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6 59.67 19.05 -99.99 Cherubini 2000 MBC
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38 0.37 30.45 -99.99 Forrest-Orr 2010 DBC
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86 2.24 35 25.41 Hatanaka-Uchida 1996 Shirasu
87 6.74 40.4 23.84 Hatanaka-Uchida 1996 Shirasu
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271 4.47 34.91 -99.99 Matsuo-Kuroda 1974 10%
272 4.02 33.54 -99.99 Matsuo-Kuroda 1974 10%
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274 6.9 32.82 -99.99 Matsuo-Kuroda 1974 10%
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278 9.84 32 -99.99 Matsuo-Kuroda 1974 10%
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283 7.86 35.53 -99.99 Matsuo-Kuroda 1974 10%
284 6.93 35.89 -99.99 Matsuo-Kuroda 1974 10%
285 7.34 36.13 -99.99 Matsuo-Kuroda 1974 15%
286 7.6 34.32 -99.99 Matsuo-Kuroda 1974 15%
287 8.81 33.02 -99.99 Matsuo-Kuroda 1974 15%
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299 17.79 31.96 -99.99 Matsuo-Kuroda 1974 15%
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321 30.75 16.78 -99.99 Schultze 1971 Rhineland
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357 61.94 10.03 12.96 Matsuo-Kuroda 1974 Watarase1
358 64.87 20.74 12.82 Matsuo-Kuroda 1974 Watarase1
359 78.69 28.32 12.25 Matsuo-Kuroda 1974 Watarase1
360 88.44 22.48 12 Matsuo-Kuroda 1974 Watarase1
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364 0.16 28.18 18.39 Parker-et-al 2008 GoodwinUpperLayer
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378 5.69 7.74 17.27 Ngoc 2012 Vietnam
379 2.52 19.75 18.64 Ngoc 2012 Vietnam
380 4.87 6.5 16.97 Ngoc 2012 Vietnam
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386 4.87 5.94 17.07 Ngoc 2012 Vietnam
387 2.58 20.23 18.34 Ngoc 2012 Vietnam
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389 5.46 6.05 16.97 Ngoc 2012 Vietnam
390 8.8 6.73 17.27 Ngoc 2012 Vietnam
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394 5.46 6.05 16.87 Ngoc 2012 Vietnam
395 16.45 13.12 18.25 Ngoc 2012 Vietnam
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1 1 88 12 0.003 0.017 0.04 13.333 2.408 25 14.715 5.7 13.9302 40.221 25 Mousavi-et-al 2011 IranTriaxial
2 2 80.4 19.61 1e-04 0.0048 0.033 330 6.982 30 17.8542 10.8 16.0884 104.967 31 Mousavi-et-al 2011 IranTriaxial
3 3 95 5 0.0012 0.011 0.04 33.333 2.521 25 19.7181 15.35 17.0694 75.537 33 Mousavi-et-al 2011 IranTriaxial
4 4 97.13 2.87 0.001 0.013 0.033 33 5.121 27 19.8162 16.5 16.9713 55.917 25 Mousavi-et-al 2011 IranTriaxial
5 5 81.6 18.4 0.0011 0.011 0.047 42.727 2.34 26 19.62 19.8 16.3827 3.924 23 Mousavi-et-al 2011 IranTriaxial
6 6 43 57 0.0025 0.024 1 400 0.23 27 18.9333 12.8 16.7751 42.183 29 Mousavi-et-al 2011 IranTriaxial
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8 8 45.9 54.1 0.001 0.03 0.5 500 1.8 26 17.9523 13.13 15.8922 36.297 13 Mousavi-et-al 2011 IranTriaxial
9 9 65.7 34.3 0.011 0.037 0.06 5.455 2.074 23 14.2245 3.4 13.734 30.411 23 Mousavi-et-al 2011 IranTriaxial
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14 14 72.7 27.3 0.001 0.0072 0.043 43 1.206 25 19.5219 18.5 16.4808 59.841 26 Mousavi-et-al 2011 IranTriaxial
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2 25 47 28 17.5 1.81 29 20 18.3 CL Abbasi-et-al 2012 fine-grained
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8 49 35 16 25.5 1.55 70 28 17.9 CH Abbasi-et-al 2012 fine-grained
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12 48 45 7 25.7 1.53 57 26 15.4 CH Abbasi-et-al 2012 fine-grained
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497 3.14 1.14 Tan-et-al 2004 klang-clay
498 2.94 1.16 Tan-et-al 2004 klang-clay
499 3.04 1.01 Tan-et-al 2004 klang-clay
500 2.87 1.36 Tan-et-al 2004 klang-clay
501 2.84 1.41 Tan-et-al 2004 klang-clay
502

1 AP-1 410 10.5 550 11.75 156.87 160.61 0.5 13.99 0.6 CPCFG AP
2 AP-2 410 10.5 550 10.2 140.96 118.34 0.65 9.88 0.93 CPCFG AP
3 AP-3 410 10.5 550 9.5 125.88 155.24 0.57 12.14 0.62 CPCFG AP
4 AP-4 410 10.5 550 9.46 142.98 105.54 0.73 7.71 1.04 CPCFG AP
5 AP-5 410 10.5 550 10.24 156.7 193.68 0.46 15.09 0.42 CPCFG AP
6 AP-6 410 11 570 13.56 154.12 115.61 0.61 10.7 1.02 CPCFG AP
7 AP-7 410 11 570 13.67 118 169.45 0.46 14.73 0.56 CPCFG AP
8 AP-8 410 11 570 11.15 178.22 127.53 0.6 10.36 0.94 CPCFG AP
9 AP-9 410 11 570 12.1 131.19 143.87 0.55 12.16 0.74 CPCFG AP
10 AP-10 410 13 710 23.67 154.24 179.75 0.43 12.17 0.68 CPCFG AP
11 AP-11 410 13 710 30.89 177.15 130.77 0.49 11.19 1.17 CPCFG AP
12 AP-12 410 13 710 25.24 138.7 129.71 0.52 10.52 1.15 CPCFG AP
13 AP-13 410 13 710 22.48 120.79 83.84 0.68 7.03 1.74 CPCFG AP
14 AP-14 410 13 710 22.89 158.87 128.12 0.56 9.29 1.1 CPCFG AP
15 AP-15 410 13 710 23.08 129.8 162.53 0.47 11.59 0.79 CPCFG AP
16 AP-16 410 13 710 30.4 76.34 194 0.38 13.21 0.61 CPCFG AP
17 AP-17 410 13 710 27.24 105.67 157.14 0.46 11.72 0.87 CPCFG AP
18 AP-18 410 13 710 23.36 145.81 119.54 0.57 9.25 1.22 CPCFG AP
19 AP-19 410 13 710 22.96 125.55 112.95 0.59 8.64 1.3 CPCFG AP
20 AP-20 410 13 568 21.88 108.65 130.04 0.53 10.34 1.1 CPCFG AP
21 AP-21 410 13 710 13.89 174.44 176.77 0.53 10.21 0.61 CPCFG AP
22 AP-22 410 13 710 26.91 160.78 142.12 0.48 11.36 1 CPCFG AP
23 AP-23 410 13 710 16.92 160.94 113.95 0.65 7.58 1.15 CPCFG AP
24 AP-24 410 13 710 21.88 161.11 106.26 0.62 8.09 1.34 CPCFG AP
25 AP-25 410 13 568 22.95 155.94 170 0.44 12.38 0.75 CPCFG AP
26 AP-26 410 13 710 25.44 103.28 126.71 0.52 10.67 1.16 CPCFG AP
27 AP-27 410 13 710 19.99 198.55 143.48 0.54 9.8 0.95 CPCFG AP
28 AP-28 410 13 710 13.29 128.55 141.09 0.62 8.24 0.86 CPCFG AP
29 AP-29 410 13 710 23.1 129.45 141.29 0.51 10.55 1 CPCFG AP
30 AP-30 410 13 710 10.86 179.32 140.4 0.68 6.88 0.81 CPCFG AP
31 AP-31 410 13 710 13.08 148.67 79.3 0.84 3.27 1.47 CPCFG AP
32 AP-32 410 13 710 12.27 240.25 156.59 0.6 8.57 0.74 CPCFG AP
33 AP-33 410 13 568 16.22 143.4 94.34 0.69 6.95 1.4 CPCFG AP
34 AP-34 410 13 710 12.73 226.35 193.99 0.51 10.67 0.52 CPCFG AP
35 AP-35 410 13 710 12.52 200.61 220.51 0.47 11.17 0.42 CPCFG AP
36 AP-36 410 13 710 14.93 272.27 133.54 0.63 8.1 0.92 CPCFG AP
37 AP-37 410 13 710 15.01 206.56 150.87 0.56 9.65 0.82 CPCFG AP
38 AP-38 410 13 710 17.35 218.63 86.93 0.72 5.31 1.63 CPCFG AP
39 AP-39 410 13 710 15.47 159.48 135.16 0.62 8.19 0.92 CPCFG AP
40 AP-40 410 16 940 17.49 103.68 367.33 0.34 10.31 0.19 CPCFG AP
41 AP-41 410 18 900 12.82 375.21 131.95 0.76 4.04 0.91 CPCFG AP
42 AP-42 410 18 900 13.29 160.42 171.1 0.65 5.72 0.72 CPCFG AP
43 AP-43 410 16 900 13.06 269.32 150.05 0.69 5.19 0.83 CPCFG AP
44 AP-44 410 16 940 17.49 103.68 367.33 0.34 10.31 0.19 CPCFG AP
45 AP-45 410 16 940 17.49 103.68 367.33 0.34 10.31 0.19 CPCFG AP
46 BP-1 400 8 956 14.86 216.81 209.78 0.57 7.03 0.57 MTCFG BP
47 BP-2 400 10.5 1170 22.25 151.31 148.05 0.67 4.31 0.98 MTCFG BP
48 BP-3 400 11.5 1194 21.93 186.48 225.36 0.54 5.94 0.61 MTCFG BP
49 BP-4 400 9.5 1110 18.14 184.07 206.37 0.59 5.56 0.63 MTCFG BP
50 BP-5 400 9.5 1028 21.16 170.44 193.62 0.56 6.52 0.71 MTCFG BP
51 BP-6 400 15 1696 24.45 235.54 253.75 0.59 3.76 0.6 MTCFG BP
52 BP-7 400 9 972 17.09 198.68 192.15 0.58 6.59 0.66 MTCFG BP
53 BP-8 400 8 904 22.05 140.46 136.64 0.62 6.3 1.03 MTCFG BP
54 BP-9 400 7 756 19.53 109.5 141.59 0.57 8.83 0.94 MTCFG BP
55 BP-10 400 5 640 17.19 111.98 98.11 0.67 8 1.33 MTCFG BP
56 BP-11 400 7 658 16.32 134.23 119.97 0.62 8.91 1.06 MTCFG BP
57 BP-12 400 9 962 16.78 169.92 218.1 0.53 7.32 0.56 MTCFG BP
58 BP-13 400 12 1036 18.3 182.25 162.13 0.65 5.07 0.81 MTCFG BP

