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### III

#### **Renewal of Danube Bridges in Budapest**

Rénovation des ponts sur le Danube, à Budapest

Renovation der Donaubrücken in Budapest

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#### **SUMMARY**

This paper outlines the importance of Danube bridges in the road traffic of Budapest and gives a brief description of the experiences gained during the renewal of Margit and Petöfi Bridges.

#### **RESUME**

Cet article décrit l'importance des ponts sur le Danube pour le trafic à Budapest. Il donne une brève description des expériences acquises au cours de la rénovation des ponts Margit et Petöfi.

#### **ZUSAMMENFASSUNG**

Dieser Artikel skizziert die Wichtigkeit der Donaubrücken im Strassenverkehr von Budapest. Eine kurze Beschreibung der Erfahrungen, die man bei den Neubauten der Margareten- und der Petöfi-Brücken gemacht hat, wird dargelegt.



## 1. INTRODUCTION

The first Danube bridge of Budapest - the Lánchíd /Chainbridge/ - was opened for traffic in 1849. The construction times of other road bridges were in close connection with the history of the country. New bridges were opened in 1876, 1896, 1903, 1937, 1950 but in the periods of the two world wars there was no bridge construction. During the second world war all of the bridges were destroyed. They were reconstructed fast in a couple of years, because of their extremely important role in traffic. The Danube bridges of Budapest represent a connection not only between the two parts of the capital but between the eastern and western parts of Hungary, so they are important for the transit traffic through the country, too.

Since 1972, there has been an increasing contradiction between the capacity of Danube bridges and the requirements of the

