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Detection of seepage around the embankments of freshwater storage reservoir in industrial complex, Thoothukudi, Tamilnadu, India

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ABSTRACT

The aim of the study is to identify the seepage of freshwater around the embankment of reservoir through 2D electrical resistivity imaging (ERI) technique. Two freshwater reservoirs were built in the industrial complex, Thoothukudi with dimensions of 500m length and 300m width each and paved with insulating material at the bottom to arrest the seepage. The 2D ERI technique was conducted with the help of resistivity meter, Multicore cable, wire spool and rods in three profiles with Wenner Configuration. The collected resistivity data was converted in to the apparent resistivity data converted in to 2D pseudosection with the use of Res2DINV software. The freshwater zone(120 Ohm.m), Saltwater (1-5 Ohm-m), Clay (5-10 Ohm.m) and Sandstone (above 200 Ohm.m) in the obtained observation using 2D ERI technique. The pseudosection pictures were used for the quality and quantity of the seepage zone in the clay formation.

Key words: Resistivity, Seepage, Damsite, 2D ERI, Freshwater, Thoothukudi

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INTRODUCTION

The study area Thoothukudi district is one of the important coastal district of Tamil Nadu State. The district is located between 80.41’50.4” and 78000’50”N Latitudes and 77040’ and 78010’E Longitudes. The Eastern part of the district is bordered by Gulf of Mannar. Of all the geophysical techniques the self potential, electrical resistivity imaging technique is widely applied to detect the seepage condition in dam sites and oil piping in recent years. The 2D electrical resistivity imaging technique has been applied to detect the seepage path around the additional storage freshwater reservoir in the industrial complex in Thoothukudi.

Location of the study area

Two identical freshwater storage reservoirs were constructed in the industrial complex in Thoothukudi. The reservoir sites are located at the superficial deposits of paleomarine deposits, comprising heterogeneous media of sands, silts and clays enriched with salts and brine water. The bottom of the reservoir is completely sealed with polypropylene sheet. The northern bound is 500 m; and the western side length is 333m and southern side length is about 400m respectively. The length of the eastern bound is 300m common and shared with another storage reservoir . The average depth of the tank is 3m. The width of the concrete bund around the reservoir is 17m. The maximum capacity of the tank is 87MG. Another storage reservoir has maintained its level of water without loss. The reservoir which is subjected to the present study has resulted heavy loss of water by subsurface seepage. To locate the subsurface seepage path of the freshwater into the ground 2D electrical resistivity imaging studies were carried out around the embankment of the storage reservoir tank (Fig.1).

