Ontwerp Rottemerentunnel, van aanbiedingsontwerp tot realisatie

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Project A16 Rotterdam - Ontwerpmanager Deelgebied 2

Project introduction – A16 Rotterdam

- Client: Rijkswaterstaat
- Consortium De Groene Boog:

  BESIX / Dura Vermeer / TBI Mobilis Croon Wolter & Dros / Van Oord / Rebel / John Laing
- Construction period: 2019 – 2024 + 20 year maintenance
- DBFM contract / -+ €800 Mio

Project introduction – A16 Rotterdam

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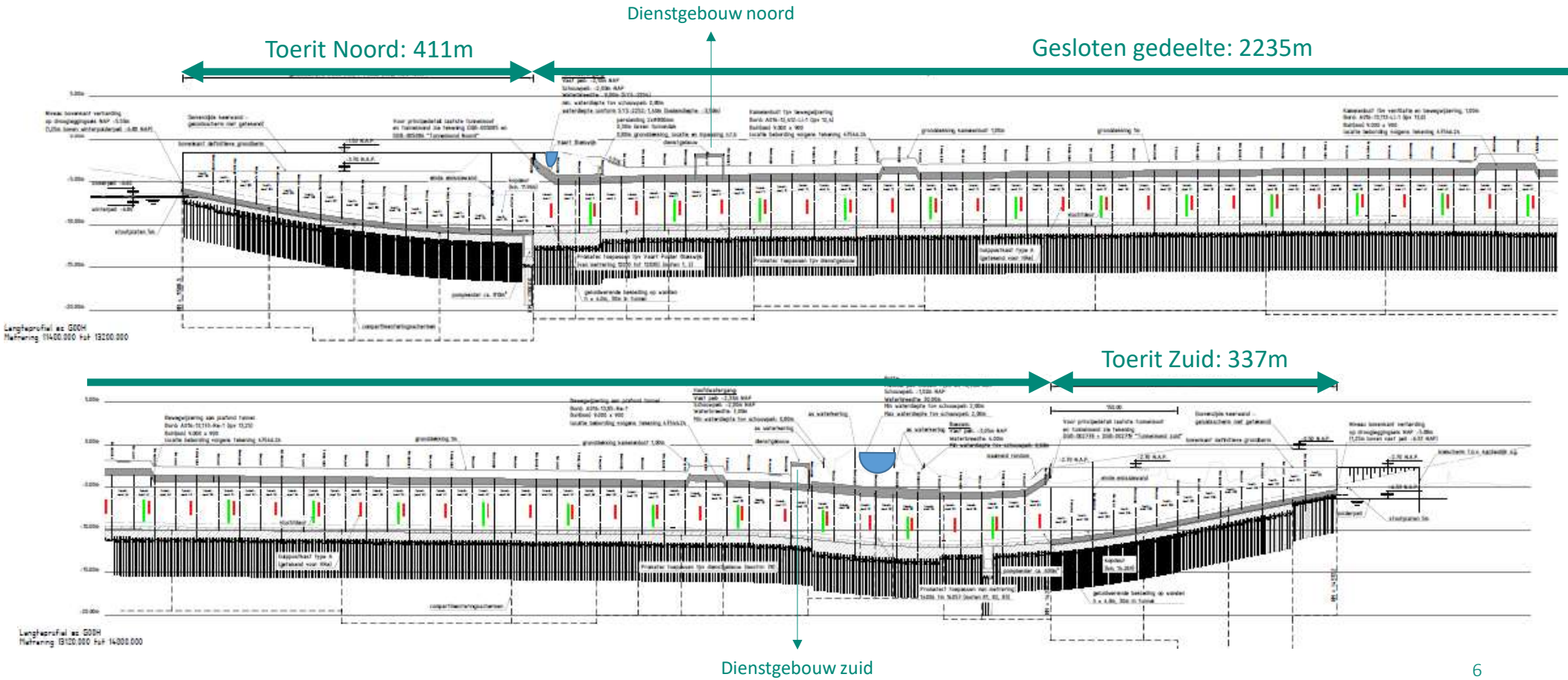
Rottemerentunnel



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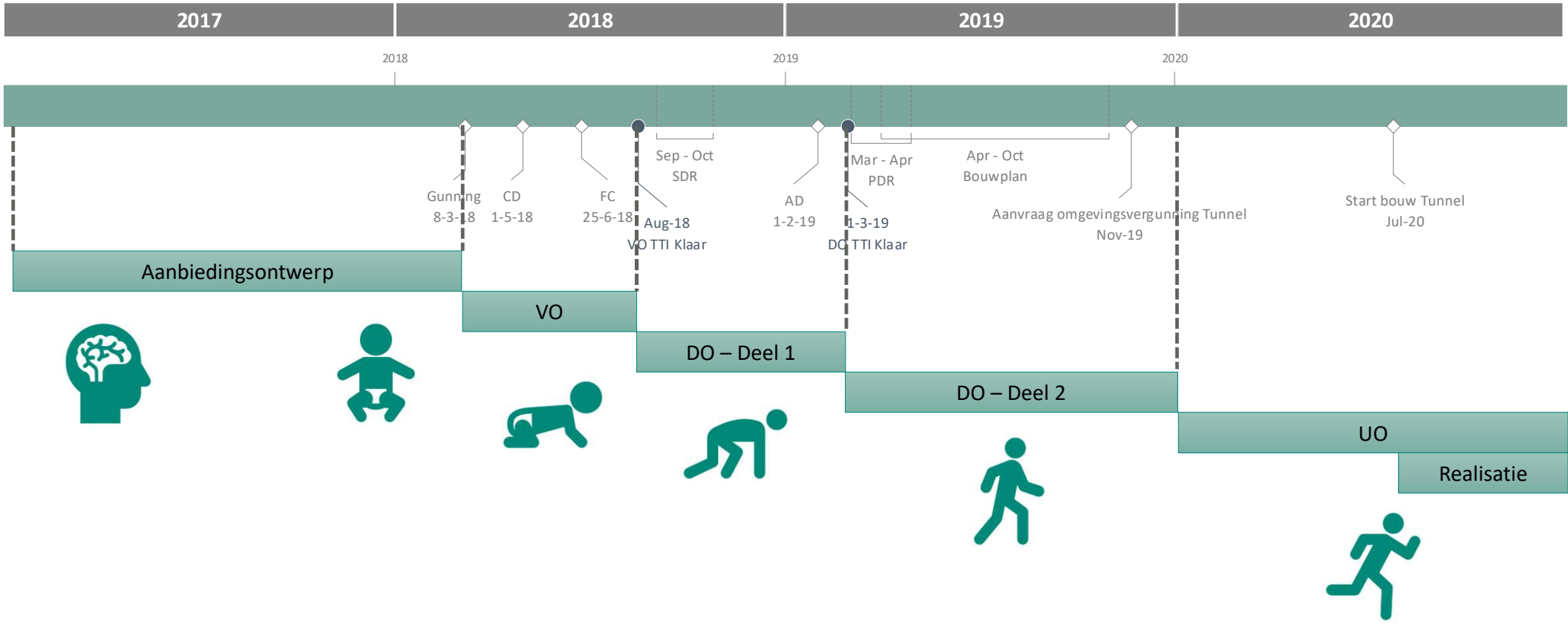
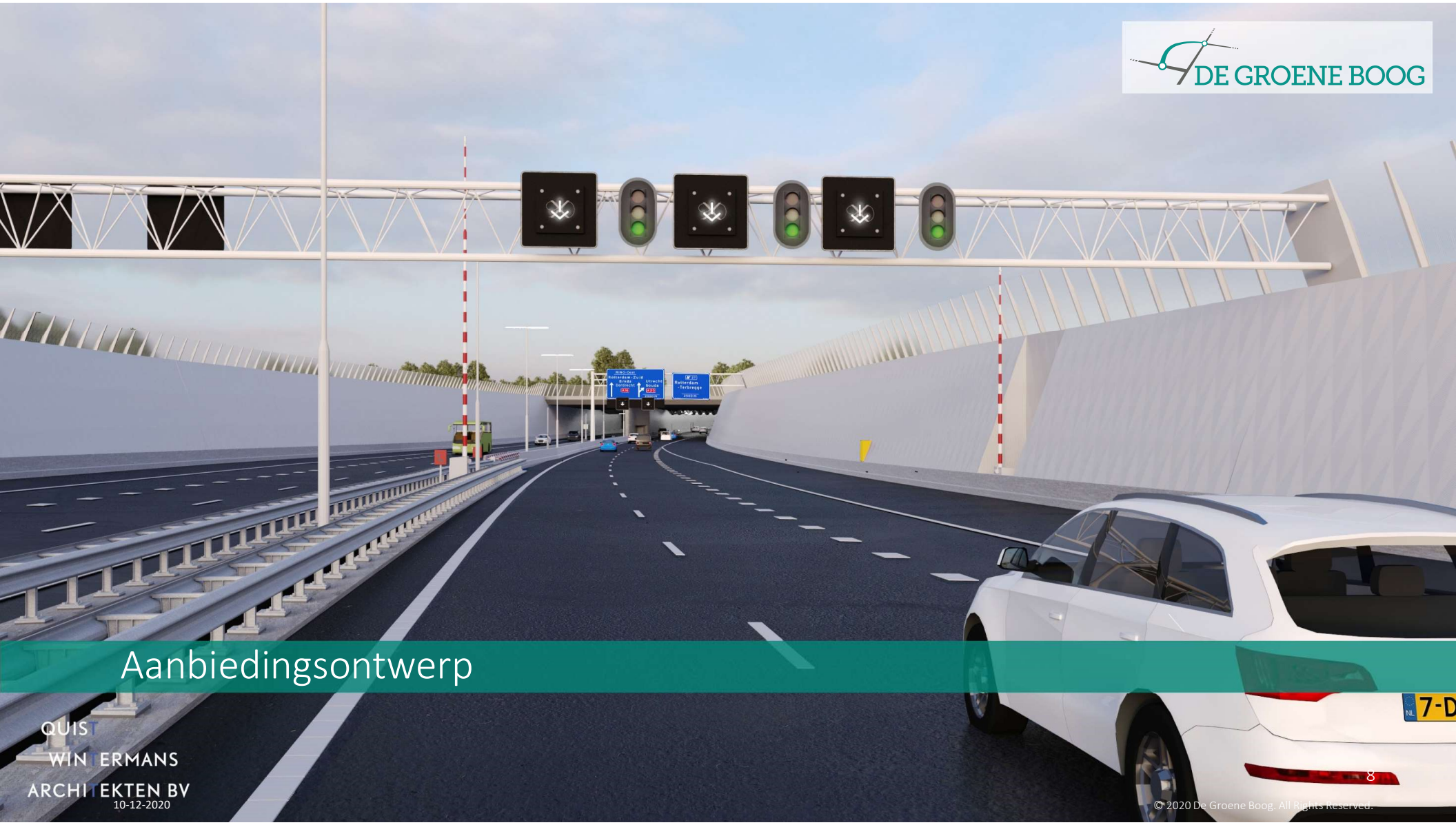
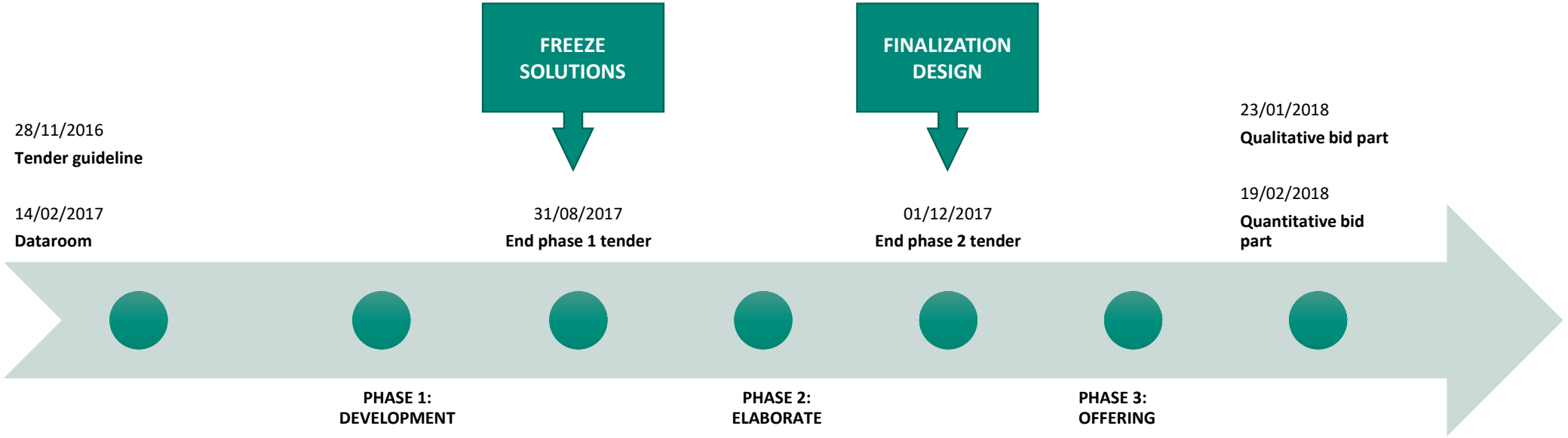




