ECO-DAM

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ABSTRACT

Egypt faces water scarcity due to climate change, population growth, and inefficient water management practices. With an arid climate, the Nile River relies heavily on it, but demand exceeds supply. Population growth is expected to reach 150 million by 2050, straining water resources. Outdated agricultural practices and climate change exacerbate the issue. To address this, we followed the EDP steps to make our dam which is going to help in solving these problems. The dam must be 30 cm long, 3 cm thick at the bottom, and 10 cm thick at the top, with a water capacity of 50-60 litters, and 30 cm high. Reinforcing bars must be 3mm in diameter and 10 cm long. We built our Mold out of wood to cast in concrete The prototype's initial construction faced issues due to incorrect concrete proportions, causing the concrete to stick and preventing the dam from being removed, resulting in potential collapse. In the next attempt, concrete components were adjusted for cohesion and durability. However, there were some negative results including incorrect gate placement, a small water container, and weak gates made of thin plastic, preventing water flow. A third experiment was conducted after improving all the points we mentioned last time. After three experiments, our prototype was successfully made, and the polycarbonate gate successfully disbursed 25% and 50% of water. so, it was concluded that we should mix the cement with the gravel and the sand by a specific proportion.

INTRODUCTION

Egypt faced many challenges that must be solved to become the best country such as: climate change. With temperatures rising ,the weather becoming more severe, and natural resources dwindling. Climate change poses a serious threat to our world. (National Geographic, 2023) Recycling is a key component in the fight against climate change because it reduces waste and conserves resources. We can reduce pollution, reduce greenhouse gas emissions, and reduce demand for raw materials by recycling materials such as glass, paper, and plastic. Reducing urban congestion is just as important as recycling .(Network, E. D, 2023)

Traffic congestion is a common problem in urban areas, which increases air pollution and carbon emissions. Congestion can be eased and carbon footprints reduced by implementing sustainable transport strategies including encouraging public transport, carpooling and cycling .(Koźlak, 2018)

Water waste can be significantly reduced by taking easy steps such as replacing fresh water-saving appliances, adjusting leaky faucets, and planting hydroponic gardens. By linking these problems, building a dam could be a useful remedy. In addition to producing hydroelectric power, dams also reduce flood risks and store water for future use. We can use dams to generate renewable energy, reduce our dependence on fossil fuels, and ensure a steady supply of water for cities, businesses, and agriculture. (UNICEF, 2021)

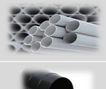
grand coulee dam from the prior solutions selected to address our challenge. These dams were made from fully artificial materials that are not eco-friendly and pollute the environment. On the other hand, Hasidim's construction has indeed become instrumental in industrialization, and they were used in storing large amounts of water that reached to 170billion m^3 helping in agriculture and reclamation purposes. (National Parks Service., 2017)

So, our project was made by taking the advantages and pros of these prior solutions and approaching some developments that made our project meet the design criteria. the project was to build a dam with one artificial material and another recycled Therefore, our dam was built from Shredded plastic(CH_2-CHX), made of (cement with sand with grains), reinforcing bars, and insulating bitumen ($C_{50}H_{48}O_4$)

We achieved the design requirements that our prototype carried 10 kg without any bending and deflection furthermore, our dam also got the required flow rate of water which was up to a total of 55 liters in three minutes that achieved our design requirements.

MATERIALS & METHODS

Table.1 Materials used

Materials	Amount Used	Cost	Source	Usage	Illustration
Cement	20 kg	60 L. E	building materials shop	Used in building prototype	
Polycarbonate sheets	2 sheets (cm/sheet)	80 L. E	‘’Recycled” Plastic factory	Used in building prototype	
Reinforcing bars	5 Kg	200 L. E	‘’Recycled” Black smith's	Used in building prototype	
Polyvinyl chloride	1 m	70 L. E	plumbing tools shop	Used in building prototype	
Bitumen	4 kg	60 L. E	Paints shop	Used in building prototype	
TOTAL COST				470L. E	

METHODS

The materials listed in table (1) were utilized to construct the prototype, which is a Gravity Dam depending mainly on a composite of cement with reinforcing bars in its body.

The first phase involved arranging all of the safety procedures, such as donning lab coats and gloves to prevent injury or textile damage, as well as wearing face masks to prevent the inhalation of any dangerous chemicals.

