
Design of Water Treatment Plant & Multi-Village Drinking Water Supply System Habitations in Yadgiri District

Katti Penchalaiah [1], Mangali Maddilety [2], Maddikera Lokanath Reddy [3]

[1] *Brindavan Institute of Technology and Science, Kurnool*

[2] *Assistant professor, Brindavan Institute of Technology and Science, Kurnool*

[3] *Assistant professor(HOD), Brindavan Institute of Technology and Science, Kurnool*

Abstract:- The paper presents the design of a rural water distribution system for an area situated in a rural region. The study focuses on creating a water supply distribution network that necessitates treatment before distribution, catering to the estimated population for the next 30 years. Utilizing software tools such as AutoCAD, WaterGEMS, and the BRANCH version of Automatic STAD, the aim is to design the most cost-effective water distribution system. The study plans for intermittent water supply in the area, considering a water consumption rate of 55 liters per capita per day (lpcd). The economic diameter of the water supply distribution system is determined by taking into account various constraints, including residual nodal pressure, pipe flow velocity, pipe material, reservoir level, peak factor, and commercially available pipe diameters. The overarching goal is to establish a multi-village drinking water supply system that encompasses rural habitation and three urban areas—Kakkera, Kembhavi, and Hunasagi—in the Yadgiri district (Jaladhare) through a Design-Build-Operate-Transfer (DBOT) water supply system under the Jal Jeevan Mission (JJM).

Keywords*: WTP&WSS, AutoCAD, water gems, automatic stad software design*.

1. Introduction

1.1 General:

The necessity of a clean and safe environment is inseparable from the presence of water. Ensuring the provision of safe and sufficient water is paramount for promoting healthy living. A well-designed water supply scheme is essential for the well-being of a civilized population. Engineers assess the water requirements for various purposes within the community and develop a water supply scheme tailored to meet those needs. Crucially, a water supply scheme must deliver water that is palatable and free from defects that could lead to water-borne diseases. A comprehensive water supply system encompasses the collection, transportation, treatment, storage, and distribution of water from its source to end-users, including residences, businesses, industries, and irrigation facilities, as well as public agencies. Yadgir district, situated in the northern part of Karnataka state, shares borders with Kalaburgi district to the north, Vijayapura district to the west, Raichur district to the south, and Telangana state to the east. It is one of the 30 districts in Karnataka and currently comprises three taluks: Shahapur, Shorapur, and Yadgir. However, a recent proposal suggests dividing these three taluks into six: Shorapur, Hunasagi, Shahapur, Wadgera, Yadgir, and Gurmitkal. The district headquarters is Yadgir town, approximately 487 kilometers from Bengaluru City. Established in 2010 as the 30th district, Yadgir is the second smallest district in terms of area in the state but is culturally rich.

1.2 Historical Development:

The district is composed of 123 gram panchayats organized into six taluks: Shahapur, Wadgera, Hunasagi, Shorapur, Yadgir, and Gurmitkal. According to the 2011 census data, there are a total of 502 inhabited revenue villages in Yadgir district, each village comprising various closely located habitations, tandas, vacations, etc. In alignment with the National Rural Drinking Water Programme (NRDWP) under the Ministry of Drinking Water & Sanitation, Government of India, data from the Rural Development and Panchayat Raj Engineering Department (RDW&SD) reveals that the district has a total of 710 habitations, encompassing extended colonies, tandas, doddies, gollarahattis, hamlets, and more.

The Ministry of Home Affairs, Government of India, has provided population figures for all cities, towns, and villages on their website http://censusindia.gov.in. According to the 2011 census data, the overall population of Yadgir district was 927,450. The rural population of the district in the 2001 census was 764,556, indicating a notable growth of 21.31% in the rural population during the decade from 2001 to 2011.

1.3 Necessity for Planned Water Supply:

Presently, the drinking water requirements of villages and habitations in Yadgir district are primarily fulfilled by existing groundwater sources, although a few surface water schemes exist to cater to certain habitations. Numerous villages situated along riverbanks receive surface water through single-village schemes, and there are also multi-village schemes that serve groups of villages from a single surface source. However, the existing water supply schemes relying on groundwater sources fall short in terms of both quality and quantity. Many villages and habitations face challenges with chemical contaminations such as fluoride, iron, and other chemicals in their groundwater. In the case of multi-village surface water schemes implemented with canal sources, impounding reservoirs have been established to store water during canal flow periods for use during non-flow periods. Discussions with officials and site visits have revealed concerns about water scarcity during the peak summer months in both the Krishna and Bhima rivers. Consequently, villages already covered by surface water schemes also encounter difficulties during these peak summer months. Moreover, canal source schemes with impounding reservoirs face challenges in scanty rainfall years when the canal flow period is significantly reduced.

2. Area and Description of Site

Yadgir District, situated in the northern part of Karnataka, was established as the 30th district of the state in 2010, having been carved out from the erstwhile Kalburgi district. The district encompasses six proposed taluks: Shorapur, Hunasagi, Shahapur, Wadgera, Yadgir, and Gurmitkal, with Yadgir serving as the district headquarters. The district boasts excellent connectivity to other regions through a well-developed network of State Highways, National Highways, and a Railway Line. In the sections that follow, the location and details of the six project taluks are provided. For visual reference, Figure 2-1 displays a key map illustrating the precise location details of these taluks within the broader context of Karnataka state, highlighting the geographical distribution of the project area.

Fig 1: Map of the Project Area.

2.1 Gurmitkal Taluka

Gurmitkal, a panchayat town in the northeast of Yadgir district, is presently administratively under Yadgir taluka but is set to become a separate taluk. Situated 41 kilometers from Yadgir town along the Vijayapura - Hyderabad highway, Gurmitkal is known for its agricultural dependence and serves as a tourist town. The town's water supply primarily relies on bore wells.

2.2 Hunasagi Taluka

Hunasagi taluk, carved out of Shorapur taluk, is known for its historical significance, with numerous early Paleolithic sites. The taluk's rural population witnessed a growth rate of 23.23% from 2001 to 2011, showcasing its developmental trajectory.

2.3 Shahapur Taluka

Shahapur, located 70 kilometers from Kalaburgi, has an average elevation of about 428 meters. The taluk's historical roots are reflected in its previous name "Sagar" and its association with various dynasties. Shahapur is a major producer of cotton, pulses, and paddy, and recently, rich uranium deposits have been discovered in the Gogi belt.

2.4 Shorapur Taluk

Shorapur, a historical place with a rich cultural heritage, witnessed a rural population growth rate of 20.07% from 2001 to 2011. Known for its agricultural production and the recent discovery of uranium deposits, Shorapur is proud to host the establishment of an Agriculture University in Bheemarayana Gudi.

2.5 Wadgera Taluka

Wadgera, located 23 kilometers from Yadgir city, is primarily an agricultural region. In 2018, a 20 MW Solar power plant was constructed at Wadgera, contributing to the economic development of the taluk.

2.6 Yadgir Taluka

Yadgir City, the administrative headquarters of Yadgir district, is rich in historical and cultural traditions. The city has natural resources, with two rivers, the Krishna and the Bhima, flowing through it. Yadgir taluk has seen a significant rural population growth rate of 24.51% from 2001 to 2011.

3. Objectives of Study

1. Identify the requirements for an integrated water supply system for a group of eight villages.
2. Plan and design an integrated water supply system for a group of eight villages using WaterCAD to provide adequate water at sufficient pressure to all consumers.

