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ABSTRACT

Conservation of water is the basic principles of green building. The efforts should be made to ensure that the material and system that are used help in reduction of water consumption in buildings and landscaping the areas. The principle of sustainable water management is achievable by using alternate sources of water that can be supplied to meet the water demand where the quality of water need not be potable. In the residential zones potable water can be supplied and in large commercial zones partly potable and a large portion of non- potable water can be supplied and this is a wise step and should be considered in urban areas of India. All the fixtures such as taps, toilets, shower heads, urinals etc. should be water efficient. Green buildings are sustainable buildings demanding the water conservation as well as preventing pollution and use reuse of grey water and recycle treated water ensuring potable water use for potable purpose only.

INTRODUCTION

Water is most critical resource and all the human activities are dependent upon water. We use water to drink, process in industries, support wild life, generate power and cultivate crops. Water is therefore said to be 'elixir' on the earth. Water has been exploited the most because of its relative abundance and inefficient usage in industry. This so called 'abundance' is illusion and encourages sheer wastage of water ultimately this has led our nation to be water stressed. [1]

Water as such covers significant part of the earth, much of the part is not suitable at all for human use as much of the freshwater is not accessible for human consumption – either the freshwater is trapped in the glaciers or snow in mountainous region or un- reachable depth in the ground water. Only 0.3% of the water is available for human consumption. Though the water is renewable source, there is a shortage of water and with the time it may aggravate and threaten the future.

Fresh water is scarce and industries today face increased competition for water from both agriculture as well as domestic sectors because of the swelling population. Water is absolutely critical for survival on earth and it must be conserved to ensure that they will have enough water in the days to come. This thus demands sustainable water resource management. [2]

CONCEPT OF WATER EFFICIENCY AND GREEN BUILDINGS

In a simple language, water efficiency means reducing usage of water and minimizing wastewater. Although water efficiency and conservation are often synonymously used, they differ in their meaning. Water efficiency implies using improved technologies and practices that deliver equal or better service with reduced water consumption. For example, the use of low flow faucet could be more effective than conventional faucets. Water conservation on the other hand implies curtailment of water usage. Water conservation also includes day-today demand management to better the water usage (GRIHA).

Green buildings are sustainable buildings demanding the water conservation as well as preventing pollution and use reuse of grey water and recycle treated water ensuring potable water use for potable purpose only.[3]

Water efficiency means responsible use of freshwater. Responsible use of water is using the water cautiously and conserving for our grandchildren. For example, all the fixtures in public area are checked periodically for leakage and are in good operating conditions. Preventing leakage of water is saving the water. [4]

LOW FLOW PLUMBING FIXTURES AND TECHNOLOGY EMPLOYED IN LOW-FLOW FAUCETS

Land-scape needs to be promoted around the building. The water efficient fixture & right flow plug, Low-flow plumbing fixtures should be used for conservation of water. Such equipment moderates the flow of water. Low-flow technology is normally applicable in faucets, aerators, urinals, showerheads and toilets. Self-closing or electronic faucets for lavatories help reducing water usage.

Technology employed in Low-flow faucets use aerator. The aerator has a tendency of breaking down the stream of water into many tiny streams and the air will get mixed with each tiny stream. When the faucet is operated this reduces the space for water and ultimately flow of water gets reduced. This can significantly reduce tap water in hand basins and kitchen sinks. The reduction in flow ranges from 50-75% compared with typical flow rates [5]

It has been observed that we use water lavishly particularly when the water flows in fixtures for more time and thereby providing more quantity. Water sensed fixtures – bathroom sink and faucets and accessories use 30% less water than standard flow and by reducing water flow and minimizing the water bill.

WATER EFFICIENT TOILETS

Toilets account for a significant portion of total water demand in residential as well as commercial buildings. Flush toilets which operate between 2 to 3 L per flush can be employed. There are different types of water efficient toilets in the market

Vacuum toilets normally used in aircrafts mare becoming common in public rest areas and commercial buildings. The waste is evacuated from the toilet bowl through a vacuum created by a vacuum pump. The average amount of water used is 1 L / flush. The waste is discharged to the sewers or treatment system [6]

Waterless toilets is dry sanitation system and does not use water at all to transport human excreta. They are called composting toilets. Such toilets require some space below the floor – either a pit or elevated platform. Such toilets can produce fertilizers if sufficient time is given to treat the excreta correctly. Decomposition occurs in the holding tank at correct pH, temperature through a biochemical reaction over an extended period. Such types of toilets are not used in India. [2]

WATER EFFICIENT URINALS

Water efficient urinals use less than 2.8 L /flush. Waterless urinals can be used in office, hotels, theatres and commercial buildings Most of these urinals use an oil barrier between the urine and the atmosphere preventing odour escaping out the atmosphere.[5]

WATER EFFICIENT APPLIANCES

Washing machines and dish washers have been used in India also. High water efficient cloth-washers and dish washers of different sizes are available in the market which use 33% less water and also save 40% energy

Many new models of dish washers do not need pre-rinsing which saves quite a lot amount of water.

