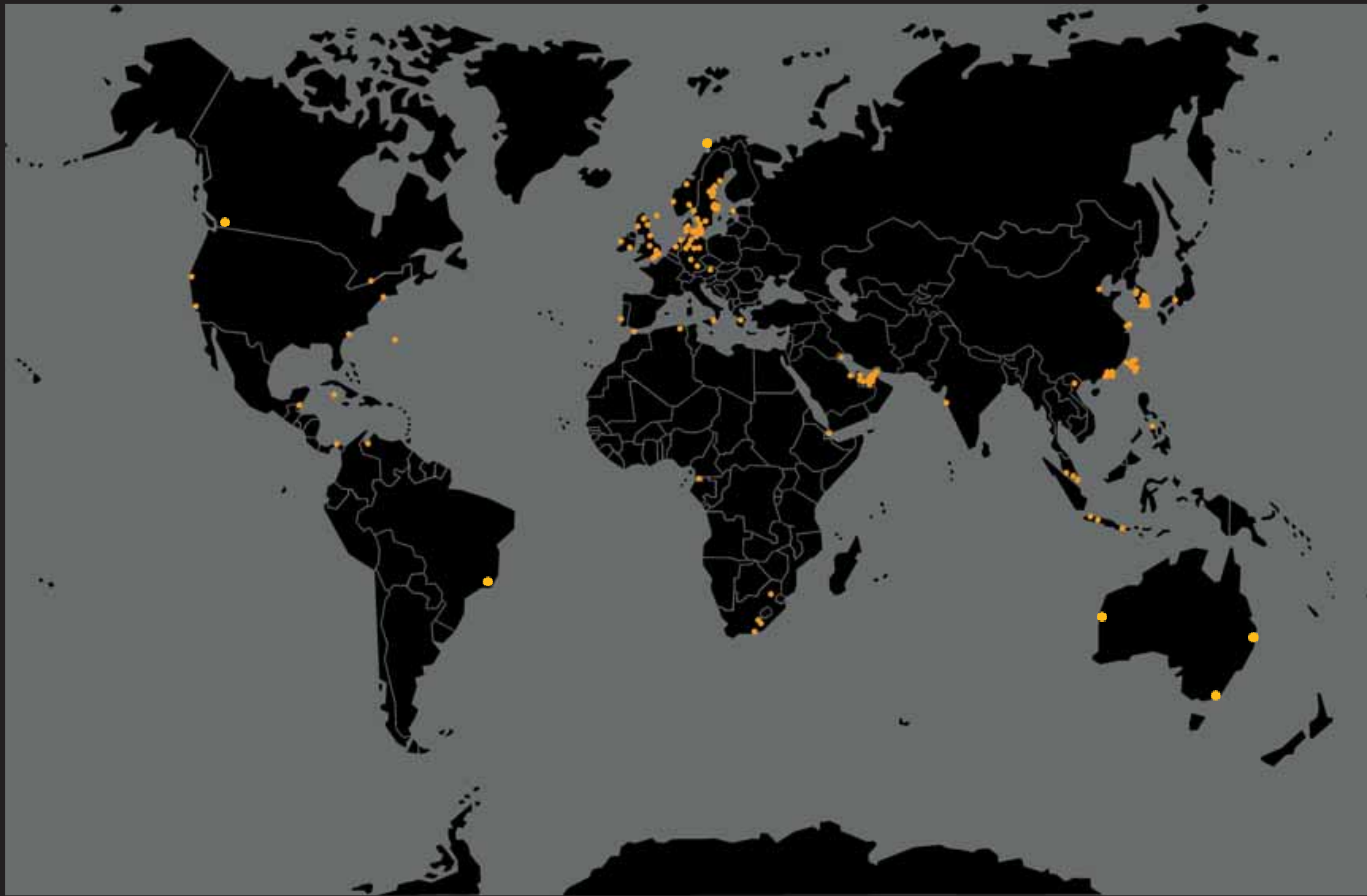
STORSTRØM BRIDGE

Jesper B. Henriksen
Partner at Dissing+Weitling - Mobility

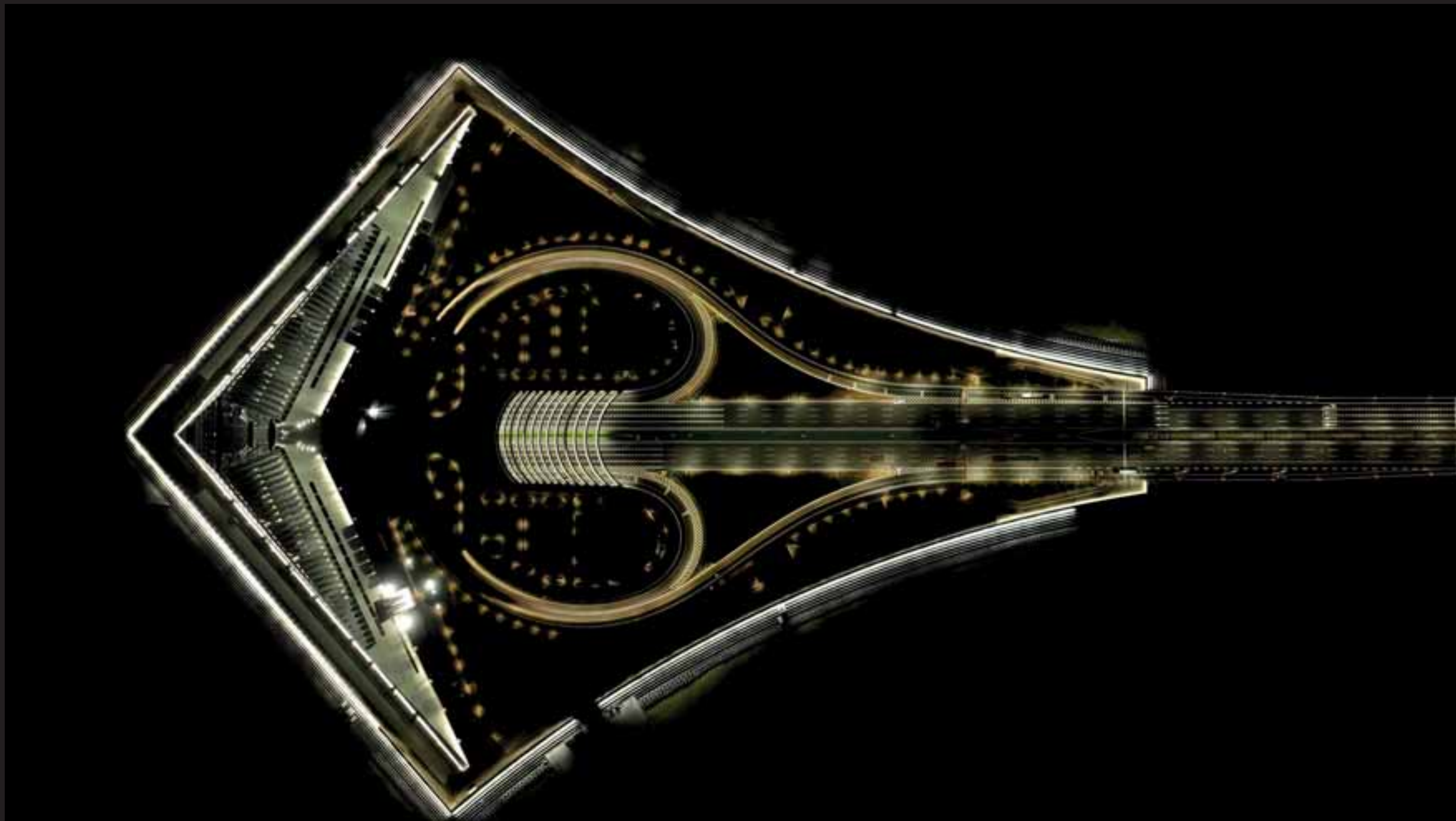
Dissing+Weitling

Dissing+Weitling



Dissing+Weitling

Dissing+Weitling



Dissing+Weitling

Client:
The Danish Road Directorate

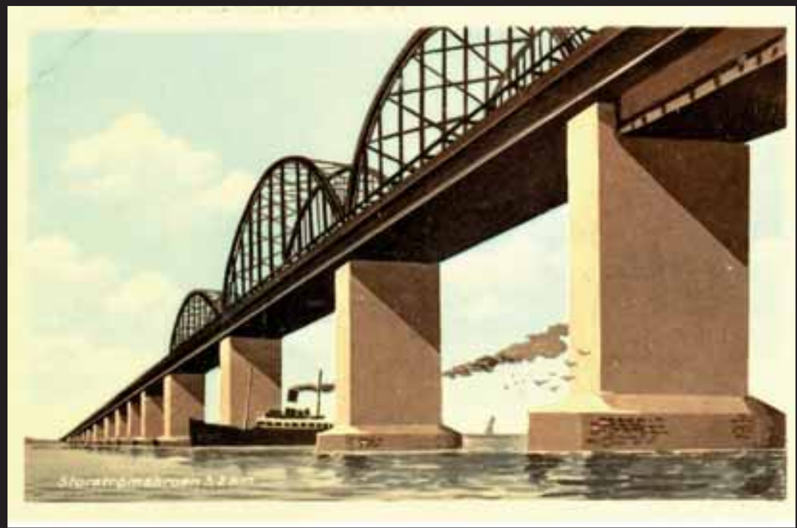
Advisory team:
COWI - DISSING+WEITLING - Hasløv & Kjærsgård

Contractor: SBJV (Itinera)

Dissing+Weitling

Replacement Project

From 1937, longest bridge in Europe in 1938



Bought in the UK, due to too much Danish export of butter and Bacon

A landmark in Denmark

