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Summer toboggan runs —

Part 1:
Safety requirements and test methods

Pistes de luge d'été —

Partie 1: Exigences de sécurité et méthodes d'essai

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 83, *Sports and other recreational facilities and equipment*.

A list of all the parts in the ISO 19202 series can be found on the ISO website.

Summer toboggan runs —

Part 1: Safety requirements and test methods

1 Scope

This document specifies the safety requirements for planning of track, design and calculation, manufacturing, erection, testing and commissioning of summer toboggan runs and their components according to Clause 3. Those are sports facilities with an inclined guided downhill track, on which the user passes a difference in height by user's dependent speed control, to a limited velocity and descending by gravity. Its basic approach is the consciousness that the sledding usually implies for the users a remaining risk, which is comparable with sports activities, e.g. bicycle riding, alpine skiing, rope courses, because

a) active independent actions without supervision are necessary on tracks in order to control descents (distance control and braking), and

b) posture and balance to ensure the balance between centrifugal and gravitational force are required.

This document is applicable to summer toboggan runs and major modification to summer toboggan runs and toboggans manufactured after the effective date of publication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 9606 (all parts), *Qualification testing of welders — Fusion welding*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 19202-2, *Summer toboggan runs — Part 2: Safety requirements for operation*

ISO/IEC 17020, *Conformity assessment — Requirements for the operation of various types of bodies performing inspection*

IEC 60364-5-54, *Low-voltage electrical installations — Part 5-54: Selection and erection of electrical equipment — Earthing arrangements and protective conductors*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

EN 349, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 1090 (all parts), *Execution of steel structures and aluminium structures*

EN 1991 (all parts), *Eurocode 1: Actions on structures*

EN 1993 (all parts), *Eurocode 3: Design of steel structures*

EN 1999-1-1, *Eurocode 9: Design of aluminium structures — Part 1-1: General structural rules*

EN 12927-3, *Safety requirements for cableway installations designed to carry persons — Ropes — Part 3: Long splicing of 6 strand hauling, carrying hauling and towing ropes*

EN 12930, *Safety requirements for cableway installations designed to carry persons — Calculations*

EN 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

EN 60529, *Degrees of protection provided by enclosures (IP code)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
summer toboggan run
sports facility with an inclined guided downhill track, on which the user passes a difference in height by user's dependent speed control, to a limited velocity and descending by gravity on the toboggan run

3.2
tub-guided summer toboggan run
track with an open tub system which guide the direction of the *toboggan* (3.4) without force guidance and the position in curves results from the balance between gravitation and centrifugal force

3.3
rail-guided summer toboggan run
track with a rail system which guide the direction of the toboggan run and is force-guided

Note 1 to entry: The direction of travel and position in curves are defined.

3.4
toboggan
sports device with runners and/or rollers without an internal or external drive

3.5
uphill transport system
rail or tub-guided system of a *summer toboggan run* (3.1) without intermediate stops intended for other activities, which returns the occupied or unoccupied toboggan from the valley to the top station

Note 1 to entry: Otherwise, the coupling or decoupling station serves as the interface to other technical systems that are subject to other standards or directives such as the Lifts Directive, Cableways Directive, Machinery Directive.

3.6
restraint system
equipment for securing the user on the *toboggan* (3.4)

Note 1 to entry: An example of a restraint system is a safety belt.

3.7
means of conveyance
means to transport the *toboggans* (3.4) uphill

Note 1 to entry: Ropes, chains, belts, etc., can be used as a means of conveyance.

3.8
supporting structure
connection of the rail/tub and the support

Note 1 to entry: Bridges, crossovers, columns, booms, hangers and structure can serve as supporting structures.

3.9
service brake
user-dependent manual braking system for individual toboggan speed control

3.10
speed limitation
user-independent toboggan braking system to limit the toboggan speed

Note 1 to entry: Eddy current brakes, centrifugal brakes and limiting inclines can serve as speed limitation.

3.11
storage brake
toboggan braking system which brakes down or holds up the *toboggan* (3.4) without the user actuating the control elements at the toboggan

EXAMPLE Spring-loaded brake.

3.12
holding or reducing brake
user-independent toboggan braking system for reduction of the toboggan speed

Note 1 to entry: Examples of holding or reducing brakes are brake bands, magnetic brakes and eddy-current brakes.

3.13
dead-weight anchor
ballast body set up on the ground or anchored in the ground

3.14
rod anchor
steel rods with eye or butted/welded head

3.15
commissioning
taking the toboggan run into public operation the first time

4 List of significant hazards

Table 1 contains the significant hazards, risk situations and hazardous incidents dealt with in this document, which have been established as being significant by way of risk assessment, as well as the technical measures for prevention or reduction of risks.

Table 1 — List of significant hazards

	Hazard related to	Risk, hazard area	Requirements from subclause
1	**Mechanical hazards**		
	Faulty production and assembly	Failure of welded or bolted joints, functional failure	5.1.1, 5.1.2, 5.1.3
	Failure of rail, tub, toboggan and support components and loss of stability, undercutting of the supports	Toboggan derailment, crushing, shearing, colliding with components; falling from the toboggan	6.2, 6.3, 6.4, 6.5
	Collision with objects on the track	Injuries of all kinds	5.3.1, 5.3.4, 5.7, 10.6
	Unauthorized access to the system, third parties climb over the equipment	Injuries of all kinds	5.3.1, 5.4, 10.6
	No observance of the clearance zone	Hitting obstacles (e.g. roads, bridges, tunnels)	5.7
	Rupture of transport rope or guy rope, failure of the tensioning device, failure of the toboggan clamping device	Toboggan roll-back, injury induced by rope ends; slack ropes and loss of pretensioning	5.5.2
	Unrestricted access to movable drive components, reaching into pulleys and rope sheaves	Injuries of all kinds	5.5, 5.6
	Unintended actuation of operating components	Injuries of all kinds	5.6, 5.8
	Failure of safety equipment (e.g. light barriers, ripping wires, emergency shutdown systems, anti-roll-back systems)	Collision of toboggans, failure of drive unit to shut down	5.6, 5.8
	Lack of a cover to protect movable toboggan parts (e.g. wheels, clamping couplings)	Injuries of all kinds (e.g. strangulation)	5.2
	Unergonomically shaped seat, backrest, footrests or handles	Uncomfortable sitting posture on the toboggan	5.2
	No means of communication with the operating company (intercom, video surveillance, etc.)	No detection of inappropriate user behaviour	5.6, 10.6
	Inadequate rescue possibilities	Assistance after accident is delayed	5.6, 10.6
2	**Hazards caused by the electrical system**		
	Faulty production and assembly	Functional failure, electric impact	5.8
	Danger caused by unintended/unauthorized start-up of the drive	Injury of persons during maintenance tasks	5.8
	Defective fault indicators	Downtimes and waiting periods on the uphill track	5.8
	Power failure	Drive failures, toboggans are standing on the uphill track, braking system failure	5.8.1
	Unprotected live components, inadequate earthing, stroke of lighting	Injury through electric impact	5.8
	Malfunctions of the emergency switch and the fault current circuit breaker system	Disturbances of operational procedures	5.8.2
3	**Chemical hazards**		
	Use of substances which pose a health hazard (e.g. PAH, coatings) made of plastic, fibreboards, leather, etc.	Increased risk of cancer through dermal absorption of substances hazardous to the health	5.1.1

Table 1 *(continued)*

	Hazard related to	Risk, hazard area	Requirements from subclause
4	**Danger through inappropriate user behaviour**	**Falling out, impact, fall, shearing and crushing, collision, etc.**	**5.2, 5.3, 5.7 10.6**
	Collision with other toboggans	Impact loads on the body, crushing caused by restraint system	5.2, 5.3.4, 5.4.3
	Standing up, leaning out	Falling out of the toboggan	5.2
	Sticking out arms or legs	Injuries caused by fixed objects, structures	5.7
	No observance of the signs at the end of the track	Impact load on braking systems due to bumping	5.2.4, 5.4.3
	Inadmissible number of persons in the toboggan	Ineffective restraint system, toboggan overload	5.2

5 Safety requirements

5.1 Manufacturing

5.1.1 Materials

Safety-relevant components require the use of materials for which design values are specified in standards.

