

Large blade deflections are typically encountered in extreme wind situations, but also in the operating condition when the yaw angle is large or when the terrain is sloping. Atypical wind profiles may also give rise to large blade deflections. Special attention should therefore be given to wind turbine designs that are sensitive to special load cases such as negative wind shear in complex terrain.

The current Danish practice uses validated stiffness data in the aeroelastic calculations for analysis of deflections. Validated stiffness data are blade stiffness data, which comply with the experimental data from static tests of the blades. This implies that one may have to produce two sets of aeroelastic calculations. The first is a load calculation, in which the model is tuned to the correct natural frequencies and damping properties of the structural system. The second is a special deflection model where the deflections are tuned to be in agreement with the static experiments. Ideally, the two models would be the same, but in practice, this is not always the case.

7.4 Tubular towers

7.4.1 Loads and responses

For the purpose of calculating section loads in the tower, the tower can be viewed as a cantilever beam as shown in Figure 7-4. External loads, denoted by index T in this figure, are applied at the tower top flange, which is located at a height H above the tower base. Note that this height may deviate somewhat from the hub height.

Section loads in the tower at height h can be calculated from the loads applied at the top of the tower:

$$F_z(h) = F_{zT} + \rho_t \int_h^H A(z) dz \cdot g$$

$$M_z(h) = M_{zT}$$

$$F_y(h) = F_{yT} + F_w(h)$$

$$M_x(h) = M_{xT} + F_{yT} \cdot (H - h) + M_w(h) + F_{zT} \cdot (\delta(H) - \delta(h))$$

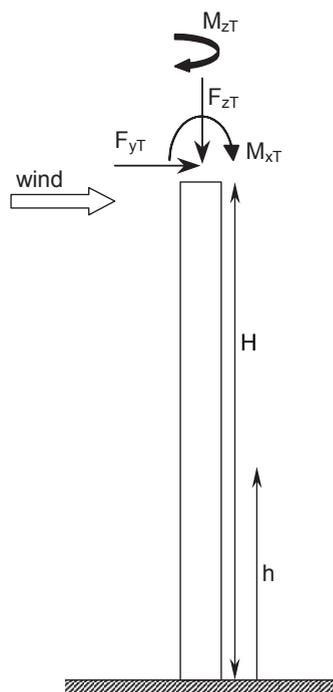


Figure 7-4. Cantilever beam model of a tubular tower subject to loading at the level of the hub.

F_y	thrust from wind load
M_x	bending moment from wind load
F_z	gravity force
M_z	torsional moment
ρ_t	density of tower including appurtenances
$A(z)$	cross-sectional area as a function of height z
δ	deflection of tower due to thrust from wind