Communication structures

Brian W. Smith
Communications structures

4.2 Icing failures, 59
4.3 Design/detail failures, 61
4.4 Maintenance failures, 63
4.5 Aircraft damage, 65
4.6 Vandal damage, 68
4.7 Lessons to be learned, 69

Chapter 5 Forms of structure

5.1 General, 71
5.2 Timber towers, 71
5.3 Concrete towers, 71
5.4 Lattice steel towers, 75
5.5 Lattice guyed masts, 81
5.6 Tubular guyed masts, 87
5.7 Concrete guyed masts, 90
5.8 Other forms of communication structures, 91

Chapter 6 Meteorological parameters

6.1 General, 93
6.2 Wind, 93
6.2.1 Wind climate, 95
6.2.2 Boundary layer, 99
6.2.3 Serviceability wind speeds, 102
6.3 Atmospheric icing, 104
6.3.1 General, 104
6.3.2 Physics and theoretical modelling of ice accretion, 107
6.3.3 Empirical models to estimate ice loads on structures, 109
6.4 Earthquakes, 113
6.5 Temperature, 114
6.6 Other meteorological aspects, 115

Chapter 7 Wind resistance

7.1 General, 117
7.2 Symmetrical structures without ancillaries, 122
7.3 Symmetrical structures with limited ancillaries, 128
7.4 General method for structures containing ancillaries, 129
7.5 Linear ancillaries, 133
7.6 Discrete ancillaries, 133
7.7 Cables, 133

iv
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.8</td>
<td>Measurements on scale model of communications tower, 134</td>
<td></td>
</tr>
<tr>
<td>7.9</td>
<td>Discrepancy between wind tunnel tests and full-scale measurements, 137</td>
<td></td>
</tr>
<tr>
<td>7.10</td>
<td>Icing, 140</td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>General, 147</td>
<td>147</td>
</tr>
<tr>
<td>8.2</td>
<td>Lattice towers, 148</td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>Guyed masts, 150</td>
<td></td>
</tr>
<tr>
<td>8.3.1</td>
<td>General, 150</td>
<td></td>
</tr>
<tr>
<td>8.3.2</td>
<td>Frequency domain analysis, 152</td>
<td></td>
</tr>
<tr>
<td>8.3.3</td>
<td>Time domain analysis, 157</td>
<td></td>
</tr>
<tr>
<td>8.3.4</td>
<td>Simplified methods, 159</td>
<td></td>
</tr>
<tr>
<td>8.3.5</td>
<td>Summary, 176</td>
<td></td>
</tr>
<tr>
<td>9.1</td>
<td>Introduction, 177</td>
<td>177</td>
</tr>
<tr>
<td>9.2</td>
<td>Design against buckling – individual members, 178</td>
<td></td>
</tr>
<tr>
<td>9.2.1</td>
<td>General, 178</td>
<td></td>
</tr>
<tr>
<td>9.2.2</td>
<td>Influence of local and torsional buckling, 180</td>
<td></td>
</tr>
<tr>
<td>9.2.3</td>
<td>Angle leg members, 181</td>
<td></td>
</tr>
<tr>
<td>9.2.4</td>
<td>Angle bracing members, 182</td>
<td></td>
</tr>
<tr>
<td>9.2.5</td>
<td>Tubular leg members, 184</td>
<td></td>
</tr>
<tr>
<td>9.2.6</td>
<td>Tubular bracing members, 184</td>
<td></td>
</tr>
<tr>
<td>9.2.7</td>
<td>Solid round members, 184</td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>Secondary members (‘redundants’), 185</td>
<td></td>
</tr>
<tr>
<td>9.4</td>
<td>Bracing types, 186</td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td>Compound members, 189</td>
<td></td>
</tr>
<tr>
<td>9.6</td>
<td>Tension, 190</td>
<td></td>
</tr>
<tr>
<td>9.7</td>
<td>Connections, 190</td>
<td></td>
</tr>
<tr>
<td>9.7.1</td>
<td>General, 190</td>
<td></td>
</tr>
<tr>
<td>9.7.2</td>
<td>Flange joints in tubular or solid round leg members, 190</td>
<td></td>
</tr>
<tr>
<td>9.7.3</td>
<td>Guy connections, 192</td>
<td></td>
</tr>
<tr>
<td>10.1</td>
<td>General, 195</td>
<td>195</td>
</tr>
<tr>
<td>10.2</td>
<td>Types of cables, 195</td>
<td></td>
</tr>
<tr>
<td>10.3</td>
<td>Strength of guy ropes, 202</td>
<td></td>
</tr>
<tr>
<td>10.4</td>
<td>Rotational characteristics of steel ropes, 202</td>
<td></td>
</tr>
</tbody>
</table>
Communications structures

