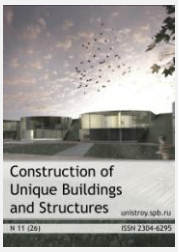
Строительство уникальных зданий и сооружений. ISSN 2304-6295. 11 (26). 2014. 107-114

Construction
of Unique Buildings and Structures



journal homepage: www.unistroy.spb.ru

Preliminary technical studies for the connection of the two Pan-European Corridors in the district between Sopotnica and Meseista

Z. Zafirovski [1], Z. Krakutovski [2], G. Gjosevski[3]

Ss. Cyril and Methodius University in Skopje, blvd. Goce Delcev 9, 1000 Skopje, Republic of Macedonia

ARTICLE INFO

Original research article

Article history

Received 19 October 2014
Accepted 19 November 2014

Keywords

construction of railways,
Investment costs,
Pan-European Corridors,
Corridor VIII,
Corridor X,
connection,
railway track;=

ABSTRACT

The purpose of this paper is to promote a solution for the connection of the two Pan-European Corridors i.e. the Corridor VIII and the Corridor X that go through the territory of Republic of Macedonia. Their single joining point is the city Skopje, and as a result we came to an idea to use their connection at another place. This connection is going to enable better railway traffic and circular motion over the rail in the country along with the uplift of the quality and service of transport in Macedonia. Moreover, we are taking about a single track section with normal width of the track section which connects both Pan-European Corridors in the district between Sopotnica and Meseista.

Contents

[1] *Corresponding author:*
zafirovski@gf.ukim.edu.mk (Zlatko Zafirovski, Ph.D., Associate Professor)
[2] krakutovski@gf.ukim.edu.mk (Zoran Krakutovski, Ph.D., Professor)
[3] ggjosevski@gmail.com (Goran Gjosevski, B.Sc., Student)

Introduction

The Corridor VIII has big economic and social influence on the development of the Republic of Macedonia. The Corridor presents an existing railroad Kumanovo – Skopje – Tetovo – Kicevo – Struga. This railroad is very important for the connection between Republic of Albania and Republic of Bulgaria. In 1992 the three countries agreed on building a transport Corridor Durres – Tirana – Gostivar – Skopje – Kumanovo – Gueshevo - Sofia - Burgas and the purpose of that Corridor will be the connection between the Italian ports (Bari,Brindisi) and Albanian ports (Durres,Vlora) from the one side, and the Bulgarian ports (Burgas,Varna) from the other side. Another important Pan- European Corridor passes on the territory of Republic of Macedonia, the Corridor X. It is a connection between Western European countries and the Greek port (Thesalloniki). The geographical position of Sopotnica and Mesheishta and their distance of only 30 kilometers is a perfect opportunity for connecting these two places with a railroad and in that case we are connecting the both Corridors (Corridor VIII and Corridor X). This connection of the two Pan- European Corridors i.e. the Corridor VIII and the Corridor X will enable better railway traffic and circular motion over the rail in the country along with the uplift of the quality and service of transport in Macedonia [1-26].

Figure 1. Pan-European Transport Corridors in the South of Europe

Terrain features and technical parameters

The Section between Sopotnica and Mesheishta is characterized with mountainous terrain, hard to reach places and mountain peaks with height of 1500 m altitude. The whole section is characterized with high mountain peaks and steep ravines which require building expensive objects and raises the price of this project. The first and the last station are on about the same altitude Sopotnica (583 m) and Mesheishta (594 m). The air distance between them is 33 km and 550 m.

