Design of Sewer System for Village using SewerGEMS

Abhishek Pawar[1]
Dept. of civil engineering
DYP COE, Akurdi
Pune, India.

Yogesh Patil[2]
Dept. of civil engineering
DYP COE, Akurdi
Pune, India.

Prof. Sachin Mane[3]
Dept. of civil engineering
DYP COE, Akurdi
Pune, India.

Satyajeet Patil[4]
Dept. of civil engineering
DYP COE, Akurdi
Pune, India.

Nikhil Toche[5]
Dept. of civil engineering
DYP COE, Akurdi
Pune, India.

Prof. Yugandhara Ingale[6]
Dept. of civil engineering
DYP COE, Akurdi
Pune, India.

---***---

Abstract— The present study focuses on design of a sewer system using SewerGEMS software for Vake village situated in malegaon Taluka, Dist-Nashik, Maharashtra, India. SewerGEMS is a software which eliminates the cumbersome and time-consuming process for design of sewer system.it is fully dynamic and offers superior interoperability (ArcGIS, stand alone, SewerCAD) which provides straight forward and easy to use environment. With hydraulics tools it provides suggestions and opportunity to come up with alternative solutions so as to have efficient and feasible design. Sewer system mainly consists of conduits, manholes, pumps and other sewer appurtenances but our project is based on gravity sewer system which doesn't require pumps and flow is carried naturally by gravity

Keywords—SewerGEMS, ArcGIS, Contours, Sewage, Sewer network, Google earth.

I. INTRODUCTION

As per the WHO report, 80% of the diseases in human being are water-borne and water related. In rural areas or some villages there is no provision of transportation of wastewater which flows to lower lying areas creating ponds due to which mosquito breeding, foul smell is experienced it is mainly due to water pollution or water contamination and water logging. According to CPHEEO in practice around 80% of the water supplied is likely to be converted into waste water. There are two types of sewage: black water and grey water. Black water is the waste water from toilets and grey is wastewater from all domestic sources except toilets. The entire system of conduits and manholes intended for the collection, transportation of sewage is called sewerage system but excluding works for the treatment of sewage. Big cities have centralized sewage systems which use underground pipes, pumping stations, and treatment plants. Small towns / village cannot afford to build such system. In this view to provide an economical sewage network, which will be sufficient for the entire village and without harming human health and environment is main reason to this project. All above mention problems can be resolved by utilizing modern methods such as SewerGEMS software by Bentley and ArcGIS.

II. INFORMATION ABOUT SEWER-GEMS SOFTWARE

SewerGEMS is a software which makes the modelling process easier by providing additional time for solving wastewater engineering problems, likewise raising capacity and restricting sewer overflows, which ultimately enable utilities to comply with sewer design regulations set by regulatory agencies. The software provides advanced engineering tools to design, plan, maintain and operate sanitary sewer system.

SewerGEMS provides interoperability with four distinguished and well known softwares and provides easy to use environment to users.
These platforms are:

Microstation mode:

Used for bridging geospatial planning and drafting environment. All SewerGEMS tools can be used in Microstation software.

ArcGIS mode:

For mapping and ArcMap design network and GIS integration. All SewerGEMS tools can be used in ArcGIS ArcMap software.

AutoCAD mode:

Used for CAD layout and drafting. Both AutoCAD tools and SewerGEMS tools are available at same time in this mode.

With advanced tools like LoadBuilder, Modelbuilder, Tracking option for changes made all along while designing the network it enables users to keep track and easy input of primary data required which software converts automatically to help in designing and analysis of sewer network. SewerGEMS provides scenario comparison to analyse different flow patterns and sanitary load conditions.

