Design of Sanitary Sewer Network for Zone 10, Belagavi city using SewerGEMSV8i Software

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***Abstract*— The paper presents an advanced modeling and design software application for sewer network-sewerGEMSV8i; it allows projects to be complete in an extremely short time, with high efficiency and less prices. In the present study the sewer network has to be designed for Zone 10, of Belagavi city. In the design of a sewerage system the sewer network is the basic unit taking place repeatedly in the design activity. Any savings during the design of this unit will affect the overall cost of the sewerage system. Bentley sewerGEMSV8i is the first and only fully dynamic, multi-platform (GIS, CAD and stand-alone) sanitary and collective sewer modeling solution. With Bentley sewerGEMSV8i, we will evaluate all sanitary sewer system in one package and the option of presenting the analyses with the SWMM algorithm or our own implicit solution of the full saint empty equations. The hydraulic design consists in the totaling of transit and total flow and hydraulic modeling for network pipes diameters or slopes. The network consists of pipes of varying diameter, manholes and outfalls. The application provides reports, layouts, longitudinal or transversal cross sections of pipe network, displayed in an advanced graphic system based on AutoCAD technology. With detailed tools and features included, sewergemsv8i offers a full range of possibilities for the designer to draw, label, dimension and plotting the drawings of sewage networks. In this work, the sewerage networks were designed by considering the rules put forth by leading bodies and using commercially available materials and results obtained are well within range.**

***IndexTerms* — ArcGIS and CAD, Microstation, Sewage, Sewer network, SewerGEMSV8i, Belagavi city.**

I. INTRODUCTION

The water and waste water together is called sewage. Domestic and industrial sewage are two types of sewage which are normally conveyed through UGD to the disposal sites. The domestic sewage contains liquid waste coming from bathrooms, latrines, washbasins, and kitchen sinks etc. Of the residential, business or institutional building. The waste generating from the mechanical processes of various industries, for example, coloring, paper making, brewing so on is called the industrial sewage. The sum of domestic and industrial sewage might be named as sanitary sewage or simply sewage. For any society sewage networks are important to hold the municipal waste to sewage treatment plant for better environment and better health condition of the people.

The city sewage system provides one of the essential infrastructure conveniences to carry sanitary waste to sewage treatment plant. In the earlier times, manual design of conveyance system was practiced and Today, due to the advent fast developing technology, well arranged computer aided design tool named as 'sewer' is being used for design commonly. Along with the newest technologies, 'info sewer' is a commanding ArcGIS – based pc program utilized for arranging, design, analysis & extension of sanitary, combined & storm sewer collection system. The 'SewerGEMSV8i' developed and implemented by Bentley's product is most versatile tool for the design of UGD and has been used in the present study.

II. ABOUT SOFTWARE

The software has three type of mode and they briefly explained in the following paragraph:

Microstation Mode

This gives us access to all microstation presentation and drafting instrument, while as yet enabling on the way to present Bentley sewergemv8i modeling tasks like altering, information administration. It association among Bentley sewergemsv8i and microstation empowers exceedingly full and correct mapping of representation components. This capacity gives the most elasticity plus the greatest level of similarity by means of additional CAD-based applications and picture information maintained at all association.

ArcGIS Mode

Every mode gives access to various functionality, with unmistakable errors that are accessible inside ArcGIS method could not be there when functioning inside the Bentley sewergemsv8i.solitary proofreader.

AutoCAD Mode

This gives us access to AutoCAD's for entire drafting and presentation contraption, at the same time as yet empowering us to perform Bentley sewergemsv8i demonstrating responsibilities like cutting, resolving problem and information administration. The connection among Bentley sewergemsv8i and AutoCAD empowers to great degree point by point and correct elements

mapping in the model, and gives the full scope of yield and presentation features accessible in AutoCAD. This competence gives the majority adaptability and the maximum amount of similarity among further CAD-based drawing information.

III. STUDY AREA – RAMATEERTH NAGAR

The study area "Ramatheerthnagar" is a new layout coming up in the limits of Belagavi city corporation area. The details of Belagvi city and the study area are given below.

ABOUT BELAGAVI CITY

Location and topography

Belagavi City is a Divisional Head Quarter of Karnataka State and is placed at a distance of about 500 Kms from the State capital city Bangalore. The total area of the city is about 94.08 sq. km as said by the Comprehensive Development Plan 'CDP' of Belagavi urban development authority. NH 4 and NH 4 A passes through the city and connects to the adjoining states Maharashtra and Goa. The city is at the foothills of the Sahyadri range (Western Ghats) at an elevation of 2,500 feet (779 m) above mean sea level.

