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TECH NOTE #3

SASH SAG OF CASEMENT WINDOWS

Sash sag is defined as downward movement of the lower corner of the sash at the lock side relative to the window frame. Sash sag has been referred to as “The single most asked question concerning operating casement windows today”. The intent of this tech note is to provide some helpful insights to manufacturers as a troubleshooting guide so that sash sag can be designed out up-front or resolved in the field.

There are four main components to sash sag which are discussed further in the following sections.

1. The entire sash has moved downward toward the sill (sash settling).
2. The frame is “out of square” (the corners are not all at 90 degrees).
3. The sash is out of square.
4. The sash is not held square in the frame (the stile on the hinge side is not parallel to the jamb).

Other considerations related to sash sag are: window proportions, mounting screws, adjustable hinges and shipping & handling.

Sash Settling

Sash settling is usually a negligible part of a sash sag problem.

Hinge tolerances contribute to this component of sash sag but the effect is relatively small. Due to manufacturing tolerances the stack height of a hinge can vary slightly. Refer to the Truth catalog for the stack height tolerance of specific hinges. The sash can also settle if the sill is flexible enough to sink downward beneath the lower hinge shoe. This is typically not a problem but should be considered as windows get heavier or when a casement window is mulled over another window.

Frame Out Of Square

The main reason for the frame to be out of square is improper installation of the window into the building opening. Casement windows need to be installed with a 90° corner between the sill and the side jamb on the hinge side. This is the most critical aspect of window installation required to minimize sash sag.

Another reason is that the frame is built with one jamb longer than the other or the sill is a different length than the head. Even if the frame is built out of square, sash sag due to this factor can be eliminated if the window is installed with a 90° corner between the sill and the hinge side jamb.

A third cause of the frame being out of square is the building itself shifting over time, distorting both the window opening and the window frame.

There are two ways to check if a window frame is square:

1. Measure the angle of the lower hinge corner of the frame with a square. If the angle is less than 90°, the result is sash sag. This method is only accurate if the sill and jamb are straight.
2. Measure the two diagonals (distance from one corner to the diagonally opposite corner) of the frame. If the diagonal including the upper hinge corner is shorter than the diagonal including the lower hinge corner, the frame is out of square and is probably contributing to sash sag.

Sash Out of Square

Tolerances of fabrication may result in long and short stiles. A lock side stile that is longer than the hinge side stile will typically have the extra length show up as sash sag.

Glass blocking in the glazing system is critical to holding the sash square. To prevent sash sag, the result of glass blocking should be a rigid sash with 90° corners.

Figure A shows a typical glazing installation with a small gap between the glass panel and the glazing blocks. The size of these gaps can affect the amount of sash sag.

Unlike other window types, casement windows carry the weight of the sash at only one point; the lower hinge corner. Since most unglazed sash are not perfectly rigid, the gaps shown in Figure A usually permit the glass weight to force the sash out of square. Because the lock side of the sash is unsupported, only the setting block closest to the hinge corner will actually support the glazing.

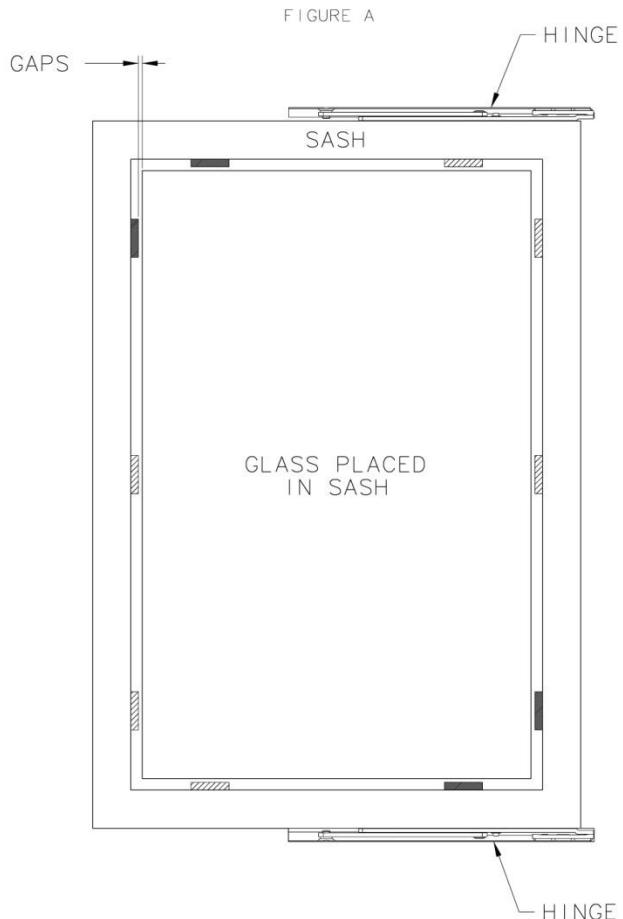
Figure B shows the natural tendency of the glass panel to settle and rotate after the sash is installed into a window frame that is held in the upright position. The actual amount of sag seen on any particular window due to this factor will depend on the strength of the corner joints as well as the stiffness of the sash rails and stiles.

