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A small valley in Greece and its bridges throughout the centuries

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Abstract

This paper refers to the bridges of the Pyli valley. The most important bridge is the stone one of St. Bessario. The single-arched bridge of St. Bessario, with an arch span of 28.73m and total length of 68m, was built in the 16th century and until 1936 it was the only link between the Thessaly fields and the mountainous villages of Pindos. In the 20th century (up to 1997), at a distance of approximately 1500m around the stone bridge, four concrete bridges which differ in size, architectural style, structural technique and use (vehicular or pedestrian crossing) have been constructed over the Portaikos river in order to serve increased modern transportation needs in the region; the oldest of them, finished in 1936 lies at the west of the stone bridge at a distance of 1000m and has a length of 45m, while the following structures at the east of the ancient bridge, where the Portaikos river is broader, reach a length up to 170m; among these reinforced or prestressed concrete bridges, a suspension one, with a length of 120m, was constructed in 1981 very close to the Byzantine church of Porta Panagia (13th century) and it is used only for pedestrian crossing. A brief description of the bridges, their present state, the necessary works for their repair, historical data as well as photographic documentation are included in the paper.

1 Introduction

Pyli, also known as Porta, is a small town located at the foot of the Itamos and Koziakas mountains just 18 km west of Trikala. Until recently, Pyli was the only pass from Thessaly to Epirus and for this reason Pyli was considered as a place of strategic importance for many centuries.

The presence of many old structures in this area, as the ancient castle «Athineon» (5th B.C. century), the famous church «Porta Panagia» (1283 A.C.), the stone arched bridge of St Bessario (1514 A.C.) and the monasteries of «Dousiko» (16th A.C. century) and «Goura» reveal this fact [1] .

Portaikos river crosses the Pyli valley and creates the need for connection over it. So, since 15th A.C. century and at a distance of 2.400 metres , five bridges have been built in different periods of time in order to serve the transportation needs. (Fig. 1)

St Bessario Post – Byzantine stone bridge is the most important among them and it has been the only connection between Epirus and Thessaly since its construction date (1514 A.C.) up to 1936.

In 1936, in the highway route which connects Trikala and Arta, a second bridge over Portaikos river, known as «Kondili bridge» was completed and connected the mountain villages of Pindos to the valley of Trikala.

A few decades later, in 1960-61, the new bridge of St Bessario was built in order to serve the local transportation needs in the area of Pyli.

For a direct connection between Pyli's centre and Porta Panagia suburb at the opposite bank of the river, and near the famous Porta Panagia Byzantine church, the first suspended with straight cables bridge was built in 1981 in Greece.

Recently in 1997, opposite the local Town Hall and in the area of the Portaikos valley, a prestressed concrete bridge was built on the by-pass road in order to serve the increased transportation needs.

It is remarkable that all these bridges constructed with so different techniques are concentrated in a small area with an approximate radius of 1.500 m around the St Bessario arched bridge and they serve for the pedestrian and motor traffic in a mainly rural area in Greece, far away from the central national roads and big cities.

Also, although Meteora monasteries are quite near to the area and belong to the prefecture of Trikala, the great number of tourists who visit the site, move through other routes far away from Portaikos valley, so this vital place remains unspoiled and thrives on its local resources.

The density of bridges in this area, the diversity in forms and the construction techniques of all these bridges as well as the existence and the importance of St Bessario bridge round which all the other bridges were built, sparked us off writing this essay.

The following paragraphs offer a brief description of these five bridges according to their construction dates.

2 The Post-Byzantine bridge of St. Bessario

2.1 Technical characteristics

The Post-Byzantine bridge in Pyli (photo 1), is considered to be a monument of great importance not only for Thessaly but for Greece and Balkan [2], because of its outstanding beauty as well as its sound construction, thanks to which it is still existing. The bridge is 68 metres long and, according to an old inscription, it was

built in 1514 A.C by St. Bessario, Larisa's Archibishop, whose name was also connected with the construction of another stone one arched bridge in Thessaly called «Koraka's bridge»,which was collapsed [3].

