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Parametric Study on Behavior of Post-Tensioned Rectangular and Trapezoidal Box-Girder Bridge using Finite Element and Classical Method

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Abstract

The present study focuses on behavior of a typical single-cell simply supported post-tensioned concrete rectangular and trapezoidal box-girder section of 40m span. Preliminary dimensioning are carried out as per IRC- 18 and the vehicular live loading is considered for the analysis includes IRC class A loading and IRC class 70R loading as per IRC-6. The range of permissible stresses in concrete is as per IS 1343. The prestress force is transferred by providing straight tendons in the bottom flange and parabolic tendons with different eccentricity in web so that resultant stress obtained are within the permissible limits at both transfer and service load stage. The limit state of collapse in flexure, shear and torsion, limit state of serviceability for deflection is carried out for the load case DL+LL, DL+PS, DL+LL+PS. FEM analysis is carried out by using CSI Bridge software and results are compared with the classical methods.

The investigation shows that the resultant compressive stress and tensile stress are 13% and 3% greater than the rectangular box-girder for DL+LL, 4% and 13% for DL+PS and 1% to 3% DL+LL+PS respectively.

In addition, the deflection of trapezoidal box-girder is 2% more than the rectangular box-girder. The stress at the transfer stage of rectangular box-girder is 12% greater than the trapezoidal box-girder. The prestress loss in rectangular box-girder is 5% greater than trapezoidal box-girder.

Keywords

Post tensioned concrete, Girder, CSI Bridge software

1 Introduction

Bridge is a combination of various elements such as deck, substructure and foundation [1]. Bridges as structures were first built with man- made materials in the ancient times during the first modern civilization in Mesopotamia [2]. Knowledge and engineering of bridges started to spread and develop all over the world. Today there are a large variety of bridges , building materials as well as construction techniques[3]. The most common known bridge materials are of0concrete, steel or both of them combined i.e. composite bridges. Long span bridges are meant to carry heavy loads such as road or railway bridges. Types of Bridges are suspension bridges, arch bridges, cable-stayed bridges, box- girder bridges and beam bridges [4].

Concrete has been in use as a building material since Roman times. Concrete is a material very strong in compressions but very weak in tension, thus it has been used in structures where it is stressed principally in compression such as in arches, vaults and walls [5]. In the middle of the 19th century, it was discovered that steel could be embedded in the concrete structures like beams, slabs, buildings and bridges. In the 1930s, Eugne Freyssinet invented prestressed concrete and discovered that the steel bars could be substituted with steel cables that were tensioned by jacks and locked to the concrete. The first prestressed concrete bridge was subsequently built-in 1941 [6] .

The Advent of prestressed concrete not only prompted innovation but also presented a whole new way of creating long span and durable structures. The ever- increasing demand for expansion of highway network, to cater for increased traffic, has thrown challenges to researchers and designers leading to the development of box-girder bridges. The closed cellular section of the box-girder provides high torsional rigidity. This is found to be ideally suitable for bridges subjected to heavy and transversely eccentric vehicle loads. The torsional strength inherent in closed box section, with its ability to distribute resisting moments and shears across the width of the bridge is advantageous. The interiors of the box sections can be used for services and in large spans can be used for traffic movement. Box-girders, often made of steel or prestressed concrete, have become popular because of their inherent qualities such as better stability, serviceability, economy, aesthetic appearance and structural stiffness due to high torsional stiffness.For such long spans post-tensioned box-girder bridges may be used where the dead load is balanced by prestressing force so that the section dimensions are required to balance live load only.

2 Modelling

The preliminary dimension of rectangular box-girder is developed on the basis of certain thumb rules presented in Rajagopala[10] and IRC:18-2000. For trapezoidal box- girder, the dimensions are taken from the literature review [11]. Box-girders are mainly chosen for spans greater than 25m because of its advantageous behavior in structural action. For spans less than 20m, box-girder cross- sections are not economical. The span to depth ratio can be around 17 to 18m for reinforced concrete sections and 21 to 25m for prestressed concrete section. The models are shown in Figures 1 and 2.

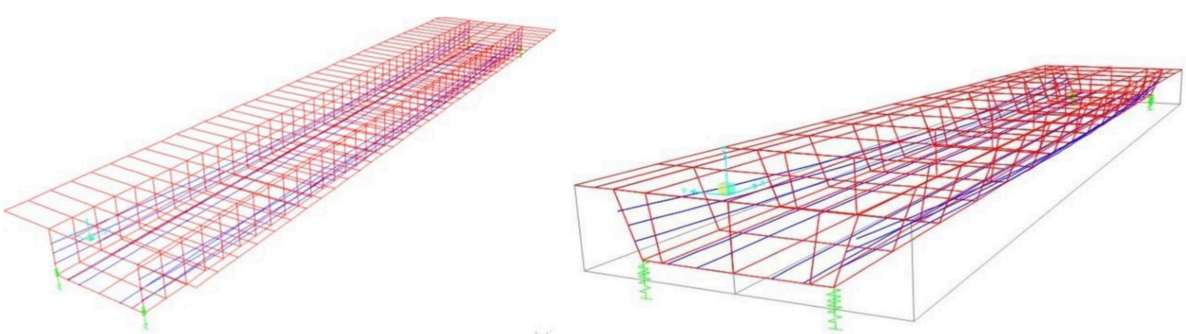

Figure 2.1: Rectangular and Trapezoidal box girder

3 Results and Discussions

Table 1 comprises the results of dead load bending moment, shear force and deflection computed by CSI bridge software and corresponding values computed from simple beam theory. The comparative results showed close agreement of 3 to 10%. The bending moment and shear force due to live load are computed using the concept of influence line in case of simple beam theory and using the concept of moving load in case of CSI bridge software for class 70R and class A loading.

In case of simple beam theory, the absolute bending moment and shear force under a wheel load are calculated by the cumulative sum of the ordinate of influence line diagram so that the maximum load is centered on the maximum influence line diagram ordinate. This shows a very good agreement in results in determining the validation of FEM.

Table 1: Shear Force and Bending Moment Values

Load case	CSI bridge software results	Classical method	Difference
Dead load BM, KN-m	43893.6	42500	3.17%
Dead load SF, KN	4510	4250	5.7%
Live load bending moment, KN-m			
IRC class A single lane load	4467.7	4431.1	0.8%
IRC class A two lane load	8936.72	8862.26	0.8%
IRC class 70R load	8941.3	9104.2	2%
Live load shear force, KN			
IRC class A single lane load	457.6	462.7	1.1%
IRC class A two lane load	915.2	917.5	0.27%
IRC class 70R load	931.5	932.5	0.11%

4 Comparison of Longitudinal Bending stresses by classical and FEM

The longitudinal flexural stress distribution at top and bottom fibers in concrete under DL+LL case obtained from both FEM analyses and classical method. Table 2 gives the longitudinal flexural stresses due to DL+LL condition at mid-span from FEM analysis and classical method of calculation shows good agreement of results. The representation of longitudinal stress for DL+LL is as shown in Figure 1 and 2.

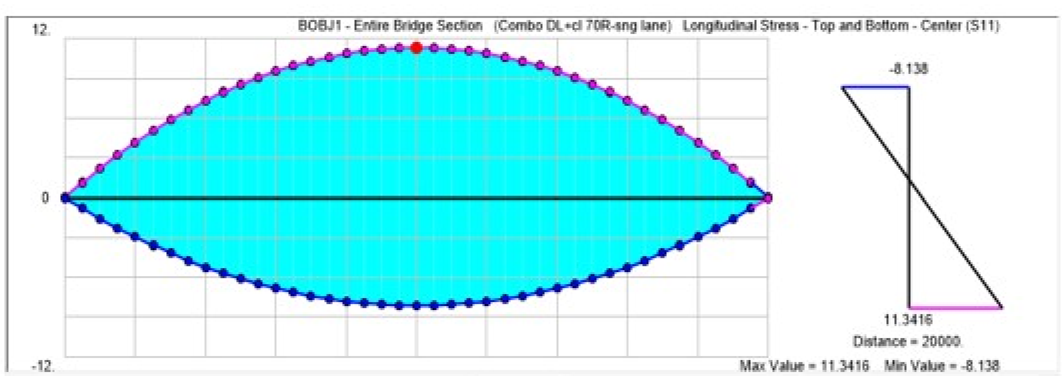

Figure 4.1: Longitudinal stress distribution due to LL+DL from FEM for rectangular section

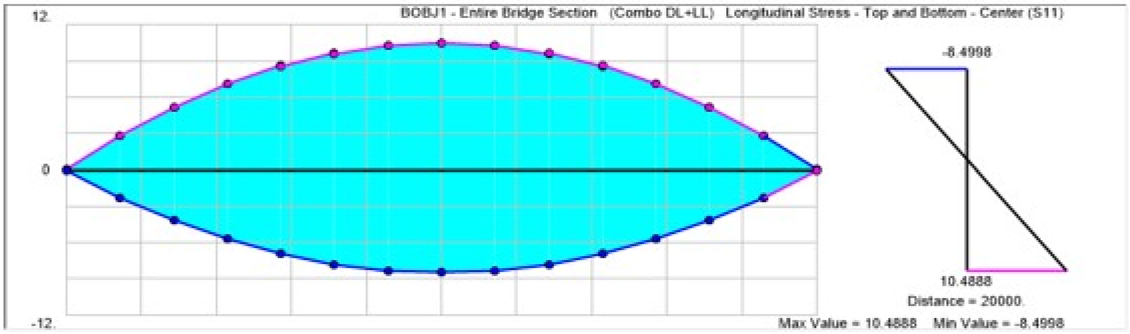

Figure 4.2: Longitudinal stress distribution due to LL+DL from FEM for trapezoidal section

The longitudinal flexural stress distribution at top and bottom fibers in concrete under DL+PS case is obtained from both classical method and FEM analysis. Table 3 gives the comparison of longitudinal flexural stresses due to DL+PS condition at mid- span from FEM analysis and classical method of calculation. Graphical representation of longitudinal stress distribution for DL+PS is as shown in Figure 3 and 4.

Table 3: Comparison of resultant stress due to DL+PS at mid-span

Stress at mid-span (DL+PS), N/mm2	Rectangular box-girder		Trapezoidal box-girder	
	Stress from FEM, N/mm2	From calculation, N/mm2	Stress from FEM, N/mm2	From calculation, N/mm2
$\frac{P}{A}+\frac{P_e}{Z_t}$	1.36	3.85	0.69	4.45
$\frac{P}{A}-\frac{P_e}{Z_b}$	-13.11	-25.15	-12.06	-24.17

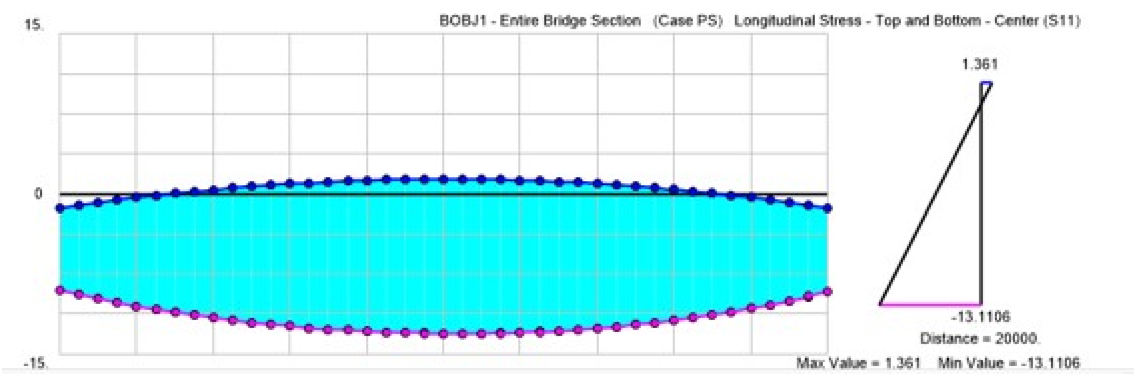

Figure 4.3: Longitudinal stress distribution due to DL+PS from FEM for rectangular section

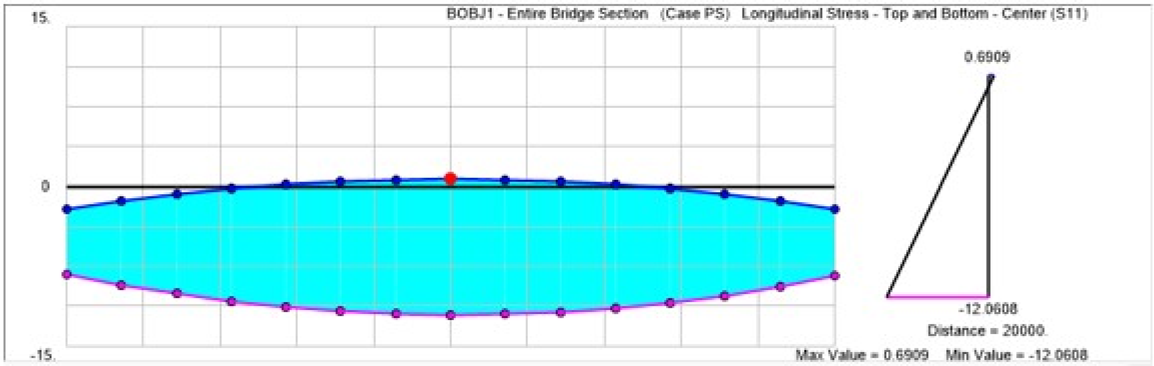

Figure 4.4: Longitudinal stress distribution due to DL+PS from FEM for trapezoidal section

Comparison of final longitudinal flexural stress due to DL+LL+PS at mid-span is shown in Table 4. The resultant stress obtained from theoretical calculation after deduction of losses shows good agreement compared with resultant stress with FEM. The final resultant stress is within the permissible limit of tension and compression stresses specified by IRC: 18-2000 code. The occurrence of the small magnitude of tension at the bottom can be eliminated by minor adjustments with magnitude and eccentricity of prestressing force. Graphical representation of longitudinal stress distribution for DL+LL+PS is as shown in Figure 5 and 6.

