International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.01, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Design of Sewerage System for Housing

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ABSTRACT

Sewage/Wastewater treatment consists of different processes which protect the environment and human health through cleansing the water pollutants. In the past people used to have different methods for this treatment which has been passed over or developed through history, due to the advancement of technology and the growing needs of society. Jaffarpur is located in the Najafgarh zone of southwest NewDelhi. The present project was undertaken to design a efficient sewerage system for Jafarpur area. In this regard, as part of the project, assessment of the present conditions of the sewerage and sanitation system was conducted by surveying the nearby areas. An estimation of the daily water requirement, available water sources and daily total water usage was conducted. Estimation of the peak runoff was also done. Survey of the houses in the area was conducted with the help of a detailed questionnaire prepared as part of the project. Surveying of the area was performed and map of the area showing the land contours was prepared. The contour map was used to select and design the gradient and slope of the area for the purpose of laying sewer lines. Hydraulic analysis was also conducted for designing storm drain system. The sewer lines were aligned to ensure economic transport of sewerage to the treatment plant. Sewer pipe materials were selected alongwith fittings and joints for the sewerage system were selected. Sewer appurtenances were also selected for the final design.

Keywords: Sewerage system, Jaffarpur, sewers, surveying, peak flow.

I.INTRODUCTION

Waste water disposal systems can either be the onsite type or where the water borne wastes are disposed offsite into a water body or on land. To keep overall costs down, most urban systems today are planned as an optimum mix of the two types depending on various factors. Therefore, planning is required at national, state, regional and community level.

The area chosen for the present project is Jaffarpur Kalan, an underdeveloped part of south-west Delhi and falls under the Najafgarh Vidhan Sabha Constituency. The present population is approximately 15,000 as per Census 2011 and the projected area is 42 hectares. Jaffarpur Kalan comprises of 92% residential structures, police station, hospital, Government Engineering College, ITI and Sarvodaya Vidyalayas. The police station at Jaffarpur Kalan has a water treatment plant within its premises [1]. Nearby Samaspur area has 95% residential with the rest 5% commercial area.

The scope of the present project was to design an efficient sewerage system for catering to the present population and also the future estimated growth.

II. METHODOLOGY

In the present project the methodology adopted includes the survey of the houses of the projected area for data collection. Then using the census data, the population based growth rate was estimated. The master plan of 2021 and 2031 forms the basis of the current project. The sewerage and drainage plans for the projected area was also studied. This formed the basis for the estimation of the water usage per day per capita. Estimations for the peak runoff and critical design rainfall intensity were determined. Also, general slope of the ground was determined by conducting surveying of the projected area. Also, the road profile of the area was mapped out to design the slope and layout of the sewer lines.

III.SURVEY RESULTS

Survey was carried out to find out the existing water supply, preference and satisfaction of the public in the area. Existing water supply includes 60% piped water supply, 11% ground water supply, 8% DJB tankers, 3% water jugs, 2% DJB water supply and the rest 16% is sources other than the above. On the other hand the public 92% of the public preferred DJB connections, 4% tankers, 2% bottled water and the rest 2% preferred submersible pump water. This shows that the people in the area are generally not satisfied (~96%). In the nearby Samaspur area, there is no other supply other than the piped water supply. The preference of the public is the DJB water supply (96%) while the rest depend on the submersible and bottled water supply. Similar to Jaffarpur area, the people in Samaspur area are not satisfied (89%) with the present system.

The sanitation systems used in the Jaffarpur area and Samaspur area was septic tanks in 96% of the houses. The main method of solid waste disposal was in the open (77%) whereas composting, community dumping and mud trucks was approximately 8% each [1]. In the Samaspur area, the

IV.DESIGN OF SEWAGE SYSTEM

The population data of the projected area was collected from Census Department for the years 1981, 1991, 2001 and 2011. The growth rate was calculated as 0.9 and the estimation of the future population for year 2041 was determined to be approximately 40000. The per capita sewage flow is taken to be 95 lpd for the projected area based on the projected population and area.

