Annex A (normative)

List of the electric safety devices

Clause	Devices checked
5.2.2.2.2	Check on closed position of inspection and emergency doors and inspection traps
5.7.2.5 a)	Stopping device in the pit
6.4.5	Stopping device in the pulley room
7.7.3.1	Check on locking of landing doors
7.7.4.1	Check on closed position of landing doors
7.7.6.2	Check on closed position of the panels without locks
8.9.2	Check on closed position of car door
8.12.4.2	Check on locking of the emergency trap and the emergency door in car
8.15 b)	Stopping device on the car roof
9.3.3	Check on the abnormal relative extension of a rope or chain in case of a two rope or two chain type suspension
9.8.8	Check on the operation of safety gear
9.10.2.10.1	Overspeed detection
9.10.2.10.2	Check on the release of the overspeed governor
9.10.2.10.3	Check on the tension in the overspeed governor rope
9.10.4.4	Check on the tension in the safety rope
10.4.3.3	Check on the return to normal extended position of buffers
10.5.2.2 b)	Check on the tension in the device for transmission of the car position in case of direct acting lift (final limit switch)
10.5.2.3 b)	Check on the tension in the device for transmission of the car position in case of indirect acting lift (final limit switch)
10.5.3.1	Final limit switch
11.2.1 c)	Check on locking of car door
12.13	Check for slack rope or slack chain
13.4.2	Control of main switch by means of circuit breaker contactor
14.2.1.2 a) 2)	Check on levelling, re-levelling and anti-creeping
14.2.1.2 a) 3)	Check on the tension in the device for transmission of the car position (levelling, re-levelling and anti-creeping)
14.2.1.3 c)	Stopping device with inspection operation
14.2.1.4 b)	Limitation of movement of the car with docking operation
14.2.1.4 i)	Stopping device with docking operation

Annex B (normative)

Unlocking triangle

Dimensions in millimetres

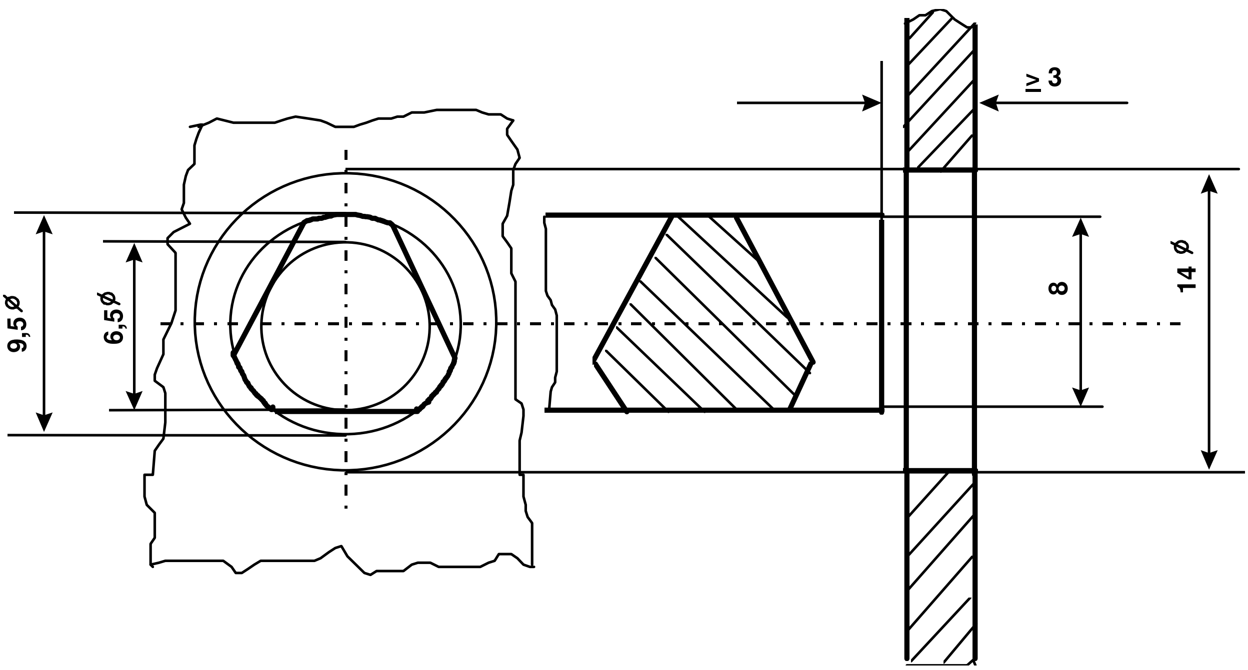


Figure B.1 : Unlocking triangle

Annex C (informative)

Technical dossier

C.1 Introduction

The technical dossier to be submitted with the application for preliminary authorization should comprise all or part of the information and documents figuring in the following list.

C.2 General

- names and addresses of the installer, the owner and/or the user ;
- address of the installation premises ;
- type of equipment - rated load - rated speed - number of passengers ;
- travel of the lift, number of landings served ;
- mass of the car and of the balancing weight ;
- means of access to the machine room, and to the pulley room, if there is one (**6.2**).

C.3 Technical details and plans

Necessary plans and sections in order to understand the lift installation, including rooms for machines, pulleys and apparatus.

These plans do not have to give details of construction, but they should contain the necessary particulars to check conformity to this standard, and particularly the following :

- clearances at the top of the well and in the pit (**5.7.1, 5.7.2**) ;
- any accessible spaces which exist below the well (**5.5**) ;
- access to the pit (**5.7.2.2**) ;
- protection of jack(s), if required (**12.2.4.1**) ;
- guards between lifts if there are more than one in the same well (**5.6**) ;
- provisions for holes for fixings ;
- position and principal dimensions of the machine room with the layout of the machine and principle devices. Ventilation holes. Reaction loads on the building and at the bottom of the pit ;
- access to the machine room (**6.3.3**) ;
- position and principal dimensions of the pulley room, if any. Position and dimensions of pulleys ;

- position of other devices in the pulley room ;

- access to the pulley room (**6.4.3**) ;

- arrangement and principal dimensions of landing doors (**7.3**). It is not necessary to show all the doors if they are identical and if the distances between the landing door sills are indicated ;

- arrangement and dimensions of inspection doors and inspection traps and emergency doors (**5.2.2**) ;

- dimensions of the car and of its entrances (**8.1**, **8.2**) ;

- distances from the sill and from the car door to the inner surface of the well wall (**11.2.1** *and* ***11.2.2****) (corrigendum)* ;

- horizontal distance between the closed car and landing doors measured as indicated in **11.2.3** ;

- principal characteristics of the suspension -safety factor - ropes (number, diameter, composition and breaking load) - chains (type, composition, pitch, breaking load) ;

- declaration of the precautions provided :

  - against free fall and descent with excessive speed ;

  - against creeping ;

- functional drawing of the pawl device, if any (**9.11**) ;

- evaluation of the reaction force from a pawl device, if any, to the fixed stops ;

- principal characteristics of the overspeed governor rope and/or safety rope : diameter, composition, breaking load, safety factor ;

- dimensions and proof of the guide rails, condition and dimensions of the rubbing surfaces (drawn, milled, ground) ;

- dimensions and proof of energy accumulation type buffers with linear characteristics ;

- proof of the full load pressure ;

- proof of the jack and the piping according to **annex K** ;

- characteristics or type of the hydraulic fluid.

C.4 Electric schematic diagrams and hydraulic circuit diagram

Outline electric schematic diagrams of :

  - the power circuits, and

  - the circuits connected with electric safety devices.

These schematic diagrams should be clear and use CENELEC symbols.

Hydraulic circuit diagram.

This diagram shall be clear and use symbols of ISO 1219-1.

C.5 Verification of conformity

Copies of type examination certificates for safety components.

Copies of certificates for other components (ropes, chains, flexible hoses, explosion proof equipment, glass, etc.), where relevant.

Setting up certificate for the safety gear according to the instructions provided by the safety gear manufacturer and calculation of the compression of the springs in the case of progressive safety gear.

Setting up certificate for the rupture valve according to the instructions provided by the rupture valve manufacturer. Manufacturer' s adjustment diagrams should be provided.

Annex D (normative)

Examinations and tests before putting into service

Before the lift is put into service, the following examinations and tests shall be carried out :

D.1 Examinations

These examinations shall cover in particular the following points :

a) if there has been a preliminary authorization, comparison of the documents submitted on that occasion (**annex C**) with the installation as it has been installed ;

b) in all cases, verification that the requirements of this standard are fulfilled ;

c) visual examination of the application of the rules of good construction of the components for which this standard has no special requirements ;

d) comparison of the details given in the verification of conformity for the safety components, with the characteristics of the lift.

D.2 Tests and verifications

These tests and verifications shall cover the following points :

a) locking devices (**7.7**) ;

b) electric safety devices (**annex A**) ;

c) suspension elements and their attachments :

it shall be verified that their characteristics are those indicated in the register or file (**16.2 a)**) ;

d) measurements of current or power and of speed (**12.8**) ;

e) electric wiring :

1) measurement of the insulation resistance of the different circuits (**13.1.3**). For this measurement all the electronic components are to be disconnected ;

2) verification of the electrical continuity of the connection between the earth terminal of the machine room and the different parts of the lift liable to be made live accidentally ;

f) final limit switch (**10.5**) ;

g) overspeed governor :

1) the tripping speed of the overspeed governor shall be checked in the direction corresponding to the descent of the car (**9.10.2.1, 9.10.2.2**) or the balancing weight (**9.10.2.3**) ;

2) the operation of the stopping control laid down in **9.10.2.10.1** and **9.10.2.10.2** shall be checked in both directions of movement ;

h) car safety gear (**9.8**) :

the energy, which the safety gear is capable of absorbing at the moment of engagement will have been verified in accordance with **F.3**. The aim of the test before putting into service is to check the correct mounting, correct setting and the soundness of the complete assembly, comprising car, safety gear, guide rails and their fixing to the building.

The test shall be made while the car is descending, with the required load uniformly distributed over the car area, keeping the downward valve(s) open until the ropes become slack, and under the following conditions :

1) instantaneous safety gear or instantaneous safety gear with buffered effect :

the car shall travel at rated speed and be loaded either :

a) with rated load when the rated load corresponds with **table 1.1** (**8.2.1**), or

b) with 125 % of the rated load, except that the load shall not exceed the corresponding **table 1.1** load when the rated load is smaller than the value given by **table 1.1 (8.2.1)** ;

2) progressive safety gear :

a) when the rated load corresponds with **table 1.1 (8.2.1)** the car shall be loaded with rated load, and travel at rated speed or lower ;

b) when the rated load is smaller than the value given by **table 1.1 (8.2.1)**, the car shall be loaded with 125 % of the rated load, except that the load shall not exceed the corresponding **table 1.1** load, and travel at rated speed or lower.

When the test is made with lower than rated speed, the manufacturer shall provide curves to illustrate the behaviour of the type tested progressive safety gear when dynamically tested with the suspensions attached.

After the test, it shall be ascertained that no deterioration, which could adversely affect the normal use of the lift has occurred. If necessary, friction components may be replaced. Visual check is considered to be sufficient ;

NOTE : In order to facilitate disengagement of the safety gear, it is recommended that the test be carried out opposite a door in order to be able to unload the car.

i) balancing weight safety gear (**9.8**) :

the energy, which the safety gear is capable of absorbing at the moment of engagement will have been verified in accordance with **F.3.** The aim of the test before putting into service is to check the correct mounting, correct setting and the soundness of the complete assembly, comprising balancing weight, safety gear, guide rails and their fixing to the building.

The test shall be made while the balancing weight is descending, under the following conditions :

1) instantaneous safety gear or instantaneous safety gear with buffered effect, tripped by overspeed governor or safety rope :

the test shall be made with empty car at rated speed ;

2) progressive safety gear :

the test shall be made with empty car at rated speed or lower.

When the test is made with lower than rated speed, the manufacturer shall provide curves to illustrate the behaviour of the type tested progressive safety gear under balancing weight application when dynamically tested with the suspensions attached.

After the test, it shall be ascertained that no deterioration, which could adversely affect the normal use of the lift has occurred. If necessary, friction components may be replaced. Visual check is considered to be sufficient ;

j) clamping device (**9.9**) :

the test shall be made while the car is travelling at normal speed downwards, with the load uniformly distributed, the contacts on the clamping device and on the tripping devices being short-circuited to avoid closing of the down direction valves, and under the following conditions :

1) instantaneous clamping device or instantaneous clamping device with buffered effect :

the car shall be loaded with 125 % of the rated load. When type-examined safety gears are used as clamping devices, however, the test may be made according to **D.2 h) 1)** ;

2) progressive clamping device :

a) when the rated load corresponds with **table 1.1 (8.2.1)** the car shall be loaded with 125 % of rated load ;

b) when the rated load is smaller than the value given by **table 1.1 (8.2.1)** the car shall be loaded with 125 % of rated load.

Additional to the test, it shall be shown by calculation that the requirements of **8.2.2.3** are satisfied.

After the test it shall be ascertained that no deterioration which could adversely affect the normal use of the lift has occurred. Visual check is considered to be sufficient ;

k) tripping of safety gear (car or balancing weight) by failure of the suspension gear (**9.10.3**) or by safety rope (**9.10.4**) :

check of the proper functioning ;

l) tripping of the car safety gear (or clamping device) by lever (**9.10.5.2**) :

visual examination of the engagement of the lever with all fixed stops and of the running clearance measured horizontally between the lever and all fixed stops during travel ;

m) pawl device (**9.11**) :

1) dynamic test :

the test shall be made while the car is travelling at normal speed downwards, with the load uniformly distributed, the contacts on the Pawl device and on the energy dissipation buffer (**9.11.7**), if any, being short-circuited to avoid closing of the down direction valves.

The car shall be loaded with 125 % of rated load and shall be stopped by the pawl device at each landing.

After the test it shall be ascertained that no deterioration which could adversely affect the normal use of the lift has occurred. Visual check is considered to be sufficient ;

2) visual examination of the engagement of the pawl(s) with all supports, and of the running clearance measured horizontally between the pawl(s) and all supports during travel ;

3) verification of the stroke of the buffers ;

n) buffers (**10.3** and **10.4**) :

1) energy accumulation type buffers :

the test shall be carried out in the following manner : the car with its rated load shall be placed on the buffer(s), the ropes shall be made slack and it shall be checked that the compression corresponds to the figures given in the technical dossier according to **C.3** and means to identify the buffers according to **C5** ;

2) energy accumulation type buffers with buffered return movement and energy dissipation type buffers :

the test shall be made in the following manner : the car with its rated load shall be brought into contact with the buffers at the rated speed.

After the test, it shall be ascertained that no deterioration, which could adversely affect the normal use of the lift has occurred. A visual check is considered to be sufficient ;

o) limitation of the ram stroke (**12.2.3**) :

verification that the ram is stopped with buffered effect ;

p) full load pressure :

measurement of the full load pressure ;

q) pressure relief valve (**12.5.3**) :

check of the correct adjustment ;

r) rupture valve (**12.5.5**) :

a system test shall be carried out, with rated load uniformly distributed in the descending car at an overspeed (**12.5.5.7**) to operate the rupture valve. The correct adjustment of the

tripping speed can be checked, for instance, by comparison with the manufacture's adjustment diagram (**C.5**).

For lifts with several interconnected rupture valves checking of the simultaneous closing by measuring the inclination of the car floor (**12.5.5.4**) ;

s) restrictor/one-way restrictor (**12.5.6**) :

check that maximum speed v_{max} does not exceed v_d + 0,3 m/s :

- either by measuring, or

- by using the following formula :

$$v_{max} = v_t \sqrt{\frac{p}{p - p_t}}$$

where :

p = full load pressure in megapascals ;

p_t = pressure measured during a downward journey with rated load in the car in megapascals ;

If necessary pressure losses and friction losses shall be taken into account.

v_{max} = maximum downward speed in the case of a rupture in the hydraulic system in metres per second ;

v_t = speed measured during a downward journey with rated load in the car in metres per second ;

t) pressure test :

a pressure of 200 % full load pressure is applied to the hydraulic system between the non-return valve and the jack included. The system is then observed for evidence of pressure drop and leakage during a period of 5 min (taking into account the possible effects of temperature change in the hydraulic fluid).

After this test it shall be visually ascertained that the integrity of the hydraulic system is maintained ;

NOTE : This test shall be carried out after the test of the devices against free fall (**9.5**).

u) creeping test :

it shall be checked that the car with the rated load, stopped at the highest level served does not move by more than 10 mm downwards within 10 min (taking into account the possible effects of temperature change in the hydraulic fluid) ;

v) emergency operation downwards (**12.9.1.5**) (in the case of indirect acting lifts) :

hand-lower the car onto a prop (or actuate the safety gear or clamping device) and check that slack rope or slack chain condition does not occur ;

w) motor run time limiter (**12.12.1**) :

check of the time adjustment (by simulating the running of the machine) ;

x) electric temperature detecting device (**12.14**) :

check of the temperature adjustment ;

y) electrical anti-creep system (**14.2.1.5**) :

functional test with rated load in the car ;

z) alarm device (**14.2.3**) :

functional test.

Annex E (informative)

Periodical examinations and tests, examinations and tests after an important modification or after an accident.

E.1 Periodical examinations and tests

Periodical examinations and tests shall not be more stringent than those required before the lift was the first time put into service.

These periodical tests should not, through their repetition, cause excessive wear or impose stresses likely to reduce the safety of the lift. This is the case in particular of the test on components such as the safety gear and the buffers. If tests on these components are made, they shall be carried out with empty car and at a reduced speed.

The person appointed to make the periodical test should assure himself that these components (which do not operate in normal service) are still in an operating condition.

