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Effect of Grey Water

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ABSTRACT
Water scarcity has many negative impacts on the environment, including lakes, rivers, wetlands, and others fresh water resources. The resulting water overuse that is related to water scarcity, often located in areas of irrigation agriculture, harms the environment in several ways including increased salinity, nutrient pollution, and the loss of floodplains and wetlands. Furthermore, water scarcity makes flow management in the rehabilitation of urban streams problematic.
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Keywords
Grey Water, Concrete, Workability, Mix Design, Compressive Strength, etc.

1. INTRODUCTION

1.1 Grey water:
Household wastewater is mainly divided in black water and grey water. Black water consists of the discharges from toilets. Black water contains nitrogen and phosphorous in high concentrations and most of the pathogens, hormones and pharmaceutical residues. Grey water consists of the discharges from kitchen sinks, showers, baths, washing machines and hand basins. It accounts for up to 75% of the wastewater volume produced by households. Grey water is relatively low in pollution and therefore, after appropriate treatment, has great potential for reuse in non-potable water applications such as infiltration, irrigation, toilet flushing, washing water, and construction.

Grey water from Bathroom: Water used in hand washing and bathing generates around 50-75% of total grey water and is considered to be the least contaminated type of grey water. Common chemical contaminants include soap, shampoo, hair dye, toothpaste and cleaning products. It also has some facial contamination and the associated bacteria and viruses through body washing.

1.2 Problem statement
Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. It already affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water.

Water scarcity involves water stress, water shortage or deficits, and water crisis. While the concept of water stress is relatively new, it is the difficulty of obtaining sources of fresh water for use during a period of time and may result in further depletion and deterioration of available water resources. Water shortages may be caused by climate change, such as altered weather patterns including droughts or floods, increased pollution, and increased human demand and overuse of water. A water crisis is a situation where the available potable, unpolluted water within a region is less than that region's demand. Water scarcity is being driven by two converging phenomena: growing freshwater use and depletion of usable freshwater resources.

1.3 What Are the Benefits of Grey water Re-use?
Re-using water does not diminish our quality of life; however it can provide benefits on many levels.

Two major benefits of grey water use are:

- Reducing the need for fresh water. Saving on fresh water use can significantly reduce household water bills, but also has a broader community benefit in reducing demands on public water supply.
- Reducing the amount of wastewater entering sewers or on-site treatment systems. Again, this can benefit the individual household, but also the broader community.

2. LITERATURE REVIEW

2.1. Janet Hartin and Ben Faber has been investigated "Use of Grey water in Urban Landscapes".(29-1-14):
The use of grey water to irrigate landscape plants is increasing throughout the United States, particularly in California and other arid states. In the United States, "grey water" most often refers to wastewater that originates from residential clothes washers, bathtubs, showers, and sinks, and it excludes wastewater generated from kitchen sinks, dishwashers, and toilets (black water).

Laundry-to-landscape grey water systems are relatively simple to install and are inexpensive. The hose exiting the clothes washing machine is attached to a valve that separates grey water from water destined for the sewer. The grey water is diverted through a 1-inch main irrigation line with ½-inch tubing outlets placed throughout the landscape terminating in a valve box set in what is termed a "mulch basin" that surrounds plants being watered. The washing machine pump distributes water directly to the landscape with no filter. A vacuum break or backflow prevention device may also be needed. Keep in mind that salt-free and boron-free liquid laundry detergents should be used for irrigating the landscape. In addition, chlorine bleach should be avoided. Because of the recent changes regarding grey water reuse under California and other state statutes, research pertaining to the long-term impacts and risks of grey water reuse on human health, plant health, soil chemistry, and ground and surface water quality is very limited. A review of current research-based information follows. Grey water should not be applied directly to edible plant parts or root crops. To be safe, it should be applied only to nonedible ornamental plants. Avoid splashing grey water on neighboring edible plants. Grey water

should not be applied through sprinkler systems, since droplets containing harmful microbes can become suspended in the air and breathed.
From the analysis of experimental results, the main following conclusion can be drawn:
Because grey water is often rich in nutrients required for plant growth, ornamental plants may benefit from its use. However, numerous studies indicate that grey water may contain significant levels of sodium and other salts harmful to plants, particularly from powdered laundry detergents. Since ornamental plants vary dramatically in their sensitivity to potentially harmful salts found in grey water, care must be taken when plants are irrigated with grey water that is high in salts, particularly over a long-term basis.