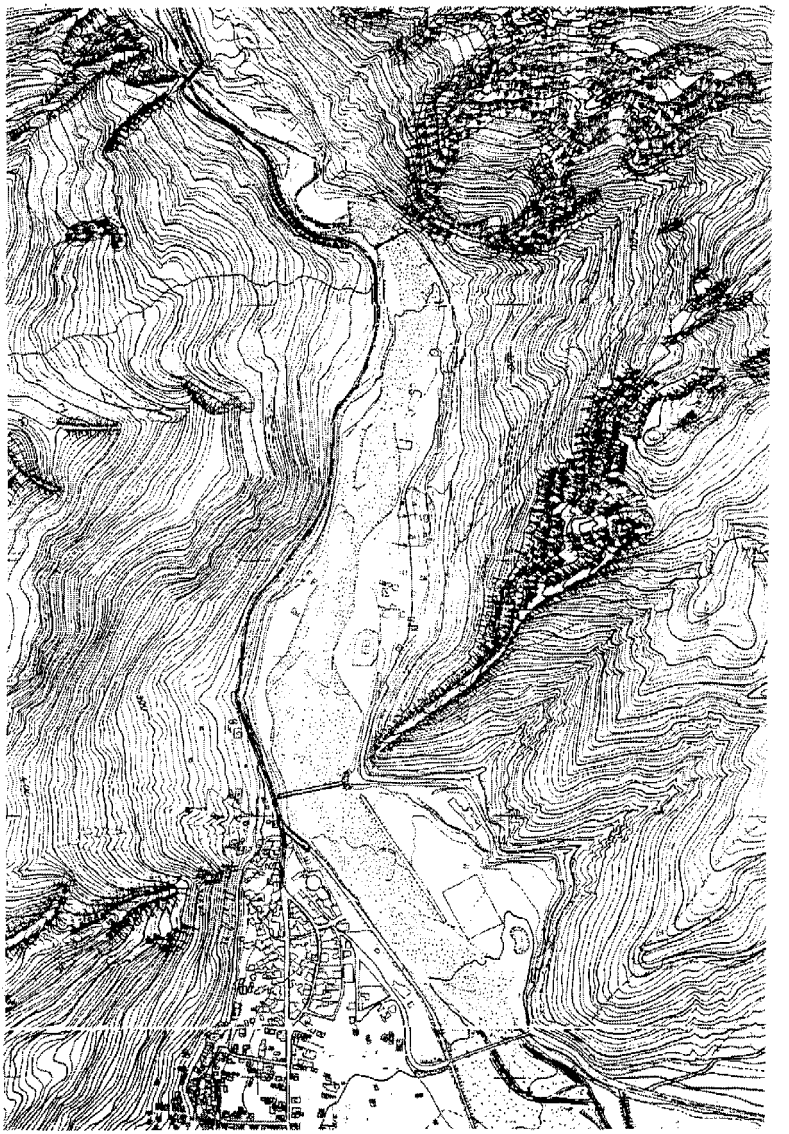

Fig.1: Location of bridges in Pyli (1 Kondili, 2 St. Bessario stone bridge, 3 Suspended pedestrian bridge, 4 The new bridge of St. Bessario, 5 City Hall bridge)

The arch of the bridge has 28.9m span and 12.77m height, while the overall width is 2.7m. The net width of the walkway is 2.1m and the height of both side parapets varies from 0.60 to 0.90m.

The bridge masonry consists of limestone carved blocks without coating. The linking coat is strong lime mortar with river sand of maximum diameter 6 mm. On the surface of the pathway, as it commonly happens in similar structures, there are slightly dents aiming at making access easier to both people and mules.

