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# Green Building with Rain Water Harvesting Approach

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## 1. Introduction

A 'green' building is a structure that, in its design, construction or operation, reduces or eliminates negative impacts, and can generate positive impacts, on our health and natural environment. Green buildings preserve precious natural resources and improve our living standard. There are a number of features which included to make a building 'green':

- Efficient use of energy, water and other resources
- Use of renewable energy, such as solar energy, wind energy, biomass.
- Pollution and waste reduction measures, by re-using and recycling
- Good indoor air quality
- Use of materials that are non-toxic, non-hazardous, eco friendly and sustainable
- Consideration of the environmental parameters in design, construction and operation
- Consideration of the quality of life of occupants while design, construction and operation
- A design that enables adaptation to a changing environment

Any building can be a green building, whether it's a home, an office, a school, a hospital, a community centre, or any other type of structure, by providing features listed above.

### 1.1 Advantages and Disadvantages of Green Building

**Advantages**

- Environmental Benefits.
- Reduction of Emissions.
- Conservation of Water.
- Reduced localised flooding.
- Waste reduction.
- Economic benefits.
- Low utility bills.
- Increase in likelihood for the property to be sold or let.
- Social Benefits.
- Improvement to the occupant's health.
- Preservation of the natural environment.
- Increased recreation and exercise opportunities.

**Disadvantages**

- Initial cost.
- Funding for projects from banks hard to get.
- Location Factor.
- Availability of Materials.
- Timescale.
- Implications on air quality due to the use of some recycled materials.

## 2. Objectives

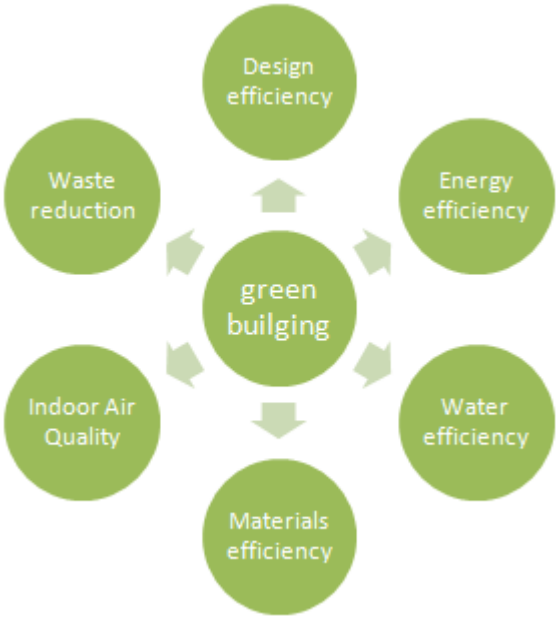
Green buildings are designed to reduce the overall impact on human health and natural environment by following ways:

1) Using energy, water and other resources efficiently
2) By reducing waste, pollution and environmental degradation

Green building is one way to reduce overall consumption of energy and reduce the life cycle cost of building. Following are the Principles of green building and the objective is to optimise at least one of them:

1) **Design efficiency:** This is the concept part of Green/sustainable building and has large impact on life cycle cost and overall performance. The main function is to reduce the lifecycle cost and provide healthy and user friendly environment.
2) **Energy efficiency:** This principle focus on reducing the active energy requirement of building by utilization of passive energy. The utilization of energy can be reduce by proper orientation of building in such way that maximum natural light and air should be utilized for ventilation purpose hence it requires proper placement of door and window opening in structure and also require thermal insulating wall, ceiling and floor to achieve energy efficiency.
3) **Water efficiency:** To reduce the consumption of water and maintain the quality of water it is necessary to focus on collecting water, use water, purification of water and reuse the purified water. one way to achieve water efficiency is rain water harvesting.
4) **Materials efficiency:** To reduce the environmental impact it is necessary to use recycled material obtain from the agricultural waste or industrial waste. A best example of this are solar power panels. solar panels not only provide lighting but also provide valuable energy source.
5) **Indoor Air Quality:** Indoor air quality can be achieve by reducing the volatile organic compounds and providing adequate ventilation by proper selection of construction material such as finishing items with low or zero emission.
6) **Waste reduction:** This can be achieve by using waste for beneficial purpose for example grey water (water from washing machine, bathroom, dishwasher) which can be easily reused for the purpose such as toilet flush and it also can be turned into fertilizer.

The initial cost of construction of such building may be more but result in reduction of life cycle cost and more protection to environment.

