



CONSTRUCTION OF LOW-COST TOILETS

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Abstract: The construction of low-cost toilets addresses the urgent need for improved sanitation in underserved communities and developing regions. Globally, inadequate sanitation facilities contribute to health risks, environmental pollution, and social disparities. Low-cost toilets offer a solution by employing cost-effective, simple, and sustainable construction methods. These toilets utilize locally available materials and innovative designs to minimize expenses while ensuring functionality and durability. Community involvement in the planning and construction process is crucial, fostering ownership and promoting long-term maintenance and hygiene practices.

Low-cost toilets have profound positive impacts on public health, dignity, and socioeconomic development. By providing access to safe sanitation facilities, they reduce the spread of diseases, enhance quality of life, and empower marginalized populations, particularly women and girls. Moreover, improved sanitation infrastructure contributes to environmental sustainability by reducing open defecation and contamination of water sources. Prioritizing the construction of low-cost toilets is essential for achieving universal access to sanitation and advancing human well-being worldwide. Through concerted efforts and strategic investments, we can make significant strides towards ensuring that everyone has access to this basic human right, thus fostering healthier, more equitable, and more prosperous societies.

Keywords- low-cost toilets, sanitation, developing regions, inadequate, health risks, social disparities, cost-effective, sustainable, innovative designs, long-term maintenance, hygiene practices, socioeconomic development, marginalized populations, environmental sustainability, strategic investments.

I. INTRODUCTION

In India there are so many peoples who don't have household toilets. India is the open defecation capital of the world with 600 million people practicing it. Open defecation, increases the risk of diarrheal diseases, fatally affecting children under the age of 5 living in the slum communities. Moreover, women of all ages and children remain at the risk of being sexually abused when they use open spaces in the dark hours to relieve themselves. Furthermore, with rapid urbanization and the number of slum dwellers increasing globally by 120000 every week, the problem is increasing rapidly. This leads to overloading of already crumbling and non-existent public infrastructure.

Toilet is a need of every human and Government spent much money on construction of these toilets, cleaning purpose and maintenance. As every construction should be sustainable but there is "Zero revenue" generation from these toilets and in India there is no such model which makes this construction sustainable. Also these toilets have surrounded by many illegal activities which effects on safety of user's particularly female users. Also constructed toilets faces many problems like faulty sanitation, lack of water, users safety etc.

I.I. COMMUNITY TOILETS

Toilets which are constructed in slum areas where there is a dense population, and huge number of users is known as community toilets. As government have scheme of toilet per house (One home one toilet provision under Swachh Bharat Mission), but in slum areas there is a dense population where there is no space to provide

individual toilets for each house so to provide toilet facility government constructs a unit of toilet for this dese populated area for peoples in slum areas. As this construction costs more investment from government but there is no revenue generation so it is not sustainable.

I.II. PUBLIC TOILETS

Toilets which are constructed for public like pedestrians, driver's etc.at road side and those are easily accessible for everyone is known as public toilets. This toilets are constructed for publics which are travelling on roads, pedestrians etc. Main purpose of these toilets is to provide easy access to users. These toilets are also called as restrooms or washrooms. These public toilets have same issue like community toilets like poor sanitation, illegal activities, user safety etc. In India there is no such smart toilet model which gives revenue to Municipal Corporation so this project mainly has focus on revenue generation from toilets in various ways

I.III. PROBLEM STATEMENT

Slum toilets are built by traditional method which is more costly and requires more maintenance cost so overcome this issue there is requirement of replacement of such material by new one which is less costly and maintenance free.

I.IV. OBJECTIVES

1. Assessing the status and expenses associated with current toilet facilities.
2. Minimizing the expenses of toilet construction through the substitution of existing materials.
3. Enhancing user safety with the installation of vandal-resistant and secure ventilation systems.
4. Exploring avenues for generating income through the utilization of toilet facilities.

