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Studies for Securing the Banks and Preserving the Flora along the Niger River in Bamako.

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ABSTRACT

This study focuses on securing the banks and preserving the flora along the Niger River in Bamako. Despite their splendid view of this international waterway, the engineered banks provide residents with a less than ideal cohabitation system. This study therefore focuses on a conceptual method proposing the most direct linear route possible before proceeding to dimensioning that links flow rate (considering the simultaneity of the devices), pressure, and velocity. As for the material used to transport water along the river, polyvinyl chloride pressure pipe (PVC P) was chosen because it is easy to install, has a low friction coefficient, and is impact-resistant.

This approach has yielded the following results: satisfaction of pressure requirements at various points where the river flows into the river, calibration to prevent scouring based on the flow rate and speed of runoff, and guidelines for workers.

The main objective of this research, which aims to integrate these sanitary plumbing rules into the Malian Standards Agency (AMANormes) using very specific methods, was requested by design offices and companies in Mali. These rules are based on standards NFP40-201 and NFP42-201, which we have adjusted and correlated to arrive at DN160/200, 200/250, 250/300, and 300/400.

Keywords : Niger River, scouring, drop points in the river.

I. INTRODUCTION

Water, a resource found in abundance on and beneath the earth's surface, is essential to all aspects of life. Discourse on this resource is therefore rich and varied [1]. This wide-ranging discourse, which highlights its indispensability in most human activities, calls on humankind to manage it appropriately [2]. To this end, various measures are being taken not only to ensure access to water, but above all to ensure that it is safe to drink.

The Earth, which is not coincidentally called the "blue planet" [3] and contains an estimated 1,420 km3 of water, or 75% of its volume [4], still has nearly 2 billion people without access to a source of drinking water. Since then, world leaders have recognized that it is incumbent upon everyone to preserve the hydrological, biological, and chemical functions of ecosystems by adapting our activities to the limits of nature's capacity and combating the vectors of diseases linked to this resource, stating that "drinking water is a right for all and not a luxury" [5].

In Mali, however, despite a significant number of exploitable water sources and the clear commitment of administrative and political authorities, problems with the supply of this precious commodity are far from being resolved. Among other things, there is a lack of supply at the national level (affecting around 32% of the population [6]) and dissatisfaction among residents of large buildings in Bamako, the capital. The World Health Organization (WHO), a leading health authority [7], states that 80% of diseases recorded on earth are water-related, i.e., closely linked to water [8].

Thus, along the Niger River in Bamako, the banks, which are lined with high-end buildings and large apartment blocks, are not immune to these concerns. Even on the banks of the river, adequate access to water is a challenge. As usual, with regard to domestic uses, namely consumption for drinking, food preparation, and sanitary and/or hygienic facilities [9], most of these problems stem from the instability and lack of hygiene in the area.

For our part, we first chose to study the system used to secure these riverbanks in order to identify the various concerns of the populations living there, then to propose solutions to them and subsequently ensure their long-term hydraulic safety. This is normal in this context, as water management weighs heavily on the international order [10], without conflict if everyone gets involved [11].

II METHODOLOGY

2.1 Study environment

Dividing the city of Bamako in two, the Niger River is the lifeblood of the capital. On both sides, the riverbanks are suffering from advanced degradation.

Figure 1 : *View of a riverbank in Bamako*

Although dotted with high-end buildings, the banks of Bamako remain undeveloped, suffering significant damage every year.

2.2 Equipment

The data collection material consists of a questionnaire for investigations with the National Directorate of Hydraulics (DNH), the National Directorate of Urban Planning and Housing (DNUH), the National Directorate of Technical and Vocational Education, the Malian Office of Engineering and Development (MIDEV), the Point G University Hospital, SACE-Sarl and EGIR BTP-Sarl companies, the Hôtels de l'Amitié and Cheranton hotels, the CFP-SK training center, and the National Library, an interview guide, and mechanical pressure gauge measuring devices.

2.3 Data collection

The reasoned choice method was adopted during this study. These interviews focused more specifically on the design of the drainage network along the river. In concrete terms, we collected information on the different types of routes, the conditions for transporting water to the river, and the difficulties associated with this. Following these interviews, the following information was made available (Table 1).

Table 1 : *Design of the drinking water supply network for high-end buildings based on their size or scope*

surveyed / Causes	DNUH	EGIR-BTP-Sarl	SACE-Sarl	CHU-PG	Hôtel amitié	Hôtel Cheranton
Limited professional capacity	Yes	Yes	Yes	Yes	No	No
Ignorance of enough Experts in the field	Yes	Yes	Yes	Yes	Yes	Yes
Lack of career plan for the few qualified workers	Yes	Yes	Yes	Yes	Yes	Yes
Lack of knowledge of impacts on user convenience	Yes	Yes	Yes	Yes	No	No

Following the analysis of our questionnaires sent to key players in the field, it appears that the various shortcomings identified throughout the process are largely due to the factors listed in the tables above.

It therefore appears that in Mali, riverbank development is not yet a priority.

