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JGJ 102-2003

Technical code for glass curtain wall engineering

玻璃幕墙工程技术规范

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Table of Contents

Introduction.....	6
Foreword.....	8
1 General Provisions	10
2 Terms and Symbols.....	11
2.1 Terms.....	11
2.2 Symbols.....	13
3 Materials	17
3.1 General Requirement	17
3.2 Aluminium Alloy Material.....	17
3.3 Steel.....	19
3.4 Glass.....	20
3.5 Weather Proofing Sealed Materials.....	22
3.6 Structural Silicone Sealant.....	23
3.7 Other Materials	23
4 Architectural Design	24
4.1 General Requirement	24
4.2 Requirements of Performance and Inspection	24
4.3 Design of Constructional Detail.....	26
4.4 Safety Provisions	28
5 Basic Requirement for Structural Design	30
5.1 General Requirement	30
5.2 Mechanical Properties of Materials	31
5.3 Load and Earthquake Action.....	34
5.4 Action Effect Combination	36
5.5 Design of Connections.....	38
5.6 Design of Structural Silicone Sealant	39
6 Structural Design of Framed Supported Glass Curtain Wall	42
6.1 Glass.....	42
6.2 Transom.....	46
6.3 Mullion.....	48
7 Structural Design of Full Glass Curtain Wall	52

7.1 General Requirement	52
7.2 Panel.....	52
7.3 Glass Rib.....	53
7.4 Sealant Joint.....	54
8 Structural Design of Point-supported Glass Curtain Wall	56
8.1 Glass Panel.....	56
8.2 Supporting Device	58
8.3 Supporting Structure	59
9 Fabrication	62
9.1 General Requirement	62
9.2 Aluminum Profiles	62
9.3 Steel Element	65
9.4 Glass.....	67
9.5 Components of Exposed Frame Supported Glass Curtain Wall	69
9.6 Components of Hidden Frame Supported Glass Curtain Wall	71
9.7 Frame Supported Glass Curtain Wall Assembled in Prefabricated Units	72
9.8 Inspection of Elements of Glass Curtain Wall	75
10 Construction.....	76
10.1 General Requirement	76
10.2 Preparations for Construction	77
10.3 Frame Supported Glass Curtain Wall Assembled in Elements	78
10.4 Frame Supported Glass Curtain Wall Assembled in Fabricated Units	80
10.5 Full Glass Curtain Wall.....	83
10.6 Point-supported Glass Curtain Wall.....	84
10.7 Safety Provisions	86
11 Project Acceptance	88
11.1 General Requirement	88
11.2 Frame Supported Glass Curtain Wall.....	89
11.3 Full Glass Curtain Wall.....	92
11.4 Point-supported Glass Curtain Wall.....	93
12 Maintenance and Repair	95
12.1 General Requirement	95
12.2 Inspection and Repair	96
12.3 Cleaning	97
Appendix A Design Value of Strength of Atmospheric Corrosion Resisting Steel	98

Appendix B Design Value of Connection Strength of Steel Structure	100
Appendix C Design of Pre-embedded Parts	103
Explanation of Wording in This Code	106

Introduction

This version is one of China's engineering construction standards in English series, which, in compliance with the relevant procedures and stipulations, has been organized to translate by China association for Engineering Construction Standardization (CECS) authorized by Ministry of Housing and Urban-Rural Development (MOHURD) of the People's Republic of China. On December 4, 2008, MOHURD published it by means of Announcement of No. 177.

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Many thanks should go to the organizations like China State Construction Energy Corp. Ltd. who have offered strong support during the course of translation and revision of this version, and also to the staff from the relevant standard development organizations and groups who have provided practical assistance through their hard work.

For the sake of improving its quality, any kind of constructive criticism, comments and suggestions in association with this version in welcome. It would be greatly appreciated if they could be fed back to CECS.

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Foreword

According to the requirements of Document Jian Biao [2000] No. 284 issued by Ministry of Construction (MOC), the standard revision group carried out extensive investigative study, summarized practical experiences, control overseas advanced standards, and with the collection of extensive comments, finally made a revision on "Technical Code for Glass Curtain Wall Engineering" JGJ 102-96.

The main technical contents in this Code are: 1. General provisions; 2. Terms and symbols; 3. Materials; 4. Architectural design; 5. Basic requirement for structural design; 6. Structural design of framed supported glass curtain wall; 7. Structural design of full glass curtain wall; 8. Structural design of point-supported glass curtain wall; 9. Fabrication; 10. Construction; 11. Project acceptance; 12. Maintenance and repair; 13. Appendix A ~ Appendix C.

The main revised contents are: 1. The limitation for maximum applicable height of glass curtain wall in this Code is abolished, at the same time the requirements are added that wind tunnel test shall be performed to determine the wind load when the height of glass curtain wall is larger than 200 m or the shape and the wind load circumstance are complicated; 2. The contents of wind load calculation, earthquake action calculation, action effect of combination are revised; 3. The content about calculation of temperature action effect is abolished; 4. In the calculation of stress and deflection of glass panel, the effect of geometric nonlinearity is considered; 5. The calculation method and relevant provisions for insulating glass and laminated glass are added; 6. The provisions for design, fabricating, construction of frame supported glass curtain wall assembled in prefabricated units are added; 7. The provisions for design, fabrication and construction of point-supported glass curtain wall are added; 8. The checking computation and control qualification for deflection of glass curtain wall in serviceability limit state are revised and adjusted; 9. The safety provisions for the processes of design, installation, and application are revised; 10. The provisions for relative detail design of glass curtain wall are revised.

Ministry of Construction is in charge of the administration of this specification and the explanation of the compulsory provisions.

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Participating drafting organizations of this Code:

Zhongshan Shengxing Curtain Wall Co, Ltd.

1 General Provisions

1.0.1 This code is formulated with a view to ensure safety and usability, advanced technique, economy and rationality in glass curtain wall project.

1.0.2 This code is applicable to the design, fabrication, Construction, project acceptance, maintenance and repair of glass curtain wall project of civilian building in non-seismic design and seismic design with earthquake fortification intensity of 6, 7, 8 degree.

1.0.3 In normal serviceability state, glass curtain wall shall keep good working performance. The curtain wall with seismic design shall work normally under the action of earthquake occurred frequently; it shall still work normally after repair under the action of fortification intensity earthquake; the framework of glass curtain wall shall not separate and fall under the action of earthquake occurred infrequently.

1.0.4 Quality control in whole process shall be implemented during design, fabrication, and construction of glass curtain wall project.

1.0.5 The materials, design, fabrication, construction and acceptance, shall comply not only with the requirements stipulated in this code, but also those in the current relevant ones of the nation.

2 Terms and Symbols

2.1 Terms

2.1.1 Building curtain wall

Exterior enclosure structure or decorative structure of building, which comprises supporting structural system and panels, and has the ability to accommodate a certain amount of relevant displacement to the main structure, without bearing the action on main structure.

2.1.2 Composite curtain wall

Building curtain wall which comprises different materials of panels (such as glass, metal, slate, etc.).

2.1.3 Glass curtain wall

Building curtain wall which takes glass as panel material.

2.1.4 Inclined building curtain wall

Glass curtain wall which is inclined at an angle larger than 75 degree and less than 90 degree to the horizontal.

2.1.5 Frame supported glass curtain wall

Glass curtain wall in which the panel is supported on circumference with metal frame. Main types are as follows:

1 According to the type of curtain wall, it may be:

1) Exposed frame supported glass curtain wall

Frame supported glass curtain wall in which elements of metal frame are fully exposed to the out surface of panels.

2) Hidden frame supported glass curtain wall

Frame supported glass curtain wall in which elements of metal frame are fully not exposed to the out surface of panels.

3) Semi-hidden frame supported glass curtain wall

Frame supported glass curtain wall in which the horizontal or vertical elements of metal frame are exposed to the out surface of panels.

Polyurethane formate or polyethylene low foam materials with adhesive on the two surfaces, which is applied to control the position and cross sectional dimension of structural sealant in curtain wall.

2.1.14 Bimetallic corrosion

Galvanic Corrosion formed by different types of metal or other electric conductors as the electrodes.

