Experiment No (5)

Calculation of turbulence intensity for wind speed components (u,v,w)

Aim : Calculation of turbulence intensity in wind speed components by direct measurement of speed components.

Tools: Wind speed device (fast response Anemometer), stopwatch.

Theoretical part :

Turbulence is an essential part of the phenomena that should be studied in the boundary layer, and turbulence is defined as the amount of difference between the instantaneous values and their average, and the intensity of the wind speed turbulence is the ratio between the standard deviation of the values to the average of those values.

Estimating and calculating turbulence is an important matter in knowing the amount of fluctuation in wind speed and direction as a result of the effect of surface roughness and air stability.

The turbulence gains its importance from its effect on the diffusion of pollutants, the mixing process, and the transfer and diffusion of moisture and heat in the boundary layer, especially in the case of atmospheric instability.

Calculating turbulence by analytical methods is not possible, so statistical methods were used to find the values of turbulence intensity as an indicator of turbulence. Where the intensity of turbulence can be calculated for a component (x) of the wind speed components as follows:

$$\mathrm{I} = \frac{\sigma x}{\bar{x}} \quad \text{.....(1)}$$

whereas:

σx: is the standard deviation of the wind speed values for any component (u, v, w)

$\bar{x}$: is the average wind speed of any component (u, v, w)

The standard deviation of the wind speed component (x) can be calculated as follows:

$$\sigma x = \sqrt{\frac{\sum(\mathrm{X_i} - \bar{x})^2}{N}} \quad \text{.....(2)}$$

whereas:

$\mathrm{X_i}$ The instantaneous value of the wind speed component (x)

$\bar{x}$ Average of wind speed component (x)

N number of records

methodology

1- Record wind speed for each component (u, v, w) per second and for every (10 seconds)
2- Find the average for each component ($\bar{u}, \bar{v}, \bar{w}$)
3- Calculate the standard deviation for each component of the equation (2)
4- Calculate the intensity of the turbulence for each component from the equation (1)