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Original Article

Advanced Hydraulic Analysis and Optimized Planning of Underground Sewerage Network For Newly Added Areas Using Sewergem Software

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Abstract: *Rapid urbanization and population growth in newly developed areas demand efficient underground sewerage systems for safe wastewater disposal and environmental protection. Traditional design methods often face limitations in hydraulic efficiency, accuracy, time consumption, and future expansion planning. This study focuses on the advanced hydraulic analysis and optimized planning of an underground sewerage network for newly added areas using SewerGEMS. The proposed model incorporates population forecasting, sewage flow estimation, pipe network design, and hydraulic simulation to ensure proper flow velocity, slope, depth, and pressure conditions throughout the system. The design process also includes peak factor analysis, load estimation, pipe diameter selection, manhole spacing, invert level calculation, and pump station requirements for efficient wastewater conveyance. Hydraulic simulation using SewerGEMS helps in evaluating discharge capacity, flow patterns, surcharge conditions, and system performance under varying demand conditions. The results indicate that the optimized design improves flow performance, minimizes overflow and blockage risks, reduces manual calculation time, and ensures economical as well as sustainable wastewater management for future urban development and expansion of newly added residential and commercial zones.*

Keywords: *Underground Sewerage System, Hydraulic Modelling, SewerGEMS, Wastewater Flow Prediction, Urban Infrastructure, Network Optimization, Newly Developed Areas.*

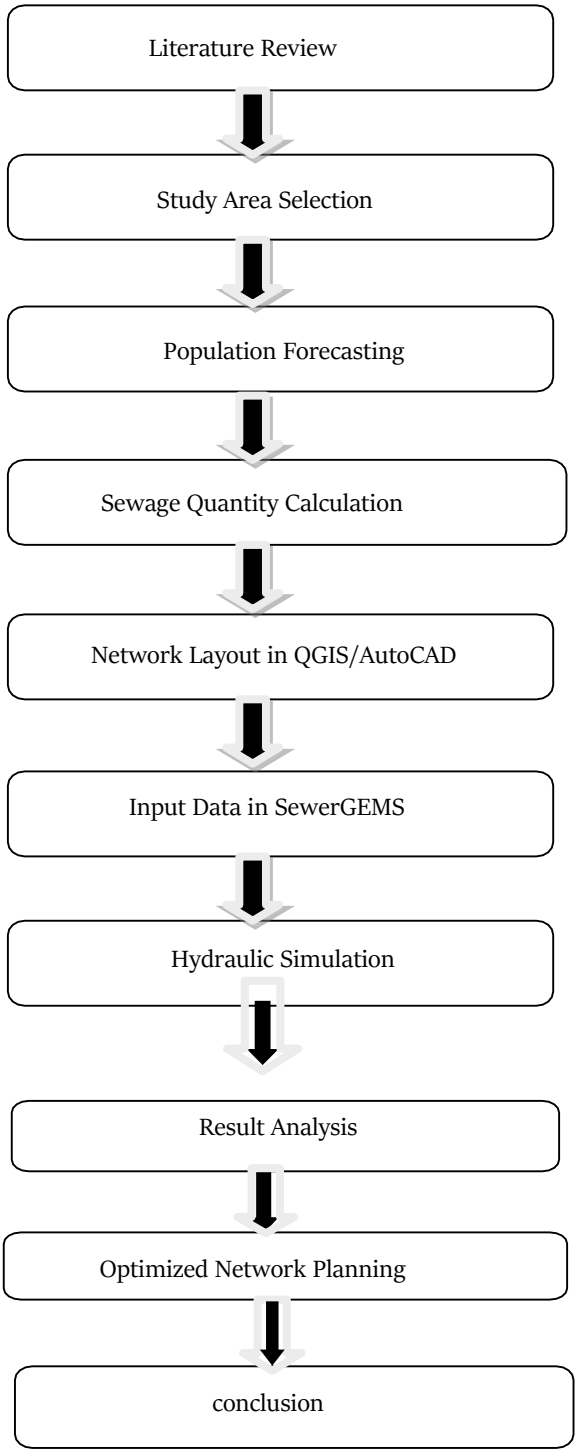
I. INTRODUCTION

The Underground sewerage systems play a vital role in urban infrastructure by ensuring the safe collection and transportation of wastewater to treatment facilities. In newly added and rapidly developing urban areas, proper planning and design of sewer networks are essential to prevent environmental pollution, water stagnation, and public health issues. However, conventional design methods involve extensive manual calculations, are time-consuming, and may not accurately predict hydraulic behavior under varying flow conditions. To address these challenges, modern hydraulic modelling tools such as SewerGEMS are widely used for efficient analysis and design of sewerage networks. This study aims to develop an optimized underground sewerage system for newly developed areas by utilizing hydraulic simulation techniques and future population-based flow prediction, ensuring efficient performance, reliability, and sustainable wastewater management.

