Foreword

According to the requirements of Document Jian Biao [2013]No. 169 issued by Ministry of Construction (MoC)——"Notice on Printing the Development and Revision Plan of National Engineering Construction Standards in 2014". The drafting committee, after conducting extensive investigation and research, summarizing practical experience carefully, referring to international standard and foreign advanced standard, has revised the standard on the basis of soliciting opinions extensively.

The main technical contents of the standard include: 1. General Provisions; 2. Terms and Symbols; 3. Ice and Snow Material Calculation Indicators; 4. Design of Ice and Snow Landscape Buildings; 5. Construction of Ice and Snow Landscape Buildings; 6. Construction of Power Distribution and Illumination; 7. Acceptance Check; 8. Maintenance Management.

The provisions in bold type in the standard are compulsory and must be implemented strictly.

The Ministry of Housing and Urban-Rural Development of the People's Republic of China is responsible for the management and interpretation of the compulsory provisions of the standard; Harbin Architectural Designing Institute is responsible for the explanation of the specific technical provisions. For any comments and suggestions in the course of implementation, please contact Harbin Architectural Designing Institute (Address: No. 117 Youyi Road, Daoli District, Harbin, Postcode: 150010).

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Contents

1 General Provisions

1.0.1 The standard B formulated for the purpose of improving the level of design, construction, inspection, maintenance and management of ice and snow landscape buildings and guaranteeing advanced technology, safety, reliability, energy conservation, environmental protection to ensure the acceptable engineering quality.

1.0.2 The standard B applicable to the design, construction, acceptance, maintenance and management of ice and snow landscape buildings with ice and snow as the main building materials.

1.0.3 The design, construction, acceptance, maintenance and management of ice and snow landscape shall comply with the standard and also the provisions of current national standard.

2 Terms and Symbols

2.1 Terms

2.1.1 Ice and snow landscape buildings

The recreational facilities and artistic landscapes with ice and snow artistic features such as ice lanterns, snow sculptures, ice sculptures and ice and snow architectures.

2.1.2 Natural ice

The ice that is naturally formed in rivers and lakes in low temperature environment.

2.1.3 Man-made ice

The ice that is formed under the artificial refrigeration conditions.

2.1.4 Rough ice

Natural ice that has not been cut purposefully.

2.1.5 Ice collecting

The process of using machines to cut apart the natural ice with certain standard, and obtain rough ice.

2.1.6 Ice masonry

Elements like walls and columns used for ice landscape buildings that are made by laying ice blocks by standard and freezing them with water.

2.1.7 Watered icescape

Ice scenery that is made bymechanically or manually spraying water on the skeletons with certain shapes and freezing them.

2.1.8 Ice flowers

The icescape in which plants, flowers, fruits, fishes or insects are frozen by putting them in a mold that is full of water.

2.1.9 Ice sculpture

A sculpture that is made of ice.

2.1.10 Ice lanterns

The icescape with artistic effects made by carving hollow ice masonry, which is created by injecting water into molds or containers using artificial refrigeration and subsequently putting lights into the lantern.

2.1.11 Natural snow

Natural snowor perennial snows in nature.

2.1.12 Man-made snow

Tiny ice crystals that are made of water using special equipment in a low temperature, or tiny ice particles made of ice shattered with special equipment.

2.1.13 Snow sculpture

A sculpture that is made of snow.

2.1.14 Rough snow masonry

Geometric shapes of compacted snow with certainstandard and strength.

2.1.15 Height of ice or snow sculpture buildings

The height from the outdoor ground to the top of ice masonries or snow masonries of ice and snow landscape buildings.

2.2 Symbols

2.2.1 Material performance

f — an ice or snow masonry's design value of compressive strength;

f_t — an ice or snow masonry's design value of axial tensile strength;

f_{tm} — an ice masonry's design value of bending tensile strength;

f_v — an ice masonry or snow masonry's design value of shearing strength;

f_w — a snow masonry's design value of bending tensile strength.

2.2.2 Actions and its effects

M — design value of cross section bending moment;

N — design value of the axial pressure;

N_L — design value of axial force in a local compression area;

N_t — design value of axial tension;

V — the design value of cross section shearing force.

2.2.3 Geometric parameters

A — cross-sectional area of a member;

A_L — local compression area;

H — height of a member;

H_0 — calculated height of a wall or column;

h — thickness of walls or short side length of rectangular columns;

S — spacing between transverse walls;

W — sectional resistance moment of a member.

2.2.4 Calculating coefficient

φ — the effect-coefficient of bearing capacity;

β — ratio of height to sectional thickness of walls or columns;

$[\beta]$ — permissible ratio of height to sectional thickness of walls or columns.

3 Ice and Snow Material Calculation Indicators

3.1 Ice Materials

3.1.1 The ultimate values of compressive strength, tensile strength and shearing strength of ice shall follow those shown in Table 3.1.1.

Table 3.1.1 The ultimate values of compressive strength, tensile strength and shearing strength of ice (MPa)

Strength Type	Ice Block Temperature Grading (℃)					
	−5	−10	−15	−20	−25	−30
Compressive strength	2.790	3.090	3.510	4.050	4.710	5.490
Tensile strength	0.108	0.109	0.111	0.114	0.119	0.125
Shearing strength	0.360	0.450	0.550	0.640	0.740	0.830

3.1.2 The standard values of compressive strength, tensile strength and shearing strength of ice masonries shall follow those shown in Table 3.1.2.

Table 3.1.2 The standard values of compressive strength, tensile strength and shearing strength of ice masonries (MPa)

Strength Type	Ice Masonry Temperature Grading (℃)					
	−5	−10	−15	−20	−25	−30
Compressive strength	0.854	0.946	1.075	1.240	1.442	1.681
Tensile strength	0.047	0.047	0.047	0.048	0.049	0.050
Shearing strength	0.078	0.088	0.097	0.105	0.112	0.119

3.1.3 The design values of compressive strength, axial tensile strength and shearing strength of ice masonries shall follow those shown in Table 3.1.3.

Table 3.1.3 The design values of compressive strength, axial tensile strength and shearing strength of ice masonries (MPa)

Strength Type	Characteristics of damage	Ice Masonry Temperature Grading (℃)					
		−5	−10	−15	−20	−25	−30
Compressive strength	Regular masonry section	0.475	0.526	0.597	0.689	0.801	0.934
Axial tensile strength	Along the ice masonry and its saw-tooth joint section	0.026	0.026	0.026	0.027	0.027	0.028
Shearing strength	Along the continuous seam and the saw-tooth joint section	0.043	0.049	0.054	0.058	0.062	0.066

Note: 1 The regular masonries in the table refer to those made by bonding small blocks together with water;
2 The bonding strength of the water between ice blocks is the same as the design value of ice masonries at the same temperature;
3 The strength design value of the branches of battened hollow ice walls shall be taken based on 90% of the value in Table 3.1.3.

3.1.4 The ice friction coefficient, linear expansion coefficient, average density and coefficient of heat transmission of ice shall meet the following requirements:

1 The ice friction coefficient (μ) shall be 0.1;

2 The coefficient of linear expansion (α) shall be 52.7×10^{-6}/K;

3 The ice average density (ρ) shall be 920kg/m^3;

4 The ice heat transmission coefficient (λ) shall be 2.30W/(m·K).

3.2 Snow Materials

3.2.1 The density values of snow masonries shall follow the values in Table 3.2.1.

Table 3.2.1 Density values of snow masonries

Snow Type	Loose Condition	Molding Pressure		
		0.05MPa	0.10MPa	0.15MPa
Man-made snow	455kg/m^3	510kg/m^3	530kg/m^3	550kg/m^3
Natural snow	190kg/m^3	350kg/m^3	390kg/m^3	410kg/m^3

Note: The density values of the snow masonries molded under other pressures shall be obtained with an interpolation method based on the values in the table.

3.2.2 The ultimate value, normal value and design value of compressive strength of snow masonries shall follow those shown in Table 3.2.2.

Table 3.2.2 The ultimate value, normal value and design value of compressive strength of snow masonries (MPa)

Snow Type	Density (kg/m^3)	Category of Values Taken for Compressive Strength	Temperature Grading				
			−10℃	−15℃	−20℃	−25℃	−30℃
Man-made snow	510	Ultimate value	0.369	0.405	0.441	0.487	0.534
		Normal value	0.199	0.218	0.238	0.263	0.288
		Design value	0.105	0.115	0.125	0.138	0.151
	530	Ultimate value	0.535	0.578	0.621	0.729	0.838
		Normal value	0.289	0.312	0.335	0.393	0.452
		Design value	0.152	0.164	0.176	0.207	0.238
	550	Ultimate value	0.701	0.751	0.801	0.971	1.142
		Normal value	0.378	0.405	0.432	0.524	0.616
		Design value	0.199	0.213	0.227	0.276	0.324
Natural snow	350	Ultimate value	0.189	0.236	0.284	0.304	0.324
		Normal value	0.102	0.128	0.153	0.164	0.175
		Design value	0.054	0.067	0.081	0.086	0.092
	390	Ultimate value	0.349	0.402	0.456	0.548	0.640
		Normal value	0.188	0.217	0.246	0.295	0.345
		Design value	0.099	0.114	0.129	0.156	0.182
	410	Ultimate value	0.429	0.485	0.542	0.670	0.798
		Normal value	0.231	0.262	0.292	0.361	0.430
		Design value	0.122	0.138	0.154	0.190	0.226

3.2.3 The ultimate value, normal value and design value of flexural strength of snow masonries shall follow those in Table 3.2.3.

Table 3.2.3 The ultimate value, normal value and design value of flexural strength of snow masonries (MPa)

Snow Type	Density (kg/m³)	Category of Values Taken for Flexural Strength	Temperature Grading				
			−10℃	−15℃	−20℃	−25℃	−30℃
Man-made snow	510	Ultimate value	0.150	0.248	0.346	0.386	0.426
		Normal value	0.076	0.125	0.175	0.196	0.216
		Design value	0.040	0.066	0.092	0.103	0.114
	530	Ultimate value	0.288	0.436	0.584	0.632	0.680
		Normal value	0.146	0.221	0.296	0.320	0.345
		Design value	0.077	0.116	0.156	0.169	0.181
	550	Ultimate value	0.426	0.624	0.822	0.878	0.934
		Normal value	0.216	0.316	0.416	0.445	0.473
		Design value	0.113	0.166	0.219	0.234	0.249
Natural snow	350	Ultimate value	0.147	0.152	0.157	0.160	0.162
		Normal value	0.074	0.077	0.080	0.081	0.082
		Design value	0.039	0.041	0.042	0.043	0.043
	390	Ultimate value	0.223	0.235	0.246	0.255	0.263
		Normal value	0.113	0.119	0.125	0.129	0.133
		Design value	0.059	0.063	0.066	0.068	0.070
	410	Ultimate value	0.389	0.404	0.418	0.422	0.425
		Normal value	0.197	0.204	0.212	0.213	0.215
		Design value	0.104	0.108	0.111	0.112	0.113

3.2.4 The ultimate value, normal value and design value of splitting tensile strength of snow masonries shall follow those in Table 3.2.4.

Table 3.2.4 The ultimate value, normal value and design value of splitting tensile strength of snow masonries (MPa)

Snow Type	Density (kg/m³)	Category of Values Taken for Splitting Tensile Strength	Temperature Grading				
			−10℃	−15℃	−20℃	−25℃	−30℃
Man-made snow	510	Ultimate value	0.093	0.106	0.113	0.120	0.121
		Normal value	0.047	0.054	0.057	0.061	0.061
		Design value	0.025	0.028	0.030	0.032	0.032
	530	Ultimate value	0.146	0.160	0.170	0.182	0.185
		Normal value	0.074	0.081	0.086	0.092	0.094
		Design value	0.039	0.043	0.045	0.049	0.049
	550	Ultimate value	0.194	0.205	0.216	0.228	0.231
		Normal value	0.098	0.104	0.109	0.115	0.117
		Design value	0.052	0.055	0.058	0.061	0.062
Natural snow	350	Ultimate value	0.066	0.071	0.076	0.079	0.081
		Normal value	0.033	0.036	0.038	0.040	0.041
		Design value	0.017	0.019	0.020	0.021	0.022
	390	Ultimate value	0.102	0.108	0.111	0.115	0.118
		Normal value	0.052	0.054	0.056	0.058	0.060
		Design value	0.027	0.029	0.030	0.031	0.031
	410	Ultimate value	0.149	0.162	0.170	0.177	0.183
		Normal value	0.075	0.082	0.086	0.090	0.093
		Design value	0.040	0.043	0.045	0.047	0.049

3.2.5 The ultimate value, normal value and design value of shearing strength of snow masonries shall follow those in Table 3.2.5.

Table 3.2.5 The ultimate value, normal value and design value of shearing strength of snow masonries (MPa)

Snow types	Density (kg/m³)	Category of Values Taken for Shearing Strength	Temperature Grading				
			−10℃	−15℃	−20℃	−25℃	−30℃
Man-made snow	510	Ultimate value	0.268	0.336	0.404	0.472	0.540
		Normal value	0.131	0.165	0.198	0.231	0.265
		Design value	0.066	0.083	0.099	0.116	0.133
	530	Ultimate value	0.362	0.439	0.515	0.587	0.659
		Normal value	0.177	0.215	0.525	0.288	0.323
		Design value	0.089	0.108	0.126	0.144	0.162
	550	Ultimate value	0.515	0.573	0.630	0.688	0.745
		Normal value	0.252	0.281	0.309	0.337	0.365
		Design value	0.162	0.141	0.155	0.169	0.183
Natural snow	350	Ultimate value	0.068	0.070	0.072	0.081	0.089
		Normal value	0.033	0.034	0.035	0.040	0.045
		Design value	0.017	0.017	0.018	0.020	0.023
	390	Ultimate value	0.145	0.164	0.183	0.190	0.196
		Normal value	0.073	0.082	0.090	0.093	0.096
		Design value	0.037	0.041	0.045	0.047	0.048
	410	Ultimate value	0.179	0.190	0.200	0.211	0.221
		Normal value	0.088	0.093	0.098	0.103	0.108
		Design value	0.044	0.047	0.049	0.052	0.054

4 Design of Ice and Snow Landscape Buildings

4.1 General Requirements

4.1.1 The design of ice and snow landscapes shall follow the principles of safety, environmental friendliness, economy and artistry.

4.1.2 The design of ice and snow landscape buildings shall include:

1 Overall design and special design of supporting facilities such as road. electric power, water supply and drainage, communication, etc;

2 The design of the ice and snow landscapes of architecture and art categories;

3 The structural design of ice and snow masonries;

4 The design of ice and snow landscape illuminating;

5 The design of ice and snow activities;

6 The design of supporting facilities for the service of scenic spot such as management, business, sanitation, medical and ambulance;

7 Individual landscape lighting, power distribution, sound design.

4.1.3 The dyes for making colored ice and colored snow shall be environmentally friendly and pollution-free.

4.1.4 Water supply shall meet the needs of the water consumption of ice making, snow making, construction, living, fire-fighting, etc.

4.1.5 The design of the ice and snow landscape buildings shall meet the needs of material utilization, equipment maintenance, construction operations and tourists' activities under cold conditions.

