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Specifying Channel Glass 101

by James Donoghue

Photo courtesy Iwan Baan

BOTH IN VERTICAL AND HORIZONTAL SYSTEMS, CHANNEL GLASS PROVIDES AN ATTRACTIVE ALTERNATIVE, OFFERING A DEPTH AND PROFILE NOT FOUND IN FLAT APPLICATIONS. IN ADDITION TO A HIGH LEVEL OF DESIGN, CHANNEL GLASS WALLS AND PARTITIONS CAN HELP PROJECTS BETTER ACHIEVE SUSTAINABILITY BY CONTRIBUTING TO DAYLIGHTING, RECYCLED CONTENT, THERMAL PERFORMANCE, AND OCCUPANT COMFORT.

Channel glass is a translucent, roll-formed, U-shaped cast glass produced in widths ranging from 229 to 483 mm (9 to 19 in.) and in lengths up to 7 m (23 ft). Used in Europe for more than 40 years, it can be employed to create sweeping walls of glass of unlimited width without vertical aluminum framing.

The ingredients of channel glass include sand, lime, soda, and, to some degree, recycled glass. The mix is combined in a melting furnace to emerge as a ribbon of high-quality molten glass. It is then drawn over a series of steel rollers to form a continuous glass channel of specific dimensions and surface finish, before being cooled and cut prior to processing and packaging.

Channel glass is available in six textures and three widths for exterior glazing, and four widths for interior use. They are open, wept systems and typically assembled onsite using extruded aluminum frames. Channel glass assemblies may be erected as single- or double-glazed walls in vertical or horizontal configurations.

Double-glazed layouts provide greater strength, and improved thermal, acoustical, and moisture performance. They also can mean an aesthetic advantage, offering a patterned glass appearance on both sides of the wall. Single-glazed systems can be laid out in a variety of configurations, which offers optimal design for the individual application. Channel glass accommodates corners and serpentine walls, without the need for vertical aluminum framing members.

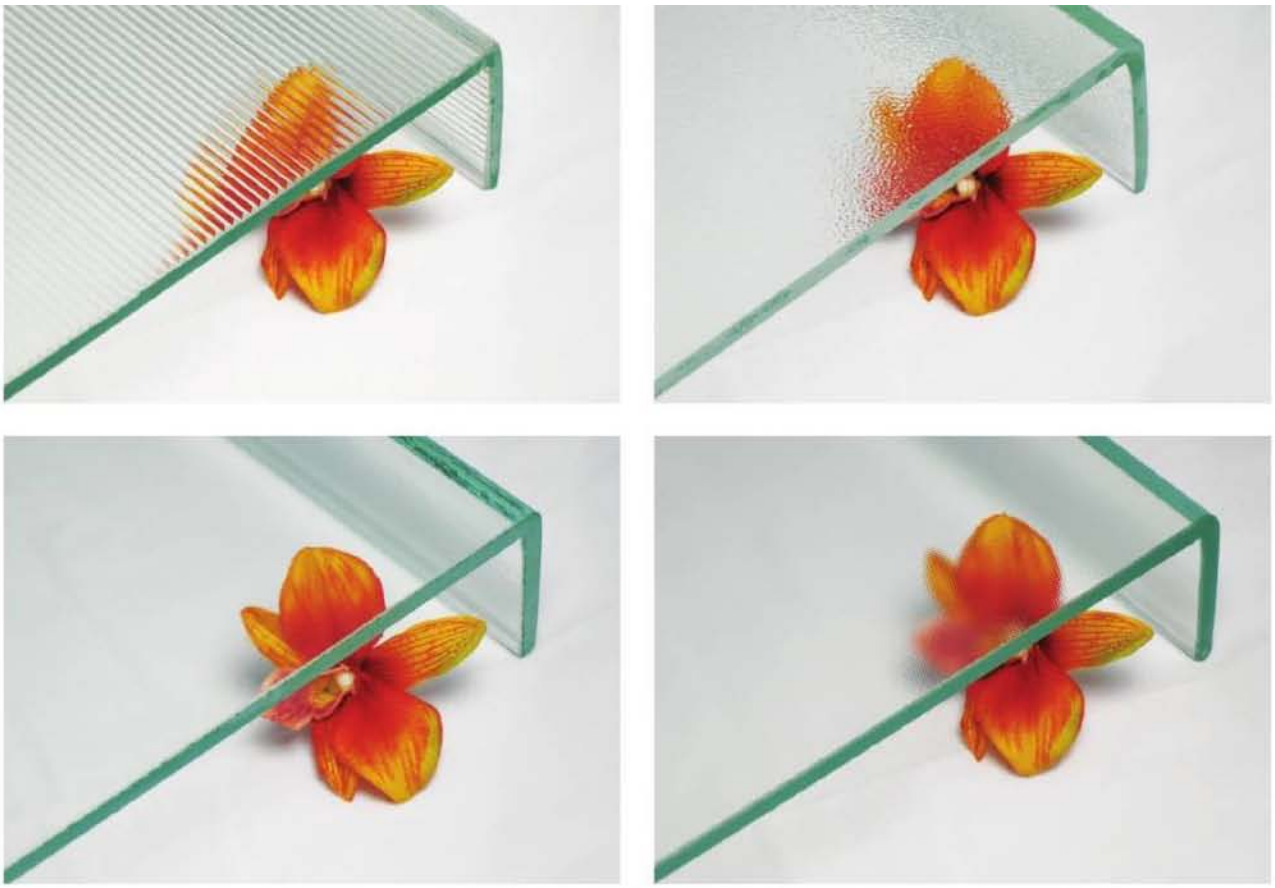
Channel glass walls and partitions can admit and distribute large amounts of natural light into a building. The proper choices of glass, decorative obscuring textures, thermal coatings, and insulation products will contribute to building envelope performance and enhance occupant comfort. The material is available with as much as 60 percent recycled content—a requirement that can also be included in the specification for projects seeking certification under Leadership in Energy and Environmental Design (LEED).