59 BP-14 400 8.5 948 20.89 151.38 132.2 0.64 5.8 1.08 MTCFG BP
60 BP-15 400 8 874 21.72 137.47 146.44 0.58 7.34 0.99 MTCFG BP
61 CP-1 410 19 1400 13.16 422.18 344.34 0.55 4.8 0.32 TZCFG CP
62 CP-2 410 19 1400 14.61 337.15 223.12 0.7 3.33 0.55 TZCFG CP
63 CP-3 410 19 1400 14.22 324.35 202 0.74 2.92 0.6 TZCFG CP
64 CP-4 410 20 1400 17.69 349.92 144.83 0.79 2.26 0.89 TZCFG CP
65 CP-5 410 20 1400 14.89 295.91 287.36 0.59 4.5 0.42 TZCFG CP
66 CP-6 410 20 1400 16.3 348.61 329.23 0.52 5.27 0.36 TZCFG CP
67 CP-7 410 19 1300 17.04 329.8 225.04 0.63 4.33 0.57 TZCFG CP
68 CP-8 410 19 1300 17.26 378.99 276.81 0.55 5.36 0.45 TZCFG CP
69 CP-9 410 19 1300 16.34 287.35 220.42 0.64 4.07 0.6 TZCFG CP
70 CP-10 410 21 1400 14.98 327.49 229.92 0.67 3.71 0.54 TZCFG CP
71 CP-11 410 21 1400 13.39 348.37 293.69 0.6 4.45 0.4 TZCFG CP
72 CP-12 410 21 1400 16.73 286.19 217.76 0.66 3.7 0.6 TZCFG CP
73 CP-13 410 21 1400 15.52 338.84 267.86 0.61 4.31 0.46 TZCFG CP
74 CP-14 410 21 1400 15.35 277.08 243.73 0.65 3.86 0.51 TZCFG CP
75 CP-15 410 21 1400 14.38 281.57 299.72 0.59 4.55 0.39 TZCFG CP
76 CP-16 410 22 1400 18 274.67 217.09 0.65 3.83 0.62 TZCFG CP
77 CP-17 410 22 1400 15.4 317.17 183.3 0.75 2.8 0.67 TZCFG CP
78 CP-18 410 22 1400 17.45 250.21 153.67 0.78 2.5 0.82 TZCFG CP
79 CP-19 410 22 1400 17.19 244.78 252.72 0.6 4.39 0.51 TZCFG CP
80 CP-20 410 22 1400 12.41 202.48 182.14 0.82 2.01 0.62 TZCFG CP
81 CP-21 410 22 1400 17.55 241.26 299.39 0.54 4.86 0.44 TZCFG CP
82 CP-22 410 22 1400 15 311.25 284.98 0.59 4.43 0.43 TZCFG CP
83 CP-23 410 22 1400 18.91 230.49 231.37 0.62 4.23 0.58 TZCFG CP
84 CP-24 410 22 1400 13.8 403.49 193.73 0.76 2.68 0.62 TZCFG CP
85 DP-1 450 24 1900 14.58 306.52 155.18 0.93 0.53 0.7 JXCFG DP
86 DP-2 450 24 1900 15.22 251.43 209.23 0.82 1.55 0.57 JXCFG DP
87 DP-3 450 24 1900 17.28 234.67 169.78 0.86 1.24 0.68 JXCFG DP
88 DP-4 450 24 1900 14.09 316.91 272.73 0.75 2.08 0.44 JXCFG DP
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90 DP-6 450 24 1900 13.89 298.51 250.61 0.78 1.86 0.47 JXCFG DP
91 DP-7 450 24 1900 13.24 409.72 200.42 0.88 1.07 0.55 JXCFG DP
92 DP-8 450 24 1900 14.83 270.81 232.78 0.79 1.77 0.52 JXCFG DP
93 DP-9 450 24 1900 15.42 239.4 270.43 0.72 2.3 0.47 JXCFG DP
94 DP-10 450 24 1900 17.58 236.4 130.66 0.94 0.58 0.83 JXCFG DP
95 DP-11 450 24 1900 15.28 328.83 191.78 0.85 1.26 0.6 JXCFG DP
96 DP-12 450 24 1900 18.08 254.96 148.57 0.89 0.96 0.77 JXCFG DP
97 DP-13 450 24 1900 15.71 239.99 146.01 0.94 0.57 0.72 JXCFG DP
98 DP-14 450 24 1900 14.14 300.32 175.6 0.91 0.83 0.62 JXCFG DP
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102 DP-18 450 24 1900 13.74 337.35 143.65 0.99 0.15 0.69 JXCFG DP
103 DP-19 450 24 1900 12.14 324.98 268.26 0.8 1.72 0.42 JXCFG DP
104 DP-20 450 24 1900 12.26 276.83 185.99 0.93 0.59 0.57 JXCFG DP
105 DP-21 450 24 1900 13.3 278.67 302.06 0.72 2.27 0.39 JXCFG DP
106 DP-22 450 24 1900 20.71 257.38 255.96 0.68 2.6 0.53 JXCFG DP
107 DP-23 450 24 1900 9.46 581.32 463.56 0.64 2.92 0.23 JXCFG DP
108 DP-24 450 24 1900 11.04 590.84 390.83 0.68 2.6 0.28 JXCFG DP
109 DP-25 450 24 1900 15.66 375.5 259.89 0.72 2.25 0.49 JXCFG DP
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111 DP-27 450 24 1900 14.95 335.41 260.63 0.73 2.17 0.48 JXCFG DP
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113 DP-29 450 24 1900 15.06 356.89 269.07 0.72 2.27 0.47 JXCFG DP
114 DP-30 450 24 1900 15.45 324.63 281.4 0.7 2.44 0.46 JXCFG DP
115 DP-31 450 24 1900 14.34 424.3 214.65 0.82 1.46 0.55 JXCFG DP
116 DP-32 450 24 1900 11.16 446.22 362.42 0.69 2.5 0.32 JXCFG DP

117 DP-33 450 24 1900 14.68 390.25 350.29 0.64 2.87 0.35 JXCFG DP
118 DP-34 450 24 1900 10.77 401.58 358.17 0.71 2.31 0.32 JXCFG DP
119 DP-35 450 24 1900 17.12 308.56 211.31 0.77 1.82 0.62 JXCFG DP
120 DP-36 450 24 1900 14.2 337.14 268.12 0.74 2.08 0.46 JXCFG DP
121 DP-37 450 24 1900 13.9 340.15 246.44 0.78 1.69 0.5 JXCFG DP
122 DP-38 450 24 1900 15.64 391.46 217.18 0.78 1.72 0.58 JXCFG DP
123 DP-39 450 24 1900 12.9 428.96 292.68 0.75 2.08 0.4 JXCFG DP
124 DP-40 450 24 1900 10.92 488.55 422.01 0.64 2.84 0.26 JXCFG DP
125 DP-41 450 24 1900 19.05 252.01 294.99 0.64 2.85 0.46 JXCFG DP
126 DP-42 450 24 1900 13.17 398.51 364.57 0.66 2.76 0.32 JXCFG DP
127 EP-1 450 24.3 2060 26.43 180.59 213.55 0.7 2.28 0.69 SCCFG EP
128 EP-2 450 24.3 2060 14.52 441.05 221.16 0.84 1.26 0.52 SCCFG EP
129 EP-3 450 24.3 2060 17.45 307.87 261.87 0.74 1.98 0.48 SCCFG EP
130 EP-4 450 24.3 2060 14.58 386.48 308.7 0.72 2.1 0.39 SCCFG EP
131 EP-5 450 24.3 2060 12.25 397.77 257.54 0.84 1.25 0.44 SCCFG EP
132 EP-6 450 24.3 2060 17.9 295.03 247.25 0.75 1.9 0.51 SCCFG EP
133 EP-7 450 24.3 2060 11.43 441.4 292.6 0.8 1.51 0.39 SCCFG EP
134 EP-8 450 24.3 2060 14.27 372.44 238.76 0.83 1.38 0.48 SCCFG EP
135 EP-9 450 24.3 2060 13.91 425.18 308.66 0.72 2.1 0.39 SCCFG EP
136 EP-10 450 24.3 2060 16.78 332.22 188.87 0.85 1.15 0.63 SCCFG EP
137 EP-11 450 24.3 2060 12.27 485.94 216.5 0.91 0.74 0.5 SCCFG EP
138 EP-12 450 24.3 2060 14.68 343.26 250.98 0.78 1.66 0.48 SCCFG EP
139 EP-13 450 24.3 2060 13.19 474.72 331.23 0.71 2.18 0.36 SCCFG EP
140 EP-14 450 24.3 2060 16.27 286.19 289.1 0.7 2.22 0.45 SCCFG EP
141 EP-15 450 24.3 2060 11.28 481.91 330.85 0.76 1.86 0.35 SCCFG EP
142 EP-16 450 24.3 2060 16.6 275.69 255.6 0.75 1.9 0.49 SCCFG EP
143 EP-17 450 24.3 2060 16.66 302.13 231.73 0.78 1.67 0.53 SCCFG EP
144 EP-18 450 24.3 2060 14.87 362.47 262.47 0.77 1.74 0.47 SCCFG EP
145 EP-19 450 24.3 2060 12.41 466.7 328.66 0.73 2.01 0.36 SCCFG EP
146 EP-20 450 24.3 2060 13.25 393.33 261.25 0.8 1.54 0.45 SCCFG EP
147 EP-21 450 24.3 2060 24.02 175.66 231.81 0.69 2.31 0.62 SCCFG EP
148 EP-22 450 24.3 2060 22.95 216.81 258.27 0.68 2.42 0.55 SCCFG EP
149 EP-23 450 24.3 2060 15.09 333.81 285.15 0.74 2 0.43 SCCFG EP
150 EP-24 450 24.3 2060 12.4 397.05 220.73 0.89 0.82 0.5 SCCFG EP
151 EP-25 450 24.3 2060 12.25 335.13 256.44 0.84 1.25 0.44 SCCFG EP
152 EP-26 450 24.3 2060 10.7 457.87 237.25 0.92 0.64 0.45 SCCFG EP
153 EP-27 450 24.3 2060 10.64 444.06 315.27 0.8 1.53 0.36 SCCFG EP
154 EP-28 450 24.3 2060 12.81 431.95 369.34 0.68 2.38 0.32 SCCFG EP
155 EP-29 450 24.3 2060 14.68 403.94 304.66 0.72 2.12 0.41 SCCFG EP
156 EP-30 450 24.3 2060 18.44 259.81 290.79 0.68 2.39 0.46 SCCFG EP
157 EP-31 450 24.3 2000 20.62 261.71 243.94 0.7 2.37 0.56 SCCFG EP
158 EP-32 450 24.3 2000 22.5 263.31 233.43 0.7 2.32 0.6 SCCFG EP
159 EP-33 450 24.3 2000 19.19 249.92 320.05 0.64 2.72 0.42 SCCFG EP
160 EP-34 450 24.3 2060 15.86 313.93 355.8 0.65 2.6 0.36 SCCFG EP
161 EP-35 450 24.3 2060 18.62 297.98 243.91 0.75 1.91 0.53 SCCFG EP
162 EP-36 450 24.3 2060 14.4 326.49 352.32 0.66 2.59 0.35 SCCFG EP
163 EP-37 450 24.3 2000 16.95 309.74 314.19 0.66 2.63 0.42 SCCFG EP
164 EP-38 450 24.3 2000 12.09 418.77 350.9 0.7 2.26 0.34 SCCFG EP
165 EP-39 450 24.3 2000 18.14 294.4 277.06 0.68 2.45 0.48 SCCFG EP
166 EP-40 450 25.3 1912 19.58 256.61 234.53 0.7 2.38 0.59 SCCFG EP
167 EP-41 450 25.3 1912 17.74 243.64 198.43 0.79 1.67 0.63 SCCFG EP
168 EP-42 450 25.3 1912 15.96 341.95 252.13 0.74 2.07 0.49 SCCFG EP
169 EP-43 450 25.3 2000 17.24 308.34 299.05 0.67 2.5 0.44 SCCFG EP
170 EP-44 450 25.3 2000 21.1 253.72 243.83 0.7 2.32 0.56 SCCFG EP
171 EP-45 450 25.3 2000 18.25 281.87 256.83 0.72 2.17 0.51 SCCFG EP
172 EP-46 450 26.5 2000 16.49 275.75 311.2 0.67 2.54 0.41 SCCFG EP
173 EP-47 450 26.5 2000 19.36 264.13 217.54 0.76 1.91 0.6 SCCFG EP
174 EP-48 450 26.5 2000 18.05 298.61 288.93 0.68 2.46 0.46 SCCFG EP