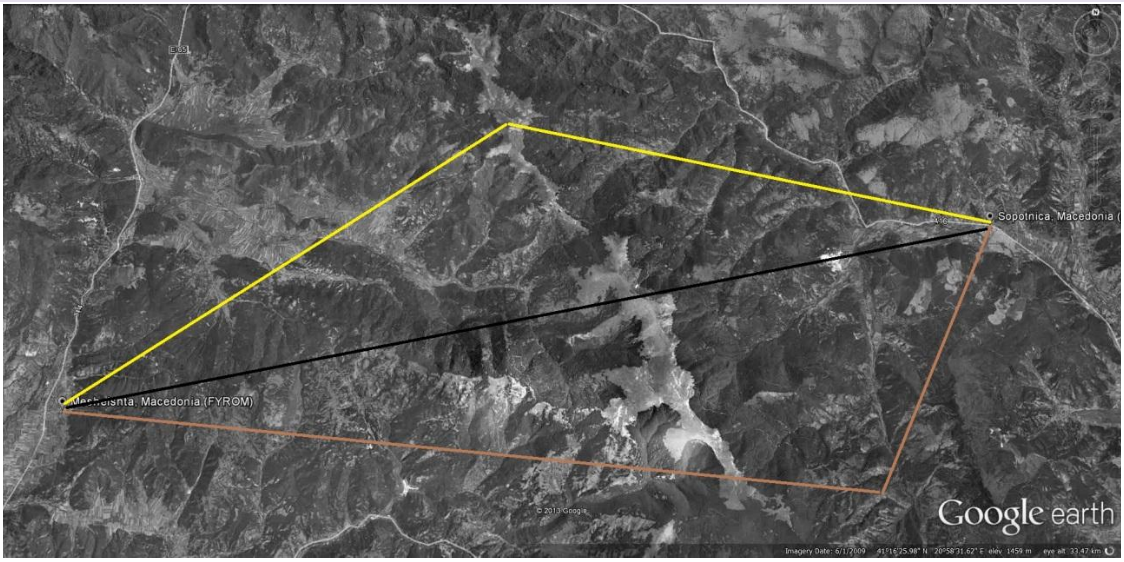


Figure 2. Terrain characteristics

The setting of the alignment offered various possibilities. The first solution was to build an object-tunnel with length of 30 km which will join these two places. This was a very expensive solution so it was omitted from the start. The price of the other two alignments was more acceptable.

Their idea was to sneak the railroad between the peaks and ravines and to offer quality and respectable railroad traffic. In this two final variants were projected satisfying technical parameters such as:

Max speed: variant 1 (100 km/h), variant 2 (80 km/h).
Min curve radius: variant 1 (500 m), variant 2 (300 m).
Max gradient: 25 ‰.
Max gradient in tunnel 10 ‰.

Technical characteristics and investment costs

1 Technical characteristics

1.1 Coefficient of developing (K_r)

$K_r = ((L_{vk} - L_0)/L_0)*100$, [%]

K_r – Coefficient of developing

L_{vk} – total length of alignment

L_0 – length of straight line

The variant with bigger Coefficient of developing has a lower quality.

1.2 Coefficient of the route in curves (K_{kr})

$K_{kr} = (\Sigma D_k / L_{vk})$, [m'/km]

K_{kr} – Coefficient of the route in curves

D_k – total length in curves

L_{vk} – total length of alignment

The variant with lower Coefficient of the route in curves has a better quality.

1.3 Coefficient of angles (α)

$\alpha = (\Sigma \alpha / Lvk)$, [◦/km]

α – Coefficient of angles

Σ α – amount of all angles

Lvk – total length of alignment

The variant with lower Coefficient of angels has a better quality.

1.4 Middle curve radius (Rsr)

$Rsr = (57.3 * (\Sigma Dk / \Sigma \alpha))$, [m]

The variant with bigger Middle curve radius has a better quality.

Technical characteristics (Variant 1) are presented in Table 1.

Table 1. Technical characteristics (Variant 1)

Variant 1	80 кm/h (300 m)
The alignment has:	
total length	Lvk= 56 833 m
49 curves with length	Dk=17 923 m
The length of straight line	L_0=38 910 m.
The amount of all angles	Σαi=2910 ◦.
Coefficient of the route in curves	Кr=46 %
Coefficient of the route in curves	Kkr=315 (m′/km)
Coefficient of angles	α=51.2 (◦/km)
Middle curve radius	Rsr=353 m

Technical characteristics (Variant 2) are presented in Table 2.

Table 2. Technical characteristics (Variant 2)

Variant 2	100 km/h (500 m)
The alignment has:	
total length	L_{vk}= 51 852 m
36 curves with length	D_k=22 605 m
The length of straight line	L_0=29 247 m
The amount of all angles	$\Sigma\alpha_i$=2298 ◦
Coefficient of the route in curves	$К_r$=77 %
Coefficient of the route in curves	K_{kr}=436 (m′/km)
Coefficient of angles	α=44,3 (◦/km)
Middle curve radius	R_{sr}=564 m

2 Investment costs

Investment costs (Variant 1) are presented in Table 3.

