Data for foundation structure analysis

This document provides lines of directions for:

- Extreme and fatigue loads on foundation unit
- Dimensions for the bottom of the tower
- Lines of directions for necessary soil investigation
- Foundation design assistance

1. Extreme and fatigue load data

Dependent on tower height and the acceptable wind condition, the foundation loads will be different. It should be noticed that the survival wind speed is normally determining the extreme bending moment on the foundation unit and thus determining the foundation design.
In the following the main design parameters for the acceptable wind classes are outlined:

Tower height	Maximum acceptable peak wind speed	Maximum acceptable mean wind speed (Rayleigh distribution)
[m]	[m/s]	[m/s]
40	64	9.3
30	59	9.3
30 (USA)	67.1	9.3

The following documents are the applicable foundation load documents for the different tower heights:

40 m tower height: N29-40-FoundLoads-01.pdf

30 m tower height: N29-30-FoundLoads-01.pdf

30 m tower height (USA): N29-30-USA-FoundLoads-02.pdf

2. Tower bottom dimensions

The tower bottom is available in one option: A double-sided bottom flange. The following contains a description of the general dimensions for the two towers and some notes on the foundation design.

Option 1: A double side flange.

The foundation is either made with a cast in steel section or with long cast in bolts (threaded bars) with an anchor ring in the bottom.
If the type of foundation with long cast in bolts is used the tower has to be mounted in to stages seperated by the curing time of the under cast material. Stage 1: The tower bottom section is placed on nuts screwed onto 3 of the cast in bolts. The tower section is then leveled out and secured with upper nuts and under cast is made except in the 3 places with nuts. After curing the nuts are removed and

under cast is made in these 3 places. Stage 2: All the nuts can now be tightened and the upper section(s) of the tower can be mounted.

The dimensions for the tower bottom flange for this option are given below. In figure 1, an example of a tower bottom is shown for reference.

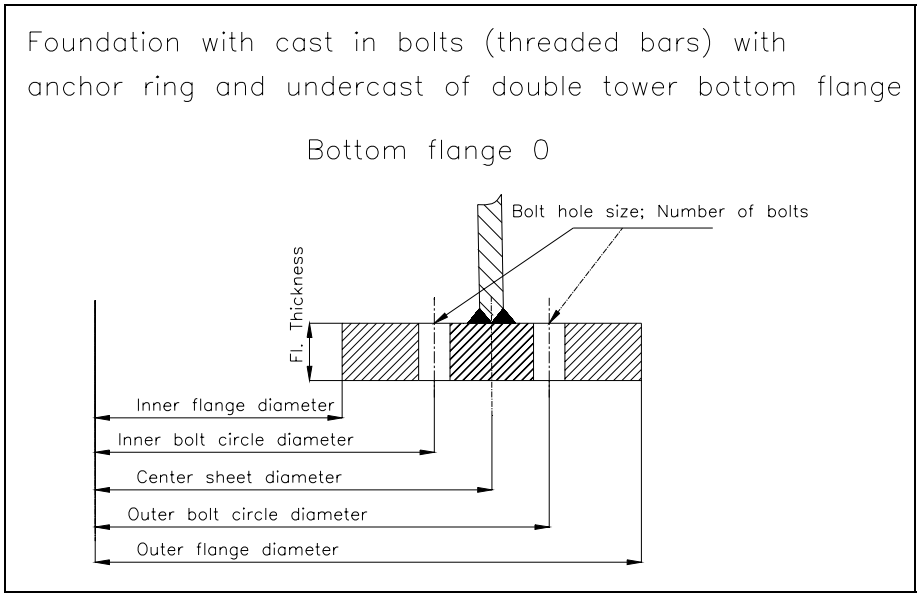

Figure 1. Example of bottom flange showing the double-sided bottom flange

Norwin 29 – 40 m tower; double flange bottom dimensions:	
Inner flange diameter:	2990 mm
Inner bolt circle diameter:	3090 mm
Center sheet diameter:	3190 mm
Outer bolt circle diameter:	3290 mm
Outer flange diameter:	3390 mm
Flange thickness:	45 mm
Number of bolts:	2 x 60 = 120
Bolt hole size:	Ø 33 mm
Flange steel type:	ISO-S275J2G4 / ASTM A-36
Bolt type:	M30-xxx-8.8-HDG (Hot Dip Galvanized)

Norwin 29 – 30 m tower; double flange bottom dimensions:	
Inner flange diameter:	1970 mm
Inner bolt circle diameter:	2090 mm
Center sheet diameter:	2190 mm
Outer bolt circle diameter:	2290 mm
Outer flange diameter:	2410 mm
Flange thickness:	40 mm
Number of bolts:	2 x 48 = 96
Bolt hole size:	Ø 33 mm
Flange steel type:	ISO-S275J2G4 / ASTM A-36
Bolt type:	M30-xxx-8.8-HDG (Hot Dip Galvanized)

Norwin 29 – 30 m tower (USA version); double flange bottom dimensions:	
Inner flange diameter:	1970 mm
Inner bolt circle diameter:	2090 mm
Center sheet diameter:	2190 mm
Outer bolt circle diameter:	2290 mm
Outer flange diameter:	2410 mm
Flange thickness:	40 mm
Number of bolts:	2 x 60 = 120
Bolt hole size:	Ø 33 mm
Flange steel type:	A709 GR50
Bolt type:	M30-xxx-8.8-HDG (Hot Dip Galvanized)

Lubrication of bolts before tightening: Molycote
Tightening torque for class 8.8 bolts with above lubrication: 1000 Nm

3. Lines of directions for necessary soil investigation

The normal information needed for the foundation design regarding soil conditions is described in the following list. It must however be emphasized that a geotechnical expert with knowledge on the local conditions always must be involved to evaluate if special things should be taken into consideration.

