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CONTRIBUTION OF THE DEPARTMENT OF SURVEYING TO THE DEVELOPMENT OF CLOSE RANGE PHOTOGRAMMETRY IN SLOVAKIA

Abstract

The contribution is focused on assessment of the trend of the close range photogrammetry on the Department of Surveying, Faculty of Civil Engineering, Slovak Technical University in Bratislava in following fields: deformation measurement of the hydrotechnical objects; geometrical parameters measurement of the steel constructions; deformation measurement of mountain massif; assessment of the cliff rock stability for safety measures, respectively pasportisation; documentation of architectural monuments; applications of the inverse photogrammetry.

1. Introduction

During five decades the photogrammetry developed from analog solutions to the present standard corresponding with current level of the optics and electronics. Development in the field of machine vision, robot vision and computer vision and fully automated photogrammetric systems (real time photogrammetry) accelerated the evolution of the close range photogrammetry.

When we want to judge the contribution of the Surveying Dept. to the development of terrestrial and close range photogrammetry in Slovakia, we have to start from a brief history of two decades (50-th and 60-th years) of the Dept.; namely from the perspective condition's of the *staff* and *instrumental equipment.*

Development of the terrestrial and close range photogrammetry as well as the non-topographic applications on the Surveying Dept. in 50-th and 60-th years, besides the staff (Prof. P.Gál, Ing. E. Adler, Ing. J. Petráš, Ing. V. Gregor, Ing. F. Kohút; from 60-th and 70-th years: Ing. P. Bartoš, Ing. J. Čerňanský, Ing. L. Salkovič) directly was connected with the evolution of new photogrammetric instruments fy Carl Zeiss Jena. In consequence of new photogrammetric instruments on the Dept. and the needs for national economy and practice founded the Scientific Laboratory of Photogrammetry (SLP) on Dept. at 1956. Laboratory created conditions for the photogrammetric research on Surveying Dept., oriented on the development of terrestrial photogrammetric methods, photogammetric theory and new photogrammetric instruments and equipment.

The first secceful presentation of Dept. on international level was presentation at the exhibition of the X-th Congres ISP in Lisabon (1960), so the Dept. became integrated in the European top in field of non-topographic photogrammetric applications.

During first three decades (50-th – 70-th years), the centre of photogrammetric applications on the Dept. were applications of terrestrial stereo-photogrammetry and close range photogrammetry with real or time base (numerical solution). Period of last two decades (80-th – 90-th years) is marked with the applications analytical and digital photogrammetry and modifications of the convergent (multi-station) photogrammetry.

2. Applications of the Dept. in close range photogrammetry.

Interdisciplinary character of the photogrammetry and its level on the Surveying Dept. made it possible for applications in hydrology, geology, engineering industry, architectural monuments and so on.

To demonstrate some photogrammetric activities of the Surveying Dept., following important close range applications are briefly presented:

- photogrammetric measurements of the geometric-hydrotechnical parameters of the lock;
- determination of geometrical parameters of suspended cable bridge;
- photogrammetric assessment of the rock cliff stability;
- photogrammetric measurements for documentation of architectural monuments;
- the perspective drawing of reconstruction design of the Štúrovo-Esztergom bridge.

For data-acquisition at all applications was used Universal Metric Camera UMK 10 Zeiss.

2.1. Photogrammetric measurement of the geometric-hydrotechnical parameters of the lock

2.1.1. Photogrammetric measurements of water level deformation in the Kralova lock. *[Batroš, 1994].*

The aim of every lock is the transit of vessels from the lower roadstead to the upper one and eventually from the upper to the lower roadstead as fast as possible, so as to maintain the safety of vessels. It is generally known that the requirements for rapid and safe lockage are to a certain extent controversial. This relation is further complicated by the design and construction of a more or less appropriate filling and emptying system and the method of manipulating the valves controlling the filling or emptying system. Of course, the greater the dimensions of the locks and the higher the amount of raising, the more complicated the mutual interactions become.

The filling process eventually becomes an emptying process and the water level in the lock is deformed in proportion to the filling time. The deformed water level creates a spatially curved surface, resulting in the water surface sloping in longitudinal and transverse directions, which causes vessel canting in the lock and possible jeopardizing of vessel safety.

