

Commission no.V
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CONTRIBUTION OF THE PHOTOGRAMMETRY ON THE
RESTORATION OF THE ANCIENT ARCHITECTURAL
MONUMENTS AND SITES OF THE OLD CITY KRAKOW

Abstract:

The old city, Kraków has many ancient monuments. The Polish Governement has decided to undertake a complex restoration of the ~~medieval~~ old city ensamble. The geodetic and photogrammetric works comprise the urbanistic and architectural recording, the documentation of the building underlay-technically interpreted, taking part in the conservatory investigations. The elaborations executed in the Cracow Geodetic Enterprise link the technical methods with the photogrammetric and remote sensing ones. The complex recording is executed by the team of 110 specialists of geodesy, photogrammetry, architecture as well as history of art.

Text:

The problem of restoration of old historical cities is very often discussed during many international meetings. The actions of UNESCO, which chose some historical monuments as the most precious and valuable heritage of the world culture are the best example. Among those monuments UNESCO placed also Cracovian Old City and the salt mine in Wieliczka which is situated few kilometers south from Cracow. Cracow, the former capitol of Poland, is very dear to every Pole. It is the only city in Poland which was not destroyed the war. And that is why it has the original medieval historical site on the area of about 100 hectares. The restoration of such a site must be permanent and it requires a wide programme, great ammount of money and a good technical base. Our needs were greater than the potentiality of the city so in 1974 The Government issued a resolution: "Of The Restoration of the historical sites in Cracow", and nominated members of the restoration of historical sites in Cracow. The resolution accounted for means of renovation of the most precious historical monuments of Polish architecture. In order to achiere better organisation of research and project works, administrative and financial activities, the whole historical site in Cracow was devided into 111 sections which are treated as separate investment units. The division was made according to the maps of Cracow. Cracow has got a basic map which is systematically supplemented and actualized. For the center of the city the map is at the scale of 1:500 while for the suburbs at the scale of 1:1000. This map includes:

1. Horizontal placement of geographical elements in the city
2. The height date

3. The course of the underground installation
4. The parcel boundaries with their numbers

For the big parts of Cracow this map was prepared according to photogrammetric measurements taken from a helicopter. Due to the differences in the height of buildings and to the big area of places that could not be seen from the air /e.g. under the eaves/. These measurements had to be supplemented with a direct measurement. In the suburbs, which have a scattered building structure, some orthophotogrammetric measurements were made on the grounds of which a hachured map was prepared.

The recording of underground installation was made by the electronic methods, using an apparatus constructed in Cracow Geodesic Enterprise. The result was that a cadastre for all underground installation in Cracow was made. Nominated by the mayor of Cracow institution, working within the enterprise is doing all the additional work and decides about the location of new installations.

Recordings measurements for the needs of architectonic - renovating design which was started eleven years ago in the Cracow Geodetic Enterprise are the new assortment of work. Modified geodetic and photogrammetric methods are used for these measurements. There is a big correlation between these two measurement techniques. It pays to use the photogrammetric methods when a proper utilization of the photogrammetric apparatus is guaranteed, or when the object or its parts are unavailable to the direct measurements and they consist of many details.

Geodetic and photogrammetric work during the whole architectonic process must precede the design activities. Before starting to prepare the project one has to make recording maps at the scale 1:200 for the town-planning group and to make the recording at the scale of 1:100 or 1:50 for individual objects.

The recording map is made in the architectonics standard and it includes:

1. projections of all storeys
2. cross-sections with projections of view
3. traverses of facades

In practice the map at the scale of 1:200 is made as the effect of photomechanical diminishing of recording maps at the scale of 1:100 or 1:50 and their compilation.

Before beginning the geodetic and photogrammetric work, detailed coordinations stating horizontal and sometimes even vertical cross-sections, details which have to be measured, elements of small architecture, etc. have to be made. Specification of the needs and the range of recording works is necessary for the proper execution of the project and the correct buildings realization.

Designing sections for particular objects one has to foresee such a course of these sections, that after setting up the map for the whole town-planning group, they could form a whole with the projections of view from one directions.

The basic good point of the geodetic method used to the recording of architecture is the support of the measurement on the free, unrelated horizontal control designed for the whole town-planning group, or for the whole historical city. Fragmentary measurements of the elements of this group constitute a part of a whole. Further more we can achieve mutual correlation between

particular buildings and constructional base, underground technical framework, underground buildings and other elements located in the city, which have some influence on making preservation decisions.