S. No.	Design Component	Design period	Remarks
1	Land Acquisition for sewers	30 years	Land acquisition in future difficult
2	Sewer network (Laterals,	30 years	Replacement difficult and

	trunk mains)		costly
3	Pumping stations and mains	30 years	Cost may be economical
4	Pumping Machinery	15 years	Life of pumping machinery is 15 years
5	Sewage treatment plants	30 years	Construction is in phases with the increase in population
6	Effluent disposal and utilization	30 years	Provision of design capacities in the initial stages itself is economical

For the purpose of hydraulic design peak flow is adopted. The peak factor is 3 for contributing population <20,000 [3]. The peak factor is also depended on density of population, topography of site, hours of water supply, etc. Also, the groundwater infiltration is considered in areas where the water table is high and the head of groundwater is more than the head of sewage in sewers. Sanitary sewers are not exposed to receive storm water. The Rational Method equation is widely used to calculate the peak storm water runoff rate [4]. The critical design rainfall intensity was calculated to be 2 cm/hr.

Average quantity of water consumed was estimated to be 0.043 m^3/s. Assuming 80% of water consumed ends up as sewage, the average quantity of sewage discharge is 0.03 m^3/s. Further the peak discharge was assumed to be 3 times the average discharge giving the value as 0.09 m^3/s. Using the coefficient of run off (K) for the area as 0.55, the peak storm water was calculated as 1.28 m^3/s which gives the combined maximum discharge as 1.37 m^3/s. Assuming that the sewers have 10% extra capacity over the combined maximum discharge gives the capacity of the sewers to be 1.52 m^3/s. The available slope of the ground is 1 in 900. Assuming manning's coefficient as 0.0013 for clay sewer and the available slope for the sewers, the velocity generated is1.74 m/s.

The disposal of the sewage safely and with no adverse impact to the environment is being emphasized presently [4]. The disposal of the sewage will depend on the characteristics of the same. Therefore, tests were conducted to determine the characteristics of the sewage. The following table presents the average results of the tests.

Parameters	BOD	COD	TS	TDS
Values (mg/l)	205	320.4	1033.2	1030

Based on the above data, the detailed sanitation system will be designed for the Jaffarpur Kalan area in the next stage of the project as mentioned in the following section.

V.SEWER CONSTRUCTION

Sewer pipes are generally circular pipes laid below the ground level and generally sloping continuously towards the outfall. The sewers are designed to flow under gravity, except for the outfall sewer which carries the treated and pumped sewage into the discharging course, and hence flow full under pressure. The sewer pipes are normally circular cross section. Egg shaped sewers are normally preferred for combined sewers. The following factors were considered before selection of the sewer pipe material and the material for pipe fittings [5]:

Availability of pipe in required sizes and strengths Availability of
fittings, connections and adapters Ease of handling and installation
Physical strength

Ductile iron pipes is utilized for sewers requiring a high resistance to external loading and is most suited for sanitary sewers including river crossings, piping at wastewater treatment facilities, pipe located in unstable soils, highway and rail crossings, water line crossings, depressed sewers and piping aboveground. However, ductile iron is susceptible to wastewaters containing acids. Therefore, ductile iron pipes are normally cement lined. Ductile iron pipes are available in 3”-54”diameters and 18’–20’ laying lengths.

Cast Iron pipes are used normally for building connections. However, if the wastewater is acidic in nature then cast iron pipes are suggested. Cast iron pipes are available in 2”-15” diameters and 5’–10’ laying lengths. If the wastewater is extremely corrosive then vitrified clay is suggested for use. These pipes are available in 4”-42” diameters and 1’–10’ laying lengths.

