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Analysis of Displacement and Deformation Due To Hormic Variations at the Inga 1 Hydroelectric Dam in Dr.Congo

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Abstract: *In this article, we present address the structure of the hydroelectric dam inga 1 and inga 2; then the parasite note intends to evolve the state of theoretical deformation of the inga hydroelectric dam , depending on the load observed after the first commissioning.*

The objective of this article is to determine the actions that contribute to displacements downstream of the Inga hydroelectric dam due to the elastic deformability of masonry mass. Displacement due to deformation hydrostatic load. Displacements by bending moment fm (raisable by the right pendulum), displacement by body forces fr (raisable by the right pendulum) and displacements by horizontal forces fn (not liftable by the right pendulum). The model of the nonlinear equations of the calculation of displacements, facilitate the determination of the displacement by bending moment, displacement by cutting force, displacement by horizontal force and displacements due to variations of temperature.

Keywords: *Analysis, Displacement and deformation, Hormic variations, Dam, Hydroelectric.*

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I.INTRODUCTION

The dam rests on ancient metamorphosed rhyolites which are in the form of a succession of beds of compact gneiss with intercalation of beds of more foliated micaschists. These layers are oriented NW-SE and inclined towards the SW with a dip of about 50°. The mechanical characteristics of the rock are very satisfactory as shown by the stratigraphic sections. The buttresses are oriented parallel to the direction of the rock, the latter being cut out naturally according to its dip, this resulted in a foundation difficulty, of a purely geometric order, for the five buttresses which cross the escarpment on the left bank, immediately after the pinion.

I.1 History

The construction of a series of large dams Colonel Vandeuren recommended at the same time the equipment of waterfalls. The Inga I and Inga II dams will be built.
Inga 1: 351MW, commissioned in 1972; Inga 2: 1424MW, commissioned in 1982

Figure I.1 Inga 1 plant

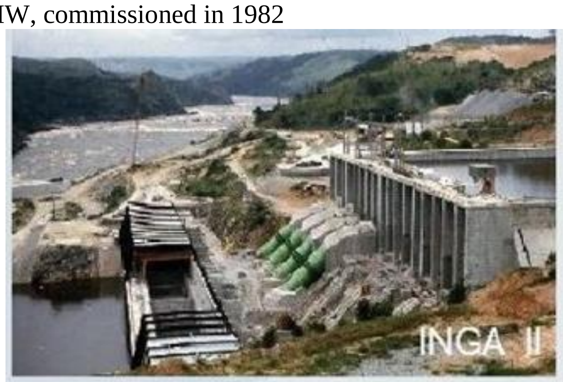


Figure I.2 Inga 2 plant

I.3 Purpose

The objective was to supply electricity to a giant aluminum factory and to the advanced chemical industry, but also to transport it from the current of Inga to the copper and cobalt mines of Katanga, which requires the displacement of the community from the Inga site, to which the Belgians were prepared to pay compensation. At the time, the prices of raw materials, which made the fortune of the Belgian colony and of Belgium, were at their highest. One can however doubt the Belgian will. To compensate the natives. Because it was not in the habit of Belgian and more generally European settlers to compensate the local populations who were victims of colonial policy, in particular the expropriation

forced . is only separated from the Makongo by a dividing crest pierced by three passes at altitudes between 170 and 180 m. Between the valleys of the Makongo and the Bundi , on the one hand, and the loop of the river, on the other, develops the plateau of Inga, the remains of an ancient plain which extended to height 320.

Figure I.3 Presentation of the Inga 1 dam

II. DISPLACEMENTS DUE TO HORMIC VARIATIONS

II.1. Coordinated geometric data.