2.1.15 Compatibility

The property that mutual harmful physical or chemical reaction does not arise when adhesive sealing material with the same or other materials.

2.2 Symbols

2.2.1 Mechanic property of materials

C20 - Concrete strength grade with cubic strength characteristic value of 20 N/mm²;

E - Modulus of elasticity of materials;

f - Design value of strength of materials;

f_a - Design value of strength of aluminum alloy;

f_c - Design value of axial compressive strength of concrete;

f_g - Design value of strength of glass;

f_s - Design value of strength of steel;

f_t - Design value of axial tensile strength of concrete;

f_y - Design value of tensile strength of steel.

2.2.2 Action and action effect

d_f - Deflection of curtain wall element caused by characteristic value of actions;

G_k - Characteristic value of gravity load;

M - Design value of bending moment;

M_x - Design value of bending moment about x axis;

M_y - Design value of bending moment about y axis;

c_s - Bonding width of structural silicone sealant;

d - Diameter of anchoring rebar;

l - Span;

t - Thickness of glass panel; thickness of section of profiles;

t_s - Bonding thickness of structural silicone sealant;

W - Gross resisting moment of cross-section;

W_n - Net resisting moment of cross-section;

W_{nx} - Net resisting moment of cross-section about x axis;

W_{ny} - Net resisting moment of cross-section about y axis;

z - Distance between centerline of anchoring rebar in outer layer.

2.2.4 Coefficients

α - Linear expansion coefficient of material;

$\alpha_{\max}$ - Maximum value of horizontal seismic influence coefficient;

β_E - Dynamic amplification factor of earthquake action;

β_{gz} - Gustiness factor;

δ - Displacement bearing capacity of structural silicone sealant;

φ - Stability factor;

γ - Plasticity adaptation factor;

γ_0 - Coefficient of the importance of structure;

γ_g - Characteristic value of self-weight of material;

γ_E - Partial coefficient of earthquake action;

γ_G - Partial coefficient of permanent load;

γ_{RE} - Seismic adjusting factor for load-carrying capacity of structural element;

γ_w - Partial coefficient of wind load;

η - Reduction coefficient;

3 Materials

3.1 General Requirement

3.1.1 Materials for glass curtain wall shall meet the requirements of the provisions in current national standards and of design. Material without relevant standard shall meet the design requirements, and have factory certification of qualification.

3.1.2 Weather resisting materials shall be selected for glass curtain wall. For metal material and metal installation kits, except stainless steel and atmospheric corrosion resisting steel, common steel shall be treated with surface hot dip galvanization or inorganic zinc-rich coating or other effective anti-corrosive measures, and aluminium alloy material shall be treated with surface anodic oxidation or electrophoretic painting or powder spraying or fluorocarbon paint spaying.

3.1.3 Glass curtain wall shall adopt non-combustible or hard-combustible materials; fire-resisting sealing detail shall adopt fire-resisting sealing material.

3.1.4 For hidden and semi-hidden frame supported glass curtain wall, neutral structural silicone sealant shall be adopted for the cementation of glass and aluminium profiles; when coated glass is used for full glass curtain wall and point-supported curtain wall, acid structural silicone sealant shall not be adopted for cementation.

3.1.5 Structural silicone sealant and weather proofing silicone sealant shall be adopted in the effective period.

3.2 Aluminium Alloy Material

3.2.1 The corresponding chemical constitution to the brand of aluminium alloy profiles used in glass curtain wall shall comply with the requirements of relevant provisions in current national standard "Wrought Aluminium and Aluminium Alloys-Chemical Composition Limits" GB/T 3190. The quality of aluminium alloy profiles shall comply with the requirements of provisions in current national standard "Wrought Aluminium Alloy Profiles for Architecture" GB/T 5237, the dimension of profiles shall reach high precision class or ultrahigh precision class.

3.2.2 When aluminium alloy profiles are treated with surface anodic oxidation or electrophoretic painting or powder spraying or fluorocarbon paint spaying, the quality requirements of the provisions in current national standard "Wrought Aluminium Alloy Profiles for Architecture" GB/T 5237 shall be complied with, and the thickness of surface treatment coat shall comply with the requirements in Table 3.2.2.

"Pan Head Screws With Cross Recess" GB/T 818

"Mechanical Properties of Fasteners-Bolts, Screws and Studs" GB/T 3098.1

"Mechanical Properties of Fasteners-Nuts-Coarse Thread" GB/T 3098.2

"Mechanical Properties of Fasteners-Nuts-Fine Pitch Thread" GB/T 3098.4

"Mechanical Properties of Fasteners-Tapping Screws" GB/T 3098.5

"Mechanical Properties of Corrosion-resistant Stainless Fasteners-Steel Bolts Screws and Studs" GB/T 3098.6

"Mechanical Properties of Fasteners-nuts are Made of Stainless-steel" GB/T 3098.15

3.3 Steel

3.3.1 The steel grade, brand, and qualification class of carbon structural steels and low alloy structural steels used for glass curtain wall shall comply with the requirements of the following current national standards and professional standards:

"Carbon Structural Steels" GB/T 700

"Quality Carbon Structural Steels" GB/T 699

"Alloy Structure Steels" GB/T 3077

"High Strength Low Alloy Structural Steels" GB/T 1591

"Hot-rolled Plain Carbon and Low Alloy Structural Steel Sheets and Strips" GB/T 912

"Hot-rolled Plates and Strips of Carbon Structural Steels and High Strength Low Alloy Structural Steels" GB/T 3274

"Seamless Steel Tube for Structure" JBJ 102

3.3.2 Austenitic stainless steel in which the amount of nickel more than 8% are stainless steel used for glass curtain wall. The stainless steel shall comply with the requirements of the following current national standards and professional standards;

"Stainless Steel Bars" GB/T 1220

"Cold Finished Stainless Steel Bars" GB/T 4226

"Cold Rolled Stainless Steel Plate Sheet and Strip" GB/T 3280

"Hot Rolled Stainless Steel Strips" YB/T 5090

"Hot Rolled Stainless Steel Plate Sheet and Strip" GB/T 4237

"Cold Rolled Stainless Steel and Heatresisting Steel Strips" GB/T 4239

3.3.3 The atmospheric corrosion resisting steel for glass curtain wall shall comply with the requirements of provisions in current national standard "Superior Atmospheric Corrosion Resisting Structural Steel" GB/T 4171 and "Atmospheric Corrosion Resisting Steel for Welded Structure" GB/T 4172.

3.3.4 The carbon structural steel and high strength low alloy structural steel for glass curtain wall shall be treated with anti-corrosive measure. When treated with hot dip galvanization, the thickness of zinc coat shall comply with the requirements of provisions in current national standard "Metallic Coatings-Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles-Specifications and Test Methods" GB/T 13912.

3.3.5 When fluorocarbon paint spaying and polyurethane paint spaying are adopted to the carbon structural steel and high strength low alloy structural steel for supporting structure, the coat thickness should not be less than 35; In the region with heavy air pollution and seashore region, the coat thickness should not be less than 45.

3.3.6 Stainless strand for point-supported glass curtain wall shall comply with the requirements of provisions in current national standard "Stainless Steel Wires for Cold Heading and Cold Forging" GB/T 4232, "Stainless Steel Wires" GB/T 4240, "Stainless Steel Wire Ropes" GB/T 9944.

3.3.7 The technical requirements of anchorages for point-supported glass curtain wall shall comply with the provisions in the current national standards "Anchorage Grip and Coupler for Pre-stressing Tendons" GB/T 14370, and "Technical Specification for Application of Anchorage Grip and Coupler for Pre-stressing Tendons" JGJ 85.

3.3.8 The supporting devices for point-supported glass curtain wall shall comply with the requirements of provisions in current professional standard "The Support Device of Point Supported Glass Curtain Wall" JG 138. The supporting devices for full glass curtain wall shall comply with the requirements of provisions in current professional standards "The Support Device of Point Supported Glass Curtain Wall" JGJ 138 and "The Support Device of Suspended Glass Curtain Wall" JG 139.