Aesthetic options

Rolled channel glass has optical qualities that are, on a fundamental level, incomparable with both the surface and transparency of float glass because the production methods are vastly different. Channel glass is available in six surface textures, including:

- clear;
- orange peel (also called 'hammered pearl,' this texture provides moderate translucency);
- pebble (heavily obscuring organic texture);
- finely scribed mesh (extremely fine texture delivering a soft sense of privacy);
- corduroy-like; and
- deep-groove pyramid (a precisely chiseled pattern that prismatically bends light and shapes).

The Ceres Community Center (California) uses channel glass as an aesthetic feature for the building.
Photo © Stephen Pizi. Photo courtesy Discovery Glass.



Channel glass is available in different surface textures. These include, clockwise from top left: corduroy, orange peel (provides some translucency), finely scribed mesh (a fine texture offering some privacy), and clear.

Photo courtesy Bendheim Wall Systems

Low-iron glass—made with raw materials containing a low-iron composition and resulting in an almost colorless cast—is also available in certain textures from some manufacturers.

Each texture disperses light in a unique way. Various surface patterns can be mixed side-by-side or coupled in pairs within the same wall to achieve different visual effects. A fairly common arrangement is to use patterned glass on the majority of the wall with interspersed sections of smooth finish 'clear' channel glass as 'vision strips.' This can eliminate the need for separate framed fixed windows.

Specifiers can also select a sandblasted finish or choose from a number of enamel colors as treatments to the inside face of the channel glass. A sandblasted treatment creates a diffusing, frosted aesthetic; a protective coating can be applied to reduce fingerprints and stains. Colored channel glass is produced by firing enamel frits onto the inside face of the channel. The result is a fade-resistant, permanent, durable, and scratch-resistant finish.

Not all textures are available in all widths, and not all coatings are available on all textures. The availability of a chosen texture and coating combination must be verified with the manufacturer.

Exterior applications

Channel glass can be used for exterior applications, such as:

- storefronts;
- curtain walls;
- rain and decorative screens; and
- Trombe and Barra walls.

For exterior walls, the type and orientation of the building, the local climate conditions, and the architectural intent are all factors in the selection of the glass and framing. Anticipated wind load, mid-point glass deflection, heat transfer requirements, safety glazing requirements, and visible light transmittance (VLT) levels for the resultant wall assembly dominate the glass selection process.

Anticipated wind load

Whether determined by local building code requirements or tunnel analysis, it is essential to clearly state the design wind load and areas where the safety wind load applies. Without affecting its finished appearance, wind loads too great to be accommodated by the annealed glass may be satisfied through tempered glazing. (For more, see "Safety Glazing and Tempered Glass," page 64.)

