QUALITY ASSESSMENT ON CONCRETE UTILISING THERMAL POWER PLANT WASTEWATER

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Abstract. This study investigates the feasibility of substituting potable water with treated wastewater from thermal power plants in concrete production, focusing on its impact on the mechanical properties of concrete. The methodology involved comprehensive chemical analysis of the treated wastewater, followed by the preparation of M20 and M30 grade concrete mixes using both potable and treated wastewater. Subsequent tests assessed workability, setting time, strength, durability, and permeability. The chemical analysis revealed that the treated wastewater had a total hardness of 125.33 mg/L and a chloride concentration of 132.90 mg/L, both within permissible limits for concrete applications. However, the pH ranged from 4.44 to 5.51, indicating acidity that may necessitate pH adjustment before use. Mechanical testing demonstrated that concrete mixed with treated wastewater exhibited comparable or superior performance in certain aspects. For instance, the 28-day flexural strength of beams using treated wastewater averaged 11.61 N/mm², surpassing the 3.53 N/mm² observed in beams with potable water. Similarly, the 7-day compressive strength of cubes with treated wastewater reached an average of 25.7 N/mm², compared to 11.09 N/mm² for those with potable water. These results suggest that treated wastewater can enhance early strength development in concrete. The findings indicate that treated thermal power plant wastewater, after appropriate treatment and pH correction, can serve as a sustainable alternative to potable water in concrete production. This approach not only conserves freshwater resources but also aligns with circular economy principles by repurposing industrial byproducts. Future research should explore long-term durability aspects and the performance of such concrete in diverse environmental conditions to fully establish its viability for widespread construction applications.

Keywords: Treated wastewater, concrete strength, thermal power plant, sustainable construction, flexural strength, compressive strength, environmental engineering.

