ANALYSIS AND DESIGN OF 10 MLD SEWAGE TREATMENT PLANT BY USING STADD.PRO

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ABSTRACT: Design and Analysis of 10 MLD Sewage Treatment Plant using of staad pro in limit state method analysis of staad pro methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. STAAD.Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification, STAAD.Pro is the professional's choice. [2-D/3-D] initially for all possible load combinations [dead, live, wind and seismic loads].STAAD.Pro has a very interactive user interface which allows the users to draw the Structures and input the load values and dimensions. Then according to the specified criteria assigned it analyses the structure and designs the members with reinforcement details for RCC frames .The Water Retaining structures are designed as per IS 3370, the structures which are not in contact with water are designed as per the IS 546. Complicated and Sewage Treatment Plant structures Comprising various components such as Wet well, SBR, Blower Room, Centrifuge Room, Chlorine Tonner Room, Sludge Thickener, Admin Building need very time taking and cumbersome calculations using conventional manual methods. STAAD.Pro provides us a fast, efficient, easy to use and accurate platform for analysing and designing structures.

Key words: 10 MLD Sewage Treatment, limit state method, STAAD-Pro analysis, RCC frames, the IS 546.

I.INTRODUCTION Existing Sewerage System

The Sewerage Network is well connected to almost all buildings in the project area. There are 2219 quarters, Public buildings, Guest houses, post office, NGT hostel beach emirs, German quarters, GM

office, CISF camp office etc., at Centenary Colony. In these 2219 quarters, there are 1930 ST2 type quarters, 154 C2 type quarters, Rani Rudrama Devi

stadium, 23 NA & NB (Official buildings for Officers), 112 NC type quarters, Public buildings, Guest houses, post office, NGT hostel beach emirs, German quarters, GM office and CISF camp in

Centenary Colony. The Sewage is collected into locally distributed septic tanks. There are 9 septic tanks in the project area.

Project Conceptualization

Proper sanitation and good hygienic conditions are essential for human survival, health and dignity. Contaminated water bodies and discharging waste water in the midst of residential localities can cause severe health problems. The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment.

Waste water is thus to be treated in order to:

□ remove organic and inorganic matter which would otherwise cause pollution

□ remove pathogenic (disease causing) organisms

protect the Environment and Human Health

NEED OF THE PROJECT

The need is twofold. One is the environmental aspect and the other is the utility aspect.

In line with Swachh Bharat Mission, with a drive to reduce pollution, the sewage disposal system is to be upgraded for meeting the standards. As the existing facilities are obsolete and dysfunctional, there is an urgent need for adopting a suitable method to tackle the wastewater in an ecofriendly manner.

As Mr. Ismail Serageldin, Vice President, World Bank-1995 rightly pointed out "Many of the wars this century were about oil, but those of the next century will be over water". Recycle and reuse is the need of the day for preserving our precious natural resources. Treated wastewater can cater to horticulture needs in public parks and areas of gardening. It can even be used for flushing of toilets, cleaning of floors, tools, plants and machinery by laying specific lines.

OBJECTIVE OF THE STUDY

The main objective of the study is to develop a technically viable plan by adoption of appropriate Technology and Construction of Sewage Treatment Plant at Centenary Colony.

It is envisaged that, upon completion of the study, the opportunity to take advantage of benefits will result in:

Rapid implementation to deliver the project on a fast track schedule.

Significant improvements in protection of human health.

Enhancement of the overall ecological environment. Improvement in quality of life by ensuring availability of organized and flexible schemes and plans for implementing short-term and long-term sewerage infrastructure improvements suitable for future development.

Opportunities for improvements in institutional and organizational capacity for sustainable solutions, with possible full cost recovery and coordination among various institutions for costeffective capital improvements and operation and maintenance activities.

GENERAL SCOPE OF THE STUDY

As per the Terms of Reference, the scope of the study can be summarized as follows:

Preparation of Detailed project report by conducting Survey, feasibility studies for collecting the sewage at optimal location, assessing the flow and its quality in the project area, finalize the STP capacity, recommend suitable method by comparative study of alternative technologies and provide design criteria and technical details for tendering process to construct STP on EPC/Turnkey basis.

II. LITERATURE REVIEWS

Thalapathy .M et al., had done "ANALYSIS AND ECONOMICAL DESIGN OF WATER TANKS". In this paper he said this project gives the detailed analysis of the design of liquid retaining structure using working stress method. This paper gives idea for safe design with minimum cost of the tank and give the designer relationship curve between design variable. This paper helps in understanding the design philosophy for the safe and economical design of water tank.

B.V. Ramana Murthy, M Chiranjeevi had done the "DESIGN OF RECTANGULAR WATER TANK BY USING STAAD PRO SOFTWARE". IN this paper he said that this mini project is conducted for a period of 15 days from 21-05-2010 to 07-06-2010 to have complete practical knowledge of various techniques and problems faced in the field. A different topic like Construction Aspects, Design Parameters, Details of Formwork, Details of reinforcement, Process of Water Treatment Plant and Execution have been dealt with in the course of our mini project.

III.METHODOLOGY, CONCEPTS AND DESIGN CRITERIA

Study of Existing system

The Sewerage Network is well connected to almost all buildings in the project area and Septic tanks. The entire project area is divided into 5 Clusters based on sewage disposal (Refer Drawing No. EMSOL/DR/ESCI/SCCL-RGIII/0101).Cluster 1 consists of 1930 nos of ST2 type quarters which are for Employees and labourers and it is the biggest area in the colony. The sewage flows of these quarters are connected to 3 septic tanks located at north of Sivaramnagar near oxidation ponds.Cluster 2 consists of 154 nos of C2 type quarters and Rani Rudrama Devi stadium which are for Employees. The sewage flows of these quarters are connected to the septic tank in this cluster that is located at the back side of the C2 type quarters.Cluster 3 consists of 4 nos of A type quarters and 19nos of NB (official building) type quarters which are for higher grade officers. There is one Septic tank in this cluster that is located at the back side of the NB type quarters. The sewage flows of these quarters are connected to the septic tank.Cluster 4 consists of 112 nos of NC type quarters, Ramagiri guest house, Hostel, OC II project office, Chummeries, Transit Accommodation for employees, Visitors etc. There are 2 septic tanks in this cluster, located at backside of NC type quarters. The sewage flows of these quarters are connected to 2 septic tanks.Cluster 5 consists of GM office, CISF camp office. The Septic tank in this cluster is located near the CISF camp. The sewage flows of these quarters are connected to the septic tank. The sewerage lines at places are choked and at some places are broken, causing obstructions to the flow. Desiccated manholes and gushing flows substantiate obliterated network.

