Chapter 2

Wind Tunnel Configuration

The data analyzed in this work was obtained from eight different configurations of the boundary layer wind tunnel at Clemson University. The Clemson tunnel is an open-return wind tunnel with a test section, that is 21m long, 3m wide and 1.8m high. In this facility, flow simulations can be varied by changing roughness configurations, and by placing spires, baffles and trips varying in shape, size and quantity at different upstream locations with respect to the model prism. The main purpose of such variations is to determine configurations that simulate the atmospheric boundary layer for the purpose of obtaining realistic wind loads [Tieleman et al. (1998)]. In the following, a detailed description of the eight different configurations is given.

The bare tunnel will be referred to as **Configuration #1**. In this configuration, no floor roughness is added. Figure2.1 shows plan and side views of the Clemson tunnel in **Configuration #2**. In this configuration, a $0.025\times0.20(m^2)$ trip was introduced at the entrance of the tunnel, together with 3 big spires, each extending the height of the tunnel. As shown in figure 2.2, the dimensions of these spires are 0.24m at the top and 0.41m at the floor, and their thickness is 0.013m.

Configuration #3 is equivalent to Configuraion #2, with the addition of a row of six small spires 1.50m upstream of the model location as shown in figure2.3. The

placement locations of the six spires are shown in figure2.4. Their shape and size are given in figure2.5.

Configuration #4 has all the elements of Configurations #2 and #3. In addition, four baffles, placed 0.91m apart are placed 2.18m downstream of the tunnel entrance (Figure2.6). At 6.1m downstream of the entrance, a roughness section is added. Another roughness section is placed further 1.22m downstream. The last part of the roughness section is made of randomly placed 0.025m cubes over a length of 4.88m. The dimensions, placement locations, and characteristics of all elements in Configuration #4 are shown in figure2.6.

Configuration #5 is the same as Configuration #4, except that, the row of small spires of Configuration #3 placed at the 1.5 m upstream of model location.

In **Configuration #6**, a 0.41×0.82 m^2 trip is placed at the entrance along with four spires. The spires are shown in figure2.7. In addition, three different roughness configurations are placed further downstream at locations shown in figure2.8.

In **Configuration #7**, five larger spires in two rows are added to the setup of Configuration #6. The positions and shapes of these spires are shown in figure2.9. These spires will be referred to as Configuration #7 spires since they are used in this configuration only. It should be noted that the outer spires made an angle of approximately 30 degrees with the mean flow directions.

In **Configuration #8**, no trip and big spires were at the entrance of the tunnel. Instead they were placed at 6.4 m upstream of the model. Also, a row of small spires was added at 1.5m upstream of the model. Figures2.3 and 2.4 could be referred to for the size, shape and position of the small spires. For the big spires, the position and size are shown in figures 2.10 and 2.11.

