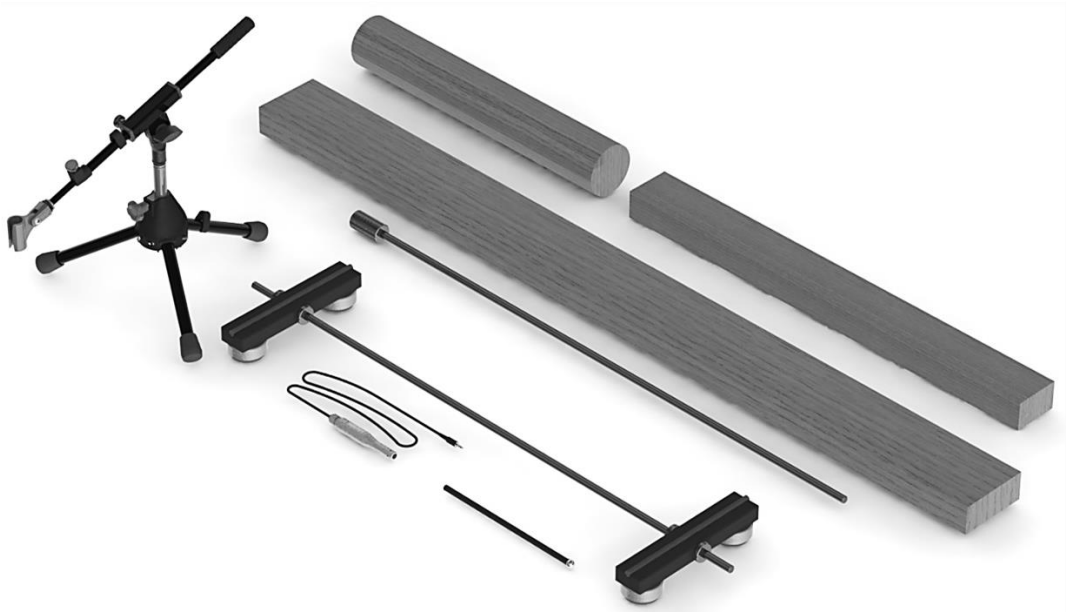
SONELASTIC
Advanced Impulse Excitation Technique

Installation and Operation Manual

SA-AG

Adjustable support for large specimens



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SA-AG

Adjustable support for large specimens

Manufactured by:

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1. Introduction

ATCP Physical Engineering equipment and products were projected and manufactured to provide a long-lasting and top-rated performance. This Installation and Operation Manual contains all necessary information regarding the use and maintenance of SA-AG Support.

Carefully read this manual before using the support. Improper use may damage the product and affect its performance.

2. Definitions

Impulse Excitation Technique: The Impulse Excitation Technique is a non-destructive technique to determine the elastic moduli and damping of materials by the resonance frequencies of test specimens. ASTM E1876 is the main standard related to the Impulse Excitation Technique.

Resonance Frequencies: Specimen natural frequencies of vibration.

Elastic modulus: Elastic modulus or Young's modulus is defined as the slope of the stress-strain curve at the elastic region, as described by Hooke's Law. The elastic modulus determined by Impulse Excitation Technique is also termed as dynamic elastic modulus.

Damping: Damping is the phenomenon by which mechanical energy is dissipated in dynamic systems. It is directly linked to the presence of defects and to the material microstructure.