Detailed survey

A Detailed Survey is done to check the feasibility of interconnecting Septic tanks and to recommend appropriate alignments. Invert levels are taken for all the inlets at respective septic tank locations. Ground levels at the proposed STP site are taken.

The consultant has considered the characteristics of the raw sewage as follows:

- □ BOD : 220 mg/L
- □ COD : 300 mg/L

	: 400 mg/L
	: 40 mg/L
□ Phosphorous	: 25mg/L
□ Faecal Coliform	: >106 Col/100ml

Analysis of Outlets and Sewerage Route

The collector sewer route is chosen taking cognizance of the following:

- Ground slope
- The existing sanitation infrastructure
- Other existing developments
- Future expansion plan
- Location of treatment works

Design Consideration

The consultant developed methodology, concepts and criteria for undertaking the detailed design of the proposed assignment in reference to policy documents, legislations, codes and standards identified. The system to improve the environment of the Colony consists of subsystem, major part of which is sewage, its collection, treatment and disposal or reuse. This DPR has proposed design of conveyance system for sewage from present outlets, dealt in depth with the treatment and disposal.Domestic sewage consists of mainly liquid waste from toilets, kitchen, baths and washing of floors. The liquid waste is also generated from industries, commercial establishment etc. The liquid waste of township, having no industries, is purely of domestic nature. It is generallyconveyed to a suitable place out of the limits of the proposed master plan area through sewers/rising main and then treated to such an extent that the effluent meets the standards laid down by the State Pollution Control Board for final disposal on the land or natural water courses.

Treatment

Analysis of Treatment Processes

The important criterion of a wastewater treatment system design is its suitability to the local conditions. There are many aspects that must be considered when designing wastewater treatment facilities to ensure that the design will not only meet the treatment standards, but that it will also be able to work within the local technical and economic environ. The wastewater treatment design hinges around the influent and effluent criteria.

The dependability of performance of a process lies in spite of fluctuations in influent quality and quantity. The process must ensure a stable effluent quality. Similarly, ability to withstand power and operational failure is a consideration in the final choice of process. The more sophisticated the process the more sensitive is its operation. Some processes like digesters, lagoons, and ponds are sensitive to temperature. Wastewater treatment processes that typically will be considered are described below:

Secondary Treatment System Option

The secondary treatment system is in use in most sewage treatment facilities. There are several secondary treatment options that could be used in local conditions. Each option has a unique set of advantages and disadvantages that must be considered in relation to each individual site. Various factors affecting selection of secondary treatment processes include:

i. Land ii. Power supply availability and dependability iii. Operating (and control) equipment and its indigenous availability Skilled staff iv. v. Nature of maintenance problems vi. Extent of sludge production and disposal requirements vii. Loss of head through plant in relation to available head (to avoid/ minimize pumping as far as possible) viii. Ease of strategic expansion of plant capacity over time **Standards for Treatment** Revised Indian Standards for discharge of sewage in surface waters are given in the table below

Characteristic of the Effluent	<i>Tolerance limit for</i> <i>Discharge of Sewage</i> <i>in surface water</i>
BOD5	10 mg/L
TSS	10 mg/L

The unit operations and processes commonly employed in domestic wastewater treatment, their functions and units used to achieve these functions are given in the following table

Unit Operations/Processes, Their Functions and Units Used

Unit Operations/Processes	Functions	Treatment Devices
Screening	Removal of large floating, suspended and <u>settleable</u> solids	Bar racks and screens of various Description
Grit Removal	Removal of inorganic suspended solids	Grit chamber
Primary Sedimentation	Removal of organic/inorganic settleable solids	Primary sedimentation tank
Aerobic Biological Suspended Growth Process	Conversion of colloidal, dissolved and residual suspended organic matter into settleable biofloc and stable inorganics	Activated sludge process units and its modifications, Waste stabilization ponds, Aerated lagoons
Aerobic Biological Attached Growth Process	same as above	Trickling filter, Rotating biological Contactor
Anaerobic biological growth processes	Conversion of organic matter into $CH_4 \& CO_2$ and relatively stable organic residue	Anaerobic filter, Fluid bed submerged media anaerobic reactor, Upflow anaerobic sludge blanket reactor, Anaerobic rotating biological contactor
Anaerobic Stabilization of Organic Sludge	same as above	Anaerobic digester

Technology Selection

Treatment technologies can be classified into four broad groups:

- □ Natural system
- Conventional Technologies
- Advanced Technologies
- □ Emerging Technologies

Advanced Technologies

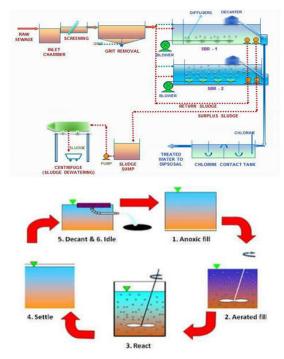
The consultant had submitted the preliminary report to Singareni Collieries Companies Limited (SCCL) and advised to consider any of the above technologies. Based on various factors, SBR and MBBR technology options were shortlisted.In order to understand functioning of these technologies in a better way, the concerned SCCL officials have visited some of the plants with SBR and MBBR technologies. And finally, the SCCL has opted for SBR technology for their proposed Sewage Treatment Plant at Centenary Colony, RG-III.

