

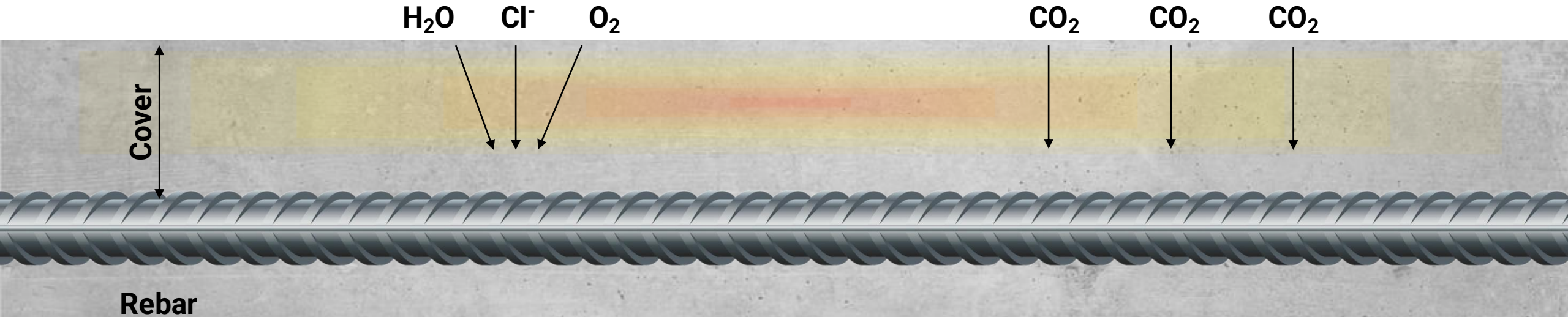
Proof of reinforcement





Proof of reinforcement

Why is it important to measure concrete cover?



Durability depends on the health of the reinforcing steel

The time it takes for corrosive elements to reach the rebar layer depends on:
environmental conditions, concrete quality and concrete cover



Proof of reinforcement

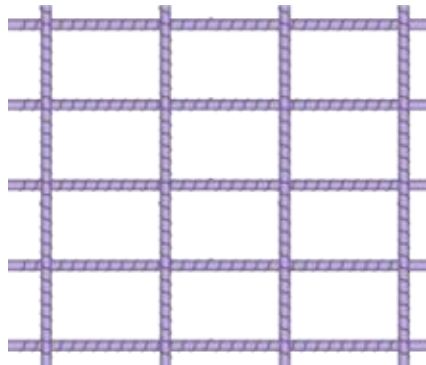
Proof of reinforcement is a multi-technology application

Proof of reinforcement consists of two complementary tasks.

Mapping the reinforcement structure – For this task GPR is the best technology

Measuring the concrete cover – For this task a magneto inductive cover meter is the best technology

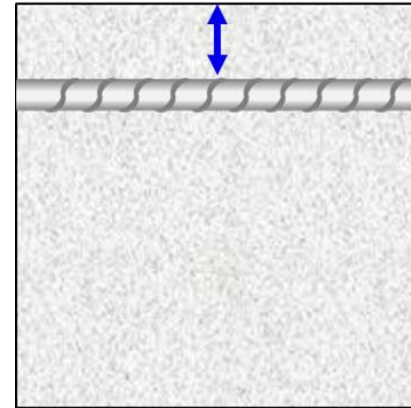
Reinforcement
structure



GPR



Concrete cover



Magneto Inductive





Proof of reinforcement

Traditional Solution

Traditionally, magneto inductive cover meters were used for both tasks. This was before the advent of GPR instruments for concrete.

Technical specifications for cover meters are quoted with the possibility to locate reinforcing steel down to depths of 15 – 18 cm.

While this is technically true, in reality it is not practical on site. It only works for very large diameter isolated reinforcing steel.