In order to test the Gabčíkovo twin-chambered lock, it was necessary to verify the photogrammetric method of determining water level deformation in a smaller lock, for example the Králová lock (100 m x 24 m x 13 m) (Fig. 1)

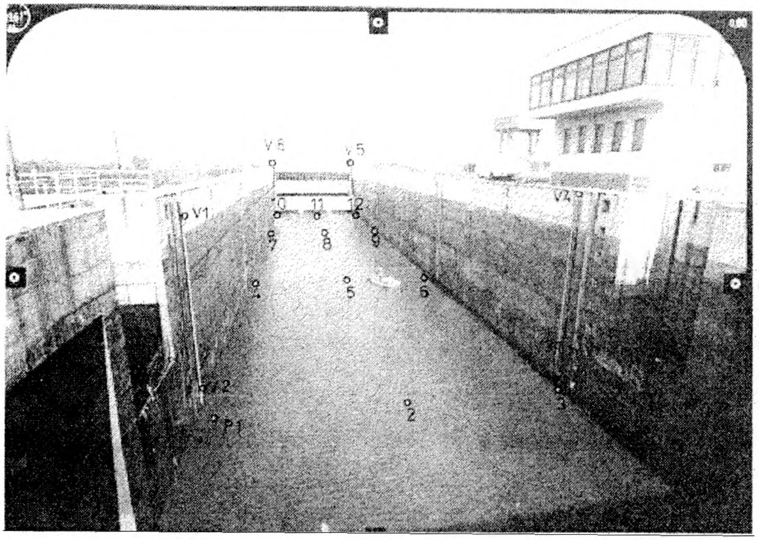

Fig. 1: Distribution of control and observed points

The aforementioned method utilize the principle of collinearity conditions, applied in the from a single-picture analytical method of spatial resection, which is convenient for structures with depth, as is the case with locks.

2.1.2. Photogrammetric measurement of deformations of the Gabčíkovo lock gate. *[Bartoš, Gregor, 1996]*

The loading test on the left gate of the Gabčíkovo lock arised the question, whether the lock filling process may cause the deformation, eventually deflection of the gate to a greater extent than theoretically permitted.

The method applied to solve this problem should determine the spatial position of observed points, marked by targets on the tested gate in very short time intervals. The single stages depend on the water level in the lock. Observed points, distributed on the surface of the lock gate (Fig.2) were measured during the load test at six stages of water level starting with an empty lock.

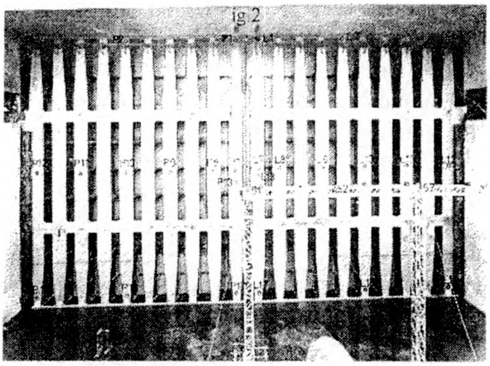

Fig. 2: Distribution of observed points

Analytical solution by bundle method with ORIENT ***/ORIENT, 1991/*** gives the accuracy mxyz = 1–3 mm.

2.2. Determination of geometrical parameters of suspended cable bridge */Gregor, Bartoš, 1992/*

The original shape of the structure gradually deforms or distorts in time as a result of the structure corrosion, load, intermittent cross winds and similarly, as is the case of pipe line suspended cable bridge (bridge length: 165.95 m, distance of anchoring: 225.9 m, max. cable sag: 15.4 m, pylons height: 25.05 m) (Fig.3) in the Winter port in Bratislava. One of the basic conditions for the construction as well as the reconstruction of building structures is the determination of their actual spatial shape.

Fig. 3: Cable bridge

When measuring the spatial shape of the suspended cable bridge by means of the photogrammetric method we used the analytical modification of convergent (multi-station) photogrammetry.

