Contact line: Design. Constructions

1 Purpose and scope

The purpose of this chapter is to ensure the correct selection of foundations, masts and portal structures when designing an overhead contact line system.

The requirements apply to newly constructed systems and to the refurbishment of existing systems.

The actual external loads are defined in the system description for System 35, 20 and 25. A detailed survey of each mast point must be conducted regarding the loads the masts are subject to. A survey must also be conducted for re-designs resulting from changes to the load scenario if the existing masts are to be retained.

When designing masts in an AT system, the requirements of kapittel 9 (Autotransformatorsystem med seksjonert kontaktledning) must be complied with. The requirement to take into account AT systems when refurbishing overhead contact lines on sections of line where AT systems may be required at some later date must also be noted.

2 Contact wire displacement

It must be documented with calculations that the maximum displacement has not been exceeded. When calculating maximum displacement, the relevant design wind speed must be used and anything affixed to the particular mast must be taken into account. Calculations may be carried out using the programmes 'Kl-fund' and 'Fundamast', refer to vedlegg a (Beregning av master og fundamenter).

2.1 Displacement resulting from static loads on masts and foundations

Contact wire displacement resulting from displacement and buckling of masts (including cantilevers) due to static loads must not exceed 12 mm horizontally in relation to the track plane. The requirement applies at a contact wire height of 5.6 m.

The necessary evaluations/calculations must be conducted to ensure that contact wire displacement resulting from static loads on the foundations are not so significant that the requirement regarding calibration options for a fully designed cantilever cannot be complied with. Refer to Chapter 5. The displacement should not exceed 25 mm horizontally in relation to the track plane at a contact wire height of 5.6 m.

2.2 Displacement resulting from environmental loads on masts and foundations

Contact wire displacement resulting from displacement and buckling of masts (including cantilevers) due to environmental loads in the form of wind load, ice load, temperature load, etc., must not exceed 18 mm horizontally in relation to the track plane. The requirement applies at a contact wire height of 5.6 m.

Contact wire displacement resulting from displacement and buckling of foundations due to environmental loads in the form of wind load, ice load, temperature load, etc., must not exceed 45 mm horizontally in relation to the track plane. The requirement applies at a contact wire height of 5.6 m.

3 Masts

Overhead contact line masts such as portal structure masts and single masts are generally used on open lines and at stations.

Masts located in insulated overlap sections/overlap sections or at points must be adequately torsion-resistant so that undesirable twisting of masts does not occur. In the design phase, consideration must be given to the fact that masts may occasionally be subject to greater loads than they would usually be subject to as part of a finished installation.

Components that do not concern the cable installation must not be erected on or in overhead contact line masts.

3.1 Steel masts

Among steel masts, H masts and B masts are normally used. H masts are most often used as anchoring masts, masts for outermost section cantilevers in parallel fields, and by section cantilevers across sets of points. B masts may be used as pendulum masts on portal structures. Both types are also used as self-supporting or free-standing masts.

Steel masts must be used for all permanent installations and the following designations are to be employed:

- When using B masts, B3 or B6 must be chosen depending on the load scenario.
- When using H masts, H3 or H5 must be chosen depending on the load scenario, as well as H6 for cantilever yokes.
- Beam masts with designation in accordance with profile.

3.1.1 Anti-climb protection for steel masts used in overhead contact line systems

All steel masts, including special lattice masts and other types of mast that can be naturally climbed, must be equipped with anti-climb protection in accordance with § 8-5 [FEF].

If the lowest edge of the anti-climb protection is installed between 1.0 and 2.0 metres above the mast foot, anti-climb protection with a total length of 1.80 metres may be used.

No objects are permitted to be present within the area of the anti-climb protection that may reduce its functionality.

On masts equipped with anti-climb protection, high voltage warning signs must be fitted to the anti-climb protection, in accordance with the guidelines stipulated in § 8-5 [FEF].

3.2 Wooden masts

Wooden masts may only be used as a provisional measure and in emergency situations.

3.3 Mast tables

Mast tables must be available for all designed installations and should contain the following information as a minimum:

- Mast number
- Kilometre
- Mast type and length
- Directional orientation to the track/s it serves
- Other structural loads it will be subject to
- Contact wire height
- Overhead contact line stagger
- Distance from centre of mast to centre of track
- Incline at front of mast
- Track cant

- Anchoring wires
- Tensioning gear
- e-measurements

3.4 Mast distance to track

Masts must be erected at a distance from the track that enables the passage of cable ducts between the foundations and the track. Reference is made to Underbygning/Prosjektering og bygging/Profiler og minste tverrsnitt.