A duplicate copy of the report should be attached to the register or file in the part covered by **16.2**.

E.2 Examinations and tests after an important modification or after an accident

The important modifications and accidents shall be recorded in the technical part of the register or file covered in **16.2**.

In particular, the following are considered as important modifications :

a) change :

- of the rated speed ;
- of the rated load ;
- of the mass of the car ;
- of the travel ;

b) change or replacement :

- of the type of locking devices (the replacement of a locking device by a device of the same type is not considered as an important modification) ;
- of the control system ;
- of guide rails or the type of guide rails ;
- of the type of door (or the addition of one or more landing or car doors) ;
- of the machine ;
- of the overspeed governor ;

- of the buffers ;
- of the safety gear ;
- of the clamping device ;
- of the pawl device ;
- of the jack ;
- of the pressure relief valve ;
- of the rupture valve ;
- of the restrictor/one-way restrictor.

For the tests after an important modification or after an accident the documents and the necessary information shall be submitted to the responsible person or organization.

Such person or organization will decide on the advisability of carrying out tests on the modified or replaced components.

These tests will, at the most, be those required for the original components before the lift was put into service.

Annex F (normative)

Safety components - Tests procedures for verification of conformity

F.0 Introduction

F.0.1 General provisions

F.0.1.1 For the purposes of this standard it is assumed that the laboratory undertakes both the testing and the certification as an approved body. An approved body may be that of a manufacturer operating an approved full quality assurance system. In certain cases the test laboratory and the body approved for the issue of type examination certificates may be separate. In these cases the administrative procedures may differ from those described in this annex.

F.0.1.2 The application for type examination shall be made by the manufacturer of the component or his authorized representative and shall be addressed to an approved test laboratory.

NOTE : At the request of the laboratory the necessary documents may be required in triplicate. The laboratory may likewise call for supplementary information, which might be necessary for the examination and tests.

F.0.1.3 The dispatch of samples for examination shall be made by agreement between the laboratory and the applicant.

F.0.1.4 The applicant may attend the tests.

F.0.1.5 If the laboratory entrusted with the complete examination of one of the components requiring the supply of a type examination certificate has not available appropriate means for certain tests or examinations, it may under its responsibility have these made by other laboratories.

F.0.1.6 The precision of the instruments shall allow, unless particularly specified, measurements to be made within the following tolerances :

a) ± 1 % masses, forces, distances, speeds ;

b) ± 2 % accelerations, retardations ;

c) ± 5 % voltages, currents ;

d) ± 5 °C temperatures ;

e) recording equipment shall be capable of detecting signals, which vary in time of 0,01 s ;

f) ± 2,5 % flow rate ;

g) ± 1 % pressure $p \le 200$ kPa ;

h) ± 5 % pressure $p > 200$ kPa.

F.0.2 Model form of type examination certificate

The examination certificate shall contain the following information.

MODEL TYPE-EXAMINATION CERTIFICATE

Name of the approved body : ....
....
....

Type-examination certificate : ....
....
....
....

Type-examination N° : ....

1 Category, type and make or trade name : ....

2 Manufacturer's name and address : ....
....
....

3 Name and address of certificate holder : ....
....
....

4 Date of submission for type-examination : ....

5 Certificate issued on the basis of the following requirement : ....
....

6 Test laboratory : ....

7 Date and number of laboratory report : ....

8 Date of type-examination : ....

9 The following documents, bearing the type-examination number shown above, are annexed to this certificate : ....
....

10 Any additional information : ....
....
....

Place : ....
(Date)

....
(Signature)

F.1 Landing door locking devices

F.1.1 General provisions

F.1.1.1 Field of application

These procedures are applicable to locking devices for lift landing doors. It is understood that each component taking part in the locking of landing doors and in the checking of the locking forms part of the locking device.

F.1.1.2 Object and extent of the test

The locking device shall be submitted to a test procedure to verify that insofar as construction and operation are concerned, it conforms to the requirements imposed by this standard.

It shall be checked in particular that the mechanical and electrical components of the device are of adequate size and that in the course of time the device does not lose its effectiveness, particularly through wear.

If the locking device is needed to satisfy particular requirements (waterproof, dust proof or explosion proof construction) the applicant shall specify this and supplementary examinations and/or tests under appropriate criteria shall be made.

F.1.1.3 Documents to be submitted

The following documents shall be attached to the application for a type test :

F.1.1.3.1 Schematic arrangement drawing with description of operation

This drawing shall show clearly all the details relating to the operation and the safety of the locking device, including :

a) the operation of the device in normal service showing the effective engagement of the locking elements and the point at which the electrical safety device operates ;

b) the operation of the device for mechanical checking of the locking position if this device exists ;

c) the control and operation of the emergency unlocking device ;

d) the type (A.C. and/or D.C.) and the rated voltage and rated current.

F.1.1.3.2 Assembly drawing with key

This drawing shall show all parts, which are important to the operation of the locking device, in particular those required to conform to requirements of this standard. A key shall indicate the list of principal parts, the type of materials used, and the characteristics of the fixing elements.

F.1.1.4 Test samples

One door locking device shall be submitted to the laboratory.

If the test is carried out on a prototype, it shall be repeated later on a production model.

If the test of the locking device is only possible when the device is mounted in the corresponding door (for example, sliding doors with several panels or hinged doors with several panels) the device shall be mounted on a complete door in working order. However, the door dimensions may be reduced by comparison with a production model, on condition that this does not falsify the test results.

F.1.2 Examination and tests

F.1.2.1 Examination of operation

This examination has the aim of verifying that the mechanical and electrical components of the locking device are operating correctly with respect to safety, and in conformity with the requirements of this standard, and that the device is in conformity with the particulars provided in the application.

In particular it shall be verified :

a) that there is at least 7 mm engagement of the locking elements before the electric safety device operates. Examples are shown in **7.7.3.1.1**.

b) that it is not possible from positions normally accessible to persons to operate the lift with a door open or unlocked, after one single action, not forming part of the normal operation (**7.7.5.1**).

F.1.2.2 Mechanical tests

These tests have the purpose of verifying the strength of the mechanical locking components and the electrical components.

The sample to the locking device in its normal operating position is controlled by the devices normally used to operate it.

The sample shall be lubricated in accordance with the requirements of the manufacturer of the locking device.

When there are several possible means of control and positions of operation, the endurance test shall be made in the arrangement which is regarded as the most unfavourable from the point of view of the forces on the components.

The number of complete cycles of operation and the travel of the locking components shall be registered by mechanical or electrical counters.

F.1.2.2.1 Endurance test

F.1.2.2.1.1 The locking device shall be submitted to 1 000 000 (± 1 %) complete cycles (one cycle comprises one forward and return movement over the full travel possible in both directions).

The driving of the device shall be smooth, without shocks, and at a rate of 60 (± 10 %) cycles per minute .

During the endurance test the electrical contact of the lock shall close a resistive circuit under the rated voltage and at a current value double that of the rated current.

F.1.2.2.1.2 If the locking device is provided with a mechanical checking device for the locking pin or the position of the locking element, this device shall be submitted to an endurance test of 100 000 (± 1 %) cycles.

The driving of the device shall be smooth, without shocks, and at a rate of 60 (± 10 %) cycles per minute.

F.1.2.2.2 Static test

For locking devices intended for hinged doors, a test shall be made consisting of the application over a total period of 300 s of a static force increasing progressively to a value of 3000 N.

This force shall be applied in the opening direction of the door and in a position corresponding as far as possible to that which may be applied when a user attempts to open the door. The force applied shall be 1000 N in the case of a locking device intended for sliding doors.

F.1.2.2.3 Dynamic test

The locking device, in the locked position, shall be submitted to a shock test in the opening direction of the door.

The shock shall correspond to the impact of a rigid mass of 4 kg falling in free fall from a height of 0,50 m.

F.1.2.3 Criteria for the mechanical tests

After the endurance test (**F.1.2.2.1**), the static test (**F.1.2.2.2**) and the dynamic test (**F.1.2.2.3**), there shall not be any wear, deformation or breakage, which could adversely affect safety.

F.1.2.4 Electrical test

F.1.2.4.1 Endurance test of contacts

This test is included in the endurance test laid down in **F.1.2.2.1.1**.

F.1.2.4.2 Test of ability to break circuit

This test is to be carried out after the endurance test. It shall check that the ability to break a live circuit is sufficient. This test shall be made in accordance with the procedure in EN 60947-4-1 and EN 60947-5-1, the values of current and rated voltage serving as a basis for the tests shall be those indicated by the manufacturer of the device.

If there is nothing specified, the rated values shall be as follows :

a) alternating current : 230 V, 2 A ;

b) direct current : 200 V, 2A.

In the absence of an indication to the contrary, the capacity to break circuit shall be examined for both A.C. and D.C. conditions.

The tests shall be carried out with the locking device in the working position. If several positions are possible, the test shall be made in the most unfavourable position.

The sample tested shall be provided with covers and electric wiring as used in normal service.

F.1.2.4.2.1 A.C. locking devices shall open and close an electric circuit under a voltage equal to 110 % of the rated voltage 50 times, at normal speed, and at intervals of 5 s to 10 s. The contact shall remain closed for at least 0,5 s.

The circuit shall comprise a choke and a resistance in series. Its power factor shall be 0,7 ± 0,05 and the test current shall be 11 times the rated current indicated by the manufacturer of the device.

F.1.2.4.2.2 D.C. locking devices shall open and close an electric circuit under a voltage equal to 110 % of the rated voltage 20 times, at normal speed, and at intervals of 5 s to 10 s. The contact shall remain closed for at least 0,5 s.

The circuit shall comprise a choke and a resistance in series having values such that the current reaches 95 % of the steady-state value of the test current in 300 ms.

The test current shall be 110 % of the rated current indicated by the manufacturer of the device.

F.1.2.4.2.3 The tests are considered as satisfactory if no tracking or arcing is produced and if no deterioration occurs which could adversely affect safety.

F.1.2.4.3 Test for resistance to leakage currents

This test shall be made in accordance with the procedure in CENELEC HD 21.4 S2 (IEC 112). The electrodes shall be connected to a source providing an A.C. voltage which is sinusoidal at 175 V, 50 Hz.

F.1.2.4.4 Examination of clearances and creepage distances

The clearances in air and creepage distances shall be in accordance with **14.1.2.2.3**.

F.1.2.4.5 Examination of the requirements appropriate to safety contacts and their accessibility (14.1.2.2)

This examination shall be made taking account of the mounting position and the layout of the locking device, as appropriate.

F.1.3 Test particular to certain types of locking devices

F.1.3.1 Locking device for horizontally or vertically sliding doors with several panels

The devices providing direct mechanical linkage between panels according to **7.7.6.1** or indirect mechanical linkage according to **7.7.6.2** are considered as forming part of the locking device.

These devices shall be submitted in a reasonable manner to the tests mentioned in **F.1.2**. The number of cycles per minute in such endurance tests shall be suited to the dimensions of the construction.

F.1.3.2 Flap type locking device for hinged door

F.1.3.2.1 If this device is provided with an electric safety device required to check the possible deformation of the flap and if, after the static test envisaged in **F.1.2.2.2** there are any doubts on the strength of the device, the load shall be increased progressively until the safety device begins to open. No component of the locking device or of the landing door shall be damaged or permanently deformed by the load applied.

F.1.3.2.2 If, after the static test, the dimensions and construction leave no doubt as to its strength, it is not necessary to proceed to the endurance test on the flap.

F.1.4 Type examination certificate

F.1.4.1 The certificate shall be drawn up in triplicate, i.e. two copies for the applicant, and one for the laboratory.

F.1.4.2 The certificate shall indicate the following :

a) information according to **F.0.2** ;

b) type and application of locking device ;

c) the type (A.C. and/or D.C.) and values of rated voltage and rated current ;

d) in the case of flap type door locking devices : the necessary force to actuate the electric safety device for checking the elastic deformation of the flap.

F.2 Kept free

F.3 Safety gear

F.3.1 General provisions

The applicant shall state the range of use provided, i.e. :

- minimum and maximum masses ;
- maximum rated speed and maximum tripping speed.

Detailed information shall be provided on the materials used, the type of guide rails and their surface condition (drawn, milled, ground).

The following documents shall be attached to the application :

a) detailed and assembly drawings showing the construction, operation, materials used, the dimensions and tolerances on the construction components ;

b) in the case of progressive safety gear, also a load diagram relating to elastic parts.

F.3.2 Instantaneous safety gear

F.3.2.1 Test samples

Two gripping assemblies with wedges or clamps and two lengths of guide rail shall be submitted to the laboratory.

The arrangement and the fixing details for the samples shall be determined by the laboratory in accordance with the equipment that it uses.

If the same gripping assemblies can be used with different types of guide rail, a new test shall not be required if the thickness of the guide rails, the width of the grip needed for the safety gear and the surface state (drawn, milled, ground) are the same.

F.3.2.2 Test

F.3.2.2.1 Method of test

The test shall be made using a press or similar device, which moves without abrupt speed change. Measurements shall be made of :

a) the distance travelled as a function of the force ;

b) the deformation of the safety gear block as a function of the force or as a function of the distance travelled.

F.3.2.2.2 Test procedure

The guide rail shall be moved through the safety gear.

Reference marks shall be traced onto the blocks in order to be able to measure their deformation.

The distance travelled shall be recorded as a function of the force.

After the test :

a) the hardness of the block and the gripping element shall be compared with the original values quoted by the applicant. Other analyses may be carried out in special cases ;

b) if there is no fracture, deformations and other changes shall be examined (for example, cracks, deformations or wear of the jaws, appearance of the rubbed surfaces) ;

c) if necessary, photographs shall be taken of the block, the gripping elements and the guide rail for evidence of deformations or fractures.

F.3.2.3 Documents

F.3.2.3.1 Two charts shall be drawn up as follows :

a) the first shall show the distance travelled as a function of the force ;

b) the other shall show the deformation of the block. It shall be done in such a way that it can be related to the first chart.

F.3.2.3.2 The capacity of the safety gears shall be established by integration of the area of the distance-force chart.

The area of the chart to be taken into consideration shall be :

a) the total area if there is no permanent deformation ;

b) if permanent deformation or rupture has occurred, either :

1) the area up to the value at which the elastic limit has been reached, or

2) the area up to the value corresponding to the maximum force.

F.3.2.4 Determination of the permissible mass

F.3.2.4.1 Energy absorbed by the safety gear

A distance of free fall, calculated with reference to the maximum tripping speed of the overspeed governor fixed in **9.10.2.1** shall be adopted.

The distance of free fall in metres shall be taken as :

$$h = \frac{v_1^2}{2 \cdot g_n} + 0{,}1 + 0{,}03$$

where :

v_1 = tripping speed of overspeed governor in metres per second ;

g_n = standard acceleration of free fall in metres per square second ;

0,10 m corresponds to the distance travelled during the response time ;

0,03 m corresponds to the travel during take-up of clearance between the gripping elements and the guide rails.

The total energy the safety gear is capable of absorbing :

$$2 \cdot K = (P + Q)_1 \cdot g_n \cdot h$$

from which :

$$(P + Q)_1 = \frac{2 \cdot K}{g_n \cdot h}$$

where :

$(P + Q)_1$ = permissible mass in kilogrammes ;

P = masses of the empty car and components supported by the car, i.e. part of the travelling cable, compensating ropes/chains (if any), etc. in kilogrammes ;

Q = rated load in kilogrammes ;

K, K_1, K_2 = energy absorbed by one safety gear block in joules (calculated in accordance with the chart).

F.3.2.4.2 Permissible mass

a) If the elastic limit has not been exceeded :

K is calculated by the integration of the area defined in **F.3.2.3.2 a)**.

2 is taken as the safety coefficient. The permissible mass in kilogrammes will be :

$$(P + Q)_1 = \frac{K}{g_n \cdot h}$$

b) If the elastic limit has been exceeded :

two calculations shall be made taking the one which is the more favourable to the applicant.

1) K_1 is calculated by the integration of the area defined in **F.3.2.3.2 b) 1)** ;

2 is adopted as the safety coefficient and this will give the permissible mass in kilogrammes as :

$$(P + Q)_1 = \frac{K_1}{g_n \cdot h}$$

2) K_2 is calculated by the integration of the area defined in **F.3.2.3.2 b) 2)** ;

3,5 is adopted as the safety coefficient, and this will give the permissible mass in kilogrammes as :

$$(P + Q)_1 = \frac{2 \cdot K_2}{3{,}5 \cdot g_n \cdot h}$$

F.3.2.5 Checking the deformation of the block and of the guide rail

If too great a deformation of the gripping elements in the block or the guide rail might cause difficulty in disengaging the safety gear, the permissible mass shall be reduced.

F.3.3 Progressive safety gear

F.3.3.1 Statement and test sample

F.3.3.1.1 The applicant shall state for what mass in kilogrammes and tripping speed in metres per second of the overspeed governor the test is to be carried out. If the safety gear has to be certified for various masses, he shall specify them and indicate in addition whether adjustment is by stages or continuous.

> NOTE : The applicant should choose the suspended mass in kilogrammes by dividing the anticipated braking force in newtons by 16 to aim at an average retardation of 0,6 g_n.

F.3.3.1.2 A complete safety gear assembly mounted on a cross-piece, with the dimensions fixed by the laboratory, together with the number of brake shoes necessary for all the tests shall be placed at the disposal of the laboratory. The number of sets of brake shoes necessary for all the tests shall be attached. For the type of guide rail used, the length specified by the laboratory shall also be supplied.

F.3.3.2 Test

F.3.3.2.1 Method of test

The test shall be carried out in free fall. Direct or indirect measurements shall be made of :

a) the total height of the fall ;

b) the braking distance on the guide rails ;

c) the sliding distance of the overspeed governor rope, or that of the device used in its place ;

d) the total travel of the elements forming the spring.

