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WATER AUDITING IN RESIDENTIAL BUILDING (G+7)

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Abstract : The need of water in India is gradually increasing day by day and we are facing water shortages due to less rainfall, drying up of different water sources and change in climatic conditions. So, we analyzed this water shortage situation and tried to find the root of the problem and we found that residential buildings are, one of the sources of more water usage. The method we used was water auditing of residential building. The water auditing is a method of quantifying water flows and quality in simple or complex systems, with a view to reduce water usage and often saving money. By doing water auditing we found that the water was used more than it should be and also losses were higher. We should do water audits once in a year to find leakages. This study helps to identify water usage and water wastage of a high-rise residential buildings and can help authority to provide adequate amount of water to buildings, which can result in less water bill for the building and also save's water.

Index Terms **-** Water audit, Per capita demand, Residential building, Water consumption, Water meter.

I. INTRODUCTION

The water is essential element for living beings. The water is used in various ways by humans like bathing, drinking, cleaning purposes, etc. India is a vast country and has a population more than 130 crores to provide clean water to everybody is difficult task for the government. The per capita demand by the IS code 1172(1993) is given as, for communities with population above 100000 is 150 to 200 lpcd with full flushing system. But this is practically not followed by the people because the usage is considered ideally and can even vary due to addition in population or any other factor. Water auditing is only a practical way to ensure optimum use and less water wastage by the communities in high rise residential building. The water meter is provided to every building is a reading common to whole building and is billed accordingly. As water meter shows total number of waters used by the whole building, it lacks to tell per capita demand or even one household per day usage.

II. AIM OF STUDY

The aim of the study is to calculate per capita demand, future water requirement by the building and to show how easy it to find per capita demand practically.

III. STUDY LOCATION

This study was done in 7th January 2022 to 14th January 2022 and it focuses on domestic use of water in seven floor building which is Shree Heaven building in New Panvel area of Sector 8, Plot no: - 15 & 16, which lies under Panvel City Municipal Corporation (PCMC) but the water supply and charges are managed by City and Industrial Development Corporation (CIDCO). The population of Panvel and Uran taluka, developed by CIDCO as south Navi Mumbai, has reached 20 lakhs. By considering the increasing population in the city, the water demand of the city is likely to increase to 1,275 MLD by the year 2050. Hence, CIDCO is looking to get additional 120 MLD water from Hetawne dam. [source: Times of India].

. **Figure 1**: Shree Heaven building, New Panvel

IV. LITERATURE REVIEW

A literature review is an overview of the previously published works on a specific topic. It can provide clues so as to where future research is heading or recommended areas which to focus.

Peeyush Bajpai, et. al (2001), studies that water strategy for levying user charges for different economic status households. How urban Indian households obtain water for their daily requirements and also out the number of households involved and their economic characteristics in India.

Harpreet Singh Kandra, et. al (2004), author was conducted research in order to examine the Water losses and determining the system's conservation need and the method why the water loss is occurring (through pipe lines). They suggest a management information system is needed for managing the water supply, covering the treatment plant and accountability.

R.A. Ganorkar, et. al (2013), the case study is mainly focussed on calculation of different consumption done in water audit like calculation of authorized consumption, evaluate apparent losses, Evaluate real losses, performance measurement. The paper covered the holistic approach towards total water resource, distribution and its efficient use to reduce the capital and operating cost as an added advantage over the optimized use of water resource with environment protection.

Aditya Gupta, et. al (2016), the students of VNIT Nagpur, conducted the project of need of smart water systems in India. Water stress is increasing day by day and so India is going to face scarcity city. So, there is a need of low cost and low maintenance smart water system which is simple in field implementation and has high efficiency in terms of data reliability.

Khushbu Gandhi, et. al (2016), the students of SCET, conducted a thorough case study on water consumption in different areas and in different type of residential building like bungalows and high-rise buildings. From the water audit, the metered water, unmetered water, theft water, unaccounted water, leakage etc. is known. The quality of water supply is also known.

Ramraje D. Sonvane, et. al (2016), the researcher from G.H. Raisoni College of Engineering describes a review on Water audit. They studied about the benefits of water audit, steps of water audit (supply and usage study, process study and system audit and discharge analysis), water balance. Their aim is to improvement of not only water use efficiency and distribution system, but also on the efficient development and management of the source of water.