For other materials, proof of suitability shall be provided.

Materials shall be ageing-resistant. For safety-relevant components, the manufacturer shall indicate the time limits for ageing resistance.

Materials which come into contact with the skin of the user shall not be hazardous to health.

5.1.2 Safety measures against loosening of connections

Bolts, nuts, tapered washers and other fasteners, which might loosen as a result of fluctuating stresses, shall be secured by well-recognized methods, e.g. prestressing, cotter pin, retaining compound, counter nut, self-lock nut, spring washers, toothed lock washers, fan type (serrated) lock washers, etc.

5.1.3 Welded joints

The manufacturer of welding construction shall have an appropriate welding qualification according to suitable international or national accepted standards, e.g. EN 1090 (all parts).

The welder shall have an appropriate welding qualification according to ISO 9606.

5.1.4 Corrosion and surface protection, protection against rot

All parts shall be protected by means of adequate measures to prevent corrosion or rotting, e.g. EN 1090 (all parts). The type of protection and inspection intervals shall be specified.

5.2 Toboggan

5.2.1 General

The passenger compartment shall be designed in such a way that the user is properly seated and kept on the toboggan (e.g. backrests, armrests). Handles, seat with lateral reinforcement and footrests shall also be provided on the toboggan.

It shall be ensured that the users can safely operate the toboggan as it is intended.

The toboggan shall be designed in such a way that users cannot reach hazardous parts when conducting themselves as intended.

The toboggan shall be designed in such a way that no unexpected forces occur as a result of changes in transverse gradients, curves, crests or depressions and as a result of wear.

It shall be ensured that the toboggan is decelerated if the user is not using the toboggan control elements. If this cannot be realized for all operating conditions, at least one user-independent brake shall be provided in the entrance and/or exit zone.

A backrest shall be provided for uphill passengers facing in driving direction if inclines exceed 35 %.

5.2.2 Toboggan for rail-guided summer toboggan runs

The system shall be designed to prevent derailment of the toboggans.

An emergency running device shall ensure a safe-guided toboggan all the time.

Restraint systems are mandatory for each user and shall be verified (e.g. by calculation, tests and certificates).

Restraint systems shall be designed in such a way that the devices cannot open at purely or unintentionally.

The restraint system shall be designed in such a way that crushing or trapping of body parts is not possible.

The toboggan shall be provided with a shock-absorbing device, which shall be effective at any part of the downhill track. The design basis for shock-absorbing devices and restraint system shall be the maximum speed. An analysis of the loads expected to act on the users is mandatory.

The restraint system shall be able to withstand such loads.

Passing over or under the shock-absorbing devices in a collision shall be prevented by the system's design devices.

5.2.3 Toboggan for tub-guided summer toboggan runs

Tub-guided toboggans may be used without restraint system because the toboggans are not force-guided and the user can overturn with the toboggan.

The toboggan shall be provided with a shock-absorbing device, which shall be effective at any part of the downhill track. Shock absorbing may also be ensured by the toboggan design and/or selecting appropriate material for the toboggan. The shock-absorbing device shall be designed for maximum speed. An analysis of the loads expected to act on the users is mandatory.

Running over of toboggans shall be prevented.

5.2.4 Braking

The braking systems of the summer toboggan run fall into the following categories: limitation of speed, service brake (manual brake), storage brake and holding or reducing brake.

a) Limitation of speed (e.g. eddy-current brake, centrifugal brake): It shall be ensured that a speed of 40 km/h can only be exceeded for 3 s and by 4 km/h and this is only permitted at 5 % of the downhill track length. This applies for downhill travel without using the manual braking system. If the speed of 40 km/h is not limited by the gradient, it shall be ensured that malfunction of one component does not result in failure of the whole braking system.

b) Service brake (manual brake): It shall be ensured that the user can control the toboggan speed anytime by using the manual braking system. The service brake shall be calculated according to 6.3.6 with verification of the brake's fail safety.

c) The storage brake shall ensure that a toboggan does not move or stop to move on the downhill track if the control element is released.

d) Deceleration of the holding or reducing brake shall be limited to ensure that the user remain seated all the time.

5.3 Track

5.3.1 Structural design of the system on the site

The suitability of the site (composition of the ground, vegetation, rock, etc.) for the erection and operation of a summer toboggan run shall be determined.

The substructure (e.g. foundations, dead-weight anchors, rod anchors) shall not be impaired in its stability by ground water, rain water and snowmelt.

All foundations shall be designed to withstand the loads according to Clause 6.

The anchoring/supporting of the structure shall be effected by means of, for example, rod anchors or foundations.

For temperature compensation, expansion joints shall be provided to prevent constraints in the track.

Based on risk assessment, the manufacturer shall specify the access restrictions and other safety equipment (e.g. signage, barriers) for the summer toboggan run that are essential for safe use and operation.

On the basis of a risk assessment, the access restrictions and other safety devices (e.g. signage, barriers) that are required for safe use and operation of a summer toboggan run as given in ISO 19202-2 shall be presented.

5.3.2 Rail-guided summer toboggan runs

If the toboggan is rail-guided, the acceleration shall not be <0,2 g acting vertically on the seat.

At points where the toboggan can be stopped during operation, the highest transverse rail gradient shall be limited to 25°.

Track calculation for rail-guided summer toboggan runs shall be carried out according to Annex B.

5.3.3 Tub-guided summer toboggan runs

If the toboggan is guided inside a tub, the acceleration shall not be <0,2 g acting vertically on the seat.

In accordance with Formula (B.1), the theoretical transverse gradient, α, shall be such that the forces acting transversally to the toboggan reach the value zero.

If swinging of the vehicle is limited by contacting boundaries, the boundaries shall be calculated to withstand the contacting impact. If no detailed calculations are given, the impact shall be at least assumed using Formula (1):

$$H_A = 0{,}30 \cdot Q \tag{1}$$

where

Q is the vehicle and imposed load.

The accelerations occurring from the toboggan's swinging movement shall also be calculated for toboggan, tub and substructure.

The layout of the track shall be such that a user can safely travel along the track at an adequate speed.

5.3.4 Visibility down the track and braking distances

5.3.4.1 Rail-guided runs

a) The visibility down the track shall be chosen as a function of the braking distance plus a reaction time of about 1 s, but shall be at least 20 m.

b) At top speed, the braking distance resulting from a "dry" emergency braking situation shall be no more than 10 m.

c) At top speed, the braking distance resulting from a "wet" emergency braking situation shall be no more than 20 m.

In exceptional cases such as in tunnels and on hilltops, signs requesting the user to brake or to drive slowly shall be used to indicate a reduced range of vision.

5.3.4.2 Tub-guided runs

a) The visibility down the track shall be chosen as a function of the braking distance plus a reaction time of 1 s, but shall be at least 25 m.

b) At top speed, the braking distance resulting from a "dry" emergency braking situation shall be no more than 15 m.

c) At top speed, the braking distance resulting from a "wet" emergency braking situation shall be no more than 40 m.

For runs which can also be operated in "wet" conditions, the range of vision should be at least 50 m.

In exceptional cases such as in tunnels and on hilltops, signs requesting the user to brake or to drive slowly shall be used to indicate a reduced range of vision.

5.4 Entrance and exit area

5.4.1 General

These areas shall be designed such that the operation and the entry and exit of the user can be achieved in a safe and smooth manner.

The station area prohibited for the users shall be secured against unauthorized access. Barriers, stairs, etc., shall be designed in compliance with national regulations.

Walkways shall be even and slip-resistant.

At the entrance and exit areas, the users shall be informed by signs, according to ISO 19202-2, which the correct behaviour is.

5.4.2 Entrance areas

The area assigned to users and areas used by supervisors/operators shall be separated from each other for safety reasons. System control units shall be separated from users, but with free access for operators.

The station area needs to be designed to secure the direct communication between the operator and the users.

5.4.3 End of downhill track

The end of the downhill track shall be clearly indicated by signs.