II. METHODOLOGY

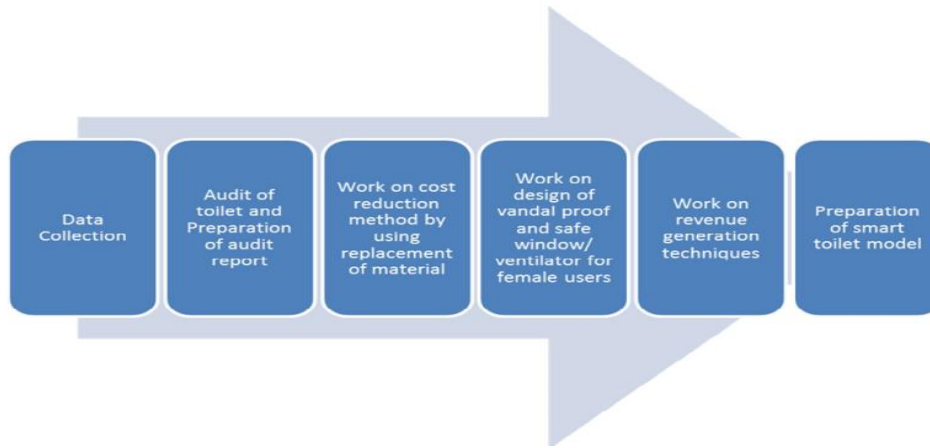
PMC had launched the D&R Programme i.e. demolition of dilapidated toilet blocks & reconstruction of the same in 1999-2000. Several older toilet blocks were in a dilapidated condition and also did not serve the purpose for the slum communities. A model of developing Community toilets with the participation of the community, an increased number of seats and connected to the city's sewerage network was developed. It was implemented through the participation of NGOs like SPARC, Mashal, Shelter associates, Civic International Social Service, City clean foundation, Gramin bahuddeshiya Shikshan Sanstha, Akhil Bhartiya paryavaran Sanstha etc.

Table.no.1 Total Number of toilets

Year	Toilets
1999-2001	223
2001-2002	195
2002-2003	100
2003-2004	106
2004-2005	69
2005-2006	43
2006-2007	36
Total	772

Table no.1 shows there are total of 772 toilet blocks were constructed during the period 1999- 2007 at an approximate cost of Rs. 50 Cr. Furthermore, every year a separate amount has been earmarked for the construction and maintenance of these community toilets. (Reference from PMC/Solid Waste Management Dept. Pune) As per NGO Mashal, has prepared slum atlas of Pune in 2018 which shows that 31, 00,000 peoples resides in slums. Means Approx.6,20,000 Families out of this 80% families uses community toilet so as per fees calculation 10-30/- per family per month it should be nearly Rs.1 Cr. But there is no revenue generation so to make these toilets sustainable a smart toilet model is necessary from which maintenance work is to be carried out.

II.I. FLOW CHART



II.II. DATA COLLECTION

Firstly I have collected data required for “SUSTAINABLE PUBLIC TOILETS.” Collection of data includes literature review, research paper etc. All this data was collected from various search engines on internet. Data Collection work consist of actual site visit of toilet for which I have selected a community toilet in Janata Vasahat, Near Parvati Payatha, Pune. From this toilet data regarding number of users per day, also audit work of this toilet to get overall view of toilet is done.

II.III. REPORT PREPARATION

This stage consists of making audit of toilet and collection of current conditions of toilets with photographs. It contains following items:-

- Current condition of toilet block
- Current condition of flooring
- Current condition of ventilation, door & windows.
- Current status of illegal activities.

For audit purpose I have selected a community toilet at Parvati Payatha Slum area, Pune.