3.3.9 When steel elements are welded, the requirements stipulated in current national standards "Technical Specification for Welding of Steel Structure of Building" GB/T 8162, "Carbon Steel Covered Electrodes" GB/T 5117, "Low Alloy Steel Covered Electrodes" GB/T 5118 and current professional standard "Technical Specification for Welding of Steel Structure of Building" JGJ 81 shall be complied with.

3.4 Glass

3.4.1 The appearance quality and performance of glass of curtain wall shall comply

3.4.4 Glass of curtain wall shall be treated with mechanical edging in which the number of grinding wheel shall be more than 180. The edges of holes and sides of glass of point-supported glass shall be ground and chamfered, and the edge grinding shall be fine, the chamfering width should not be less than 1mm.

3.4.5 Tempered glass should be processed by secondary thermal treatment.

3.4.6 When adopted in glass curtain wall, laminated glass shall be fabricated with dry method, and polyvinyl-butylal (PVB) film shall be adopted as the interlayer; When the layers are combined, temperature and humidity shall be controlled strictly.

3.4.7 When single sheet low emissivity coated glass is adopted in glass curtain wall, online heat spaying low emissivity coated glass shall be used; off-line coated low emissivity coated glass should be fabricated into insulating glass, and the coated surface shall face the middle gas layer.

3.4.8 When fire-resistant requirements for glass of curtain wall are considered, single sheet fire-resistant glass or its product shall be used according to the requirements of fire-protection grade.

3.4.9 For daylighting glaze-colored glass in glass curtain wall, the glaze should be printed with silk screening.

3.5 Weather Proofing Sealed Materials

3.5.1 Rubber production used in glass curtain wall should be ternary ethylene propylene rubber, chloroprene rubber and silicone rubber.

3.5.2 Sealed rubber strip shall comply with the requirements of provisions in current national standards "Rubber Building Gaskets - Materials for Preformed Solid Vulcanized Structural Gaskets-specification" HB/T 3099 and "Industrial Rubber Sheet" GB/T 5574.

3.5.3 Hot-melt butyl sealant used as the first sealant in insulating glass shall comply with the requirements of provisions in current professional standard "Hot Melt Butyl Sealant for Insulating Glass" JC/T 914. The secondary sealant not bearing load shall comply with the requirements of provisions in current professional standard "Resilient Sealant for Insulating Glass" JC/T 486. The secondary sealant in hidden or semi-hidden frame supported glass curtain wall shall comply not only with the relevant requirements stipulated in "Resilient Sealant for Insulating Glass" JC/T 486, but also those in section 3. 6 in this code.

3.5.4 Weather proofing silicone sealant shall be used for the weather proofing sealing of glass curtain wall. When non-coated glass is used in point-supported curtain wall and full glass curtain wall, acid structural silicone sealant may be adopted for the weather proofing sealing, with the performance in accordance with the provisions in

4 Architectural Design

4.1 General Requirement

4.1.1 The type, structure and material of glass curtain wall shall be selected with comprehensive technical and economical analysis according to service function and elevation design.

4.1.2 Glass curtain wall shall be in harmony with the entire building and surrounding environment.

4.1.3 The elevation division grid should be compatible with indoor space combination, and should not interfere the interior function and vision. The determination of dimension of glass panels shall increase the utilization ratio of original glass, and shall be compatible with processing ability of manufacturing facilities for tempered, coated, laminated glass.

4.1.4 The glass panel of curtain wall shall be convenient for replacing.

4.1.5 The open window of curtain wall shall be set in accordance with the requirements of service function and elevation effect, shall be convenient for opening, and avoid the position of beams, columns and partition walls. The open angle of open window should not be larger than 90 degree, and the open should not be larger than 300 mm.

4.1.6 Glass curtain wall shall be convenient for maintenance and cleaning. Cleaning equipment should be set for curtain wall project with a height more than 40 m.

4.2 Requirements of Performance and Inspection

4.2.1 The performance design of glass curtain wall shall be carried out according to the type, height, shape of the building and the geography, climate, environment conditions at the building site.

4.2.2 The performance gradation of glass curtain wall for wind pressure resistance, air-tightness, water-tightness, heat preservation, sound insulation, shall comply with the requirements of provisions in current national standards "Gradation of Physical Performances for Building Curtain Walls" GB/T 15225.

4.2.3 The performance of wind pressure resistance of glass curtain wall shall meet the requirement in which under the action of characteristic value of wind load, its deformation shall not exceed the defined value, and no damage arises.

4.2.4 When heating, ventilation and air conditioning are required, the air-tightness performance of glass curtain wall shall not be lower than grade 3.

performances of wind pressure resistance, air-tightness and water-tightness. The inspection of performance of in-plane deformation and other performance may be added if necessary.

4.2.11 The performance inspection shall be carried out by national authorized organization. The material, detail, construction method of inspection specimen shall be the same with those of practical project.

4.2.12 In the performance inspection, when some performance item does not meet the requirements stipulated because of installation defect, re-inspection is allowed after the installation technique is improved and defect is mended. The inspection report shall include content about the improvement, and the construction of glass curtain wall shall be performed according to the improved installation technique. When the performance inspection does not reach the stipulated range because of defect of design or materials, inspection shall be ceased, specimen shall be remade and new inspection shall be performed after design is revised or materials are changed.

4.3 Design of Constructional Detail

4.3.1 The constructional detail of glass curtain wall shall satisfy the principle of being safe, practical useful, aesthetic, and shall be convenient for fabrication, installation, repair, maintenance and partially-replacing.

4.3.2 In the joint position of exposed frame supported glass curtain wall, the butt inserting position of frame supported glass curtain wall assembled in prefabricated units and open position of curtain wall, detail design shall be performed according to rain screen principle. For the position where rain probably penetrates and condensate water probably forms, detail measure of water transmitting and draining shall be adopted.

4.3.3 Structural silicone sealant shall be adopted for the non-bearing sealant joint of glass curtain wall. The surrounding joints of open sash should be sealed with sealing strip product of chloroprene rubber, ternary ethylenepropylene rubber or silicone rubber.

4.3.4 For glass curtain wall with canopy, coping and other architectural details that project from wall surface, the detail design of water proofing and draining at the conjugation regions.

4.3.5 The thermal isolated materials with damp proofing property or detail measures of vapor insulation and damp proofing shall be adopted in glass curtain wall.

4.3.6 When butt-inserted type of composite elements are adopted for units in frame supported glass curtain wall assembled in prefabricated units, detail measures of sealing of anti-seepage shall be taken in the intersection position.

Note: In non-seismic design. U_{lim} shall be determined according to the limit value of elastic story drift rotation of main structure; in seismic design. U_{lim} shall be determined according to 3 times of the limit value of elastic story drift rotation of main structure.

4.3.13 The panel unit of glass curtain wall shall not cross the deformation joints of main building, of which the design of detail joint corresponding to the deformation joint of main building, shall be capable to meet the requirements of accommodating the deformation of main building.

4.4 Safety Provisions

4.4.1 Safety glass should be adopted for frame supported glass curtain wall.

4.4.2 Tempered glass shall be adopted for the glass panel of point-supported glass curtain wall.

4.4.3 Tempered glass shall be adopted as glass rib for point-supported glass curtain wall supported by glass ribs.

4.4.4 In the public site where there is large flow density of humans, juveniles or infants exercise and the position which is subject to suffer collisions, safety glass shall be adopted in the glass curtain wall; in the position which is subject to suffer collisions, conspicuous signs of warning shall also be set.

4.4.5 Collision proof facility shall be set when there is no solid wall at the floor edge adjacent to glass curtain wall.

4.4.6 Fire protection design of glass curtain wall shall comply with the requirements of relevant provisions in current national standard "Code of Design on Building Fire Protection and Prevention" GB 50016. Fire protection design of glass curtain wall of tall building shall also comply with the requirements of relevant provisions in current national standard "Code for Fire Protection Design of Tall Building" GB 50045.

4.4.7 Fire resistance plugging design shall be carried out of the clearance between glass curtain wall and the surrounding fire-resisting partition elements, the outer edge of floor or partition wall, the edge of open in solid wall.

4.4.8 In the normal service state, the fire-resisting plugging detail systems of glass curtain wall shall have the capability of expansion and contraction, tightness and durability; in the on-fire state, it shall maintain relevant stability, not dehisced or fall off within the stipulated fire-resisting limit.

