

TÍNH TOÁN CÁC ĐẶC TRƯNG THỐNG KÊ CỦA GIÓ ĐO ĐẶC TẠI TRẠM NHA TRANG

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Tóm tắt Xác định các đặc trưng thống kê của gió tại một khu vực cụ thể nhất là tại các vùng ven biển có vai trò rất quan trọng phục vụ việc tính toán các thông số thiết kế của các thủy công trình, đảm bảo an toàn cho các hoạt động kinh tế, du lịch như giao thông vận tải, đánh bắt – nuôi trồng thủy sản, vui chơi giải trí trên biển và bảo vệ môi trường. Báo cáo trình bày kết quả tính toán các đặc trưng thống kê của gió đo đạc tại trạm Nha Trang từ năm 1986 đến 2000. Tốc độ gió cực đại ứng với các hoàn kỳ khác nhau được xác định bằng hàm phân bố FT-I (Fisher-Tippett – I). Kết quả nghiên cứu cho thấy rằng tần suất lặng gió chiếm 41%, gió có tốc độ ≤ 8 m/s chiếm 98%, gió có tốc độ $V \geq 13$ m/s tập trung chủ yếu tại cung phần tư N đến E, tốc độ gió $V = 28$ m/s xuất hiện tại hướng NE. Thời kỳ gió mùa tây nam (tháng 6 đến tháng 8) hướng gió thịnh hành là SE; thời kỳ gió mùa đông bắc (tháng 11 đến tháng 3) hướng gió thịnh hành là NE; thời kỳ chuyển mùa (tháng 4 và tháng 9) tốc độ gió thường yếu và hướng thay đổi. Dự báo cho hoàn kỳ 50 năm cho thấy tốc độ gió cực đại $V = 30$ m/s xuất hiện trên hướng N, $V = 28$ m/s xuất hiện trên hướng NE, $V = 20$ m/s xuất hiện trên các hướng E và SE. Các hướng còn lại tốc độ gió đều có giá trị tương đối nhỏ.

ESTIMATION OF THE STATISTICAL CHARACTERISTICS OF MEASURED WIND AT NHATRANG STATION

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Abstract Estimation of the statistical characteristics of measured winds in a particular nearshore area have an important role for economic, tourism developments and environmental protection such as design of marine structures, transportation, fisheries and mari-culture, marine recreation and environmental protection. The statistical characteristics of measured winds at Nhatrang Station during 1986-2000 are presented in this paper. Maximum wind speed for different return periods was estimated by FT-I (Fisher-Tippett-I) distribution function. The studied results show that total frequency of calm condition was 41.1 % of time (NE monsoon period was 30%, SW monsoon period was 50%), wind speed of less than 8 m/s was 98% of time, wind speed of greater than 13 m/s mainly occurred in the sector from N to E directions, maximum wind speed of 28 m/s occurred in NE direction. From June to August (SW monsoon) the major wind direction was SE; from November to

March (NE monsoon) the major wind direction was NE; in the transition periods (May and September) the wind direction was varying and wind speed was weak. Prediction of maximum wind speed for 50 years return period show that maximum wind speed of 30 and 28 m/s are in N and NE directions, respectively; maximum wind speed of 20 m/s are in E and SE directions; in the remaining directions maximum wind speed are relatively small.

I. INTRODUCTION

Ocean wind is a forcing factor to generate circulation, wave, storm surge, etc., especially the litho-hydro-dynamics processes in the nearshore. Therefore, estimation of the statistical characteristics of measured wind data in a particular nearshore area have an important role for supplying the design parameters to construct of nearshore structures, and planning of transportation, fisheries, mari-culture, marine recreation and environmental protection.

Statistical methods for analyzing long-term information covering many years are an integral part of most design application. Typically the largest parameter values are the primary design concern. Extreme events are often highly variable in terms of intensity and sequencing. By definition, they are rare. The preferred approach to data selection is to take the maximum value from each event to create a partial duration series of extreme values. According to CEM (2002) a series of wind data for 15-year sample is too short to give a reliable estimate of the 50 year event if using normal distribution functions such as Weibull distribution function. The FT-I distribution function is found to provide a good fit in this case, a simple approach using monthly extreme wind speeds may be helpful in conjunction with limited data sets. By this approach, based on the assumption that extreme wind speeds follow the FT-I (Fisher-Tippett – I) distribution function.

