Design of Rainwater Harvesting System
WCEM, Nagpur

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Abstract: The Water scarcity is serious problem throught the world for both urban and rural community. The conventional water sources namely well, river and reservoirs, etc. are inadequate to full fill water demand due to unbalance rainfall. While the rainwater harvesting system investigate a new water sources. This project evaluates the potential for water saving by using rain water in waiinganga collage in dongargoan. The roof top of the collage having catchment area is 4426 sq. m. Using average rainfall data, calculation for rainwater endownment and rain water haversting (RWH) potential were made. Volume of water that can be collected in one year was calculated. Suitable filter media for removing suspended particles and reducing turbidity has been proposed. The testing of pure water and comparison with the standard of drinking water parameter .design the filter media for removing the suspended matter present in water. The well is to be design for storage filter water purpose and recharge a ground water table. The developed system satisfies the social requirements and can be implemented in rural area by considering almost all the technical aspect.

Keywords: catchment, rain water harvesting (RWH), filter, recharge pit

1. Introduction
Rainwater harvesting is a technology used to collect, convey and store rain water for later use from relatively clean surfaces such as a roof, land surface or rock catchment RWH is the technique of collecting water from roof, filtering and storing and further uses rain water harvesting is a simple technique of catching and holding rain water where it is fall. Either we can store in a tanks for further use or we can use a recharge ground water depending upon a setution. RWH system provide sources of soft, high quality water reduce dependence on well and other sources and it many contexts are cost effective. RWH system is economically cheaper in construction compared to other sources. i.e., well, canal, dam, diversion, etc.

2. Literature review
1. Meda Kalyam Kumar (Dec 2015)
They use average data rainfall calculate the water harvesting potential volume of water collecting per year provide suitable hydro cyclone for removing suspended particles and reducing turbidity by using various layers.
• They are working at LIMT Faridabad campus study.
• The volume of tank has been ascertained with most suitable strategy for estimation.
• The darcy equation is used to know the potential of rainwater harvesting collection and pipe

3. Methodology
• Analysis the condition of WCEM Campus.
• Study the various Literature paper.
• Rainfall data collection, assume suitable data.
• Design of rainwater harvesting component.
• Cost analysis.

4. Design potential harvesting
V = volume of water that can be harvested annually in m³
C= Runoff coefficient
P = Annual rainfall in (m)
A = Catchment area in (m²)
By applying values,
\[ V = A \times P \times C \]
\[ \text{volume} = 803.76 \text{ m}^3 \]

Discharge calculation,
Area \( A = 4426 \text{ m}^2 \)
Intensity of rain fall \( I = 60 \text{ mm/hour} \)
Coefficient \( C = 0.8 \)

\[ Q = C \times I \times A \]
\[ Q = 0.8 \times (60/1000000) \times 4426 \]
\[ Q = 0.05901 \text{ m}^3/\text{s} \]

Assume rainfall days = 35 days
Volume of water harvesting per year = 803.76 \text{ m}^3/year
So,
Volume of water collected per day = 803.76 / 35 = 22.90 / day
We are considering factor of safety = 3
Therefore,
volume of water harvested = 22.90 \times 3 = 68.70 \text{ m}^3/\text{day}

**Design of pipes:**
Size of downtake pipes:
Roof area
Intensity of rainfall
Discharge (m³/sec) = Roof area (m²) \times intensity of rainfall (m/sec)

\[ Q = A \times I \]

Intensity of rainfall = highest amount of rainfall in mm per hour
Also, Discharge = area of pipe \times flow through velocity

\[ Q = a \times V \]

Flow through velocity = 1 to 1.8 (m/sec) (standard)
\[ A \times I = a \times V \]
\[ a = (A \times I) / V \]
\[ a = Q / V \]
\[ \pi d^2 / 4 = Q / V \]
\[ D = \text{Square root of } 4Q / 4 \]

Roof area = 4426 m²

Assume Intensity of rainfall = 60 mm/hr.
\[ = 60/1000 \times 60 \times 60 = 0.0016/1000 \text{ m/sec} \]

Discharge (m³/sec) = Roof area (m²) \times intensity of rainfall (m/sec)

\[ Q = A \times I \]

Discharge = 4426 \times 0.0016/1000 = 0.00708 m³/sec
\[ = 0.0078 m^3/\text{sec} \]

Discharge = area of conduit/pipe \times flow through velocity
\[ Q = a \times V \]
\[ (Q) 0.0078 = a \times V \]
Area of pipe = \( Q/V \)

\[ \pi d^2/4 = 0.0078/1.2 \]

Diameter of the pipe/conduit
\[ D = \sqrt[4]{4Q / 4} \]
\[ = \sqrt[4]{4 \times 0.00708 / \pi \times 1} \]
\[ = 7.28 \text{ cm} \]
\[ = 3 \text{ inches} \]

Nearest standard size of pipe for available = 3 inches

Design of well
Time Concentration
\[ Tc = 0.0195 \times L0.77 \times S^{-0.385} \]
\[ = 0.0195 \times 227 \times 0.005 \]
\[ Tc = 9.205 \text{ minutes} = 9.025/60 = 0.1673 \text{ hr} \]

Total discharge of building = 0.05901 \text{ m}^3/\text{hr}
\[ Q = 212.43 \text{ m}^3/\text{hr} \]

Volume of well = \( Q \times T.L \) = 212.43 \times 0.163 = 35.62 \times 2 = 71.24 \text{ m}^3

Volume of well = 71.24 \text{ m}^3
Area \( V = A \times h \) …… Assume 12 m deep
71.24 = \( \pi/4 \times d^2 \times 10 \)
\[ H = h + F.B \]
\[ = 12 + 0.5 \]
\[ H = 12.5 \text{ m} \]
\[ d = 2.8 \text{ m} \]

<table>
<thead>
<tr>
<th>Material</th>
<th>Particle Size (mm)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>2–4 mm</td>
<td>0.4 m</td>
</tr>
<tr>
<td>Course gravel</td>
<td>12–20 mm</td>
<td>0.4 m</td>
</tr>
<tr>
<td>Pebbles</td>
<td>0–40 mm</td>
<td>0.5 m</td>
</tr>
<tr>
<td>Boulder</td>
<td>60–80 mm</td>
<td>0.5 m</td>
</tr>
</tbody>
</table>

### 5. Result
- Total Annual Rain water harvesting = 8,03760 Liter
- Size of filtration tank = 1.8 \times 1.5 \times 2.1
- Diameter of Rain water pipe = 75 mm and length 227
- Size of well 2.8 m diameter and 12.5 m depth
- Approximate cost of filtration tank = 33,117.76 /
- Approximate cost of well = 60,630.99 /

### 6. Benefits
- Rainwater is a comparatively clean and totally free source of water.
- It is free, the only cost is for collection and used.
- It is used in those areas which face insufficient water resources.
- It can be used to recharge the ground water.
- It can provide an excellent backup sources of water for emergencies.

### 7. Conclusion
This paper presented design of design of rainwater harvesting system.
References

[4] Last 10 yrs rainfall data from dongargoan grampanchyat.
[5] Using a IS code 15797: 2008 Roof Top rainwater harvesting (water resources)