Industrial Sewer System Design required and the Design criteria

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Abstract:The design of industrial sewer design system is a large scale optimization problem, involving many complex calculations. Recently, this problem has been compounded by the evident need to embrace more than a single measure of performance into the design process, since by nature multi-objective optimization methods require more iteration .these problem properties have motivated several prier studies to use computational software‘s because these software‘s have been shown to obtain higher quality solutions for large sewer system design problems. They do not require much time in order to achieving a satisfactory solution. Hence the use of design software's for design of an industrial sewer system could be a remedy to this problem. These specific software's are capable of achieving a satisfactory level of performance with limited number of function evaluations represent a valuable alternative. A sewer system is an underground conduit or drain though which sewerage is conveyed to the point of discharge or disposal. many design & construction factors need to be considered before sewer design can be completed .factors such as design period , peak ,average , minimum flows ,sewer slopes ,minimum and maximum velocities ,design equation, sewer material ,joints and connection, appurtenance and sewer installation etc. are all important in developing sewer design. In this study sewer cad software is being used for designing problem of a real medium size sewer system in Chopanki ,an industrial area in district Alwar (Rajasthan).Results obtained suggest that the use of sewer CAD software could be successfully extended to the efficient design of large scale sewer systems.

Index items-Industrial Sewer Design, Software, Design Criteria, and parameters.

1. Introduction

Every community is to control both liquid and solid wastes. the liquid portion of the waste is basically the used up of water supplied to the community, duly been fouled as waste water by verity of uses .thus wastewater may be considered to have been generated at different sources such as residences, institutions, commercials and industrial establishments together with apportion of ground water along water carrying wastes from such generations found in it. if the above waste water is allowed to remain shell result the following adverse effect to the environment.

a) Decomposition of stagnant organic material shell lead to the production of large quantity of odorous and pollutional gases
b) Stagnant waste containing toxic and hazardous ingredients may affect the ecosystem adversely.

Thus the main objectives of proper wastewater disposal are:

1. To prevent public health.
2. To prevent adverse conditions caused by discharge of pollution to the environment.
3. To limit the disposal of waste onto land.

For safely disposal of waste water and domestic waste water, we require to dispose the waste water carefully through a network of pipeline known as the sewer lines which carry the waste water to the waste water treatment plant. These sewer lines which carry the wastewater to the waste water treatment plant. These sewer lines are provided with specific discharge rates depending upon the population and utility of the particular region. The 21st century is called to be a compute century .the computer is a device, which works accurately, fast and efficiently .Now due to computer the work done by hundreds of people and taking months.

2. General Design considerations for sewer system

2.1 Design Formula: Manning's formula shall be used for designing the sewerage system.

V=1/n r 2/3 s ½

Where: V=Velocity of flow in mps s=Slope of Hydraulic gradient
N= Manning's coefficient of roughness Q=Discharge in lps=AX V
r= Hydraulic gradient A= area of cross section of pipe, sqm

Value of the Manning's roughness's coefficient is taken as 0.012 for the HDPE pipe as per the value in the CPHEEO manual no.3.4

2.2 Basic Design Considerations: While planning for the design a trunk pipeline, there are several design considerations that must be taken into account to make the trunk pipeline effective in upstream town sewage collection and conveyance as it is received at its inception as well as to meet requirements of reasonable design period .these include characteristics of the sewage ,its quantity and rate of flow, design period, construction cost O & M costs etc, and the factors relevant to proposed project are discussed below.

2.3 Design period/ design life of components: Machines and equipments used in any system have life 5-15 years, during which they may be serviced and overhead several times, civil structures, if properly constructed can easily last 30 years. the sewerage system is also normally designed for a period of 30 years and in the present case, where sewerage and STP are planned simultaneously ,the treatment plant should be considered as a part of sewerage system. As per the guidelines in CPHEEO manual, the trunk pipeline shell be designed to meet the requirements existing after 30 years.

