Nonlinear analysis of Rozenoordbrug

Ewa Krysiak

15.09.2022

Diana Users Association - Lecture Evening

Involved parties

ZUIDPLUS
WE CONNECT

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

IBZ
ARCADIS en Witteveen+Bos

TNO

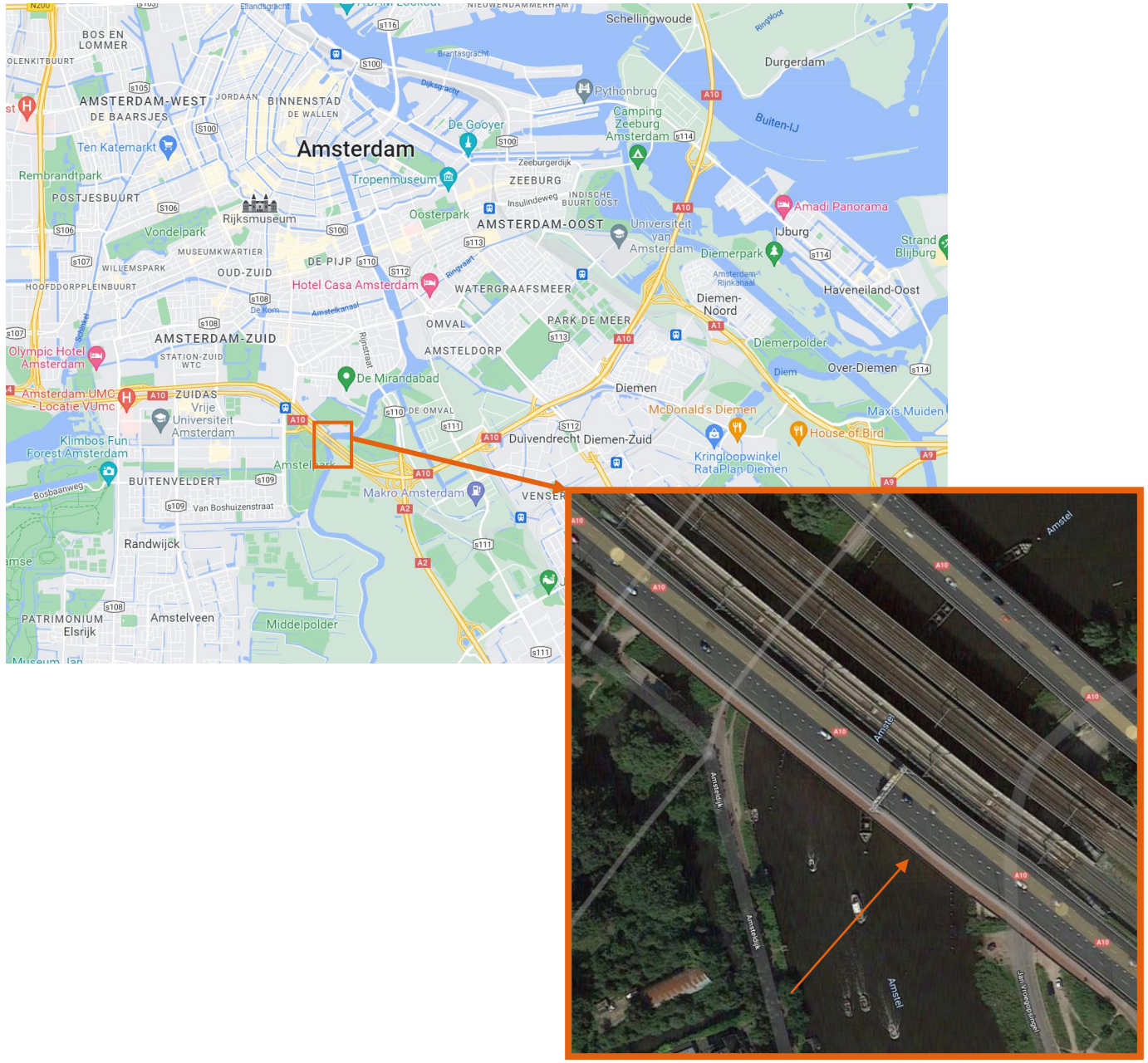
Arcadis. Improving quality of life.

Presentation plan

- Introduction
- Bridge layout
- Plans for the road adjustments
- Cracks
- Linear analysis
- Nonlinear Analysis
- Final strengthening

History and location

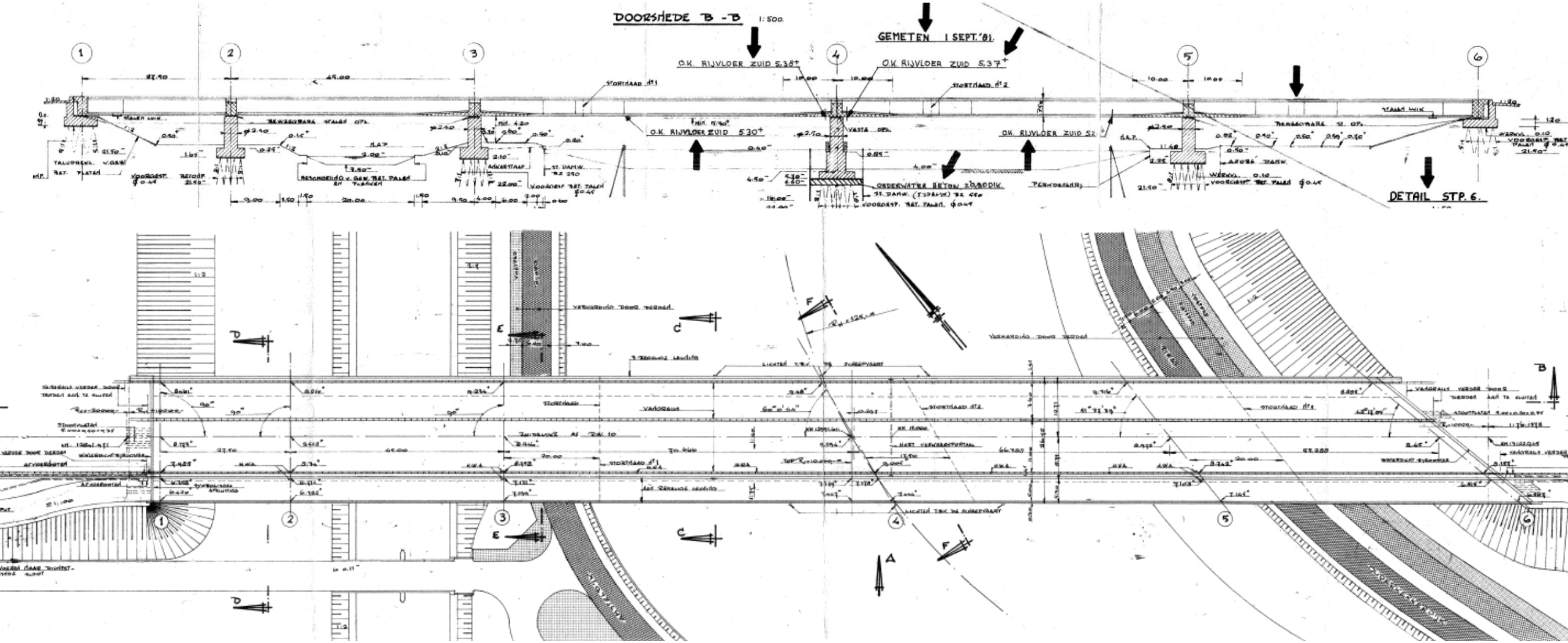
- The bridge has been built in the 80’s.
- Crosses Amstel river
- Consists of 5 traffic lanes and 1 bicycle lane
- Since 2018, the bridge has been the subject of a series of recalculations to verify whether it complies with the applicable regulations with regard to constructive safety at the current situation