4.4.9 Non-combustible or hard-combustible materials of which the fire-resisting limit meets the design requirement shall be adopted as the filling material and protective facing material of the fire-resisting plugging detail system of glass curtain wall.

5 Basic Requirement for Structural Design

5.1 General Requirement

5.1.1 Glass curtain wall shall be designed as enclosure structure.

5.1.2 Glass curtain wall shall have adequate load-carrying capacity, rigidity, stability and capability to accommodate the relevant displacement to the main structure. Reliable measures to prevent loosening and slipping shall be taken for elements of curtain wall which are connected with bolts; reliable measures to prevent abscising and slipping shall be taken for elements of curtain wall which are suspending-connected or inserting-connected.

5.1.3 In the design of structure for glass curtain wall, the following action effects shall be calculated:

1 In non-seismic design, the effects of gravity load and wind load shall be calculated.

2 In seismic design, the effects of gravity load, wind load and earthquake action.

5.1.4 In the design of structure for glass curtain wall, the action effects in construction stage and in normal service stage may be calculated with elastic method respectively, and action effect combinations shall be carried out according to the provisions in section 5.4 in this code.

5.1.5 The elements in glass curtain wall shall be designed under the most unfavourable action among all the effect combinations.

5.1.6 Load-carrying capacity and deflection of structural elements of glass curtain wall shall be checked computed according to the following provisions:

1 For effect combination without seismic action, load-carrying capacity shall meet the requirement of the following formula:

$$\gamma_0 S \leq R \quad (5.1.6-1)$$

2 For effect combination with seismic action, load-carrying capacity shall meet the requirement of the following formula:

$$S_E \leq R/\gamma_{RE} \quad (5.1.6-2)$$

where

S - Design value of fundamental combination of load effect;

$$S = \gamma_G S_{Gk} + \psi_w \gamma_w S_{wk} + \psi_E \gamma_E S_{Ek} \quad (5.4.1-2)$$

where

S - Design value of action effect combination;

S_{Gk} - Characteristic value of permanent load effects;

S_{wk} - Characteristic value of wind load effect;

S_{Ek} - Characteristic value of earthquake action effect;

γ_G - Partial coefficient of permanent load;

γ_w - Partial coefficient of wind load;

γ_E - Partial coefficient of earthquake action;

ψ_w - Combination value coefficient of wind load;

ψ_E - Combination value coefficient of earthquake action.

5.4.2 In design of load-carrying capacity of elements of curtain wall, partial coefficients of actions shall be determined according to the following provisions:

- 1** Generally, the partial coefficients of permanent load/wind load and earthquake action, γ_G , γ_w and γ_E , shall be taken as 1.2, 1.4 and 1.3 respectively.
- 2** When permanent load effect plays a control role, its partial coefficient γ_G shall be taken as 1.35; at this time, variable load effect in combination shall be confined to vertical load effect only;
- 3** When permanent load effect plays a favorable role to structural elements, its partial coefficient γ_G shall be taken as a value which not be larger than 1.0.

5.4.3 The combination value coefficients of variable actions shall be taken according to the following provisions:

- 1** Generally, the combination value coefficient of wind load ψ_w shall be taken as 1.0, the combination value coefficient of earthquake action ψ_E shall be taken as 0.5;
- 2** For horizontal inversely suspended glass and its frame, the combination of earthquake action effect may not be considered, and the combination value coefficient of wind load ψ_w shall be taken as 1.0 (when permanent load effect does not play a control role) or 0.6 (when permanent load effect plays a control role).

5.4.4 In the checking computation of element deflection of curtain wall, both of partial coefficient of wind load γ_w and partial coefficient of permanent load γ_G shall both be taken as 1.0, and load effect combination may not be considered.

5.5 Design of Connections

5.5.1 The main structure or structural elements shall be capable to bear the load and action transferred from curtain wall. Design value of load-carrying capacity of anchorage between connection parts and main structure shall be larger than design value of load-carrying capacity of connection parts.

5.5.2 The design of connection parts, weld joints, bolts, rivets in the connection region of elements of glass curtain wall, shall comply with the requirements of relevant provisions in current national standards "Code for Design of Steel Structures" GB 50017 and "Technical Specification for Steel Structure of Tall Building" JGJ 99. The number of bolts, rivets carrying load in connection region shall not be less than 2.

5.5.3 The mullion of frame supported glass curtain wall should be suspended from main structure.

5.5.4 The mullion of glass curtain wall shall be connected to main concrete structure with pre-embedded parts which shall be embedded during the concrete construction of main structure with exact position; other reliable connection measures shall be adopted when connection with pre-embedded parts is not practicable, and tests shall be performed to determine its load-carrying capacity.

5.5.5 The load-carrying pre-embedded parts comprised of anchorage slab and anchor bars configured symmetrically may be designed according to the provisions in Appendix C in this code.

5.5.6 Pre-embedded slab and other connection measures of channel type pre-embedded parts shall be designed according to the relevant provisions in current national standard "Code for Design of Steel Structures" GB 50017, and tests shall be performed to determine its load-carrying capacity.

5.5.6 When the frame of glass curtain wall is connected to main structure with post connection of anchor bolts, the following provisions shall be complied with:

- 1** There shall be factory certificate of qualification for products;
- 2** The carbon steel anchor bolts shall be treated with anti-corrosive measure.
- 3** Field test for load-carrying capacity shall be performed, and ultimate tensile test shall be performed if necessary;
- 4** The number of anchor bolts in each connection joint shall not be less than 2;

5 The diameter of anchor bolt shall be determined by load-carrying capacity calculation, which shall not be less than 10 mm;

6 Weld operation should not be performed to the connection parts which contact with chemical anchor bolts;

7 Design value of load-carrying capacity of anchor bolt shall not be larger than 50 % of its ultimate load-carrying capacity.

5.5.8 When curtain wall is connected to masonry structure, concrete or steel structural beam or column should be set on the main structure in connection region. Lightweight filler wall shall not be taken as the supporting structure for curtain wall.

5.6 Design of Structural Silicone Sealant

5.6.1 The adhibited width of structural silicone sealant shall meet the requirements stipulated in article 5.6.3 or article 5.6.4 in this code, which shall not be less than 7 mm; its adhesive thickness shall meet the requirements stipulated in article 5.6.5, which shall not be less than 6 mm. For structural silicone sealant, the adhesive width should be larger than the thickness, but not larger than 2 times of the thickness. The adhesive thickness of structural silicone sealant of hidden frame supported glass curtain wall shall not be larger than 12 mm.

5.6.2 Computation on ultimate limit state of load-carrying capacity shall be performed for structural silicone sealant according to different load conditions. Design value of tensile stress and shear stress of structural silicone sealant shall not be larger than design value of strength f_1 which shall be taken as 0.2 N/mm², under the action of wind load, horizontal earthquake. Design value of tensile stress and shear stress of structural silicone sealant shall not be larger than the design value of strength f_2 , which shall be taken as 0.01 N/mm², under the action of permanent load.

5.6.3 The adhesive width c_s of structural silicone sealant between glass and aluminum frame in vertically hidden, semi-hidden frame supported glass curtain wall shall be calculated according to the following provisions in different conditions. In non-seismic design, it shall be taken as the larger one of the calculation results in item 1 and item 3; in seismic design, it shall be taken as the larger one of the calculation results in item 2 and item 3.

1 Under the action of wind load, adhesive width c_s shall be calculated according to the following formula:

$$c_s = \frac{wa}{2000f_1} \quad (5.6.3-1)$$

where

7 Structural Design of Full Glass Curtain Wall

7.1 General Requirement

7.1.1 Full glass curtain wall in which the height of glass exceeds the limit values in Table 7.1.1 shall be suspended from main structure.

Table 7.1.1 Maximum Height of Bottom-supported Full Glass Curtain Wall

Glass thickness (mm)	10, 12	15	19
Maxim height (m)	4	5	6

7.1.2 The clearance between the wall of peripheral-closing groove and glass panel or glass rib should not be less than 8 mm, the clearance between lower end of suspended glass and groove bottom shall meet the requirement of extension deformation of glass. Resilient pad block shall be adopted for supporting or filling between glass and groove bottom, and the length of pad block should not be less than 100 mm, the thickness should not be less than 10 mm; structural silicone sealant shall be adopted for sealing between groove wall and glass.

