LABORATÓRIO NACIONAL
DE ENGENHARIA CIVIL

CONSTRUCTION AND FIRST FILLING OF PINHÃO CONCRETE FACE ROCKFILL DAM

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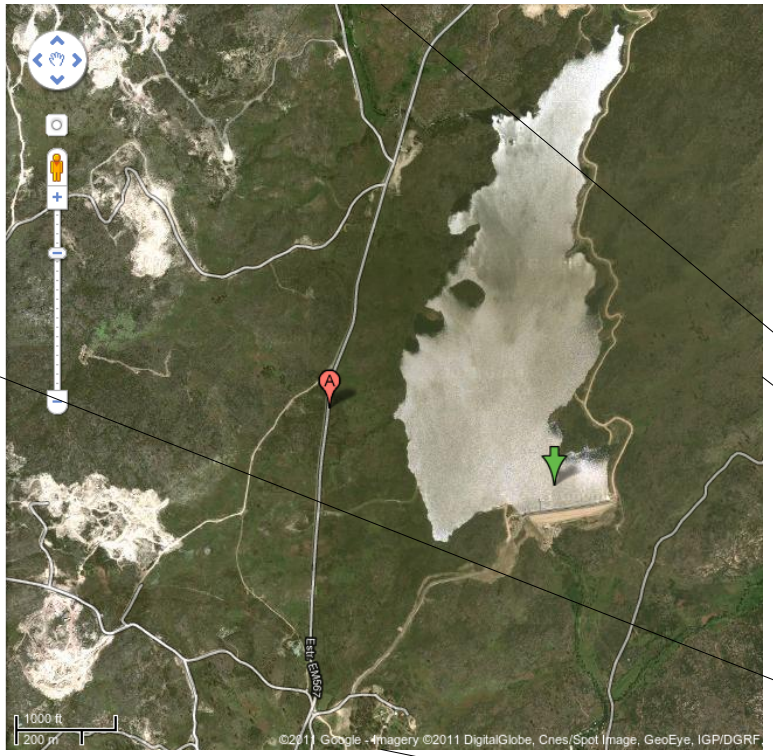
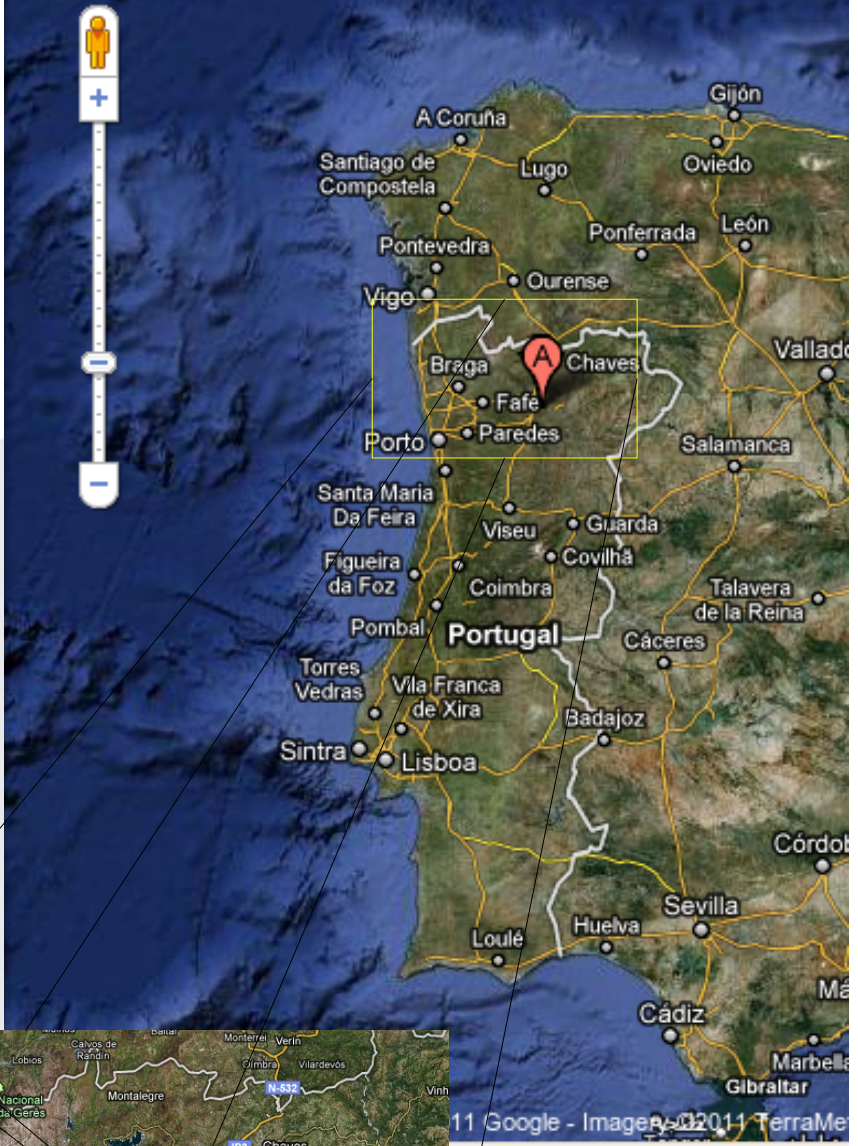
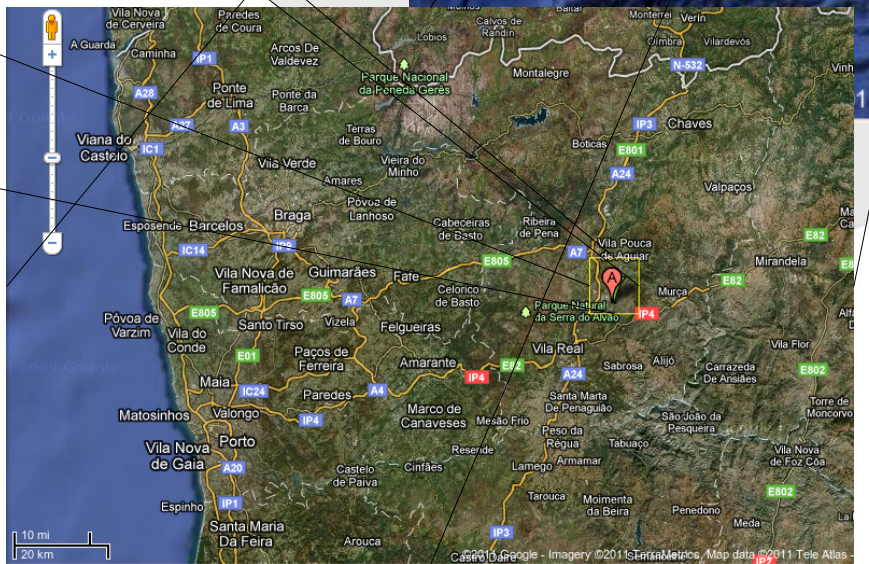
Synopsis

