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LONG-SPAN RAILWAY BRIDGES IN THE TRANSPORT SYSTEM OF HUNGARY[1]

Abstract

The lessons learned from wars and a large number of local armed conflicts of the past centuries and from the consequences of increasingly frequent terrorist attacks and natural disasters clearly underpin the strategic significance of transport. This is also proven by the damage to and losses of transport networks and facilities and by the resulting supply problems and transport difficulties. Structures whose damage or complete destruction may significantly limit transport process have specific importance. In my opinion railway bridges across rivers comprise such structures. The objective of this article is to present the role of long-span railway bridges in the national transport network, the impact of their damage, and some alternatives of their replacement.

Az elmúlt évszázad háborúinak, számtalan helyi fegyveres konfliktusának tapasztalatai, az egyre gyakrabban előforduló terrorcselekmények és természeti katasztrófák következményei egyértelműen alátámasztják a közlekedés stratégiai fontosságát és jelentőségét, amelyet a közlekedési hálózatokat és objektumait ért károk és veszteségek, az ezek következtében megjelenő ellátási-szállítási problémák is igazolnak. Különös jelentőséggel bírnak azon műtárgyak, melyek sérülése, esetlegesen teljes megsemmisülése jelentős mértékben korlátozhatja a közlekedési folyamatokat. Ilyen kiemelt műtárgyak megítélésem szerint a folyókat átszelő vasúti hidak. A cikk célja bemutatni a nagyfolyami vasúti hidak közlekedési rendszerben betöltött szerepét, sérülésének hatásait, valamint helyettesíthetőségének alternatíváit.

Keywords: *critical infrastructure, transport system, railway network, railway bridges ~ kritikus infrastruktúra, közlekedési rendszer, vasúthálózat, vasúti hidak*

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INTRODUCTION

In order to ensure the functioning of a country both in peace time and at the time of emergency situations it is necessary to analyse and secure the general preconditions of particular branches to shape a comprehensive system of requirements and to establish the necessary conditions for the defence of the nation, the living conditions of the population and the economic processes.

In the field of defence requirements such tasks appear in the defence preparation of the country. Defensive area-preparation[2] – besides the provision of the defence capabilities of the armed forces – obviously comprises an organic part of defence preparation involving a complex set of tasks. In the past few years the components of this task and the conditions of its realisation changed in a negative way both from defence and national economic aspects. While in the pre-regime-change era – due to coalition considerations – the defence preparation of the country was aimed at providing support to the east-west (southwest) transfer of own defence forces and that of Warsaw Pact troops. In the current situation both own and NATO troop movements are to be provided with multidirectional deployment opportunities, replacing the previous concretely defined directions of movement. An important part of such defence-area preparation is the preparation of transport network and the establishment of pre-conditions for the permanent flow of transport.

After the bipolar world order dissolved the direct threat of an imminent war was minimalised, however, phenomena that had threatened security before increased. These are: ethnic and religious conflicts, illegal drug trafficking, migration, organised crime, environment pollution, international terrorism, or the risks generated by climate change. Nowadays the amount of news about disasters or terrorist attacks putting the operation of critical infrastructure at risk has increased. [1] This means the risks of an all-out war were replaced by the risks of damage or deliberate destruction of critical infrastructures[3] –including transport infrastructure – whose preservation is of vital interest of society. With regard to all this I wish to take into consideration both aspects when analysing the current status of railway network – with a focus on long-span railway bridges – and the level of meeting the expected requirements.

CHANGES IN THE ROLE OF RAILWAY TRANSPORT

Before focusing on the examination of railway bridges the current role of railways in the transportation system should be overviewed. Thus the roles of bridges, the impact of their damage and limitations of their use can be evaluated.

As early as the ancient times it was a well-known fact that the geographic systems determining the structure of society, human life and economy both in peace time and wartime are determined by transport opportunities. The close interrelations between infrastructure and the development level of economy were also highlighted by domestic research conducted in the 1960s. Within infrastructure transport has always been one of the most significant factors.