In case of misbehaviour of the user at the end of the downhill track, the speed shall be reduced by user-independent measures. These measures (e.g. brakes, limiting gradient, deceleration zone) shall reduce a fully occupied toboggan to a speed of ≤18 km/h.

5.4.4 Exit areas

The exit area shall be designed to enable the user to exit comfortably. The exit area shall accommodate at least five toboggans and the floor shall have a paved surface.

The exit height as from the vehicle seat should be between 20 cm and 60 cm.

The maximum speed shall be ≤2 km/h.

5.5 Uphill transport system

5.5.1 General

The uphill transport system comprises:

a) drive systems;

b) means of conveyance (e.g. steel cables, chains, belts);

c) coupling between the means of conveyance and the toboggan;

d) structures and rail or tub system;

e) safety equipment, rescue facilities.

5.5.2 Technical design

If the uphill track requires the installation of an anti-roll-back system, this shall be redundant, where

a) at least one of the devices shall act on the toboggan (e.g. wheels with anti-roll-back), and

b) at least one of the devices shall be form-fitted between the toboggan and the uphill track (e.g. anti-roll-back hook, return flaps, toothed rails).

The system's effectiveness shall be calculated and the impact loads acting on the user shall be analysed.

In a coupled state, toboggans shall be guided uphill in a manner that precludes derailment. Where occupied toboggans are coupled to the uphill transport system, this should be largely jolt-free, e.g. by using a damping system or adjusting the speed.

The decoupling point shall be monitored and kept free of congestion to ensure safe toboggan decoupling. Occupied toboggans shall be automatically decoupled from the uphill transport system.

The whole track shall be accessible for maintenance and control purposes and rescue tasks.

On the track of the uphill transport system, the user shall be informed by signs, according to ISO 19202-2, which the correct behaviour is.

5.5.3 Means of conveyance and connection to the means of conveyance

If the passenger safety cannot be ensured either by the means of conveyance or the connection to the means of conveyance, the passenger safety shall be guaranteed by means of an anti-roll-back system in accordance with 5.5.2.

A verification of strength in accordance with EN 12930 shall be carried out to determine the passengers' safety with regard to the means of conveyance or the connection to the means of conveyance.

Other means of conveyance and their connections to the means of conveyance shall be calculated using a method based on the state of the art and referred to specific standards or other recognized methods.

Connections to the means of conveyance comprise clamps, tappets or similar.

For the means of conveyance, manufacturer's certificates, markings or test certificates shall be provided.

For spliced ropes, the splice length shall be at least 1 000 times of the rope diameter. The distance between the splices shall be at least 3 000 times of the rope diameter. There shall be a maximum of five splices per rope. A splice certificate shall be provided in accordance with EN 12927-3.

The derailment of the ropes shall be monitored or prevented by design.

5.5.4 Tensioning devices

The ropes used as a means of conveyance require pretensioning.

If no tensioning weights are used, devices for the pretensioning control are required. The control devices shall be easily accessible and legible.

Rope winches shall be secured form-fitted against unreeling.

In case of a rope defect/failure, no additional protection against unreeling or runaway rope ends along the track are required if the pretensioning is only affected in a static way and the rope acts as a simple spring.

Rope end attachments shall be secured with rope locks, wedge locks, crimping sleeve connections, thimble splices or spelter sockets.

The foundation for struts shall withstand all tensile forces from all operating conditions.

5.5.5 Drives and their components

A proof of strength shall be provided for all safety-relevant components.

The diameter of the drive bull wheel and the return station bull wheel shall be at least 60 times the diameter of the rope. It is sufficient to provide proof of structural strength for the bull wheels, if the bull wheels do not present any danger to persons. In other cases, proof of fatigue or fatigue strength shall be provided.

The dimension/specification of the uphill drive system shall be selected to provide a smooth start up with a maximum acceleration of 0,5 g in all operating conditions.

The drive shall stop automatically

a) in case of power failure,

b) in case of overload situations,

c) in case one of the safety devices is switched on, or

d) if one of the safety devices is actuated.

An independent rolling back of the means of conveyance during standstill shall be prevented (e.g. anti-roll-back on the drive). A service brake is not required if secure braking can be achieved from any operating state.

Independent start-up of the drive due to malfunctioning is not permitted.

5.6 Special safety equipment and precautions

The evacuation of the user from the toboggan shall be possible at any point of the track.

Maintenance and evacuation measures (e.g. evacuation paths) equipped with fall protection devices shall be provided (e.g. nets, handrails) where the falling heights are ≥1,5 m above ground level. Maintenance and evacuation paths shall be at least 0,4 m in width. National regulations about the width of the paths shall be considered.

In passable areas where unoccupied toboggans are moving, a lateral safety distance of at least 0,50 m between the toboggan and fixed stationary objects is required.

The drive station and the return station shall be inaccessible for unauthorized persons.

Accessible sheaves and bull wheels shall be protected against unintended intervention.

Unoccupied stations and/or stations that are outside the visibility

a) at the start or end of the uphill track, and

b) in the uphill transport system

shall be kept under video monitoring system and provided with an intercom system.

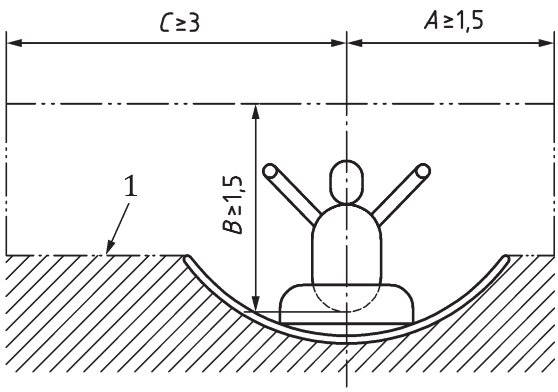
5.7 Clearance zone

5.7.1 Downhill travel

5.7.1.1 Tub-guided summer toboggan run

For the downhill track, the clearance envelope and the fall areas shall be kept free of obstacles as shown in Figure 1.

Dimensions in metres



Key

1 upper tub edge is the lower clearance limit

A horizontal clearance from tub centre

B vertical clearance from seat

C fall area (e.g. at the outside of curves in tub-guided runs)

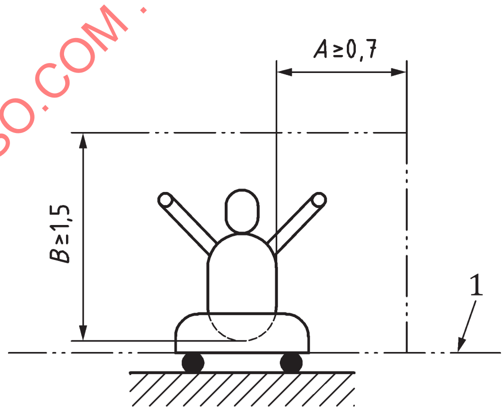
Figure 1 — Clearance zone for downhill track in tub-guided summer toboggan runs

For topographical characteristics as e.g. bottlenecks, the fall area may be reduced to a minimum of 1,5 m if measures are in place to limit the consequences of a fall (e.g. safety nets).

5.7.1.2 Rail-guided summer toboggan run

For the downhill track, the clearances stipulated shown in Figure 2 shall be observed.

Dimensions in metres



Key

1 lower clearance limit is the upper rail edge

A horizontal clearance from outer edge of toboggan seat

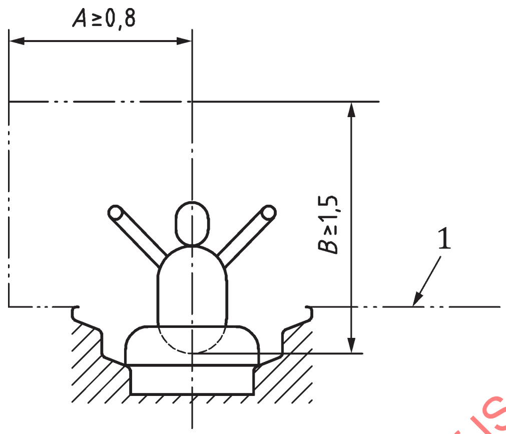
B vertical clearance as from seat

Figure 2 — Clearance zone for downhill track in rail-guided summer toboggan runs

5.7.2 Uphill transport

For the uphill transport of occupied toboggans, the clearances for tub-guided summer toboggan runs according to Figure 3 and for rail-guided summer toboggan runs according to Figure 4 shall be observed.

