NCMA TEK

National Concrete Masonry Association
an information series from the national authority on concrete masonry technology

GLASS UNIT MASONRY

TEK 2-2A
Unit Properties (1998)

Keywords: channel-type restraints, cleaning, cold weather construction, fire resistance rating, glass block, joint reinforcement, lateral loads, lateral support, mortar, openings in walls, panel anchors, stack bond construction, wind loads

INTRODUCTION

Glass block panels complement all architectural styles by providing natural or borrowed light, openness, texture, and varying degrees of privacy. In addition, glass is naturally resistant to graffiti, allowing easy removal of paints and other substances. Glass block can be used as fire rated windows, as sound barriers, and can easily be replaced when broken.

Glass unit masonry can be used as nonloadbearing walls, windows, or partitions. This TEK focuses primarily on the vertical mortared application within a structural wall system, rather than horizontal or mortarless methods.

MATERIALS

Units

Glass masonry is composed of glass units bonded together with mortar. The units may be either hollow or solid, and are available in a wide variety of sizes, shapes, patterns, and textures. Units typically have a minimum face thickness of 3/16 in. (4.8 mm). Thicker faces, as well as 100% solid units, are available and provide increased impact resistance, sound insulation, and fire ratings.

The units are manufactured by fusing two molded glass halves together to produce a partial vacuum in the center. Edges that will receive mortar are then treated with a polyvinyl butyral coating or latex-based paint to increase mortar bond and to provide an expansion and contraction mechanism to reduce cracking.

A wide variety of patterns and textures are available. In addition to providing varied aesthetics, units with smooth, stippled, sandblasted, fluted, and wavy faces provide varying degrees of light transmission and privacy.

Glass masonry units are typically square, and are available in nominal 6, 8, and 12 in. (152, 203, and 305 mm) sizes. Rectangular units are also available. Actual sizes are 1/4 in. (6.3 mm) less, to allow for the typical 1/4 in. (6.4 mm) mortar joints. Unit thicknesses are either "standard," 3 7/8 in. (98 mm), or "thin," 3 1/8 or 3 in. (79 or 76 mm) for hollow units and for solid units, respectively. Thin unit panels are typically used in residential and light commercial applications.

A variety of shapes are also available to accommodate corners, radii, and exposed wall ends.

Mortar

Glass masonry units are required to be laid using Type S or N mortar. For exterior applications, integral water repellents can be incorporated into the mortar mix to help prevent water penetration.

STRUCTURAL PROPERTIES

Requirements for glass unit masonry are provided in *Building Code Requirements for Masonry Structures*, ACI 530/ASCE 5/TMS 402 (ref. 1). These requirements are prescriptive and govern panel size, panel support, expansion joints, mortar, and joint reinforcement. The requirements are based on previous codes, a history of successful performance, testing by independent laboratories, and manufacturers' recommendations.

Table 1 Glass Unit Masonry Maximum Panel Sizes

Panel description	Maximum panel size, ft² (m²)	Maximum panel dimension, ft (m), Height OR Width	
Exterior standard-unit	see Figure 1	20 (6.1)	25 (7.6)
Exterior thin-unit[a]	85 (7.9)	10 (3.1)	15 (4.6)
Interior standard-unit	250 (23.2)	20 (6.1)	25 (7.6)
Interior thin-unit	150 (13.9)	20 (6.1)	25 (7.6)

[a] thin unit panels may not be used in applications where the design wind presure exceeds 20 psf (958 Pa)

