International Standard ISO 5049/1

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Mobile continuous bulk handling equipment — Part 1 : Rules for the design of structures

Appareils mobiles de manutention continue pour produits en vrac — Partie 1 : Règles pour le calcul des charpentes

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ISO 5049/1-1980 (E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5049/1 was developed by Technical Committee ISO/TC 101, *Continuous mechanical handling equipment*, and was circulated to the member bodies in June 1978.

It has been approved by the member bodies of the following countries :

Austria	France	South Africa, Rep. of
Belgium	Germany, F. R.	Spain
Chile	India	Sweden
Czechoslovakia	Mexico	Turkey
Finland	Netherlands	USSR

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
Denmark
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Mobile continuous bulk handling equipment — Part 1 : Rules for the design of structures

1 Scope

This International Standard lays down rules for determining the loads, kinds and combinations of loads (main, additional and special loads) which must be taken into account when designing metallic structures for mobile continuous bulk handling equipment.

2 Field of application

This International Standard is applicable to mobile continuous handling equipment for bulk products : among others, stackers and reclaimers by bucket wheels and their conveyors, bucket wheel and bucket excavators for open-cast working, ship loaders and unloaders.

The annex provides further details on methods of applying the rules.

ISO 5049/2 will deal with rules for the design of mechanisms.

3 Reference

ISO 2148, *Continuous handling equipment — Nomenclature.*

4 Loads

Depending on their frequency, the loads are divided into three different load groups : main loads, additional loads and special loads.

a) The main loads comprise all the permanent loads which occur when the equipment is used under normal operating conditions.

They include, among others :

- dead loads;
- useful loads;
- incrustation;
- normal digging and lateral resistances;
- forces at the conveying elements for the useful load;
- permanent dynamic effects;
- inclination of the machine;
- loads on the gangways, stairs and platforms.

b) The additional loads are loads that can occur intermittently during operation of the equipment or when the equipment is not working; these loads can either replace certain main loads or be added to the main loads.

They include, among others :

- wind load for machines in operation;
- snow load;
- temperature load;
- abnormal digging and lateral resistance;
- resistances due to friction and travel;
- horizontal lateral forces during travelling;
- non-permanent dynamic effects.

c) The special loads comprise the loads which should not occur during and outside the operation of the equipment but the occurrence of which is not to be excluded.

They include, among others :

- clogging of chutes;
- resting of the bucket wheel or the bucket ladder;
- locking of travelling devices;
- lateral collision of the bucket wheel with the slope;
- wind load for machines not in operation;
- buffer effects;
- loads due to earthquakes.

4.1 Main loads

4.1.1 Dead loads

Dead loads are load forces of all fixed and movable construction parts, always present in operation, of mechanical and electrical plants as well as of the support structure.

4.1.2 Useful loads

The effective load carried on conveyors and reclaimers is considered.

4.1.2.1 Effective load carried on the conveyors

These loads are determined from the design output (m^3/h).

4.1.2.1.1 Units with no built-in reclaimer

a) Where the belt load is limited by automatic devices, the load on the conveyor will be assumed to be that which results from the output thus limited.

b) Where there is no output limiter, the design output is that resulting from the maximum cross-sectional area of the conveyor multiplied by the conveying speed.

Unless otherwise specified in the agreement, the cross-sectional area shall be determined assuming a dynamic repose angle $\varphi = 20°$.

The annex shows the maximum sections of products conveyed as a function of φ for different conveyor or designs and for the trough angle λ.

c) Where the design output resulting from a) or b) on the upward units is lower than that of downward units, the downward units may have the same output as the upward units.

4.1.2.1.2 Units fitted with a reclaimer (bucket wheel or bucket chain)

a) where there is no output limiter, the design output is 1,5 times the filling capacity of the buckets multiplied by the maximum number of discharges. In the case of bucket wheels, the factor 1,5, which takes into account the volumes which can be filled in addition to the buckets, can be replaced by the actual value of additional filling.

b) Where there are automatic output limiters, the design output shall be the output thus limited.

Where the unit is intended to convey materials of different densities (for example coal and ore) safety devices shall be provided to ensure that the load will not be exceeded with the heavier material.

Dynamic load factor

In order to take into account the dynamic loads which could be applied to the conveyor during transport, the load must be multiplied by the factor 1,1.