Dimensions in metres



Key

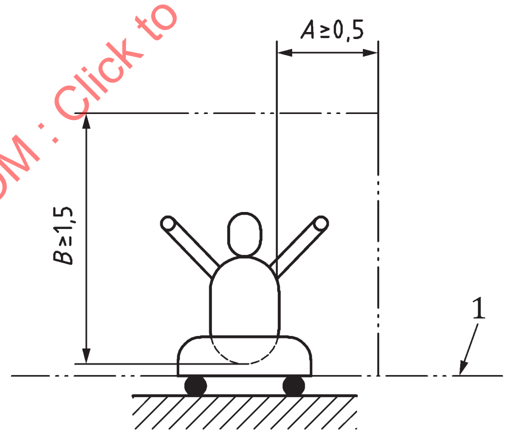
1 lower clearance limit is the upper tub edge

A horizontal clearance from outer tube centre

B vertical clearance from seat

Figure 3 — Clearance zone for uphill travel in tub-guided summer toboggan runs

Dimensions in metres



Key

1 lower clearance limit is the upper rail edge

A horizontal clearance from outer edge of the toboggan seat

B vertical clearance from seat

Figure 4 — Clearance zone for uphill travel in rail-guided summer toboggan runs

5.7.3 Squeezing and shearing points

Crush and shear points shall be prevented, for example, by observing the requirements of ISO 13857 and EN 349.

Obstacles which users can reach with their hands shall not be tapered in travel directions as these might cause crush and shear points.

5.8 Electrical equipment

5.8.1 Electrical systems

5.8.1.1 General

All parts of the electrical systems shall be in accordance with EN 60204-1, except where the following subclauses contain relevant extensions or modifications.

The degree of protection of equipment such as sockets, plug connections, cable inlets, etc., shall be at least IPX4 as in EN 60529 in rooms or in spaces protected from atmospheric precipitation and they shall be IP65 according to the EN 60529 in outdoor spaces unprotected from precipitation.

The electrical grounding system and protection against electric shock shall be designed in accordance with IEC 60364-5-54.

If the local situation requires precautions against lightning, these shall also comply with applicable standards.

In the case of power failure, the system shall remain in a state that does not pose additional risks to persons.

5.8.1.2 Lighting and emergency lighting

Lighting, including emergency lighting is required for all accessible areas, including access roads that are used without daylight.

Lighting shall be designed such that minimum visibility is 25 m on the downhill track and the uphill transport. During night operation, the uphill transport system shall be illuminated so that the minimum range of visibility is 25 m.

5.8.2 Control systems

5.8.2.1 General

Control systems with pneumatic, hydraulic and mechanical elements shall be in compliance with the requirements of ISO 13849-1 and with the risk assessments carried out in accordance with ISO 12100:2010, Table B.1. Systems with electrical, electronic and programmable electronic elements shall also comply with the requirements of IEC 61508 (all parts).

The uphill transport system, braking belts, means of conveyance, etc., shall be protected against unauthorized and unintended start-up, e.g. by means of a lockable key switch. Control elements shall be located in areas that are only accessible to the staff.

5.8.2.2 Stop functions

The control systems shall provide the following stop functions: “Operation Stop”, “Emergency Stop” and/or “Emergency Shut Down”. Stop functions shall be designed in a redundant or diversified manner and take precedence to start functions.

The uphill transport system shall be fitted with a separate “emergency off” circuit, which does not shut off the downhill braking systems. Emergency off switches shall be provided in the entrance and/or exit areas at the operator station and in drive and return station.

6 Calculations

6.1 General

Among others, the following standards shall be observed for summer toboggan run verifications:

a) EN 1090 (all parts);

b) EN 1993 (all parts);

c) EN 1999-1-1.

The chosen method of overall calculation of a summer toboggan run shall be specified and adhered to throughout.

For verification of materials other than steel and aluminium, calculation methods based on the state of the art and referred to specific standards or other recognized methods shall be used.

Verifications shall cover at least the following:

a) proof of structural safety;

b) proof of fatigue and fatigue;

c) proof of stability, e.g. buckling of bars, plates and shells;

d) if required, proof of deformation properties;

e) proof of tilting, sliding and lift-off safety;

f) dynamic calculations.

The above verifications shall comprise as a minimum:

a) load assumptions under consideration of possible operating conditions or installation variants;

b) main dimensions and cross-section values of all load-bearing elements, as well as detailed information on the assessment of fatigue strength;

c) information on materials and components;

d) determination of unfavourable stresses (maximum and minimum stress as well as range of stress) and details on the permitted loads for load-bearing components and joints. If calculations for the assessment of component limit states appear to be insufficient, proof may also be provided by way of practical testing at the same safety level;

e) details of elastic deformation (bending/torsion) to the extent that this is relevant for the summer toboggan run's stability and operational safety.

6.2 Actions

6.2.1 General

All applicable actions shall be selected in accordance with EN 1991 (all parts). Adaptations to special conditions in summer toboggan runs are detailed below.

NOTE See also Annex A for load combinations.

6.2.2 Permanent actions

The actual self-weight of machine parts, electrical facilities, toboggans and like that shall be confirmed by weighing.

6.2.3 Variable actions

6.2.3.1 Imposed loads

For toboggans, the following loads shall be assumed:

a) for the fatigue analysis, Q_k = 0,8 kN per person;

b) for the structural analysis, the highest load indicated by the manufacturer.

The following vertical imposed loads shall be applied for any area designed for access by foot:

— Universal, public access:

  — q_k = 3,5 kN/m^2 for floors, stairways, landings, ramps, entrances, exits and other similar features in summer toboggan runs and facilities;

  — q_k = 2,0 kN/m^2 for the revolving or boom area walked on by the public during operation (load and unload) or twice the full passenger load of all passenger units and carriages, whichever is the more unfavourable, in order to make the necessary allowance for change of passengers;

  — Q_k = 1,0 kN/step for stairs; alternatively, an area load in accordance with above clauses, whichever is the more unfavourable.

— Not open for public access:

  — q_k = 1,5 kN/m^2 for all floors, platforms, ramps, staircases, catwalks, stages and like that which are walked over by individual persons, or

  — Q_k = 1,5 kN for individual loads, whichever is the more unfavourable.

6.2.3.2 Horizontal imposed loads

The following horizontal imposed loads shall be applied for parapets, fences, railings, wall panels and other similar features.

When bounding floors intended for public access designed for q_k = 3,5 kN/m^2:

— p_k = 0,5 kN/m at hand rail height;

— p_k = 0,1 kN/m at intermediate rail height.

When bounding floors not intended for public access designed for q_k = 1,50 kN/m^2:

— p_k = 0,30 kN/m at hand rail height;

— p_k = 0,10 kN/m at intermediate rail height;

— p_k = 0,15 kN/m at hand rail height;

— p_k = 0,10 kN/m at intermediate rail height.

6.2.3.3 Wind loads

Verification shall be carried out in accordance with EN 1991-4 and under consideration of official national standard of the country of use of the device.

6.2.3.4 Snow loads

Snow loads need not be taken into account if summer toboggan runs

a) are erected in areas where snow is improbable, or

b) are already dismantled when snow sets in.

If required, verification shall be carried out in accordance with EN 1991-1-3 and under consideration of official national standard of the country of use of the device.

6.2.3.5 Centrifugal, drive and braking forces

Centrifugal forces for rail-guided runs shall be calculated analogous to Formulae (B.5) and (B.6).

Braking or starting forces shall be calculated based on actual deceleration or acceleration using Formula (2):

$$B = a_b \cdot (m_v + m_p) \tag{2}$$

where

B is the force during braking or starting, in N;

a_b is the acceleration during braking or starting, in m/s^2;

m_v is the toboggan self-weight, in kg;

m_p is the overall mass of the users on the toboggan in accordance with the manufacturer's data, in g.