This paper presents the statistical characteristics of measured and prediction wind data at Nhatrang Station during 1986-2000 on 16 directions. The Authors hope that the paper will be come a good data base for related scientists and decision makers.

II. MATERIALS AND METHODS

1. Statistic wind data

Wind data were collected from Nhatrang Meteorological Station during 1986 – 2000, which were measured at elevation of 10m; at six-hourly interval (1h, 7h, 13h, 19h); and in 16 directions. Classification based on Beaufort Wind Scale and statistic based on Equation (1).

$$A^j = \frac{\sum_{i=1}^{S_i} n_i^j}{N} \quad (1)$$

$i = 1,2,3, \dots, S_i$
 $j = 1,2,3, \dots, 16$

A^j = frequency (i) in (j) direction
 S_i = number of data at level (i) in (j) direction
 N = sum of data.

2. Estimation of extreme wind condition for different return periods

Using FT-I (Fisher-Tippett – I) distribution function wind speed with r-return period is calculated as follow:

$$U_r = \bar{U}_m + 0.78\sigma_m [\ln(12T) - 0.577] \quad (2)$$

where,

U_r = wind speed with r-year return period

\bar{U}_m = mean value of maximum monthly wind speeds

T = return period in years

σ_m = standard deviation of maximum monthly wind speeds

and

$$\sigma_{rm} = \sqrt{0.49 + 0.89 \ln(12\bar{U}_m) + 0.67 [\ln(12\bar{U}_m) - 0.577]^2} \frac{\sigma_m}{\sqrt{N_m}} \quad (3)$$

where,

σ_{rm} = standard deviation of the sampling error in estimating U_r

N_m = number of months of data

III. RESULTS

1. Yearly distribution of wind characteristics

In general, mean wind speed range from 1.4 to 5.5 m/s with significant value occurred in the sector from N to E directions. Maximum wind speed range from 6 to 28 m/s with significant value occurred in the sector from NW to E directions (Table 1).

Table 1. Mean and maximum measured wind speed (1986-2000)

| Sr. No. | Directions | Mean (m/s) | Max (m/s) |
|---------|------------|------------|-----------|
| 1 | N | 5.3 | 24 |
| 2 | NNE | 5.5 | 15 |
| 3 | NE | 4.7 | 28 |
| 4 | ENE | 4.3 | 13 |
| 5 | E | 3.7 | 16 |
| 6 | ESE | 3.6 | 7 |
| 7 | SE | 3.8 | 8 |
| 8 | SSE | 3.6 | 9 |
| 9 | S | 3.1 | 8 |
| 10 | SSW | 2.5 | 6 |
| 11 | SW | 1.4 | 6 |
| 12 | WSW | 1.6 | 6 |
| 13 | W | 1.4 | 6 |
| 14 | WNW | 1.4 | 9 |
| 15 | NW | 1.6 | 10 |
| 16 | NNW | 4 | 13 |

Joint distribution of wind speed and directions during 1986-2000 are shown in Figure 1. Distribution features of frequency and cumulative of occurrence are shown in Figure 2.

Data from Figs 1 and 2 show that predominant directions of wind were NW, N, NE, SE and E. In the remaining directions the occurring frequency of wind was less. Maximum wind speed was 28m/s and occurred in NE direction. Frequency of calm condition was 41.1 % of time, wind speed of less than 8 m/s was 98% of time.

In general, Nhatrang area is subjected to wind speed of less than 8 m/s. Wind speed of greater than 8 m/s is rare and mainly occurred in extreme conditions such as tropical storm or typhoon.

