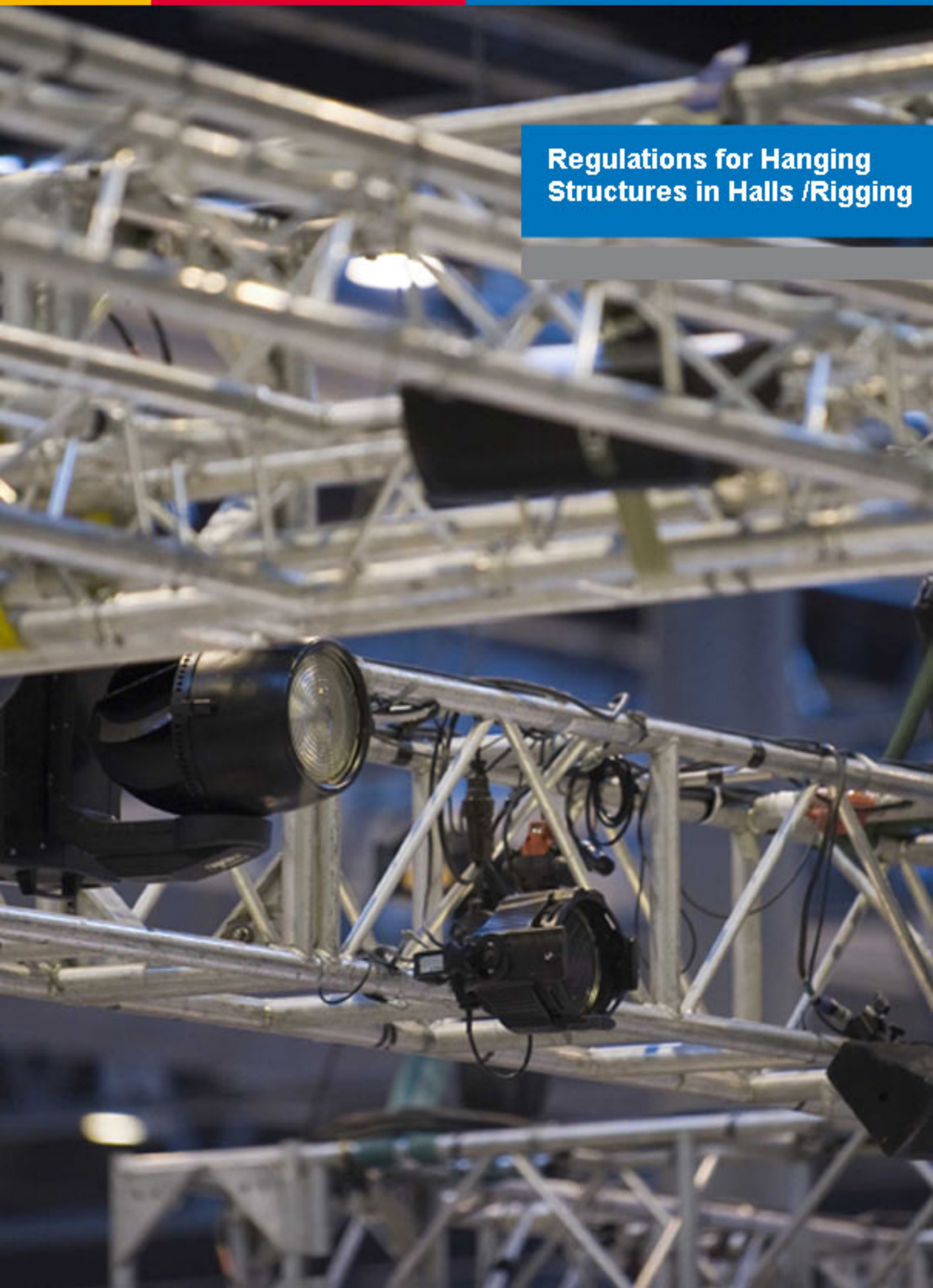
Regulations for Hanging Structures in Halls /Rigging



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I.- REGULATIONS

1. GENERAL CONDITIONS

Exhibiting companies may hang elements from hall roofs which fulfil the stipulated specifications and by following the procedure which is detailed in this document.

Any structures to be hung shall be designed in a way which does not compromise the safety of persons or the facilities. The main project objectives and requirements are as follows:

- The safety coefficients of the structure in the halls subjected to the loads which are transmitted to them by hanging elements shall be higher than those laid down in valid regulations.

- The safety coefficients of hanging elements shall be higher than those laid down in valid regulations.

- The loads which are transmitted to the structure during the assembly of stands, whether this is due to the hoisting of elements or on account of any other assembly or dismantling operation, shall be such that the structure of the halls is not subjected to safety coefficients lower than those laid down in valid regulations.

- Materials shall be chosen so that the structure of the halls is not damaged by adopting measures such as the protection of slings with rubbers.

- The materials used shall be good quality and shall be in good condition, which shall be guaranteed through compliance with the regulations mentioned in Section 5 of this document.

- The minimum diameter of any steel cables used shall be 6 mm.

- Structures shall be fitted with a safety system comprising stress-free safety wires which would support the load in the event of the main cables breaking. The minimum diameter of these elements shall be 8 mm.

- Each exhibitor shall only use the hanging points located in the vertical line of the space occupied by the stand. If points need to be located outside this area, it will be IFEMA which marks the position.

2. PROCEDURE TO BE FOLLOWED

Any exhibitors wishing to hang an element from the structure of the halls shall adhere to the following procedure:

A rigging project shall be sent to the following e-mail address: inspeccion.rigging@ifema.es . It shall contain the minimum contents which are specified in Section 3 of this document together with a completed application form.

Any projects which are received in the last 30 days prior to the commencement date of the event for which the application is made may not be taken into account and, therefore, hanging from the hall structure may not be authorised.

Within a time period of 7 days from receiving an application, IFEMA will issue a report on the application. Its outcome will be one of the following:

i. Application approved. The exhibitor may, therefore, carry out the assembly which is shown on the application form.

ii. Application with remarks. The exhibitor must adapt the project to IFEMA's remarks and submit it again so it can be rechecked. The remarks may refer to any aspect of the installation, such as the need to increase the number of force transmission points, to reduce the amount of each one, to modify their location or their configuration, to change the materials to be used, etc.

iii. Unapproved application. These are cases which do not meet the conditions laid down in this document.

Once the rigging project has been approved, on the dates set for each event, the exhibitor may carry out the assembly, which shall be exactly in keeping with the approved application. Any changes must be approved by IFEMA. During the assembly, the applicant must ensure the project approval document and copies of the approved plans are made available.

During assembly, technicians from IFEMA or from companies contracted for this purpose shall check it adheres to the approved projects. The assembly of any installations which are not in keeping with the contents of the approved projects shall be prohibited.

If, during the assembly of any elements, there should exist reasonable doubts about their suitability, IFEMA may insist that proper verification tests are carried out which shall be paid for by the exhibitor.

