



ICBO Evaluation Service, Inc.

A subsidiary corporation of the International Conference of Building Officials

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ACCEPTANCE CRITERIA FOR GLASS BLOCK MASONRY CONSTRUCTION

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PREFACE

Evaluation reports issued by the ICBO Evaluation Service, Inc. (ICBO ES), are based upon performance features of the Uniform Building Code,[™] Uniform Mechanical Code, Uniform Plumbing Code and related codes. Section 105 of the Uniform Building Code is the primary charging section upon which evaluation reports are issued. Section 105 reads as follows:

The provisions of this code are not intended to prevent the use of any material or method of construction not specifically prescribed by this code, provided any alternate has been approved and its use authorized by the building official.

The building official may approve any such alternate, provided he finds that the proposed design is satisfactory and complies with the provisions of this code and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in suitability, strength, effectiveness, fire resistance, durability, safety and sanitation.

The building official shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use. The details of any action granting approval of an alternate shall be recorded and entered in the files of the code enforcement agency.

The attached acceptance criteria for the general code sections noted have been issued to provide all interested parties with guidelines on implementing performance features of the codes. The attached acceptance criteria were developed and adopted following public hearings conducted by the Evaluation Committee. These criteria may be revised from time to time as the need dictates.

ICBO ES may consider alternate criteria, provided the proponent submits valid data demonstrating that the alternate criteria are at least equivalent to the attached criteria and otherwise meet the applicable performance requirements of the codes. Notwithstanding that a material, type or method of construction, or equipment, meets the attached acceptance criteria, or it can be demonstrated that valid alternate criteria are equivalent and otherwise meet the applicable performance requirements of the codes, if the material, product, system or equipment is such that either unusual care with its installation or use must be exercised for satisfactory performance, or malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use thereof, ICBO ES retains the right to refuse to issue or renew an evaluation report.

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1. INTRODUCTION

1.1 Scope The purpose of these criteria is to establish requirements for ICBO Evaluation Service, Inc., (ICBO ES) evaluation reports on glass block masonry construction, extending limitations in Section 2407 (j) of the 1991 Uniform Building Code hereinafter referred to as the “code.”

2. DEFINITIONS

2.1 Channel Anchor: A channel used as a panel connector to laterally support glass block panels normal to the plane of the panel while allowing in-plane movement to occur.

2.2 Expansion Joint: A separation between a glass block panel and adjoining construction to allow unrestrained movement due to lateral loads on the structure, temperature-volume change, shrinkage, creep and other movements occurring parallel to the panel plane.

2.3 Panel Anchor: A panel connector made from galvanized steel strips, embedded in the mortar joint, and extended through the movement joint, anchoring the panel to adjoining construction.

2.4 Panel Connector: A mechanical device laterally supporting glass block panels normal to the plane of the panel while allowing in-plane movement to occur.

2.5 Testing Agency: An independent testing agency recognized by the ICBO ES or NES and having the personnel, expertise, equipment and facilities for testing in accordance with this criteria.

3. TESTING

Component materials and assemblies shall be tested according to this section.

3.1 Test Specimen Materials:

3.1.1 Glass Block:

3.1.1.1 Description: Glass block used in the test specimens shall be of standard manufacture and representative of the product on which recognition is sought. Glass block used for test specimens must be sampled by the testing laboratory at production facilities. The glass block may be solid or hollow with optional inserts. Glass block surfaces normally bonded with mortar shall be described by the laboratory and documented in the test report.

3.1.1.2 Testing Requirements: The units’ overall dimensions, including width, height and length, shall be measured to the nearest $1/100$ inch. Weight of units shall be measured to the nearest $1/100$ pound.

3.1.1.3 Number of Specimens: Three full size units of each type used in structural test specimens are required.

3.1.1.4 Report: The test report includes unit identification, average width, average height, average length, and average received weight.

3.1.2 Mortar:

3.1.2.1 Requirements: Mortar used in test specimens shall comply with U.B.C. Standard No. 24-20, Mortar for Unit Masonry and Reinforced Masonry other than Gypsum.

3.1.2.2 Testing: The mortar shall be evaluated in accordance with the referenced U.B.C. Standard.

3.1.2.3 Number of Specimens: Representative mortar samples shall be taken for each masonry test assembly as required by the referenced U.B.C. Standard.

3.1.2.4 Report: The mix identification number, mix proportions, water retention, air content, consistency, and compressive strengths of three 2-inch cubes shall be reported.

3.1.3 Joint Reinforcement:

3.1.3.1 Requirements: Joint Reinforcement shall comply with U.B.C. Standard No. 24-15, Part 1, Joint Reinforcement for Masonry.

3.1.3.2 Testing: The joint reinforcement shall be evaluated in accordance with the referenced U.B.C. Standard.

3.1.3.3 Number of Specimens: Four individual wires cut from the finished product across the welds.

3.1.3.4 Report: The manufacturer’s name, identification, tensile strength, yield strength, reduction of area, bend properties, corrosion protection and dimensions shall be reported.

