

ASTM C719 Sealant Adhesion and Cohesion Test – Complete Testing Procedure, Hockman Cycle and Equipment Requirements

Description

1. Introduction

ASTM C719 is a standardized laboratory test method used to evaluate the adhesion and cohesion performance of elastomeric joint sealants subjected to repeated compression and extension under controlled environmental conditions.

The method is commonly known as the **Hockman Cycle** and is particularly important for assessing sealants used in construction joints, building façades, curtain walls, glazing systems, concrete structures and other applications involving joint movement.

Building joints are continuously subjected to dimensional changes caused by temperature variations, structural movement and environmental exposure. Sealants installed in these joints must accommodate expansion and contraction without losing adhesion to the adjoining surfaces or developing internal cracks.

ASTM C719-22, titled *Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)*, provides an accelerated laboratory procedure for evaluating these characteristics.

The test combines water immersion, high-temperature compression, mechanical movement cycling and low-temperature extension.

Unlike conventional tensile testing, ASTM C719 primarily evaluates the integrity of the sealant and its bond to the substrate rather than determining tensile strength.

2. Scope and Purpose of ASTM C719

The main purpose of ASTM C719 is to determine whether an elastomeric sealant can withstand specified joint movements while maintaining adhesion to the substrate and cohesion within the sealant material.

The test is designed to identify:

- Adhesive failure between the sealant and substrate
- Cohesive failure within the sealant material
- Permanent deformation or distortion
- Bubble formation
- Cracking or other visible deterioration

- Failure caused by repeated joint compression and extension

The test simulates selected environmental and mechanical stresses experienced by sealants in service.

However, ASTM C719 does not evaluate every possible cause of sealant failure in actual buildings. Improper joint design, incorrect installation, excessive movement and poor application practices may affect field performance independently of laboratory results.

3. Principle of the Hockman Cycle

The Hockman Cycle evaluates the ability of a cured sealant joint to accommodate repeated changes in joint width.

A standard sealant specimen is prepared between two rigid, parallel substrates.

The original joint width is: **12.7 mm (0.500 in.)**

During testing, the specimen is compressed to a specified minimum joint width and extended to a specified maximum joint width.

The required movement depends on the selected sealant movement class.

The procedure includes four major stages:

1. Water immersion for seven days.
2. Compression at elevated temperature for seven days.
3. Ten automated compression-extension cycles at standard laboratory conditions.
4. Ten additional thermal compression-extension cycles involving high-temperature compression and low-temperature extension, unless complete failure occurs earlier.

Following the specified stages, specimens are inspected for adhesive and cohesive defects.

The method is intended to assess resistance to movement-related deterioration rather than measure the force required to break the sealant.

4. ASTM C719 Movement Classes

ASTM C719 provides example joint dimensions for different movement classes.

Movement class represents the percentage of dimensional change relative to the original joint width.

For example, a Class 25 sealant is evaluated using 25% compression and 25% extension relative to the original joint width.

Movement Class and Joint Dimensions

Movement class	Compressed width (mm)	Extended width (mm)
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Class 12.5	11.1	14.3
Class 25	9.5	15.9
Class 35	8.3	17.1
Class 50	6.4	19.1
Class 50/100	6.4	25.4

The original joint width for all these configurations is 12.7 mm.

For Class 50/100, the specimen undergoes 50% compression and 100% extension.

These dimensions are the rounded metric equivalents of the inch-pound dimensions specified in the standard.

Example: Class 25

Original joint width: 12.7 mm

Compression movement:

$$12.7 - 0.25 = 3.175 \text{ mm}$$

Minimum joint width:

$$12.7 - 3.175 = 9.525 \text{ mm}$$

Extension movement:

$$12.7 + 0.25 = 3.175 \text{ mm}$$

Maximum joint width:

$$12.7 + 3.175 = 15.875 \text{ mm}$$

Therefore, the specimen must be compressed to approximately 9.5 mm and extended to approximately 15.9 mm.

Example: Class 50/100

Original width: 12.7 mm

Minimum compressed width:

$$12.7 - (1 \times 0.50) = 6.35 \text{ mm}$$

Maximum extended width:

$$12.7 + (1 + 1.00) = 25.4 \text{ mm}$$

The total movement between the compressed and extended positions is approximately 19.05 mm.