3. MINIMUM CONTENTS OF RIGGING PROJECTS

The projects which are attached to rigging application forms shall contain an accurate definition of anything whose hanging is intended. The following data, at the very least, shall be included:

- Explanatory brief of the installation to be carried out.

- A description of the assembly, as long as it involves the transmission of loads to the structure.

- Weight values of all the elements which form part of the rigging system (spotlights, loudspeakers, motors, sheathing, truss weights, etc).

- Scale diagrams showing floor and elevation measurements of the installation, indicating the location of each hanging point both on the elements to be hung and on the hall structure. Schedule 1 of this document contains an example for guideline purposes.

- Value of the load transmitted by each hanging point.

- List of materials with a structural purpose to be used.

- The quality certificates of these materials.

- A description of the safety system to be used doubling the capacity of the initial system.

- The documentation must be signed by someone in charge in the installing company.

4. CONDITIONS FOR PROJECT ACCEPTANCE

All projects which comply with the following conditions will be accepted:

- Their minimum contents must be those laid down in Section 3 of this document.

- No mistakes must be found when they are checked.

- During their analysis, together with the other applications and the structure of the halls involved, they lead to safety coefficients in keeping with valid regulations.

- Suitable materials are used which transmit loads safely.

- Quality certificates of the materials needed are provided.

- Assembly procedures are used which do not damage the hall structure nor entail risks for the safety of persons or the facilities.

All the data in the projects shall be noted in the International System of Units and shall be submitted in Spanish or in English.

5. COMPULSORY REGULATIONS

- UNE EN 13414. Steel cable slings. Safety.

- UNE-EN 1677. Series of regulations for sling accessories. Safety.

- UNE-EN 12385:2003. Steel cables. Safety.

- UNE-EN 13411:2002. Steel cable grips. Safety.

- CTE. Technical building code.

6. QUALITY DOCUMENTATION TO BE PROVIDED IN PROJECTS

Installers must provide the quality certificates of all materials used for resistance purposes which are going to be used in the assemblies.

7. COLLABORATION WITH INSPECTION WORK

IFEMA may perform any inspections it deems fit during assembly for which the installers shall offer all the necessary means. To this end, they shall place at the disposal of the inspectors appointed by IFEMA the auxiliary means they are using such as lifting baskets, scaffolds, ladders or any others which are available.

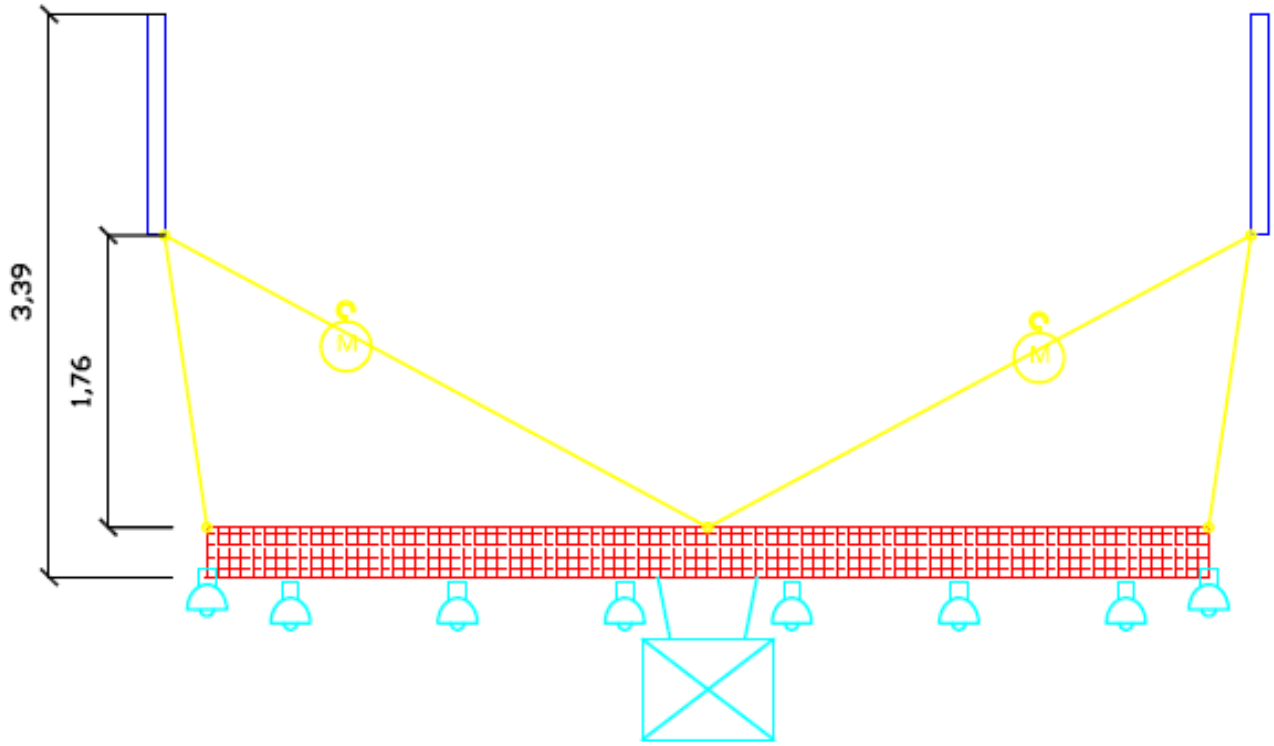
8. COMMUNICATION CHANNELS BETWEEN IFEMA AND THE APPLICANTS

Rigging applications shall be sent by e-mail to the following address: inspeccion.rigging@ifema.es. Any modifications shall also be submitted via this address.

SCHEDULE 1

EXAMPLE OF GRAPHIC DOCUMENTATION TO BE SUBMITTED

ELEVATION



FLOOR

II.- MANUAL

1. PURPOSE

On 1 January 2009, compulsory regulations come into force for the hanging of structures in IFEMA's halls. The aim of this manual is to offer a series of guidelines both for the drafting of applications for hanging structures and for the assembly and dismantling operations of elements to be hung. Its contents are complemented with those of the abovementioned regulations. In the event of any discrepancy between both documents, the provisions of the regulations shall prevail.

2. ACCEPTABLE RIGGING LOCATIONS

Elements may only be hung from points on the main structure of the halls. There are special cases in Halls 12, 14.0 and 14.1 in which some points have been fitted which are distributed throughout the entire surface area and which are the only ones for which authorisation will be given to hang elements on. Fastening, therefore, from the following elements, among others, is totally prohibited:

- Installation elements, whether they are ducts, channels, lighting elements, etc.

- From other hung elements such as information panels, etc.

- Secondary elements on the structure, such as belts, bracing, etc.

3. STRUCTURE SUPPORT SPECIFICATIONS

Supports on hall structures will be designed so that the latter are not damaged. The main rules to be obeyed in this sense are as follows:

- The arrangement of rigging elements will be vertical provided that this is permitted by the structure, except in Hall 14.1, where it will be compulsory in all cases.

- Support will be provided by a simple steel sling.

- Steel thimbles shall be fitted at both ends.

