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SAFETY GLASS

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INTRODUCTION

Contemporary architecture and interior design can not be imagined without the use of glass. Glass - a modern building material that can be transparent, colour, heat and sound insulation. It is quickly mounted. However, glass has the ability to break. Current technology allows the manufacture of safety glass, which has prolonged lifetime and lasted from the environment, undermine the people around.

EU statistics show that every year 5,720 of work and domestic accidents of the glass breakage occurs in the European Union. Social responsibility to create a safe environment for humans is one of the advanced countries and commercial enterprises priorities. Therefore, the manufacture of glass, a construction company produce and promote the safe use of glass for furniture, construction and interior design.

What is safety glass? This glass, which is further processed to reduce the human risk of injury from a piece of glass. Trying to secure the glass break, it crumbles into small pieces without sharp edges that could injure someone. Safety glass standards have been create in 1970. Known these types of safety glass: tempered glass, laminated glass and toughened laminated. This guide is delivered to types of safety glass, quality standards, production technology features, the use of safety glass areas.

This guide is - briefly summarize the types of safety glass, their properties, production and quality requirements that are put. E-manager of safety glass can be widely used for students, managers, working in glass manufacturing and trading companies, architects and designers.



TYPES OF SAFETY GLASS (toughened, laminated, tempered, laminated) AND QUALITY STANDARDS

Safety glass is called the glass, breaking the sharp fragments are not in compliance or they stick to the transparent organic film. In other words, the safety glass is glass, which does not breaking sharp fragments which may be cut or otherwise injured. Safety glass are as follows:

- tempered or toughened,
- laminated,
- tempered-laminated glass.

Toughened glass is called different chemical composition, color, shape and dimensions of glass, specially heat treated for mechanical strength and heat resistance increased. Glass heat-treated as follows: heated slightly above the softening temperature and suddenly cooled uniformly. Such glass uniform distribution of relatively high internal stresses. Outer layers of high compression occurs, the inner (thin layer) - tensile strength. Compressive strength of glass 10 times greater than the tensile strength, and tempered glass is very strong. Such a 6 mm thick glass unbreakable, dropping it from a height of 1.2 m 0.8 kg metal ball. Boosted by higher forces, crumbles honeycomb shaped area up to 100 mm² fragments without sharp corners. Hardening increases the heat resistance of glass: it does not break while suddenly change in temperature of up to 270 degrees. Toughened glass bending strength not less than 125 MPa (1250 kgf/cm²), which 5-7 times higher than ordinary glass.

Toughened glass definition and description, as well as the conformity assessment and testing methods sets the standard. Lithuania applies the Lithuanian Standardization Department of the Ministry of Environment of the Republic of Lithuania approved standards:

BS EN 12150-1:2002 - Glass in building. Thermally toughened soda lime silicate glass. 1. Definitions and description;

BS EN 12150-2:2005 - Glass in building. Thermally toughened soda lime silicate glass. 2. Conformity assessment. Product standard. After tempering glass visually the same, but the attempt, it defines the quality of tempering its collapse into small chunks of mild, as shown in Figure 1.



Figure1. Test of tempered glass breakage.

All these basic standards are used for flat hardened glass to describe and assess a take over from the European Committee for Standardization (CEN / TC 129), i.e. the European Standard EN 12150-1:2000. Lithuanian Standards Board (LST TK 60) took over as the approval by the Lithuanian standard LST EN 12150-1:2002, which runs from 2002 September 15, while the European standard EN 12150-2:2004 Lithuanian Standards Board has taken over as the approval by the Lithuanian standard BS EN 12150-2:2005, which runs from 2005 12 February. Another standard BS EN 12600:2003 - Glass in building. The pendulum test. Sheet glass impact test method and classification is borrowed from the European Committee for Standardization in the

European Standard EN 12600:2002 E, defined by plumb an impact test method single flat glass panes in buildings. The test describes the classification of flat glass products into three classes according to the principled conduct and the impact breakage awoke. Furniture used in the glass properties and test methods are defined by the Lithuanian standard BS EN 14072:2003 - Glass used in furniture. Test methods for approval by the adoption of the European Committee for Standardization European standard EN 14072:2003 and entered into force in 2004 2 February.