7.1.3 Main structure or structural element which suspends the full glass curtain wall shall have adequate stiffness, when steel truss or steel beam is taken as bearing element, the limit value of deflection $d_{f,lim}$ should be taken as the 1/250 of the span.

7.1.4 Rigid device for horizontal force transmission shall be set between hanging clamp of suspended full glass curtain wall and main structure.

7.1.5 Structural glazing sealant joint should not individually bear the self-weight of glass.

7.1.6 The surface of panel in full glass curtain wall shall not be contact directly with other rigid materials. Clearance between panel surface and decoration surface or structural surface shall not be less than 8mm, which shall be sealed with sealant.

7.1.7 Hanging clamp shall meet the requirements of relevant provisions in current professional standard "The Support Device of Suspended Glass Curtain Wall" JG 139.

7.1.8 The glass in point-supported glass curtain wall shall meet the requirements stipulated in article 4.4.2 and article 4.4.3 in this code.

7.2 Panel

7.2.1 The thickness of panel glass should not be less than 10 mm; the thickness of single sheet of laminated glass shall not be 8 mm.

7.2.2 When panel glass is connected with glass rib by sealant joint, panel may be

$$d_l = \frac{5}{32} \times \frac{w_k l h^4}{E t h_t^3} \quad (\text{single-rib}) \quad (7.3.3-1)$$

$$d_l = \frac{5}{64} \times \frac{w_k l h^4}{E t h_t^3} \quad (\text{double-rib}) \quad (7.3.3-2)$$

Where w_k — Characteristic value of wind load (N/mm²);

E — Modulus of elasticity of glass (N/mm²).

7.3.4 Under the action of characteristic value of wind load, the limit value of deflection for glass rib $d_{f,lim}$ should be taken as 1/200 of the calculation span.

7.3.4 For glass ribs that are connected with metal parts, the thickness of metal connection parts shall not be less than 6mm. Stainless bolts should be adopted for connection bolts, of which the diameter shall not be less than 8 mm.

7.3.5 Connection joint shall be capable to bear design value of bending moment and shear force of cross section.

Shearing calculation for bolts and compression calculation for wall of glass hole shall be performed, and design value of strength of lateral face shall be taken in checking computation for glass.

7.3.6 The equivalent section thickness of laminated glass rib may be taken as the sum of thickness of two glass sheets.

7.3.7 Out-plane stability should be considered for glass ribs with a height larger than 8 m; Checking computation of out-plane stability shall be performed for glass rib with a height larger than 12 m, and detail measures shall be taken to prevent lateral buckling.

7.4 Sealant Joint

7.4.1 For full glass curtain wall in which sealant joint transfers force, structural silicone sealant must be adopted as sealant joint.

7.4.2 Load-carrying capacity of sealant joint in full glass curtain wall shall meet the requirements stipulated in the following:

1 For rib which is flush with or projecting to glass panel:

$$\frac{q l}{2 t_1} \leq f_1 \quad (7.4.2-1)$$

2 For back-positioning or joint-riding glass rib:

8 Structural Design of Point-supported Glass Curtain Wall

8.1 Glass Panel

8.1.1 Quadrilateral glass panel may be supported on four points, or may be supported on six points with basis. Triangular glass panel may be supported on three points. The distance between the edge of supporting hole of glass panel and the edge of panel should not be less than 70 mm.

8.1.2 The thickness of curtain wall glass that is connected with connection parts of floating head type shall not be less than 6 mm; the thickness of curtain wall glass which is connected with countersunk connection parts shall not be less than 8 mm.

The thickness of single sheet of laminated glass and insulating glass with connection parts shall meet the requirements stated above.

8.1.3 Width of clearance between glass shall not be less than 10 mm, and the clearance shall be sealed with weather proofing silicone sealant.

8.1.4 The circumference of supporting hole in point-supported glass shall be reliably sealed. When insulating glass is adopted as point-supported glass, multiple sealing measures shall be adopted on the circumference of supporting hole.

8.1.5 Under the action of wind load and earthquake normal to the plane of curtain wall, the stress and deflection of glass panels supported on four points shall meet the requirements stipulated in the following:

- 1** The characteristic value of maximum stress and maximum deflection may be calculated according to FEA method in which geometric nonlinearity is considered, and may also be calculated according to the following formula:

standard "The Support Device of Point Supported Glass Curtain Wall" JG 138.

8.2.2 Supporting head shall be capable to accommodate the rotational deformation of glass panel at the supporting point.

8.2.3 Gasket or bush of resilient materials should be set between steel and glass of supporting head, the thickness of gasket and bush should not be less than 1mm.

8.2.4 Supporting device shall not be used for other purposes, except to bear the load or action transferred from glass panel.

8.3 Supporting Structure

8.3.1 The supporting device in point-supported glass curtain wall should be calculated individually, glass panel should not be part of supporting structure.

FEA method should be taken for calculation and analysis of complicated supporting structure.

8.3.2 Glass rib may be designed according to the provisions in section 7.3 in this code.

8.3.3 The design of supporting steel structure shall meet the requirements of relevant provisions in current national standard "Code for Design of Steel Structures" GB 50017.

8.3.4 When single shaped steel or steel tube is used as supporting structure, the following provisions shall be complied with:

1The connection detail between end and main structure shall be capable to accommodate the displacement of main structure;

2Vertical elements should be designed as per eccentrically compressive element or eccentrically tensile element; horizontal elements should be design as per bi-directional bending element, and the adverse effect of torsion moment shall be considered when element is under the action of torsion moment;

3Slenderness ratio of compressive element shall not be larger than 150;

4Under the action of characteristic value of wind load, the limit value of deflection should be taken as 1/250 of the span. The span of cantilever elements may be taken as two times of the projecting length during calculation.

8.3.5 The design of truss or open-web truss shall meet the following provisions:

1Shaped steel or steel tube may be adopted as the element. Elements should be welded directly at the joint when steel tubes are used, and holes should not be made in chord element, bracing element should not penetrate in chord element;

- 2 The diameter should not be larger than 50 times the wall thickness for steel tubes, the outer diameter of bracing element should not be less than 0.3 times that of chord element. The wall thickness of steel tube should not be less than 4 mm, the wall thickness of chord element shall not be less than that of bracing element;
- 3 Elements of truss should not be connected eccentrically. The angle between web elements, chord element and web element should not be less than 30 degrees;
- 4 Welded steel tube truss should be calculated as per rigid joint system, welded steel tube open-web truss shall be calculated as per rigid joint system;
- 5 For axial compressive or eccentrically compressive elements of truss, the slenderness ratio shall not be larger than 150; for axial tensile or eccentrically tensile elements of truss, the slenderness ratio shall not be larger than 350;
- 6 When the out-plane stationary supporting points of truss or open-web truss are far from each other, stable supporting structure in the orthogonal direction shall be set;
- 7 Under the action of characteristic value of wind load, the limit value of deflection $d_{f,lim}$ be taken as 1/250 of the span. The span of cantilever truss may be taken as two times of the projecting length during calculation.

8.3.6 The design of tensile strut-cable system shall meet the requirements of the following provisions:

- 1 Stable structural system which bears the action of wind load or earthquake shall form in both positive and negative directions. In the orthogonal direction of the main load-bearing direction, tensile rod, cable or truss for stability shall be set if necessary;
- 2 For connection part, compressive rod and tensile rod, stainless steel material should be adopted, the diameter of tensile rod should not be less than 10 mm; for compressive rod in self-balanced system, carbon structural steel may be adopted. For cable, stainless strand, high-strength strand should be adopted, and aluminum-coated strand may be adopted. The diameter of steel wire of strand should not be less than 1.2 mm, the diameter of strand should not be less than 8 mm. The surface shall be treated with anti-corrosive coating when high-strength strand is adopted;
- 3 Geometric nonlinearity should be considered in structural mechanical analysis;
- 4 The region connected with main structure shall be capable to accommodate the displacement of main structure, main structure shall be capable to bear the pre-tensile force and load action of tensile-rod system or tensile-cable system;

- 5**The slenderness ratio A of compressive element in self-balanced system, strut-cable system shall not be larger than 150;
- 6**Tensile rod should not be welded; cable may be connected with cold-squeezed anchorage, cable shall not be welded;
- 7**Under the action of characteristic value of wind load, the limit value of deflection $d_{f,lim}$ should be taken as 1/200 of the distance between supporting points.
- 8.3.7** The minimum value of pre-tensile force of tensile strut-cable system shall make the tensile rod or cable maintain definite pre-tensile force reservation under the action of design value of load.