ICGB has desired that the efficiency of plumbing fixtures can be enhanced and thereby the potable water use can be minimized.

In LEED Rating system, the weightage of the component of water efficiency is 7%. Out of 70 points, 5 points are earmarked for water efficiency having considerations given to reducing water use in landscaping, wastewater treatment and water use reduction. Use of items like waterloo bio filter, waterless urinals and composting toilets are entitled for points in the category of water efficiency. Reclaiming water for both vehicle washing and landscape watering is considered important aspects under LEED water efficiency category. [2]

WATER AUDIT

It is suggested that water audit should be made in all existing buildings for conservation of water. Let us tract the use of eater by the occupants. Identify the key use areas. Install sub meters and monitor all such water use areas. This will also help the occupants understand where most of the water is used and how it can be reduced.

Following measures can be suggested based on the above discussion: [7]

There are many ways to increase water efficiency in buildings—primarily through plumbing-fixture replacement and implementing new technologies:

- Cleaning of pipeline must be done before installing new fixtures if required during water audit and ensure proper drainage flow

- Replace ancient high-flow water closets and flush valves with the lower flow rate new fixtures, existing buildings often have older, high-flow flush valves
- Utilize dual-flush valves on water closets. Dual-flush valves have provision of a full flush and an half flush to be used if required
- Replace existing plumbing fixtures with high-efficiency fixtures. High-efficiency fixtures include high efficiency water closets, high efficiency urinals and waterless urinals and ultra-low flow shower head.

High efficiency water closets use less water than conventional. High-efficiency urinals use little water per flush, Waterless urinals use a typical formulated liquid to maintain the trap seal. Ultra-low-flow showerheads typically use less water Install or replace existing lavatory and sink aerators with more restrictive aerators. Significant savings can be achieved by replacing high flow aerators with smaller flow aerators. [2]

Use wherever possible grey water (considered non-potable, but is suitable for use in water closets and urinals) distribution systems. Use of grey water can significantly reduce consumption of domestic water and qualify for score under the water efficiency category of Green rating system.

EFFICIENT IRRIGATION

India faces severe water scarcity due to highly uneven distribution of monsoon with time and space unlike western countries. We have long dry periods in the year. A large percentage of population is dependent on agriculture for its survival. In the dry period, the agriculture sector requires large quantities of water. We consume more than 80% of our water for agriculture. In order to feed our growing population, we need to promote effective irrigation.

By installing rain or soil moisture sensors, over watering can be prevented. A rain sensor senses rainfall for a designated amount of water. Rain sensors are smaller devices, easier to install and relatively less expensive than soil moisture sensors. Soil moisture sensors little complicated to install can detect exact moisture at the level of the root system and offer greater water savings. [8]

EFFICIENT USE OF WATER DURING CONSTRUCTION

Construction industry needs huge water and almost 20% of its requirement can be reduced by effective building design construction and management.

The simple ways to reduce water consumption during construction are given as under:

- Using buckets of water to clean the tools rather than running water. Water needed using the buckets manually will require significantly less water compared with running water. Sometimes high pressure hoses instead of running water will also reduce water as cleaning becomes faster with less use of water.
- Concrete mixers containing fly ash generally requires less water (1-10%) for a given slump than concrete containing Portland cement. (GRIHA-Manual volume: 4) [9]
- There are various methods of curing. Curing by ponding method is suitable for curing horizontal surfaces such as roof slabs or floors or pavements of highways.
- This type of curing can reduce the demand for curing water. After placing the concrete the surface is covered with moist canvass. After 24 hrs, these covers are removed and small ponds of sand are formed around the concrete slab. The area is divided into no. of rectangles. The water is filled up between the ponds.
- Membrane curing is an important method of curing as it is water efficient. The concrete surface is covered by a layer of water proof material. The layer of water proof material is known as membrane. The membrane could be either in solid form or in liquid form. Thus it is a moist curing of concrete. The moist curing needs less water. Moist curing maintains the satisfactory temperature by preventing evaporation of the water. The sealing compounds used as membrane are wax emulsions, bitumen emulsions and plastic films. This method is employed at places where water is scarcely available. In India most of the contractors use dumps gunny bags for this purpose.

