Fieldwork Surveying FS01

10. Lecture

Setting-out of buildings and land survey for construction industry II

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4. Setting-out of a circular arc

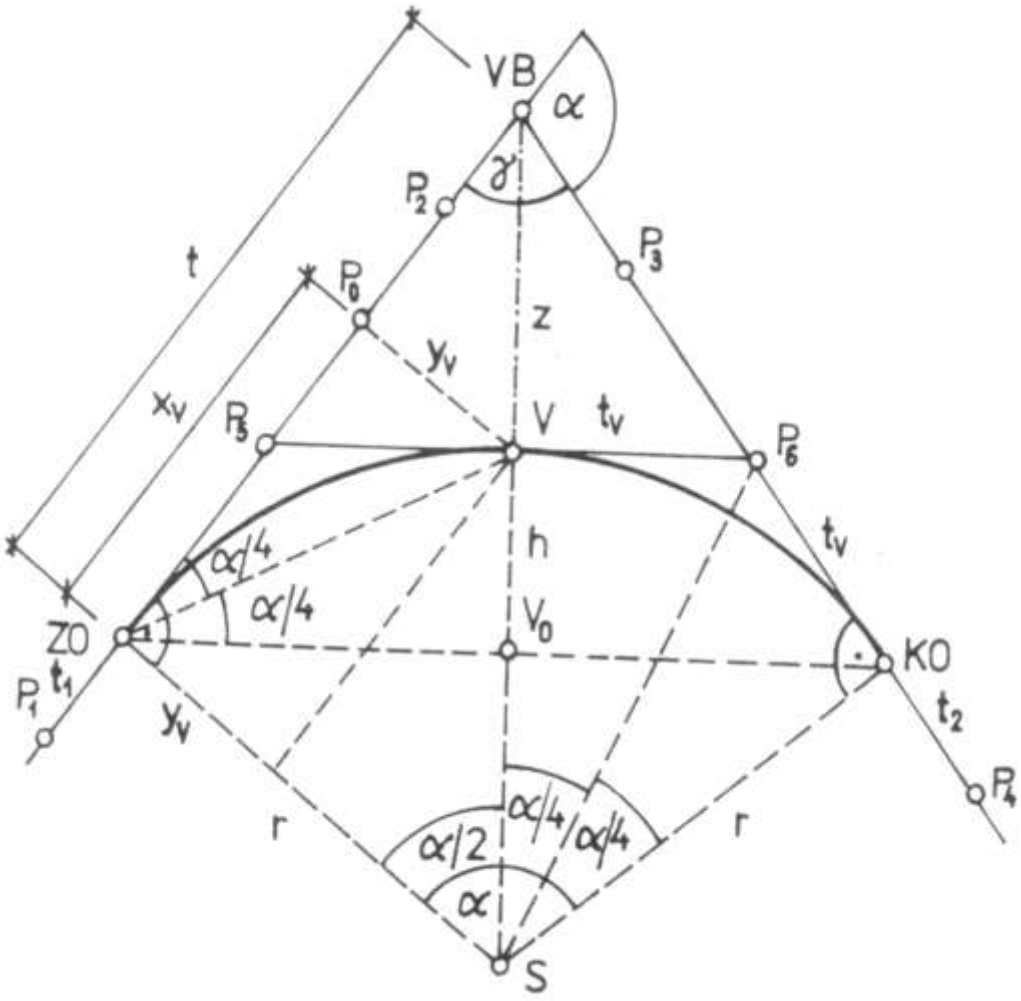
- it is used for linear constructions (roads, railways, regulated watercourses)
- **circle** is most often used, a **transition curve** is usually inserted between the straight section and the circle (for fluent passing)

A clothoid (Euler's spiral) is the transition curve for roads and a cubic parabola is the transition curve for railways.

Setting-out of the main points of a circular arc

A circle is generally defined by 3 elements (usually by 2 tangents t_1, t_2 and by the radius r).

Horizontal angle γ is measured and the central angle α is calculated:
α = 200 gon – γ.