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[2] Defensive area preparation: (preparation of theatre) part of the defensive preparation of a country, a collection of rules and regulations to be implemented on the entire territory of a country both in peace and war time. During the area preparation the conditions for deploying armed forces, continuous resupply and evacuation efficient administrative and military leadership are established. The tasks involve building and developing railways, roads, airfields and preparation of storage facilities.

[3] Critical infrastructure is usually infrastructures, assets, or processes, whose destruction or distressing would have a weakening impact on national security, economic and social welfare. The protection concept of strategically important was part of national defence planning for decades. With the Cold War over and in the years afterwards an attack against or other chances of damage to infrastructures were high priority among security challenges but it was given top priority only in the late 1990s.

In Hungary roads and railways are still the main elements in goods transport. However, since the 1980s the volume of railway transport has begun decreasing while the road transport has started growing. After Hungary joined the European Union (EU) the Hungarian modal split was nearly similar to that in the Western European countries, where road transport is dominant. In 2011 the total volume of goods transport in Hungary was 50.937 bn ton-kilometre with 68% on roads, 18% on railways, 11% through pipelines, and 4% on waterways. As far as the road and railway transport is concerned the neighbouring EU member states – except for Austria – have similar proportions. The low percentage of waterways is mainly due to the fact that a large number of traditional goods did not return on the Danube waterways long closed because of the destroyed bridges4 damaged by the air campaign during the Yugoslav war.

Recently the railways have been increasingly in the focus of attention as more and more attention is given to changes in this field. The problems of the sector are increasingly visible and they have grown clear in everyday life. Railway has lost ground in both passenger transport and goods transport to the other subdivisions of transport while roads are increasingly crowded, delays are regular in air transport, and air pollution data are indicating rapid deterioration of environment.

The changes in the output of each subdivision are summarised in figures 1 and 2. It is clear that the main loser of the events following the regime change is the railway, which can hardly reach its 1990 output even in 2030.

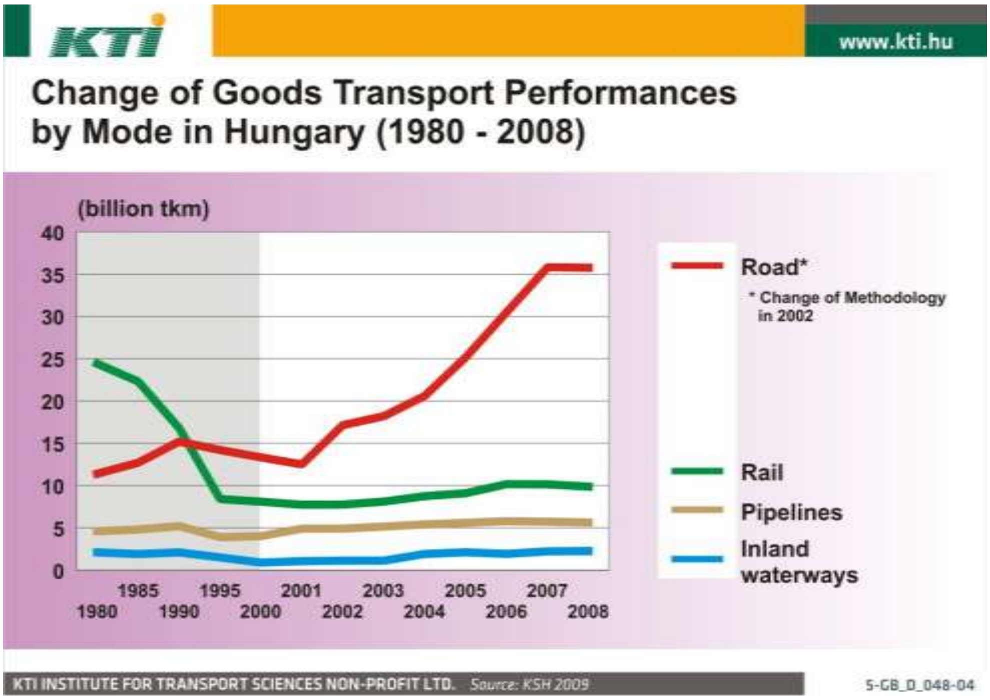

Figure 1. Change of Goods Transport Performances by Mode in Hungary [2]

4 This fact clearly shows the adverse effects of damage or destruction of transport infrastructure – including bridges – on other systems (domino effect).

