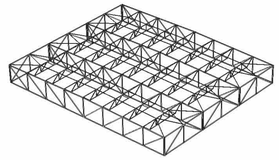
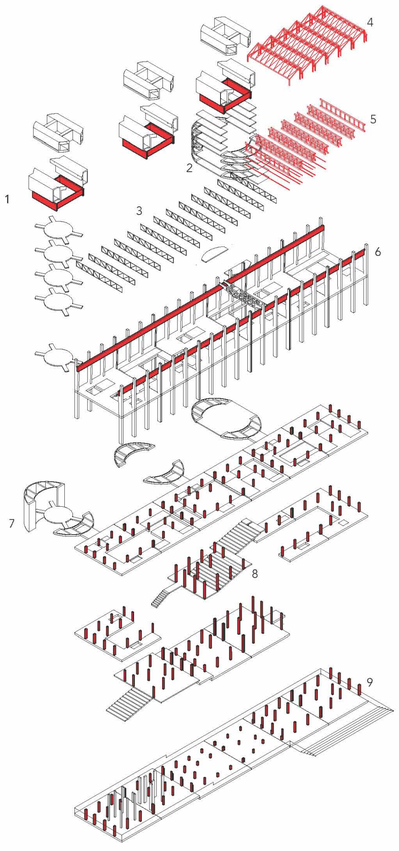
The comprehension of the existing roof helps served as a guide to design the new one. It is based on a system of light trusts beams that are stabilized by the triangulation at the sidelines and in every vertical upright of the main trust beam. The new design reduces at the half the amount of steel required thanks to a more efficent triangulation and beams sections.



Existing roof structure



STRUCTURE

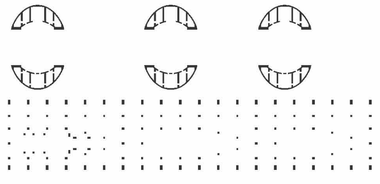
The building is constructed of concrete poured on site. Due to its especial condition as military target it was designed to resist much more than standard constructions.

The floors are soported by a grid system of pilars with quite generous spans. The roof is construct of a steel beam that spans the 33m of the portico. There are other systems of pilars for the machinery which are removed except in the case of the turbine #1.

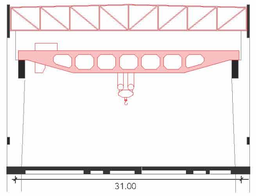
The floors in the towers are hanging from the beams (1) once where use on the towers' construction process. The tower is based on two concrete screens stabilized at the top by a crossed beam system. The loads are brought to the ground through a huge concrete slab together with 30 meter long piles.

The new floors added on the portico structure of the nave are of two types. In the lower floors they are connectd to the existin pilars and their spans are maximum of 14 meters. Do to new load some of the existing columns might be reinforced. The box that is placed in the turbine gallery is based on a system of virendeels that generates column free floors and the top some columns hold the light roof.

Structure defines the spaces



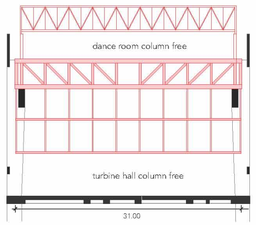
Actual loads dstribution



Roof: 29,4 T
Crane: 32,6 T
Bridge weight: 83,4 T
Load capacity: 180 T

TOTAL: 325,4 T

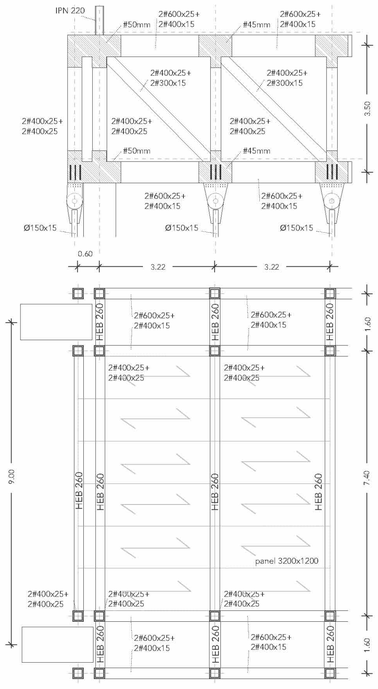
New loads dstribution



Roof: 35,3 T
Steal structure: 61,4 T
Floors: 224 KN (56Tx4)

