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Sealing of Sandy Soil Ponds with Clay Layer

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Abstract: ***In rural areas the need of surface water is sufficient for domestic purposes in winter and rainy seasons but in summer the scarcity is more in all regions. To eliminate this condition we can use summer storage tanks. The purpose of these tanks are for the storage of water after meeting all the demands and losses in the rainy season, but the construction of summer storage tank is difficult and unsuitable and create problems. Where the existing land is silty, gravel, and loose sand, because of its high permeability it has a dominating influence on the total engineering behaviour of soil. When compared to the evaporation losses the water percolation loss is more, the soil in this region is free to allow water. The dimensions of summer storage tanks are based on rural requirement. The discharge of summer storage tank is 50lt/head & the depth of storage tank is based on ground water table. In the salty areas at more depth due to capillarity the saline water will enter into storage tanks. So that care should be taken while providing the depth for S.S TANK (summer storage tank). The solution for this problem is to improve the soil characteristics using the inorganic matter such as asphalt, gypsum etc., or by using geo-synthetic materials such as geo-textiles, geo-membranes but these two are very uneconomic. Inorganic matters like fly-ash & GGBS these materials are very cheap but they increase the turbidity load on filters & filtration cost. By using naturally material like clay, we can reduce the seepage loss of water. The clay layer will not permit the water to flow because of its small pore spaces. The clay layer will be compacted to its optimum moisture content (OMC), so that the permeability will be very low. We have provided ten centimeters thick clay layer over the sandy soil to decrease the seepage of water stored in the tank.***

***Keywords*—sandy soils, clay layer, summer storage tank, optimum moisture content and permeability.**

I. INTRODUCTION

A. GENERAL

Civil Engineering embraces the analysis, design and construction of a diversity of structures and systems that may be built on, built in or built with soil or rock namely, Building, Dams, Tunnels, Highways, Airfields, Bridges and so on. The behavior of soil at the location of the project and interactions of the earth materials during and after construction of the structures has a major influence on the success, economy and safety of the work. The properties of geotechnical engineering materials, such as soil and rock, exhibit uncertain behavior from one location to another due to the complex and varied physical processes associated with the formation of these materials. This is in contrast to most other civil engineering materials, such as steel and concrete, which exhibit far greater homogeneity and isotropy. Another complexity associated with some geotechnical engineering materials, such as sand and gravel, is the difficulty in obtaining undisturbed samples for laboratory testing. In rural areas the need of surface water is sufficient for domestic purposes in winter and rainy seasons but in summer the scarcity is more in all regions. To eliminate this condition we introduce the summer storage tanks, the purpose of these tanks are for the storage of water after meeting all the demands and losses in the rainy season, but the construction of summer storage tanks, is difficult and unsuitable and create problems where the existing land is silty, gravel, and loose sand. Otherwise we have to supply water to the villages through water tanks. The solution for this problem is to improve the soil characteristics using the inorganic matter such as asphalt, gypsum etc., or by using geo-synthetic materials such as geo-textiles, geo-membranes but these two are very uneconomic. Inorganic matters like fly-ash & GGBS these materials are very cheap but they increase the turbidity load on filters & filtration cost. The clay layer will not permit the water to flow because of its small pore spaces. The clay layer will be compacted to its optimum moisture content (OMC). We have selected TALLAPALEM village, TALLAPALEM is resided near to the canal. This village is suffering from water scarcity in summer as well as in the normal seasons. Due the local soil properties the water is not retaining in the existing ponds. TALLAPALEM is nearer to the sea coast MACHILIPATNAM, so that there will be higher the sea water intrusion and the water stored in the pond is getting increased its salinity, so the depth of excavation of pond is limited to very low value.

B. WORK AREA CHARACTERISTICS

TALLAPALEM village getting water from the canal during normal season, but in summer from April 15 to july15 total of 90 days water should be stored. But in that region the soil is sand and it is very loose leads to seepage of water into the earth. In hot summer the evaporation losses also reaches to peak values. The depth of sea water availability is too low, so that the water from sea shore will intrudes in the stored water. Actual the water requirement is for 90 days, but due to the permeable soil the water retains only for 30-45 days only, we have to overcome these seepage losses and store water for future usage. Turbidity is too high for the water stored in the sandy location because of high silt content. During the summer the temperature of the atmosphere is high, so that there is a higher chance for the evaporation of the stored raw water. The evaporation losses are to be minimized by planting trees on the banks of

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the raw water storage tank. Most of these storages are shallow (water depth 4 to 5 meters) and the annual evaporation loss could be as high as 40%.

