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Wind analysis for wind power : Part II

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ABSTRACT. The paper contains the frequency distribution of hourly values of winds of Baroda in south Gujarat in the four ranges, *viz.*, light, moderate, strong and very strong with the objective of utilisation of energy from winds for tthe windmills. A comparison has also been made with the results of similar studies made earlier in respect of Ahmedabad in north Gujarat.

1. Introduction

Utilisation of energy from the winds has assumed significant importance in the context of the energy crisis which is one of the challenging problems facing the world to day. In India there is much scope for making use of the wind power. In planning the locations, the type and design of the most suitable types of windmills information on winds at the desired locations is very valuable. In an earlier communication (Thomas 1981) the author has analysed the hourly values of winds at Ahmedabad for a five-year period 1973-77 and has presented a frequency distribution of hourly values of winds in the four ranges 0-9, 10-14, 15-19 kmph and 20 kmph & above. A monthwise frequency distribution was also presented. In the present paper the author has made a similar study in respect of Baroda which is situated in south Gujarat. Wind data from the Dines Pressure Tube Anemograph records during the five-year period from 1973-1977 have been analysed. Whereas Ahmedabad may be taken to be representative of north Gujarat, Baroda may be taken to be representative of south Gujarat in a broad sense.

2. Procedure

The Dines Pressure Tube Anemograph is located at Science College, M. S. University (within the university campus). Its sensor is at a height of 22.6 m above ground level.

From the records of the Dines Pressure Tube Anemograph at Baroda ten-minute average wind speed value for each hour (ten-minute ending at the full hour) for all the 24 hours of the day were tabulated. These values are representative of the wind speeds at the corresponding hours. These tabulated values for a period of five years, *viz.*, 1973 to 1977 have been analysed.

Then, as in the case of the earlier study of the Ahmedabad winds, wind speeds have been classified into four groups as follows: Wind speeds (i) Light (L) 0-9 kmph, (ii) Moderate (M) 10-14 kmph, (iii) Strong (S) 15-19 kmph and (iv) Very Strong (VS) 20 kmph & above.

The number of days in a month when the wind speed at each hour was falling in each of the above four groups was determined. This was done in respect of all the 24 hours. Thus the classification was done for one month. In the same manner classification for all the months for all the above five years was made. Thus the frequency distribution according to the four groups L, M, S and VS, in respect of each hour for all the months for all the five years was prepared.

3. Frequency analysis and results

The first type of analysis made was to find the hourly frequency distribution of all wind data in the four groups. It was found that there were 26,578 hours of light winds, 9,184 hours of moderate winds, 4,108 hours of strong winds and 2,449 hours of very strong winds during the five year period. This is graphically indicated in

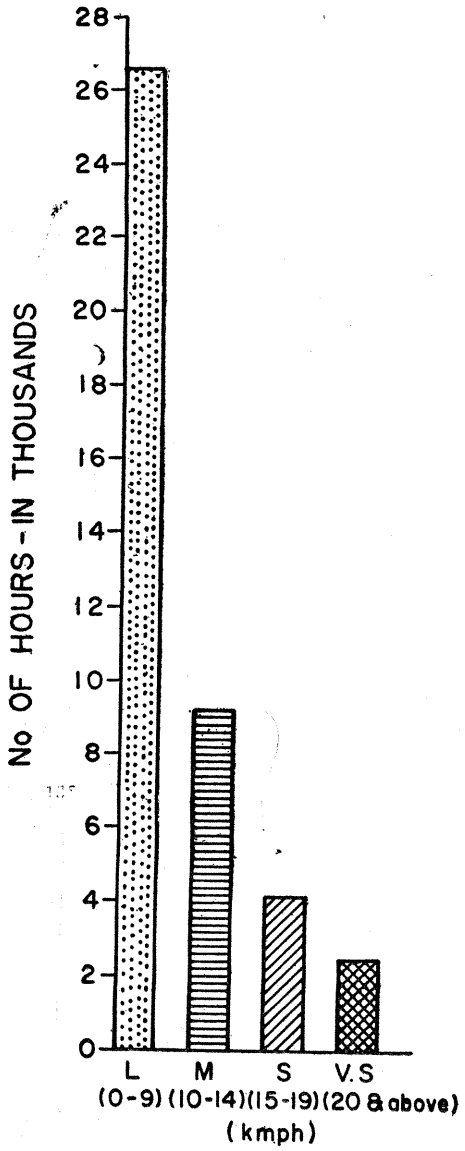

Fig. 1. Winds at Baroda, Period: 5 years (1963-1977)

