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SAFETY GLASSING FOR PROTECTION AGAINST THE IMPACT BY FIREARM SHOTS AND AGAINST EXPLOSION EFFECTS

Zijad Pašić, Ilhan Bušatlić
Faculty of Metallurgy and Materials Science,Travnička cesta 1, Zenica
Bosnia and Herzegovina

ABSTRACT
In this paper two kinds of safety glasses are considered: safety glasses for protection against the impact by firearm shots and safety glasses against the impact due to the explosion effects. The methods were explained for testing the resistance of glass against the shots and explosion, as well as the criteria to be fulfilled by particular classes (C1 – C5 and D1 – D3). Cited are main features of safety glassing of protection class C and D.
Key words: safety glasses, shot, explosion

1. INTRODUCTION
The demands are often posed for a protection of human life, that some glass barriers use to be resistant against the bullets and explosion. In last time such glass barriers are often applied in the business and residence buildings as well as in the vehicles. The safety glasses for the protection against shots belong to the protection class C, while the safety glasses for the protection against the explosion effects belong to the protection class D.

2. SAFETY GLASSES FOR THE PROTECTION AGAINST FIREARM SHOTS (GLASSING ACCORDING TO THE DEMANDS FROM DIN 52 290 T2) THE PROTECTION CLASS C
The glassing for protection against a fired bullet, anti-break glasses, are divided on the protection degrees C1 – C5 depending of the kind of weapon (calibre number).
The protection class C glasses are yet named armoured or anti-break glasses and they are purposed for the protection against firearm.
The standard demands that these glasses stands three shots from certain firearm, which are fired from a determined distance. Each of mentioned protection degrees are divided in two groups SF and SA. The group SF demands that the internal side of the glass element remains intact after the impact of third shot. The glasses with damaged internal side by the shots are classified in the group SA.

Table 1. The protection class C safety glasses, the protection degrees and protection groups (SF, SA)

Charge degree	Shot calibre	No break	
		SF / thickness	SA / thickness
		not rimed	rimed
1	9 mm x 19	C1 – SF / 23	C1 – SA / 17
2	357 Magnum	C2 – SF / 34	C2 – SA / 23
3	44 Magnum	C3 – SF / 50	C3 – SA / 28
4	7,62 mm x 51 mz	C4 – SF / 70	C4 – SA / 44
5	7,62 mm x 51 tz	C5 – SF / 77	C5 – SA / 77

The conditions are determined for each calibre and mass of bullet, the initial speed and distance between the weapon and the target. The impact energy of the bullet (J) is calculated from the data.

Table 2. The conditions of testing the protection class C safety glasses

Demand designation	Calibre	Bullet			Distance to the target (m)
		Kind	Masse (g)	Speed (m/s)	
1	9 mm x 19	og / mz	8,0 ± 0,1	355 – 365	3
2	.357 Magnum	zg / mz	10,25 ± 0,1	415 – 425	3
3	. 44 Magnum	tg / mz	15,55 ± 0,1	435 – 445	3
4	7,62 mm x 51 mz	kg / mz	9,45 ± 0,1	785 – 795	10
5	7,62 mm x 51 tz	kg / tz	9,75 ± 0,1	800 - 810	25

Og/mz = round head/soft bullet, zg/mz = rounded head/soft bullet,
Tg/mz = blunt head/soft bullet, kg/mz = conical head/soft bullet,
Kg//tz = conical head/ hard bullet

