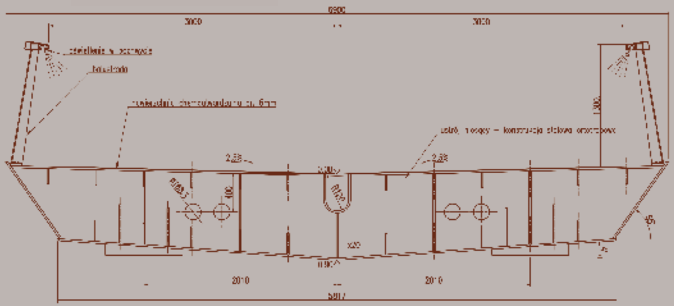
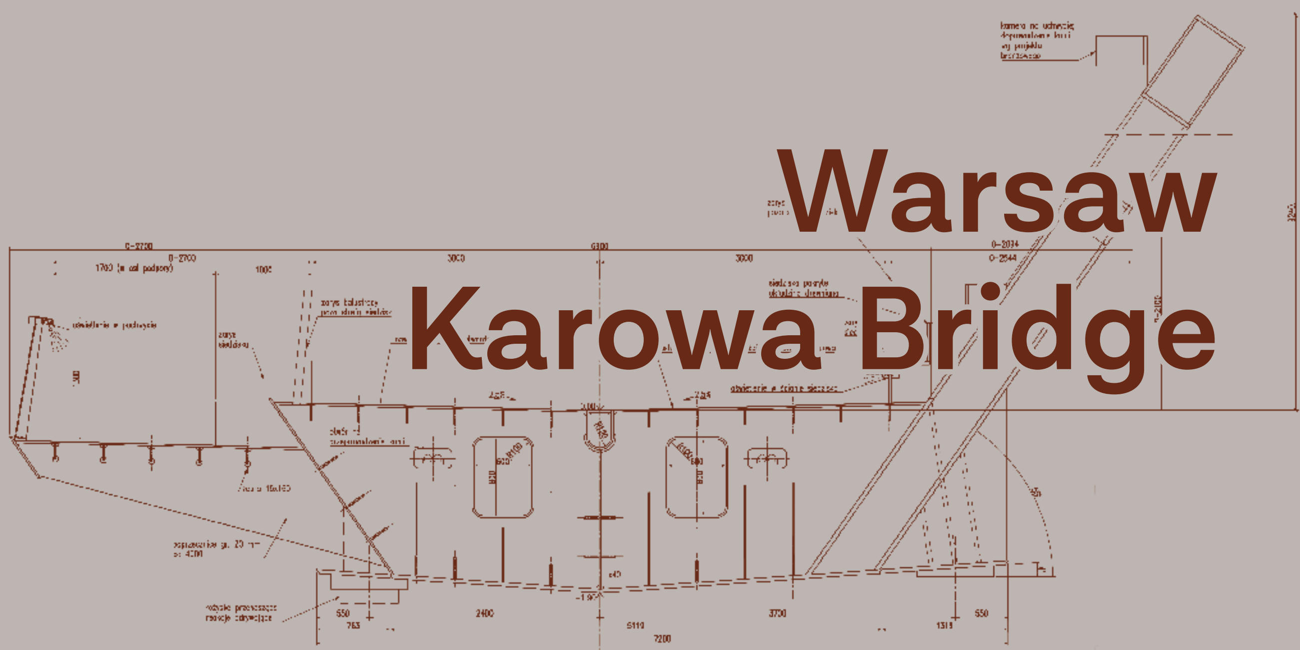
Bartlett Design Research Folios



# DKFS Architects



# Warsaw Karowa Bridge

# DKFS Architects

# Warsaw Karowa Bridge

**1 (previous)** The platform on the Praga side, where the structure emerges from a cluster of trees. The views towards the basilica resemble the gate to Warsaw.

**2** The viewing platforms are logically located on the kinks of the plan form and act as a continuation of urban space, allowing views towards the Old Town that could not be experienced previously.

## Project Details

| | |
|---|---|
| Author | Dirk Krolikowski |
| Co-author | Falko Schmitt |
| Practice | Krolikowski and Schmitt have realised this project through their design and architectural practice, DKFS |
| Title | Warsaw Karowa Bridge |
| Output Type | Design |
| Open International Competition Winner | September 2017 |
| Expected Completion | 2023 |
| Function | Bicycle and pedestrian bridge |
| Location | Warsaw, Poland |
| Span | 480 m |
| Budget | €24 million |
| Designers | Dirk Krolikowski, Falko Schmitt |
| Practice Team | Tom Baldwin, Ryan Blackford, Alex Bramhill, Michael Scheuvens |

| | |
|---|---|
| Commissioning Body / Client | City of Warsaw |
| Selection Committee / Jury | Andrzej Brzeziński, Faculty of Civil Engineering, Warsaw University of Technology; Jacek Grunt-Mejer, Housing Policy and Revitalisation Department, City of Warsaw; Marlena Happach, Architecture and Spatial Planning Department, City of Warsaw; Renata Kaznowska, Deputy Mayor of Warsaw; Agnieszka Kulesza, Municipal Roads Authority; Ewa Kuryłowicz, Polish Architects' Association; Rainer Mahlamäki, Finnish Association of Architects (SAFA); Hubert Markowski, Faculty of Architecture, Warsaw University of Technology; Marek Mikos, Architecture and Spatial Planning Department, City of Warsaw |
| Jury Chairs | Maciej Mąka, Polish Architects' Association Juror; Adam Pawłowski, Faculty of Architecture, Warsaw University of Technology; Wojciech Wagner, Architecture and Spatial Planning Department, City of Warsaw; Wojciech Zabłocki, architect; Patryk Zaręba, landscape architect; Henryk Zobel, Faculty of Civil Engineering, Warsaw University of Technology |
| Structural Engineer Competition Collaborators | Frank Ehrlicher, Benedikt Lüdtke, Lars Niessen (Schüßler-Plan Berlin) |
| Structural Engineer | Tadeusz Stefanowski, Paweł Stefanowski (Mostex) |
| Execution Collaborators | Justyna Grzesiak, Piotr Piotrkowicz, Thomas Stein, Zbigniew Wichański (Schüßler-Plan Warsaw) |

# Statement about the Research Content and Process

**Description**

Warsaw Karowa Bridge is a new bridge in the centre of Warsaw, over the Vistula River. It is designed by DKFS for the City of Warsaw after winning an open international architecture competition. Its design and length of 480 m, plus a secondary span of 60 m, makes it one of Europe's most prominent urban pedestrian bridges. The bridge is an urban destination with views towards the UNESCO World Heritage Old Town. As such, it functions as public space and landmark for the Praga District in Warsaw.

**Questions**

1. How can the bridge integrate and continue urban space, as well as the experiential qualities of the city, while responding to the local cultural context?

2. How can an interdisciplinary understanding of belt-bridge structural system principles and a bridge's programmatic function be tailored to a site-specific solution?

3. How can onerous limitations of vessel freeboard height and structural restrictions due to pillar location be respected without being an obvious constraint?

**Methodology**

1. Strategies of historical, spatial and urban contextualisation from studying the local architectural context at the abutments to creating space on the bridge;

2. Critical analysis of the impact of the structure on the view corridors towards the Old Town;

3. Research into the principles of the structural typology of a belt bridge;

4. Research into the technical contextualisation and structural behaviour of the bridge, resulting in an iterative and interdisciplinary approach, enabling the design team to develop an architectural form that is highly differentiated and legibly reflects the flow of forces.

**Dissemination**

The project has been exhibited at the Palace of Culture and Science in Warsaw. The exhibition programme included public talks by the designers and the Mayor of Warsaw. It has received significant media attention in Poland. International publications include articles on the website *BauNetz* and an extensive article by the author in the journal *Brückenbau: Construction & Engineering*.

**Project Highlights**

Warsaw Karowa Bridge is a significant urban intervention due to its prominent location in Warsaw, opposite the UNESCO World Heritage Old Town. The project is key to the ongoing public rejuvenation strategy plan of the City of Warsaw and will become an urban catalyst for the Praga District. The open international architecture competition for the site received approximately 140 expressions of interest with 40 second-stage submissions from international expert design teams. DKFS' winning scheme received broad attention amongst industry and the public. Its structural system is original in its combination of scale, plan form and programme, as well as its use of an asymmetric belt system for the main span. At 480 m long, Warsaw Karowa Bridge is estimated to be Europe's longest urban pedestrian bridge.

3

**3** The elegant silhouette of the structure mirrors the flow of forces.

4

**4** View from Copernicus Science Centre roof with the Vistulan Boulevard river bank activation project on the left.

## Introduction

Warsaw Karowa Bridge is a 480 m weathered-steel pedestrian and bicycle bridge over the Vistula River, connecting the city's Old Town with the Praga District. At the time of writing, the project is in the execution design phase, having completed all necessary research and getting ready for tender. Praga is a central district of Warsaw, east of the Vistula River, directly opposite the Old Town. The district is of historical importance due to its exposure to the East. The site of the new bridge is roughly the location of several preceding timber pontoon bridges, dating back to the Middle Ages, that connected Warsaw to Praga **(5–6)**.

DKFS' Warsaw Karowa Bridge synthesises all brief requirements with a highly architectural form that represents a new generation of technically and culturally integrated infrastructure. This has been achieved through its responsive form and continuous differentiation in structural shape and experiential space **(7)**. The key architectural components are the asymmetric belt system on the east side of the structure, which informs the continuous elevation, as well as two viewing platforms located over pillars that define the zigzag plan form and provide vistas towards the Old Town **(8).**

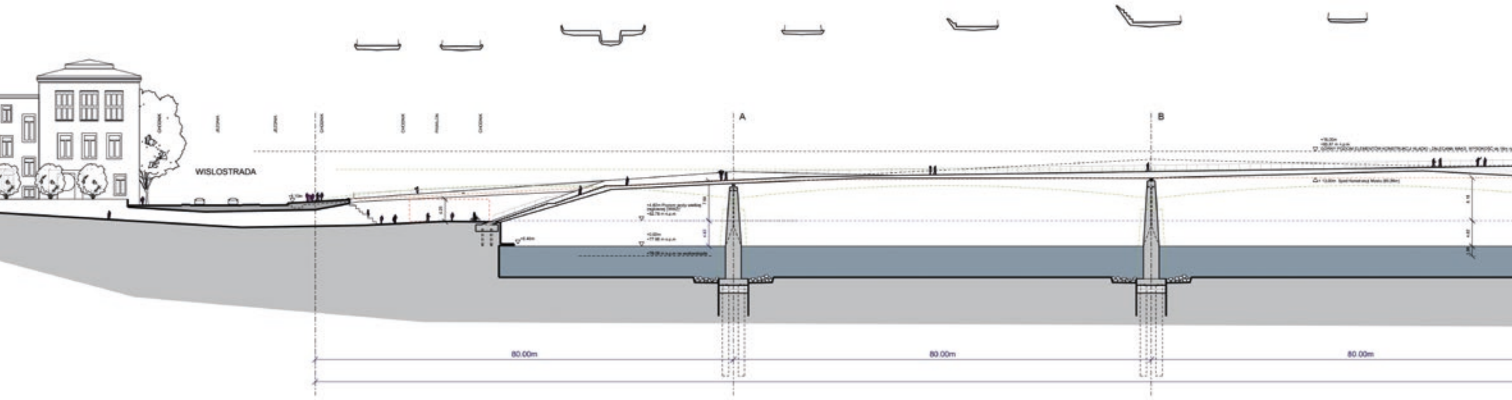
Already demonstrated at competition stage in DKFS' submission, the engineered shape of the structure assumes the application of recent EU research outcomes, published in the report *Human-Induced Vibration of Steel Structures* (Hicks et al. 2010), to assess the vibration behaviour of the bridge. Historically, structures in Poland have to comply with a 3.0 Hz national code requirement for serviceability. Codes for structures command a certain threshold for eigenfrequencies – the discrete frequencies at which a system is prone to vibrate – and sway-induced acceleration, which can be uncomfortable if too significant. Structures also need to meet serviceability codes for comfort. It is mostly the case that these thresholds and the requirements of serviceability tend to depend on local cultural context and regulations. DKFS' bridge design challenges Poland's strict national requirements for serviceability, which are understood to stem from pre-computational guidelines that do not reflect modern methods of structural analysis. The low eigenfrequency of the proposed structure initiated an extensive discourse amongst engineering experts and institutions, which resulted in exemption from national guidelines.

5

6

**5** Painting by Marcin Zaleski depicting the Poniński Bridge during the November Uprising against the Russian Empire, 1830–1.

**6** The Poniński Bridge was a timber pontoon bridge built in 1775. The bridge was dismantled during the winter to avoid damage by drifting ice on the Vistula River.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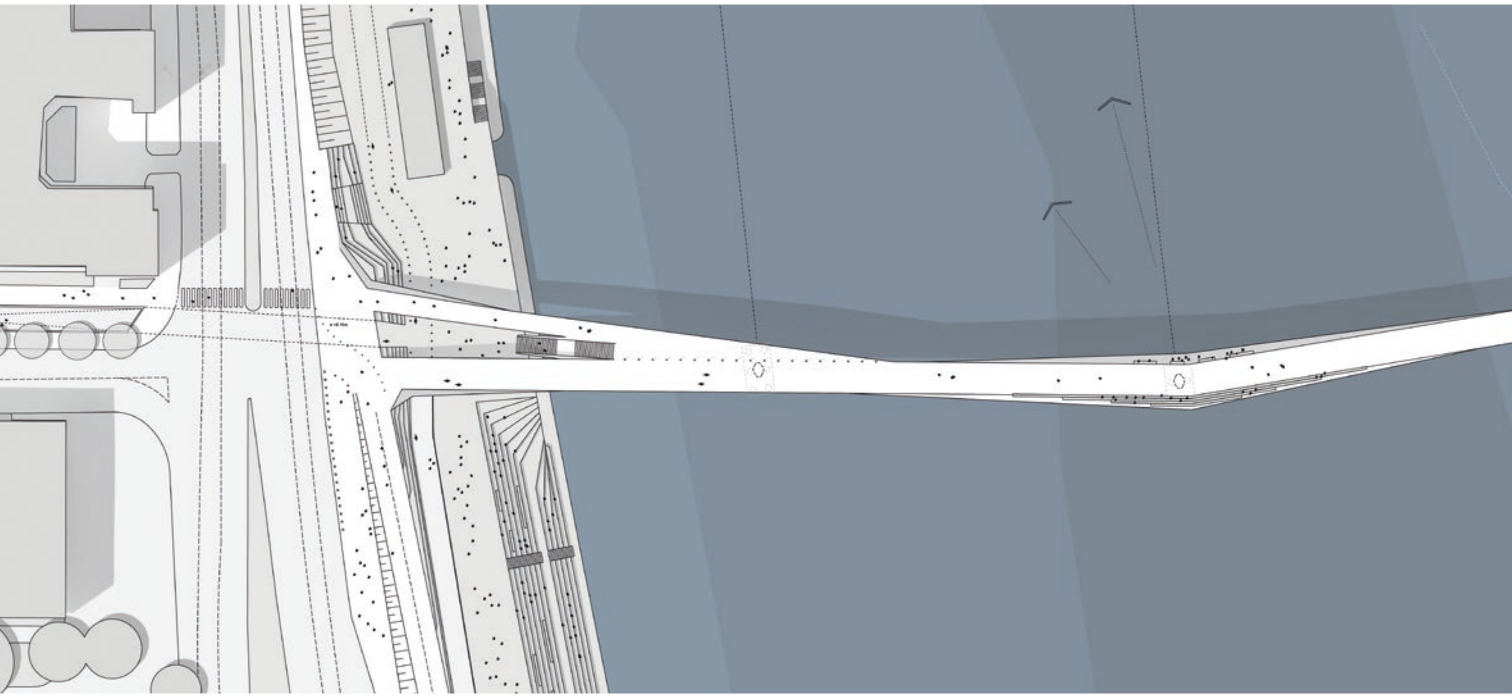

