NGA
NATIONAL GLASS ASSOCIATION with GANA

Frameless Shower Enclosure Design and Installation Manual

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Introduction

The National Glass Association (NGA) is proud to present the *Frameless Shower Enclosure Design and Installation Manual*. Frameless shower hardware has been in North America since the 1980s. What started out as an opulent design option has steadily developed into shower enclosures found in many millions of homes and commercial buildings.

This Manual was created to provide guidance and specific best practices for frameless shower enclosures. It is meant to educate and assist glass professionals on designing, measuring and installing safe, functional shower enclosures. The Manual also serves as a tool to the professional installer to point out potentially unsafe design to an end user.

The *NGA Frameless Shower Enclosure Design and Installation Manual* has been divided into three sections:

- Designing Frameless Glass Showers
- Measuring Frameless Glass Showers
- Installing Frameless Glass Showers

The Design section addresses varied circumstances that can arise in the crucial design phase of a frameless shower enclosure. The Measuring section focuses on the practical methods and the accuracy required when measuring an opening for an all-glass enclosure. Finally, the Installation section explains best practices for installing the numerous components that make up a frameless shower enclosure.

This Manual is not meant to be a complete technical guide to all aspects of shower enclosure systems. Manufacturers, material suppliers and glazing subcontractors can and will support any effort by those using this Manual to research the technical aspects of shower enclosures.

Specific systems are covered, describing in detail how the systems work, how they respond to either specified or design criteria, and what is involved with their design, fabrication, installation, and performance once installed. Other resources, such as industry groups, manufacturers or standards organizations, can and should be consulted for specifics of how materials perform or how material is sized for specific instances.

The photographs and diagrams of products shown in the Manual have been supplied by NGA member companies, are used in this Manual with their consent, and are believed to be reasonably representative of the products offered by the membership specifically and the industry generally. The publication of these photographs is not intended as an endorsement of one product or vendor over another. There are other vendors whose products perform well and are suitable for the systems shown.

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The Manual is a "living document," and the Provider reserves the right, in its sole discretion, to update, revise and amend the Manual from time to time as it sees fit and to do so without notice to prior recipients or current users of the Manual.

It is the responsibility of the user of this Manual to ensure that glass is selected and installed by competent professionals in compliance with all relevant laws, rules, regulations, codes, standards and other requirements.

Drawings contained herein are not-to-scale.

The standards referenced in the NGA Frameless Shower Enclosure Design and Installation Manual are under the jurisdiction of third-party organizations and agencies and are constantly subject to review and revision. The standards and similar documents referenced in this Manual are those in effect as of 2023. The Manual user should refer to, consult, and comply with the most recent edition of the referenced standards.

Acknowledgements
NGA appreciates the many companies and individuals who have contributed time and resources in making the NGA Frameless Shower Enclosure Design and Installation Manual a reality. The contents of this Manual are the result of the collaborative work of the following hardworking group of volunteers:

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Our thanks go to all those who contributed information, assistance, and advice.

About NGA

The National Glass Association (NGA) was founded in 1948 and combined with the Glass Association of North America (GANA) in 2018 to create the largest trade association serving our industry. NGA is an advocacy and technical powerhouse that brings the best minds to the table to create technical resources, and to promote and advocate for glass in buildings.

The NGA member community is 1,800 companies strong. We are contract glaziers and full-service glass companies. We are manufacturers and suppliers. We are fabricators of insulating, laminating, tempering, decorative/mirror, fire-rated, protective glazing and high-performance glass products.

NGA's technical papers, manuals, and business resources help guide you and your company to success. Our online training courses at MyGlassClass.com, plus NGA Glazier Apprentice Curriculum, teach job skills and knowledge that will complement your company's on-the-job training.

NGA brings news, product announcements and financial insights directly to you through our official magazines Glass Magazine and Window + Door.

Our many events throughout the year—GlassBuild America, the Building Envelope Contractors (BEC) Conference, NGA Glass Conferences, Glazing Executives Forum, GPAD (Glass Processing Automation Days) and Thirsty Thursday webinars—provide a gathering place for you to learn, share, engage, and make connections.

Learn more at glass.org.

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Glossary of Terms

Frameless Heavy Glass Enclosures are typically constructed from ⅜" or ½" thick monolithic tempered safety glass with glass edges that are exposed as much as possible. The glass can be clear, translucent, or opaque tempered glass with optional tints and textures. A shower enclosure is still considered 'frameless' even when using hardware such as channels or headers. According to the International Building Code (IBC), shower enclosure glass must be safety glazing, meeting the impact requirement of the federal standard CPSC 16 CFR 1201 Cat II.

Glass typically used in frameless heavy glass enclosures is monolithic tempered glass that is a minimum of ⅜" or thicker. Frameless shower enclosures using glass less than ⅜" thick, semi-frameless showers and framed showers are not within the scope of this document.

Swing Doors utilize side-mounted or top and bottom mounted hinges in a variety of configurations.

Sliding Doors are used in frameless enclosures. They utilize rollers, either on a header bar or within a header track. Some are bottom rolling systems that roll within or on a track. Sliding doors may also bifold with the aid of a top track.

Steam Showers are completely enclosed and are designed to minimize water and steam from escaping.

Splash Panels are glass panels designed to cover some or most of an opening, allowing the user to walk around the glass to enter the enclosure. Splash panels can be either fixed or operable.

ADA Accessible enclosures offer a zero threshold (no raised curb) and wider egress openings. The entry threshold has a gradual slope to contain water but does not prohibit wheelchair and walker access.

Managing Expectations

Managing End User Expectations for Watertightness

The following statements can be used to explain to an end user what can be expected from frameless shower enclosures:

A frameless shower enclosure is not the same as its framed or semi-frameless counterpart.

Minimal use of hardware achieves an all-glass look. This all-glass look does not allow for a kit that is assembled from aluminum extrusions that interlock into one another, preventing water from leaking. An end user must be prepared for these differences and have expectations that align with this knowledge. A frameless shower is not an aquarium, meaning it will not hold water without any leakage. The amount a frameless shower will leak is dependent on various factors.

The primary factor in determining whether a frameless shower will leak or not is the configuration of the shower itself and the type of enclosure being installed. Some showers, by virtue of their design, are not likely to have water escape. For example, a very large shower with the door far away from the water source will be unlikely to leak out of the enclosure.

A shower type on the other side of this spectrum may be, for example, a corner-installed enclosure of small proportions, which would be almost guaranteed to leak. Most showers fit somewhere between these two extreme examples.

Frameless shower enclosures are not watertight.

Managing End User Expectations for Glass Quality

Glass Fabrication Tolerances
ASTM C1048 *Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass* provides fabrication guidelines for tempered glass including, but not limited to, holes, notches, cutouts, minimum dimensions, and tolerances (see Table 1). If hardware requires fabrication to more stringent tolerances than ASTM C1048 guidelines, the purchaser should consult with the glass fabricator.

TABLE 1 *Glass Fabrication Requirements for Frameless Shower Enclosures, adapted from ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass*

Note t = thickness of the glass panel.
* indicates multiplication, for example 1*t indicates one times the thickness.

Hole dimensions:	6 mm or 1*t minimum
Distance between edges of holes:	10 mm or 2*t, whichever is greater
Distance from edge of hole to edge of glass:	6 mm or 2*t, whichever is greater
Distance from edge of hole to corner of glass:	6.5*t
Length and width tolerances:	+/- 3⁄32 inch (for 10 mm thick glass) to +/- ⅛ inch (for 12 mm thick glass)
Bow:	Refer to ASTM C1048 Overall Bow, Maximum table

End User Visual Quality Expectations

Refer to Tables 2, 3, 4 and Figure 1 based on ASTM C1036 *Standard Specification for Flat Glass* for visual glass quality guidelines. If quality expectations exceed those indicated in Tables 2 - 4, the purchaser should consult with the glass fabricator.

TABLE 2 *Allowable Point Blemish Size and Distribution for Cut Size Quality 3[A] (based on ASTM C1036[B])*

Glass Thickness (nominal)	Allowed [C,D]	Allowed with a Minimum Separation Distance of 600 mm (24 inches)[E]	Not Allowed
⅜-inch (10 mm)	Smaller than 2.25 mm	2.25 mm up to 3.0 mm	3.0 mm and larger
½-inch (12 mm)	Smaller than 3.0 mm	3.0 mm up to 4.0 mm	4.0 mm and larger

[A]Quality 3 is defined by ASTM C1036 as "Production of architectural glass products including coated, heat treated, laminated, and other select glass products." Note: For laminated glass, refer to ASTM C1172.

[B]Values quoted directly in the corresponding ASTM C1036 table (ASTM C1036 Table 5) are for 6.0 mm (¼-inch) and less. Values in Table 2 above are calculated as instructed by ASTM C1036 as follows: for glass thicker than 6.0 mm (¼-inch) and less than or equal to 12.0 mm (½-inch), they may contain proportionally larger blemishes for the same minimum separation distances. ASTM C1036 Table 5 does not apply to glass thicker than 12.0 mm (½-inch). Allowable blemishes for glass thicker than 12.0 mm (½-inch) shall be determined by agreement between the buyer and the seller.

[C]See ASTM C1036 section 6.1.1.1 for detection of point blemishes.

[D]See ASTM C1036 section 6.1.1.2 for measurement of point blemishes.

[E]See ASTM C1036 section 6.1.1.4 for minimum blemish separation.

TABLE 3 *Excerpt from ASTM C1036 Allowable Linear Blemish Size and Distribution for Cut Size and Stock Sheet Qualities*

Linear Blemish Size Intensity Length[A]	**Q3 Quality 3 Distribution**
Faint ≤ 75 mm (3 inches)	Allowed
Faint > 75 mm (3 inches)	Allowed
Light ≤ 75 mm (3 inches)	Allowed
Light > 75 mm (3 inches)	Allowed
Medium ≤ 75 mm (3 inches)	Allowed with a minimum separation of 600 mm (24 inches)
Medium > 75 mm (3 inches)	None allowed
Heavy ≤ 150 mm (6 inches)	None allowed
Heavy > 150 mm (6 inches)	None allowed

[A]See ASTM C1036 Table 12 ("Blemish Intensity Chart") for definition of Faint, Light, Medium and Heavy blemish intensity and viewing detection distances for each blemish intensity.

TABLE 4 *Excerpt from ASTM C1036 Allowable Shell Chip Size and Distribution for Cut Size and Stock Sheet Qualities for Type 1 – Transparent Flat Glass*

Description	Q3
Chip depth (D)	Chip depth ≤ 50 % of glass thickness
Chip width (W)[A]	Chip width ≤ glass thickness or 6 mm (1⁄4 in.) whichever is greater
Chip length (L)[A]	Chip length ≤ 2 times the chip width

[A]For stock sheets, there is no limit for chip width and length.

Note from ASTM C1036: Glass edges are typically supplied as factory cut. Optional edge work can be specified as seamed, ground, polished, beveled, mitered, or other, as arranged with the manufacturer. See manufacturer's literature for more information.

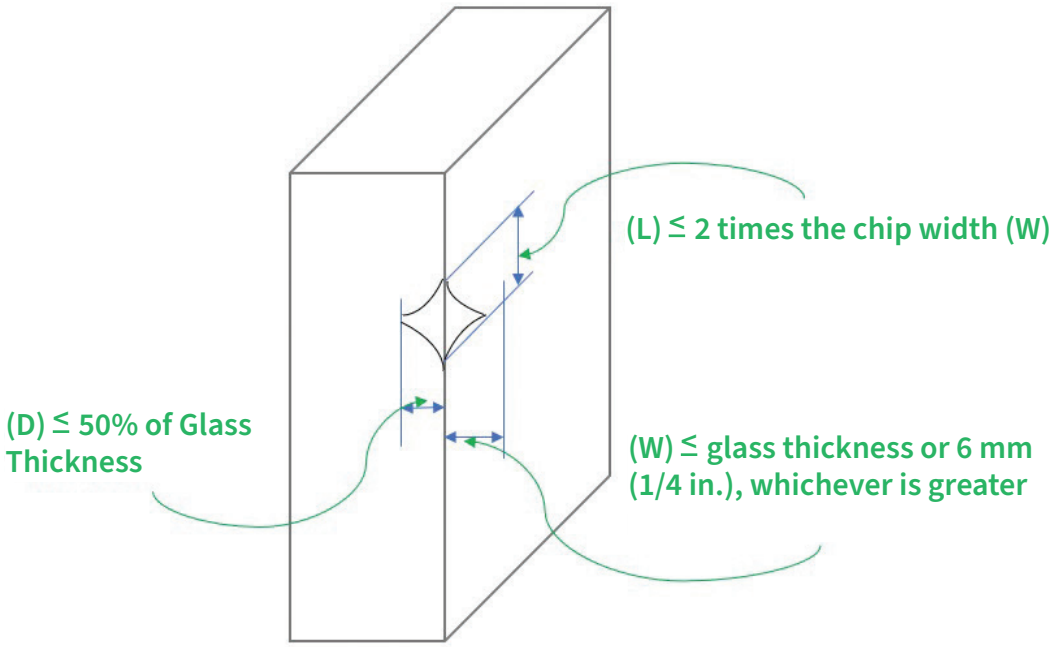


FIGURE 1 *Allowable shell chip for cut edges (see chart and figure above). Note: Shell chip width (W) shall be ≤ glass thickness or 6 mm (¼ in.), whichever is greater, length (L) shall be ≤ 2 times the chip width, and depth (D) ≤ 50 percent of the glass thickness, per ASTM C1036. Source: NGA Engineering Standards Manual*

Section 1: Designing Frameless Glass Showers

For the purposes of this Manual, the process of designing a frameless glass shower enclosure is converting the design envisioned by the customer into the individual panels of glass and appropriate hardware needed to create a safe glass enclosure. In cases where the customer has an expectation that is physically impossible or renders the end product unsafe, the glass professional should attempt to arrive at feasible and safe solutions or provide options for redesign.

The timing of the design phase will be dictated by the customer, who will in effect determine when to involve the glass professional in the project. In some projects, the glass professional may be consulted before construction begins, but more often the glass professional is brought in after all construction is complete and it is time for glass to be installed. Even when an experienced glass professional immediately designs the enclosure in his/her mind upon first look at the shower, the design process is a separate and distinct step that must occur before measuring begins.

One benefit of being involved early is having the ability to identify potential issues with the proposed concept and offer a wide variety of solutions or suggest a redesign. However, even in these early stages, the glass professional cannot control how the project will be constructed. When arriving after construction of the surroundings is finished, important elements such as the substrate or surface slope may be in place but may not be adequate, and this potential flaw can be difficult and costly to correct.

This Manual provides a discussion of shower glass best practices as a guide, while recognizing that the glass professional may arrive at the project too late to advise or influence the customer's actions.

Understanding Existing Conditions

Consider the Entire Room
If the bathroom is complete, and all the fixtures are in place, determining the shower door configuration will be more straightforward. The swing of the door may be determined by the location of the toilet, vanity, or other fixtures. Pocket doors, pipes, or other obstacles in the wall may hinder the desired configuration. In cases where the area is too crowded to accommodate a hinging door, a sliding door may be required. In instances when the fixtures are not in place, special care should be taken to ensure that no obstructions will interfere with the operation of the door after the enclosure is installed.

Care should be taken to imagine how the door will operate while the shower is in use. It is advisable to have the door hinged in such a way that the user does not have to go around it to exit the bathroom and has easy access to the controls. If a person must leave the shower in an emergency, ideally, the door should not impede exit.

Adequate Substrate
There should always be a suitable attachment substrate wherever the hinges, clamps, clips, or channel will be installed for the shower enclosure. However, it is surprising how often this suitable substrate has been omitted. It is difficult to install a suitable substrate after the tile is complete and the time to install the glass has come. The person who measures the layout will have no easy way to confirm there is an adequate substrate in the necessary locations where hardware or channels will be installed. The shower installer must rely on the trades that preceded them to have built the openings correctly. Generally, the default location for a frameless shower enclosure is the center of the curb. However, a customer may want the glass moved closer to the outer edge of the curb. These factors should be kept in mind when locating adequate substrates during the build-out of the shower stall.

If no adequate substrate was provided to support the shower type selected, the enclosure may need to be redesigned to a configuration that is not reliant on an adequate substrate. Some options might include a header with pivot hinges or another type of enclosure.

Three Most Common Types of Adequate Substrates

A frameless shower door hinged from a wall is only as sound as the substrate to which it is attached. Trying to fasten a heavy frameless shower door to a wall without proper structural support may result in an unsafe installation. It is important to ensure the wall from which the door will hinge includes an adequate substrate. There are several types of adequate substrates:

1. Wood stud behind tile/stone layered on masonry mortar/cement board/ greenboard (Figure 2). Fastening into a wood stud directly behind the bedding material (masonry mortar/cement board/greenboard) is the best form of structural backing.