This movement range must be considered when designing the testing machine and specimen fixtures.

5. ASTM C719 Testing Machine Requirements

A suitable ASTM C719 testing system must be capable of automatically compressing and extending the sealant joint at a controlled, very low displacement rate.

The principal equipment requirements are described in Section 6 of ASTM C719-22.

5.1 Compression-Extension Testing Machine

The machine must automatically move the specimen between the required compression and extension positions.

The required displacement rate is: **3.2 mm/hour (1/8 in./hour)**

This is significantly slower than the speeds typically used for tensile testing of plastics and rubber.

The machine must provide controlled, repeatable displacement without damaging or bending the specimen substrates.

Main Technical Requirements

Parameter	Requirement
Testing principle	Automated compression and extension
Original joint width	12.7 mm
Movement control	Controlled joint displacement
Displacement rate	3.2 mm/h
Minimum joint width	According to movement class
Maximum joint width	According to movement class
Standard-condition cycling	10 cycles
Thermal cycling	Up to 10 cycles
Specimen fixtures	Rigid, deformation-resistant grips
High-temperature equipment	Forced-draft oven
Low-temperature equipment	Cold chamber
Cycle evaluation	Visual inspection for adhesion and cohesion defects

The standard does not specify a universal motor power, load-cell capacity, number of testing stations or mandatory digital controller.

These features should be selected according to the equipment design and intended testing applications.

5.2 Displacement Control System

Accurate displacement control is essential because movement classification is based on the joint width.

A suitable system may use:

- Motor-driven lead screw
- Precision ball screw
- Geared motor with controlled rotational speed
- Servo motor with position feedback
- Stepper motor with suitable motion control

These are possible engineering solutions, not mechanisms mandated by ASTM C719.

The drive must be capable of maintaining the required low movement speed over extended testing periods.

For example, a screw mechanism with a lead of 2 mm/revolution would require:

$$3.2 / 2 = 1.6 \text{ revolutions/hour}$$

Equivalent rotational speed:

$$1.6 / 60 = 0.0267 \text{ rpm}$$

This example illustrates why a properly designed reduction drive or precision electronic motion control system is important.

5.3 Position Measurement and Feedback

A position measurement system is recommended to monitor actual joint width.

Suitable options include:

- Linear displacement transducers
- Linear encoders
- Rotary encoders with a calibrated screw mechanism
- Digital position sensors

A closed-loop control system can help maintain the programmed compression and extension positions.

The ASTM C719-22 document does not prescribe a specific encoder resolution or displacement accuracy class.

The manufacturer should establish appropriate positioning tolerances and verify them during equipment qualification.

5.4 Specimen Gripping System

The machine must incorporate grips sufficiently rigid and strong to resist deformation caused by high-strength sealants.

The gripping system should:

- Maintain the substrates in correct alignment
- Prevent unintended specimen movement
- Transfer displacement uniformly
- Avoid bending of the substrate plates
- Accommodate the required joint movement range
- Permit safe specimen installation and removal

Special fixtures may be necessary for mortar, glass and aluminum substrates because their mechanical characteristics differ.

5.5 Number of Testing Stations

ASTM C719 requires three specimens for each substrate selected for testing.

A multi-station machine can increase testing efficiency by allowing several specimens to undergo identical movement cycles simultaneously.

For example, an eight-station machine may accommodate eight specimens in one automated movement program.

However, **eight stations are not a mandatory requirement of ASTM C719.**

The machine must provide sufficient positions for the laboratory's testing workload.

5.6 Force Measurement

ASTM C719 evaluates specimen condition after prescribed movements.

The standard does not require continuous force measurement or specify a mandatory load-cell accuracy.

A load cell may nevertheless be included as an optional engineering feature for monitoring resistance forces or detecting abnormal loading.

Force measurement should not replace the specified visual assessment of adhesive and cohesive failures.

6. Temperature-Controlled Equipment Requirements

Temperature exposure is a fundamental part of ASTM C719 testing.

The test requires equipment capable of maintaining the specified elevated and subzero temperatures.

