



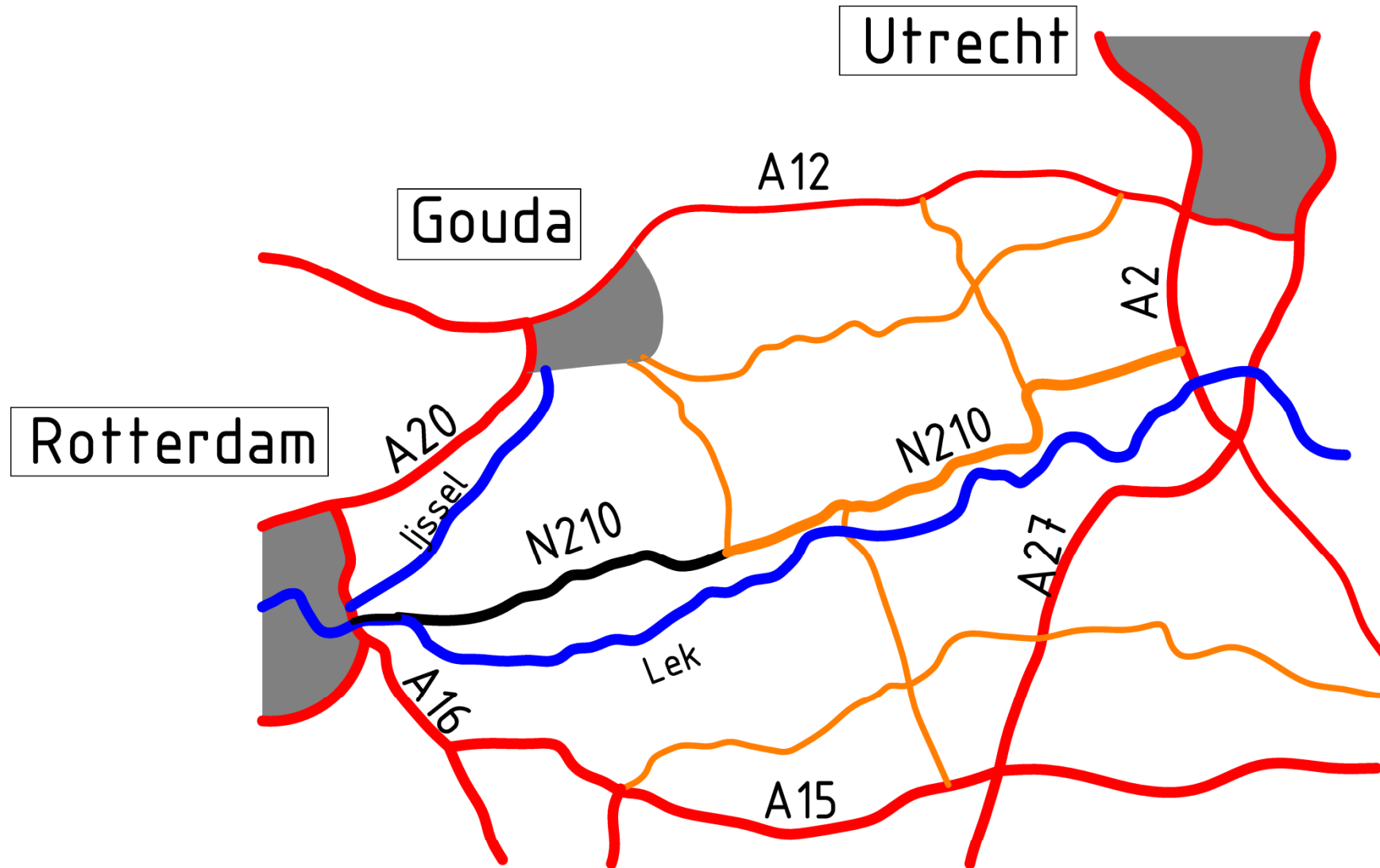


**Joint UK-IGS EGGGS Meeting London
08/Dec/2009**

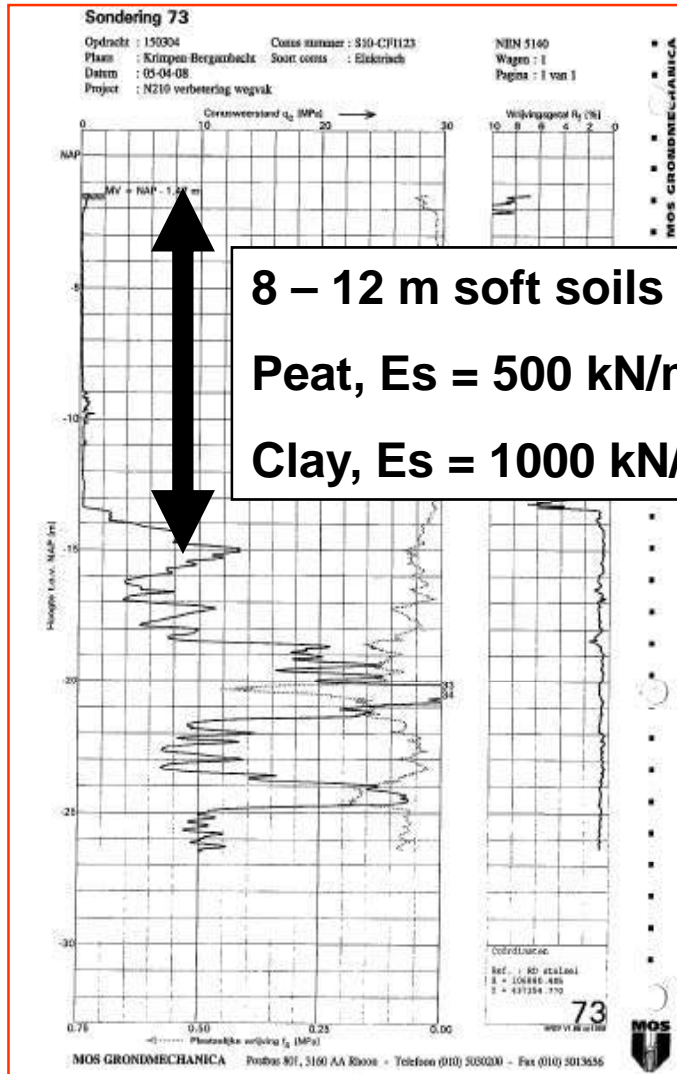
**National Road N210 –
Construction Experience and
Monitoring Results**