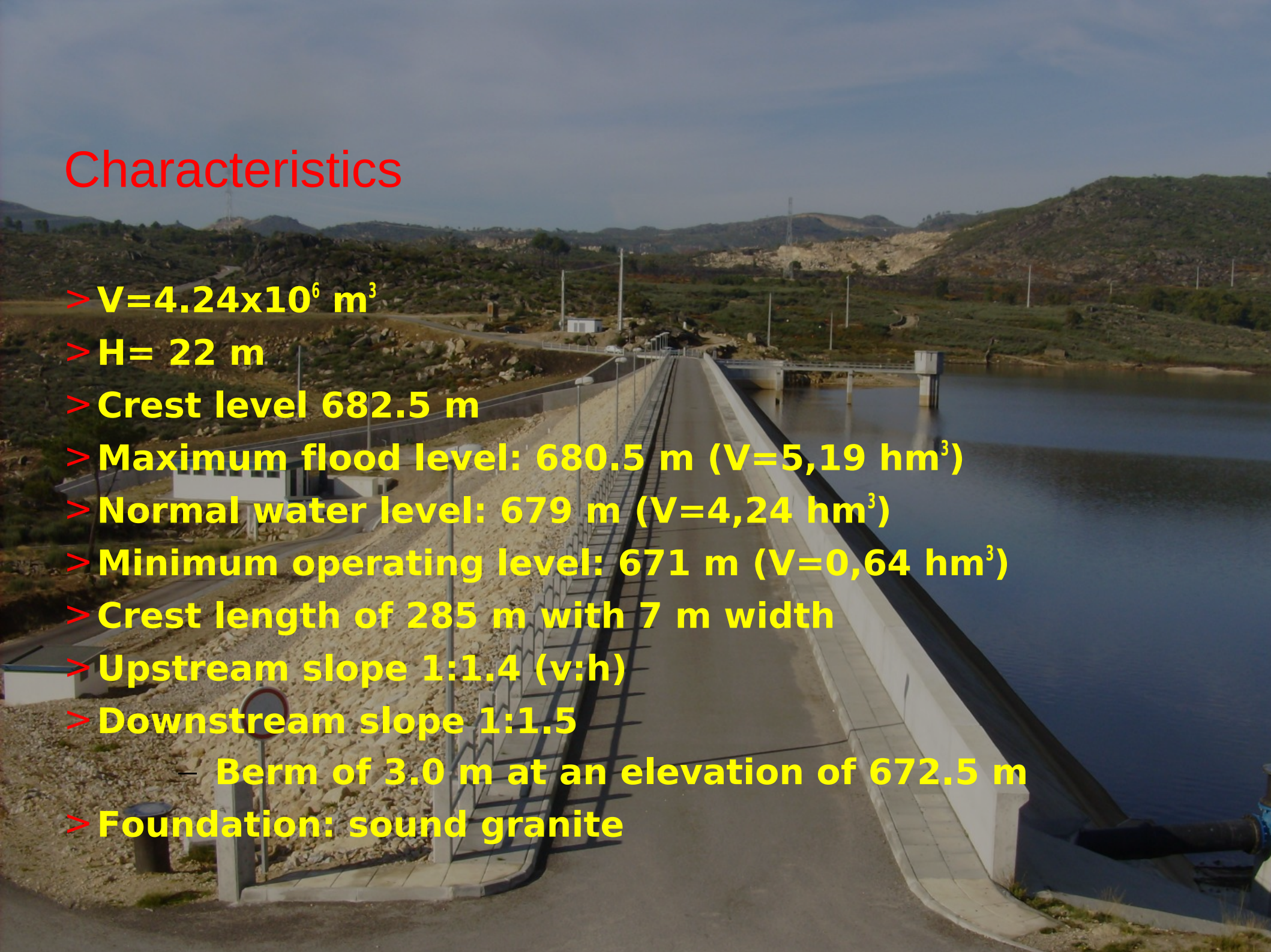
- Dam characteristics
- Monitoring system
- Results of the monitoring during the 1st filling
- Final remarks

General data - location









Characteristics

- V=4.24x10^{6} m^{3}
- H= 22 m
- Crest level 682.5 m
- Maximum flood level: 680.5 m (V=5,19 hm^{3})
- Normal water level: 679 m (V=4,24 hm^{3})
- Minimum operating level: 671 m (V=0,64 hm^{3})
- Crest length of 285 m with 7 m width
- Upstream slope 1:1.4 (v:h)
- Downstream slope 1:1.5
  - Berm of 3.0 m at an elevation of 672.5 m
- Foundation: sound granite

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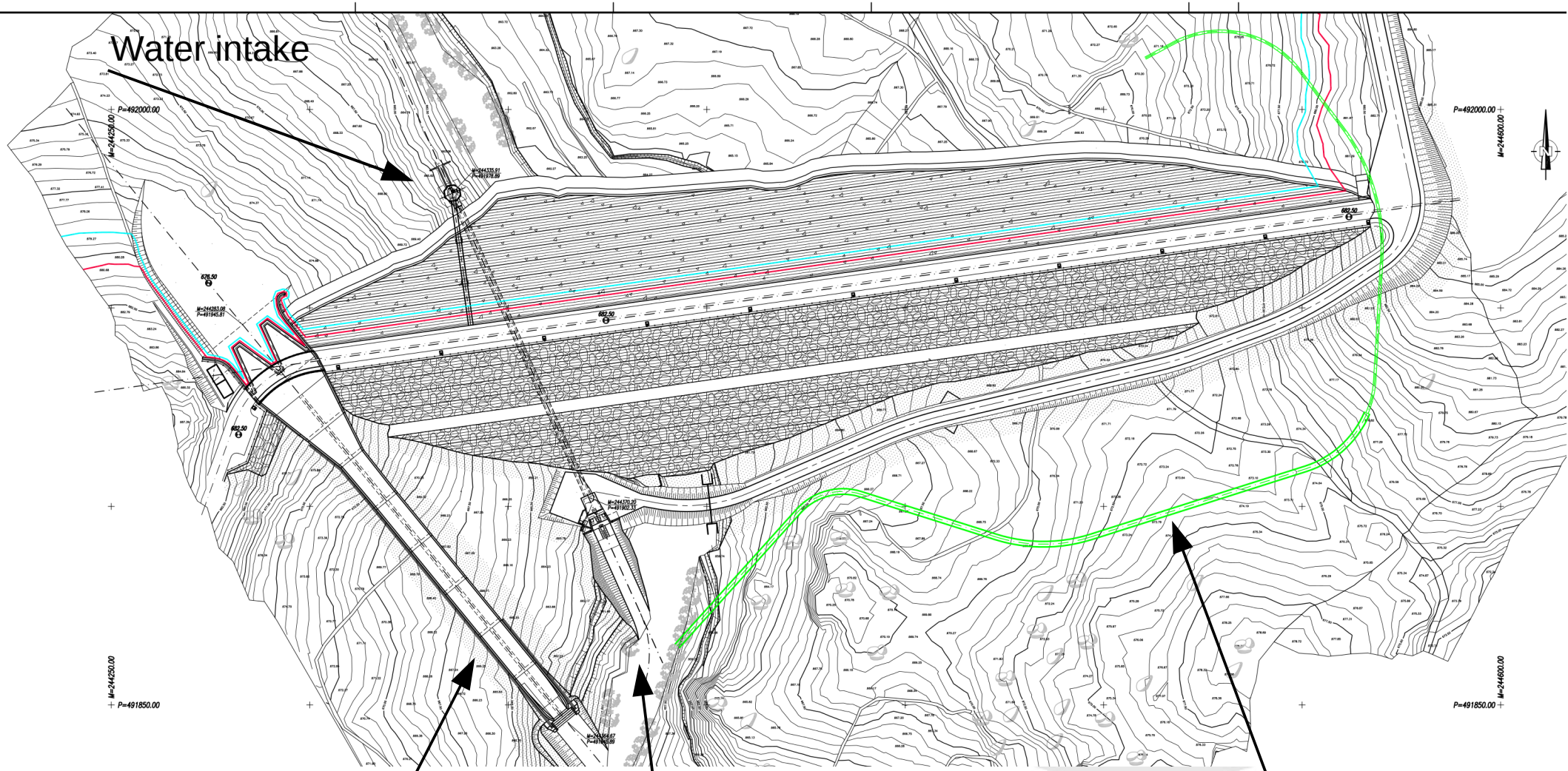