2.2 Lynn Schneider has been investigated "Grey water Reuse in Washington State".(2-6-2009 to 17-9-2009):

This report summarizes the literature on the characterization of grey water by source inside of a home from on potable reuse in the State of Washington for single family homes, multi-family homes, and businesses. It summarizes available data related to the average quantity and constituents of concern associated with a variety of sources of grey water. It is meant to be used as a tool by the grey water rule advisory committee during rule development.
This literature review demonstrates that the level of pollution in the total grey water stream that includes kitchen sinks, dishwashers, laundry machines used to wash dirty diapers can be equal to or greater than black water and requires regulations consistent with on-site sewage regulations. Wastewater from kitchens can be heavily polluted with pathogens, chemicals from dish detergents, and fats, oils and grease. Wastewater from clothes washing machines used for washing soiled diapers contains increased levels of bacteria.
Using grey water for subsurface irrigation is a preferred method for reducing the use of potable water because it is cost effective and has relatively low risk of exposure. More expensive and complicated methods for grey water reuse include treating grey water to a safe level for other non-contact uses. The Leadership in Energy and Environmental Design (LEED) certificate and other green building certification programs reward developers for including grey water reuse systems into building designs. The expanded use of green building certificates and programs is increasing the demand for permitted grey water systems.
From the analysis of experimental results, the main following conclusion can be drawn:
Grey water does need to be managed properly to avoid exposing people to pathogens, harming plants, clogging the irrigation system, and creating unpleasant odors. Management options used to address the risk associated with grey water re-use include using a graduated frame-work to manage risks.
Grey water is a source of bacteria, virus, and protozoa which can cause illness. Direct exposure routes should not be allowed. Subsurface irrigation is acceptable; however, ponding and other direct contact paths need to be avoided.

3. Methodology

3.1 Procedure:

- Collection of sample.
- Performing tests on collected water sample: - a) pH b) Chlorination.
- Analyzing test Results.
- Comparing test results with potable water sample.
- Collection of materials
- Performing tests on materials collected.
  Test to be conducted:-
  a) Specific gravity of cement
  b) Specific gravity of: - 1) Coarse aggregate, 2) Fine aggregate
  c) Water absorption of: - 1) Coarse aggregate, 2) Fine aggregate
  e) Sieve analysis
  f) Workability: - 1) Slump cone, 2) Compaction factor test
- Casting of concrete cubes using Grey water & potable water.
- Performing tests On both cubes
  Compressive strength Test
  Comparing test results
  Comparison of compressive strength at 7 days of curing.
  Comparison of compressive strength at 28 days of curing.

3.2 Grey Water Treatment

Grey water reuse methods can range from low cost methods such as the manual bucketing of grey water from the outlet of bathroom, to primary treatment methods that coarsely screen oils, greases and solids from the grey water before use via small systems, to more expensive secondary treatment systems that treat and disinfect the grey water to a high standard before using.

3.3 IS Method

Advantages and Limitations of IS Method:

The IS method treats normal mixes (up to M35) and high strength mixes (M40 and above) differently. This is logical because richer mixes need lower sand content when compared with leaner mixes. The method also gives correction factors for different w/c ratios, workability and for rounded coarse aggregate. In IS method, the quantities of fine and coarse aggregate are calculated with help of yield equation, which is based on specific gravities of ingredients. Thus plastic density of concrete calculated from yield equation can be close to actual plastic density obtained in laboratory, if specific gravities are calculated accurately. Thus actual cement consumption will be close to that targeted in the first trial mix itself. The water cement ratio is calculated from cement curves based on 28 days strength of cement. This can be time consuming and impractical at times. The IS method gives separate graphs using accelerated strength of cement with reference mix method. This greatly reduces the time required for mix design.

