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Planning of Water Distribution Network to Desapatrunipalem (55th ward, Visakhapatnam) by using EPANET& GIS

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Abstract: The present existing water supply system adopted in Desapatrunipalem is an irregular supply and the network implemented is a dead end/Tree system. Water distribution system in Desapatrunipalem is insufficient to meet the demand of upcoming years. Hence the present project is all about the study of existing network and concludes about the reliability on the network for the future demand and proposal of the new network and simulation of the network by EPANET and to check whether the new network output values are within the limits or not. This study is carried out based on public demand, quantities of inflows and outflows of the over-head service reservoirs. The design is done based on population growth rate, and the developments in the village. This analysis provides the information about various demands, losses, pressures and head ofthe network. This proposed network will assist the municipality to be aware of the new demands, rate of increase in the demand.
Keywords: Water distribution network, Population forecast, Water demand, Nodal demand and Network Analysis

I. INTRODUCTION

Water supply system is a system of engineered hydrologic and hydraulic components which provide water supply. Design of surface water supply system concerns the locations and capacities of diversion works and storage, as well as the operations of these to meet multiple purposes and objectives. Therefore, in order to ensure the availability of sufficient quantity of good quality of water, it becomes almost imperative in a modern society, to plan and build suitable water supply schemes, which may provide potable water to the various section of the community in accordance with their demand and requirements. Due to the advent of Geographical Information Systems (GIS), it is possible to visualize, and model the entire cycle of water supply network from source to household. The network system must be modeled, analyzed, and its performance is evaluated under the various physical and hydraulic parameters or conditions. This process is called as "Simulation'. EPANET is a computer program that performs extended period simulation of hydraulic and water quality behaviour within pressurized pipe networks. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps.

A. Objectives

Objectives of the study are as follows.

1) Population Forecast by different methods.
2) Generation of thematic layers for Desapatrunipalem village by Digitization process using GIS.
3) Design of pipe network for the future demand.
4) Finding out the Nodal demand of the Network.
5) Simulation of the water distribution network for various hydraulic parameters.

II. STUDY AREA

Desapatrunipalem is a village in Gajuwaka Mandal part of 55th Ward and Zone 5 of Visakhapatnam district, Andhra Pradesh state, India lies between the latitudes 17^{0}.37' to 17^{0}.38' North and longitudes of 83^{0}.07' to 83^{0}.08' East and an average elevation of 46m above MSL. The total area of village is 1414.78 ha which covers the whole village for which water supply system is designed and pipe network has to be simulated. This village doesn't have any surface water source, the present system is an intermittent system running by 3 bore wells by Pumping system and the existing network is a dead end system. The present system is not at all sufficient to meet the demand of the people. So, this study is carried out as part of ongoing project of JNNURM by Greater Visakhapatnam

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Municipal Corporation (GVMC), Visakhapatnam, India in a view of providing sufficient water supply to the village from Yeleru canal. The total population of the village is 5832 as per the Census 2011. The village consists of 1531 households.