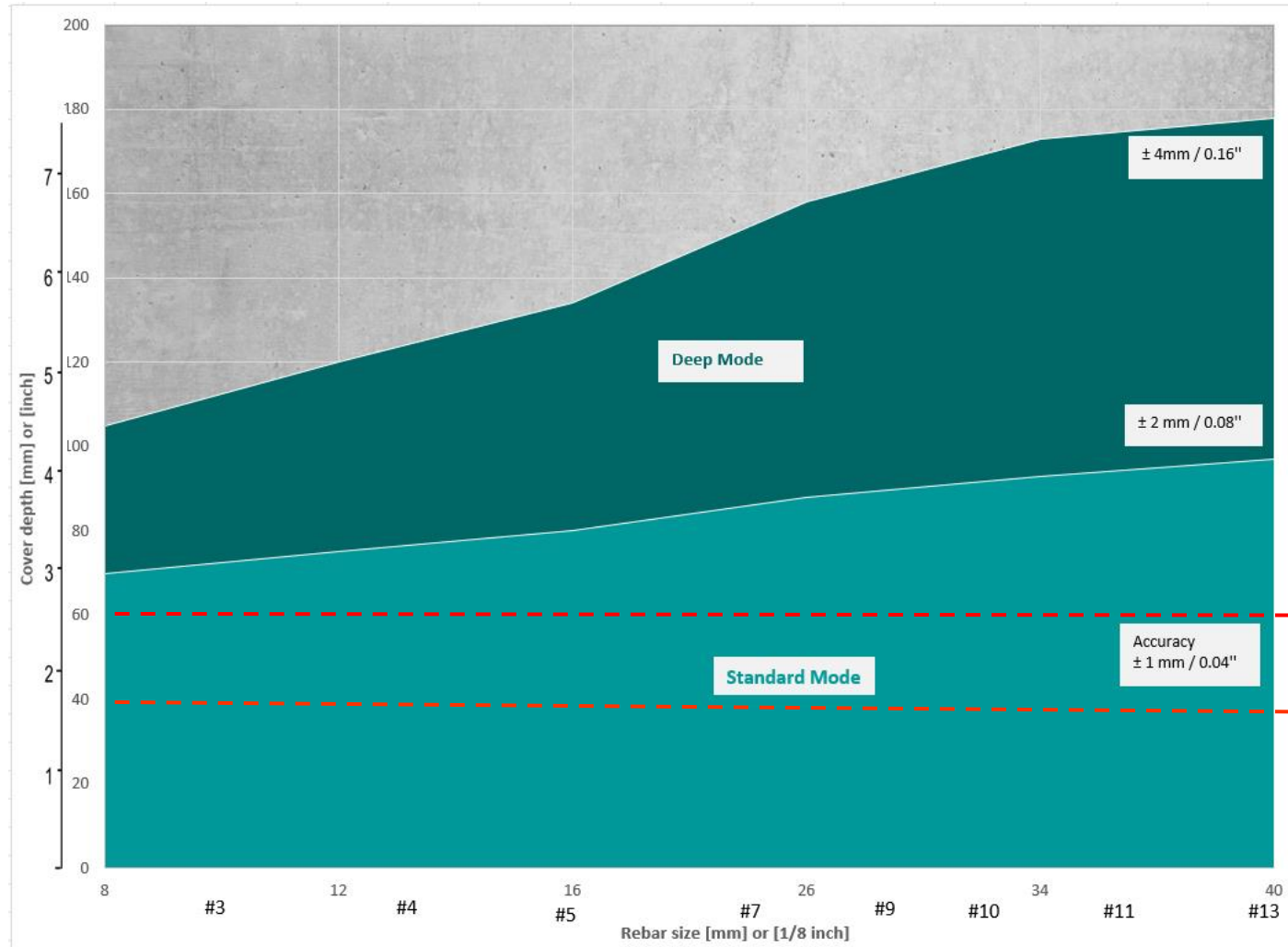
The strength of magneto inductive cover meters lies in the cover measurement accuracy for the first layer reinforcement.

This can be seen in the next slide which shows the technical specifications of the Profometer PM8000



