JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN CIVIL ENGINEERING

RAIN WATER HARVESTING IN SANDY SOIL

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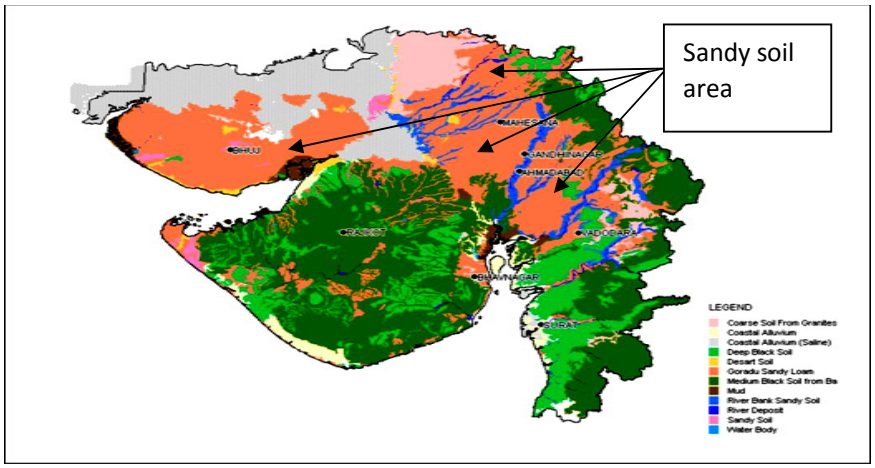
ABSTRACT: *water resulting in augmentation of pressure on the permitted freshwater resources. Ancient method of damming river and transporting water to urban area has it own issues of troubles of social and political. In order to conserve and meet our daily demand of water requirement, we need to think for alternative cost effective and relatively easier technological method of conserving water in Sandy soil area of north gujarat. First of all, required data are collected i.e. catchment areas & hydrological rainfall data. Water harvesting potential of sandy soil strata and reservoir capacity with suitable design is being considered. Finally preparing a reservoir bed with appropriate method in detail.*

Keywords: Details Of Sandy Soil Area, Laboratory Test On Clay, Design Of Impermeable Bed, Comparison, Conclusion

1. Introduction: Only a small fraction of the rainfall falling in arid and semi-arid areas of north Gujarat percolates into deeper soil. Small fraction is used for transpiration of vegetation or of agricultural crops. The majority of the precipitation evaporates from the often sandy soil or from surface depressions. To feed the growing population in the dry areas of the world, rain water harvesting is needed. Groundwater is part of the Earth's water or hydrological cycle. When rain falls, a part infiltrates the soil and the remainder evaporates or runs off into rivers. The roots of plants will take up a proportion of this moisture and then lose it through transpiration to the atmosphere, but some will infiltrate more deeply, eventually accumulating above an impermeable bed, saturating available pore space and forming a reservoir.

Reservoirs meant for augmentation of supplies during lean period should usually be operated to fill as early as possible during filling period, while meeting the requirements[1]].

Map of Study area:



Details of Study area:

Soil: Mostly red sandy soils are seen in the study area. The rate of infiltration through such soils is relatively fast. The thickness of the soil, on the whole is within 1 m. Further south, very much outside the study site, the regional geology changes from a dominantly hard-rock.

Temperature: After mid-March, normally there is a rapid rise in temperature. May and first half of June are the hottest months. Temperature shoots up to 45oC in the month of May and remains around that for about a month. Even the night temperature is about 35o C during that period. After October both night and day temperature decreases to 20oC and 32oC respectively. Cool months are from mid December to mid-February

Rainfall and Evaporation: The average annual rainfall is around 680 mm but is highly variable. The monsoon occurs by the second week of June. July and August are the peak monsoon months. About 80% of the rainfall occurs in these two months. The highest rainfall of 1458 mm was experienced in 1994.Similarly, the lowest rainfall of 309 mm was experienced in 2002.

Scope of work: Development of rain water harvesting in sandy soil reservoir in region of north Gujarat. For rain water harvesting in reservoir applying various method like as preparing a impermeable layer of reservoir soil. and design of impermeable bed of reservoir.

