Operating Manual

RA 100 Concrete,
non-destructive, quick determination of compressive strength
and modulus of elasticity on samples
of cement, mortar and concrete

Model 1.0390

Importance of this Operating Manual:
We expect and require that the User reads, understands and observes all parts of this Operating Manual.

Contents: **Page no.:**

1.   Safety instructions

Application

Product for commercial use only!

Product exclusively for intended use with building material samples!

Safety

Do not interfere or modify our products. Never open the device. Otherwise any warranty / conformity expires.

Operating temperatures

Microphone: -10 ÆC to +85 ÆC

Tablet: +10 ÆC to +40 ÆC

If you have any questions, please contact us:

service@testing.de

2. Scope of delivery

The scope of delivery of the product RA 100 Concrete includes the following parts:

- 1 test stand with integrated USB microphone and 1.8 m USB cable
- 1 tablet, 10", 32 GB, Windows 10
- Pre-installed RA 100 Concrete Software
- 1 stainless steel base plate
- 6 screwable vibration absorbers
- 4 steel balls (2x 20 mm Ø, 2x 14 mm Ø)
- 1 acrylic downpipe
- 1 height-adjustable sample holder
- 1 adjustable tablet holder
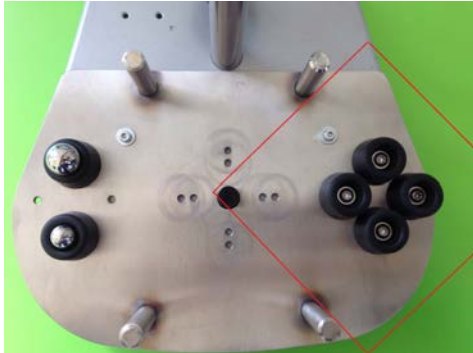- 1 Bluetooth keyboard
- 1 Bluetooth mouse

3.   Start-up

For easy and uncomplicated starting the following steps are recommended:
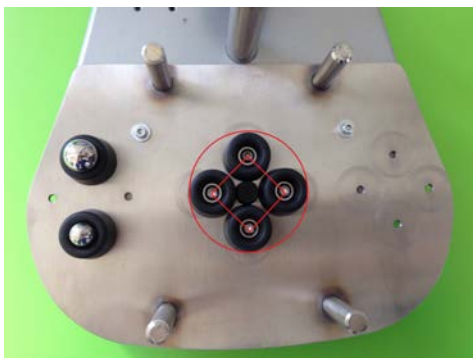

1. Place the RA 100 Concrete test stand firmly on a fat surface

2. Assemble base plate

3. Screw in vibration absorbers

4. Set up the test specimen
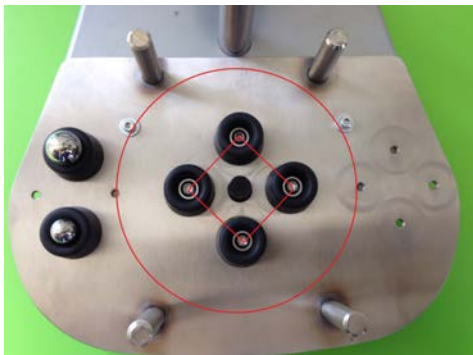
(Position recommendation marked in red)

Recommended sample position of a cube sample 150mm/150mm/150mm

Recommended frequency range (cube): 3500 Hz - 9500 Hz

Stable sample position for cylinder samples with small diameter and prism samples with small width

Recommended frequency range (prism): 10000 Hz - 16000 Hz

Optimum sample position for cylindrical samples with larger diameters and prism samples with larger widths

Recommended frequency range (cylinder): 3000 Hz - 9000 Hz

Smaller specimens such as 40 x 40 x 160 mm prisms and smaller drill specimens can be clamped centrally in the supplied multi-purpose clamp.