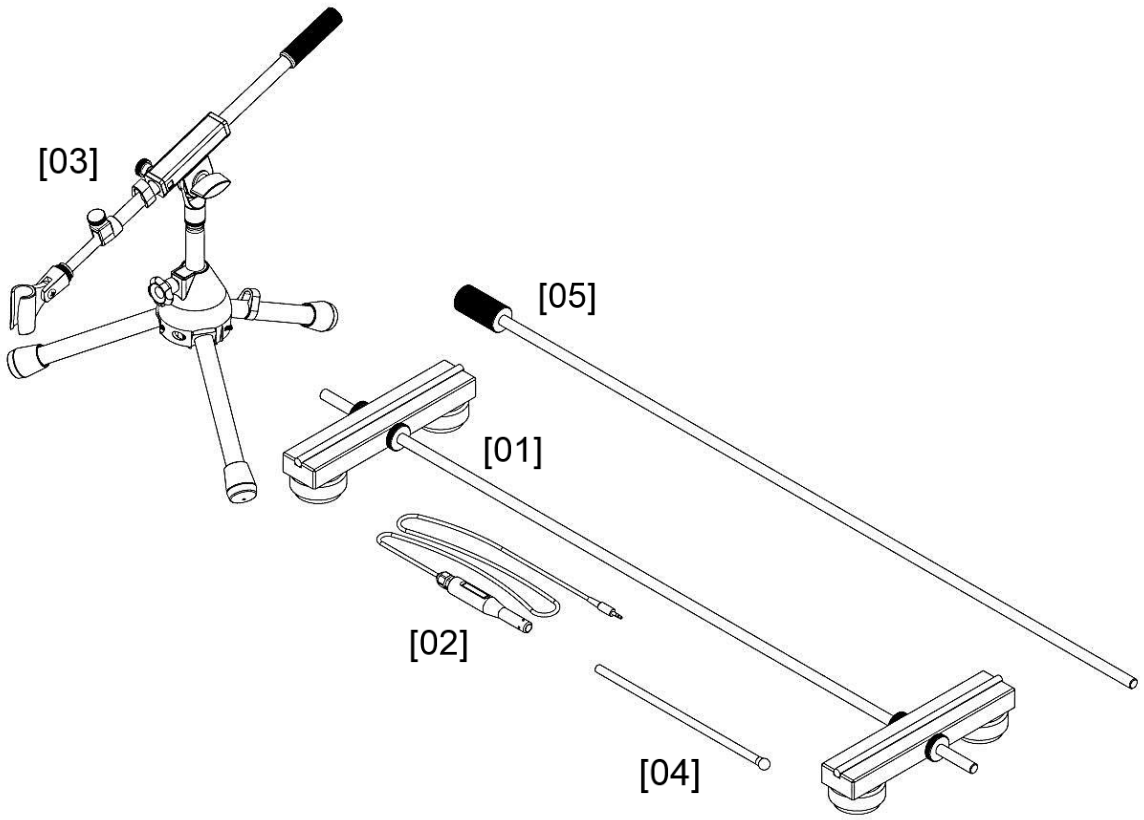
3. Application and features

SA-AG Support is an apparatus to support specimens for non-destructive characterization of Young's modulus and damping of materials by Impulse Excitation Technique, in agreement with ASTM E1876 and correlated standards. SA-AG Support was developed to be used alongside Sonelastic® Systems.

SA-AG Support allows large rectangular and cylindrical specimens to rest on the nodal lines of the fundamental flexural vibration mode (for a specimen of length L, these nodal lines are 0.224L distant from the ends). This support offers a practical system to adjust the distance between the supporting blocks. SA-AG Support also allows tests based on torsional and longitudinal vibration modes for bars and cylinders.

4. Configurations, parts, accessories and optional items

SA-AG Support consist of two supporting blocks linked by a threaded rod, allowing practical adjustment. It also has an extension rod to expand the maximum distance between the supporting blocks.



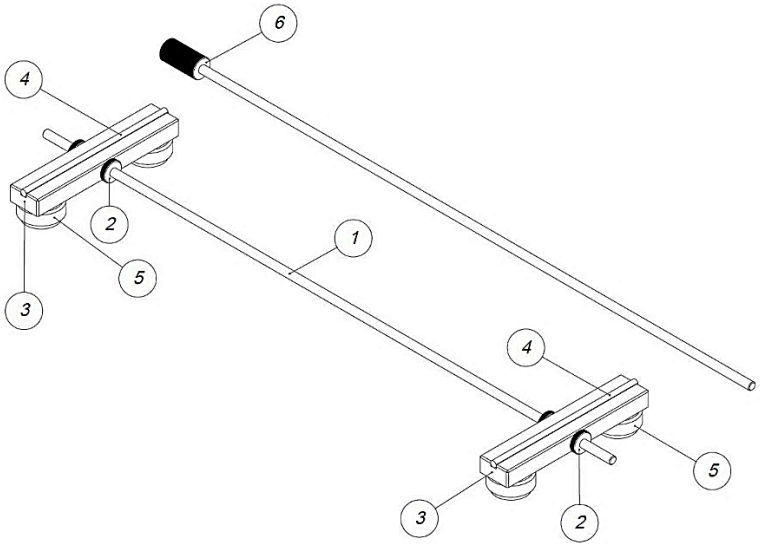
Parts:
[01] – SA-AG Support;
[02] – Acoustic Sensor CA-DP;
[03] – Sturdy Tripod.

Accessories:
[04] – Medium Manual Impulse Device;
[05] – Extension rod (01 UNIT).

Optional items:
[05] – Extension rod.

