechnical failures, including excessive cracking and the quality of built-in concrete. To a lesser extent, these reports also examined

façade and plaster deterioration, the adverse effects of fire and moisture, and leakages. The diverse range of investigated structures included:

- Bridges and tunnels on highways and regional roads;
- Heritage monuments and sacral architecture;
- Structures affected by the tunnelling of the new D line of the Prague metro;
- Airport and river port terminals, shopping malls, industrial halls, etc.


Note that the key industrial partner (KS Prefa – #1 in UHPC production in the Czech market) has expressed interest in the application of the patented method related to UHPC. Details of the contract have been negotiated since 2024, expected revenues are 16 k€/year.

Main users of KI results:

1. Authorities responsible for the management of transportation networks (RSD – Czech highways, motorways, and 1st class roads manager, TSK – technical road management of Prague, SZ Sprava zeleznic – Czech manager of national and regional railway infrastructure):

- surveys of large, exposed, heavily deteriorated and/ or unique structures – mainly bridges and tunnels,
- methodologies and strategies for surveys and maintenance,
- advanced experimental and survey methods.

See also Section 3.3 Research projects.

2. Concrete producers (KS Prefa – #1 in UHPC production in the Czech market, Metrostav and Eurovia – #1 and #2 – construction companies, Skanska, etc.):

- developments of ultra-high performance concrete UHPC – mix design, technology, structural reliability
- concretes for special applications (aggressive environments, long service life),
- massive structures – design to eliminate hydration heat issues, structural health monitoring, including the upgrade of the 2nd largest Czech dam Orlik (Vltava river) and design of a new dam Nove Herminovy to protect the northern Moravia from floods
- statistical methods for conformity control using advanced laser-based techniques.

It should be noted that similar long-term collaboration focused on applications of glass structures has been established with design office HABENA and producer NAUPO, with several successfully completed applied research projects and pilot practical applications.

3. Owners of industrial structures (CEZ, a.s. – the leader in nuclear and conventional power generation in Central and South-Eastern Europe, ORLEN Group – crude oil processing, production, and distribution, petrochemical products etc.) – buildings, towers, masts, and industrial bridges:

- steel structures – specialised corrosion surveys, anticorrosion protection including advanced coatings,
- large concrete structures – recommendations for maintenance, predictions, support for decision-making,
- advanced methods of structural surveys (UAV-based, specialised chemical analyses).

See also 3.3 Research projects and 3.4 Research results.

4. Owners of heritage monuments (mainly the Czech government and municipalities):

- surveys (primarily based on non- and semi-destructive techniques) and interpretation of results, reliability assessments, and optimisation of maintenance strategies, long-term structural health monitoring systems,
- methodologies certified by NPU the National Heritage Institute for heritage preservation, focused on specific issues (preservation of historic metal and masonry bridges, industrial heritage buildings, Czech concrete heritage,
- 2019-2023 applications include:
    - UNESCO-protected masonry and historic steel bridges (part of the Historic Centre of Prague),
    - UNESCO monument – the Cathedral of the Assumption of Our Lady and St John the Baptist in Sedlec near Kutna Hora, 1142: innovative measurement and regulatory system of the interior microclimate (prototype developed by the KI) was installed in 2018 in the treasury of the cathedral:
        - Valued monstrances, paintings, and historical writings require specific conditions for storage and preservation (humidity and ambient temperature, avoiding surface condensation and conditions for mould growth).
        - While being challenged by the influence of the external climate and the requirement to expose these valuables to visitors, the KI's system controls ventilation and air conditioning systems to maintain the indoor climate within the limits and prevent significant rapid fluctuations in the indoor microclimate parameters.
        - Following its validation, the system has been successfully controlling air conditioning units since 2019.



    - industrial heritage – historic buildings of several railway stations (e.g. in Prague or in Ceske Budejovice),
    - sacral architecture – many churches.

5. Universities – as an example of cooperation with research institutions, a long-term cooperation with Brno University of Technology is presented:

- Team of Prof. R. Drochytka, Institute of Technology of Building Materials and Components:

- UHPC,
- surveys and rehabilitation of exposed concrete structures,
- the two institutes jointly organise annual WTA conferences on rehabilitation of buildings (WTA Days and CRRB Int Conf on Rehabilitation and Reconstruction of Buildings),

- Team of Prof. D. Lehky and Prof. D. Novak, Institute of Structural Mechanics:
  - joint research efforts related to reliability theory and numerical simulation methods, degradation processes, uncertainty quantification,
  - reliability of degrading structures, cracking in reinforced concrete structures, time-variant reliability analysis (durability and service life predictions).

