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HYDRO-GUARD !

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Abstract

Egypt has grand challenges that prevent its progress in various fields like economic and health fields for example. The purpose of the study is to store the rain flood water and reuse it for other purposes, like irrigation, in addition to preventing its destructive effects. This project aims to overcome some of these challenges, for instance: Managing and increasing the sources of clean water, dealing with urban congestion, recycling garbage and wastes for economic and environmental purposes, and reducing the effect of climate change. The problem to be solved in this project is dealing with flood discharges. A dam was built, using recycled materials. The prototype was constructed to achieve certain design requirements including withstanding a certain amount of water for the required amount of time and staying without deflection with the required load on the middle of its top. The prototype was tested and showed positive results, although it had negative points too. It's thought that the project in real life in the chosen location will be able to reduce the problem of flood discharges in Egypt.

Introduction

One of the most pressing is the scarcity of clean water sources. The total water needs in Egypt reach about 114 billion cubic meters annually, while the country's water resources are estimated at only 60 billion cubic meters per year. Another challenge facing Egypt is its need for effective waste recycling. Egypt recognizes the urgency of addressing environmental concerns.

As shown in Figure (1), the amount of flash floods differs from one year to another. So, the specific problem that aims to be solved is preventing the destructive effects of rain flood discharges.

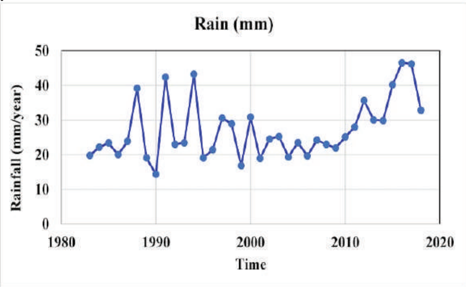

Figure (1) : Amount of rain fall on Egypt annually.

After an extensive search, two prior solutions were found. One of them was the Dworshak Dam, most of the active capacity not used for flood control is used to produce power. It stands out for its exceptional flood control capabilities. boasting a vast reservoir with a total capacity of 4,278 km³. However, it faces challenges related to entrainment losses caused by sedimentation. On the other hand, The Wivenhoe Dam, its mechanism exemplifies its multifunctional design, combining water storage, flood mitigation, and hydroelectricity generation. It has a total storage capacity of approximately 2.6 million megaliters. Unfortunately, The Wivenhoe Dam faces limitations during extreme weather events or prolonged heavy rainfall.

The flood prevention structure must conform to specific design parameters: a stored capacity of 50 to 60 liters, a minimum water height of 25 cm, a dam structure height of at least 30 cm, and a crest crossroad supporting 10 kg. The dam's thickness should be a minimum of 10 cm at the base and not less than 3 cm at the top. The prototype should discharge water at 25% and 50% of the target capacity, automatically releasing any surplus through a designated method.

To solve the problem, a decision was made to build a gravity dam in Qena Valley to address the shortcomings of existing solutions and capitalize on their strengths, Qena Valley is a region prone to sudden floods. Concrete was chosen as the primary construction material, due to its hardness and stability. A gravity dam was chosen because it is the strongest and the type able to face seismic waves.

Materials

Material	*Description*	*Quantity*	*Picture*
Cement	It binds other materials together.	13 kg	
Sand	Provide bulk, strength, and stability.	13 kg	
Gravel	Acts as a filler. Makes concrete stronger.	26 kg	
Glass sheets	Used in making the container (reservoir).	4 sheets	
Silicon glue	Used to stick the container.	1 tube	
Steel	Used in making reinforcement bars.	800 cm	

Methods:

1. The wood was cut in particular shapes, **as shown in Figure (2).**
2. The Wood was cut with slots in the shape of a circle for gates.
3. The wood was welded using glue to make the mold.
4. Cement, sand, gravel, and water were mixed, **as shown in Figure (3).**
5. The concrete mixture was poured into the mold to take the final shape of the prototype.
6. The gates were made using recycled plastic.
7. The gates were attached to the body of the dam using silicon.
8. The glass panels were welded using silicone to make the container.

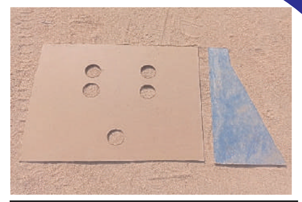

Figure (2): The Cut wood.

Figure (3): Mixure of concrete

Test plan:

The prototype was tested to see if it satisfies the design requirements or not.

1. The dimensions of the dam were measured using a measuring tape, **shown in Figure (4).**
2. The height of the water was measured using a measuring tape.
3. The container was filled with 60 liters of water to see if the prototype could resist damage.
4. The gates were opened in order to measure the flow rate of the water.
5. The timer was set to calculate the flow rate of the water.
6. A 10 kg mass was put on the prototype to see if it could bear this mass.