TABLE 1

Highest maximum gust recorded Baroda (BRD) *versus* Ahmedabad (AHM)

Year	Highest maximum gust (kmph)	
	Baroda	Ahmedabad
1973	75	79
1974	78	84
1975	79	84
1976	80	77
1977	91	105

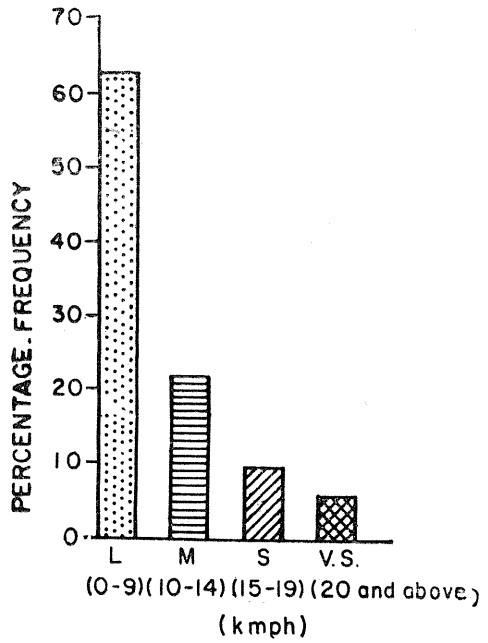

Fig. 2

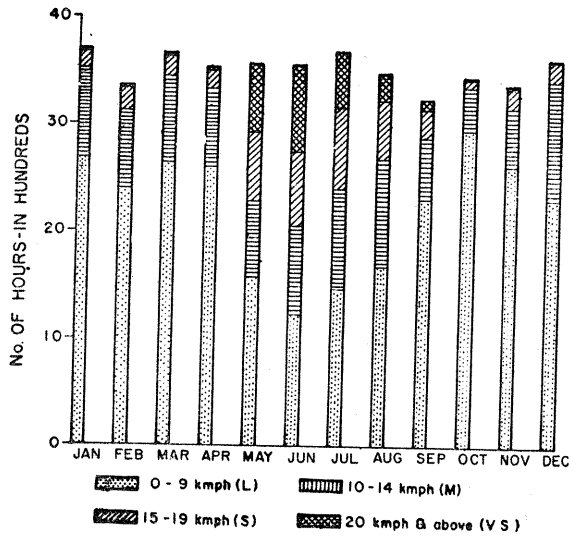

Fig. 3. Histograms of winds at Baroda, Period : 5 years (1973-1977)

Fig. 1 (for about 560 hours during this five year period data were not available due to some break in the records or unserviceability of the instrument). This frequency distribution expressed as percentage distribution is represented in Fig. 2. It can be seen from Fig. 2 that light winds prevail for 62.8 per cent, moderate winds for 21.7 per cent, strong winds for 9.7 per cent and very strong winds for 5.8 per cent of all the hours in a year at Baroda. In other words, for 37.2 per cent of the hours in a year the winds are above 9 kmph, when windmills could be

TABLE 2

Percentage frequency distribution of the No. of hours of winds falling in different groups (monthwise) Baroda *versus* Ahmedabad

Month	L (0-9 kmph)		M (10-14 kmph)		S (15-19 kmph)		V.S. (20 kmph & above)	
	BRD (%)	AHM (%)	BRD (%)	AHM (%)	BRD (%)	AHM (%)	BRD (%)	AHM (%)
January	73.2	46.9	22.5	29.7	4.2	14.5	0.2	8.8
February	70.9	38.2	22.3	34.5	6.2	15.2	0.6	12.1
March	72.2	46.8	21.7	29.1	5.4	14.4	0.7	9.7
April	73.6	35.5	21.2	34.8	4.4	20.8	0.8	9.0
May	42.9	21.7	21.1	30.8	18.0	25.6	18.0	21.9
June	34.4	21.6	22.9	26.1	19.6	23.7	23.1	28.5
July	39.9	35.9	25.3	33.8	20.7	17.5	14.1	12.8
August	48.6	41.9	28.4	31.1	15.8	17.8	7.2	9.2
September	71.6	49.1	17.1	31.9	8.4	12.4	2.9	6.6
October	87.2	63.2	10.1	23.1	2.4	8.8	0.4	4.9
November	77.9	65.5	15.9	21.3	5.9	7.5	0.4	5.7
December	64.0	56.0	30.8	25.3	5.0	12.1	0.2	6.7

effectively operated. However, as most of the light winds are at night times, the hours when windmills could be effectively operated in day time alone will have a higher percentage.