175 EP-49 450 26.5 2000 20.55 264.99 281.09 0.66 2.57 0.49 SCCFG EP
176 EP-50 450 26.5 2000 17.47 300.81 296.79 0.68 2.45 0.44 SCCFG EP
177 EP-51 450 26.5 2000 18.34 306.63 346.34 0.61 2.97 0.39 SCCFG EP
178 EP-52 450 27 2000 17.74 281.1 357.86 0.61 2.96 0.37 SCCFG EP
179 EP-53 450 27 2000 17.02 321.72 288.43 0.71 2.26 0.44 SCCFG EP
180 EP-54 450 27 2000 20.01 245.14 256.01 0.69 2.4 0.54 SCCFG EP
181 FP-1 400 16 1220 12.7 302.08 260.84 0.61 4.89 0.44 DXCFG FP
182 FP-2 400 16 1260 18.22 201.31 106.45 0.84 1.79 1.16 DXCFG FP
183 FP-3 400 16.5 1280 13.2 290.54 207.21 0.7 3.58 0.59 DXCFG FP
184 FP-4 400 16 1240 18.12 246.93 149.68 0.74 3.3 0.85 DXCFG FP
185 FP-5 400 16 1240 11.49 446.18 183.29 0.8 2.6 0.61 DXCFG FP
186 FP-6 400 14 1120 17.65 197.21 166.92 0.67 4.56 0.79 DXCFG FP
187 FP-7 400 16 1240 16.28 223 152.47 0.76 3.06 0.82 DXCFG FP
188 FP-8 400 16 1240 20.29 166.14 175.01 0.66 4.22 0.8 DXCFG FP
189 FP-9 400 16 1240 18.81 192.97 174.43 0.69 3.85 0.76 DXCFG FP
190 FP-10 400 16 1240 23.4 143.51 173.95 0.63 4.51 0.84 DXCFG FP
191 FP-11 400 16 1240 21.01 192 181.49 0.64 4.4 0.77 DXCFG FP
192 FP-12 400 16 1240 14.37 262.39 194.49 0.7 3.73 0.64 DXCFG FP
193 FP-13 400 16 1220 22.34 157.51 137.54 0.71 3.64 1 DXCFG FP
194 FP-14 400 16 1240 16.92 209.43 167.66 0.7 3.8 0.77 DXCFG FP
195 FP-15 400 16 1240 21.63 145.39 136.18 0.72 3.54 1.02 DXCFG FP
196 FP-16 400 16 1240 17.15 211.48 170.08 0.71 3.63 0.76 DXCFG FP
197 FP-17 400 16 1160 18.54 154.61 156.26 0.7 4.08 0.84 DXCFG FP
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200 FP-20 400 16 1120 16.04 263.74 146.5 0.75 3.56 0.85 DXCFG FP
201 FP-21 400 16 1120 11.64 355.87 166.36 0.79 2.91 0.68 DXCFG FP
202

1 AI-1 3.24 400 19.91 75.48 35.35 0.82 7.62 3.46 CPPSI AI
2 AI-2 3.24 400 19.45 93.67 66.84 0.59 16.07 2.04 CPPSI AI
3 AI-3 3.24 400 15.25 125.55 110.62 0.47 20.24 0.94 CPPSI AI
4 AI-4 3.24 400 17.41 75.81 84.52 0.55 17.59 1.44 CPPSI AI
5 AI-5 3.24 400 19.65 65.19 52.39 0.69 12.45 2.48 CPPSI AI
6 AI-6 3.24 400 18.17 73.16 106.46 0.47 20.2 1.02 CPPSI AI
7 AI-7 3.24 400 17.3 125.88 30.12 0.93 3.92 3.45 CPPSI AI
8 AI-8 3.24 400 18.22 116.51 80.52 0.55 17.36 1.58 CPPSI AI
9 AI-9 3.24 400 21.59 108.01 34.45 0.8 8.04 3.69 CPPSI AI
10 AI-10 3.24 400 20.2 64.16 31.33 0.85 6.35 3.75 CPPSI AI
11 AI-11 2.89 660 21.93 245.73 104.92 0.59 9.42 1.44 CPPSI AI
12 AI-12 2.89 660 28.95 102.36 65.84 0.68 7.55 2.39 CPPSI AI
13 AI-13 2.89 660 32.02 114.73 65.06 0.67 7.41 2.55 CPPSI AI
14 AI-14 2.89 660 27.38 125.77 75.61 0.65 8.36 2 CPPSI AI
15 AI-15 2.89 660 26.8 107.03 85.97 0.61 9.27 1.8 CPPSI AI
16 AI-16 2.89 660 29.23 125.9 67.66 0.67 7.53 2.39 CPPSI AI
17 AI-17 2.89 660 31.13 87.62 32.16 0.88 3.05 3.8 CPPSI AI
18 AI-18 2.89 660 28.18 98.62 61.01 0.71 6.69 2.44 CPPSI AI
19 AI-19 2.89 660 29.58 107.49 49.19 0.77 5.6 2.87 CPPSI AI
20 AI-20 2.89 660 33.13 101.15 58.84 0.7 7.25 2.61 CPPSI AI
21 AI-21 2.89 660 31.82 119.8 65.81 0.67 8.22 2.34 CPPSI AI
22 AI-22 2.89 495 26.44 45.2 102.82 0.55 10.83 1.46 CPPSI AI
23 AI-23 2.89 495 31.85 48.26 76.85 0.59 9.43 2.4 CPPSI AI
24 AI-24 2.89 330 32.47 171.88 47.62 0.7 8.67 3.23 CPPSI AI
25 AI-25 2.89 660 31.28 53.7 56.79 0.73 6.61 2.52 CPPSI AI
26 AI-26 2.89 660 30.97 100.31 63.23 0.7 7.35 2.35 CPPSI AI
27 AI-27 2.89 660 31.33 71.53 57.94 0.71 6.75 2.74 CPPSI AI
28 AI-28 2.89 660 34.96 98.07 95.33 0.54 10.45 1.89 CPPSI AI
29 AI-29 2.89 660 22.96 107.16 67.87 0.73 6.58 2.02 CPPSI AI
30 AI-30 2.89 660 28.96 106.67 46.32 0.79 5.19 2.93 CPPSI AI
31 AI-31 2.89 660 31.93 89.05 61.65 0.68 7.9 2.47 CPPSI AI
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33 AI-33 2.89 660 23.2 149.53 57.65 0.77 5.6 2.3 CPPSI AI
34 AI-34 2.89 660 21.63 97.19 83.34 0.68 7.94 1.59 CPPSI AI
35 AI-35 2.89 660 30.28 81.66 66.87 0.68 7.6 2.25 CPPSI AI
36 AI-36 2.89 495 23.65 135.68 70.14 0.68 8.12 2.06 CPPSI AI
37 AI-37 2.89 495 30.4 94 67.77 0.65 8.83 2.3 CPPSI AI
38 AI-38 2.89 660 26.42 100.56 67.21 0.72 6.75 2.04 CPPSI AI
39 AI-39 2.89 660 22.79 103.39 84.58 0.66 8.03 1.64 CPPSI AI
40 AI-40 2.89 660 23.9 69.69 87.88 0.64 8.68 1.65 CPPSI AI
41 AI-41 2.89 660 32.16 60.8 129.99 0.48 12.29 1.11 CPPSI AI
42 AI-42 2.89 660 23.33 57.19 82.84 0.67 7.92 1.66 CPPSI AI
43 AI-43 2.89 660 29.2 68.24 67.95 0.69 7.49 2.15 CPPSI AI
44 AI-44 2.25 600 11.59 179.57 80.24 0.82 4.48 1.45 CPPSI AI
45 AI-45 2.25 600 17.05 151.32 89.93 0.67 8.63 1.41 CPPSI AI
46 AI-46 2.25 600 17.15 149.74 59.02 0.82 4.83 2.04 CPPSI AI
47 AI-47 2.25 600 15.36 153.73 52.15 0.9 2.99 2.1 CPPSI AI
48 AI-48 3.24 520 20.53 135.49 66.25 0.68 9.67 2.06 CPPSI AI
49 AI-49 3.24 520 18.91 125.73 66.81 0.7 8.53 2.04 CPPSI AI
50 AI-50 3.24 520 20.11 98.27 50.12 0.78 6.66 2.59 CPPSI AI
51 AI-51 3.24 520 24.61 104.39 24.7 0.96 1.79 4.22 CPPSI AI
52 AI-52 3.24 520 23.4 100.21 53.83 0.72 8.54 2.59 CPPSI AI
53 AI-53 3.24 520 25.45 77.54 33.54 0.84 4.51 3.82 CPPSI AI
54 AI-54 3.24 520 24.1 69.06 48.18 0.75 7.68 2.8 CPPSI AI
55 AI-55 3.24 520 26.21 102.04 50.8 0.72 8.38 2.89 CPPSI AI
56 AI-56 3.24 520 26.69 68.92 28.97 0.87 4.06 4.18 CPPSI AI
57 AI-57 3.24 520 26.88 130.93 40.48 0.77 7.05 3.42 CPPSI AI
58 AI-58 3.24 520 19.17 115.5 75.8 0.66 10.33 1.77 CPPSI AI