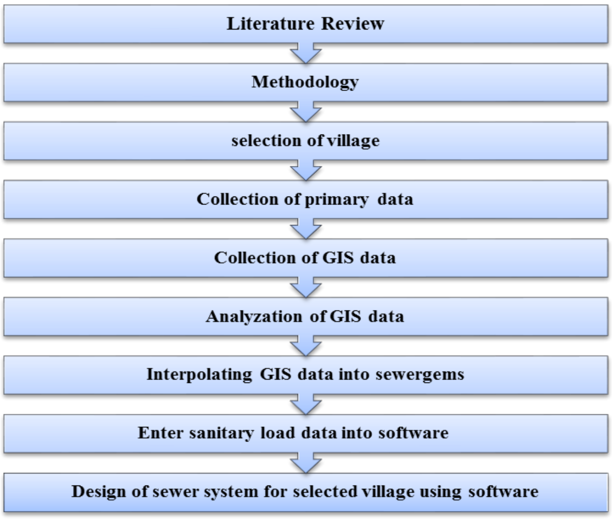
III.AIM

To study the use of SewerGEMS in order to design reliable sewer system for selected village.

IV.RESEARCH OBJECTIVES

- To perform primary survey of the selected village.
- To conduct a literature review and study of CPHEEO manual.
- To design a sewer system using hydraulics and hydrology tools of SewerGEMS software.

V.WORK FLOW



VI.METHODOLOGY

Selection of village

Vake village was selected for the design of sewer system. This village does not have any existing sewer system.

village - Vake, tal- malegaon, dist-nashik, maharashtra

Collection of data

a) *Collecting satellite view of village*
Satellite view was collected from Google earth software. This image is a actual view of village from above. It shows all the structure, road, ground, trees and natural streams.

b) *Collecting counter map and GIS data*
Contour map of village was unavailable at government sources or other internet sources. So, a new contour map was obtained using ArcGIS software. This process needed assist of GoogleEarthPro software for counter formation.

1. At first a grid of points was made on Google earth software. the data was exported in .xml format.

2. The .xml file was uploaded to site named GPS-visualizer. The site had embedded each point on grid with respective elevation data and the data was exported in .gpx format.

3. Then data was feed into ArcGIS- ArcMap software where analyzation of the data and formation of counter map was carried out. The counter map was exported into .shp format which is compatible with the openFlow SewerGEMS software.

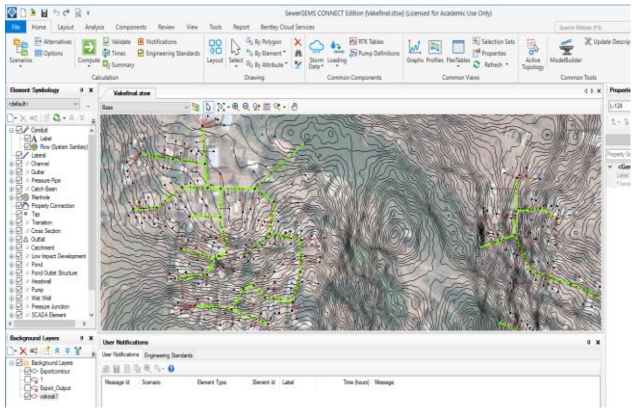


Figure: Contour Map used as layer

Collecting sanitary load data

Sanitary load data was collected from gram panchayat vake. The average sanitary load for each household in vake was found to be 240 L/day.

Design and analysis of sewer system

1. Different layers of data like satellite view and contour map was added to the sewer-gems software as a base map. Sewer lines, man-holes, conduit, outfall, etc. were drawn using the tools available in SewerGEMS software. Each household seen in the base map was marked with property connection.

2. Each property connection represent single household and was given with sanitary load of 240L/day.

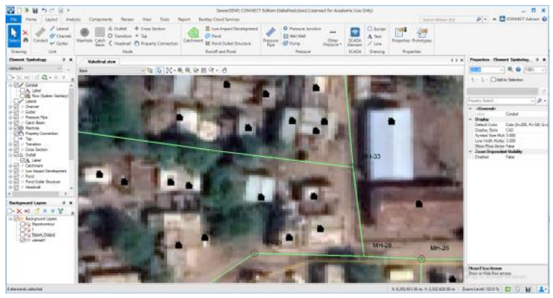


Figure: Property Connections

3. After laying out sewer lines and addition property connections, Loadbuilder tool was used to connect each property connection to the nearest manhole or conduit. Property connections get connected to nearest conduit by lateral and tap.

4. Using TRex tool elevation was given to each element in sewer system using .shp file i.e., EsriShape file of contour map obtained through ArcGIS-ArcMap software.