Dissing+Weitling

Competition:

Nov. 2011

Phase 2 + 3 Defenition Design:
Jan. – Nov. 2015

Tender materiale:
Feb. 2015

Tender process:
2016

Completion:
2025 ?

Facts:

Length 3.840 m

Pylon height 102 m

Navigational clearance 26 m

2 Navigation channels with a width of 160 m each

Girder width is 24 m

Girder span 80 m

Combined cross section for road and rail

Alignment, horizontal curve radius 6.200 m

44 piers, 1 pylon og 2 abutments

18 cable stays (each side of pylon)

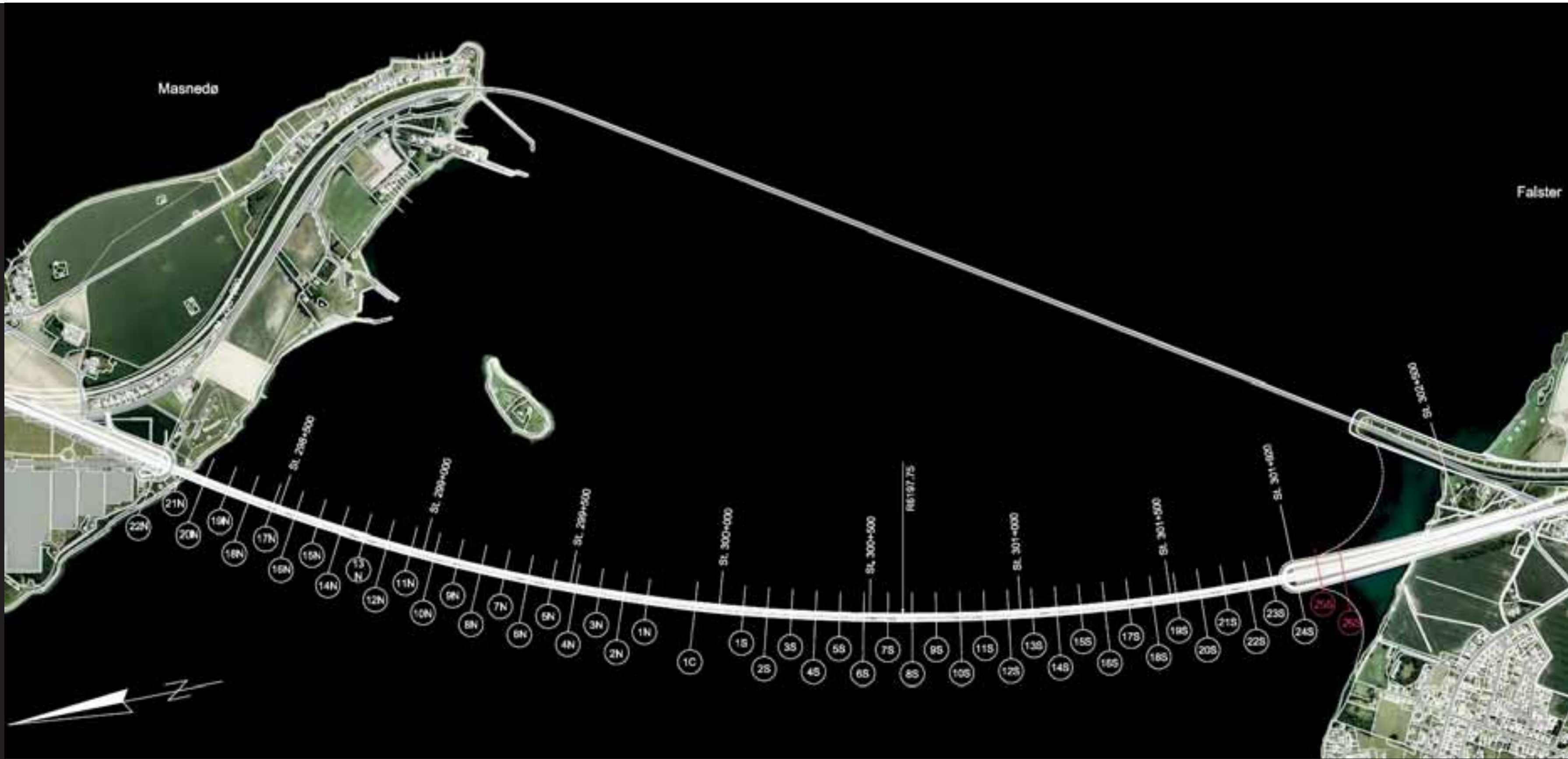
Three ekspansion sections

Concrete structure

Rail design Speed (200 / 120 km/t)

