

synergetic efficient infrastructure

Dutch infrastructural solutions

Adriaan Kok

ipv Delft creative engineers

mail: adriaankok@ipvdelft.nl
website: ipvdelft.nl or ipvdelft.com

- Hovenring Development Process
- Other Project Examples
- Lessons Learned

January 14 2019, Oakland USA



- context adapted
- supports the city branding
- user friendly
- easy maintainable

- structural efficient
- multifunctional
- modular buildable
- cost efficient



Hovenring characteristics

**Analysis of
Requirements**

Traffic Network

Context

Users

Design Checklist

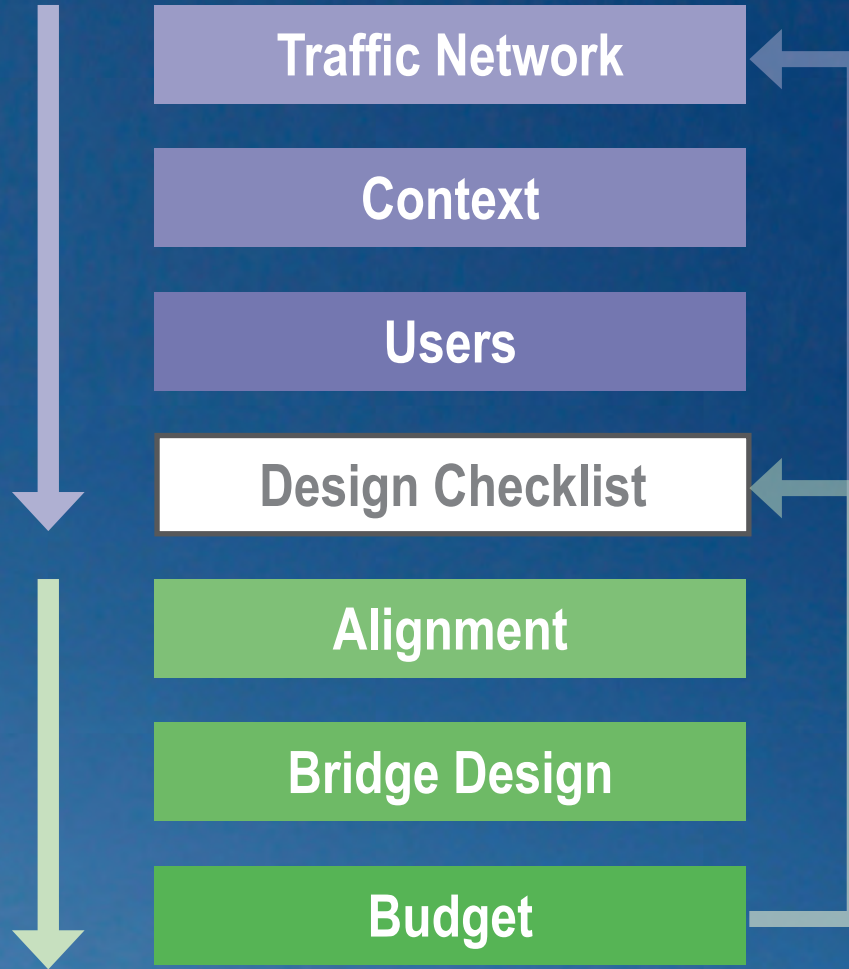
Alignment

Bridge Design

Budget

**Design
Development**

Hovenring development process



city

- project management
- civil engineers
- traffic planners
- urbanists
- light planners
- maintenance

Others

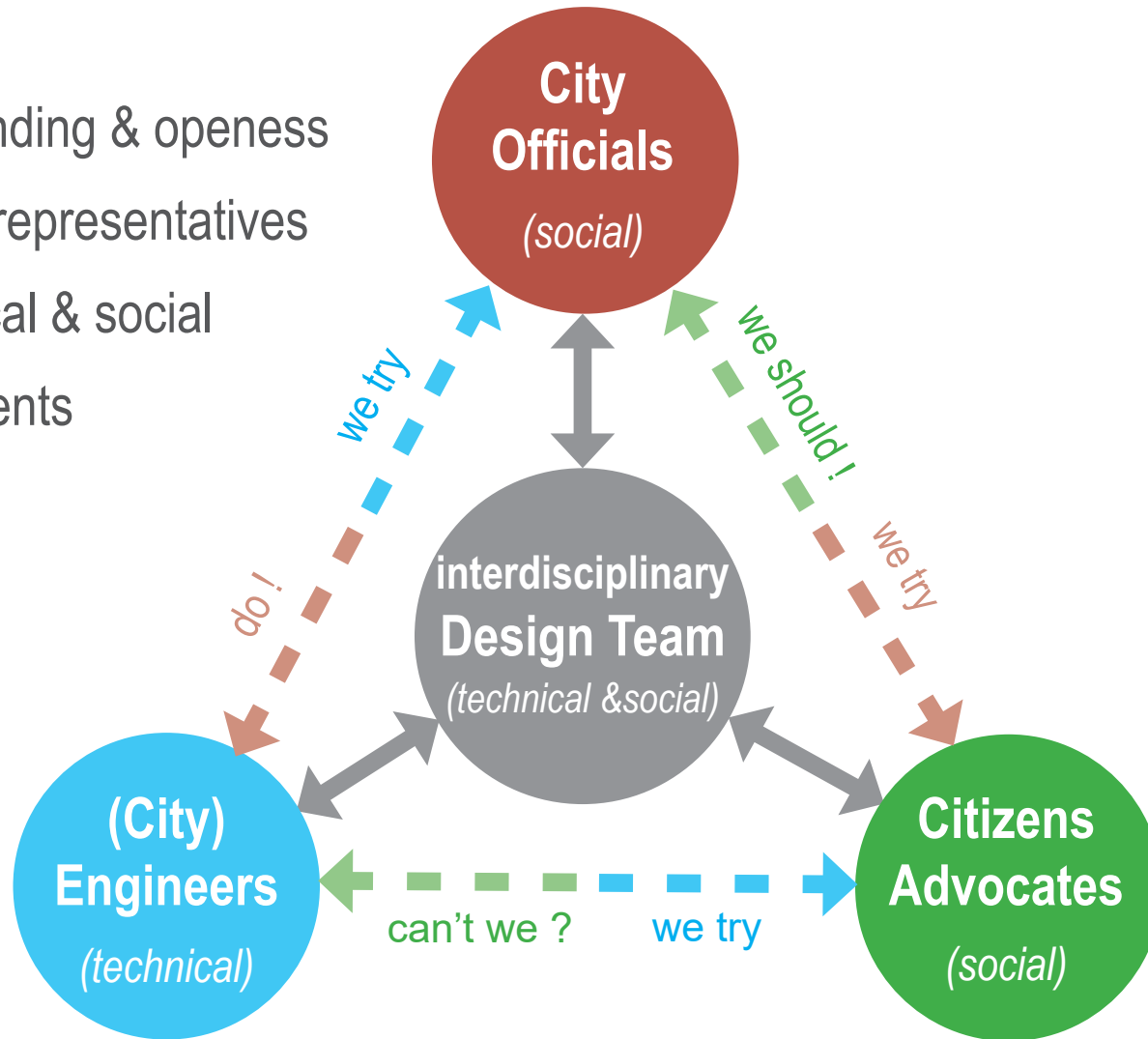
- architects / designers
- advocates (cycling, etc.)
- local residents
- commercial stakeholders
- contractors



Hovenring involvement of disciplines and stakeholders

Create

understanding & openness
between representatives
of technical & social
requirements



Hovenring involvement of disciplines and stakeholders

Involvement of disciplines & stakeholders: *De-Siloing the Process*



Client	Network	Context	Users	Checklist	Alignment	Design
Management	●	●	●	<input type="checkbox"/>	●	●
Engineering		●	●	<input type="checkbox"/>	●	●
Traffic	●	●	●	<input type="checkbox"/>	●	●
Urban planning	●	●	●	<input type="checkbox"/>	●	●
Lighting	●	●		<input type="checkbox"/>	●	●
Maintenance		●	●	<input type="checkbox"/>	●	●
Consultants						
Engineer		●	●	<input type="checkbox"/>	●	●
Architect		●	●	<input type="checkbox"/>	●	●
Subsoil		●		<input type="checkbox"/>	●	●
Local						
Businesses		●	●	<input type="checkbox"/>	●	●
Citizens		●	●	<input type="checkbox"/>	●	●
Advocates	●		●	<input type="checkbox"/>	●	
Contractor						●

Hovenring involvement of disciplines and stakeholders



Hovenring, Eindhoven



Context (national) Eindhoven - population 220.000



ASML



Context (regional) Eindhoven - technology and innovation



Context (regional) Eindhoven - Brainport of the netherlands



Network (regional) Project Location in the region



Context (regional) Eindhoven - Brainport Avenue (highway A2)



Context (regional) Eindhoven - Impression Brainport Avenue (highway A2)



Network (local) Project Location - old situation



Network (local) Traffic Situation



New developments

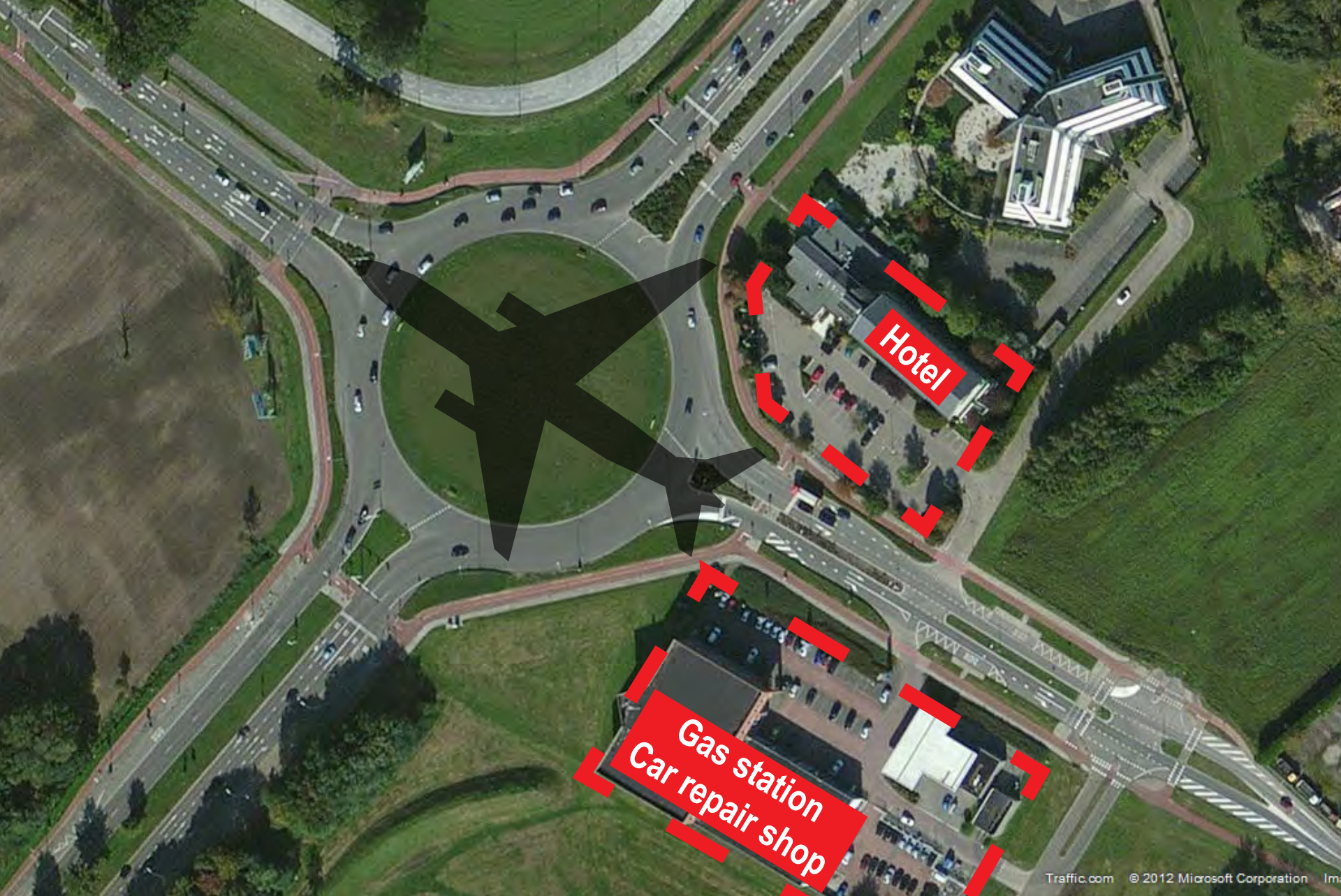
- hightech bussiness areas
- residential areas
- highway connection

high tech
business area

new Highway connection

Highway A2

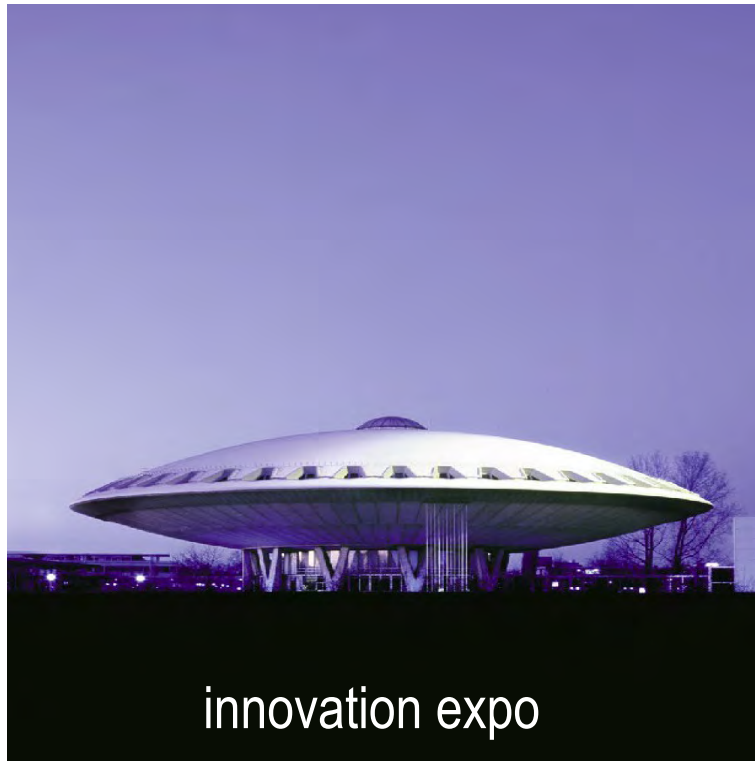
Network, Context (local) New Developments



Context (local) Commercial and Safety Requirements



landmark bridge



innovation expo



Light Needle

Hovenring

Evoluon



Westcorridor Eindhoven

Context (regional) Existing landmarks



Users Deck Width



Users Not intended visitors (Latin American mayor delegation 2017)

