# TSG

TECHNICAL SAFETY REGULATION FOR SPECIAL EQUIPMENT

## TSG 71-2023

# Regulation on safety technology for large-scale amusement facilities

大型游乐设施安全技术规程

**Issued on: November 29, 2023, Implemented on: November 29, 2023**

**Issued by: State Administration for Market Regulation**

# Table of Contents

# Regulation on safety technology for large-scale amusement facilities

## 1 General

### 1.1 Purpose

In order to ensure the safe use of large-scale amusement facilities, prevent and reduce accidents, protect personal and property safety, promote economic and social development, this Regulation is formulated, in accordance with the "Special Equipment Safety Law of the People's Republic of China" and "Special Equipment Safety Supervision Regulations".

### 1.2 Meaning of large-scale amusement facilities

The term "large-scale amusement facilities" as mentioned in this Regulation refers to the equipment and facilities used for business purposes to carry passengers for amusement; its scope is specified as the manned electromechanical amusement equipment, water amusement facilities, unpowered amusement facilities (Note 1-3), which have the designed maximum operating linear speed (Note 1-1) greater than or equal to 2 m/s, or the operating height (Note 1-2) higher than or equal to 2 m. Equipment and facilities used for sports, theatrical performances, non-business activities are excluded. The specific categories and varieties are specified in the "Special Equipment Catalog".

Large-scale amusement facilities include the body of the large-scale amusement facility, ancillary equipment that is inseparable from its safe operation, decorations fixed on its body, excluding the power distribution part, foundation and building (structure) part of the large-scale amusement facility.

Note 1-1: The design maximum operating linear speed (hereinafter referred to as operating speed) refers to the maximum linear speed, that passengers may experience during normal operation of the designed large-scale amusement facilities.

Note 1-2: The operating height generally refers to the maximum vertical distance between the passenger restraint supporting surface and the installation base surface during operation. For large-scale amusement facilities installed on buildings (structures), the operating height refers to the maximum vertical distance between the passenger restraint supporting surface and the drop surface during the operating process. The operating height of the high-altitude bungee refers to the maximum vertical distance between the take-off point and the water surface or the ground with the lowest drop. The operating height of the water slide refers to the maximum

vertical distance between the take-off point and the water surface or the ground with the lowest drop.

Note 1-3: The operating speed and operating height are generally judged, based on the product design data of the manufacturer. The manufacturer shall ensure that the actual operating parameters are consistent with the design data and parameters in the product quality certification document.

### 1.3 Scope of application

This Regulation applies to the production (including design, manufacturing, installation, modification, repair), use, inspection, testing, supervisory management of large-scale amusement facilities.

Ancillary equipment of large-scale amusement facilities, if it belongs to other types of special equipment (such as pressure vessels, pressure pipes, elevators, etc.), shall be managed in accordance with the requirements of the corresponding equipment.

### 1.4 Classification and grading of large-scale amusement facilities

Large-scale amusement facilities are divided into grade A and grade B, according to the corresponding categories, types, parameters. See the classification and grading table of large-scale amusement facilities (Appendix A).

### 1.5 Relationship with technical standards and management systems

This Regulation stipulates the basic safety requirements for large-scale amusement facilities. The technical standards and management systems of large-scale amusement facilities shall not be lower than the requirements of this Regulation.

### 1.6 Handling of special situations

If large-scale amusement facilities use new materials, new technologies, or new processes that are inconsistent with the requirements of this Regulation, or if this Regulation does not make requirements and may have a significant impact on safety performance, the relevant organizations shall make application to the State Administration for Market Regulation (hereinafter referred to as SAMR). The State Administration for Market Regulation shall entrust a safety technical consulting agency or relevant professional institution to conduct a technical review. The review results shall be approved by the State Administration for Market Regulation, before it can be put into production and use.

### 1.7 Supervisory management

Organizations that produce, operate, use large-scale amusement facilities, as well as inspection and testing agencies, etc., shall strictly implement this Regulation; accept the supervisory management of the market supervisory management department;

submit relevant information in a timely manner in accordance with the relevant provisions of the information management of special equipment.

# 2 Materials

## 2.1 General requirements

The selection of materials for large-scale amusement facilities shall be comprehensively considered based on factors such as their load characteristics, structural type, stress state, manufacturing process, working environment.

## 2.2 Metal materials

### 2.2.1 Steel

(1) Steel shall comply with relevant national or industry standards; its mechanical properties, heat treatment properties, welding properties, etc. shall meet the requirements of actual working conditions;

(2) When the thickness direction performance steel plate is used as the welded load-bearing structural steel plate, the performance level in thickness direction shall at least meet the requirements of Z15 in GB/T 5313 "Steel plate with through-thickness properties";

(3) It is prohibited to use boiled steel for structural parts.