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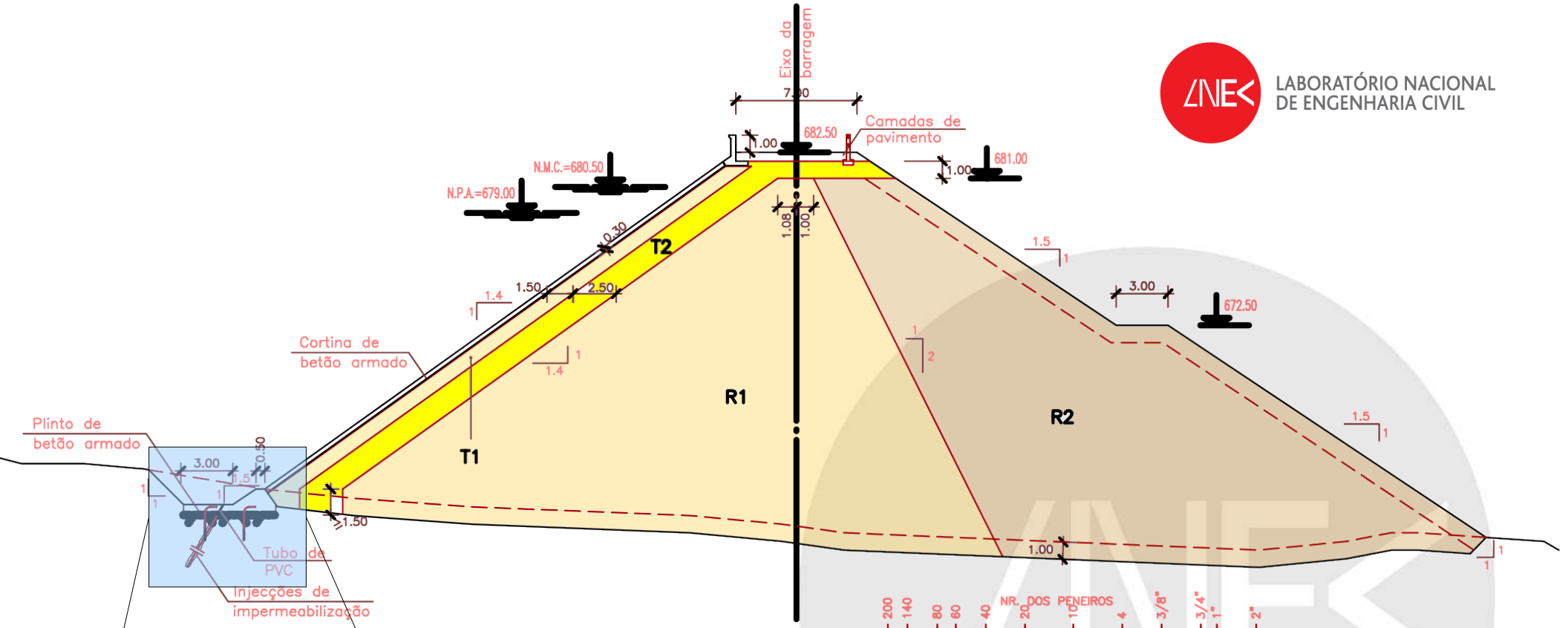

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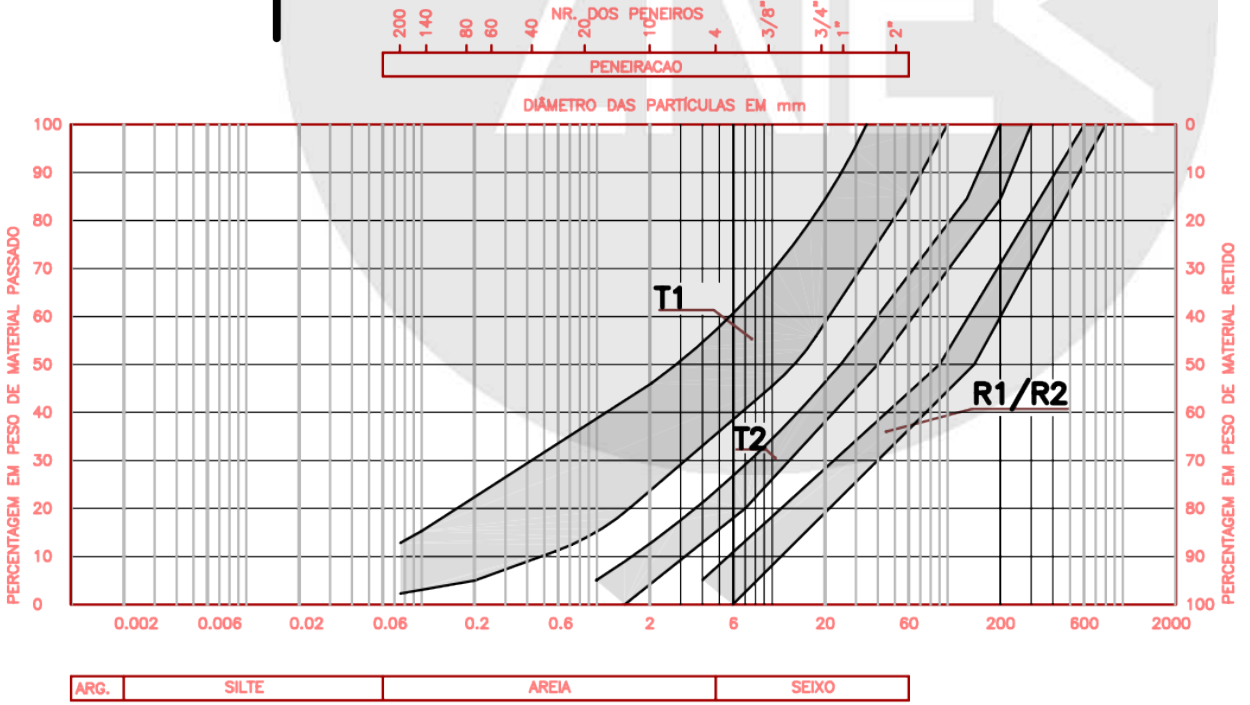

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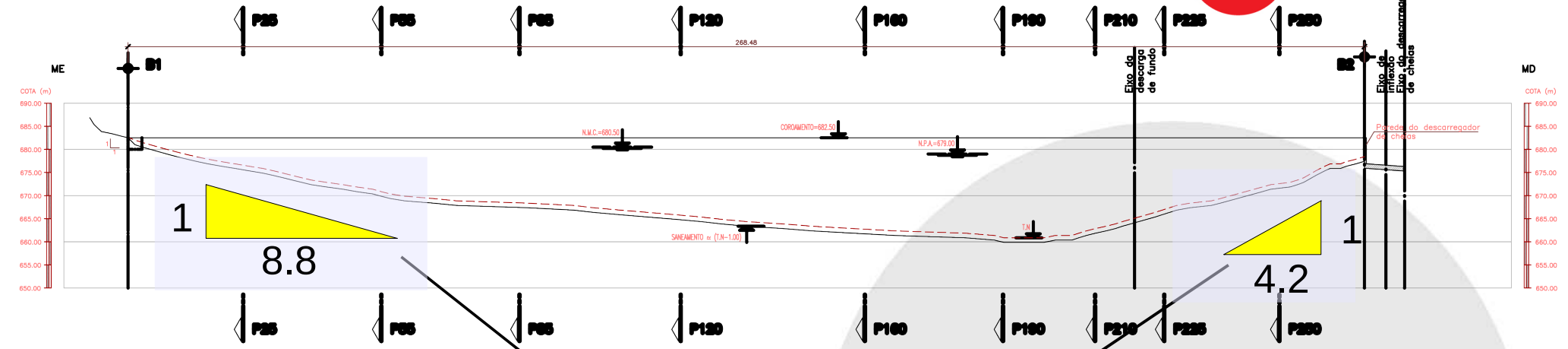

