SONELASTIC
Advanced Impulse Excitation Technique

Installation and Operation Manual

SB-AP

Support for small specimens and cantilever beams

ATCP Physical Engineering, Sonelastic® Division

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Support for small specimens and cantilever beams

Manufactured by:
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1. Introduction

ATCP Physical Engineering equipment and products were designed 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 SB-AP 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. Applications and features

SB-AP Support is an apparatus to hold and position specimens to non-destructive characterization of materials' Young's modulus and damping by the Impulse Excitation Technique in agreement with ASTM E1876 and correlated standards. SB-AP Support was developed to be used in Sonelastic® Systems.

SB-AP Support allows practical positioning of small specimens in the geometry of disks, rings, rectangular and cylindrical bars. This support consists of a block of low-density foam, which is fixed over a massive metallic surface supported by vibration dampers. It also presents a clip for acoustic sensor with adjustable height and angular position.

According to the Impulse Excitation Technique standard ASTM E1876, the ideal support should hold the specimen under its nodal lines by wires. The use of low-density foam does not meet this requirement, however enables the characterization of small specimens that would be unstable on wires at the least interference possible.

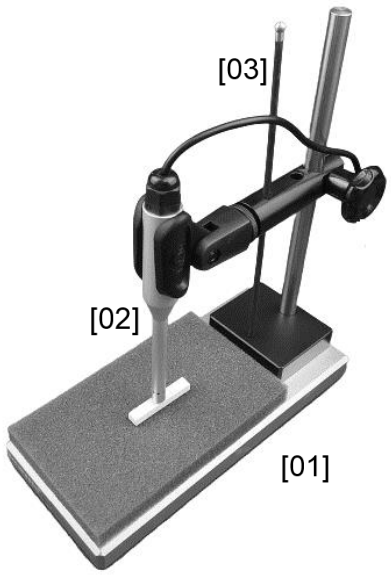
SB-AP Support may be purchased with a jaw system (optional item) to test cantilever beams for Young's modulus. This possibility is limited to materials of low stiffness (up to 5 GPa).

For greater convenience, SB-AP Support may be combined with IED Automatic Impulse Device.

4. Configurations, parts, accessories and optional items

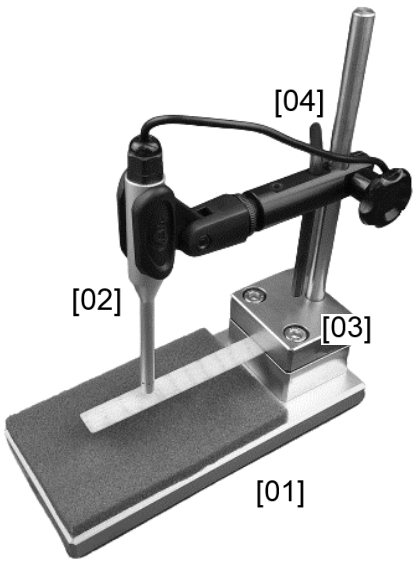
SB-AP support is available in both standard and cantilever configurations. Optional items are offered to adjust the Sonelastic® System to the customer specific needs.

Standard configuration



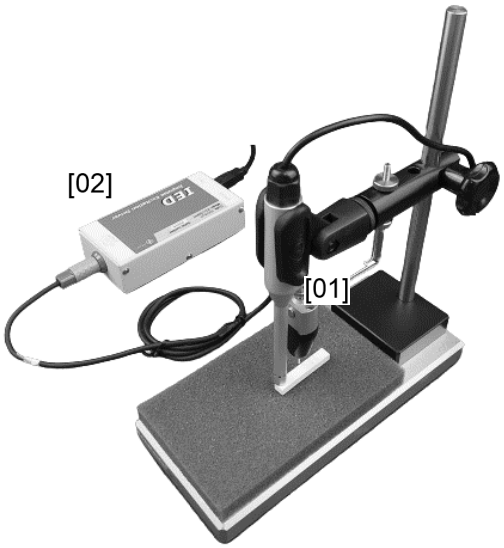
Parts:	**Accessories:**
[01] – SB-AP Support; [02] – CA-PD Acoustic Sensor model CADPS.	[03] – Light Manual Impulse Device.

