TRAFFIC SIGNS RESEARCH STUDY FOR MIAMI-DADE COUNTY

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Hurricane Activity

The graph illustrates the NOAA ACE Index for hurricane activity from 1950 to 2007. The index is measured in $10^4$kt$^2$. The years 2004-2005 and 2007 are highlighted, showing above-normal levels of hurricane activity. The graph also indicates normal levels of hurricane activity from 1950 to 2000.
Background

A considerable proportion of traffic signs failed in the 2004-2005 season
Problem Description

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Strong</th>
<th>Medium</th>
<th>Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>Strong</td>
<td>Medium</td>
<td>Weak</td>
</tr>
<tr>
<td>Clay</td>
<td>Strong</td>
<td>Medium</td>
<td>Weak</td>
</tr>
</tbody>
</table>

Installation Depth

Utilities

Wind Speed

<table>
<thead>
<tr>
<th>Category</th>
<th>Sustained Speed</th>
<th>3-Sec Gust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat1</td>
<td>74-95</td>
<td>90-119</td>
</tr>
<tr>
<td>Cat2</td>
<td>96-110</td>
<td>120-139</td>
</tr>
<tr>
<td>Cat3</td>
<td>111-130</td>
<td>140-164</td>
</tr>
<tr>
<td>Cat4</td>
<td>131-155</td>
<td>165-194</td>
</tr>
<tr>
<td>Cat5</td>
<td>&gt;155</td>
<td>&gt;194</td>
</tr>
</tbody>
</table>

Sustained Speed

3-Sec Gust
Design Standards

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals 2001 includes provisions for hurricane winds
Proposed Alternatives

Increase Installation Depth

- Cat 1
- Cat 2
- Cat 3
- Cat 4-5
Proposed Alternatives

Soil Plates

<table>
<thead>
<tr>
<th>Category</th>
<th>Wind Gust (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat 1</td>
<td>110-120</td>
</tr>
<tr>
<td>Cat 2</td>
<td>120-130</td>
</tr>
<tr>
<td>Cat 3</td>
<td>130-140</td>
</tr>
<tr>
<td>Cat 4-5</td>
<td>140-150</td>
</tr>
</tbody>
</table>

- Loose
- Medium
- Strong

- Maintain depth (2ft)
- Soil plate (2ft)
- Soil plate (3ft)
- Increase depth (4ft)
Proposed Alternatives

Concrete Foundation

- Cat 1
- Cat 2
- Cat 3
- Cat 4-5

Wind Gust (mph)

- Increase depth 4ft
- Concrete 3ft
- Soil plate 3ft
- Concrete 2ft
- Soil plate 2ft
- Maintain depth (2ft)
- Loose
- Medium
- Strong
Proposed Alternatives

Drive Anchors
Conclusions and Recommendations

- Revise the local standards against the 2001 AASTHO standards and take the appropriate actions.

- Design traffic signs capable of withstanding at least Category 1 hurricane wind which accounts for 90% of the scenarios for Miami-Dade County.

- For the installation depth of 2 ft., the top two alternatives are concrete foundation and drive anchors.

- The main advantage of drive anchors is that the installation time is significantly shorter than that required for concrete foundations.

- If the installation depth is greater than 2 ft., then the selected two alternatives can perform better.
Recommendations for Improvements

- Perform physical testing of the proposed alternatives. In the case of the drive anchors, testing 2, 3 or 4 anchor blades may be helpful.

- Promote the regulations in the Utility Accommodation Manual which states that utilities should not be placed within 3 ft. of the right-of-way.

- The purchase or rental of ground penetrating radars could be considered as an alternative to safely bypass the process of requesting horizontal clearance (verify with SSOCOF).

- The implementation of a GIS-based signage inventory will allow to relate sign failures with soil and wind data.
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Appendix

Soil Map
Charts for Installation Depth
Charts for Soil Plates
Charts for Concrete
Drive Anchor Picture
Cost Effectiveness Table
AASHTO Formulations
Hurricane Probabilities
Proposed Testing Procedure
Wall of wind
Miami-Dade Soil Survey
Increase installation depth in sand

Increase installation depth in clay
Charts

Soil plates in sand

Soil plates in clay
Charts

Concrete in sand

Concrete in clay
Cost Effectiveness

<table>
<thead>
<tr>
<th>Rank</th>
<th>Soil</th>
<th>Action</th>
<th>CE (mph/$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Drive anchor 3ft</td>
<td>8.6</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Increase depth 4ft</td>
<td>3.8</td>
</tr>
<tr>
<td>3</td>
<td>Loose</td>
<td>Concrete 3ft</td>
<td>1.9</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Soil plate 3ft</td>
<td>1.8</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Soil plate 2ft</td>
<td>1.2</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Concrete 2ft</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Soil</th>
<th>Action</th>
<th>CE (mph/$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Drive anchor 3ft</td>
<td>6.4</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Increase depth 4ft</td>
<td>2.9</td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>Concrete 3ft</td>
<td>1.4</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Soil plate 3ft</td>
<td>1.4</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Soil plate 2ft</td>
<td>0.8</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Concrete 2ft</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Cost Effectiveness

for signs in sand

Cost Effectiveness

for signs in clay
AASHTO Parameters

\[ P_z = 0.613 K_z GV^2 I_r C_{d} \quad (Pa) \]
\[ P_z = 0.00256 K_z GV^2 I_r C_{d} \quad (psf) \]

Where,

- \( V \): Design wind speed at 10 m. (32.8 ft.)
- \( C_{d} \): Drag coefficient
- \( G \): Gust effect factor
- \( K_z \): Height and exposure factor
- \( I_r \): Wind importance factor

In summary, for street signs in the Miami-Dade case, \( K_z=0.87 \), \( G=1.14 \), \( V=150 \) mph, \( I_r=0.71 \). The drag coefficient should be established for each sign type; for the regular stop sign with street name, the coefficient is 1.14.
The probabilities for a hurricane to be category 1, 2, 3 or 4 are 37, 21, 26 and 16 percent, respectively, based on the information presented in Figure 9. Therefore, for the most likely scenario for Miami-Dade the probabilities of occurrence of hurricanes category 1, 2 3, and 4 or more are 5.6 (once every 10 years), 3.2 (once every 30 years), 4 (once every 25 years), and 2.4 percent (once every 40 years), respectively.
Drive Anchor Picture
Proposed Testing Procedure
Proposed Testing Procedure
Wall of Wind