In the case of the suspended cable bridge in the Winter port we utilized the ORIENT software besides the given traditional routine. The main contribution of the ORIENT software in the given case is the determination of the real cable course compared to its theoretical shape defined by a quadratic parabola according to Fig.4.

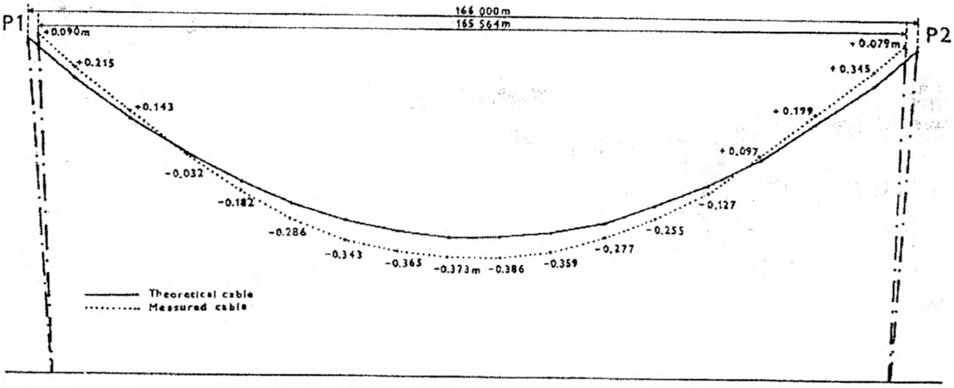

Fig. 4: Theoretical and measured cable

2.3. Photogrammetric assessment of the rock cliff and rock cuts stability.

In engineering geology for last decades have been used methods of terrestrial photogrammetry for monitoring of the stability of rock masses. In the application presented are taken into consideration:

- terrestrial stereophotogrammetry suitable especially for profile measurement, measurement of the orientation of discontinuity planes as well as expanding the rock cliff wall into the plane or transformation of perspective contour lines respectively;
- analytical method used in the case of measuring not too many points with high accuracy required;
- methods of time base, yielding the highest accuracy of displacements determination in theplane parallel with the image plane.

Contribution to uses of methods mentioned above in different engineering-geological applications can be ***[Holzer, 1995]***:

- detailed expression of the morphology of rock massif;
- determination of structural, lithologic and tectonic lines of the massif;
- yielding of quantitative data concerning position, orientation, density of discontinuities, blocks etc. in massif;
- metric photographs are primary materials for engineering-geological interpretation of basic characteristics of the massif as well as for the quantitative spatial evaluation of the massif as by detail points or profiles;
- possibility of identification of quasihomogeneous parts with respect to the stability together with indirect data necessary for stability measures;
- outstanding data for remote evaluation of geodynamic events.

