MONITORING OF ELLIPTICITY AND DEFORMATIONS OF THE CHAIN RANGE OF THE PISTON TUNNEL OF METROPOLITEN

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During the operation of the structures in the soil, the structures are exposed to various negative factors, due to complex hydrogeological conditions, defects of waterproofing, additional loads, errors during design and installation. These factors can affect both individually and jointly. This combination of negative factors often leads to accidents and deformation of the main carriers, therefore, timely care and periodic diagnostics of the condition of bearing structures is required. The monitoring of the status of the tunnel structure allows to prevent the development of defects, to determine the patterns of their manifestation, and if it is necessary to involve the relevant organizations to perform repair work.

In the construction of the tunnels of the Kiev subway in unstable water-soaked soils, as a permanent fixture, cast iron tubes were used. Cast iron has a number of drawbacks, the main of which is their high cost, so they are almost not used at present, but the massive use in the industrial period of development has caused today's engineers to reflect on the processes of deformation, settling and ellipticity of this type of fastening.

The cast iron rim of the tunnel is formed from sequentially mounted rings connected by bolts. Each ring consists of segments (tubing) which in turn are divided into: normal, adjacent, annular.

Most are prone to cracks – adjacent tubes (Figure 1), due to the concentration of stress in the zone of their placement. Depending on the working conditions of the structure and the external factors, deformation can occur in the vault of the tunnel in the form of its settling.

In case of excessive deformations of the tunnel circuit (according to SNiP III-44-77, the allowable deviations of the actual dimensions of the tunnel from the design position should not exceed ± 50 mm for the overpass tunnels of the subway [1, p. 38]) there is an appearance of ellipticity, which in turn leads to to the violation of the dimensions of the approach of buildings and equipment and to reduce the carrying capacity of more than 25% [2, p. 12]. In connection with the restriction of space, as a result of changes in the geometric position of the vault, a threat to the safe movement of trains is created.

As an example of the development of deformation processes in the structures of the cast-iron structure of the tunnel, a displacement between the art. "Taras Shevchenko" –

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art. “Pochaina” on the Obolon-Teremkiv line of the Kiev Metro, where the cast-iron tubing frame was fitted with the inserted flat reinforced concrete tray unit of the Lentrlubit plant (Figure 2).

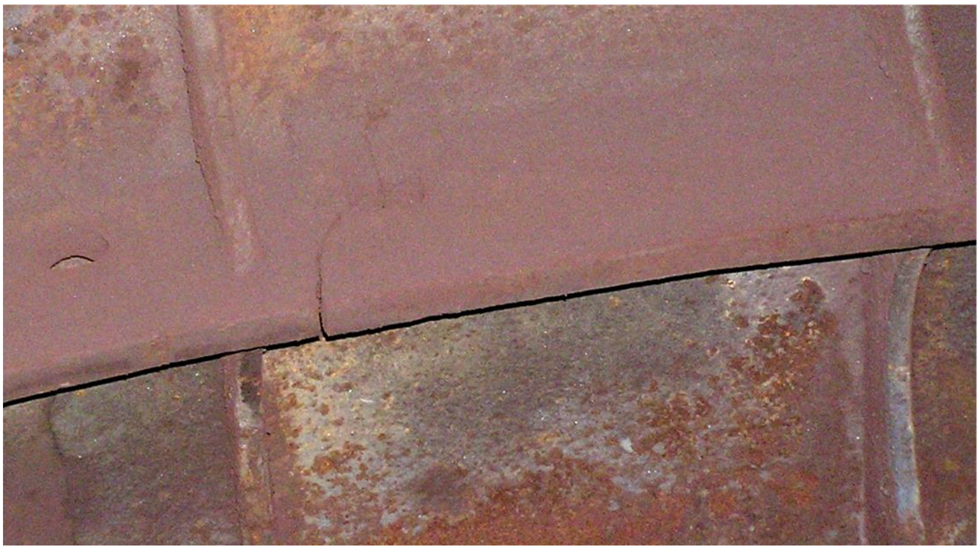

Figure 1. Fracture in the annular side of the adjacent tubing

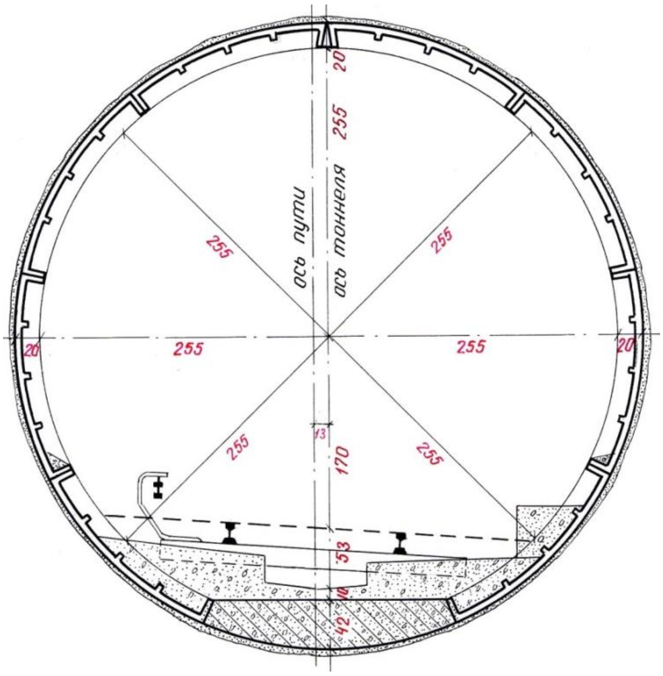

Figure 2. Tunnel frame with inserted flat reinforced concrete tray unit

The tunnels are constructed in water-soaked soils, which include layers of fine and medium-grained sand, soups and loam with peat layers. Depth range from 4 to 8 meters. The inner diameter is 5.1 m.

Fastening of a flat tray on longitudinal bonds with tubing – bolt, ring joints of bolted joints do not have. A wedge-shaped gasket was used as a fixing element instead of a ring tube. The disadvantage of such processing is the difficulty of obtaining a dense connection of the tray unit with a tube on the plane of the longitudinal joint due to the different precision of the manufacture of the docking elements. The gap formed during the installation of the block is eliminated by the tightening of bolts is impossible, as a result of the vibrodynamic loads of rolling stock there is an expansion of the joint with the deformation of the concrete base of the track and the emergence of the flow with the removal of sand in the tunnel. In addition, such processing eliminates the laying of joints and the necessary tight fastening of elements along the development pathway, which, together with the complicated hydrogeological conditions, vibrodynamic loads from the movement of trains of the subway, and periodic loads from the surface, from the movement of many freight trains, causes the appearance of ellipticity [3, p. 67].

Ellipticity is to expand the horizontal diameter and compression of the vertical (Figure 3).

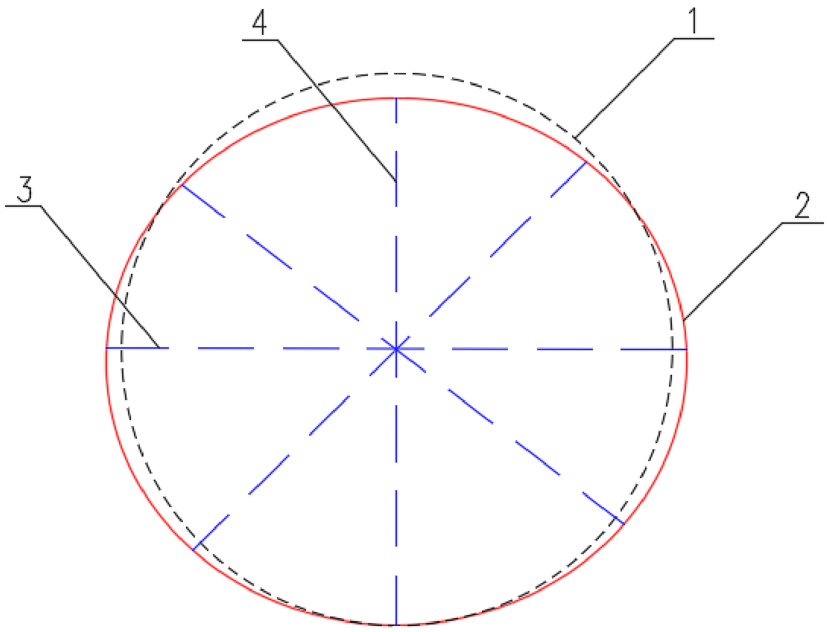

Figure 3. Elliptic ring

1, 2 – the design and the actual situation; 3, 4 – horizontal and vertical ellipticity

During the survey (at the stage of operation of the tunnel), monitoring of elipticity is carried out by measuring the horizontal diameter and the size of the depressions of the vault using a spacer or laser instrument. Thus, during the period of operation, the maximum settling of the vault of the tunnel arm reached -277 mm with an intensity of up to 10 mm per year. In rings exposed to deformation, there were cracks with the opening up to 2 mm in the annular board with the transition to the back of the tubing.

12 mm thick metal plates, which were installed by fastening bolts to the cluster of the tunnel (Figure 4), were used as reinforcement of the frame. Thus, it was possible to distribute the stresses and to partially reduce the further settling of the top of the tunnel.

The main reasons for the appearance of deformations in such designs can be attributed:

– absence of uniform hardening of the setting, due to design features;

– complicated hydrogeological conditions of the tunnel;

– influence of vibration dynamical load;

Figure 4. Metal plates in the vault of the tunnel

Based on the foregoing, it can be concluded that for the control of the elasticity and strain of the tunnel, a periodic inspection of the technical condition of the structures with fixing of damage and sedimentation measurements is necessary.

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