Design stress information for channel glass is available from data published by RWTH Aachen University (Germany). For example, under a 1.2-kPa (25-psf) imposed wind load, a double-glazed annealed channel glass configuration reaches spans up to 4.5 m (14.7 ft) at a probability of breakage of 1/1000. Tempered glass in the same application would span 7 m (22 ft 11 in.).

Deflection

Mid-point deflection under applied wind loads can be quite large for the relatively thin, long channels. Depending on the wind load and the length of unsupported span, the maximum anticipated deflection may be greater than 76 mm (3 in.). This requires adequate clear space on both sides of the glass wall and could be a factor in its location on the building.

While the glass channels may perform adequately at a 76-mm mid-point deflection (or greater), the psychological effect of such movement on building occupants must be considered. Specifiers should consult the manufacturer to determine the anticipated performance under the design-imposed wind loads.

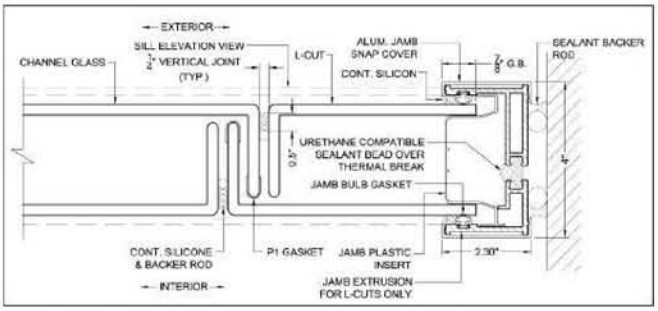
Heat transfer characteristics

Energy considerations are extremely important in the exterior envelope's design. In most cases, the exterior channel glass wall requires a double layer of glass. For all but the deep-groove pyramid-shaped texture, surface texture has negligible impact on heat transfer through a double-glazed wall. U-value is enhanced by adding a low-emissivity (low-e) coating. Solar heat gain coefficient (SHGC) is enhanced by the addition of an azure (blue-gray) or bronze (amber) coating.

Channel glass has a higher surface porosity than float glass, and application of clear low-e coatings results in an iridescent visual appearance when viewed from the exterior of the wall. The surface to which the low-e coating is to be applied should be clearly stated. If the coating is applied to Surface 2,[1] it results in a lower SHGC and a more pronounced iridescence. Double-glazed channel glass walls using both low-e (Surface 3) and azure (Surface 2) coatings, delivering a minimum U-value of approximately 0.41 and a minimum SHGC value of approximately 0.53.

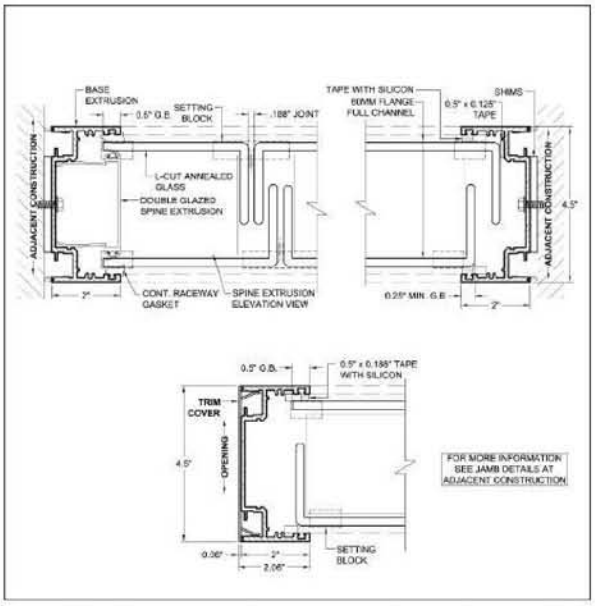
Translucent thermal insulation materials

Energy requirements for building envelopes may need addition of translucent insulating materials to achieve acceptable heat transfer characteristics. It is extremely important the wall assembly's thermal requirement be stated clearly and completely.



SF60 jamb condition for L-cut channel glass, for exterior application systems.

Images courtesy Benheim Wall Systems



Top: I-60 jamb details at adjacent construction. Bottom: I-60 jamb details at the opening. Both are for interior application systems.

