



Glass Floors and Stairs

Introduction

Glass floors and stair treads are found in both residential and commercial settings, and are growing in popularity because of their aesthetic appeal as well as for the daylighting benefits they bring to a space. While there are manufacturers that provide engineered and tested flooring systems, most glass floor and stair tread projects require the input of a structural engineer to provide load calculations and an experienced installer to provide glazing details.

Because pedestrian safety is a critical objective, the glazing in-fill must provide an acceptable level of slip resistance. If there is a possibility for inappropriate lines of sight, the glass will require greater opacity or translucency to address a concern for modesty.

Combining Loads

The design of glass floors and stair treads typically calls for load calculations. Those calculations are typically the responsibility of a structural engineer. The load requirements are taken from the applicable building code or, if none, from the American Society of Civil Engineers¹ (ASCE) Standard 7 - *Minimum Design Loads for Buildings and Other Structures*. The uniform loads include live, snow, dynamic and dead loads. Other loads include impact and point loads, but careful consideration should be given to applying point and impact loads to glass. Special consideration should be given to high loading conditions, such as dance floors. An important consideration is the ability of the walkway to support the design loads, even after breakage. Glass is by nature a brittle material and surface damage can occur by impact from hard objects, which can greatly reduce the load carrying capacity. Redundancy and suitable safety factors must be used in the design of glass flooring. The edge support conditions must be identified as four-, three-, or two-sided in order to understand the load-carrying capabilities of the glass.

Recently, an ASTM International² (ASTM) Task Group, E 06.56.04, was formed to begin work on a *Standard Practice for the Design and Performance of Supported Glass Walkways*. Once finalized, this document will assist the designer in better understanding the elements related to performance, design, and safe behavior of glass walkways that include interior and exterior walking surfaces constructed and intended for pedestrian use, including floors, ramps, sidewalks, and stair treads.

Choosing the Glazing

Several types of glass products are used in floors and stair treads, including laminated glass and glass block systems. A description of these glass types follows:

- *Laminated glass* - two or more pieces of glass bonded together with an interlayer. The glass may be annealed, heat- or chemically-strengthened or fully tempered.
- *Glass block* - a decorative hollow glass building block that is set in an aluminum or concrete framework and sealed against moisture.

Providing Slip Resistance

Slip resistance of a walking surface is an important safety consideration. The Occupational Safety and Health Administration³ (OSHA) requires a minimum slip resistance, expressed as a static coefficient of friction of 0.50. However, special activities, such as dancing, may require a different level of slip resistance. Glass floors used near entrances that may get wet require special consideration.

There are a variety of ASTM test methods that measure slip resistance using specific test equipment under dry or wet conditions. These are:

- F 609 - *Standard Test Method for Static Slip Resistance of Footwear, sole, Heel, or Related Materials by Horizontal Pull Slipmeter (HPS)*
- F 1677 - *Standard Test Method for Using a Portable Inclined Articulated Strut Tester (PIAST)*
- F 1679 – *Standard Test Method for Using a Variable Incidence Tribometer (VIT)*
- D 2047 - *Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine*

Other industry standards, such as ASTM F 1637 - *Standard Practice for Safe Walking Surfaces*, ASTM F 1646 - *Standard Terminology Relating to Safety and Traction for Footwear* and Underwriters Laboratory⁴ (UL) UL 410 – *Slip Resistance of Floor Surface Materials*, address the safety issues of walkway surfaces from a more general point of view.

Processes designed to roughen the top surface of the glass to provide slip resistance include sandblasting, acid-etching, ceramic frit, and embossing. It is important to note that sandblasting may reduce the strength of the glass by as much as 50%; therefore, glass flooring should never be sand blasted in the field without a complete engineering analysis.

Considering Modesty

Modesty becomes an issue when glass floors are found on upper levels and inappropriate lines of sight are created from spaces below. When modesty is a concern, it may be necessary to incorporate a ceramic enamel finish or a decorated or translucent interlayer in the glass to create opacity.

Testing

Glass floors can be tested for strength or impact resistance. Test methods that are used include:

- ASTM E 72 - *Standard Test Methods of Conducting Strength Tests of Panels for Building Construction*
- ASTM E 695 - *Standard Method for Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading*
- ASTM E 2322 - *Standard Test Method for Conducting Traverse and Concentrated Tests on Panels Used in Floor and Roof Construction*

Installation

Any sealants or caulking that is used must be checked for compatibility with the glass flooring. The framing and supports for glass floors comprised of laminated glass must provide drain holes or weep systems to avoid the possibility of water or cleaning fluids building up in the system.

Fire Resistance

Glass floors are not normally fire resistant so careful consideration should be given to maintaining adequate fire barriers between floors.

Maintenance

Glass floors should be regularly inspected for damage, as impact from hard objects can crack the upper surface. Any damaged glass should be replaced as soon as possible. Cleaners and polishes may change the coefficient of friction and should be avoided.

Conclusion

Glass floors and stair treads are aesthetically appealing and beneficial as a way of bringing additional light into a space. These systems are used in both commercial and residential spaces and require careful attention to engineering, installation, and pedestrian safety. All parties are alerted to the potential of liability for consequential damages.

The Glass Association of North America (GANA) has produced this Glass Informational Bulletin solely to provide general information as to identify issues related to glass flooring and stair applications. The Bulletin does not purport to state that any one particular type glass flooring design process or procedure should be used in all applications or even in any specific application. The user of this Bulletin has the responsibility to ensure the design, engineering and installation guidelines from the glass flooring and stair system supplier(s) are followed. GANA disclaims any responsibility for any specific results related to the use of this Bulletin, for any errors or omissions contained in the Bulletin, and for any liability for loss or damage of any kind arising out of the use of this Bulletin.

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