Proof of reinforcement

PM8000 technical specifications



$\leq \pm 2 \text{ mm}$

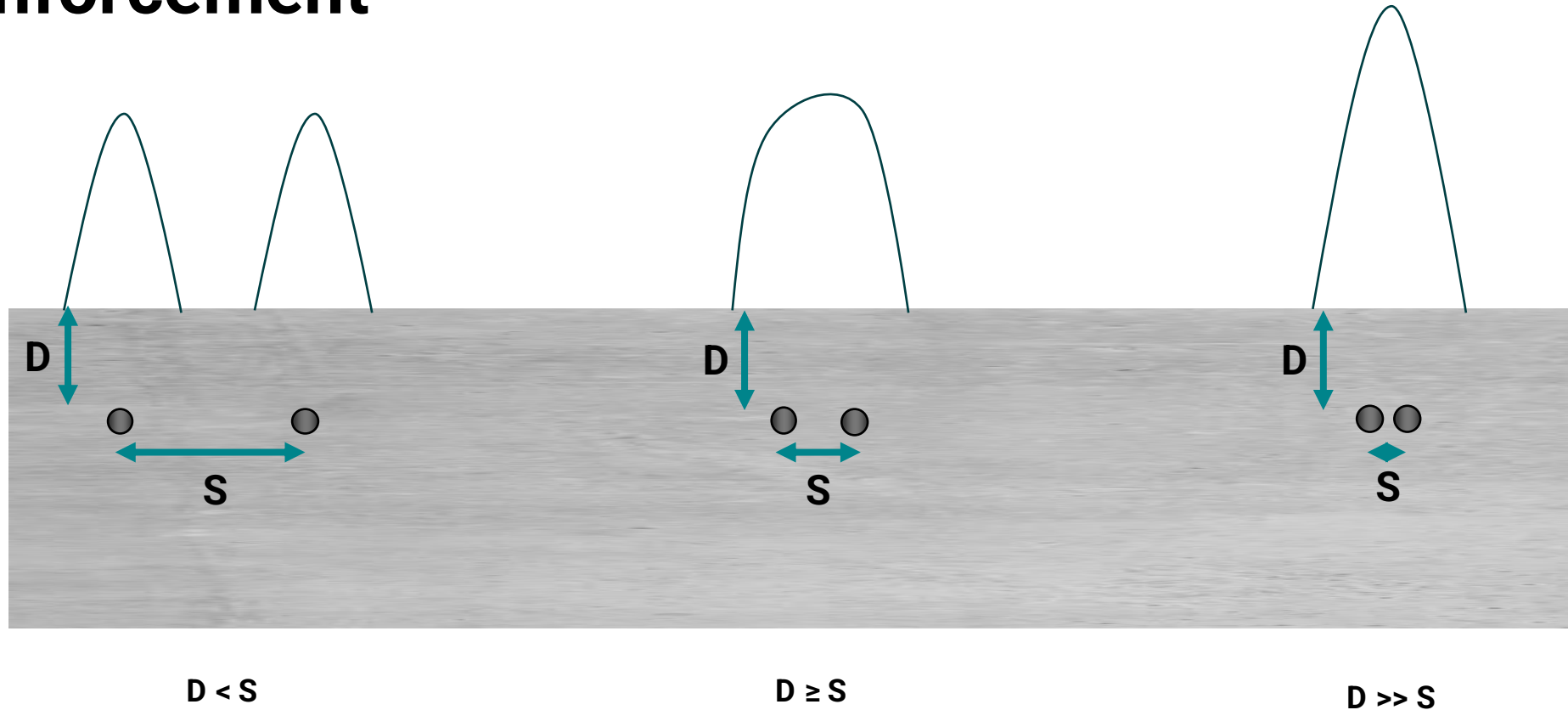
$\leq \pm 1 \text{ mm}$

**DBV (German
Concrete Society)
accuracy
requirements for
cover measurement**



Proof of reinforcement