INTRODUCTION

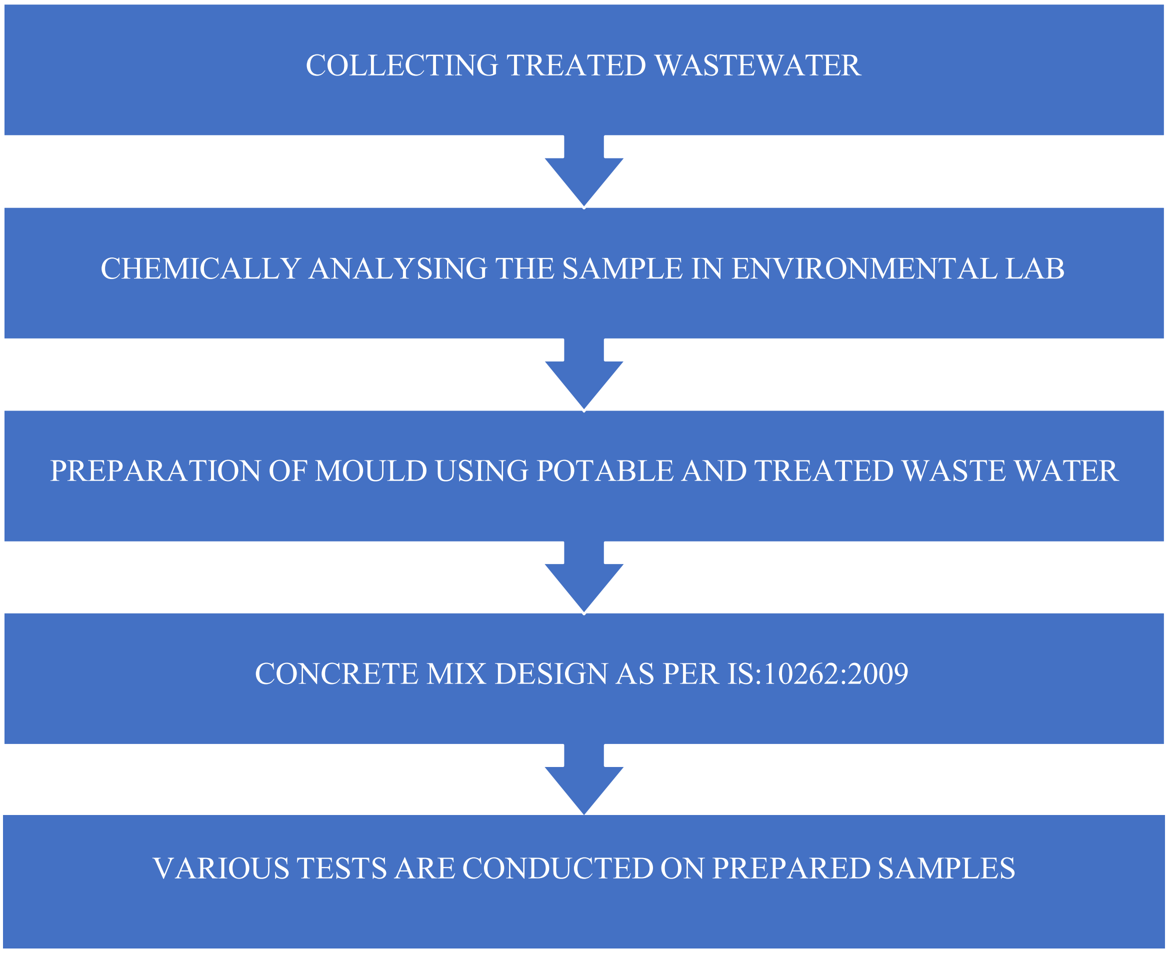
Concrete is essential in modern infrastructure but poses sustainability challenges due to its high water consumption. Thermal power plants generate substantial volumes of wastewater, often requiring extensive treatment before disposal. Recent studies suggest that, after appropriate treatment, this wastewater can be repurposed for concrete production, offering a sustainable alternative to freshwater sources. Utilizing treated thermal power plant wastewater in concrete production aligns with circular economy principles, promoting resource efficiency and environmental stewardship. This study aims to assess the feasibility of using treated thermal power plant wastewater in concrete mixing processes, evaluating its impact on concrete's mechanical properties and overall performance.In conclusion, the assessment of concrete quality utilizing thermal power plant wastewater represents a promising avenue for sustainable construction practices. By harnessing alternative water sources and repurposing industrial byproducts, this approach offers a viable solution to environmental challenges while maintaining high standards of construction quality.

OBJECTIVES

- To find sustainable or economical solution for construction industry by replacing potable water to treated wastewater.
- Evaluate the effects of wastewater on the Mechanical and Physical properties of concrete by conducting various tests, (including workability, setting time, strength, durability, and permeability)
- Assess the economic viability of using treated wastewater in concrete production, considering both material cost and environmental benefits.

METHODOLOGY

- Samples of treated wastewater were collected from the sewage treatment plant.
- The wastewater was chemically analyzed as per standard methods for water and wastewater examination. The analysis was carried out in the environmental engineering laboratory
- The concrete mix design was carried out as per IS: 10262-2009
- The mix design of concrete for M20 and M30 grades of concrete were taken, and experiments were conducted for both potable water and treated wastewater in the laboratory.
- The strength, durability, and workability of the concrete are the essential parameters that remain in view when designing the concrete mixtures



Test Results

Total Hardness: The treated wastewater exhibited an average total hardness of 125.33 mg/L, indicating a moderate level of mineral content.

pH Value: The pH values of the samples ranged from 4.44 to 5.51, highlighting an acidic nature that may necessitate pH correction prior to use in concrete mixing.

Chloride Concentration: Measured at 132.90 mg/L, the chloride levels are within permissible limits for concrete applications, minimizing the risk of corrosion in reinforced structures.

Sieve Analysis: The fineness modulus of the fine aggregates was calculated to be 4.435, classifying the sand as coarse, which is suitable for certain concrete mixes.

Specific Gravity: Tests confirmed that both cement and fine aggregates possess specific gravity values within standard acceptable ranges, ensuring material quality and consistency in concrete production.