Any parts of the cables which are in contact with the structure of the halls will be covered with a sleeve of PVC, reinforced polyurethane or other plastic material which protects both the cables and the structure paint.

Slings must be prevented from resting on the sharp edges of the structure. To this end, protection corner pieces and brackets must be inserted between the sharp edges and the cable.

The maximum load to be hung at each point will be 5 kN (500 kg) at truss connections in Halls 1 to 10 and 250 at positions between connections. In Halls 12, 14.0 and 14.1, the maximum load will be 3.5 kN (350 kg).

4. ADMISSIBLE MATERIALS

For hanging elements on hall structures, the use of cables and slings which are made of steel, nylon or a combination of these will be admitted.

The use of nylon slings is allowed provided that the safety cable system described in Section 5 is made of steel in order to give the system adequate stability in the case of the fire.

t each end, slings shall have a loop or eye which can be obtained by means of a forged end fitting, a conic end fitting, a pressure-fit ferrule (sleeve) or a welded end ferrule. Loops shall always be formed using thimbles.

Clamps (staples) or clips can only be used to form eyes on the safety cable, reducing the load resistance of the cable by at least 20%. Thimbles will always be used to form eyes or loops.

Before slings are positioned, the company must check their condition along their whole length. Slings which are unsuitable or if over 5 years have passed since their date of manufacture cannot be used.

Cables which have breakages in their wires, loose thin wires or are frayed, knotted, folded or kinked cannot be used.

When end fittings, ferrules or thimbles are damaged or bent, the sling shall be considered to be unsuitable and cannot be used for hanging jobs in halls.

All elements must be documented via manufacturer quality certificates and must be properly marked.

The manufacturer or its representative established in the European Economic Community must issue a certificate which at least includes the following information:

- The manufacturer's name and address or that of the latter's representative in the European Economic Community.

- Geometrical specifications.

- In the case of cables, the following shall be detailed; the type and direction of the wiring (braiding to the right or to the left, preformed or not, crossed or Lang type), the wiring feedthrough, the manufacture (cable composition, nature and composition of the cable core, number of thin wires and number of wires). A section diagram giving measurements shall be attached.

- Material specifications. In the case of cables, the nominal resistance of the wires to breakage through traction, the practical minimum resistance of the cable to breakage through traction, information about the nature of the protection against internal and external corrosion (in the event of galvanization its quality must be given), a certificate stating that the cable is manufactured in one single piece and that its specifications are the same along its entire length.

- Temperature limits for the use of the cable.

- Maintenance and inspection regulations

Compliance with the following regulations is compulsory:

- UNE EN 13414:2004. Steel cable slings. Safety.

- UNE-EN 1677:2001. Series of regulations for sling accessories. Safety.

- UNE-EN 12385:2003. Steel cables. Safety.

- UNE-EN 13411:2002. Steel cable grips. Safety.

- CTE. Technical building code.

Compliance with the provisions in documents NTP 155 and NTP 221 is also recommended.

5. SAFETY CABLES

In all assemblies, safety cables will be put in place so that if any elements should break, the hanging structure will not fall. The following conditions must be complied with:

- When the two ends of the safety cables are fixed, they must be stress free.

- Their section will be that needed to bear the loads of the cable for which they act as a safety cable increased by 25% in order to take into consideration the effect of the entry of sudden stress.

- Once its structure is in its final position, the installing company will fix it.

- Fixing to hall structures shall be undertaken using slings and shackles. The other end shall be executed using staples (cable grips) or any other duly approved system.

6. REACTION CALCULATIONS PROCEDURE DURING ASSEMBLIES

Structure hanging applications must contain information on the loads to be transmitted to the structure at each of the points. In order to determine these values, the real weight of each component to be hung, as well as their distribution, must be taken into consideration. Depending on the characteristics of the system to be installed, the use of one of the following procedures will be admitted:

- An estimate of reactions by means of distribution by load areas. This simplified procedure will only be admitted in any cases in which the load per point is lower than 3 kN (300 kg). A diagram showing the location of each weight and a corroboration of their value will also be required. The procedure consists in assigning to each point the loads which correspond in distribution by load areas. Schedule 1 of this document includes an example of its application.

- An estimate of reactions via a structural model. This is the general, compulsory model for systems in which loads greater than 3 kN (300 kg) are applied.

7. PROCEDURE DURING ASSEMBLIES

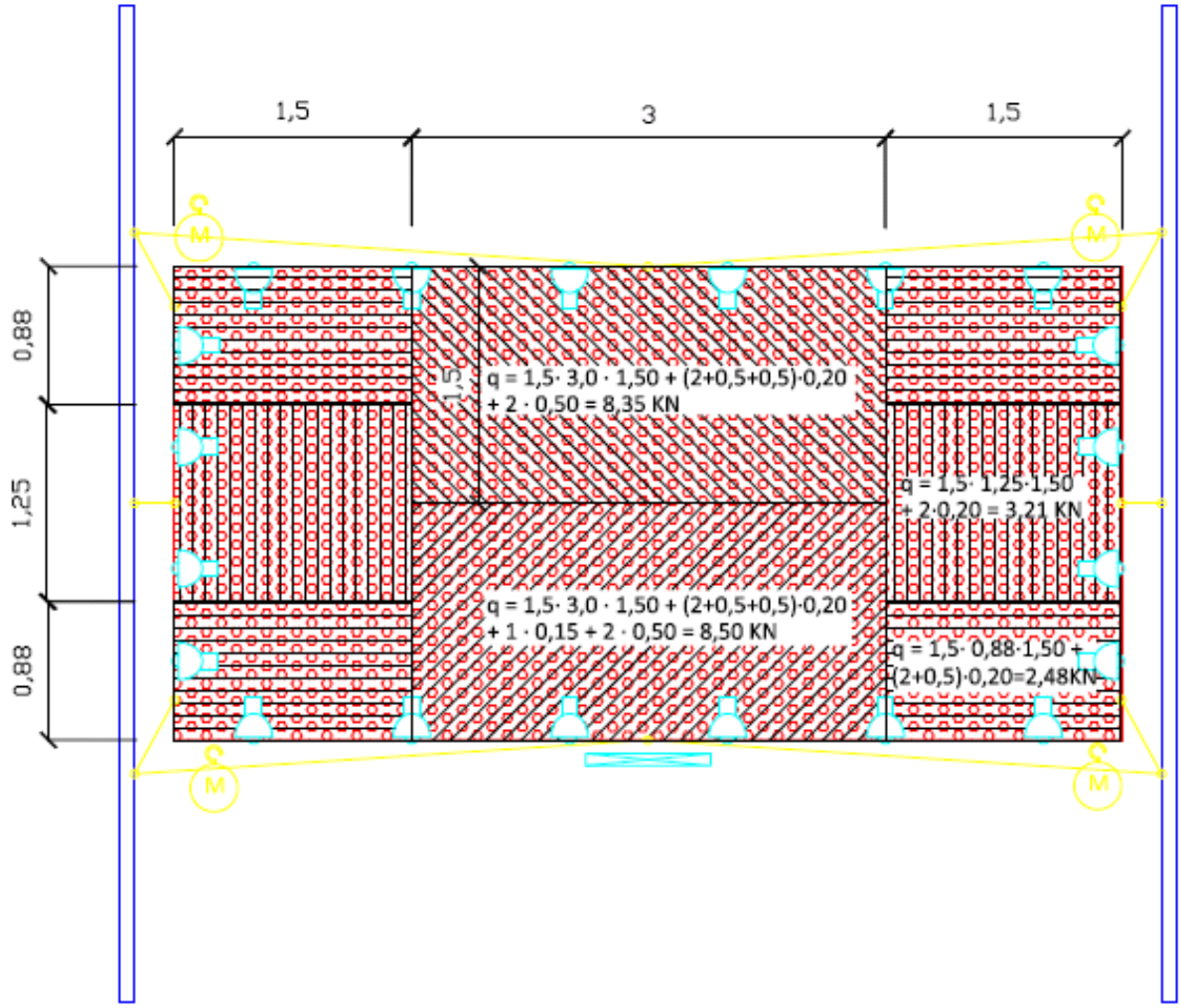
Before beginning any work, installing companies which have been authorised to hang rigging in any of the halls must get in touch with the hall manager, who must authorise the commencement of the assembly.