In a similar way, the KI collaborates with other major Czech TUs. For instance, the memorandum of cooperation with TU Ostrava with the Centre of nanotechnologies provided a framework for cooperation that resulted in Czech patent, prototype, and application for a European patent on anticorrosion surface treatment of steels; the results of the joint research under the KI's leadership are utilised in a dissertation. In the field of chemical engineering, a long-term cooperation is established with The University of Chemistry and Technology, Prague.
The KI experts intensively cooperate with colleagues from other CTU's units, mainly Faculty of Civil Engineering, Fac. Architecture, and Transportation Sciences. They run joint research projects and cooperate on expert reports.

BUT and CTU leading experts serve as members in scientific boards of the Faculty of Civil Engineering BUT and of the KI.

Note that the key industrial partner (KS Prefa – #1 in UHPC production in the Czech market) has expressed interest in the application of the patented method related to UHPC. Details of the contract have been negotiated since 2024, expected revenues are 16 k€/year.

Table 3.5.1 - Summary of non-public revenues received during the period under evaluation.

Type of revenue	Revenue (in thousands CZK/EUR)				
	year 1	year 2	year 3	year 4	year 5
-	-	-	-	-	-
Total					

Note: Enter funds raised for R&D&I from non-public sources besides grants or contract research (e.g. licences sold, spin-off company revenues, donations, etc.) in the calendar year.

POPULARIZATION OF VAVAI

3.6 The most important activities in the field of popularization of R&D&I and communication with the public

During the evaluation period, the KI actively focused on the popularization of R&D&I and public engagement. Beyond the social media initiatives (see #3 below), these efforts were primarily conducted in collaboration with CTU faculties (notably FCE and FA). The flagship event was the Children's University summer camp, led by Dr. Michaela Kostelecka (formerly of KI, now at the Faculty of Civil Engineering). In the KI, this program engaged primary school students in hands-on activities, including

static and dynamic structural testing, controlled chemical experiments, microstructure analysis, and 3D printing of concrete elements and sculptures.

To illustrate KI's public engagement, the following 10 key examples are provided (see attachment *KI_3.6_KI in media 2019-2023_summary.pdf*):

1. Television and Radio Broadcasts

- 35 TV appearances (mainly on Czech public television and local Prague stations) and numerous radio segments
- Topics covered: seismic events in Turkey and Syria (2023), local floods, and the 2021 Liberec cable car collapse


DNES Mladá fronta DNES
5. září 2022

Oprava lávky má omezit provoz na hrázi Jordánu

V Táboře řeší rekonstrukci téměř 100 let staré lávky pro pěší na hrázi nádrže v centru. Jednou z variant je její zbourání.

2. Print media: ~400 contributions in the evaluated period in the Czech media including the leading newspapers (MF DNES, Metro, Hospodářské noviny, Lidové noviny, Právo, E15, Kladenský deník), leading professional journals (SILNICE ŽELEZNICE, Konstrukce), and local newspapers (Zpravodaj mesta Písku, Nymburský deník).

3. Social Media Impact

- KI launched its Facebook page in 2022; the post about the Dretovicky Brook bridge (see Section 3.2) reached 1.2 million followers.
- International reach: primarily English (119 mentions), followed by German (11) and six other languages (disregarding Slovak).
- Top platforms: ResearchGate (~930k reach), Wikipedia (510k), Wiley (194k).
- The audience ratio is female/male 55%/45%.

Details in the first 25 pages of the attachment *KI_3.6_KI in media 2019-2023_summary.pdf*.

4. Repair of heritage bridge in Liben (Libeňský most, 1928)

- KI conducted structural surveys and monitoring for the pioneering plain concrete bridge, proposing an innovative UHPC repair to maintain heritage value while meeting modern traffic demands.
- Experts advised the Prague City Council and communicated findings via public fora.

https://www.praha.camp/magazin/detail/bourani-a-rozsireni-ci-rekonstrukce-jaka-je-budoucnost-dost-mozna-jedineho-kubistickeho-mostu-na-svete

5. International Colloquium on Bridge Repair/ Replacement of Steel Bridge in Vyton

The railway bridge (1901), with a span of 72 meters and a total length of 285 meters, is a key element but also a bottleneck in the TEN-T trans-European railway network. It is part of a UNESCO World Heritage site and a notable landmark in Prague. The KI has conducted an advanced structural survey and is currently running an online monitoring system to ensure safe traffic flow under constrained conditions. KI experts were involved in the conceptual design, provided advisory support to the Prague City Council in decision-making, and collaborated with the public in partnership with SZ (Czech railway manager), FCE, and internationally recognized experts, including Prof. Brühwiller from EPFL, Switzerland. The Director of KI is also a member of the Colloquium (expert panel).