4.2 Scenic Area Planning and Design

4.2.1 The site selection shall follow the following provision:

1 The scenic area shall be reasonably planned and scientifically and conveniently sited, with fresh air, and no dust or smoke pollution, away from residential areas, with comprehensive consideration given to such factors as climate, geology, physiognomy, electrical power, telecommunications, traffic, ice sources, snow making, water sources, etc;

2 The scenic area shall be designed to meet the exhibitive function requirements, with large parking lots available, and be easy for people to gather and evacuate;

3 The site shall facilitate construction and meet the construction safety and environmental protection requirements.

4.2.2 The overall planning for the scenic area shall define the planning programs for major items or overall design thoughts.

4.2.3 The overall planning for the scenic area shall define functional division, transportation system, tour routes, auxiliary projects and corresponding signs. The area occupied by the scenic area shall be determined based on not less than $10m^2$ per tourist at peak hours. The ice and snow consumption, power consumption and investment shall be estimated. The overall planning design achievements shall include the scenic area location map , the present situation diagram; the overall planning diagram; the overall effect drawing; the functional division diagram; the external transport organization planning diagram; scenic area's internal road transport planning diagram, personnel evacuation organization, ice collection location and transport route, location of water source for ice making and snow making, overall lighting and lighting color analysis chart and technical and economic indicators.

4.2.4 The detailed design planning for the scenic area construction shall - according to the overall plan - determine the theme, contents of each functional division, and propose the originality, position, amount of space occupied, function and technical design requirements of each ice and snow landscape. The detailed planning and design result shall include the subdivision planning diagram, the detailed scenic area construction drawings, division effect drawing, vertical design drawing, visual analysis drawing of the scenic area, tour route map, scenic area recreational activity diagram, service facilities and signage system diagram, illumination distribution diagram, background music distribution map, electric power distribution diagram and planning instructions .

4.2.5 Considering the traffic flow and people flow in peak tour hours and static and dynamic traffic organization, the traffic planning shall propose a plan for guiding people flow direction and evacuation, a plan for vehicle parking by category and canalized traffic organization and emergency plan for people and vehicle evacuation in case of sudden incidents, and determine road width, parking lot area and traffic signs.

4.2.6 The scenic area shall be equipped with emergency signs, with emergency evacuation escape and fire escape planned, emergency plan and disaster relief measures taken.

4.2.7 The scenic area shall plan and reserve charging facilities required by electric vehicles.

4.3 Architectural Design

4.3.1 Design of ice and snow landscapes of architecture category shall meet the following requirements:

1 The design shall guarantee the safety and functions of all structures;

2 The scheme design shall include horizontal drawing, vertical drawing, sectional drawing, effect drawing, rough ice and snow masonry drawing, lighting effects and technical and economical indicators; a three-dimensional model, if necessary, shall be established for important landscape buildings;

3 The construction drawing design shall include a site plan, building construction drawing, structure construction drawing, illumination power distribution drawing, and other special item, special design and description, material and equipment statistic list and related safety and technical measures;

4 The inside of the masonry of a massive ice landscape building can be designed to be hollow or filled with rough ice or crushed ice, and then watered layer by layer. The laying thickness of outside ice wall blocks shall be determined by calculation and annotated in the construction drawing.

4.3.2 Structural design shall be done for an ice and snow landscape building which has a height of more than 10m or allows tourists to go inside for activities or has load exposed on top.

4.3.3 The ice staircase shall go through anti-skid treatment, with the width of the steps not less than 350mm, and height not more than 150mm; the stairs shall lean inward, and the relative height difference shall not exceed 10mm. The height of ice handrails of the ice staircases and platforms shall not be less than 1200mm, and the thickness shall not be less than 250mm, with anti-slip warning signs provided.

4.3.4 The height of ice masonry buildings shall not exceed 30m. The height of snow masonry buildings shall not exceed 20m. The ice masonry building whose length exceeds 30m shall preferably have expansion joints whose width is not less than 20mm.

4.3.5 The masonry structures which tourists can directly touch shall be tucked or made into a staircase when their vertical height exceeds 5m. Meanwhile, the following requirements shall be observed:

1 Measures shall be taken against overturn and slippage;

2 The thickness of ice masonries shall not be less than 800mm and be constructed in layers. The cohesion-ratio of the seam shall be no less than 80%;

3 The thickness of snow masonries shall not be less than 900mm and shall be tamped in layers according to the design density value;

4 The distance between the vertical projection of the highest masonry or overhanging part and the outer edge of the landscape's foundation shall be no less than 600mm.

4.3.6 The design of ice and snow landscapes of art category shall comply with the following requirements:

1 Distinct themes and obvious intention and clear framework;

2 Demonstration in an exaggerated way with a prominent overall image. The relationship between the local part and the snow building as a whole must be distinctive;

3 The amount of space occupied shall be proper. Art effects shall be prominent with good viewing effects under various illuminations. The ice and snow artistic landscapes shall be easy to carve;

4 The gravity of works shall overlap with the form center. In case of gravity center displacement, stability technical measures that coordinate with the artistic effect of the works shall be taken.

4.3.7 The main surface of ice and snow sculptures and colored ice walls shall be opposite, fully or partially, to natural light (sunlight). It shall not directly face the prevailing wind direction. The front elevation and the back elevation of the snow landscape shall avoid direct sunlight when it's higher than 15m. If necessary, sheltering measures shall be taken. For a large snow landscape building, environmentally friendly jelly sun screen shall be sprayed over the surface facing the sunlight.

4.3.8 The design of Ice and snow recreational activity item category shall follow the following requirements:

1 If the height of ice and snow buildings for climbing surpasses 5m, safety devices shall be incorporated, and security-tested devices shall be available. The maintenance devices for safety, an evacuation platform and channel shall be required on the top of the building.

2 The slideway of ice and snow slides shall be plain and smooth. In addition, the following requirements shall be met:

1) The width of the straight slideway shall not be less than 500mm, and the width of curve

slideway shall not be less than 600mm; the slideway guardrail shall not be lower than 500mm, and the thickness shall not be less than 250 mm;

2) The slideway guardrail around the bend shall be heightened and reinforced. The guardrail in the curve parts shall not be less than 800mm. Caution signs shall be fixed in the turning slope change area. Buffer shall be provided at the slope end, and the length of the buffer shall be determined by field testing. At the ice-slide's end, safety facilities shall be available;

3) For sliding activities, skating apparatus shall be applied when the slide length is longer than 30m. The average slope of the slideway without skating apparatus shall not exceed 25° and that with skating apparatus shall not exceed 10°;

4) The skating apparatus shall be made of durable light material and prove qualified through safety testing.

3 For special recreational activities involving ice bicycles, snowmobiles, ice bumper cars and snow bumper cars, safe and eligible products shall be used and protective facilities shall be provided.

4.3.9 The design scenic area service supporting facilities shall meet the following requirements:

1 Barrier-free facilities shall be available at the entrance and exit, major roads, and service facilities of the scenic area. For the platforms, roads, stairs and rampways, where the traffic is heavy and people are easy to push, squeeze or slip, shall be equipped with anti-skid and protective facilities such as carpets, handrails, etc.;

2 For the service rooms for commerce, catering, toilets, rest, recreation, etc., equipment rooms such as the power distribution room and snow machine room and management rooms such as custom service center, ticketing center and management center, they shall be rationally laid out based on function and landscape requirements. The housing facilities shall have thermal insulation function, and their shape and material shall coordinate properly with the surroundings; for the ice and snow activity items involving skating apparatus, it shall be preferred to provide tourist and tool traction devices;

3 The service radius of commercial rooms can be 100m～150m. The service radius of public toilets can be 50m～100m.

4.4 Structural Design of Ice Masonry

4.4.1 The structure elements of ice masonries shall be designed based on the ultimate state of the bearing capacity, and meet the requirements under normal conditions.

4.4.2 When the structure elements of ice masonries are designed based on the ultimate state of the bearing capacity, calculation shall be conducted based on the most unfavorable combination of the following formulas:

$$\gamma_0 (1.2 S_{Gk} + 1.4 \gamma_L S_{Q1k} + \gamma_L \sum_{i=2}^{n} \gamma_{Qi} \psi_{ci} S_{Qik}) \leqslant R_d \quad (4.4.2\text{-}1)$$

$$\gamma_0 (1.35 S_{Gk} + 1.4 \gamma_L \sum_{i=1}^{n} \psi_{ci} S_{Qik}) \leqslant R_d \quad (4.4.2\text{-}2)$$

Where: γ_0——structure importance coefficient, 1.0 taken;

γ_L——for variable loads, considering service life adjustment coefficient in structure design, only limited to floors and roofing, 0.9taken;

S_{GK}——effect of permanent load standard value;

S_{Q1k}——effect of a variable load standard value that plays a controlling role in basic combinations;

S_{Qik}——effect of the ith variable load standard value;

R_d——design value of resisting force of structure elements;

γ_{Qi}——subentry coefficient of the ith variable load, 1.4 taken;

ψ_{ci}——coefficient of the combination value of the ith variable load, 0.7taken.

4.4.3 The calculation of structure elements of ice masonries shall comply with the following provisions:

1 The bearing capacity of structure elements of ice masonries shall be calculated based on the ice masonry strength value at −5℃ in the temperature grading;

2 The dead weight of ice masonries shall be 9.2kN/m^3;

3 The values of dead weight of non-ice masonry structure elements and the acting load shall be taken according to the relevant provisions of the current national standard *Load Code for the Design of Building Structure* GB 50009.

4.4.4 The force modes in the design of ice and snow landscape buildings shall be dominated by compression, with other force modes like tensile and shear stress to be reduced.

4.4.5 The foundation design of ice landscape buildings shall meet the following requirements:

1 For ice buildings higher than 10m, and the shorter landing edge exceeding 6m, the foundation design shall be required. The bearing capacity of the foundation shall be calculated based on non-frozen soil strength, with consideration given to the frozen expansion coefficient of the soil around it, with corresponding anti-frozen expansion measures taken;

2 For the foundation that can't meet the requirements of design, measures shall be taken to conduct foundation reinforcement , increase the bearing capacity of the foundation and at the same time, measures to improve the overall rigidity of ice masonries shall be taken;

3 As for frozen soil foundation, underlying layer calculation and foundation frozen expansion stability calculation shall be conducted.

4.4.6 For ice landscape building which has a height of less than 10m frozen soil ground foundation can be adopted, which can be accomplished by freezing the watered soil. When the thickness of frozen soil is larger than 400mm, 400mm shall be taken as the design value; when less than 400mm, the actual value of the thickness shall be adopted. The bearing capacity of frozen soil shall be determined through the in-situ test. The underlying layer calculation and foundation frozen expansion stability calculation of frozen soil foundation shall be conducted.

4.4.7 For the ice masonries, static force calculation shall be conducted in accordance with the current national standard *Code for Design of Masonry Structures*. GB 50003 Generally, the ice masonry shall be considered as a rigid structure.

4.4.8 When the ice masonry structure is regarded as a rigid structure and the overall stability (overturn-resistance, slipping-resistance, etc.) needs to be checked based on the most unfavorable combination of the following formulas:

$$\gamma_0(1.2S_{G2k}+1.4\gamma_L S_{Q1k}+\gamma_L\sum_{i=2}^{n}S_{Qik})\leqslant 0.8S_{G1k} \quad (4.4.8\text{-}1)$$

$$\gamma_0(1.35S_{G2k}+1.4\gamma_L\sum_{i=1}^{n}\psi_{ci}S_{Qik})\leqslant 0.8S_{G1k} \quad (4.4.8\text{-}2)$$

Where: S_{G1k}——positive effect of permanent load standard value;

S_{G2k}——negative effect of permanent load standard value.

4.4.9 The bearing capacity of a structural member in compression, shall meet the following formula:

$$N \leqslant \varphi f A \tag{4.4.9}$$

Where: N——design value of axial pressure;

φ——The influence coefficient of β (the ratio of height to thickness) and e (eccentricity of axial force) to elements in compression shall follow the provisions in Appendix A of the standard. The value of β shall be taken according to Articles 4.4.14-1 and 4.4.12-2 of the standard; when e is calculated based on the endogen force design value, it shall be no less than 60% of the distance from cross section gravity center to the edge of axial eccentric section;

f——the design value of compressive strength of ice masonries, to be taken according to the provisions in Table 3.1.3of the standard;

A——area of section. Ice masonry shall be calculated based on the net cross section; the flange widths of the wall sections with pilasters and ice structure columns shall follow the Items 1 and 2 of Artide 4.4.14-2 of the standard respectively; net section lengh shall be taken for the walls between pilasters or ice structure columns.

4.4.10 The bearing capacity of local compression shall suit the following formula:

$$N_l \leqslant 1.2 f A_l \tag{4.4.10}$$

Where: N_l——design value of axial force in a local compression area;

f——an ice masonry's design value of compressive strength, taken based on the provisions in Table 3.1.3 of the standard;

A_l——local compression area.

4.4.11 The bearing capacity of a structure element subject to axial tension shall suit the following formula:

$$N_t \leqslant f_t A \tag{4.4.11}$$

Where: N_t——design value of axial tension;

f_t——design value of tensile strength of an ice masonry, taken based on the provisions in Table 3.1.3 of the standard;

A——section area, calculated based on the net cross section of an ice masonry.

4.4.12 The bearing capacity of an element subject to shearing force shall suit the following formula:

$$V \leqslant f_v A \tag{4.4.12}$$

Where: V——the design value of shearing force;

f_v——design value of the shearing strength of an ice masonry, taken based on the provisions in Table 3.1.3 of the standard;

A——section area, calculated based on the net cross section area for an ice masonry.

4.4.13 The bearing capacity of member subject to bending force shall suit the following formula:

$$M \leqslant 0.8 f_{tm} W \tag{4.4.13}$$

Where: M——design value of cross section bending moment;

f_{tm}——design value of the bending strength of and ice masonry, design value of bending strength can be taken, taken based on the provisions in Table 3.1.3 of the standard;

W——ice masonry's resistance moment.

4.4.14 The height to thickness ratio of walls and columns shall follow the formulas below:

1 The height to thickness ratio of ice walls and columns shall suit the following formula:

$$\beta=\frac{H_0}{h}\leqslant[\beta] \quad (4.4.14\text{-}1)$$

Where: H_0——calculated height of walls and columns, with reference to Table 4.4.14-1;

h——thickness of wall or the shorter edge of the rectangle column;

$[\beta]$——the acceptable ratio of height to thickness of walls and columns, with reference to Table 4.4.14-2.

Table 4.4.14-1 Calculated height of walls and columns H_0

Ice Mansory Building and Element Category	Floor or Roof Category	Spacing between Transverse Walls S (m)	Wall with Pilaster or Wall with Ice Structure Columns or Wall Connected with Others		
			$S>2H$	$2H\geqslant S>H$	$S\leqslant H$
Rigid scheme for ice masonry buildings	Fabricated light-duty floor and roof with purlin	$S<20$	$1.0H$	$0.4S+0.2H$	$0.6S$
	Wooden or light steel roof of tile roofing	$S<16$			
Non-rigid scheme for ice masonry buildings	Fabricated light-duty floor and roof with purlin	$S\geqslant 20$	$1.5H$		
	Wooden or light steel roof of tile roofing	$S\geqslant 16$			
Upper end is free		$2.0H$			

Note: 1 In the base course, H is the distance from top floor (or the level of supporting points) to bottom bearing of the element; on other floors, H is the distance between floors or other horizontal supporting points;

2 When the upper end of element is free, H is the length of the element;

3 For the gable without pilaster, H is to be the height between floors plus a half of the gable; for the gable with pilaster or ice column, H is the height of the gable wall at the place of the pilaster or ice column;

4 For the three-side supporting walls without cover, H is the distance from the upper free edge to bottom bearing point, and there shall be an ice ring beam, pilaster or ice construction column.