Cantilever configuration



Parts:	**Accessories:**
[01] – SB-AP Support; [02] – CA-PD Acoustic Sensor model CADPS.	[03] – Jaw system for cantilever beams; [04] – Fastening key for the jaw system.

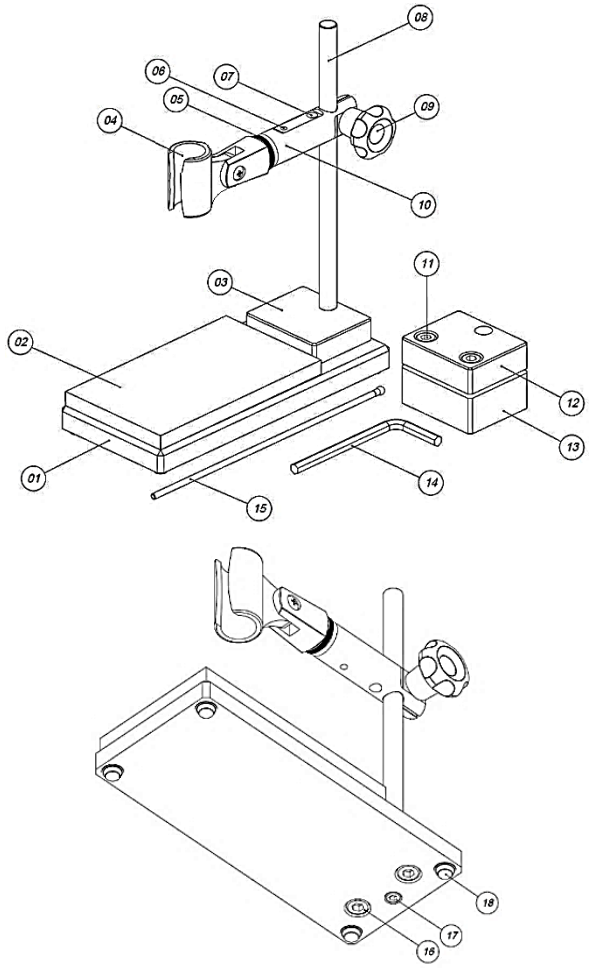
Optional items



[01] – Light RT Impulse Device (IED Automatic Impulse Device);
[02] – Control unit (IED Automatic Impulse Device).

5. Parts identification

SB-AP Support



01- Base made of aluminum;
02- Low-density foam block;
03- Supporting block of the vertical rod;
04- Acoustic sensor clip;
05- Clip fastening ring;
06- Hole for storing the Manual Impulse Device;
07- Hole for storing the fastening key;
08- Vertical rod;
09- Handle for securing the acoustic sensor;
10- Acoustic sensor arm;
11- Adjustable jaw* fastening bolt;
12- Adjustable jaw*;
13- Jaw base;
14- Fastening key for the adjustable jaw*;
15- Light Manual Impulse Device;
16- Fixation bolt for the supporting block;
17- Fixation bolt of the vertical rod;
18- Damper feet.
*Items available for the support in cantilever configuration.

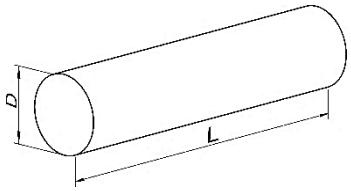
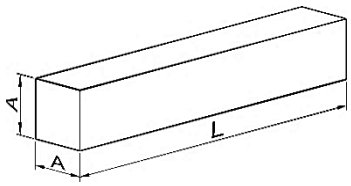
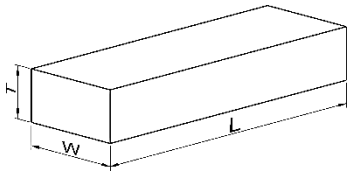
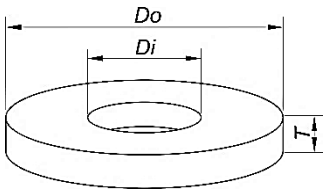
6. Specifications