Table.No 2 Audit Report

General Details of Toilet Block		
Location Of toilet block	Janata Vasahat, Parvati Paytha, Pune	
Type Of toilet	Community Toilet	
Number of Seats		
Male	5 Seats	
Female	5 Seats	
Urinals	NA	
Care Taker Room	Available	
Care Taker	Not Available	
Water Arrangement	NA	Users have to take water from home
Electricity	Available	
Number of Users	Approx. 60 users per day	
Audit Report on Condition of Toilet Block		
Condition of pan	Male	Bad
	Female	Bad
Type of Pan	Male	Indian Type
	Female	Indian Type
Condition of Door	Male	Bad
	Female	Bad
Type of Door	Male	Wooden
	Female	Wooden
Condition of ventilator	Male	Bad
	Female	Bad
Type of ventilator	Male	Conventional Type
	Female	Conventional Type
Condition of Flooring	Damaged	
Condition of outlet pipes	Damaged and Leakage issue	
Type of drainage pipe	Cement pipes (4'' & 6'')	
Illegal activity	Present (Pigeon house, local interfere)	
Surrounding of Toilet	Waste material is present	

Current condition of toilet blocks As per audit report from following images we can get an idea about current condition of toilets also it shows poor condition of each individuals.



Fig.1 Broken Dado of toilet block



Fig.2 Damaged electric system

Fig.1 shows the current condition of toilet is really poor it has broken dado due to lack of maintenance, poor quality material and bad supervision, it is harmful for users Also Fig.2 shows damaged electric system in which wires are open and it is dangerous from which short circuit can be occurs and it may lead to fire and harmful to users.

From this audit report we have get an idea about current condition of community toilet it requires lot of maintenance work which requires more money so there is no source of income from this toilets also as per audit it don't have proper safety for users so it is possible to do any illegal activity from ventilators. As per images we can get idea about illegal activities at toilet, poor electric system, poor water provision also poor drainage system which is dangerous to users health also it is surrounded by waste which is unhealthy for persons health who are living near this toilet so to overcome this all problems we require a smart toilet model which is maintenance free so it saves maintenance cost, also it generates money as a revenue to municipal corporation.

II.IV. ESTIMATE AND COSTING OF EXISTING TOILET BLOCK

Existing toilets are constructed by using traditional methods. It has wall of burnt brick masonry of thickness 0.23m, also inner walls of toilets blocks are also built up of burn brick masonry, also it have dado provided with tiles to protect walls from damage due to water and chemicals used for washing of toilet seats. It have slab of reinforced cement concrete (RCC) which is combination of steel reinforcement and concrete and current costing of toilet is as follows

Measurement Sheet							
Sr.No	Description	No	L	B	H	Qty	Unit
1	Excavation						
	<i>Long wall</i>	1.00	9.00	0.90	0.90	7.29	Cum
	<i>Short wall</i>	1.00	4.70	0.90	0.90	3.81	Cum
					Total	11.10	Cum
2	PCC						
	<i>Long wall</i>	1.00	9.00	0.90	0.10	0.81	Cum
	<i>Short wall</i>	1.00	4.70	0.90	0.10	0.42	Cum
					Total	1.23	Cum
3	Foundation						
	<i>Long wall</i>	1.00	9.00	0.90	0.90	7.29	Cum
	<i>Short wall</i>	1.00	4.70	0.90	0.90	3.81	Cum
					Total	11.10	Cum
4	DPC						
	<i>Long wall</i>	1.00	9.00	0.90	0.10	0.81	Cum
	<i>Short wall</i>	1.00	4.70	0.90	0.10	0.42	Cum