Measurements a) and b) shall be recorded as a function of the time.

The following shall be determined :

1) the average braking force ;

2) the greatest instantaneous braking force ;

3) the smallest instantaneous braking force.

F.3.3.2.2 Test procedure

F.3.3.2.2.1 Safety gear certified for a single mass

The laboratory shall carry out four tests with the mass $(P + Q)_1$. Between each test the friction parts shall be allowed to return to their normal temperature.

During the tests several identical sets of friction parts may be used.
However, one set of parts shall be capable of :

a) three tests, if the rated speed does not exceed 4 m/s ;

b) two tests, if the rated speed exceeds 4 m/s.

The height of free fall shall be calculated to correspond to the maximum tripping speed of the overspeed governor for which the safety gear can be used.

The engagements of the safety gear shall be achieved by a means allowing the tripping speed to be fixed precisely.

> NOTE : For example, a rope may be used, the slack of which should be carefully calculated, fixed to a sleeve which can slide with friction over a fixed smooth rope. The friction effort should be the same as the effort applied to the operating rope by the governor attached to this safety gear.

F.3.3.2.2.2 Safety gear certified for different masses

Adjustment in stages or continuous adjustment.

Two series of tests shall be carried out for :

a) the maximum, and

b) the minimum value applied for.

The applicant shall supply a formula, or a chart, showing the variation of the braking force as a function of a given parameter.

The laboratory shall verify by suitable means (in the absence of anything better, by a third series of tests for intermediary points) the validity of the supplied formula.

F.3.3.2.3 Determination of the braking force of the safety gear

F.3.3.2.3.1 Safety gear certified for a single mass

The braking force of which the safety gear is capable for the given adjustment and the type of guide rail is taken as equal to the average of the average braking forces determined during the tests. Each test shall be made on an unused section of guide rail.

A check shall be made that the average values determined during the tests lie within a range of ± 25 % in relation to the value of the braking force defined above.

> NOTE : Tests have shown that the coefficient of friction could be considerably reduced if several successive tests were carried out on the same area of a machined guide rail. This is attributed to a modification in the surface condition during successive safety gear operations.
>
> It is accepted that, on an installation, an inadvertent operation of the safety gear would have every chance of occurring at an unused spot.
>
> It is necessary to consider that if, by chance, this were not the case, the braking force would have a lower value until an unused portion of guide rail surface was reached. Hence, greater sliding than normal.
>
> This is a further reason for not permitting any adjustment causing too small a retardation at the beginning.

F.3.3.2.3.2 Safety gear certified for different masses

Adjustment in stages or continuous adjustment.

The braking force of which the safety gear is capable shall be calculated as laid down in **F.3.3.2.3.1** for the maximum and minimum values applied for.

F.3.3.2.4 Checking after the tests

a) The hardness of the block and the gripping elements shall be compared with the original values submitted by the applicant. Other analyses may be made in special cases ;

b) the deformations and modifications (for example, cracks, deformations or wear of the gripping elements, appearance of the rubbing surfaces) shall be checked ;

c) if necessary, the safety gear assembly, the gripping elements and the guide rails shall be photographed in order to reveal deformations or fractures.

F.3.3.3 Calculation of the permissible mass

F.3.3.3.1 Safety gear certified for a single mass

The permissible mass shall be calculated using the following formula :

$$(P+Q)_1 = \frac{Braking\ force}{16}$$

where :

$(P+Q)_1$	= permissible mass in kilogrammes ;
P	= masses of the empty car and components supported by the car, i.e. part of the travelling cable, compensating ropes/chains (if any), etc. in kilogrammes ;
Q	= rated load in kilogrammes ;
Braking force	= the force in newtons determined in accordance with **F.3.3.2.3**.

F.3.3.3.2 Safety gear certified for different masses

F.3.3.3.2.1 Adjustment in stages

The permissible mass shall be calculated for each adjustment as laid down in **F.3.3.3.1**.

F.3.3.3.2.2 Continuous adjustment

The permissible mass shall be calculated as laid down in **F.3.3.3.1** for the maximum and minimum values applied for and in accordance with the formula supplied for the intermediate adjustments.

F.3.3.4 Possible modification to the adjustments

If, during the tests, the values found differ by more than 20 % from those expected by the applicant, other tests may be made with his agreement, after modification of the adjustments if necessary.

NOTE : If the braking force is clearly greater than that allowed for by the applicant, the mass used during the test would be clearly smaller than that which one would be led to authorize by calculation **F.3.3.3.1** and consequently the test would not allow the conclusion that the safety gear is able to dissipate the required energy with the mass resulting from the calculation.

F.3.4 Comments

a) 1) When it is applied to a given lift, the mass stated by the installer shall not exceed the permissible mass for the safety gear (for instantaneous safety gear or instantaneous safety gear with buffered effect), and the adjustment considered ;

2) in the case of progressive safety gear, the mass stated may differ from the permissible mass defined in **F.3.3.3** by ± 7,5 %. It is accepted in these conditions that the requirements of **9.8.4** are met on the installation, not withstanding the usual tolerances on the thickness of the guide rails, the surface conditions, etc. ;

b) to evaluate the validity of welded parts, reference shall be made to standards on this subject ;

c) a check shall be made that the possible travel of the gripping elements is sufficient under the most unfavourable conditions (accumulation of manufacturing tolerances) ;

d) the friction parts shall be suitably retained so that it can be certain that they will be in place at the moment of operation ;

e) In the case of a progressive type safety gear, it shall be checked that the travel of the components forming the spring is sufficient.

F.3.5 Type examination certificate

F.3.5.1 The certificate shall be drawn up in triplicate, i.e. two copies for the applicant, and one for the laboratory.

F.3.5.2 The certificate shall indicate the following :

a) information according to **F.0.2** ;

b) type and application of safety gear ;

c) the limits of the permissible masses (see **F.3.4 a)**) ;

d) the tripping speed of the overspeed governor ;

e) the type of guide rail ;

f) the permissible thickness of the guide rail blade ;

g) the minimum width of the gripping areas ;

and, for progressive safety gear only :

h) the surface condition of the guide rails (drawn, milled, ground) ;

i) the state of lubrication of the guide rails. If they are lubricated, the category and specification of the lubricant.

F.4 Overspeed governors

F.4.1 General provisions

The applicant shall indicate the following to the laboratory :

a) the type (or the types) of safety gear which will be operated by the governor ;

b) the maximum and minimum rated speeds of lifts for which the governor may be used ;

c) the anticipated value of the tensile force produced in the rope by the overspeed governor when tripped.

The following documents are to be attached to the application :

detailed and assembly drawings showing the construction, operation, materials used, the dimensions and tolerances on the construction components.

F.4.2 Check on the characteristics of the governor

F.4.2.1 Test samples

The following shall be submitted to the laboratory :

a) one overspeed governor ;

b) one rope of the type used for the overspeed governor and in the normal condition in which it should be installed. The length to be supplied is fixed by the laboratory ;

c) a tensioning pulley assembly of the type used for the overspeed governor.

F.4.2.2 Test

F.4.2.2.1 Method of test

The following shall be checked :

a) the speed of tripping ;

b) the operation of the electric safety device called for in **9.10.2.10.1** causing the machine to stop, if this device is mounted on the overspeed governor ;

c) the operation of the electric safety device called for in **9.10.2.10.2** preventing all movement of the lift when the overspeed governor is tripped ;

d) the tensile force produced in the rope by the overspeed governor when tripped.

F.4.2.2.2 Test procedure

At least 20 tests shall be made in the speed range for tripping corresponding to the range of rated speeds of the lift, indicated in **F.4.1 b)**.

NOTE 1 : The tests may be made by the laboratory in the component manufacturers works.

NOTE 2 : The majority of tests should be made at the extreme values of the range.

NOTE 3 : The acceleration to reach the tripping speed of the overspeed governor should be as low as possible, in order to eliminate the effects of inertia.

F.4.2.2.3 Interpretation of the test results

F.4.2.2.3.1 In the course of 20 tests the tripping speeds shall lie within the limits called for in **9.10.2.1**.

NOTE : If the limits laid down are exceeded, an adjustment may be made by the manufacturer of the component and 20 new tests carried out.

F.4.2.2.3.2 In the course of the 20 tests the operation of the devices for which the test is required in **F.4.2.2.1 b)** and **c)** shall occur within the limits laid down in **9.10.2.10.1** and **9.10.2.10.2**.

F.4.2.2.3.3 The tensile force in the rope produced by the overspeed governor when tripped shall be at least 300 N or any higher value which is specified by the applicant.

NOTE 1 : Unless otherwise requested by the manufacturer of the device and specified in the test report, the arc of engagement should be 180°.

NOTE 2 : In the case of a device, which operates by gripping the rope it should be checked that there is no permanent deformation of the rope.

F.4.3 Type examination certificate

F.4.3.1 The certificate shall be drawn up in triplicate, i.e. two copies for the applicant, and one for the laboratory.

F.4.3.2 The certificate shall indicate the following :

a) information according to **F.0.2** ;

b) type and application of overspeed governor ;

c) the maximum and minimum rated speeds of the lift for which the overspeed governor may be used ;

d) the diameter of the rope to be used and its construction ;

e) in the case of an overspeed governor with traction pulley, the minimum tensioning force ;

f) the tensile force in the rope which can be produced by the overspeed governor when tripped.

F.5 Buffers

F.5.1 General provisions

The applicant shall state the range of use provided, i.e. maximum impact speed, minimum and maximum masses. The following are to be attached to the application :

a) detailed and assembly drawings showing the construction, operation, materials used, the dimensions and tolerances on the construction components.

In the case of hydraulic buffers, the graduation (openings for the passage of the liquid), in particular, shall be shown as a function of the stroke of the buffer ;

b) specifications for the liquid used.

F.5.2 Samples to be submitted

The following shall be submitted to the laboratory :

a) one buffer ;

b) in the case of hydraulic buffers, the necessary liquid sent separately.

F.5.3 Test

F.5.3.1 Energy accumulation type buffers with buffered return movement

F.5.3.1.1 Test procedure

F.5.3.1.1.1 The mass necessary to compress the spring completely shall be determined, for example, with the aid of weights loaded on to the buffer.

The buffer may only be used :

a) for rated speeds downwards :

1) for lifts provided with a restrictor (or a one-way restrictor) :

$$v_d \leq \sqrt{\frac{F_L}{0{,}102}} - 0{,}3$$ (see **10.4.1.1.1 a)**),

where :

F_L = total compression of the spring in metres ;

2) for all other lifts :

$$v_d \leq \sqrt{\frac{F_L}{0{,}135}} - 0{,}3$$ (see **10.4.1.1.1 a)**) ;

b) for masses between :

1) maximum $\frac{C_r}{2,5}$

2) minimum $\frac{C_r}{4}$

where :

C_r = mass needed to compress the spring completely in kilogrammes.

F.5.3.1.1.2 The buffer shall be tested with the aid of weights corresponding to the maximum and minimum masses falling in free fall from a height above the buffer equal to $0,5 \cdot F_L = 0,067 \cdot v^2$.

The speed shall be recorded from the moment of impact on the buffer and throughout the test. At no time shall the rising speed of the weights (during return) exceed 1 m/s.

F.5.3.1.2 Equipment to be used

The equipment shall satisfy to the following conditions :

F.5.3.1.2.1 Weights falling in free fall

The weights shall correspond, with the tolerances of **F.0.1.6**, to the minimum and maximum masses. They shall be guided vertically with the minimum of friction possible.

F.5.3.1.2.2 Recording equipment

The recording equipment shall be capable of detecting signals with the tolerance of **F.0.1.6**.

F.5.3.1.2.3 Measurement of speed

The speed shall be recorded with the tolerance of **F.0.1.6**.

F.5.3.1.3 Ambient temperature

The ambient temperature shall lie between + 15 °C and + 25 °C.

F.5.3.1.4 Mounting of the buffer

The buffer shall be placed and fixed in the same manner as in normal service.

F.5.3.1.5 Checking of the condition of the buffer after tests

After two tests with the maximum mass, no part of the buffer shall show any permanent deformation or be damaged so that its condition shall guarantee normal operation.

F.5.3.2 Energy dissipation buffers

F.5.3.2.1 Test procedure

The buffer shall be tested with the aid of weights, corresponding to the minimum and maximum masses, falling in free fall to reach at the moment of impact the maximum speed called for.

The speed shall be recorded at least from the moment of impact of the weights. The acceleration and the retardation shall be determined as a function of time throughout the movement of the weights.

NOTE : This procedure relates to hydraulic buffers ; for other types proceed by analogy.

F.5.3.2.2 Equipment to be used

The equipment shall satisfy to the following conditions :

F.5.3.2.2.1 Weights falling in free fall

The weights shall correspond, with the tolerances of **F.0.1.6**, to the maximum and minimum masses. They shall be guided vertically with the minimum of friction possible.

F.5.3.2.2.2 Recording equipment

The recording equipment shall be able to detect signals with the tolerances of **F.0.1.6**. The measuring chain, including the recording device for the recording of measured values as a function of time, shall be designed with a system frequency of at least 1000 Hz.

F.5.3.2.2.3 Measurement of speed

The speed shall be recorded at least from the moment of impact of the weights on the buffer or throughout the travel of the weights with the tolerances of **F.0.1.6**.

F.5.3.2.2.4 Measurement of the retardation

If there is a device for measuring retardation (see **F.5.3.2.1**), it shall be placed as near as possible to the axis of the buffer, and shall be capable of measurement with the tolerances of **F.0.1.6**.

F.5.3.2.2.5 Measurement of time

Time pulses of a duration of 0,01 s shall be recorded and measured with the tolerances of **F.0.1.6**.

F.5.3.2.3 Ambient temperature

The ambient temperature shall lie between + 15 °C and + 25 °C.

The temperature of the liquid shall be measured with the tolerances of **F.0.1.6**.

F.5.3.2.4 Mounting of the buffer

The buffer shall be placed and fixed in the same manner as in normal service.

F.5.3.2.5 Filling of the buffer

The buffer shall be filled up to the mark indicated following the instructions of the component manufacturer.

F.5.3.2.6 Checks

F.5.3.2.6.1 Checking of retardation

The height of free fall of the weights shall be chosen in such a way that the speed at the moment of impact corresponds to the maximum impact speed stipulated in the application.

The retardation shall conform to the requirements of **10.4.3.2** of this standard.

A first test shall be made with maximum mass with a check on the retardation.

A second test shall be made with minimum mass with a check on the retardation.

F.5.3.2.6.2 Checking of the return of the buffer to the normal position

After each test the buffer shall be held in the completely compressed position for 5 min. The buffer shall then be freed to permit its return to its normal extended position.

When the buffer is of a type with spring or gravity return, the position of complete return shall be reached in a maximum period of 120 s.

Before proceeding to another retardation test there shall be a delay of 30 min. to permit the liquid to return to the tank and for bubbles of air to escape.

F.5.3.2.6.3 Checking of the liquid losses

The level of liquid shall be checked after having made the two retardation tests required in **F.5.3.2.6.1**, and after an interval of 30 min. the level of liquid shall again be sufficient to ensure normal operation of the buffer.

F.5.3.2.6.4 Checking of the condition of the buffer after tests

After the two retardation tests required in **F.5.3.2.6.1** no part of the buffer shall show any permanent deformation or be damaged so that its condition shall guarantee normal operation.

F.5.3.2.7 Procedure in the case of tests failing the requirements

When the test results are not satisfactory with the minimum and maximum masses appearing in the application, the laboratory may, in agreement with the applicant, establish the acceptable limits.

F.5.3.3 Buffers with non linear characteristics

F.5.3.3.1 Test procedure

F.5.3.3.1.1 The buffer shall be tested with the aid of masses falling in free fall from a height to reach at the moment of impact the maximum speed called for, but not less than 0,8 m/s.

The falling distance, the speed, the acceleration and retardation shall be recorded from the moment of release of the weight to the complete standstill.

F.5.3.3.1.2 The masses shall correspond to the maximum and minimum masses called for. They shall be guided vertically with a minimum of friction possible, so that at the moment of impact at least 0,9 g_n are reached.

F.5.3.3.2 Equipment to be used

The equipment shall correspond to **F.5.3.2.2.2**, **F.5.3.2.2.3**, and **F.5.3.2.2.4.**

F.5.3.3.3 Ambient temperature

The ambient temperature shall lie between + 15 °C and + 25 °C.

F.5.3.3.4 Mounting of the buffer

The buffer shall be placed and fixed in the same manner as in normal service.

F.5.3.3.5 Number of tests

Three tests shall be made with :

a) the maximum mass ;

b) the minimum mass called for.

The time delay between two consecutive tests shall lie between 5 and 30 min.

With the three tests with maximum mass the value of reference of the buffer force at a stroke equal to 50 % of the real height of the buffer given by the applicant shall not vary by more than 5 %. With the tests with minimum mass this shall be observed in analogy.