Road design Speed 80 km/t

Dissing+Weitling



Dissing+Weitling

SKETCHING OF DIFFERENT CONCEPTS 2011

Dissing+Weitling

OPTIMIZATION OF SECTION, SIMPLE CONSTRUCTION

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

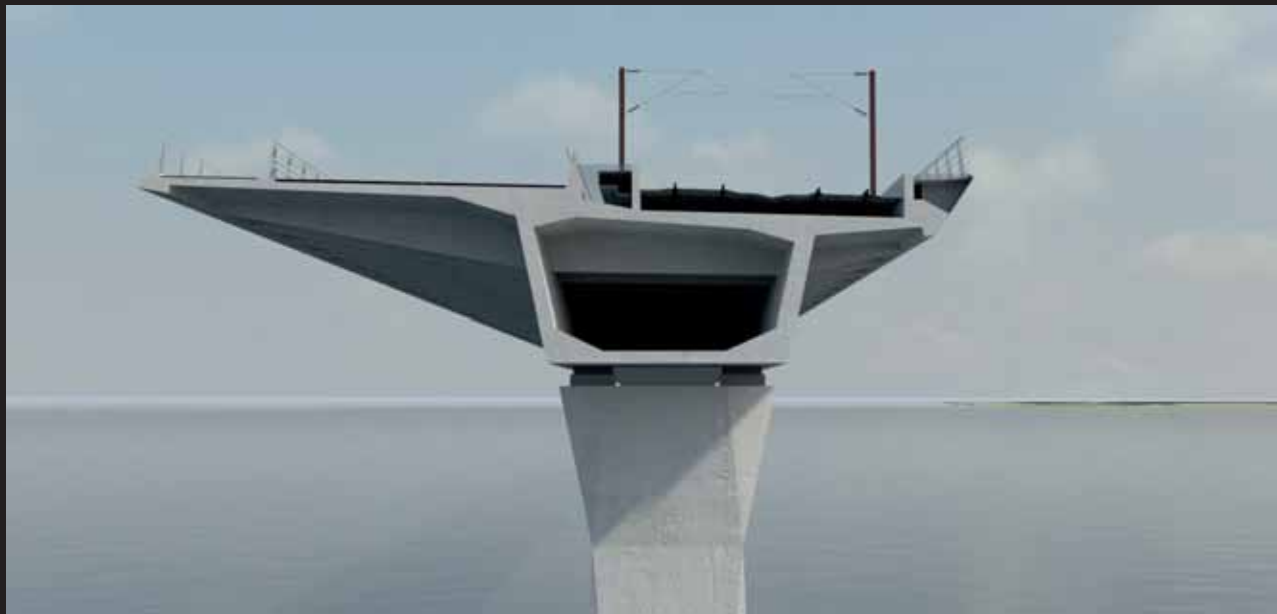
"ASYMMETRICAL CROSS SECTION"