2.4 Design Approach: The peak flow velocity, Depth of flow in sewer, Invert levels, Elevations,depth of Excavation ,slope etc. calculations are as per formulas given in CPHEEO manual. The calculations have been done for Excel computer sheet and formula considered has also been given separately for verification .the excel sheet is used as it is easy to check the individual calculation on excel sheet. Design approach is as per Chapter 3.5.4 of CPHEEO manual 1993EXCEL sheet prepared for designing the outfall sewer is similar to the Appendix 3.5 of CPHEEO Waste Water treatment & Disposal Manual.

2.5 Flow Conditions: Flows in sewers are directly related to the per capita water supply to the contributing population and other users. The contributing areas are mostly residential and commercial. Flows in different sewer sections in these designs have been estimates bt estimating the contributing population and multiplying the same by per capita waste water contribution and peak factor corresponding to the population as per the design principles for sewers.

2.5 Ground water infiltration: The water table is 100-120 meter below the ground level in Chopanki industrial area. The total rainy days are 30 days in rainy season. The sewer is to be laid along the Nallah in some area where flow exist in the Nallah.No infiltration of rain water has been considered in this design.

2.6 Depth of Flow: From consideration of ventilation in waste water flow, sewers should be designed to carry full flow (Peak Flow) not exceeding 0.8 of depth of sewer. Therefore full flow is considered 0.8 of depth of sewer.

2.7 Peak Factor: Peak Factor is applies to the average flow to estimates the flow during peak hours. The speak factors given in Table - 9.1 applicable is found to be a function of the contribute population. the following peak factors recommended by the CPHEEO manual have been adopted.

Table 2.1: Peak Factors for Sewerage flow

Contributory Population	Peak Factor
Up to 20,000	3.00
— 20,000 50,000	2.50
—50,000 750,000	2.25
Above 750,000	2.00

2.9 Minimum and Maximum Velocity: Minimum i.e. self-cleansing velocity should be achieved at least once in a day during peak flow. The minimum velocity targeted during design is 0.6 m/s for present (2009) peak flow and 0.8 m/s for ultimate (2041) peak flow in accordance with the recommendations of the CPHEEO manual. However, at the head of the network (starting lines), the self cleansing velocity is rarely achieved because of low flow contribution. The velocity norms will therefore be relaxed at the head of the system to prevent the network for unnecessarily going deep. Maximum velocity (scouring velocity) has been restricted to 2.0 m/s as recommended in the CPHEEO manual.

2.10 Pipe Materials: HDPE pipe are adopted in the project. For all sewers at all depths, HDPE pipes conforming to IS; 458 have been adopted. The diameter of HDPE pipes ranges from 150 to 600 mm.

2.11 Selection of sewer slopes: Slope taken proposed in the design of outfall sewer is up to an extent on which the self cleansing velocity is within the limit given in the manual (minimum 0.6 m/sec to max.3.0 m/sec

2.12 Trench: Trench is excavated as per the drawing section and trench width depends up on the diameter of pipe and depth of excavation. After 1.5 m depth and up to insufficient attention to the safely aspects; it sometimes becomes a major hazards and cause of many serious accidents. Hence we have to provide timbering and shoring to the trenches and manholes where the strata are sandy and trances may collapse. Safety measures should be according to IS 3764.

2.13 Timbering and Shoring: Excavation is one of the important phases of construction activities, due to insufficient attention to the safety aspects; it is sometimes becomes a major hazards and cause of many serious accidents. Hence we have to provide timbering and shoring to the trenches and manholes where the strata is sandy and may collapse .safety measures should be according to IS 3764.

2.14 Bedding: The type of the bedding of the sewers (granular bedding, concrete cradle, R.C.C. bedding, R.C.C. concrete encasement etc.) depends upon the width of trench, type of the pipes calculated and the bedding factors have been selected accordingly. The bedding for RCC NP4 pipes shall be in general granular bedding, with carefully compacted backfill unless local site conditions demand the concrete cradle type bedding. for RCC NP2 pipes, the appropriate bedding shell be provided based on the bedding factor calculated ,considering load due to back fill, the super imposed load and three edge bearing Strength of RCC pipes. The bedding factor has been determined as per the methodology given in the manual.