- 9 metric tons maintenance vehicle



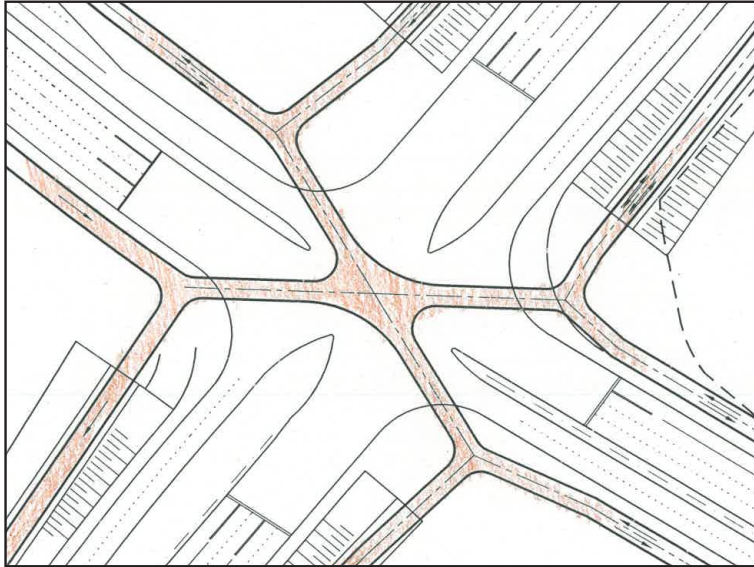
Users bridge Maintenance

- height above the road
- collision loads

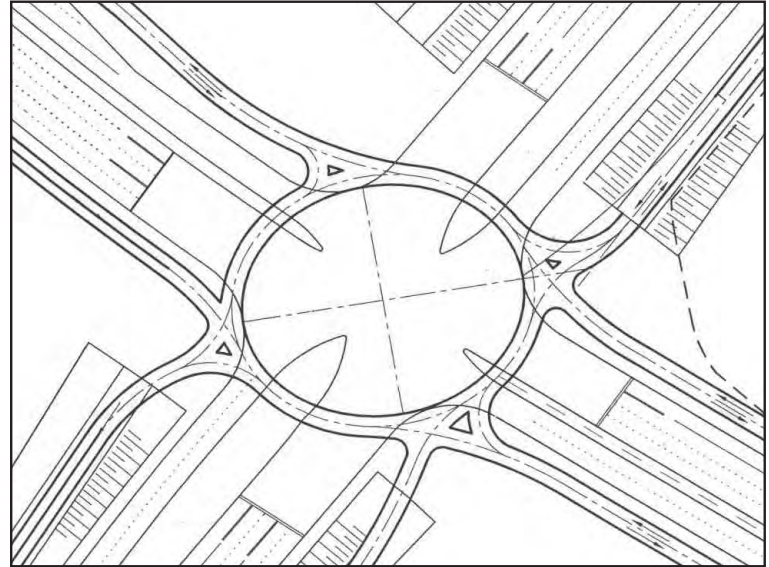


Users Intersecting Infrastructure

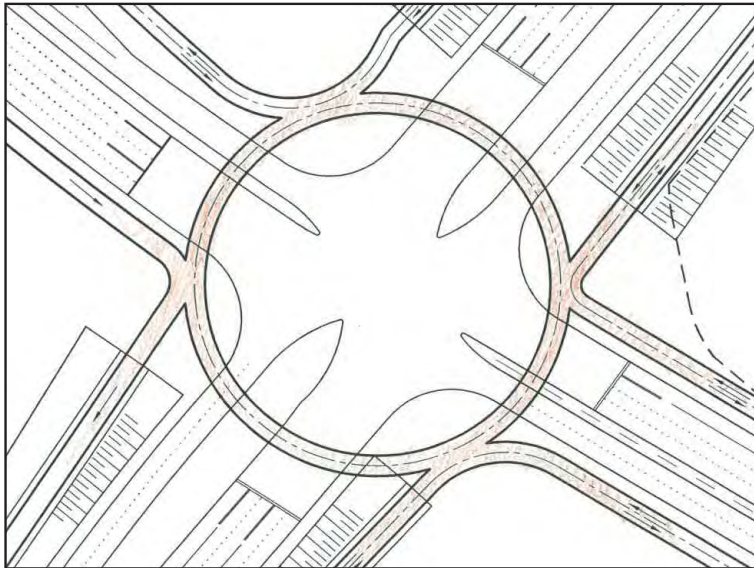
Cross



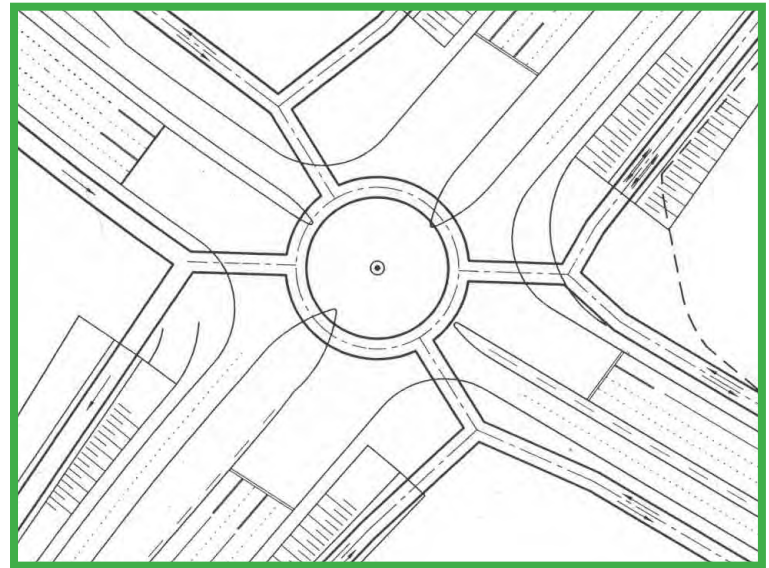
Ellipse



Large roundabout

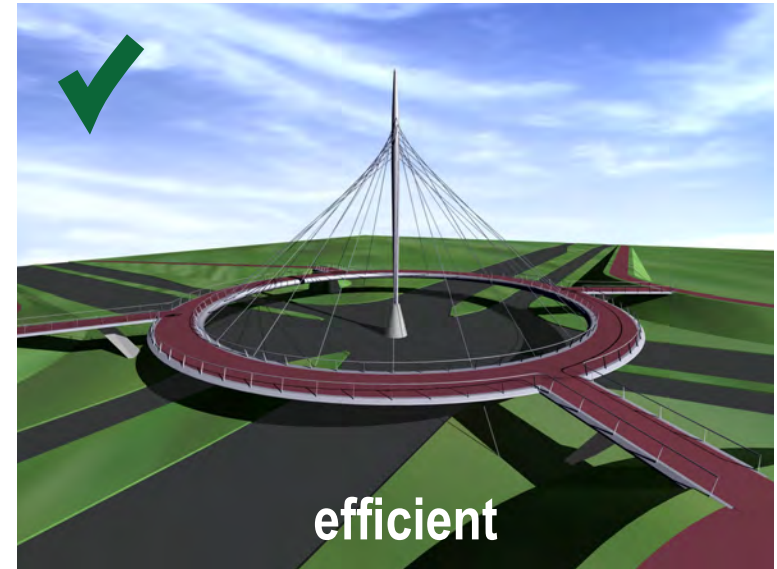
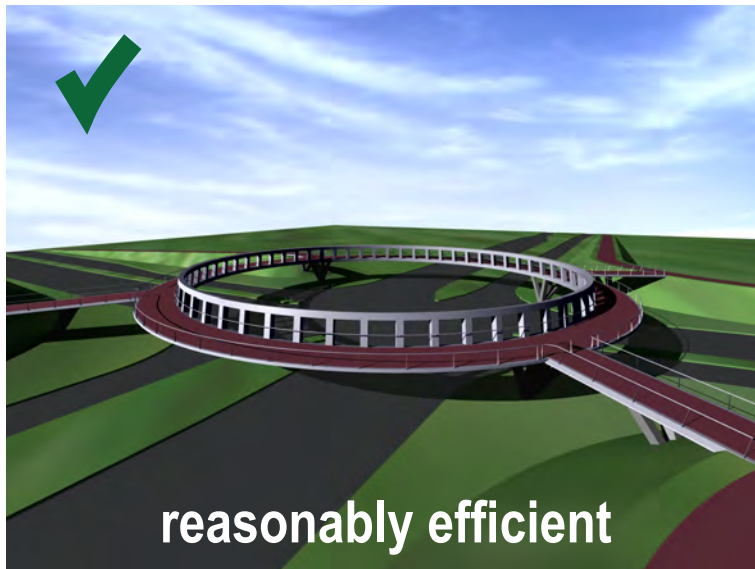
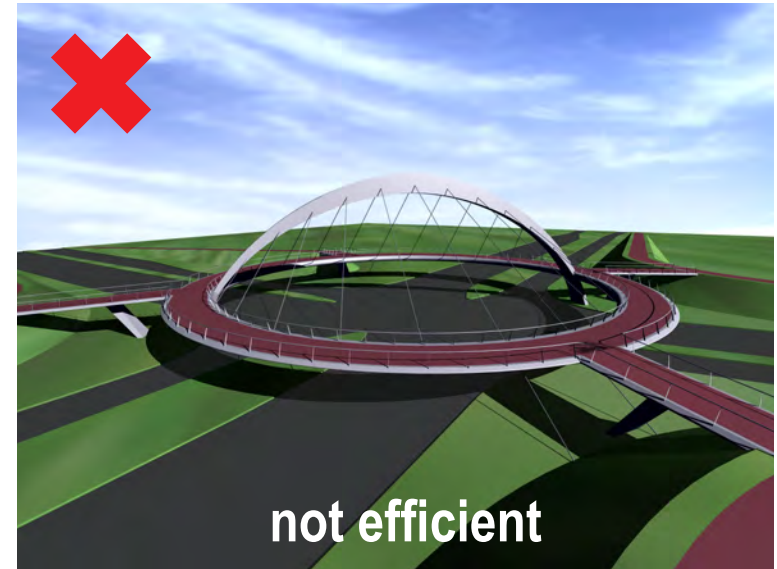
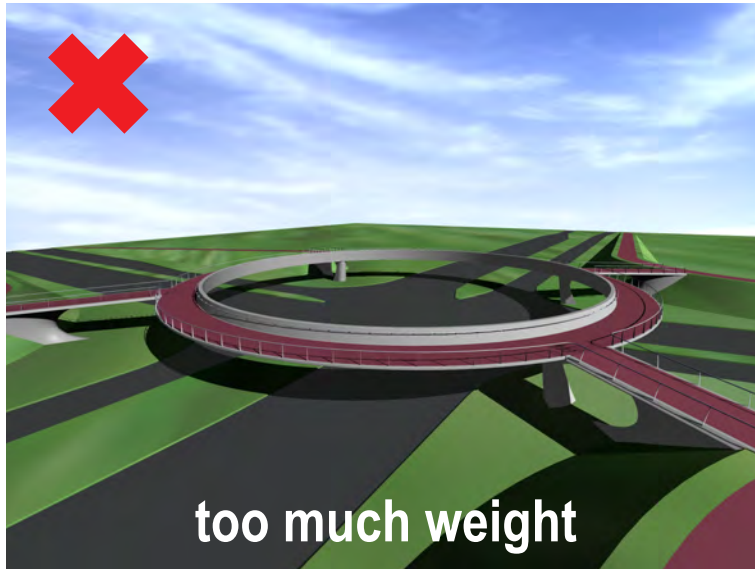