2. Literature Review:

On literature Paper Soil amelioration techniques for improving runoff characteristics of soils for better water harvesting are available and include using plastic sheets, bitumen spreads, concrete layers and chemical additives mixed into the top soils to improve bonding of the soils particles. The use of less permeable soils as a top layer dressing to reduce infiltration and enhance runoff. This will especially be useful in areas with sand, sandy loam and loamy sand soils having high infiltration rates. Various locations in Ghana especially along the coastal stretch of the country and in some inland valley alluvial plains could benefit from this process if these areas are consciously lined with laetrile and clay soils[2].

The water resources most important issue today the country is divided into hydro rich and poor rich regime and both cases local technology has been maintaining all kind of water stress. local technology like artificial reservoir, Tube well ,Infiltration galleries.

3. Methodology:

- Literature study of various rain water harvesting technique.
- The first step is to work out the water requirement for various needs.
- Collection of rain fall data.
- Preliminary test on Clay sample.
- Prepare reservoir bed with clay
- Test of bed for permeability.
- Calculate catchment area of reservoir.
- Cost analysis.
- Conclusion.

4. Data Collection:

Water requirement of various needs:

Table No 4.1 Water requirement

Purpose	**Amount for four people (L)**
Bathing	60
Flushing	230 (7x8x4)
Washing	35 (5x7)
Washing Machine	150 (four times in a week)=85 per day
Washing Vehicle	14[(2x7) (once a week)]=14/7=2
Drinking	28
Total	480
For a Single Person	120

Annual Rainfall data of North Gujarat Region:

Table No 4.2 Rain fall data[3]

District/Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Patan	282	720	603	750	1675	1005	763	287	671	765	563	865
Sidhdhpur	238	541	468	2029	1397	1290	570	363	912	725	339	991
Chansama	142	495	526	824	566	595	426	256	480	549	276	641
Harij	180	805	517	702	766	835	554	303	461	685	316	771
Sami	163	880	356	729	685	1065	600	263	880	525	320	776
Palanpur	250	843	411	781	629	560	344	254	882	688	452	729
Radhanpur	209	989	453	427	1107	989	576	576	311	825	178	1137
Total in mm	**1464**	**5263**	**3334**	**5247**	**6825**	**6369**	**3833**	**2037**	**5111**	**5020**	**2444**	**5910**

Table 4.3 Infiltration rate[4]

Infiltration Rate of various Soil:	
Soil type	Basic infiltration ra
Sand	less than 30
sandy soil	20 – 30
Loam	10 – 20
clay loam	5 – 10
Clay	1- 5

Above data get information about water requirement per day of study area. Annual rain fall of sandy soil region. Infiltration rate of particular soil. In sandy soil region infiltration occur high, so decrease infiltration rate in sandy soil reservoir providing impermeable bed. The aims of this research are to design and develop Impermeable bed according to head and area of reservoir so, decrease infiltration rate and harvesting water by preparing impermeable layer. For Prepare Impermeable layer using clay or fly ash, water proofing chemicals or pvc coating. After prepare Impermeable layer then perform various type of testing to check permeability of layer. For prepare impermeable layer colleting clay sample from deep black soil region.

Preliminary test on Clay sample[5]:

Table No 4.4 Test result

Sr.No	Description	Result
1	Grain size distribution	**99% Silt and Clay present in sample**
2	Liquid limit	**65%**
3	Plastic limit	**27**
4	shrinkage limit	**17.1**
5	Standard Proctor test	**1.69 gm/cc dry density And 20.7 % moisture content**
6	Free swell index	**47.5 %**
7	Permeability test	**10^-7 cm/sec**

5. Design :

- Mixing of clay, fly ash, lime
- Design of bed of Reservoir
- Stability of Slope of Reservoir
- Test of bed after design

Mixing:

Table 5.1 Mix Proportion

Sr. No	**Clay**	**Lime**	**Fly ash**	Liquid Limit	Plastic Limit	Plastic Index
1	**60**	**5**	**35**	48	28.79	19.21
2	**40**	**10**	**50**	45	25	20
3	**30**	**10**	**60**	47	26	19
4	**20**	**20**	**60**	47	29	18

- Above mixing Proportion got liquid limit, plastic limit Moderate.
- Liquid limit range should be 40 to 48 % here 45 to 48 %.
- So mix the proportion is unique.
- Take above any Proportion for making reservoir bed.

