Effect of the wind speed Turbulence on the total wind speed in the surface boundary layer in Baghdad city

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Abstract- In this work the total wind speed has been estimated by using a fast response anemometer , so we calculate the turbulence in the wind speed components (u,v,w) ,horizontal momentum flux, and turbulent kinetic energy. The effect of the above-mentioned variables on the total wind speed also studied and We had access to a number of empirical formulas describing these effects .

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Index Terms- Total wind speed – wind turbulence – momentum flux–turbulent kinetic energy.

I. INTRODUCTION

Wind motion over the surface is can be classified into three types of motion (average, turbulent, wavy) Both of these items as possible to separate Alone or in combination withOther two types. The average of wind speed is responsible of the advection [1], turbulent motion appearance near the surface it is more effective in the transport [2]. The wave motion transporting few of the heat and humidity but its effective in the energy and momentum transfer [1].

The total wind speed affected by all of these types of motion butthe greatest affecting in the surface layer is Turbulence motion.

(GRIMOND AND OKE 1988) tray to Studying the wind motion properties over urban surfaces and they depended In their study on the analysis of the surface shape [3]. (Carolyn Janelle Banker 2010) Attempt to study the wind direction and wind speed effect on the turbulence and wind shear [4]. (Roth 1993) tray to measured wind speed by using (Fast response instrument) and (Slow -response instrument) then hecompare between two types of instrument result [5] (Aqeel G.H. AL – Draaji 2007)Try to study the relationship between wind speed and the stability And reach to an empirical equationDescribe this relationship [6]. In 2013aqeelg.hmutarmeasured the wind speed turbulence intensity in Baghdad city and he found relationship between wind speed and wind speed turbulence intensity [7].

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II. Theory

We can calculate the total wind speed(V_{Total}) by using fast response anemometer as shown:

$$|V_{Total}| = \sqrt{u^2 + v^2 + w^2} \ldots\ldots\ldots\ldots\ldots (1)$$

When u,v and w the wind speed components in x , y and z axis

we can calculate the turbulence in the wind speed components as shown[8]:

$$\acute{u} = u_i - \bar{u} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

When $u_i$is the(u) component wind speed (in x-axis)

$\bar{u}$the average of wind speed component

$\acute{u}$turbulence of wind speed component

The calculation of turbulent kinetic energyTKEcan be written as shown:

$$\mathrm{TKE} = \frac{1}{2}\left(\overline{\acute{U}^2} + \overline{\acute{V}^2} + \overline{\acute{W}^2}\right) \ldots\ldots\ldots\ldots (3)$$

TKE is an importantVariables which can be used to estimation How is the wind turbulent in the boundary layer [8].

All so the momentum flux Take an important role asOne of the indicatorswhich is used to know who the wind turbulent in the boundary layer and we can calculate it as shown:

$$Mf = \overline{\acute{u} \times \acute{w}} \ldots\ldots\ldots\ldots (4)$$

III. Observation

Data recording period extendedfrom 14/12/2015 to 16/12/2015 and we select More than forty observation each one observation include six hundred record, Wind speed on three axes(x,y and z) have been recordedEvery one second by using fast response anemometer from type (Ultrasonic anemometer ,Wind master pro UMG07914-1189-PK-021)

IV. The study area

The study place is in the Baghdad city (Longitude (44.5) east and latitude (33.14) north).the Mustansiriyah neighborhood (Where the study location is one of the north-eastern outskirts of Baghdad and is one of the urban areas,
measuring devices have been installed at a height of up to (18 m) , The study area is generally surrounded by buildings mostly consisted of two floors to three floors.