F_1 =base area 460.5m^2

J_1 =moment of inertia of the base section 110.6.10$^3 m^4$

C_1 =distance from the center of gravity of the base section of the upstream arm b =width of the block 18.00 m

h =dam height 52.00 m

β_i= fruit of the inner facing = 0.55

β_e= fruit of the exterior facing = 0.40

a =calculation franc (150.00 – 153.70) = 4.30 m

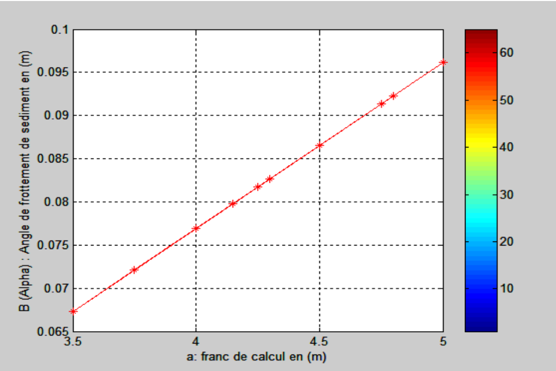
E_c= Concrete elastic modulus: 200,000kg/cm^2

ν =concrete fish coefficient : 0.15

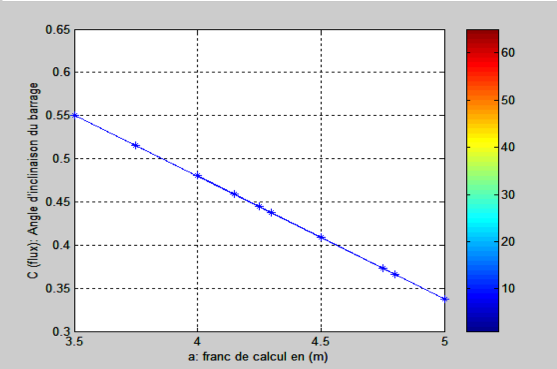
γ =weight and specificity of water 1000 kg/m ^{3}

$$\alpha = \frac{a}{h} \qquad (1.1)$$

II.2 Displacement results due to hormic variations



FigII.1: Alpha result according to calculation franc



FigII.2: Flow result according to calculation franc

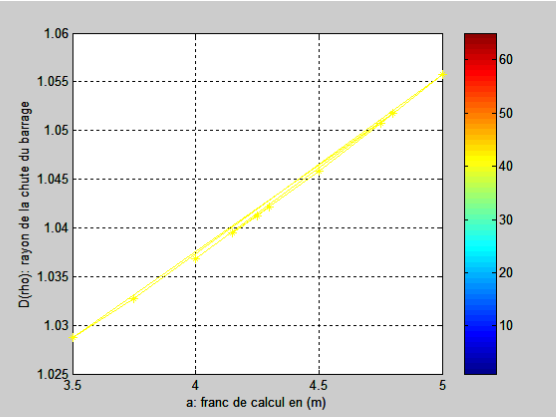
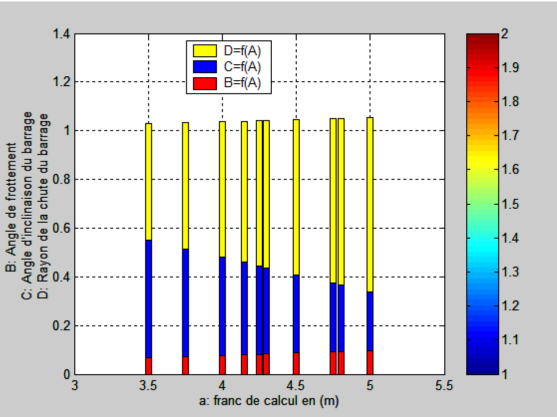


Fig.II.3: Rho result according to calculation franc



FigII.4: Three-dimensional result

III. DISPLACEMENTS BY ELASTIC DEFORMABILITY

III.1 Calculation of displacement parameters

III.1.1 Calculation of displacements

Displacement by elastic deformability of the masonry mass (hydrostatic level 153.70)

III.1.2 Displacement by bending moment fm

$$f_m = \frac{\alpha b h^4}{2\, E_c J_1}\left[\frac{\gamma}{6}(1+B_1)\phi - \frac{C_1 B_i}{2}\Omega\right] \quad (3.1)$$

III.1.3 Displacement by cutting force

$$f_C = x\,\frac{1+v}{E_C}\,b\,\frac{\gamma h^3}{2F_1}\Omega \quad (3.2)$$

For a lightened dam section we take $X = 1$ in our case:

III.1.4 Displacement by horizontal forces

The right pendulum installed in the body of the dam is not able to record this kind of displacement, which is why the theoretical determination has been left aside, in the absence of terms of comparison with the real values.