Decide Thickness of reservoir bed:

Thickness of bed changing according to head of reservoir. Thickness of bed decided by falling head permeability equation.[**$(2.3\ aL \log h_1/h_2) / At$].**Thickness of bed layer assume till permeability of soil 10^-7 coming.

Here, a = area of rainfall

L = Thickness of bed layer

H_1 = Total head of reservoir with thickness of bed

H_2 = Head of reservoir without thickness of bed

A = Area of Reservoir, T = time duration, K = permeability of bed.

Table 5.2 Different Head

Sr.No	Head	**Thickness of bed**
1	5 m	**0.42 mt**
2	10 m	**0.84 mt**
3	15 m	**1.26 mt**
4	20 m	**1.68 mt**

Suitable slope of Reservoir bed:

Table 5.3 Various Soil[6].

Soil Type	Slope (horizontal:vertical)
Clay	1:1 to 2:1
Clay loam	1.5:1to 2:1
Sandy loam	2:1to 2.5:1
Sandy	3:1

Design After Test of Sample:

Table: 5.4 Test Result

Sr.No	Description	Result
1	Grain size distribution	**99% Silt and Clay present in sample**
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6	Free swell index	**48.5 %**
7	Permeability test	**10^-7 cm/sec**

6. Cost Analysis:

If Area of reservoir is 10 mt * 20 mt. Head of Reservoir 5m, Thickness of bed of reservoir 0.42 mt.

Table 6.1 Measurement Sheet

Description of work	Length (Meter)	Width (Meter)	Depth (Meter)	**Quantity in m^3**
Mixing and Laying reservoir Bed	10	20	0.42	**84**

- **Proportion is 60% clay , 5 % lime , Fly ash 35 %**
- So Clay need 50.4 m^3 in 84 m^3 total quantity.
- Lime need 4.2 m^3 in 84 m^3 total quantity.
- Fly ash need 29.4 m^3 in 84 m^3 total quantity.

Table 6.2 Rate Analysis[7]

Quantity	**Description**	**Rate (based on S.O.R)**	**Total Amount**	**Unit**
Quantity in 84 m^3	Providing & Filling & Mixing including watering ,compacting, consolidating and dressing etc.	300 rs/ cum	**25200 total**	**Rs**
50.4 m^3	Clay transportation	1000 rs per tractor per 8 m^3	**6300**	**Rs**
			Around 35,000	**Rs**

7. Comparison:

Comparison Clay Bed with Cement Bed:

- Generally in underground structure like as water tank, reservoir bed use M25, M30 grade.
- Thickness of Cement bed for water structure is varies 0.2mt to 0.3mt according its design criteria.

Table 7.1 Measurement Sheet

Description of work	Length (Meter)	Width (Meter)	Depth (Meter)	**Quantity in m^3**
Mixing and Laying reservoir Bed	10	20	0.30	**60**

Table 7.2 Rate Analysis

Quantity	**Description**	**Rate (based on S.O.R)**	**Total Amount**	**Unit**
Quantity in 60 m^3	Providing & Filling & Mixing.	1500 Rs per cum(RMC)	**90,000total**	**Rs**
			Around 90,000	**Rs**

8. Conclusion:

- Provide clay bed cost around 30,000 Rs is very cheap and eco friendly. Provide Cement bed cost around 90,000 is very high amount without calculate steel reinforcement quantity. In cement bed highly amount of water absorption. Heat of hydration generally occur in cement bed..Clay reduce highly amount infiltration rate. Ease in constructing system in less time. Economically cheaper in construction compared to other sources, i.e. dams, diversion, etc.

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