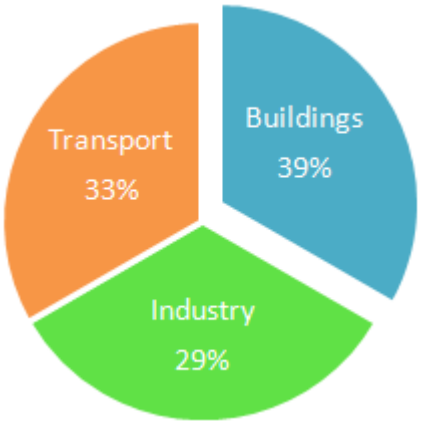



## 3. Methodology

### 3.1 Building and Climate Change

As per united state green building council (USGBC) Buildings Account for 39% of CO2 emissions in the United States. The commercial and residential sector in united states contribute 39% of total carbon dioxide ($co_2$) emission which is more than any other sector in united states. Most of these emissions come from the combustion of fossil fuels for the purpose of heating, cooling and lighting, and to power appliances and electrical equipment. By transforming the built environment to more climate/environment friendly and energy efficient the building sector can play a major role in reducing the threat of climate change.

$CO_2$ Emissions from Fossil Fuels




Green buildings are a vital tool in the fight against climate change:
Emissions of CO2 and other greenhouse gases from human activities will raise global temperatures by 2.5°F to 10°F this century. This results in rising sea levels, more frequent floods and droughts, and increased spread of serious infectious diseases. To overcome the danger of climate change, greenhouse gas emissions must be slowed, stopped, and reversed.

Green building is one of the best strategies for meeting the challenge of climate change because the tool to make substantial reductions in energy and $CO_2$ emissions already exists. The average LEED (Leadership in Energy and Environmental Design) certified building uses 32% less electricity and saves 350 metric tons of $CO_2$ emissions annually.

### 3.2 Rain Water Harvesting (RWH)

Rain water harvesting is the process of collecting rain water as much as possible and store it for further beneficial use. In desert or areas where overall rainfall is comparatively less the rain water harvesting (RWH) is the key measure or solution to drought.

Rain water is fresh water, It is said that water is the liquid gold. Hence it is necessary to store as much as possible. Flowing water through the streets joins various main and submains streams, river and finally mix with sea water and become non-usable. Also the fresh rain water mix with drainage water and gets polluted and increase load on treatment units. Hence it is necessary to prevent wastage of water by adopting proper method of rain water harvesting

**Methods of Rain Water Harvesting (RWH)**

a) **Surface runoff harvesting:** In urban areas water flows over surface as surface runoff this runoff could be collected and used for recharging aquifers by adopting appropriate methods.
b) **Rooftop rainwater harvesting:** It is a system of collecting rain water where it falls. in rooftop harvesting roof becomes catchment area, and the rain water is collected by roof of house/building. The collected water is either stored into tanks or diverted to artificial recharge system. This method is less expensive and very effective and if implemented properly helps in increasing the groundwater level of the area.

**Components of Rooftop Rain Water Harvesting**

- **Catchments:** Catchment is an area which collects rain water which fall over the surface It may be terrace, courtyard, or paved or unpaved open ground.
- **Transportation:** Water collected by catchment area is diverted towards the gutter provided at the edge of roofing system, and it is further shifted to down pipe through wired mesh to prevent entry of floating matter. Pipes should be provided with sufficient dimension depending upon intensity of rainfall.
- **First flush system:** First flush is an provision made to flush off the water received in first shower. The first shower of rain may contain pollutants which contaminates storable or rechargeable water. It also help in cleaning silt deposited in dry season. for flushing first shower simple manually operated valve is provided to down pipe to flush off first shower.
- **Filter unit**: There are some minute or dissolved impurities are always remain in water which cause contamination of ground/storable water if proper filter unit is not provided.

Also leakage through underground sewer cause contamination of water hence recharging system should be provided away from sewerage units.

Filters are used for treatment of raw water by removing turbidity, colour, microorganisms. After flushing of first shower water is passed through the filter. There are various types of filter such as gravel, sand and 'netlon' mesh filter. These are designed and placed over the top of storage tank. It removes silt, dust, leaves and other organic matter and prevent entering in storage tank. The filter media should be cleaned daily after every rainfall event. If not cleaned periodically then they gets clogged and prevent the easily entering of rain water into storage tank results in overflow of filter.

Types of Filters

1) **Sand Gravel Filter:** This is an most common type of filter which is constructed by brick masonry and filled with layers of pebbles, gravel and sand. Each layer is separated by wire mesh.

