

# 2EN Lattice 500 Triangular Tower



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 (formerly known as Unigraphics).

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 euro code 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)	500mm lateral length				
0-600	Available up to 80m				
600-1200	Available up to 50m				
	Available up to 65m				
1200-1500	Available up to 35m				
	Available up to 50m				
1500+	500+ Available up to 35m				



Property	Value		
Density	2.70 g/cm3		
Melting Point	605		
Modulus of Elasticity	70 GPa		
Electrical Resistivity	0.034x10-6Ω.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 6000, 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 2en lattice 500 tower sections are built by three columns fixed with circular bars forming a collateral cross section of 500mm wide. Each section is 3m long and weights 35kg.

This new tower features a new heavy duty column profile 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

# 500mm 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

**2EN LATTICE 500 TRIANGULAR TOWER SPECIFICATIONS** 

# **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 tubes 152mm or 203mm diameter, depending on the tower height being erected. Each tube is either 3.0m or 2.2 meter long depending on the gin pole length and diameter.

For higher masts, the gin pole consists of 2EN-LAT470/500 lattice sections of 3.0 meters 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 a cross-section of 8 mm and a steel core (type 1X7) of ultimate tensile strength 1570 or 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.



# Tilt up erection and Anchors layout for 50m mast

The anchors are placed in three concentric circles of 13m, 20m and 26m radius where the center of each circle is the base of the lattice tower.

Adjacent anchors form  $120^{\circ}$  angle and should not exceed a <u>+</u>  $2^{\circ}$  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 50m model, the tower erecting winch (or tirfor) should have pulling capacity of 6.5 tons, at least more than the tilt up force, which is approximately 3.5 tons.

The lift anchors, where the gin pole is mounted, are placed  $12.2m \pm 0.5m$  from the tower base, opposite the spread out lattice mast as shown in the schematic.



2EN recommends double anchors per tirfor for safety reasons.

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



ERECTION LOAD	Gin Pole 8.7m TUBULAR 152mm	Gin Pole 12.2m TUBULAR 203mm	Gin Pole 14.2m TUBULAR 203mm	Gin Pole 18.0m LATTICE 470/500 mm
LAT500 35/38/ 41/44	2.1† - 3.1†			
LAT500 50/53		3.0t - 3.3t		
LAT500 59/65			3.2t - 3.7t	
LAT500 71/80				4.5t – 5.5t

# 500mm 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 designed according to the following Eurocodes 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.

# 500mm Lattice tower design







### Booms

According to IEC 61400-12 Annex G isospeed 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 Ct: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 Ct=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 Ct=0.30.

So for a sensor distance to the centre of the tower over 2750mm, the centre-line wind speed deficit Ud is below 0.5%.

A 2.5meter boom mounted on one of the three columns of the tower results a distance from the tower center equal to 2.7-2.8 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-LAT500 35m	10	1	3	8.7m tubular (152mm)	680 Kg	10. 10. 10. 10. 10.
2EN-LAT500 38m	11	1	3	8.7m tubular (152mm)	750 Kg	-33
2EN-LAT500 44m	13	1	4	8.7m tubular (152mm)	880 Kg	
2EN-LAT500 50m	15	1	5	12.2m tubular (203mm)	1050 Kg	
2EN-LAT500 59m	18	1	5	14.2m tubular (203mm)	1190 Kg	
2EN-LAT500 65m	20	1	6	14.2m tubular (203mm)	1280 Kg	
2EN-LAT500 71m	22	1	6	18.0m lattice (470/500mm)	1450 Kg	
2EN-LAT500 80m	25	1	7	18.0m lattice (470/500mm)	1680 Kg	





www.2en.com e-mail: info@2en.com