Cover meter limitations – Resolution of closely spaced reinforcement

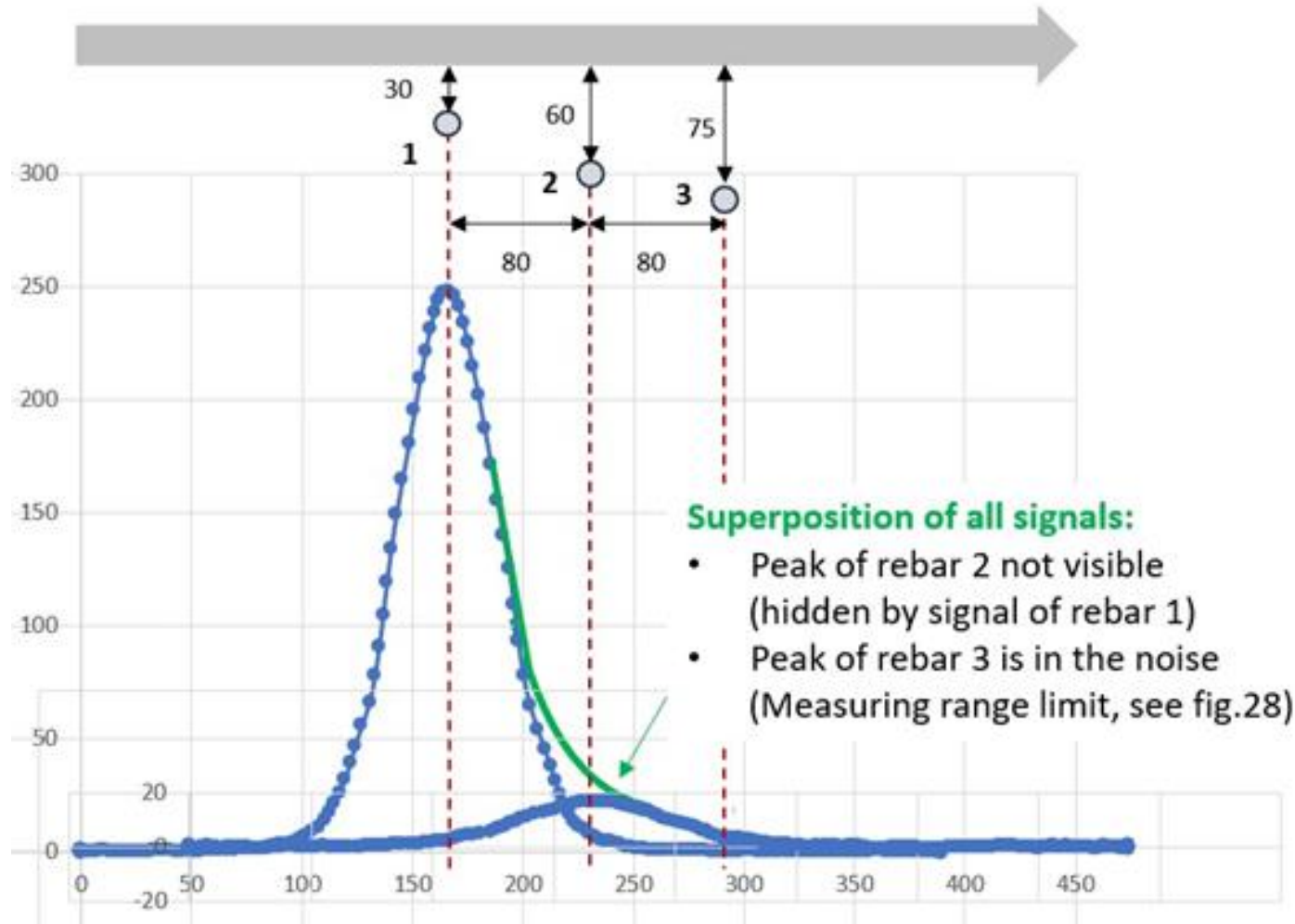


Rule of thumb – $D \leq S$ for resolution of individual rebars



Proof of reinforcement

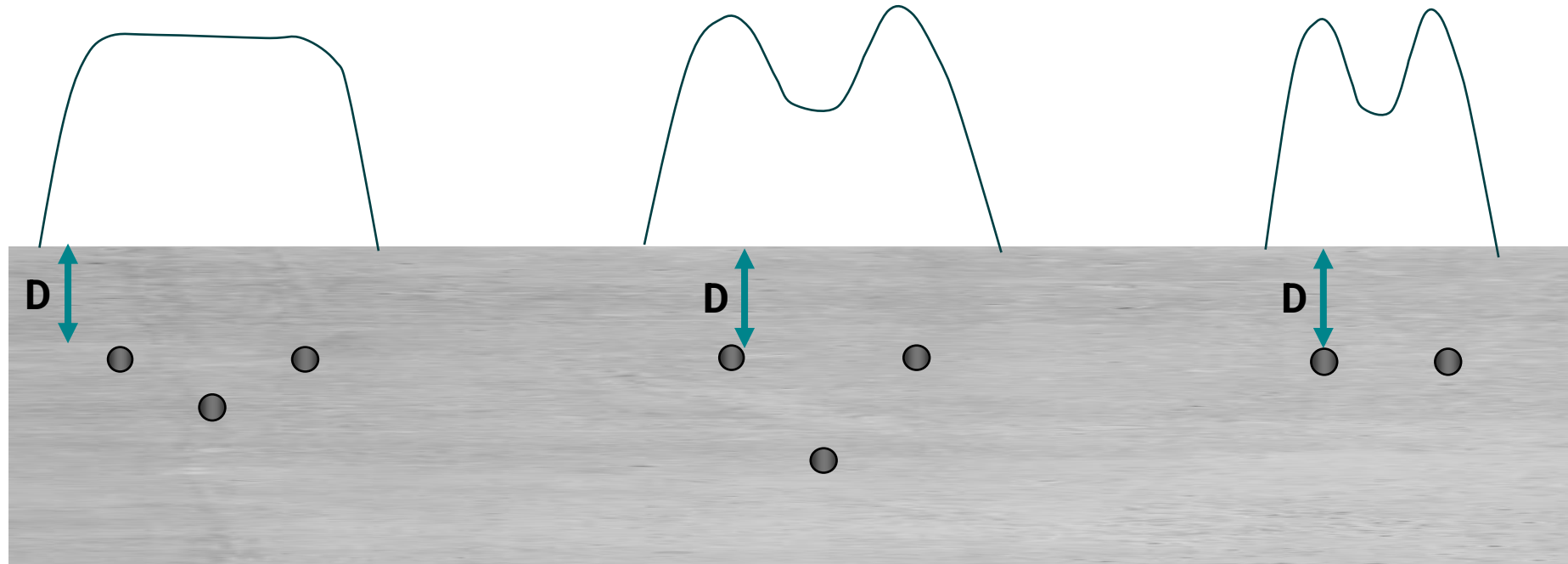
Cover meter limitations – Shadowing of lower layers