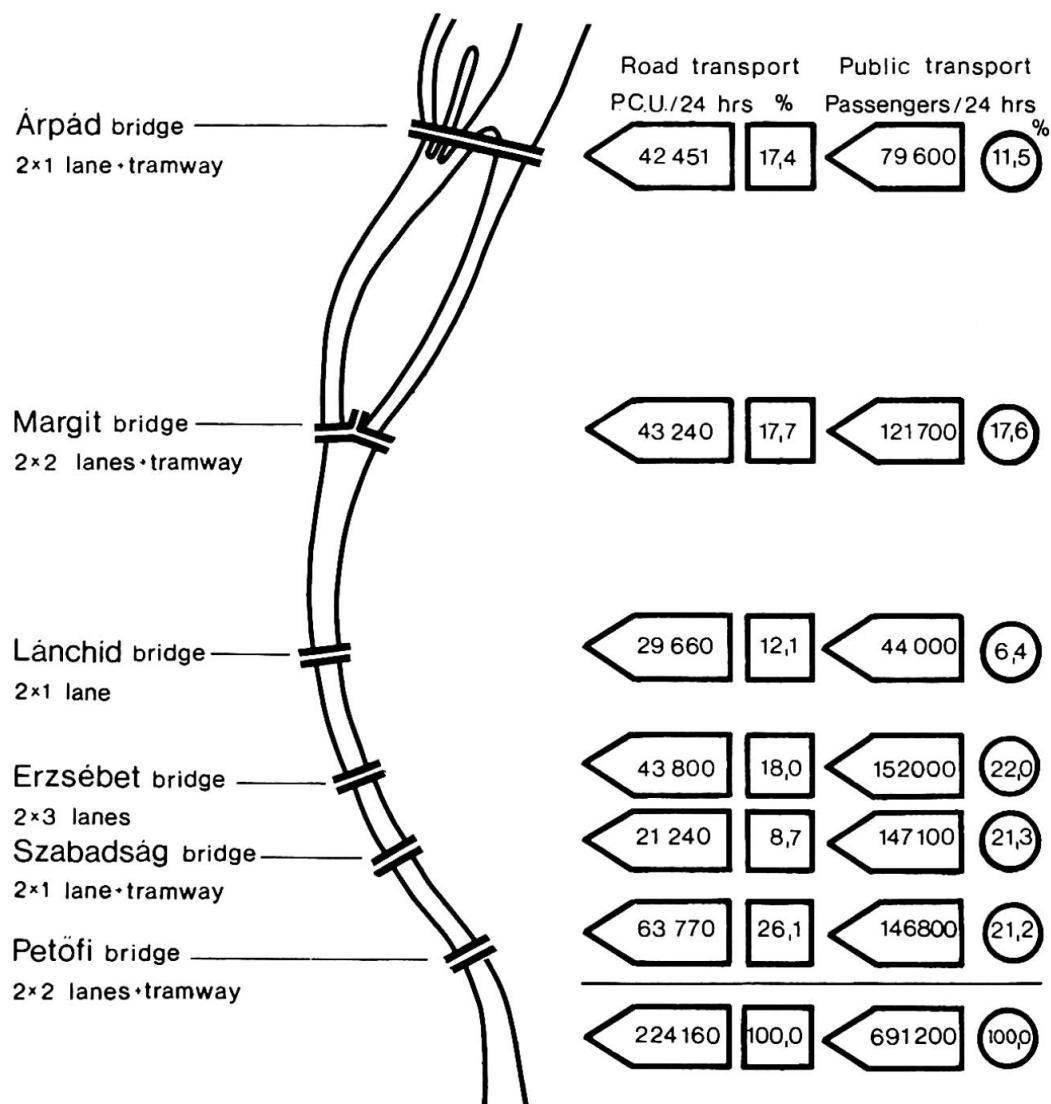


Fig.1. Traffic on Danube bridges in Budapest

traffic. /Fig.1./ The lack of capacity is shown by the six road bridges in average in the peak traffic period. Some of the bridges were relieved by the East-West metro line in this decade. The construction of metro-network is in progress and three more lines cross the Danube in the future, nevertheless, it is inevitable to construct new road bridges, too. The first step will be the reconstruction and the widening of Árpád bridge by 2-2 lanes. The construction should be executed between 1981-84 and it will be followed by the construction of new Danube bridges.

After their postwar reconstruction the recent main task is the first complete renewal of the existing bridges. The renewal should be executed in a very short period not to hinder the traffic of the capital beyond a certain extent. The importance of the Danube bridges in Budapest determines the basic principles of decision for the execution of renewals. They are as follows:

- The renewals should be carried out according to a strict time schedule; only one Danube bridge can be under construction in a certain period.
- The connecting main streets should be renewed together with the bridge renewal. Moreover, the main traffic junctions should be altered, pedestrian underpasses should be constructed and proper measures in the traffic control should be taken - where necessary - in order to increase the traffic handling capacity of the bridge.
- The consequences of restrictions in traffic - during the renewal of bridges - should be facilitated by proper measures in the street network and traffic control of the district concerned.
- The renewals should be executed with the concentration of manpower and machinery in double shifts.

The basic principles are supported on the side of economics by the following data: in case of Petőfi bridge the transport on the long bypasses costs about 320 million Ft in the construction period planned of 18 months for the Hungarian state /through different transporting companies etc./ while the total construction cost is about 500 million Ft. A 5 percent increase in the construction cost for the Saturday Sunday and weekday overtime-wages which could result in a 25 percent shortening of the construction period is obviously economical because of the savings in the costs of traffic. The optimal solution is to reduce the construction period to the technically possible minimum, regardless to the construction costs, because the costs of the traffic on the bypasses can be minimized on this way. On the other hand, a part of the road traffic should be maintained on the bridge under reconstruction not only to minimize the traffic expenses but mainly because the other bridges are unable to carry the whole traffic volume in peak periods.



Two Danube bridges - the Margit and the Petőfi bridges - were renewed between 1978 and 1980, according to the above mentioned basic principles. Both bridges have nearly the same role in traffic: they are situated on the inner grand-boulevard /Nagy-körút/ of Budapest, they have 2x2 road lanes and tramway.

## 2. THE MARGIT BRIDGE

The axis of the bridge is a broken-line, with a side branch bridge at the break point to the Margit island. The structure consists of six two hinged arches with 77 - 92 m range of spans and of 22 m span approaches on both sides. The following tasks were executed during the renewal: the demolition and reconstruction of 102 years old steel superstructures of the approaches; strengthening the piers; inspection, change of rivets and repainting of the steel superstructure; water-proofing of the reinforced concrete slab; change of expansion joints; construction of new tracks for tramway; new asphalt pavement. In order to increase the traffic capacity of the bridge nearly by 10 % two pedestrian underpasses had to be built at both ends, at the same time of the renewal. In the same period a 2 km long connecting boulevard was renewed together with the system of public utilities.