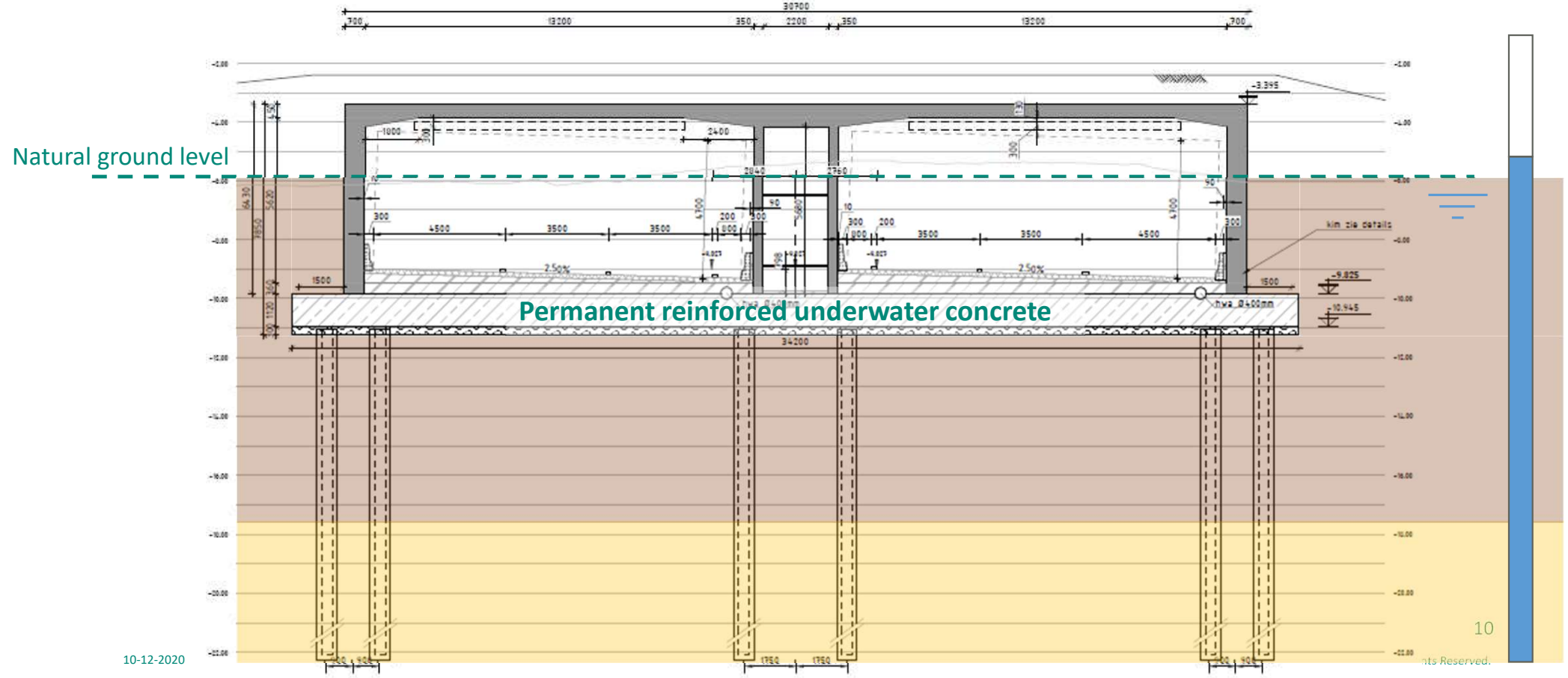
Aanbiedingsontwerp

Tender: Planning & Strategy



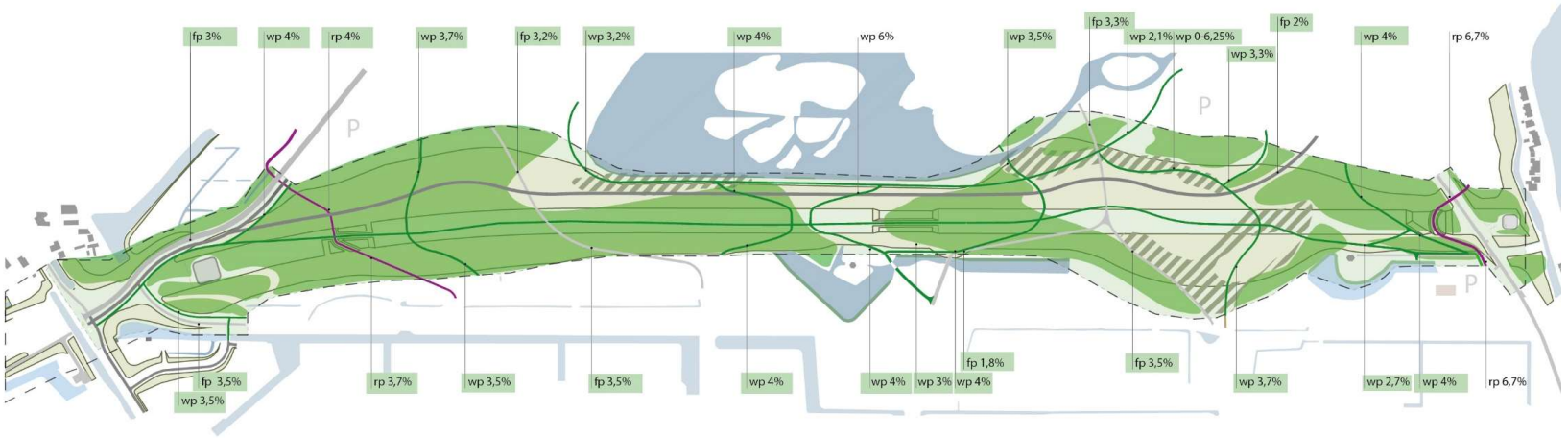
Tender design

1. Construction method



Tender design

2. Geometry: longitudinal alignment & internal dimensions



CROW richtlijnen

ruiterpad

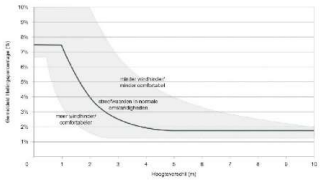
fietspad tussen 0%-7%

wandelpad <4%

Helling berekening
(Hoogte : Lengte) x100 = helling %

Maximale hoogteverschil: 3,5m

Fietspad

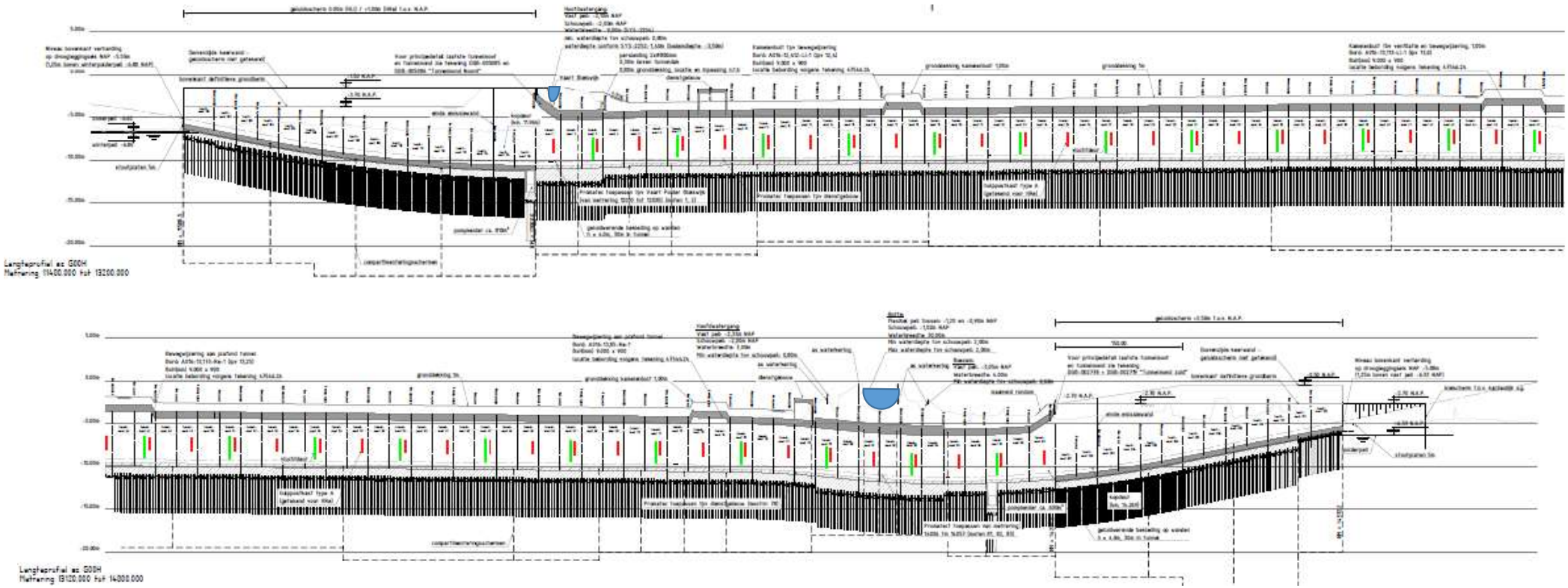


<1m hoogteverschil: advies 7,5%, max 10%
3m hoogteverschil: advies 2,5%, max 7%

Wandelpad
- Hoogteverschil >1m: helling 1:25max (4%) (helling flauwer dan 1:25 worden benoemd als "vals plat", vlakke voet-gangersroute.

