2nd International Workshop on

Evaluation of Eurocode 7

Pavia, Italy, April 2010

Example 2.4:
Earth and pore water pressures on basement wall

Hans R. Schneider
Switzerland

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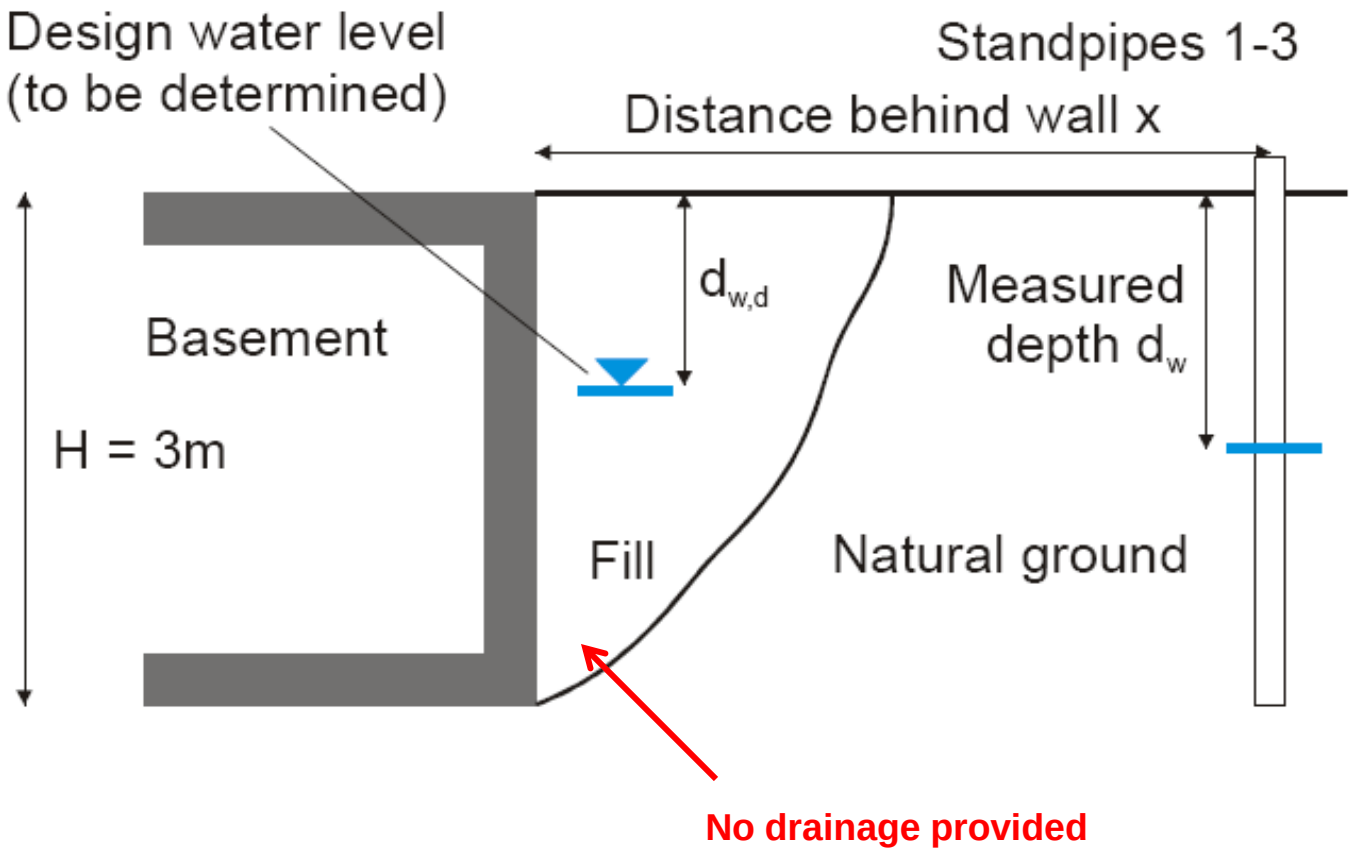
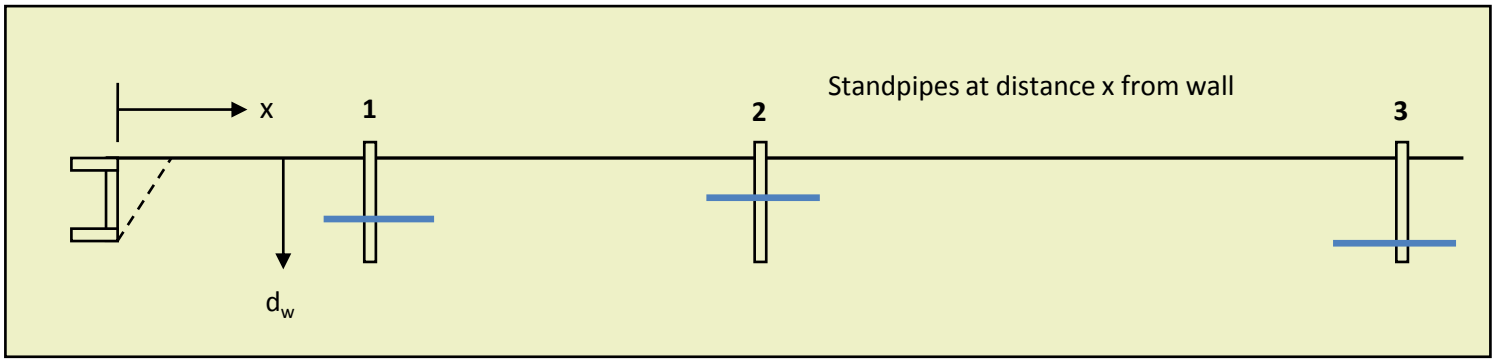