Together, these factors give rise to a method for calculating the pressure at a water intake point, for which the following formula has been adopted:

$Pr=Pco-\Delta P-Ph-Pz$ (bar) (1)

With

- Pr at the most unfavorable point;
- Pco: pressure at the drop;
- ΔP: $1.25\times\sum RiLi$: sum of unit losses in the different sections of the flow;
- Ph: difference in level (h=3.40 m per level) between the most distant power point and the meter;
- $Pz = \sum Pzi$: sum of pressure losses in filter meter devices present in the pipe upstream of the point.

❖ "Dimensioning of banks" [14]: addresses the same issues as previous reports. It also emphasizes the importance of correctly dimensioning a facility in order to: ensure user comfort, Achieve savings on installation costs, save energy and prevent premature wear and tear on installation equipment.

It proposes sizing the pipes of a drinking water supply system based on flow rate (Q) and velocity, without placing too much emphasis on pressure at the various draw-off points, using the well-known relationship:

$Q=v\times s$ (2)

❖ **Software: Currently, several software programs dominate the world of building AEP. These include Edraw for plumbing diagrams, Autofluides, and, above all, Revit. Combined with Saniwin or Magicad, Revit provides not only plan views and vertical sections, but also pressure, velocity, and pressure loss data for pipes.**

2.1 Traitement et analyse des données :

Our data processing consisted of forming a system of equations with formulas for calculating overall pressure and flow until we obtained the desired results.

Dimensioning procedure:

The approach consisted of estimating the highly variable water needs of users [12], then opting for a separate distribution system, and finally applying a water network layout.

Table 4: Calculation of large pipes

Section	∑q (l/s)	K	Qp (l/s)	di (mm)	Vc (m/s)	Ꞷ (m/s)
OA	2,35	0,20	0,477	300	0,55	2,07
AB	2,35	0,20	0,477	300	0,55	2,07
BD	0,35	1	0,35	200	0,95	1,38
BE	2	0,20	0,40	250	0,68	1,71
EF	1,05	0,57	0,61	250	1,03	1,71
FG	0,75	0,7	0,60	250	1,02	1,71
GH	0,40	1	0,40	200	1,09	1,38

We therefore propose:

-PVC P DN20/25 for sections BD and GH, which are tertiary

-PVC P DN25/32 for sections BE, EF, and FG, which are secondary, and

-PVC P DN32/40 for sections OA and AB, which are of the same generation. These are therefore main sections.

These diameters should only be used when the pressure is sufficient at the most unfavorable point, in accordance with Table 3 relating to this verification.

Table 5: *Pipe inspection*

Contrôle					
Section	**L (m)**	**Di (mm)**	**Qp (l/s)**	**Ri (mbar/m)**	**1,25×RiLi (Mbar)**
OB	**67,15**	**32**	**0,447**	**13,57**	**1139,03**
BG	**5**	**25**	**0,61**	**7,2**	**45**
GH	**7,30**	**20**	**0,35**	**8**	**73**
HI	**3**	**15**	**0,20**	**46,2**	**173,25**
Total					**1430,28**

Pr=Pco - ∑Pzi -1,25∑RiLi -Ph (1)

Pr=1,05 bar

We conclude that the pressure at the most unfavorable point I, where there is even a shower I, is sufficient because **Pr=1,05 bar>Pmin=0,5 bar**.

Therefore, we will ultimately retain PVC P DN150/200, PVC P DN200/250, PVC P DN250/300, and PVC P DN300/400. Dimensions valid for offcuts.

These pipes, which must not pass through flue pipes, must first be subjected to a pressure test to check for water hammer or other anomalies.

Figure 3 below summarizes the proportion of pipe length according to diameter.

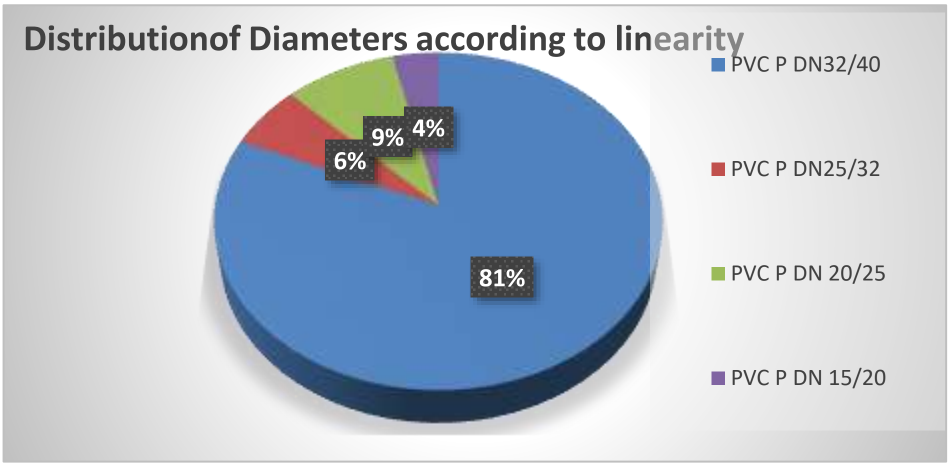

Figure 3 : *Distribution of diameters according to linearity*

III. RESULTS AND DISCUSSIONS

3.1 RESULTS :

The results given below are data calculated from the combination of the two (2) formulas, i.e., (1) and (2) applied to the AutoCAD and Revit plans of the experimental (or sample) building and compiled in Excel.

