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Replacing GB/T 18159-2008

Specifications of amusement rides coaster category

滑行车类游乐设施通用技术条件

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Foreword

This Standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This Standard replaces GB/T 18159-2008 "Specifications of Amusement Rides Coaster Category". Compared with GB/T 18159-2008, in addition to editorial modifications, the main technical changes are as follows:

- modified the scope;
- added the requirements for running speed error;
- added the requirements for connection bolt calculation;
- modified the requirements for design load value;
- modified the impact coefficient;
- added the requirements for material;
- added the requirements for column and track deformation;
- added the requirements for redundant safety structure of vehicle connector;
- added the requirements for gear train shock absorption measures;
- added the requirements for vehicle safety envelope;
- added the requirements for transmission system impact coefficient;
- added the requirements for main connection form;
- modified the safety factor of traction wire rope and traction chain;
- added the requirements for electrical safety functions and their demand levels;
- added the requirements for paint coating;
- added non-reverse test;
- added vehicle speed testing;
- added acceleration testing;
- added column and track deformation testing;
- added interlocking testing;

Specifications of amusement rides coaster category

1 Scope

This Standard specifies general rules, technical requirements, inspection, testing and test requirements, accompanying documents, marks, packaging, transportation and storage for amusement rides coaster category.

This Standard is applicable to amusement rides coaster category.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 191, *Packaging and storage marks*

GB/T 755-2008, *Rotating electrical machines - Rating and performance*

GB/T 1032, *Test procedures for three-phase induction motors*

GB/T 1447, *Fiber-reinforced plastics composites - Determination of tensile properties*

GB/T 1449, *Test method for flexural properties of glass fiber-reinforced plastics*

GB/T 1451, *Test method for the Charpy impact resistance of glass fiber-reinforced plastics*

GB/T 3805-2008, *Extra-low voltage (ELV) - Limit values*

GB 4706.1, *Household and Similar Electrical Appliances - Safety - Part 1: General Requirements*

GB/T 5226.1, *Electrical safety of machinery - Electrical equipment of machines - Part 1: General requirements*

GB 8408-2018, *Large-scale amusement device safety code*

GB/T 8923 (all parts), *Mapping requirements for the natural disaster remote sensing thematic maps*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 20306 as well as the followings apply.

3.1 single train roller coaster series

the amusement rides coaster category designed as that the operating condition is that there is a single train or a group of trains running on the same track

3.2 multi train roller coaster series

the amusement rides coaster category designed as that there are two groups or more groups of single train or trains running on the same track

3.3 splash

the amusement rides coaster category that after the passenger device is lifted, it inertially slides into the water (waterway) along the track, is decelerated by the water resistance, and the passenger device is driven by the water to run along the waterway in the water

3.4 powered U-shape roller coaster series

the amusement rides coaster category that, a roller coaster that is driven by a driving device and inertia to drive a passenger device during operation, its body is equipped with driving device, there is only one trolley on each track to reciprocate back and forth along the track during operation

3.5 wooden roller coaster

the amusement rides coaster category of which the supporting structure is mainly wood material

3.6 launch coaster

the amusement rides coaster category that enables the passenger device to obtain a large initial kinetic energy in a short time through external power driving

NOTE: The driving device of launch coaster is generally linear motor, pneumatic device, hydraulic device, flywheel energy storage device and other equipment.

3.7 non-continuous rail roller coaster

the amusement rides coaster category that, after the passenger device leaves the platform and maintenance area, during the running process, the normal operation of the vehicle body on the track is realized through local movement and rotation of the track

maximum allowable deformation of the track between the two supports is 1/300 (excluding the deformation of the support). For roller coaster track and support with a speed greater than or equal to 50km/h, under normal operating conditions, the maximum allowable deformation is 1/500; the maximum allowable deformation of the track between the two supports is 1/500 (excluding the deformation of the support).

5.1.17 For the vehicle connector redundant insurance structure, the impact factor is not less than 2, and the safety factor is not less than 2.

5.1.18 The uniform load of the personnel activity area shall be taken as follows:

- a) General area for passengers on and off the passenger platform, stairs, entrance and exit station: 3.5kN/m²;
- b) Non-open areas such as maintenance platforms and evacuation platforms: 1.5kN/m².