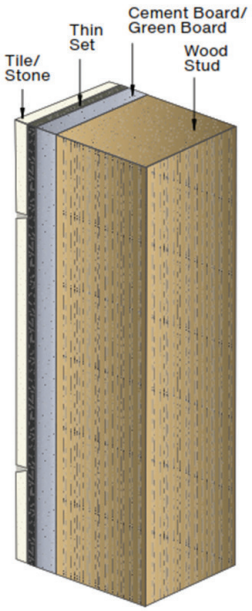


FIGURE 2 *Example of adequate substrate – wood stud*

2. A minimum of 1 inch of a "cement-like" material with the correct screw anchors (Figure 3). The tile/stone thickness is counted as "cement-like" material. The thin-set used to attach the tile/stone to the wall also counts as "cement-like material. The last component is either a masonry-floated wall or cement-board. Greenboard does not count as "cement-like" material. The thickness of the three components must add up to 1 inch thickness. As an example: ⅜-inch thick tile/ stone + ⅛-inch thin set + ½-inch cement board = 1 inch.

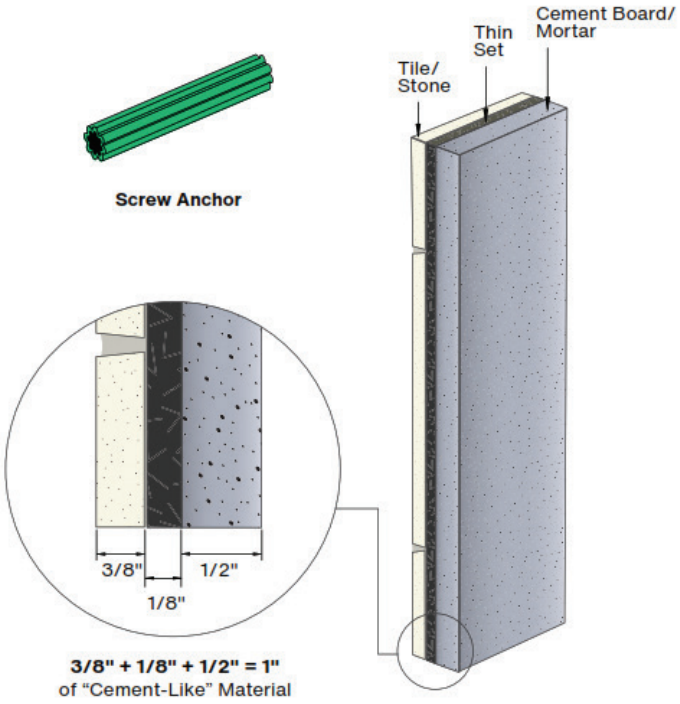


FIGURE 3 *Example of adequate substrate – "cement-like" material*

3. Metal studs are often used in hospitality applications and can qualify as an adequate substrate (Figure 4). The metal stud should be directly behind the bedding material (masonry mortar/cement board/ greenboard). There should not be an airspace between the bedding material and the metal stud. When fastening to a metal stud, a small pilot hole should be drilled in the metal stud, then the hinge fastening screw should be drilled through the metal stud, threading into it as it goes through.

FIGURE 4 *Example of adequate substrate – metal stud*

Curb Pitch Guidelines

One of the simplest and most important factors of a well-designed and executed shower installation is a properly pitched curb. The slope of the curb should be ⅛-inch to ¼-inch over a 6-inch span and should slope in the direction of the shower drain. This basic feature of the shower enclosure is the primary means for containing water when combined with the glass enclosure. If the curb slopes to the outside (away from the drain), no amount of caulking or application of plastic seals will prevent water from draining out. A perfectly level curb will create an issue with water pooling up, and eventually spilling out. A gradual slope is ideal, and a slope that is too steep may create problems with the bottom of the door scraping or the door sweep binding (see Figure 5).

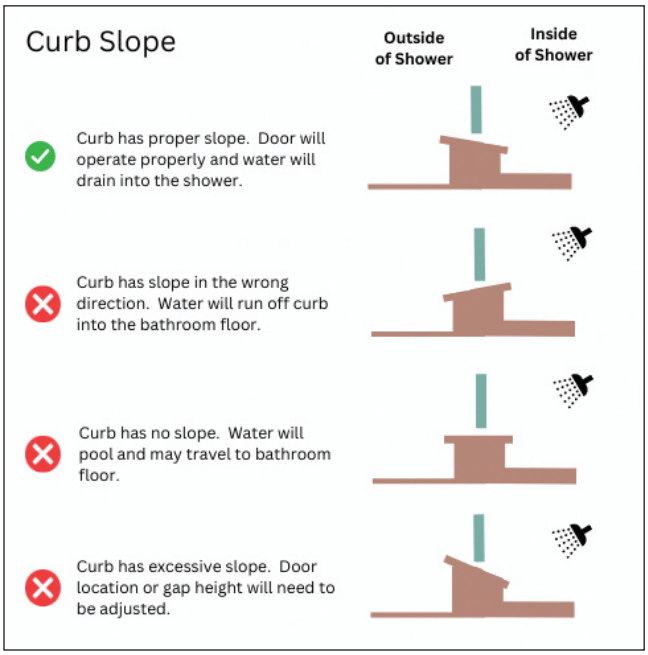


FIGURE 5 *Curb slope*

Zero-entry Showers

"Zero-entry" showers (also known as curbless or barrier-free showers) are enclosures without raised transitions at the entrances. The major benefit of zero entry showers is that they are easy to enter and exit without stepping over a curb. They provide a more user-friendly experience for people with reduced mobility, making the space accessible using a walker or wheelchair.

The primary challenge when designing a zero-entry enclosure is containing the water without the use of a raised threshold of any kind. Curbless showers normally employ a long, rectangular drain that is designed for this condition. Since there is no curb to separate the shower area from the rest of the bathroom, the floor should be sloped in such a way that the water will run toward the drain. The area where the glass enclosure will be installed should be flat and not pitched (see Figure 6). In the case of a standard hinged door, the floor within the outward swing arc of the door should be level to prevent the door from dragging when it is opened. This is not a concern with a sliding door or fixed panel application.

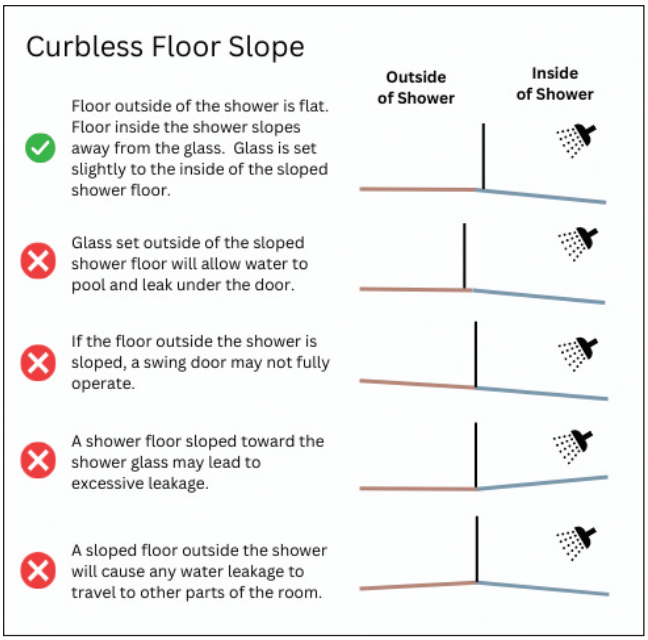


FIGURE 6 *Curbless floor slope*

Heated Floors

Radiant heat flooring is not recommended where the floor will be drilled into for hardware installation. If the shower enclosure installer drills into the radiant flooring system, it could be damaged.

Glass Tiles

Glass tile can prove to be a troublesome opponent to a shower installer. If the glass contractor is included in the planning stage of construction, they can guide the homeowner or contractor to use glass tile as a decorative component and not the primary tile.

If the customer is set on using glass tiles, one option for mounting hinges is to leave a blank space for the hinge to be mounted to the wall. This way, drilling into glass tile is avoided altogether. The customer can have the contractor or tile installer modify the opening to accept wall plates. If this method is used, make sure to align the hinges with one another.

If glass tiles have already been installed, it is important to advise the customer of realistic expectations. Advise the customer glass tiles can break after being drilled. Even if the glass tiles are drilled without any breakage, over time they

may crack from the pressure from the fittings and weight of the glass. Obtaining a waiver from the customer or other written documentation evidencing the customer has been informed of the inherent issues associated with drilling glass tiles is recommended.

Raised Decorative Tiles
Decorative tiles with a profile designed to protrude beyond the plane of the wall tile should be avoided when they extend within the area of the swing of the shower door. Generally, flat tiles that match the other raised accent tiles in every way except for the profile can be used in the locations where the glass meets the wall. The edge of the door glass can be notched around the raised accent tiles, but it is desirable to clearly describe how that is going to look for the customer. Having photos that show the way a notch may look is a good way to help the customer reach an informed decision. It is possible to notch the tile, rather than the glass, to accommodate the swing of the door. However, this accommodation requires a notch large enough to account for the radius of the door's swing and is likely not going to be attractive.

Notching Overhangs
A bullnose or overhang, typically associated with a tub deck or shower bench, can generally be notched to accommodate the glass where it meets the tile in that location. There is always the option of notching the glass around the protrusion. Another solution might be to build out the area under the overhang using a metal filler, or other suitable material.

Designing the Shower

Structural Support
The structural integrity of a glass shower enclosure is paramount. The glazing professional is normally expected to provide a safe shower environment. Installing an unsafe enclosure, proclaiming "the customer signed a waiver, so they know it is not installed right" is not usually an acceptable excuse for doing the wrong thing. If anything happens down the line, the waiver could be used against the glazier. Such a waiver might be perceived to be an admission of guilt as the glazier holds themselves out as an experienced and knowledgeable professional.

Glass Selection
Frameless shower enclosures are made with safety glass that is typically ⅜-inch or ½-inch thick. There are a variety of glass types, textures, and colors to choose from. Low-iron glass has become much more popular over time; the customers should be made aware of the available extra clear glass options. ⅜-inch glass is suitable for many applications. ½-inch glass should be used for larger panels of glass. If in question, it is recommended to use the thicker glass. There are size limits to the width and overall dimensions of the various thicknesses, so these variables should be considered.

The tempering of glass is one of the final stages of the fabrication process. All cutting, notching, edging, and polishing should be done before the glass is tempered. NEVER ATTEMPT TO CUT OR DRILL TEMPERED GLASS. Some have attempted to remove material from the edge of a tempered glass panel or inside of a cutout by grinding, but it is not advisable and could possibly compromise the integrity of the tempered glass panel. Refer to NGA Glass Technical Paper FB13-07 "The Importance of Fabrication Prior to Heat-Treatment" for more information. This paper can be downloaded for free at glass.org/store.

Patterned glass should be installed with the smooth side facing inside the shower. Selecting a patterned glass without a smooth side is not recommended. Alternatives to patterned glass used for obscurity include acid-etched and sandblasted glass. Contact the glass supplier for detailed information regarding these specialty products. Special considerations for hardware may be required when using deep-patterned glass types. Issues such as the hardware having no flat surface on the glass to clamp on the glass and patterned glass not fitting into a U-Channel must be considered when choosing this glass type.

Glass coatings can be used in frameless shower enclosures. Glass manufacturers can provide glass with coatings that can be tempered. Glass fabricators and installers can also provide coatings that are applied after tempering. When using coatings applied by the glass fabricator or installer, the installer should verify with the coating manufacturer whether the coating may cause slippage if applied at the location(s) of the hardware attachment. The installer should determine what locations, if any, should be free of the coating. Contact the coating manufacturer for appropriate cleaning instructions, which may vary from one coated product to another.

Handle Placement

At the time of initial design, handle placement depends on a few factors. A standard height range to the center of a handle/towel bar/knob is 36 to 42 inches from the finished floor. Once the height from the finished floor has been determined, make the necessary deductions, considering the height of the zero-entry, curb, or tub. Also, if the customer is on-site, consider where it would be comfortable for them.

Towel Bars on Doors

When considering a towel bar on a swinging shower door, some planning is required to ensure the door can open without the end of the towel bar colliding with an adjacent wall. This is primarily an issue when using wall-mounted hinges. In some cases, a door will be prevented from fully opening. When using glass-to-glass hinges, this is rarely an issue unless the end of the towel bar is less than 3 inches from the hinge edge of the glass. When using pivot hinges, moving the pivot point inward from the end of the door can result in creating the space needed for the towel bar. Using a smaller towel bar may provide a solution. Another possible adjustment may be to add a small inline panel and use glass to glass hinges. This may provide enough room for the door to open a full 90° without the towel bar interfering.

Sometimes locating the shower enclosure closer to the outside of the curb and/or using offset wall mount plate hinges will allow more clearance for a towel bar (see Figure 7). In some cases, the end of the towel bar may be able to clear the outer corner of the shower tile/stone. It is necessary to understand the variables that determine where the towel bar needs to be in order to avoid hitting any obstacles.

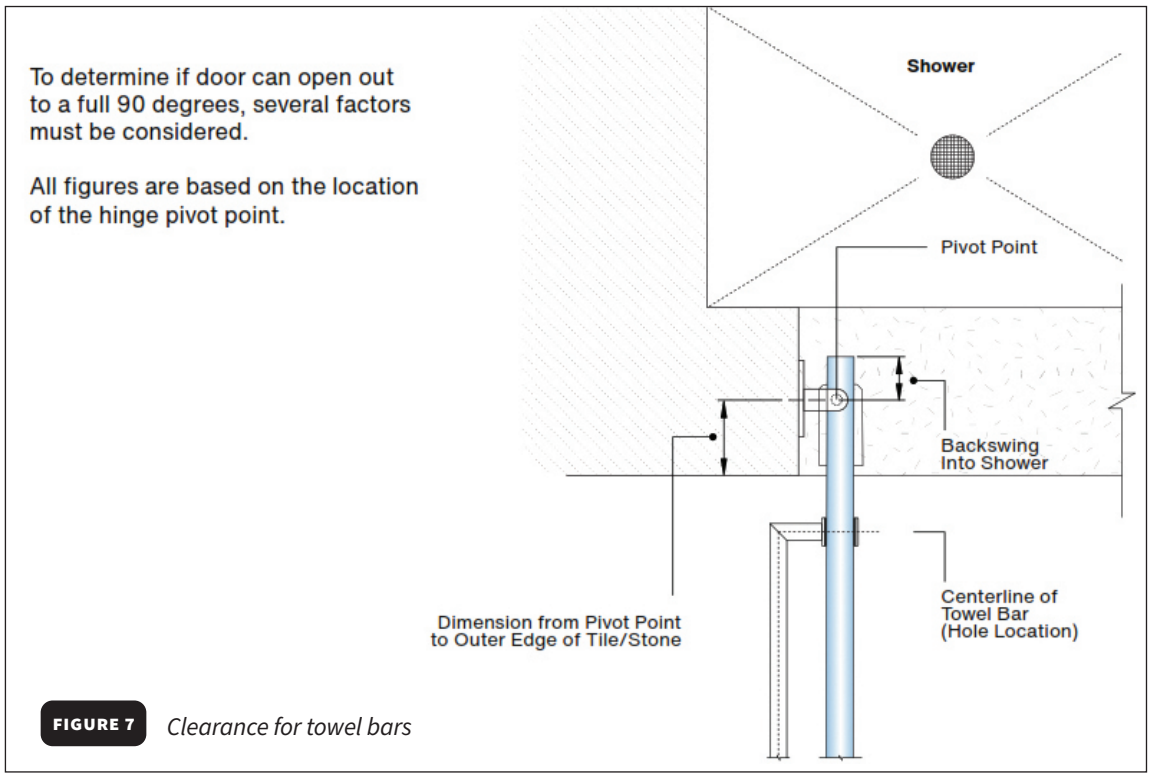


FIGURE 7 *Clearance for towel bars*

Seals
Polycarbonate wipes and seals may be used in frameless shower enclosures to help minimize water escape. The decision on whether to use seals should be made before generating glass sizes. An enclosure that utilizes seals generally requires different glass size deductions in comparison to a shower with no seals.

Without the use of seals, most clearances are calculated leaving a minimal gap. If seals are being used, the clearances are generally larger. Please consult manufacturer recommendations on gap sizes for the selected seals.

Another practical use for seals is to render a swing door single-acting (swinging out only). Most shower hinges are double-acting, meaning they allow the door to open in and out. The best way to make a door single-acting is to use a stop or strike at the handle side of the door. Quite often the stop/strike is a polycarbonate seal.

It is important to note, most single-acting doors should be an outswing only (check local building codes). A door that is an inswing only could result in a person collapsing against the door, preventing access by emergency personnel.