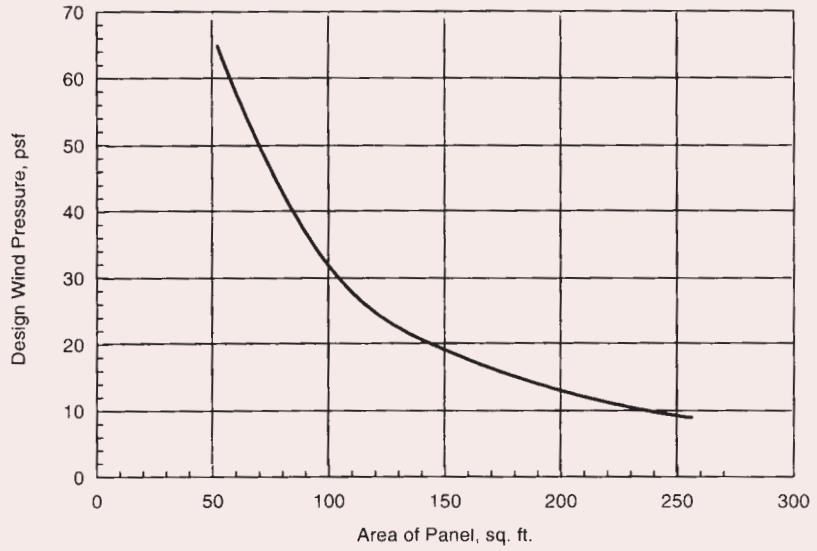

Figure 1–Design Wind Load Resistance of Exterior Standard-Unit Glass Masonry Panels

Table 2 - Approximate Installed Weight of Glass Unit Masonry Panels, psf (Pa)	
Thin units	16 (766)
Standard units	20 (958)
Thick-faced units	30 (1436)
Solid units	40 (1915)

Panel Size

Regardless of load, a maximum panel dimension between structural supports is prescribed to help ensure adequate structural performance. These panel dimensions are listed in Table 1. In addition, fire resistance ratings may further limit panel size.

In exterior applications, maximum standard-unit glass masonry panel sizes are based on the design wind pressure, and are governed by the graph in Figure 1, which includes a safety factor of 2.7.

For example, from Figure 1, a maximum 144 ft^2 (13.4 m^2) panel can be used in an area with a design wind pressure of 20 psf (958 Pa). Based on this maximum panel size and the maximum height or length requirements, this panel could be 12 x 12 ft, 7 x 20 ft, or 25 x 5 ¾ ft (3.7 x 3.7 m, 2.1 x 6.1 m, or 7.6 x 1.7 m), but could not be 30 x 4.8 ft (9.1 x 1.5 m). Thin-unit panels are limited to applications where the design wind pressure is 20 psf (958 Pa) or less.

Interior walls are typically designed to a lateral load of 5 psf. Because of this lower load, interior glass unit masonry panels are permitted to be larger than similar exterior panels.

Lateral Support

Glass masonry panels are not a structural part of the surrounding wall. They need, therefore, to be attached to the wall and supported such that:

- panels stay in place during design load conditions,
- loads from the surrounding wall are not transferred to the glass panel,
- deflection of the supporting wall does not crack the panel, and
- adequate provision is made for differential movement between the glass and the surrounding wall.

To limit the impact of wall movement on the panel, *Building Code Requirements for Masonry Structures* (MSJC code) requires that glass unit masonry panels be structurally isolated to prevent the transfer of in-plane loads. Vertical deflection of the supporting members is limited to *l*/600 to limit deflection cracking. Table 2 is provided for use in designing structures to support glass unit masonry panels.

In addition, it is recommended that movement joints in the surrounding wall be located at the sides and top of the glass masonry panel. This isolates the glass masonry panel to prevent a movement crack in the wall from projecting through the glass panel.

Lateral support is provided along the top and sides of each panel using either channel-type restraints or panel anchors. These supports are designed to resist the applied loads, or a minimum of 200 lb per lineal foot (2918 N/m) of panel, whichever is greater. When the panel is only one unit high or one unit long, however, lateral support is not required at the sides or top, respectively.

Channel-type restraints, shown in Figure 2, provide a physical chase which holds the glass units. The channel can be constructed of concrete, masonry, metal, or wood, as long as they provide the required support. The channel must be sized to accommodate expansion material between the panel and the restraint in addition to the 1 in. (25 mm) recess for the glass units. If the panel is made up of a single glass unit, channel-type restraints must be used.

Panel anchors, shown in Figure 3, are perforated steel straps which are fastened to the building frame on one end, while the other end is embedded into the bed joint between two units. The panel anchors are 1¾ in. (19 mm) wide, 24 in. (610 mm) long, 20 gage steel strips, punched with three staggered rows of elongated holes, galvanized after fabrication. The holes provide a mechanical bond between the mortar and anchor.