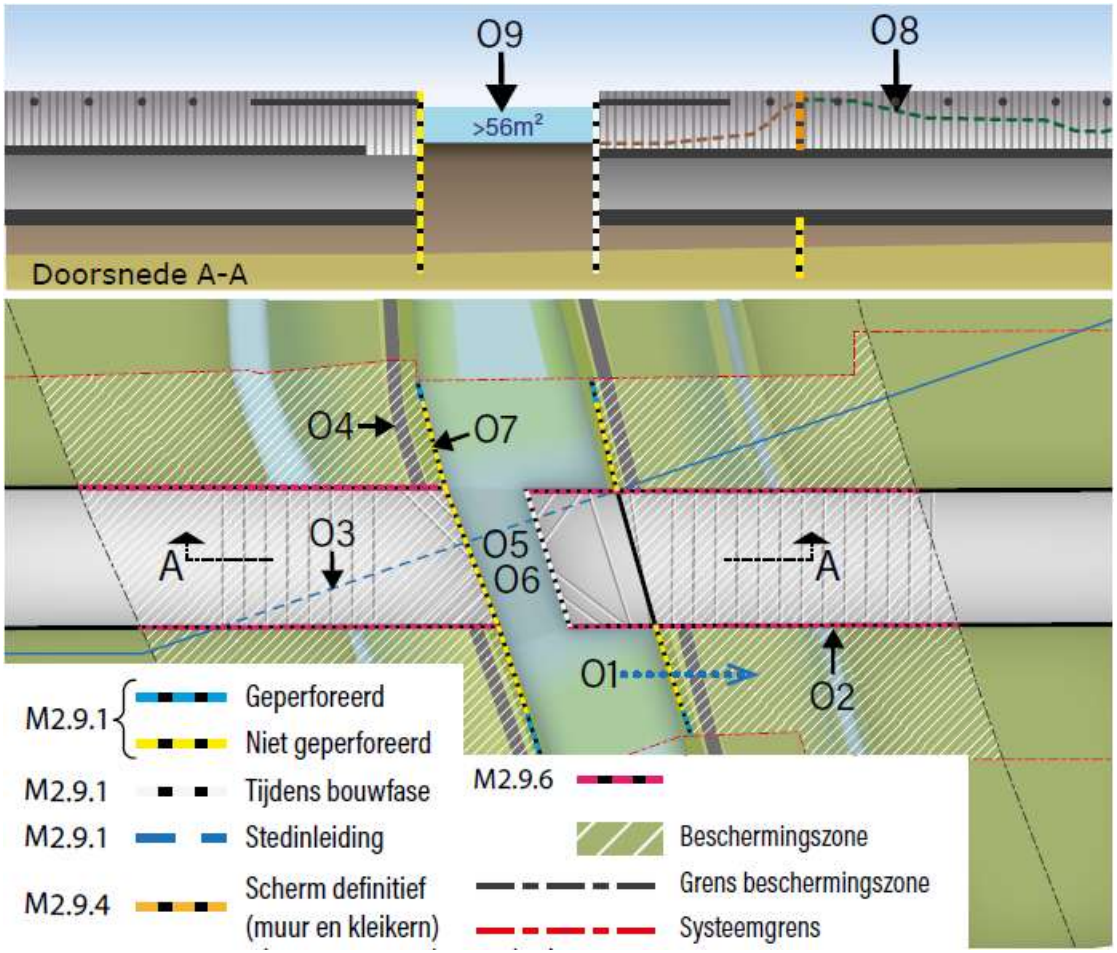
Tender design

2. Geometry: longitudinal alignment & internal dimensions



Tender design

3. Crossing Rotte



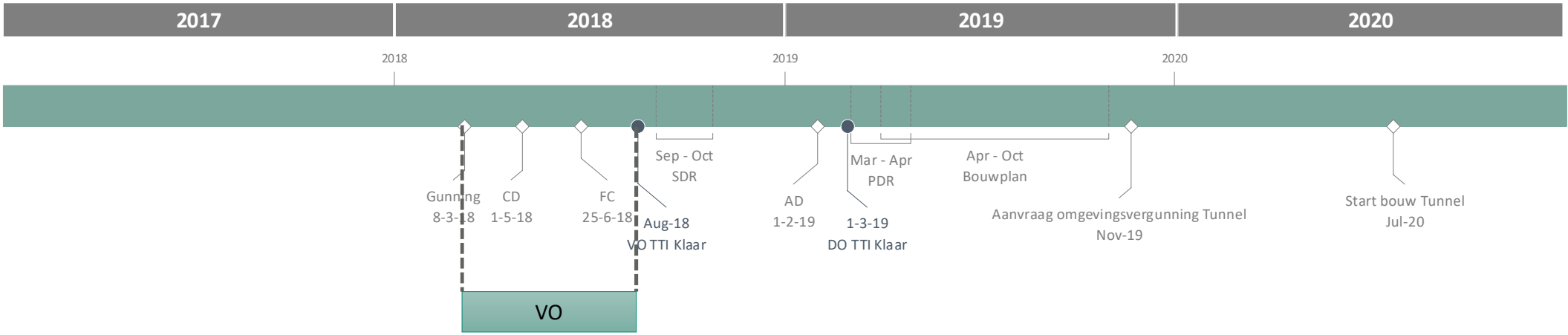
DE GROENE BOOG

VO / DO / UO

QUIST
WINTERMANS
ARCHITEKTEN BV

10-12-2020

Voorontwerp



1. Scrum sessions and thematic sessions:

a. Scrum sessions: Validate client's requirements and agree on verification method

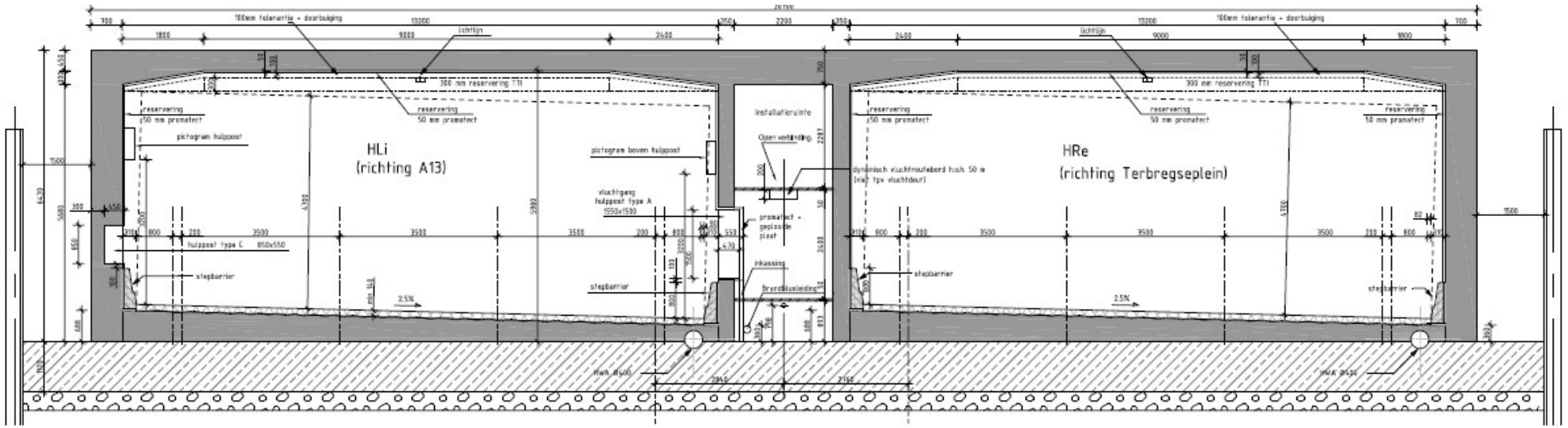
b. Thematic sessions: Meet stakeholders, validate tender design, create goodwill, collect stakeholders' knowledge and boundary conditions,…

2. Integrated design incorporating procurement, construction, maintenance, safety,…

Boundary conditions from procurement, construction, planning, maintenance, safety, … shall be fixed with each other to serve as starting point for the DO stage.

Road alignment has been frozen.

VO – Example of requirement validation



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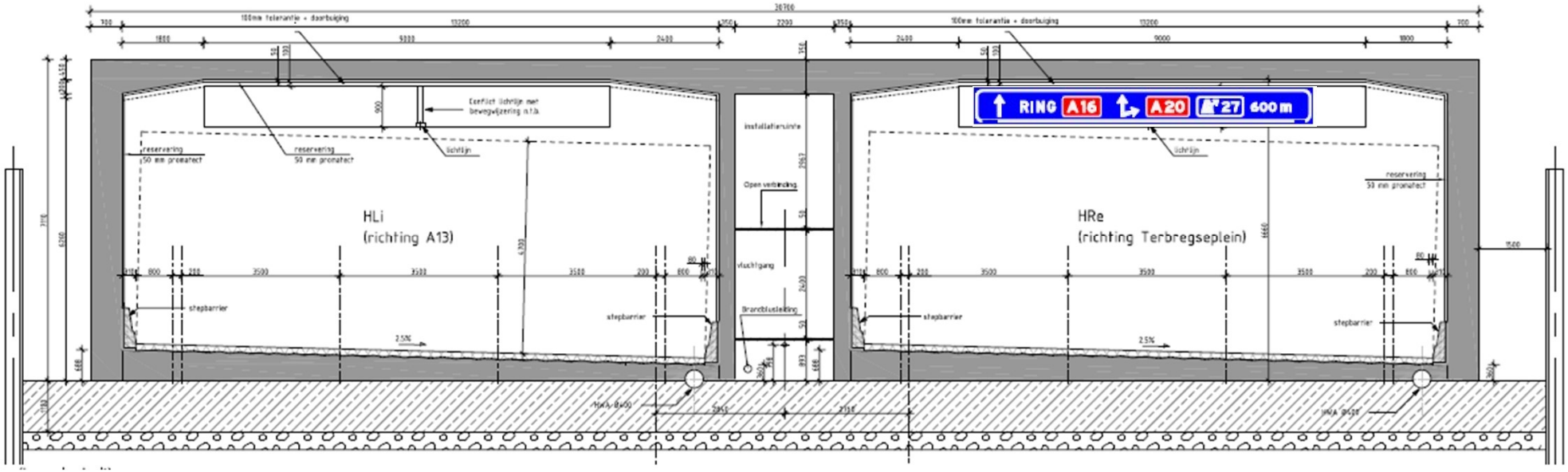
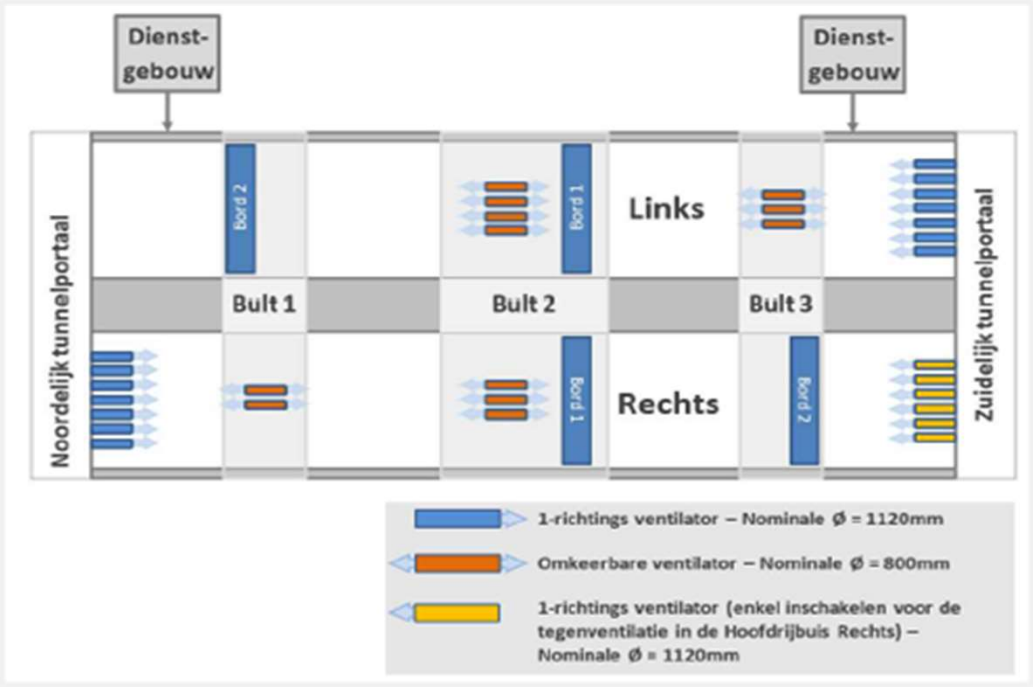
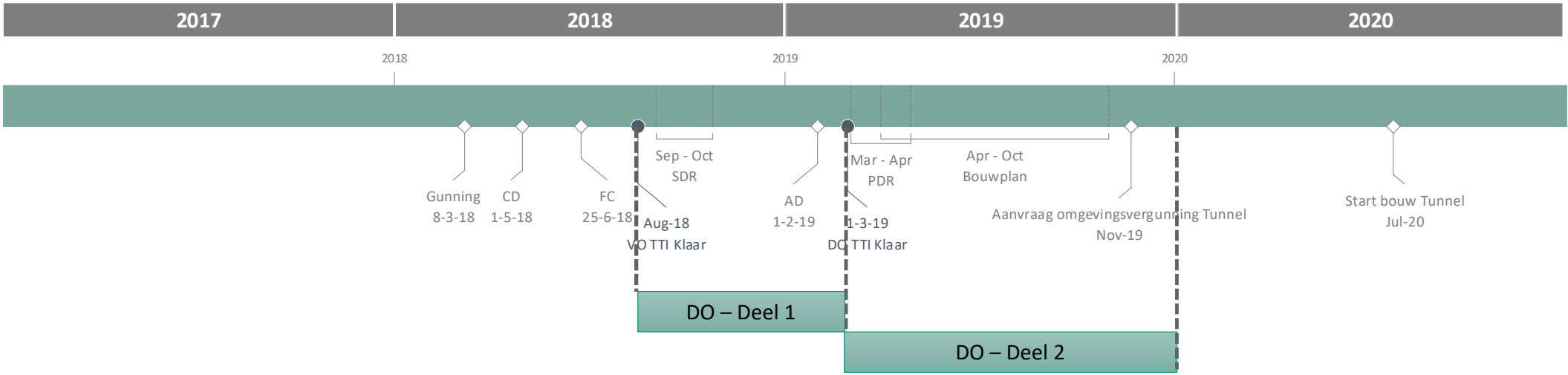


VO – Example of integrated design



Definitief ontwerp



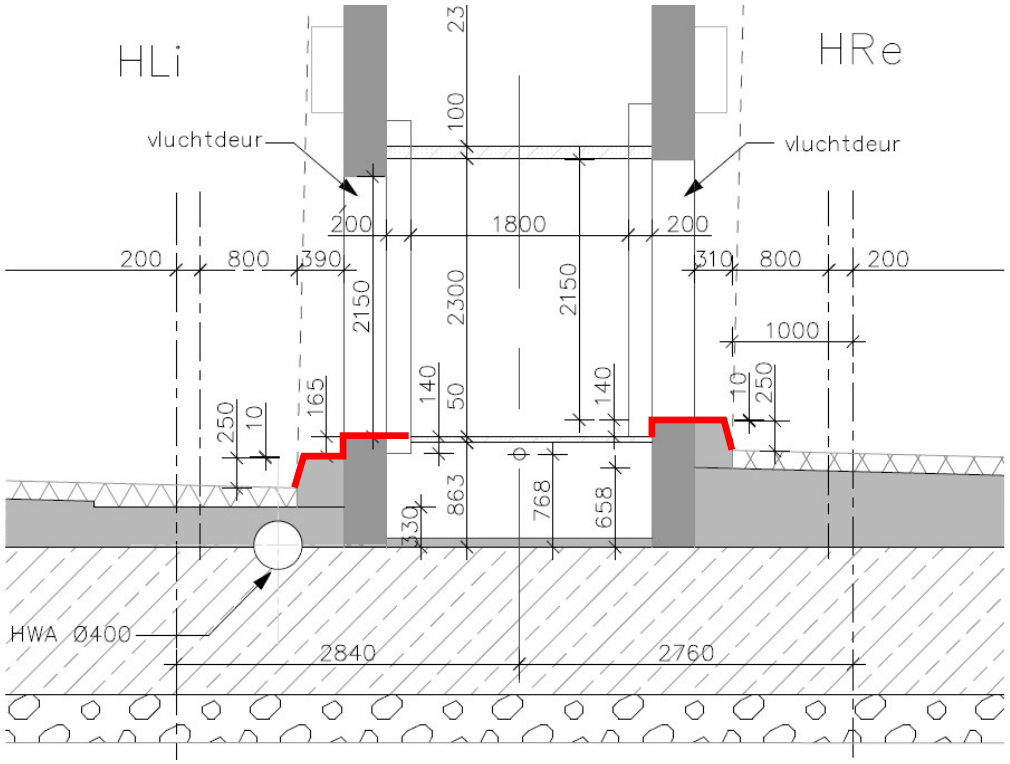
1. DO – Part 1: Multidisciplinary geometrical coordination + requirement verification

At the end of the DO part 1, the whole functional geometry is frozen, tolerances are agreed, the calculation basis of design is ready, and requirements are verified as much as possible. These design deliverables serve to proceed with PDR, review by Veiligheidsbeambte, and construction permit.

