FOUNDATION
project for
SMALL WIND TURBINE TUGE 10

Project client:

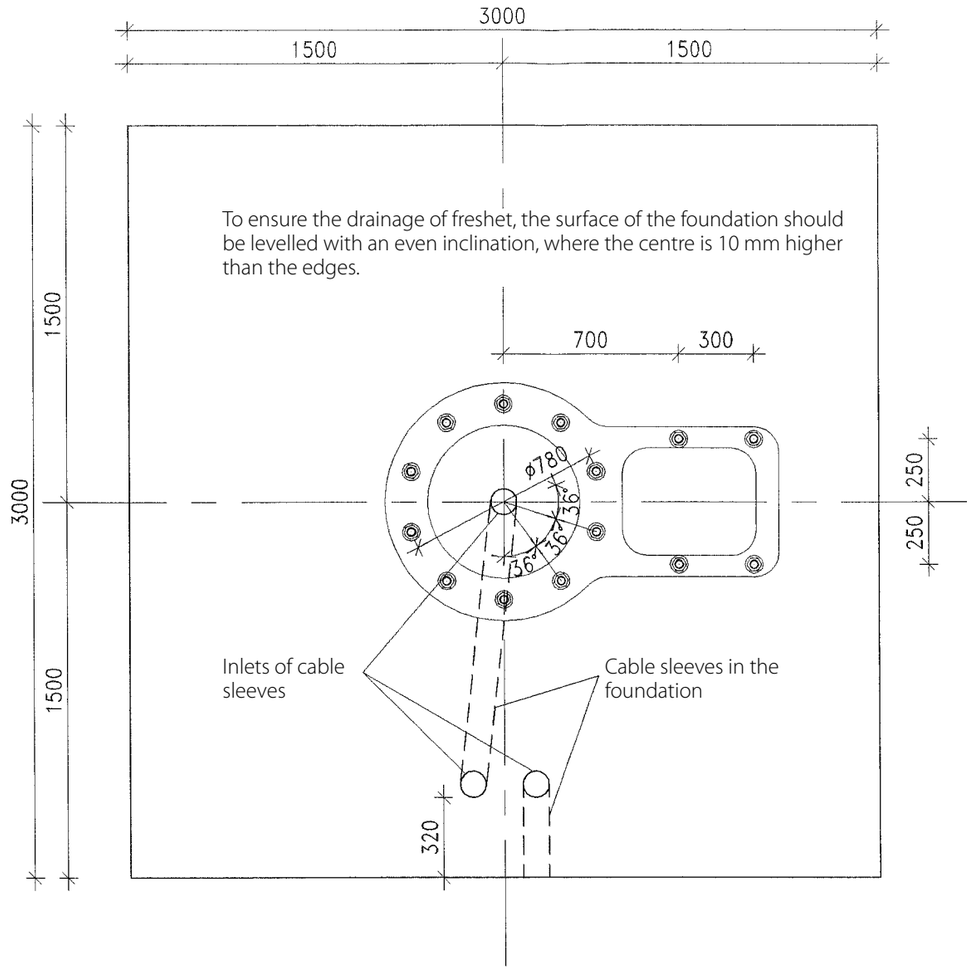
Konesko AS

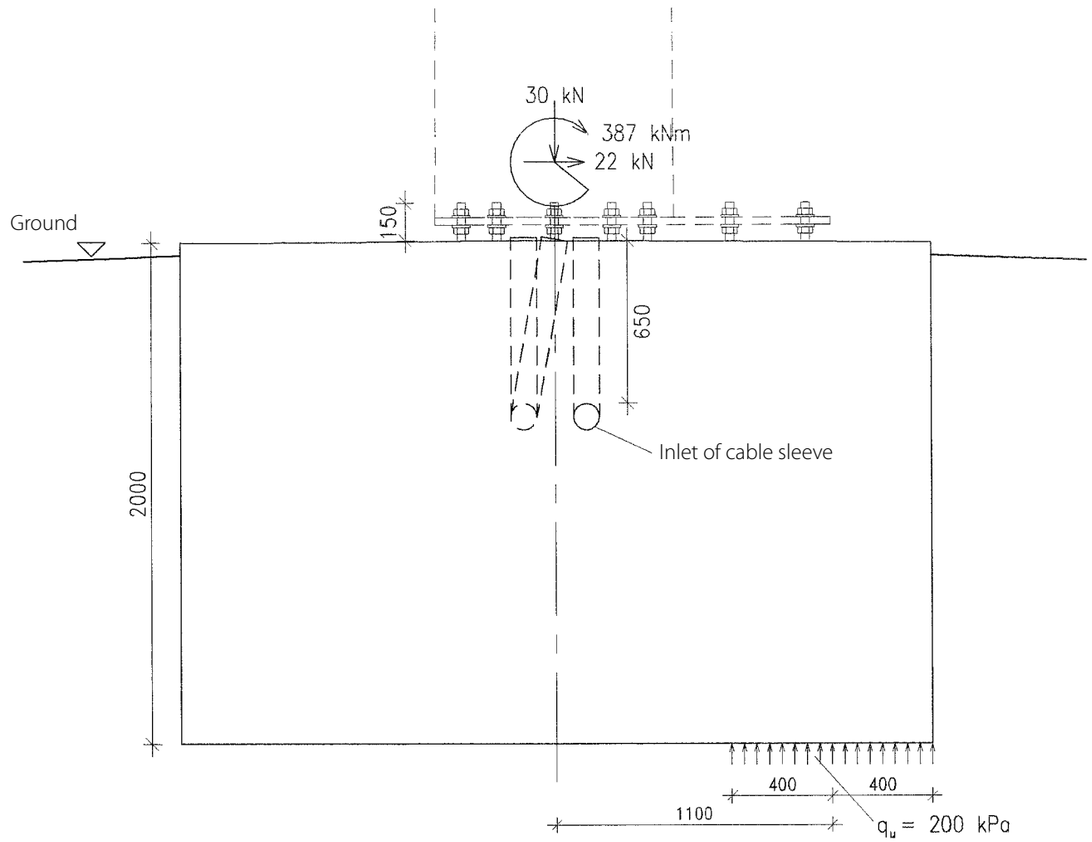
Project planner:

Johannes Pello IB OÜ
Reg. no.: 11131550
MTR EEP 000494
Project no. 15-2012

/Johannes Pello/

Tallinn, July 2012



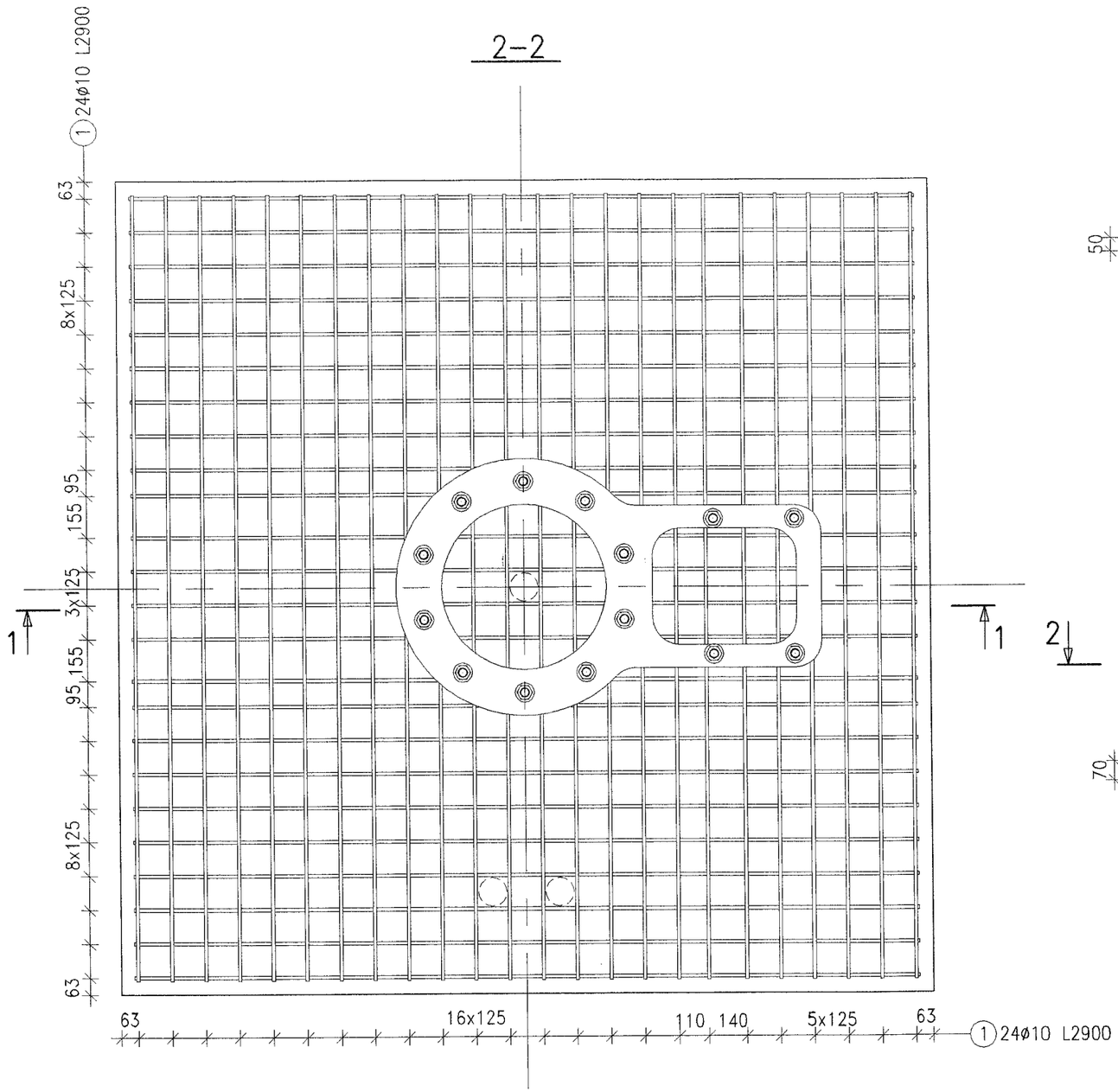


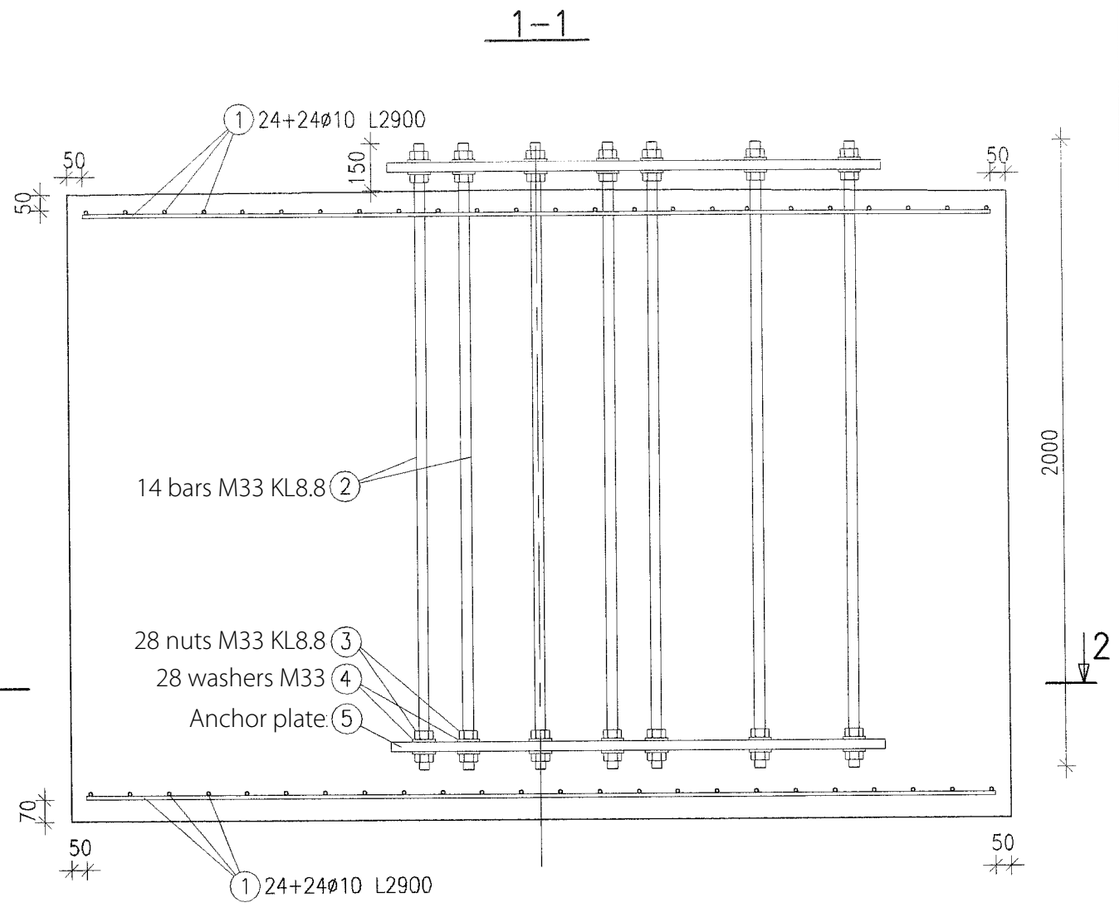
Notes:

1 A 5 to 10 cm consolidated sand base to be laid under the foundation, consolidate up to 80 MPa on the modulus of elasticity.
2 Foundation made of concrete C25/30 XC2 (EVS-EN 206:-1:2001)
3 Volume of concrete in the foundation - 18.0 m3.
4 Armature B500B (EVS-EN 1992-1-1:2007).
5 Concrete protection layer of the armature under the foundation 70 mm, in other areas 50 mm.
6 Anchor bolts M33 KL8.8 L=2000, upper 25 cm of the bolt hot-galvanized.
7 For cable sleeves Ø 100 plastic-sewerage pipes should be used.