The Nelson-Atkins Museum of Art Bloch Building features five 'lenses' of custom glass channels in a double-glazed curtain wall application.

Photo courtesy Roland Halbe

Vertical channel glass systems allow for virtually unlimited glass façades without interim frame support.

Photo courtesy Michael Tryon

There are three major types of insulation: fiberglass, acrylic straws, and silica gel. Products in the first category are usually a coated, open-weave fiberglass occupying the full width of the space between the layers of channel glass. Acrylic straws and silica gel, on the other hand, are encapsulated in either a sheet of fiberglass facing or a polycarbonate shell and formed into flat slabs to be installed in the cavity between the glass layers. All three types of insulation change the wall assembly's visual appearance from relatively transparent to a white translucence, and all reduce the visible light transmission.

Depending on the glass texture used, insulation patterns may be visible to varying degrees when viewing the final assembly. The installation method and the performance characteristics of each of these insulations should be clearly stated so sagging or settling of the material over time within the glass cavity is prevented. The specification should require a visual mockup be built before final approval of the glass and insulation.

The available data from the insulation manufacturers are all based on insertion of insulating material between two layers of uncoated channel glass and indicate a typical resultant decrease in the wall assembly's U-value to 1.3 W/m^{2}K (0.23 Btu/sf deg F Hr).

Combining coated channel glass with this material would further lower the U-value. The visual light transmission of uncoated, double-glazed channel glass may be as high as 73 percent, and the introduction of a translucent thermal insulation material may reduce it to 38 to 48 percent, depending on the material used. The specification should clearly state the U-value, SHGC,

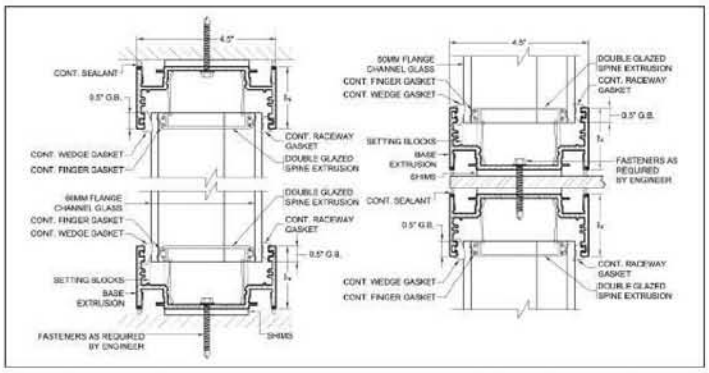
and VLT needed for the assembly and require written verification of compliance with simulated modeling or recognized test standards (*e.g.* ASTM International or National Fenestration Rating Council [NFRC]).

Visible light transmittance

A double-glazed configuration of uncoated channel glass has a VLT of 0.73. The addition of a tinted coating, enamel frit, or sandblasting to the configuration may decrease the visible light transmission by a third or more.

Sound transmission

Outdoor-indoor transmission class (OITC) rating is the preferred standard for exterior performance walls. (It should not be confused with sound transmission class [STC], which is a measure for interior partitions.) OITC measures how well outdoor sounds—such as automobiles, trains, and aircraft noises—are isolated from entering the building. The higher the OITC rating, the better the performance. However, the specification should require the submission of test reports for the full range of noise reduction as a function of sound frequency.



Left: I-60 sill/head details. Right: 1-60 stacked joint detail for an interior application system.

Interior applications

While interior partition channel glass walls do not have as severe a set of performance needs as their exterior counterparts, the applicable requirements should be clearly stated. Interior partitions may be configured as single- or double-glazed; they can be oriented either vertically or horizontally.

The STC rating is a single number describing how an interior partition isolates higher frequency noises such as speech, television, and office equipment. The use of this single number solely as a performance requirement

SAFETY GLAZING AND TEMPERED GLASS

Safety glazing requirements for entry areas, pedestrian accessible areas, and elevator shaft enclosures can vary according to local building codes.