Doors Wall Mounted
All frameless shower doors with hinges fastened to vertical walls should be attached to an adequate substrate that will support the weight and motion of the door. It is up to the glazier to ensure there is adequate support in the wall for the hinges to be safely fastened. Examples of adequate support include wood studs, or at least 1 inch of cement-like material, including tile or stone itself, or cement float or cement board. Anchors must be compatible with the support provided. The only application in which “tile on drywall” application can be used should be when a stud is directly behind the connection point. Tile on drywall without a stud immediately behind the connection point is not normally an adequate anchoring substrate.

Operable Door Limitations
The width and weight limitations for operable doors – sliding or swinging – are typically determined by the manufacturer of the selected hardware. Hardware manufacturer width and weight limitations should be followed and maintained. No implied performance should be assumed based on any similarities in hardware from different manufacturers. Strict adherence to the manufacturer’s specifications is strongly advised.

Use of Three Side-Mount Hinges
If three side-mount hinges are to be fastened to a wall, the pivot points should align with one another. If the pivots are misaligned, the door may slip over time. To check for pivot alignment, view the pivot points of the hinges from two directions: left to right and front to back.

- Left to Right alignment: A wall that is not very flat, has undulating tiles, or has a high point in the tile may present a center hinge that is either drawn inward on the wall or is pushed out into the door opening on the wall, creating a potential alignment problem. When hinge pivot points are out of alignment with one another, they tend to bind and work against each other, and the glass door sags (comes out of adjustment).

- Front to Back alignment: Tempered glass is quite often bowed or slightly twisted. When doors are hung, the hinges are clamped on the door and the glass is placed in the opening for marking the holes in the wall. Hinges mounted to a wall on a bowed piece of glass can result in a center hinge that is “pushed in or out” into the room more than the top and bottom hinges. When hinge pivot points are out of alignment with one another, they tend to bind and work against each other, and the glass door sags (comes out of adjustment).

Fixed Panels

Fixed Panel Attachment

- All fixed panels that contact a vertical wall should be fastened mechanically on two edges: (1) horizontal and (1) vertical (bottom and side) or (2) horizontal (top and bottom). The substrate to which the fixed panels are fastened should be adequate to support the fixed panels.
- Fixed panels can be attached using U-channel extrusions or clamps.
- All U-channels (see Figure 8) should be mechanically fastened to substrates using stainless steel screws. When a screw penetrates the tile/stone, silicone sealant should be used to fill the hole before the screw is fastened. After the U-channel is permanently fastened to the base/wall, the heads of all screws should be fully covered using silicone sealant to prevent water infiltration.
- Clamps can also be used to capture fixed panels. All clamps should be mechanically fastened to adequate substrates using stainless steel screws. When screws penetrate stone or tile, the pre-drilled hole should be filled with silicone sealant before the screw is installed to prevent water leakage. At least one clamp should be used at the bottom for fixed panels up to 12 inches in width. Panels wider than 12 inches should use at least two clamps. Consult with the hardware manufacturer for recommended clamp spacing/placement.

FIGURE 8 *U-channel extrusions*

Fixed Panel Size Limitations

Most frameless shower enclosures are assembled using ⅜-inch and ½-inch (10 mm and 12 mm) thick glass. The glass thickness to be used on an enclosure is typically determined based on three factors: total height, total weight, and total square area. See Table 5 for industry-standard panel size and thickness limitations based on the panel support configuration.

Maximum recommended heights are associated with ⅜-inch and ½-inch (10 mm and 12 mm) thick glass. The maximum height recommended for ⅜-inch (10 mm) glass when it is supported on either two sides and the bottom, or two horizontal sides is 84 inches (2114 mm). For ½-inch (12 mm) glass when it is supported on either two sides and the bottom, or two horizontal sides, the maximum recommended height is 120 inches (3048 mm).

TABLE 5 *Fixed Panel Height Limitations for Frameless Glass Panels*

Fixed Panel Size:	*Under 7 feet (84 inches) (2133.6 mm)*	*Up to 10 feet (120 inches) (3048 mm)*
Two-Sided Support (L-shape)	⅜-inch (10 mm) glass thickness	½-inch (12 mm) glass thickness
Three-Sided Support	⅜-inch (10 mm) glass thickness	½-inch (12 mm) glass thickness

Contact a shower professional to address panels exceeding these guidelines.

An additional factor to consider when determining what glass thickness to use is the maximum "unsupported corner" width. An unsupported corner of glass is one that is adjacent to a door or an opening to enter a shower, created by an L-shaped support. The panel of glass that is next to a door or walk-through opening that has no top support has a top corner of glass that is unsupported. The wider the panel, the more the top unsupported corner of glass will move. Thicker glass helps this corner to remain more rigid. The maximum recommended width for an unsupported corner using ⅜-inch (10 mm) glass is 30 inches (762 mm). If ½-inch (12 mm) glass is used on an unsupported corner, the maximum recommended panel width is 36 inches (914 mm) (see Table 6).

TABLE 6 *Fixed Panel Size Limitations for Frameless Glass Panels with Unsupported Top Corner*

Glass Thickness	*Maximum Height*	*Maximum Width with Unsupported Top Corner*
⅜-inch (10 mm)	Up to 84 inches (2133.6 mm)	30 inches (762 mm)
½-inch (12 mm)	Up to 120 inches (3028 mm)	36 inches (914.4 mm)

Fixed Panel Weight Limitations

When **floor supported** panels are installed plumb and on setting blocks, the hardware does not support the panel weight. A plumb fixed panel, conceptually, has no reason to "fall" one way or another. If the glass is reliably resting on setting blocks at the bottom, is installed plumb, and the substrate upon which it is resting is sufficient to support the weight, no weight limitations on a fixed panel should be required.

Suspended Panels (not supported on the base) are not recommended in a frameless shower enclosure.

Doors Hinged to Fixed Panels

Any door hinged directly to a fixed panel of glass imposes a load on the fixed panel. For the door to operate safely, the fixed panel should be held firmly in place. There are several ways to safely secure the fixed panel from which the door will hinge. One way is to attach the fixed panel to a ceiling/soffit, capturing the top and bottom edges of the glass. Another method is to use a header extrusion across the top of all fixed panels or a support bar. In reference to support bars, see the manufacturer for the specific application and limitations. Doors may also hinge from a fixed panel of glass that has no top support, creating a header-free application. This header-free application has very specific criteria that should be strictly adhered to create a safe application. The header-free criteria are:

- Fixed panel should be ½-inch (12 mm) glass and attached to a vertical wall.
- The fixed panel should not exceed 22 inches (559 mm) in width, or 84 inches (2134 mm) in height.
- The fixed panel should have valid bottom support (mechanically fastened to the curb/floor).
- The fixed panel should use large, heavy-duty wall mount brackets (3-½ inches (89 mm) in height and with a 90° "L" shape that fastens to the wall) and there should be the same number of wall brackets as there are hinges.
- The door cannot exceed 30 inches (762 mm) in width and can be either ⅜-inch (10 mm) or ½-inch (12 mm) glass.

These criteria will work for doors hinging from a panel that is aligned at 180° and 135° to the door. It is not recommended for 90° return panels.

Doors Installed with Pivot Hinges

Pivot hinges offer an alternative to wall mount hinges. One advantage of using pivot hinges instead of wall mount hinges is that the weight of the door is focused on the bottom of the door instead of along the wall. This reduces the likelihood of the glass slipping from the hinge, which is the most common reason for call-backs related to installation

issues. This option is particularly important when inconsistencies in the wall make it difficult to align the pivot points of wall hinges. Pivot hinges are a useful alternative to the combination bottom wall hinge attached to a knee wall and using a glass-to-glass top hinge, which can be difficult to properly align (See Figure 9).

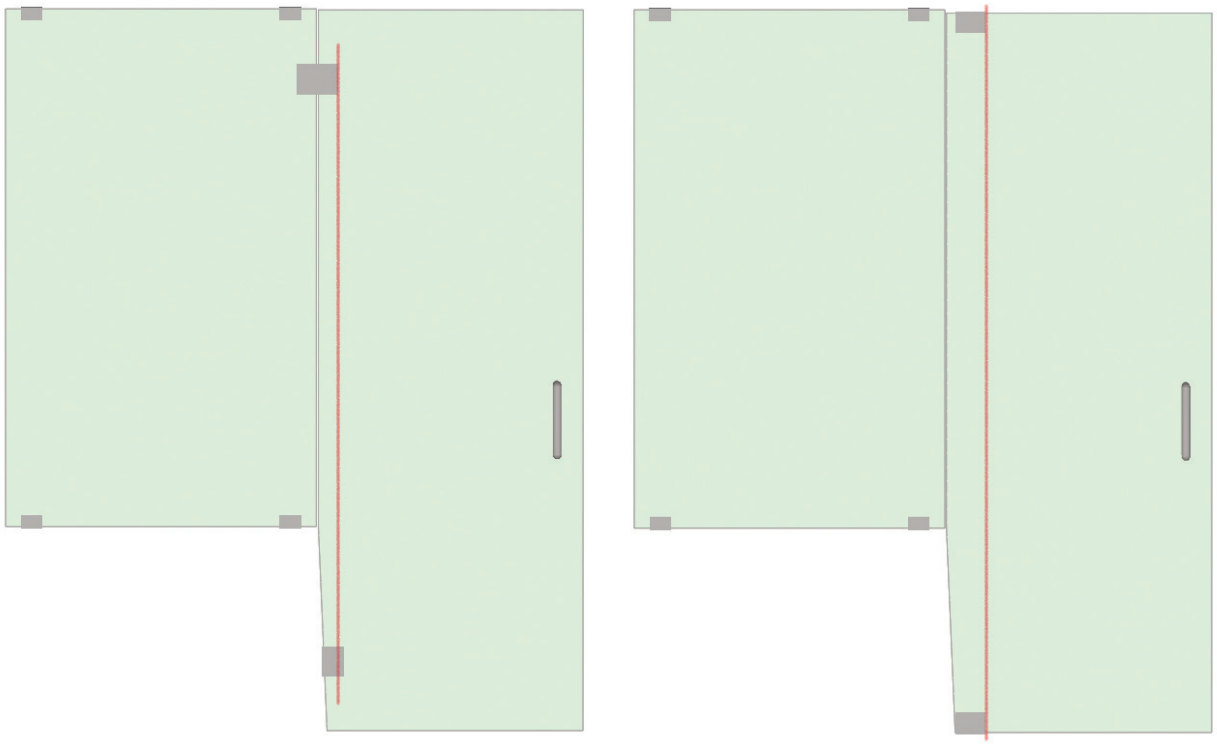


FIGURE 9 *Example of pivot hinges used in knee wall applications.*

Pivot hinges, like most wall hinges, are self-centering and may be available with 5° pin adjustment. Unlike most wall hinges, pivot hinges can rotate a full 360°, or until they encounter another object in the room. This is different from wall hinges that only open to 90° outside of the shower and 90° into the shower. This may be an important distinction to some homeowners, depending upon their environment. There is also a difference in the distance between the wall and the pivot point of a pivot hinge versus the distance between the wall and the pivot point on a wall mounted hinge. Usually, the pivot hinge will be at a greater distance from the wall, which reduces the entry width of the door and increases the distance that the back of the door swings into the shower.

Specific Types of Showers

Splash Panel

The customer should be informed that this configuration may not minimize water escape nor trap heat as well as a full enclosure. There are standard limitations to the glass width and height to be considered.

Sliding Showers

Some openings are too narrow to accommodate a sliding door kit. Openings smaller than 48 inches have a small walk-thru space when the door is in the open position.

Consider the shower head location. If it is on the same side as the door, then the sliding door should be mounted on the inside of the header bar so water will not come out of the gap between the glass. If the shower head is on the opposite side of where the door will need to go, the door should be mounted on the outside of the header bar for the same reason.

If a barn door slider is being installed on a tub, measure the depth of the portion on which the sliding door guide will rest (see Figure 10). Barn door sliders may not work if the tub ledge does not have enough flat surface to accommodate the depth of the assembled unit.

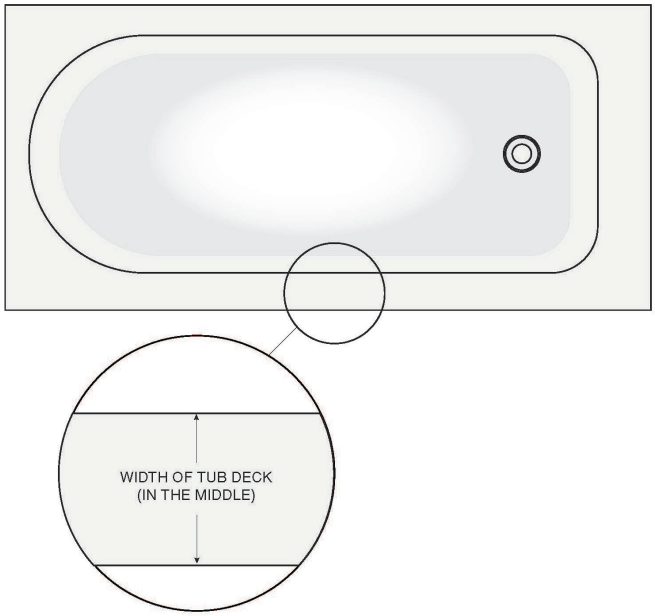


FIGURE 10 *Consider the width of the tub deck to ensure adequate flat surface is available to support sliding doors.*

Check the base for an out-of-level condition. If there is an out-of-level condition, you may have to revise the deduction(s) on the door(s) so that when it/they slide(s) it does not hit on the high side. If the out-of-level is severe, then a barn door might not be your best option.

As always, frameless doors are not designed to be watertight. Sliders are no exception. The gaps at the bottom of the door and between the glass create the potential for water to escape (see Figure 11). Review with the customer the reasons their enclosure design could have water escape with the slider option.

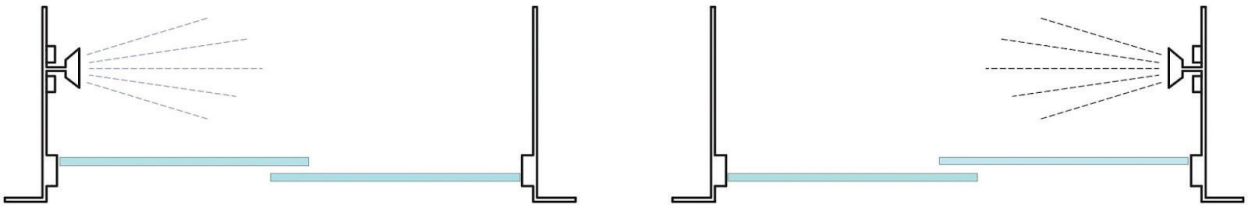


FIGURE 11 *Diagram of sliding door orientation with respect to shower head*

Types of Frameless Sliders

When installing Sliding Showers, please refer to all manufacturer's instructions for ordering glass and installation. See Figure 12 for examples of types of frameless sliding doors.

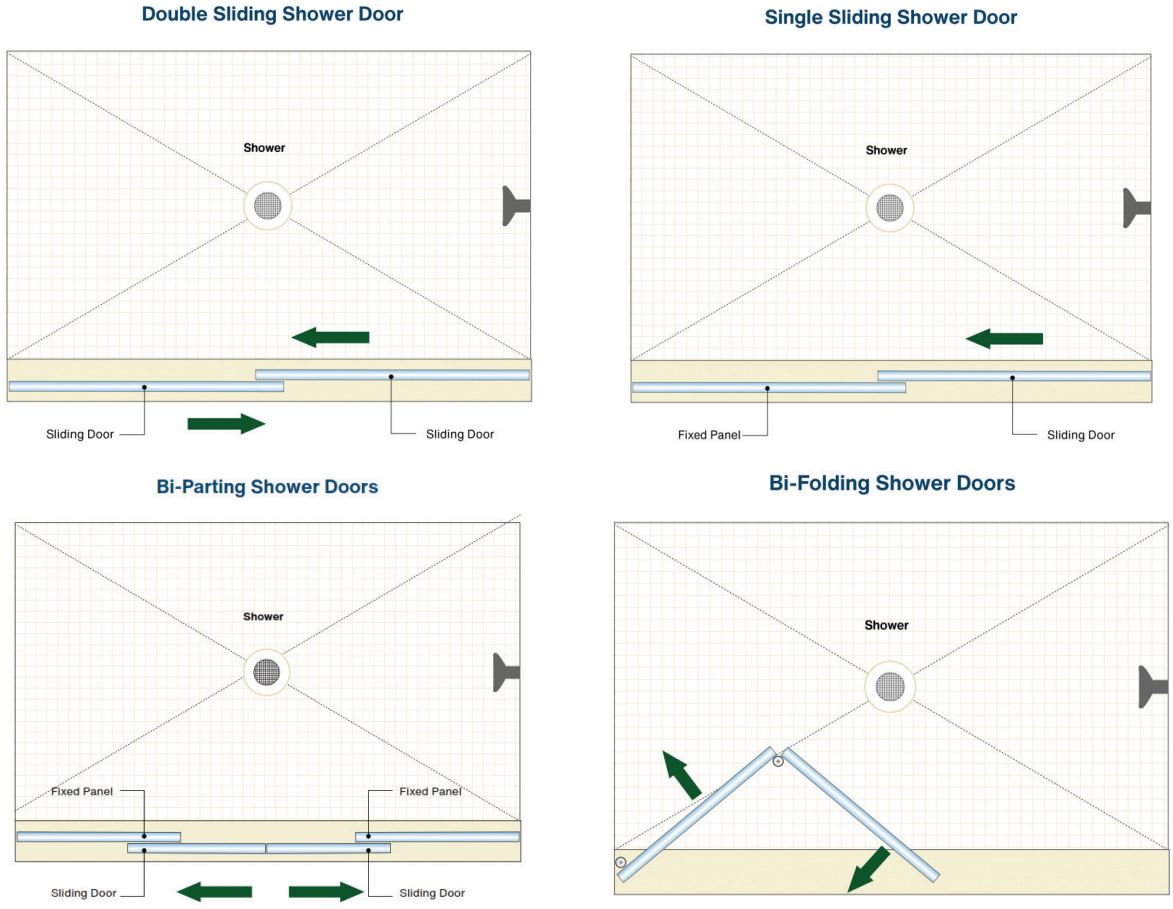


FIGURE 12 *Examples of frameless sliding doors*

Neo-Angle Showers

A neo-angle shower can be a challenge for an installer based on the field conditions. There are several variables that can dictate how to approach such a configuration.