The renewal of the bridge was carried out in two steps: the road traffic was passing on one side of the bridge on two lanes while the other side was under construction. In the second step the road traffic passed on the already finished two lanes while the other side of the bridge was under construction. The tramway was substituted by bus service in a 2 km long section. As the importance of the bridge is remarkable mainly in the public transport of the capital, only the bus service had a permission to use it in the peak traffic periods / between 6 - 9 o'clock a.m. and 2 - 7 o'clock p.m./. More than 25 km long bypass network was assigned for the passenger car and lorry traffic /1600 p.c.u/h. in one direction/ to reach the other Danube bridges.

It was a difficult task technically to strengthen the top part of the piers in river by cast-in-situ reinforced concrete crown-beams under the stringer bearings while the traffic was passing on but finally a good solution was found. The reinforced concrete slab of the bridge was in proper condition but the tramway tracks had to be reconstructed using block-rails which had been proved good elsewhere in the capital. The reconstruction of the approach spans was fast using precast prestressed concrete beams. The pedestrian underpasses were as usual reinforced concrete closed frames.

The construction period was limited by eight months. The main contractor - together with 34 subcontractors - finished the renewal in six months to the satisfaction of the capital /see Fig.2./ Then the workers moved to the Petőfi bridge at the southern part of the grand-boulevard.



Fig.2. The Margit bridge after renewal.

### 3. THE PETŐFI BRIDGE

The volume of reconstruction of the Petőfi bridge was about twice as big as that of the Margit bridge mainly because the completely corroded reinforced concrete slab had to be demolished and a new reinforced concrete slab had to be constructed. The old reinforced concrete slab was not water-proofed and the salt spread in winter to melt the snow went through the cracked asphalt pavement and caused a serious damage in the concrete. The five span approach bridge /steel frame/ on Pest side had to be demolished, too and a three span prestressed concrete structure had to be constructed instead. The construction of two new pedestrian underpasses and the complete renewal of the 2.5 km long connecting section of grand-boulevard made the task similar to that of Margit bridge.

The main steel structure - a three span continuous truss with 112+154+112 m span lengths - was in proper condition so only inspection, change of rivets and repainting was necessary. The piers in the river were also in good condition but the abutments at both ends of bridge were widened because of the altered traffic junctions.



The heavy lorries are dominant in the traffic of Petőfi bridge, because the bridge is connecting the southern industrial districts of the capital and besides the international camion transit traffic takes this route, too. So the principle of restrictions in traffic was found out on this basis. Two lanes on the bridge was used only by the bus service /substituting the tramway/ and by lorries over 3.5 tons.

According to the original concept the renewal of the bridge was planned in three phases within a construction period of 18 months. The site manager of the main contractor however found a solution to include the working processes of the third phase into the first and the second one. As it seen on Fig.3. two lanes the tramway tracks and a sidewalk was closed for public traffic.