9 Fabrication

9.1 General Requirement

9.1.1 Before Fabrication, glass curtain wall shall be checked with construction drawings of civil design, repeating survey shall be performed to the built main structure, and necessary adjustment shall be taken for design of glass curtain wall according to the survey result.

9.1.2 The equipment and tools used for processing of glass curtain wall shall meet the requirements of processing precision standard, and measuring certification shall be carried out to the measuring tools periodically.

9.1.3 When structural silicone sealant is adopted for cementation and fixation of hidden frame supported glass curtain wall, filling of sealant shall be performed in clean and ventilate building interior, and the condition of circumstance temperature and humidity shall meet the requirements of provisions for structural glazing sealant product. The width and thickness of filling sealant shall meet the design requirements.

9.1.4 The perfusion of structural silicone sealant shall not be performed on site, except for full glass curtain wall.

9.1.5 Components of unit of frame supported curtain wall assembled in prefabricated units, assembly components of hidden frame supported curtain wall shall both be processed and assembled in factory.

9.1.6 Fabrication technique for low radiation coated glass shall be determined according to the adhesive performance and other technical requirements; when the coat is incompatible with structural silicone sealant, the coat shall be removed.

9.1.7 Structural silicone sealant should not be adopted as weather proofing silicone sealant.

9.2 Aluminum Profiles

9.2.1 Fabrication of aluminum alloy elements for glass curtain wall shall meet the following requirements:

1 Before blanking, aluminum alloy profiles shall be treated with alignment adjustment;

2 Allowable deviation of length of transom is ± 0.5 mm, allowable deviation of length of mullion is ± 0.1 mm, Allowable deviation of inclined angle at the end is $-15'$ (Fig. 9.2.1-1, 9.2.1-2);

1 Stretch bending equipment should be used for bending processing of aluminum alloy elements.

2 The surface of elements after bending processing shall be smooth, and shall not be corrugated, concavo-convex and cracked.

9.3 Steel Element

9.3.1 Fabrication precision of flat-plate pre-embedded part shall meet the following requirements:

1 Allowable deviation of side length for anchor slab is ± 5 mm;

2 Allowable deviation of common anchor bar is $+10$, allowable deviation of length of anchor bar in penetration pre-embedded part of which two surfaces are whole anchor slabs is $+5$, and negative deviation is not permissible;

3 Allowable deviation of center line of circular-sectioned anchor bar is ± 5 mm;

4 Allowable deviation of perpendicularity between anchor bar and surface of anchor slab is $l_s/30$ (l_s is the length of anchor bar, with unit of mm).

9.3.2 The surface and interior of groove of groove-type pre-embedded part shall be treated with anti-corrosive measure, and processing precision shall meet the following requirements:

1 Allowable deviations of the length, width and thickness of pre-embedded part are $+10$ mm, $+5$ mm and $+3$ mm respectively, and negative deviation is not permissible;

2 Allowable deviation of groove is $+1.5$ mm, and negative deviation is not permissible;

3 Allowable deviations of the length of anchor bar is $+5$ mm, and negative deviation is not permissible;

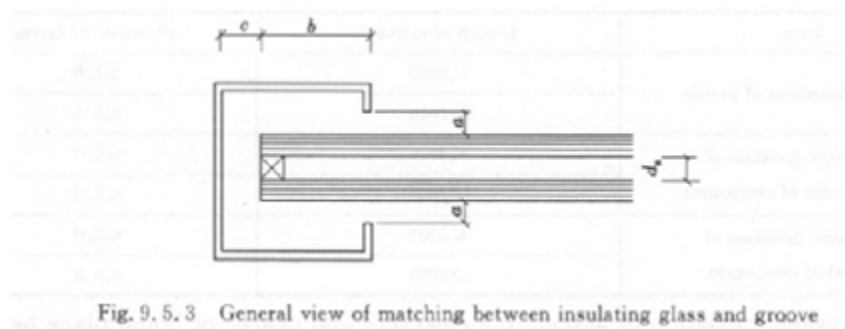
4 Allowable deviation of center line of anchor bar is $+1.5$ mm;

5 Allowable deviation of perpendicularity between anchor bar and surface of groove slab is $l_s/30$ (l_s is the length of anchor bar, with unit of mm).

9.3.3 Fabrication precision of connection parts, supporting parts of glass curtain wall shall meet the following requirements:

1 The appearance of connection parts, supporting parts shall be flat, without defects such as crack, burr, irregularity, warp, deformation, etc.;

2 Allowable deviation of processing dimensions of connection parts, supporting



9.5.4 The arrangement of gas-guide hole and drainage hole of component of exposed frame supported glass curtain wall shall meet the design requirements, smoothness of gas-guide hole and drainage hole shall be ensured during assembly.

9.5.5 Components of exposed frame supported curtain wall shall be assembled tightly. Structural silicone sealant shall be adopted for sealing when sealing is required in design.

9.5.6 During the assembly of exposed frame supported curtain wall, measures shall be taken to control the clearance between glass and aluminum alloy frame. The bottom edge of glass shall be supported with two press formed neoprene pad blocks, of which the dimension shall meet the requirements in article 4.3.11 in this code.

9.6 Components of Hidden Frame Supported Glass Curtain Wall

9.6.1 Cleaning of glass panel and aluminum frame in semi-hidden, hidden frame supported curtain wall shall meet the following requirements:

- 1 Dust, grease stain and other smudge on cementation surface between glass and aluminum frame shall be cleared with duster cloth containing solvent and dry duster cloth;
- 2 Adhesive shall be filled within one hour after cleaning; it shall be re-cleaned if contaminated again before filing adhesive;
- 3 Renewal of clean dry duster cloth shall be done every time a new component or glass is ready to be cleaned.

9.6.2 When solvent is used in cleaning, the following requirements shall be complied with:

- 1 Duster cloth shall not be immersed in solvent; solvent shall be poured to duster cloth;
- 2 Clean container shall be used for the use and storage of solvent;
- 3 Fire is prohibited in the place where solvent is used;

10 Construction

10.1 General Requirement

10.1.1 Main structure construction for glass curtain wall shall meet the requirements stipulated in relevant standard of acceptance of structural construction quality.

10.1.2 The material types, specifications, colors and characteristics of elements and accessories of glass curtain wall on site for installation shall meet the design requirements.

10.1.3 Construction management planning shall be programmed individually for the Construction of glass curtain wall, and the following items shall be included:

- 1 Project schedule plan;
- 2 Coordination schemes matching the construction, equipment installation, decoration and fitment of main structure;
- 3 Transportation and hoisting method;
- 4 Measuring method;
- 5 Installation method;
- 6 Installation sequence;
- 7 Field protection method for elements, components and finished products;
- 8 Inspection and Acceptance;
- 9 Safety measures.

10.1.4 Construction management planning for frame supported glass curtain wall assembled in prefabricated units shall also include the following items:

- 1 The type of hoisting equipment and moving method for hoisting equipment, methods and equipment for vertical transportation and horizontal transportation on floor;
- 2 Position of units for closing-up, technique for closing-up and operating method;
- 3 Hoisting sequence for components of units, methods and measures of hoisting, adjusting, positioning and fixing;
- 4 Construction management planning of curtain wall shall link with that of main

qualifications needed for construction of curtain wall.

10.2.2 Elements shall be laid in sequence in storage, storage shelf shall have enough load-carrying capacity and stiffness. Protective measures shall be taken when elements are stored outdoors.

10.2.3 Pre-embedded parts that connect glass curtain wall and main structure shall be embedded according to the design requirement before construction of main structure; the position deviation of pre-embedded parts shall not be larger than 20 mm.