Only installations which strictly adhere to the project approved by IFEMA will be authorised. Any modifications which have to be introduced owing to *in situ* redesigning must be approved by IFEMA once again.

IFEMA may perform any inspections or tests it deems fit during assembly for which the installers shall offer all the necessary means. To this end, they shall place at the disposal of the inspectors appointed by IFEMA the auxiliary means that they are using, such as lifting baskets, scaffolds, ladders or any others which are available.

SCHEDULE 1

EXAMPLE OF CALCULATION BY LOAD AREAS



	ELEMENTS	LOAD
	Spotlight	20 Kg/Unit = 0.20 KN/Unit
	Sign	15 Kg/Unit = 0.15 KN/Unit
	Stand roof + truss	150 Kg/m^2 = 1.50 KN/m^2
	Motor lifting	50 Kg/Unit = 0.50 KN/Unit

SCHEDULE 2
NTP REGULATIONS

NTP 155: Cables de acero

Câble en acier
Steel ropes

Vigencia	Actualizada por NTP	Observaciones	
Válida		Complementa a la NTP 221	
ANÁLISIS			
Criterios legales		Criterios técnicos	
Derogados:	Vigentes:	Desfasados:	Operativos: Si

Translation by Courtesy of IFEMA
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Introduction

Metallic cables are elements that are widely used in most industrial activities. Consequently, we can find them forming part of the equipment for handling and securing loads (cranes, winches, slings, etc.) and even in the transportation of people (cable-cars, lifts, etc.).

It is because of this that it is advisable to know the characteristics of these elements, as well as the basic conditions which must be borne in mind both for their installation or assembly in equipment, as well as for their handling and maintenance.

This Technical Advice includes practical instructions and recommendations which are the fruit of the knowledge and experience both of users and of manufacturers.

Cable Specifications

Constitution

A metallic cable can generically be considered to comprise diverse metallic cords arranged in a helicoidal manner around a core, which may be textile, metallic or a combination of both. This arrangement is such that it works as one sole unit. In turn, a cord may be considered to comprise diverse metallic wires arranged in a helicoidal manner in one or several layers.

When the direction of the winding of the cords in the cable is opposite to that of the wires it is called cross winding. If the wires and cords are in the same direction, the winding is called Lang.

Diameter and useful section

The diameter of a cable is considered to be that of the maximum circle which circumscribes its straight section, which is commonly expressed in millimetres. This diameter must be measured with the help of a slide gauge.

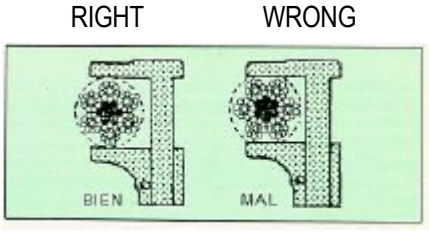


Fig. 1

The useful section of a cable is the sum of the sections of each of the wires which comprise it. The useful section of a cable must never be calculated using its diameter.

Cable designation

In practice, the composition of a cable is expressed in an abbreviated form using a notation comprising three signs, whose generic form is: A x B + C, where A is the number of cords; B is the number of wires in each cord and C is the number of textile cores. When the cable core is not textile, in other words it is formed by wires, the last figure C is replaced by a notation between brackets indicating the composition of said core. If the cords or cable legs are other cables, the second figure B is replaced by a notation between brackets indicating the composition.

For designation purposes, the following aspects must also be considered: the different ways the wires are arranged in cords, the type of winding and whether the material comprising it is preformed or not.

Example:

A cable comprising 6 cords with 25 wires in each cord, arranged around a core formed by a metallic cord formed by 7 cords containing 7 thin wires each, would be represented by:

6 x 25 + (7 x 7 + 0) Filling

Cable resistance

The resistance to traction breakage of a cable is determined by the quality of the steel used to manufacture the different wires, their number and section and their condition.

The breakage load of a wire is the product of its minimum resistance multiplied by its straight section.

The calculated breakage load of a cable is the sum of the breakage loads of each of the wires comprising it.

The effective breakage load of a cable is the value that is obtained by breaking a piece of cable by traction in a testing machine.

Safety coefficient

A cable's work safety coefficient is the quotient between the effective breakage load and the load which the cable must really bear.

$$K = \frac{C_{re}}{Q}$$ siendo K = Coeficiente de seguridad; C_{re} = Carga de rotura efectiva; Q = Carga a soportar por el cable

Where K = Safety coefficient
C_{re} = Effective breakage load
Q = Load to be borne by the cable

Article 112.2 of the General Regulations on Workplace Safety and Hygiene sets forth that for lifting and transportation devices, the safety factor or coefficient shall be no lower than 6. Nevertheless, there are different specific rules and regulations (Lifting devices, mining, etc.) to which each piece of equipment must be adapted.

Cable use

On being bent, on passing through a pulley or on being wound, cables suffer stresses which are inversely proportional to the diameter of the winding and according to the constructive rigidity of the cable.

Arrangement on pulleys and rotatable drums

Fatigue owing to the bending of a cable is closely related to the winding diameter on drums and pulleys. In order to prevent these values from being too great, it is advisable to take two minimums into account:

a. The relationship between the diameter of the pulley or drum and that of the cable.
b. The relationship between the diameter of the pulley or drum and that of the largest wire.
c. Each manufacturer has established the above for their products.

Article 112.6 of the General Regulations on Workplace Safety and Hygiene sets forth that the diameter of hoisting drums shall not be smaller than 30 times that of the cable, provided that it is also 300 times the diameter of the largest wire.

For pulleys, manufacturers recommend that the relationship between their diameter and that of the cable fulfils D/d > 22. The diameter of the pulley is considered to be measured from the bottom of the groove.