V. Results and discussion

The Figure {1} shows that the relationship between total wind speed (V_{Total}) and the turbulence of wind speed in x – axis $\acute{u}$ It has strong relationship , the type of relationship is a linear Steadily proportion ,The increase in turbulence lead to increase in the total wind speed andThis seems clear from eq.(2) when

$$u_i = \acute{u} + \bar{u}$$

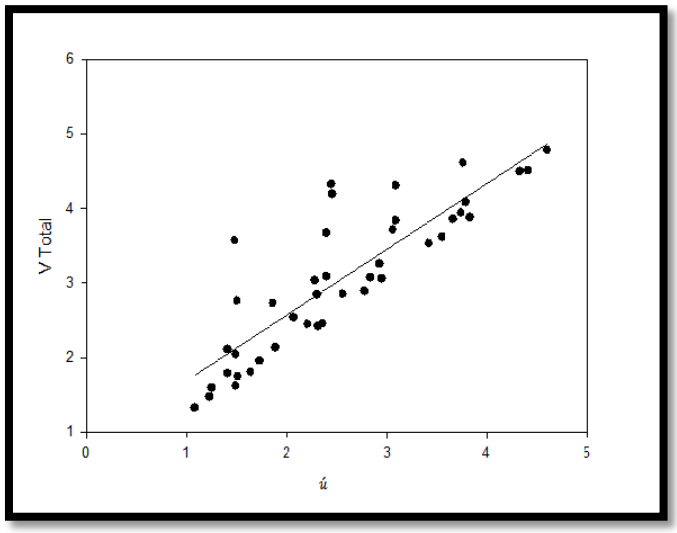

Fig.[1] the relationship betweenturbulence of wind speed in x – axis $\acute{u}$(m/s) and total wind speed V_{total} (m/s).

The value of the correlation coefficient for this relationship was (R=0.86) we can obtained empirical equation from this relationship as follow:

$$V_{TOTAL} = 0.8086 + 0.8818 \times \acute{u} \dots\dots\dots\dots (5)$$

The turbulence in the wind speedcomponent on the x- axis (u) It is the main effect on total wind speed Whilethe other components (v,w) on y and z axis have weak effective and as shown in Figures {2} , {3}

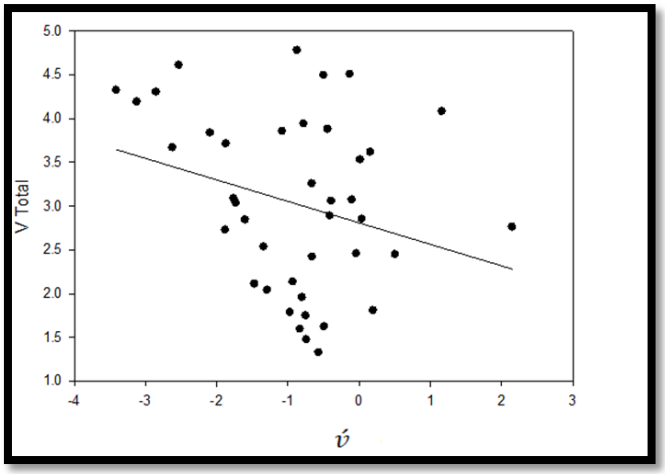

Fig.[2] the relationship between turbulence of wind speed in y – axis $\acute{v}$(m/s) and total wind speed V_{total} (m/s).

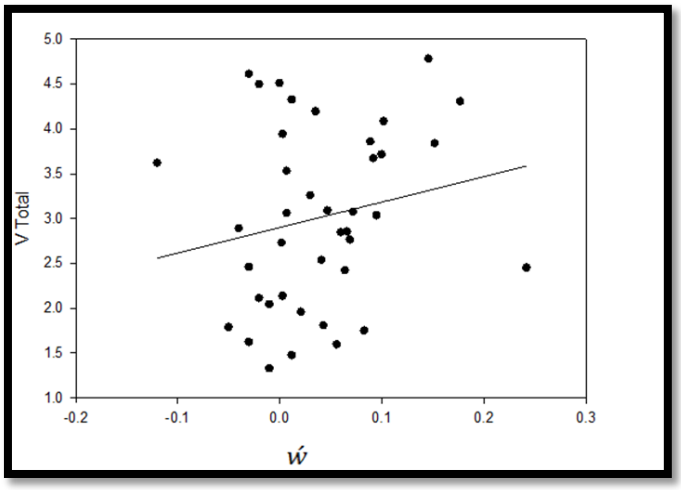

Fig.[3] the relationship between turbulence of wind speed in z – axis $\acute{w}$ (m/s) and total wind speed V_{total} (m/s).