5.1.19 For amusement rides coaster category, when the steel track of roller coaster adopts round pipe, the track wall thickness shall not be less than 4mm. When the track uses welded pipe, the elongation at break of the material shall be greater than 40%. There shall be no cracking defects in the weld after the track is formed.

5.1.20 The trajectory shall be designed as smooth. It shall not cause excessive impact during vehicle operation.

5.1.21 The braking system shall adopt normally closed brake. Leave enough brake allowance. The most unfavorable braking conditions shall be considered when calculating. The braking acceleration shall transit smoothly. Prevent shock. The maximum acceleration during braking is not more than 1.5g.

5.1.22 When the speed is greater than 36km/h, the gear train shall have shock absorption measures.

5.1.23 Roller coaster is in the taxiing area. When the vehicle speed is greater than or equal to 2.5m/s, no obstacles are allowed within the safety envelope of the vehicle and no part of the human body can touch the running wheels of the vehicle body. The vehicle safety envelope refers to the space where the standard human body leans on the seat to stretch the body, the fingertips and toes sweep the maximum range and extends 100mm outward when the pressure bar allows, as shown in Figure 1. Where, the size of the standard human body corresponds to the male body size of 99 percentile of GB/T 10000.

5.2 Machinery and structure

5.2.1 The design of the transmission system shall ensure safe operation. In the event of failure of the system, the vehicle shall be in a safe state. There shall be no obvious skidding when amusement rides coaster category starts. The transmission mechanism shall operate normally.

5.2.2 When the transmission system is designed, the impact coefficient shall be selected according to Table 2 based on the maximum lifting speed.

5.2.3 Pull the traction wire rope and traction chain of roller coaster upwards along the track. After considering the appropriate impact coefficient according to the requirements of 5.1, the ratio of the minimum breaking load to the maximum load shall not be less than 5.

5.2.4 When using gear and rack drive, it shall comply with relevant gear and rack standards. The contact spot requirements and measurement methods for gear meshing are in accordance with GB 50231.

5.2.5 When using belt drive, its assembly requirements meet the requirements of GB 50231. The belt shall be properly tensioned. There shall be no obvious deviation. The guiding device shall be flexible and reliable.

5.2.6 When using steel wire rope and chain drive, the tension shall be moderate. When using wire rope for lifting, there shall be a device to prevent the wire rope from over-winding, skipping and slack.

5.2.7 The lifting and transmission system shall be stable and reliable. There shall be no abnormal shock and vibration. The installation accuracy shall meet the requirements of GB 50231.

5.2.8 Reasonable lubrication measures shall be provided for lifting chains and steel wire ropes. Set up corresponding waste oil collection device to prevent pollution of equipment and the environment.

5.2.9 The motor, reducer and coupling shall be installed well. The co-axiality and end gap of the two shafts of the coupling shall meet the relevant regulations of GB 50231.

5.2.10 The vehicle connector shall have a reasonable structure and flexible rotation. It shall be equipped with secondary safety device.

5.2.11 For roller coaster and launch coaster that are towed along a slope or vertically upward, when there is a safety risk or the speed of the vehicle is uncontrollable, there shall be a device to prevent the vehicle from going backward.

5.2.12 For the train system that is composed of multi trains, if a non-reverse

5.2.22 The track support spacing shall be reasonably configured. Pillars shall not bear external loads other than those specified in the design documents.

5.2.23 The track shall not have abnormal shaking.

5.2.24 The height difference of the moving track of non-continuous rail roller coaster shall not be more than 1mm.

5.2.25 Non-destructive testing shall meet the following requirements:

- a) The important shafts of amusement rides coaster category (see Annex A) shall undergo 100% magnetic particle (or penetration) flaw detection during manufacture. Important shafts with a diameter greater than 30mm shall undergo 100% ultrasonic flaw detection during manufacture. It shall specify reasonable testing standards, cycles and ratios for the equipment in use.
- b) The important welds of amusement rides coaster category (see Annex A) shall undergo magnetic particle inspection (or penetrant inspection) during manufacture. Level I welds shall be ultrasonically inspected during manufacture. It shall specify reasonable testing standards, cycles and ratios for the equipment in use.
- c) Visual inspection, ultrasonic inspection, magnetic particle inspection, penetrant inspection, radiographic inspection methods and requirements shall be implemented in accordance with GB/T 34370.