4. Literature Review

Bharat Bhushan Jindal, March of 2012- The outcome of this research is that the size of the member remains the same for working stress technique by both IS 3370(1965) or3370(2009), and the area of steel needed increased in IS:3370(2009) as the allowed stresses in steel were lower. Furthermore, the size of the member or the steel required by LSM by 3370:2009 is reduced as compared to WSM by IS 3370:2009 or 3370:1965.

Dr. P.S. Pajgade, Neeta K. Meshram- August(2014)When comparing WSM to the LSM, the steel quantity for a reservoir is more. And the crack width estimate must be obtained if we want to design a water tank using LSM. The recent implementation of the LSM of design in IS:3370Part 2:2009 and IS 456: 2000 with a crack width limit of 0.2 mm and by international codes of practice has been proven to result in more durable structures.

R.V.R.K.Prasad and Akshaya B.Kamdi (2012)- In 2009, BIS released the upgraded version of IS 3370 (parts 1&2) after a long period since its 1965 edition. The incorporation of the limit state approach into the water tank design is critical in this edition. LSM water tank design is the most cost-effective since the amount of material required is smaller than that of WSM. The most significant container for storing water is the water tank. As a result, water tank crack width calculation is also required.

5. Coverage of Water Supply

Habitations are categorized based on the percentage of population coverage for safe drinking water, ranging from 0% (not covered) to > 100% coverage. This classification will be utilized to assess the water supply situation in the region.

Table 1: Percentage Coverage For Taluks As Per Imis Data

Sl. No.	Taluk	Percentage Coverage Status (Number of habitations)						
		0	**0 - 25**	**25 - 50**	**50 - 75**	**75 - 100**	**> 100**	**Total**
1	Gurmatkal	14	42	20	5	1	1	83
2	Hunasagi	29	87	22	7	6	6	157
3	Shahapur	38	64	19	7	7	2	137
4	Shorapur	20	60	16	13	5	2	116
5	Wadgera	10	39	9	4	1	3	66
6	Yadgir	58	53	30	2	3		146
Grand Total		**169**	**345**	**116**	**38**	**23**	**14**	**705**

5.1 Selected Sources

In this section, the focus is on the selection of materials for the proposed water supply schemes. Four options were considered, and preliminary scheme proposals were formulated for each option in Revision R0 of PSR. The detailed scheme proposals are outlined below.

5.2 Selection of Pipe Material

The choice of pipe material for rising mains and feeder mains was made after a comprehensive techno-feasibility study. Various pipe materials were considered, and their advantages and disadvantages were carefully evaluated.

5.3 Reinforced Cement Concrete (Rcc)

RCC pipes adhere to the specifications outlined in IS: 458 (2003) and are offered in various classes such as NP1, NP2, NP3, NP4, P1, P2, P3, etc. They find widespread use in the construction of gravity sewers across the country. However, it is not typically recommended to employ RCC pipes for pumping mains and water supply mains. These pipes are manufactured with diameters ranging from 300 mm to 2400 mm and a standard length of 2.50 m. Besides the specified diameter range, customization is possible to meet specific diameter and strength requirements based on site conditions. Adjustments to the size and strength involve altering the wall thickness, percentage of reinforcement, and the configuration of the reinforcement cage.

5.4 Ductile Iron (Di)

Ductile iron (DI) pipes are produced by the specifications outlined in IS: 8329 (2000), while DI specials are crafted following IS: 9523 (2000). These pipes are categorized into K7 and K9 classes. Ductile iron pipes are extensively utilized for pumping mains and gravity mains throughout the country, facilitating the conveyance of both raw water and treated water. Available in diameters ranging from 80 mm to 1000 mm, DI pipes come in lengths of 5.5 m and 6.0 m. Internally, the pipes are lined with cement mortar, and externally, they are coated with zinc.

5.5 Glass Fibre Reinforced Plastic (Grp)

Glass fiber-reinforced plastic (GRP) pipes are extensively utilized as both gravity mains and rising mains in numerous developed countries worldwide. In India, the adoption of GRP pipes has seen a notable increase in recent years, with widespread usage for conveying both raw water and treated water. The growing presence of numerous manufacturers in the local market has further contributed to their rising popularity. These pipes are categorized based on pressure class (PN3, PN6, PN9, PN12 & PN15) and stiffness class (A, B, C & D), adhering to the standards outlined in IS: 12709 (1994). Available in diameters ranging from 300 mm to 3000 mm, the pipes come in lengths of 6.0 m, 9.0 m, and 12.0 m. Fittings are crafted to meet specific requirements.

5.6 Mild Steel (Ms)

Mild steel pipes have been a longstanding choice for both gravity and pumping mains in the country. Manufactured by IS: 3589 (2001), with specials crafted as per IS: 7322 (1985), these pipes are produced through electrical radial welding (ERW) or spiral welding (SW) with submerged arc welding (SAW). The manufacturing process involves the use of mild steel (MS) plates meeting IS 2062 standards or MS coils conforming to IS: 10748. The size and strength of the pipes can be tailored to site-specific requirements by adjusting the wall thickness. Internally, MS pipelines are lined with cement mortar to create a smooth surface, reducing friction loss, while external uniting provides corrosion protection to the mild steel shell.

5.7 High-Density Polyethylene (Hdpe)

High-density polyethylene (HDPE) pipes are extensively employed for the transportation of both raw water and treated water in many developed nations globally. In India, the adoption of HDPE pipes has gained traction in the recent past, with widespread use at present. These pipes are categorized based on pressure classes, specifically PN 6, PN 10, PN 12.5, and PN 16, adhering to the standards outlined in IS: 4984 (1995). Available in diameters ranging from 16 mm to 1000 mm, these pipes are conveniently provided in large-length coils.

5.8 Conclusion

After thorough analysis, mild steel pipes with internal epoxy coating and external uniting were deemed most suitable for higher diameters. For pumping mains, DI pipes are considered for diameters up to 450 mm, and MS pipes are chosen for diameters above 500 mm. For gravity feeder mains, HDPE pipes are considered for diameters up to 250 mm, while DI pipes are chosen for diameters above 300 mm.

6. Population & Water Demand

6.1 Population Projection and Water Demand Analysis

Population projections are based on the 2011 census and NRDWP data. Various growth rates are considered for each taluk, with the design base year set as 2023, the intermediate design year as 2038, and the ultimate design year as 2053. Detailed projections for the Muliti-village water supply project covering 696 Nos are enclosed.