GOOD USER EXPERI-ENCE

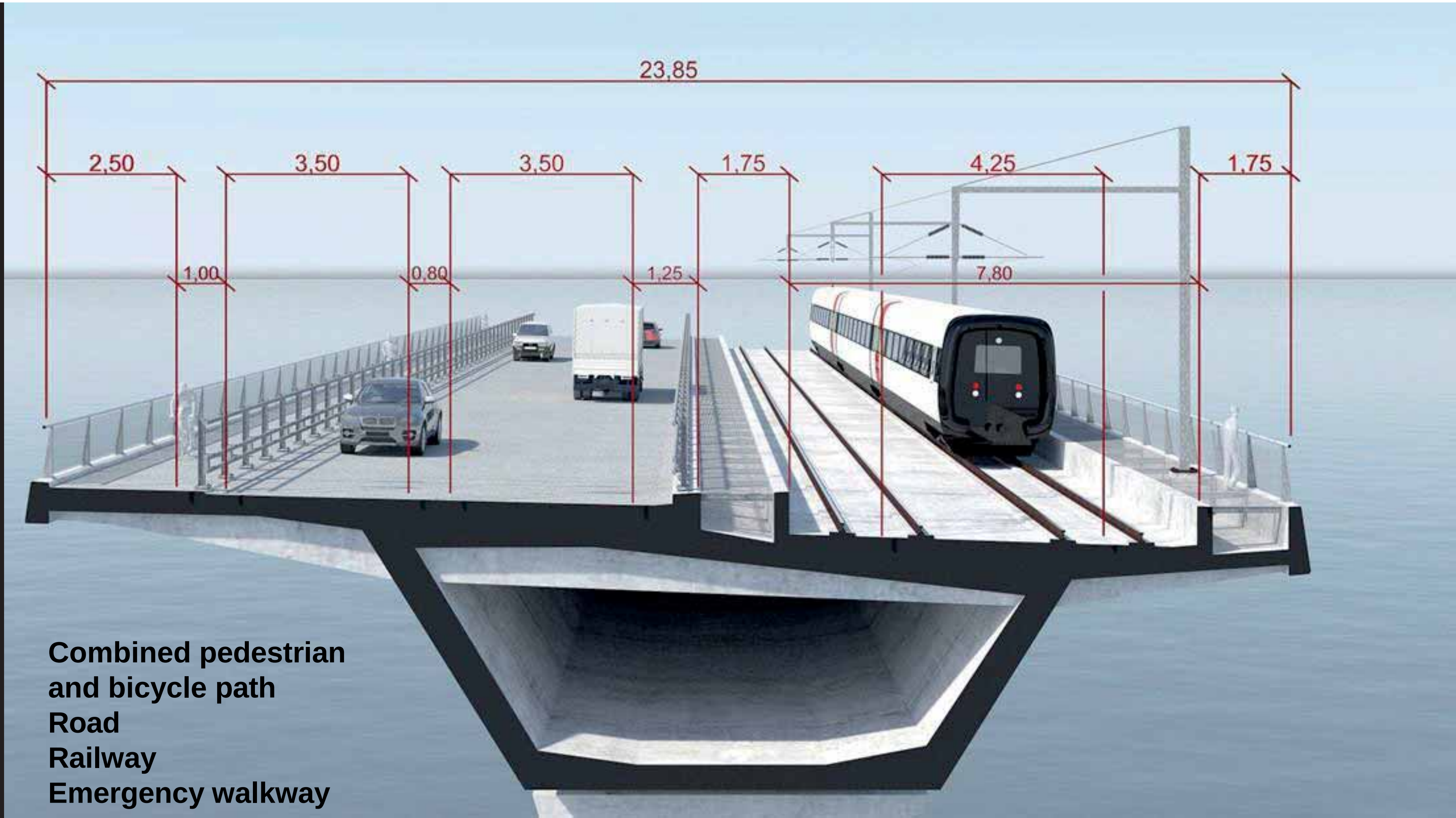
LESS PIERS AND FOUNDATIONS

OPTIMIZATION OF MATERIALS

ELEGANT EXPRESSION - ARCHITECTURE



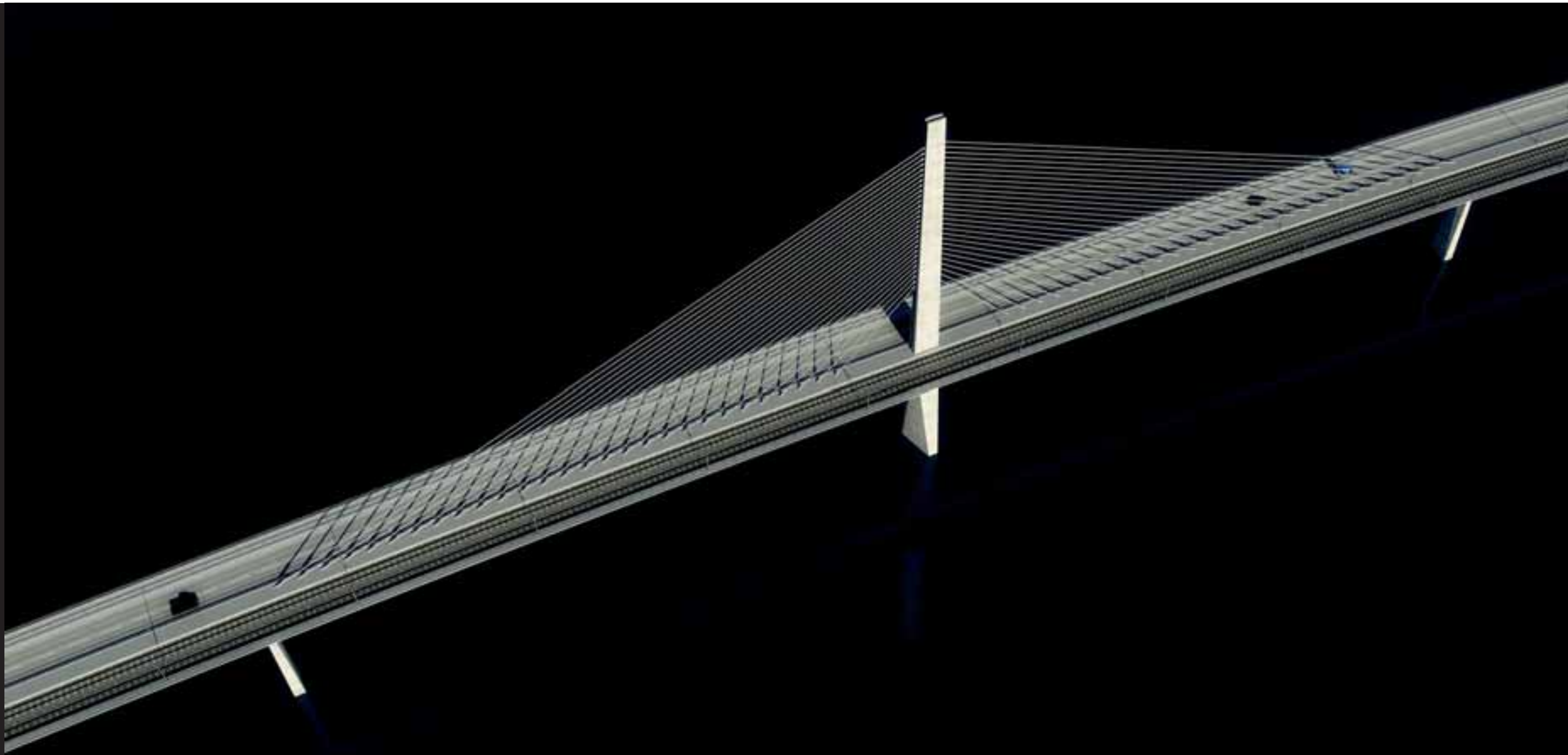
Dissing+Weitling



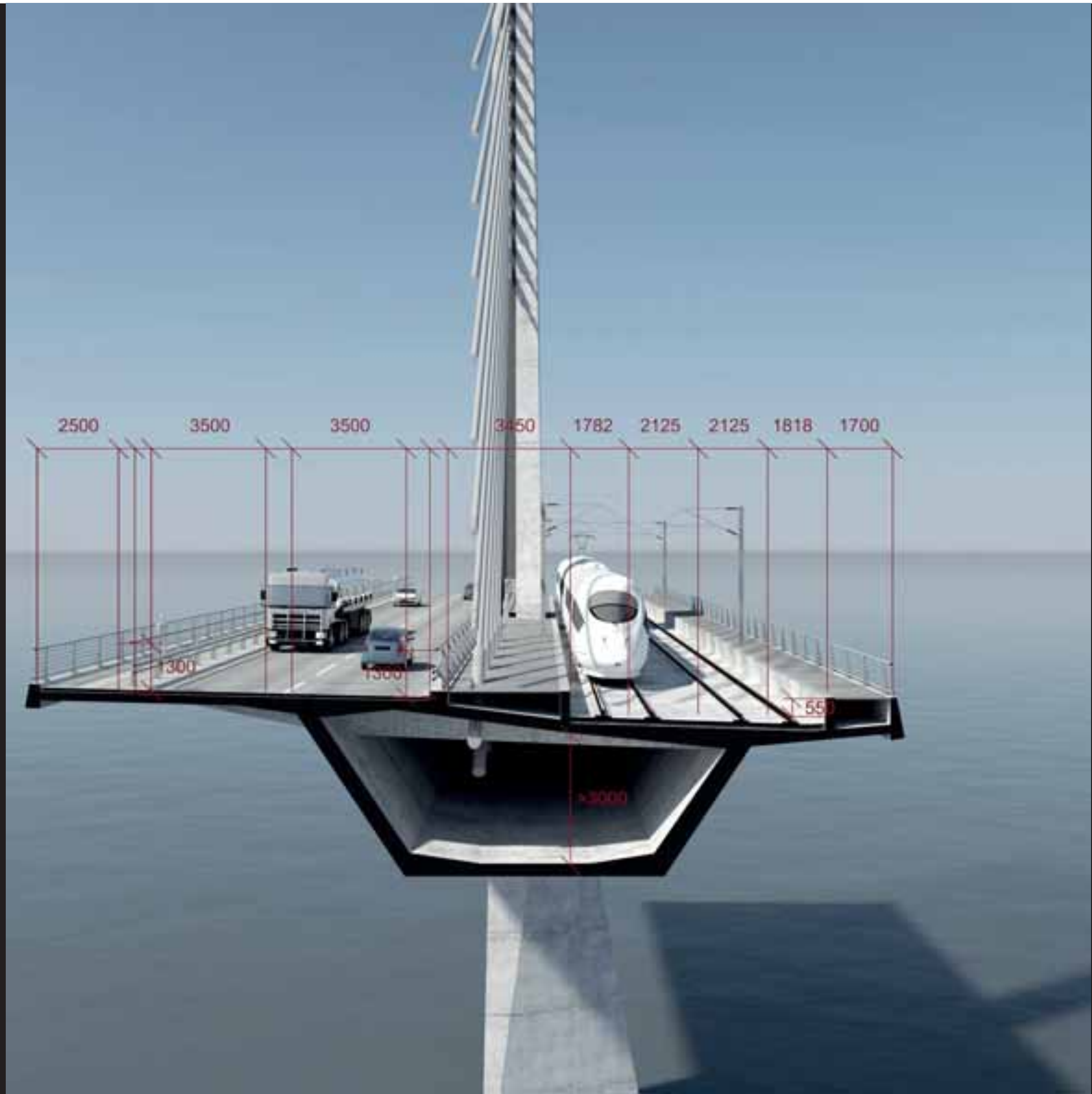
Dissing+Weitling

Dissing+Weitling

Dissing+Weitling



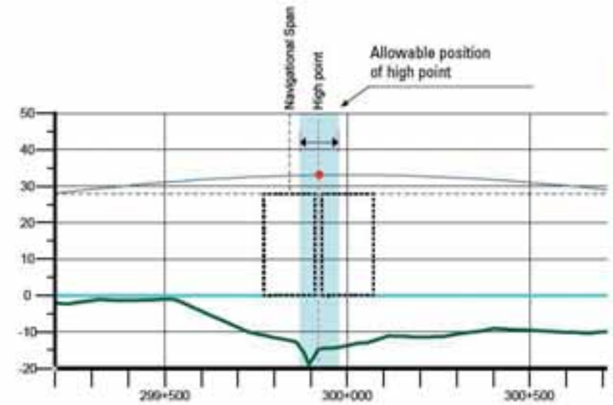
Dissing+Weitling



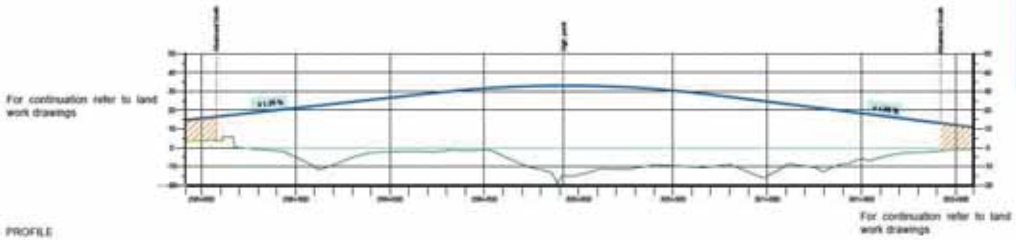
Dissing+Weitling

Definition design

Dissing+Weitling



NAVIGATIONAL SPAN AND HIGH POINT PLACEMENT



PROFILE

NAME OF PARAMETER	DESCRIPTION	STATIONING IN ILLUSTRATIVE DESIGN	DBS	ALLOWED VARIATIONS
$ST_{high\ point}$	Station of high point	299+920	DBS01-0-2.2-070 MR	299+870 - 299+970

PROFILE/ DRAWINGS NOT TO SCALE

Design Parameters 2.2.A / Parameters of Chainage

NOTES

2.2 NAVIGATION SPANS

The navigation spans shall be centred around the high point of the vertical alignment.

The navigational spans shall be min. 2x160m.
DBS01-1-2.2-310 MR

2.3 PROFILE

The minimum vertical radius over the navigation spans shall be min. 40000 m. (60000 m PMR)
DBS01-2.2-120 MR

The maximum vertical radius over the navigation spans is 72000 m.
DBS01-0-2.2-125 R

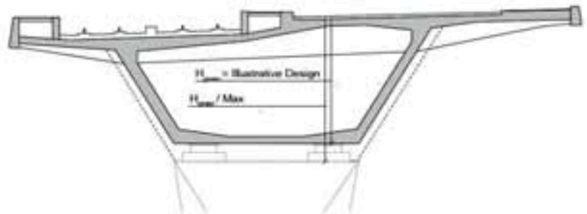
The longitudinal profile for the reference line (PRL) shall be determined as follows:

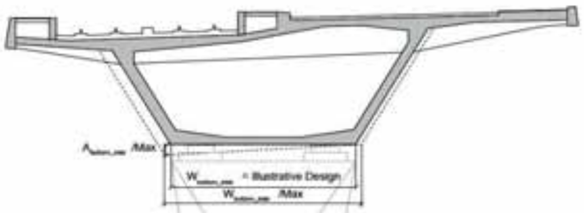
The level to the lowest point of the girder soffit shall be ≥ 26.85 m (DVR90) within the navigation spans in load combinations SLS1 and SLS2.
DBS01-0-2.2-100 MR

Allowance for future sea level rise shall not be added.