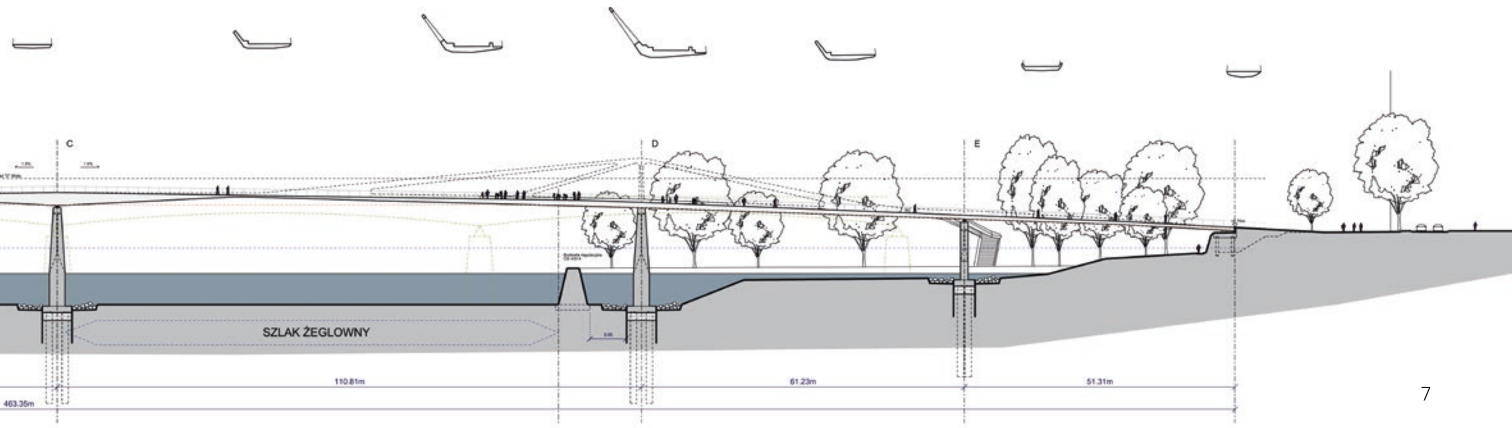


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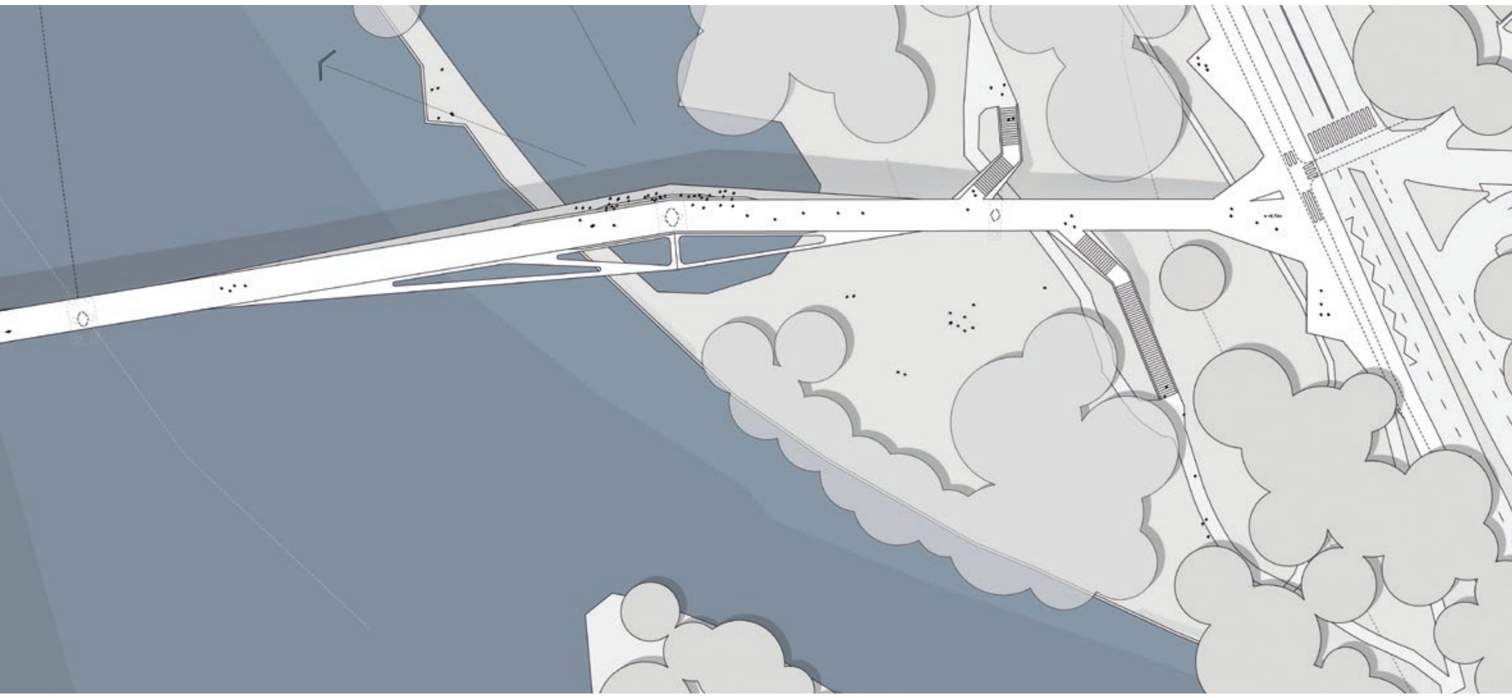

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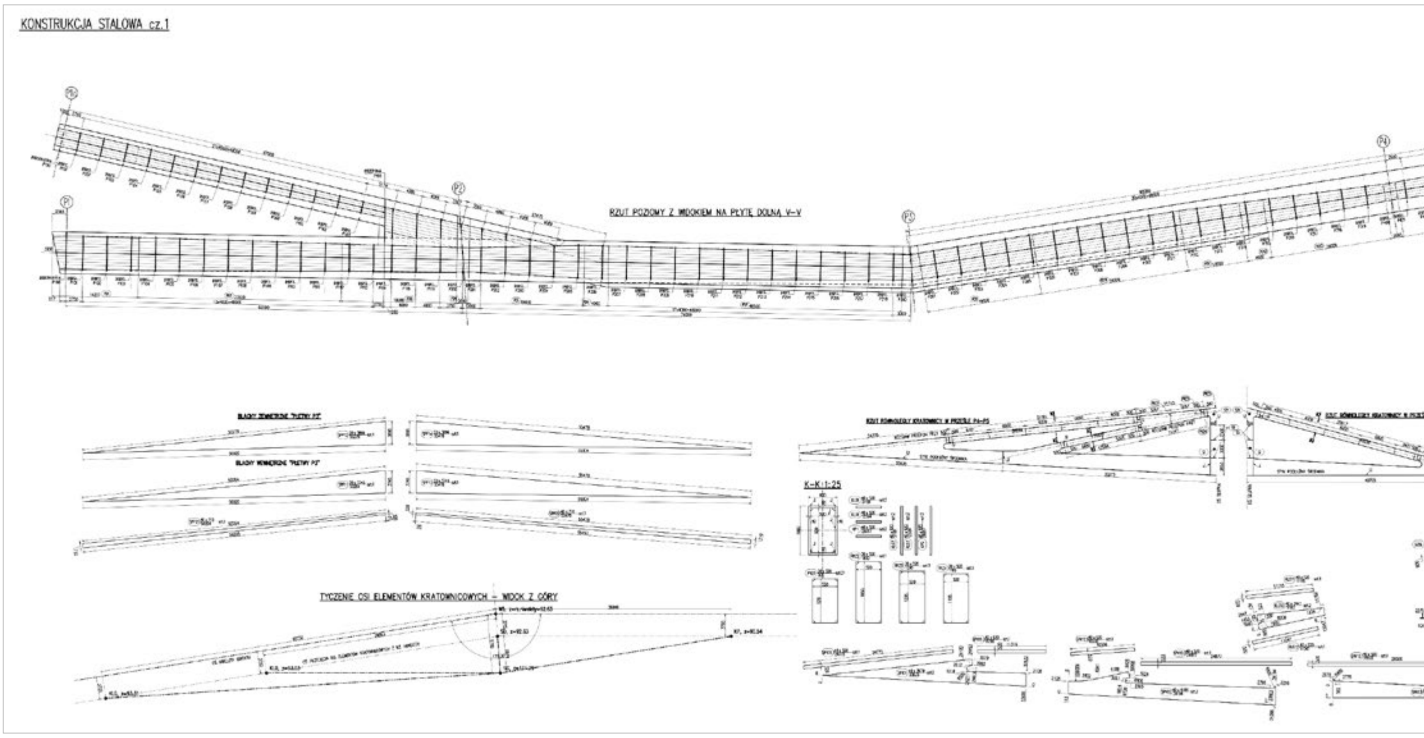
**7** Long section of the structure with a continuously changing short section. The bridge has an architecturally and structurally differentiated form along its length.

**8** Plan of the new bridge showing its integration into the banks and the viewing platforms that extend the urban realm onto the structure.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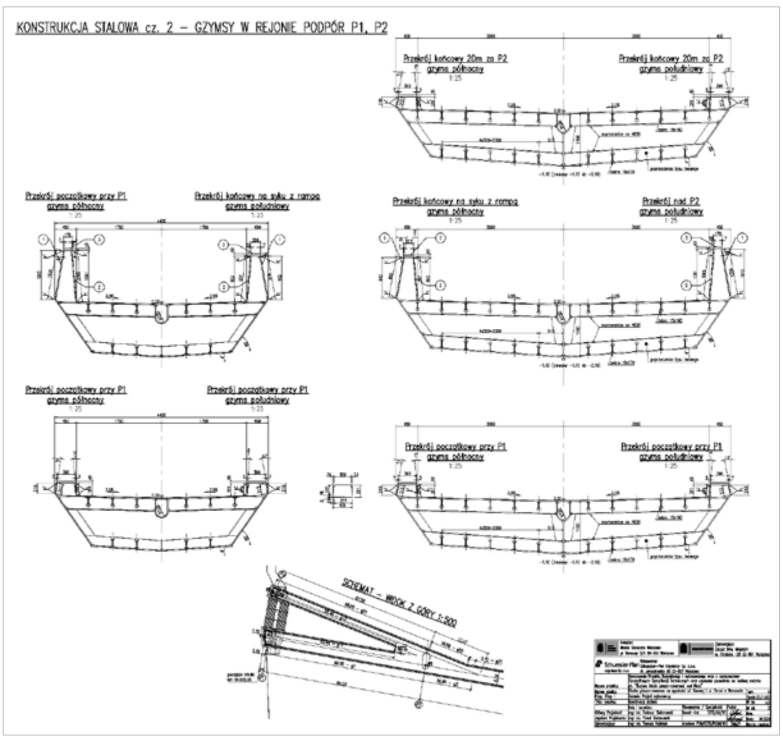
KONSTRUKCJA STALOWA cz. 2 – GZYMSY W REJONIE PODPÓR P1, P2
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Przekrój końcowy 20m za P2
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Przekrój początkowy przy P1
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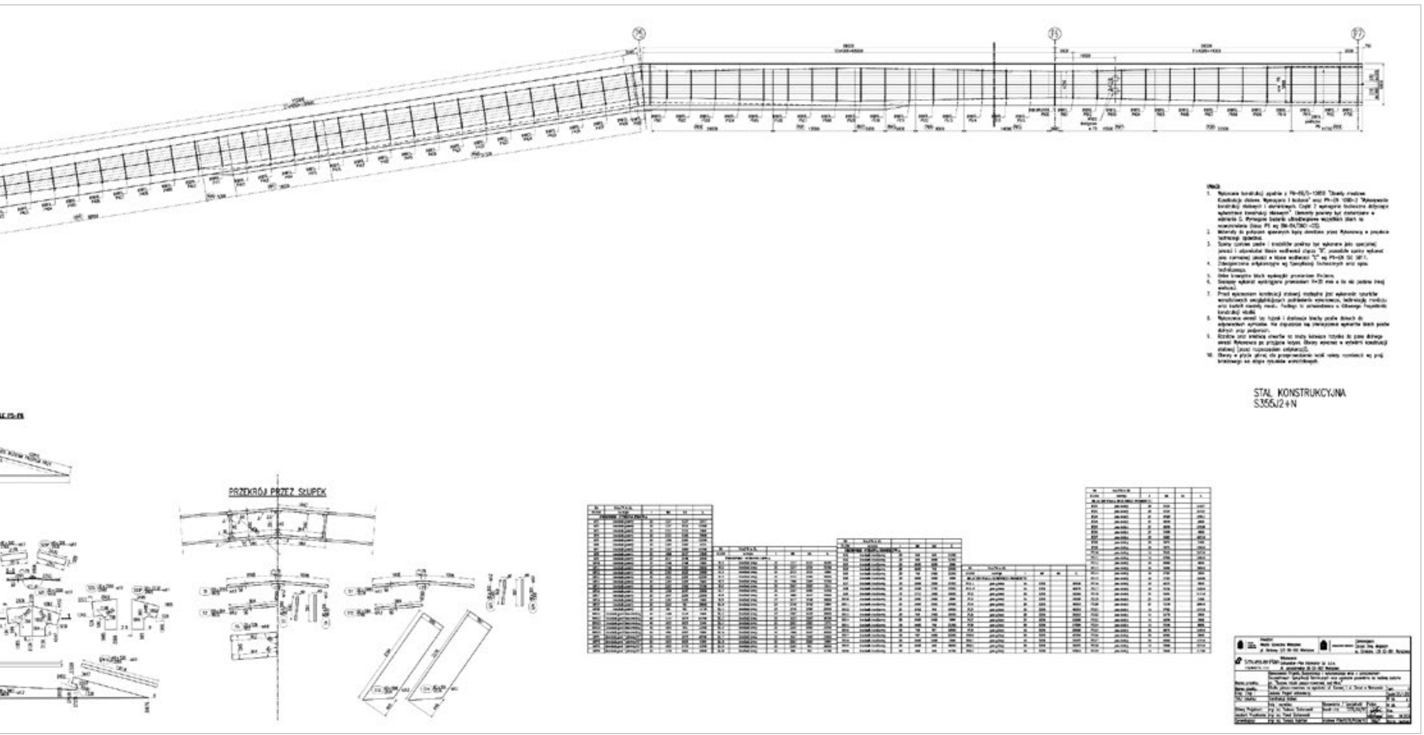



9

**9** Steelwork assembly drawing of superstructure, including stiffener arrangement and cross-girder locations, with a geometric description of belt geometry.

**10** Standard sections of superstructure above boulevard.

## Aims and Objectives

The aim of the research is to respond to a wide range of structural and programmatic objectives, thus making the new pedestrian bridge a synthesised public asset that offers urban integration. The bridge design aspires to achieve the highest level of topographical as well as cultural contextualisation as part of the vista towards the Old Town. This approach is key to the project and is an established principle in the work of DKFS, who argue that the contemporary generation of urban infrastructure should avoid the mistakes of solutions from the last century. They suggest that more attention needs to be paid to the experience of public space and considerations of human scale as aspects of sustainability. Post-war infrastructure followed a limited set of objectives, such as constructional constraints or efficiency requirements of the transport mode. In contrast, this project attempts to offer multi-objective integration in the bridge structure with a synthesis of requirements from the architectural, technological and social domains **(12).**

A central objective of the research was to contribute to the broader regulatory discussions around modern infrastructure. DKFS and the design team instigated an important debate about building regulations, including requesting and achieving a reconsideration of the national design codes according to new findings that are based on modern computational methods of structural analysis of footbridge vibration. The design team's close study of the EU guidelines, *Human-Induced Vibration of Steel Structures* (Hicks et al. 2010), that validate lower eigenfrequencies for the behaviour of pedestrian bridges influenced discussions amongst engineers and authorities, and disseminated new and significant knowledge on footbridge design.

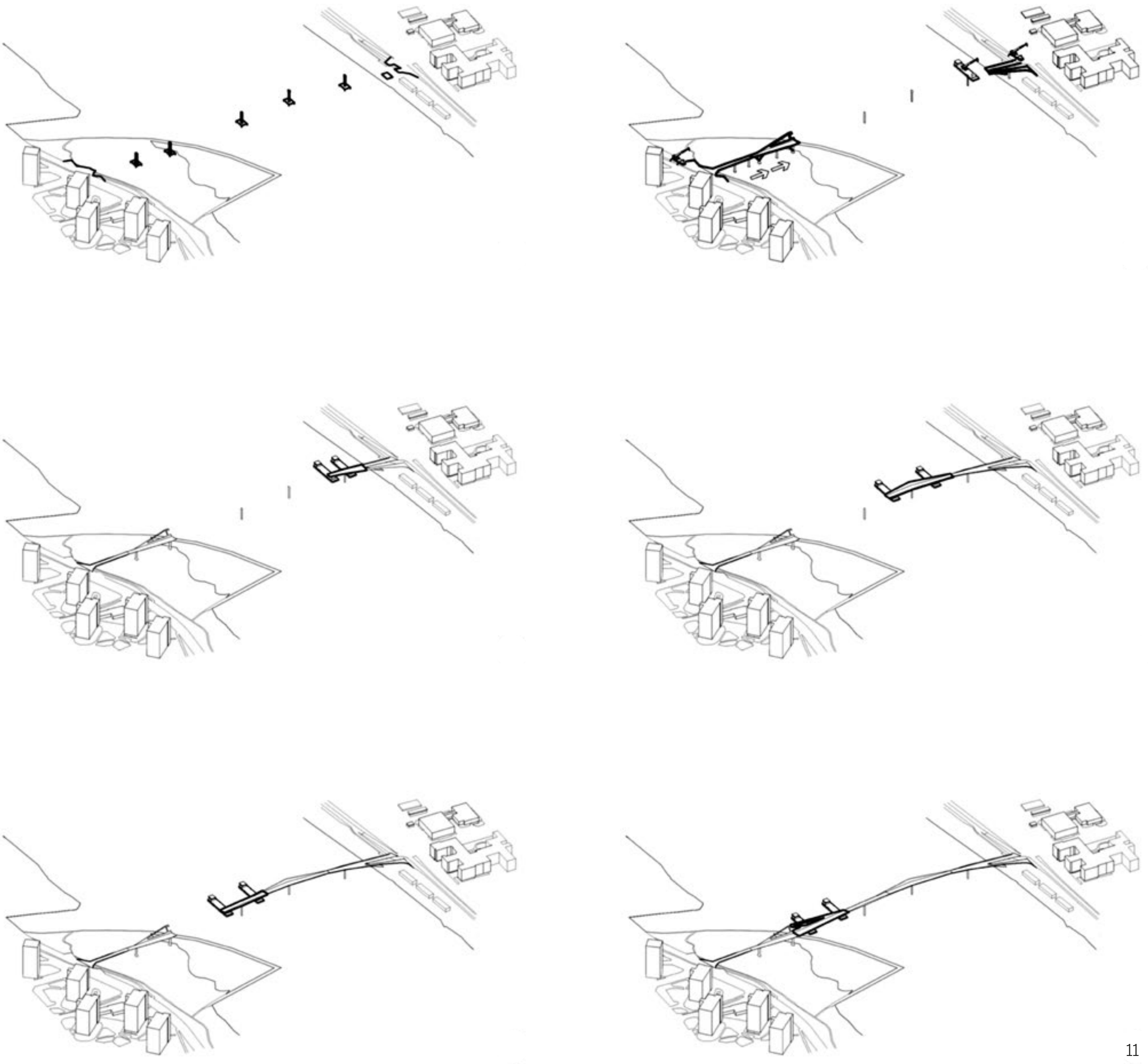
## Questions

1. How can the bridge integrate and continue urban space, as well as the experiential qualities of the city, while responding to the local cultural context?

