

ACP THERMAL EXPANSION AND STIFFENER BONDING: WHY ADHESIVE FLEXIBILITY MATTERS

Learn how ACP thermal expansion affects façade panels, joints and bonded stiffeners—and why flexible, tested adhesive systems are essential for long-term façade quality.

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Aluminium composite panels move every day.

When temperatures rise, the aluminum skin expands. When temperatures fall, they contract. This movement is normal, unavoidable and entirely predictable.

The critical question is therefore not whether an ACP façade will move.

The real question is whether the complete façade and bonding system can move with it.

When thermal movement is restricted by rigid fixings, insufficient joints, incorrectly detailed cassettes or unsuitable stiffener adhesives, stresses can build up inside the panel assembly. Over time, these stresses may become visible as oil-canning, telegraphing, buckling, joint compression or local distortion.

A façade that looks perfect on the day of installation offers little value if defects become visible after several summers.

Thermal movement is a design condition—not a product defect

ACP thermal expansion is the dimensional movement of aluminum composite panels caused by temperature changes.

The aluminum skins are the main drivers of this movement. As their temperature increases, they become longer and wider. When they cool down, they contract again.

The total movement depends primarily on:

- panel length and width;
- the coefficient of thermal expansion;
- the difference between minimum and maximum panel temperature;
- panel color;
- façade orientation;
- solar exposure;
- local climate;
- fixing and joint design.

Long panels move more than short panels. Dark panels can become hotter than light-colored panels. South- and west-facing façades may experience greater solar heating than shaded elevations.

Thermal expansion only becomes a problem when the façade system prevents the panel from moving freely.

Panel temperature matters more than air temperature

Façade design should not be based solely on ambient air temperature.

Under direct solar exposure, the surface temperature of an ACP panel can become significantly higher than the surrounding air. In hot regions and Gulf climates, dark-colored façades may approach or exceed surface temperatures of 70 °C, depending on orientation, color, ventilation and solar intensity.

This means movement calculations should be based on realistic panel surface temperatures—not only the temperatures shown in a weather forecast.

Important influences include:

- **Panel color**

Dark surfaces absorb more solar energy and can reach higher temperatures than light-colored panels.

- **Façade orientation**

Different elevations of the same building may experience very different temperature cycles.

- **Climate**

Desert, coastal and continental climates create different combinations of heat, cooling and moisture exposure.

- **Cavity ventilation**

The performance of the ventilated cavity can influence heat accumulation and the drying behavior behind the panel.

The temperature range considered in the design must therefore reflect the actual project conditions.

The longer the panel, the greater the movement

Thermal expansion is directly related to panel length.

The basic relationship can be expressed as: Thermal movement = panel length × temperature change × expansion coefficient.

A relatively small dimensional change per meter can become significant when applied to a long cassette or continuous panel.

Large-format ACP panels may offer a clean architectural appearance, but they also create greater demands regarding:

- expansion joints;
- cassette design;
- fixed and sliding points;
- stiffener positioning;
- panel flatness;
- handling and installation;
- adhesive movement capacity.

The largest panel that can be manufactured is not automatically the best panel for long-term façade performance.

Panel size should be optimized in relation to appearance, wind loading, thermal movement, fabrication capability and system approval.

Movement must be accommodated throughout the system

Correct ACP detailing allows movement through a combination of:

- sufficiently wide panel joints;
- slotted fixing holes;
- clearly defined fixed points;
- floating or sliding fixing points;
- correctly designed cassette returns;
- movement-capable sealants;
- aligned and dimensionally stable substructures.

A good façade design normally uses one defined fixed point to control panel position, while the remaining points allow expansion and contraction away from that location.

When all fixing points are rigid, movement becomes restrained. The resulting stresses must then be absorbed somewhere else in the system.

This may lead to:

- panel bowing or buckling;
- oil-canning;
- fastener stress;
- compressed joints;
- sealant failure;
- noise during heating and cooling;
- deformation of the substructure.