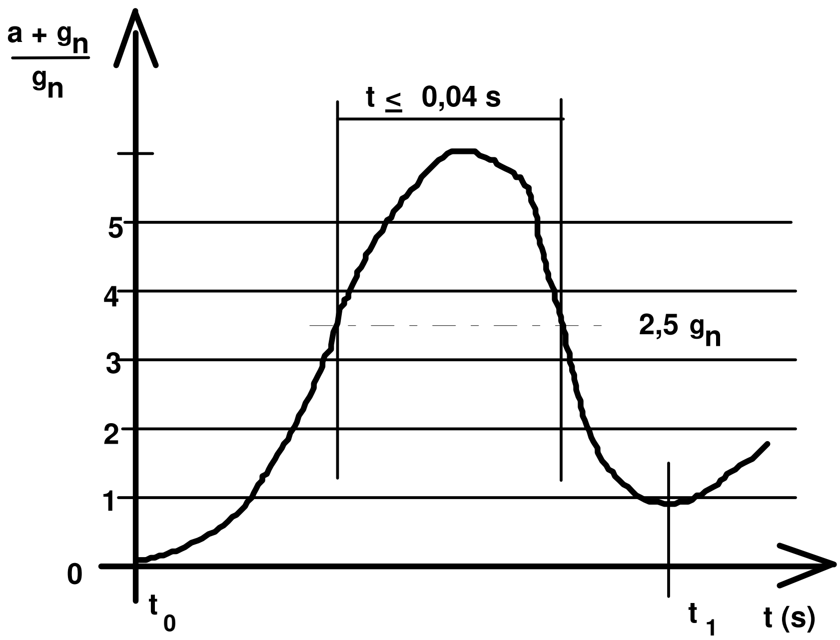
F.5.3.3.6 Checks

F.5.3.3.6.1 Checking of retardation

The retardation 'a' shall conform to the following requirements :

a) the average retardation in case of free fall with a load in the car according to **table 1.1** from a speed equal to 115 % of the rated speed shall not exceed 1 g_n. The average retardation will be evaluated taking into account the time between the first two absolute minima of the retardation (see **figure F.1**) ;

b) peaks of retardation with more than 2,5 g_n shall not be longer than 0,04 s.



t_0 = moment of hitting the buffer (first absolute minimum) ;
t_1 = second absolute minimum.

Figure F.1 : Retardation graph

F.5.3.3.6.2 Checking of the condition of the buffer after tests

After the tests with the maximum mass no part of the buffer shall show any permanent deformation or be damaged so that its condition shall guarantee normal operation.

F.5.3.3.7 Procedure in the case of tests failing the requirements

When the test results are not satisfactory with the minimum and maximum masses appearing in the application, the laboratory may, in agreement with the applicant, establish the acceptable limits.

F.5.4 Type examination certificate

F.5.4.1 The certificate shall be drawn up in triplicate, i.e. two copies for the applicant, and one for the laboratory.

F.5.4.2 The certificate shall indicate the following :

a) information according to **F.0.2** ;

b) type and application of buffer ;

c) the maximum impact speed ;

d) the maximum mass ;

e) the minimum mass ;

f) the specification of the liquid in the case of hydraulic buffers ;

g) environmental conditions for use (temperature, humidity, pollution, etc.) in case of buffers with non-linear characteristics.

F.6 Safety circuits containing electronic components

For safety circuits containing electronic components, laboratory tests are necessary because practical checks on site, by inspectors, are impossible.

In the following, mention is made to printed circuit board. If a safety circuit is not assembled in such a manner, then the equivalent assembly shall be assumed.

F.6.1 General provisions

The applicant shall indicate to the laboratory :

a) the identification on the board ;

b) working conditions ;

c) listing of used components ;

d) layout of the printed circuit board ;

e) layout of the hybrids and marks of the tracks used in safety circuits ;

f) function description ;

g) electrical data inclusive wiring diagram, if applicable, including input and output definitions of the board.

F.6.2 Test samples

There shall be submitted to the laboratory :

a) one printed circuit board ;

b) one printed circuit board bare (without components).

F.6.3 Tests

F.6.3.1 Mechanical tests

During the tests, the tested object (printed circuit) shall be kept under operation. During and after the tests, no unsafe operation and condition shall appear within the safety circuit.

F.6.3.1.1 Vibration

Transmitter elements of safety circuits shall withstand the requirements of :

a) EN 60068-2-6, Endurance by sweeping : Table C.2 :

20 sweep cycles in each axis, at amplitude 0,35 mm or 5 g_n, and in the frequency range 10-55 Hz ;

and also to :

b) EN 60068-2-27, Acceleration and duration of pulse : Table 1 :

the combination of :

- peak acceleration 294 m/s^2 or 30 g_n ;

- corresponding duration of pulse 11 ms, and

- corresponding velocity change 2,1 m/s half sine.

NOTE : Where shock absorbers for transmitter elements are fitted, they are considered as part of the transmitter elements.

After tests, clearances and creepage distances shall not become smaller than the minimum accepted.

F.6.3.1.2 Bumping (EN 60068-2-29)

Bumping tests are to simulate the cases when printed circuits fall, introducing the risk of rupture of components and unsafe situation.

Tests are divided into :

a) partial shockings ;

b) continuous shockings.

The tests object must satisfy the following minimum requirements :

F.6.3.1.2.1 Partial shocking

1) Shocking shapes : half-sinus ;

2) amplitude of acceleration : 15 g ;

3) duration of shock : 11 ms.

F.6.3.1.2.2 Continuous shocking

1) Amplitude of acceleration : 10 g ;

2) duration of shock : 16 ms ;

3) a) number of shocks : 1000 +/- 10 ;

b) shock frequency : 2/s.

F.6.3.2 Temperature tests (HD 323.2.14.S2)

Operating ambient limits : 0 °C, + 65 °C (the ambient temperature is of the safety device).

Test conditions :

- the printed circuit board must be in operational position ;

- the printed circuit board must be supplied with normally rated voltage ;

- the safety device must operate during, and after the test. If the printed circuits board includes components other than safety circuits, they also must operate during the test (their failure is not considered) ;

- tests will be carried out for minimum and maximum temperature(0, + 65 °C). Tests will last a minimum of four hours ;

- if the printed circuit board is designed to operate within wider temperature limits, it must be tested for these values.

F.6.4 Type examination certificate

F.6.4.1 The certificate shall be drawn up in triplicate, i.e. two copies for the applicant and one copy for the laboratory.

F.6.4.2 The certificate shall indicate :

a) information according to **F.0.2** ;

b) type and application in the circuitry ;

c) design for pollution degree according to IEC 60664-1 ;

d) operating voltages ;

e) distances between the safety circuits and the rest of the control circuits on the board.

NOTE : Other tests like humidity test, climatic shock test etc. are not subject for tests because of the normal environmental situation where lifts are operating.

F.6.5 Type examination certificate

F.6.5.1 The certificate shall be drawn up in triplicate, i.e. two copies for the applicant and one copy for the laboratory.

F.6.5.2 The certificate shall indicate :

a) information according to **F.0.2** ;

b) type and application in the circuitry ;

c) designed for pollution degree according to IEC 664-1 ;

d) operating voltages ;

e) distances between the safety circuits and the rest of the control circuits on the board.

NOTE : Other tests like humidity test, climatic shock test, etc. are not subject for tests because of the normal environmental situation where lifts are operating.

F.7 Rupture valve/one-way restrictor

In the following the term “rupture valve” means “rupture valve/one-way restrictor with mechanical moving parts”.

F.7.1 General provisions

The applicant shall state :

a) the range of flow ;

b) the range of pressure ;

c) the range of viscosity ;

d) the range of ambient temperature ;

e) the method of mounting ;

of the rupture valve to be type examined.

The following are to be attached to the application :

- details and assembly drawings showing the construction, operation, adjustment, materials, dimensions and tolerances of the rupture valve and the construction components.

F.7.2 Samples to be submitted

There shall be submitted to the laboratory :

a) one rupture valve ;

b) a list of liquids which may be used together with the rupture valve or a sufficient amount of special liquid to be used ;

c) if necessary adaptation means to the test facilities of the laboratory.

F.7.3 Test

F.7.3.1 Test installation

The rupture valve, mounted in its intended method, shall be tested in a hydraulic system, where :

a) the required testing pressure is depending from a mass ;

b) the flow is controlled by adjustable valves ;

c) the pressure before [9)] and behind the rupture valve can be recorded ;

d) installations to vary the ambient temperature of the rupture valve and the viscosity of the hydraulic liquid are provided.

The system shall allow to record the flow over the time. To determine the values of flow, the measurement of an other figure, i.e. the speed of the ram, from which the flow can be derived, is permitted.

F.7.3.2 Measuring instruments

The measuring instruments shall have an accuracy according to **F.0.1.6** (see ISO 6403).

F.7.4 Test procedure

The test shall :

a) simulate a total piping failure occurring at a moment when the speed of the car is zero ;

b) evaluate the resistance of the rupture valve against pressure.

[9)] "Before the rupture valve" means between the cylinder and the rupture valve.

F.7.4.1 Simulation of a total piping failure

Simulating a total piping failure, the flow shall be initiated from a static situation by opening a valve under the condition that the static pressure before the rupture valve decrease to less than 10 %.

The following shall be taken into account :

a) tolerance of the closing value within the stated range of flow ;

b) tolerance of the closing value within the stated range of viscosity ;

c) tolerance of the closing value within the stated range of pressure ;

d) tolerance of the closing value within the stated range of ambient temperature.

That can be achieved by 2 test series :

a) with maximum pressure, maximum ambient temperature, minimum adjustable flow and minimum viscosity ;

b) with minimum pressure, minimum ambient temperature, maximum adjustable flow and maximum viscosity.

In each test series at least 10 tests shall be carried out, to evaluate the tolerances of operation of the rupture valve under these conditions.

During the tests the relation between :

- flow and time, and

- pressure before and behind the rupture valve and time

shall be recorded.

The typical characteristics of these curves are shown in the **figure F.2**.

F.7.4.2 Resistance against pressure

Showing the resistance of the rupture valve against pressure it shall be submitted to a pressure test with 5 times the maximum pressure over 2 min.

F.7.5 Interpretation of the tests

F.7.5.1 Closing operation

The rupture valve fulfils the requirements of the standard if the curves recorded according to **F.7.4.1** show that :

a) the time t_o between rated flow (100 % flow) and the maximum flow Q_{max} does not exceed 0,16 s ;

b) the time t_d for the decrease of flow is :

$$\frac{|Q_{max}|}{6 \cdot A \cdot 9{,}81} \leq t_d \leq \frac{|Q_{max}|}{6 \cdot A \cdot 1{,}96}$$

where :

Q_{max} = maximum flow of the hydraulic fluid in litre per minute ;

t_d = braking time in seconds ;

A = area of jack, where pressure is acting in square centimetres ;

c) pressure of more than 3,5 · P_s shall not be longer than 0,04 s ;

d) the rupture valve shall be tripped before the speed is equal to rated speed + 0,3 m/s.

F.7.5.2 Pressure resistance

The rupture valve fulfils the requirements of the standard if after the pressure test according to **F.7.4.2** it shows no permanent damage.

F.7.5.3 Readjustment

If the limits of flow decrease or pressure peaks are exceeded, the manufacturer is allowed to modify the adjustment of the rupture valve. After that an other test serie may be carried out.

F.7.6 Type examination certificate

F.7.6.1 The certificate shall be drawn up in triplicate, i.e. two copies for the applicant and one copy for the laboratory.

F.7.6.2 The certificate shall indicate :

a) information according to **F.0.2** ;

b) type and application of the rupture valve ;

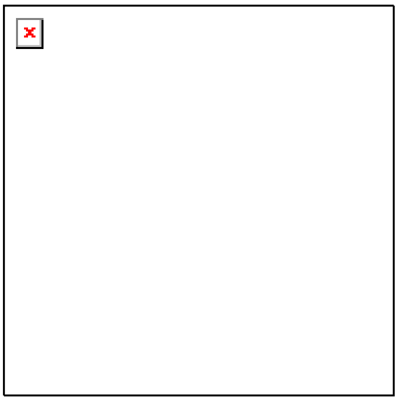
c) the range of flow of the rupture valve ;

d) the range of pressure of the rupture valve ;

e) the range of viscosity of hydraulic fluids to be used ;

f) the range of ambient temperature of the rupture valve.

The certificate shall be accompanied with a graph according to **figure F.2** showing the relationship between flow of hydraulic fluid and pressure from which Q_{max} and t_d can be obtained.



P_p	pressure peak	— · — ·	pressure after rupture valve
P_s	pressure static	————	hydraulic fluid flow
t	time	— — —	pressure before rupture valve

① the rupture valve must be tripped before the speed is equal to rated speed + 0,3 m/s

Figure F.2 : Hydraulic fluid flow through, pressure before and after the rupture valve

Annex G (informative)

Proof of guide rails

G.1 General [10)]

G.1.1 In order to fulfil the requirements of **10.1.1** guide rail calculations based on the following are accepted where no specific load distribution is intended.

G.1.1.1 The rated load - *Q* - is considered to be unevenly distributed over the car area, see **G.2.2**.

G.1.1.2 It is assumed that the safety devices operate simultaneously on the guide rails and that the braking force is equally distributed.

G.2 Loads and forces

G.2.1 The acting point of the masses of the empty car and components supported by the car such as ram, part of travelling cable, compensating ropes/chains (if any) - *P* - shall be the centre of gravity of the mass of the car.

G.2.2 In the load cases “normal use” and “safety device operation” the rated load - *Q* - according to 8.2 shall be evenly distributed over those three quarters of the car area being in the most unfavourable position as depicted in the examples given in **G.7**.

However, if different load distribution conditions are intended after negotiations (**0.2.5**), the calculations shall be made on the basis of this conditions.

G.2.3 The buckling force - F_k - of the car shall be evaluated by using the formula :

$$F_k = \frac{k_1 \cdot g_n \cdot (P + Q)}{n}$$

10) This annex is valid for both standards EN 81 part 1 and part 2.

where :

k_1 = impact factor according to **table G.2** ;

g_n = standard acceleration of free fall (9,81 m/s^2) ;

P = masses of the empty car and components supported by the car, i.e. part of the travelling cable, compensating ropes/chains (if any), etc. in kilogrammes ;

Q = rated load in kilogrammes ;

n = number of guide rails.

G.2.4 The buckling force of the counterweight or balancing weight with safety gear - F_c - shall be evaluated by using the formula :

$$F_c = \frac{k_1 \cdot g_n \cdot (P + q \cdot Q)}{n} \quad \text{or} \quad F_c = \frac{k_1 \cdot g_n \cdot q \cdot P}{n}$$

where :

k_1 = impact factor according to table **G.2** ;

g_n = standard acceleration of free fall (9,81 m/s^2) ;

P = masses of the empty car and components supported by the car, i.e. part of the travelling cable, compensating ropes/chains (if any), etc. in kilogrammes ;

Q = rated load in kilogrammes ;

q = balance factor indicating the amount of counterbalance of the rated load by the counterweight, or amount of counterbalance of the mass of the car by the balancing weight ;

n = number of guide rails.

G.2.5 Whilst loading or unloading a car, a force on the sill -F_s- has to be assumed to act centrally on the sill of the car entrance. The amount of the force on the sill shall be :

$F_s = 0{,}4 \cdot g_n \cdot Q$ for lifts with rated loads less than 2500 kg in private premises, office buildings, hotels, hospitals etc. ;

$F_s = 0{,}6 \cdot g_n \cdot Q$ for lifts with rated loads of 2500 kg or more ;

$F_s = 0{,}85 \cdot g_n \cdot Q$ [11] for lifts with rated loads of 2500 kg or more in case of forklift truck loading.

Applying the force on the sill the car shall be regarded as empty. At cars with more than one entrance the force on the sill needs to be applied at the most unfavourable entrance only.

[11] 0,85 is based on the assumption of 0,6.Q and half of the weight of the forklift truck, which - due to experience (ANSI class C 2) - is not bigger than half the rated load (0,6 + 0,5 · 0,5) = 0,85.

G.2.6 The guiding forces of a counterweight or balancing weight - *G* - shall be evaluated taking into account :

- the acting point of the mass ;

- the suspension, and

- the forces due to compensating ropes/chains (if any), tensioned or not.

On a counterweight or balancing weight, centrally guided and suspended, an eccentricity of the acting point of the mass from the centre of gravity of the horizontal cross area of the counterweight or balancing weight of at least 5 % of the width and 10 % of the depth shall be taken into consideration.

G.2.7 Forces per guide rail due to auxiliary equipment fixed to the guide rail - *M* - shall be considered, except for overspeed governors and their associated parts, switches or positioning equipment.

G.2.8 Windloads - *WL* - shall be considered with lifts outside a building with incomplete well enclosure, and be determined by negotiation with the building designer (**0.2.5**).

G.3 Load cases

G.3.1 The loads and forces and the load cases to be taken into consideration are shown in **table G.1.**

Table G.1 : Loads and forces to be taken into consideration in the different load cases

Load cases	Loads and forces	P	Q	G	F_s	F_k or F_c	M	WL
Normal use	running	+	+	+	-	-	+	+
	loading + unloading	+	-	-	+	-	+	+
Safety device operation	safety devices or similar	+	+	+	-	+	+	-
	rupture valve	+	+	-	-	-	+	-

G.3.2 In the documents intended for the first examination and test, it is sufficient to submit only the calculation of the most unfavourable load case.

G.4 Impact factors

G.4.1 Safety device operation

The impact factor due to safety device operation k_1 depends on the type of safety device.

G.4.2 Car

In the load case "normal use, running", the vertical moving masses of the car ($P + Q$) shall be multiplied by the impact factor k_2 to take into consideration hard braking due to electric safety device actuation or by an accidental interruption of the power supply.

G.4.3 Counterweight or balancing weight

The forces applied to the guide rails of the counterweight or balancing weight as specified in **G.2.6** shall be multiplied with the impact factor k_3 to take into account the possible counterweight or balancing weight bounce when the car is stopped with a retardation higher that 1 g_n.

G.4.4 Values of impact factors

The values of the impact factors are given in **table G.2**.