Fig1. Satellite Image of GVMC Zone 5

Fig2. Satellite Image of Desapatrunipalem

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III. METHODOLOGY

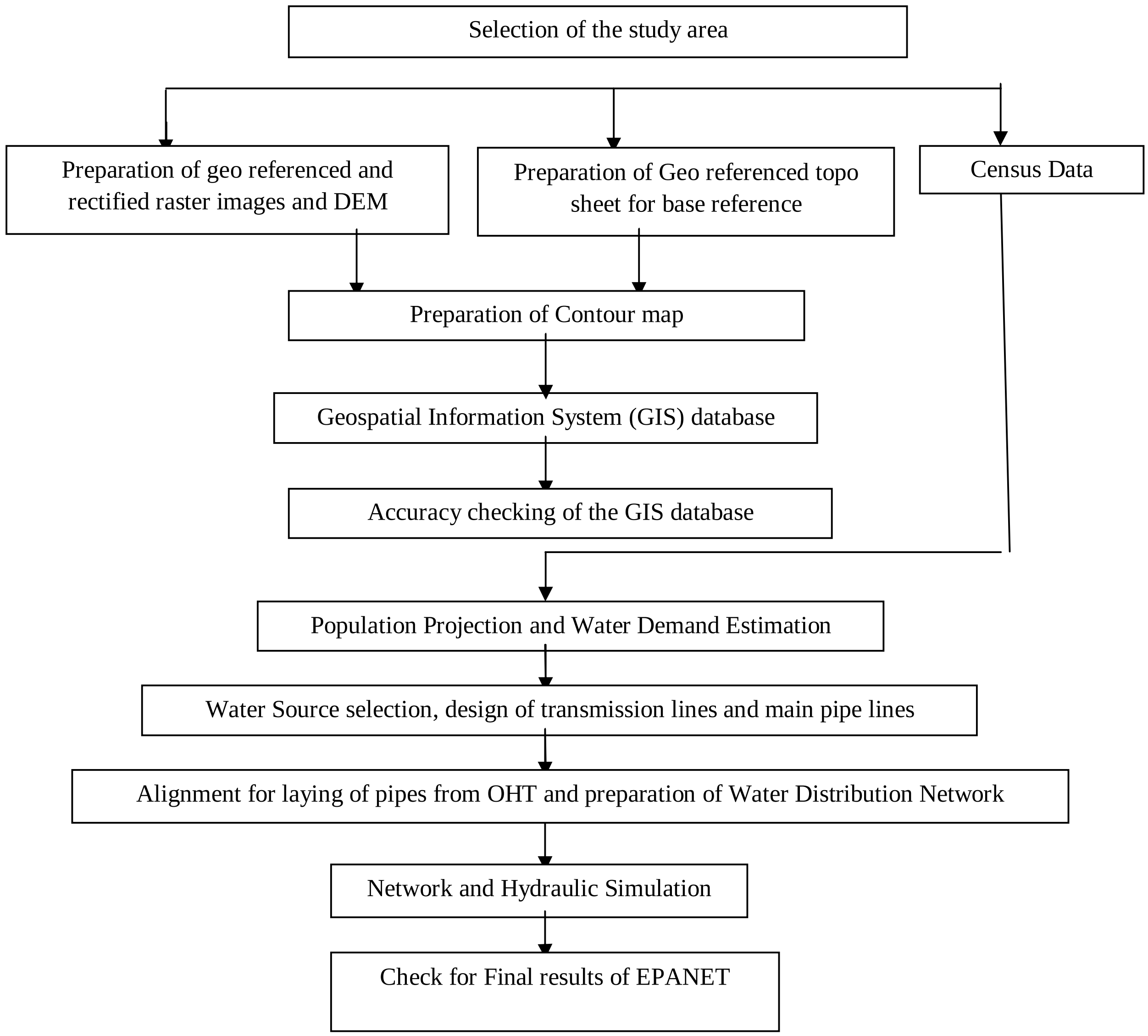

Fig3. Flowchart of Methodology

A. Methodology

The latest imagery of the study area is collected using Google Earth as per the known latitudes, longitudes which can be extracted from the software as 17^0.37' to 17^0.38' North and longitudes of 83^0.07' to 83^0.08' East. Base map is generated by the method of digitizing using QGIS software. Different layers are generated to distinguish well-known places such as roads, water bodies, rail track, built up area, green land and temples etc., representation of sources for the distribution of water to study area if any existing, which was shown in Fig2. As the EPANET tool is user friendly, one can adopt the following procedure as mentioned with the generated base map.

1) Importing layout of distribution network as backdrop into EPANET tool from QGIS.
2) Fixing the total demand from reservoir or tank based on the hydraulic scheme design.
3) Assigning the units of flow as LPS, fix the head loss formula to Hazen – Williams (H – W) method.
4) Assigning the hydraulic properties to the network of pipes like length, diameter, roughness etc.
5) Calculation of nodal demand by using representative length method according to population growth.

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6) Assigning node properties like node id, elevation and nodal demand.
7) Thoroughly check the pipes and nodes are properly connected at intersections and reservoir nodes.
8) Preparing a suitable basic design with the available data.
9) Run the hydraulic analysis.

B. Desapatrunipalem Digitization in QGIS

Contour map of the village was prepared by using Google Earth and Surfer to study the terrain behavior and the digitization of roads, streets and buildings in Desapatrunipalem was done in QGIS and that file was further used as a backdrop in EPANET to carry out the hydraulic simulation as shown in Fig3.

