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Effect Of Grey Water On Concrete Properties

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1. Janet Hartin and Ben Faberhas been investigated "Use of Gray water in Urban Landscapes". The use of Gray water to irrigate landscape plants is increasing throughout the United States, particularly in California and other arid states. In the United States, "gray 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 Gray water systems are relatively simple to install and are inexpensive. The house exiting the clothes washing machine is attached to a valve that separates Gray water from water destined for the sewer. The Gray 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 (see below). 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 Gray water reuse under California and other state statutes, research pertaining to the long-term impacts and risks of Gray 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. Gray 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 Gray water on neighboring edible plants. Gray water should not be applied through sprinkler systems, since droplets containing harmful microbes can become suspended in the air and breathed.

Because Gray water is often rich in nutrients required for plant growth, ornamental plants may benefit from its use. However, numerous studies indicate that Gray 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 Gray water, care must be taken when plants are irrigated with Gray water that is high in salts, particularly over a long-term basis.

2. Lynn Schneider has been investigated "Gray water Reuse I N Washington State". This report summarizes the literature on the characterization of gray water by source inside of a home for non-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 gray water. It is meant to be used as a tool by the gray water rule advisory committee during rule development.

This literature review demonstrates that the level of pollution in the total gray 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 gray 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 gray water reuse include treating gray 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 gray water reuse systems into building designs. The expanded use of green building certificates and programs is increasing the demand for permitted gray water systems.

Gray 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 gray water re-use include using a graduated frame-work to manage risks. Gray 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. James Crook and Alan E. Rimer, has been investigated "Technical memorandum On Gray water". Gray water is wastewater which is not expected to be grossly contaminated by feces or urine and is generally defined as all wastewater generated in a household except toilet wastes. This could include water from bathtubs, showers, kitchen and bathroom sinks, clothes washing machines, laundry tubs, and dishwashers; however, kitchen sinks and dishwaters usually are not incorporated into Gray water flow due to high organic content that may cause oxygen depletion and increased microbial activity of the Gray water and the possibility that the wastewater may contain food borne pathogens.

Gray water may contain: microorganisms (some of which are likely to be pathogenic); chemicals that include dissolved salts such as sodium, nitrogen, phosphates, and chloride, and organic chemicals such as oils, fats, milk, soap and detergents; or particles of dirt, food, lint, sand, etc. Gray water may also contain oils, paints, and solvents from household activities that could have detrimental effects on areas irrigated with the Gray water. Gray water is contaminated with human and animal excretions from bathing, food preparation, and from clothes washing. Because it is not practical to analyze wastewater for all of the pathogenic organisms that may be present, sampling for organisms that are indicative of the presence of fecal contamination and the potential presence of pathogenic organisms originating from human fecal matter is universally used. Based on the high concentrations of indicator organisms found in Gray water, all forms of Gray water are deemed to be capable of transmitting disease, and pathogens have been found in some Gray water sampled.

Controls on the construction and use of Gray water systems are primarily based on the potential threat to human health and the potential long term impact of Gray water on plants and the soil. Data reported in the literature consistently demonstrate that Gray water contains high levels of pathogen indicator organisms and other potential pollutants. None of the publications reviewed indicated that untreated Gray water is acceptable for toilet flushing or other uses within a home.

Sampling Gray water for pathogenic organisms is seldom done, and testing for all potential pathogens is never done. Where sampling has been done, the water has been analyzed for only a few specific pathogens, and most – but not all - analyses have been negative for the presence of the pathogens. Several states have Gray water regulations. Most regulatory agencies that have Gray water regulations or guidelines either prohibit or recommend against the use of gray water.

I. SYSTEM DEVELOPMENT

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.