Small roundabout



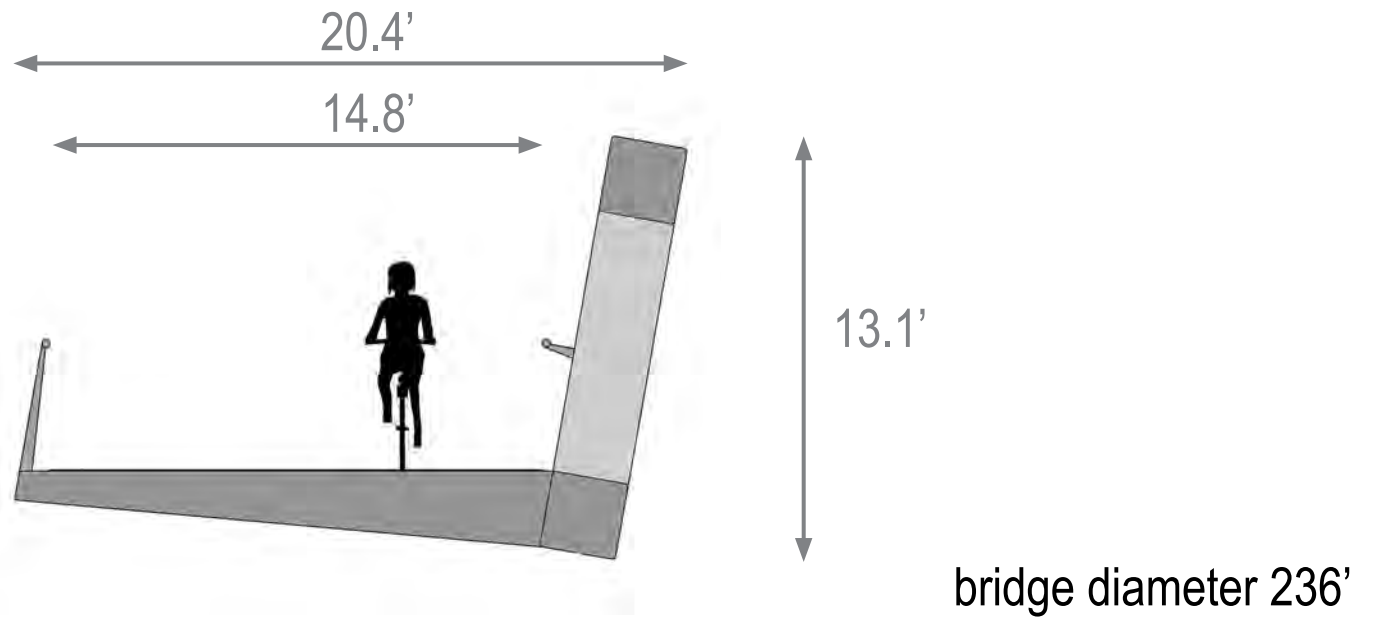


Alignment Preferred bridgeform within existing traffic circle

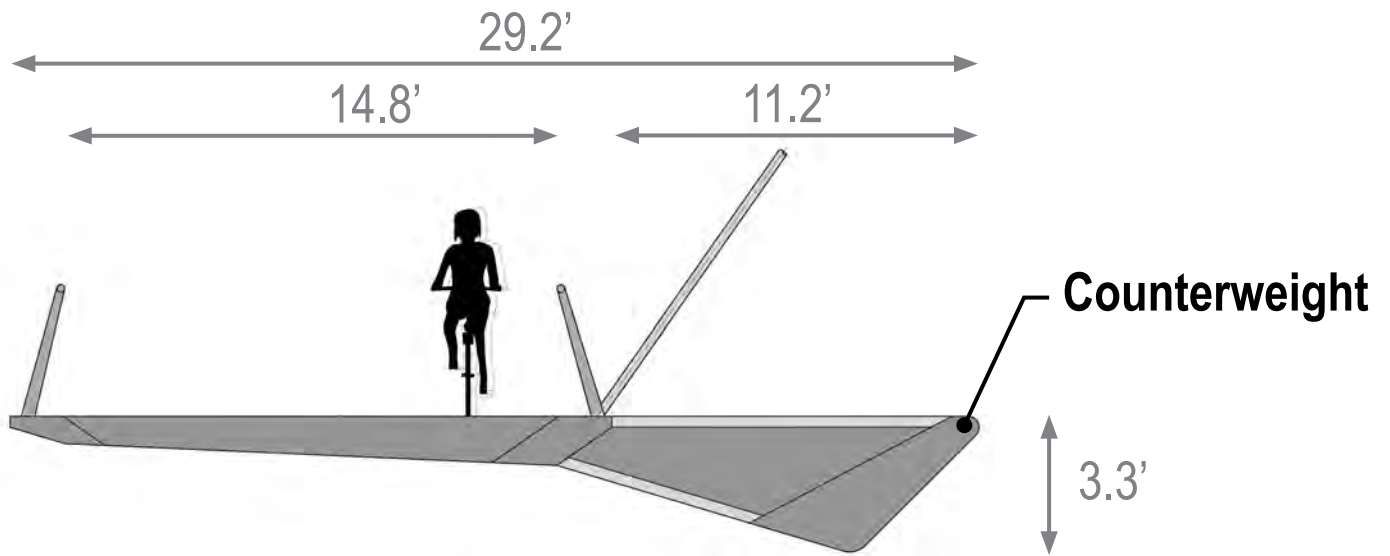


Design Concept Evaluation

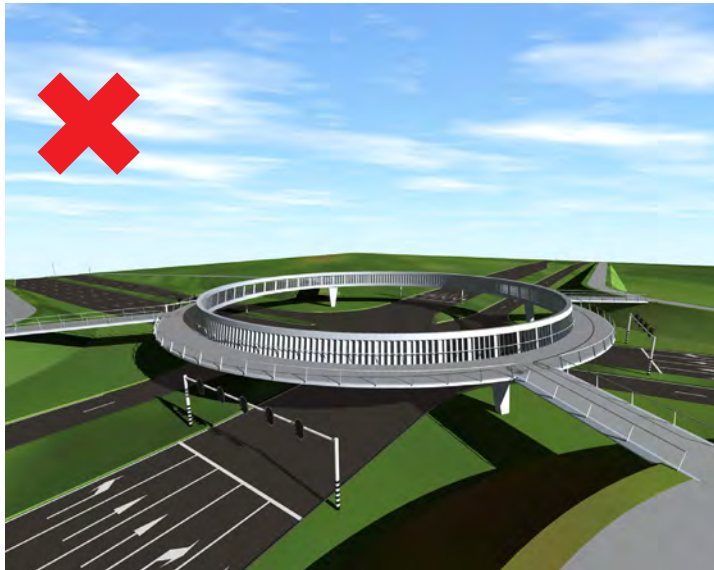
Steel-ring bridge



Cable-stayed bridge



Steel-ring bridge



Appearance

- spectacular and distinct
- landmark visible form vicinity

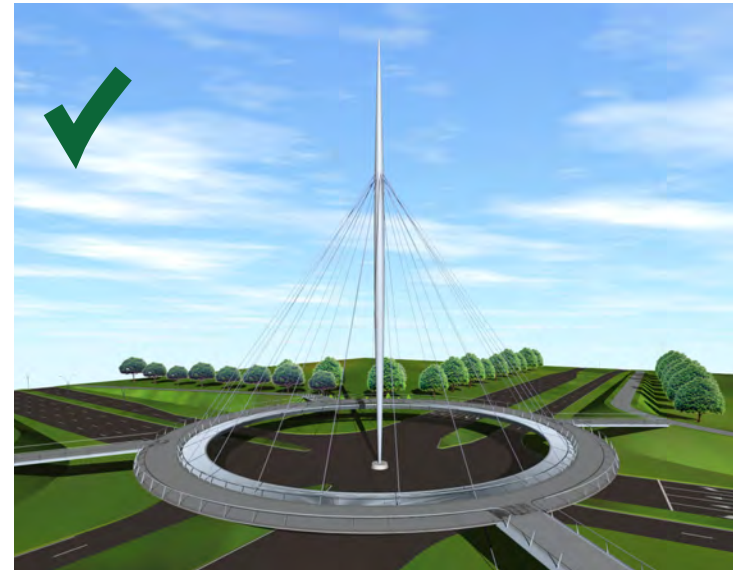
Structural Efficiency

- less optimal

Costs

- not distinctive

Cable-stayed bridge

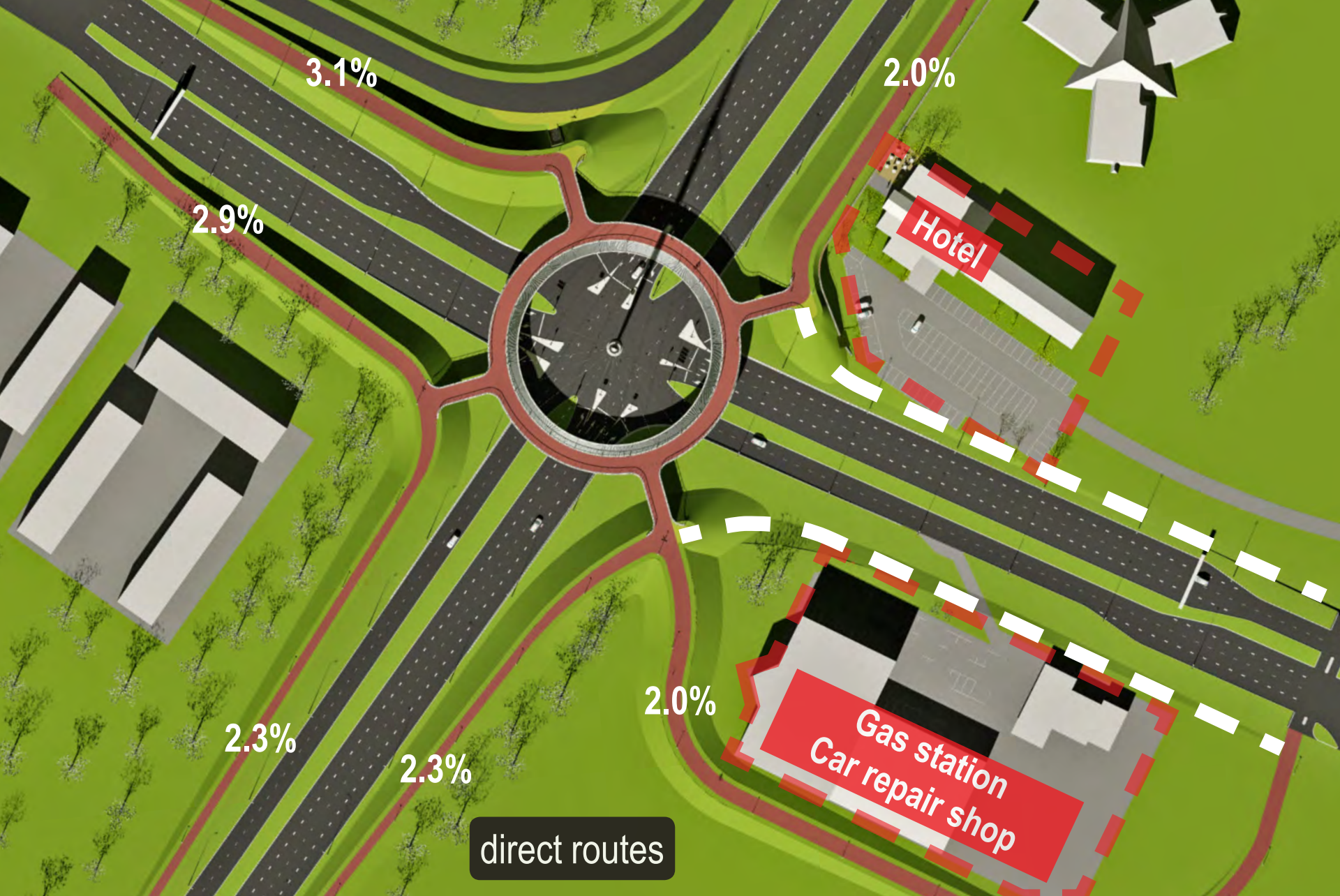


● spectacular and subtle

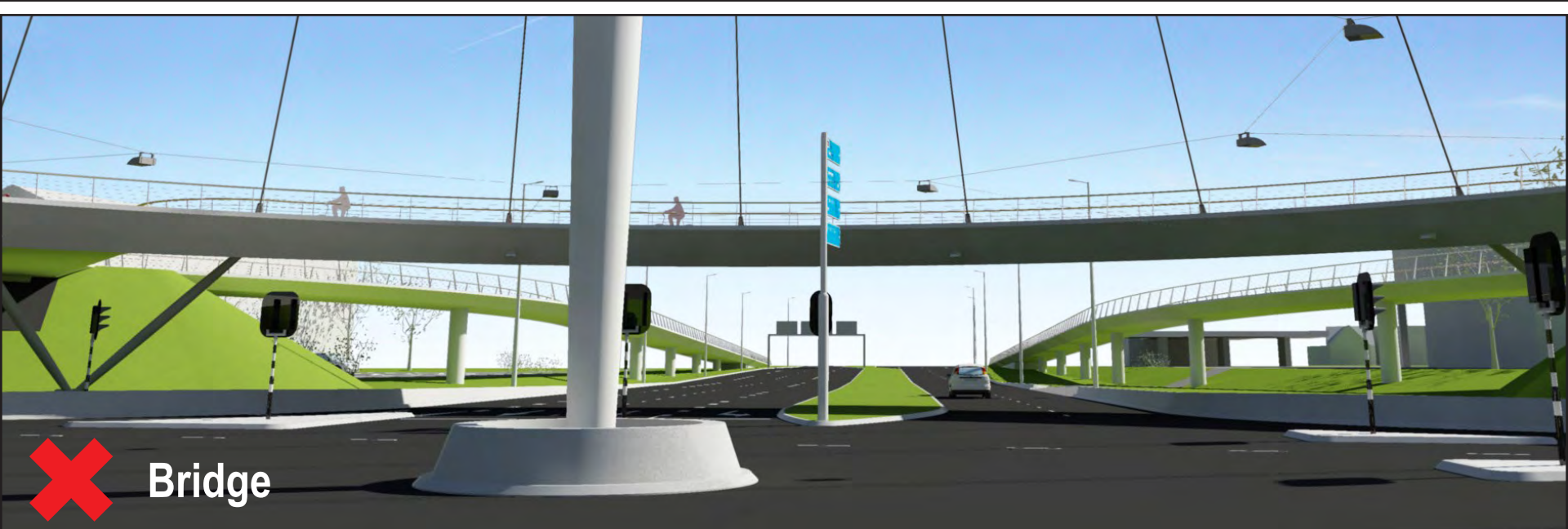
● landmark visible form afar

● optimal

● not distinctive



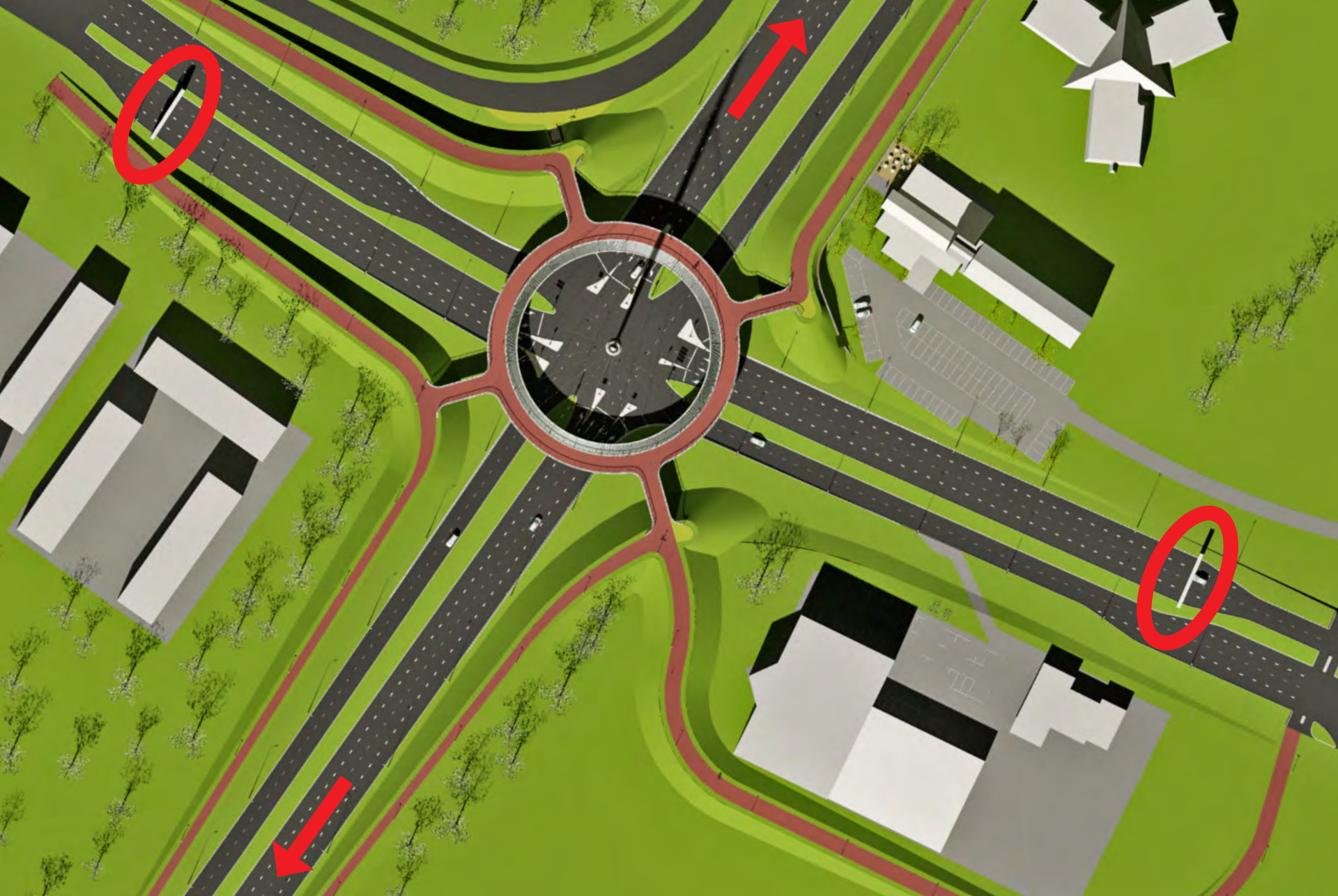
Alignment Optimization



Alignment Ramp Type



Collision Loads



Collision Loads Signage Portals as Anti-Collision Portals



Collision Loads Commonly used Signage Portals



Collision Loads Custom designed Anti-Collision Portals

Think Filter !



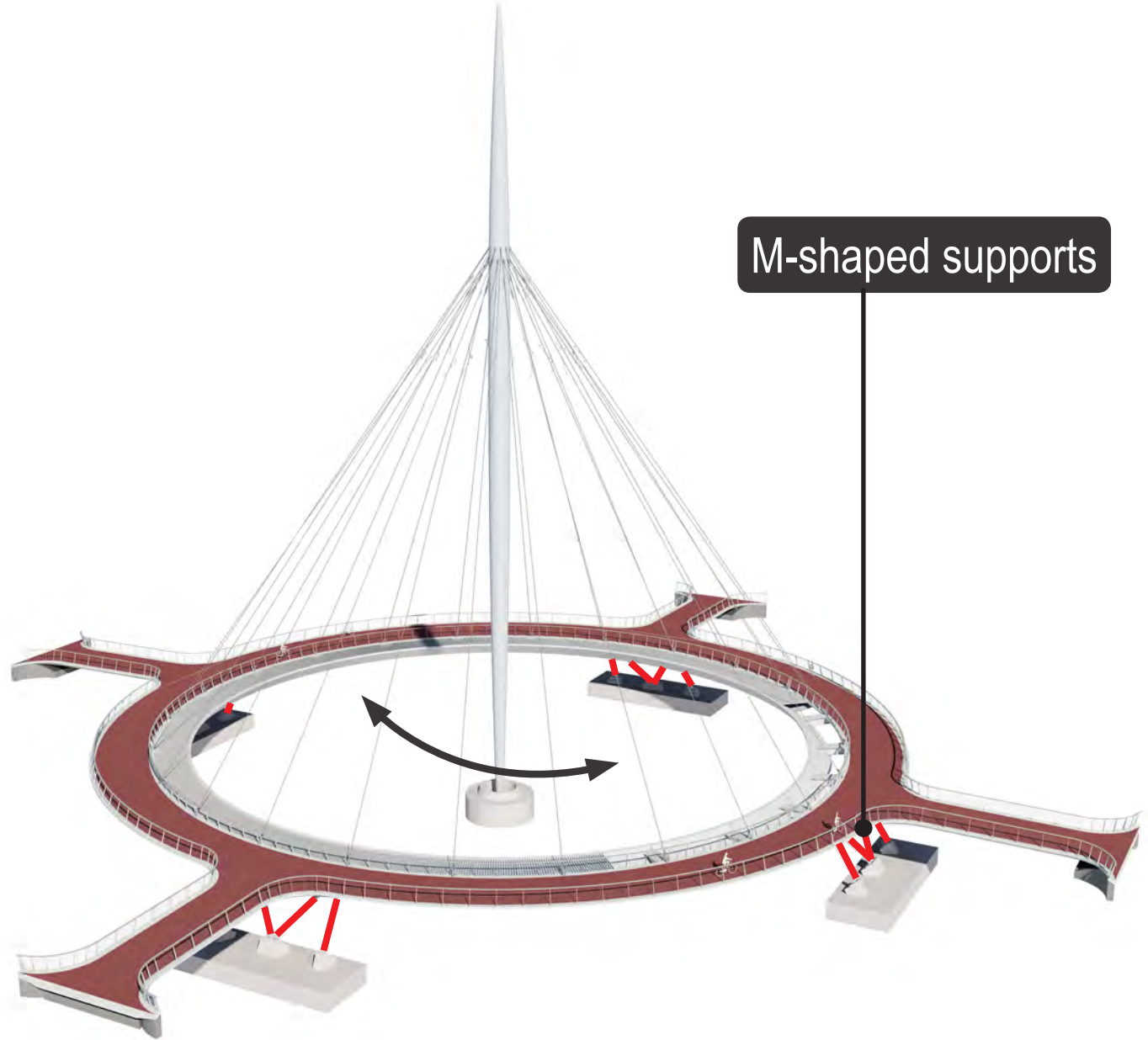
Collision Loads Anti-Collision Portals proven usefull



Collision Loads Concrete Barrier Pylon Foot



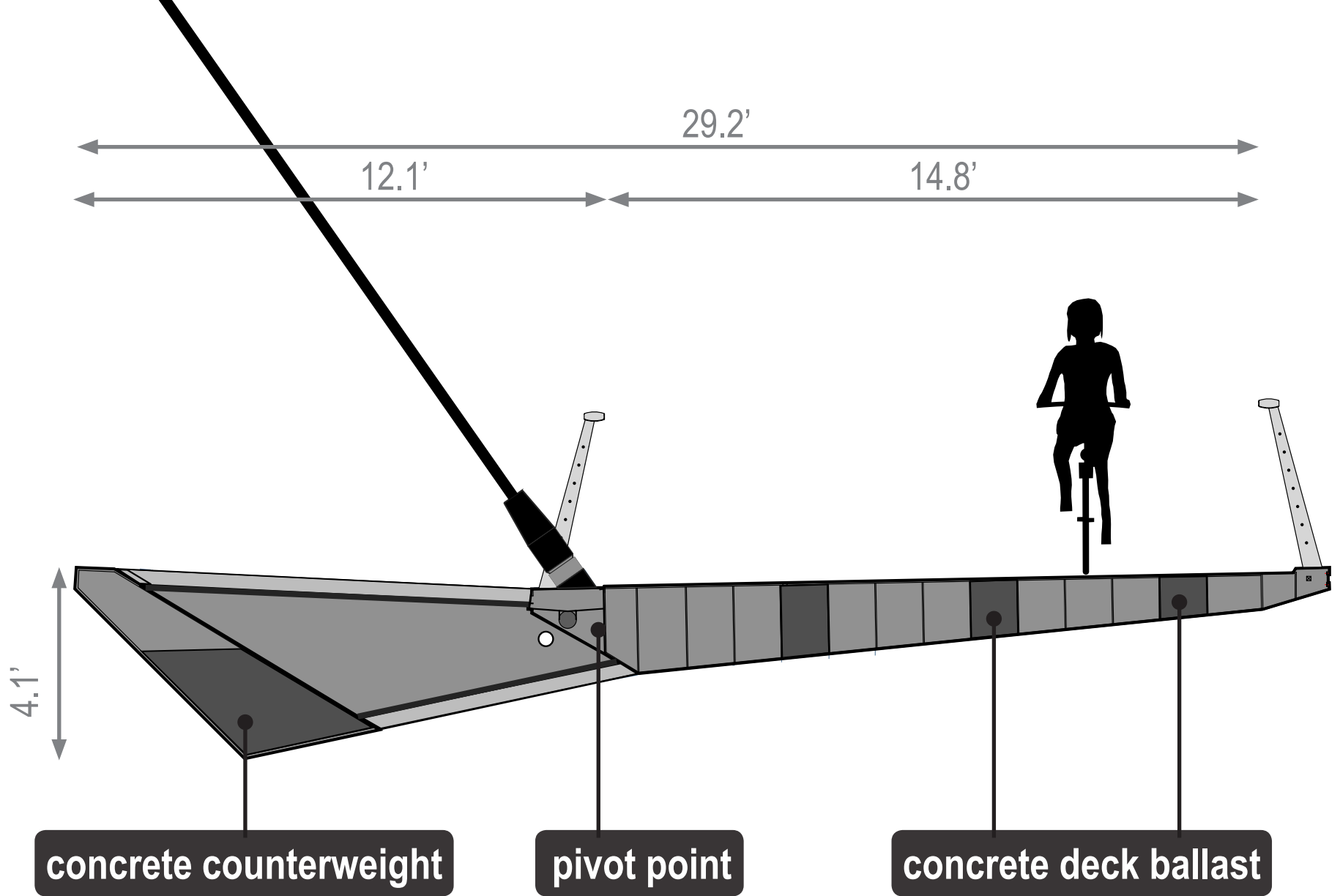
Collision Loads Concrete Barriers protect supports