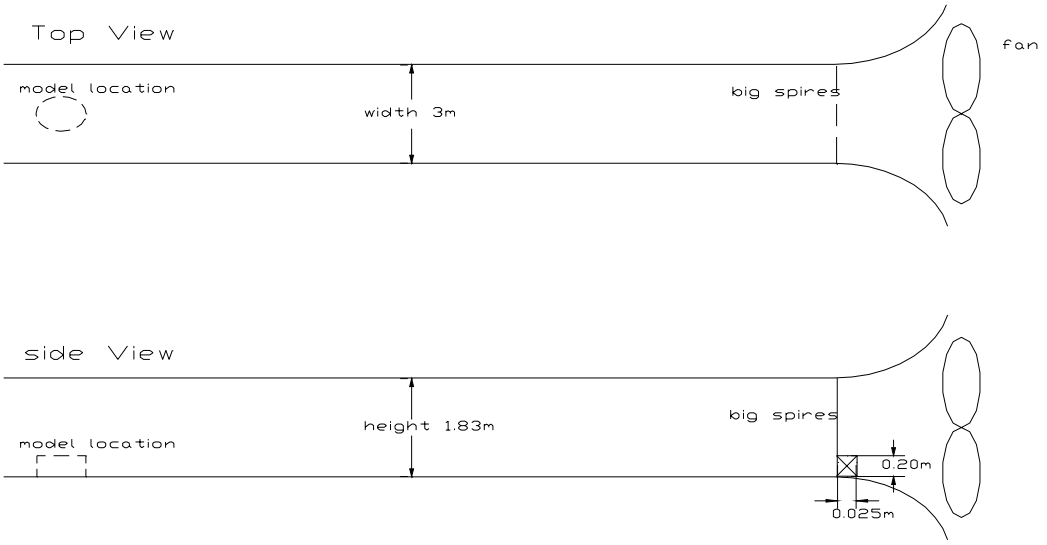

Figure 2.1 Plan and Side views of the Clemson tunnel for configuration #2

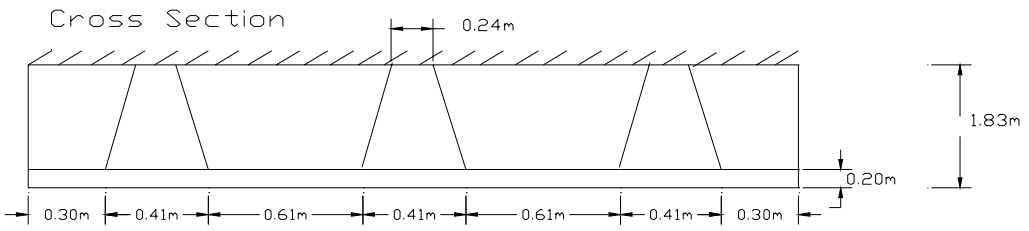

Figure 2.2 Cross-Section of big spires placed at tunnel entrance for configuration #2