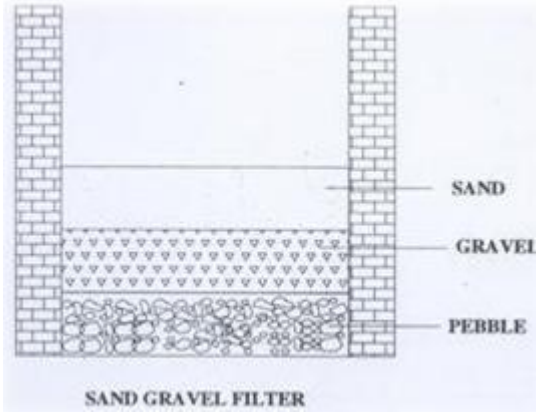



Figure of Sand Gravel Filter

2) **Charcoal Filter:** Charcoal filter can be made in-situ or in a drum. Layers of pebbles, gravel, sand and charcoal are filled into chamber or drum. Each layer is separated by wire mesh. Thin layer of charcoal is used to absorb odour if any.

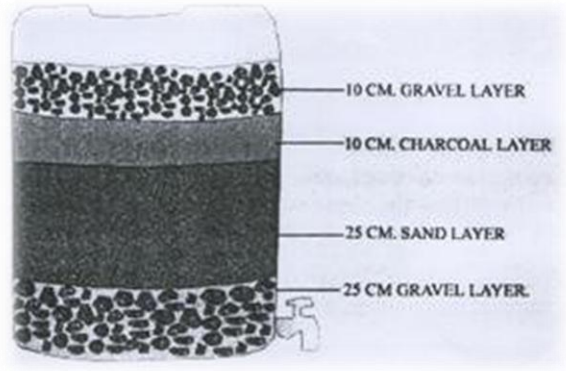
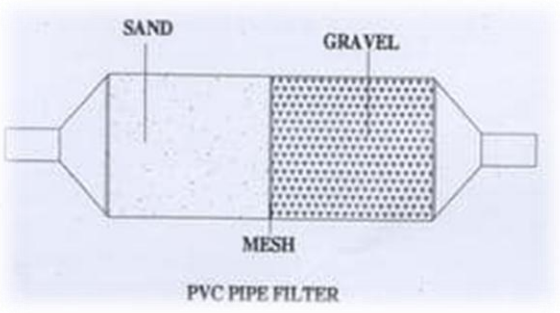



Diagram of Charcoal filter

PVC –Pipe filter: This filter is made by PVC pipe of length 1m to 1.20m length. Diameter of pipe is depend on catchment area. Six inches dia. pipe is enough for a 1500 Sq. Ft. roof and 8 inches dia. pipe should be used for roofs more than 1500 Sq. Ft. Pipe is divided into three compartments by wire mesh. Each component is filled with gravel and sand alternatively. Layer of charcoal is also inserted in between two layers. Cross section of both ends should be reduced to connect inlet and outlet. This filter can be placed vertically or horizontally in system.




PVC-Pipe filter

3) **Sponge Filter:** It is a simple filter made from PVC drum having a layer of sponge in the middle of drum. It is the easiest and cheapest type of filter, suitable for small residential units.

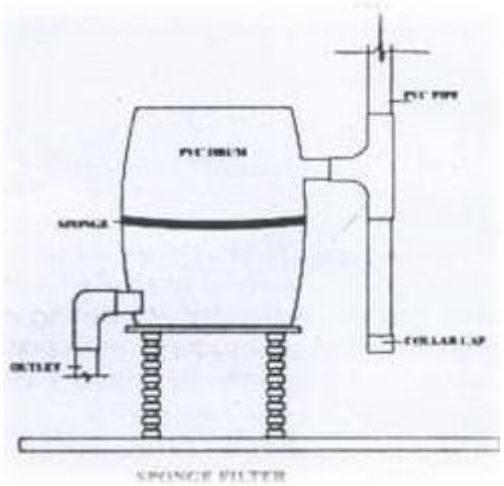


Figure of sponge filter

## 4. Methods of Roof Top Rain Water Harvesting

1) **Storage of Direct Use:** In this method rain water collected by roof is diverted to storage unit. The capacity of storage tank is decided by catchment area and intensity of rainfall. Each pipe should have wired mesh at mouth and first flush system followed by filtration unit before connecting to storage tank. Each tanks should have provided with excess flow system. Excess water could be diverted to recharge system. Water stored in storage tank can be used for secondary purposes such as gardening, washing, etc. This is the most cost effective way of rainwater harvesting. The main advantage of collecting and using rain water during rainy season is not only save water from conventional resources but also helps to save energy incurred on transportation and distribution of water at the doorstep.