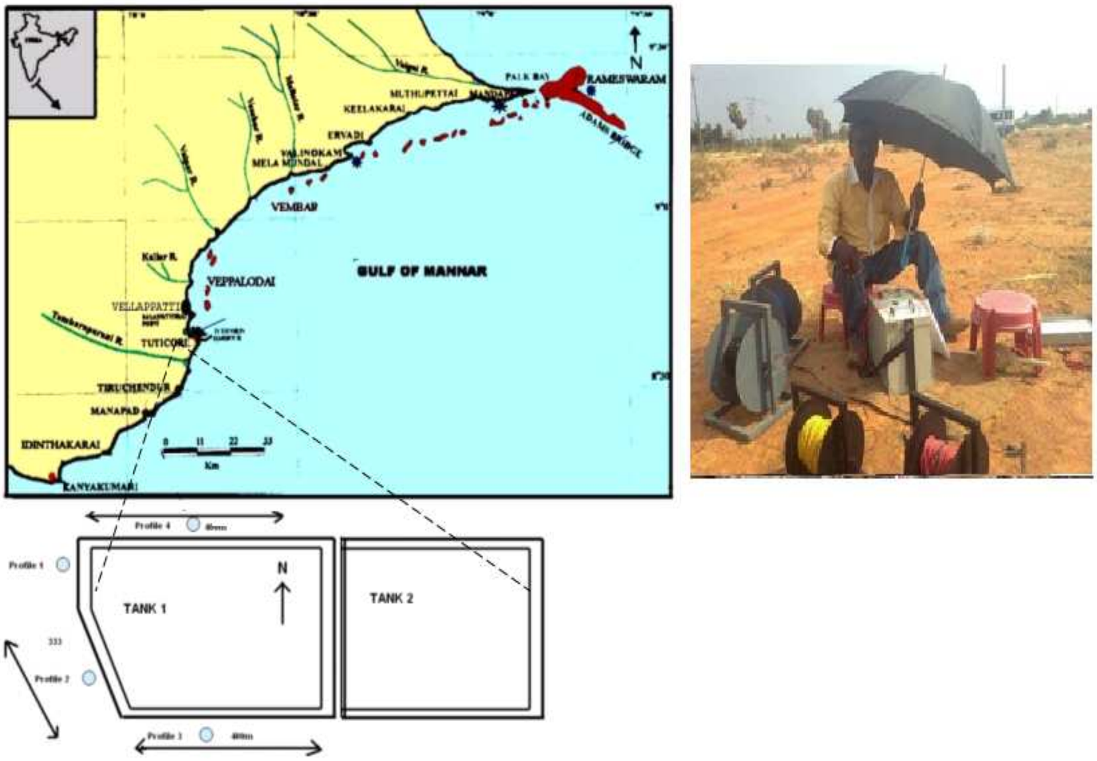

Fig. 1 Location map of Thoothukudi and schematic diagram of the storage reservoirs at Industrial Complex, Thoothukudi.

Profile 1, to a length of 180m with electrode intervals of 5, 10, 15, 20, 25, 30 and 35m in the NW corner of the reservoir tank in N-S orientation was carried out. Profile 2 was orientated in N10ºW - S10ºE direction, to a distance of 180m with electrodes interval of 5, 10, 15, 20, 25, 30 and 35m. This profile covers the SW sides of the reservoir tank. The trends of the profile 3 is E -W direction to a distance of 180m with electrodes interval of 5, 10, 15, 20, 25 and 30m; covered the southern part of the reservoir tank. Profile 4 covers the northern boundary of the tank with E-W trend to a distance of 180m. The electrodes intervals of these profiles are 5, 10, 15, 20, 25 and 30m.

2D Electrical resistivity imaging measuremnts

The electrical resistivity imaging technique is extensively used for all the geotechnical applications. Now the imaging technique is also applied to detect the seepage conditions around the embankment of freshwater storage reservoir located in the Industrial Complex, Thoothukudi. For the 2D electrical resistivity imaging, Wenner array was adopted. The resistivity contrast displayed in the pseudosection was used to find out the seepage of fresh water discharged from the reservoir into the paleomarine deposits around the tank in the study area. Archie, 1942 [1],[2],[3],[4],[5] have studied seepage condition around the dam site through resistivity and self potential methods. The electrical resistivity of the soil depends on saturation, porosity, permeability, ionic content of the pore fluids and clay content. The characteristic features of resistivity and streaming potential were studied by Butter et. al., 1989 [6],[7],[8],[9] and [10] using the 2D electrical resistivity method.

MATERIALS AND METHODS

The 2D electrical resistivity imaging technique is a fast and cost effective technique, which covers both vertical and horizontal changes in the surface and the subsurface of the geological formations of the study area. To determine the true subsurface resistivity, the collected resistivity data are inverted into apparent resistivity data by using RES2DINV Ver.3.56 software and iterated to calculate a resistivity model section. This approach minimizes the difference between the observed data and the calculated apparent resistivity values. The data were collected using the equipment of Aquameter CRM 500, 48 steel electrodes, 12 Volts battery, multi core cables to a length of 240m and manually operated switching unit have been used for the data collection. Wenner electrode configuration has been used for 2D electrical resistivity imaging studies.

RESULTS

The 2D electrical resistivity imaging profile generally corresponds with low and high resistivity zones respectively. The resistivity contrast technique is used to identify and correlate sub surface lithological and aquifer characteristics features of salt and fresh water around the embankments of freshwater storage reservoir tank tank.

