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Removal of Heavy Metals and Planning of Pilgrim Facilities at Religious Places Near Rivers

Jayesh Sudhir Patil[1*], Walmik Shankar Marathe[2]
[1]PG Scholar, Department of Civil Engineering, SSVPS's Bapusaheb Shivajirao Deore College of Engineering, Dhule, India
[2]Professor, Department of Civil Engineering, SSVPS's Bapusaheb Shivajirao Deore College of Engineering, Dhule, India

***Abstract*: India is blessed with the best of nature's bounty. We have everything like mountains, rivers, seas, dessert, greenery, etc. We have a large number of rivers which are the major source of fresh surface water. Some of these rivers are of religious importance, lakhs of people visit the river and pollute the river due to bathing, pooja material disposal, etc. The industrial influents and the pooja material disposal have contributed to the increase in heavy metal concentration in the river. The pollution in the river has increased to such an extent that this water is not safe for drinking and even for bathing purposes. The pilgrims visiting these holy rivers face many problems like bathing in polluted water, drinking the polluted water, resulting in skin diseases, changing clothes in open, and many others. Hence, we have proposed a filter using peanut husk that removes and reduces iron and lead concentration from the water. Also providing preliminary treatment to the water is introduced in the grey water treatment bed which removes BOD, COD, and toxic compounds making the river water safe for bathing and drinking. We have also developed a representative model for the facilities of bathing, drinking, changing rooms, and toilets for the pilgrims visiting the river, which has the potential to improve the current scenario at these riverbanks.**

***Keywords*: Heavy metals adsorbent, Pilgrim facilities, Low-cost adsorbent.**

1. Introduction

India is among the fastest developing countries. India's human population of 1.2 billion covered about 17% of the earth's total population. As it is indicated that India covered almost 17% of the world's population, its requirement of freshwater resources is 4%. India is one of such country in the world which is bestowed with good number of rivers and tributaries, which are helpful not only in the field of agricultural but also in inland transport system of the country. Rivers also form the basis for domestic and industrial water supply, generation of hydroelectricity, inland fishing, are responsible for deposition of fertile soil in the plains as well as formation of deltas. Some river basins are also responsible for trapping of oil and natural gas which also contribute to the list of usefulness of these rivers. Most of the rivers in India either flow into the Arabian Sea or the Bay of Bengal, which is determined by the water shed and the physical features of the country. The drainage system in India can be broadly divided into 2 groups namely: 1. The Himalayan Rivers and 2. The Peninsular Rivers.

In India, the Ganga, the Indus, the Brahmaputra, Mahanadi, Narmada, Krishna and Cauvery are attributed as the major river basins. Among them, highly polluted rivers (in terms of highly toxic organic and inorganic compounds and bacteria, virus, fungi, protozoa, parasites) are classified as the Ganges and its sub basin Yamuna, Kaveri, Indus (only Satluj), Godavari, Mahanadi, Krishna, Brahmini Sabarmati and Tapi. However, relatively clean rivers such as the Brahmaputra, Narmada, Indus (only Beas), Penner and Mahi serves comparatively clean water.

Among the above-mentioned rivers, Ganga, Godavari, Krishna etc. have religious importance in Hindu mythology. As a result of which these rivers are being visited by lakhs of pilgrims every year. As per the survey of India Today magazine 10 lakhs people visit these rivers every month for pilgrimage.

With the increasing number of pilgrims and poor quality of management and facilities the quality of river water has been degraded adversely Water pollution is one of the biggest issues facing India right now. As may be evident, untreated sewage is the biggest source of such form of pollution in India. There are other sources of pollution such as runoff from the agricultural sector as well as unregulated units that belong to the small-scale industry. The situation is so serious that perhaps there is no water body in India that is not polluted to some extent or the other.

In fact, it is said that almost 80% of the waterbodies in India are highly polluted. This is especially applicable of ones that some form or the other of human habitation in their immediate vicinity. Ganga and Yamuna are the most polluted rivers in India therefore it is high time to counter this degradation, improve the quality of water and planning for pilgrim facilities.

Water pollution can have some tremendously adverse effect on the health of any and every life form living in the vicinity of the polluted water body or using water that has been polluted to some extent. At a certain level polluted water can be detrimental to crops and reduce the fertility of soil thus harming the overall agricultural sector and the country as well. When sea water is polluted, it can also impact oceanic life in a bad way. The most fundamental effect of water pollution is however on the quality of the water, consuming which can lead to several ailments.

*Corresponding author: jayeshpatil846@gmail.com

2. Identify, Research, and Collect Idea

Indian rivers are getting polluting day by day and some of the rivers have great religious importance their people take a pilgrimage in polluted water hence to address this problem I am proposing pilgrimage site planning with a low-cost method to remove heavy metal and grey water treatment using canna plants.

Over the years many researchers have studied about alarming pollution levels of Indian rivers. Paul et al have shown that River Ganga has exceeded the safe permissible limits of heavy metals also Mishra et al shown that Ganga has a High concentration of Cd, Cr, Ni, and Pb. Kshirsagar et al did similar studies on River Bhima, Maharashtra using Correlation Matrix, and Jadhav et al studied Heavy metals pollution at Mula-Mutha Rivers which are also some of the religious rivers in Maharashtra.