Sl. No.	Taluk Name	No of Habitations	Projected Population		
			2023	2038	2053
1	Hunasagi	165	1,66,800	1,94,459	2,22,117
2	Shorapur	123	1,88,760	2,21,995	2,55,217
3	Shahapur	139	2,32,546	2,74,415	3,16,178
4	Wadgere	69	1,21,134	1,42,683	1,64,220
5	Yadgir	138	1,73,237	2,01,742	2,30,243
6	Gurmitkal	62	79,906	91,393	1,02,877
SUBTOTAL		696	9,62,383	11,26,687	12,90,852

Table 2: The summary of the projected population for the habitations covered in the project taluks

7. Mix Calculations

Structural Design Calculation for Cascade Aerator Raft

						Horizontal		Vertical		Horizontal
	Node	L/C				Fx N/mm2		Fy N/mm2		Fz N/mm2
Max Px	12111	201 (DL+LL)				0		0.015		0
Min Px	12111	201 (DL+LL)				0		0.015		0
Max Py	12558	244 (DL+1.0SOIL+1.00EQ+X)				0		0.029		0
Min Py	12558	211 (DL+EQ-X)				0		0.008		0
Max Pz	12111	201 (DL+LL)				0		0.015		0
Min Pz	12111	201 (DL+LL)				0		0.015		0

Crack width Calculation

Unfactored Moment	**Effective cover (mm)**	**Spacing b/w main bars**	**Modular Ratio (m)**	**mc**	x	**fast**	**ε1**	**ε2**	**εm**	**a critical**	**Crack width (Wcr)**	**Allowable Crack width**
17.07	56	150	7.3	9.95	52.15404207	81.84	0.001	0.001	-3.1E-04	87.6	0.000	**0.2**

				From STAAD	
	pt	beta	TC	actual	
	%		N/mm²	N/mm²	
SQX(inside)	0.26	13.6	0.37	0.106	SAFE IN SHEAR
SQX(outside)	0.22	15.8	0.35	0.214	SAFE IN SHEAR
SQY(inside)	0.26	13.6	0.37	0.095	SAFE IN SHEAR
SQY(outside)	0.19	18.1	0.33	0.102	SAFE IN SHEAR

Table 3: Stadd Pro Values of the Design

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Structural Design Calculation for Cascade Aerator Shaft Wall 200m Thk.

Design of Shaft Wall

	Enter Forces from STAAD										Modified as per Woods's criteria		
		Plate	**L/C**	**SQ$_X$**	**SQ$_Y$**	**M$_X$**	**M$_Y$**	**MXY**	**S$_X$**	**S$_Y$**	**SXY**	**M***	**S***
				N/mm^2	N/mm^2	kNm/m	kNm/m	kNm/m	N/mm^2	N/mm^2	N/mm^2	kNm/m	N/mm^2
Mx	+ve	4278	244 (DL+1.0SOIL+	-0.029	0.05	**2.267**	**9.604**	-0.922	-0.292	0.043	0	3.19	0.29
	-ve	4227	231 (DL+WATER+	0.005	-0.07	**-0.654**	**-1.076**	0.11	-0.219	-0.007	0	0.76	0.22
My	+ve	4273	244 (DL+1.0SOIL+	-0.002	0.055	**0.871**	**11.572**	0.268	-0.32	0.138	0	11.84	0.14
	-ve	4273	211 (DL+EQ-X)	0.004	-0.073	**-0.617**	**-2.103**	0.132	-0.186	-0.004	0	2.24	0.00

Crack width Calculation

Unfactored Moment	**Effective cover (mm)**	**Spacing b/w main bars**	**Modular Ratio (m)**	**mc**	**x**	**fast**	**ε1**	**ε2**	**εm**	**a critical**	**Crack width (W cr)**	**Allowable Crack width**
2.66	50	150	7.3	9.95	37.13577661	27.08	0.000	0.001	-7.1E-04	85.14	0.000	0.2

				From STAAD	
	pt	beta	□c	actual	
	%		N/mm^2	N/mm^2	
SQX(inside)	0.26	13.3	0.38	0.028	SAFE IN SHEAR
SQX(outside)	0.26	13.3	0.38	0.035	SAFE IN SHEAR
SQY(inside)	0.26	13.3	0.38	0.139	SAFE IN SHEAR
SQY(outside)	0.26	13.3	0.38	0.099	SAFE IN SHEAR

Table 4: Staad Pro Values of the Design

Structural Design Calculation for Cascade Aerator Dome

Design of Dome

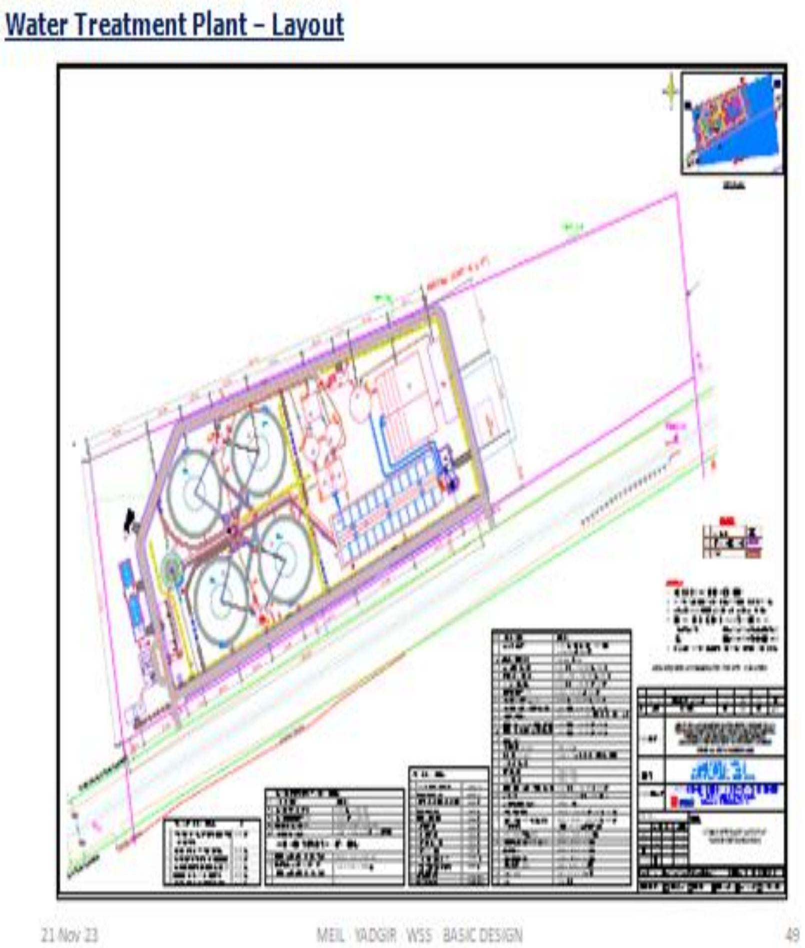
	Enter Forces from STAAD										Modified as per Woods's criteria		
		Plate	L/C	SQX	SQY	MX	MY	**MXY**	**Sx**	**SY**	**SXY**	**M***	**S***
				N/mm2	N/mm2	kNm/m	kNm/m	kNm/m	N/mm^2	N/mm^2	N/mm^2	kNm/m	N/mm^2
Mx	+ve	18586	232 (DL+WATER+	0.13	0.048	10.566	2.213	0.708	-0.272	-0.084	0	11.27	0.27
	-ve	18606	245 (DL+1.0SOIL+	0.214	0.003	-8.085	-3.97	-0.363	-1.298	0.021	0	8.45	1.30
My	+ve	17174	231 (DL+WATER+	-0.069	-0.044	1.242	4.987	0.199	-0.275	-0.013	0	1.44	0.28
	-ve	17124	244 (DL+1.0SOIL+	0.287	0.147	-7.504	-20.233	-2.868	-1.415	-0.593	0	10.37	1.42

Crack width Calculation

Unfactored Moment	**Effective cover (mm)**	**Spacing b/w main bars**	**Modular Ratio (m)**	**mc**	**x**	**fast**	**ε1**	**ε2**	**εm**	**a critical**	**Crack width (W cr)**	**Allowable Crack width**
9.40	55	150	7.3	9.95	32.95742524	133.96	0.001	0.001	2.1E-04	88.01	0.037	0.2