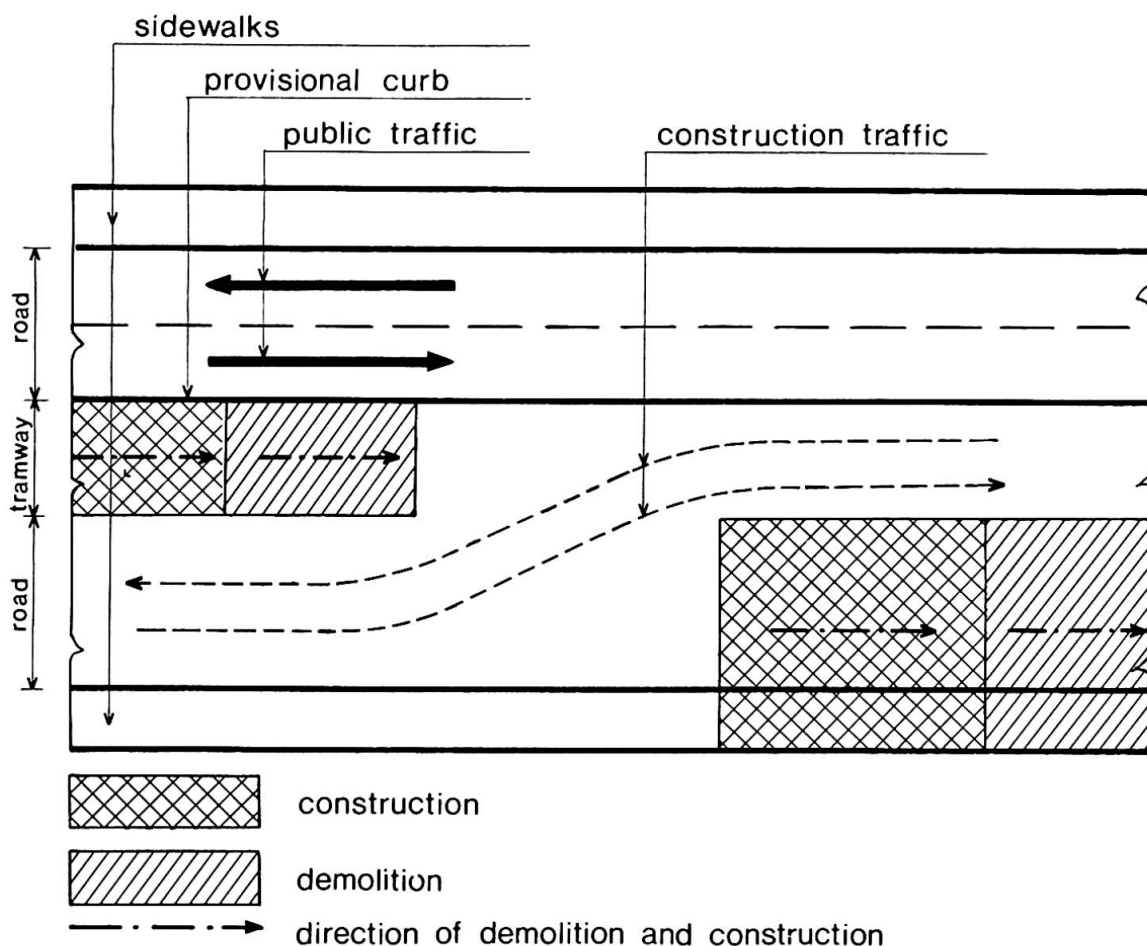


Fig.3. The construction phases.



The demolition started on the road lanes and the sidewalk and proceeded from one end to the other. The zone of demolition was followed by the construction of the new reinforced concrete slab while the construction traffic was passing on the old tramway tracks. When the concrete of the new slab had strengthened the construction traffic passed on it by an S curve and the demolition started on the tramway tracks. So the demolition and the construction of the roadway and the tramway tracks was carried on at the same time but at different places and it was possible to maintain the construction traffic too. In the second phase the road traffic passed on the reconstructed two lanes while the demolition and the construction started on the other side.

In order to save time and labour the precasting of the new reinforced concrete slab was planned but because of several difficulties this solution was rejected and self-supporting steel plate shuttering was used under cast-in-situ concrete. The new tramway tracks were the same as that of the Margit bridge. The three span approach bridge on Pest side was made of precast prestressed concrete blocks and beams including the abutments too. The construction started in May, 1979 and finished by June, 1980. The Petőfi bridge can be seen on Fig.4.