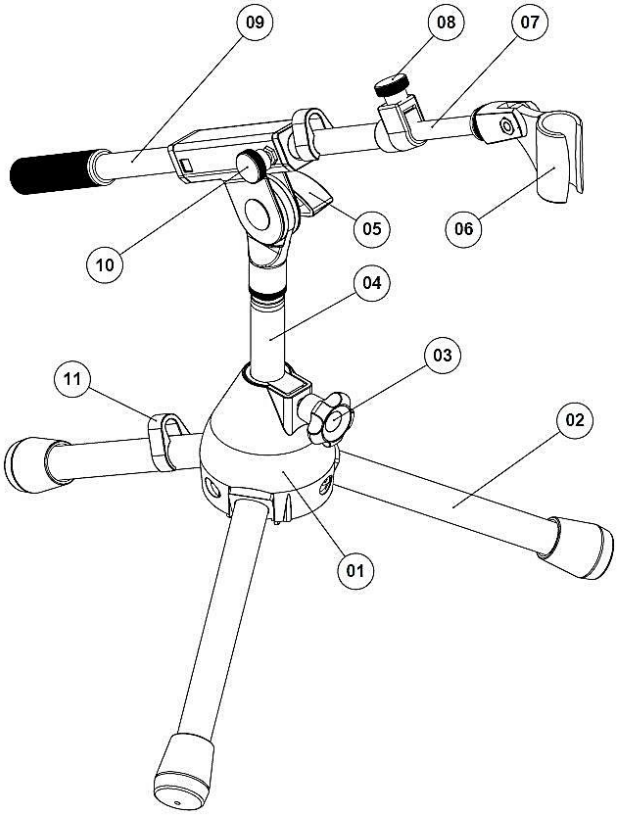
5. Parts identification

SA-AG Support



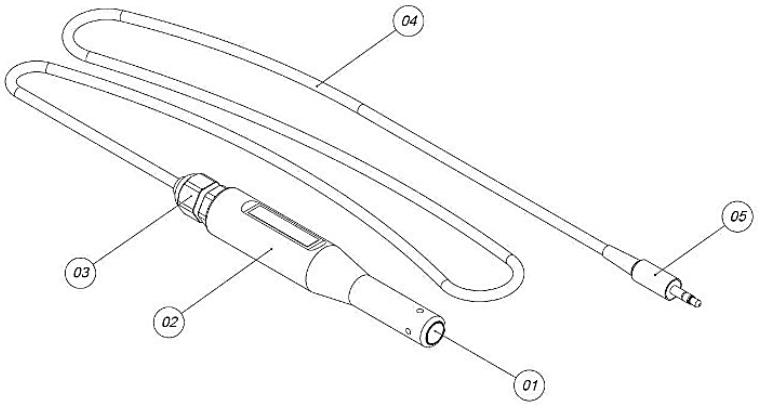
01- Threaded rod;
02- Fastening nut of the supporting block;
03- Supporting block;
04- Supporting frieze;
05- Damper foot;
06- Extension rod.

Sturdy Tripod



01- Frame;
02- Articulated tripod;
03- Handle for securing the tube;
04- Pillar;
05- Handle for the tube articulation;
06- Acoustic sensor clip;
07- Inner tube;
08- Handle for the inner tube articulation;
09- Outer tube;
10- Handle for the outer tube articulation;
11- Cable's organizer.

CA-PD Acoustic Sensor



01-CA-DP Acoustic Sensor;
02- P2 plug (3.5 mm);
03- Flexible cable;
04- Cable gland;
05- Acoustic sensor frame;
06- Vertical mounting base*;
07- Height-adjusting disc**.

* The Vertical mounting base allows positioning the acoustic sensor on the vertical, directly below the specimen, for measurements under the manual configuration.

** The height-adjusting disc should be used to balance CA-DP Acoustic Sensor and / or IED Impulse device heights, when testing lightweight specimens.

6. Specifications

Maximum dimensions for rectangular specimens (L x W x T) ..... 5,300 x 200 x 200 mm

Minimum dimensions for rectangular specimens (L x W x T) ..... 120 x 20 x 20 mm

Maximum dimensions for cylindrical specimens (L x D) ..... 5,300 x 200 mm

Minimum dimensions for cylindrical specimens (L x D) ..... 120 x 30 mm

Maximum dimensions for the Standard Support (L x W x T)..... 1,000 x 250 x 57 mm

Maximum dimensions for the extended support (L x W x T) ..... 3,000 x 250 x 57 mm

Maximum weight capacity..... 200 kg

Standard Support weight, without a specimen..... 2.8 kg

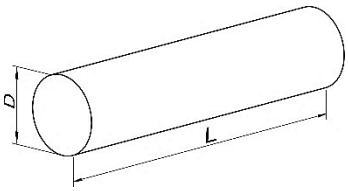
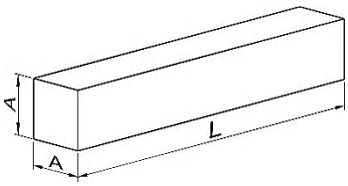
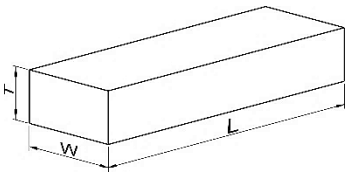
Extended support weight, without a specimen..... 5.2 Kg

Working temperature range ..... 10 - 40°C (50 - 104 °F)

7. Specimens

7.1 Recommended aspect ratios

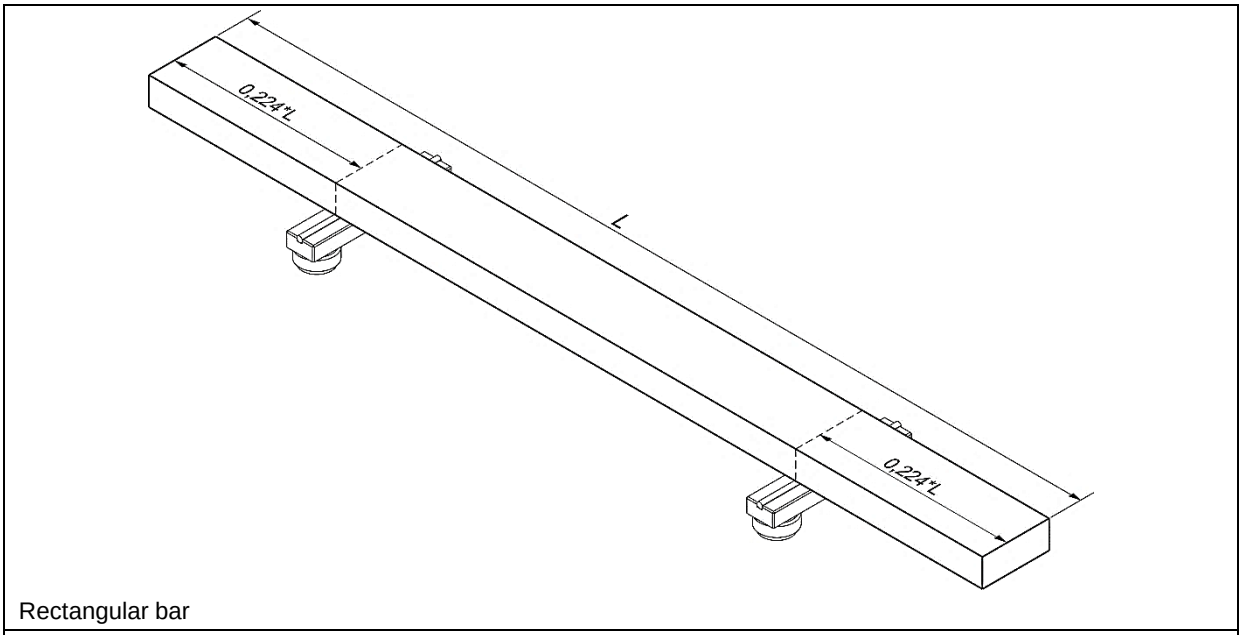
Minimum aspect ratios must be observed to avoid coupling between specimen's vibration modes. In addition, aspect ratio determines the pattern of frequency spectrum of the acoustic response. We advise users to standardize the aspect ratio in order to facilitate the frequencies identification. The table below presents the recommended aspect ratio for bars and cylinders.

