The North Donets–Donbass Canal, which was put into operation in 1958, supplies the central and western industrial regions of Donets Basin (Donbass) with drinking and industrial water. The total canal length, from the water intake installation in the village of Raigorodok to the Verkhne-Kal'mius storage reservoir in the vicinity of Donetsk, is about 130 km. The canal's capacity which is equal to its design value at the present time is 25 m³/sec in summer and 17 to 18 m³/sec in winter. It comprises five gravity sections, each at a different height. Water from the gravity sections is lifted a total height of 228 m by four pumping systems.

For a distance of 10.8 km the canal flows through a siphon pipe line. The two end sections, with a total length of 4.3 km, are made of 2.2 m diameter prestressed reinforced concrete pipe, and the central sections consists of two metal pipes laid on the ground (Fig. 1). At each 100-120 m the pipes are anchored to massive concrete supports, between which the pipes rest on intermediate sliding supports. The inside diameter of the metal pipe is 2.3 m and its wall thickness is 10 to 14 mm.

The siphon pipe line is transverse to the strike of coal strata and its central section has been undermined by tunnels since 1959. The mining of coal beneath the canal section is carried out below a safe depth of 500 m, where m is the thickness of exploitable stratum. Above 500 m protective pillars are left.

In the planning of the North Donets–Donbass Canal, special structural features were provided for the siphon pipe-line section. They protect the installation from harmful effects of mining. Stuffing-box type compensators are one of these measures. They were designed for compensation of ground-surface displacement and temperature deformations. The free movement of these compensators was ± 50 mm. The number of compensators is equal to the number of spans between the anchored supports. In addition, temperature compensators were installed at the points where the pipe line adjoins massive concrete structures. They are able to adjust to longitudinal deformations and vertical drops of the adjacent supports in the range of ±350 mm.

The next structural features are the intermediate sliding supports (Fig. 2) installed at a 4.5 m spacing between the anchored supports. The design load on each support is 12 tons. The support construction permits a mutual longitudinal shift of the pipe and support of up to 150 mm and a transverse displacement of up to 50 mm. Vertical control of up to 12 mm can be achieved by a wedge arrangement and up to 60 mm by means of packing.

Fig. 1. General view of the siphon pipe line; North Donets–Donbass Canal.
Fig. 2. Intermediate sliding support of the siphon pipe line.

Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 12, pp. 10-13, December, 1967.
## TABLE 1

<table>
<thead>
<tr>
<th>Coal strata symbols</th>
<th>Stratum angle symbols of dip, deg</th>
<th>Stratum thickness, m</th>
<th>Mining depth, m</th>
<th>Time of the shaft passage under the pipe line axis</th>
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<tr>
<td>$I_7$</td>
<td>64</td>
<td>0.92</td>
<td>485-585</td>
<td>1959</td>
</tr>
<tr>
<td>$I_5$</td>
<td>64</td>
<td>0.50</td>
<td>320-485</td>
<td>1959</td>
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<tr>
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<td>64</td>
<td>0.80</td>
<td>620-740</td>
<td>February 1965</td>
</tr>
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</table>

The body of the support is embedded in a circular concrete foundation slab; its bottom surface is conical and rests on a rubble ballast. The support foundation slab is movable and can be displaced horizontally as well as vertically, in case the shifting capabilities provided by the support design are exhausted. The thickness of the rubble ballast layer is variable. The ballast is the factor which provides a rough balance between the differential settlement of the anchored and intermediate supports.

The canal project as a whole, including the protective measures against the harmful effects of undermining, was designed by S. Ya. Shuk "Gidroproekt" Institute. In the design of the protective measures, the forecasted magnitude of ground-surface displacement in the mining area was taken as the criterion. Due to a lack of experience in the protection of similar structures against the effects of undermining, a determination of the efficiency of the applied measures became necessary. For this purpose, Don Industrial Construction Research and Planning Institute has conducted observations since 1959 on ground-surface deformations in the vicinity of the pipe line and on the installation operation. In certain years, the fellow-members of the Ukrainian Branch of the All-Union Mine Surveying Research Institute have taken part in the observations of ground-surface deformations.

Measurements of stuffing box compensator displacements, determinations of intermediate support displacements, and strain measurements in the metal pipes of the siphon installation were included in the observations. Some results of the observations are presented below. During the operation, the metal pipe line was being undermined by removal of the underlying coal strata, the characteristics of which are given in Table 1.

The data in Table 1 show that the pipe line was being undermined by two to three coal mine passages yearly. Furthermore it is evident that the maximum ground surface settlement during the pipe line operation was 400 mm (Fig. 3).

The most intensive vertical settlement occurred in 1964 in the section between anchored supports Nos. 16 and 23 (rate 50-60 mm/month). The maximum horizontal deformations of the ground surface in the observed section were on the order of -2.5 mm/m. The minimum radius of curvature (5.5 km) was between anchored supports Nos. 20 and 21 in 1964. As a rule, it exceeded 10-15 km in the remaining sections.

To determine the efficiency of the compensators in the mining region, three sections were selected on the metal portion of the pipe line. The first was situated outside the mining zone between the No. 1 and No. 2