6. Holesovice-Karlin footbridge:

- The award-winning structure generated significant public interest.
- KI experts, including Dr. Peter Tej and Prof. Jiri Kolisko, participated in numerous interviews and media reports; see *KI_3.2_UHPC footbridges_monograph.pdf* or:

https://www.jednoustopouceskem.cz/listing/stvanicka-lavka-holka/

7. Trojska lavka (footbridge in Troja, Prague)

- Following its catastrophic collapse, the KI provided technical analyses and expert testimonies in court proceedings (finished in 2022-2023).
- The case strengthened KI's media reputation, leading to coverage of international bridge failures since then (e.g., Morandi Bridge, bridges in Baltimore and Dresden, the collapse of the cable car in Liberec, CZ).

8. Load tests and monitoring of bridges and buildings – The KI is regularly commissioned to conduct load tests on major road (highway), railway, and pedestrian bridges. Between 2019 and 2023, these tests were performed on reinforced and prestressed concrete, steel, masonry, and timber bridges. For instance, continuous structural health monitoring systems have been installed to provide real-time data on two key road bridges and one railway bridge in Prague, all of which are UNESCO-protected. Additionally, deformations are being monitored on the Liben Bridge and the Holesovice-Karlin footbridge.

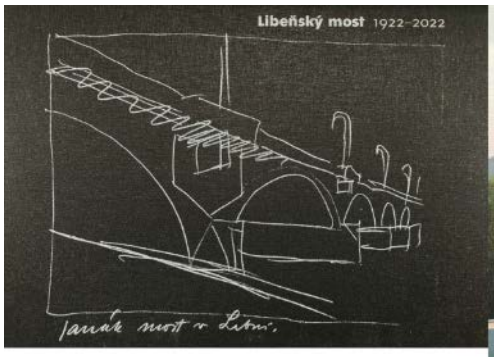
Furthermore, the institute has carried out crack monitoring and structural assessments, offering operational recommendations for several critical structures, including:

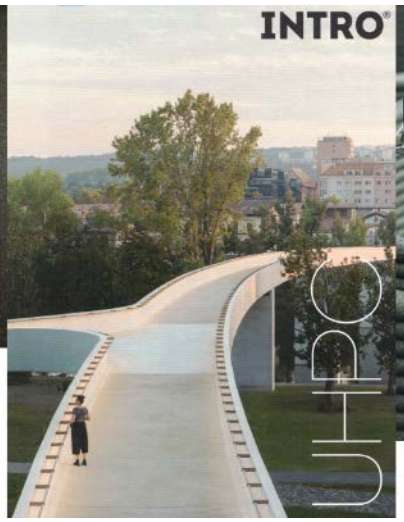
- Veletrzni palac (the main market hall at the Prague Exhibition Grounds),
- Vodni tvrz Jesenik (Water Fortress),
- ED Kladno (a key station in the power distribution network between the Czech Republic and Germany),
- The International Laser Centre ELI in Brezany,
- Pavilion G of Nemocnice Kralovske Vinohrady (one of Prague's main hospitals).

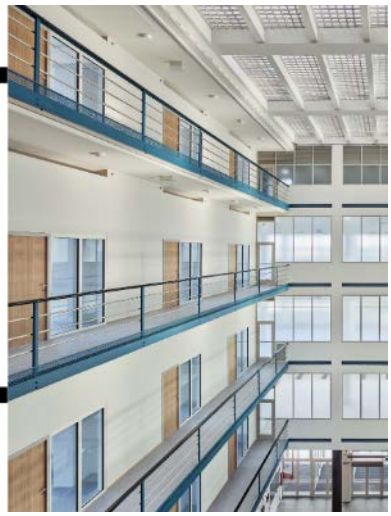
Additionally, structural assessments and operational recommendations were provided for glass structures, particularly facades, including those of the Moravian Regional Archives in Brno and the National Technical Library in Prague.