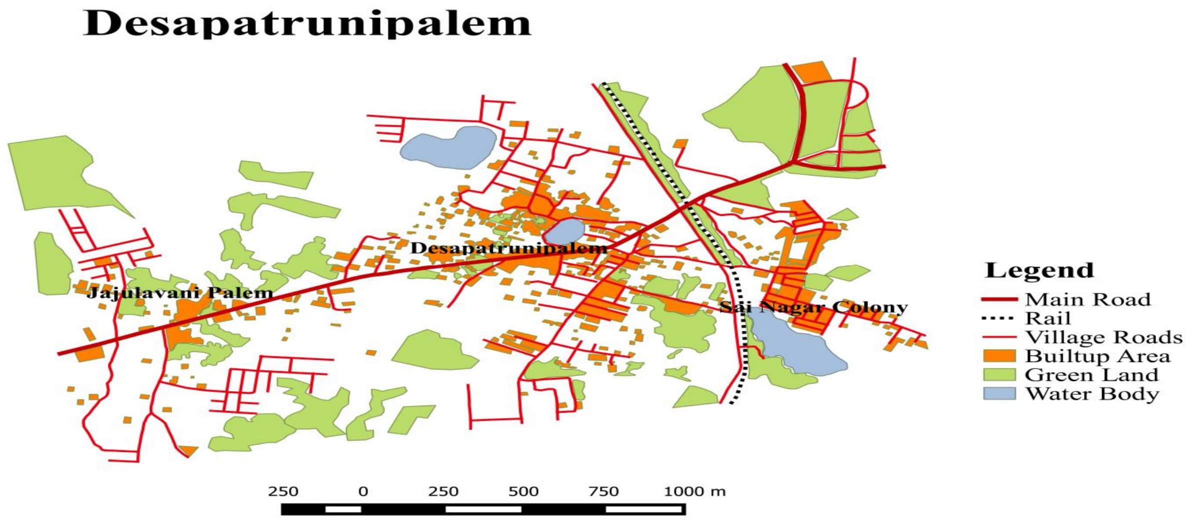

Fig4. Digitized map of Desapatrunipalem

The layout of road network is extracted from the base map of the study area as stated earlier is shown in Fig4. It was assumed that the pipes used for supplying of water to the end users will be laid along the side of roadway. In this image road network of study area is shown clearly.