Sequencing Batch Reactor (SBR)

TECHNOLOGY

This variant of ASP technology is essentially a batch treatment by combining primary settling, aeration, secondary settling and decanting the treated sewage in a series of sequenced and/or simultaneous reactions in the same basin on a time deferred cycle. As different from the well-known reaction kinetics of continuous flow steady state ASP for our sewage characteristics, the bio-kinetic reaction rate in this non-steady state batch process needs to be evaluated for its higher rate or otherwise.

Schematic diagram of Sequencing Batch Reactor process



Treated Sewage Quality

The treated sewage quality of final effluent for which sewage treatment plant is designed and to be guaranteed by the contractor during operation and maintenance period is as under:

BOD 5 days at 200C

Suspended Solids

Total Nitrogen as N

Dissolved Phosphorous as P

Faecal Coliform Count after chlorination

Process Description

The treatment works will receive flows from the sewer system and will undergo preliminary treatment consisting of inlet screens, grit removal and if required Fat oil and grease (FOG) removal.Flows will be forwarded to a biological treatment stage where, in conjunction with aeration, bacteria will treat the sewage and be separated from the treated effluent before discharge. The Treatment works shall be based on a continuous inflow sequencing batch reactor (SBR) process. The SBR process shall be based on distinct phases for nitrification, de-nitrification, phosphorus release and uptake, which are controllable by duration of air-on and air-off/mixing phases to provide operational flexibility.In each continuous inflow SBR basin, the activated sludge is alternately aerated and mixed over a number of pre-determined cycles. Solids liquid separation shall occur during a settling phase of the cycle. After the settling phase, treated effluent shall be decanted or withdrawn from the liquid surface. Flow to the vessel is not interrupted at any time. The functions of flow equalization, biological oxidation, nitrification, denitrification, phosphorus release and uptake, sedimentation and aerobic sludge stabilization shall all be carried out in a single basin. Systems that require reactor bypassing during the settle and/or decant phases shall not be acceptable.

Design Requirements SBR Hydraulic Design

All structures pipes and processes shall be capable of handling maximum flows with one tank or unit in each treatment process stream isolated for maintenance. The complete secondary treatment stream shall not incur a head loss greater than 2.4 m. Every weir shall have a scum guard to ensure that no floating material passes at all times while the weir is operating.

Hydraulic peaks will be managed by reducing the treatment cycle times, and thus increasing the number of decants per day.

The system should be designed in such a way that process is hydraulically capable of passing 100% of the design and peak flow with one basin out of operation. The decanter mechanisms and sizing should be designed to cope up with this feature. The sludge settlement times shall be shown to be sufficient to have a 0.9 m clear water zone between the sludge blanket and the end of the decant zone at this period to stop sludge blanket carryover.

SBR Aeration Design Requirements

Actual Oxygen Requirement (AOR) calculations shall be based on the design BOD and Nitrogen loads. A de-nitrification benefit for oxygen recovery is acceptable. An alpha factor (α) of 0.65 and Beta factor (β) of 0.95 shall be used in the Standard Oxygen Transfer Requirement (SOTR) calculations, provided as part of the document submittal requirements. The aeration system shall be designed to be able to provide sufficient aeration at both average and maximum aeration depth, and shall be shown in the aeration calculations. All air flows rates will be specified at Normal (20 0C, 1 bar and 0% humidity) air volumes. The aeration calculations shall include for local air intake maximum temperatures, humidity and elevation as follows:

Maximum Ambient Temperature	45 0C
Relative Humidity	55 %
Site Elevation	162 m

Aeration shall be full floor coverage fine bubble aeration. Aeration design and blower capacity shall allow for peak loads from diurnal variations. The aeration design shall include the piping and pressure loss at maximum aeration requirement. The blower shall be specified to achieve the maximum air flow and pressure. The aeration system shall control the dissolved oxygen to an operator adjustable set point. Air flow rate shall be controlled by direct signal to the blower to increase or reduce air output, and not by an air control valve. The aeration piping shall have a control valve for control isolation of each aeration-main per tank.

SBR Control Requirements

The design control philosophy and detailed functional statement shall be proved by the process designer. The system designer shall provide the control system for the secondary biological treatment system. Variable speed aeration control shall be provided to give dissolved oxygen control of the system. The control philosophy shall allow for increasing or decreasing the nitrification and denitrification capacity of the system.Any electromagnetic decanter shall be controlled to drive down through the water so that the weir starts at the design top water level (TWL) at the start of the decant period and reaches bottom water level (BWL) at the end of the decant period.

DESIGN REPORT FOR CHLORINE CONTACT TANK FOR PROPOSED 10-MLD-STP DESIGN PHILOSOPHY

Project Title: Design of CHLORINE CONTACT TANK for the Proposed 10 MLD STP

Scope of the Project: Structural Analysis & Design of CHLORINE CONTACT TANK as per IS codes.

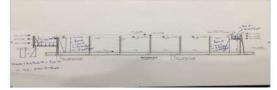
The Water Retaining structures are designed as per IS 3370, the structures which are not in contact with water are designed as per the IS 546.

Design Data:

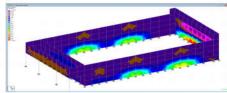
1. Grade of Concrete:	M30 (Liquid Retaining Structures)
2. Density of Concrete:	25 kN/m ³
3. Grade of Steel:	Fe 500
4. Safe Bearing Capacity:	70 kN/m ² (Refer soil Report)
Minimum Cover to Main Reinforcemen	at:
1. Base Slab:	40 mm
2. Beams:	25 mm
3. Columns:	40 mm
4. Footings:	50 mm
5. All Walls:	40 mm
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All the structural elements are analyzed as per the IS codes of practice for a given set of loads and Load combinations (Refer References).