Proof of reinforcement

Cover meter limitations – Shadowing of lower layers



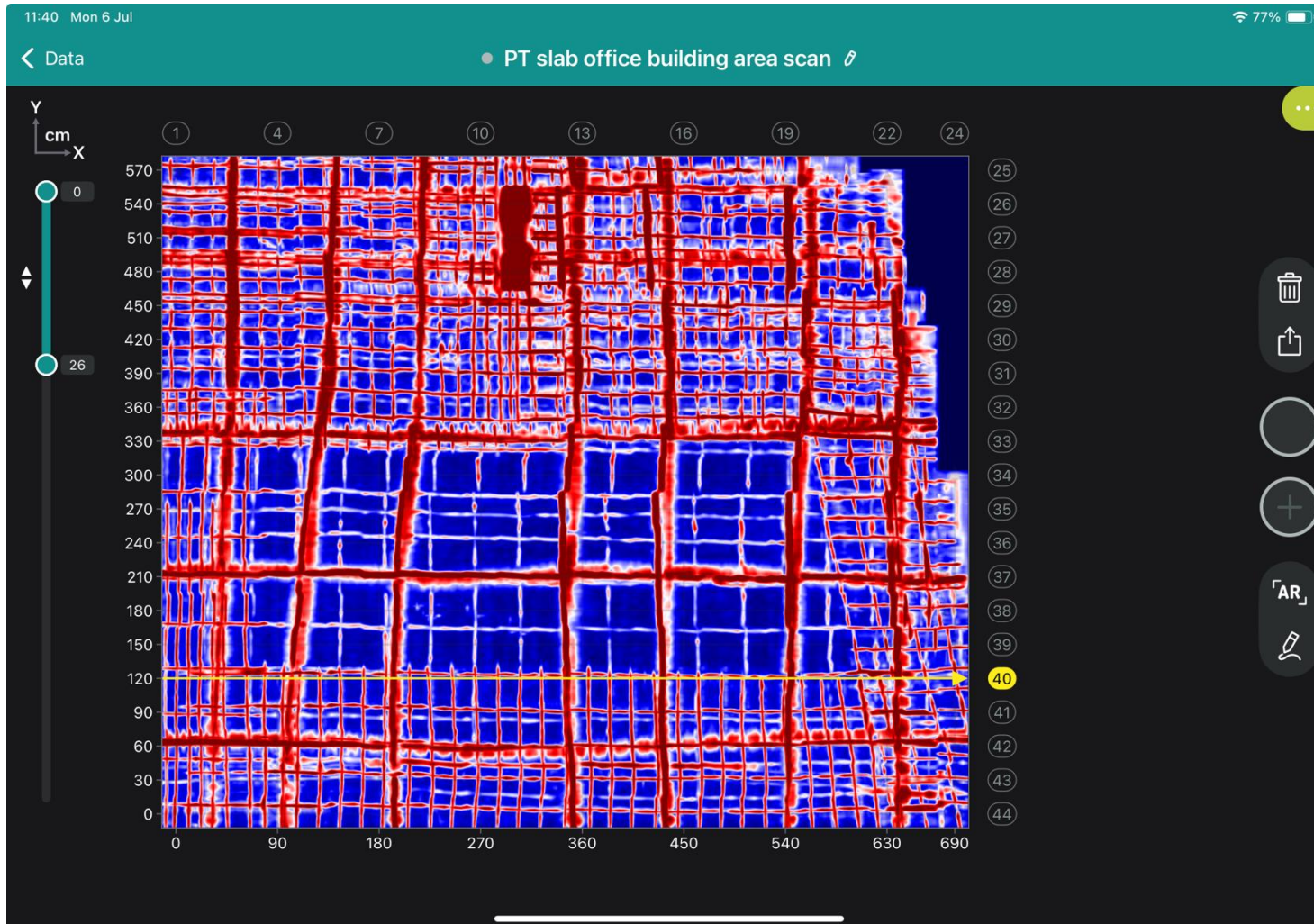
Lower layer rebar not
indicated

Lower layer rebar not
indicated



Proof of reinforcement

GPR scan of reinforcement



GPR has much better resolution when it comes to closely spaced reinforcement and is also less affected by the shadowing effect that prevents magneto inductive devices from seeing lower lying objects

Proceq recommendation. Map out the rebar mesh by scanning with a GPR instrument before selecting suitable locations for cover measurements