The effect of horizontal momentum flux Mf on the total wind speed are shown in fig.{4}we can see the relationship between theTwo variablesRepresentinverse linear correlation the value of Mf depended on the value of $\acute{u}$ and $\acute{w}$ so any increase in the value of two variablesleads to an increase in the value of Mf , the increase of the value of $\acute{w}$leads to

increasing in vertical wind motion which caused obstruction in the horizontal wind motionSo total wind speed will decreasing .

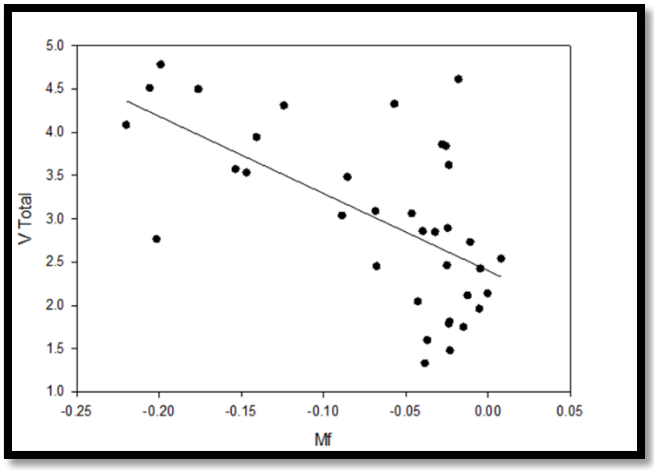

Fig.[4] the relationship betweenmomentum flux Mf on x-axis and total wind speed V_{total} (m/s) on y- axis .

The value of the correlation coefficient for this relationship was (R=0.6) we can obtained empirical equation from this relationship as follow:

$$V_{total} = 2.4017 + (-8.9173) \times Mf \dots\dots\dots\dots\dots\dots (6)$$

The effect of turbulent kinetic energy Tke On the total wind speed velocity $V_{total}$the fig. [5] show that the relationship between Tke and V_{total} is alinear Steadily proportion and That means that the increase in Tke lead to increased in the V_{total}

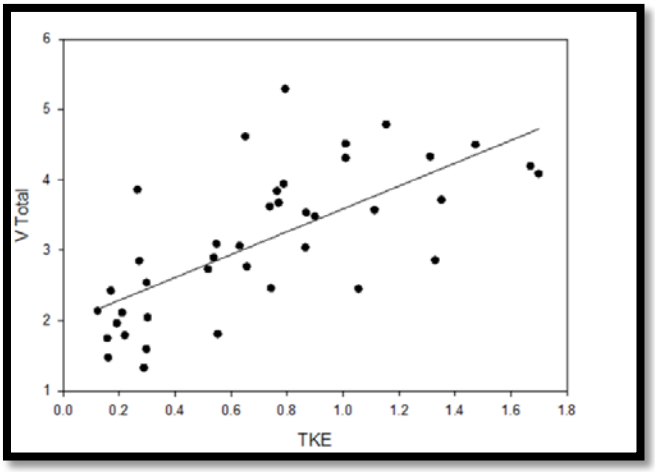

Fig.[5] the relation betweenturbulent kinetic energy TKE on x-axis and total wind speed V_{total} (m/s) on y- axis .

The value of the correlation coefficient for this relation was (R=0.7) so we can obtained an empirical equation from this relationship as follow:

$$V_{Total} = 1.9661 + 1.6233 \times Tke \dots\dots\dots\dots\dots\dots (7)$$

VI. Conclusions

The turbulence component on the x-axis has a positive effect on total wind speed (the increase in turbulence increase in wind speed).

It seems that turbulence at the axes (y) and (z) does not affect clearly on total wind speed .

We wear able to obtained an empirical equationDescribes the relation betweenturbulence component on the x-axis and total wind speed equation (5).

The horizontal momentum flux has a negative effect on total wind speed (decrease in horizontal momentum flux lead to increasing in the total wind speed)

The relation between the horizontal momentum flux and total wind speed has been described in equation (6).

The relation between turbulent kinetic energy and total wind speed has been described in equation (7) and As already shown the Linear correlation form between tow variables is a positive.

VII. References

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