Design And Analysis of Economical Drainage System

[1]Dr. Shrikant Tekade, [2]Dr. Tejas Bhatkar, [3]Ashay Shende

[1]Assistant Professor, Department of Civil Engineering, Government College of Engineering, Nagpur

[2]Geotech Engineer, SD Geotesting Solutions and Consultant, Amravati

[3]Assistant Professor, KDK College of Engineering, Nagpur

Abstract : Drainage water contains so many impurities like floating material, suspended waste, sludge etc. Which can cause blockage of drains. Drainage water with all these impurities is allowed to flow in rivers which causes pollution. In order to avoid such conditions these impurities need to be taken out from drainage water from time to time from drainage water. So, to keep river water clear and to avoid blockage of drainage water we made a system called "ECONOMICAL DRAINAGE SYSTEM". Economical drainage system is nothing but the system which will remove the floating and suspended matter from drainage water such that when water is discharged in rivers or other resources, resource water will not get polluted. This system is provided with storage tank which stores drainage water, water will discharge from storage tank to passage which will spread the water and will reduce velocity of flow, then water will flow through barrier wall which is provided with drainage sock opening to trap floating matter, after this water will flow through reducer which will reduce the velocity of flow and then it flows through sedimentation tank where sediments get settled. As a result, we have successfully trapped floating matter and sediments.

I. INTRODUCTION

Water is the basic need for the presence of life on earth. In spite of 70% water on earth, the majority of water on earth is not suitable for drinking purposes. There is a major requirement of clean water as it is used for a variety of purposes such as drinking, bathing, cleaning, cooking, etc. Waste water is defined as the flow of used water from home, business, industries, commercial activities and institutions which are subjected to the treatment plants by a carefully designed and engineered network of pipes. Typically, everyday each person generates 200-500 liters of waste water. Impurities in drainage water can lead to flow in rivers and causes several problems in the rainy season as well as on normal days. Due to blocking of drainage, we see that the waste gets overflowed on the road which is a big problem mostly in the rainy season. In order to avoid such a situation these impurities need to be taken out from time to time for the continuous flow of drainage water. The solid waste can be removed from the drainage system before the water is thrown into the river so that the water in the river will not get contaminated.

II. OBJECTIVES

1. Public health and safety: To maintain such an environment that does not affect the public health in general.
2. Environmental protection: It is the control of environmental pollution, improving environmental quality to enable a healthy ecosystem and comfortable habitation to humans.
3. Sustainable development: Drainage systems should be designed, constructed, operated, maintained and rehabilitated in such a way that they are sustainable and can be operated with the minimum use of energy.

III. METHODOLOGY

The whole structure of economic drainage system is divided into following parts:
Storage tank, Passage, Barrier wall, Drainage sock, Sock passage, Reducer, Sedimentation tank (Hopper tank)

Storage tank

Storage tank is constructed to store the discharged water that will be used in testing. 110 mm opening is provided at the bottom of the tank with a valve.

Fig. 1. Storage Tank

The dimensions of the storage tank are 1.2m×1.2m×0.8m with 0.15m thickness therefore the length of the tank is 1.5 m. Capacity of the storage tank is 1000liters.

Passage

The passage is provided to reduce the flow velocity of water. So we provide a length of passage 4/3 times its width. It should not be less than 4/3 times width to avoid turbulence of flow and backflow of water from barrier wall. The slope provided is 1V:100H.

Fig. 2. Passage

Barrier wall

Height of the barrier wall is 0.4m with three openings of 150 mm diameter. One is at the center and 0.15 m high from bottom, the other two are at the center of the side wall and central opening. When the flow is more than floating matter will go through the central opening and when water level is normal then all the matter will flow through the side opening.

Fig. 3. Barrier Wall

Drainage socks and socks passage

The drainage socks are connected to the openings present in the barrier wall. The opening of the socks is 5mm. The floating and non-floating matter having dimensions smaller than the opening of the sock will get trapped in socks. The time of removal of socks for cleaning should be in the afternoon because flow velocity is low in the afternoon. The length of the socks passage is 1.5 m with a bed slope of 1:50. The length of socks passage should be at least 0.8 m longer than sock length. Socks of 0.6m length are used and length of sock passage 1.5m is provided.

Fig. 4. Drainage Socks and Socks Passage

Reducer

Reducer is provided to reduce velocity; a reducer is provided. Length of the reducer in structure is 0.8 m. The dimension of reducer is 0.8m*1.5m*0.3m. Some of the particles will settle in the reducer and because of increase in area, velocity of flow reduces and helps for the settlement of particles in the sedimentation tank.

Fig. 5. Reducer

Sedimentation tank

Sedimentation tank is made of iron sheet. The tank is provided with a dimension of 0.7m x 1.25m x 0.55m. Length of the tank is 0.7 m with a slope of 1:5 from all four sides. A 4inch outlet pipe diameter is provided at the center with a sieve. The sieve avoids the passage of settling particles into the outlet pipe.

Fig. 6. Sedimentation Tank

Working of model

Working of the Economical drainage system is very simple. First make dirty water in the storage tank by adding soil, sand and floating matter, weigh it before adding and then open the valve of the storage tank. Now measure the time required to discharge a specific volume of water from the tank. Let water flow through passage and drainage sock. All the matter of size more than opening of drainage sock will trap in socks and remaining will flow through water to the reducer. Measure the velocity of flow in sock passage by measuring time required by particles to cover specific distances. Flow of water will be continuous till the storage tank gets empty. While flowing through the reducer to the sedimentation tank some of the particles will settle in the reducer and remaining will settle in the sedimentation tank. Now let the system dry and then weigh the impurities present in each unit of the system and find efficiency of experiment.

