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Design of Underground Sewerage System for Kalapatti, East Zone Coimbatore

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Abstract: The paper presents modelling and the hydraulic design of underground sewerage system using different software. Kalapatti town panchayat was taken as a model for the study. The area under consideration was selected based on the existing facility and the prioritized area in need of sanitary facility. The analysis and design were carried out using the macro enabled excel sheet and SewerCAD to find the diameter, type of pipe, slope to be maintained and depth of cutting for manhole.

Keywords : Kalapatti, panchayat, panchayat, CPHEEO
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1.Introduction

Infrastructure facility is important for the development of city in a healthy way. Water supply system and drainage are the foremost facilities to be provided considering the future development of the area. Coimbatore is one of the rapidly developing urban city. Many developing part of the city lacks common sewerage system.

Kalapatti town panchayat is a suburb of the city recently merged with municipal corporation of Coimbatore. The area is developing rapidly because of the IT companies, industries in and around the area. So it is necessary to provide the infrastructure facility for the benefit of the people. The objective of the project involves planning, analysis and design of underground sewerage system for part of Kalapatti town panchayat located in the east zone of Coimbatore.

The analysis and design were carried out using macro enabled Excel sheet. Contour level, length of pipe between manholes and population data were used as a input data as per the guidelines of CPHEEO manual.

The computer software package SewerCAD is one of the helpful tool for designing an economic sewer network.It can give the practically feasible layout and optimum cost which can handle a large network. The possible design results are diameter of the pipes, depth of excavation, slopes to achieve desired self-cleansing velocity. The design was taken up to satisfy the set of design constrains prescribed by CPHEEO manual. Thus considering all these parameters, an underground sewerage system was analysed and designed by using SewerCAD.

2.Literature Review

Shruthi Kannur presented, manual calculations and SewerGEMS software for the analysis and design of underground drainage for Tumkur city and reported, 'SewerGEMS' software consumes lesser time for analysis and design compared to 'Microsoft excel'. Similar natures of results were obtained by software & manual calculations, but with slight percentage variations and so this study focused on design using similar software called SewerCAD.

Punam Harising Rajpurohit presented (2016), design of sanitary network using SewerGEMS software for Gandhinagar city and concluded, the process is easy and uncomplicated for the design of sewerage networks using the software and it is accommodating for designing large sanitary sewer network efficiently and producing satisfactory results

3 Methodology

3.1 Data collection

Population data were collected from statistical department of Coimbatore. Existing drainage facility, land use and topography details were collected from TWAD board and other required details were collected from Kalapatti town panchayat.

Based on the collected data it was observed that the Kalapatti town panchayat has inadequate drainage facility. So the planning has been made to design the underground sewerage system for the Kalapatti town panchayat consisting of ward numbers 34,35&36 of Coimbatore municipal corporation. The study area has been divided into 7 zones as shown in Fig 1. The paper presents the analysis and design of underground sewerage system for Zone- 1.

The maximum ground elevation of 418.0 m was observed in Zone-2 and the lowest elevation of 384.0m was observed in Zone-5. The planning has been made to locate the outfall of the sewer in the Zone-5.

3.2 Population forecasting

Changes in the population of the city will occur over the years. Design of sewerage system should be carried out using projected population of a city because any underestimated value will make the system inadequate for the purpose intended, similarly overestimated value will make it costly.

The population has been forecast for the design period of 30 years using geometric progression method as it was observed that nature of the development of the city is rapid growth pattern. The projected population is shown in Table 1 for the zones.

Table. 1 Population forecasting

Zone	Population for design period(2045)
1	9818
2	11781
3	9818
4	15458
5	6685
6	35379
7	10630

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3.3 Layout of the sewer network

Layout of the sewer network consist of the location of trunk mains and branch sewers based on the ground elevation and the population in that region. The following are the steps involved in the layout of network.

(a) Selection of an outlet or disposal point

Figure 2 location of outfall

The outfall of the sewer has been located in such a way that the point having lowest ground elevation than other points to make the sewer network system by gravity flow. The outfall was located in ward number 34. The proposal was made to discharge the water in the outfall by providing the sewage treatment plant and utilizing the treated water for agriculture and gardening purpose.