### 2.2.2 Non-ferrous metals

Nonferrous metals shall comply with relevant national or industry standards. Their mechanical properties, heat treatment properties, welding properties, wear resistance, corrosion resistance, lubrication properties, etc. shall meet the requirements of actual working conditions.

## 2.3 Non-metallic materials

### 2.3.1 Wood

Wood shall comply with the requirements of GB 50005 "Standard for design of timber structures". Its mechanical properties, corrosion resistance, combustion performance, etc. shall meet the requirements of actual working conditions.

### 2.3.2 Engineering plastics

Structural engineering plastics shall comply with relevant national or industry standards. Their mechanical properties, heat resistance, aging resistance, etc. shall meet the requirements of actual working conditions.

### 2.3.3 Rubber

Rubber shall meet the requirements of relevant national or industry standards. Its mechanical properties, aging resistance, corrosion resistance, etc. shall meet the requirements of actual working conditions.

### 2.3.4 Glass

The glass shall be made of plexiglass or safety glass that is not easily broken. The plexiglass sheets shall comply with the requirements of GB/T 7134 "Poly (methyl methacrylate) cast sheets". The safety glass shall comply with the requirements of GB 15763 "Safety glazing materials in building".

The mechanical properties, thermal shock resistance, appearance quality of glass shall meet the requirements of actual working conditions.

### 2.3.5 FRP

FRP materials and FRP parts shall meet the following requirements:

(1) The resin used to make fiberglass parts has good water resistance and aging resistance;

(2) The fiberglass of the water slide slideway is made of alkali-free glass fiber; the fiber surface has good wettability;

(3) FRP parts are not allowed to have defects such as poor impregnation, poor curing, blisters, delamination on the cutting surface, uneven thickness, etc.;

(4) The surface of FRP is not allowed to have cracks, damage, exposed cloth lines, wrinkles, uneven unevenness; it shall have smooth corner transitions, without burrs;

(5) The mechanical properties of FRP meet the requirements of actual working conditions.

# 3 Design

## 3.1 General requirements

(1) The manufacturer is responsible for the design of large-scale amusement facilities, ensuring that the design of large-scale amusement facilities meets the requirements of this Regulation and ensuring the safety of people and property;

(2) The design of large-scale amusement facilities shall be reasonable, convenient for operation, maintenance, inspection and testing; meet the requirements of the use site and environment;

(1) Normal operating conditions under no-load, partial load, full load conditions;

(2) Abnormal operating conditions under emergency stop, emergency rescue, maintenance, etc.;

(3) Limit state conditions under local extreme conditions, such as typhoons and earthquakes.

### 3.3.4 Load combinations

According to the working condition analysis, load combinations of various loads borne by the large-scale amusement facility structure are analyzed and calculated separately. Load combinations under abnormal operating conditions and limit state conditions shall not cause damage or plastic deformation of the structure.

### 3.3.5 Static strength

For large-scale amusement facilities designed using the allowable safety factor method, the static strength safety factor is $n \geq 5$ for important shafts (pins) and important welds (Note 3-2); the static strength safety factor is $n \geq 3.5$ for other parts, welds and FRP; the static strength safety factor $n \geq 8$ for parts made of brittle materials.

For large-scale amusement facilities using the limit state design method, the static strength of metal parts shall comply with the requirements of the limit state design method in GB 8408 "Large-scale amusement device safety code".

The calculation of wooden structures shall comply with the requirements of GB 50005.

Note 3-2: The ratio -- of the material's ultimate stress to the calculated maximum stress -- is the static strength safety factor.

### 3.3.6 Fatigue strength

The main stressed parts and important welds shall be checked for fatigue strength. When the maximum calculated stress of the cyclic load is less than the fatigue limit of the material, the main stressed parts have an infinite life. When the maximum calculated stress of the cyclic load is greater than the fatigue limit of the material, the design service life of the main stressed components shall be calculated and analyzed in conjunction with the fatigue load spectrum.

### 3.3.7 Stiffness

For components and structural parts with deformation requirements, it shall perform stiffness calculations.

### 3.3.8 Stability

To prevent structural instability, overall and local stability calculations shall be

performed for slender, thin-walled structural members.

### 3.3.9 Anti-overturning

Large-scale amusement facilities, that are likely to overturn as a whole during operation, shall undergo anti-overturning calculations.