Geometry	Recommended proportions
 Cylinder	$\frac{L}{D} \geq 2$ The ratio between length (L) and diameter (D) must be greater than or equal to 2.
 Square section bar	$\frac{L}{A} \geq 3$ The ratio between length (L) and edge (A) must be greater than or equal to 3.
 Rectangular section bar	$\frac{L}{W} \geq 4$ The ratio between length (L) and width (W) must be greater than or equal to 4. $\frac{W}{T} \leq 8$ The ratio between width (W) and thickness (T) must be less than or equal to 8.

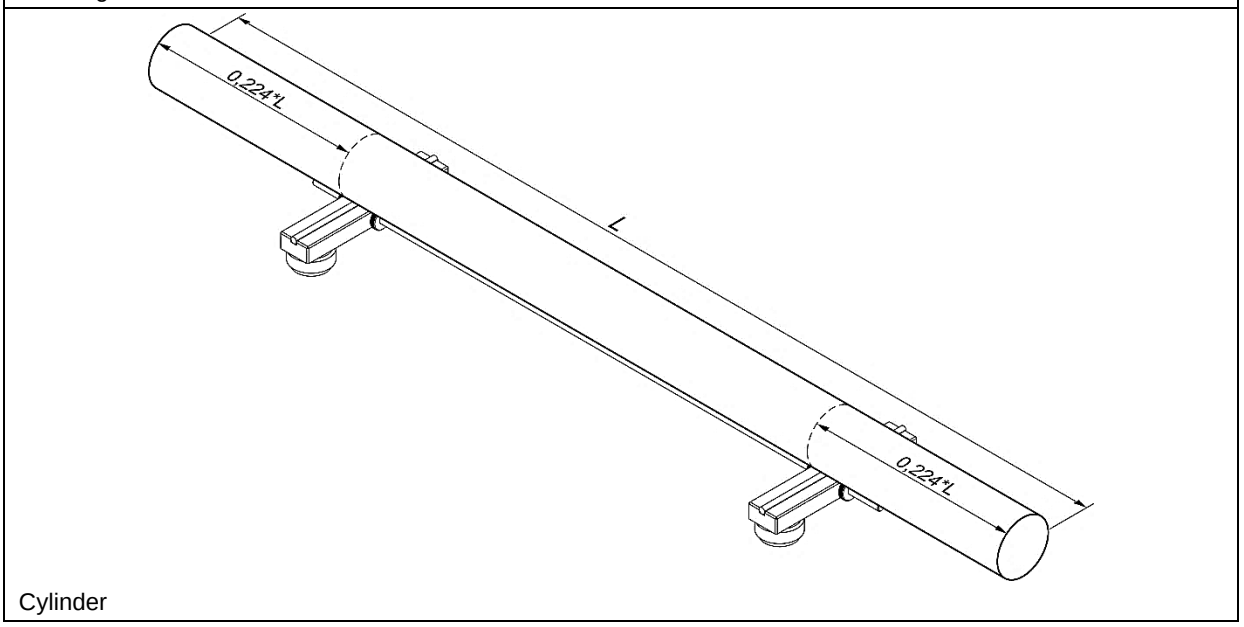
Important observations for preparing and finishing the specimens:
- The recommended dimension tolerance is 2%;
- Faces should be flat and parallel;
- Corners should not be rounded.

7.2 Placing the specimen

The specimen should be symmetrically supported and placed over the supporting blocks, with these resting at a distance of 0.224 L from the specimen ends (L is the length of the specimen). For instance, if a specimen's length (L) is 1,000 mm, the supporting blocks should be positioned at a distance of 224 mm from each end. The positions of 0.224 L correspond to the nodal lines of the flexural vibration mode.



Rectangular bar



Cylinder

The corresponding distance calculation of 0.224 L is automatically generated and informed by Sonelastic® Software. Markings on the specimen are generally done by using a pencil and a ruler or caliper ruler.

8. Support installation

8.1 Requirements

- Floor or a flat surface to place the support with a free area large enough to fit the SA-AG Support and the specimens to be tested.