5. The material and shape of all conduits was changed to cement and circle respectively.

6. For design purposes the active numerical solver in Calculation options was changed to GVF-Convex (SewerCAD).

7. In the conduit catalog, catalog for circle-concrete was imported from engineering library, so that it could be available for design.

8. Minimum and maximum velocity constraint was given 0.6 m/s and 3 m/s respectively

9. To check existence of any errors validation of network was done using validate tool.

10. Clicking on Compute results in new design of sewer system.

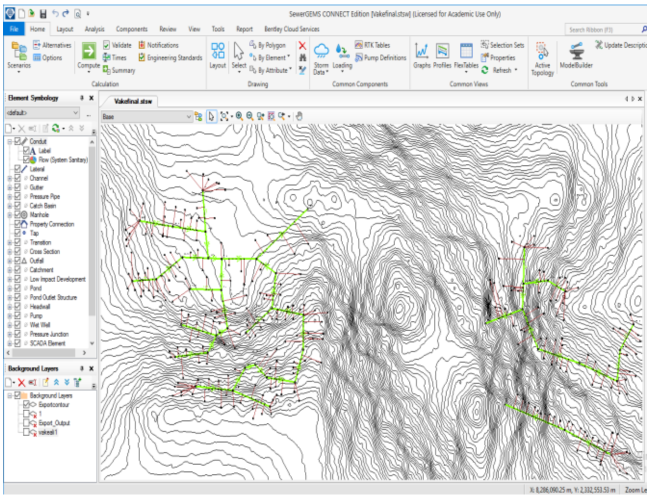


Figure: interface of SewerGEMS software with contour and sewer lines

VII. RESULTS AND OBSERVATION

SewerGEMS software designed conduits according to given sanitary load. We get all designed data through flex table and visualization of cross section of conduit through profiles. The software also provide us the direction of flow.

FlexTable: Manhole Table (Current Time: 0.000 hours) (Vakefinal.stsw)

