



# CALCULATION SHEET

| MEMBER<br>REFERENCE                                                                                                                                                       | CALCULATION<br>Member Actions and Utilisation Factors                                                                |             |             |          |             |             |             |          | OUTPUT/<br>REFERENCE |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-------------|-------------|----------|-------------|-------------|-------------|----------|----------------------|
| Element<br>Main Rib P1-P6<br>Main Rib P1-P6<br>Main Rib P6-P6<br>Main Rib P6-P6<br>Main Rib Taper<br>Main Rib Taper<br>Bottom Fork<br>Bottom Fork<br>Top Fork<br>Top Fork | Factored Maximum structure actions from SuperSTRESS pinned support model                                             |             |             |          |             |             |             |          |                      |
|                                                                                                                                                                           | SAG BENDING                                                                                                          |             |             |          | HOG BENDING |             |             |          |                      |
|                                                                                                                                                                           | Moment                                                                                                               | Axial Force | Shear Force | Loadcase | Moment      | Axial Force | Shear Force | Loadcase |                      |
|                                                                                                                                                                           | 107.235                                                                                                              | 188.690     | 27.410      | c3       | 100.283     | 139.520     | 2.250       | c3       |                      |
|                                                                                                                                                                           | 42.980                                                                                                               | 244.250     | 30.290      | c5       |             |             |             |          |                      |
|                                                                                                                                                                           | 62.700                                                                                                               | 73.100      | 10.600      | c3       | 78.950      | 111.520     | 5.790       | c3       |                      |
|                                                                                                                                                                           |                                                                                                                      |             |             |          | 43.460      | 149.340     | 3.770       | c5       |                      |
|                                                                                                                                                                           | 107.230                                                                                                              | 203.480     | 1.370       | c3       | 69.060      | 185.710     | 52.530      | c3       |                      |
|                                                                                                                                                                           | 12.640                                                                                                               | 266.260     | 12.640      | c5       |             |             |             |          |                      |
|                                                                                                                                                                           | 54.550                                                                                                               | 86.810      | 19.390      | c3       | 55.030      | 367.060     | 42.170      | c3       |                      |
| 6.260                                                                                                                                                                     | 378.480                                                                                                              | 9.980       | c3          |          |             |             |             |          |                      |
| 23.055                                                                                                                                                                    | 251.710                                                                                                              | 5.277       | c3          | 33.150   | 174.610     | 16.430      | c3          |          |                      |
|                                                                                                                                                                           |                                                                                                                      |             |             | 1.380    | 258.770     | 8.120       | c3          |          |                      |
| Cl. 4.8.3.2                                                                                                                                                               | <u>Cross section capacity</u>                                                                                        |             |             |          |             |             |             |          |                      |
|                                                                                                                                                                           | $\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} \leq 1$                                                                    |             |             |          |             |             |             |          |                      |
| Cl. 4.8.3.3.1                                                                                                                                                             | <u>Member Buckling Resistance</u>                                                                                    |             |             |          |             |             |             |          |                      |
|                                                                                                                                                                           | $\frac{F_c}{P_c} + \frac{m_x M_x}{p_y Z_x} \leq 1$                                                                   |             |             |          |             |             |             |          |                      |
|                                                                                                                                                                           | for hog bending case using Annex G, $m_x$ & $m_t = 1$ as allowance for moment shape inherent in calculation of $M_b$ |             |             |          |             |             |             |          |                      |
|                                                                                                                                                                           | and                                                                                                                  |             |             |          |             |             |             |          |                      |
|                                                                                                                                                                           | $\frac{F_c}{P_{cy}} + \frac{m_{lt} M_{lt}}{M_b} \leq 1$                                                              |             |             |          |             |             |             |          |                      |
|                                                                                                                                                                           | <u>Equivalent Uniform Moment Factors</u>                                                                             |             |             |          |             |             |             |          |                      |
| Table 18                                                                                                                                                                  | $m_{LT} = 0.2 + \frac{0.15M_2 + 0.5M_3 + 0.15M_4}{M_{max}} \geq 0.44$                                                |             |             |          |             |             |             |          |                      |
| Table 26                                                                                                                                                                  | $m_x = 0.2 + \frac{0.1M_2 + 0.6M_3 + 0.1M_4}{M_{max}}$ but $m_x \geq \frac{0.8M_{24}}{M_{max}}$                      |             |             |          |             |             |             |          |                      |
| CALCS BY:                                                                                                                                                                 | AGW                                                                                                                  |             |             | DATE:    | June 09     |             |             | REV.     |                      |
| CHECKED BY:                                                                                                                                                               |                                                                                                                      |             |             | DATE:    |             |             |             | PAGE A2  |                      |