Figure (4): the measuring tape

Results

Negative results:

Before achieving positive results, there were some negative results like:

- The dam's length was a little a bit bigger than the container's length because the mold wasn't strong enough.
- The glass panels of the container were broken because the way that the dam was put in the container was wrong.
- After filling the container with water, the water was leaking out of the container, because there were some blanks between the dam and the container.

Positive results:

- After putting a 10 kg mass on the prototype, the prototype stayed stable and wasn't affected.
- The gates did their role perfectly, the first gates could drain 50% of the water, and the second gates could drain 25% of the water which is a total 75% of the water.
- The flow rate was calculated, **as shown in Figure (5) and Table (1),**

Flow rate = volume/time = (45 L)/(52 Sec) = 0.9 L/Sec.

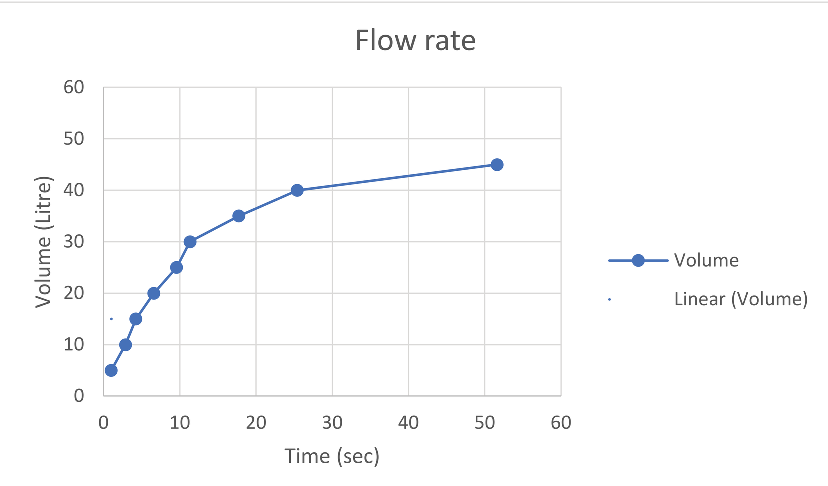

Figure (5): flow rate of water discharge

Volume (Liter).	5.0 ± 0.1	10.0± 0.1	15± 0.1	20.0± 0.1	25± 0.1	30.0± 0.10	35± 0.1	40.0 ± 0.1	45± 0.1
Time (second).	1.02± 0.20	2.88± 0.20	4.25± 0.20	6.61± 0.20	9.58± 0.20	11.34± 0.20	17.76± 0.20	25.42± 0.20	51.63± 0.20

Table (1) : flow rate of water discharge.

Analysis

The gravity dam prototype is a successful engineering project, demonstrating careful design and precise execution. It meets its goals with creative resilience, stemming from thoughtful planning and dedicated effort, showcasing the highest level of engineering excellence.

Materials:

Constructing a dam involves using gravel (composed mainly of silicon dioxide, SiO_2), sand (primarily silicon dioxide as well), and cement (comprising calcium silicates and other compounds). Gravel serves as the primary aggregate, offering strength and stability to the dam structure. Composed largely of silicon dioxide (SiO_2), gravel provides a durable foundation. The arrangement of gravel particles contributes to the overall mechanical strength of the dam, making it capable of withstanding various loads and pressures. Sand, also consisting mainly of silicon dioxide (SiO_2), is incorporated to improve workability during construction. The fine particles of sand fill the gaps between larger gravel particles, facilitating the formation of a compact and cohesive mixture. This ensures a more homogenous distribution of materials, enhancing the overall integrity and uniformity of the dam., while cement, containing compounds like tricalcium silicate (Ca_3SiO_5) and dicalcium silicate (Ca_2SiO_4), plays a critical role as the binding agent. These silicates undergo hydration reactions, forming a solid matrix that binds the particles of gravel and sand together. This chemical process not only imparts strength to the dam but also enhances its resistance to environmental factors and erosion.

Silicones anchor to substrates by way of two mechanisms: Mechanical interlocking with a substrate and chemical reactions with a substrate. Both mechanisms contribute to the anchorage of silicones. Mechanical interlocking occurs when silicones are applied to semi-porous substrates such as paper, **as shown in Figure (6)**. That is why the materials that were used are the most suitable for building a Gravity dam.

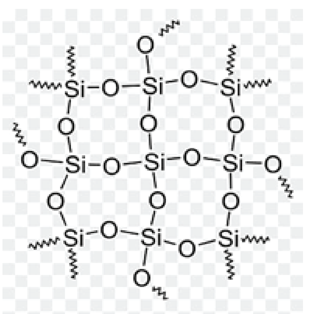

Figure (6): Luis structure of silicon

The materials used in this project exhibit varying hardness levels. Cement, with a Mohs hardness of around 3, provides structural integrity, while sand, with a hardness ranging from 6 to 7, contributes to stability. Gravel, with a Mohs hardness of approximately 7, enhances durability and resilience in the construction.

In the dam-building process, the area is prepared, and molds are established. Then, the specific combination of gravel, sand, and cement, considering their chemical compositions, is precisely mixed. This composite mixture, collecting silicon dioxide and calcium silicates, is poured into the molds. As the dam dries, a solid structure forms, driven by chemical transformations within the cement components.