Dipl.-Ing. H. Hangen, HUESKER

N210 / Krimpen – Bergambacht / NL



Geotechnical Situation

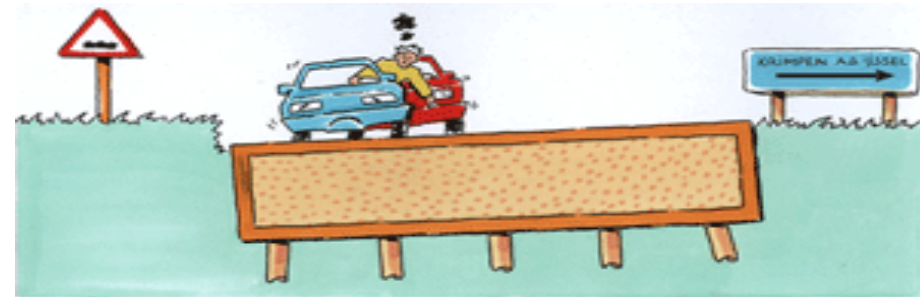


- Construction in 1941 (Prof. Buismann)
- Sand filled RC caisson on wooden piles
 $s = 1.5\text{m}$



Structure failed because of:

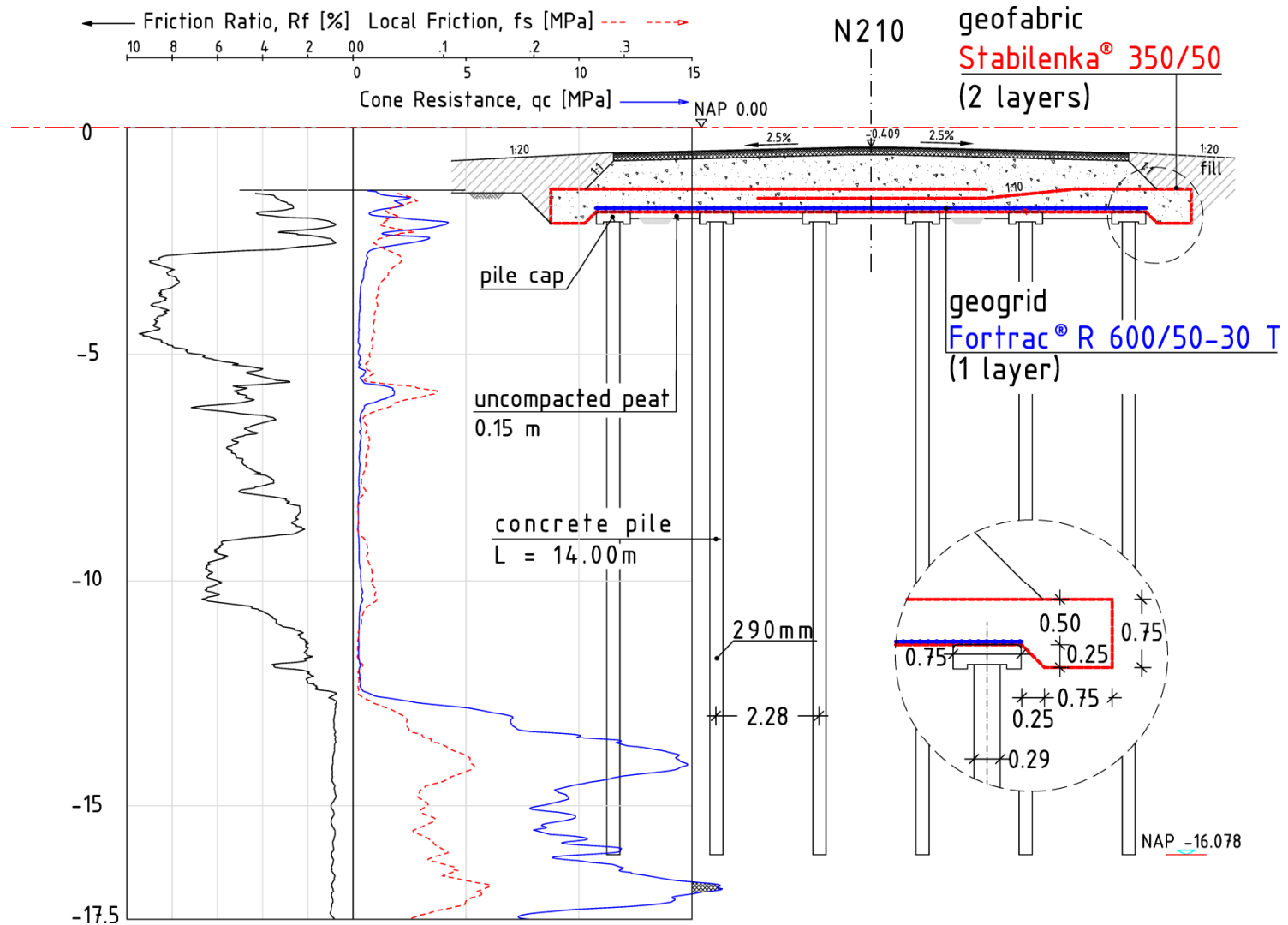
- insufficient durability and length of piles
 - Erosion of sand through the joints of the concrete sections (should have used nonwoven...)
 - Increased traffic load
 - **Construction of parallel road**
- ⇒ Yearly repair, tremendous traffic problems, tremendous cost