(b) Location of trunk main and branch sewers

Trunk mains are generally large diameter pipes that transfer water from one area to another. The trunk mains were provided to collect the waste water from laterals through the branch sewers and to discharge at the end node called, lift station or outfall of the sewer network. Branch sewers are the secondary pipe used to collect the waste water from the house connections through the laterals. The most common location of sanitary sewer is in the centre of the street. A single sewer serves both sides of the street with approximately same length for each house connection.

The manhole provided at every 30m or at the junctions called as nodes. The trunk mains are connected from the node having highest elevation of 401.841 m to the node having lowest elevation of 387.805 m in the Zone 1.

(c) Location of pumping stations

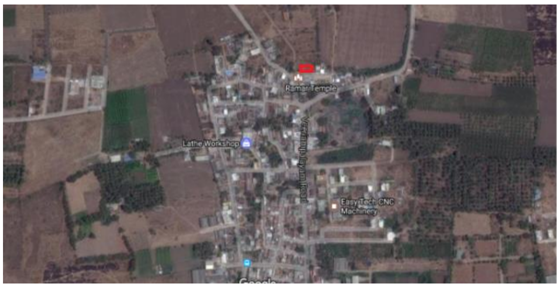

Fig. 3 Location of pumping station for Zone 1

The lift stations, also called as pump stations, are used for pumping sewage from a lower to higher elevation, particularly where the elevation of the source is not sufficient for gravity flow and/or when the use of gravity conveyance will result in excessive excavation and higher construction costs.

Since there exists, 7 zones draining at different directions, a provision has been made to combine the zones at a low lying area. Sewage storage structure called wet well and a set of pumping stations are provided in the four locations. The lift station has been located at ward number 34 for the Zone 1.

4. Analysis and Design Using Excel

Design of sewer system as per CPHEEO manual includes the following design parameters.

4.1 Design period

The length of time up to which the capacity of a sewer will be adequate is referred to as the design period. The sewerage system of the selected area has been designed for the period of 30 years.

4.2 Peak factor

The flow in sewers varies from hour to hour and seasonally. However, for the purpose of hydraulic design estimated peak flows are adopted. The peak factor is the ratio of maximum to average flows depends upon contributory population. The peak factor was adopted as 3.

4.3 Per capita sewage flow

The entire spent water of a community is normally contributing to the total flow in a sanitary sewer. However, the observed dry weather flow quantities usually are slightly less than the per capita water consumption. The assumption has been made that the supply of the water to the city at a uniform rate of 135 lpcd. The rate of sewage generation I was taken as 80% of the water supply.

4.4 Depth of flow

The sewers shall not run full as otherwise the pressure will rise above or fall below the atmospheric pressure and condition of open channel flow will cease to exist. Moreover, from consideration of ventilation, sewers should not be designed to run full for the ultimate design period, the sewers are designed flowing 80% full (d/D = 0.8)

4. 5 Velocity of flow

For the hydraulic design, minimum velocity has to be maintained in the sewers even during minimum flow conditions. At the same time the velocity should not be excessive to cause erosion. For design of sewer minimum velocity should be 0.6 m/sec. To avoid erosion in the sewer network, velocity more than 3.0 m/sec will not be allowed.

4.6 Minimum depth of cover

The starting manhole depth of the proposed sewers ranges from 1m to 1.5 m depending upon the topography and details of road planning network available. The minimum depth of cover depends on the depth of the starting manhole and subsequent ground level of the road along the sewer. The minimum depth of cover of 1m has been provided.

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4.7 Recommended slopes for minimum velocity

For sewers running partially full, for a given flow and slope, velocity is influenced by pipe diameter. The recommended slopes as per design manual for minimum velocity has been adopted

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Table.2 Adopted slope for minimum velocity

Sewer size (in mm)	Minimum slope	
	In %	**1 in**
150	0.6	170
200	0.40	250
250	0.28	360
300	0.22	450
375	0.15	670
450	0.12	830
>_ 525	0.10	1000

4.8 Size and shape of the sewers

The circular pipes were adopted for the trunk mains and branch sewers .The study area having present base year population of less than 1 lakh, so the minimum diameter of 150 mm has been adopted.

