
Saulius Gegieckas
JSC “Kelprojektas” I. Knito g. 25, Kaunas
E-mail: saulius.gegieckas@kelprojektas.lt

Abstract. In the Republic of Lithuania, there had been almost no experience in the road (roadbed) construction prior to the Panemunė bypass in terms of very complex geological, geotechnical and paleogeomorphological territories. All the roads constructed in previous decades in the Nemunas River Delta were built practically without special geotechnical and geological research and the resulting problems were solved either on the spot during construction or rectified later upon the emergence of reclaimed deformation. The article analyzes the whole process of the geological and geotechnical research during the bypass construction – from the first exploration work and designing to construction completion. The geological and geotechnical research stages are described; methods, research conditions, mistakes made, and recommendations for geotechnical investigations under similar conditions in the future are given. At the same time, the article contains the detailed geological and geotechnical conditions of the bypass, roadbed construction problems, forecasts of the roadbed seating during the design and construction with the assumption of additional factors. The article provides and analyses the actual results of the bed deposition monitoring and further forecast of the bed deposition.

Keywords: the road, engineering geological researches, weak and very weak soils, settlement, monitoring.

Conference topic: engineering geological and geotechnical researches, monitoring.

Introduction

Already in the last decade of the 20th century, with growing transport flows from North to South in the Eastern Europe and in order to distribute them within the economic commission of the United Nations, it was decided for Europe to expand the European corridor E77 Pskov – Riga – Kaliningrad – Warsaw – Cracow – Budapest. In the Republic of Lithuania, this is the highway A12 Riga – Šiauliai – Tauragė – Kaliningrad.

Having started implementation of the idea, it became obvious that neither the road through Panemunė nor interstate bridge of Queen Luisa built at the beginning of the 20th century nor local customs on both sides with the Russian Federation at that time succeeded to secure constant and comparatively fast traffic. Without this the international tract would become senseless. Therefore, there arises focus on a new state-of-art customs and new roundabout way leading around urbanized territories on both sides of the Nemunas River.

Under an agreement with the Russian Federation and at the initiative of the Government of the Republic of Lithuania, in 2002 the Lithuanian Road Administration started works for selection of the route and preparation of its special plan for the highway A21 “Panemunė Roundabout” (the initial name A12 Riga – Šiauliai – Tauragė – Kaliningrad 180.50–187.90 km (Eastern roundabout of Panemunė Settlement) (see Fig. 1) (Antanavičius, Jazbutis 2005).

Natural conditions of the highway route

From the perspective of geomorphology, the road was intended in the beginning (eastern part) of the Nemunas delta. The river flood land stipulated for the road is covered with water here in every flood. In the flood land, there are many old branches – old riverbed of the...
Nemunas, forming closed lakes (“grasshoppers”). Moreover, for the purpose of drainage rather deep (up to 3.0–4.0 m) canal were dug in the fields. The height of flood land at the riverbed of Nemunas is around 7.5 m, further 5.5–6.5 m. During floods, there occurs the process of sedimentation (deposition) in the distance up to 300 m from the Nemunas riverbed. Further from the riverbed there is less of this process today, but it appeared that in the past it was very significant to the relief formation, as the total flood land had been covered with young alluvial sediments of 2–5 m in thickness. Such fast process is seen also in the history of the last 300 years of the left and right banks of the Nemunas delta. On the left bank, in East Prussia, in the 17 century already there was built a causeway system protecting from floods; meanwhile, on the right side causeways were started at the end of 19th century only. Because of blocked flood waters deposits could not get in, the height of the relief on the left of the delta now is at 1.5 m lower than the right one (Basalykas 1965). No other active geological process is observed in the flood land; only traces of water erosion – are noticed (Gegieckas, Končius 2003).

Start of the work. Special plan

The road was intended in a sensitive area from the point of view of environment protection: at the very beginning of the Nemunas delta where with flooding brought waters fast sedimentation occurs, and any radical change can slow down or stop this process. In such case waters would carry deposits further to the Curonian Lagoon, where the siltation process is rather fast. Thus, the first task was to clarify how a subgrade built through the entire valley will influence movement of the river waters during floods that in separate cases take up to 8 months per year.