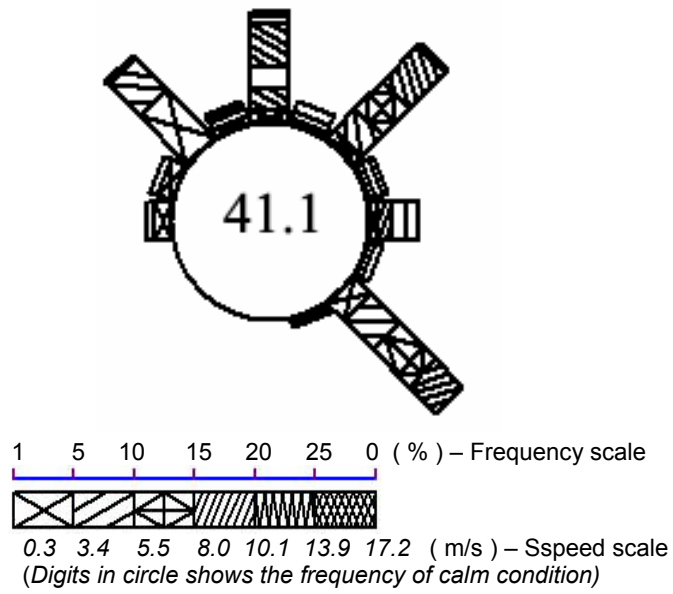


Fig. 1. Wind rose diagram (1986 – 2000)

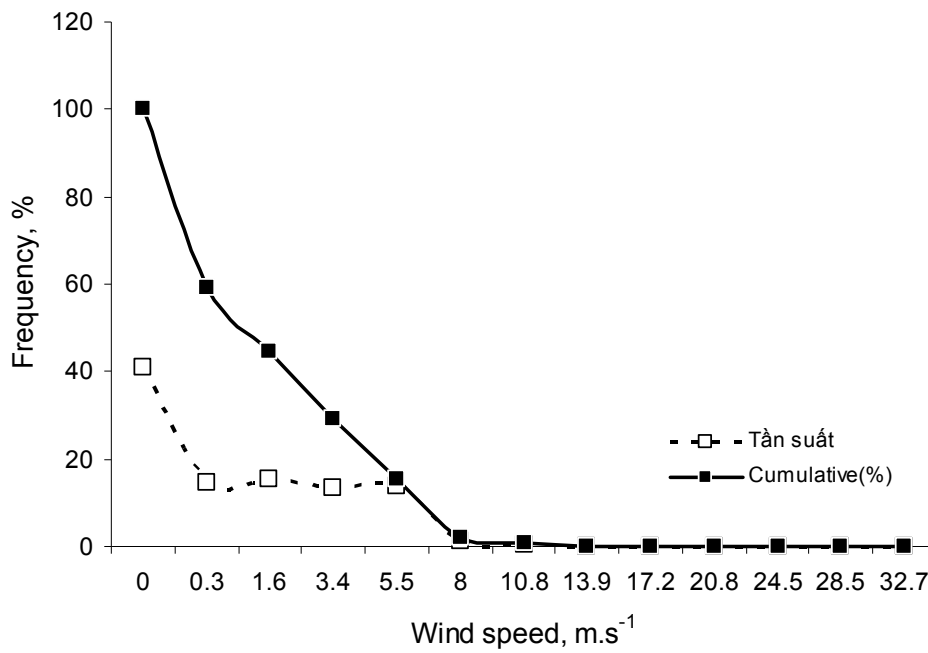


Fig. 2. Frequency of occurrence and cumulative frequency of measured wind data (1986-2000)