6.2.3.6 Scheduled impact during operation

The effect of the impact forces only needs to be considered for directly affected components and related connections. The impact shall be assumed at the most adverse point of the components, with calculation being based on the mass of a fully occupied toboggan. If impact is only possible at an angle of $\varphi < 90°$, impact force F (in N) is calculated using Formula (3):

$$F = g \cdot (m_v + m_p) \sin\varphi \tag{3}$$

where

m_v is the toboggan self-weight, in kg;

m_p is the overall mass of the users on the toboggan in accordance with the manufacturer's data, in kg;

g is the gravitational acceleration = 9,81 m/s^2;

φ is the impact angle;

but not less than $0{,}3 \cdot g \cdot (m_v + m_p)$.

If the impact is not a scheduled operational event, it shall be deemed an accidental action.

6.2.4 Accidental actions

Seismic forces and loads from collisions, overload, pulling defect toboggans along on the uphill transport track, overspeed and slinging points shall only be considered in case of special requirements; it is not necessary to combine them with wind load cases.

6.2.5 Impact

If travel movement generates impact forces inside the structure or inside individual parts of the structure (e.g. on rail joints or owing to wear), the relevant moving loads (self-weight and imposed loads) shall be multiplied by an impact factor of at least φ_1 = 1,2, unless the type of construction requires a higher factor.

If trial runs on the finished system reveal significantly higher impact forces (e.g. at the rail joints) and if these forces cannot be reduced to their design value by means of constructional measures, the impact factor shall be increased in a modified calculation. Start-up and braking forces are not considered as impact forces (but as common imposed loads).

6.2.6 Vibrations occurring in directly passable components

Due to the effect of vibrations in directly passable components such as rails, all resulting internal forces shall be multiplied by a vibration coefficient of φ_2 = 1,2. If trials, drive tests, etc., reveal lower vibration coefficients, a lower coefficient of φ_2 = 1,0 to 1,2 may be assumed. Calculation without a vibration coefficient is permitted for:

a) supports or suspensions of directly passable components;

b) soil pressure;

c) deformations;

d) stability and safety against sliding.

In certain systems, additional structural measures may be necessary to reduce or dampen inadmissible vibrations (e.g. resonances).

6.3 Strength verification by calculation

6.3.1 General

The limit states resulting from the various actions shall be calculated for the load cases and load combinations stated in 6.2. Proof shall be provided that no limit state is exceeded.

Proof is to be provided that the design value for internal forces or torques does not exceed the design resistance of the respective component and that ultimate limit states and serviceability limit states are also not exceeded.

The limit states of deformation and stability of the summer toboggan run shall be determined and verified as maximum deformation can be the most important dimensioning criterion. A positive influence resulting from the finite element method, second order theory, may be taken into account.

All verifications shall be provided for the least favourable load case. The permanent, variable and accidental actions, as well as dynamic forces, shall always be assumed to occur in the position and magnitude resulting in the least favourable limit states for the structural and mechanical parts to be analysed.

6.3.2 Toboggan calculation

Toboggans shall be designed considering the self-weight, imposed load and the forces resulting from movement.

The arm and back rests, safety belts and related locking devices shall withstand the forces resulting from passenger loads, e.g. starting and braking forces, impact and forces due to unequal load distribution.

All occurring forces shall be followed from the place of origin to the supports. For toboggans with pendular axles, it shall be taken into account that torques resulting from forces acting transversally on the toboggan can only be withstand by the rigid axle.

NOTE Wheels can only withstand the forces, if they are absorbed by the rail/tub.

Oscillating forces shall be considered for tub-guided runs. Vibrations and impact shall be multiplied by coefficients φ_1 and φ_2 to account for the driving dynamics as a result of vibration and impact factors. The values given in 6.2.5 and 6.2.6 shall apply.

Steering forces acting on the axles shall also be considered. This also applies to lateral forces acting on the guide wheels due to steering movement. If no specific values are indicated, a friction coefficient of $\mu = 0{,}2$ between rail and wheels shall be used for calculation.

If an uphill transport system is used, fatigue strength verification for toboggan components with the opposed loads is required. Structural analysis is sufficient in cases where there is no risk for persons or if personal safety can be ensured by means of other components. Coupling impact shall be considered (if applicable). The effect of such impact shall also be considered for the axles of the toboggan.

Anti-roll-back system shall be designed for fully loaded toboggans.

6.3.3 Tub calculation

The tub shall be verified assuming the maximum bearing loads calculated from the toboggan. The bearing loads can be taken as an area imposed loads acting on the wheels/runners.

All loads shall be considered as moving loads, the most unfavourable load position shall be considered.

The static calculation of the tub shall take into account the maximum number of toboggans considering the

a) maximum span,

b) maximum transverse and longitudinal gradient, and

c) maximum braking forces.

The fatigue of the tub shall be verified on the basis of a single toboggan. If the tub rests on the soil, the support this provides may be taken into account.

6.3.4 Rail calculation

The rail shall be verified assuming the maximum bearing loads based on the toboggan calculation.

All loads shall be considered as moving loads considered in the most unfavourable position cases.

The static calculation of the rail shall take into account the maximum number of toboggans considering the

a) maximum span,

b) maximum transverse and longitudinal gradient, and

c) maximum braking forces.

The fatigue of the rail shall be verified on the basis of a single toboggan.

6.3.5 Calculation of supporting structure

The bearing loads resulting from rail/tub dimensions shall be used as a basis for the verification of the supporting structure.

A static analysis, verification of fatigue and stability analysis shall be provided.

6.3.6 Brake calculation

A fatigue verification shall be provided for the service brake.

For the calculation of the parts of the brake, the following assumptions shall be considered:

a) the force resulting from maximum braking deceleration with the maximum friction coefficient;

b) the maximum force at the braking lever.

6.4 Verification of fatigue

6.4.1 General

A distinction shall be made between predominantly static stress and predominantly fluctuating stress.

If the fatigue calculation is based on the stress ranges calculated on the load collectives, the service life (period in service) shall be indicated. However, all components shall be calculated with a safety margin against fatigue.

If the fatigue analysis for specific components is based on a certain life cycle specified by the manufacturer, these components shall be specially identified in the operating manual and shall be subject to specific controls.

If there is no analysis of fatigue, endurance strength shall be verified.

For materials other than steel and aluminium, the same safety level shall be chosen.

Loads occurring from the anti-roll-back effects and storage, holding and reducing brakes do not have to be taken into account in the calculation of fatigue strength.

6.4.2 Fatigue loads

Calculation of fatigue loads shall at least include the following actions:

a) dead loads;

b) imposed loads;

c) drive and braking forces;

d) impact and vibrations of parts directly travelled over;

e) centrifugal forces.

6.5 Verification of stability

6.5.1 Safety against overturning, sliding and lifting off

6.5.1.1 General

The safety of summer toboggan runs and their components against overturning, sliding and lifting off shall be verified.

Favourable acting imposed loads shall not be considered in the calculation of safety against overturning, sliding and lifting off. Only the lowest value of continuously acting favourable loads shall be taken into account.

If an adequate degree of safety cannot be achieved by virtue of the dead load of a structure alone, then further additional steps shall be taken to ensure it, such as counterweights, anchors and buttresses.

See Table 2 for safety coefficients against overturning, sliding and lifting off.

Table 2 — Safety coefficient against overturning, sliding and lifting

Loads	Loading	γ
1	Favourably acting proportions of the dead load	1
2	Unfavourably acting proportions of the dead load	1,1
3	Unfavourably acting wind loads	1,2
4	Unfavourably acting proportions of loads other than the loads listed in items 2 and 3	1,3

6.5.1.2 Safety against overturning

The safety against overturning shall be calculated using Formula (4):

$$\sum \gamma M_{\mathrm{St,k}} \geq \sum \gamma M_{\mathrm{K,k}} \quad (4)$$

where

γ is the safety coefficient according to Table 2;

$M_{\mathrm{St,k}}$ is the stabilizing moment values;

$M_{\mathrm{K,k}}$ is the overturning moment values.

It is important to ensure that the loads entered in the calculation can be accommodated by the shear stiffness of the structure.