On the whole the urban traversing has too small accuracy to mark the network of survey lines and polygonal course inside the particular sections.

That is why a method of a local increasing of accuracy of this net through the one point junction of net polygonal course around the section to the net, and the next measuring, was introduced. These new, calculated coordinates differ from the urban coordinates in about few centimetres /within the range of the accuracy of the urban traversing/.

For the traverses the linear discrepancy:

$$f_1 = \sqrt{f_x^2 + f_y^2}$$

is calculated from the formula:

For the circumferential traverse

$$f_1 = \sqrt{u^2 L + \left(\frac{m}{\rho}\right)^2 \frac{(n+1)(n+2)}{12n} L^2}$$

For the internal traverse joined to the circumferential traverse

$$f_1 = \sqrt{u^2 L + \left(\frac{m}{\rho}\right)^2 \frac{(n+1)(n+2)}{12n} L^2 + c^2}$$

L = the length of the traverse

n = the number of sections in the traverse

m = 30" /90^{cc}/ - an average error in the measurement of angles

u = coefficient of accidental errors in linear measuring

for the circumferential traverses u=0.0015

for the internal traverses u=0.0030

c = 0.03 the result of the error of the junction point position

The levelling net is placed as the benchmark on the storeys which are marked by the methods of levelling, with the accuracy less than 1 cm.

In spite of so great accuracy requirements there are some cases where the adjacent buildings have serious measurement errors. It is seen when, for instance, the external contour of a window was measured by the photogrammetric method, while the internal contour - by the direct measuring /e.g. polar method/. In the case of summing up of the errors, the deformation of the window can have even few centimeters. In order to avoid that, a method of incalculating traverse is used more often. During the photogrammetric measuring of facades some points on the window panes are signalized, for which coefficients are made. Those points are later on the junction points for the incalculated traverses of considerably simple geometrical con-

structions. Beside the fact that we obtain the correct distribution of errors within the measured object, this method is more economical, such a procedure requires, however, the proper system of work in order to achieve mutual correlation between the photogrammetric method and the direct measuring.

The most often the photogrammetrical method is used for drafts of facades, drafts cross-sections with projections of views, details, ornaments of the small architecture, interior decorations, recordings of the equipment. Sometimes external contours of vertical and horizontal projections are made.

We can assume that the contribution of the photogrammetric method to the whole complex work of recording is depending on an object, from 30% to 60%.

These numbers refer to the whole town-planning group and not to the only one architectonic element, which sometimes can be worked out using only photogrammetric methods.

The range of the work and the plotting scale for the typical recording, are shown in the table 1.

- works during which the photogrammetric method was used

- works during which only the photogrammetric method was used

During 11 years of the recording of historical monuments few internal measuring instructions were prepared in Cracow Geodetic Enterprise. Subsequent issues covered bigger assortment as the Enterprise undertook wider range of recording.

Present version entitled "Technical direction - recording of buildings and historical monuments of architecture" was worked out under the auspices of specialists from the Institute of Geodesy and Cartography and with the help of specialists from Warsaw Politechnic, University of Mining and Metallurgy in Cracow and Cracow Politechnic.

This direction refers to the urban and architectonic recording.

The range of recording documentation is shown in the table 1.

The compilation of this direction was finished in February 1980. After its ratification, the direction will be valid in the whole country.

The direction consists of nine chapters:

1. The general resolution
2. The range of the recording documentation
3. The essence of the recording measuring
4. Geodetic measuring of the net
5. The accuracy of the recording measuring
6. Methods and technologies of geodetic measuring
7. The system of works
8. The photogrammetric documentation
9. The norms of the recording analysis control

41 enclosures /tables, pictures/ illustrate purport of the direction.

The trend towards making complex recording analysis requires introduction of new techniques and organization of new assortments of work. The enlargement of the range of information included in the recording documentation moves towards qualification of moulding structure, both in the walls of historical documents and in the building base. Here the methods of remote sensing are introduced.

Observations in infra-red radiation together with the multi-spectral photography direct making of outcrops for architecto-

nic, archeologic, and constructional research. Penetration of the constructional base is possible due to the system of underground radar representation.