5.RESULTS

Adopting the above mentioned design parameter a detailed analysis and design of sewer network were carried out using macro enabled excel sheet and the results obtained were listed as follows

Table .3 Size and length of pipes

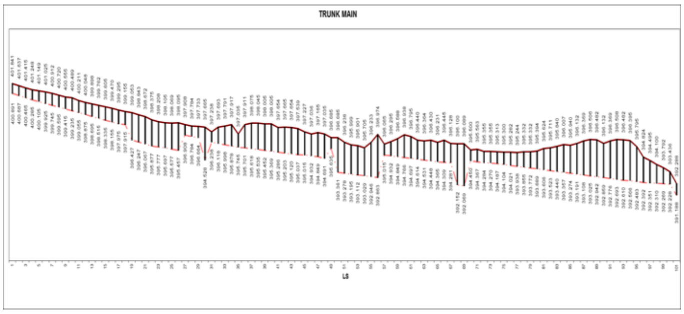


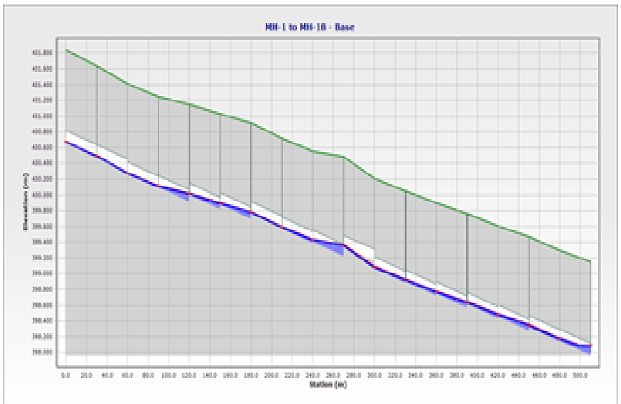
Fig.4 The profile of the trunk main from MH1 to MH138

6. CHECKING THE RESULT USING SewerCAD

SewerCAD is an extremely efficient tool for laying out a storm or sanitary sewer network. It is easy to prepare a schematic or scaled model and let SewerCAD take care of the link-node connectivity. A schematic drawing is one in which pipe lengths are entered manually, in the user defined length field. In a scaled drawing, pipe lengths are automatically calculated from the position of the pipes and nodes. The layout of the pipe network for zone 1 is shown in Fig.4

- The number of manholes connecting the trunk mains - 138
- The total number of manholes in the Zone 1- 522
- RCC pipes and stoneware pipes were used with the varied diameter ranges from 150 to 300mm
- The depth of cutting for the length of the pipe corresponding to different sizes of pipe diameter are shown in Table.3
- The profile of the trunk main is shown in Fig.4

Figure 4. layout of sewer network using sewercad



The results of sewer network were derived from SewerCAD and was analysed as per standard design constraints and guidelines prescribed by CPHEEO. The results derived were well within the design parameters and they were in acceptable manner so as to implement on the field without much difficulty. The summary of the results are narrated in Table.4 The typical analysis of sewer network for the area was represented in the form of graphs with respect to elevation invert level versus length as shown in Fig.5

7.CONCLUSIONS

- Analysis and design of sewer network for the proposed area was carried out using macro enabled Excel sheet. which provides the optimum size for the pipe network.

- The SewerCAD was used for optimizing the design of sewer network.
- The satisfactory results were obtained for the diameter and the slight variations in the slope of the sewerage network ,due to which the depth of cutting also varied.
- For large area, the manual calculations are tedious, Software like macro enabled Excel sheet or SewerCAD can be used for the analysis and design with engineering judgement when applying in the field.
- Sewage treatment plant was suggested in the ward number 34 to treat the water and further to use the treated waste water for the agriculture purpose.

ACKNOWLEDGEMENT
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Fig 1 Zonal boundaries for the proposed area