4.1.2.2 Load in the reclaimers

To take into account the weight of the material to be conveyed in the reclaimers it is assumed that :

a) for bucket wheels :

— one-quarter of all available buckets are 100 % full.

b) for bucket chains :

— one-third of all the buckets in contact with the face are 33,3 % full;

— one-third of all the buckets in contact with the face are 66,7 % full;

— all other buckets up to the sprocket are 100 % full.

4.1.2.3 Material in the hoppers

The mass of the material in the hoppers is obtained by multiplying the density of the product by the volume (filled to the brim).

In case of the mass of the material being limited by reliable automatic controls, deviation from the above-mentioned value is permissible.

4.1.3 Incrustation

The degree of incrustation (dirt accumulation) depends on the specific material and operating conditions prevailing in each given case. The data which follow are to be taken as guidance. The actual values can deviate towards either higher or lower values.

For storage yard appliances, the values are generally lower, while for reclaimers they are to be taken as minimum values.

Loads due to dirt accumulation must be taken into account :

a) on the conveying devices, 10 % of the theoretical effective load calculated according to 4.1.2;

b) for bucket wheels, the weight of a 5 cm thick layer of material on the centre of the bucket wheel, considered as a solid disc up to the cutting circle;

c) for bucket chains, 10 % of the design useful load calculated according to 4.1.2, uniformly distributed over the total length of the ladder.

4.1.4 Normal digging and lateral resistances

These forces are to be calculated as concentrated loads, i.e. on bucket wheels as acting at the most unfavourable point of the cutting circle, and on bucket chains as acting at a point one-third of the way along the part of the ladder in contact with the face.

4.1.4.1 Normal digging resistance

The normal digging resistance acting tangentially to the wheel cutting circle or in the direction of the bucket chain on digging units, and in general on units for which the digging load is largely uncertain, is obtained from the rating of the drive motor, the efficiency of the transmission gear, the circumferential speed of the cutting edge, and the power necessary to lift the material, and in the case of bucket feeders from the power necessary to move the bucket chain.

To calculate the lifting power, the figures indicated in 4.1.2.2 with respect to the outputs may be used.

For storage yard applications, the above method of calculation may be ignored if the digging resistance of the product is accurately known as a result of tests and if it is known for sure that this digging resistance will not be exceeded during normal operation.

4.1.4.2 Normal lateral resistances

Unless otherwise specified, the normal lateral resistance can be assumed as 0,3 times the value of the normal digging resistance.

4.1.5 Forces on the conveying elements for material

Belt tensions, chain tensions, etc. must be taken into consideration for the calculation as far as they have an effect on the structures.

4.1.6 Permanent dynamic effects

4.1.6.1 In general the dynamic effect of the digging resistances, the falling masses at the transfer points, the rotating parts of machinery, the vibrating feeders, etc. need only be considered as acting locally.

4.1.6.2 The inertia forces due to acceleration and braking of moving structural parts must be taken into account. These can be neglected for appliances working outdoors if the acceleration or deceleration is $\leqslant 0{,}2$ m/s^2.

If possible the drive motors and brakes must be designed in such a way that the acceleration value 0,2 m/s^2 is not exceeded.

If the number of movements giving rise to inertia forces due to acceleration and braking is lower than 2×10^4, the effects must be considered as additional loads (see also 4.2.7).

4.1.7 Loads due to inclination of the machine

In case of inclination of the working level, forces will be formed by breaking down the weight loads acting vertically and parallel to the plane of the working level. The slope loads are to be based on the maximum inclinations specified in the delivery contract and have to be increased by 20 % for the calculation.

4.1.8 Loads on the gangways, stairs, platforms and walkways

Stairs, platforms and gangways must be calculated to bear 300 daN of concentrated load under the worst conditions, and the railings and guards to stand 30 daN of horizontal load.

When higher loads are to be supported temporarily by platforms, the latter must be designed and sized accordingly.

4.2 Additional loads

4.2.1 Wind load for machines in operation

During handling, a wind speed of v_w = 20 m/s = 72 km/h shall be assumed. The dynamic pressure q is calculated, in decapascals, using the following generally applied formula :

$$q = \frac{v_w^2}{16}$$

where v_w is the wind speed in metres per second.

The dynamic pressure during the handling operation is then :

$$q = 25 \text{ daPa}$$

Calculating wind action

It shall be assumed that the wind can blow horizontally in all directions.

