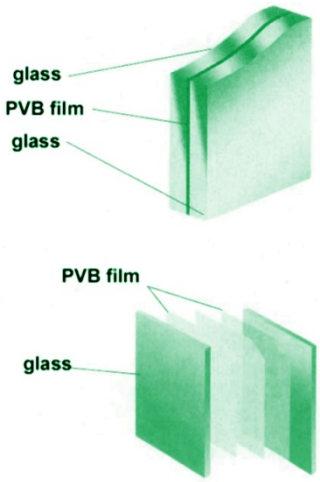
2. LAMINATED GLASS

2.1 General Information



Laminated glass consists of a tough plastic interlayer made of polyvinyl butyric (PVB) bonded together between two panes of glass under heat and pressure. Once sealed together, the glass "sandwich" behaves as a single unit and looks like normal glass. Annealed, heat strengthened or tempered glass can be used to produce laminated glass.

Similar to the glass in car windshields, laminated glass may crack upon impact, but the glass fragments tend to adhere to the plastic interlayer rather than falling free and potentially causing injury.
Laminated glass is the only glass to provide durability, high-performance and multi-functional benefits while at the same time preserving the aesthetic appearance of the glass. Laminated glass furnishes solutions to many architectural design problems and offers increased protection from the effects of disasters such as hurricane, earthquake and bomb blast.

2.2 Technical Information

2.2.1 Vertical Safety Glazing Applications

The Consumer Product Safety Commission (CPSC) and the architectural glazing safety sections of the major model building codes (Basic National Building Code; Standard Building Code; Uniform Building Code) all set uniform requirements for the performance of glazing materials used in applications which present a potential hazard to the public. These applications include entrance doors, storm doors, patio-type sliding doors, shower and bath enclosures, sidelights and fixed glazed panels. Performance requirements are determined by the application and the size of the glazing area. Laminated glass meets all of these established building codes.

2.2.2 Sloped and Overhead Glazing Applications

The use of glass in sloped and overhead glazing presents a design and safety challenge. If the glass should break for any reason, the glazing system specified needs to be able to provide protection from glass fallout. With adhesion of the glass to the plastic interlayer and its ability to remain integral if broken, laminated glass has passed the requirements

set of all the major model building codes in the United States and the Glazing Industry Code Committee for sloped and overhead glazing.

2.2.3 Burglaries

Burglaries are frequently directed towards targets of easy opportunity and low perceived risk by the burglar. A simple deterrent, security glazing, may be enough to send the intruder to the next easier target. Glazing materials which meet these test requirements are generally strong enough to deter a "smash and grab" burglary, and is often specified for residences, shop fronts and display cases in stores, museums and libraries.

2.2.4 Ballistic Protection

Security glazing with laminated glass of appropriate thickness and configuration can reduce death and injury from bullets in high-risk locations, while still providing the aesthetic and visions benefits of glass.

Bullet-resistant glass is made by bonding alternate layers of glass or glass and polycarbonate to form a single, multiple-ply laminate. Laminated glass between 1" and 2" inches thick can generally resist bullets from weapons ranging from a .38 super automatic to a high power .30-06 rifle.

2.2.5 Bomb Blast Resistance

Unfortunately, bomb attacks and threats are on the rise all over the world. The fear generated by a bomb's instant holocaust of property damage, injury, flame and noise can be more powerful than conventional armed attacks. Bomb blasts propagate blast energy in all directions, making buildings nearby the intended target candidates for destruction as well. Experts report that approximately 75 percent of all damage and injury from bomb blasts can be attributed to flying and falling glass following the explosion.
Laminated glass can substantially reduce injury resulting from explosions, and even reduce the cost to repair a bombed facility by reducing the extent of damage and opportunity for looting.

2.2.6 Electronic Eavesdropping

With high technology playing an increasing role in corporate and government security operations, electronic eavesdropping to obtain classified or proprietary information can result in staggering losses. Interference with computer networks from electromagnetic

noise generators (such as heavy machinery operating outside the facility) can also be the source of loss.
Electronic security glazing uses PVB metalized fabric mesh and glass. When the glass is manufactured, the fabric mesh is extended an inch or more from the edge of the glass on all four sides and then connected to the metal frame. The frame members are connected to each other, and then to an effective ground. The result is a facility that is isolated from external electro-magnetic signals and occupants are capable of communicating without interception from the outside.

2.2.7 UV Protection

With time, sunlight can cause considerable damage to buildings furnishings, carpets, artwork, photographs, plants and other valuables. These items need special protection from the damaging effects of the sun's ultraviolet (UV) rays. Laminated glass can be effective in screening out the harmful UV rays, controlling glare and decreasing solar energy transmittance.

Glazing solar control is accomplished in laminated glass by the inter-layers ability to reflect and/or absorb and re-radiate much of the solar UV radiation. Laminated glass screens out more than 99% of damaging UV light.

While protecting buildings from harmful and damaging solar UV radiation, laminated glass has no adverse affect on the health of indoor plants. In fact, laminated glass is commonly used in greenhouses and atriums to help protect flower color and reproductive development from the damaging effects of UV radiation. Photoreceptors in plants are still able to absorb sunlight which the interlayer allows to be transmitted.

2.2.8 Sound Control

Laminated glass is the sound solution to keeping unwanted noise where it belongs outside. Low-flying airplanes, highway traffic, railways, lawnmowers, or the occasional noisy neighbourhood, can make relaxing difficult. Ordinary windows are the weakest link for allowing unwanted sound to invade the home. Laminated glass offers exceptional sound control because of the sound-dampening characteristics of the plastic interlayer, regardless of the source of the sound.

2.2.9 Hurricane protection

Hurricanes are unpredictable forces within Mother Nature's arsenal of destruction. A hurricane's turbulent winds and strong gusts of air often carry wind-borne debris which can slam into glass windows and doors. Once the window panes are broken, the protective exterior "envelope" of a building is compromised, allowing strong winds to rush into a building creating internal pressurization within the structure. The trapped wind forces then push upward on the roof, outward on the exterior walls and can eventually cause complete destruction of the building.

2.2.10 Earthquake protection

Breaking and falling glass represents a major hazard in a seismic event. In moderate earthquakes, broken glass may exit the window opening, causing damage to the contents of a building. In severe quakes, falling glass can cause serious injury or death to people below the windows at street level.

While the inherent tendency of laminated glass to stay in the opening when broken is well-established, architects and engineers have only recently begun to research the performance of architectural glazing systems during an earthquake. Currently, the U.S. National Science Foundation has funded a multi-year research project at the University of Missouri-Rolla to further investigate glass performance during earthquakes. Early results indicate that annealed or heat-strengthened laminated glass has shown expected superior performance over ordinary glass in its ability to resist fallout, thus reducing the hazard to a building's occupants and pedestrians and property below.

Test results also found laminated glass is highly resistant to the dynamic racking motions of a quake, once again helping to maintain the integrity of the buildings envelope and prevent injury and damage from glass fallout. Laminated glass also provides protection after an earthquake, as it helps to keep the building secure and weather-tight until repairs can be made.