5. Fasten the acrylic downpipe in the holder with the M8 screw

6. Start Tablet and connect the USB adapter to the tablet

7. Start the program Resonance Analysis and make basic settings (see Chapter 4 – Software)
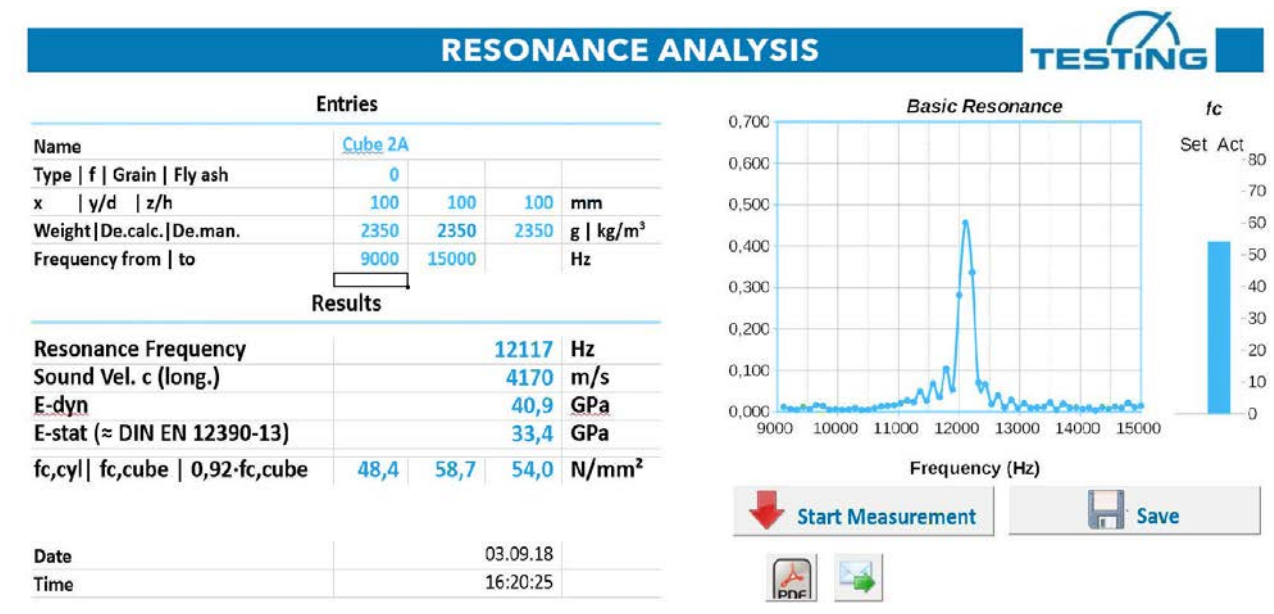
8. Start Measurement

4.   Software

The device measures the natural resonances of test specimens by means of a steel ball impact and microphone. The sound vibrations are digitized and evaluated spectrally. Vibrations are selected and evaluated which allow analytically simple conclusions to be drawn about the elastic material values. Based on empirical insights, compressive strength values are also estimated from the elasticity values for concrete.

4.1. Tab „Measurement"

Correct measurement with clear resonance peak

Entries

In this area the settings are entered in advance of the measurement process.

Description

Name of the measuring process / the sample - free text.

Concrete type, Grain, Fly ash

In the first input cell, the sort description of a concrete can be entered with which properties stored from the sort table (own spreadsheet of the calculation program) can be called up, of which - if available - the characteristic cube strength value, the maximum grain size and the fly ash content are displayed.

The fck-cube compressive strength value is used for the target display (first column next to the diagram) for comparison with the measurement. The maximum grain display is not used directly, it indirectly influences an otherwise determined calibration correction factor, which is listed in the last column of the sort list and corrects the determination of compressive strength according to empirical experience.

x y/d z

Describes the sample shape for calculating the velocity of sound from the resonant   frequency and is used to calculate the sample volume required for density calculation if the sample weight is entered.

x and y/d describe the base area, z the sample height. If x = 0, x/d input means the diameter of a cylinder, if x is entered a value, x/d means the second side of a base area rectangle (the sample then corresponds to a rectangular or square prism, or even a cube).

Example:

300mm standard cylinder	160mm standard prism	150mm standard cube
x = blank	x = 40	x = 150
y/d = 150	y/d = 40	y/d = 150
z = 300	z = 160	z = 150

Weight. De.calc. De.man.