Structural Design M-shaped supports ensure stability



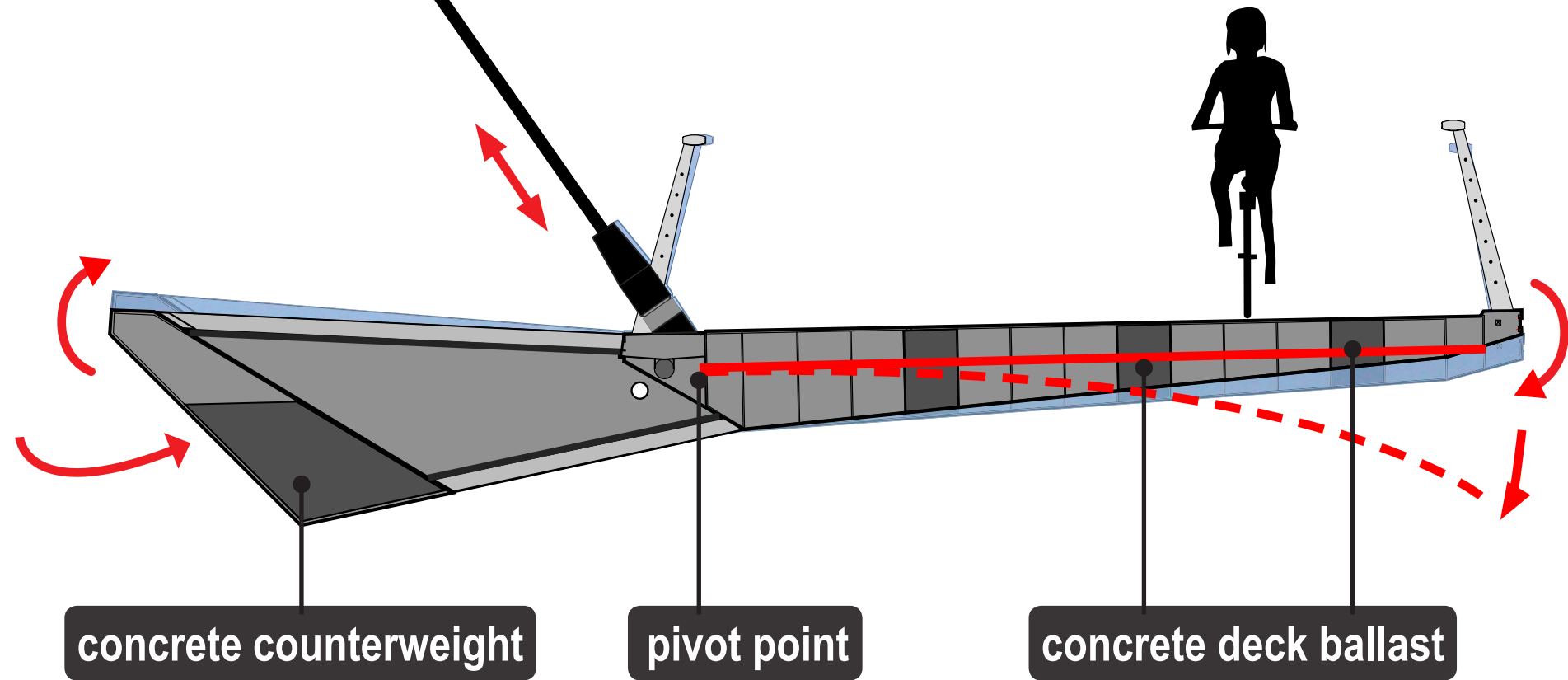
Structural Design Custom Made M-shaped supports



Structural Design

Structural Principle of circular bridge deck

- total deflection allowed at outer edge: 1.8"
- estimated self-frequency < 3 Hz
- damping by adding extra weight (concrete)



Structural Design Structural Principle of circular bridge deck



bridge deck

pivot point

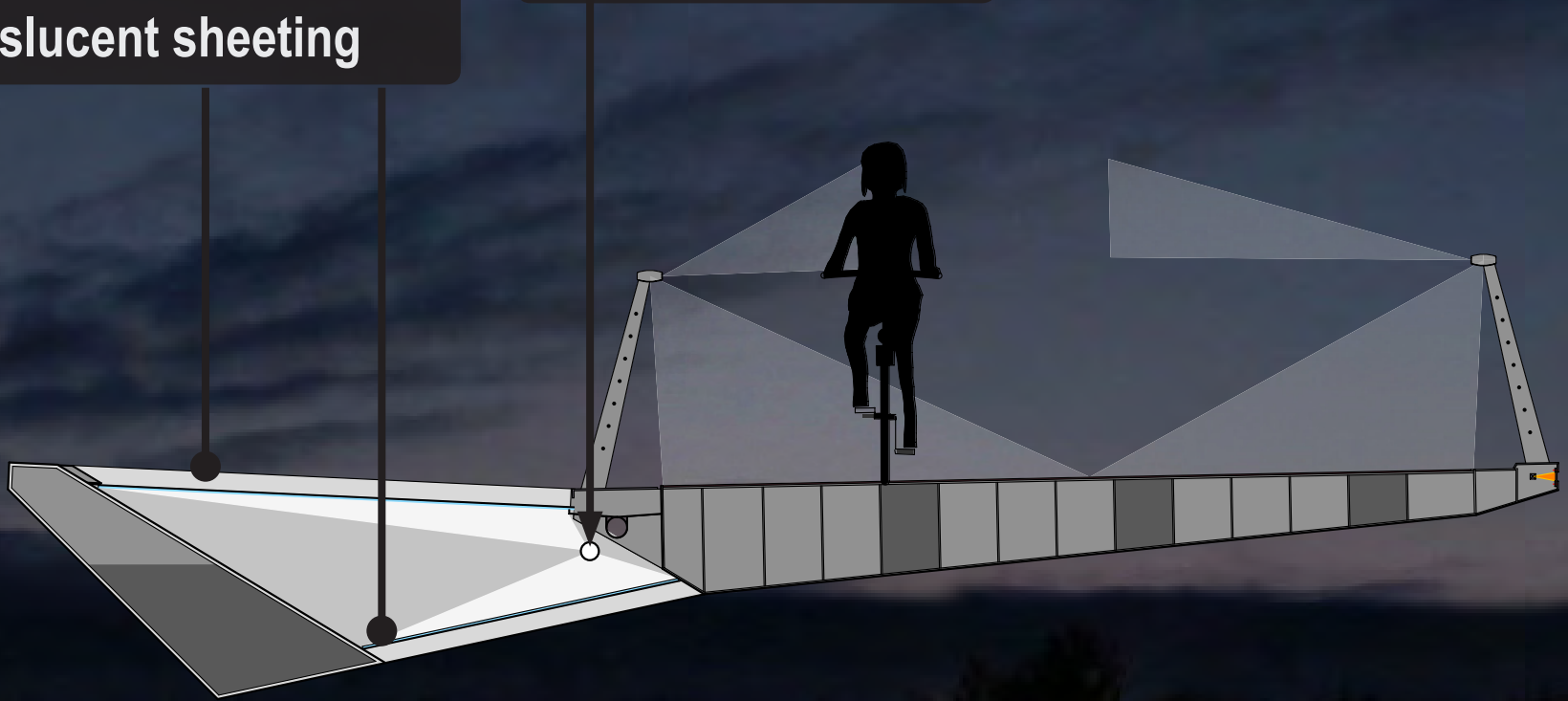
structural beam

counterweight

Structural Design Bridge Deck and Counterweight

**aluminium lamellas with
translucent sheeting**

one fluorescent tube



Lighting Design Architectural & Deck Lighting



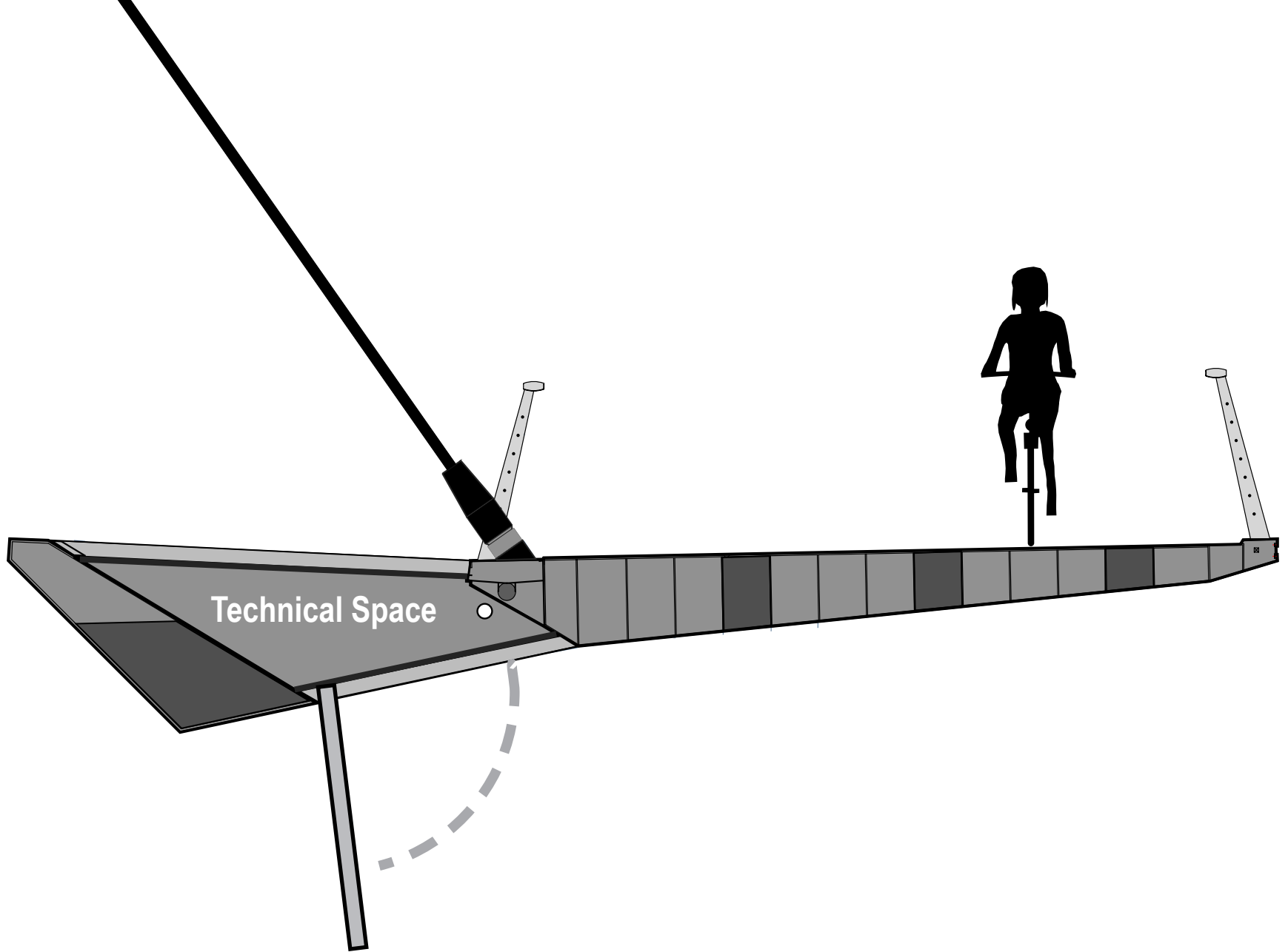
**aluminium lamellas with
translucent sheeting**