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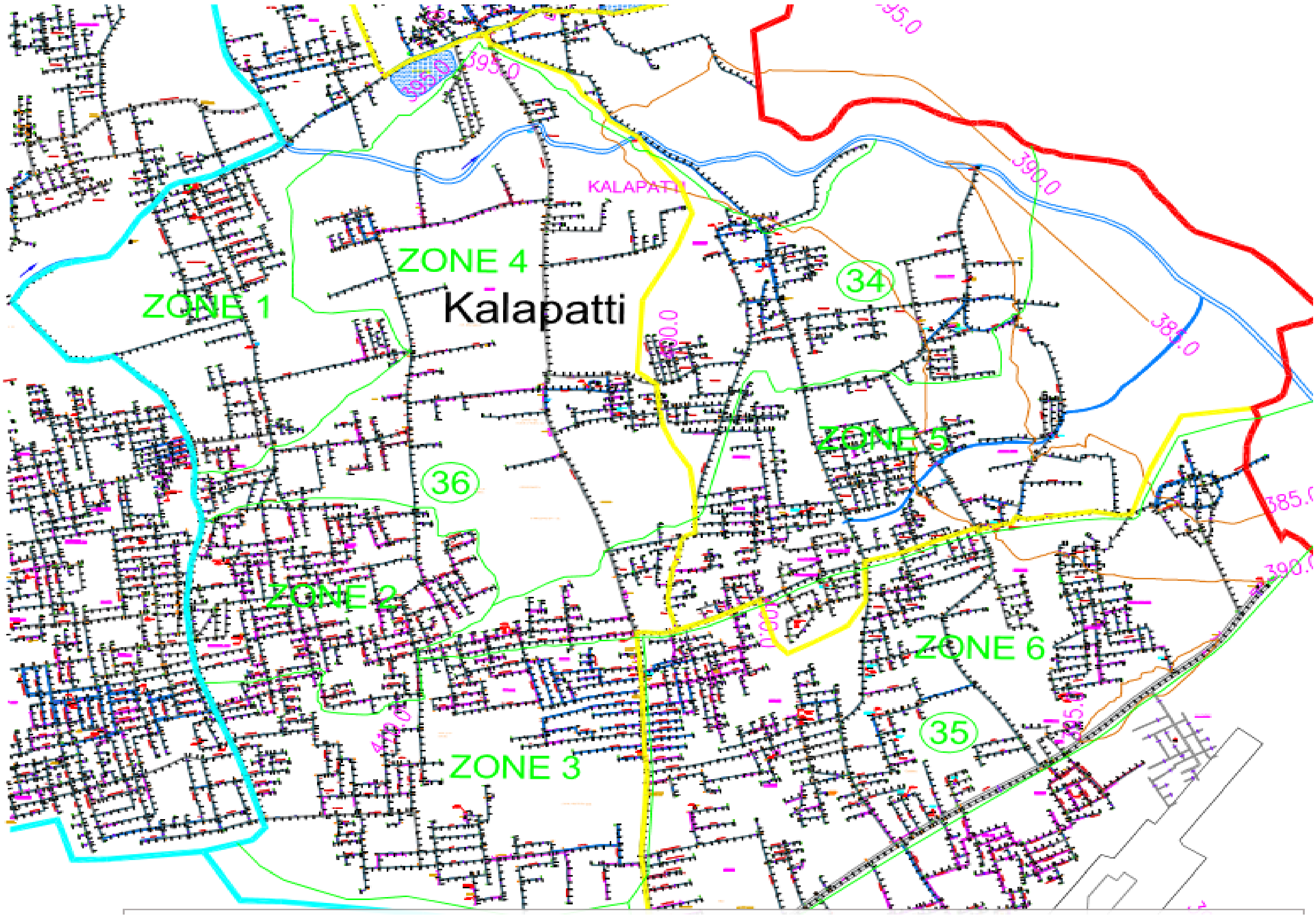

Fig 5 the profile of trunk main from MH1 to MH138

Table .3 Size and length of pipes

Diameter(mm)	150			200			250			300		
Depth range (m)	0 - 2	2 - 3	3 - 4	0-2	2 -3	3 - 4	0 - 2	2 -3	3 - 4	0-2	2 - 3	3 -4
Length (m)	7869	1424	300	290	0	30	226	710	70	1221	665	210

Table.4 Conduit report using SewerCAD

FlexTable: Conduit Table (Current Time: 0.000 hours) (CHECK 3.stsw)