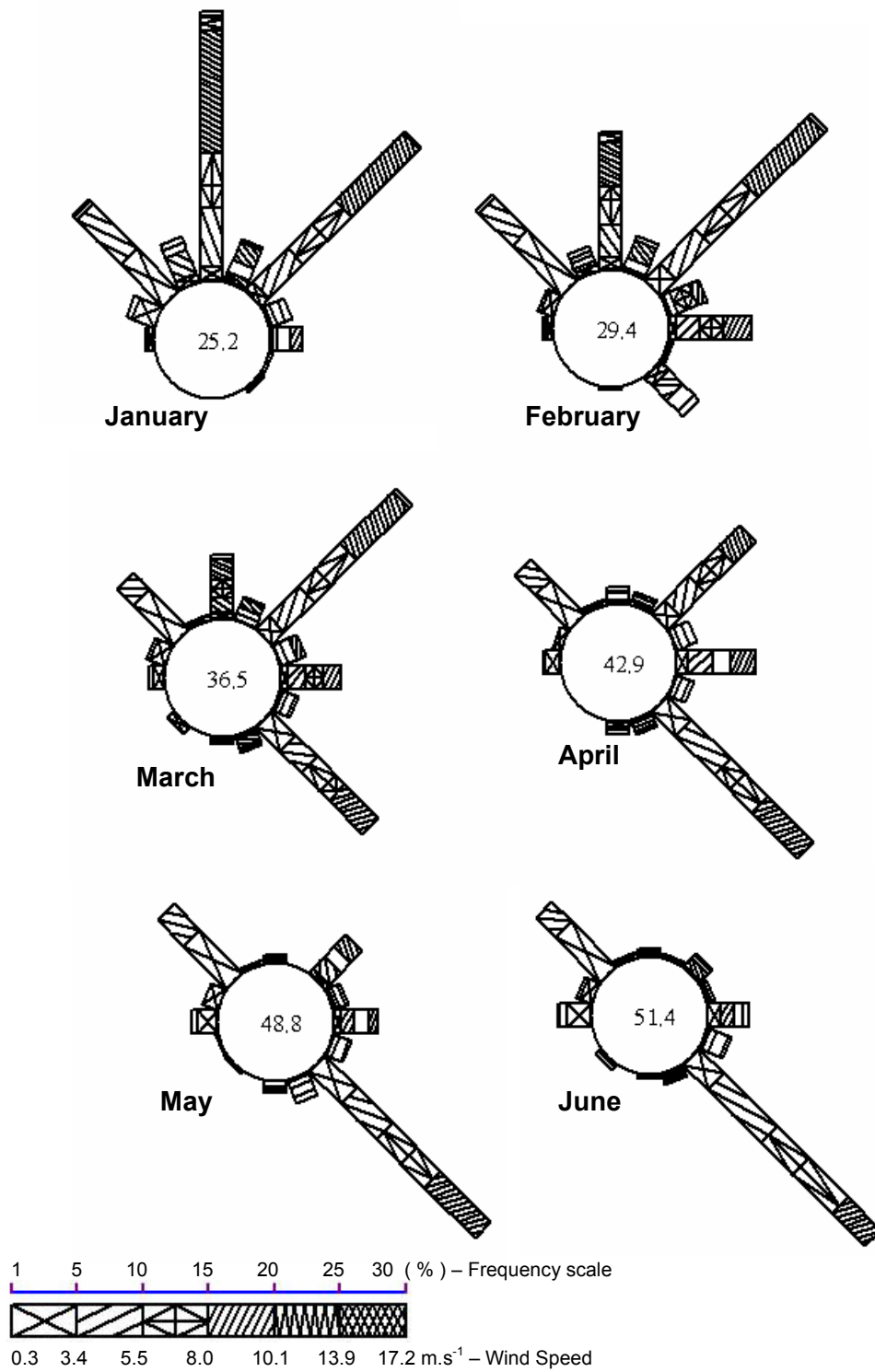


Fig. 3a. Wind rose diagram in a year from January to June

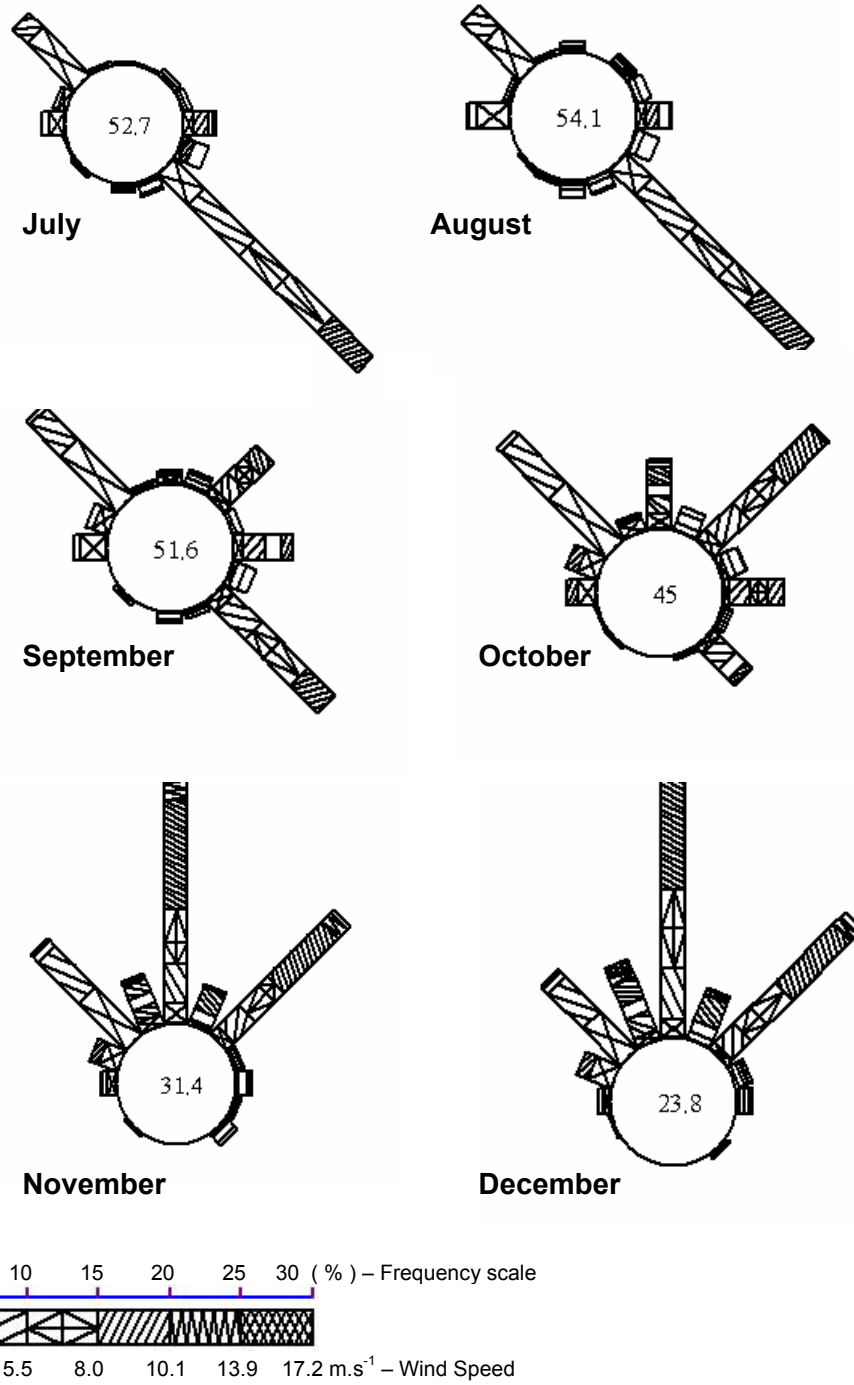


Fig. 3b. Wind rose diagram from July to December

2. Monthly distribution of wind characteristics

Monthly joint distribution of wind speeds and directions are shown in Fig. 3.

Monthly statistical results show that during January (Fig. 3a) calm condition was 25.2% of time, maximum wind speed was 12 m/s in N direction; significant wind speed occurred in N, NNE, NE, ENE; predominant wind directions were N, NE, and NW. During February (Fig. 3a), calm condition was 29.4% of time, maximum wind speed was 13 m/s occurred in ENE and NNW directions; significant wind speed occurred in ENE, NNW, N and NNE directions; predominant wind directions occurred in NW, N and NE. During March (Fig. 3a), calm condition was 36.5% of time, maximum wind speed was 12 m/s occurred in N direction; significant wind speed occurred in N, NNE and NE directions; predominant wind directions occurred in NE and SE. During April and May (Fig. 3a), calm condition was range from 43 to 49% of time, maximum wind speed was 10 m/s in NE and E directions; significant wind speed occurred in the sector from NE to S directions; predominant wind directions occurred in NW, NE, E and SE. During June (Fig. 3a), calm condition was 51.4% of time, maximum wind speed was 9 m/s in WNW direction; significant wind speed occurred in the sector from E to S direction; predominant