59 AI-59 3.24 520 28.28 109.87 41.83 0.76 7.56 3.37 CPPSI AI
60 AI-60 3.24 520 25.21 97.66 54.27 0.71 9.08 2.61 CPPSI AI
61 AI-61 3.24 520 24.95 140.59 35.86 0.83 5.16 3.61 CPPSI AI
62 AI-62 3.24 520 26.16 73.58 45.56 0.74 7.49 3.18 CPPSI AI
63 AI-63 2.25 360 15.96 162.51 39.93 0.8 8.78 3 CPPSI AI
64 AI-64 2.25 360 13.34 118.42 99.25 0.49 22.29 0.97 CPPSI AI
65 AI-65 2.25 360 13.39 169.37 53.03 0.74 12.08 2.16 CPPSI AI
66 AI-66 2.25 360 11.57 117.79 114.73 0.48 21.97 0.77 CPPSI AI
67 AI-67 2.25 360 12.65 118.88 48.12 0.82 8.85 2.25 CPPSI AI
68 AI-68 2.25 360 14.4 75.69 71.87 0.61 16.06 1.73 CPPSI AI
69 BI-1 3.9 480 21.61 64.09 58.21 0.7 9.99 2.32 MTPSI BI
70 BI-2 3.9 480 20.94 105.88 49.36 0.76 8.23 2.63 MTPSI BI
71 BI-3 3.9 480 21.33 97.23 45.68 0.78 7.23 2.86 MTPSI BI
72 BI-4 4 480 21.18 96.16 34.67 0.87 4.65 3.42 MTPSI BI
73 BI-5 4 480 20.86 116.26 60.56 0.69 10.32 2.25 MTPSI BI
74 BI-6 4 480 20.41 99.06 39.86 0.83 5.49 3.13 MTPSI BI
75 BI-7 4 480 21.27 93.15 36.78 0.85 5.26 3.29 MTPSI BI
76 BI-8 4 480 18.13 112.48 83.04 0.62 12.85 1.51 MTPSI BI
77 BI-9 4 480 21.55 124.69 52.26 0.72 9.18 2.6 MTPSI BI
78 BI-10 3.6 500 22.39 102.55 31.29 0.9 3.74 3.56 MTPSI BI
79 BI-11 3.6 500 21.22 114.75 55.88 0.72 9.07 2.4 MTPSI BI
80 BI-12 3.6 500 23.17 95.6 37.64 0.82 5.73 3.35 MTPSI BI
81 BI-13 3.7 480 18.49 97.13 68.98 0.67 11.4 1.85 MTPSI BI
82 BI-14 3.7 480 16.7 121.81 80.77 0.64 12.03 1.56 MTPSI BI
83 BI-15 3.7 480 19.93 103.73 66.33 0.66 11.26 2.01 MTPSI BI
84 BI-16 4 680 23.49 107.87 57.07 0.79 5.19 2.26 MTPSI BI
85 BI-17 4 680 22.96 119.2 64.91 0.75 5.55 2.1 MTPSI BI
86 BI-18 4 680 21.28 131.57 87.28 0.68 7.55 1.53 MTPSI BI
87 BI-19 3.5 480 22.57 112.85 59.1 0.67 10.59 2.4 MTPSI BI
88 BI-20 3.5 480 24.55 78.35 49.87 0.71 9.76 2.84 MTPSI BI
89 BI-21 3.5 480 18.98 97.23 81.67 0.61 12.86 1.6 MTPSI BI
90 BI-22 3.06 480 21.96 88.28 48.65 0.74 8.82 2.73 MTPSI BI
91 BI-23 3.06 480 21.58 140.25 64.7 0.66 11.09 2.17 MTPSI BI
92 BI-24 3.06 480 19.5 114.65 75.52 0.62 12.86 1.76 MTPSI BI
93 BI-25 4 360 18.13 98.55 35.25 0.81 8.49 3.43 MTPSI BI
94 BI-26 4 360 19.48 91.01 51.51 0.67 14.63 2.53 MTPSI BI
95 BI-27 4 360 19.14 93.81 60.26 0.62 16.68 2.14 MTPSI BI
96 BI-28 4 320 20.94 82.67 25.68 0.83 8.46 4.77 MTPSI BI
97 BI-29 4 320 19.41 75.5 19.52 0.94 3.03 5.59 MTPSI BI
98 BI-30 4 320 18.86 67.29 28.33 0.82 9.11 4.37 MTPSI BI
99 BI-31 3.9 340 17.07 76.48 39.25 0.78 10.92 3.07 MTPSI BI
100 BI-32 3.9 340 17.75 71.61 61.4 0.61 17.75 2.04 MTPSI BI
101 BI-33 3.9 340 15.37 94.07 45.43 0.75 12.21 2.6 MTPSI BI
102 BI-34 4 360 16.71 71.31 51.12 0.7 13.44 2.47 MTPSI BI
103 BI-35 4 360 13.71 109.64 78.51 0.59 17.93 1.41 MTPSI BI
104 BI-36 4 360 16.01 112.03 59.26 0.65 15.28 2.09 MTPSI BI
105 BI-37 4 460 16.9 102.2 66.33 0.69 10.68 1.89 MTPSI BI
106 BI-38 4 460 17.99 128.12 69.74 0.66 11.64 1.86 MTPSI BI
107 BI-39 4 460 16.06 138.97 55.23 0.77 8.17 2.19 MTPSI BI
108 BI-40 3.06 500 21.01 95.01 61.66 0.69 9.54 2.22 MTPSI BI
109 BI-41 3.06 500 21.83 92.11 63.79 0.68 10.43 2.1 MTPSI BI
110 BI-42 3.06 500 20.18 127.78 62.14 0.71 9.43 2.08 MTPSI BI
111 BI-43 4 440 17.8 85.98 50.02 0.75 8.64 2.58 MTPSI BI
112 BI-44 4 440 18.97 110.46 46.22 0.78 8.26 2.67 MTPSI BI
113 BI-45 4 440 23.45 106.44 36.99 0.8 7.7 3.47 MTPSI BI
114 CI-1 3.23 900 17.95 176.07 102.27 0.76 4.2 1.24 TZPSI CI
115 CI-2 3.23 900 18.56 171.01 93.02 0.79 3.91 1.33 TZPSI CI
116 CI-3 3.23 900 19.6 164.97 110.09 0.71 4.97 1.22 TZPSI CI

