NUMERICAL SIMULATION OF WIND PATTERN FOR WIND ENERGY GENERATOR

Rajendra V. Kharul , Surendra S. Parasnis * and M. G. Takwale

School of Energy Studies, Department of Physics,
University of Pune, Pune - 411007
* Indian Institute of Tropical Meteorology ,
Dr. Homi Bhabha Road, Pashan,Pune - 411008

Introduction

Though meteorological observational network is increased largely in last few years, it is inadequate for the accurate estimation of wind potential of India. Economically it is not feasible for the developing country like India to have large dense and automatic weather observational network. Hence, here an attempt has been made to studynumerical simulation of wind pattern for wind potential assessment, which is commercially accepted approach.

Numerical simulation provides an objective method for interpolation or extrapolation of wind data and also estimate the effects of terrain, surface roughness, stability of the atmosphere and the distance from the coast of the station on air flow mechanism. Different types of numerical simulation models whose use depends on the type of application, area under consideration, topography of the terrain, type and density of available observations for the input of the model are available in various space dimensions like 1-D, 2-D and 3-D. Each model has its own advantages and disadvantages over one another. Among these are the prominently used WAsP (1), MS-Micro/2 (2) etc models for wind potential assessment.

Study of these models reveals that

1) These models have been developed for temperate latitude countries and are based on geo - strophic similarity principle; assuming reasonably high coriolis forces.

2) In the tropical country like India where the air flow is dominated by large stability variations in the atmosphere and the monsoon phenomenon; these models may not give appropriate results. The major problem in studing these models for tropical region is inadequacy of suitable meteorological data for input of the model in high wind speed located regions.

In this work an attempt has been made to study vertical extrapolation of wind data using single or two level hourly averages of wind speed using generally used power law method.

Method of Analysis

Numerical simulation of wind speed simply means horizontal and vertical extrapolation of wind data. Horizontal extrapolation of wind speed is some what difficult task if we consider the data availability in India. Hence vertical extrapolation is studied. Out of different methods available for vertical extrapolation based on power law and similarity theory in literature, the simplest power law method is used here in two different manners summarized below in table no. 1.

Table no. 1 Vertical Extrapolation Methods Based on Power Law

Data available at/ near the site	Method to be used	Mathematical formula
Wind speed at single level with height of anemometer	1/7th power law, generally used, gives rough estimates.	$\frac{\overline{U}_2}{U_1} = \left(\frac{Z_2}{Z_1}\right)^{1/7}$
Wind speed at two levels with height of anemometers	Monthly/hourly means of power law index, gives better estimates	$\frac{\overline{U}_2}{U_1} = \left(\frac{Z_2}{Z_1}\right)^{x}$

Experimental Work

Single level wind speeds data (hourly averages) were extrapolated upto 200m a.g.l. at differnt levels such as 10, 25, 35, 50, 75, 100, 125, 150 and 200 m.a.g.l. Here after the method I and II means the using 1/7th power law and monthly mean of the power index respetively, which were used for extrapolations. Ten stations data from Maharashtra which includes Chalkewadi, Cobala, Deogad, Lonawala, Malwan, Nagpur, Panchgani, Santacruz, Vengurla and Vijaydurg were used for analysis which was available with references (3,4).

Computer simulation programmes were developed for the purpose of vertical extrapolation . The extrapolated annual mean wind speeds variation with height are shown in figures for different stations.

Results And Discussion

The results generated by computer simulation programs using method -I and -II shows that, in general, method -II gives better estimates of annual mean wind speeds than normaly used method -I . It is observed that method -I gives over estimates than method -II in case of Deogad, Chalkewadi and Vijaydurg .While for Colaba, Panchgani, Santacruz, Malwan and other stations it gives lower estimates of annual mean wind speeds .

Wind speed increases with height tending to saturation i.e. geo-strophic wind speed with method-I, while using method -II it may decrease in different months depending on location . Generally, maximum wind speed are noted in the months of July/August and minimum in September/October months which is expected because of monsoon and post monsoon season.

For Chalkewadi wind data at 20 m.a.g.l. were used for extrapolation. The figure 1.0 shows that if method -II is used, which is more accurate and depends on actual data base collected at the site, the annual mean wind speeds for different heights are same as that of at 20 m.a.g.l. Wind speed do not increase vertically. While method -I shows exponential increase in wind speed with height. This may be because of wrong exposure to the anemometers. As annual mean power law index calculated from the 'two level actually measured data' from the same station is 0.0013, which is very much less than the normal value of power index, it is seen in figure 1.0 that method -I gives over estimates than method-II .

This can be concluded with keeping in mind that validation/testing of these methods with actual wind profiles is not carried out because of non-availability of wind profiles at these stations. It is possible to improve the methods of assessments of wind potential using more realistic approach for vertical extrapolation of wind speeds. It is being tried to develop full fledge 3-D numerical simulation model for assessment of wind potential, incorporating influences of complexity of terrain, physical processes in surface boundary layer, stability of atmosphere etc which influences the wind flow.