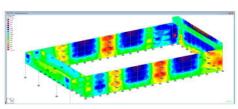
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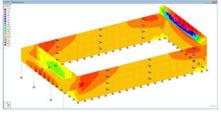
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Horizontal Moment-HYDROSTATIC LOAD MX-



SX-Axial Tension-HYDROSTATIC LOAD

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DESIGN OF CCT. MAIN VALL FOOTING MAIN VALL

6D 6011

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			Design	of Roof Sla	<u>ab</u>	
Fy=	500 N/	mm ²	Ly =	6.200 m		
Fck =	25 N/	mm ²	Lx =	6.125 m		
Clearcover	20 m	n				
Slab thickr	150 m	n e	am width	300 mn	n	
D.L.of slab	3.750		Ley =	6.025 m		
Floor finisl	1.500		Lex =	5.95 m		
Partition	0.000					
Live load =	1.500		dx=	125		
Total	6.750		dy=	115		
	kN	√m²				
Ly/Lx =	1.013				Ast	Required
	One long ed				Ast	10 mm
	xx*1.5*w*		20.82 kl		410	192 c/c
Mx + = 0	ax*1.5*w*	0.044	15.61 kl	N-m	302	260 c/c
						10 mm
My- = 0	xy*1.5*w*	0.000	0.00 k	N-m	180	436 c/c
My+ = 0	xy*1.5*w*	0.044	15.59 kl	N-m	331	237 c/c
Check for d	eflection					
fs =	167					
Pt =	0.42]	Modification	factor =	1.90	
required =	120.7					
provided =	125.0 O					

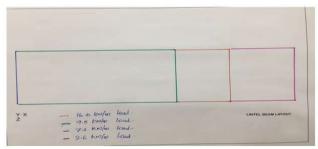
DESIGNREPORTFORBLOWERROOMFORPROPOSED 10-MLD-STP DESIGN PHILOSOPHY

DESIGN PHILOSOPHY Project Title: Design of BLOWER ROOM for the Proposed 10 MLD STP Scope of the Project: Structural Analysis & Design of BLOWER ROOM as per IS codes. The Water Retaining structures are designed as per IS 3370, the structures which are not in contact with water are designed as per the IS 546. Design Data: 5. Grade of Concrete: M30 (Liquid Retaining Structures) 25 kN/m³ 6. Density of Concrete: 7. Grade of Steel: Fe 500 8. Safe Bearing Capacity: 70 kN/m2 (Refer soil Report) Minimum Cover to Main Reinforcement: 6. Base Slab: 40 mm 7. Beams: 25mm 8. Columns: 40 mm 9. Footings: 50 mm 10.All Walls: 40 mm

All the structural elements are analyzed as per the IS codes of practice for a given set of loads and Load combinations (Refer References).



16.6 kn/m - 230 MM BRICK WALL LOAD



16.6 kn/m -230 MM BRICK WALL LOAD 9.5 kn/m -230 MM BRICK WALL LOAD 7.2 kn/m -230 MM BRICK WALL LOAD 2.6 kn/m -PARAPET WALL LOAD