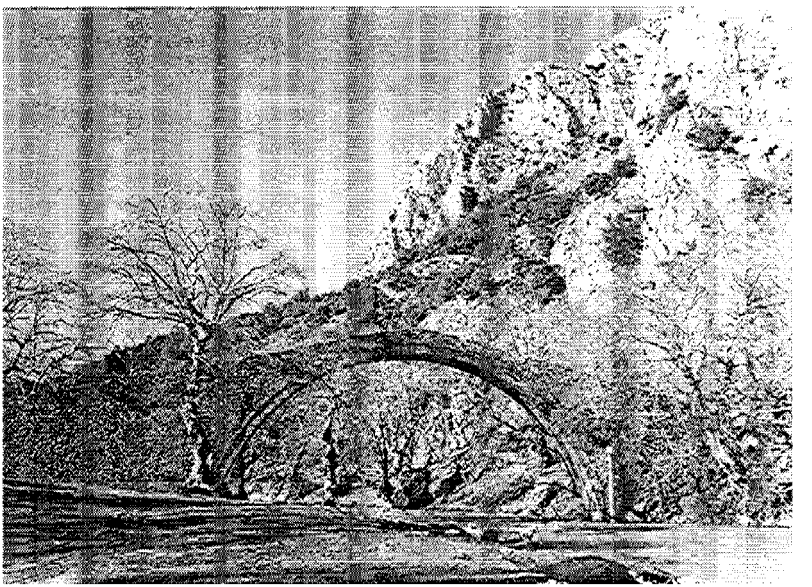

Photo 1: The Post-Byzantine bridge of St. Bessario

2.2 Previous interventions

For the prevention of possible collapse some works of restoration have been done during the last 50 years, which decreased the deterioration of the monument.

These repairing works were:

- Construction of a buttress on the west side of the north abutment as its masonry suffered from deformations.
- Enlargement of the foundation of the abutments. This enlargement can be seen at the north abutment during all the year whereas at the south abutment it can not be seen only during the winter months, when the water covers it.
- Repair works of the pathway, which showed local deformation.
- Reconstruction of the parapets which had collapsed completely in the middle of the bridge, as it is shown in pictures of 1960 [3]. This

intervention is noticeable from the use of different bonding material and the way the stones have been built at this part of the bridge.
- Filling of a longitudinal crack with cement mortar, located at the south part of the arch's intrados.
- Joints fillings in various parts of the masonry.

2.3 Reasons behind damages

Despite the fact that the monument itself is in a generally sound condition, there is some damage that requires urgent repair. The observed damages of the structure are:
- Missing of stones particularly at the central part of the bridge.
- Deterioration of mortar in the joints of the stone structure.
- Deterioration and moisture effects on the stones due to the growth of plants and algae.
- Cracking of the arched vaults – the most serious is the longitudinal crack in the intrados of the southern part of the bridge.
- Deformation of the masonry at the north part of the bridge.
- Surface retreating of the pathway.
- Deterioration of the buttress' base at the north abutment.

From the above mentioned description, it is evident that some of the damage due to the effect of the climate on the bridge's masonry (temperature effect, moisture, frost) especially because of the lack of surface coating [4]. Additionally, heavy rainfalls on this specific region encourage both the growth of algae and other harmful plants, which destroy the stone masonry of the structure.

2.4 Restoration

After making an intense study on the bridge's present condition, the following repairing works were regarded as necessary:
- Strengthening of the bridge's north abutment combined with an arrangement of the mountain slopes in the wide area.
- Enhancement of the load bearing ability of the south abutment, by pointing-filling of joints with cement mortars and by restoring various parts of the built construction.
- Replacing the missing stone blocks.
- Eliminating harmful plants together with algae by using the appropriate chemical means.
- Restoring pathway.
- Filling cracks with mortars on the masonry by applying injection methods.
- Pointing-filling of mortar joints.
- Arrangement of the river banks to prevent both soil movement and erosion near the foundations.

The fact that, St Bessario's bridge still remains in a fairly sound condition in a strategic position adjacent to road Arta-Trikala and next to Pyli, facilitate the monument's care and exhibition [5].

3 Kondili bridge

In the late 1930s, a number of bridges in Greece were made of reinforced concrete while their structural system was intended to be as clear as possible. Among these types of bridges is «Kondili bridge», which has the form of a 'Vierendeel' beam. It also stands above Portaikos river and connects Trikala with the mountainous villages of Pindos, thus providing motor access to the area. Its construction was based on fairly contemporary principles and lasted from 1934 till June 1936.