The effect of wind action on a structural element is a force the component of which resolved along the direction of the wind is given by the equation

$$P = A \times q \times c$$

where

P is the resultant force, in decanewtons;

A is the area, in square metres, presented to the wind by the structural element, i.e. the projected area of the structural element on a plane perpendicular to the direction of the wind;

q is the aerodynamic pressure, in decapascals;

c is an aerodynamic coefficient taking into account the overpressures and underpressures on the various surfaces. It depends on the configuration of the structural elements; its values are given in table 1.

When a girder or part of a girder is protected from the wind by another girder, the wind force on this girder is determined by applying a reducing coefficient η. It is assumed that the protected part of the second girder is bound off by the projection in the direction of the wind of the contour of the first girder on the second. The wind force on the unprotected parts of the second girder is calculated without the coefficient η.

The value of this coefficient η will depend on b, on h and on the ratio

$$\varphi = \frac{A}{A_e}$$

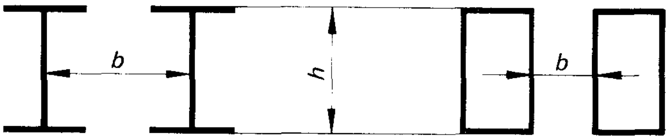
where

A is the visible area (solid portion area);

A_e is the enveloped area (solid portions + voids);

h is the width of the girder;

b is the distance between the surfaces facing each other.



When, for lattice girders, the ratio $\varphi = \frac{A}{A_e}$ is higher than 0,6, the reducing coefficient is the same as for a solid girder.

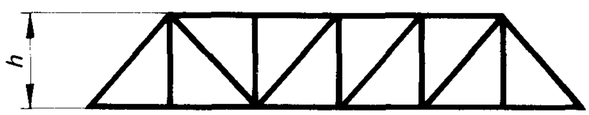
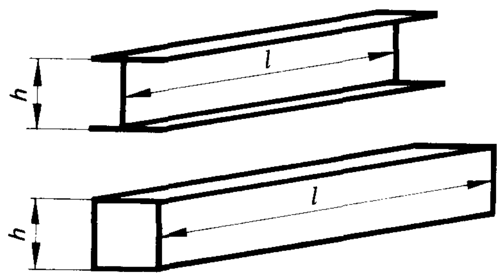
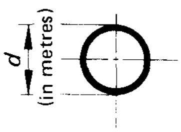
4.2.2 Snow and ice load

The loads due to snow and ice have been considered by the load case 4.1.3 (incrustation). As far as the customer does not prescribe load values due to particular climatic conditions, snow and ice need not be included.

4.2.3 Temperature

Temperature effects need only be considered in special cases, for example when using materials with very different expansion coefficients within the same component.

Table 1 — Values of the aerodynamic coefficient, c

Type of girder			c
Lattice of rolled sections			1,6
Solid-web or box girders		for l/h ratio of 20 10 5 2	1,6 1,4 1,3 1,2
Members of circular section Tubular lattice	 q (in decapascals)	$d\sqrt{q} < 1$ $d\sqrt{q} > 1$	1,2 0,7

NOTE — Certain values of c can be lowered if wind tunnel tests show that the values contained in the table are too high.

Table 2 — Values of reducing coefficient η as a function of $\varphi = A/A_e$ and the ratio b/h

$\varphi = \frac{A}{A_e}$	**0,1**	**0,2**	**0,3**	**0,4**	**0,5**	**0,6**	**0,8**	**1**
$b/h = 0{,}5$	0,75	0,4	0,32	0,21	0,15	0,05	0,05	0,05
$b/h = 1$	0,92	0,75	0,59	0,43	0,25	0,1	0,1	0,1
$b/h = 2$	0,95	0,8	0,63	0,5	0,33	0,2	0,2	0,2
$b/h = 4$	1	0,88	0,76	0,66	0,55	0,45	0,45	0,45
$b/h = 5$	1	0,95	0,88	0,81	0,75	0,68	0,68	0,68

These values are also represented by the curves in figure 1.

