Aerodynamic Properties of Urban Areas

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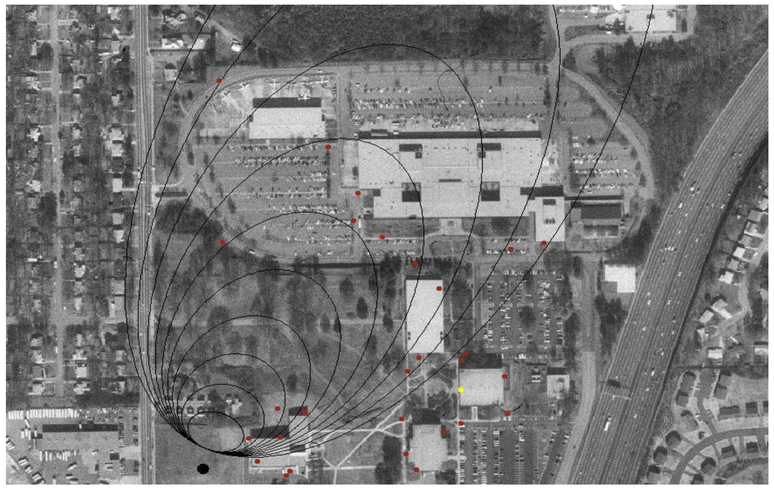
Introduction

The basic purpose of this project is to relate wind patterns to certain surfaces, particularly urban city areas. Cities are probable the roughest surface areas due, of course, to the many buildings and roads in addition to trees and other natural objects. It is essential to have an accurate knowledge of the aerodynamic characteristics of an area to properly determine the behavior of winds.

The particular area that was observed was the Atlanta Metropolitan College campus. Using certain instruments, the dimensions of the most major buildings in the area were taken. The heights of the major tree groups were taken also.



Atlanta Metropolitan College

(Overhead View)

Displacement Distance

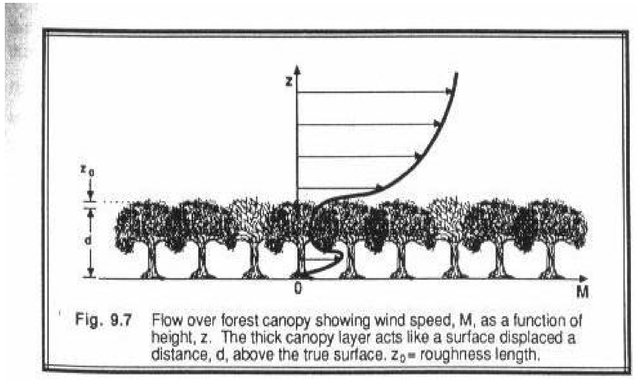


Fig. 9.7 Flow over forest canopy showing wind speed, M, as a function of height, z. The thick canopy layer acts like a surface displaced a distance, d, above the true surface. z_0 = roughness length.

If individual objects such as trees pictured above, for instance are closely packed together, then the tops of the objects act as a displaced surface. Above the very top of the trees, the wind profile increases logorithmically with height. From this a displacement distance, d, can be defined with a roughness length, z_o such that:

$$M=(u_*/k)\ln[(z-d)/z_o]$$

If one knows the windspeed at three separate heights, then an algebraic expression can derived for the displacement distance.

$$(M_2-M_1)/(M_3-M_1)\ln[(z_3-d)/(z_1-d)] = \ln[(z_2-d)/(z_1-d)]$$

The Morphometric Method

The morphometric method is a method that uses algorithm that relate aerodynamic parameters to measures of surface morphometry. The morphometric method has the advantage of not needing tall towers and instrumentation to determine values. The disadvantage of the morphometric method is that it usually describes idealistic situations

This picture shows a graph of M vs.. z-d. The displacement distance, d, is a guessed value. If d is not large enough, then the graph will curve concave upward. If d is too large, then the graph will curve concave downward. This graph is only true under neutral conditions.

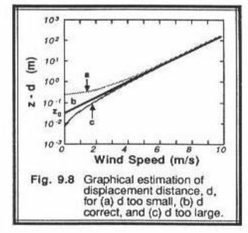


Fig. 9.8 Graphical estimation of displacement distance, d, for (a) d too small, (b) d correct, and (c) d too large.

Summary

In conclusion, we began construction a data base of values needed to calculate z_d, z_0, and the database needs to be further developed by adding plant areas to the database. Once that is done, we can then estimate the parameters and validate them using whether towers. A tower should be constructed at AMC to compute wind measurements. Hopefully this will be done sometime in the near future.