	ID	Label	Elevation (Ground) (m)	Diameter (mm)	Set Rim to Ground Elevation?	Elevation (Rim) (m)	Bolted Cover?	Elevation (Invert) (m)	Inflow (Wet) Collection	Flow (Total In) (L/s)	Flow (Total Out) (L/s)	Depth (Out) (m)	Hydraulic Grade Line (Out) (m)	Headloss Method	Hydraulic Grade Line (In) (m)	Is Ever verflowing	Is erflowin	Sanitary Loads
30: MH-1	30	MH-1	458.32	914.4		458.32		457.25	<Colle	0.02	0.02	0.00	457.26	Absolute	457.26			<Collectio
31: MH-2	31	MH-2	458.05	914.4		458.05		456.99	<Colle	0.02	0.02	0.00	456.99	Absolute	456.99			<Collectio
33: MH-3	33	MH-3	457.15	914.4		457.15		456.04	<Colle	0.04	0.04	0.01	456.04	Absolute	456.04			<Collectio
35: MH-4	35	MH-4	457.31	914.4		457.31		456.25	<Colle	0.00	0.00	0.00	456.25	Absolute	456.25			<Collectio
39: MH-6	39	MH-6	456.94	914.4		456.94		455.88	<Colle	0.06	0.06	0.01	455.88	Absolute	455.88			<Collectio
41: MH-7	41	MH-7	456.21	914.4		456.21		455.14	<Colle	0.07	0.07	0.01	455.15	Absolute	455.15			<Collectio
53: MH-13	53	MH-13	458.47	914.4		458.47		457.37	<Colle	0.06	0.06	0.01	457.37	Absolute	457.37			<Collectio
55: MH-14	55	MH-14	458.49	914.4		458.49		457.43	<Colle	0.06	0.06	0.01	457.44	Absolute	457.44			<Collectio
57: MH-15	57	MH-15	459.21	914.4		459.21		457.93	<Colle	0.05	0.05	0.01	457.94	Absolute	457.94			<Collectio
59: MH-16	59	MH-16	459.22	914.4		459.22		458.15	<Colle	0.02	0.02	0.00	458.16	Absolute	458.16			<Collectio
61: MH-17	61	MH-17	459.60	914.4		459.60		458.54	<Colle	0.01	0.01	0.00	458.54	Absolute	458.54			<Collectio
63: MH-18	63	MH-18	459.03	914.4		459.03		457.28	<Colle	0.07	0.07	0.01	457.29	Absolute	457.29			<Collectio
65: MH-19	65	MH-19	459.27	914.4		459.27		457.11	<Colle	0.09	0.09	0.01	457.12	Absolute	457.12			<Collectio
67: MH-20	67	MH-20	458.63	914.4		458.63		456.95	<Colle	0.11	0.11	0.01	456.96	Absolute	456.96			<Collectio
69: MH-21	69	MH-21	457.87	914.4		457.87		456.79	<Colle	0.13	0.13	0.01	456.80	Absolute	456.80			<Collectio
71: MH-22	71	MH-22	456.94	914.4		456.94		455.87	<Colle	0.16	0.16	0.01	455.88	Absolute	455.88			<Collectio
73: MH-23	73	MH-23	456.50	914.4		456.50		455.43	<Colle	0.17	0.17	0.01	455.44	Absolute	455.44			<Collectio
77: MH-25	77	MH-25	456.20	914.4		456.20		454.23	<Colle	0.38	0.38	0.02	454.25	Absolute	454.25			<Collectio
79: MH-26	79	MH-26	456.12	914.4		456.12		454.43	<Colle	0.20	0.20	0.01	454.44	Absolute	454.44			<Collectio
82: MH-27	82	MH-27	456.55	914.4		456.55		455.49	<Colle	0.00	0.00	0.00	455.49	Absolute	455.49			<Collectio
85: MH-28	85	MH-28	456.21	914.4		456.21		454.51	<Colle	0.13	0.13	0.01	454.52	Absolute	454.52			<Collectio
87: MH-29	87	MH-29	456.39	914.4		456.39		455.33	<Colle	0.04	0.04	0.01	455.33	Absolute	455.33			<Collectio
89: MH-30	89	MH-30	456.78	914.4		456.78		455.71	<Colle	0.03	0.03	0.00	455.72	Absolute	455.72			<Collectio
93: MH-32	93	MH-32	457.19	914.4		457.19		456.12	<Colle	0.01	0.01	0.00	456.13	Absolute	456.13			<Collectio
95: MH-33	95	MH-33	456.14	914.4		456.14		454.63	<Colle	0.08	0.08	0.01	454.64	Absolute	454.64			<Collectio
97: MH-34	97	MH-34	456.64	914.4		456.64		455.57	<Colle	0.01	0.03	0.00	455.58	Absolute	455.58			<Collectio
99: MH-35	99	MH-35	455.89	914.4		455.89		454.82	<Colle	0.01	0.01	0.00	454.83	Absolute	454.83			<Collectio
109: MH-39	109	MH-39	458.51	914.4		458.51		456.95	<Colle	0.14	0.14	0.01	456.96	Absolute	456.96			<Collectio
111: MH-40	111	MH-40	458.62	914.4		458.62		457.56	<Colle	0.06	0.06	0.01	457.56	Absolute	457.56			<Collectio
113: MH-41	113	MH-41	459.76	914.4		459.76		458.69	<Colle	0.04	0.04	0.01	458.70	Absolute	458.70			<Collectio
115: MH-42	115	MH-42	460.07	914.4		460.07		459.00	<Colle	0.03	0.03	0.01	459.01	Absolute	459.01			<Collectio
117: MH-43	117	MH-43	460.83	914.4		460.83		459.77	<Colle	0.01	0.01	0.00	459.77	Absolute	459.77			<Collectio
119: MH-44	119	MH-44	461.53	914.4		461.53		460.46	<Colle	0.00	0.00	0.00	460.46	Absolute	460.46			<Collectio
121: MH-45	121	MH-45	458.57	914.4		458.57		457.07	<Colle	0.04	0.04	0.01	457.08	Absolute	457.08			<Collectio
123: MH-46	123	MH-46	459.80	914.4		459.80		458.74	<Colle	0.02	0.02	0.00	458.74	Absolute	458.74			<Collectio
125: MH-47	125	MH-47	460.67	914.4		460.67		459.61	<Colle	0.01	0.01	0.00	459.61	Absolute	459.61			<Collectio