### CALCULATION SHEET

| MEMBER<br>REFERENCE                                                                                                                                                       | CALCULATION |                    |                   |                   |                                             |                    |                   |                   | OUTPUT/<br>REFERENCE |                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------------------|-------------------|---------------------------------------------|--------------------|-------------------|-------------------|----------------------|-----------------------------|
| Element<br>Main Rib P1-P6<br>Main Rib P1-P6<br>Main Rib P6-P6<br>Main Rib P6-P6<br>Main Rib Taper<br>Main Rib Taper<br>Bottom Fork<br>Bottom Fork<br>Top Fork<br>Top Fork | SAG BENDING |                    |                   |                   | conservatively used $m = 1$ , except line 2 | HOG BENDING        |                   |                   |                      | conservatively used $m = 1$ |
|                                                                                                                                                                           | Loadcase    | $m_{LT}$           | $m_x$             |                   |                                             | Loadcase           | $m_{LT}$          | $m_x$             |                      |                             |
|                                                                                                                                                                           | c3          | 1.000              | 1.000             |                   |                                             | c3                 | 1.000             | 1.000             |                      |                             |
|                                                                                                                                                                           | c5          | 0.602              | 0.638             |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           | c3          | 1.000              | 1.000             |                   |                                             | c3                 | 1.000             | 1.000             |                      |                             |
|                                                                                                                                                                           | c5          | 1.000              | 1.000             |                   |                                             | c5                 | 1.000             | 1.000             |                      |                             |
|                                                                                                                                                                           | c3          | 1.000              | 1.000             |                   |                                             | c3                 | 1.000             | 1.000             |                      |                             |
|                                                                                                                                                                           | c5          | 1.000              | 1.000             |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           | c3          | N/A - Tension      |                   |                   |                                             | c3                 | 1.000             | 1.000             |                      |                             |
|                                                                                                                                                                           | c3          | 1.000              | 1.000             |                   |                                             |                    |                   |                   |                      |                             |
| c3                                                                                                                                                                        | 1.000       | 1.000              |                   | c3                | N/A - Tension                               |                    |                   |                   |                      |                             |
| c3                                                                                                                                                                        |             |                    |                   | c3                | 1.000                                       | 1.000              |                   |                   |                      |                             |
| Element<br>Main Rib P1-P6<br>Main Rib P1-P6<br>Main Rib P6-P6<br>Main Rib P6-P6<br>Main Rib Taper<br>Main Rib Taper<br>Bottom Fork<br>Bottom Fork<br>Top Fork<br>Top Fork | Loadcase    | X section capacity | Member Buckling 1 | Member Buckling 2 | Loadcase                                    | X section capacity | Member Buckling 1 | Member Buckling 2 |                      |                             |
|                                                                                                                                                                           | c3          | 0.278              | 0.918             | 0.943             | c3                                          | 0.244              | 0.634             | 0.867             |                      |                             |
|                                                                                                                                                                           | c5          | 0.181              | 0.980             | 0.983             |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           | c3          | 0.147              | 0.395             | 0.487             | c3                                          | 0.193              | 0.571             | 0.688             |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   | c5                                          | 0.142              | 0.649             | 0.713             |                      |                             |
|                                                                                                                                                                           | c3          | 0.228              | 0.253             | 0.598             | c3                                          | 0.166              | 0.189             | 0.411             |                      |                             |
|                                                                                                                                                                           | c5          | 0.111              | 0.144             | 0.185             |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           | c3          | 0.200              | 0.121             | 0.297             | c3                                          | 0.287              | 0.495             | 0.720             |                      |                             |
|                                                                                                                                                                           | c3          | 0.134              | 0.347             | 0.373             |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           | c3          | 0.150              | 0.292             | 0.386             | c3                                          | 0.062              | N/A - Tension     |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   | c3                | 0.082                                       | 0.228              | 0.234             |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |
|                                                                                                                                                                           |             |                    |                   |                   |                                             |                    |                   |                   |                      |                             |