3.4 IS MIX DESIGN FOR 0.5W/C RATIO: STIPULATIONS FOR PROPORTIONING

a) Grade designation
b) Type of cement :
OPC 53 grade conforming to IS8112
c) Maximum nominal size of aggregate :
20mm
d) Minimum cement content :
300 kg/m^3
e) Maximum water-cement ratio: 0.50

f) Workability: Medium
g) Exposure condition: Mild (for reinforced conc.)
h) Method of concrete placing: Hand placing
j) Degree of supervision: Good
k) Type of aggregate: Crushed angular aggregate
m) Maximum cement content: 450 kg/m^3

3.4.1 Test Data For Materials

a) Cement used: OPC 53 grade conforming to IS8112
b) Specific gravity of cement: 3.15\
c) Specific gravity of:
1) Coarse aggregate: 2.74
2) Fine aggregate: 2.63
e) Water absorption:
1) Coarse aggregate: 0.5 percent
2) Fine aggregate: 1.0 percent
f) Free (surface) moisture:
1) Coarse aggregate: Nil (absorbed moisture also nil)
2) Fine aggregate: Nil

3.4.2.Selection of Water-Cement Ratio

Adopt water-cement ratio as 0.50.

3.4.3 Selection Of Water Content

From Table 2 , maximum water content = 186 Kg/m^3 for 20 mm aggregate.

3.4.3 Calculation Of Cement Content

Water-cement ratio Cement content =0.50
Cement content =186/5
=372 kg/m^3

3.4.4. Proportion Of Volume Of Coarse Aggregate And Fine Aggregate content

From Table 3, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone I) for water-cement ratio of 0.50 = 0.60.
Therefore, volume of coarse aggregate = 0.60
Volume of fine aggregate content =1 - 0.60 =0.40

3.4.5 Mix Calculations

Calculations of quantity of aggregate
Volume Balancing Equation Volume of concrete = 1 m^3

A) For Fine Aggregate:

$$V = \left[\frac{\text{Water}}{S_w} + \frac{\text{Cement}}{S_c} + \frac{1}{p}\frac{F\,A}{S_{fa}}\right] \times \frac{1}{1000}$$

$$1 = \left[\frac{186}{1} + \frac{372}{3.15} + \frac{1}{0.4}\frac{\text{Fine Aggregate}}{2.63}\right] \times \frac{1}{1000}$$

F. A. =732.09 kg/m^3

B) For Coarse Aggregate:

$$V = \left[\frac{\text{Water}}{S_w} + \frac{\text{Cement}}{S_c} + \frac{1}{(1-p)}\frac{C\,A}{S_{ca}}\right] \times \frac{1}{1000}$$

$$1 = \left[\frac{186}{1} + \frac{372}{3.15} + \frac{1}{(1-0.4)}\frac{\text{Coarse Aggregate}}{2.74}\right] \times \frac{1}{1000}$$

C. A. =1143.65 kg/m^3

Where,
V= Absolute volume of fresh concrete, which is equal to gross volume
W= Mass of water kg per m^3 of concrete
C= Mass of cement kg per m^3 of concrete
FA= Mass of fine aggregate kg per m^3 of concrete
CA= Mass of coarse aggregate kg per m^3 of concrete
S_w = Specific Gravity of Water
S_c = Specific Gravity of Cement
S_{fa}= Specific Gravity of Fine Aggregate
S_{ca}= Specific Gravity of Coarse Aggregate

4. PERFORMANCE ANALYSIS & RESULT

4.1 Comparison of workability by slump cone test:

% of grey water	Slump (mm)
0	40
20	46
40	55
60	60
80	67
100	72

As shown in above we can conclude that as the percentage of grey water increases then workability of concrete also increases. . As the percentage of grey water increases by 20%, 40%, 60%, 80%, 100% , workability increases by 15%, 37.5%, 50%, 67%, 72% respectively.

Some synthetic detergents, fatty and resinous acids and their salts, alkylbenzeneulfonates are materials of air entraining admixtures and also of soaps and detergents. Therefore soapy water can improve workability.

4.2 Comparison of Workability By Compaction Factor Test

% of grey water	C.F
0	0.870
20	0.880
40	0.890
60	0.895
80	0.902
100	0.910

As shown in above we can conclude that as the percentage of grey water increases then workability of concrete also increases. As the percentage of grey water increases by 20%, 40%, 60%, 80%, 100% , workability increases by 1.149%, 2.29%, 2.87%, 3.67%, 4.59% respectively.

Some synthetic detergents, fatty and resinous acids and their salts, alkylbenzenesulfonates are materials of air entraining admixtures and also of soaps and detergents. Therefore soapy water can improve workability.