structural beam

Lighting Design Architectural Lighting



Lighting Design Architectural & Deck Lighting



Bridge Design Integrated Technical Space



Lighting Design Deck & Facial Lighting

LED facial lighting

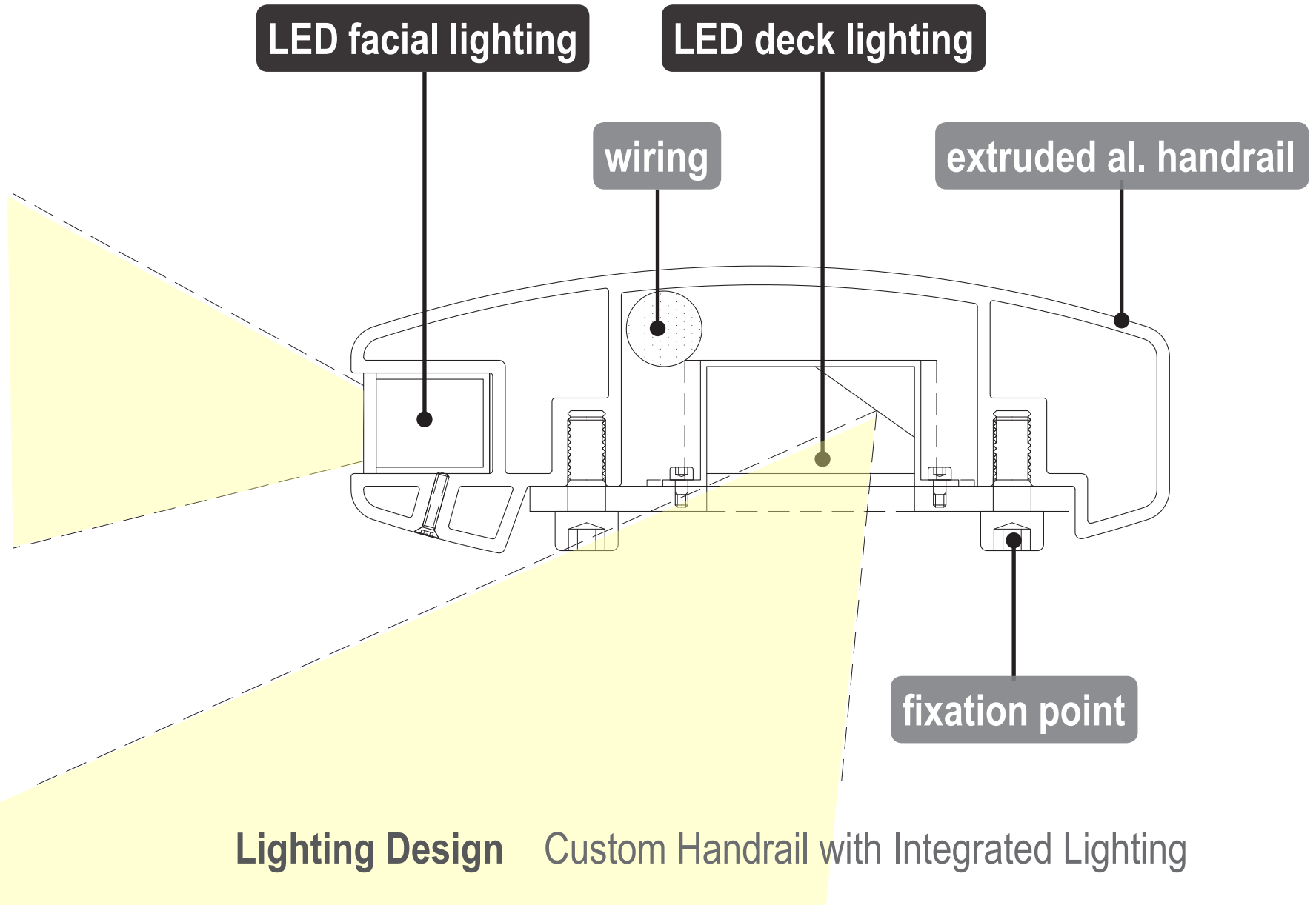
LED deck lighting

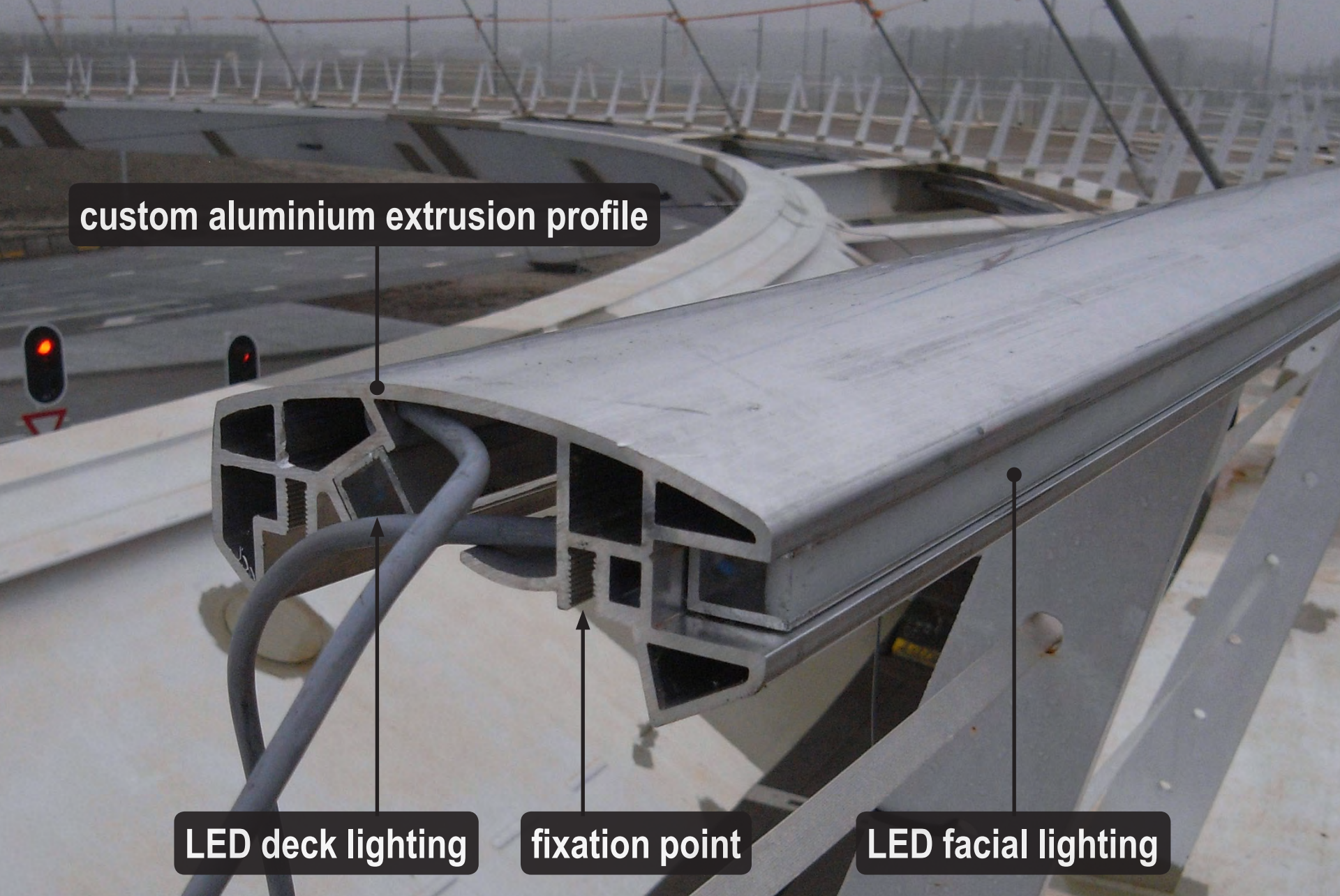
wiring

extruded al. handrail

fixation point

Lighting Design Custom Handrail with Integrated Lighting





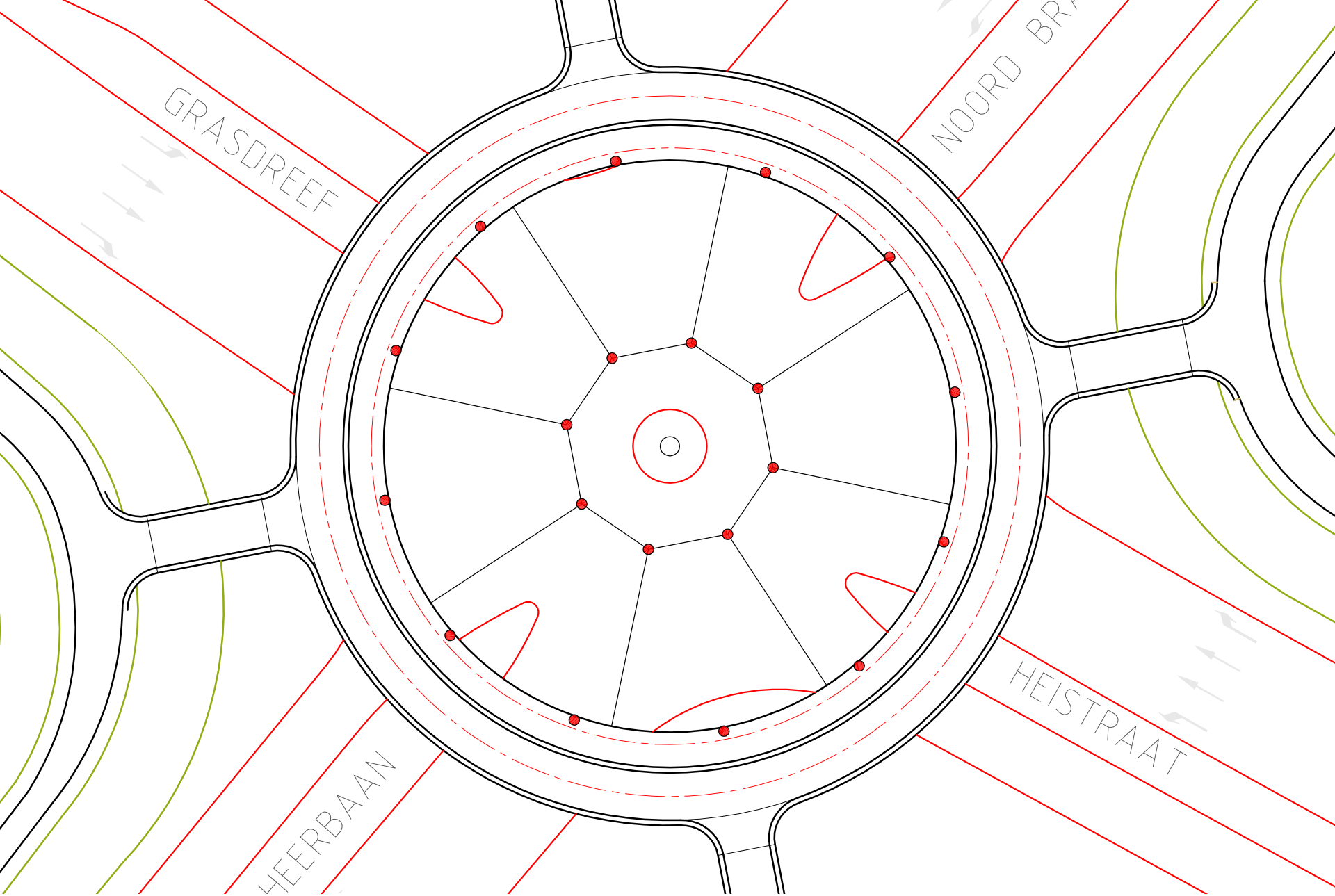
custom aluminium extrusion profile

LED deck lighting

fixation point

LED facial lighting

Lighting Design Custom Handrail with Integrated Lighting



Lighting Design Intersection Lighting



Lighting Design Intersection Lighting



Lighting Design Intersection Lighting

Seek Integration !

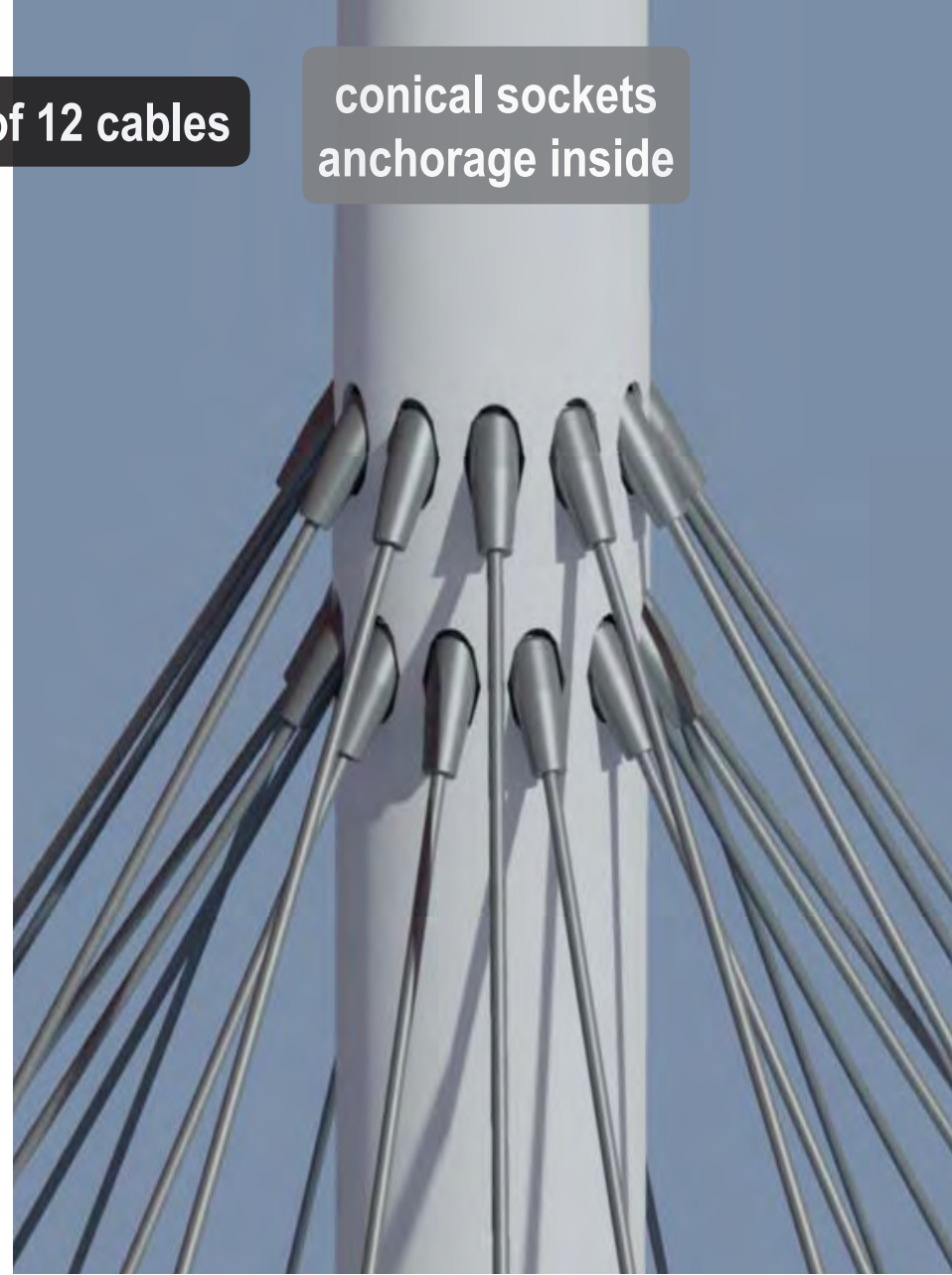
- design multi-purpose structures

Integral Design Integration of traffic lights, lighting and signage

**gussets and forks
anchorage outside**

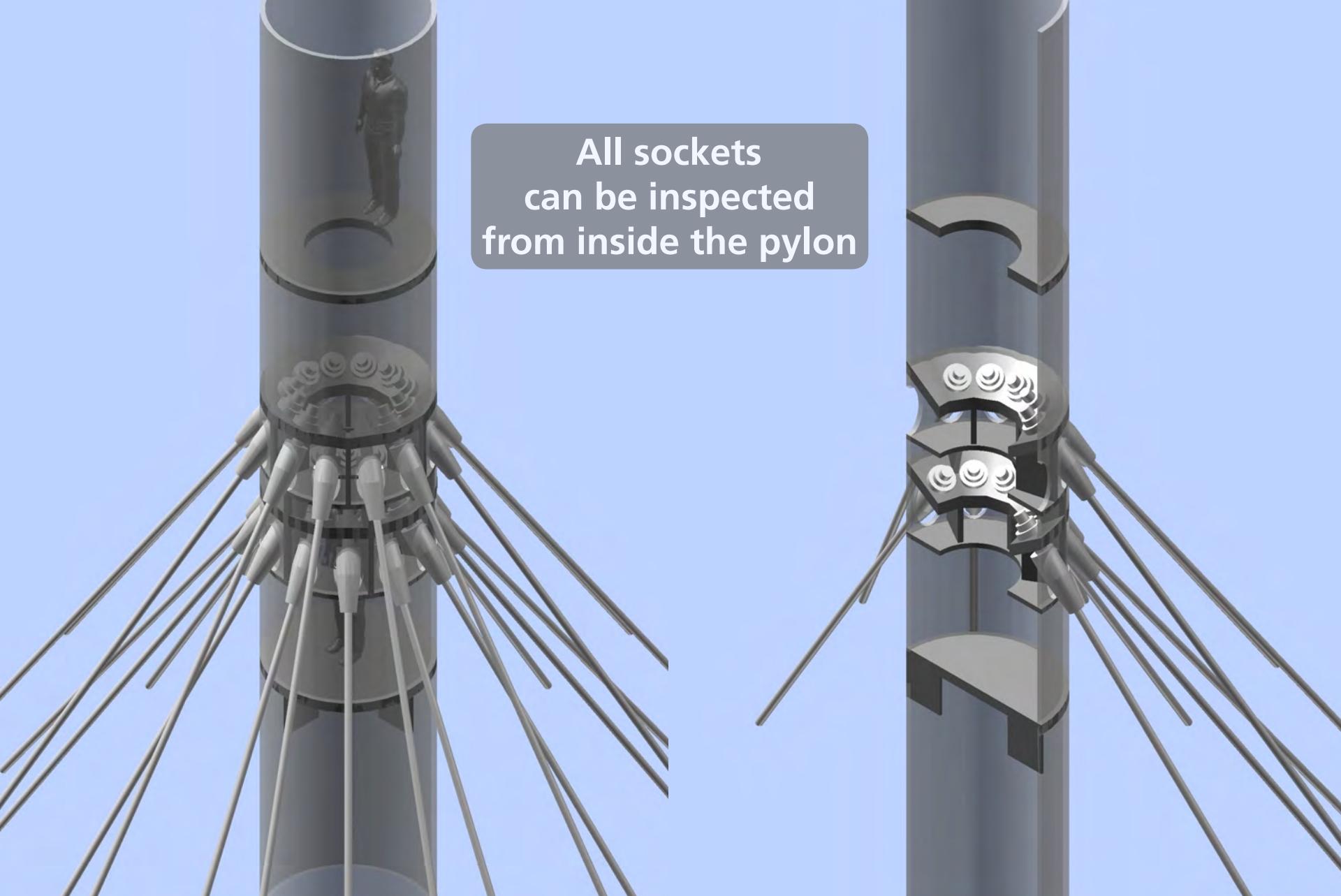
2 layers of 12 cables

**conical sockets
anchorage inside**

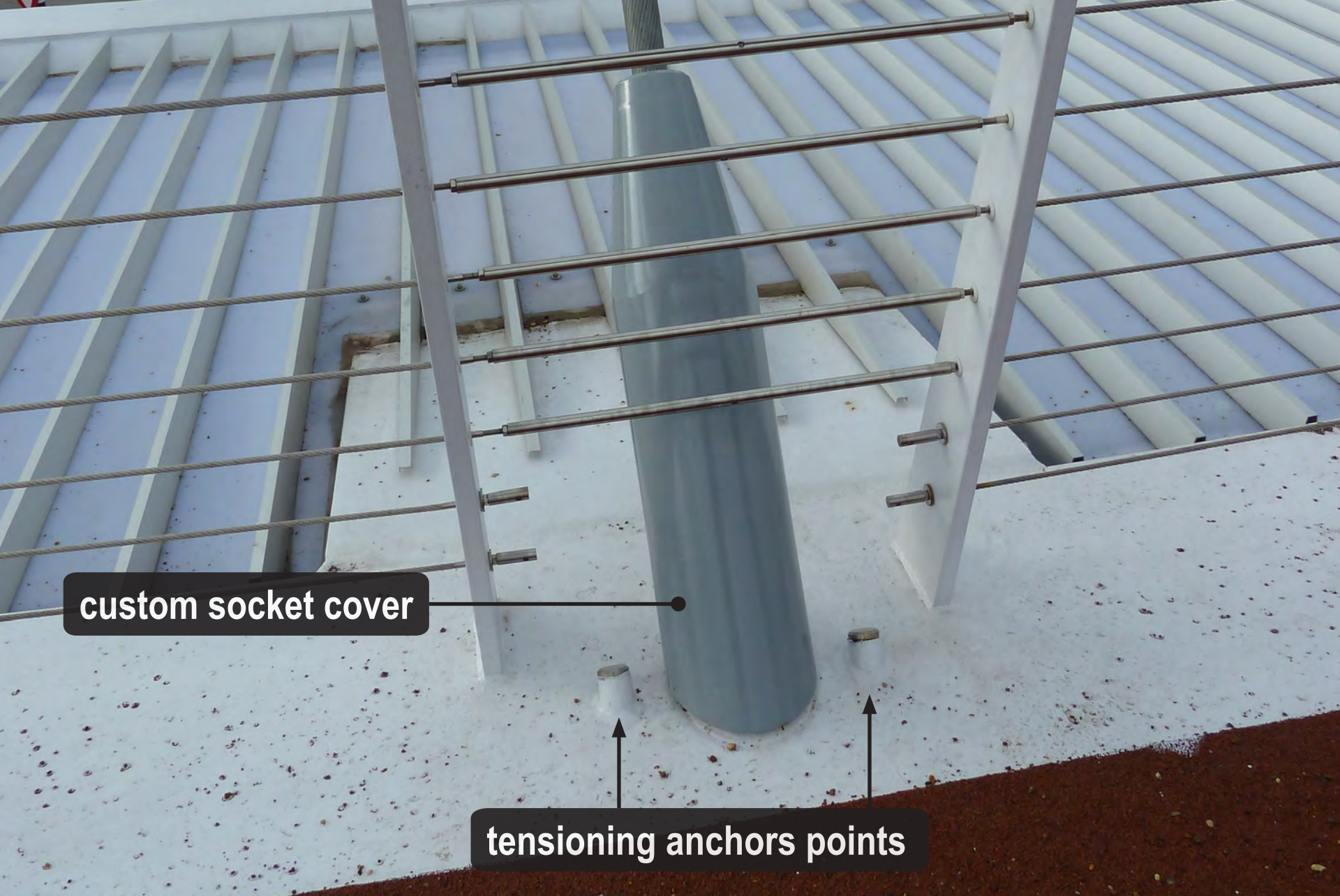


Design details Pylon Cable Anchorage

All sockets
can be inspected
from inside the pylon



Design details Pylon Cable Anchorage



custom socket cover

tensioning anchors points

Design details Custom Deck Cable Anchorage Cover



Design details Wind Induced Cable Vibrations

High Frequency



Low Frequency



Solution: 2 Types of Dampers

Design details Dampers to Prevent Wind Induced Cable Vibrations

Think Modular !