5.2.26 Effective anti-corrosion measures shall be adopted for important parts of roller coaster.

5.2.27 Reliable waterproof, leak-proof and rust-proof measures shall be adopted for parts that will come into contact with water during operation. If water leakage has a safety impact on the equipment, anti-leakage measures shall be taken. Effective anti-corrosion measures shall be adopted for the hull of splash and parts in contact with water.

5.2.28 The basic quality requirements shall meet the requirements of GB 50202 and GB 50204. The foundation shall not have any abnormal phenomena such as uneven settlement, cracking and loosening that affect the normal operation of amusement rides.

5.2.29 Mobile foundation shall meet the requirements of equipment bearing capacity. The base frame shall meet the requirements of equipment for anti-skid.

5.2.30 Generally, auxiliary rails or hanging devices shall be installed to facilitate vehicle maintenance.

buttons shall meet the requirements of GB/T 5226.1.

5.4.7 The sensor protection selected by the safety protection device shall meet the requirements of 4.4.5 in GB/T 28265-2012.

5.4.8 When the altitude of the place where the device is used exceeds 1000m, the motor capacity shall be verified according to GB/T 755. When it exceeds 2000m, power distribution and protection devices shall be verified.

5.4.9 In any running state of roller coaster, when the power supply is suddenly cut off, the equipment shall enter a "safe" state.

5.4.10 For amusement rides coaster category with the design acceleration in zone 4 and zone 5 and equipped with safety lever, it shall ensure that the safety lever is closed and locked and the equipment starts interlocking. The position testing or locking testing of the safety lever shall be convenient for the operator to test its effectiveness. Or test its effectiveness by the control system.

5.4.11 Insulation resistance, grounding resistance and lightning protection devices shall meet the requirements of the standard. The measurement method is implemented in accordance with GB 4706.1, GB/T 1032 and GB 50065. The safety voltage shall meet the relevant regulations of GB/T 3805-2008.

5.4.12 The electricity collector shall meet the following requirements:

- a) The electricity collector and the trolley wire shall be in good contact and meet the current capacity requirements. The slider seat shall be flexible and reliable and have sufficient compensation capabilities. Trolley wires shall be made of wear-resistant materials. The joint shall be flat and properly tightened.
- b) The exposed electricity collector shall be waterproof or have waterproof function to meet the requirements for use in exposed situations.

5.4.13 Decorative lighting shall meet the following requirements:

- a) A safe voltage not greater than 50V shall be used for the decorative lighting voltage easily accessible to passengers.
- b) When a non-safe voltage is used for decorative lighting voltage that is not easily accessible to passengers, leakage circuit breaker protection device shall be used.
- c) The electrical control system of decorative lighting and other auxiliary facilities shall be independent of the electrical control system of the equipment body.

5.4.14 The electrical connection used in the vehicle shall adopt a cable

5.5 Emergency rescue system

5.5.1 Under sudden power failure or emergency stop conditions, emergency rescue work shall be carried out to avoid long-term detention of passengers. The rescue process shall ensure the safety of passengers. Prevent secondary risks.

5.5.2 When the equipment is in the emergency stop condition, the automatic running mode shall be cleared automatically. Automatically stop all sports that affect safety. After the emergency stop is reset, there shall be no movement that affects safety.

5.5.3 Safety walkways shall be provided in areas along the track where vehicles may stop unexpectedly or used for maintenance. Otherwise, there shall be measures to guide passengers. Passenger evacuation measures shall meet the requirements of safe and effective evacuation of passengers at any position in the lifting section or along the track where accidental stopping of vehicles may occur.

5.6 Surface protection

5.6.1 Appropriate surface protection measures shall be taken for the metal structure of amusement rides coaster category, such as anti-rust paint, hot (dip) galvanizing or use of stainless steel materials.

5.6.2 Structural parts such as vehicle body and track shall be sprayed (shot) blasted to remove rust, to reach level Sa2 in GB/T 8923. The remaining components shall reach level Sa2 or St2 (manual rust removal). The paint surface shall be uniform, detailed, bright, complete and consistent in color. There shall be no defects such as roughness, leaking paint, wrong paint, wrinkles, pinholes and severe sagging. It is recommended that the total thickness of the paint film is not less than 80μm. The adhesion of paint film shall meet the first-class quality requirements specified in GB/T 9286-1998.

5.6.3 When it uses hot (dip) galvanizing for surface protection of metal structures, the hot (dip) galvanized layer shall meet the requirements of GB/T 13912.