117 CI-4 3.23 900 16.67 258.73 211.53 0.52 8.45 0.52 TZPSI CI
118 CI-5 3.23 900 16.94 250.97 113.68 0.74 4.62 1.1 TZPSI CI
119 CI-6 3.23 900 17.77 218.88 110.17 0.73 4.56 1.21 TZPSI CI
120 CI-7 2.4 840 17.47 213.73 122.59 0.68 5.95 1.08 TZPSI CI
121 CI-8 2.4 840 16.69 139.77 135.98 0.66 6.12 0.94 TZPSI CI
122 CI-9 2.4 840 18.83 202.62 83.25 0.8 3.88 1.47 TZPSI CI
123 CI-10 2.88 900 16.22 226.85 102.86 0.79 3.79 1.18 TZPSI CI
124 CI-11 2.88 900 17.25 298.09 164.79 0.6 7.14 0.74 TZPSI CI
125 CI-12 2.88 900 16.69 305.23 95.58 0.8 3.52 1.28 TZPSI CI
126 CI-13 2.88 864 17.87 227.99 132.97 0.65 6.22 1 TZPSI CI
127 CI-14 2.88 900 18.45 239.54 135.61 0.66 5.97 0.95 TZPSI CI
128 CI-15 2.88 900 18.46 210.17 136.21 0.66 5.91 0.95 TZPSI CI
129 CI-16 2.88 900 15.83 188.14 125.68 0.72 4.92 1 TZPSI CI
130 CI-17 2.88 900 16.29 201.79 106.63 0.78 3.95 1.15 TZPSI CI
131 CI-18 2.88 900 16.19 230 78.56 0.89 2.06 1.41 TZPSI CI
132 CI-19 2.46 900 16.64 182.59 168.59 0.61 6.65 0.73 TZPSI CI
133 CI-20 2.46 900 16.79 168.85 136.29 0.67 6 0.93 TZPSI CI
134 CI-21 2.46 900 17.5 265 116.12 0.72 4.75 1.11 TZPSI CI
135 CI-22 3.15 900 18.04 199.32 122.16 0.7 5.4 1.04 TZPSI CI
136 CI-23 3.15 900 19.48 197.87 126.04 0.67 5.72 1.05 TZPSI CI
137 CI-24 3.15 900 19.01140684 216.18 57 0.94 1.01 1.9 TZPSI CI
138 DI-1 2.25 960 22.89 96.75 72.6 0.84 2.98 1.67 JXPSI DI
139 DI-2 2.25 960 15.98 114.21 100.33 0.82 3.15 1.15 JXPSI DI
140 DI-3 2.25 960 19.73 112.55 69.68 0.89 2.12 1.62 JXPSI DI
141 DI-4 2.25 960 16.88 136.87 99.55 0.8 3.34 1.21 JXPSI DI
142 DI-5 2.25 960 22.1 93.56 81.48 0.8 3.37 1.55 JXPSI DI
143 DI-6 2.25 960 15.66 161.68 100.63 0.83 3.01 1.15 JXPSI DI
144 DI-7 2.25 960 15.84 119.33 73.39 0.94 1.27 1.43 JXPSI DI
145 DI-8 2.25 960 17.15 133.39 74.47 0.9 1.7 1.49 JXPSI DI
146 DI-9 2.25 960 15.76 133.37 115.48 0.77 3.76 1.06 JXPSI DI
147 DI-10 2.25 960 14.21 150.99 106.43 0.83 2.85 1.09 JXPSI DI
148 DI-11 2.25 960 13.53 163.09 83.45 0.94 1.1 1.26 JXPSI DI
149 DI-12 2.25 960 17.29 127.35 73.09 0.91 1.63 1.52 JXPSI DI
150 DI-13 2.25 960 16.18 136.02 86.95 0.87 2.31 1.31 JXPSI DI
151 DI-14 2.25 960 18.22 116.29 67.58 0.92 1.51 1.6 JXPSI DI
152 DI-15 2.25 960 19.84 116.93 90.98 0.8 3.51 1.35 JXPSI DI
153 DI-16 2.25 960 15.28 133.98 100.75 0.83 2.86 1.14 JXPSI DI
154 DI-17 2.25 960 17.77 135.87 97.57 0.8 3.41 1.24 JXPSI DI
155 DI-18 2.25 960 9.13 215.7 112.33 0.98 0.58 0.88 JXPSI DI
156 DI-19 2.25 960 11.72 192.92 82.54 1 0.18 1.19 JXPSI DI
157 DI-20 2.25 960 13.39 311.21 91.27 0.91 1.7 1.17 JXPSI DI
158 DI-21 2.25 960 10.36 379.8 129.55 0.86 2.35 0.85 JXPSI DI
159 DI-22 2.25 960 7.46 351.48 235.16 0.72 4.64 0.42 JXPSI DI
160 DI-23 2.25 960 10.24 418 208.11 0.67 5.57 0.51 JXPSI DI
161 DI-24 2.25 960 11.87 360.71 146.94 0.76 3.87 0.79 JXPSI DI
162 DI-25 2.25 960 16.47 188.5 106.01 0.79 3.63 1.13 JXPSI DI
163 DI-26 2.25 960 12.74 269.94 132.42 0.78 3.76 0.86 JXPSI DI
164 DI-27 2.25 960 23.62 169.57 93.22 0.75 4.34 1.44 JXPSI DI
165 DI-28 2.25 960 15.49 203.56 121.58 0.77 3.95 0.96 JXPSI DI
166 DI-29 2.25 960 13.85 257.4 136.52 0.75 4.27 0.87 JXPSI DI
167 DI-30 2.25 960 14.69 261.44 113.6 0.79 3.31 1.07 JXPSI DI
168 DI-31 2.25 960 9.78 318.55 180.27 0.75 4.22 0.59 JXPSI DI
169 DI-32 2.25 900 15.18 222.72 111.34 0.78 4.09 1.06 JXPSI DI
170 DI-33 2.25 900 16.83 180.57 75.85 0.88 2.16 1.52 JXPSI DI
171 DI-34 2.25 900 12.24 296.42 151.48 0.73 4.83 0.75 JXPSI DI
172 DI-35 2.25 900 15.43 261.02 94.04 0.82 3.11 1.26 JXPSI DI
173 DI-36 2.25 900 17.47 226.91 94.38 0.79 3.81 1.32 JXPSI DI
174 DI-37 2.25 900 14.04 226.73 93.75 0.86 2.63 1.18 JXPSI DI

175 DI-38 2.25 960 16.81 238.99 98.35 0.81 3.23 1.23 JXPSI DI
176 DI-39 2.25 960 15.29 315.61 124.63 0.76 4.21 0.96 JXPSI DI
177 DI-40 2.25 960 8.73 447.06 141.41 0.9 1.94 0.73 JXPSI DI
178 EI-1 1.8225 1160 16.64 191.44 105.39 0.85 2.03 1.11 SCPSI EI
179 EI-2 1.8225 1160 18.2 162.96 102.87 0.84 2.28 1.16 SCPSI EI
180 EI-3 1.8225 1160 18.37 176.53 77.43 0.93 1 1.39 SCPSI EI
181 EI-4 1.8225 1160 17.94 171.34 91.74 0.89 1.69 1.23 SCPSI EI
182 EI-5 1.8225 1160 27.25 114.84 64.29 0.88 1.72 1.88 SCPSI EI
183 EI-6 1.8225 1160 18.2 185.15 121.47 0.79 3.02 1.01 SCPSI EI
184 EI-7 1.8225 1160 17.18 230.88 118.77 0.81 2.69 1.01 SCPSI EI
185 EI-8 1.8225 1160 21.26 129.99 93.18 0.84 2.49 1.28 SCPSI EI
186 EI-9 1.8225 1160 20.44 157.46 115.15 0.77 3.18 1.11 SCPSI EI
187 EI-10 1.8225 1160 20.57 134.62 118.06 0.77 3.32 1.08 SCPSI EI
188 EI-11 1.8225 1160 15.1 221.57 115.97 0.85 2.07 1 SCPSI EI
189 EI-12 1.8225 1160 15.51 220.69 103.95 0.89 1.67 1.05 SCPSI EI
190 EI-13 1.8225 1160 18.14 185.75 116.34 0.8 2.83 1.04 SCPSI EI
191 EI-14 1.8225 1160 13.93 200.15 118.49 0.88 1.85 0.92 SCPSI EI
192 EI-15 1.96 1120 10.87 258.48 141.88 0.88 1.93 0.74 SCPSI EI
193 EI-16 1.96 1120 15.38 198.74 113.87 0.84 2.33 1.01 SCPSI EI
194 EI-17 1.96 1120 14.21 202.98 96.36 0.93 1.07 1.11 SCPSI EI
195 EI-18 1.96 1060 15.45 187.37 99.76 0.87 2.09 1.13 SCPSI EI
196 EI-19 1.96 1060 18.28 174.48 61.61 0.99 0.41 1.63 SCPSI EI
197 EI-20 1.96 1060 17.52 167.49 100.04 0.83 2.53 1.22 SCPSI EI
198 EI-21 1.8225 1160 15.05 198.85 94.06 0.93 1.02 1.15 SCPSI EI
199 EI-22 1.8225 1160 21.46 139 107.53 0.78 3.09 1.19 SCPSI EI
200 EI-23 1.8225 1160 19.03 167.55 89.95 0.87 1.88 1.28 SCPSI EI
201 EI-24 1.8225 1160 17.33 168.54 93.88 0.89 1.69 1.18 SCPSI EI
202 EI-25 1.8225 1160 15.99 177.78 99.72 0.89 1.64 1.12 SCPSI EI
203 EI-26 1.8225 1160 16.66 181.53 78.29 0.96 0.62 1.33 SCPSI EI
204 EI-27 1.96 1060 18.28 216.24 131.65 0.73 4.1 0.95 SCPSI EI
205 EI-28 1.96 1060 15.13 287.7 142.7 0.74 3.78 0.87 SCPSI EI
206 EI-29 1.96 1060 15.39 202.41 159.21 0.7 4.44 0.77 SCPSI EI
207 EI-30 1.96 1060 17.85 237.69 197.19 0.59 6.12 0.65 SCPSI EI
208 EI-31 1.96 1060 16.57 210.75 139.51 0.73 4.08 0.88 SCPSI EI
209 EI-32 1.96 1060 15.85 200.05 159.71 0.69 4.78 0.76 SCPSI EI
210 EI-33 1.8225 1160 16.96 283.06 236.18 0.56 6.02 0.52 SCPSI EI
211 EI-34 1.8225 1160 11.88 436.9 145.23 0.85 2.2 0.74 SCPSI EI
212 EI-35 1.8225 1160 15.19 308.28 111.12 0.86 1.91 1.04 SCPSI EI
213 EI-36 1.96 1060 10.61 342.94 188.55 0.74 3.84 0.59 SCPSI EI
214 EI-37 1.96 1060 14.28 201.74 161.34 0.72 4.26 0.74 SCPSI EI
215 EI-38 1.96 1060 15.55 234.83 137.66 0.76 3.73 0.87 SCPSI EI
216 EI-39 1.96 1060 15.8 208.88 139.98 0.75 3.87 0.86 SCPSI EI
217 EI-40 1.96 1060 15.37 229.62 159.46 0.71 4.45 0.75 SCPSI EI
218 EI-41 1.96 1060 14.62 248.24 164.26 0.71 4.41 0.73 SCPSI EI
219 EI-42 1.96 1060 13.75 266.75 204.77 0.64 5.33 0.57 SCPSI EI
220 EI-43 1.96 1060 22.23 141.01 60.64 0.93 1.18 1.8 SCPSI EI
221 EI-44 1.96 1060 17.4 221.63 119.19 0.78 3.54 1.01 SCPSI EI
222 EI-45 1.96 1060 17.57 244.06 80.57 0.9 1.53 1.38 SCPSI EI
223 EI-46 1.96 1060 15.05 284.82 162.99 0.71 4.5 0.73 SCPSI EI
224 EI-47 1.96 1060 14.93 220.82 73.48 1 0.31 1.33 SCPSI EI
225 EI-48 1.96 1060 16.88 207.68 85.98 0.9 1.7 1.28 SCPSI EI
226 EI-49 1.96 1060 17.65 214 102.37 0.83 2.78 1.16 SCPSI EI
227 EI-50 1.96 1060 15.72 277.89 177.79 0.66 5.15 0.69 SCPSI EI
228 EI-51 1.96 1060 15 279.56 176.69 0.66 4.97 0.71 SCPSI EI
229 EI-52 1.96 1060 18.95 195.56 99.27 0.82 2.88 1.2 SCPSI EI
230 EI-53 1.96 1060 16.16 245.45 131.8 0.76 3.72 0.91 SCPSI EI
231 FI-1 3.42 700 15.56 163.47 73.99 0.82 3.88 1.61 DXPSI FI
232 FI-2 3.42 700 19.07 142.9 83.69 0.72 6.57 1.55 DXPSI FI