### 3.3.10 Anti-slip sideways

Large-scale amusement facilities, that are likely to slip sideways during operation, shall be subject to anti-sideslip calculations.

## 3.4 Speed and acceleration

### 3.4.1 Speed limit requirements

For large-scale amusement facilities that operate while loading and unloading passengers OR synchronous platforms that assist passengers to get on and off, their relative running speed shall not be greater than 0.3 m/s, to avoid damage to passengers caused by excessive speed.

For large-scale amusement facilities with speed limits, their speeds shall comply with relevant national standards.

### 3.4.2 Acceleration limit requirements

In order to prevent injuries to passengers caused by excessive acceleration or too long duration, the acceleration and duration of passengers in large-scale amusement facilities shall comply with the requirements of GB 8408.

## 3.5 Welding design

### 3.5.1 Welding joint design

(1) The weld metal shall be compatible with the base metal; welds made of different materials shall also have measures to eliminate residual stress;

(2) The shape and size of the groove of the welded joint shall be reasonably designed, based on the welding structure type, the importance of the weld, the welding process method;

(3) When welding parts of unequal thickness or width are welded together, the cross-sectional transition shall be gentle;

(4) Welded joints shall avoid or reduce stress concentration areas.

### 3.5.2 Weld grading

The grade of welds shall be determined through risk assessment, based on factors such as the possibility of weld failure, the severity of failure consequences, the detectability of the welds. Welds that directly involve personal safety are important welds. According to the stress conditions and joint forms, important welds that are prone to damage or failure due to severe stress conditions are grade I welds; the other important welds are grade II welds. Those not involving personal safety are ordinary welds. According to the stress conditions and joint forms, ordinary welds that are prone to damage or failure due to severe stress conditions are grade III welds; the other ordinary welds are grade IV welds.

**3.6 Structural design**

(1) The structural design of large-scale amusement facilities shall be reasonable to avoid or reduce stress concentration;

(2) The stress-bearing frames such as the support for the passenger part, the car, the vehicle shall be made of metal materials or other high-strength non-metallic materials; it shall be a solid structure as a whole;

(3) The important shaft (pin) design shall have a reasonable structure and appropriate transition fillets, to avoid excessive sudden changes in the cross-section and reduce stress concentration;

(4) The dimensional accuracy, geometric tolerance, surface roughness of important shafts (pins) and other parts shall meet the requirements of the working conditions;

(5) The pin connections between parts shall have measures to prevent them from falling off;

(6) Important bolt connections shall meet load requirements; measures shall be taken to prevent bolt loosening; bolts shall have obvious anti-loosening signs after installation;

(7) The strength and stiffness of the lifting parts of the parts shall meet the lifting requirements, to prevent plastic deformation or fracture during lifting;

(8) FRP parts shall have sufficient strength when directly connected to structural parts; otherwise, metal parts that meet the strength requirements need to be embedded in advance;

(9) Parts that require regular inspection and non-destructive testing during use shall be easy to inspect and detect; those that need to be disassembled shall be easy to disassemble; there shall be measures to ensure the safety of parts that require inspection and testing;

(10) The geometric dimensions of inspection holes and manholes shall meet

The roller chain that transmits power shall be calculated, based on the working conditions of static strength, fatigue resistance, wear resistance, gluing resistance. The selected roller chain shall meet the requirements of bearing capacity, transmission power, interchangeability.

The sprocket shall match the roller chain. The center distance of the chain drive and the tightness of the chain shall meet the requirements of actual working conditions.

**3.7.2.3 Wire rope**

(1) The material, structural form, appearance quality, mechanical properties, etc. of the steel wire rope shall meet the requirements of actual working conditions, to ensure the effectiveness, safety, reliability of the use of the steel wire rope and its accessories. In corrosive environments, zinc-plated steel wire ropes or stainless steel wire ropes shall be selected ;

(2) The diameter of the steel wire rope used for friction transmission shall not be less than 10 mm; the diameter of the steel wire rope used for drum transmission shall not be less than 6 mm;

(3) It shall consider the end fixation efficiency of the steel wire rope used for lifting and hanging passenger devices; the end fixation shall be firm and reliable; the ratio -- of the minimum breaking tension of the steel wire rope to the maximum static load it can bear -- shall not be less than 10;

(4) The ratio -- of the diameter of the drum and pulley used to lift the passenger device TO the diameter of the wire rope -- shall not be less than 30. When the angle of the wire rope to the pulley is not greater than 90°, the ratio -- of the diameter of the pulley to the diameter of the wire rope -- shall not be less than 20;

(5) If the lifting system of scooters and slides has an anti-retrograde device, the ratio -- of the minimum breaking tension of the traction wire rope TO the maximum static load it can bear -- shall not be less than 5;

(6) The terminal end of the wire rope shall have a margin of no less than 3 turns on the drum. When pulley transmission or guidance is used, a structure shall be installed to prevent the wire rope from falling off and jumping out from the pulley;

(7) Large-scale amusement facilities that move along wire ropes shall be equipped with safety devices to prevent the passenger devices from falling off; the safety devices shall have sufficient strength.