4.3 Comparison of compressive strength at 7 days of curing:

% of Grey water	Casting Date	Test Date	Weight (Kg)	Strength (MPa)	Mean Strength (MPa)	Peak Load (KN)
0%	8/2/18	10/4/18	8.451	25.81	31.55	580.90
			8.600	37.30		851.7
20%	8/2/18	10/4/18	8.390	25.70	26.44	579.00
			8.315	26.60		598.50
40%	10/2/18	10/4/18	8.385	21.30	24.21	480.90
			8.295	27.12		610.40
60%	10/2/18	10/4/18	8.225	21.60	20.30	486.10
			8.383	19.00		427.60
80%	12/2/18	10/4/18	8.110	20.93	21.55	471.00
			8.161	22.18		499.10
100 %	12/2/18	10/4/18	8.360	22.37	21.65	503.40
			8.356	20.94		571.20

4.3.1Conclusion from Result

When the grey water is increased by 20% , 40%, then compressive strength of concrete at 7 days curing increases by 5.2%, 0.3% respectively and for increase in grey water by 60%, 80%, 100% then compressive strength of concrete at 7 days curing decreases by21.96%, 12.71%, 15.56%.From above results we can replace pure water by 40% grey water.

4.4 Comparison of compressive strength at 28 days of curing:

% of Grey wtr.	Casting Date	Test Date	Weight	Strength	Mean Strength	Peak Load
0%	16/2/18	10/4/18	9.319	40.01	41.28	900.40
			9.579	43.00		967.60
20%	16/2/18	10/4/18	8.447	37.64	40.72	869.50
			8.485	43.80		986.70
40%	18/2/18	10/4/18	8.377	36.95	38.22	831.50
			8.311	39.50		889.30
60%	18/2/18	10/4/18	9.471	32.14	33.620	723.30
			9.404	35.10		790.10
80%	21/2/18	10/4/18	8.267	34.15	32.850	768.50
			8.173	31.55		709.90
100%	21/2/18	10/4/18	8.329	25.70	28.23	579.00
			8.470	30.76		692.76

5. CONCLUSION

Improvement in workability, strength, durability and increase in setting time due to use of grey water for mixing concrete.

Grey water usually contains hair dyes, hair oils, vegetable oils, cosmetics chemicals, soaps, detergents etc. But soaps and detergents are present more predominantly than others. Soaps and detergents generally contain carboxylic acid group, sodium alkyl sulphate, sodium alkylbenzenesulfonate, glycerol (a non-ionic detergent), sodium carbonate, sodium tetraborate, synthetic detergents, fat or oil, potassium hydroxide, sodium hydroxide, etc.

Soap is a salt of a compound known as a fatty acid. A soap molecule consists of a long hydrocarbon chain (composed of carbons and hydrogen) with a carboxylic acid group on one end which is ionic bonded to a metal ion, usually a sodium or potassium. The hydrocarbon end is nonpolar and is soluble in nonpolar substances (such as fats and oils), and the ionic end (the salt of a carboxylic acid) is soluble in water.

Detergents are structurally similar to soaps, but differ in the water-soluble portion. Because soaps are the salts of strong bases and weak acids they should be slightly basic. A laundry detergent composition generally comprises six groups of substances: surfactants, builders, enzymes, bleaching agents, fillers and other minor ad-ditives such as dispersing agents, fabric softening clay, dye-transfer inhibiting ingredient, and optical brighteners. Laundry detergents and, household and personal-care products account for over half the use of surfactant.

Surfactant is an abbreviation for surface active agent, which literally means active at a surface. Surfactants are the single most important ingredients in laundry and household cleaning products, comprising from 15% to 40% of the total detergent formulation.

Increase in workability:

Air entraining admixtures can improve workability of concrete. Some synthetic detergents, fatty and resinous acids and their salts, alkylbenzenesulfonates are materials of air entraining admixtures and of soaps and detergents both. Therefore soapy water can improve workability. At the same time these materials are helpful for improving durability in freeze-thaw, deicer, sulphate, and alkali-reactive environments.

Low water absorption:

Damp-proofing admixtures retard moisture penetration into dry concrete. Soaps of calcium or ammonium stearate or oleate are materials of Damp-proofing admixtures and of soaps and detergents both.

Permeability reducer decreases permeability the material used for this is Calcium stearate and is soap.

Soaps and detergent in mixing water act like Damp-proofing admixtures and Permeability reducer resulting in low water absorption.

Improvement in strength:

Compressive strength of concrete will be known after conducting tests i.e. compression testing machine.

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