233 FI-3 3.42 700 13.98 190.04 66.23 0.9 2.49 1.62 DXPSI FI
234 FI-4 3.42 700 19.13 152.76 96.32 0.68 7.18 1.34 DXPSI FI
235 FI-5 2.56 700 14.31 237.07 106.42 0.73 6.23 1.11 DXPSI FI
236 FI-6 2.56 700 15.92 208.18 70.37 0.83 3.98 1.67 DXPSI FI
237 FI-7 3.24 700 13.67 328.68 96.62 0.77 5.25 1.22 DXPSI FI
238 FI-8 3.24 700 11.91 207.71 102.69 0.78 5.08 1.1 DXPSI FI
239 FI-9 2.16 700 14.18 214.32 94.86 0.74 5.66 1.31 DXPSI FI
240 FI-10 1.96 700 23.32 159.08 76.94 0.71 6.49 1.84 DXPSI FI
241 FI-11 2.25 700 15.71 187.95 136.93 0.6 9.06 0.87 DXPSI FI
242 FI-12 1.95 700 16.53 224.93 49.64 0.94 1.4 2.15 DXPSI FI
243 FI-13 1.96 700 23.91 104.97 60.7 0.78 5.12 2.18 DXPSI FI
244 FI-14 2.25 700 15.88 147.5 134.62 0.61 8.67 0.9 DXPSI FI
245 FI-15 1.72 700 13.47 204.84 107.32 0.73 6.07 1.1 DXPSI FI
246 FI-16 1.96 700 19.98 148.79 103.54 0.65 8.01 1.29 DXPSI FI
247 FI-17 1.82 700 16.1 244.1 53.57 0.92 1.68 2.04 DXPSI FI
248 FI-18 1.96 700 17.09 210.17 101.94 0.68 7.06 1.26 DXPSI FI
249 FI-19 2.52 540 23.01 94.44 51.08 0.75 7.27 2.65 DXPSI FI
250 FI-20 2.52 540 23.82 108.12 52.96 0.74 7.84 2.56 DXPSI FI
251 FI-21 2.52 540 22.8 112.27 75.97 0.64 10.57 1.84 DXPSI FI
252 FI-22 3.24 700 17.66 185.55 94.92 0.69 7.04 1.36 DXPSI FI
253 FI-23 2.52 700 12.97 180.83 95.85 0.79 4.95 1.19 DXPSI FI
254 FI-24 2.4 700 15.38 162.08 75.43 0.81 4.16 1.59 DXPSI FI
255 FI-25 3.24 700 16.68 204.53 71.35 0.81 4.39 1.69 DXPSI FI
256 FI-26 3.44 400 16.08 74.88 73.32 0.62 14.61 1.67 DXPSI FI
257 FI-27 3.69 400 9.99 227.61 91.73 0.66 13.78 1.13 DXPSI FI
258 FI-28 2.96 400 13.71 114.73 64.61 0.71 11.55 1.8 DXPSI FI
259 FI-29 3.4 400 17.74 73.71 45 0.76 9.38 2.81 DXPSI FI
260 FI-30 1.89 700 14.76 230.47 89.3 0.78 5.14 1.33 DXPSI FI
261 FI-31 2.56 700 19.17 179.2 41.25 0.96 0.99 2.55 DXPSI FI
262 FI-32 2.16 700 18.18 186.1 75.55 0.77 5.27 1.69 DXPSI FI
263

```
1 # author Xingzheng Wu email xingzhengwu@gmail.com
2 #references
3 #Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
  problems in R. Journal of Earth System Science.
4 #2015/5/22
5
6 library(fitdistrplus)
7 strPack01=("H:/XWUBJ/CFaiCopula/GeoRiskR/GeoRiskR3.0/GeoRiskR3.0/")
8 install.packages(paste(strPack01,"GeoRiskR_3.0.zip",sep=""),repos=NULL)
9 library(GeoRiskR)
10 CFAIEM2<- RockShear[which(RockShear[["type"]]=='weathered-clay-stone'),1:2]
11 Cohe<-CFAIEM2[,1]
12 Fric<-CFAIEM2[,2]
13 #---Fig.1a 1b
14 hist(Cohe,probability=TRUE,breaks=20,col=grey(.9),ylim=c(0,0.01),xlim=c(0,250),xlab='Cohesion (kPa)')
15 hist(Fric,probability=TRUE,breaks=20,col=grey(.9),ylim=c(0,0.06),xlim=c(0,50),xlab='Friction angle
  (degree)')
16 fitCohe5<-fitdist(Cohe,"weibull")
17 summary(fitCohe5)$aic; summary(fitCohe5)$loglik
18 gofstat(fitdist(CFAIEM[,1],"gamma"))$ad
19
```

```
1 # author Xingzheng Wu email xingzhengwu@gmail.com
2 #references
3 #Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
  problems in R. Journal of Earth System Science.
4 #2015/5/22
5
6 strPack01=("H:/XWUBJ/CFaiCopula/GeoRiskR/GeoRiskR3.0/GeoRiskR3.0/")
7 install.packages(paste(strPack01,"GeoRiskR_3.0.zip",sep=""),repos=NULL)
8 library(GeoRiskR)
9 CFAIEM2<- RockShear[which(RockShear[["type"]]=='weathered-clay-stone'),1:2]
10 Cohe<-CFAIEM2[,1]
11 Fric<-CFAIEM2[,2]
12 #---Fig. 3
13 library(fitdistrplus)
14 library(copula)
15 CPhiEM<-cbind(Cohe, Fric)
16 theta1<-cor(CPhiEM,method = "pearson")[1,2]
17 myMvd01 <- mvdc(copula = ellipCopula(family = "normal", param = theta1), margins = c("weibull",
  "gamma"), paramMargins =list(list(shape=fitdist(Cohe, "weibull")$estimate[1], scale=fitdist(Cohe,
  "weibull")$estimate[2]), list(shape=fitdist(Fric, "gamma")$estimate[1], rate=fitdist(Fric,
  "gamma")$estimate[2])))
18 denss01<-contour(myMvd01, dmvdc,xlim=c(0,250),ylim=c(0,50))
19 sim.number<-200; set.seed(123)
20 O11 <- rmvdc(myMvd01, sim.number); points(O11)
21
```

```
1 # author Xingzheng Wu email xingzhengwu@gmail.com
2 #references
3 #Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
  problems in R. Journal of Earth System Science.
4 #2015/5/22
5
6 library(fitdistrplus)
7 strPack01=("H:/XWUBJ/CFaiCopula/GeoRiskR/GeoRiskR3.0/GeoRiskR3.0/")
8 install.packages(paste(strPack01,"GeoRiskR_3.0.zip",sep=""),repos=NULL)
9 library(GeoRiskR)
10 #---Fig. 2
11 library(ResourceSelection)
12 kdepairs(cbind(MousaviSet[["FineContent"]],MousaviSet[["Liquid.limit"]],MousaviSet[["cohesion"]],Mousa
  viSet[["friction.angle"]],MousaviSet[["dry.unit.weight"]],MousaviSet[["Moisture.content"]]))
13
```

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1   # author Xingzheng Wu email xingzhengwu@gmail.com
2   #references
3   #Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
problems in R. Journal of Earth System Science.
4   #2015/5/22
5
6   library(fitdistrplus)
7   strPack01=("H:/XWUBJ/CFaiCopula/GeoRiskR/GeoRiskR3.0/GeoRiskR3.0/")
8   install.packages(paste(strPack01,"GeoRiskR_3.0.zip",sep=""),repos=NULL)
9   library(GeoRiskR)
10  CFAIEM2<- RockShear[which(RockShear[["type"]]=='weathered-clay-stone'),1:2]
11  Cohe<-CFAIEM2[,1]
12  Fric<-CFAIEM2[,2]
13  #---Fig. 5
14          xlim_low<-0;xlim_up<-250;
15          ylim_low<-0;ylim_up<-50;
16
17          coreff10<-cor(CFAIEM2,method = "pearson")
18          coreff20<-cor(CFAIEM2,method = "kendall")
19          coreff30<-cor(CFAIEM2,method = "spearman")
20          strEMP=paste("-T",TestCase,"L",ium_Type,sep="")
21          plot(CFAIEM2, xlab="Cohesion (kPa)", ylab="Friction angle (degree)",
xlim=c(xlim_low,xlim_up),ylim=c(ylim_low,ylim_up), cex.axis = 1.0,cex=0.8,pch=4,col =
"chocolate4") #pch=22: filled square,
22          par(new=T)
23  mat.sort <- function(mat,n)
24  {
25      mat[rank(mat[,n]),] <- mat[c(1:nrow(mat)),]
26      return(mat)
27  }
28
29  CFAIEM33<-mat.sort(CFAIEM2,1)
30
31  xyear<-CFAIEM33[,1]
32  ypars<-CFAIEM33[,2]
33  CFAIPRED<-CFAIEM33
34  cfai_lm<-lm(ypars~xyear) #linear regression
35  summary(cfai_lm)
36  cfai_pred0 <- data.frame( predict(cfai_lm, newdata = as.data.frame(CFAIPRED), interval =
"confidence"))
37
38  #sorting with xyear order fit
39  df<-cbind(xyear,cfai_pred0[,1])
40  dfnfit<-df[order(df[,1],df[,2],decreasing=FALSE),]
41  lines(dfnfit,lty=1,type='l',lwd=2,col='darkviolet')
42
43  #sorting with xyear order lwr
44  df<-cbind(xyear,cfai_pred0[,2])
45  dfnlwr<-df[order(df[,1],df[,2],decreasing=FALSE),]
46  lines(dfnlwr,lty=4,type='l',col='violet')
47
48  #sorting with xyear order upr
49  df<-cbind(xyear,cfai_pred0[,3])
50  dfnupr<-df[order(df[,1],df[,2],decreasing=FALSE),]
51  lines(dfnupr,lty=4,type='l',col='violet')
52
53  #nonlinear regression
54

```