Arcadis. **Improving quality of life.**

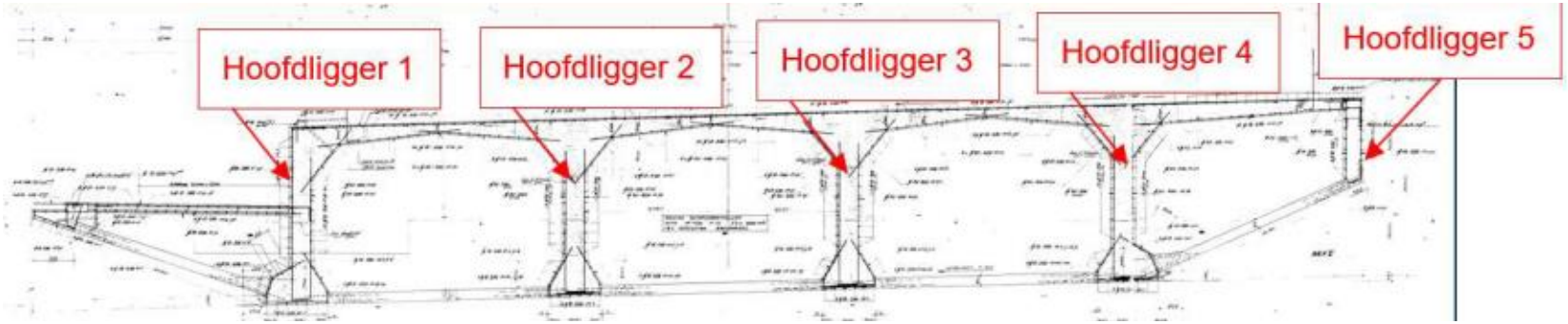
Bridge layout

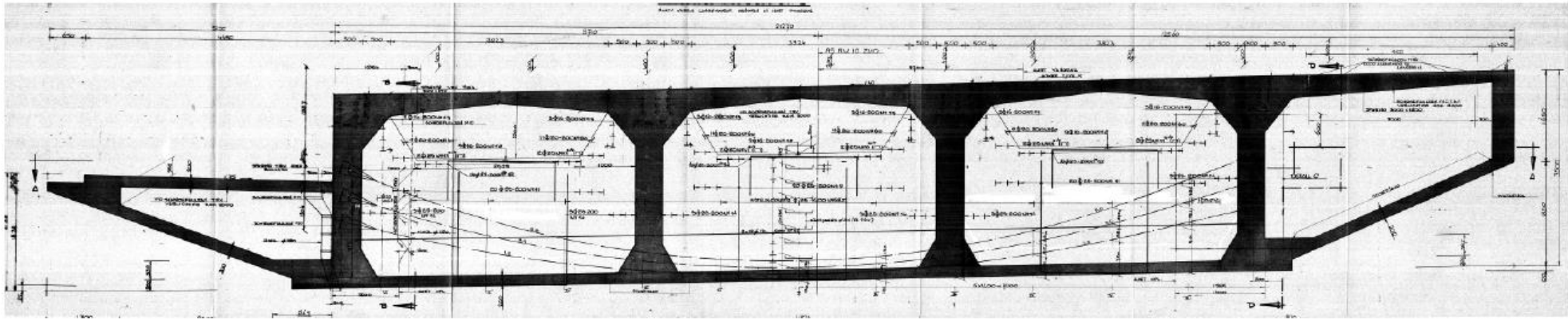
Top and side view

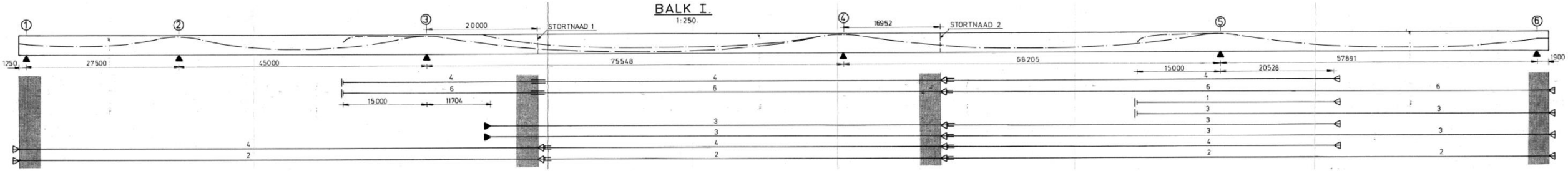


- 5 spans: 27.5 – 45 – 67 – 65 – 53.3

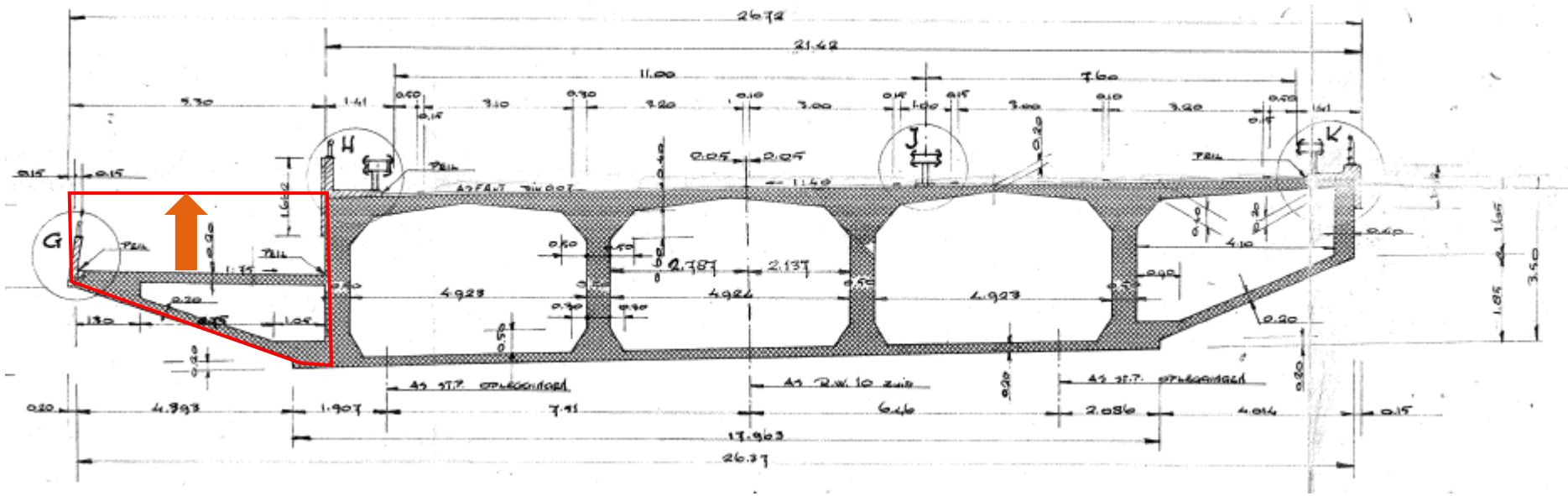
Cross section, prestress





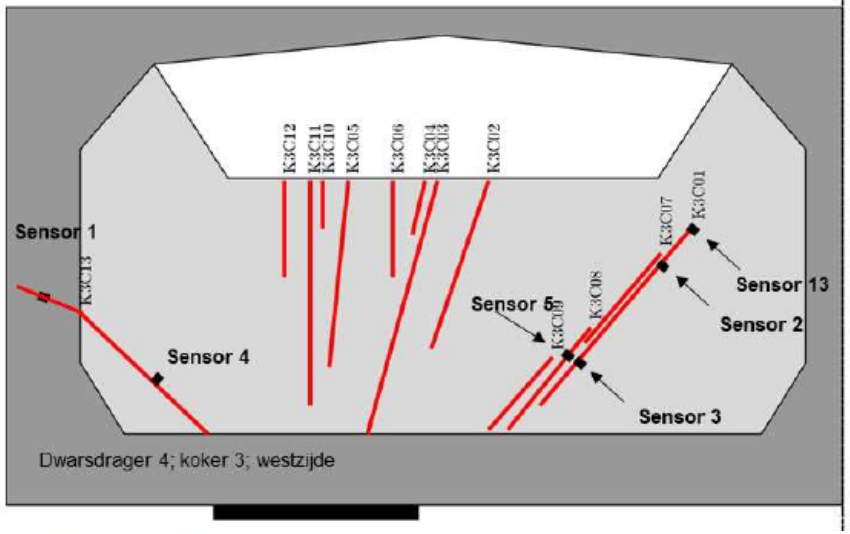


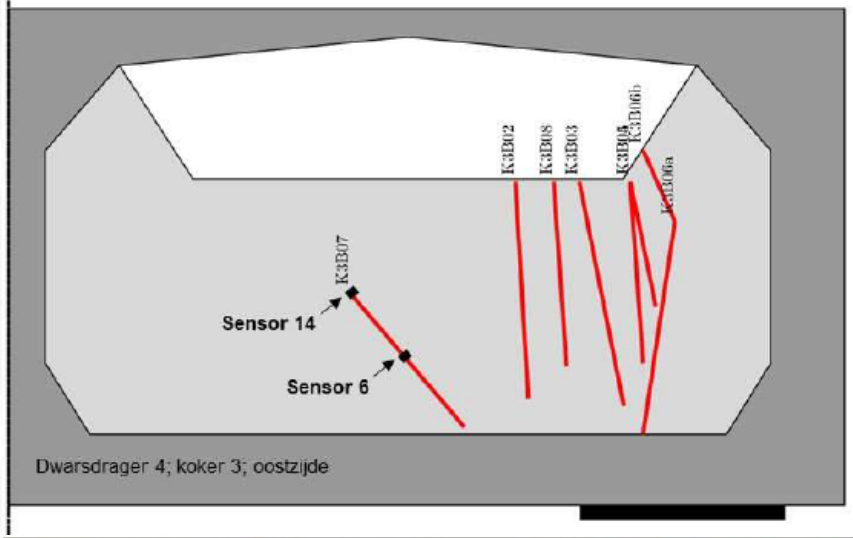
Repurposing

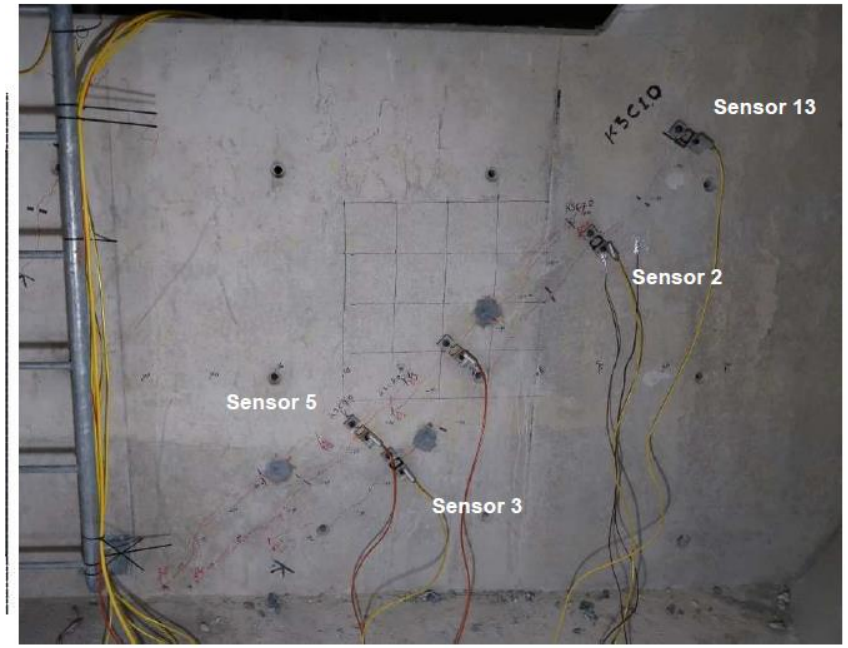

G
H
J
K