				From STAAD	
	pt	beta	TC	actual	
	%		N/mm2	N/mm2	
SQX(inside)	0.36	9.6	0.43	0.287	SAFE IN SHEAR
SQX(outside)	0.36	9.6	0.43	0.100	SAFE IN SHEAR
SQY(inside)	0.36	9.6	0.43	0.147	SAFE IN SHEAR
SQY(outside)	0.36	9.6	0.43	0.124	SAFE IN SHEAR

Table 5: Staad Pro Values of the Design



8. Design of Water Tank

Capacity V	=	**1660 m³**
Dead storage water column d s	=	**0.15 m**
Internal dia of tank D	=	**21.75 m**
Height of water in the tank (Excluding D.S and FB) h	=	**4.50 m**
Freeboard of water FB	=	**0.30 m**
Total height of the wall till the top of the roof slab [0.15+4.5+0.3+0.2] H	=	**5.15 m**
Ground Level GL	=	**+441.550 M**
L.W.L	=	**+441.000 M**
M.W.L	=	**+445.500 M**
Ht. of the wall above GL	=	**4.45 m**
Centre to center internal dia of columns Dci	=	**14.75 m**
Dome		
•Rise h_1	=	**1.84 m**
•Thickness @ springing	=	**200 mm**

•Thickness @ center	=	150 mm
•Avg Thickness t_1	=	175.00 mm
Top Annular slab		
•Thickness tia	=	200 mm
•Length Lia	=	3.85 m
Internal dia of the tank	=	21.75 m
External dia of the tank at top	=	22.45 m
External dia of the tank at bottom	=	22.65 m
Ring Beams		
Width	=	0.45 m
Depth	=	0.6 m
Internal columns, C_1 Number of columns	=	12
Width	=	0.3 m
Depth	=	0.3 m
Wall thickness At top	=	0.35 m
At bottom	=	0.45 m
Foundation thickness of column	=	0.35 m
Foundation thickness of wall	=	0.5 m
Depth of foundation below the GL	=	1.2 m
(From GL to Bottom of foundation)		
Capacity Calculation :		
Vol. of the water in tank [(π*21.75^2/4) * 4.5]	=	1671.94 m^3
Deductions Vol. of internal columns, C_1	=	5.56 m^3
Vol. of the ladder inside the sump	=	1.00 m^3
Net vol. of the tank	=	1665.40 m^3
Therefore, Capacity of the tank provided	=	1665.40 > 1660 m^3

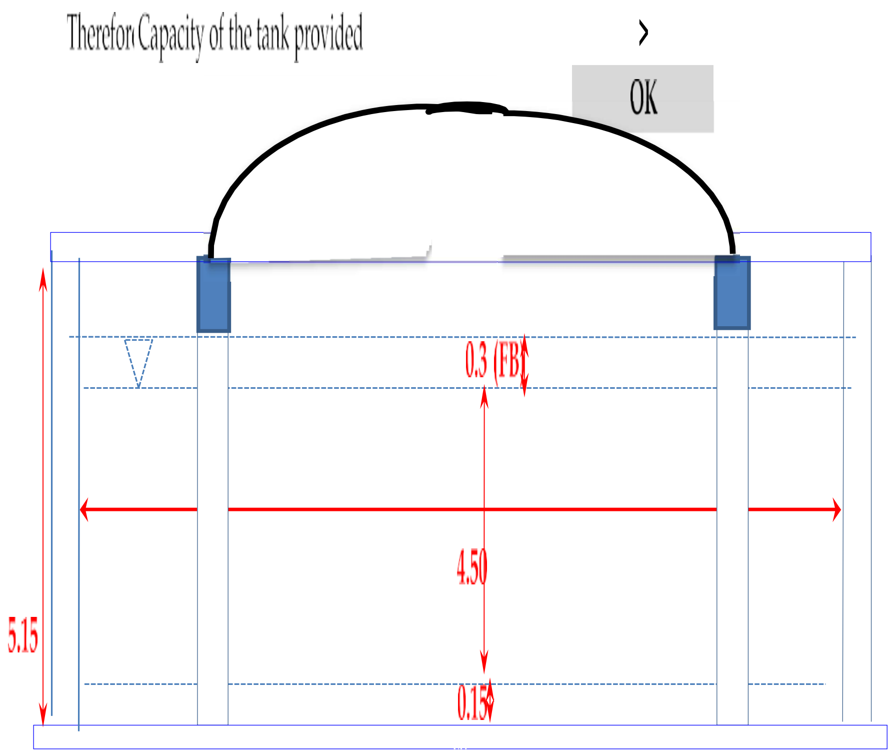


Fig 2: Water Tank Design

9. Design of Cylindrical Wall

Water Case :

The internal diameter of the tank = 21.75 m

Water depth for design purposes = 4.95 m

Average thickness adopted = 400 mm H^2/Dt 4.95^2/(21.75x400/1000) = **2.816**

Clear cover to the reinforcement = **45** mm

The wall shall be designed as per Clause No. 3.1.2 & 3.1.3 of IS 3370, Part IV for the Hoop tension.

The cylindrical wall has been considered as hinged at the base and free at the top subjected to triangular load.

The hoop tension in the wall = Coefficient x w HD/2 Kg/m 130

Distance from top (m)	Distance from bottom (m)	Coefficient nt for Hoop Tension	Hoop tension per m kN	Area of steel reqd. for hoop tension per m mm²	Min. Thickness required (mm)	Provide Thickness (mm)	Remarks
0.000	4.950	0.0981	52.808	406.215	31.820	350.00	**O.K.**
0.495	4.455	0.1939	104.379	802.915	62.895	360.00	**O.K.**
0.990	3.960	0.2884	155.249	1194.223	93.548	370.00	**O.K.**
1.485	3.465	0.3746	201.652	1551.169	121.508	380.00	**O.K.**

1.980	2.970	0.4420	237.934	1830.262	143.371	390.00	**O.K.**
2.475	2.475	0.4928	265.280	2040.615	159.848	400.00	**O.K.**
2.970	1.980	0.5006	269.479	2072.915	162.378	410.00	**O.K.**
3.465	1.485	0.4588	246.978	1899.831	148.820	420.00	**O.K.**
3.960	0.990	0.3575	192.447	1480.362	115.962	430.00	**O.K.**
4.455	0.495	0.1991	107.178	824.446	64.582	440.00	**O.K.**
4.950	0.000	**0.0000**	0.000	0.000	0.000	450.00	**O.K.**

Table 6: Design Values of the Cylindrical Wall.

