Vital Sign

Rebound (Schmidt)

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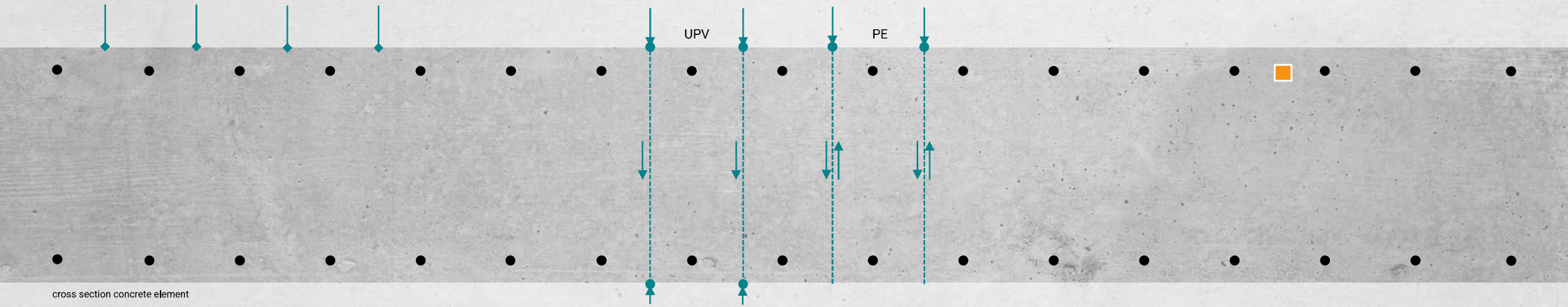
Compressive Strength: Rebound – Ultrasound – Maturity Sensor

Concrete Strength & Uniformity
Schmidt Rebound

Concrete Strength & Homogeneity
Pundit UPV or Pundit PE Ultrasound

Concrete Strength
Maturity / Temperature Sensor



cross section concrete element

Application: Construction – Strength Development (Curing)
Existing Structures – Strength & Uniformity

Remark: Requires surface access

Measurement: Rebound – **2D surface information**
Strength correlation via standard or custom curves

Result: Characteristic Strength per Test Location / Region
Heat Map: Strength & Uniformity

40 MPa	41 MPa	35 MPa	29MPa

Head Map – top view concrete element

Application: Construction – Strength Development (Curing)
Existing Structures – Strength & Homogeneity

Remark: Required access – UPV from both sides – PE from **ONE side**

Measurement: Ultrasound – **3D volumetric information**
Strength correlation via standard or custom curves

Result: Characteristic Strength per Test Location / Region
Heat Map – Strength & Homogeneity

39 MPa	40 MPa	36 MPa	28MPa

Application: Construction – Strength Development (Curing)
Existing Structures – **n/a**

Remark: **Sensor & Battery Waste** left inside the concrete

Measurement: Temperature – **1D point information**
Strength correlation via standard or custom curves

Result: Single Strength Value at Sensor Location
Heat Map – **n/a**

?	38 MPa	?	?

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Concrete Strength
Maturity / Temperature Sensor

40 MPa	41 MPa	42 MPa	43 MPa
42 MPa	41 MPa	41MPa	40 MPa
4 MPa	41 MPa	35 MPa	32 MPa
41 MPa	41 MPa	34 MPa	28 MPa
39 MPa	41 MPa	35 MPa	29MPa

Head Map – top view concrete element

39 MPa	40 MPa	41 MPa	42 MPa
39 MPa	40 MPa	42 MPa	41 MPa
39 MPa	40 MPa	36 MPa	31 MPa
39 MPa	40 MPa	36 MPa	26 MPa
39 MPa	40 MPa	36 MPa	28 MPa

?	?	?	?
?	?	?	?
?	?	?	?
?	?	?	?
?	38 MPa	?	?