26.72
21.42
11.00
7.60
5.30
4.923
4.924
4.923
2.137
6.46
2.086
4.014
17.963
26.37

Linear analysis

Cracks



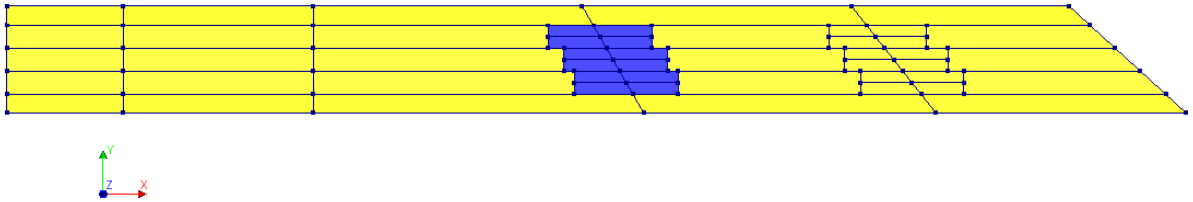


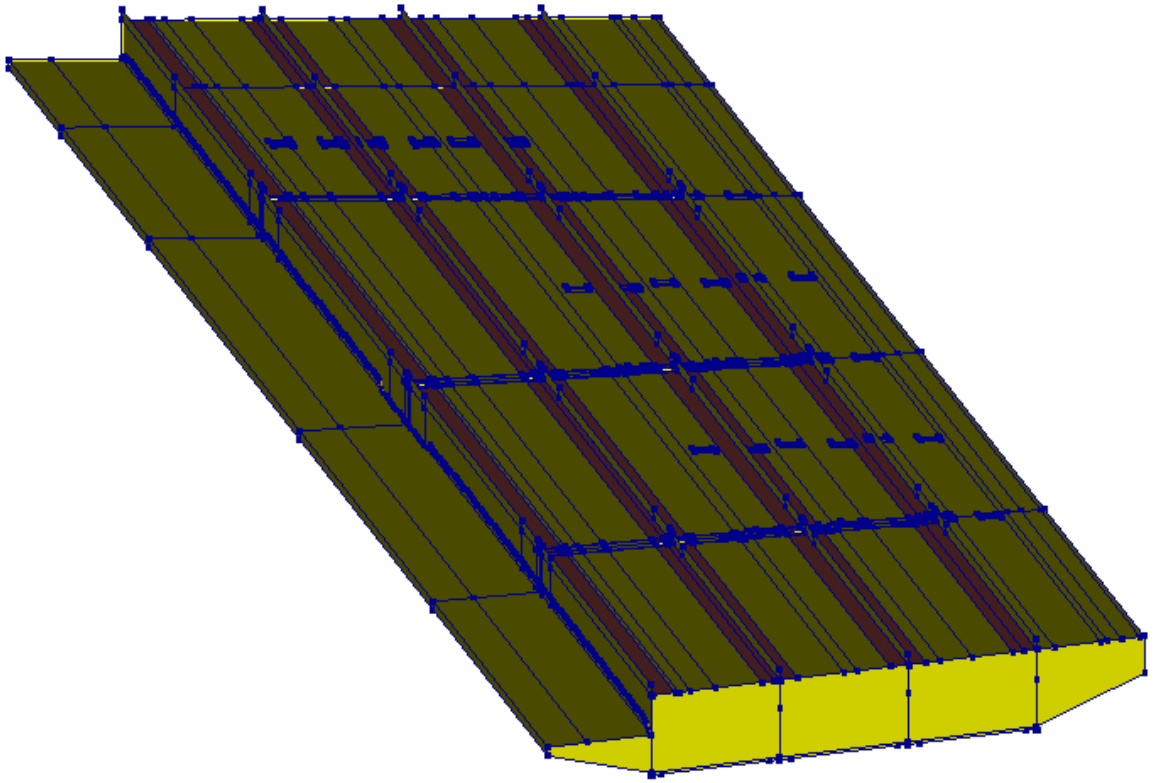


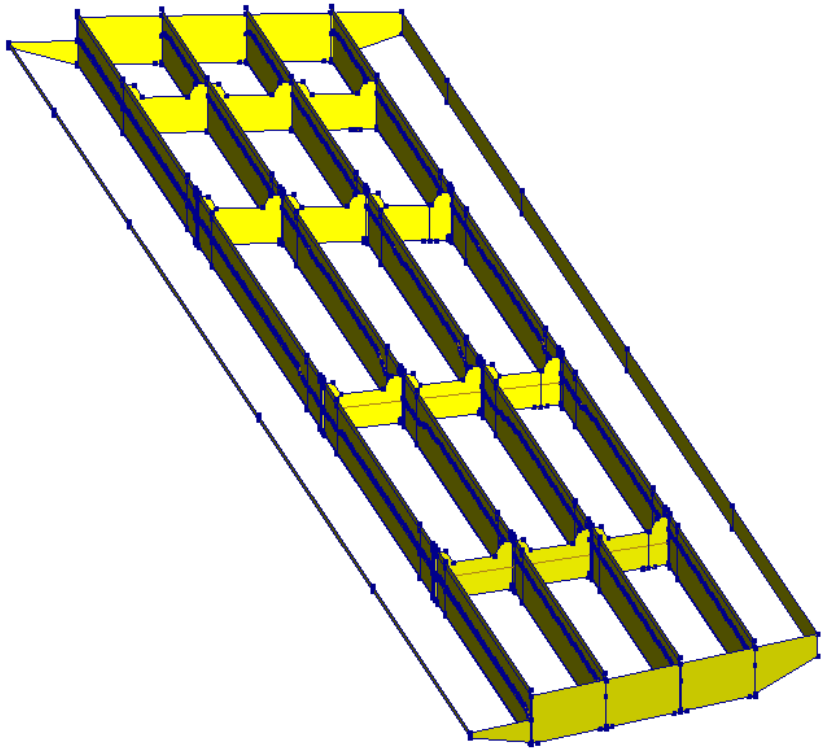
Pictures by TNO

Nonlinear model

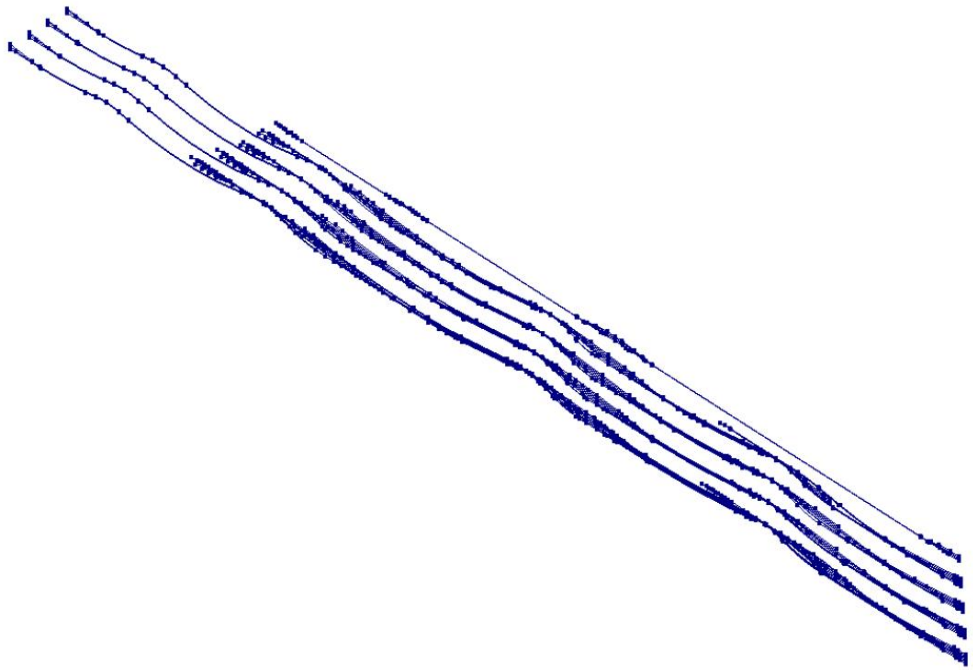
Geometry

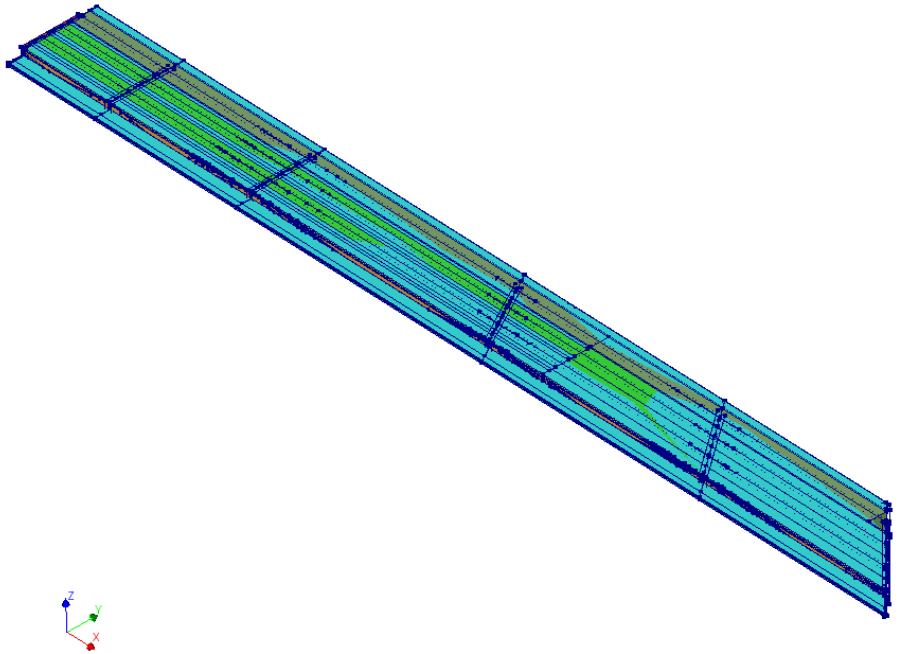






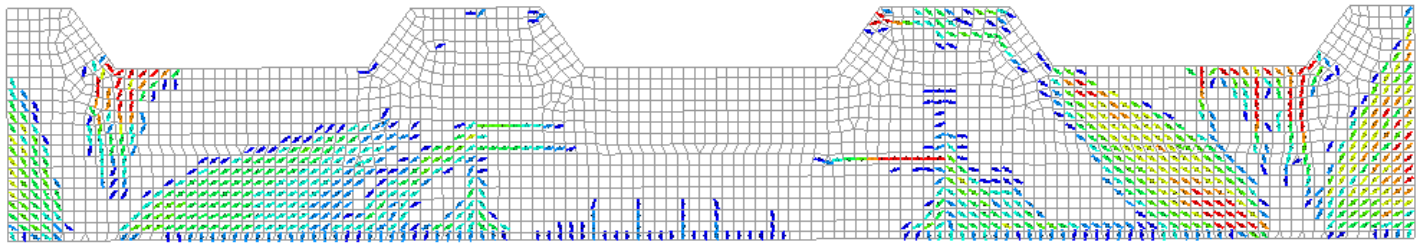
Reinforcement

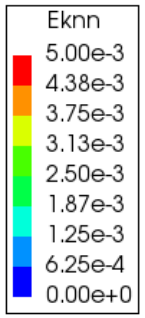