If a weight is entered in the first input cell, the program determines the density with the calculated volume. If the weight is 0, a density value must be entered manually in the rear input cell or the value there is taken.

Frequency from to

Here are the frequencies that can be changed at any time (also after the measurement) and between which a resonance is sought. This area is also used for the adjacent graphic.

Recommendations for common sample shapes:

150mm cube sample: 3500 Hz - 9500 Hz

300mm cylinder sample: 3000 Hz - 9000 Hz

160mm prism sample: 10000 Hz - 16000 Hz

These settings cover the most common varieties.
For very soft or very hard samples the frequency window must be shifted up or down.

Start measurement
When this button is pressed, the microphone goes into standby mode and waits for the pulse that triggers the measurement process

Save
If this button is pressed, the current measurement is stored in the archive

Export as PDF
With this function, the measurement can be exported as a PDF report

Send as e-mail
After completion of the measurement, the measurement data can also be sent as an e-mail to a stored e-mail address

Results

After the measurement process, the result values are displayed in this area. The isolated resonance frequency of the sample and the value of the compressive strength are shown graphically on the right in a target-actual diagram. The target value of the compressive strength is either entered manually or taken from the corresponding sort list.
Incorrect measurements due to premature triggering, incorrect sample storage or other interference can be identified directly on an uneven frequency image.
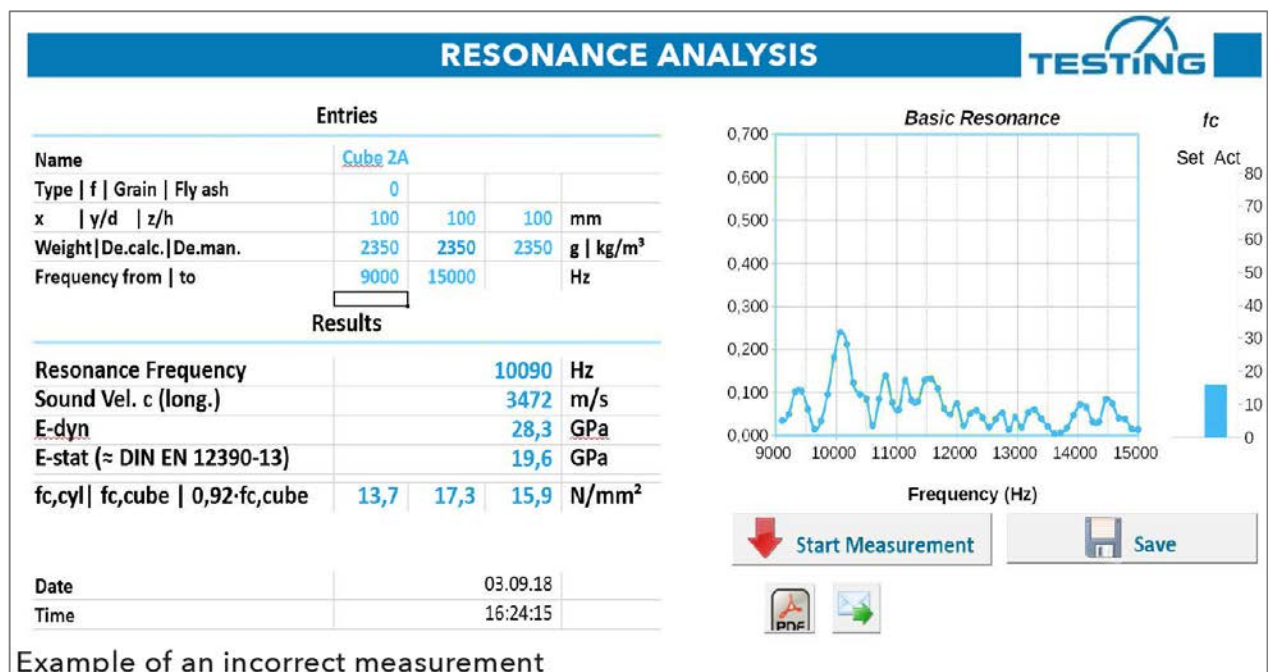
Example of an incorrect measurement

Resonant Frequency

This is the actual and most important measured value.