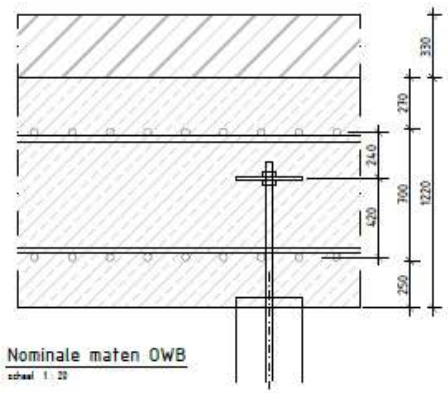
2. DO – Part 2: Calculations + finalisation dimensions

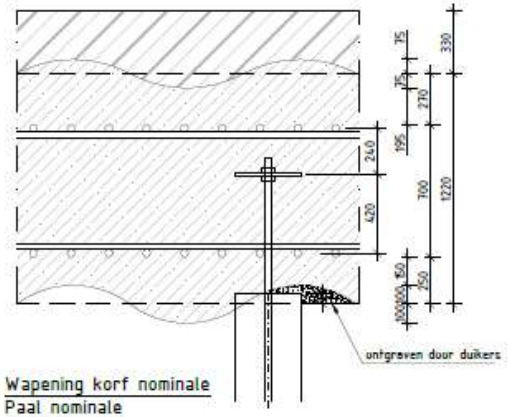
At the end of the DO part 2, all calculations are done and structural dimensions are fixed. Furthermore specifications are generated intended for procurement.

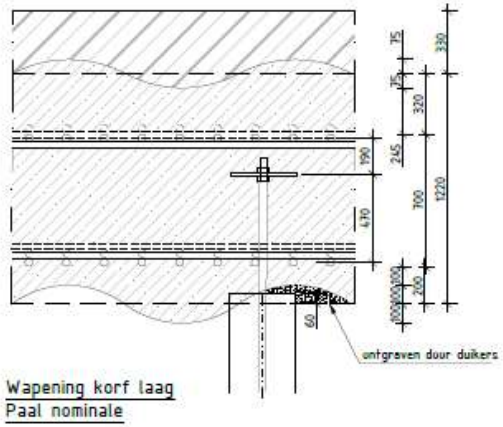
DO – Part 1: Example of geometrical coordination

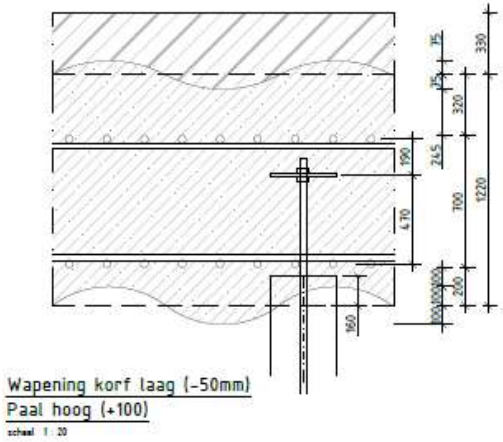


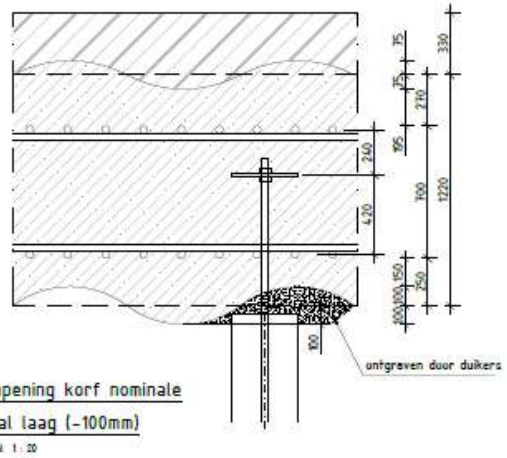
DO – Part 1: Example of tolerance analysis



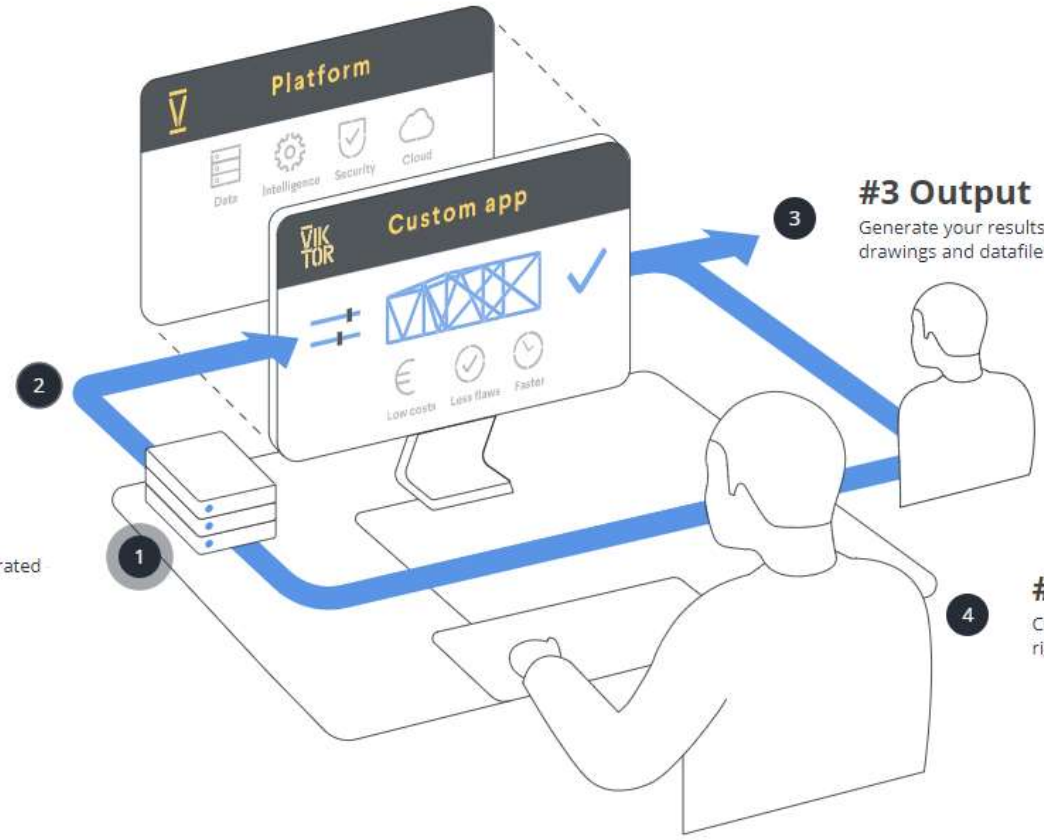








VIKTOR – The first date …



#1 Integrate
All engineering software is integrated within one VIKTOR application.

#2 Input
Easy input of data, rules and requirements by the user or datafiles.

#3 Output
Generate your results in reports, drawings and datafiles.

#4 Multiple users
Create user groups with tailored access rights

Automation, integration and parametrisation – Why?

- Repetitive sections aren't identical
  - Different depth due to longitudinal alignment of the road
  - Varying geotechnical profile (i.e. subsoil sand dunes)
  - Different swelling pressure after excavation
  - Variable loads on tunnel (i.e. roads vs. sidewalks)
  - Different ground water levels
  - Different preloading time of backfill along tunnel

Optimisation:

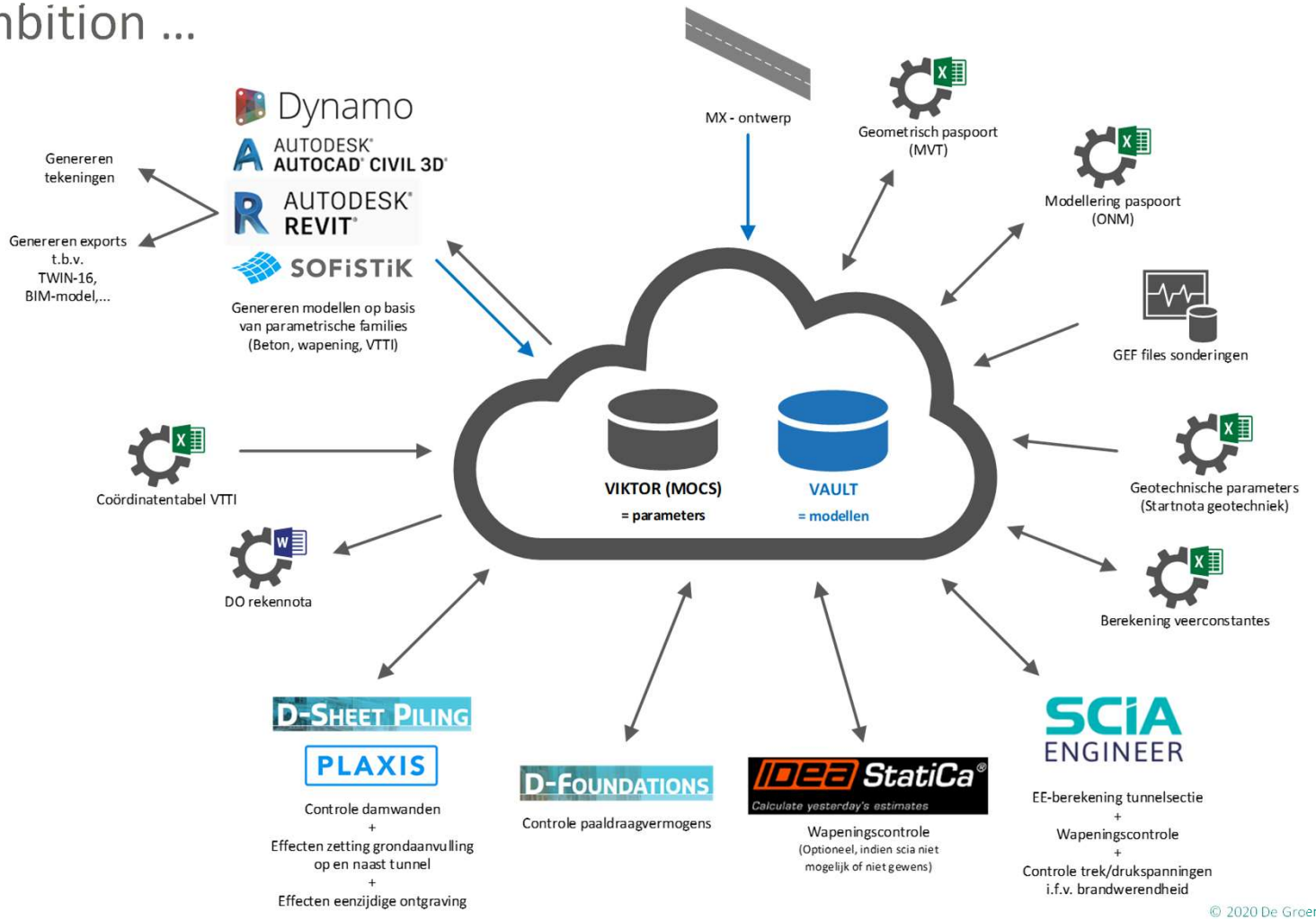
1. 'Choose' no determining loads to create 'manual' envelope, but run automated calculation of all sections based on correct parametric input
2. Strive for uniform design to serve repetitive execution

   BUT: Maybe the overview of U.C.'s shows the advantage of 5 'special' sections to optimise all others

Automation, integration and parametrisation – Why?