2. How can an interdisciplinary understanding of belt-bridge structural system principles and a bridge's programmatic function be tailored to a site-specific solution?

3. How can onerous limitations of vessel freeboard height, and structural restrictions due to pillar location, be respected without being an obvious constraint?

The composite of these questions and their answers led to an integral multidisciplinary approach documented in a set of genesis diagrams that attempt to articulate the synthesis of all objectives as succinctly as possible **(11)**.



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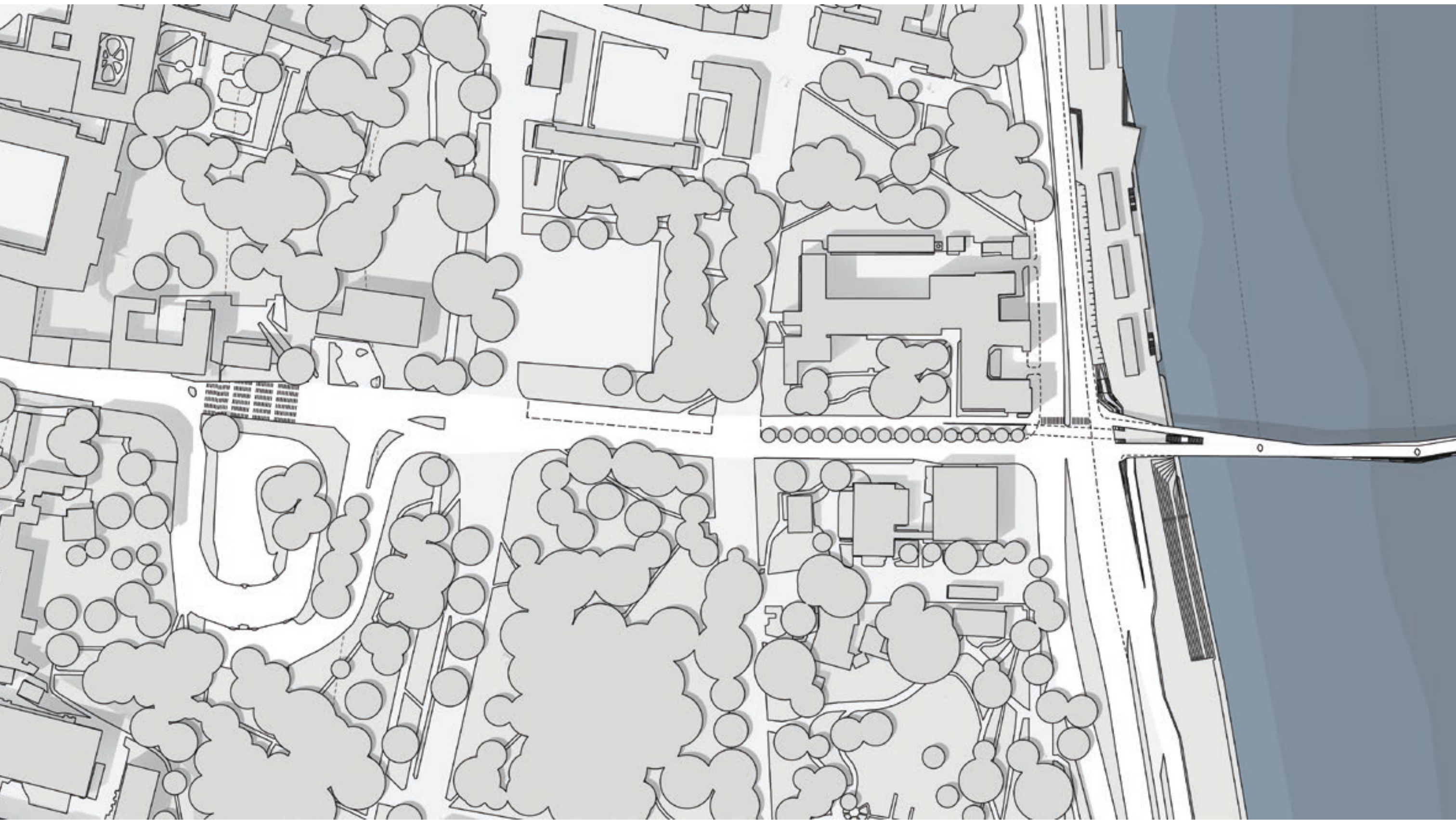
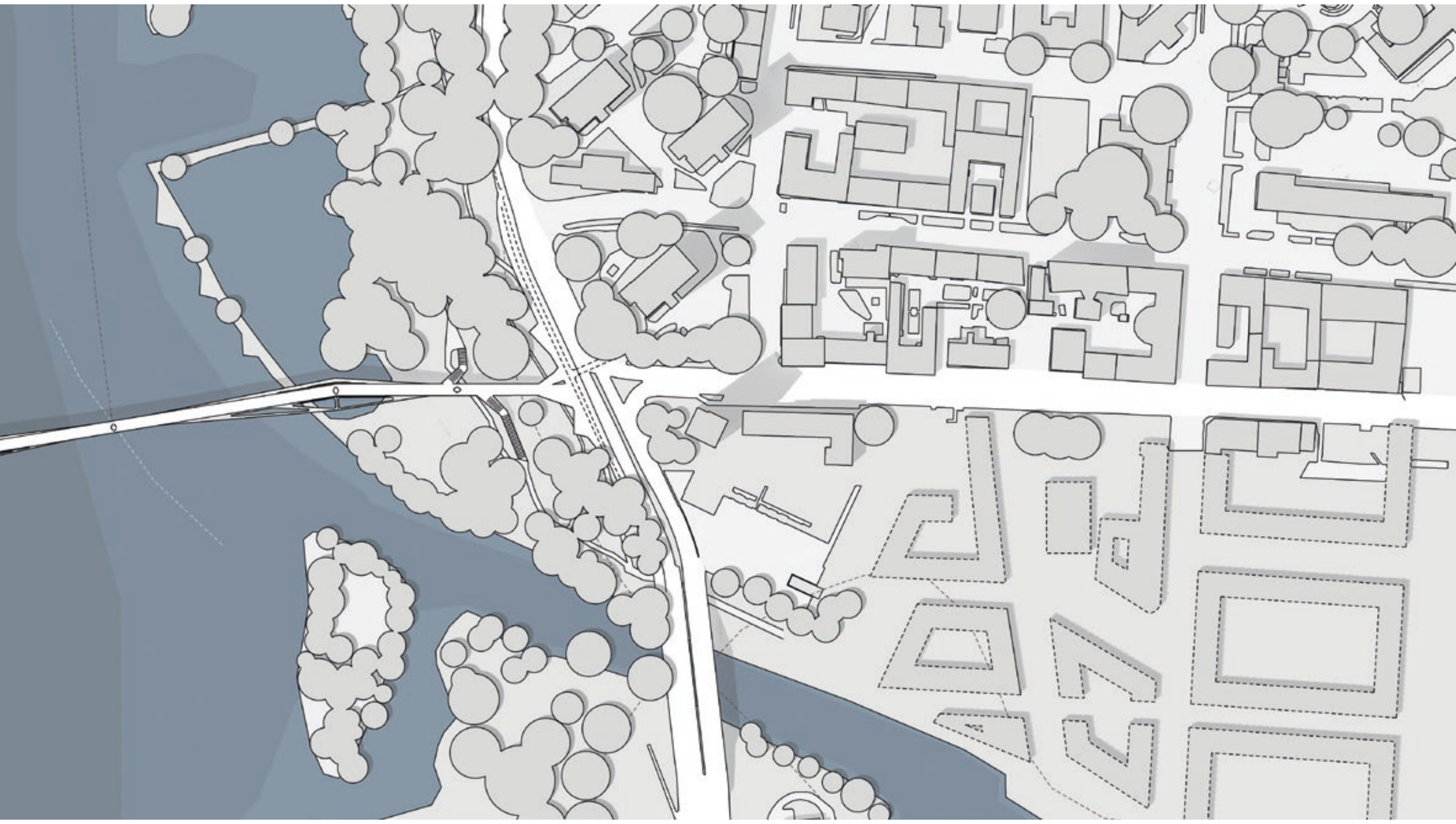
**11** Warsaw Karowa Bridge,
construction sequence.





12

**12** Urban plan form. The structure responds to a multitude of objectives, including the local and wider urban contexts.

# Context

The reconstruction of the historic centre of Warsaw is an outstanding example of rebuilding a city that has been deliberately and almost fully destroyed by war. As a reconstruction project of a span of history from the thirteenth to the twentieth century it is of enormous national and international significance since it has recovered a city's heritage 'on a unique scale in the history of the world' (UNESCO 2020). Notably, Warsaw's conservation programme of the Old Town has material, functional and symbolic dimensions, including supporting a residential quarter. DKFS' winning design was selected because it responds innovatively to this context. The design enhances a panoramic and cohesive picture of the Old Town on a critical location on the Vistula, contributing significantly to the city's experience while also addressing contemporary bridge design.

The project sits within a broader context of urban and architectural bridge projects in capital cities, including such well-known examples as the Millennium Bridge in London by Foster+Partners and Arup. Although the Warsaw Bridge is almost twice as long, the projects share a comparable location relative to historic city centres and function as urban catalyst with similar urban intent.

A structural and historic precedent for the belt-bridge typology is the Kaiser Wilhelm Bridge in Wilhemshaven, Germany **(13)**. As all belt bridges, the system is self-anchoring and introduces horizontal loads of the hanging belt structure back into the deck system beam, instead of being resisted by substructure such as an abutment block. The belt system acts similar to a truss but tension forces are bundled and resisted mainly by the upper cord.


13

**13** Kaiser Wilhelm Bridge, Wilhelmshaven, 1907. A historical precedent for the belt system.

## Lechsteg

The project also sits within DKFS' significant body of architectural bridge structures notable for their cultural, technological and urbanistic integration. Weathering steel and its material logic and architectural behaviour has been tested by the practice in Landsberg, near Munich, for the Lechsteg project, which is currently in execution **(11–4)**.

14

15

**14** The 130 m long Lechsteg in Landsberg.

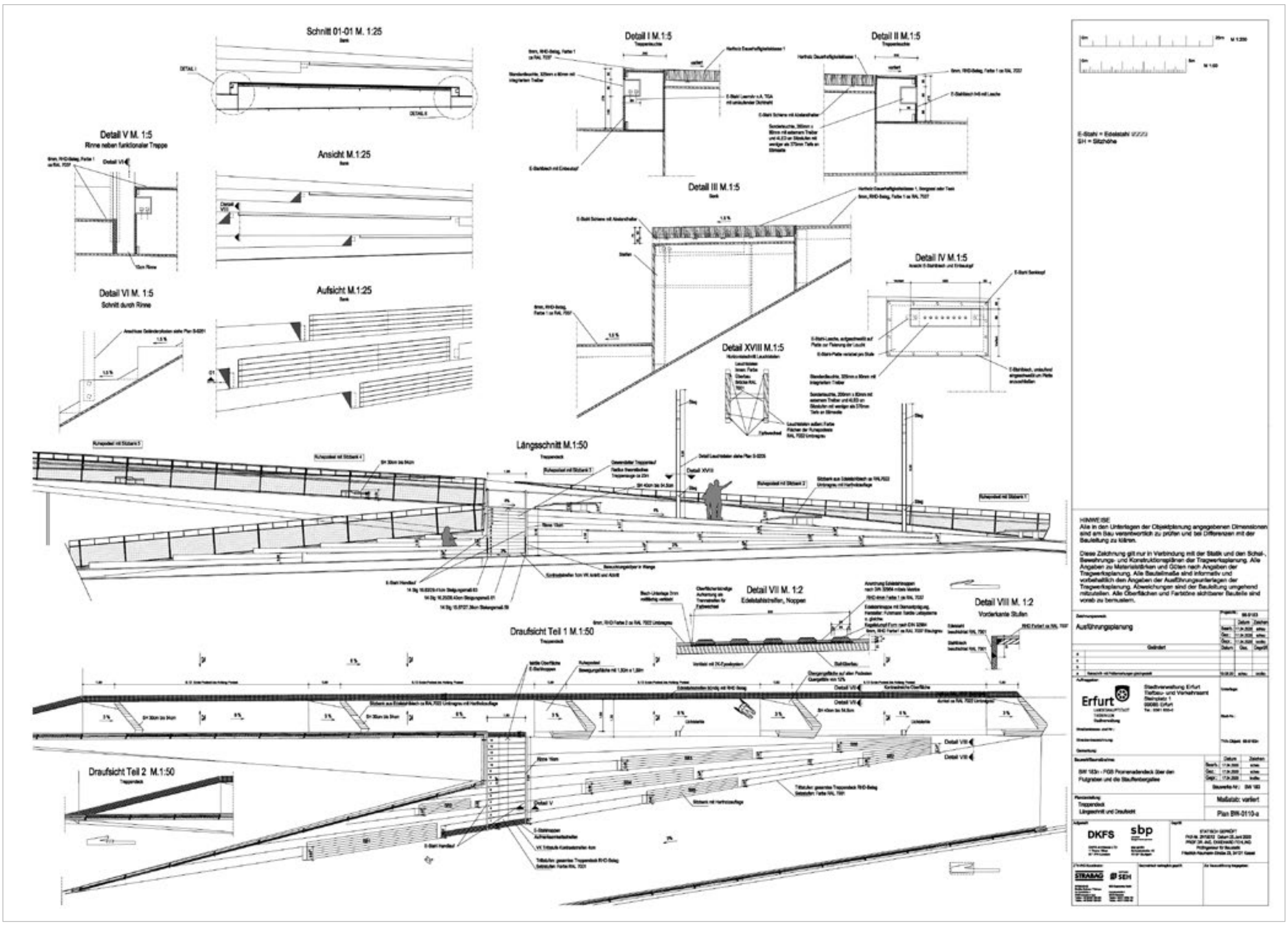
**15** Lechsteg, lifting in of the first weathered-steel section.

## Promenade Deck

Another example for the multi-objective approach explored here is the Promenade Deck, an urban bridge structure in the centre of Erfurt, currently in execution **(16–7)**.

16

**16** Promenade deck at Erfurt, merging urban realm and elegant landmark.




17

**17** Promenade deck at Erfurt, tender stage information for an inhabitable bridge. The bridge platform takes cues from the strategies developed for Warsaw Karowa Bridge.

## Silver Arrow Bridge

One more design informed by the research carried out by DKFS, particularly with a view to the belt system, is the winning design for the Silver Arrow bridge in Castrop-Rauxel **(18)**.

18

**18** The Silver Arrow bridge in Castrop-Rauxel, scheduled for completion in 2021.

## Neckar Bridge

Similarly, the shortlisted proposal for the new Neckar Bridge in Heidelberg was also based on DKFS' developed body of research **(19)**.

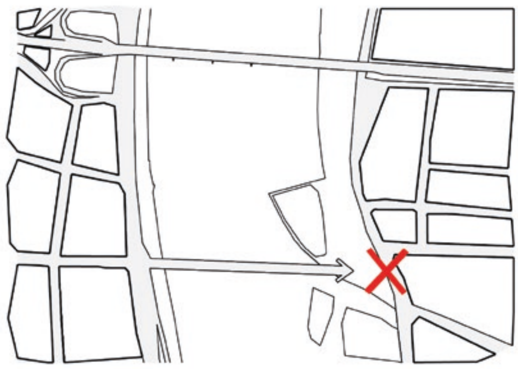
19

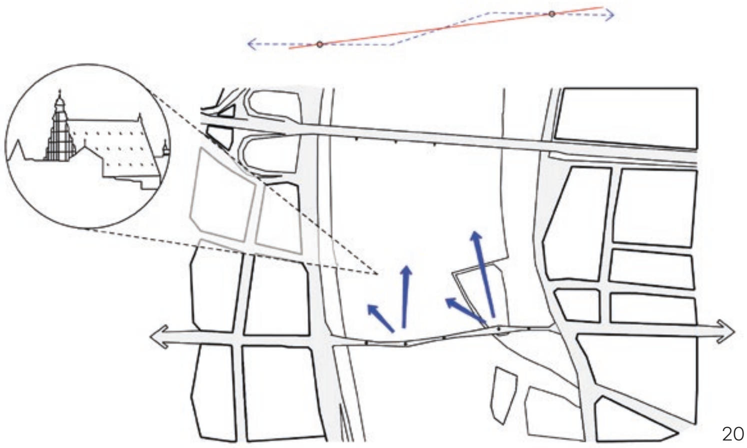
**19** DKFS' shortlisted entry for the new Neckar Bridge in Heidelberg employs a variant of the developed asymmetric belt system.