Figure: Flex Table - Manhole

Conduit and Pressure Pipe Inventory

Circular Pipe | Laterals

	Conduit Description	Count	Length (Concrete) (m)	Length (All Materials) (m)
Circle - 150.0 m	Circle - 150.0 mm	41	1,437.4	1,437.4
Total Length	Total Length	41	1,437.4	1,437.4

Figure: Conduit And Pipe Inventory

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

	ID	Label	Start Node	Invert (Start) (m)	Stop Node	Invert (Stop) (m)	Length (Scaled) (m)	Slope (Calculated) (m/m)	Section Type	Material	Diameter (mm)	Manning's n	Depth (Middle) (m)	Capacity (Full Flow) (L/s)	Flow / Capacity (Design) (%)	Depth/Rise (%)
32: CO-1	32	CO-1	MH-1	457.25	MH-2	456.99	38.1	0.007	Circle	Concrete	150.0	0.013	0.00	12.69	0.2	2.9
34: CO-2	34	CO-2	MH-2	456.99	MH-3	456.04	18.8	0.051	Circle	Concrete	150.0	0.013	0.01	34.25	0.1	3.3
36: CO-3	36	CO-3	MH-3	456.04	MH-4	456.25	41.8	0.005	Circle	Concrete	150.0	0.013	0.00	10.77	0.0	2.6
42: CO-6	42	CO-6	MH-6	455.88	MH-7	455.14	36.4	0.020	Circle	Concrete	150.0	0.013	0.01	21.64	0.3	5.1
56: CO-13	56	CO-13	MH-13	457.37	MH-14	457.43	12.5	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	0.6	5.8
58: CO-14	58	CO-14	MH-14	457.43	MH-15	457.93	25.3	0.020	Circle	Concrete	150.0	0.013	0.01	21.54	0.3	5.1
60: CO-15	60	CO-15	MH-15	457.93	MH-16	458.15	43.3	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	0.2	3.9
62: CO-16	62	CO-16	MH-15	457.93	MH-17	458.54	45.8	0.013	Circle	Concrete	150.0	0.013	0.00	17.45	0.0	3.1
64: CO-17	64	CO-17	MH-13	457.37	MH-18	457.28	17.6	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	0.7	6.2
66: CO-18	66	CO-18	MH-18	457.28	MH-19	457.11	33.1	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	0.8	6.8
68: CO-19	68	CO-19	MH-19	457.11	MH-20	456.95	31.6	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	1.0	7.4
70: CO-20	70	CO-20	MH-20	456.95	MH-21	456.79	32.5	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	1.2	7.5
72: CO-21	72	CO-21	MH-21	456.79	MH-22	455.87	37.1	0.025	Circle	Concrete	150.0	0.013	0.01	23.96	0.6	7.7
74: CO-22	74	CO-22	MH-22	455.87	MH-23	455.43	32.8	0.013	Circle	Concrete	150.0	0.013	0.01	17.65	1.1	8.2
78: CO-24	78	CO-24	MH-23	455.43	MH-25	454.23	26.1	0.046	Circle	Concrete	150.0	0.013	0.02	32.69	0.6	11.1
80: CO-25	80	CO-25	MH-25	454.23	MH-26	454.43	40.4	0.005	Circle	Concrete	150.0	0.013	0.02	10.77	2.2	12.2
81: CO-26	81	CO-26	MH-26	454.43	MH-7	455.14	28.8	0.025	Circle	Concrete	150.0	0.013	0.01	23.91	0.3	7.8
83: CO-27	83	CO-27	MH-7	455.14	MH-27	455.49	36.3	0.010	Circle	Concrete	150.0	0.013	0.01	14.85	0.0	3.3
84: CO-28	84	CO-28	MH-3	456.04	MH-6	455.88	14.6	0.011	Circle	Concrete	150.0	0.013	0.01	16.04	0.3	4.4
86: CO-29	86	CO-29	MH-26	454.43	MH-28	454.51	15.7	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	1.4	9.3
88: CO-30	88	CO-30	MH-28	454.51	MH-29	455.33	30.0	0.027	Circle	Concrete	150.0	0.013	0.01	25.16	0.2	6.3
90: CO-31	90	CO-31	MH-29	455.33	MH-30	455.71	36.5	0.011	Circle	Concrete	150.0	0.013	0.01	15.65	0.2	3.9
94: CO-33	94	CO-33	MH-30	455.71	MH-32	456.12	27.9	0.015	Circle	Concrete	150.0	0.013	0.00	18.49	0.1	2.7
96: CO-34	96	CO-34	MH-28	454.51	MH-33	454.63	24.8	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	0.9	7.4
100: CO-36	100	CO-36	MH-33	454.63	MH-35	454.82	38.3	0.005	Circle	Concrete	150.0	0.013	0.01	10.77	0.2	4.8
110: CO-41	110	CO-41	O-2	454.88	MH-39	456.95	44.7	0.046	Circle	Concrete	150.0	0.013	0.01	32.78	0.5	6.4
112: CO-42	112	CO-42	MH-39	456.95	MH-40	457.56	41.2	0.015	Circle	Concrete	150.0	0.013	0.01	18.47	0.4	6.3
114: CO-43	114	CO-43	MH-40	457.56	MH-41	458.69	49.7	0.023	Circle	Concrete	150.0	0.013	0.01	23.02	0.2	4.6