The second type of analysis made was to classify the wind speeds into the four groups monthwise. The number of occasions under each group for all hours for each month for all the five years were added up. This gives the frequency distribution in the four groups of all the winds for all the hours for each month for all the five years. The results are graphically represented by histograms in Fig. 3. These give useful information as to which are the months when windmills could be used with the best advantage. It can be seen from the figures that the more favourable months are May, June, July and August and the least favourable month is October.

4. Protection against very strong winds

There is one more factor which has to be considered in the design of windmills, *viz.*, the sturdiness or the minimum requirement for the windmill to withstand some unusual gust of very strong wind likely to be encountered at the locality. For this the peak winds recorded at Baroda for the five-year period in question were examined and the values of the highest maximum gust of wind recorded year wise are indicated in Table 1 (along with corresponding values for Ahmedabad).

5. Comparative study

As Ahmedabad could be taken as representative of north Gujarat and Baroda as representative of south Gujarat, it would be worthwhile making a comparison of the results of the analysis of winds at Ahmedabad presented by the author in earlier paper (Thomas 1981) and the results of the analysis of winds at Baroda presented in this paper. Table 2 presents the percentage frequency distribution of winds, monthwise for Baroda *versus* Ahmedabad. On making a comparative study, the following facts emerge:

(*i*) The percentage frequency of the number of hours of light winds is considerably more in Baroda than in Ahmedabad during practically all the twelve months of the year.

(*ii*) Taking the year as a whole, at Baroda only for 37.2 per cent of the hours in a year the wind speed is more than 9 kmph whereas at Ahmedabad for 56.3 per cent of the hours in a year the wind speed is more than 9 kmph.

(*iii*) The percentage frequency of the number of hours of medium winds (10-14 kmph) is less at Baroda than at Ahmedabad during all the months except December when it is more at Baroda.

(*iv*) If we consider the strong winds (15-19 kmph), the percentage frequency of the number of hours in practically all the months is less in Baroda than in Ahmedabad by an appreciable margin except in the monsoon months when the margin is less and in July the percentage frequency of the number of hours is, in fact, more in Baroda than in Ahmedabad.

(*v*) If we consider the very strong winds (20 kmph & above) the percentage frequency of the

number of hours at Ahmedabad is higher than at Baroda by a remarkably large margin during the non-monsoon months and by a relatively small margin during the monsoon months. In July the percentage frequency of the number of hours is, in fact, more in Baroda than in Ahmedabad.

(*vi*) In order to make a comparison of the required degree of sturdiness of the windmills at Ahmedabad and Baroda the findings of Jain (1971) will be very useful. Jain, based on the highest wind speed in gusts recorded in each year, has determined maximum wind pressure force (kg/m^2) for various return periods in respect of various stations in India by using the theory of distribution of extreme values. He has found that at Ahmedabad for return periods of 10 years and 25 years the maximum wind pressure force is 95 and 133 kg/m^2 respectively, whereas at Baroda for return periods of 10 years and 25 years the maximum wind pressure force is 40 and 46 kg/m^2 respectively. (These findings of Jain are based on 10 years data, *viz.*, 1948-57 for Baroda and 17 years' data, *viz.*, 1953-69 for Ahmedabad). It can be inferred from this that, depending upon whether the windmills will have an expected life of 10 years or 25 years, those at Ahmedabad will have to be able to withstand about 2 or 3 times respectively the maximum wind pressure force at Baroda.

6. Conclusion

(*i*) Generally speaking, conditions in north Gujarat are more favourable for the operation of windmills than in south Gujarat.

(*ii*) Only in the month of July, due to more frequent occurrence of strong to very strong winds in south Gujarat, conditions are more favourable there for operation of windmills than in north Gujarat.

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