The **main elements** of a circular arc (calculated using *r* and α):

1. length of the tangent $t = r \cdot tg(\alpha / 2)$
2. rise of the arc $$z = r.\left(\frac{1}{\cos(\alpha/2)} - 1\right)$$
3. rectangular coordinates of the central point of the arc (related to the tangent) $x_V = r \cdot \sin(\alpha/2)$, $y_V = r \cdot (1 - \cos(\alpha/2))$.
4. length of the arc $$o = r.\alpha = r.\frac{\alpha^g}{\rho^g}$$

$$\rho^g = \frac{200^g}{\pi} = 63,6620^g$$

The **main points** of an arc = ZO, V, KO

The beginning (point ZO) and the end (point KO) of the arc are set out from the intersection of the tangents (point VB) by means of the tangent length. The central point of the arc V is set out either by means of the rise of the arc in the direction of the angle γ /2 or by means of the rectangular coordinates related to the tangent.

Setting-out of detailed points of a circle arc:

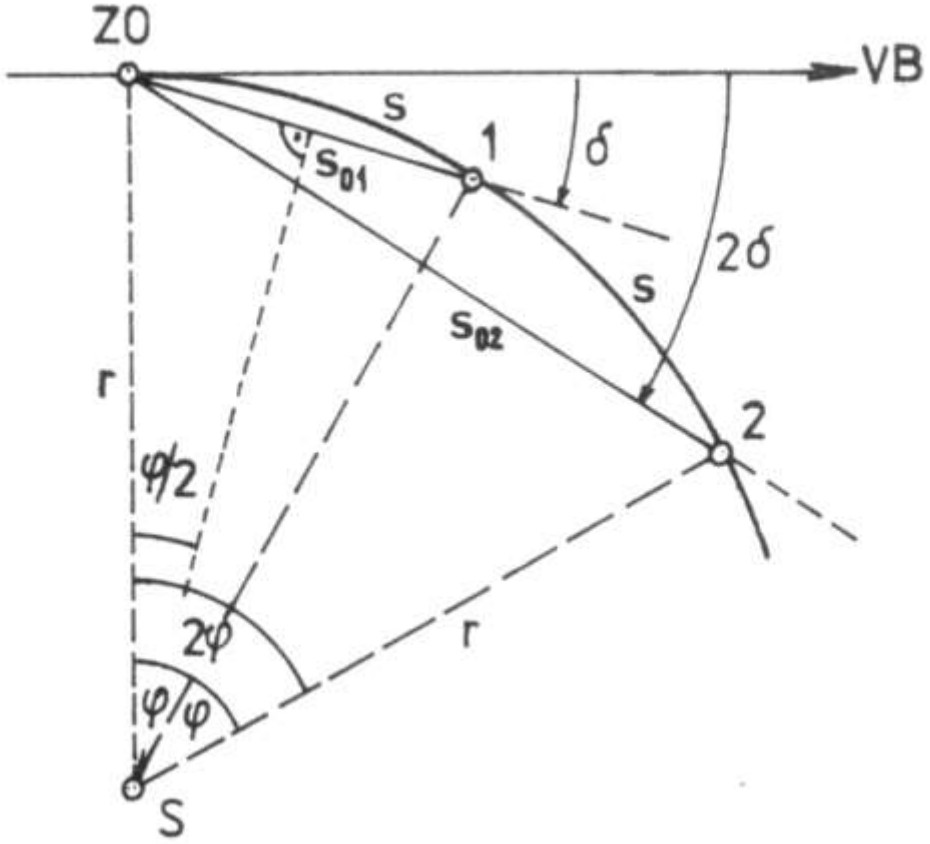
- from polar coordinates

- from semipolar coordinates

Setting-out of detailed points of a circular arc from polar coordinates

Detailed points are set out from the points ZO or KO.

Setting-out elements:
horizontal angle δ
horizontal distance s_{0i}



$$\varphi^g = \frac{s}{r}.\rho^g$$

$$\delta = \frac{\varphi}{2}$$

$$s_{01} = 2r.\sin\frac{\varphi}{2}$$

It is useful to choose the lengths of the arc between nearby points *s* identical, then

$$\varphi_i = i \,.\, \varphi$$

$$\delta_i = i \,.\, \delta$$

Setting-out of detailed points of a circular arc from semipolar coordinates

- when a total station is not available

- the horizontal angle δ is set out from the point ZO (like at the polar method), but the distance is set out from the foregoing detailed point. It is possible to use a tape for the setting-out of the distance because the distance is usually shorter than 20 m.