The IS method suffers from following limitations: -

a. The IS method recommends 35 % sand content by absolute volume for zone II sand with correction of +1.5 % for zone I and –1.5 % for zone III. These zones have wide range and this correction is not adequate to achieve a cohesive mix. Sometimes a correction may be required even when fine aggregate varies from upper side to lower side of a particular zone.

b. Though sand content is adjusted for lower water cement ratio there is no direct adjustment for cement content. As discussed earlier, the cement particles act, as fines in concrete and richer mixes often require lesser fine aggregate when compared to leaner mixes. A mix in which cement content has been lowered by use of plasticizers may require higher sand content to improve cohesion.

c. The IS method gives different tables for determining sand content for concrete up to M 35 grade and above M 35 grade. There is an abrupt change in sand content from 35% to 25% in the two tables when shifting from M 35 grade concrete to M40 grade concrete. The change may be justified to account forhigher cement content but it should be gradual in nature.

d. The IS method considers compaction factor as measure for workability, to calculate the water demand. Compaction factor may not correctly represent workability and the revised IS 456 2000 has excluded compaction factor as a measure of workability. It recommends use of slump as a measure for workability. Relationship between slump and compaction factor is difficult to standardize.

e. The IS method does not take into account the effect of the surface texture and flakiness of aggregate on sand and water content. It does not recommend any corrections when crushed fine aggregate is used against natural fine aggregate as in case of DOE method.

f. The IS method does not easily account for blending of different fine aggregates or coarse aggregates when they individually do not conform to IS requirements. On the other hand in RRL method, coarse sand can be blended with fine sand or stone dust to get the required gradation (Natural sand and stone dust will have different specific gravities). Even coarse aggregates of different sizes, gradation and specific gravities can be blended to achieve the required gradation in RRL method.

g. The IS method gives water demand and fine aggregate content for 10mm 20mm and 40mm down aggregate .In practice the maximum size of coarse aggregate is often between 20mm and 40mm, the estimation of water and sand content is difficult.

h. The quantities of fine aggregate and coarse aggregates are calculated from the yield equation. The yield equation is based on concept, that volume of concrete is summation of absolute volumes of its ingredients. Absolute volume of ingredients are function of specific gravities of ingredients .The plastic density of concrete if theoretically calculated on the basis of specific gravities, may not match with that actually measured from concrete.

i. The IS method does not have a specific method of combining 10mmaggregates with 20 mm aggregates. The grading limits for combined aggregates in IS383 are too broad and do not help much to arrive at particular ratio of different coarse aggregates. The combined grading curves of RRL method help us to arrive on particular ratio of coarse aggregates.

j. The IS method does not have an adjustment in fine aggregate content for different levels of workability. Higher workability mixes require more fine aggregate content to maintain cohesion of mix.

Project Work

This project aims at finding out the “Effect of Gray water on properties of concrete”. This project work include the concrete mix design for w/c 0.5 as IS 10262-2009 by varying the % of gray water as 0%,20%,40%,60%,80%,100% as replacement of potable water. Where conducted at concrete lab of Civil Department Mitthulalji Sarda polytechnic, Beed. The testing of greywater was conducted in Government Hydrology Lab Aurangabad. The cubes where casted & cured at Concrete Technology Lab Civil Department at MSP Beed.

The fresh concrete was tested for workability by Compaction Factor Test & Slump Cone Test Confirming to IS 1199-1959& Workability was compared for different proportions of gray water. Harden concrete was tested for compressive strength on Compression Testing Machine (i.e. Destructive Testing) of concrete & compressive strength was compared for different proportions of gray water.

Specific Gravity of Aggregate and Water Absorption

Fig.3.3.1Specific Gravity of Aggregate and Water Absorption

Procedure:

1. About 2 Kg of the coarse aggregate sample is washed thoroughly to remove fines, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22^{o} and 32^{oC}.
2. Immediately after immersion the entrapped air is removed from the sample by lifting basket containing it 25 mm above the base of the tank and allowing it to drop 25 times at rate of one drop per second.
3. The basket and aggregate should remain completely immersed in water for a period of 24 ± ½ hours afterwards.
4. The basket and the sample are then weight while suspended in water at a temperature of 22^{oC} to 32^{oC}. The weight is noted while suspended in water = A_1 g.
5. The basket and aggregate are then removed from water and allowed to drain for few minutes.
6. After which the aggregates are transferred to one of the dry absorbent cloths. The empty basket is returned to the tank of water, jolted 25 times and weighted in water = A_2 g.
7. The surface dried aggregate is then weighted = B g.
8. The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110^{o}C for 24 hours.
9. It is then removed from the oven, cooled in an oven air-tight container and weightd = C g.