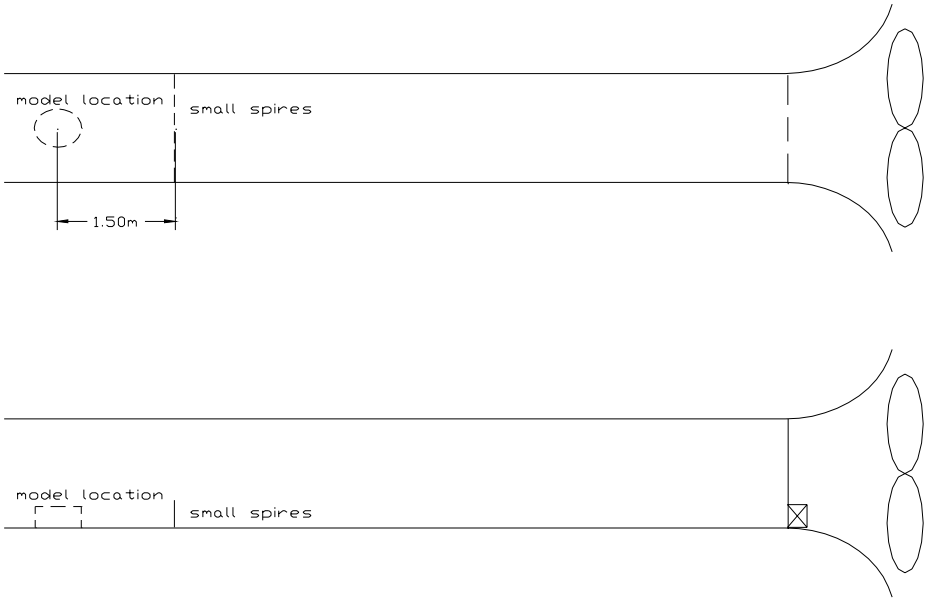

Figure 2.3 Trip and spires locations for configuration #3

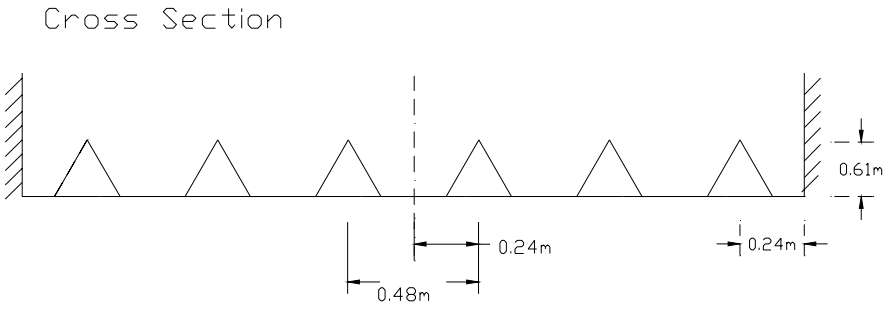

Figure 2.4 Placement locations of the six small spires for configuration #3

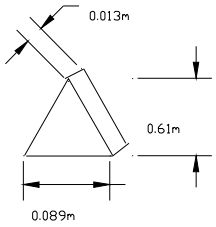

Figure 2.5 Shape and dimension of small spires used for configuration #3

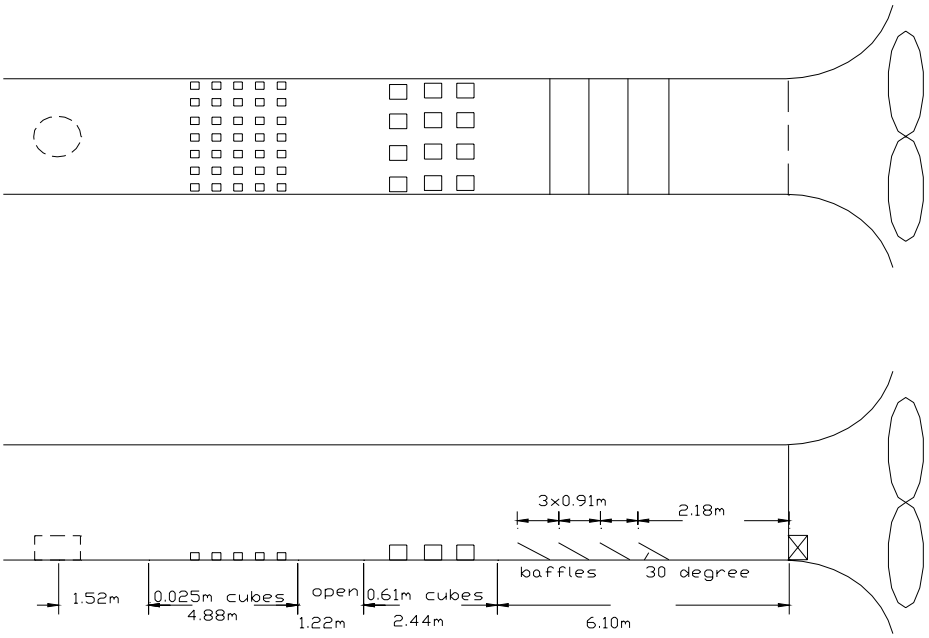

Figure 2.6 Dimensions, placement locations and characteristics of roughness elements used for configuration #4

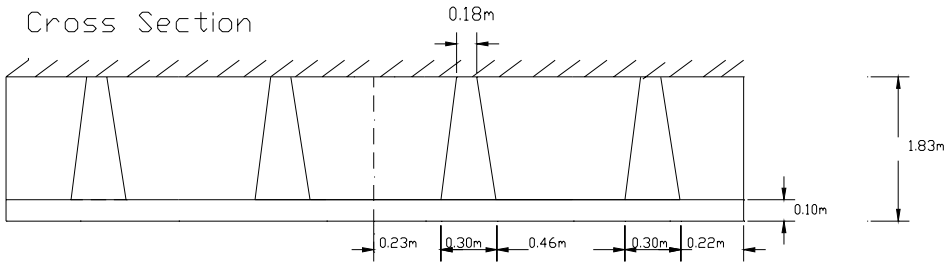

Figure 2.7 Dimensions and placement locations of large spires used for Configuration #6