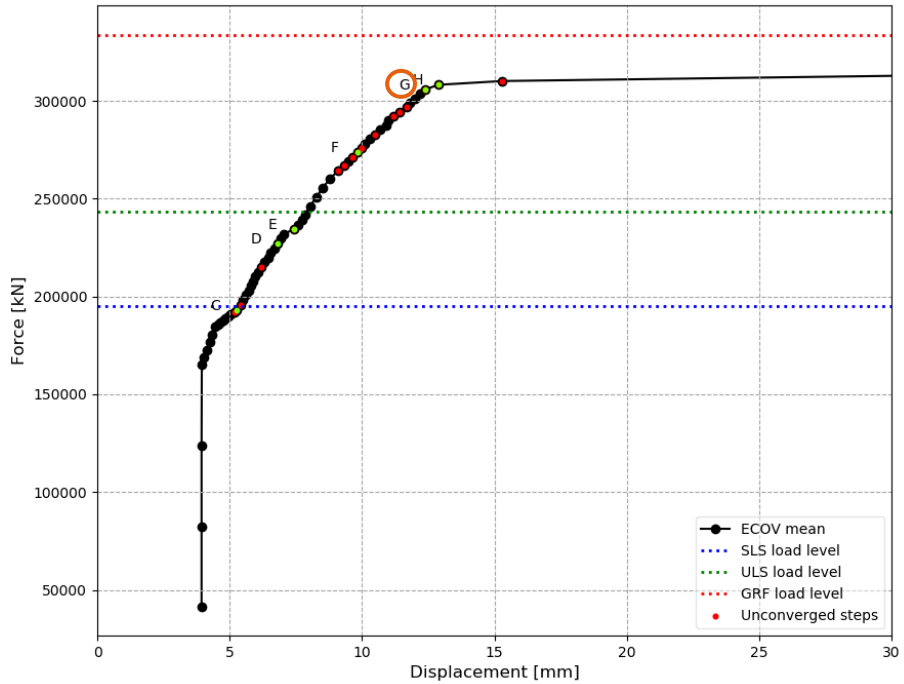


Results of phase 4

Analysis1
Phased 1, Load-step 60, Load-factor 0.70000
Crack Strains Eknn maximum of 3 layers
min: 0.00e+0 max: 1.15e-2

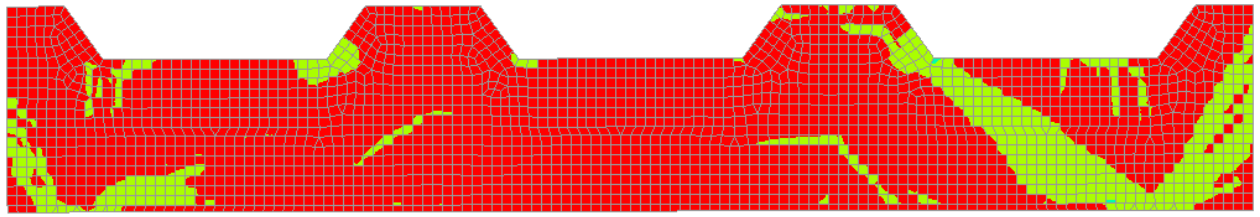




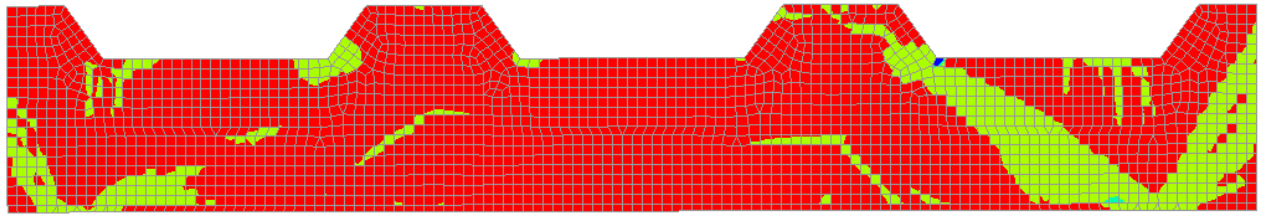


Memo Maciej Kraczla

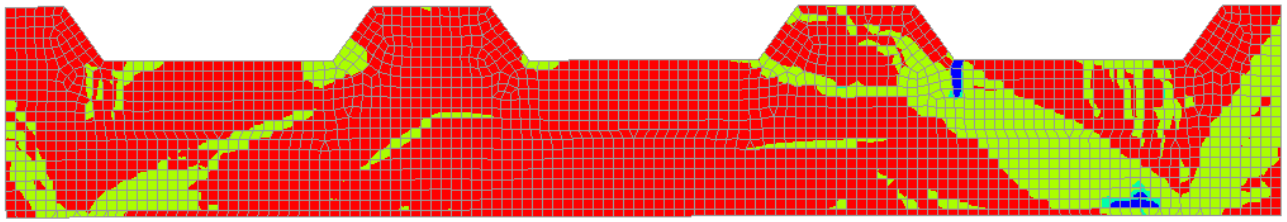
Analysis1
Phased 1, Load-step 60, Load-factor 0.70000
Total Strains E3 minimum of 3 layers
min: -5.21e-3 max: -4.40e-6