REAMING	TOPREM	FORCEM	ENT REQU	RED	BOTTOME	EI NFORCEME	NT REOURE	D	TOP RE	INFORCEMENT	T REOU RED	
BEAM NO	LEFT	MIDC		RIGHT	LEFT	MIDDLE	RIG	-	LEFT	MIDDLE		RIGHT
1000	1022.52	0		022.52	212.67	346.04	334			2L 8'@ 150 m	m c/c 2L8	@ 150 mm c/c
1001	830.23	0		101.96	213.69	370.58	220.			2L 8 @ 150 mr		@ 150 mm c/c
1002	830.23	0		101.96	213.69	370.58	220.	38 2L8i@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
1003	619.06	0		619.06	416.88	213.69	234	95 2L8í@	150 mm c/c	2L 8 @ 150 mr	m c/c 2L8	@ 150 mm c/c
1004	956.62	0		779.56	0	302.13	247.	-		2L 8 @ 150 m		
1005	956.62	0		779.56	0	302.13	247.	58 2L8i@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
1006	750.82	0		750.82	556.56	213.69	308.	48 2L8í@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
1007	720.74	0		646.12	213.69	213.69	213	59 2L8i@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
1008	720.74	0		646.12	213.69	213.69	213	59 2L8í@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
1009	616.98	0		616.98	420.7	213.69	237.	55 2L8í@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
1010	772.88	0		751.35	214.2	288.49	364	2 2L8í@	150mmc/c	2L 8 @ 150 mr	m c/c 2L8	@ 150 mm c/c
1011	772.88	0		751.35	214.2	288.49	364	2 2L8i@	150mmc/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
1012	788.92	0		788.92	0	327.53	219.	51 2L8i@	150 mm c/c	2L 8 @ 150 mr	m c/c 2L8	@ 150 mm c/c
2000	0	214	2	214.2	0	0	0	2L8i @	300 mm c/c	2L & @ 300 mr	m c/c 2L8	@ 300 mm c/c
2001	214.2	214	2	0	0	0	0	2L8i @	300 mm c/c	2L 8' @ 300 mr	m c/c 2L8	@ 300 mm c/c
2002	655.45	0		714.49	214.2	232.39	214	2 2L8í@	150mmc/c	2L 8' @ 150 mr	m c/c 2L8	@ 150 mm c/c
2003	655.45	0		714.49	214.2	232.39	214	2 2L8i@	150mmc/c	2L 8 @ 150 mr	m c/c 2L8	@ 150 mm c/c
2004	0	214	2	214.2	0	0	0	2L8i @	300 mm c/c	2L 8 @ 300 mr	m c/c 2L8	@ 300 mm c/c
2005	214.2	214	2	0	0	0	0	2L8í @	300 mm c/c	2L & @ 300 mr	m c/c 2L8	@ 300 mm c/c
2006	634.57	0		663.34	213.69	214.65	213	59 ZL8í@	150mmc/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
2007	634.57	0		663.34	213.69	214.68	213			2L 8 @ 150 m		@ 150 mm c/c
2008	916.11	1168	15	433.05	311.42	272.34	251	54 2L8i@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 300 mm c/c
2009	910.26	0		910.26	313.05	574.31	466	7 2L8i@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/d
2010	1438.05	1168	15	916.11	229.96	272.34	292.	32 2L8i@	300 mm c/c	2L & @ 150 mr	m c/c 2L8	@ 150 mm c/d
2011	660.08	0		714.62	213.69	311.99	213	59 2L8í @	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/d
2012	660.08	0		714.62	213.69	311.99	213	-		2L 8 @ 150 m		@ 150 mm c/d
2013	1736.67	0		736.67	367.94	1087.06	518	43 2L8i@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/o
2014	621.81	0		469.44	214.2	230.87	278			2L 8 @ 150 m		
2015	621.81	0		469.44	214.2	230.87	278			2L 8 @ 150 m		
2016	570.27	0		570.27	0	404.38	229.	19 21.8í @	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/d
2017	687.76	0		687.76	214.2	214.2	223.	23 2L8i@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
3000	659.79	0		659.79	0	402.51	211	32 2L8i@	290 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 290 mm c/c
3001	470.82	0		777.48	0	416.45	200.	94 2L8í@	150 mm c/c	2L & @ 150 m	m c/c 2L8	@ 150 mm c/c
3002	470.82	0		777.48	0	416.45	200.	94 2L8i@	150 mm c/c	2L & @ 150 mr	m c/c 2L8	@ 150 mm c/c
3003	1070.13	0		070.13	201.45	824.98	449	11 2L8i@	280 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 280 mm c/c
3004	780.52	0		582.79	0	427.75	306			2L 8 @ 150 m		
3005	780.52	0		582.79	0	427.75	306			2L & @ 150 mr		
3006	1057.51	0		057.51	0	427.56	250.			2L & @ 150 mr		
4000	621.83	0		621.83	0	338.27	201	45 2L8í@	150 mm c/c	2L & @ 150 mr	m c/c 2L8	@ 150 mm c/c
4001	286.41	0		233.57	200.94	200.94	200.	34 2L8í@	150 mm c/c	2L 8 @ 150 m	m c/c 2L8	@ 150 mm c/c
4002	285.41	0		233.57	200.94	200.94	200.	94 2L8í@	150 mm c/c	2L 8 @ 150 mr	mic/ci 2L8	@ 150 mm c/c
4003	723.57	0		723.57	200.94	332.49	227.	13 21.8í@	150 mm c/c	2L 8 @ 150 mr	mic/ci 2L8	@ 150 mm c/c
6	42 DL+EL(4	×	21,414	329.77	5 -18.657	-14.715	-42.397	50.45	0K	3	3	F1
1	5000-0.41	6X)	21.44	252.2	1 18.675	14.724	-42.42	51.97	0X	3	3	FI
6	5000-00-40	£X0	21.44	252.2	1 -18.675	-14.724	-42.42	\$1.97	ox	3	;	F1
1	44 01-514	0	12,367	245.0	2 40.294	61.925	-9.313	54.17	08	-	-	
	-		12,367			-61.926		24.17				
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1	52 DL+U,+R			+			-9.313	54.17	OX	3	3	FI
6			12,292	259.0	9 40.251	61.995	-9.246	54.17 55.7	OK OK	3	-	
	51 DL+U+EU			258.0 258.0	9 40.251					-	3	FI
2		(+1)	12,292		9 40.251 9 -40.251	61.995	-9.246	55.7	оĸ	3	3	हा हा
2	51 DL+U+EU	(+2)	12.393	258.0	9 40.251 9 -40.251 1 -6.072	61.925 -61.925	-9.246 -9.246	55.7 55.7	OK OK	3	3	ភា ភា ភា
7	51 DL+U+EU 26 DL+U 26 DL+U	(+I)	12.393 12.393 -1.165 -1.165	258.6 442.3 442.3	9 40.251 9 -40.251 1 -6.072 1 6.072	61.925 -61.925 -4.445 4.445	-9.246 -9.246 1.126 1.126	55.7 55.7 64.32 64.32	0K 0K 0K	3 3 3.2 3.2	3 3 3 33 33	n n n n