8 Bend Parts type 1

4 Bend Parts type 2

4 Connector Bridges

Construction Modularity

← Ø 72 m

8.9 m

L: 16 m



Construction Bend part Type 1

Costs

Bridge	€ 6.3 million
Intersection	€ 4.5 million

Funding

Eindhoven	40%
3 Grants	60%
Bridge Budget	€ 8.5 million

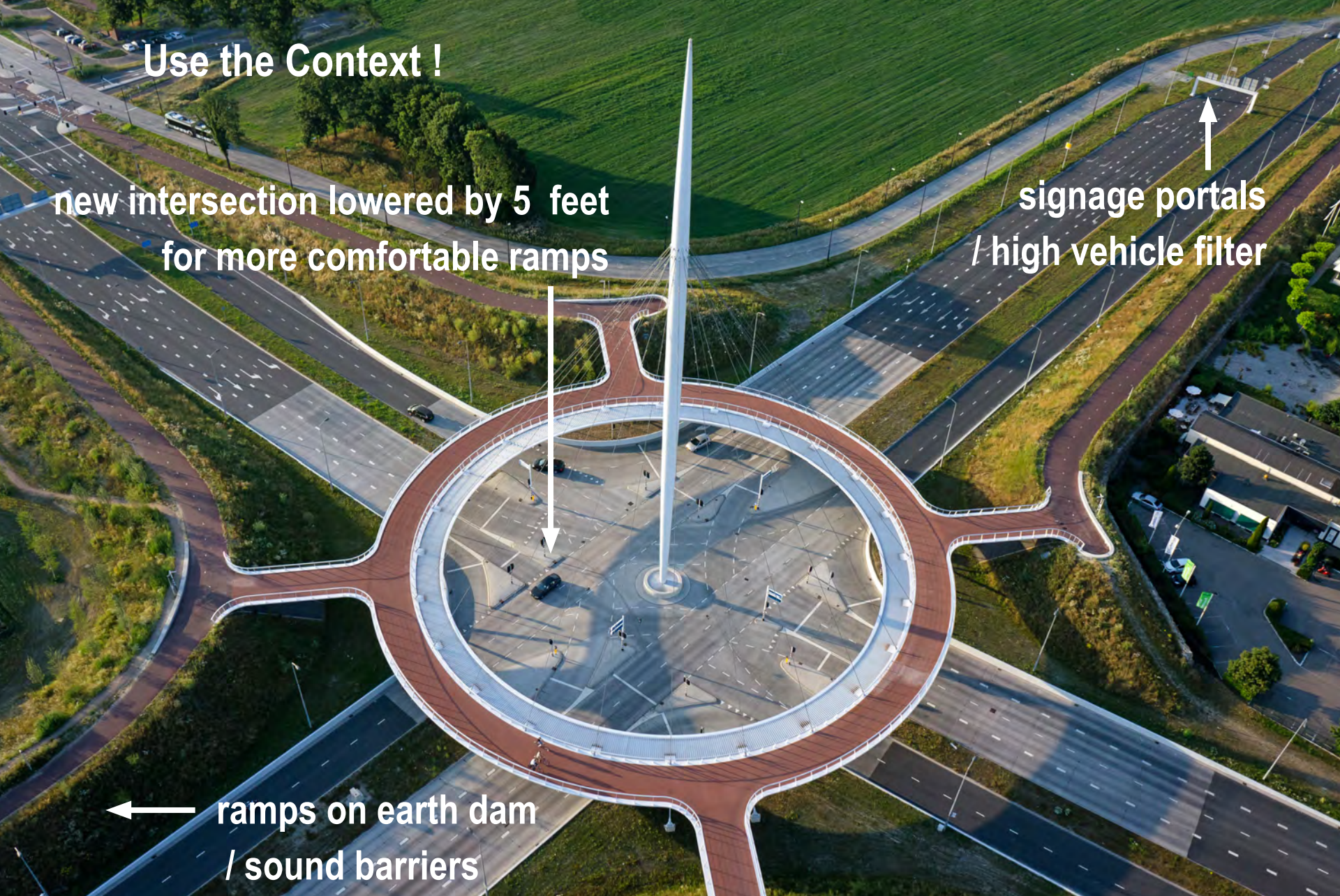
Daily Users

Cars	25000
Cyclists	5000 - 10000

Dimensions

Deck width	4.5 m
Deck Area	1300 m ²
Steel	1015 metric ton





Use the Context !

new intersection lowered by 5 feet
for more comfortable ramps

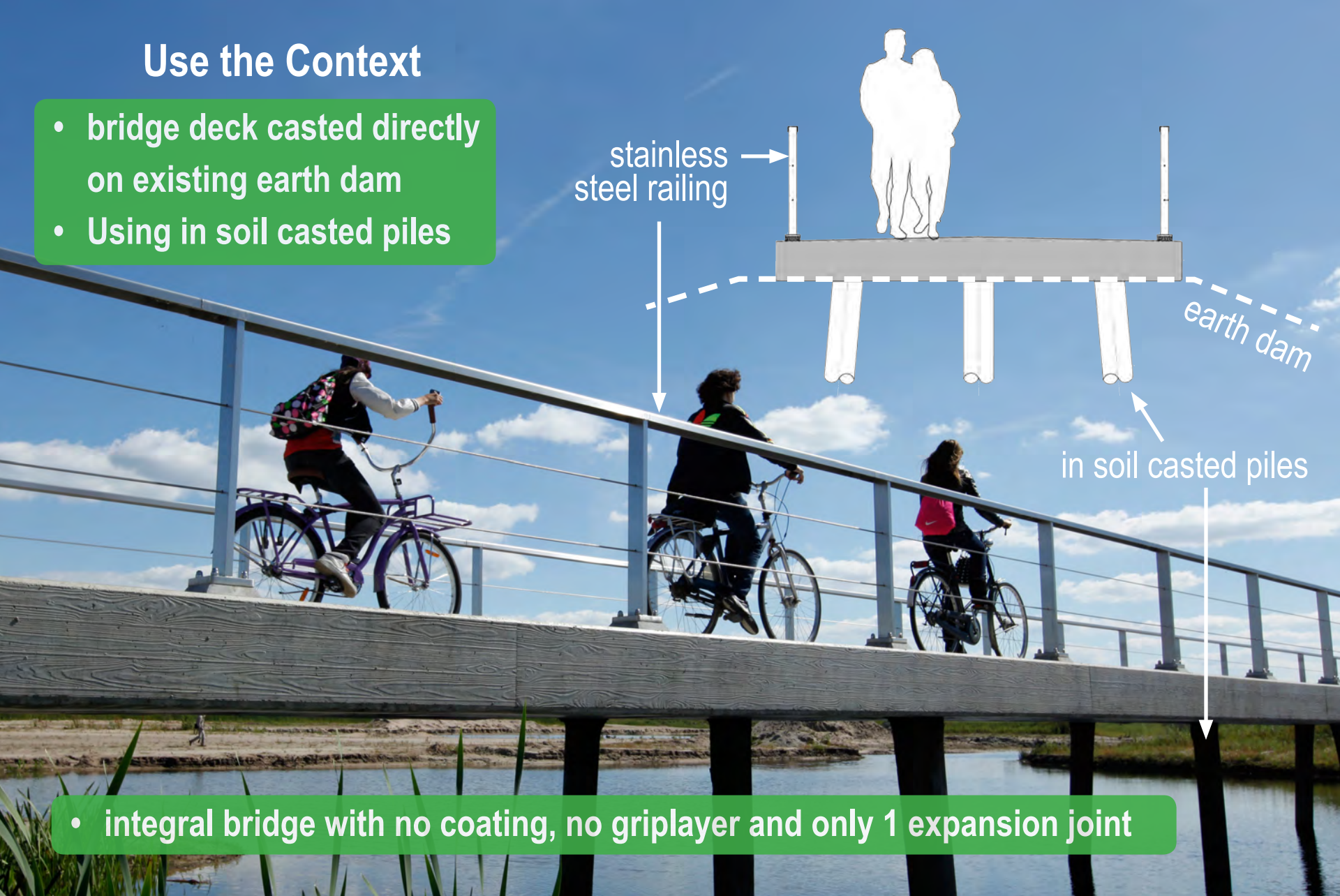
signage portals
/ high vehicle filter

← ramps on earth dam
/ sound barriers

Hovenring - Eindhoven

Use the Context

- bridge deck casted directly on existing earth dam
- Using in soil casted piles



- integral bridge with no coating, no griplayer and only 1 expansion joint

Breda Werkdonken bridge maintenance free using the context

Use the Context !



- costefficient and minimal hindrance during construction by using the context

Haarlem submerged bridge

Think Filter !



standard signage portal

- use the context to minimize the cost effects of extreme requirements

signage portals as high vehicle filter



Hovenring signage portal
saving 1 million in steel

Hovenring - Eindhoven

Think Filter !

- design a trucktrap before your foot-bridge preventing overdimensioning and unnecessary structural costs



stop unintended users

Think Modular ! / Use the Context !

- Economies of Scale by repeating parts

- Minimal construction hindrance by building within existing roundabout



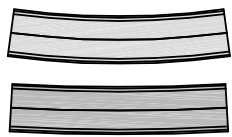
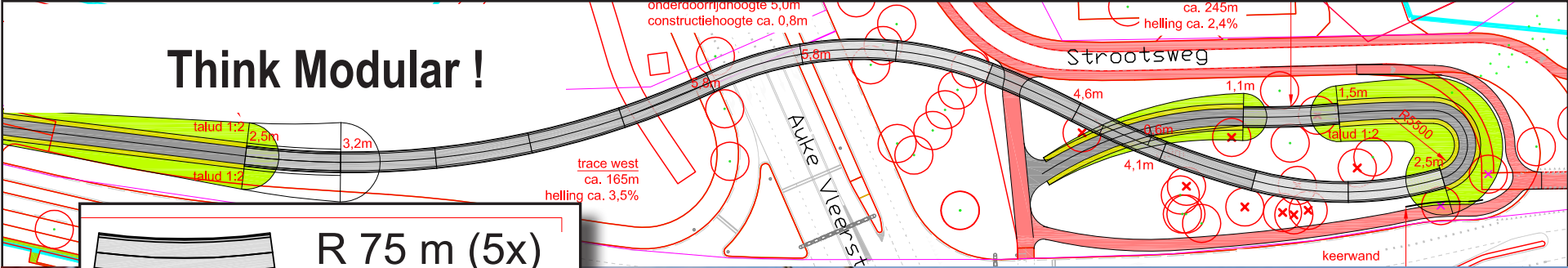
8 Bend Parts type 1

4 Bend Parts type 2

4 Connector Bridges

Hovenring - Eindhoven

Think Modular !



R 75 m (5x)

R 180 m (5x)

2 deck modules

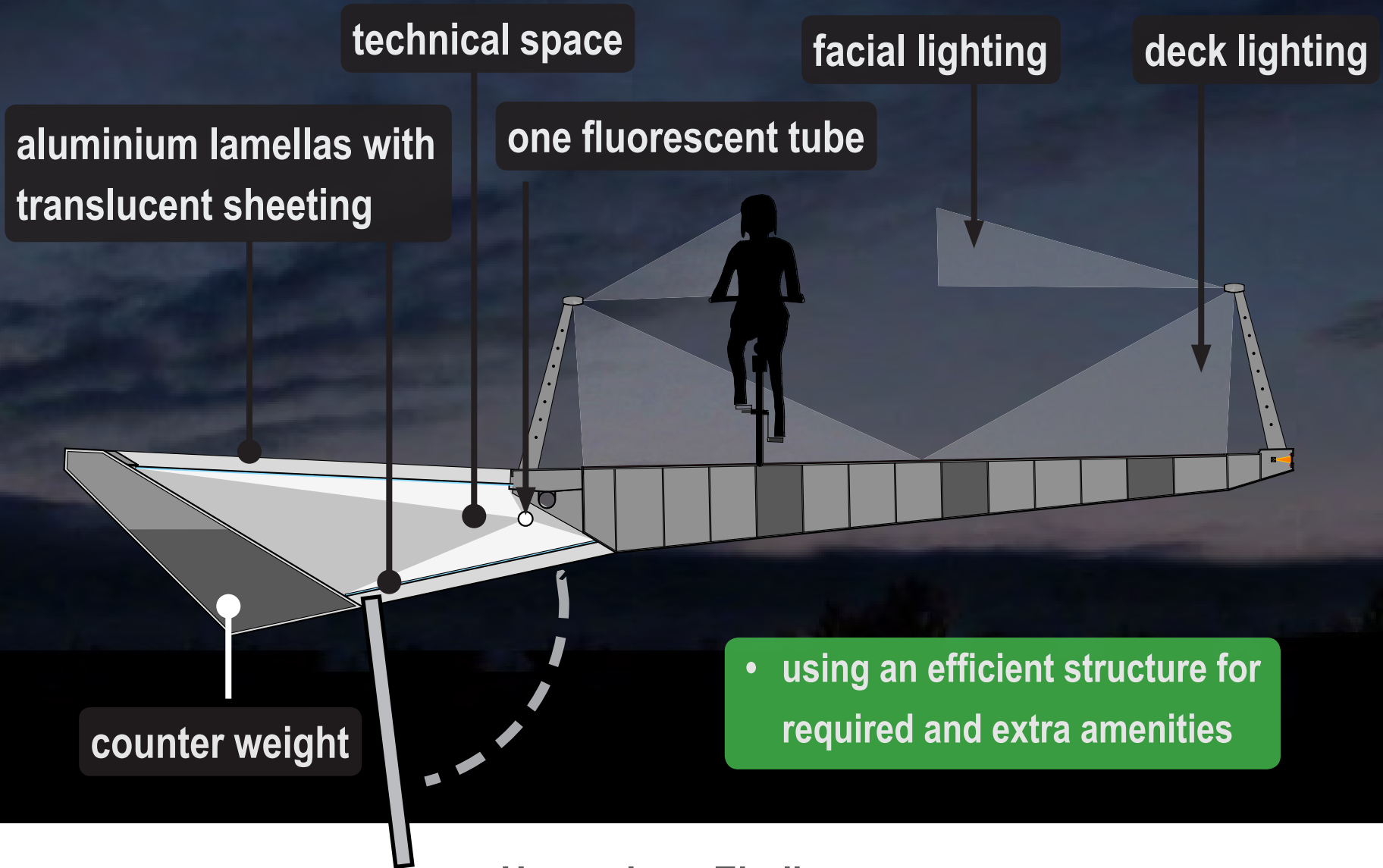
1 pier type

prefab deck

- economies of scale
- minimal hindrance during construction

Bicycle Bridge Enschede - build like a model train track

Seek Integration !



Hovenring - Eindhoven

Seek Integration !

- Easy to install and maintain by integration
- Economies of Scale by repeating parts

custom aluminium extrusion profile

LED deck lighting

fixation point

LED facial lighting

Hovenring - Eindhoven

Seek Integration !

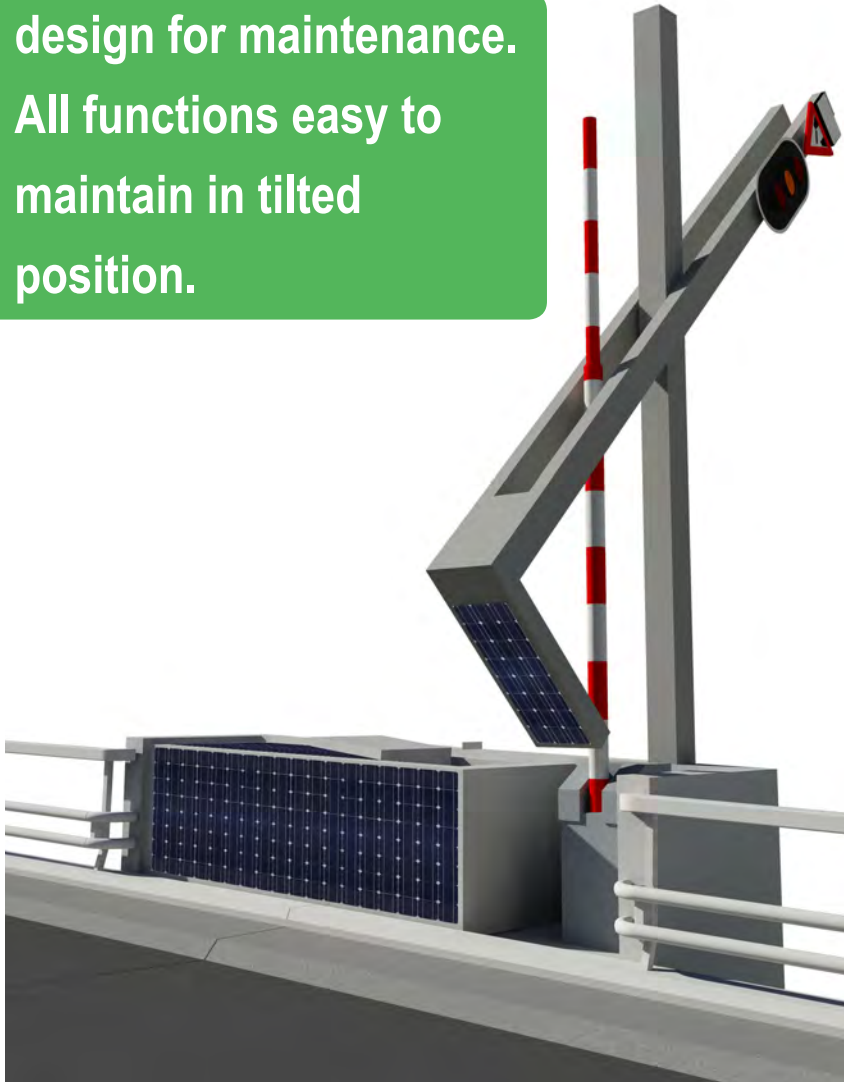


- design multi-purpose structures

Intersection Nijmegen Integration of traffic lights, lighting and signage

Seek Integration !

- design for maintenance.
All functions easy to maintain in tilted position.



tiltable multi-functional mast for movable bridge

Seek Integration !



- design multi-purpose structures

antithrow-screen

Seek Integration !

- structural railing to minimize height to overcome and spare the context



Rotterdam Waalhaven bridge

Seek Integration !

- structural railing to minimize height to
- overcome and vertical clearance below deck



Amersfoort Bridges Park Randenbroek

Seek Integration !

pedestrian deck

bike deck with low grade

- one structure for two decks

Zwolle Tanerij Bridge structure between decks

Seek Integration !



Modular Truss Bridge offering shading, green, park and all you can think off

Seek Integration !



