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Extension of Runway at Pantnagar Civil Airport for Water Logged Region

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Abstract—*Water logging is the natural occurrence of water on the surface of the soil, due to lack of percolation and excessive capillary action of water in the sub-soil layers. Water logged areas are those lands where the level of sub-soil water and the standing water layers are such that, the sub layer just below the land surface is well beneath the capillary fringe of the water table. Various techniques like providing sub-layer drains, introducing capillary cut-off, raising embankment height, etc. are considered in the field while encountering such conditions*

Pantnagar airport being a neighbor to the Rudrapur city is also a central hub for industries which demand an extension in length of the existing runway. Water logging is experienced at different locations, as this region receives a heavy amount of rainfall year long. This paper provides details of field inspection, laboratory test results and remedial measures suggested for lowering ground water table for future consideration of extension of the runway.

1. INTRODUCTION

The Pantnagar Civil Airport is located near G. B. Pant University of Agriculture & Technology, approximately at 247km distance from Delhi, and is a prime location for air travels as is located on the foothills of Himalayas and lying at an elevation of about 234m above MSL. Also the airport is situated at a distance of mere 15km from Rudrapur City and at a distance of about 5km from SIDCUL, Tata Motors and Ashok Leyland. Due to the presence of heavy density of industries and commercial sectors the airport gains a huge amount of importance from even business point of consideration, leaving part the transport point of consideration. All these aspects demand for a smooth and regular functioning of the airport and hence there may arise the need for extension of the present runway or even development of an additional one. Considering the future perspective of development a study of the surrounding region of the present airport runway was conducted and a mammoth problem of water logging was encountered. Water logging is a natural accumulation of water on the surface of the soil and in the sub-soil layers. Pantnagar being a region receiving a heavy rainfall of about 80 to 90mm in a single day and at times have even registered as heavy as 200 to 225mm in a single day. Due to the heavy rainfall conditions and a high ground water table, the region experiences a widespread problem of water logging.

2. SUB-SOIL LAYER INVESTIGATION

In order to get a clear view of the various considerations of the geotechnical aspects, a thorough study of the sub-soil layers is necessary. Hence, to obtain a detailed knowledge of the sub-soil layers, certain disturbed and undisturbed samples of soil were collected from different locations and tested under standard conditions as prescribed by the Indian Standard Codes (i.e. I. S. Codes). The undisturbed soil samples were collected with the help of standard core-cutters. Further the disturbed soil samples were obtained from the two boreholes dug, namely Point 1(P1) and Point 2 (P2), both of depth 10.5 feet, as shown in fig.1 with a dia. of 100mm using a hand auger and extension rods. Laboratory experiments were conducted at the Civil Engineering Department's Laboratories of College of Technology, G. B. Pant University of Agriculture and Technology, Pantnagar.

A detailed description of the two bore holes P1 and P2 is provided below along with the various soil properties and the results obtained after the laboratory experiments tabulated in Table 1 and Table 2 for Point1 (P1) and Point 2 (P2) respectively.

Fig. 1: Bore Hole at Point 2 (P2)

Fig. 2: Location of the Points of Boring i.e. Points P1 and P2

2.1 Sub-Soil Investigation Results at Point 1(P1)

Co-ordinates: Latitude: 29.034103N

Longitude: 79.476162E

Elevation: 762 feet MSL

Bulk Density of Soil: 1.543g/cm^3

Ground Water Table: 9.5 feet below soil surface

Table 1: Test Results on Sub-soil Samples at Point 1(P1).

Properties	Quantities			
Depth (in feet)	2.5	5.5	7	10.5
Soil Type	SM	SM	SM	ML
Liquid Limit (LL)	30	25	25	27
Plasticity Index (PI)	8	N. P.	N. P.	7
Gravel %	9.15	4.72	5.7	0
Sand %	44.650	38.120	48.480	15.945
Silt %	46.850	56.480	45.400	76.000
Clay %	3.475	0.680	2.240	8.315

2.2 Sub-Soil Investigation Results at Point 2(P2)

Co-ordinates: Latitude: 29.035521N

Longitude: 79.455629E

Elevation: 745 feet MSL

Bulk Density of Soil: 1.687g/cm^3

Ground Water Table: 5 feet below soil surface

Table 2: Test Results on Sub-soil Samples at Point 2(P2).