GRIHA recommends use of chemical admixtures such as High Range Water Reducers (HRWR) or super plasticizers as they act as indirect accelerators. Similarly wax and resin-based compounds are also suggested. [9]

WATER HARVESTING

In its simple terms, water harvesting means collection and storing of rain water falling on the earth (Rain water harvesting). Water so collected can be used for the purpose of drinking after treatment. The rain water can safely be used for irrigation, toilet flushing washing laundry, operating mechanical heating and cooling equipment that use water etc. It will lessen the municipal water supplies and considerable water can be saved.

Water harvesting in Green Rating is considered important aspect of water efficiency.

The Indian Urban Ministry has already issued "Model Building Bye-laws 2016" The bye law has made provisions mandating rain water harvesting. Municipal corporations have been assigned responsibility to undertake and maintain water harvesting projects at all public spaces and public buildings. The ministry has expressed the desire that citizens should come forward and voluntarily install rain water harvesting system. [10]

GRIHA has suggested that rainwater runoff from following catchments should be avoided: [11]

- Tar felted roofs as they are a source of biological and heavy metal contamination
- Asbestos sheets as the fibres of it are toxic
- Roofs chemically treated for water proofing or reflective coating as there is possibilities of contamination with heavy metals and other harmful chemicals
- Water from bathroom and kitchen should not be harvested

The delivery system from the rooftop catchment usually consists of PVC conduits taken from the sides of the roof sloping towards a down pipe entering the tank. PVC pipes are thus used to transport rainwater collected from the roof to the storage reservoir. The storage reservoir could be any storage container like RCC, masonry or plastic water tanks. They need to be regularly maintained for cleaning and disinfection.

GRIHA considers rain water harvesting as green rating and recharge of surplus rainwater into aquifer has maximum 2 point score.

WASTEWATER TREATMENT-WATER COLLECTION AND REUSE

According to GRIHA, grey water is wastewater generated from baths, showers, hand basins, washing machines and dishwashers, laundries and kitchen sinks. The grey water constitutes about 70% of the wastewater generated. Thus there is a huge potential to treat this water and reuse for various applications. Grey water recycling in all new construction will help conservation of water to a great extent.

The water used for bathing can be recycled for toilet flushing through ultra-low flush toilets.

Grey water from the residential as well as commercial zone can be collected from indoor sources other than toilets and treated. The plant may include screening, oil & grease removal from the kitchen wastewater, filtration and finally disinfection. Treated grey water can be used for cooling tower- make up water, landscape irrigation, green roof top and toilet flushing. [12]

Thus '**Dual plumbing system**' employs separate piping systems for recycled water (non- potable quality) and potable water. The recycled water system serves non potable use such as flushing toilets, land-scape and external washing etc. This is therefore required to be separated from plumbing system supplying water for potable use such as drinking, cooking, bathing etc. [13]

Criterion 20 of GRIHA very clearly specifies the use of dual plumbing system and encourages decentralized wastewater treatment. [14]

LANDSCAPE DESIGN

Black water is the discharge from the toilets and may contain nutrients and microbial population. Black water can be treated with utmost care using higher dose of disinfection. Treated black water is most suited for sub surface irrigation for land-scape.

Even combined wastewater containing grey as well as black water can be adequately treated to a very high quality by adding micro filtration followed by high dose disinfection and activated carbon treatment. The treated combined wastewater can be safely used both for toilet flushing as well as irrigation purposes.

The landscape should be designed in such a way that it ensures minimum water consumption. It includes only pervious vegetation. ICGB compliance option suggests limiting use on the site to conserve the water and /or ensure that landscaped area is planted with drought tolerant/ native/adaptive species.