5.7 Whole equipment

5.7.1 The whole amusement equipment shall be in good appearance, without damage.

5.7.2 The overall operation of amusement rides coaster category shall be normal. Starting and braking shall be stable and reliable. No crawling, abnormal vibration, shock, heat and noise are allowed. The action of the braking device shall be coordinated and reliable to ensure that the vehicle enters the station

equipment characteristics. The inspection plan shall include inspection, testing and test of machinery and structures, loading systems, electrical control systems, emergency rescue systems, and complete machines.

6.1.2 Each product shall be inspected, detected and tested according to the inspection plan after installation and commissioning. It can only be delivered for use after all inspection items are accepted.

6.1.3 According to different structure, operation mode and test purpose, inspection, testing and test items may be increased or decreased.

6.1.4 The test conditions shall meet the following requirements:

- a) The wind speed during the open-air test shall not be greater than 8m/s.
- b) Unless there are special requirements, the test environment temperature shall be -5°C~35°C. The relative humidity shall not be greater than 85%. When there are special requirements for operating environment temperature and humidity, it shall add the test under the most unfavorable temperature and humidity conditions.
- c) The error between the test load and its design load value shall be within $\pm 5\%$.

6.1.5 Before the test, the amusement rides shall be in normal technical condition, to ensure the correctness of the test results.

6.1.6 Before the test, check the mechanical structure, the loading system, the electrical control system of the amusement rides, the parts, components and their connection methods in the emergency rescue equipment and facilities, the fastening degree of the fasteners, and the lubrication seal of each lubrication point degree, which shall be consistent with the design.

6.1.7 The test of FRP shall be carried out in accordance with the provisions of GB/T 1447, GB/T 1449 and GB/T 1451.

6.1.8 After the test, the parts with problems or doubts shall be inspected. Identify the causes of the problems found and take measures in time. Make detailed records. It may use text and photographs to record.

6.1.9 After each inspection, an inspection report shall be prepared. The inspection report shall contain at least the following information:

- a) Inspection time and place;
- b) Equipment name, number, main technical parameters;
- c) Inspection basis;

6.3.2 Idle stroke test of safety lever

After the safety lever is compressed and locked, use a caliper to measure the amount of travel at the end. The maximum swimming amount shall be less than 35mm.

6.3.3 Compacting force test of safety lever

For safety lever with automatic compaction, respectively select the safety lever at the highest position, the middle position and the lowest position. Use a dynamometer to measure the compacting force of the safety lever. The value, for adults, is not greater than 150N; for children, it is not greater than 80N.

6.3.4 Locking device test of safety lever

When the safety lever is closed and locked, apply a force of 500N to the passenger armrest position. The direction of the force shall be perpendicular to the connection of the safety lever rotation arm. The safety lever and its locking device shall be effective. There shall be no obvious deformation or damage. According to the requirements of GB 8408, when there are two locking devices, each locking device shall function independently. Each type of safety lever test is not less than 3. Test each set of locking devices not less than 3 times.

6.3.5 Manual opening test of safety lever

According to the test method specified in design, simulate the case that safety lever is in the failure of automatic opening device, the safety lever shall be opened manually. Test each set of safety levers not less than 3 times.

6.3.6 Load test of braided type sliding equipment

Hoist 7500N of load to the braided type sliding equipment. Leave it still for 5min. Visually inspect it. The sliding equipment shall not be damaged.

6.3.7 Distance between the end of safety lever and the restriction surface in the minimum closed position

Put the safety lever to the lowest position to close and lock. Measure the distance between the end of the safety lever and the restriction surface (refer to Figure 2 and Figure 3). Measure 3 times and take the average value.

6.4 Electrical system and control system

6.4.1 Interzone interlocking test

Multi train roller coaster, in the zone where only single (train) vehicle is allowed to run, simulate that there are vehicles occupying this zone (may through artificially simulated signals, line short circuit, vehicle placement). The rest

vehicles are not allowed to enter this zone.

6.4.2 Emergency stop button test

Respectively test the function of each emergency stop button in the lifting (launching) section and the sliding section. Press the emergency stop button. The vehicle shall stop at the set safe position. After resetting the button, the vehicle shall remain in the original position.

6.4.3 Speed interlocking test of launch roller coaster

Simulate that it does not reach the set launch speed. Check the interlocking system. It shall act as designed.