With the glazing block locations shown in Figure C, having as little as .030" gaps at each glazing block can result in about .138" of sash sag on a 32" x 48" window (.176" sash sag on a 32" x 32" window). Keeping the glazing blocks close to the corners can make a big difference to the amount of sash sag seen. For example: Putting all four of these glazing blocks at the $\frac{1}{4}$ points along the glass edges (with the .030" gap at each block) allows sash sag to increase to about .191" for a 32" x 48" window (.260" for a 32" x 32" window).

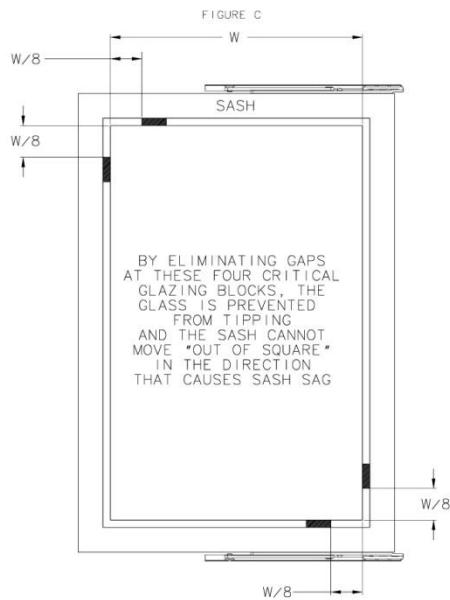
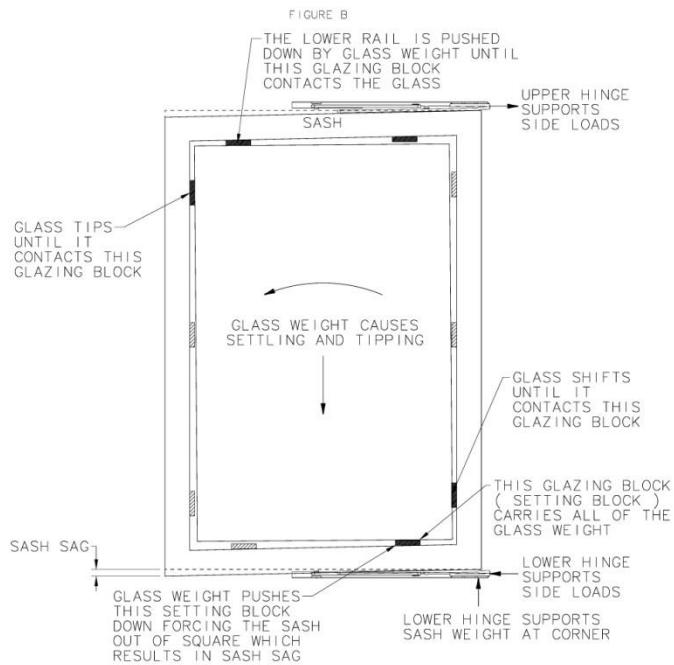
The component of sag shown in Figure B can happen slowly over time if the glazing tape or sealant is not strong enough to prevent creep. With wet glaze (sealant based) systems; however, this sag is most likely to occur before the glazing sealant cures. One method to prevent it is to hold the sash perfectly square until the sealant cures but this is not usually practical in a high volume manufacturing environment.

Figure C shows how making the four most critical glazing blocks tight when the sash is square can prevent the sash from experiencing this source of sag. These four glazing blocks should be large enough and hard enough not to compress over time.

Due to fabrication tolerances, it may be difficult to always assure that these four glazing blocks are tight, especially if only one glazing block size is used. Having a variety of glazing block thicknesses to choose from or using shims will help. If these glazing blocks are slightly oversize (due to glass, stile & rail tolerances), they will distort the sash in a way that raises the corner of the sash rather than allowing it to sag. This may actually be beneficial provided it is not excessive.



