TECHNICAL REPORT

Base project for editing riverbed Kozjacka, village Karbinci, Karbinci Municipality

Introduction

River Kozjacka is a left tributary of the river Bregalnica basin of northwestern exposure. Springs are formed from the western slopes of Mount Plackovica the main source of altitude 1240 meters above sea level, the river Vrteska and sources of river Kodzha Dere 1100 meters altitude.

In the composition of these two rivers form Kozjacka river to the confluence of the river Bregalnica has northwestern direction of flow. In the upper river Kozjacka has developed hydrographic network and wide basin with greater forest and mild slopes, while the middle reaches of the river have seen quite pronounced narrowing of the basin, a rare forest and steep slopes to the monastery Kozjak.

Of this section until the confluence of the river Bregalnica river takes lowland character and shaped progress only in terms of larger waters. In periods of less water, especially in the summer months lower flow remains without water, the main reasons deposit of water and extraction of the water for irrigation. Elevation Kozjacka River Basin extends from the highest elevation of 1569 meters above sea level on top of Dzalija to the lowest point at the confluence of the river Bregalnica at Karbinci village in elevation of 280 meters above sea level.

The presumed height distribution in the catchment areas of the river Kozjacka, notes that the largest share in the total catchment area have areas with an altitude of 800-1000 meters above sea level with representation of 23 km^2, or about 50% of the total area of the watershed to the considered profile.

Kozjacka natural bed of the river in recent years does not provide sufficient bandwidth to safely miss the big waters flooding after torrential rains on the slopes of Mount Plackovica the catchment area of the river Kozjacka.

By morphological view existing bed undergoing deformation of the part over the bridge where the existing dykes (existing bed) is deformed and insufficient purification of sludge and obstacles that arise under the bridge it comes to reducing the flow so it comes to spill over the bridge section. The section of the bridge towards the river Bregalnica through existing cascading skirts and leveled their good placement does not arise filling the bottom. Only part of the corner about 200 m from the bridge on the right side of the river has come to undermine the embankment with bigger sizes there is an outbreak of helical flow in turn causing destruction of concave mound. All that can be seen from geodesic recording is performed after the flood ie made cross-sections of an existing bed. It can be seen from the accompanying photographs of the current state of the river

According to hydrological analysis undertaken Kozjacka River Centennial leading low probability of occurrence amount Q_{100} = 48.0 m^3/sec, therefore, together with the quantities of rainwater Q_{atm} = 202 m^3/sec will be taken as authoritative quantity dimensioning trough regulation the riverbed. This amount of Qmax = 250 m^3/sec are shown in this year's floods that hit the municipality of Karbinci and come to fulfillment and spill over the bridge section. So the further dimensioning taken this amount of maximum results.

The level of the existing riverbed is formed with cascades that are pre-formed, due to the small decline in route . .New Projected leveling route ,vertical alignment of the route will be the same slope J = 0.60% as the remaining existing cascading thresholds. When performance is required in the operation of the route of construction machinery to continuously record the route of the vertical alignment of the riverbed and the embankments of the river bed. On the subject of section elected a structural profile in the shape of a trapezoid, and sizing is done Qmax = 250m^3/sec.

The hydraulic calculations for throughput capability of the regulated river bed made and adopted a kind of typical cross section that will fit in the surroundings.

Key elements of the profile in the form of a trapeze are:

Width bottom: b = 18 m

Maximum height of filling: h = 1.70 m

Overall height of the river bed h = 1.50 m

Steepness of the slopes of the basin: 1: 1

As required height can be obtained by dike, because there is not enough space as it should and walkway where flood of great waters they will be prevented from overfill protection with reinforced concrete fence with a height of 1.00 m above ground and reinforcement of its adoption constructive because the pressures are balanced, and it does not need a static calculation. The same applies to the stairs to join the promenade.

Reinforcing the basin is provided by coating the slope of crushed stone and concrete MB30. Below it has a coating of sand and rubble stone with a thickness of 10 cm. The minimum dimension stone cladding needs to be 15 centimeters. Because these are existing thresholds with slapishte and they are already in operation more than 60 years and the appearance of them will damage and undermine them, and no occurrence of rejection jump over existing slapchishte, with no need for calculation and dimensioning them.

Current state

The current status of the existing river bed of r.Kozjachka is determined based on the prospect of the field, and by carrying out surveying recording the entire length of the section of r.Kozjachka, village Karbinci. The position of the objects is determined with a high degree of precision.

The starting point of the project is located at the bridge on the regional road Karbinci - Argulica 50 m above the bridge.Along the riverbed there are cascading skirts that are in good condition and design is required to comply with them.

During the last flood in 2015 made major damage to the dikes as the left and the right side of the river Kozjacka and Karbinci Municipality perform cleaning intervention on which the embankments have been returned in its original condition and cleared the riverbed.With undertaken interventions that would come back to such a flood in those sizes, damages would be the same and it is necessary to regulate the riverbed r.Kozjachka.

The following photos showing the current state of the field after the interventions by the Karbinci Municipality:

Picture No.1 Looking to bridge the regional riverbed of r.Kozjachka, village Karbinci

Picture No.2 Existing cascading thresholds riverbed of r.Kozjachka, village Karbinci

Hydraulic calculations

According to the adopted authoritative amount of water Q_{max} = 250m^3/sec. They made calculations for dimensioning the cross-section of a table covered with a stone bed in a layer of concrete MB25. The hydraulic calculation is given of the flow curve. Hydraulic calculations for sizing the regulated watercourse are given below. The hydraulic calculation is given of the flow curve. Hydraulic calculations for sizing the regulated watercourse are given below.

h	B	O	A	R	C	V	Q
0.2	18.39	18.56	3.64	0.196102	25.40735	1.89886	6.91185
0.4	18.77	19.11	7.356	0.38486	28.42906	4.665724	34.32106
0.6	19.15	19.67	11.148	0.56689	30.32461	7.819537	87.17219
0.7	19.34	19.94	13.0725	0.655558	31.06804	9.491394	124.0763
0.8	19.53	20.22	15.016	0.742745	31.72138	11.21076	168.3408
1.0	19.91	20.77	18.960	0.912916	32.83098	14.76011	279.8517
1.2	20.29	21.32	22.98	1.077844	33.7524	18.41859	423.2592
1.4	20.67	21.87	27.076	1.237926	34.54044	22.15346	599.827
1.6	21.05	22.42	31.248	1.39352	35.22878	25.94176	810.6282
1.8	21.43	22.98	35.496	1.544949	35.8397	29.76693	1056.607
2.0	21.81	23.53	39.82	1.692506	36.38875	33.61674	1338.619
2.2	22.19	24.08	44.22	1.836457	36.88719	37.48203	1657.456

Rough coefficient which performed calculations is n = 0.03, and the projected decline in the riverbed is Sf = 0.6%.

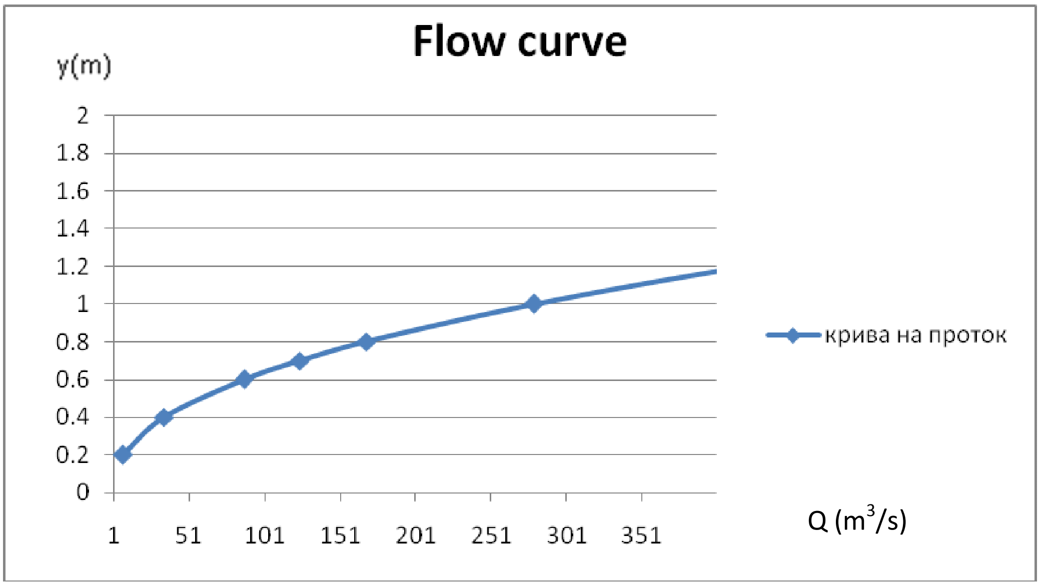


Table 1: Calculating the ability of failure of natural watercourse

stasionary	A(m^2)	O (m)	R	1/n	R^1/6	C	i	(R*i)^1/2	V(m/s)	Q(m^3/s)
0+000.00	48.59	66.79	0.728	33.33	0.95	31.61	0.7	0.71	22.56	1096.14
0+050.00	17.23	55.74	0.309	33.33	0.82	27.41	0.7	0.47	12.75	219.68
0+051.69	22.34	55.04	0.406	33.33	0.86	28.68	0.7	0.53	15.29	341.54
0+060.87	29.19	60.25	0.484	33.33	0.89	29.54	0.7	0.58	17.20	502.17
0+069.95	33.53	57.83	0.580	33.33	0.91	30.44	0.7	0.64	19.39	650.20
0+100.00	38.89	47.23	0.823	33.33	0.97	32.27	0.7	0.76	24.50	952.82
0+150.00	34.19	60.10	0.569	33.33	0.91	30.34	0.7	0.63	19.15	654.65
0+200.00	36.66	50.22	0.730	33.33	0.95	31.63	0.7	0.71	22.61	828.89
0+250.00	55.63	57.69	0.964	33.33	0.99	33.13	0.7	0.82	27.22	1514.29
0+300.00	32.37	43.86	0.738	33.33	0.95	31.69	0.7	0.72	22.78	737.26
0+350.00	44.12	49.17	0.897	33.33	0.98	32.74	0.7	0.79	25.94	1144.69
0+373.94	32.7	47.40	0.690	33.33	0.94	31.33	0.7	0.69	21.77	712.01
0+374.48	35.56	53.77	0.661	33.33	0.93	31.11	0.7	0.68	21.17	752.78
0+400.00	43.58	42.17	1.033	33.33	1.01	33.52	0.7	0.85	28.51	1242.33
0+450.00	31.63	43.76	0.723	33.33	0.95	31.58	0.7	0.71	22.46	710.46
0+500.00	33.8	46.01	0.735	33.33	0.95	31.66	0.7	0.72	22.71	767.46
0+510.61	39.26	46.72	0.840	33.33	0.97	32.38	0.7	0.77	24.83	975.01
0+511.57	38.13	46.72	0.816	33.33	0.97	32.22	0.7	0.76	24.36	928.69
0+513.76	30.8	44.44	0.693	33.33	0.94	31.36	0.7	0.70	21.84	672.71
0+550.00	37.25	48.04	0.775	33.33	0.96	31.95	0.7	0.74	23.54	876.80
0+600.00	33.9	43.67	0.776	33.33	0.96	31.96	0.7	0.74	23.56	798.56
0+650.00	30.22	42.55	0.710	33.33	0.94	31.49	0.7	0.71	22.20	670.89
0+700.00	31.02	40.06	0.774	33.33	0.96	31.94	0.7	0.74	23.52	729.50
0+750.00	28.4	38.82	0.732	33.33	0.95	31.64	0.7	0.72	22.64	643.06
0+793.26	36.64	46.00	0.797	33.33	0.96	32.09	0.7	0.75	23.96	878.04
0+794.66	25.22	41.65	0.606	33.33	0.92	30.66	0.7	0.65	19.96	503.42
0+800.00	25.32	45.97	0.551	33.33	0.91	30.18	0.7	0.62	18.74	474.48
0+854.30	31.14	42.86	0.727	33.33	0.95	31.61	0.7	0.71	22.54	701.87
0+862.36	27.93	41.25	0.677	33.33	0.94	31.24	0.7	0.69	21.50	600.62

Hydrological calculations

Critical drop charge, speed

For adopted prevail flow and adopted trapezoidal cross-section of water calculated:

a/ Critical depth h_{kr}

A=h(b+mh)=0.7(18+0,95*0.7)=13.06m^2

B=b+2mh=18+2*0.95*0.7=19.33m

Critical-flow in the riverbed valid:

$(\alpha Q^2)/g=Akr^3/bkr$

$(\alpha Q^2)/g=(1.1*48^2)/9.81=258.35\ m^5= Akr^3/bkr$ за h= hkr

The solution of the equation is a table with several superiors value and eye diagram.

Y	B	A	A3	A^3/B
0.2	18.39	3.64	48.23	2.623
0.4	18.77	7.356	398.04	21.206
0.6	19.15	11.148	1385.45	72.347
0.7	19.34	19.94	7929.45	410.003
0.8	19.53	20.22	8263.11	423.098
1.0	19.91	20.769	8958.25	449.937
1.2	20.29	21.32	9691.32	477.640
1.4	20.67	21.87	10463.33	506.208
1.6	21.05	22.42	11275.28	535.643
1.8	21.43	22.98	12128.19	565.945
2.0	21.81	23.53	13023.07	597.114
2.2	22.19	24.08	13960.91	629.153

hkr=0.68m

y_0 =0.9 m > y_k =0.68m - a quiet mode

b/ Critical fall

A=h(b+mh)=0.68(18+0.95*0.68)=13.06m^2

$O=b+2hkr(1+m^2)^{0.5}$

$O=18+2*0.68(1+0.95^2)^{0.5}=19.93m$

R=A/O=13.06/19.93=0.655

$Ikr=n^2Q^2/A^2R^{4/3}=0.7$

Ikr=0.7m/m> S_o =0.6m/m - a quiet mode

Transmission of sediment

The occurrence of the traction roller and sediment in natural water flows and transfer in the bed of the watercourse is the result of eroziskite processes primarily of fluvial erosion. General intensity of erosion can determine the transfer of sediment through one or more hydrometric profiles of the natural water flow.

At the current practice on flow measurement and transmission of the sediment profiles performed hidrometriskite is determining the amount of sediment. Due to heavy monitoring and measurement of sediment, especially in noisy streams, in practice defining the regime of this silt is carried out by empirical formulas (Herheulidze1947, Poljakov 1948, Sokolovski 1952, Gavrilovik).For our conditions and operator can apply the formula of Gavrilovik (1972) for calculating the average annual amount of traction and floating sediment for calculation, Nup (m^3) of a noisy stream or area subject to erosion.$Nup=\pi AHgsrTk(Ke^3)^{0.5}$

$Tk=(Tgsr/10+0.1)^{0.5}$

Tgsr-Average annual temperature of the noisy basin =12.4℃

Hgsr- Average annual rainfall (mm)= 680mm

$Tk=(Tgsr/10+0.1)^{0.5}$

$Tk=(12.4/10+0.1)^{0.5}=1.157$

$Nup=3.14*48*680*1.157(0.776^3)^{0.5}=81059.84\ m^3$ Total quantity of sedimentin the basin

Nu=Kr*Nup (m^3)

$Kr=((Osl*\Delta h)^{0.5})/((0.25(L+10))$

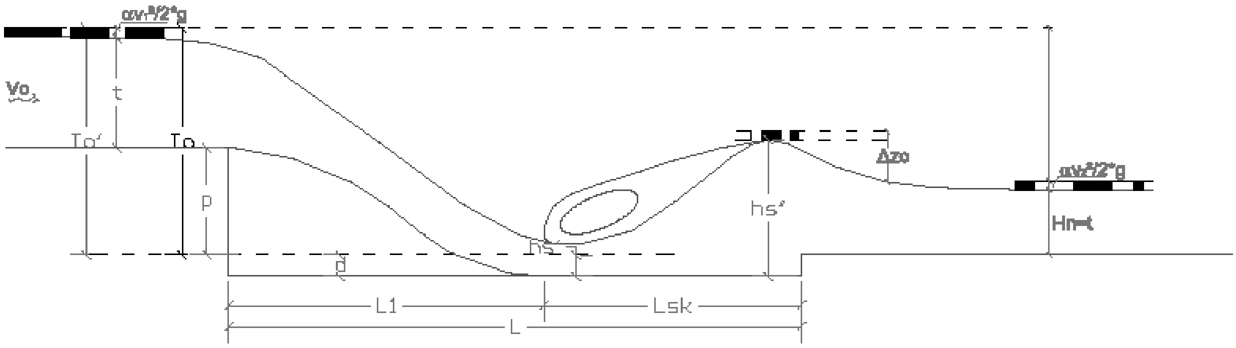
$Kr=((19.93*0.09)^{0.5}/((0.25(18+10))=0.191$

Nu**=**Kr*Nup =0.191 *81059.84 =15510 m^3/god

CALCULATION OF STORAGE

Cascade H=0.70m J=0.4% stasionary:

Storage scheme



Flow .... Q=250m^3/s
Height of inflow water... h_{dol}=1.7m
Downstream height... h_{niz}=1.7m
Input speed .... V_{doz}=19.14m/s
Height of scale.. p=0.70m
Steepness of slope.. m=0.9
Static Security rebound .... σ=1.05
Coefficient of speed.. φ=0.95
Koriolisov'scoeficient.. α=1.05

Energetic height :

$Ho=h_{doz}+(\alpha*v^2_{doz})/2*g$ (m)

Ho=1.7+(1.05*19.14^2)/19.62 = **21.30m**

-Lenght of hidraulic rebound: $L1=\varphi*(Ho(2*p+h_{voz}))^{0.5}$

$L1=\varphi*(Ho(2*p+h_{voz}))^{0.5}=0.95((21.30(2*0.70+1.70))^{0.5}$

L1=7.72m

Calculated storage width with a rectangular cross section corresponding to the trapezoidal profile of the basin upstream of storageby prof.Gurovik is calculated:br'=b+0.8*m*t+0.1*L1 wheres

b width of trapezoidal profile of the bottom

m inclination of the slope of the table bed

L1Lenght of hidraulic rebound

br'=18+0.8*0.9*19.6+0.772 = 32.884m

Shrunken down depth hc'

The first assumption is for **hc'=0**

$hc'=Q/br''*\varphi((2*g(Eo-hc'))^{0.5}$ (m)

$hc'=250/((0.95*32.884((2*9.81*(21.3-0))^{0.5})$

hc'=0.391m Does not fit

The second assumption is for **hc'=0.391**

$hc'=250/((0.95*32.884((2*9.81*(21.3-0.391))^{0.5})$

hc'=0.395Does not fit

The third assumption is for **hc'=0.395m**

$hc'=70/((0.95*32.884((2*9.81*(21.3-0.391))^{0.5})=0.395$ m- **It fits**

Determination of the second coupled depth

for a single flow q = Q/br' = 250/32.884 = 7.6 m^3/sek m'

$hc''= (hc'/2)*((1+8*\alpha\, q^2/g*hc'^3))^{0.5}-1))$

$hc''= (0,395/2)*((1+8*1.05*7,6^2/(9.81*0,395^{3'}))^{0.5}-1) =1.3m$

Since hc''=1.3<hvoz=1.7m the jump of the water is not rejected there will not require lowering the bottom of the stortage.

Calculation of the minimum size material coating

Calculation of the resistance

τ=ρ g R I

where :

ρ-Density of water=1000kg/m3

g-Earth acceleration=9.81

R -hydraulic radius

J-fall

τ=ρ g R I=9.81*1000*0,655*0.06=385,53 N/m^2

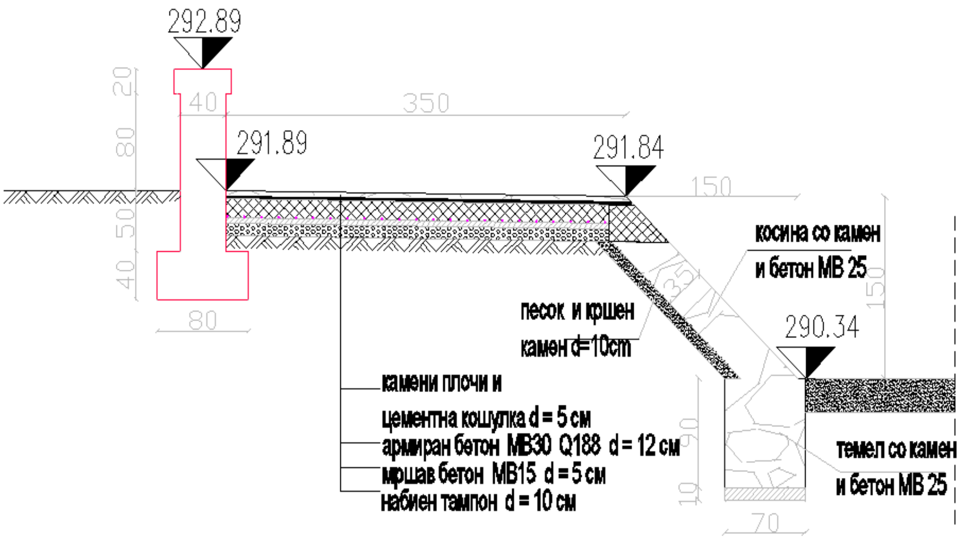
dp=52*(ρv*g/ ρk*g)*h*J

dp=52*(10/ 24)*0.68*0.04=0.6 m

Minimum size of the stone at the bottom of the stable bed is 60 cm.

A typical (normal) cross-section

A typical cross section of new proposed watercourse with AB fence is shown with the following details:



Legend:
sand and crushed stone d = 10 cm - песок и кршен камен d = 10 cm
cement screed d = 5 cm – цементна кошулка d = 5 cm
reinforced concrete MB30 Q188 d= 12 cm - армиран бетон MB30 Q188 d= 12 cm
carcass concrete MB15 d = 5 cm - мршав бетон MB15 d = 5 cm
compacted pad d=10 cm - набиен тампон d=10 cm
slope with stone and concrete MB 25 -косина со камен и бетон MB 25
foundation stone and concrete MB 25 - темел со камен и бетон MB 25

Situational solution

During the preparation of horizontal decision took into consideration the same thing to adjust the existing cascading thresholds, which enabled rapid flow of river water. The input and output are provided intake thresholds, intended to prevent the occurrence of deformation or damage of the regulated river basin of the river Kozjachka.

The dimensioning of these cascade thresholds used the same procedure as for the dimensioning of the cross section of the tray table for the same maximum amount of water.

The situational horizontally solution is shown in graphical attachments in a 1: 1000. The positioning of the shaft is a list of numeric data for the left and right edges of each profile are marked coordinates X and Y.

Longitudinal solution

The current state of the longitudinal profile is determined by the position of the level of the riverbed of the river Kozjachka and the existing cascading thresholds.

The longitudinal slope varies with constant max gradient of 0.6%.

In graphic attachments has a longitudinal profile in M 1: 1000/100 and is shown with a section of km 0+000.00 to km 0+862.36.

Transverse profiles

For the subject section are designed transverse profiles with all the necessary information for further use in the performance of the object in M 1: 200 of the level of this same project given in the graphic part of the project.

Facilities (Objects)

Along the section it register existing cascading skirts and two bridges. Bridging the two bridges is at km 0 + 415.00 of a steel pedestrian bridge km 0 + 51.69 and a regional bridge. Following along the riverbed was obtained information that under the riverbed near the steel pedestrian bridge passes existing water supply and during the performance need to be careful to not make some damages to it.

Bill of quantities and calculation of the works

Bill of quantities is designed to cover all positions defined by the technological process for the construction of such facilities. All amounts of work are calculated within the scope.

According to the bill for the amount of work for each position according design aware of the price of each position, made a bill of quantities and calculation of the works.

Display technology for manufacturing and quality of materials to be applied in the preparation of the object

The technological process starts with clearing, marking and denote the route. When the field is prepared it starts with operational matters according to the operational plan that is prepared by the contractor and which consists of earthworks - wide excavation with rolled off on the deployment of local planning and forming the profile of the excavation combined clawed hand where needed.

During the excavation is necessary to work continually per parts and if necessary to divert water for smooth operation. In addition to keeping an eye on weather conditions or to monitor weather forecasts to avoid damage to the already prepared positions. Parallel depending on the operating plan can start making foundations and slopes where they should not be doing time rupture between the foundation and slope. To use local materials by local community which is examined in this kind of work.

Foundations and slopes are provided to bring the stone combined with cement mortar with a well sealed fugues and dimensions given in graphic contributions made to the project. To align the existing slope with the newly been talking of necessary construction work such as demolition or upgrades. In constructing the slopes with stone and cement mortar for building be used rubble stone and river material as outlined in graphic detail.

As a second stage in parallel can be performed reinforced concrete security fence consisting of incorporating a bed of concrete carcass MB15 d = 15 cm on which to set up the necessary fittings to the wall. After the completion of reinforcement are treated concrete wall with 30 MB and dilating every 5 m with bitumenizirana track d = 6mm.

After making the slope and wall approaches making footpath in a well compacted base. On a well pressed layer of compacted pad incorporates a layer of mixed concrete d = 5cm on which reinforcement is done with merzha Q188.

On the already installed reinforcement approach towards cementing the footpath MB 30 d = 12 cm dilation of 5m with (denote) bitumenizirana track d = 3mm. As the final decoration on the footpath sets screed cement mortar and stone slabs with maximum thickness up to 6 cm.

After completion of all construction and craftsmanship of the object to access to editing and clearing the environment of construction debris and settlement of the ground.

Measures of security and technical protection

In addition there will be include the necessary security measures and technical protection.

- To respect and enforce all laws and regulations in the operation of this type of work, and the regulations written by the employer;
- To noticing all the necessary requirements and conditions that are part of this project, in terms of standards, regulations and legal provisions for performing this type of work;
- To take care for personal protection of the employees during the working actions in accordance prescribed legal provisions and regulations;
- During transportation, all participants are obliged to use personal protective equipment;
- Constanttly to carry out maintenance and cleaning of the riverbed;

Overall, it recommended adherence to all other prescribed legal provisions and regulations (Law on Safety and Health at Work Official Gazette no. 92/2007, as well as other laws and rulebooks) that are associated with this type of work and activities.

Findings, conclusions and recommendations

Based on the overall work done in the project, can be made the following findings, conclusions and recommendations:

- If the planned location for construction of the facility provided for construction works on the underground networks installation, recommendation by the same designer is to be aligned for a parallel performance;

- In the performance of construction work to be noticing all the construction - artisan norms for care of the materials and their harmonization.
- During the performance of the facility to be careful not to hinder the building materials along the river in the riverbed, and also in construction works do not remain open the riverbed of the river Kozjachka to avoid its overflow its banks.

Static calculation for protective fence:

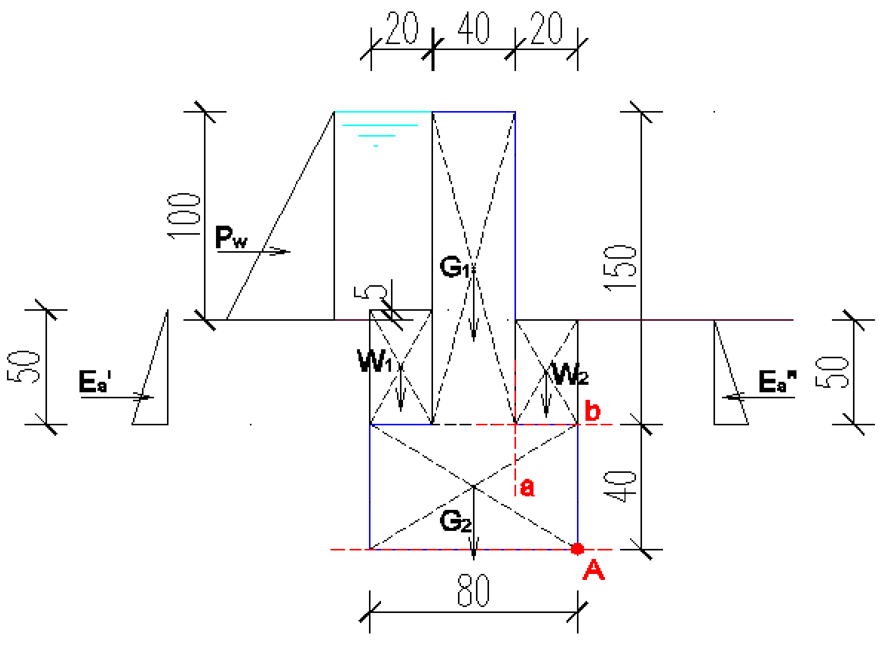
Note: because there is no geo-mechanical elaborate in the calculation of walls are taken superiors values to the ground. To make improvements on the ground if a buffer spot checks of the need to consult the designer if in the meantime preparing a survey to control the calculation.

If there are differences in the height of the wall projected it will be necessary to consult the designer.

$\gamma = 21\ kN/m \quad c = 0\ kPa \quad \varphi = 30^{\circ}\ \sigma_{doz} = 150\ kN/m^2 \quad \gamma_b = 25\ kN/m^2$

- SAFETY FENCE

Geometric features:
$H = 2.35\ m$
$B = 1.00\ m$
$h = 0.60\ m$
$b = 0.40\ m$
$L = 1.0\ m$
$\gamma_b = 25\ kN/m^3$
$\gamma_w = 10\ kN/m^3$



Static calculation:

$P_w = \rho * g * h = 1000*9.81*1 = 98.10\ kN$
$P = 5\ kN/m^2$ - *Balanced load of path*
Turning balanced load out on the over- layer j of soil material with the same characteristics as the geomechanical soil material and height:
$h_o = p/\gamma = 5.00/21 = 0.24\ m \Rightarrow H = 1.25\ m$
$E_a = E_a' + P_w = ½*H^2*\gamma'*k_a + ½*\ \gamma_w*\ H^2$
$k_a = tg^2(45-\varphi/2) = 0.33$
$E_a = 0.5*0.5^2*21*0.33 + 0.5*10*1.00^2 = 0.87 + 5.00 = 5.87\ kN$
$E_a'' = 0.5*0.5*21*0.33 = 1.73\ kN$

Assumed dimensions:
$G_1 = 0.40*1.5*25 = 15\ kN$
$G_2 = 0.8*0.40*25 = 8\ kN$
$W_1 = 0.5*0.20*21 = 2.1\ kN$
$W_2 = 0.5*0.20*21 = 2.1\ kN$

Control of stresses in soil:
$M = E_a'*(0.167 + 0.4) + P_w*(0.33+0.9) - E_a''*(0.167 + 0.4) - W_1*\ bw_1 + W_2*\ bw_2 =$
$0{,}87*0.567 + 98.1*1.23 – 1.73*0.567 - 2.1*0.2 + 2.1*0.2 =$
$0{,}50 + 120.66 - 0.98 - 0.42 + 0.42 = 120{,}18\ kNm$
$N = G_1+G_2+ W_1+W_2 = 27.2\ kN$
$bw_1=0.20;\ bw_2=0.20;$
$e = M/N = 4.645m > B/6 = 0.133\ m.$ – ***large eccentricity***
$c = B/2 – e = 0.267 > B/5 = 0.16\ m$ – ***satisfies***
$\sigma_{max} = 2N/3Bc = 54.4/0.6408 = 84.89\ kN/m^2 < \sigma_{doz}$

Calculation of moments in sections:
Intersection a-a
$M_{a\text{-}a} = 0.87*(0.5/3) + 5*(1/3 + 0.5) – 1.73*(0.5/3) = 4.03\ kNm$
Intersection b-b
$M_{b\text{-}b} = G_1*0.20+ W_1*0.50 + G_2'*0.20= 3{,}00 + 1{,}05 + 1{,}6 = 5{,}65\ kNm$

Control of turning:
Standby time
$Mp = G_1*0.40 + G_2*0.40 + W_1*0.70 + W_2*0.10 = 6.0+3.2+1.47+0.21 = 10.88\ kNm$
Active time (section A)
$M_a = 0.87*0.57 + 5*1.23 = 0.50 + 6.15 = 6.65\ kNm$
$M_p/M_a = 1.64 > 1.5$ - ***satisfies***

Traction control:

$(N*\mu)/E_a > 1.5$

$\mu = tg\varphi = 0.58$

*(27.2*0.58) / 5.87 =2,69 > 1.5 - **meets***

Dimensioning:

Cross sectiona-a

$M_U = 1.7*M_{a-a}= 6,85$ kNm

$k_h = h_{st}/(\sqrt{M} * 100/100) = 37/2,62 = 14,122$

за $k_h = 10.764$, $\varepsilon_a = 10.0‰$ $\varepsilon_b = 0.30‰$ $k_x = 0.029$ $k_z = 0.990$;

$$A_{pot} = \frac{Mu}{\sigma v * kz * hst} = \frac{6,85*100}{40*0.990*37} = 685/1465.2 = 0.5\ cm^2$$

Adopted: Φ8/15 cmco $A_a = 3.52\ cm^2$

Split: Φ8/20 cm

Cross sectionb-b

$M_U = 1.7*M_{b-b}= 9,6$ kNm

$k_h = h_{st}/(\sqrt{M} * 100/100) = 11,94$

за $k_h = 10.764$, $\varepsilon_a = 10.0‰$ $\varepsilon_b = 0.3‰$ $k_x = 0.029$ $k_z = 0.990$;

$$A_{pot} = \frac{Mu}{\sigma v * kz * hst} = \frac{9,6*100}{40*0.990*57} = 960/2257.20 = 0.42\ cm^2$$

Adopted: Φ8/15 cm co $A_a = 3.52\ cm^2$

Split: Φ8/20

- *Note: Was adopted the smallest constructive reinforcement,*

REINFORCED -CONCRETE STAIRS SK1

dpl = 10 cm
b= 30 cm
h = 15 cm
3 -number of stairs

L = 1.42m

Hsk = 0.9 m

1. ANALYSIS OFLOADS
PERMANENT LOADS

- Own weight a stairs	=	1.80 kN/m²
- Own weight of a plate	=	3.23 kN/m²

g_1 = 5.03 kN/m²

USEFUL LOADS

p = 2.50 kN/m²

2. SIZES AND STATIC DIMENSIONING

IN FIELD

Mg = 1.01 kNm
Mp = 0.50 kNm

ABOVE VERAGE

Rg = 3.57 kN
Rp = 1.78 kN
Mg = 0.51 kNm
Mp = 0.25 kNm

3. DIMENSIONING

MB 30 fb = 2.05 KN/cm2 τr = 0.11 KN/cm²

RA400/500-2 σv = 40 kN/cm2

Mu^{max} = 2.53 kNm
Mu^{min} = 1.27 kNm

IN FIELD

kh = 5.340
kz = 0.937
Apot= 0.79 cm²
Ar = 0.16 cm²
Adopted : **RA** **7F10/15** so A =5.5 cm²
Split: **RA** **f8/15** so A =2.5 cm²

OVER LEVERAGE

kh = 7.56
kz = 0.981
Apot= 0.38 cm²
Adopted : **RA** **7F10/15** so A =5.5 cm²
Split: **RA** **f8/15** so A =2.5 cm²

4. CONTROL UGIV:

Fdoz= L/250 =**0.57** cm

f = (5*q*L**4)/(384*E*I) =

f = **0.02** cm - **meets**

REINFORCED -CONCRETE STAIRS SK2

dpl = 10 cm		L_1=0.7m		
b= 30 cm		L_2=2.0m	L =	2.7m
h = 16.67 cm				
6 -numbers of stairs		Hsk =1.17 m		

5. ANALYSIS OFLOADS

PERMANENT LOADS

- Own weight of stairs	=	2.00	kN/m²
- Own weight of a plate	=	2.89	kN/m²

g_1 = 4.89 kN/m²

USEFUL LOADS

p = 2.50 kN/m²

6. SIZES AND STATIC DIMENSIONING

IN FIELD

Mg = 3.57 kNm

Mp = 1.82 kNm

ABOVE LEVERAGE

Rg = 4.89 kN

Rp = 3.38 kN

Mg = 1.78 kNm

Mp = 0.91 kNm

7. DIMENSIONING

MB 30 fb = 2.05 KN/cm² τr = 0.11 KN/cm²

RA400/500-2 σv = 40 kN/cm²

Mu^{max} = 8.99 kNm

Mu^{min} = 4.49 kNm

IN FIELD

kh = 2.830

kz = 0.917

Apot= 2.88 cm²

Ar = 0.58 cm²

Adopted : **RA 7F10/15** so A =5.5 cm²

Split: **RA f8/15** so A =2.5 cm²

ABOVE LEVERAGE

kh = 4.010

kz = 0.971

Apot= 1.360 cm²

Adopted : **RA 7F10/15** so A =5.5 cm²

Split: **RA f8/15** so A =2.5 cm²

8. CONTROL UGIV:

Fdoz= L/250 =**1.08** cm

f = (5*q*L**4)/(384*E*I) =

f = **0.16** cm - **meets**

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