CE2354 – ENVIRONMENTAL ENGINEERING-II

(FOR VI – SEMESTER)

UNIT – I

PLANNING FOR SEWERAGE SYSTEM

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1 INTRODUCTION

1.1 BACKGROUND

Urbanization has encouraged the migration of people from villages to the urban areas. This has given rise to a number of environmental problems such as, water supply with desirable quality and quantity, wastewater generation and its collection, treatment and disposal. In urban areas, for industrial and domestic uses the source of water is generally reservoir, river, lake, and wells. Out of this total water supplied, generally 60 to 80% contributes as a wastewater. In most of the cities, wastewater is let out partially treated or untreated and it either percolates into the ground and in turn contaminates the ground water or it is discharged into the natural drainage system causing pollution in downstream water bodies.

The importance of water quality as a factor constraining water use has often gone unacknowledged in the analyses of water scarcity. Water scarcity is a function not only of volumetric supply, but also of quality sufficient to meet the demand. The drinking water demand is perhaps the largest demand for high quality water apart from many industrial uses which also require high quality water. Agriculture, by far the largest consumer of water, also suffers when water supplies become saline. In India, water pollution comes from the main sources, such as, domestic sewage, industrial effluents, leachets, and run-off from solid waste dumps and agriculture land. Domestic sewage and sullage is the main source of water pollution in India, especially in and around large urban centers. The regular monitoring of the water quality in the rivers and wells in the country revealed that the total coliform counts far exceeds the desired level in water to be fit for human consumption [CPCB, 1997].

In the past disposal of waste from water closets was carried out manually and wastewater generated from kitchen and bathrooms was allowed to flow along the open drains. This primitive method was modified and replace by a system, in which these wastes are mixed with sufficient quantity of water. This waste is carried through closed conduits under the conditions of gravity flow. This mixture of water and waste products is known as sewage.

The **advantages** offered by the water carriage system are:

- The carriage of wastes on head or carts is not required.
- The bad smell, which was unavoidable during open transport of sewage, is not occurring due to transport of this polluted water in closed conduits.
- The old system may pose the health hazards to sweepers and to the near by residents, because of the possibilities of flies and insects transmitting disease germs from the accessible carts to the residents food eatables. This is avoided in new system because of transport of night soil in close conduit.
- In addition, the human excreta is washed away as soon as it is produced, thus storing is not required as required in the old system of manual disposal. Thus, no bad smells are produced in closed conduit transport.
- In the old system, the wastewater generated from the kitchen and bathrooms was required to be carried through open roadside drains for disposal. This is avoided in sewerage system as the open drains could generate bad odours when used for disposal of organic waste.
- The water carriage system does not occupy floor area, as the sewers are laid underground.
- In addition, the construction of toilets one above the other is possible in water carriage system and combining latrine and bathrooms together as water closets is possible.

However, this water carriage system also has certain **drawbacks** such as:

- A large network of pipes is required for collection of the sewage; hence, the capital cost for water carriage system is very high.
- In addition, the operation and maintenance of sewerage system is very expensive.
- Large wastewater is required to be treated before disposal.
- Assured water supply is essential for efficient operation of the water carriage system.

1.2 DEFINITIONS

Sullage: This refers to the wastewater generated from bathrooms, kitchens, washing place and wash basins, etc. Composition of this waste does not involve higher concentration of organic matter and it is less polluted water as compared to sewage.

Sewage: It indicates the liquid waste originating from the domestic uses of water. It includes sullage, discharge from toilets, urinals, wastewater generated from commercial establishments, institutions, industrial establishments and also the ground water and storm water that may enter into the sewers. Its decomposition produces large quantities of malodorous gases, and it contains numerous pathogenic or disease producing bacteria, along with high concentration of organic matter and suspended solids.

Sub Soil water: Groundwater that enters into the sewers through leakage is called sub soil water.

Storm water: It indicates the rain water of the locality.

Sanitary sewage: Sewage originated from the residential buildings comes under this category. This is very fouling in nature. It is the wastewater generated from the lavatory basins, urinals and water closets of residential buildings, office building, theatre and other institutions. It is also referred as domestic wastewater.

Industrial wastewater: It is the wastewater generated from the industrial and commercial areas. This wastewater contains objectionable organic and inorganic compounds that may not be amenable to conventional treatment processes.