- How to find the drivers and sensitivity of the design?
  - → Parametric design gives opportunity to easily determine key influencers
- Soil investigation will be available late in time
  - → Automated re-run after importing new GEF-files and allocating soil layers
- Manual transfer of output software X as input for software Y = time consuming and error prone
  - → Ideally, calculation and modelling software use the same, centralised information about geometry, soil conditions, concrete cover, reinforcement configuration …

The ambition …



Approach

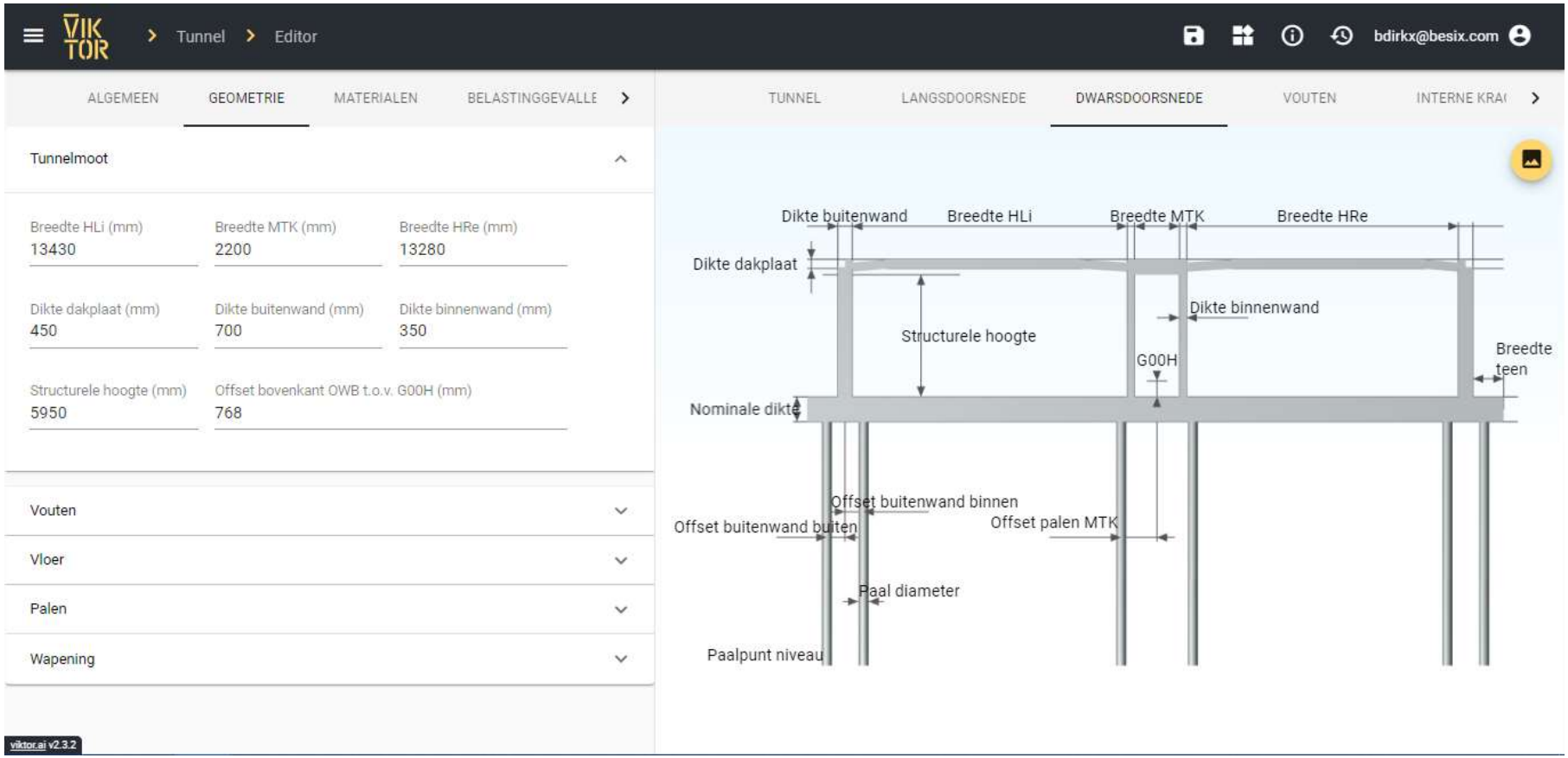
- Partner: 

- Scrum methodology with 2-weekly return period
- Team:
  - BED: Senior designer
    - Prepares all FE modelling and calculations in a ‘classic’ way
    - Defines the parametric data and decides about ‘hard coded’ items
    - Makes a functional analysis about the functionalities he wants to have developed
  - VIKTOR: 2 python software developers
    - Build project specific platform with GUI for parametric input
    - Build parametric FE model
    - Create central database with output and input
    - Integrate different software tools by managing data output towards data input
    - Build GUI for visualization of results

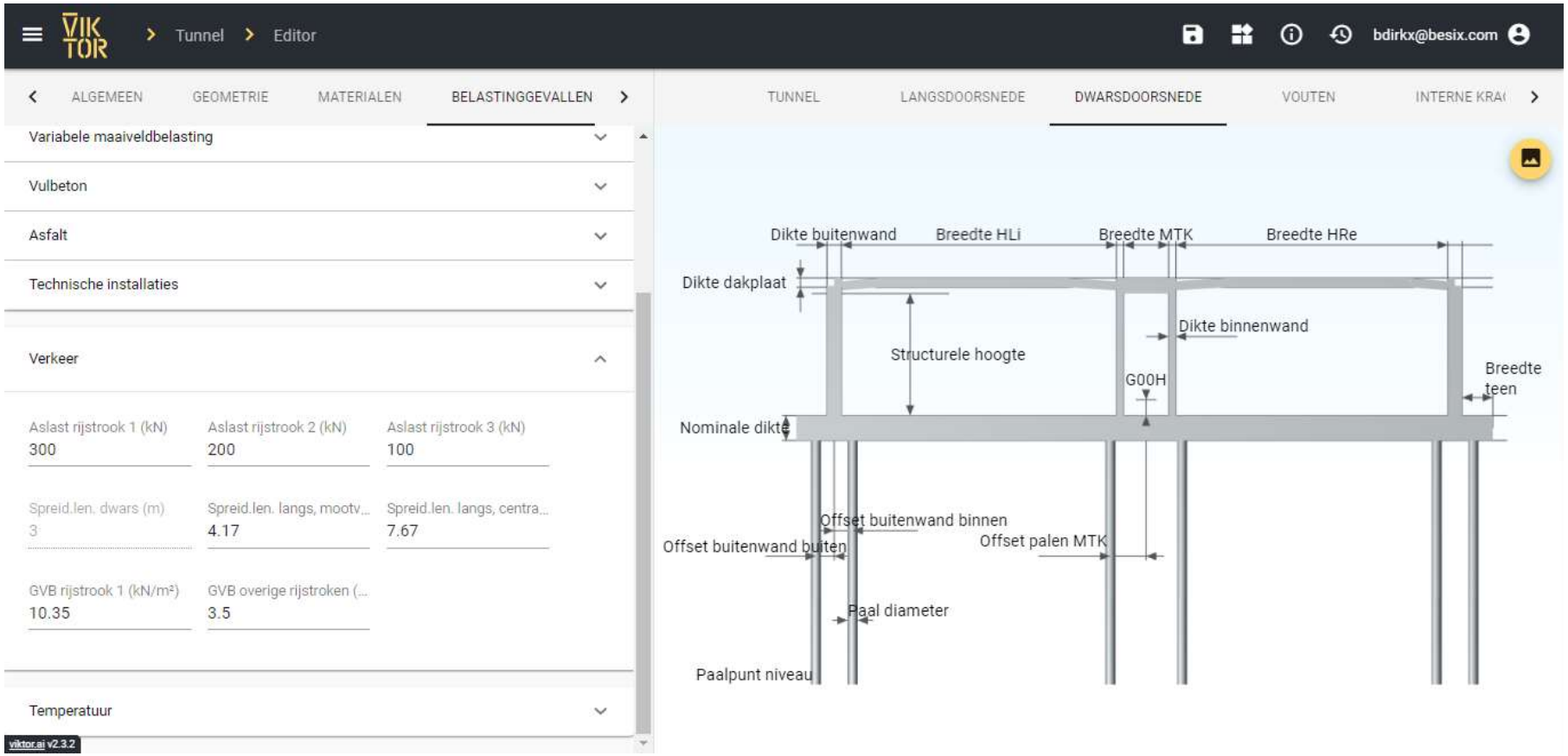
Platform structure

- Level 1: Overall tunnel
  - General geometric parameters, materials and load cases
  - Import MX-file with road alignment
  - Import load combinations and result classes
  - Create different reinforcement configurations
  - Visualise global results
- Level 2: Individual sections
  - Local soil conditions
  - Define deviations from overall parameters
  - Define applicable reinforcement configuration
  - Visualise local results