6.4.4 Track alignment interlocking test of non-continuous rail roller coaster

Simulate that it does not reach the position of the set alignment accuracy. Check the interlocking system. It shall act as designed.

6.4.5 Interlocking function test of lifting platform or mobile platform

For amusement rides coaster category that uses lifting platform or mobile platform, simulate maloperation of lifting platform or mobile device. Test whether the interlock control function is effective. Test not less than 3 times.

6.4.6 Safety interlocking control function test of safety lever closing, locking and equipment start

According to the test method specified in design, simulate the closing and locking of safety lever. The safety interlock control function shall be consistent with the design. Test each set of safety levers not less than 3 times.

6.5 Emergency rescue system

6.5.1 The emergency rescue inspection shall at least include the rescue devices under various foreseeable working conditions in the plan, the effectiveness and timeliness of rescue measures.

6.5.2 Under full load conditions, respectively trigger emergency stop function or power-off function in lifting section and sliding section. Simulate emergency rescue. All passengers shall be rescued to a safe area within 1h.

6.5.3 The equipment with backup power supply, under the operating conditions allowed by the design, switches to backup power supply. The capacity of backup power supply shall meet the requirements of emergency rescue. Disconnect the normal power supply system. Use emergency rescue backup power. The equipment can work according to the set function or implement

6.7.3.1 No-load test

6.7.3.1.1 Perform manual and automatic tests separately. Test more than 3 times each.

6.7.3.1.2 Conduct continuous operation test 1h according to actual working conditions.

6.7.3.2 Full-load test

Load according to the design rated value. Conduct continuous operation test according to actual working conditions, not less than 8h per day. The cumulative running test for continuous trouble-free operation shall not be less than 80h.

6.7.3.3 Offset load test

The offset load test shall be loaded according to 1/2 times the rated load of the actual working condition. The load shall be concentrated on one side of the seat or carriage and the front and rear ends of the pulley. Continuously test 1h according to actual working conditions.

6.7.4 Testing of acceleration

When amusement rides coaster category is under rated load, offset load and full load conditions, measure each working condition at least 3 times. The maximum value of each working condition is the average value of the maximum value of 3 measurements.

6.7.5 Lifting speed

Use a steel tape to mark a length in the lifting section, s . Use a stopwatch to measure the time when the vehicle body passes through this distance, t . Then the lifting speed can be calculated as $v=s/t$.

6.7.6 Stress testing

6.7.6.1 The first amusement rides coaster category with a speed greater than 72km/h shall be subjected to stress test. The tested structure includes but is not limited to the following:

- a) Support: According to the calculation report, select at least 3 locations with larger stress values for measurement.
- b) Track: According to the calculation report, select at least 3 locations with larger stress values for measurement.
- c) Vehicle body: For typical locations such as wheel frame, car body frame, seat frame, car body connector, at least one location shall be selected for

factor value given by GB 8408.

7 Accompanying documents, marks, packaging, transportation and storage

7.1 Accompanying documents, marks

7.1.1 The following random documents shall be included at least before product delivery. They shall be placed in the control cabinet packaging box or the host packaging box:

- a) Product conformity certificate;
- b) Product maintenance instructions and maintenance drawings;
- c) List of spare parts and easy-to-be-worn parts;
- d) Certificates and manuals of main purchased parts;
- e) List of special tools and instruments (if any);
- f) Mobile amusement rides coaster category shall be accompanied by disassembly instructions.

7.1.2 Amusement rides coaster category shall be equipped with nameplates in prominent positions. The content of the nameplate shall at least include the name of manufacturer, manufacturing address, equipment name, production license number, equipment level, equipment model, product number, manufacturing date, main technical parameters (capacity of people, number of vehicles (ships), track height, maximum speed and design service life of whole machine].

7.2 Packaging, transportation and storage

7.2.1 The packaging of products and their parts and components of amusement rides coaster category shall meet the relevant regulations of GB/T 191 and GB/T 13384.

7.2.2 In disintegration transportation, the joints of disassembled parts shall have clear corresponding permanent marks and numbers. Wire connectors shall be numbered.

7.2.3 The exposed processing surface shall be treated with rust prevention.

7.2.4 The mass, center of gravity, and hanging points of large parts and packaging boxes shall be marked. Indicate the piece number.

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