Adding more rigid fixings does not necessarily solve the problem. It may increase restraint and make the visible distortion worse.

Stiffener bonding is part of the movement design

Rear stiffeners are often added to fabricated ACP cassettes to improve rigidity, handling and visual flatness.

However, once a stiffener is bonded to the rear of the panel, the adhesive becomes part of the thermal movement system.

The ACP cassette and stiffener do not necessarily experience identical temperatures, movement or deformation. If the adhesive between them is too rigid, brittle or dimensionally unstable, it can restrict differential movement.

The stresses may then be transferred to the visible surface of the panel.

Possible consequences include:

- telegraphing of the stiffener position;
- local surface distortion;
- oil-canning;
- visible lines or irregularities;
- stress concentration in the aluminum skin;
- progressive debonding.

These effects are often blamed on the ACP material itself. In practice, the cause may lie in the combination of stiffener geometry, adhesive selection, curing behavior, fabrication method and restricted thermal movement.



The movement cannot be stopped. It can only be accommodated.

What should an adhesive for ACP stiffeners provide?

An adhesive used for stiffener bonding should do more than achieve high initial strength. It should remain sufficiently flexible and elastomeric after curing so that it can accommodate differential movement between the panel and stiffener.

Before approving an adhesive system, the following questions should be answered:

- Does the adhesive remain flexible throughout its intended service life?
- Can it accommodate repeated thermal expansion and contraction?
- Has adhesion to the actual aluminum skin or coating been verified?
- Is it compatible with the stiffener material and adjoining components?
- Has its performance been assessed after heat, moisture and ageing exposure?
- Is the adhesive bead geometry defined and reproducible?
- Are application and curing conditions controlled?
- Has the complete combination been tested rather than the adhesive alone?

A high strength but highly rigid adhesive is not automatically the safest choice.

For ACP stiffener bonding, movement capacity can be just as important as initial strength.

Product properties alone are not enough

A technical data sheet may provide values for tensile strength, elongation, hardness and temperature resistance.

These values are useful, but they do not automatically prove that an adhesive is suitable for a specific ACP construction.

Long-term performance depends on the complete combination of:

- ACP rear coating or aluminum skin;
- stiffener material and finish;
- surface preparation;
- adhesive chemistry;
- adhesive thickness;
- bead width and length;

- temperature range;
- moisture exposure;
- curing conditions;
- fabrication tolerances.

Even panels described under the same general ACP category may have different coatings, aluminum alloys, surface treatments or backing conditions.

The actual materials intended for the project should therefore be assessed and tested.

Adhesive geometry determines movement capacity

The thickness and geometry of an elastomeric adhesive layer influences how much movement it can accommodate.

A very thin layer has limited deformation capacity and may transfer higher stress between the stiffener and panel. An uncontrolled or excessively thick bead can lead to uneven support, variable curing and inconsistent panel flatness.

The bonding process should therefore be defined:

- the required adhesive thickness;
- the width of the adhesive bead;
- the spacing and orientation of the beads;
- the effective bonding length;
- the required compression;
- the curing period before handling or further fabrication.

Applying “enough adhesive” is not a technical specification.

A reliable process requires measurable and repeatable geometry.

Oil-canning is often a system issue

Oil-canning describes visible waviness or irregular reflection across a metal façade surface.

It may be influenced by:

- residual stress in the aluminum;
- panel size and skin thickness;
- fabrication tolerances;
- substructure alignment;
- uneven support;
- temperature differences;
- restricted panel movement;
- rigidly bonded stiffeners;
- inconsistent adhesive curing.

It is therefore rarely sufficient to evaluate only the ACP sheet.

The complete fabricated cassette, stiffener arrangement, fixing method and adhesive system must be considered together.

A movement-capable bonding system cannot correct every possible panel or fabrication defect, but it can prevent the adhesive connection from becoming an unnecessary source of restraint.

Joint and fixing design remain essential

A flexible stiffener adhesive does not replace correct façade detailing.