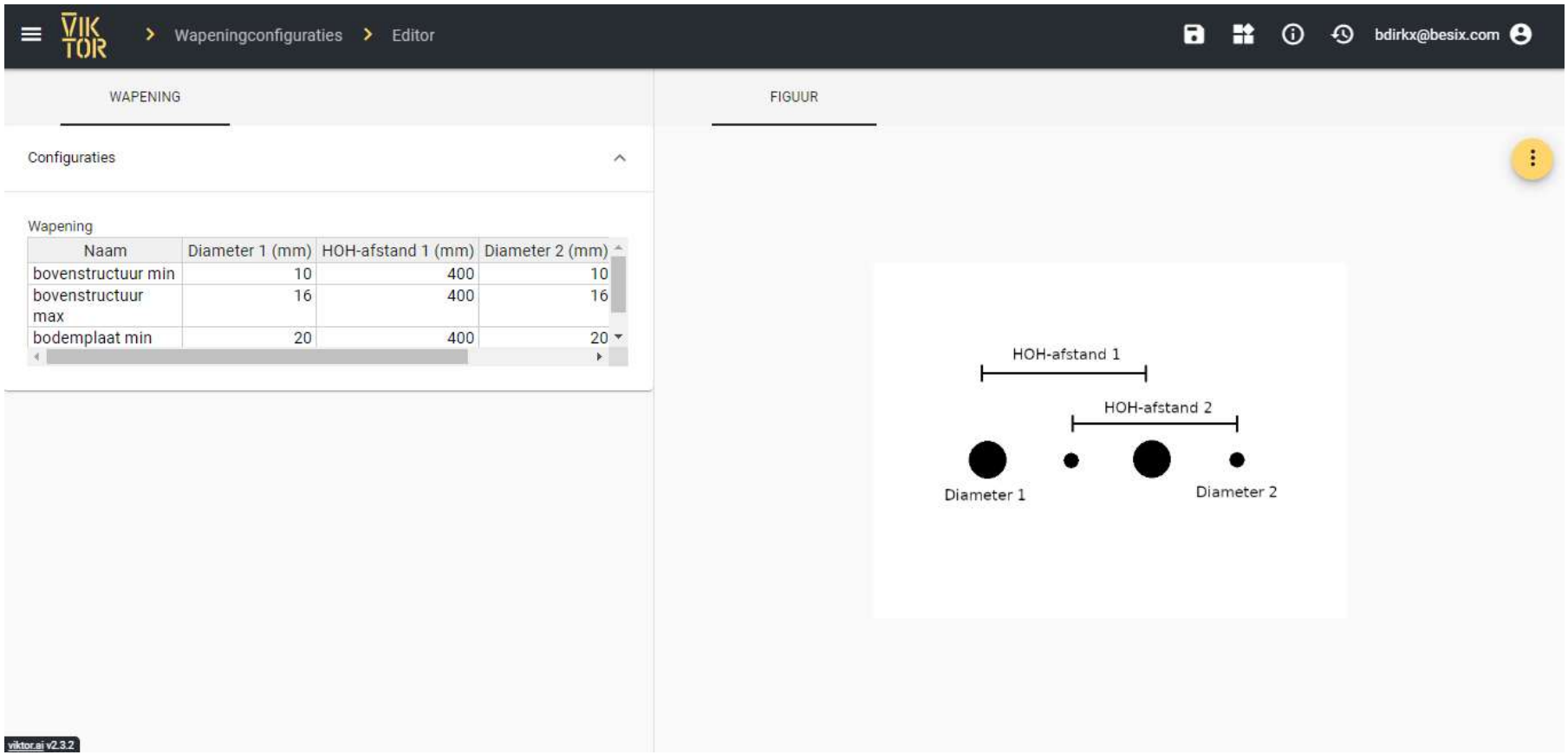
Level 1: Overall tunnel - Geometry



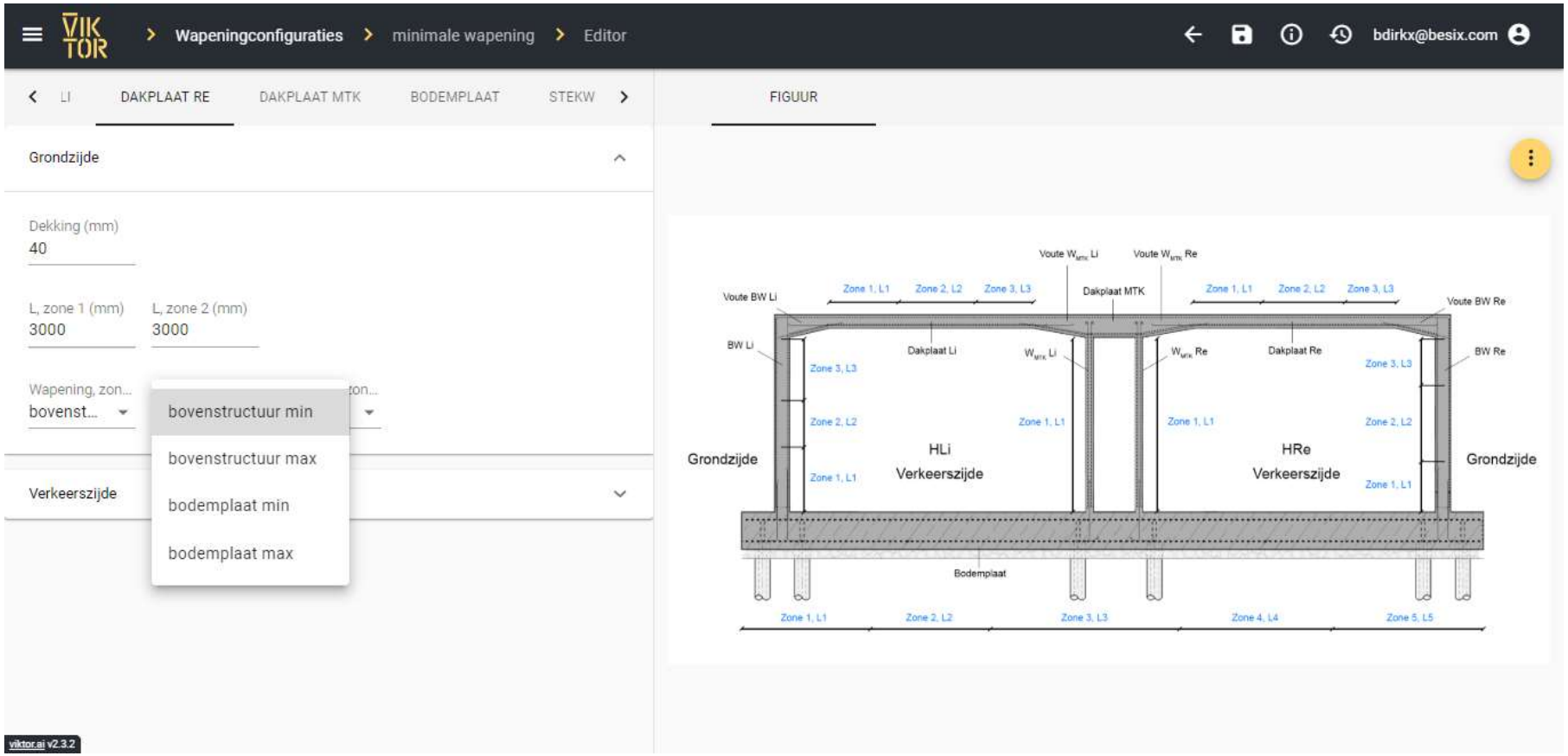
Level 1: Overall tunnel – Load cases



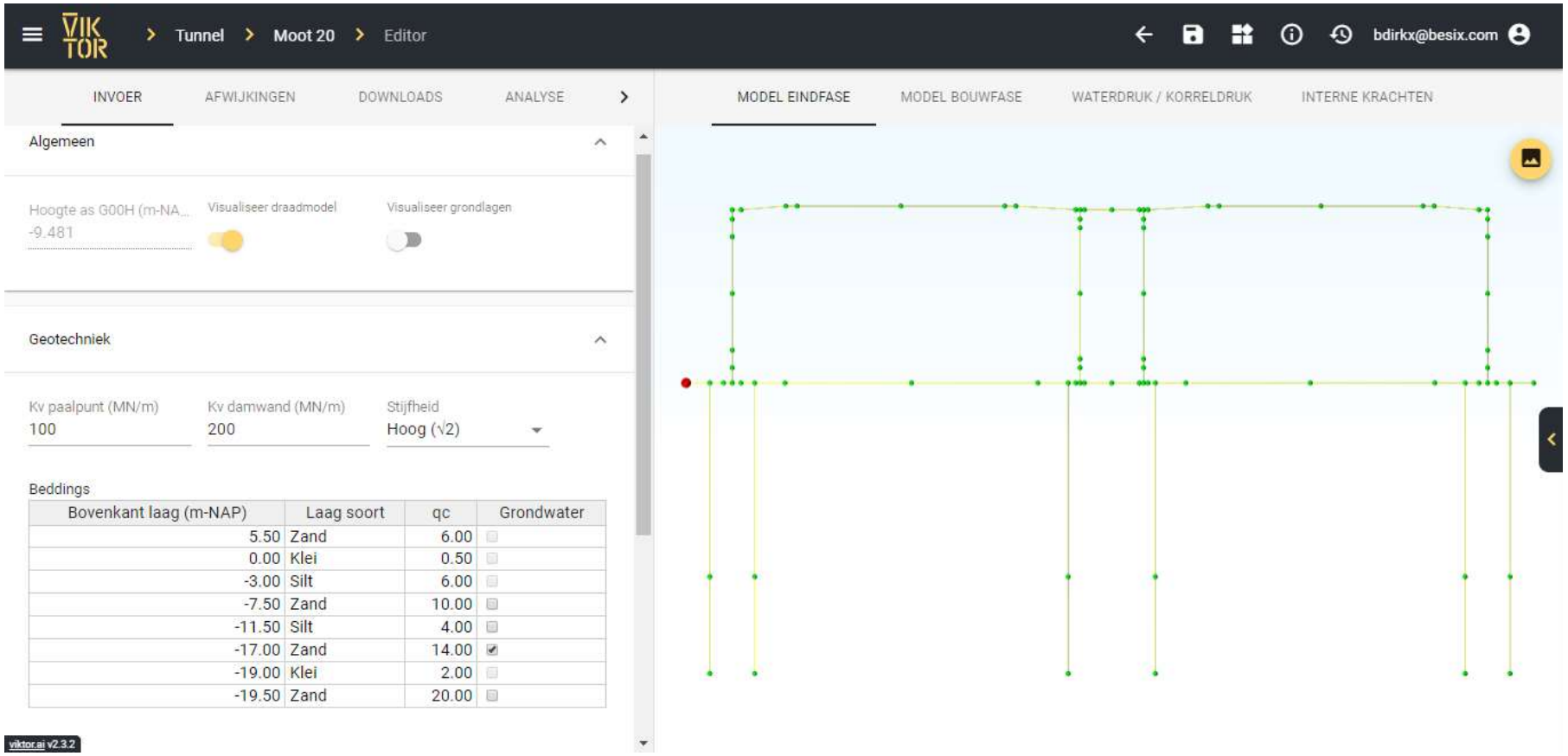
Level 1: Overall tunnel – Reinforcement configuration



Level 1: Overall tunnel – Reinforcement configuration



Level 2: Individual section – Local soil conditions



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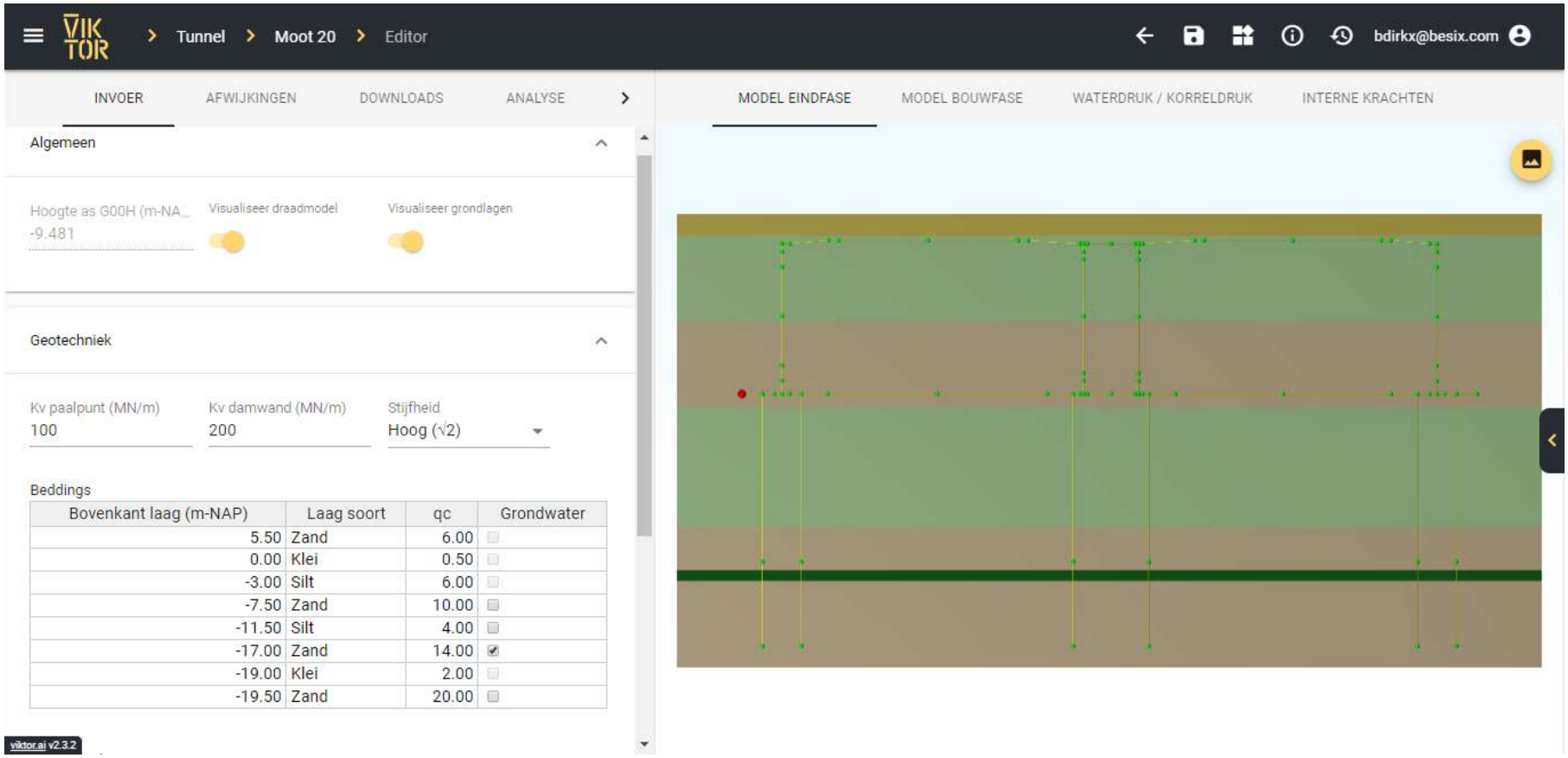