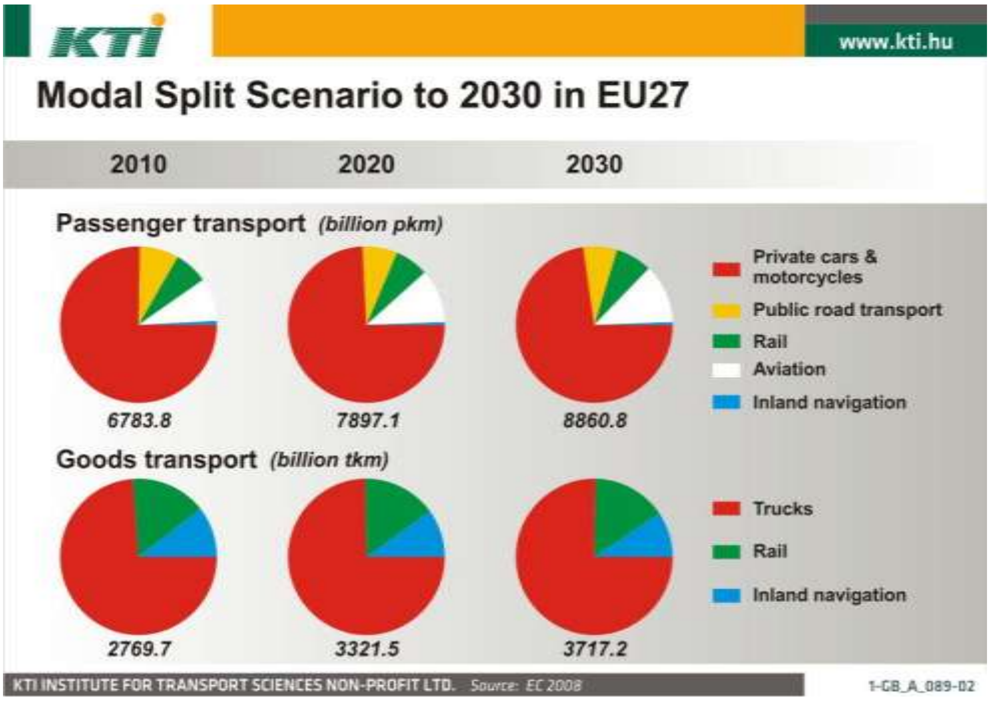

Figure 2. Modal Split Scenario to 2030 in EU27 [2]

The EU regards the solution of the problems outlined above in the revitalisation of railway transport. The objectives are included in the White Paper published in 2011. The EU 2011 White Paper on transport policy sets the objective to channel 30% then 50% of goods transport on distances longer than 300 kilometres from roads to other ways of transport by 2030 and 2050 respectively. [3] Meanwhile there seems to be a general consensus among analysts that the dominance of road transport – meeting the demands of consumers – remains steady in the long term. Hungary is no exception from this trend – although the development level of Hungarian Railway meets the European standards the backwardness and poor conditions of the track structure, technological background, rolling stock, and the high costs of development it is unable (and will remain unable for long time) to compete at speed of delivery with road transport. For customers the speed of delivery and the flexibility of road transport is a real advantage over the cumbersome nature of railways adapting to the "just in time" demands, gaining ground.

According to the statement of the European Commission (EC) besides the technological differences in the technological background of individual member states it is the lack of interoperability and the differing rules and regulations of national railways that are responsible for the disintegration of railway transport market among the member states. These differences generate significant additional costs and a loss of time at crossing national borders; consequently railways have a serious competition disadvantage over the rest of transport subdivisions.