PERFIL LONGITUDINAL PELO EIXO DA BARRAGEM

Esc. 1:500


07 06 2007


Placing in “cord”
Abundant watering

Monitoring system

- Reservoir water level
- Meteorological data
  - Rainfall & temperature
- Surface and internal displacements
  - 12 surface benchmarks
  - 8 inclinometers in 4 cross-sections
- Water pressure in the foundation
  - 2 standpipe piezometers in 4 cross sections
- Total flow discharge
  - two V shaped weirs
- Visual inspection

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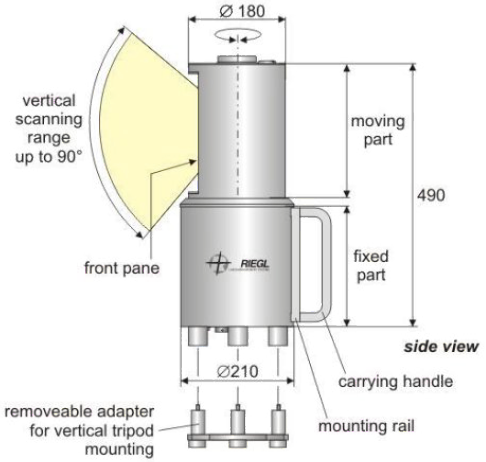
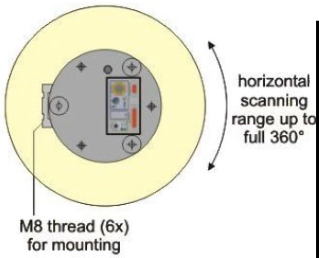
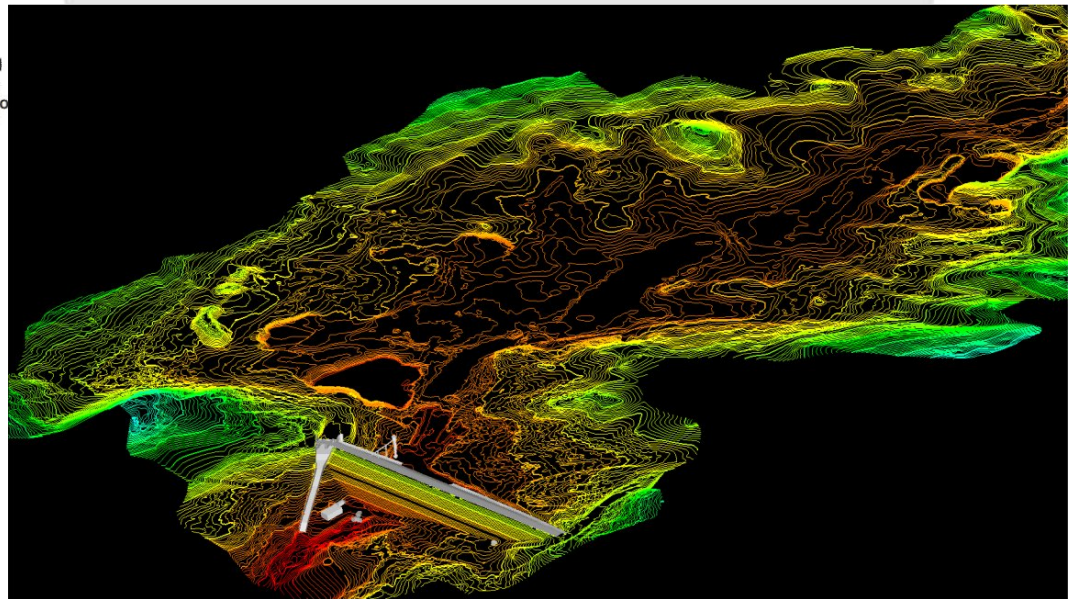
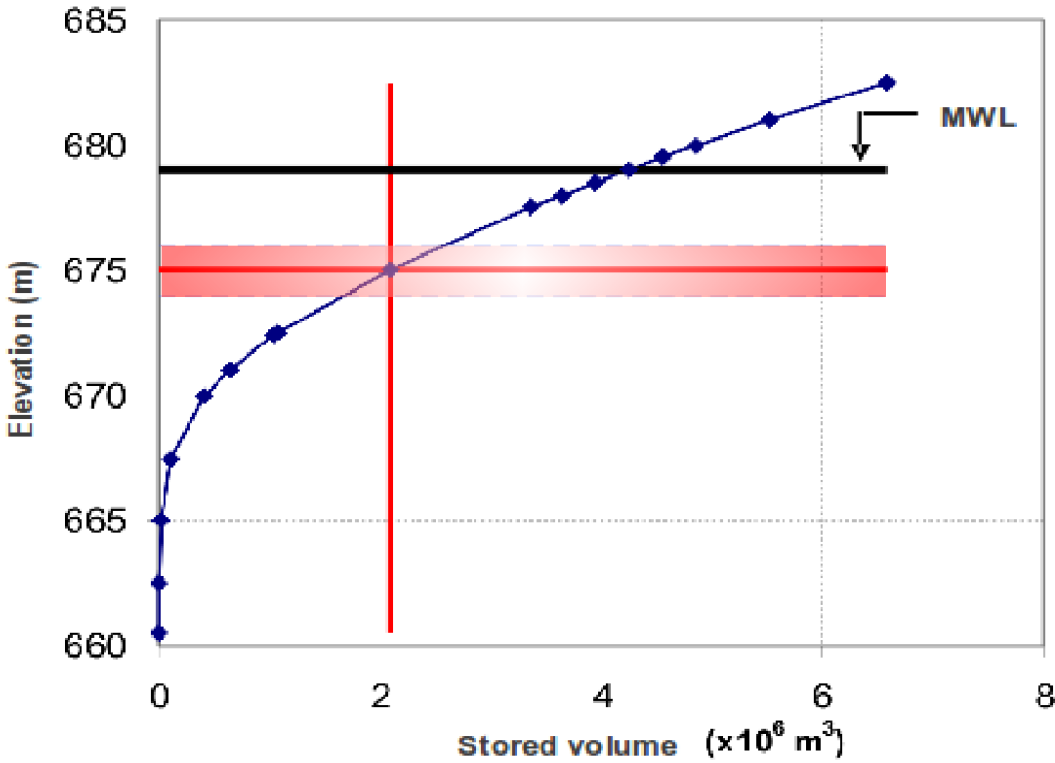






1st filling

Filling step	*Elevation (m)*	*% height*	*Storage x10⁶ m³*	*% of maximum volume*
Ideal value	675	65.9	2.09	49.3
Mínimum value	674	61.4	1.69	39.8
Maximum value	676	70.5	2.6	61.3