TOTAL: 318,7 T

Structural elements dimension



Dimension plywood panels

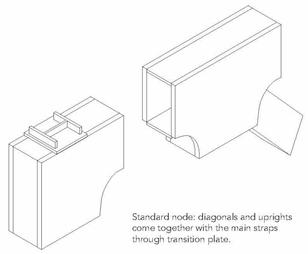
Standard model KERTO-RIPA Panell 1.200mm wide
Rafter de 45 mm and panel 27 mm thickness
According to catalog: 3.5 m span = rafter height 120 @ 600

advantatges:
height package optimization for 3,22 m span
efficient relation load capacity /weight
fire resistance
easy construction
thermal insulation and acustic isolation

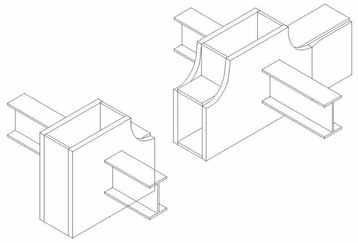
Dimension floor beam HEB

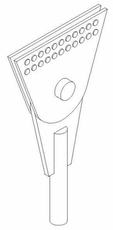
- Estat de càrregues
Coeficients de majoració d'esforços CP = 1.33 i N = 1.5
Ample de banda = 3.22 m (HEB més desfavorable)
CP = 100 kg/m² x 3.22 = 322 Kg/m
322 kg/m x 1.33 = 428 kg/m = 0,428 T/m
SU = 500 kg/m² x 3.22 = 1.610 kg/m
1.610 kg/m x 1.5 = 2.415 kg/m = 2.42 T/m
TOTAL (CP + SU) = 0.42 + 2.42 = 2.84 T/m
- Càlcul del mòdul resistent
Moment màxim aplicat sobre el perfil a conseqüència de la càrrega distribuïda
Mmàx = (q · l²) / 8 = (2.84 · 7.35²) / 8 = 19,1 T·m = 19.1 x 10^5 kg·cm
fy = 2.600 kg/cm2 (tensió de l'hacer)
y = 1.05 (coeficient de minoració de la capacitat resistent del material)
W = (1.05 · 19.1 x 10^5 · 1.5) / 2.600 = 1181 cm³ = HEB 260 (prontuari)
- Fletxa maxima admissible
L / 250 = 735 / 250 = 2.94 (OK)

Junction roof's column-virendeel

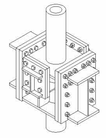


Standard node: diagonals and uprights come together with the main straps through transition plate.