As a Solution of this low-cost solution has been studied Al - Qahtani used fruit cortex for removing heavy metals which showed around 30% efficiency for Cd, Zn, and Cr. Mohivaden et al studied the Bypass Purification method which is an expensive method of purification as it required more structural work. Atela et al proposed in situ Bioremediation technique which is one of the most efficient ones it uses aquatic plants to serve a purpose. Prabha et al used peanut husk as a low-cost adsorbent that is readily available and has great efficiency.

3. Methodology

As mentioned above nearly 10 lakhs people visit the holy rivers and take a deep in it and they follow their rituals and dispose of the pooja materials in the river itself, this has resulted in increasing heavy metal concentrations and pollution of the river to such an extent that the river water is not safe even for bathing hence, there is need to purify the water and plan pilgrim facilities. According to Prabha R.T., Dr. Udayashankara T.H. in their paper "Removal heavy metal from wastewater' using rice husk and peanut husk as adsorbent" mentioned that peanut husk can be used as adsorbents for the removal of lead and iron.

A. Collection and Testing of Sample

Samples collected from River Chandrabhaga and River Mula as per standard guidelines. The samples were taken from one foot below the surface. Sampling containers were rinsed three times before collecting the samples. The collected sample was sealed with aluminum foil tightly. The sample was tested at laboratories for BOD, COD, DO, & Heavy Metals within six hours of sample collection. The results received are shown in table 1.

This result shows values of above parameters are exceeding the permissible limits. Thus, this sample was used as input sample for filter bed which contain peanut husk as low-cost adsorbents for removal of heavy metals like iron and lead. The output of river bed is collected and again tested to check the removal efficiency of these metals. The results are shown in table 2.

As per the results the efficiency of lead removal is 55.23% and that of iron is 60.17%. Although these values are above permissible limit significant number of heavy metals was removed by using peanut husk as adsorbent in a filter bed. We can increase the efficiency by batch testing to find out optimum pH, contact time, Adsorbent dose at which the maximum efficiency can be achieved. Due to time limit and limited funds batch testing is not possible as it requires huge amount of time and money.

B. Planning of Pilgrim Facility and Design of Filter Bed

People who visit these holy rivers take a holy dip in the river water. There is belief that if one takes bath in the water of these rivers, the holy water washes away their sins, hence people gather around these places in huge amount and take bath, they dispose of various pooja materials, Asthi in the water. Because of this the pollution in the river increases. People also face many problems like unavailability of changing rooms, faulty toilets, etc. Hence to reduce the pollution and providing a pilgrim facility a representative model is prepared to show the details of model.

Components of proposed model:

1) Heavy metal removal bed

This bed lies below the ground level and consist of three layers viz. bottom one being made up of 20 to 40 mm coarse aggregates, second one made up of fine aggregates and the third one made up of locally available soil mixed with pulverized peanut husk. These layers have thickness in the ratio 3:2:1 respectively.

For experimental purpose 25-liter water can is used as container and filled in three layers. The can is cut from the bottom and is kept upside down as shown in the fig. 1.

The bottom layer is made up of 20mm to 40mm coarse aggregate upto 18 cm height. The second layer is made up of sand upto the height of 12 cm. the topmost layer is made up of locally available clay which should be able to hold the peanut husk mixed in it and does not allow to wash it away. The water to be treated is introduced from the top, the water is retained for at least 50 to 60 minutes and the peanut husk adsorbs iron and lead from the water. The second layer and third layer provide

Table 1

S.No.	Parameter	Unit	Result	Method of Analysis
1	pH	mg/l	6.79	APHA 4500-H*B
2	Iron as Fe	mg/l	1.26	IS:3025 (Part 53) 2014
3	COD	mg/l	262.6	IS:3025 (Part 58) 2006
4	BOD	mg/l	80	IS:3025 (Part 44) 1993
5	Dissolved Oxygen	mg/l	Nil	APHA 5210 B
6	Lead as Pb	mg/l	2.02	APHA 3111-B

Table 2

S.No.	Parameter	Unit	Initial Concentration	Final Concentration	Efficiency
1	Iron as Fe	mg/l	1.26	0.5	60.17%
2	Lead as Pb	mg/l	2.02	0.91	55.23%

the preliminary treatment of filtration. This removes the coarse sediments that can clog the pipes and create difficulty in purifying water in the grey water treatment bed.

