CONSIDERATIONS ON THE EXECUTION OF A COLLECTOR FOR WASTEWATER LOCATED IN THE DOWNTOWN OF CLUJ-NAPOCA

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Abstract: *Sewer located in the center of Cluj-Napoca is particularly important for the purposes of collection and transport wastewater as designed route and adjacent areas. To avoid disruption of urban transportation, the designed collector diameter of 2280 mm situated at 4-9 m depth, was made by underground mining. The collector design was intended that it be placed under the highway and street construction to avoid undermining the prosecution to subsidence from underground excavations. The collector execution was performed using a T.B.M. complex whose diameter is 2710 mm excavation. To achieve the leveling and plotting topographic network, at the collector end points were fit through multiple retro-intersections method and through global positioning method. The connection between the end points was achieved by a micro triangulation and by supported polygonal routes. Transmitting the reference system from surface to underground was made through the input pit, located near the Someş and the lead in digging was performed using a laser device. Basic constructive elements (collector tunnel axis, longitudinal slope, support elements positioning, centers of visitation pits and the development altitude from natural ground level), were implemented in the field from the polygonal surface-underground route points.*

1. General considerations

Sewer made between Cipariu and Michael the Brave markets has a length of 1080 m and is composed of alignments and curves with curvature radii between 120 and 200 m, located under the street network at a depth of 5 to 9 m.

The collector is limited by the input pit (large diameter) located near the Someş and final pit situated on the Cipariu market, with required points given by the intermediate collector pits P1, P2, P3. Collector is performed in one direction, with a punctate mechanical cutting, support interim shield, permanent support reinforced concrete ring with a length of 1 m, outer diameter rings of 2.25 m and thickness of 0.175 m. Transportation of the unrocked material is made with special carriages on a narrow railway, with removal from the underground through the input pit, using a crane.

Fig,1 Collector design route

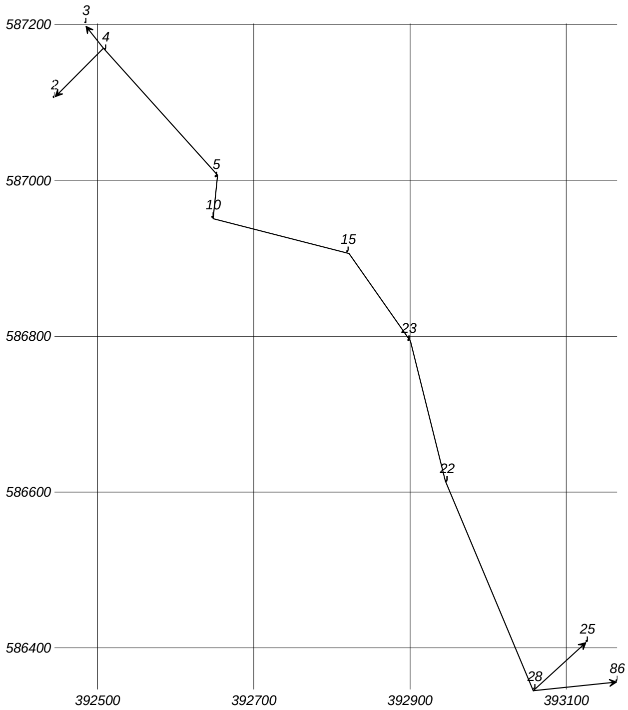

Fig.2 Polygonal route

2. Material and method

To achieve homogeneous coordinate system from the start to end point of the collector, was made a supported polygonal route (Fig. 2), with forced centering, starting from the final point of the work 28 to the point 4 located on a metal pillar placed in the collar pit.

Azimuth, zenith and the distances observations were performed with a 610 Sokkia total station and two prisms placed on tribrach with optical plummet and for checking the surface stability was used Trimble DiNi12.

Observations processing and coordinates calculation were made according to the speciality literature [1], obtaining from processing unclosures that were within the tolerances. In the design and implementation of wastewater collector, manufacturer requested a local coordinate system with the X axis direction on advance of the work, and Y axis to the east.

Reference system transmission from surface to underground was made through the starting pit, using a direct sight of the point 4, situated on a pillar located on the pit collar, to the point 7005 located on the console side of the collector (Fig. 3).

a)  b)

Fig.3 a) Console mounting, b) Station location on the console

The method used for transmitting the reference system underground, other than the methods known in mining topography [2], could be used because of large diameter input pit (D = 10 m) and small design depth (h = 7.2 m). Reference system materialization in the underground was made through the group of stable points 7005, 7043, 7079 rigorously materialized with equal size console.

Note that the reference system transmission from the surface to underground was made simultaneously both for planimetry and for leveling using the polar method for planimetry and the trigonometric leveling method for leveling.

Accuracy of altimetry transmission is given by the average square error for determining the level difference "h" given by:

$$m_h = \sqrt{(tg\varphi)^2 m_D^2 + \left(\frac{D}{\cos^2\varphi}\right)^2 \left(\frac{m_\varphi}{\rho}\right)^2}$$

Where:

φ – the measured vertical angle;
m_D – distance measurment error (m_D- 2 mm)
m_φ – angle measurment error (m_φ=15 ^{cc})
ρ – conversion factor from seconds to radians.

The underground topographic works consisted of:

1. Realization of the underground support network and materialization of a new stable point group after advancing the working front with 300-500 m;
2. Positioning the collector axis laser device;
3. Materialization direction laser spot;
4. Extension the direction and correction of directions;
5. Final positioning the support rings.

1. Underground network was done by a forward-backward polygonal route on the same route. In order to reduce working time first were measured the left and right angles of the polygonal route, so we had control on orientations and coordinates. Relations are those known from the closed polygonal route, except the coordinates compensation which is made only in the first tour.

2. The laser was positioned in a metal collector axis, shown in Figure 4, with the help of a device which has a toric leveling bubble (Figure 5).

Fig.4 Device for the laser positioning

Fig.5 Positioning the laser support

3. Direction materialization is realized with the help of three lead wires located in the ceiling of the collector, as follows: a string to a clearance of 20-50 cm from the laser, a second plummet to about 5 m and the third wire at 5 m behind the cabin of T.B.M.

For positioning the wire steering, the total station is placed in place of the laser (fig. 6).

Fig.6.Positioning the total station in the work axis

Fig.7.Positioning the topographic points

Check the designed direction, giving visas to two or three points behind, after which are positioned the topographic points (fig.7) which materializes the extension direction [3].

Materialization of the topographic points is made with permanent topographic marks placed in the ceiling of the mining work.

Fig.8 Laser targeting

Fig.9 Slope checking

With the steering wire is guided the laser spot, which must intersect the three lead wires. To check the laser spot declivity, it is measured the height from the laser radius to the ceiling collector.

4. With advancing the working front, the laser spot increases in diameter and 10 mm when the diameter overcomes 10 mm is required repositioning the laser support. When the laser

spot size overcomes the target size (Fig. 10), located in TBM's cabin, pass the correct direction.

Fig.10 Positioning the TBM's direction target

5. The concrete ring position for the final sponsoring is determined from the poligonal route points and these are verified, with the designed position on the digital plan of scale 1:200.

3. Results and discussion

The lifting network from the surface, is made from the starting point to final point of the collector, behind the planimetric and altimetric details of the road network, on which was designed the sewage collector axis.

Also, from the lifting network were traced the cutting pits centers and intermediate pits.

For a better precision at the surface longitudinal profile drawing, from the starting point to the final point of the work, beasides the tachimetric measurments with the total station was also performed a middle geometric levelling route using a Trimble DiNi12 level.

For the reference system transmission on a vertical pit, direct targeting from the surface to the underground offers a better precision for the collector orientation than then known classical methods.

For the altitudes transmission from the underground was used the trigonometric leveling and the transmission error has been computed with the previous presented relation:

$$m_h = \pm\sqrt{(tg(35.5695)^2 * 2^2 + \left(\frac{11.52}{0.719}\right)^2 \left(\frac{15}{636620}\right)^2} = 1.4mm$$

The error is millimetric for which is accepted the trigonometric method for the undergroud altitudes transmission.

Positioning the underground characteristic points (points of entry and exit from the curve, laser device placement points) will be made from the group of stable points, placed on the console or in the work axis.

From characteristic points of the curves are calculated the trace elements between curves and intermediate pit.

The curve leading elements of the TBM, using the laser device, are determined on the 1:200 scale digital plan (fig. 11).

Observations - When the laser spot is to the left of the target, the curve is on the right, and when the target is on the right, the curve is on the left.

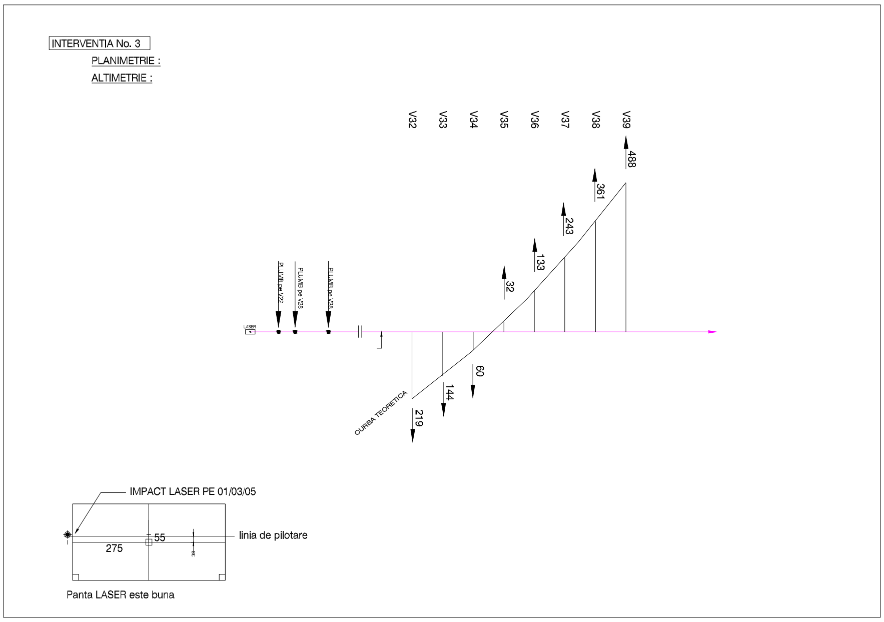

Fig.11.Curve leading elements

4. Conclusions

- Direct transmission use of the reference system from the surface to the underground, on a vertical pit, provides better accuracy compared with classical methods known from mining topography [2].
- The method used eliminates the auxiliary operations for installation of work bridges and substantially reduce the time allocated for underground transmission system.
- Use poligonației suspended poligonal route, measuring angles on both sides of the polygonal route provides the possibility for compensation the orientations and the coordinates and so obtaining higher accuracy.

5. References

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