Table 4: : Comparison of resultant stress due to DL+LL+PS at mid-span

Stress at mid-span (DL+PS), N/mm2	Rectangular box-girder		Trapezoidal box-girder	
	Stress from FEM, N/mm2	From calculation, N/mm2	Stress from FEM, N/mm2	From calculation, N/mm2
f_{top}	-1.28	-4.98	-1.56	-4.92
f_{bot}	-9.22	-25.15	-8.39	-9.15

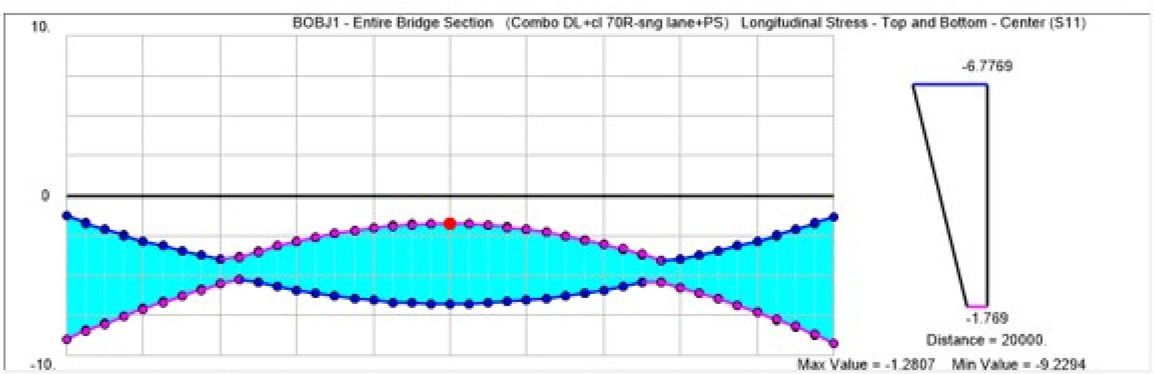

Figure 4.5: Longitudinal flexural resultant stress due to DL+LL+PS from FEM for rectangular section

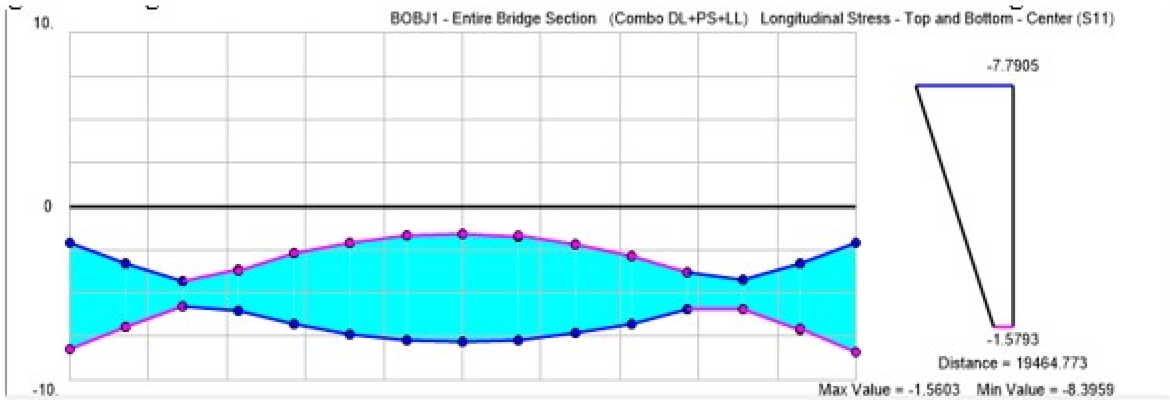

Figure 4.6: Longitudinal flexural resultant stress due to DL+LL+PS from FEM for trapezoidal section

5 Conclusions

Through this work, the following conclusions are summarized:

1. From the comparison of the dead load, live load bending moment, dead load, live load shear forceobtained from the classical method and FEM results shows convergent.

2. The longitudinal resultant flexural stress of a trapezoidal box-girder shows compressive stress and tensile stress 13% and 3% greater than the rectangular box-girder for DL+LL condition, 4% and 13% for DL+PS condition and 1% to3% DL+LL+PS.

3. The deflection of trapezoidal box-girder is 2% more than the rectangular box girder.

4. The stress at the working stage of trapezoidal box-girder is 4% greater than the rectangular box-girder.

5. The stress at transfer stage of rectangular box-girder is 12% more than the trapezoidal box- girder.

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EFFECT OF SIZE OF RECYCLED AGGREGATE ON PROPERTIES OF SELF COMPACTED CONCRETE

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Abstract

The present Study focused on the Experimental study and Prediction on the influence of Recycled Aggregate on fresh and hardened property self-compacting concrete as substitute to natural coarse aggregate. A total 45 concrete mixtures having various replacement level of (0%,25%,50%,75% and 100%) were designed. Fresh Properties of SCC were observed through Slump Flow, U Box, V funnel. Compressive Strength and Bond strength was determined at 28 days of curing. From the laboratory test of determination, the fresh property has shown better performance in 10mm size aggregate and hardened property are shown better performance for 12.5 mm size recycled aggregate.

Keywords

Post tensioned concrete, Girder, CSI Bridge software

1 Introduction

Self-compacting concrete (SCC) is a flowing concrete that does not require vibration and, indeed, should not be vibrated. It uses super-plasticisers and stabilizers to significantly increase the ease and rate of flow. SCC is an achievement in concrete research, Prof. Okamura and his colleagues are to be credited for SSC as they created it in 1986 at University of Tokyo, Japan in order to improve the way of construction and to win over the problems of flawed handiwork in thick reinforcement environment and complex state of the art buildings. It was first presented publically in 1988 and was renamed to " High-Performance Concrete" and later to "Self- Compacting High-Performance Concrete".

2 Literature Review

Compaction has a huge part in the advancement of hardened properties. It is expected that concrete is all around compacted and homogenous when certain properties are considered for execution of concrete structures; the motivation behind compaction thus is in this manner is to accomplish the most elevated possible density. The most well-known method for compacting concrete is Vibration, which has the impact of fluidifying the mortar component of the blend with the goal that internal friction is diminished, and closer packing of concrete total happens. Be that as it may, compaction by means of vibration is an intermittent procedure bringing about solidified cement with uneven compaction and subsequently with various mechanical and toughness properties. In Japan in the 1980's, initially, SCC was created and characterized. To improve the SCC, shirking of vibration was not really the reason. Guaranteeing the nature of complex concrete structures in view of poor compaction of in-situ concrete was the challenge in the initial stage. This prompted expanded development costs and imperiled long-term strength of structures. The fair alternative was to dispense with depending on the concrete compaction, on concrete specialists also to supplant it with the capacity of concrete to compact itself, fill the formwork, exemplification of all strengthening bars. Utilizing recycled aggregate is certainly an important step towards sustainable development in the concrete industry and management of construction waste. Recycled aggregate (RA) is a viable alternative to natural aggregate, which helps in the preservation of the environment. One of the critical parameters that affect the use of recycled aggregate is variability of the aggregate properties. Quality of the recycled aggregate is influenced by the quality of materials being collected and delivered to the recycling plants. Therefore, production of recycled aggregate at an acceptable price rate and quality is difficult to achieve due the current limitations on the recycling plants.

3 Tests and Results

3.1 Slump Flow Test

The Figure 1 shows the variation of slump flow of self-compacted concrete developed with percentage replacement of recycled coarse aggregate and reference concrete. The slump flow increases as an increase in the percentage of replacement of recycled coarse aggregate. But for a concrete mix with 10mm size of aggregate shows maximum slump flow of 788mm compared to a conventional concrete slump flow of 726mm.

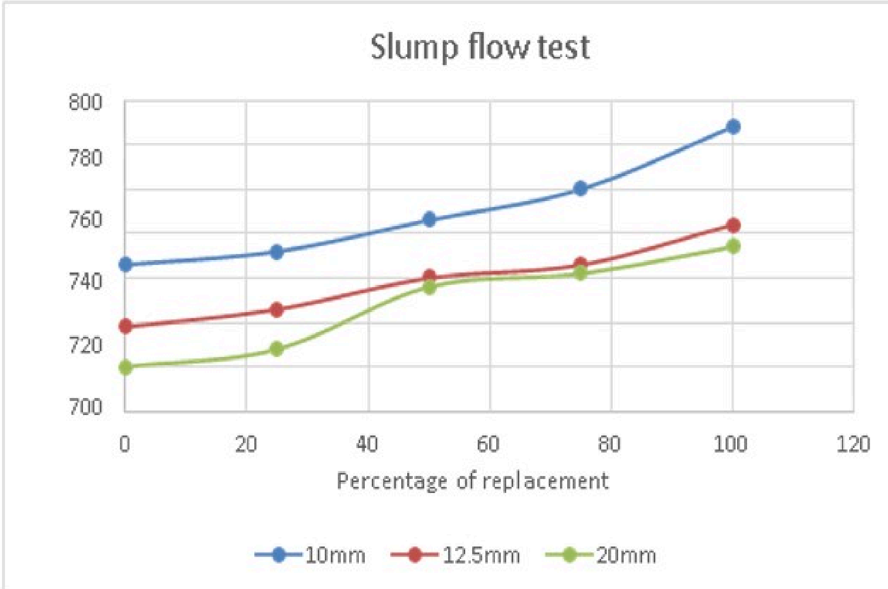

Figure 1: Variation of slump flow with Size of Aggregate

3.2 V Funnel Test

The Figure 2 shows the variation of V funnel test of self-compacted concrete developed with percentage replacement of recycled coarse aggregate and reference concrete. The V funnel test result decreases as an increase in the percentage of replacement of recycled coarse aggregate. But for a concrete mix with 10mm size of aggregate shows minimum V funnel value of 7.2 sec compared to a conventional concrete V funnel value of 8.9sec.

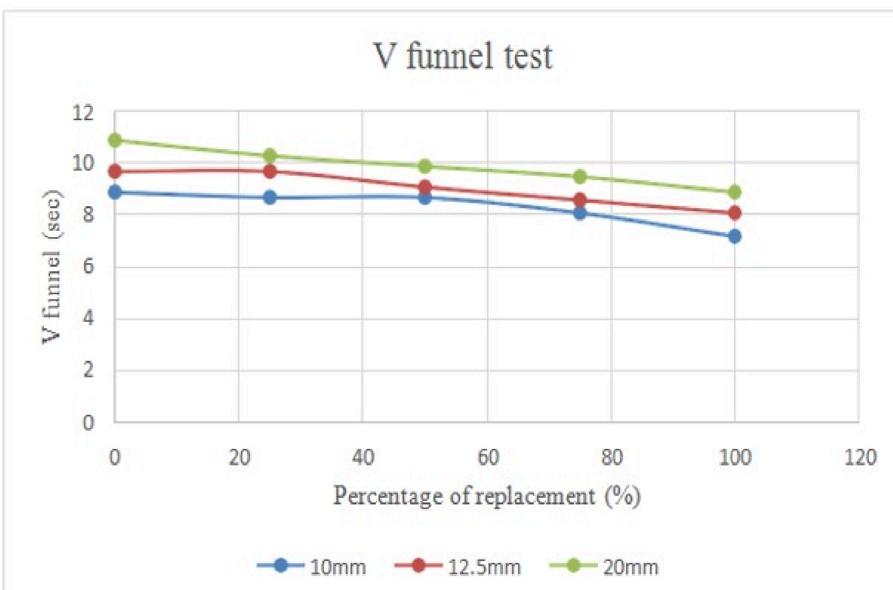

Figure 2: Variation of V flow with Size of Aggregate

3.3 L Box Test

The Figure 3 shows the variation of the L box ratio test of self-compacted concrete developed with percentage replacement of recycled coarse aggregate and reference concrete. The L box ratio test result increases as an increase in the percentage of replacement of recycled coarse aggregate. But for a concrete mix with 10mm size of aggregate shows minimum L box ratio value of 1 compared to a conventional concrete L box ratio of 1.

