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Classification and test method of air-blast resistance performance for curtain walls, windows and doors

玻璃幕墙和门窗抗爆炸冲击波性能分级及检测方法

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1 Scope

The document lays down the terms and definitions, the classification, the test specimens, the test site and instruments, the test procedure, the data processing, the assessment of results and the test report for the air-blast resistance performance of building curtain walls, windows and doors.

It applies to the classification and testing of the air-blast resistance performance of curtain walls, windows and doors that use glass as the panel material. The air-blast resistance performance of other building components may be tested by reference to it.

2 Normative references

Two documents are cited: GB 6722, Safety regulations for blasting, and GJB 338A, Specification for TNT. For dated references only the edition cited applies; for undated references the latest edition, including all amendments, applies.

3 Terms and definitions

3.1 air-blast resistance performance: the ability of glass curtain walls, windows and doors, in the normal service state with the opening sashes closed, to protect people or objects

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indoors when acted on by an explosion air-blast wave.

3.2 free-field air-blast pressure: the value of the air-blast pressure at a point during propagation of the wave, not affected by other boundaries.

3.3 air-blast pressure history: the course of change of the free-field pressure, or of the reflected pressure, of the air-blast wave borne at a point on the surface of an object.

3.4 vehicle bombs classification: the class of air-blast wave produced when a charge of 100 kg TNT equivalent explodes. The document notes that 100 kg TNT equivalent means that the power of the explosion of the charge equals that produced by the explosion of 100 kg of TNT, and that the vehicle bomb classes are commonly used to test glass curtain walls of larger size.

3.5 hand-carried satchel bombs classification: the class of air-blast wave produced when a charge of a mass a person can carry explodes. The document notes that these classes are commonly used to test glass windows and doors of smaller size.

3.6 blast mat: the steel plate placed under the charge during the air-blast resistance test.

3.7 peak-positive air-blast pressure: the maximum pressure value of the positive pressure phase of the air-blast wave.

3.8 hazard rating: the degree of injury or harm that glass curtain walls, windows and doors may cause to people or objects indoors after being acted on by the specified air-blast wave.

3.9 witness panel: the polystyrene or polyurethane board mounted behind the specimen to record the scatter of material shed from the specimen during the test.

3.10 perforations: the holes produced on the witness panel by material of the specimen thrown against it.

3.11 indents: the visible deformation produced on the surface of the witness panel by material of the specimen thrown against it.

3.12 rateable perforation: a hole greater than 3 mm in length, width or depth.

3.13 rateable indents: an indent greater than 3 mm in length, width or depth.

3.14 breach: a hole or opening produced after the test, in the specimen itself or at the connection between the specimen and the supporting frame, large enough to let a rigid rod 10 mm in diameter pass through easily.

3.15 united dimension: the sum of the width, the length and the thickness of a particle.

3.16 fragment: a particle whose united dimension is not less than 25 mm.

3.17 standoff distance: the distance from the centre of the explosive source to the centre of the outer surface of the specimen.

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4 Classification

4.1 The classification indicators are the air-blast wave class and the hazard rating.

4.2 The air-blast wave class is expressed by the peak-positive air-blast pressure p max and the positive-phase impulse I POS. It comprises the vehicle bomb classes, denoted EXV and divided into seven classes whose parameters are given in Table 1, and the hand-carried satchel bomb classes, denoted SB and divided into seven classes whose parameters are given in Table 2.

Table 1 pairs each vehicle bomb class with a peak-positive air-blast pressure in kPa and a positive-phase impulse in kPa.ms: EXV1, 30 and 180; EXV2, 50 and 250; EXV3, 80 and 380; EXV4, 140 and 600; EXV5, 250 and 850; EXV6, 450 and 1 200; EXV7, 800 and 1 600.

Table 2 pairs each hand-carried satchel bomb class with the same two quantities: SB1, 70 and 150; SB2, 110 and 200; SB3, 250 and 300; SB4, 800 and 500; SB5, 700 and 700; SB6, 1 600 and 1 000; SB7, 2 800 and 1 500. The printed pressure column does not rise steadily from SB4 to SB5; the values are given here exactly as the document prints them.