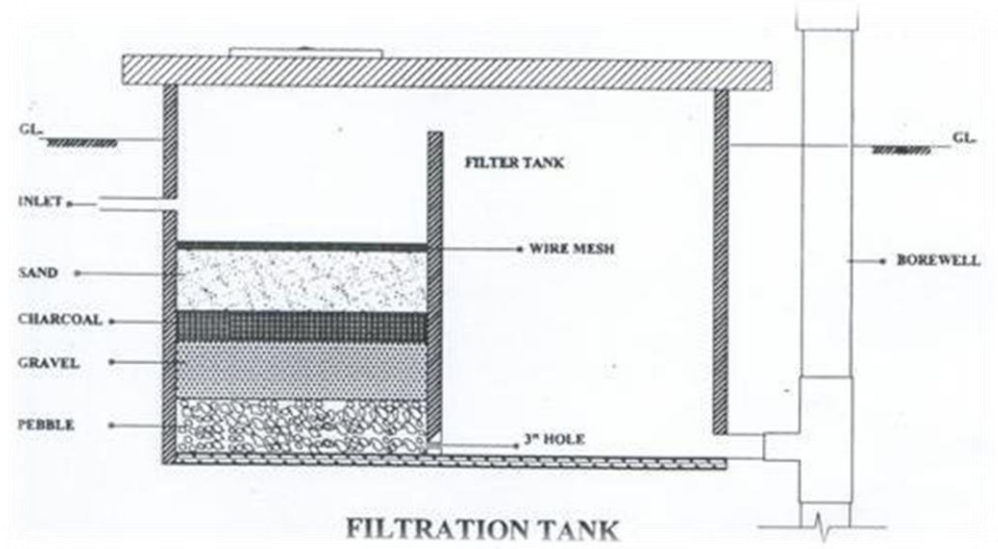
2) **Recharging groundwater aquifers:** Recharging of ground water aquifer can be done by various process by ensuring the percolation of rain water instead of draining away from the surface. Methods of recharging ground water:

a) Recharging of bore wells

b) Recharging of dug wells.
c) Recharge pits
d) Recharge Trenches
e) Soak away or Recharge Shafts
f) Percolation Tanks

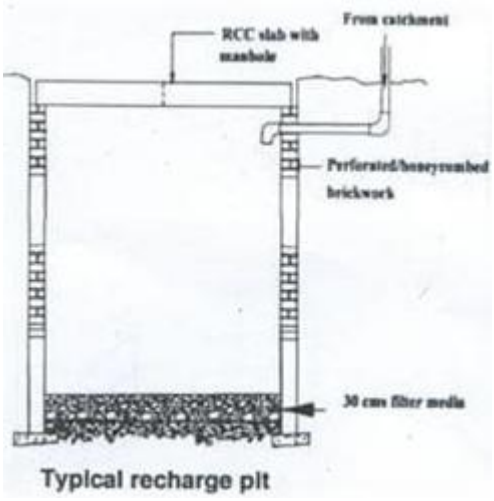
**3) Recharging of bore wells:** Rain water collected by roof is diverted to filtration tank through pipes. After settlement of suspended matter water is diverted to bore wells to recharge deep aquifers. capacity of settlement tank/filtration tank can be designed on the basis of area of catchment, intensity of rainfall and recharge rate. To prevent clogging entry of suspended matter or solid should be prevented. First flush system should be provided to prevent contamination of water.

**Filtration tank recharging to bore well**



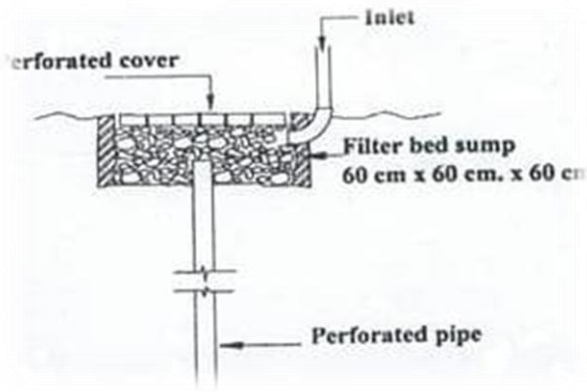

4) **Recharge pits:** Recharge pits are pits on any shape or size such as rectangular, circular, square constructed with brick or stone masonry walls having weep holes as regular intervals. Pit is covered with perforated topping covers. Bottom of pit is filled with filter media. The capacity of pit is depend upon catchment area, rainfall intensity and rate of recharge of soil. Usually size of pit is 1 to 2 m width and 2 to 3 m deep depending on the depth of pervious strata. This system is only suitable for shallow depth aquifers and small houses