In addition to the requirements above, curved panels require additional structural support where the curved section joins a straight section and at inflection points in multicurved walls, as shown in Figure 4. This support can be provided by connecting the panel to a structural member using wall ties. A less visible support is provided by a steel plate installed in a vertical head joint. Panel anchors are attached to the steel plate, which is rigidly attached to the structural frame at the bottom. At the top, the plate is typically supported in a slotted connection, which allows the lintel

above to deflect without loading the steel plate. In this case, it is important that expansion material be installed on both sides of the steel plate to allow the steel to deflect without chipping or damaging the glass.

Expansion Joints

Expansion joints are required along the top and sides of glass unit masonry panels at all structural supports to accommodate movement of the glass. They should be at least 3/8 in. (9.5 mm) thick, but also need to accommodate displacements of the structure as well. Larger expansion joints may be required for glass masonry panels installed in fire-rated walls to accommodate the expansion of the glass under high heat exposure. Expansion joints are filled with a resilient material such as polyethylene. This material replaces the mortar and allows the panel to expand and contract. In exterior walls, these joints must be well caulked to prevent water penetration through the joint.

At the bottom of the panel, a water-based asphalt emulsion is placed on the sill prior to laying the first mortar bed. This serves two purposes. It provides a slip plane for the panel and also prevents water from being drawn out of the glass block mortar by an absorbent sill material, such as concrete.

Reinforcement

Horizontal joint reinforcement is important to control cracking due to expansion and contraction. The MSJC code requires joint reinforcement to be spaced no more than 16 in. (406 mm) on center and to extend the length of the panel. Joint reinforcement should also be placed in the bed joint immediately above and below openings in the panel. The reinforcement must have at least two longitudinal W1.7 (9 gage) wires, with welded W1.7 cross wires. For curved walls, the inner wire is cut periodically so the reinforcement can be bent to the radius of the curve. As with concrete masonry, joint reinforcement should not extend across movement control joints.

The reinforcement is pressed into the partially filled mortar joint, then covered with the remaining mortar and trowelled smooth. Mortar joints should not be furrowed.

NONSTRUCTURAL PROPERTIES

Glass unit masonry panels are often rated for fire resistance and for sound transmission, with solid and thick-faced units providing higher ratings in both areas. Specific design values are available from manufacturers of the units.

It is important to note that fire resistance ratings are assigned based on fire testing criteria for windows, rather than that for walls. As such, fire ratings of glass unit masonry panels should not be applied to glass wall assemblies.

CONSTRUCTION

Glass unit masonry is typically constructed in stack bond, i.e., head joints in successive courses are vertically aligned. Edges of glass units are shaped to provide a mechanical key with the mortar, so full mortar beds should always be