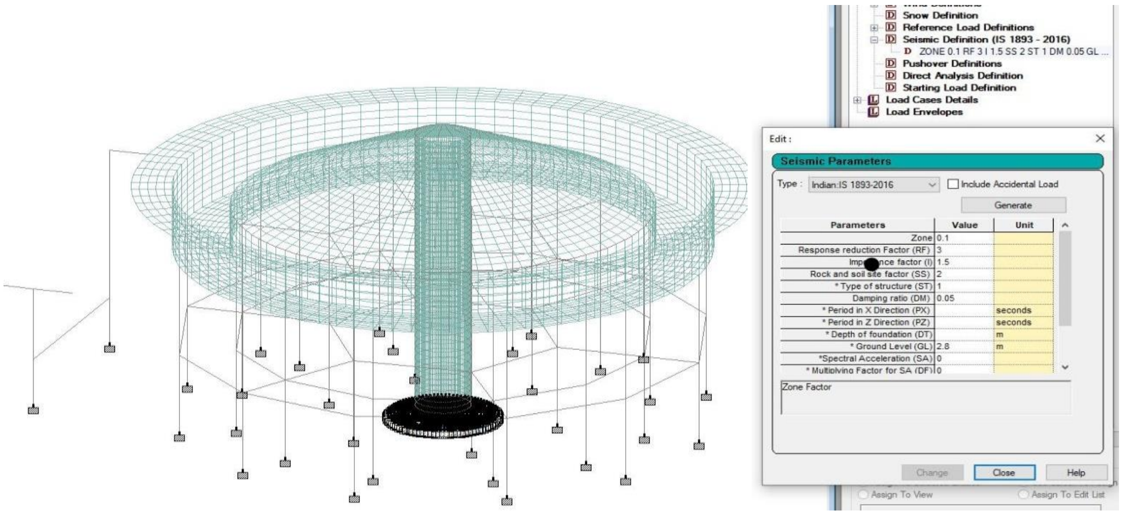
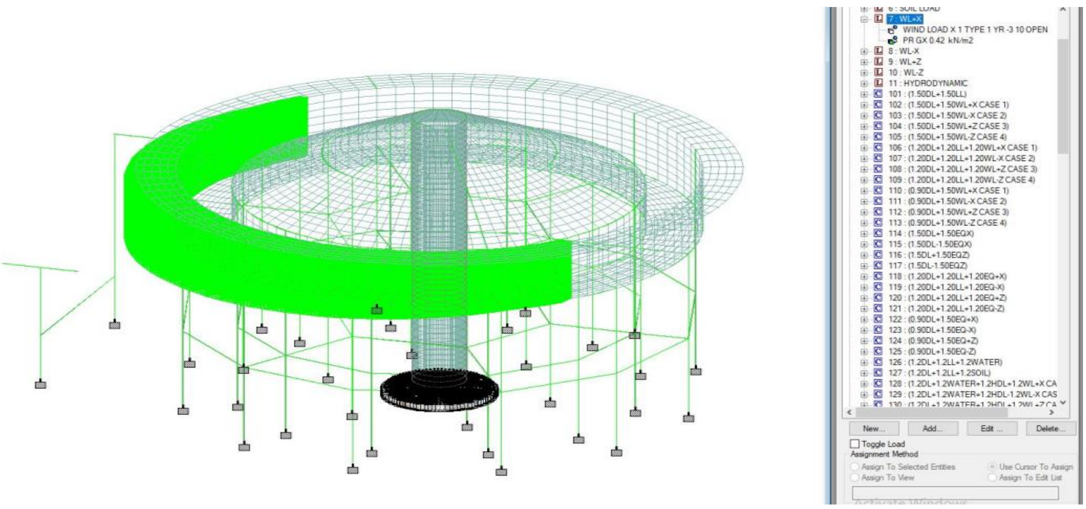
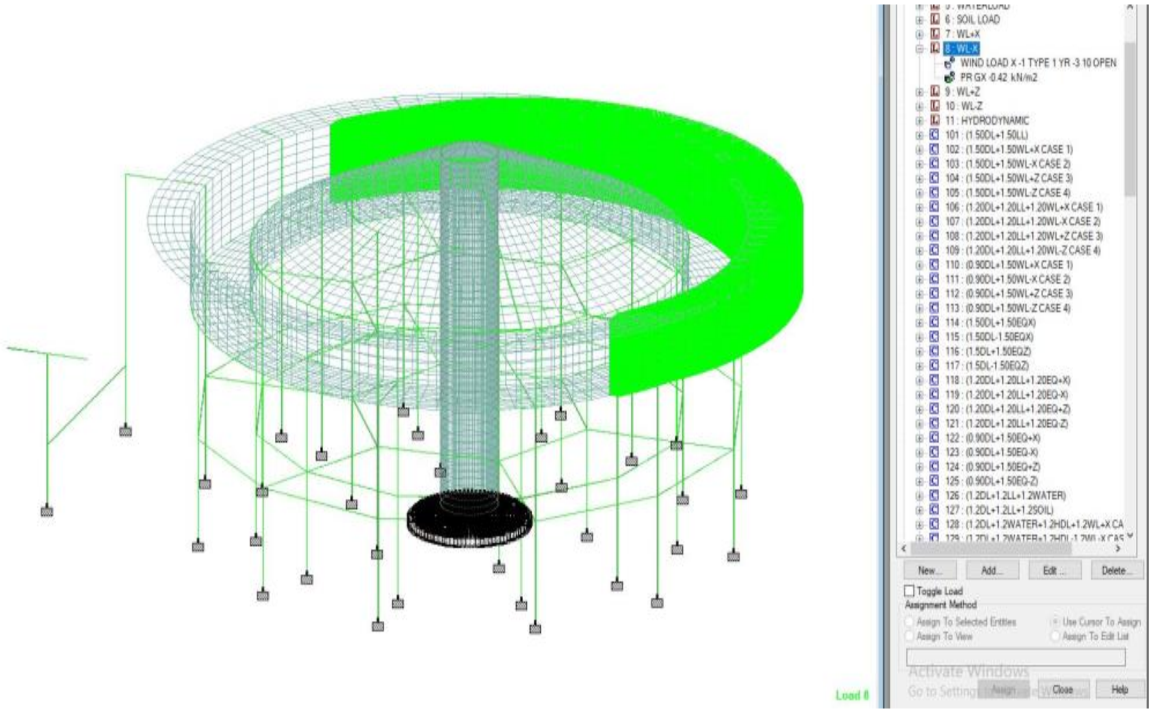
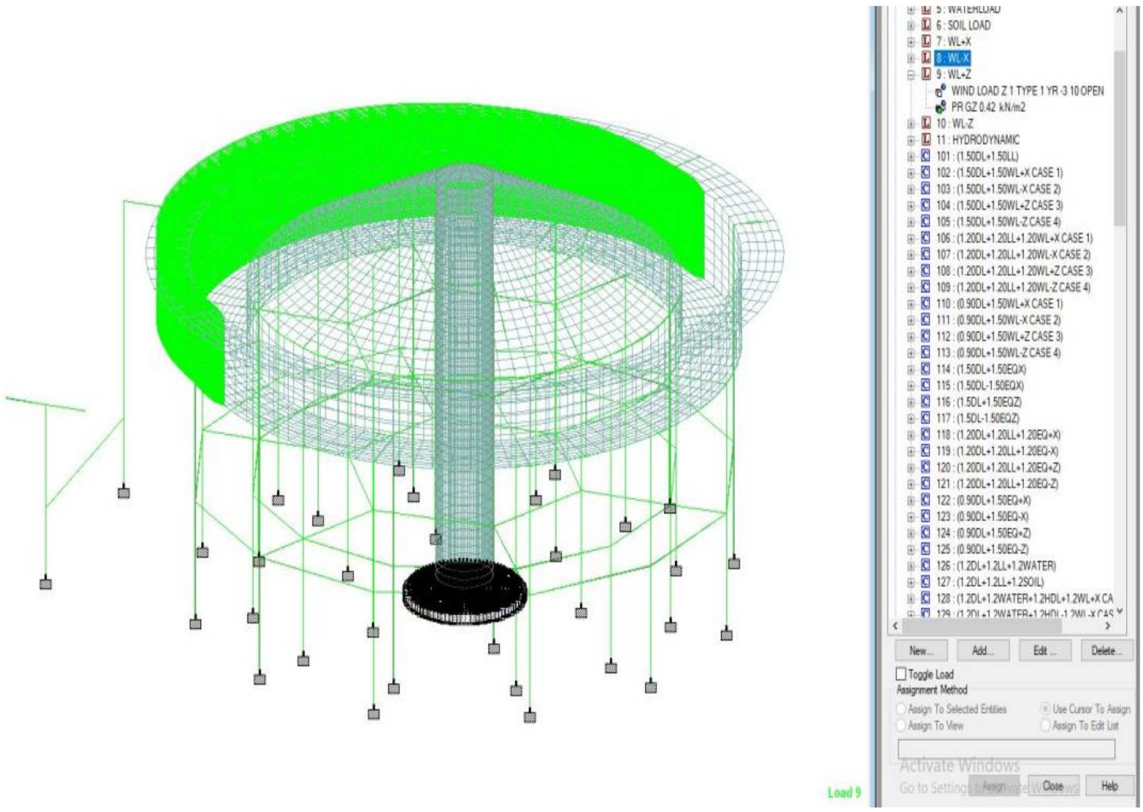


