




Portable Instruments for the Field Assessment of Rock Properties



Application Overview

Recommended Instruments

Recommended Instruments	Hardness Testing				Equotip 3	Ultrasonic Pulse Velocity
	RockSchmidt		Original Schmidt			Pundit PL-200 / Pundit Lab+
						
	Type N	Type L	Type N	Type L		
Geomorphological applications which investigate the bulk hardness properties of a rock outcrop	•		•	•		
Prediction of weathering grades	•		•	•		
Relative dating of landforms such as moraines and rock glaciers	•		•	•		
Correlation to Unconfined (or Uni-axial) Compressive Strength (UCS)	•	•			•	•
Correlation to Young's Modulus	•	•				
Prediction of penetration rates for tunnel boring machines and rotary drum cutters	•		•	•		•
Testing on weak rocks, porous rocks and those with thin weathering crusts		•		•	•	
Testing on cores	≥ 84 mm Ø	≥ 54.7 mm Ø		•	•	
Testing on rectangular blocks	> 100 mm thick	•	> 100 mm thick	•	•	
Investigation of hardness near to edges					•	
Determination of the pulse velocities of compression (P) waves and shear (S) waves in rock from which the dynamic elastic constants are calculated						•
Assessing the state of preservation of historical stone buildings						•
Quality classification of building stone						•



RockSchmidt



The world's most advanced rebound hammer, with unmatched dispersion characteristics, durability and measuring range has now been fully adapted for rock testing. The following features of the hammer make it ideal for rock testing applications:

- ✓ **Impact Angle Independence:** The rebound value is independent of the impact direction.
- ✓ **Optimized for Field Work:** Tighter sealing against dirt and dust intrusion for longer life. Significantly lighter and more ergonomic than the classic Schmidt hammer. A large number of readings can be saved and downloaded later to a PC.
- ✓ **Preset Statistics:** Statistics methods recommended by ISRM and ASTM are implemented into the hammer for automatic calculation of the rebound number. The option is also there to define a user specific statistics method.
- ✓ **Unconfined Compressive Strength:** ISRM recommends a correlation between UCS and the rebound value based on the formula $UCS = ae^{bR}$ (where R is the rebound value). A correlation in this format may be defined in the PC software and downloaded onto the RockSchmidt.
- ✓ **Young's (E-) Modulus:** ISRM recommends a correlation between elastic modulus and the rebound value based on the formula $E_t = ce^{dR}$ (where R is the rebound value). A correlation in this format may be defined in the software and downloaded onto the RockSchmidt.
- ✓ **Weathering Grade:** Impacting on the same location twice can be used to correlate to weathering grade. The ISRM recommended method has been included in the device.

Models

Type N: Standard impact energy, 2.207 Nm. Recommended for field work. For core testing ISRM* recommends that cores should be at least moderate strength (> 80 MPa) and at least T2 size (≥ 84 mm).

Type L: Low impact energy, 0.735 Nm. Recommended impact energy in the ASTM D 5873 standard for testing of cores. ISRM* recommends for testing on cores of moderate strength and above of at least NX size (≥ 54 mm).

*See section "Standards and Guidelines".

Technical Specifications

Impact energy	(N) 2.207 Nm, (L) 0.735 Nm
Dimensions of housing	55 x 55 x 250 mm (2.16" x 2.16" x 9.84")
Weight	570 g
Max. impacts per series	99
Memory capacity	Dependent on length of test series Example: 400 series of 10 impacts
Display	17 x 71 pixel, graphic
Battery lifetime	> 5000 impacts between charges
Operating temperature	0 to 50°C (32 to 122°F)
IP Classification	IP54



"The specific advantage of the Schmidt Hammers for surface exposure dating is the reliable and reproducible testing of high numbers of boulders."

Dr. Stefan Winkler, Geological Sciences, University of Canterbury

Original Schmidt

The benchmark against which all rebound hammers are compared and the basis of every international rebound hammer standard. The Original Schmidt Type N is the most widely used hammer for geomorphological applications. A large number of UCS to rebound value correlations exist based on tests made with this hammer.