7	51 DL+LL+EU 26 DL+LL 36 DL+LL 26 DL+LL	(+Z)	12.393 12.393 -1166 -1166 2.205	258.6 442.3 442.3 4589	9 40.251 9 -40.251 1 -6.072 1 6.072 9 -4.955	61.925 -61.925 -4.445 4.445 -2.427	-9.246 -9.246 1.126 1.126 -2.257	55.7 55.7 64.32 64.32 64.32 64.33	0K 0K 0K 0K	3 3 32 32 32	3 3 31 32 32 32	n n n n n
7 4 9	51 DL+U+QL 36 DL+U 36 DL+U 36 DL+U 36 DL+U	(II)	12.393 12.393 -1.165 -1.165 2.105 2.105	258.6 443.2 443.2 4585 4585	9 40.251 9 -40.251 1 -6.072 1 6.072 9 -4.955 9 4.955	61.925 -61.925 -4.445 4.445 -2.427 2.427	-9.246 -9.246 1.126 1.126 -2.257 -2.257	55.7 55.7 64.32 64.32	0K 0K 0K	3 3 3.2 3.2	3 3 3 33 33	ก ก ก ก
7	51 DL+LL+EU 26 DL+LL 36 DL+LL 26 DL+LL	(II)	12.393 12.393 -1166 -1166 2.205	259.6 442.3 442.3 4599 4599 291.3	9 40.251 9 -40.251 1 -6.072 1 6.072 9 -4.955 9 -4.955 9 4.955 9 -2.859	61.925 -61.925 -4445 4.445 -2.427 2.427 -1.935	-9.246 -9.246 1.126 1.126 -2.257	55.7 55.7 64.32 64.32 64.32 64.33	0K 0K 0K 0K	3 3 32 32 32	3 3 31 32 32 32	n n n n n
7 4 9	51 DL+U+QL 36 DL+U 36 DL+U 36 DL+U 36 DL+U	(+I)	12.393 12.393 -1.165 -1.165 3.105 3.105	258.6 443.2 443.2 4585 4585	9 40.251 9 -40.251 1 -6.072 1 6.072 9 -4.955 9 -4.955 9 4.955 9 -2.859	61.925 -61.925 -4.445 4.445 -2.427 2.427	-9.246 -9.246 1.126 1.126 -2.257 -2.257	5557 5557 66.32 66.32 66.33 66.33 66.33 66.33	0K 0K 0K 0K 0K	3 3 3.1 3.1 3.1 3.1 3.1	3 3 33 33 33 33 33 33 33 33 33	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
7 4 9 4	51 DL+U+5U 36 DL+U 36 DL+U 36 DL+U 36 DL+U 42 DL+E_(-	(+I)	12.393 12.393 -1.165 -1.165 3.125 3.125 31.421	259.6 442.3 442.3 4599 4599 291.3	9 40.251 9 -40.251 1 -6.072 1 6.072 9 -4.955 9 -4.955 9 4.955 9 -2.853 9 2.853	61.925 -61.925 -4445 4.445 -2.427 2.427 -1.935	-9.346 -9.346 1.126 1.126 -2.357 -2.357 -42.457	557 557 6632 6532 6535 6536 6536	0K 0K 0K 0K 0K	3 3 3.2 3.2 3.2 3.2 3.2	3 3 33 33 33 33 33 33 33 33 33 33	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
7 4 9 4 9 4	51 DL+LL+EU 36 DL+LL 36 DL+LL 36 DL+LL 36 DL+LL 42 DL+EL(+ 42 DL+EL(+ 43 DL+EL(+	(+I)	12 393 12 393 -1165 -1165 3 205 3 1421 21 421 4 392	258.6 442.3 442.3 459.9 459.9 291.9 291.9 291.9	 40.251 40.251 40.251 40.251 40.72 4072 4072 4072 4055 4955 4955 4955 22853 22853 402222 	61.925 -61.925 -4445 4.445 -2.427 2.427 -1.925 1.925 -50.099	-9.346 -9.346 1.126 -2.357 -2.357 -42.457 -2.942	557 557 6132 6132 6132 6135 6135 6136 6136 6136 6136 6136 6136	0K 0K 0K 0K 0K 0K 0K 0K	3 3 32 32 32 32 32 32 32 32 32 32	3 3 3 11 12 12 12 12 12 12 12 12	
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7 4 9 4 9 4 9 9 2	51 0L+U+FU 36 0L+U 36 0L+U 36 0L+U 36 0L+U 42 0L+E 42 0L+E 42 0L+E 42 0L+E 42 0L+E 42 0L+E 42 0L+E 42 0L+E	(+I)	112393 -1155 -1155 2.25 21421 21421 4.322 4.322 24655	258.6 442.3 442.3 4599 291.9 291.9 291.9 295.2 255.2 409.7	40.251 40.251 9 40.251 1 -6072 1 6072 2 -4955 4 4955 2 -2853 2 2853 4 -20.222 4 -20.222 7 -4.12	61.85 -61925 -4445 4.445 4.445 2.427 -1995 1.995 -60.099 60.099 60.099	-9.346 -9.346 1.125 -1.357 -1.357 -1.357 -42.457 -42.457 -3.966 -2.966 -2.6694	55.7 55.7 61.32 61.52 61.52 61.52 61.55 61.55 61.54 61.54 61.54 61.51 61.55 61.55	0K 0K 0K 0K 0K 0K 0K 0K	3 3 32 32 32 32 32 32 32 32 32 32 32	3 3 33 33 33 33 33 33 33 33 33 33 33 33	
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7 4 9 4 9 4 9 2 7 7 2	51 DL+U+5U 36 DL+U 38 DL+U 38 DL+U 38 DL+U 38 DL+U 42 DL+2(- 42 DL+2(- 42 DL+2)- 42 DL+2(- 42 DL+2)- 42 DL+2(- 42 DL+2)- 42 DL+2(- 42 DL+2)-	(+2)	11 393 12 393 -1166 -1166 3 205 3 205 21 421 21 421 4 392 4 392 24 625 24 625 -0 328	258.6 442.3 442.3 459.9 251.3 251.3 255.2 255.2 409.7 409.7 291.9	40.201 40.201 40.301 40.301 40.201 6.072 6.072 4.4955 4.9255 2.2853 4.20222 4.20222 4.20222 4.20222 4.20222 4.20222 4.20222 4.20222 4.20223 4.20223 4.20223 4.20223 4.20232 4.20232	61.935 -61.935 -4445 -2427 2427 -1995 1995 -60.099 60.099 60.099 -2574 2.974 -55.176	-9.346 -9.346 1.126 1.126 -2.357 -2.357 -42.457 -42.457 -2.9400 -2.9400	55.7 55.7 64.32 64.32 64.33 64.34 64.34 64.34 64.34 64.34 64.31 67.23 67.23 67.42 67.42	0K 0K 0K 0K 0K 0K 0K 0K 0K 0K 0K	3 3 12 12 12 12 12 12 12 12 12 12 12 12 12	3 3 3 11 12 12 12 12 12 12 12 12 12 12 12 12	
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7 4 9 4 9 4 9 2 7 7 2 7 4 9	51 DL+LL+EU 35 DL+LL 35 DL+LL 35 DL+LL 42	(+2)	11200 11200 -1166 -1165 2105 21471 21471 21471 21471 21471 24455 24455 24455 24455 24455 24455 24455 24455	258.6 443.3 4443.3 4443.3 4443.3 4443.3 4443.3 4443.5 4443.5 4453.5 4453.5 4453.5 4453.5 1450.5 1450	40.251 9 40.251 1 -6072 1 6.072 1 6.072 2 4.955 3 -12632 2 2.853 4 -20.322 4 -20.322 7 -4.12 7 4.32 4 -26.823 1 -2.855 1 2.855 2 2.855	61.925 61.925 -4445 -4445 -2437 2437 -1955 1985 -50.098 60.098 60.098 60.098 50.098 50.098 50.094 -2974 -35176 55.776 -1995 1985 1985	- 9.346 - 9.346 - 1.126 - 1.126 - 1.257 - 42.457 - 42.4577 - 42.457 - 42.4577 - 42.45777 - 42.45777 - 42.45777 - 42.45777777 - 42.4577777777777777777777777777777777777	55.7 55.7 64.32 64.32 64.32 64.53 64.54 64.54 64.51 67.23 67.23 67.42 67.42 67.65 67.65	0K 0K 0K 0K 0K 0K 0K 0K 0K 0K 0K	3 3.1 3.2 3.1 3.2	3 3 3 12 12 12 12 12 12 12 12 12 12 12 12 12	