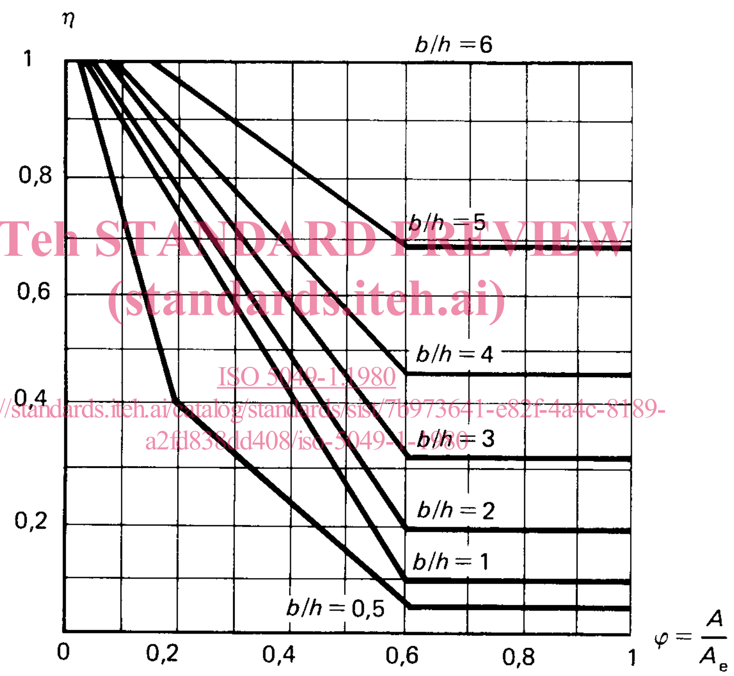


Figure 1 — Curves giving values of η

4.2.4 Abnormal digging resistance and abnormal lateral resistance

The abnormal digging resistance acting tangentially to the bucket wheel or in the direction of the bucket chain is calculated from the starting torque of the drive motor or from the cut-off torque of the built-in safety coupling, taking into account the more unfavourable of the two cases listed below :

a) if the wheel or chain is not loaded :

in this case account is not taken of the power necessary to lift the product to be transported, and the load due to the starting torque of the motor is considered as a digging load.

b) if the wheel and chain are loaded according to 4.1.2.2 :

in this case the digging power can be reduced by the lifting power.

The abnormal lateral resistance is calculated as in 4.1.4.2, thereby considering a load of 0,3 times the abnormal digging resistance.

If appropriate, this load can be calculated from the working torque of an existing cut-out device at least equal to 1,1 times the sum of the torques due to the inclination of the machine (see 4.1.7) and to wind load for machines in operation (see 4.2.1).

4.2.5 Resistances due to friction and travel

a) Frictional resistances need only be calculated as long as they influence the sizes.

The friction coefficients are to be calculated as follows :

- for pivots and ball bearings : $\mu = 0{,}10$
- for structural parts with sliding friction : $\mu = 0{,}25$

b) For calculating the resistances to travel, the friction coefficients are as follows :

- on wheels of rail-mounted machines : $\mu = 0{,}03$
- on wheels of crawler-mounted machines : $\mu = 0{,}10$
- between crawler and ground : $\mu = 0{,}60$

4.2.6 Reactions perpendicular to the rail due to movement of appliance

In the case of appliances on rails, which do not undergo any reaction perpendicular to the rail other than those reactions due to wind and forces of inertia, account must be taken of the reactions resulting from the rolling movement of the unit taking a torque of force H_y directed perpendicularly to the rail as in figure 2.

The components of this torque are obtained by multiplying the load exerted on the wheels or bogies by a coefficient λ depending on the ratio of the rail gauge, p, to the wheel or bogy wheel base, a.

To calculate the torque H_y, take the centre of gravity S of the appliance on axis y in unfavourable position in relation to the sides 1 and 2.

If there are horizontal guiding wheels, the distance between the guiding wheels is to replace value a.

The values of λ can be found in figure 3 as a function of the p/a ratio :

4.2.7 Non-permanent dynamic effects

The mass forces due to the acceleration and braking of moving structural parts occurring less than 2×10^4 during the lifetime of the appliance are to be checked as additional loads. They may be disregarded if their effect is less than that of the wind force during operation as per 4.2.1.

If the mass forces are such that they have to be taken into account, the wind effect can be disregarded.

4.3 Special loads

4.3.1 Clogging of chutes

The weight of the clogging is to be calculated using a load which is equivalent to the capacity of the chute in question, with due reference to the slope angle. The material normally within the chute may be deducted. The actual bulk weight must be taken for calculation.