					Total	1.23	Cum
5	BBM for wall						
	<i>Long wall</i>	3.00	9.00	0.23	3.10	19.25	Cum
	<i>Short wall</i>	3.00	4.70	0.23	3.10	10.05	Cum
	<i>Internal walls 1</i>	8.00	1.50	0.23	3.10	8.56	Cum
	<i>Internal walls 2</i>	4.00	1.20	0.23	3.10	3.42	Cum
						41.28	Cum
	<i>Deductions</i>						
	<i>Door</i>	12.00	0.90	0.23	2.10	5.22	Cum
	<i>Ventilation</i>	10.00	0.70	0.23	0.90	1.45	Cum
						6.67	Cum
					Total	34.62	Cum
6	Plaster for wall						
	<i>Long wall</i>	6.00	9.00	-	3.10	167.40	Sqm
	<i>Short wall</i>	6.00	4.70	-	3.10	87.42	Sqm
	<i>Internal walls 1</i>	16.00	1.50	-	3.10	74.40	Sqm
	<i>Internal walls 2</i>	8.00	1.20	-	3.10	29.76	Sqm
						358.98	Sqm
	<i>Deductions</i>						
	<i>Door</i>	12.00	0.90	-	2.10	22.68	Sqm
	<i>Ventilation</i>	10.00	0.70	-	0.90	6.30	Sqm
						28.98	Sqm
					Total	330.00	Sqm
						3552.12	Sqft
7	Daddo	10.00	1.20	-	1.00	12.00	Sqm
		20.00	1.50	-	1.00	30.00	Sqm
					Total	42.00	Sqm
						452.09	Sqft

8	Slab	1.00	9.50	5.00	0.12	5.70	Cum
9	Flooring	1	9.5	5	-	47.5	sqm
						511.29	Sqft
10	Painting						
	Primer						
	Long wall	6.00	9.00	-	3.10	167.40	Sqm
	Short wall	6.00	4.70	-	3.10	87.42	Sqm
	Internal walls 1	16.00	1.50	-	3.10	74.40	Sqm
	Internal walls 2	8.00	1.20	-	3.10	29.76	Sqm
						358.98	Sqm
	Deductions						
	Door	12.00	0.90	-	2.10	22.68	Sqm
	Ventilation	10.00	0.70	-	0.90	6.30	Sqm
						28.98	Sqm
					Total	330.00	Sqm
						3552.12	Sqft
	Painting						
	Long wall	6.00	9.00	-	3.10	167.40	Sqm
	Short wall	6.00	4.70	-	3.10	87.42	Sqm
	Internal walls 1	16.00	1.50	-	3.10	74.40	Sqm
	Internal walls 2	8.00	1.20	-	3.10	29.76	Sqm
						358.98	Sqm
	Deductions						
	Door	12.00	0.90	-	2.10	22.68	Sqm
	Ventilation	10.00	0.70	-	0.90	6.30	Sqm
						28.98	Sqm
					Total	330.00	Sqm
						3552.12	sqft

Material							
Sr.No	Material	Cement	Unit	Sand	Unit	Aggregate	Unit
1	PCC	6	Bags	0.12	Brass	0.25	Brass
2	Plaster	17	Bags	0.12	Brass	0	Brass
3	Slab	1175	Bags	1.01	Brass	1.15	Brass
4	Stone Masonry	20	Bags	1.35	Brass	0	Brass
5	DPC	6	Bags	0.12	Brass	0.25	Brass
	Total	1224	Bags	2.72	Brass	1.65	Brass

Abstract Sheet					
Sr.No	Description	Quantity	Unit	Rate	Amount
1	Excavation	11.10	Cum	1500.00	16645.50
2	PCC	1.23	Cum	3000.00	3699.00
3	Foundation	11.10	Cum	2000.00	22194.00
4	DPC	1.23	Cum	1500.00	1849.50
5	BBM for wall	1935.00	Sqft	20.00	38700.00
6	Plaster for wall	330.00	Sqm	20.00	6600.00
7	Dado	452.00	Sqft	50.00	22600.00
8	Slab	512.00	Sqft	20.00	10240.00
9	Flooring	511.00	Sqft	45.00	22995.00
10	Painting	3550.00	Sqft	18.00	63900.00
11	Cement	1224.00	Bags	350.00	428400.00
12	Sand	2.72	Brass	8500.00	23154.00
13	Aggregate	1.65	Brass	4500.00	7425.00
14	Steel	1.00	MT	48000.00	48000.00
15	Bricks	18180.00	No's	10.00	181800.00
16	Stones	13.87	Cum	1000.00	13870.00
17	Tiles	475.00	Sqft	100.00	47500.00
18	Toilet Pan	10.00	Nos	2200.00	22000.00
19	Door	12.00	Nos	3000.00	36000.00
20	Ventilator	10.00	Nos	2000.00	20000.00
21	Labor				35000.00
22	Transport				50000.00
				<i>Total</i>	<i>1122572.00</i>
Contractors Profit (10%)					112257.20
Tools & Plants (5%)					56128.60
Total Amount					1290957.80