MIX PROPORTIONS

Cement	=	360 Kg/m^3
Water	=	144 Kg/m^3
Fine aggregate	=	727.68 Kg/m^3
Coarse aggregate	=	1214.56 Kg/m^3
Water cement ratio	=	0.4

∴ Mix ratio = 1:2.02:3.37 with w/c ratio 0.4

TABLE NO:1 Material Calculation per Cube

Material	Quantity
Cement	1.4 Kg
Fine aggregate	2.82 Kg
Coarse aggregate	4.71 Kg
Water	0.56

TABLE NO:2 Material Calculation per Beam

Material	Quantity
Cement	1.94 Kg
Fine aggregate	3.91 Kg
Coarse aggregate	6.53 Kg
Water	0.776

TABLE NO: 3 Material Calculation per Cylinder

Material	Quantity
Cement	2.06 Kg
Fine aggregate	4.16 Kg
Coarse aggregate	6.94 Kg
Water	0.824

Flexural Strength of Beam For 7 Days: -

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**BEAM (Potable Water)**	**12.9**	**3.8**	**1.92**	**1.42**
2		**12.75**	**1.8**	**0.9**	
3		**12.55**	**2.8**	**1.45**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**BEAM (Treated Waste Water)**	**12.4**	**5.75**	**2.93**	**8.24**
2		**12.6**	**5.12**	**2.61**	
3		**12.3**	**5.3**	**2.70**	

Flexural Strength of Beam For 14 Days: -

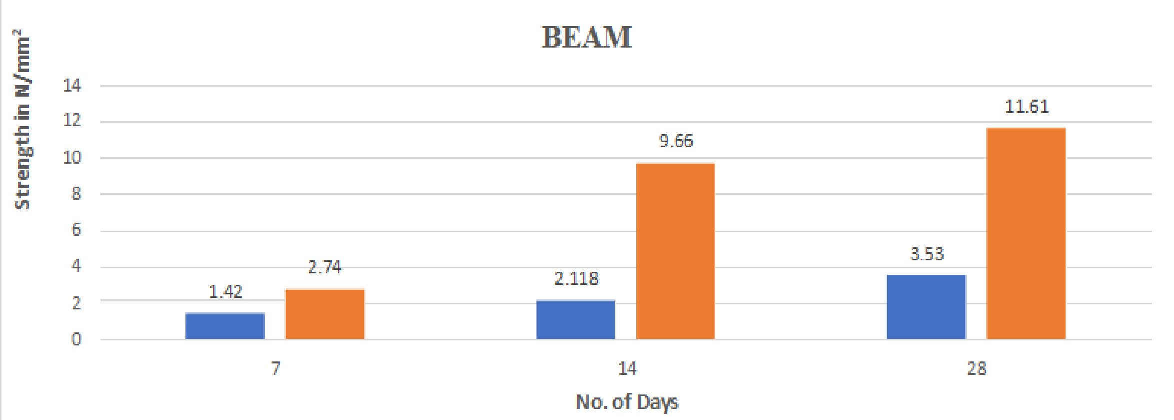
TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**BEAM (Potable Water)**	**13.5**	**3.3**	**2.1**	**2.118**
2		**13.9**	**4.6**	**2.9**	
3		**12.9**	**2**	**1.35**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**BEAM (Treated Waste Water)**	**13.4**	**6.65**	**4.19**	**9.66**
2		**13.1**	**14.49**	**9.56**	
3		**12.8**	**22.1**	**15.2**	

Flexural Strength of Beam For 28 Days:

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**BEAM (Potable Water)**	**13.1**	**5.5**	**3.5**	**3.53**
2		**13.5**	**5.4**	**3.7**	
3		**13.9**	**5.2**	**3.59**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**BEAM (Treated Waste Water)**	**12.7**	**22.1**	**13.3**	**11.61**
2		**12.2**	**21.79**	**13.1**	
3		**12.7**	**21.25**	**8.5**	