II. MATERIAL FOR CONSTRUCTION OF S.S TANK

A. TYPE OF MATERIALS

The main component in the protected water supply scheme is s.s tank. The construction of s.s tank is effective, so that we have select suitable material for construction of s.s tank. Government sanction less amount for the water supply works. So it is the responsibility of mandalparishats work to use engineering applications and reduce the cost of construction of s.s tank. The importance of the work is very high as it is located in the highly permeable sandy soil location. So to overcome these problems we require a new technique to retain water in the sandy location. So we have to stabilize the sandy soil, we require a low cost material and it should have the property to reduce permeability. We have selected different low permeable material to reduce permeability. They are

1. Cement concrete layer
2. Geo synthetics
3. Polythene lining
4. Prefabricated asphalt membrane lining
5. Clay carpet.

1. CEMENT CONCRETE LAYER

Concrete coating is not cheaper but it is resistant to the percolation of raw water. The cost of cement bag is two hundred and eighty rupees, the preparation of paste and adding on to the inner surface of the tank is costlier. Fig.1 shows the laying of concrete coating.

Fig. 1 Concrete Coating

2. GEO SYNTHETICS

Geo synthetic material can be used for the obstruction of percolation of gravity water into the sandy soil.

Fig. 2 Geo Synthetic Material Covering

Fig. 2 shows the geo synthetic material placement in the site. Geo synthetic materials are somehow costlier; per one square feet the value of geo synthetic material is high.

III. POLYTHENE LINING

Polythene lining is preferred for small scale projects, but there will be more unevenness in the arrangement of polythene lining within the tank. The arrangement of polythene lining is shown in Fig. 3. There is a chance for the loss of water, when there is a hole in the sheet of polythene.

Fig. 3 Polythene Lining

IV. PREFABRICATED ASPHALT MEMBRANE LINING

Asphalt is a solid or semi-solid mixture of bitumen commonly used for paving, roads, and waterproofing. Its cost is dependent on the world oil prices, and following the rise in world oil prices during the 1970s the use of asphalt as a hard surface lining declined because it was less durable and much more expensive than concrete lining. Asphalt products became much thinner and more flexible, and are now mainly classed as flexible membranes. Placing of Pre-fabricated asphalt membrane lining is shown in Fig. 4.

Fig. 4 Pre-Fabricated Asphalt Membrane Lining

CLAY CARPET

By using engineering application, we found out that the material which is cheaper and easily available in nature is clay. As the clay is natural material, there will be no side effects. The cost of clay is cheap, so it can be easily available in the nearby field locations. The laying of clay carpet is shown in Fig. 5.

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Fig. 5 Clay Carpet

V. EXPERIMENTAL PROGRAMME

A. *STANDARD PROCTOR COMPACTION TEST (IS: 2720 (PART VIII-1983)) [6]*

Fig. 6 Compaction

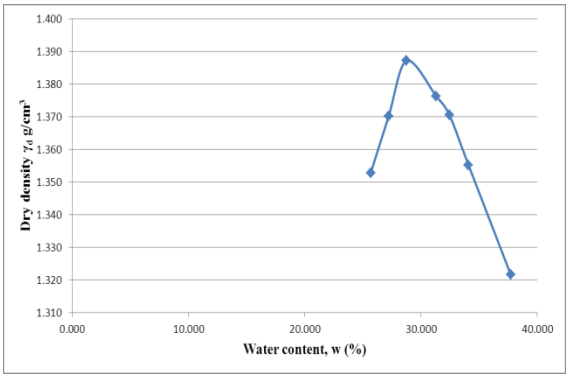

Fig. 7 Compaction Curve

From the graph as shown in Fig. 7, the maximum dry density obtained is at the water content of 28.2%. At this water content the dry density is 1.37 g/c.c.