Table G.2 : Impact factors

Impact at	Impact factor	Value
Operation of instantaneous safety gear or clamping device, neither of the captive roller type		5
Operation of instantaneous safety gear or clamping device, both of the captive roller type or pawl device with energy accumulation type buffer or energy accumulation type buffer	k_1	3
Operation of progressive safety gear or progressive clamping device or pawl device with energy dissipation type buffer or energy dissipation type buffer		2
Rupture valve		2
Running	k_2	1,2
Auxiliary parts	k_3	(....) 1)
1) The value has to be determined by the manufacturer due to the actual installation.		

G.5 Calculations

G.5.1 Range of calculation

Guide rails shall be dimensioned taking into account bending stresses.

In cases where safety devices will act on guide rails, they shall be dimensioned taking into account bending and buckling stresses.

With hanging guide rails (fixed at the top of the well) instead of buckling, tensile stresses have to be taken into account.

G.5.2 Bending stresses

G.5.2.1 Depending on :

- the suspension of the car, counterweight or balancing weight ;

- the position of the guide rails of the car, counterweight or balancing weight ;

- the load and its distribution in the car ;

the supporting forces - F_b - at the guide shoes create bending stresses in the guide rails.

G.5.2.2 Calculating the bending stresses in the different axis of the guide rail (**figure G.1**), it can be assumed that :

- the guide rail is a continuous beam with flexible fixing points at distances of the length l ;

- the resultant of forces causing bending stresses act in the middle between adjacent fixing points ;

- bending moments act on the neutral axis of the profile of the guide rail.

Evaluating the bending stress - σ_m - from forces acting at right angles to the axis of the profile, the following formulae shall be used :

$$\sigma_m = \frac{M_m}{W}$$

with :

$$M_m = \frac{3 \cdot F_b \cdot l}{16}$$

where :

σ_m = bending stress in newtons per square millimetre ;

M_m = bending moment in newtons millimetres ;

W = cross sectional area modulus in cubic millimetres ;

F_b = force applied to the guide rail by the guide shoes in the different load cases in newtons ;

l = maximum distance between guide brackets in millimetres.

This is not valid for the load case «normal use, loading» provided the relative position of the guide shoes to the guide rail fixings has been taken into account.

G.5.2.3 Bending stresses in different axes shall be combined taking into account the guide rail profile.

If for W_x and W_y the usual values of tables (respectively $W_{x\min}$ and $W_{y\min}$) are used and therewith the permissible stresses are not exceeded, no further prove is necessary. Otherwise it has to be analysed at which outer edge of the guide rail profile the tensile stresses have their maximum.

G.5.2.4 If more than two guide rails are used, it is permitted to assume an equal distribution of the forces between the guide rails, provided their profiles are identical.

G.5.2.5 If more than one safety gear is used according to **9.8.2.2,** it can be assumed that the whole braking force is equally distributed between the safety gears.

G.5.2.5.1 In the case of vertical multiplex safety gears acting on the same guide rail, it shall be assumed, that the braking force of a guide rail is acting on one point.

G.5.2.5.2 In the case of horizontal multiplex safety gears, the braking force in one of the guide rails shall be in accordance with **G.2.3** or **G.2.4**.

G.5.3 Buckling

Determining the buckling stresses the “omega” -method shall be used with the following formulae :

$$\sigma_k = \frac{(F_k + k_3 \cdot M) \cdot \omega}{A} \quad \text{or} \quad \sigma_k = \frac{(F_c + k_3 \cdot M) \cdot \omega}{A}$$

where :

σ_k = buckling stress in newtons per square millimetre ;

F_k = buckling force on a guide rail of the car in newtons, see **G.2.3** ;

F_c = buckling force on a guide rail of the counterweight or balancing weight in newtons, see **G.2.4** ;

k_3 = impact factor, see **table G.2** ;

M = force in a guide rail due to auxiliary equipment in newtons ;

A = cross sectional area of a guide rail in millimetres.

ω = omega value.

The "omega"-values can be taken from the **table G.3** and **G.4** or can be evaluated by using the following polynomials with :

$\lambda = \frac{l_k}{i}$ and $l_k = l$

where :

λ = slenderness ;

l_k = buckling length in millimetres ;

i = minimum radius of gyration in millimetres ;

l = maximum distance between guide brackets in millimetres.

For steel with tensile stress R_m = 370 N/mm^2 :

$20 \leq \lambda \leq 60$: $\omega = 0{,}00012920 \cdot \lambda^{1{,}89} + 1$;

$60 < \lambda \leq 85$: $\omega = 0{,}00004627 \cdot \lambda^{2{,}14} + 1$;

$85 < \lambda \leq 115$: $\omega = 0{,}00001711 \cdot \lambda^{2{,}35} + 1{,}04$;

$115 < \lambda \leq 250$: $\omega = 0{,}00016887 \cdot \lambda^{2{,}00}$.

For steel with tensile stress R_m = 520 N/ mm^2 :

$20 \leq \lambda \leq 50$: $\omega = 0{,}00008240 \cdot \lambda^{2{,}06} + 1{,}021$;

$50 < \lambda \leq 70$: $\omega = 0{,}00001895 \cdot \lambda^{2{,}41} + 1{,}05$;

$70 < \lambda \leq 89$: $\omega = 0{,}00002447 \cdot \lambda^{2{,}36} + 1{,}03$;

$89 < \lambda \leq 250$: $\omega = 0{,}00025330 \cdot \lambda^{2{,}00}$.

The determination of "omega"-values of steel with tensile stress R_m between 370 N/ mm^2 and 520 N/ mm^2 shall be carried out by using the following formula :

$$\omega_R = \left[\frac{\omega_{520} - \omega_{370}}{520 - 370} \cdot (R_m - 370) \right] + \omega_{370}$$

"Omega"-values of other tough metallic material have to be submitted by the manufacturer.

G.5.4 Combination of bending and buckling stresses

The combined bending and buckling stresses shall be evaluated using the following formulae :

bending stresses	$\sigma_m = \sigma_x + \sigma_y$	$\leq \sigma_{perm}$
bending and compression	$\sigma = \sigma_m + \frac{F_k + k_3 \cdot M}{A}$	$\leq \sigma_{perm}$
	or	
	$\sigma = \sigma_m + \frac{F_c + k_3 \cdot M}{A}$	$\leq \sigma_{perm}$
buckling and bending	$\sigma_c = \sigma_k + 0{,}9 \cdot \sigma_m$	$\leq \sigma_{perm}$

where :

σ_m = bending stress in newtons per square millimetre ;

σ_x = bending stress in the X-axis in newtons per square millimetre ;

σ_y = bending stress in the Y-axis in newtons per square millimetre ;

σ_{perm} = permissible stress in newtons per square millimetre, see **10.1.2.1** ;

σ_k = buckling stress in newtons per square millimetre ;

F_k = buckling force on a guide rail of the car in newtons, see **G.2.3** ;

F_c = buckling force on a guide rail of the counterweight or balancing weight in newtons, see **G.2.4** ;

k_3 = impact factor see **table G.2** ;

M = force in a guide rail due to auxiliary equipment in newtons ;

A = cross sectional area of a guide rail in square millimetre.

G.5.5 Flange bending

Flange bending has to be taken into consideration.

For T-shaped guide rails, the following formula has to be used :

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

where :

σ_F = local flange bending stress in newtons per square millimetre ;

F_x = force exerted by a guide shoe to the flange in newtons ;

c = width of the connecting part of the foot to the blade in millimetres, see **figure G.1** ;

σ_{perm} = permissible stress in newtons per square millimetre.

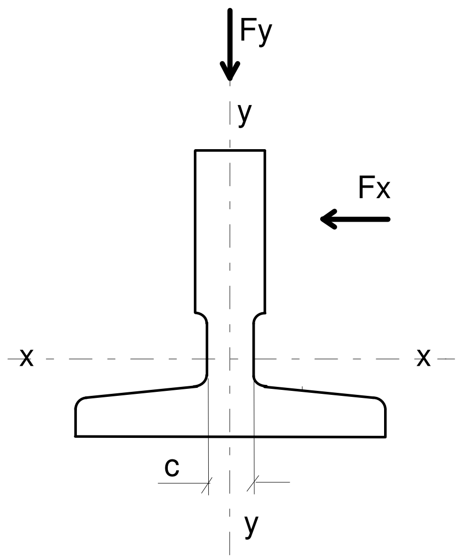


Figure G.1 : Axis of the guide rail

Table G.3 : "Omega"-value ω related to λ for steel with tensile stress of 370 N/mm²

λ	0	1	2	3	4	5	6	7	8	9	λ
20	1,04	1,04	1,04	1,05	1,05	1,06	1,06	1,07	1,07	1,08	**20**
30	1,08	1,09	1,09	1,10	1,10	1,11	1,11	1,12	1,13	1,13	**30**
40	1,14	1,14	1,15	1,16	1,16	1,17	1,18	1,19	1,19	1,20	**40**
50	1,21	1,22	1,23	1,23	1,24	1,25	1,26	1,27	1,28	1,29	**50**
60	1,30	1,31	1,32	1,33	1,34	1,35	1,36	1,37	1,39	1,40	**60**
70	1,41	1,42	1,44	1,45	1,46	1,48	1,49	1,50	1,52	1,53	**70**
80	1,55	1,56	1,58	1,59	1,61	1,62	1,64	1,66	1,68	1,69	**80**
90	1,71	1,73	1,74	1,76	1,78	1,80	1,82	1,84	1,86	1,88	**90**
100	1,90	1,92	1,94	1,96	1,98	2,00	2,02	2,05	2,07	2,09	**100**
110	2,11	2,14	2,16	2,18	2,21	2,23	2,27	2,31	2,35	2,39	**110**
120	2,43	2,47	2,51	2,55	2,60	2,64	2,68	2,72	2,77	2,81	**120**
130	2,85	2,90	2,94	2,99	3,03	3,08	3,12	3,17	3,22	3,26	**130**
140	3,31	3,36	3,41	3,45	3,50	3,55	3,60	3,65	3,70	3,75	**140**
150	3,80	3,85	3,90	3,95	4,00	4,06	4,11	4,16	4,22	4,27	**150**
160	4,32	4,38	4,43	4,49	4,54	4,60	4,65	4,71	4,77	4,82	**160**
170	4,88	4,94	5,00	5,05	5,11	5,17	5,23	5,29	5,35	5,41	**170**
180	5,47	5,53	5,59	5,66	5,72	5,78	5,84	5,91	5,97	6,03	**180**
190	6,10	6,16	6,23	6,29	6,36	6,42	6,49	6,55	6,62	6,69	**190**
200	6,75	6,82	6,89	6,96	7,03	7,10	7,17	7,24	7,31	7,38	**200**
210	7,45	7,52	7,59	7,66	7,73	7,81	7,88	7,95	8,03	8,10	**210**
220	8,17	8,25	8,32	8,40	8,47	8,55	8,63	8,70	8,78	8,86	**220**
230	8,93	9,01	9,09	9,17	9,25	9,33	9,41	9,49	9,57	9,65	**230**
240	9,73	9,81	9,89	9,97	10,05	10,14	10,22	10,30	10,39	10,47	**240**
250	10,55										

Table G.4 : "Omega"-value ω related to λ for steel with tensile stress of 520 N/mm²

λ	0	1	2	3	4	5	6	7	8	9	λ
20	1,06	1,06	1,07	1,07	1,08	1,08	1,09	1,09	1,10	1,11	**20**
30	1,11	1,12	1,12	1,13	1,14	1,15	1,15	1,16	1,17	1,18	**30**
40	1,19	1,19	1,20	1,21	1,22	1,23	1,24	1,25	1,26	1,27	**40**
50	1,28	1,30	1,31	1,32	1,33	1,35	1,36	1,37	1,39	1,40	**50**
60	1,41	1,43	1,44	1,46	1,48	1,49	1,51	1,53	1,54	1,56	**60**
70	1,58	1,60	1,62	1,64	1,66	1,68	1,70	1,72	1,74	1,77	**70**
80	1,79	1,81	1,83	1,86	1,88	1,91	1,93	1,95	1,98	2,01	**80**
90	2,05	2,10	2,10	2,19	2,24	2,29	2,33	2,38	2,43	2,48	**90**
100	2,53	2,58	2,64	2,69	2,74	2,79	2,85	2,90	2,95	3,01	**100**
110	3,06	3,12	3,18	3,23	3,29	3,35	3,41	3,47	3,53	3,59	**110**
120	3,65	3,71	3,77	3,83	3,89	3,96	4,02	4,09	4,15	4,22	**120**
130	4,28	4,35	4,41	4,48	4,55	4,62	4,69	4,75	4,82	4,89	**130**
140	4,96	5,04	5,11	5,18	5,25	5,33	5,40	5,47	5,55	5,62	**140**
150	5,70	5,78	5,85	5,93	6,01	6,09	6,16	6,24	6,32	6,40	**150**
160	6,48	6,57	6,65	6,73	6,81	6,90	6,98	7,06	7,15	7,23	**160**
170	7,32	7,41	7,49	7,58	7,67	7,76	7,85	7,94	8,03	8,12	**170**
180	8,21	8,30	8,39	8,48	8,58	8,67	8,76	8,86	8,95	9,05	**180**
190	9,14	9,24	9,34	9,44	9,53	9,63	9,73	9,83	9,93	10,03	**190**
200	10,13	10,23	10,34	10,44	10,54	10,65	10,75	10,85	10,96	11,06	**200**
210	11,17	11,28	11,38	11,49	11,60	11,71	11,82	11,93	12,04	12,15	**210**
220	12,26	12,37	12,48	12,60	12,71	12,82	12,94	13,05	13,17	13,28	**220**
230	13,40	13,52	13,63	13,75	13,87	13,99	14,11	14,23	14,35	14,47	**230**
240	14,59	14,71	14,83	14,96	15,08	15,20	15,33	15,45	15,58	15,71	**240**
250	15,83										

G.5.6 Examples of guidance, suspension situations and load cases of the car and the relevant formulae are given in **G.7**.

G.5.7 Deflections

The deflections shall be calculated by using the following formulae :

$$\delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x}$$ Y -Y guiding plane

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y}$$ X - X guiding plane

where :

δ_x = deflection in the X-axis in millimetres ;

δ_y = deflection in the Y-axis in millimetres ;

F_x = supporting force in the X-axis in newtons ;

F_y = supporting force in the Y-axis in newtons ;

l = maximum distance between guide brackets in millimetres ;

E = modulus of elasticity in newtons per square millimetre ;

I_x = second moment of area in the X-axis in fourth power millimetres ;

I_y = second moment of area in the Y-axis in fourth power millimetres.

G.6 Permissible deflections

The permissible deflections of T-profiled guide rails are stated in **10.1.2.2**.

Deflections of guide rails other than T-profiles shall be limited such as to fulfil **10.1.1**.

The combination of permissible deflections with the deflection of brackets, play in the guide shoes and straightness of the guide rails shall not affect the requirement of **10.1.1**.

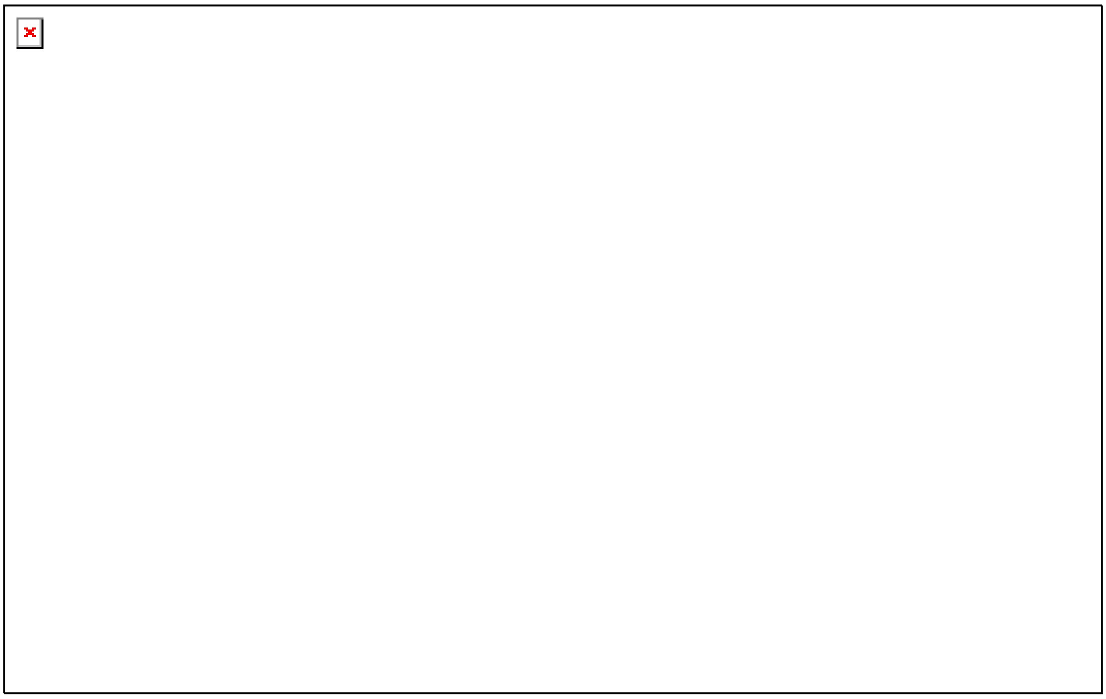
G.7 Examples of calculation method

The following examples are used to explain the calculation of the guide rails.

The following symbols will be used in a computer algorithm with a Cartesian coordinates system for all possible geometrical cases.