GRAPH NO: 1 FLEXURAL STRENGTH OF BEAM TEST RESULT

Split Tensile Strength of Cylinder For 7 Days: -

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm²	AVG STRENGTH (N/mm²)
1	**CYLINDER (Potable Water)**	**14.2**	**103**	**1.46**	**1.46**
2		**13.9**	**105**	**1.49**	
3		**13.95**	**101**	**1.43**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm²	AVG STRENGTH (N/mm²)
1	**CYLINDER (Treated Waste Water)**	**13.9**	**171**	**2.41**	**2.46**
2		**13.6**	**174.86**	**2.47**	
3		**13.7**	**178.23**	**2.52**	

Split Tensile Strength of Cylinder For 14 Days: -

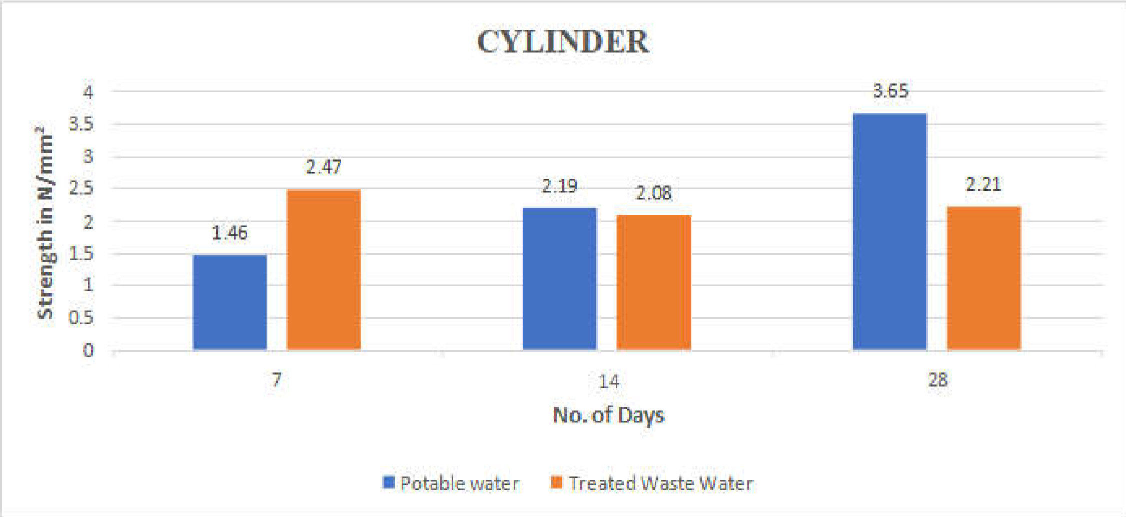
TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**CYLINDER (Potable Water)**	**12.9**	**148**	**2.1**	**2.19**
2		**13.5**	**163**	**2.3**	
3		**13.85**	**152**	**2.16**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**CYLINDER (Treated Waste Water)**	**13**	**152**	**2.15**	**2.08**
2		**13.1**	**149.54**	**2.11**	

Split Tensile Strength of Cylinder For 28 Days: -

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**CYLINDER (Potable Water)**	**13.5**	**254**	**3.6**	**3.65**
2		**13.9**	**268**	**3.8**	
3		**13.35**	**272**	**3.85**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH N/mm^2	AVG STRENGTH (N/mm^2)
1	**CYLINDER (Treated Waste Water)**	**13.8**	**222.05**	**2.14**	**2.21**
2		**13.2**	**192.75**	**2.72**	
3		**13.4**	**126**	**1.78**	



GRAPH NO: 2 SPLIT TENSILE STRENGTH OF CYLINDER TEST RESULT

Compressive Strength of Cube For 7 Days: -

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH (N/mm²)	AVG STRENGTH (N/mm²)
1	**CUBE (Potable Water)**	**8.95**	**249**	**11.06**	**11.09**
2		**8.79**	**250**	**11.1**	
3		**9.23**	**250**	**11.09**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH (N/mm²)	AVG STRENGTH (N/mm²)
1	**CUBE (Treated Waste Water)**	**9.01**	**422.05**	**8.56**	**25.7**
2		**8.96**	**202.95**	**9.02**	
3		**8.65**	**366.25**	**8.12**	