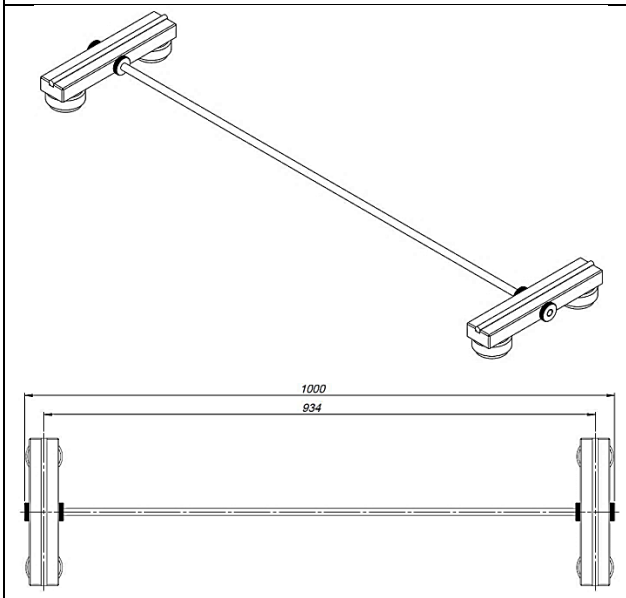
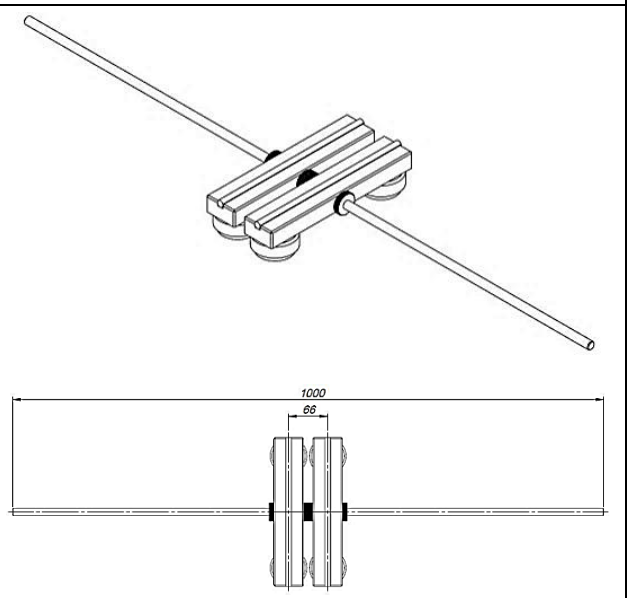
- A workbench flat and leveled with a free space of at least 60 x 60 cm (depth and width). This space is enough to fit the computer.

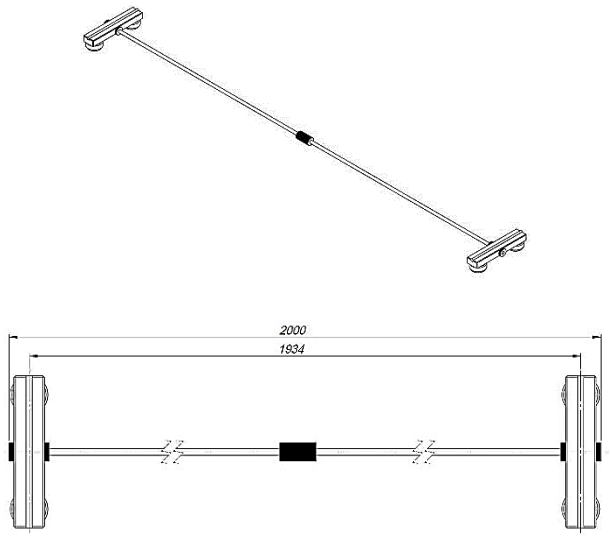
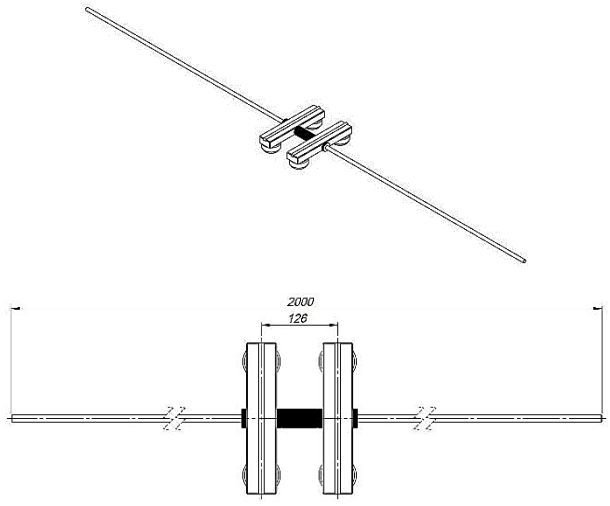
- A 127 or 220 VAC three-pin ground wired electrical mains plug. This plug is needed to power the computer up.

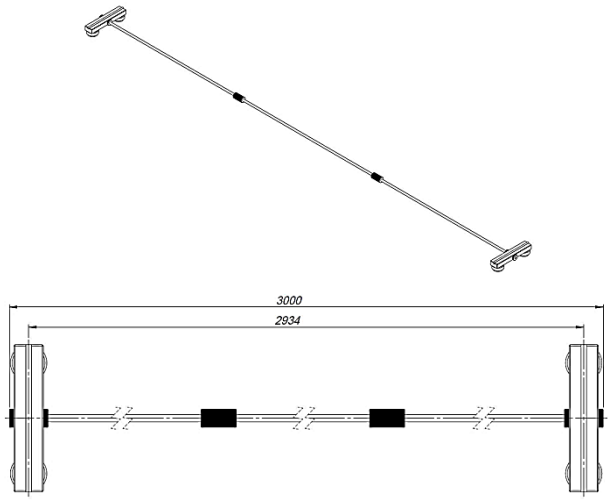
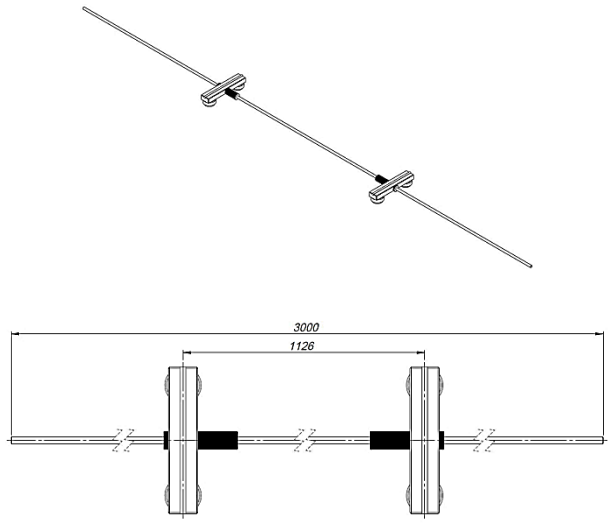
The support installation consists of positioning it over the floor, coupling the acoustic sensor to the Sturdy Tripod and adjusting the distance between the supporting blocks according the specimen length.