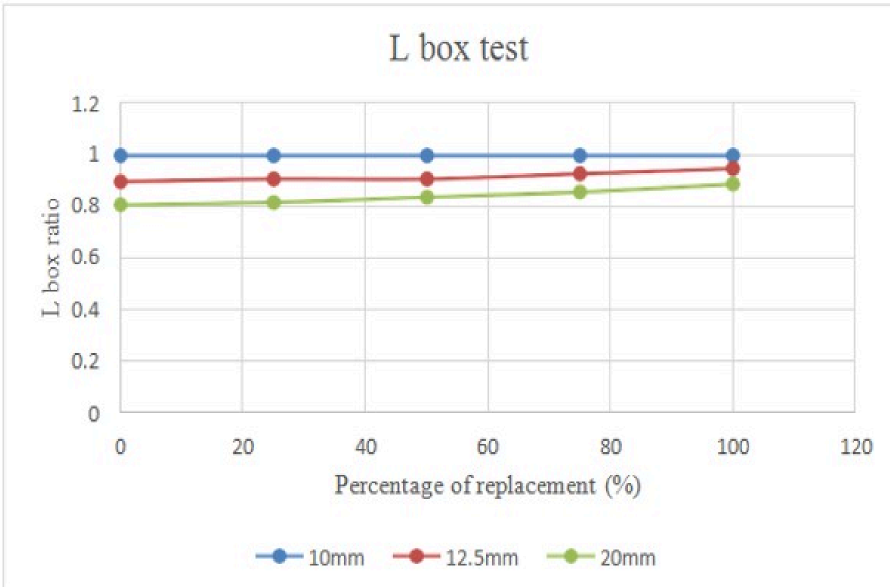

Figure 3: Variation of L box values with Size of Aggregate

3.4 U Box Test

The Figure 4 shows the variation of U box test of self-compacted concrete developed with percentage replacement of recycled coarse aggregate and reference concrete. The U box test result decreases as an increase in the percentage of replacement of recycled coarse aggregate. But for a concrete mix with 10mm size of aggregate and 400kg of cement content shows minimum U box value of 4mm compared to a conventional concrete U box value of 11mm.

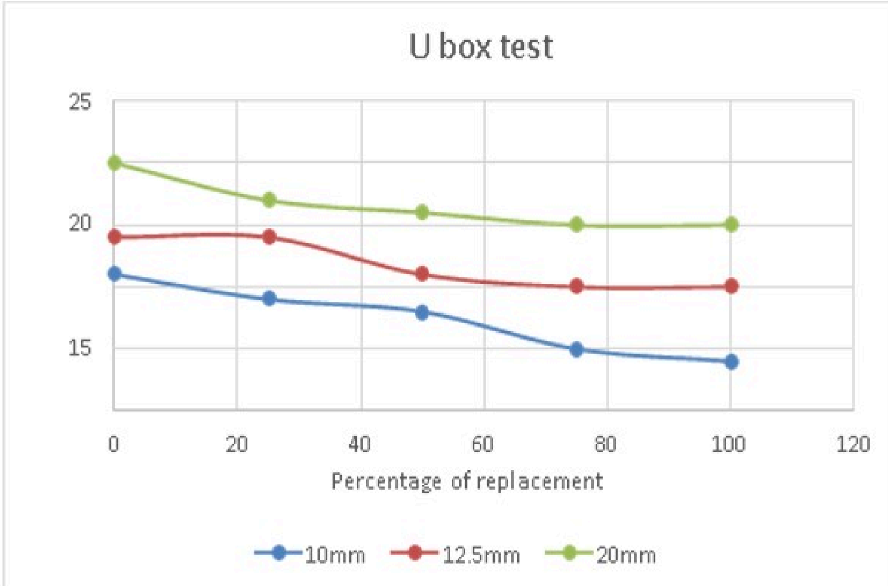

Figure 4: Variation of U box values with Size of Aggregate

3.5 Compressive Strength Test

The compressive strength at 7 and 28 days decreases as an increase in the percentage of replacement of recycled coarse aggregate. The 12.5mm size of aggregate for 100% replacement of recycled coarse aggregate by natural aggregate the compressive strength marginally less than that for reference concrete as shown in figure 5.

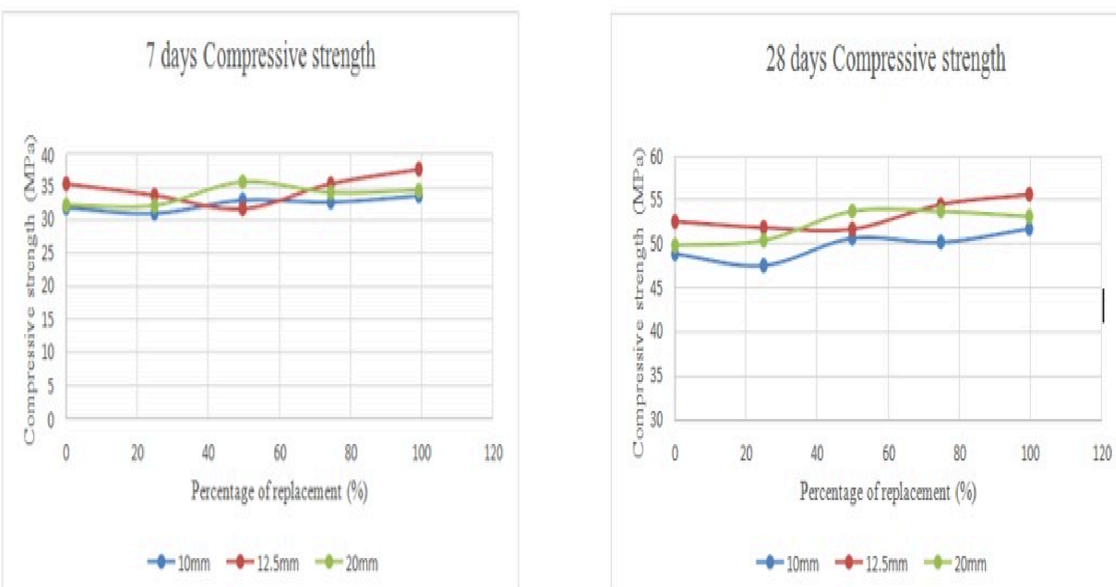

Figure 5: Compressive Strength of concrete with Size of Aggregate

3.6 Bond Strength Test

The figure 6, shows the variation of the bond strength of concrete developed with different percentage replacement of recycled coarse aggregate and reference concrete. The bond strength at 28 days decreases as an increase in the percentage of replacement of recycled coarse aggregate. The 20 mm size of aggregate for 75% replacement of recycled coarse aggregate by natural aggregate the bond strength marginally less than that for reference concrete.

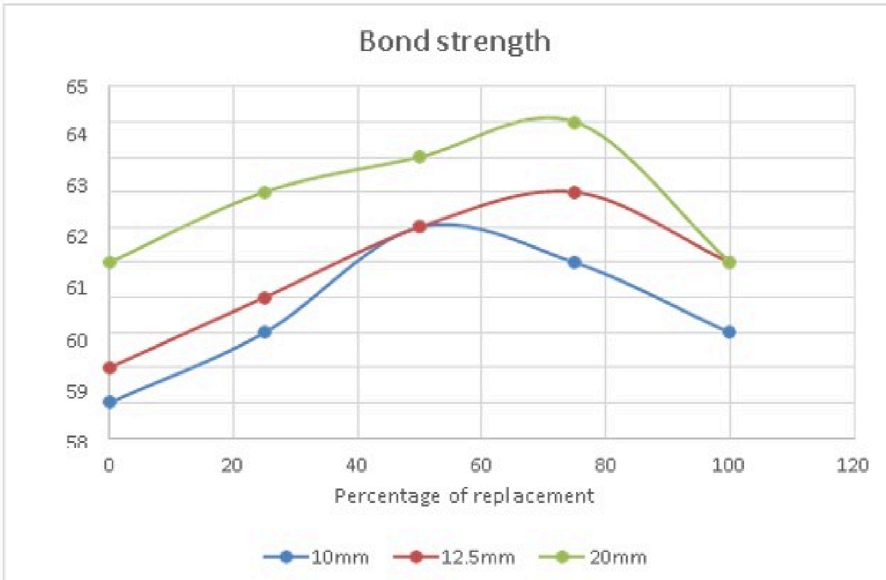

Figure 6: Bond Strength of concrete with Size of Aggregate

4 Conclusions

Through this work, the following conclusions are summarized:

1. The slump flow for concrete mix of 100% of 10mm size of recycled coarse aggregate shows a maximum slump value of 788mm compared to conventional concrete slump of 726mm.

2. The V funnel value for concrete mix of 100% of 10mm size of recycled coarse aggregate for a shows a minimum V funnel value of 6.9sec compared to conventional concrete V funnel value of 8.5sec.

3. The L box ratio value for concrete mix of 100% of 10mm size of recycled coarse aggregate shows 1 similar to conventional concrete.

4. The compressive strength of concrete mix for 400kg of cement and 100% replacement recycled coarse aggregate by natural aggregate of 12.5mm size at 7 and 28 days shows 37.6MPa and 55.61MPa compared to a conventional concrete mix of 35.4MPa and 52.44MPa.

5. The Pullout test load for a concrete mix for 100% recycled coarse aggregate size of 10mm , 12.5mm and 20mm is of 58kN, 60kN and 60kN for 19mm compared to a conventional concrete of 56kN , 57kN and 60kN for 19mm.

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IMPACT OF MICROPLASTIC POLLUTION IN FRESH WATER SOURCES

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Abstract

Plastic is everywhere. A large portion of it is found in water bodies. Most plastics in water degrade into extremely small particles, known as "Microplastics." From drinking water to the air we breathe microplastics are everywhere. Active research is being conducted but much remains unanswered. “The research question for this study was, "How does a microplastics effect fresh water?" As we examine the issue of microplastics in freshwater systems, these preliminary freshwater studies assist us in summarizing our current understanding of microplastics, identifying knowledge gaps, and proposing future research goals. Evidence suggests that freshwater systems may be similar to marine systems in terms of the forces that transport microplastics, the prevalence of microplastics, the methods used for detection, identification, and quantification and the potential consequences. Given that the study of microplastics in freshwaters has indeed increased, we are still limited in our understanding of 1) their appearance and dispersion in the environment; 2) methods for accurate identification and quantification; 3) their transport pathways and factors influencing distributions; and 4) the scope and significance of their impacts on freshwater. We also don’t know how microplastics might transfer from land to fresh water, and we don’t know if and how they affect human health. This is concerning because human populations rely heavily on freshwater resources for drinking water and food. Raising awareness in these areas is critical if we are to develop appropriate policies and management tools to address this emerging issue.