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7 4 9 4 9 4 9 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2	53 DL+LL+DL 38 DL+LL 38 DL+LL 38 DL+LL 38 DL+LL 38 DL+LL 38 DL+LL 42 DL+LL 42 DL+LL 42 DL+LL 42 DL+LL 42 DL+LL 42 DL+LL 42 DL+LL 42 DL+LL 41 DL+DL 41 DL+DL 41 DL+DL 41 DL+DL 41 DL+DL 41 DL+DL 40 DL+LL+LL 40 DL+LL+LL 40 DL+LL+LL 40 DL+LL+DL 40 DL+LL+DL+LL+DL 40 DL+LL+DL+LL+DL+LL+DL+LL+DL+LL+DL+LL+DL+LL+DL+LL+DL+LL+DL+LL+DL+LL+DL+	(42) (42) (42) (42) (43) (11 399	225 8 4 442 3 25 8 4 452 9 201 W 455 9 200	40.21 40.21 40.21 40.21 1 40.21 1 40.21 1 40.21 1 40.21 1 40.21 1 40.21 1 40.21 1 40.21 2 2.252 2 2.852 4 40.221 1 4.251 1 4.251 1 1.252 2 2.852 3 1.252 4 4.252 1 1.252 2 4.252 3 4.252 4 4.252 4 4.252 5 4.452 4 4.252 5 4.452 5 4.452 5 4.452 5 4.452		-9.346 -9.346 -1.126 -1.127 -1.257 -1.257 -4.2457 -4.2457 -4.2457 -3.8484 -3.84944 -3.8494 -3.8494 -3.8494 -3.8494 -3.	947 947 947 947 947 947 947 947 947 947	0 x 0 x 0 x 0 x 0 x 0 x 0 x 0 x 0 x 0 x	J J	3 3 3 22 22 22 22 22 22 22 22 22 22 22 2	
4 9 4 9 4 9 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 2 7 4 9	51 DL+LI-FU 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 42 DL-FL 42 DL-FL 42 DL-FL 42 DL-FL 42 DL-FL 42 DL-FL 42 DL-FL 42 DL-FL 42 DL-FL 50 DL-LL 50 DL-LLL	(42)	11.389 11.389 11.265 11.265 11.265 1.125 1.255 1.421 1.421 1.422 1.422 1.422 1.422 1.422 1.425 1.42	223 8 4 42 3 2 4 42 4 2 4 42 4 4 7 5 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	4 4 1 4 4 1 4 1 4 1 1 4 1 1 4 1 1 4 1 1 1 4 1 1 4 1		-0.346 -0.346 -1.126 -1.126 -1.257 -1.257 -1.257 -2.247 -2.2427 -2.2427 -2.24244 -2.24244 -2.24244 -2.24244 -2.24244 -2.24244 -2.2424	527 527 6432 6432 6434 6434 6434 6434 6434 6434	200 200 200 200 200 200 200 200 200 200	J J	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	
4 9 4 9 4 9 2 7 4 9 4	51 D, +L-FU 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 36 DL-LL 42 DL-EL(+ 42 DL-EL(+))))))))))))))))))))))))))))))))))))		11.393 11.393 11.265 11.265 11.265 1.125 1.255 12.421 14.322 14.322 14.322 14.322 14.322 14.325 14.3555 14.3555 14.3555 14.3555 14.355555 14.35555555555555	233. 6 442. 3 442. 3 453. 9 453. 9 255. 7 255. 7 25	4 4 4 4 4 4 4 4 4 2 4 2 4 2 1 4 6 1 1 4 2 1	41.82 -41.82 -4.44	-9.346 -9.346 -1.126 -1.126 -1.257 -1.257 -2.257 -2.247 -2.2474 -2.2424 -2.2424 -2.2424 -2.2424 -2.2424 -2.2424 -2.2424 -2.2424 -2.2424 -2.2424 -2.2424	947 947 947 947 947 947 947 947 947 947	2000 2000 2000 2000 2000 2000 2000 200	3 1 2	3 3 3 22 22 22 22 22 22 22 22 22 22 22 2	
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7	43 DL+EL(+Z)	-2.124	444.072	-18.646	-49.275	2.494	52.93	οĸ	3.2	3.2	n
	49 EL+LL+EL(+X)	-25.22	470.16	-4955	-2.427	27.759	55.66	οĸ	3.2	3.2	n
8	49 DL+LL+EL(+X)	-25.22	470.16	4,955	2.427	27.759	55.66	οĸ	3.2	3.2	52
4	44 DL+EL(-Z)	1.9%	449.791	24,524	55.20	-0.94	543	οĸ	3.2	3.2	52
8	43 DL+EL(+Z)	1.9%	449.791	-24,514	-55,209	-0.94	543	οĸ	3.2	3.2	52
2	52 DL+LL+BL(Z)	-2.059	474.76	16.652	47.78	2.419	55.56	οĸ	3.2	3.2	52
7	51 DL+LL+EU(+Z)	-2.059	474.76	-16.652	-97.78	2.419	55.56	OK	3.2	3.2	52
	52 DL+LL+R_(-Z)	1.99	505.349	22.44	54,755	-0.835	59.52	OK	3.2	3.2	52
8	51 DL+LL+EU(+Z)	1.996	505.349	-22,414	-54.765	-0.92	59.52	OK	3.2	3.2	я
	41 DL+EL(+X)	-22.274	459.694	-0.262	-0.022	42.562	41	OK	3.6	3.6	8
	41 DL+EL(+X)	-22.274	459.694	0.262	0.022	42.562	61	οĸ	3.6	3.6	8
3	43 DL+EL(+Z)	-4941	412.524	-24.552	-72.795	2.51	41.77	οĸ	3.6	3.6	53
	44 DL+EL(2)	-4941	412.524	24.52	72.785	2.51	41.77	οĸ	3.6	3.6	8
3	36 DL+LL	-6.056	591.58	-1666	-1095	5.092	61.52	οĸ	3.6	3.6	8
	36 DL+LL	-6.059	591.58	1.599	1095	5.092	61.52	OK	3.6	3.6	5
3	42 DL+EL(40)	20.592	490.275	-0.265	-0.025	-22,525	42.17	οĸ	3.6	3.6	8
	42 DL+8L(40)	20.592	490.275	0.265	0.035	-22,525	42.17	OΧ	3.6	3.6	8
	49 DU+LL+EL(+X)	-82.54	515.789	-1695	-1095	43,595	65.56	OK	3.6	3.6	53
	49 DU+LL+EU(+X)	-32.54	515.789	1.595	1085	43.595	65.56	οĸ	3.6	3.6	8
	51 DL+LL+EU(+Z)	-5108	470.579	-25.979	-73,945	2.724	66.32	οĸ	3.6	3.6	8
	52 DL+LL+EL(Z)	-5.108	470.979	25.978	72.946	2.724	66.32	οĸ	3.6	3.6	8
3	50 DL+LL+LL+X)	20.425	547.421	-1.69	-1097	-22,502	66.69	οĸ	3.6	3.6	8
8	50 DL+LL+CL(-X)	20.425	547.421	1.5	1.087	-22,502	66.69	οĸ	3.6	3.6	8
3	44 DL+EL(-Z)	-6.941	525, 126	24.027	72.726	6.226	51.46	οĸ	3.6	3.6	8
	43 DL+EL(+Z)	-6.941	525.126	-24.027	-72.726	6.226	51.66	оĸ	3.6	3.6	53
3	52 DL+LL+R_(-Z)	-7.007	592.191	32.602	71.675	645	55.76	οĸ	3.6	3.6	53
8	51 DL+LL+EU(+Z)	-7.007	592.391	-22.602	-71.675	645	55.76	οĸ	3.6	3.6	8