Laminated glass is produced by combining two or more flat sheets of glass with organic film (PVB or EVA - polyvinyl butyral). Between the heated and exposed to high pressure in the glass plate and film melted glass bonds. This design provides a secure glass in its resistance to various mechanical damage. Broken glass does not even drop - takes fragments of adhering to the film. This ensures protection against potential injuries.

Laminated glass has characteristics as well as a versatile glass. It may be intended to protect against UV rays, since the reflective glass in sunlight alters the glass envelope of reflectivity, transmission and absorption properties. Also, laminated glass can protect the museum valuables in the bank's premises against an armed attack or other valuable property on the premises and to ensure the safety of working people. A special laminated glass structure has a transparent bullet-proof glass partition or even a gun Kalashnikov.

The use of laminated glass, you can create a variety of interior color combinations, designs, located inside the glass plates. In addition, the color and patterned glass can be combined with metal, wood and other materials. The entire building life cycle laminated glass remains in the same color and same-resistant. He requires no special care.

A special sound-insulating laminated glass without increasing the thickness of the glass, can significantly reduce the noise: 6 mm laminated glass sound insulation equivalent to 12 mm, single-glass acoustic insulation (6 mm laminated glass acoustic insulation - 35 dB, 1 dB less than 12 mm, single-glass sound insulation) .

Tinted laminated glass can reduce the amount of heat emitted by the sun, thereby reducing the cost of room ventilation and glare.

Glass design - aesthetic, comfortable and practical, but there is no guarantee that the glass from the simple mechanical effect. Every year large numbers of people injured during a collision with the glass, many of the victims are children. Reduce the likelihood of accidents at the buildings of glass - an important factor. Glass shards crash resulting from sharp edges, they usually are accidents and can cause extremely painful consequences - even death occur.

So far, Lithuania does not have any special security requirements, defining the type of glass can be used in certain places, causing risks to humans. Places such as doors, door and shower enclosures shall be used in laminated glass break event, without jeopardizing the injury.

All glass laminating defects are removed. Intentional or accidental impact the laminated glass may be cracked, but the fragments of glass adheres to the film and the neiškrenta frames. Thus, the risk of accidents is reduced.

Glazing is safe by the EU Directive 89/654/EEC (European Union Council Directive on minimum standards for the workplace safety and health requirements). The Directive points out that in all places where the human and glass structure collision risk, the glass must be safe.

According to the EN standard, laminated glass strength heading into shock-resistant hand (EN 356) and shots resistance (EN 1063). In accordance with the requirements of strength class, the glass must withstand a hammer and ax blows, shots and even an explosion. Made of tempered glass, laminated glass is considered the safest.

Laminated glass in the inventory and assessment of compliance with standards established by the Lithuanian Department to adopt standards for:

LST EN ISO 12543-1:2002 - Laminated glass and laminated safety glass. 1. Components

of the definition and description;

LST EN ISO 12543-2:2002 - Laminated glass and laminated safety glass. 2. Laminated safety glass;

LST EN ISO 12543-2:2002 / A1: 2005 - Laminated glass and laminated safety glass. 2. Laminated safety glass;

LST EN ISO 12543-3:2002 - Laminated glass and laminated safety glass. 3. Laminated glass;

LST EN ISO 12543-4:2002 - Laminated glass and laminated safety glass. 4. The durability test methods;

LST EN ISO 12543-5:2002 - Laminated glass and laminated safety glass. 5. Dimensions and edge finishing;

LST EN ISO 12543-6:2002 - Laminated glass and laminated safety glass. Part 6. Appearance.

Toughened - laminated glass - a safe combination of the two types of glass. It is used rarely, only in cases where the doubled protection needed from wind gusts, strokes, and weight. Normally, this type of glass is used in the ceiling or roof construction. Purpose of use - the mechanical break hardened glass to maintain the fine glass particles stick to the film and thus to protect people from accidents.

SAFETY GLASS PRODUCTION TECHNOLOGY FEATURES

1. Toughened glass production technology

One essential thing to know before quenching the glass, it is that the glass before quenching to be processed, i.e., seaming or ground the edges, otherwise glass during tempering process will be broken. Thus, it is necessary to maintain the glass processing sequence:

- 1) cutting;
- 2) grinding (when all glass edge is worked) or seaming (processed only the arrises of edge);
- 3) drilling or milling, if necessary holes in glass;
- 4) washing;
- 5) continuous painting or a drawing forms of screen-printing method, if necessary.

