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Design of Domestic Airport in Hilly Terrain

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Abstract: ***In this project we have designed a domestic Airport for hilly terrain. In this we had designed the terminal building, runway and taxiway. Also we had used the natural light for day time and solar panels for electrical needs of the Airport. We have provided service road and ambient parking for passengers. By testing the site conditions such as soil testing, wind speed test and collection of rainfall data we have decided the direction of runway then after we have designed the pavement for runway .For convenience of passengers we have also planned the terminal building. Taxiway and other communication facilities also have provided for airport. We have provided concentric panels for the electricity generation and supplied to the terminal building.***

Keywords: Domestic Airport, Helipad, Hilly Terrain, Runway, Terminal Building.

I. INTRODUCTION

There are very few airports constructed in hilly terrain, there are many constraints which must be considered in designing an airport in hilly region. Transport means to carry from one place to another. It is difficult to imagine those old days when small communities were inhibiting in distant tracks of land and were economically self-sufficient with respect to production of all vast range of goods. As we are in 21st century the need for transportation and communication are increasing day by day. Air transport is fastest way of transport flying at more than speed of 300 Kmph. The aim of this project is to demonstrate accessibility and feasibility of Domestic airport for hilly area and also to design domestic airport in hilly terrain considering various parameters.

II. SELECTION CRITERIA

i) For the site selection of airport design we have observed two sites

Sr. No.	Factors	Dabewadi Site	Mahagaon Site	Remark
1.	Atmospheric & metrological conditions	Occurance of Fog And Smoke	No Occurance	Mahagaon site suitable.
2.	Land for expansion	Available	Available	Both are suitable.
3.	Utility services	Available	Available	Both are suitable.
4.	Surrounding Area	Nearby Hilly Area	Away From Hilly Area	Mahagaon site suitable.
5.	Economy of construction	Economical	Economical	Both are suitable.
6.	Ground Accessibility	Accessible	Not Easily Accessible	Dabewadi site suitable.
7.	Regional Plan	Not Found	Found	Mahagaon site suitable.

8.	Soil characteristics	Easily Drainage Available	Easily Drainage Available	Both are suitable.
9.	Surrounding obstructions	Obstruction Due To Hilly Area	No Nearby Obstructions	Mahagaon site suitable.
10.	Topography	Flat Ground	Raised Ground	Mahagaon site suitable.
11.	Use of Airport	Domestic Or Military use	Domestic Or Military use	Both are suitable.

-The above sites observed are located in Satara district, Maharashtra, India. From the above two sites the Mahagaon site is taken into consideration for construction of airport.

(a)Mahagaon site, Satara, India **(b)Dabewadi site, Satara, India**

Fig. 1 Site observed (a) & (b)

ii) Typical wind data for observed site

The table given below shows the average wind data of 5 to 10 years for Observed site.

Table 3 Wind data

Wind Direction	Percentage of time/duration of wind			Total percentage of wind blowing in each direction
	6-25 Km p.h.	25-50 Km p.h.	50-80 Km p.h.	
N	5.90	1.40	0.00	7.30
NNE	6.90	0.02	0.00	6.92
NE	4.60	1.40	0.10	6.10
ENE	3.40	0.75	0.00	4.15
E	1.80	0.03	0.10	1.93
ESE	2.80	0.02	0.03	2.85
SE	2.10	2.20	0.00	4.30
SSE	5.40	4.75	0.00	10.15
S	6.40	1.40	0.00	7.80
SSW	7.50	0.02	0.00	7.52
SW	4.60	1.40	0.10	6.10
WSW	2.40	0.75	0.00	3.15
W	1.20	0.03	0.10	1.33
WNW	3.60	0.02	0.03	3.65
NW	1.80	2.20	0.00	4.00
NNW	6.00	4.75	0.00	10.75
Total	66.40	21.14	0.46	88.00

From the above wind data the wind rose diagram can be drawn.