6.5.1.3 Safety against sliding

The safety against sliding shall be calculated using Formula (5):

$$\sum \gamma \mu N_{\mathrm{k}} \geq \sum \gamma H_{\mathrm{k}} \quad (5)$$

where

γ is the safety coefficient according to Table 2;

N_{k} is the vertical load component;

H_{k} is the horizontal load component;

μ is the coefficient of friction according to Table 3.

The following coefficients of friction may be assumed for the determination of the frictional forces, unless higher values determined by tests are available in individual cases, or unless the effect of moisture requires the adoption of lower values.

It shall be borne in mind that loosening by vibration may occur in the case of supports subjected to vibrating stress.

Table 3 — Coefficient of friction, μ

	Wood	Steel	Concrete
Wood	0,4	0,4	0,6
Steel	0,4	0,1	0,2
Concrete	0,6	0,2	0,5
Clay	0,25	0,2	0,25
Loam	0,4	0,2	0,4
Sand and gravel	0,65	0,2	0,65

If stability is not obtained by static friction alone, then the structure shall be anchored in the ground. In such cases, the safety against sliding shall be calculated in conjunction with the action of soil anchors. Under these conditions, the coefficients of friction in accordance with Table 3 shall only be entered in the calculation at 70 % of the listed values. See Formula (6).

$$\sum \gamma \mu_r N_k + Z_{h,d} \geq \sum \gamma H_k \tag{6}$$

where

μ_r is equal to $0{,}7\mu$;

$Z_{h,d}$ is the horizontal design capacity of the anchor;

μ is the coefficient of friction according to Table 3.

6.5.1.4 Safety against lifting off

Safety against lifting off shall be calculated using Formula (7):

$$\sum \gamma N_{st,k} \geq \sum \gamma N_{a,k} \tag{7}$$

where

γ is the safety factor in accordance with Table 2;

$N_{st,k}$ is the vertical stabilizing load components;

$N_{a,k}$ is the vertical lifting off load components.

With anchor ties, the following relationship shall be applied; see Formula (8):

$$\sum \gamma N_{st,k} + Z_{v,d} \geq \sum \gamma N_{a,k} \tag{8}$$

where

$Z_{v,d}$ is the vertical design capacity of the anchor.

6.5.2 Ground anchorages

6.5.2.1 General

The load bearing capacity of the ground anchorages shall be verified.

6.5.2.2 Design load bearing capacity of rod anchors

The design load bearing capacity of simple rod anchors with a circular cross section and with a minimum driving-in depth of 80 cm shall be determined in accordance with the empirical formulae given in Table 4. For other ground conditions, anchor lengths, anchor diameters or load directions, the load bearing capacity require an additional verification.

Table 4 — Design capacity of anchors

Angle of pull	Design capacity	
$\beta = 0°$	$Z_d = f_{load}\, d\, l' = 6{,}5\, d\, l'$ For stiff cohesive and for dense cohesionless soils	(9)
	$Z_d = f_{load}\, d\, l' = 8\, d\, l'$ For semi-solid cohesive soils	(10)
$\beta \geq 45°$	$Z_d = f_{load}\, d\, l' = 10\, d\, l'$ For cohesive soils of at least medium to stiff consistency	(11)
	$Z_d = f_{load}\, d\, l' = 17\, d\, l'$ For dense cohesionless soils	(12)
$0 < \beta < 45°$	The design capacity for the soil types shall be determined by interpolation (see Figure 6).	

Symbols used in Formulae (9) to (12) in Table 4:

Z_d is equal to Z_u/γ_M;

d is the anchor diameter, in cm;

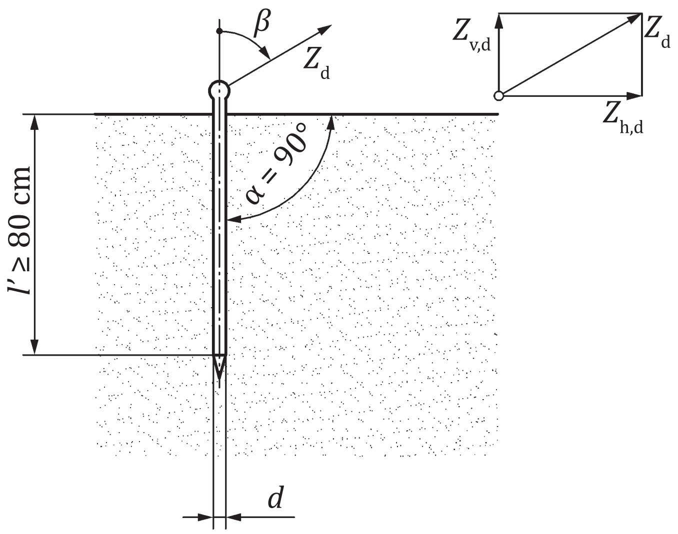
l' is the depth of penetration (minimum length 80 cm).

Formulae (9) to (12) are only valid on the condition that the anchor will "pull" when driven in. For $\beta = 0°$, the friction shall be effective along the entire length of the rod; for $\beta \geq 45°$, the angle of penetration $\alpha = 90°$. At this driving-in angle, the obliquely loaded anchor will attain its maximum design load bearing capacity, as shown by experience. In order to prevent any bending of anchors subjected to shear loading, the following minimum diameter shall be respected, for simple round steel rod anchors, see Formula (13):

$$d_{min} = 0{,}025\, l' + 0{,}5 \quad (13)$$

with l' in cm.

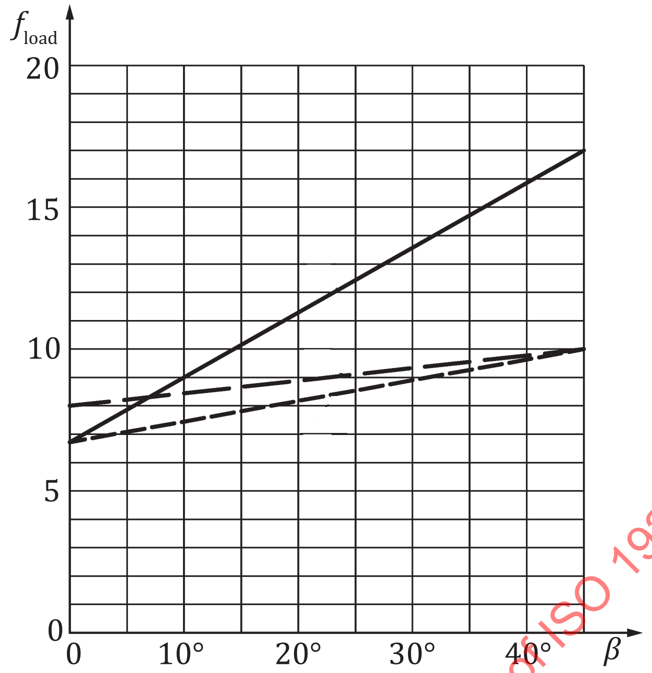
The point of application of the force on rod anchors subjected to bending stress shall be situated either as close to the ground surface as possible or beneath it.



Key

β	angle of acting tensile force to the vertical
$Z_d = Z_u/\gamma_M$	design capacity of anchor in N
$\gamma = 1{,}5$	safety factor
$Z_{h,d}$	horizontal design capacity of anchor in N
$Z_{v,d}$	vertical design capacity of anchor in N
d	anchor diameter, in cm
l'	depth of penetration (minimum length 80 cm)
α	angle of penetration

Figure 5 — Rod anchor



Key

β	angle of pull
f_{load}	$= Z_d$
——— (solid line)	dense cohesion less soils
— — — (long dashes)	very stiff cohesive soils
— — — — (short dashes)	stiff cohesive soils

Figure 6 — Factors for determining the load bearing capacity of rod anchors

6.5.2.3 Testing of anchors (Numbering)

The calculated design load bearing capacities may be exceeded, if this can be substantiated by loading tests, or if experimental data relating to the installation site are available. When test loading an anchor, at least three tests shall be carried out. A safety factor of γ = 1,5 shall be applied to the lowest test value (Z_u) in order to determine the design capacity (Z_d) in subsequent calculation. The design load bearing capacity determined in this manner shall not result in anchor movement which would result in stresses, deformations or instability which cannot be accommodated by the structure.