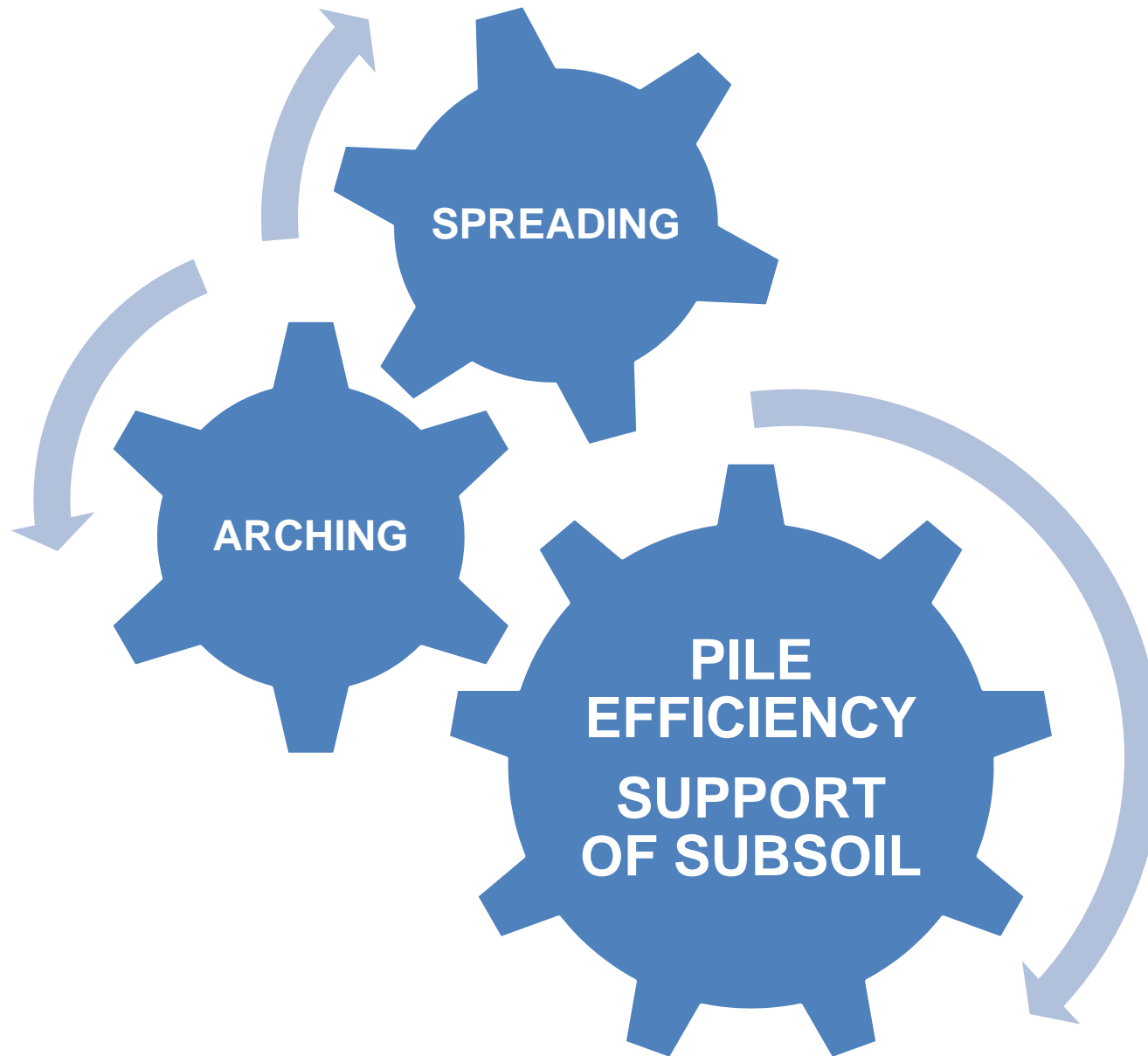
New N 210: Trade Off Matrix / DCM

Construction scheme	Classification*					
	Feasibility (technical)	Construction		Environmental impact	maintenance / Risk	Reliability / references
		cost	time			
Soft soil replacement	+	0	--	--	+	++
Preload embankment	+	+	--	+	-	+
EPS	-	0	+	+	-	0
Stone columns	0	0	+	+	0	0
GEC	+	+	+	+	0	+
Concrete piles + concrete plate	+	--	+	+	+	+
Pref. concrete piles + GSY	+	+	+	+	+	+

Design Section of the new N 210



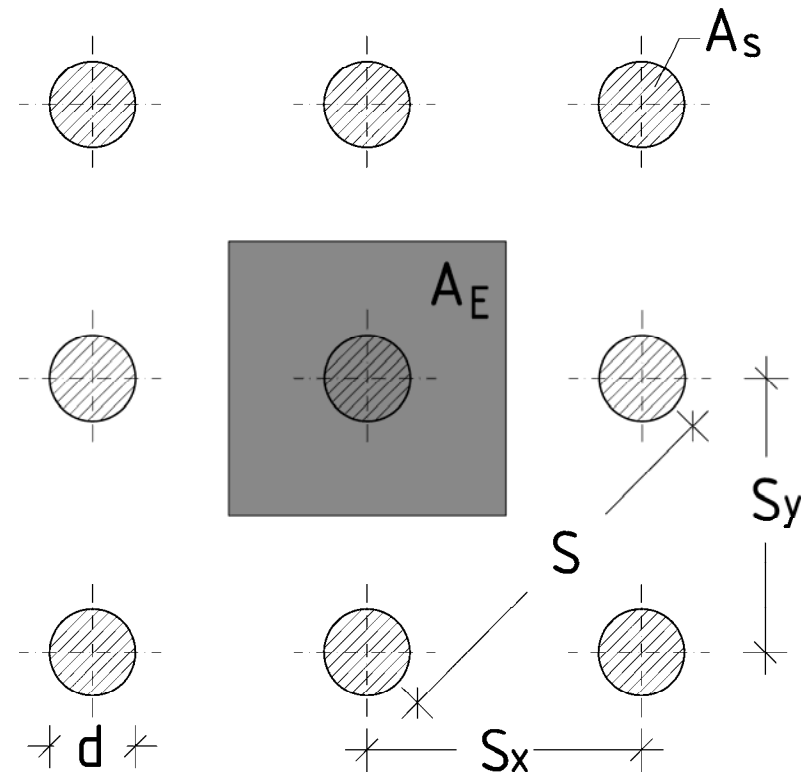
Key questions of design



BS 8006:1996

- Only “real” standard
- Long (positive) experience
- Allows for shallow embankments
- EBGEO (new):
 $(s_x^2 + s_y^2)^{1/2} = s (= 1.41 \times 2.35\text{m})$
 $h > 1.0 (s - d) \gg h > (3.32 - 0.84)$
 $= 2.48 \text{ m}$
- BS 8006:
 $s = s_x = s_y$
 $h > 0.7 (s - a) \gg h > 0.7 (2.35 - 0.75)$
 $= 1.12 \text{ m}$
- CUR 159B:
 $h > 0.66 (s - d) \gg h > 0.66 (3.32 - 0.84)$
 $= 1.64 \text{ m}$

$$d_{ers} = (4a^2 / \pi)^{1/2}$$



- Arching model / pile efficiency
- Arching stability / dynamic loading (Heitz / Kassel)
- Differential stiffness (column / soft-soil)
- Number of geogrid layers
- Triangular pile pattern

- Optimise construction sequence
- Verify design calculations
- Quality assurance (20 years)