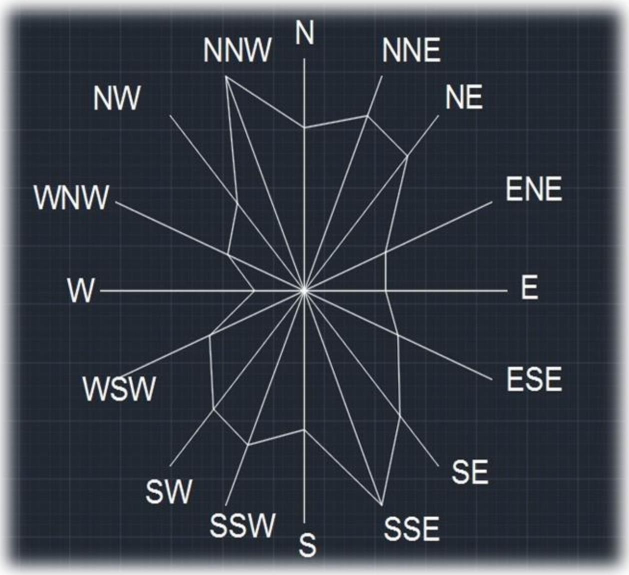


Fig. 2 Wind rose diagram

iii) Rainfall data from 2005-2016

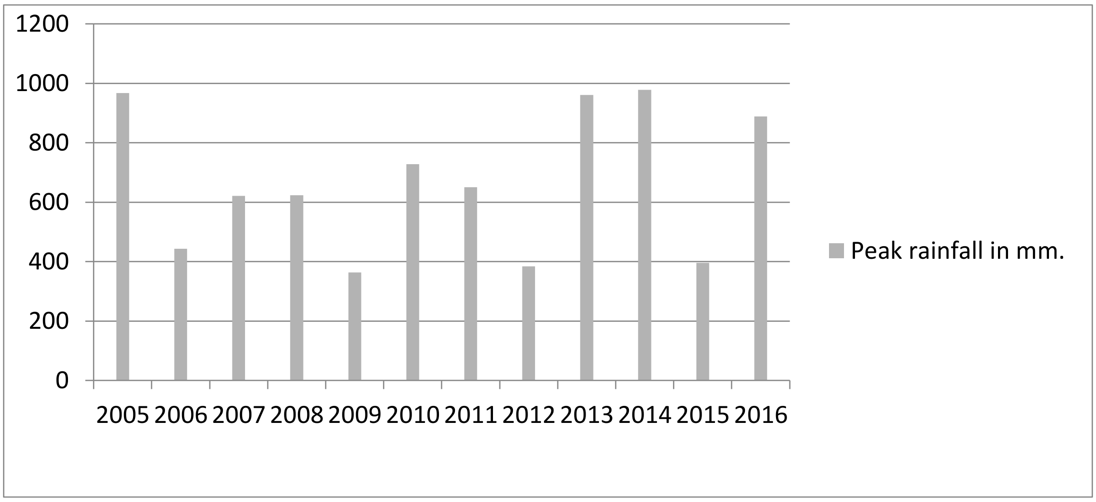


Fig. 3 Rainfall data

III. TEST CONDUCTION AND EXPERIMENTATION

A) Determination of Moisture Content by oven drying method.

Fig 4 (a) & (b)-Water content by oven drying method.

Table 4 Observation Table

1.Container no.	D_1	D_2	D_3	D_4	D_5
2.Mass of container(M_1) gm	17.68	18.29	19.20	17.70	19.11
3.Mass of container+wet soil (M_2)gm	73.56	69.27	73.27	73.59	72.99
4.Mass of container with oven dried soil (M_3)gm	66.20	65.94	69.37	66.96	63.50
5.Mass of dried soil (M_3-M_1)gm	48.52	48.10	50.17	48.46	45.39
6.Mass of water fill (M_2-M_3)gm	7.36	3.33	3.90	7.43	9.49
7. Water content (%)	15.16	6.92	7.77	15.33	20.90

i) Result: The average water content of the soil is 13.21%.

ii) Conclusion: Water content of soil is 13.21%, which is feasible. The permissible limit is 20-30%, which indicates no preventive measures to remove water content are required.

B) Determination of field density by Core Cutter Method.

Fig. 5 (a) & (b) - Field density by Core Cutter Method.

Table 5 Observation Table

Determination no.	D_1	D_2	D_3	D_4	D_5
1.Mass of empty core cutter (M_1)gm	940	940	940	940	940
2. Mass of core cutter + wet soil (M_2) gm	2590	2980	2765	2830	2598
3. Mass of wet soil (M_2-M_1) gm	1650	2040	1825	1926	1648
4.Volume of core cutter (V)m^3	1300	1300	1300	1300	1300
5.Bulk Density = (M_2-M_1)/V) gm/cc	1.27	1.57	1.40	1.47	1.28
6.Density of soil $\rho_{d=}\rho/(1+w)$ gm/cc	0.083	0.102	0.221	0.238	0.092

i) Result: The average bulk density of the soil is 1.43 gm/cc.

ii) Conclusion: The bulk density of the soil is 1.43 gm/cc. Thus the soil is fairly dense therefore compaction is required so we dry compaction by pneumatic roller.

C) Determination of specific gravity by using Pyconometer.

Table 6 Observation table

Pycnometer details	D_1	D_2	D_3
1.Mass of empty bottle (M1)gm	640	610	645
2. Mass of bottle + soil (M2)gm	745	705	745
3. Mass of bottle + soil + water (M3)gm	1595	1550	1575
4. Mass of bottle full of water (M4)gm	1520	1490	1520
5. Mass of soil (M2-M1)gm	105	95	100
6. Mass of water used (M3-M2)gm	850	845	830
7. Mass of water in full bottle (M4-M1)gm	880	880	875
8.Volume of soil particles (M4-M1)-(M3-M2)	30	35	45
9.Specific Gravity $G_{s=}$(M2-M1)/((M4-M1)-(M3-M2))	3.50	2.70	2.22
10.Average specific gravity		2.80	

i) Result: The average specific gravity of soil is 2.80

ii) Conclusion: The Specific gravity of soil is 2.80. The permissible limit is 2.65-2.85 hence the values of soil properties such as void ratio, porosity and degree of saturation etc. are within the permissible limits.

