RUNNING PRECISION SURVEYS WITH LONG SPEEDS OVER THE HIGH STREAM WATERS OR OVER VARIOUS OBSTACLES

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ABSTRACT

The practice of surveying requires often times that the levelling be made over wide water or other obstacles areas. In case of existing resistent bridges (from steal or re-inforced concrete) the levelling should be done on these, but in their absence the proccess will be carried out using long points.

One such levelling is necessary also in connection to the main survey networks (ord I) with the isles near to the beach or with the mareographs forseen on the isles.

The present study demonstrates this aspect.

MATERIALS AND METHODES

This article will briefly study the precision survey conducted with long points that has been used in order to connect the survey networks of Romania and Bulgaria in 1962.
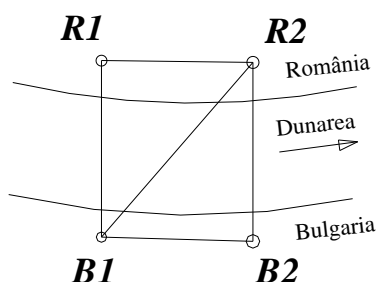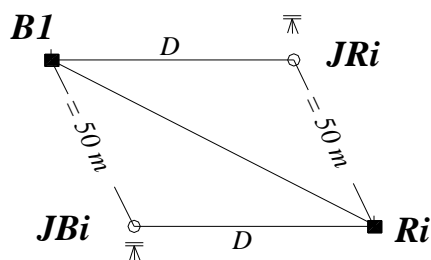

Fig. 1   Fig. 2

The connectioon between the survey networks in Romania and Bulgaria has been done in a few points over the Danube, contemporary by teams of land surveyors in both countries.

To this purpose and for each point, the so called *initial survey landmarks* (RIN), is placed just like in fig. 1. The measurement of the level differences is conducted through three ranges for each point: from B_1 to R_1 and backwards, from B_2 to R_2 and backwards, as well as from B_1 towards R_2 or from R_2 towards B_1 (following the cross-bar of the figure) and backwards.

The survey differences among the initial land marks B_1 and B_2, R_1 and R_2, have been measured through a geometrical regulated survey of category I. with the shaping of closed poligons, in order to make the control of the initial survey marks connections with those of each country, also conducted through regulated surveys. The level differences for each range are measured contemporaneousely with two levelling devices by two operators.

The devices are placed at approx. 50 m to one of the survey marks, so also the big distances JBi- Ri and JRi- Bi can be be identical, under the condition that the influence of non-parallelism between the range axis and the tangent of the device level can be equal (fig. 2).

In case of such a placement of the devices on the inital land marks Bi and Ri levelling rods are foreseen with two scales, having placed on this and below the opposite levelling´s level, the so called superior and inferior marks. These marks present a white board with a black belt of about 2 cm (accordind to the value of the distance).

The centers of the marks are places on certain gradations of the leveling rods. The distance of the rod between the superior and inferior mark is marked by "d" (fig.3).
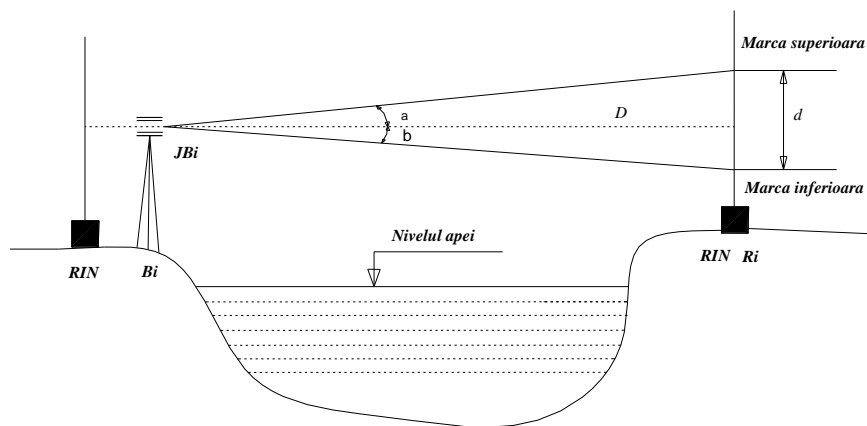

Fig. 3

Measuring the level differences among the initial levellling marks is done several times (25…..30), in the following order:

First the JBi device is pointed towards the RIN levelling rod closest to the Bi and a backwards reading is being conducted.

Next, the JBi device is being oriented towards the further distanced levelling rod Ri (RIN opposed) conducting the following reading:

a) with the horizonzal wire oriented towards the superior land mark the reading will mark notes on the grading of the device level according to the two extremities of the air bubble, i.e. aiming to obtain the α tilt placed on the horizontal of the device, following an orientation towards the superior part of the visual ray;

b) for the device in horizontal position, the gradation of the levelling device will be the notes to wich the two extremities of the air bubble coincide;

c) with the horizontal wire towards the inferior land mark, the readings will be marked on the device gradation for both extremities of the bubble, following the below orientation of the visual ray, that is the tilt β towards the horizontal line of the device.

Once these readings are conducted, there will be the measurement of the level difference for an area, while also conducring the same difference level measurement by the opposite device for an area, conducting the same level difference measurement by an opposite device from Ri. Thus, in concomitence with the help of a flag signaling, there will be readings in 25…..30 areas, after witch the operatos and the devices will change positions and will conduct a similar number of measurements.

Through concomitent mesurement of two opposite devices *the elimination of the refraction influence* will be obtained, which shows up in the same moment and with the same value and opposite sign for both signatures, being variable according to the atmosphere conditions.

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By changing the postion of the devices errors of parallel misalignment will be eliminated (of value and different sign for each device) between the range axis and the tangent to the air bubble. It is easily visible that the difference for the level measured with the same device from two places had in both cases the same error, but a different sign. It results that the real value of the level difference measured is the arithmetic average of all the mesurements.

Based on the readings conducted this way we will obtain the angles (tilts) α and β, and from the readings on the leveling rods on which the superior and inferior marks are secured we will obtain the values

$d = Ms\text{-}Mi$.

For here it results that the level differences

RIN Bi *and* Ri = *reading backwards- (h+x)*

and for control a backwards reading (closed levelling rod) – (Ms – y) where:

$$x = \frac{\beta}{\alpha + \beta} * d \quad ; \quad y = \frac{\alpha}{\alpha - \beta} \quad \text{şi} \quad h = Mi$$

Since distance $D = \frac{x}{tg\beta}$ şi $D = \frac{y}{tg\alpha}$, y = d – x, so that

$$\frac{x}{tg\beta} = \frac{d - x}{tg\alpha} , \quad \text{from where the result is:}$$

$$x = \frac{tg\beta}{tg\alpha + tg\beta} * d \quad \text{or} \quad x = \frac{\beta}{\alpha + \beta} * d \quad \text{and} \quad y = \frac{\alpha}{\alpha + \beta} * d$$

It can be seen that for the calculation of the horizontal reading on a long distance levelling rod is necessary to measure the tilts α and β, to be measured in any but identical kind of units.

The best way to conduct the described methods of surveyng over large water surfaces is through levelling similar to the Zeiss Ni 004 type.

More comfortable are the surveys in which the tiltings α and β are read on a gradated circle with the screw (Wild), the advantage of these is in the fact that it wont be waited until the air bubble settles in case of its orientation towards the upper or lower mark (Ni 2).

CONCLUSIONS

The survey connections over the Danube conducted in the year 1962 have been conducted in atmospheric conditions relatively unfavorable, freezing up to -15° and wind.

Even thought the results obtained by both groups, from Bulgaria and Romania are very good.

The incongruity to the poligons closing for different points is between 0.11-4.86 mm, for a total length of the poligons of 2.50 km.

The average error $m_o = +/- \sqrt{\frac{(pvv)}{r}}$ is up to 2.20 mm.

Based on the above it results that a precision survey over large water surfaces and other obstacles can be successfully conducted at large distance, in regular atmospheric conditions.

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