Table 4.4.14-2 Permissible ratio of height to thickness of walls and columns $[\beta]$

Member	Ice Wall	Ice Column
Main load-carrying member	10	8
Minor load-carrying member	12	10

2 The ratio of height to thickness of walls with pilaster and ice structure columns shall be verified and calculated based on the following formula:

$$\beta=\frac{H_0}{h'}\leqslant[\beta] \quad (4.4.14\text{-}2)$$

Where: H_0——calculated height of walls with pilaster, walls with ice structure columns or walls between pilasters, walls between ice structure columns shall follow the provisions in Table 4. 4. 14-1 and Table 4. 4. 14-2, Subitem 3;

h'——the converting thickness of walls with pilaster, walls with ice structure columns shall be in accordance with Subitems 1 and 2 of Article 4. 4. 14-2, and the thickness of walls between pilasters and walls between ice structure columns shall be that of the walls;

$[\beta]$——the permissible ratio of height to thickness of walls and columns shall follow the Table 4. 4. 14-2.

1) The converting thickness of the wall with pilaster shall be 3. 5 times the gyration radius of the section. For the strip foundation of the walls with pilaster, the flange width of the section of the wall with pilasters can be the distance between adjacent pilasters. For single- story ice landscape buildings, flange width of the section of the wall with pilasters can be the width of pilaster plus 2/3 of wall height, but it shall not exceed the width of the wall between windows or the distance between two adjacent pilasters. For multi-story ice landscape buildings, when there is opening between windows, flange width of the section of the wall with pilasters can be the width of ice wall; for walls without door and window openings, the width of the flange wall on each side can be 1/3 of pilaster height and shall not exceed the distance between two adjacent pilasters.

2) The flange width of the section of the wall with ice structure columns can be the distance between two adjacent ice structure columns. The converting thickness shall be 1. 05 times the thickness of the wall.

3) During the verification and calculation of the ratio of height to thickness of the wall between pilasters or between ice structure columns, spacing S between transverse walls shall be the distance between pilasters or structure columns; calculated height H_0 of the wall with pilasters or ice structure columns that has an ice ring beam shall follow Table 4. 4. 14-1, but element height H shall be defined according to the following rules: when the ice ring beam b is not less than 1/30 of the distance S_o between pilasters or ice structure columns, the ice ring beam can be considered as the supporting point of fixed hinges of the wall between pilasters or the wall between ice structure columns, and element height H shall be the distance between adjacent fixed hinges; when the width of ice ring beam is not allowed to be increased, the height of the ice ring beam can be increased according to the constant stiffness principle of the wall surface.

4. 4. 15 The ice masonry construction shall meet the following requirements:

1 When the overall height of the battened hollow ice wall exceeds the allowed ratio of height to thickness, the ice masonry construction shall meet the following requirements:

1) The thickness of the single wall shall not be less than 250mm;

2) The battened hollow ice wall shall be connected with ice blocks and two binding ice blocks between which horizontal steel plates (3mm thick) shall be set. The width of connecting ice blocks shall not be less than the sum of the two single walls. The overlapped part of each block shall not be less than 200mm; the two kinds of ice blocks above shall be set alternately along the height of the battened hollow ice wall. The space between the blocks shall not be greater than half of the permissible ratio of height to thickness of a single wall.

2 The sectional dimension of the independent supporting hollow ice column shall not be less than 600mm×600mm, with wall thickness not less than 200mm; the sectional dimension of the solid ice column shall not be less than 400mm×400mm.

3 When the height of the independent ice column exceeds 15m, the reinforcement set in the ice column shall meet the following requirements:

1) The ratio of vertical reinforcement shall be no less than 0.2%, and the reinforcement shall be no less than 8Φ16. Ribbed steel bars shall be used;

2) Vertical reinforcement shall be connected by lapping, mechanical connections or welding; when lapping is adopted, the overlapping length shall not be less than 60d (d is the larger value of the diameter of the steel bars involved in the overlapping), and not less than 1200mm. The anchorage length shall not be less than 80d, and not less than 1500mm;

3) The diameter of hoop reinforcement shall not be less thanΦ12, and the spacing between shall be no more than a triple ice block, and no more than 600mm.

4 Ice masonries shall be laid layer by layer in a staggered manner, and the overlapped length of the stagger joint shall not be less than 120mm.

5 The expansion joints of ice masonries shall meet the following requirements:

1) The maximum spacing between expansion joints shall be no more than 30m;

2) The width of expansion joint shall not be less than 20mm. with cold-resistance and moistureproof elastic material filled through the joint, with no debris in the joint.

6 Steel plate mesh or transparent partition shall be set at the top of the entrance when there are people or vehicles passing through the arch entrance of an ice masonry and the entrance is 3m wide.

7 For a large-volume ice building or ice landscape with crushed ice filled inside, when the height of the external ice wall is greater or equal to 6m, the laying thickness of the ice wall shall not be less than 900mm; when the height of the external ice wall is less than 6m, the laying thickness of the ice wall shall not be less than 600mm and shall meet the requirements for the ratio of height to thickness of the ice wall.

4.4.16 In an area involving seismic fortification, for an ice landscape building that has a height of more than 12m or whose number of stories are greater than four, corresponding seismic construction measures shall be taken based on the possible destruction caused by earthquakes.

4.4.17 Lintel setting shall meet the following requirements:

1 The flat arch entrance of an ice masonry shall not be wider than 3m. The section steel lintel shall be selected based on Table 4.4.17-1.

Table 4.4.17-1 Table of channel steel and angle steel lintel selection

Width of Ice Masonry Portal L_n (mm)	Section Steel Type	Section Steel Spacing (mm)	Section Steel Standard and Quantity
$L_n<1000$	Channel steel	500	2[8
	Angle steel	500	2L50×5
$1000\leqslant L_n<2000$	Channel steel	500	2[10
	Angle steel	500	2L75×6

Table 4.4.17-1(continued)

Width of Ice Masonry Portal L_n(mm)	Section Steel Type	Section Steel Spacing (mm)	Section SteelStandard and Quantity
$2000 \leqslant L_n \leqslant 3000$	Channel steel	500	2[12
	Angle steel	500	2∟110×8

Notes: 1 The ice masonry over the section steel lintel shall be laid layer by layer in a staggered manner, and the overlapped length of the stagger joint shall be half of the ice block. When there is additional load on ice masonry over the lintel, section steel standard shall be determined through calculation;

2 The support length of section steel lintel shall not be less than 300mm.

2 When an ice arch lintel with ice block is used, the size and rise of the ice lintel shall follow Table 4.4.17-2.

Table 4.4.17-2 Size and rise of ice arch

Width of Ice Portal L_n(mm)	Height of Wedgy Ice Arch d (mm)	Rise f_o(mm)
$L_n \leqslant 3000$	$d \leqslant 300$	$f_o \leqslant 1500$
$3000 < L_n \leqslant 6000$	$300 < d \leqslant 600$	$1500 < f_o \leqslant 3000$
$6000 < L_n \leqslant 9000$	$600 < d \leqslant 900$	$3000 < f_o \leqslant 4500$

Note: 1 The wedged ice arch is an arched portal. When the height of the ice arch is over 550mm, it shall be laid in two layers and the height of it is the sum of the two layers of wedged ice blocks;

2 The ice masonry upward the portal shall be built layer by layer in a staggered manner, and the overlapped length of the stagger joint shall be no less than half of the ice block length;

3 The ice arch height shall not be less than 1/10 the portal width and the ice arch rise shall not be less than 1/2 the portal width.

3 Considering the horizontal cross-section bearing capacity of ice masonry arch foot pedestal, shearing and slipping resistance calculation shall be conducted according to the pushing force of the arch foot. Considering the decreasing bearing capacity because of thawing, corresponding construction measures shall be taken.

4.4.18 When the cantilever beam length exceeds 0.6m, section steel cantilever beam structural treatment shall be used based on the cantilever structure.

4.4.19 Anti-overturning verification and calculation of the section steel cantilever beam in the ice masonry wall shall be conducted according to the current national standard *Code for Design of Masonry Structure* GB 50003.

4.4.20 When the height of an ice landscape building is more than 12m, or the number of stories is greater than four stories, rigid connections or floors shall be designed at the elevation of the ring beam. The main load-bearing structure of floors and roofs shall be fabricated steel structures equipped with a purline system, and section steel can be used for the spandrel girder.

4.5 Structural Design of Snow Construction

4.5.1 The structure elements of snow masonries shall be designed based on the ultimate state of the bearing capacity, and meet the requirements under normal conditions.

4.5.2 When the structure elements of snow masonries are designed based on the ultimate state of the bearing capacity, calculation shall be conducted based on the most unfavorable combination of the following formulas:

$$\gamma_0(1.2S_{Gk}+1.4\gamma_L S_{Q1k}+\gamma_L\sum_{i=2}^{n}\gamma_{Qi}\psi_{ci}S_{Qik})\leqslant R_d \quad (4.5.2\text{-}1)$$

$$\gamma_0(1.35S_{Gk}+1.4\gamma_L\sum_{i=1}^{n}\psi_{ci}S_{Qik})\leqslant R_d \quad (4.5.2\text{-}2)$$

Where: γ_0——structure importance coefficient, 1.0 taken;

γ_L——for variable loads, considering service life adjustment coefficient in structure design, only limited to floors and roofing, 0.9 taken;

S_{Gk}——effect of permanent load standard value;

S_{Q1k}——effect of a variable load standard value that plays a controlling role in basic combinations;

S_{Qik}——effect of the ith variable load standard value;

R_d——design value of resisting force of structure elements;

γ_{Qi}——subentry coefficient of the ith variable load, 1.4taken;

ψ_{ci}——coefficient of the combination value of the ith variable load, 0.7taken.

4.5.3 The bearing capacity of structure elements of snow masonries shall comply with the following provisions:

1 The bearing capacity of structure elements of ice masonries shall be calculated based on the ice masonry strength value at −10℃ in the temperature grading;

2 During the calculation of dead weight of ice masonries, conversion to gravity density (kN/m^3) shallbe conducted according to the values in Table 3.2.1;

3 The values of dead weight of non-snow masonries structure elements and the acting load shall be taken according to the relevant provisions of the current national standard *Load Code for the Design of Building Structure* GB 50009.

4.5.4 The foundation design of snow masonry building shall meet the following requirements:

1 For the snow masonry building whose height is over 10m and the short edge exceeds 6m, foundation design shall be undertaken. The bearing capacity of the foundation shall be calculated based the strength of non-frozen soil, with consideration given to the frozen expansion of the soil around it, with corresponding anti-frozen expansion measures taken;

2 For the snow masonry building whose height is more than 10m, when the natural foundation design conditions cannot be met, the use of frozen soil by pouring water or using other reinforcing methods can be adopted. The bearing capacity of the treated foundation shall meet the design requirements. As for frozen soil foundation, underlying layer calculation and foundation frozen expansion stability calculation shall be conducted.

4.5.5 For a snow masonry building whose building height is less than 10m, frozen soil ground base can be adopted which can be obtained by watering and freezing the watered soil. When the thickness of frozen soil is more than 400mm, 400mm shall be taken; when the thickness is less than 400mm, the actual thickness of frozen soil shall be taken. The bearing capacity of frozen soil foundation shall be determined with the in-situ test. The underlying layer calculation and stability calculation of frozen soil foundation shall be conducted.

4.5.6 For the snow masonry building, a static force calculation scheme for static force calculation can be determined in accordance with the current national standard *Code for Design of Masonry Structures* GB 50003 and design can be conducted according to a rigid scheme.

4.5.7 The bearing capacity of elements in compression shall use the following formula:

$$N \leqslant \varphi f A \tag{4.5.7}$$

Where: N——design value of axial pressure;

φ——The influence coefficient of β (the ratio of height to thickness) and e (eccentricity of axial force) to elements in compression shall follow Appendix B of he standard; The ratio β of height to thickness shall be calculated with 4.5.12-1 and 4.5.12-2 of this regulation; When e is calculated based on endogen force design value, it shall be no less than 60% of the distance from gravity center to the edge of axial eccentric section. The compressive strength of snow masonry shall follow Table 3.2.2 of the standard;

f——the design value of compressive strength of snow masonry to be taken according to the provisions in Table 3.2. 2 of the standard;

A——area of section. Snow masonry shall be calculated based on the net cross section; the flange widths of the wall with pilasters and the wall with ice structure columns shall follow Items 1 and 2 of 4.5.12-2 of the standard respectively . The net section length shall be taken for the walls between pilasters or ice structure columns.

4.5.8 The bearing capacity of local compression shall use the following formula:

$$N_l \leqslant 1.2 f A_l \tag{4.5.8}$$

Where: N_l——design value of axial force in a local compression area;

f——an snow masonry's design value of compressive strength, value taken based on the provisions in Table 3.2.2 of the standard;

A_l——area in compression.

4.5.9 The bearing capacity of the element in axial tension shall use the following formula:

$$N_t \leqslant f_t A \tag{4.5.9}$$

Where: N_t——design value of axial tension;

f_t——design value of tensile strength of snow masonry, value taken based on the provisions in Table 3.2.4 of the standard;

A——section area, calculated based on net cross section of the snow masonry.

4.5.10 The bearing capacity of the element subject to shearing force shall use the following formula:

$$V \leqslant f_v A \tag{4.5.10}$$

Where: V——the design value of shearing force;

f_v——design value of the shearing strength of snow masonry, value taken based on the provisions in Table 3.2.5 of the standard;

A——section area, calculated based on the net cross section of the snow masonry.

4.5.11 The bearing capacity of the element subjected to bending force shall follow this formula:

$$M \leqslant f_W W \tag{4.5.11}$$

Where: M——design value of cross section bending moment;

f_W——design value of the bending strength of snow masonry, which can adopt the design value of bending strength , value taken based on the provisions in Table 3.2.3 of the standard;

W——cross section resistance moment.

4. 5. 12 The ratio of height to thickness of walls and columns shall be in accordance with the following provisions:

1 The ratio of height to thickness of snow walls and columns shall follow this formula:

$$\beta = \frac{H_0}{h} \leqslant [\beta] \tag{4. 5. 12-1}$$

Where: H_0——calculated height of walls and columns, see Table 4. 5. 12-1;

h——thickness of wall or length of the shorter edge of the rectangle column;

$[\beta]$——the permissible ratio of height to thickness of walls and columns, see Table 4. 5. 12-2.