Seyed M. K. Sadr, et. al (2016), the authors had studied An Analysis of Domestic Water Consumption in Jaipur, India. It includes Factors Influencing Domestic Consumption, Household Water-using Appliances like Bath and shower, Clothes washing, Dish-washing. And other characteristics like Household characteristics, Water use characteristics. Per capita water consumption is higher in smaller families and vice versa. Family size and income were also found to be important indicators in estimating household water consumption. in order to undertake further research, conducting a diary study on water use habits would be worthwhile.

V.METHODOLOGY

This section of the paper discusses the methodology of the research. The process involved in research is considering various factor of water usage in a residential building, calculation of water used by per person per day, overall used by the building, finding and calculating losses, forecasting future water demand for the building.

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References Table 1. Assessment of water requirement for residential units
Source: Drafting guideline for water audit by Ministry of Water Resources, RD&GR Annex-C
Number of persons / users in the residential unit =

Sr. No.	Fixture	Measurement of Water Uses per Residential unit					
		Rate of Discharge (litre/min)	Average Duration of Use (min)	Average Quantity per Use (litre)	No. of Uses (No.)	Total Daily Use (litre)	Per Capita Daily Water Use (litre)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Kitchen faucet						
2	Utility faucet						

4	Bathroom faucet						
5	Other faucet						
6	Shower						
7	Toilet						
8	Washing Machine						
9	Dish Washer						
10	Other or extra tap						
TOTAL							

This table can also be used by a non-professional person for water auditing and can be done at their household. The table can hold many more fixtures in other or extra tap row depending on the building.
The population of the residential building as such not varies very much so for the future water usage the bills provided by the water supplying authority is considered and taking average of that will be the future water usage.

For calculation of the terms mentioned in the Table 1: -

- Rate of discharge: -The rate of discharge is to be calculated by using a measuring container and a stopwatch. Firstly, hold the container under each tap of the household then open the tap for exact 10 seconds, note the reading. After recording each tap reading multiply it by 60, what it does is it converts seconds to min and you will get the reading in litres per minute.
- Average duration of use per day: - Totally based on each household, but as the average of 4 to 5 people living in the houses, the usage is recorded by asking the people as per each house, then take average for the building usage in minutes.
- Average quantity per use: - This is recorded by considering number of works done by the people using specific tap. Firstly, list all the work that can be done by that tap on daily basis then calculate average by adding total daily usage of the tap and then dividing by the number of times it has been used.
- Number of uses: - Due to covid 19 pandemic the uses has been increased drastically. This can be recorded by number of times the work has been carried out by the tap.
- Total daily use: - By multiplying average quantity per use and number of uses.
- Average per capita daily use: - This can be calculated by dividing total daily use to the number people living in the house.

For firefighting water calculation IS code 3844 (1989) is to be used. For leakages calculating the number of fixtures leaking and how much drops of water per fixture per minute will give appropriate results. The water is also used outside the household like for washing cars, watchman bathroom, cleaning building floors so to be calculated by recording 7-day usage and taking average of it.

VI.RESULTS AND DISCUSION

Collection of data is one of the important in order to achieve main objective of study. The auditing was initiated by calculating population living in every house and number taps inside the household, by recording these values the further study was done.

The table 2 and 3 shows the water usage per capita per daily usage in 1 and 2 BHK housesnrespectively. The figure 2 is the pie chart representing the percentage of water used in 1 BHK houses according to table 2 and figure 3 is the pie chart representing the percentage of water used in 2 BHK houses according to table 3

Table 2. Water requirement in 1 BHK household.

