

TOWER CASTLE OF GARCIA D'AVILA - FIRST OUTCOMES FOR THE RESTORATION PROCEDURES

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ABSTRACT :

In attention to what was recommended by ICOMOS (International Council of Monuments and Sites) , according to the resolution number 2 of 10/15/1987 from CIPA (International Committee for Architectural Photogrammetry) , this article intends to show the Brazilian experience in preservation of historical monuments , using the terrestrial photogrammetry technique . It was chosen one of the most important historical monuments , which was built in Brazil in the middle of the century (1551) , the TOWER CASTLE OF GARCIA D'AVILA , situated approximately 80 kilometers north of Salvador - Bahia . In this stage of the work it was obtained the photogrammetric restitution and color digital orthophotos of two façades . The final goal is to preserve the ruins of this monument that was the first defense tower of the Brazilian territory , considered the first large Portuguese construction built in Brazil .

1. INTRODUCTION

An agreement for technical support between the Ministry of the Army , on one side, with the Military Institute of Engineering as executive Military Organization, and the Garcia d'Avila Foundation , on the other side, with the participation of the Cultural Assets Brazilian Institute and of the Culture and Research Center Castle of the Tower, started the restoration procedure of the House of the Tower . They used terrestrial photogrammetries of historical and archeological sites, which also means a cartographic contribution for the "Brazilian Historical Monuments Photogrammetric Archives".

The Castle of the Tower Garcia d'Avila located in Brazil, Forte Beach, north shore of Bahia, will have its majestic ruins consolidated, its hexagonal chapel redone, and will host a modern historical museum plus cultural activities.

Built in 1551 and considered the first major Portuguese construction in Brazil, it is one of the most important monuments of the Brazilian Cultural Assets and held the greatest estate in the world with 129 farms over 800.000 (eight hundred thousand) square kilometers, one tenth of the Brazilian territory.

The Castle of the Tower is the only feudal sample in all Americas, and together with the Fortress Garcia d'Avila represent important witnesses of Brazilian tradition and history. They took part in fights against pirates and foreign invasions, as well as in the settlements of the northeast, for over three centuries. They also had important roles in the movement for Brazilian Independence.

At present, a maxistructure for cultural and ecological tourism is being planted at the Coqueiros Coast, between Forte Beach and Sauípe Port, thus making possible one project Castle of the Tower , as a whole, turning the entire area into a cultural, leisure, ecological, and historical park.

2. DEVELOPING

2.1. Phase One

The first phase of this project was presented at the XVI Brazilian Congress of Cartography in Rio de Janeiro in October 1993 and consisted of :

- Implementing eight ground bases, thirty seven targets where the intersection method for spatial definition of control points was used, and a polygonal around the construction.
- Fixing eight concrete signposts in pyramids , bearing on top a bronze inscription : M. EX. - IME
- C. CART - POL .
- Photographing one hundred twenty eight shots of the ten façades , with camera P-32 Wild .
- Elaborating an orthophoto , at the Prospec Enterprise using software SORA and a OR-1 Wild equipment .

2.2. Phase Two

This part of the project consisted of :

- Redoing four vortex of the concrete poles from phase one .
- Settling six bases through wood stakes and nail stitches .
- Fixing thirty three targets for spatial definition of control points .
- Leveling and counter leveling the polygonal .
- Planimetric measuring of the settled polygonal .
- Taking photos of main façade and of the left side one with special film , closer to the object for clearer details in the negatives to be used for colored orthophotos .
- Elaborating the restitution of two façades and one color digital orthophoto at the ESTEIO Engineering and Airprospect S.A. from Curitiba , PR .

3. FIELD EQUIPMENT

For the topographic tasks the following equipment was used :

- One Wild P-32 Camera plus accessories
- One NA-2 Level
- One Wild T-2 Theodolite
- One "Total Station" Wild TC-1600
- Several topographic items (fillet , sight , field notebooks, parasol, tripods , range poles , etc ...)

4. PHOTO EQUIPMENT

Three types of films were used :

4.1 - Color films

- **Kodak EKTAR 25** , sensitivity ISO 25 , shape 120 , colored negative balanced for daylight . It offers extremely powerful and clear solution , thus allowing great enlargement thanks to the tabulation emulsion grains . It is perfect for construction photos requiring minor detail reproduction , such as scientific photos .

- **Kodak VERICOLOR HC**, ISO 100 , shape 120 , colored negative for daylight or electronic light flash , short , short exposure about 1/10 to 1/100 second . This film has extremely fine granulation , high definition and color saturation . Also offers higher contrast and so clearer images including details in deep shade or light ideal for architecture studies .

4.2 - Black and white film

Kodak TMAX 100- professional , sensitivity ISO 100 , shape 120 , panchromatic extra fine grain , super high definition , super powerful resolution . This film combines the technology of tabular grains which allows better light profit . This makes it ideal for scientific use and for constructions with excess of details requiring great enlargements and resisting exposure mistakes .

4.3 - Safety

For this purpose the exposure time was combined from 1/30 s , 1/60 s , 1/125 s , diaphragm opening of F/8 , F/11 , F/16 , F/22 , fifty two photos were taken in color and twelve in black and white of the main and side façades .