wind directions occurred in NW and SE. During July (Fig. 3b), calm condition was 52.7% of time, maximum wind speed was 8 m/s in E and SE directions; significant wind speed occurred in the sector from N to S directions; predominant wind directions occurred in NW and SE. During August (Fig. 3b), calm condition was 54.1% of time, maximum wind speed was 8 m/s in SE direction; significant wind speed occurred in the sector from NE to S directions; predominant wind directions occurred in NW, W and SE. During September (Fig. 3b), calm condition was 51.6% of time, maximum wind speed was 16 m/s in N direction; significant wind speed occurred in the sector from N to SE directions; predominant wind directions occurred in NW, NE, E and SE. During October (Fig. 3b), calm condition was 45% of time, maximum wind speed was 16 m/s in NE and E directions; significant wind speed occurred in the sector from N to E directions; predominant wind directions occurred in NW, N, NE, E and SE. During November (Fig. 3b), calm condition was 31.4% of time, maximum wind speed was 28 m/s in NE direction; significant wind speed occurred in the sector from NW to NE directions; predominant wind directions occurred in the sector from NW to NE. During December (Fig. 3b), calm condition was 23.8% of time, maximum wind speed was 24 m/s in N direction; significant wind speed occurred in the sector from NW to E directions; predominant wind directions occurred in the sector from NW to NE.