II. LITERATURE REVIEW

Several studies have highlighted the importance of hydraulic modelling in underground sewerage system design and planning. Software-based tools have significantly improved the accuracy of flow simulation, pressure analysis, and network optimization when compared to conventional manual methods. Research studies indicate that hydraulic models play a major role in predicting sewage discharge based on population growth, selecting appropriate pipe sizes and slopes, minimizing blockage and overflow conditions, improving maintenance planning, and ensuring the feasibility of future expansion in developing urban areas. In addition, previous works emphasize that the use of SewerGEMS enables engineers to analyze flow velocity, discharge capacity, manhole spacing, and pump station requirements more effectively. Many case studies have reported that hydraulic modelling helps in reducing design time, improving operational efficiency, and optimizing overall project cost. Furthermore, these studies demonstrate that software-based sewer network analysis provides reliable solutions for sustainable wastewater management and long-term urban infrastructure development.

III. METHODOLOGY



IV. MATERIALS AND METHODS

A. Study Data and Input Parameters

The study was carried out for a newly developed urban area requiring an efficient underground sewerage network. The base data collected for the analysis included the layout plan of the area, road alignment, ground levels, existing drainage pattern, and population details. The projected population for the design period was estimated to determine the future sewage generation. In addition, site slope and elevation details were considered for proper gravity flow planning of the sewer network.

B. Manual Calculation Method

The initial design calculations were performed manually using standard hydraulic design equations. The sewage flow was estimated based on per capita wastewater generation as per CPHEEO standards. Important design parameters such as discharge, pipe diameter, velocity, slope, and head loss were calculated manually. These calculations were used as a reference for comparing the software-generated results.

C. Software Modeling Using SewerGEMS

After completing the manual design, the same sewer network was modeled using SewerGEMS software. The study area layout was created in the software by inserting nodes, junctions, and pipe segments according to the proposed alignment. Input parameters such as pipe length, invert level, diameter, roughness coefficient, and flow values were assigned to each element of the network.

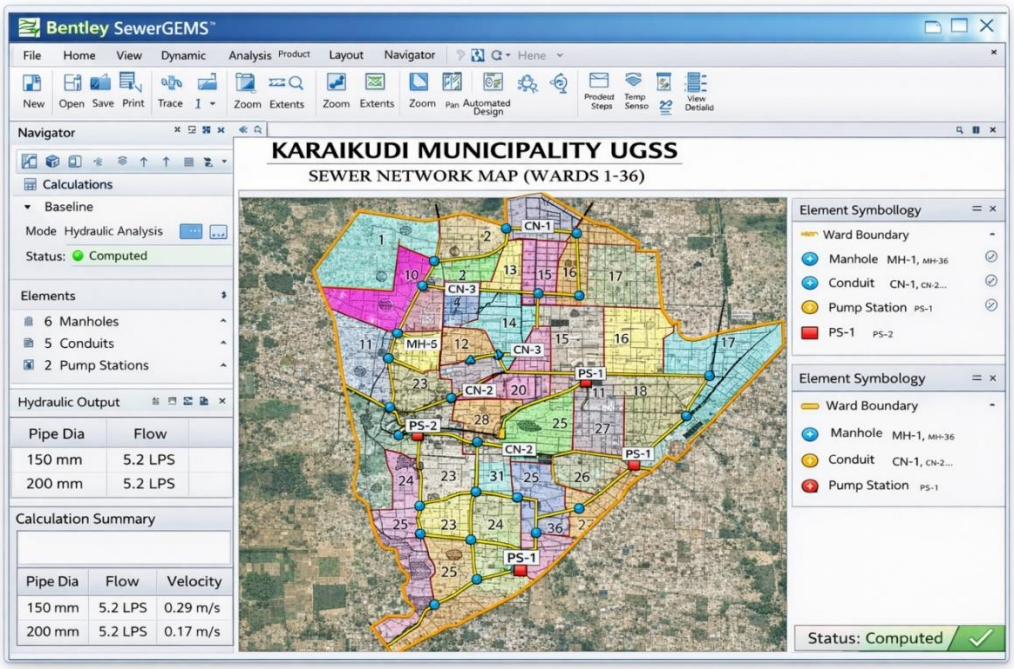


Figure 1: SewerGEMS Software Input Data

D. Hydraulic Simulation Procedure

The software simulation was carried out to analyze the hydraulic performance of the sewerage network. Parameters such as flow velocity, hydraulic grade line, slope variation, and head loss were evaluated. The software provided optimized values for pipe sizes and flow conditions, ensuring efficient wastewater conveyance through the underground drainage system.

