
BRIEF TECHNICAL DESCRIPTION FOR EXECUTION OF PREPARATORY WORKS ON ESTABLISHING THE CONSTRUCTION SITE, INCLUDING: ORGANIZATION OF THE CONSTRUCTION SITE, CONSTRUCTION OF THE SITE ACCESS ROAD AND WORKS ON THE CONSTRUCTION OF SUPPORTING STRUCTURES FOR SECURING THE FOUNDATION PIT

SITE ORGANIZATION

The organization of the construction site is part of the preparatory works design. To define the organization of the construction site means to determine the spatial and organizational layout of all elements of the construction site, based on an analysis and depending on:

- characteristic of the location,
- characteristics of building structures,
- available machinery, equipment and temporary facilities,
- human resources,
- construction schedule/dynamics.

Schematically presented on the layout drawing, the following items are precisely defined:

- lengths of individual sides of the construction plot
- elevations of existing land and leveling
- location and numbers of adjacent cadastral parcels and buildings, as well as the name of the street
- presentation of the building on which the works are to be executed, position of the building and number of floors
- key construction machinery (tower cranes); working position of work equipment, with marked maneuver zones for mobile work equipment, i.e., with marked manipulation zones for cranes with a schematic representation of the lines of protective fences, obstacles and other;
- temporary construction site routes.
- display of energy supply facilities and installations, with marked safe approaches during use and maintenance

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- presentation of the network of drinking, technical and waste water with facilities and equipment for use and maintenance and method of prevention
 - stockpiles/storage places for construction material,
 - working plateaus/decks (carpentry, reinforcement works, etc.),
 - temporary facilities,

The layout of all previously defined elements in the scheme is organized in accordance with the Rulebook on the content of the study on the construction site layout ("Official Gazette of RS", No. 121/2012 and 102/2015) and Article 62 of the Rulebook on the content, manner and procedure of preparation and the manner of performing technical control of technical documentation according to the class and purpose of the facility ("Official Gazette of RS", No. 73/2019), as well as based on the principles for the organization of a construction site.

The sizing of the temporary facilities was done on the basis of the assumption that there will be 200 workers on the construction site at the same time.

According to the principles of the construction site organization, the order of executing organizational works will begin with works on clearing the terrain, transporting and depositing unnecessary material, as well as securing the construction site area, which includes the erection of a fence. The construction site fence is placed so that it has the smallest possible length, but effectively separates the construction site from the surrounding space. A full panel fence is to be erected, with similar characteristics as given in the attachment.



Temporary electrical, plumbing and sewage installations are to be installed, along the temporary road, all the way to temporary facilities and places of consumption.

The existing connections at the site of the planned excavation are to be relocated towards the existing entrance from Deligradska Street. These connections should be used as construction site connections in consultation with the competent public utility companies.

From the construction site connection to the electrical network, power supply should be provided for all construction machinery, lighting of the entire construction site, dining and living quarters for workers, as well as the guardhouse at the entrance to the construction site complex. The distribution of the electrical network goes along the entire construction site fence in order to provide adequate lighting of the construction site area.

The existing connection to the water supply network is located at the entrance to the old complex, from Deligradska Street. This connection should provide drinking and technical water, for the needs of the construction site in accordance with the conditions set by the competent public utility companies.

Access to the construction site is provided via a temporary construction site road, with a minimum number of entrances to the construction site. The temporary road is designed as a two-way road, 10.0 m wide. Only one entrance to the construction site has been organized. At the very entrance to the construction site, there is a guardhouse with a toilet.

After the completion of the works on the temporary road, the works will begin on the construction of the plateau/deck for the installation of temporary facilities. The terrain is to be leveled and possibly a crushed stone path is to be provided as well. For the needs of the previously defined number of workers, 8 toilets have been provided, which are set up so that the workers can access them as easily as possible, and at the same time they are far from the work areas where the workers stay longer. The offices of the heads of the construction site, the cloakroom and the barracks for the workers are erected along the road, but always out of the reach of the tower crane. The tool shed is set up near the working plateaus. According to the requirements of the building under construction, the following stockpiles/storage areas and working plateaus have been set up on the construction site:

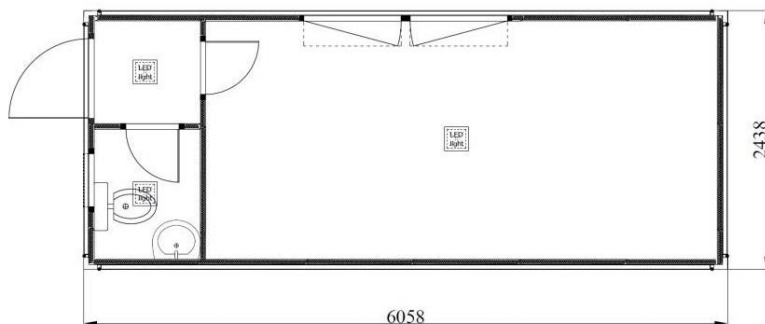
- carpenter's plateau/deck (dimensions 8/12m, circular saw 2/2m),
- formwork storage area (4 / 6m),
- reinforcement stockpile, which also represents a reinforcement plateau/deck (4/6m),
- sand stockpile ($R = 3.0$ m),
- lime and cement storage area/pit (3/3m),
- excavated soil stockpile ($R = 4.5$ m),
- waste material disposal dumpster (3/4m).

Temporary accommodation facilities, canteen facilities and offices are set up in order to provide accommodation and ensure normal living conditions for workers during construction. Base on relevant analysis and calculation, these capacities are provided in the form of modular-assembly containers. The containers can be interconnected, which will provide facilities of the required structure and surface.

The designed characteristics of temporary facilities depend on:

- duration of works,
- scope of work,
- location conditions.

An example of a necessary accommodation capacity is given in the attachment.



Osnovni tehnički opis			
Dimenzije:	Širina 2,4 / Dužina 6,0 m / Visina 2,6 (unutrašnja 2,3)	Vrata:	Aluminijumska termoizolovana
Konstrukcija:	pocinkovani čelični profile, vijčana veza	Prozori:	PVC sa IZO ostakljenjem, dvozonsko otvaranje
Izolacija:	Pod/krov/zidovi: plastificirani sendvič paneli PU 50 mm RAL 9002	El. instalacije:	Razvodna table sa aut. osiguračima, FID sklopka, LED rasveta 2 x 36W
Pod završno:	PVC 2 mm	Oprema:	Prema nacrtu

The main transport construction machinery, which provides communication with other parts of the building, are 3 Potain tower cranes, model MD3200 or equivalent characteristics. The specification of the tower crane is given in the attachment.

The structure of the tower crane impacts the definition of the necessary technical characteristics, relative to:

- reach (required boom length),
- load capacity within a certain radius,
- tower height.

which is defined based on the characteristics of the building structure to be built and the organization of the site itself.

The required reach of the tower crane depends on:

- building configuration,
- position of the crane relative to the building,
- place for grasping load to be lifted,
- points on the building to which the load is transported.

Required load capacity of the tower crane is determined based on the weight of the elements and their maximum radiuses.

Height of the tower, as an important parameter depends on the maximum height of the building, and it must be increased by the height of the worker of 2m + 1m, for safety.

Earthworks, in the case of the building in question, are performed with an excavator with a digging bucket, and the excavated earth material is deposited as a humus material stockpile, which is located on the platform itself. From the said stockpile, the material is used to fill the soil material around the excavation.

Concrete for the needs of the construction site is produced in a nearby concrete plant.

The carpenter's plateau/deck is divided into two parts. The part where the circular saw is located, is used for manufacturing or eventual finishing of the formwork assemblies. In the second unit, ready-made formwork assemblies are deposited. The plateau/deck is within the obligatory reach of the working crane. Formwork stockpiles have been set up to increase the stability of the construction process and reduce the chances of its failure. The formwork assemblies from the carpenter's plateau/deck are transferred to the stockpile area by a tower crane.

Reinforcement assemblies are delivered to the construction site, and their preparation and eventual correction is done on the reinforcement plateau/deck. Reinforcement stockpiles are set up according to the same principles as formwork stockpiles, along the construction site road, to facilitate that unloading of finished assemblies from the means of transport.

The organization of stockpiles for sand, cement and lime is carried out at the beginning of the phase of erecting the supporting structures, and site mixers are put in place. The said stockpiles are intended for the production of mortar for bricklaying and plastering, so they are, accordingly, placed in the immediate vicinity of construction site mixers.

After the completion of all necessary segments foreseen by the preparatory works design, the works on clearing and arranging the surrounding area may commence, if required.

- **SECURING THE AREA**

The area where the works are to be carried out needs to be secured and protected from access by any and all persons who are not employed at the construction site, with a protective fence, in the part where it is not possible to set up constant surveillance that will prevent unplanned entry. In case of interruption/suspension of work at the construction site, these measures must be extended until the construction site is closed down.

Existing connections need to be dismantled and relocated in accordance with the requirements of the competent public companies.

If, during the execution of works, a part of one of the utility networks is encountered, which does not exist on the map, it is necessary to inform the competent utility company.

- **TECHNOLOGICAL SEQUENCE OF ACTIVITIES**

Site preparation:

- Fencing and formation of construction site, marking,
- Organization of security services and temporary lighting
- Setting up temporary facilities
- Delivery of machines and other means of work
- Locating and separating installations
- Execution of protective structures
- Installation of key construction machinery for internal transport

Constructing routes and facilities:

- Temporary construction site road
- Development of a temporary operative crushed stone plateau/deck
- Load-bearing substructure - retaining walls

Note: *If the presence of hazardous waste is found during the work, it has to be treated separately. The actions to be taken are dismantling, removal, and transport for permanent disposal, all in accordance with the law*

Removal of waste material:

- Removal of dismantled non-hazardous waste into a waste material dumpster
- Storage, transport and disposal of unnecessary material at an auxiliary location

Shutting down the site:

- Removal of fences, temporary lighting and protective structures
- Taking away machines and other means of work
- Final cleaning and washing of surrounding surfaces
- Geodetic as-built survey
- Handover

- **PLANNED MEANS AND HUMAN RESOURCES:**

Workforce:

During the execution of works on the Investor's plot, it is necessary to engage a large workforce and technical means for work. At all times, at least 2 technical professionals should be present at the construction site, and mechanization operators and workers according to the needs and phases of work.

Technical personnel:

- Responsible Contractor - Graduated engineer with a responsible contractor's license
- Deputy Responsible Contractor - A person with a responsible contractor's license
- Assistant Responsible Contractor - Foreman or Technician
- Person responsible for occupational safety and health at work
- Head of mechanization, transport and maintenance
- Responsible contractor of geodetic works

Mechanization operators and drivers:

- Excavator operator
- Bulldozer operator
- Grader operator
- Loader operator
- Tipper drivers
- Tanker drivers

Other skilled workers:

- KV (skilled) and PKV (semi-skilled) construction workers
- NK (unskilled) construction workers
- Locksmith
- Mechanic
- Electrician

TECHNICAL MEANS:

Construction machinery:

- Tracked excavator (with vertical reach boom of required height)
- Tracked excavator equipped with hydraulic drive and device for quick change of working tools
- Bulldozer (weight up to 25t)

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- Loader (with loading bucket 3 to 5 m³)
 - Tower crane (as previously described)
 - Compressor
 - Grader

Vehicles:

- Tipper truck
- Water tanker truck
- Delivery vehicle for passenger transport
- Van with maintenance tools
- Passenger vehicles

Equipment:

- Fence
- Construction site containers
- Autogenous cutting equipment - as required
- Manual pneumatic tapping hammer
- Traffic signals, notice boards, construction info board

- CONSTRUCTION SITE SHUTTING DOWN:

Removing the fence, taking away machines and equipment, cleaning and washing the surrounding surfaces. Completing an as-built geodetic survey of the building structure and enclosing a topographic plan during the handover of works.

CONSTRUCTION SITE TRAFFIC ROUT E

In the course of preparing a design for obtaining the construction permit for the new University Children's Clinic "Tiršova 2", the need for the construction of an access road that would connect the clinic with the highway E-75 was defined.

Since access to the site is currently possible only from the direction of Deligradska Street, which due to its technical characteristics is not capable of meeting the needs of the future construction site, within Phase 1 of the Preparatory Works, the level of detail of the supporting structures, the construction site road and the organization of the construction site itself have been specially elaborated. Difficult terrain characteristics have conditioned the construction of supporting structures that will secure both the slope and the road, and these auxiliary structures will become a permanent solution. This solution requires that the situational and leveling elements of the construction road be retained during the construction of the future access road.

The construction site road stretches from the “Hitna pomoć” (Emergency medical aid service) intersection, i.e., from the "Hitna pomoć" loop exit to the highway E-75, directly to the intersection with Deligradska Street, with an approximate length of 400 m.



Figure 1 – Present view of the “Hitna pomoć” intersection at E-75 highway

Situational and leveling elements of the construction site road are conditioned by the position of the “Hitna pomoć” intersection and the restriction related to the substantial de-leveling of the terrain between the existing intersection (83 m above sea level) and Deligradska street (113 m above sea level) which had to be overcome and at the same time, the connection of the contents of the future clinic had to be provided. In this regard, the situation plan consists of directions and radii of horizontal curves: $R = 25\text{m}$, $R = 30\text{m}$, $R = 40\text{m}$, $R = 80\text{m}$, $R = 120\text{m}$.

The designed width of the construction road is 9.7 m and 10.0 m in the zone of the future clinic, which corresponds to the future width of the road and sidewalks of the access road.

The grade line of the road was guided along the axis of the road and is characterized by significant ascents, maximum inclination being $i_n = 10\%$ in the immediate zone in front of Deligradska Street and it was conditioned by the elevations and the slope of Deligradska Street itself. The rounding of the grade breaks is designed with appropriate radii of vertical curves, namely $R_v = 350\text{m}$, $R_v = 500\text{m}$ and $R_v = 1000\text{m}$.

From the survey mark at km 0 + 210.00 to the survey mark at km 0 + 338.27, along the left edge of the construction site road (in the width of 15.00 m) space is provided for the needs of the construction site organization. The plateau is designed with an inclination of 0.5% and it is oriented towards the construction site road.

The road structure of the construction site road is designed according to the elements of the future access road and is dimensioned for the average traffic load. This phase envisages the construction of the lower bearing layers from:

- crushed stone aggregate fraction 0/63mm t = 20cm
- crushed stone aggregate fraction 0/31.5mm t = 15cm

It is important to note that the material that will be used for filling as a sub base for the road construction must be resistant to the effects of frost.

The bill of quantities/priced bill of quantities were prepared on the basis of graphic attachments given in this design. Quantities of materials were calculated based on the evidence from the cross sections given as an attachment in this design. The surfaces of the layers of the road construction are calculated based on the situational plan.

SUPPORTING STRUCTURES

Geological structure of the terrain

Geotechnical investigation works were performed for the purpose of determining the geotechnical conditions of construction. In the zone of the construction site, exploration wells were drilled at the top and at the foot of the slope.

It was concluded that one section passes through by cutting into the limestone zone, and the next section partially cuts through the zone of filled material. The configuration and composition of the terrain necessitate the application of supporting structures along the cuts.

Retaining walls will be constructed along the route of the construction site road that will be built on the embankment.

Technical solution

Along the road, various technical solutions for auxiliary and supporting structures are applied:

Anchored supporting structure

From km: 0 + 015.45 to km: 0 + 067.36 it is envisaged that the excavation of the slope will be protected by an anchored reinforced concrete supporting structure.

Excavation of the road-cut slope should be done from top to bottom, so that anchors could be placed and protection of the slope surface with concrete structure could be performed successively.

The road cut in the limestone zone is secured by the use of passive SN anchors with a diameter of 25 mm and RC cladding walls. For heights in excess of 10.0 m, the plan is to form a berm 2.5 m wide. The anchors are inserted in a maximum of 4 rows on the lower and in 2 rows on the upper slope at an inclination of 10° relative to the horizontal line. The height axle distance of the anchors is 2.0 m, and the distance of the anchors in the longitudinal direction is also 2.0 m. The length of the anchor is 10.0m. When drilling holes for anchors, the use of water should be avoided, i.e., its use should be reduced to the minimum necessary.

The sloping surface has an inclination of 5: 1 and is cladded with RB wall MB-30, 40 cm thick.

In order to drain the water behind the wall, PVC pipes are to be installed – barbacane (drain down pipes) with a diameter of 100 mm.

Retaining wall

In the toe of the slope, from km: 0 + 079.30 to km: 0 + 225.18, planned is the construction of RB retaining wall. As the grade line of the access road rises, a platform is formed behind the retaining wall, from which a supporting structure is cascaded, to hold the trunk of the road - the RB retaining wall in the toe of the slope.

Along the entire embankment, the wall is 3.80-8.40 m¹ high. The foundation is 0.80-0.90 m¹ high, and the wall pillar is 3.0-7.50 m¹ high. The wall will be founded in limestone with a previously executed leveling layer of thin concrete MB-15 at least 10 cm thick. In the zones where the embankment is present at the level of the foundation joint, it is necessary to replace the subsoil with compaction until the modulus of compressibility $M_c = 40 \text{ MPa}$ is reached. If the thickness of the required replacement material is greater than 1 m, the supported wall must be founded on piles. RB retaining wall is erected on foundations 3.25-4.20m wide.

The pillar (rib) of the retaining wall is 40 cm wide at the top, with a one-sided slope of 10: 1.

The retaining wall is constructed in segments (rings) 4.00 m long. The wall needs to be constructed in segments in order to preserve the stable balance of the wall, and this measure needs to be especially respected. When the pillar is finished, the space behind the wall is to be filled with sandy-gravel soil, to facilitate the draining of groundwater, possibly collected behind the supporting structure, and through barbacane pipes in the wall, the water is then discharged outside of the embankment zone. Backfilling the walls should be done in layers up to 25 cm thick, and compacted with light compaction tools. Compaction can start only after moving 1.0 m away from the back of the wall, and continued in the direction of the wall. The adopted parameters used in geostatic stability calculations are as follows: $\varphi = 30^\circ$, $c = 0 \text{ kN/m}^2$, $\gamma = 20 \text{ kN/m}^3$. If the material to be used

in the embankment has poorer characteristics, the designer is to be consulted in order to check the stability of the adopted structure of the retaining walls.

The sandy-gravel soil behind the wall is to be protected from siltation and separated from the autochthonous terrain with non-woven geotextile type 300 (300 gr/m²).

Static calculations of wall stability were performed and gave satisfactory results on translational motion, rotational motion and stress state between soil and foundation.

Supporting pile structure

The cut in the slope on the left-hand side of the road from km: 0 + 130.66 to km: 0 + 186.18, which is located in the zone of filled material, is protected by a supporting structure of RB piles connected by a head beam. The bored piles are 1000 mm in diameter and are executed at a distance of 1.5 m along the entire endangered stretch. The lengths of the piles are 10.00-12.25 m. A 20 cm thick cladding wall is planned over the piles.

In order to perform boring and concreting of piles, it is necessary to fill the temporary platform necessary for this type of work.

Securing neighboring facilities and surrounding roads

An anchored supporting structure made of reinforced concrete piles is foreseen for securing the neighboring buildings and surrounding roads. The piles are being driven in order to stabilize the terrain after the demolition of the existing buildings and in order to protect the surrounding buildings and roads. The supporting structure consists of piles with a diameter of 800 mm and which are made at a distance of 1.1 - 1.6 m with a head beam measuring 80x80 cm that connects them. The lengths of the piles range from 10.20 to 23.20 m. A wall of shotcrete concrete is foreseen over the piles, to be executed successively to prevent landslides and leaching soil between the piles.

Temporary geotechnical anchors in one, two, three or four levels have been designed to support the piles. The anchors are pre-stressed over steel beams mounted over piles. For all walls with anchors, a geostatic calculation was performed according to the Geo-5 program.

The height and spacing of installation levels of temporary anchors are determined by iteration in the calculation to meet the following requirements:

- That the height position and the number of levels on the walls are determined from taking into account the condition that the average static force in the anchor is 400KN, and that the bearing capacity of the piles may not be exceeded. When the anchors are placed at a distance of 110 cm, the adjacent anchors must have an inclination that differs by 5 °

(example: 20 ° even anchor, 25 ° odd anchor) so that the anchoring zones are at sufficient distances. The load-bearing capacity of the anchors must be proven by testing on test anchors. It is adopted in the design that the anchors have an anchoring length of 8.0m. It is necessary to examine at least 4 anchors, one on each contour wall.

- that the anchors are synchronized with the excavation and construction of concrete slabs so that when their function begins and ends, static influences remain within the permissible limits in all load-bearing elements. Therefore, the calculation was made for both the preparatory phase and the construction phase.

- that the deformations in the zone of the neighboring streets are such that there is no damage to the buildings or installations.

Work on execution of designed works shall be carried out in the following phases:

- execution of piles,
- production and testing of pilot anchors,
- installation of observation benchmarks,
- excavation to the level of placement of anchors s per design,
- construction of a wall between piles using shotcrete,
- leveling the surface on which the steel beams are to be mounted,
- marking the position and number of anchors on the constructed wall,
- preparing anchors,
- drilling holes an inserting prepared anchors,
- installation of steel beams for tightening,
- tightening of inserted anchors according to the prescribed procedure,
- monitoring built-in benchmarks.

Drilling of holes for anchors is performed using appropriate drilling equipment with designed elements and according to the parameters of the test anchors (drilling speed, number of rotations, angle, depth, mass consumption in the anchor zone, etc.). Anchors are formed by 3 ropes Ø15.2 mm. The free part of the anchor is fitted in protective tubes made of polyethylene material.

When installing anchors, it is obligatory to keep a record of each individual anchor. This record in two copies must contain the mark from the design, place and time of installation, type of anchor, type of material through which it passes according to the Geological Study, depth and angle of the drilled hole, signatures of the contractor and the resident engineer.

When the injection mass in the anchor zone reaches the required hardness, pre-stressing is carried out with a hydraulic press. Pre-stressing is performed in several phases until reaching the ultimate force according to the static calculation. The maximum force achieved in the pre-stressing process is greater than the force obtained by the static calculation, and then force returns to the designed value. This procedure should prove the bearing capacity of the anchors, eliminate parasitic influences, and adjust the blocking force to the nature of earth pressures. During this procedure, a record is kept and data are entered on force and elongations, time cycles, designed and realized pre-stressing force as well as other data foreseen by regulations.

For the purpose of monitoring deformations, it is necessary to install visible benchmarks at all levels where the anchors are placed. This is a measure of early notification of displacements that could possibly be greater than the calculated ones. The benchmarks should be installed in such a way that it is possible to observe them until the underground construction is completed up to the ground level. In all series, all previously installed benchmarks are observed vertically and horizontally. Each observation report is accompanied by a drawing with the layout of the benchmarks, measured vertical and horizontal displacements, differences in displacement compared to previous measurements, total displacement, installation date and measurement date. In the note, it is necessary to describe the phase of works at the time of observation as well as the reasons for additional series if any. In order to monitor the forces in the anchors during the works, the installation of dynamometers on 10 anchors is planned. It is also necessary to install eight inclinometer sets in order to monitor the movement in depth in the zone of the supporting structure. Inclinometer tubes are to be fitted into the pile reinforcement cage. The exact locations of dynamometers and inclinometers will be agreed in consultation with the resident engineer.

Once the anchors as temporary supports of piles are put in place, and excavation to elevation 92.0 is completed, the underground part of the building must be built as soon as possible, all the way to the ground floor, i.e., to the level of the head beams. Temporary anchors in clay soil must not be allowed to remain activated and tightened for a long time, due to corrosion and thixotropy.

According to the description, a bill of quantities was made with a description of the works which will contain the works performed according to this design, as well as the works needed for the completion the accompanying safety works (installation and monitoring of benchmarks, drainage, etc.). The amount of reinforcement for reinforced concrete supporting structures is the estimated one. The exact quantity will be submitted by the contractor on the basis of the plans of the reinforcement that the contractor is obliged to prepare before the start of the works and submit for approval.

PLEASE NOTE:

Before starting the works, it is necessary to determine the position of the existing installations in the streets along the contour of the location from the cadaster of underground installations.

If a significant deviation of geotechnical conditions from the Geotechnical Study is determined on site, alternative technical solutions are to be applied. The Contractor is obliged to undertake adequate changes to the designed protective structure in consultation with the resident engineer and the responsible designer.

Reinforced concrete supporting structures are made of concrete MB30 (C25/ 30), frost resistance M-150 and are reinforced with ribbed reinforcement B500B. Anchor steel is of high tensile strength $f_{pk}=1860\text{N/mm}^2$.

NOTE: In the file "Technical description-Execution of preparatory works on the arrangement of the construction site for the construction of the new university children's hospital Tiršova 2 in Belgrade" which is given in Serbian, in addition to the above, it contains a detailed description locations, valorization of existing vegetation, legal regulations and safety measures during the execution of works.