9. Monographs: selected results of the KI's research activities were communicated to the public. Besides many contributions in media, the following selected books provided an overview of research findings, including civil engineering, architecture, and heritage preservation aspects:

- Schneiderová Heralová, R. et al. Udržitelná správa stavebních objektů kulturního dědictví (Sustainable Management of Cultural Heritage Buildings), 2021
- Ráftl, J.; Cítek, D. et al. 3D STAR - 3D tisk ve stavebnictví a architektuře (3D STAR - 3D Printing in Construction and Architecture), 2022 (attachment *KI_3.6_3D Star-monograph about 3Dprinting.pdf*)
- Tej, P.; Scheinherr, A.; Kolísko, J.; Beran, L.; Hulec, M. Libeňský most 1922-2022 (Liben bridge 1922-2022), 2022 (attachment *KI_3.6_Libensky_most_1922_2022_ebook.pdf*)
- Tichý, M.; Sedláková, R.; Kolísko, J.; Hrabánek, M. Palác Elektrických podniků v běhu času (Palace of Electric Companies in Course of Time), 2023







10. Presentation of research results on exhibitions – KI organized or participated in exhibitions presenting the research results to the professional and general public. Posters with basic technical information and photographic documentation were prepared, fragments and models were exhibited, and moderated discussions with the authors were held. The exhibitions were usually accompanied by book publications. Selected examples of exhibitions:

- Building Fair Brno 2023, Festival of Architecture, 2-4 March 2023 - 3D printing in construction and architecture, including statues, 16 thousand visitors from 10 countries; large-scale demonstration by the statues of Karyatid of Erechthea in the Acropolis optimized for 3D printing from concrete - without human intervention, with complete digitization process including computational methods (nozzle paths on edges, overhangs)

- exhibition on heritage steel bridges, their surveys, assessments and maintenance, organised as part of the international conference IABSE Symposium Prague, 2022: Challenges for Existing and Oncoming Structures, 25-27 May 2022 (~360 visitors)

- exhibition in the lobby of the Faculty of Architecture, CTU in Prague, 27 September - 7 October 2022, with participation of e.g. SZ (railway manager), TSK Prague, National Heritage Institute, CTU leaders, the chairman of the editorial board of the magazine Stavebnictvi (Civil Engineering), the director of CKAIT (Czech Chamber of Authorised Civil Engineers) and representatives of major design offices and testing laboratories (~1,000 participants over two weeks)

- this successful exhibition then took place in 15.11.-30.12.2022 in Ceske Budejovice, in February 2023 in Hradec Kralove (~350 visitors). In 2023, it has been permanently installed in the exhibition hall of the National Heritage Institute in Ostrava.




IMPLEMENTATION OF RECOMMENDATIONS

3.7 Implementation of the recommendations in Module 3

Evaluation (2014-2020) – only critical comments highlighted:

Report 2020 - Recommendation 3.2, 3.3 and 3.4: … Efforts should be made to **reduce the number of small tasks** in favor of larger ones of presumably greater scientific value… However, **more cooperations with foreign entities** would open up new research topics.

To enhance the visibility of the KI, the scope of the main R&D topics (flowchart in Section 3.1) has been narrowed. Based on current research trends and industry needs, key topics now include modern cement-based composites, laminated glass, 3D printing, reliability and risk analysis with a focus on sustainability and climate change effects. The KI continues to rely on both experimental and theoretical research activities.

In contract research, several major framework contracts have been established, including those with TSK, RSD, and SUZ (road management across Czechia), SZ (railway network), as well as design and consultancy offices such as AFRY and Mot McDonald, and VCES (see Table 3.3.2). Additionally, several long-term projects have been initiated, such as the National Centre for Industrial 3D Printing (2023-2028).

Revenues from cooperation with foreign entities have, on average, doubled compared to the 2014-2018 period, and more than tripled in 2023 following the resolution of the COVID-19 pandemic (see Section 3.1).

Report 2020 - Recommendation 3.5 through 3.9: … A **critical internal assessment of the benefits from the patents** would be useful…. No spin-offs or licensed patents are listed in the self-evaluation report in the time period 2014-2018. This suggests a **careful consideration of the spin-off strategy of both the Klokner Institute and the Czech Technical University**. If necessary, this strategy should be adapted to the needs of the Klokner Institute. Given its excellent cooperation with industry and, thus, its understanding of the industrial needs, the set-up of spin-offs should be feasible provided a clear patent strategy was available.

The KI follows the CTU's general patent and spin-off strategies, with patents primarily resulting from collaborations with industrial partners who become co-owners. Given their investment in development, these partners typically aim to protect know-how and maintain control over patent transfers. The established model of cooperation between public research organizations and industry supports this approach, emphasizing long-term collaboration over immediate revenues from intellectual property.