From above calculation we get to know that existing 10 seated toilet (5 Male seated & 5 Female seated) is requires Rs.12, 90,960/- (Twelve lack Ninety thousand Nine hundred Sixty rupees) excluding plumbing, drainage and electrification.

II.V. CURRENT REVENUE GENERATION

The Demolition and reconstruct program was implemented in various phases with the community's involvement at every step.

Salient Features of the program were –

- Paying the periodic maintenance charges and appointing a caretaker were two key elements of D and R Program that resulted out of community participation.
- Toilet blocks were reconstructed which included toilets, bathrooms, and urinals for women.
- Under this innovative scheme, a room for the caretaker was constructed above the toilet as an incentive to maintain the toilet.
- The Design for the new toilet blocks varied in size from 10 to 80+ seats.
- The blocks were connected to a septic tank in places where a municipal sewage supply wasn't available.

- The blocks were also provided municipal water supply and electricity as well.
- A user fee of Rs. 10-30/- Per month was charged for this facility. Urinal facility was also made available at public places and markets.

III. RESULTS AND DISCUSSION

III.I. WORK ON REDUCTION IN COST OF CONSTRUCTION OF TOILET

As per estimation existing toilet of 10 seated requires Rs.12, 90,960/- but existing toilets requires more maintenance cause of faulty material, lack of skilled labors also due to users so to overcome this issues and to reduce maintenance cost instead of traditional method here we can use waste construction plastic by recycling it. Following fig. shows plan of plastic toilet with details. Plastic is a measure issue on earth, and due it is non disposable so day by day plastic pollution is increasing rapidly and to overcome this we can use it by recycling process. Recycling and reuse of plastic is very effective process to reduce plastic pollution and it is more beneficial to prepare toilets. As it is non disposable so it doesn't have any damage due to water in toilets but due to water Burnt brick masonry walls and dado get damaged so reuse of plastic is more beneficial.

III.II. DETAILS OF TOILET DESIGN

1. Column: - Columns are made by using HDPE, PVC material. Size of column provided is 400mm X 400mm which have hollows part in it in which sheets which are acts as a wall can be installed. At the bottom of column groove is fixed so column can be installed in beam and burnt brick masonry of foundation so it can be stable and strong.

Also same groove is provided to top for installation of slab. This groove holds slab strongly. Instead of groove we can provide nut & bolt facility for fitting and fixing of columns into foundation.

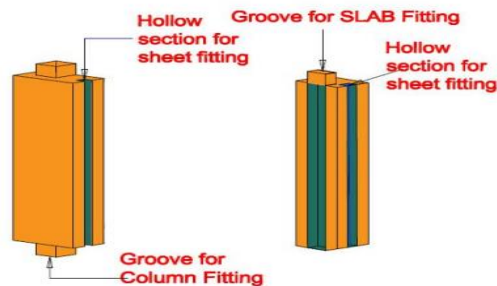


Fig.3 3D View of column

2. Sheets: - These sheets are made up of PVC material. It is installed in between two columns by just pushing it downwards in hollow section in columns. These sheets are having thickness of 100mm and each sheet is 1.2 m long with height 0.7m so in single wall it requires 3 numbers of sheets. These sheets are easily installable and removable so if in case of damage particular damaged sheet can be replaced. This is more beneficial than dado because in case of damage to dado whole fitted dado should be replaced which is more costly. Also this sheet reduces cost of dado which are provided for protection of wall from water damage.