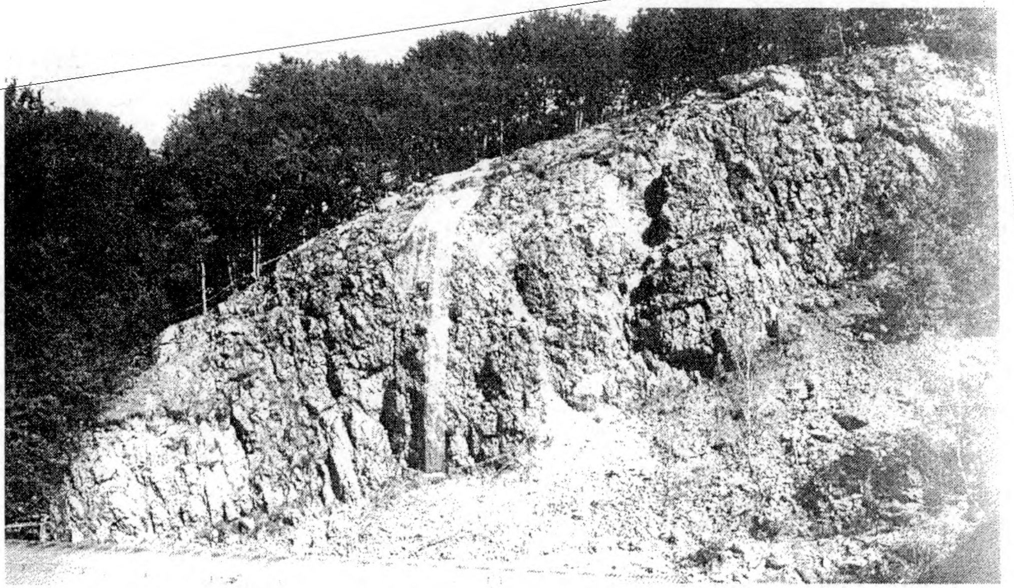

Fig. 5: Rhyolite rock cliff

2.3.1. Rhyolite rock cliff Vyhne. */Gregor, Bartoš, 1996/*(**Fig. 5**)

Rhyolite rock cliff in Vyhne is in neighbourhood of the brewery Steiger on the slope NE over main road in elevation of 306-360 m above sea level, while the base of the rock cliff is at the level of 306-335 m above sea level and the top of rock cliff at the level of 331-360 m above sea level. The exposed part of the rock cliff taken in account is in average 75 m long and 26 m high with inclination of 80°-90°. Rhyolite rock cliff was divided into three areas (I, II, III) with two subareas (a, b) with the most potentially dangerous subarea Ia, the most predisposed to fall down (Fig.6).

Among essential input data for preliminary engineering geologic investigation as well as for safety measures and monitoring are results of three geodetic-photogrammetric measurements:

- XII/1998 – stereophotogrammetry used for profile measurements, orientation of discontinuities and expanding the rock cliff wall into the plane XZ in combination with tachometric measurement,
- IX/1999 – stereophotogrammetry for repeated profile measurement after cleaning the rock wall from loosen fragments, smaller blocks and vegetation and simultaneously stereomodel for digital terrain model (DTM) (Fig.7) of the rock cliff,
- X/1999 – pictures for monitoring of rock cliff stability using the method of analytical terrestrial photogrammetry from metric as well as semimetric and nonmetric cameras.