Earth and pore water pressures on basement wall
Design situations



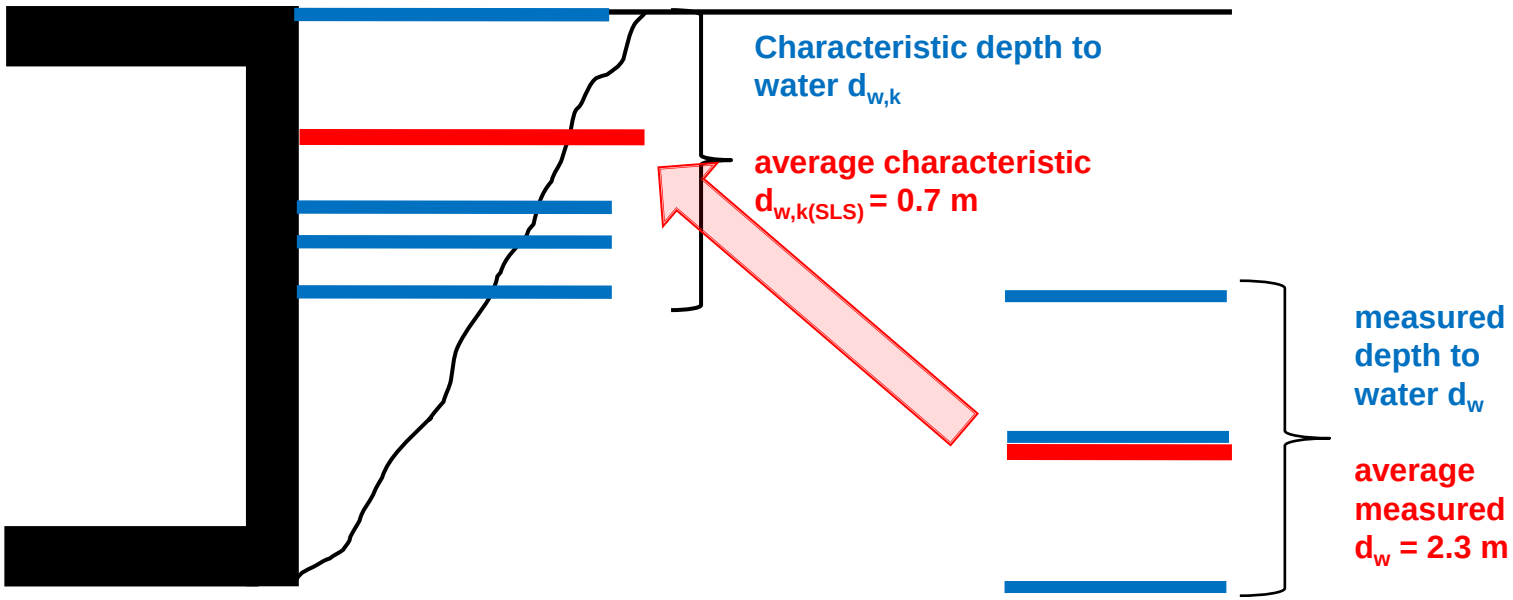
Standpipe	Distance x	Measured water depth d_w
1	10 m	2.2 m
2	25 m	1.5 m
3	50 m	3.1 m

Design situation	Natural ground	Fill
A	Clay γ_k = 22 kN/m³ $c_{u,k}$ = 35 kPa $\phi`_k$ = 25° $c`_k$ = 0	Clay γ_k = 22 kN/m³ $c_{u,k}$ = 35 kPa $\phi`_k$ = 25° $c`_k$ = 0
B	Clay γ_k = 22 kN/m³ $c_{u,k}$ = 35 kPa $\phi`_k$ = 25° $c`_k$ = 0	Imported granular fill γ_k = 18 kN/m³ $\phi`_k$ = 35° $c`_k$ = 0
C	Gravel γ_k = 19 kN/m³ $\phi`_k$ = 40° $c`_k$ = 0	Imported granular fill γ_k = 18 kN/m³ $\phi`_k$ = 35° $c`_k$ = 0

What is the characteristic water depth $d_{w,k}$?
What is the design water depth $d_{w,d(SLS)}$?