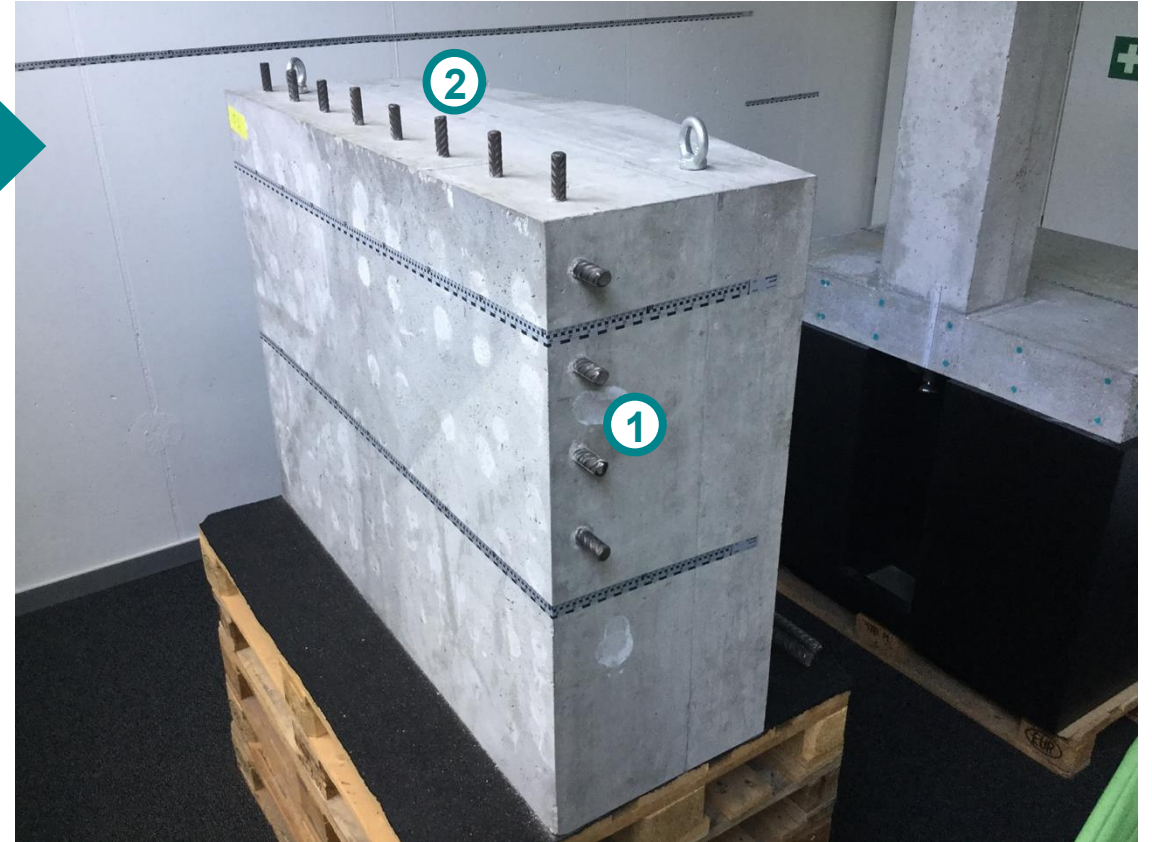


Proof of reinforcement

GPR limitations – Precise cover measurement

Comparison test block

- ① 1st layer horizontal rebar, Ø 20 mm
Actual cover is 35 mm
- ② 2nd layer vertical rebar, Ø 16 mm