It is advisable for the drums to be of the grooved type and to be arranged as is shown in Figure 2.

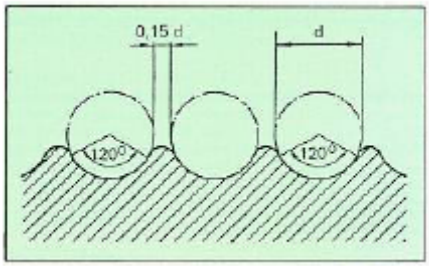
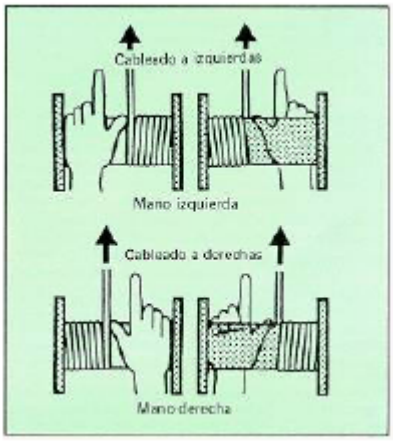


Fig. 2

The lateral deviation angle ∞ which occurs between the drum and the cable must be lower than 1.5º.
In order to wind a cable on a drum, the direction of the cable must be taken into consideration. It should be carried out as is shown in Figure 3.

Cabling to the left Left hand



Cabling to the right Right hand

Fig. 3

Joining cables

This section will consider both splicing cables and making different types of end fittings. The most commonly used systems are:

Braiding

Joining cables using braiding is very delicate work which requires highly specialised operators. The operation consists in unbraiding the ends of the cables to be spliced to then braid them together manually.

The recommended length for splices is: 900 times their diameter for cross winding cables; and 1,200 times their diameter for Lang winding cables.

In order to make end fittings using braiding, it is recommended that the length of the braiding should not be shorter than 30 times the diameter of the cable in question.

Using ferrules

This consists of a sleeve of special alloys which is highly suited to cold forming. It is pressure-fitted on the legs of the cable which needs to be joined.

With molten metal

As a general rule, conic-shaped ferrules are used into which the cable is introduced through the smallest end, and into which a molten metal, which is usually pure zinc or a lead-antimony alloy, is poured.

This system is somewhat more laborious than the others, but it is the one which provides the highest safety rate.

In order to prepare the end fittings, the following must be done:

1. Make a splice at the end of the cable and another two at a distance slightly greater than the depth of the ferrule.
2. Remove the splice from the end and undo the wires, removing the textile core if it has one.
3. Carefully clean both the ferrule and the wires, submerging them in hydrochloric acid and lastly washing them with water.
4. Tie the wires at the end to then pass them inside the ferrule and remove the splice.
5. Empty the cast of molten metal inside the ferrule, ensuring that none of the metal leaks. The temperature of the cast must be suitable so as not to “anneal” the cable wires.

With clamps

This system is the simplest way to join cables and to form end rings or eyes.

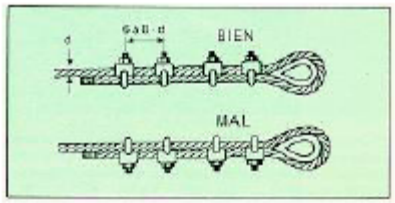
The number of clamps or cable grips to be used in each case will vary depending on whether end rings or cable connections are being formed; and according to the diameter of the cable. The following table is for guideline purposes:

Diameter of the cable in mm.	Clamps needed	
5 to 12	To form a ring	To join cables

Clamps must be suited to the diameter of the cable to which they must be applied (commercially clamps are designated by the diameter of the cable). This circumstance must be scrupulously obeyed since if a small clamp is used the cable will be damaged by crushing of the clamp. On the other hand, if a clamp or a clip is used which is too big, sufficient pressure will not be exerted on the cable legs and, therefore, unexpected slipping may occur. Meticulous compliance with the following measures is of utmost importance in order to ensure an effective, suitable arrangement of the shackles or clamps:

1. Metallic thimbles must be used to make end rings or eyes.
2. In rings or eyes, the first clamp must be located as close as possible to the corner of the thimble.
3. The separation between clamps must fluctuate between 6 and 8 times the diameter of the cable (Figure 4).

RIGHT



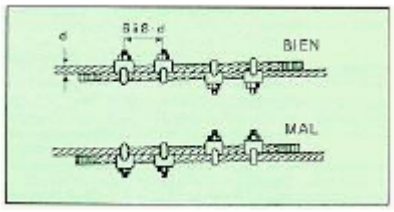
WRONG

Fig. 4: Forming a ring

4. The cable leg which works by traction must remain in the groove of the body of the clamp insofar as the inert leg must remain in the groove of the hoop.

5. The nuts for tightening the clamp must be situated on the long leg of the cable, which is the one which works by traction (Figure 5).

RIGHT



WRONG

Fig. 5: Joining cables

6. Nuts must be tightened gradually and alternatively, without over tightening. After subjecting the cable to the first load, the degree of tightening of the nuts must be checked, correcting it if necessary.

The recommendation of using thimbles when executing the end eyes or rings is due to the advisability of protecting the cable against over-bending which will occur on subjecting it to tension or load stresses. Commercially, thimbles are designated by the diameter of the corresponding cable.

Cable handling

Cables usually leave factories on rolls or coils, reels, etc, which are properly greased and protected against rusting or corrosive elements and environments.

During its transportation and storage, the roll must be prevented from rolling around the floor so that dust or stand does not stick to it which would act as an abrasive and require cleaning and subsequent greasing before its use. Neither must it receive knocks or pressure which scratch or break the wires. They must be protected from high temperatures which cause the original grease to be lost.

Cable installation

The main risk which is run on unrolling and handling a cable is that kinks, loops or bends may be formed. Consequently, when it is rolled on a drum, it is advisable to do so directly, ensuring that the cable is not dragged around the floor and maintaining the same direction on rolling it up.

Before installing a cable, it must be checked that the pulleys and drums it has to pass along have no projections or points which may damage the cable, and that the latter passes correctly round the pulleys and the drum channels. In general, operators must use leather gloves when handling cables.

Cable cutting

Before cutting a cable, the operator must ensure that it will not come unravelled, that there will be no slipping between the different layers of cords and that there is no general fraying of the cable. To this end, a series of ties must be made on both sides of the cutting point using annealed iron wire.

The following table shows the recommended data for making ties:

Cable diameter in mm.	No. of ties on each side	Length in mm.		ø of wire
		Of each tie	Between ties	
Up to 12 13 to 20				0.5 to 0.8

The methods commonly used to make the cut vary according to the place where the operators have to work and the resources available. The most commonly used are: wire cutters, electric by resistance, cutting machine or portable grinder, oxyacetylene blowtorch and electric welding.

The ends of the cables must always be protected with ties to prevent them from unravelling. On some occasions, ties are replaced by welding which joins all the wires.