Table 4. 5. 12-1 Calculated height of walls and columns H_0

Snow masonry Building and Element Category	Floor and Roof Category	Spacing between Transverse Walls S(m)	Wall with Pilasters or Wall with Ice Structure Columns or Wall Connected with Others		
			$S>2H$	$2H \geqslant S>H$	$S \leqslant H$
Rigid scheme for snow masonry buildings	Fabricated light-duty floor and roof with purlin	$S<20$	$1.0H$	$0.4S+0.2H$	$0.6S$
	Wooden or light steel roof of tile roofing	$S<16$			
Non-rigid scheme for snow masonry buildings	Fabricated light-duty floor and roof with purlin	$S \geqslant 20$	$1.5H$		
	Wooden or light steel roof of tile roofing	$S \geqslant 16$			
Upper end is free		$2.0H$			

Note: 1 In the base course, H is the distance from top floor (or the level of supporting points) to bottom bearing of the element; on other floors, H is the distance between floors or other horizontal supporting points;

2 When the upper end of element is free, the height H equals the length of the element;

3 For the gable without pilasters or ice structure column, H is to be the height between floors plus a half of the gable; for the gable with pilasters or ice structure column in snow masonry, H is the height of the gable wall at the place of the pilaster or ice column;

4 For the three-side supporting walls without a cap, H is the distance from the upper free distance to bottom bearing point, there shall be an ice ring beam, pilaster or ice structure column.

Table 4. 5. 12-2 Permissible ratio of height to thickness of walls and columns$[\beta]$

Member	Snow Wall	Snow Column
Main load-carrying member	8	6
Minor load-carrying member	10	8

2 The ratio of height to thickness of wall with pilasters and wall with ice structure column shall be verified and calculated based on the following formula:

$$\beta = \frac{H_0}{h'} \leqslant [\beta] \tag{4. 5. 12-2}$$

Where: H_0——calculated height of wall with pilaster, wall with ice structure column in snow masonry or wall between pilasters, wall between ice structure columns, see table 4. 5. 12-1 and Table 4. 5. 12, Item 2, Subitem 3 respectively;

h'——the converting thickness of the wall with pilasters and wall with ice structure columns, see Table 4. 5. 12, Item 2, Subitems 1 and 2. The thickness of wall between pilasters and wall between ice structure columns, shall be the thickness of the wall itself;

[β]——the permissible ratio of height to thickness of wall and column, see Table 4.5.12-2.

1) The converting thickness of the column wall with pilaster shall be 3.5 times the gyration radius of the section. For the strip foundation of wall with pilaster, flange width of the section of the wall with pilasters can be the distance between adjacent pilasters; For single story snow masonry buildings, flange width of the section can be the width of the pilaster plus 2/3 the height of wall, but it shall not exceed the width of the wall between windows, or the distance between two adjacent pilasters. For multi-story snow masonry buildings that have walls with doors and windows, the width of the flange of the section of the wall with pilasters can be the width of the snow wall; for walls without doors and windows, the width of the flange wall on each side can be 1/3 of pilaster height and shall not exceed the distance between two adjacent pilasters;

2) The flange width of the section of wall with ice structure columns in the snow masonry can be the distance between two adjacent ice structure columns. The converting thickness shall be 1.05 times the thickness of the wall;

3) During the verification and calculation of the ratio of height to thickness of wall between pilasters or between ice structure columns, spacing S between transverse walls shall be the distance between pilasters or structure columns; calculated height H_0 of the wall with pilasters or ice structure columns that has an ice ring beam shall follow Table 4.5.12-1, but element height H shall be defined according to the following rules: when the ice ring beam b is not less than 1/30 of the distance S_0 between pilasters or ice structure columns, the ice ring beam can be considered as the supporting point of fixed hinges of the wall between pilasters or the wall between ice structure columns, and element height H shall be the distance between adjacent fixed hinges; when the width of ice ring beam is not allowed to be increased, the height of the ice ring beam can be increased according to the constant stiffness principle of the wall surface.

4.5.13 The snow masonry construction shall meet the following requirements:

1 For the snow wall whose height is less than 6m, its thickness shall not be less than 800mm. For the snow wall whose height is more than 6m but less than 10m, its thickness shall not be less than 1000mm; the section size of the independent snow column section shall not be less than 1200mm×1200mm;

2 For the snow wall and the independent snow column over 10m in height, it shall be reinforced with bamboo, wood or steel structures;

3 The arch portal with a span wider than 2m, the portal for people and vehicle flows, shall be reinforced with bamboo, wood or steel structures outside the snow masonry.

4.5.14 In the area where seismic resistance is needed, the snow masonry building whose construction height is higher than 9m or that has more than three stories, shall have corresponding seismic construction measures to avoid the possible damage caused by earthquakes.

4.5.15 Lintel setting shall meet the following requirements:

1 The flat arch portal of snow masonry shall not be wider than 3m, with section steel lintel to be selected based on Table 4. 5. 15-1.

Table 4. 5. 15-1 Table of channel steel and angle steel lintel

Width of Snow Masonry Portal L_n (mm)	Section Steel Type	Section Steel Spacing (mm)	Section Steel Standard and Quantity
$L_n<1000$	Channel steel	500	2［8
	Angle steel	500	2 L50×5
$1000\leqslant L_n<2000$	Channel steel	500	2［10
	Angle steel	500	2 L75×6
$2000\leqslant L_n\leqslant 3000$	Channel steel	500	2［12
	Angle steel	500	2 L110×8

Note: 1 The snow masonry over the section steel lintel shall be built layer by layer in a staggered manner, and the overlapped length of the stagger joint shall not be less than a half of the snow block. In the case of additional load on the snow masonry over the section steel lintel, section steel standard shall be determined through calculation;

2 The support length of section steel lintel shall not be less than 400mm.

2 When a snow arch lintel with snow block is used, the size and the height of the snow lintel shall be based on Table 4. 5. 15-2.

Table 4. 5. 15-2 Size and rise of snow arch

Width of Snow Portal L_n (mm)	Height of Wedgy Snow Arch d (mm)	Rise f_o (mm)
$L_n\leqslant 3000$	$d\leqslant 500$	$f_o\leqslant 1500$
$3000<L_n\leqslant 6000$	$500<d\leqslant 800$	$1500<f_o\leqslant 3000$
$6000<L_n\leqslant 9000$	$800<d\leqslant 1100$	$3000<f_o\leqslant 4500$

Note: 1 The wedge snow arch is for an arched portal. When the height of the snow arch is over 550mm, it shall be built into two layers and the height of the wedgy snow arch is the sum of the two layers of wedge snow blocks;

2 The snow masonry over the structural steel lintel shall be built layer by layer, and the overlapped length of the stagger joint shall not be less than a half of the snow block;

3 The snow arch height shall not be less than 1/10 the portal width and the snow arch rise shall not be less than 1/2 the portal width.

3 Considering the horizontal cross-section bearing capacity of a snow masonry arch foot pedestal, shearing and slipping resistance calculation shall be conducted according to the pushing force of the arch foot. Considering the decrease of the bearing capacity because of thawing, corresponding construction measures shall be taken.

4. 5. 16 When the cantilever beam length exceeds 0. 4m, section steel cantilever beam shall be used. Anti-overturning verification and calculation of the section steel cantilever beam in the snow masonry wall shall follow the requirements of *Code for Design of Masonry Structure* GB 50003.

4. 5. 17 When the height of a snow landscape building is greater than 9m, or the number of stories of the snow landscape building is over three, rigid connections or floors shall be designed at the elevation of the ring beam. The main load-bearing structure of floors and roofs shall be fabricated steel structures equipped with a purlin system, and section steel can be used for the spandrel girder.

4. 6 Illumination Design of Snow and Ice Landscapes

4. 6. 1 The illumination design of ice and snow landscapes shall follow the relevant provisions of existing national standard *Standard for Lighting Design of Buildings* GB 50034 and meet the requirements for electric power of civil buildings and urban night landscape lighting.

4.6.2 Overall lighting design and monomer lighting design shall be conducted for landscape lighting in the scenic area and meet the following provisions:

1 Both inside and outside lighting facilities shall be designed for ice and snow landscape lighting;

2 The lights' color and illumination and change frequency shall be rationally allocated according to the theme;

3 The arrangement of lighting equipment shall comply with the general lighting design and monomer lighting design requirement, and a reasonable position shall be determined. The luminance illumination, and the lights' color and shadow shall comply with the lighting design effect requirements;

4 The lighting equipment shall be environmentally friendly, energy saving and highly efficient;

5 Make sure that the outdoor ancillary facilities such as lighting equipment, and frameworks can work properly in cold weather.

4.6.3 The illumination quality of ice and snow landscapes shall follow the regulations below:

1 The color temperature of the illuminating light source for ice and snow landscapes shall follow the provisions in Table 4.6.3-1.

Table 4.6.3-1 Color temperature of illuminating light source for ice and snow landscape buildings

Light Source Color Classification	Color Temperature (K)	Color Characteristics	Applicable Landscape
Ⅰ	<3300	warm	Classical, European-style ice architecture and commercial facilities
Ⅱ	3300～5300	middle	Ice sculpture works and advertising
Ⅲ	>5300	cold	Ice and snow sculpture, recreation activities

2 The color of lighting source shall match the theme of the ice lanterns and snow sculptures.

3 For ice and snow landscape lighting, the quality of lighting direct glare Level (*UGR* value) shall follow Table 4.6.3-2.

Table 4.6.3-2 For ice and snow landscape lighting the quality of lighting direct glare level(*VGR*-value)

Value of *UGR*	Description of Corresponding Degree of Glare	Examples of Vision Requirements and Places
<13	No glare	—
13～16	Noticeable	Ice sculpture
17～19	Drawing attention	Ice sculpture
20～22	Causingminor discomfort	Snow sculpture
23～25	Uncomfortable	Snow sculpture and scenic area illumination
26～28	Very uncomfortable	—

4 In places where ice and snow landscape lighting is used, if the (UGR) is greater than 25, the following measures against glare shall be taken:

1) For large scale snow sculptures and ice buildings, lighting equipment shall not be set at the interfering space or in an area where it may form specular reflection to the eyes;

2) For small ice and snow landscape architecture and artistic ice sculpture illumination, light distribution or indirect measure of lighting along line-of-sight direction could be adopted, with lighting equipment that has a big area of light-emitting surface, low brightness and proliferation of good optical performance.

4.6.4 Illumination level of ice and snow landscape buildings shall meet the following requirements:

1 The visual working illumination range value shall be preferably selected based on Table 4.6.4.

Table 4.6.4 Visual working illumination range value

Nature of Visual Working	Illumination Range(lx)	Region or Type of Activity	Examples of Applicable Places
Simple visual working	30～75	Simple identification of materials characterization	Places for entertainment Activities
General visual working	100～200	Landscape inside lighting, commercial workplace, etc.	Inside the ice sculpture and ice landscape buildings
	200～500	Projector lighting outside the landscape	Ice sculpture sketch, small-scale snow sculpture
	500～750	Large-scale ice and snow landscape buildings, landscape display areas, important viewing places	Important landscape area such as symbolic landscapes, stage performances, etc.

2 Landscape illumination of ice and snow landscape buildings may use the following classification (lx): 20, 50, 100, 200, 300, 500 and 750.

3 The performance lighting in the performance area shall be equipped with a professional illumination system based on the performance requirements.

4 The roads in a scenic area shall be equipped with functional lighting equipment, and a single-color source with a favorable illumination level of 20 lx～50 lx is preferred. Indirect lighting can also be applied such as light boxes, advertising lights or lights embedded in the ground.

5 The scenic area surrounding lightning effects shall involve rational design the combination of bright and dark effects, color change and rational control of combination of points, lines and planes of the light source. When lights with special performance such as lasers are used, program control shall be provided, and the illumination degree in the central scenic area and main landscapes shall be higher than that in the other scenic areas.

6 The lighting design shall include preparing illumination distribution, scenic area and large-scale landscape light color effect sketches, lighting change program design and dynamic demonstration scheme.

4.6.5 Light source and lighting equipment for ice and snow landscape architecture shall meet the following requirements:

1 Light source and lighting equipment in landscape areas shall be selected and configured for a good visual effect, reasonable distribution, appropriate light illumination, prominent colors and appropriate exchange.

2 Light sources shall be chosen considering factors such as scenic area environment, light effect, color rendering property and durability.

3 The light sources inside the icescape shall be energy-saving, environmentally friendly, waterproof, with low heat generation amount (LED, etc.).

4 LED can be applied in designated areas for advertising, information release, guide maps and big screens.

5 Electroluminescent panel can be used in the guiding signs as auxiliary lighting.

6 Landscape illuminating equipment shall be selected with the qualities of low heat-production, safety, energy conservation, environmental friendliness and durability, and shall also be suitable for use at low temperature. In addition, the following requirements shall be met:

1) The lamps inside the icescape and clearance light which contact the icescape shall be high-bright and luminescent;

2) Those lamps inside the icescape which cannot be dismantled shall be low-cost, less-polluting and durable;

3) The outdoor lamps shall be water resistant, moisture resistant and easy to replace.

7 Durable spotlight, floodlight and upper-air signal lamp (luminaries with durable light source) shall be used when the lamps cannot be easily overhauled and maintained.

8 Bright gas discharge lamps shall be used for functional lighting in the scenic area and square.

4.6.6 The lighting of ice and snow landscape buildings shall adopt energy-saving measures, the following requirements shall be met:

1 Light sources which are economical, eco-friendly and energy saving shall be chosen.

2 Straight tubular fluorescent lamps shall use energy-conserving electronic ballasts which can work normally at low temperature. When electronic ballasts are used, the energy consumption of the fluorescent lamps shall meet the current national standard *Limited Values of Energy Efficiency and Evaluating Values of Energy Conservation of Ballasts for Tubular Fluorescent Lamps* GB 17896.

3 Lighting control modes shall be properly selected to meet the lighting design requirements:

1) The light may be controlled separately or in a multipoint way;

2) Illumination in public shall have a centralized control, or clock-control;

3) A light reducing scheme for different time periods can be provided;

4) The voltage can be properly reduced when high-efficiency lanterns are turned on.

4 Such energy-saving management measures as infrared sensor controls, time switches and intelligent lighting control systems shall be used to satisfy the scenic area's illumination function requirements in the scenic area.

5 Lamps taking advantage of solar power and wind energy can be used for the illumination on the square, roads and courtyard.

4.6.7 The lighting power supply system for ice and snow landscape buildings shall meet the following requirements:

1 The load level and power supply solutions shall be properly designed.

2 The major lighting power load supply system shall adopt a duplicate supply and double-loop supply. Each level of the systems shall have its own power control.

3 The load balance of a three-phase lighting line shall be kept. The maximum phase load current shall not be greater than 115% of a three-phase load average. The minimum phase load current shall not be less than 85% of the three-phase load average.

4 In important areas, for the end load distribution box, power shall be supplied by the power source which switches automatically. For the heavy load, power can be supplied by two particular circuits with a 50% load for each.

5 In the branch circuit of illumination, three-phase low-voltage circuit breakers shall not be applied to control and protect three-phase branch circuits.

6 The electric current of each single-phase branch circuit in the lighting system shall not exceed 16A, the number of light sources shall not be greater than 50. The electric current of each single-phase branch circuit in the combined lanterns of a large ice building shall not exceed 25A, and the number of light sources shall not be greater than 120.

7 Neutral conductors and phase conductors shall follow the same standard when gas discharged lamps are used for lighting lines.

8 The same light or the adjacent tubes of different light (light source) can be connected to the lines of different phases when inductance ballasts gas discharge lights are used.

9 The overall power supply solution shall consider the scenic area planning and monomer ice and snow landscape building lighting design to calculate electrical load, determine power supply solutions and complete power distribution system design and shall meet the following provisions:

1) When a constant power supply is used, power distribution equipment and power supply lines shall be fixed facilities. Power supply lines shall be buried directly underground; protective measures shall be taken where such lines run through roads or heavy-duty vehicles passes;

2) When temporary power supply is adopted, power distribution lines shall be laid in metal troughs either visibly or invisibly.