Table 3. Investment costs (Variant 1)

Variant 1	80 кm/h (300 m)
Total length	56,833 m
Length of tunnels	6,260 m
Length of bridges	830 m
Investment costs	569,497,000 €
Total cost of the project	710,000,000 €
Cost of the project by km	12,493,000 €/km

Investment costs (Variant 2) are presented in Table 4.

Table 4. Investment costs (Variant 2)

Variant 2	**100 км/h (500m)**
Total length	51,852 m
Length of tunnels	6,350 m
Length of bridges	700 m
Investment costs	631,939,000 €
Total cost of the project	787,000,000 €
Cost of the project by km	15,178,000 €/km

Conclusion

The results of the analysis are quantitatively and qualitatively talking about two variants.

The results are saying that the second variant (80 km\h and 300 m) is longer (56,833 km) and has less objects along the alignment which means that it is cheaper with amount of 12,500,000 € per 1 km length.

The first variant (100 km/h and 500 m) is characterized with shorter route (51,852 km), but with more objects along the alignment which means it is more expensive i.e. with amount of 15,200,000 € per 1 km length. The aspect of time is very important and it is clear that the first variant (100 km/h) provides better solution for transport of people and goods.

The Technical characteristics are clearly saying that the second variant (80 km/h) provides better quality and in this stage of development it is a better choice for this kind of mountain route and gives satisfying technical parameters and costs less.

In our opinion, we may conclude that in this development stage the second variant is recommended as being a more rational solution.

Reference

[1]. Profillidis V.A. (2006) Railway Management and Engineering, Third Edition, USA.

[2]. Europeam Commission, Trans-European transport Network, TEN-T priority axes and projects 2005, Brussels, 2005.

[3]. Pre-feasibility study on the development of the railway axis, final report september 2007, Ministry of International Trade – Italy, CEI [web source] URL:www.corridor8.org (date of reference: 19.10.2014)

[4]. Esveld, C.: Modern Railway Track, Second edition, TU-Delft, 2001.

[5]. [web source] www.corridor8.org (date of reference: 19.10.2014)

[6]. Klotzinger E., (2008), Teaching Aid – Track, Plasser&Theurer, Wien Austria.

[7]. Tomicic-Torlakovic M., Rankovic S., (1996), Gornji Stroj železnica, Univerzitet u Beogradu.

[8]. Bozidar J. Furundzic, Slobodan B. Furundzic, Zbirka Tehnickih Propisa u Gradzevinarstvu, Gradzevinska knjiga. Beograd, 1983. 864 p.

[9]. [web source] www.mzi.mk (date of reference: 19.10.2014)

[10]. Roanes–Lozano, E., Galán–García, J. L., García–Álvarez, A., Mesa, L. Estimating radial railway network improvement with a CAS (2014) Journal of Computational and Applied Mathematics, Vol. 270, pp. 294-307

[11]. Duffy, M.C. George Stephenson and the introduction of rolled railway rail (1981) Journal of Mechanical Working Technology, Vol. 5, (3–4), pp. 309-342.

[12]. Roanes-Lozano E., Laita L. M., Roanes-Macías E., Wester M. J., Ruiz-Lozano J. L., Roncero C. Evolution of railway network flexibility: The Spanish broad gauge case (2009) Mathematics and Computers in Simulation, Vol. 79, (8), pp. 2317-2332.

[13]. Zhang J., Xu B., Guan X. A combined simulation procedure for wear assessment of the HXN5 locomotive (2014) Vol. 314(1–2) 15 pp. 305-313.

[14]. Ma, W., Song, R., Liu, W., Luo, S. The influence of journal box position error on wheelset asymmetric flange wear of the 2C0-type locomotive (2014) Vol. 314(1–2), pp. 314-320.

[15]. Vo, K.D., Zhu, H.T., Tieu, A.K., Kosasih, P.B. FE method to predict damage formation on curved track for various worn status of wheel/rail profiles (2014) Wear, Vol. 324, pp. 654-662.

