Lab No. (4)

Drag coefficient Calculation using engineering methods in urban area

Aims: calculate the total drag coefficient C_D for urban area

Tools:

1- Miniature model of buildings and plants that simulate reality and at a known scale

2- Distance measuring tape

Theoretical:

The importance of the calculation of drag coefficient C_D which is a dimensionless quantity in fluid dynamics to estimate the resistance of obstacles to the air flow as a fluid. It depends on the surface roughness and the shape of the obstacles.

In general the drag coefficient equation is as follows:

$$C_D = \frac{2Fd}{\rho U^2 A} \dots\dots\dots (1)$$

whereas:

A: The cross-section area of a moving fluid.

C_D: Drag coefficient.

F_d: drag force due to wind flow.

ρ : The density of fluid (air).

u: Wind speed.

Lettau has developed a geometric formula to calculate drag coefficient as follows:

$$\frac{Z_0}{ZH} = \frac{C_D}{0.79}\frac{A_F}{A_d} \dots\dots\dots (2)$$

whereas:

A_d: Is an indicator of the density of obstacles $= \frac{\text{total area}}{\text{number of obstacles}}$

A_F: Area of obstacle side front which in front of wind direction = horizontal dimension Ly * height of the element ZH

Z_0 : Surface roughness.

$\overline{ZH}$: The average of obstacle element height.

Methodology:

1- Calculate the obstacle density index for each sector by

$$A_d = \frac{\text{The total area of the } region}{The\ number\ of\ obstacles\ in\ the\ area}$$

2- Calculate area of obstacle side front which in front of wind direction = horizontal dimension Ly * height of the element ZH then using the follow equation

$$AF = \sum LY * ZH$$

3- Z_0 , $\overline{ZH}$ constant values for each sector are as follows:

Z_0 (cm)	$\overline{ZH}$ (cm)	sector
3.2	4.3	1
1.24	3.8	2
1.13	3	3
0.38	2.3	4

4- Calculate the value of drag coefficient C_D using equation No. (2) for each sector.