



## Toughened Laminated Safety Glass – TuffLam

### ESG TuffLam

Toughened glass is four to five times stronger than annealed glass of the same thickness and is ideally suited to most safety critical applications. However, its use at high level must be subject to careful consideration because if it is broken the glass will shatter into small pieces and will no longer support a load or act as a barrier. Consequently, toughened glass that is not fully framed is likely to fall from its fixings.

The safe solution is ESG TuffLam which consists of sheets of toughened safety glass bonded together with a tough plastic interlayer which enhances safety and security as well as retaining glass fragments in the event of breakage.

ESG TuffLam normally has two panes of glass and either a clear PVB (PolyVinyl Butyral) or EVA (Ethylene and Vinyl Acetate copolymer) interlayer for design applications. Multi-ply laminates with three or more glass panes and two or more interlayers are available for use as flooring, fins, beams and other structural applications.

Clear toughened laminated glass has a slightly lower light transmission than ordinary glass of the same thickness. It is thermally safe and will resist high temperatures without breakage.

ESG TuffLam is available in a wide range of glass, interlayer and thicknesses and can be used to satisfy all safety glazing requirements of Approved Document N of the Building Regulations and BS 6262 part 4. Subject to calculation it can be used to form full height barriers, infill panel barriers as well as free standing barriers (structural balustrades) in compliance with Approved Document K of the Building Regulations and BS 6180.

### Design Applications

Special interlayers include sound control, privacy and decorative effects. Patterned and tinted glasses can be laminated and materials such as film, wood, fabrics and metal can be bonded between the panes to create unique finishes.



Where the edges of laminated panels are exposed after glazing, ESG can apply an additional specialist process to enhance the visual appearance of the edge finish. Please ask for a quotation prior to placing your order.

### Benefits

The principle benefits of toughened laminated glass are its strength and performance under impact. It is capable of withstanding very large loads and in the unlikely event of being broken the resulting fragments will be retained by the interlayer. When properly glazed, it will normally remain in place until replacement is convenient. The strength of ESG TuffLam makes it ideal for use as balustrades and barriers, canopies, floors, fins and for bomb blast resistance.

The interlayers have additional benefits. Standard interlayers reduce sound transmission, particularly at the higher frequencies. High performance acoustic interlayers provide enhanced sound control. Ultra-violet light transmission (between 320 and 380 nanometres) is reduced by 99% and solar control (tinted) interlayers are also available.



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## Structural Applications



### Roof glazing

ESG TuffLam toughened laminated glass is ideal for roof glazing, particularly where there is a need for maintenance access. Such work requires careful consideration and must always be subject to appropriate testing. All roof glazing must be subject to professional calculation on the basis of accurate snow and wind loads. Full four edge support is strongly recommended.

Testing usually involves the application of a concentrated load to the top surface of the glass. Loading is increased until a pre-determined factor of safety is reached or failure occurs. It is normal for the load to be set by the specifier and loads of 0.9 or 1.5kN have both been used on major projects. A load of 1kN is broadly that of a 15-stone man. Some specifications include drop-bag tests similar to that of BS 6206.

### Canopies

All canopy glazing must be subject to professional calculation on the basis of accurate snow and wind loads.

**Laminated toughened glass.** Special hard nylon fixings should be employed to prevent compression of the laminating interlayer and excessive localised stress around the fixings.

**Toughened / Heat-strengthened laminated glass.** The toughened glass is designed to withstand the imposed loads and has laminated to it a 6 mm thick heat strengthened "carrier glass" intended to maintain integrity in the event of breakage. Such systems require specially designed fixings that fully clamp only on the toughened glass.

**Centre fixings.** All types of glass panes that have centre fixings must be subject to finite element analysis based on the provision of accurate wind and snow loads. This is due to the high local stress induced by the effects of hogging and sagging. Glass subject to such effects is specially toughened to 120 N/mm<sup>2</sup> whereas the normal design stress limit is 59 N/mm<sup>2</sup>.

### Balustrades

ESG TuffLam can be used in two and four edge supported infill panel barriers and provides the highest level of safety for structural balustrades (free standing barriers) where the glass is clamped only by its bottom edge. Specifications for different sizes and design loads are given below –

Infill panel barriers, glass supported by two vertical edges, panel height 1000 mm.