Number of persons / users in the residential unit = (24 people)

Sr. No.	Fixture	Measurement of Water Uses per Residential unit					
		Rate of Discharge (litre/min)	Average Duration of Use per day (min)	Average Quantity per Use (litre)	No. of Uses (No.)	Total Daily Use (litre)	Average Per Capita Daily Water Use (litre)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Kitchen Faucet	10.8	90 to 120	60	4	240	60
2	Water Purifier (RO) Tap	4.5	180	13.5	1 to 2	13.5 to 27	6.75
3	Washing machine Tap	10.8	50	70 to 140	1 to 2	140 to 280	35
4	Shower Faucet	11	60	50	4 to 8	200 to 250	50
5	Bathroom Tap	9	30	10	4	30 to 40	10
6	Toilet Flush tank	18.93	60	12	8 to 10	96 to 120	24
7	Wash Basin Tap	10.8	50	3	32	96	24
TOTAL							209.75

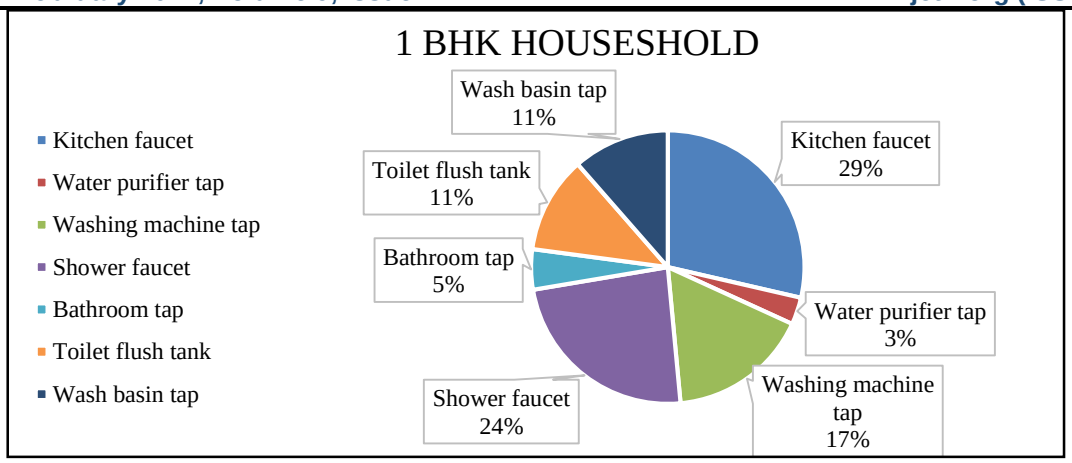

Figure 2: Pie-chart representing per capita demand in 1 BHK.

Table 3. Water requirement in 2 BHK household

Number of persons / users in the residential unit = (56 people)

Sr. No.	Fixture	Measurement of Water Uses per Residential unit					
		Rate of Discharge (litre/min)	Average Duration of Use per day (min)	Average Quantity per Use (litre)	No. of Uses (No.)	Total Daily Use (litre)	Average Per Capita Daily Water Use (litre)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Kitchen Faucet	10.8	90 to 120	60	4	240	60
2	Water Purifier (RO) Tap	4.5	180	13.5	1 to 2	13.5 to 27	6.75
3	Washing machine Tap	10.8	50	70 to 140	1 to 2	140 to 280	35
Bathroom-1							
4	Shower Faucet	11	60	50	4 to 8	200 to 250	50
5	Bathroom Tap-1	9	30	10	4	30 to 40	10
6	Bathroom Tap-2	9	0	0	0	0	0
7	Toilet Flush tank	18.93	0	0	0	0	0
8	Wash basin Tap	10.8	30	3	20	60	15
Bathroom-2							
9	Shower Faucet	11	0	0	0	0	0
10	Bathroom Tap-1	9	30	10	4	30 to 40	10
10	Bathroom Tap-2	9	0	0	0	0	0
11	Toilet Flush tank	18.93	60	12	8 to 10	96 to 120	24
12	Wash basin Tap	10.8	20	3	12	36	9
TOTAL							219.75