```
55     cfai_nlm<-nls(ypars~b0*xyear^4+b1*xyear^3+b2*xyear^2+b3*xyear+a,start = list(b0=-0.004,b1=0.005,  
56     b2=-0.00765, b3=-0.543, a=-0.123)) #polynomial regression  
57     #cfai_nlm <- nls(ypars ~ xyear, data = as.data.frame(CFAIPRED))  
58     summary(cfai_nlm)  
59     cfai_pred1 <- data.frame( predict(cfai_nlm, newdata = as.data.frame(CFAIPRED), interval =  
60     "confidence"))  
61     #sorting with xyear order fit  
62     df<-cbind(xyear,cfai_pred1[,1])  
63     dfnfit<-df[order(df[,1],df[,2],decreasing=FALSE),]  
64     lines(dfnfit,lty=5,type='l',col='red',lwd=2)
```

```

1 #Solution of the second-order reliability method (SORM) using Phoon (2008) 's algorithm
2
3 # author Xingzheng Wu email xingzhengwu@gmail.com
4 #references
5 #[1] Breitung K 1984 Asymptotic approximations for multinormal integrals; J. Eng. Mech. (ASCE), 110(3)
6 357-366.
7 #[2] Phoon K K 2008 Numerical recipes for reliability analysis—a primer; In: Phoon, K.K. (Ed.),
8 Reliability-based Design in Geotechnical Engineering: Computations and Applications. Taylor & Francis
9 (Chapter 1).
10 #[3] Phoon K K and Honjo Y 2005 Geotechnical reliability analyses: towards development of some
11 user-friendly tools; In Proceedings of the 16th International Conference on Soil Mechanics and Geotechnical
12 engineering. Osaka.
13 #[4] Tvedt L 1983 Two second-order approximations to the failure probability. Veritas Report
14 RDIV/20-004083. Det norske Veritas. Veritas Report RDIV/20-004083: Oslo.
15 #[5] Tvedt L 1990 Distribution of quadratic forms in normal space: Application to structural reliability; J.
16 Eng. Mech. (ASCE), 116(6) 1183-1197.
17 #[6] Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
18 problems in R. Journal of Earth System Science.
19 #[7] Wu X.Z. 2013. Probabilistic slope stability analysis by a copula-based sampling method. Computational
20 Geosciences. 2013. 17(5):739-755.
21 #2015/5/22
22
23 # Appendix A3.3 of Wu (2015)
24 # The following R code is modified from the Matlab code written by Phoon (2008)
25 # This subroutine can be run after calling the first-order reliability analysis, i.e., FORM-LT. !!!!
26
27     ##---- Should be DIRECTLY executable !! ----
28     ##-- listing the code.
29     pf1<-pnorm(-beta1)
30     zz<-ret$par; mm<-nVars
31     grad<-matrix(nrow=mm,ncol=1)
32     for (i in 1:mm) {ww<-zz;
33         ww[i]<-zz[i]+0.01; P2<-gFn(ww);
34         ww[i]<-zz[i]-0.01; P1<-gFn(ww);
35         grad[i]<-(P2-P1)/2/0.01}
36     Hess<-matrix(nrow=mm,ncol=mm)
37     for (i in 1:mm){
38         for (j in 1:mm){ww<-zz;
39             if (i==j) {P0<-gFn(ww); ww[i]<-zz[i]+0.01;
40                 P2<-gFn(ww); ww[i]<-zz[i]-0.01;
41                 P1<-gFn(ww); Hess[i,j]<-(P2-2*P0+P1)/(0.01)^2}
42             if (i!=j) {ww[i]<-zz[i]+0.01; ww[j]<-zz[j]+0.01;
43                 P6<-gFn(ww); ww[j]<-zz[j]-0.01;
44                 P5<-gFn(ww); ww[i]<-zz[i]-0.01;
45                 P3<-gFn(ww); ww[j]<-zz[j]+0.01;
46                 P4<-gFn(ww); Hess[i,j]<-(P6-P4-P5+P3)/4/(0.01)^2}}
47     library(pracma) #Norm function
48     dP<-Norm(grad); QQ<-diag(mm);
49     QQ[1:mm,1]<-zz; qrstr<-qr(QQ)
50     QQR<-qr.Q(qrstr); QQR1<-t(apply(QQR,1,rev))
51     AA<-t(QQR1) %*% Hess %*% QQR1;
52     AAN<-AA[1:mm-1,1:mm-1]/dP
53     tmpEG=eigen(AAN); WW=tmpEG$values; kappa<-as.matrix(WW)
54     correction1<-prod(1.0/sqrt(1+beta1*kappa),1);
55     pf2<-pf1*correction1; #Breitung's formula
56     beta2<-qnorm(pf2);
57     TermAA<-beta1*pnorm(-beta1)-dnorm(-beta1)
58     correction2<-prod(1.0/sqrt(1+(beta1+1)*kappa),1);

```

```
50 A2Term<-TermAA*(correction1-correction2); i_complex<-sqrt(as.complex(-1))
51 correction3<-Re(prod(1.0/sqrt(1+(beta1+i_complex)*kappa),1));
52 A3Term<-(beta1+1)*TermAA*(correction1-correction3)
53 pf3<-pf1*correction1+A2Term+A3Term; #Tvedt's formula
54 beta3<--qnorm(pf3)
55
56 beta2 #Breitung's solution
57 beta3 #Tvedt's solution
58
59
```

```

1 #Solution of the first-order reliability method (FORM) using Ang and Tang (1984) 's algorithm
2
3 # author Xingzheng Wu email xingzhengwu@gmail.com
4 #references
5 #[1] Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
6 problems in R. Journal of Earth System Science.
7 #[2] Ang A H S and Tang W H 1984 Probability Concepts in Engineering Planning and Design. Volume II,
8 Decision, risk and reliability; John Wiley, New York, 562pp.
9 #[3] Phoon K K and Honjo Y 2005 Geotechnical reliability analyses: towards development of some
10 user-friendly tools; In Proceedings of the 16th International Conference on Soil Mechanics and Geotechnical
11 engineering. Osaka.
12 #[4]Wu X.Z. 2013. Probabilistic slope stability analysis by a copula-based sampling method. Computational
13 Geosciences. 2013. 17(5):739-755.
14 #2015/5/22
15
16 # Appendix A3.1 of Wu (2015)
17 ##-- listing the code.
18 library(rootSolve) #for uniroot.all( )
19 library(mosaic) #for D( )
20 Y_mu=18; Y_sd=Y_mu*0.1; Z_mu=40; Z_sd=Z_mu*0.2; X12.Corr<-0.66
21 DD<-10; BW<-1; ed<-1; FL<-1000
22 dTerm<-0.5/(ed+DD)*BW*DD^3
23 corrm2<-matrix(c(1,X12.Corr,X12.Corr,1.0),ncol=2,nrow=2,byrow=TRUE)
24 eig<-eigen(corrm2,EISPACK=FALSE); eig.X01<-eig$values[1];
25 eig.X02<-eig$values[2]; tranMat<-eig$vectors;
26 for (iTer in 1:100) { # iteration start
27   if (iTer==1) {Y1<-0; Y2<-0; X0.sigma.mat<-diag(c(Y_sd,Z_sd));
28     muX<-as.matrix(c(Y_mu,Z_mu));
29     CY<-X0.sigma.mat %*% tranMat;
30     Beta<-0.0; BetaNew1<-3
31   }
32   dBeta<-abs(Beta-BetaNew1)
33   if (dBeta<=0.0002) {Beta; break} #success and exit
34
35   if (iTer!=1) {Y1<-X21.Mn; Y2<-X22.Mn}
36   Beta<-BetaNew1
37   D.Y1Fun<-D(dTerm*(CY11*Y1+CY12*Y2+muX1))*(tan((45+0.5*(CY21*Y1+CY22*Y2+muX2))/180
38 *pi))^2-FL~Y1)
39   D.Y2Fun<-D(dTerm*(CY11*Y1+CY12*Y2+muX1))*(tan((45+0.5*(CY21*Y1+CY22*Y2+muX2))/180
40 *pi))^2-FL~Y2)
41   D.Y1Val<-D.Y1Fun(CY11=CY[1,1],CY21=CY[2,1],CY12=CY[1,2],Y1=Y1,CY22=CY[2,2],
42   Y2=Y2,muX2=muX[2],muX1=muX[1],dTerm=dTerm,FL=FL)
43   D.Y2Val<-D.Y2Fun(CY11=CY[1,1],CY21=CY[2,1],CY12=CY[1,2],Y1=Y1,CY22=CY[2,2],
44   Y2=Y2,muX2=muX[2],muX1=muX[1],dTerm=dTerm,FL=FL)
45   D.Y1Vals<-D.Y1Val*sqrt(eig.X01); D.Y2Vals<-D.Y2Val*sqrt(eig.X02)
46
47   Alfa.Y1<-D.Y1Vals/sqrt(D.Y1Vals*D.Y1Vals+D.Y2Vals*D.Y2Vals)
48   Alfa.Y2<-D.Y2Vals/sqrt(D.Y1Vals*D.Y1Vals+D.Y2Vals*D.Y2Vals)
49   DP.Y1<-Alfa.Y1*sqrt(eig.X01); DP.Y2<-Alfa.Y2*sqrt(eig.X02)
50
51   CY11=CY[1,1]; CY21=CY[2,1]; CY12=CY[1,2]; CY22=CY[2,2]; muX1=muX[1]; muX2=muX[2];
52
53   g109.x<-function(x)(dTerm*(CY11*x*DP.Y1+CY12*x*DP.Y2+muX1))*(tan((45+0.5*
54 (CY21*x*DP.Y1+CY22*x*DP.Y2+muX2))/180*pi))^2-FL)
55   BetaNew<-uniroot.all(g109.x, interval=c(0,250)); BetaNew1<-min(BetaNew)
56
57   X21.Mn<-DP.Y1*BetaNew1; X22.Mn<-DP.Y2*BetaNew1;

```

52 } #next iTer
53 BetaNew1
54