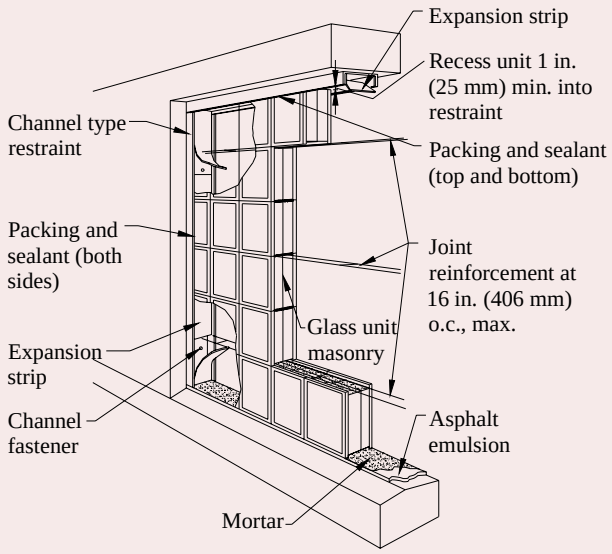

Figure 2–Channel-Type Restraints

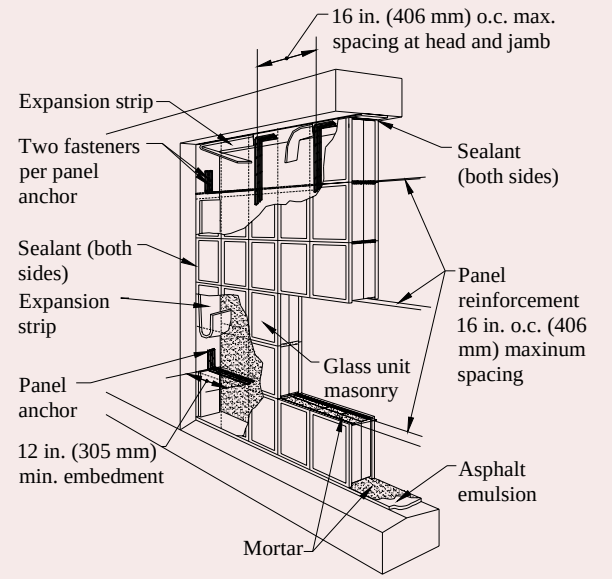

Figure 3–Panel Anchors

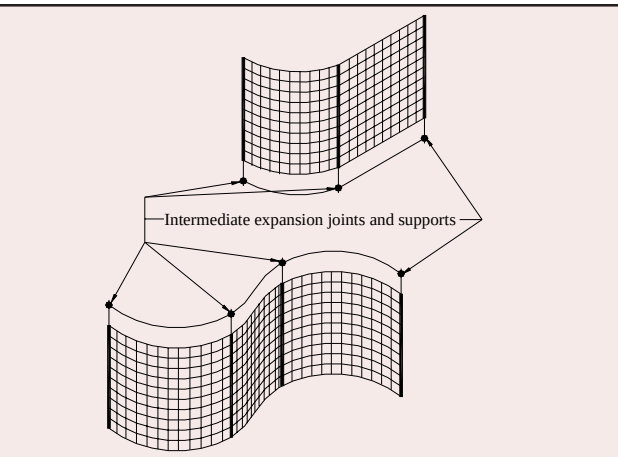

Figure 4–Supplemental Support for Curved Panels

used to provide maximum bond between units and mortar. Wood or rubber tools, rather than steel, should be used to tap the units into place to help prevent damage to the units.

With concrete masonry units, some of the mortar mix water is absorbed into the units, reducing the amount of water in the mortar and promoting bond between the unit and mortar. Since glass is not absorptive, mortar for glass units should be mixed drier than for other masonry to compensate. The edge coating on glass units also helps to promote bond.

Head and bed joints are 1/4 in. (64 mm) nominal thickness, although *Specification for Masonry Structures* (ref. 2) allows bed joints to vary between 3/16 in. and 3/8 in. (1.6 and 3.2 mm), and head joints to be between 1/8 in. and 3/8 in. (3.2 and 9.5 mm). Other construction tolerances for masonry in the Specification apply to glass unit masonry as well.

Curved panels can either be constructed with standard (i.e., rectangular) units or with radial units which are tapered to allow tighter curves. In either case, the interior head joints must be at least 1/8 in. (3.2 mm) thick, and the exterior head joints can be no wider than 5/8 in. (16 mm).

Mortar should not be retempered after initial set, and should be discarded if not used within 1 1/2 hours after initial mixing. Mortar joints should be tooled when thumbprint hard to compact the surface. A concave shape helps the joints shed water. In very humid or damp applications, such as pools or bathrooms, a clear acrylic or silicone sealer can be applied to the mortar joints at least 48 hours after construction to help prevent mildew.

During cold weather, glass units should not be laid when either the ambient temperature or the temperature of the units is below 40°F (-7 C). In addition, the temperature of the units should be maintained above 40°F (-7 C) for the first 48 hours after construction.

Mortar should be cleaned off while still plastic using a damp cloth or sponge. The remaining film, after drying to a powder, can be cleaned off with a clean cloth. This minimizes the potential for scratching or damaging the glass while trying to remove dried mortar droppings and smears. Similarly, abrasive or harsh cleaners and wire brushes should not be used on glass unit masonry.

REFERENCES

1. *Building Code Requirements for Masonry Structures*, ACI 530-95/ASCE 5-95/TMS 402-95. Reported by the Masonry Standards Joint Committee, 1995.
2. *Specification for Masonry Structures*, ACI 530.1-95/ASCE 6-95/TMS 602-95. Reported by the Masonry Standards Joint Committee, 1995.