Maximum dimensions for cylindrical specimens (L x D) ..... 120 x 60 mm
Minimum dimensions for cylindrical specimens (L x D) ..... 15 x 2 mm
Maximum dimensions for rectangular specimens (L x W x T) ..... 120 x 40 x 40 mm
Minimum dimensions for rectangular specimens (L x W x T) ..... 15 x 2 x 2 mm
Maximum dimensions for cantilever beams (L x W x T) ..... 200 x 25 x 5 mm
Minimum dimensions for cantilever beams (L x W x T) ..... 120 x 10 x 0,5 mm
Maximum dimensions for disks and rings (D x T) ..... 80 x 8 mm
Minimum dimensions for disks and rings (D x T)..... 15 x 1 mm
Support maximum dimensions (L x W x T) ..... 90 x 225 x 265 mm
Standard configuration weight..... 1.2 kg
Cantilever configuration weight ..... 2.1 kg
Working temperature range ..... 10 - 40°C (50 - 104 °F)

7. Specimens

7.1 Recommended aspect ratios and typical dimensions

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 shows the recommended aspect ratios and typical dimensions for cylinders, bars, disks and rings.

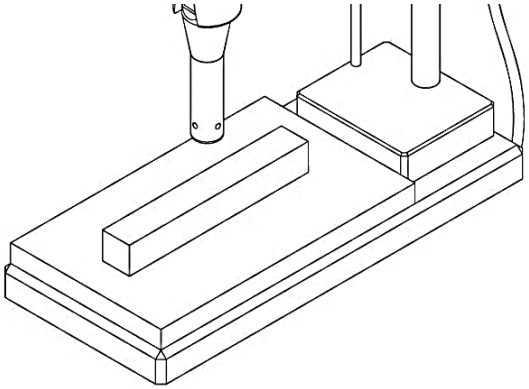
Geometry	Recommended aspect ratios	Typical dimensions
 Cylinder	$\frac{L}{D} \geq 2$ The aspect ratio between length (L) and the diameter (D) must be greater than or equal to 2.	(L x D) - 50 x 5 mm - 50 x 10 mm - 100 x 50 mm
 Square section bar	$\frac{L}{A} \geq 3$ The aspect ratio between length (L) and edge (A) must be greater than or equal to 3.	(L x A x A) - 30 x 5 x 5 mm - 40 x 8 x 8 mm - 50 x 10 x 10 mm - 100 x 25 x 25 mm
 Rectangular section bar	$\frac{L}{W} \geq 4$ The aspect ratio between length (L) and width (W) must be greater or equal to 4. $\frac{W}{T} \leq 8$ The aspect ratio between width (W) and thickness (T) must be less than or equal to 8.	(L x W x T) - 30 x 6 x 2 mm - 40 x 10 x 4 mm - 60 x 12 x 4 mm - 100 x 15 x 2 mm
 Rings and disks. *Note: For disks, disregard the inner diameter information.*	$\frac{D_o}{T} \geq 10$ The aspect ratio between outer diameter (D_o) and thickness (T) must be greater or equal to 10. $\frac{D_o}{D_i} \geq 2$ The aspect ratio between outer diameter (D_o) and inner diameter (D_i) must be greater than or equal to 2.	(D x T) - 10 x 1 mm - 20 x 2 mm - 30 x 2 mm - 25,4 x 2,5 mm - 50.8 x 2.54 mm

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

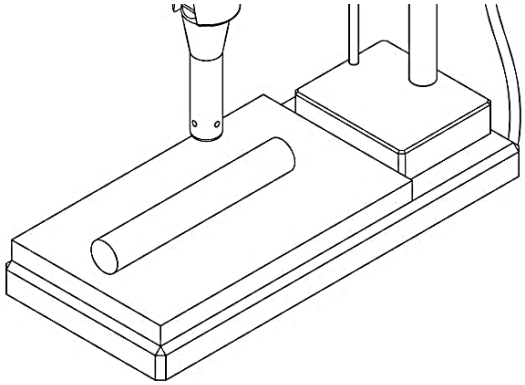
Note: *Minimum dimensions may vary as a function of aspect ratio and material Young's modulus; the frequency should be lower than CA-DP Acoustic Sensor maximum frequency (96 kHz). It is possible to estimate the frequency using Sonelastic® Software simulation tool. The higher the Youngs' modulus, the higher the frequency.*