The built construction (class 30), has a total length of 49.35m forming three spans of 11.60m, 31.10m and 6.64m respectively. The middle span consists of two 'Vierendeel'-type beams (photo 2), 28.00m span, upon which the slab of the deck rests, while the other two spans form a beam – slab system bearing on both sides.

The bridge is 5.2m wide and it stands 22.00m higher than the river bed.

Furthermore, the structural details of both deck and parapets are of exceptional beauty.

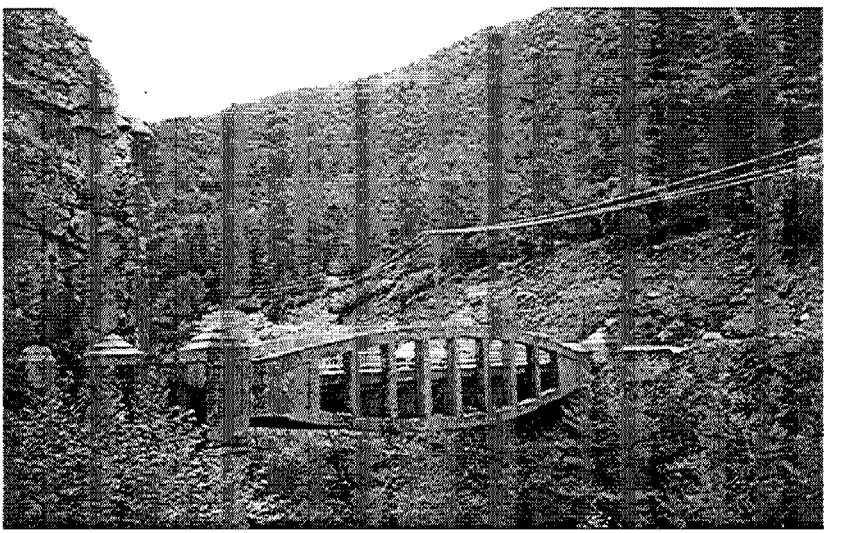

Photo 2: Kondili bridge

Additionally, the concrete used for the upper structure is B300, for both abutments and foundation is B150. Steel St I was also used [6].

During the Second World War (1943), the Greek army blew up the left part of the bridge in an attempt to prevent the Italian forces from crossing the river. During restoration, the sound upper structure of the bridge was pulled up from the rocky bottom of the river and was put again on its position, so the bridge serves until nowdays the transportation needs of the area.

Currently, after 66 years of constant use, the bridge presents several signs of structural deterioration mainly due to its ageing and lack of preservation. More specifically, cracking and surface wearing are noticeable, so that its reinforcement is observable and hence exposed to rusting. Repairing of these damages is a relatively easy and not costly work, but it is a matter of great importance to take some urgent action as the bridge is still in use by vehicles including heavy lorries.

Undoubtedly, the "clear" form of the bridge together with its unique structural system reveals the necessity for its formal recognition as a contemporary monument, which belongs to the heritage of the special technical works in Greece. Thus, there is a need to employ conservation measures against its gradual destruction to ensure its future presence even in the case that it stopped operating. Finally, it is worth mentioning that this bridge stands on a beautiful but still not so well-known landscape, and it could easily become a point of tourist attraction, thus promoting the image of the whole area.

4 The new bridge of St. Bessario

The construction of the new bridge of St Bessario began in 1960 (photo 3) and was completed a year later. Its main purpose was to provide motor access to the small villages of Trikala's county (St Bessario, Pialia, Filyra, Pyli etc.).

The bridge itself has a total length of 170m, and it stands east of the Post-Byzantine bridge near to the city entrance, where the river bed is considerably wide (Fig. 1).