Concrete sewer pipes are appropriate when large diameter sizes are required. It should be noted that unlined concrete pipe is subject to scouring by wastewaters carrying grit and sand at high velocities. Reinforced concrete pipes are used when extremely high external loadings are anticipated. The main advantage of reinforced pipes is the wide range of diameters 12”-108” and laying lengths of 4’- 24’. A main disadvantage is the lack of resistance to corrosion. Based on the above, for the projected area, concrete sewer pipes are expected to be used as the as they will provide sufficiently satisfactory performance and also will be economical for the area [6].

The soil and subsurface conditions need to be considered when iron or concrete pipes are used. The characteristics of the soil in which a pipe is placed affect the rate of corrosion, with the most corrosive soils being those having poor aeration and high values of acidity and moisture content. As the concrete pipes are being considered for the area, the next phase of the project will be to conduct the California bearing ratio (CBR) test to have an idea of the soil strength of the sub grade soil. Also, the compaction test which determines the relationship between the moisture content and the dry density of a soil for a specified comp active effort will be carried out. The specified comp active effort is the mechanical energy that is applied to the soil mass. Out of the various methods available for compaction, the tamping or impact compaction method also known as the Proctor test will be used. Mechanical compaction is one of the most common and cost effective means of stabilizing soils.

Following the design of the sewer pipelines, the sewer appurtenances will also be designed [7]. Manhole is an opening constructed on the alignment of sewer for facilitating a persons' access to the sewer for the purpose of inspection, testing, cleaning and removal of obstruction from the sewer line. If required, manhole can also serves as a joining of sewers or changing the direction or alignment or both. Manhole also facilitates the laying of sewers lines in convenient lengths. Depending upon the alignment of the sewer line the manholes is expected to be mostly circular manholes. The size of the manhole covers will be such that there will be clear opening of not less than 560mm diameter for manholes exceeding 0.90m depth.

Oil and grease traps will be provided depending on the presence of oil and grease in the wastewater. The previous tests carried out did not test for oil and grease. During the next phase of testing, the sewage will be tested for the presence of oil and grease. The presence of oil and grease in the sewage is detrimental to the treatment of the sewage further downstream. The suspended solids stick to the sides of the pipes which would otherwise been carried to the treatment plant. As seen from the previous test, the amount of suspended solids is not high, however, the amount of dissolved solids is significant. The oil and grease trap are located near the source contributing grease and oil to the sewage if possible. The output of sewage from the trap is at the bottom while the oil and grease is removed from the top. The cleaning frequency of the chamber will also be determined to ensure proper functioning of the trap.

Catch basin is another appurtenance that will be provided along the sewer line to allow the entry of clean rain water into the combined water. It is a masonry chamber and will be constructed below the street inlets to prevent the flow of grit, sand, debris, etc. in the sewer lines. Flushing tanks are used to hold water for the purpose of flushing the sewer lines. Flushing is provided will be located at the head of the sewers. Cleanout is another appurtenance provided at the upper ends of the lateral sewer in place of a manhole. It is an inclined pipe connected to the underground sewer. Water is flushed through the inclined pipe to clear the obstacles in the sewer lines. In the final design, the design of either one or all three will be carried depending on the requirement of the sanitation system.

Storm water inlets are located at the side of the roads at a distance of about 30 to 60 m. The inlets will not be more than 25mm and connected to nearby manholes. In the location where storm water inlets are not possible to be incorporated, storm water regulators will be designed. The storm water regulators diverges part of the excess storm water to a nearby stream or river.

As required, at various places, ventilators will be placed. Finally, a number of inverted siphons will be designed as the projected area has fairly large areas which are depressed than the surrounding areas [8]. This will also ensure to minimize the earth work involved in the construction of the sewer lines. Cost estimation of the complete design will be conducted to ensure that the most optimum design of the sanitation system for Jaffarpur Kalan area. Also, the users of the area will be involved during the final design of the system to give a sense of ownership of the project. Alternatives will be proposed and based on the input by the users a efficient system will be designed.

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