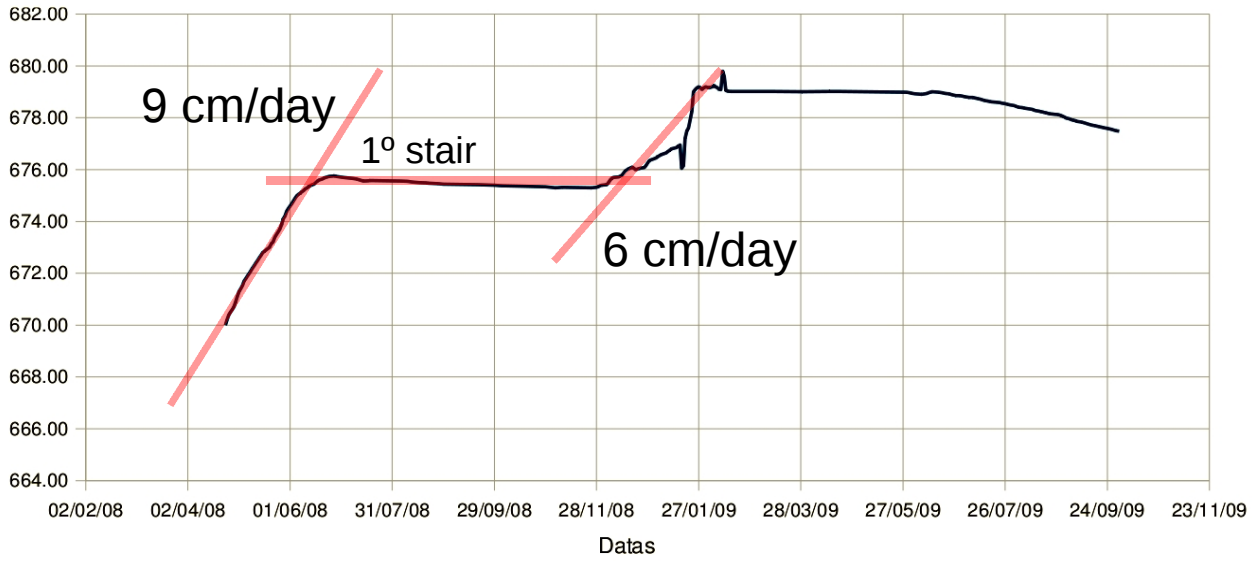


Variable	*Minimum frequency*	*Mandatory measurements*
Reservoir level	Daily	Not applicable
Surface displacements	Annual	a)
Internal displacements		
Flow	Biweekly	a)
Piezometric levels	Monthly	a)
Rain fall	Daily	Not applicable
Routine visual inspection	Monthly	a)
Special visual inspection	Annual	a)
Exceptional visual inspection	After event	Not applicable

a)Beginning, end of stairs, and end of first filling or rapid drawdown

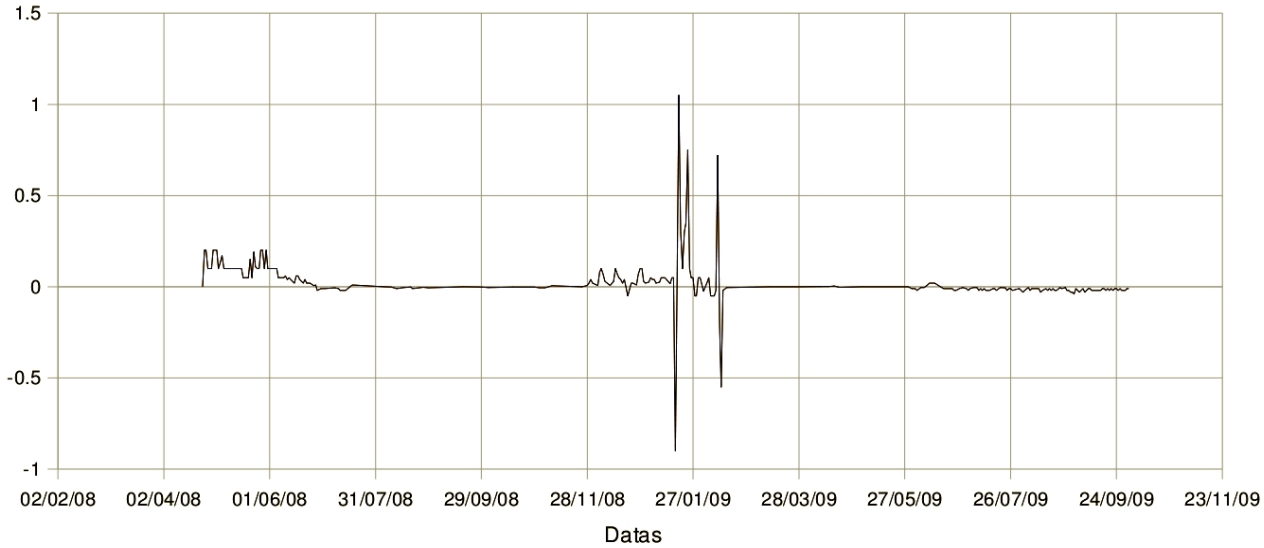
1st Filling

Water level (m)



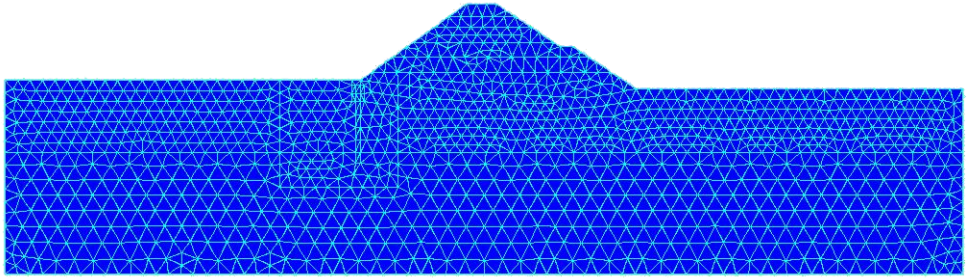
Máximo=	679.8	em	10/02/09	Média=	676.61
Mínino=	670	em	24/04/08	Desvio Padrão=	2.26

$\frac{\partial wl}{\partial t}$

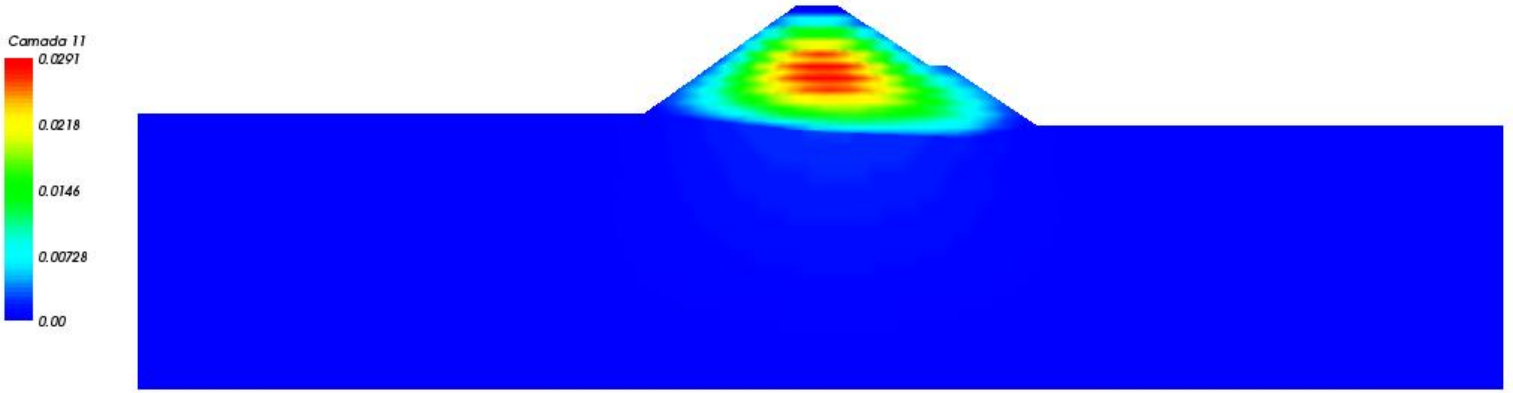


Mechanical Model

Code Aster (EDF)