$$\text{Specific Gravity} = \frac{\text{weight of aggregate}}{\text{weight of equal volume of water}}$$

$$= \frac{C}{(B-A)} \times 100 \text{Where, } A = (A_1 - A_2)$$

$$\text{Water Absorption} = \frac{B-C}{C} \times 100$$

3.3.2 Specific Gravity of Fine Aggregate and Water Absorption

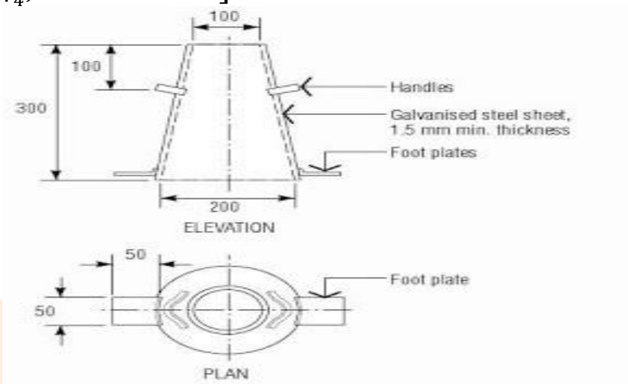
Pycnometer bottle

Procedure:

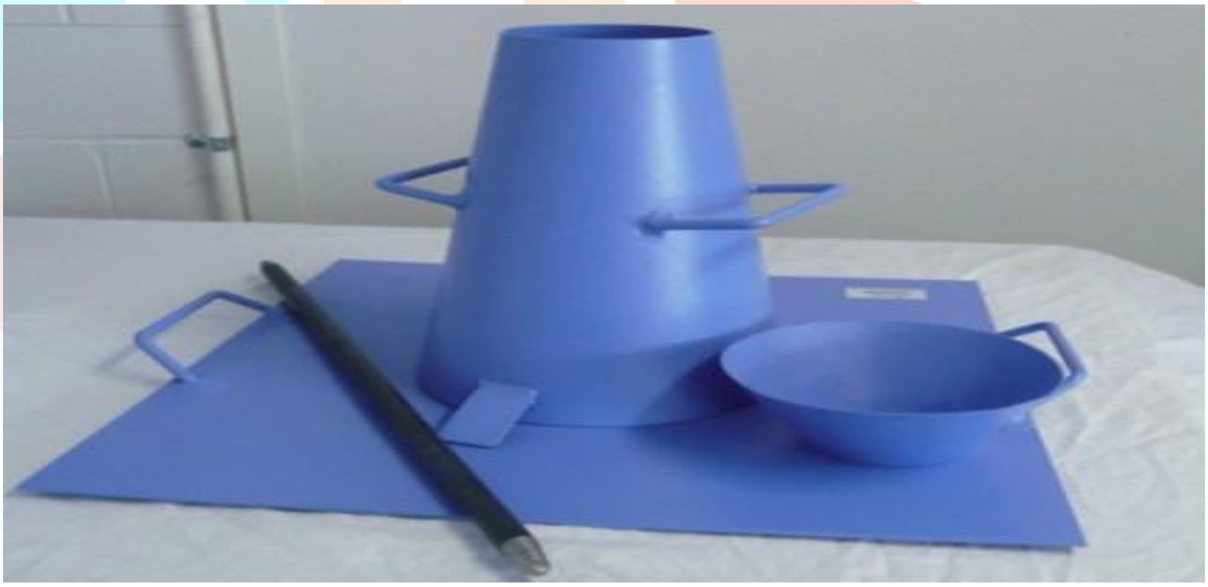
1. Clean the pycnometer bottle, dry it and take the empty weight of pycnometer bottle (W_1 g).
2. Fill the pycnometer bottle approximately one third of its capacity with given sand sample and record its weighed (W_2 g).
3. Fill the pycnometer bottle containing sand with water, shake bottle properly to remove air voids and record its weight (W_3 g).
4. Empty the pycnometer bottle, clean it and fill it with distilled water and record its weight (W_4 g).
5. Repeat the procedure for another sample.