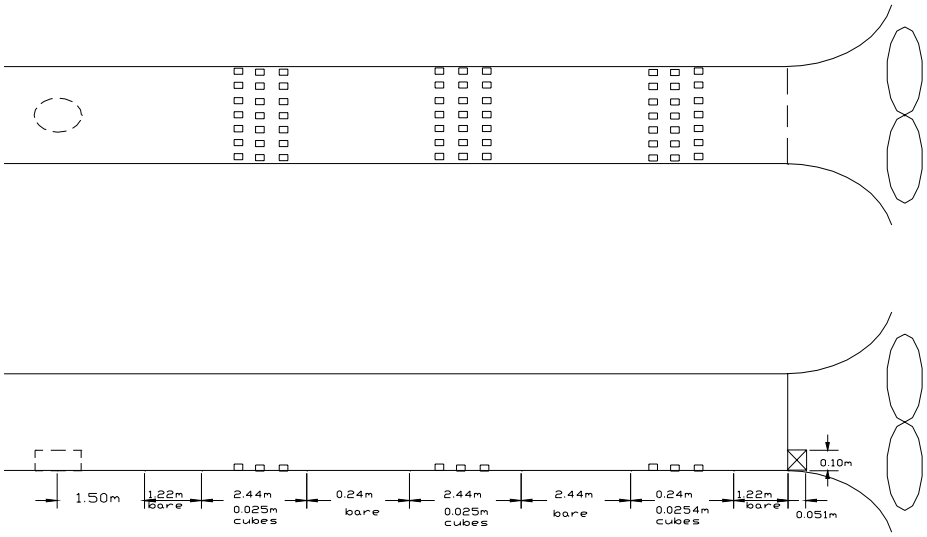

Figure 2.8 Trip dimensions, and roughness locations used for configuration #6

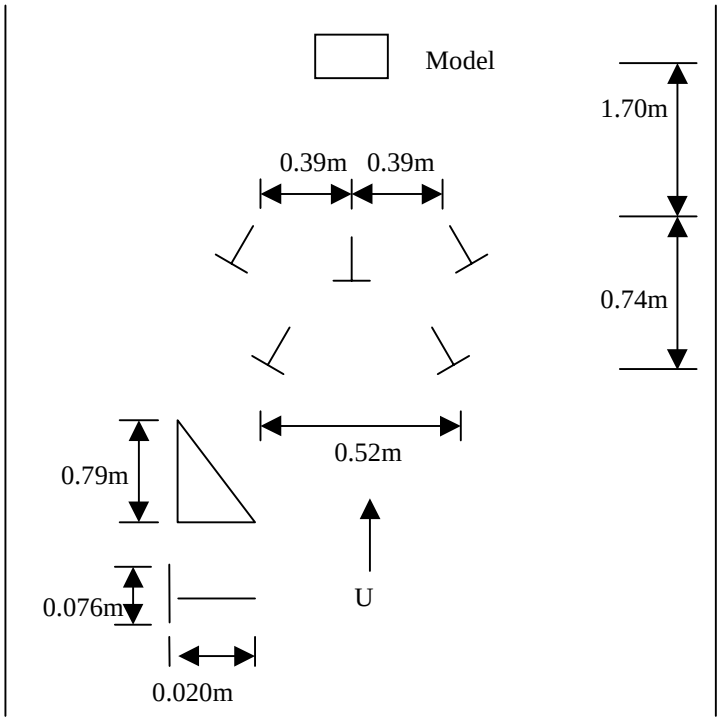

Figure 2.9 Placement of spires for configuration #7

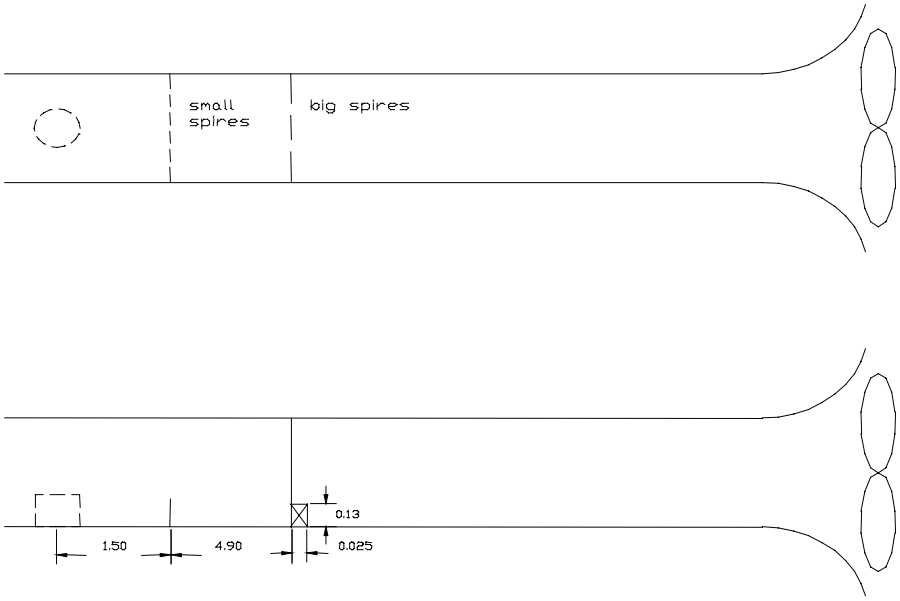

Figure 2.10 Trip dimensions and spires locations used for configuration #8

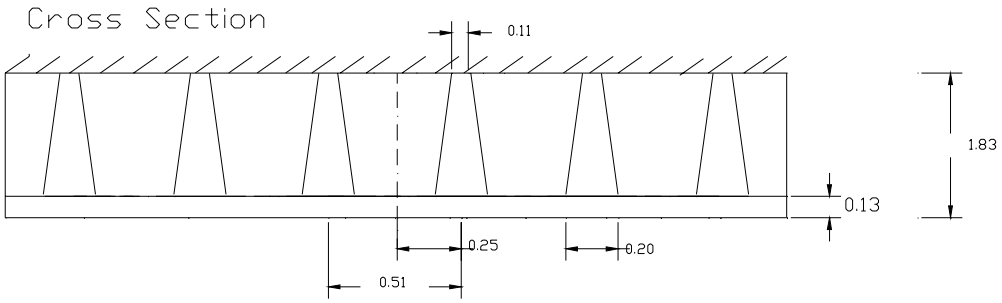

Figure 2.11 Dimensions, placement locations of small spires used for configuration #8