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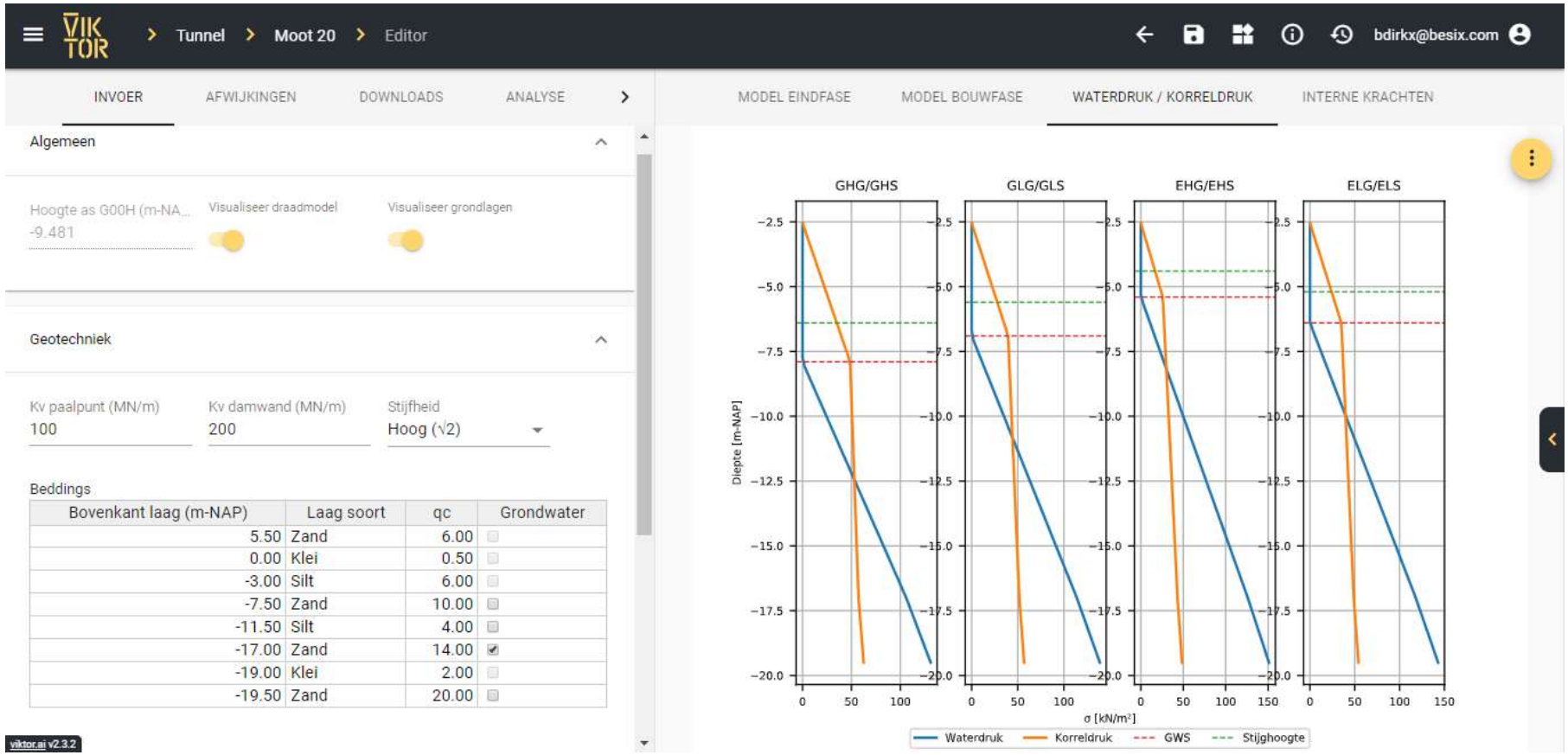
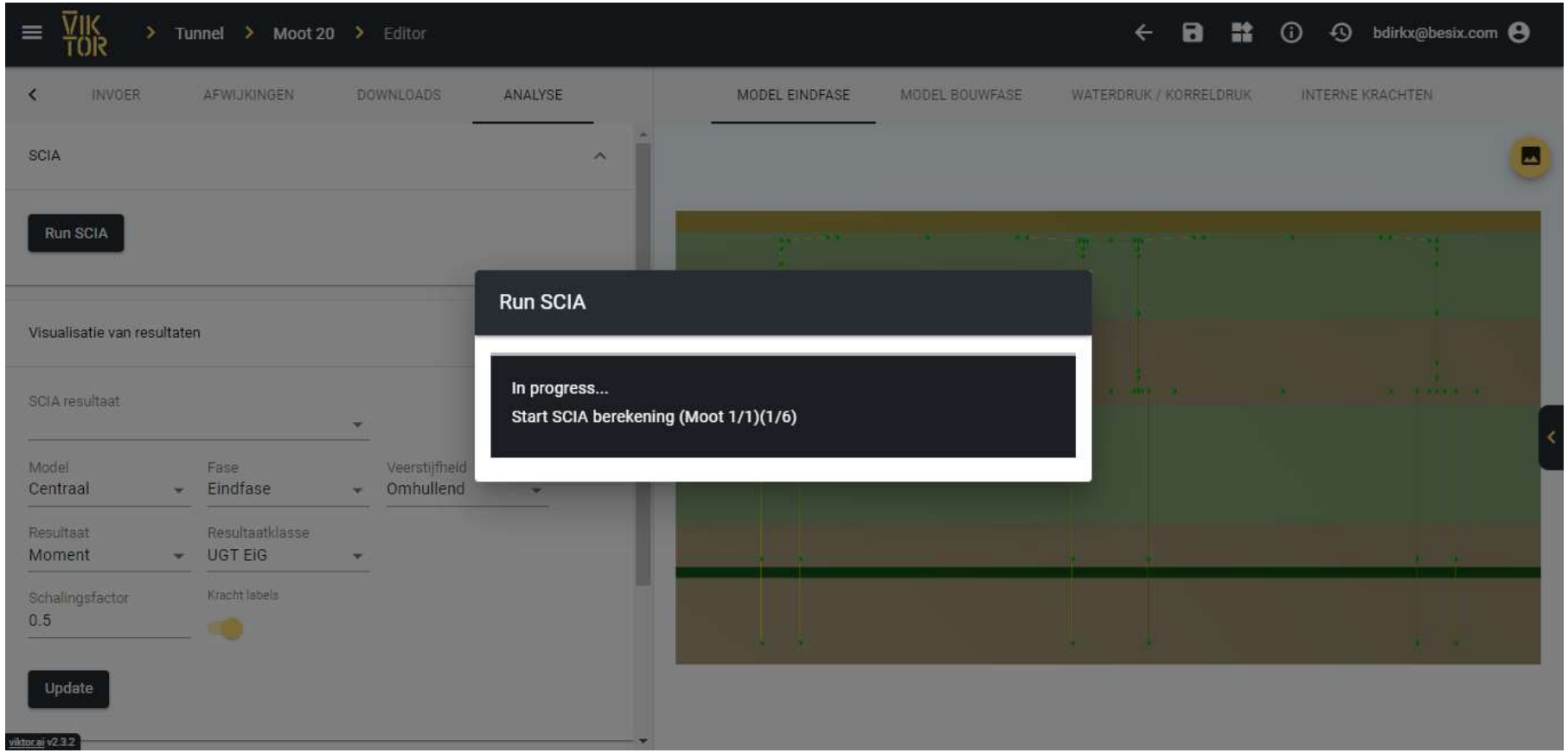


Level 2: Individual section – Visualise local results



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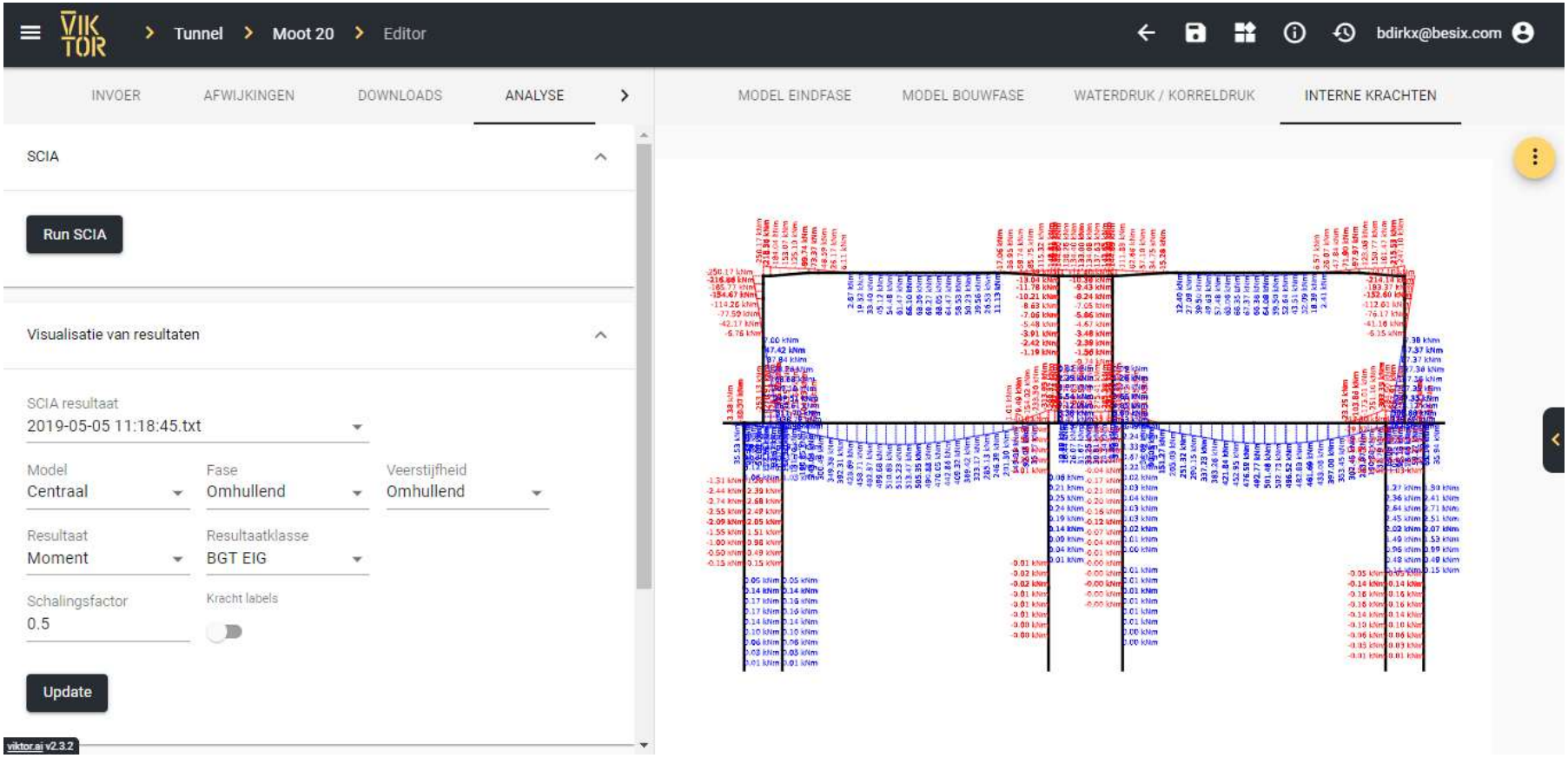