10 On-duty personnel in charge of lighting are to be stationed in the landscape area.

11 Electric equipment and circuit breakers (including miniature circuit breakers) shall be able to work properly below −30℃.

12 For outdoor branch circuits, RCD shall be installed.

13 A short-circuit protector, overload protector and overvoltage and undervoltage protectors shall be installed on power distribution lines.

14 The protection grade for an outdoor power distribution cabinets or power distribution boxes shall be no less than IP33.

4.6.8 The lighting design of ice and snow landscape buildings shall meet the following requirements:

1 The main lighting source shall be appropriate to the theme of the icescape architecture. The light shall be changeful. The lighting system of large scale ice landscapes shall be controlled with a program-control system. Art icescapes can adopt projection light, of which the color, illumination, disposition of lighting and the type of lanterns shall be in accordance with the theme and its artistic expression.

2 Light source selection shall meet the following provisions:

1) The chromatic aberration of the rendering light color in the ice body shall not be too small. It is preferred to choose primary colors, such as white, yellow, red, blue and green, as sheme;

2) Tubular fluorescent lamps or moldable LED lamps shall be used inside the icescape;

3) The clearance lights of the icescape can be neon light, moldable LED lamps, optical fiber lamps, flash lamps or strobe lamps, etc;

4) Gas-light shall be the main light source of the icescape architecture, luminaries and spotlights are preferred;

5) Halogen lamps, flashlights, spotlights and some other warm light can be used to show the effect of local lighting of the ice sculpture and large icescape buildings. These lamps shall be energy-saving and compact.

3 T8 tubular fluorescent lamps, or T5 small size tubular fluorescent lamps combined with a color filter plate shall be preferably used as the inner light source of the ice architecture. Tricolor tubular fluorescent lamps, energy-saving compact lights and LED can also be used.

4 For the ice architecture and anaglyptic icescapes that are more than 3m high and 1.5m wide and thick, the main light source shall be embedded lamps. Floating light for complementary color can be used locally. Program control shall be designed for the light source to make the light sparkling, flowing and colorful. The distance between built-in lights and the surface ice is determined by the transparency of the ice. Usually, the distance is between 150mm and 350mm.

5 The cast lights shall be used as the light source for the artistic icescape. The distance between lamps and landscapes shall be greater than 1.5m. The lamps shall be set snugly and at a certain angle with the icescape. The type, color, intensity and distance of the main light source and the assisting light source shall meet the needs of manifestation effect. The lamps shall be installed on lamp hangers whose height from the ground shall not be less than 0.5m.

6 Incandescent lamps and halogen lamps can be used as the main light source of the local icescape, assisted with spot lights.

7 Large scale starry light can be used in large areas such as ice galleries and bushes.

8 The new LED light source embedded in the icescape shall preferably meet the following requirements:

1) Considering the directionality of the light source, the light distribution in the ice masonry shall be uniform;

2) The selected light types, accessory standard and models shall be unified and universal;

3) It shall be preferred not to use equipment with large heat dissipation amount for the light source and accessories in the ice masonry;

4) Recycling measures shall be taken for reusable lamps and electrical materials.

4.6.9 The lighting design of snow landscapes shall meet the following requirements:

1 Metal halide lamps and high-voltage sodium lamps can be used for snow sculptures. The distance between the lamps and snow landscapes shall be greater than 2.0m;

2 Lighting devices shall be installed on a lamp holder and shall be as least 0.5m above the ground;

3 Light color and its illumination shall be appropriate to the design theme. Key light, side light and back light shall be designed to achieve the corresponding effects;

4 The key light and other lights for large icescapes shall be distinguishable. The power of the flood lamp directly illuminating the snow landscape shall be less than 400W;

5 Small floodlights shall be preferably used. Lamps and accompanying stands shall be preferably painted white.

4.6.10 The ground connection for low-voltage distribution system in ice and snow scenic areas shall meet the following requirements:

1 The grounding form of the low-voltage distribution system in ice and snow scenic areas shall adopt TT or TN-S system.

2 If a TT system is adopted, every power distribution box shall be equipped with an earth electrode and the operating characteristic of the earth fault protection shall comply with the provisions in the formula below:

$$R_A \times I_a \leqslant 50 \tag{4.6.10}$$

Where: R_A——the sum of the resistance of the earth electrode and the resistance of e protective conductor of the exposed conductive part (Ω)

I_a——the operating current cutting off the fault circuit to protect appliance (A)

3 If an over-current protector is adopted, the operating current of the fault circuit of inverse time over-current protector (I_a) shall cut off the current within 5 seconds. The operating current (I_a) which adopts the fault circuit of instantaneous characteristics of the over-current protector, shall be the minimum instantaneous current ensuring instantaneous action. If a residual current operating protector is adopted, it shall be the rated residual operating current.

4 If a TN-S system is adopted and the protective electric conductor (PE) exceeds 50m, then the grounding shall be repeated. If the line is too long, the exposed conductive parts at the end of the distribution box, as well as the external conductive parts, are supposed to be local or auxiliary equipotential bonding.

4.6.11 Grounding methods of distribution distribution lines, equipotential bonding and protection shall conform to the current national standard *Code for Design of Low Voltage Electrical Installation* GB 50054.

4.7 Intelligentization Design

4.7.1 Broadcasting system and sound system should be devised in the scenic area.

4.7.2 The sounds and light music shows of separate performing areas should not disturb other areas in the scenic area.

4.7.3 Wireless explanation system and wireless mobile terminal which provide electronic maps, attractions commentary, travel route query, traffic information, scene navigation, commercial navigation, location services and other related services to tourists should be put to use in the scenic area.

4.7.4 The monitoring system for continuous monitoring of the area, and the automatic alarm system in important areas should be set up in the scenic area.

5 Construction of Ice and Snow Landscape Buildings

5.1 General Requirements

5.1.1 Before the construction, the operating organization should assemble all of those involved in design, construction and supervision to make a joint checkup of the drawings and technical disclosure.

5.1.2 Those involved in building the environment should compile organizational designs for the construction, and work out the schemes accordingly. Bearing capacity and stability of the bracing structure should be calculated and supervised, determining the technical measures for working aloft; construction survey; machine selection; embedding of profiled bars; installation of building blocks; ice and snow incision and transportation.

5.1.3 For the height of the ice building more than 30m or that of the snow building more than 20m, sedimentation and deformation observation during the construction should be taken.

5.1.4 On-spot inspection of the materials and equipment involving structural safety and functions of use should also be undertaken.

5.1.5 After the completion of the main building construction of ice and snow landscape, the surface of ice landscape should be cleaned and the surface of snow masonry should be polished so as to achieve the effects of transparence for ice masonry, and bright and clean surface for snow masonry.

5.2 Construction Survey

5.2.1 The construction of ice and snow landscape building should meet the design requirements to generally set off lines of the site. The location of the individual landscape and its pile point should be well-protected after it has been properly determined through inspection.

5.2.2 The profile should be measured on the basis of the set stakes or control point of the ice and snow landscape. After its closed calibration gives a satisfactory result, the detail axis and relevant borderline should be in accordance with the permissible deviation shown in Table 5.2.2

Table 5.2.2 Permissible deviation of the detail axis

Item		Permissible deviation
Detail Axis		±10mm
Elevation	Floor Height	±15mm
	Total Height	±30mm
Total Height Verticality (m)	$H \leqslant 15$	±20mm
	$H > 15$	The minor of $H/750$±50mm
Outline Side Length (m)	$L(B) \leqslant 30$	±20mm
	$L(B) > 30$	±30mm
Diagonal Line (m)	$L(B) \leqslant 30$	±30mm
	$L(B) > 30$	±40mm
Axes Angle (")	$L(B) \leqslant 30$	±20″
	$L(B) > 30$	±30″

5.3 Ice-collecting and Snow-making

5.3.1 The collection of natural ice should follow the following regulations:

1 The suitable temperature for natural ice collection is below −10℃.

2 Only when the thickness of natural ice is not less than 200mm, and the ice material meets the following conditions, can the ice be collected:

1) The strength can meet the demand of the design;

2) A good transmission of light, no obvious air bubbles, silt, sundries as well as cracks and no possibilities of the ice breaking away (abruption) are required.

3 Under natural conditions, rough ice should be kept for more than 12 hours before use.

4 Rough ice should match the following standard: the length is 1000mm, the width is 700mm and the thickness is more than 200mm, or 1300mm long, 1200mm wide and not less than 300mm thick. The ice sculpture should adopt the whole rough ice of 2000mm long, 1200mm wide and not less than 400mm thick.

For the masonry, the ice block should have a length of 600mm, a width of 300mm and a thickness of not less than 200mm.

5.3.2 Rough ice should be divided by rack saw, and processed into ice masonry as required.

5.3.3 Artificial ice making should follow the following regulations:

1 The temperature of the environment should be below −10℃;

2 Measures should be taken to make the ice transparent when making transparent artificial ice;

3 When making colored ice, the colored dye should be easy to dissolve in water, pollution-free, good in suspension and light transmission. It should meet the requirements of environmental protection. The degree of hue saturation should conform to those of the design;

4 The dimensions of the artificial ice could be 600mm×300mm×200mm.

5.3.4 The fabrication of artificial snow should follow the following regulations:

1 The temperature of the environment should be below −10℃;

2 When making snow on a large scale, the water supply should be sufficient and its quality should meet the standard of the snowmaker;

3 When making snow indoors, a snowmaker with a high degree of atomization and thinner spray nozzle is preferred. Snow can also be made with crushed ice using big ice crushers.

5.3.5 Large snow blocks can be made in the following ways:

1 When adopting the method of snow accumulation, templates can be used according to the design requirements to form geometries, which are then filled with snow and compacted layer by layer;

2 When adopting the method of snow building, the snow blocks whose strength meets requirements should be employed to form larger snow blocks. The joint and geometric dimension of the snow block should be neat.

5.4 Foundation Construction of Ice Building

5.4.1 Before the construction, level and smooth the ground base, ensuring it is entirely frozen after water flooding, and then constructs the upper masonry.

5.4.2 If the slope of the ground base is less than 1% and the height difference is less than 100mm, level and smooth it by watering and freezing entirely. If more than 1% or the height difference is more than 100mm, then level and smooth it by ice masonry.

5.4.3 The bearing wall and columns should be built on the ground base. It is forbidden to base it on the crushed ice, snow and loose soil layers.

5.4.4 The base construction of ice building should meet the following regulations:

1 Adopt the method of combining and piling up layer-separated ice blocks, the upper and lower part should lap off the set joints. The lapping length should be half of that of the ice block, and should not be less than 200mm. The method of making masonry on the surrounding sides and filling in the middle should be avoided.

2 The masonry height of every layer of ice should be horizontally identical. The horizontal and vertical seams of ice masonry should be less than 2mm wide and be frozen by pouring water. The ratio of frozen area of ice seams should be more than 80%.

3 The ice building which is designed to be hollow or filled with crushed ice should have a foundation bed, the height of which should be 1/10 that of the ice building and not less than 1m.

5.5 Construction of Ice Masonry

5.5.1 The exterior of the ice landscape building should adopt ice blocks which has high transparency with no incisions or cracks.

5.5.2 The freezing water between the ice blocks should be natural water or tap water.

5.5.3 The ice landscape should be constructed by combining and piling up ice blocks layer by layer.

5.5.4 The temperature for poured water during the construction should be 0℃, and special infusing tools should be adopted to perfuse ice crack, and the frozen rate should not be less than 80%.

5.5.5 During the construction, monitoring the temperature of ice masonry should be carried out. When the temperature is higher than the design temperature, or the masonry water cannot be frozen, construction should be suspended and methods should be adopted to protect the ice landscape, such as using shading and wind-proofing, etc.

5.5.6 The size of ice blocks should be determined by the thickness of the ice masonry (wall) and the size of the ice material. Every masonry side should be leveled up. And the permissible deviation of the ice height is ±5mm. The allowable deviation of length and width of ice blocks is ±10mm.

5.5.7 The masonry of ice masonry wall should meet the following regulations:

1 The upper and lower layer of ice masonry should be combined with staggered joints and laid internally and externally. The overlapped length should be 1/2 of ice masonry and should not be less than 120mm;

2 The masonry height of every ice layer should be identical; a water flooding line should be sawn on the surface. The horizontal and vertical seam should not exceed 2mm, and the surface should be smooth and flat;

3 The ice masonries (wall) of monomer ice building of the same height should be constructed in synchrony. If not, a vertical dog tooth end should be left. The dog tooth shaped wall should not be higher than 1.5m.

5.5.8 For the large volume ice landscape which adopts hollow masonry, structural methods should be adopted between the masonry, while for the non-bearing internal part, crushed ice can be adopted to fill in.

5.5.9 When it is allowed to fill the large volume of ice landscape buildings with crushed ice, the ice should be compacted, the particle size distribution of which should be reasonable; the maximum particle size should not exceed 300mm and stratification padding of the crushed ice is needed. The thickness of every layer should not exceed 1.5m. When freezing it with water, ensure it is entirely frozen. The water should not overflow the external surface of the ice masonry. The crushed ice texture should not be observed through the main facade of the ice building.

5.5.10 The ice blocks for arches should be made in a wedged mold according to the design. The deviation of upper and bottom length should be within 2mm. The width of the vertical seams should be not exceed 1mm, filled with water and must be frozen.

5.5.11 Using circular arch and the height of the wedge shaped ice arch lintel should not be less than 1/1 of the width of the hole. When the height of the ice arch is greater than 550mm, it should be divided into two layers for the masonry. The rise value should be based on the standard of Table 4.4.17-2. When the length of the ice arch hole is greater than that of the bottom of the wedge shaped ice arch lintel, the ice arch should be laid layer by layer in a staggered manner, and the staggered joint length should be 1/2 of that of the bottom of the wedge shaped ice arch lintel.

5.5.12 Holes for lamps in the ice masonry should be reserved according to the design requirements. The distance between the hole and the external surface should follow the regulation of the 4th Paragraph in section 4.6.8. And the crushed ice in the hole should be cleaned. For taller ice architecture, a concealed hole and vertical access well, in which reinforcing steel ladders should be set, should be reserved for maintenance workers.

5.5.13 All masonry surfaces of the colored ice should be smoothed. The ice seams of the colored masonry, between the colored and non-colored, should be filled with a mixture of water and colored ice powder.

5.5.14 After the construction of the outside of the ice landscape, net surface treatment should be made from top to the bottom.

5.5.15 Scaffolds and vertical transportation devices for construction must be installing individually and shall now touch with the ice masonry to avoid disturbing it.

5.6 Construction of Steel Structure in Ice Masonry

5.6.1 Seams between vertical steel reinforcements and ice blocks should be filled and frozen with ice powder mixed with water which is laid layer by layer, with vertical steel bars and horizontal hoop reinforcement should be installed in the horizontal ice trough and frozen with water but should not be higher than the ice surface or installed in the seams.

5.6.2 The seams between steel lintel, steel frame and ice blocks should be filled with water or crushed ice mixed with water.

5.6.3 The embedded parts and ice masonry should be infused and frozen with water, and there shall be no seams.

5.7 Construction of Watered Icescape

5.7.1 Framework of watered icescape should be made before construction, and only then should water be sprayed. The framework can be made at one time or made during spraying

5.7.2 The icescape can be made mechanically or manually. Spray water on frameworks made with branches or other materials, thickening the ice cover to make icicle, ice galalith, iceberg and ice cave, etc.