7.2 Placing the specimen

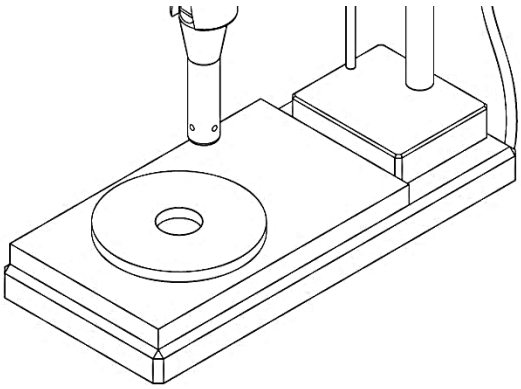
The specimen is placed on the foam block and positioned according to the vibration mode that is intended to be acquired. See *10 – Acquisition and excitation modes.*



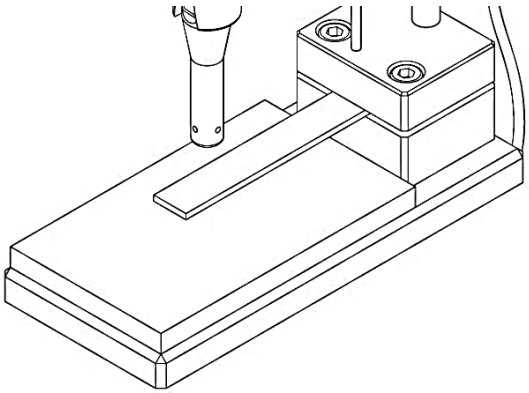
Rectangular specimen



Cylindrical specimen



Ring-shaped specimen



Ruler-shaped specimen (cantilever configuration)

8. Support installation

8.1 Requirements

- A flat and leveled workbench with at least a free space of 60 x 120 cm (depth x width). This space is enough to place the SB-AP support, specimens, computer and optional items.

- 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 place it over the workbench, coupling the acoustic sensor and connecting it to the acquisition card.

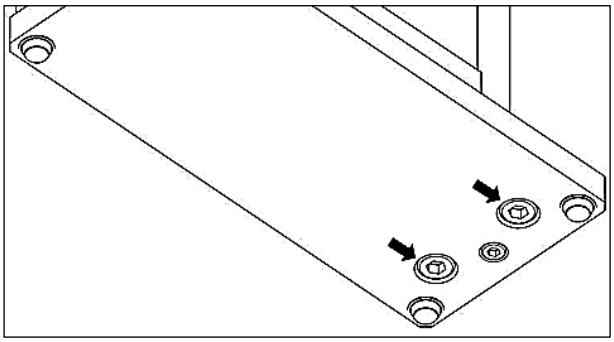
8.2 Mounting the jaw set

To mount the jaw system (optional item), follow the steps described next:

Step 01 - Firstly, remove the CA-PD Acoustic Sensor from the SB-AP Support clip;

Step 02 - Release the acoustic sensor arm handle and remove it completely of the SB-AP Support;

Step 03 - Using the Allen fastening key supplied with the jaw set, unbolt and remove the larger bolts of SB-AP Support base inferior part as shown below.



Step 04 – Remove the supporting block for the vertical rod off the SB-AP Support and replace it by the jaw set, ensuring that both bolts of the set have their heads facing upwards.

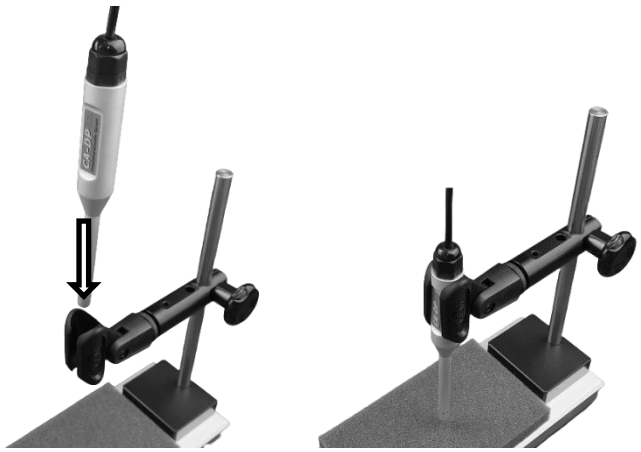
Step 05 – At the support inferior base, align both base holes with the jaw set holes and re-inset the bolts that were taken out in *step 03*, tightening them until the set is completely secure.