Fig. 2. Scheme of flood water flow

When the works started, several route versions were provided, but considering that the locations of the customs and the bridge over the Nemunas had been already decided on upon the interstate agreement, driving possibilities were poor, and the key factor determining the location of the route were mathematical hydraulic modeling’s carried out in the then Lithuanian Institute of Melioration in 2002. The studies performed for 6 route versions revealed that the highway has to be built as close to the existing old riverbeds as possible; to let flood waters go a bridge needs to be built in the valley, and for better water movement it is recommended to dig a channel, 350 m in width and 1.5–2 m in depth, near the bridge and behind it. It was suggested using the excavated soil for the road subgrade (Fig. 2) (Vaikasas, Rimkus 2002).

To decide on the route and find the subgrade soil wide scope geological researches were carried out. They were started together with preparation of the special plan at the end of 2002. While a final decision on the route location was taken, studies were carried out focusing on the intended location of the channel. At that time boreholes were made only and samples were taken for laboratory researches, since the goal of studies was to decide on the most optimal route version and find a possibility to use local materials for building the road subgrade. Boreholes were made with a grid every 100–150 m, the depth of a bore was 7.5–15.0 m.

At the very beginning of research works, only I and II (IV) route versions remained for consideration, and with field works still continuing the version of route II (IV) was the only one (Fig. 2). Even though it revealed afterwards that from the perspective of geology and geotechnics this version was not favourable. All further engineering geological researches were carried out in this route only. Boreholes of 3 m in depth were made in the total route of 3.3 km in length every 200–300 m, and observational boreholes 7.0–15.0 m in depth were made in locations of the intended bridge over the Nemunas channel and a trestle to the Nemunas Bridge. Geological researches for preparation of the special plan were carried out till floods of the spring of 2003. 44 boreholes 3.0–15.0 m in depth, 244 totally, were made in this stage of the researches. The boreholes were made in the auger boring, diameter 151–198 mm. The soil lifted during boring was described in detail and samples for laboratory studies were selected. In the laboratory, natural density, distribution structure and filtration ratio were discovered after optimal consolidation, also liquid and plastic limits, moisture content and quantity of organics were found. The Proctor compaction test and moisture content were found for a part of the samples. In the summer of 2003, the report of engineering geological studies based on these researches (Gegieckas, Končius 2003).

Due to the environmental institutions coordination of the special plan took till the end of 2004. In the final edition, the version of the artificial channel appeared to be not favourable not only from the point of view of environment but also of economical ones, as various fine soils, in some places with organic admixtures – clays and silt clays (Cl, siCl) – in the upper part of the cross-section contained much moisture and were actually not suitable for the formation of the route subgrade. When it was decided not to dig the channel, the bridge height was increased, and the road profile had to be lifted up automatically; however, the researchers were not informed hereof.
Continuing the work. Researches for technical projects

Since in 2003–2004 for more than half a year the area was flooded, without the special plan approved, there were started studies for the technical project already. Floods were feared, so studies for the bridge trestle at the Nemunas were performed in September of 2004, and at the end of 2004, when cold came and flood waters retreated, studies doe the bridge over the Nemunas channels started. It was planned also to consolidate boreholes for the route, but it failed in some locations due to the flood that started in March of 2005 and continued nearly till the winter of 2005.

Boreholes of 15–20.5 m in depth were made for the bridge and trestle, and static probing was performed. In this stage, 22 boreholes 3.0–20.5 m in depth, 261 m in total, were made. The soil excavated during boring was described in detail and samples for laboratory tests were taken. Overall, 38 soil samples were taken in this stage. To define soil deformation features and soil strength, 27 cone penetration tests were performed. The tests were carried out getting at least 2 m deep into strong soils, up to 8.4–18.6 min depth, 311.4 m in total.

The researches were finished in the autumn of 2005 when reports were delivered. They described in detail engineering geological conditions of soils and recommendations for designing and construction.