Belagavi can be reached by road from main cities of India such as Mumbai, Pune, Hyderabad and Goa. The city is enclosed by the agricultural fields. City is increasing quickly because of urbanization and growing number of several Institutions, Industries, etc. The population of the city as per 2011 survey is 488157 and present population is about 525000 including Cantonment area.

Climate

The climate of Belagavi city is

1) Rain fall: about 1300mm (Average)
2) Maximum temperature: 35.4^0 C in May
3) Minimum temperature: 14.3^0 C in December

Geographical status

The city is having level and rough ground and the strata met with all kinds of geological formations including black cotton to hard rock and sum portion is also met with lateritic soil.

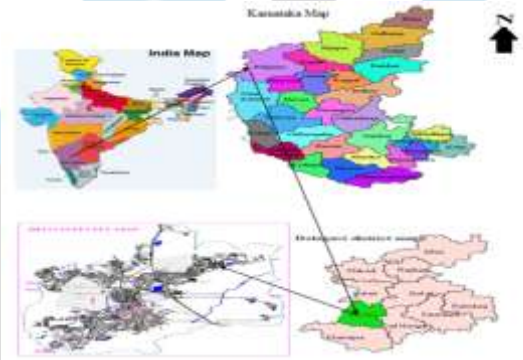


Fig.1: Key map of belagavi city

Existing Water Supply and Sewer Arrangement

The Belagavi city has 3 sources of water supply systems namely, Rakkasakoppa Reservoir Built across the Markendaya River about 18 Kms from the city in the year 1962 exclusively for providing drinking water to Belagavi City. Water from this source flows through gravity for about 12 Kms. The ability of the reservoir is 0.60 TMC. Hidkal Reservoir builds across Ghataprabha River at a distance of about 52 Kms from the Belagavi city. Capacity of this major irrigation reservoir is 51 TMC in which 1.752 TMC water is allocated for drinking water requirement of Belagavi city. Ground Water Sources, in addition to the above 380 Bore Well with Hand pumps and 416 are fitted with Power Pumps are provided in city.

The present sewer network is about 337 Kms comprising of 150mm to 300mm dia stoneware / RCC pipe along with the trunk mains of 28 Kms. The trunk mains vary from 300mm to 1200mm diameter RCC pipes. As there is no sewage treatment facility, the effluent is let into the close-by nalas and the main out fall sewer is let in-to Bellary nala and Lendi nala. The existing sewerage network serves for the area extent of 53% of the city. At present, the quantity of sewage generated is more than 35 MLD.

Necessity of project

Belagavi city is provided with UGD sewer network laid since 1965 which covers 53% of UGD in city and rest 47% have their own septic tank facility. There is no sewage treatment plant in the city. The sewage is let into the nalas without treatment. The city requires the underground drainage network for

- For better hygienic condition
- For better development of area
- Proper sewage disposal and management

- Economic design and `preparation of sewer

Fig.2**:** Master plan of Belagavi

Design proposal for sewer network

The preparatory work for design engineer is to carry out field examination and further to study carefully the characteristics of study area pertaining to the street network pattern, projected population, invert level of pipe at manhole, existing network, land topography, natural barrier, existing and proposed land use, uncertainly proposed site for sewage treatment plant and the outfall etc. trunk sewer arrangement has been proposed by considering the geography of the city and major deterrents like national highway and railway track. Zoning has been done such that trunk sewer line has to cross NH and railway line at very least points. Based on this entire Belagavi city is isolated into 14 zones, Ramatheerthnagar comes in the zone 10 of Belagavi city.

IV. MATERIAL AND METHODS

Data collection

For design a sewer network of Belagavi city, the following data were obtained from Karnataka urban water supply and drainage board (KUWDB) Belagavi.

[1] Collection of population of last 5 decades of Belagavi city.
[2] Collection of existing water supply detail.
[3] Topographical map of Belagavi city.
[4] Road map of Belagavi city.
[5] Data of previous existing sewer network and invert level of existing manhole.

Fig. 3: Population projection of Ramatheerthnagar (zone 10)

