Water Scarcity and the Construction Industry: Implementation of Alternative Sources of Drinking Water for Civil Works

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***Abstract*— This article focuses on the importance of using potable water, a limited and essential resource, in the production of concrete in the construction industry. It is also highlighted that the use of non-potable water in the production of concrete is inefficient. Additionally, it explores various innovative solutions to obtain drinking water that does not depend on conventional water sources. These solutions include desalination, transforming wastewater into drinking water, rainwater harvesting, and modifying concrete mixes to make them less sensitive to the type of water used. It is expected that this work can generate a significant impact on readers and encourage the adoption and promotion or alternative ways of generating safe water for civil works.**

***Keywords:* water scarcity - concrete - drinking water – alternative potable water generation methods**

***Resumen*— Este artículo se enfoca en la importancia del uso del agua potable, un recurso limitado y esencial, en la producción de hormigón en la industria de la construcción. Se destaca también que el uso de agua no potable en la producción de hormigón es ineficiente. Además, explora diversas soluciones innovadoras para obtener agua potable que no depende de las fuentes de agua convencionales. Estas soluciones incluyen la desalinización, la transformación de aguas residuales en agua potable, la recolección de agua de lluvia y la modificación de las mezclas de hormigón para que sean menos sensibles al tipo de agua utilizada. Se espera que este trabajo pueda generar un impacto significativo en los lectores e incentivar la adopción y promoción de formas alternativas de generación de agua segura para obras civiles.**

***Palabras clave*: escasez de agua – hormigón - agua potable - métodos alternativos de generación de agua potable**

I. INTRODUCTION

Water is one of the most abundant elements on planet Earth and it is an essential element for life. However, it is a fact that it is a limited resource and not universally available.

The demand for drinking water is continuously increasing all over the world, as it is used not only for personal or household consumption, but it is also used in many other areas such as agriculture, industry in general or the construction industry, in particular.

The use of water in civil constructions, specifically in the context of concrete production, is a topic that needs further research. Concrete must meet specific standards to ensure the necessary properties for its durability, including the requirement that the water used must be potable or drinking water. By using potable water in the production of concrete, an inefficient use of this limited resource is made, which should be used for life-related activities. In this sense, it is essential to look for new alternative methods to obtain clean water to produce concrete.

By demanding that water be used efficiently, this project is in tune with the Sustainable Development Goals (SDGs) from the United Nations 2030 Agenda. SDG number 6, “Clean Water and Sanitation”, aims to guarantee the availability of water and its sustainable management for all. In addition, one of its targets, specifically 6.4, proposes that by 2030, the efficiency of water use in all sectors should substantially increase, sustainable extractions and supplies of freshwater should be guaranteed to address water scarcity and the amount of people suffering from water scarcity should substantially decrease [1, p. 28-29].

It is essential to explore new alternatives to obtain drinking water that do not depend solely on the available water resources, take advantage of other sources, such as rainwater. Given the need to study and deepen this topic, this article will present ways to generate clean water that can be used in civil works, without making use of the drinking water from the municipal grid.

To achieve this objective, this work is organized as follows. First, the amount of drinking water available in the world and the way in which its use is distributed, be it for personal consumption, in industries or in civil constructions will be presented; where we will seek to present the need for drinking water in concrete, comparing this use to other types of water. After this, the proposed methods of obtaining drinking water will be presented. Finally, the major benefits and possible weaknesses of the proposals will be highlighted. It is expected that this work can generate a significant impact on readers and encourage the adoption and promotion or alternative ways of generating safe water for civil works.

II. WATER FOR HUMAN CONSUMPTION VS. WATER USE IN CONCRETE

Water is one of the most vital resources for sustaining life on our planet, but only 3% of water on the surface is fresh; the remaining 97% resides in the ocean. Of freshwater, less than 1% is within our reach [2].

Moreover, as shown in [3, Fig. 1], the distribution of fresh water is largely determined by industries and irrigation. On the other hand, it can also be observed that 783 million people do not have access to drinking water.