Selection of plants having less need of water should be made plantation will increase the aesthetics and

yield cooling and pollution control. It can reduce carbon foot print. [2]

MULCH FOR CONSERVING MOISTURE

Mulch is nothing but a layer of material which is applied on the soil with a broad purpose of conserving moisture, reducing the growth of weed and improves the general health of the soil. The process of applying mulch on the soil is called 'Mulching' Bark chips mulching is popular. This is normally applied to bare soil or around existing plants. This also gives aesthetic appeal. Mulches with manure can also be applied to improve the crop production and land- scape as it helps in enhancing soil productivity. Mulches help soil retain moisture in summer, prevent weeds from growing and protect the roots of plants in winter.[15]

Organic or biodegradable mulches such as conifer bark, pine needle, spent mushroom compost, compost, bark, wood chippings, leaves, newspaper or card board straw, grass clippings, nut shells; add nutrients to the soil as they decompose. This type of mulch needs to be periodically reapplied.

Inorganic mulches (Non-biodegradable) such as gravel, slate, pebbles, stone chippings, black plastic, or fabric, crushed CDs, tumbled glass, sea shells etc. cannot improve soil structure but help suppress the growth of the weeds and also conserve moisture.

The layer of mulches is normally 5cm.to 7.5 cm. Mulch stabilizes the soil temperature and moisture, and prevents the growing of weeds from seeds. Mulch actually creates a layer between the soil and environment preventing sun light reaching the soil surface and thus evaporation is reduced. Similarly munch also prevent water from reaching the soil by absorbing water from light rains. Ruth Stout, father of mulch recommends a thick mulch of any vegetable matter in flower garden all the year as it enriches soil.

Mulches should be applied when the soil is moist and warm not in winter when the soil is very cold and not in summer when soil is very hot.[15]

Plastic mulch is commercially used for commercial production. The plastic is rolled out on top and seedlings are transplanted through the plastic mulch as the plastic mulch is impermeable to water. In Drip irrigation plastic mulch is used.

ENSURING WATER QUALITY

Potable water quality standards must be maintained irrespective of any type of source of supply. If the municipal water supply is not meeting with the desired standard of the potable water, it is recommended by GRIHA (Criterion 28) that additional relevant treatment must be given and desired quality of potable water must be supplied to the end users.

The standard to be followed are BIS 10 500-1991 standards. This standard is applicable in India and is based on World Health Organization (WHO) standard and has been amended subsequently to take care of Total Dissolved Solids (TDS), hardness and chlorides. [11]

POROUS PAVING SYSTEM USING PERVIOUS CONCRETE

The conventional concrete as is known is a mixture of cement paste and aggregates. Cement paste is composed of cement and water and aggregates are composed of fine and coarse aggregates. The cement paste actually coats on the aggregates and forms a coherent mass known as Concrete. This concrete can be moulded into any shape when freshly mixed. It is therefore called as plastic and it becomes strong and durable when it gains strength and is known as hardened concrete. Thus the careful proportioning and mixing of the ingredients place very important role to get the desired workability for the fresh concrete and the required durability and strength of hardened concrete.

Pervious concrete is different from the conventional concrete. It is defined as "no fines concrete". The pervious concrete mix contains very little or practically no fine aggregate. It is a mixture of cement paste which forms a thick coating on coarse aggregates.

Compared with the conventional concrete proportions, proportioning pervious concrete mixture must have better control on batching all the ingredients necessary to produce the desired results.

Aggregate grading used in pervious concrete are typically either single sized coarse aggregate or grading between 19 and 9.5 mm. Pervious concrete uses the same materials as conventional concrete. With the exception that the fine aggregate is eliminated entirely and the size distribution of the coarse aggregate is kept narrow, allowing for relatively little particle packing. This not only

provides the useful hardened properties but also results in a mix that requires different considerations in mixing, placing, compaction and curing.

It is possible to use the eco-friendly material in India. For the smart cities the use of pervious concrete will be suitable specifically for parking lots, pedestrian ways in the green spaces, morning walkways and in rural areas. The roads around the houses in rural and even in urban areas could be successfully constructed in pervious concrete and surfacing inside the compound can be made with pervious concrete. The objective however should be to improve the ground table. There are systems where un-compacted gravel crushed stone porous paving blocks or pervious concrete block are used to construct walk ways or parking lots where the traffic is light. This helps in allowing storm water runoff recharging the ground water table. [16]

CONCLUSION

The prime objective of this paper is to stress the need for conservation of water especially on the World Water Day, highlight the various technologies available for implementing water efficiency. This paper also empathise on construction of green building and adopting practices of water efficient, energy efficient, material efficient and indoor environment. The several technologies discussed in the present paper have been successfully put into practice for saving water. Many nations have adopted policies of green building to conserve water and reducing the use of natural resources. Protecting the existing sources of freshwater is most essential for avoiding crisis of water in future.

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