```

1 #Solution of the first-order reliability method (FORM) using Low and Tang (2007) 's algorithm
2
3 # author Xingzheng Wu email xingzhengwu@gmail.com
4 #references
5 #[1] Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
6 problems in R. Journal of Earth System Science.
7 #[2] Low B K and Tang W H 2007 Efficient spreadsheet algorithm for first-order reliability method; J. Eng.
8 Mech. 133(12) 1378-1387.
9 #[3] Phoon K K and Honjo Y 2005 Geotechnical reliability analyses: towards development of some
10 user-friendly tools; In Proceedings of the 16th International Conference on Soil Mechanics and Geotechnical
11 engineering. Osaka.
12 #[4]Wu X.Z. 2013. Probabilistic slope stability analysis by a copula-based sampling method. Computational
13 Geosciences. 2013. 17(5):739-755.
14 #2015/5/22
15
16 # Appendix A3.2 of Wu (2015)
17 ## install.packages("Rdonlp2") #Rdonlp2_0.3-1.zip
18 library(Rdonlp2)
19 nVars<-2; ncols<-nVars; nrows<-nVars
20
21 FunXiLT<-function(DistName,para1,para2,ni){if (DistName=="norm") {
22   xi_LT=para1+ni*para2}; list(xi_LT=xi_LT)
23 }
24
25 ObjFn<-function(par){
26   x1<-par[1]; x2<-par[2];
27   ncols<-2; nrows<-2
28   X12.Corr<-0.66; X21.Corr<-0.66
29   corrm4<-matrix(c(1,X12.Corr,X21.Corr,1.0),ncol=ncols,nrow=nrows,byrow=TRUE)
30   CormInv<-solve(corrm4)
31   matXMinusM<-t(t(c(x1,x2)))
32   sqrt(t(matXMinusM) %*% CormInv %*% matXMinusM)
33 }
34 par.l<-c(-500,-500); par.u<-c(50,60)
35 nlinbd<-matrix(0,nr=1,nc=2)
36
37 gFn<-function(par){
38   x1<-par[1];x2<-par[2];
39   X1_mu=18.00; X1_sd=1.8; X2_mu=40.00/180*pi; X2_sd=8/180*pi;
40   z1<-FunXiLT("norm",X1_mu,X1_sd,x1)$xi_LT
41   z2<-FunXiLT("norm",X2_mu,X2_sd,x2)$xi_LT
42   BW<-1; DD<-10; ed<-1; FL<-1000
43   z1*BW*DD^3/(2*(ed+DD))*tan(pi/4+z2/2)^2-FL
44 }
45 nlinbd[1,]<-c(-Inf,0)
46 p0<-c(0.0,0.0) #n1,n2
47 cntl<-donlp2.control(del0=0.2,tau0=1.0,tau=0.1,taubnd=5e-6)
48 res<-donlp2(par=p0,fn=ObjFn,par.u=par.u,par.l=par.l,nlin=list(gFn),nlin.upper=nlinbd[2,],
49 nlin.lower=nlinbd[1,],control=cntl)
50 beta1<-res$f
51 beta1
52

```

```

1 #Function of defination of the original basic variables by the dimensionless numbers using Low and Tang (2007) 's
  algorithm
2   #The following R code is modified from the VB code written by Low and Tang (2007).
3   # author Xingzheng Wu email xingzhengwu@gmail.com
4   #references
5   #[1] Low B K and Tang W H 2007 Efficient spreadsheet algorithm for first-order reliability method; J. Eng.
  Mech. 133(12) 1378-1387.
6   #[2] Low B K and Tang W H 1997 Efficient reliability evaluation using spreadsheets; J. Eng. Mech. 123(7)
  749-752.
7   #2015/5/22
8
9
10  FunXiLT<-function(DistName,para1,para2,ni){
11    if (DistName=="norm") {
12      xi_LT=para1+ni*para2
13    }
14    if (DistName=="lnorm") {
15      lamda=log(para1)-0.5*log(1+(para2/para1)^2)
16      zeta = sqrt(log(1+(para2/para1)^2))
17      xi_LT = exp(lamda+zeta*ni)
18    }
19    if (DistName=="gumbel") {
20      alfa=1.28255/para2
21      u=para1-0.5772/alfa
22      xi_LT =u-log(-log(pnorm(ni)))/alfa
23    }
24    if (DistName=="weibull") {
25      xi_LT =para2*(-log(1-pnorm(ni)))^(1/para1)
26    }
27    if (DistName=="gamma") {
28      xprev=para1*para2
29      for (i in 1:100) {
30        pdfg=dgamma(xprev,para1,1/para2)
31        xnew=xprev-(CDFg-pnorm(ni))/pdfg
32        if (abs((xnew-xprev)/xprev)<0.000001) break
33        if (xnew<=0) xnew=0.5*xprev
34        xprev=xnew
35      }
36      xi_LT=xnew
37    }
38
39    list(xi_LT=xi_LT)
40  }
41

```

```

1 #Solution of the second-order reliability method (SORM) using Phoon (2008) 's algorithm
2
3 # author Xingzheng Wu email xingzhengwu@gmail.com
4 #references
5 #[1] Breitung K 1984 Asymptotic approximations for multinormal integrals; J. Eng. Mech. (ASCE), 110(3)
6 357-366.
7 #[2] Phoon K K 2008 Numerical recipes for reliability analysis—a primer; In: Phoon, K.K. (Ed.),
8 Reliability-based Design in Geotechnical Engineering: Computations and Applications. Taylor & Francis
9 (Chapter 1).
10 #[3] Phoon K K and Honjo Y 2005 Geotechnical reliability analyses: towards development of some
11 user-friendly tools; In Proceedings of the 16th International Conference on Soil Mechanics and Geotechnical
12 engineering. Osaka.
13 #[4] Tvedt L 1983 Two second-order approximations to the failure probability. Veritas Report
14 RDIV/20-004083. Det norske Veritas. Veritas Report RDIV/20-004083: Oslo.
15 #[5] Tvedt L 1990 Distribution of quadratic forms in normal space: Application to structural reliability; J.
16 Eng. Mech. (ASCE), 116(6) 1183-1197.
17 #[6] Wu XZ. 2015. Implementing multivariate fitting and reliability analyses for geotechnical engineering
18 problems in R. Journal of Earth System Science.
19 #[7] Wu X.Z. 2013. Probabilistic slope stability analysis by a copula-based sampling method. Computational
20 Geosciences. 2013. 17(5):739-755.
21 #2015/5/22
22
23 # Appendix A3.3 of Wu (2015)
24 # The following R code is modified from the Matlab code written by Phoon (2008)
25 # This subroutine can be run after calling the first-order reliability analysis, i.e., FORM-LT. !!!!
26
27     ##---- Should be DIRECTLY executable !! ----
28     ##-- listing the code.
29     pf1<-pnorm(-beta1)
30     zz<-ret$par; mm<-nVars
31     grad<-matrix(nrow=mm,ncol=1)
32     for (i in 1:mm) {ww<-zz;
33         ww[i]<-zz[i]+0.01; P2<-gFn(ww);
34         ww[i]<-zz[i]-0.01; P1<-gFn(ww);
35         grad[i]<-(P2-P1)/2/0.01}
36     Hess<-matrix(nrow=mm,ncol=mm)
37     for (i in 1:mm){
38         for (j in 1:mm){ww<-zz;
39             if (i==j) {P0<-gFn(ww); ww[i]<-zz[i]+0.01;
40                 P2<-gFn(ww); ww[i]<-zz[i]-0.01;
41                 P1<-gFn(ww); Hess[i,j]<-(P2-2*P0+P1)/(0.01)^2}
42             if (i!=j) {ww[i]<-zz[i]+0.01; ww[j]<-zz[j]+0.01;
43                 P6<-gFn(ww); ww[j]<-zz[j]-0.01;
44                 P5<-gFn(ww); ww[i]<-zz[i]-0.01;
45                 P3<-gFn(ww); ww[j]<-zz[j]+0.01;
46                 P4<-gFn(ww); Hess[i,j]<-(P6-P4-P5+P3)/4/(0.01)^2}}
47     library(pracma) #Norm function
48     dP<-Norm(grad); QQ<-diag(mm);
49     QQ[1:mm,1]<-zz; qrstr<-qr(QQ)
50     QQR<-qr.Q(qrstr); QQR1<-t(apply(QQR,1,rev))
51     AA<-t(QQR1) %*% Hess %*% QQR1;
52     AAN<-AA[1:mm-1,1:mm-1]/dP
53     tmpEG=eigen(AAN); WW=tmpEG$values; kappa<-as.matrix(WW)
54     correction1<-prod(1.0/sqrt(1+beta1*kappa),1);
55     pf2<-pf1*correction1; #Breitung's formula
56     beta2<-qnorm(pf2);
57     TermAA<-beta1*pnorm(-beta1)-dnorm(-beta1)
58     correction2<-prod(1.0/sqrt(1+(beta1+1)*kappa),1);

```

```
50 A2Term<-TermAA*(correction1-correction2); i_complex<-sqrt(as.complex(-1))
51 correction3<-Re(prod(1.0/sqrt(1+(beta1+i_complex)*kappa),1));
52 A3Term<-(beta1+1)*TermAA*(correction1-correction3)
53 pf3<-pf1*correction1+A2Term+A3Term; #Tvedt's formula
54 beta3<--qnorm(pf3)
55
56 beta2 #Breitung's solution
57 beta3 #Tvedt's solution
58
59
```