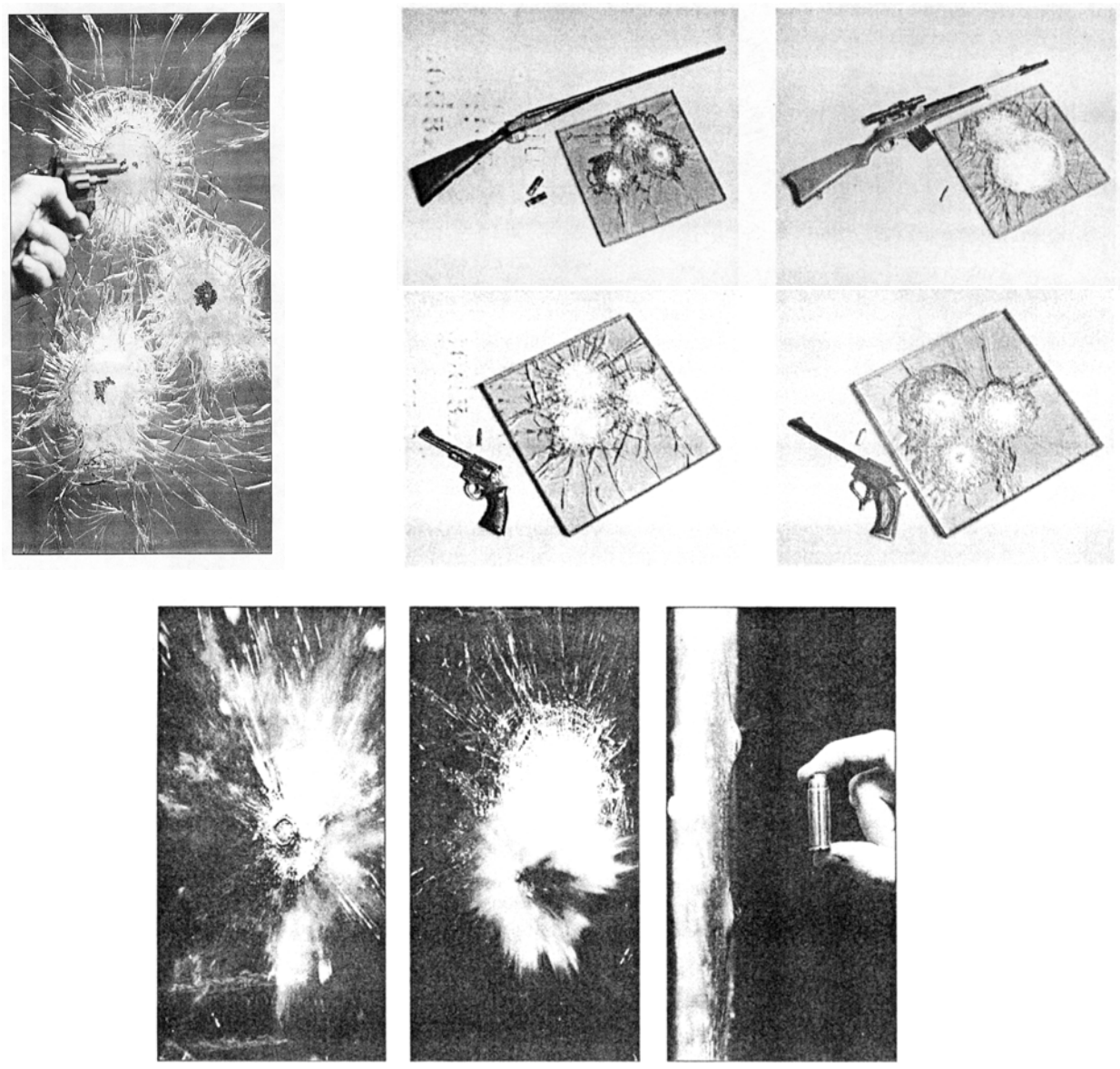

Figure 1. The protection class C safety glasses - testing

Since the anti-break glasses from the class C are consisted of several layers of glued glass, they are at the same time excellent anti-crash glasses, and they are characterised too with a high sound isolating property. Certain glasses are easily built in an isolating glass. Numerous combinations are performable, including those with an excellent heat isolating property.
Through GH technology, today the several layers safety glasses are produced, which, due to different composition and mechanical properties of GH glues, are importantly thicker then the glasses made with PVB foil.