Conservation and maintenance

Periodic checks

Cables must be subjected to a program of periodic checks according to the recommendations made by the manufacturer and bearing in mind the work type and conditions to which they are subjected. This examination must be extended to any elements which may have contact with the cable or impact it. It must basically comprise: winding drums, the pulleys it runs along, support rollers. The state of splices, anchoring devices, fastenings and their surrounding areas must be especially checked.

Article 103.3 of the General Regulations on Workplace Safety and Hygiene sets forth that hoisting cables must be thoroughly checked at least once every quarter.

Maintenance

In general, maintenance materializes in cleaning and greasing operations. For greasing, it is advisable to undertake thorough cleaning beforehand and then to grease the cable by irrigation as it passes along a pulley, as this makes penetration inside the cable easier. Owing to the consequences that greasing has as regards the duration of the cable, it is advisable to follow the manufacturer's instructions and to use the recommended lubricant.

Cable replacement

For cables with great responsibility such as lifts, mine shafts, cable-cars for people, etc., special regulations exist which set forth both inspections as well as replacement conditions.

In cases not subject to specific regulations, a cable must be replaced when the following can be seen:

- Cord breakage
- Knot formation
- When the loss of section of a cable cord, due to the breakage of its visible wires in a cable feedthrough, amounts to 40% of the total section of the cord.
- When the reduction of diameter of the cable at any of its points reaches 10% in cord cables or 3% in closed cables.
- When the loss of effective section, owing to breakage of visible wires, in two cable feedthroughs, reaches 20% of the total section.

Special control devices exist which detect defects which are both visible and inside cables, thus determining with certainty whether replacement is advisable or not.

Bibliography

(1) HELLMUNT ERNST
Lifting and transportation devices. Volume 1
Barcelona. Blume Publishing House, 1970
(2) INRS
Safety coefficients of cables, chains and cords
Note No. 563-49-64
(3) TYCSA
General catalogue and instruction manual
Barcelona, TYCSA, 1975
(4) NUEVA MONTAÑA QUIJANO, S.A.
Steel Cables. General Catalogue.

MINISTERIO DE TRABAJO Y ASUNTOS SOCIALES ESPAÑA

INSTITUTO NACIONAL DE SEGURIDAD E HIGIENE EN EL TRABAJO

NTP 221: Eslingas de cables de acero

Eslingues de cables en acier
Slings of steel cables

Vigencia	Actualizada por NTP	Observaciones	
Válida		Complementada por la NTP 155 y 866	
ANÁLISIS			
Criterios legales		Criterios técnicos	
Derogados: Si	Vigentes:	Desfasados:	Operativos: Si

Translation by Courtesy of IFEMA
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Introduction

The cable used to make slings must comply with the safety requirements already laid down in the preceding Technical Prevention Advice NTP-155 “Steel cables”, which complements this NTP.

When choosing cables for slings, two of the basic characteristics to be taken into account are flexibility, so that they can be adapted to the load to be lifted, and resistance both to the load by traction and to crushing.

When handling loads, auxiliary means are frequently placed in between said loads and the device or mechanism used which serve to engage them in order to facilitate their lifting or transfer, as well as making this operation safer. These auxiliary means are known as slings.

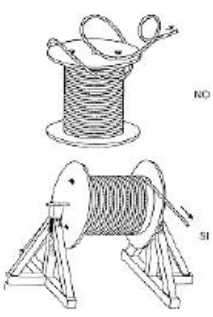
Their breakage or deficient use may cause serious or even fatal accidents owing to persons becoming trapped by the load which has broken free. It is necessary, therefore, to use suitable slings which are in perfect condition and to use them correctly. This involves training in this regard of the workers who undertake slinging and mechanical load transportation operations.

Depending on the material they are made of, slings may be cables of steel, chains or fibres, etc.

Manufacture

This begins with the unreeling and unrolling of the cable; the latter operations must be undertaken with the utmost care as if they are completed incorrectly they may lead to a loss of torsion in the cable or the forming of folds or kinks. In both cases, the effect on the cable is disastrous.

NO



YES
Fig. 1: Unreeling

Ties

Before cutting a cable, it is necessary to make ties on both sides of the cutting point in order to prevent it from becoming unravelled. In order to carry this out correctly, the following operations must be completed:

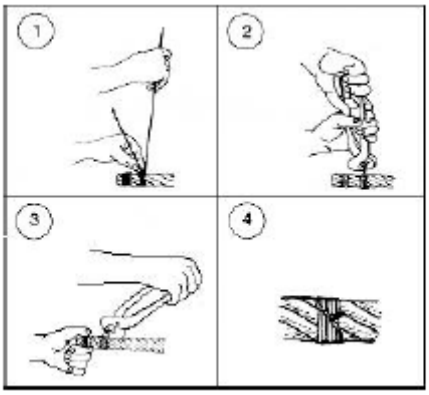


Fig. 2: Making a tie

1. Coil the tie wire by hand so that all the spires are perfectly tight and together.
2. Join the ends of the wire manually by twisting them and twist with pliers so that any slack is taken up.
3. Tighten the tie by levering with the pliers and twist the ends again. Repeat these operations as many times as necessary.
4. The tie is finished.

When ties in cables with a diameter of over 25 mm have to be made, it is advisable to use a rod or screwdriver to tighten the tie well.

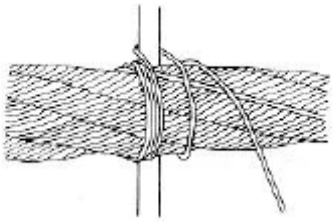


Fig.3: Using a rod to make ties

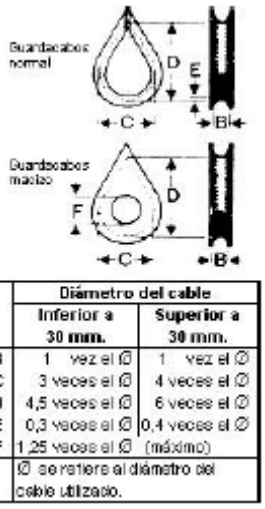
End fittings

To join cables to other devices, their ends must be given the proper shape which is usually that of an eye which can be obtained in several ways:

- Braided eye
- Eye with ferrule
- Welded end ferrule (with molten metal)
- Eye with cable grips or clamps

Eye adjustments will be fitted with resistant thimbles to prevent excessive folding under the effect of the load, which would lead to rapid deterioration of the cable. The size specifications of the thimble used must be in keeping with the diameter of the cable.

	Normal thimble	Solid thimble
	Diameter of the cable	
	Smaller than 30 mm	Larger than 30 mm
B C D E F	Once the ø 3 times the ø 4.5 times the ø 0.3 times the ø 1.25 times the ø	Once the ø 4 times the ø 6 times the ø 0.4 times the ø (maximum)
	ø refers to the diameter of the cable used	



	Diámetro del cable	
	Inferior a 30 mm.	Superior a 30 mm.
B	1 vez el Ø	1 vez el Ø
C	3 veces el Ø	4 veces el Ø
D	4,5 veces el Ø	6 veces el Ø
E	0,3 veces el Ø	0,4 veces el Ø
F	1,25 veces el Ø (máximo)	
	Ø se refiere al diámetro del cable utilizado.	