: The prototype consists of a group of components

- **Constructing template**
- **Reinforcing bars**
- **The composite (matrix)**

1. Mold (constructing template)

The mold (Construction template) will be an iron mold modeled in the shape Chosen for the Dam in the form of a rectangular shape and a triangle forward. There will be two gates made of polycarbonate sheets ($C_{15}H_{16}O_2$) at a greater height than the other so that we can release 50% of the stored water using the highest gate, and 25% of the stored water using the lowest gate. Dimensions are (35 cm in length, 50 cm in width, and 40 cm in height).

Figure (1): **the mold**

2. Reinforcing bars

A network of reinforcing was made with the same dimensions as the mold, but it will be smaller than the mold by 1.5 cm in height and width. Each reinforcing bar piece should equal 3mm in diameter and 5cm in length, so the reinforcing parts were forged together to form a reinforcing skeleton for the body of the dam. The reinforcing skeleton will be installed in the mold before adding the matrix.

Figure (2): **Reinforcing bars**

3. The composite (matrix)

The last component is the matrix, this matrix consists of Cement, with sand and gravel to give it the strength that withstand the water's thrust. We will use bitumen (a derivative of petroleum derivatives); to coat the walls of the dam to prevent water leakage. We have chosen bitumen over any other material because it is considered one of the best water-resistant insulating materials, in addition It does not interact with the properties of water, so it does not change the taste or smell of the water.

RESULTS

First attempt

In the first attempt to build our prototype, we fell into some negative points and mistakes, we incorrectly calculated the proportions of the concrete components increased the proportions of sand, and reduced the proportions of cement, which led to the disintegration of the concrete after it was poured and incoherence of the dam. What increased this problem was that we did not paint the wooden Mold with an insulating material so that the concrete stuck to the Mold walls, and as a result, we were unable to remove the dam from the Mold. Ideally, part of the prototype collapsed.

Second attempt

In the second attempt, we approved some points, and these were the results:

➢ ***Positive results:***

1. We have corrected the proportions of the components of the concrete, and this led to the cohesion of its parts, its solidity, and its endurance.
2. we can fully separate the prototype from its mold because we have painted the mold walls with insulating material.

➢ ***Negative results:***

1. We have built gates in the wrong places in the dam that did not allow 25% and 50% of water to come out.
2. The water container was too small, as it did not accommodate the required volume of water, estimated at 90 liters.
3. the gates were too weak to withstand the pressure of the water as it was made of thin plastic.

Third attempt

➢ ***Positive results:***

1. we used a gate made from polycarbonate that can resist water pressure.
2. the gates dispersed 25% and 50% of water successfully.
3. we make a new container that accommodates the specified amount of water.

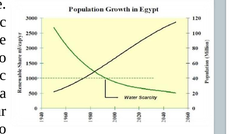
Table(2): **water flow rate table**

Time (sec)	Volume (m^3)
4	0.01
6	0.015
9	0.02
14	0.025
19	0.03
25	0.035
32	0.04
40	0.045
48	0.05
60	0.055

ANALYSIS

Egypt faces a lot of grand challenges: Manage and increase the sources of clean water , Deal with urban congestion, Recycling garbage and wastes for economic and environmental purposes. Reduce the effect of climate change. Each one of these grand challenges forms a large risk. Seven billion cubic meters of water are lost in Egypt each year, and by 2025, 1.8 billion people will be living in complete water scarcity globally. Our research helped us to select the places that have heavy precipitation and Egypt has topographic nature helped it to build many dams in different places (ES.1.01). building a dam helps Egypt to store much clean water and it can produce electricity. Our dam construction included using recyclable materials that are eco-friendly to save the environment.

Figure (3): **Water scarcity level in Egypt index**



The type of dam is a gravity type which has a structure designed to withstand loads by its weight and by its resistance to sliding and over-turning on the foundation which seems to be one of the best choices to store water. It has many advantages it can be constructed to the greatest practical height provided they are placed on a solid base; it doesn't break all at once. It is possible to foresee their collapse well in advance, preventing loss of life and property, It has the lowest maintenance costs and the highest benefit-to-cost ratio, and It is particularly beneficial in areas with a lot of precipitation and snowfall

This type will be well used in making the solution which is to make a Mold (constructing template) made of wood with dimensions (35 cm in length, 50 cm in width, and 40 cm in height) it measured by vernier calliper (PH.1.01) A network of reinforcing bars was smaller than the Mold by 1.5 cm in each dimension. Each reinforcing bar piece should be 3 mm in diameter and 10 cm in length, so the reinforcing parts were forged together to form a reinforcing skeleton for the body of the dam. The reinforcing skeleton will be installed to the Mold before adding the concrete and pipes.