CALCULATION SHEET

| MEMBER<br>REFERENCE    | CALCULATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | OUTPUT/<br>REFERENCE |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| NR/GN/CIV/025 Table A2 | $K_e = (U_s/1.2)/p_y$ <p>Wrought Iron UTS = 285 N/mm<sup>2</sup><br/>271 N/mm<sup>2</sup> x gm = 1.05</p> $K_e = 1.250$ <p>An = Net Area<br/>Gross Area = 28.563 sq inch</p> <p>Less rivet holes, assumed rivet size = 0.75 " (based on record drawing)<br/>Area of Rivet hole = 0.38 sq inch through angle<br/>0.28 sq inch through web plate<br/>0.19 sq inch through flange plate</p> <p>Total Deduction = 4.313 sq inch</p> <p>Net Area = 24.250</p> <p>Effective Area = 30.313 &gt; Ag therefore use Ag</p> <p>Pt = 3538.8 kN for fork section</p> <p>Lantern T section Gross Area = 3.25 sq inch<br/>Lantern formerly had a second T section rivetted to top section, which has subsequently been removed<br/>assume that the holes remain and should be deducted, assume 1/2" rivets<br/>Area of hole = 0.25 sq inch</p> <p>Net Area of T = 2.8 sq inch</p> <p>Effective area = 3.44 sq inch &gt; Ag therefore use Ag</p> <p>Pt = 379.42 kN</p> |                      |
| CALCS BY:              | AGW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | DATE: June 09        |
| CHECKED BY:            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | DATE:                |
|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | REV.                 |
|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | PAGE A4              |



CALCULATION SHEET

| MEMBER<br>REFERENCE | CALCULATION                                                              |         |                |         | OUTPUT/<br>REFERENCE |
|---------------------|--------------------------------------------------------------------------|---------|----------------|---------|----------------------|
|                     | Temporary Works load effects on Main Shed Roof Arches<br>Cracked O-Rings |         |                |         |                      |
|                     | $\phi = 123.4$                                                           |         | $\phi = 123.4$ |         |                      |
|                     | pc = 23.22                                                               |         | pc = 23.22     |         |                      |
|                     | Pc = 312.50                                                              |         | Pc = 312.50    |         |                      |
|                     | Member Capacities                                                        |         |                |         |                      |
|                     |                                                                          | Mcx     | Mb             | Pv/Vw   | Pcy                  |
|                     | Main Rib p6-p6 Mb, minor axis Pc                                         | 535.721 | 299.5          | 629.451 | 262.952              |
|                     | Main Rib p1-p6 sag Mb, Maj axis Pc                                       | 535.721 | 475.5          | 629.451 | 1387.252             |
|                     | Annexe G Main Rib p1-p6 hog Mb&Pc                                        | 535.721 | 238.3          |         | 312.505              |
|                     | Annexe G Main Rib p1-p6 hog Mb&Pc                                        | 535.721 | 286.8          |         | 312.505              |
|                     | Main Rib Taper                                                           | 681.368 | 213.4          | 649.676 | 2122.973             |
|                     | Top & Bottom Fork                                                        | 310.197 | 136.5          | 281.935 | 1157.070             |
|                     |                                                                          |         |                |         | For Fixed Model      |
|                     |                                                                          |         |                |         | For Flexible Model   |
| CALCS BY:           | AGW                                                                      | DATE:   | June 09        | REV.    |                      |
| CHECKED BY:         |                                                                          | DATE:   |                | PAGE    | B1                   |