41 of 41 elements displayed SORTED

Figure: Flex Table - conduit

Figure: final view of sewer system

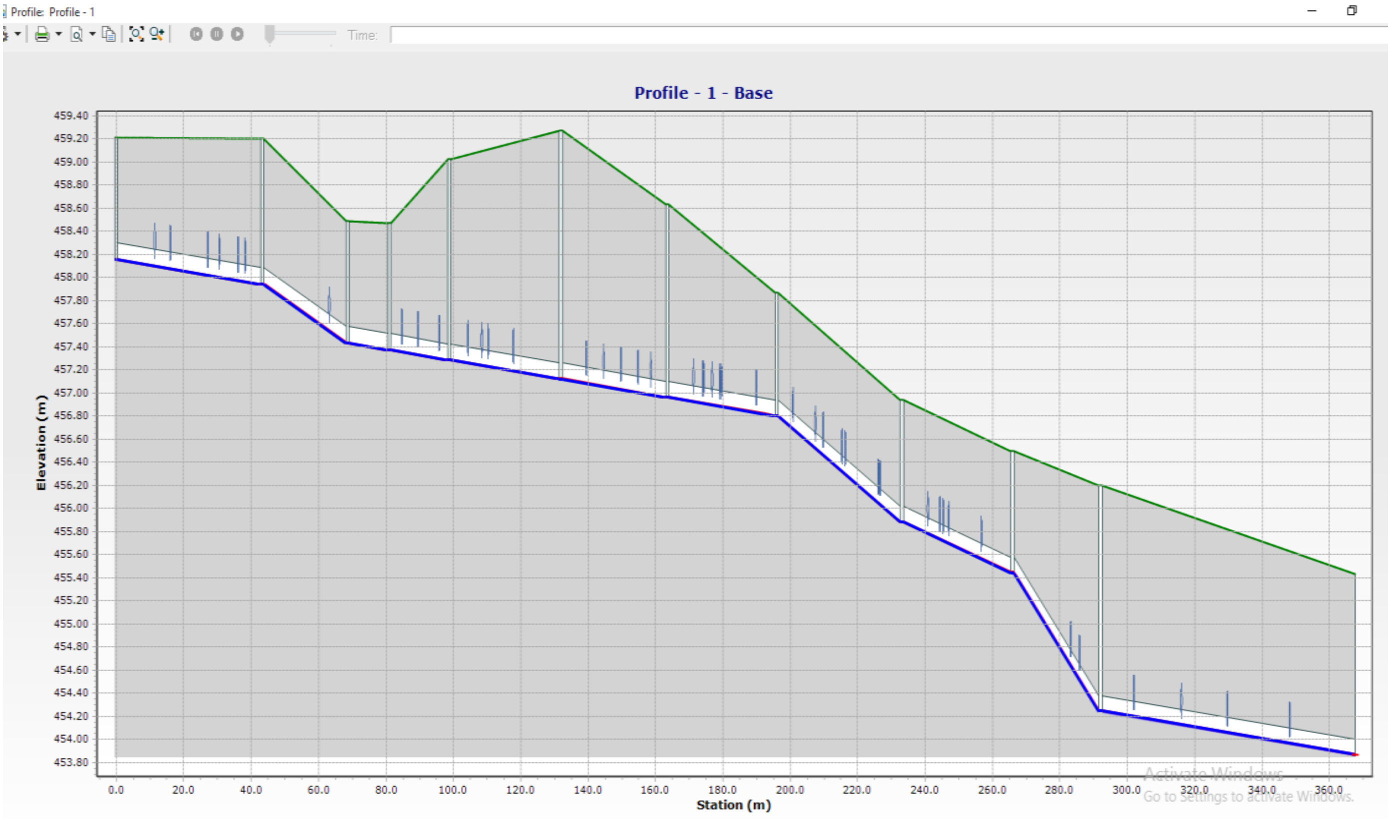


Figure: Profile Diagram

VIII. CONCLUSION

1. The project presents sewer system for vake village with detailed design of conduits and manholes.
2. The results are represented in tabular format including details like length, slope, section type, material, diameter, etc.
3. Overall, the software is easy to use with visual and tabular results consuming less time.

REFERENCES

1. MURUGESH KATTI, AND KRISHNA B.M, "DESIGN OF SANITARY SEWER NETWORK USING SEWER GEMS V8I SOFTWARE". INTERNATIONAL JOURNAL OF SCIENCE TECHNOLOGY & ENGINEERING | VOLUME 2 | ISSUE 01 | JULLY 2015
2. HINAL SOPARIYA AND PROF R.L.PATEL "ANALYSIS AND DSIGN OF SEWER NETWORK USENG SEWER GEMS ". 2018 IJCRT | VOLUME 6 | ISSUE 2 APRIL 2018 | ISSN: 2320-2882
3. SHRADDHA TIWARI AND MANGESH BHORKAR , "DESIGN OF UNDERGROUND DRINAGE SYSTEM IN RURAL AREA USING SEWER GEMS SOFTWARE". IRJET | VOLUME 07 ISSUE 06 | JUNE 2020. E-ISSN : 2395-0056 , P-ISSN : 2395-0072