Summing up the above it can be stated that the post-World-War dominance of railways has significantly decreased and by now it has become a real obstacle to the realisation of requirements generated by expectations towards sustainable mobility and environment-conscious ways of transport. Recognising this the EU is making huge efforts to increase the role of railways in transport division of labour. Thus, in my opinion, it is reasonable to examine the current status of long-span railway bridges and its impact on achieving the set objectives in connection with the above statements.

AN ANALYSIS OF THE STATUS OF RAILWAY BRIDGES

The status of railway bridges can only be examined and presented sufficiently in the context of the entire railway network as there is a clear interrelation between each particular element.

Both positive and negative impacts can be identified in this field. As far as railway density is concerned that factor in Hungary is fairly advantageous. The railway density calculated on the basis of the length of lines is 83 km/1000 km^2, which equals the average of developed European railway systems (figure 3).

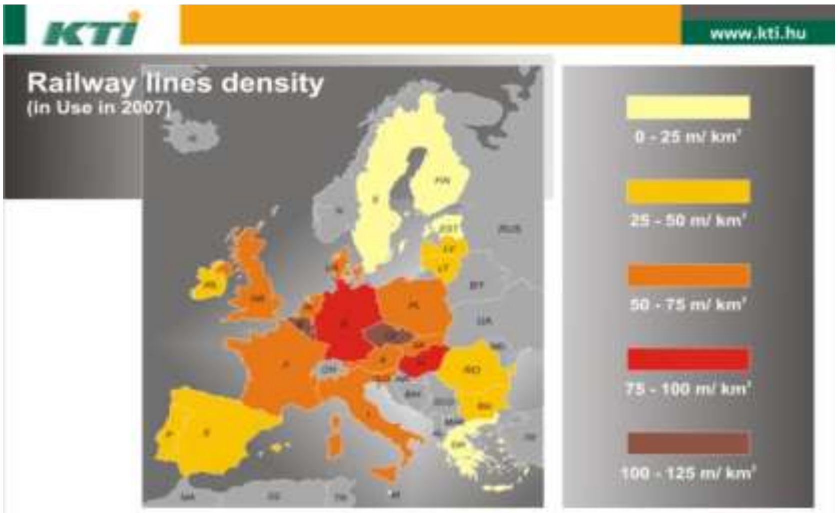

Figure 3. Railway Lines Density (in Use in 2007) [2]

Taking into consideration the fact that there was practically no railway construction in the past decades in Hungary this figure indicates primarily the development level of Hungarian railway achieved during the period of the great railway construction. Examining the density of national basic network lines involved in the overwhelming majority of railway transport it can be stated that this number changes to 50.1 km/1000 km2 (figure 4). Comparing this network to the current role of railways it is oversize therefore – parallel with conducting the necessary developments – streamlining is unavoidable. Naturally, development should take into consideration the demands of users of infrastructure (both economic and defence considerations must be enforced).

Currently two public railway companies5 maintain some 7,700 kilometres of railway lines. However, while the network of GySEV is made up by 91% of basic national lines this proportion is only 58% in the case of MÁV. This objective feature is reflected in the quality indicators of both railway companies. [4]

It may not be a very well known fact that if the roughly 10,000 railway bridges of Hungary were lined up, their combined length would be some 50 kilometres. This imaginary railway would include a huge number of bridges from few-metre-long culverts to the 1,400-metre-long viaduct in Nagyrákos or the 673-metre-long Újpest railway bridge. The viaduct over the River Zala along the Zalaegerszeg - Őrihodos (Hodos) railway line is the longest of such structures both in Hungary and Central Europe. The repair and maintenance of such a large number of railway structures is a tremendous task even in peace time therefore their reconstruction or replacement can only be resolved with the necessary reserve capacities and if proper peace-time preparation is conducted.