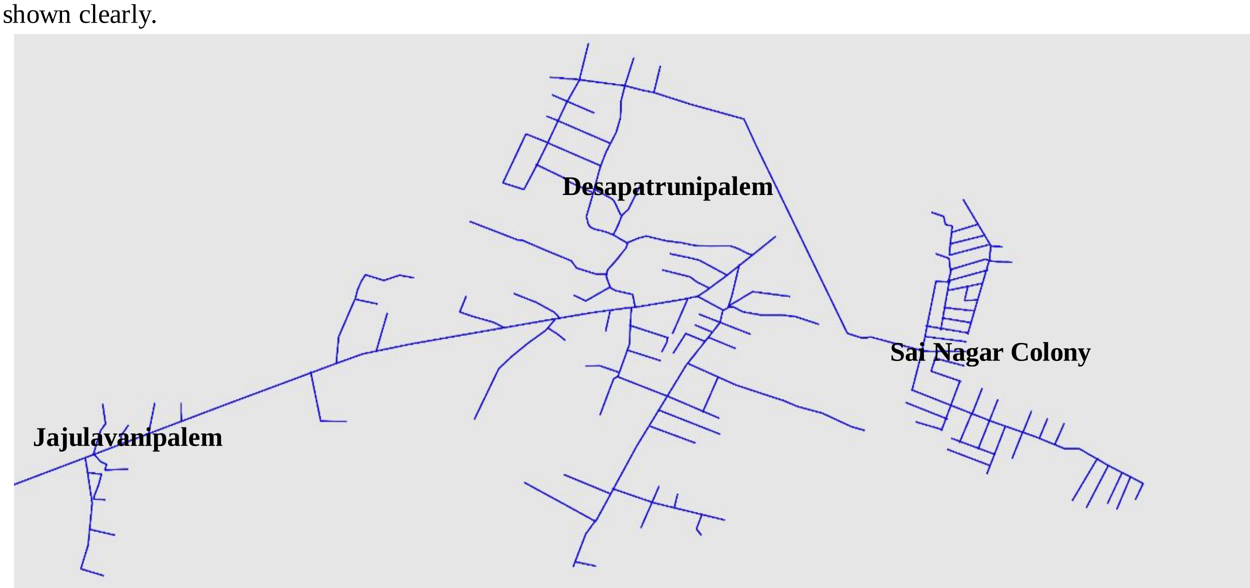

Fig5. Existing road network of study area

C. Population Forecasting

Design of water supply system is based on the projected population of a particular village or town, estimated for the design period. The present and past population record for the village can be obtained from the census population records. After collecting these

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population figures, the population at the end of design period is predicted using various methods as suitable for that village considering the growth pattern followed by the village.

Population forecasting is based on the following methods

1) Arithmetical Increase Method
2) Geometrical Increase Method
3) Incremental Increase Method
4) Graphical Method
5) Comparative Graphical Method
6) Master Plan Method
7) Logistic Curve Method

For this project, both Geometrical and Incremental increase methods were used because the population growth trend follows these methods.

Table 1: Demographic Details

Year	Population	Male	Female	No. of Households
1991	2029	1013	1016	465
2001	3186	1604	1582	1003
2011	5832	2972	2860	1531

Table 2: Forecasted Population Data

Year	Geometrical Increase Method	Incremental Increase Method
2021	9843	9222
2031	16613	12737
2041	28039	16200
2051	47323	19612

Table 3: Various Types of Water Demands (as per CPHEEO Manual)

S. No	TYPE OF DEMAND	QUANTITY
1	Domestic water demand	135 to 225 lpcd
2	Industrial water demand	50 lpcd
3	Institution and commercial water demand	20 to 50 lpcd
4	Demand for public uses	10 lpcd
5	Fire demand	1 lpcd
6	Water required for compensating losses in wastes, thefts	15% of the total compensation

D. Water Demand calculation

Domestic water demand for GVMC is 100lpcd+ 15% is unaccounted flow

Design Population = 9222

water demand Q = Population x Per capita demand

$= 9222 \times 115$ lpcd $/10^6$

Q = 1.06MLD = 12.27lt/sec

E. Systems of Supply

The water may be supplied either continuously for 24 hours of the day or may be supplied intermittently only for the peak periods during morning and evening. The intermittent supply system may sometimes lead to some saving in water consumption due to losses occurring for lesser time and more vigilant use of water by consumers. The intermittent supply system is employed for this project.

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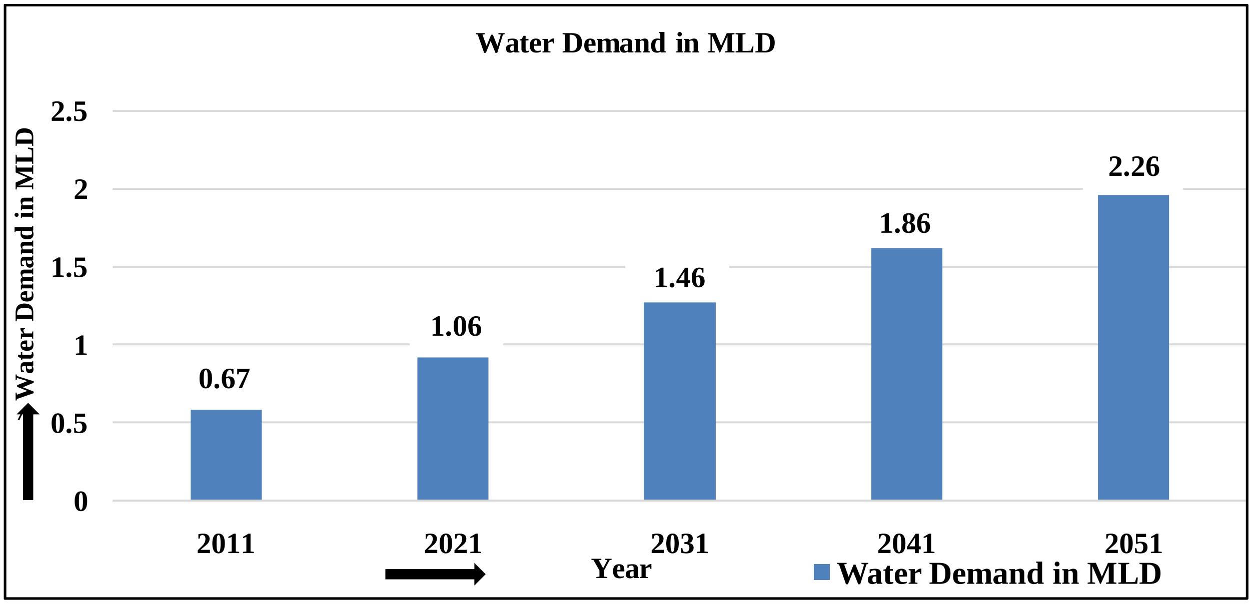