(Questions 6 and 8)

Serviceability Limit State SLS: design situation A (clay – clay)

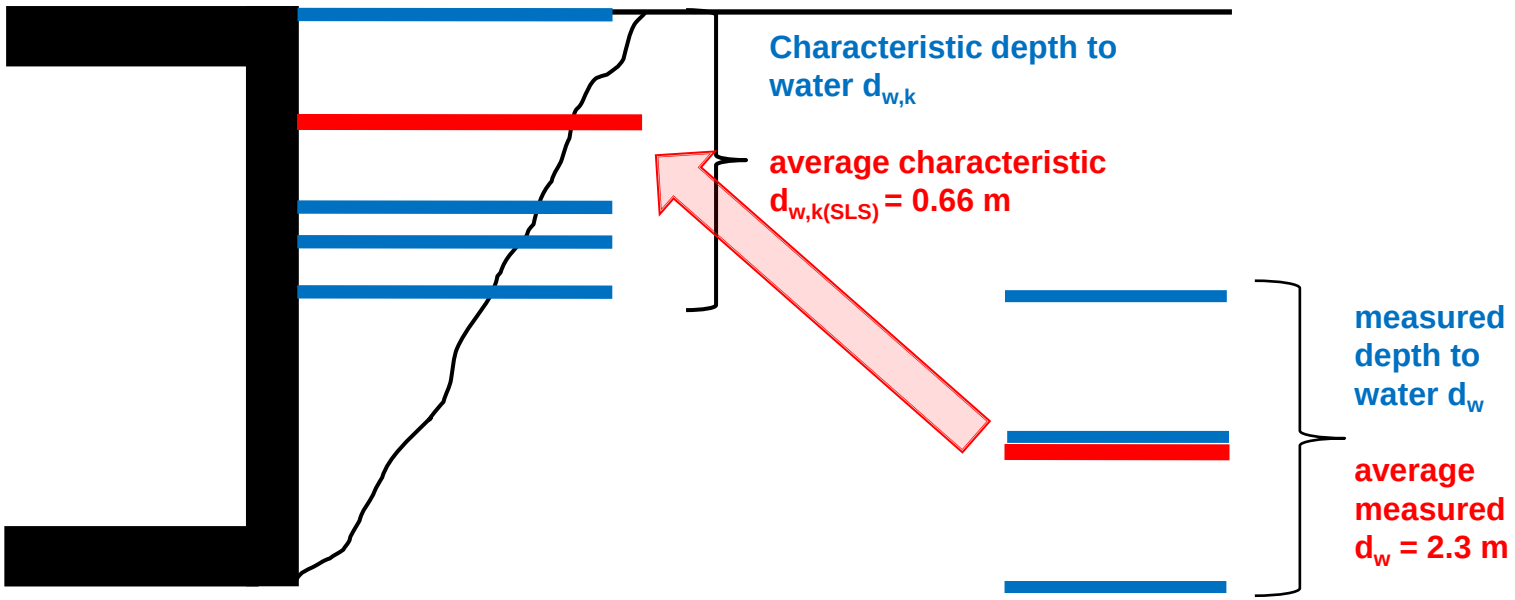


$d_{w,d(SLS)} = d_{w,k}$ in all responses, except 2

What is the characteristic water depth $d_{w,k}$?
What is the design water depth $d_{w,d(SLS)}$?

(Questions 6 and 8)

Serviceability Limit State SLS: design situation B (clay – granular fill)