6.1 Forced-Draft Oven

The required oven temperature is: $70 \pm 2^\circ\text{C}$

The oven is used for the initial seven-day compression conditioning and for the elevated-temperature compression stages of the thermal cycling procedure.

The oven should provide:

- Controlled temperature
- Forced air circulation
- Adequate internal space for specimens and compression fixtures
- Stable temperature throughout the conditioning period
- Suitable monitoring of chamber temperature

A timer and temperature recording system are recommended for laboratory traceability.

6.2 Low-Temperature Chamber

The required cold chamber temperature is: $-26.1 \pm 1.7^\circ\text{C}$

The chamber must accommodate the specimen extension arrangement.

During the thermal cycling stage, specimens are extended while being cooled to the specified temperature.

The cold chamber must therefore permit controlled specimen movement or accommodate a suitable extension mechanism.

A stationary refrigerator without a suitable specimen extension arrangement is not sufficient to perform this stage exactly as specified.

6.3 Standard Laboratory Conditions

Specimen preparation, curing and room-temperature cycling are performed under the applicable standard conditions referenced in ASTM C717.

Temperature and relative humidity must be controlled according to the referenced requirements.

The actual conditioning conditions should be documented in the laboratory test report.

7. Test Specimen Geometry

ASTM C719 uses sealant joints formed between two parallel rigid substrates.

The standard sealant bead dimensions are:

Dimension	Value
Original joint width	12.7 mm
Sealant bead depth	12.7 mm
Sealant bead length	50.8 mm

The sealant is installed between the opposing faces of the selected substrate blocks or plates.

The specimen geometry is designed to provide a controlled and repeatable joint configuration.

Standard Substrates

ASTM C719 identifies three standard substrate materials:

Portland Cement Mortar

Typical block dimensions: 76.2 Å— 25.4 Å— 25.4 mm

Float Glass

Typical plate dimensions: 76.2 Å— 25.4 Å— 6.4 mm

Aluminum Alloy

Typical plate dimensions: 76.2 Å— 25.4 Å— 6.4 mm

The specified aluminum alloys include 6063-T5 and 6061-T6 with the required anodized finish.

Other substrates, including brick, marble and wood, may be tested when specified by the interested parties.

The selected substrate must be identified in the test report.

8. Substrate Preparation

Surface preparation directly affects adhesion test results.

8.1 Mortar Substrates

Mortar blocks are prepared using Type III high-early-strength Portland cement and suitable fine aggregate.

The standard specifies a cement-to-sand proportion of 1:2 by weight.

The mortar mixture is adjusted to the required consistency and cured under the prescribed conditions.

The bonding surface is wet-ground to expose the aggregate uniformly.

Before specimen preparation, the surface is cleaned, dried and conditioned according to the specified procedure.

8.2 Glass Substrates

Float glass surfaces are cleaned using an appropriate solvent followed by detergent cleaning and rinsing with distilled or deionized water.

The cleaned surface must be allowed to air-dry without contamination.

Glass specimens require reinforcement to withstand the subsequent compression-extension cycling.

The standard describes the use of aluminum reinforcing plates attached to the outside surfaces of the specimen assembly.

8.3 Aluminum Substrates

Aluminum plates must have the specified alloy and surface finish.

Cleaning follows the procedure applicable to float glass.

The sealant manufacturer may request omission of the detergent-cleaning stage where permitted by the standard.

8.4 Primer Application

Where the sealant manufacturer recommends a primer, the substrate must be treated with the appropriate primer before applying the sealant.

Primer identification and application details should be recorded.

9. Test Specimen Preparation

Three specimens are prepared for each substrate type selected for testing.

9.1 Multicomponent Sealants

For multicomponent sealants:

1. Maintain the unopened material at standard conditions for at least 24 hours.
2. Prepare the sealant mixture using the specified base compound and curing agent proportions.
3. Thoroughly mix the components.
4. Position the two substrates parallel to each other.
5. Install suitable non-adherent casting spacers.
6. Apply the sealant between the substrate surfaces.
7. Form the required joint dimensions.

8. Remove excess material and maintain the assembly during curing.

The standard specifies mixing at least 250 g of base compound with the appropriate curing agent for five minutes.