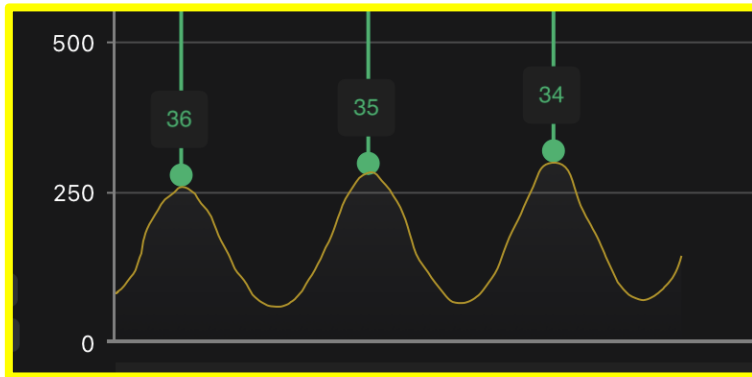


Proof of reinforcement

GPR limitations – Magneto Inductive cover measurement



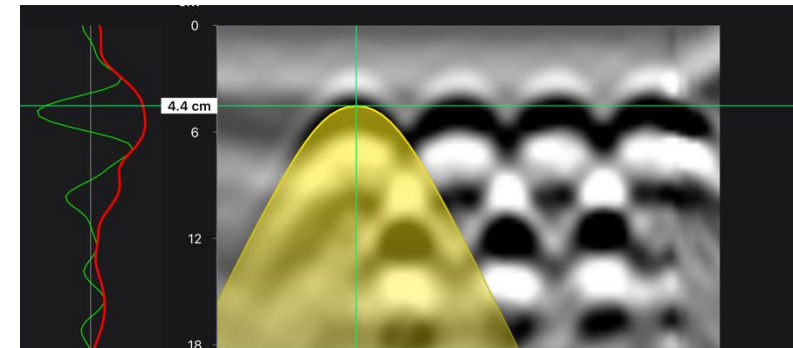
Profometer PM8000



- Actual cover is 35 mm
- Measured cover is within +/- 1 mm of the actual cover



Proceq GPR

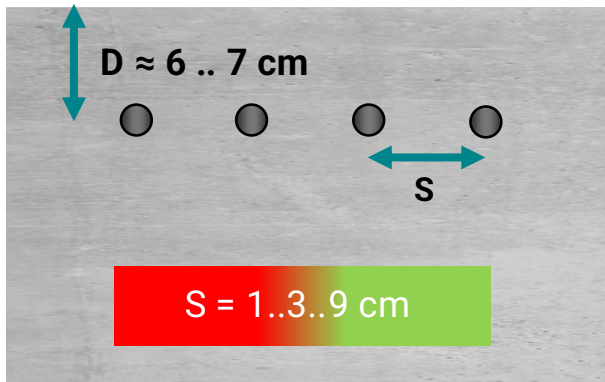


- Actual cover is 35 mm
- Measured cover using hyperbola matching is 44 mm



HTW technology comparison

Magneto Inductive



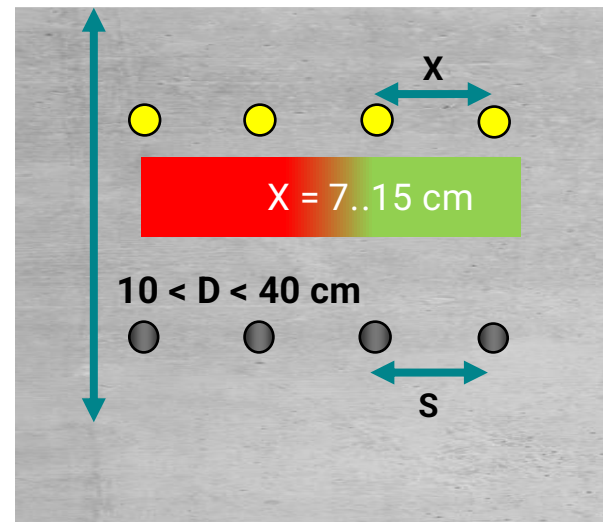
D = Detection depth
 S = rebar spacing

$$D/S \approx 0.5 \dots 1$$

Deviation $\pm 1 \dots 2 \text{ mm}$
with known diameter

$5 \text{ cm} < S < 9 \text{ cm}$
requires NRC

GPR

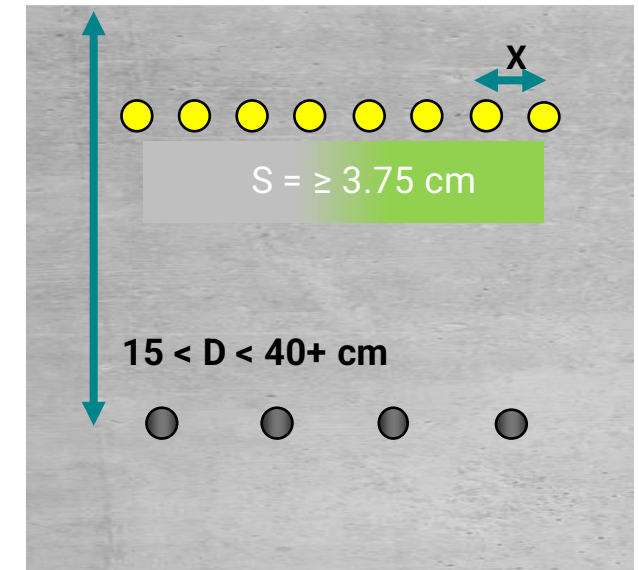


$$D/S \approx 2 \dots 6$$

Diameter of detectable
object $\geq 6 \text{ mm}$

Deviation $\pm 2\%$
with $D > 10 \text{ cm}$

UPE



$$D/S \approx 3 \dots 6$$

Diameter of detectable
object $\geq 16 \text{ mm}$ at $D = 40 \text{ cm}$

Deviation $\pm 5 \dots 10 \text{ mm}$

X = spacing of
surface rebars



Recommendations based on HTW findings

- Cover measurements relevant for durability of a structure to a depth of 6 .. 7 cm
– **Magneto Inductive (Profometer PM8000)**
- Depth measurement of objects relevant for structural stability from 10 cm onwards- **GPR (Proceq GP8x00) , UPE (Pundit PD8050)**

Source: Taffe, A. und N. Bernhard: Detektion von Hüllrohren und Bewehrungsstäben und Genauigkeit der Messung von deren Einbautiefen mit Ultraschallecho; in Beton- und Stahlbetonbau 117 (2022) 7, S. 460-471. <https://doi.org/10.1002/best.202200014>



Proof of reinforcement

Recommended Procedure

- Map out the reinforcement by scanning with GPR
- Look for suitable locations for cover measurements
- Avoid areas with lower lying rebars, overlapping rebars and very closely spaced rebars
- Measure the cover with a Profometer PM8000 using neighbouring rebar correction (NRC) for the highest accuracy