# CALCULATION SHEET

| MEMBER<br>REFERENCE                                                                                                                                                       | CALCULATION<br>Member Actions and Utilisation Factors                                                  |               | OUTPUT/<br>REFERENCE                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------------|
| Element<br>Main Rib P1-P6<br>Main Rib P1-P6<br>Main Rib P6-P6<br>Main Rib P6-P6<br>Main Rib Taper<br>Main Rib Taper<br>Bottom Fork<br>Bottom Fork<br>Top Fork<br>Top Fork | Factored Maximum structure actions from SuperSTRESS pinned support model with cracked o-rings          |               |                                                          |
|                                                                                                                                                                           | SAG BENDING                                                                                            |               | HOG BENDING                                              |
|                                                                                                                                                                           | Moment                                                                                                 | Axial Force   | Shear Force Loadcase                                     |
|                                                                                                                                                                           | 116.916                                                                                                | 189.315       | 25.766 c3                                                |
|                                                                                                                                                                           | 53.999                                                                                                 | 211.969       | 24.219 c2                                                |
|                                                                                                                                                                           | 66.354                                                                                                 | 76.347        | 13.083 c3                                                |
|                                                                                                                                                                           | 116.916                                                                                                | 203.878       | 9.649 c3                                                 |
|                                                                                                                                                                           | 30.464                                                                                                 | 231.233       | 17.061 c2                                                |
|                                                                                                                                                                           | 63.014                                                                                                 | 65.600        | 20.708 c3                                                |
|                                                                                                                                                                           | 6.334                                                                                                  | 381.274       | 10.039 c3                                                |
| 27.189                                                                                                                                                                    | 224.021                                                                                                | 6.027 c3      |                                                          |
| 0.020                                                                                                                                                                     | 231.086                                                                                                | 8.874 c3      |                                                          |
| Cl. 4.8.3.2                                                                                                                                                               | Cross section capacity                                                                                 |               | Wind load S not included as no damaged rings @ south end |
| $\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} \leq 1$                                                                                                                         |                                                                                                        |               |                                                          |
| Cl. 4.8.3.3.1                                                                                                                                                             | Member Buckling Resistance                                                                             |               |                                                          |
| $\frac{F_c}{P_c} + \frac{m_x M_x}{p_y Z_x} \leq 1$                                                                                                                        |                                                                                                        |               |                                                          |
| and                                                                                                                                                                       |                                                                                                        |               |                                                          |
| $\frac{F_c}{P_{cy}} + \frac{m_{lt} M_{lt}}{M_b} \leq 1$                                                                                                                   |                                                                                                        |               |                                                          |
| Equivalent Uniform Moment Factors                                                                                                                                         |                                                                                                        |               |                                                          |
| Table 18                                                                                                                                                                  | $m_{LT} = 0.2 + \frac{0.15M_2 + 0.5M_3 + 0.15M_4}{M_{max}} \geq 0.44$                                  |               |                                                          |
| Table 26                                                                                                                                                                  | $m_x = 0.2 + \frac{0.1M_2 + 0.6M_3 + 0.1M_4}{M_{max}} \text{ but } m_x \geq \frac{0.8M_{24}}{M_{max}}$ |               |                                                          |
| CALCS BY:                                                                                                                                                                 | AGW                                                                                                    | DATE: June 09 |                                                          |
| CHECKED BY:                                                                                                                                                               |                                                                                                        | DATE:         | PAGE B2                                                  |