3.2 Flexural Bond Wrench Prism Tests:

3.2.1 Construction: Prisms shall be constructed in a laboratory according to Section 24.3004 of U.B.C. Standard No. 24-30, Standard Test Method for Flexural Bond Strength of Mortar Cement with the following exceptions: The first unit is set on a firm horizontal surface without the use of mortar. Remaining units are laid in a full mortar bed in a stack bond configuration. Mortar joints shall be of consistent thickness. Joints may be tooled or cut flush.

3.2.2 Testing: Each prism joint must be tested in accordance with Section 24.3005 of U.B.C. Standard No. 24-30, using glass block prisms constructed in accordance with Section 3.3.1.

3.2.3 Number of Specimens: At least 12 prism joints are required for each wall specimen.

3.2.4 Report: The following details shall be included in the test report:

3.2.4.1 Prism identification number.

3.2.4.2 Average prism dimensions.

3.2.4.3 Weight of prisms.

3.2.4.4 Mortar in compliance with Section 3.1.2.

3.2.4.5 Individual and mean modulus of rupture, and position of mortar joint within the specimen (top mortar joint shall be designed as joint Number 1, the second joint Number 2, etc.).

3.2.4.6 Description of failure.

3.2.4.7 Description of bonding pattern and joint tooling.

3.2.4.8 Location of tooled joint during test.

3.2.4.9 Joint thickness.

3.2.4.10 Sketch or photo of masonry unit.

3.2.4.11 Curing history.

3.2.4.12 Age of specimen at each break.

3.2.4.13 Photograph of bond-wrench test apparatus in operation shall be reported.

3.3 Flexural Wall Tests:

3.3.1 Wall Specimens Supported on Four Sides: Glass block masonry walls supported on four sides using the manufacturer's recommended connection details shall be evaluated.

3.3.1.1 Construction: Walls shall be constructed in accordance with Section 2407 (j) of the code and the glass block manufacturer's recommendations.

3.3.1.2 Number of Specimens: Three full-scale walls, minimum 12 feet high by 12 feet wide shall be tested.

3.3.1.3 Testing: Testing shall be in accordance with Section 12, ASTM E 72, Standard Methods of Conducting Strength Tests of Panels for Building Construction. An air bag shall apply uniform incremental lateral loads to the test specimens.

3.3.1.4 Report: The following details shall be included in the test report:

3.3.1.4.1 Deflection and set for each increment of load according to Section 4.3, ASTM E 72.

3.3.1.4.2 Panel Construction Details: Size and description of units, description of bond pattern and joint tooling method, reinforcement location, and method of panel anchorage to supports.

3.3.1.4.3 Mortar information according to Section 3.1.2.

3.3.1.4.4 Panel curing duration, temperature, and humidity.

3.3.1.4.5 Description, location, and photographs of the specimen failure.

3.3.1.4.6 Mortar type and proportions.

3.3.1.4.7 Age of specimen at time of test shall be recorded.

3.3.2 Simply Supported Wall Specimens: Glass block masonry walls simply supported at each end and free at perpendicular edges shall be evaluated.

3.3.2.1 Construction: Walls shall be constructed according to Section 2407 (j) of the code and the glass block manufacturer's recommendations.

3.3.2.2 Number of Specimens: Three full-scale walls, minimum 4 feet by 8 feet with longest dimension spanning between supported ends, shall be tested.

3.3.2.3 Testing: Testing shall be in accordance with Section 12 ASTM E 72. An air bag shall apply uniform incremental lateral loads to the test specimens.

3.3.2.4 Report: The following details shall be included in the test report:

3.3.2.4.1 Panel Construction Details: Size and description of units, description of bond pattern and joint tooling method, reinforcement type and location, and method of panel anchorage to supports.

3.3.2.4.2 Mortar information according to Section 3.1.2.

3.3.2.4.3 Panel curing duration, temperature and humidity.

3.3.2.4.4 Deflection and set for each increment of load in accordance with Section 4.3 of ASTM E 72.

3.3.2.4.5 Description, location, and photograph of the specimen failure.

3.3.2.4.6 Age of specimen at time of test.

3.3.3 Curved Panels: Curved panels are beyond the scope of these criteria.

3.4 Fire Resistance: Glass blocks may function as a fire-resistive assembly for protection of openings in accordance with Section 4306 of the code. Qualification requires tests in accordance with U.B.C. Standard No. 43-4, Fire Tests of Window Assemblies.

3.5 Reports: All tests must be conducted by our ICBO ES or NES recognized independent testing agency.

In addition to information required for each test, test reports must include the following:

3.5.1 Preparation of test specimens and complete information on the mixing, application, curing, etc.

3.5.2 Description of test procedures.

3.5.3 Test observations, including description of specimens after completion of tests.

3.5.4 Statement on passing or failing, where applicable.

4. INTERPRETATION OF TEST REPORTS

To develop a structural design data base, the following analyses are required.