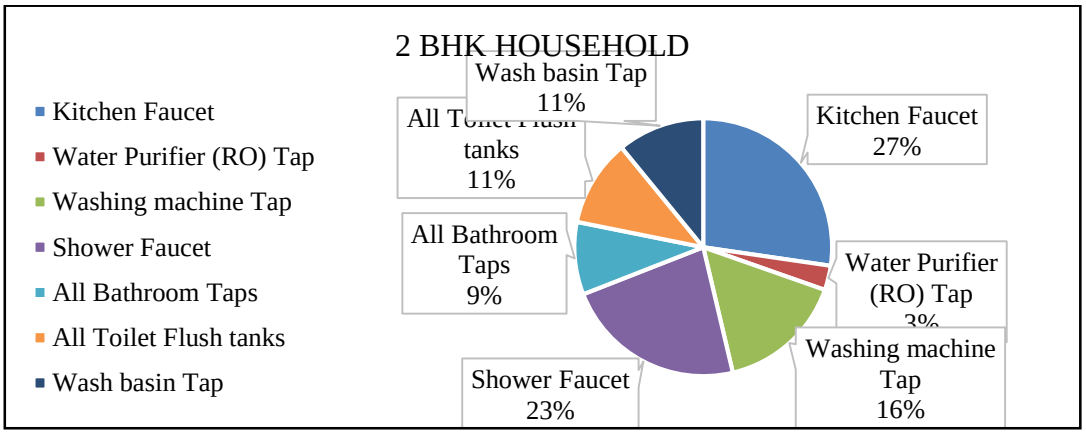

Figure 3: Pie-chart representing per capita demand in 2 BHK

Table 4. Water requirement in Building
Number of people / users = (2 people)

Sr. No.	Fixture	Measurement of Water Uses per Residential unit					
		Rate of Discharge (litre/min)	Average Duration of Use (min)	Average Quantity per Use (litre)	No. of Uses (No.)	Total Daily Use (litre)	Average Per Capita Daily Water Use (litre)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Watchman Bathroom	18.93	60	20	6 to 8	140 to 160	80
2	Water Basin Tap	10.8	15	2	4	8	4
3	Fire Fighting hose	450	-	-	-	-	-
4	Common Water Tap	11	120	260	1	260	260
TOTAL							344

Firefighting hose: - 9 kgf/cm2 pressure and 450 litre/min rate of discharge was calculated by hydrometer and with the help of IS CODE 3844 (1989), above tank had capacity of 10000 litres

1. LOSSES CALCULATION

The building in 2020 had done renovation for various parts and also repaired electricity wirelines and water pipeline leakages. So, the leakages were minimum per house.

- For houses: -

No. Of homes = 19
No. of faucets = 5 (number based on observed leakage per house)
No. Of drips per minute = 2
Volume of drip = 0.33ml
No. Of drips in 1 litre water = 3000 drips
No. Of drips per day in 1 tap = ?
1 min = 2 drips
60 min =120 drips
1 day= 120 × 24 = 2880 drips
No. Of drips per day in 5 taps = 2880 × 5 = 14400 drips
No. Of drips in 19 homes per day = 14400 × 19 = 2,73,600 drips
How much water is waste in(litre) per day = Total no. Of drips ÷ no. Of drips in 1 litre
= 2,73,600 ÷ 3000
= 91.2 litres
Total volume of water waste in a month = 91.2 × 30 = 2736 litres
2736 litre of water is waste in a month.

- For building: -

Taps in building for public use like car washing, watchman's toilet and gardening, washing hands, etc.
No. Of taps = 4
No. Of drips per minute = 10
No. Of drips per day in 1 tap = ?
1 min = 10 drips
60 min = 600 drips
1 day = 600 × 24 = 14400 drips
No. Of drips per day in 4 taps = 14400 × 4 = 57600drips
How much water is waste in(litre) per day = Total no. Of drips ÷ No. Of drips in 1 litre
= 57600÷3000
= 19.2 litre
Total volume of water waste in a month = 19.2×30 = 576 litres

Total water waste per month = Houses + Building
= 2736 + 567
= 3303 litres per month

2. FINAL CALCULATION: -

The final calculation done for 1 day water usage by whole building is,

- House calculation: - For 1 BHK

Number of houses = 5
Total number of people = 24
Per capita demand × Number of people = 209.75 × 24 = 5034 litres per day.

- House calculation: - For 2 BHK

Number of houses = 14
Total number of people = 56
Per capita demand × Number of people = 219.75 × 56 = 12306 litres per day.

- Building calculation: -

Total number of water = (bathroom=160 litres)+(washbasin=8 litres) + (car washing=260 litres)
= 428 litres per day

So, the total number of litres per day can be calculated as = For 1 BHK + For 2 BHK + Building
= 5034 + 12306 + 428
i.e., Total water used in litres per day by the building = 17768 litres per day

- For 30 days water usage will be: -

Total water used by the building × 30 days = 17768 × 30 = 533040 litres per month
+ Losses per month = 3033 litres per month
+ Cleaning whole building once a week = 200 litres × 4 = 800 litres per month

= 536873 litres per month

As per our analysis the total water usage for January 2022 will be 5,36,873 litres.