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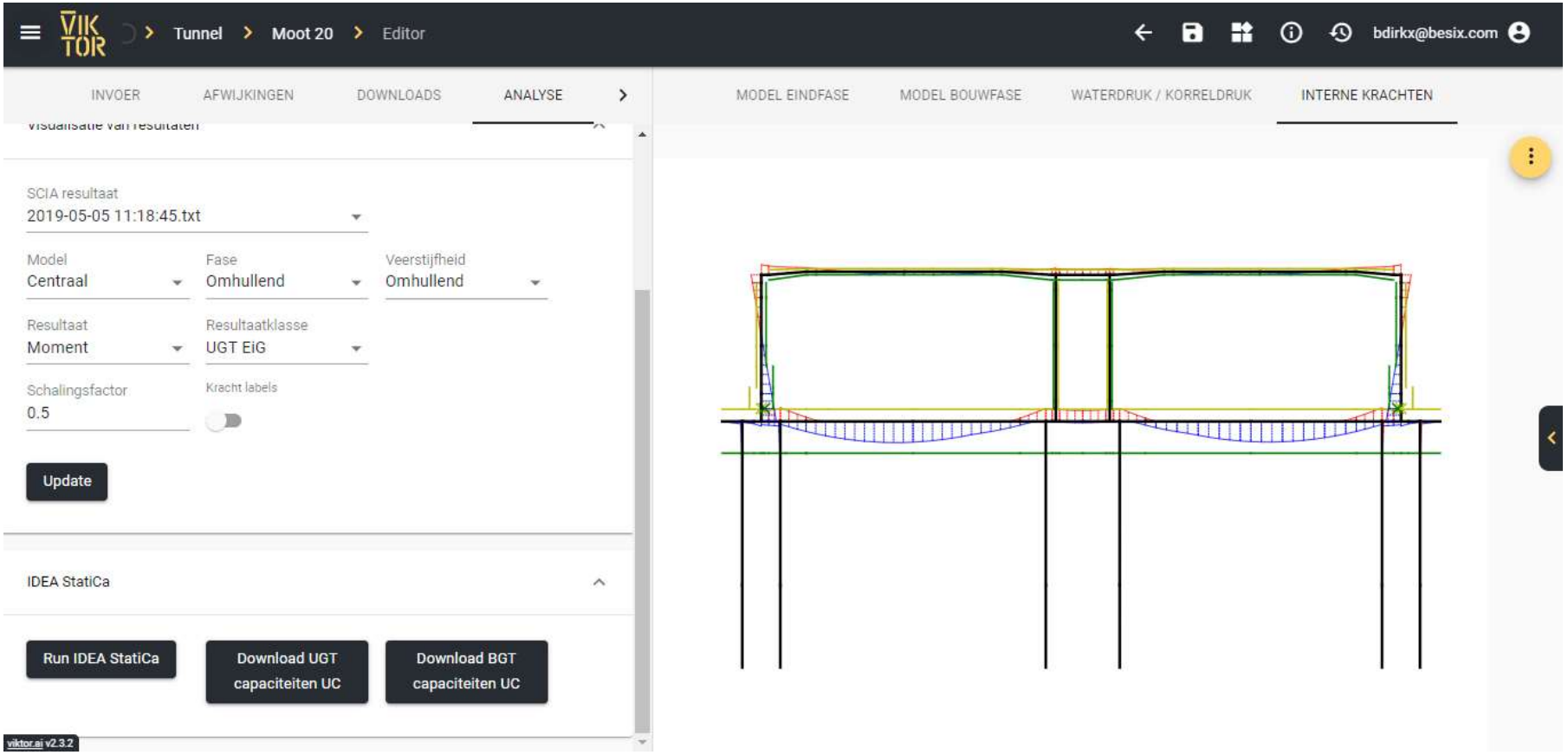
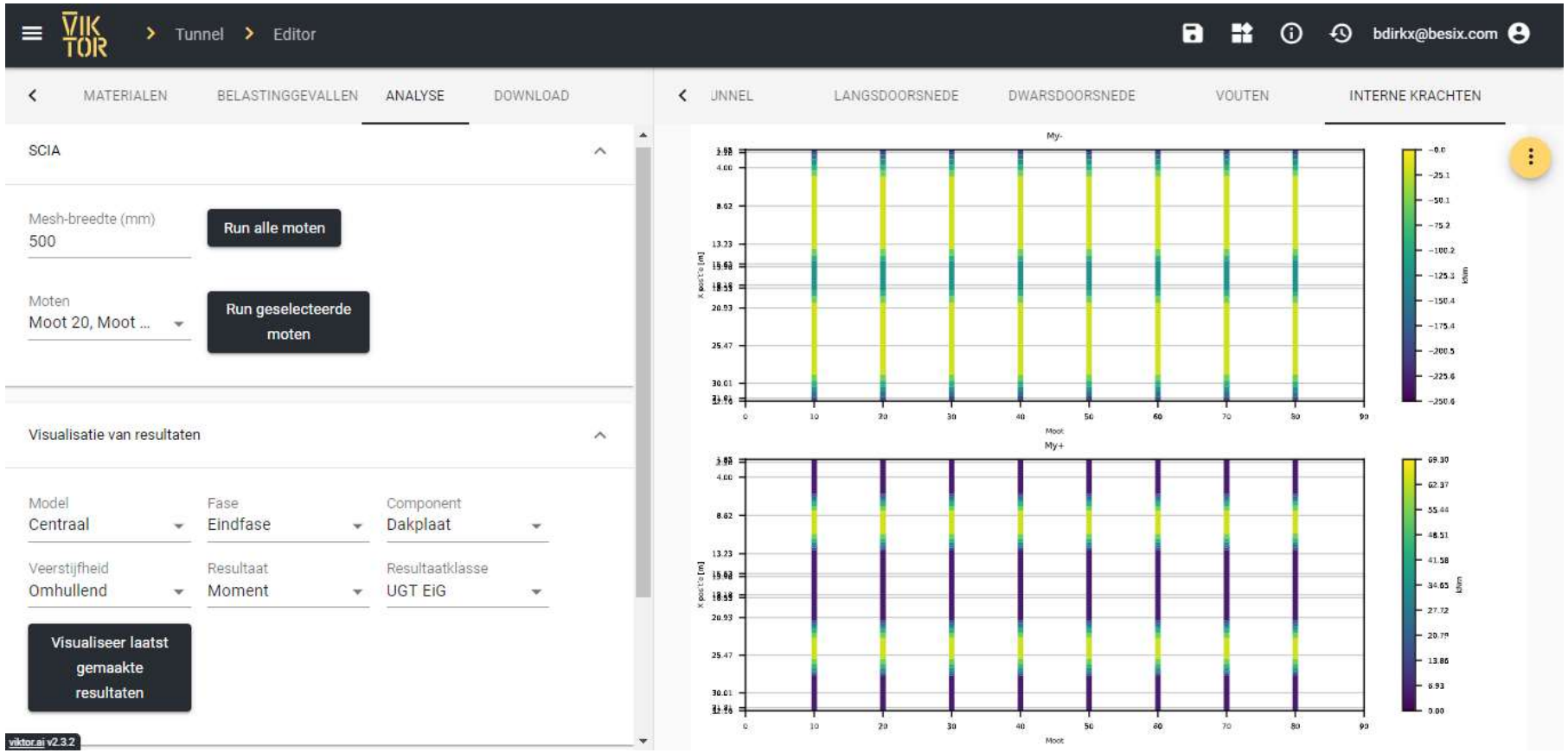
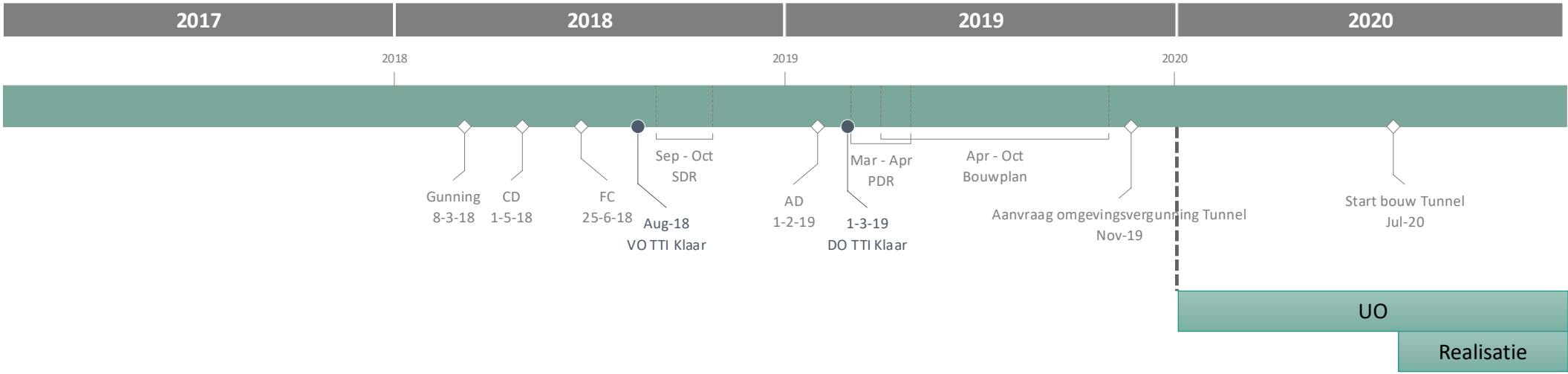


Level 1: Overall tunnel – Visualise global results



Uitvoeringsontwerp & realisatie



1. UO: Monodisciplinary detailed design – First Time Right

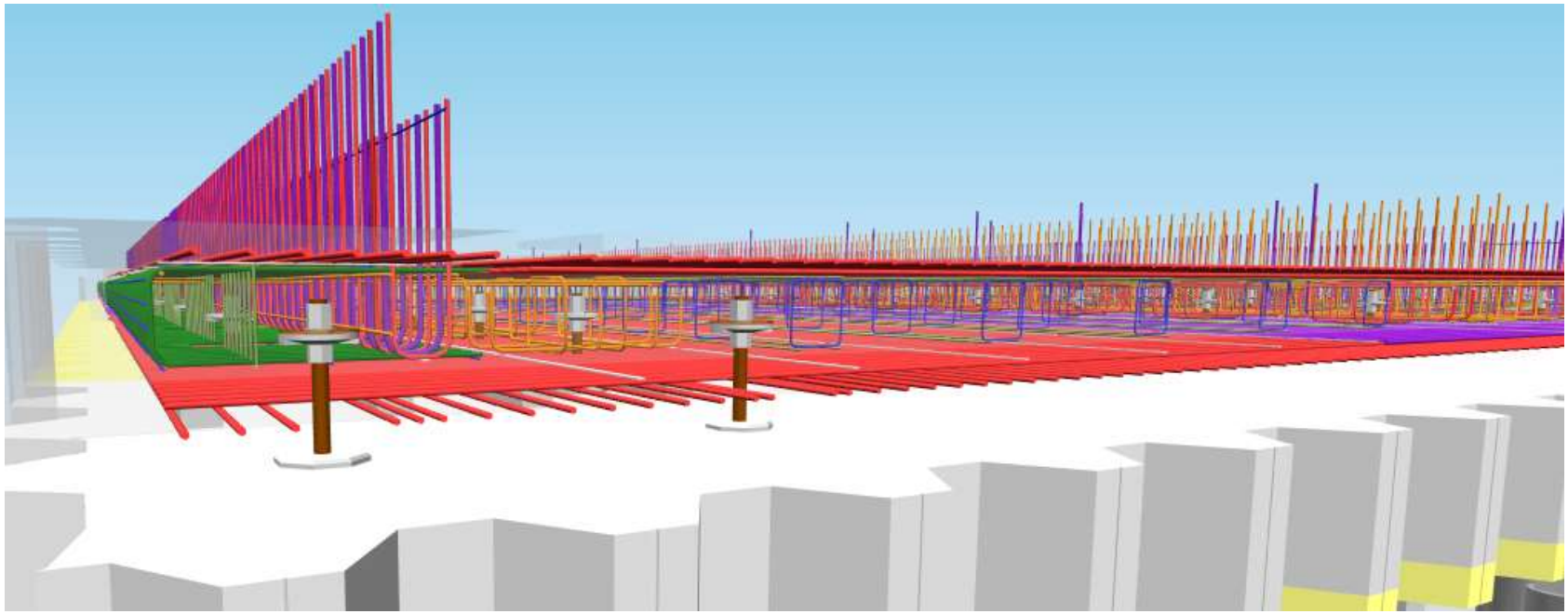
Only detailed development of DO calculation notes and models towards execution drawings. Changes with impact on integrated design result in major failure costs

2. Execution – Site engineering

Support on site related questions and nonconformities

UO – Reinforcement detailing

- Allplan model by Buigcentrale Steenbergen

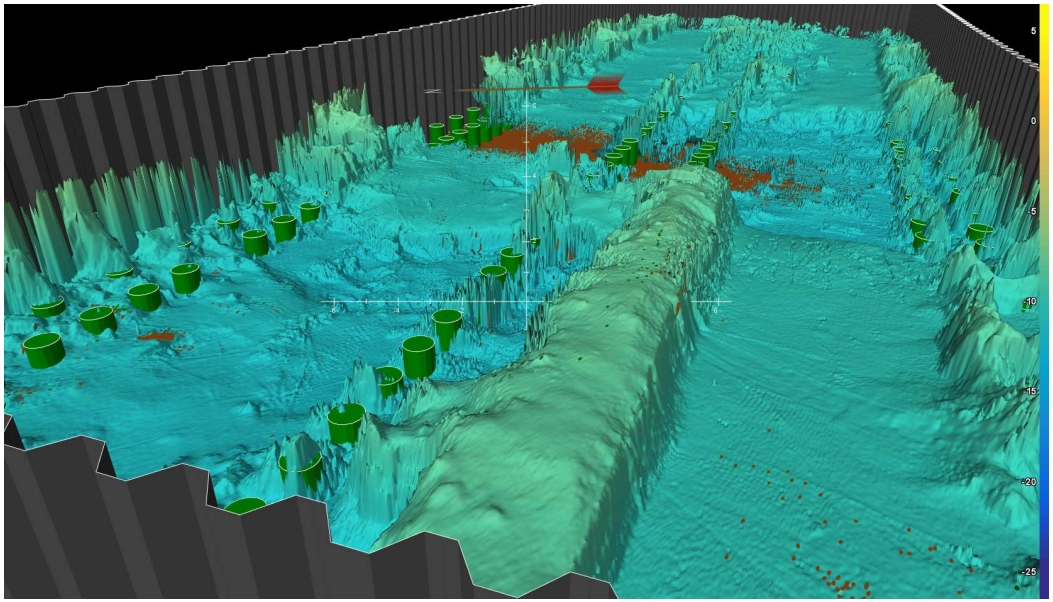


UO – Reinforcement detailing

- Mock-up in dry conditions

Proefbouwkuipen

Omgevingsvergunning verleend 20-04-2020
→ Planningsbuffer tot start bouw (30-07-2020) niet nodig
→ 2 proefbouwkuipen geven kans tot leercurve



Execution

Thank you!

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