



WHAT KIND OF GLASS SCORES BEST AT WHAT?

	laminated glass	flat glass /rubber
Weight	-	+
Thickness	-	+/-
Surface mass	-	+
Shape options	-	+
Multi-hit	+/-	+/-
Cost price	-	+
Can be used in:		
Vehicles	+/-	+
Buildings	+	+
Offers protection against:		
Handguns	+	+
Shotguns	+	+
Blast	+/-	+

Flat glass and moulded rubber – a cast-iron combination

A glass pane, known as flat glass/rubber, patented by TNO offers better protection against explosions or gunfire than ordinary glass, and has many more benefits than laminated panel glass.

When a glass pane shatters during an explosion, the razor-sharp, glass shards flying rapidly through the air constitute a major hazard, causing serious injury to people inside the building or vehicle concerned. In such circumstances, glass is responsible for about eighty per cent of all injuries.

To date laminated glass has been used to make bullet-proof glass, the thickness of the laminate layer varying according to the nature of the perceived threat. The 2-20 centimetre-thick laminated glass, often containing a polycarbonate layer on the reverse to capture the splinters, is very heavy and optically distorting (lower transmission and discolouration of the light). Explosion or blast-resistant glass also exists, mainly composed of a thin laminate of two glass layers, which is quite lightweight and flexible. However, products that are both blast and bullet-proof do not actually exist although thick (and therefore heavy) laminated glass in a modified frame also has considerable blast resistance.

CONCEPT BROADLY APPLICABLE

Recently TNO has been working on the development of new 'transparent armour' concepts on the basis of polymer-glass combinations. One of these is flat glass/rubber, a composite that is both blast and bullet-resistant. This composite pane is only 1 to 2 cm thicker than a normal, window pane and, given the low density of the rubber, much lighter than conventional armour glass. This makes it easier to fit, even on existing panes and in existing frames. Other benefits of the flat glass/rubber composite are that the rubber layer is virtually invisible (and so causes little or no optical distortion) and such a glass pane backed with a moulded rubber layer does not have to be straight. The principle is therefore broadly applicable for both buildings (embassies, police stations, hotels) and vehicles (police cars, VIP vehicles). By simply applying a layer of moulded rubber even a normal double glazed

window can be upgraded from a threat (fragment-generating and non bullet-resistant) to a protective (bullet-resistant) construction.

CAST-IRON COMBINATION

A glass pane alone will not keep bullets at bay, nor will a layer of polyurethane. But together they are a cast-iron combination that offers excellent explosion/blast protection and is resistant to criminal munitions like .44 Magnum and 9 mm FMJ. The TNO invention is equally effective in the event of a bomb attack: a bomb fragment penetrates a normal glass pane at a speed of 300 m/s but a rubber-reinforced glass pane is resistant up to a speed of 1300 m/sec. Both bomb fragments and bullets are stopped by the glass layer so that the transparent rubber rear layer is only stretched elastically. Once the projectile has been stopped, the layer springs back in place undamaged. This undamaged layer provides excellent residual vision. This is important for vehicles that may need to race clear from the scene of the attack or to return fire. The latter is possible through the pane glass since the bullets come from behind the rear layer.

For more serious military threats and better multi-hit capacity (that is, the capacity to stop several bullets sequentially), TNO has developed a different transparent armour concept comprising a large number of adjacent short glass rods in a moulded rubber matrix. An incoming projectile is able to hit at most up to three such cylinders while cracks in the glass are unable to extend outside a cylinder. This means that much more glass remains intact and is thus able to stop subsequent projectiles. The armour can be used at varying levels of threat according to the height and material of the cylinders.

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