Mapping



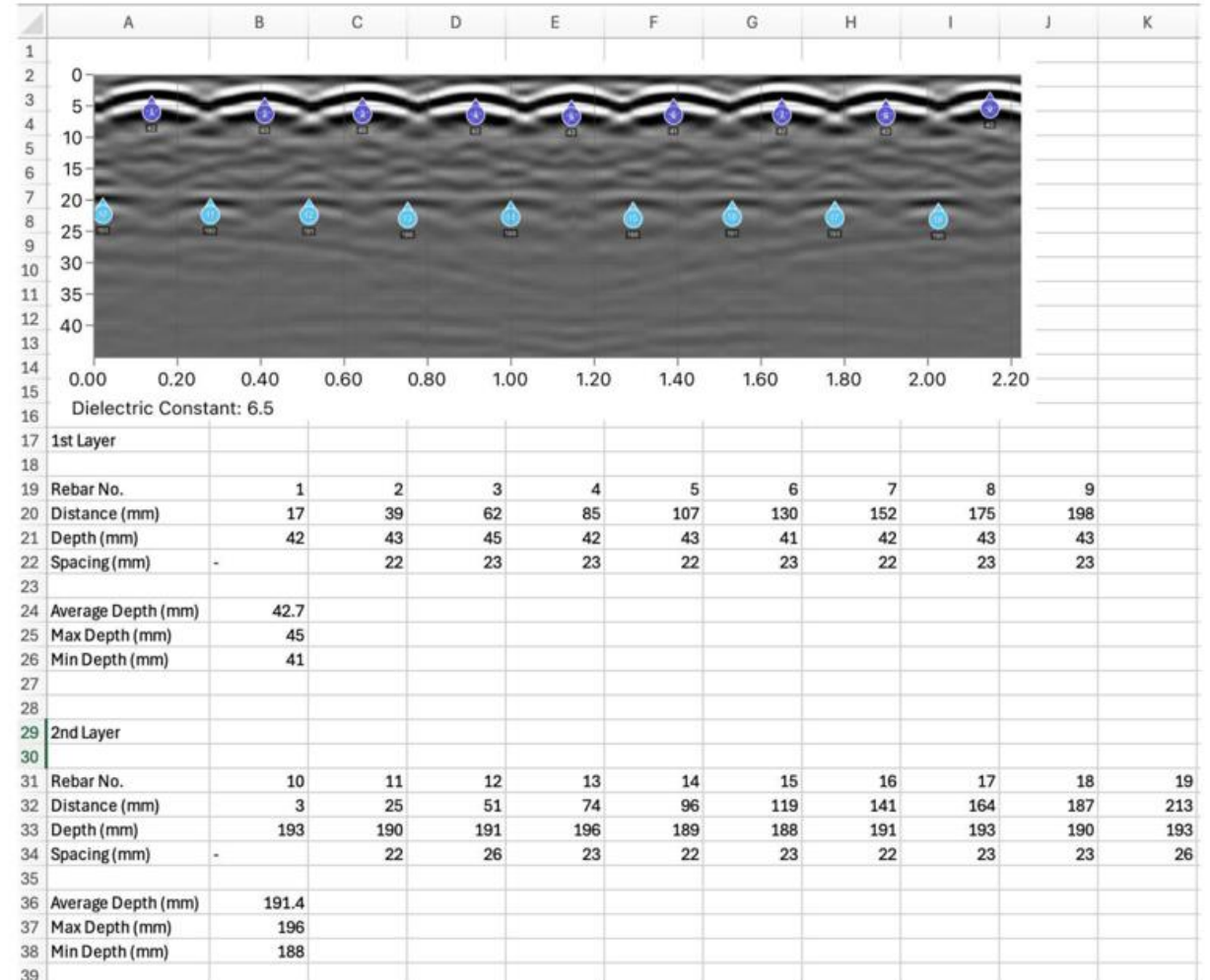
Cover



Proof of reinforcement

Alternative Procedure

- Measure the cover with a Profometer PM8000
- Use the cover meter measurement to calibrate the dielectric constant of the GPR instrument
- Use AI rebar tagging function of the GPR instrument for comprehensive cover measurements



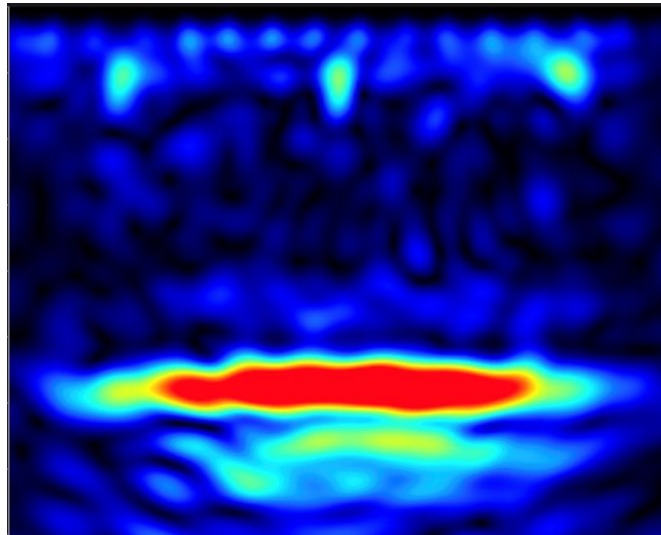


Proof of reinforcement

Proof of reinforcement – limitations and special applications

Rebar diameter– Traditionally done with cover meters, but it can only be estimated. GPR techniques exist also, but again it can only be estimated

Steel fibre reinforced concrete – Both magneto inductive cover meters and GPR are electromagnetic technologies. Neither of them can be used to measure cover in steel fibre reinforced concrete as there is too much interference from the steel fibres. So for this task ultrasonic pulse echo technology is the best option. This is also recommended in the German Society of Non-Destructive Testing guideline B2.



**Ultrasonic Pulse
Echo**

PROTECT THE BUILT WORLD