This type of foundation can be used in areas where the calculated load bearing capacity of the ground under the footing is at least 200 kPa (2 kgf/cm^2) and the level of the surface water is 0.5 m lower than the footing.

Client: Konesko AS Object: FOUNDATION OF SMALL WIND TURBINE TUGE 20	Date: 27.07.2012 Project no. 15-2012
Design: VIEW FROM THE TOP, SIDEVIEW	Drawing mark EK-01 Scale 1:25 Stage TJ
Project planner: Johannes Pello (signature)	Johannes Pello IB OÜ, MTR EEP 000494





Armature and anchor details specifications

Pos.	Cross-section and steel	Mass per meter (kg)	Length (mm)	Mass (kg)	Amount (pcs)	Total mass (kg)
1	Ø10 B500B	0.616	2900	1.79	96	172
2	Bar M33 type 8.8	5.549	2000	11.10	14	155
3	Nut M33 type 8.8				56	
4	Washer for bar M33				56	
5	Anchor plate – see detail drawing G20-VL001					

Client: Konesko AS
Object: FOUNDATION OF SMALL WIND TURBINE TUGE 20

Design: REINFORCING, ANCHORING DETAILS

Date:	27.07.2012
Project no.	15-2012
Drawing mark	EK-02
Scale	1:20
Stage	TJ

Project planner: Johannes Pello (signature)

Johannes Pello IB OÜ,
MTR EEP 000494

Explanatory letter

The foundation of the small wind turbine TUGE 20 has been designed as a massive (bock) foundation, with planned dimensions of 3000 x 3000 mm and height of 2000 mm. On the surface of the foundation other equipment requiring concrete base are installed, besides the mast (mast lifting devices, electrical panels).

The foundation will be laid of concrete C25/30 (environmental class XC2. Near the upper and lower edge of the foundation an armature mesh 10/10/125/125, made of armature steel B500B will be installed. The mast of the wind turbine will be fixed to the foundation with 14 threaded bars M33 x 2000, with strength class 8.8, reaching out of the upper surface of the foundation for 15 cm and penetrate the foundation, reaching 15 cm out of the lower surface of the foundation.
Due to its massiveness (the height is two-thirds of the length and width), the strength of the foundation as well as the reinforced concrete, is guaranteed. The fixity of the foundation against tipping over must be checked. Such calculation is given below.

According to the wind turbine manufacturer, the wind turbine will impose on the foundation

- vertical force V= 30 kN,
- horizontal force H= 22 kN and
- bending moment M= 386 kNm

The bending moment and the horizontal force, imposed by the wind turbine, will try to tip the wind turbine over. Total tipping over moment

$$M_{dst} = 386+2.00x22 = 386+44 = 430 \text{ kNm}.$$

Counteracting the tipping over is the moment imposed by the foundation net weight and the vertical load of the mass.
The foundation net weight (the volume weight of reinforced concrete 25 kN/m^3)

$$G = 3.00x3.00x2.00x25 = 450 \text{ kN}.$$

The vertical force of the net weight and the wind turbine adds up to

$$N_{stb} = G + V = 450 + 30 = 480 \text{ kN}.$$

The moment and centric vertical force affecting the foundation simultaneously can be replaced by the eccentric vertical force of the same magnitude. The eccentricity of that force is

$$e_{dst} = M_{dst}/N_{stb} = 430/480 = 0.90 \text{ m}.$$

This eccentric force must be balanced by the counter reaction of the soil under the foundation. Allowing for calculated tension of q_u= 200 kPa (2 kgf/m^2) to be imposed on the soil, the calculated effective area of the foundation footing, on which the soil reaction, balancing the eccentric force imposing on the foundation (see drawing EK-01) equals

$$A = N_{stb}/q_u = 480/200 = 2.4 \text{ m}^2.$$

Since the dimensions of the foundation footing are 3.00x3.00 m, the dimensions of the foundation footing part are 3.00x0.80 m and the eccentricity of the soil counter reaction balancing the eccentric force imposed on the foundation in relation to the foundation centre is

$$e_{stb} = 3.00/2 – 0.80/2 = 1.10 \text{ m}.$$

The calculated moment resisting the tipping over created by that force is

$$M_{stab} = N_{stb} \text{ x } e_{stb} = 480 \text{ x } 1.10 = 528 \text{ kNm}.$$

Therefore, the moment resisting the tipping over M_{stb} = 528 kNm is bigger than the tipping over moment by M_{dst}= 430 kNm, 1,23 (528/430) and the fixity of the foundation (wind turbine) is ensured. In fact, the fixity is greater, because in the above calculation, the effects between vertical surfaces of the foundation and its surrounding soil is not taken into account.