Another important factor before tempering is glass washing. If the washing of the glass is bad, on the surface will be contaminated by dirt or stains, which burnt during the tempering of glass and to clean it after it is not possible without damaging the glass surface.

As mentioned earlier, during the tempering the glass is heated to approximately 600 °C and then suddenly blown by strong air currents. Such a process is derived from a large glass of internal stress, i.e. the outer layers of high compression occurs, the inner (thin layer) - tensile strength. This the glass is much more resistant to mechanical and thermal effects, and the split breaks into small pieces with blunted edges, and injury to the surrounding.

According to shape tempered glass is sorted into:

- 1) flat tempered glass;
- 2) bent tempered glass.

1.1 Flat tempered glass manufacturing equipment and features

There are such types of flat tempered glass manufacture lines:

- 1) continuous operation;
- 2) oscilating (periodical) operation.

Tempering furnace for continuous operation in the production process is a continuous mode, i.e. these furnaces are stopped when necessary to carry out preventive or furnace repairs. The most common type tempering furnace, is strengthened mass production, that is where there are large quantities of uniform size and thickness of the flat glass products.

Oscilating (periodical) operation of furnaces is dedicated to facilitate the transition from one mode to another tmpering, so here is characterized by a variety of products.

Same tempering equipment consists of the following sections:

- 1) loading conveyor;
- 2) heating furnace;
- 3) tempering section (also known as chillers);
- 4) In some furnaces are installed on separate cooling section, but in most cases cooling is the tempering section;
- 5) unloading conveyor.

Glass tempering process follows: to prepare the glass products are displayed on the loading conveyor, and selecting the appropriate mode and run the program, transported in a heating furnace. Here electric heating elements and (or) hot air currents help glass heated to the required temperature and transported to the tempering section, which is rapidly blow up by the air steam supplied from the room (in winter) or outside (in summer). After cooling to room temperature glass is transported on a conveyor unloading and placed on the pyramids and other stocking devices. Both the heating furnace and quenching section, a glass is always oscilated in order to keep flatness, to prevent waviness and other defects.

In the tempering process the most important parameter is tempering treatment. Tempering

tempering mode provides the operator of the installation. According to tempered glass type, size, thickness, hole location, or lack of them, operator selects the heating temperature of the glass heating furnace, maintenance time, adjusting intensity of quenching.

A very important parameter is heating of the glass. To obtain a high quality tempered glass, it is necessary to evenly heat the glass product. Heated uniformly, glass deforms and breaks into different small safe pieces of glass. The heating section of tempering lines can be of two types:

- Radiation - the heat is transferred by radiation;
- Convection - heat is transferred to the carrier, in this case, the heated air support.

Nowadays, when every day there are new types of glass, in some cases, tempering of the glass is extremely difficult, for example.: Glass, which protects against sun rays, is coated with a special coating that reflects the rays. Therefore, in order to heat such type of glass, it is needed not only the usage of heat radiation, but the perpendicular to the surface of the glass it is blown hot air to facilitate the heat transfer. Glass with a soft coating is classified under the Low-E ratio. The rate is lower, while the glass is more difficult to harden. Currently, the market might offer the glass with the smallest Low-E ratio 0.02.

Another important parameter of the glass tempering is intensity of quenching. Tempered glass is to be blown by different intensity depending on the thickness of the glass. The glass is thinner, the more air must be filed. This is because the glass is thinner, the faster it cools down, and it's hardening faster, therefore, in order to be on time to create internal stresses in the glass, it must be cooled down outside faster than inside. As a result, the thin glass will be toughened. For the very thin glass, ranging from 3 mm and less, even used compressed air compressors, as usual is not enough fan power supply the necessary blow of glass.

Tempering intensity depends on the supply air flow rate, the pressure nozzle and the distance from the glass. Weather for glass tempering section is available from ventilators, which might be two types:

1) AC when the fan is always rotating at a constant speed, thus supplying a uniform air flow. In this case, air is stored in certain containers, and then fed adjustable dampers help annealed glass surface reciprocal;

2) DC, when the fan rotates at different speeds depending on the required supply air flow. In this case, use less electricity.