Fig6. Graph of Water Demand in MLD

F. Nodal Demand Calculation

In this method network is generated and total length generating from one node to other nodes is determined. Half of above length is taken as representative length (L) for that particular node. Demand for each node is calculated by multiplying the representative length and demand per meter length (L**x**q). Demand per meter length is calculated by q = Q/total network length (here 19km), where Q is total demand of concerned area (i.e., Population x per capita demand). Here q and Q varies as population increases for each decade and representative length (L) remains same.

Table 4: Nodal demand for 3 decades

Nodal Demand (LPS)					
S No	Representative Length (m)	2021	2031	2041	2051
1	27	0.02	0.02	0.03	0.04
2	26	0.02	0.02	0.03	0.04
3	27	0.02	0.02	0.03	0.04
4	33	0.02	0.03	0.04	0.05
5	10	0.01	0.01	0.01	0.01
6	49	0.03	0.04	0.05	0.07
16	10	0.01	0.01	0.01	0.01
17	35	0.02	0.03	0.04	0.05
18	37	0.03	0.03	0.04	0.05
19	29	0.02	0.03	0.03	0.04
20	31	0.02	0.03	0.03	0.04
21	37	0.03	0.03	0.04	0.05
22	46	0.03	0.04	0.05	0.06
23	67	0.05	0.06	0.07	0.09
24	58	0.04	0.05	0.06	0.08
25	32	0.02	0.03	0.04	0.04
26	30	0.02	0.03	0.03	0.04
7	15	0.01	0.01	0.02	0.02

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8	61	0.04	0.05	0.07	0.09
9	57	0.04	0.05	0.06	0.08
10	44	0.03	0.04	0.05	0.06
11	37	0.03	0.03	0.04	0.05
12	37	0.03	0.03	0.04	0.05
13	52	0.04	0.05	0.06	0.07
14	35	0.02	0.03	0.04	0.05
15	11	0.01	0.01	0.01	0.02
27	35	0.02	0.03	0.04	0.05
28	42	0.03	0.04	0.05	0.06
29	63	0.04	0.06	0.07	0.09
30	44	0.03	0.04	0.05	0.06
31	53	0.04	0.05	0.06	0.07
32	46	0.03	0.04	0.05	0.06
33	56	0.04	0.05	0.06	0.08
34	58	0.04	0.05	0.06	0.08
35	17	0.01	0.02	0.02	0.02
23	67	0.05	0.06	0.07	0.09

G. EPANET 2.0 Software Details

EPANET is a computer program that performs single and extended period simulation of hydraulic and water quality behavior within pressurized pipe networks. A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps. In addition to chemical species, water age and source tracing can also be simulated.

H. Network generation, modelling and simulation in EPANET

By using the required data like base map, road network, elevation details, pipe lengths, tanks, valves, reservoir, pumps etc., generated a distribution network in EPANET by using road network map and assigned the hydraulic properties like pipe length, pipe diameter, roughness values, node elevation and nodal demand to the network. The water distribution network of Desapatrunipalem consists of 275 pipes of uniform material, 263 junctions, 8 valves and 1 elevated service reservoir from which water is distributed to the entire network. The pipes used in the network system are of different diameter ranges from 90mm to 315mm (as per IS 4895:2000). The PVC pipes having roughness coefficient of 145 are used throughout the network system (as per standards of CPHEEO).