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Strength & Uniformity ► Rebound (Schmidt)

Silver Schmidt OS8200

Original Schmidt OS8000

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OS

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schmidt

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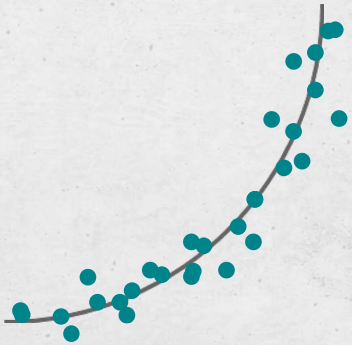
Strength & Uniformity ▶ Rebound (Schmidt)

	Measure	Convert to Strength	Result
			MPa
Original Schmidt	mechanical	**R** historic reference	10 – 70
Silver Schmidt	optical	**Q** higher accuarcy	5* 10 – 100

* with Mushroom Head

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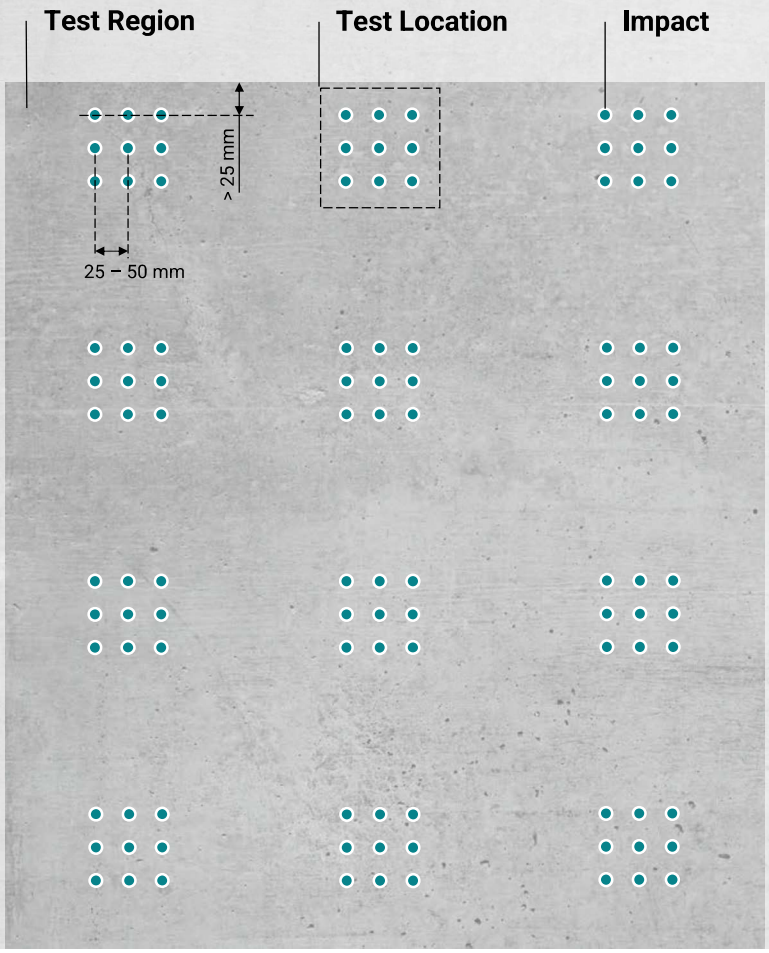
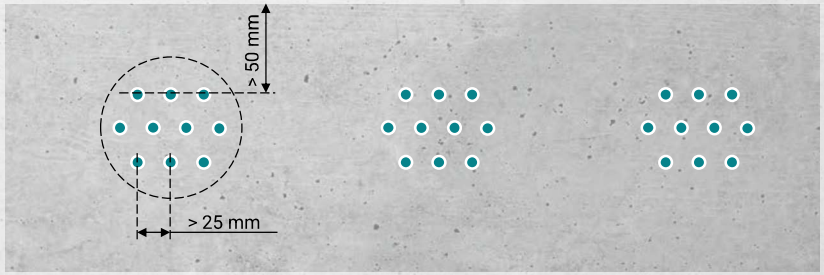
Strength & Uniformity ► Rebound (Schmidt)





ASTM C805 “Standard Test Method for Rebound Number of Hardened Concrete”

ASTM INTERNATIONAL

Example with 12 Test Locations

EN 12504-2 “Testing concrete in structures. Non-destructive testing. Determination of rebound number”
EN 13791 “Assessment of in-situ compressive strength in structures and precast concrete components”

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Strength & Uniformity ► Rebound (Schmidt)

Inspection Procedure - Original Schmidt OS8000 & Silver Schmidt OS8200

- EN 12504-2 “Testing concrete in structures. Non-destructive testing. Determination of rebound number”
- EN 13791 “Assessment of in-situ compressive strength in structures and precast concrete components”

