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Proposal for Verification of the Stability of Observation Pillars for Monitoring of Structures by GPS – The Case of ITAIPU Dam

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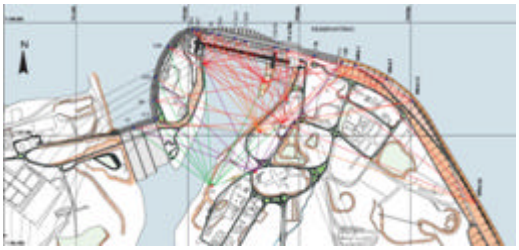
Localization

- The ITAIPU hydro-electrical power plant is situated in the Southwest of Brazil on the Paraná River, which forms the border with Paraguay.
- The ITAIPU dam is composed of concrete, earth fill and rock fill dams with a total length of 7700m and a maximum height of 196m.

Observation Pillars



- Positioning of the observation pillars of the control network (P1, P2, P3, P4, P5, P6, P7) and sights to Object Points

OBJECTIVIES

- Analyze the geodetic control system presently in use at ITAIPU dam
- Consolidate the discrepancies revealed after processing the data collection from several observation campaigns
- Study the case, define and propose alternative methodologies to monitor the structures displacements of the dam using GPS observations

Definition of the methodology

- The observation pillars of the reference system should be occupied simultaneously, with Double-frequency receivers.
- A fixed reference station, named ITAIPU-CHI-FOZ was chosen as the reference station, and its coordinates determined and adjusted from two stations (UEPP and SMAR) of the so-called RBMC.

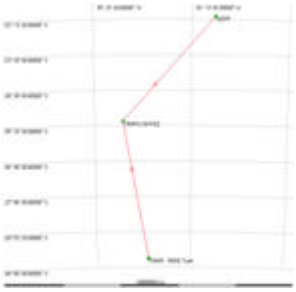
Data Collection

- The data collection of the first GPS campaign took place during the period between April 3rd and 6th of 2006 by using a total of eight GPS receivers (including ITAIPU-CHI-FOZ station) such as:
  Double-frequency receivers of Leica:
  model GX 1220 (5mm+0.5ppm)
  model SR 520 (5mm+1ppm)
  model SR 530 (5mm+1ppm)



Example of Installation of GPS Antennas on top of pillars P2, P4 and the fixed Station ITAIPU-CHI-FOZ respectively

Processing and Adjustment of data



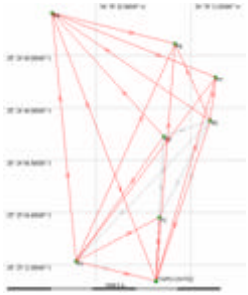
- Vectors to be processed and adjusted for ITAIPU-CHI-FOZ station

Processing and Adjustment of Data

Station		Coordinate	Corr.	Sd	
ITAIPU - CHI-FOZ	Latitude	25° 25' 14.44422"S	-0.0578 m	0.0033 m	
	Longitude	54° 35' 17.85546"W	0.0440 m	0.0034 m	
	Alt. Elip	183.2479 m	-0.2666 m	0.0085 m	
SMAR - RBMC	Latitude	29° 43' 08.12600"S	0.0000 m	-	fixed
	Longitude	53° 42' 59.73530"W	0.0000 m	-	fixed
	Ellip. Hgt	113.1100 m	0.0000 m	-	fixed
UEPP - RBMC	Latitude	22° 07' 11.65710"S	0.0000 m	-	fixed
	Longitude	51° 24' 30.72220"W	0.0000 m	-	fixed
	Ellip. Hgt	430.9500 m	0.0000 m	-	fixed

Adjusted coordinates of ITAIPU-CHI-FOZ station

Processing and Adjustment of Data



- Configuration of adjustment network of the pillars P1 to P7 with ITAIPU-CHI-FOZ as a control station

Processing and Adjustment of Data

Station		Coordinate	Corr.	Sd
P1	Latitude	25° 25' 11.43354" S	0.0003 m	0.0005 m
	Longitude	54° 35' 31.35061" W	0.0002 m	0.0004 m
	Ellip. Hgt	168.9706 m	0.0018 m	0.0012 m
P2	Latitude	25° 25' 04.73241" S	0.0001 m	0.0006 m
	Longitude	54° 35' 17.29388" W	0.0001 m	0.0006 m
	Ellip. Hgt	181.8506 m	0.0009 m	0.0016 m
P3	Latitude	25° 24' 52.37908" S	0.0008 m	0.0007 m
	Longitude	54° 35' 16.59240" W	0.0007 m	0.0007 m
	Ellip. Hgt	183.5065 m	0.0063 m	0.0020 m
P4	Latitude	25° 24' 33.50140" S	0.0002 m	0.0005 m
	Longitude	54° 35' 35.37786" W	0.0001 m	0.0004 m
	Ellip. Hgt	147.1760 m	0.0014 m	0.0012 m
P5	Latitude	25° 24' 49.95606" S	0.0001 m	0.0004 m
	Longitude	54° 35' 08.68436" W	0.0001 m	0.0004 m
	Ellip. Hgt	186.5680 m	0.0008 m	0.0012 m
P6	Latitude	25° 24' 38.18338" S	0.0001 m	0.0005 m
	Longitude	54° 35' 14.65325" W	0.0001 m	0.0004 m
	Ellip. Hgt	152.8969 m	0.0008 m	0.0012 m
P7	Latitude	25° 24' 43.30520" S	0.0001 m	0.0005 m
	Longitude	54° 35' 07.79188" W	0.0001 m	0.0004 m
	Ellip. Hgt	176.3051 m	0.0008 m	0.0012 m

Adjusted coordinates of the network of pillars P1 to P7

ANALYSIS OF THE RESULTS OF THE FIRST CAMPAIGN

- The adjusted final coordinates of the basic network for the observation pillars P1 to P7, computed after the first campaign, show standard deviations better than GPS receivers nominal values of +/- 6mm.

CONCLUSIONS

- The adjusted coordinates for the observation pillars, calculated after the first campaign, could be considered as a reference to compare with the results of further campaigns which should make use the same methodology.

  Therefore, it could be possible to propose the components for displacement vectors and their precision between several campaigns.