## CALCULATION SHEET

| MEMBER<br>REFERENCE                                                                                                                                                                   | CALCULATION                                                                                                                                                                                                                                                                               |                       |                      |                                | OUTPUT/<br>REFERENCE |                       |                      |                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------|--------------------------------|----------------------|-----------------------|----------------------|--------------------------------|
| Element<br>Main Rib P1-P6<br>Main Rib P1-P6<br>Main Rib P6-P6<br>Main Rib P6-P6<br>Main Rib Taper<br>Main Rib Taper<br>Bottom Fork<br>Bottom Fork<br>Top Fork<br>Top Fork             | SAG BENDING                                                                                                                                                                                                                                                                               |                       |                      | conservatively used<br>$m = 1$ | HOG BENDING          |                       |                      | conservatively used<br>$m = 1$ |
|                                                                                                                                                                                       | Loadcase                                                                                                                                                                                                                                                                                  | $m_{LT}$              | $m_x$                |                                | Loadcase             | $m_{LT}$              | $m_x$                |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | c3                   | 1.000                 | 1.000                |                                |
|                                                                                                                                                                                       | c2                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | c3                   | 1.000                 | 1.000                |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | c2                   | 1.000                 | 1.000                |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | c3                   | 1.000                 | 1.000                |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | c3                   | 1.000                 | 1.000                |                                |
|                                                                                                                                                                                       | c2                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | c3                   | 1.000                 | 1.000                |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | #                    | 1.000                 | 1.000                |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 1.000                 | 1.000                |                                | c3                   | 1.000                 | 1.000                |                                |
| Element<br>Main Rib P1-P6<br>Main Rib P1-P6<br>Main Rib P6-P6<br>Main Rib P6-P6<br>Main Rib Taper<br>Main Rib Taper<br>Bottom Fork<br>Bottom Fork<br>Top Fork<br>Top Fork             | Loadcase                                                                                                                                                                                                                                                                                  | X section<br>capacity | Member<br>Buckling 1 | Member<br>Buckling 2           | Loadcase             | X section<br>capacity | Member<br>Buckling 1 | Member<br>Buckling 2           |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 0.296                 | 0.938                | 0.966                          | c3                   | 0.266                 | 0.668                | 0.925                          |
|                                                                                                                                                                                       | c2                                                                                                                                                                                                                                                                                        | 0.188                 | 0.907                | 0.920                          | c3                   | 0.210                 | 0.594                | 0.724                          |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 0.155                 | 0.414                | 0.512                          | c2                   | 0.174                 | 0.621                | 0.715                          |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 0.242                 | 0.268                | 0.644                          | c3                   | 0.172                 | 0.196                | 0.427                          |
|                                                                                                                                                                                       | c2                                                                                                                                                                                                                                                                                        | 0.125                 | 0.154                | 0.252                          | c3                   | 0.293                 | 0.503                | 0.734                          |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 0.234                 | 0.123                | 0.326                          | c3                   | 0.063                 | 0.264                | 0.404                          |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 0.200                 | 0.189                | 0.209                          |                      |                       |                      |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 0.155                 | 0.281                | 0.393                          |                      |                       |                      |                                |
|                                                                                                                                                                                       | c3                                                                                                                                                                                                                                                                                        | 0.069                 | 0.200                | 0.200                          |                      |                       |                      |                                |
| 0.296 0.938 0.966                                                                                                                                                                     |                                                                                                                                                                                                                                                                                           |                       |                      | 0.293 0.668 0.925              |                      |                       |                      |                                |
| - The top fork member has significant tension combined with bending moment, check these using Cl. 4.8.2<br>(Checks in table above subject to capacities calculated on following page) |                                                                                                                                                                                                                                                                                           |                       |                      |                                |                      |                       |                      |                                |
| Cl. 4.8.2                                                                                                                                                                             | <u>Combined moment and axial tension</u><br><br>Member subject to moment and axial tension are: Top forked section and the lantern main frame<br><div><math display="block">\frac{F_t}{P_t} + \frac{M_x}{M_{cr}} \leq 1</math></div><br>$P_t = p_y A_e$<br>Effective area $A_e = K_e A_n$ |                       |                      |                                |                      |                       |                      |                                |
| Cl. 4.6.1<br>Cl. 3.4.3                                                                                                                                                                |                                                                                                                                                                                                                                                                                           |                       |                      |                                |                      |                       |                      |                                |
| CALCS BY:                                                                                                                                                                             | AGW                                                                                                                                                                                                                                                                                       |                       |                      | DATE:                          | June 09              |                       |                      | REV.                           |
| CHECKED BY:                                                                                                                                                                           |                                                                                                                                                                                                                                                                                           |                       |                      | DATE:                          |                      |                       |                      | PAGE B3                        |



CALCULATION SHEET

| MEMBER<br>REFERENCE    | CALCULATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | OUTPUT/<br>REFERENCE |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| NR/GN/CIV/025 Table A2 | <p><math>K_e = (U_s/1.2)/p_y</math></p> <p>Wrought Iron UTS = 285 N/mm<sup>2</sup><br/>271 N/mm<sup>2</sup> x gm = 1.05</p> <p><math>K_e = 1.250</math></p> <p>An = Net Area<br/>Gross Area = 28.563 sq inch</p> <p>Less rivet holes, assumed rivet size = 0.75 " (based on record drawing)<br/>Area of Rivet hole = 0.38 sq inch through angle<br/>0.28 sq inch through web plate<br/>0.19 sq inch through flange plate</p> <p>Total Deduction = 4.313 sq inch</p> <p>Net Area = 24.250</p> <p>Effective Area = 30.313 &gt; Ag therefore use Ag</p> <p>Pt = 3538.8 kN for fork section</p> <p>Lantern T section Gross Area = 3.25 sq inch<br/>Lantern formerly had a second T section rivetted to top section, which has subsequently been removed<br/>assume that the holes remain and should be deducted, assume 1/2" rivets<br/>Area of hole = 0.25 sq inch</p> <p>Net Area of T = 2.8 sq inch</p> <p>Effective area = 3.44 sq inch &gt; Ag therefore use Ag</p> <p>Pt = 379.42 kN</p> |                      |
| CALCS BY:              | AGW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | DATE: June 09        |
| CHECKED BY:            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | DATE:                |
|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | REV.                 |
|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | PAGE B4              |