Technical Note No 43
FILM BACKED GLASS

This Technical Note gives advice on films that are applied to glass to improve performance and recommends that a risk assessment should be carried out prior to installation to establish how risks have changed and to inform all parties of any changes in hazards and risks.

Introduction

In some instances the performance of glass panes may be improved prior to installation or more commonly after installation. One of the simplest, least disruptive and cost-effective solutions is to add a plastic film to one or both sides of the glass. The films can improve safety, security, solar control and visual appearance, while providing privacy, resistance to graffiti, UV protection and glass manifestation. Some films can fulfil more than one purpose. A major advantage of using film is that the need to purchase and install new glazing can be avoided.

Films

The films have a thickness of less than 1 mm and are generally available up to 1500 mm in width. Professional installation is required to achieve desired performance, but films are often easy to apply, easy to remove and can in some cases be reused. They have the potential to be attached in any climate and to any glazing product, whether they be single glazing or insulating glass units.

Films range from completely transparent that cannot be detected by the human eye to nearly opaque, which can be used to reduce fading and provide privacy. Films are also available in a variety of colours or tints (e.g. blue, bronze, gold, green, grey), patterns and logos for decoration and to provide manifestation so that the glass can be seen easily.

Reflective and tinted films are used to enhance the appearance, ambience and energy efficiency of buildings. They will in general result in less light being transmitted and an increase in the absorption of solar radiation by the glazing. Newly developed tinted films can have only a very light tint and good solar energy rejection, which will reduce the absorption of solar radiation by the glazing.

Films are normally applied to the inside of the glazing, although they may in some circumstances be applied to the outside surface or to both surfaces of the glazing, where required for performance.

In general, the addition of films to glass is a remedial action to improve glazing performance or meet demands of legislation. There can however be instances when they are added to new buildings for the same reasons and/or for decoration.

The use of films can help non-safety glass in pre-existing buildings comply with safety glass regulations. They can also improve the thermal comfort of pre-existing buildings.

BS 6262 mentions film backed annealed glass, but does not provide significant guidance.

Film types

Most films are produced from multiple polyester sheets bonded together with adhesive. They will often have a powerful self-adhesive on one side of the film that sticks to the glass. Polyester film is used due to its toughness and high optical clarity. Other layers such as metallised film, alloys, dyes and various oxides for solar control may also be present. UV protection is provided by ultraviolet absorbers within the film body and/or adhesive layer. A scratch resistant coating may be applied onto the exterior surface to improve resistance to abrasion and cleaning. The films have a number of uses, which include:

- Anti-graffiti
- Decoration/manifestation
- Environmental control
- Safety/security
Anti-graffiti film is a clear thick film attached to the exterior/interior of window glass or any other smooth surfaces. The film is designed to protect surfaces from abuse and is aimed at protecting shop fronts, office buildings, and public facilities that may be subjected to graffiti. It can help prevent the need for costly replacement in cases of severe graffiti. The film if professionally installed is not obvious to vandals and can be easily removed and replaced with new film should graffiti occur.

Decoration/manifestation film is designed to make glass attractive and/or noticeable in appearance. Films can be used to cover the visible surface of the glass and may incorporate a pattern or design.

The film can be a cheaper, more efficient, non-permanent alternative to the use of sandblasting and silkscreen printing to create decorative and/or manifestation patterns on glass.

For manifestation film the pattern or design must make the location of the glass door apparent:
- For people including the visually impaired, and
- When the door is open or closed.

Specific requirements are outlined in Building Regulations Part M and take precedence over manifestation requirements in Building Regulations Part N and BS 6262 Part 4.

In manifestation applications the glazing is likely to be either single glazing or insulating glass units that may utilise thick robust annealed glass, toughened safety glass or laminated safety glass. The effect of the film on the post-failure breakage characteristics of the safety glass should therefore be considered.

Environmental control film is formulated to help control the environment inside a building. Such films can provide the following functions:
- Heat gain control
- Heat loss control
- Privacy
- Glare control
- UV resistance

Some products are capable of providing more than one of these functions. The films function by either absorbing or reflecting radiation, such as visible light, due to the presence of layers of metal alloys, dyes, or various oxides in the film.

Solar control film works by reflecting incoming heat and allowing light in. This helps prevent overheating in warm summer months. It may also help to minimize heating and cooling imbalances that occur within a building as a result of parts of the building being in sunny areas while other parts are in shaded areas.

Use of solar control films can therefore lead to improved building comfort as well as energy and cost savings, due to air conditioning costs being reduced. Up to 76% of incoming solar heat can be reflected by film-backed glass. This can result in up to 83% of incoming solar heat being rejected by film-backed glass.

Some films can act to reflect outgoing heat back into a building, while allowing light and solar heat in. This will help to keep buildings warm in cold winter months and improve building comfort.

The energy saving performance of solar control films depends upon film type, location, climate, building size, sun orientation, rebate amount and other factors.

The International Window Film Association (IWFA) suggests caution, where non-clear solar control film is used in the following circumstances:
- Single pane glass larger than 9 m².
- Double pane glass larger than 3.5 m².
- Clear glass thicker than 9.5 mm.
- Tinted glass thicker than 6 mm.
- Window framing systems of concrete, solid aluminium, or solid steel.
- Glass where sealant or glazing compound has hardened.
- Visibly chipped, cracked or otherwise damaged glass.
- Reflective, wired, textured, or patterned glass.
- Triple pane glass.
- Laminated glass windows.

This is because of an increased likelihood of glass failure from thermal stresses. Film manufacturers or suppliers should be consulted for guidance in these circumstances.
Translucent and opaque environmental control film can also help provide privacy and reduce eyestrain and glare. The latter should improve a building’s internal viewing conditions in sunlight.

Most films will block 95-99 per cent of incoming ultraviolet light and may help reduce fading and deterioration of furnishings such as upholstery, fabrics and carpeting. It should be noted that fading may also occur as a result of light and infra-red radiation, which may not be blocked by the film. The film may also potentially protect people from eye and skin disorders caused by the presence of UV radiation.

**Safety/security film** is applied to glass to impart the properties of safety and/or security glazing. The film is designed to hold the glass fragments together in the event of breakage, thereby reducing the risk of injury from flying fragments and sharp edged glass shards protruding from the surface.

Security films also improve building security by impeding penetration, including entry by burglars and vandals. Special security films are available for buildings that may be subjected to violent storms, earthquakes and explosions, such as bomb blasts. Safety and security films may also prevent damage caused by the entry of wind and rain into the building in the event of glass failure. Film also aid clean up of glass after failure.

Films are available with sufficiently high performance that they can be fitted to glass already installed to achieve compliance with safety glass standards, such as BS EN 12600. Some of these films may also provide solar control and protection from ultra-violet light, which may contribute to fading. These films are useful in retail premises, such as on shop fronts, where they can help protect goods on display.

Special heavy-duty security or anti-shatter film is designed to resist the effects of explosions. Explosion resistant glazed products are classified in accordance with standards, such as BS EN 13541. It is applied to glass to prevent glass fragments flying away after bomb blasts or industrial explosions. Flying glass fragments are known to be a major cause of injury in explosions and the film will help to protect people both inside and outside the building. Property damage caused by flying fragments may also be reduced.

**Selection**

Films for a given application need to be correct to ensure they perform as required and the advice of manufacturers or suppliers should be sought.

Films will modify the light and heat transmission of the glass. Increased heat absorption will cause the glass to get hotter thereby increasing the risk of thermal fracture. This should not be a problem with toughened glass although it may accelerate the occurrence of nickel sulphide induced failures.

For annealed glass thermal calculations should be carried out to ensure the glass can withstand the increased stresses without breaking. The addition of a film to the room-side of a double-glazed unit, particularly if made with annealed glass is undesirable, as the higher thermal resistance of the glazing air-space (cavity) restricts heat loss from the warmer pane, leading to potentially high thermal stresses in the glass.

The increase in temperature of film-backed glass in use will lead to an increased thermal expansion of the glass. This should not normally be a problem, but may lead to contact with the frame if the edge clearance provided is insufficient to accommodate the increased glass expansion.

If applying film to glazing, where it may be expected to have fire resistant properties, consideration to the potential for the film to impair integrity during a fire and cause premature failure should be given. Films will normally have been tested to ensure they do not give off toxic fumes, ignite freely, allow the surface spread of flame, etc in the event of a fire.

The installation of a film may alter the light transmitted and reflected by the glazing. This can have a negative or positive effect on the building appearance and ambience. It is recommended that clients be informed of possible changes to avoid subsequent disputes.

At the moment, films are not as durable as the glasses they are applied to. Consequently, care should be taken to ensure the correct film is chosen and is installed and maintained correctly if it is to perform as expected.

Durability of plastic films can be low, particularly if of poor quality materials, construction, installation, etc. and may age if
not protected from the effects of ultra-violet light. This can be evident as peeling, cracking, demetallisation and delamination. Manufacturers may guarantee films for 5-10 years when used internally and for 2-10 years when used externally. The better films can have guaranteed lifetime of between 10-20 years when installed on the interior glass surfaces of occupied commercial buildings. Film lifetime will vary with the type of film, type of glass, method of glazing, glass orientation, building location and climate. The manufacturer or supplier should be consulted regarding any conditions that may need to be met if the film-backed glass is to meet its expected lifetime.

Films placed on external surfaces must be robust and allow for possible damage by the cleaning process. Films with special scratch resistant coatings are available for this purpose. Also, if the film is applied after the glass is installed then the film is only likely to be fitted up to the edge of the glazing gaskets, leaving a path for cleaning fluids and water to reach the adhesive layer and the edge of the film. Delamination of the film and/or separation of the film from the glass could then occur. To overcome this, external films should be edge sealed.

**Installation**

The use of specialist installation contractors is recommended.

A guide to the installation of film is produced by the Glass and Glazing Federation. Manufacturers instructions should also be followed.

Most film-backed glass is installed by deglazing and filming the glass into the rebate. This approach is often best at holding the film in place on glass breakage. It is however expensive and time consuming.

Other methods of installation have been developed and include:

- Taking the film into the bolt fixing assembly in bolted glazing
- Use of anchoring frame which secures the film to the glass frame
- Use of anchoring fixings which secure the film to the glass frame

These may not hold or anchor the film in place on glass breakage to the same degree.

Another method of installation is to apply the film in-situ without deglazing or the use of special fixings or anchoring frame. In this method a gap of 0.5 to 4 mm between the film and the frame margin should be left to allow water present in the adhesive to dissipate. No contact with the frame margin should occur as this may raise the film edge and cause film peeling. On dark films (e.g. tinted, metallised, tinted/metallised and sputtered films) an edge gap of up to 2 mm is normally recommended to reduce the size of the light band around the edge of the film. This approach may not hold the film in place on glass breakage and could have implications for safety in situations such as where explosion resistance is required. It is the least expensive and quickest method of installation.

Films may not be available in suitable widths to fit large glazed areas. Consequently, films may need to be cut and spliced together. This joint may be a visible feature on the glazing. To minimise any visual distraction the joint should be vertical, in the middle of the pane and placed parallel to one edge of the frame margin. Films should also be placed a maximum of 1 mm away from each other. Overlapping should only be used where films are <50 µm thick and are not used for safety and security applications.

After application the film will need time to cure so that maximum adhesion can be produced. Curing time can be instantaneous for solar control films and up to a few hours for safety/security films. The exact time is dependent upon film/adhesive type, thickness and atmospheric conditions. Where the film is to be applied externally a sealant may be required and the manufacturers instructions should be consulted.

A guide to assessing the visual quality of applied film is produced by the Glass and Glazing Federation. The film can be of sufficient quality that with good installation they may add no additional visual defects to the glass. The applied film is considered acceptable if the presence of dirt particles, hair and fibres, adhesive gels, fingerprints, insects, edge lift, water haze, scores and scratches, film distortion, creases, air bubbles, and nicks and tears are very low. Inspection can occur within one day of application or at anytime before the film fully cures.

Normal maintenance is by cleaning with a soft cloth, sponge or towel and a mild soap/water solution.
All films complying with safety glass regulations should be permanently and clearly marked during installation.

If films are incorrectly applied they may not adhere to the glass, thereby reducing any safety or performance benefit.

**Safety considerations**

The application of a film may alter the safety characteristics of the glass and its post failure breakage characteristics. The effect can be positive if the correct film is selected, negative if the incorrect film is chosen or have no significant effect on safety. As a result, its effect on building safety should be determined using a risk assessment.

Risk assessments are part of good building practice and should be carried out prior to the selection and installation of the film to ensure that all parties are aware of any residual hazards that the film backed glass may pose. This risk assessment should be included in the building’s health and safety file.

Where film backed glass exists and no risk assessment has previously been carried out, a risk assessment should be completed at the earliest opportunity, shown to all relevant parties and placed inside the building’s health and safety file, where present.

Particular consideration should be given to the potential alteration of the post-failure characteristics of film-backed glass. The film may cause glass fragments to be held together on failure, which may be an advantage or disadvantage, depending upon the circumstances.

In some circumstances, such as those involving glass failure on human impact this may be an advantage. Glass fragments will be more likely to be held together and prevented from forming jagged protruding shards that will pose a higher risk of causing cutting and piercing injuries should they come into contact with the body. The likelihood of the person falling through the glass possibly from height will also be lower.

In other circumstances a greater risk of injury may occur should the film backed glass fall or collapse after glass breakage. This is a particular risk in sloping or vertical glazing where monolithic toughened glass may be used. Broken film backed glass may fall or collapse under its own weight or the effects of external forces, such as fire, wind, etc.

This could occur because the film is insufficiently strong to withstand load, that it tears or where there is insufficient restraint or rigidity, such as an anchoring system, to hold the film backed glass in place on failure. The end result may be a large weight of glass falling as a single object, which may have the potential to cause fatalities, injuries and break bones depending upon the height of the fall. Consideration should also be given to the potential for the film-backed glass to withstand the effects of accumulated rainwater or snow when broken.

It has been reported by Bannerman that filmed bolted toughened glass was held in place for 5 days after failure. He has also reported that the use of film and a suitable anchoring system in a vertical situation retained the glass for 6 months and in a horizontal situation for 9 months after failure.

In the case of heavy-duty security or anti-shatter film, it can provide significant resistance to blast pressures produced by explosions. This is dependent upon the properties and thickness of the film and its adhesive. Installation should either be applied to the full surface of the glass, possibly including that part within the rebate of the frame or an appropriate anchoring system used, depending upon the degree of protection required, film type, etc. Such systems should be tested to ensure performance is satisfactory for the situation.

Films have the advantage that they will hold glass fragments together on failure reducing the potential for flying debris in an explosion. If subjected to high explosive pressures the film backed glass may be ‘punched’ out its frame as a single piece of glass or the film may have insufficient strength to hold the glass fragments together on failure creating large pieces of flying debris. Furthermore, laminated glass is generally preferred to heavy-duty security film, since it may give greater blast protection and the plastic component is protected from atmospheric degradation.

Monolithic toughened glass doors, will be fully or partially covered in manifestation film, which may affect the breakage characteristics of the door. Consideration should therefore be given to the area of film manifestation in the risk assessment. Advantages of filming the whole door, particularly if on both sides or on large areas of the door are:
Film backed glass

- It can aid manifestation.
- Improves visual appearance.
- May resist penetration and provides security.
- Reduces the potential for flying glass.
- Reduces the likelihood of cutting injuries from contact with broken glass.
- Makes clearing-up of glass fragments easier after glass failure.

Disadvantages include:

- Potential to fall on failure as a single object causing injury to people in the immediate vicinity at the time of failure.

Failure mode will also be affected by whether or not the film extends beneath fixings. This may prevent the glass from falling on failure. Also, if the fixings are independently supported this may prevent fixings falling on glass failure.

The potential for injury should be considered in all situations where film backed glass is used. Where doubts exist over the safety of the film backed glass, testing of samples representative of the expected conditions, should be carried out. This includes using representative loads and temperatures for a length of time sufficient to ensure the glass will not fall from height before it can be replaced. The test should enable the hazards and risks from the post-failure characteristics of film-backed glass to be determined.

Summary

This Technical Note gives advice on film-backed glass, including information on the type of films available, their uses, guidance on sources of information for installation and inspection, and various performance issues. It is recommended that where a film is applied to glass a risk assessment should be carried out prior to application to ensure that the safety of the glazing is not adversely compromised and that all parties are aware of any residual hazards and risks.

References and bibliography


GGF, Installation quality standard for applying window film to glass, Glass and Glazing Federation, London.