4.1 Cracking Moment: The modulus of rupture of glass block masonry shall be determined from the flexural and test results of the simply supported wall specimens described in Section 3.3.2. The modulus of rupture, f_r , of simply supported wall tests shall be determined as follows:

$$f_r = \frac{M_{cr}}{S}$$

Where:

f_r = Modulus of rupture, the mean flexural strength of the simply supported wall tests, psi.

S = Section modulus of fully bedded mortar joint, in³ per foot.

M_{cr} = The mean initial cracking moment, based on mean value of simply supported wall panels, inch-pound per foot.
= 0.1235 $W_{cr} L^2$

Where:

W_{cr} = Uniform lateral load on simply supported panel at initial cracking, psf.

L = Span between simply supported panel ends, feet.

4.2 Nominal Flexural Strength: The nominal flexural strength, M_n of glass block masonry is the mean flexural strength of simply supported wall specimens (Section 3.3.2). The strength reduction factor, ϕ , is:

$$\phi = \frac{(M_n - 1.886\sigma)}{M_n} - 0.1$$

Where:

ϕ = Strength reduction factor.

M_n = Nominal flexural strength, or the mean flexural strength of simply supported wall panels, foot pounds per foot.

σ = Standard deviation of M_n , for simply supported wall panels tested, foot-pounds per foot.

0.1 = Coefficient to accommodate workmanship variability.

4.3 Verification of Design Strength: The cracking moment strength of full-scale panels supported on four sides, M_{cr} (full scale) (foot-pounds per foot), is:

$$M_{cr} \text{ (full scale)} = K_s W_{cr} X_s^2$$

Where:

w_{cr} = Uniform lateral load on glass block panel at initial cracking, psf.

K_s = Maximum short span moment coefficient (Table No. I).

X_s = Length of panel's short span, feet.

TABLE NO. I

R^1	K_s
1.0	0.0479
1.1	0.0554
1.2	0.0627
1.3	0.0694
1.4	0.0755
1.5	0.0812
1.6	0.0862
1.7	0.0908
1.8	0.0948
1.9	0.0985
2.0	0.1017
2.5	0.1129
3.0	0.1189
4.0	0.1235
Infinite	0.1250

R^1 = Ratio of panel's long dimension (height or length) to panel's short dimension (height or length).

If the mean cracking moment strength M_{cr} (full scale) of the full-scale panels supported on four sides is less than 0.9 times M_{cr} (where M_{cr} is determined in accordance with Section 4.1), then M_{cr} used in Section 5.1 shall be taken as the average cracking moment of both the simply supported panels and full-scale panels.

The flexural strength of full-scale panels supported on four sides, M_n (full scale) (foot-pounds per foot), is:

$$M_n \text{ (full scale)} = 0.1235 w_{max} X_h^2$$

Where:

w_{max} = Maximum load resisted by the glass block panels, psf.

X_h = Horizontal length of panel, feet.

If the mean flexural strength M_n (full scale) of the full-scale panels is less than 0.9 times M_n (where M_n is determined in accordance with Section 4.2) then M_n used in Section 5.2 shall be taken as the average flexural strength of the simply supported and full-scale panels.

5. DESIGN CRITERIA

Glass block masonry shall be designed to resist lateral loads acting perpendicular to the surface of the panel. Design lateral

loads shall be determined in accordance with Chapter 23 of the code.

5.1 Serviceability: The cracking moment, M_{CR} of glass block masonry shall equal or exceed 1.1 times the moment due to design loads, M_{DESIGN} :

$$M_{CR} \geq 1.1 M_{DESIGN}$$

5.2 Strength: The required flexural strength, M_u shall be derived using the design lateral loads multiplied by a load factor. Load factors shall be: 1.3 for wind loads, and 1.5 for earthquake loads.

The nominal flexural strength, M_n of the glass block panel times the strength reduction factor, ϕ , shall equal or exceed the required flexural strength M_u .

$$\phi M_n \geq M_u$$

6. QUALITY ASSURANCE

Quality of glass block production shall be monitored through an approved quality control program with periodic inspections by an independent agency recognized by ICBO ES. The program must be documented in a manual complying with the ICBO ES Acceptance Criteria for Quality Control Manuals.

The quality control program requires the following evaluations, conducted at appropriate intervals.

6.1 Dimensional Tolerances of Units:

Thickness: $\pm 1/16$ inch.

Alignment between sealed halves: $\pm 1/16$ inch.

Bulge or sink of face measured diagonally across the face of the units: $\pm 1/16$ inch.

6.2 Weight tolerance of units: ± 10 percent.

6.3 Thermal Shock: Units shall comply with the method of Thermal Shock Test for Glass Block, detailed in the National Concrete Masonry Association Procedures.

6.4 Impact: Units shall comply with the Method of Impact Tests for Glass Block, detailed in the National Concrete Masonry Association Procedures.

6.5 Mortar Surface of Unit: The edge and surface treatments of glass block units to be mortared shall be inspected to verify that they are representative of units used in test specimens.