# Methodology

The design-led, highly iterative research and design process employed an extensive variant study to understand structural, legal and urban requirements that provided the framework for all possible solutions. Constraints and restrictions imposed by the Polish National Water Management Authority, regarding the possible location of the columns and the required freeboard of approximately 8 m, were an important driver for the structural solution.

Central Warsaw and the Praga District have historically developed offset urban grids. The variant study took the given column locations into account and generated a logical response to the existing urban grids: the so-called 'zigzag' plan form **(20)**. The plan form also allows the otherwise linear experience of a 500 m crossing to be broken, and locates two platforms at structurally and experientially logical locations over the piers, close to the abutments on the east and west side of the bridge. The viewing platforms act as a continuation of urban space and provide views towards the Old Town **(24)**.





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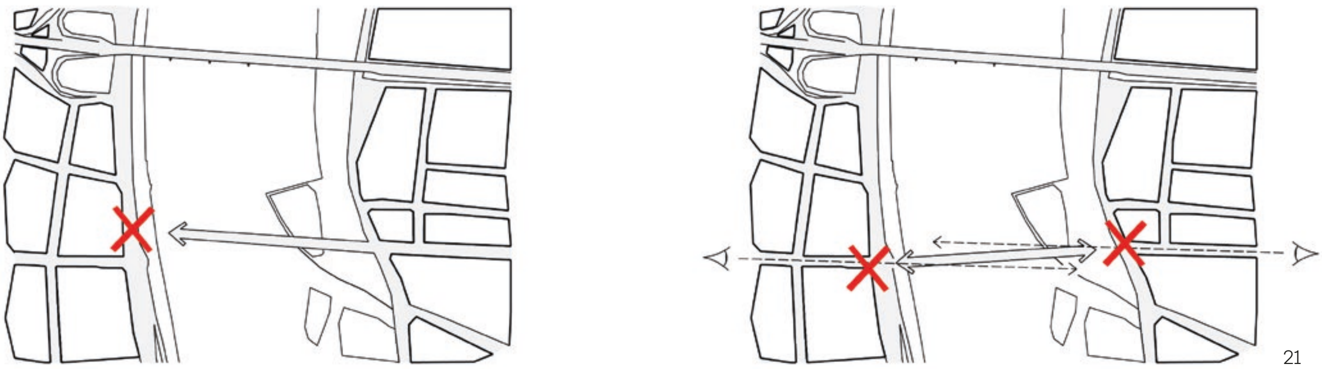
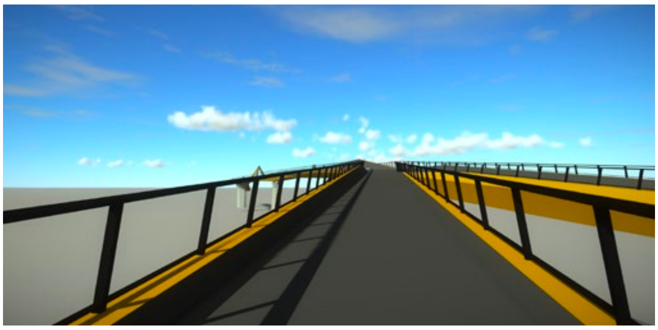
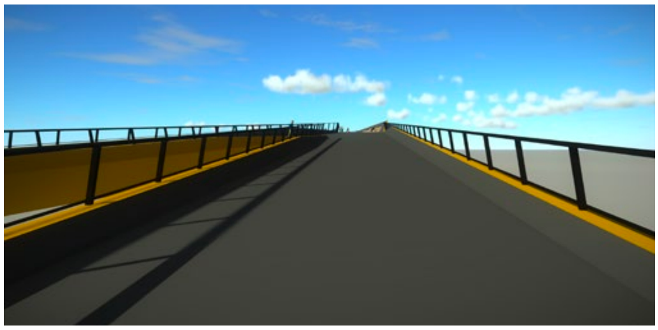
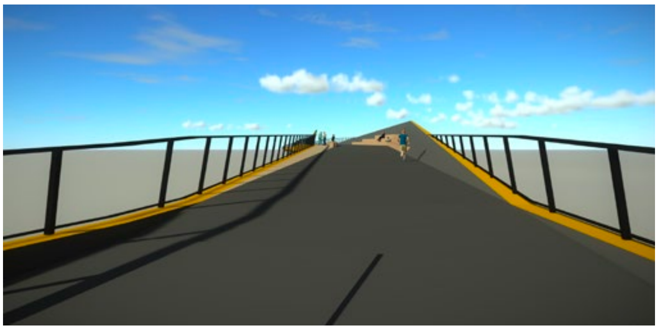
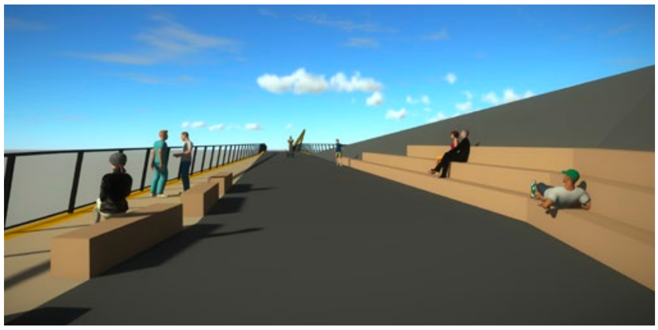
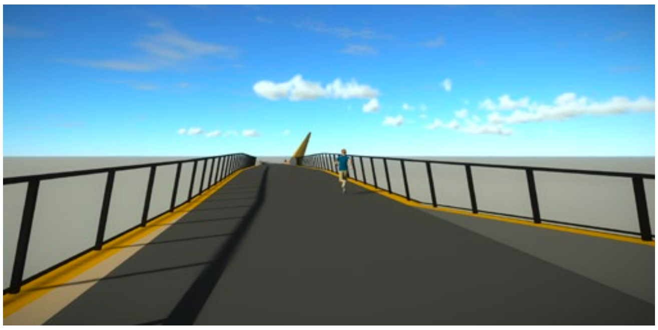
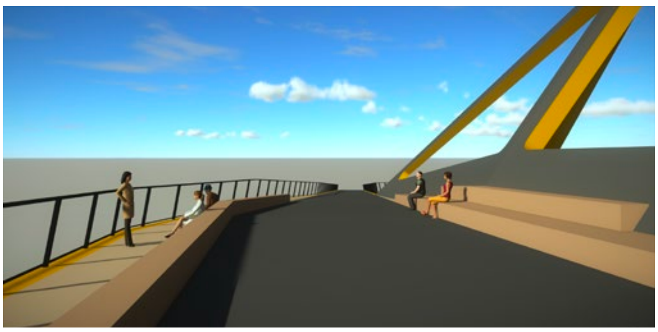
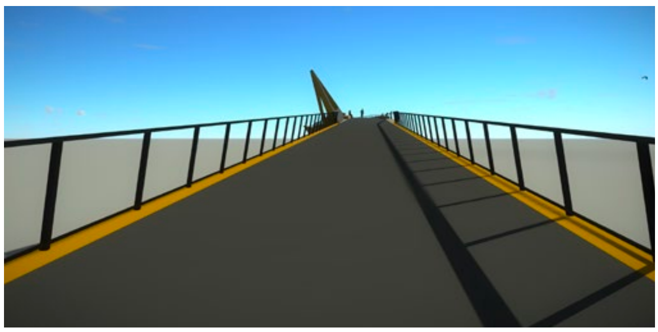
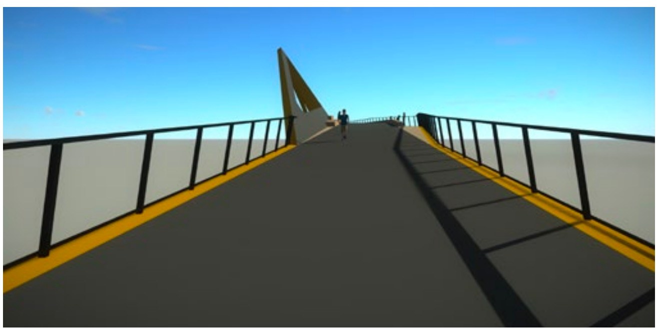
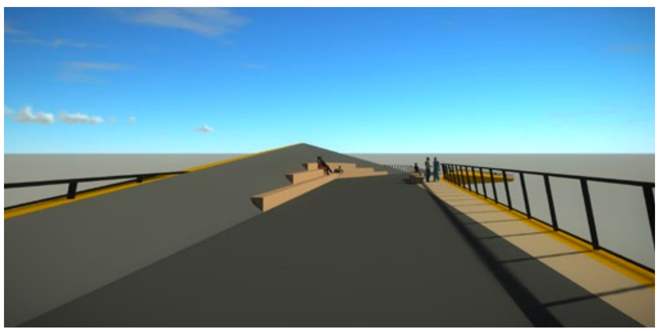


21

**20** Diagram illustrating the constraints imposed by the fixed column locations and the resulting zigzag plan form.

**21** Set of diagrams explaining the impact of the urban grids of Warsaw and Praga on the genesis of the form in plan.

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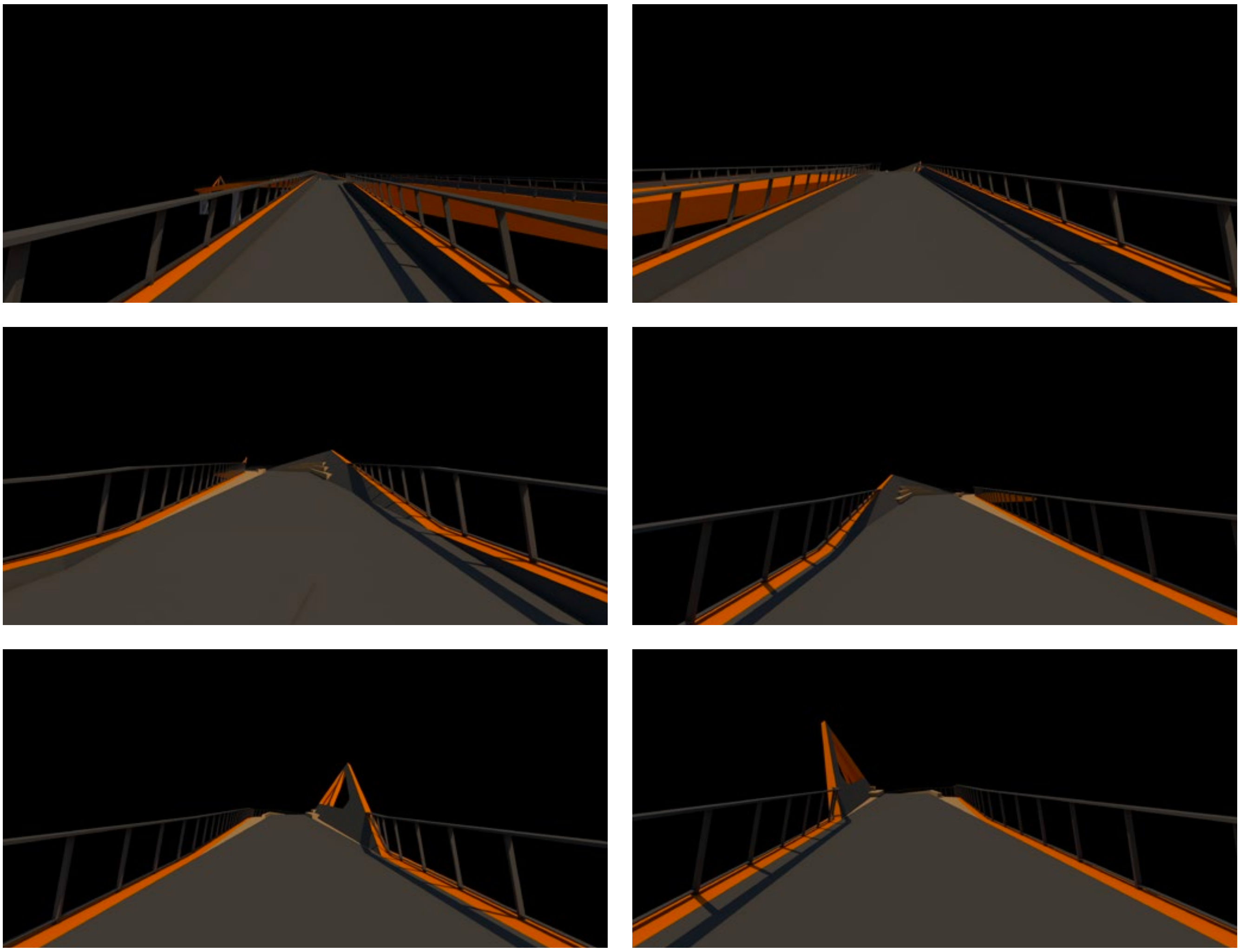


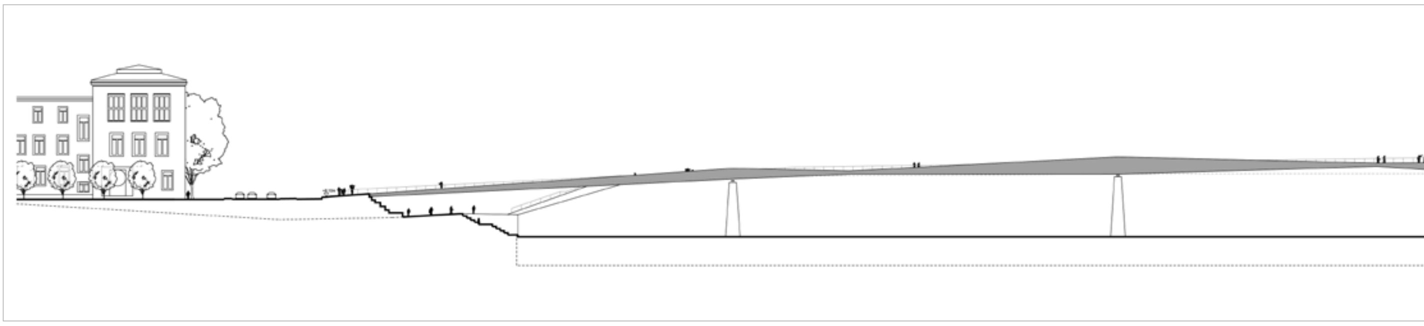
23

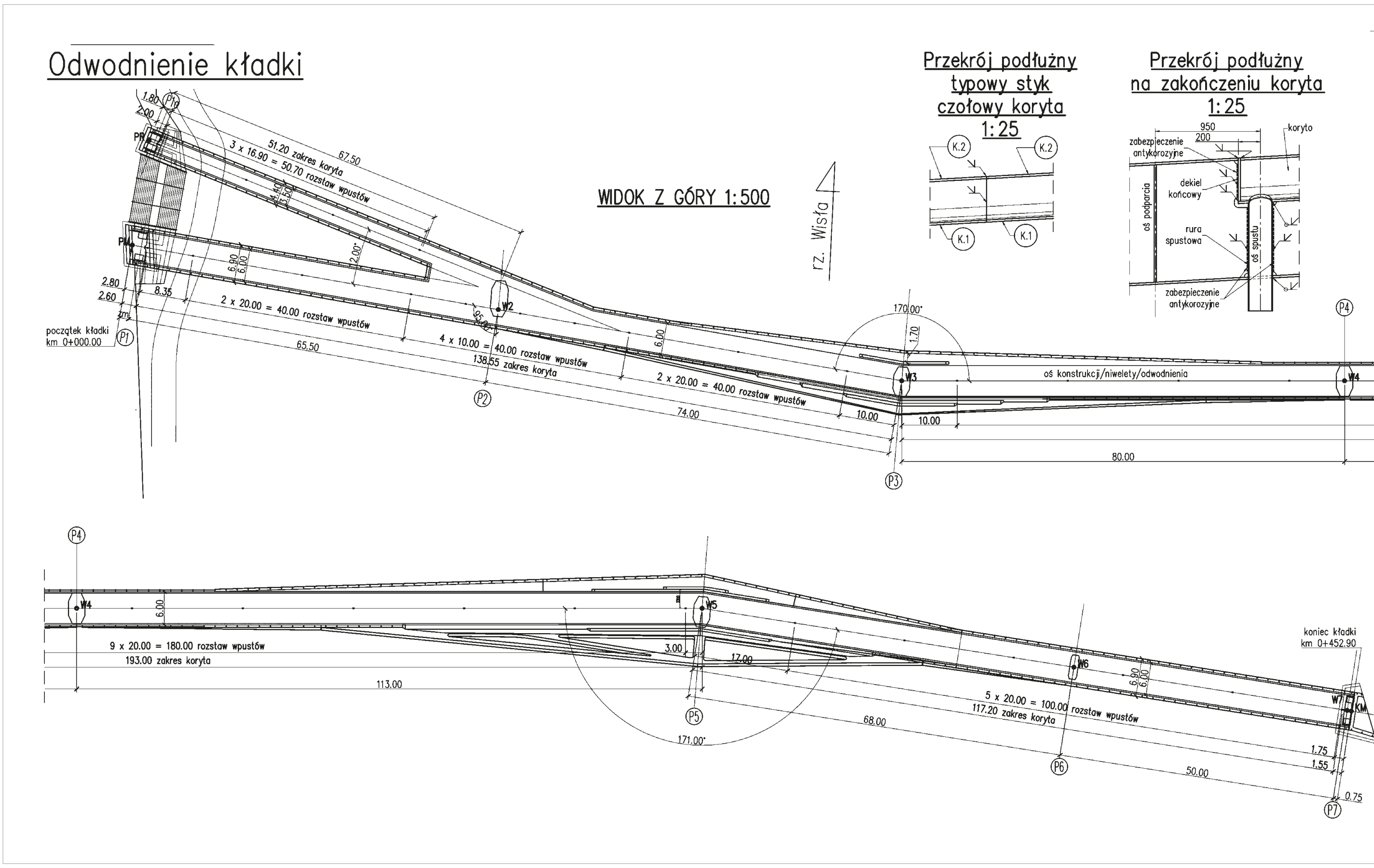
**22–3** Geometric studies of superstructure – user perspectives.