Control measurement is made using electronic measuring of the wall thickness, electro-magnetic plumbing and levelling. More and more often, the recording is supplemented with the data about the cours of installation and the kind of construction. These methods are also used to designate the distribution and diameters of reinforced rods in concrete and distribution of metal anchors in the walls.

The full information about the historical buildings is the basis to working out a good project and carrying out proper renovation.

Table 2 shows the range of work in the whole process of revalorization. At the left side of the table there is a percentage contribution of geodetic, photogrammetric, and remote sensing work in particular activities of this process. The table shows that the work constitutes about 30%. Assuming that photogrammetric covers 1/2 of this work, we can say that: the contribution of the photogrammetry to the renovation of historical sites in the Cracovian Old City is about 15%. This work is done in the Cracow Geodetic Enterprise by more than 100 people and specialists in geodesy, architecture, photogrammetry, electronics and history of Arts.

ARCHITECTONICAL RECORDING		URBAN RECORDING		RANGE OF THE FOR THE RECORDING DOCUMENTATION.	
Small architecture	-	1:100 to 1:200	1:5000 to 1:1000	Orientation	-
Details and equipment	-	1:20	-	Projections of particular storeys	-
Interiors	-	1:20	-	Views of the roofs	-
Wooden architecture	1:100 to 1:20	1:20	1:10	Vertical cross-sections with projections of view	1:10
Brick architecture	1:1000 to 1:200	1:50	1:20	Facades traverses Facades	1:10
Architectonic groups	1:5000 to 1:1000	1:50	1:50	Photographic documentation	yes
Recording of the landscape and green belt	1:5000 to 1:1000	1:50	1:50	Technical description	yes
Exploit of terrain	-	1:20	1:50	Tables	-
		+	+	Basic map	1:5000 to 1:1000
		+	+	Constructional junction and details	1:5000 to 1:1000
		+	+	Projections with views	1:5000 to 1:1000
		+	+	Details	1:5000 to 1:1000
		+	+	Permanent interior equipment	1:5000 to 1:1000
		+	+	Projections with the indication of rooms for recording	1:5000 to 1:1000
		+	+	Projection with the view and elements of the floor	1:5000 to 1:1000
		+	+	Projections with the views of the ceiling	1:5000 to 1:1000
		+	+	Unfolding of walls and ceilings, and their equipment	1:5000 to 1:1000
		+	+	Projections with the localization of details	1:5000 to 1:1000

Table 2

The range of the work in the process of revalorization with the statement of the per centage participation of geodetic work /photogrammetric work included/.

	<ol style="list-style-type: none"> 1. Making a decision 2. Preparing maps 1:25000 and 1:10000 3. Preparing general direction 4. Preparing maps 1:5000 and 1:2000 5. Making thematic maps 6. The view 7. Analysis of the formation stability 8. Establishing ratios 9. Establishing financial needs 	Preparing a program of revalorization	Preparing the material
	<ol style="list-style-type: none"> 10. Establishing protective spheres for historical buildings 11. Demographic prognosis 12. Defining the development of infrastructure 13. Defining the development of the public transport 14. Functional prognosis 	Preparing a detailed plan	Program
	<ol style="list-style-type: none"> 15. Preparing maps 1:500 or 1:1000 16. Recording of the underground installation 17. Preparing a record map 18. Defining geologic conditions 19. Descriptive documentation for the record of the grounds 20. Recording of the green belt 	Preparing a detailed plan	Town planning project
	<ol style="list-style-type: none"> 21. Deviding of the architectonal group 22. Defining the function - raudom analysis 23. Defining the range of renovation and demolition 24. Ratification 	Preparing a detailed plan	The frame proj.
	<ol style="list-style-type: none"> 25. Preparing a recording documentation 1:200 26. Preparing the recording 1:50 or 1:100 27. Specification of the functions 28. Analysis the structural base 29. Constructive reports 30. Recording of the details 31. Recording of the working order 32. Archeological research 33. Measuring of deformations 34. Research of preservation 35. Photographic documentation 	Preparing the architectonic project	
	<ol style="list-style-type: none"> 36. Archeological work 37. Demolishion work 38. Installation work 39. Protection of the constructional base 40. Eviction 41. Building work 42. Gradual introduction of some changes to the project 43. Other structural activities 	Preparing the architectonic project	Buildings realization