In the set frequency range, the signal frequency response recorded by the microphone is determined in the manner of a digital short-term Fourier transformation and also displayed graphically.

A resonance curve expected in the set frequency range is visible and evaluated with regard to its maximum position in the frequency range and the resonance frequency is used to determine the corresponding elastic material constants.

Velocity of sound

The pure material constant sound velocity is determined from the resonant frequency and sample dimensions.
Solids have different types of sound wave propagation, each with its own speed. In an isotropic solid such as concrete (uniform behaviour in all directions) there are two types of waves in the unlimited medium, which propagate at different speeds and are described by two independent elastic constants. These waves are generally detected by ultrasound, since the larger dimensions of the specimens do not play a role in the small wavelengths and the transit time measurements.
In resonance measurements, the interfaces with their abrupt elastic property changes come into play and complicate sound propagation, according to the sample dimensions. Sound propagation is simplest measured in long bars where the transverse dimensions are small compared to the wavelengths. For the velocity of sound determined by longitudinal oscillation resonance the following applies:

c-shaft = radical (E/den)
and therefore: $E = den*c^2$ (E = Young's modulus and den = density)

In this table result cell, c always means shaft speed. Other measured velocities, including torsional wave velocities, are converted by means of relationships between elastic constants and consideration of the specimen shape.

If the transverse contraction coefficient must be used, the mean value 0.2 valid for concrete is used. The possibility of variation of 0.14...0.26 for concrete has little effect on the result.

Due to the cube specimen shape, which is widely used in the concrete industry, not a longitudinal oscillation shape but the isolated lowest torsional oscillation was selected for reliable detection, which is converted into a comparable longitudinal speed of sound. The cube basic frequencies are described in:

Harold H. Demarest, Jr. The journal of the Acoustical Society of America Volume 49 Number3 (Part 2) 1971, Cube-Resonance Method to Determine the Elastic Constants of Solids

E-dyn

The dynamic modulus of elasticity is a pure material property, not dependent on specimen geometry and measuring conditions. For concretes, it is largely identical to the modulus of origin of the stress-strain curve.

E-stat DIN EN 12390-13

The static modulus of elasticity is estimated from the dynamic modulus of elasticity according to theoretical models, similar comparison measurements from literature and own measurements.

Fc-cyl fc-cube 0,92 fc-cube

The result values correspond to a conversion of the measured sound velocity according to empirical values obtained in test series with several hundred cube compressive strength values produced in the ready-mixed concrete product monitoring. For standard concrete, the standard curve, which can be adjusted with correction factors, corresponds to a dependence of the modulus of elasticity on compressive strength with a power of approx. 0.3, i.e. E proportional fc high 0.3, which is usually preferred in the literature.

The dependence on density implied in E-dyn is not considered in standard concrete, fc is thus calculated directly from the speed of sound. However, in the case of lightweight concrete, a smaller power number is used for the compressive strength dependence: The central calibration curve is designed for the cube strength in the cell fc-cube, the cylinder strength for a 150mm/300mm cylinder is calculated back into the cell fc-cyl. The dry cube storage for the 28-day value with that is taken into account for standard concrete with the factor 0.92 in the cell 0.92 fc-cube.

4.2. Tab „Archive"

Date	Time	Name	Concrete Type	Resonance Frequency	Sound Vel. c (long.)	E-dyn	E-stat (DIN EN 12390-13)	fc cyl	fc cub	fc 0,92	fc cube	Grain	Fly Ash	x	y/d	z	Weight	De. calc.	Frequency from	Frequency to	y Max	Version	Factor
						Hz	m/s	GPa	GPa	N/mm²	N/mm²	N/mm²				mm	mm	mm	g	kg/m³	Hz	Hz	
14.02.17	16:16:15		Balsaholz	0	3613	3613	1,2	0,8	7752,5	8005,4	7365,0		0	0	0	30	30	500	41	91	1000	4000	0,342	1.13.6	1,000
21.08.18	17:00:40		Prisma 1 long	0	8169	3921	35,4	28,1	31,7	39,0	35,8		0	0	0	80	80	240	3633	2365	6000	10000	0,601	1.14.2	1,000
21.08.18	17:04:12		Prisma 1 bieg füll	0	4247		35,2				48,9		0	0	0	80	80	240	3633	2365	3000	7000	0,583	1.14.2	1,000
21.08.18	17:04:48		Prisma 1 bieg füll	0	4080		33,4				38,6		0	0	0	80	80	240	3633	2365	3000	7000	0,559	1.14.2	1,000

ANALYSISES ARCHIVE — No. of meas.: 4 — [Erase Archive] [Export Archive]

On the basis of the measurement processes stored in the archive, it can be precisely traced at any time under which pre-setting's, measurement conditions and at which time which characteristic properties of the test specimens existed.