To enhance patent commercialization, the KI is strengthening industry partnerships, optimizing licensing strategies, and expanding expertise in technology transfer. Ongoing efforts include reviewing licensing agreements, exploring new collaboration models, and seeking partners beyond the construction sector. Additionally, expert support in commercialization has been enhanced through training of its researcher, and discussions with government institutions are underway to refine support mechanisms for innovation.

Report 2020 - Recommendation 3.10 and 3.11: Scientific acknowledgments are first of all a consequence of the high quality of research, carried out by the members of a research unit. Personal acquaintances, made e.g. at international congresses and conferences, may result in an increase of such acknowledgments. The same holds true for memberships in editorial boards of scientific journals and in working commissions of professional associations. Hence, apart from striving for scientific excellence, **efforts to enhance the scientific visibility should be made**.

KI is a partner in numerous international research initiatives and collaborations (see mainly Section 3.2). Relative to its size, KI is well-integrated into international research networks, associations, and organizations. The internationalization of its research is further supported by its active involvement in international standardization (CEN, ISO).

Report 2020 - Recommendation 3.12: **The Klokner Institute should improve public relations concerning its activities in the popularization of R&D&I and communication with the public**.

The popularization and communication with the public have been significantly improved. The main communication channels include TV and radio broadcasting, print media, and social networks (see Section 3.6).

While the KI's focus on technical topics for the coming years is given at the end of Section 3.1, brief remarks on the personnel KI's strategy to be followed are given at the end of this report. Based on the available personnel data from the Klokner Institute, the age structure appears to be relatively favourable, with more than 72% of scientific and academic staff under the age of 50. This indicates a strong potential for further professional development and long-term institutional stability. Regarding a lower number of associate professors, this can be interpreted in several ways:

1. Openness to young researchers – The KI actively provides opportunities for younger scientific staff, aligning with the broader academic trend of supporting early-career researchers in their professional growth.
2. Focus on applied research – Given the nature of the Institute's research activities, there may be a stronger emphasis on applied research and collaboration with industry partners, where academic titles are a secondary measure of expertise.
3. Systematic development plan – A lower number of associate professors can be seen as an opportunity for future growth. The KI can actively support habilitations among its staff and implement a strategy to systematically enhance scientific excellence.
4. Interdisciplinary collaboration – The engagement of external associate professors and senior researchers in various research projects and teaching activities allows for a dynamic involvement of top experts without the necessity of direct employment.

To conclude, while the current personnel structure reflects a strong foundation with a predominance of younger researchers, the KI recognizes the need for continuous academic advancement. By fostering career progression, expanding strategic collaborations, and emphasizing excellence in both research and education, the Institute is well-positioned to strengthen its academic standing and maintain its leading role in the field.

A LIST OF SUPPORTING DOCUMENTS/LINKS FOR MODULE 3

Document name	No. criteria	Location (link in HTML)
KI_3.2_awards UPHC footbridges_OTHERS.pdf	3.2	https://owncloud.cesnet.cz/index.php/s/kmIfL4EvclmJooP
KI_3.2_UHPC footbridges_monograph.pdf	3.2	https://owncloud.cesnet.cz/index.php/s/9ICip3LN4tWKjFy
KI_3.3_detailed description of 10 projects.pdf	3.3	https://owncloud.cesnet.cz/index.php/s/1YH8dhKHZiVpuwC
KI_3.4.1_ Overview of research results.pdf	3.4	https://owncloud.cesnet.cz/index.php/s/1vYgdLv4fkCRPP9
KI_3.6_KI in media 2019-2023_summary.pdf	3.6	https://owncloud.cesnet.cz/index.php/s/Mo4LUVwHbQAA7m0
KI_3.6_3D Star-monograph about 3Dprinting.pdf	3.6	https://owncloud.cesnet.cz/index.php/s/ZVpkAYxbXFkKA4x
KI_3.6_Libensky_most_1922_2022_ebook.pdf	3.6	https://owncloud.cesnet.cz/index.php/s/aLGhKKLCU2I0ka1
Repair of heritage bridge in Liben	3.6	https://www.praha.camp/magazin/detail/bourani-a-rozsireni-ci-rekonstrukce-jaka-je-budoucnost-dost-mozna-jedineho-kubistickeho-mostu-na-svete
Holesovice-Karlin footbridge	3.6	https://www.jednoustopouceskem.cz/listing/stvanicka-lavka-holka/