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[5] In accordance with Government Decree 168/2010. (V.11.) to Act CLXXXIII. of 2005 on Railway Transport the operation of national main railway lines, regional and other lines is the responsibility of Hungarian Railways (MÁV – Magyar Államvasutak Zrt.) and of Győr-Sopron-Ebenfurt Railways (GySEV – Győr-Sopron-Ebenfurti Vasút Zrt.).

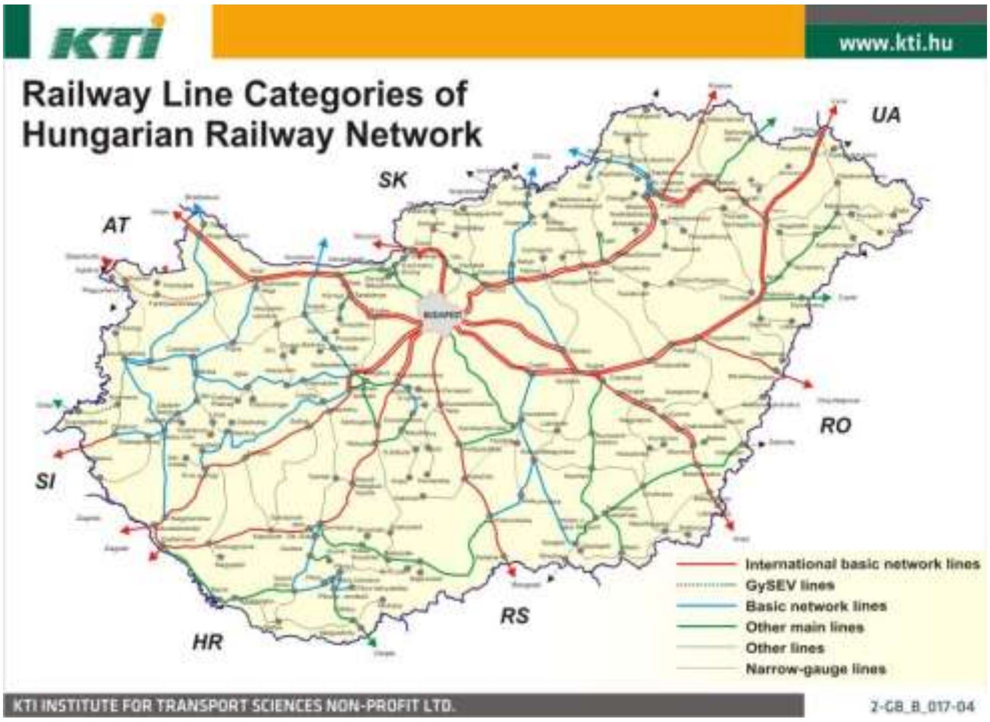

Figure 4. Railway Line Categories of Hungarian Railway Network [2]

THE PROBLEMS OF RAILWAY BRIDGES FROM DEFENCE PREPARATION ASPECTS

The destruction of the elements of a transport network, vital from defence aspects, (for example bridges over rivers Danube or Tisza) may result in the isolation of certain areas (or entire regions) of the country. This can mean an interrupted flow of traffic which can generate problems both in the organisation of military defence, national economy and the supply of goods to the population. This is why from defence aspect not only the increase in the number of long-span railway bridges and the maintenance of their technical status are expected but the elimination of damage consequences and the fastest possible reconstruction of traffic/transport also comprise a fundamental mission. However, this objective can only be achieved with the use of mobile bridges which are available in peace time too, together with the professional knowledge ensuring the deployment of temporary bridges together with their continuous operation.