1. Smoothen the concrete surface in the Test Location with a grinding stone
2. Perform minimum 9 Impacts in a Test Location
3. Determine mean Q or R value (if > 20% of Impact values differ from median > 25%, discard test series)
4. Perform steps 1 to 3 for multiple (minimum 9) Test Locations within a Test Region
5. Review **Uniformity** of the Mean Values of the Test Location across the Test Region ► **Weak Spots in the Test Region**
6. Determine **Concrete Strength Class** (EN13791) ► **Characteristic Compressive Strength f_{ck}**

7. If the value determined by the rebound test alone is deemed insufficient, then a combination with core data can be used for verification
8. Use the data collected from the rebound testing to determine the ideal location for cores
9. Create custom curve correlating rebound and data from coring to determine the compressive strength at any location in the test region

Steps 3 to 6 and 9 are fully automated with the Original Schmidt App

Strength & Uniformity ► Rebound (Schmidt)

Determine Concrete Strength Class according EN13791

Q		$f_{ck,cylinder}$ / $f_{ck,cube}$	R	
Lowest for all Test Locations	Median for Test Region	**Compressive Strength Class EN206**	Lowest for all Test Locations	Median for Test Region
≥ 25	≥ 34	**C8/10**	≥ 26	≥ 30
≥ 29	≥ 40	**C12/15**	≥ 30	≥ 33
≥ 36	≥ 45	**C16/20**	≥ 32	≥ 35
≥ 42	≥ 49	**C20/25**	≥ 35	≥ 38
≥ 46	≥ 52	**C25/30**	≥ 37	≥ 40
≥ 51	≥ 56	**C30/37**	≥ 40	≥ 43
≥ 56	≥ 60	**C35/45**	≥ 44	≥ 47
≥ 58	≥ 62	**C40/50**	≥ 46	≥ 49
≥ 60	≥ 64	**C45/55**	≥ 48	≥ 51
≥ 62	≥ 66	**C50/60**	≥ 50	≥ 53
≥ 64	≥ 68	**C55/67**	≥ 53	≥ 57
≥ 66	≥ 71	**C60/75**	≥ 57	≥ 60
≥ 69	≥ 73	**C70/85**	≥ 62	≥ 65
≥ 71	≥ 75	**C80/95**	≥ 66	≥ 69

EN 13791 “Assessment of in-situ compressive strength in structures and precast concrete components”

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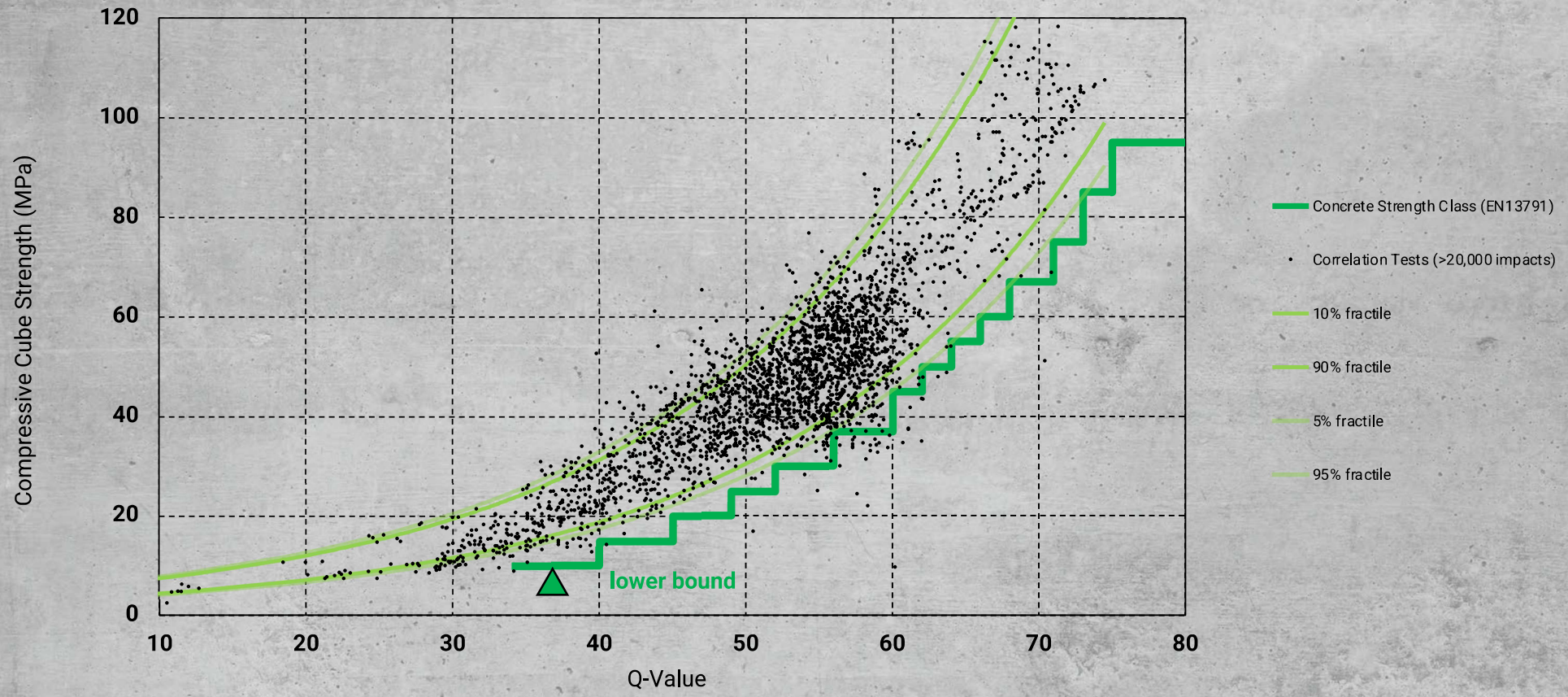
Strength & Uniformity ► Rebound (Schmidt)