DISCUSSION AND CONCLUSION

The profile 1 (Fig.2) trends N-S direction to a length of 180m. From the pseudosection the range of inversion resistivity values vary from 2.92 to 1552 Ohm.m. The field observation and the distribution pattern of resistivity values in the pseudosection are used to classify the field conditions as dry zone at the surface; saline soil at the bottom; freshwater admixtured sands / clay layers distributed in the subsurface and at some places upto a depth of 10m. The resistivity values for the dry layers show the variations from 137 to 503 Ohm.m. The saline soil/clay layers are distributed in the bottom of the pseudosection with the range of resistivity values from 5.36 to 19.6 Ohm.m. The sandy layers soaked with freshwater recharged from the reservoir show the resistivity values from 19.6 to 137 Ohm.m.

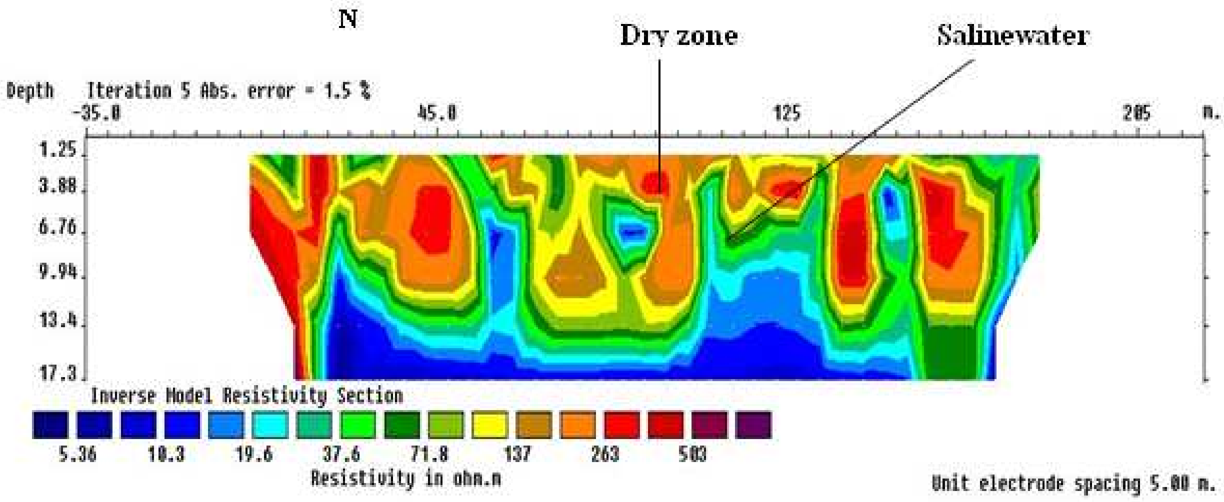

Fig. 2 2D electrical resistivity imaging pseudosection along profile 1 depicts the seepage zone around the embankment of freshwater storage reservoir.

The psedosection along the profile 2 (Fig.3) trends N10ºE-S10ºW direction to a length of 110m show the range of resistivity values from 137-503 Ohm at a depth in between 3.88 to 13.9m is interpreted as the dry zone . The sand and freshwater layers which are soaked with freshwater recharged from reservoir show the resistivity values from 19.6-137 Ohm.m are seen at a depth of 12m. The vertical seepage structure of the groundwater recharged zone is clearly demarcated in the pseudosection (120 Ohm.m) with width of 15m and to a depth 12m. The saline water formation with clay bed / alluvium sediments are identified with the low range of resistivity values from 5.36-19.6 Ohm.m at a depths of 3.88-13.4 m.