III.1.5Displacement derived from the development of heat setting and cooling of the different parts of the structure

The elevation of these thermal stresses is not left, given the absence of thermometer in the mass of masonry the only way to go consists in covering to analogies withstructures similar to the one under consideration and for which a large amount of data is available.By analogy with the sabbionis dam (Italy), a crest displacement per shrinkage of 5 mm was estimated.

$$F_R = 5\ mm$$

(effect equivalent to a cooling of 20 ° ÷ $25°C$)

III. 1.6 Total Displacement

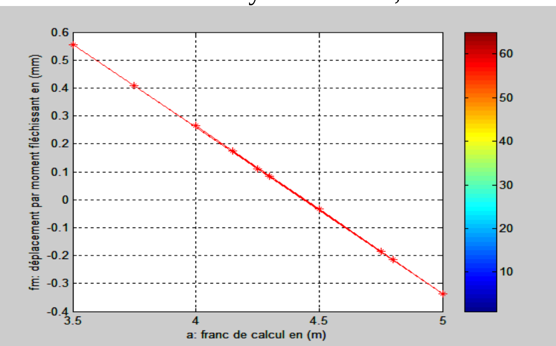
The total displacement of the mass of masonry in the elastic domain is therefore:

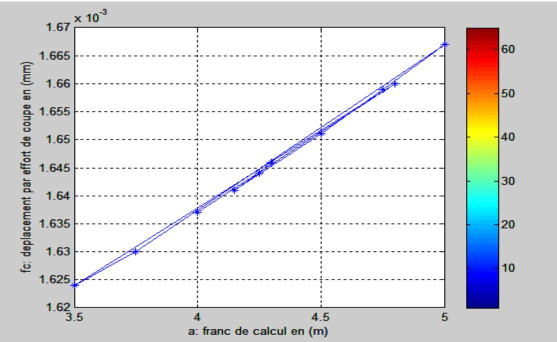
$$f = (fm + f_c + f_R) \qquad (3.3)$$

In the arc of the year, the average variations of reservoir have evolved to 2.1 m and the thermal variations to around 5°C between the months of February and July.

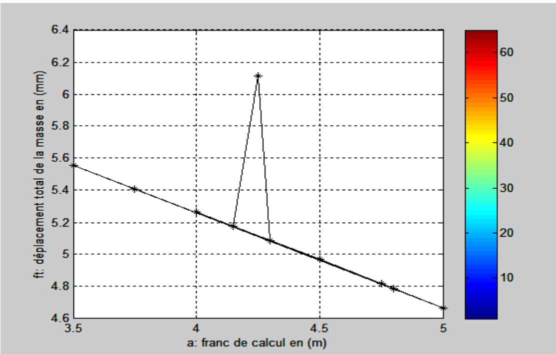
III.2 Travel Results

From the results of the analytical method, we can conclude as follows:





FigIII.1: Result of displacement per fluidizing moment Fig.III.2: Result of displacement by cutting force



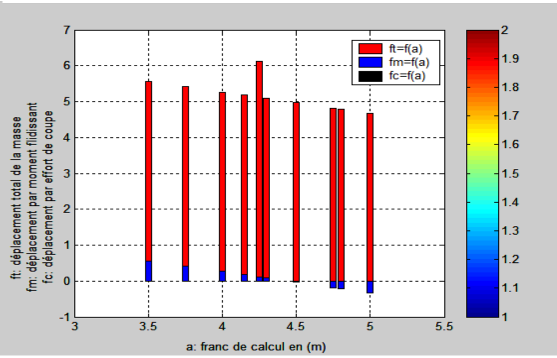


Fig.III.3: Result of total displacement of the mass Fig.III.4: Three-dimensional result