Symbols

$\overline{U}$ ---- Mean wind speed at different levels.
x ---- Power law index.
Z ---- Height of anemometers at different levels.

Acknowledgement

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References

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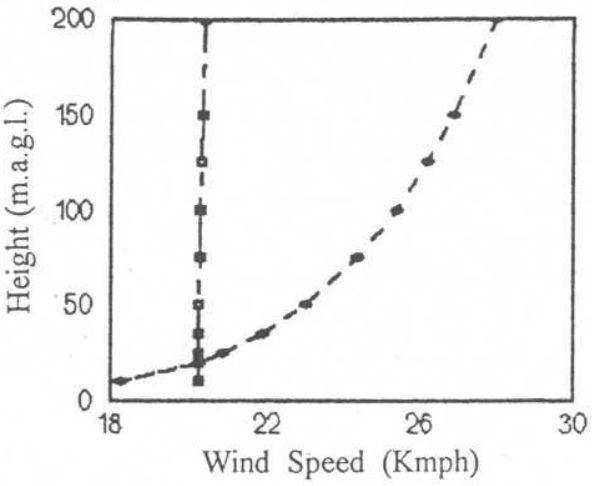
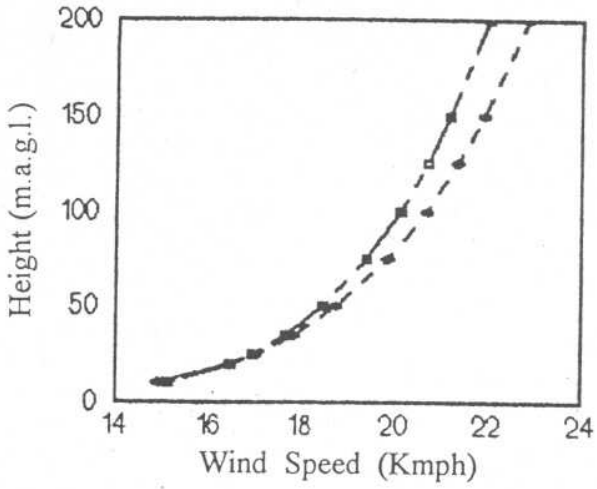
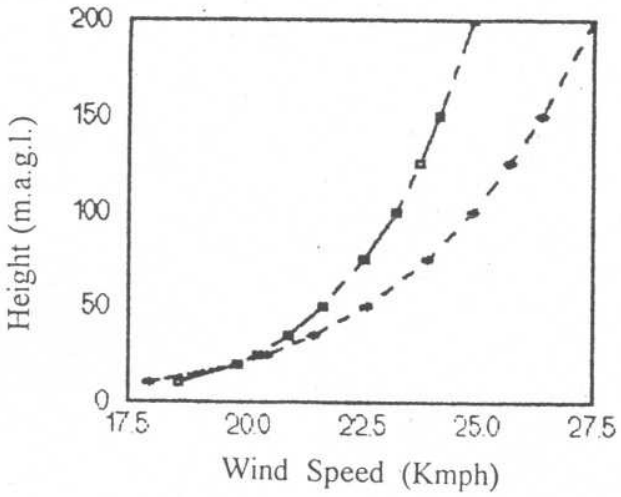
Annual Mean Wind Speed Variation With Height For Different Stations



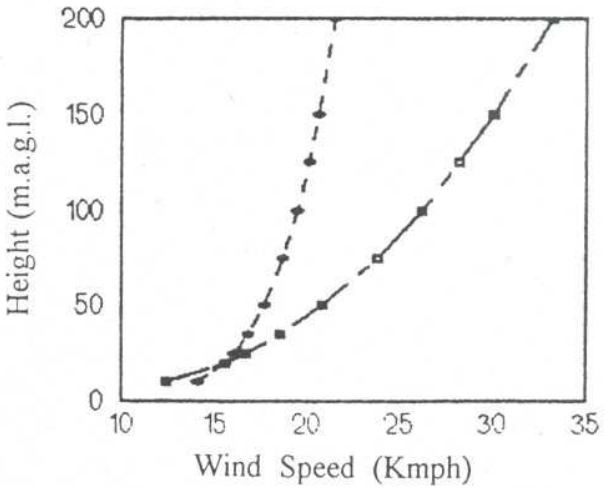
(Figure : 1.0, Station : Chalkewadi)



(Figure : 2.0, Station : Deogad)



(Figure : 3.0, Station : Vijaydurg)



(Figure : 4.0, Station : Lonawala)

● ___ Method - I (1/7th Power Law)

□ ___ Method - II (Monthly/Annual Means of Power Law Index)