8.2 Typical arrangements

Typical SA-AG Support arrangements are presented next:

Standard	
	
Maximum distance between supporting friezes: 934 mm.	Minimum distance between supporting friezes: 66 mm.

With one extension rod	
	
Maximum distance between the supporting friezes: 1,934 mm.	Minimum distance between the supporting friezes: 126 mm.

Arrangement with two extension rods	
	
Maximum distance between the supporting friezes: 2,934 mm.	Minimum distance between the supporting friezes: 1,126 mm.

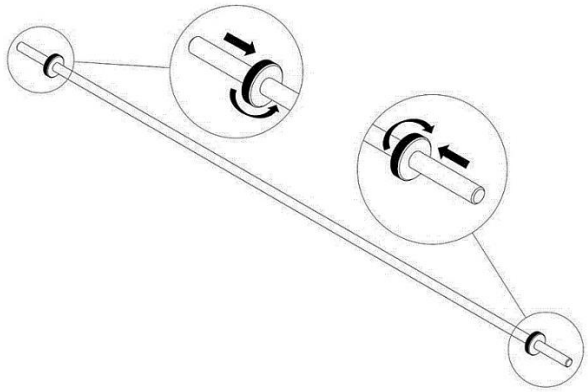
Notes:

- The maximum and minimum lengths for which it is possible to detect the resonance frequencies also depend on the material elastic properties. For wood, recommend the characterization by the longitudinal mode because it presents a frequency higher than the flexural one.

- SA-AG Support comes partially disassembled to facilitate its transportation. To be able to use it, follow the assembling instructions in 8.3 – Mounting the support in the default configuration, whist checking for descriptions in 5 – Parts identification.

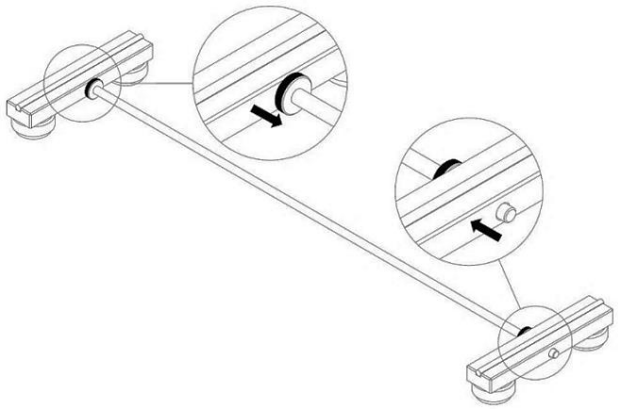
8.3 Mounting the support in the default configuration

Step 01 - Hold the threaded rod [01] and fit the supporting block fastening nuts [02] on each end at a minimum distance of 60 mm from the tip, as shown next:

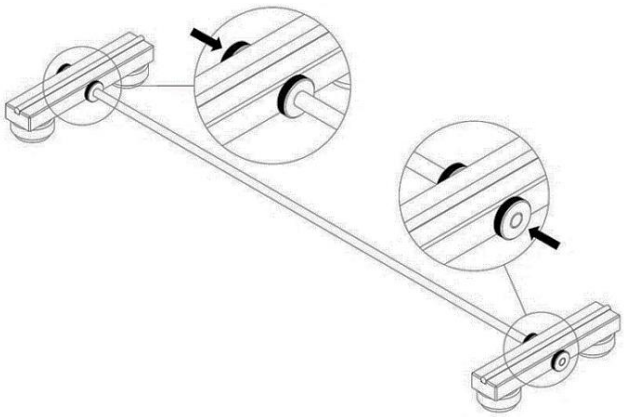


Step 02 - Fit the supporting blocks [03] on each rod end through the central holes, positioned on the sides of each block, until the blocks are touching the fastening nuts [02], as shown next:

Observation: to facilitate this step, rest the support on a hard and flat surface.



Step 03 - Finalize mounting the support by fitting the other two fastening nuts on the end of each rod, tightening them well to lock the supporting blocks, as shown next:

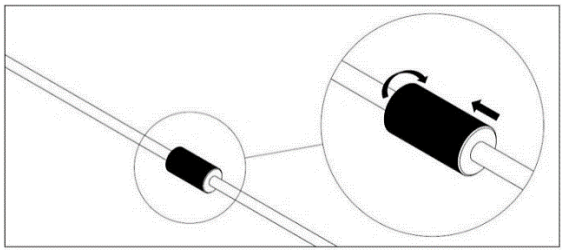


Step 04 – To adjust the distance between the supporting blocks, release the fastening nuts, positioning them on the threaded rod together with the supporting blocks until an ideal distance between the supporting friezes [04] is achieved. After that, secure the supporting blocks by tightening the fastening nuts. The maximum and minimum distances between the supporting friezes in each of the possible Support SA-AG mounting arrangements are presented in *8.2 – Typical arrangements*.