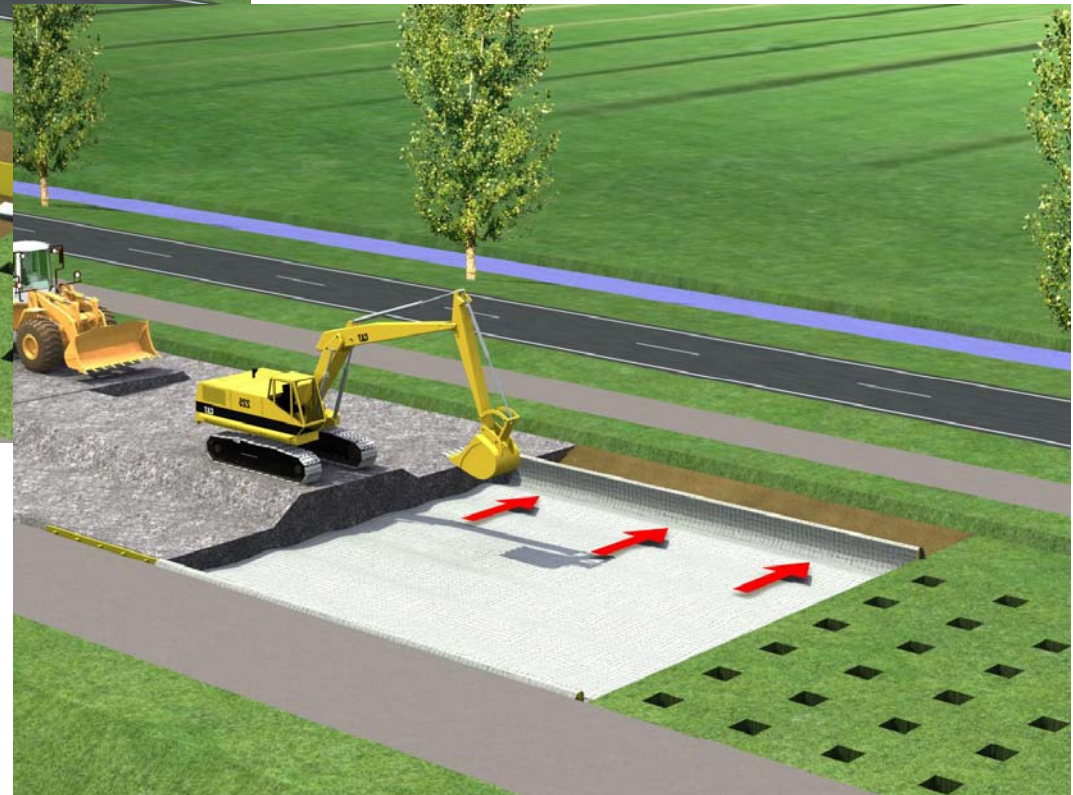
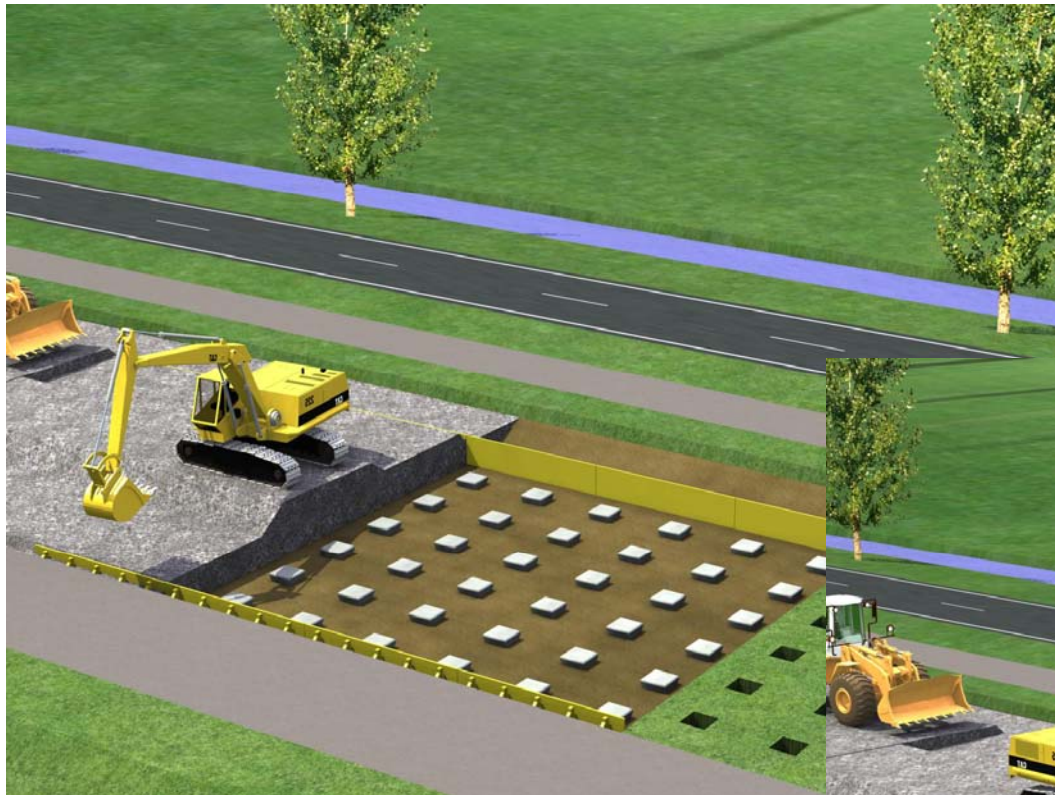
- Trial embankment as part of the final stretch
Length of test section: $L = 50$ m
part 1: without preloading
part 2: with add. preloading