**3.7.2.4 Bearings**

(1) Bearing design and selection shall consider factors such as load-bearing capacity, speed, life, lubrication, temperature rise; it shall be able to meet actual working

conditions;

(2) The bearings and contact surfaces with relative movement shall have lubrication measures; if lubricant needs to be added, it shall be easy to operate;

(3) For bearings that need to be replaced during use, clear replacement requirements shall be given in the use and maintenance instructions.

### 3.7.3 Hydraulic (pneumatic) system

#### 3.7.3.1 General requirements

(1) All components selected for the hydraulic (pneumatic) system shall be able to operate reliably; failure or malfunction shall not cause danger, to ensure safe use;

(2) The hydraulic (pneumatic) system shall have an over-pressure protection device, to ensure that the system pressure does not exceed the maximum allowable pressure of the system and the rated pressure of any component. If the pressure is lost or the pressure is too high, which will cause danger, the system shall take protection measures to avoid putting personnel at risk;

(3) The design of the hydraulic (pneumatic) system shall reduce the influence of impact; the impact pressure shall not cause danger;

(4) When the passenger device is lifted and lowered by a hydraulic cylinder or a pneumatic cylinder, if the failure of pipes, hoses, pumps, etc. may cause danger to passengers, effective buffer devices or protective devices shall be installed;

(5) For single-acting piston hydraulic cylinders or cylinders, a liquid (gas) outlet shall be provided at an appropriate location, to avoid danger to personnel from ejecting liquid or gas;

(6) For hydraulic (pneumatic) systems that drive the passenger system through accumulator energy, it shall be able to automatically relieve the pressure of the accumulator or reliably isolate the accumulator pressure, when loading or unloading passengers or shutting down the machine (except for special circumstances where pressure is still required, when loading or unloading passengers or shutting down the machine).

#### 3.7.3.2 Hydraulic system

(1) The operating temperature range of the hydraulic system and hydraulic components shall not exceed the specified safe use limits; the equipment shall be able to work normally, under the specified maximum or minimum ambient temperature;

(2) The design of the hydraulic cylinder shall meet the requirements of actual working

conditions and avoid dangers caused by instability, looseness, accidental pressurization, impact, vibration;

(3) The installation position of the hydraulic cylinder shall be convenient for installation and adjustment, so that the reaction force of the load passes through the center line of the hydraulic cylinder;

(4) The inflatable accumulator and its hydraulic schematic diagram shall have clear text warning signs; if the failure of components or pipe joints in the inflatable accumulator system will cause danger, THEN it shall take effective protective measures;

(5) The rated pressure of pipelines, pipe joints, hoses and other parts shall not be lower than the maximum working pressure of the system part where they are located; the hose assembly shall comply with GB/T 3766 "Hydraulic fluid power - General rules and safety requirements for systems and their components";

(6) Medium and high-pressure (≥ 12 MPa) hydraulic systems with large working flow shall have hydraulic buffer protection measures, to avoid or reduce hydraulic shocks generated when the system is started and valves are switched.

#### 3.7.3.3 Pneumatic system

For systems with many pneumatic braking points, separate air storage tanks shall be installed at multiple points, according to actual needs, to ensure that each braking device can reach the rated working pressure.

### 3.8 Electrical and control systems

#### 3.8.1 Basic requirements

The design of electrical and control systems shall meet the needs of operation control and safety protection of large-scale amusement facilities, meanwhile comply with relevant national or industry standards.

The design of wires and cables shall pay attention to the isolation and protection between moving parts.

#### 3.8.2 Electrical system

#### 3.8.2.1 General requirements

(1) The electrical system shall be equipped with devices with corresponding electrical safety protection functions (such as overcurrent, overvoltage, undervoltage, phase loss, short circuit, leakage, overspeed, under-speed, interlocking, etc.) and necessary sound and light alarm devices; the protection components in the device shall match the protection characteristics;

**This is an excerpt of the PDF (Some pages are marked off intentionally)**



**------ The End ------**