There used to be commissioned TS floating bridges developed on domestic basis and designed for doubling long-span bridges – on the Danube River two railway and two road bridges while on the Tisza River three road bridges could have been built from those sets simultaneously. Today only one road bridge can be constructed on the Danube and one or two road bridges on the Tisza although the opportunity has not been examined in practice in the past ten years. In 2004 there was an exercise planned for this purpose but unfortunately that was not accomplished thus the training and preparation of the personnel for such an operation is still to be conducted. Currently none of the barges necessary for building such a floating bridge is among the government reserve assets and the companies operating the barges are requested to have them available for defence purposes. However, there is another problem too – the branch lines, constructed in the past towards the emergency crossing places are unattended and a large part of them have already been dismantled. Due to their current conditions the floating bridge sets would need renovation but most probably they will be decommissioned instead. [5]

The decommissioning of TS floating bridges would not produce a problem on its own, however, currently there is no mobile bridge set among the reserve assets of the country which would be able to replace a long-span railway bridge should the need arise. Although there is no direct threat to Hungary in the field of defence preparation there is a necessity to find long-term solutions which are able to ensure the temporary replacement of long-span bridges.

THE PROBLEMS OF RAILWAY BRIDGES FROM THE ASPECTS OF CRITICAL INFRASTRUCTURE NETWORK

In the field of critical railway infrastructures the use of technologies improving survivability has an outstanding role, mainly with regard to stationary structures. In railway transport the issue of the technological standards of long-span bridges and of their potential substitution is of paramount significance. In this chapter I wish to highlight the current situation in this field in Hungary and the role of railway bridges as critical infrastructure elements.

First of all it is the above mentioned technological reliability that should be assessed. Analysing the age pyramid of railway bridges the picture is far from ideal. On the basis of the available data – concerning the age of railway bridges (figure 5) – it can be seen that half of these bridges were built after the 2nd World War that is many of them are nearly or more than 50 years old. 25% of them are more than 100 years old. These figures indicate that the wear and tear closely related to the age of bridges constantly increase the labour and expenses spent on the maintenance of the bridges. [6] Unfortunately, reconstruction works were done only on the Trans-European Transport Networks (TEN-T) in the recent years consequently there are structures over 100 years old in several places.

The situation is further worsened by the fact that the number of railway bridges on our large rivers (Danube and Tisza) is low and their status in insufficient, except for the recently renovated Northern Railway Bridge in Budapest. A specific problem is produced by the fact that the transit transport between the eastern and western parts of Hungary practically concentrates on one single structure, the Southern Railway Bridge on the Danube River. Due to the significant traffic and the lack of appropriate maintenance the chances of technical problems may significantly grow, consequently even without “external” impacts to critical infrastructure it can suffer some damage. Therefore with the targeted use of currently available EU resources the technological standards of critical railway infrastructure should be increased to an acceptable level.

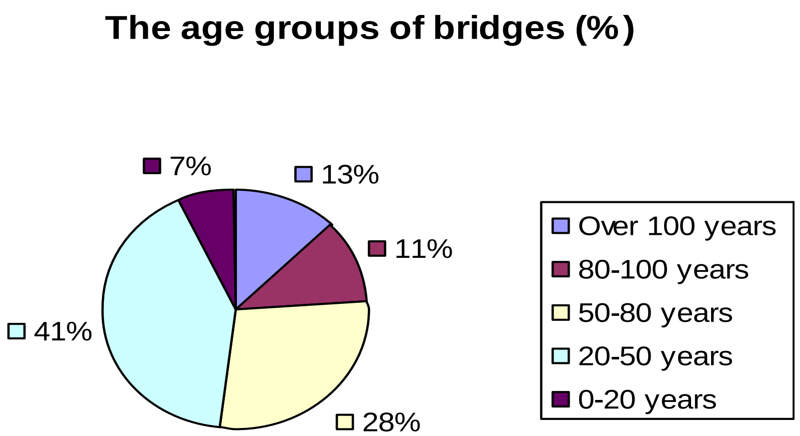

Figure 5. The age groups of bridges
(Edited by the author on the basis of [6])

As it has already been mentioned the Southern Railway Bridge is one of the most critical infrastructure elements of the Hungarian railway network. In accordance with the main line requirements the bridge has two electric tracks and the line section between railway stations Budapest-Ferencváros and Budapest-Kelenföld is one of the busiest in Hungary therefore it is among the first in the hierarchy of railway infrastructures.