Channel glass is available in a fully tempered form that is approximately four times stronger than annealed glass. A safety film approved by American National Standards Institute (ANSI) Z 97.1, *Safety Glazing Materials Used in Buildings: Safety Performance Specifications and Methods of Test*, and Consumer Product Safety Commission (CPSC) Title 16 Part 1202 (16 *Code of Federal Regulations* [*CFR*] category II) may be applied to the three inside faces of annealed channel glass to qualify it as a safety glass. However, since safety film offers no additional strength, the resultant glass remains only about a quarter the strength of tempered glass. Consideration should also be given to the possibility of the film's eventual deterioration.

Tempering should be performed by a certified facility with an ongoing quality control program in accordance with ANSI Z 97.1 and CPSC Title 16 Part 1202 (16 *CFR* category II). It is recommended the tempering be done via ovens specifically designed to accommodate three-dimensional channel glasses. The facility should be periodically inspected and certified by an independent third-party agency such as the Safety Glazing Certification Council (SGCC).

Since the glass already has an imposed pattern, tempering does not materially affect the finished appearance. This allows tempered channel glass to be intermixed within an annealed channel glass wall without affecting the final assembly's look. (A physical mark denoting which is which should be required.)

Heat-soak test

Heat-soak testing of all exterior applied tempered glasses should be required in all specifications to reduce the possibility of spontaneous breakage resulting from the development of nickel sulfide inclusions during the tempering process. The recognized standard for the heat soak test of channel glass is the European Union's *Bauregelliste* 2002/1, Part 11.4.

Wire in-lays

Although wire glass is available for use as a decorative effect, it is not a qualified, safety-rated glass unless it is filmed with an approved safety film. Wired glass cannot be tempered. **CS**

For either exterior or interior applications, various framing systems are available for both single- and double-glazed and vertical or horizontal configurations, as shown here at the Genomic Center (Princeton, New Jersey).

Photo courtesy Bendheim Wall Systems

is insufficient to describe a wall's adequate performance. The decibel absorption at the range of frequencies targeted for reduction should also be examined to ensure acceptability.

As one might expect, the requirement for wind load resistance is much lower for an interior partition than for an exterior wall. Nevertheless, tall interior channel glass walls found in lobbies, atria, and other areas will deflect under interior wall pressures. The most important performance factor is the anticipated mid-point deflections of the interior glass under imposed wind loads (*i.e.* those created by door openings and closings, air-conditioning, etc.).

Maintenance issues should be considered in the performance requirements of all wall systems. For example, single-glazed sandblasted channel glass could be susceptible to permanent staining from fingerprints, dirt, and water. An alternative would be translucent white enamel frit coating of similar appearance—this offers a hard, smooth surface impervious to such soiling issues.

Frame systems

For either exterior or interior applications, there are various framing systems available for both single- and double-glazed configurations (vertical or horizontal). The framing system for the channel glass must provide adequate structural strength, maintain watertight performance under imposed wind loads, and accommodate building movement from all of the sources (including seismic events) while also conforming to the architectural intent and the building's structural framing.

Most framing systems are stick-built onsite and the channel glass is pocket-set in individual pieces. There are some unitized and semi-unitized framing systems available for particular building configurations. All framing should provide

Channel glass is a translucent, roll-formed, U-shaped cast glass that can create sweeping walls of glass of unlimited width without vertical aluminum framing. Note the all-glass corner at the San Francisco, California, building.

Photo courtesy Richard Barnes

sealant and gasket configurations in accordance with sealant manufacturer's requirements. Exterior performance wall systems should have an abraded cavity to receive a polyurethane thermal break, and be configured to facilitate anchoring on both sides of the break to minimize any stress.

The specification should clearly state the maximum anticipated wind load imposed on the glass, the maximum amount of expected vertical movement at the floor lines and the category of seismic performance required during an earthquake. The clear statement of maximum expected wind load dictates the type, size, and location of fasteners used to attach the frame to the building, as well as ensure adequate strength of the glass framing system.

The building movement from all of the sources—including live load, thermal movement, creep, inter-story drift, and concrete shrinkage—must be accommodated by the extrusion system, and a clear determination of required movement is essential for selecting the appropriate frame.

A sill and sub-sill configuration that accommodates greater lateral building movement is recommended for exterior wall assemblies. The use of a sub-sill (which contains all anchoring holes) also limits penetrations in the sill to weep holes for egress of any possible water accumulation.