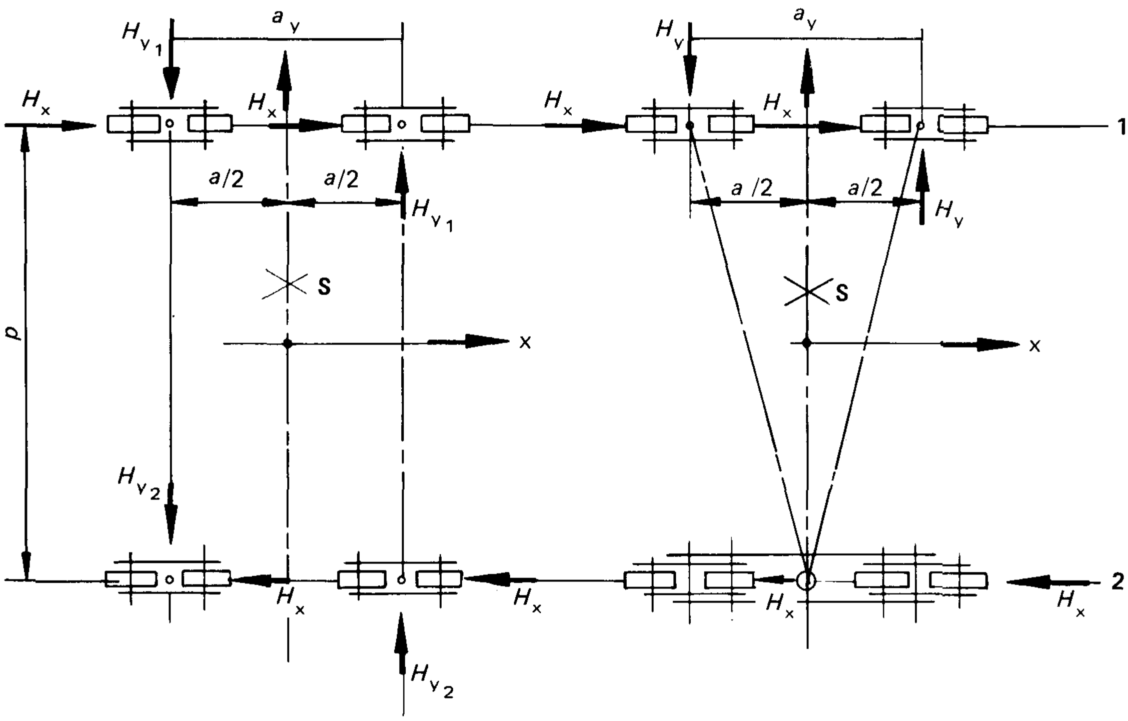


Figure 2 — Appliances on rails

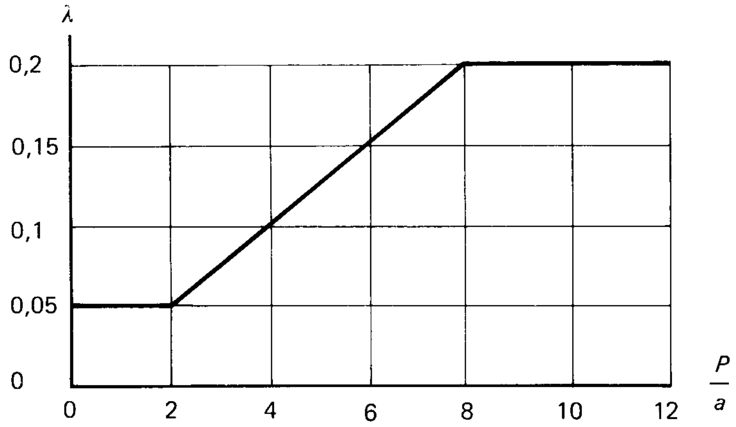


Figure 3 — Values of λ

4.3.2 Resting of the bucket wheel or the bucket ladder on the face

Where safety devices, for example slack rope safeguard for rope suspensions or pressure switches for hydraulic hoists, are installed which prevent the full weight of the bucket wheel or the bucket ladder coming to rest, the permissible resting force is to be calculated as a special load at 1,1 times its value.