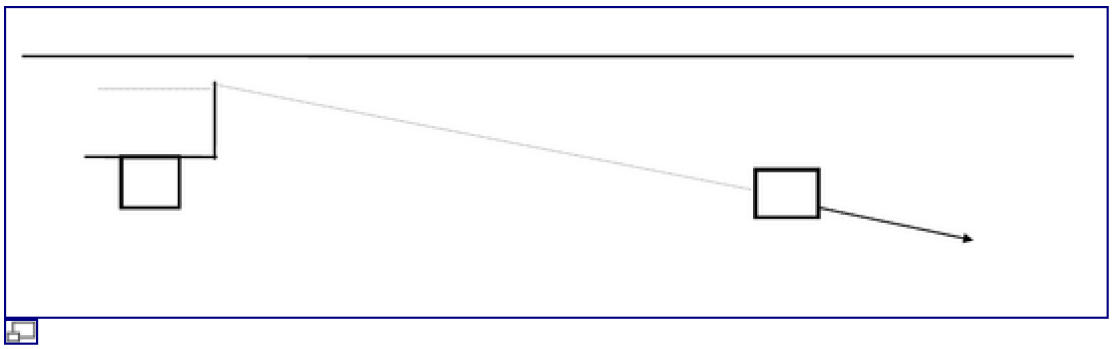
A clear line of sight at signals of at least 250 metres must be established so that an unrestricted view of signals is achieved. In this respect it is important to note that the lower insulator on cantilevers generally obscures light signals if the mast is sited too close to the track.

In large station areas, mast zones must be established in order to keep portal structures to a reasonable length. The length of portal structures must be viewed in the context of the segmentation of the station area so that systems can be both mechanically and electrically separated.

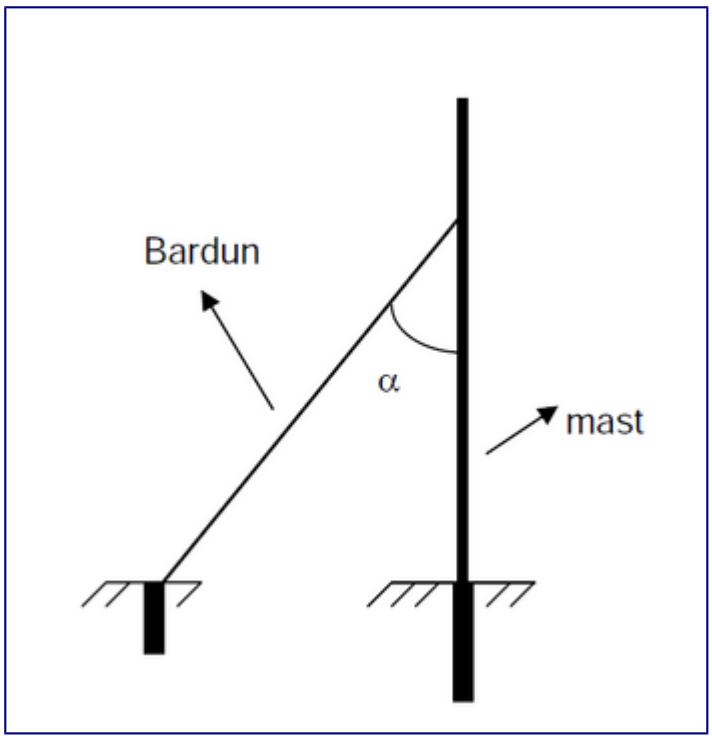
3.5 Mast tensioning

For anchoring wires reference is made to the drawing E - 2147 'Anchoring wires for steel and concrete masts' and E - 7162 'Overhead contact line system, anchoring wires, System 35, 20 and 25'.

The direction of anchoring wires must be positioned in continuation of the direction of the strain that the anchors are intended to manage; refer to Figure 7.1. The angle α, between the mast and the anchoring wire must be between 40° and 50°, refer to Figure 7.2.



Figur 1: Principles of tensioning



Figur 2: Angle between mast and anchoring wire.

3.6 Mast numbering

All overhead contact line masts must be numbered for identification purposes, refer to § 8-5 [FEF]. Numbering must be consecutive in the direction of increasing kilometres.

3.6.1 Numbering methods

Numbering method 1. The mast number is written as XXX-YY. In this example, XXX represents the whole kilometre number in which the section is located, and YY represents a running number for the relevant section kilometre. The running number begins at 01 and continues consecutively until the next whole section kilometre.

Numbering method 2. The mast number is written as XXXX. In this example, XXXX represents the relevant number series in accordance with the drawing EK.703490-000.

When constructing new sections of line, numbering method 1 must be used.

When constructing new overhead contact line systems with new masts, on existing sections of line, numbering method 2 may be used instead of numbering method 1.

3.6.2 Guidelines for mast numbering

The guidelines apply when facing in the direction of increasing kilometres.

For single-track lines: Numbering is consecutive regardless of which side of the track the mast is on.

For double-track lines: Odd numbers are used on the left hand side of the tracks and even numbers on the right hand side of the tracks.

For more than two parallel tracks: These should be numbered consecutively. If several masts are located at the same section kilometre, these should be numbered consecutively from left to right.