ACP movement must still be accommodated at:

- panel joints;
- cassette connections;
- rivets and screws;
- brackets and clips;
- perimeter details;
- sealant joints;
- transitions between different materials.

Approved shop drawings should be clearly identified:

- fixed and sliding points;
- movement directions;
- round and slotted holes;
- joint widths;
- fastener tension;
- sealant geometry;
- cassette dimensions;
- stiffener layout.

Panels should never be forced into an opening or installed against a misaligned substructure. Over-tightened fasteners and undersized joints can lock movement even when the original design was technically correct.

Sealants must also accommodate movement

ACP joints are not merely visual gaps.

They must accommodate thermal movement, installation tolerances and weather sealing.

Sealant selection should be considered:

- expected joint movement;
- joint width and depth;
- backing-rod position;
- adhesion to the ACP coating;
- compatibility with adjacent materials;
- long-term UV and weather exposure.

A narrow joint filled with a rigid or incompatible sealant can fail even when the panel and fixing system are otherwise correctly designed.

Every flexible component in the façade must be selected as part of one coordinated movement strategy.

Installation quality determines the result

Even a well-engineered ACP system can underperform when installation blocks the designed movement.

Critical installation checks include:

- maintaining the specified joint width;
- using the correct hole dimensions;
- avoiding over-tightening at movement points;
- installing panels on a flat and aligned substructure;
- respecting fixed and floating fixing details;
- applying the approved adhesive geometry;
- controlling surface preparation;
- respecting open and curing times;
- protecting panels from uneven heating during storage.

The approved design must be translated accurately into the finished façade.

Small deviations at individual panels can accumulate across a large elevation and create significant stress.

TWEHA®: flexibility supported by system validation

TWEHA® adhesive systems are developed for applications in which durable adhesion and controlled movement must work together.

For ACP and bonded metal applications, TWEHA® focuses on more than initial adhesive strength. The complete system can include:

- substrate and coating assessment;
- representative adhesion testing;
- compatible cleaning and surface preparation;
- a permanently elastic adhesive;
- controlled adhesive geometry;
- ageing and durability verification;
- application guidance;
- technical support.

This system approach is essential because the performance of the final connection is determined by the interaction between the adhesive, ACP skin, stiffener, preparation method and service conditions.

With TWEHA®, you are not simply selecting an adhesive. You are selecting a technically supported solution designed to remain flexible while the façade moves.

A consultant and fabricator checklist

Before approving an ACP stiffener bonding system, confirm that:

- realistic minimum and maximum panel temperatures have been established;
- panel dimensions and expected thermal movement have been calculated;
- joint widths and fixing details allow the required movement;
- the stiffener design does not unnecessarily restrain the cassette;
- the adhesive remains elastomeric after curing;
- compatibility with the actual ACP coating has been verified;
- compatibility with the stiffener has been verified;
- adhesive thickness and geometry are defined;
- fabrication and curing conditions are documented;
- long-term heat and moisture performance have been assessed;
- site and factory quality-control procedures are available.

When these elements are controlled, thermal movement becomes a manageable design parameter rather than a source of defects.

Conclusion: design for movement, not against it

ACP expands and contracts throughout every day and every season.

This behavior cannot be eliminated through additional screws, tighter joints or more rigid bonding. Attempts to stop movement generally transfer stresses elsewhere in the façade.

The correct strategy is to provide controlled freedom of movement through:

- suitable panel dimensions;
- correctly designed joints;
- fixed and sliding connections;
- aligned substructures;
- movement-capable sealants;
- flexible stiffener bonding;
- controlled fabrication and installation.

A successful façade must do more than look flat immediately after completion. It must retain its appearance and technical performance after years of thermal cycling.

Movement is unavoidable. Visible defects are not.

With correct engineering, compatible materials and a flexible, validated TWEHA® bonding system, ACP façades can move as designed—without transferring unnecessary stress to the visible surface.