



2EN

renewable energy
services & applications

2EN Lattice 750/600 Triangular Hybrid Tower



Lattice Meteorological Towers

The lattice tower design was implemented using CAD CAE technology.

Modelling design and assembly as well as finite element analysis techniques were integrated within NX platform provided by Siemens.

The software is equipped with NX - Nastran Solver which is widely used for the finite element analysis.

These techniques improve the design and optimize the strength of the components for the specific system development. All 2EN towers are certified for Eurocode compliance.

The lattice tower is designed to withstand wind velocities of more than 40m/sec with icing.

- Optimum Reliability
- Special study proposed

In high altitude areas, (> 1000) the heavy snowfall during the winter might build ice over the guy wires, which results in heavy loading of the anchors and the lattice structure. During the winter, the lattice tower should preventively be visited following extreme events to ensure its stability and operability.

Several other heights of aluminum lattice tower could also be manufactured.

Altitude (m)	750/600mm lateral length
0-600	Available up to 101m
600-1200	Available up to 80m
	Available up to 95m
1200-1500	Available up to 59m
	Available up to 65m
1500+	Available up to 59m



750/600mm Lattice tower design

Property	Value
Density	2.70 g/cm ³
Melting Point	605
Modulus of Elasticity	70 GPa
Electrical Resistivity	0.034x10 ⁻⁶ Ω.m
Thermal Conductivity	188 W/m.K
Thermal Expansion	24x10 ⁻⁶ /K

Mechanical properties and design limits

The whole structure is manufactured out of aluminum alloy 6005, aged with T6 heat treatment and electro-statically painted in red RAL3020 and white RAL9010 seaside class according to Civil Aviation authority rules.

Lattice sections

The lattice tower sections are built by three columns fixed with circular bars forming a collateral cross section of either 750mm or 600mm wide.

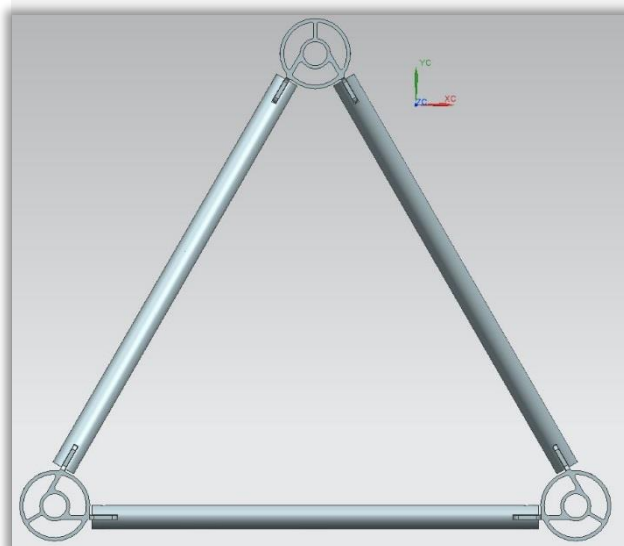
Each 2EN lattice 750mm and 600mm section is 3m long and weights approximately 66kg and 55kg respectively.

The new aluminum 2EN lattice 750 and 600 section models are brand new design all from scratch. These new towers feature new heavy duty column profiles with round reinforced geometry and round geometry reinforced bars.

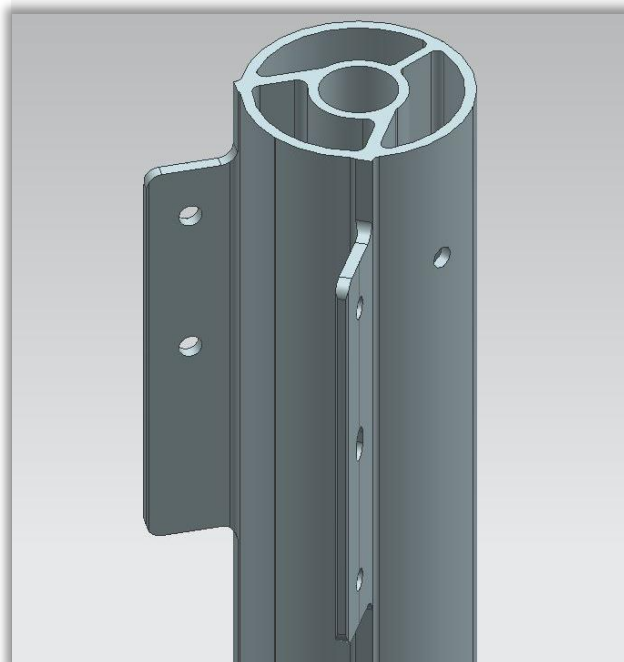
Profiles and machining

The column profile is made with extrusion molding and is afterwards CNC machined in order to remove all unnecessary geometries that would increase the tower solidity and would affect the wind flow over the construction.