[16]. Descartes, S., Saulot, A., Godeau, C., Bondeux, S., Dayot, C., Berthier, Y. Wheel flange/rail gauge corner contact lubrication: Tribological investigations (2011) Wear, Vol. 271, (1–2), pp.54-61

[17]. Kovačič, B., Kamnik, R., Premrov, M. Deformation measurement of a structure with calculation of intermediate load phases (2011) Survey Review, 43 (320), pp. 150-161.

[18]. Ćosić, M., Brčić, S. Iterative Displacement Coefficient Method: Mathematical formulation and numerical analyses (2013) Gradjevinar, 65 (3), pp. 199-211.

[19]. Popović, Z. Program za proračun prolaska obrtnog postolja kroz krivinu [Program for budget passage bogie in curves] (1999) Građevinski fakultet u Beogradu, 273 p.

[20]. Popović, Z., Lazarević, L. Defining the cause and mechanism of track widening phenomenon on reconstructed sections Trebaljevo - Kolašin and Mijatovo Kolo - Mojkovac on rail line Vrbnica – Bar, The Case Study (2013) Montenegro, 185 p.

[21]. Provisional national technical specifications, 07-03-01-10 (2006) 48, 274 p.

[22]. CEN: EN 13848 - Railway applications - Track - Track geometry quality - Part 5: Geometric quality levels - Plain line, (2010)

[23]. Iwnicki, S. Handbook of Railway Vehicle Dynamics (2006) Taylor & Francis Group, 262 p.

[24]. Vatin, A.S. Sinelnikov A.S. *Bolsheproletnyye nadzemnyye peshekhodnyye perekhody iz legkogo kholodnognutogo stalnogo profilya* [Large span pedestrian crossings of cold formed light steel profiles], Construction of Unique Buildings and Structures, 1 (2012), pp. 47-53.

[25]. Kishinevskaya Ye. V., Vatin N. I., Kuznetsov V. D. *Perspektivy primeneniya nanobetona v monolitnykh bolsheproletnykh rebristykh perekrytiyakh s postnapryazheniyem* [Application of nanoconcrete in post-stressed monolithic span ribbed slabs], Magazine of Civil Engineering. 2 (2009), pp. 54-58.

[26]. Vatin N. I., J. Havula, L. Martikainen, A. S. Sinelnikov, A. V. Orlova, S.V. Salamakhin: Thin-walled cross-sections and their joints: Tests and FEM-modelling. Advanced Materials Research. (2014). Vols. 945-949. pp. 1211-1215.

Предварительные технические исследования для соединения двух общеевропейских транспортных коридоров на участке Сопотница - Мешеишта

З. Зафировски[1], З. Кракутовски[2], Г. Гйошевски[3]

Университет Святых Кирилла и Мефодия в Скопье, бульвар „Гоце Делчев“ бр. 9, 1000 Скопье, Республика Македония

Информация о статье	История	Ключевые слова
УДК 69 Научная статья	Подана в редакцию 19 октября 2014 Принята 19 ноября 2014	строительство железных дорог, Инвестиционные затраты, общеевропейская коридоры, коридор VIII, коридор X, транспортная связь, железнодорожные пути

АННОТАЦИЯ

Целью данного исследования является содействие развитию двух общеевропейских коридоров: коридора VIII и коридора X, которые идут через территорию Республики Македония. В настоящее время их единственной точкой пересечения является город Скопье. В результате, появилась идея соединить эти два коридора и в другом месте. Это соединение должно обеспечить лучшее железнодорожное движение и круговое движение по железной дороге в стране наряду с поднятием конкурентоспособности дорог в Македонии, улучшением качества услуг на железнодорожном транспорте. Рассматривается участок пути, который соединяет оба общеевропейских коридора в районе между селениями Sopotnica и Meseista.

Контактный автор:
1. zafirovski@gf.ukim.edu.mk (Зафировски Златко, к.т.н., доцент)
2. krakutovski@gf.ukim.edu.mk (Кракутовски Зоран, к.т.н., профессор)
3. ggjosevski@gmail.com (Гйошевски Горан, студент)

Литература

[1]. Horvatić, D. Spregnute konstrukcije Čelik – Beton, MASMEDIA d.o.o., Zagreb, (2003), 355 p.

[2]. EN 1992 – 1 – 1: 2004, (2006).