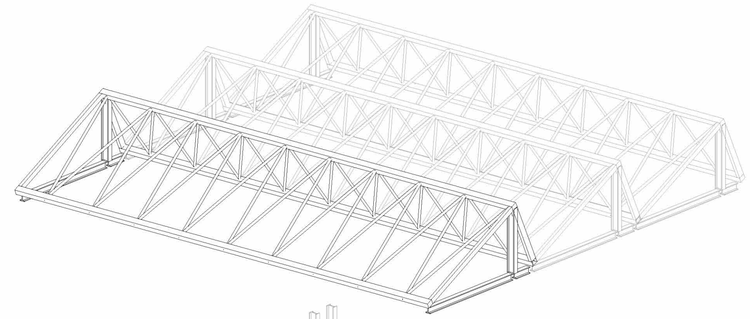


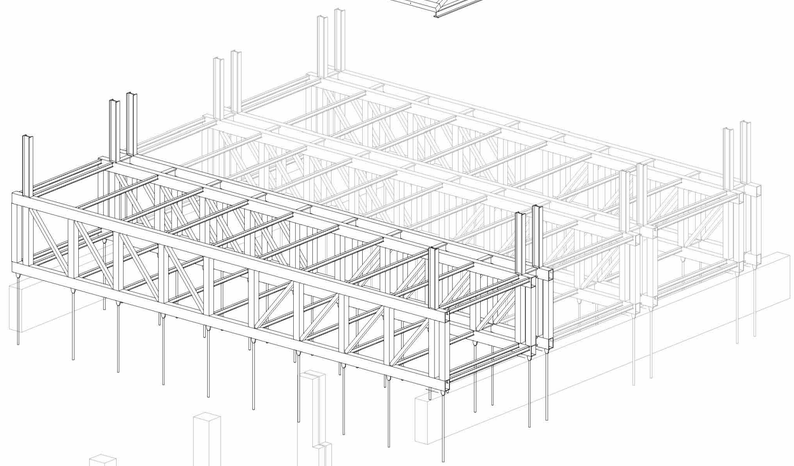


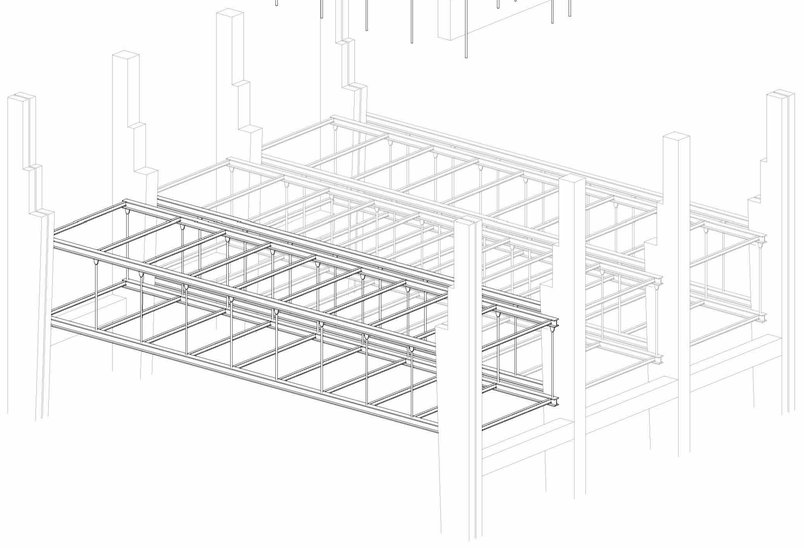
Union of brace with straps through an oversized pin.



Standard node: brace with floor beams.







Dimensionat main portico

A_Correja superior

Estat de càrregues forjat A TOTAL= 600 kg/m²
Pes propi= 50 kg/m² (forjat KERTO fusta laminada)
Càrregues permanents = 50 kg/m²
Sobrecàrrega d'ús = 500 kg/m²

Qt muntants intermitjos correja superior:
Q1= 0.6T x 3.22 (dist. entre muntants) x 9 = 17,3 T

Estat de càrregues coberta TOTAL= 330 kg/m²
Pes propi= 100 kg/m² (forjat KERTO fusta laminada)
Càrregues permanents = 50 kg/m²
Sobrecàrrega d'ús = 40 kg/m²
Sobrecàrrega de neu = 40 kg/m²

Qt muntants extrems correja superior:
Pes Coberta = 35.3 T / 4 pilars = 8.8 T
Q2 = 8.8 + 17,3 = 26,1 T

B_Correja inferior

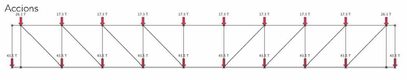
Estat de càrregues forjat B,C,D TOTAL= 500 kg/m²
Pes propi= 50 kg/m2 (forjat KERTO fusta laminada)
Càrregues permanents = 50 kg/m²
Sobrecàrrega d'ús = 400 kg/m²

Qt correja inferior:

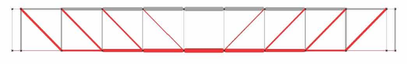
Q1= 0.5T x 3.22 (dist. entre muntants) x 9 = 14,5 T
14,5 x 3 forjats = 43,5 T

Steel is preferable. Webbing of ijoints eaier, also extra plating or haunching is eaciser, plus fabrcation

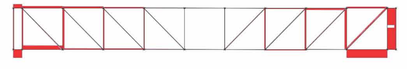
Accions



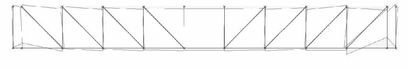
Axils



Tallants

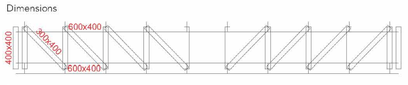


Moments

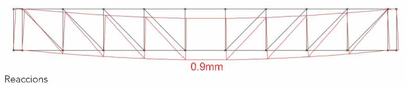


Results
Tensions màximes = 2561,1 kg/cm² < fy acer 2.600 kg/cm² (OK)
Fletxa màxima: 1/3729 < 1/500 (OK)

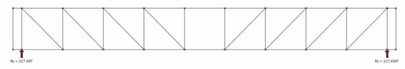
Dimensions



Deformada



Reaccions



Tensions