Keywords

Microplastics, freshwater, human health, knowledge gaps, drinking water

1 Introduction

Water contamination and its consequences are becoming ever more complicated around the planet. Plastic products distinguish out for their exceptional qualities, including their light weight, durability, and adaptability (Ivleva et al., 2017, Hammer et al., 2012). However, the ubiquitous nature and related environmental effects of plastic debris have raised concern on a massive level. Microplastics pollution of marine structures is a major environmental issue that has affected even the most distant areas globally. According to a preliminary study, linkages and distribution of microplastics are just as significant in freshwater systems as they are in marine structures. In 2004, the first huge proportion of microplastics was found in the fresh waters. That made one thing abundantly clear: plastic pollution does not magically disappear. We are dealing with a tremendous, global environmental issue that is not "just" with plastic but also with microplastics. The term "microplastics" (MP) was originally introduced by (Thompson et al., 2014) who also brought attention to the growing problem of plastic discharge into the water. Since then, its presence in the environment has drawn more attention from the general public, scientists, policymakers, and the public. Atmospheric, terrestrial, and freshwater systems have all been found to contain microplastics particles (Wagner and Lambert, 2018). It is widely distributed in the air, soil, and water, and is frequently found in biota. It is commonly known that plastic waste exists in freshwater and that it eventually dissolves. Small plastic fragments known as microplastics are produced during the breakdown of larger polymers and during the design of commercial items. Microplastics(MP) pose a pollution risk to both the environment and health. Microplastics are tiny fragments of plastic, as the name implies. They are officially described as plastics with a diameter of less than five millimeters (0.2 inches). There are two categories - primary and secondary microplastics. The most widespread MPs are those that have already been manufactured in a micro size, such as the microspheres (500 nm or smaller) used in several cosmetic products, the mixtures used in sandblasting and shot blasting, and MPs used as medicines accelerator and in 3D printing. The mechanical or photo-oxidative breakdown of bigger plastic materials produces secondary MPs as a by-product. Given the size of this water contamination, it is projected that 1.5 million tonnes of primary MPs are released into the environment year. The physical properties of MPs, which often take the form of fibres, shreds, or spherical beads, can also be used to divide them into different types. MPs are a wide class of materials that include a variety of polymer types, particle sizes, forms, and chemical formulations that are likely to be found in water. Depending on the properties taken into account, MPs can be divided into a number of classes. Effects are still entirely unknown. Although it is poorly understood, washing-related fibres have recently been acknowledged as a significant source of the microplastics component of pollution. MPs have previously been extensively documented in practically all aquatic environments on Earth. This happens because proper and reliable sampling and analytical methodologies aren't used. Due to the high degree of stability of plastics and, consequently, MPs, they remain in the environment for a very long time after being discarded. In this situation, it is vital to find ways to stop MPs from contaminating the water supply. The removal of MPs from water systems has been accomplished by a number of techniques, including engineering and biotechnology. However, removal techniques are still in their infancy, and many issues are yet open. This viewpoint compiles the advancements in MPs pollution analysis and prevention in order to provide a thorough assessment of the state of aquatic environments. This analysis reveals several research biases and knowledge gaps in MP contamination and fresh water. Finally, a variety of realistic solutions are suggested to fill these knowledge gaps.

1.1 Impact of Microplastics on Environment:

The definition of plastic as a material typically refers to synthetic (produced from fossil fuels) and/or natural organic (derived from biomass) polymers that may be molded into desired shapes and forms (Wagner & Lambert, 2018). Plastics are useful for a variety of packing purposes because they prevent food and other products from causing problems, becoming dirty, may become contaminated. Water contamination risks can be decreased by using plastic pipe work and storage containers (Hahladakis et al., 2018). It can be assumed that plastics will travel great distances in freshwater systems because they are known to do so in the oceans (Desforges et al., 2014; Ryan, 2014; Barnes et al., 2009; Collignon et al., 2014). Plastic is a common environmental pollutant. Although the problem of plastics in the marine environment has been recognized for decades (Ryan, 1987), initial acceptance was delayed. In a sense, plastic pollution has're-emerged' as a significant issue. Polypropylene, 21%, Polytethylene, 18%, Polyvynil Chloride, 17%, High-Density Polyethylene, 15%, Polystyrene, 8%, and Polyethylene Terephthalate, 7% are the most important pure polymer plastics in terms of demand worldwide (Hahladakis et al., 2018). Larger particles of plastic are noticeable and obvious in comparison to "invisible" pollutants like POP molecules, which is one of their distinguishing features. Since synthetic polymer plastic is manufactured to survive for a very long time, it is typically not biodegradable. As a result, they build up in landfills or the environment, rather than decomposing. Only destructive heat processing, such combustion or pyrolysis, which just changes the contaminant's form, can lower the volume of plastic waste. The near-permanent pollution of the natural environment by plastics and their persistence is a developing problem. This realisation has already prompted numerous measures to reduce the amount of plastic released into the environment, including limitations on or outright bans on plastic bags. (Verster & Bouwman, 2017; Wagner, 2018; Xanthos & Walker 2017; Erikson et al., 2014; Geyer et al., Jambeck et al., 2015).

Table 1: Plastic additives (Lambert & Wagner, 2018; Hahladakis et al., 2018)

Additive	Function	Example
Accelerants	Speeds up curing of polymers	Ethylene thiourea
Antidegradents	Reduces the rate of degradation due to oxygen, heat, and light	N,N'-bis(1,4-Dimethylpentyl)-p-phenylenediamine
Antioxidants	Slow down the oxidation cycle during processing	2-2-Hydroxy-5-tert-octyphenyl benzotriazole
Antizonants	Slows degradation due to ozone	Nickel dibutyl dithiocarbamate
Biocides	Reduces biodegradation	Arsenicals, organotin, triclosan, Sn, Hg, Hg
Cross-linking additives	Links the polymer chains	2-Mercaptobenzothiazole
Flame retardants	Reduces flamability	Tetradecachloro-p-terphenyl
Inorganic fillers	Improves impact resistance	Mica and clays
Plasticisers	Making the material more pliable	Bis(2-Ethylhexyl) terephthalate
Photosensitizers	Absorbs radiation of a particular wavelength	Benzophenones
Surfactants	Modifies surface properties	Polysiloxanes
UV stabilizers	Protects plastic against UV or sunlight damage	2-(2-Hydroxy-5-methylphenyl) benzotriazole

1.2 Definitions of Microplastics

The term "microplastics" was first used to describe particles up to 20 µm in size (Thompson et al., 2004). Practically, the size of the net or mesh sieve employed for sampling determines the smallest size in the majority of investigations (Blair et al., 2017). The field is still emerging, thus it may be necessary to acknowledge and/or assume some presumptions and knowledge gaps. Microplastics are a size group of plastic that lies between microplastics and Nano plastics in terms of size. The size of manufactured Microbeads, which are tiny, typically ranges from 5µm to 1 mm (Hernandez et al., 2017). However little known about these tiny particles since they are challenging to detect and measure. The range was increased by Arthur et al. (2009) to include all particles less than 5 mm. However, there is currently a suggestion in recent literature to limit the maximum size of "microplastics" to 1 mm (1000 µm) (Van Cauwenberghe et al., 2015). There is no clear definition of the precise size parameters that constitute microplastics. Different parameters can be used to describe and characterise microplastics (Wagner et al., 2014). These comprise classification according to size, shape (such as fragment or fibre), and polymer composition, and source, location, application, and release patterns.

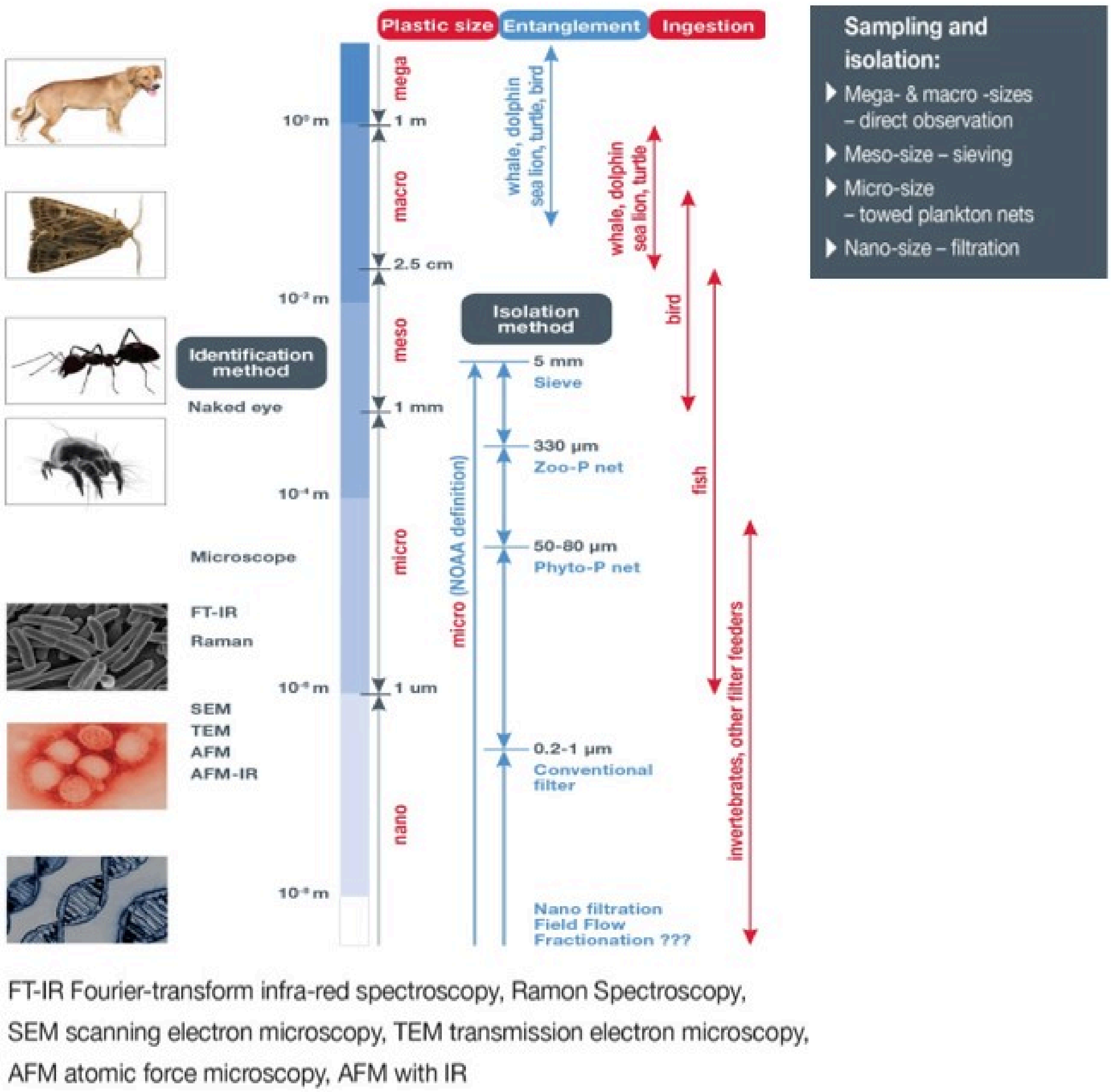

Figure 1: Proposed classification, comparisons, properties, impacts, and examples of various size ranges of plastics (GESAMP 2015)

1.3 Sources of Microplastics:

According to origin and shape, the three main groups of microplastics are primary particles, secondary pieces, and fibres. Primary particles are defined as plastic fragments that are produced in the micro- to small-plastic size range (Cauwenberghe et al., 2015). These include tiny plastic particles that get into water systems from body washes and exfoliators using municipal waste water as a transporter or plastic pellets used as raw plastic in industries (Arthur et al., 2009). Mechanical, biological, and solar action breaks down larger plastic fragments to create secondary microplastics. Considering they originate from washing garments. The microplastics community has recently become interested in fibres as microplastics. Degradation patterns are important to consider because the size, shape, density, and texture of microplastics affect how they interact with factors that affect their existence in the environment and the physical forces that push their movement (Ballent et al., 2012).