**Recharge pit**

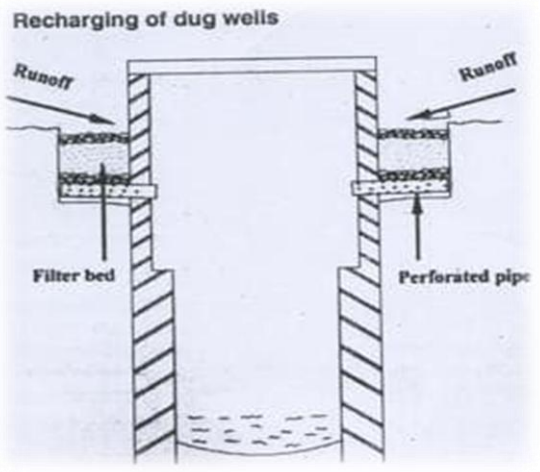



5) **Soak away or Recharge shafts:** Soak away or recharge shafts are provide where upper layer of stratification of soil is impervious or less pervious. These are bored hole of 30 cm dia. Depth is up to 10 to 15 m, depending upon depth of pervious layer. Bore is lined with slotted/perforated PVC/MS pipe to prevent collapse of the vertical sides. To prevent entry of runoff before filtration at the top of pit sump of appropriate size should be provided. Sump should be filled with filter media.

**Diagram of Recharge shaft**




**6) Recharging of dug wells:** Dug wells can be used as recharge system. Rain water from rooftop is diverted towards dug wells after passing it through filter media. Cleaning and desalting of dug well should be done regularly to enhance filtration rate

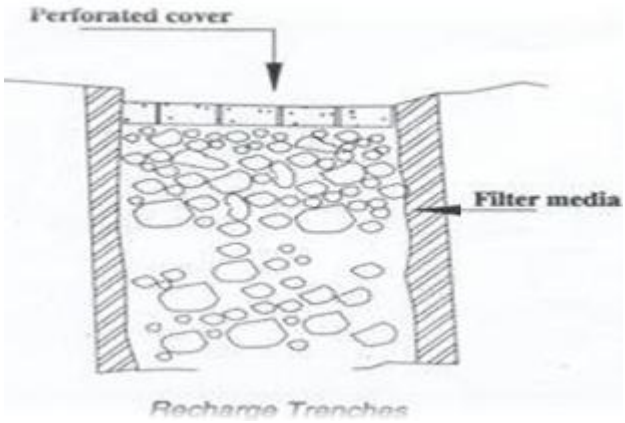



**7) Recharge trenches:** These type of trenches are provided where depth of impervious strata is available up to shallow depth. It is a trench excavated on the ground and refilled with porous materials such as pebbles, boulder or brickbats. This system is provided to recharge surface runoff.

Bore wells can also provided inside the trenches to enhance percolation. Length of trench is depend upon amount of runoff.

This method is suitable for parks, small houses, roadside drains, playgrounds. Cross sectional dimension of trench can be of size 0.50 to 1.0 m wide and 1.0 to 1.5 m deep.

**Recharging to trenches**




8) **Percolation tank:** Percolation tanks are artificially constructed water bodies to submerge land area with adequate permeability for sufficient percolation of water to recharge ground water. These can be built in big areas where land is available and on suitable topography.

Surface runoff and roof top water is diverted to percolation tank. Water accumulated in tank is percolate and join ground water. The stored water can be directly used for washing or gardening or raw use. Percolation tank should be constructed in gardens, open spaces and roadside greenbelts of urban areas.

## 5. Conclusion

The goal of green building or sustainable building is to use resources more efficiently and reduce negative impact of building while construction and during life cycle.

Rain water harvesting (RWH) achieves one key of green building goal by reducing the water requirement and recharging ground water.

It is necessary to adopt various approaches towards green building to protect health and environment and reduce the pollution. There are various methods of rain water harvesting which are explained above as per their suitability by adopting proper method we can put one step to protect environment and healthy lifestyle.

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