- Detailed instrumentation



Construction / optimize method

HUESKER
Engineering with Geosynthetics





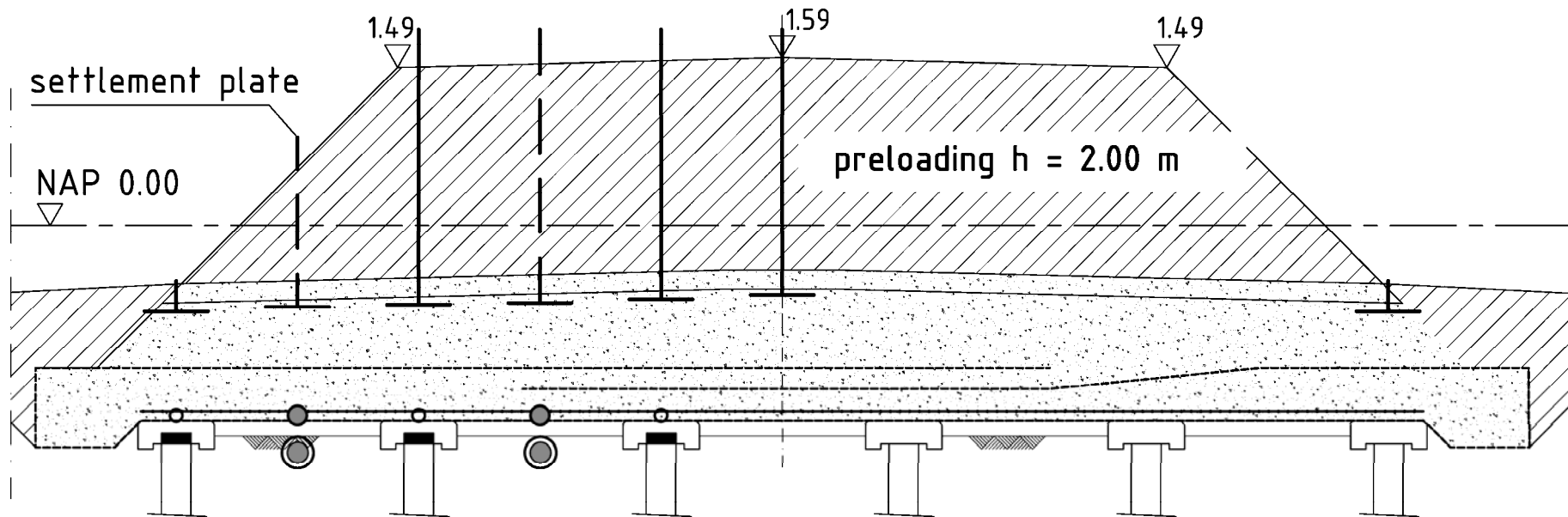
Construction



Section of new N 210



Section MV 2 / preloading



⊙ earth- and pore water pressure

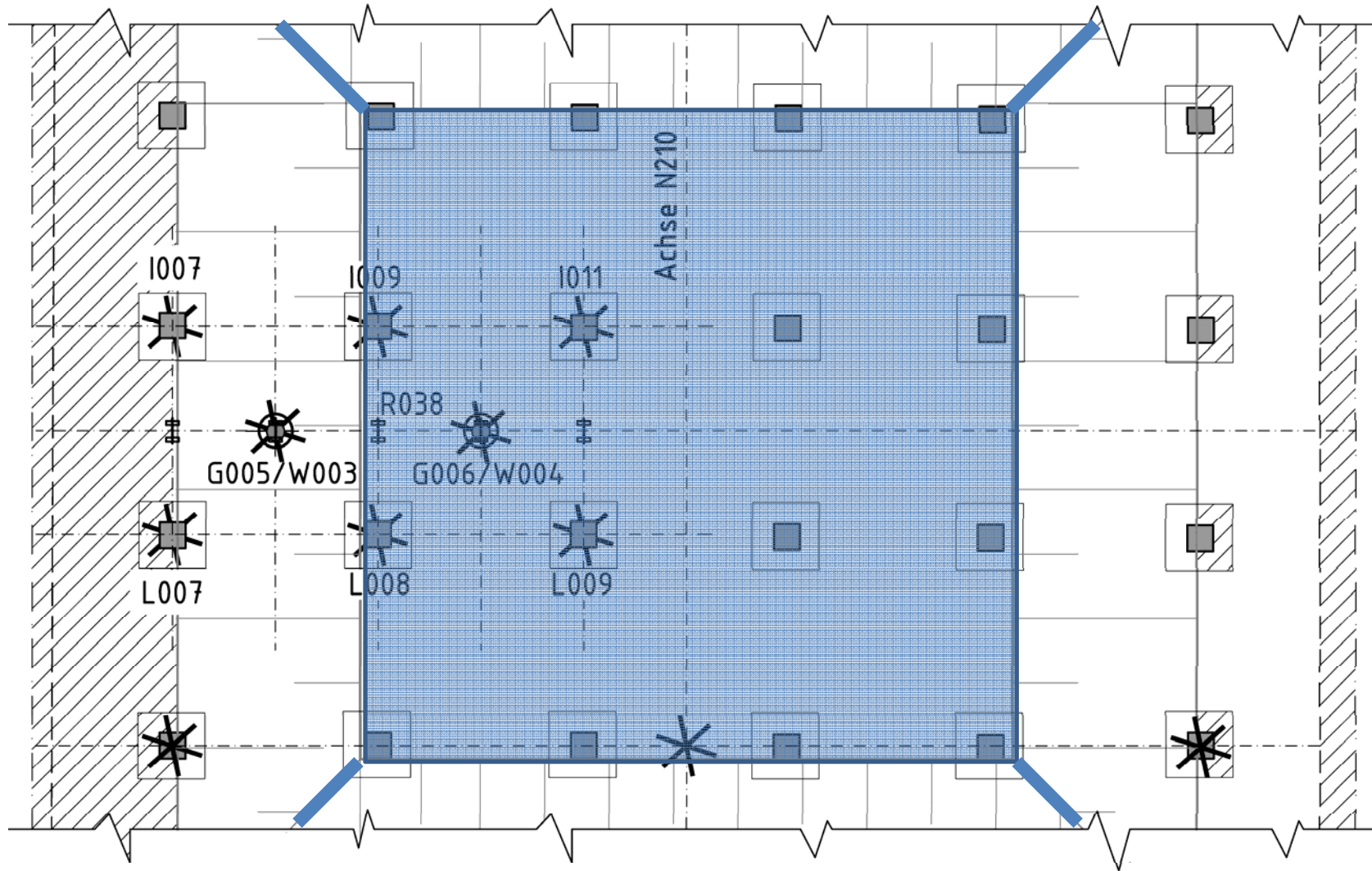