Table 2: Summary of selected research on microplastics (MPs) in freshwaters

Article	Summary
Microplastics in Irish freshwaters: a preliminary study. (Credo & Cleary, 2015)	Few freshwater bodies contain microplastics, and when they do, it's usually in sediment samples. MP is discovered in various concentrations in WWTP effluent. MP levels dropped during the waste water treatment process.
Presence and abundance of microplastics in the Thames River basin, UK. (Horton et al., 2015)	MP found in all sites sampled.
Microplastics in freshwater systems: A review of the emerging threats, identification of knowledge gaps and prioritisation of research needs (Eerkes-Medrano et al., 2015)	Microplastics pose similar issues for freshwater systems as they do for marine ones. Aquatic and marine systems both contain comparable quantitative microplastic densities. The proximity of the source to freshwater, the size of the particles (smaller in aquatic), and the mixing and transit of the particles are differences between marine and aquatic microplastics. What is known about freshwater microplastics, including its prevalence and distribution in the environment, its modes of transportation and the variables influencing its dispersion, its techniques of detection and measurement, and the severity of its effects on aquatic life?
Microplastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities (Horton et al., 2017)	Particle size, rather than polymer density or bio film, has a significant impact on the mobility and accumulation of MPs. Lowest retention for 5 µm-sized intermediate particles. The size distribution is significantly influenced by river hydrodynamics.
Microplastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities (Horton et al., 2017)	It is estimated that 4-23 times as much plastic is released annually to land than to oceans. The primary source of oceanic MP pollution is fresh water.
Microplastic is an abundant and distinct microbial habitat in an urban river. (McCormick et al., 2014)	On microplastic particles in waterways, diseases and organisms that decompose plastic are more prevalent. taxa have a different makeup than organic debris. MP bio films are considerably less varied. PVA can be weakened by pseudomonas.
Microplastics in the aquatic and terrestrial environment: sources (with a specific focus on personal care products), fate and effects. (Duis & Coors, 2016)	MP is mostly produced by abrasion on bigger polymers. MP consumption results in less food being consumed, which decreases energy. Minimal bioaccumulation MP levels in the environment are not high enough to endanger biota.
Microplastics: An emerging contaminant – with potential threat to aquatic systems – less studied in India (Ramasamy, 2016)	Preliminary analysis to determine the amount of microplastics in southern India's Venbanad Lake. This is India's first investigation on microplastics. A heavily populated area with rivers running through it is similar to the study's setting. A monsoon season that lasts 4 to 6 months has an impact on river drainage, 60 650 particles per km2 with the majority being polyethylene.

2 Factors affecting quantity of microplastics in the environment:

There is evidence that a number of variables affect how much microplastics is present in freshwater ecosystems. These variables, in addition to physical ones, include the number of nearby residents, their proximity to urban centres, the length of time individuals spend in the water, the size of the water body, the way waste is handled, and the frequency of sewage overflows (Moore et al., 2011; Eriksen et al., 2013; Zbyszewski and Corcoran, 2011;Free et al.,2014). The authors suggest that human usage of specific goods, such as microbeads in cosmetic and cleaning products, combined with wastewater treatment that can successfully absorb floating, contributes to the occurrence of microplastics in freshwater bodies (Eriksen et al., 2013).

2.1 Factors involved in dispersal

Although the distributions of microplastics in marine environments are still largely undefined, it is essential to take into account the external factors that affect the mobility of these materials when estimating their global distributions. Through quantitative and modelling approaches, the role of numerous physical elements that influence transport and dispersion at different spatial scales is highlighted. External elements that produce dispersion interact with the properties of the particles themselves (such as density, shape, and size) and other components of the environment (such as seawater density, sea bed topography, and pressure) (Ballent et al., 2012, 2013). Particle density frequently arises in marine studies as a factor influencing mobility and dispersal (Law et al., 2010; Moret-Ferguson et al., 2010; Ballent et al., 2012, 2013). According to preliminary freshwater experiments, physical parameters that have been postulated for marine systems have an impact on the transport and dispersion of microplastics. According to studies of suspended sediments, additional physical factors that may influence particle mobility in freshwater include flow velocity, water depth, substrate type, bottom topography, and seasonal fluctuations in water flows (Simpson et al., 2005). Storms, floods, or manmade action (such a dam release) are a few examples of events that could have a temporal component. Tidal cycle (only in estuaries) is another (Moatar et al., 2006; Kessarkar et al., 2010). Travel distances can vary depending on physical forces and particle characteristics (density, size and charge).

2.2 Detecting and Monitoring Microplastics

Challenges of detecting microplastics include: • The ability to extract plastic fragments from a sample of water or sediment is one challenge.

• The other is separating the plastic fragments from other particles in the sample.

• A third challenge is identifying the types of plastics present and dealing with identification challenges brought on by processes like the discoloration of microplastics by biofilms (Eriksen et al., 2013; Hidalgo-Ruz et al., 2012).

Different collecting, identifying, and quantification strategies are employed to sample microplastics in marine research (Hidalgo-Ruz et al., 2012).Both bulk or volume-decreased sampling and selective sampling are included. Sediment or water parcels have been sampled using bulk or volume-reduced techniques, whereas surface sediments have been sampled selectively. Plastics are separated from the sample by density separation, filtering, sieving, and/or visual sorting after it has been collected. The characterization of particles has made use of morphological descriptions, sources, types, forms, colours, chemical compositions, and particle disintegration phases. As the most trustworthy method of identification, infrared spectroscopy has emerged since it offers information about chemical composition (Hidalgo-Ruz et al., 2012).

Table 3: Methods for Detecting Microplastics

Methods	Drawbacks
Visual inspection Including stereoscopy and manual microscopy	Can underestimate or over estimate the size of particles/plastics
Thermogravimetric Analysis	Complex method with labour – intensive cleaning and concentration processes. Costly and time consuming
FTIR (Fourier Transform Infrared) Spectroscopy	Can't analyse microplastics whose sizes are under 10 micrometer
Raman Spectroscopy	Takes a long time to get a descent signal to noise ratio because of weak Raman scattering
Atomic Force Spectroscopy	Slow scanning rate in order to get high-quality images

Despite being a crucial technique for finding microplastics, light microscopy lacks the chemical details required to identify the polymers at operation. However, this identification is crucial to determining the impact and source of the discovered microplastics. Microplastic specialists are now using FT-IR imaging in connection with machine learning evaluation techniques precisely because of this. Complete particle characterisation is made feasible as a result, human error is removed, and accurate, repeatable findings are produced.

2.3 Potential Impacts of Microplastic

Researchers do not even completely understand how microplastics from freshwater or marine habitats affect people. For instance, due to a lack of knowledge, literature evaluations in the field of food safety have not been able to evaluate the impacts of microplastics presence (Hollman et al., 2013). Investigating whether microplastics could have an effect on economies or human health, either directly or indirectly, is vital. The following topics could be the main focus of research in this area:

• Resources that are directly used by humans (such as drinking water, bathing water, or food resources);

• Logistics of water use; and

• Ecosystem services.

The following are examples of possible research methodologies:

• Presence of Microplastic

• Compounds from microplastics or chemicals they have absorbed and carried that are transferred to food.

• Economic factors, such as the degree of the expenditures connected with cleanup activities or if the presence of microplastic in aquaculture species could result in revenue losses.

3 Health Risks Associated with Exposure to Microplastics

Evaluation of the impact of MP and NP in food on human health is challenging for two basic reasons. First, some plastics may be chemically dangerous, either because they are poisonous in and of themselves or because they absorb and transport additional elements. Second, it can be challenging to distinguish between comparative exposure to pollution and exposure from food and water. Scientists were unsure of the potential danger because we constantly breathe in and swallow dust. Exposure determines the dangers to human health, and it is widely known that microplastics can enter the body through drinking water. In order to appropriately determine the hazards to human health, the accuracy of the examination of microplastics in drinking water and its sources is crucial. Scientists made an effort to predict the average American citizen's annual intake of microplastics in 2019 based on the data currently available. Depending on the age and sex of the citizen, this was estimated to range between 74,000 and 121,000 particles; however, the scientists believe this is an exaggeration because only 15% of the food consumed could be analysed. According to this study, drinking bottled water, which typically contains 100 microplastic particles per litre, is one of the worst ways to consume plastic particles. Since then, more study has been done; for instance, it has been discovered that plastic teabags and baby bottles discharge millions of micro- and billions of nanoplastics into tea and infant formula. These results imply that the degree of our exposure has been grossly underestimated, but additional study is necessary to completely comprehend the amount of plastic we consume and the amount that stays in our bodies. Drinking water exposure can also be affected by airborne pollution, however in order to understand contamination that originates in the water supply and to ensure comparability and reproducibility, we advise taking precautions against airborne contamination. Last but not least, exposure to microplastics could also occur through ingesting them through food or breathing them in (Wright and Kelly, 2017), which is not addressed in this research, which primarily focuses on drinking water and its sources. Direct studies of the impact of microplastics on persons have not yet been conducted. The difficult part is determining the overall risk they pose to our health. The degree of toxicity we may be exposed to from ingested microplastics is highly dependent on how rapidly they leave the body. Researchers are just recently beginning to focus on this.

4 Conclusions and Research Gaps

Below are the findings discovered after a comprehensive literary and scientific review: Since there are currently no standardised procedures for detecting microplastics, it is challenging to compare current data with or against other data. These procedures can be both expensive and technically difficult. Information on microplastics in the freshwater is lacking. The tracking and subsequent removal of microplastics are challenging due to study gaps in understanding the sources, pathways, distributions, and accumulation of microplastics. Because microplastics are so tiny and the ocean contains such a large area, it is difficult, expensive, and time-consuming to identify them using conventional methods. The majority of studies on microplastics came from wealthy nations, while there is little literature from underdeveloped nations. The incidence of microplastics in aquatic systems in these locations could be higher than previously believed due to the absence and/or inadequate implementation of environmental legislation in developing countries, as well as the corresponding inadequate solid waste and wastewater management methods. The risk to human health could be very severe in these developing nations where a substantial section of the population relies on untreated groundwater and open sources for drinking water. There are still a lot of unsolved problems because research on microplastics in freshwaters is still in its early stages and has only recently started. More research is needed to: 1) develop the most effective method for monitoring microplastics in freshwater systems; 2) quantify all factors affecting the appearance, abundance, and dispersion of microplastics in the environment; 3) understand the behaviour of degradation, including particle lifetimes and ultimate fate in freshwater; and 4) assess the effectiveness of remediation strategies. 5) Assess and comprehend how microplastic interacts with biota; 6) determine how microplastic affects ecosystem services; and 7) investigate at how microplastic affects people. Combined efforts on all frontiers, including survey, monitoring, research, and policy, will be necessary to better identify any new issues caused by microplastics in freshwater systems and to build efficient, knowledgeable management plans. The World Health Organization (WHO) came to the conclusion that there is no harm to human health from drinking water containing microplastics based on the existing scientific data. To evaluate the health effects of microplastics, according to the Plastic Health Coalition, there are simply too many knowledge gaps. Due to a lack of analytical techniques, the current data on human exposure are insufficient and do not account for the smallest and most dangerous plastic particles. Additionally, worldwide scientific investigation into the possibly hazardous consequences of microplastics on people is still in its early stages. New scientific research is urgently needed.

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THE USE OF MORINGA OLIFERA SEEDS AND ALUM AS A NATURAL COAGULANT FOR DOMESTIC WASTE WATER TREATMENT IN SUMMER, WINTER & RAINY SEASONS.

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Abstract

Moringa olifera is a pan tropical, multipurpose tree whose seeds contain a high quality edible oils (up to 40% by weight) and water soluble proteins that act as effective coagulants for water and waste water treatment. The use of this natural coagulant material has not yet realised its potential. A water extract of Moringa olifera seeds was applied to a waste water treatment sequence comprising coagulation-floculation-sedimentation-Filtration. The objective of this study is to evaluate the removal efficiency of turbidity, suspended solids, B O D, C O D& Total solids in three different seasons by using moringa olifera as a natural coagulant.Indiscriminate disposal of waste water with suspended solids have led to higher amount of pollution to the natural water bodies. Turbidity imparts a great problem in waste water treatment. It attempts the investigation of the coagulation performance of some parameters in contaminated domestic wastewater. The test results will be carried out using the conventional jar test apparatus.This study aims to add the fine powder of pre mentioned seeds as a natural coagulant in treating the domestic waste water which is turbid and the same water will be studied with synthetic coagulants such as alum. Both of these coagulant materials the removal efficiency is obtained very high in moringa olifera seeds. When used moringa olifera seed powder as coagulant, it caused favourable changes in the pH of the treated water and the best colour, turbidity & BOD removal at acceptable pH was obtained.