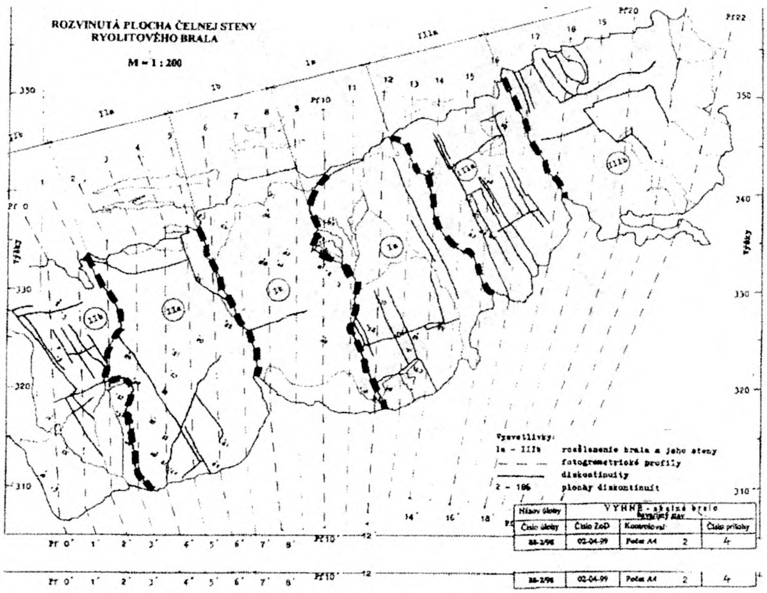

Fig. 6: Rock cliff wall into the plane XZ

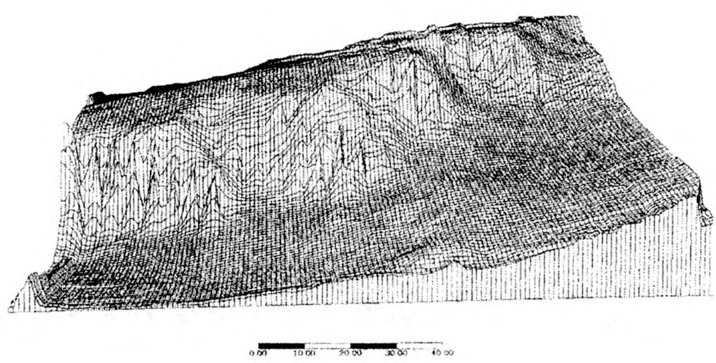

Fig. 7: DTM of the rock cliff

2.3.2. Rock cut Harmanec.

The rock cut Harmanec is part of the dolomite complex of rout Harmanec-Horná Štubňa. The centre of the stereo-photogrammetric monitoring is the central tectonic part, which is mostly destroyed. As the most successful is method of the photogrammetric horizontal profiles (Fig.8). From 1995 were determine horizontal deformations of the vertical slot, with repeated measuring of 17 profiles with its length of 4.5 m.

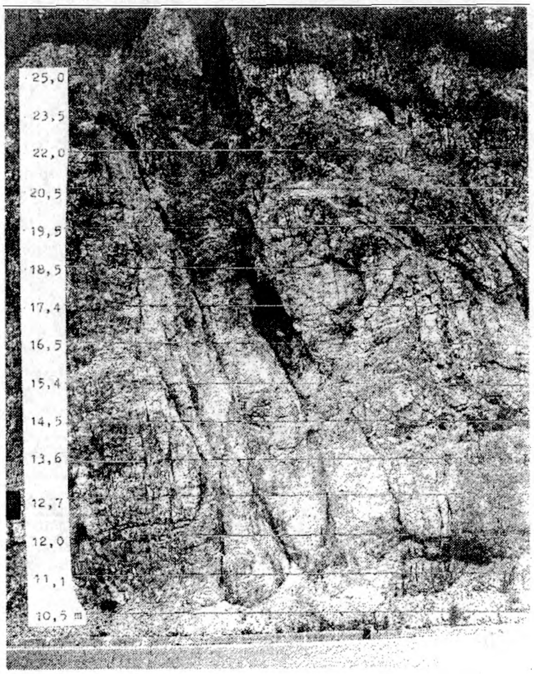

Fig. 7: Rock cut Harmanec

2.4. Photogrammetric measurements for documentation of architectural monuments

A survey of facades at a scale 1:50 was required for the restoration of the architectural monuments. It was evident, that with regard to the application of terrestrial stereophotogrammetry combined with digital processing using the workstation DVP (Digital Video Plotter FY Leica) was an optimal solution both concerning accuracy as well as economy. Image were scaned at 600 dpi, corresponding to the accuracy required (1–2 cm in facade). Corresponding parts of the photo and plotting are in Fig. 9a and 9b Gastrocentrum B. Bysatrica; Fig. 10a, 10b and 10c Pastofórium of the Dóm Sv. Alžbety.