Simulation of this network had done using EPANET, during the network simulation, changes in selected parameters such as head, flow, velocity, unit head loss and water pressure at various nodes and links were observed and found that the output values are in the range of standard output values.

IV. CONCLUSIONS

1) Design period of Water Distribution Network is 30yrs, present existing system of supply in Desapatrunipalem is not sufficient for 3 decades. A new water distribution network is designed as per the requirements by following the standards and Simulation of the network is done in EPANET.
2) Using QGIS and its tools, geo-referenced features such as Nodes, Water distribution network, village polygons, ESR location and topographic contours have been created in no time. As the data which have been created are geo-referenced, this method is very useful for designing and planning of distribution system to villages with great accuracy. Moreover, the data which have been created can be easily incorporated in the Hydraulic Simulation software such as EPANET.
3) This type of study with the use of GIS, gives accurate results, visualization of water supply network for better understanding. This study also helps in water supply engineering for saving the time.

4) The designed network should also withstand for increase in population for 3 decades i.e., 27.6% for 2021 – 2031, 21.38% for 2031 – 2041 and 17.4% for 2041 – 2051, as the nodal demand is also increasing i.e., 27.61% for 2021 – 2031, 43.09% for 2031 – 2041 and 52.99% for 2041 – 2051 as we consider in the design.

5) One of the major problems is the presence of dead ends within the distribution system. Despite this constraint, it can be overcome by looping the pipes in the network but, the site conditions are not conducive for looping, as the village is developed in a haphazard manner.

6) By using tools like EPANET, the analysis can be done with in a period of time even for complex type of networks.

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REFERENCES

[1] R. Sathyanathan, Mozammil Hasan, V.T. Deeptha (2016), Water Distribution Network Design for SRM University using EPANET, Asian Journal of Applied Sciences (ISSN: 2321 – 089), Volume 04 – Issue 03, June 2016

[2] G. Anisha, A. Kumar, J. Ashok Kumar, P. Suvarna Raju (2016), Analysis and Design of Water Distribution Network Using EPANET for Chirala Municipality in Prakasam District of Andhra Pradesh, International Journal of Engineering and Applied Sciences (IJEAS) ISSN: 2394-3661, Volume-3, Issue-4, April 2016.

[3] Dr. H. Ramesh, L. Santhosh and C. J. Jagadeesh (2012), Simulation of Hydraulic Parameters in Water Distribution Network Using EPANET and GIS, International Conference on Ecological, Environmental and Biological Sciences (ICEEBS'2012) Jan. 7-8, 2012 Dubai

[4] D. Ram Mohan Rao, Zameer Ahmed, Dr. Y. Ellamraj, Dr. D. Ram Mohan Reddy (2015), EPAnet Demand Calculation Methods and Implications, International Journal of Scientific Engineering and Research (IJSER), ISSN (Online): 2347-3878, Volume 4 Issue 11, November 2016

[5] Piplewar S.K, Chavhan Y.A (2013), Design of Distribution Network for Water Supply Scheme at Pindkepar Village by Branch Software, Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 3, Issue 5, Sep-Oct 2013, pp.854-858

[6] KakadiyaShital, MavaniKrunali, Darshan Mehta, Vipin Yadav (2016), Simulation of Existing Water Distribution Network by using EPANET: A Case Study of Surat City, Global Research and Development Journal of Engineering | Recent Advances in Civil Engineering for Global Sustainability | e-ISSN: 2455-5703, March 2016

[7] Shivalingaswami.S. Halagalimath, Vijaykumar.H, Nagaraj.S.Patil (2016), Hydraulic modeling of water supply network using EPANET, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056, p-ISSN: 2395-0072, Volume: 03 Issue: 03 | Mar-2016

[8] Maulik Joshi, ShilpaChavda, DharmeshRajyaguru, Sohamsarvaiya (2014), Design of Water Distribution Supply Network forKuchhadi Village, Paripex - Indian journal of research, ISSN - 2250-1991, Volume: 3 | Issue: 2 | Feb 2014

[9] IS 4895:2000, Unplasticized PVC pipes for potable water supplies -- specification, (Third Revision), March 2005.