Movable Bridge assen bench as technical space

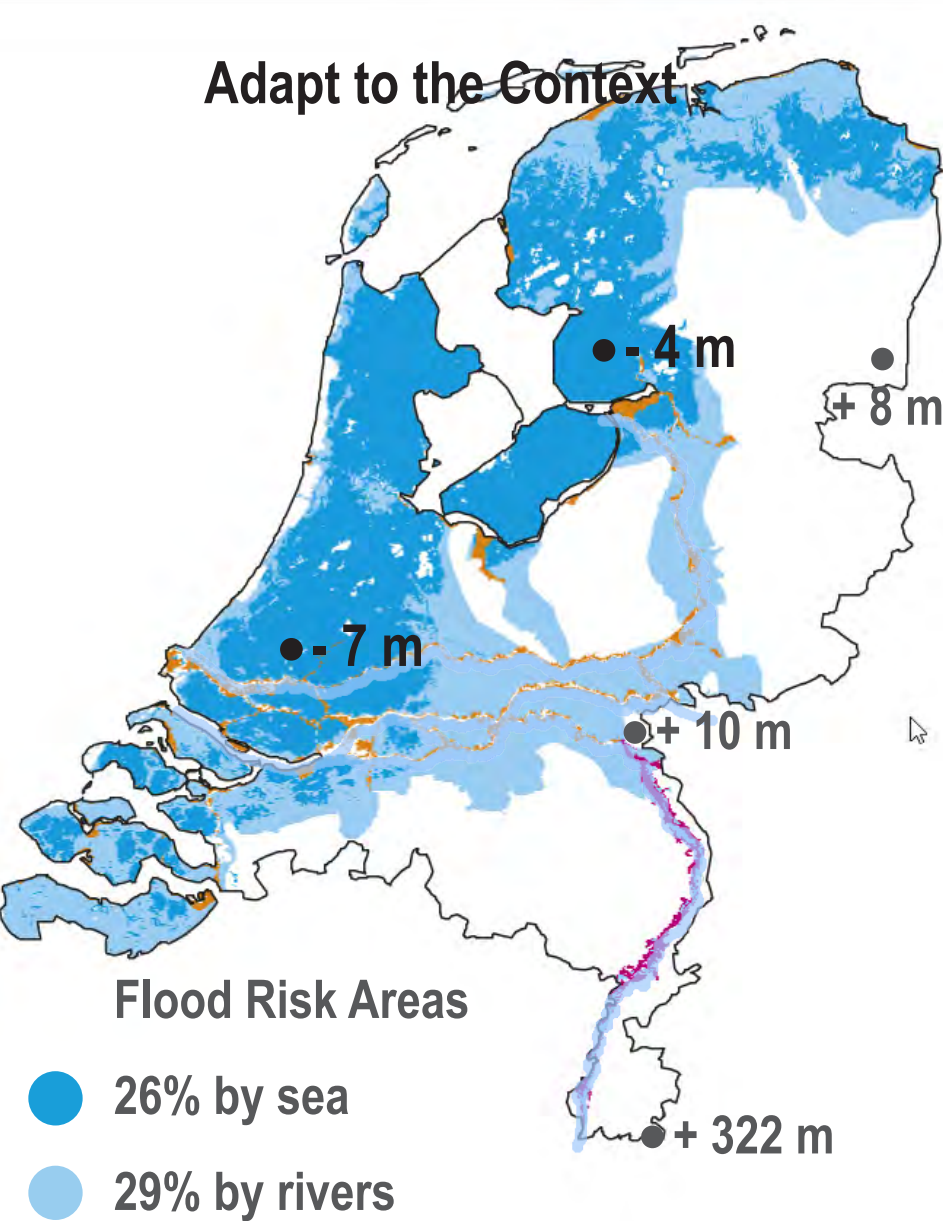
Seek Integration !



- multi use of this tollway gantry could have resulted in a free footbridge and easier maintenance when using ramps

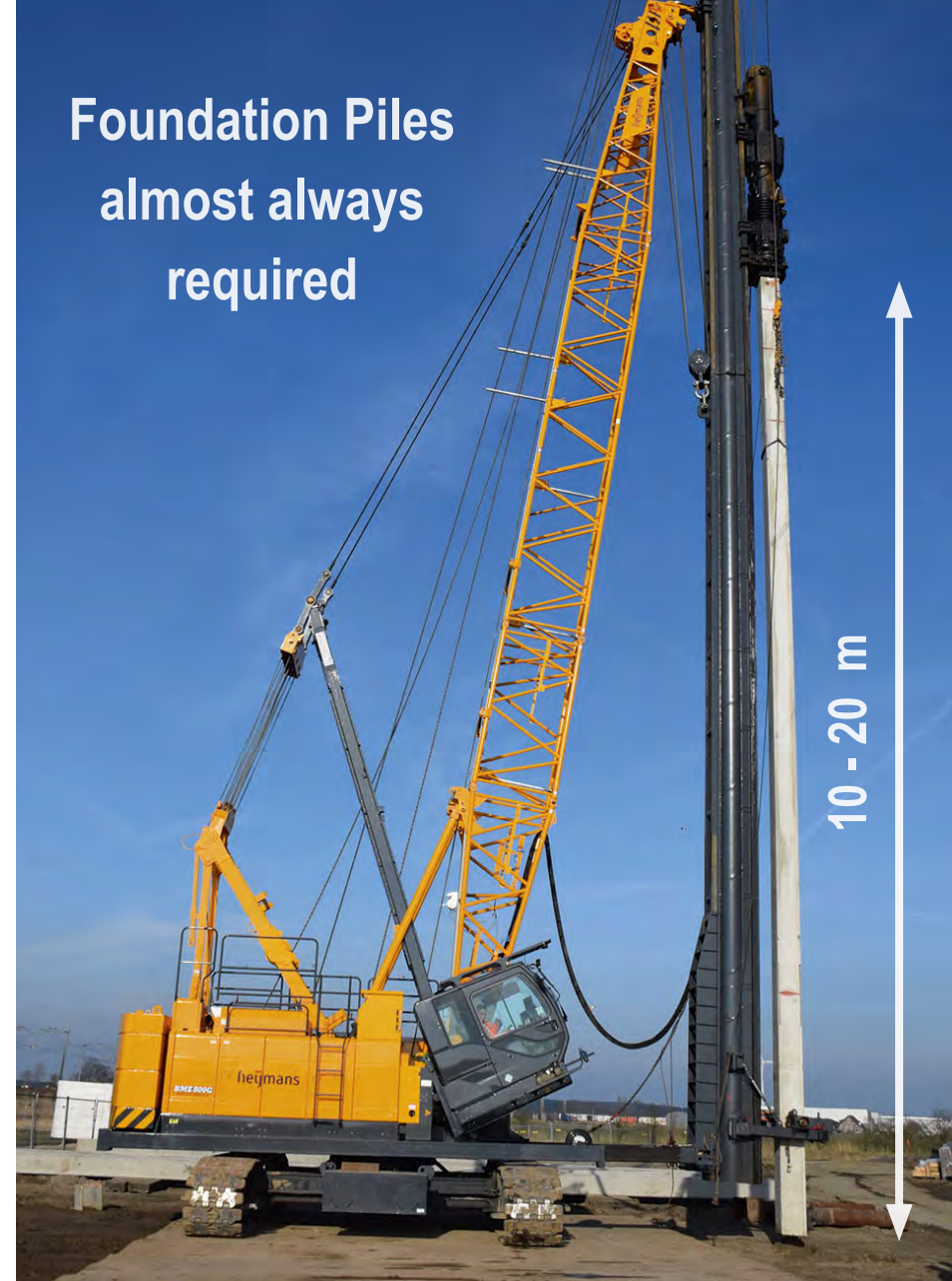
Rigid Tollway Gantry A footbridge can offer the same functionallity better

Adapt to the Context



Context (national) natural constraints

Foundation Piles
almost always
required



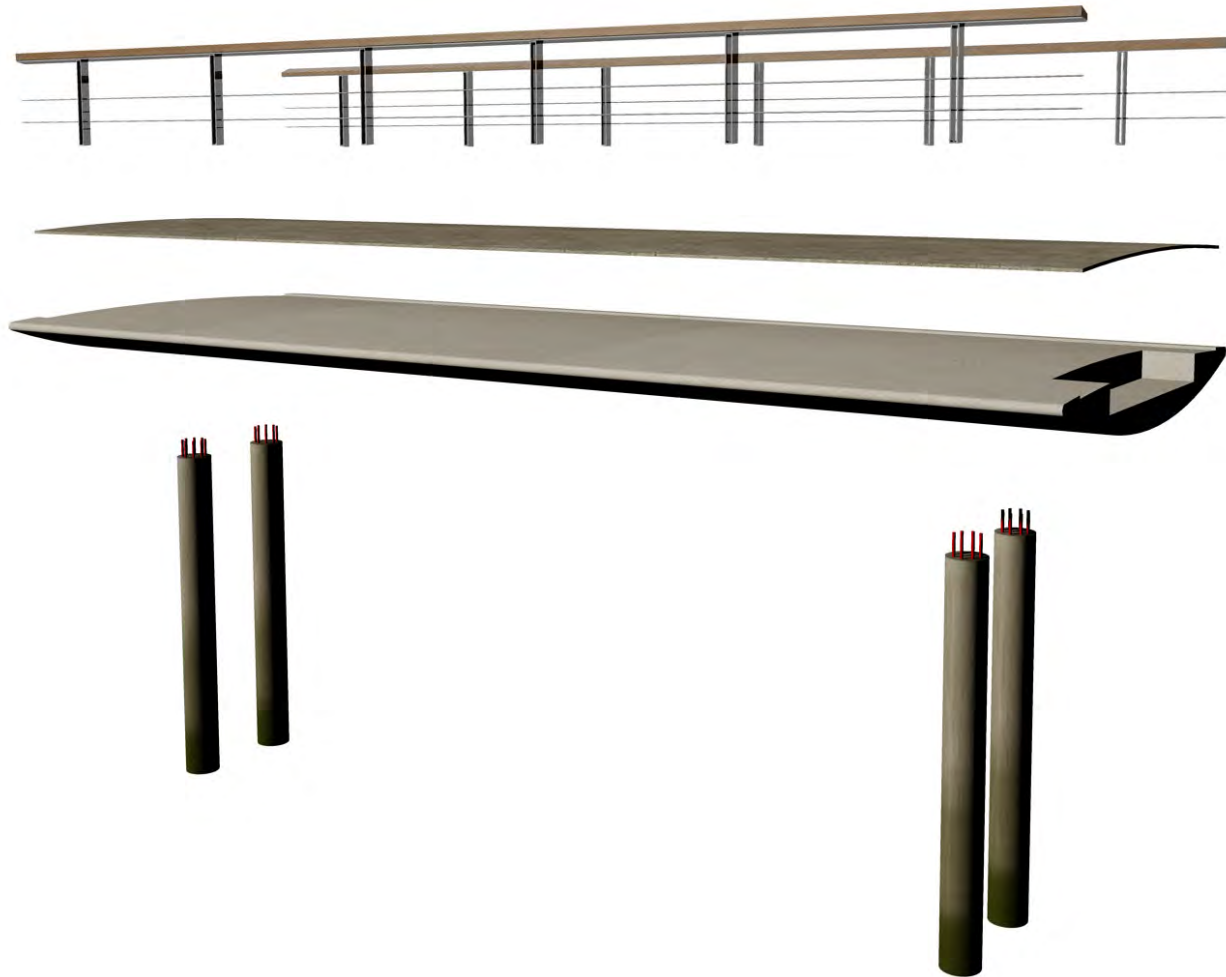
Adapt to the Context



- hydrodynamic deck
- breakaway railing

Submersible Hydrodynamic bridge for floodplains

hydrodynamic bridge - module principle



Context (national) bridge concepts to cross flooded area

Adapt to the Context



Seek Integration

- **integrate amenities for wildlife and leisure in contextproof solution**



bridges for floodplains

Seek Integration !



pumping stations
with viewing platforms



- integrate amenities for wildlife and leisure

Amenities for Wildlife and Leisure

Seek Integration !

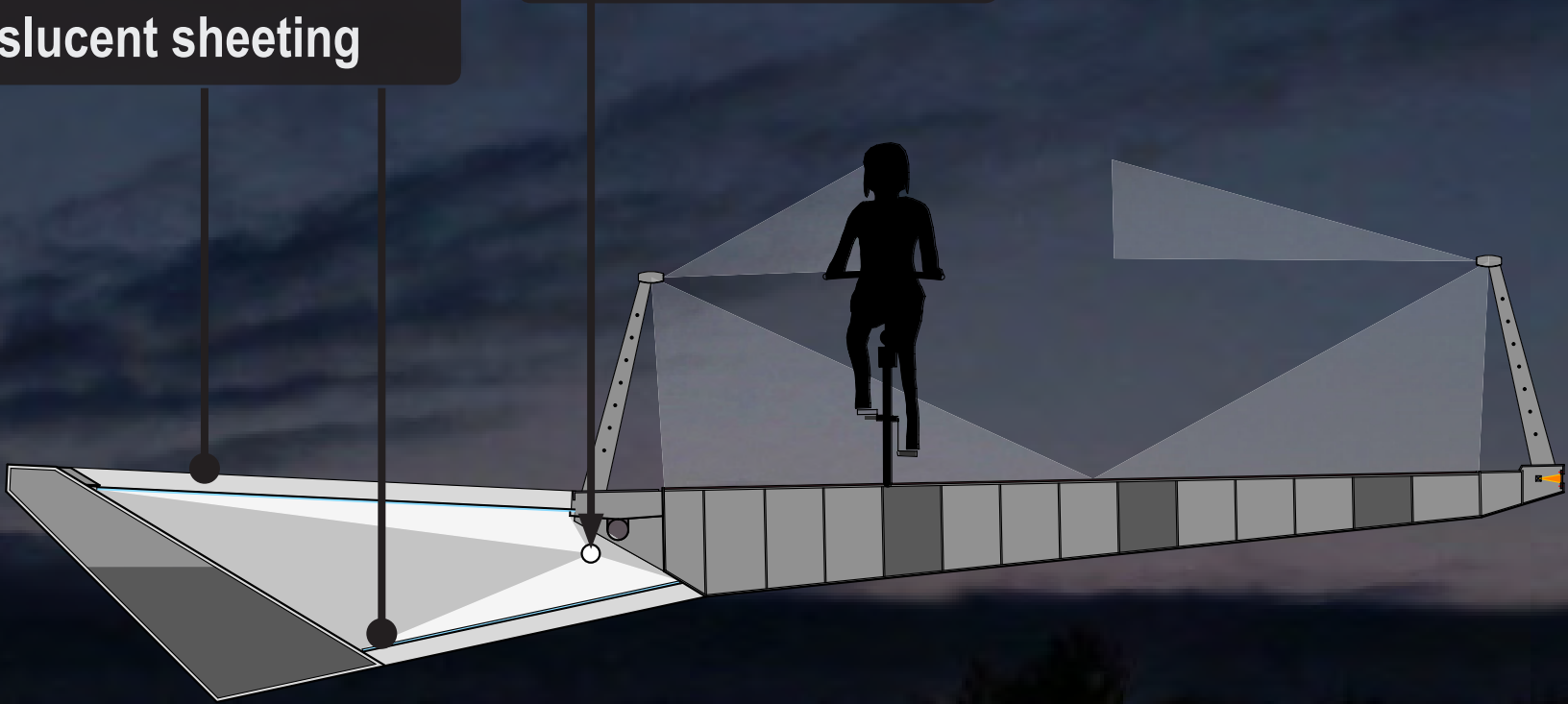


Amenities for Wildlife - San Rafael The Marin North-South Greenway

Lighting and Illumination !

aluminium lamellas with
translucent sheeting

one fluorescent tube



Lighting Design Architectural & Deck Lighting

Lighting and Illumination !

- costs bridge: €1.200.000
- costs illumination €10.000



Dolder Bridge Steenwijk



Landgraaf Arch Bridge - Arch illumination



Landgraaf Arch Bridge - Arch illumination

Lighting and Illumination !



bridge Venlo

Lighting and Illumination !



bridge Venlo

Lighting and Illumination !



Square Roosendaal

Lighting and Illumination !



Bernard Viaduct The Hague

Lighting and Illumination !



Schiphol Airport Amsterdam

Lighting and Illumination !



Undercrossings Leiden

Lighting and Illumination !



China Town The Hague

Lighting and Illumination !



Illumination of parliament building The Hague

Lighting and Illumination !



Illumination of old railroad bridge Rotterdam

Tender smart !