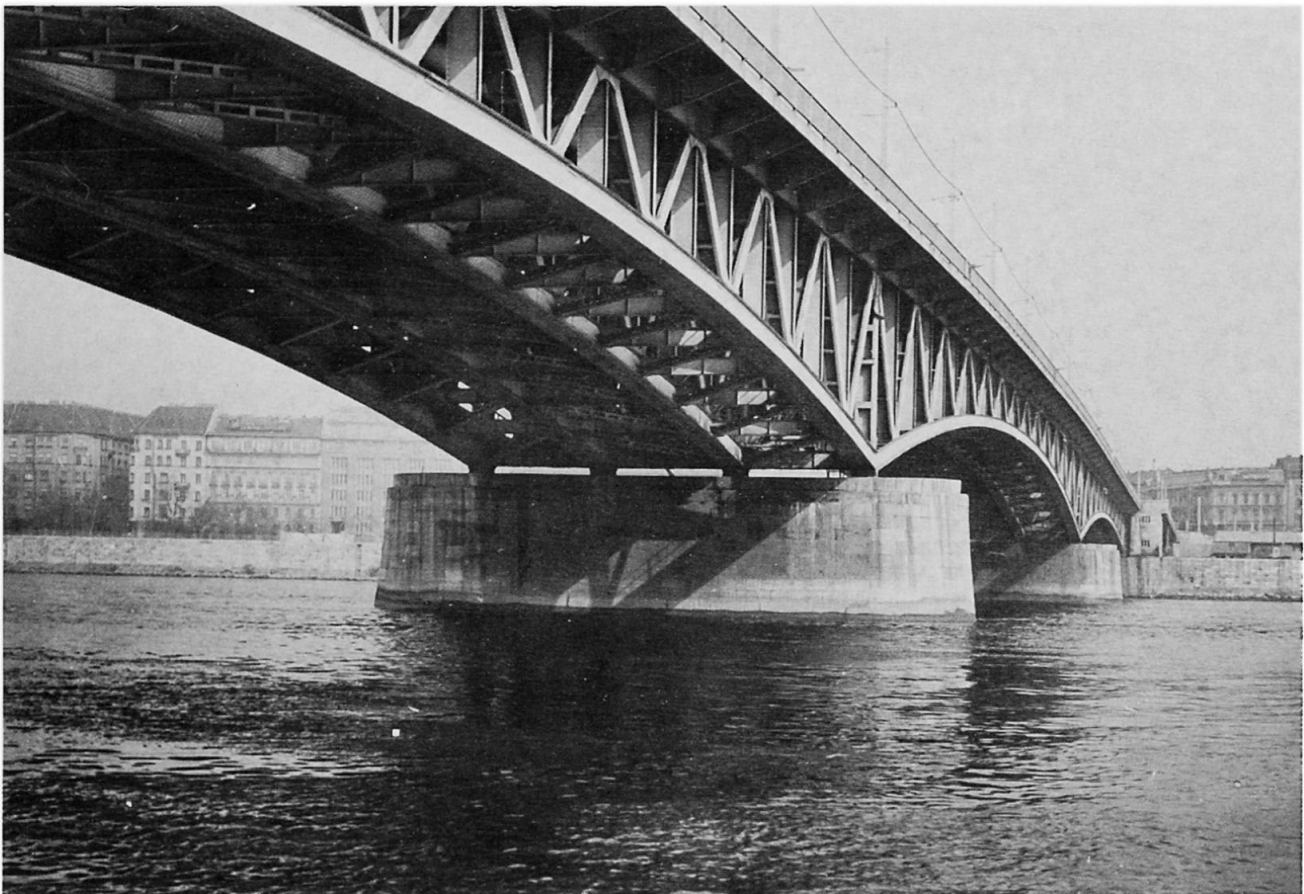


Fig.4. The Petőfi bridge.





#### 4. CONCLUSION

The renewal of bridges consists of such working processes which require a high manpower consumption, cannot be easily mechanized, contains a lot of demolition, etc. The activity of many trades should be co-ordinated in a short period, and the backlog of a trade affects the whole phase. It is not permitted to bother the population, to stop the service of public utilities, to hinder the traffic beyond a certain extent. The most important experiences on this kind of constructions are as follows.

- The restrictions in traffic is to be designed and executed carefully, under the proper information of the population.
- The time-schedules carefully designed is to be checked in every week. It is necessary to concentrate surplus manpower and machinery on the working processes which lay on the "critical way" and to concentrate balanced ones on the others. One working proces should press forward the other.
- Planning the costs and the construction period the optimal solution for such kind of projects is to reduce the construction period to the technically possible minimum because the surplus costs of traffic on the bypasses can be minimized on this way and economy can be achieved on the level of state.

The construction organization system used at Margit and Petőfi bridges is applied at the renewal of the Szabadság /Freedom/ bridge which is under construction now.