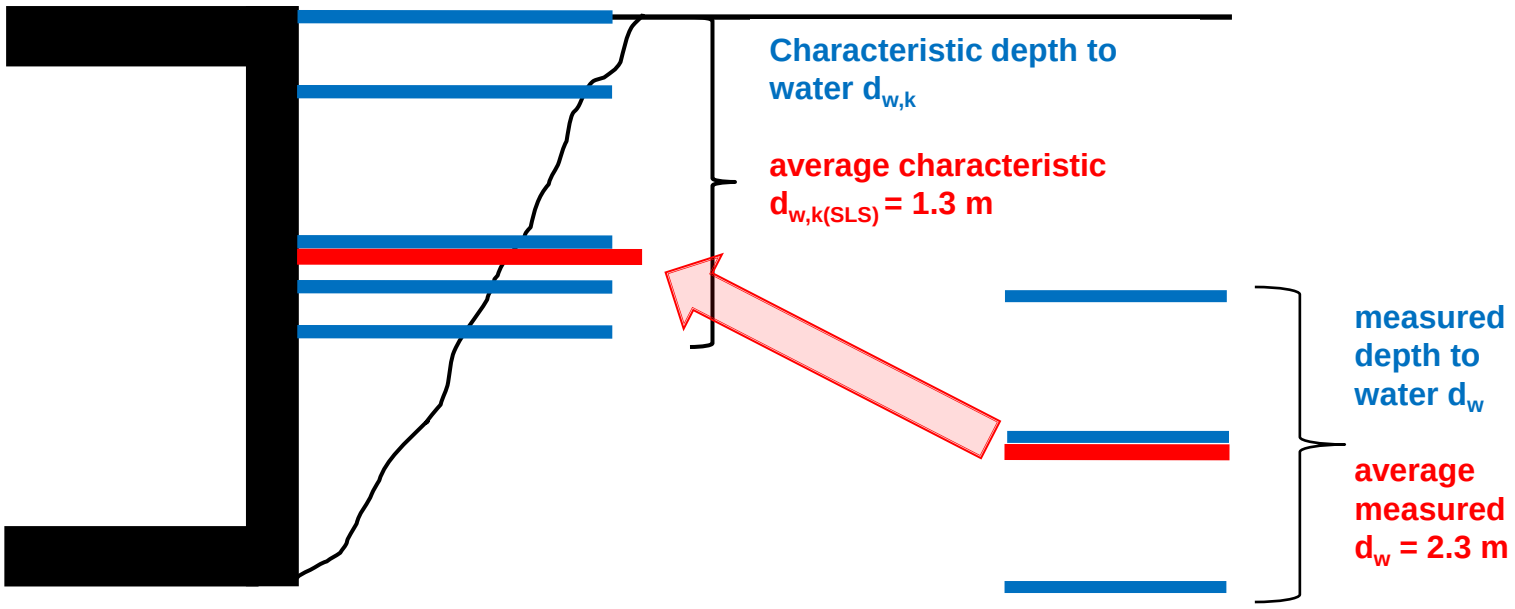


$d_{w,d(SLS)} = d_{w,k}$ in all responses

What is the characteristic water depth $d_{w,k}$?
What is the design water depth $d_{w,d(SLS)}$?

(Questions 6 and 8)

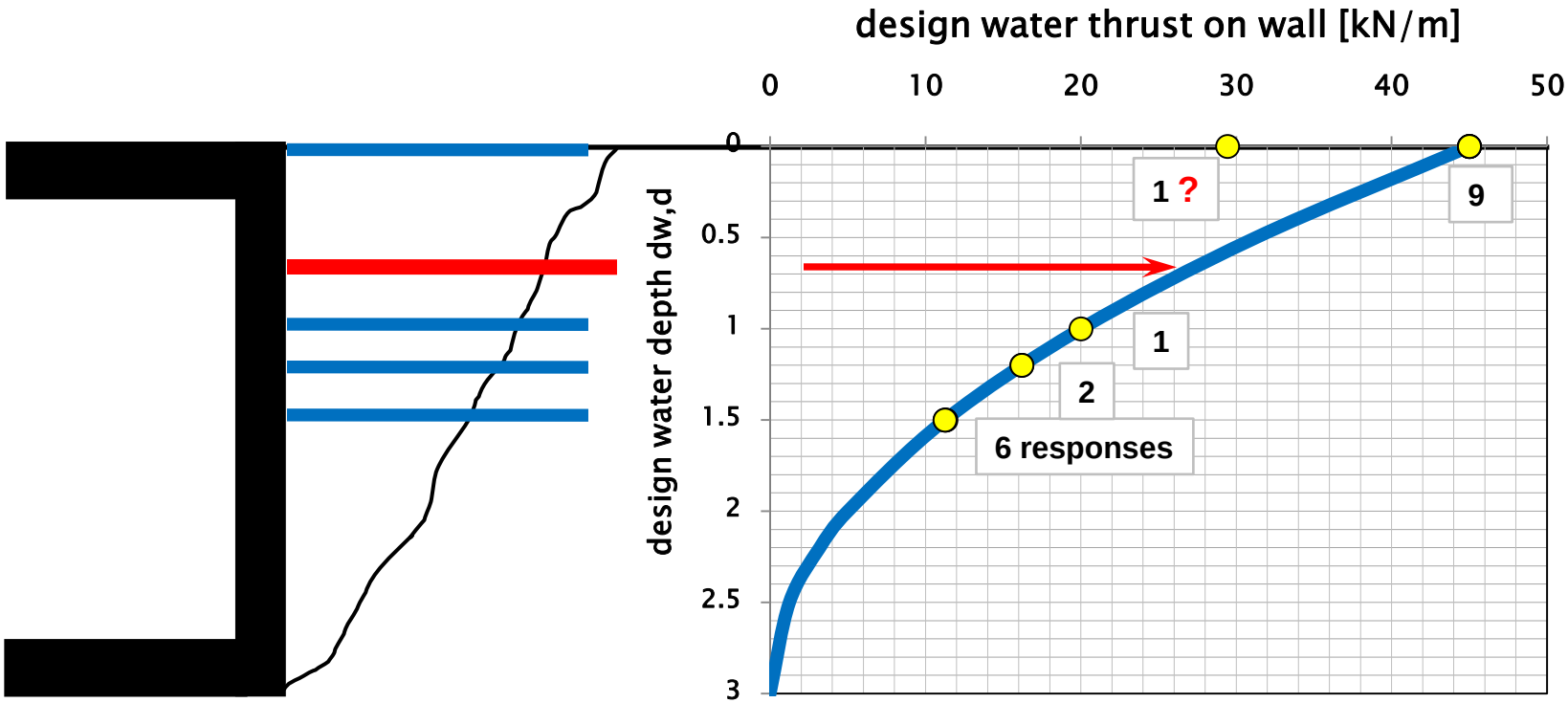
Serviceability Limit State SLS: design situation C (gravel – granular fill)