Specific Gravity (G) = $\frac{(W_2-W_1)}{(W_2-W_1)-(W_3-W_4)}$

Water Absorption = $\left[\frac{(W_2-W_1)}{(W_3-W_4)} \times \left(\frac{G-1}{G}\right) - 1\right] \times 100$



Typical cone for slump test



Slump Cone Test

Procedure

1. To obtain a representative sample, take samples from two or more regular intervals throughout the discharge of the mixer or truck. Do not take samples at the beginning or the end of the discharge.
2. Dampen inside of cone and place it on a smooth, moist, non-absorbent, level surface large enough to accommodate both the slumped concrete and the slump cone. Stand or, foot pieces throughout the test procedure to hold the cone firmly in place.
3. Fill cone 1/3 full by volume and rod 25 times with 15mm diameter x 600mm-long hemispherical tip steel tamping rod. (This is a specification requirement which will produce nonstandard results unless followed exactly.) Distribute rodding evenly over the entire cross section of the sample.
4. Fill cone 2/3 full by volume. Rod this layer 25 times with rod penetrating into, but not through first layer. Distribute rodding evenly over the entire cross section of the layer.
5. Fill cone to overflowing. Rod this layer 25 times with rod penetrating into but not through, second layer. Distribute rodding evenly over the entire cross section of this layer.

6. Remove the excess concrete from the top of the cone, using tamping rod as a screed. Clean overflow from base of cone.

7. Immediately lift cone vertically with slow, even motion. Do not jar the concrete or tilt the cone during this process. Invert the withdrawn cone, and place next to, but not touching the slumped concrete. (Perform in 5-10 seconds with no lateral or torsional motion.)

8. Lay a straight edge across the top of the slump cone. Measure the amount of slump in inches from the bottom of the straight edge to the top of the slumped concrete at a point over the original center of the base. The slump operation shall be completed in a maximum elapsed time of 2 1/2 minutes. Discard concrete. Do not use in any other tests.

Procedure:

1. Prepare the dry concrete mix as per the mix design.
2. Add water as per the calculation made in concrete mix design.
3. Take the weight of empty cylinder.
4. Place the concrete mix in upper hopper (A) of the compaction factor apparatus and up the brim.
5. Open the trap door so that concrete falls into lower hopper (B)
6. Then trap door of lower hopper (B) is opened and the concrete is allowed to fall into cylinder. The excess concrete remaining above the top level of cylinder is then cut off with the help of plane blades supplied with the apparatus.
7. Take the weight of cylinder in which concrete is compacted by free fall due to gravity (i.e. weight of partially compacted concrete)
8. Remove the concrete and refill the cylinder in three layers and give 25 blows on each layer by tamping rod.
9. Again take the weight of cylinder with concrete and record it as weight of fully compacted concrete and calculate the compaction factor value by using formula

$$\text{Compaction Factor} = \frac{\text{weight of partially compacted concrete}}{\text{weight of fully compacted concrete}}$$

Upper Hopper (A)	**Dimension in cm**
Top internal diameter	25.4
Bottom internal diameter	12.7
Internal height	27.9
Lower Hopper (B)	
Top internal diameter	22.9
Bottom internal diameter	12.7
Internal height	22.9
Cylinder	
Internal diameter	15.2
Internal height	30.5
Distance between bottom of upper hopper and top of lower hopper	20.3
Distance between bottom of lower hopper and top of cylinder	20.3

3.4 IS MIX DESIGN FOR 0.5W/C RATIO

A-1 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 concrete)
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

A-2 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
g) Sieve analysis:
1) Fine aggregate : Conforming to grading Zone I of Table 4 of IS 383

A·4 SELECTION OF WATER-CEMENT RATIO

Adopt water-cement ratio as 0.50.