The following symbols are used for the dimensions in the lift :

D_X	= car dimension in *X*-direction, car depth ;
D_Y	= car dimension in *Y*-direction, car width ;
x_C, y_c	= position of the car centre (C) in relation to the guide rail cross coordinates ;
x_S, y_S	= position of the suspension (S) in relation to the guide rail cross coordinates ;
x_P, y_P	= position of the car mass (P) in relation to the guide rail cross coordinates ;
x_{CP}, y_{CP}	= position of the car mass centre of gravity (P) in relation to the car centre (C) ;
S	= car suspension ;
C	= car centre ;
P	= car bending mass - mass centre of gravity ;
Q	= rated load - mass centre of gravity ;
$\longrightarrow$	= direction of loading ;
1,2,3,4	= centre of the car door 1, 2, 3 or 4 ;
x_i, y_i	= position of the car door, i = 1, 2, 3 or 4 ;
n	= number of guide rails ;
h	= distance between car guide shoes ;
x_Q, y_Q	= position of the rated load (Q) in relation to the guide rail cross coordinates ;
x_{CQ}, y_{CQ}	= distance between the car centre (C) and the rated load (Q) in the X-direction, Y-direction.



G.7.1 General configuration

G.7.1.1 Safety gear operation

G.7.1.1.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

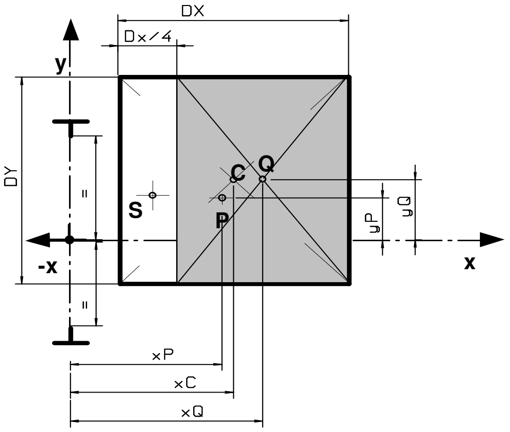
$$F_x = \frac{k_1 \cdot g_n \cdot (Q \cdot x_Q + P \cdot x_P)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-axis of the guide rail due to guiding force :

$$F_y = \frac{k_1 \cdot g_n \cdot (Q \cdot y_Q + P \cdot y_P)}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

Load distribution

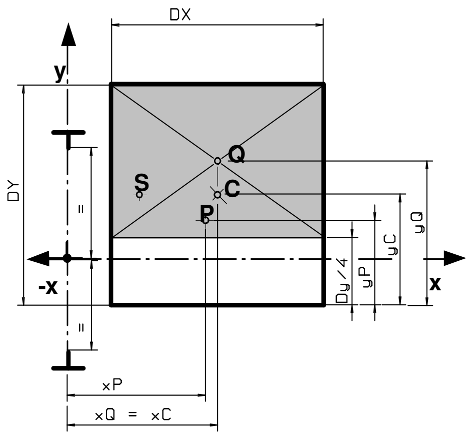
case 1 relative to the X-axis



$$x_Q = x_c + \frac{D_x}{8}$$

$$y_Q = y_c$$

case 2 relative to the Y-axis



$$x_Q = x_c$$

$$y_Q = y_c + \frac{D_y}{8}$$

G.7.1.1.2 Buckling

$$F_k = \frac{k_1 \cdot g_n \cdot (P+Q)}{n}, \qquad \sigma_k = \frac{(F_k + k_3 \cdot M) \cdot \omega}{A}$$

G.7.1.1.3 Combined stress [12)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{F_k + k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

$$\sigma_c = \sigma_k + 0{,}9 \cdot \sigma_m \qquad \leq \sigma_{perm}$$

G.7.1.1.4 Flange bending [13)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.1.1.5 Deflections [14)]

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \leq \delta_{perm}$$

G.7.1.2 Normal use, running

G.7.1.2.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_2 \cdot g_n \cdot [Q \cdot (x_Q - x_S) + P \cdot (x_P - x_S)]}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-axis of the guide rail due to guiding force :

$$F_y = \frac{k_2 \cdot g_n \cdot [Q \cdot (y_Q - y_S) + P \cdot (y_p - y_s)]}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

Load distribution : Case 1 relative to the X-axis (see **G.7.1.1.1**)

Case 2 relative to the Y-axis (see **G.7.1.1.1**)

---

12) These figures apply to both load distribution cases 1 and 2, see **G.7.1.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

13) These figures apply to both load distribution cases **G.7.1.1.1.**

14) These figures apply to both load distribution cases **G.7.1.1.1.**

G.7.1.2.2 Buckling

In normal use, running, buckling does not arise.

G.7.1.2.3 Combined stress 15)

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

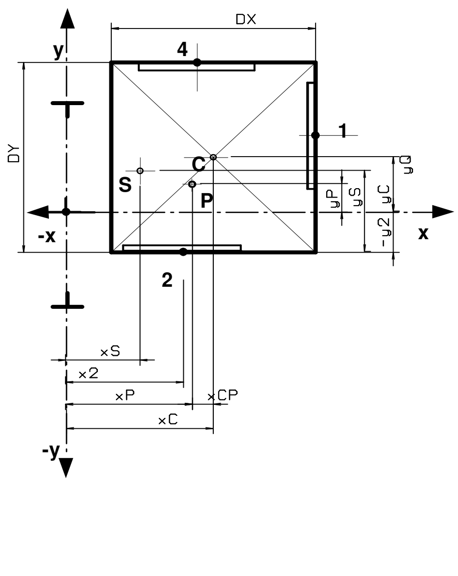
G.7.1.2.4 Flange bending 16)

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.1.2.5 Deflections 17)

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

G.7.1.3 Normal use, loading



15) These figures apply to both load distribution cases **G.7.1.2.1.**
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

16) These figures apply to both load distribution cases **G.7.1.1.1.**
17) These figures apply to both load distribution cases **G.7.1.1.1.**

G.7.1.3.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{g_n \cdot P \cdot (x_P - x_S) + F_s \cdot (x_i - x_S)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-axis of the guide rail due to guiding force :

$$F_y = \frac{g_n \cdot P \cdot (y_P - y_S) + F_s \cdot (y_i - y_S)}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

G.7.1.3.2 Buckling

In normal use, loading, buckling does not arise.

G.7.1.3.3 Combined stress [18)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

G.7.1.3.4 Flange bending

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.1.3.5 Deflections

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

---

18) If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

G.7.2 Centrally guided and suspended car

G.7.2.1 Safety gear operation

G.7.2.1.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_1 \cdot g_n \cdot (Q \cdot x_Q + P \cdot x_P)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

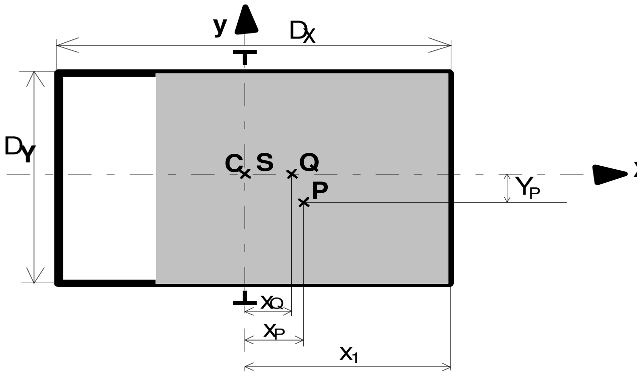
b) Bending stress relative to the X-axis of the guide rail due to guiding force :

$$F_y = \frac{k_1 \cdot g_n \cdot (Q \cdot y_Q + P \cdot y_P)}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

Load distribution

case 1 relative to X-axis

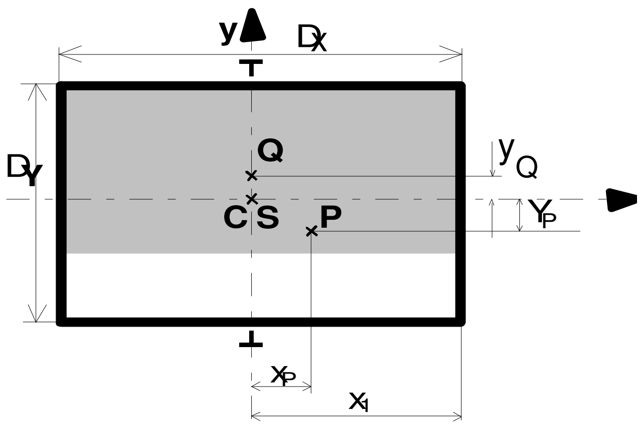
P and Q on the same side is the worst case, so Q in X-axis.



$$x_Q = \frac{D_x}{8}$$

$y_q = 0$

case 2 relative to Y-axis



$x_Q = 0$

$$y_Q = \frac{D_y}{8}$$

G.7.2.1.2 Buckling

$$F_k = \frac{k_1 \cdot g_n \cdot (P+Q)}{2}, \qquad \sigma_k = \frac{(F_k + k_3 \cdot M)}{A} \cdot \omega$$

G.7.2.1.3 Combined stress [19)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \le \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{F_k + k_3 \cdot M}{A} \qquad \le \sigma_{perm}$$

$$\sigma_c = \sigma_k + 0{,}9 \cdot \sigma_m \qquad \le \sigma_{perm}$$

G.7.2.1.4 Flange bending [20)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \le \sigma_{perm}$$

G.7.2.1.5 Deflections [21)]

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \le \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \le \delta_{perm}$$

G.7.2.2 Normal use, running

G.7.2.2.1 Bending stress

a) Bending stress relative to Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_2 \cdot g_n \cdot (Q \cdot x_Q + P \cdot x_P)}{n \cdot h} \qquad M_y = \frac{3 \cdot F_x \cdot l}{16} \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to X-axis of the guide rail due to guiding force :

$$F_y = \frac{k_2 \cdot g_n \cdot (Q \cdot y_Q + P \cdot y_P)}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

Load distribution : Case 1 relative to the X-axis (see **G.7.2.1.1**)

Case 2 relative to the Y-axis (see **G.7.2.1.1**)

---

19) These figures apply to both distribution load cases **G.7.2.1.1**.
20) These figures apply to both distribution load cases **G.7.2.1.1**.
21) These figures apply to both distribution load cases **G.7.2.1.1**.

G.7.2.2.2 Buckling

In normal use, running, buckling does not arise.

G.7.2.2.3 Combined stress [22)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

G.7.2.2.4 Flange bending [23)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.2.2.5 Deflections [24)]

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

G.7.2.3 Normal use, loading

G.7.2.3.1 Bending stress

a) Bending stress relative to Y-axis of the guide rail due to guiding force :

$$F_x = \frac{g_n \cdot P \cdot x_P + F_s \cdot x_1}{2 \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to X-axis of the guide rail due to guiding force:

$$F_y = \frac{g_n \cdot P \cdot y_P + F_s \cdot y_1}{h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

G.7.2.3.2 Buckling

In normal use, loading, buckling does not arise.

---

22) These figures apply to both load distribution cases **G.7.2.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

23) These figures apply to both distribution load cases **G.7.2.1.1**.

24) These figures apply to both distribution load cases **G.7.2.1.1**.

G.7.2.3.3 Combined stress [25)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

G.7.2.3.4 Flange bending

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.2.3.5 Deflections

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

G.7.3 Eccentrically guided and suspended car

G.7.3.1 Safety gear operation

G.7.3.1.1 Bending stress

a) Bending stress relative to Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_1 \cdot g_n \cdot (Q \cdot x_Q + P \cdot x_P)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to X-axis of the guide rail due to guiding force :

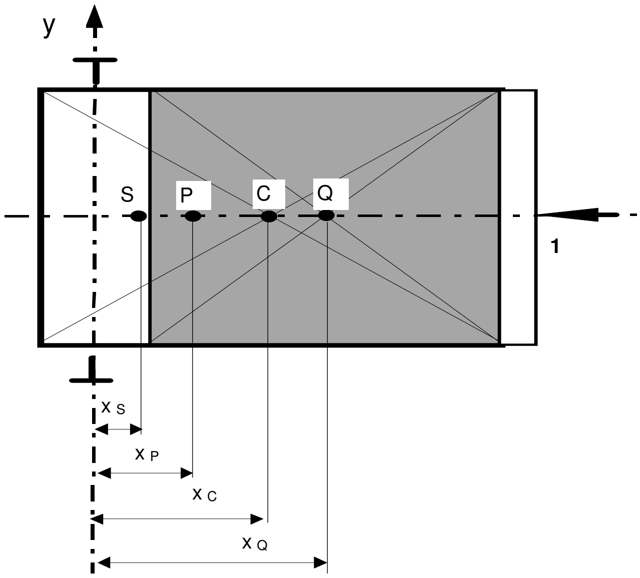
$$F_y = \frac{k_1 \cdot g_n \cdot (Q \cdot y_Q + P \cdot y_P)}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

---

25) If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

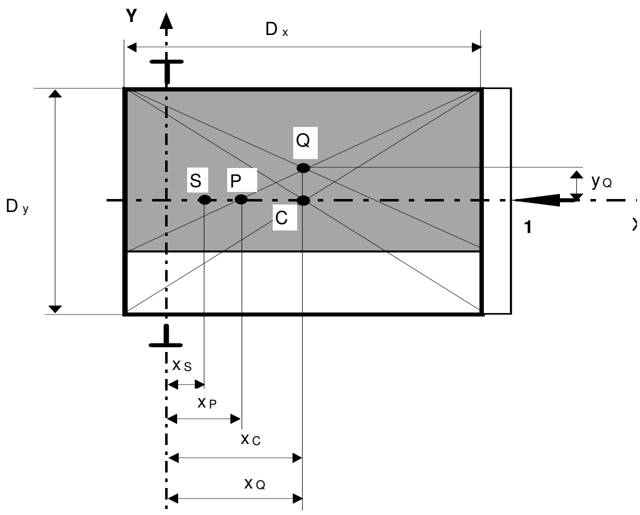
Load distribution

case 1 relative to X-axis



$$x_Q = x_C + \frac{D_x}{8}$$
$$y_P = y_C = y_Q = y_S = 0$$

case 2 relative to Y-axis



$$y_Q = \frac{D_y}{8}$$
$$x_C = x_Q$$

G.7.3.1.2 Buckling

$$F_k = \frac{k_1 \cdot g_n \cdot (P+Q)}{n}, \qquad \sigma_k = \frac{(F_k + k_3 \cdot M) \cdot \omega}{A}$$

G.7.3.1.3 Combined stress [26)]

$$\sigma_m = \sigma_x + \sigma_y \quad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{F_k + k_3 \cdot M}{A} \quad \leq \sigma_{perm}$$

$$\sigma_c = \sigma_k + 0{,}9 \cdot \sigma_m \quad \leq \sigma_{perm}$$

G.7.3.1.4 Flange bending [27)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \quad \leq \sigma_{perm}$$

G.7.3.1.5 Deflections [28)]

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \quad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \quad \leq \delta_{perm}$$

G.7.3.2 Normal use, running

G.7.3.2.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_2 \cdot g_n \cdot [Q \cdot (x_Q - x_S) + P \cdot (x_P - x_S)]}{n \cdot h} \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-axis of the guide rail due to guiding force:

$$F_y = \frac{k_2 \cdot g_n \cdot [Q \cdot (y_Q - y_S) + P \cdot (y_p - y_s)]}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

Load distribution : Case 1 relative to the X-axis (see **G.7.2.1.1**)

Case 2 relative to the Y-axis (see **G.7.2.1.1**)

G.7.3.2.2 Buckling

In normal use, running, buckling does not arise.

---

26) These figures apply to both load distribution cases **G.7.3.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

27) These figures apply to both load distribution cases **G.7.3.1.1**.
28) These figures apply to both load distribution cases **G.7.3.1.1**.

G.7.3.2.3 Combined stress [29)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

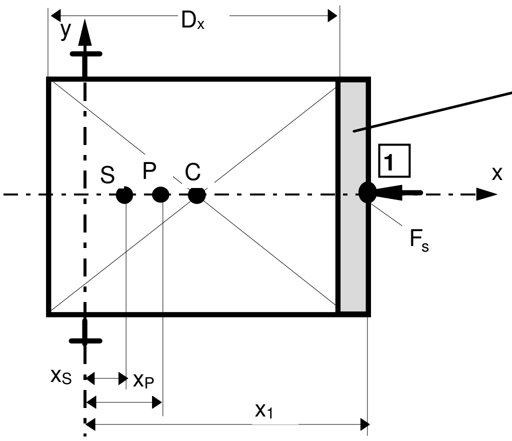
G.7.3.2.4 Flange bending [30)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.3.2.5 Deflections [31)]

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad\qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

G.7.3.3 Normal use, loading



G.7.3.3.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{g_n \cdot P \cdot (x_P - x_S) + F_s \cdot (x_1 - x_S)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-axis of the guide rail due to guiding force :

$F_y = 0$

---

29) These figures apply to both load distribution cases **G.7.3.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

30) These figures apply to both load distribution cases **G.7.3.1.1**.
31) These figures apply to both load distribution cases **G.7.3.1.1**.

G.7.3.3.2 Buckling

In normal use, loading, buckling does not arise.