Fig. 9a: Gastrocentrum - photograph

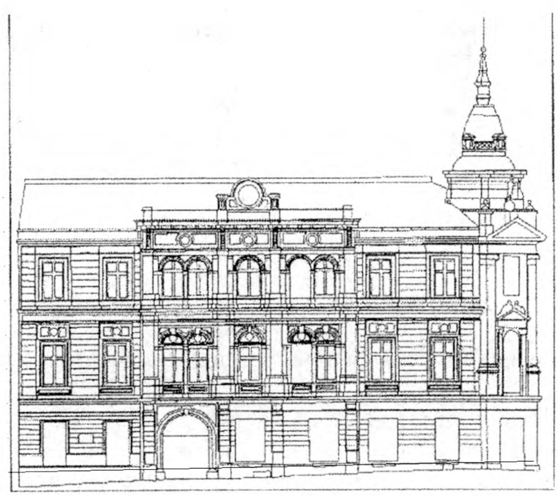

Fig. 9b: Gastrocentrum - plotting

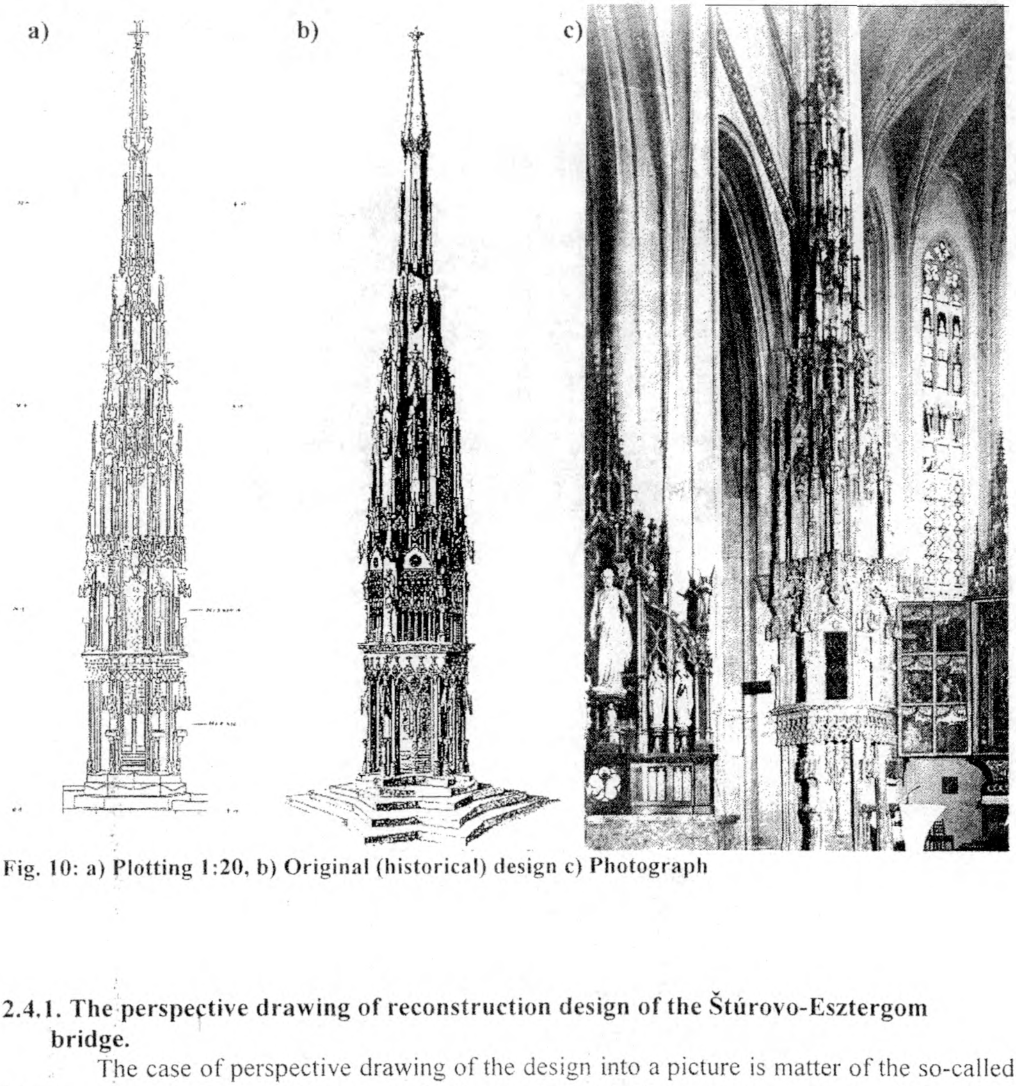

Fig. 10: a) Plotting 1:20, b) Original (historical) design c) Photograph

2.4.1. The perspective drawing of reconstruction design of the Štúrovo-Esztergom bridge.

The case of perspective drawing of the design into a picture is matter of the so-called inverse photogrammetry and more methods may be used. The contemporary development of computers enables the utilization of computer graphics, in the given case the graphical software Micro Station.

The standpoint of the camera is on the left Danube River bank, about 115 m south of bridge with the camera axis oriented to the cupola of the Esztergom basilica. The subjects of drawing the are four variants of bridge reconstruction design according to Prof. Agócz (Fig. 11 and 12).