A-5 SELECTION OF WATER CONTENT

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

A-6 CALCULATION OF CEMENT CONTENT

Water-cement ratio Cement content = 0.50

Cement content = $\frac{186}{0.5}$

= 372 kg/m^3

A·7 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.

A-8 MIX CALCULATIONS

Calculations of quantity of aggregate

Volume Balancing Equation

Volume of concrete = $1\ m^3$

A) For Fine Aggregate

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

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

F. A. = $732.09\ kg/m^3$

B) For Fine Aggregate

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

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

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
F A	=	Mass of fine aggregate kg per m^3 of concrete
C A	=	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

Actual Quantities of Ingredients (kg/m^3)

Cement	=	372
Water	=	186
F A	=	732.09
C A	=	1143.65
Total	=	2433.74
Proportion		1 : 1.97 : 3.1 : 0.5
Sum of Proportions		6.54

Weight of concrete for 6 cubes = $6\times1.1\times0.15\times0.15\times0.15\times2433.74$

= 54.2115 kg

Weight (in kg)

Cement	=	8.286
Water	=	4.143
F A	=	16.30
C A	=	25.47

Correction for water absorption

Water = $4.143 + \frac{3.83}{100} \times 4.143$

= 4.30 kg

C A = $25.47 - \frac{3.83}{100} \times 25.47$

= 24.5 kg

Corrected Weight (in kg)

Cement	=	8.286
Water	=	4.30
F A	=	16.30
C A	=	24.5

Quantities of Material
As per IS 10262-2009 for W/C ratio 0.5

% of Grey water for replacement of potable water	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Potable water (kg)	Gray water (kg)	Proportion
0%	8.2868	16.3014	24.4979	4.303	0	1:1.97:3.1:0.5
20%	8.2868	16.3014	24.4979	3.4424	0.8606	1:1.97:3.1:0.5
40%	8.2868	16.3014	24.4979	2.5818	1.7212	1:1.97:3.1:0.5
60%	8.2868	16.3014	24.4979	1.7212	2.5818	1:1.97:3.1:0.5
80%	8.2868	16.3014	24.4979	0.8606	3.4424	1:1.97:3.1:0.5
100%	8.2868	16.3014	24.4979	0	4.303	1:1.97:3.1:0.5

Quantities of Material

Comparison of Workability by Slump Cone Test

Following table shows the value of slump in mm for different proportions of gray water as a replacement of potable water.