For suspended masts in portal structures: Suspended masts should be numbered with the mast number of the portal mast, which is located on the left hand side of the portal structure. In addition to the mast number, a serial number is added, calculated from left to right. Example of numbering a suspended mast in accordance with numbering method 1: 345-11-2. In this example, the left hand portal mast has been assigned the number 345-11 and the suspended mast is number 2 from the left.

For suspended masts in tunnels: Suspended masts in tunnels are numbered in the same way as ordinary masts.

3.7 Shared rows of masts/centrally positioned masts

For new installations or when establishing new masts on main lines and passing loops, shared rows of masts/centrally positioned masts must not be used.

On main lines and passing loops that form part of existing installations, shared rows of masts/centrally positioned masts should not be used. If such masts are used nevertheless, the following requirements apply:

- No technical or electrical factors preventing this type of use must exist.
- Such masts must be established on existing steel masts.
- The design requirements for masts and foundations must be observed.

3.8 Masts in double-track tunnels

In double-track tunnels, suspended masts must be located along the centre line of the tunnel. The distance between the suspended masts for the separate sections of overhead contact line must be between 7.0 m and 15.0 m in the longitudinal direction of the tunnel.

This is necessary to achieve a sufficient insulation gap between live components and the tunnel profile. In order to avoid voltage affecting the roof of a catenary maintenance vehicle during work on the overhead contact line system, the masts must have a sufficiently long reciprocal distance in

the longitudinal direction of the tunnel. This is to avoid the roof of a catenary maintenance vehicle being simultaneously exposed to two suspended masts with different voltage potentials.

4 Portal structures

There are three types of portal structure to choose from, based on the same method of production and calculation.

The designations are: Portal structure type 12, 14 and 40, as well as cantilever yoke or what is often described as “åkunge”.

Portal structures are based on the premise that both the messenger wire and the contact wire are suspended beneath the portal structure in separate cantilevers on suspended masts, permitting easy tensioning and maintenance. For further information, reference is made to portal structure drawings and calculations. Foundations must be assigned a coordinate position so that there is sufficient time to order portal structures.

Components that do not concern the overhead contact line should not be fitted on or to portal structures.

4.1 Portal structure sketches

A portal structure sketch must be available for all designed installations and should contain the following information as a minimum:

- Mast number
- Mast type and length
- Distance between masts
- Distance between tracks
- Contact wire height for each track
- Stagger at each track
- Height of each track with a reference track
- Cant
- Type of portal structure
- Length of portal structure and choice of frame
- Portal structure mounting dimensions
- Cantilever mounting dimensions
- Mounting dimensions for other equipment

4.2 Portal structure numbering

All portal structures must be numbered. Numbering must be consecutive in the direction of increasing kilometres.

Portal structures must be divided into natural groups such as a station, part of an open line or a shunting yard. The first portal structure in each group is assigned portal structure number 1 and the remaining portal structures in the group are numbered consecutively.

If several portal structures are located at the same section kilometre, these should be numbered consecutively from left to right.

5 Foundations

Foundations for overhead contact line systems must be approved by the NNRA before production

commences.

Foundations must either be prefabricated or cast-in-place. The following foundations may be used: Pile foundations (cylindrical) Cast-in-place foundations (stepped with footings).

When designing foundations, consideration must be given to the momentum (M), shear force (V) and normal force (N) that occur on the top of the foundations as a result of external forces.

Horizontal displacement and buckling of the foundations increases in proportion to an increasing load, and in softer ground conditions. When designing foundations, consideration must also be given to local ground conditions, as well as to the forces that occur on the top of the foundations.

An evaluation should be conducted regarding the construction of oversized foundations so that the foundations possess the reserve mechanical strength necessary to absorb potential additional loads in the future.

Foundation drawings must contain the necessary construction tolerances. The interface with masts must be particularly described to ensure that foundation bolts and other measurements are tailored to the mast foot.

It must not be possible for any form of chemical reaction to occur between the concrete and the foundation bolts.

Foundations must not be established in lineside ditches, refer also to Underbygning/Prosjektering og bygging/Profiler og minste tverrsnitt og Underbygning/Prosjektering og bygging/Drenering.

The maximum permissible protrusion of foundations is 700 mm.

5.1 Foundation record

A foundation record must be available for all designed installations, refer to Vedlegg c Fundamentprotokoll (.odt) (.doc), which must contain, as a minimum:

- Mast number
- Foundation number
- Kilometre
- Foundation type, diameter and length/width of footing and length of column
- Foundation for mast type/tensioning
- Distance from centre of mast to centre of track
- Type of ground conditions
- X, Y and Z coordinates
- e-measurements
- Protrusion of foundations

6 Signage and fencing for high voltage installations

Signage for high voltage installations must be implemented in accordance with [FEF] and Skilt/Plassering av skilt langs sporet.

All masts must be equipped with high voltage warning signs.

Fencing for high voltage installations must be constructed in accordance with Underbygning/Prosjektering og bygging/Gjerder.

7 Appendix

Vedlegg a Beregning av master og fundamenter