5.7.3 The most suitable temperature for watering icescape construction is below −20℃ and should not be exposed to direct sunshine.

5.7.4 Tap water and clear groundwater can both be used to make a watered icescape. The flux, strength and pulverization rate should be properly controlled when spraying.

5.8 Ice Sculpture Making

5.8.1 Ice with inclusion, bubbles or flaws should not be used for making ice sculpture.

5.8.2 Ice blocks are to be frozen together into geometric entities and then be sculpted according to the design requirement.

5.8.3 Entire ice blocks can be used for small ice sculptures. It could be sculptured after the ice blocks are built into ice base, or combined into ice sculptures after being carved. But textures and joints should meet the requirement of the works.

5.8.4 When using ice blocks to form the ice base, the seams between ice blocks should not exceed 2mm, and the infused area should not be less than 80%. The ice seams should be firmly jointed; the surface should be smooth.

5.8.5 For large ice sculptures, three - dimensional sample s can be made first, and then lines can be magnified and drawn directly on the ice base.

5.8.6 Different techniques of expression such as full relief, anaglyph, openwork carving and intaglio are all applicable to ice sculpture.

5.8.7 The ice sculpture should demonstrate the ice characteristics of transparency, refractive index, stiffness, friability and easy-weathering. It should be sculpted with clear texture and proper strength, focusing on the hollow out technique and the expressive effect as a whole.

5.8.8 According to the theme, the ice sculpture could adopt techniques of figurative or abstract. Figurative technique should represent the performance of fine, deep and vividness. Abstract technique should adopt geometric shape, physical characteristics to perform the theme and its physique characteristic.

5.9 Ice Lantern Making

5.9.1 Ice lanterns can be made into hanging-type, floor-type or other types according to different functional requirements with delicate and exquisite size. Sufficient ventilation ports should be set on the ice masonry.

5.9.2 Making ice lanterns should follow the steps as follows:

1 Make mould according to the design requirements;

2 Pour clear water or colored water into the mold; freeze it and the thickness of the ice billet should be between 20mm and 40mm;

3 Empty the unfrozen water in the ice billet through digging a hole in it;

4 Draw or sculpt on the ice crust;

5 Set up lamps and lanterns inside the ice masonry;

6 Install auxiliary components.

5.9.3 Ice flowers can be made in the following ways:

1 Pour clear water into the mold or container and freeze it in low temperature into ice billet which is hollow inside. The forms of portrayal, carving, inlaid landscapes, fish boats, flowers, trees, old-fashioned lamps, historic buildings and characters, etc. can be adopted to reveal the theme of the icescape by drawing or sculpting inside or outside the ice blocks;

2 Pour clear water into the mold or container; put models of fish, insects, plants, flowers, small animals, which shall form into the icescapes after being frozen;

3 Pour clear water into the mold or container; mix colored solutions with different density, solubility and infusibility during the process of freezing to make special icescapes.

5.9.4 External lighting can be used for the ice flower; spotlights or other colored lights can also be used as light sources.

5.9.5 Exhibition platforms, whose height should not less than 1.0m and made of ice or other materials, should be set up in the lower part of the ice flower.

5.10 Snowscape Building Construction

5.10.1 Natural snow can be used for snow landscape building construction. Man-made snow could be used in the areas with less snow. The water ratio of man-made snow for large snow landscape building should be increased, and that for small snow landscape building should be reduced appropriately.

5.10.2 A mold of a snow billet should be firmly set up and installed layer by layer referring to the filling speed. The filling snow should be clean, and larger snow blocks and impurities are not allowed. The snow billet should be suppressed evenly and densely, and the density should follow the regulation in Table 3.2.1.

5.10.3 Snowscapes can be built by carving and shaping. Edges and corners should be smooth and the height difference of adjacent surfaces should not be less than 100mm.

5.10.4 The ornamentation of other materials on the snowscape should be firmly inlaid. Factors such as load-bearing and weathering should be taken into consideration. Large decorations should be reinforced or have an independent ground base.

5.10.5 After the completion of a small or medium-sized snowscape, surface treatment should be done to form a protecting coat.

5.10.6 Recreational facilities made of snow should be structurally strong, safe, and easily maintained.

5.11 Snow Sculpture Making

5.11.1 The snow sculpture should be designed according to the design requirements of snow base molds. The snow masonry should be compacted and the compaction should meet the design requirements.

5.11.2 The snow masonry base dimensions of art sculpture competition should be based on the game time, weather conditions, the theme of the requirements. The display effect should be reasonably determined already. In addition to the special requirements, the dimensions of length, width and height should be 3000mm×3000mm×5000mm.

5.11.3 The facade of snow sculptures should avoid direct sunlight and whole backlight. The orientations should choose illumination angle with better side light to highlight the stereoscopic sensation of snow sculptures.

5.11.4 The making process should be completed up to down and step by step, and should not make repeated adjustments.

5.11.5 The base of snow sculpture works should be used, and the base should be solid and serve as a foil to the theme landscape.

5.11.6 The performance of snow sculptures should be exaggerated, highlighting style and emphasizing outline. The sculpture form should be rough, clear with precise longitudinal and transverse lines and edges.

5.11.7 Should fully consider the influences of maintenance, conservation and weathering of the snow sculptures.

5.11.8 The illumination for nighttime viewing snow sculptures should use cold light source which placed in reasonable positions and should not influence the ornamental effect of the works.

5.11.9 The lighting fixtures should be selected according to the design requirements, rational allocating the main lights, side lights, background lights, contour lights, choose the colors meet the theme, and contorting frequencies according to the effect.

5.11.10 The regular maintenance should be conducted based on the weathering degree, maintaining a good ornamental effect.

6 Construction of Power Distribution and Illumination

6.1 Construction of Power Distribution Cable

6.1.1 Aluminum alloy cable which can work normally at or below −25℃ should be used and meet the insulation requirements.

6.1.2 Selection of low-voltage cables and its cross-section should meet the following regulations:

1 Four-core cable should be used when the type of grounding is TN-C and the guard wire shares the same conductor with the neutral wire.

2 Five-core cable should be used when the grounding type is TN-S and the guard wire and neutral wire are mutually independent.

3 Four-core cable should be used when the grounding type is TT.

4 When the neutral point of the electric power source below 1kV grounds directly, the cross-section of neutral conductors of quadruple three-phase cable should meet the requirement for maximum unbalanced electric current to work continuously. The effect of the harmonic current on circuit should be taken into consideration and comply with the following principles:

1) The cross-section of neutral conductors should be no less than that of phase circuits when gas discharge lamps are the main load on the circuit;

2) The cross-section of neutral conductors should be no less than 1/2 of that of phase circuits for other loaded circuits.

5 When single-core cable is used as the grounding wire (PE), the cross-section area of neutral and protective conductors should match the regulation in Table 6.1.2. Cross section of neutral grounding wire should meet the following regulations:

1) Area of copper core should be not less than $10mm^2$;

2) Area of aluminum core should be not less than $16mm^2$.

6 Area of cross section of protective grounding wires should meet the requirements of protecting the reliable action of appliances in circuits. It should accord with the regulations in Table 6.1.2.

Table 6.1.2 The permissible minimum area of the protective conductor qualifiedfor heat stability (mm^2)

Cross section of phase circuits (S)	The permissible minimum area of the cross section of protective conductors
$S \leqslant 16$	S
$16 < S \leqslant 35$	16
$S > 35$	S/2

7 Since circuits of alternating current consist of many parallel cables, conductors made of the same material and with the same cross section should be used.

6.1.3 Cables should be delivered to the worksite with quality certificate, product safety certificate, product inspection report or other valid documents.

6.1.4 Appearance inspection and insulation test of cables should be made before the cables are sent to the worksite. The following regulations should be met:

1 The protective layer should not be impaired;

2 The insulated layer should not be damaged. No flattening, distortion and loose winding of cable will be allowed. Obvious trademarks and factory marks should be labeled on the external coat of cold proof cable;

3 Insulation test should be made; an on- the -spot test report should be completed.

6.1.5 Cable handling should meet the following regulations:

1 Stevedoring of coil cable should be adopted when unloading. Coil cable cannot be kept flat or thrown directly off the vehicle;

2 Non-coiled cable should be coiled to its minimum bending radius and transported after being lashed down at four points. The cable must not be dragged on the ground. Centre yarn of the cable must be sealed up with lead or insulated. It must not be affected with damp.

6.1.6 Before installation, the cable should be kept at least 24 hours in the environment with a temperature of 10℃ or higher and be set up in order.

6.1.7 Laying cable should accord with the following regulations:

1 Cables should be inspected before laying to check if there is any damage on its surface.

2 Cables should not be intersected when laid; they should be laid in an orderly manner and fixed. A signboard should be placed above where the cable is buried. Installation of signboards should be determined by the following principles:

1) Signboards should be set at the beginning, ending, turning and connected joints of the cable;

2) The line number should be marked on the signboard. Cables connected in parallel should be numbered in sequence. Handwriting on the signboard should be clear and not be easy to erase. When there's is no label incorporated in the design, types, standard, staring and destination locations should be marked.

3 When the cable is laid, the ends of the cable should have reserve length. The direct-buried cable should keep 1.5% to 2% of the total length as redundancy, and should be laid in undee form.

4 Protective tubes and covers should be used when cables are buried in the ground or go through the icescape. Metal steel tubes should be used when the cable might be prone to mechanical damage. The protective tube extending out of the ice architectures should be longer than 250mm.

5 Prophylactic power cables with armour should be used in circuits of the electric power substation and box-type electric power substation, as well as all functional substations in subzones'. Steel tubes can also be added to power cables without armour and buried directly.

6 When the cable cannot be laid beneath the scenic areas, squares or roads, the cable should be protected with galvanized steel tubes and should be covered with cracked ice which is frozen by water and not protrude above the ground.

6.2 Illumination Construction

6.2.1 Lighting lanterns should be installed according to the design requirement. The installation inside the icescape should be synchronized with the construction of the ice architecture. Electricity detection should be done accordingly, insulated measures should be adopted, and no leakage of electricity is allowed.

6.2.2 Wires beneath the ground base of the icescape should be protected with tubes. Cryophylactic insulated degree of 0.45/0.75kV should be adopted when wiring. Copper-core rubber-sheathed wire or neoprene rubber-sheathed wire should be used.

6.2.3 Thermovent should be reserved when lights are installed inside the icescape.

6.2.4 Lamps inside the icescape should be easy to install, maintain and remove.

6.2.5 The lighting inside the icescape should be integrated. Connections between two lamps should be made with module sockets or flexible connections. Joints at the power lead should be kept damp proof and encapsulated.

6.2.6 Cryophylactic electronic ballast with thermo vents shall be water and damp proof.

6.2.7 Inductive electronic ballasts should be installed intensively inside the icescape, measures of heat insulation and galvanic isolation should be taken at the bottom of it.

6.2.8 Compact energy-saving fluorescent lamps or LED lamps should be used as the point light in public areas.

6.2.9 Inside the ice masonry, LED lamps should be used with good ventilation and heat dissipation space.

6.2.10 If the ice architecture is higher than 15m or bigger than $500m^3$, and an inspection channel is provided inside, a service port should be provided in the bottom or on the top of it.

6.2.11 Integrated lanterns should be installed on the stand when using project lamps or flood lights. Lamps on the stand should be able to rotate freely and make it easy to adjust the projecting angle.

6.2.12 When moldable LED lamp is used to illuminate the outline of the icescape, the distance of fixing points should be no more than 1.5m.

6.2.13 If the reactive power of gas discharge lights is too large, the diffused reactive power make-up should be done in the distribution boxes in the scenic area.

6.2.14 Illumination control in the scenic area should be controlled in situ or by using an integrated control in the duty room or electric power substation.

6.2.15 On duty and functional lighting should be provided after the scenic area is closed.

6.2.16 Power distribution wiring should conform to the following regulations:

1 The protective grounding electric conductor (PE) should be linked with the grounding main line and a series connection is not allowed. Metal framework, the component parts of lamps and lanterns, as well as metal tubes should be grounding with marks.

2 The color of the wire insulating layer which uses a polyphase power supply of the same landscape should be identical. The protective electric conductor (the line of PE) should choose double color wire of green and yellow. Light blue is suitable for zero line. For the color of phase conductors, A is yellow, B is green and C is red. The double color wire of green and yellow should not be chosen as load lines. The circuit mark of lighting and distribution boxes (or switchboards) should also be consistent. Load load names should be marked inside the distribution box (or switchboard) or at the bottom of the circuit breakers.

3 Floor-type or bracket-installed lamps in crowded pedestrian paths and other places, protective measures should be taken to avoid accidental electric shock.

6.2.17 The installment of distribution boxes (or switchboards) should meet the following regulations:

1 Distribute the wires in order, and avoid twisting joints. Leading wires should connect firmly without stressing the wires. The sectional area of underlying wires on both sides of gasket bolts should be identical. No more than 2 wires are allowed to be linked to branch-wires. Components such as locking gaskets should be well prepared.

2 Switches should be flexible and reliable. Specific leakage action current with protector of residual current should be no more than 30mA, the time less than 0.1s.

3 Cylinder manifold of zero line (N) and neutral conductor (the line of PE) should be set up inside the distribution box (or switchboard). Zero line and protective conductor should be distributed through the cylinder manifold.

4 Lightning protection and grounding electrical equipments of machines that can be connected to the PE line are strictly prohibited of installing switches or fuses. The repeat lightning protection and grounding electrical equipments on machine can use the same grounding. However, grounding resistance should meet the repeated grounding resistance requirements. The working power supply connection is strictly prohibited and none circuit breaker.

5 Power and lighting circuits connected to the same load line.

6.2.18 All kinds of measuring instruments, metering devices and related electric protection (or devices) on the electrical equipment for installation, adjustment and inspection, should be quality-assured after testing. They should be in service within the period of validity.

7 Acceptance Check

7.1 General Requirements

7.1.1 The quality control of the snow landscape building construction shall meet the following requirements:

1 The main materials, semi-finished products, finished products, architectural components, instrument and equipment used in the project shall be tested. Where related to safety, energy saving, environmental protection and main function of important materials, the products should be in accordance with the provisions of the various professional engineering codes for construction and acceptance standard and design documents to conduct re inspection, and shall be subject to supervision engineer's inspection and acceptance.

2 The construction procedures should be according to the construction technical standard for quality control, each construction process is completed, the construction unit after the self-inspection in accordance with the provisions, in order to carry out the next process of construction. The related working procedures shall be carried out for inspection and recordings.

3 For the important working procedures which the supervision units ask for inspection, it should be approved by the supervision engineer in order to carry out the next process of construction.

7.1.2 When the professional acceptance of the project in the acceptance of the project do not make the corresponding provisions, the construction unit shall be organized by the supervision unit, design, construction and other relevant units to develop special acceptance requirements. Involving safety, energy conservation, environmental protection and other items of the special inspection requirements shall be borne by related personnel of the construction unit.