Silver Schmidt Data correlating Q and Compressive Strength

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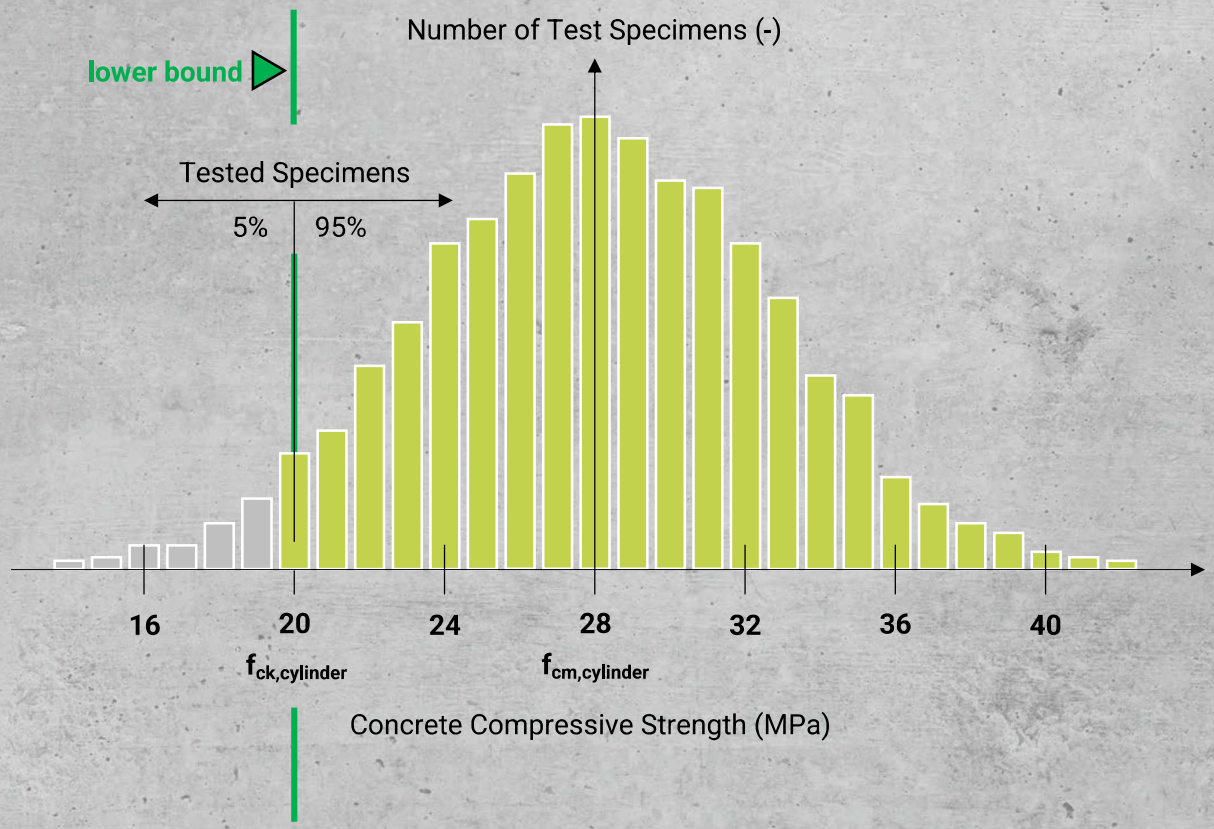
Compressive Strength: Crush Test