Where such safety devices are not provided, the special load is to be calculated with the full resting weight.

4.3.3 Failure of safety devices as in 4.1.2.1

In the case of failure on the part of the automatic safety devices mentioned in 4.1.2.1 to limit the useful loads on the conveyors, the output can be calculated as follows :

a) in the case of appliances without built-in reclaiming device, according to 4.1.2.1.1 b);

b) in the case of appliances with built-in reclaiming device, according to 4.1.2.1.2 a).

For this purpose account need not be taken of the dynamic factor 1,1.

4.3.4 Locking of travelling gears

For rail-mounted equipment, it must be taken into account that bogies may be locked, for example by derailment or rail fracture. For the loads occurring under such conditions the coefficient of friction between driven wheels and rails is to be calculated as μ = 0,25 so that the drive motors can generate sufficient power.

4.3.5 Lateral collision with the slope in the case of bucket wheel machines

The maximum lateral resistance in bumping against the slope is determined by the safety coupling in the slewing gear or the kinetic energy of the superstructure. This load is to be applied in accordance with 4.1.4. In calculating the lateral resistance from the kinetic energy, a theoretical braking distance of 30 cm and a constant braking deceleration are to be assumed.

4.3.6 Wind load on idle machines

For this case, the wind speeds and aerodynamic pressures given in table 3 are to be taken, with reference to the above-ground height of the structural element in question.

Table 3 — Wind speeds and aerodynamic pressures

Above-ground height of the structural element involved	Wind speed v_w		Aerodynamic pressure q
m	m/s	km/h	da Pa
2 to 20	36	130	80
20 to 100	42	150	110
above 100	46	165	130

For wind effect calculation, refer to 4.2.1.

4.3.7 Buffer effects

For horizontal speeds below 0,7 m/s no account shall be taken of buffer effects. For speeds in excess of 0,7 m/s account must be taken of the reaction on the structure by collisions with buffer, when buffering is not made impossible by special devices.

It shall be assumed that the buffers are capable of absorbing the kinetic energy of the machine with operating load up to a certain fraction of the rated travelling speed v_T; this fraction is fixed at minimum 0,7 v_T.

The resulting loads on the structure shall be calculated in terms of the retardation imparted to the machine by the buffer in use.

4.3.8 Loads due to earthquakes

As far as the delivery contract contains data concerning the effects due to earthquakes, these loads have to be considered in the calculation as special loads.

5 Load cases

The main, additional and special loads mentioned in clause 4 must be combined in load cases I, II and III according to table 4.

Only loads which can occur simultaneously and which produce, with the dead weight, the greatest forces at the cutting points, are combined.

For case III the most unfavourable combination is retained.

6 Design of structural parts other than joints

6.1 General

The stresses arising in the structural parts shall be determined for the three load combinations and a check shall be made to

Table 4 — Load combinations

Sub-clause	Type of load	Main loads	Additional and special loads	Main, additional and special loads							
		I	II	III 1	III 2	III 3	III 4	III 5	III[2] 6	III 7	III 8
4.1.1	Dead loads	*	*	*	*	*	*	*	*	*	*
4.1.2	Useful loads on conveyors, reclaimers and hoppers	*	*	*	*	*	*	*		*	*
4.1.3	Incrustation	*	*	*	*	*	*	*	*	*	*
4.1.4	Normal digging and lateral resistances	*		*		*		*			
4.1.5	Forces on the conveying elements	*	*	*	*	*	*	*	*	*	*
4.1.6	Permanent dynamic effects	*	*	*	*	*	*	*		*	*
4.1.7	Loads due to inclination of machine	*	*	*	*	*	*	*	*	*	*
4.2.1	Wind force during operation[1]		*	*	*	*	*	*		*	*
4.2.2	Snow and ice (possibly)										
4.2.3	Temperature (possibly)										
4.2.4	Unusual digging and lateral resistances		*								
4.2.5	Resistances due to friction and travel		*								
4.2.6	Reactions perpendicular to the rail		*								
4.2.7	Non-permanent dynamic effects		*								
4.3.1	Chute clogging			*							
4.3.2	Bucket-wheel resting				*						
4.3.3	Failure of safety devices					*					
4.3.4	Travelling device locking						*				
4.3.5	Lateral collision with the slope (bucket wheel)							*			
4.3.6	Wind force outside of operation								*		
4.3.7	Buffer effects									*	
4.3.8	Earthquake stresses										*

1) Refer to 4.2.7.