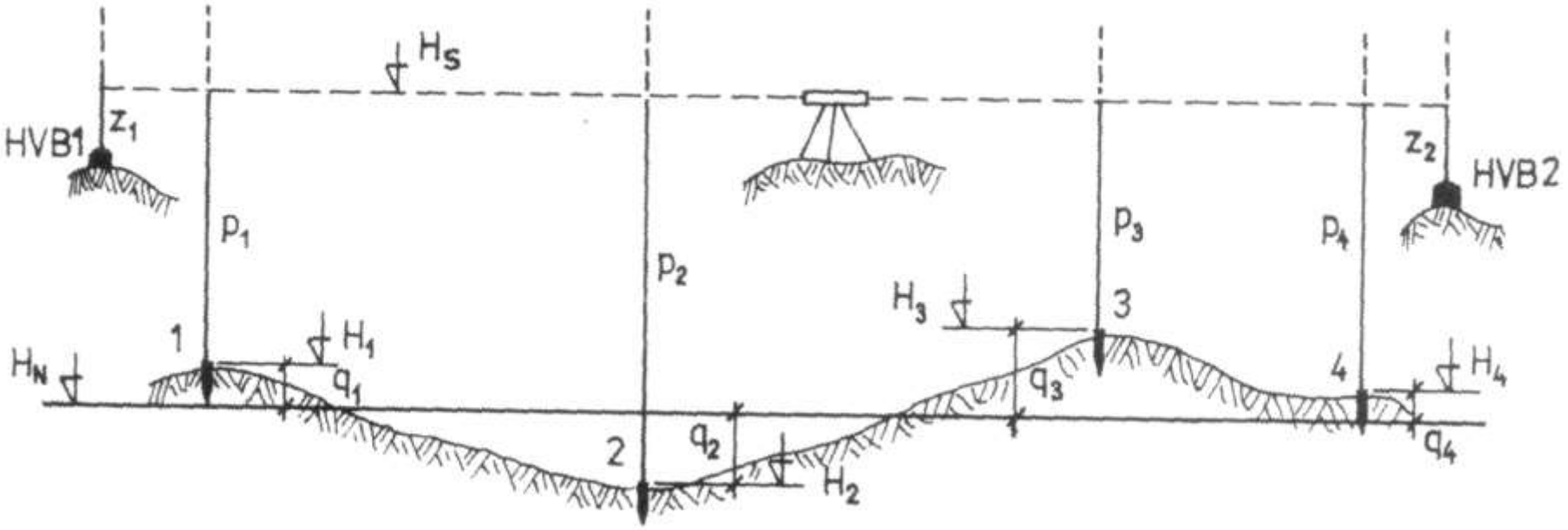
Setting-out of heights

1. Setting-out of points of a horizontal plane or of a horizontal straight line

2. Setting-out of points of a sloping straight line

3. Setting-out of a contour line

Setting-out of a horizontal straight line



At first a position of the straight line is set out and its points are marked by stakes.

H_N … planned height

A levelling line is connected to 2 height points HVB1 and HVB2 at least and the absolute height of the horizon of the instrument H_S is determined :

$H_S = H_{HVB1} + z_1 = H_{HVB2} + z_2$

$H_i = H_S - p_i$

$q_i = H_N - H_i$

$+ q_i$ … filling

$- q_i$ … cutting

The calculated values q_i are written at stakes and to the setting-out plan.

Setting-out of a horizontal plane

First of all positions of several parallel straight lines are set out. A distance between the straight lines is constant. Points of the straight lines are marked by stakes. These points are measured by surface levelling and earthworks q_i are calculated using mentioned formulas.

Setting-out of a sloping straight line

a) setting-out of a sloping straight line whose gradient *s* % is given and which comes through a given point,

b) setting-out of a sloping straight line connecting two given points

a) Given: point A, planned height of the straight line at point A (H_{NA}), direction of the straight line and its gradient *s* %.

Points 1, 2, … of the straight line are marked in fixed distances *a* (e.g. 10 m) by stakes.