In a DC fan while you are next to the furnace, it is very easy to figure out how thick the glass is tempering. If the fan is working relatively quietly, you can understand that there is a thick toughened glass, for example.: 10 mm thick or thicker, as such glass cooling down relatively slow, and for such reciprocal glass not supplied a lot of air. As already mentioned, the glass is thinner, the tempering is more difficult as the glass cools quickly and the need to supply a high air flow, assuming that the quality of its tempering. For this reason, the quenching glass of 4 mm DC fan is working so intensely that the noise is loud enough.

The choice of the tempering furnace from the manufacturer depends on necessary to decide what the maximum and minimum glasses will be on desired production, while at the same time to be verified the features of tempering lines capability. The standard production that is usually found is in the following dimensions of the working of glass tempering furnaces:

- 1200 x 2400 mm;
- 1500 x 3000 mm;
- 2000 x 4000 mm;
- 2400 x 4800 mm;
- 2600 x 5400 mm;
- 2800 x 6000 mm.

Maximum glass size is important in selecting a tempering line that will be produced accordingly and it can not be placed bigger sizes glasses in it, so the furnace will not be able to expand or reduce.

The minimum dimensions of the tempered glass are important because all the glass during tempering process is transferred by shaft support. Among the shafts it is a certain distance, so the minimum size of tempered glass is to be selected so that the glass would not drop in between shafts, for example.: if the distance between the rollers is 200 mm, the minimum size of the glass will be 250 mm in length.

Talking about rollers it is worth to say that in the furnace silica rollers are used. Silica rollers are covered with heat-resistant material or made from it. Entrance and loading conveyor and tempering section shafts are usually covered in heat-resistant rope (also known as Kevlar rope).

Another important criteria in choosing the tempering furnace is that you need to decide whether you will require tempered glass with a soft coating. As mentioned previously, that glass is harder to temper than usual, because glass is harder to absorb heat. In order to temper the glass with a soft cover, many of today's manufacturers use different variations of convection: one takes the hot air from the furnace bottom and blows to the top of the other lodges in the furnace, compressed air, which is passing through the heating elements and heat as the heat of glass, others creates turbulent currents within the furnace fan.

When you need furniture or interior design tempered glass, usually it is used the smaller sizes tempering furnaces, because upholstery and interior windows are oversized. Those furnace are not always able to temper glass with a soft coating as they have not hot air convection option.

Glass with a soft coating and oversized glasses are used in architecture, therefore, for a such glasses the big tempering furnaces are normally used. Tempered glass with a soft coating is possible to temper on such furnaces, which have an option to temper coatings. Double-glazed windows with tempered glass facades are mainly used in order to increase their resistance to thermal or mechanical stress, thereby protecting surrounding a possible crash event.

The most common defects are tempered glass be as follows:

- 1) curvature;
- 2) waviness;
- 3) anisotropy.

To avoid all these defects, it is important to choose the proper installation of tempering and annealing treatment. Glass size waviness or curvature usually caused by uneven heating up the glass around the perimeter. Waves resulting from the excessive heating up of glass or incorrectly selected oscillation mode. Anisotropy - this is a fact when on the glass surface after tempering appears a visible spot. With this defect is most difficult to combat. Anisotropy comes from blowing the glass in the tempering section, i.e. blowing cold air onto hot glass surfaces results some changes that are visible on the surface of the glass and this is a consequence of anisotropy. To avoid this, the most recent attempt plants are not blow air at one point, but the flow of air to dissipate. This is achieved by gradually moving the nozzle of blowing walls.

1.2. Bent tempered glass manufacturing equipment and features

Bent tempered glass production technology is more complex than flat, as in this case it is not only curved glass, but it hardening. This is made more difficult by the need to bend the glass to maintain the diameter or template, and to be on time to blow the glass before it cools down.

Depending on where a bent tempered glass is used, it is usually divided the following way:

- 1) Auto Glass;
- 2) industrial glass or furniture;
- 3) architectural glass.

Bent hardened glass are used in two technologies:

- 1) glass bending and tempering on the frame (shape);
- 2) glass bending and tempering on movable shafts.

In the first case the bent tempered glass for the cars, furniture or industrial glass are usually produced. In terms of the complexity of the production of glass-shaped glass is bent only gravity method and the press, or even help, that is curved glass to get only one axis of the cylinder form, it is enough gravitational forces to bend the heated glass from its gravity, and the like to get curved glass, both lengthwise and crosswise, and then used to press.

Glass bending and tempering takes place on the frame to as follows:

manufactured glass is placed on a frame-matrix, which is made in accordance with the required production of glass shape, and fitted with a loading / unloading conveyor. The frame-matrix together with the transport of a glass goes through bending / tempering section and press section and stops at the heating section. Here glass is heated to the required temperature, and shuttle-frame with the glass back into the press section, which descends from the top of the mold-punch, which makes glass for the appropriate form. After the frame with the glass matrix transported to the tempering section, where a progressive step in the rushing back and forth, and even glass blown up and cooled. Then the frame-matrix transported to the loading / unloading conveyor, where the glass is removed. This bending-tempering line can be extended by adding a section bending, tempering with or without pressing on the other side of the heating section, so double the performance. Glass bending and tempering on the frame of the prophets, in this case, the glass can be bent in various forms, i.e. not only the standard cylindrical shape, but the "S", "V" or "S"-type format. Such glass is used in household appliances, furniture, interior design and commercial equipment. Architectural glass is mainly used to produce other bent tempered glass production technology, i.e. **glass bending and tempering on movable shafts**. In this case, bending glass without the use of templates. This technology allows you to bend the glass only in the form of a cylinder, but in this case, the bending radius is adjusted computer, i.e. bending takes place quickly, accurately and reliably, thereby avoiding the human factor.

Glass bending and tempering on the shaft is as follows:

glass is placed on the loading conveyor, which is transported from the heating section. Here electric heating elements and forced convection aid glass heated to the required temperature. Glass product during heating oscillates on ceramic rollers. When the glass reaches the desired temperature, it is transported to the bending and quenching section. There may be two types of bending-tempering section:

- 1) when the shafts are located along a sheet of tempered glass;
- 2) when the shafts are located across the tempered glass sheet.

Once the glass comes from the heating section, the bending-tempering section rolls automatically at the appropriate bend radius, which was raised by computer. As a result, since the glass is soft, it gets drawn shaft bending form. Bending the glass is oscillating on wheels or rollers which support the glass bending. After the glass takes on the required form, the glass starts hardening, i.e. filed in the air the whole process of tempering and cooling time. After hardening the outer air injection nozzles pull back the top of the glass and transported on the unloading conveyor. At that time, the bending-tempering conveyor comes into flat position and begin a new working cycle.

As it is known, architectural glass facades are mainly used. In this way, one glass is rarely encountered. Usually mounted façade glazing. Manufacture of the insulated glass units of the curved glass, glass exterior is a larger radius than the inner glass. For each of the glass to be bent individually. For this reason, the movable shaft principle is much more convenient compare to the principle of frame, as required for each dimension and shape of the glass to produce a separate form, which is sufficient to determine the required bending radius of computer support and installation automatically. This saves time and avoids the additional cost form of production results in higher accuracy and productivity. The only drawback in this case is that it can produce various forms of curved toughened glass, but the cylinder, however, architectural glass, and used mostly is a cylindrical curved tempered glass, which sometimes, in order to obtain other forms, combined with flat tempered glass.

2. Laminated glass production technology

Laminated glass is produced by combining two or more flat sheets of glass with organic film (PVB or EVA - polyvinyl butyral). The film located between two sheets of glasses and afterwards heated and exposed to high pressure is melted into glass. This design provides a secure glass in its resistance to various mechanical damage. Broken glass doesn't drop down - keeps fragments of adhering to the film. This ensures protection against potential injuries.

2.1 Laminated glass production technology features

Depending on the destination and laminated glass production volume allocated to the two main laminated glass production technology:

- 1) vacuum lamination;
- 2) Lamination autoclave.

Some require small amounts of laminated glass or decorative glass is produced, usually used in vacuum lamination furnaces. These ovens easier to manage, serve and help them move from one production to another.

Vacuum lamination manufacturing process consists of the following steps: prepare a "sandwich" of two glasses, which paves the way for the laminating film (EVA or PVB). EVA film is used for internal use (partitions, wall cabinets), and PVB for more glazing where there is exposure to the field (elevation), because it is resistant to moisture and UV rays. The prepared sandwich is placed in a silicone bag which is connected to a vacuum pump. Sealed bag with drawing container is placed in the glass lamination oven where vacuum pumps takes air off and afterwards this is kept for 3 hours in 120 °C (EVA films) or 130 °C (PVB films). While autoclave is applied the laminated glass is more reliable and used for a very particular cases and big batches.

2.2 Equipment for the manufacture of laminated glass for mass production and the unit

Usually, manufacture of laminating line with an autoclave is older and more reliable. This method is worked out on lines already pressed "sandwich" and the glass is finally getting brightness in the autoclave. Lines can be continuous, so laminating process gives high productivity. Generally encountered in measurements of glass:

- 2600 mm x 3600 mm, max. productivity 600-800 m² / 8 h;
- 2600 mm x 4800 mm, max. Performance 1000-1600 m² / 8h.

The single chamber vacuum lamination is used for lower productivity. Those equipment might be with a single rack or multirack systems. The most common single rack laminating ovens with the standard glass sizes - 1500 x 3000 mm.

Multirack systems of laminating furnace may be 2, 4, 8 chambers. In this case, usually the glass sizes are larger, for example: 1800 x 3100 mm, 2500 x 4500 mm.

2.3 Bent glass laminating features

Curved laminated glass are mainly used windscreen. This is because it is an emergency in the windshield usually strikes near the driver or a passenger. That the person to withstand shock or injured by fragments of broken glass in the car, people are used laminated windscreens. Curved glass lamination process comprises the following steps:

- 1) glass manufacturing;
- 2) silk screen (if needed);
- 3) glass bending;
- 4) lamination.

Processed glass goes to bending oven. Here glass are placed on a frame, and due to settled temperature glass bends by gravity, i.e. from its own weight. Since the laminated glass panes needed two, they are tilted by superimposing. It takes two glasses and a better recurrence laminating

more fit to each other. To bend the glass without forming before it is sprinkled among them a special powder. After bending glass falls onto the PVB film loading conveyor and transported horizontally. To clean up after bending the rest of the glass powder, glass top is tilted at an angle of 90°. After that paves the way for the PVB film glass top and returned to the horizontal position. Glass is placed and lowered tentacle aid. Ready "sandwich" goes within the primary vacuum and the press cabin. Here by heating and by the vacuum sucked the bent laminated glass is produced by the initial adhesion to the PVB film. The final film adhesion to glass and brightening (remove the air) is in an autoclave, where up 12 to 13 bar pressure and temperature of 135-145 0°C. Process parameters are controlled by the main control panel.

3. Laminated tempered glass production technology

Laminated tempered glass is produced by lamination of two or more sheets of toughened glass. In this case, the production technology is not much different from that described in the tempering and laminating processes, but here are two techniques used in one article, i.e., firstly needed sheets are tempered, and then they go to lamination process. Get the laminated-tempered glass, which has characteristics superior to each of them separately, because this product combines features of two safety glasses, so we can say it is twice as safe.

3.1 Laminated tempered glass production importance

Laminated tempered glass, in the fact, can be used where special security is required, for example.: multi-storey buildings, or otherwise known as high-rises. Here is fitted to the glass and broke it, and if it is tempered glass, you can imagine what weight and power would be gained in strength of even small glass particles, falling from 30th or 40th floor of the building onto a head of people. For this reason, the use of laminated tempered glass construction is specific, only in a high constructions where particular prevention is required.

3.2 Laminated tempered glass subtleties

As is known, quenching of glass increases mechanical resistance several times. After laminated this feater becomes even more stronger. Therefore, laminated tempered glass is used even in places where there is daily contact with the outside factor. You probably know all of the shopping center "Akropolis", and then we have been operating near the skating park. During ice hockey, roller often hits around the bay is fitted with glass structures. Sometimes a blow to the glass is so strong that insensibly think that the glass and will soon collapse. However, the glass doesn't. This is because there used to thick laminated tempered glass, which can withstand severe shocks and protects the surrounding from possible injury and be able to admire the game. Surely, during manufacture process there are difficulty to adjust process of laminated due to the fact that tempered glass is a bit bent, so it is required to have a knowledge of lamination process to avoid bubbles in the final product.

USE OF SAFETY GLASS

Safety glass is widely used in:

- Buildings (windows, walls, balconies, frameless)
- Interior (partitions, decorative kitchen wall, glass tiles)
- Furniture (tables, shelves, chairs, table tops)
- Household appliances (oven, refrigerator shelves, a microwave oven)
- Other areas (greenhouses, conservatories, car windshields)

Safety glass is prepared in accordance with the specific dimensions of a given object according to architects, designers and constructors generated drawings. Most popular are the AUTOCAD drawings, dressed in a computer program which files are compatible with the equipment needed to prepare for glass applications. In today's world is not enough to use one type of material products (buildings, interiors, furniture, etc.). Often required to coordinate the glass with wood, concrete, metal, plastic or other materials. In general, the requirements for buildings, shown in Fig. 2: a - appearance, security, integrity, durability, easy maintenance, heat, moisture and sound insulation. Safety glass has to meet all these requirements.



Fig.2 . Requirement for safety glass to be used in constructions

Depending on safety glass to be used for different purpose there are those glass mounting options:

- **System with the Framework**
- **Frameless System**

Frame system or line-lock mode (linearly supported glazing) is the oldest and simplest systems. Safety glass used in frame system first of all simply processed – seamed and tempered. The most common in architecture glass frames used to manufacture glass as insulating glass unit. There are only different ways of insulating glass unit composition: plain glass with tempered glass, laminated glass with plain glass, plain glass with laminated tempered glass. In this system to ensure the safety of glass design as well as to keep lifetime of the construction the impact made by seaming quality of the glass, which guarantees freedom of movement of the glass unit, also, testing of glass unit in the heat test oven.

Frameless system or a way to capture spot (point fixed glazing) is a new system. There is no linear sections, covering the perimeter of the glass. Spot sensing method based on point to specific holders. This is a big challenge for designers, manufacturers and installers. Of course a number of spot-fixing supports (Fig. 3), which vary in diameter, intermediate composition, mounting bracket against the glass, area and form holes in the glass holder record.



Fig. 3. Samples of fittings.

Fittings vary depending on whether they join the glass edge, or hole, drill the glass in any place. Holders, mounting hole may be one or two planes of the cone-shaped inlet. According to motion stereo can be stable or flexible. All fittings, depending on their origin, can cope with different loads. On the other hand, an interim, which is supplied with brackets, can be made of different materials, which shrinks, crack depends on external factors. For all of the factors affecting the life of the glass structure, the majority of structures are necessary to carry out the static calculation in accordance with German standard DIN 18008 and the ball impact test. Figure 4 shows what tests must be carried out in different windows secure, depending on their mounting position. It appears that the glass is installed over people's heads, made of steel ball weighing 4.1 kg, which falls from a height of 3 m test. Glass, which allowed to walk, tested a steel cylinder weighing 40 kg, with a head M8 beat. Glass, which allowed a short climb cleaning work is carried out tests with the bag, filled with glass beads.

	Possible Kind of glass	Testing of residual resistance
Facade (no anti drop device) 	ESG-H LG of ESG LG of TVG	No testing necessary
Overhead glazing 	LG of TVG	Ball drop test or Hammer and center punch 
Accessible glazing 	LG of TVG 3 layers of glass, top layer ESG or TVG	Test with steel cylinder 
Accessible glazing: work / cleaning 	LG of TVG 2 layers of glass	Test with bag filled with glass pearls 
Railing 	ESG-H LG of ESG LG of TVG	Pendulum impact test 

TVG Heat strengthened glass
ESG Fully tempered glass
ESG-H Fully tempered glass with heat soak test
LG Laminated glass

Fig.4. Test of safety glass to be carried out by DIN 18008.

Safety glass installed in the building can break for a several reasons:

- Quality of tempering of glass and lamination quality
- Type of lamination (PVB film, resin lamination)
- Geometry of fixing elements

Currently, there are new laminated glass production methods. Metallized film is used, strengthening the connection between the windows. It also used a new type of adjustment to the veil. These new inputs are installing safety glass ensures a safer environment for people. Different types of safety glass has a different impact resistance. Figure 5 shows how the impact laminated glass is still

broken, but not dropped down. Such glass should always be used in structures passing over our heads. Depicted in Figure 6 broken tempered glass, which pass at fixing the mild chunks. This glass is recommended only for the wall construction.



Fig. 5. Broken laminated glass.



Fig.6. Broken tempered glass.