Step 07 – Using the fastening key for the adjustable jaw, loose the adjustable jaw fastening bolts and move it upwards to verify if the same is freely sliding through the vertical rod.

Step 06 – To return SB-AP Support to the standard configuration (initial one), repeat the processes described up to this point to replace the jaw set for the supporting block for the vertical rod.

8.3 Mounting the acoustic sensor to the support

Step 01 – Insert the Acoustic Sensor CA-DP, model CADPS, in the clip attached to the acoustic sensor arm and slide it into the clip as shown below.



Step 02 – Connect the Acoustic Sensor to the acquisition card.

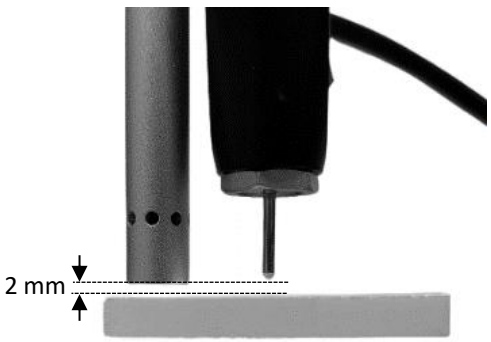
9. Support operation

After following 8 – Support Installation steps, the SB-AP support will be ready for use:

9.1 Positioning the specimen - standard configuration:

Step 01 – Considering the SB-AP Support in its standard configuration, place the specimen on the most appropriate place of the foam base (verify *10 – Acquisition and excitation modes)*;

Step 02 – Loose the acoustic sensor arm handle and position the acoustic sensor at approximately 2 mm away from the specimen, then tighten the handle back to fix the chosen position, as shown next.



Notes: a) This distance is not critical for the test results. b) The closer, the easier to detect torsional mode. c) The distance between the Light RT Impulse Device tip and the specimen surface should also be 2 mm.

After completing these steps, the specimen will be supported and positioned for characterization.

9.2 Positioning the specimen - cantilever configuration:

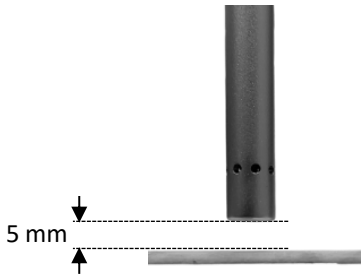
Step 01 – Verify if SB-AP Support is correctly configured to the cantilever beam option, as described in *8.2 – Mounting the jaw set*;

Step 02 – Using the adjustable jaw fastening key, loosen the fastening bolts and rise it enough for the specimen to fit in the space between the jaws and its base.

Step 03 – Keeping part of the specimen inserted in the jaws, align the specimen using as a reference the central line of the support base.

Step 04 – Strongly tighten the adjustable jaw fastening bolts so the specimen is as clamped as possibly.

Step 04 – Place the acoustic sensor at approximately 5 mm away from the specimen as shown next.