Keywords

Moringaolifera Seed Powder, Alum, Domestic Effluent, Coagulation, Jar test Apparatus

1 Introduction

Water is a basic necessity of life for both animal and plants. Water covers over70.9% of the Earth's surface, of which 97% of the total water is covered by oceans, 2.4% by polar ice caps and 0.60% by other land surface water bodies like river, lakes. Water has become the most commercial product of the century; this may sound bizarre but true. In fact what oil was to the 20th century, water is for the 21st century? Human beings are putting an increasing pressure on the planet's water resources. In the earlier days when earth's population was less, it was imagined that oceans were too big to pollute. But in the recent century with increasing population the oceans also seems to be too smaller for getting polluted. (Harushet al.2011). Generation of wastes is part of human activity from the ancient times. Disposal of waste on land, surface waters is a general practice, but the capacity to treat the waste water by natural process is limited. The two different ways in which water pollution can occur. If pollution comes from a single location then it is known as point source of pollution. A great deal of water pollution happens not from one single source but from many different scattered sources, which is called Non point Source pollution.(Harushet al.2011). Reuse of treated wastewater should not be limited to domestic discharges. In some cases, industrial wastewater discharges are of significant quantities and, when treated, should be considered part of the wastewater reuse. One of the most industrial sectors that produce large quantities of wastewater is the slaughterhouse sector which often contains high concentration of biodegradable organic matter. (Al–Mutairi et al., 2004) From the environmental engineering point of view, this indicates that their treatment might be more demanding than domestic wastewaters. However, these wastewaters may be quiet useful when it comes to wastewater reuse for agriculture. As has been reported.(Al–Mutairi et al., 2004) Domestic wastewater is very harmful to the environment. Effluent discharges from domestic wastewater can result in the depletion of oxygen from water bodies, and the contamination of groundwater. These effluents contain high levels of organic matter, which generally arise from paunch, faecal, fat and undigested food, blood, suspended material, urine, loose meat, soluble proteins, excrement, and particles. The pollution potential of meat-processing and slaughterhouse plants has been estimated at over 1 million population equivalent in the Netherlands (Sayed 1987), and 3 million in France (Festino and Aubart 1986).

2 Objectives of the Study

- Determine the efficiency of moringaolifera & Alum as a coagulant in different seasons. (Summer, winter & rainy Seasons).
- To treat the domestic waste water using moringaolifera & Alum as a coagulant to get the quality of water for agriculture.
- To determine optimum dosage of coagulant in different seasons. (Summer, winter & rainy Seasons.)

3 Materials & methods

Sample Collection; Samples were collected from the sedimentation tank it is situated outside of chickballapur town before any treatment was given. Initial colour of sewage is grey. Preserving the sample: Till the analysis was conducted, the samples were preserved at 4 degree centigrade and kept in refrigerator to prevent contamination. Analysis of Sample: Parameters like BOD, Turbidity, COD, pH, Chlorides, Alkalinity, Total Solids of domestic waste water has been analysed as per standard methods by referring a code APHA book. The coagulation process conducted by jar test apparatus with moringaolifera seed powder& alum. Major parameters selected for the study were Turbidity, BOD & Total Solids.

The procedure for the preparation of MO seed powder is given below: • High quality pods, those which were new and not infected with disease and insects were selected.

• Seeds were opened and from pods and then dried sun light 48 hr to remove any moisture content if present.

• Hulls and wings from the kernels were removed manually to increase the effect of powder as coagulant and to reduce to waste sludge formation.

• The seed kernels were ground to a medium fine powder in grinder and sieved to get particles of the size 600 µm .

The fine powder was used as coagulant for analysis.

3.1 Definitions of Microplastics

The term "microplastics" was first used to describe particles up to 20 µm in size (Thompson et al., 2004). Practically, the size of the net or mesh sieve employed for sampling determines the smallest size in the majority of investigations (Blair et al., 2017). The field is still emerging, thus it may be necessary to acknowledge and/or assume some presumptions and knowledge gaps. Microplastics are a size group of plastic that lies between microplastics and Nano plastics in terms of size. The size of manufactured Microbeads, which are tiny, typically ranges from 5µm to 1 mm (Hernandez et al., 2017). However little known about these tiny particles since they are challenging to detect and measure. The range was increased by Arthur et al. (2009) to include all particles less than 5 mm. However, there is currently a suggestion in recent literature to limit the maximum size of "microplastics" to 1 mm (1000 µm) (Van Cauwenberghe et al., 2015). There is no clear definition of the precise size parameters that constitute microplastics. Different parameters can be used to describe and characterise microplastics (Wagner et al., 2014). These comprise classification according to size, shape (such as fragment or fibre), and polymer composition, and source, location, application, and release patterns.

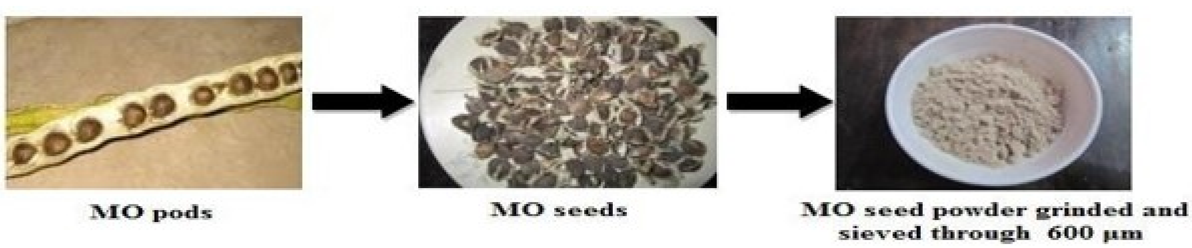

Figure 1: Preparation steps of Moringaoleifera seed powder

3.2 3.1 Coagulation Test

Jar test is most widely used experimental methods for coagulation-flocculation. A conventional jar test apparatus was used in the experiments to coagulate sample of domestic wastewater using moringaoleifera and beans seed powder. It was carried out as a batch test, accommodating a series of six beakers together of 1 liter capacity with six spindle steel paddles. Before operating the jar test, the sample is mixed homogenously. Then analyzing the parameters Turbidity, pH, total dissolved solids, suspended solids, total solids, colour, BOD and COD for both the moringaoleifera and alum by referring APHA book. Then results are plotted on graphs than they are compared. (Nabiet al.2007).

The batch experiment involving rapid mixing, slow mixing and sedimentation.The apparatus consists of six beakers to be agitated simultaneously. 500 ml of the domestic wastewater samples is put in to each 6 one-liter beakers and placed under jar test apparatus. The required dose of Moringaoleifera seed powder and Alum is added simultaneously. The paddles are inserted in the jars, the apparatus is switched on and the whole procedures in the jar test are conducted in different rotating speed, which consist of rapid mixing (100 rotations per minute, rpm) for 1 minute and slow mixing (30rpm) for 10 minutes. After the agitation being stopped, the suspensions are allowed to settle for 20 minutes. Finally, a sample was withdrawn using a pipette from the middle of supernatant for physicochemical measurements, so that the effect of coagulant dose on coagulation could be studied. Then, the samples are measured for different parameters.

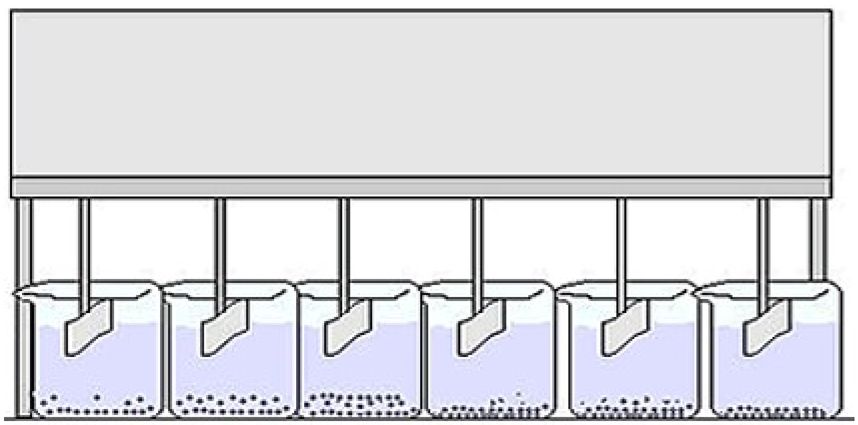

Figure 2: Jar Test Apparatus

4 Results and Discussions

4.1 Domestic Waste Water in Summer Season

The Coagulant powder has been prepared and Optimum dosage of Moringa Olifera seed powder has been determined, graphs & Comparative study have been done. The domestic waste water was analyzed to understand the basic characteristics of wastewater in terms of parameters like pH, colour, turbidity, Total Solids, Total Suspended Solids, BOD, COD, Chlorides, Alkalinity, Oil and grease, Total Nitrogen, Electrical Conductivity and Iron. The tests are conducted by using moringaolifera seed powder tabulated below.

Table 1: Characteristics of Domestic Waste Water in Summer Season

Sl. No	Parameter	Units	K.S.P.C.B	Raw Water
1	pH	-	5.5-9.0	9.37
2	Turbidity	NTU	2 max	85.1
3	TDS	mg/l	600	1100
4	B.O.D	mg/l	0	166
5	Chlorides	mg/l	250	85.1
6	Total hardness	mg/l	300	650
7	Total Alkalinity	mg/l	200	600
8	Total Solids	mg/l	600	2180
9	Electical conductivity	μ ohms/cm	2250	8050
10	Dissolved Oxygen	mg/l	4-8	8.5
11	C.O.D	mg/l	250	289
12	Colour	-	Agreeable	-

4.2 Domestic water in summer season

The domestic waste water was analyzed to understand the basic characteristics of waste water in respect of parameters like turbidity, BOD, COD, pH, TS, TSS, Chlorides, Hardness, Electrical Conductivity. The results of the analysis are tabulated below.

Table 2: Characteristics of Domestic Waste Water in Winter Season

Sl. No	Parameter	Units	K.S.P.C.B	Raw Water
1	pH	-	5.5-9.0	7.34
2	Turbidity	NTU	2 max	237
3	TDS	mg/l	600	550
4	B.O.D	mg/l	5	625
5	Chlorides	mg/l	250	455
6	Total hardness	mg/l	300	1050
7	Total Alkalinity	mg/l	200	612
8	Total Solids	mg/l	600	522
9	Electical conductivity	μ ohms/cm	2250	570
10	Soluble solids	mg/l	600	555
11	C.O.D	mg/l	250	970
12	Colour	-	Agreeable	-

From the above desk it is clear that parameters like turbidity, BOD, COD, pH, TS, TSS, Chlorides, Hardness, Electrical Conductivity in that total dissolved solids, conductivity, suspended solids are under the permissible limits quoted by KSPCB.

4.3 Domestic water in rainy season

Table 3: Characteristics of Domestic Waste Water in Winter Season

Sl. No	Parameter	Units	K.S.P.C.B	Raw Water
1	pH	-	5.5-9.0	8.15
2	Turbidity	NTU	2 max	148.5
3	TDS	mg/l	600	412
4	B.O.D	mg/l	5	550
5	Chlorides	mg/l	250	340
6	Total hardness	mg/l	300	955
7	Total Alkalinity	mg/l	200	500
8	Total Solids	mg/l	600	402
9	Electical conductivity	μ ohms/cm	2250	455
10	Soluble solids	mg/l	600	450
11	C.O.D	mg/l	250	980
12	Colour	-	Agreeable	-

From the above table it is clear that parameters like turbidity, BOD, COD, pH, TS, TSS, Chlorides, Hardness, Electrical Conductivity in that total dissolved solids, conductivity, suspended solids are within the permissible limits prescribed by KSPCB.

4.4 Tests carried out with MOSP (Moringa Oleifera Seed Powder) in Summer Season.

Jar tests were performed to obtain the optimum dosage of MOSP. Tests had shown that the best dosage of MOSP is in the range of 0.75g/l to 1.5g/l of domestic wastewater. The initial turbidity of waste water had been reduced in the after using MOSP as a coagulant. Fig 1 & 2 shows the variation in the reduction of turbidity with respect to various MOSP & ALUM dosages. The various parameters of Domestic Waste water were found to vary with the treatment of MOSP. The following test results gives an insight to change in parameters occurred after the treatment of domestic waste water with MOSP.

