International Journal of Multidisciplinary Research and Modern Education (IJMRME)
International Peer Reviewed - Refereed Research Journal, Website: www.rdmodernresearch.com
Impact Factor: 7.315, ISSN (Online): 2454 - 6119, Volume 11, Issue 1, January - June, 2025

EVALUATING THE USE OF STP TREATED WATER IN CONCRETE PRODUCTION FOR ENHANCING STRENGTH AND OPTIMIZING WATER RESOURCES

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Cite This Article: Aman Dahiya & Er. Sandeep Pannu, "Evaluating the Use of STP Treated Water in Concrete Production for Enhancing Strength and Optimizing Water Resources", International Journal of Multidisciplinary Research and Modern Education, Volume 11, Issue 1, January - June, Page Number 135-138, 2025.

Abstract:

Water is an essential resource that sustains all forms of life and ecosystems on Earth. Its conservation, quality and equitable accessibility are increasingly significant in global development discourse. The recognition of water as a fundamental human right highlights the importance of clean and safe water for health and dignity. Despite this, water pollution remains a pressing global concern, with numerous sources such as industrial discharges, untreated sewage, agricultural runoff, oil spills and atmospheric deposition compromising water quality. Additionally, the paper discusses the use of treated wastewater, such as Sewage Treatment Plant (STP) water and untreated wash water, in concrete production as an innovative approach toward sustainable water management. Recent studies suggest that while early-age strength may be slightly affected, long-term compressive strength and durability remain within acceptable limits, supporting the reuse potential of such water in construction. This research contributes to both environmental sustainability and engineering by bridging water conservation strategies with construction material performance analysis.

Key Words: Water Terminology, Water as a Human Right, Water Pollution, Industrial Discharge, STP Treated Water, Concrete Compressive Strength, Greywater Reuse, Environmental Sustainability, Sustainable Construction, Water Quality Management

Introduction:

Water is a precious resource that sustains life on Earth. Understanding its properties, conservation and ensuring equitable access to clean water are crucial for the well-being of both humans and the environment. Water as a Human Right is access to clean and safe water is recognized as a fundamental human right by the United Nations. However, many regions around the world still face challenges in providing adequate access to clean water and sanitation facilities for all. Water pollution refers to the contamination or degradation of water bodies such as lakes, rivers, oceans, groundwater and even drinking water sources. It occurs when harmful substances or pollutants are introduced into the water, making it unfit for its intended use or harmful to the environment and living organisms. Industries release various pollutants into water bodies, including toxic chemicals, heavy metals and organic compounds. Industrial discharges refer to the release of various substances and pollutants into the environment as a result of industrial activities. These discharges can occur in different forms, such as liquid effluents, airborne emissions and solid waste. They can originate from a wide range of industries, including manufacturing, mining, power generation, chemical production and wastewater treatment plants. Industrial discharges can have significant environmental and health impacts.

Improperly treated or untreated sewage and wastewater from households, commercial establishments and industries can introduce harmful bacteria, 2 viruses and chemicals into water bodies. Sewage and wastewater are terms used to describe the water that is discharged from various human activities, such as residential, commercial and industrial sources, as well as storm water runoff. It contains a combination of domestic and industrial waste, along with water from sinks, toilets, showers, laundry and other sources. Excessive use of fertilizers, pesticides and herbicides in agriculture leads to runoff into nearby water sources, causing contamination. Agricultural runoff refers to the movement of water, along with associated pollutants and sediments, from agricultural lands into water bodies such as rivers, lakes and groundwater. It occurs when precipitation or irrigation water flows over the surface of agricultural fields, picking up various substances and carrying them into nearby waterways.

Accidental or deliberate oil spills from ships, pipelines, or offshore drilling activities contaminate large areas of water, harming marine life and ecosystems. An oil spill occurs when liquid petroleum hydrocarbons are released into the environment, typically due to accidents or incidents involving oil tankers, pipelines, offshore drilling platforms, or storage facilities. Oil spills can have significant environmental, economic and social consequences. Dumping solid waste, including plastics and other non biodegradable materials, directly into water bodies contributes to pollution. Improper waste disposal refers to the incorrect or inadequate management and disposal of waste materials, which can have detrimental effects on the environment, human health and ecosystems. It involves actions such as dumping waste in unauthorized areas, littering, open burning and the improper handling of hazardous substances. Air pollution can deposit pollutants onto water surfaces through rain or airborne particles, leading to water pollution. Atmospheric deposition refers to the process by which particles and pollutants from the atmosphere are deposited onto the Earth's surface. It involves the settling or deposition of solid and liquid particles, including gases, aerosols and particulate matter, onto land, water bodies, vegetation and man-made structures. Mining operations can release heavy metals, sediments and other contaminants into water bodies, particularly through acid mine drainage. Mining activities refer to the extraction of minerals, ores and other valuable geological resources from the Earth's crust. Mining plays a vital role in the global economy by providing raw materials for various industries, including manufacturing, construction, energy production and technology.