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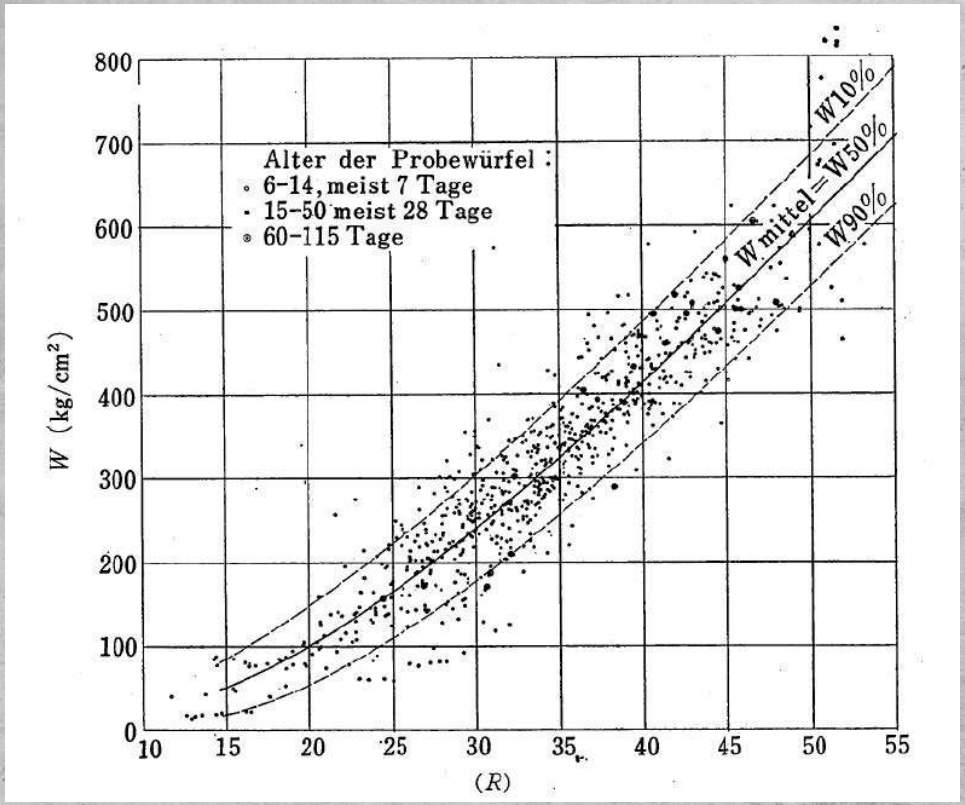
Strength & Uniformity ► Rebound (Schmidt)



Original Schmidt N data collected in 1960 by Dr. A. Gaede
(German Committee for Reinforced Concrete)