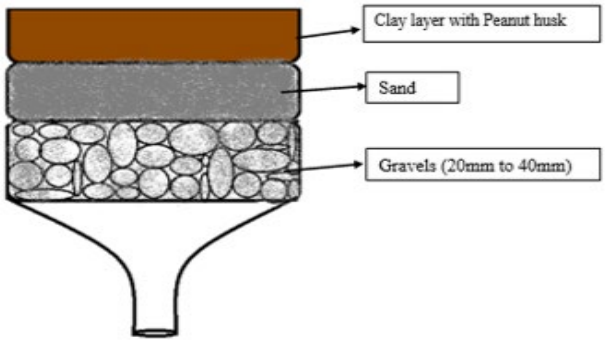

Fig. 1. Heavy metal removing bed

Fig. 2. Input and output of heavy metal removing bed

2) Grey water treatment bed

This bed is filled with layers of different sizes of aggregates of 6 inch each out of which three layers of the aggregates, one layer of sand and one layer of soil from the bottom respectively. The Canna plants are planted over the top layer and the inlet and outlet arrangements are provided.

3) Underground storage tank

This tank is used to disinfect the water by suitable disinfection method and also stores the water and consist of pumping unit that pump the water from storage tank to the bathing channel and other units.

4) Piping system

This system of pipes helps to regulate and circulate the water horizontally as well as vertically.

5) Overhead deck

This consist of an RCC deck supported on Y shaped columns on the bank of river and the bathing channel, pooja material disposal unit and the changing rooms. A ramp is provided from ground level to deck.

6) Miscellaneous units

Bathing channel is provided for bathing purpose. Pooja material disposal unit is provided for disposing pooja materials Changing rooms are provided for changing purpose.

C. Mechanism

This model is divided into three levels one is over bridge, one is ground level and last one is below ground level. Over bridge is constructed over the river channel which consist of a channel of flowing water. This is supported by a Y shaped column. Purified water is introduced in this channel for bathing purpose. A small separate chamber is provided for disposal of pooja materials. People are prohibited from bathing in river directly. Changing rooms for male and females are provided separately on this level itself.

The second level is a ground level which supports this structure and a ramp is provided from ground level to top level for circulation purpose.

Third level consist of the proposed filter beds for removal of heavy metals and for purification of grey water. This level also has a storage tank exactly below the bridge. The purified water is stored in this tank and pumped to the bathing channel with the help of pumps.

D. Working

1. At first the water is introduced in the heavy metal removal bed and water is kept in contact with the bed for at least one hour. In this bed the adsorbent used i.e., peanut husk adsorbs the heavy metals like iron and lead and reduces the heavy metal concentration of the water. An outlet is provided at water which is connected to the grey water treatment bed for further treatment of water.
2. In this bed the water flows in horizontal as well as vertical direction due to the baffle walls provided in the bed. The Canna plant roots helps in removing BOD, COD by root zone method which activates the microbial processes that actively stimulates the down-break of toxic compounds. Large amount of organic matter metabolized in short time. While flowing in vertically downwards the water id filtered due to sand and coarse aggregates beds provided. The odour produced is trapped by clay layer. The output of this bed is directed to the underground storage tank.
3. Storage Tank is provided below the ground level exactly below the deck. The water is collected in this tank and disinfected by using suitable disinfection method. Water is pumped by pumping techniques to bathing channel and other units.
4. Bathing channel is provided for bathing purpose. Water is kept flowing in this channel. This channel is exactly above the river so that pilgrims will feel that they are bathing in the river itself. For this purpose, a glass railing is provided near the bathing channel. The outlet water from bathing channel is directly regulated to grey water treatment. Output of disposal unit is directly connected to heavy metal removal unit.
5. Changing rooms are provided on the RCC deck. These can also be provided with facilities of toilets for pilgrims.

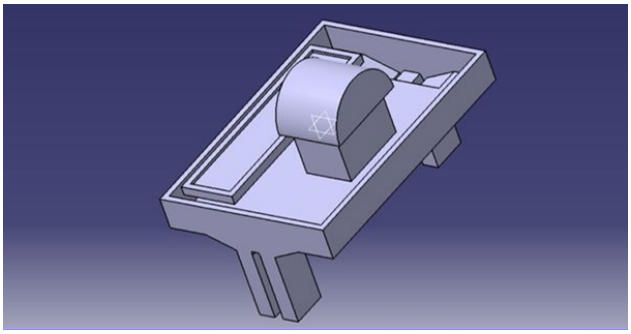

Fig. 3. Isometric view of the representative model

4. Results and Conclusion

A. Results

1. Peanut husk is 55.23% efficient in removing lead and 60.17% efficient in removing iron.
2. As per the experimental results from grey water treatment bed the reduction for Total solids is 58.8%, for BOD is 89.23%, for COD is 39.71%, for Chlorides is 42.8%, for Total Volatile Solids is 14%, for Total suspended solids is 80.9% and for Dissolved solids is 26.36%.

B. Conclusion

1. The river water passed through the designed heavy metal removal beds has the reduced concentration of iron and lead than the initial concentration.
2. The grey water filter bed is efficient in removing BOD, COD and some toxic compounds.
3. The proposed pilgrim facilities model will prove to be an efficient one in providing safe water for bathing and regulating the same into the system. It will also provide the essential facilities i.e., changing rooms and toilets on the bank of river.
4. Disposal of pooja material in separate facility will reduce the introduction of heavy metals in the river and the water from it will be circulated and purified in the model itself.

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