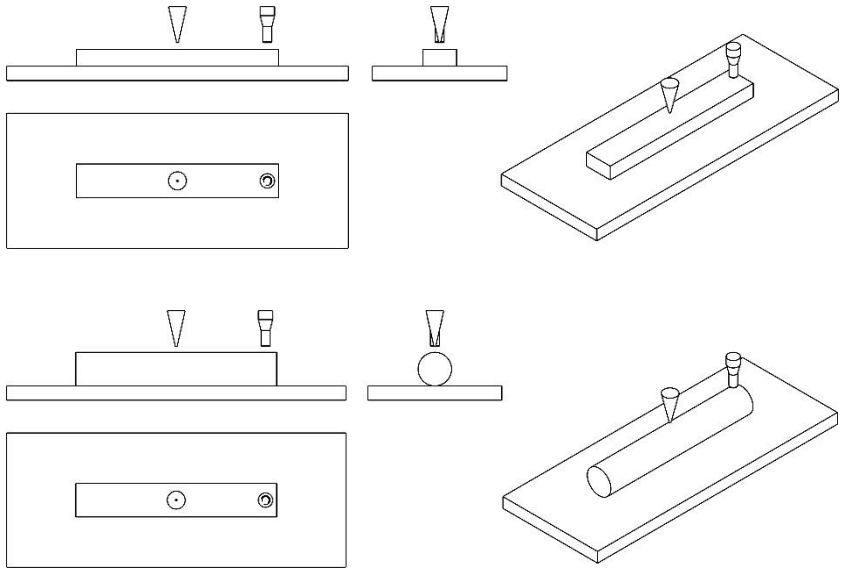
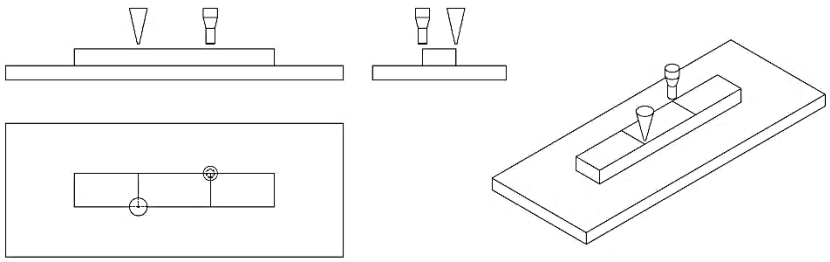
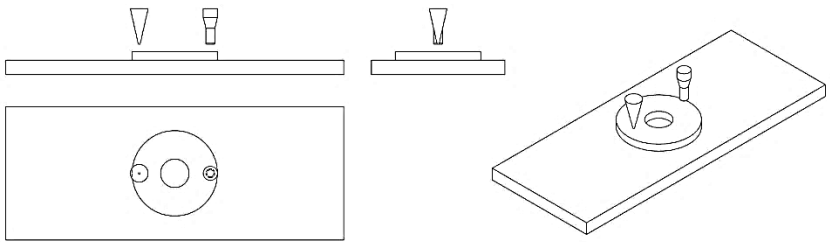
After completing this sequence of step, the specimen will be supported and positioned for characterization.

Attention! Respect the maximum and minimum acceptable dimensions for the specimen as describe in 6. Specifications.

10. Acquisition and excitation modes

The table below describes the positioning of the acoustic sensor and excitation for characterizing rectangular, cylindrical and circular specimens, using flexural, flexural + torsional and planar modes.

Impulse: Acoustic sensor:

Flexural mode *Excitation at the center and acquisition at the end, both width-centered.* *Allows Young's modulus (E) characterization.*	
Flexural + torsional node *Excitation and acquisition from opposed edges at 0.32 L (L = length).* *Allows E, G and Poison ratio characterization.* *Applicable only to rectangular bars.*	
Planar mode *Excitation and acquisition on diametrically opposed sides.* *Allows the Young's modulus (E) characterization.* *Applicable only to disks and rings.*	

Note: *The optimum support is to have wires aligned with the nodal lines as stablished by ASTM E1876. However, the use of a low-density foam presents minimum influence and allows the characterization of small specimens that would be instable on wires after receiving the impulse excitation. For materials with E superior to 100 GPa, the variation is inferior to 0.1%; for material with E lower than 10 GPa, the variation may reach up to 1%.*

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 electricity network where the optional items and accessories will be connected for use 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 the 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 or snow, 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 working order and extend its life, keep all accessories and optional items.

Troubleshooting:

Problem	Possible causes	Solution
Jaws does not easily slide when the fastening bolts are loosened.	The jaws base may have been slightly mounted on the wrong position.	Release the bolts for securing the jaws base and reposition it until the adjustable jaw slides freely. secure it immediately after.
The support wobbles when placed over a bench.	The bench surface may not be completely flat or may present some irregularities.	Find a flatter area of the workplace.
The specimen does not properly fit underneath the acoustic sensor.	Specimen dimensions do not comply with the specifications.	*Verify the 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 loss 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 SB-AP Support and guarantees that all information here provided are true.

Notes: