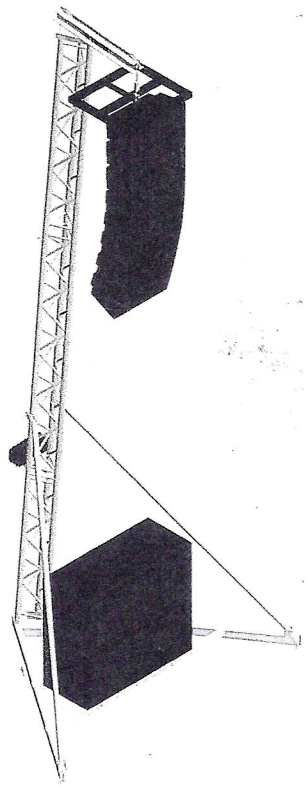
TRABES

DRAFT

CALCULATION REPORT

LIFT 6 m



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1 - Description of the structure

It deals with an inclined tower 5 ° corner compared to the vertical axis. The tower is made with Euro 29 trio truss, to which 2 tubulars are fastened, through the use of a base element. These tubes create a 70° corner and are placed as shown in the attached drawing. As head of the inclined tower, a profile with pulleys is used to lift loads up by a mechanical winch which is placed on the back of the tower. The trio trusses have 3 main tube 50 x 2 mm while diagonal tubes 20X2.0 mm and welded to main tubes. Specific bushings guarantee the structure's secure fastening. Interaxis length is equal to 23.9 cm . The structure, laying on a horizontal surface is used to lift loads up to a maximum of 300 kg.

2 - MATERIAL USED.

The structure is made of aluminium alloy AlMgSi1 known as EN AW 6082 T6 HB 90 according to UNI 9006 standard. This alloy shows a yield resistance equal to σ =2650 Kg/cmq, and a module E=700000 kg/cmq. A security coefficiente qual to υ=1.7 is considered and this is carried out as σ adm=1550 kg/cmq . Next to the weldings, the thermally altered material experiences the decline of its mechanical standard features . Therefore the remaining resistance is equal to σ =733 kg/cmq. The welding processes are performed through the use of S-Al Mg5 material, with a resistance equal to 1200 kg/cmq. Taking into account that a first class welding process is performed, the welding resistance is equal to 650 Kg/cm^2 for loading conditions I and for a head-to-head welding. While it is 480 Kg/cm^2 for fillet corner welds.

We use steel C45 for connection pin with the following features:

Yield point is equal to 7000 kg/cmq and admissible tension equal to 3500 kg/cmq.

Female and male coupler of the coupling bushing are made in aluminium alloy AlMgSi1 known as EN AW 6082 T6 HB 90 with same mechanical features of the tubulars.

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3- LOADS CONSIDERED

The calculation has been performed by considering a load rigged in vertical position equal to 300 kg plus the windspeed force both on the truss and the rigged load. Considering the selfweight of the structure, it is necessary to use steel wire ropes and/or ballasts, to avoid the structure's overturning.

4- METHOD OF CALCULATIONS

In order to carry out the calculations for this structure the Admissible Tension method was used. The calculation used for actions M T N subjected to loads is carried out in compliance with the one of a truss which undergoes pressure and bending force at a time.

5- CALCULATIONS

Geometrical features of the section:

Main tube data:

Dimensions 50 x 2 mm

Area = 3.01 cm^2 (N1)

J=8.7 cm^4

W=3.48 cm^3

Diagonal tube data:

Dimensions 20 x 2.0

Area = 1.13 cm^2 (N2)

J = 0.46 cm^4

W= 0.46 cm^3

Length = 32.25 cm

Features of the section as a whole:

Area = 9.03 cm^2

J = 600 cm^4

W = 42 cm^3

W = 72 cm^3 (upper/lower)

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Geometrical features of the conical pin:

The steel conical pin resists thanks to its shear stress resistance given by 2 cross areas with different diameter:

ϕ=8 mm

Considering diameter being 8 mm the resistant area is equal to:

A=2x0,5 =1,00 cmq (N3)

Geometrical feature of the male of the bushing:

External diameter of the tubular = 4,5 cm

Tube thickness = 0,3 cm

Total Area = $\pi\phi_1^2/4$- $\pi\phi_2^2/4$=3,95 cmq

Lost area according to hole presence = 1,0x2x0,3=0,60 cmq

Net Area = 3,35 cmq (N4)

Contact area pin-hole = 0,6 cmq

Geometrical features of the truss tubular:

External Diameter = 5,0 cm

Internal Diameter = 4,6 cm

Total Area = 3,01 cmq

Hole Area = 1,0x2x0,2=0,4 cmq

Net Area =2,61 cmq (N5)

Contact Area pin-hole = 0,4 cmq (N6)

Considering these features and the admissible tensions, it is possible to carry out as a result the normal maximum stress of the single components of a truss.

N1=3,01x 733=2206 kg	(main tube traction)
N2=1,13x733=828 kg	(diagonal tube traction)
N3=1,56x3500/1,73= 3156 kg	(steel pin resistance)
N4=3,555x1550=5502 kg	(bushing – male – resistance)
N5=7,61x1550=11795 kg	(bushing – female – resistance)
N6=1,68x480 = 3072 kg	(bushing – female – resistance to bearing stress)
N7=6,4x480=3072 kg	(welding resistance)

According to the mentioned calculations the maximum resistance is equal to:

Mmax=Wx733 = 45666 kgcm

Maximum effort to traction of the truss is equal to :

N=3X2206 = 6616 kg

The shear stress maximum resistance is equal to:

Tmax=2xN2*sin45*sin60 = 1014 kg

STRESS CALCULATION.

WINDSPEED RESISTANCE VALUE IS CARRIED OUT THROUHG THE FOLLOWING STANDARDS **UNI ENV 1991-2-4 DEL 31/03/1997 Titolo "Eurocode 1. Action on structures. Parte 2-4: Action on structures – Wind actions."**

Accidental load due to wind:

Prif=V^2/1,6=17,35 kg/mq (Vrif=16,66 m/s)

We assume as a coefficient of the site Ce=1.75.

Maximum horizontal load on rigged loads is assumed to be P_1=prif*Ce*1,2 = 36,43 kg/mq

Maximum horizontal load on trusses is assumed to be P_1=prif*Ce*2,4 = 72,86 kg/mq

ANALYSIS OF LOADS ON THE TOWER

Self-weight	:	10	kg/m
Horizontal load of the wind	:	10,9	kg/m
Windspeed on 2 mq	:	72,86	kg
Rigged Vertical load	:	50	kg

STRESS CALCULATION CONSIDERING SPAN OF 4.5 M

Normal effort considers self-weight and rigged load.

N=pp+F=4,5*10+50=95 kg

Bending moment due to windspeed force on the truss

M1=10,9*4,5^2/2=110,4 kgm

Bending moment due to windspeed on rigged load:

M2=72.86x(4,5-0,7)= 277 kgm

Bending moment due to eccentricity of load over the truss base.

M=100 x e=50x0,7=35 kgm

Most disadvantaging condition undergoes therefore the following stress:

Nmax=95 kg

M=422,4 kgm

CHECKING THE TRUSS TO STRESS

CHECKING TRUSS TO NORMAL EFFORT

$\sigma = N/A = 10.6$ kg/cm$^2 < \sigma_A$

CHECKING TRUSS TO BENDING MOMENT

$\sigma = M/W = 1005.0$ kg/cmq$< \sigma_A$

CHECKING TRUSS TO COMBINED COMPRESSIVE AND BENDING STRESS

$\sigma = N/A + M/W = 1016$ kg/cmq$< \sigma_A$

EULER'S TEST TO INSTABILITY

$P_{cr} = \pi^2 EJ/l_0^2 = 5117$ kg (considering 4 m height)

$P_{cr}/3 = 1706$ kg

INSTABILITY TEST

$\omega = f_y/\sigma_{cr} = 4.13$

$\psi = (1-1{,}5N/N_{cr}) = 0{,}97$

$M_{eq} = 0{,}75 \times M = 317$ kgm

$\sigma = \omega N/A + M_{eq}/\psi W = 178 + 577 = 755$ kg/cm$^2 < \sigma_A$

6 Calculations results by electronic machine

With reference to the Italian original file, page 8 to 59

7- LIMITATIONS OF USE

Cesena li' 20/05/2012

OGGETTO: BUILDING LIFT 6 M

The undersigned Eng. Genghini Enrico, registered engineer to the certified engineering order in Forlì, has his office in Cesena, Via Tarantelli Ezio n.54, loc. Borello, appointed by the manufacturing company (TRABES Srl), here declares that:

1) he has carried out all the needed static calculations of the structure mentioned in the current certification, and that he checked its stability.
2) According to calculations the structure can be used, considering the following **limitations of use**:

- Windspeed loads carried out as follows:
  - Vrif)=16,66 m/s, ce =1,75 (exposure coefficient), cd=1.0 (dynamic coefficient), cf=1,2 (form coefficient for windspeed on vertical surfaces) , cf=2,4 (form coefficient on vertical surfaces on truss). NORME UNI ENV 1991-2-4:1997
- No load or stress depending on snow or earthquake.
- Vertical maximum load is equal to 300 kg, meant as static and vertical. Load must not overcome 2,0 mq in the front and 1,5 mq in the side .
- Rigged load must be static and there must be no oscillation.
- During tower use, people must stay out of the eventual overturning distance (6 m).
- For loads which are different to the mentioned ones or for exceeding surfaces a new static report needs to be carried out by a skilled and allowed technician.

- Structure must always work on a solid and perfectly horizontal ground. At this regard we must clarify that the load on each of the basis truss reaches 400 kg in case of wind.
- For windspeed exceeding 60 km/h (16,67 m/s) structure becomes unstable. Therefore the rigged load must be immediately placed on the ground. It is necessary that a skilled technician is constantly taking care of the structure while working.
- It is compulsory to use ballasts on the basis (steel cable to avoid structure's overturning, can be a solution). The attached drawing for loads and ballasts is to be checked on the basis of the place where the structure is working.
- The structure must be strictly assembled following Trabes srl's manual instructionsand ONLY using components manufactured by Trabes Srl.
- Make sure you follow the regulations in force, according to assemby/disassembly process (Here you are some of the most important regulations D.P.R. 164/56 , D.P.R. 547/55, Legge 494/96 , Legge 626/94)
- Make sure you use the safety clothes and instruments: safety helmets, safety shoes, safety belts.
- Considering this is a metal structure, make sure you comply with the local regulations in force. (A titolo indicativo si ricorda la Legge 1086/71)
- Before assembling the structures, make sure you have all the necessary permission documents of the local authorized bodies.
- Before starting the assembly process, make sure you have checked the integrity of each component. If you see any deformation, crack, or any other sign of structural failure, do not start assembling the tower. In this case you must replace the failing elements.
- In some countries, the structure may need a certification of "correct assembly", written by any authorized technician but the undersigned engineer.
- During tower assembly/disassembly, people must stay out of the eventual overturning distance (7 m).

- As any other temporary structure, the tower must be regularly checked. If no extraordinary maintenance occurs, normal structural life is equal to T=3 years. (UNI standard).
- Basically, a metal structure should be tested and verified by a skilled and authorized technician, once a year.

The authorized technician