IV. RETAINED DISPLACEMENT

IV.1 Calculation of parameters

IV.1.1 Displacement minimum retained

The corresponding upstream-downstream displacement, due to the hydrostatic load, is:

On the side retained minimum 150.00 mN.GF .

$$f_{min} = (fm + f_2)$$

IV.1.2 Maximum retained displacement

A maximum restraint side 153.00mN.GF

$$f_{max} = (fm + f_2) \qquad (4.1)$$

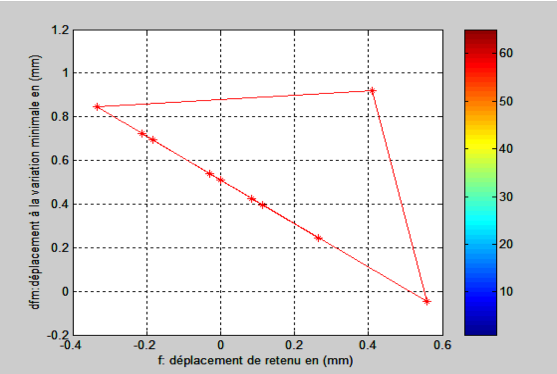
IV.1.3 Displacement due to thermal variation

The upstream-downstream displacement corresponds to the thermal variation is about 1 mm hence the 5°C, therefore ent :

$$\Delta f = 0{,}51 - f_{min} \quad (4.2)$$

$$\Delta f = 0{,}98 - f_{max} \quad (4.3)$$

IV.2 Results of the upstream-downstream displacement corresponds to the thermal variation



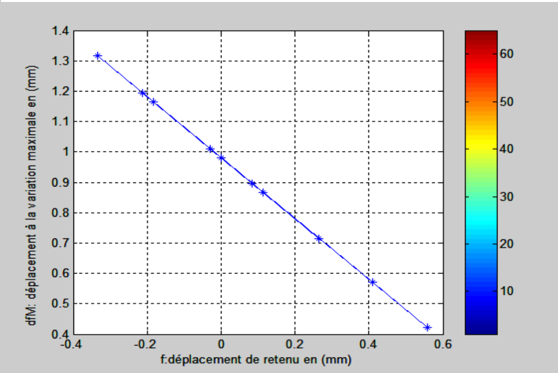


Fig.IV.1: Displacement corresponds to the minimum variation Fig.IV.2: Displacement corresponds to the maximum variation

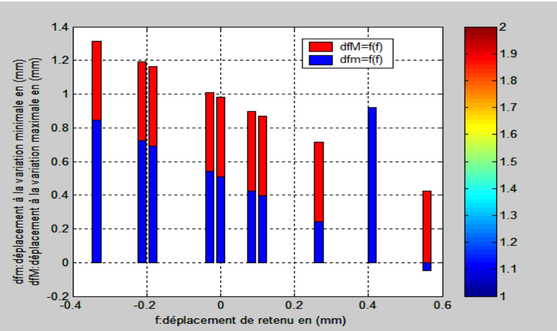


Fig.IV.3: Dimensional upstream-downstream displacement

V. CONCLUSION

In this article, we researched the displacement and the deformation of a dam, going through different stages on the actions that contribute to the displacements downstream of the dam due to the elastic deformability of masonry mass.We proceeded to the calculations of the displacement due to the elastic deformability of masonry under hydrostatic load and the displacement due to thermal variations. For a section of lightened dam with an exceptional low water period, we obtain almost the same on the diagnoses carried out, but we now have more precise results and information from this method.

The displacements are still small compared to its duration of use, that is to say that we have nothing to fear on displacements and subsidence, but on the contrary, we must take precautions by carrying out frequent monitoring or periodic auscultation before or after the rainy or hurricane season.

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