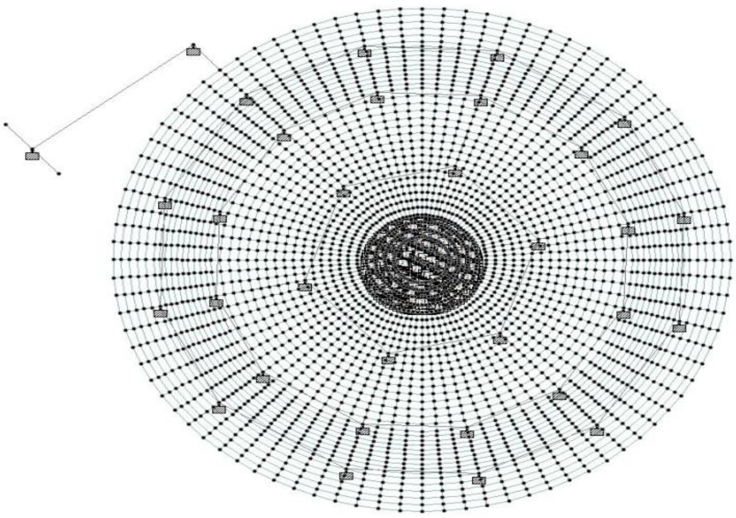
Fig 3: Design Layout of the Tank in Auto-Cad

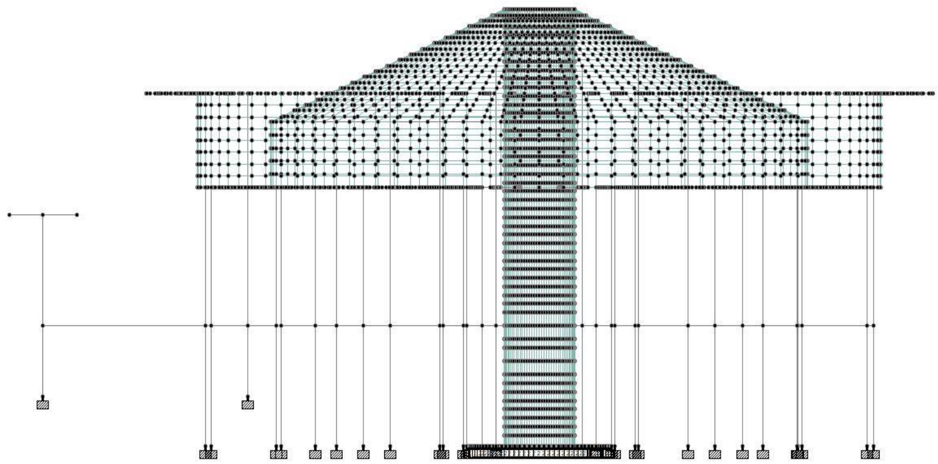
Layouts of the Tank Designed in Staad Pro

