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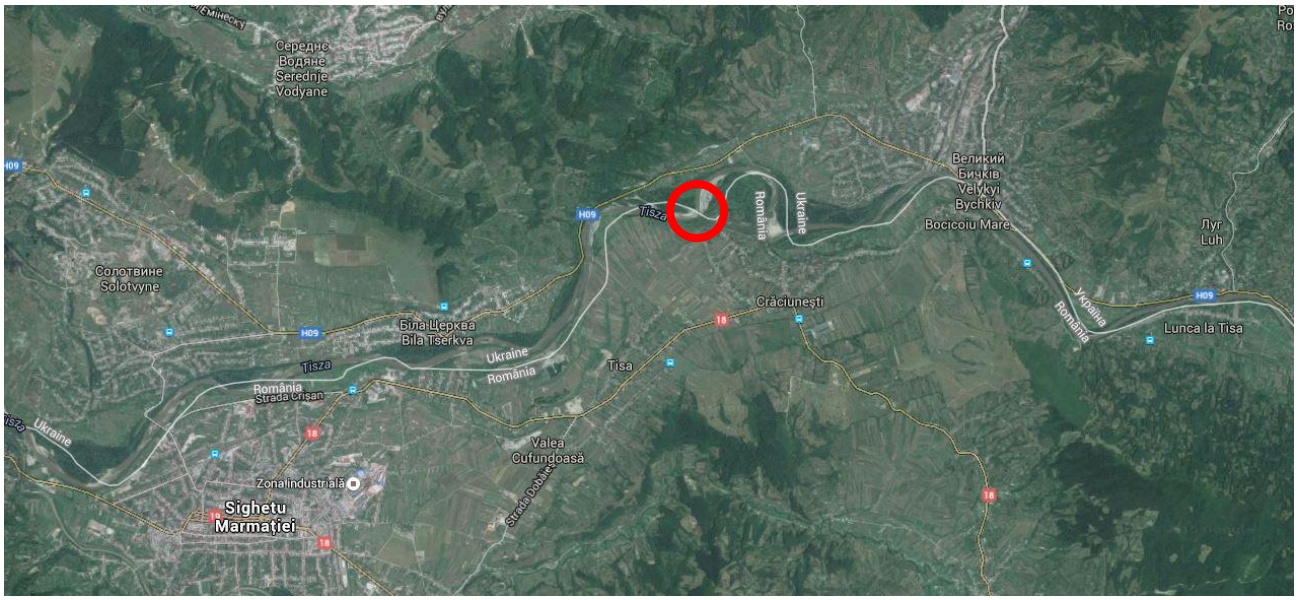
ROMANIAN NATIONAL COMPANY OF MOTORWAYS AND NATIONAL ROADS S.A. (CNADNR SA)

Project co-financed by the European Union through the European Regional Development Fund

Review / Update Feasibility Study

„Bridge over Tisa in Teplita area on Sighetu Marmatiei "

92/23639/16.04.2015



TECHNICAL REPORT

Consultant: Expert Proiect 2002 S.R.L & Betarmex S.R.L. Parternership

BENEFICIARY:	**ROMANIAN NATIONAL COMPANY FOR MOTORWAYS AND NATIONAL ROADS S.A. (CNADNR SA)**
CONTRACT NO:	**92/23639/16.04.2015**
PROJECT CODE:	**P 343**
OBJECTIVE:	**Review / Update Feasibility study „Bridge over Tisa in Teplita area in Sighetu Marmatiei"**
VOLUME:	**Technical report**
VOLUME CODE:	**P343/V10 rev. 0**

Contents

1. GENERAL DATA

1.1. Name of the investment objective

Review / Update Feasibility Study For „Bridge Over Tisa In Teplita Area On Sighetu Marmatiei"

1.2. Location (country, region, county, city)

The proposed site for the project development targeting an area at 47°56' - 47°57' north latitude and 23°55' - 23°56' eastern longitude, on both sides of the Tisa between DN18 in Romania and H09 in Ukraine. The investigated land it is located within incorporated area and in unincorporated area of Sighetu Marmatiei Municipality (Teplita District) in Romania and Bila Tserkva (Biserica Alba) in Ukraine.

1.3. Investment holder

Romanian National Company for Motorways and National Roads S.A.

1.4. Elaborator of the study

Expert Proiect 2002 S.R.L & Betarmex S.R.L. Partenership

2. GENERAL INFORMATION REGARDING THE PROJECT

2.1. The current situation and information on the entity responsible for the project implementation

The Romanian National Company for Motorways and National Roads S.A. (CNADNR) from Ministry of Transport and Infrastructure is the entity responsible for the implementation of the project "Bridge over Tisa in Teplita area in Sighetu Marmatiei".

For financing the project can be used structural instruments, i.e. the Cohesion Fund, Structural Funds and other financial (budgetary sources).

The project will create a modern communication ways with implications for regional development of the area, flow of the traffic, increase traffic safety, decrease travel times, decrease pollution at all levels in areas transited and shortening the road connections with Russia, Baltic's Countries, Poland, Hungary and Slovakia.

The project proposes to achieve a road connection between Maramures County and Ukraine, near the most important locality in north of the county – Sighetu Marmatiei – through its implementation contributing to the integrated development of the northwest border region of Romania (Maramures) south-western Ukraine (Transcarpatia region).

To create a cross-border economy competitive at regional level, it is necessary to have access to, from and between various parts of the region.

Due to the geographical location of the border area, its accessibility depends on the number and quality of roads. In the project area, the roads do not comply with European standards. For the Romanian side, in Maramures, secondary roads allow access to Ukraine by European road E81 and E85.

According to the website of the Romanian Border Police (http://www.politiadefrontiera.ro/) between the two countries there are six land border crossing points that operate in international traffic to specific road and / or rail, namely:

- **Halmeu - Diakovo**: international traffic with road and rail specific;
- **Campulung la Tisa - Teresva**: international traffic with railway specific regime (non-operational border crossing point, according to the Romanian Border Police);
- **Sighetu Marmatiei - Solotvino**: international traffic with road specific;

The Sighetu Marmatiei - Solotvino border crossing point is for crossing pedestrians and small vehicles, with the following regime: a lane bridge, 3.5 t maximum tonnage.

- **Valea Viseului - Delovoe**: international traffic with railway specific (non-operational border crossing point, according to the Romanian Border Police);
- **Vicşani - Vadul Siret**: international traffic with railway specific;
- **Siret - Porubne**: international traffic with road specific.

In the study area, the transport infrastructure is underdeveloped and poorly maintained, limiting traffic speeds and increased travel times, so that it can ensure the accessibility and connectivity to international standards, leading to an isolation effect.

The available technical conditions and the capacity available for custom clearance are inadequate to handle the traffic volume. Queues and waiting periods are significant for tourism development in the project area, as well as cooperation between its inhabitants.

Opportunity of the project is given by the opportunity to integrate the project in a cross – border vision, namely in the ENPI Programme Romania - Ukraine – Hungary - Slovakia. Besides international valence, the bridge over Tisa in Teplita area on Sighetu Marmatiei area will serve in good conditions the traffic on Romania territory.

2.2. Description of the investment

2.2.1. The conclusions of the prefeasibility study or of the detailed plan of long-term investments (if they were previously issued) regarding the current situation, the need and opportunity of promoting the investment, as well as the selected technical and economic scenario

The project will create a modern communication ways with implications for regional development of the area, flow of the traffic, increase traffic safety, decrease travel times, decrease pollution at all levels in areas transited and shortening the road connections with Russia, Baltic's Countries, Poland, Hungary and Slovakia.

Opportunity of the project is given by the opportunity to integrate the project in a cross – border vision, namely in the ENPI Programme Romania - Ukraine – Hungary - Slovakia. Besides international valence, the bridge over Tisa in Teplita area on Sighetu Marmatiei area will serve in good conditions the traffic on Romania territory.

The aim of the project is:

- achievement of the bridge over Tisa in Teplita area in Sighetu Marmatiei, which is part of a series of projects in completion;
- implementation of part of the Government program of development of road infrastructure in Romania;
- reducing the time for travel and transit.

2.2.2. The technical and economic scenarios through which the objectives of the investments project may be achieved (if before the feasibility study there was not issued a prefeasibility study or a detail long-term investments plan)

The overall objective is to improve Romania's economic competitiveness by developing transport infrastructure that facilitates economic integration in the EU, contributing to the development of the internal market in order to create conditions for increasing the volume of investments, promoting sustainable transport and cohesion in the European road network.

Besides its international importance, the bridge over the Tisa in Teplita area in Sighetu Marmatiei will serve in good condition the international transit traffic of goods and people on the Romanian territory.

2.2.3. The constructive, functional, and technological description, if applicable

Functionality of the connection road and the bridge over Tisa have been achieved primarily through the geometrical elements of the road, horizontally and vertically, in accordance with STAS 863/1985 - "Geometry of the routes – Design norms".

Functionality of the connection road and the bridge over Tisa have been ensured by designing a road system suitable to a traffic perspective, for a period of 20 years, so to be maintained in time without malfunction the roadway surface flatness: cracks, holes, pits , creases, etc.

Also in terms of functionality, it was also considered the traffic safety. In this regard has been provided the development of intersections with the national road DN 18. At these works have been added related works: different types of fences, vertical road signals and horizontal markings.

In order to achieve these objectives have been proposed:

- **two technical solutions for the bridge over Tisa, namely:**
  - **technical solution 1: parallel bridges with mixed deck steel – concrete,** continuous beam with variable height (a bridge in each direction of movement). The proposed static scheme for art work will be continuous beam with three spans of 70 m + 100 m + 70 m and a total length of 261.20 m.
  - **technical solution 2: parallel reinforced concrete bridges - continuous beam with variable height** (a bridge in each direction of movement). The proposed static scheme for art work will be continuous beam with three spans of 70 m + 100 m + 70 m and a total length of 261.20 m.
- **two solutions for road structure:**
  - **Solution 1 – Flexible road structure;**
  - **Solution 2 – Semi-rigid road structure (mixed);**
- **two route alternatives:**:
  - **Alternative 1 (red)** Alternative 1 has a length of 1.200 ml and is located upstream of version 2.
  - **Alternative 2 (blue)** has a length of 1.340 ml and have been proposed in the feasibility study prepared in 2009 by S.C. AEDILIS PROIECT SRL, beneficiary Maramureş County Council.

2.2.4. Presentation of studied alternatives

2.2.4.1. Art works

For crossing the Tisa River have been proposed several technical solutions, based on the solution designed in the feasibility study prepared in 2009 by SC AEDILIS PROJECT SRL. The technical solutions proposed are described below:

- **technical solution 1: parallel bridges with mixed deck steel – concrete, continuous beam with variable height (a bridge in each direction of movement)**

The proposed **static scheme** for art work will be continuous beam with three spans of 70 m + 100 m + 70 m and a total length of 261.20 m.

The infrastructure of the bridge will consist of two abutments and two piers. Reinforced concrete piers will have lamellar elevations with hydrodynamics forms upstream and downstream. Abutments will have the elevations made from walls of reinforced concrete.

Bearings used will be of modern type with seismic isolators.

The superstructure of each bridge will be made from metallic box with variable height, provided on top with prestressed reinforced concrete flooring.

The path of each bridge ensure a carriageway of 8.00 m and 2.50 m pavement width including pedestrian guardrail beam and space for mounting the safety parapet.

Equipment: The bridge will be equipped with system for collection and discharge of rainwater provided with heaters cables, lighting on the bridge and the box, warning and information systems for road users and modern systems for monitoring the behaviour in time of the structure.

- **technical solution 2: parallel reinforced concrete bridges - continuous beam with variable height** (a bridge in each direction of movement)

The proposed **static scheme** for art work will be continuous beam with three spans of 70 m + 100 m + 70 m and a total length of 261.20 m.

The infrastructure of the bridge will consist of two abutments and two piers. Reinforced concrete piers will have lamellar elevations with hydrodynamics forms upstream and downstream. Abutments will have the elevations made from walls of reinforced concrete.

Bearings used will be of modern type with seismic isolators.

The superstructure of each bridge will be made from prestressed concrete box with variable height.

The path of each bridge will have the same characteristics like the variant 1.

Equipments: The bridge will be equipped with the same equipment as in variant 1.

2.2.4.2. Road structures

Have been analyzed two alternatives of road structure:

- **Option 1 – Supple road structure:**
  - 4 cm of wear layer of stabilized asphalt mixture MAS16 - AND 605/2014;
  - 6 cm connection layer of asphalt concrete BAD20 - AND 605/2014;
  - 8 cm bituminous base layer with protecting gravel chippings AB31.5 - AND 605/2014;
  - 20 cm foundation top layer of crushed stone optimal mix - SR EN 13242/2008 and STAS 6400/1984;
  - 30 cm lower foundation layer of ballast - STAS SR EN 13242/2008 and 6400/1984;
  - 15 cm form layer of ballast - SR EN 13242/2008 and STAS12253 - 1984;
  - geo-textile with non contaminant purpose;
  - earth filling;
  - stripping of 30 cm topsoil;

- **Option 2 – Semi-rigid road structure (mixed)**
  - 4 cm of wear layer of stabilized asphalt mixture MAS16 - AND 605/2014;
  - 6 cm connection layer of asphalt concrete BAD20 - AND 605/2014;
  - 8 cm bituminous base layer with protecting gravel chippings AB31.5 - AND 605/2014;
  - anti-fracture layer;
  - 20 cm foundation top layer of natural aggregates stabilized with hydraulic binders – STAS 10473 2 – 86 and STAS 6400/1984;
  - 30 cm lower foundation layer of ballast - STAS SR EN 13242/2008 and 6400/1984;
  - 15 cm form layer of ballast - SR EN 13242/2008 and STAS12253 - 1984;
  - Geo-textile with non contaminant purpose;
  - earth filling;
  - stripping of 30 cm topsoil.

2.2.4.3. Road works

The project aims to achieve a road connection between Maramures County and Ukraine, near the most important locality from north of the county – Sighetu Marmatiei.

For the achievement of this objective have been studied two route alternatives. These are presented in figure 1 and are the followings:

- Alternative 1 has a length of 1.200 ml and is located upstream of version 2.
- Alternative 2 (blue) has a length of 1.340 ml and have been proposed in the feasibility study prepared in 2009 by S.C. AEDILIS PROIECT SRL, beneficiary Maramureş County Council.

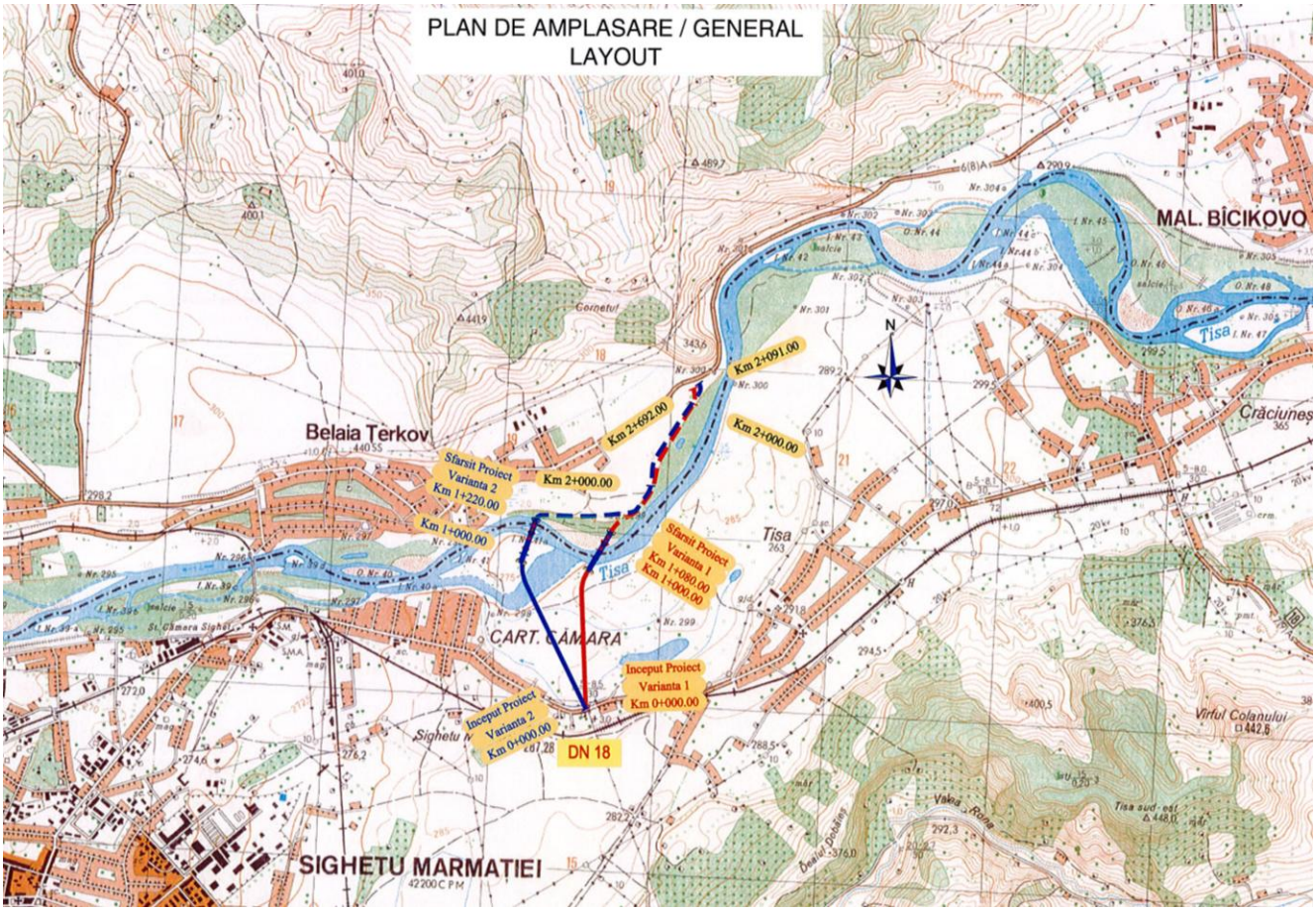


Figure 1. Studied route alternatives

The optimum variants have been selected based on the multi-criteria analysis. These are:

- Solution 1 - twin bridges with mixed steel – concrete deck;
- Solution 1 – flexible road structure;
- Route alternative 1 (red) with total length of 1,200 m.

2.2.5. Recommended scenario advantages

2.2.5.1. Advantages of recommended scenarios in case of art works

The advantages presented by technical solution 1 (parallel bridges with mixed steel – concrete deck) compared with technical solution 2 (concrete deck executed in console) are:

• In terms of execution technology and of the design process:

- the metal deck is a more delicate structure in terms of the design process, but the execution requires a technology easier than in case of concrete deck executed in the console;

- **In terms of structure applicability depending on the openings and the possibility of increasing the load of bearing capacity:**
  - in the selected structure, load capacity increase for eventual development of loading in time can be achieved more easily and with lower costs in case of mixed concrete steel deck;
- **In terms of the material use:**
  - mixed concrete steel deck is a modern structure with more judicious distribution of the used material and net weight lower than the reinforced and / or prestressed superstructures;
  - infrastructures dimensions are smaller (width, thickness) than in case of concrete superstructure;
  - lower bearings block corresponding to lower reagents of the mixed deck in comparison with concrete superstructure;
- **In terms of maintenance costs:**
  - maintenance cost are relatively close for both superstructure type;
  - replacement of damaged items in case of events (earthquakes, accidents) can be achieved more easily and quickly if it is used the mixed concrete steel deck towards in case of concrete superstructure;
- **In terms of comfort in traffic:**
  - Elimination of expansion joints on each opening in case of continuous beam presents a clear advantage for the traffic amenity and in order to avoid leakage from joints that can lead to degradation in the concrete slabs or infrastructure shoulder;
- **In terms of aesthetics and of framing in the ambient environment created by the bridge existence in the site:**
  - the mixed concrete steel deck is a flexible structure than concrete superstructure executed in the console, with a high architectural value.

In base on these advantages and disadvantages has been selected solution 1: **twin bridges with mixed steel – concrete deck, continuous beam with variable height**

2.2.5.2. Advantages of the recommended scenario in case of road structure

Both road structures withstand the stress due to traffic for the 15 year perspective period.

Semi-rigid road structure presents disadvantages comparing to the supple road structure, namely:

- the mixture of natural aggregates, cement and water are prepared in fixed stations;
- surface protection of the layer is required for maintaining the humidity;
- superior road layer execution begins after a minimum of 7 days, during this time can't circulate;
- for prevention of reflective cracking, the stabilized layer pre-cracking is required;
- stabilized layers are subject to high demands of stretch through bending;
- stabilized layers show contractions due to the binder outlet and it shows heating contractions;
- cracks of shrinkage, under traffic action, doubles, which favours the penetration of water into the road structure;

Disadvantages of the flexible structure

- natural aggregates from the foundation composition have a low rigidity which depends on the foundation soil and its thickness;
- the relatively low rigidity of these road structures determines a special sensitivity of the bearing capacity of these roads to hydrological variation of the embankments;

Advantages of the semi-rigid road structure

- stabilization with hydraulic binders of natural aggregates gives a high rigidity to the layers composed of these materials, which causes reduced tension transmitted to the road bed level;

Advantages of the flexible road structure

- crushed stone layers in optimal mixture are used for roads with heavy and very heavy traffic classes;
- the structure module, on the principle of minimum volume of voids, ensures a high pickup capacity and distribution of supporting layer of traffic demands;
- the mechanized technology of execution represents another argument for using this layer in the formation of modern roads.

2.2.5.3. Advantages of the recommended scenario in case of the route alternative

The main advantages of the route alternative 1 (red) related to alternative 2 (blue) are the following:

- shorter overall length;
- smaller occupied area;
- lower cost for land obtaining;
- lower construction cost (C + M) lower
- lower maintenance costs on life cycle;
- lower impact on fauna and flora during construction and operating;
- lower negative impact in natural protected area.

3. TECHNICAL DATA OF THE INVESTMENT

3.1. Area and location

The proposed site for the project development targeting an area at 47°56' - 47°57' north latitude and 23°55' - 23°56' eastern longitude, on both sides of the Tisa between DN18 in Romania and H09 in Ukraine. The investigated land it is located within incorporated area and in unincorporated area of Sighetu Marmatiei Municipality (Teplita District) in Romania and Bila Tserkva (Biserica Alba) in Ukraine.

The purpose of this project is the connection road that emerges from the national road DN 18 (from km 69 + 200), the platform of customs point and bridge over Tisa (up in Ukraine).

3.2. The legal status of the land to be occupied

According to planning documentation no. 3/2009 PUG phase approved with Sighetu Marmatiei Local council decision no 61/18.12.2013, according the provisions of the law 50/1991 on the authorization of execution of construction works, republished with subsequent amendments and on town planning certificate no. 115 / 23.07.2015 issued by the Maramureş County Council, is certified:

- **The legal status of the land**

  The land is in administrative territory of the town (partly inside the town and partly in unincorporated area).

  Ownership of the building: public domain and private properties, border area

- **The economic status of the land**
  - current use of the land: water course (Tisa river – border), road communication routes – national road DN 18, local roads, agricultural lands – arable and meadows;
  - Destination set by town planning documentation and landscaping approved: bridge over Tisa river connected to DN 18.

3.3. The situation of the definitive occupancies of land: total surface, representing incorporable/un-incorporable lands

The project it is located within incorporated and unincorporated area of the Sighetu Marmatiei Municipality, currently the lands are occupied mainly by privately owned cultivated fields.

Obtaining the lands for construction of the road infrastructure will be done according to Law no. 255 of 14 December 2010 on expropriation for public utility causes, necessary to achieve objectives of national, county and local level, published in Official Gazette no. 853 of 20 December 2010, art. 5 and Art. 11 point 7, 8 and 9 buildings affected by

the works of public utility with subsequent modifications and art. 8 GD. 53/2011 approving the Methodological Norms for the application of Law no. 255/2010.

The total surface occupied is 100.600 m^2.

Alternative route involves the expropriation of about 77.500 m^2 surface.

3.4. Field study

Topographic studies

The land surveys have been performed by specialists of the S.C. Topcadex 99 S.R.L and they comprised the area of the bridge, the river bed upstream and downstream of the bridge, on a length enough for designing the works. They allowed the identification of the location and of the surfaces where the future fitting works shall be carried out.

The performed topographical studies have been realized in the national system of coordinates STEREO 70 and elevations with reference plan the Black Sea and endorsed by OCPI.

Geotechnical study

The geotechnical study has been performed by the specialists of the S.C. GEO-SERV S.R.L. Bucharest. At the request of general designer have been executed 26 geotechnical surveys in order to reveal the lithology in the future bridge location:

- F – 8 geotechnical surveys for bridge with total length of 133.5 m, from which 5 geotechnical surveys on the Romanian border with length between 15.0 - 20.5 m and 3 geotechnical surveys on the Ukrainian border, with length of 15.0 m;
- fp – 4 surveys for culverts, with total length of 20.0 m, all the surveys on the Romanian border, with length of 5.0 m;
- fd - 5 surveys for road, with length of 30.0 m, from which 4 surveys on the Romanian border and 1 survey on the Ukrainian border with length of 6.0 m;
- fr – 7 surveys for embankments with total length of 46.0 m, from which 6 surveys on the Romanian border and 1 survey on the Ukrainian border, with length between 6.0-8.0 m;
- fi - 2 intermediate surveys with total length of 12.0 m, both on the Romanian border, with length of 6.0 m;

The surveys have been even mechanized type and manual type, with depths between 5.00 m - 20.50 m above ground level

Hydrological and hydraulic study

The hydrological study have been performed by the Water Basin Administration Somes – Tisa on the Tisa River (cadastral code I – 1) in order to determine the hydrological conditions in the project area. The data refers to the maximum naturally flow with the probability of 0,1%, 1% and 2%.

In hydrological terms, the study section it is located on the Tisa river, 7.40 km upstream of the confluence with Iza river.

3.5. Main features of the constructions within the investments objective, specific to the field of activity, and the constructive variants for achieving the investment, recommending the optimum option for approval

3.5.1. Road works

The route plan

In plan, the studied route emerges from the km 69 + 200 of the national road DN 18. At the exit of the connection road from the national road DN 18 was designed a roundabout intersection type.

The proposed route has a total length of 1,200 ml and unfolds mainly in alignment. Before entering the ramp of the bridge, the route crosses a curve with 200 m radius. At the exit of the bridge the road get onto a 185 m radius curve.

The longitudinal profile

The maximum gradient is 4.00% and the minimum is 0.30%.

The connection rays are summarized between 1,500 and 5,000 m.

Transverse profile

The proposed route of the road is a connection road, technical class III, for which, according to GO no. 43/1997 on 'Legal Regime of the road" and MT Order No.45 / 1998 on "technical rules for the design, construction and modernization of roads" the transverse profile has the following dimensions and elements:

- road platform: 19,53 m;
- width of carriageway: 4 x 3.75 = 15.00 m;
- width of the frame strips: 2 x 0,90 m = 1,80 m;
- directional separators – concrete cross-beam H2 type – 0,67 m;
- width for concrete cross-beam H2 type 2 x 1,03 m;
- left – right footway 2 x 2,50 m;
- transverse profile in the carriageway will be type roof with a slope of 2.5%;
- the transverse slope of the shoulders will be 4.0%.

On the bridge ramps will be placed a verge culvert and on the slopes will be placed side ditch from 25 in 25 m.

Road structure

In order to dimensioning the road structure on the access road to the bridge over the Tisa was established the perspective traffic, according to the study traffic appendix to the feasibility study. In determining the future traffic were considered evolution coefficients for the European roads in medium variant.

The perspective period for whose have been made the sizing is 15 years from commissioning. Based on perspective traffic, it was established the volume of computation traffic for the perspective period of 15 years.

Depending on computation traffic volume expressed in million standard axles (M.O.S.) of 115 kN, the access road km 0 + 000-1 + 200 frame in the following traffic class:

Access road to the bridge: $Nc_{15\ years}$ = 0.045 m.o.s LIGHT

The road structure under review it is characterized by the thickness of each layer and by the deformability characteristics of the materials in the road layers and the foundation soil.

Verifying the road structure at the demands of the standard axle involves computation of specific strains and tensions in critical points of the road complex, characterized by a state of maximum stress. The calculations were made with the program CALDEROM 2000.

For the connection road will be utilised a supple road structure:

- 4 cm of wear layer of stabilized asphalt mixture MAS16 - AND 605/2014;
- 6 cm connection layer of asphalt concrete BAD20 - AND 605/2014;
- 8 cm bituminous base layer with protecting gravel chippings AB31.5 - AND 605/2014;
- 20 cm foundation top layer of crushed stone optimal mix - SR EN 13242/2008 and STAS 6400/1984;
- 30 cm lower foundation layer of ballast - STAS SR EN 13242/2008 and 6400/1984;
- 15 cm form layer of ballast - SR EN 13242/2008 and STAS12253 - 1984;
- geo-textile with non contaminant purpose;
- earth filling;
- stripping of 30 cm topsoil;

3.5.2. Art works: bridge over Tisa

For crossing the Tisa River have been adopted the following technical solution: **Parallel Bridges with joint deck concrete steel, continuous beam with variable height** (a bridge in each direction of movement).

Static scheme of the art work is continuous beam with three spans of 70 m + 100 m + 70 m and a total length of 261,20 m.

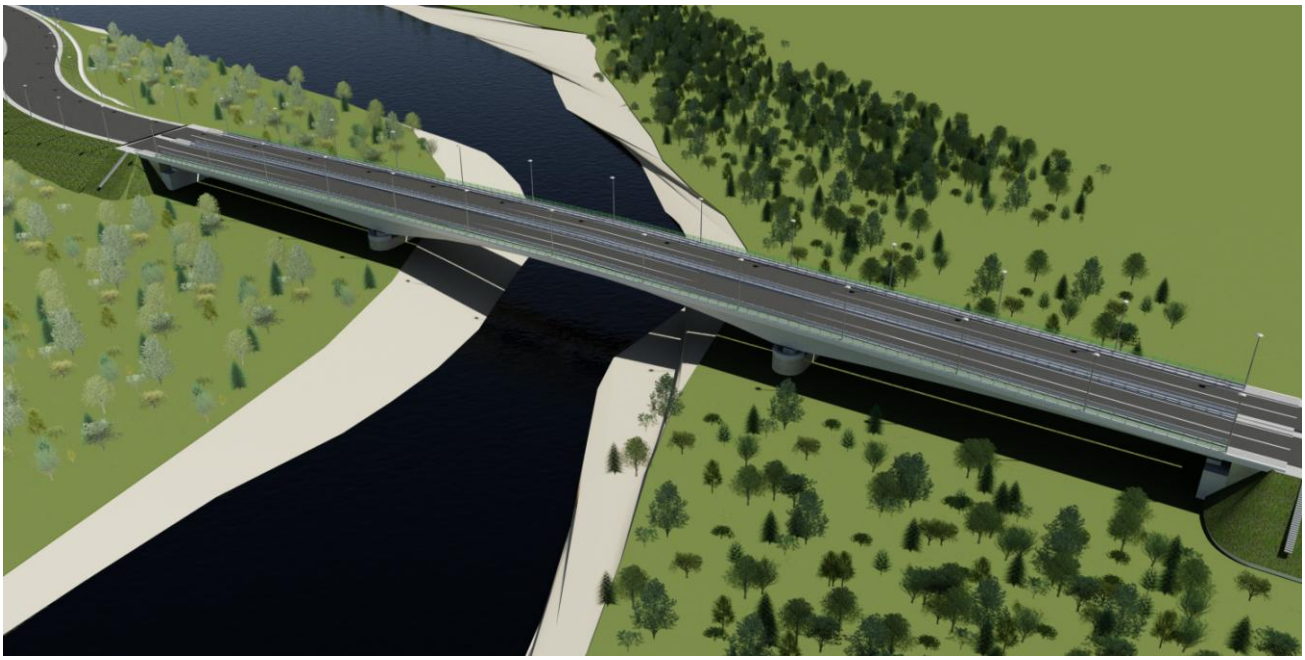


Figure 2. 3D simulation

- **Infrastructure**

Infrastructure of the bridge will consist of two abutments and two piers, direct founded on two concrete blocks.

The first block (basic step) will be of reinforced concrete, will have dimensions in plan of 12.00 x 26.20 m in plan, height of 3.00 m and will be built into the bedrock consists of argillaceous rock, rag stone.

The second foundation block (cylinder) will be from reinforced concrete and will have in plan the hydrodynamic form downstream and upstream. Dimensions in plan will be 8.00 x 25.80 m, and the height is 2.50 m.

Elevations of the piers are laminated and provided in plan with hydrodynamic shape upstream and downstream. The section composition is cassette type with three partitions with 0.85 m thick, the resulted nils will be filled with simple concrete.

Abutments elevation is made of vertical walls, completed with beam-seat, guard wall and concrete reinforcement between foundations and banquets.

In the lateral side of the abutments are provided turned concrete walls, trapezoidal forms, with variable thickness (0.50 m at the ends and 1.00 m in embedment vertical section from front to flush filler picked.

The bearings used will be of modern type with seismic isolators.

- **Connection with embankments**

For the connection of the bridge with the ramps road structure have been provided connection boards.

Bridge connecting with embankments in the abutments area, is made with pears cone quarters. They were provided with scales and chase.

- **Superstructure**

The superstructure of each bridge will be made of a metal box with variable height provided at the top with prestressed reinforced concrete flooring.

The static scheme of the bridge planks is continuous beam mixed concrete-steel with variable height, with theoretical openings 100.00 m + 70.00 m + 70.00 m. The bridge deck length is 242.60 m (including heads deck over the bearings) and the length of the bridge is 261.2 m.

The concrete deck is cased with tilt vertical walls and has varying height from 3.00 m in field and on the abutment, and up to 5.00 m in the intermediate supports area. Inside the box are provided diaphragms with hollow board in order to ensure access of maintenance personnel. The deck will be industrial achieved in section that will be assembled on the site. Flooring tiles will be made of precast reinforced concrete. For up taking the negative moments on intermediary supports it was provided in the longitudinal prestressing concrete slabs. At the edges of the deck beams are provided with prefabricated parapet with architectural composition.

At beneficiary request, has been opted for manufacturing the deck from weatherproof special steel, CORTEN type. The weather resistance it is due to the oxide layer that forms on the steel surface. This oxide layer represent the patina, it is formed in time and has a brownish tint.

If will be adopted the classic solution for manufacturing the metal deck, the colour of corrosion protection will be chosen from RAL 8004 Copper brown  and RAL 6018 Yellow green 

- **Path, pavement, fences, bridge equipment**

Each bridge related to a movement sense is ensured a carriageway of 8.00 m for two lanes and a 2,05 m sidewalk for pedestrians, separated from the roadway by a metal safety fences which match the level of protection very high H4b according to Standard AND 591/2005 and "Standard for traffic safety protection systems, roads, bridges and highways" indicative AND 593-2014.

For pedestrian protection have been provided metal pedestrian parapets. The road bridge has the following composition:

- stabilized asphalt mixtures MAS16 - 4 cm;
- asphalt concrete for bridges BAP16 - 4 cm;
- screed protection waterproofing BA8 - 2 cm;
- hydro - insulation - 1 cm.

The road pavement has the following composition:

- asphalt mixture BA8 - 3 cm;
- concrete pavement filler in C 35/45;
- hydro-insulation - 1cm.

- **Joint-covering devices**

The joint-covering devices are tightly type and will be mounted on the right of each abutment joint. All parts of dilatation devices will be provided by the manufacturers. After sizing, resulting expansion joints that must provide a breath of 30 cm.

Sizing coverage expansion joints was made taking into account the following considerations:

- maximum-minimum temperature difference during their operation;
- movements generated by seismic shifts;
- multiple functionality: dilated longitudinal and transverse, correlation with bearings and seismic devices;
- assembly temperature of + 15 ° C. For other mounting temperatures will make the necessary corrections.

- **Devices for collection and disposal of rainwater from the bridge**

For the collection and disposal of storm water has been provided a modern drainage system with drains placed in curbs and pipes for directing water toward pre-treatment stations and oil separators mounted on abutments and their discharge in the emissary respectively Tisa river. The drainage system consists of PVC-KG pipes DN 250 mm, with a total length of 505,20 m, and connections are PVC-KG DN 110 mm with a length of 41.00 m.

To avoid problems caused by adverse winter frost, piping for directing rainwater from spouts to oil separators will be provided with modern defrost systems. This system consists of special heating cables with UV protection which will be installed on the piping storm water control and be controlled via thermostats with temperature and humidity sensors, fully equipped by the related electrical switchboards.

The system also includes elements for sealing the heads, junction doses, clamps and other items that are provided by manufacturers. The components are provided by system manufacturers.

- **Lightning system**

The bridge will be equipped with a modern lighting system, complemented by an adjacent architectural lighting art works of this type. Lighting columns, which will provide lighting and visual guidance during the night, are made of metal material, having a height of 10 m above the carriageway.

Lightning with a power of 150 W / pcs are mounted on poles using consoles with 1.20 m length. Sizing lighting system was made taking into account the required lights, the distribution of lighting and other considerations.

Technically, it took into consideration the provisions in relation with connection to existing substations and safety panels. The lighting system consists of adjacent architectural lighting projector type power 1000 W / pcs.

The lighting system will be LED type, with remote system, system that will be able to control, monitor, measure and manage the operation in optimal parameters of the lighting network in order to reduce the electricity consumption, CO_2 emissions and operating costs.

- **Markings and signs**

Will be provided horizontal and vertical markings required for traffic safety on the bridge.

- **Technical Inspection Equipment**

On bridges with variable height, as is the case of the bridge over Tisa, the classic solution for maintenance is to ensure the access nils inside the box for ensuring the inside inspection.

For ensuring the inspection outside the bridge will be used devices like "Bridge inspector". Given the variable height of the box, it would be difficult installation and operation of maintenance trolleys outside the box.

For access on the infrastructure and therefore to enable maintenance works of bearings have been provided accesses from the nils of the box equipped with safety features. The infrastructure bench will be provided with safety railings for safety of the maintenance operations.

- **Bridge time behaviour monitoring systems**

Due to important dimensions of the work, it has been planned to establish a modern system for monitoring the behaviour of the structure in time, in accordance with current rules. This continuous monitoring system involves:

- installation of sensors aiming continuous displacements under loading of road convoys and the climatic effects (in the structure, in sections with maximum displacements, at infrastructure supports in order to verify the possible subsidence);
- sensors that continuously monitor the temperature levels and wind pressure in some sections of the bridge;
- sensors which measure the change in convoys efforts and other actions in sections and bars characteristic of the major structural elements;
- sensors that constantly measure the water level evolution;
- real time transmission of all the information gathered by the monitoring system to a central dispatch and processing of measurements based on the interpretation of specialized software for databases.

This monitoring system will be operable at the time of static and dynamic test and will be used to collect additional data on the behaviour of the structure under test convoys.

Information will be collected centrally by CESTRIN through regional directorates of roads and bridges, respectively DRDP Cluj in case of the bridge over the Tisa, and will be used in the BMS and in the research field.

3.5.3. Discharge bridges at km 0+530, 0+620, 0+720

In order to discharge the water at high flow rates, at km 0+530, 0+620 and 0+720 will be carried discharge bridges with 12,00 m openings. The designed bridged will have flexible structures composition of galvanized corrugated steel plates joined by bolts.

For the achievement of these bridge could be adopted two solutions:

a. open structure with a single opening, founded on concrete blocks. Implementation of this solution involve works for the thalweg;
b. two adjacent enclosed structures. In this case, the steel structures will sit on a loose sand layer of 15 cm thick settled upon a foundation of ballast compacted at least 98% Proctor, wrapped in geo-textile material.

The filler around the steel structure will be made of Proctor compacted ballast at least 98% in layers up to 30 cm. In filling embankment will provide a layer of non-woven geo – textile 500 g / m^2 and 1 mm geo – membrane which protects the metal structure.

The slopes will be paved on the height of 1.00 m height above the calculated level of the flow with insurance 1%. The outsides ends of the steel structure will be provided crown concrete elements with the role of stiffness the heads and supporting the embankment pears.

The bridge platform and road structure will have the same characteristics as the connection road in the current path.

3.5.4. Achievement of the customs checkpoint

It was designed a custom checkpoint that will accomplish the forecasted traffic. It will have a length of about 540 m and will be provided with parking area for cars and freight weighing, parking for cars, office building.

Access to / from the country will be on five lanes in each movement direction (a band for bus / minibus, each with 5 m width, two lanes for cars with a width of 3.50 m each and two lanes for trucks with 5 m width each).

- **Romania – Ukraine sense**

Before the border crossing point have been designed the following car parks:

- administrative buildings parking (32.50 m x 15.50 m) - 23 places for cars (size 2.50 m x 5.00 m);
- parking for cars and trucks - 10 places for trucks (size 4.00 m x 16.50 m);
  - 13 places for cars (size 3.00 m x 5.50 m).

Before the checkpoint will be installed two cars scales, each with dimensions 27.00 m x 4.50 m.

After passing through the checkpoint was designed a closed space for detailed inspection of cars with 3 parking spaces (with dimensions of 3.00 m x 5.00 m) and a space for detailed verification of barrages with 4 parking spaces (with dimensions of 4.00 m x 16.50 m with storage possibility) and space for barrages scanning (Roboscan).

The movement directions are separated by a New Jersey cross-beam and a netting fence and at the exit from border checkpoint, have been designed a bend space with 20.00 m length.

For pedestrian transit through the border crossing point has been designed a pedestrian sidewalk, 2.50 m width.

- **Ukraine – Romania sense**

Before the border crossing point have been designed the following car parks:

- trucks parking – 10 places for large vehicles (4.00 m x 16.50 m dimensions);
- parking for administrative building (32.50 m x 15.50 m) – 20 places for cars (2.50 m x 5.00 m dimensions).

Before the checkpoint will be installed two cars scales, each with dimensions 27.00 m x 4.50 m.

After passing through the checkpoint was designed a closed space for detailed inspection of cars with 3 parking spaces (with dimensions of 3.00 m x 5.00 m) and a space for detailed verification of barrages with 4 parking spaces (with dimensions of 4.00 m x 16.50 m, with storage possibility) and space for barrages scanning (Roboscan).

The movement directions are separated by a H2 concrete cross-beam and a netting fence and at the exit from border checkpoint, have been designed a bend space with 20.00 m length.

For pedestrian transit through the border crossing point has been designed a pedestrian sidewalk, 2.50 m width.

- ***Composition of the road structure for the parking:***
  - 4 cm of wear layer of stabilized asphalt mixture MAS16 - AND 605/2014;
  - 6 cm connection layer of asphalt concrete BAD20 - AND 605/2014;
  - 8 cm bituminous base layer with protecting gravel chippings AB31.5 - AND 605/2014;
  - 20 cm foundation top layer of crushed stone optimal mix - SR EN 13242/2008 and STAS 6400/1984;
  - 30 cm lower foundation layer of ballast - SR EN 13242/2008 and STAS 6400/1984;
  - 15 cm form layer of ballast - SR EN 13242/2008 and STAS12253 - 1984;
  - geo-textile with non contaminant purpose;
  - earth filling;
  - stripping of 30 cm topsoil;
- **Lightening systems**

The custom checkpoint platform will be equipped with a modern lighting system, being provided electric poles of metallic material, having a height of 10 m. Lightning pieces with a power of 150 W / pcs are mounted on poles using consoles with 1.20 m length.

Sizing lighting system was made taking into account the required lights, the distribution of lighting and other considerations. Technically, it took into consideration the provisions in relation with connection to existing substations and safety panels. The lighting system consists of adjacent architectural lighting projector type power 1000 W / pcs.

The lighting system will be LED type, with remote system, system that will be able to control, monitor, measure and manage the operation in optimal parameters of the lighting network in order to reduce the electricity consumption, CO_2 emissions and operating costs.

Functionally endowment of custom checkpoint includes the following:

- **Construction**
  - 2 x 250 m^2 administrative buildings, necessary for activities of Border Police and Customs Directorate of the ANAF;
  - area for detailed inspection of the travellers – only those entering in Romania;
  - area for cars detailed inspection – 2 x 160 m^2;
  - control cabins for border crossing points;
  - administrative cells, for custom commissioner, trucks weigh office, vignettes sales office;
  - toilets.
- **Platform works and equipments**
  - a sidewalk for control booth for border crossing points;
  - blinds necessary for the control zone of border crossing points and of the truck scales;
  - Radiation protection wall (in the Roboscan's area);
  - Trucks scale – 4 pieces;
  - ramp and detailed control channel for trucks - 2 pieces;
  - automatic barriers - 18 pieces;
  - automated traffic sign;
  - electric generators - 2 pieces;
  - ITS system - one piece.

3.5.5. Rainwater discharge

To collect rainwater has been designed the following works:

- ditches and culverts for rainwater collecting;
- oil separators for purifying rainwater;
- culverts to maintain the natural drainage system existing before construction of the connection road.

The rain water that washes the platform of the site organization will be collected trough perimeter ditches and will be driven by a settler tank.

At the base of the backfill slope have been designed concrete ditches and culverts for collection of the rainwater from the road. At backfill heights greater than 2.00 m have been designed verge gutters to be discharged trough chase located on the backfills. For treatment of the rainwater that washes pollutants deposited on the road platform have been foreseen oil separators.

Also, for rainwater drainage have been designed three box culverts presented in Table 1.

Table 1. Location and technical description of the culverts

No.	km position	Designed culvert	Apointements
1.	69+200 of DN 18, before and roundabout intersection	Box culvert	D=5.00 m, 2 pcs
2	0+040 of the designed road	Box culvert	D=5.00 m + paved chanel, 1 pc

3.5.6. Traffic safety

Warning signs comply with requirements, regulatory (priority, restriction and obligation) and guidance - information.

To ensure traffic safety have been provided the installation of a concrete way switcher on the entire length of the connection road with a certain level of protection (according to EN 1317 / 1.2).

It has also been provided the installation of a safety fence along the entire length of the connection road and bridge.

Will be ensured the warning signs system necessary for traffic safety on the connection road and on the custom checkpoint.

- **Intersections**

At the exit of the connection road from the national road DN 18 (km 69+260 on DN 18), km 0+000 of the connection road was designed a roundabout intersection type. This will be properly arranged, respecting the norm for arranging intersections on public roads - AND 600-2010.

The roundabout type intersection will be equipped with a modern lighting system, being provided electricity poles from metallic material, with a height of 10 m. Luminaires with an output of 150 W / units are mounted on poles using consoles with a length of 1.20 m.

3.6. The current utilities situation and consumer analyse

3.6.1. Consumer analyse

The utilities necessary for the achievement of the construction works are present in the vicinity of the project site (of the site organization location). The water necessary for the project will be taken from a proper drilling and bottled drinking water will be purchased.

For electricity supply will be installed a generator in the site organization or the site organization will be connected to the existing electricity from the vicinity of the site.

The quantities of raw materials and energy which will be necessary for the achievement of the project have been forecasted on base of the works volume. The raw materials will be achieved from gravel pits and quarries from the neighbourhood of the project site. It is strictly forbidden up-taking the natural resources from the project location.

The asphalt and concrete mixtures necessary for achievement of the works will not be prepared on the project location, but will be brought from authorized centers in order to reduce the level of air pollutants and noise in the project location.

The fuels necessary for the raw materials transport will be achieved from fuels station from the neighbourhood of the project location.

Consumption of the raw materials for the achievement of the project

Quantities of raw materials required for building the bridge

1. Concrete = 10.303 m^3;
2. Formwork = 5.244 m^2;
3. Steel Concrete = 1.292 tons;
4. Bituminous membrane = 5.919 m^2;
5. Asphalt mixture BA8 = 4.597 m^2 (138 tons);
6. Asphalt concrete BAP16 = 4.202 m^2 (1.572 tons);
7. Asphalt concrete MAS16 = 4.202 m^2 (1.572 tons);
8. Metal scaffolding to support the deck = 280 tons;
9. Corrosive paint = 8.466 m^2 (3.810 kg);
10. Metal guardrail = 1.133 m;
11. Steel structure = 2.970 tones;
12. Precast tiles = 242 pieces;
13. Expansion joints D = 260 mm = 45.00 m;
14. Connection plates L = 6,00 m = 32 pieces;
15. Ballast = 1.780 m^3.

Quantities of raw materials required for the road

1. Concrete = 6.042 m^3;
2. Ballast = 40.748 m^3;
3. Crushed stone = 15.900 m^3;
4. Asphalt mixture AB31.5 = 14.375 tones;
5. Binder BAD20m = 10.750 tons;
6. Asphalt concrete BA16m = 73.962 m^2 (6.953 tons);
7. Geo-textile = 22.750 m^2;
8. Panel culverts L = 5.00 m = 3 pieces;
9. Steel parapet = 3.550 m;
10. New Jersey parapet = 1.170 m;
11. Oil separators 30 m^3/s = 8 pieces;
12. Corrugated metal culverts L = 140 m, L = 45 m, L = 50 m.

During execution of the construction works of the bridge over Tisa and the connection road, will be used even chemical substances for longitudinal road marking, according to table 2.

Table 2. The amounts of chemicals substances used for road marking

Chemical	Quantity
Clear paint - rubber	60 kg (50 kg/km of continuous band)
Glass micro-beads	19,2 kg (16 kg/km)
Thinner	3 kg (2.5 kg/km)

For the achievement of the bridge over Tisa and access roads will be utilised the following equipments:

Table 3. The total time of use of equipment for achievement of the works at the access roads

No.	Equipment name	Pcs	Hours	Specific fuel consumption
1	EXCAVATOR	3	4.260 hours	20 l/h
2	BULLDOZER	3	1.227 hours	24 l/h
3	STEAMROLLER 8 – 14 t	5	4.416 hours	16 l/h
4	AUTOGRADER WOLLA	3	1.134 hours	35 l/h
5	ROAD TANK 5 – 8 t (21600 t)	3	3 pieces/day/120 days	22 l/h
6	ASPHALT MIXTURES DISTRIBUTOR	4	3.064 hours	20 l/h
7	ROAD MILL	1	1.293 hours	27 l/h
8	CRANE 15 t	1	454 hours	16 l/h
9	DUMPER 16 t (363.918 t)	20	20 auto/day/115 days	6 l/h

Table 4. The total time of use of equipment for the construction of the bridge over Tisa in Teplita area in Sighetu Marmatiei

No.	Type of equipment	Pcs.	Hours	Specific fuel consumption
1	CRANE 40 ft	2	5.384 hours	35 l/h
2	EXCAVATOR	3	4.850 hours	20 l/h
3	AUTOINCARCATOR WOLLA L34	2	1.773 hours	35 l/h
4	DUMPER 16 t (46680 t)	-	15 vehicles/day/20 days	6 l/h
5	STEAM ROLLER 8 – 14 t	2	1.667 hours	16 l/h
6	CIFAROM 9 m^3/bucket (34750 t)	-	10 pcs./day/43 days	7 l/h
7	CONCRETE PUMP 40 m^3/hour	1	382 hours	20 l/h
8	ASPHALT MIXTURES DISTRIBUTOR	1	288 hours	20 l/h
9	DRY DROP HAMMER 3 TF	1	2.100 hours	20 l/h

3.6.2. Movement of the underground and aerial networks

The project location has been verified in order to identify the utility networks which could be affected by the construction works of the bridge over Tisa in Teplita area in Sighetu Marmatiei.

Have been requested and obtained / ongoing the principle permits from utilities holders, for which have been prepared the necessary documentation or studies of solution (coexistence), the principle permit will be released for the most advantageous relocation / protection solution in technical and economical terms. Documentation includes the land areas affected by the relocation / protection of utility networks, which have been included in the expropriation corridor for road infrastructure works.

Have been identified all the lands area on which exist utilities networks and have been included in the expropriation corridor that so does not exist the risk of appearance of new areas that require expropriation during execution of the construction works.

Utility holders which have networks located in the area in which will be carried out the construction works of the bridge over Tisa will be notified in order to release the site in accordance with law 255/2010 on expropriation for public utility.

4. EXECUTION PERIOD AND THE MAIN STAGES

The execution period of the construction works is 24 months. The main stages of realization of the investment are:

- site organization establishment;
- road foundation execution;
- bituminous layers execution;
- rainwater drainage system execution;
- construction of the bridge over Tisa;
- culverts execution;
- road markings achievement;
- vertical signalling achievement.

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