$d_{w,d(SLS)} = d_{w,k}$ in all responses, except 2

What is the design water thrust P_w on the wall ? (Question 11)

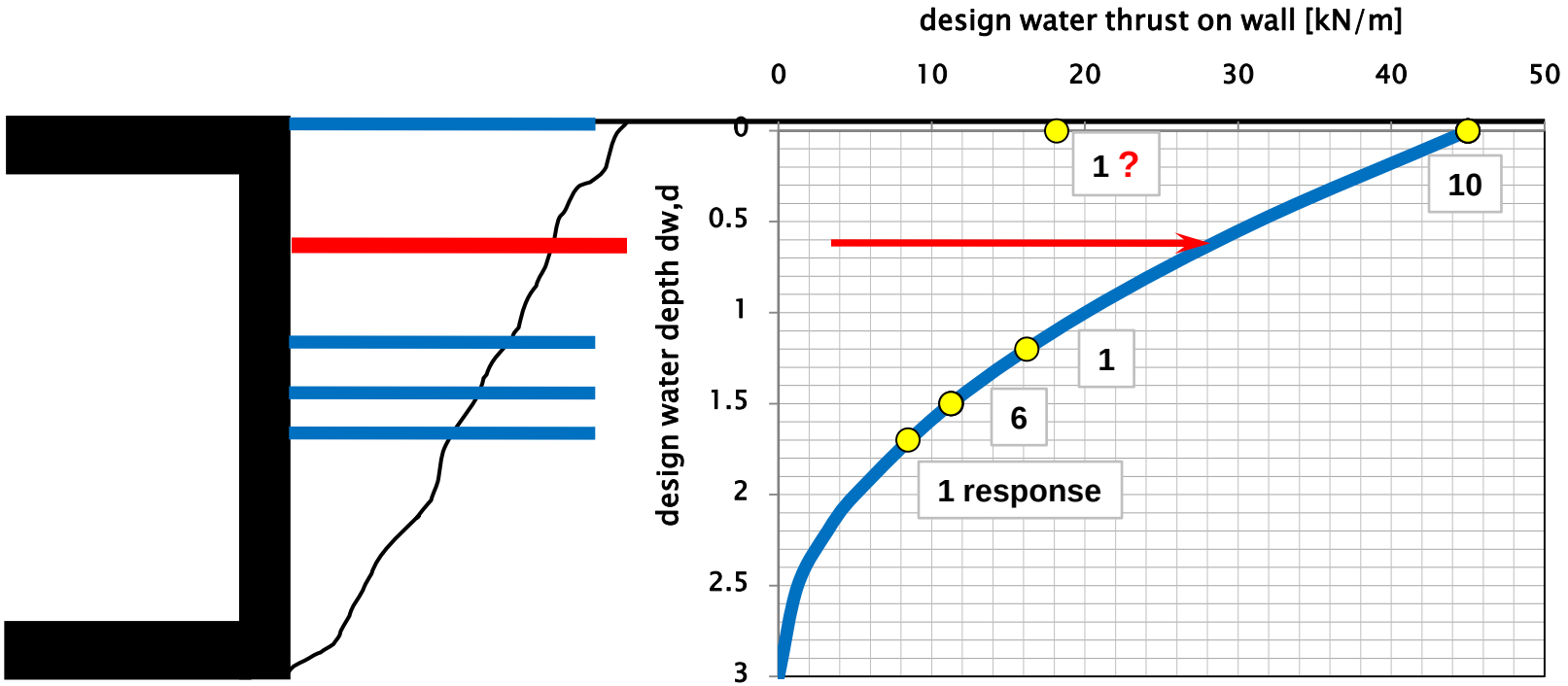
Serviceability Limit State SLS: design situation A (clay – clay)



average design water depth
$d_{w,d(SLS)}$ = 0.7 m

What is the design water thrust P_w on the wall ? (Question 11)