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

Slump

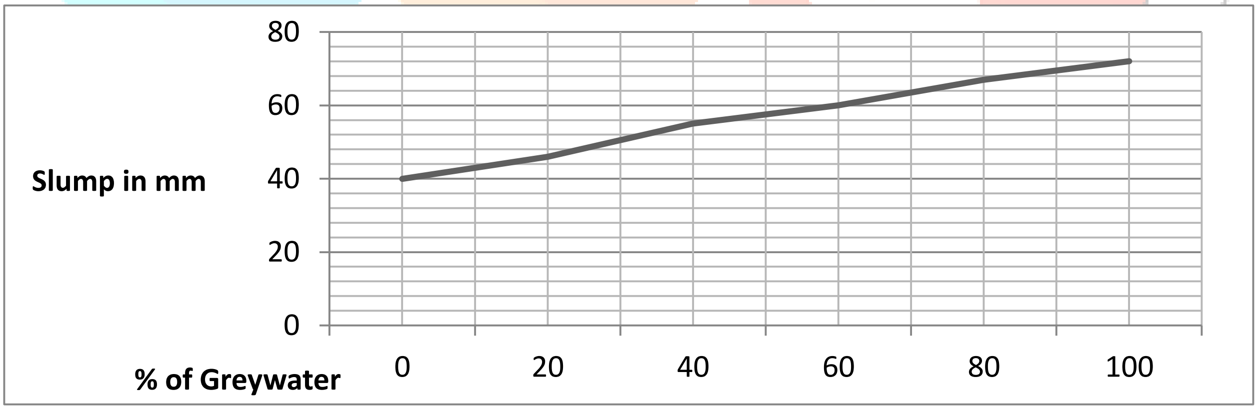


Fig-4.1 Comparison of Workability by Slump Cone Test

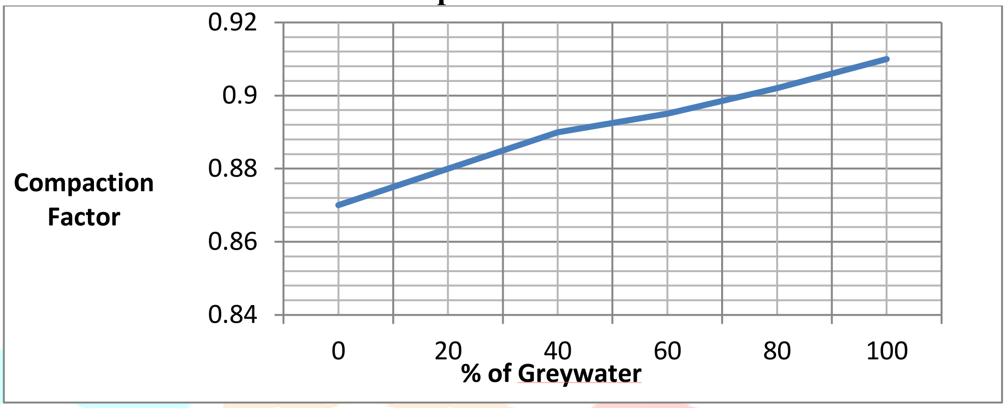
As shown in above graph we can conclude that as the percentage of gray water increases then workability of concrete also increases. . As the percentage of grey water increases by 20%, 40%, 60%, 80%, 100% , workability increases by 15%, 37.5%, 50%, 67%, 80% respectively. Some synthetic detergents, fatty and resinous acids and their salts, alkyl benzene sulfates 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

Following table shows the value of Compaction factor for different proportions of gray water as a replacement of potable water.

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

Compaction Factor



Comparison of Workability by Compaction Factor Test

As shown in above graph we can conclude that as the percentage of gray 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%, and 4.59% respectively. Some synthetic detergents, fatty and resinous acids and their salts, alkylbenzene sulfonates are materials of air entraining admixtures and also of soaps and detergents. Therefore soapy water can improve workability.

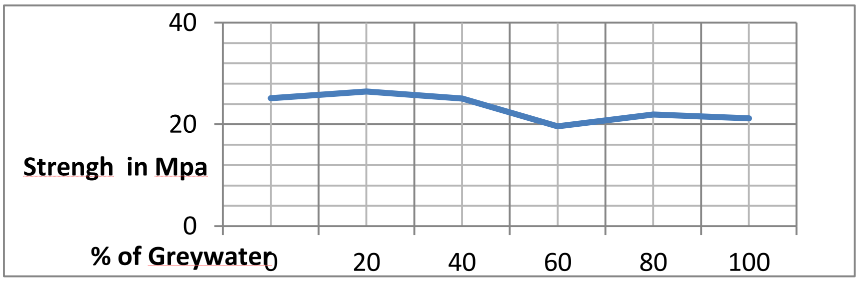
Comparison of Compressive Strength at 7 days of Curing

Following table shows the value of Comparison of compressive strength at 7 days curing for different proportions of gray water as a replacement of potable water.