Objectives:

The main objective is to cast & study the harden properties of concrete using STP treated & Untreated wash water. The specific objectives are:

- Property & tests on water (Treated & Untreated)
- Study of strength properties of the concrete casted with STP treated & untreated wash water.

Literature Review:

Study by Patel et al. (2024): The researchers investigated the effects of STP treated water on the compressive strength and durability of concrete. The study found that using STP treated water as a partial replacement for freshwater resulted in slightly reduced early-age strength but comparable long-term strength. The concrete exhibited good resistance to chloride ion penetration and showed no adverse effects on durability.

Research by Silva et al. (2024): This study evaluated the influence of untreated wash water, collected from concrete truck mixers, on the properties of fresh and hardened concrete. The results indicated that incorporating untreated wash water led to a decrease in compressive strength and an increase in setting time. However, the concrete still met the specified strength requirements and exhibited acceptable durability performance.

Investigation by Singh and Baghel (2025): The researchers examined the impact of using STP treated water on the workability and compressive strength of concrete. The study showed that the incorporation of STP treated water as a complete or partial replacement for freshwater resulted in reduced workability and slightly lower compressive strength compared to conventional concrete. However, the concrete maintained adequate strength levels and met the relevant standards.

Study by Siddique et al. (2025): This research explored the effects of STP treated water on the compressive strength, setting time and chloride ion permeability of concrete. The findings revealed that the use of STP treated water had a minor effect on the compressive strength and setting time. However, the concrete exhibited improved resistance to chloride ion penetration, suggesting a potential benefit in terms of durability.

Sullage Water:

Sullage water, also known as greywater or gray water, is wastewater generated from non toilet domestic activities. It includes water from sinks, showers, bathtubs, washing machines and dishwashers. Sullage water typically does not contain fecal matter or urine. It may contain residues from household cleaning products, soap, food particles and other substances. Sullage water mainly consists of water from various domestic activities, while sewerage water includes both sullage water and blackwater from toilets. The composition of sullage water is relatively cleaner compared to sewerage water. Sullage water generally requires less intensive treatment compared to sewerage water. Since it does not contain fecal matter, the treatment process for sullage water may focus on removing solids, disinfection and sometimes filtration. Sewerage water, on the other hand, requires more comprehensive treatment, including processes such as screening, sedimentation, biological treatment and disinfection to remove contaminants and pathogens. Sullage water has significant potential for reuse in certain applications. With proper treatment and appropriate measures to ensure safety, sullage water can be used for non-potable purposes like irrigation, toilet flushing and industrial processes. Sewerage water, after extensive treatment, can also be treated to a high standard and used for indirect potable purposes or groundwater recharge.

Analysis and Findings:

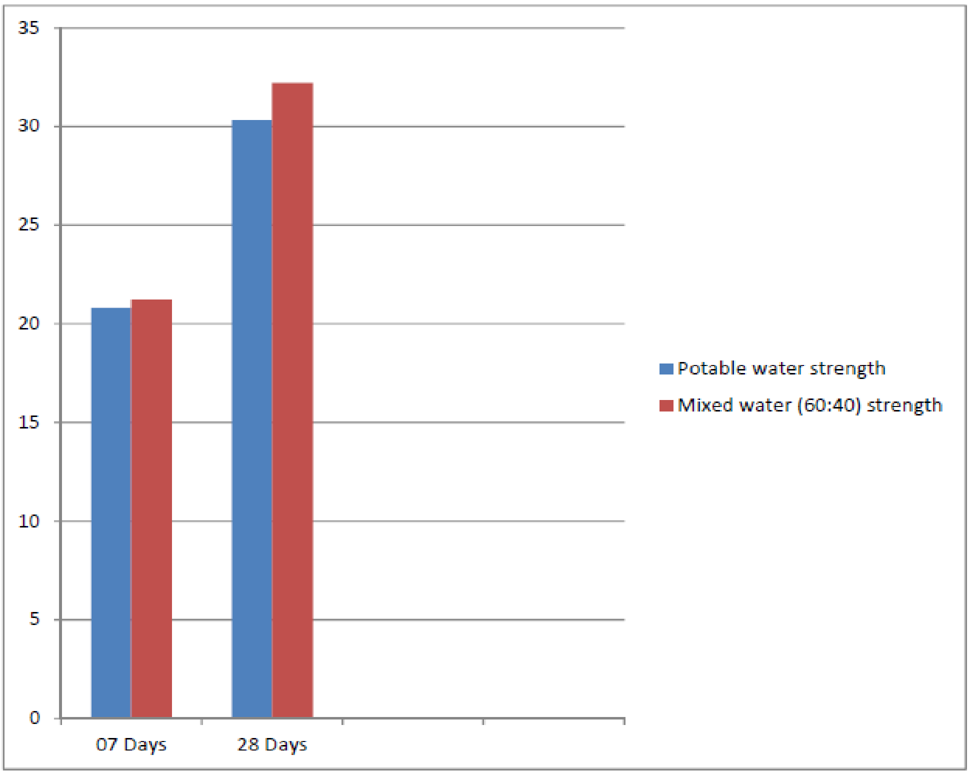
There are various tests conducted on concrete to assess its properties and quality. This test determines the compressive strength of concrete by subjecting cylindrical or cube-shaped specimens to a compressive load until failure. It is a fundamental test that assesses the concrete's ability to withstand compressive forces. The compressive strength test is one of the most important tests conducted on concrete. It determines the ability of concrete to withstand compressive forces without failure. This test helps in assessing the quality of concrete and ensuring its suitability for specific applications. Here's an overview of the compressive strength test procedure: Cylindrical or cube-shaped specimens are prepared from fresh concrete. The most common specimen sizes for compression testing are cylinders with a diameter of 150 mm (6 inches) and a height of 300 mm (12 inches) or cubes with a side length of 150 mm (6 inches). After casting the specimens, they are cured under specific conditions to promote hydration and achieve proper strength development. Common curing methods include moist curing (immersion in water), steam curing, or curing in a controlled laboratory environment. The cured specimens are placed on the compression testing machine, which consists of two steel plates with hardened flat surfaces. The bottom plate is stationary, while the top plate moves down to apply the compressive load. The specimen is carefully aligned and centered on the testing machine. Proper alignment is crucial to ensure even distribution of the load during testing. The compressive load is applied gradually and continuously until the specimen fails. The load is typically applied at a constant rate specified by relevant standards (e.g., 20 to 50 kN/s). The load is measured by a load cell connected to the testing machine.

Site Photographs:

Compressive Strength of Concrete Cube Using Potable Water (On 28 Days):

No. of Cube	Date of Casting	Grade of Concrete	Date of Testing	Weight of Cube (Kg)	Load in (kN)	Compressive Strength (MPa)	Average Compressive Strength (MPa)
1	13.04.2024	M 25	11.05.2024	8.271	680	30.22	
2	13.04.2024	M 25	11.05.2024	8.397	695	30.89	
3	13.04.2024	M 25	11.05.2024	8.01	672.5	29.89	**30.33**

Graph 1 Plot of compressive strength of concrete block (150x150x150 mm3) using STP treated water (60%) and potable water (40%)



Conclusion:

Water is a critical and finite resource that demands responsible usage and efficient management, especially in sectors like construction where large volumes are consumed. The implementation of quality management practices in the construction industry must extend beyond structural integrity to include environmental sustainability. The reuse of treated wastewater-such as STP treated water and untreated wash water-in concrete production offers a promising solution to water scarcity. Despite minor reductions in early-age compressive strength, studies confirm that long-term strength and durability remain within acceptable standards, making such practices both feasible and effective. Moreover, addressing water pollution sources such as industrial discharge, agricultural runoff and improper waste disposal is vital for maintaining the health of ecosystems and public well-being. Thus, integrating water quality management with construction practices not only ensures regulatory compliance and cost-effectiveness but also contributes significantly to sustainable development goals.

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