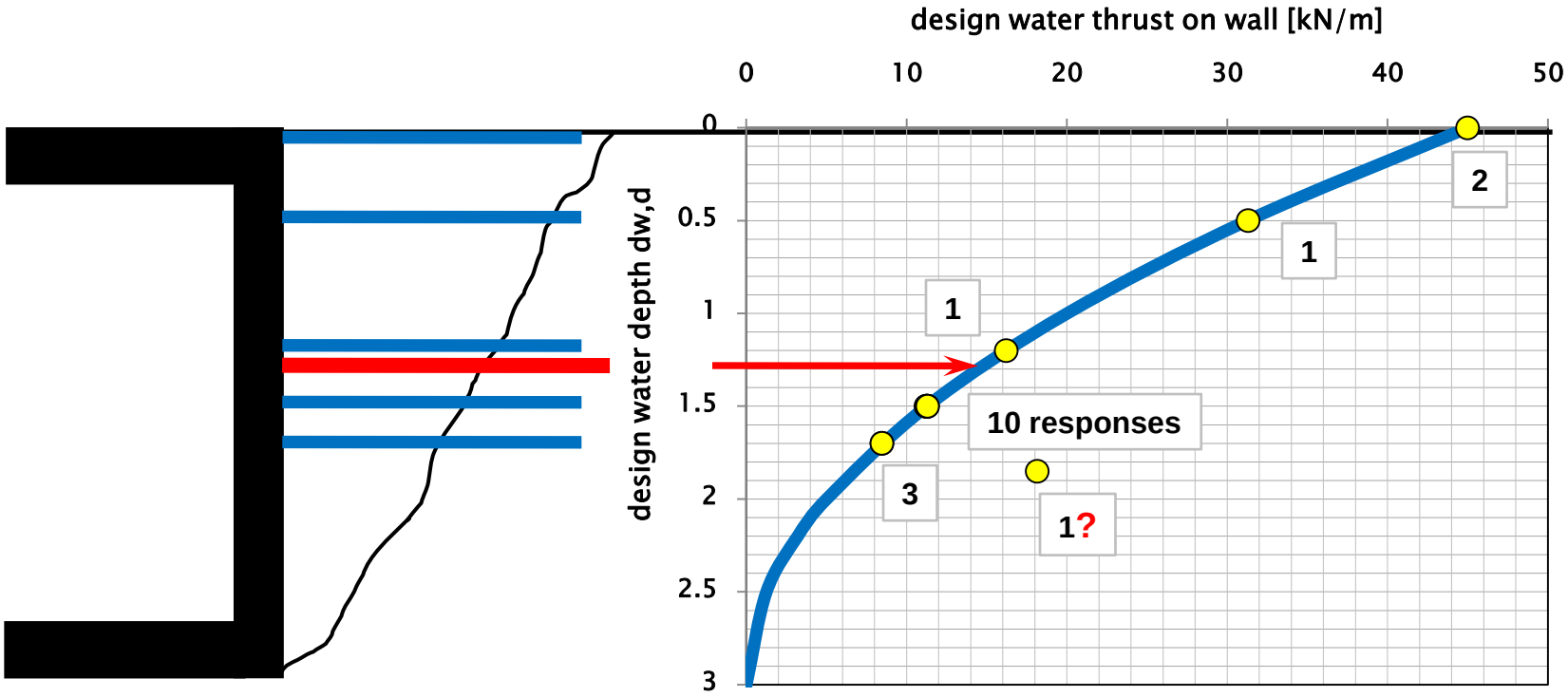
Serviceability Limit State SLS: design situation B (clay – granular fill)



average design water depth
$d_{w,d(SLS)}$ = 0.66 m

What is the design water thrust P_w on the wall ? (Question 11)