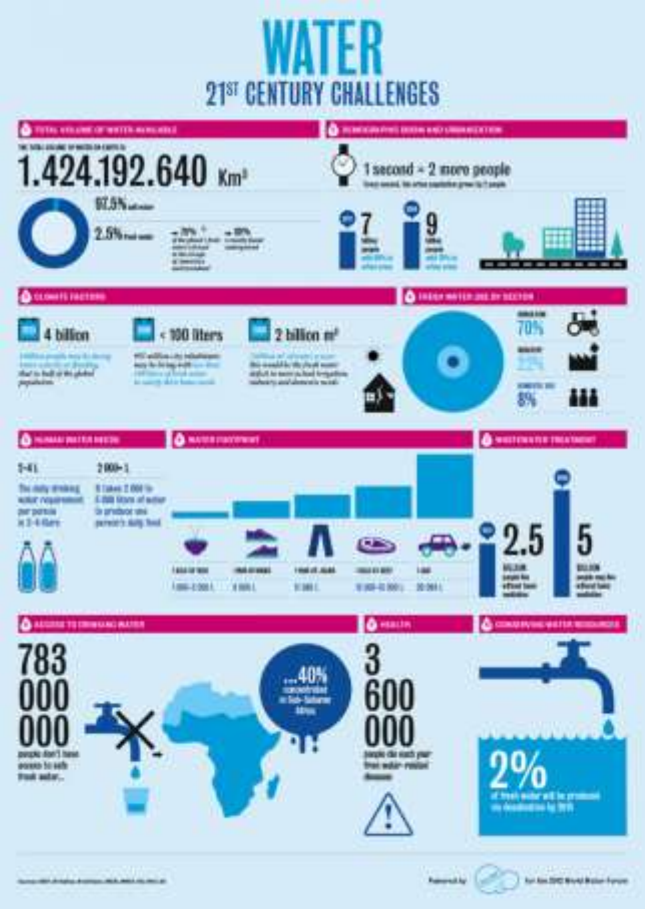

Fig. 1. Water 21st Century Challenges [3]

The importance of this lies in the representation of water as a finite and unequally distributed good, which requires maximum conservation. Therefore, it is vitally important to explore alternatives to obtain drinking water that do not involve using what is easily available to people in the mains, but rather implementing alternatives that are generally not taken into account.

The construction industry makes use of water for a variety of functions in building sites. They use this resource for concrete dosing, grouting, dust suppression, soaking tests, pond filling, hydraulic demolition, and drilling and piling. Needless to say, water is also used for human consumption. If companies mismanage this water use, they can increase their environmental impact.

In addition to the mentioned uses, the construction industry also relies on water for various essential processes, including mixing mortar, curing concrete, and cleaning equipment. The responsible management of water resources within construction sites is imperative, not only to reduce environmental impacts but also to ensure sustainability and compliance with regulatory standards.

The inadequate management of water usage by construction companies not only contributes to water scarcity and pollution but also incurs potential legal and reputational risks.

The possibility of partially or completely replacing drinking water with another type of water is often raised. However, it is vitally important to note that this approach can have unfavourable consequences for the strength and quality of the resulting concrete.

It is true that in the construction industry, during the cleaning processes of machinery and elements used in the concrete, a considerable volume of discarded water is generated that could be reused in the preparation of the concrete. However, despite this apparent solution, it is important to consider that wastewater has characteristics that negatively impact the compressive strength of concrete.

Through previously developed tests [4, p. 4-6], it has been shown that choosing to use water that is not suitable for human consumption is not a viable option. The resistance of concrete made with this type of water is significantly compromised, negatively affecting its durability and structural performance. The results of previous investigations have been conclusive in pointing out that the properties and quality parameters of both the concrete mix and the hardened concrete are below the permitted values when wastewater is used.

In fact, it has been studied that wastewater has a significant impact on the compressive strength of concrete, an impact that is clearly perceptible at 7, 14 and 28 days, and the values obtained are around 1/3 lower than the values obtained for concrete made with drinking water [4, p. 6].

Considering this situation, it is imperative to propose innovative solutions to obtain drinking water that does not depend directly on conventional resources available to people. In an ever-changing world, it is essential to explore alternatives that are sustainable and respectful of the environment.

III. Innovative Solutions for Clean Water: Desalination, Wastewater to Drinking Water, Rainwater Harvesting, and Concrete Mix Modification

One of the possible solutions to the generation of potable water other than the one from the mains lies in the implementation of advanced desalination technologies, which make it possible to convert sea or brackish water into drinking water. This technology involves various techniques such as reverse osmosis and distillation.