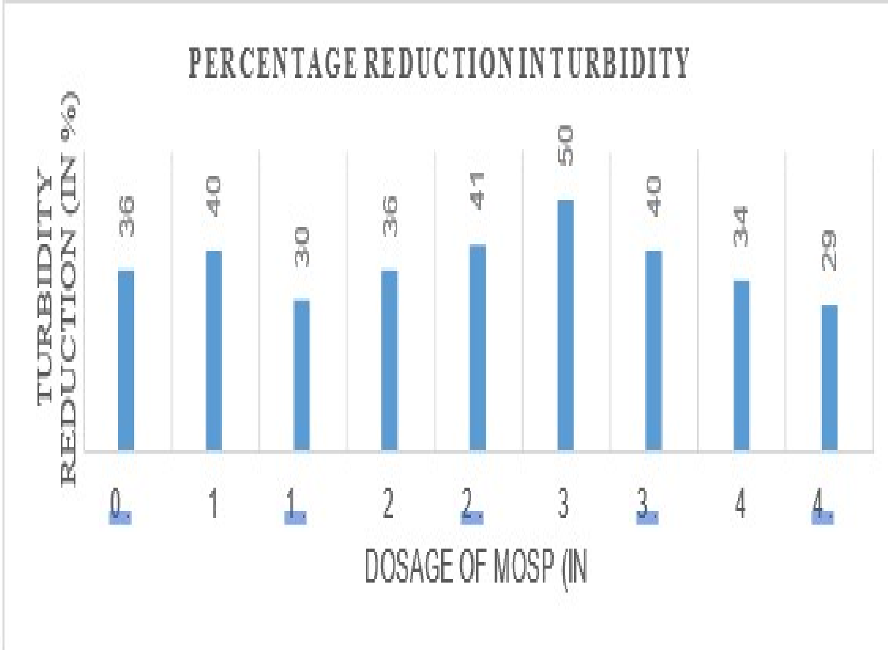

Figure 3: Percentage reduction in turbidity with varying MOSP dosages

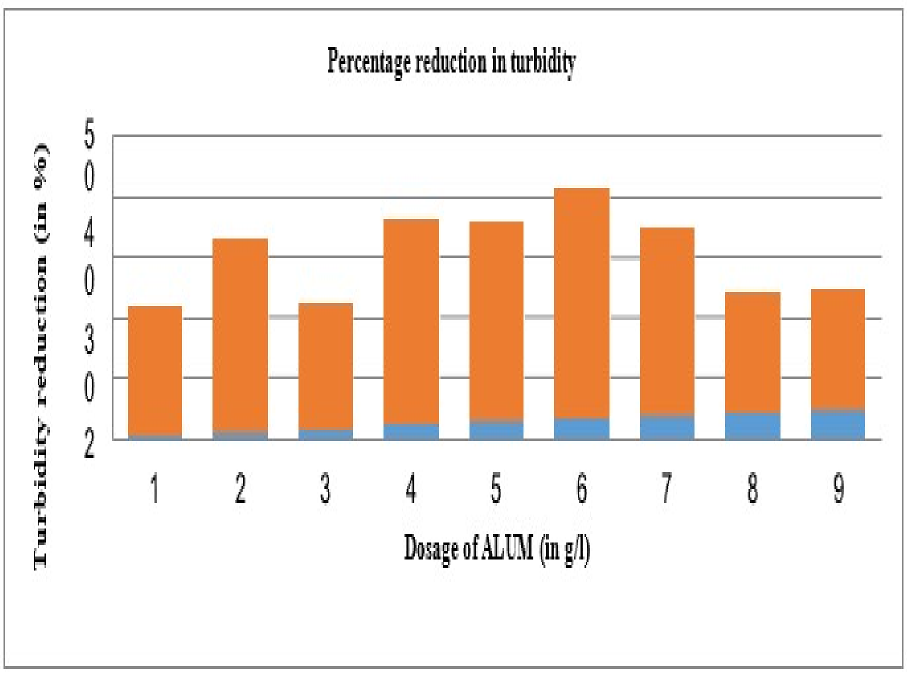

Figure 4: Percentage reduction in turbidity with varying MOSP dosages

Some parameters like turbidity, total hardness, total solids and Electrical Conductivity had greatly reduced after treatment with MOSP. Total hardness content was reduced to 650mg/l from 500 mg/l (76.92%). Turbidity was reduced from 85.1 to 28.5 NTU (32.9%). EC reduction was from 8.050µmhos/cm to 3.100µmhos/cm (71.76%) and Total Dissolved solids content reduced from 1100 mg/l to 800 mg/l (72%).

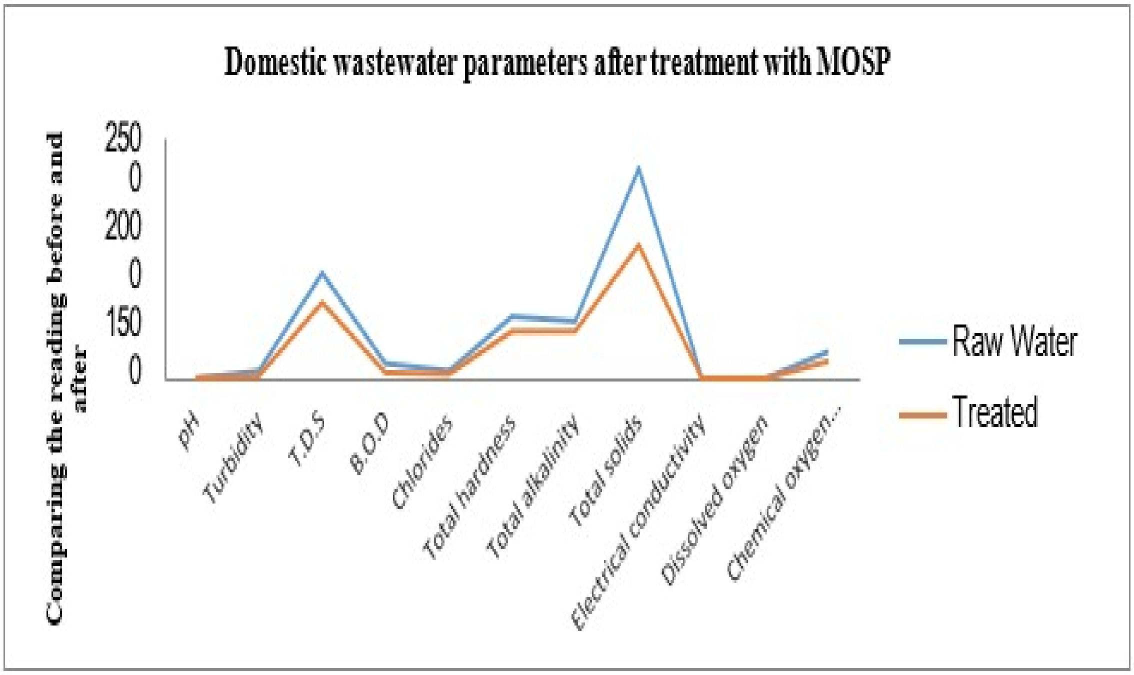

Figure 5: Test results after treatment with MOSP

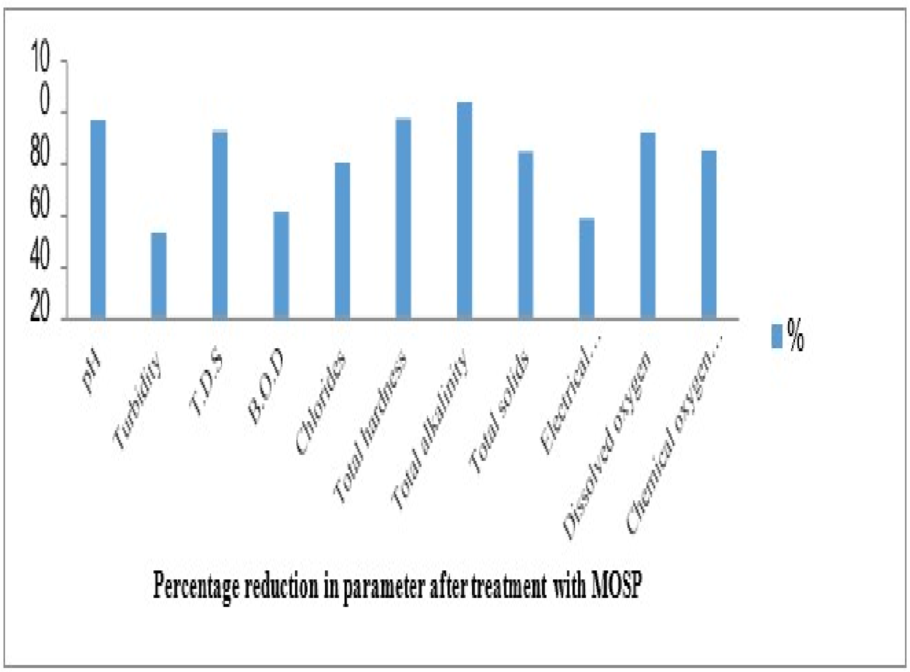

Figure 6: Percentage reduction in turbidity with varying MOSP dosages

Figure 6&7 shows the percentage reduction in parameter after treatment with MOSP& ALUM. The various parameters of domestic waste water were found to vary with the treatment of MOSP. The following test results give an insight into the change in parameters efficiency occurred after the treatment of domestic waste water with MOLP.

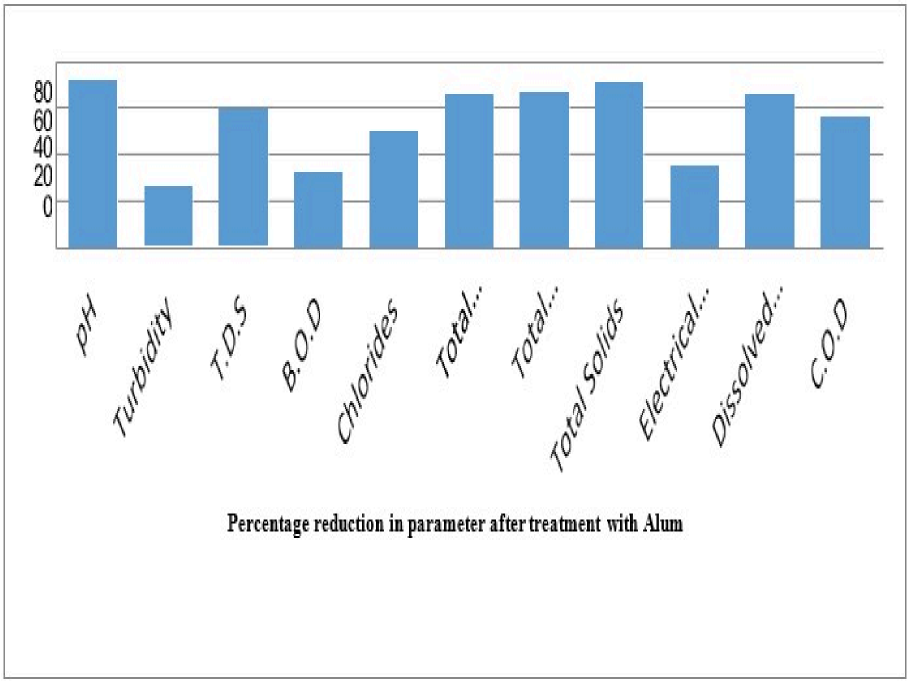

Figure 7: Percentage reduction in turbidity with varying ALUM dosages

4.5 Tests Carried out with MOSP & Alum in Winter Season

Jar test were performed to obtain the optimum dosage of MOSP & Alum. Tests had shown that the best dosages of MOSP & alum are in the range of 0.4 mg/l of domestic waste water. The initial turbidity of water had been reduced in the after using MOSP as a coagulant. The obtained removal efficiency of turbidity, BOD was 83.54 & 76.80 in winter season.

Table 4: Change in pH for MO and Alum in Winter Season

Dosage (g)	Influent(mg/L)	MO	ALUM
		Effluent mg/L	Effluent mg/L
0.1	7.34	7.12	5.7
0.2	7.34	7.18	5.8
0.3	7.34	7.13	5.9
0.4	7.34	7.29	6.4
0.5	7.34	7.02	5.1

Table 5: Change in Turbidity for MO and Alum in Winter Season

Dosage (g)	Influent(mg/L)	MO	ALUM	% Removal with MO	% Removal with Alum
		Effluent mg/L	Effluent mg/L		
0.1	237	119	56	49.78	76.37
0.2	237	101	61	57.38	74.26
0.3	237	87	66	63.29	72.15
0.4	237	39	72	83.54	69.62
0.5	237	52	65	78.05	72.57

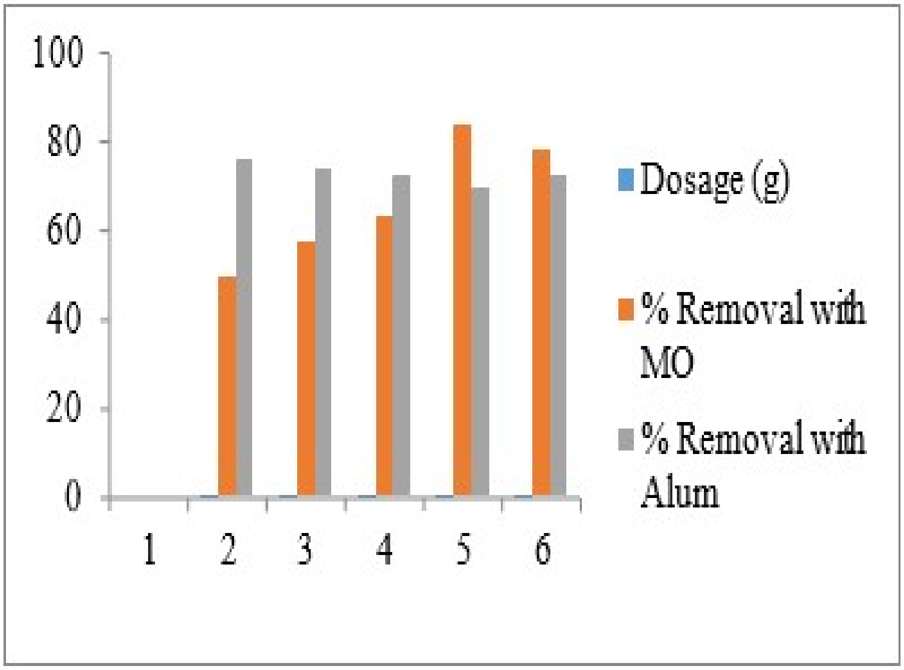

Figure 8: Variation in the reduction of turbidity

The above Figure 8 showcase the variation in the reduction of turbidity with respect to varying dosages of MOSP & ALUM in winter season. The removal efficiency of turbidity was 83.54 & 69.62 for 0.4 gm/L dosage. At an optimum dosage of 0.4mg/l of MO, the turbidity of waste water sample was reduced from 237 NTU to 39 NTU. From this we are observing the greater reduction of turbidity by using natural coagulant Moringa olifera Seeds. It is therefore concluded that the method of allowing water to settle without coagulation is not efficient in addressing the challenges facing potable water supply especially where the scarcity of water. Removal of organic matter is high in winter season due to the availability of DO.