With this technology there is no need for welding and all the members are assembled using bolts.

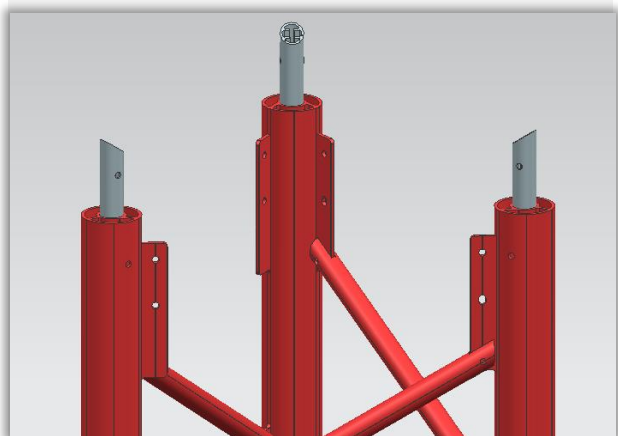
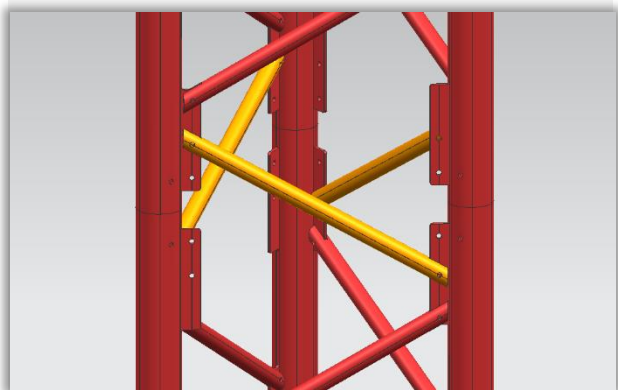
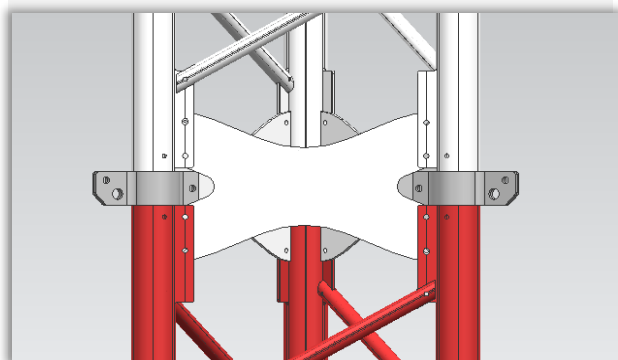
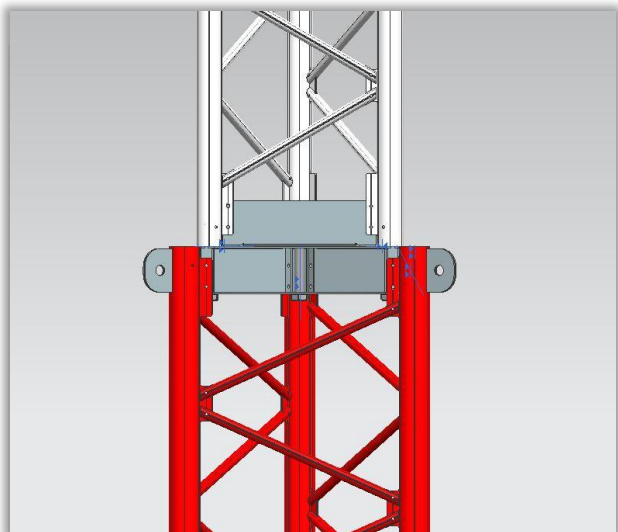


Lattice tower cross section



Column profile

750/600mm Lattice tower design



Section connection patterns

The sections, where a guy wire level is attached, are connected to each other with three aluminium plates (one per side).