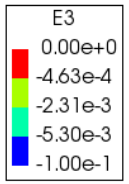


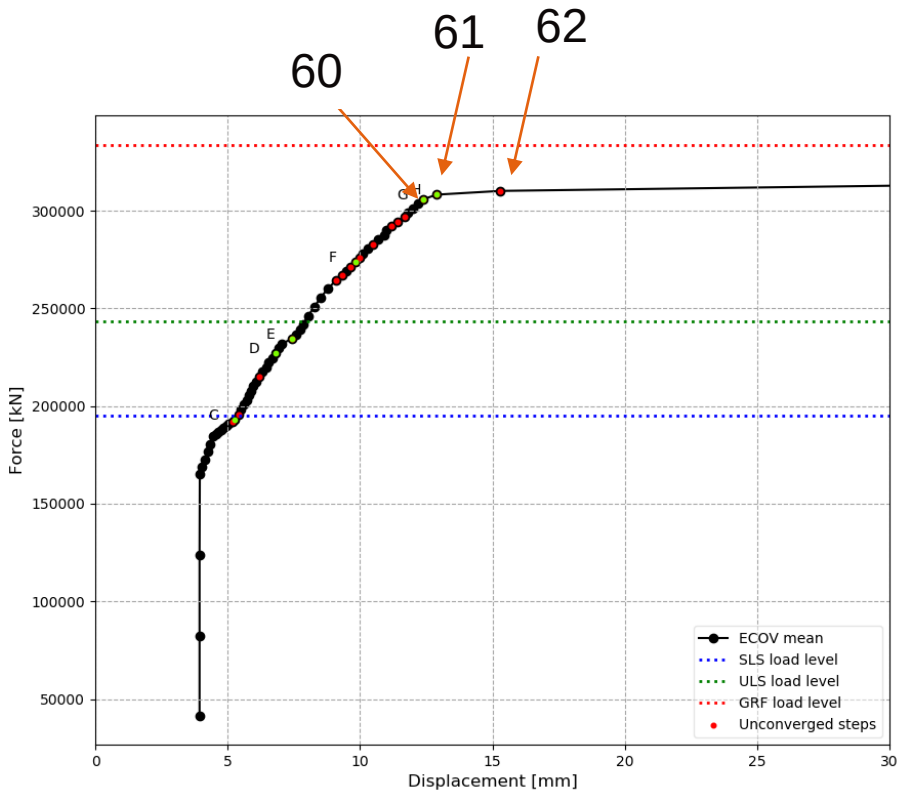
Analysis1
Phased 1, Load-step 61, Load-factor 0.72500
Total Strains E3 minimum of 3 layers
min: -1.80e-2 max: -7.25e-6



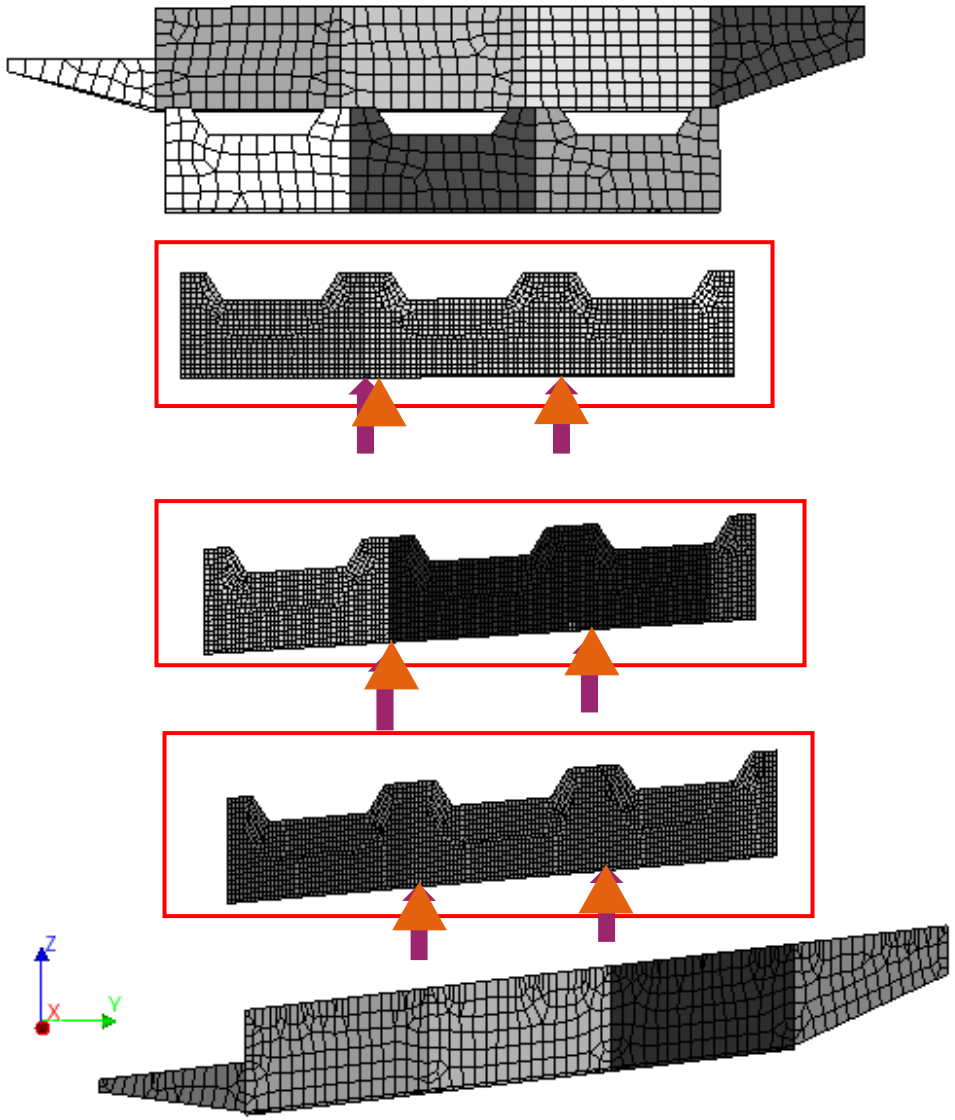
Analysis1
Phased 1, Load-step 62, Load-factor 0.75000
Total Strains E3 minimum of 3 layers
min: -5.08e-2 max: -5.57e-6