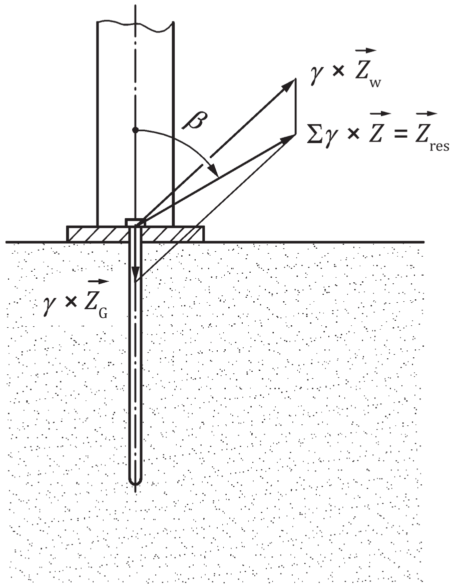
If the foundation conditions are comparable, loading tests carried out in another location may be adopted for substantiation purposes.

The safety coefficients featured in Table 2 shall be taken into consideration when determining the permissible load.

6.5.2.4 Calculation of loads on anchors

The resulting load, Z_{res}, acting on the anchorage shall be determined by vector summation, taking into account the partial safety factors shown in Table 2 (see Figure 7). This load Z_{res} shall be less than the permissible loading of the anchorage according to 6.5.2.2:

$$Z_{res} = \Sigma \gamma \vec{Z} \leq Z_d \quad (14)$$



Key

$\vec{Z}_G$ is the favourably acting resultant of permanent actions;

$\vec{Z}_w$ is the unfavourably acting portion of variable actions;

γ is the safety factor in accordance with Table 2.

Figure 7 — Anchor loading

6.5.2.5 Further requirements

If displacements in excess of 2 cm occur on loaded rod anchors or similar devices, then the load bearing capacity of the anchor will no longer be fully ensured. An increase of the resistance against pull-out failure can be achieved either by means of additional anchors or by driving in wooden wedges. In the case of pure tensile stress in the direction of the axis of the rod anchor, the danger of a complete failure of the anchor arises when very small movements occur.

The foot of the anchor (pointed tip) shall not exhibit any widening of the cross section in the case of rod anchors, so as to prevent any reduction of the skin friction in the zone of the anchor shank.

After the driving in of a rod anchor, the soil on the surface shall be tamped against the anchor, as far as practicable, in order to prevent the infiltration of surface water.

If groups of anchors are used, each individual anchor may only be assessed in the calculation at its full, calculated load bearing capacity on condition that the spacing between adjoining anchors amounts to not less than five times the anchor diameter. Dynamic loads can lead to the loosening of an anchorage; consequently, repeated checks of the anchors are essential. For groups of anchors consisting of more than six anchors, the load bearing capacity of such groups of anchors shall be verified by calculation. Without further verification, an angle of excavation of 45° starting from the outer anchor may be assumed for this calculation.

7 Testing and inspection

7.1 General

Summer toboggan runs and their components shall be subject to

a) a design review of the technical documentation,

b) an acceptance test prior to commissioning (initial acceptance test),

c) periodic inspections, and

d) tests and inspections following modifications/additions.

The inspection body performing the initial approval shall operate in accordance with ISO/IEC 17020.

7.2 Examination of the technical documentation

The technical documentation for at least the following components/assemblies shall be reviewed:

a) toboggan;

b) elevated supporting structure and rail/tub of the downhill track and the uphill transportation system;

c) drive and braking systems;

d) foundations;

e) electric wiring diagrams;

f) risk assessment and analysis under consideration of the list of significant hazards (see Clause 4);

g) technical drawings as specified in 10.3.

The following documents shall be available for the initial acceptance test:

— constructor's welding qualification;

— rope and splice certificates;

— acceptance certificates for materials used;

— manufacturer's declarations, certificates, etc., for purchased parts;

— construction, operating and maintenance manual.

The results of the review shall be taken into consideration in the acceptance test.

7.3 Acceptance test prior to commissioning (initial acceptance test)

7.3.1 General

The following tests shall be carried out:

a) comparison of the manufactured toboggan run system on site with the approved drawings regarding the basic track layout and the on-site facilities, etc.;

b) comparison of parts in the assembled state with the approved technical drawings:

   1) downhill track and, if applicable, the uphill transport system;

   2) drive and braking systems;

   3) toboggan;

   4) entrance and exit stations;

   5) electrical system.

c) examination of safety requirements in accordance with Clause 5;

d) availability of manufacturer's data on type plates in accordance with Clause 8;

e) functional check in accordance with 7.3.2.

If the construction deviate from the origin design and the technical planning due to adaptation of the system to the terrain, e.g. regarding the support height and span, curve radii, the slope, etc., the deviation shall be explained in the submitted documents and if necessary reviewed again.

7.3.2 Functional check

7.3.2.1 General

Functional checks shall be performed based on the manufacturer's specifications.

The inspection body shall use the summer toboggan run and the uphill transport system at least five times and at varying speeds.

7.3.2.2 Speeds

The maximum speed on the downhill track shall be measured in a proper way.

7.3.2.3 Running time

The minimum downhill running time shall be measured for a toboggan (indication of overall mass) without braking action to determine the average speed per run along the whole downhill track.

7.3.2.4 Braking distance

For all braking systems, a test shall be performed approving the requirements in 5.3.4 regarding the indication of the overall mass of the toboggan and the braking distance from maximum speed (see 5.2.4).

7.3.2.5 Connection to the means of conveyance

The coupling and decoupling function of the toboggan shall be checked by visual inspection. Possible malfunctions shall be considered; for this purpose, the existing safety equipment shall be tested.

The connection to the means of conveyance shall be checked for the uphill track at the largest gradient and at 1,2 times the loading capacity. At this point, malfunction is not permitted.

7.3.2.6 Drive and rope of the uphill transport system

A visual inspection of the rope shall be performed at 0,3 m/s (crawling speed).

A visual inspection of the splice shall be performed during standstill of the rope.

The start-up ramp of the control unit shall be checked by recording the time required until maximum drive speed is reached.

7.3.2.7 Safety systems

All electrical safety systems shall be checked.

The anti-roll-back systems shall be checked for proper functioning at the steepest part of the uphill track. For this purpose, the toboggan shall not be connected to the means of conveyance and shall be loaded at 1,2 times the imposed load. Friction values, form-fitting connections, frictional connections and geometry shall be taken into consideration.

The function of the restraint system on rail-guided summer toboggan runs shall be checked.

7.3.2.8 Crush and shear points

All crush and shear points shall be checked in accordance with ISO 13857 and EN 349.

7.3.2.9 Inspection of anchors

Theoretical bearing capacities may be exceeded if safety is verified by means of load tests or if test data are available for the installation location.

An anchor load test shall comprise a minimum of three tests. Bearing capacity (Z_d) shall be determined using the lowest trial value multiplied by the factor γ = 1,5 and rounded. It shall be used as a basis for subsequent calculations. For loadbearing capacities determined this way, anchor movement is not permitted as this may create inadmissible stresses, deformation and instability. Where there are comparable ground conditions, load tests performed elsewhere may serve as verification. In the determination of permitted bearing capacity, the safety coefficients given in Table 2 shall be considered.

Pull-out tests shall be performed as a function of the load directions which result from the bearing load calculation in different rail sections. Local ground conditions shall be taken into account.

If failure of a bearing point in stability analysis does not impair stability, regular pull-out tests can be omitted.

Every 3 years, at least 1 % of the rod anchors under tensile load (but a minimum of three anchors) should be tested to determine if twice the permitted vertical load bearing capacity of a rod anchor specified in 6.5.2.2 is achieved.

7.4 Periodic inspection

Periodic inspection is carried out on site at the installed and fully working system. The overall system shall be inspected.

Inspections shall be performed as indicated in 7.3.1 and 7.3.2. A full comparison as performed during the initial acceptance test can be reduced to random testing.