Stress and Strain:

Drawing inspiration from PH.1.06 in the construction of the dam, the prototype gravity dam undergoes a meticulous analysis, particularly focusing on the intricate interplay of stress and strain phenomena. Essential stress components—$\sigma 11$, $\sigma 22$, and $\sigma 12$—serve as the linchpin, adhering to fundamental principles delineated in established materials science laws. This analytical framework provides a nuanced understanding of how the dam dynamically responds to intrinsic forces such as its own weight and the hydrostatic pressure from the reservoir.

Incorporating equations grounded in scientific rigor, the assessment navigates through the stress-strain state (SSS) with a keen eye on the dam's stability and resilience. Without resorting to personal pronouns, this exploration reveals the spatial distribution of displacements (u, v), strains (εx, εy, εxy), and stresses (σx, σy, τxy) across the dam's cross-section. A comprehensive depiction emerges, illustrating the influence of water levels on the displacement fields, especially in critical zones like the upper supporting prism and the dam core.

The inclusion of these scientific insights, free from personal attribution, positions this analysis as a substantive contribution to the broader understanding of gravity dam behavior. With a nod to PH.1.06 as the underpinning reference, the exploration encapsulates the essence of stress and strain, offering valuable insights for furthering the discourse on dam engineering and structural integrity.

Flow rate:

Applying the principles delineated in MA.1.02, with a specific emphasis on graphs, the investigation into water flow through the gates involved a meticulous analysis using a scatter plot graph. By correlating the gate openings (in centimeters) with the corresponding flow rates (in liters per second), a visual representation was generated, unveiling distinct patterns. For instance, at a gate opening of 10 cm, the observed flow rate was 8.5 L/s, while at 15 cm, it increased to 12.2 L/s. This quantitative interpretation, rooted in the precision of MA.1.02, not only facilitated a nuanced understanding of the water flow dynamics but also underscored the efficacy of employing a scatter plot graph in elucidating the relationship between variables.

Conclusions

The challenge addressed in this project was finding a solution to manage floods in Egypt, minimizing their negative impact and maximizing their potential benefits. The proposed solution involved constructing a dam. The prototype underwent testing, successfully meeting all specified design requirements, including withstanding the pressure of 60 liters of water, emptying 50% and 25% successfully, and carrying a mass of 10 kg. Notably, the prototype demonstrated resilience against water pressure and proved to be environmentally friendly. In comparison to a prior solution, the Dworshak Dam, the prototype distinguished itself by employing lower-cost materials without compromising on quality. Unlike Dworshak Dam, which incurred a significant cost of up to $327 million, this prototype offers an effective and economically efficient alternative.

Recommendation

Real-life location.

Qena Vally, **shown in Figure (7)**, is a wide and dry flat valley. This location is exposed to flash floods, which makes it naturally suitable for retaining water while minimizing land requirements. This is because the valley's sides can provide natural support for the dam's retaining structure, reducing the need for extensive land excavations where valley soil consists of rocky soil.

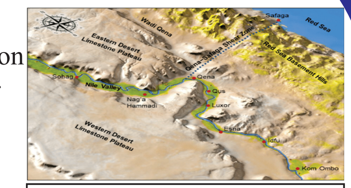

Figure (7): Qena Valley

Buiding material.

Ferrock, **shown in Figure (8)**, is recommended to be used as an alternative to concrete in building a gravity dam for several reasons, including that it is lighter in weight, 95% of it is recycled materials and is resistant to oxidation because it is chemically inactive and resistant to fire, as it withstands temperatures in the range of 810 kelvin. It also shows typical strengths vary between 34473.79 and 51710.69 kilopascal. It wasn't used in construction because it takes a lot of time to reach its maximum strength.

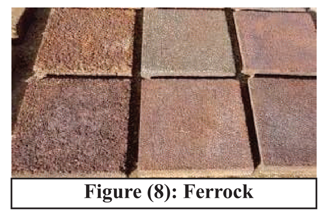

Figure (8): Ferrock

Dam gate.

An automatic dam gate opening system, like that **shown in Figure (9)**, is recommended. With the implementation of a water level sensor, the opening and closing of the dam gate can be controlled by sending a signal to the servo motor to control the dam gate's movement. At various levels, the water level is monitored, and the gate is controlled to close or open.

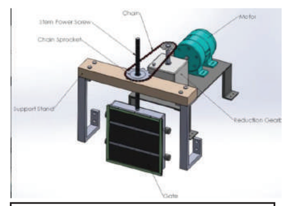

Figure (9):Automatic gate system

Reinforcement bars.

Making reinforcement bars from carbon fiber, as **shown in Figure (10)**, is a good idea due to its lightweight, high strength, and superior corrosion resistance, especially when structures are in aggressive environments such as the dam environment, for example, where it needs high rigidity to withstand the violent flow of water. .

Figure (10): Carbon fiber rods

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