These programmatic platform spaces and the plan form coincide with the required increase of structural height in elevation at these locations. A hierarchy of the platforms is accentuated by the required belt system on the Praga side, which is the most spectacular and references the historical gate to the city, indicating a formal as well as experiential gradient **(24)**. Further strategies of local urban integration

**24** The viewing platforms are logically located on the kinks of the plan form and act as a continuation of urban space, allowing views towards the Old Town that could not be experienced previously.






Odwodnienie kładki
WIDOK Z GÓRY 1:500
rz. Wisła
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koryto
oś podparcia
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51.20 zakres koryta
3 x 16.90 = 50.70 rozstaw wpustów
2 x 20.00 = 40.00 rozstaw wpustów
4 x 10.00 = 40.00 rozstaw wpustów
138.55 zakres koryta
oś konstrukcji/niwelety/odwodnienia
9 x 20.00 = 180.00 rozstaw wpustów
193.00 zakres koryta
5 x 20.00 = 100.00 rozstaw wpustów
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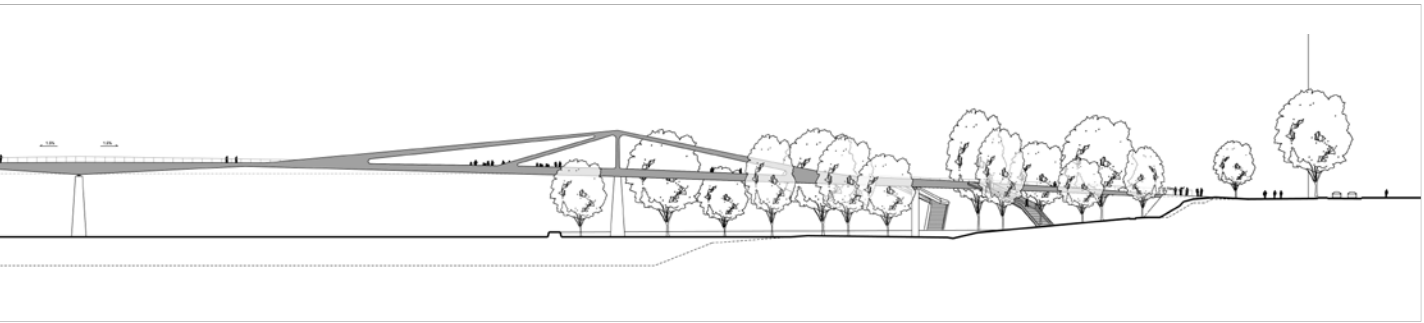

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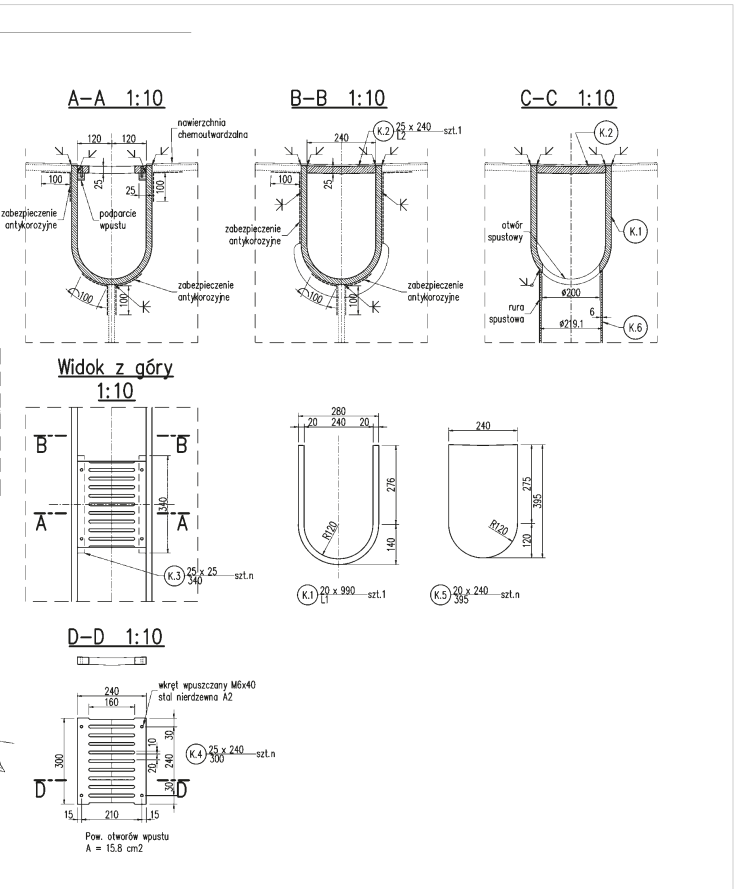


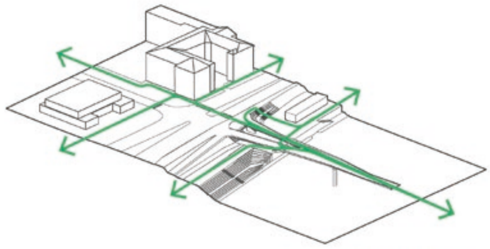

26

**25** The elevation expressing structural diagram, gradient and direction.

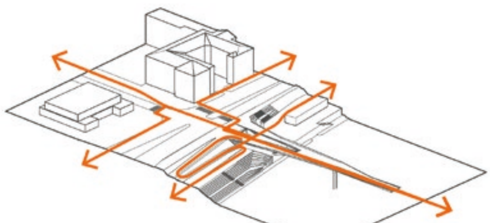
**26** Geometry and details of the viewing platform over P3, close to the Warsaw abutment.

at the abutments respond to the newly built Vistulan Boulevards, a landscape architecture project and successful activation of the river's banks using staircases and other interventions. Flow analysis led to several alternative routes being created for the different user groups to help weave the new infrastructure into the urban realm **(27)**.
In general, the bank interfaces are designed to flexibly incorporate future town planning developments and ensure that connections blend in consistently.

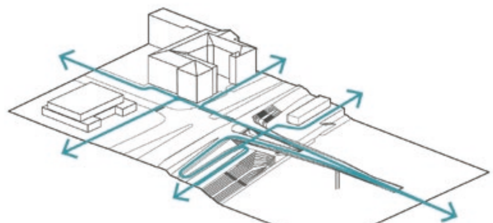
An additional staircase acts like a column on the Warsaw side and allows for quick access to the bridge deck for pedestrians from the lower embankment. Steps on the west form a 3D intersection with the architecture of the Vistulan Boulevards and the bridge. On the east bank, informal steps connect the bridge with the existing landscape and footpaths **(29)**. The east abutment with its terraces becomes a place for the passer-by to rest, offering unique views towards the west **(28)**.



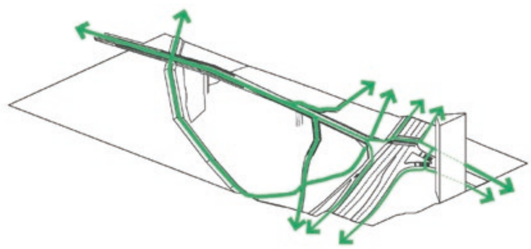
Ciągi piesze (Zachód)



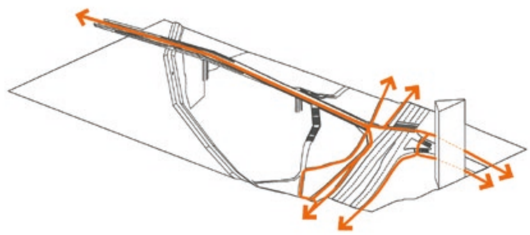
Trasy rowerowe (Zachód)



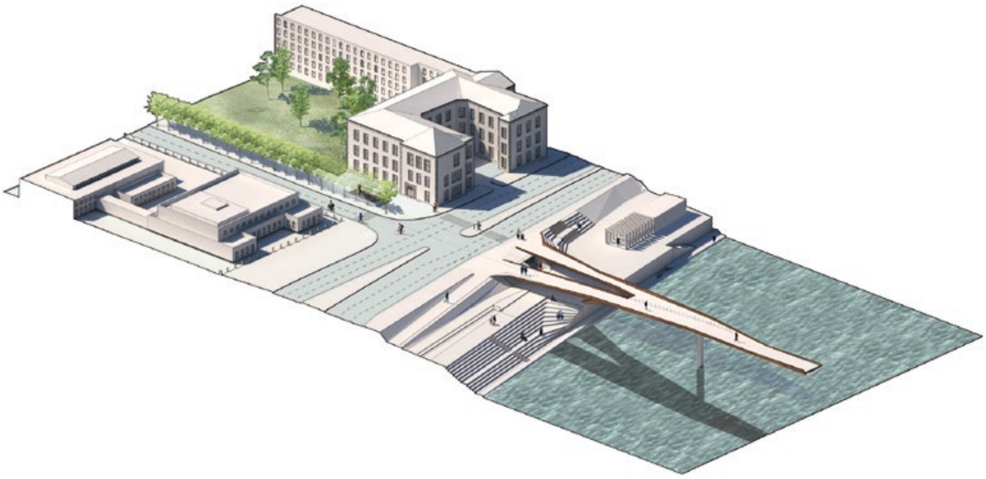
Trasy dla niepełnosprawnych (Zachód)

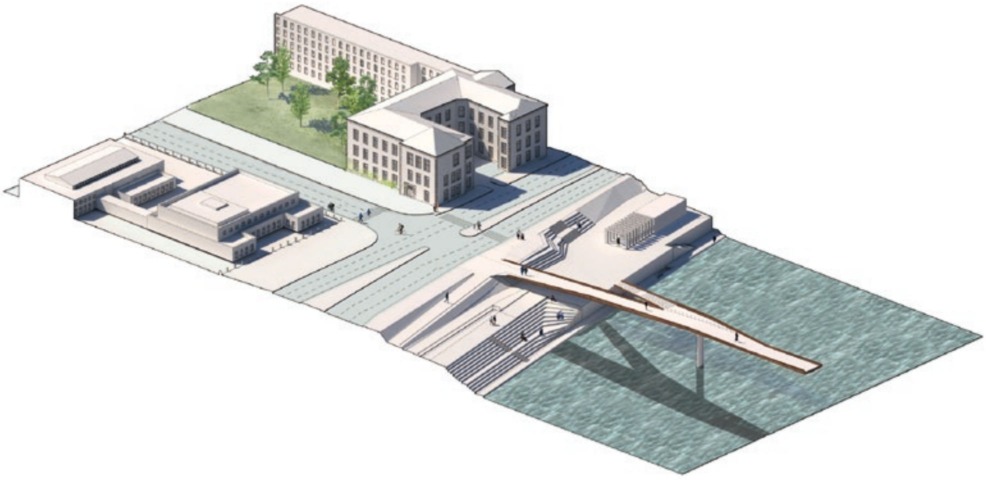


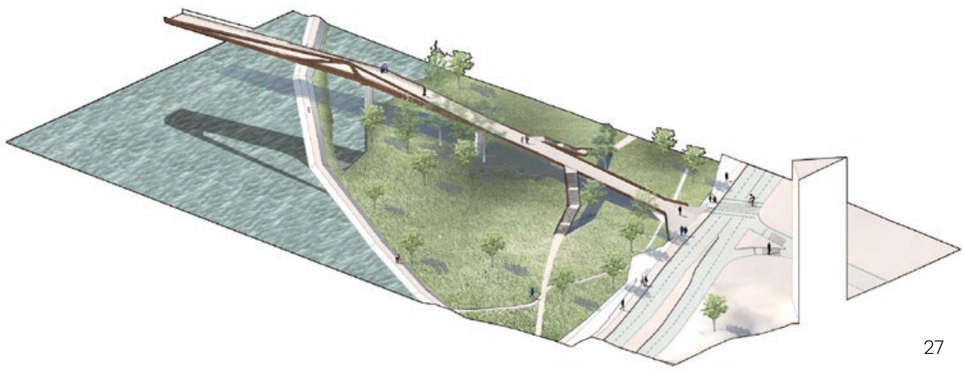
Ciągi piesze (Wschód)



Trasy rowerowe (Wschód)







27

**27** The abutments are a 3D network landing the bridge structure on both boulevard levels, creating several alternative routes for the different user groups that effectively weave through the new infrastructure into the urban realm.

**28 (overleaf)** An additional staircase acts like a column on the Warsaw side and allows for quick access to the bridge deck from the lower embankment.

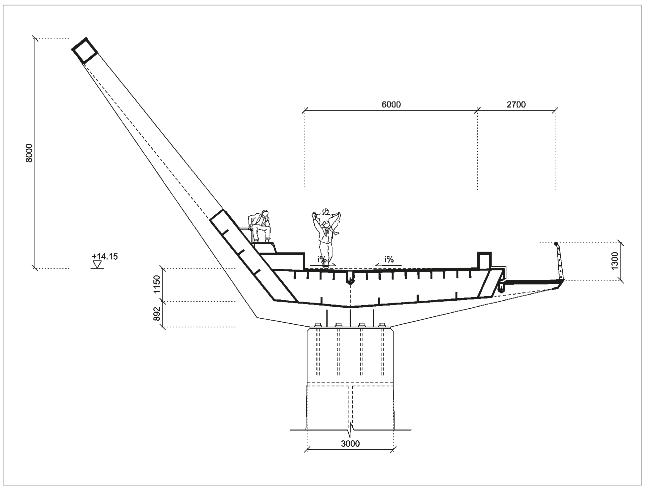
29

**29** On the Praga abutment, more informal staircases connect the bridge with the existing landscape and footpaths.

The developed choreography of the experience of the plan continues with the elevation of the new infrastructure. As the bridge is in direct proximity to Port Praski and its access route, water rights restrictions demand that a clearance of 120 m is maintained between the eastern river columns, resulting in a significant span. This structural challenge triggered a precedent study in search of an appropriate structural system that would not interfere with but would complement the Old Town. The chosen structural system of the belt bridge responds to the given parameters and makes use of the in-plan geometry **(30)**.

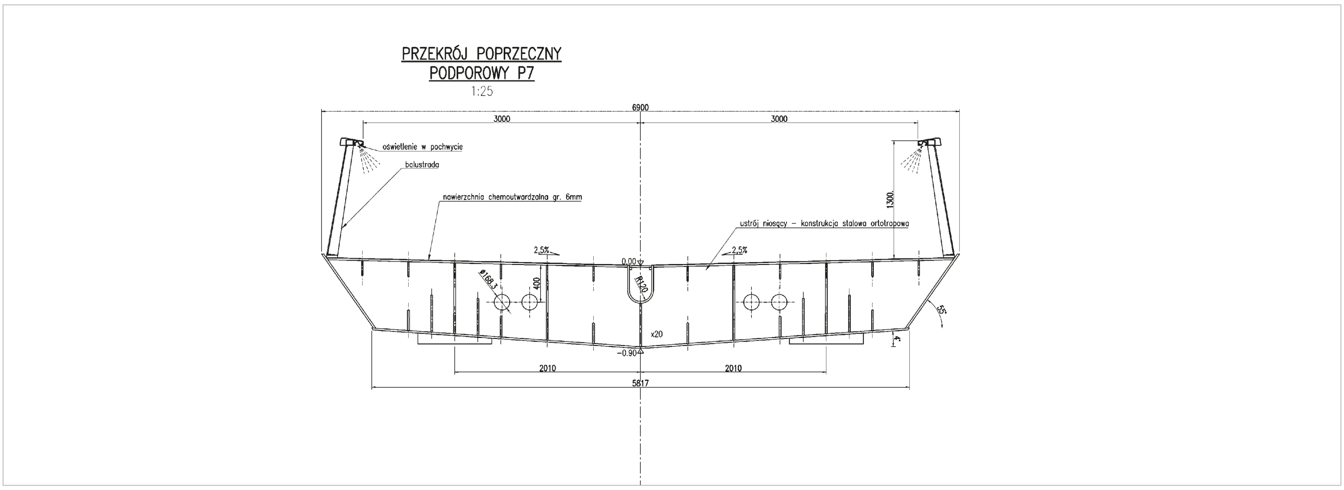
The asymmetric plan suggested that the shorter south side of the bridge corresponded with the objective to move all over-parapet structure away from the north elevation to create platforms with clear urban orientation. The integral nature of the belt negates the need for architectural details usually associated with structures in tension. It also complements the desired continuous morphology of the structure while creating a unique and original architectural form **(32)**. The belt and pylon system is a reinvention of a historical bridge type, and spatially resembles the gate from Praga to Warsaw where the structure emerges from a cluster of trees **(29)**.