Finite element mesh (2383 triangular elements w/ 4875 nodal points)



Settlements due to the construction less than 3 cm

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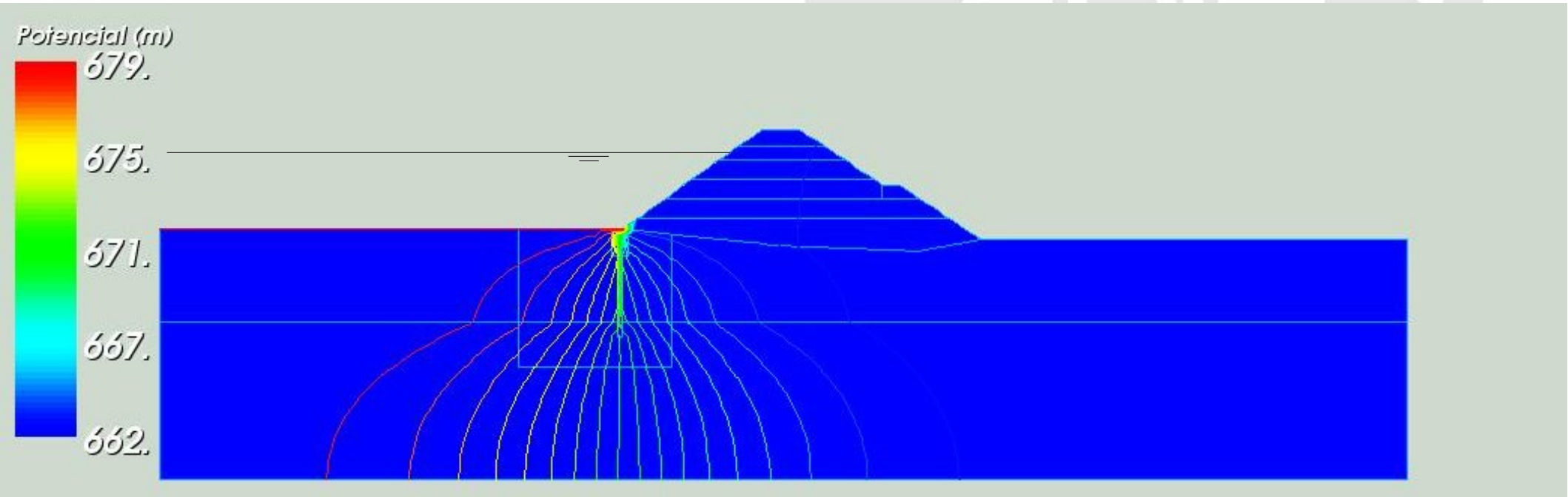
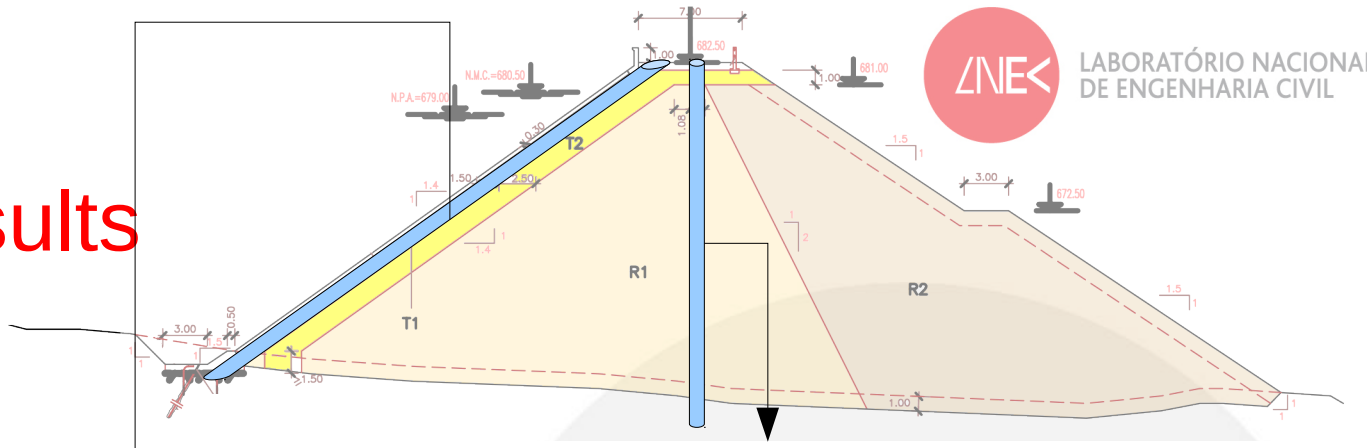
Models

