Communication Tower

Developed by: IT +46
Goals

• To understand the basic process of erecting tower/masts from start to finish
• Gain useful knowledge for decision making in terms of types of towers, tools, time planning etc.
• To be aware of the greatest risks involved in erecting towers/masts
Table of Contents

• Standards, definitions and types of towers/masts
• How to choose a tower style
• Practical implementation
  – Concrete base with re-bar cage
  – Assembling of tower (inspection, pre-assembly, gin pole)
  – Guy wires (pre-load, plumb, termination)
• Climbing (equipment, safety)
• Lightening protection (rods and surge arrestors)
• Corrosion
Standard

• Structural Standards for *Steel Antenna Towers and Antenna Supporting Structures* (ANSI/TIA 222-F-1996)

• Published by TIA (Telecommunications Industry Association)

• Provides a set of minimum criteria for specifying and designing steel antenna towers and antenna supporting structures.

• Includes regulations concerning wind loading, paint, guys, foundations, bolt tightening, climbing and maintenance.

• Approx. 100 USD (highly recommended to purchase)
Tower or Mast?

- American English: All structures are **towers**
- British English: All structures are **masts**
- Engineering definition:
  - Tower: A self-supporting structure
  - Mast: A structure supported by stays or guys
Monopole

- Urban environments
- Limited space needed
- Max. footprint of a 200 ft monopole is approx. 6x6 ft (2x2m)
- Expensive
Self Supporting Tower

- Constructed without guy wires
- Larger footprint than monopoles
- Smaller footprint than guyed masts
- Commonly seen in urban areas
Guyed Mast

• Secured with guy wires that are anchored in a set of concrete bases on the ground
• Largest footprint, but
  – can be taller than a non-guyed tower
  – allows larger antenna load
• Rural areas
How to choose a Tower Style?

- Antenna load
- Tower footprint
- Height of tower
- Budget
The Tower Base

• Self supporting tower
  – One central base

• Guyed mast
  – One central base
  – Three-four bases for guy anchors
Digging the hole

- Undisturbed soil
- Larger volume than expected
- Sharp edges
- Good tools
  - Backhoe
Building a Re-bar Cage

• To give the concrete the tensile strength it needs to support the load of the tower
• Two layers of re-bar grids (bottom/upper)
• The layers are joined together with standees
• All re-bars **must not** be in contact with other material than concrete
  – Will cause corrosion which weakens the re-bars
Re-bar Cage with Standees
J-bolts as Anchor
Concrete Foundation

- The hole is filled up with concrete
- Concrete must be of good quality
- Concrete must be filled with an accurate method
- Concrete must “dry” in a correct way
Concrete Composition

- Paste (water and cement) and aggregates
  - 10-15 % cement
  - 60 - 75 % aggregate
  - 15 - 20 % water
- Portland cement is the most common type
- Hydration is the chemical reaction that makes the paste harden and gain its strength
Mixing Water

• Clean water: no taste or odor
  – Impurities will affect the setting time, the concrete strength, may cause efflorescence and staining
  – Additionally, it may cause corrosion of the re-bar structure which will cause volume instability and reduced durability

• Upper limits for the level of chlorides, sulphates, alkalis, and solids in mixing water
Aggregates

- The type and size of aggregates affects the thickness of the concrete
- Aggregates are inert granular materials such as sand, gravel, or crushed stone
Mixing and Pouring

- Choose equipment according to size
  - By hand or machine?
- Use a tamping/vibrating tool to remove air pockets
Hydration

• A chemical process between the paste and the aggregates which requires **time** and **water**
• Concrete continues to gain strength though hydration as long as it stays moist
• When it gets dry, the hydration process stops and the material does not gain any more strength
• Never put stress on a moist concrete (<10 days)
Curing

• Curing is a process that aids the hydration of the concrete

• Keep concrete moist with a temperature of 50-75°F (10-24°C)