ROCK TESTING

Equotip 3 with Impact Devices D and S



Extensively used for rock hardness and for investigating weathering effects on rocks. The impact energy is approximately 1/200th that of the Type N rebound hammer.

This makes it very suitable for testing on historical sites, very soft types of rock that cannot be tested with a rebound hammer and also on brittle rock cores that would be damaged by a rebound hammer.

The impact device type S features the same impact energy and a much more durable ceramic impact body that is more suited to heavy users on harder rock.



"Using Proceq's NDT instruments significantly improves our understanding of the deterioration processes affecting heritage buildings."

Prof. Heather Viles, Professor of Biogeomorphology and Heritage Conservation, University of Oxford

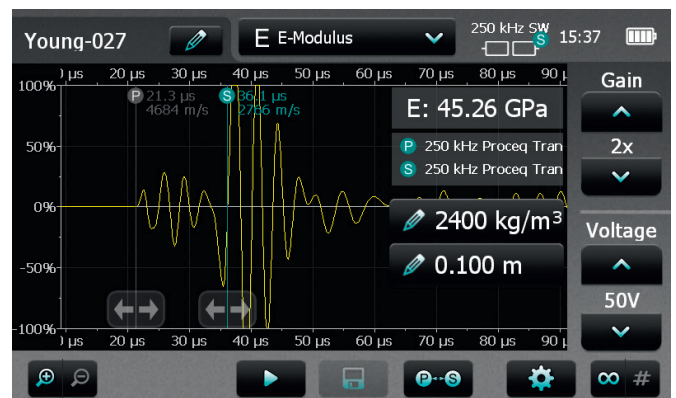
Pundit Ultrasonic Pulse Velocity Application



Elastic Constants of Rock – Modulus of Elasticity and Poisson's Ratio

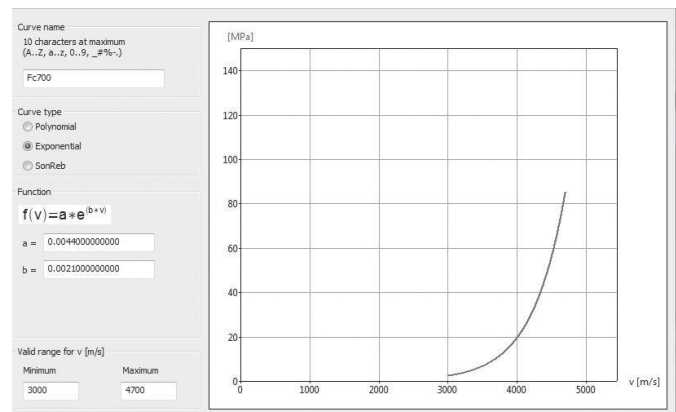
Ultrasonic testing is widely used for rock material characterization. The pulse velocity is directly related to the physical and mechanical properties of the rock.

Proceq's Pundit PL-200 and Pundit Lab+ ultrasonic test instruments allow an accurate measurement of both compression (P-wave) and shear (S-wave) pulse velocity. The procedure is described in both ASTM and ISRM recommendations. Once these have been determined, the elastic constants of the material, (P-wave modulus, the shear modulus, Poisson's ratio and dynamic modulus of elasticity) can be calculated.



Unconfined Compressive Strength

A correlation to UCS in either polynomial or exponential format may be defined in the Link software and downloaded onto the Pundit PL-200 or Pundit Lab+.





