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 (equipent, 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**
- Brittish English: All structures are **masts**
- Engeneering 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 supporing tower
  - One central base
- Guyed mast
  - One central base
  - Three-four bases for guy anchors

Digging the hole

- Undirsturbed 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 cemical 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

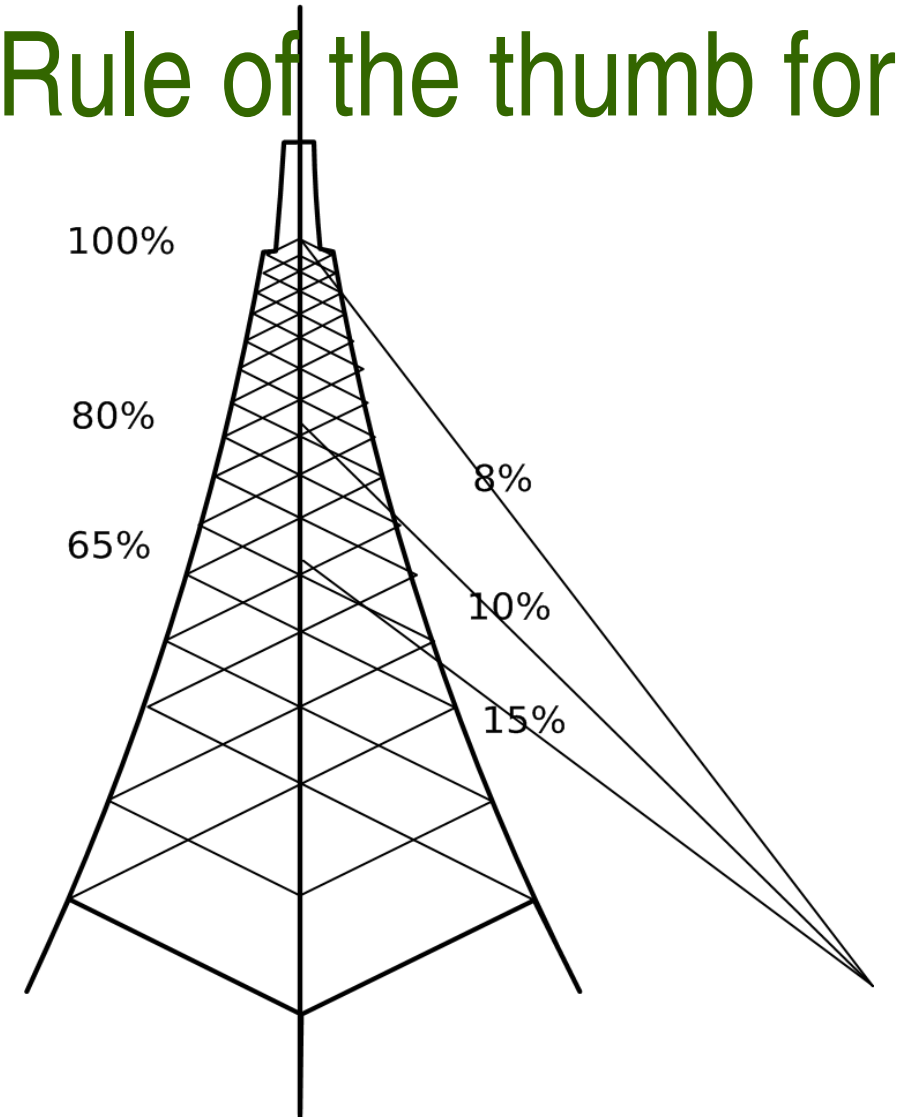
Guy Cables

- EHS Steel Guywire
  - most commonly used
- Phillystran
- Pultruded fiberglass

Pre-load (initial tension)

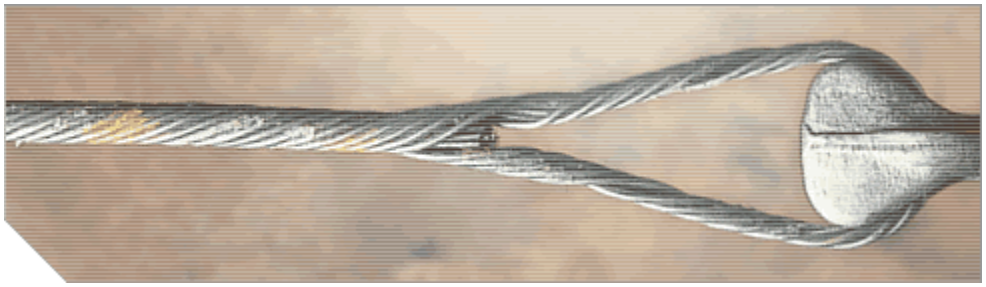
- A pre-load of approx. 10-15% of the ultimate breaking strength should be applied to guy wires
- Pre-load will stretch out the slack
- The amount (lb/kg) depends on the type of guys used and how high up in the tower/mast they are attached
- Too large pre-load will reduce the ability to absorb additional 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 probable 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