Design of Roof Slab

Fy=	500 N	√mm²	Ly=	6.200 m			
Fck =	25 N	√mm²	Lx =	4.250 m			
Clearcover	20 n	nm					
Slab thickness =	150 n	nm	Beam width	300 mm			
D.L.of slab =	3.750		Ley =	6.025 m			
Floor finishes =	1.500		Lex =	4.075 m			
Partition	0.000						
Live load =	<u>5.000</u>		dx=	125			
Total	10.250		dy=	115			
	k	:N/m²					
Ly/Lx =	1.479				Ast	Required	Ast Provided
Edge Condition= 0	•••				Ast	10 mm	10
Mx- = α	x*1.5*w*lx²:	0.084	21.35	xN-m	421	186 c/c	150
$Mx + = \alpha$	x*1.5*w*lx²:	0.063	16.01 l	:N-m	310	253 c/c	150
						10 mm	10
My- = α	y*1.5*w*lx²:	0.000	0.00 1	:N-m	180	436 c/c	150
$My + = \alpha$	y*1.5*w*lx²:	0.044	11.11	xN-m	231	339 c/c	150
Check for deflection							
fs =	172						
Pt =	0.42	Ν	lodification fact	or =	1.85		
d required =	84.9						
1	10000						

d provided =

125.0 **O.K**

CONCLUSIONS

One is the environmental aspect and the other is the utility aspect.

In line with Swachh Bharat Mission, with a drive to reduce pollution, the sewage disposal system is to be upgraded for meeting the standards. As the existing facilities are obsolete and dysfunctional, there is an urgent need for adopting a suitable method to tackle the wastewater in an ecofriendly manner.

As Mr. Ismail Serageldin, Vice President, World Bank-1995 rightly pointed out "Many of the wars this century were about oil, but those of the next century will be over water". Recycle and reuse is the need of the day for preserving our precious natural resources. Treated wastewater can cater to horticulture needs in public parks and areas of gardening. It can even be used for flushing of toilets, cleaning of floors, tools, plants and machinery by laying specific lines.

References Codes & Standards:

- 1. IS 456 2000 : Code of Practice for Plain & Reinforced Concrete
- IS 875 1987: Codes of Practice for Design Loads (Part 1 to IV)
- 3. IS 1893 -2002_Part- I: Criteria for Earthquake Resistant Design
- 4. SP 16- 1980 : Design Aids for Reinforced Concrete
- 5. SP 34 1987 : Hand Book For Concrete Reinforcement & Detailing

Book: Design Principles & Detailing of Concrete Structures by Prof. D.S.Prakash