10.2.4 When the position deviation of pre-embedded parts is overlarge or pre-embedded parts are not set, remedial measures or scheme of reliable connection shall be made, which can be implemented only with the agreement of employer and civil design organization after consultation.

10.2.5 When the construction deviation of main structure impedes the Construction of curtain wall, corresponding measures shall be taken after consultation with employer and civil construction organization, which shall be implemented before the installation of curtain wall.

10.2.6 For curtain wall in which new material, new structures are adopted, prototypes should be fabricated on site, and Construction can be carried out after approval of employer, supervisor, and civil design organization.

10.2.7 Inspection and correction shall be performed before the installation of elements. Unqualified elements must not be used for installation.

10.3 Frame Supported Glass Curtain Wall Assembled in Elements

10.3.1 The installation of mullion of glass curtain wall shall meet the following requirements:

- 1**The deviation of installation axes of mullions shall not be larger than 2 mm;
- 2**The deviation of installation height marks between adjacent mullions shall not be larger than 3 mm, the maximum deviation of installation height marks of mullions in the same floor shall not be larger than 5 mm; the deviation of distance between fixing points of two adjacent mullions shall not be larger than 2 mm;
- 3**Mullions shall be fastened in time after positioning and adjusting.

10.3.2 The installation of transom of glass curtain wall shall meet the following requirements:

- 1**Transom shall be installed firmly, when there is clearance between transom and mullion in design, the width of clearance shall meet the design requirements;

2The deviation of horizontal height marks of two ends of the same transom or two adjacent transoms shall not be larger than 1 mm. The deviation of height marks in the same floor: when the width of the curtain wall is not larger than 35 m, it shall not be larger than 5 m; when the width of the curtain wall is larger than 35 m, it shall not be larger than 7 m;

3Inspection, adjusting and fixing shall be performed in time after installation of one story height is complete.

10.3.3 The installation of other main accessories of glass curtain wall shall meet the following requirements:

1Fire-resistant material and thermal isolated material shall be laid flatly and fixed firmly, without clearance in the joining region;

2Condensate draining pipe and its accessory shall be connected tightly with pre-retained holes of horizontal elements, the connection region with outflow holes of inner board shall be sealed;

3Other air slotted hole and rain drainage hole shall be constructed according to the design requirements, and shall not be omitted;

4Closing treatment shall be taken for sealing according to the design requirements;

5Temporary bolts used in the installation of glass curtain wall shall be removed in time after the fastening of elements;

6Elements which are welded on site or fastened with high-strength bolts, shall be treated with rust prevention measures in time after fastened.

10.3.4 The installation of glass curtain wall shall be implemented according to the following requirements:

1Cleaning of surfaces shall be performed before the installation of glass. For single sheet solar controlled coated glass, the surface with coating shall face interior, and the surface without coating shall face exterior, except the condition of other design requirements;

2Rubber strip around glass shall be selected according to specified types, its length should be 1.5 % ~ 2 % larger than that of inner rabbet of outer frame; rubber strip shall be jointed to redefined design angle after cut in inclined plane, and shall be adhered firmly with adhesive; the inlaying shall be flat and smooth.

10.3.5 Aluminum alloy decorative press plates installed shall be surface-flat, uniform in color, the joint shall be homogeneous and tight.

10.3.6 Sealing of structural silicone sealant should not be carried out at night or in raining day, temperature for sealing shall meet the design and product requirements, the surface for sealing shall be clean and dry before sealing.

10.3.7 The construction of weather proofing silicone sealant in frame supported glass curtain wall assembled in elements shall meet the following requirements:

1 Construction thickness of weather proofing silicone sealant shall be larger than 3.5 mm, the construction width should not be less than 2 times of construction thickness; the bottom of some deep sealing rabbet shall be plugged with polyethylene foam material;

2 Weather proofing silicone sealant shall be used to cement two opposite faces, and not to cement three faces.

10.4 Frame Supported Glass Curtain Wall Assembled in Fabricated Units

10.4.1 Preparation of unit hoisting equipment shall meet the following requirements:

1 Proper hoisting equipment shall be selected according to unit plates, which shall be installed firmly on main structure;

2 Before the usage, overall quality and safety inspection shall be performed to hoisting equipment;

3 Hoisting equipment shall be designed to avoid horizontal force component between itself and unit plate;

4 The operating velocity of hoisting equipment shall be controllable, and safety measures shall be taken;

5 Measures shall be taken for hoisting equipment to prevent the swinging of unit plate.

10.4.2 The transportation of unit components shall meet the following requirements:

1 Before transportation unit plates shall be numbered in sequence, and finished products shall be protected;

2 During the processes of loading, unloading and transportation, transfer shelf with adequate load-carrying capacity and stiffness shall be adopted, resilient pad shall be used, and make sure that panels are separated reciprocally and fixed relatively, with no extrusion with each other and dislocation;

3 Special measures shall be taken for unit plates of which the dimension exceeds the allowable value of transportation;

trial hoisting shall be carried out;

3 Steel structure shall be fastened in time after the positioning and adjusting, and acceptance for concealed work shall be carried out;

4 The connection regions for installation where the coat of steel elements is damaged during transportation, storage and installation or coating is not conducted, shall be coated for complement according to current national standard "Code for Acceptance of Construction Quality of Steel Structures" GB 50205.

10.6.2 In tensile strut-cable system, the applying of pre-tension force of tensile rod and cable shall meet the following requirements:

1 When the steel tensile rods and steel cables are installed, pre-tension force must be applied according to the design requirements, and adjusting device for pre-tension force should be set; pre-tension force should be measured with dynamometer. When torque spanner is used to apply pre-tension force, calibration shall be performed beforehand;

2 Tensile force shall be taken as the controlling parameter in the applying of pretension force; fractionated, batched symmetrical stretching shall be performed for applying the pre-tension force of tensile rod and cable; in the stretching, adjustments shall be made for the pre-tension force of tensile rods and cables at all time;

3 Full inspection shall be performed to elements and anchorages before stretching, and notice for stretching shall be issued. In notice for stretching, the date for stretching, the number of batched stretching, the controlling fore in each stretching, equipment for stretching, force-measuring device, safety measures applied and matters for attention are included;

4 Stretching record shall be established;

5 Construction temperature shall be considered for the actual applied value of pretension force in tensile rods and cables.

10.6.3 The deviation for installation of elements of supporting device shall meet the requirements in Table 10.6.3.

10.6.4 Before the installation of spider linking part, its installed position shall be determined accurately. The allowable deviation for installation of spider linking part shall meet the requirements stipulated in Table 10.6.3 in this code.

10.6.5 The installation quality of panels of point-supported glass curtain wall shall meet the requirements of relevant provisions in Table 10.5.6 in this code.

11 Project Acceptance

11.1 General Requirement

11.1.1 The surfaces shall be cleaned before the acceptance of glass curtain wall project.

11.1.2 The following materials shall be submitted in the acceptance of glass curtain wall:

- 1** As-built drawings or construction drawings, structural calculation document, design alteration document and other design document of curtain wall project;
- 2** The certification of product qualification, performance inspection report, site acceptance record and acceptance report for types of materials, accessories, fasteners, elements and components in curtain wall project;
- 3** Commodity inspection certification for imported structural silicone adhesive; compatibility and bonding failure and cementation test report formed by national authorized testing organization;
- 4** Field pull-out performance test report for post-embedded parts;
- 5** The inspection report for performances of deformation under wind pressure, air-tightness, water-tightness and other performance inspection reports;
- 6** Records of ambient temperature and humidity for sealing and curing; Mixedness property test record and tension failure test for structural silicone sealant with two constituents;
- 7** Testing record for lightning prevention device;
- 8** Documents of acceptance of concealed work;
- 9** Record for Fabrication of elements and components of curtain wall; Record for Construction of curtain wall;
- 10** Record for stretching of pre-tension force of tensile strut-cable system;
- 11** Record for rain-shower test;
- 12** Other quality guarantee materials.