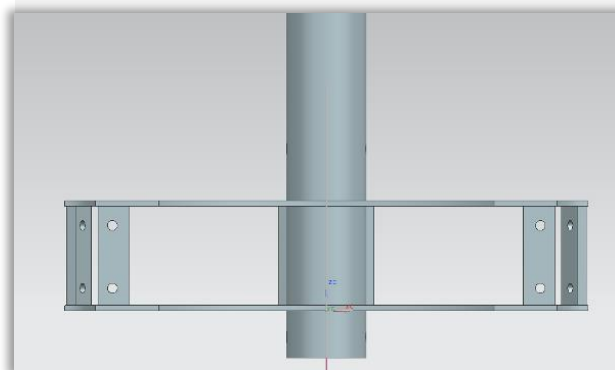
All the other sections are connected using internal connecting rods, which are used for reinforcing the section connection.

Although all the sections have the same geometry, two of them are different.

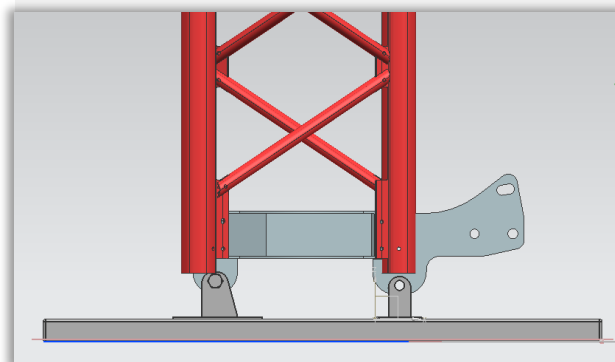
The one is equipped with the gin pole hinge, which is obviously the one that has to be mounted on the base plate.

The other section is equipped with an adaptor for $\Phi 70$ tube and is mounted as the top section.

For compliance with the new ISO 61400 -12 -1 edition 2.0/2017 standard, the top adaptor is telescopic.



Top Adaptor

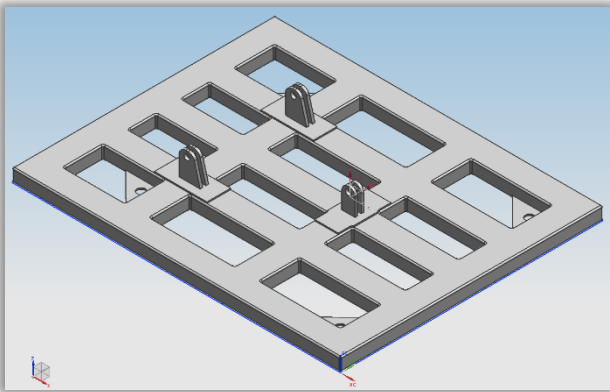


Base Hinge

750/600mm Lattice tower design

Base plate

The tower base plate is welded made of st37 steel rectangular profiles 100x50mm with 5mm wall thickness. At the corners of the base plate there are holes for anchoring.



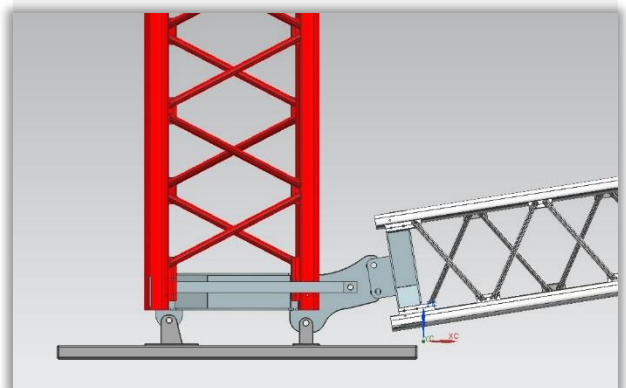
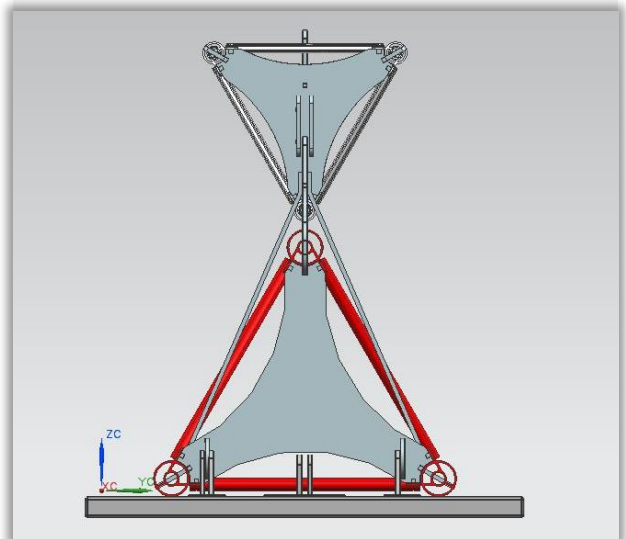
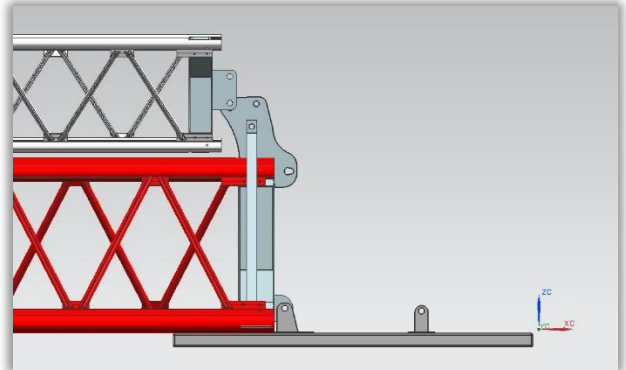
Gin pole