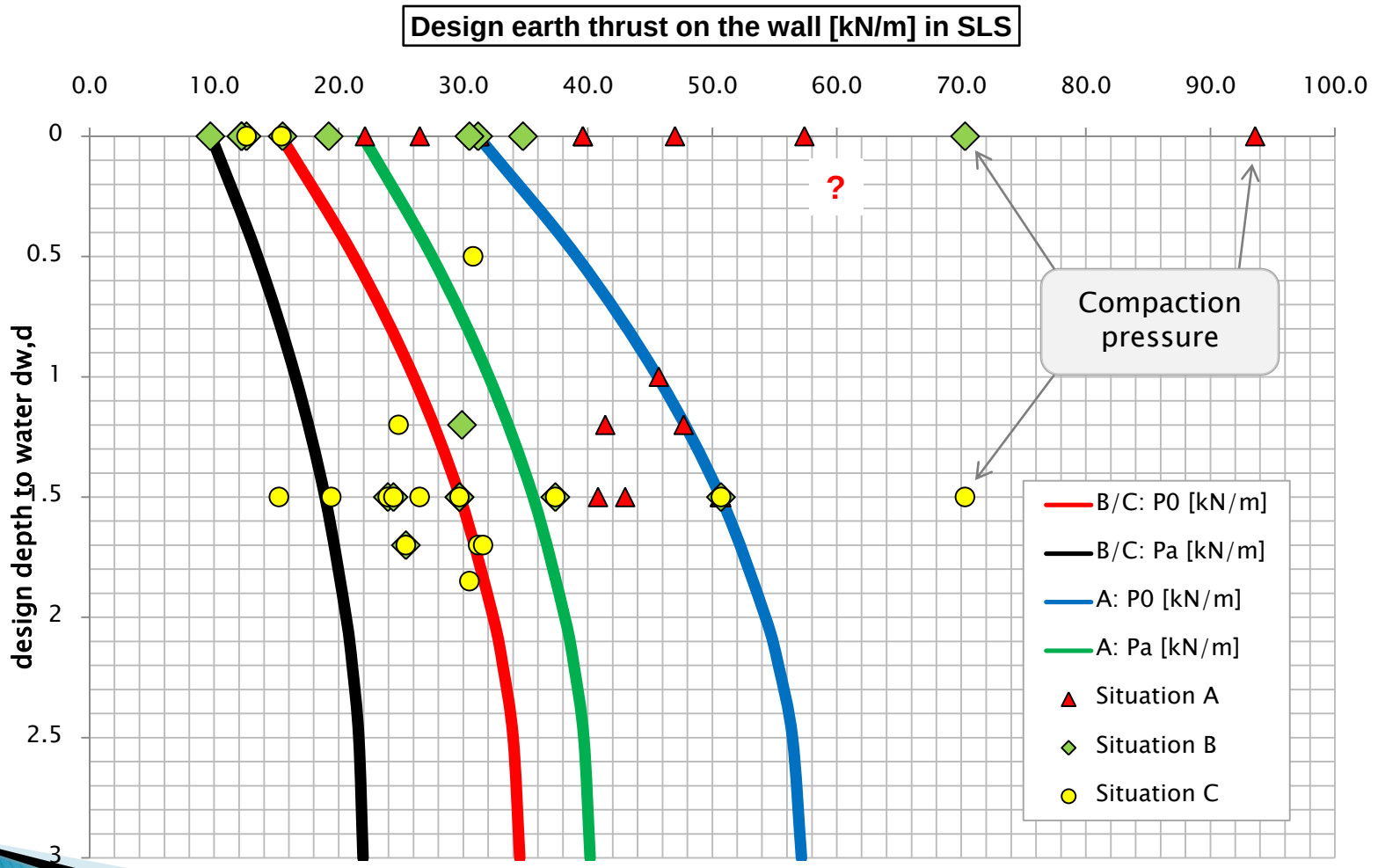
Serviceability Limit State SLS: design situation C (gravel – granular fill)



average design water depth
$d_{w,d(SLS)}$ = 1.3 m

What is the design earth thrust on the wall ? (Question 12)