• A correct curing process in essential for the quality of the concrete

• Good curing implies that evaporation of water should be prevented or reduced
Assembling the Tower/Mast

• Inspection of hardware
• Pre-assembly sections
• Assembly tower sections
  – Gin pole vs crane
• Guy cables
  – Termination
  – Pre-load and tension measurement
Inspection

- Bent or twisted sections or braces
- Gaps, flakes or separations in the galvanizing
- Missing assembly bolts
- Improperly drilled bolt holes
- Legs that you cannot see light through which are clogged with debris
- Rust that is more than light surface rust.
- Legs that have been repaired or welded to other than the original factory brace and joint-sleeve.
Pre-assembly

- Pre-assembly tower sections on the ground
- Install the **guy attachment points**
- Pre-cut and mark each guy cable
- Pre-install the **guy grips** on one end of each guy cable
- Install all bolts with the nuts on the inside of the tower
Assembly low tower: Gin Pole

• Tool for lifting tower sections on top of each other
• Typically a long piece of metal tubing with a pulley in the top with a set of ropes attached to it
• Mounted at the top of the last tower section
  – By pulling ropes from the ground, the gin pole allows to lift up a tower section above the top section
• Braided (not twisted) ropes are recommended
• TIA/EIA-PN-4860 - Gin Poles
Assembly High Tower

- Using a crane is an obvious must
Guy Cables

- EHS Steel Guywire
  - most commonly used
- Phillystran
- Pultruded fiberglass
Pre-load (initial tension)

• A pre-load of approx. 10-15% of the ultimate breaking strength should be applied to guy wires

• Pre-load will stretch out the slack

• The amount (lb/kg) depends on the type of guys used and how high up in the tower/mast they are attached

• Too large pre-load will reduce the ability to absorb additional load (from the tower moving) before the guy reaches its breaking strength
Rule of the thumb for Pre-load
Termination of guy cables

- Dead ends
- Thimbles
Tightening of guy cables

• Turnbuckle

• Guy wire tension gauge
Plumbing the tower

• Bob plumb
Climbing

• Training and equipment
Climbing

• Do not be cheap when it comes to climbing equipment. One mistake might be one too much!
• Do not use leather belts as leather can dry out and become seriously weakened
• Climbing gear must be comfortable to wear for long periods as you will probably be up in the tower for many hours
• Try to keep all equipment as light as possible
Climbing

A rule of the thumb:

“A person with no climbing experience, should not climb a tower higher than he/she can survive of a possible fall to the ground”
Lightening Protection

• A must for any structure elevated above the surroundings

• Lightening is a common enemy to wireless installations in high structures and must be prevented as far as it can

• Direct and indirect hits
Lightening Protection: Direct hits

• Franklin rods properly grounded to the base
• If the lightening hits the tower itself (or the equipment) there is very little that can save it
• Low resistant cable (copper or other conductive material) should be used
• Feed lines and guy cables should also be grounded
Lightening Protection: Indirect hits

• Induction currents (indirect hits) through nearby lightning strike can cause damage to outdoor radio equipment
• Can be prevented by using surge protectors to vulnerable equipment
• Choose radios that have a higher voltage rating
• Surge protectors does not protect the antenna, only the radio
Corrosion

• An attack on material though a chemical reaction with the environment
• Air (oxygen), water and chemical substances can cause corrosion
• Implies deterioration of useful properties in the material and is something you want to avoid to all price
Corrosion

- Cathode

- + Anode

Reduction

Oxidation
Corrosion Prevention

• Antioxidant joint compound
  – Finely divided metal particles (zinc or copper)
  – A durable grease (based on silicone or petroleum)

• Cathodic protection
  – Sacrificial anode that is higher on the galvanic series than the material you want to protect
Conclusions

• Type of tower/mast depends on antenna load, footprint, height needed and budget
• A base of high quality is essential for a stable tower with a long lift time
• Good planning, experienced crew and good equipment is the key to success!