Standards and Guidelines

The following standards and guidelines apply to rock testing:

- **ASTM D 5873** – Standard Test Method for Determination of Rock Hardness by Rebound Hammer Method. (Applicable for UCS between 1 MPa and 100 MPa.)
- **ASTM D 2845** – Standard Test Method for Laboratory Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock.
- **ISRM** – Aydin A., ISRM Suggested method for determination of the Schmidt hammer rebound hardness: Revised version. Int J Rock Mech Mining Sci (2008), DOI: 10.1016/j.ijrmms.2008.01.020.
- **ISRM** – Aydin A., Upgraded ISRM Suggested Method for Determining Sound Velocity by Ultrasonic Pulse Transmission Technique: Rock Mech Rock Eng (2014) 47:255-259, DOI: 10.1997/s00603-013-0454-z.
- Viles M. et al, The use of the Schmidt Hammer and Equotip for rock hardness assessment in geomorphology and heritage science: a comparative analysis. Earth Surface Procs and Landfs (2010), DOI: 10.1002/esp.2040 illustrates some common uses of the Schmidt Hammer for testing rocks in the field.

Proceq Recommendations for Hardness Testing

RockSchmidt / Original Schmidt type N. Impact energy 2.207 Nm. For measurements on bulk rock with a UCS of 20 - 150 MPa.

RockSchmidt / Original Schmidt L. Impact energy 0.735 Nm. May be used on a similar range of UCS as the N type, but is recommended for use on weaker rocks (UCS <20 MPa), porous rocks and rocks with thin weathering crusts.

Equotip 3 with impact device D. Impact energy 0.011 Nm. Recommended for testing on very weak rocks, small samples, brittle core samples and also for testing edge effects.

Ordering Information

RockSchmidt

PART NO.	DESCRIPTION
343 10 000	RockSchmidt Type N, including battery charger with USB cable, DVD with PC software, carrying strap, grinding stone, documentation and carrying bag
343 20 000	RockSchmidt Type L, including battery charger with USB cable, DVD with PC software, carrying strap, grinding stone, documentation and carrying bag

Original Schmidt

PART NO.	DESCRIPTION
310 01 001	Original Schmidt Type N
310 03 002	Original Schmidt Type L

Pundit

PART NO.	DESCRIPTION
327 10 001	Pundit PL-200 consisting of: Touchscreen, 2 Transducers 54 kHz, 2 BNC cables 1.5 m, couplant, calibration rod, BNC adapter cable, battery charger, USB cable, DVD with PC software, documentation, carrying strap and carrying case
326 20 001	Pundit Lab+ consisting of: Display unit, 2 transducers (54kHz), 2 BNC cables 1.5 m, couplant, calibration rod, battery charger with USB-cable, 4x AA(LR6) batteries, data carrier with PC software, documentation and carrying case
325 40 176	2 Exponential transducer 54 kHz, including calibration rod
325 40 049	2 Shear wave transducers 250 kHz, including couplant

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Equotip 3

PART NO.	DESCRIPTION
353 10 100	Equotip 3 Hardness Tester, unit D, includes Equotip 3 indicating device, AC adapter, Equotip 3 impact device D with cable, test block D, USB-cable, Equotip CD, cleaning brush, coupling paste, carrying case, support ring D6 and D6a, operating instructions, quick reference guide, calibration certificate
353 10 050	Equotip 3 Hardness Tester Basic Unit consisting of: indicating device with stand, AC adapter, USB cable, Equotip CD with Equolink 3 software and product documentation, operating instructions, quick reference guide, product certificates, carrying case
353 00 200	Equotip 3 impact device S
357 13 200	Equotip test block S, calibrated by Proceq (~815HLS/~630HV/~56HRC)

Service and Warranty Information

Proceq is committed to providing complete support for each testing instrument by means of our global service and support facilities. Furthermore, each instrument is backed by the standard Proceq 2-year warranty and extended warranty options for electronic portion.

Standard warranty

- Electronic portion of the instrument: 24 months
- Mechanical portion of the instrument: 6 months

Extended warranty

When acquiring a new instrument, max. 3 additional warranty years can be purchased for the electronic portion of the instrument. The additional warranty must be requested at time of purchase or within 90 days of purchase.

Subject to change without notice. All information contained in this documentation is presented in good faith and believed to be correct. Proceq SA makes no warranties and excludes all liability as to the completeness and/or accuracy of the information. For the use and application of any product manufactured and/or sold by Proceq SA explicit reference is made to the particular applicable operating instructions.