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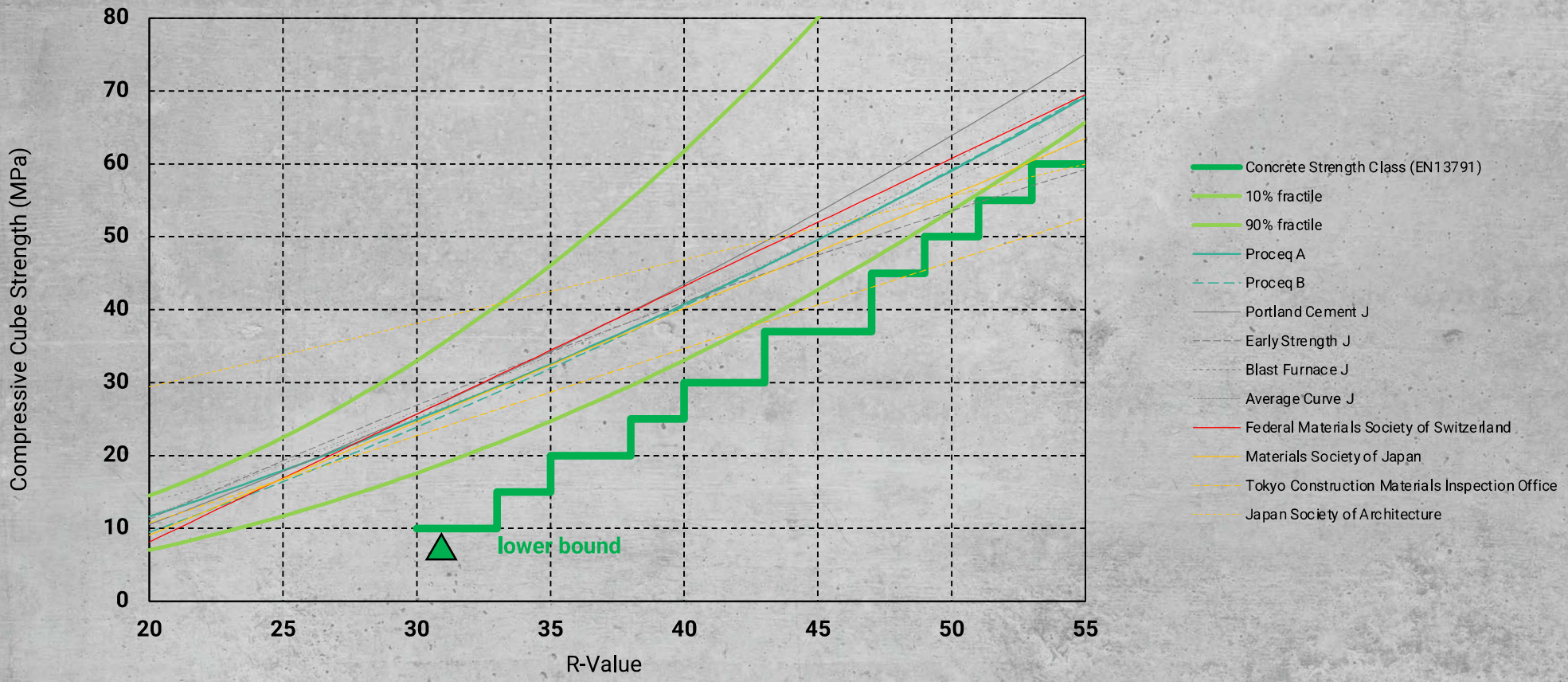
Strength & Uniformity ► Rebound (Schmidt)



Original Schmidt Curves correlating R and Compressive Strength

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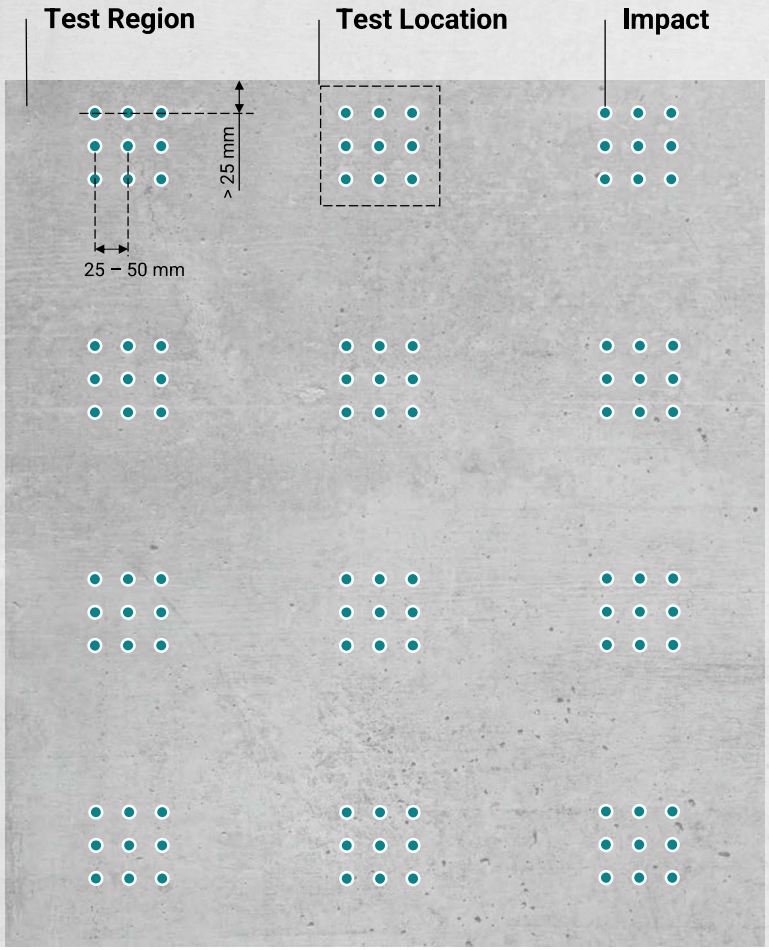
Strength & Uniformity ► Rebound (Schmidt)