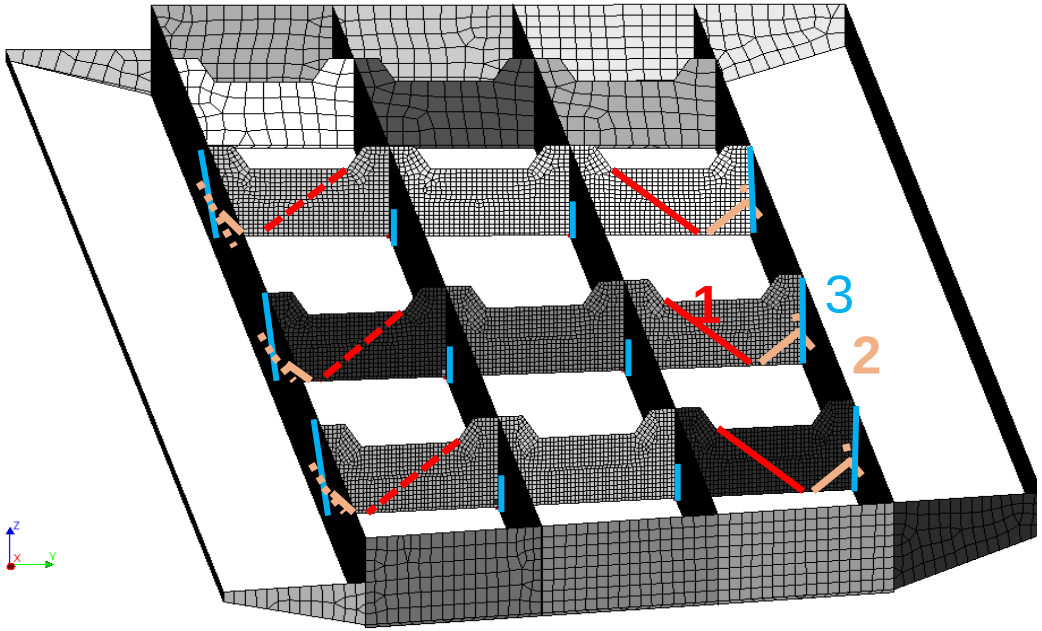
Passive support

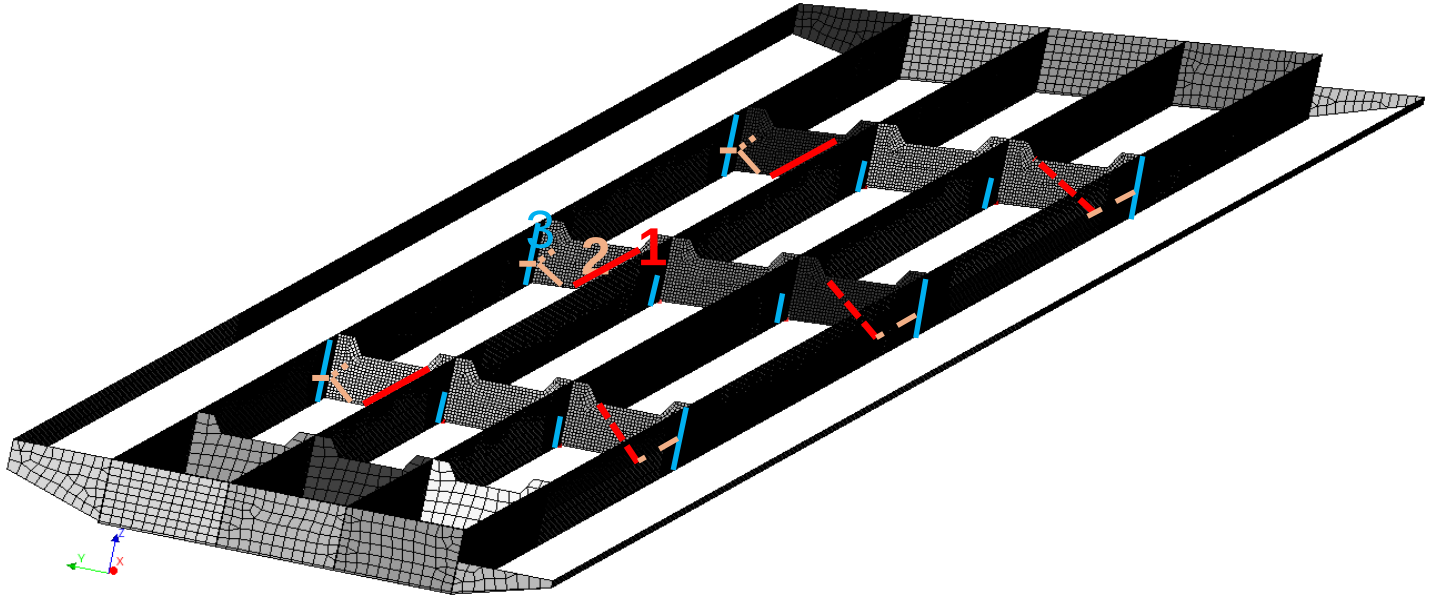


As first: jack up cross beams 3, 4, 5

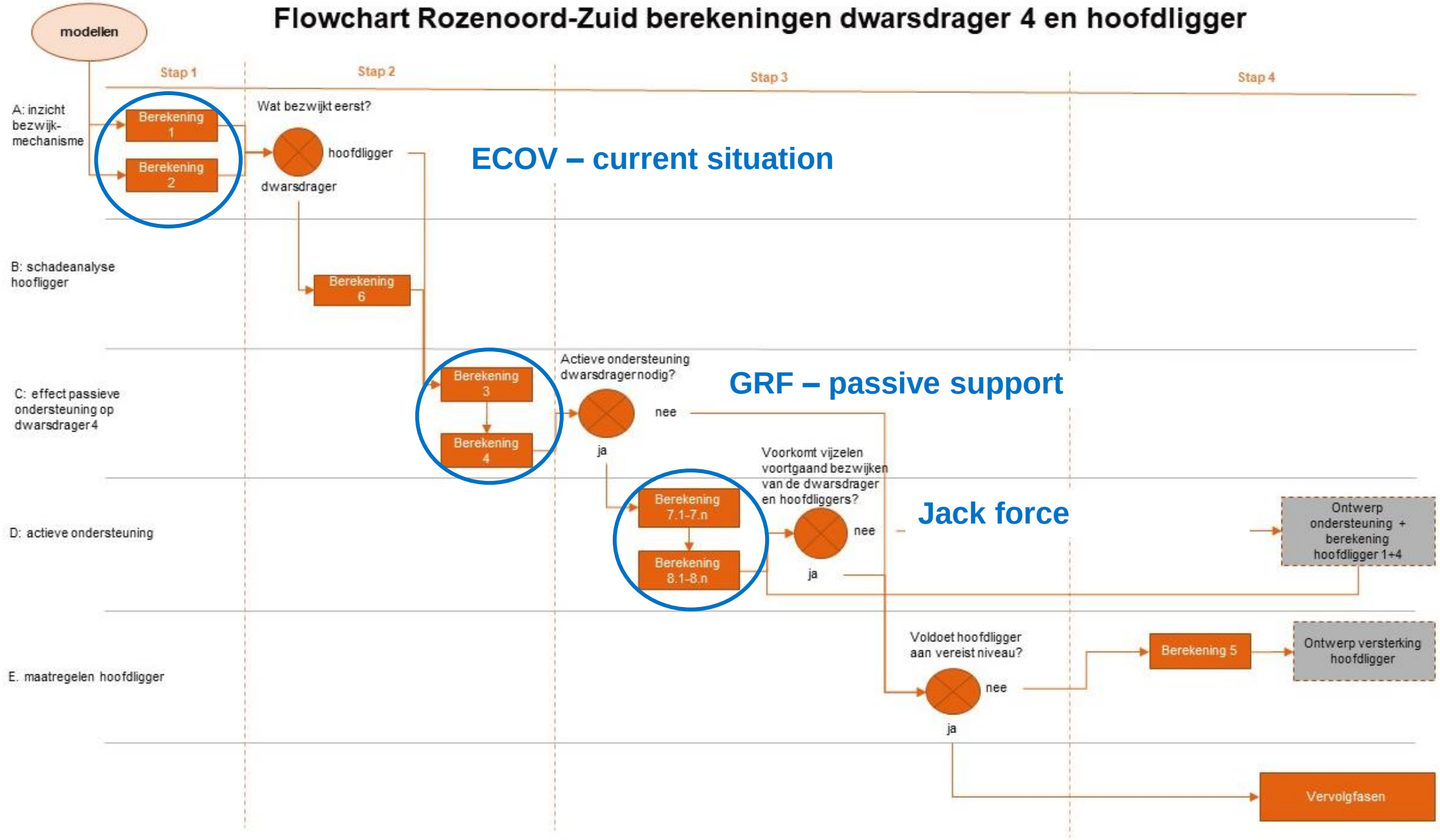
Second: Fixing supports

Discovered failure mechanisms

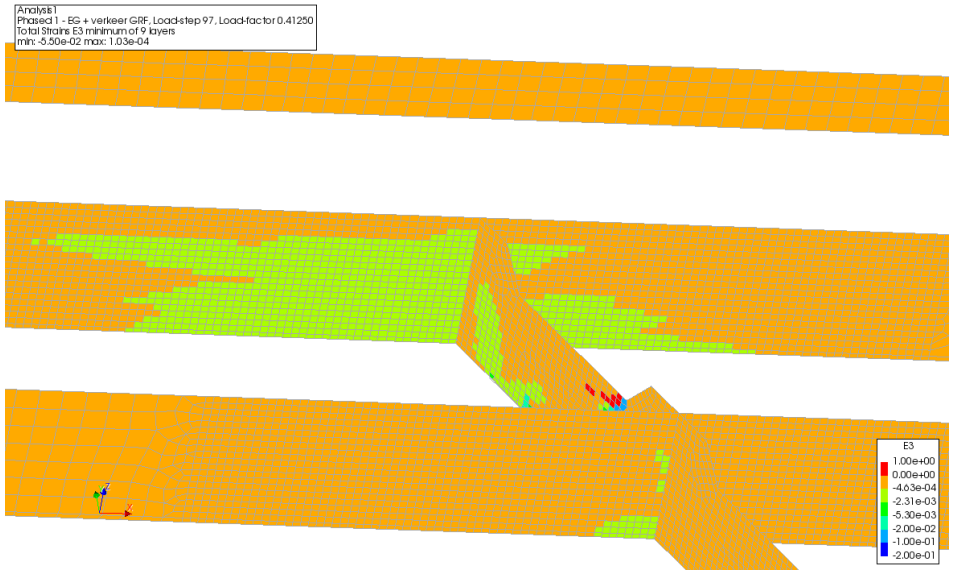


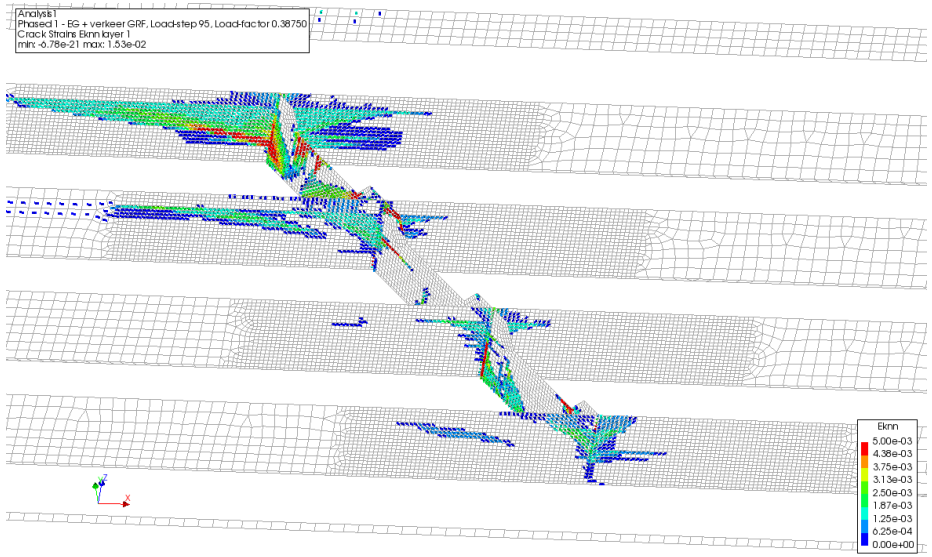


1. The collapse of the pressure diagonal weakened by diagonal cracks in the transverse beams, as a result of concentrated compressive stresses near the supports;
2. Tearing the main beam from the crossbeam, shear;
3. Breaking the main beam on bend, by crushing the compression diagonal, right next to the connection to the cross beam.

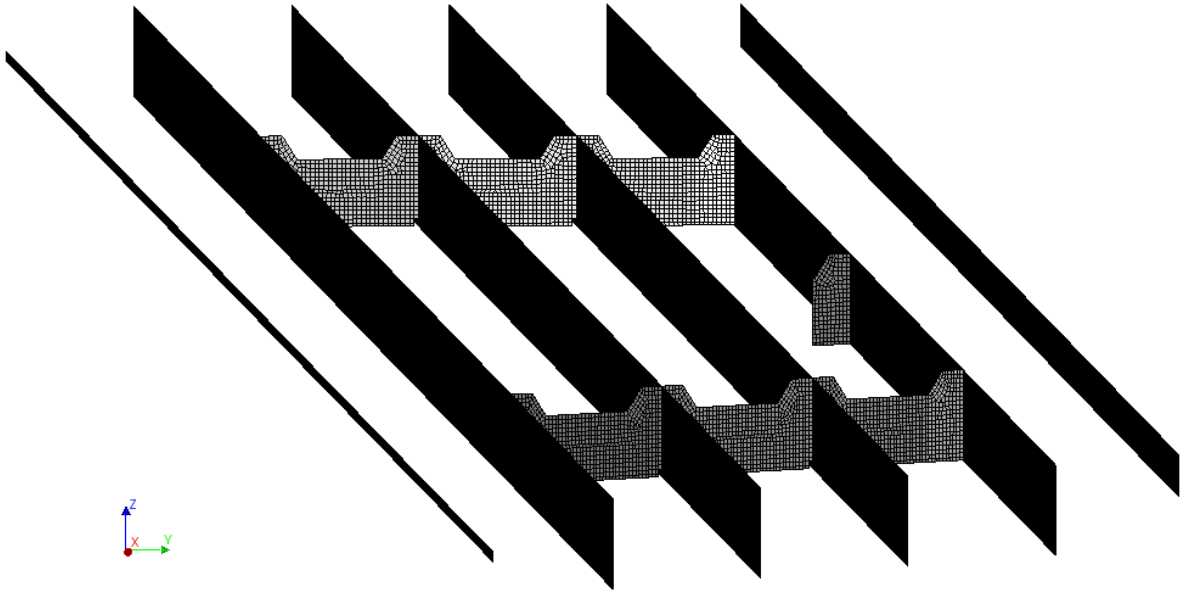


Cross beam 4 – ECOV analysis





Passive support of cross beam 4

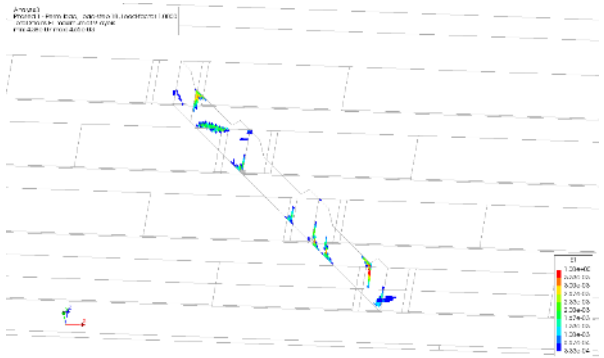


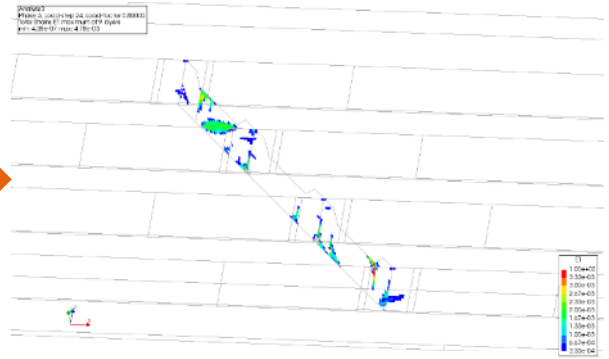
The main girders and the outer corner of crossbeam 4 are elastic under compression, and have a high tensile energy to prevent failure in these zones

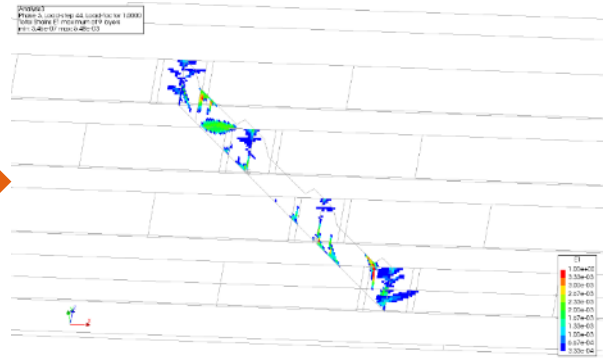
Permanent (a)

SLS (b)

ULS(c)

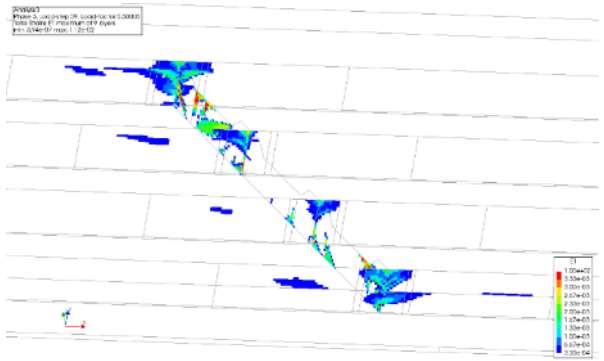


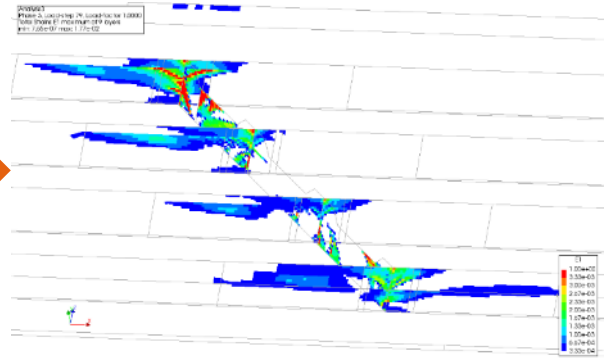


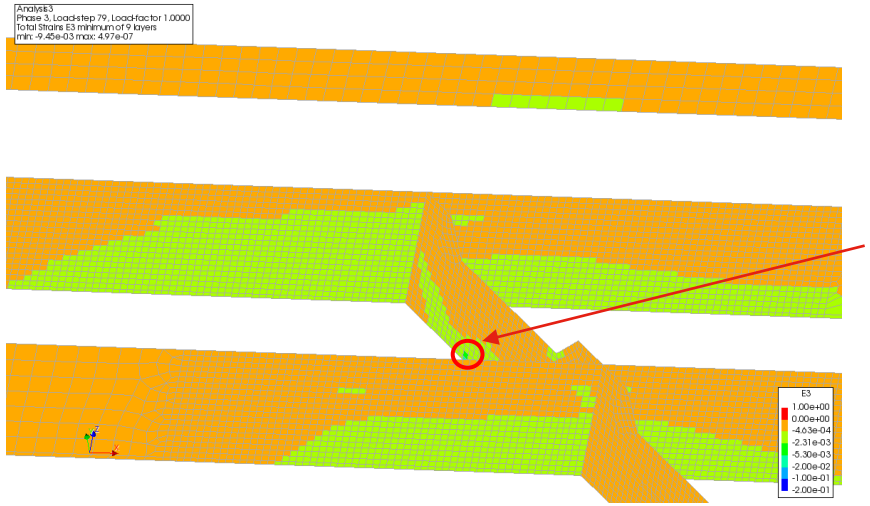


0.5 GRF(d)

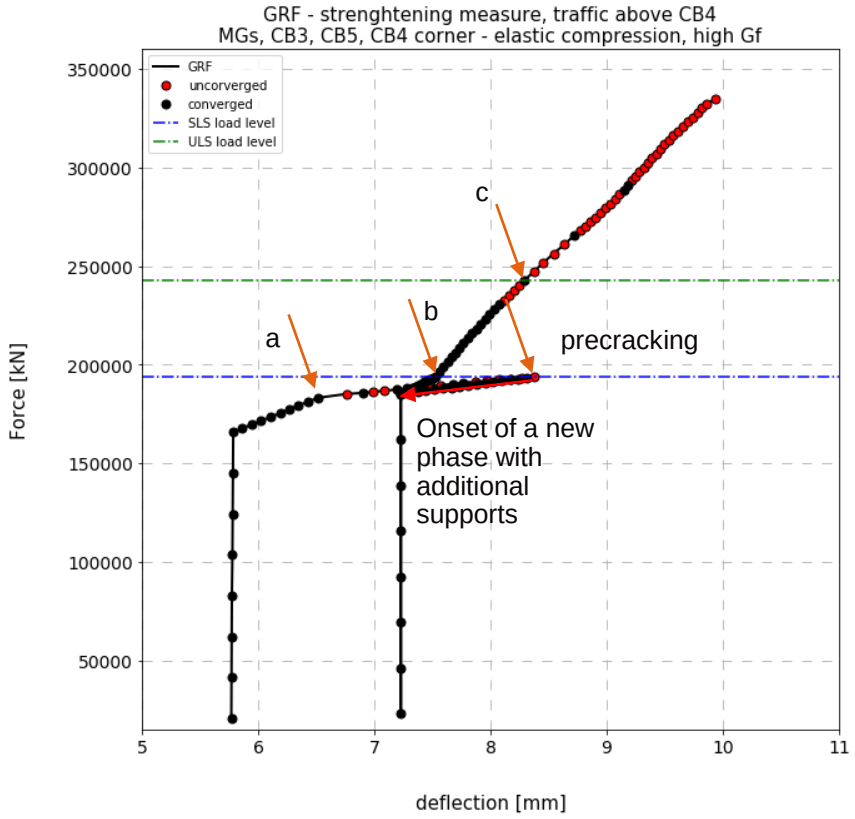
1.0 GRF (e)

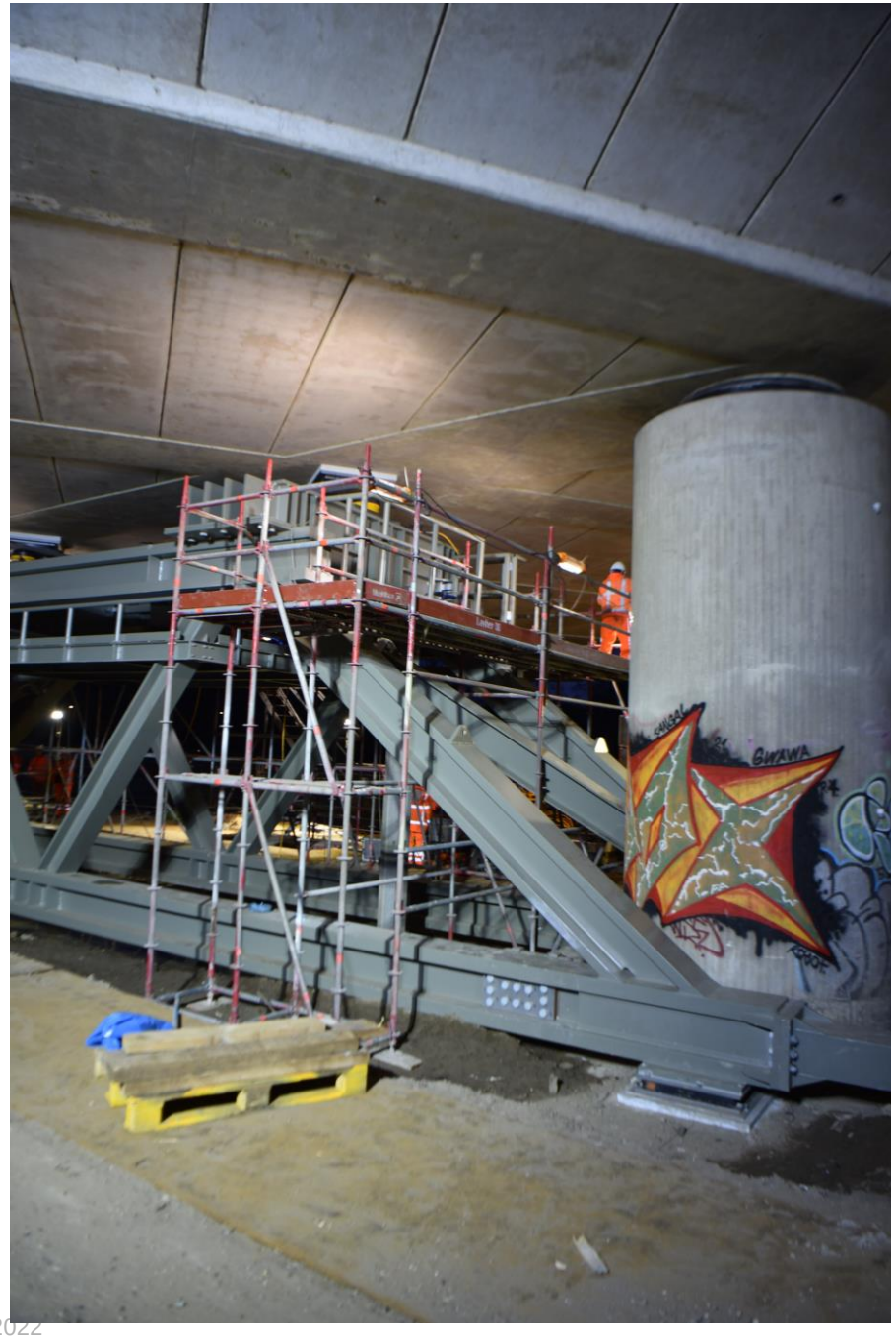


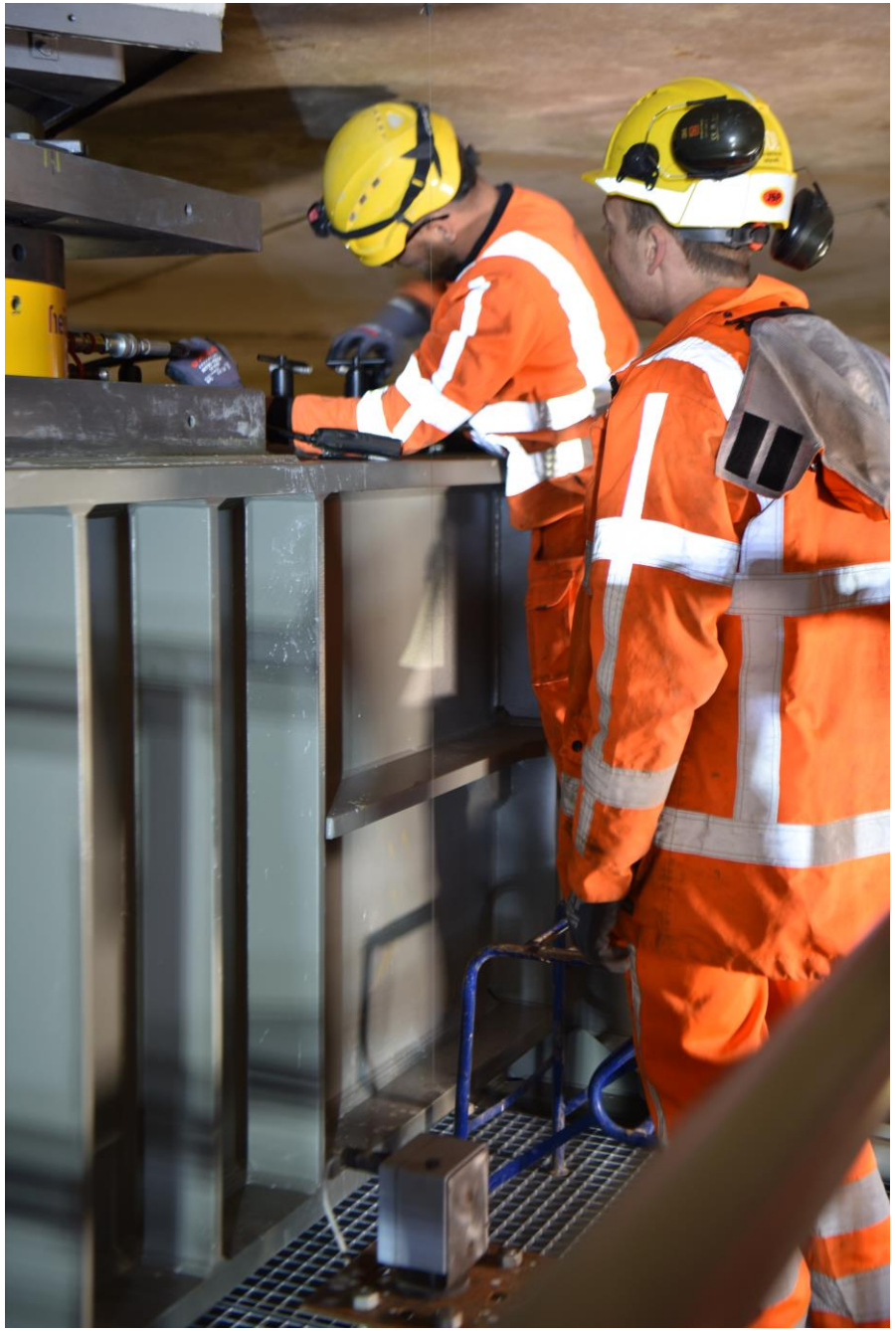




E3 strain upon reaching GRF level. In the lower corner of the pressure diagonal, the crush has just started (ε = -2.3‰).







Google street view now

Thank you for your attention!

Questions?