	ID	Label	Start Node	Stop Node	Invert (Start) (m)	Length (Scaled) (m)	Slope (Calculated) (1/S)	Manning's n	Flow (L/s)	Conduit Description
4: CO-1	64	CO-1	MH-1	MH-2	400.669	33.8	167	0.013	0.06	Circle - 150.0 mm
8: CO-2	68	CO-2	MH-3	MH-4	400.265	30.0	167	0.013	0.18	Circle - 150.0 mm
0: CO-3	70	CO-3	MH-4	MH-5	400.098	29.2	167	0.013	0.24	Circle - 150.0 mm
2: CO-4	72	CO-4	MH-5	MH-6	399.999	29.1	167	0.013	0.30	Circle - 150.0 mm
4: CO-5	74	CO-5	MH-6	MH-7	399.875	28.2	167	0.013	0.36	Circle - 150.0 mm
6: CO-6	76	CO-6	MH-7	MH-8	399.762	30.7	167	0.013	0.42	Circle - 150.0 mm
8: CO-7	78	CO-7	MH-8	MH-9	399.570	29.6	167	0.013	0.48	Circle - 150.0 mm
0: CO-8	80	CO-8	MH-9	MH-10	399.405	30.4	167	0.013	0.54	Circle - 150.0 mm
2: CO-9	82	CO-9	MH-10	MH-11	399.339	29.5	167	0.013	0.60	Circle - 150.0 mm
4: CO-10	84	CO-10	MH-11	MH-12	399.061	32.7	167	0.013	0.66	Circle - 150.0 mm
6: CO-11	86	CO-11	MH-12	MH-13	398.898	26.2	167	0.013	0.72	Circle - 150.0 mm
8: CO-12	88	CO-12	MH-13	MH-14	398.748	33.0	167	0.013	0.78	Circle - 150.0 mm
0: CO-13	90	CO-13	MH-14	MH-15	398.612	29.2	167	0.013	0.84	Circle - 150.0 mm
2: CO-14	92	CO-14	MH-15	MH-16	398.455	30.1	167	0.013	0.90	Circle - 150.0 mm
4: CO-15	94	CO-15	MH-16	MH-17	398.320	26.7	167	0.013	0.96	Circle - 150.0 mm
6: CO-16	96	CO-16	MH-17	MH-18	398.145	19.5	167	0.013	1.02	Circle - 150.0 mm
8: CO-17	98	CO-17	MH-18	MH-19	398.005	12.6	250	0.013	7.91	Circle - 200.0 mm
100: CO-18	100	CO-18	MH-19	MH-20	397.903	30.6	250	0.013	7.97	Circle - 200.0 mm
102: CO-19	102	CO-19	MH-20	MH-21	397.093	29.7	250	0.013	8.03	Circle - 200.0 mm
104: CO-20	104	CO-20	MH-21	MH-22	397.522	30.0	250	0.013	8.09	Circle - 200.0 mm
106: CO-21	106	CO-21	MH-22	MH-23	395.576	27.8	250	0.013	8.15	Circle - 200.0 mm
108: CO-22	108	CO-22	MH-24	MH-23	396.955	49.3	250	0.013	8.86	Circle - 200.0 mm
110: CO-23	110	CO-23	MH-24	MH-25	396.955	13.0	250	0.013	10.12	Circle - 200.0 mm
112: CO-24	112	CO-24	MH-26	MH-25	396.945	30.1	250	0.013	10.18	Circle - 200.0 mm
114: CO-25	114	CO-25	MH-26	MH-27	396.945	29.5	250	0.013	10.84	Circle - 200.0 mm
116: CO-26	116	CO-26	MH-27	MH-28	396.634	30.3	250	0.013	11.98	Circle - 200.0 mm
118: CO-27	118	CO-27	MH-28	MH-29	396.585	27.9	250	0.013	12.04	Circle - 200.0 mm
120: CO-28	120	CO-28	MH-30	MH-29	396.578	31.9	250	0.013	12.52	Circle - 200.0 mm
122: CO-29	122	CO-29	MH-30	MH-31	396.578	19.1	250	0.013	12.58	Circle - 200.0 mm
124: CO-30	124	CO-30	MH-31	MH-32	396.543	11.0	545	0.013	13.66	Circle - 375.0 mm
126: CO-31	126	CO-31	MH-33	MH-32	396.767	29.9	667	0.013	13.72	Circle - 375.0 mm
128: CO-32	128	CO-32	MH-33	MH-34	396.767	30.1	545	0.013	13.78	Circle - 375.0 mm
130: CO-33	130	CO-33	MH-35	MH-34	396.761	28.5	536	0.013	13.84	Circle - 375.0 mm

67 of 567 elements displayed