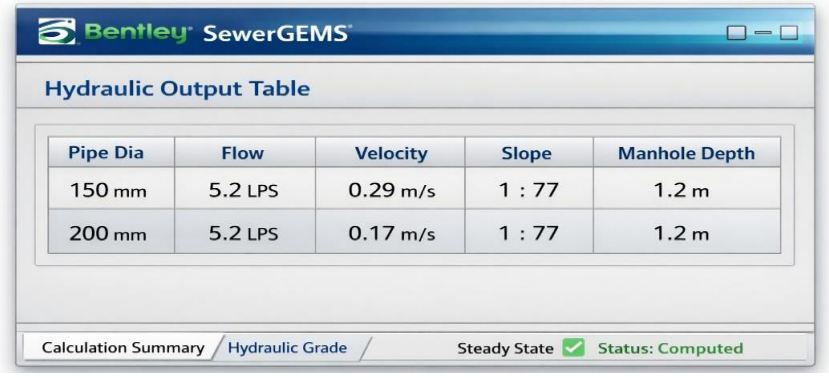


Figure 2: SewerGEMS Hydraulic Data

V. RESULTS AND DISCUSSION

A. Hydraulic Comparison

The hydraulic performance of the underground sewerage network was evaluated using both the conventional manual design method and the SewerGEMS software-based analysis. The comparison of major hydraulic parameters is presented.

Table 1: Hydraulic Comparison

Parameter	Manual Method	SewerGEMS
Flow	16.00 MLD	16.00 ML
Pipe Diameter	200 MM	150-200 mm
Velocity	0.75 m/s	0.82 m/s
Slope	1 in 200	1 in 220
Headloss	0.42 m	0.38 m

From the above comparison, it is observed that the software-based analysis provides better hydraulic optimization than the manual method. The flow remains the same in both methods; however, SewerGEMS offers improved pipe size selection and higher flow velocity, which helps in reducing sediment deposition and blockage risks. The reduced head loss value indicates better hydraulic efficiency. This improvement is mainly due to the software's ability to consider actual ground levels, invert levels, and flow continuity throughout the network.

B. Time Comparison

Table 2: Time Comparison

Method	Required Time
Manual Method	6-10 days
SewerGEMS	2-4 days

The software-based design significantly reduced the overall design time by approximately 50–60% compared to the conventional manual method. This reduction is achieved through automated hydraulic calculations, faster pipe network analysis, and easier modification of design parameters.

C. Cost Comparison

Table 3: Cost Comparison

Method	Estimated Cost (In Lack)
Manual Method	5,600-10,500
SewerGEMS	3,000-5,000

The results indicate that the software-assisted approach is more economical in terms of design and analysis cost, particularly when academic or institutional access is available. In addition to cost savings, the optimized design also improves operational efficiency and long-term maintenance planning.

Figure 3: Bar Chart of Comparison of manual method and sewerGEMS

VI. CONCLUSION

From This concludes that the hydraulic analysis and design of the underground sewerage system carried out using both manual calculation and SewerGEMS modelling shows a clear difference in accuracy, time, and cost. While the manual method provides theoretical design values based on standard equations and assumed conditions, the software method gives more precise and optimized results by considering actual field parameters such as ground levels, pipe invert levels, flow continuity, and surcharge conditions. The comparison indicates that the design time was reduced from 6–10 days in the manual method to 2–4 days using SewerGEMS, thereby saving nearly 50–60% of the time and reducing effective labour cost. Hence, the software-based design is found to be more reliable, time-saving, cost-effective, and suitable for sustainable future expansion of the underground sewerage system.

REFERENCES

[1] Katti, M., Krishna, B. M., and Manoj Kumar, B., Design of Sanitary Sewer Network using SewerGEMS V8i Software, International Journal of Science Technology & Engineering, 2(1) (2015) 45–52.

[2] Khan, M., and Regulwar, D. G., Design of Sanitary-Storm Network Using SewerGEMS: A Case Study, Journal of Water Resource Engineering and Management, 5(2) (2024) 112–120.

[3] Babar, V., and Gaikwad, J., Design of Sewerage Network, International Journal of Innovative Research in Technology, 11(6) (2024) 388–393.

[4] Bhagat, R. M., Pande, P. B., Raut, J. M., Dhengare, S. W., Borse, A. S., and Jasutkar, D. B., Optimizing Urban Infrastructure: Design and Analysis of Sewer Networks with SewerGEMS, International Journal of Engineering Trends and Technology, 72(10) (2024) 225–234.