Casting spacers should be made from non-adherent materials such as PTFE or treated with a suitable release material.

9.2 Single-Component Sealants

Single-component sealants are prepared using the same specimen geometry.

No component mixing is required.

The sealed cartridge or bulk container must be conditioned for at least 24 hours at standard conditions before specimen preparation.

10. Specimen Curing Requirements

The curing procedure depends on whether the sealant is single-component or multicomponent.

Multicomponent Sealants

The curing period is: **14 days at standard conditions**

During the second week, attempts are made to remove the casting spacers without damaging the sealant.

Single-Component Sealants

The standard curing procedure requires 21 days:

Stage	Duration	Conditions
Initial curing	7 days	Standard conditions
Humidity conditioning	7 days	37.8 Â± 2Â°C and 95% RH
Final curing	7 days	Standard conditions

Alternative curing conditions may be requested by the sealant producer under the limitations specified in ASTM C719.

Improper curing can significantly influence adhesion, cohesion and deformation behavior.

11. Complete ASTM C719 Test Procedure

The procedure described below follows the principal sequence of Section 9 of ASTM C719-22.

Step 1 – Water Immersion

After completing the curing procedure, immerse the specimens in distilled or deionized water.

Duration: 7 days

This stage evaluates the sealant joint after prolonged water exposure.

Step 2 – Preliminary Adhesion Check

After water immersion, manually flex each specimen twice through approximately 60° to check the bond.

If the bond remains firm, proceed with compression conditioning.

Step 3 – High-Temperature Compression Conditioning

Compress the joint to the minimum width specified for the selected movement class.

Maintain the compressed width using suitable clamps and dimensional spacers.

Place the compressed specimens in the forced-draft oven.

Test conditions:

- Temperature: 70 ± 2°C
- Duration: 7 days
- Joint condition: Compressed

This stage subjects the sealant to sustained compression at elevated temperature.

Step 4 – Cooling Before Mechanical Cycling

Remove the specimens from the oven and release the compression fixtures.

Allow the specimens to cool to standard laboratory temperature.

Within 24 hours after removal from the oven, install the specimens in the automated compression-extension machine.

Step 5 – Automated Compression-Extension Cycling

Perform ten movement cycles at standard laboratory conditions.

Each cycle follows this sequence:

1. Start at the original joint width of 12.7 mm.
2. Compress the joint to Dimension C.

3. Extend the joint to Dimension E.
4. Return the joint to the original width of 12.7 mm.

The displacement rate is: **3.2 mm/hour**

The movement limits depend on the selected movement class.

Example: Class 25

Starting width: 12.7 mm

Compression position: 9.525 mm

Extension position: 15.875 mm

Final position: 12.7 mm

The total travel during one cycle is:

$$3.175 + 6.350 + 3.175 = 12.700 \text{ mm}$$

At 3.175 mm/hour, corresponding to the exact inch-pound rate:

$$\text{Cycle duration} = 12.700 / 3.175 = 4 \text{ hours}$$

Therefore, ten uninterrupted cycles require approximately 40 hours of machine movement.

This calculation excludes specimen handling and any additional delays.

Step 6 – Inspection After Mechanical Cycling

After completing ten cycles, extend the specimen to Dimension E.

Insert suitable dimensional separators and remove the specimen from the machine.

Inspect for:

- Adhesive separation
- Cohesive cracking
- Permanent deformation
- Bubble formation
- Other visible defects

Specimens exhibiting complete adhesive or cohesive failure at this stage are removed from further testing.

Step 7 – Thermal Compression Stage

Compress the remaining specimens to Dimension C using suitable clamps and separators.

Place the specimens in the forced-draft oven.

Conditions:

- Temperature: $70 \pm 2^{\circ}\text{C}$
- Duration: 16–20 hours
- Joint condition: Compressed

Step 8 – Low-Temperature Extension Stage

Remove the specimens from the oven.

Release the clamps and separators and allow the specimens to cool for 2–3 hours to standard temperature.

Install the specimens in the extension mechanism located within the cold chamber.

Set the grips to Dimension C, regardless of any recovery of the sealant after compression.