ESG TuffLam Thickness	Loads	Maximum span
9.5 mm	1.0 kN/m <sup>2</sup> and 0.5 kN	1400 mm
11.5 mm	1.0 kN/m <sup>2</sup> and 0.5 kN	1750 mm
11.5 mm	1.5 kN/m <sup>2</sup> and 1.5 kN	1300 mm
13.5 mm	1.0 kN/m <sup>2</sup> and 0.5 kN	2000 mm
13.5 mm	1.5 kN/m <sup>2</sup> and 1.5 kN	1700 mm

### Free standing barriers

Fully clamped as per BS 6180 with handrail continuously attached to the top edge of the glass, maximum height 1100 mm above FF.

ESG TuffLam Thickness – PVB Interlayer	ESG TuffLam Thickness – SGP Interlayer	Load
17.5 mm	13.5 mm	0.36 kN/m
21.5 mm	17.5 mm	0.74 kN/m
25.5 mm	21.5 mm	1.5 kN/m
31.5 mm	25.5 mm	3.0 kN/m

The use of a free standing barrier without a handrail or with one that is only decorative not only does not comply with the British Standard but also is fraught with danger if only single toughened glass is used. Whilst compliance with a British Standard may not be mandatory, it is understood that if ignored, they can take the force of law in a Court. Building Regulations are mandatory (i.e. – a legal requirement) and demand containment.

It is becoming common to see this type of barrier installed without a handrail, but with laminated glass used to provide security. It is advisable for each element of a toughened laminated design to be capable of withstanding the design loads with deflection being controlled by the full thickness. Such applications should be subject to professional calculation with appropriate technical data for Building Control approval.

### Full height barriers

Top and bottom edges supported, minimum panel width 1000 mm.

ESG TuffLam Thickness	Load	Maximum height
11.5 mm	0.36 kN/m	2600 mm
11.5 mm	0.74 kN/m	2000 mm
13.5 mm	0.36 kN/m	3200 mm
13.5 mm	0.74 kN/m	2400 mm
13.5 mm	1.5 kN/m	1850 mm
17.5 mm	0.36 kN/m	4000 mm
17.5 mm	0.74 kN/m	3450 mm
17.5 mm	1.5 kN/m	2400 mm
17.5 mm	3.0 kN/m	2000 mm
21.5 mm	0.74 kN/m	4000 mm
21.5 mm	1.5 kN/m	3200 mm
21.5 mm	3.0 kN/m	2600 mm

## ESG Designer Range



The new 'ESG Designer' range of laminated glass enables our clients to create bespoke designs incorporating a vast array of colours, patterns and materials giving their designers greater creative freedom.

Using glass as a substrate, a colourful range of surface paints or laquers can be applied to the inner surface or designers may choose to encapsulate a diverse selection of materials such as films, graphics (full colour printed manifestation), fabrics, some plastics and acrylics and even wood or metal.

The primary benefits from encapsulation are that the interlayers used to bond the materials help reduce colour fading, the inks used are UV stable and also the glass protects the decorated surface from cleaning products and general daily use. In this way the designers' original work is protected and preserved.

With such a breadth of designer finishes and materials available the potential applications are vast and include:- Screens, Doors, Furniture, Tiles and Splashbacks, Work Tops, Signage, Table Tops, Corporate Art, Exhibition displays, Lighting, Partitioning and Flooring.

The 'ESG Designer' range is available in a broad range of thicknesses, in float or toughened glass (subject to application and relevant regulations), and offers the flexibility to be used either internally or externally. We recommend that our clients use 'ESG Crystal' white glass as this has less of a green hue than that found in standard float glass and therefore helps retain the designers' original colour scheme. 'ESG Crystal' white glass is available in 4mm to 19mm thickness and all can be laminated.

### Partitioning

Incorporating products from the 'ESG Designer' range into partitioning projects can create stunning results. Whether using coloured, translucent or opaque film or paint between the glass to create screens, to integrate corporate branding or for manifestation solutions, the flexibility is exceptional.