Night Soil: It is a term used to indicate the human and animal excreta.

Sewer:

It is an underground conduit or drain through which sewage is carried to a point of discharge or disposal. There are two types of sewer systems are commonly used for sewage collection. Separate sewers are those which carry the house hold and industrial wastes only. Storm water drains are those which carry rain water from the roofs and street surfaces. While combines sewers are those which carry both sewage and storm water. House sewer (or drain) is used to discharge the sewage from a building to a street sewer. Main sewer or trunk sewer is a sewer that receives sewage from many tributary branches and sewers, serving as an outlet for a large territory. Branch sewer or submain sewer is a sewer which receives sewage from a relatively small area. Lateral sewer is a sewer which collects sewage directly from the household buildings. Depressed sewer is a section of sewer constructed lower than adjacent sections to pass beneath an obstacle or obstruction. It runs full under the force of gravity and at greater than atmospheric pressure, the sewage entering and leaving at atmospheric pressure. Intercepting sewer is a sewer laid transversely to general sewer system to intercept the dry weather flow of sewage and such additional surface and storm water as may be desirable. An intercepting sewer is usually a large sewer, flowing parallel to a natural drainage channel, into which a number of main or outfall sewers discharge. Outfall sewer receives entire sewage from the collection system and finally it is discharged to a common point. Relief sewer or overflow sewer is used to carry the flow in excess of the capacity of an existing sewer.

Sewerage: The term sewerage refers the infrastructure which includes device, equipment and appurtenances for the collection, transportation and pumping of sewage, but excluding works for the treatment of sewage. Basically it is a science of collecting and carrying sewage by water carriage system through sewers.

Wastewater: The term *wastewater* includes both organic and mineral content of liquid waste carried through liquid media. Generally the organic portion of the wastewater undergoes biological decompositions and the mineral matter may combine with water to form dissolved solids.

Sewage Treatment Plant is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems or land.

1.3 SOURCES OF SEWAGE

The wastewater generated from the household activities contributes to the major part of the sewage. The wastewater generated from recreational activities, public utilities, commercial complexes, and institutions is also discharged in to sewers. The wastewater discharged from small and medium scale industries situated within the municipal limits and discharging partially treated or untreated wastewater in to the sewers also contributes for municipal wastewater.

1.4 SEWAGE DISCHARGE

The quality of sewage and its characteristics show a marked range of hourly variation and hence peak, average and minimum discharge are important considerations. The process loadings in the sewage treatment are based on the daily average characteristics as determined from a 24 hour weighted composite sample. In the absence of any data an average quantity of

150 lpcd may be adopted for design. The hydraulic design load varies from component to component of the treatment plant with all appurtenances, conduits, channels *etc.*,

being designed for the maximum discharge, which may vary from 2.0 to 3.5 times the average discharge. Sedimentation tanks are designed on the basis of average discharge, while consideration of both maximum and minimum discharge is important in the design of screens and grit chambers. Secondary treatment is generally designed for average discharge, with sufficient safety margin to accommodate the peak discharge.

1.5 EFFECT OF UNTREATED WASTEWATER DISPOSAL

The daily activities of human beings produce both liquid and solid wastes. The liquid portion of the wastewater is necessarily the water supplied by the authority or through private water sources, after it has fouled by variety of uses. The sources of wastewater generation can be defined as a combination of the liquid or water-carried wastes removed from residences, institutions, and commercial and industrial establishments, together with groundwater, surface water, and storm water as may be present.

If the untreated wastewater is allowed to accumulate, it will lead to highly unhygienic conditions. The organic matter present in the wastewater will undergo decomposition with production of large quantities of malodorous gases. If the wastewater is discharged without treatment in the water body, this will result in the depletion of Dissolved Oxygen (DO) from the water bodies. Due to depletion of DO, the survival of aquatic life will become difficult, finally leading to anaerobic conditions in the receiving waters. The nutrients present in the wastewater can stimulate the growth of aquatic plants, leading to problems like eutrophication. In addition, the untreated domestic wastewater usually contains numerous pathogenic or disease causing microorganisms, that dwell in the human intestinal tract or which may be present in certain industrial wastewaters. Apart from this, the wastewater contains inorganic gritty materials. The continuous deposition of this inorganic material may reduce the capacity of water body considerably over a period.