Full Height Wall Conditions

A shower enclosure that has full height angled walls other than 90° is generally going to require the use of either adjustable clamps/hinges or another method of installing the door/fixed panel terminating into a wall at an angle to the threshold/base.

If a fixed panel is butting a wall at an angle to the threshold/base, the installation is now non-traditional (not a 90° angle). An adjustable wall mounted fixed panel clamp may be used to fasten the fixed panel to the angled wall. Another answer is to capture the panel at the top by using a header or bringing the height of the panel directly to the ceiling. In a top support condition, the glass can be mitered (or not) and butt directly adjacent to the wall.

A third method of supporting a panel to an angled wall is to fasten an "L" angle on the back side of a U-Channel, effectively shimming the channel until it is in-line with the threshold/base (see Figure 13).

If a door is hinged from a wall that is at an angle to the threshold/base, using adjustable hinges is the most common method of compensating for the angle. An adjustable hinge has a mechanism that changes the self-centering location of the door and aligns it to the threshold/base.

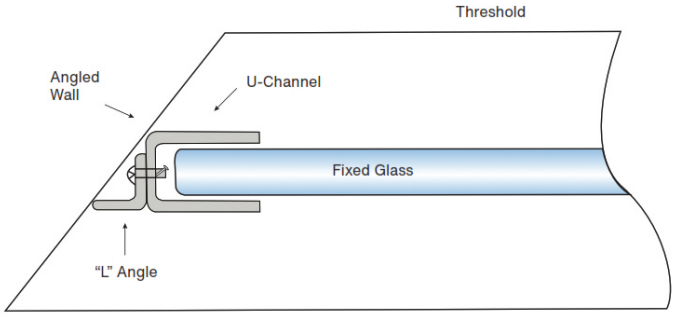


FIGURE 13 *Example of supporting a glass panel to an angled wall.*

Knee-Wall Conditions

Any time there is a change of angle and a change of elevation, there typically is a need to identify exactly how this condition looks. When rendering a drawing that contains a change of angle/elevation, an overhead/plan view should be used. There are numerous possibilities, the most common of which are found in Figure 14. All views shown in Figure 14 are at 135° and all are different from one another.

Referring to Figure 14, the best scenario is to have the threshold/base butt the knee-wall at 90° (top image). If the threshold/base runs into the knee-wall at an angle other than 90°, using side mount hinges on the knee-wall may not be possible. Conflicting pivot points from the wall mount hinge to the glass-to-glass hinge may rule out the use of side mount hinges. Particular attention must also be paid to any out-of-plumb conditions which might be present on the knee-walls.

Not all variables are addressed in this manual. Redesign may become necessary through homeowner and installer conversations. Remaining questions should be directed to a frameless shower professional.

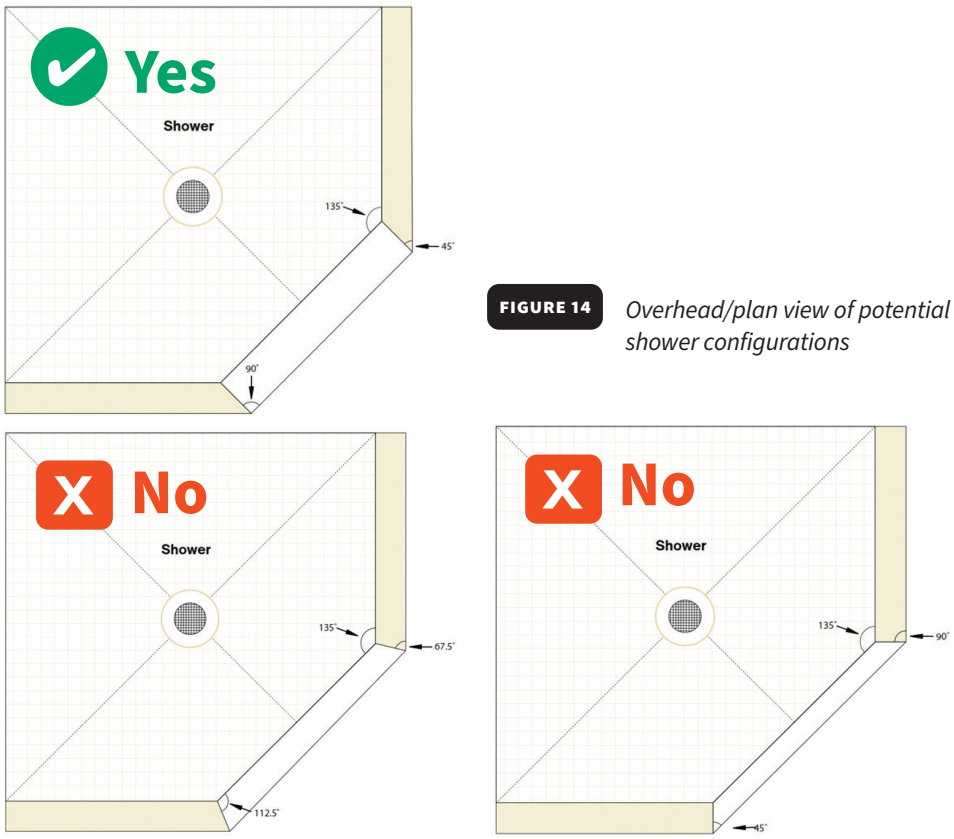


FIGURE 14 *Overhead/plan view of potential neo-angle shower configurations*

"True" Neo-Angle?

A neo-angle shower is one that has one or more angles at 135°/45°. The angles of 135°/45° make up what is known as a "true neo-angle". Care should be taken to ensure the angles being measured are, in fact, true neo-angles. Quite often the angles recorded will depict angles that are not exactly 135°/45°. The best way to be sure is to measure the angle(s) using an angle measuring tool or making a paper pattern and using a protractor. Once the angles have been verified choosing a hinge type is the next step. Pivot hinges or side mount hinges can be used.

If the angles are 135°/45°, then standard 135° glass-to-glass side mount hinges can be used, or pivot hinges adapted into a header or transom, or a 135° glass hinge bracket can be used. If the angle is non-standard, decisions must be made on how to approach. Pivot hinges in either a header or transom are possibilities. If glass-to-glass hinges are being used, an adjustable 135° hinge should work best. Using standard glass-to-glass 135° hinges may be a viable option on a non-standard angle in some circumstances.

Steam Showers

A true steam shower includes a system to create steam and pump it into the space. However, some units are built simply to trap the steam that is created while taking a shower. A frameless glass steam shower is built using floor to ceiling panels. Seals are used to close the gaps as much as possible, but homeowners should be made aware that a frameless glass steam shower will never be completely airtight.

Common Hardware Options

Frameless Glass Hinges – Typically made of solid brass or stainless steel, frameless glass hinges can offer dual acting, self-centering operation. Hinges come in a variety of configurations (see Figure 15) including glass-to-wall or glass-to-glass (180°, 90° and 135°). Multiple hinge backplate options are available for wall mount hinges: full backplate, "H" backplate, short backplate, offset backplate, offset short backplate or jamb mounted to minimize water escape or adjustability depending on the manufacturer. Many hinges offer the capability to create a 5° offset inward to facilitate a positive closure against a strike/stop.

FIGURE 15 *Examples of frameless glass hinges*

Frameless Glass Pivot Hinges – Typically made of solid brass or stainless steel, frameless pivot hinges differ from side mount hinges in that they are mounted at the top and bottom of the door rather than the vertical edge (see Figure 16). Pivot hinges can be mounted at the curb or floor at the bottom. The top pivot hinge can be mounted to the ceiling, into a header, to the wall or to an adjacent panel. A suitable substrate should be installed in the ceiling for a ceiling mounted pivot hinge application.

FIGURE 16 *Example of frameless glass pivot hinge*

FIGURE 17 *Examples of wall mount pivot (top hinge)*

Wall Mount Pivot (Top Hinge) – To allow for wall mounting, a specialized bracket normally replaces the standard pivot base (see Figure 17). An adequate substrate should exist in the location where the hardware will be screwed to the wall. Keep in mind that the pivot point of the top wall hinge should be in line with the bottom pivot point. This may not be possible in some out of plumb wall situations, which should be determined at time of measure. Also consult manufacturer recommendations to determine the maximum width and weight of the door for the selected top hinge. This hinge may not support the same size door as the bottom hinge.

Top Hinge Installed in Header – If the top hinge is going to be installed in a header, then the base plate may be replaced with an adaptor that is secured into the header (see Figure 18). Other header mount pivot hinges may come pre-assembled and will not require removal of the base plate.

FIGURE 18 *Examples of top hinge installed in header.*

Top Pivot Hinge Mounted to Same Height Fixed Panel –Pivot hinges are available with a clamp that attaches to a glass panel that is the same height as the door (see Figure 19). See hardware manufacturer recommendations for size and weight constraints for both the support panel and the door. This hinge typically has two methods for fabricating the glass. The first method is a shallower cutout in the glass, resulting in the top of the hardware sitting above the height of the door and panel. The second method is a deeper cutout that allows the glass to wrap around the hinge and flush mount the hardware.

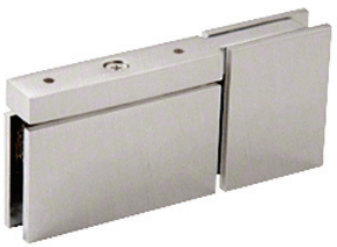


FIGURE 19 *Example of top pivot hinge for a fixed panel at the same height*

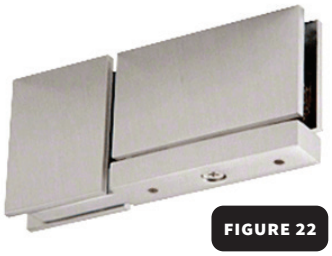
Glass-to-Glass Top Hinge Mounted to Taller Fixed Panel – Pivot hinges are available with a clamp that attaches to a glass panel that is affixed to the ceiling. See hardware manufacturer recommendations for size and weight constraints for both the support panel and the door.

Transom Mounted Glass-to-Glass Top Hinge – Glass-to-glass pivot hinges can be mounted to a transom above the door (Figure 20). See hardware manufacturer recommendations for size and weight constraints for both the support panel and the door, and appropriate methods for securely attaching the glass transom.

FIGURE 20 *Example of transom mounted glass-to-glass top hinge*

Bottom Pivot Hinge Alternatives – Wall mounted pivot hinges can be installed upside down as a bottom hinge, as shown in Figure 21. This is useful in situations when secure mounting into the bottom curb or floor is not possible or not desirable. Ensure that the wall has suitable substrate for a secure attachment and consult the manufacturer recommendations for maximum door width and weight. Consider reviewing and adjusting the fabrication cutout if needed to achieve the desired gap under the door.

FIGURE 21 *Example of wall mounted pivot hinge installed as a bottom hinge*



The Top Pivot Hinge Mounted to Same Height Panel can also be used as a bottom hinge as shown in Figure 22. In this application, a special cutout is needed to wrap the glass around the panel portion of the hardware but maintain a gap at the door portion of the hardware. Note that this application still includes attaching the hardware securely to a curb or floor with suitable substrate.

FIGURE 22 *Example of top pivot hinge installed as a bottom hinge*

Frameless Sliding Shower Doors – Can be either a single sliding door or double sliding doors (see Figure 23) and are available in many designs and configurations. Sliding doors are most often used when space is limited or as desired for aesthetics.

FIGURE 23 *Example of frameless sliding doors*

U-Channels – Aluminum, solid brass or stainless steel “U” channels typically are used on frameless enclosures either below a fixed glass panel, vertically up a wall, or above the fixed panel to secure and seal the glass. Channels offer more adjustability than frameless glass brackets and can hide some inconsistencies in the wall surface. If not using a channel, the surface must be near-perfect.

There are numerous types of U-Channels that can be used. Channels are available in various widths and depths. The material used to construct the U-Channel also varies. Channels can be made of aluminum, brass, or stainless steel. There is quite a variety of Channels on the market and installers have their preferences. See Figure 24 for a sampling of U-Channels.

FIGURE 24 *Examples of U-Channels*

Frameless Glass Clamps –Typically made of solid brass, frameless glass brackets (also called “clamps” or "clips”) are accepted as a secure way to fasten glass in an opening with minimal hardware. Brackets can be used at the base, the wall or the ceiling. The benefit of brackets is to expose more of the glass edge, creating a more frameless look.

The 2” clamps with a single hole in the middle are by far the most popular but are not the only clamps available for use. There are two-hole versions of the 2” clamps, offset mounting leg versions and full-size brackets which match the proportions of hinges. The centerline marking method is still used; however, the clamp should be placed on the mounting surface and aligned to where the center of the glass would relate to the clamp. The holes can then be marked for drilling. See Figure 25 for examples of frameless glass clamps.

FIGURE 25 *Examples of frameless glass clamps, also known as brackets or clips*

Handles/Pulls/Knobs - There is a wide variety of styles of handles/pulls/knobs to match bath hardware or design intent (see Figure 26). Typically constructed of solid or tubular brass, stainless steel or aluminum, handles typically mount through holes in the glass. Rubber or plastic washers should be used between handle and glass to prevent metal on glass contact.

FIGURE 26 *Example of handle/pull*

Headers – Headers are typically used at the top of some frameless showers to lend stability to what may be an otherwise unstable configuration. Headers are most often made from aluminum or brass. The most common use for a header is on a shower structure that does not go to the ceiling and has one or more panels that need support. Headers can also be used with pivot hinge doors that have no fixed panel. There are headers available in different shapes and sizes depending on the desired look (see Figure 27). A commonality across all headers is the ability to use them to capture the top of fixed glass.

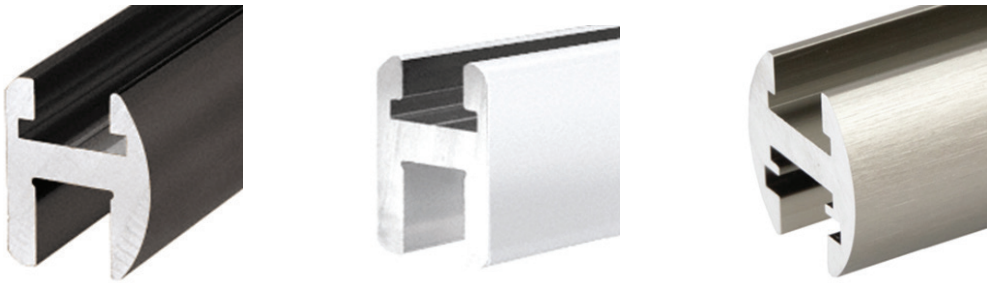


FIGURE 27 *Examples of headers*

Support Bars – Typically made of tubular brass, support bars are most often used on a fixed glass panel when support is required or desired to provide additional stability (see Figure 28). Support bars can be mounted horizontally from the glass to a wall, glass to glass or vertically from the glass to the ceiling. Options include sleeve-over mounting and through the glass mounting.

FIGURE 28

Example of support bar

Sleeve-over Clamps – Clamps that slide over the top of the glass (tightened in place with a nylon-tipped set screw) can be used to mask alignment issues and add stability, but should not be used on glass under any structural load. The clamps do not require fabrication and come in glass-to-wall and glass-to-glass configurations of 90° and 135° and adjustable angles (see Figure 29).

FIGURE 29 *Example of sleeve-over clamp*

Polycarbonates (seals, bubbles, fins, strikes, or sweeps, etc.) – Extruded polycarbonates (see Figure 30) used to fill gaps can be self-adhesive or slip over (slide-on or sleeve-on). They are designed to minimize water escape. When used between the glass and the wall, seals can reduce usage of silicone by creating a caulk backer as well as cushion glass from contacting the wall or curb material.

