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Greywater Recycling and Rainwater Harvesting Integration in High-Rise Residential Complexes

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***Abstract*— Rapid urbanization and vertical structural developments, particularly 45-story high-rise complexes, place significant stress on municipal water grids. This paper presents an integrated Public Health Engineering (PHE) framework to minimize municipal water dependency through Greywater Recycling (GWR) and Rainwater Harvesting (RWH). Utilizing National Building Code (NBC) guidelines, the project outlines the methodology for estimating roof-top rainwater yield and calculating the continuous generation of domestic greywater. A quantitative hydraulic model is applied to a standard high-rise residential footprint, determining that a per-capita allocation of 135 liters per day yields sufficient greywater to offset 100% of the building's flushing demand. The study details the volumetric sizing of collection pits, equalization units, and treated water storage tanks (UGWT and OHT). By integrating these hydraulic parameters with spatial coordination in AutoCAD and Revit, the proposed design offers a scalable MEP solution that reduces freshwater demand without compromising structural integrity or occupant sanitation.**

***Keywords*— AutoCAD Layouts, Greywater Recycling, National Building Code (NBC), Rainwater Harvesting, Tank Sizing.**

I. INTRODUCTION

The rising density of high-rise residential structures demands innovative approaches to Public Health Engineering (PHE). Traditional reliance on municipal water grids is increasingly unsustainable due to seasonal scarcity and infrastructural limitations. Integrating Rainwater Harvesting (RWH) and Greywater Recycling (GWR) within the Mechanical, Electrical, and Plumbing (MEP) framework provides a decentralized, highly efficient solution.

RWH captures seasonal precipitation, which is critical in regions experiencing heavy monsoon periods, while GWR reclaims lightly contaminated wastewater from showers and washbasins for non-potable uses such as flushing and landscaping. Proper spatial coordination using drafting software ensures that the structural load of underground water tanks (UGWT) and overhead tanks (OHT) remains balanced.

This paper standardizes the calculations, capacity sizing, and spatial planning required to implement these dual systems in strict compliance with the National Building Code (NBC) of India.

II. METHODOLOGY

A. Baseline Water Demand Estimation

The foundation of tank sizing begins with estimating the total building population. For a standard 45-floor high-rise residential complex (assuming 6 flats per floor and 5 persons per flat), the estimated population is 1,350 residents. According to NBC standards for cities equipped with complete sewerage systems, the standard domestic water requirement is 135 Liters Per Capita per Day (LPCD).

- *Total Daily Demand:* 1350 × 135 = 182,250 Liters/Day (182.25 KLD).
- *Flushing Demand (Non-Potable):* Typically estimated at 45 LPCD. Total flushing demand is 1350 × 45 = 60,750 Liters/Day (60.75 KLD).

B. Greywater Generation and Treatment Sizing

Greywater yield is estimated by isolating non-faecal wastewater streams (bath and washbasin). Based on standard PHE practices, approximately 60% of the total domestic consumption can be recovered as greywater.

- Greywater Generated: 182,250 × 0.60 = 109,350 Liters/Day (109.35 KLD).

Because the generated greywater (109.35 KLD) comfortably exceeds the total flushing demand (60.75 KLD), the high-rise can sustain a 100% offset of its flushing requirements using recycled water. The treatment plant sizing involves calculating the peak flow rates in Liters Per Minute (LPM) and Liters Per Second (LPS) to appropriately dimension the equalization tank and aeration units within the basement plant room.

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C. Rainwater Yield Estimation

The potential rainwater harvesting volume is calculated based on available roof catchment area and local precipitation patterns. The standard hydrological equation utilized is:

$$V = A \times R \times C$$

Where V = Harvested Volume (liters), A = Catchment Area (assumed 1,500 square meters for the tower footprint), R = Annual Precipitation (utilizing an average regional rainfall of 1.036 meters), and C = Runoff Coefficient (0.85 for concrete terrace surfaces).

Applying these parameters: $V = 1500 \times 1.036 \times 0.85 =$ 1,320,900 Liters of harvested rainwater annually.

D. Spatial Integration and Drafting

The physical footprint of the GWR treatment plant and RWH storage pits must be optimized within basement or podium levels. AutoCAD and Revit are employed to route the dual-plumbing networks (segregating soil waste pipes from greywater pipes) and to perform clash detection with structural foundational beams and columns.

III. Tank Sizing And Optimization

TABLE I
CAPACITY SIZING SUMMARY FOR 45-FLOOR TOWER

System Component	Parameter Applied	Calculated Volume
Total Daily Water Demand	135 LPCD	182.25 KLD
Greywater Generated	60% of total demand	109.35 KLD
Flushing Requirement	45 LPCD	60.75 KLD
Annual Rainwater Yield	$V = A \times R \times C$	1,320.90 Kilo-Liters

IV. Conclusion

The integration of Greywater Recycling and Rainwater Harvesting in high-rise developments presents a highly viable method for reducing reliance on municipal water grids. By strictly adhering to NBC guidelines, public health engineers can accurately size dual-plumbing systems that capture sufficient greywater to entirely offset flushing demands. Furthermore, utilizing tools like AutoCAD and Revit ensures that the necessary Underground Water Tanks (UGWT) and Overhead Tanks (OHT) are spatially coordinated without compromising the structural integrity of the building. This methodology provides a sustainable, standardized approach to modern MEP design.

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