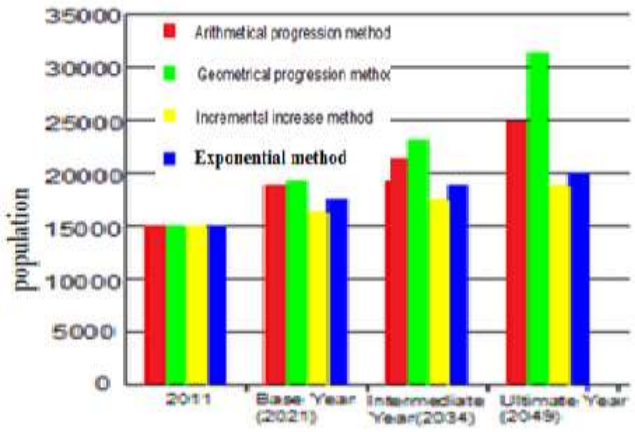
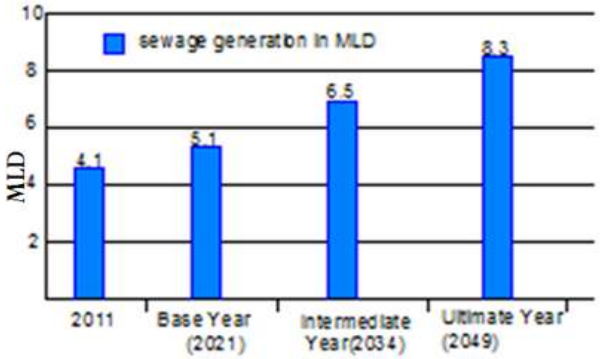


Fig.4: Sewage generation of Ramatheerthnagar (zone10)



Design criteria

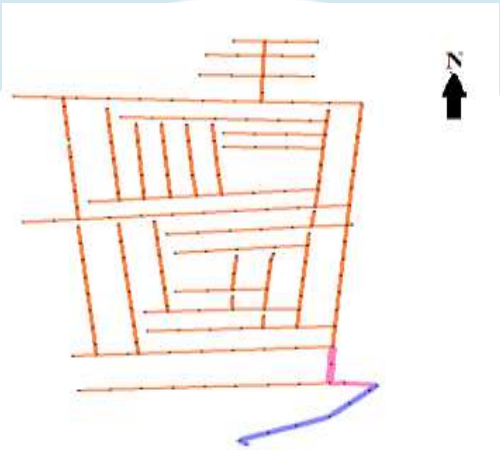
The major design criteria adopted for this project are as listed below. The per capita sewage generation is taken as 135 lpcd i.e.80% of water supply level as suggested by CPHEEO. The minimum diameter of sewer adopted is 150 mm. Materials used are concrete pipe. The minimum velocity is 0.6 mps at present peak flow and peaking factor from 2.25 to 3.00 based on cumulative population as suggested in CPHEEO manual. However since it is practically not possible to ensure this in starting laterals, the sewers have been designed to have minimum slopes suggested in CPHEEO manual.

V. DESIGN OF SEWER NETWORK

Laying Out a Network

The network is designed by using a software sewergemv8i. This software is exceedingly efficient tool for laying out network. It is simple to set up a diagram or graphic and sewergemsv8i take concern link node connectivity. In laying the network there is no necessary to be valid the labels to pipes and nodes, since the software assign labels mechanically.

Fig.5: Lay out network for Ramatheerthnagar (Zone 10).



Working in GIS Mode

Bentley sewergemsv8i gives three conditions in which to work Bentley sewergemsv8i modeler mode, AutoCAD coordinated mode, and bend delineate mode, every mode gives access to switch usefulness - certain capacities that are accessible inside Bentley sewergemsv8i modeler mode may not be accessible when working in circular segment outline, mode, and the other way around. Furthermore, we can make utilization of circular segment index to perform activities or occasions on any Bentley sewergemsv8i information base. The advantages of working in ArcGIS mode include:

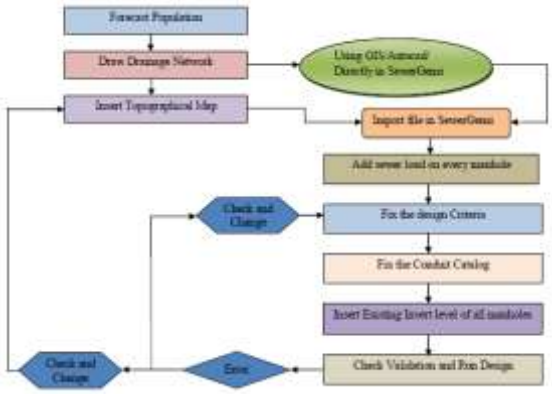
1. Full usefulness from inside the GIS itself, without the requirement for information import and fare, or change
2. The capacity to see and alter different situations in the same geo database
3. Minimum information replication
4. GIS custom questioning capacities
5. Build models without any preparation utilizing basically any current information source
6. Make use of the powerful reporting and presentation capability of GIS

Working in AutoCAD Mode

The AutoCAD usefulness has been executed in a way that is same as the sewergemv8i base item. When we get comfortable with the stand –alone mode, we won't have any many-sided quality utilizing the item in AutoCAD mode. Some of points of interest of working in auto scoundrel mode include:

1. Format organizes connections and structures in completely scaled mode in a similar outline and drafting condition that we use to execute building arranges.
2. Utilize local AutoCAD inclusion snaps to precisely position Bentley sewergemsv8i components concerning substances in auto miscreant drawing.
3. Utilize local AutoCAD summons, for example, move, delete, and pivot on Bentley sewergemsv8i display elements with programmed refresh and synchronization with the model database.