[10] Dr. G. VenkataRamana , Ch. V. S. S. Sudheer , B.Rajasekhar (2015) Network analysis of water distribution system in rural areas using EPANET, Elsevier, 13th Computer Control for Water Industry Conference, CCWI 2015, Procedia Engineering 119 (2015) 496 – 505.

[11] RASOOLI Ahmadullah, KANG Dongshik (2016), Designing of Hydraulically Balanced Water Distribution Network Based on GIS and EPANET, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 7, No. 2, 2016.

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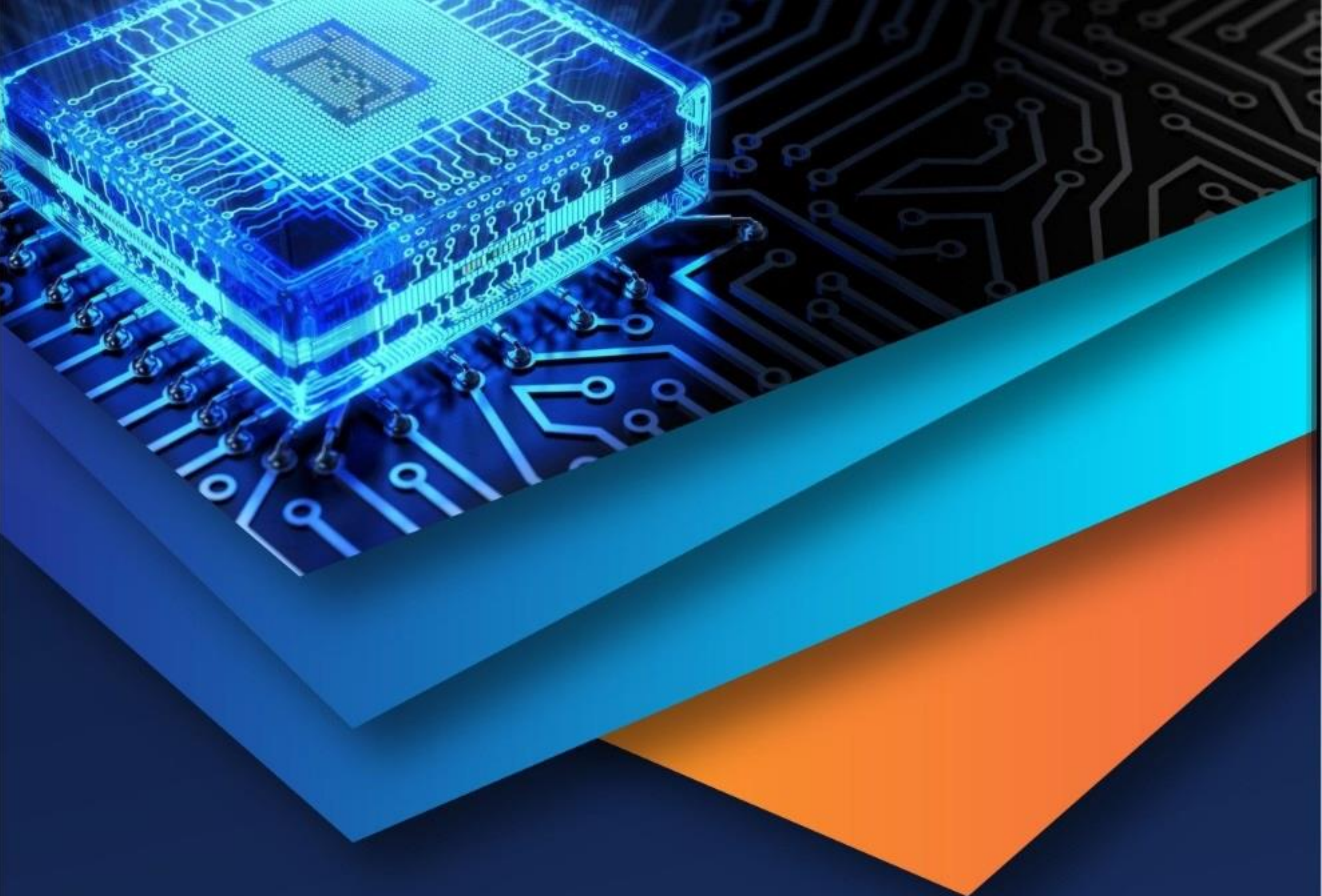

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