The height of the bridge widens in elevation over the columns, thus responding to hogging moments over the pillars. It creates a clear gesture towards Warsaw, making the form of the bridge directional. The silhouette of the elevation mirrors the engineering logic with a clear and legible form within the view corridors towards the Old Town.

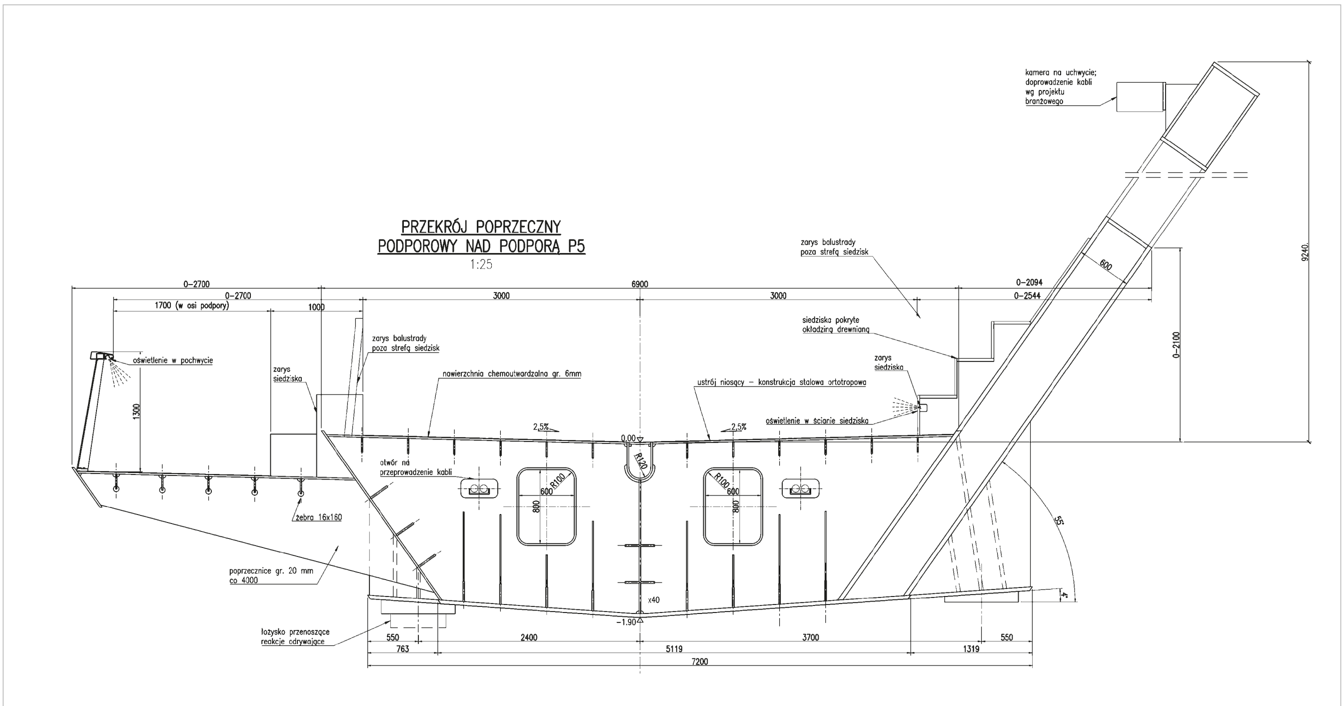



30

**30** Technical section of the belt structure on the Praga side, making use of the asymmetric in-plan geometry of the bridge.




31

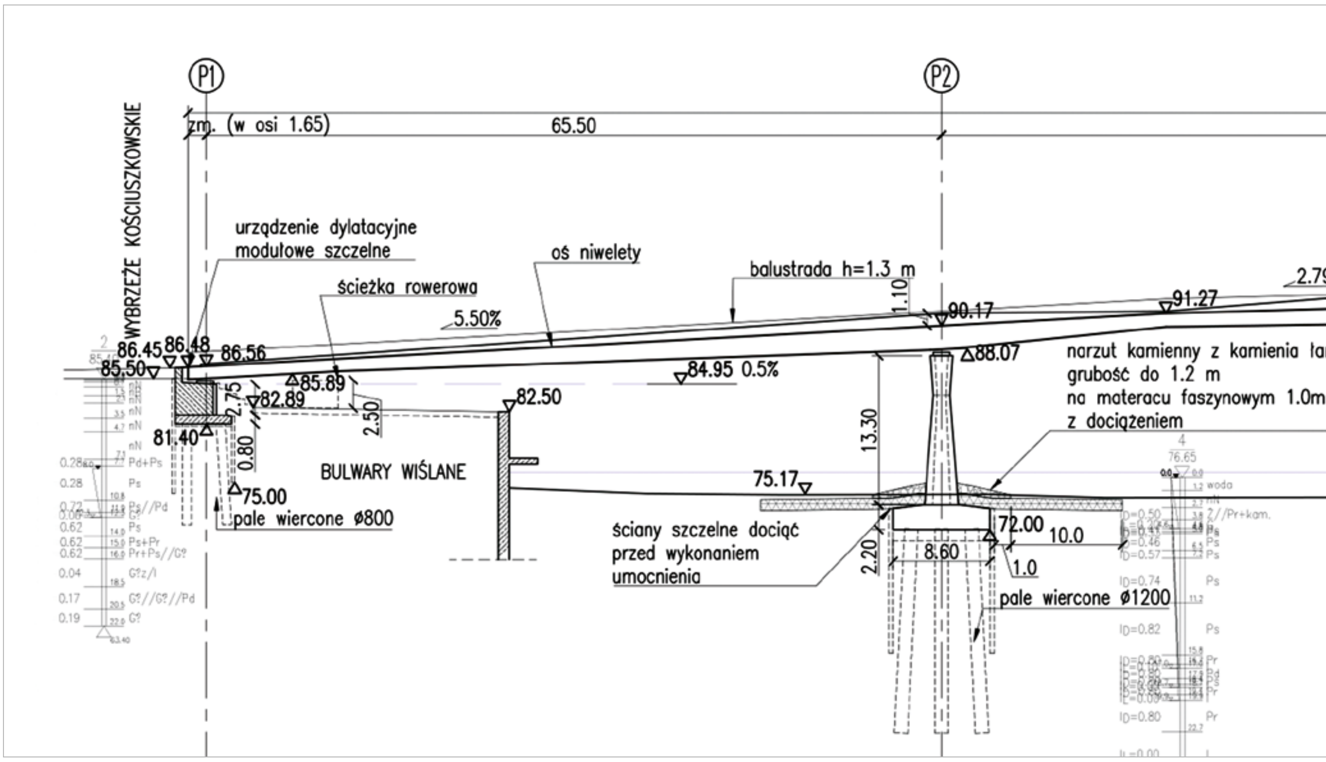


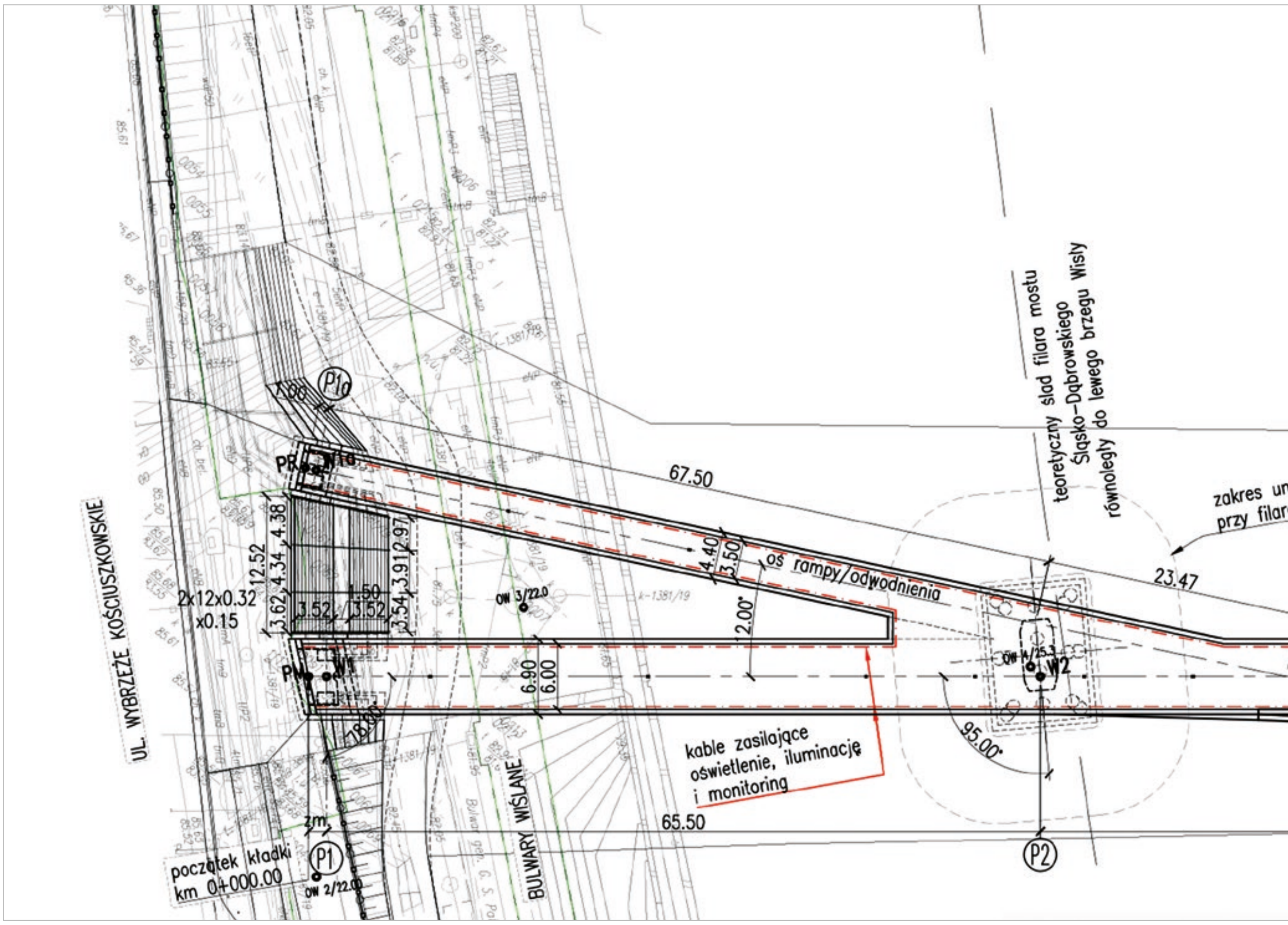

32

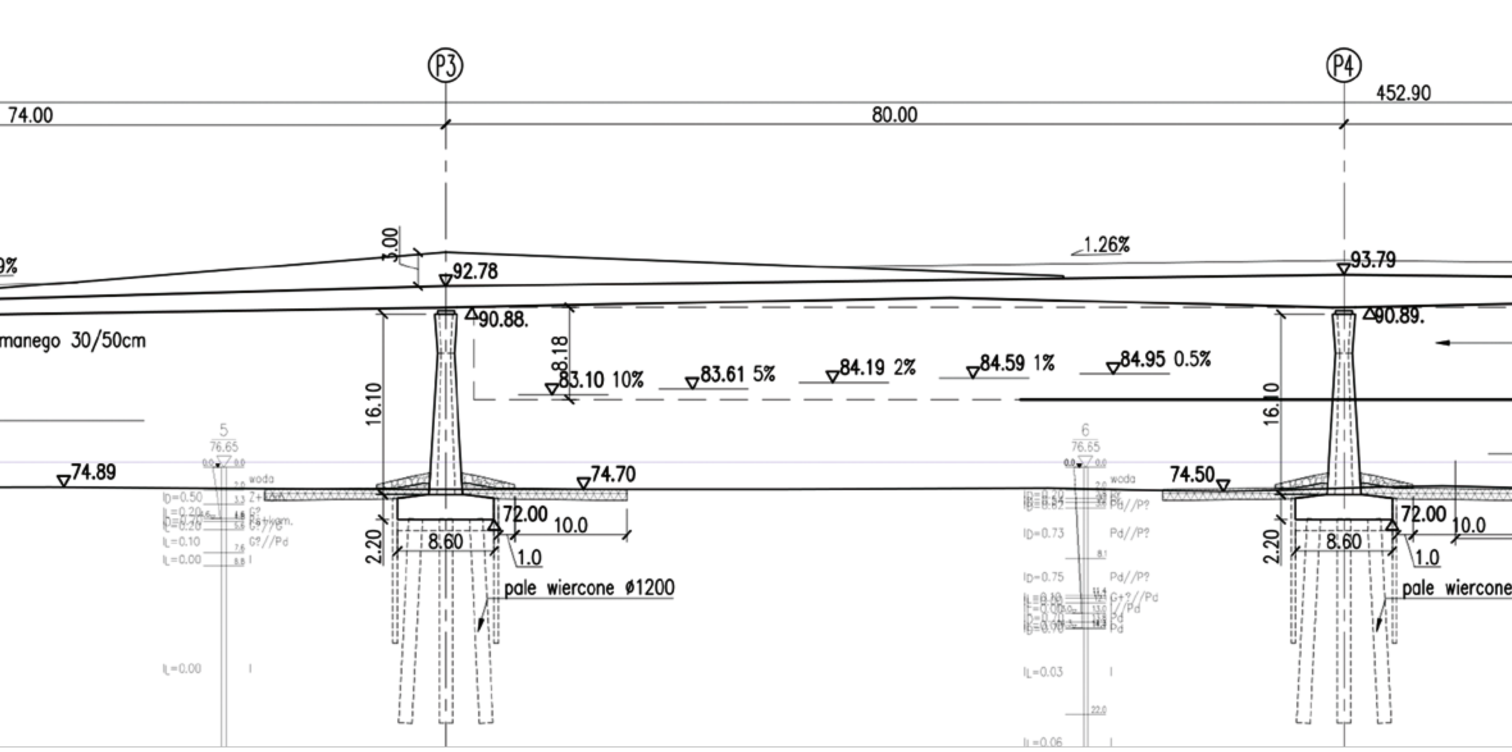
**31** Standard sectional geometry over column location 7.

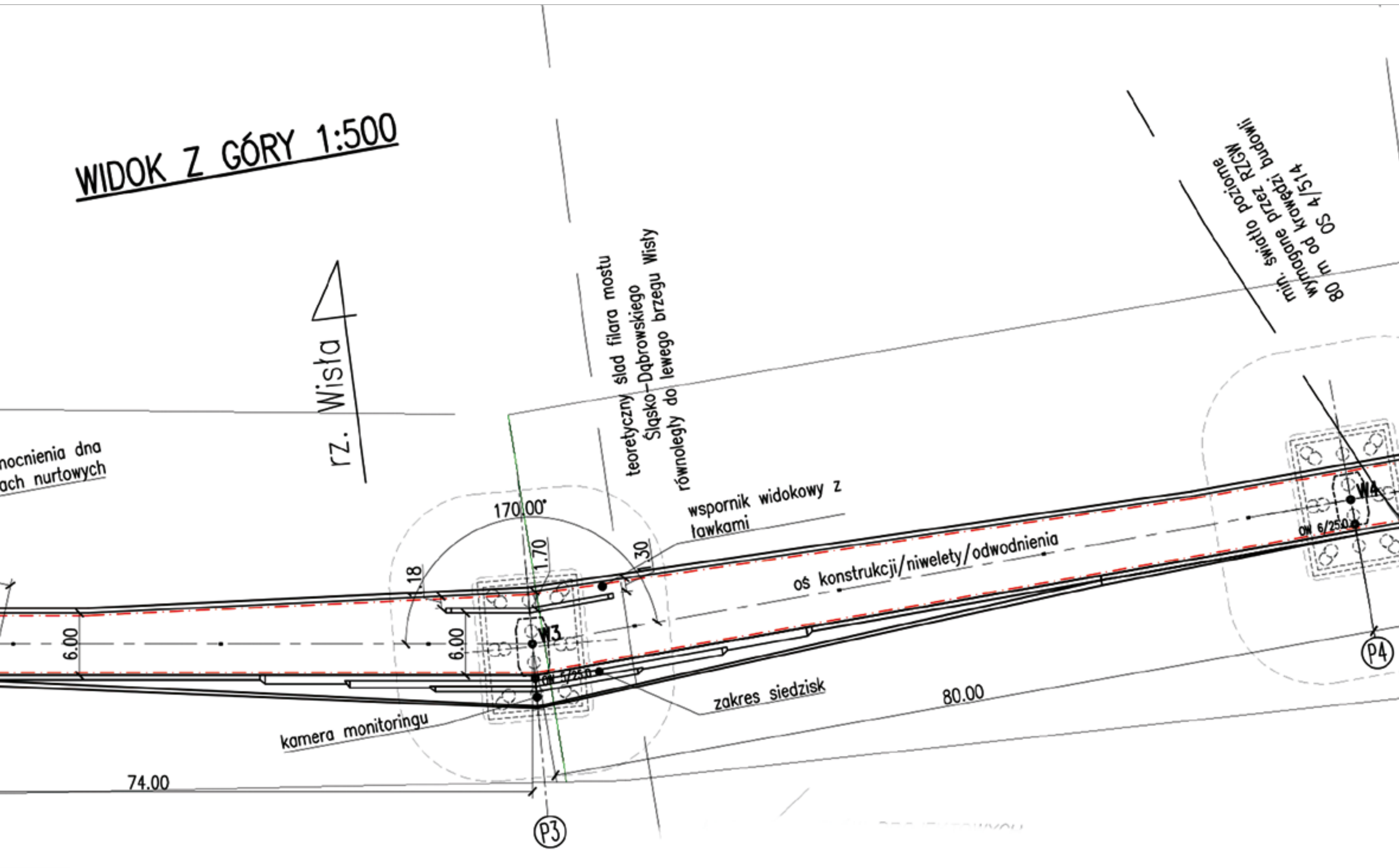
**32** Section at column location 5 (belt) with viewing platform close to Praga.