3. **FUTURE REQUIREMENT: -**

To calculate this, what we did is we Followed the trend of last 8 months bill. CIDCO always provides bill of 2 month, in the month of January 2022 we had received the last bill of October and November 2021.

Table 5. Water Bill

Months	Quantity used in Cubic meter	Billed amount in Rupees
April-May (2021)	1173	12316.5
June-July (2021)	1075	11287.5
August-September (2021)	1059	11119.5
October-November (2021)	1102	11571

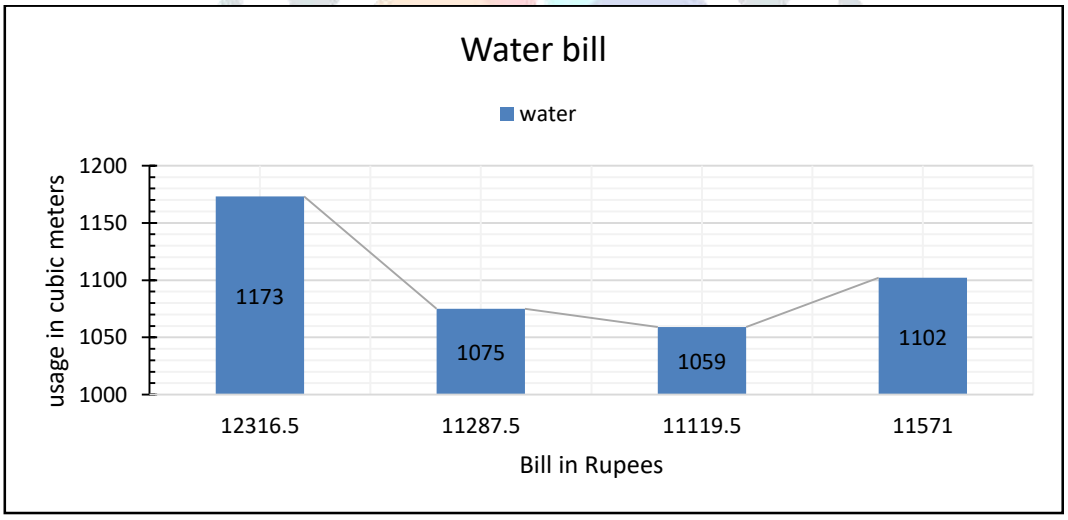

Figure 4: Graph of trend of water bill and water usage

The X axis on the graph shows amount paid for water and Y axis shows the water used in 2 months period as shown in table 5. Using this data, we observed that the season had huge impact on the water usage, so after calculating water usage for January 2022, by combing our case study data and last 8 months billed data the requirement of January 2023 would be 5,51,000 litres of water.

VII.CONCLUSION

As we are facing water shortage for the entire population, uneven rainfall is just adding up to this problem and we have recognized this issue but are working on large area to save water due to this the small factors that needed to consider are getting neglected. The water auditing for every building should be done every year and the authority should provide that much amount of water so that there will less water wastage and the additional water can be directed to necessary places.

After doing water auditing in Shree Heaven building, we calculated January 2022 water requirement for the building and future water requirement in January 2023 of the building. Our observations were- the CIDCO the water authority provides clean water to building still all houses used reverse osmosis purifier which wastes more water than ultraviolet purifier, for cleaning vehicles pipe hose was used directly used, leakage per house were minimum because of renovation and repairing work of the building was done in year 2020, covid 19 pandemic has very much affected water usage per house as people wash hands, clothes and some take bath twice a day to maintain cleanliness, the criteria of 145 litre per capita per day is an ideal condition which cannot practically be

followed by urban area households as they willing to pay high water charges and the building did not had plants or any other modern amenities like swimming pool, etc.

Thus, our study done in residential gives exact idea of the water usage of and other authorities could follow this method so they can divert the saved water to the water deficit areas. This auditing method can save water and water bill.

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