The gin pole consists of 2EN-LAT500 sections. Each section is either 3.0 meter long depending on the gin pole length. The gin pole is connected to the main mast base hinge using a special adapter attached to its bottom.

Guy Wires

The guy wires are made of galvanized steel of cross-sections of 8mm & 10mm and a steel core (type 1X7) of ultimate tensile strength 1770 MPa.

Guy wires are attached to the gin pole during tower erection. When the tower is erected, the gin pole guy wires are transferred to the back anchors.



750/600mm Lattice tower design

Tilt up erection and Anchors layout

The anchors are placed in three concentric circles of 20m, 30m and 40m radius where the center of each circle is the base of the lattice tower.

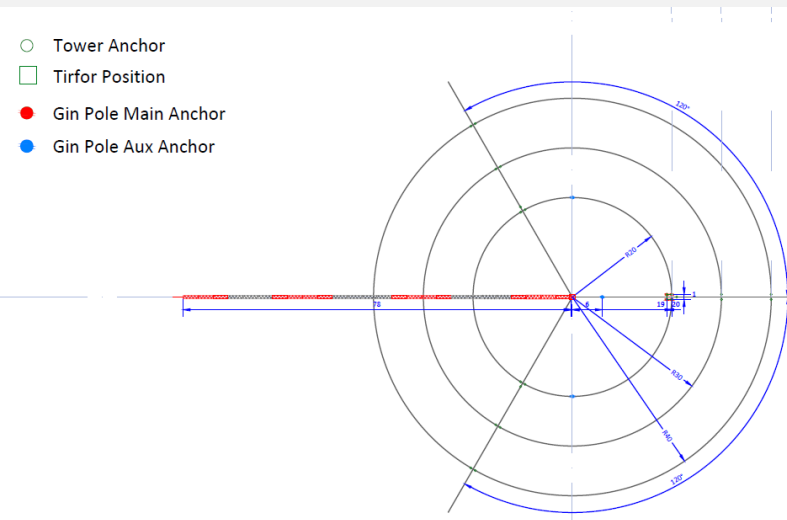
Adjacent anchors form 120° angle and should not exceed a $\pm 2^\circ$ orientation tolerance.

One of the main characteristic of this tower, due to the lightweight of the aluminum profiles, is the tilt up erection method.

The tower can be erected using a gin pole and handheld tools without the need of a crane or trained climbers.

For the 80m model, the tower erecting winch (or tirfor) should have pulling capacity of 6.5 tons (max), at least more than the tilt up force, which is approximately 5.5 tons.

The lift anchors, where the gin pole is mounted, are placed $20\text{m} \pm 0.5\text{m}$ from the tower base, opposite the spread out lattice mast as shown in the schematic.



2EN LAT750/600-80 Anchoring layout

2EN recommends double anchors per tirfor for safety reasons.

All installation components (Eye links, shackles of Ω type, tensioning devices, etc.) must be provided by 2en in order to have the right specifications.



750/600mm Lattice tower design



Certification

2EN is ISO 9001 certified for the design & manufacture of lattice towers and holds a certificate of conformity of the factory production control.

The tower construction has been studied and verified using finite element analysis (FEA).

Every part is verified and checked separately and the whole structure has been certified for euro code compliance.

This construction is made to withstand very high winds with 10 minute average higher than 50m/sec which leads to gusts over 80m/sec at the top of the mast.

The tower is certified according to the following standards and their Greek annexes where applicable.

■ Eurocode 1.

EC1PART1.4En1991-1-4 Wind Actions,
EC1 PART1.3 En 1991-1-3 Snow Loads.

■ Eurocode 3.

EC3 PART3.1 1993-3-1 Towers and Masts,
EC3 PART3.11 1993-1-11 Design of structures with tension elements.