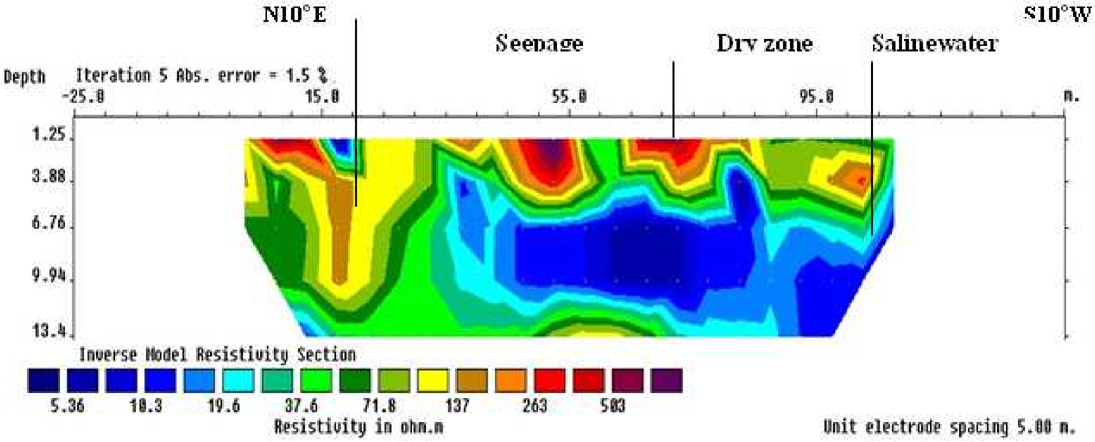

Fig. 3 2D electrical resistivity imaging pseudosection along profile 2 depicts the seepage zone around the embankment of freshwater storage reservoir.

The pseudosection along the profile 3 (Fig .4) trends N -S direction to a length of 180m exhibit the resistivity range of 137-503 Ohm.m at a depths in between 1.25 to 9.94m for dry sandy layer. For the sands saturated with freshwater the resistivity values that range from 19.6-137 Ohm.m extended to a depth of 12m. The vertical seepage is clearly identified in the profile at two points of the pseudosection and a maximum width of 15m. The vertical range of seepage zone is 18 m. Saline water with clay bed / alluvium sediments are distinguish with the low range of resistivity values from 5.36-19.6 at a depths of 9.44-17.3m.

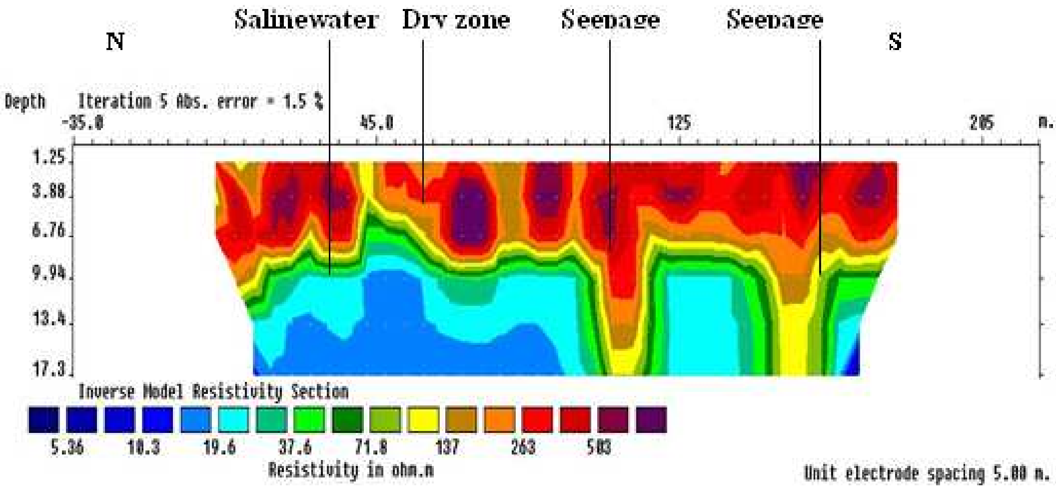

Fig. 4 2D electrical resistivity imaging pseudosection along profile 3 depicts the seepage zone around the embankment of freshwater storage reservoir.

The profile 4 (Fig.5) trends E -W direction to a length of 180m. Dry sandy layer covered in the top of the pseudosection illustrate resistivity values from 137-503 Ohm.m from surface to a depths of 1.25 to 13.4 m. For the sand immersed with freshwater reveal resistivity values that ranges from 19.6-137 Ohm.m at a depth of 17.3m. This vertical seepage feature is identified from resistivity values from 19-137 Ohm.m. The depth of the vertical seepage feature is enlarged up to a depth of 18m. Saline water with clay bed / alluvium sediments are differentiated with the low resistivity values that range from 5.36-19.6 at a depth in between 9.44-17.3m.

