No building project today can be implemented without corresponding geodetic support. The requirements on the precision of geodetic services are regulated by state standards and sanitary norms and regulations.

Geodetic support includes layout works and periodic monitoring of structural deformations in buildings, service lines, and machinery during installation and service. The mean quadratic error in geodetic measurements can be accepted as 20% of the admissible deviation specified in the Construction Norms and Specifications. Hence one can estimate the required accuracy of geodetic measurements. It should be noted that contemporary engineering involves construction of large industrial facilities that require a high precision of geometrical relations of all units in the technological lines. Furthermore, such industrial complex should satisfy the condition of time stability of the deformation properties of its structural and technological elements. This is especially important for industrial conveyors in fine-technology lines.

A modern facility is an integrated complex, where the final result depends on precise operation of all technological units, although their operating regimes may be different. Examples of such production facilities are sheet glass production lines in Saratov, which integrate several technological units continuously operating under different service conditions.

Different service condition of machines impose certain requirements on geodetic servicing of the production complex. The conditions of geodetic measurements in the course of installation are roughly the same for the whole complex, but later on, when each machinery item requires deformation stability control, the traditional methods of geodetic measurements in some cases do not provide necessary accuracy. Therefore, one needs new methods for performing geodetic work in particular conditions. Furthermore, additional problems arise in operation, which do no exist in the installation period, such as protecting instruments from unfavorable ambient conditions, vibration fields, and machinery wear.

The results of geodetic measurements are relevant to solving the above problems. Thus, the Saratov sheet glass production line has four main machinery components: the glass-melting furnace, the melt tank, the annealing furnace, and the roller conveyor. They operate in different conditions, which differ significantly from the installation conditions; the temperature in the glass-melting furnace, the melt tank, and the annealing furnace increases significantly in operation, furthermore, intense vibration fields arise in the annealing furnace and on the roller conveyor. The monitoring of the annealing furnace and the roller conveyor to detect deformation processes requires geodetic measurements on rotating surfaces.

In this context, the aim of the authors was to develop tools and methods for geodetic measurements to be used for rotating rollers of the roller conveyor and the annealing furnace and also under the conditions of poor visibility and intense vibration in the production zone.

In the first case a special leveling rod was designed allowing for leveling the conveyor rollers during their rotation and in the second case we developed a laser sighting device combined with another leveling rod to compensate for poor lighting and intense vibration.

Rods for precision leveling of rotating surfaces. The use of traditional geodetic measurement methods in the course of installation, adjustment, and periodic monitoring of certain segments of the conveyor lines containing rotating surfaces, for instance roller conveyors, is problematic. In fact, the traditional method of precision leveling ensures the required precision of installation works, but these methods
become inapplicable during operation. The conveyor, as a rule, has a continuous production cycle, therefore, stopping a technological unit even for a short time is impossible. This calls for new measuring methods and sometimes new measuring instruments. In our case we propose a modified leveling rod for precision leveling of conveyors rolls during their rotation. The modification consists in designing a special rod heel that would allow for precision leveling of the rollers both in the stationary mode and in rotation. For this purpose the leveling rod was placed on a platform enabling its rotation around the vertical axis (Fig. 1).

Leveling using this rod was performed as follows. The telescopic systems were detached and the rod was placed atop the roller for the support and fixing bearings to contact the roller surface. This preparatory work was carried out before leveling for the purpose of taking into account the roller diameters at the given production line. Having fixed this position with the telescopic system clamps, the rod was turned facing the observer. After that the reading procedure was performed, which is prescribed by precision leveling requirements.

The advantages of the specified rod were tested during the repair of the sheet glass production line at the Saratovstroisteklo Company.

Experimental studies were performed in two stages: during the installation of the conveyor rollers and during the operation of the conveyor. This made it possible to evaluate more objectively the proposed rod design in leveling the rotating roller surfaces. The validity of the estimate was determined by means of leveling rollers in first statically and then in dynamics.

In the first case, the measurement conditions fully satisfied the requirements on precision leveling. Altogether 103 rollers were leveled during the installation of the conveyor, each on the left and the right side. Leveling was carried out using a standard rod with 5-mm graduation and the rod with the modified heel (Fig. 1).

Accepting the results of the first leveling as true values, we estimated the results of leveling with a modified rod. In general the results were satisfactory: the mean quadratic error in determining the roller elevation was ± 0.3 mm. True, we excluded gross errors from the error series, since our analysis indicated that they were caused by inaccurate roller manufacture and their unsatisfactory asbestos coatings: the roller diameters in some cases differed nearly by the value of leveling accuracy. This affected the mounting of the leveling rod on the roller top: sometimes when the lateral fixing bearings were fixed, the support bearing did not touch the roller surface, in other cases the end of the rod was unsteady and the support bearing kept slipping off the top to one or the other side, which changed the readings. The values of such variation was relatively low, however, it existed. This circumstance suggested the idea of replacing the single support bearing by two bearings and leaving only fixing spring clamps in the lateral telescopic systems. In such a case the bearings would be positioned on both sides of the roller top and their constancy would be maintained. This modification was not studied by the authors, since it required making a new heel.

After obtaining positive results in leveling with the modified rod, experiments were continued on rotating rollers, where the standard rod could not be applied. The modified rod allowed for leveling, although certain difficulties were observed.

These difficulties originated on the operating line due to inaccurate manufacture of rollers and their asbestos coatings. It could be expected that roller vibration is inevitable, but the true situation was discovered in dynamics, i.e., in the course of the roller rotation. We had to register the maximum and minimal indications and the final value was taken as the mean of the obtained values. Despite taking this measure, the leveling precision was lower than on stationary rollers: the error increased 2 – 3 times. It should be noted that vibration of rollers is the main source of error in leveling rotating surfaces. These difficulties increase in finding mean indications on the sites of vibration fields, where vibration directions are added to the roller vibrations. Furthermore, a certain difficulty arises in mounting the rod to a vertical position on a rotating surface, therefore, the rod should be equipped with a circular level, which will eliminate the error caused by the deviation of the rod from the vertical direction.

The vibrations of the rollers decrease the accuracy of measurements, whereas the presence of general vibration occasionally prevented getting any results due to the rod image in the telescope becoming blurred. This suggested that the