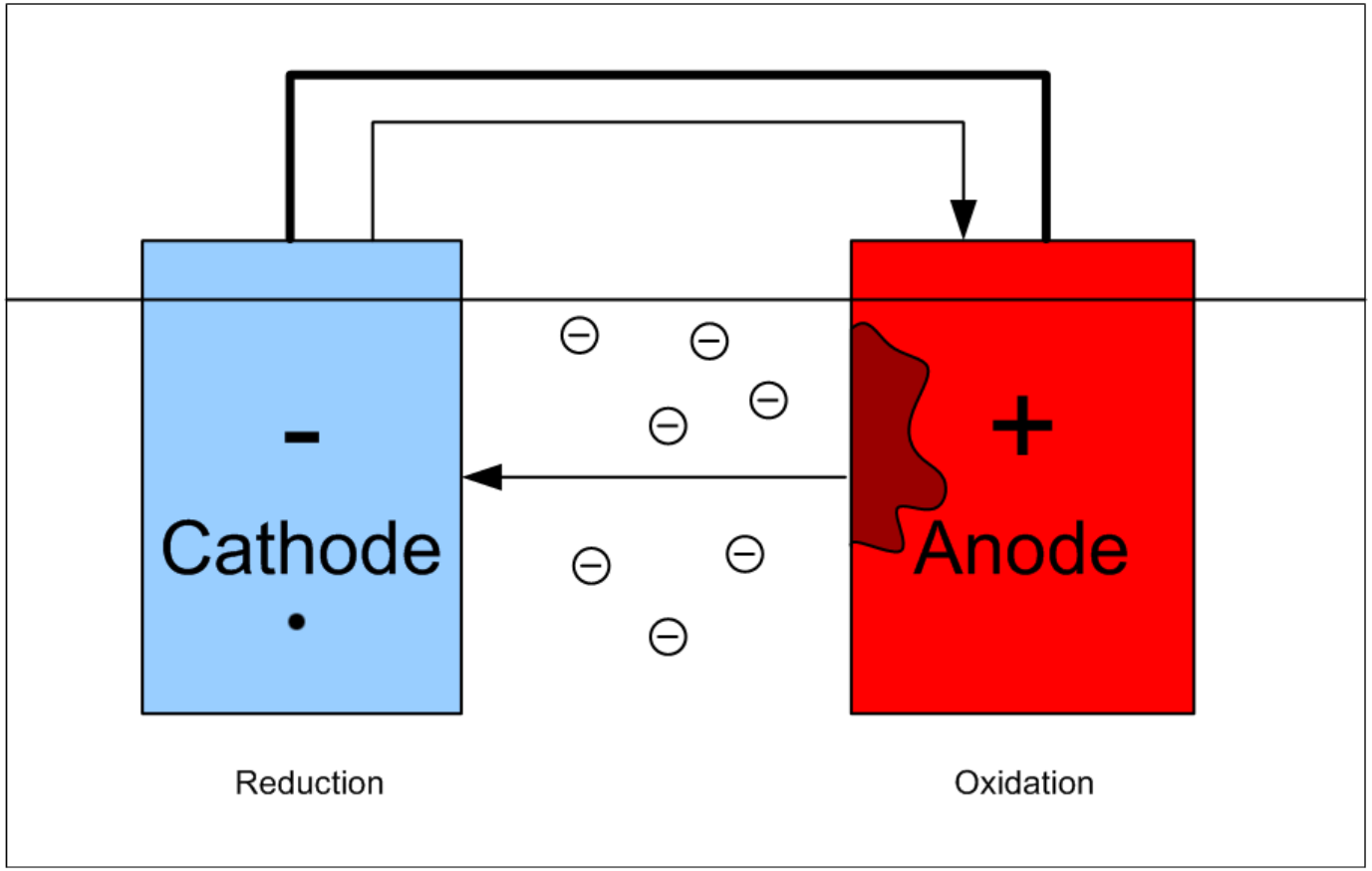
Lightening Protection: Indirect hits

- 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



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!