Table 3. The characteristics of protection class C safety glasses

Producer's type designation	Composition out /inside	Coefficient of heat transfer	Safety class according to DIN 52 290	Thickness	Mass	Max. glass length	Max. surface	Max. side proportion
	mm	W/m^2K	-	mm	Kg/m^2	mm	m^2	-
C1SA	17/10/6	5,8	B1/C1SA	33	56	225/400	8,00	1:6
C1SF	19/10/6	5,8	C1SF	38	64	225/400	7,80	1:6
C2SA	11/10/10	5,8	B2/C2SA	51	48	225/400	6,80	1:6
C2SF	28/10/11	5,8	C2SF	49	93	225/400	5,30	1:6
C3SA	11/10/19,5	5,8	B3/C3SA	40	69	225/400	6,80	1:6
C3SF	34/10/11	5,8	C3SF	55	109	225/400	4,50	1:6
C4SA	17/10/21	5,8	C4SA	48	90	225/400	5,50	1:6
C5SA	32,5/10/32,5	5,8	C%SA	75	156	225/400	3,20	1:6

3. SAFETY GLASSES FOR THE PROTECTION AGAINST EXPLOSION EFFECTS (GLASSING ACCORDING TO THE DEMANDS FROM DIN 52 290 T5) THE PROTECTION CLASS D

These safety glasses for the protection against explosion effects are yet cold the D class glasses. According to the protection degree they can be divided in three sub-groups. Their testing is connected with that of the glasses from the A3 protection degree, then the glasses from B and C class. It does implicate that the properties of the class D glasses are important for anti-crash or anti-break glasses.
Such glasses are tested under special conditions. In so doing it is established what is the biggest pressure of impact wave which the glass can stand in a longer time period (table 4.).
The glassing for the protection against an explosion impact is also divided into three groups, concerning the protection degree. The technical data for some kinds of such glassing are given in the table 5.

Table 4. The protection class D safety glasses

Protection degree	The biggest passive pressure of impact wave (bar)	The shortest time of duration of positive pressure (ms)	Effect of explosion (TNT) which is being broadened in concentric circles			
			Kinds of glassing (laminated at the internal side)	Thickness (mm)	Mass (kg/m^2)	Max. dimen-sion (cm)
D1	0,5	12	Simple	11	24	90/110
			Ins. Glass 6-8-11	25	40	90/110
D2	1,0	10	Simple	17	40	90/110
			Ins. Glass 6-8-17	31	57	90/110
D3	1,5	8	Simple	28	66	90/110
			Ins. Glass 6-8-28	42	83	90/110

Table 5. The characteristics of protection class D safety glassing

Type Designation of the producer	Composition: out/inside	K	LT	LR	EA	g	B – Shading coefficient	Safety class according DIN 52 290	Thickness	Masse	Max. length of the glass	Max. surface	Max. side dimension
	mm	W/m^2K	%	%	%	%	-	-	mm	kg/m^2	mm	m^2	-
D1-Standard	6/18/11	3,0	78	15	11	69	86	A3-D1	25	40	90/110	1,0	1:6
D2-Standard	6/8/17	3,0	75	14	11	68	85	B1/D2/C2	31	57	90/110	1,0	1:6
D3-Standard	6/8/28	2,9	70	13	11	65	81	B3/D3/C3	42	83	90/110	1,0	1:6

4. CONCLUSION

In this paper are considered the safety glasses for protection against a shot (protection class C) and the safety glass for protection against an explosion effect (protection class D). Concerning the safety glasses for protection against a shot, their class depends of the firearm calibre and according to it they are divided in five classes, C1 – C5. These glasses are most frequently done as several layers glued ones, so that they can be classify in the anti-crash glasses too, and besides they have too a good sound insulation property. The glasses from protection class D are classified in three categories D1 – D3 depending on maximal passive pressure of striking wave, which they can stand. The glasses from D3 class can bear the biggest passive pressure of the striking wave, which amounts 1,5 bar (table 4.). From the table 5. it is visible that with a class increase it comes to a decrease of light and sun energy passing through, while the thickness and mass of glass barriers are increasing.

5. REFERENCES

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