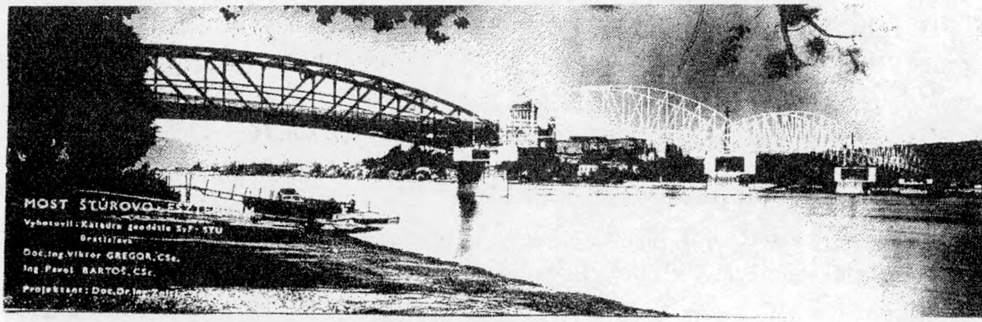

Fig. 11: Perspective drawing – alternative 1

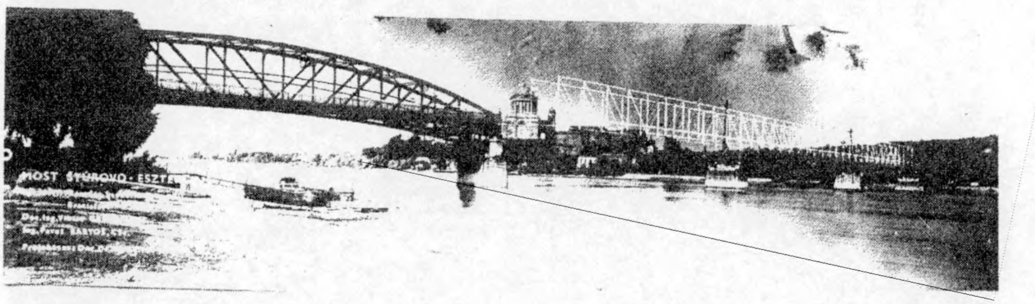

Fig. 12: Perspective drawing – alternative 2

References

1. Bartoš P., 1994, *Photogrammetric measurements of the geometric-hydrotechnical parameters of locks,* Slovac Journal of Civil Engineering 1994/4, pp.: 12-22.

2. Bartoš P., Gregor V., 1992, *Geodetic and photogrammetric measurements for the reconstruction of the Štúrovo-Esztergom bridge,* In.: Bridges on the Danube, Viena-Bratislava-Budapest, sept. 1992, pp.:I/327-I/336.

3. Bartoš P., Gregor V., 1995, *Digital video plotter applications in architectural photogrammetry,* Slovac Journal of Civil Engineering 1995/2, pp.: 33-36.

4. Bartoš P., Gregor V., 1996, *Photogrammetric measurement of deformations of the Gabčíkovo lock gate,* In.: XVIIIth Congres ISPRS, Viena 1996, pp.: 33-37.

5. Bartoš P., Gregor V., 1999, *Podiel katedry geodézie na rozvoji fotogrametrie na Slovensku,* In.: XI.Medzinárodní vědecká konference, Brno, okt. 1999, pp. 81-84

6. Bartoš P., Gregor V., 1999, *Interdisciplinárne aplikácie fotogrametrie na Katedre geodézie SvF STU,* In.: Interdisciplinárne aplikácie fotogrametrie, Kočovce, apríl 1999, pp.: 43-45.

7. Fussgänger E., 1999, *Čiastková informačná správa,* GEOFOS, Žilina, 15pp.

8. Gregor V, Bartoš P., 1992, *Photogrammetric deformation of geometrical parameters of suspended cable bridge* In.: XVIIth Congres ISPRS, Washington, D.C., 1992, pp.: 259-263.

9. Gregor V., Bartoš P., 1996, *Použitie moderných geodetických a fotogrametrických metód pri prieskume zosunov* In: Zborník „Výskum, prieskum a sanácia zosuvných území na Slovensku", Nitrianske Rudno, pp. 84-89.

10. Holzer R., 1995, *Horninové masívy, ich stabilita a modely,* Habilitačná práca, Katedra inžinierskej geológie, PRIF UK, Bratislava, pp. 47.