G.7.3.3.3 Combined stress [32)]

$$\sigma_m = \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

G.7.3.3.4 Flange bending

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.3.3.5 Deflections

$$\delta_x = 0{,}7\frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0$$

G.7.4 Cantilevered guidance and suspension

G.7.4.1 Safety gear operation

G.7.4.1.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_1 \cdot g_n \cdot (Q \cdot x_Q + P \cdot x_P)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-axis of the guide rail due to guiding force :

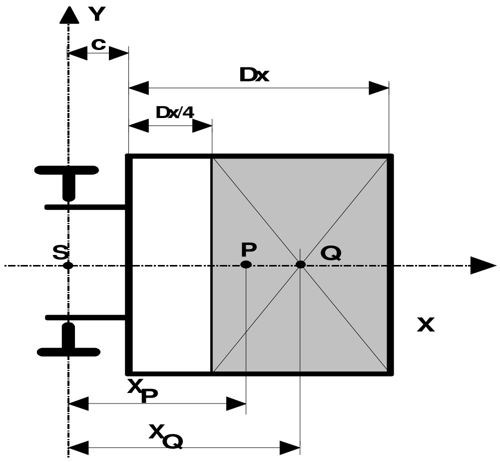
$$F_y = \frac{k_1 \cdot g_n \cdot (Q \cdot y_Q + P \cdot y_P)}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

---

32) If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

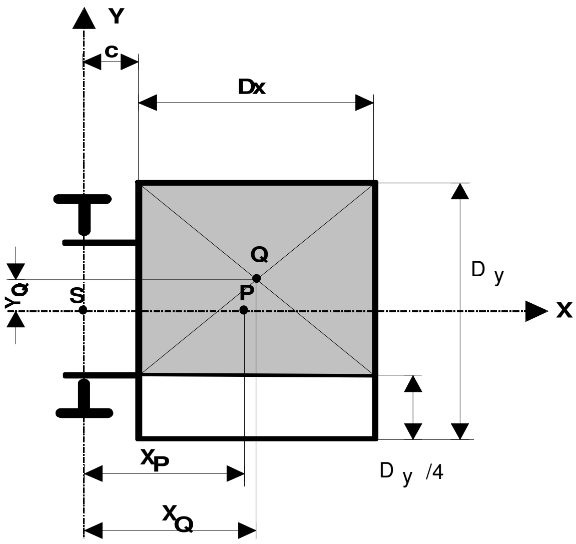
Load distribution

case 1 relative to the X-axis



$x_P > 0$	$y_P = 0$
$x_Q = c + \frac{5}{8} \cdot D_x$	$y_Q = 0$

case 2 relative to the Y-axis



$x_P > 0$	$y_P = 0$
$x_Q = c + \frac{D_x}{2}$	$y_Q = \frac{1}{8} \cdot D_y$

G.7.4.1.2 Buckling

$$F_k = \frac{k_1 \cdot g_n \cdot (P + Q)}{n}, \qquad \sigma_k = \frac{(F_k + k_3 \cdot M) \cdot \omega}{A}$$

G.7.4.1.3 Combined stress [33)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{F_k + k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

$$\sigma_c = \sigma_k + 0{,}9 \cdot \sigma_m \qquad \leq \sigma_{perm}$$

G.7.4.1.4 Flange bending [34)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.4.1.5 Deflections [35)]

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

G.7.4.2 Normal use, running

G.7.4.2.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_2 \cdot g_n \cdot [Q \cdot (x_Q - x_S) + P \cdot (x_P - x_S)]}{n \cdot h} \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-axis of the guide rail due to guiding force :

$$F_y = \frac{k_2 \cdot g_n \cdot [Q \cdot (y_Q - y_S) + P \cdot (y_P - y_S)]}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

Load distribution : Case 1 relative to the X-axis (see **G.7.4.1.1**)

Case 2 relative to the Y-axis (see **G.7.4.1.1**)

G.7.4.2.2 Buckling

In normal use, running, buckling does not arise.

[33)] These figures apply to both load distribution cases **G.7.4.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

[34)] These figures apply to both load distribution cases **G.7.4.1.1**.
[35)] These figures apply to both load distribution cases **G.7.4.1.1**.

G.7.4.2.3 Combined stress [36)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

G.7.4.2.4 Flange bending [37)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.4.2.5 Deflections [38)]

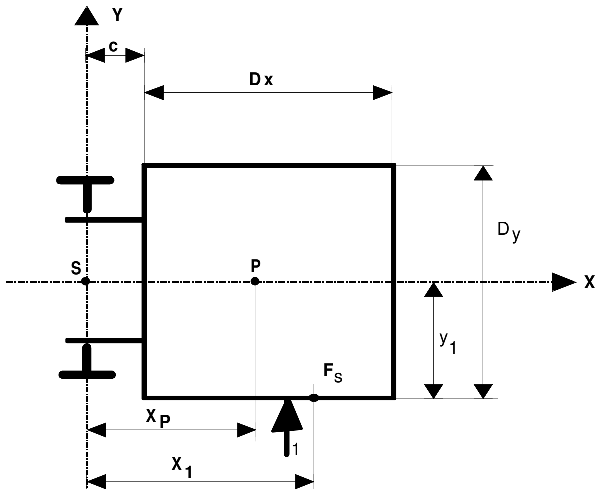
$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

36) These figures apply to both load distribution cases **G.7.4.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

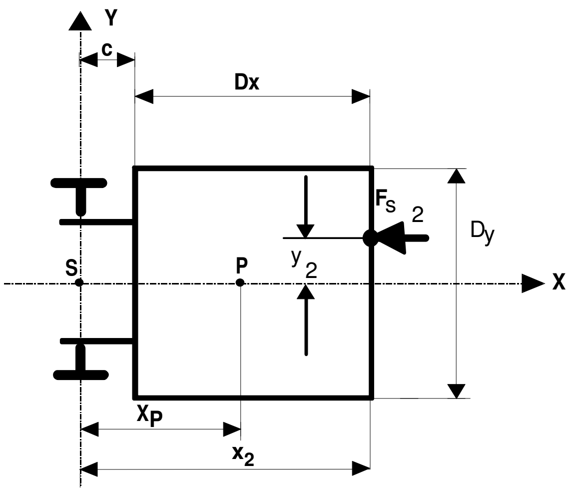
37) These figures apply to both load distribution cases **G.7.4.1.1**.

38) These figures apply to both load distribution cases **G.7.4.1.1**.

G.7.4.3 Normal use, loading



$$x_P > 0 \qquad y_P = 0$$
$$x_1 > 0 \qquad y_1 = \frac{D_y}{2}$$



$$x_P > 0 \qquad y_P = 0$$
$$x_2 > c + D_x \qquad y_2 > 0$$

G.7.4.3.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{g_n \cdot P \cdot x_P + F_s \cdot x_i}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_y = \frac{F_s \cdot y_i}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

G.7.4.3.2 Buckling

In normal use, loading, buckling does not arise.

G.7.4.3.3 Combined stress [39]

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

G.7.4.3.4 Flange bending

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.4.3.5 Deflections

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

G.7.5 Panoramic lift - General configuration

The following example is based on a panoramic car with eccentric guiding and suspension.

G.7.5.1 Safety gear operation

G.7.5.1.1 Bending stress

a) Bending stress relative to the Y-axis of the guide rail due to guiding force :

$$F_x = \frac{k_1 \cdot g_n \cdot (Q \cdot x_Q + P \cdot x_P)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

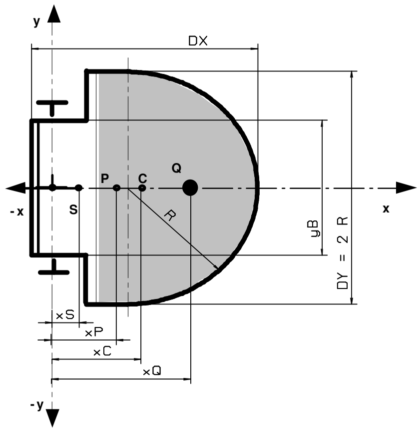
b) Bending stress relative to the X-axis of the guide rail due to guiding force :

$$F_y = \frac{k_1 \cdot g_n \cdot (Q \cdot y_Q + P \cdot y_P)}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

[39] If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

Load distribution

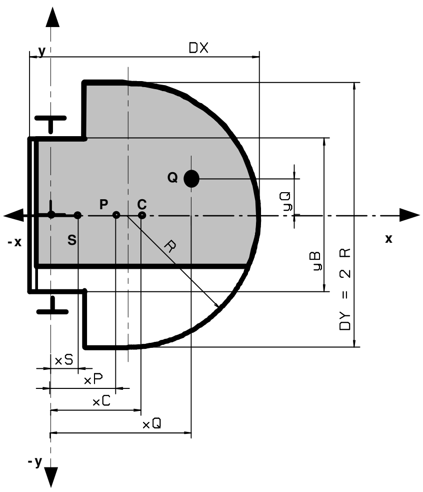
case1 relative to the X-axis



x_Q = The lever x_Q *(corrigendum)* means the distance from the centre of gravity of the area marked, which is equal to 3/4rds of the total area covered by the car.

$Y_Q = 0$

case 2 relative to the Y-axis



$x_Q =$
$Y_Q =$

The levers x_Q *and* y_Q *(corrigendum)* mean the distances from the centre of gravity of the area marked which is equal to 3/4rds of the total area covered by the car

G.7.5.1.2 Buckling

$$F_k = \frac{k_1 \cdot g_n \cdot (P+Q)}{n}, \qquad \sigma_k = \frac{(F_k + k_3 \cdot M) \cdot \omega}{A}$$

G.7.5.1.3 Combined stress 40)

$$\sigma_m = \sigma_x + \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{F_k + k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

$$\sigma_c = \sigma_k + 0{,}9 \cdot \sigma_m \qquad \leq \sigma_{perm}$$

G.7.5.1.4 Flange bending 41)

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.5.1.5 Deflections 42)

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \leq \delta_{perm}$$

G.7.5.2 Normal use, running

G.7.5.2.1 Bending stress

a) Bending stress relative to the Y-Axis of the guide rail due to guiding force :

$$F_x = \frac{k_2 \cdot g_n \cdot [Q \cdot (x_Q - x_S) + P \cdot (x_P - x_S)]}{n \cdot h} \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-Axis of the guide rail due to guiding force :

$$F_y = \frac{k_2 \cdot g_n \cdot [Q \cdot (y_Q - y_S) + P \cdot (y_P - y_S)]}{\frac{n}{2} \cdot h}, \qquad M_x = \frac{3 \cdot F_y \cdot l}{16}, \qquad \sigma_x = \frac{M_x}{W_x}$$

Load distribution : Case 1 relative to the X-axis (see **G.7.5.1.1**)

Case 2 relative to the Y-axis (see **G.7.5.1.1**)

G.7.5.2.2 Buckling

In normal use, running, buckling does not arise.

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40) These figures apply to both load distribution cases **G.7.5.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

41) These figures apply to both load distribution cases **G.7.5.1.1**.
42) These figures apply to both load distribution cases **G.7.5.1.1**.

G.7.5.2.3 Combined stress [43)]

$$\sigma_m = \sigma_x + \sigma_y \qquad \le \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \le \sigma_{perm}$$

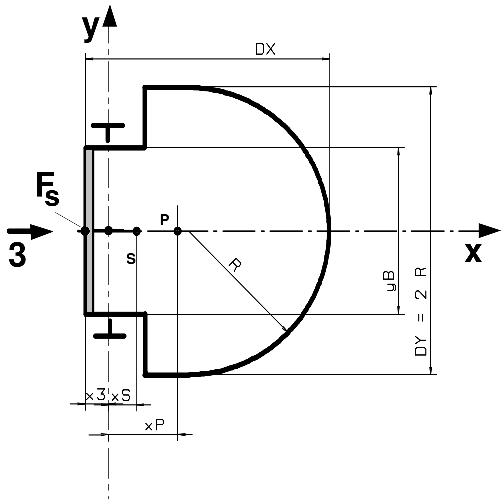
G.7.5.2.4 Flange bending [44)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \le \sigma_{perm}$$

G.7.5.2.5 Deflections [45)]

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \le \delta_{perm}, \qquad\qquad \delta_y = 0{,}7 \frac{F_y \cdot l^3}{48 \cdot E \cdot I_x} \qquad \le \delta_{perm}$$

G.7.5.3 Normal use, loading



$y_i = 0$

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43) These figures apply to both load distribution cases **G.7.5.1.1**.
If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

44) These figures apply to both load distribution cases **G.7.5.1.1**.
45) These figures apply to both load distribution cases **G.7.5.1.1**.

G.7.5.3.1 Bending stress

a) Bending stress relative to the Y-Axis of the guide rail due to guiding force :

$$F_x = \frac{g_n \cdot P \cdot (x_P - x_S) - F_s \cdot (x_i + x_S)}{n \cdot h}, \qquad M_y = \frac{3 \cdot F_x \cdot l}{16}, \qquad \sigma_y = \frac{M_y}{W_y}$$

b) Bending stress relative to the X-Axis of the guide rail due to guiding force :

$F_y = 0$

G.7.5.3.2 Buckling

In normal use, loading, buckling does not arise.

G.7.5.3.3 Combined stress

$$\sigma_m = \sigma_y \qquad \leq \sigma_{perm}$$

$$\sigma = \sigma_m + \frac{k_3 \cdot M}{A} \qquad \leq \sigma_{perm}$$

G.7.5.3.4 Flange bending [46)]

$$\sigma_F = \frac{1{,}85 \cdot F_x}{c^2} \qquad \leq \sigma_{perm}$$

G.7.5.3.5 Deflections

$$\delta_x = 0{,}7 \frac{F_x \cdot l^3}{48 \cdot E \cdot I_y} \qquad \leq \delta_{perm}, \qquad \delta_y = 0$$

46)) If $\sigma_{perm} < \sigma_m$, the figures for **G.5.2.3** may be used in the interest of minimum guide rail dimensions.

Annex H (normative)

Electronic components - Failure exclusion

The faults to be considered in the electric equipment of a lift are listed in **14.1.1.1**. In **14.1.1** it is stated that certain faults can be excluded under specified conditions.

Failure exclusion shall only be considered provided that components are applied within their worst case limits of characteristics, value, temperature, humidity, voltage and vibrations.

The following **table H.1** describes the conditions under which the faults envisaged in **14.1.1.1 e)** can be excluded.

In the table :

- the “NO” in the cell means : failure not excluded, i.e. shall be considered ;
- the unmarked cell means : the identified fault type is not relevant.

Table H.1 : Exclusions of failures

Component	Possible failure exclusion					Conditions	Remarks
	Open circuit	Short circuit	Change to higher value	Change to lower value	Change of function		
1 Passive components							
1.1 Resistor fixed	NO	(a)	NO	(a)		(a) Only for film resistors with varnished or sealed resistance film and axial connection according to applicable IEC standards, and for wire wound resistors if they are made of a single layer winding protected by enamel or sealed.	
1.2 Resistor variable	NO	NO	NO	NO			
1.3 Resistor, non linear NTC, PTC, VDR, IDR	NO	NO	NO	NO			
1.4 Capacitor	NO	NO	NO	NO			
1.5 Inductive components - coil - choke	NO	NO		NO			
2 Semiconductors							
2.1 Diode, LED	NO	NO			NO		Change of function refers to a change in reverse current value.
2.2 Zener Diode	NO	NO		NO	NO		Change to lower value refers to change in Zener voltage. Change of function refers to change in reverse current value.

"to be continued'

Table H.1 (*continued*)

Component	Possible failure exclusion					Conditions	Remarks
	Open circuit	Short circuit	Change to higher value	Change to lower value	Change of function		
2 Semiconductors (Continued)							
2.3 Thyristor, Triac, GTO	NO	NO			NO		Change of function refers to self triggering or latching of components.
2.4 Optocoupler	NO	(a)			NO	(a) Can be excluded under condition that the optocoupler is according to IEC 60747-5, and the isolation voltage is at least according to table below, IEC 60664-1, Table 1.	Open circuit means open circuit in one of the two basic components (LED and photo transistor). Short circuit means short circuit between them.

Voltage phase-to-earth derived from rated system voltage up to and including V_{rms} and d.c.	Preferred series of impulse withstand voltages in volts for installation Category III
50	800
100	1 500
150	2 500
300	4 000
600	6 000
1 000	8 000

"to be continued"

Table H.1 (*continued*)

Component	Possible failure exclusion					Conditions	Remarks
	Open circuit	Short circuit	Change to higher value	Change to lower value	Change of function		
2 Semiconductors (continued)							
2.5 Hybrid circuit	NO	NO	NO	NO	NO		
2.6 Integrated circuit	NO	NO	NO	NO	NO		Change in function to oscillation, “and” gates becoming “or” gates, etc...
3 Miscellaneous							
3.1 Connectors Terminals Plugs	NO	(a)				(a) The short circuits of connectors can be excluded if the minimum values are according to the tables (taken over from IEC 60664-1) with the conditions : - the pollution degree is 3 ; - the material group is III ; - inhomogeneous field . The column "printed wiring material" of table 4 is not used. These are absolute minimum values which can be found on the connected unit, not pitch dimension or theoretical values. If the protection of the connector is IP 5X or better, the creepage distances can be reduced to the clearance value, e.g. 3 mm for 250 V_{rms}.	
3.2 Neon bulb	NO	NO					

“to be continued”

Table H.1 (*continued*)

Component	Possible failure exclusion					Conditions	Remarks
	Open circuit	Short circuit	Change to higher value	Change to lower value	Change of function		
3 Miscellaneous (continued)							
3.3 Transformer	NO	(a)	(b)	(b)		(a) (b) Can be excluded under condition that isolation voltage between windings and core is in line with EN 60742, 17.2 and 17.3, and the working voltage is the highest possible voltage of table 6 between live and earth	Short-circuits include short-circuits of primary or secondary windings, or between primary and secondary coils. Change in value refers to change of ratio by partial short-circuit in a winding.
3.4 Fuse		(a)				(a) Can be excluded if the fuse is correctly rated, and constructed according to the applicable IEC standards.	Short circuit means short circuit of the blown fuse.
3.5 Relay	NO	(a) (b)				(a) Short-circuits between contacts, and between contacts and coil can be excluded if the relay fulfils the requirements of **13.2.2.3** (**14.1.2.2.3**). (b) Welding of contacts can not be excluded. However, if the relay is constructed to have mechanically forced interlocked contacts, and made according to EN 60947-5-1, the assumptions of **13.2.1.3** apply.	