IV. RESULTS AND DISCUSSIONS

Table 1. **Chemical test performed on drainage water**

Sr. no.	Tests performed	Storage tank before trial	Hopper tank before settlement	Hopper tank after settlement
1.	Chloride test	200 mg/l	180 mg/l	20 mg/l
2.	Total Hardness	320 mg/l	300 mg/l	260 mg/l
3.	Residual chlorine	0.1 ppm	0.1 ppm	0.1 ppm
4.	Fluoride test	1 ppm	0.5 to 1 ppm	0 to 0.5 ppm
5.	Iron content test	0.5 to 1 ppm	0.3 to 0.5 ppm	0 to 0.3 ppm
6.	pH	pH =10	pH = 9	pH = 9
7.	Total Alkalinity (In terms of CaCO3)	320 ppm	230 ppm	25 ppm
8.	TDS	1008 ppm	852 ppm	366 ppm

Table 2. **Chemical test performed on artificial drainage water**

Sr. No.	Tests performed	Storage tank before trial	Hopper tank before settlement	Hopper tank after settlement
1.	pH	9	9	9
2.	Alkalinity (in terms of $CaCO_3$)	160ppm	149ppm	130ppm
3.	Chloride test	80 mg/l	70 mg/l	60 mg/l
4.	Turbidity test	50 to 60 NTU	10 to 20 NTU	0 to 10 NTU
5.	Iron content test	1 ppm	0.5 ppm	0.3 ppm
6.	Total Hardness	190 mg/l	180 mg/l	130 mg/l
7.	Total Dissolved Solids	516ppm	478.8ppm	384ppm

Table 3. **Velocity, Discharge and Efficiency at different conditions**

Sr.No	Title	Velocity of flow from tank (M/Sec)	Discharge from tank (M^3/Sec)	Velocity of flow in sock passage (M/Sec)	Efficiency of drainage sock (%)
1.	Full open valve (Artificial drain water)	0.522	0.0496	0.517	75.8
2.	Half Open valve (Artificial Drain water)	0.473	0.045	0.203	75.8
3.	Full open valve (Drainage water)	0.00133	0.14	0.3488	71
4.	Half open valve (Drainage water)	0.001066	0.11	0.1327	71

RESULTS

- From the experiment performed it is clear that the results are good for removing suspended and colloidal waste matter.
- The efficiency of the floating matter trapped is 75.83% for artificial drain water and 71% for drainage water.
- The efficiency of the reducer is 3.82% for artificial drainage water and 6.66% for drainage water.
- The efficiency of the sedimentation tank is 16.26% for artificial drainage water and 0.24% for drainage water.

DISCUSSIONS

➢The cost of reinforcement in a conventional drainage system is high but in this method of drainage system the use of reinforcement is less and hence its cost is less.
➢As conventional drainage systems use reinforcement it gets rusty with time and needs to be changed regularly. But in this method of drainage system, the maintenance cost of reinforcement required is also less.
➢The socks which are used in sock passages to collect floating materials must be changed regularly.
➢The area of the reducer, passages are to be cleaned regularly as some suspended dust and sludge particles settle there.

CONCLUSIONS

1. We have designed such a system of drainage cleaning which is quite important for the safety purpose.
2. The operational cost has been reduced which will also eliminate human labor work which makes it time consuming,
3. Effective way of collecting the wastage.
4. This research is very much beneficial to keep the river clean.
5. The problem of drainage blockage due to plastic waste and other solid waste can be eliminated by using this drainage system.
6. The solid waste and floating matter are collected by the drainage socks. Sludge is removed from the sedimentation tank and the reducer.
7. The wastewater treated by this system is thrown into the river and helps the river to be clean.
8. The water treated by this system is more clear than untreated water.

REFERENCES

1)Dr. R.K. Bansal Seventh Edition Nov 1998 (reprint march 2002) “Fluid Mechanics and Hydraulic Machines”
2)G.S Birdie and J.S. Birdie, Eighth Edition, 2007 “Water supply and sanitary engineering”
3)https://sciencing.com/maintain-alkalinity-wastewater-874062.html,May 5,2022
4)IS 1742(1983): Code of practice for building drainage [CED 24: Public Health Engineering].
5)IS 3025 (Part 11) (1983, Reaffirmed 2002): Method of Sampling and Test (Physical and Chemical) for Water and Wastewater, Part 11: pH Value (First Revision). ICS 13.060.50
6)IS 3025-16 (1984): Methods of sampling and test (physical and chemical) for water and wastewater, Part 16: Filterable residue (total dissolved solids)
7)IS 3025-21 (2009): Methods of sampling and test (physical and chemical) for water and wastewater, Part 21: Total hardness [CHD 32: Environmental Protection and Waste Management]
8)IS 3025-23 (1986): Methods of sampling and test (physical and chemical) for water and wastewater, Part 23: Alkalinity [CHD 32: Environmental Protection and Waste Management]

9)IS 3025-34 (1988): Methods of sampling and test (physical and chemical) for water and wastewater, Part 34: Nitrogen [CHD 32: Environmental Protection and Waste Management]
10) IS 3025-44 (1993): Methods of Sampling and Test (physical and