Table 6: Change in BOD for MO and Alum in Winter Season

Dosage (g)	Influent(mg/L)	MO	ALUM	% Removal with MO	% Removal with Alum
		Effluent mg/L	Effluent mg/L		
0.1	625	310	340	50.04	45.6
0.2	625	285	380	54.4	54.4
0.3	625	267	415	57.28	33.6
0.4	625	145	430	76.8	31.2
0.5	625	165	310	73.6	50.4

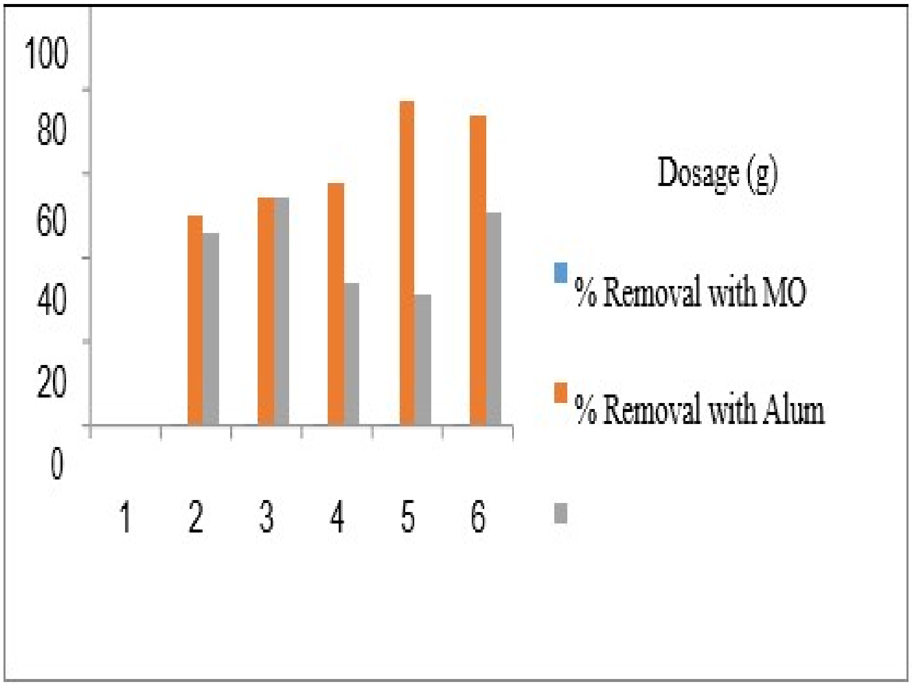

Figure 9: Variation in the reduction of BOD with respect to varying dosages.

From above fourth chart it shows the variation in the reduction of BOD with respect to varying dosages of MOSP & ALUM in winter season. The removal efficiency of BOD was 76.80 & 31.20 for 0.4 gm/l dosage. At an optimum dosage of 0.4 mg/l of MO, the BOD value of waste water was reduced from 625mg/l to 145 mg/l. From this we are observing the greater reduction of BOD by using natural coagulant Moringaolifera Seeds. Here we are observing the removal of organic compounds is very high.

Table 7: Change in pH for MO and Alum in Rainy Season

Dosage (g)	Influent(mg/L)	MO	ALUM
		Effluent mg/L	Effluent mg/L
0.1	8.15	6.08	7.12
0.2	8.15	5.99	7.05
0.3	8.15	5.95	7.02
0.4	8.15	5.95	6.99
0.5	8.15	6	6.91

Table 8: Change in BOD for MO and Alum in Winter Season

Dosage (g)	Influent(mg/L)	MO	ALUM	% Removal with MO	% Removal with Alum
		Effluent mg/L	Effluent mg/L		
0.1	148.5	56	71	76.37	52.18
0.2	148.5	51	64	65.65	56.9
0.3	148.5	46	61	69.02	58.95
0.4	148.5	42	55	71.71	62.96
0.5	148.5	55	62	62.96	58.24

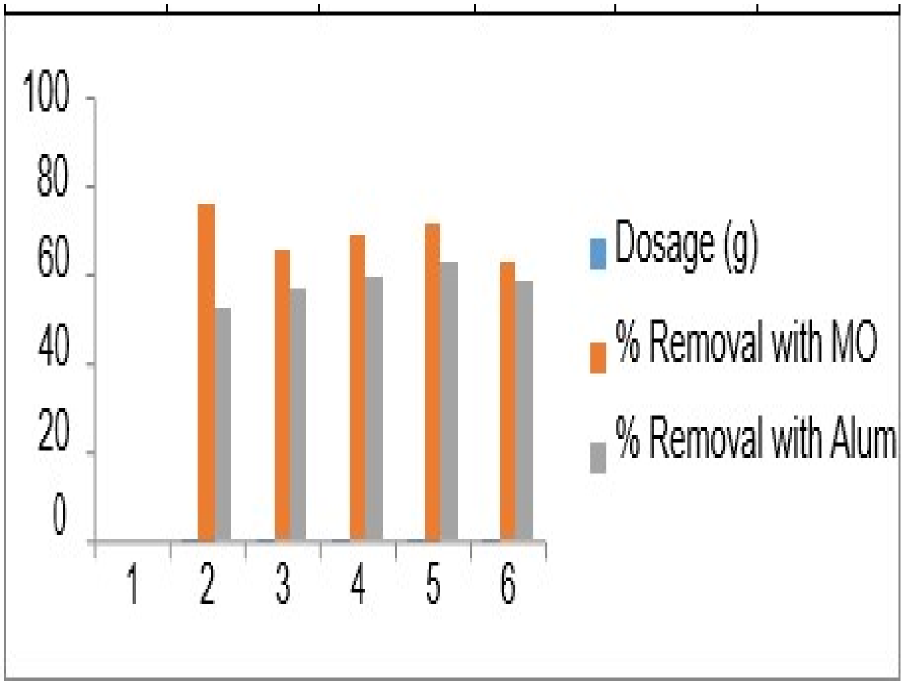

Figure 10: Variation in the reduction of turbidity with respect to varying dosages.

Figure 10 shows the variation in the reduction of turbidity with respect to varying dosages of MOSP & ALUM in rainy season. The removal efficiency of turbidity was 71.71 & 62.96 for 0.4 gm/l dosage. At an optimum dosage of 0.4mg/lof MO, the turbidity value of waste water was reduced from 148.5 NTU to 42 NTU. From this we are observing the higher reduction of turbidity by using natural coagulant Moringa Olifera Seeds.

Table 9: Change in BOD for MO and Alum in rainy Season

Dosage (g)	Influent(mg/L)	MO	ALUM	% Removal with MO	% Removal with Alum
		Effluent mg/L	Effluent mg/L		
0.1	550	305	340	44.54	38.18
0.2	550	297	325	46.60	40.0
0.3	550	271	305	50.72	44.54
0.4	550	235	294	57.27	46.54
0.5	550	262	321	52.36	41.63

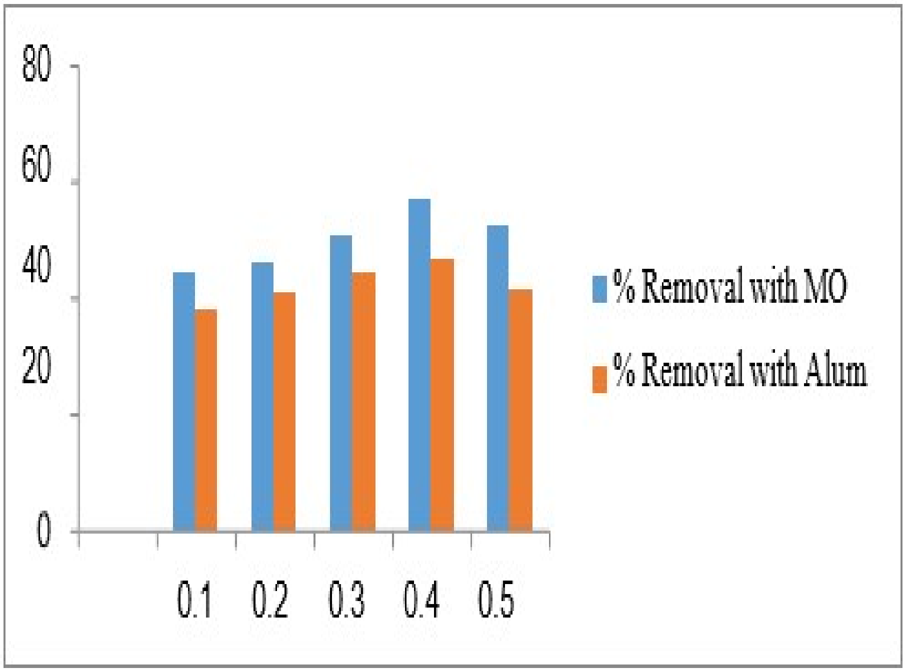

Figure 11: Variation in the reduction of BOD

Figure 11 shows the variation in the reduction of BOD with respect to varying dosages of MOSP & ALUM in rainy season. The removal efficiency of BOD was 57.27 & 46.54 for 0.4 gm/l dosage. At an optimum dosage of 0.4gm/l of MO, the BOD value of waste water was reduced from 550 mg/l to 235 mg/l. From this we are observing the great reduction of BOD by using natural coagulant Moringa Olifera Seeds. So, overall in winter season the removal efficiencies is higher as compare to rainy season.

5 Conclusions

MoringaOlifera seeds are an environmentally friendly natural coagulant it is best suitable for the treatment of waste water containing undesirable parameters like Turbidity, BOD, Electrical conductivity, Total solids, Hardness, Chlorides etc... Observed on the test results; the following conclusion can be drawn

• The best dosage of MOSP in treatment of domestic waste water is in the range of 0.75g/l to 1.5g/l in summer season.

• The initial turbidity of waste water had been reduced in the range of 8% to 36% after using MOSP as a coagulant in summer.

• Compare to MOSP removal efficiency is less in Alum in summer season.

• On the other hand, some parameters which can be easily removed, like turbidity, oil and grease, total nitrogen and Electrical Conductivity, total solids and total hardness had greatly reduced after treatment with MOSP.

• The trials with MOSP had decreased the following parameters; Electrical conductivity decreased by around 71%. Turbidity content of waste water was decreased by 32% in summer season.

• The best dosage of MOSP in treatment of domestic waste water for reduction in turbidity by using in winter & rainy season are 83.54 &71.71.

• The best dosage of MOSP in treatment of domestic waste water for reduction in BOD by using in winter & rainy season are 76.80 &57.27.

• The initial turbidity of waste water had been reduced in the range of 80% after using MOSP as a coagulant.

• On the other hand remaining parameters also greatly reduced after treatment with MOSP.

• The trials with MOSP had decreased the following parameters; Electrical Conductivity decreased by about 65.88%. Chlorides content of waste water was decreased by about 42.50%.

• The generation of sludge is greatly reduced by using MOSP as a coagulant.

• It was observed that the removal efficiency is higher in winter season compare to rainy season because, dilution ratio is high in winter seasons.

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