Reverse osmosis utilizes a semipermeable membrane with very small pores that traps contaminants while water is pushed through. In addition, blocks contaminants from entering the less concentrated side of the membrane. For example, when pressure is applied to a volume of saltwater during reverse osmosis, the salt is left behind and only clean water flows through [5].

The implementation of advanced desalination technologies for converting seawater or brackish water into drinking water is a viable solution, but it may require significant investment and infrastructure. Challenges include the high energy consumption, environmental impact from brine disposal, and the initial cost of setting up desalination plants. However, ongoing research aims to enhance efficiency, reduce costs, and mitigate environmental concerns, making desalination an increasingly viable option for communities facing acute water scarcity.

Municipal wastewater can also be transformed into drinking water to improve water security. These waters can be reprocessed to obtain quality drinking water. Reverse osmosis is also used in this method [6].

Another option to consider is the development and application of large-scale rainwater harvesting and harvesting techniques for later use. Large-scale rainwater harvesting techniques can capture significant volumes of water, especially in regions with regular and substantial rainfall. These techniques are feasible and can be cost-effective, given that the collected rainwater can be purified and utilized for various purposes, including irrigation, sanitation, and even drinking. However, the success of rainwater harvesting systems can depend on local climatic conditions and infrastructure, encompassing factors such as precipitation patterns, size and efficiency of harvesting infrastructure, and water quality collected. Proper filtration and storage methods are crucial to ensure the water's safety for consumption.

This method collects rainwater and travels from the catchment to the storage unit vias followings [7]:

- Gutters: These semicircular or rectangular-shaped structures collect rainwater and transport it to the inflow pipe.
- Conduits: These are PVC or galvanised iron pipes that transport rainwater from the rooftop to the harvesting system.
- Mesh Filter: A mesh filter is fixed at the mouth of the inflow pipe to prevent the entry of debris.
- First Flush Device: This device ensures that debris that was settled in the gutters before rainfall does not end up in the rainwater harvesting system.
- Storage tanks: A storage tank collects the filtered water for future use, come in various shapes and sizes. These structures are durable, cost-effective, and can hold a significant amount of water.

In addition to desalination and rainwater harvesting, research into alternative concrete mixes that are less sensitive to the type of water used may provide a practical solution to address water quality concerns. These innovative approaches collectively contribute to ensuring a sustainable and clean water supply for communities around the world.

IV. Advantages and Disadvantages in the Implementation of Alternative Methods for Obtaining Drinking Water.

The proposed solutions offer different advantages. They can be summarized as follows:

Resource Conservation: Implementing alternative methods to obtain clean water for concrete production reduces the use of potable water, preserving this resource for essential human needs.

Alignment with Sustainable Goals: The suggested solutions align with the United Nations Sustainable Development Goal 6, "Clean water and sanitation", by promoting the efficient use of water.

Reduced Environmental Impact: Responsible water management in construction can lead to a decrease in environmental impacts, such as pollution and over-extraction of freshwater sources.

Reputation Benefits: Appropriate water use improves a company's reputation for environmental responsibility.

Apart from the advantages stated above, there are some disadvantages that need to be considered. They include:

Concrete Strength: Maintaining or improving concrete quality with alternative water sources is an ongoing challenge, as quality cannot be accurately determined without prior testing.

Infrastructure Investment: Developing and implementing rainwater harvesting or desalination infrastructure can require large financial investments.

Environmental Impact Assessment: It is crucial to assess the overall environmental impact of proposed solutions, including energy consumption and waste generation in desalination or rainwater harvesting systems.

The challenges and opportunities in this context include raising awareness in the responsible use of water, exploring alternatives such as the one proposed in this work. However, this requires research. These investigations also require time and financing since to corroborate the resistance of concrete with alternative water sources it is necessary to make test tubes, following current standards. Additionally, test results must be within acceptable results according to these standards. This involves constant trial and error, but they create the possibility of taking care of a resource as valuable as water.

V. Conclusion

In conclusion, the growing demand for drinking water in various sectors, including civil construction, highlights the need for innovative solutions that reduce dependence on drinking water while ensuring water sustainability. This article has explored the challenges and opportunities associated with obtaining potable water for concrete production, emphasizing the importance of resource conservation. However, it is essential to recognize the challenges that come with implementing alternative water sources. These challenges present opportunities for greater research, collaboration, and innovation in the search for clean and sustainable water solutions.

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