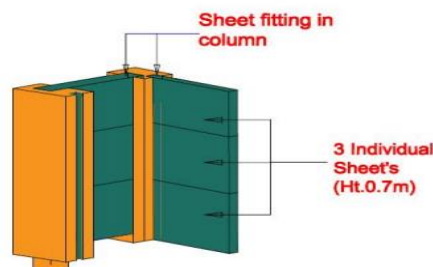


Fig.4 3D View of column and sheet fitting

3. Doors: - Doors are made up of scrap PVC material which is attached to column by hinges and bolts. As existing toilets have wooden doors or steel doors both can get damaged by water and required more maintenance cost so PVC made doors are less costly and maintenance free. Also it is light weight material and easy to install.

4. Ventilators: - Ventilators of size 0.45m X 0.45m is built in sheets with small mesh at top. Mesh provision can prevent any illegal activity from ventilator and it is good for user safety.

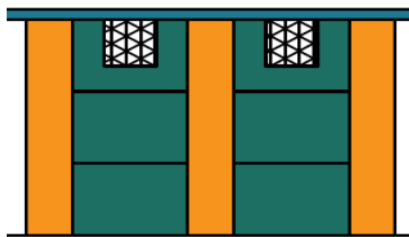


Fig.5 Front View of Ventilator

5. Slab: - Slab is made up of expanded polystyrene which is typically used for slab or sheets. Slab is having 100mm thickness which is installed in column groove so it can be stable and should be kept protected from wind and rain.

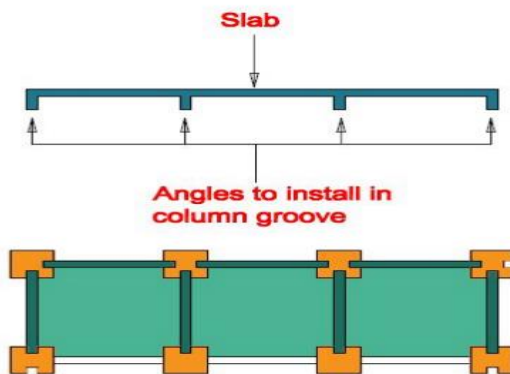


Fig.6 Details of slab fitting

III.III. ESTIMATION AND COSTING OF TOILET

Table. No 3 Estimation and costing of Plastic made toilet

Sr.No	Description	No	L	B	H	Qty.	Unit
1	Excavation	28.00	0.61	0.61	0.90	9.38	Cum
2	PCC	28.00	0.61	0.61	0.10	1.04	Cum
3	BBM for	28.00	0.46	0.46	0.65	3.85	Cum

	Foundation						
4	Beam						
	Long side	4.00	8.60	0.45	0.15	2.32	Cum
	Short side	3.00	3.00	0.45	0.15	0.61	Cum
						2.93	
5	Flooring						
	Toilet block	10.00	1.00	1.00	-	10.00	Sqm
	Passage	2.00	3.20	1.40	-	8.96	Sqm
	Entrance	2.00	1.40	1.40	-	3.92	Sqm
						22.88	246.28

Material							
Sr.No	Material	Cement	Unit	Sand	Unit	Aggregate	Unit
1	PCC (M10)	3	Bags	0.10	Brass	0.2	Brass
2	Beam	13	Bags	0.40	Brass	0.9	Brass
	Total	16	Bags	0.50	Brass	1.1	Brass

Costing of Plastic Recycling and Molding							
Sr.No	Description	No	L	B	H	Qty.	Unit
1	Column	28.00	0.40	0.40	2.50	11.20	Cum
2	Sheet (Wall)	81.00	1.20	0.10	0.70	6.80	Cum
3	Slab	2.00	8.00	1.40	0.10	2.24	Cum
4	Door	10.00	1	0.1	2.1	2.10	Cum
					Total	22.34	
					Say	23	Cum
				Density of Plastic		900	Kg/m3
			Total Weight of Chamber			20700	Kg

Rate Analysis				
Particulars	Qty	Rate	Unit	Amount
Scrap	20700	12.00	Kg	248400
Molding	20700	25.00	Kg	517500.00
Misc.				5000.00
Total costing of Toilet Block				770900.00