Generally domestic sewage does not contain any inorganic matter or organic compounds in highly toxic concentration. However, depending upon the type of industries discharging in to the public sewers and the dilution that is offered by sewage; the municipal wastewater may have these inorganic substances or toxic organic compounds with the concentration more than the discharge limits stipulated by the authorities. Certain compounds, such as sulphates, metals such as cromium, etc., if presents in higher concentration, may disturb the secondary treatment of the sewage.

URBAN STORMWATER MANAGEMENT

INTRODUCTION

Urban stormwater management systems are meant to guide, control and modify the quantity and quality of surface runoff. There are basically five subsystems which characterizes the urban drainage system: (i) surface runoff subsystem (2) storm sewer subsystem (3) detention subsystem (4) open channel transport subsystem and (5) receivers such as rivers, lakes or oceans. In this lecture we will discuss about the various subsystems and the design of storm sewers using various methods.

SUBSYSTEMS

The surface runoff subsystem transforms the rainfall input into surface water runoff. The outputs runoff hydrograph from surface runoff subsystem is the input to the storm sewer subsystem. Storm sewer subsystem transports runoff to either a detention subsystem or an open channel transport subsystem or a receiver subsystem. Output releases from a detention subsystem can be the input to an open channel subsystem or a receiver subsystem. Output releases from open channel subsystem can be the input to a detention subsystem or a receiver subsystem.

In urban stromwater management, the determination of runoff yield and the optimal design of storm sewer networks are very important. Strom water runoff alleviation is a major task.

STORM SEWERS

Strom sewers play an important role in urban stromwater management.A storm sewer system may consist of a number of sewers, junctions, manholes and inlets in addition to regulating and operating devices. The design of storm sewer includes determining the diameter, slopes and crown elevations of each pipe in the network. The design models can be divided as hydraulic design models and optimization design models. The hydraulic design models determine the sewer diameters by considering only the hydraulic parameters. In optimization design models, the minimum sewer size that is able to carry the design discharge under full pipe gravity conditions is determined. In these design models, the sewer system layout is predetermined and the sewer slope is assumed to be same as that of ground slope. The assumptions and constraints commonly used in storm sewer design are:

(i) Sewer is usually designed for gravity flow, No need of pumping stations or pressurized sewers.

(ii) The pipes used are commercially available circular ones with a minimum diameter of 20 cm.

(iii) The design diameter should the smallest available pipe with flow capacity equal or greater than the design discharge and satisfies all constraints.

(iv) The storm sewers must be placed well below the ground level to prevent frost, drain basements and also to allow sufficient cushioning against breakage due to ground surface loading. Therefore, minimum cover depths should be specified.

(v) At junctions, the crown elevation of the upstream sewer should not be lower than that of the downstream sewer.

(vi) A minimum permissible flow velocity at design discharge or at barely full pipe gravity flow should be specified to prevent excessive deposition of solids in the sewers.

(vii) A maximum permissible flow velocity should be specified to prevent scouring effects.

(viii) The downstream sewer should not be smaller than any of the upstream sewers at any junction.

(ix) The sewer system is a dendritic network converging towards downstream without any closed loops.

DISPOSAL STANDARDS

Param	On land for	Into inland	Into public
pH	5.5 -	5.5 -	5.5 -
BOD (for five days at 20^0C)	10	3	35
COD	-	25	-
Suspended solids	20	10	60
Total dissolved solids (inorganic)	210	210	210
Temperature (^{0}C)	-	4	4
Oil and grease	1	1	2
Phenolic compounds	-	1	5
Cyanides	0.	0.	2
Sulphides	-	2	-
Fluorides	-	2	1
Total residual chlorine	-	1	-
Pesticides	-	-	-
Arsenic	0.	0.	0.
Cadmium	-	2	1
Chromium (hexavalent)	-	0.	2
Copper	-	3	3
Lead	-	0.	1
Mercury	-	0.0	0.0
Nickel	-	3	3
Selenium	-	0.0	0.0
Zinc	-	5	1
Chlorides	60	100	100
Boron	2	2	2
Sulphates	100	100	100
Sodium (9%)	6	-	6
Ammoniacal nitrogen	-	5	5
Radioactive materials			
• Alpha emitters (milli-	10	10	10
• Beta emitters (micro-	10	10	10