

Lab No ()

Calculation of the surface roughness by engineering methods according to Bottema's formula

Aims: Calculate the surface roughness of an area through engineering methods that depend on the geometric shape and the size of the geometric obstacles away from the speed and direction of the wind.

Tools:

- 1- Miniature model of buildings and plants at a known scale, which represent the obstacles in the reality.
- 2- area measuring device.

Theoretical Part:

The engineering methods depend on the geometric analysis of the surface, and this method depends on the dynamic factors and through the Bottema formula, which depends on the average of obstacle element height ZH , as well as the area of the obstacles elements, which is the following formula:

$$Z_0 = \{ZH - Z_d\} \exp \left\{ \frac{-0.4}{\left[\frac{0.5 \cdot (\sum C_{db} L_{yb} Z_{Hb} + \sum C_{dt} L_{yt} Z_{Ht})}{AT} \right]^{0.5}} \right\} * ZH \dots \dots [1]$$

Where the letter b refers to buildings and the letter t refers to trees and plants

C_{db} : drag coefficient for building , its value (0.8)

C_{dt} : drag coefficient for trees and plants, its value (0.48)

L_y : the horizontal dimension of the obstacle element, L_{yb} for buildings and L_{yt} for trees

ZH :The average of obstacle element height (constant)

Z_d : Displacement Length (constant)

Z_{Hb} : The average of obstacle element height for buildings.

Z_{Ht} : The average of obstacle element height for trees and plants.

AT : is the total area for which the roughness is calculated

Methodology:

- 1- Determine the direction for which the roughness is to be calculate .
- 2- Calculate the horizontal dimensions L_{yb} and L_{yt} for buildings and trees for each sector.
- 3- Calculate the average of obstacle element height for the buildings Z_{Hb} and the average of obstacle element height for trees and plants Z_{Ht} is by summing the lengths of the roughness elements and dividing them by their number.
- 4- Calculate the total area A_T whose surface roughness is to be calculated.
- 5- Calculate the value of surface roughness Z_0 using equation No. (1) for each sector.

First sector:

$Z_H=4.3$ cm

$Z_d=1.3$ cm

Second sector:

$Z_H=3.8$ cm

$Z_d=1.5$ cm

Third sector:

$Z_H=3$ cm

$Z_d=0.8$ cm

Fourth sector:

$Z_H=2.3$ cm

$Z_d=0.48$ cm