Abstract Sheet					
Sr.No	Description	Quantity	Unit	Rate	Amount
1	Excavation	9.38	Cum	1500.00	14070.00
2	PCC	1.04	Cum	1500.00	1560.00
3	Foundation	3.85	Cum	2000.00	7702.24
4	Beam	2.93	Cum	1500.00	4394.25
5	Flooring	246.28	Sq.ft	45.00	11082.61
6	Cement	16.00	Bags	350.00	5600.00
7	Sand	0.50	Brass	8500.00	4250.00
8	Aggregate	1.10	Brass	4500.00	4950.00
9	Steel	0.30	MT	48000.00	14400.00
10	Tiles	246.28	Sq.ft	80.00	19702.43
11	Toilet structure				770900.00
12	Toilet Pan	10.00	No's	1000.00	10000.00
13	Labor				5000.00
14	Transport				10000.00
				<i>Total</i>	883611.53
Contractors Profit (10%)					88361.15
Total Amount					971973.00

As per above estimate plastic made toilet structure costs Rs.9, 71,973/- (Nine Lack Seventy One thousand Nine hundred Seventy Three only)

IV. CONCLUSION

In conclusion, the objectives set out to address various aspects of toilet facilities management have been successfully achieved through comprehensive assessment and strategic planning. By evaluating the status and expenses linked with current facilities, we have gained valuable insights into areas requiring improvement and cost-saving measures. Through the substitution of materials, we aim to minimize construction expenses while maintaining quality standards. Enhancing user safety through the installation of vandal-resistant and secure ventilation systems underscores our commitment to providing a secure and comfortable environment. Furthermore, exploring avenues for generating income from toilet facilities highlights our innovative approach towards sustainability and financial viability. Overall, these objectives collectively contribute to the optimization of toilet facility management, ensuring efficiency, safety, and economic viability for all stakeholders involved. This project report concluded that 10 seated toilet construction by conventional method is requires Rs.12, 90,960/- plastic made toilet structure costs Rs.9, 71,973/- so it reduces amount of

construction by Rs.3, 18,985/- so plastic made toilet is more profitable than existing one with less maintenance and easy to maintain.

V. REFERENCES

- [1] Emma Larsson & Maja Nilsson, "Towards Sustainable sanitation in slum areas- A field study in Mumbai", (2013).
- [2] Jonthan J Ignacio, Roy A Malenab, "Perceptions and attitude towards Eco-Toilet system in Rural Areas: A Case study of Philippines" 20,521; doi: 10.3390, su 10020521 2018
- [3] Moatassem Abdllah, & Khaled El-Rayes, "Economic and GHG Emission analysis of Implementing Sustainable Measures in Existing Public building"s", M.ASCE Library
- [4] Meera Mehata & Dinesh Mehata, "Sanitation in Slums of Mumbai- View from the Field" CEPT University, August 2014
- [5] Naoyuki Funamizu,, Miguel Angel & Lopez Zavala, "Composting Toilet for sustainable water management" M.ASCE Library, 2015
- [6] Phoebe Mac, "Assessment of Appropriate Sanitation Technologies in a Development Context-Case Study: Tangkae, Timor-Leste" (2006)
- [7] Shikun Zeng, Zifu Li, Sayed Mohammad, et.al,"Toilet Revolution in China, Journal of Environmental Management 216 p.no 347-356, 2018
- [8] S.Mansi & N. Latha, "Toilet access among the urban poor – Challenges and concerns in Bengaluru city slums", isbn 978-81-7791-239-5
- [9] Yangyu Xu, & Qibo Jia, "Public Toilet wastewater treatment system using Forward Osmosis , M.ASCE Library, 2016
- [10] Yasemin Afcan, & Melten O Gurel, " Public Toilets: An Exploratory study on the demands, needs and expectations in Turkey", Environment and Planning B: Planning and Design 2015, volume 42, pages 242 – 262, 201