Compressive Strength of Cube For 14 Days: -

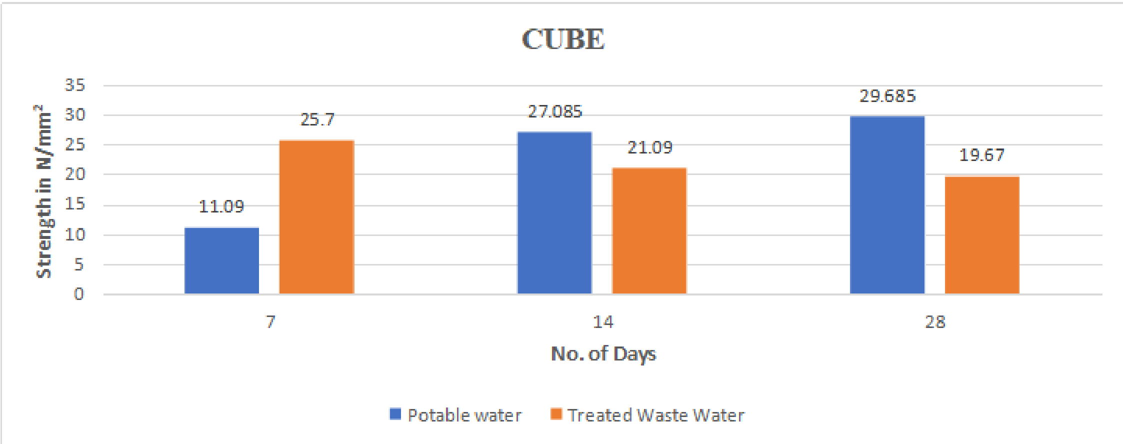
TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH (N/mm^2)	AVG STRENGTH (N/mm^2)
1	**CUBE (Potable Water)**	**8.97**	**608**	**27**	**27.085**
2		**9.5**	**619**	**27.5**	
3		**8.69**	**605**	**26.9**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH (N/mm^2)	AVG STRENGTH (N/mm^2)
1	**CUBE (Treated Waste Water)**	**9.34**	**489.3**	**21.7**	**21.09**
2		**9.01**	**484.43**	**21.5**	
3		**8.92**	**450.15**	**20**	

Compressive Strength of Cube For 28 Days: -

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH (N/mm^2)	AVG STRENGTH (N/mm^2)
1	**CUBE (Potable Water)**	**8.57**	**650**	**28.9**	**29.685**
2		**8.8**	**686**	**30.5**	
3		**8.25**	**668**	**29.7**	

TRIAL NO	IDENTIFICATION	WEIGHT (Kg)	LOAD (KN)	STRENGTH (N/mm^2)	AVG STRENGTH (N/mm^2)
1	**CUBE (Treated Waste Water)**	**8.35**	**432.2**	**19.2**	**19.67**
2		**8.26**	**442.8**	**19.7**	
3		**8.15**	**453.2**	**20.1**	



GRAPH NO: 3 COMPRESSIVE STRENGTH OF CUBE TEST RESULT

CONCLUSIONS

This study investigated the feasibility of substituting potable water with treated wastewater from thermal power plants in concrete production, focusing on its impact on the mechanical properties of concrete. The methodology involved comprehensive chemical analysis of the treated wastewater, followed by the preparation of M20 and M30 grade concrete mixes using both potable and treated wastewater. Subsequent tests assessed workability, setting time, strength, durability, and permeability.

The chemical analysis revealed that the treated wastewater had a total hardness of 125.33 mg/L and a chloride concentration of 132.90 mg/L, both within permissible limits for concrete applications. However, the pH ranged from 4.44 to 5.51, indicating acidity that may necessitate pH adjustment before use.

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The findings indicate that treated thermal power plant wastewater, after appropriate treatment and pH correction, can serve as a sustainable alternative to potable water in concrete production. This approach not only conserves freshwater resources but also aligns with circular economy principles by repurposing industrial byproducts. Future research should explore long-term durability aspects and the performance of such concrete in diverse environmental conditions to fully establish its viability for widespread construction applications.

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