B. *TRIAXIAL COMPRESSION TEST ((IS 2720(PART XI))*

The tri axial compression test apparatus [8] or simply tri axial test is used for the determination of shear strength characteristics of soils under different drainage conditions. In this test a cylindrical specimen as shown in Fig. 8 is stressed under conditions of axial symmetry. In the first stage the specimen is subjected to on all round confining pressure on the sides and at the top and the bottom .This stage is known as consolidation stage. In the second stage of the test called the shearing stage and an additional axial stresses known as deviator stresses (σ_d) .thus the total stress in the axial stress in the axial direction at the time of shearing is equal to the ($\sigma_{d+}\sigma_c$).the vertical sides of the specimen are principal planes as there are no shear stresses on the sides. The confining pressure is equal to the minor principal stresses.th top and bottom of the planes are major principal stresses. The total axial stress which is equal to the sum of confining pressure and deviator stress is the major principal stress.

Fig. 8 Tri-axial sample

Fig. 9 Tri-axial failure

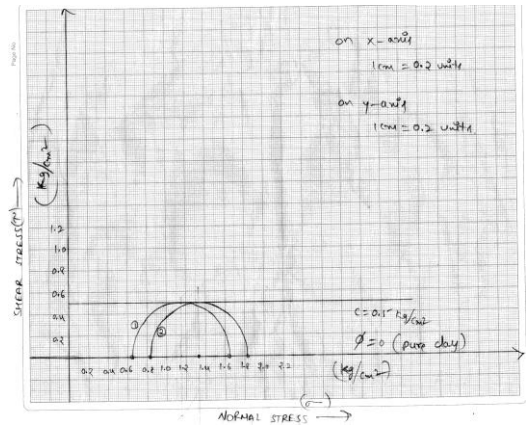

Fig. 10 Tri Axial Graph from the Graph, Cohesion (C) =0.5 Kg/Cm^2 and Angle of Internal Friction (Ø) = O (Pure Clay)

C. *VARIABLE HEAD PERMEABILITY TEST (IS: 2720(PART XVII-1986))*

Permeability is defined as ease with which water can flow through it. Soil is highly pervious when the can flow through it easily. In an impervious soil the permeability is very low and water cannot flow through it easily flow are through it. The permeability of soils [10] is also required in the design of filters used to prevent piping in hydraulic structures. The work as a whole is to know the thickness, with which we have to apply on the surface of the sandy soil. We can know the effective thickness of clay layer by using the variable head method. In the apparatus we change the thickness of the clay layer as shown in table I, and repeat the procedure to know the effective thickness of clay layer to arrest permeability.

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Fig. 11 Permeability Apparatus

Table. I Thickness of clay layer

S.NO	THICKNESS OF SOIL MATERIAL	COEFFICIENT OF PERMEABILITY
1.	Sandy soil	3.2*10^-1
2.	**Clay(at OMC & MDD)**	**2.7*10^-6**
3.	SAND+CALY(4 cm THICK)	1.8*10^-4
4.	SAND+CLAY(8 cm THICK)	2.3*10^-5
5.	**SAND+CLAY(10 cm THICK)**	**2.4*10^-6**

VI. CONCLUSION

We have designed summer storage for the tallapalem village, which is very nearer to sea shore, and the village as a whole covered with sandy soil. The water retaining capacity is too low in sandy soil, so we have introduced a new technique to reduce seepage losses and to increase retaining capacity. To reduce losses we have analyzed materials which stop permeability. When compared to concrete coatings, polythene linings etc. the clay is best material to be used as carpet for sandy ponds to reduce seepage.

Fig. 12 Clay Carpet

Clay is naturally available material. The cost of the clay is very cheaper so we have used clay material for the coating of sandy soil ponds. Due to the sandy soil the water percolation is too high and the storage of the tank decreases so we applied clay coating for the sandy ponds. Availability of the clay material is high during the summer season. The permeability is low and nearly zero at the optimum moisture content. By compacting the soil at the optimum moisture content we can decrease the permeability of the soil and ultimately reduces seepage losses in ponds. We are providing ten centimeters of thick clay layer to restrict the seepage of water into the existed sandy soil. placing of clay carpet is as shown in Fig.12. Ultimately by using clay carpet we can reduce the water scarcity in sea shore villages in summer, reduce the project cost and there will be no environmental effects.

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