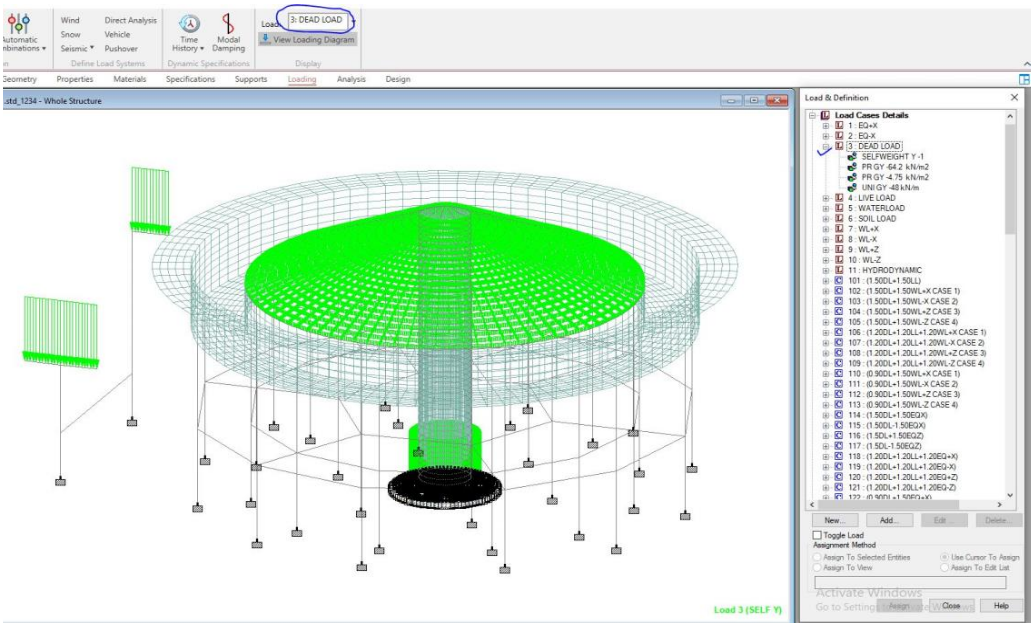


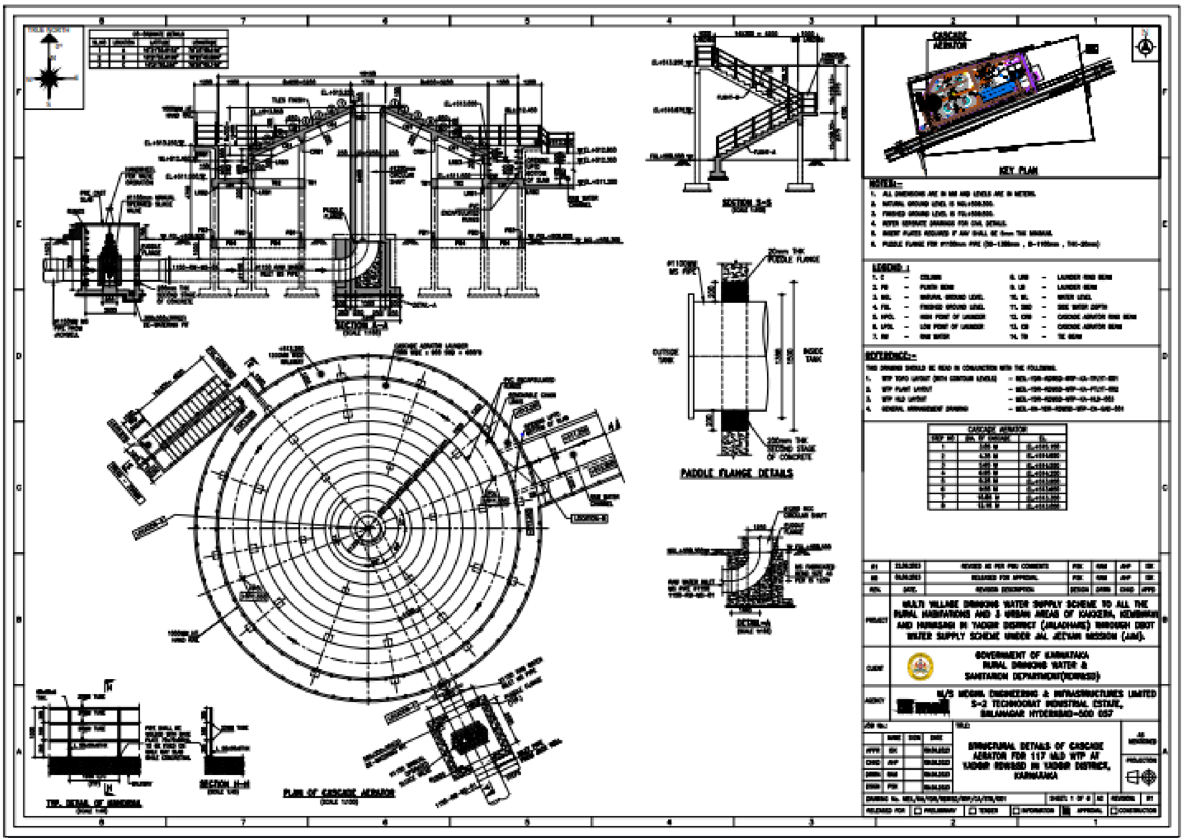

6 : SOIL LOAD
7 : WL+X
8 : WL-X
WIND LOAD X -1 TYPE 1 YR -3 10 OPEN
PR GX -0.42 kN/m2
9 : WL+Z
10 : WL-Z
11 : HYDRODYNAMIC
101 : (1.50DL+1.50LL)
102 : (1.50DL+1.50WL+X CASE 1)
103 : (1.50DL+1.50WL-X CASE 2)
104 : (1.50DL+1.50WL+Z CASE 3)
105 : (1.50DL+1.50WL-Z CASE 4)
106 : (1.20DL+1.20LL+1.20WL+X CASE 1)
107 : (1.20DL+1.20LL+1.20WL-X CASE 2)
108 : (1.20DL+1.20LL+1.20WL+Z CASE 3)
109 : (1.20DL+1.20LL+1.20WL-Z CASE 4)
110 : (0.90DL+1.50WL+X CASE 1)
111 : (0.90DL+1.50WL-X CASE 2)
112 : (0.90DL+1.50WL+Z CASE 3)
113 : (0.90DL+1.50WL-Z CASE 4)
114 : (1.50DL+1.50EQX)
115 : (1.50DL-1.50EQX)
116 : (1.5DL+1.50EQZ)
117 : (1.5DL-1.50EQZ)
118 : (1.20DL+1.20LL+1.20EQ+X)
119 : (1.20DL+1.20LL+1.20EQ-X)
120 : (1.20DL+1.20LL+1.20EQ+Z)
121 : (1.20DL+1.20LL+1.20EQ-Z)
122 : (0.90DL+1.50EQ+X)
123 : (0.90DL+1.50EQ-X)
124 : (0.90DL+1.50EQ+Z)
125 : (0.90DL+1.50EQ-Z)
126 : (1.2DL+1.2LL+1.2WATER)
127 : (1.2DL+1.2LL+1.2SOIL)
128 : (1.2DL+1.2WATER+1.2HDL+1.2WL+X CA
New...
Add...
Edit ...
Delete...
Toggle Load
Assignment Method
Assign To Selected Entities
Use Cursor To Assign
Assign To View
Assign To Edit List
Assign
Close
Help
Load 8

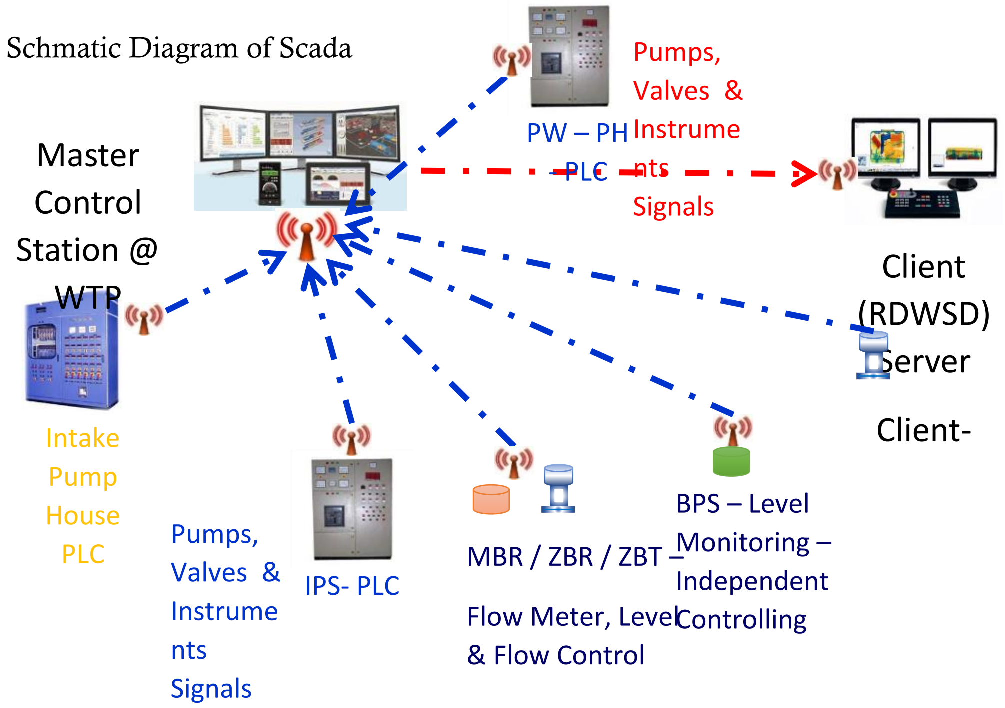

6 : SOIL LOAD
7 : WL+X
8 : WL-X
9 : WL+Z
WIND LOAD Z 1 TYPE 1 YR -3 10 OPEN
PR GZ 0.42 kN/m2
10 : WL-Z
11 : HYDRODYNAMIC
101 : (1.50DL+1.50LL)
102 : (1.50DL+1.50WL+X CASE 1)
103 : (1.50DL+1.50WL-X CASE 2)
104 : (1.50DL+1.50WL+Z CASE 3)
105 : (1.50DL+1.50WL-Z CASE 4)
106 : (1.20DL+1.20LL+1.20WL+X CASE 1)
107 : (1.20DL+1.20LL+1.20WL-X CASE 2)
108 : (1.20DL+1.20LL+1.20WL+Z CASE 3)
109 : (1.20DL+1.20LL+1.20WL-Z CASE 4)
110 : (0.90DL+1.50WL+X CASE 1)
111 : (0.90DL+1.50WL-X CASE 2)
112 : (0.90DL+1.50WL+Z CASE 3)
113 : (0.90DL+1.50WL-Z CASE 4)
114 : (1.50DL+1.50EQX)
115 : (1.50DL-1.50EQX)
116 : (1.5DL+1.50EQZ)
117 : (1.5DL-1.50EQZ)
118 : (1.20DL+1.20LL+1.20EQ+X)
119 : (1.20DL+1.20LL+1.20EQ-X)
120 : (1.20DL+1.20LL+1.20EQ+Z)
121 : (1.20DL+1.20LL+1.20EQ-Z)
122 : (0.90DL+1.50EQ+X)
123 : (0.90DL+1.50EQ-X)
124 : (0.90DL+1.50EQ+Z)
125 : (0.90DL+1.50EQ-Z)
126 : (1.2DL+1.2LL+1.2WATER)
127 : (1.2DL+1.2LL+1.2SOIL)
128 : (1.2DL+1.2WATER+1.2HDL+1.2WL+X CA
New...
Add...
Edit ...
Delete...
Toggle Load
Assignment Method
Assign To Selected Entities
Use Cursor To Assign
Assign To View
Assign To Edit List
Assign
Close
Help
Load 9