**33 (overleaf)** Plan and elevation.

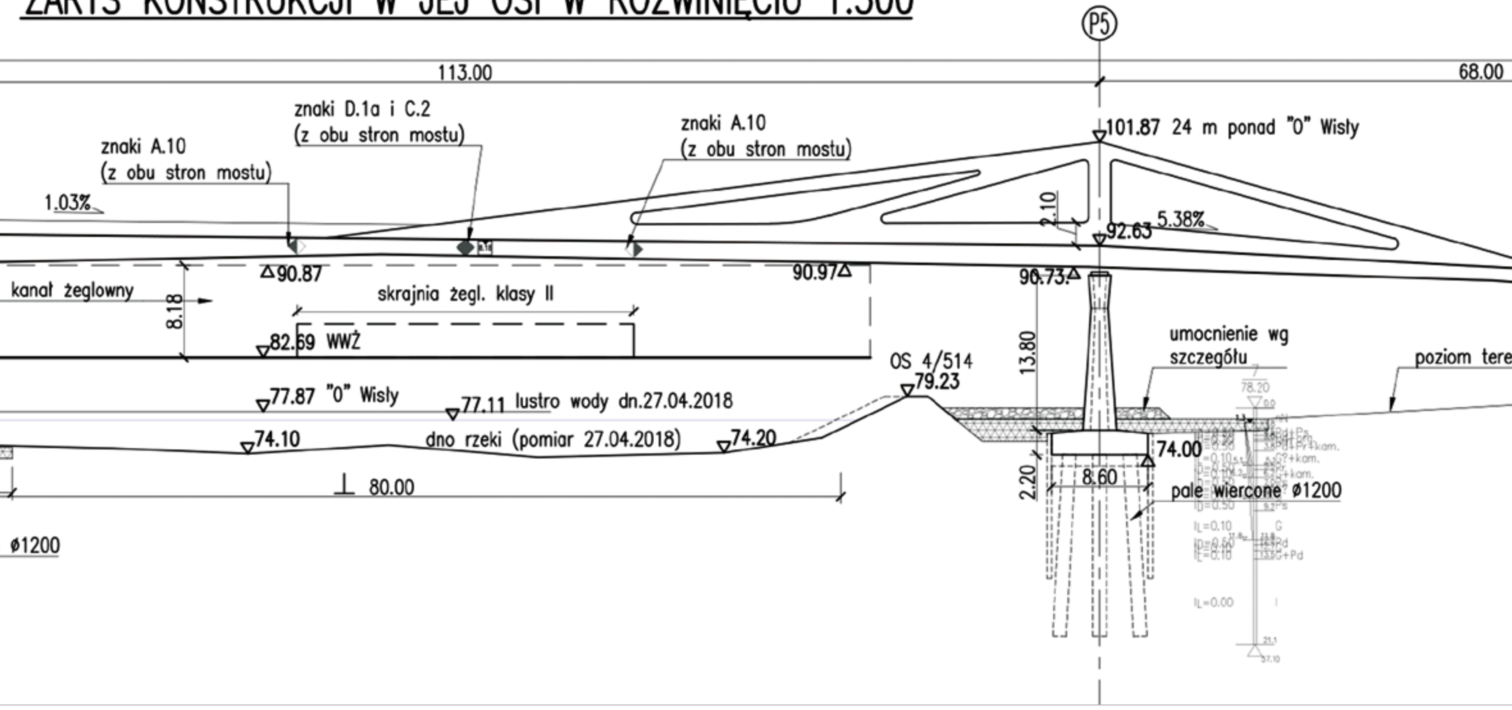

P1
P2
zm. (w osi 1.65)
65.50
WYBRZEŻE KOŚCIUSZKOWSKIE
urządzenie dylatacyjne
modułowe szczelne
oś niwelety
ścieżka rowerowa
5.50%
balustrada h=1.3 m
1.10
90.17
91.27
86.45
86.48
86.56
85.50
85.89
82.89
84.95 0.5%
88.07
82.50
81.40
2.75
2.50
0.80
13.30
BULWARY WIŚLANE
75.00
pale wiercone ø800
75.17
narzut kamienny z kamienia ła
grubość do 1.2 m
na materacu faszynowym 1.0m
z dociążeniem
ściany szczelne dociąć
przed wykonaniem
umocnienia
2.20
8.60
72.00
10.0
1.0
pale wiercone ø1200

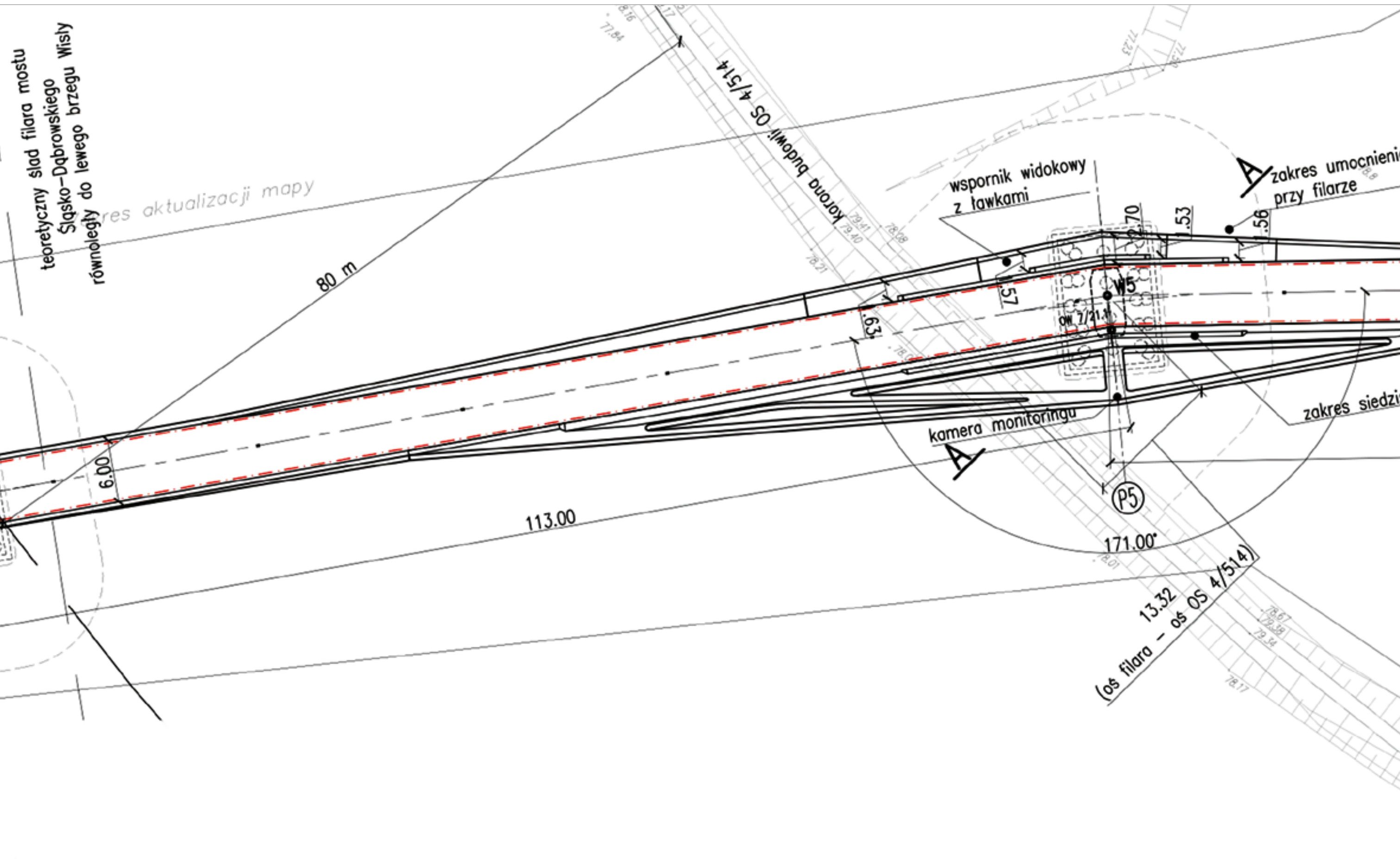

P1a
7.00
PR
W1a
67.50
4.40
3.50
oś rampy/odwodnienia
2.00
12.52
4.38
4.34
3.62
3.52
3.52
1.50
3.91
2.97
3.54
2x12x0.32
x0.15
UL. WYBRZEŻE KOŚCIUSZKOWSKIE
PW
W1
6.90
6.00
OW 3/22.0
18.00
kable zasilające
oświetlenie, iluminację
i monitoring
65.50
zm
P1
początek kładki
km 0+000.00
OW 2/22.0
BULWARY WIŚLANE
teoretyczny ślad filara mostu
Śląsko-Dąbrowskiego
równoległy do lewego brzegu Wisły
zakres u
przy filar
23.47
OW 4/25.3
W2
95.00°
P2

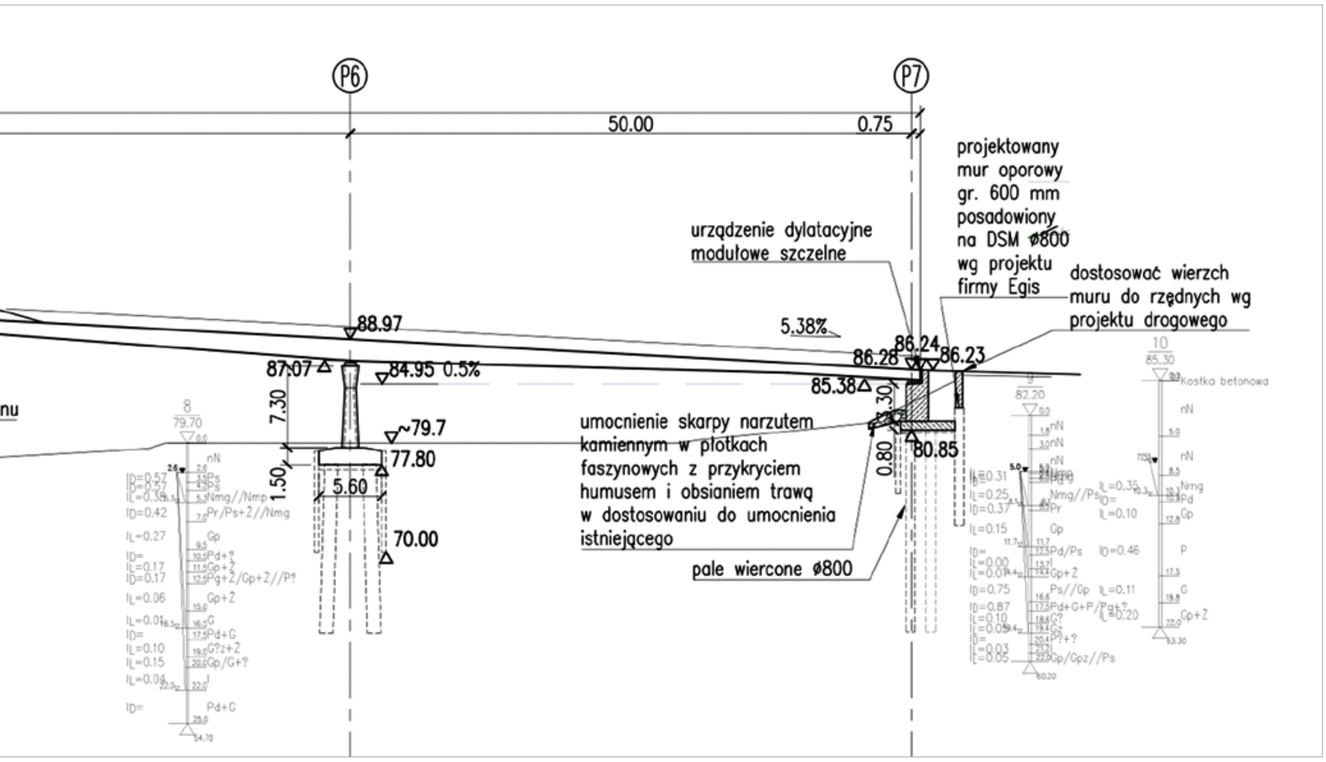

P3
P4
452.90
74.00
80.00
3.00
1.26%
92.78
93.79
90.88.
90.89.
manego 30/50cm
8.18
83.10 10%
83.61 5%
84.19 2%
84.59 1%
84.95 0.5%
16.10
74.89
74.70
74.50
72.00
10.0
8.60
2.20
1.0
pale wiercone ø1200
pale wiercone


WIDOK Z GÓRY 1:500
rz. Wisła
teoretyczny ślad filara mostu Śląsko-Dąbrowskiego równoległy do lewego brzegu Wisły
min. światło poziome wymagane przez RZGW
80 m od krawędzi budowli
OS 4/514
nocnienia dna
ach nurtowych
170.00°
1.70
1.30
18
wspornik widokowy z ławkami
oś konstrukcji/niwelety/odwodnienia
6.00
6.00
W3
W4
zakres siedzisk
kamera monitoringu
80.00
74.00
P3
P4

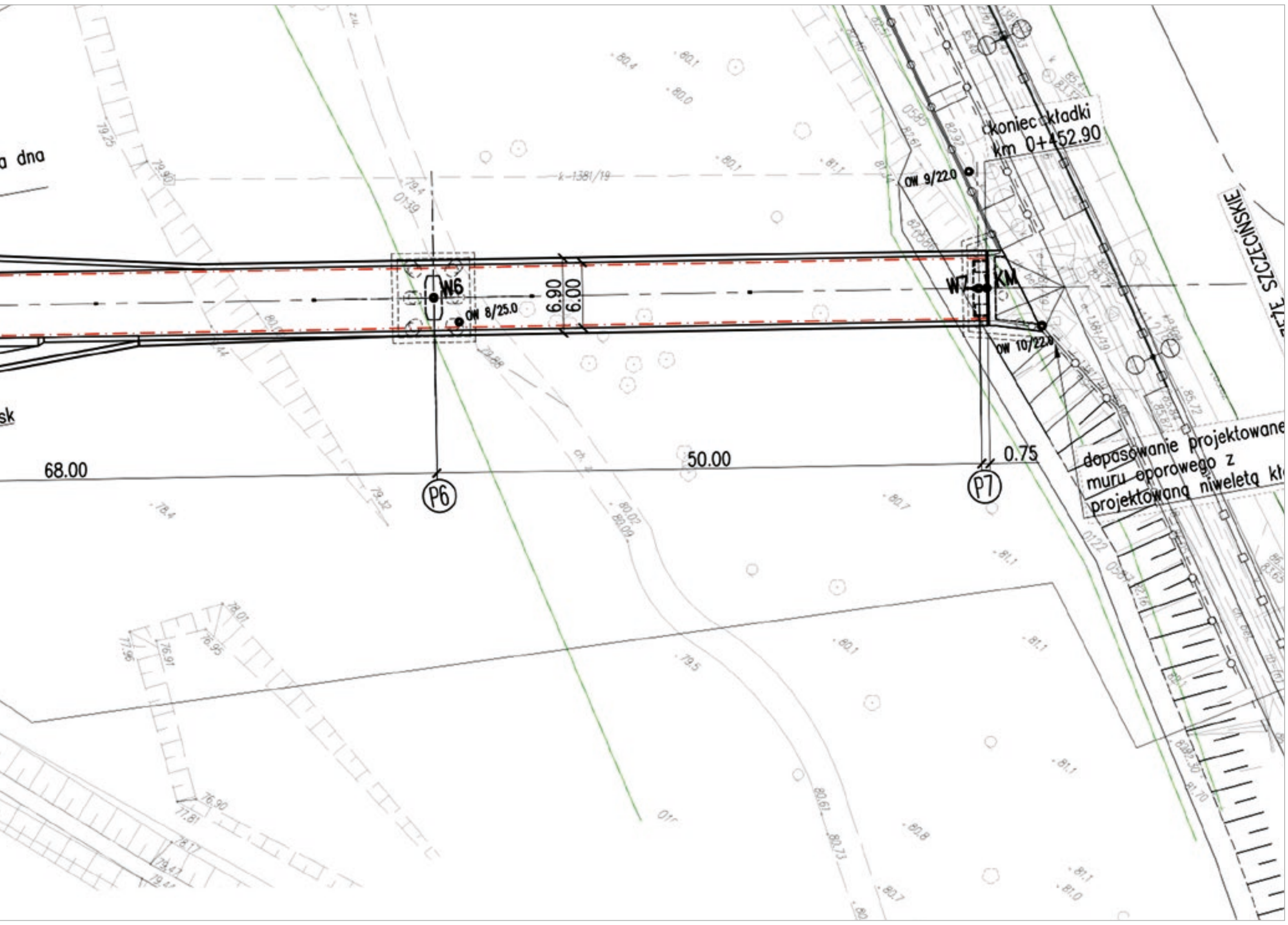
## ZARYS KONSTRUKCJI W JEJ OSI W ROZWINIĘCIU 1:500