Fig. 4: Approximate criterion for choosing thimbles

Connection elements

On occasions, the sling and the means of lifting are joined by using large rings or rings, shackles or steel or forged iron hooks.

Rings must be suitably chosen depending on the loads they will have to bear.

For rings with the same material and the same straight section diameter

Round rings are the weakest	Oval rings offer average resistance	Pear-shaped rings offer the greatest resistance

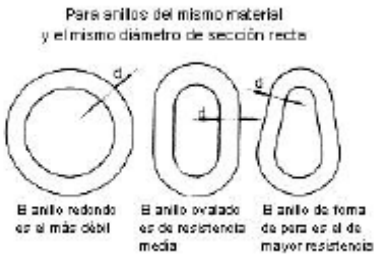


Fig. 5: Influence of the shape of rings on their resistance.

Shackles or flanges may be straight or bow-shaped and they will also be chosen in relation to the stresses they have to transmit. They will be fitted with a catch or another safety device to prevent the load from breaking free.

Main sling types

Slings will be suitably built and sized for operations they have to be used in.

Simple sling Endless sling Knot sling 2-leg sling 4-leg sling

Fig. 6: Types of slings

Other slings exist which are formed by several parallel steel cable legs which are flexibly entwined using pieces of cork forming a support band. They are usually manufactured to work with a safety coefficient of 8.

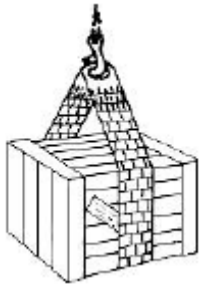


Fig. 7: Band sling (Talurit type)

Loading and unloading capacity

A sling's loading capacity involves the cable itself, the other elements which may form it, such as rings, shackles, hooks, etc, and also the type of end fitting.

A safety coefficient will also be taken into consideration which, for cables, the General Regulations on Workplace Safety and Hygiene stipulates shall not be lower than six and, according to Regulation DIN 655 "Metallic cables for cranes, lifts, rigging and similar purposes", will be from 6 to 9.

The following coefficients can be considered in the case of slings:

- For slings with a single leg. K=9
- For slings with two legs. K=8
- For slings with three legs. K=7
- For slings with more than three legs. K=6.

The load capacity "Q" of a cable will be determined by the following expression:

$$Q \leq \frac{Cr}{K}$$

Where:
Cr= Cable breakage load.
K= Safety coefficient applied.

In thin cable slings, the danger exists that they may be easily overloaded which is why it is advisable to adopt safety coefficients which are greater when the breakage load is lower.

On the other hand, it is better to use a sling which is suited to the weight to be lifted, as a sling whose load capacity over-exceeds the weight could be very rigid and does not recover on being put out of shape.

For the other elements, the load capacity will be that which results once the safety coefficient has been applied, at least five, for the maximum nominal load. It is fundamental that they keep their geometrical shape over time.

The type of end fitting also has great importance for safety as their resistance accounts for 75% to 100% of the cable breakage load.

Open type	Closed type
Forged end fitting	100%
Conic end fitting with cast zinc	100%
Clips (The number varies with the diameter)	75-80%
Thimble cpm hand covered loop	

Wedged end fitting (depends on the design) 75 – 90%

Hand-covered loop

Sturdy loop with mechanical sleeve
Diameter of 25 mm (1M) and less 95%
Diameter of 28 mm (1.1/8M) 92.5%

End fitting with thimble and pressure-fitted sleeve
Diameter of 25 mm (1M) and less 95%
Diameter of 28 mm (1.1/8M) 92.5%

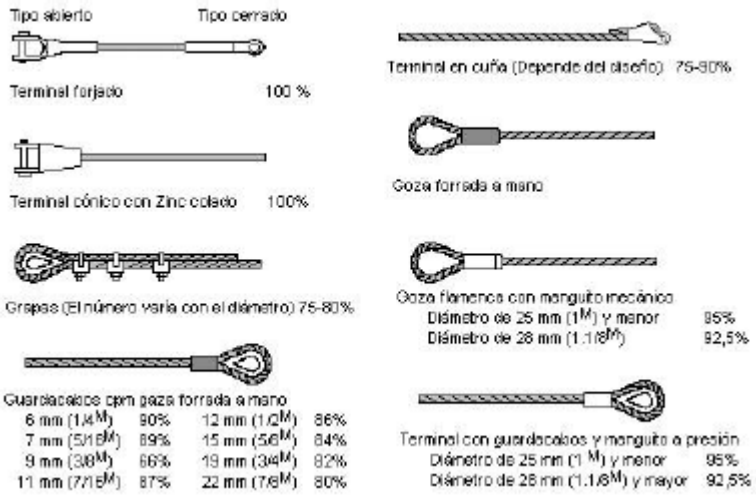


Fig. 8: Load capacity performance depending on end fitting connection

“It is more reliable to use slings manufactured by specialised companies”.

Bear in mind that the load capacity of a sling is determined by that of its weakest element. Said maximum load capacity must be marked on the sling in a clearly visible place.

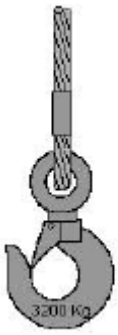


Fig. 9: Identification marked on the support element itself.

In order to determine a sling's work load, it must be taken into consideration that, when the legs do not work vertically, the stress that each leg exerts grows as the angle they form increases. In order to calculate it, the load which is borne by each leg must be multiplied by the coefficient which corresponds to the angle.

Angle between legs Coefficient
LOAD

Ángulo entre ramales / CARGA	Coeficiente
0°	1,00
40°	1,06
50°	1,10
60°	1,16
70°	1,22
80°	1,31
90°	1,42
100°	1,56
110°	1,75
120°	2,00
130°	2,37
140°	2,93
150°	3,86
160°	5,76

Fig. 10: Overload depending on the angle between support legs.

Note that over 90º, the coefficient grows at an extraordinary rate and that for an angle of 120º, the load has doubled.

Sling Use

There are numerous regulations which must be adhered to when using slings. We will explain the following:

- Safety in the use of a sling begins with its selection, which must be suited to the load and to the stresses it has to bear.
- Under no circumstances must the sling's work load be exceeded, therefore, the weight of the loads to be lifted must be known. When it is not known, the weight of a load can be calculated by multiplying its volume by the density of the material which comprises it. For practical purposes, it is worth remembering the following relative densities:

- Wood: 0.8
- Stone and concrete: 2.5
- Steel, iron, cast iron: 8

In cases of doubt, the weight of the load must be overestimated.

- In the event of lifting loads with slings in which the legs work in a tilted position, the effective load they are going to bear must be checked.
- On considering the angle of the legs in order to determine the maximum load admitted by the slings, the largest angle must be taken.
- It is advisable that the angle between the legs does not exceed 90º and, under no circumstances, must it exceed 120º. Consequently, short slings must be avoided.
- When a sling with three or four legs is used, the largest angle which must be taken into consideration is that formed by diagonally opposing legs.
- The manoeuvre load of a four-legged sling must be calculated based on the case that the total weight of the load is supported by:

  - Three legs, if the load is flexible.
  - Two legs, if the load is rigid.