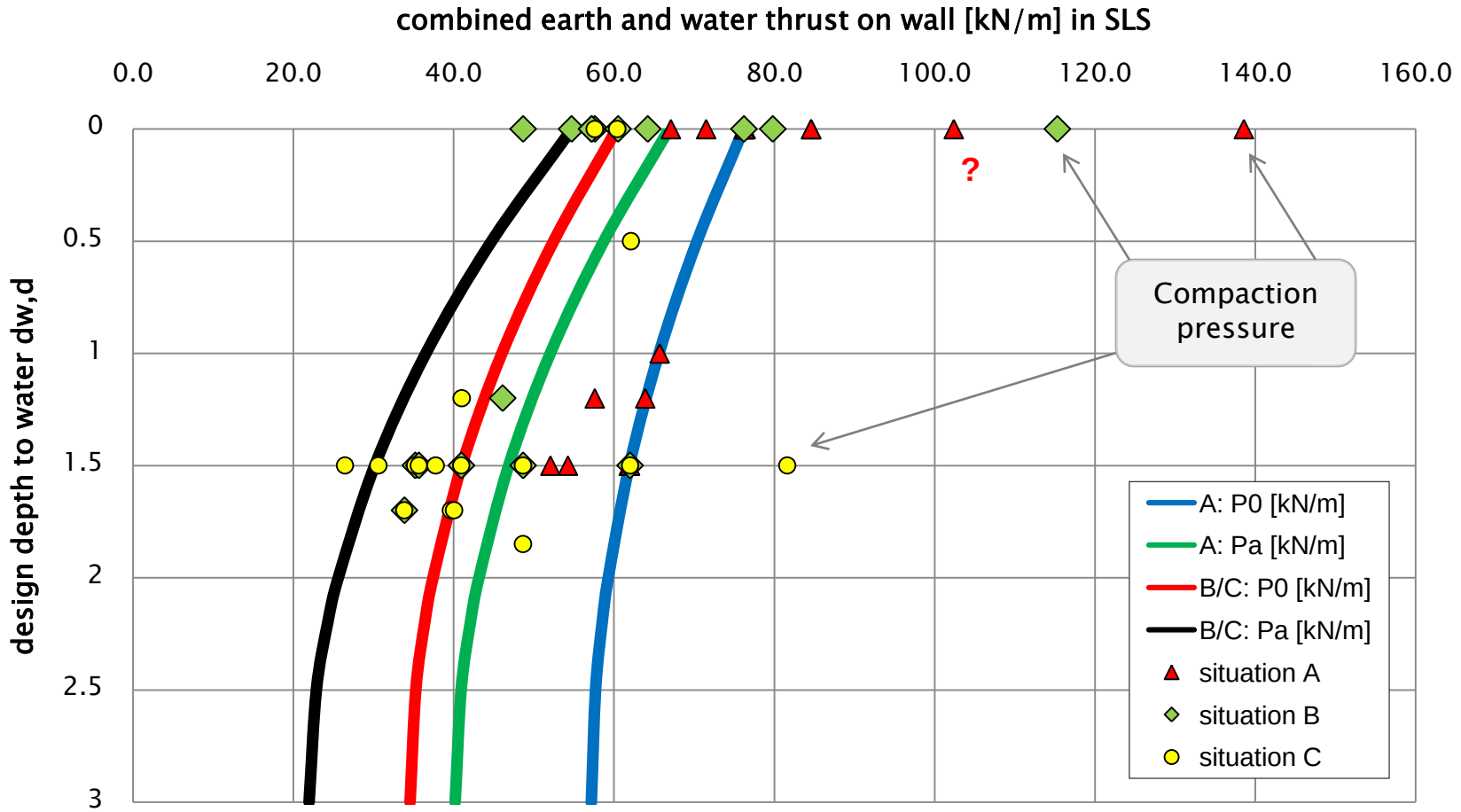
Serviceability Limit State SLS: design situation A, B and C



What is the design earth + water thrust on the wall ?

(Question 11 + 12)

Serviceability Limit State SLS: design situation A, B and C



SLS Design: Summary of evaluated responses

- **Questions 6 and 8**: The characteristic depth of water $d_{w,k} = d_{w,d(SLS)}$
- **Question 11**: The calculation of water thrust was straightforward and did not pose any difficulties
- **Questions 13**: earth pressure calculation with: Ka (22 %), Ko (50 %), (Ka+Ko)/2 used by (11 %), compaction pressure (6 %) and 6 % unclear
- Situation A and B were almost identical with respect to d_w whereas situation C was designed with the deepest average water level
- Nobody assumed ponding or inundation at the ground surface
- The depth of design water level is mainly responsible for the total thrust on the wall. There is however a large spread in the values of d_w selected, which produces a maximum factor of about 2 between the highest and lowest total thrust. **There seems to be a definite need for more guidance to select the characteristic value of d_w.**

ULS design: summary of evaluated responses

- **Question 15**: what is the **design water table** $d_{w,d(ULS)}$:
  - $d_{w,d(ULS)} = d_{w,d(SLS)}$ in 56 % of the cases
  - In other cases: $d_{w,d(ULS)} < d_{w,d(SLS)}$, often up to ground surface
- **Question 19**: **Design Approach** (DA) for ULS
  - DA 1 (combination 1 only) = 18 %
  - DA 1 (combination 1 and 2) = 24 %
  - DA 2 = 58 %
- **Question 20 and 21**: **Partial factors**
  - Earth pressure: **1.35** (44 %), **1.3** (17 %), **1.2** (11 %), 28 % unclear or unknown
  - Water pressure: **1.5** (6 %), **1.35** (50 %), **1.3** (6 %), **1.0** (33 %), **1.35/1.0** (17 %) …often 1.0 in case of water level at ground surface otherwise 1.35

More guidance is needed for:

- **Determination /selection of design water levels for SLS and ULS**

- **Partial factors for water pressures and questions such as:**
  - e.g. can a partial factor of >1 be applied in case of a characteristic water level selected at the ground surface?
  - does a partial factor > 1 on characteristic water pressure make sense at all on physical grounds or should a partial factor only be applied to the depth of water d_w?

Thank you
for your attention