Extend the joint to Dimension E at the specified rate while the specimen is cooled to: $-26.1 \pm 1.7^{\circ}\text{C}$

After extension, insert suitable separators and remove the specimen.

Allow the specimen to warm for two hours to standard temperature while maintaining the extended configuration.

Inspect for adhesion failure, cohesion failure and deformation.

Step 9 – Repeat Thermal Cycling

Repeat the high-temperature compression and low-temperature extension stages for a total of ten thermal cycles.

If complete adhesive or cohesive failure occurs before the tenth cycle, the test is considered complete for the affected specimen.

Step 10 – Final Evaluation

Following the specified testing sequence, inspect and document the condition of each specimen.

Record the observed type and extent of failure.

The results describe the sealant's performance under the prescribed laboratory movement and environmental exposure conditions.

12. Adhesive and Cohesive Failure Evaluation

ASTM C719 distinguishes between two important failure mechanisms.

Adhesive Failure

Adhesive failure occurs when the sealant separates from the substrate surface.

Examples include:

- Sealant detachment from aluminum
- Separation from glass
- Loss of adhesion to mortar
- Partial or complete bond separation

Adhesive failure may be influenced by surface preparation, primer selection, substrate characteristics and sealant formulation.

Cohesive Failure

Cohesive failure occurs within the body of the sealant.

Examples include:

- Internal cracks
- Tearing of the sealant bead
- Splitting of the material
- Complete rupture within the joint

Cohesive failure indicates that the internal integrity of the sealant has been compromised.

Other Observations

The test also considers deformation, bubble formation and other visible changes.

The type and extent of deterioration should be documented for each specimen.

ASTM C719 itself does not establish a universal numerical pass/fail limit applicable to every sealant product.

Acceptance criteria should be taken from the applicable product specification or agreed testing requirements.

13. Testing Machine Design Considerations

A testing machine intended for ASTM C719 should be designed around the actual movement requirements and long-duration operating conditions.

13.1 Mechanical Drive

The movement mechanism should provide:

- Stable, low-speed operation
- Controlled displacement
- Repeatable travel limits
- Adequate structural rigidity
- Reliable continuous operation
- Suitable overload protection

A precision screw-driven system is a practical engineering option.

13.2 Motion Control

An electronic controller may provide:

- Movement class selection
- Automatic positioning
- Compression-extension sequencing
- Adjustable displacement limits
- Cycle counting
- Automatic stopping after the programmed number of cycles
- Emergency stop
- Operating status indication

These functions are recommended for modern equipment but are not all explicitly required by ASTM C719.

13.3 Specimen Fixture Design

The specimen fixtures must accommodate the specified substrate geometries.

Important design considerations include:

- Alignment of opposing substrate surfaces
- Adequate clamping force
- Prevention of substrate bending
- Repeatable joint-width positioning
- Compatibility with different substrate thicknesses
- Ease of specimen installation

13.4 Thermal Compatibility

The mechanical system used for low-temperature extension must operate reliably under the required cold-chamber conditions.

Components exposed to low temperatures should be selected for suitable dimensional stability and mechanical performance.

Lubricants, seals, sensors and drive components must also be compatible with the intended operating temperature.

13.5 Optional Data Recording

Although ASTM C719 is primarily based on controlled movement and visual inspection, digital recording can improve laboratory documentation.

Optional recorded parameters include:

- Joint displacement
- Cycle number
- Cycle duration
- Chamber temperature
- Test start and completion times
- Equipment alarms

These data can support traceability and quality assurance.

14. Example Testing Machine Configuration

The following table provides a possible engineering configuration for an ASTM C719 testing system.

These are suggested equipment features and must not be interpreted as specifications of a particular commercial machine.