‡ displacement transducer

● earth pressure

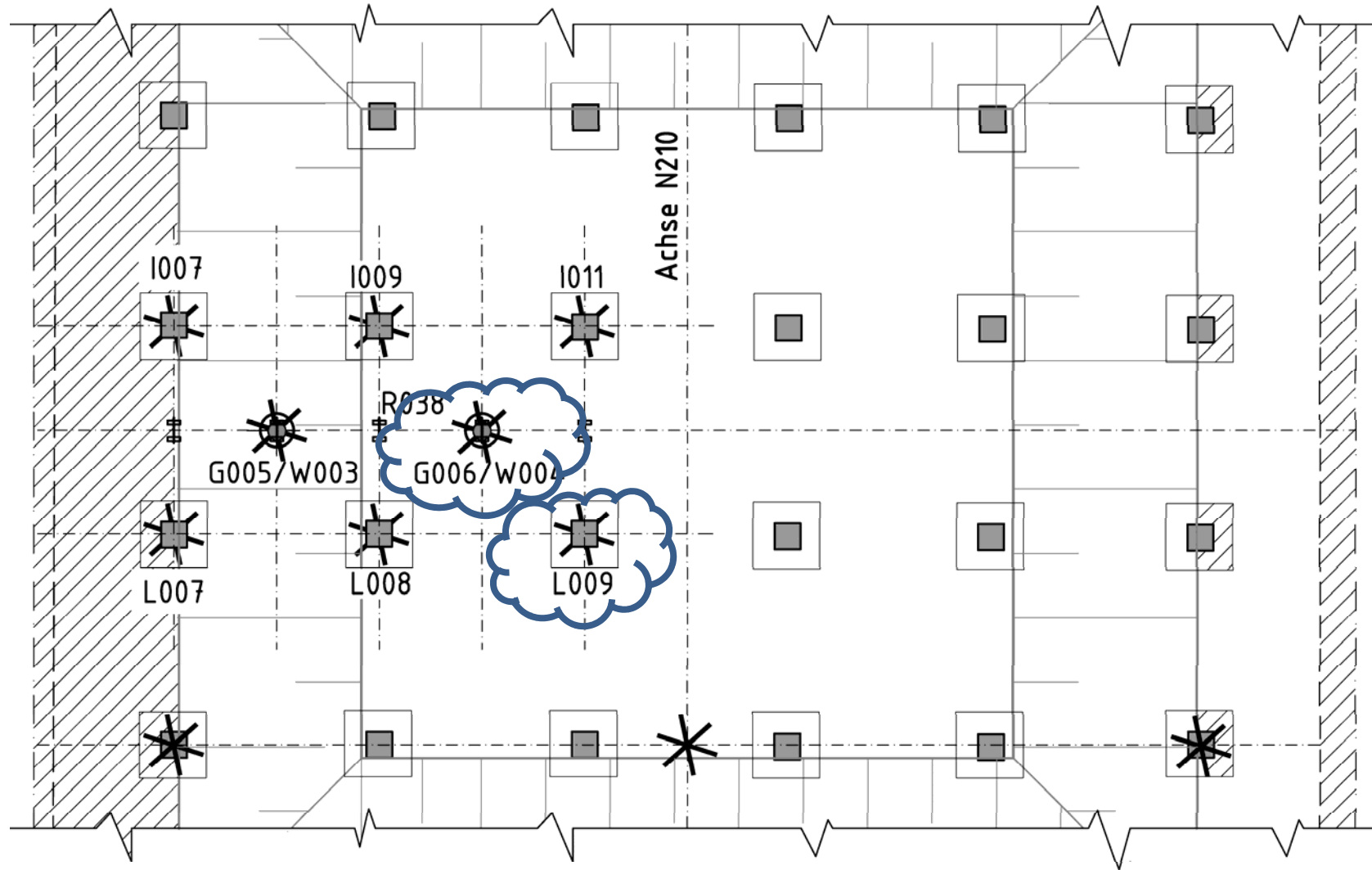
* settlement plate

■ load cell

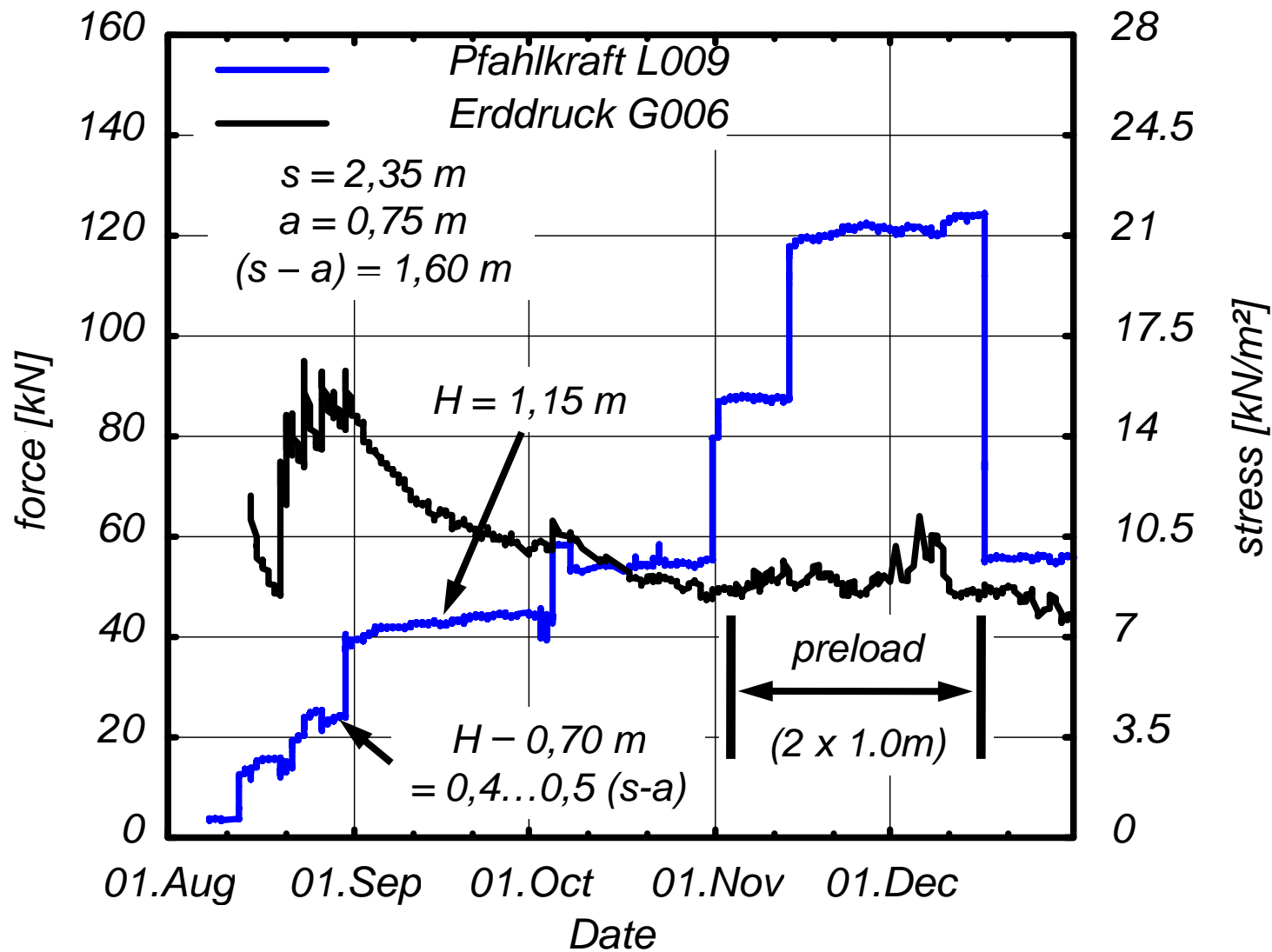
Section MV 2 / preloading



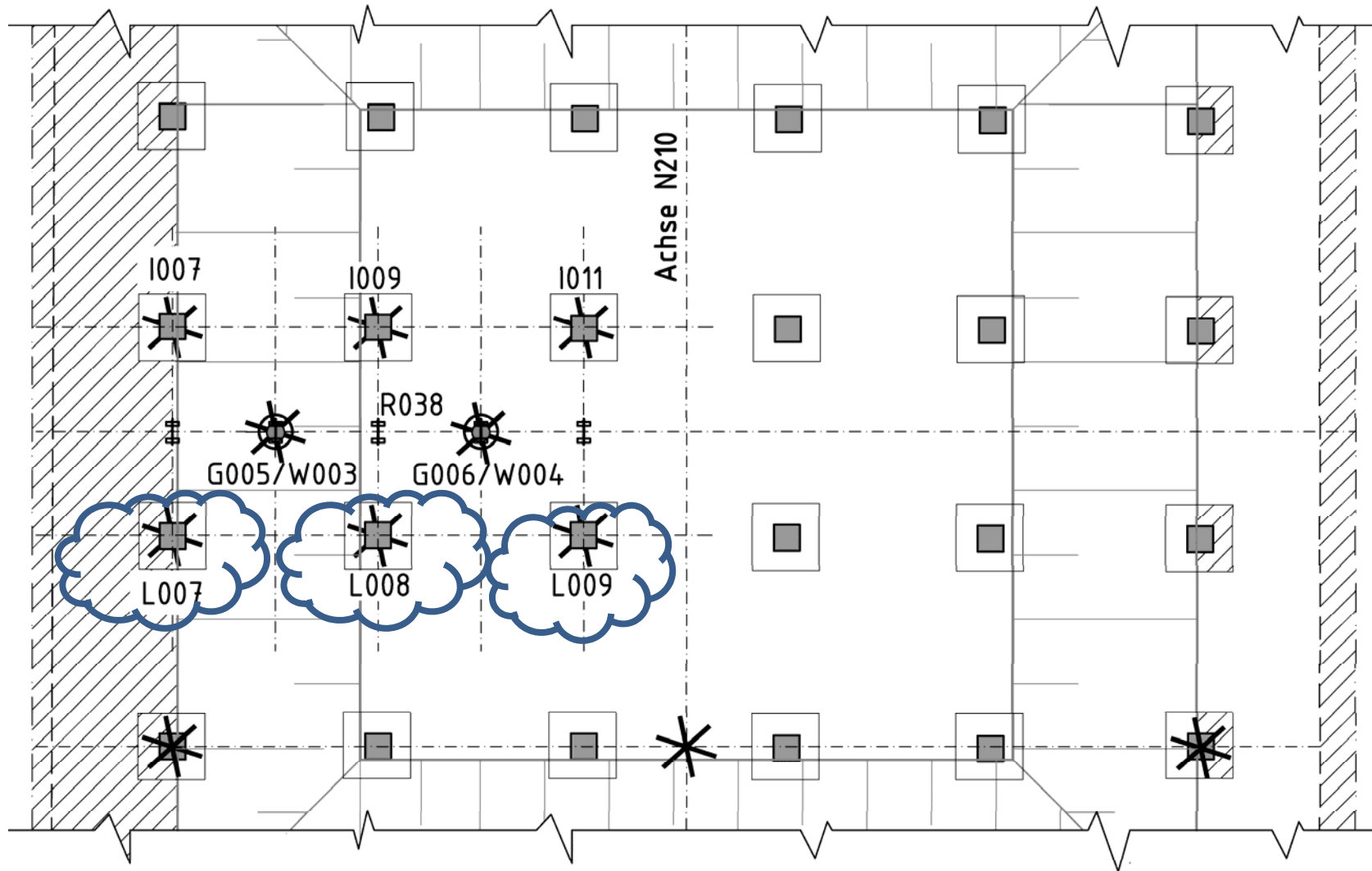
Section MV 2 / arching



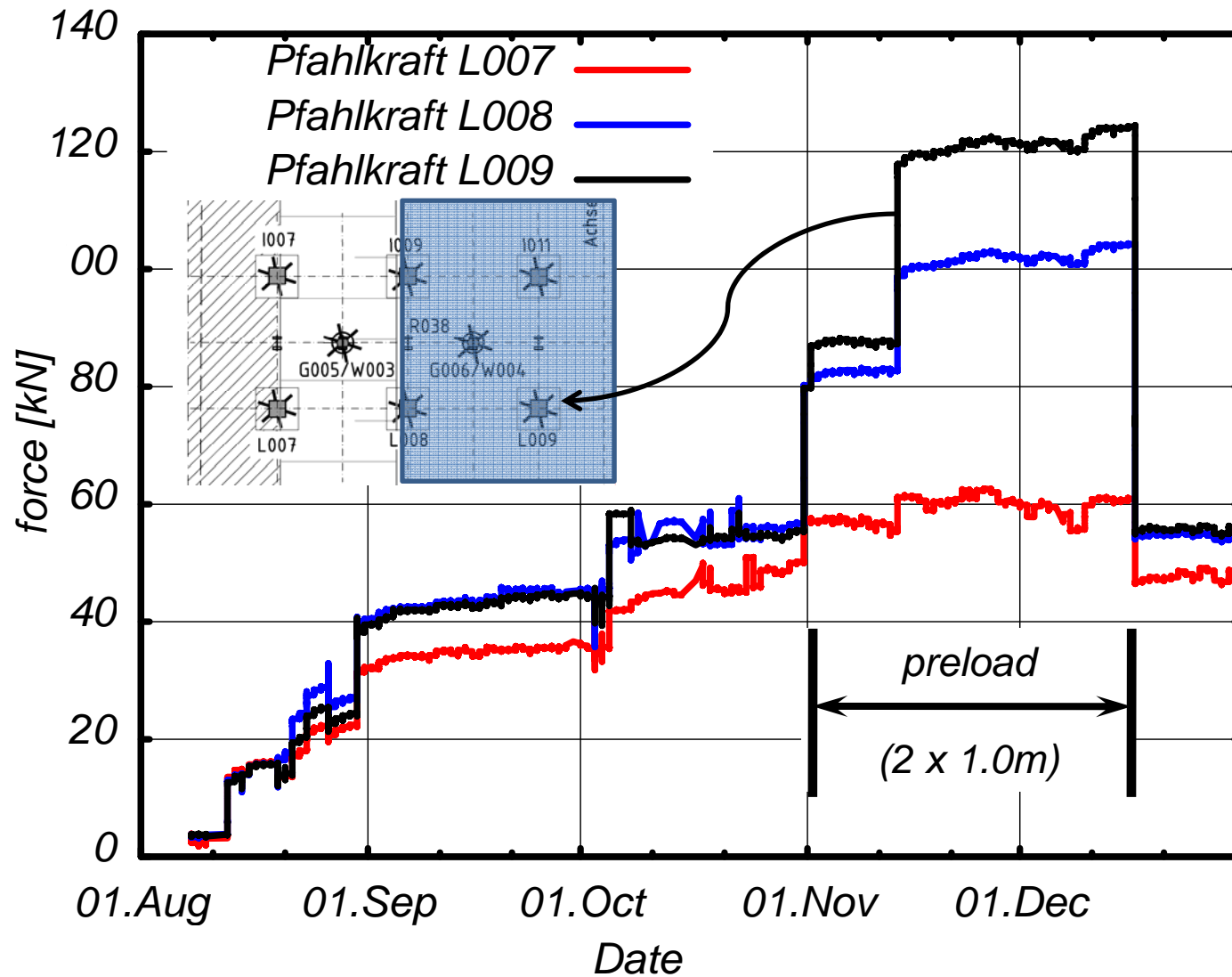