Note: *After positioning the supporting blocks at ideal distance, ensure they are locked well using the fastening nuts so the support is always sturdy enough to carry out the characterizations.*

8.4 Mounting of the extension rod on the support

Step 01 - If the support has already been assembled as previously described, remove the fastening nuts and the supporting blocks off one of the ends of the threaded rod, then couple the extension rod [06] to it. For that, screw the extension rod until the end, checking that it is totally locked and fastened, as shown next:

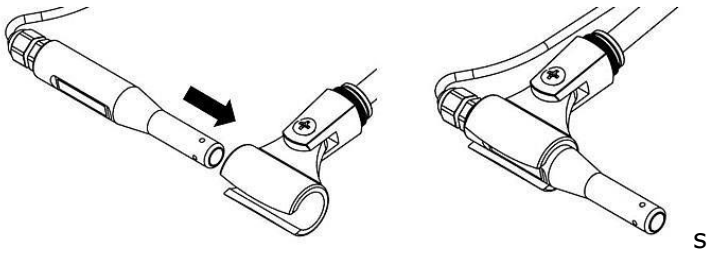


Step 02 - After mounting the extension rod, assemble the supporting block [03] and couple the respective fastening nuts to the extension rod ends, as described in *step 01.*

Note: *Depending on the specimen length, the SA-AG support may be further extended by using a second extension rod (optional item).*

8.5 Mounting the acoustic sensor

Step 01 - Insert the CA-DP Acoustic Sensor in the Sturdy Tripod microphone clip, as shown below:



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Step 02 – Slide the acoustic sensor into the clip until the whole microphone frame is fully secured, then place its cable over the Sturdy Tripod inner tube.

Step 03 – Connect the acoustic sensor to the computer's acquisition board audio input.

9. Operating the support

After following the steps of *8 – Support Installation*, your SA-AG Support are ready for use.

9.1 Positioning the specimen

To carry out a fast and precise characterization of specimens using SA-AG Support, follow carefully the steps:

Step 01 – Prepare the support according to the size of the specimen to be characterized and to the information in *8 – Support Installation*;

Step 02 – Using a measuring tape and a pencil, trace on the sides of the specimen the nodal line where it should be supported, according to the distance indicated by the Sonelastic® Software;

Step 03 – Shift the supporting blocks, as described in *8.3 – Setting up the Standard Support,* until the distance between them is the same as the one marked on the specimen.

Step 05 – Carefully place the specimen over the supporting friezes, ensuring the traced marks are precisely aligned with the friezes below them.

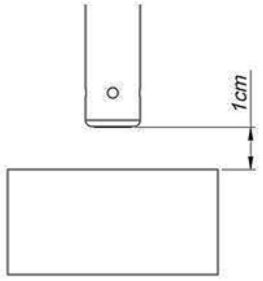
After completing this step sequence, the specimen should be correctly supported and positioned for the characterization.

Note: *To measure the torsional mode, it is necessary to trace marks on the specimen at a distance of 0.32 L, as the ideal supporting for acquisition and excitation modes. For more details, check 10 - Acquisition and excitation modes.*

9.2 Positioning the acoustic sensor

Step 01 – Mount the acoustic sensor on the Sturdy Tripod, as described in *8.5 – Mounting the acoustic sensor for characterization.*

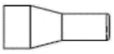
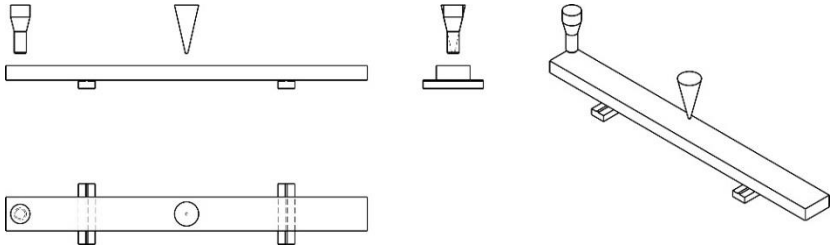
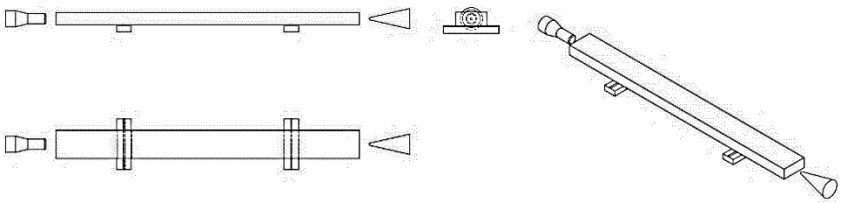
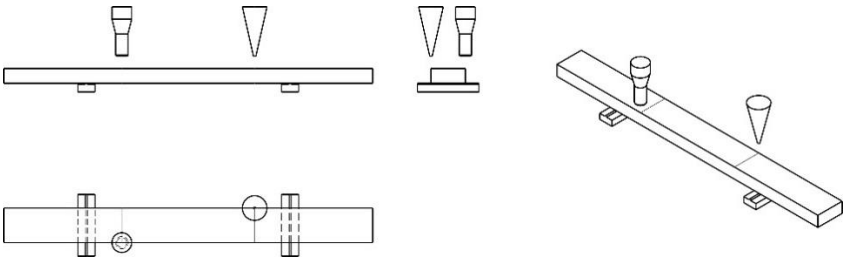
Step 02 – Adjust the acoustic sensor distance so its face is approximately 1 cm away from the specimen face. This distance is not critical for the results.