5. FIELD SUPPORT AND PRECISION

5.1 - Results

After the materializing of the four destroyed sign poles , a polygonal outline of the building was established measuring 227.95 meters in length , measurement taken with electronic equipment Wild TC-1600 . Two series of observation were undertaken , at left circle and right circle , giving the following results :

OUTLINE POLYGONAL		
	TECHNICAL SPECIFICATIONS	RESULTS
ANGLE TOLERANCE	$T = 20'' \sqrt{n}$	48.9''
ANGLE CLOSURE	$n = 6$	9.2''
LINEAL TOLERANCE	$T = 0.1 \sqrt{L}$	4.7 cm
LINEAL CLOSURE	$E = \sqrt{fx^2 + fy^2}$	1.0 mm

The technical specification values referring to precisions are included in the service Bulletin 1602- Resolution Presidency of the Republic n. 22 of July 21st, 1983, of the Brazilian Institute of Geography and Statistics Foundation. So, in our case, n = number of vortex equals six, fx = axis closure at the x and fy = axis closure at the y. Value L represent, in the form above, the total length of the polygonal.

The altimetry of main polygonal was done through geometric leveling and also the counter leveling was done.

5.2. Topographic bases

Once the polygonal settled and measured, there followed a phase of determining the photographic bases which were obtained by double irradiating. Six bases were established on ground, four of which were at main façade and two at side façade.

5.3. Support points

The coordinates for the photogrammetric support points were determined from the bases and materialized through previously settled targets at points on the façades on the building. All points were obtained by using intersection process from fore, two series of observation (right and left circle), totaling thirty eight support points. The height of the targets was obtained by trigonometric leveling.

For azimuth control of the construction was used the sun azimuth oriented toward the Garcia d'Avila light house, which belongs to the Ministry of Navy and has well known coordinates.

All data were stored in field notebooks and computer diskette for further possible needs (calculations, conferences, etc...)

6. OFFICE WORK

6.1. Photogrammetric restitution

These works were elaborated in the analytical system airtriangulator- restitutor first class PLANICOMP C-120 it was processed as thoroughly as possible, displaying all details and possible representation in a scale 1:50. No discrepancy was found in the field support; there even over abundance of points and the precision was excellent. As to the main façade, the final remnants of the absolute orientation showed an average result of $x = 5 \mu$; $y = 6 \mu$ and $z = 8 \mu$; for the side façade $x = 8 \mu$; $y = 14 \mu$ and $z = 20 \mu$ which are perfectly compatible with the final scale. Working time was eighty five hours of restitution and eighteen hours of editing for both façades. Plus, for the main façade the borders of the model were not used, but a third one instead, the photos being taken from another base of the ground.

Editing took place on a specific software CAD TEMAP of the enterprise ESTEIO Engineering and Airdrafting S.A.

Final product is presented in magnetic file DXF. A conventional form was established for items such as hole, stone, plaster, cleft, etc.

Also a frame was elaborated in the software AUTOCAD to display organizations engaged, project data, conventions, etc. The negatives presented greater difficulty in color - restitution of details in general - than in black and white.

The above mentioned frame will allow a final presentation of the work at the stand of IME (Military Engineering Institute) at the XVII Brazilian Congress of Cartography.

6.2. Digital Orthophoto

The following data were used in forming digital orthophotos of main and side façade:

- Camera WILD : P-32
- Gauged focal distance: 63.95 mm
- Object distance: 19 m
- Bases length: 3 m
- Photo scale: 1:300
- Orthophoto scale: 1:50
- Longitudinal covering: 87 %

The orthophotos were produced at the Digital Photogrammetric station Leica - Helava - DPW 770, which belongs to the ESTEIO Engineering and Airdrafting S.A. from Curitiba-PR.

Several technical aspects had their role in the process , as follows : the SOCET SET was the logical module used , for its orienting the models , molding the ground automatically , manual and automatic mosaic of photos , gathering vectorial data and so forth . First the color negatives were scanned with the station DSW 100 (Leica-Helava) and 2000 dpi which correspond to 13 microns pixel. Each negative generated a magnetic file in positive of around 100 megabytes ;this was adapted expecting a possible restitution at the very station . For execution there should be a choice of DTM for the PLANICOMP C-120 . Due to great differences in depth (z) of details , it was decided to use DTM since the restituted structural lines , which were placed to form a grid every 50 cm regularly . Correction is automatic in software with field support points and DTM . No discrepancies there . Due to some image distortions it was necessary to edit part of DTM and to compare it with the elaborated restitution . Working time - considering the tests made and the pioneer aspect - was of about 50 (fifty) hours . Due to great differences in depth , the details at the back could not be corrected . As a final product , it was generated a digital orthophoto in magnetic file TIF with a 600 dpi resolution (was shown at the stand of IME at the Brazilian Cartography Congress).

As for restitution also a convention board was elaborated . This product was sent to the United States to be made in a Laser photoplotter with 2000 dpi resolution .

7. CONCLUSIONS

7.1 - The final products , namely the photogrammetric restitution of two façades and its colored

orthophotos , have fundamental roles in the restoration process .

7.2 - Detail definition was somewhat damaged by the use of colored negatives . The absence of specialized laboratories to develop this type of film is a great obstacle .

7.3 - An interesting technical aspect was the motivation aroused in many professionals of photogrammetry who were willing to cooperate .

7.4 - Digital orthophoto is a quite modern technique though not yet fully popular in Brazil , specially the color aspect . We believe this was a pioneer achievement in our country .

7.5 - The final products was displayed at the stand of the Military Institute of Engineering at the XV EXPOSICARTA of the XVII Brazilian Congress of Cartography .

7.6 - This work means one more cartographic contribution to form the Photogrammetric Archives of Brazil's Historical Monuments .

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