FIGURE 30 *Example of extruded polycarbonate sweep*

Sealants/Caulking/Adhesives – There are many different options for silicone (see Figure 31). Preferably, a mildew resistant silicone or a "water clear" silicone would be used for long-term cleanliness and clarity.

FIGURE 31 *Example of tube of sealant*

Considerations when Removing an Existing Shower Enclosure

When removing an existing framed or semi-frameless shower enclosure and prepping a new one, these steps should be followed:

1. Assess how the original shower enclosure is secured. Review all visible fastening points.
2. Remove all enclosure doors. This may involve lifting sliding doors out of the top track or unscrewing the fasteners attaching a swing door to the frame.
3. Begin with the door opening; unscrew all visible fasteners and remove components.
4. Tap the vertical frame pieces to help loosen them.
5. Cut loose and remove all glued and caulked frame pieces.
6. Thoroughly clean the opening in preparation for the new enclosure.
7. Align new enclosure such that it will utilize and/or cover existing holes left by the previous enclosure. If this is not possible, consider covering holes with new tile or devising hardware ideas to cover existing damage/stains.

Section 2: Measuring Frameless Glass Showers

Measuring is arguably the most important aspect of the frameless shower installation process. It has been said that a well-measured, thoughtfully engineered frameless shower can be installed by a technician with limited experience, as all the glass should fit into the opening. On the other hand, even the most experienced installer cannot make poorly measured glass fit correctly. The importance of measuring and designing a safe enclosure cannot be underestimated.

The tools of the measuring trade are simple: tape measure (or alternate device), various lengths of levels (torpedo, 2, 4, and 6 feet), laser level if preferred, painter's tape, paper and pen (or equivalent electronic device), step stool, and shims.

Once the design of the enclosure has been decided upon, measuring can begin. Here are the recommended steps:

1. Create a rendering of the shower (as viewed from the outside of the shower) to make note of the dimensions and all other pertinent information.

2. Using a measuring tool, take dimensions of all surfaces which will have glass mounted on them. Measure at least twice and get exact dimensions.

3. One of the simplest and most important factors of a well-designed and executed shower stall is a properly pitched curb. The slope of the curb should be ⅛-inch to ¼-inch over a 6-inch span and should slope in the direction of the shower drain. If the curb slopes to the outside (away from the drain), no amount of caulking or application of plastic seals is likely to prevent water from draining out. A perfectly level curb is likely to create an issue with water pooling up and eventually spilling out.

4. If there are angles other than 90° associated to the enclosure, take paper patterns of the angles, assuring to make notes to orient the folded paper angles. Plot the angles on graph paper and use a protractor to document the angles.

Centerline Glass Dimensions

Centerline glass dimensions are ideal when measuring and laying out the shower design. Most fabricators prefer centerline glass dimensions if they are calculating deductions. In a case when outside or inside dimensions are being used, they should be noted so the fabricator can account for them when making the glass deductions.

Identifying Out of Plumb and Out of Level Conditions

Once all the dimensions of the enclosure are documented, it is time to use a level on all surfaces that are going to have glass mounted to them. The level is used to determine the out-of-plumb/level conditions and to check the surfaces for flatness (see examples in Figures 32, 33 and 34). **Key tip: Out-of-Plumb refers to vertical walls and Out-of-Level indicates horizontal planes.** Make notes of the out-of-plumb/level conditions that exist in the opening. Once all the out-of-plumb/level figures have been transcribed to the measure sheet, make sure the original shower dimensions and out-of-plumb/level figures reconcile. Write clear, concise numbers so there can be no mistake when reading the numbers back.

Sometimes the design of the shower enclosure can change at this point based on the information gathered when measuring the opening. For example: the customer may have wanted to use clamps as a fixed panel fastening method, but after using a level as a straight edge to check the surfaces for flatness, it may be determined that using clamps will expose wavy wall surfaces making for a bad look (see Figures 33 and 34). Perhaps using a U-channel in lieu of clamps would solve the issue. The point being: field conditions outside the control of the shower installer can lead to tweaking the customer's design.

Another issue to contend with during the measuring process relates to minimum and maximum glass sizes based on the application. There are minimum size requirements which may require contacting the fabricator to determine their capabilities. The minimum glass width may vary depending on how the glass is used. Does it have only flat polish on the edges, does it have a miter on one or two vertical edges, or does a door hinge from this small panel? All may have different answers and may affect glass-size specification. It becomes important to get these answers before generating finished sizes.

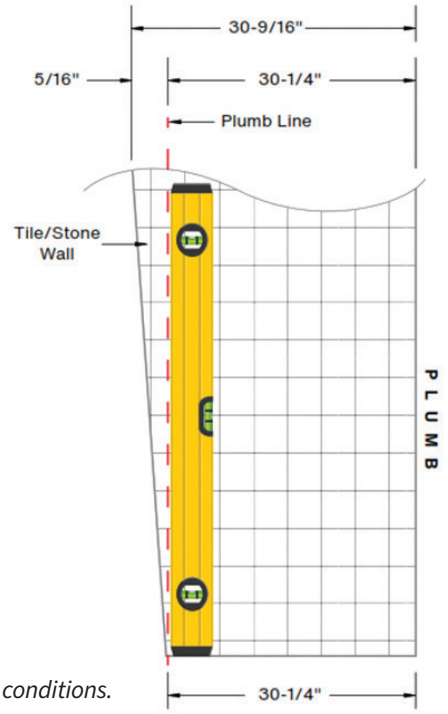


FIGURE 32 *Use a level to determine out-of-plumb wall conditions.*

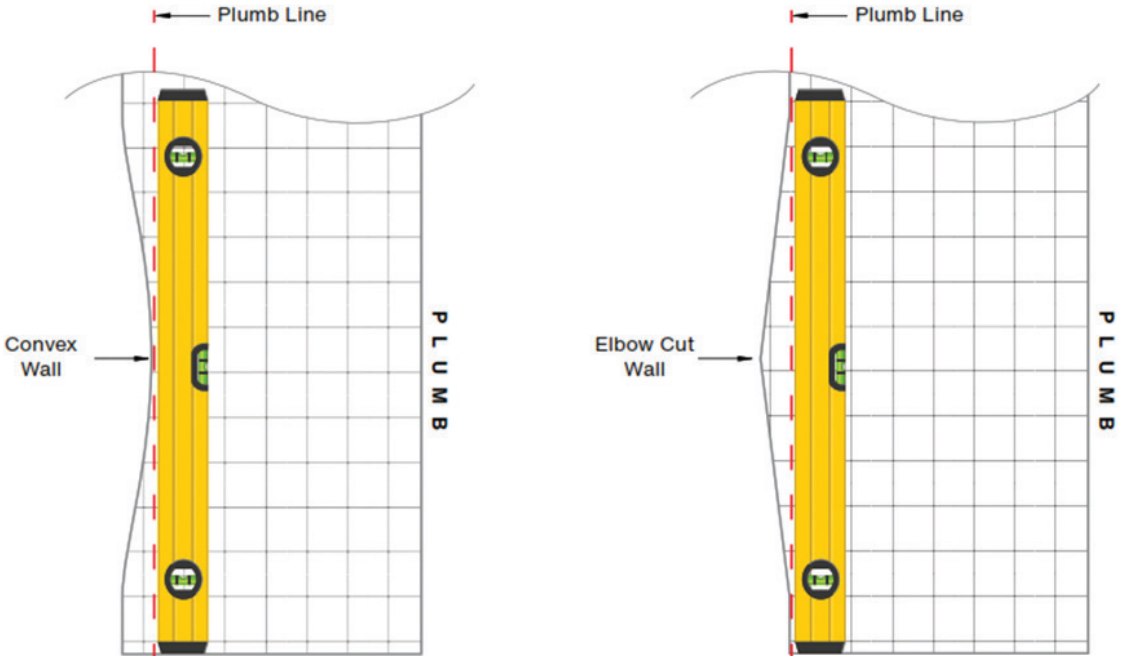


FIGURE 33 *A level indicating convex and elbow cut wall conditions*

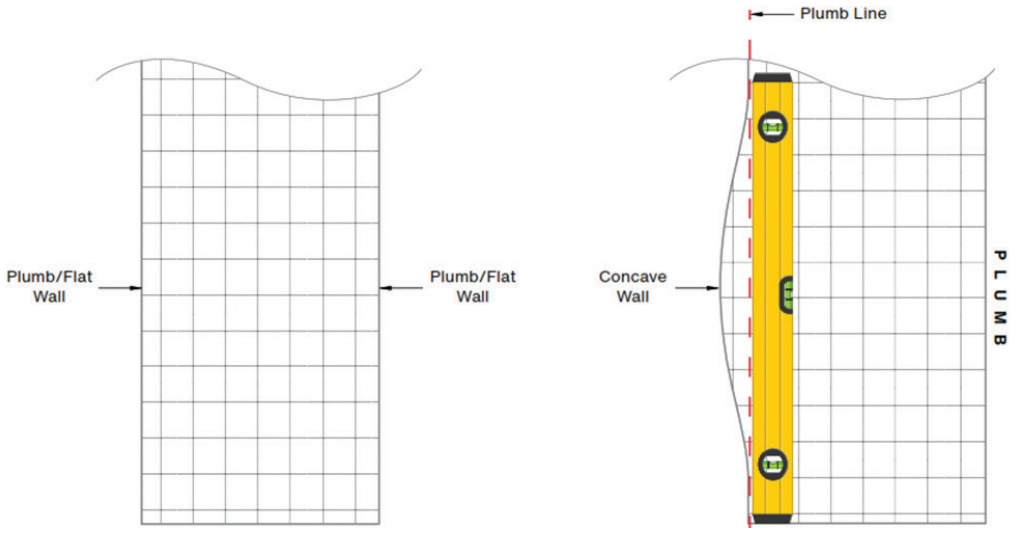
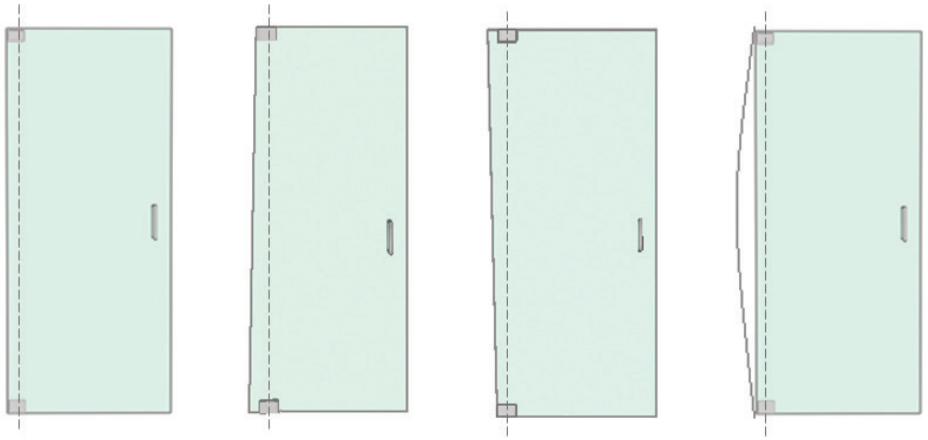


FIGURE 34 *Plumb/flat and concave wall conditions*

Compensating for Out-of-Plumb in Wall Mounted Hinge Installations
When a wall is out-of-plumb, but straight, the glass can be cut out of square and installed with hinges in alignment. When there is a bow or elbow in the wall where hinges will attach, determine how to address the situation (see Figures 33 and 34). For example, shims may be needed behind a hinge plate to align it with the other hinge. It may also be necessary to reduce the finished width of the door glass if a convex wall, elbow, or other uneven tile situation is reducing the finished width of the opening.

Compensating for Out-of-Plumb in Pivot Hinge Installations
The most important part of the fabrication and installation of the pivot hinges is to ensure that the pivot points of the top and bottom hinges are in alignment. Misaligned hinges will not work properly and could cause damage to the hardware, and potentially the glass, over time. If the glass is cut out of square to compensate for an out-of-plumb wall condition, the position of the top or bottom hinge should adjust to remain in alignment (see Figure 35). Note that inconsistencies in the wall may not affect the operation of the hinges, but unsightly, leak-prone gaps should be discussed with the customer.



FIGURES 35 *Examples of compensation for out-of-plumb in pivot hinge installations*

Verify Measurements While On-Site

If the physical dimensions and out of plumb/level figures do not add up correctly, they should be refigured while still on the jobsite.

Figure 36 illustrates an example of reconciling the math: if a single door opening measures 30-¼ inches tight from wall to wall at the bottom of the opening, the right vertical wall is plumb and the left vertical wall is 5⁄16-inch out-of-plumb growing wider at the top, then the width of the opening at the top must be 30-9⁄16 inches.

This dimension to out-of-plumb/level relationship is crucial and plays a much larger role as the enclosure types get more complex, with panels to the ceiling. If the numbers do not reconcile, the miscalculation should be found and corrected while still on the jobsite.

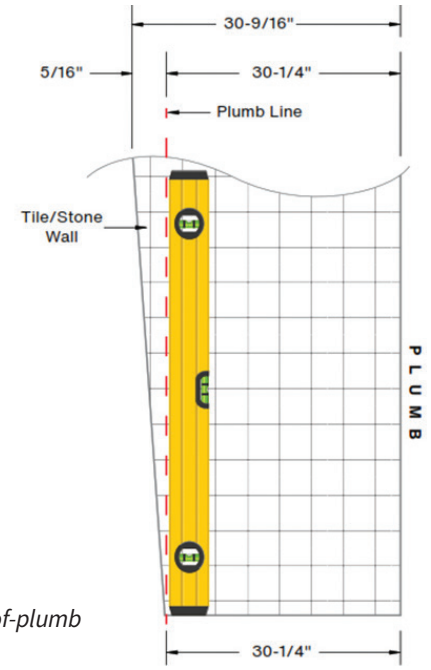


FIGURE 36

Example of out-of-plumb condition.

Specifying Hardware Type & Location

When generating glass sizes by hand, one can make all the decisions for which hardware is to be used, the placement of the various hardware types and the clearances used between the glass and other glass/walls. However, many glass professionals opt to send their drawings to a source outside their company to figure glass sizes and hardware placement using a computer program.

If the measurement drawings are sent to an outside source for computer glass sizing, it is advisable to note all preferred hardware and any special conditions or clearances that may be required. For example, if wall mount hinges need to be mounted in a special position instead of a default location, make notes on the drawings for the special placement. The same goes for special clearances between glass panels and other panels/walls. Also, it is advisable to verify that all the dimensions presented add up with one another and the drawing is mathematically sound.

Not all shower hardware fittings use the same fabrication templates as one another and though a hardware fitting may appear to be visually the same as another, there can be fabrication differences.

Calculating Deductions and Finished Glass Size

Once all the accurate measurements are recorded and the hardware has been selected, glass sizes can be generated. There are several different ways in which glass sizes can be calculated.

Glass sizes can be drawn and calculated without the assistance of a computer glass calculating program. A glazier that figures their sizes manually will often have pre-drawn template pages depicting doors and various panel types, ready to fill in the sizes.

Another way of producing finished glass sizes is the use of a glass sizing computer program. A user enters the field dimensions of the shower enclosure and any out of plumb/level conditions. The user selects the hardware, then the program generates the finished glass sizes with deductions. Special clearances can be generated in the program. Shower design programs can also provide glass and hardware pricing and metal cutting instructions. Some shower programs can also be used to generate customer quotes.

Glass sizes can also be generated by sending the field dimensions to a glass fabricator and having the sizes figured by the fabricator. Many fabrication professionals use a computer program to calculate the glass sizes. This puts the responsibility on the fabricator to make sure the sizes are correct. Check with the fabricator to see if this is an option.

Consider Install Location Accessibility

Make sure to evaluate the entire room to determine whether all large pieces of glass can be brought into the bathroom for installation. Sometimes a shower is sold, ordered, and brought to the jobsite only to find a panel of glass is too large to go through a doorway or upstairs. It is best to figure all of these variables at the time of measure.

Rakes

Rakes are a field condition requiring a glass panel (or panels) to have a clipped corner. Applications with rakes can be a challenge to measure. To generate finished glass sizes mathematically, a rake should be accurately measured. It is always better to take more dimensions and have too much information, instead of too little. An alternate method of measurement is to produce a physical template that can be provided to the glass fabricator.

If the rake is on the hinge side of a door, care should be taken to assure the glass doesn't collide with the tile/stone when the door is opened. See Figure 37 for an explanation of what to measure and key dimensions to record.