7.1.3 The quality control of the snow landscape building construction shall be conducted acceptance according to the following requirements:

1 Process quality acceptance shall be carried out on the basis of the qualification of the construction unit;

2 Personnel participating in the project construction quality acceptance of the parties should have the appropriate qualifications;

3 The quality of inspection lot shall be according to the main control project and general project acceptance;

4 In the construction of safety, energy conservation, and environmental protection, and the test blocks, test pieces and materials of the main use of the functions should be conducted witness and inspection in accordance with the regulations when marching into the site or during the construction;

5 Concealed works shall be carried out after the construction unit conducts inspection and acceptance as well as the acceptance documents is formed, and continue construction only after the acceptance;

6 For the structure safety, energy conservation, environmental protection and use function in the important individual works, the sampling inspections shall be carried out in accordance with the regulations before the acceptance;

7 Appearance quality acceptance should be carried out on-site inspections by the project personnel for joint confirmation.

7.1.4 Partial and sub-projects of the snow landscape building construction should quote from Appendix D.

7.1.5 The sampling inspection of main control project quality shall all be qualified. The sampling inspection of general project shall be qualified. When using the counting sampling method, qualified rate shall be in accordance with the provisions of the code and requirements of acceptability criterion of the related professions, and there should be no serious defects.

7.2 Acceptance Check of Dominant Items of Ice Masonry

7.2.1 The intensity of ice blocks should meet the design requirements.

Test method: Check the test report on the intension of ice blocks.

7.2.2 Pure natural water or tap water should be used for freezing water.

Test method: Observation inspection and check the record of acceptance.

7.2.3 The structure contracture of ice blocks or staged treatment should meet the demands of the design.

Test method: Observation inspection and check the record of acceptance.

7.2.4 The installation of expansion joints of ice masonry should meet design requirements. If not, the regulation in Parag raph 5 of Article 4.4.15 should be met.

Test method: Observation inspection and check the record of acceptance.

7.2.5 The installation of lintels should meet design requirements. The regulations of Article 4.4.17 should be consistent with if the requirement is not stated.

Test method: check the record of acceptance.

7.2.6 The frozen area of water crack infusion should be no less than 80%.

Test method: Check the record of acceptance.

7.2.7 The quality of outside ice blocks should accord with the regulation of Article 5.5.1 and Article 5.5.6.

Test method: Observation inspection and check the record of acceptance.

7.2.8 The thickness of ice wall should meet design requirements.

Test quantity: Every inspection lot should be drawn out 10% for test; every wall space should have at least 2 tested points.

Test method: Check by measuring with a ruler.

7.2.9 The remainder of the oblique stubble should conform to the regulation in Paragraph 3 of Article 5.5.7.

Test method: Check the record of acceptance.

7.2.10 The width of ice seam should be not more than 2mm.

Test method: Observation inspection and check the record of acceptance.

7.2.11 Crushed ice padding should conform to the regulation in Article 5.5.9.

Test method: Observation inspection and check the record of acceptance.

7.2.12 The construction of curved beams should conform to the regulation in Article 5.5.10 and

Article 5. 5. 11.

Test method: Observation inspection and check the record of acceptance.

7. 2. 13 With the steel construction inside the ice masonry, the length of vertical steel bar overlap should not be less than 60*d* and 1200mm, the length of steel bar anchor should be not be less than 80*d* and 1500mm.

Test method: Check the record of acceptance.

7. 2. 14 The method of laying ice blocks should meet the requirements of Article 5. 5. 7.

Test method: Observation inspection and check the record of acceptance.

7. 2. 15 The length of the supportive profiled bar lintel should meet the demands of design. If no requirements are stated, it should not be less than 300mm.

Test method: check the record of acceptance.

7. 2. 16 The seam between reinforcing steel, profiled bar and ice should conform to the regulations in Section 5. 6.

Test method: Check the record of acceptance.

7. 2. 17 The location of horizontal reinforcing steel should be set up according to design requirements.

Test method: Check the record of acceptance.

7. 3 Acceptance Check of General Items of Ice Masonry

7. 3. 1 The external dimension deviation, check methods and sampling number of ice masonry construction should be accordance with the regulations in Table 7. 3. 1.

Table 7. 3. 1 The permissible external size deviation of ice masonry construction

Serial number	Item	Permissible Deviation (mm)	Test Methods	Sampling Quantity
1	Floor Height	±15	check by level gauge and ruler	not less than 4
2	Total Height	±30		
3	Surface Evenness	5	check by running ruler of 2m and wedged feeler gauge	check all the natural walls, every of which should be no less than 2
4	The Height and Width of Opening for Doors and Windows	±5	check by ruler	every test should draw out 50% and no less than 5
5	Upper and Lower Window Deviation	20	Follow the sublayer of window, check by altometer or suspension wire	every test should draw out 50% and no less than 5
6	Flatness of Horizontal Seam	7	draw a line of 10m and check by ruler	check all the external wall space, every of which should be no less than 2
7	Irregular Vertical Seam	20	check by suspension wire and ruler, follow the first peel of every layer	check all the external wall space, every of which should be no less than 2

Table 7.3.1(continued)

Serial number	Item		Permissible Deviation (mm)	Test Methods	Sampling Quantuty
8	Manhole Steps		High outside and low inside, no less than 10	draw a line and check by ruler	every test should draw out 30%, pick 3 points and should be no less than 5
9	Sideboard		±10		
10	Perpendicularity (m)	$H \leqslant 15$	±20	check by altometer, suspension wire and ruler	external wall, exposed corners of columns should not be less than 4, 1 for every 20m and should not be less than 4
		$H > 15$	$H/750$ and $\leqslant 50$		
11	Profile (axes), Length (L), Width B (m)	$L(B) \leqslant 30$	±20	check by altometer, suspension wire, ruler or other measuring instruments	all the external walls and internal load bearing walls
		$L(B) > 30$	±30		

7.4 Acceptance Check of Dominant Items of Snow Masonry

7.4.1 The intensity of snow masonry should conform to the design requirements.

Test method: Check the test report of snow masonry intensity.

7.4.2 The thickness of a snow masonry wall should meet the design requirements. If no requirements are stated, the thickness of wall whose height is no more than 6m should not be less than 800mm, while the thickness of wall whose height is more than 6m but less than 10m should not be less than 1000mm.

Test quantity: Every inspection lot should be drawn out 10% for test; every wall space should have at least 2 tested points.

Test method: Check by measuring with a ruler.

7.4.3 The size of the snow section should match design requirements.

Test quantity: Every inspection lot should be drawn out 10% for test; every wall space should have at least 2 tested points.

Test method: Check measuring with a ruler.

7.4.4 The profiled bar lintel of a jack-arch opening should be match design requirements. If no requirements are stated, conformance should be in accordance with the regulations in Table 4.5.15-1.

Test method: Observation inspection and check the record of acceptance.

7.4.5 The staggered joints length of upper masonry of a profiled bar lintel should be 1/2 that of snow masonry.

Test method: Observation inspection and check the record of acceptance.

7.4.6 The length of the supporting profiled bar lintel should not be less than 400mm.

Test quantity: Every inspection lot should be drawn out 10% for test; every wall space should have at least 2 tested points.

Test method: Check by measuring with a ruler.

7.4.7 The dome-shape snow should be constructed according to design requirements. If no requirements are stated, conformance should be in accordance with the regulations in Table 4.5.15-2.

Test method: Observation inspection and check the record of acceptance.

7.4.8 The profiled bar cantilever beam should match design requirements. If no requirements are stated, conformance should be in accordance with the regulations in Article 4.5.16.

Test method: Check the record of acceptance.

7.4.9 The snow-padding quality and density should meet the design requirements. If no requirements are stated, conformance should be in accordance with the regulations in Article 5.10.2.

Test method: Check the record of acceptance.

7.4.10 The tessara construction of snowscapes should match the regulations in Article 5.10.4.

Test method: Check the record of acceptance.

7.4.11 The construction of recreational snow facilities matches the regulations of Articles 4.3.9 and 5.10.6.

Test method: Check the record of acceptance.

7.5 Acceptance Check of General Items of Snow Masonry

7.5.1 The permissible external size deviation, check methods and sampling number of snow masonry construction match the regulations in Table 7.5.1.

Table 7.5.1 The permissible external demension deviation of snow masonry construction

Serial number	Item		Permissible Deviation (mm)	Test Methods	Sampling Quantity
1	Floor Height		±15	check by level gauge and ruler	no less than 4
2	Total Height		±30		
3	Surface Evenness		5	check by running rule of 2m and wedged feeler gauge	check all the natural walls, every of which should be no less than 2
4	The Height and Width of Opening for Doors and Windows		±5	check by ruler	every test should draw out 50% and no less than 5
5	Upper and Lower Window Deviation		20	follow the sublayer of window, check by altometer or suspension wire	every test should draw out 50% and no less than 5
6	Sideboard		± 10	draw a line and check by ruler	every test should draw out 30%, pick 3 points and should be no less than 5
7	Perpendicularity (m)	$H \leqslant 15$	±20	Check by altometer, suspension wire and ruler	external wall, exposed corners of columns should be less than 4, 1 for every 20m and should not be less than 4
		$H > 15$	$H/750$ and $\leqslant 50$		
8	Profile (axes), Length (L), Width B(m)	$L(B) \leqslant 30$	±20	check by altometer, suspension wire, ruler or other measuring instruments	all the external walls and internal load bearing walls
		$L(B) > 30$	±30		

7.6 Acceptance Check of Power Distribution and Illumination

7.6.1 Acceptance Check of Power Distribution and Illumination should be accordance with the following requirements:

1 The acceptance shall be conducted by the construction unit in conjunction with the supervision, design, construction (including sub-units), complete sets of equipment manufacturers, etc., in the construction unit on the basis of self-inspection;

2 Power cable construction, lighting engineering construction, lightning protection and grounding should meet the requirements of this regulation, and should be completed in accordance with Appendix C;

3 Power distribution and illumination works in the outdoor electric, variable power distribution room, main-supply, electrical power, standby and uninterrupted power supply sub-branch of engineering acceptance of sub projects should be combined with ice and snow area specific situations and the relevant professional acceptance criteria for acceptance,. The projects related to the sub projects should be implemented in accordance with the provisions of existing national standard, *Unified Standard for Constructional Quality Acceptance of Building Engineering*, GB 50300 and fill out the acceptance records according to Appendix C;

4 Acceptance of the sub projects of power distribution and illumination should be fully accepted and approved.

7.6.2 Power distribution and illumination equipment, materials, finished products and semi-finished products in the ice and snow landscape buildings should provide quality certification information when entering into the site. For the new electrical equipment, equipments and materials should provide installation, use, maintenance and test requirements and other technical information when entering into the sit.

7.6.3 Tests of power distribution and illumination projects shall meet the following requirements:

1 Leakage protection devices of power and lighting should be carried out of simulated action test, and make the test records.

2 The uninterrupted preliminary operating time of energizing with full loads of large architecture lighting system within the ice and snow landscape should be no less than 24h, while that within ice landscapes should be no less than 12h and trouble free.

3 Lamps of preliminary operate with full loads should be open. The operating situation should be recorded every 2 hours.

4 Lamps, circuit breakers, starters, controllers, strobe and light controllers should be tested for low temperature resistance before operation. Repeated startup should not be less than 10 times and the energizing uninterrupted preliminary operating time should be more than 24 hours. Each time in the starting test of gas discharge lamps, the interval between start and stop should be not less than 15 minutes; repeated setup should be not less than 5 times. Phenomena like overheating, electricity leakage, scintillation, decay of power, exceeding starting time or abnormal starting should be avoided.

5 With the normal operation of voltage drop, the permissible deviation of terminal voltage of power consumption equipment like lighting and electromotor (if shown by the percentage of rated voltage) is $\pm 5\%$. Monitoring surveys should be recorded.

8 Maintenance Management

8.1 Monitoring

8.1.1 Temperature monitoring of ice and snow landscapes in use should be done and the following regulations should be conformed to:

1 At least 1 representative ice and snow landscape should be selected as a monitoring target for every sector in the scenic area;

2 An icescape building higher than 12m or a snow landscape building higher than 9m should be used as the monitoring target;

3 Main structural parts or parts exposed to the sun should be selected as monitored targets. The distribution of the monitoring points should reflect the actual situation of temperature variation;

4 8:00, 14:00, 20:00 are appropriate monitoring periods. When the temperature of the monitoring point is close to the design temperature, monitoring times should be added and properly analyze the data and the deformation so as to take relevant measures.

8.1.2 The sedimentation and deformation monitoring of the ice and snow landscapes should be taken.

8.1.3 The ice and snow landscape building masonry should be maintained and removed according to the monitoring results of temperature and deformation. Corresponding maintenance measures should be taken when cracks, looseness and weathering appear locally in the ice and snow landscape building, which may affect the viewing effect by temperature, daylight and wind.

8.2 Maintaining

8.2.1 Professional and technical staff should be organized to make specific inspections of ice and snow landscapes in use. The following regulations should be conformed to:

1 Special examination should include the structural safety state of ice and snow masonry and the safe operating state of power equipment;

2 The structural safety state of ice and snow masonry should focus on deformation monitoring at an early period and on temperature monitoring in the later period. During the examination, one should monitor the temperature and deformation in the masonry's main structural parts in the monitored target;

3 The safety examination of power equipment should focus on the operating states and records of all kind of apparatus;

4 The inspection should include the operating state of impression quality, anti-skid facilities, safeguarding measures, power distribution and illumination circuits, lamps and lanterns of the distribution box or switchboard;

5 Special examination should be done once a day, while the inspection tour should be made once both before and after exhibition each day. Examinations should be increased if abnormal environmental temperature variation appear;

6 After every examination, maintenance schemes should be made on the basis of the related data and this Standard.

8.2.2 The following situations in operation need immediate maintenance:

1 The surface is polluted by snow and/or dust, etc.;

2 The ice masonry melts due to lamps inside so that holes are produced;

3 Viewing effect is influenced because of the appearance of honeycomb and pitted surfaces in the snowscape;

4 Severe weathering and partial deformation through melting. The appearance of cracks on the ice surface and absorption, wind erosion caused by adhesive joint ice seams, together with partial looseness and collapse;

5 The appearance of seams between ice or snow masonry and structural components;

6 Foundation deformation;

7 Other situations such as partial damage that affect impression quality;

8 The ice and snow landscape architecture which needs maintaining at any time.

8.2.3 Protection measures, anti-skid facilities and warning signs of recreational facilities should be maintained, strengthened or changed as needed.

8.2.4 After the completion of watering the icescape, maintenance should be made every 5 days. Water spraying should be supplemented in time to keep landscapes in good condition.

8.2.5 When the ice and snow landscape buildings reach the design temperature value for 5 consecutive days, it should be taken the measures to prohibit personnel into the upper and internal spaces, going out of service and etc.

8.3 Dismantling

8.3.1 The ice and snow landscape buildings should be dismantled when one of the following circumstances occurs:

1 If the daily maximum temperature is above 0℃ successively for 5 days;

2 If obvious displacement and slope appear which may lead to danger;

3 If the surface or parts of the landscapes are melted and the visual effect loses.

8.3.2 When the ice and snow landscape buildings are dismantled, the reusable equipment and materials should be recycled in time.

8.3.3 When removing ice and snow landscape buildings, environmental protection measures should be taken, and the environment of scenic spots should not be polluted.

8.3.4 Ice and snow landscape demolition should be based on the actual situation to take measures such as mechanical, artificial, blasting, natural melting and etc.