The design of safety glass products of the future is calculated glass product strength shocks, winds, weight, etc., depending on the use of safety glass.

Facades, glass partitions used in the laboratory fixation method, which technically can be fulfilled in different ways. Design in terms of incremental locking bolts can be flashed or Flush. Increasingly used in countersunk locking luggage, because the facade aesthetically looks, easy to clean, because there is no screw head bumps. The most important difference between the flashed and countersunk screw - a screw head, the inner wall of shape and the associated geometry of the holes drilled in the glass (Fig. 7)

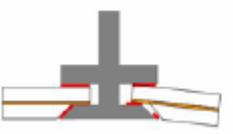
	Raised head fixture: Good residual resistance
	Countersink-fixture poor residual resistance
	Safe-countersink-fixture Good residual resistance

Fig.7. Fixing point methods.

As per German standard glass, which is mounted at an angle of 10 degrees from vertical, is assigned to the glass as it passes over their heads, which is used in the manufacture and installation of high security standards. Such glass shall be laminated tempered glass with PVB film is not thinner than 1.52 mm and a safe spot was claimed by either flashed or screw countersunk screw sound. The surest way to a spot flashed mounting screw, which ensures that the glass is split in 24-neištrupēs. If the glass is mounted countersunk screw, it is critical for the geometry of the holes. Figure 8 demonstrated Flush transport, where milling is particularly important that the edges of the holes are 45 ° and the PVB film to work around a 20 mm hole to ensure that the strength degradation of glass.

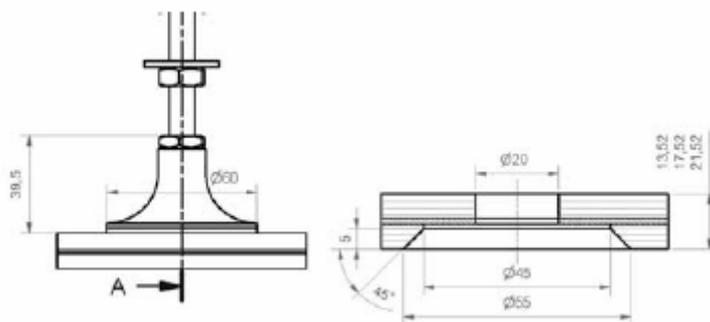


Fig.8. Flash mounting screw.

Use of glass in architecture, interior design, furniture become increasingly popular because of transparency, lightness, an impression space. Glass is increasingly being used as weights and mechanical crush-resistant material. Glass is an excellent building material, but how safe it is made, is always the risk that the glass styles. The most important things for the longer life of glass, a glass-like quality of the raw material, edge treatment, appropriate technological process sauagaus glass production, the correct installation. Most of the glass fixing systems have been tested and verified. but a lot of important issues relating to the safety glass structure design and installation of yet unanswered.

In summary, the glass structures of security and reliability of quality can only be achieved through professional work and quality of professional care of any safety glass production stage:

- Projecting;
- Team work;
- Production of components: fixing, glass, keeping constructions;
- Production and assembling.

The main criteria for daily architects, designers, glass manufacturers, investors, installers - a quality of each work permanent quality system in all the glass processing chain, high-quality raw material usage. All that it allows for proper, safe and reliable use of shatterproof, laminated, tempered-laminated glass.

CONCLUSIONS

Glass - a modern building material that can be transparent, colored, heat and sound insulation. It is quickly mounted. However, glass has the ability to break. Modern technology allows the glass to reinforce the seven times and treated in a way that it will not injure people around.

The safety glass can be tempered, laminated, or tempered and laminated. Glass treatment depends on the purpose of usage. The safe manufacture of glass using a variety of technologies. They differ in their technical solutions, productivity, quality glass processing. However, safety glass production dependent on the basic principles.

Safety glass to be met the international standards EN12150, DIN18008. If the glass is installed in high buildings or roofs, it sure is tempered and laminated. This method is the safest. If glass is used in the interior (partition walls, doors, furniture), it can be tempered, or just laminated.

Safe use of glass in architecture, interior design, furniture become increasingly popular because of transparency, lightness, an impression space. Glass is increasingly being used as weights and mechanical crush-resistant material. The increasing use of glass for safe use requires tighter cooperation between manufacturers of glass, glass processors, constructors, designers, installers, in order to create a safe environment for humans.