The maximum allowable gradient on the railway on the viaducts is 1.25%.
DBS01-0-2.2-110 MR

Dissing+Weitling





VALUE OF W_{bottom_slab}
- Illustrative Design / 8000 mm
- Max / 8500 mm — DBS01-0-2.2-410 PMR

VALUE OF A_{bottom_slab}
- Illustrative Design / Min / 0 %
- Max / 3.33 % — DBS01-0-2.2-470 MR

3.2.1 HEIGHT

The girder height shall be constant throughout the bridge. *See chapter 3.1.2 for exceptions when varying span lengths.*

The girder height shall be modified to correlate with the viaduct span length.

$$H_{Girder} \leq L_{Span} / 14$$

DBS01-0-2.2-390 PMR

In the diagram as well as the parameter list, it is indicated that a large girder height produces a road cantilever length, which can be below the minimum requirements. It is presented as a note and reminder, since it is possible to adjust other parameters and reach a design, which is within the given design parameters.

3.2.2 UNDERSIDE

The W_{bottom_slab} shall be constant throughout the bridge

$W_{bottom\_slab} = W_{pier\_top}$

The bottom slab shall align with the top width of the pier, although the pier top always shall be horizontal. The bottom can not alter its location with relations to road and rail alignments. DBS01-0-4.4-115 MR

The A_{bottom_slab} shall be constant throughout the bridge.

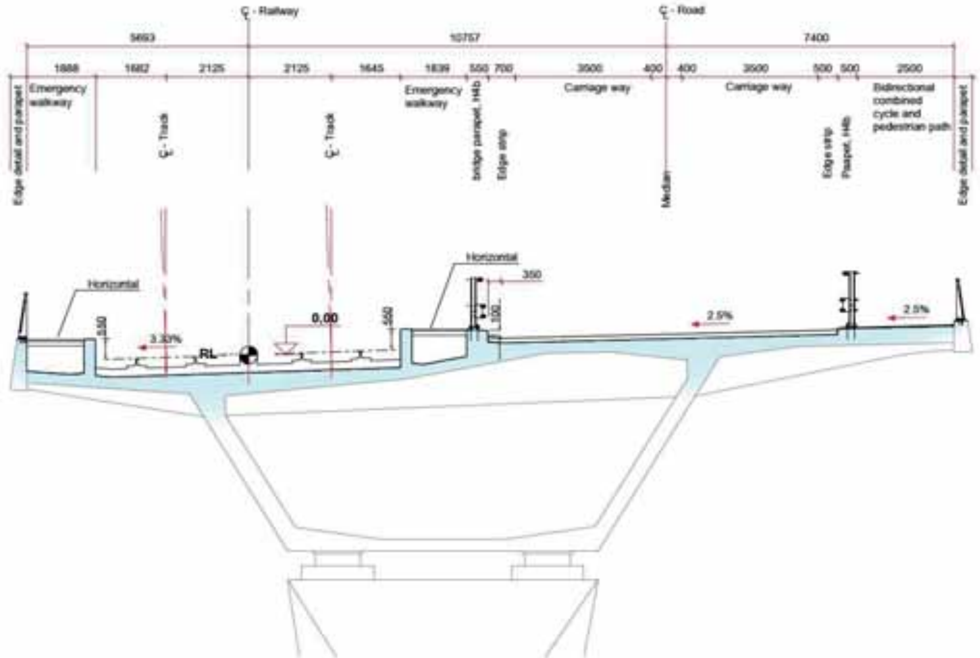
DBS01-0-4.4-115 MR

If A_{bottom_slab} is introduced the pier top shall still be horizontal. *DBS01-0-2.2-475 MR*

Two variations can be made to the bottom slab. The width can be altered and a cross slope can be introduced.