A levelling line is connected to 2 height points HVB1 and HVB2 at least and the absolute height of the horizon of the instrument H_S is determined

$H_S = H_{HVB1} + z_1 = H_{HVB2} + z_2$

Heights of points are determined by levelling

$H_i = H_S - p_i$

Planned heights of points 1, 2, … are calculated:

$H_{N1} = H_{NA} - \Delta$,

$H_{N2} = H_{NA} - 2\Delta$,

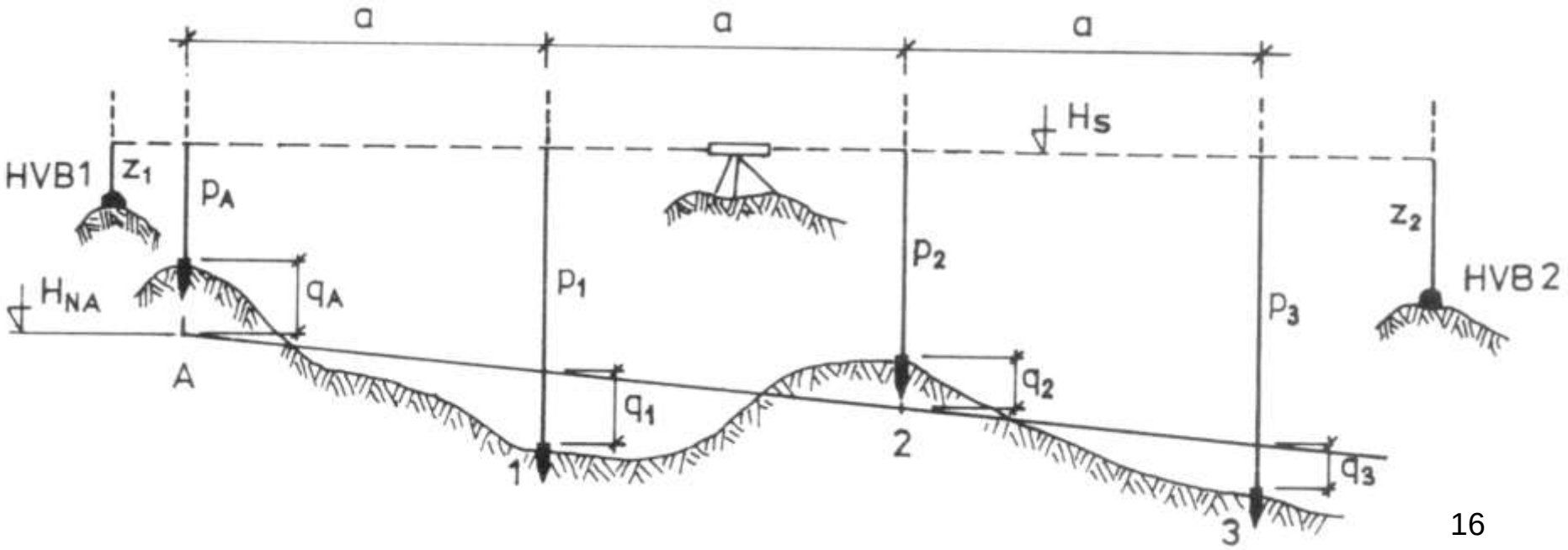
$H_{N3} = H_{NA} - 3\Delta$,

$H_{Ni} = H_{NA} - i\Delta$.

Δ = a . s % / 100.

the definition of the gradient:

$$s = \frac{h}{d}.100\%$$



Fillings or cuttings:

$q_A = H_{NA} - H_A = H_{NA} - H_S + p_A$,

$q_i = H_{Ni} - H_i = H_{Ni} - H_S + p_i$

The calculated values q_i are written at stakes and to the setting-out plan.