With the button >Erase archive< the measuring processes are deleted.
In the "Settings" tab, you can define the selection and sequence of the data fields displayed.

4.3. Tab „Settings"

Recording											
Sampling rate [Hz]:	44100										
Recording length [s]:	0,1										
Signal gain [dB]:	0										
High pass filter [Hz]:	0										
Trigger threshold [%]:	30										
Trigger min. duration [s]:	0,01										
Trigger wait timeout [s]:	10										
Read temperature:	0	(0=no, 1=yes)									
Audio device											
Audio playback device [no.]:	0	(0 = system setting, 1..n = audio device no.)									
Audio recording device [no.]:	0	(0 = system setting, 1..n = audio device no.)									
View											
Language:	English		4								
Full screen:	0	(0=no, 1=yes)									
Chart Y scaling:	0,7	(Y max. value, 0 = auto)									
Archive											
Copy cells from "Measurement":	C22	C23	C6	C7	C14	C15	C16	C17	C19	D19	E19	D7	E7
Separation char for CSV export:	;	("TAB = Tab character)									
Signal											
Time range [s]:	0,1										
Email											
Recipient:											
Info Text in email subject line:	TEST										
Email text (lines, "EQ", "LF"):	B14	EQ	C14	F14	LF	B16	EQ	C16	F16	LF	
Open email application window:	0	(0 = send without open, 1 = open application window)									
Licensing											
License no.:	432080										
Version:	1.14.2										

The values entered represent the basic software settings.

Recording

Sampling rate:
Sampling rate of the audio recording

Recording time:
Length of the recording

Trigger limit:
Level at which the recording is triggered

Trigger minimum duration:
Time period for which the level must be increased in order to trigger a measurement

Maximum waiting time:
Waiting time for trigger - if the measurement is not triggered, the software returns to the normal state

Changes to these settings can strongly influence the quality of the measurement.
Please contact us if you have any questions:

service@testing.de

Audio device
Selecting the recording and playback device. (Not necessary from Windows 8.1)

View
Optionally, the screen can be switched to full screen mode using the
> Switch Screen button <
When changing the setting with the number 1, the program is displayed in full screen mode at each start.
The desired maximum Y value can be entered for scaling the Y-axis of the "basic resonance" diagram. If the value is "0", the diagram is automatically scaled.

Archive
Here you can select the cells that are to be stored in the archive after saving.

E-Mail
The addresses of the desired recipients can be entered here (separate multiple entries with commas). In addition, the subject line of the e-mail can be pre-set. The evaluation data to be sent can be supplemented or reduced in the "E-Mail Text" area by entering the table fields.

Licensing
License number for using the software

4.4. Tab "Concrete Types"

Type Name	Concrete Type	Compr. Strength Class	Cube Compr. Strength	Max. Grain	Consistency Class	Fly Ash	Factor
8				8			1,05
8F				8		1	1,13
16				16			0,90
16F				16		1	0,94
22				22			0,81
22F				22		1	0,95
32				32			0,80
32F				32		1	0,85
0							1,00
S			1	2		3	1,60

Exemplary excerpt from a stored list of varieties

If a variety list of types is stored, additional details can be used for the display and calculation.

If you have any questions, please contact us:

service@testing.de

5.   Troubleshooting

Issue:
As soon as you click on "Start measurement" - the software immediately jumps to "process".

Solution:
USB microphone of the test stand not connected.

OR

Correct the trigger limit upwards in the "Settings" tab.

Issue:
The software does not start processing after the ball is dropped.

Solution:
Correct the trigger limit downwards in the "Settings" tab.

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