To calculate the volume of the dam by the following equation (MA.1.05)

volume of cuboid = 48 *50 *5.5 = 13200 cm^3.

The volume of scalene triangular prism = 0.5 * base* length* height = 0.5* 48* 32*26 = 19968 cm^3.

So, the volume of the dam = 19968 + 13200 = 33168 cm^3.

cement, sand, and gravel were used to make the concrete that was used to build the dam (ES.1.03), we used polycarbonate sheet to make the gate we chose it as it is considered a very strong recycled material, we used PVC pipes, we used reinforcing bars pieces to make a reinforcing skeleton to coherence the concrete with each other, and we used a bitumen as it considered a hydrophobic material that insulates the concrete of the dam and water we use a pully to open the gate of the dam (BI.1.03)

In the first attempt, sand and cement were used, both were used to make the concrete needed to build the dam, but the prototype broke down. the proportions of cement and sand were wrong which led to incoherence of the concrete and the disintegration of the dam, What increased this problem was that the wooden Mold wasn’t painted with an insulating material therefore, the concrete stuck to the Mold walls, as a result, the Mold couldn’t be removed Ideally, part of the prototype collapsed, some modifications were made to overcome the negative results of the first trial.

In the second attempt corrected proportions of cement and sand and car oil were used, and new proportions of cement and sand were used to make concrete, and this led to the adhesion of its parts, its solidity, and its endurance. The car oil was painted on the walls of the wooden Mold and this was a perfect choice. After that, the dam came out from the Mold without any collapsing in the dam parts. Another negative result occurred when the container was too small and the gates were too weak as it was made of plastic, the gates were in the wrong places in the dam that did not allow 25% and 50% of water to come out.

In the third attempt, we made some modifications to overcome the negative results that we faced in the second attempt, in the third attempt, a gate made from polycarbonate was used that could resist the water pressure, and the gates disbursed 25% and 50% of water successfully after, the position of gates was changed. A new container was made that accommodates the specified amount of water.

the flow rate of water was calculated by observing the amount of water that passes through the two gates per second. The first four seconds the water passed was 10 litres and then at 6 seconds it became 13.5 Liters and here the first gate was successfully drained, and the second gate also was drained. After 32 seconds, 40.5 litres were drained successfully so,

the flow rate in the first gate = $\frac{13.5\ liters}{5\ second}$ = 2.7 L / sec.(0.0027 m^3 / sec)

and in the second gate = $\frac{40.5\ liters}{32\ second}$ = 1.27 L / sec (0.0013 m^3 / sec) at the end all of the water (55 L) in 60 sec. (Serway & Vuille, 2017) after that this is an accumulative frequency curve graph represent the flow rate.(MA.1.01)

Figure (4): **water flow rate graph**

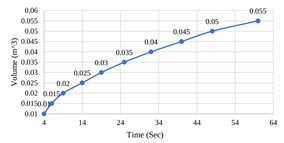
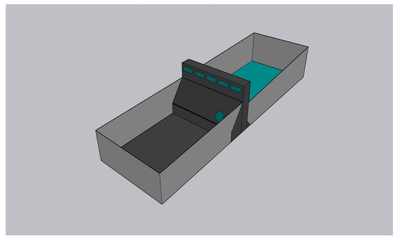


Figure (5): **3D design for the dam**



CONCLUSION

Throughout the project, numerous trials and attempts were made, and after the prototype was completed and tested, certain conclusions were drawn using the chosen materials. An environmentally friendly dam made of renewable materials was successfully built. another conclusion is that the load should be put on the centre of mass of the dam one by one to enhance the precision and accuracy in results. We also found that the area of the pipe is inversely proportional with the velocity of water, so a proportionality between the velocity and area should be made to get the greater volume of water that can pass through the pipe in a small time. We have discovered also that when we change the proportions of the materials that make up concrete inaccurately, the concrete is ruined. So, when mixing concrete, we should be careful to ensure that it is prepared appropriately. Another conclusion is that Bitumen is a good hydrophobic material so it will not let the water pass through it.

RECOMMENDATION

- Make sure the dam's design includes an effective system for draining extra water. The safety of the dam and the areas around it must be guaranteed by this system, which must be able to withstand possible flooding.
- Place smart monitoring devices on the dam to help keep track of the water level, manage the flow, and defend against floods.
- Establishing a system of traffic on the route to make a balance in the traffic.
- Waterproofing cement can be used better than painting the dam with waterproofing materials “We didn’t use it because of the budget.”

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