Test Region with 12 Test Locations

Prepare ► Measure ► Characteristic Compressive Strength ► Report

Silver Schmidt (Digital) ► 6 minutes

Productivity 15x

Original Schmidt (Analogue) ► 90 minutes

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Strength & Uniformity ► Rebound (Schmidt)

Cores for structural assessment according to EN13791 with and without Schmidt testing

Purpose	Test region	Minimum Number of	
		Test Locations with Schmidt	Cores
Conforming compressive strength class		**9**	**0**
Doubtful compressive strength class	30 m^3	**9**	**2** at locations with lowest NDT result
	60 – 120 m^3	**12**	**3** 1 at lowest NDT test location 2 at median NDT test location
	150 – 180 m^3	**20**	
Compressive strength with Cores only		not required but recommended	**8 – 10**

EN 13791 "Assessment of in-situ compressive strength in structures and precast concrete components"

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Strength & Uniformity ► Rebound (Schmidt)

Important

1. Silver Schmidt or Original Schmidt Hammer
   - ► **Silver Schmidt**, for higher accuracy, Concrete Strength 5 - 100 MPa
   - ► **Original Schmidt**, if compared to historic R value records, Concrete Strength 10 - 70 MPa
2. Type N or Type L
   - ► **Type N** for Concrete Thickness > 10cm
   - ► **Type L** for Concrete Thickness < 10cm
3. Measure over Rebar with low cover
   - ► as for cores, rebars in the test region can influence the strength measurement
   - ► use Profometer to secure that impacts are not performed over rebar
4. Carbonated Concrete
   - ► increases the hardness of the concrete surface to give higher Q and R values
   - ► EN13791 recommends a correction for carbonation > 5mm
   - ► carbonation values can be corrected directly in the Schmidt app for the Q (Silver Schmidt)
5. Regional Concrete Mix or Local Conditions
   - ► **custom correlation curve** between destructive cylinder or cube test vs. Q or R values

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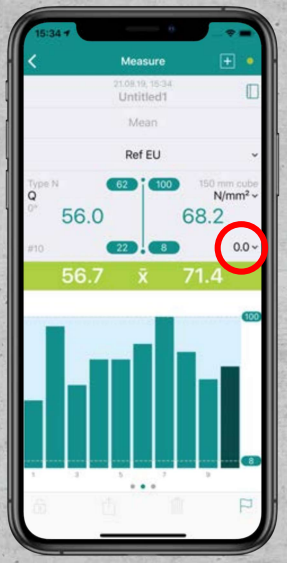
Strength & Uniformity ► Rebound (Schmidt)

Carbonation Correction

1. Measure on the carbonated concrete
2. Remove the carbonated layer and measure directly on the non-carbonated concrete
3. Calculate the correction factor = measurement on non-carbonated concrete surface / measurement on carbonated surface
4. Enter correction factor directly in the Schmidt app (Q value and **Silver Schmidt** only)



International Standards & Guidelines

Rebound (Schmidt)

EN 12504-2 **EN 13791** (Europe)	"Testing concrete in structures. Non-destructive testing. Determination of rebound number" "Assessment of in-situ compressive strength in structures and precast concrete components"
ASTM C805 (USA)	"Standard Test Method for Rebound Number of Hardened Concrete"
ACI 228.1R (USA)	"In-Place Methods to Estimate Concrete Strength"
ISO 1920-7 (International)	"Testing of concrete — Part 7: Non-destructive tests on hardened concrete"
JGJ/T 23 (China)	"Technical specification for inspecting of concrete compressive strength by rebound method"
CECS02-2020 (China)	"Technical specification for inspecting compressive strength of concrete by ultrasonic-rebound combined method"
JSCE-G504 (Japan)	"Hardened concrete test hammer strength test method"
JIS A1155 (Japan)	"Method of measurement for rebound number on surface of concrete"
ГОСТ 22690 (Russia)	"Determination of strength by mechanical methods of non-destructive testing"