4. MR RAVIKIRAN K AND MR ARJUN S VIRUPAKSHI, "DESIGN OF SEWER NETWORK SYSTEM FOR THE JANWAD VILLAGE USING SEWERCAD V8I". IRJET VOLUE 03 ISSUE 07| JULLY-2016. E-ISSN :2395-0056, P-ISSN: 2395-0072,
5. MR. NAVEEN KUMAR RAI," SEERAGE SYSTEM ASSESSMENT USING SEWER GEMS V8I AND AUTOCAD CIVIL 3D". INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE INVENTION ISSN:2319-6734, VOLUME 9 ISSUE 5 SERIES 2| MAY 2020|| PP 24-29,
6. MS .HARSHA S. BHAVIMANI AND DR. ANAND V. SHIVAPUR, "DESIGN OF SANITARY SEWER NETWORK FOR ZONE 10 , BELAGAVI CITY USING SEWERGEMS V8I SOFTWARE". INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING AND TECHNOLOGY (IRJET) VOLUME 2, ISSUE B| E-ISSN: 2456-3315
7. B.SINGH, "CITY OF WATERLOGGED STREETS CHOCKED DRAINS?: VARANASI NEWS – TIMES OF INDIA," THE TIMES OF INDIA, 19-AUG-2013. [ONLINE]. AVAILABLE: HTTPS://TIMESOFINDIA.INDIATIMES.COM/CITY/VARANASI/CITY-OF-WATERLOGGED-STREETS-CHOKED-DRAINS/ARTICLESHOW/21914753.CMS. [ACCESSED: 28-APRIL-2021]
8. MR . UDITI CHAUDHARY , TANISHA KUMARI , SARA BAMIRI AND B.R.G.ROBERT " SANITARY GRAVITY SEWER DESIGN USING SEWER GEMS SOFTWARE CONNECT EDITION FOR UTSAV VIHAR , KARALA" INTERNATIONAL RESEARCH JOURNAL OF ENGINEERING AND TECHNOLOGY ISSN: 2277-3878, VOLUME 9 ISSUE | JULY 2020