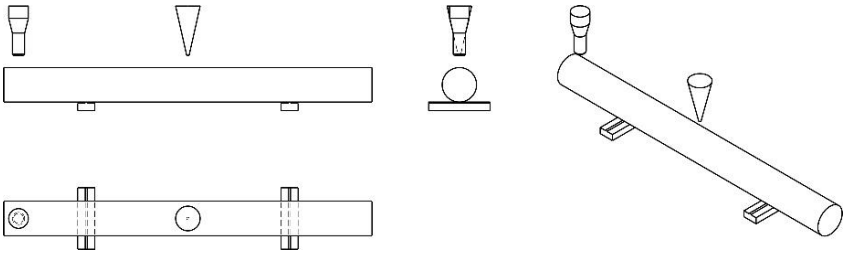
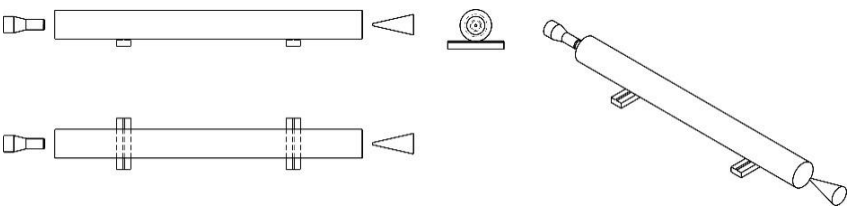
Step 03 – Position the CA-DP Acoustic Sensor according to *10 - Acquisition and excitation modes*. After positioning the acoustic sensor, start the characterization process using the Medium Manual Impulse Device.

10. Acquisition and excitation modes

The table below describes in detail the most practical positions of the acoustic sensor and impulse device for characterizing rectangular specimens, using flexural, torsional and longitudinal vibration modes.

Impulse:  Acoustic sensor: 	
Flexural mode for bars *Excitation at the center and acquisition at the end of the specimen, both from above and width-centered. Supporting at 0.224L.*	
Longitudinal mode for bars *Top-centered excitation and signal acquisition from opposite sides of the specimen. Supporting at 0.224L.*	
Flexural + Torsional modes *Excitation and signal acquisition from above, positioned at 0.32L from opposed edges. Supporting at 0.224L.*	

The next table provides detailed information on the most practical forms for characterizing cylindrical specimens using flexural and longitudinal modes.

Flexural mode for cylinders *Excitation at the center and acquisition at the end of the specimen, both from above and width-centered. Supporting at 0.224L.*	
Longitudinal mode for cylinders *Face-centered excitation and signal acquisition from opposite faces of the specimen. Supporting at 0.224L.*	

Note: *Considering the typical arrangements presented, the optimum support form for the flexural mode is also proposed for torsional and longitudinal modes. Nodal lines and the optimum support for these vibration modes, however, do not match the ones for the flexural mode. The longitudinal mode, for example, is not sensitive to the supporting positions (when faces are free) and the sensitivity of the torsional mode is less than 1%. As a result, it is possible to use the flexural mode boundary conditions to characterize the longitudinal and torsional modes efficiently, without invalidating the results.*

11. Warnings and support transportation

⚠ Reading all the information contained in this Installation and Operation Manual is compulsory for the correct use of the support;
⚠ The power outlet where the computer will be connected must have a functional ground pin;
⚠ Do not use this support for other purposes apart from the ones specified by this Manual;
⚠ The non-compliance with the instructions provided by this manual in what regards the use of this support may reduce or invalidate warranty time.

Support Transportation:
- Transport the support with care;
- Avoid impacts and falls when transporting the support;
- Do not transport the support under the rain, even when wrapped in its original packaging.

12. Maintenance and troubleshooting

- Depending on the specimen material, detachment of residues may occur during handling. To avoid hazards and possible damages to the support, clean frequently using a slightly damp cloth.
- To maintain the support in a good condition and extend its life, keep all accessories, optional items and chutes clean.

Problem	Possible cause	Troubleshooting
The support wobbles when mounted over a surface.	The surface may not be completely flat or may present some irregularities.	Find a flatter area around the place where the support should be mounted.
The specimen cannot be properly positioned under the MICROPHONE.	The specimen dimensions do not comply with the specifications.	Check specific dimensions limits in *8 – Specifications.*

13. Symbology

Attention! Risk of danger.

14. Technical support and warranty

If the support presents any abnormality, verify if the problem is listed in 12 – Maintenance and troubleshooting. If the problem still cannot be fixed, contact ATCP.

ATCP Physical Engineering offers a 12-month warranty with this support, starting from the date of purchase. It covers manufacturing defects or materials defects, but some factors may cause the invalidation of warranty:

1 - The non-compliance with the recommended care regarding the installation and operation of this support, as describe herein;

2 - Accidents, falls, inadequate installation or any other damage cause by incorrect use or action of natural agents;

3 - Violation, repair or any other modification or alteration done in the support or parts of the support carried out by non-authorized agents (non-authorized by ATCP Physical Engineering).

After the 12 months of warranty, parts, expenses and services shall be charged.

15. Statement of responsibility

ATCP Physical Engineering takes total technical and legal responsibility over the SA-AG Support and guarantees that all information here provided are true.

Notes: