CYCLE AND FOOT BRIDGE OVER THE RIVER MORAVA BETWEEN SLOVAKIA AND AUSTRIA

This type of construction is the first one over the border river name Morava, which connects two neighbours' states. Statement to build a new cycle and foot bridge in this area was conclusion of regional co-operation of Slovak and Austria states from the year 2006. The bridge is connecting the existing cycle road in the part of town named Devinska Nova Ves (Slovakia) and the part with historic mansion in the village named Schlosshof on the Austrian side.

Розглядається конструкція нового пішохідно-велосипедного моста через р. Морава, що з'єднує дві сусідні держави – Словаччину та Австрію згідно з рішеннями 2006 р., що стосуються регіонального співробітництва між цими державами. Міст з'єднує наявну велосипедну доріжку в районі м. Девінска Нова Вес (Devinska Nova Ves), Словаччина, і село Шлосгоф (Schlosshof), з австрійської сторони, де розташований маєток історичного значення.

Keywords: cycle and foot bridge, inclined tension bars, stiffening girder, pylons, orthotropic bridge deck.

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1. INTRODUCTION

During the Austrian – Hungary monarchy Moravian field and Slovakia was connected with 24 bridges. In 1990 after the fall of the Iron curtain there were none of them. And to this date, only one bridge was built that is connecting Moravsky Sväty J a n in Slovakia and Hohenau in Austria. In March 2010, representatives of Bratislava region and Lower Austria decided to build a new bridge for cyclists and pedestrians between Devinska Nova Ves and Schlosshof.

Cycle-bridge will be built in a historical route. The total length of the bridge is 525,0 meters, width is 4,0 m. The height of the bridge above the river Morava will allow safe navigation of ships on the river. On 25 September 2011 was officially laid cornerstone of the bridge.

Author of the architectural design of the bridge is Ing. arch. M. Bela ček. Prof. Z. Ago cs, Ing. M. Vanko and Ing. A. Pa lfi are the authors of the structural design and also of the documentation for realization of the steel structure. On preparing of the documentation also cooperated Ing Ja n Palkovič, Ing. Ja n Ivančik and Ing. Csaba Ne meth. Construction contractor is association Cycle-bridge INGSTEEL&Doprastav; leading participant of the association is Ingsteel, Ltd.

2. DISCRIPTION OF THE STRUCTURE OF THE BRIDGE

When choosing the shape of the bridge that connects the two neighbouring states in the vicinity of capital cities (Bratislava and Vienna), it is difficult to decide what type of bridge to build. The fact that the bridge is built over the inundation area of protected lowland forests played important role during the process of designing of the bridge.

The route from the end supports of the cycle-bridge towards Devinska Nova Ves continues on embankment and is connected to the communication on the street Na my te. The route towards Schlosshof continues to an already renewed vaulted stone bridge and to the embankment. Works on foundations has begun on November 2011.

The superstructure consists of three parts:

- three span triangular lattice continuous girder with spans 30,0 + 120,0 + 30,0 m over the river flow,
- bridge over the inundation area on the Slovak side. Distance between vertical supports is 8 30,0 = 240,0 m,
- bridge over the inundation area on the Austrian side. Distance between vertical supports is 3 30,0 + 15,0 = 105,0 m.

The bridge has 5 dilatation parts. In respect to layout of bicycle tracks on the bridge the width

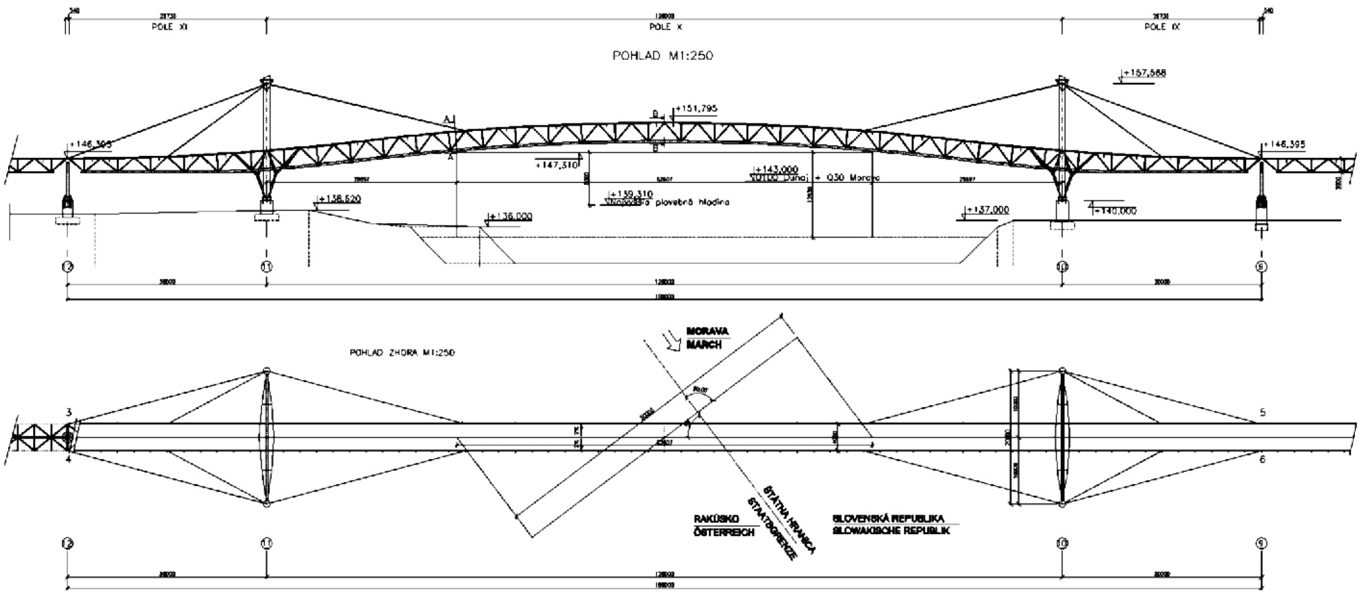

Fig. 1. The scheme of the structure over the flow of the river Morava

of the bridge is constant – 4,0 m. The width of the orthotropic steel deck is equal to the width of the road. The deck has roof shape with a transverse gradient of 2 % from the longitudinal axis of the bridge to the edges. Vertical alignment of the bridge is defined in the axis of the bridge at the top of the road.

The bridge has welded steel structure with welded assembly joints.

2.1. The bridge over the Morava River

This bridge is a suspended symmetrical three span independent dilatation unit with spans 30,0 + + 120,0 + 30,0 = 180,0 m. Stiffening girder has triangular shape and is made of tubes. It has orthotropic deck. Theoretical height of the stiffening girder is variable; changing from 2,0 to 2,8 m. In the middle of the main span, the height is constant 2,8 m (Fig. 1).

In the middle span the stiffening girder has shape of a circular arch with radius of curvature 376,350 m.

The deck (Fig. 2) is orthotropic with same skeleton along the length, which is composed of following components:

- bridge deck plate,
- cross beams over the end supports,
- cross beams in the location where the hangers M100 are connected to the beam and in place where the beam is connected to branch of tree support,

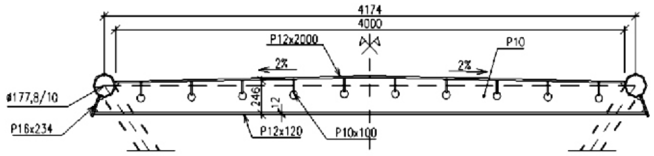

Fig. 2. Orthotropic deck – intermediate cross beam

- intermediate cross beams,
- longitudinal stiffeners.

End cross beams of the main span at the supports P9 and P12 have a walls with variable height with a thickness of 16 mm. Lower flange P25 200 is enlarged in place where the cross beam is connected to the supports. These cross beams are hinged to the steel columns via centring pad. The tensile reaction is transmitted to the supports with 4 screws M30 10.09.

Cross beams in the location where the hangers M100 are connected to the beam and in area where the beam is connected to branch of tree support have variable wall height with a thickness of 16–20 mm. Flange is made of the plate P25 200.

Intermediate cross beams are of variable height wall (according to transverse gradient of the deck) with a thickness of 10 mm. Flange is straight; made of plate P12 120. The lower flange is to the upper chord connected by a vertical plate P16. Intermediate cross beams in area of connection of diagonals to the upper chord are placed between the diagonals. In areas where are the verticals the wall of the

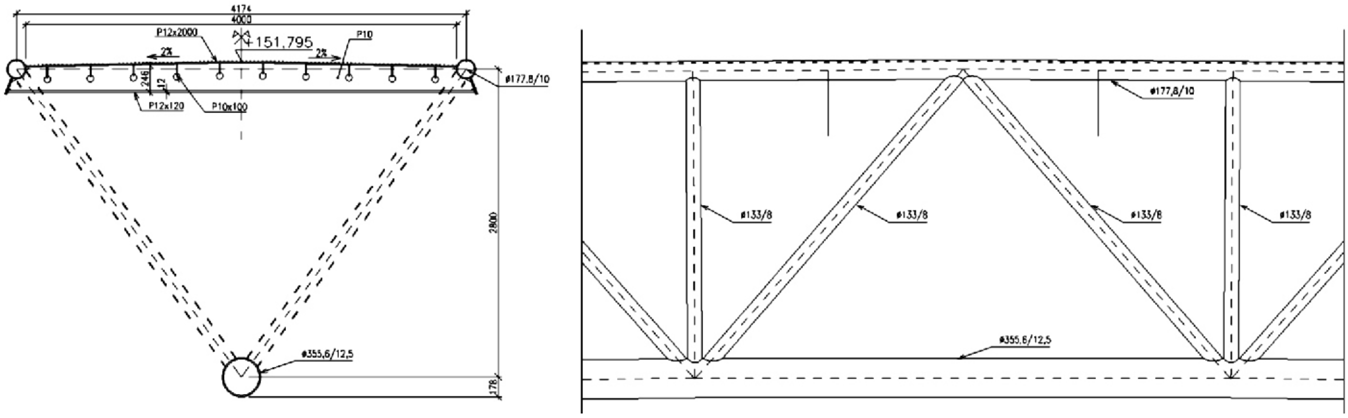

Fig. 3. Triangular tubular stiffening girder

cross beam passes through a hole burned in these verticals and is terminated with radial direction sheet P16.

Mutual distance between cross beams is 2,5 m. Cross beams are connected to the deck by fillet welds. The bottom flange of the cross beam is also connected to the wall by fillet welds. In areas where the cross beam is directly loaded by reactions of the bearings are fillet welds replaced with butt welds.

Longitudinal stiffeners of the bridge deck are opened; made of plate P10 100. They are placed in mutual axial distance 400 mm. They pass through the burned holes in the walls of the cross beams without interruption. They are welded to the deck by a fillet welds.

Construction of the bridge deck interacts with the upper of the girder chords. Thus formed triangular cross-section is rigid in torsion.

Triangular stiffening girder (Fig. 3) with variable height from 2,0 to 2,80 m consists of a tube chords and of tube diagonals and verticals. Axial distance between the upper chords is 4174 mm and it is constant along the entire length of the bridge. The upper chords have a constant outer diameter of 177,8 mm and variable wall thickness are 10 and 20 mm. The lower chord also has a constant outer diameter of 355,6 mm. The wall thickness is 12,5 or 20 mm. Diagonals and verticals have an outer diameter of 133 mm. The wall thickness of verticals is uniform 8 mm. Diagonals have wall thicknesses 8, 10 and 16 mm.

Pylons (Fig. 4) of the bridge are designed as rectangular two hinge frames. Columns of the pylons are fixed to the substructure. Cross-frame beam is hinged to the heads of the pylons.

The columns are of large diameter tubes 914 12,5 mm. They are 10,0 m away from the

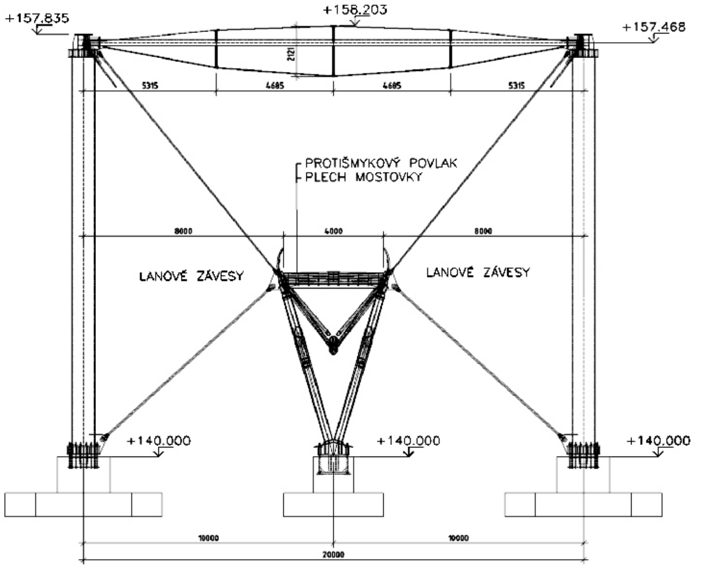

Fig. 4. Pylon and transverse braces of the bridge

longitudinal axis of the bridge, so the frame span is 20,0 m. Anchoring of the pylon (Fig. 5) is radial, with 16 anchoring bolts M36 made of steel S355. Pylon shaft is welded to the ring-shaped baseplate with a thickness of 30 mm. 300 mm above the baseplate is a circular ring of steel P30 welded to the shaft of the pylon. Shaft between the baseplate, ring and anchoring bolts is reinforced by vertical stiffeners of plate P16. Effects of horizontal loads in place fix connection is transferred into the concrete base with skid of «I» shape. In the direction of the transverse axis of the pylons there are welded plates for transverse braces.

Detail of the head of the pylon is drawn on the picture no. 6. Besides the cross-frame beam the suspenders and transverse braces are also connected to the head of pylons.

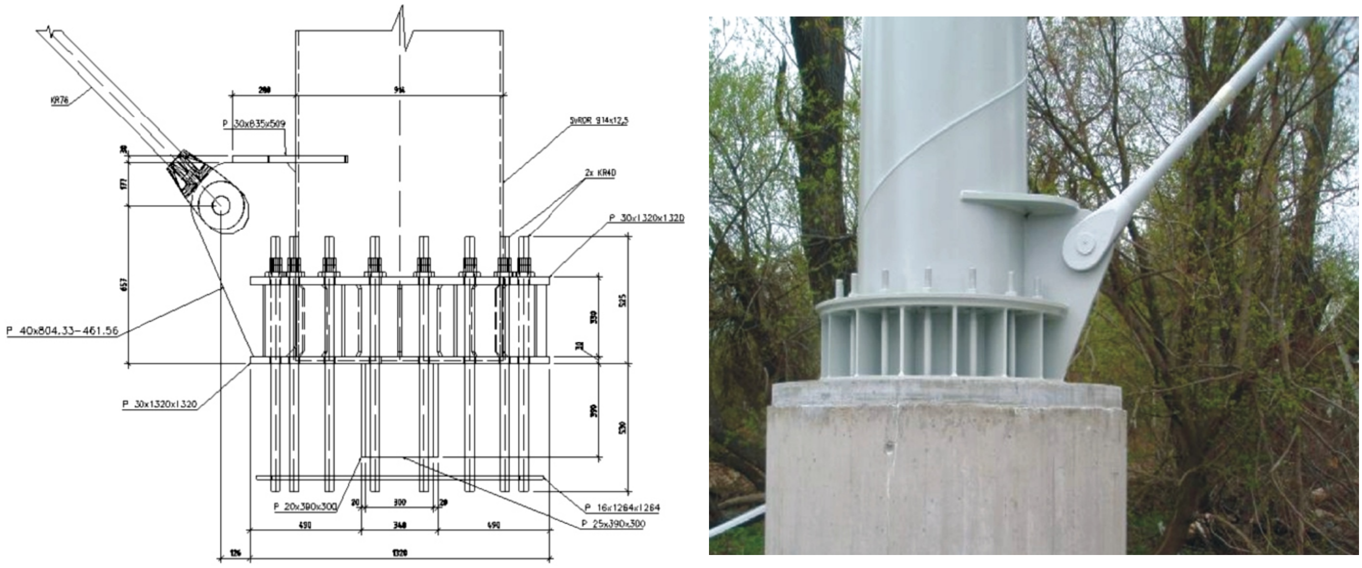

Fig. 5. Anchoring of the pylon – proposal and realization

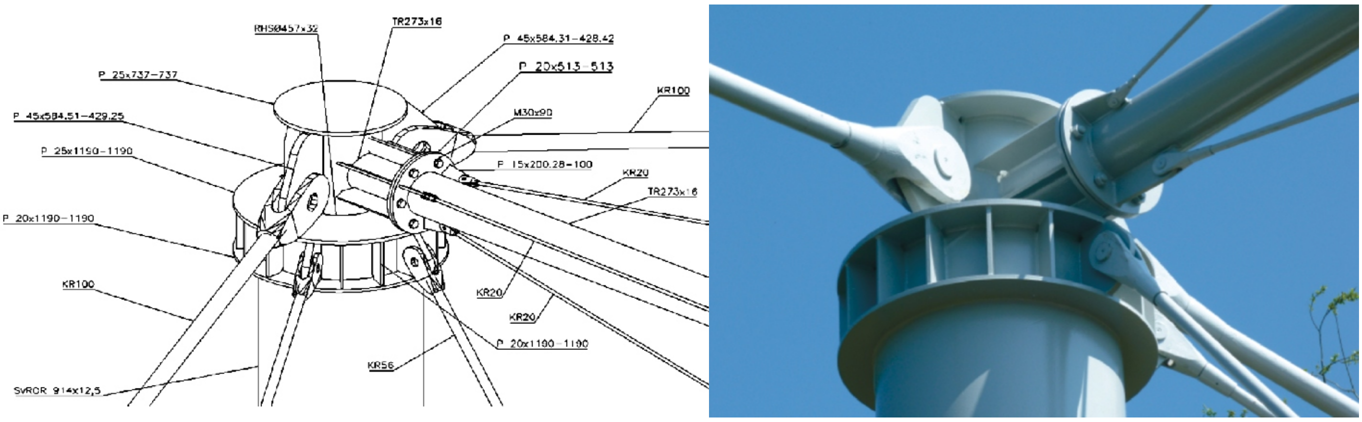

Fig. 6. Head of the pylon

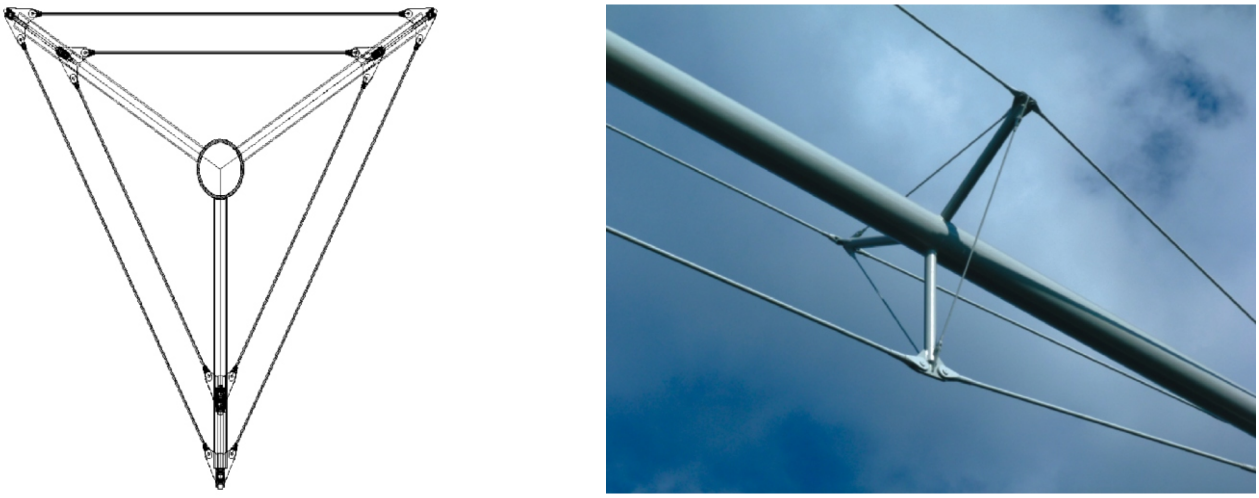

Fig. 7. Cross-frame beam – spatial beam string structure

Suspenders are connected to the plates with pins. Cross-frame beam (Fig. 7) with overall length of 18740 mm is proposed as spatial beam string structure with central tube and is connected to the head of the pylon via short tube.

Inclined hangers are made of round bars Macalloy. Diameters of the bars are M100 and M56 and they are made of steel S460. Hangers are anchored to the upper chord of the beam through pin plates that are welded to the short cantilevers (Fig. 8). In areas of the connection of the hangers to the beam the deck plate is with bigger thickness and reinforced with short transverse stiffener with shape of T.

Steel supports of the stiffening girder at the end of the girder have «V» shape (Fig. 9). They are made of steel tubes 457 22,2. Supports P9 and P12 are fixed to the reinforced concrete foundation construction in both directions. In place of connection are welded to the inclined plate of P25 of steel anchoring core. Baseplate of this core is 40 mm thick. Central part of the core is a short tube 660 25 mm. The space between the upper and lower baseplate is reinforced by stiffeners of P16. Horizontal reactions are transferred into the concrete base with skid of «I» shape with a height of 342 mm. Columns are anchored with radial arranged bolts 12 M42 which are made of steel S355. In the assembly stage, the head of «V» columns are interconnected with horizontal rod U80, which will be removed after the erection is completed.

Supports (P10 and P11) near pylons are shaped in the longitudinal direction as branch of tree

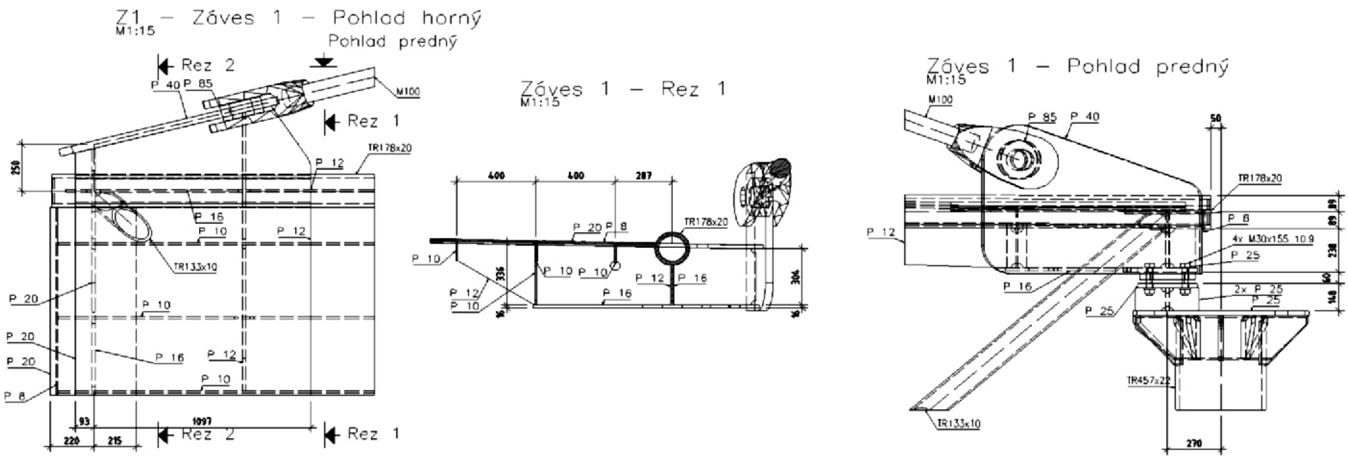

Fig .8: Anchoring of the inclined hanger Macalloy M100 to the stiffening girder

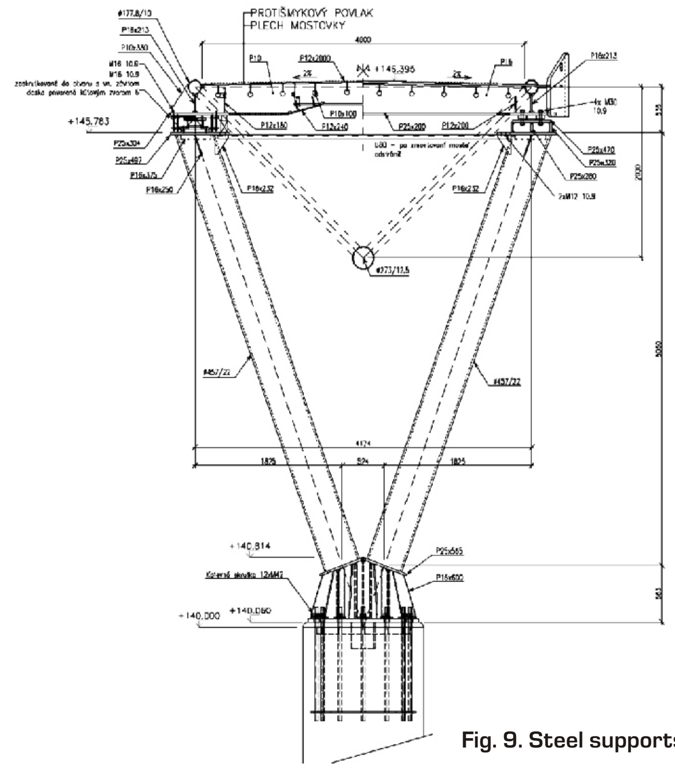

Fig. 9. Steel supports of the stiffening girder

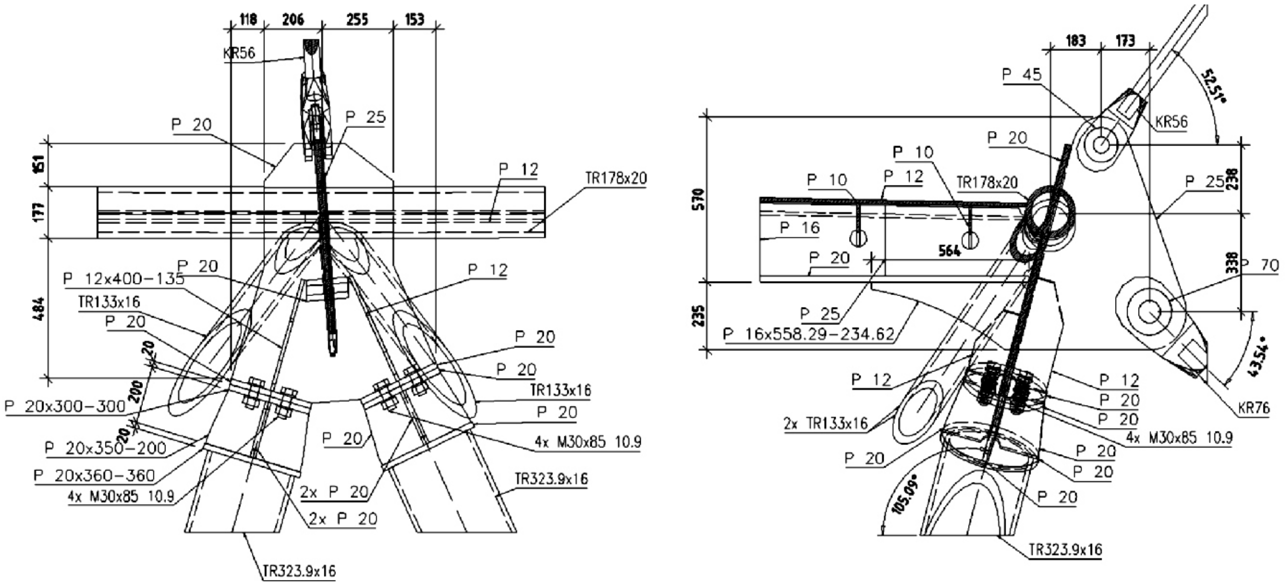

Fig. 10. Detail of the connection between the stiffening girder and branch of tree support in location of transverse bracing

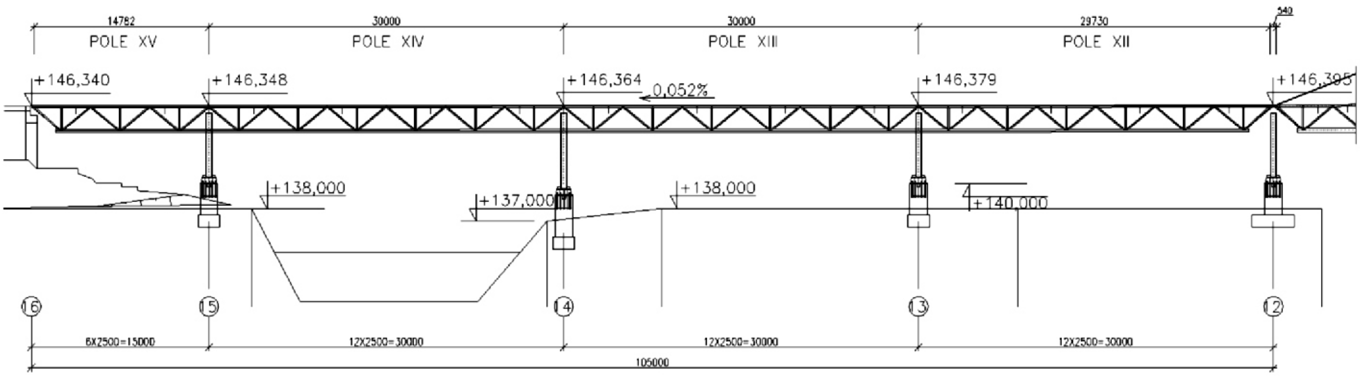

Fig. 11a. Scheme of the bridge on Austrian side

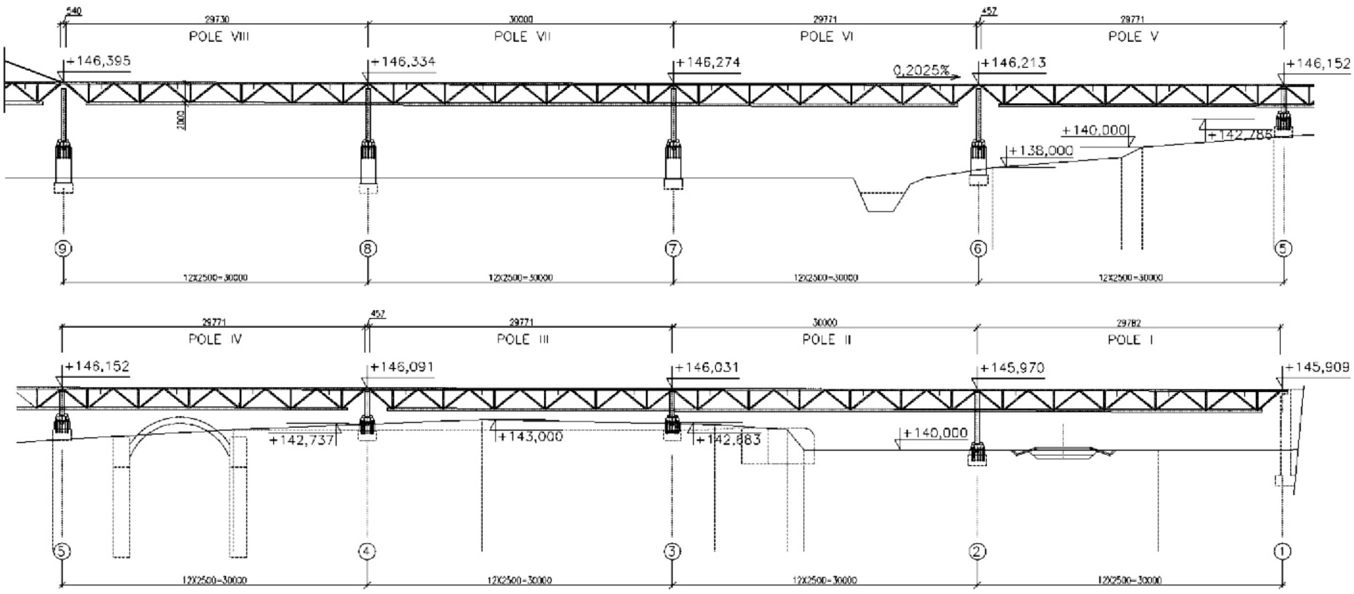

Fig. 11b. Scheme of the bridge on Slovak side

Fig. 12. Basic static test

Fig. 13. View on steel structure

Fig. 14. View on finished bridge

system. These supports are hinged in the longitudinal direction of the bridge and in the transverse direction they are fixed. All rods of branch of tree system are made of tubes 323,9 16 mm. In place of connection to the substructure are columns of the supports welded to the upper plate of the anchoring core. The upper plate has roof shape and thickness is 25 mm. The central tube of the core is of 660 25. The thickness of the baseplate is 30 mm. On the bottom of the baseplate is welded a strong double-walled indent skid with dimensions 400 480 mm which is transferring mainly horizontal reactions in the longitudinal direction. The support is anchored by four anchor bolts M56 which are made of steel S355.

The space between the upper and lower baseplate is reinforced by vertical stiffeners. Stiffening girder is hinged connected to the head of branch of tree supports in the nodes of lattice structure. Mutual connection is secured with screws (Fig. 10).

2.2. Bridges over the inundation areas

The superstructure of the bridge on the Austrian side (Fig. 11. a) consists of a continuous three-span truss beam with spans of 3 30,0 + 15,0 = = 105,0 m. Theoretical height of the stiffening girder is constant; 2,0 m. Deck width is 4,0 m.

Construction of the bridge deck and the road of inundation bridges are identical to the solution of the bridge over the river flows.

Upper chords of triangular stiffening girder are made of tubes 177,8 10. The lower chord has a constant outer diameter. It is made of tubes 273 10 and in location of the intermediate supports are tubes 273 12,5. Diagonals are made of tubes 133 8 and in location of the intermediate supports of tubes 133 10. The verticals are made of the tubes 133 8.

The superstructure on Slovak side consists of three separate dilatation units (Fig. 11b). It consists of a triangular continuous truss girder with spans of dilatation units 3 30,0 + 2 30,0 + 3 30,0 = 240,0 m. Theoretical height of the stiffening girder is constant; 2,0 m. Deck width is 4,0 m. Dimensions of the rods of the stiffening truss girder are of the same size as on the inundation bridge on Austrian side. Steel supports of the stiffening girder have also in the transverse direction shape of the letter «V». They are made of tubes 457 22,2. These supports are fixed in both directions into reinforced concrete foundation structures. In place of connection are welded to the inclined plate of P25 of steel anchoring core. Baseplate of the core is 40 mm thick. Central part of the core is a short tube 660 25 mm. The space between the upper and lower baseplate is reinforced by stiffeners P16. Horizontal reactions are transferred into the concrete base with skid of «I» shape with a height of 342 mm. Columns are anchored with radial arranged bolts 12 M42 which are made of steel S355.

3. CONCLUSION. The structure is mainly made of steel S355K2+N. Less-stressed structural elements are made of steel S355J2. Handrails shall be made of steel S235JR. Hangers are from the construction company Macalloy made of steel S460. The total utilization of steel for structure is a 553 t.

Reliability of the bridge structure was verified by basic static (fig. 12) and dynamic tests. Based on the results of dynamic tests were in the middle of the bridge main span installed vibration dampers.

Works on steel structure has started on January 2012. All works were finished on June 2012 View on the finished bridge is on last pictures.

[1] *Ago cs Z., Vanko M, Pa lfi A.*, Document for the realization of the construction of the Cycle bridge D. N. Ves – Schlosshof., Ingsteel, September 2011

[2] *Ago cs Z., Vanko M, Pa lfi A.*, Ocel ova konštrukcia cyklomosta Devinska Nova Ves – Schlosshof (Steel structure of the Cycle Bridge Devinska Nova Ves – Schlosshof), Konstrukce 5/12 (2012) pp. 23–29.

[3] *Ago cs Z., Beza k A., Vanko M, Pa lfi A.*, Cycle and Foot Bridge over the River Morava between Slovakia and Austria, Proceedings of the IASS symposium 2013 (in print)

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