IV COMPONENTS OF AIRPORT

i) Runway: The basic runway length will depend on the category in which the airport falls as per ICAO classification. The actual runway length is obtained by making adjustments for elevation, gradient and temperature with the basic runway length.

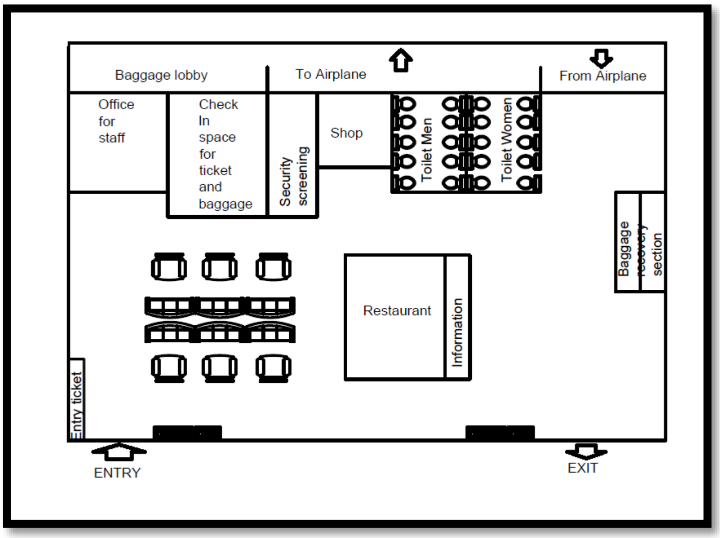
a) Safety area: The runway safety area is an area which is cleared, drained and graded
As per the ICAO recommendations, the minimum width of safety area should be as follows:
For instrumental runway: 300 m
For non-instrumental runway: 150 m for A, B and C types of airports.

b) Sight distance: For A, B and C types of airports, any two points 3 m above the surface of runway should be mutually visible from a distance equal to half the runway length.

For D and E types of airports, there should be unobstructed line of sight from any point 3 m above runway to all other points 2 m above runway within a distance of at least one-half the runway length.

c) Width: The runway width varies from 45 m to 18 m depending upon the type of airport. The midway of runway is governed by the following two main considerations that is Air-traffic and Outermost edge of aircraft.

ii) Terminal Building: It usually refers to a building which is mainly used for the passengers, airline staff and administrative management. For big commercial airports, it may also provide accommodation for various operational activities like control tower, weather bureau, etc. In hilly terrain the



(Fig. 6- Plan for terminal building)

iii) Taxiway: The main function of taxiways is to provide access from the runways to the terminal area and service hangars. It is evident that the speed of aircraft on the taxiway will be much less than that on the runway at the time of landing or take off. The standards for the taxiway design and construction will therefore not be as rigorous as for the runway. A terminal taxi lane is a taxiway on an apron used for the access to the gate positions.

iv) Concentrating type solar panels

Concentrated solar power systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight, or solar thermal energy, onto a small area. Such solar panels can be installed parallel direction along the runway. The process of power generation is initiated from the parabolic reflector, then the rays are concentrated to a receiver this heat is stored in two forms viz. Hot storage and cold storage then after transmitted to the heat engine with further converts the heat energy into electric energy.

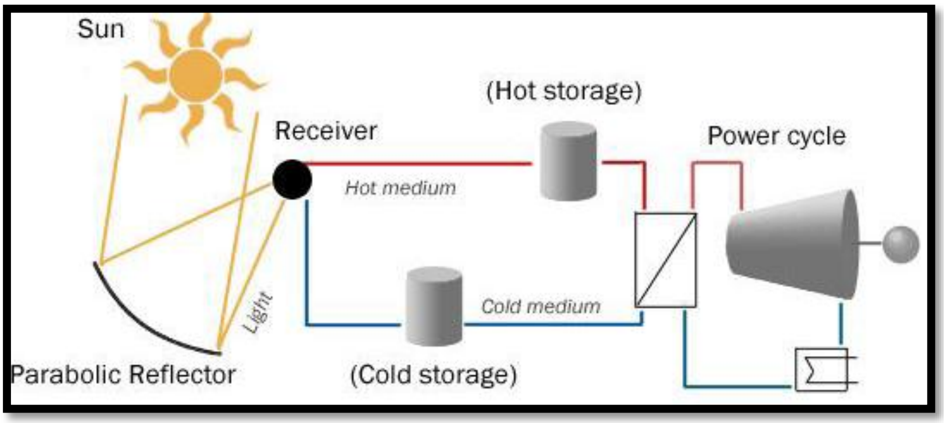


Fig. 7 concentrating type solar panels.

CONCLUSION

The aim of this paper is to demonstrate feasibility and accessibility for construction of domestic airport in hilly terrain by considering well known characteristics of such as soil, climatic conditions and geographical conditions. This paper covers various experiments and their actual results. The constraints occurs during the design of airport can be minimised through various techniques and equipment's.

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