■ Eurocode 8.

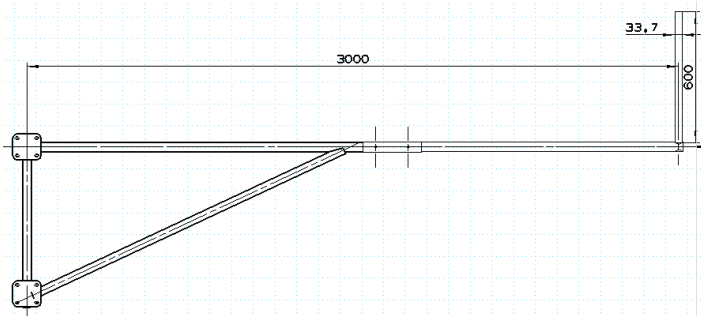
EC8 1998.06 - Design of structures for earthquake resistance - Part 6: Towers, masts and chimneys.

■ Eurocode 9.

EC9 Aluminium structures.

■ **BS EN 795** - Protection against falls from a height - Anchor devices - Requirements and testing.

750/600mm Lattice tower design



Booms

According to IEC 61400-12 Annex G iso-speed plot, with local speed normalised by free - field wind speed, of flow round triangular lattice masts analysis by two dimensional Navier-Stokes computations, a wind speed deficit of 99% for a lattice tower of $C_t:0,5$ will reduce the distance R to 3,7 times the mast leg distance.

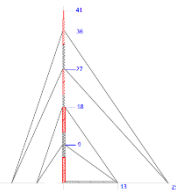
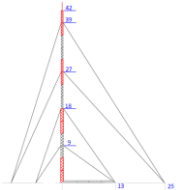
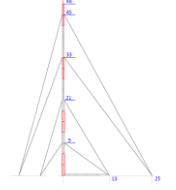
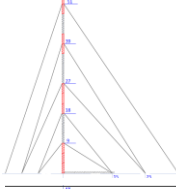
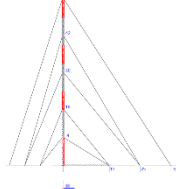
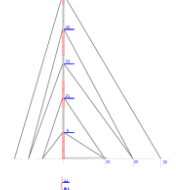
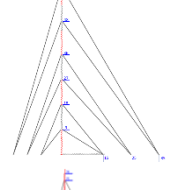
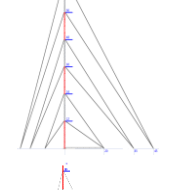

For a 99,5% centre line wind speed deficit and $C_t=0,5$, a boom mounted anemometer should be no closer than 5.7 tower leg from the centre of the tower.

At the same time, the boom must remain stable, so that it does not oscillate. With analytical computation taking into account the solidity of the tower the thrust coefficient is $C_t=0.30$ (for 750mm sections) and $C_t=0.33$ (for 600mm sections).

The booms are mounted on 600mm sections. So for a sensor distance to the centre of the tower over 3100mm, the centre-line wind speed deficit U_d is below 0.5%.

A 3.0meter boom mounted on one of the three columns of the tower results a distance from the tower center equal to 3.2-3.3 meters depending on the orientation angle.

Available models

Models	3m sections	3m section incl. adapter for 3m tube (70mm)	Levels of guy wires	Gin pole type	Total structure weight	Schema
2EN-LAT750/600 41m	6 – Lat750 6 – Lat600	1	4	12m Lattice (500mm)	1260 Kg	
2EN-LAT750/600 44m	6 – Lat750 7 – Lat600	1	4	12m Lattice (500mm)	1330 Kg	
2EN-LAT750/600 50m	7 – Lat750 8 – Lat600	1	4	12m Lattice (500mm)	1470 Kg	
2EN-LAT750/600 56m	6 – Lat750 11 – Lat600	1	5	15m Lattice (500mm)	1670 Kg	
2EN-LAT750/600 59m	6 – Lat750 12 – Lat600	1	5	15m Lattice (500mm)	1730 Kg	
2EN-LAT750/600 62m	7 – Lat750 12 – Lat600	1	5	15m Lattice (500mm)	1820 Kg	
2EN-LAT750/600 65m	9 – Lat750 11 – Lat600	1	6	15m Lattice (500mm)	1890 Kg	
2EN-LAT750/600 80m	8 – Lat750 17 – Lat600	1	6	18m Lattice (500mm)	2230 Kg	
2EN-LAT750/600 95m	6 – Lat750 24 – Lat600	1	8	21m Lattice (500mm)	2900 Kg	



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