The analyses of the psedosections along the profiles 1-4 clearly show three broader divisions viz., dry zone; fresh water mixed sandy, clay sands and saline water enriched soil zone. The seepage zones in these psedosections are found vertical geometrical sections cutting across the overlying dry formations and underlying saline sands and clay formations.

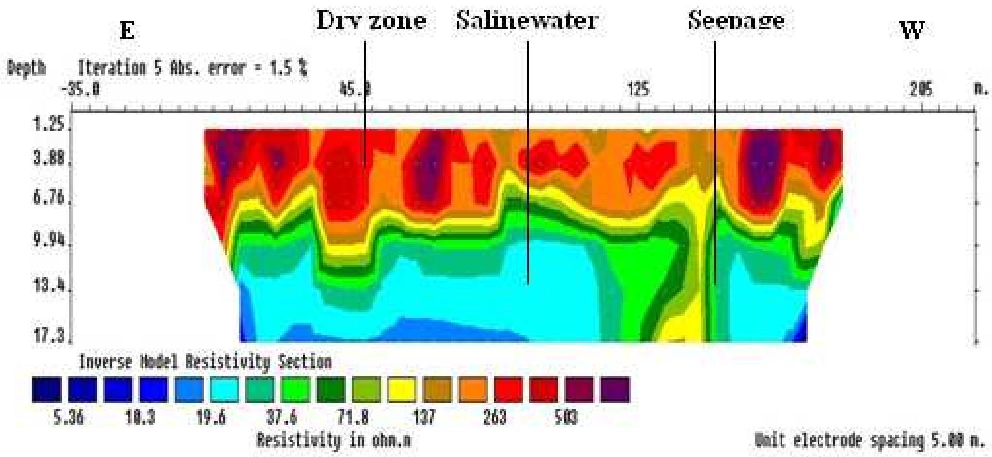

Fig.5 2D electrical resistivity imaging pseudosection along profile 2 depicts the seepage zone around the embankment of freshwater storage reservoir.

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REFERENCES

[1]. Archie GE, Electrical resistivity log as an aid in determining some reservoir characteristics": Am.Inst. *Mining and Metal. (Engr. Transl.),* **1942**,pp 54-62.
[2]. Antony Ravindran,A. Ramanujam., Manimaran and Manimaran., *Research Journal of Earth Sciences*.,2011,pp 57-62.
[3]. Sirles P,*Seepage investigation using geophysical techniques at Coursier Lake Dam, B. C., Canada". Symposium of the Geophysical Application to Environmental and Engineering Problems (SAGGEP),* Reno-Nevada, **1997**,pp.321-331.
[4]. Johansson S, and Dahlin T., Seepage monitoring in Hällby embankment dam by continuous resistivity measurements" *Procs. 8th Congress of the International Association of Engineering Geology and the Environment*,**1998**, pp.21-25.
[5]. Johansson S, "Seepage monitoring in embankment dams. Doctoral Thesis", *TRITA-AMI PHD 1014*, ISBN 91-7170 792-1, *Royal Institute of Technology*, Stockholm.,**1997**, pp49.
[6]. Butler D.K, Llopis J.I., and Deaver C.M., "Comprehensive geophysical investigation of an existing dam foundation. Geophysics" *The Leading Edge of Exploration*,**1989**,pp10-18.
[7]. Johansson S, and Dahlin T, *European Journal of Engineering and* Geophysics., 1, **1996**, pp 229-247.
[8] Debashri Mondal, Joydeb Pal, Tarun Kanti Ghosh and Arun Kanti Biswas, *Advances in Applied Science Research*. ,3(3), **2012** pp. 1335-1345.
[9] Aigbogun and J.C. Egbai, *Advances in Applied Science Research* 3(2),**2012** pp.625-633.
[10] George, N.J., Obianwu V.I. and Obot, I.B, *Advances in Applied Science Research 2(1).**2011.*** Pp163-177.