- On the load to be lifted, the hooks or fastening points of the sling must not allow it to slip. If necessary, spacers, etc. must be used. At the same time, the abovementioned points must be suitably positioned in relation to the centre of gravity.
- When lifting very long pieces, it is advisable to use porticos.

Fig. 11: Portico for lifting loads.

- Sling cables must not form sharp angles when they are in operation and must be fitted with suitable thimbles.

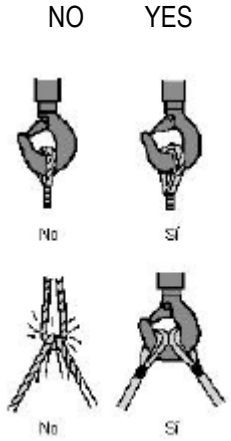


Fig. 12: Application of thimbles

- Slings must never rest on sharp edges, for which corner pieces and protection angles must be inserted.

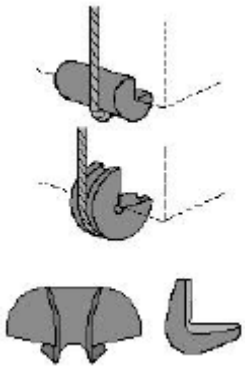
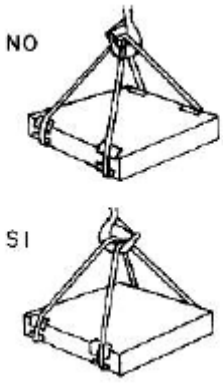


Fig. 13: Protection corner pieces.

The legs of two different slings must not cross over each other, in other words, they must not be positioned on top of each other on the lifting hook as one of the cables would be compressed by the other and may even break.

NO



YES

Fig. 14: Crossed legs must be avoided.

- Before completely lifting the load, the sling must be gently tautened and raised no more than 10 cm to check its anchoring and balance. While the slings are being tautened, neither the load nor the slings themselves must be touched.
- When a sling has to be moved, loosen it sufficiently in order to move it without it rubbing against the load.
- Never try to move a sling by standing under the load.
- You should never allow the cable to rotate on its axis.
- In the event of slings being spliced, it must be taken into consideration that the load to be lifted is limited by the least resistant sling.
- The sling must not be exposed to large thermal radiations nor reach a temperature higher than 60ºC. If the sling is made exclusively of steel cable, the temperature which should not be reached would be 80º.

Sling storage, maintenance and replacement

Slings shall be stored in a dry, well-ventilated place which is free from corrosive and dusty atmospheres.

They will not be in direct contact with the floor and will be hung from wood supports with rounded profiles or placed on posts or palettes.

Slings must not be exposed to the rigours of the sun or to the effect of high temperatures.

In order to prevent unexpected breakages, it is necessary to periodically inspect the condition of all the elements which form part of the sling.

The frequency of the inspections will be related to the use of the slings and the strictness of the service conditions. As a general rule, they will be inspected daily by the personnel who use them and every quarter at the most by specialised personnel.

Slings must be greased with a frequency which will depend on the work conditions and may be determined through inspections.

The manufacturer's instructions must be followed for greasing, and special care must be taken so that the cable core recovers lost grease. As a general rule, so that lubrication is effective, the following will be taken into account:

- Clean the cable beforehand using a brush or compressed air. The use of a solvent to remove the remains of old grease is advisable.
- Use suitable lubricant.
- Grease the cable thoroughly.

Although a sling works in optimum conditions, a time comes when its components have become weak and it must be removed from service and replaced by a new one.

The wearing out of a cable can be determined depending on the number of broken wires which, according to the OGSHT is:

- More than 10% of the same wires counted along two sections of cabling, with a separation between them of a distance of less than eight times their diameter.

A cable shall also be considered to be worn:

- On account of cord breakage.
- When the lost of section of a cable cord, due to the breakage of its visible wires in a cable feedthrough, reaches 40% of the total section of the cord.
- When a reduction in the diameter of the cable at any point on the latter reaches 10% in cord cables or 3% in closed cables.
- When the loss of effective section, owing to the breakage of visible wires, in two cable feedthroughs reaches 20% of the total section.

In addition to the abovementioned criteria for replacing a cable, it must also be removed if it shows any other defect which is considered to be serious, such as, for example, crushing, the formation of knots, kinks, etc.

A sling will also be discarded when its accessories and terminals have serious deficiencies, such as:

- Points of decay and advanced oxidation.
- Permanent distortions (bending, crushing, lengthening, etc.).
- Flattened areas due to wear.
- Cracks.
- Slipping of the cable with regard to the end fittings.
- Loose nuts.

Bibliography

1. COUNCIL DIRECTIVE of 9 November 1973: 73/361/CEE related to the approximation of legal, regulatory and administrative provisions of member states on the certificate and marks on cables, chains and hooks (D.O.C.E. 5-12-74 No. L 335/51)
2. COMMISSION DIRECTIVE of 13 April of 1976: 76/434/CEE on adaptation to the technical progress of the Council Directive, of 19 November 1973, related to the approximation of legislation of the member states on the certificate and marks on cables, chains and hooks (D.O.C.E. 8-5-76 No. L 122/20)
3. General Regulations on Workplace Safety and Hygiene (M.O. 9-3-71).
4. UNE 27-075: Joining shackles for cables and chains.
5. UNE 27-169: End fitting and steel cable connections.
6. UNE 27-171: Closed end fittings. For steel cables.
7. UNE 27-172: Open end fittings. For steel cables.
8. UNE 27-176-74: Chain slings.
9. UNE 36-710-84: Steel cables for general uses.
10. UNE 58-510-80: Cable thimbles.
11. TRENZAS Y CABLES DE ACERO, S.A.: Catalogue.
12. ARMENGOU MARSANS, Luis Mª

Slings. Communication to the talk Machines and Auxiliary Lifting Means.

Annual meeting of experts in the prevention of professional risks in companies of the S.E.O.P.A.N. Eduardo Torroja Institute, April, 1981.

13. ASSOCIATION FOR THE PREVENTION OF ACCIDENTS

Safety requirements for ropes, cables, chains, slings and rigging

CAE Group San Sebastián, 2nd edition, January, 1981.

14. ENHER

Safety in mechanical jobs.

15. HELLMUNT ERNST

Lifting and transportation devices. Volume 1: Constructive principles and elements

Translation Julio Pinto. Blume Publishing House, 1st Spanish edition. Barcelona, 1970.

16. MAPFRE

Prevention Manual for Industrial Operations

17. NATIONAL SAFETY COUNCIL

Recommended loads for wire rope slings

18. PEREZ GUERRA

Safety in building construction work

Ed. Daniel Pérez Guerra, Barcelona, 1969

19. TRENZAS Y CABLES DE ACERO, S.A.: A cable is a machine.