Periodic inspection shall be performed annually. More frequent inspections may be agreed between the operator and the manufacturer and/or the inspection body or other relevant authorities to ensure the integrity of the device.

In the context of periodic inspection, it shall be checked if the requirements defined in previous inspections are met.

7.5 Inspection after modification

7.5.1 Examination of calculations

Stability analysis for modifications shall be substantiated and examined based on structural calculations according to the provisions stated in Clause 6.

7.5.2 On-site inspection

The inspection of the modification shall take place on site, with the system in a fully operating condition. As a minimum, the modified parts of the system shall be inspected, unless the modification does not affect the whole system.

Inspections shall be performed as indicated in 7.3.1 and 7.3.2.

A target comparison shall be performed for the modified components.

7.6 Test report

The test report shall contain at least the following information:

a) name and address of the inspection body;

b) unique report reference (e.g. serial number) on each page, together with the total number of report pages;

c) place and date at which testing was carried out;

d) a reference to this document as basis for testing and further test requirements, i.e. ISO 19202-1;

e) name and address of the manufacturer and operator;

f) year of manufacture;

g) description of the summer toboggan run or the modified component;

h) allowable special operating conditions for this summer toboggan run (e.g. summer and winter operation, operating in the dark);

i) test documents (structural calculations, drawings, associated test reports) submitted and their titles;

j) weather conditions during the inspection;

k) all deviations from, and supplements or exceptions to, the scope of the inspection and all other information relating to a specific test (if required);

l) determination of measurement uncertainties (if required);

m) tests performed on the system;

n) list of identified faults;

o) time limit for repair work or correction of the faults (if required);

p) time limit for re-examination after correction of faults (if required);

q) year of periodic inspection;

r) restrictions and notes;

s) maintenance log control.

The issued test reports shall be included in the technical documentation to be retained by the operator. The documents shall be stored securely and shall be available for subsequent inspections.

8 Marking

8.1 Summer toboggan run

Each summer toboggan run shall be marked in a legible and permanent manner indicating the following information:

a) number of this document;

b) manufacturer's name and address;

c) product identification information:

   1) designation of project or type;

2) manufacturers identification code;

3) year of manufacture.

8.2 Toboggan

The manufacturer shall mark each toboggan in a uniquely identifiable manner.

9 Commissioning

Commissioning requires a successful initial acceptance test.

Permission to commissioning can require compliance to local regulations.

10 Technical documentation

10.1 General

The manufacturer shall prepare the technical documentation containing all documents required to assess the safety of the overall system. This technical documentation shall be handed to the operator.

10.2 Construction specification

A construction specification shall be drawn up.

In this document, the summer toboggan runs and in particular its construction, intended use and the system's structure shall be described in detail. It shall also contain information on mechanical (hydraulic, pneumatic), electrical and electrotechnical equipment with all control systems. The summer toboggan run's special features and any installation variants, as well as its main dimensions and required movement spaces, boundaries, special structural features and materials, movement sequences, types of drives, speeds, acceleration, electrical equipment, function and operating sequences and any restrictions on persons permitted to use the toboggan run, shall also be described in detail.

10.3 Structural drawings and manufacturing drawings

The drawings shall contain all required dimensions and profile information, as well as information on materials, building structures, mounting devices and fasteners. This is required for all assemblies and individual components which in case of fracture or failure endanger the system's stability or operating reliability.

The design drawings shall at least comprise:

a) assembly drawings with ground plan and elevation, as well as sections with indication of radii, lengths and gradients for the overall system;

b) indication of the clearance zone required for movable parts;

c) drawings of component assemblies and detail drawings of connections and individual construction, machine and electrical components which may have an effect on safety and system operation.

To this aim, the following parts shall be illustrated:

a) the toboggan with all necessary views and sections, with indication of exterior dimensions, interior dimensions relevant to the user (seats, arm and back rests, legroom and footwell), handholds and locking and safety devices;

b) the chassis with data on runners, guide and counter wheels and their bearings, axles, shafts and the corresponding mountings as well as clearance to the vehicle, steering and control, anti-rollbacks, derailment and tilting protection, buffers, trailers, protection equipment, drives and brakes as well as the anchorage in the ground;

c) the rail or tub, elevated mountings, struts, adjacent constructions, anchorage, supports, drive and deflection stations, etc.;

d) mechanical equipment;

e) pneumatic, hydraulic, electrical circuit diagrams (if applicable).

10.4 Structural calculations

The manufacturer shall provide calculations for all components in accordance with Clause 6. It is the manufacturer's responsibility to have the documents checked in accordance with Clause 7 and to include the test reports.

10.5 Risk assessment

The manufacturer shall perform a risk assessment consisting of a risk analysis and a risk evaluation.

10.6 Operating manual

The manufacturer shall provide an operating manual.

As a minimum requirement, the operating manual shall contain the following:

a) information required for the safe and proper operation of the system according to ISO 19202-2;

b) a request that the manual shall be kept for future reference and made available to the staff;

c) information on commissioning and decommissioning, maintenance and repair work;

d) information on all safety functions;

e) safety guidelines for the staff;

f) installation and assembly instructions regarding equipment components;

g) instructions on how to eliminate faults;

h) weather-induced restrictions on operation;

i) spare parts list;

j) list of parts subject to regular inspection;

k) ongoing inspections;

l) user advice.

Texts referring to difficult and complicated tasks should also include figures.

Annex A
(informative)

Example of load combinations in accordance with EN 1993

A.1 Basic combinations

Design values of actions shall be determined using Formulae (A.1) and (A.2):

$$\sum \gamma_{G} G_{k} \left(= \sum 1{,}35 G_{k} \right) \quad \text{(A.1)}$$

$$\sum \gamma_{G} G_{k} + \sum \gamma_{Q} Q_{k,i} \left(= \sum 1{,}1 G_{k} + \sum 1{,}35 Q_{k,i} \right) \quad \text{(A.2)}$$

where

γ_G = 1,1 or 1,35	is the partial safety coefficient for permanent actions;
γ_Q = 1,35	is the partial safety coefficient for variable actions;
G_k	is the characteristic value of permanent actions;
$Q_{k,i}$	is the characteristic value of variable actions.

Both cases shall be checked.

A.2 Combination of accidental actions

$$1{,}0 \cdot G_{k} + A_{d} + \sum 1{,}0 \cdot Q_{k,i} \quad \text{(A.3)}$$

where

$Q_{k,i}$	is the characteristic value of permanent actions;
G_k	is the characteristic value of permanent loads;
A_d	is the design value of accidental actions.

Accidental actions (e.g. seismic forces) shall only be considered where specified by requirements. In such cases, Formula (A.3) shall apply.

A.3 Fatigue combination

Each stress or stress range which contributes to the overall collective of an individual component shall be included in the analysis with a partial safety coefficient of at least γ_{Ff} = 1,0.

Combination coefficients shall not be used.

γ_{Ff} is the partial safety coefficient for fatigue loads.

The following values shall be used as a partial safety coefficient for steel (see Table A.1):

Table A.1 — Partial safety coefficient for fatigue strength deviating from EN 1993

Inspection and accessibility	Fracture does not result in collapse	Fracture results in collapse
The component is accessible for periodic inspection	γ_{Mf} = 1,0	γ_{Mf} = 1,1
The component is not accessible for periodic inspection	γ_{Mf} = 1,05	γ_{Mf} = 1,15

Annex B
(normative)

Track calculation

In accordance with the following formulae, the theoretical transverse gradient of the rail, α, shall be chosen so that the forces acting transversely to the toboggan are absorbed by the restraint system and are kept at a minimum (see Figures B.1 to B.3):

$$\tan\alpha = \frac{v^2 \cdot \cos^2\gamma}{R_h \cdot \left(g \cdot \cos\gamma + \frac{v^2}{R_v} \right)} \quad \text{(B.1)}$$

where

- v is the toboggan speed;
- γ is the longitudinal gradient of rail;
- R_h is the horizontal radius;
- R_v is the vertical radius, with the sign

  + = trough,

  − = peak.

The angle α shall be measured normal to R_h and to the rail.