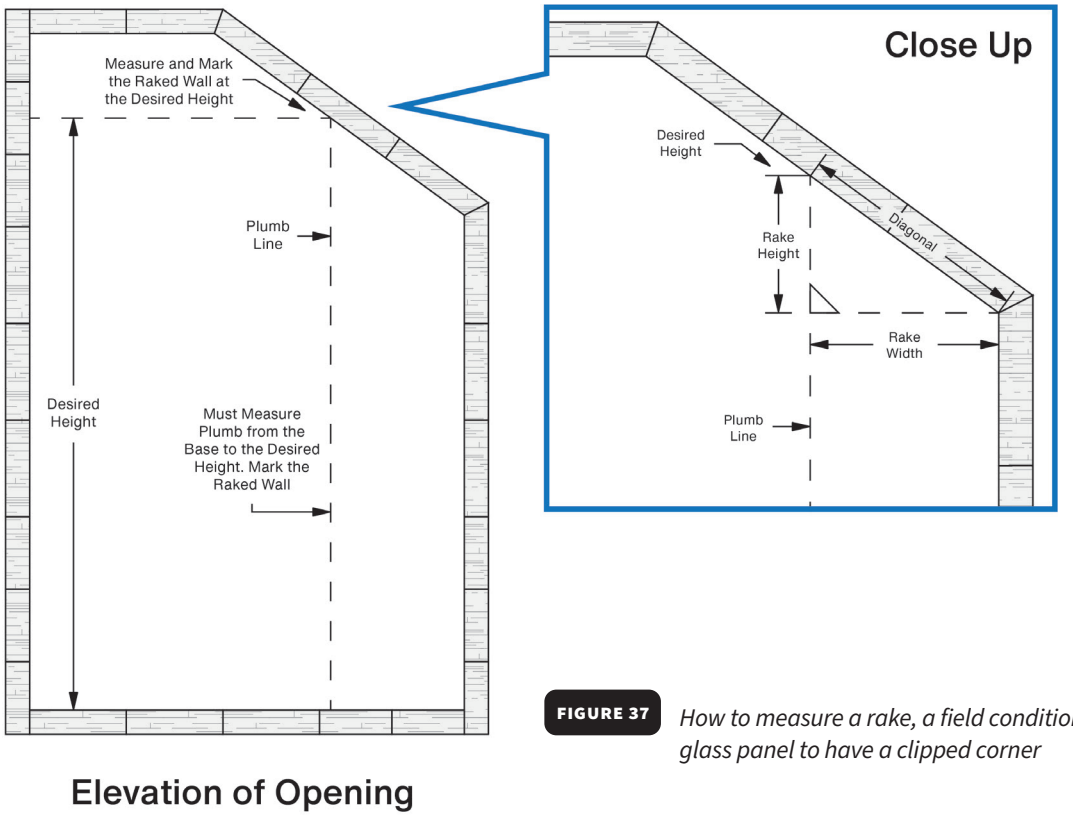


FIGURE 37 *How to measure a rake, a field condition requiring a glass panel to have a clipped corner*

Arches

Arched openings will generally require a physical pattern to be made. If any of the arched portion is a door and the idea is to bring the glass close to the top of the arch, care should be taken to assure the glass does not collide with the tile/stone arch when the door is opened. It is advisable to use the physical arch pattern, position it in the opening and "pivot it open" (both in and out, if required) as if it is the door to see how close the glass can get to the ceiling without colliding when the "door" is opened. If the door is to swing out only, a stop may be required.

Section 3: Installing Frameless Glass Showers

Preparation at the Shop

Before leaving the shop for a glass shower installation, the installers should ensure they have all tools and materials needed to complete the job. Many projects require some preparation or fabrication, for example: cutting aluminum, adding glass surface treatments, etc. Keep in mind that, while these tasks may be performed in the field, it is almost always easier to do them in the shop. This is not always possible, but it makes sense to do as much work as feasible before leaving for the jobsite. Some installers place hinges on doors in advance, depending on their method of installation.

It is normally best to inspect the glass as soon as it is received, as many tempering companies have a limited window to report damages or mis-fabrication, as do the trucking companies for filing claims for damage attributable to transportation of the glass. Details to be noted include the overall dimensions of each panel, scratches, chips and blemishes, placement of holes, cutouts, out-of-square conditions, type of glass, glass thickness, glass style and texture.

It is likewise normally best to check that the proper hardware is set aside for the installation. Check inside the hardware boxes to verify the hardware has the correct finish, as even direct from the supplier, the box is not always correct. Many glass professionals equip their service vehicles with spare parts in various finishes in case something is missed, or material gets damaged on the job. Additionally, some jobs require special tools that may not be carried in every vehicle. Having the correct tools and materials are of little use if they are forgotten in the shop. Consider making a checklist to be sure nothing is left behind.

Basic Tools

- Measuring Tape
- Hand Screwdriver with #2 (undercut) and #3 Phillips Bits
- Hand-Held Hacksaw
- Cordless Drill/Screw-gun
- Metal File (flat, two-sided)
- Rubber Mallet
- Level
- Razor Blades
- Allen Wrench Sets (imperial/metric)
- Caulking Gun
- Glass Suction Cup
- Flat Knife
- Plumb-Bob/Laser
- Glass Gloves
- Low Adhesive Tape (painters tape)

Important Tools

- Hammer Drill
- Diagonal Cutters
- Various Extension Cords/Adapters
- Spring Clamps
- Metal Countersink Set
- Rounded Metal Files
- Step Stool
- Powered Miter Saw
- Small Framing Square
- Small Hardwood Block
- Utility Knife
- Pry Bar
- Paint Brush (clean up)
- Tin Snips
- Shop vac

Consumables

- Correct Drill Bits
- Solvents
- First-Aid Kit
- Glass Cleaner
- Razor Blades
- Paper Towels
- Drop Cloths
- Lubricant
- Wax Stick
- Silicone
- Screw Anchors

Drilling

There are various substrates that require drilling to safely mount frameless shower hardware. Since there are many types of substrates, and not everybody is a tile/stone expert, there is bound to be some trial and error along the way. There are several types of drill bits to be used (see Figure 38):

FIGURE 38 *Examples of drill bits*

Regular Masonry
The Regular Masonry bits are quite often used on ceramic tiles. This is a good bit to start with to see how effective it will be. It is also good to start with this bit if working on smaller ceramic tiles.

Special Tip Percussion
The Special Tip Percussion bits are designed for the hardest tiles and stone types. Some substrates that require the use of these bits are the very popular porcelain tiles, as well as very dense stone, such as granite. Special Tip Percussion bits are designed to be used with a hammer drill. Avoid prolonged drilling periods by removing the bit from the hole and cooling the bit. Drill coolant is best to use, though many also use water. Simply remove the bit from the hole and allow the drill motor to stop. Dip the hot bit into the coolant. A satisfying hiss will occur.

Spear-Point
Spear-Point bits are for drilling glass tile and some marble materials. The key to using spear-point bits is to use them at very low RPM (revolutions per minute). These bits are designed to cut material while barely turning. If these bits are used at high speeds, they may burn up and be rendered useless. These bits also require a break from drilling to cool. When using spear-point bits, drill through the thickness of the glass tiles or marble, and then stop once the thickness has been penetrated. Spear-Point bits are not meant to drill through thin set/cement mortar/cement board. It may be time to switch to a masonry bit to finish the drilling job.

High-Speed
Some synthetic stones (cultured marble or faux stone) are used in shower applications. Use of high-speed drill bits can be recommended depending on the make-up of the material. If the high-speed bits do not yield results, consider going to regular masonry bits and work up from there.

Prismatic Bits
Prismatic bits are for drilling glass tile and some marble materials. The key to using prismatic bits is to use them at very low RPM (revolutions per minute). These bits are designed to cut material while barely turning. If these bits are used at high speeds, they may burn up and be rendered useless. These bits also require a break from drilling to cool the bit. When using prismatic bits, drill through the thickness of the glass tiles or marble, and then stop once the thickness has been penetrated. Prismatic bits are not meant to drill through thin set/cement mortar/cement board. It may be time to switch to a masonry bit to finish the drilling job.

Diamond Core
The Diamond Core bits are designed for the hardest tiles and stone types. Some substrates that require the use of these bits are the very popular porcelain tiles, as well as very dense stone, such as granite. Diamond Core bits are designed to be used with diamond tool coolant and must stay wet. Avoid prolonged drilling periods by removing the bit from the hole and cooling the bit. Drill coolant is best to use, though many also use water. Simply remove the bit from the hole and allow the drill motor to stop. Dip the hot bit into the coolant. A satisfying hiss will occur.

One of the most important practices when drilling substrates is to waterproof the holes that have been drilled on the horizontal plane. Before running any screws or inserting plastic anchors, be sure to apply silicone into the hole. Additionally, once the screws have been permanently fastened in place, silicone over the screw heads to further waterproof the penetrating fasteners.

FIGURE 39 *Examples of metal countersinks and cobalt drill bit*

Drilling is not limited to tile/stone applications; metals often require drilling. The two most common metals to drill in a shower installation are aluminum and stainless-steel. For drilling aluminum (headers and U-channels), a high-speed bit normally is required. Use of metal countersinks can come into play when drilling aluminum and should be available for use (see Figure 39). A tough material to drill is stainless-steel. Many sliding shower systems are made from stainless-steel and require holes to be drilled through the stainless-steel material. The best bits for drilling through stainless-steel are cobalt bits. They are specifically designed for drilling through stainless steel (see Figure 39).

Installing Clamps (Clips) and U-Channel

Shower Clamp Installation

Before laying out dimensions on the curb/threshold, the following steps should normally be followed: verify the number, finish and type of clamps for the project. Compare the glass fabrication to the cut sheets sent to the fabricator. Measure the glass panels to confirm the fabrication is correct. Check the glass for the correct size, out-of-square (if applicable) holes, notches, miter direction, etc. Use the actual glass sizes and hole/notch locations of the glass panels rather than the dimensions depicted on the drawings.

Prior to marking the curb/threshold, wall, or ceiling, it is recommended to use painter's tape on the locations where marks will be made. Some natural stones may absorb the marker color and staining may occur. If there are intersecting panels of glass, the intersecting panels should be clearly drawn on the curb/threshold or ceiling. It is best to use centerline dimensions when laying out where the clamps are to be placed. Even if the shower enclosure was measured using different dimensions (outside dimensions or other), it may be best to convert them to centerline for ease of laying out and marking hole locations.

The following portion addresses guidelines and recommendations for using standard 2 inch clamps with one mounting hole in the center of the clamp.

FIGURE 40 *Example of clamp with one mounting hole in the center of the clamp (front and back views)*

Use the information from measuring the glass and making note of the hole/notch locations in the glass. When laying out the locations for the holes, account for any clearances allowed for in the glass sizing phase. If the glass size in question requires a ⅛-inch clearance between the glass and the vertical wall, figure that clearance into the layout.

For example, if a panel of glass has a hole/notch on the bottom edge and it is located exactly 4 inches in from the vertical edge to the center of the hole/slot, consider the clearance between the glass and the wall. An ⅛-inch gap between the glass and the vertical wall is added to the 4-inch dimension, making the hole location on the curb/threshold to be 4-⅛ inches from the wall to the center of the hole to be drilled. Mark the location in the centerline of the glass at 4-⅛ inches from the wall. See Figure 41.

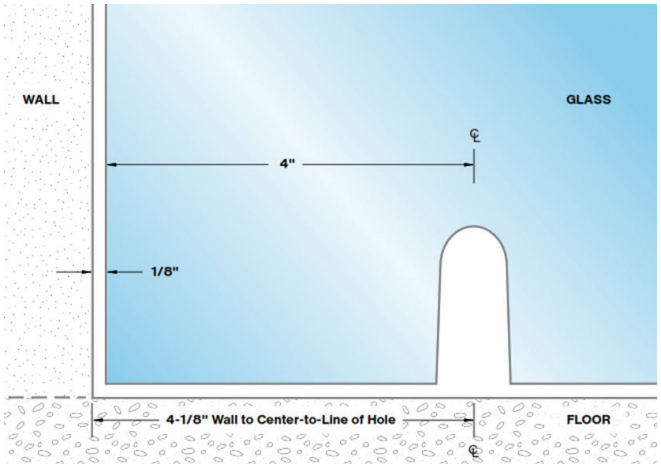


FIGURE 41 *How to account for clearances when laying out locations for clamps*

The same information applies to using clamps on the vertical walls or the ceiling. When marking the vertical walls, use a level/laser to assure the hole(s) marked are plumb. Using the same measurement logic as above, allow for the clearance under the panel. Extra precaution should be taken when marking the ceiling for clamps. Not only should the position of the holes be located using the logic above, but the glass line on the ceiling should match the lines on the base. Use a laser or plumb bob to align the holes from the ceiling to the base.

Drilling the Mounting Surface

Once the clamp holes have been marked, drill the holes for mounting using the appropriate size and type of bit. Refer to drilling instructions in the section Drilling above. Apply a small amount of silicone (or other approved material based on manufacturer's warranty) into the hole prior to inserting the anchors. Fasten the clamps into position, ready to receive the glass. Use setting blocks under the glass at the base to keep the glass from resting on the tile/stone and to leave the desired gap between the glass and the mounting surface. With the glass positioned correctly in place, adjust by raising or lowering the glass by using different setting block heights to assure the glass is where it needs to be (plumb) and tighten the cover plates of the clamps, capturing the glass.

Drilling Glass Tiles
Use a 3⁄16-inch or ¼-inch glass-specific drill bit. Use caution to prevent the drill bit from overheating; use low RPMs to help keep the bit cool. For best results, spray with drill bit coolant or water while drilling to keep both the tile and the bit cool. Position the drill bit perpendicular to the tile and do not start the drill until the bit is touching the tile. Take care to keep the bit in the hole and avoid slipping.

Sealing the Fixed Glass

Prior to setting the glass into its permanent location, clean the surfaces and assure they are dry and free of contaminants.

There are different ways to install fixed glass using clamps. If the fixed glass has been installed using a bulb seal on the perimeter of the glass, the bulb seal should be making contact with the surface to which it is mounted. The most common way to seal fixed glass is to use silicone sealant. Note that not all showers using clamps must be sealed using silicone. There are some enclosures that, based on the design, won't see any water where the clamps are mounted.

When using silicone sealant in a shower with clamps, the job should be done cleanly. Silicone can make quite a mess, if attended to improperly. The best method includes leaving a gap between the glass and the mounting surface. Apply painter's tape to the face of the glass (inside and outside) right up to the edge of the chamfer on the glass. Next, apply tape to the tile/stone inside the shower and outside the shower. Apply the tape in a way that is even with the face of the glass. Once all the tape has been applied inside and out, sealing can begin. It is best to seal in sections, so the silicone does not "skin up", or start to cure. Pump the silicone from inside the shower into the gap between the glass and mounting surface. The objective is to have the silicone make its way under the glass to the outside of the glass. Pump silicone until it comes out from under the glass on the outside of the enclosure. Once the section has been completed, tool off the excess silicone. It may take several passes to get rid of the excess adhesive. Once the silicone is thinned out with all the excess removed from inside and outside, the tape can be removed to reveal a smooth clean line.

Shower U-Channel Installation

Screws are required to fasten the U-Channel to the mounting surface. Stainless-steel screws, or an equivalent, should be used. Use of zinc screws can cause rusting and should be avoided.

Before laying out dimensions on the curb/threshold, verify the quantity, finish, and type of U-Channels for the project. Compare the glass fabrication to the cut sheets sent to the fabricator. Measure the glass panels to confirm the

fabrication is correct. Check the glass for the correct size, out-of-square (if applicable), holes, notches, miter direction etc. Use the actual sizes of the glass panels rather than the dimensions depicted on the drawings for laying out the U-Channel.

Prior to marking the curb/threshold, wall, or ceiling, it is recommended to use painter's tape on the locations where marks will be made. Some natural stones may absorb the marker color and staining may occur. If there are intersecting panels of glass, clearly draw the intersecting panels on the curb/threshold or ceiling. It is best to use centerline dimensions when laying out where the U-Channel(s) is/are to be placed. Even if the shower enclosure was measured using different dimensions (outside dimensions or other), convert them to centerline for ease of laying out and marking hole locations.

U-Channel Preparation

When preparing to cut U-Channel, use the appropriate blade to cut the channels to approximate size. Refer to resources and follow all recommended safety measures when cutting U-Channel. Cut the channel a bit long initially and re-measure to get exact size. It is easier to shave off a small amount and get to the correct size. Once the channel has been cut to the correct length, use a file to clean up the cut ends, removing any burrs. Use a file to remove any sharp edges on the cut ends of the channel to avoid any possible scratches or cuts. This is also a good opportunity to thoroughly inspect the channel for any scratches or other surface issues. If there is a channel at the base and up the vertical wall, a choice will be made to either miter the U-Channel or stack the square cut channels. If the U-Channel is installed and sealed correctly, this choice is solely cosmetic and a matter of preference. See Figure 42 for an example of each.