Building use determines the level of seismic performance required. Critical facilities (*e.g.* police stations and hospitals) need a Category III performance level, which requires the wall assembly to return to the original specified performance after a seismic event without needing any remedial work. Framing systems should accommodate 6.4 mm (¼ in.) of lateral movement per lineal foot (*i.e.* 0.3 m) of unsupported channel glass height.

The specification should call for documentation showing conformance to the design requirement via industry standard performance tests for the selected configuration. The specification should also stipulate that the installing contractor keeps a complete, updated set of approved shop drawings onsite at all times.

At Azusa Pacific University's (APU's) Segerstrom Science Center (Azusa, California) the single- and double-glazed walls of obscuring channel glass combine privacy with light-scattering properties.

Photo © Jim Watkins. Photo courtesy Specialty Glazing Systems.

Westwood Branch Library (Los Angeles, California) uses channel glass walls and partitions to admit and distribute large amounts of natural light into the building.

Photo courtesy Bendheim Wall Systems

Many design concepts require custom-extruded or bent trim pieces be incorporated into the channel glass assembly. The requirement to furnish all of the system components by one contractor is extremely important. Demanding the whole wall assembly meet the specified performance criteria is also crucial. All of the framing components, standard and custom extrusions, and custom-fabricated trim pieces need matching finishes. This necessitates a clear and complete statement of color and composition of any paint finishes used for the wall.

Installation

Selection of installers should be limited to firms with a proven record of successful glass curtain wall and/or storefront systems. They should understand the site assembly procedures and be capable of furnishing a full set of adequately detailed shop drawings, stamped structural calculations, custom-fabricated trim, and other components required to complete the installation of the entire glass system. The contractor should be required to commit the necessary management personnel familiar with the logistics, fabrication requirements, and techniques for completing the work on a timely basis.

Bidders should be pre-qualified; on the substantial projects, a performance bond is a good idea. It is also advisable the glazing contractor be given responsibility for the total glass wall assembly, including non-channel

ADDITIONAL **INFORMATION**

Author

Jim Donoghue is the technical services manager for Bendheim Wall Systems. He has more than 40 years of construction industry experience. Donoghue possesses both an MBA and a degree in mechanical engineering. He can be contacted via e-mail at jdonoghue@bendheim.com.

Abstract

For exterior curtain walls and storefronts or interior partitions, channel glass provides an attractive alternative, offering a depth and profile not found in flat glazing applications. In addition to a high level of design and security options, channel glass walls and partitions can help projects better achieve sustainability by contributing to daylighting, recycled content, thermal performance, and occupant comfort.

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glass areas (*e.g.* doors, windows, and stick-built glass areas). The interfacing between these different systems should be clearly shown on the shop drawings.

Due to considerable discrepancies between concrete and steel erection tolerances and the requirements of any curtain wall, the glazing installer should be involved in the design and installation of the structural framing systems.

The specification should require that a complete fabrication and installation manual from the channel glass system supplier be included in the submission materials. This information should clearly illustrate that all cutting and notching procedures be performed by the glazier to correctly fabricate the aluminum frames.

Channel glass arrives to the site in strapped bundles and should be thoroughly inspected and cleaned. All installed glass channels should be completely sealed by the end of the workday. If this is unfeasible, the joints of all channels should be taped closed until they can be sealed in a timely manner to prevent insects and dirt from infiltrating the glass cavities. (The joint should have a silicone backer rod between the channels, followed by the silicone sealant.) During channel glass installation, temporary water dams must be employed at the end of each day's production to avoid any water infiltration into the sill area of the previously installed channels.

In addition to performance walls and screen walls, channel glass façades can be effective components of Trombe and Barra wall configurations. A double-glazed wall can be an excellent exterior skin of pre-heated wall chambers due to its ability to transmit solar warmth to an interior wall. The glass's surface pattern can diffuse the light so that the colors—but not the details of the interior wall construction—are clearly visible.

Conclusion

Channel glass offers many benefits. In addition to high design image, a variety of textures and coatings, gains of daylighting and privacy, and potential for façades up to 7 m (23 ft) tall without intermediate metal supports, channel glass can deliver enhanced thermal performance. The proper specification of channel glass ensures optimal aesthetics, superior performance, and the possibility for point contribution under the LEED program. **CS**

Notes

[1] For counting glass surfaces, the outside of the exterior is 1, the inside of the exterior is 2, the outside surface of the interior is 3, and the interior surface is 4.