11.1.3 Before the acceptance of glass curtain wall project, the field acceptance of following concealed items shall be finished in Construction:

- 1 Pre-embedded parts or post-installed bolt connection parts;
- 2 The connection joints of elements and main structure;
- 3 The plugging between circumference, inner surface of curtain wall and main structure;
- 4 Expansion joint, settlement joint, isolation joint of curtain wall and corner joint of wall surface;
- 5 Fixation of hidden frame glass panels;
- 6 Connection joints of lightning resistance of curtain wall;
- 7 Joints of fire prevention, smoke insulation of curtain wall;
- 8 Closing-up joint of frame supported curtain wall assembled in prefabricating units.

11.1.4 Appearance inspection and sampling inspection shall be performed for quality inspection of glass curtain wall project, the inspection lots shall be determined according to the following requirements, each glass curtain wall shall be inspected.

- 1 For Glass Curtain Wall engineering with the same design, material, technique and construction condition, every area of 500 ~ 1000 m² shall be taken as one inspection lot, area less than 500 m² shall be taken as one inspection lot. At least one place which shall not be less than 10 m², shall be spot checked in each 100 m² of every inspection lot;
- 2 The discontinuous curtain wall projects in one identical unit of project, shall be divided into inspection lots individually;
- 3 For curtain wall with irregular shape or special requirements, the dividing of inspection lots shall be determined by the consultation of supervision organization, development organization and construction organization according to the characteristics of structure and technique of curtain wall and the scale of curtain wall project.

11.2 Frame Supported Glass Curtain Wall

11.2.1 Appearance inspection of glass curtain wall shall meet the following requirements:

- 1 The frame of exposed frame supported curtain wall shall be horizontal or vertical; the unit joint of frame supported curtain wall assembled in prefabricating units, or glass joint of division grid of hidden frame supported curtain wall shall be horizontal or vertical, with uniform width, and meet the design requirements;

be larger than 1 mm.

11.3.3 The clearance between glass and embedded groove shall meet the design requirements, the filling of sealant shall be homogeneous, compact and continuous.

11.3.4 The clearance between glass and surrounding structure or decoration shall not be less than 8 mm, sealant joint shall be homogeneous, compact and continuous.

11.4 Point-supported Glass Curtain Wall

11.4.1 The frontal face of glass curtain wall shall be flat, sealant joint shall be horizontal or vertical with uniform width and smooth surface. The weld of steel structure shall be smooth, anti-corrosive coat shall be homogeneous without damage. Glossiness of stainless steel element shall be consistent with design, and rusty spot is not allowed.

11.4.2 The acceptance of steel structure shall meet the requirements stipulated in current national standard "Code for Acceptance of Construction Quality of Steel Structures" GB 50205.

11.4.3 The pre-tension force of tensile rod and cable shall meet the design requirements.

11.4.4 The allowable installation deviation of point-supported glass curtain wall shall meet the requirements stipulated in Table 11.4.4.

11.4.5 The installation deviation of steel spider linking part shall meet the following requirements:

- 1 Installation deviations for horizontal distance and vertical distance between adjacent steel spider linking parts is;
- 2 Allowable height deviation of steel spider linking parts of the same floor shall meet the requirements stipulated in Table 11.4.5.

12 Maintenance and Repair

12.1 General Requirement

12.1.1 In acceptance for completion of curtain wall project, contractor shall provide employer with "Instruction manual for operation of curtain wall", which shall comprise the following contents:

- 1** Design basis for curtain wall, main performance parameters and design service life of curtain wall structure;
- 2** Matters need attention in service;
- 3** Influence of variation of environment condition on curtain wall project;
- 4** Requirements for daily and regular maintenance;
- 5** Main structural characteristics of curtain wall and method of replacing for wearing part;
- 6** List for spare materials and parts and names, specification of main wearing parts;
- 7** Responsibility of contractor for maintenance guarantee.

12.1.2 Before the curtain wall being taken over by the employer, contractor shall train staff of repair and maintenance of curtain wall for employer.

12.1.3 After the works being taken over, the employer shall establish plan and system of repair and maintenance for curtain wall in time according to relevant requirements in "Instruction manual for operation of curtain wall".

12.1.4 Under weather condition of raining day or with wind scale larger than 4 opening windows should not be used; when wind scale is larger than 6, opening windows shall be all closed.

12.1.5 Works of inspection, cleaning, maintenance and repair for outer surface of curtain wall shall not be carried out under weather condition with wind scale larger than 4 and heavy rain (snow).

12.1.6 Working machines and tools (lifting device, window wiper, hanging basket, etc.) used for works of inspection, cleaning, maintenance and repair for outer surface of curtain wall shall be maintained properly, well functioned, convenient in operation, safe and reliable; inspection of safety apparatus shall be performed each time before use, to ensure the safety of equipment and staff.

12.1.7 In works of inspection, cleaning, maintenance and repair for outer surface of

curtain wall, ones which belong to works high above the ground, shall meet the requirements of relevant provisions in current professional standard "Technical Code for Safety of High Altitude Operation of Building Construction" JGJ 80-1991 „

12.2 Inspection and Repair

12.2.1 Daily maintenance shall comply with the following provisions:

- 1** Curtain wall surface shall keep neat and clean, and be refrained from contacting with sharp objects and corrosive gas or liquid;
- 2** Drainage system shall keep smooth, plugging shall be removed in time once detected;
- 3** If phenomena that door or window can not be opened or closed, or accessories damage are found during usage, repair or replacing shall be performed in time;
- 4** When sealants or sealing tapes fall off or damage, they shall be repaired or replaced in time;
- 5** When members of curtain wall are corrupted, rust cleaning and paint complement or other rust resisting measures shall be taken in time;
- 6** When rustiness of the curtain wall component is found, the rust shall be removed and the paint shall be coated, or other proper anti-rust measures shall be adopted.

12.2.2 Periodic inspection and maintenance shall comply with the following provisions:

- 1** At the time of one year after acceptance for completion of curtain wall project, full inspection shall be carried out for curtain wall project, and after that inspection shall be done every 5 years. Items for inspection shall comprise:
 - 1)** If the whole curtain wall has deformation, dislocation or loose, if it does, further inspection shall be performed for concealed structure corresponding to this region; whether main load-carrying members, connection members and connection bolts damage, whether connection is reliable, whether there is rust corrosion, etc.;
 - 2)** Whether glass panels are loose and damaged or not;
 - 3)** Whether there are phenomena that sealant deglues, cracks or bubbles, whether sealing tape falls off and ages;
 - 4)** Whether opening part is opened and closed flexibly, whether hardware accessories have dysfunction or damage, whether installation bolts or screws loose and fail;

5) Whether drainage system of curtain wall is smooth.

2 Inspection items in item 1 which do not meet the requirement shall be repaired or replaced;

3 For curtain wall project with tensile rod or cable structure on which pre-tensile force is exerted, a full inspection and adjustment of pre-tensile force must be carried out at the time of six months after acceptance for completion of project, and after that inspection shall be done every three years;

4 After ten years of service of curtain wall project, sampling inspection for adhesive property shall be carried out for structural silicone sealant in different regions of the project; after that inspection should be done every three years.

12.2.3 Inspection and restoration after hazard shall comply with the following provisions:

1 After curtain wall is hit by strong wind, full inspection shall be carried out in time for curtain wall, to repair or replace damaged members. For curtain wall project with tensile rod or cable structure on which pre-tensile force is exerted, a full inspection and adjustment of pre-tensile force shall be carried out;

2 After curtain wall is suffered from hazards like earthquake, fire, etc., full inspection shall be performed by professional technical staff, and treating scheme shall be established according to damage degree, and be implemented in time.

12.3 Cleaning

12.3.1 Proprietor shall determine the cleaning frequency according to the degree of dust deposition and contamination, but it shall not be less than once a year.

12.3.2 In cleaning of curtain wall, cleaning solution shall be selected according to the requirements in "Instruction manual for operation of curtain wall".

12.3.3 It is not allowed to collide with or damage curtain wall during cleaning.

Explanation of Wording in This Code

1 Words used for different degrees of strictness are explained as follows in order to mark the differences in executing the requirements in this code:

1) Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation; "must not" for negation.

2) Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation; "shall not" for negation.

3) Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit:

"Should" is used for affirmation; "should not" for negation.

"May" is used to express the option available, sometimes with the conditional permit.

2 "Shall comply with..." or "shall meet the requirements of..." is used in this code to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

_____ **END** _____

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