Appendix A　Influence Coefficients of Bearing Capacity of Ice Masonry

Table A　Influence coefficients of bearing capacity of ice masonry φ

Ratio of height to thickness β	Relative eccentricity $\frac{e}{h}$						
	0.00	0.05	0.10	0.15	0.20	0.25	0.30
3	1.00	0.89	0.78	0.70	0.61	0.58	0.55
4	1.00	0.88	0.76	0.68	0.60	0.57	0.54
5	1.00	0.87	0.73	0.66	0.59	0.56	0.52
6	1.00	0.86	0.71	0.65	0.58	0.55	0.51
7	1.00	0.85	0.69	0.63	0.57	0.53	0.49
8	1.00	0.84	0.68	0.62	0.56	0.52	0.47
9	1.00	0.83	0.66	0.60	0.54	0.50	0.45
10	1.00	0.82	0.65	0.59	0.53	0.49	0.44

Notes: 1　e——eccentricity of axial force;

2　h——side length of regular section which is parallel to axial force.

Appendix B Influence Coefficients of Bearing Capacity of Snow Masonry

Table B Influence coefficients of bearing capacity of snow masonry φ

Ratio of height to thickness β	Relative eccentricity $\frac{e}{h}$						
	0.00	0.05	0.10	0.15	0.20	0.25	0.30
2	1.00	0.91	0.82	0.71	0.60	0.53	0.45
3	1.00	0.89	0.79	0.70	0.60	0.53	0.45
4	1.00	0.88	0.76	0.66	0.55	0.50	0.44
5	1.00	0.87	0.73	0.62	0.51	0.46	0.40
6	1.00	0.85	0.70	0.59	0.47	0.42	0.37
7	1.00	0.84	0.67	0.56	0.43	0.38	0.34
8	1.00	0.83	0.64	0.53	0.39	0.34	0.31

Notes: 1 e——eccentricity of axial force;

2 h——side length of regular section which is parallel to axial force.

Appendix C Records of Engineering Quality Acceptance

C. 0. 1 The record of inspection lot is completed by a specialized quality inspector of the construction project, and the supervision engineer should arrange for the specialized quality inspector to check and record according to Table C. 0. 1.

Table C. 0. 1 The record of Quality Acceptance for Inspection ______ No. ____

Unit (sub-unit) works name			Branch (sub-branch) works name		Individual works name	
Construction unit			Project manager		Capacity of inspection lots	
Subcontracting unit			Project manager of subcontracting unit		Position of inspection lot	
Construction basis				Acceptance basis		
Acceptance items			Design requirements and standard	Minimum / actual number of samples	Inspection records	Inspection results
Major items	1					
	2					
	3					
	4					
	5					
	6					
	7					
General items	1					
	2					
	3					
	4					
	5					
Inspection results of construction unit			Professional foreman: Specialized quality inspector of project: Date:			
Inspection results of supervisor			Professional supervising engineer: Date:			

Notes: Acceptance records shall be filled out by the construction unit, and the acceptance conclusion shall be filled out by the supervision unit. Comprehensive acceptance of the conclusion should be filled in by the construction unit and agreed by the parties participating in the acceptance. Giving opinions and making comments on whether the quality of the project is in accordance with the design documents and the relevant standard and the overall quality level.

C. 0. 2 The quality of individual works should be checked by the specialized technical leader of the project organized by the supervision engineer (specialized technical manager of the project of the construction unit) and recorded according to the Table C. 0. 2.

Table C. 0. 2 The Quality Acceptance Record of Individual Works ______ No. ____

Unit (sub-unit) works name		Branch (sub-branch) works name			
Engineering quantity of individual works		Quantity of inspection lots			
Construction unit		Project manager		Technical manager of the project	
Subcontract unit		Project of subcontract unit		Subcontract content	

No.	Name of inspection lot	Capacity of inspection lot	Parts / sections	Inspection results of construction unit	Inspection results of supervisor

Description:	
Inspection results of construction unit	Specialized technical leader of project: Date:
Inspection results of supervisor	Professional supervising engineer: Date:

C. 0. 3 The quality of the branch (sub-branch) project should be checked by project manager of construction organization and related managers of prospecting and design organization organized by Chief supervision engineer (Professional technical leader of the construction unit project) and filled out in Table C. 0. 3.

Table C. 0. 3 The Record of Engineering Acceptance for Branch Works of ______ No. ____

Unit (sub-unit) works name		Engineering quantity of sub-branch works		Engineering quantity of individual works	
Construction unit		Project manager		Technical (quality) leader	
Subcontract unit		Leader of subcontract unit		Subcontract content	
No.	Name of branch works	Name of individual works	Quantity of inspection lot	Inspection results of construction unit	Inspection results of supervisor
Quality control materials					
Report of safety and functional inspection (test)					
Acceptance of Impression quality					
Conclusions of comprehensive inspection					
Construction unit Project manager: Date:		Surveying unit Project manager: Date:	Design unit Project manager: Date:	Supervisor Chief supervision engineer: Date:	

Notes: 1 Construction, surveying, design units and chief supervision engineers shall participate in and sign the acceptance of foundation and basic division of engineering;

2 The acceptance of the main structure shall be attended and signed by the construction and design unit project leaders and the chief supervision engineers.

C. 0. 4 Acceptance check should be recorded according to Table C. 0. 4-1, which is the collective table and should be used together with Table C. 0. 4-2 is the checking record of quality control materials. Table C. 0. 4-3 is the acceptance of safety and functional testing materials together with the selective inspecting record of main functions. Table C. 0. 4-4 is the checking record of impression quality.

Table C. 0. 4-1 The Acceptance Record of Completion of Unit Project Quality

<table>
<tr><td>Project name</td><td></td><td>Structural type</td><td></td><td>Number of layers/ area of construction</td><td></td></tr>
<tr><td>Construction unit</td><td></td><td>Technical principal</td><td></td><td>The starting date</td><td></td></tr>
<tr><td>Project manager</td><td></td><td>Technical principal of the project</td><td></td><td>The ending date</td><td></td></tr>
<tr><td>No.</td><td>Project</td><td colspan="3">Record of acceptance</td><td>Acceptance Conclusion</td></tr>
<tr><td>1</td><td>Acceptance of branch works</td><td colspan="3">Altogether there are __ branches
After the inspection, the branches which accord with standard and design requirements are __</td><td></td></tr>
<tr><td>2</td><td>Quality control & material check</td><td colspan="3">Altogether there are __ items
__ items conform to requirements after inspection</td><td></td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Safety and main function check & random inspection</td><td colspan="3">Altogether __ items are checked
__ items meet the requirements after inspection</td><td rowspan="3"></td></tr>
<tr><td colspan="3">__ items are of random inspection
__ items conform to requirements after inspection</td></tr>
<tr><td colspan="3">__ items of which are qualified after reworking</td></tr>
<tr><td>4</td><td>Acceptance of view quality</td><td colspan="3">__ items are of random inspection
__ items are qualified with “excellent” and “good”
__ items of which are qualified after reworting</td><td></td></tr>
<tr><td colspan="2">Comprehensive inspecting Conclusion</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Participating acceptance units</td><td>Building unit</td><td>Supervisor</td><td>Construction unit</td><td>Design unit</td><td>Surveying unit</td></tr>
<tr><td>(seal)
Project manager:
Date:</td><td>(seal)
Chief supervision engineer:
Date:</td><td>(seal)
Project manager:
Date:</td><td>(seal)
Project manager:
Date:</td><td>(seal)
Project manager:
Date:</td></tr>
</table>

Notes: Unit acceptance of the project, the signature should be authorized by the corresponding unit of legal representative authorized by the unit.

Table C. 0. 4-2 The Checking Record of Quality Control Material

Project name				Construction unit				
No.	Project	Material name	Copies	Construction unit		Supervisor		
				Inspecting suggestions	Inspector	Inspecting suggestions	Inspector	
1	Construction & structure	Drawing inspection, change of design, discussion record.						
2		Raw material factory certificate of acceptance and inspection (test) report						
3		Checking acceptance of concealed project						
4		Construction Record						
5		System testing and commissioning record						
6		System technical, operating and maintenance manual						
7		System management and operating personnel training records						
8		System test report						
9		Quality acceptance record of branch and individual works						
10		Records of new technology demonstration, putting on file and construction						
1	Power distribution and illumination	Drawing inspection, change of design, discussion record.						
2		Raw material factory certificate of acceptance and inspection (test) report						
3		Equipment testing record						
4		Grounding and insulation resistance test record						
5		Checking acceptance of concealed project						
6		Construction Record						
7		Quality acceptance record of branch and individual works						
8		Records of new technology demonstration, putting on file and construction						

Conclusion:

Project manager of construction unit: Chief supervision engineer:

Date: Date:

Table C. 0. 4-3 The Safety and Function Inspection of Survey Data and Random Inspection Record of Main Function

Project Name			Construction Unit			
No.	Project	The inspection items of safety and function	Copies	Checking Suggestions	Inspection results	Inspector
1	Construction & structure	Test report of ground bearing capacity				
2		Test report of bearing capacity of pile foundation				
3		Concrete strength test report				
4		Body structure size and location sampling records				
5		Building verticality and elevation, full height measurement records				
6		Record of building settlement observation				
7		Activity and entertainment project trial record				
1	Building electricity	Building lighting test running record				
2		Load strength test record of fixture and suspension device				
3		Insulation resistance test record				
4		Residual current action protector test record				
5		Emergency power supply time record of emergency power supply device				
6		Grounding resistance test record				
7		Pedestrian street, such as crowded places lamps anti shock measures to check records				
8		Action current and time test record of leakage protection device				
9		Sensitivity test record of electrical protection measurement instrument				

Conclusion:

Project manager of construction unit　　　　　　　　Chief supervision engineer:

Date:　　　　　　　　　　　　　　　　　　　　　　　Date:

Notes: Spot checks by the inspection group of the project consultation.

Table C. 0. 4-4　Record of View Impression Quality Acceptance

Project name			Construction unit	
No.	Project		Quality state of random inspection	Estimation of quality
1	Construction & structure	The main structure appearance	Total ____points，____points good，____points average，____points bad	
2		External walls	Total ____points，____points good，____points average，____points bad	
3		Deformation seams	Total ____points，____points good，____points average，____points bad	
4		Roofs	Total ____points，____points good，____points average，____points bad	
5		Internal walls	Total ____points，____points good，____points average，____points bad	
6		Ceiling	Total ____points，____points good，____points average，____points bad	
7		Floor	Total ____points，____points good，____points average，____points bad	
8		Stairs，treads，railings	Total ____points，____points good，____points average，____points bad	
9		Doors & windows	Total ____points，____points good，____points average，____points bad	
10		Steps，ramps	Total ____points，____points good，____points average，____points bad	
1	Building electricity	Distribution box，plate，plate，junction box	Total ____points，____points good，____points average，____points bad	
2		Equipment，and instruments，switches，sockets	Total ____points，____points good，____points average，____points bad	
3		Lightning protection，grounding，fire protection	Total ____points，____points good，____points average，____points bad	
4		Leakage protection device for distributionbox (switchboard)	Total ____points，____points good，____points average，____points bad	
5		Distribution box (switchboard) N line and PE line configuration，	Total ____points，____points good，____points average，____points bad	
6		Lighting quality，illumination level and effect	Total ____points，____points good，____points average，____points bad	
Overall evaluation of impression quality				
Conclusion： Project manager of construction unit：　　　Chief supervision engineer： Date：　　　Date：				

Notes：1　Projects that quality evaluation is bad should be reworked；

2　Original records of impression quality site inspection should be kept as the attachment of the table.

Appendix D　Division Works of Ice and Snow Landscape Buildings

Table D　Division Works of Ice and Snow Landscape Buildings

No.	Branch works		Individual works
1	Foundations		Water frozen foundation，gravel foundation，assembled masonry ice foundation，wood pile foundation，steel foundation，dynamic compaction foundation，other
2	Main structure of ice masonry structure landscape construction		Ice masonry structure，reinforcement assembled ice masonry structure，steel structure，crashed ice infilling，ice arch，cantilever
3	Main structure of snow structure landscape construction		Templates，snow base，snow infilling，tessera
4	Building electricity	Outdoor electricity	Transformer；box type substation installation；whole suite of distribution cabinets；control cabinet（screen，table）and power；lighting distribution box (panel) and control cabinet installation；ladder frame，bracket，tray and slot box installation；conduit laying；cable laying；tube thread and laying within slot box；cable head fabrication，wire connection and routing insulation test；ordinary lamps installation；dedicated lamps installation；building lighting trial with power；grounding device installation
5		Substation & distribution room	Transformer；box type substation installation；whole suite of distribution cabinets；control cabinet（screen，table）and power；lighting distribution box (panel) installation；busway installation；ladder frame，bracket，tray and slot box installation；cable laying；cable head fabrication，wire connection and routing insulation test；grounding device installation；laying of grounding main line
6		Main line of power supply	Electrical equipment test and trial；busway installation；ladder frame，bracket，tray and slot box installation；conduit laying；cable laying；tube thread and laying within slot box；cable head fabrication，wire connection and routing insulation test；laying of grounding main line
7		Electrical power	Whole suite of distribution cabinets；control cabinet (screen，table) and power distribution box（panel）installation；electric motor，electric heater and power executor Inspection wiring；electric equipment test and trial；ladder frame，bracket，tray and slot box installation；conduit laying；cable laying；tube thread and laying within slot box；cable head fabrication，wire connection and routing insulation test
8		Electrical lighting	Whole suite of distribution cabinets；control cabinet (screen，table) and power distribution box（panel）installation；ladder frame，bracket，tray and slot box installation；tube thread and laying within slot box；plastic protective cased line straight laying and cabling；steel cable wiring；cable head fabrication，wire connection and routing insulation test；ordinary lamps installation；dedicated lamps installation；switch，socket and fan installation；building lighting trial with power
9		Standby and UPS	Whole suite of distribution cabinets；control cabinet (screen，table) and power；lighting distribution box (panel) installation；diesel generator unit installation；UPS device and emergency power supply device installation；busway installation；conduit laying；cable laying；tube thread and laying within slot box；cable head fabrication，wire connection and routing insulation test；grounding device installation
10		Lightning proof and grounding	Grounding device installation；lightning proof down lead and lighting arrester installation；potential connection for buildings and so on；surge protector installation

Explanation of Wording in This Standard

1 For the convenience of application of this regulation in terms of strictness, the words of different level are explained as follows:

1) Words expressing extremely rigorous and inevitable:

Positive: must Negative: must not;

2) Words expressing rigorous and should be done under normal circumstances:

Positive: shall Negative: shall not;

3) Words expressing an alternative can be primarily done if the conditions permit:

Positive: should Negative: should not or cannot;

4) Words expressing an alternative and can be done under given conditions: may/can/could.

2 Provisions should be specified in accordance with other relevant standard should be drafted as follows: "Shall meet the requirements of......" or "Shall comply with......".

List of the Quoted Standards

1. *Code for Design of Masonry Structures* GB 50003
2. *Load Code for the Design of Building Structures* GB 50009
3. *Standard for Lighting Design of Buildings* GB 50034
4. *Code for Design of Low Voltage Electrical installations* GB 50054
5. *Unified Standard for Constructional Quality Acceptance of Building Engineering* GB 50300
6. *Limited Values of Energy Efficiency and Evaluating Values of Energy Conservation of Ballasts for Tubular Fluorescent Lamps* GB 17896