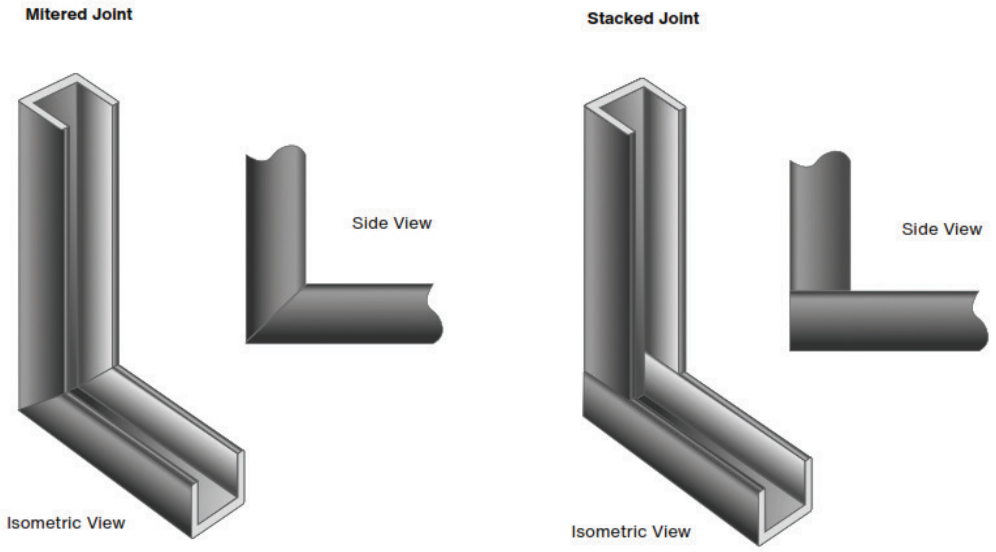


FIGURE 42 *Example of U-Channel with mitered joint (left) and stacked joint (right)*

Some U-Channels come with pre-drilled holes while others may not. Even when there are pre-drilled holes, they may not be positioned favorably, and they may not align with grout lines where it may be easier to drill, especially when glass tile is involved. If this is the case, drill holes in the U-Channel to align with grout joints. This may make it easier to drill and mount the channel. Use the correct bit to drill holes through the U-Channel. Some channel applications call for the holes to be countersunk and to use flat head screws, while others can use a standard clearance hole and pan head screws.

Fixing the U-Channel to the Mounting Surface

It is best to lay out all the channels at once to ensure all pieces relate to one another correctly. Small adjustments in position can be made when laying out all the pieces of the channels at once. When the point is reached that all pieces are correctly placed, mark the holes for drilling and permanent fastening. Using the appropriate bit for the mounting surface and the correct size for the anchor being used, drill through the mounting surface. After drilling all holes for the channels, clean up the area thoroughly and remove the painter's tape. All surfaces to which the channel will be fastened should be free of all dust and any other contaminants. The ready-to-mount U-Channel should also be clean and free of all contaminants. The U-Channel may have a flat bottom design, or there may be a void on the bottom for the purpose of using silicone on the base of the channel. Apply a small amount of silicone (or other approved material based on manufacturer's warranty) into the hole prior to inserting the anchors. Using stainless steel or equivalent screws, permanently fasten the U-Channel to the mounting surface.

Installing the Glass Panel(s)

Once the U-Channel has been permanently mounted, install the correct thickness of setting blocks that corresponds to the deduction made in the glass sizing phase. Two setting blocks should be installed per panel, one near each end of the U-Channel/Fixed Panel. The setting blocks should support the glass above the screw heads so no glass-to-metal contact can occur. It is advisable to fit the fixed panel(s) into the channel to see if any fine tune adjustments are required prior to permanently setting the glass. This is commonly referred to as "dry-fitting" the glass. The purpose of dry-fitting the glass is simple: the glass may need to be installed in and removed from the U-Channel as needed to get the correct adjustment. Once the correct adjustments have been made and the glass is going to be set into the U-channel for the last time, it is time to seal the screw heads with silicone. Apply silicone completely covering the screw heads assuring they have been properly sealed.

Wet-Set Installation

Many U-Channels are designed as "wet-set" which means the glass is sealed using silicone, instead of a vinyl/rubber. Before wet-setting the panel into the U-Channel permanently, it is common to apply silicone into the U-Channel along the bottom. The silicone shouldn't fill the U-Channel because it could prevent the glass from fitting all the way inside. Running the silicone in the deep part of the U-Channel is designed to keep your glass in place (not rattling) and seal the edge to the inside bottom of the Channel. A common practice is to run a bead of silicone just thicker than the setting blocks for about 6 to 8 inches, skip a few inches and resume (see Figure 43).

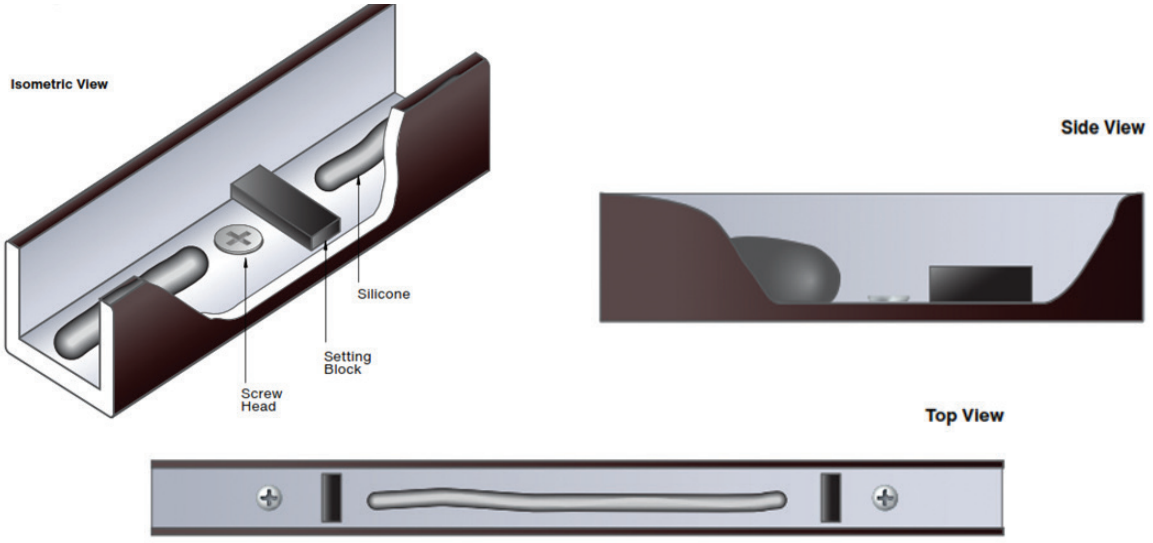


FIGURE 43 *Wet-set installation of U-Channel*

The purpose of leaving a gap between the beads applied inside the U-Channel is to allow for the silicone to be displaced and have somewhere for it to go. Do not apply the silicone directly to the setting block material. The glass panel can be set into position. If silicone overflows out of the top of the channel, remove the excess. Once all the glass has been set, seal the small gap between the glass and the U-Channel, inside and outside. Seal the U-Channel to the mounting surface inside and out as well unless using a concave base channel which allows hidden caulking (see Figure 44).

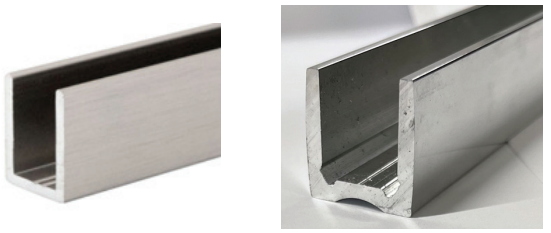


FIGURE 44 *Examples of flat bottom and concave bottom U-Channels*

Dry Glazed Installation
For those applications that are "dry-set", position the glass and place a few short pieces of the correct vinyl to temporarily hold the panel in place. Once all the glass has been set, the glazing vinyl can be installed into the U-Channel. Follow manufacturer's instructions for installing the vinyl. Once all the glass and vinyl has been installed, the U-Channel can be sealed to the mounting surface, inside and outside the enclosure, unless using a concave base channel which allows hidden caulking.

Side Mounted Hinges

There are two main categories of side mount hinges: Wall Mount and Glass to Glass Mount. Within these two categories are multiple designs requiring separate sets of installation instructions.

Wall Mount Hinges
Before beginning any installation, double-check to ensure the correct hinges are accounted for and the glass has the corresponding cutouts. Measure the door to confirm it is the correct size to fit into the opening. Measure the cutouts in the glass for accuracy. Use a leveling device or a straightedge, check the wall for any irregularities such as bows or humps. Confirm the opening is as it was measured. Once all factors are assured, attach the hinges to the door glass prior to fitting the door into the opening.

Step 1) When attaching the hinges to the door glass, the glass should be cleaned around the cutout, removing all contaminants. There should be a clean surface on the glass for the hinges and gaskets to work correctly. While fitting the hinges onto the glass, follow the hinge manufacturer's instructions regarding gasket use. Remove the inside cover plate and position the gasket on the main body of the hinge. Using the clearance allotted to leave between the glass and the wall as a guide, position the hinge inside the cutout of the glass and align the edge of the hinge to the edge of the glass. Center the hinge within the cutout to maximize any needed adjustment. Once the hinge is placed in the cutout, position the gasket on the inside glass surface (unless the hinge is pre-gasketed) and install the inside cover plate tightening down the provided machine screws to be barely snug. Leave the clamping screws barely snug to allow for glass adjustment later in the process.

For hinges with removable posts, tighten post screws to avoid dimpling the face plate (see Figure 45).

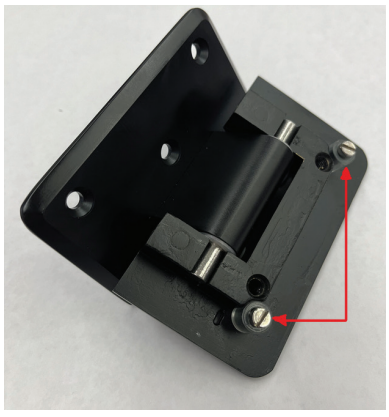


FIGURE 45 *Example of hinge with removable posts, indicating location of post screws*

Step 2) Once the hinges are on the door, prepare the opening for the door glass. Prior to placing the door glass into the opening, position either setting blocks, shims, or other preferred material on the curb/threshold. The setting blocks/shims should act as a buffer to prevent any contact from the glass to the tile/stone and also serve as an adjustment tool to accurately position the door glass. Place the setting blocks/shims on the curb/threshold a few inches inward from each end of the door glass. The opening is now ready to accommodate the door glass. This task is more easily accomplished with a team of two people. It can, however, be done by one experienced person. Place the bottom of the door on setting blocks/shims and lean the top of the door glass slowly into the opening. Using the setting blocks/shims, adjust the door to the desired height and adjust the glass position to leave even clearances all around the door. Check everywhere for door alignment. Once the door has been properly positioned, mark the wall with the location for each screw.

Step 3) With the wall marked for drilling, carefully remove the door glass and set it safely aside. Drill the vertical wall where the door will be fastened. Prepare the holes in the wall according to the method being used to mount the hinges. Rest the door glass on setting blocks/shims (see step 2) and screw the hinges to the wall with the glass in place.

Step 4) With the door fastened to the wall, check all the clearances to assure the door is in the correct position. If the door needs adjusting, take this opportunity to perfect the fit. Now tighten the screws that clamp the glass. Whether Allen or Phillips screws are used to tighten the cover plate, TIGHTEN THE SCREWS BY HAND. **Over-tightening screws by using a screw-gun can result in damaging the hinge.** It is best to tighten the screws by alternating from one screw to the other until the screws are as secure as possible through hand tightening. Once all of the clamping screws have been tightened, the setting blocks/shims can be removed from under the door.

Important Note: After about 10 minutes, re-tighten the screws by hand. It is surprising that the screws will rotate about a quarter turn more, after having been tightened only 10 minutes before. It is this second (and third) tightening that finalizes the installation session.

Glass-to-Glass Hinges

Before beginning any installation, double-check to assure the correct hinges are accounted for and the glass has the corresponding cutouts. Measure the door to confirm it is the correct size to fit into the opening. Measure the cutouts in the glass for accuracy. The fixed panel of glass to which the door will hinge has already been installed and the door opening is ready to hang the door.

Step 1) The fixed panel from which the door will hinge can be at 180° (in-line), 135°, 90° or at an odd angle to the door. When attaching the glass-to-glass hinge to the fixed panel, the glass should be cleaned around the notch removing all contaminants. There should be a clean surface on the glass for the hinges and gaskets to work correctly. While fitting the hinges onto the fixed glass, follow the hinge manufacturer's instructions regarding gasket use. Remove the inside cover plates and position the gaskets on the fixed panel portion of the hinges. Place the hinge inside the cutout of the glass and align the edge of the hinge to the edge of the glass. Make sure to center the hinge within the cutout to maximize any needed adjustment. Once the hinge is placed in the cutout, position the gasket on the inside glass surface (unless the hinge is pre-gasketed) and install the inside cover plate tightening down the provided machine screws to be barely snug. The outside edge of the hinge should be even with the outside edge of the glass. Now, thoroughly tighten the fixed panel portion of the hinge using the clamps screws. Whether Allen or Phillips screws are used to tighten the cover plate, TIGHTEN THE SCREWS BY HAND. **Over-tightening screws by using a screw-gun can result in damaging the hinge.** It is best to tighten the screws by alternating from one screw to the other until the screws are as secure as possible through hand tightening.

Important Note: After about 10 minutes, re-tighten the screws by hand. It is surprising that the screws will turn about a quarter turn more, after having been tightened only 10 minutes before. It is this second (and third) tightening that finalizes the installation session.

Step 2) Once the hinges are on the fixed panel, the door glass can be installed. This task is more easily accomplished with a team of two people. It can, however, be done by one experienced person. Prior to placing

the door glass into the opening, position either setting blocks or shims on the curb/threshold. The setting blocks/shims should act as a buffer to prevent any contact from the glass to the tile/stone and also serve as an adjustment tool to correctly position the door glass. Position the gaskets on the door portion of the hinges. Place the setting blocks/shims on the curb/threshold about a few inches inward from each end of the glass.

Step 3) From inside the shower, rest the bottom of the door on setting blocks/shims and lean the top of the door glass slowly into the opening. Carefully guide the cutouts in the door glass to fit onto the hinges. Raise or lower the door until the cutouts in the door fit onto the hinges. When the cutouts in the door glass are aligned properly with the fixed panel portion of the hinges, position the gasket on the inside glass surface (unless the hinge is pre-gasketed) and install the inside cover plate tightening down the provided machine screws by hand to be barely snug. Using the setting blocks/shims, adjust the door to the desired height and adjust the glass position to leave even clearances all around the door. By slightly raising or lowering the door glass, position to the desired location. Check everywhere for door alignment.

Step 4) Tighten the screws that clamp the door glass. Whether Allen or Phillips screws are used to tighten the cover plate, TIGHTEN THE SCREWS BY HAND. **Over-tightening screws by using a screw-gun can result in damaging the hinge.** It is best to tighten the screws by alternating from one screw to the other until the screws are as secure as possible through hand tightening. Once all of the clamping screws have been tightened, the setting blocks/shims can be removed.

Important Note: After about 10 minutes, re-tighten the screws by hand. It is surprising that the screws will turn about a quarter turn more, after having been tightened only 10 minutes before. It is this second (and third) tightening that finalizes the installation session.

Pivot Hinge Installation

Curb or Ceiling

Before beginning any installation, double-check to assure the correct hinges are accounted for and the glass has the corresponding cutouts. Measure the door to confirm it is the correct size to fit into the opening. Measure the cutouts in the glass for accuracy. Confirm the opening is as it was measured.

Step 1) Prior to placing the door glass into the opening, place tape at each of the locations where the hinges will be installed. The tape will be used for marking the locations of the hinges. Position either setting blocks, shims, or other preferred material on the curb/threshold. The setting blocks/shims should act as a buffer to prevent any contact from the glass to the tile/stone and also serve as an adjustment tool to accurately position the door glass. Place the setting blocks/shims on the curb/threshold inward from each end of the door glass and out of the way of the notch in the glass for the hinge. The opening is now ready to accommodate the door glass. This task is more easily accomplished with a team of two people. It can, however, be done by one experienced person. Place the bottom of the door on setting blocks/shims and lean the top of the door glass slowly into the opening. Using the setting blocks/shims, adjust the door to the desired height and adjust the glass position to leave even clearances all around the door. Check everywhere for door alignment. In preparation for marking the hinge location, remove the inside cover plate and identify the proper gasket to use with the glass. Slide the hinge and gasket into the cutout, centering it from side to side to allow for maximum adjustment. Mark the tape with the footprint of the hinge. If the top hinge is being mounted in the ceiling, the same process should be used to position and mark the footprint of the hinge on the tape at the ceiling.