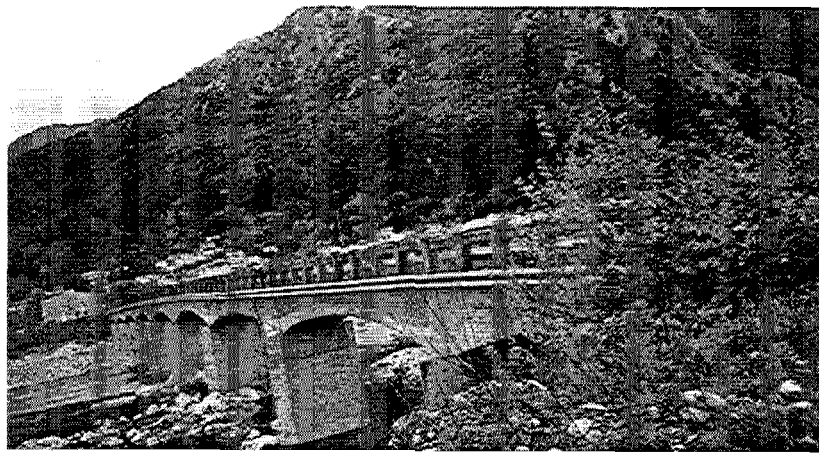

Photo 3: The new bridge of St. Bessario

The static system of the bridge is based on a Gerber-type beam, forming four opposite-projecting parts each of 26.49m long, and five opposite-bearing parts (three of those are 11.33m long and the remaining two are 11.75m). The cross section of the structure has a Π shape while the height is variable-the intrados of the slab forms a parabolic curvature, which expands from the abutments towards the spans (photo 3). The total width of the structure is 4.4m and the upper deck-road is 3.10m wide. The bridge rests on abutments, which are 8.50m high.

According to DIN 1072/1952, the bridge's class is 30. The construction is made of reinforced concrete B300, B225 and Steel St I (about 240 kg Steel/m^3 concrete) [6].

Even now, after 40 years of use, the load bearing ability of the bridge still manages to meet the standards and there are not any serious damages.

5 Suspended pedestrian bridge

Pyli's suspended pedestrian bridge (photo 4) stands in a distance of 1000m away from the arched masonry bridge at the west entrance of the city (Fig. 1). It was constructed in 1981 and, as it has been already mentioned, it is the first bridge in Greece with a framework hanging from straight cables. Currently, it is used in order to cover the access of local people, thus moving from the city center to the Porta Panagia suburb, where there is also the homonymous famous Byzantine church.

The length of the bridge is 122m and the pathway is 2m wide. The two middle piers allow a total span of 54m beneath them, while supporting two great gateways of 14m high (photo 4).

The static system of the bridge is based on a continual beam which bears three spans of 24m, 54m and 24m respectively, while hanging every 6m from linear cables, which are connected with the two gateway's top. The latter were made of two triangular frames linked to each other with cross sectional beams.

Both deck and gateways were made of concrete B300. Concrete B225 was used for piers and B160 for foundation. Also, steel St III was used for the reinforcement of concrete and St 160/180 for cables and suspenders [6].

6 City Hall bridge

In 1997, on the bypass between the south part of the city and Portaikos river and behind the City Hall, a new prestressed concrete bridge was built (Class 60/30) with a total length of 75m (Fig.1). The road surface and pavement were 9m and 2*2m wide respectively.

The structural system of the bridge is based on a continual beam, which forms three spans of 22.10m, 24.90m and 22.10m respectively. The cross section of the load bearing structure is a box with an average height of 1,35m and 4m wide at the slab's base level.

Both deck and piers were made of concrete B25. Concrete B15 was used for foundation, while steel St I and St III were used for achieving reinforcement. The Freyssinet system was employed in order to achieve prestressing of the structure.

Photo 4: Suspended pedestrian bridge

7 Conclusion

Near Pyli, a relatively small town of Trikala, and in an exceptionally beautiful landscape, there is a considerable number of bridges, which are all unique in terms of construction and form. Thus, Portaikos valley should be considered not only as a link between Central Greece and Epirus, but also as the location where bridge making began and developed. In other words, a visit to this region could easily help someone to witness the evolution that took place from the Post-Byzantine years until today.

Having as a focal point the masonry arched bridge, which is equally important not only for the Balkans but for the whole of Europe, the authors of this essay have a strong belief that the Greek Government could develop these structures. By doing so, there could be fertile ground for further development to take place, also including the promotion of the regional image as well as the distinction of forgotten traditional techniques.

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