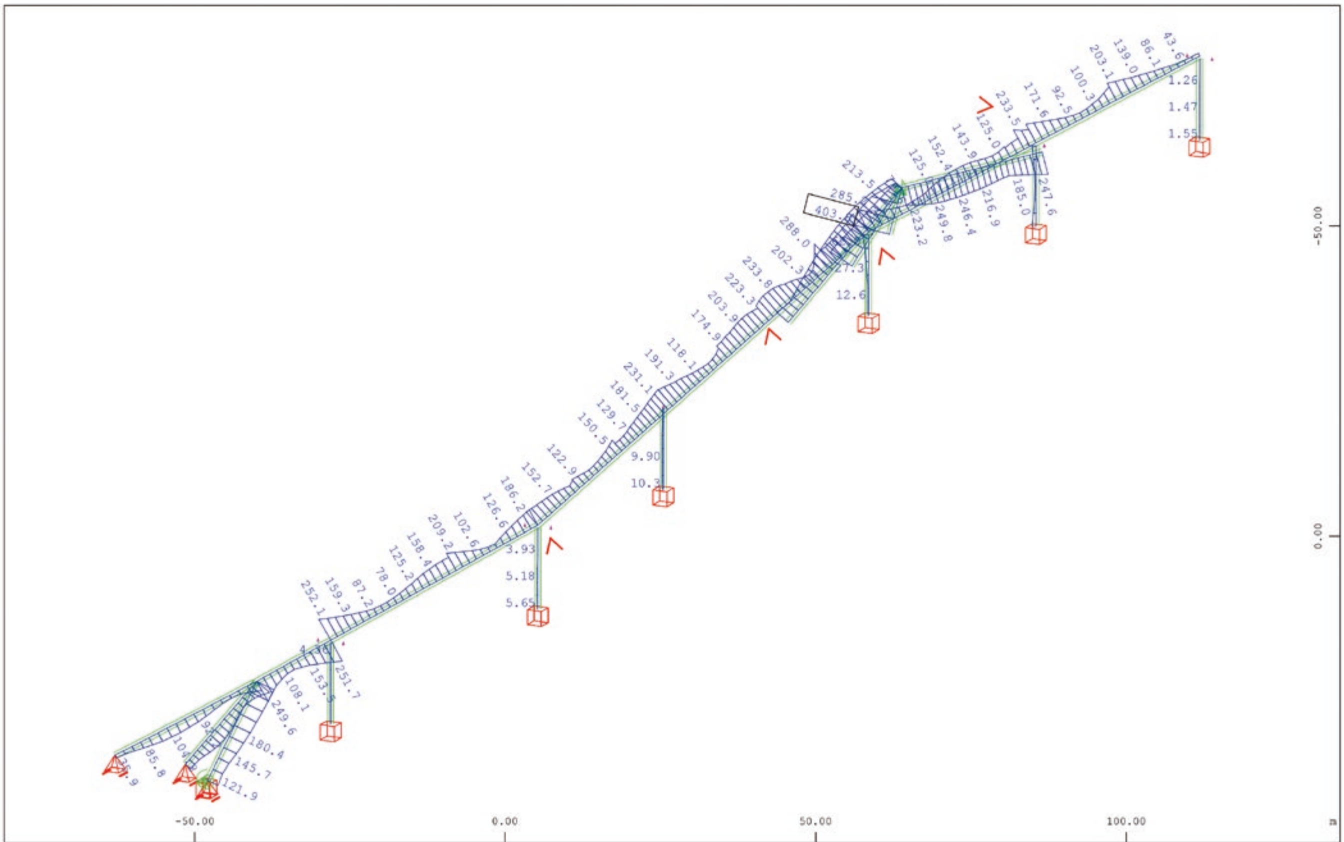


P6
P7
50.00
0.75
projektowany mur oporowy gr. 600 mm posadowiony na DSM ø800 wg projektu firmy Egis
urządzenie dylatacyjne modułowe szczelne
dostosować wierzch muru do rzędnych wg projektu drogowego
88.97
5.38%
86.24
86.28
86.23
87.07
84.95 0.5%
85.38
7.30
~79.7
77.80
5.60
1.50
70.00
umocnienie skarpy narzutem kamiennym w płotkach faszynowych z przykryciem humusem i obsianiem trawą w dostosowaniu do umocnienia istniejącego
pale wiercone ø800
80.85
0.80
3.30
Kostka betonowa

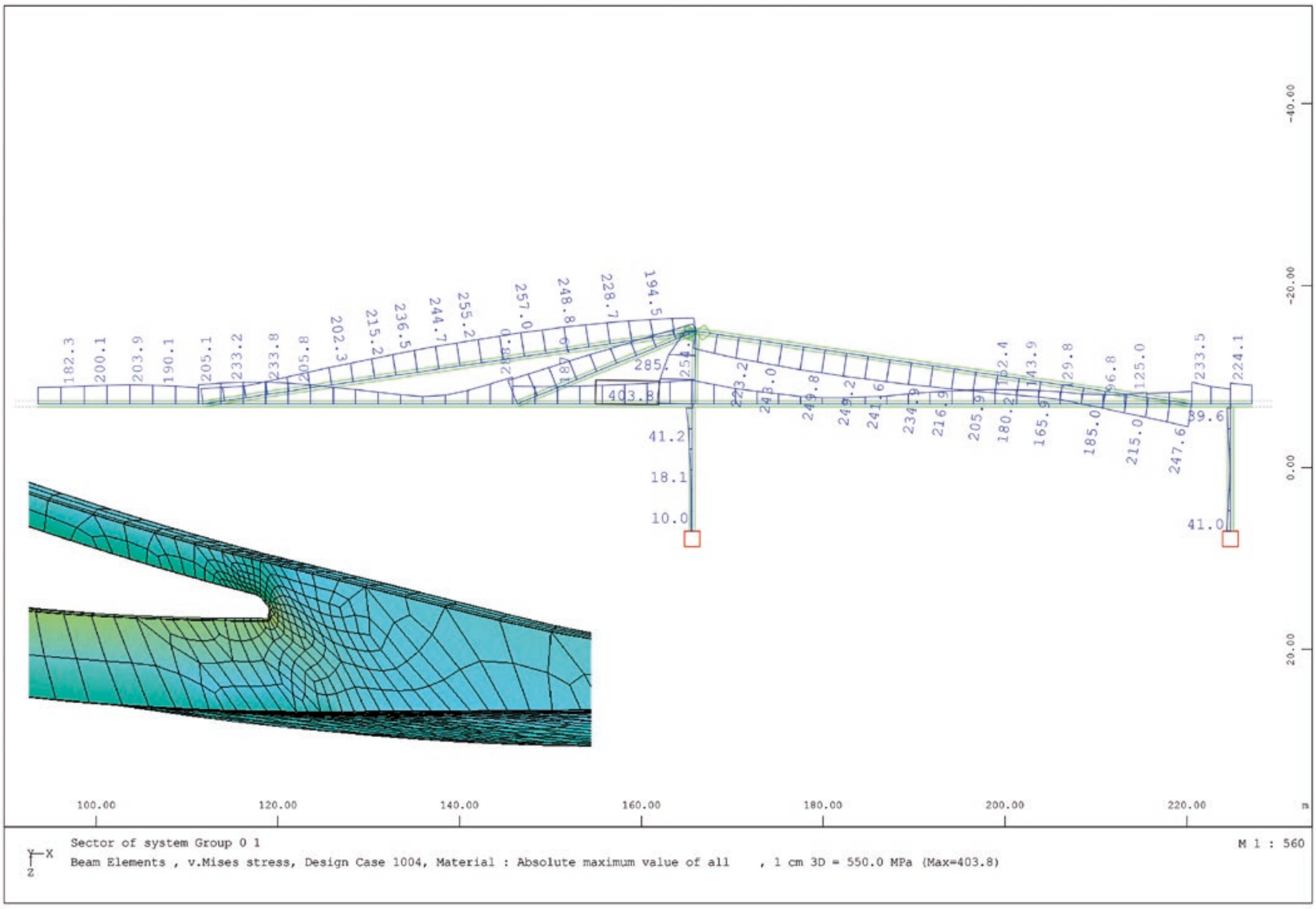



koniec kładki km 0+452.90
OW 9/22.0
W6
OW 8/25.0
6.90
6.00
W7
KM
OW 10/22.0
68.00
50.00
0.75
P6
P7
dopasowanie projektowane muru oporowego z projektowaną niweletą
SZCZECIŃSKIE


33



Sector of system Group 0 1
Beam Elements , v.Mises stress, Design Case 1004, Material : Absolute maximum value of all , 1 cm 3D = 550.0 MPa (Max=403.8)
M 1 : 837
X = 0.502
Y = 0.906
Z = 0.962




34

**34** Structural analysis
of the belt system
(*Zügelgurt*).

The choice of weathering steel as building material aims to reflect the relationship of the new structure with its environment as the bridge is not coated with a paint system to disguise its materiality. This reinforces the modern design approach of the infrastructure and also responds to the perceived tonality of the surrounding urban fabric. Weathering steel is seen as a rather unusual material for city infrastructure, and the significant change of its tonality due to atmospheric conditions and age has been studied extensively. This bold yet low-maintenance choice contributes to the perception of the bridge as a fresh interpretation of what city infrastructure can be in the future **(37)**. Although weathering steel is an alloy that was invented in the early twentieth century for application in railroad structures in the USA, it has not yet found broad application in bridge structures in Europe.

**35** Lechsteg east abutment in fabrication, 2020. DKFS have tested the use of weathering steel on their 130 m long bridge in Landsberg, which is currently under construction.

**36** Workshop photo of Lechsteg subassembly over column head truss.

35

36

**37 (overleaf)** View from the boulevards towards the belt system on the Praga side. Weathering steel significantly changes tonality under certain atmospheric conditions.

## Dissemination

The project has been exhibited at the Palace of Culture and Science in Warsaw (2017). The exhibition programme included public talks by the designers and the Mayor of Warsaw. The bridge has received significant national media attention, including an article on the website *BauNetz* and an extensive piece by the author in the journal *Brückenbau: Construction & Engineering* (2019). It has also featured on television (*TVN Warsawa*).

Talks on Warsaw Karowa Bridge:

- Architecture and Spatial Planning Department, Warsaw (2019)
- Bartlett School of Architecture, UCL (2019)
- SPI Warsawa (2018)
- Palace of Culture and Science, Warsaw (2017)

## Project Highlights

Warsaw Karowa Bridge is a significant urban intervention due to its prominent location in Warsaw opposite the UNESCO World Heritage Old Town. The project is key to the ongoing public rejuvenation strategy plan of the City of Warsaw and will become an urban catalyst for the Praga District. The open international architecture competition received approximately 140 expressions of interest with 40 second-stage submissions from international expert design teams. DKFS' winning scheme received broad attention amongst industry and the public. Its structural system is original in its combination of scale, plan form and programme, as well as its use of an asymmetric belt system for the main span. At 480 m long, Warsaw Karowa Bridge is estimated to be Europe's longest urban pedestrian bridge.

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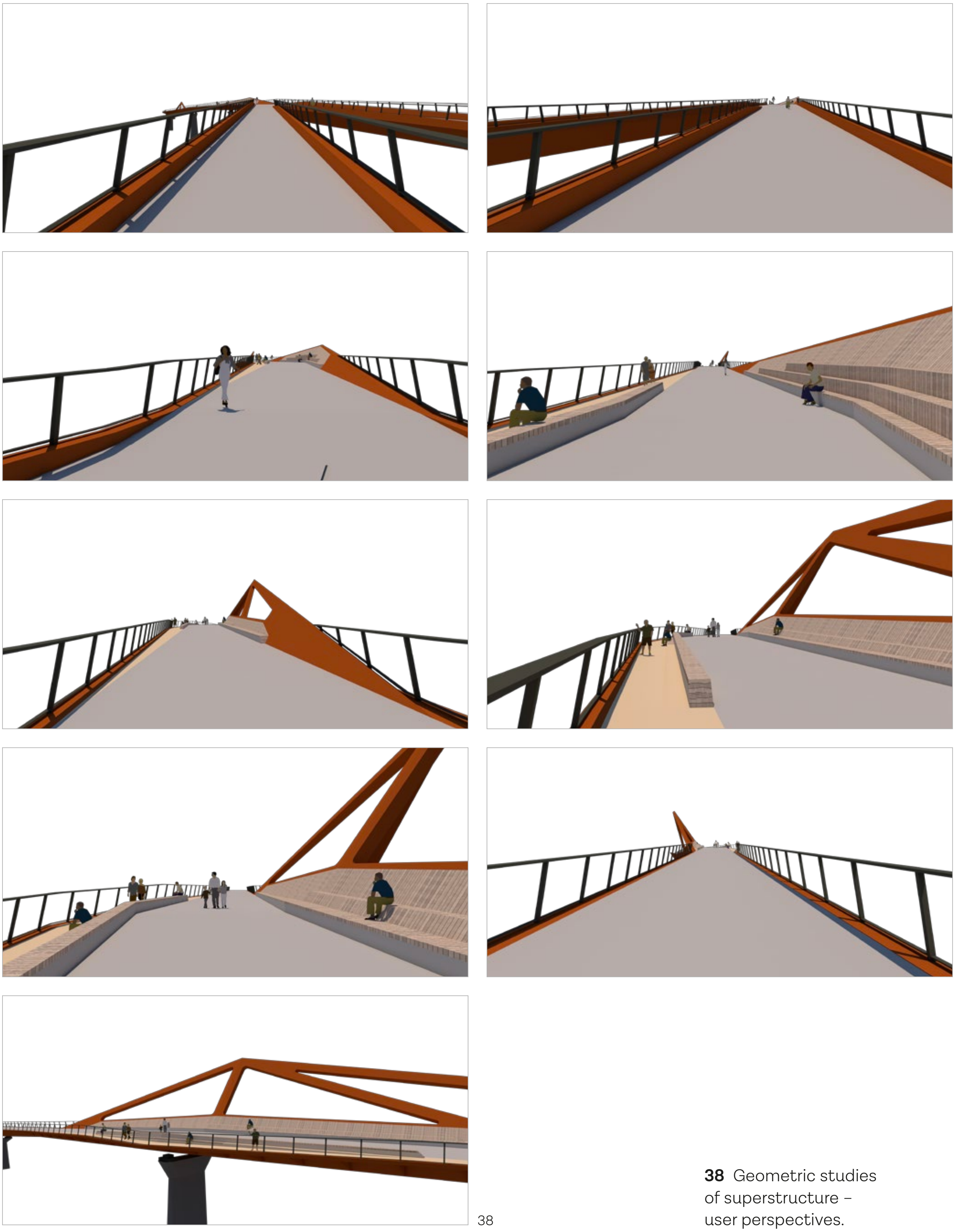
Keil, A. (2013). *Pedestrian Bridges: Ramps, Walkways, Structures*. Munich: Detail.

UNESCO (2020). 'Historic Centre of Warsaw'. *UNESCO*. (Viewed 7 November 2020). https://whc.unesco.org/en/list/30/



57



38

**38** Geometric studies of superstructure – user perspectives.

## Related Publications by the Researchers

Ehrlich, F., Grzesiak, J., Krolikowski, D., Piotrkowicz, P., Schmitt, F., Stein, T. (2019). 'Die Karowa-Brücke in Warschau: Neue Querung der Weichsel'. *Brückenbau: Construction & Engineering.* **3.** pp. 22–6. 🕮

## Related Writings by Others

BauNetz (2017). 'Zügelgurt über die Weichsel: Brückenprojekt von DKFS Architects und Schüßler-Plan in Warschau'. 27 September. 🖵

Dybalski, J. (2017). 'Małgorzata Dembowska: Warsaw has Potential When it Comes to the River'. *Transport Publiczny.* 🖵

Sztuka Architektury (2017). 'On Foot – a Bicycle Bridge over the Vistula – We Know the Project'. *Sztuka Architektury.* 15 September. 🖵

🕮 Printed article

🖵 Online article (clickable link)

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