“to be continued”

Table H.1 (*continued*)

Component	Possible failure exclusion					Conditions	Remarks
	Open circuit	Short circuit	Change to higher value	Change to lower value	Change of function		
3 Miscellaneous (continued)							
3.6 Printed circuit board (PCB)	NO	(a)				(a) The short circuit can be excluded provided : - the general specifications of PCB are in accordance with EN 62326-1 ; - the base material is in accordance to the specifications of EN 60249-2-3 and/or EN 60249-2-2 ; - the PCB is constructed according to the above requirements and the minimum values are according to the tables (taken over from IEC 60664-1) with the conditions : - the pollution degree is 3 ; - the material group is III ; - inhomogeneous field. The column "printed wiring material" of table 4 is not used. That means that the creepage distances are 4 mm and the clearances 3 mm for 250 V_{rms}. For other voltages refer to IEC 60664-1. If the protection of the PCB is IP 5X or better, or the material involved of higher quality, the creepage distances can be reduced to the clearance value, e.g. 3 mm for 250 V_{rms}. For multi-layer boards comprising at least 3 prepreg or other thin sheet insulating materials short circuit can be excluded (see EN 60950).	

"to be continued"

Table H.1 (*ending)*

Component	Possible failure exclusion					Conditions	Remarks
	Open circuit	Short circuit	Change to higher value	Change to lower value	Change of function		
4 Assembly of components on printed circuit board (PCB)	NO	(a)				(a) Short circuit can be excluded under circumstances where the short circuit of the component itself can be excluded and the component is mounted in a way that the creeping distances and clearances are not reduced below the minimum acceptable values as listed in **3.1** and **3.6** of this **table**, neither by the mounting technique nor by the PCB itself.	

NOTE : Design guidelines.

Some dangerous situations are recognized coming from the possibility of bridging one or several safety contacts by short circuiting or by local interruptions of common lead (earth) combined with one or several other failures. It is good practice to follow the recommendations given below, when information is collected from the safety chain for control purposes, for remote control, alarm control, etc. :

- design the board and circuits with distances in accordance with specifications **3.1** and **3.6** of **table H.1** ;

- organize common of the connections to the safety chain on the printed circuit board so that the common to the contactors or relay-contactors as mentioned in **14.1.2.4** will switch off at interruption of the common lead on the printed board ;

- make always failure analyses for the safety circuits as mentioned in **14.1.2.3** and in accordance with EN 1050. If modifications or additions are made after the lift installation the failure analyses involving new and existing equipment must be carried out again ;

- always use outside (out of element) resistors as protective devices of input elements ; internal resistor of the device should not be considered as safe ;

- components shall only be used within to the manufacturer specification ;

- backwards voltage coming from electronics must be considered. Using galvanically separated circuits can solve the problems in some cases ;

- electrical installations regarding to earthing should be in accordance with HD 384.5.54 S1. In that case, the interruption of the earth from the building to the controller collection bar (rail) can also be excluded.

Annex J (normative)

Pendulum shock tests

J.1 General

Due to the fact that a European standard does not exist for pendulum shock tests on glass (see CEN/TC 129), tests to fulfil the requirements of **7.2.3.1**, **8.3.2.1** and **8.6.7** ***1*** *(corrigendum)* shall be carried out according to the following prescriptions.

J.2 Test rig

J.2.1 Hard pendulum shock device

The hard pendulum shock device shall be a body according to **figure J.1**. This body consists of a shock ring made of steel S 235 JR, according to EN 10025 and a case made of steel E 295, according to EN 10025. The overall mass of this body will be brought up to 10 kg ± 0,01 kg by filling with lead balls of a diameter of 3,5 mm ± 0,25 mm.

J.2.2 Soft pendulum shock device

The soft pendulum shock device shall be a small shot bag according to **figure J.2** made of leather, which is filled with lead balls of a diameter of 3,5 mm ± 1 mm up to an overall mass of 45 kg ± 0,5 kg.

J.2.3 Suspension of the pendulum shock device

The pendulum shock device shall be suspended by a wire rope of ~ 3 mm diameter in such a way that the horizontal distance between the outer edge of the free hanging shock device and the panel to be tested does not exceed 15 mm.

The pendulum length (lower end of the hook to reference point of the shock device) shall be at least 1,5 m.

J.2.4 Pulling and triggering device

The suspended pendulum shock device shall be swung away from the panel by a pulling and triggering device and thus lifted to the falling height required in **J.4.2** and **J.4.3**. The triggering device shall not give an additional impulse to the pendulum shock device in the moment of releasing.

J.3 Panels

A panel of doors shall be complete including its guidance elements ; a panel of walls shall have the intended size and fixations. The panels shall be fixed to a frame or other appropriate construction in such a way that at the fixation points, no deformations under test conditions are possible (stiff fixation).

A panel shall be submitted to the tests in the intended manufacturing finish (machined edges, holes, etc.).

J.4 Test procedure

J.4.1 The tests shall be carried out at a temperature of 23 °C ± 2 °C. The panels shall be stored directly before the tests at least 4 hours at that temperature.

J.4.2 The hard pendulum shock test shall be carried out with the device according to **J.2.1** with a falling height of 500 mm (see **figure J.3**).

J.4.3 The soft pendulum shock test shall be carried out with the device according to **J.2.2** with a falling height of 700 mm (see **figure J.3**).

J.4.4 The pendulum shock device shall be brought to the required falling height and released. It shall hit the panel in the middle of its width and at a height of 1,0 m ± 0,05 m above the floor level intended for the panel.

The falling height is the vertical distance between the reference points (see **figure J.3**).

J.4.5 One test only is required for each of the devices called for in **J.2.1** and **J.2.2**. The two tests shall be carried out on the same panel.

J.5 Interpretation of the results

The requirements of the standard are fulfilled if after the tests there :

a) is no total damage of the panel ;

b) are no cracks in the panel ;

c) are no holes in the panel ;

d) is no leaving its guiding elements ;

e) is no permanent deformation of the guiding elements ;

f) is no damage on the surface of the glass except a mark of 2 mm maximum in diameter without cracks and after successful repetition of the soft pendulum test.

J.6 Test report

The test report shall contain at least the following information :

a) name and address of the laboratory having made the tests ;

b) date of the tests ;

c) dimensions and construction of the panel ;

d) fixation of the panel ;

e) falling height of the tests ;

f) number of tests carried out ;

g) signature of the responsible for these tests.

J.7 Exceptions from the tests

The pendulum shock tests need not be made, if panels according to the **tables J.1** and **J.2** are used, since they are known to fulfil the tests.

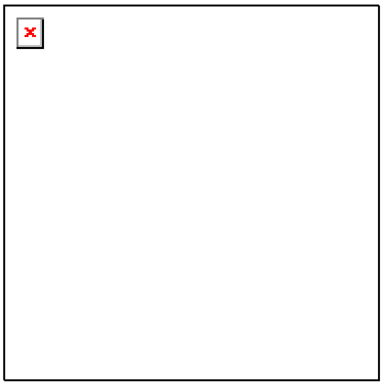
It should be noted that National Building Regulations may demand higher requirements.

Table J.1 : Plane glass panels to be used in walls of the car

Type of glass	Diameter of inscribed circle	
	1 m maximum	2 m maximum
	Minimum thickness (mm)	Minimum thickness (mm)
Laminated toughened	8 (4 + 4 + 0,76)	10 (5 + 5 + 0,76)
Laminated	10 (5 + 5 + 0,76)	12 (6 + 6 + 0,76)

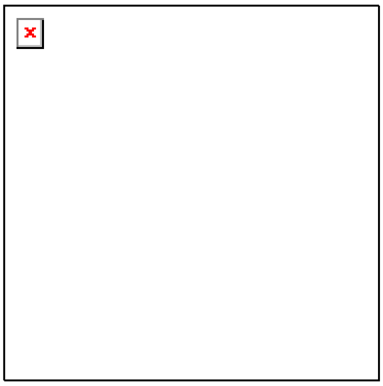
Table J.2 : Plane glass panels to be used in horizontally sliding doors

Type of glass	Minimum thickness (mm)	Width (mm)	Free door height (m)	Fixing of the glass panels
Laminated toughened	16 (8 + 8 + 0,76)	360 to 720	2,1 max	2 fixings upper and lower
Laminated	16 (8 + 8 + 0,76)	300 to 720	2,1 max	3 fixings upper/lower and one side
	10 (6 + 4 + 0,76) (5 + 5 + 0,76)	300 to 870	2,1 max	all sides
The values of this table are valid under the condition that in case of 3- or 4- side fixing the profiles are rigidly connected to another.				



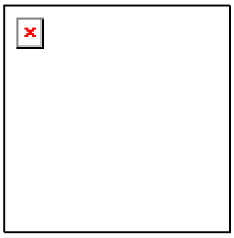
① shocking ring
② reference point for measuring the falling height
③ triggering device attachment

Figure J.1 : Hard pendulum shock device



① screwed rod
② reference point for measuring the falling height in the plane of the maximum diameter
③ leather bag
④ steel disk
⑤ triggering device attachment

Figure J.2 : Soft pendulum shock device



① frame
② glass panel to be tested
③ shock device
④ floor level with respect to the glass panel to be tested
H falling height

Figure J.3 : Test rig falling height

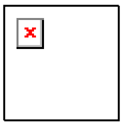
Annex K (normative)

Calculations of rams, cylinders, rigid pipes and fittings

K.1 Calculation against over pressure

K.1.1 Calculation of wall thickness of rams, cylinders, rigid pipes and fittings

(dimensions in millimetres)



$$e_{cyl} \leq \frac{2{,}3 \cdot 1{,}7 \cdot p}{R_{p0,2}} \frac{D}{2} + e_o$$

e_o = 1,0 mm for wall and base of cylinders and rigid pipes between the cylinder and the rupture valve, if any ;

= 0,5 mm for rams and other rigid pipes ;

2,3 = factor for friction losses (1,15) and pressure peaks (2) ;

1,7 = safety factor referred to the proof stress.

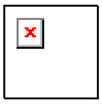
Figure K.1

K.1.2 Calculation of the base thickness of cylinders (examples)

The examples shown do not exclude other possible constructions.

K.1.2.1 Flat bases with relieving groove

(dimensions in millimetres)



Conditions for the stress relief of the welding seam :

$r_1 \geq 0{,}2 \cdot s_1$ and $r_1 \geq 5$ mm

$u_1 \leq 1{,}5 \cdot s_1$

$h_1 \geq u_1 + r_1$

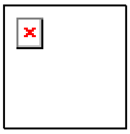
Figure K.2

$$e_1 \geq 0{,}4\ D_i \sqrt{\frac{2{,}3 \cdot 1{,}7 \cdot p}{R_{p0,2}}} + e_o$$

$$u_1 \geq 1{,}3 \cdot \left(\frac{D_i}{2} - r_1\right) \cdot \frac{2{,}3 \cdot 1{,}7 \cdot p}{R_{p0,2}} + e_o$$

K.1.2.2 Cambered based

(dimensions in millimetres)



Conditions :

$h_2 \geq 3{,}0 \cdot e_2$

$r_2 \geq 0{,}15 \cdot D$

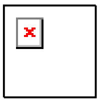
$R_2 = 0{,}8 \cdot D$

Figure K.3

$$e_2 \geq \frac{2{,}3 \cdot 1{,}7 \cdot p}{R_{p0,2}} \frac{D}{2} + e_o$$

K.1.2.3 Flat bases with welded flange

(dimensions in millimetres)



Conditions :

$u_3 \geq e_3 + r_3$

$r_3 \geq \frac{e_{cyl}}{3}$ and $r_3 \leq 8$ mm

Figure K.2

$$e_3 \geq 0{,}4\ D_i \sqrt{\frac{2{,}3 \cdot 1{,}7 \cdot p}{R_{p0,2}}} + e_o$$

K.2 Calculations of the jacks against buckling

The examples shown do not exclude other possible configurations.

The buckling calculation shall be made on the part with least buckling resistance.

K.2.1 Single jacks

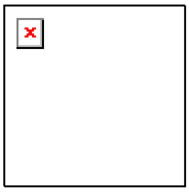


Figure K.5

For $\lambda_n \geq 100$:	**For $\lambda_n < 100$:**
$F_5 \leq \dfrac{\pi^2 \cdot E \cdot J_n}{2 \cdot l^2}$	$F_5 \leq \dfrac{A_n}{2}\left[R_m - \left(R_m - 210\right)\left(\dfrac{\lambda_n}{100}\right)^2\right]$

[47] $F_5 = 1{,}4 \cdot g_n \cdot \left[c_m \cdot (P + Q) + 0{,}64 \cdot P_r + P_{rh}\right]$

[47] Valid for rams extending in upward direction.

K.2.2 Telescopic jacks without external guidance, calculation of ram

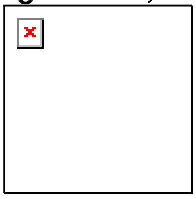


Figure K.6

$l = l_1 + l_2 + l_3$ $l_1 = l_2 = l_3$ $\nu = \sqrt{\frac{J_1}{J_2}}\ ;\ (J_3 \geq J_2 > J_1)$ (assumption for simplified calculation : $J_3 = J_2$) for 2 sections : $\varphi = 1{,}25\ \nu - 0{,}2$ for $0{,}22 < \nu < 0{,}65$ for 3 sections : $\varphi = 1{,}5\ \nu - 0{,}2$ for $0{,}22 < \nu < 0{,}65$ $\varphi = 0{,}65\ \nu + 0{,}35$ for $0{,}65 < \nu < 1$	$\lambda_e = \frac{l}{i_e}$ with $i_e = \frac{d_m}{4}\sqrt{\sqrt{\varphi}\left[1 + \left(\frac{d_{mi}}{d_m}\right)^2\right]}$ **For $\lambda_e \geq 100$:** $F_5 \leq \frac{\pi^2 \cdot E \cdot J_2}{2 \cdot l^2}\ \varphi$ **For $\lambda_e < 100$:** $F_5 \leq \frac{A_n}{2}\left[R_m - (R_m - 210)\left(\frac{\lambda_n}{100}\right)^2\right]$

[48] $F_5 = 1{,}4 \cdot g_n \cdot [c_m \cdot (P + Q) + 0{,}64 \cdot P_r + P_m + P_{rt}]$

[48] Valid for rams extending in upward direction.

K.2.3 Telescopic jacks with external guidance

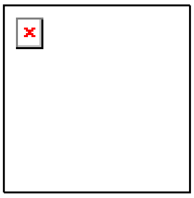


Figure K.7

For $\lambda_n \geq 100$:	**For $\lambda_n < 100$:**
$F_5 \leq \dfrac{\pi^2 \cdot E \cdot J_n}{2 \cdot l^2}$	$F_5 \leq \dfrac{A_n}{2}\left[R_m - (R_m - 210)\left(\dfrac{\lambda_n}{100}\right)^2\right]$

[49] $F_5 = 1{,}4 \cdot g_n \left[c_m \cdot (P + Q) + 0{,}64 \cdot P_r + P_{rh} + P_{rt} \right]$

[49] Valid for rams extending in upward direction.

Symbols :

A_n = cross-sectional area of the material of the ram to be calculated in square millimetres (n =1,2,3) ;

c_m = reeving ratio ;

d_m = outside diameter of the biggest ram of a telescopic jack in millimetres ;

d_{mi} = inner diameter of the biggest ram of a telescopic jack in millimetres ;

E = modulus of elasticity in newtons per square millimetre ;
(for steel : E = 2,1 x 10^5 N/mm^2) ;

e_o = additional wall thickness in millimetres ;

F_s = actual buckling force applied in newtons ;

g_n = standard acceleration of free fall in metres per square second ;

i_e = equivalent radius of gyration of a telescopic jack in millimetres ;

i_n = radius of gyration of the ram to be calculated in millimetres (n =1,2,3) ;

J_n = second moment of area of the ram to be calculated in fourth power millimetres (n = 1, 2, 3) ;

l = maximum length of rams subject to buckling in millimetres ;

p = full load pressure in megapascals ;

P = sum of the mass of the empty car and the mass of the portion of the travelling cables suspended from the car in kilogrammes ;

P_r = mass of the ram to be calculated in kilogrammes ;

P_{rh} = mass of the ram head equipment, if any in kilogrammes ;

P_{rt} = mass of the rams acting on the ram to be calculated (in the case of telescopic jacks) in kilogrammes

Q = rated load (mass) displayed in the car in kilogrammes ;

R_m = tensile strength of material in newtons per square millimetre ;

$R_{P0,2}$ = proof stress (non-proportional elongation) in newtons per square millimetre ;

$\lambda_e = \frac{l}{i_e}$ = equivalent coefficient of slenderness of a telescopic jack ;

$\lambda_n = \frac{l}{i_n}$ = coefficient of slenderness of the ram to be calculated ;

ν, φ = factors used to represent approximate values given by experimentally determined diagrams ;

1,4 = over pressure factor ;

2 = safety factor against buckling.

Annex ZA (informative)

Clauses of this standard addressing essential requirements or other provisions of EU Directives

This Standard has been prepared under a Mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of Directive relating to lift (95/16/EC).

Standards covering particular applications (e.g. accessibility for disabled, vandalism, intensive use) are under consideration.

WARNING : Other requirements and other EU Directive may be applicable to the product(s) falling within the scope of this standard.

The clauses of this standard are likely to support requirements of Directive relating to lift.

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

> **NOTE 1** : Regarding **6.2**, **6.3** and **6.4** see clause **0.2.2** of this standard
>
> **NOTE 2** : ~~Footnote~~ *Note (corrigendum)* of **5.2.1.2** implies that the installation of lifts with partially enclosed wells may be subject to the authorization of national authorities.