Section MV2 / arching



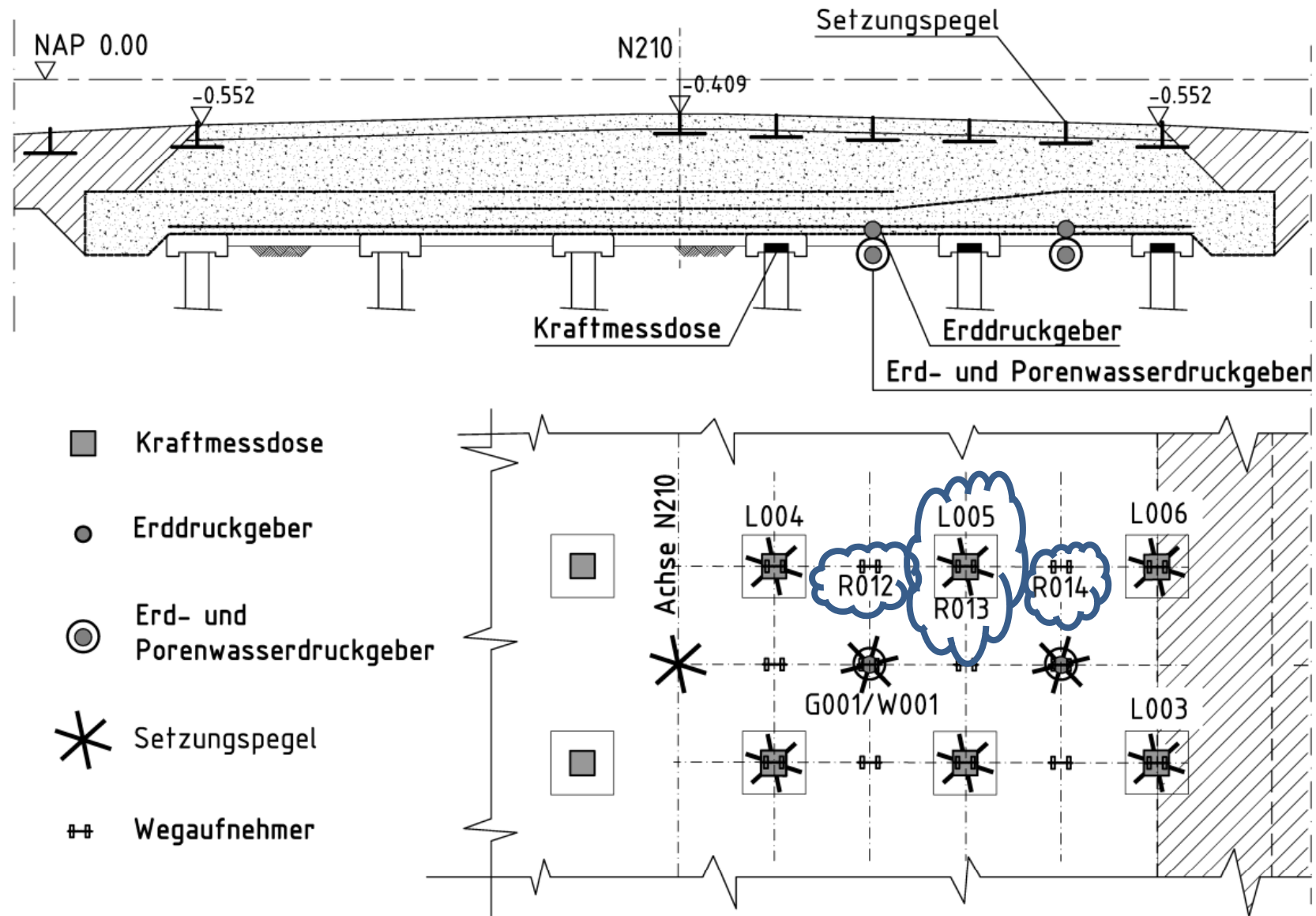
Section MV 2 / loadspreding



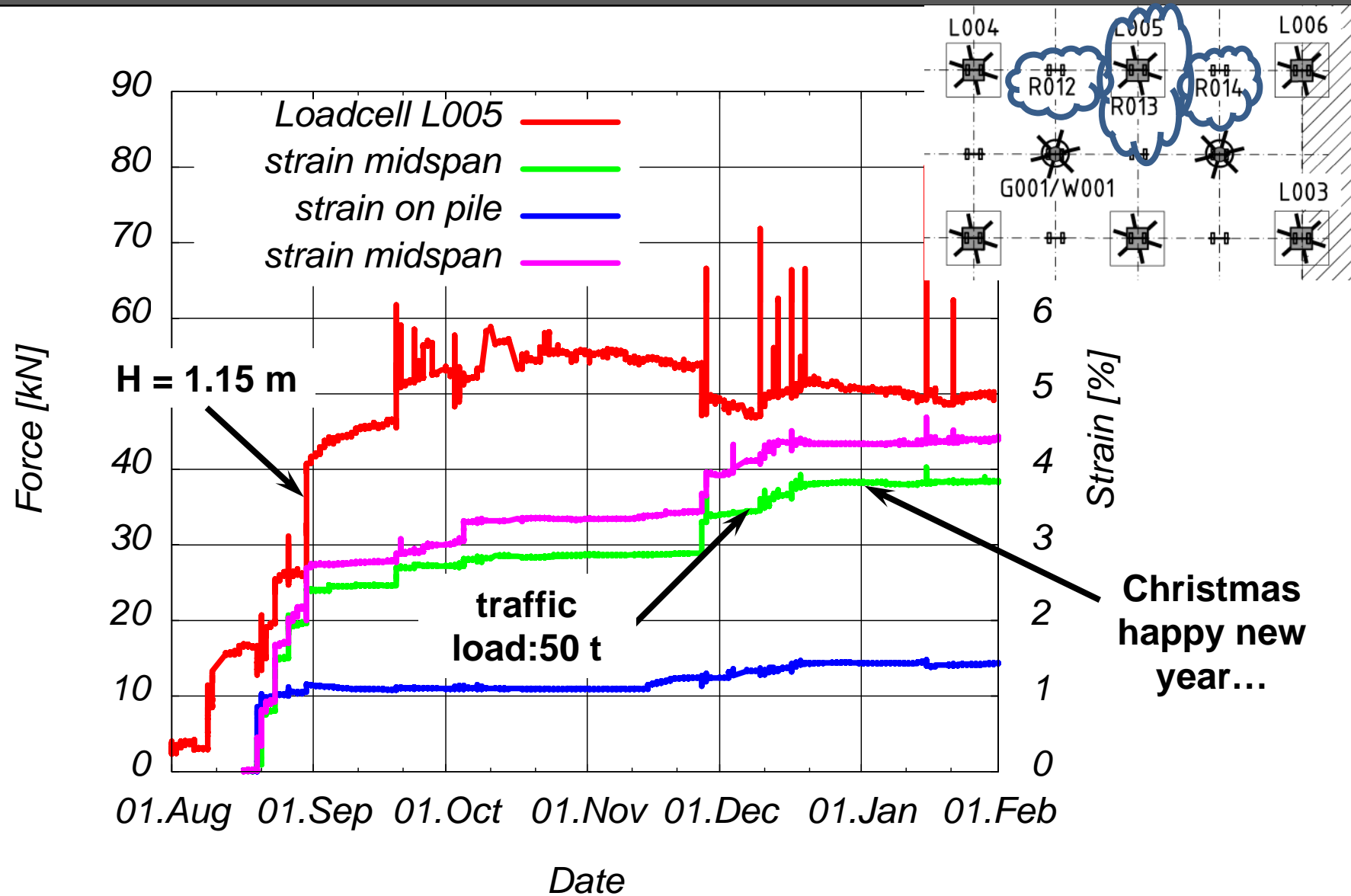
Section MV2 / loadspreading



Section MV 1 / reinforcement strains



Section MV 1 / reinforcement strains



- Cost effective construction method
- Good performance even for extremely shallow embankments
- Arching build-up is very good
- Arching re-arranges partly after first traffic load
- Arching remains stable for “road traffic”
- To be analysed:
Sensitivity with regard to lateral pressures (not shown here)
- Long term performance



... no risk no fun...
Thank you!