2) The removal of unusual digging resistances (see 4.2.4) must be ensured, when necessary, by appropriate devices (locking device which prevents slewing of appliance when out of service due to wind force).

ensure that an adequate safety margin exists in respect of the critical stresses, considering the following :

— straining beyond the yield point, or the permissible stress respectively;

— straining beyond the permissible crippling or buckling stress and possibly exceeding the permissible fatigue strength.

The cross-sections to be used in such analysis shall be the net sections for all parts which are subjected to tension (i.e. deducting the area of holes) and the cross-sections for all parts which are subjected to pressure (i.e. without deducting the area of holes); in the latter instance holes are only included in the cross-section when they are filled by a rivet or bolt.

Conventional strength of materials calculation procedures shall be used to calculate the strength.

6.2 Characteristic values of materials

For structural steel members, the figures in table 5 are to be used.

6.3 Calculation of permissible stresses with respect to the yield point

The stresses for load combination cases I, II and III calculated according to clause 5 must be compared with the permissible stresses σ_a for these load combination cases.

These latter stresses are obtained by dividing the yield point σ_E by a corresponding safety coefficient.

The permissible stresses shall be as follows, for structural members subjected to *tension or compression* and to the extent they are liable to neither crippling nor buckling :

Case I : $\sigma_a = \dfrac{\sigma_E}{1,5}$

Case II : $\sigma_a = \dfrac{\sigma_E}{1,33}$

Case III : $\sigma_a = \dfrac{\sigma_E}{1,20}$

For structural members submitted to *shear* loads :

$$\tau_a = \frac{\sigma_a}{\sqrt{3}}$$

For combined loads, if a normal stress σ_x, a normal stress σ_y perpendicular to the latter and a shear stress τ_{xy} occur simultaneously on a flat plate, the following formula shall be applied for the resultant combined stress :

$$\sigma_{cp} = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\,\tau_{xy}^2} \leqslant \sigma_a$$

The permissible stresses for the most current steels are summarized in table 6.

Other materials not shown in table 6 can be used when the mechanical properties, the chemical composition and, when applicable, the weldability of the material are guaranteed by the producer.

Table 5 — Characteristic values of materials

Material	σ_E 1) N/mm²	σ_R N/mm²	$\dfrac{\sigma_E}{\sigma_R}$	E N/mm²	G N/mm²	α_t cm/(cm·°C)
Fe 360	240	370	0,65	21×10^4	$8,1 \times 10^4$	$1,2 \times 10^{-5}$
Fe 430	260	420	0,62	21×10^4	$8,1 \times 10^4$	$1,2 \times 10^{-5}$
Fe 510	360	520	0,69	21×10^4	$8,1 \times 10^4$	$1,2 \times 10^{-5}$

1) The yield point σ_E corresponds to a permanent expansion of 0,2 %.

Table 6 — Permissible stresses

Values in newtons per square millimetre

Structural steel	**Fe 360**			**Fe 430**			**Fe 510**		
Load case	I	II	III	I	II	III	I	II	III
Tension 1) or compression σ_a	160	180	200	173	195	216	240	270	300
Shear τ_a	93	104	116	100	113	125	139	157	174

1) When crippling of the compressed members is not possible.

For high yield point steels $\frac{\sigma_E}{\sigma_R} > 0{,}7$, the permissible stresses can be obtained by means of the following formula :

$$\sigma_a \leqslant \frac{\sigma_E + \sigma_R}{\sigma_{E52} + \sigma_{R52}} \times \sigma_{a52}$$

where

σ_E and σ_R represent respectively the yield point and the ultimate stress of the steel in question;

σ_{E52} and σ_{R52} represent respectively the yield point and the ultimate stress for Fe 510;

σ_{a52} is the permissible stress for Fe 510.

6.4 Checking of elements submitted to compression and buckling loads

[This check shall be ruled by an International Standard. In the meantime, the question of maximum allowable loads regarding framework elements submitted to compression will be studied internationally.

Until a decision has been taken, the national standards relating to buckling may be used.]

7 Design of joints for general stress checking

7.1 Welded joints

The most important types of weld joints and their qualities are described in table 7.