b) Setting-out of a sloping straight line connecting two given points

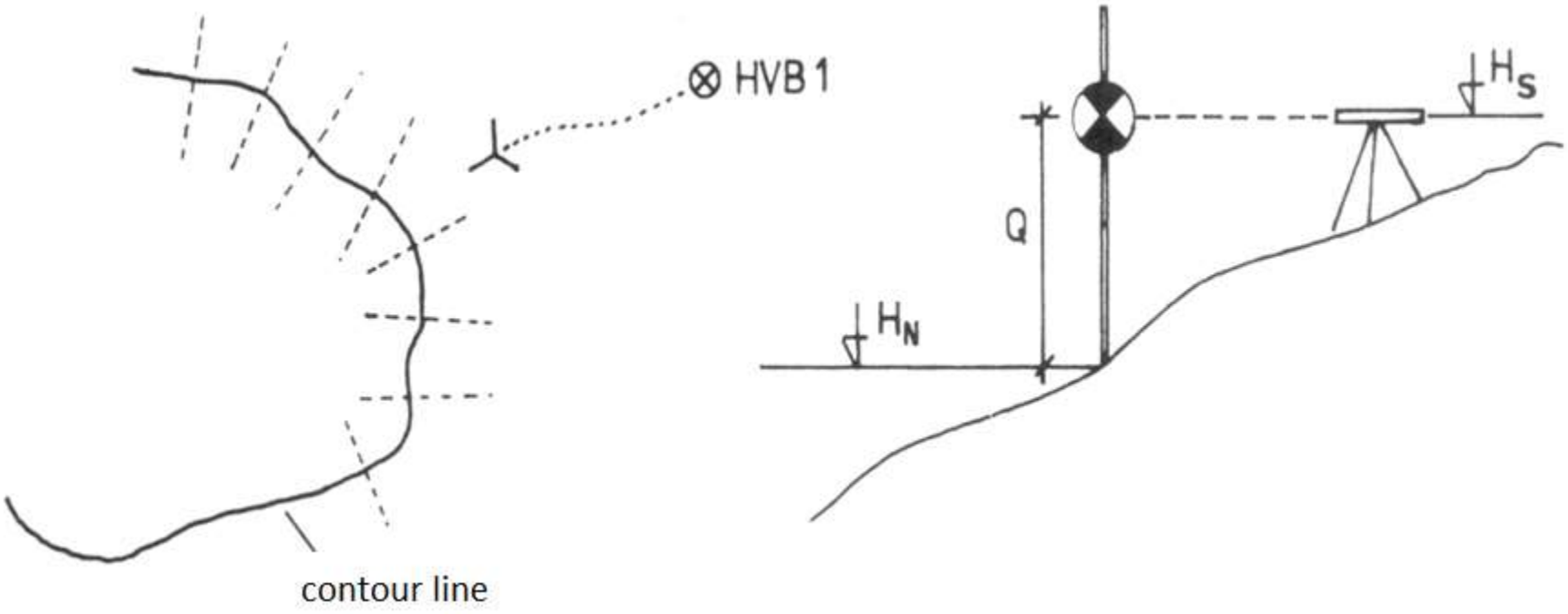
The procedure is similar the previous one, in addition to that the gradient must be calculated using planned heights of the beginning and the end points A and B and their distance *d*:

$$s\% = \frac{h}{d}.100\%$$

$h = H_{NA} - H_{NB}$

3. Setting-out of a contour line

- for water buildings where the reservoir border line must be set out.



A levelling line starts at the height point HVB1. The line is measured to a point where the horizon of the instruments H_S is from 1 to 2 m higher than the planned contour line height H_N.

Q … reading which should be on the rod standing on wanted contour line:

$Q = H_S - H_N$

The reading Q is marked on the rod by a sliding target or by an elastic belt.

A lineman moves with the rod around demanded place till the horizontal line of sight comes through the centre of the target.

The point of the contour line is marked by a stake, points are usually needed in distances from 30 m to 50 m.

Geodetic legal regulations in the Czech Republic

- Act No. 200/1994 Coll., on Surveying and Mapping
- Decree No. 31/1995 Coll.

Content of the act and the decree

- there is a definition of „geodetic activity“, a list of warrants and duties for performing of geodetic activities, who can practise land survey activities (graduates from a secondary school or an university with a view to land surveying)
- verification of results of land survey activities – authorized surveying engineer
- authorized surveying engineer – university education, land survey specialization, master´s degree at least and then 5-year practice at least, successful passing a test of professional qualification

Verification of results of land survey activities – examples:

- creation of a setting-out net
- execution of a setting-out plan
- setting-out of construction size and shape
- measurement of shifts (vertical, horizontal) and deformations of a construction

Thank you for your attention!