Properties	Quantities			
Depth (in feet)	2.5	5.5	7.5	10.5
Soil Type	SM	ML	SC	SM
Liquid Limit (LL)	26	29	25	27
Plasticity Index (PI)	N. P.	5	N. P.	N. P.
Gravel %	6.920	1.480	10.880	35.200
Sand %	43.960	12.360	25.960	38.750
Silt %	43.560	67.440	44.040	21.050
Clay %	5.560	18.720	19.120	5.000

3. CONCLUSION FROM SUB-SOIL LAYER INVESTIGATION

Considering the results obtained from the sub-soil layer investigation, a common occurrence of the sandy nature of the soil is evident, for example, considering the point P1, we obtain consecutive SM nature at depths 2.5 feet, 5.5 feet and 7 feet. Also, from point P2 a sandy nature exhibited by the soil is obtained at depths 2.5feet, 7.5feet and 10.5feet with specific nature being SM, SC and SM respectively.

3.1 Disadvantages of Presence of Sand in the Sub-Soil Layer

The presence of water in the soil layers reduces the bearing capacity of the soil, and especially in case of the sandy soil**,** the bearing capacity of the soil reduces up to 50%, which in turn results in erosion of the soil.

There is also a problem of water logging being encountered in several locations. The major reason being the location of the airport in a heavy rainfall region which receives rainfall ranging from a normal 80 to 90mm precipitation to a maximum of 200 to 225mm, considering a single day duration. The second major reason is the poor drainage of soil, which can be justified from the fact that a high concentration of clay is present in the sub-soil at point P2. The clay content is 5.560% at a depth of 2.5feet and is as high as 19.120% at 7.5feet depth. It is also observed that the point P2 lies at a lower elevation than the present airport location hence, it is a prime location for water accumulation from the surrounding regions.

Fig. 3: Water Logging at Extension Site

3.2 Disadvantages of Water logging

The prolonged exposure of the sub-soil layer towards water logging results in the development of shallow water table, which in turn causes wearing on the surface layer of the pavement, composed of thin bituminous layer, and eventually leads to the loss in binding capacity of the particles of bitumen. This loss in binding capacity may lead to development of cracks on the runway and may even make the surface of the pavement very much prone to skidding.

The results observed from the above conclusion clearly demand for the adoption of certain corrective measures which may prove effective in checking the problems encountered at the airport region. There are various methods to be implemented as corrective measures to check sandy soil disadvantages as well as that of water logging. The following listed methods may be considered most suitable.

4. CORRECTIVE MEASURES

4.1 Corrective Measures for Checking Sandy Soil Problems

4.1.1 Adoption of French Drains

French Drain, also known as Rubble Drain or Rock Drain or Blind Drain or Perimeter Drain, provides an easy channel for water to flow through in sandy soil regions where the soil can't retain the water from surface. Water runs into gravel-filled trench, then into perforated pipe at the bottom of the trench. Water flows freely through the pipe and empties a safe distance. The slope of the trench should be maintained at 1inch to 8feet in the direction of flow of water. The diversion of water can be as per the situation, and hence can be diverted to:

- Low lying area
- Drainage ditch
- Dry well

A standard French Drain is depicted in the Fig. below (**Fig. 3**). The dimensions commonly adopted are 2feet and 1.5feet across.

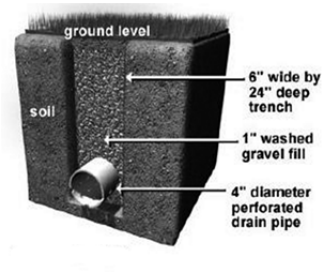

Fig. 4: Cross Section of French Drain

4.2 Corrective Measures for Checking Water Logging Problem

4.2.1 Raising the Embankment below the Surface of the Pavement

The problem of water logging can be mitigated by providing a sufficient difference between the existing water table and the surface water. The most preferred method for such a critical type of corrective measure may be considered as the digging of certain depth of a foundation trench (a.k.a. C=cut-off layer) and then pumping out the present water, either manually or through the usage of certain mechanical pump. The cut-off layer provided should comprise of certain means to drain out the regular inflow of water. This task maybe carried out using certain perforated pipes which drain the water to certain other location. Some additional material may also be provided to support the foundation cut-off layer beneath the embankment.

2.2.2 Thirsty Concrete

The problem of water logging in the airport region arises due to either the presence of high water table or due to the lack of percolation of the surface water, i.e. lack of drainage. If there happens to be a situation that both these problems need to be handled simultaneously, then a cumulative approach off draining the surface water and lowering the water table can be applied together. Hence, a unique combination of usage of "Thirsty

Concrete" and that of perforated pipes can be adopted. In this approach a concrete made up of Top mix permeable (manufactured by Tarmac) as the surface layer of the pavement and thus drain the water as soon as it falls on the surface of the pavement. This drained water can then be drained out with the help of perforated pipes present in the lower lying sub-soil. The presence of perforated pipes may even enhance the draining away of the ground water, if present, to a separate location away from the pavement surface, hence minimizing the effect of water logging. This method is still under research, and hence in future may work out as a boon for further construction, with sufficient cost effectiveness.

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