Fig.6: Stepwise Procedure of Design in sewergemsv8i Software



VI. SEWERGEMSV8I RESULTS

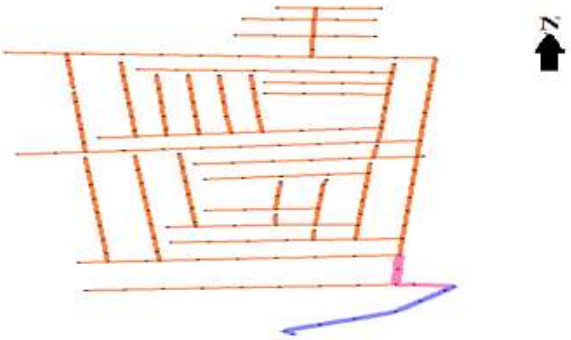
The end result of network was obtained from the 'SewerGEMSV8i' as outputs according to the parameters approved by CPHEEO. The d/D ratio of 80% is fixed for the present study as suggested by CPHEEO rules. The results obtained are within the prescribed restrictions. The summary of the results are narrated in table 1

Table 1: Summary of sewer network of the Ramateerthnagar (zone 10)

Sl. No.	Parameters	Quantity	Units
1.	Area	103843.75	m^2
2.	Manhole	201	Numbers
3.	Sewer line length	5,645.99	M

The Figure 7 shows the schematic representation of the sewerage network designed for the Ramateerthnagar (zone 10). The color coding in the map represent the different diameter of pipes.

Fig.7**:** Map representing the sewerage network of Ramateerthnagar (zone 10)



The percentage of man hole with different range of depths as obtained from the SewerGemV8i is represented in the Table 2 given below.

Table 2: Depth Wise Manhole Details In the Study Area network

Sl. No.	Depth Of MH	Number Of MH	Percentage
1.	<1.0 m	105	52.24%
2.	1m – 2m	77	38.3%
3.	2m – 3m	15	7.46%
4.	3m – 4m	4	1.99%

From the above table, it was observed that 52.24% manholes have a depth less than 1m, 38.3% of the manholes have a depth between 1 to 2 m and . 7.46% of the manholes have depth between 2 to 3 m, and remaining 1.99% of the manholes have depth between 3 to 4 m. The percentage pipes of each diameter pipes used in the design are shown in Table 3 along with the total length of each diameter pipe.

Table 3: Details of sewer lines in the study area network

Sl. No.	Diameter (mm)	Length (m)	Percentage
1.	150	5258	93.13%
2.	200	211	3.736%
3.	300	177	3.13%

The total length of pipes of all diameters together is 5646 m. It was observed that about 93.13% of the pipes were of 150 mm diameter, 3.76% was of 200 mm diameter, and remaining 1.99% of the pipes were 300mm. Depending on the sewer load generated at different nodes, pipes of diameter 150 mm, 200 mm and 300mm are provided.

Table 4: Velocity in Sewer line and number of manhole experiencing the velocity

Sl. No.	Velocity (m/s)	Number of MH	Percentage
1.	<0.3	102	50.7%
2.	0.3 – 0.6	60	29.85%
3.	>0.6	39	19.4%

It was observed from the results that 50.7% of the manholes had a velocity <0.3 m/s, about 29.85% of the manhole have 0.3 to 0.6 m/s of velocity and 19.4% of the manhole have a velocity > 0.6 m/s . The lower velocity of less than 0.3 m/s is caused due to low load generated at the starting of the starting point of branches. As per the CPHEEO guide line the % of manhole with more than 0.3 m/s velocity should be 49.25 and the present study satisfies the requirement.

VII. CONCLUSION

The fallowing conclusions were drawn based on the work carried out on a network design for sewerage system for Ramateerthnagar, zone 10 of Belagavi city.

- The software is helpful in doing iterative procedure for determining the friction factor and discharge from the hydraulic heads.
- The software used was suitable alternative to other methods particularly in view of accuracy.
- It is been found from the study that the total number of manholes to be provided is 201,among which 52.24% of manholes are found to have depth less than 1 meter.
- It is found from the study that 29.85% of the manhole has 0.3 to 0.6 m/s of velocity and 19.4% of the manholes have a velocity > 0.6 m/s.
- For the design of the sewerage network the process is found to be easy and uncomplicated by using the software.

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