1. Drilling to 6-7 m (20-23 feet) dept to clarify the soil layers.

2. Bearing capacity of the different soil layers:
   Sand - Friction angle fi (deg)
   Clay - Cohesion measured by an un-drained shear strength Cu (kN/m^2)
   or the bearing capacity directly if other methods are used.

3. Effective weight density of the different soil layers (kN/m^3)

4. Effective weight density of filling soil if excavated soil cannot be used as backfilling

5. Ground water level - assumed maximum is essential

6. Drainable capacity of the ground after installation of the foundation.

7. If the soil is weak and a pile foundation is necessary, the assumed pile length and bearing capacity for pressure and tension is needed

4. Foundation design assistance

Norwin can in many cases (not USA) through our specialized consultant assist with dimensioning and design layout of foundation if all necessary information is available, and if it is within the normal range of foundation types. In figure 2 a design example for a foundation is shown.

The estimated price for this work is 8000 EURO per foundation design to be paid in advance.

In case of seismic activities in the area of erection, it is always necessary to have a local expect involved in the design, or to have a company with knowledge in the local conditions making the foundation design.

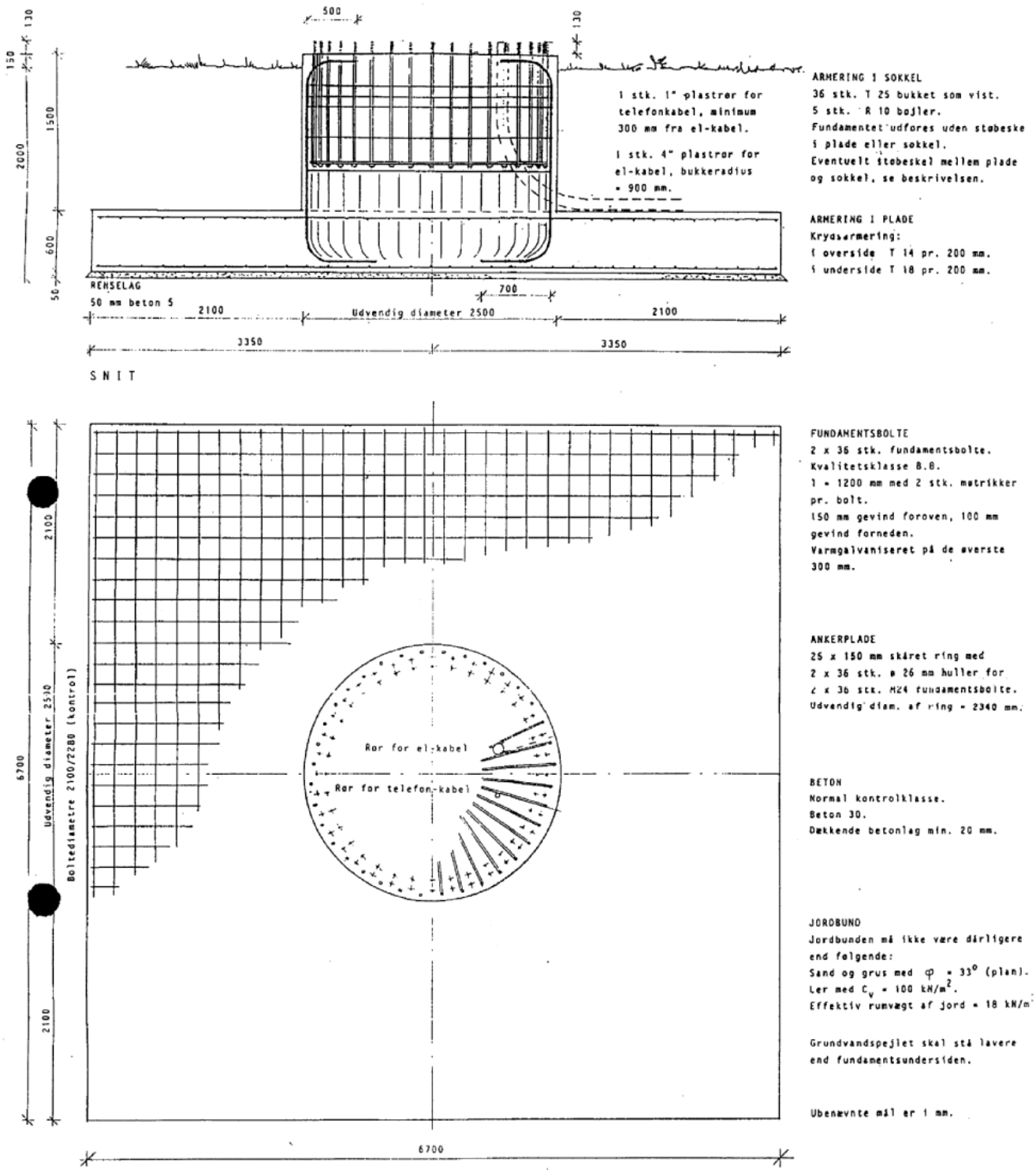

Figure 2. Example of foundation design