[3]. Johnson, R.P. Composite strucutres of steel and concrete (1994) Blackwell Scientific Publications, Oxford, 98 p.

[4]. Johnson, R.P. CSI Analysis Reference Manual (2013) Computers & Structures, pp. 158-165.

[5]. Jasiczak, J., Szymański, P., Nowotarski, P. Computerised evaluation of the early age of shrinkage in concrete (2015) Automation in Construction, 49, pp. 40-50.

[6]. Al-Saleh, S. A. Comparison of theoretical and experimental shrinkage in concrete (2014) Construction and Building Materials, 72, pp. 326-332.

[7]. Afzal, S., Shahzada, Kh., Fahad, M. Assessment of early-age autogenous shrinkage strains in concrete using bentonite clay as internal curing technique (2014) Construction and Building Materials, 15, pp. 403-409.

[8]. Maslehuddin, M., Ibrahim, M., Shameem, Ali, M.R., Al-Mehthel, M.H. Effect of curing methods on shrinkage and corrosion resistance of concrete (2013) Construction and Building Materials, 41, pp. 634-641.

[9]. Singh, M., Siddique, R. Compressive strength, drying shrinkage and chemical resistance of concrete incorporating coal bottom ash as partial or total replacement of sand (2014) Construction and Building Materials, 68, pp. 39-48.

[10]. Горшков А. С., Ватин Н. И. Инновационная технология возведения стеновых конструкций из газобетонных блоков на полиуретановый клей // Строительство уникальных зданий и сооружений. 2013. №8 (13). С. 20-28.

[11]. Cusson, D., Hoogeveen, T. An experimental approach for the analysis of early-age behavior of high-performance concrete structures under restrained shrinkage (2007) Cement and Concrete Research, 37(2), pp. 200-209.

[12]. Bentur, A., Igarashi, S., Kovler, K. Prevention of autogenous shrinkage in high-strength concrete by internal curing using wet lightweight aggregates (2001) Cement and Concrete Research, 31(11), pp. 1587-1591.

[13]. Ватин Н.И., Синельников А.С. Большепролетные надземные пешеходные переходы из легкого стального профиля // Строительство уникальных зданий и сооружений. 2012. №1. С. 47-53.

[14]. Klemczak, B.A. Modeling thermal-shrinkage stresses in early age massive concrete structures – Comparative study of basic models (2014) Archives of Civil and Mechanical Engineering, 14(4), pp. 721-733.

[15]. Gilbert, R.I., Bradford, M.A., Gholamhoseini, A., Chang, Z.-T. Effects of shrinkage on the long-term stresses and deformations of composite concrete slabs (2012) Engineering Structures, 40, pp. 9-19.

[16]. Beushausen, H., Alexander, M.G. Failure mechanisms and tensile relaxation of bonded concrete overlays subjected to differential shrinkage (2006) Cement and Concrete Research, 36(1), pp. 1908-1914.

[17]. Cortas, R., Rozière, E.,Staquet, S., Hamami, A. Effect of the water saturation of aggregates on the shrinkage induced cracking risk of concrete at early age (2014) Cement and Concrete Composites, 50, pp. 1-9.

[18]. Choi, P., Yun, K.K. Experimental analysis of latex-solid content effect on early-age and autogenous shrinkage of very-early strength latex-modified concrete (2014) Construction and Building Materials, 65, pp. 396-404.

[19]. Ismail, S., Ramli, M. Mechanical strength and drying shrinkage properties of concrete containing treated coarse recycled concrete aggregates (2014) Construction and Building Materials, 68, pp. 726-739.

[20]. Ćosić, M., Brčić, S. Iterative Displacement Coefficient Method: Mathematical formulation and numerical analyses (2013) Gradjevinar, 65 (3), pp. 199-211.

[21]. Кишиневская Е. В., Ватин Н.И., Кузнецов В.Д. Перспективы применения нанобетона в монолитных большепролетных ребристых перекрытиях с постнапряжением // Инженерно-строительный журнал. 2009. №2. С. 54-58.

[22]. Collins, F., Sanjayan, J. G. Strength and shrinkage properties of alkali-activated slag concrete containing porous coarse aggregate (1999) Cement and Concrete Research, 29(4), pp. 607-610.