In general, from June to August (SW monsoon) the major wind direction was SE for 12.5% of time. From November to March (NE monsoon) the major wind direction was NE for 10.9% of time. In the transition periods (May and September) the wind direction was varying and wind speed was weak. Measured wind speed of over 12 m/s occurred in January, February, March, September, October, November, and December especially in November and December, and mostly occurred in the sector from N to E directions. Maximum wind speed was 28 m/s in NE direction. Total frequency of calm condition was 41.1 % (NE monsoon period was 30%, SW monsoon period was 50%).

3. Extreme wind condition for different return periods

Based on the maximum monthly wind speed in 16 directions using method of FT-I distribution function. Maximum wind speeds for different return periods in different directions are shown in Table 2.

Tab. 2. Maximum wind speed (m/s) for different return period (1986-2000)

| Serial No. | Directions | Return periods (years) | | | | |
|------------|--------------------|------------------------|----|----|----|----|
| | | 1 | 5 | 10 | 25 | 50 |
| 1 | N | 15 | 21 | 24 | 28 | 30 |
| 2 | NNE | 11 | 16 | 18 | 21 | 23 |
| 3 | NE | 15 | 20 | 23 | 26 | 28 |
| 4 | ENE | 9 | 12 | 14 | 16 | 18 |
| 5 | E | 11 | 14 | 16 | 18 | 20 |
| 6 | ESE | 7 | 9 | 11 | 12 | 14 |
| 7 | SE | 11 | 15 | 16 | 18 | 20 |
| 8 | SSE | 6 | 9 | 10 | 11 | 12 |
| 9 | S | 6 | 9 | 10 | 11 | 12 |
| 10 | SSW | 4 | 6 | 6 | 6 | 7 |
| 11 | SW | 3 | 4 | 4 | 4 | 5 |
| 12 | WSW | 3 | 4 | 4 | 4 | 4 |
| 13 | W | 5 | 6 | 7 | 8 | 9 |
| 14 | WNW | 5 | 7 | 8 | 9 | 9 |
| 15 | NW | 7 | 9 | 10 | 12 | 13 |
| 16 | NNW | 7 | 10 | 12 | 13 | 15 |
| 17 | Without directions | 18 | 24 | 27 | 29 | 31 |

The computed results from Table 2 show that maximum wind speed for 1 year return period were 15 m/s occurred in N and NE directions; for 5 years return period were 21, 20 and 15 m/s occurred in N, NE and SE directions respectively; for 10 years return period were 24, 23 m/s occurred in N and NE directions respectively; for 25 years return period were 28, 26, 18 and 18 m/s occurred in N, NE, E and SE directions respectively; for 50 years return period were 30, 28, 23 m/s occurred in N, NE and NNE directions respectively. In case of without directions the maximum wind speed were 18, 24, 27, 29 and 31 m/s for 1, 5, 10, 25 and 50 years return period respectively.

IV. CONCLUSIONS

The present study has resulted in following conclusions:

- From June to August (SW monsoon) the major wind direction was SE; from November to March (NE monsoon) the major wind direction was NE; in the transition periods (May and September) the wind direction was varying and wind speed was weak.
- Measured wind speed of greater than 12 m/s occurred in NE monsoon period especially in November and December, and mostly occurred in the sector from N to E directions. Maximum wind speed was 28 m/s in NE direction.
- Total frequency of calm condition was 41.1 % (NE monsoon period was 30%, SW monsoon period was 50%).
- Maximum wind speed for 50 years return period (without direction) were 18, 24, 27, 29, and 31m/s corresponding to 1, 5, 10, 25, and 50 years return periods, respectively.
- Maximum wind speed for 50 years return period were 30, 28, 20, and 20m/s corresponding to N, NE, E, and SE directions, respectively.

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