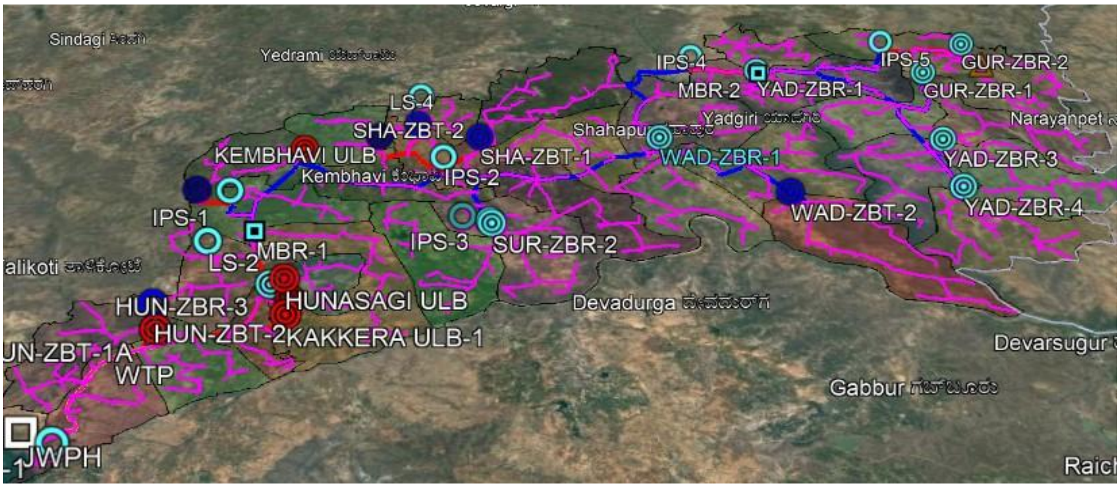





Wind
Snow
Seismic
Direct Analysis
Vehicle
Pushover
Define Load Systems
Time History
Modal Damping
Dynamic Specifications
3: DEAD LOAD
View Loading Diagram
Display
Geometry
Properties
Materials
Specifications
Supports
Loading
Analysis
Design
.std_1234 - Whole Structure
Load 3 (SELF Y)
Load & Definition
Load Cases Details
1 : EQ+X
2 : EQ-X
3 : DEAD LOAD
SELFWEIGHT Y -1
PR GY -64.2 kN/m2
PR GY -4.75 kN/m2
UNI GY -48 kN/m
4 : LIVE LOAD
5 : WATERLOAD
6 : SOIL LOAD
7 : WL+X
8 : WL-X
9 : WL+Z
10 : WL-Z
11 : HYDRODYNAMIC
101 : (1.50DL+1.50LL)
102 : (1.50DL+1.50WL+X CASE 1)
103 : (1.50DL+1.50WL-X CASE 2)
104 : (1.50DL+1.50WL+Z CASE 3)
105 : (1.50DL+1.50WL-Z CASE 4)
106 : (1.20DL+1.20LL+1.20WL+X CASE 1)
107 : (1.20DL+1.20LL+1.20WL-X CASE 2)
108 : (1.20DL+1.20LL+1.20WL+Z CASE 3)
109 : (1.20DL+1.20LL+1.20WL-Z CASE 4)
110 : (0.90DL+1.50WL+X CASE 1)
111 : (0.90DL+1.50WL-X CASE 2)
112 : (0.90DL+1.50WL+Z CASE 3)
113 : (0.90DL+1.50WL-Z CASE 4)
114 : (1.50DL+1.50EQX)
115 : (1.50DL-1.50EQX)
116 : (1.5DL+1.50EQZ)
117 : (1.5DL-1.50EQZ)
118 : (1.20DL+1.20LL+1.20EQ+X)
119 : (1.20DL+1.20LL+1.20EQ-X)
120 : (1.20DL+1.20LL+1.20EQ+Z)
121 : (1.20DL+1.20LL+1.20EQ-Z)
New...
Add...
Edit...
Delete...
Toggle Load
Assignment Method
Assign To Selected Entities
Assign To View
Use Cursor To Assign
Assign To Edit List
Assign
Close
Help







10. Scope of Work: Water Treatment Plant & Water Tank Design

10.1 Scope Overview:

- Design of water treatment plants and water tanks for habitations in Shorapur, Shahapur, Yadgir, Hunasagi, Wadgera, and Gurmitkal taluks in Yadgir district.

10.2 Identification and Mapping:

- Identify rural habitations in the project area.
- Prepare taluk-wise base maps.

10.3 Population Analysis:

- Study past population data (at least three decades).
- Project population for different project phases.

10.4 Existing Infrastructure Study:

Study existing multi-village water supply arrangements and ongoing schemes.

10.5 Water Demand Analysis:

Conduct water demand analysis on a habitation-wise basis.

10.6 Location Identification:

Use a GIS Terrain model or topo-sheet to identify locations for Head Works, Water Treatment Plant, Master Balancing Reservoirs, and Pumping Stations.

10.7 Preliminary Designs:

Carry out preliminary designs for intake structures, pumping stations, master balancing reservoirs, etc.

10.8 Hydraulic and Process Design:

- Conduct preliminary hydraulic and process design for the water treatment plant.
- Prepare layout plans and General Arrangement drawings.

10.9 Water Supply Network:

- Prepare bulk water supply network drawings with pipe diameter, material, length, and levels based on terrain modeling.

11. Objectives

1. Study on Water Treatment Plant and tank Analysis and Design
   - Understand the principles and processes involved in the analysis and design of water treatment plants and liquid retaining structures.
2. Guidelines for Design of Liquid Retaining Structures
   - Explore guidelines outlined in relevant IS codes for the design of liquid retaining structures.
3. Design Philosophy for Safe and Economical Design:
   - Investigate the design philosophy ensuring the safe and economical design of water treatment plants and water tanks.

12. Conclusion

The utilization of Staad Pro in the design of the 'Water Treatment Plant & Multi-Village Drinking Water Supply System' has proven highly effective. It enables precise modeling and assessment of structural integrity, ensuring stability and safety. The advanced features of SCADA & Staad Pro streamline the design process, allowing for efficient analysis and optimization. Overall, this contributes to the development of robust and sustainable water infrastructure.

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[3] Thalapathy.M, Vijaisarathi.R. P, Sudhakar. P, Sridharan. V, Satheesh. S (2016): "Analysis and Economical Design of Water Tanks."

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[5] M.V Waghmare and S.N Madhekar (2013): "Behavior of elevated water tank under sloshing effect," International Journal of Advanced Technology in Civil Engineering, Vol.2 (1), 51-54.