Seepage analysis



Monitoring results



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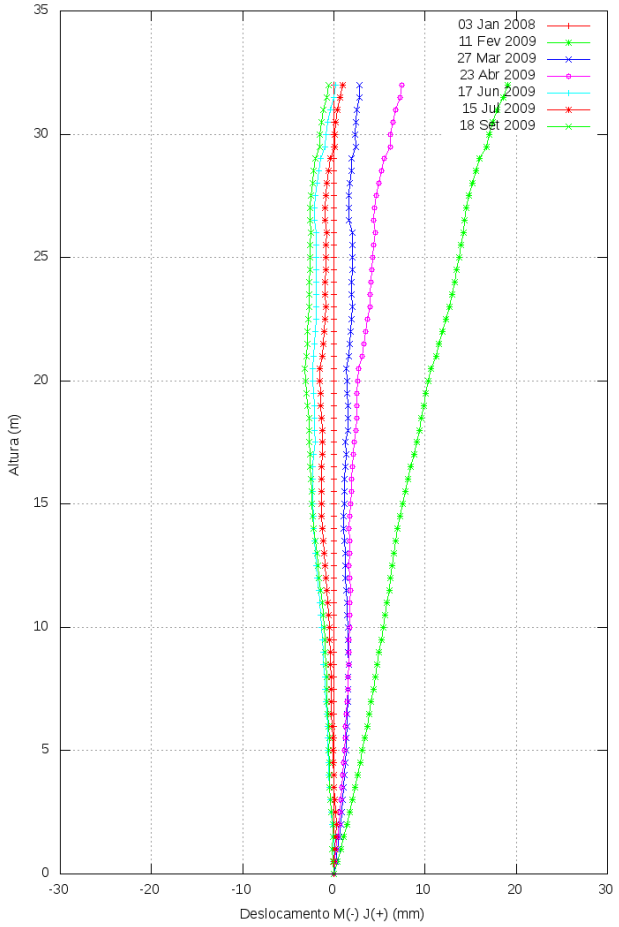
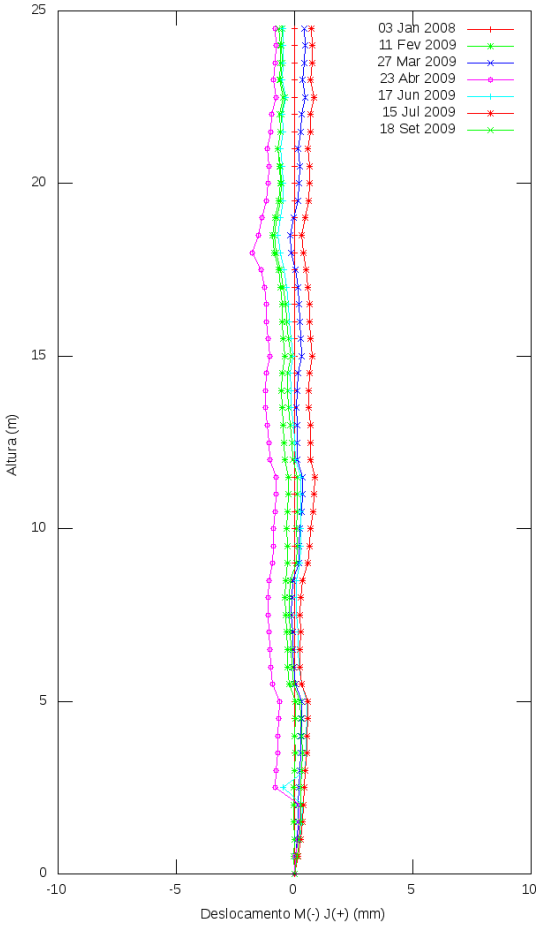
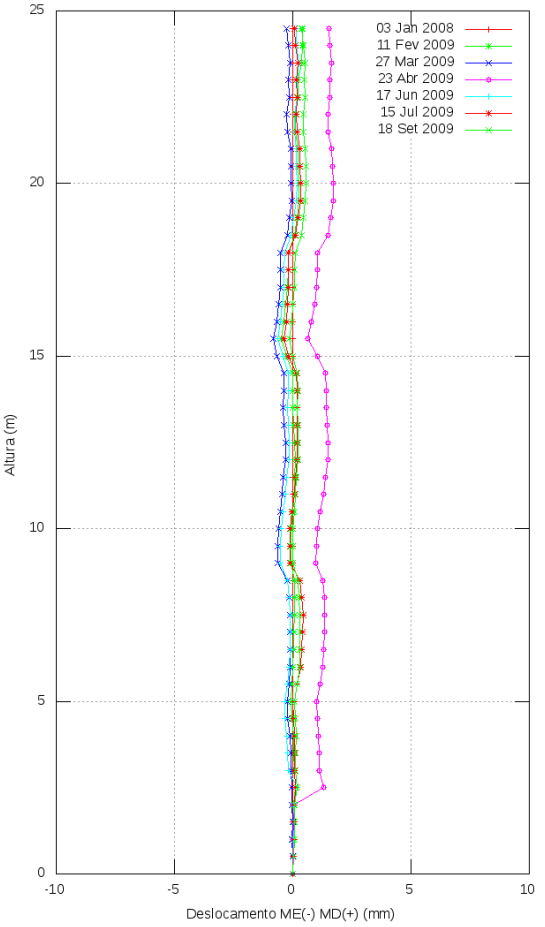
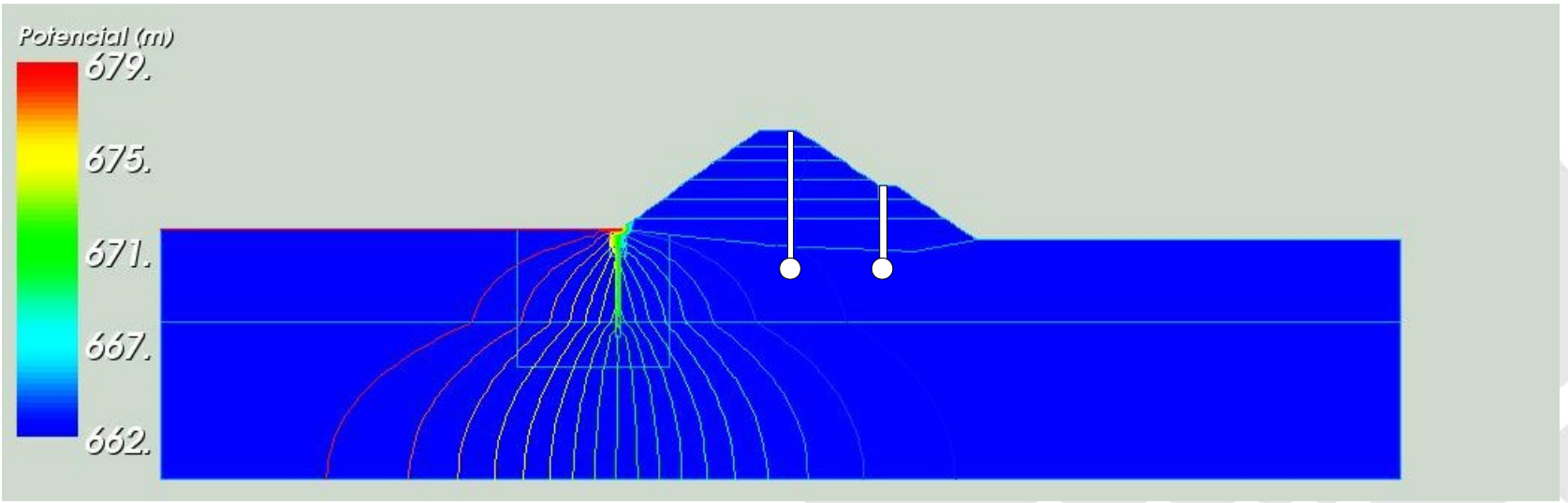
Concrete face