Upon analysis, we noted that:

- The choice of diameter is very important for the drinking water supply of a building;
- Pressure is always closely linked to flow rate; and
- Labor and thermal factors influence the pressure at the inlet when water flows through a large-scale building construction.

3.1.1 Choosing the diameter

The network sizing carried out in this way, which has resulted in (or given rise to) the choice of diameters above, clearly shows that each type and size of building structure corresponds to specific pipe dimensions. Directly derived from the total peak water demand of each user [12], the pipe diameters in a building remain the most important factor in achieving the expected pressure at the various tapping points. The pressure values collected after testing the building's pipes produced a value of 1.05 bar at the most disadvantaged point, located near the river.

3.1.2 Pressure closely linked to flow rate

Based on field observations (on 21 buildings) and calculations performed on the sample building, pressure and flow rate remain directly linked due to the simple fact that the cross-sectional area increases the flow rate (Q) during flow and, therefore, the larger the pipe, the greater the pressure. Conversely, the velocity drops. However, our approach, which sets a velocity margin to be respected for each diameter (D) depending on the type of pipe material, has good reason to include these three (3) fundamental flow parameters. Spreading its effects over the surface of a pipe (which is solid), the flow rate gives rise to pressure losses, which are an omnipresent phenomenon in the daily life of flow mechanics, the control of which is a major challenge [15]. This major challenge has no other effect than to influence the operating pressure at the various tapping points. This pressure production always obeys the various laws of pressure loss.

3.1.3 Labor and thermal factors influence the pressure at the point of entry:

A good drinking water supply system starts with good layout; then, correct installation (cutting, gluing, DIY, etc.) and proper positioning of components; all these factors have a direct effect on how easily the water flows.

In addition, it should be noted that easements along rivers often have expansion joints in order to withstand climatic parameters, mainly heat. The pipes anchored in these structures are inevitably subject to the temperature of the surrounding environment, which has an impact on viscosity and density, which in turn have a direct impact on pressure losses. However, the intrinsic flow behavior in a pipe following a thermal activation phenomenon is logarithmic, i.e., it is reflected in the flow force [16, 17, 18, 19, 20, 21]. This fact, which is a major finding in our work, can only be attributed to labor and other thermal factors.

3.2 DISCUSSIONS

The way in which large-scale buildings are supplied with drinking water is significant. Everyday observations, counter-calculations of the sizing and requirements during the validation files of the plans of our buildings remain parameters to be analyzed closely in the projects.

3.2.1 The choice of diameter

Through notes, we have just laid out a large way leading you to believe that the pipes of a building's pipeline must always be dimensioned.

This investigation concerned an old building in service with empirically dimensioned pipes within it. Despite these height increases, these parts which are increasingly tending towards abandonment have pipe diameters significantly smaller than ours.

This observation reflecting the need to calculate the diameters had been observed by [7] who, moreover, proposes for each material and each type of pipe a very detailed calculation note showing the dimensions.

3.2.2 Pressure closely linked to flow

It is entirely clear that the flow rate allowing the diameters of the pipes to be defined is the main factor determining the pressure. During our field tests, we noticed that not only to make all the devices work better and to properly calibrate the different installations in their movements, there must be a direct correlation between the flow rate and the pressure and even the speed. Moreover, according to [22, 23, 24, 25, 26, 27, 28], the adjustment of these parameters always induces in practice an unreasonably large number of scales along the flow even permanently invalidating the hydrodynamics. Consequently, this analysis fully confirms that sufficient detailed calculation notes must be issued during the concrete design of building distribution networks.

3.2.3 Labor and thermal factors have an influence on the inlet pressure :

Abandoned to the mercy of workers who are often not sufficiently qualified, labor is a big part of the problems identified in our constructions. Combined with climatic factors, the accumulation of their effects is very considerable. Among other things, we associate the loosening of the joints, the water hammers... We quite simply ended up sharing the point of [29] which attributes the resulting to the volume viscosity expressing the resistance of the particles to undergo expansion or compression, the measurement of which is still little known to this day and is the subject of numerous studies.

IV. CONCLUSION

The objective of the present study was to study the security of the banks and preservation of flora along the Niger River in Bamako. During our efforts, we were able, in the company of the few Design Offices and Companies in the field with which we worked, to arrive at a certain number of resolutions on this subject currently making up the bulk of the debates in Mali. Among other things, we mainly note that to overcome these problems in Bamako, it is now necessary to dimension each building according to its size (and/or scale), calibrate in direct connection the three (3) parameters of the flow; namely, flow, pressure and speed in addition to a qualified and increasingly efficient workforce.

After receipt of the security work, the methods thus deployed have truly contributed to the resolution of this problem from which local residents suffer in Bamako

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