2.15 Manholes: The design of manholes shell spends upon the depth and the diameter of the sewer. Manholes have been provided at the junction of the sewers, Deviation in alignments atc. Apart from the once at regular 30 m intervals to facilitate system maintenance. The maximum spacing between manholes is 60 m for sewer diameter up to 900 mm. for sewer diameters> 900 mm, the spacing shell be 100 m as per the guide lines given in CPHHEO manual.

Typical manhole cover and frame would be in steel fiber reinforced concrete (SFRC) as the trunk main is to laid along the road where heavy traffic flow regularly therefore to with stand heavy load, class AA loading is taken. No provision has been made for direct connections from adjacent properties. For property Connections separate service sewer shell be laid & will connected to outfall sewer.

No provision has been made for direct connections to sewer pipe between manholes to prevent interference to the sewer. Manhole configuration for Outfall sewer as per Manual are considered as below:

Type C Manhole- Depth Varying from 2.5 to 5.0 m
Type D Manhole- Depth Varying from 5.0 to 9.0 m
C and D types Manhole diameter – 1.5 m

3. Industrial sewer system designing using SEWER CAD

Design Approach: Designing sewer system by using SEWER CAD is more efficient than conventional methods; it utilizes less input data and provides the data in Avery short duration of time interval. The user needs to input the following data for designing of sewer system by utilizing SEWER CAD.

Main Inputs are:

- Auto Cad drawing which has to convert in to DXF. Format.
- Set the units in Meters or inch.

- Draw the Network Layout according to Upstream to Down Stream side .Finally connected to all by main outlet say STP (Sewerage Treatment plant).The minimum Pipe Length 30 m not less than it.
- Give Ground Levels (G.L.) At all Manholes.
- Describe a population density for particular area, it's (Population/area).
- Detail data of Industrial demand, so that finalized the total sewer generated.
- After finalizes the industrial demand finalized the Industrial sewerage treatment plant capacity, made a table each industries flow so that flow given to nodes.

There are inputs for pipe material N value for that, minimum to maximum size of pipe say from 150 to 1000 mm, minimum to maximum slope for pipes say 1/2000 to 1/150. Minimum to maximum cover say (o.80m to 2.0 m).
For this particular area CHOPNAKI area is 2138.38 acres .according the plot size the flow is given in table-3.1

Table 3.1Area wise flow for Industries

Type	Size	Area	Flow in KL
SP3	AS per site	40 acres	129.5
SP2	280x425	30 acres	97.1
SP1	215x280	15 acres	48.6
SPA	140x300	10 acres	32.4
SP	100x200	5 acres	16.2
A	80x125	10000	8
B	80x100	8000	6.4
C	60X100	6000	4.8
D	50X80	4000	3.2
E	30X65	2000	1.6
F	30X50	1500	1.2
G	25X40	1000	0.8
G1	20X35	700	0.56
H	20X25	500	0.40
H1	12.5x20	250	0.20
K	10x15	150	0.12

These all data along with flow tables are directly imported in the SEWERCAD software for its design and run the project. After much iteration we have to find out the unique optimize solution in which we get design velocity, sufficient depth according the site and appropriate maximum size of sewer.
The calculations have been done within the software after finding the all data. The result of design given in the excel.

Conclusion

Software "SEWER CAD" was found to be more efficient and faster than conventional designing method, as was be in accordance with the calculations as per formulas given in Chapter 3.4.5 of CPHEEO manual 1993. Auto CAD drawing is essentially required for designing with SEWER CAD, as the AUTO CAD drawing is directly imported into the SEWER CAD software, it is also required for getting ground levels for base of designing for all data. The maximum peak flow gives the value of discharge of an effluent to be finally disposed off. Therefore, helps in determination of the total capacity of an effluent treatment plant to be installed in a particular low laying area and proper land is available for STP .Overall ,this study suggests that SEWERCAD is a promising way forward to solving network design problems when time or financial considerations allow for a limited number of hydraulic simulations to be performed .it's good performance, coupled with a simple implementation and relative to more standard approaches for successfully applied to reduce the number of expensive simulations required when the complexity of design problem is small to medium in terms of number of pipe sizes .therefore, it can be concluded that application of design software's in civil engineering design is more fruitful than to conventional design criteria.

5 References:

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