The idea to construct a third track in order to increase the capacity of the bridge has been on the agenda several times. It would improve the transit capacity of the bridge but in my opinion it would not provide an alternative solution in the field of substitution. Among others with this point in consideration, the government, supported by the professional organisations, approved Railway Ring-Road Concept “V0”, aimed at a new east-west railway bypass south of Budapest, which would include the construction of a new railway bridge on the Danube River in the EU budget cycle 2014-2020.

In the capital city the other railway crossing place supports the originally branch line Esztergom railway line. Besides its regional position the Northern Railway Bridge also has a strategic role as in the case of a damaged Southern Railway Bridge there would be no other link in Budapest between the two parts of the country. In my opinion, however, it can be regarded as a secondary route only therefore there has been no real alternative for substituting the Southern Railway Bridge.

South of Budapest the nearest crossing place on the Danube is in 210 kilometres, at Baja. The Baja railway bridge connects lightly used lines, it is far from main lines due to the Budapest-centred nature of the network, and therefore as an alternate route for railway transport between the two parts of the country it can generate very large additional distances.

A positive factor is that in 2000 the Baja railway bridge was renovated with the separation of road transport from railway traffic – through building two outer consoles. The Baja railway bridge – similarly to the Northern Railway Bridge in Budapest – can provide only partial solution when it comes to the substitution of a damaged critical railway infrastructure since only a part of the traffic on the Southern Railway Bridge can be channelled on it, with significant detour and smaller capacities. [7]

According to experts, in spite of the scarce resources there have been no serious, track-related railway accidents thanks to the permanent maintenance works. It is the sometimes extreme amount of precipitation which causes much bigger problems, causing significant damage to the network. For example, in 2010 protective works had to be done on a total of 26 railway lines because of the emergency situation yet the extreme weather conditions caused damage in several places and sections. Similar situation emerged this year because railway tack embankments also serve as flood control dams in several places. Due to fundament problems caused by the flooding or sliding of tracks important main lines had to be closed from traffic for days. On the Budapest - Hegyeshalom line between Szőny and Komárom sandbags were used along several kilometres to protect the embankment from the flooding Danube River.

Floods cause damage not only to railway tracks but sometimes they can also pose a threat to bridges over rivers. In the case of long-span bridges their securing with the use of railway cars loaded with crushed stone has become necessary several times, for example on the Szolnok railway bridge over the Tisza River. However, in such cases railway bridges on minor rivers are in much bigger danger. In 2010, for example, both Szuha Stream and Heréd Stream reached the structure of the bridge near the station Apc - Zagyvaszántó on the Hatvan - Somoskőújfalu - State border line. In order to prevent the structure of the bridge from being drifted away it had to be burdened with railway cars loaded with crushed stone therefore railway traffic had to be stopped across the bridge (figure 6). [8]

Figure 6. The water of Szuha Stream reached the bridge structure on line 81 [8]

CONCLUSION

In conclusion it can be stated that long-span bridges comprise a determining element of critical infrastructure so their absence or significant reduction of their transport capacity would to a great extent decrease the operation of railways as a sub-branch of national transport network.

As far as the network structure is concerned a much more advantageous situation can be outlined. The density exceeding the European average allows alternate routes for ensuring railway transport, which can be taken into consideration also in the case of damaged long-span bridges.

It is a general truth that the development level of a country's transport network and its capability and technological status have a significant impact on the scope of economic activities of that country and also have their influence on its defence capabilities. Therefore both in defence preparation and in the field of critical infrastructure protection the sustainment of operability of the transport system and networks and the implementation of rules increasing the survivability of the system are of paramount importance.

It follows from the above that sustaining and developing the transport infrastructure of our country is common interest. It is only the reliability of the transport network of the nation and the permanent maintenance of its flawless operability that can guarantee the execution of movements (manoeuvres) necessary for economic, social and defence interests.

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