10.5 Modulus of elasticity, 203
10.6 Prestretching, 203
10.7 Still air tension, 206
10.8 Terminations, 206
10.8.1 General, 206
10.8.2 Types of terminations, 207

Chapter 11 Aerodynamic stability

11.1 General, 210
11.2 Vortex shedding, 211
11.2.1 General, 211
11.2.2 Background and critical wind speed, 211
11.2.3 Practical implications, 213
11.2.4 Damping devices, 214
11.3 Galloping, 216
11.3.1 General, 216
11.3.2 Critical wind speed, 216
11.3.3 Damping devices, 219

Chapter 12 Fatigue

12.1 General, 220
12.2 Lattice towers, 223
12.3 Lattice masts, 223
12.4 Guys, 226

Chapter 13 Foundations

13.1 General, 228
13.2 Foundation types, 228
13.2.1 Type I: to resist uplift, 228
13.2.2 Type II: to resist overturning, 231
13.2.3 Type III: to resist down thrust, 233
13.2.4 Type IV: guy anchorages, 233

Chapter 14 Codes and standards

14.1 History, 239
14.1.1 General, 239
14.1.2 Wind loading, 239
14.1.3 Ice loading, 242
14.1.4 Strength, 243
14.1.5 Other aspects, 243
14.2 Current codes, 244
14.2.1 General, 244
14.2.2 Comparison of current Codes, 245

Chapter 15 Access and safety 246
15.1 General, 246
15.2 IASS Recommendations for safe access, 249

Chapter 16 Fabrication and erection 251
16.1 Materials and fabrication, 251
16.1.1 Steel for towers and mast columns, 251
16.1.2 Aluminium, 257
16.1.3 Timber, 257
16.1.4 Plastics, 258
16.2 Erection, 258
16.2.1 General, 258
16.2.2 Erection of lattice towers, 259
16.2.3 Erection of guyed masts, 259

Chapter 17 Maintenance 264
17.1 General, 264
17.2 Constraints, 264
17.3 Minimizing maintenance at the design stage, 265
17.4 Manuals, 267

Chapter 18 Seismic response 269
18.1 General, 269
18.2 Seismicity and earthquake-resistance performance levels, 270
18.3 Prediction of seismic response of structures, 271
18.3.1 General, 271
18.3.2 Self-supporting lattice towers, 272
18.3.3 Monopoles, 273
18.3.4 Guyed masts, 273
18.3.5 Antennas and ancillary components, 275
18.4 Geotechnical considerations, 275

Annex A Codes of Practice and Design Standards 276
A.1 General, 276
A.2 Comparisons of National Codes, 277
A.3 Scope, 277
A.4 Limit states/reliability classes, 277
A.5 Wind structure, 279
Communications structures

A.5.1 General, 279
A.5.2 Wind resistance, 286
A.6 Ice loading, 292
A.7 Displacements/serviceability, 293
A.8 Partial safety factors, 295
A.9 Strength, 298
A.9.1 Compressive strength, 298
A.9.2 Tensile strength, 303
A.9.2.1 Steel structure, 303
A.9.2.2 Guys, 303
A.10 Guy assemblies, 304
A.10.1 General, 304
A.10.2 Prestretching, 304
A.10.3 Terminations, 304
A.10.4 Initial tensions, 305
A.11 Erection, 305
A.12 Insulators, 305
A.13 Access, 307

Annex B IASS Working Group Number 4: Masts and Towers

B.1 Brief history, 308
B.2 Role in the future, 308
B.3 The members of the Group, 309

References 311

Index 327