Step 2) Once all surfaces have been marked, carefully remove the door glass and set it safely aside. Pro Tip: A preferred method, if possible, is to set it safely inside the shower, as the door glass will be set from the inside in the next step. Set the base of the hinge within the previously marked footprint, turn the face 90°, and mark the locations of the screw holes. Prepare the holes in the curb and ceiling according to the method being used to attach the hinges. Fill the screw holes at the floor with silicone to guard against water penetration. Remove the tape and screw the hinges in place.

Step 3) With the hinges fastened and setting blocks/shims in place, bring the door glass back into the opening, lining up the cutouts with the hinges. Tighten the cover plates, leaving the clamping screws barely snug. Check all the clearances to assure the door is in the correct position. If the door needs adjusting, take this opportunity to perfect the fit. Now tighten the screws that clamp the glass. Whether Allen or Phillips screws are used to tighten the cover plate, TIGHTEN THE SCREWS BY HAND. **Over-tightening screws by using a screw-gun can result in damaging the hinge.** It is best to tighten the screws by alternating from one screw to the other until the screws are as secure as possible through hand tightening. Once all the clamping screws have been tightened, the setting blocks/shims can be removed from under the door.

Important Note: After about 10 minutes, re-tighten the screws by hand. It is surprising that the screws will turn about a quarter turn more, after having been tightened only 10 minutes before. It is this second (and third) tightening that finalizes the installation session.

Top Hinge Attached to Wall
When the top pivot hinge is to be attached to the wall and the bottom hinge is to be attached to the curb, add the following recommended steps to the instructions above:

Step 1) Attach the top hinge to the glass. While the glass is being positioned for the bottom pivot at the curb, it will also be positioned for the top hinge at the wall. Mark the wall for the location of the screw holes for the top hinge.

Step 2) In addition to preparing the holes in the curb, also prepare the holes in the wall.

Step 3) While positioning the glass in the bottom hinge, also pay attention to the position of the wall hinge. Screw the top wall hinge to the wall and fine-tune as needed to be in alignment with the bottom hinge.

Top Hinge Attached to Glass
When the top pivot hinge is to be attached to another panel of glass, follow the initial instructions for the bottom hinge, with the following recommended additional steps:

Step 1) Attach the supporting portion of the glass-to-glass hinge to the fixed glass. Make sure the manufacturer's recommended gasket is in place. The top hinge is now the guide to be used for positioning the door in the opening.

Step 2) The cover plate should be left off the door portion of both hinges. Both hinges are now ready to receive the glass.

Step 3) The instructions for positioning the glass, confirming clearances, and securing the face plates should apply to both hinges.

Top Hinge Attached to Header
When the top pivot hinge will be installed in a header with the bottom hinge attached to the curb, follow the initial instructions for the bottom hinge, with the following recommended additional steps:

Step 1) Prepare the pivot hinge for installation into the header. In some cases, this means removing the standard base and replacing it with a header adapter block, while in other cases an adjustable pivot is inserted into the end of the header. Install header in desired location. For specific header installation instructions, see the manufacturer's recommendation. Secure the top pivot hinge into its correct position. Remove the back plate and position the gasket(s) so the hinge is ready to receive glass.

Step 2) The instructions for positioning the glass, confirming clearances, and securing the face plates should apply to both hinges.

Headers

Measuring and Cutting
The cutting of headers to size can take place in the field or in the shop. Often headers are cut on the job site. A miter saw is the most common method used to cut headers. Miter saws have the capability to change angles readily and cut through rather heavy aluminum/brass materials quickly and cleanly. Use the appropriate blade for the material you are cutting, and do not use a wood blade. You may want to use a different blade for cutting brass versus aluminum.

Wall to Wall (Inline)
Measuring an opening that is straight in-line with only one piece of header, no changes in angle, and walls that are 90° to the threshold may be achieved by measuring the tight opening wall to wall and making note of it. MEASURE IT TWICE. Once the wall-to-wall dimension has been accurately recorded, simply deduct 1/16" to get the exact header size. Cut the header to size and finish both ends by using a fine metal file to smooth all the edges for the best look and for safety purposes.

Angles
Working with an opening that has a change of angle presents new variables. Any change of angle requires cutting the header using miters. Get accurate angle readings from the threshold/base in order to get the best results for the header miters meeting correctly.

There are two conditions that call for a miter to be cut on the end of a header:

1. The header runs into a vertical wall at an angle.

2. There is a change of angle that doesn't involve the header running into a wall and the headers are joined in an open space (panel to panel or panel to door).

The challenge installers face is the need to correctly figure what miter needs to be a cut on the header based on the field conditions. There are simple math formulas associated with cutting miters on headers either running into a wall or in open space.

Formula for Header Running into a Vertical Wall at an Angle
Measure the angle at which the threshold/base runs into the wall. Clarify that a header that meets a wall straight/square is running into the wall at 90°. A header butting into a wall at 90° requires no miter (0° on the miter saw). Here is the rule: to find the correct angle reading on the miter saw, make note of the angle. If the angle is greater than 90°, deduct 90 from the angle recorded. If the angle is lower than 90°, deduct the recorded number from 90. The bottom line is how many degrees the noted angle is from 90°. An angle reading of 115° or 65° would result in an angle reading of 25° on a miter saw. Both figures are 25° away from 90°.

Formula for Headers Joined in Open Space
A very common application is joining two (or more) headers together to make a structural member that is attached to a wall at each end. Cutting and joining these header components require defining the miters correctly. Shower angles are almost always between 90° and 180°. Angles less than 90° are nearly unheard of. Angles over 180° define the shower structure as having panels that are inverted, meaning they are coming out into the room, as opposed to into the shower. Start with obtaining the correct angle. To get the correct figure required for use on a miter saw:

A) Record the angle as measured
B) Begin the formula with the number 180
C) Deduct the recorded angle from 180
D) Take the difference and divide by two
E) This is the figure to use on the miter saw

Examples A and B below use familiar angles:

Example A using 90° recorded angle:	Example B using 135° recorded angle:
A) Record the angle as measured: 90	A) Record the angle as measured: 135
B) Begin the formula with the number 180: 180	B) Begin the formula with the number 180: 180
C) Deduct the recorded angle from 180: 180 – 90 = 90	C) Deduct the recorded angle from 180: 180 – 135 = 45
D) Take the difference and divide by two: 90 ÷ 2 = 45° Miter	D) Take the difference and divide by two: 45 ÷ 2 = 22.5° Miter
E) This is the figure to use on the miter saw: **45° Miter**	E) This is the figure to use on the miter saw: **22.5° Miter**

How to Measure for Header Cut Sizes
Most headers are mounted to the vertical walls from above the header. This means the glass can be installed before measuring for finished header sizes. Unless all header sizes have been pre-cut, it is recommended to set all fixed panels in the shower structure before measuring for the header lengths. Once the fixed panels are all set and temporarily held in position, measure to the centerline of the glass itself to each change of angle. Make note of all these centerline dimensions.

How to Measure the Header for Cutting a Miter
It is recommended to use the centerline of the glass measurement for cutting the header material. Some headers are asymmetrical, so measuring to the long point of a header can be troublesome. The centerline of where the glass is going to fit into the header is constant and reliable. Use the centerline dimension and make a mark on the header where the center of the glass would be situated when the header is installed. Cut the desired miter first, leaving the length a little long. It is a good idea to trial fit your miters together at this time to ensure the joinery is correct. Don't try to cut the header to size on the first miter cut; it is too easy to make a mistake by cutting it short. When cutting the miter, leave the header about ¼-inch or so too long. Now, measure from the miter cut side, at the centerline of where the glass fits into the header, and mark the end of the header that may be either square cut or has another miter. The point is to "nibble" the size down to the correct size, measuring after each cut to ensure accuracy. Cut the header to size and finish both ends by using a fine metal file to smooth all the edges for the best look and safety purposes.

Joining Header Lengths
Once the header sizes are accurately fabricated, they must be joined. There are always corner brackets of some type to join header pieces. Often the corner brackets slip into a groove in the header and are fastened using set screws. Corner brackets can be fixed in shape and angle or adjustable. Slip the brackets into position, evenly join the header corner and tighten the set screws.

Wall Mounting the Header
Since there are various header types and all are not the same, follow the manufacturer's recommendation for locating the hole(s) for mounting the header to the vertical wall.

Positioning the Header for Final Mounting
The header has been cut and joined to all other header pieces and is ready for mounting. Many headers require the use of a "U-shaped" vinyl gasket on top of the glass. Position the gasket (if required) on the fixed panels, preparing them to accept the header. Bring the header structure to the opening and carefully set it into position on top of the glass, with the header ends touching the vertical wall. Now is the last chance to make sure all joints look good and fit correctly. With the header resting on all the fixed panels and the ends tight against the wall, the header can now be pressed down incrementally onto the glass. Using a rubber mallet (or other such tool), tap the header down onto the glass slowly, taking all sections into account. Carefully tap the header down onto the glass. If the header is tapped down too far, it can be extremely difficult to bring it back off the glass. It is best to tap the header down, in all sections, evenly and take measurements until the header is in the desired position.

Fastening the Header to the Wall
With the header in position on the fixed glass, fasten the header to the vertical wall using the manufacturer's recommended method.

Snap in Filler
With the header installed on the fixed glass, if there is a door opening, a snap in filler is to be inserted in the glass cavity on the bottom of the header. The purpose of the snap in filler is to seal the opening where the glass fits into the rest of the header. Measure the required length for the snap in filler and cut the filler to the same size as the opening. The filler should fit snug so it can't slide back and forth after installation. After cutting the filler to size (use a miter saw or alternative), test fit it to see how tightly it fits into the length of the opening. If it is tight, install the filler. If the filler was cut a bit short, use a small amount of silicone in the underside of the header cavity so when the snap in filler is installed and the silicone dries, the filler won't move.

Finishing
Headers that require a gasket for installation may have portions of the gasket protruding from the bottom of the header. Trim off excess gasket material using a new razor blade. Headers that do not require a gasket may need to have silicone used to seal/adhere between the bottom edge of the header and the glass. If there is no gasket used to fasten the header to glass, consult the manufacturer to ascertain the recommended fastening method.

Seals
Most of the rigid seals can be cut using a hacksaw/miter saw. Some of the softer seals may be cut with diagonal cutters or even a razor knife. Once a hard seal has been cut, it should be filed to soften any sharp edges. Any sharp edges should be rounded and, once filed down to a safe radius, remove any excess plastic filings by using a razorblade. Never leave a sharp edge on which an end user can be injured.

Maintenance/Cleaning

Hardware
Properly cared for hardware should maintain its original appearance. Neglecting or ignoring the maintenance needs and procedures may result in reducing the hardware's quality, appearance and/or service life.

The best way to maintain the original finish on the hardware is to wipe it down after every use. After showering, use a dry towel to thoroughly dry the hardware. If the hardware is kept clean after every use, it is unlikely to collect mineral deposits that require the use of a soap solution (noted below).

If unable to dry the hardware after every use, a weekly cleaning is suggested. Cleaning the hardware with a mild soap and warm water mixture and using a soft, non-abrasive cloth is suggested. Rinse thoroughly with clean warm water, then dry.

Warning: Never use an abrasive cleanser of any kind on the hardware. Many of the components are coated with a clear lacquer that will likely be irreparably damaged if subjected to harsh abrasive chemicals or scrubbing devices.

Glass
Squeegee the glass frequently with a non-metallic squeegee, then dry with a soft cloth. Using a squeegee after each shower helps keep spots and scaling from forming and accumulating on glass components. Clean the glass regularly with a glass cleaner and read labels on cleaning products thoroughly before using. If the glass is coated or treated with surface protectants, follow the instructions on the labels provided by the manufacturer. A short list of cleaning agents that should be avoided, because they could either damage the metal or scratch the glass surface, includes:

- Avoid abrasive or soft abrasive powders and liquid
- Avoid acidic or vinegar-based cleaners
- Avoid bleach or bleach-based cleaners
- Avoid steel or Teflon pads

Troubleshooting/Best Practices

1. If a wall mounted hinge door continues to slip and fall out of adjustment, use a hard setting block material between the body of the hinge and the cutout glass to essentially block it into position and prevent further slipping (see Figure 46).

2. When working on an enclosure that has angles, lay out the project based on the dimensions of the glass on hand, and shift the panels slightly during the layout to ensure an accurate fit.

3. Measure all glass panels and check for visual imperfections at the shop before loading the vehicle for transport. Check all hardware to confirm the fittings and finishes are correct and make sure all the supplies needed for the project are present.

4. Use bulb gaskets on the edge of a fixed panel as a setting block when not using bottom channels. Bulb gaskets also provide protection against contact on tiles with high points, and they can be caulked to provide an additional seal.

5. When making deductions for door glass sizes, determine if seals are to be used, as their inclusion can affect glass sizing. If a seal is to be used adjacent to a door, the gap required for the seal may be larger than if no seal were used.

6. Single-acting doors may need to be limited to out-swing only depending on health and safety issues and/or code requirements.

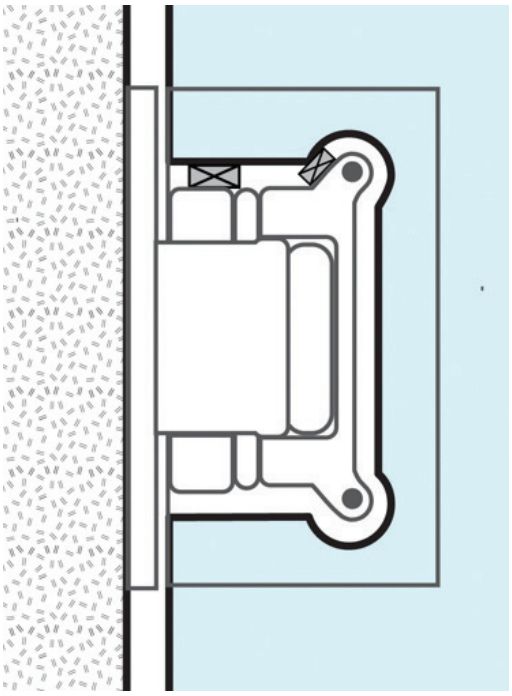


FIGURE 46

A wall mounted hinge door with setting block material between the body of the hinge and the glass cutout to block the glass into position

General Guidelines for Installation Safety

Protect the Installer

- Wear appropriate personal protective equipment (PPE) including protective eyewear.
- File all sharp edges on plastics and metal. Leave no sharp edges that could cause harm.
- Lift any heavy materials safely using proper techniques.
- Be OSHA compliant on commercial jobs.

Protect the Surroundings

- Lay out tarps in residential jobs protecting all finished materials.
- Keep your materials/tools out of the way of other trades on the jobsite.
- Do not set tools or hardware fittings on adjacent finished surfaces.

Protect the Glass, Hardware, and Tools

- All glass should be positioned on setting blocks or a similar material to protect glass edges during transport and storage.
- Lay unboxed finished hardware on the un-finished side.
- Avoid laying a suction cup with the flat cup side down.
- Always avoid glass-to-glass contact.
- Tape over the shower drain or cover with blanket/tarp to avoid dropping fasteners into the drain.

After the Installation

- Advise the client not to use the shower for 24 hours to allow caulking to cure.
- Hand-tighten hinges before leaving the residence/jobsite.
- Thoroughly clean all glass and hardware. If possible, have the owner/contractors visually inspect the project.
- Remove any trace of having been on the jobsite, leaving the space clean.

References

- *ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass*
- *ASTM C1036 Standard Specification for Flat Glass*
- *ASTM C1172 Standard Specification for Laminated Architectural Flat Glass*
- NGA Glass Technical Paper *Proper Procedures for Cleaning Architectural Glass*
- NGA Glass Technical Paper *Assessing the Compatibility of Glazing Materials and Components*
- *NGA Engineering Standards Manual*
- *ANSI Z97.1 Standard Specifications and Methods of Test for the Safety Properties of Safety Glazing Materials*
- *CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials*
- Safety Glazing Certification Council (SGCC) - sgcc.org
- *CAN/CGSB 12.1 Safety Glazing*

The *NGA Frameless Shower Enclosure Design and Installation Manual* is a companion to *NGA's GANA Glazing Manual.* Look for this and other documents provided by the National Glass Association with GANA at glass.org/store.

- *NGA's GANA Glazing Manual*
- *Project Manager's Reference Manual*
- *Glass and Glazing Estimating Essentials (an accompanying course "Reading Plans and Blueprints" can be found on MyGlassClass.com.)*
- *Laminated Glazing Reference Manual*
- *Engineering Standards Manual*
- *Commercial Fenestration Systems Manual*
- *Glossary of Architectural Glass and Glazing*
- *Heavy Glass Door Design Manual*
- Glass Technical Papers
- Test Methods
- Educational Videos

This Manual was created by the members of the National Glass Association to provide guidance and specific best practices for frameless shower enclosures. It is meant to educate and assist glass professionals on designing, measuring and installing safe, functional shower enclosures. The Manual also serves as a tool to the professional installer to point out potentially unsafe design to an end user.

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