GIRDER GEOMETRY AND VARIABLE HEIGHT AND WIDTH + INCLINATIONS / DIAGRAMMATIC SECTIONS /DRAWINGS NOT TO SCALE

NOTES



3.2.4 DECK DIMENSIONS

A standard cross section of the top of the girder is shown. All dimensions are locked vertically and horizontally.

The top dimensions of the girder, vertical as well as horizontal, shall be identical to the dimensions that are shown in this section.

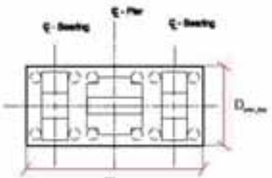
DBS01-0-2.4-040 MR
DBS01-0-2.4-050 PMR
DBS01-0-2.4-060 MR
DBS01-0-2.4-070 MR
DBS01-0-2.5-030 MR
DBS01-0-2.5-050 MR
DBS01-0-2.5-070 MR
DBS01-0-4.4-110 PMR

The railway is lowered relative to the road, in order to obtain a horizontal emergency walkway harmonised with a steel parapet and to allow the road users to have a two-sided view of the surroundings.

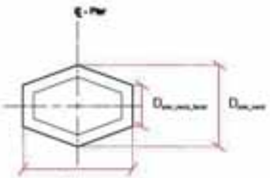
GIRDER GEOMETRY AND DECK DIMENSIONS / SECTION / 1:100