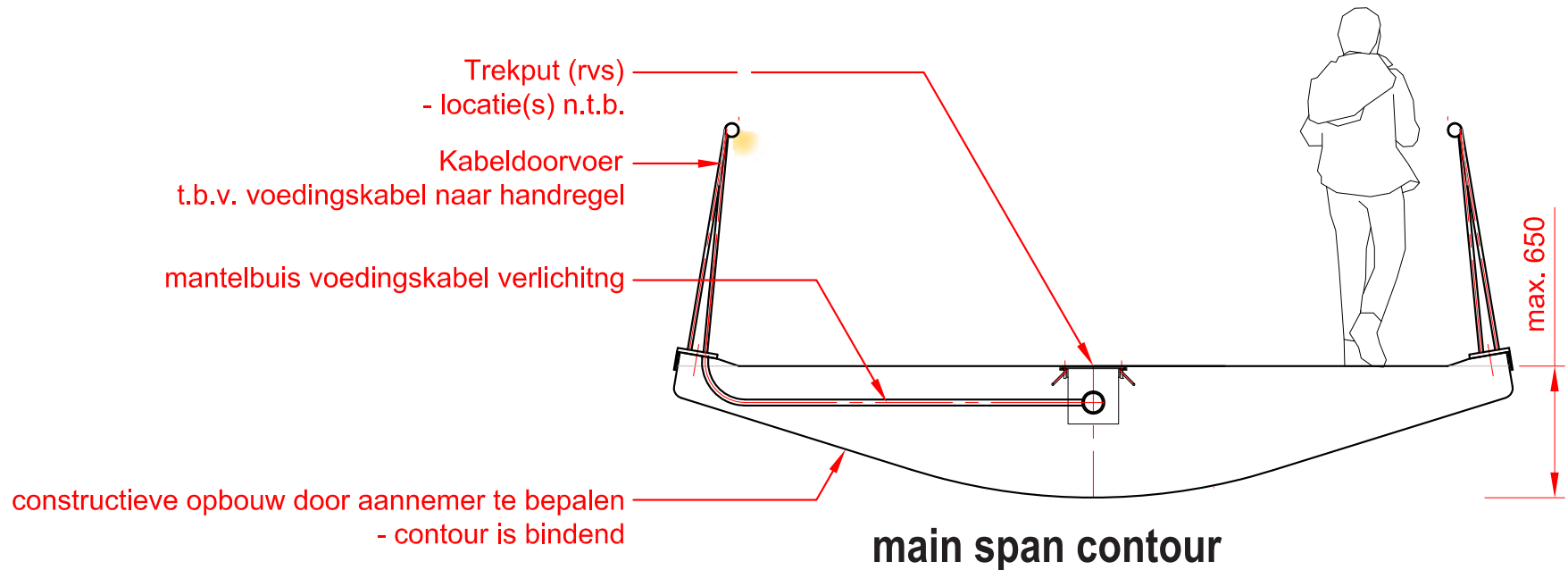
Heerhugowaard Station bridge Alignment Fitting in the Context

Possible main span materials

- steel
- stainless steel
- high performance concrete
- fiber re-inforced composite

bonus

no bonus
€ - 125.000,-
€ - 175.000,-
€ - 175.000,-



Facts & Figures

- bridge length 450'
- ramp length 360'
- width 12' mainspan, 13' straight slopes, 20' corners
- costs: €1.7 million



Main Span

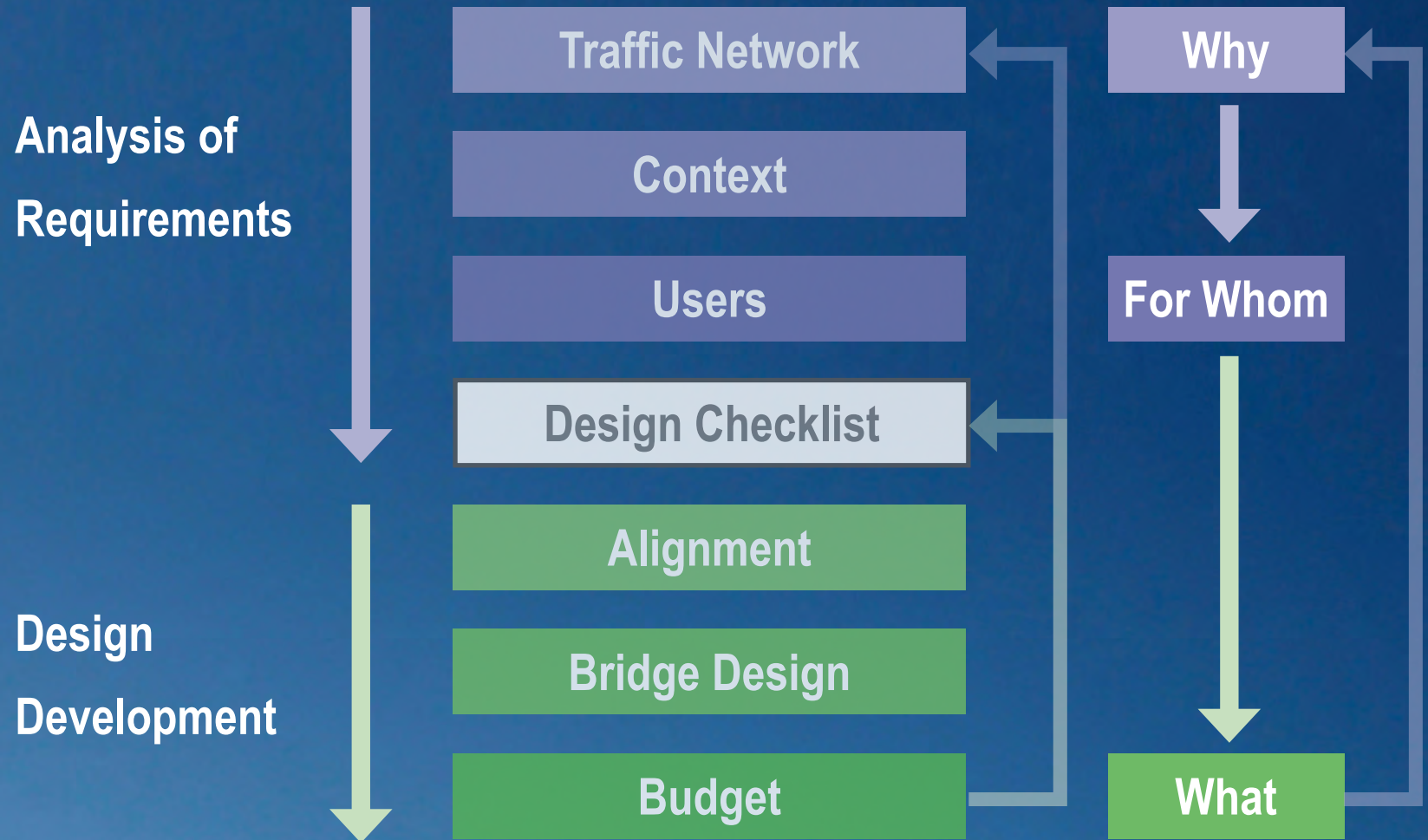
High Performance Concrete

Ramps

On Site Concrete

Heerhugowaard Station bridge Maintenance Free Main Span

A Thorough Analysis

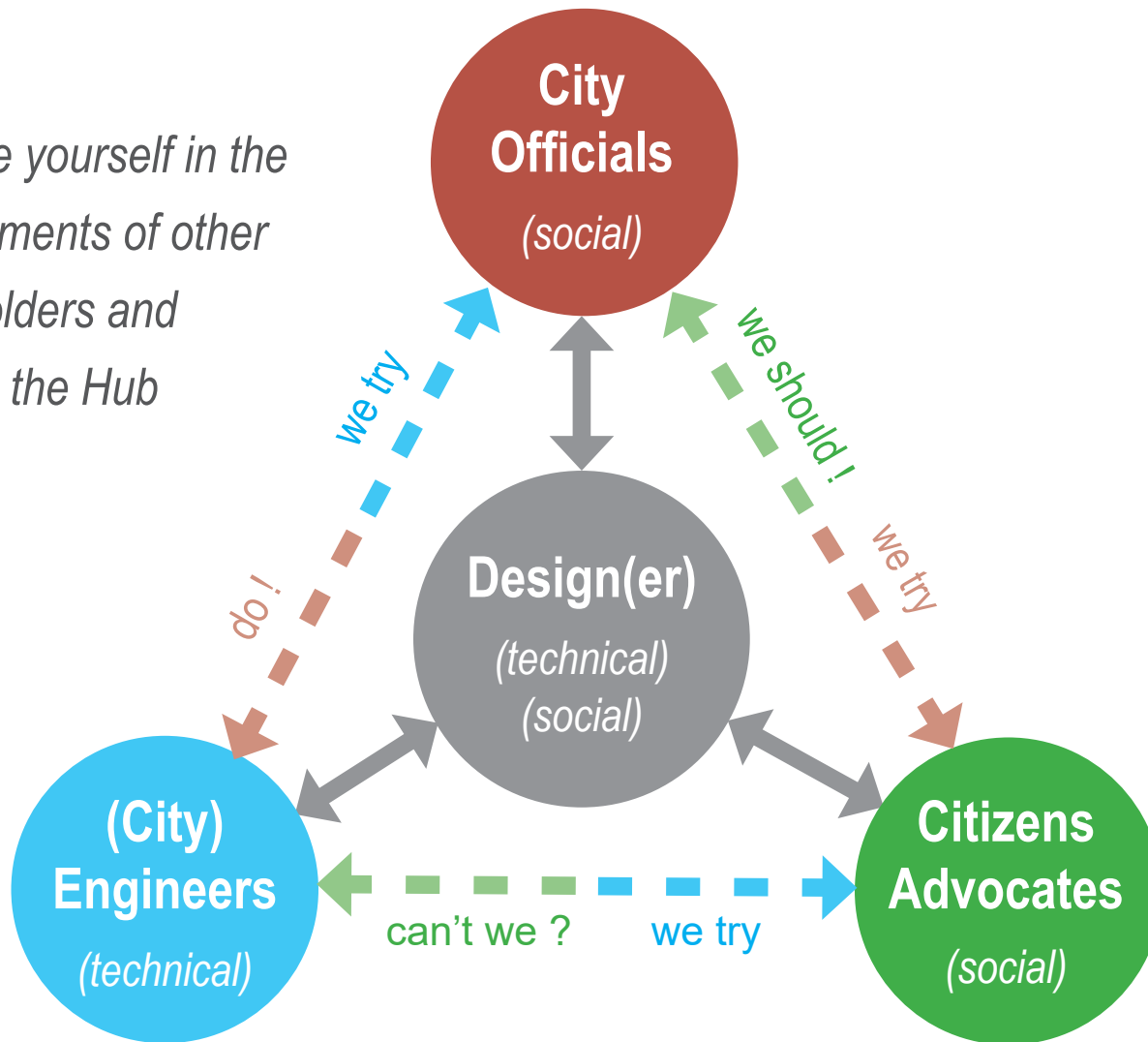


Dutch Design Manual

Create Understanding

Between representatives of Technical & Social requirements

Immerse yourself in the Requirements of other Stakeholders and become the Hub



Dutch Design Manual

Start with the Crossings

Because Crossings are:

- Hard to Integrate
- Hard to Upgrade
- Advertisers / Kickstarters
- Gapclosers



Contextual Benefits

- Lowering intersection for comfortable ramps



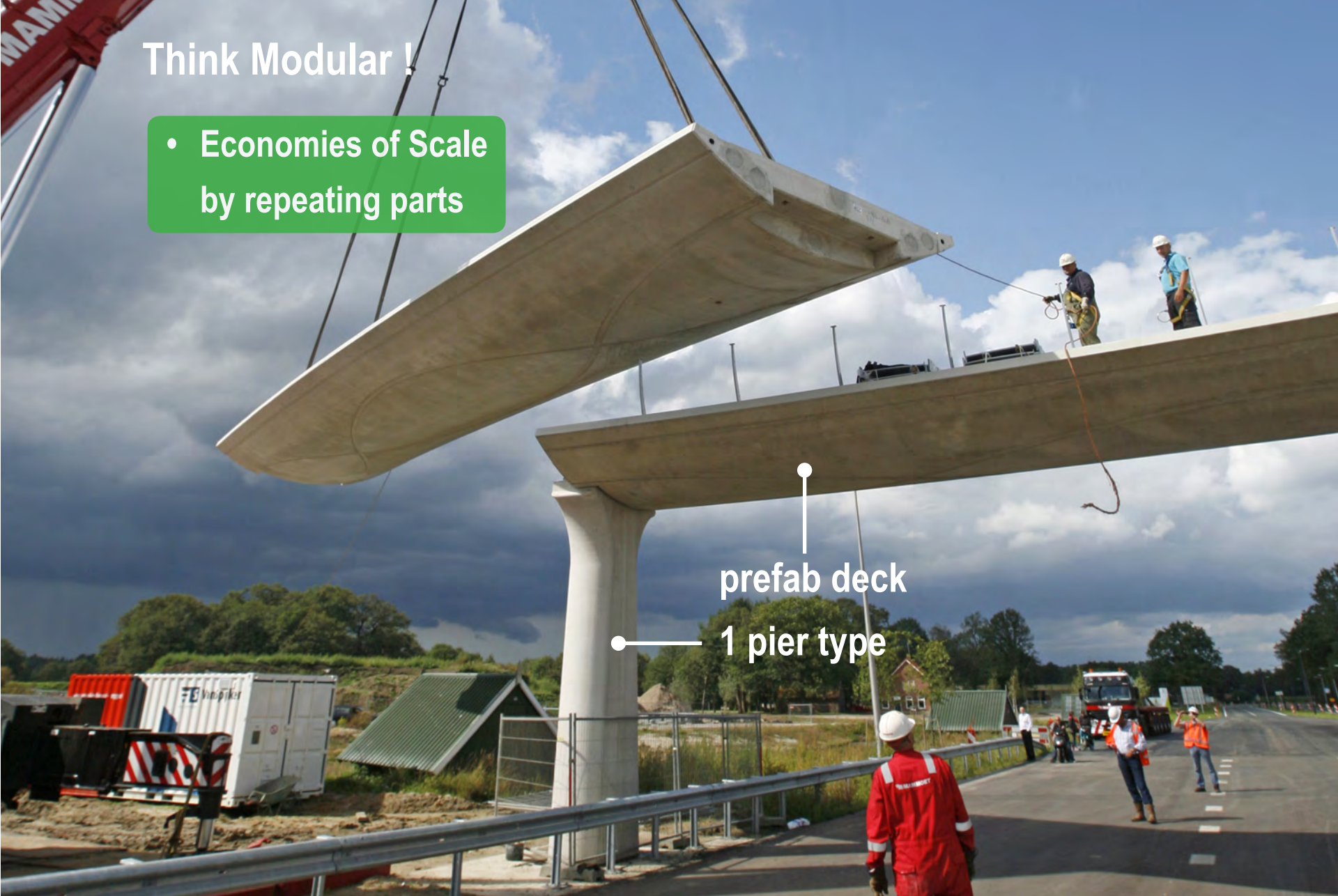
Eindhoven Hovenring benefits from the context

Think Modular !

- Economies of Scale by repeating parts

prefab deck
1 pier type

Enschede Bridge Modular Construction



Think Filter !

- Signage portals as high traffic filter



Collision Loads Anti-Collision Portals - Cost-saving Filters

Seek Integration !

custom aluminium extrusion profile

LED deck lighting

fixation point

LED facial lighting

Lighting Design Custom Handrail with Integrated Lighting

Seek Integration !



Users Not intended visitors (Latin American mayor delegation 2017)

Seek Integration !



Integral Design Integration of traffic lights, lighting and signage

Tender Smart: Develop Client Side what you know best !



Budget Tender & Contract format

[illegible]

Travel Time bike & car
Equal up to 4 mile

Beach

8 mi

4 mi

Amsterdam

Airport

Haarlem

Schiphol

Diemen

Amsterdam-Noord

Amsterdam-Nieuw-West

Amsterdam-Zuidoost

Amstelveen

Stadshart

Ouderkerk aan de Amstel

Weesp

Aalsmeerderbrug

Aalsmeer

Nieuw-Vennep

Lisse

Hillegom

Zwaanshoek

Bernebroek

Cruquius

Vijhuizen

Heemstede

Landvoort

Bloemendaal

Bloemendaal aan Zee

Nationaal Park Zuid-Kennemerland

Santpoort-Noord

IJmuiden

Velsen-Noord

Beverwijk

Wijk aan Zee

Wormerveer

Wijdewormer

Landdijk

Koog aan de Zaan

Zaandam

Oostzaan

Den IJp

Ilpendam

Mennickendam

Katwoude

Gouwzee

Mark

Uithoorn

Broek in Waterland

N247

N518

N235

N208

N200

N201

N205

N206

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Seperate Bikepath /
Maintenance Path

Cycling infrastructure seperate bike paths along roads

Dutch King

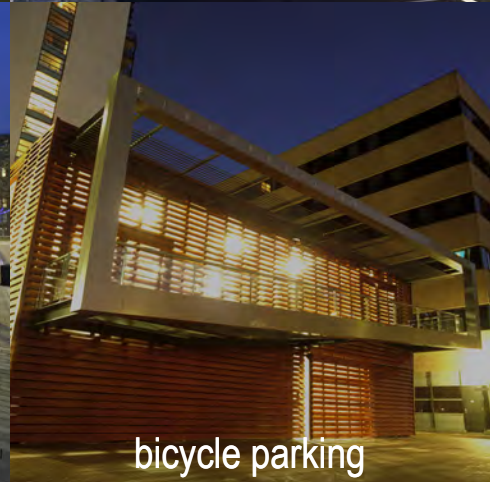
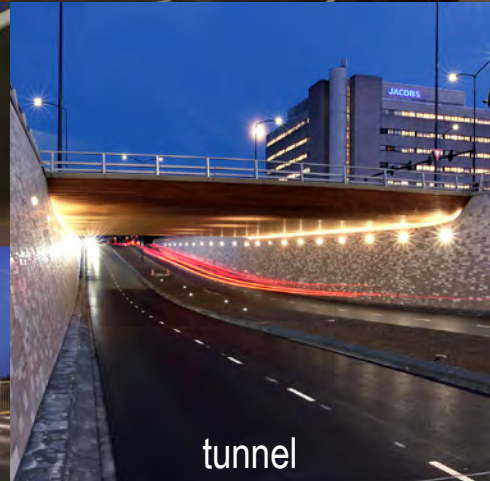
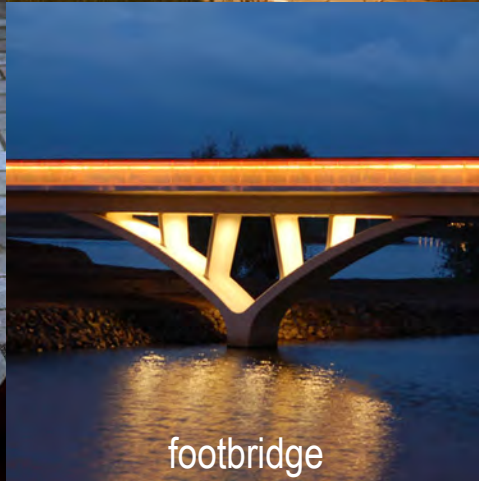
18 million bikes

- **> 14 million trips / day**
- **21.700 mi bike path**
- **1550 mi highway**
- **8 million cars**

Cycling infrastructure separate bike paths along railroads

ipv Delft

- infrastructure
- urban furniture
- architecture
- lighting



Conclusions

To develop interwoven infrastructure that satisfies all involved and their requirements:

- **Analyse** requirements thoroughly
- **Involve** all from the start
- **Create** understanding & openness
- **Start** with the crossings
- **Seek**
 - Modularity
 - Contextual Benefits
 - Filters
 - Integration
- **Outsource** Only what you can't do yourself
 - *Be open to practical custom new solutions.*
 - *Bridges are almost never standard solutions.*
 - *A custom solution can be best and cheapest.*



Thanks for your Attention !