% of Grey water for replacement of potable water	Casting Date	Test Date	Weight (Kg)	Strength (MPa)	Mean Strength (MPa)	Peak Load (KN)
0%	01/02/25	01/03/25	8.300	27.24	25.136	613.10
			8.451	25.81		580.90
			8.172	22.36		503.36
20%	03/02/25	04/03/25	8.554	26.52	26.443	596.90
			8.315	26.60		598.50
			8.390	26.21		589.90
40%	05/02/25	06/03/25	8.385	21.33	25.063	480.10
			8.291	26.74		601.70
			8.295	27.12		610.40
60%	07/02/25	08/03/25	8.320	18.25	19.616	410.70
			8.383	19.00		427.60
			8.225	21.60		486.10
80%	09/02/25	10/03/25	8.110	20.93	21.94	471.00
			8.161	22.18		499.10
			8.261	22.71		511.00
100%	11/02/25	12/03/25	8.360	22.37	21.223	503.40
			8.356	20.94		571.20
			8.359	20.36		458.10

Comparison of Compressive Strength at 7 days of Curing

Graph of Comparison of Compressive Strength at 7 days of Curing



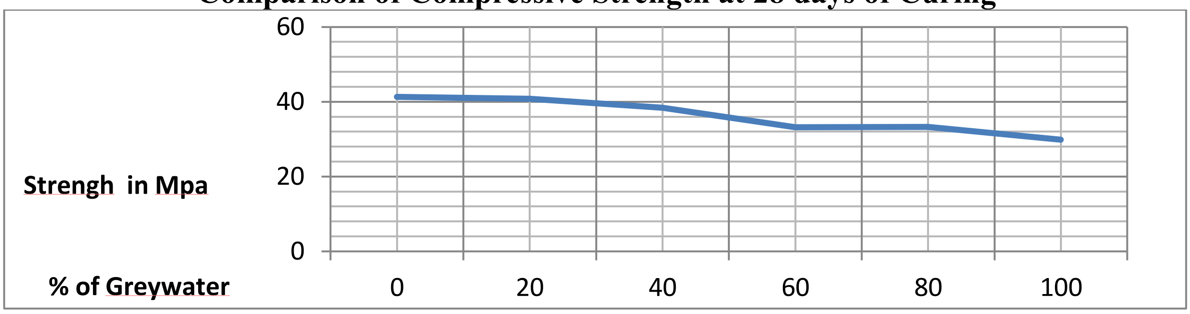
When the grey water is increased by 20% , 40%, then compressive strength of concrete at 7 days curing increases by 5.2%, 0.3% respectively and for increase in gray water by 60%, 80%, 100% then compressive strength of concrete at 7 days curing decreases by21.96%, 12.71%, 15.56%.From above results we can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

Comparison of Compressive Strength at 28 days of Curing

Following table shows the value of Comparison of compressive strength at 28 days curing for different proportions of grey water as a replacement of potable water.

% of Grey water for replacement of potable water	Casting Date	Test Date	Weight (kg)	Strength (Mpa)	Mean Strength (Mpa)	Peak Load (KN)
0%	01/02/25	01/03/25	9.497	33.66	41.280	757.40
			9.579	42.56		957.80
			9.319	40.01		900.40
20%	03/02/25	04/03/25	8.447	38.64	40.820	869.50
			8.485	43.88		987.40
			8.363	39.94		898.70
40%	05/02/25	06/03/25	8.377	36.95	38.400	831.50
			8.446	38.66		869.90
			8.311	39.59		890.80
60%	07/02/25	08/03/25	9.471	32.14	33.170	723.30
			9.404	34.20		769.70
			9.395	29.63		666.80
80%	09/02/25	10/03/25	8.267	34.15	33.306	768.50
			8.173	31.55		709.90
			8.221	34.22		770.00
100%	11/02/25	12/03/25	8.329	23.87	29.830	537.10
			8.303	28.90		650.90
			8.470	30.76		692.76

Comparison of Compressive Strength at 28 days of Curing



Graph of Comparison of Compressive Strength at 28 days of Curing

As shown in above graph we can conclude that as the percentage of gray water increases then compressive strength of concrete at 28 days curing goes on decreases. When the grey water is increased by 20% , 40%, 60%, 80%, 100% then compressive strength of concrete at 28 days curing decreases by 1.1%, 6.9%, 19.40%, 19.20%, 27.74% respectively and variation of gray water as replacement of drinking water for concrete gives nearly same strength as concrete with drinking water at 28 days curing.