NOTES

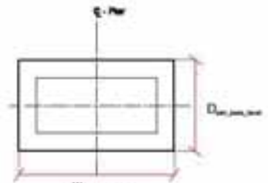
Dissing+Weitling



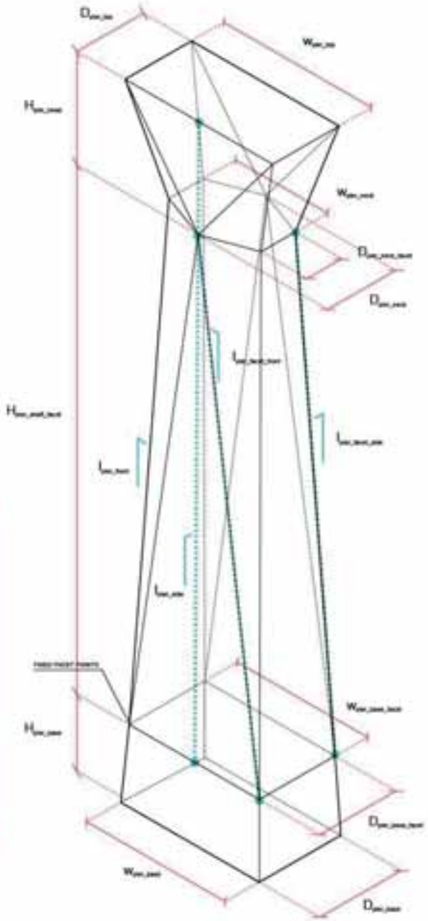
PLAN SECTION AT TOP



PLAN SECTION AT NECK



PLAN SECTION AT FACET BASE



3.3.1 GEOMETRY/FACETING

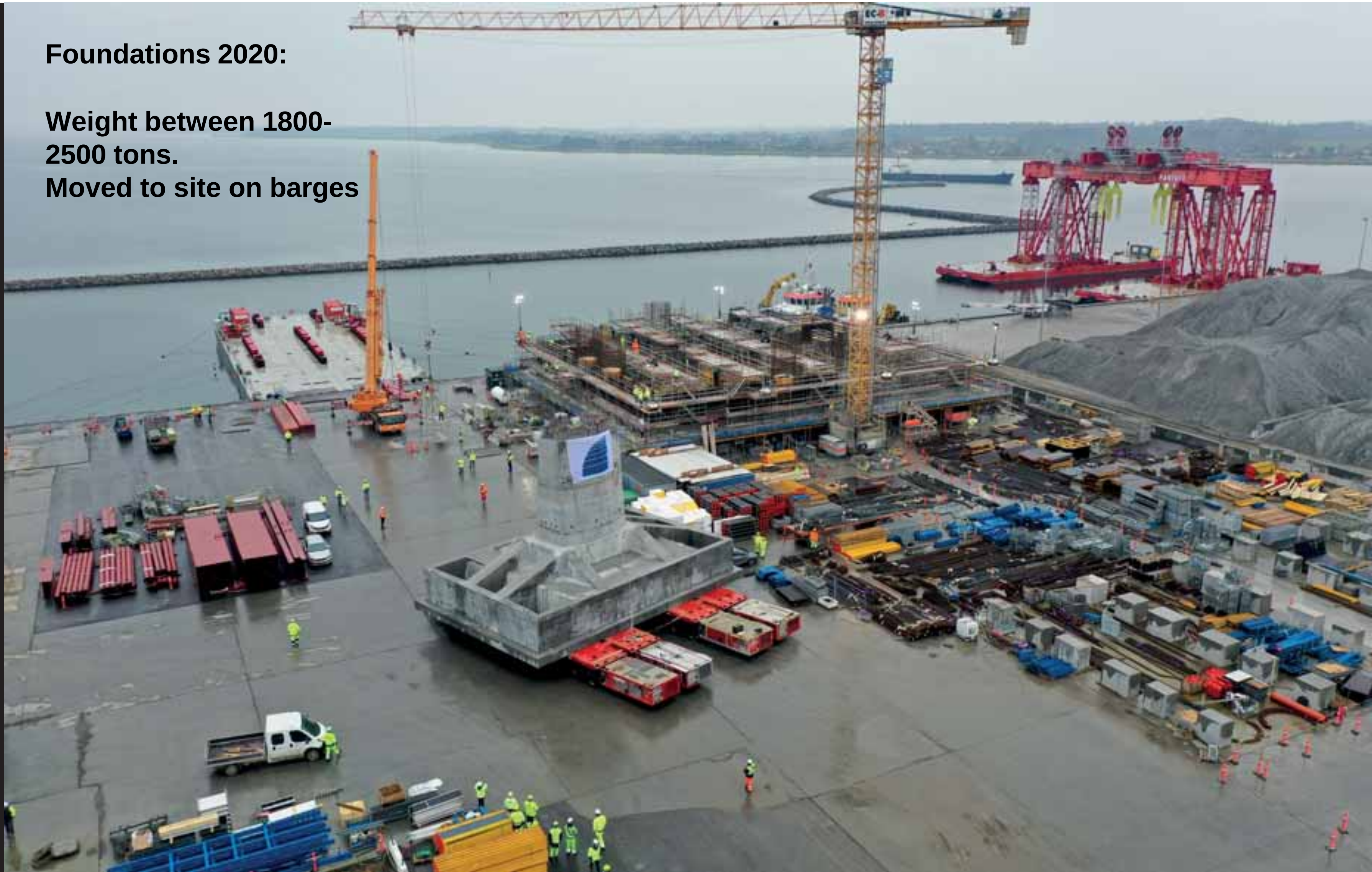
NAME OF PARAMETER	DESCRIPTION	DIM*	DESIGN BASIS	PARAMETER VALUES
H_{pier_head}	Height of pier head	5300	DBS01-0.2.2-430 PMR	NT
$H_{pier\_shaft\_facet}$	Height from pier neck to facet point	24700	——·——	NT - only for definition purposes
H_{pier_base}	Height from foundation top to facet point	Varies		N/A - can be <0
W_{pier_top}	Width of pier top	6000	DBS01-1-2.2-410 PMR	W_{pier_top} = W_{bottom_slab} (min. 8500)
W_{pier_neck}	Width of pier shaft top	5000	DBS01-0-2.2-430 PMR	W_{pier_top} x (5/6)* *(5/6): aesthetical proportion
$W_{pier\_base\_facet}$	Width at pier base facet	7057	——·——	depends on I_{pier_front} and W_{pier_neck}
W_{pier_base}	Width at pier base	Varies	——·——	depends on I_{pier_front} and W_{pier_neck} and foundation top level
D_{pier_top}	Depth of pier top	3600	——·——	3000 mm - (2000+L/40) L= normal viaduct span length in mm
$D_{pier\_neck\_facet}$	Depth of pier facet	1650	——·——	between 40% and 60% of D_{pier_top}
D_{pier_neck}	Wider depth of pier neck	3690	——·——	depends on inclination I_{pier_side} from pier top (side elevation) and D_{pier_top}
$D_{pier\_base\_facet}$	Depth at pier facet base	4105	——·——	depends on inclination I_{pier_side} from pier top (side elevation) and $D_{pier\_neck\_facet}$
D_{pier_base}	Depth at pier base	Varies	——·——	depends on I_{pier_side} and D_{pier_neck} and foundation top level
I_{pier_side}	Inclination of pier side	1:120	——·——	1:50 to vertical
$I_{pier\_facet\_side}$	Inclination of pier facet side	1:22	——·——	depends on $D_{pier\_neck\_facet}$, I_{pier_side}
$I_{pier\_facet\_front}$	Inclination of pier facet front	1:7	——·——	$I_{pier\_facet\_front}$ = $I_{pylon\_mid\_facet}$
I_{pier_front}	Inclination of pier front	1:24	——·——	depends on inclination $I_{pier\_facet\_front}$ and width W_{pier_neck}

GEOMETRY PARAMETERS / AXONOMETRIC VIEW, PLAN / DRAWINGS NOT TO SCALE

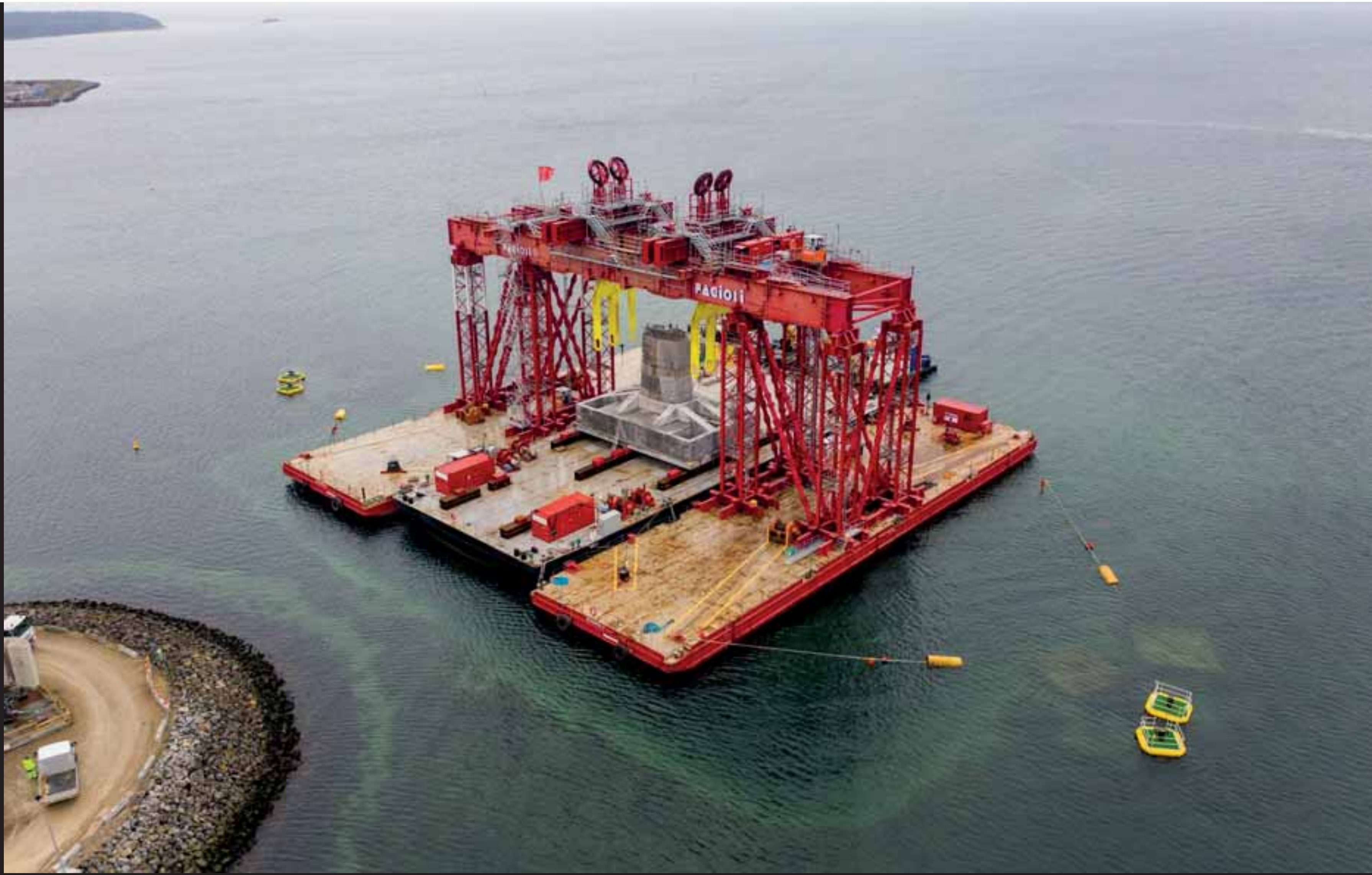
*DIMENSION IN ILLUSTRATIVE DESIGN

Foundations 2020:

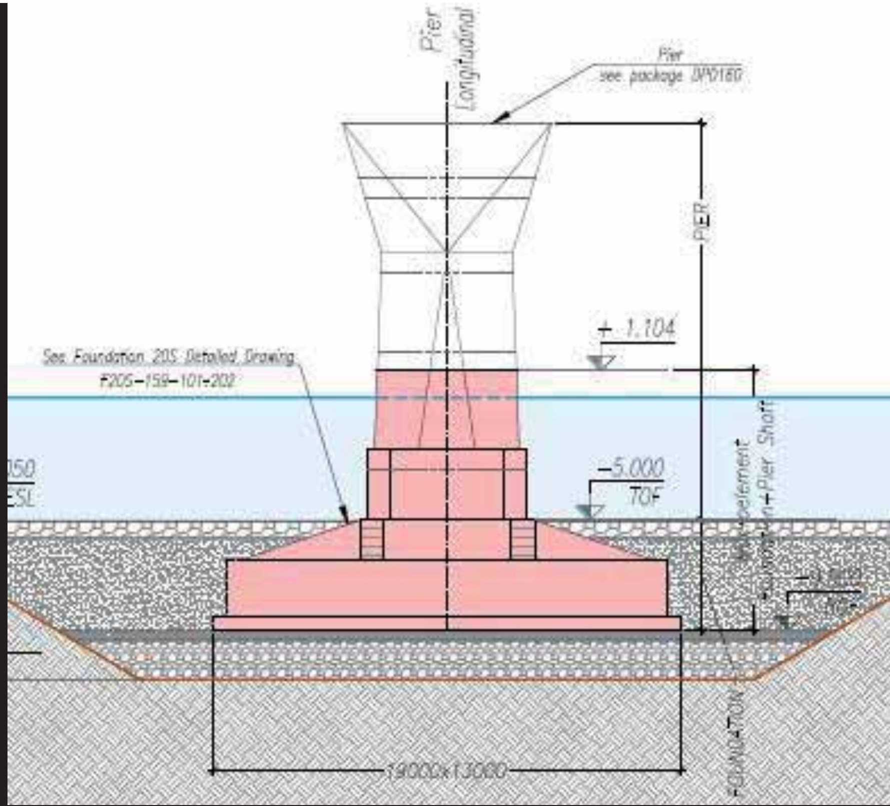
Weight between 1800-2500 tons.
Moved to site on barges



Dissing+Weitling

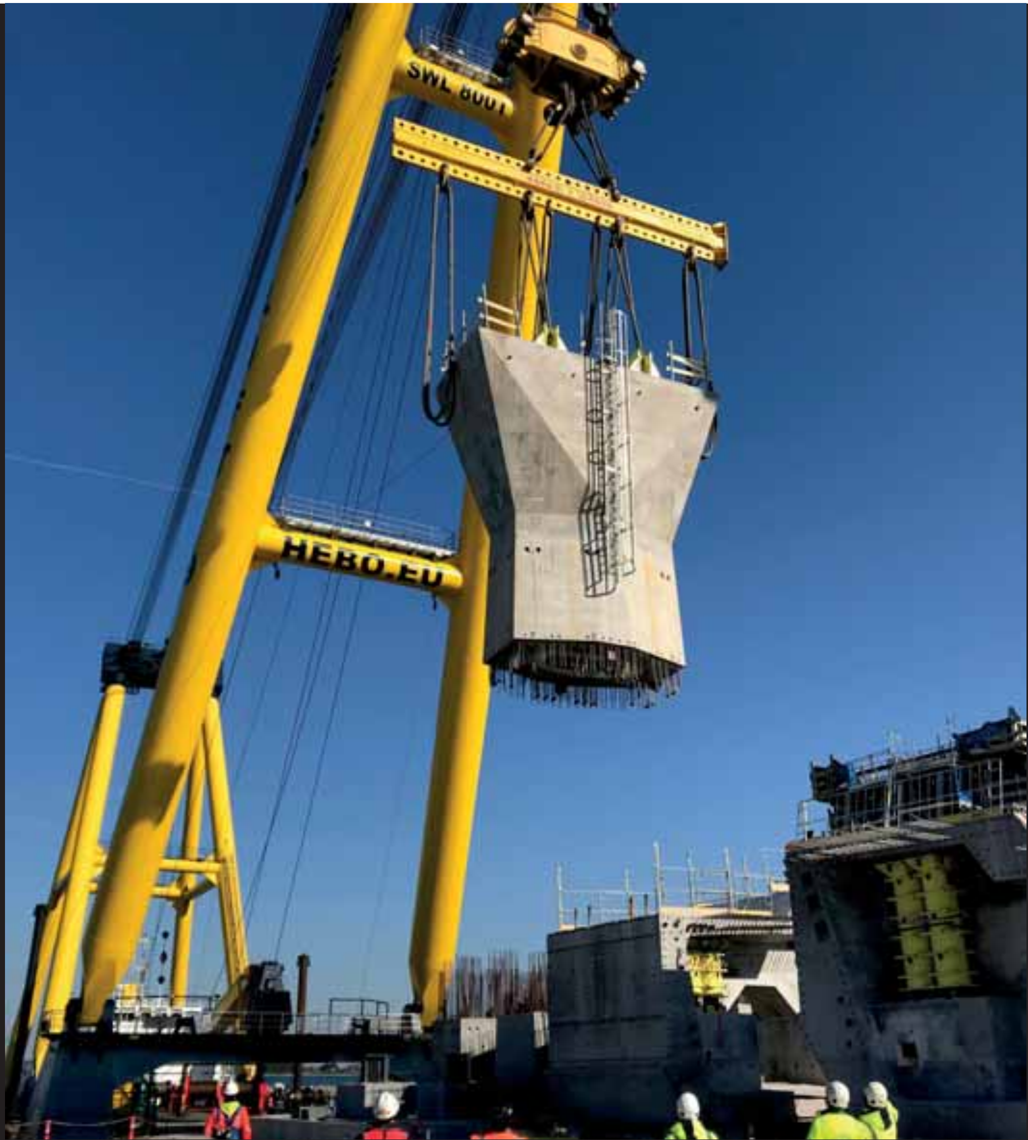


Dissing+Weitling



Dissing+Weitling

Dissing+Weitling



Dissing+Weitling

Prefab bridge deck
Length approx 70 m

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Pylon Foundation moved to barge

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Dissing+Weitling

Conclusion:

Denmarks 3'rd longest bridge
A replacement of the existing Storstrøms Bridge

Dissing+Weitling involved in all Phaese from Sketching to on-site supervision. Major challenges:

Design and build with definition design

Arcitectural especially the production of piers was challenging But

Bridge moving forward, delayed, but the architectural intend is kept.

Expected opening for trafic late 2025 and trains in 2028

Dissing+Weitling

Dissing+Weitling

"THE CATHEDRALS OF OUR TIME"

Dissing+Weitling