Engineering geological conditions of the route

From the geological perspective, modern (a IV) and postglacial (a III–IV) alluvial subformations prevail in the route. In some locations (at the Nemunas River), in the depth of 10.5, there occur glacial subformations of Pleistocene (g III nm), and in the whole valley, in the depth of 10.5–16.5 m, there occur aquaglacial subformations (ag II–III) (Fig. 3).

Alluvial subformations occur immediately under the fertile top soil within the whole route up to 10.5–16.5 m in depth. According to the lithologic structure and conditions of occurrence, there can be distinguished modern alluvial (a IV) and postglacial alluvial (a III–IV) subformations.

Modern alluvial subformations (a IV) occur in the whole route in the upper part of the cross-section, up to 4.7 m, and up to 16.5 m in depth in the beginning of the route and at the bridge through channels (at the old Nemunas river bed). Big porosity and bigger or smaller quantity of organics is characteristic to all these subformations. These were formed under the conditions of the river head, with almost no water flow, so there prevail fine clays and silt soils.

In the upper part up to 1.5–3.5 m, and deeper when closer to the river, alluvial subformations are similar in the whole route – mainly average plastic clays (Cl, sCl), of hard or soft plasticity consistence; plastic silts (Si, saSi) closer to the river, mainly of hard plasticity consistence. On the very surface here and there occur interlayers of fine and average silt sand (siFs, siMSa).

Deeper, from 1.5–3.5 m, at the beginning of the route till the bridge and in the location of the bridge, typical soils of deltas and old river beds accumulated – black or blue grey average plastic clays with organic admixtures (orCl, orsiCl) and sapropels (orCl) formed close river beds. Peat found in the deepest part of the river bed (siOr) is decomposed, consolidate and brown. All these subformations partially consolidated from the weight of soils occurring above, and now they are of fluidly or softly plastic consistence.

Postglacial alluvial subformations (a III–IV) appeared in formation of the Nemunas valley. These are soils washed by the river flow (river-bed alluvia) – average, minor silt (MSa) and well sorted average and course (MSa, CSA) sands with almost no organic mixture. The closest to the ground surface (0.9–2.0 m) theses subformations occur at the river, and further their ridge goes down to 5.0–6.0 m or even deeper. The bottom is reached mainly in the depth of 10–12 m (around –5 m altitude). The total bored thickness of these subformations changes from 1.1 to 9.5 m.

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Fig. 3. Principal geologic cross-section of the route
Glacial subformations of the upper Pleistocene (g III nm) bored very locally; only at the Nemunas River these are from 10.8 m. The thickness of subformations is from 1.7 to 3.5 m. The bottom in boreholes is reached in the depth of 12.5–15.0 m. This is typical grey till minor plasticity clay (sasiCl), hard and very resistant.

Aquaglacial subformations (ag II–III) are met under glacial subformations, and further from the river – under postglacial alluvial subformations, 10–15 m or deeper. These are white off, silt fine watery sands (silFSa, FSa). Yellow brown dense gravelly sands (grMSa) are found in the central part of the valley, in the depth from 20.2–22.6 m.

Hydrogeological conditions of the route are very complicated, as underground waters remain at the very surface of the ground (in the depth of 0.2–0.5 m), and in the cross-section there are met a number of intermixing watery horizons, the key of which are undersoil, modern till alluvial (the depth of 1.8–2.5 m) and alluvial interlayer waters (the depth of 4.7–16.5 m). They are compression, the height of it fluctuates from 2.9 to 12.2 m, and these waters are related to upper modern alluvial water and even to undersoil waters, and the level of all of them is in a similar height (Gegieckas et al. 2005).

### Mechanical and physical characteristics of soils

From the geotechnical point of view, two sections are distinguished in the route, as well as 3 genetic lithological complexes of soils with different geotechnical features.

#### The route from the beginning till Pk 140

Where geotechnical conditions are very complicated – from 1.6–3.8 m in depth, under weak and average strength soils (clays, sands and silts) to 6.4–18.0 m in depth there occur weak soils: boggy clays, peat and sapropels.

#### The route from Pk 140 till the Nemunas River

Geotechnical conditions are poor – to 3.0 m and deeper, there occur average strong and stronger silt sands and silts. No very weak soils appear in the profile or these are very episodically.

According to geotechnical characteristics of soils, origin and lithology, there can be 3 genetic-lithological complexes distinguished in the route (Fig. 3).

1. **the upper part of modern alluvial subformations** (floodplain alluvial), average strength soils mainly – clays (Cl, sCl), silts (Si, saSi) silt or clayey sands (FSa, sFSa, eFSa). 1.4–3.8 m, from 1.4 km 3–6 m thick in the route.

2. **the lower part of modern alluvial subformations** (delta, old river bed alluvial), weak and very weak soils settled in closed river beds. These are average plastic clays with organic admixture (orCl, orsiCl) and sapropels (orCl). In the deepest places of river beds, in two horizons – from 3 and from 14 m in depth – there is found 1.5–2 m thick peat, well decomposed, consolidate (Or, siOr), occasionally interlayered with very loose, low plasticity silts (saSi). All these subformations partially consolidated from the weight of soils occurring above, and now they are of fluidly or softly plastic consistence.

These subformations expand from the beginning of the route till 1.4 km.

### Table 1. Geotechnical properties of upper part of modern alluvial subformation

<table>
<thead>
<tr>
<th>Geotechnical parameters</th>
<th>Units</th>
<th>Values</th>
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</thead>
<tbody>
<tr>
<td>Natural density ρ</td>
<td>Mg/m³</td>
<td>1.13 0.5 2.02</td>
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<tr>
<td>Water content w</td>
<td>%</td>
<td>89 20 94</td>
</tr>
<tr>
<td>Void ratio e</td>
<td></td>
<td>0.77 0.69 0.93</td>
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<tr>
<td>Liquid limit wL</td>
<td>%</td>
<td>35.0 29.5 41.2</td>
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<tr>
<td>Plasticity index Ip</td>
<td>%</td>
<td>12.9 6.1 17.2</td>
</tr>
<tr>
<td>Modulus of deformation Eo</td>
<td>MPa</td>
<td>6.3 1.2</td>
</tr>
<tr>
<td>Cone resistance qc</td>
<td>MPa</td>
<td>1.1 0.5 5.5</td>
</tr>
</tbody>
</table>

### Table 2. Geotechnical properties of lower part of modern alluvial subformations

<table>
<thead>
<tr>
<th>Geotechnical parameters</th>
<th>Units</th>
<th>Values</th>
</tr>
</thead>
<tbody>
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<td>Natural density ρ</td>
<td>Mg/m³</td>
<td>1.53 1.05 1.94</td>
</tr>
<tr>
<td>Water content w</td>
<td>%</td>
<td>89 29 294</td>
</tr>
<tr>
<td>Void ratio e</td>
<td></td>
<td>2.09 0.77 5.09</td>
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<tr>
<td>Liquid limit wL</td>
<td>%</td>
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<tr>
<td>Plasticity index Ip</td>
<td>%</td>
<td>22.3 5.6 45.6</td>
</tr>
<tr>
<td>Modulus of deformation Eo</td>
<td>MPa</td>
<td>1.5 1.2</td>
</tr>
<tr>
<td>Cone resistance qc</td>
<td>MPa</td>
<td>0.72 0.2 1.2</td>
</tr>
<tr>
<td>Organic content</td>
<td>%</td>
<td>14.5 3.5 62.7</td>
</tr>
</tbody>
</table>

### 3. the upper Pleistocene and older soils – formed mainly in the postglaciation alluvial dense sands (FSa, MSa, CSA), hard till low plasticity clays (sasiCl), dense (strong) glacial sands (sifSa) and silts (saSi). They occur is the whole route from 5–6 m, at the beginning of the route – from 7–1, 50 m in depth.

### Table 3. Geotechnical properties of upper Pleistocene soils

<table>
<thead>
<tr>
<th>Geotechnical parameters</th>
<th>Units</th>
<th>Values</th>
</tr>
</thead>
<tbody>
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<td>Natural density ρ</td>
<td>Mg/m³</td>
<td>2.08 2.02 2.16</td>
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<tr>
<td>Void ratio e</td>
<td></td>
<td>0.58 0.47 0.6</td>
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<tr>
<td>Density index Ip</td>
<td></td>
<td>0.72 0.48 0.96</td>
</tr>
<tr>
<td>Modulus of deformation Eo</td>
<td>MPa</td>
<td>62 28 84</td>
</tr>
<tr>
<td>Cone resistance qc</td>
<td>MPa</td>
<td>21 6.4 29.7</td>
</tr>
</tbody>
</table>
Key solutions of the technical project

Technical projects were prepared separately for the highway, the bridge over the channels and for the trestle before the Nemunas Bridge. Their preparation started in the middle of 2005, but due to in determination where soils for the roadbed could be taken from and what kind of soil it could be, preparation of the technical project for the road continued till 2007. The technical projects for the bridge and trestle were prepared under a usual order, stipulating supporting the bored pole foundation to strong and very strong soils of the Upper Pleistocene.

The process of designing the roadbed slightly differed. Since following the Technical Regulation for Construction of the Republic of Lithuania “Building design” geotechnical design is not established in the scope of the project (as not established till nowadays), the roadbed soils, as support for the roadbed, was not analysed and likely settlements were not calculated. Considering recommendations of engineering geological studies, it was taken into account that the roadbed was built on soils of insufficient stability, and settlements may occur. Thus, to secure its stability and prevent wash out of soils by flood waters, it was intended to reinforce the roadbed with a geosynthetic material. It was planned to build the roadbed using washed out course soils – average course and course sands (MSa, Csa). The intended Proctor compaction index \( I_p \) is 1.0–1.05. The roadbed had to be entirely reinforced with geosynthetic material, forming 60 cm thick sand packs (Antanavičius, Jazbutis 2007).

Road construction. Research during construction

Technical projects for the road, bridge and trestle were finalized in 2007; however, construction works started only after the agreement of the Republic of Lithuania and the Russian Federation on the construction of the bridge over the Nemunas River in 2013. Additional control studies in the location where the bridge goes over the channels were carried out since places of supports had been changed, and due to large thickening of weak soils, there were deeper foundations designed; therefore, researches in bigger depth were necessary. At that moment, there were totally 3 boreholes of 22–26 m and 4 boreholes of 11 m made and there was cone penetration test carried out to 15–22 m (Svirplis et al. 2013). The attempt to get sand from the river failed, so the roadbed was built from brought poorly silt sands (FSa, MSa), reinforcing with geosynthetic material every 1.20 m. With some breaks in the wintertime, the road construction took 2 years, and it was finished in June of 2015. Generally, the main works of the road construction were finished in the autumn of 2014: till October the asphalt concrete was covered almost everywhere and barriers were built.

After 2 month, settlement of Pk 6 asphalt concrete covering was noticed in the joint to the bridge. In the end of November of 2014 the technical levelling of the cover was carried out, and it revealed the cover settlement in the section of 40–50 m before the bridge. Then, settlement at the bridge reached up to 50 mm of the project height; further, it was lower in proportion. It was necessary to establish the reasons for such settlement of the roadbed. Therefore, at the beginning of 2015, additional control engineering geological researches were performed. During these researches, dynamic probing and cone penetration test were carried out in the section of 60 m of the roadbed; boreholes were made both in the roadbed and next to it; 2 depth-rappers were arranged under the roadbed that, as well as the cover, have been constantly levelled since 3 March of 2015 till today (April of 2016). Overall, during additional researches, by means of auger boring, O198 mm, there were 4 boreholes 3.0–26.0 m in depth made, 35.0 m totally; 2 dynamic probing with heavy dynamic probe were made to the depth of 7.0 m, and 9 cone penetration tests (CPT), to 24.70 m, 133.4 m totally, were carried out. The cone penetration tests was performed using cone penetrometer following LST EN 1997–2:2007. Additional researches helped clear out that the roadbed was made of fine and average course sands (FSa, MSa), with low silt in some places. The bridge support I and the roadbed next to it were built in an especially complicated place from the geological and paleogeomorphological point of view. Besides big thickening of weak soils “buried” here, there we have a very complex paleo-relief. The thickening of weak soils in section 15–20 m varies from 8 m to 13–14 m. Moreover, it revealed that the roadbed in the studied section was built in a very short period of time (a week or two), and even though it was well consolidated further from the bridge, in the approaches to the bridge (10 m from the bridge) consolidation is not sufficient, and in some intervals the roadbed is even loose. It was stated that communication laying works were performed in the roadbed in this section and clay on the surface was destroyed – instead, there remained up to 0.6 m thick layer of weak soil polluted with mould. Additionally, next to support I there was found an area of especially weak soils that could occur during building of boring poles and breaching very weak soils due to very complicated geological and hydrogeological conditions. It was stated that all the aforementioned reasons could determine the total settlement of the roadbed, and due to the mentioned conditions small settlements of the roadbed are likely in the future, so it is recommended to fix deformations next to the bridge support I with as long delay as possible, building in section 30–35 m a new road basis and covering, and when restoring the covering, a compensation should be stipulated at the point of connecting the bridge and the covering.

Since the additional researches disclosed great (over 50 %) fluctuations of the depth of the bottom of weak soils, it was decided to once again bore the entire route till the bottom of weak soils and try to bind the results of the entire route leveling with thickness of weak soils. For this purpose, 7 more boreholes were made near the roadbed, 10.5–15.0 m in depth, 85.5 m totally, a geological lithological cross-section was supplemented and technical leveling of the covering was performed.
When comparing the leveling results with the project heights of the covering, attempts were made to equate the difference with thickenings of weak soils in the route. However, no direct dependence was discovered, even if discrepancies with the project heights are numerous. Recalling the conclusion that especially complicated conditions in the route continue to Pk 10 + 50 only, it can be stated that discrepancies with the project heights before the bridge (Pk 6 + 23) are bigger than after it (from Pk 10 + 92) (Gegieckas et al. 2015).

Monitoring of settlement of the covering and depth-rappers. Settlement forecast

The covering monitoring started immediately after noticing its settlement, since the end of November of 2014. Planned monitoring has been carried out since 3 March of 2015, building 17 covering and 2 depth-rappers (lower than the roadbed). Monitoring has been carried out in the road section Pk 5+45 – Pk 6 + 22, in the road axis and the left edge of the covering where the greatest settlements observed after the construction. The depth-rappers were built in the road axis Pk 6 + 00 and Pk 6 + 19. At the beginning, the technical leveling was performed every 2 weeks, and after finalizing the construction, since July of 2015, every month. It is intended to continue monitoring within the entire warranty period (5 years after the construction) or till settlements are set out during the technical leveling.

Having summarized the results, it was established that within the period of 13 months the covering settlement is 121 mm on average, at the bridge (from Pk 6 + 10) 132–161 mm. A same tendency for bigger settlement at the bridge remained from the beginning to the end of monitoring, only in the beginning the difference was bigger, in the period December 2014 – April 2015, the covering settlement at the bridge (from Pk 6 + 10) was twice faster (up to 20 mm/month) compared to the section further from the bridge. The settlement of the depth-rappers was 139 mm, almost the same as of the covering in this location. Within the period of monitoring, the average settlement speed of the roadbed reduced threefold: from 14–15 mm per month (March–May 2015) to about 5 mm per month (January – March 2016). The settlement of depth-rappers slowed down similarly: from 15–16 mm/month to 6 mm/month respectively. The speed of the roadbed settlement is shown in the chart below (Fig. 4).

The chart gives a curve of forecast settlement speed in time, calculated using actual measurements. It shows that in the first months after the roadbed construction, the settlement speed could reach about 30 mm per month, and the total roadbed settlement from its construction till today can reach about 30 cm. With such trend, the settlement of the roadbed in this location within the following year will be 5 cm more and overall within five years from the end of construction (June 2015 to June 2020) it can be 15 cm more. Afterwards, the settlement speed should not be more that 2–3 mm per year (Fig. 4).

Thus, within five years for the end of the construction, when settlement should actually stop, the total settlement of the roadbed can reach up to 40 cm. In any case, this is significantly less that theoretical calculations performed when the first deformations appeared. Calculations made using the way of sum consolidation of weak layers showed settlements from 45–70 cm (an optimistic scenario) to 115–140 cm (a pessimistic scenario). Even greater settlements were demonstrated by various computer settlement calculation programs – these were from 170 to 240 cm, or even around 4 m.

It can seem strange but the scope of the roadbed settlement and speed does not relate with thickness of very weak soils. Thickness of weak and very weak soils in the monitored section vary from 5.5 m Pk 5 + 50 to 145 m Pk 6 + 00 and 8.0 m Pk 6 + 20. However, the settlement speed is actually equal, with greater one at the
bridge only, knowing that thickness of weak soils is not the biggest here. It is very likely that the main reason for this is a rather thick layer of average strength binding clayey soils occurring under the roadbed from above, operating as a solid body and distributing load of the roadbed in much larger area, and therefore the load do not affect very weak soils occurring in a great depth. This theory is also confirmed by the history of construction rappers, when in the second year of the construction there was noticed a non-relation of 6 cm between the bridge and the roadbed rappers. The latter ones could undergo settlement caused by the weights of the built roadbed with the entire massif under the roadbed at once.

Conclusions and recommendations

1. The road was built in a very complicated area from the point of view of environment, hydrology, geology and geotechnics.
2. Within the entire period of researches, design and construction the researcher, designer and constructor failed to work in a close relation. The route selection and project solutions were made without advice of the researchers.
3. From the very beginning of researches, there were no clear program and research tasks. The researches were not informed about the height of the causeway, thus, researches were carried out for the standard causeway of 3 m in height.
4. When designing the roadbed and causeway, no likely settlements of the roadbed due to weak soils occurring deeper were analysed. Since different authors designed the bridge and the causeway, nobody took under consideration the likely scope of causeway settlements in the approaches to the bridge. The intended standard means – a transitional plate of 6 m in length – was obviously not enough under such conditions.
5. The main reason for all defects in Points 2–4 is that the Technical Regulation for Construction of the Republic of Lithuania “Building design” does not establish and stipulate a geotechnical project part; there is no also a project manager for such part whose duties could be coordination of all issues related to the basis for buildings.
6. Under complicated geological or geotechnical conditions, it is recommended for the project manager, at his own initiative, to assign a specialist for evaluation and coordination of the entire geotechnical part of the project following Eurocode 7, till this is not regulated by laws of the Republic of Lithuania.
7. It is recommended to carry out engineering geological and geotechnical researches under similar conditions according to geotechnical category III at least in separate complicated sections. Additionally, detailed researches are necessary at the bridge approaches.
8. Under complicated conditions where thickness of weak soils significantly changes every ten and something meters, the route researches should widely use unconventional study methods, including geophysical methods that could provide a possibility to establish the geometry and distribution of weak soils in more detail to compare with boreholes or field tests. The most rational way is to select locations for boreholes based on the data of geophysical studies.
9. In the absence of detailed and precise researches of weak soils, forecast calculations of settlements are very scattered and unreliable. The settlement curve made according to the actual data demonstrates several times smaller settlement when compared with theoretical calculations based on geotechnical parameters.
10. The total settlement of the roadbed in the junction of the bridge and the road within 13 month of monitoring was 121 mm. Within the same period the settlement speed reduced threefold: from 15–16 mm/month to 5 mm/month.
11. The forecast settlement curve based on actual settlement data shows that in the nearest future the roadbed can deposit by 5 cm, and more significant settlements will stop within the following three years. The total settlement of the roadbed till its full stabilization can reach around 10 cm.
12. Thickness of weak soils, at least within the period of monitoring, had no impact on the scope and speed of the roadbed settlement.

References