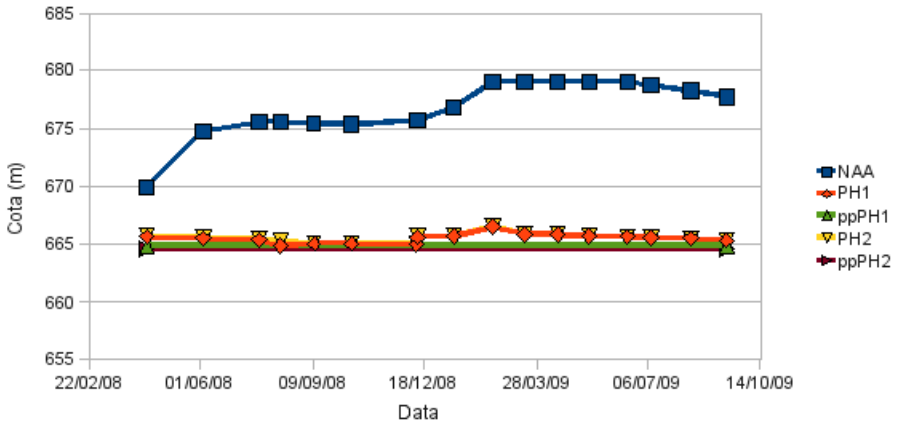


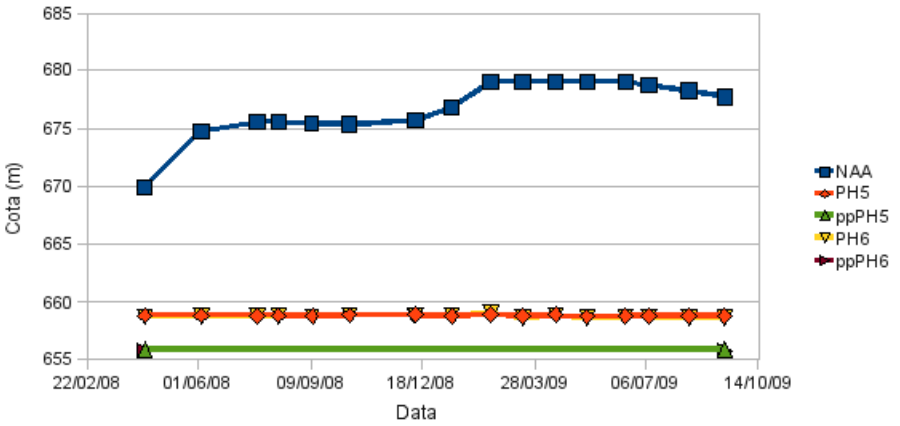
Dam Axis

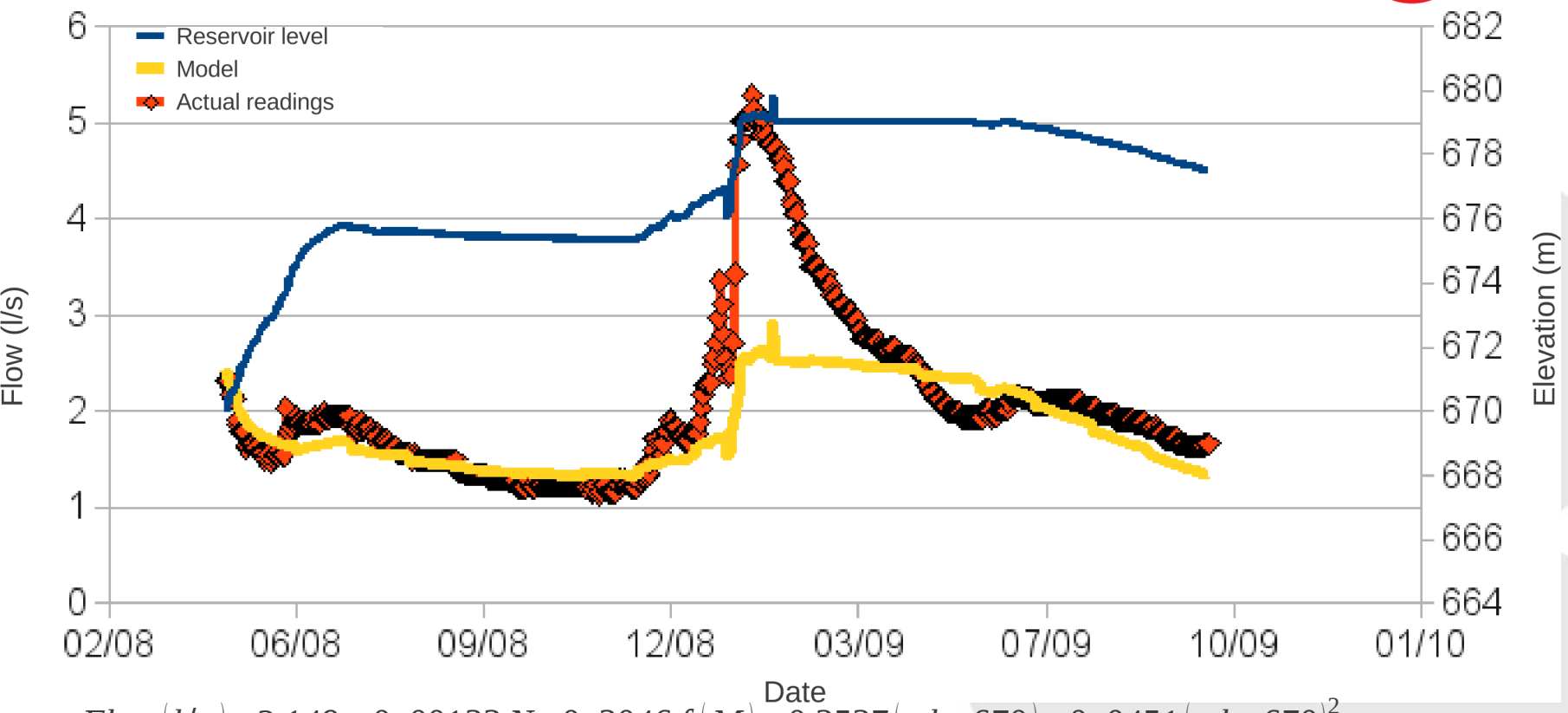




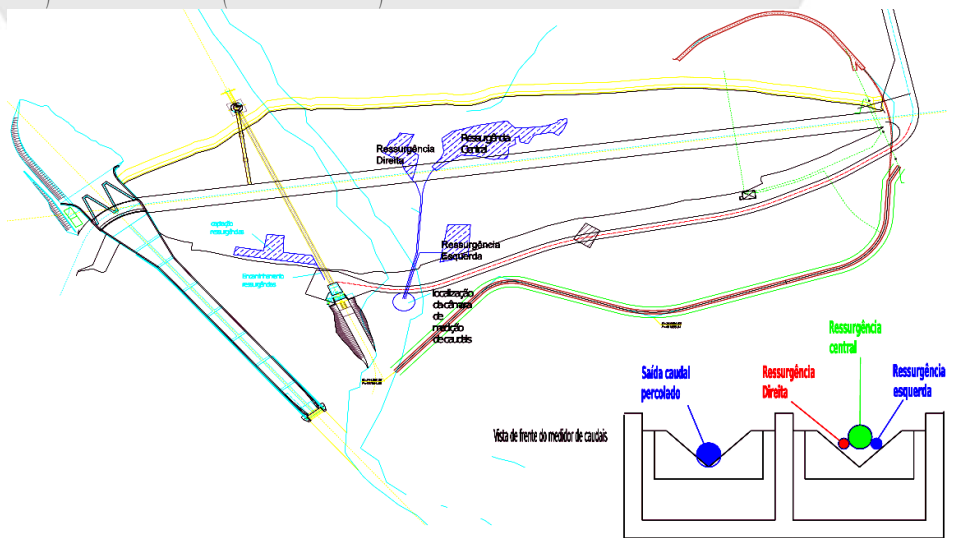

Potencial (m)
679.
675.
671.
667.
662.


685
680
675
670
665
660
655
Cota (m)
22/02/08
01/06/08
09/09/08
18/12/08
28/03/09
06/07/09
14/10/09
Data
NAA
PH1
ppPH1
PH2
ppPH2


685
680
675
670
665
660
655
Cota (m)
22/02/08
01/06/08
09/09/08
18/12/08
28/03/09
06/07/09
14/10/09
Data
NAA
PH5
ppPH5
PH6
ppPH6



$$Flow(l/s) = 2{,}149 - 0.00133\,N + 0.3046\,f(M) - 0{,}3537(wl - 670) + 0.0451(wl - 670)^2$$



Model → 98 m^3/day
Actual measurements → 118 m^3/day

Final remarks

The dam presents a behaviour that can be classified as good, within the forecasts made prior to construction, both for the hydraulic behaviour of its foundations and for the stress-strain behaviour.

Continuation of the monitoring activities will soon allow the preparation of models for the validation of the monitoring results and its integration into safety control systems.


Thank you!