Study Committee B2

Overhead Lines

11076_2022

Design and construction of a high and heavy lattice tower for 380 kV transmission

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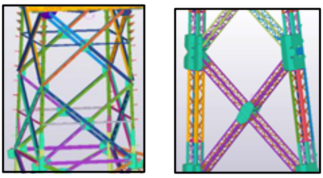
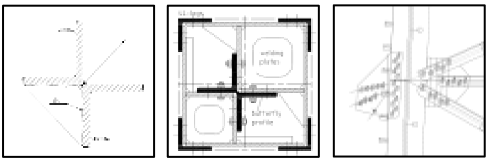
Motivation

- Upgrade of old 220kV transmission line to 380kV in northern Germany with high demands on ground clearance, deviation angle of 106.8°, line junction, dead-end tower
- Development of a customized 4-circuit double barrel shape pole, of a total height of 99.5 m (pole 19)

Materials/Model/Loads

- Hot dip galvanised steel construction of grade S355J2 for the profiles and S355J2+N for the flange plate
- Upper part with equal L-angles / Lower part with inter-joint reinforced steel construction
- Truss structure and pin connections for the modelling (bending moments negligible acc. to DIN EN50341)
- Minimalizing the eccentricities





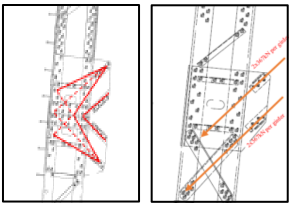
- Wind loads calculation through profiles of the dynamic wind pressure until 300 m above ground - these profiles are based on the logarithmic equations in DIN EN 50341

Construction Details

- Tower divided into 11 segments, 5 segments for the upper part and 6 segments for the lower part
- Foundations: a combination of concrete piles and horizontal concrete beams
- Pre-assembly test before mounting

Method/Approach

- Finite Element Method (FEM) in combination with Load Path Analysis implemented at joints and critical positions
- Lower part – load transfer trajectories via the stiffest route
- Transition piece: high compression-tension loads with simultaneous shear loads - fitting bolts with small tolerances H11 in use



Discussion

- Pole 19 is a tension tower ideal for heavy loads and high ground clearance
- Flexibility due to dead-end function
- Relative small land easement of 20 m for such a design
- Possible use for cross river

	$F_{d,compression}$	$F_{d,tension}$	M_d (in the centre)
Tension tower (h=99.5 m)	15,020 kN	11,605 kN	458,719 kNm
Suspension tower (h=97.5 m)	4,705 kN	3,543 kN	109,865 kNm

Conclusion

- Development of a customized tension and dead-end transmission tower
- Bearing of heavy loads with small land easement
- Implementation of a sophisticated analysis – combination of FEM and load path analysis
- Special mounting concept

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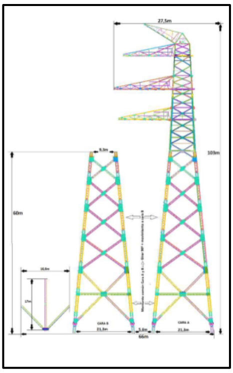
Wind loads

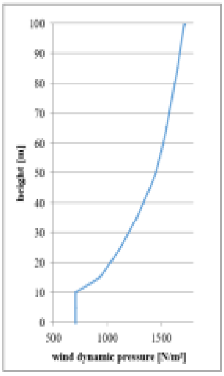
- Logarithmic equations acc. to DIN EN 50341
- Dynamic wind pressure in 99.5m equal to 1,713 N/m²

$$q_p(z) = 1.5 \times q_0 \qquad \text{für } z \leq 7 \text{ m}$$

$$q_p(z) = 1.7 \times q_0 \times \left(\frac{h}{10}\right)^{0.37} \qquad \text{für } 7 \text{ m} \leq z \leq 50 \text{ m}$$

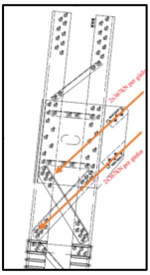
$$q_p(z) = 2.1 \times q_0 \times \left(\frac{h}{10}\right)^{0.24} \qquad \text{für } 50 \text{ m} \leq z \leq 300 \text{ m}$$



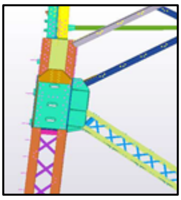


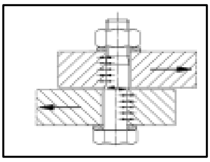
Method/Approach - Explanation

- The axial forces are extremely high at the lower point (Fd,x=735 kN). The load path, marked in orange shows that the load transfer of the upper diagonal occurs via the stiffest route, which is beneath the slotted hole. The load transfer of the lower diagonal occurs through the bracing to the main legs, without any resistance. That way the flow is facilitated, and it is not needed any local strengthening



- Transition piece between upper and lower part: Joints of category A have been chosen predominantly - the bolts are stressed perpendicular to their axis and work in shear and compression
- The use of fitting bolts with small tolerances of the holes (H11) and the avoiding of thread in the shear plane guarantee that the slippage is considerably smaller than the normal bolts





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Construction Details

- Tower 19 consists of 11 segments (5 segments common lattice tower and 6 segments with reinforced steel construction)

Foundation

- A combination of concrete piles Fundex and horizontal concrete beams – minimizing the lateral displacements

Montage

- Pre-assembling of the segments to avoid mistakes
- Conductors installation with the help of helicopter
- Transition piece is a combination of bolting and welding with tight tolerances

Conclusion

- Development of a customized tension and dead-end transmission tower
- Bearing of heavy loads with small land easement
- Implementation of a sophisticated analysis – combination of FEM and load path analysis
- Special mounting concept