Our latest innovation is the encapsulation of graphics (high resolution images) printed onto the glass or interlayer and used to create unique pieces of Corporate Art, displays or stunning screens. For full details or to request samples please contact our Customer Service team.

### Floors

All of the designer finishes above can be incorporated into floor treads and panels with the benefits as mentioned. However, the additional benefits of the 'ESG Designer' range in flooring are that structural fixings, bolts for example, can also be encapsulated



between the glass and either hidden beneath an opaque decorative finish or left prominently exposed in order to accentuate the design scheme. To create the non-slip upper surface, grooves, strips or dots etc. can be deep sandblasted into the glass.

The use of single toughened glass is not appropriate for flooring as if broken it disintegrates and no longer supports a load.

For four-edge supported glass there must be at least two panes of toughened glass, each fully capable of supporting the design loads. For support by two edges there must be three thicknesses of glass. All glass floor and stair tread specifications must be professionally calculated using the loads appropriate for the building type or use detailed in BS 6399 : Part 1 : 1996.



## Quality Standards



All ESG TuffLam products are manufactured in accordance with relevant British Standards and are manufactured in a clean environment to a quality management system approved to BS EN ISO 9001 : 2000.

**Toughened Glass:** manufactured in accordance with the latest standard 'Glass in building – thermal toughened soda lime silicate safety glass BS EN 12150 : (Parts 1 & 2) : 2000, incorporating 'Glass in building – impact test BS EN 12600 : 2002' and 'Glass in building – four point bending test BS EN 1288-3 : 2000'.

**Heat-soak testing:** Conducted in accordance with 'Glass in building – Heat-soaked thermally toughened soda lime silicate safety glass – BS EN 14179 (pts 1&2) : 2005. Testing to the German DIN standard 18516 is available on request.

A copy of the heating profile graph can be provided as supporting evidence that the Heat-soak test has been conducted correctly.

**Heat-strengthened glass** is sometimes confused with Heat-soak tested glass. This is annealed glass that is heat treated by raising its temperature to 700° C and then cooling it more slowly than toughened glass. It is not a safety glass and breaks in a similar way to ordinary annealed glass. The process adds strength (twice that of annealed glass) and thermal safety. Maximum thickness is 10 mm.

There is very little risk of breakage due to nickel sulphide inclusions and if broken it will tend to stay in place and reduce the risk of falling glass. It can be used in overhead glazing only when laminated.

It is of particular benefit when used to ensure the thermal safety of vertically glazed solar control glasses and cladding panels and as a carrier glass to ensure the integrity of canopies when laminated to toughened glass.

**Laminating:** conducted in accordance with 'Glass in building – Laminated glass and laminated safety glass – BS EN 12543 (Parts 1-6 : 1998 and BS EN 14449 : 2005).

The EVA interlayer is manufactured in accordance with 'UNI EN ISO 12543 – 4 : 2000' and is certified by the manufacturer

### Safety

ESG TuffLam satisfies all safety glazing requirements of BS 6262 : Part 4 : 'Safety related to human impact', Regulation 14 of the Health and Safety at Work Act as well as Approved Document N of the Building Regulations. It is particularly suited to areas where enhanced performance is required.

## Products, Applications and Capabilities



### Products

4 mm to 19 mm float and toughened glass in clear, 'ESG Crystal' white glass, various tints and satin etched. A wide range of patterned and coloured glass is also available.

### Applications

- Balustrades
- Canopies
- Stair treads
- Fins and beams
- Lift Shafts and Flooring
- Partitioning
- Doors
- Screens
- Worktops
- Splashbacks
- Furniture
- Lighting

### Capabilities

Maximum toughening size: 4500 mm x 2500 mm  
Maximum size ESG TuffLam: 4300 mm x 2200 mm  
Minimum size annealed laminated: 150 mm x 150 mm  
Minimum size ESG TuffLam: 250 mm x 250 mm  
Glass thicknesses: 4 mm to 19 mm

Common thicknesses of ESG TuffLam for partitions, balustrades and canopies are two x 6, 8, 10 or 12 mm panes incorporating either 0.76 mm or 1.5 mm PVB or EVA interlayer subject to application.



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