Feature	Suggested configuration
Equipment	Sealant Compression-Extension Tester
Test standard	ASTM C719-22
Drive mechanism	Precision motorized screw system
Motion control	Programmable electronic controller
Displacement rate	3.2 mm/h
Movement classes	12.5, 25, 35, 50 and 50/100
Original joint width	12.7 mm
Maximum example extension	25.4 mm joint width
Specimen stations	Multiple stations, as required
Cycle programming	Automatic 10-cycle operation
Fixture design	Rigid substrate holders

Position monitoring	Encoder or linear displacement sensor
Heating equipment	Forced-draft oven, $70 \pm 2^\circ\text{C}$
Cooling equipment	Cold chamber, $\hat{26.1} \pm 1.7^\circ\text{C}$
Safety	Emergency stop and overload protection
Optional recording	Position, temperature and cycle history

The complete test system must also include the separate conditioning and compression fixtures needed for the oven and thermal cycling stages.

15. Common Testing Errors

Incorrect Movement Speed

The specified movement rate is extremely low.

Excessive displacement speed may produce different deformation behavior and invalidate the intended test conditions.

Inaccurate Joint Width

Incorrect initial specimen dimensions or movement limits can change the actual compression and extension percentages.

Insufficient Curing

Testing before the sealant has completed the required curing procedure may lead to premature adhesive or cohesive failure.

Improper Surface Preparation

Contaminated or incorrectly prepared substrates can significantly influence adhesion performance.

Fixture Deformation

Flexible or insufficiently rigid fixtures can introduce unintended movement and reduce test repeatability.

Temperature Instability

Failure to maintain the required oven and cold chamber temperatures can affect specimen behavior.

Incorrect Thermal Cycle Sequence

The high-temperature compression and low-temperature extension stages must follow the specified sequence, including cooling, warming and inspection periods.

16. Test Report Requirements

ASTM C719-22 requires reporting the following information:

1. Sealant manufacturer, sealant type and identifying number.
2. Percentage of cyclic movement.
3. Substrates used and their cleaning methods.
4. Primer identification and description, where applicable.
5. Nature and extent of adhesive or cohesive failure, deformation, bubbles and other observed effects.
6. Any deviations from the prescribed procedure and the reasons for them.
7. Curing time, temperature and humidity, including the curing sequence.

For improved laboratory traceability, the report may additionally include specimen identification, testing equipment identification, movement class, cycle history, photographs and relevant environmental records.

17. ASTM C719 Compared with Conventional Tensile Testing

Although both methods involve mechanical deformation, ASTM C719 differs substantially from conventional tensile testing.

Parameter	ASTM C719	Conventional tensile testing
Primary objective	Sealant adhesion and cohesion under movement	Tensile mechanical properties
Specimen	Sealant joint between rigid substrates	Dumbbell or other tensile specimen
Loading	Repeated compression and extension	Predominantly tensile extension
Test speed	3.2 mm/h	Depends on material and standard
Environmental exposure	Water, heat and cold	Depends on test specification
Primary result	Visible adhesion/cohesion performance	Stress, strength and elongation
Load cell	Not explicitly required	Generally required
Movement control	Essential	Essential

A conventional universal tensile testing machine should not be assumed suitable for ASTM C719 without the required low-speed movement capability, joint fixtures and thermal testing arrangements.

18. Applications of ASTM C719 Testing

ASTM C719 testing is relevant to manufacturers and laboratories evaluating:

- Silicone construction sealants
- Polyurethane joint sealants
- Polysulfide sealants
- Hybrid polymer sealants
- Elastomeric façade sealants
- Expansion joint sealants
- Glazing and curtain-wall sealants
- Sealants for concrete and metal joints

The method is useful for research and development, formulation comparison, product qualification and laboratory quality control.

19. Conclusion

ASTM C719-22 provides a systematic procedure for evaluating the adhesion and cohesion performance of elastomeric joint sealants subjected to repeated movement and environmental exposure.

The test combines water immersion, prolonged high-temperature compression, controlled room-temperature cycling and repeated thermal cycling involving low-temperature extension.

Reliable results require accurately prepared specimens, correctly controlled joint movement, rigid gripping fixtures and suitable temperature-conditioning equipment.

The compression-extension machine must be capable of maintaining a displacement rate of 3.2 mm/hour while moving the specimen between the specified joint widths.

AHP PLASTIK MAKINA manufactures material testing equipment for industrial quality control and laboratory applications.

For technical information regarding sealant compression-extension testing equipment, custom specimen fixtures and laboratory testing systems, please contact AHP PLASTIK MAKINA.

Category

1. Uncategorized