For the longitudinal loads, the permissible stresses in the structural members shall be applied according to table 6.

For the combined stresses flush with the plate, a comparative value will have to be established for all the types of welds which will have to be compared with the permissible stress σ_a.

$$\sigma_{wcp} = \sqrt{\bar{\sigma}_x^2 + \bar{\sigma}_y^2 - \bar{\sigma}_x \bar{\sigma}_y + 2\,\tau^2} \leqslant \sigma_a$$

where

$$\bar{\sigma}_x = \frac{\sigma_a}{\sigma_w \text{ perm.}} \times \sigma_x$$

$$\bar{\sigma}_y = \frac{\sigma_a}{\sigma_w \text{ perm.}} \times \sigma_y$$

The weld joint must have at least the tensile strength and the yield point of the steel of the welded structural members.

7.2 Bolted and riveted joints

7.2.1 Fitted bolts

The permissible stresses according to table 9 presuppose bolts the shanks of which bear against the full length of the hole.

The holes must be drilled and reamed. The tolerance in the hole must be as follows :

— in the case of variable load always in the same direction ($\kappa \geqslant 0$) : ISO H11/h11 gauge;

— in the case of alternating load ($\kappa < 0$) : ISO H11/k6 gauge.

7.2.2 Non-fitted bolts (forged black bolts)

Bolts of this type are tolerated only for secondary joints of members subjected to little load. They are not tolerated for joints subjected to fatigue.

7.2.3 Rivets

The rivet holes must be drilled and reamed.

The rivets must not be subjected to tensile load.

7.3 Joints using high tensile bolts with controlled tightening

This type of bolted joint offers the best guarantee against loosening; it is especially recommended for the joining of members subjected to dynamic loads.

7.3.1 Forces parallel to the joint plane (symbol T)

These forces are transmitted by friction to the mating surfaces after tightening.

The transmissible force of a bolt is equal to

$$T_a = \frac{F \times \mu \times n}{\nu_T}$$

where

F is the tensile force after tightening;

μ is the friction coefficient of the mating surfaces;

n is the number of friction surfaces;

ν_T is the slipping safety.

The tensile force after tightening is calculated on the basis of the permissible stress of the bolt material.

The permissible stress is :

— for a normal case : $\sigma_F = 0{,}7\ \sigma_{E(0,2)}$

(This determination takes into account the additional stresses when the bolt is tightened.)

— for an exceptional case : $\sigma_F = 0{,}8\ \sigma_{E(0,2)}$

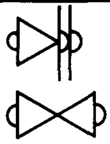
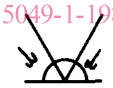
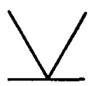
In this instance, the danger of stripping when the bolt is tightened must be taken into account.)

The tensile forces after tightening shall be guaranteed by methods allowing the forces produced to be checked (tightening by means of a torque wrench or according to the nut tapping method).

The coefficient can be taken from table 10.

The minimum condition consists in this case in cleaning the mating surfaces so as to remove all traces of paint and oil and in eliminating rust with a wire brush.

Table 7 — Main types of weld joints

Type of weld	Weld quality	Weld preparation	Example of symbols	Test to determine acceptable weld: Test methods	Test to determine acceptable weld: Symbols
Single or double v butt weld	Special quality	Root of weld back gauged before sealing run execution, ground flush with the plate parallel to the direction of the stress without terminal crater		Non-destructive test of the seam over its full length, for example : Xrays	**P 100**
	Standard quality	Root of weld back gauged before sealing run execution, without terminal crater		As for the special quality, but solely : — under tensile stress (see table 8) with σ_{max} calculated $\geqslant 0{,}8\ \sigma_a$, σ_a as a function of κ (see 8.2.2)	**P 100**
				Non-destructive testing on a spot check basis over at least 10 % of the seam length, for example : X rays	**P**
Double level butt weld with double fillet welds	Special quality	Root of weld back gauged. Complete penetration weld. Notchless weld edges, ground if necessary		Non-destructive test of the plate under tensile stress perpendicularly to its surface to detect laminations (for example : by ultrasonic examination)	**D**
	Standard quality	Width of unwelded portion at root of joint, less than 3 mm or less than 0,2 times the thickness of the welded portion The lowest value is determinant			
Fillet weld	Special quality	Notchless weld edges, ground if necessary			
	Standard quality