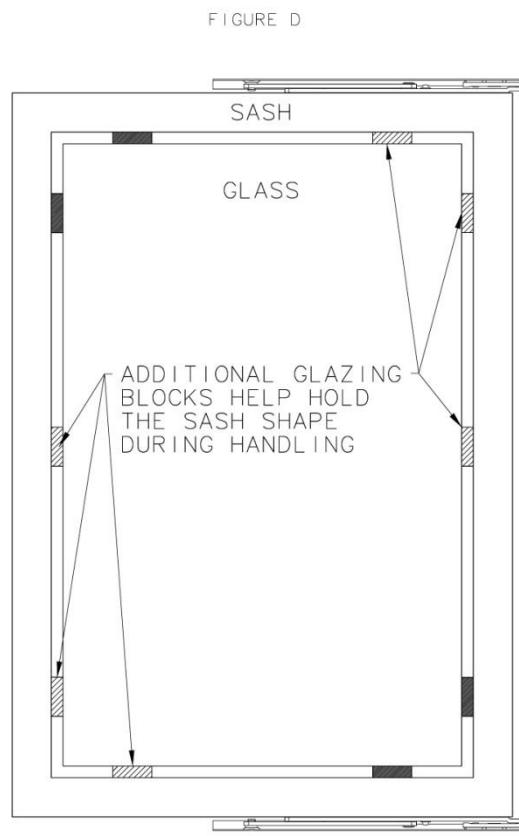
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Because the glass weight is carried on one setting block that is not directly over the support given by the hinge shoe, there is a bending load put on the bottom rail. The farther the setting block is from the hinge corner and the heavier the glass, the more likely the bottom rail is to bend. Any bending will result in sash sag. To minimize bending of the bottom rail, locate the setting block as close to the hinge corner as permitted by the GANA Glazing Manual. With heavy glazing, it may sometimes be necessary to have a stiffener inside a vinyl profile to prevent bending.

If the gaps shown in Figure A cannot be completely eliminated, wet glaze systems may be helped by placing a shipping block between the sash and the sill to support the lock side of the sash while keeping the window in the upright position until the sealant cures.

Additional glazing blocks (Figure D) can be used to prevent the sash from distorting in other directions (those not resulting in sash sag) during handling even though they aren't needed to carry long term loads. To accommodate expansion and contraction of sash components due to temperature or humidity, a lower durometer material for these additional glazing blocks is helpful.



There are two methods used to check if a window sash is square.

1. Measure the angle of the lower hinge corner of the sash with a square. An angle greater than 90° indicates sash sag. This method is only accurate if the stile and rail are straight.
2. Measure the two diagonals of the sash. If the diagonal including the upper hinge corner is longer than the diagonal including the lower hinge corner, the sash has sag. The amount of sag due to an out of square sash is roughly 60% of the difference between the two diagonals.

Example: The diagonal from an upper hinge corner to the lower lock corner measures 55.000" and the other diagonal measures 54.812". The difference between the diagonals is $55.000 - 54.812 = .188$ ". The amount of sash sag is roughly 60% of .188" which is $.60 \times .188 = .113$ " of sash sag.

Sash Not Held Square in the Frame

In order to hold the sash square in the frame, the top and bottom hinges need to be precisely located on both the sash and the frame. Truth recommends predrilled holes and screws driven in straight to achieve the necessary accuracy.

Example: Mounting all four hinge components (sash arms and tracks) out of position by just 1/32" could contribute about 5/64" of sash sag to a 30" x 48" casement (about 1/8" sash sag to a 30" x 30" casement).

Concealed hinges position the sash in the frame and are a minor contributor to sash sag. Due to manufacturing tolerances, the hinges have some play in their joints. The sash weight, interacting with this play, will shift the top of the sash toward the lock side and the bottom of the sash toward the hinge side causing a small amount of sash sag. Each hinge will typically shift less than .010" from nominal, contributing less than .013" of sash sag to a 30" x 48" window (less than .020" sash sag to a 30" x 30" window). To overcome this effect and to bias the window slightly against other sources of sash sag, Truth recommends that the bottom hinge track be mounted about 1/32" farther from the side jamb than the top hinge.

To check if the sash is held square in the frame, measure the reveal between the stile and the jamb on the hinge side near the top and bottom of the sash. If the reveal is larger at the top, the sash is not being held square in the frame and this is contributing to sash sag.

Window Proportions

Because (on average) short and wide casement windows display much more sash sag than tall and narrow windows, Truth has traditionally recommended that the sash width be no more than 66% of the sash height. This is not an absolute rule but extra care needs to be taken when exceeding this recommendation in order to avoid problems with sash sag.

Mounting Screws

Mounting screws must securely hold the hinges to prevent movement that can contribute to sash sag. Some hinge tracks require undercut flat head screws. Standard flat head screws used in these locations will not seat tightly to the hinge track on a hard mounting surface (such as PVC, fiberglass and aluminum), allowing the hinge to move. Predrilled holes help prevent material from being displaced by the screw and bulging up under the screw head. Extra material under the screw head may prevent it from seating properly.

Truth recommends that extruded profiles have double walls for the screws to pass through or an insert to ensure the proper retention of the screws and to keep them from tipping, which could shift the hinge location.

Screws that have been over-tightened and stripped-out cannot hold as much load as they should and may allow the hinge to move, resulting in sash sag.

Adjustable Hinges

Truth Hardware offers concealed hinges with an adjustable stud that can be used to help correct a sagging sash. Adjustment of these hinges has the same effect as relocating the hinge track. The adjustment can be used to help minimize sash sag or to correct an uneven reveal.

Shipping and Handling

Shipping and handling of assembled casement windows can also contribute to sash sag. If a window is bounced or dropped, high loads can be put on the hinges that could cause hinge damage or shift the hinges on their mounting screws. See Tech Note #13 for information about using shipping blocks to prevent problems.