4.3 The hazard rating is divided into six grades, assessed from the state of breakage of the glass and of the curtain wall or window and door members after the test. Table 3 sets out the division. Grade A, no damage: the glass has not broken; the members show no obvious damage and the opening sash and the hardware open and close normally. Grade B, no hazard: the glass has broken but the glass of the indoor surface stays whole in the specimen frame, with no breach and no material fragments shed from the indoor surface, while the outdoor glass may bulge or fall away after breaking; the members stay whole and the opening sash and the hardware have not come off and can be opened and closed. Grade C, minimum hazard: the number of rateable perforations or rateable indents on the witness panel shall not be greater than three, and the sum of the united dimensions of the fragments on the floor between 1 m and 3 m from the indoor surface of the glass shall not be greater than 250 mm; the glass has broken, the outdoor glass may fall away or bulge after breaking, the glass of the indoor surface shall stay whole in the specimen frame, and the sum of the length of the glass cracks and of the edge length by which the glass has come out of the frame shall be less than 50 % of the visible perimeter of the glass. Where, by design intent, that edge length exceeds 50 % of the visible perimeter but the glass is still held by a special clamp, the specimen may still be rated C if the fragments meet the requirement of this hazard grade, the state of the broken glass and of the clamping being stated in the test report; the members stay whole, the opening sash has not come off and can be opened after simple repair, and sealing strips and hardware may come off without affecting the integrity of the system. Grade D, low hazard: the glass has broken and the glass shed inside the test chamber lies mainly on the floor within 1 m of the indoor surface of the glass; the sum of the united dimensions of the fragments on the floor between 1 m and 3 m from that surface does not exceed 250 mm; there shall not be three or more

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rateable perforations or rateable indents on the witness panel; the members are substantially whole and the opening sash has not come off, while some hardware may come off, the place where it falls lying within 1 m of the initial position of the glass behind it. Grade E, medium hazard: the glass has broken and glass fragments or whole panes fly onto the floor between 1 m and 3 m from the indoor surface of the specimen and onto the area of the witness panel below 0.5 m; at the same time the number of rateable perforations in the area of the witness panel above 0.5 m shall not be greater than ten and the depth of the rateable perforations shall not be greater than 12 mm; connecting parts of the opening sash come off and hardware flies onto the floor between 1 m and 3 m from the indoor surface of the specimen and onto the vertical witness panel not more than 0.5 m up, the specimen suffering systemic damage. Grade F, high hazard: the glass has broken and the number of rateable perforations in the area of the witness panel above 0.5 m is greater than ten, or that area shows one or more rateable perforations deeper than 12 mm; the opening sash comes off as a whole, but the frame of the specimen shall not come off. A footnote to the table states that glass dust, thin flakes and all other smaller particles are not fragments, and that common glass fragments are shown in Annex A.

4.4.1 Classification is made according to the hazard rating assessed after the specimen has borne the action of the air-blast wave, and is composed of the air-blast wave class code and the hazard rating code.

4.4.2 Table 4 gives the classification of the performance against vehicle bomb blast: each of the seven EXV classes is combined with each of the six hazard ratings A to F, written in the form EXV1(A) through EXV7(F).

4.4.3 Table 5 gives the same for the hand-carried satchel bomb classes, written in the form SB1(A) through SB7(F).

5 Test specimens

5.1 Windows and doors. One specimen is used for the test. The specimen shall be a conforming product made to the drawings supplied, or a specimen developed for the purpose; no superfluous parts shall be attached and no special assembly process or improving measure shall be used. The specimen shall be combined and assembled as the design requires and kept clean and dry; a steel sub-frame is preferred for mounting it.

5.2.1 Curtain walls. One specimen is used for the test.

5.2.2 The specification, the model and the materials of the specimen shall agree with the drawings supplied by the manufacturer.

5.2.3 The width of the specimen shall include at least one vertical load-bearing member that carries the design load. The height of the specimen should not be less than one storey height, and there shall be two or more connections to the supporting structure in the vertical direction.

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