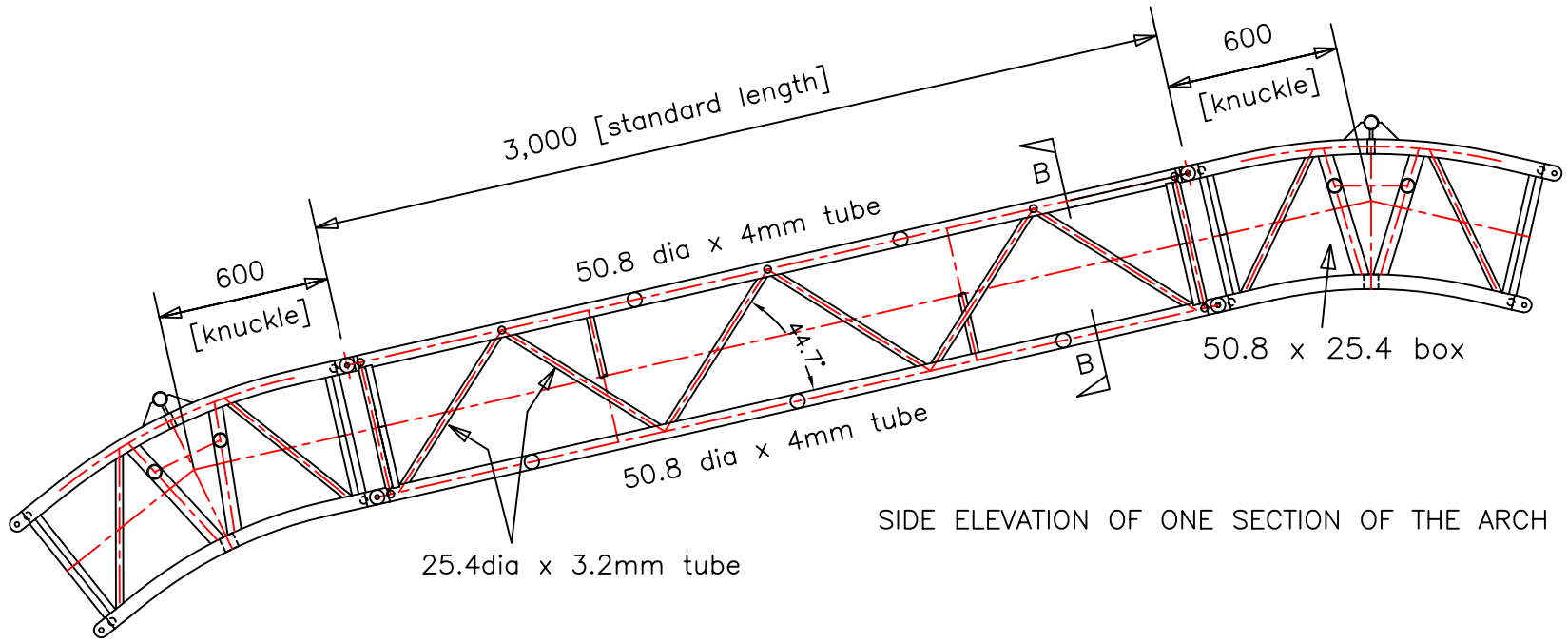
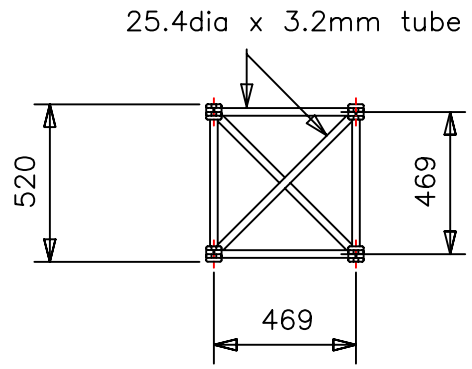


SIDE ELEVATION OF ONE SECTION OF THE ARCH



B – B

By examination of the forces and moment diagrams, it can be seen that the greatest forces will occur in one of two combinations of loading, being either a) self–weight plus maximum applied loading, or
b) self–weight plus wind blowing at 45 degrees to the front face.
In all other combinations of loading, either the wind forces are less than for the chosen case, or the forces generated by the addition of the applied loading act in opposition to those from the wind, thereby reducing the overall effects.

A load factor of 1.33 x 1.2(dynamic) = 1.6 will be applied to the self–weight plus applied loading figures.
A load factor of 1.2 x 1.2(dynamic) = 1.44 will be applied to the self–weight plus wind force condition.

Considering condition a) it can be seen that the two panels with the critical forces are
i) at the bottom of the leg, where there is an axial compressive force of 1.6x[3.84+12.55] = 26.22kN, plus a moment of 1.6x[3.12+14.70] = 28.51kNm.
ii) at the first panel up the arch, where there is an axial compressive force of 1.6x[1.15+5.55] = 10.72kN, plus a moment of 1.6x[2.96+14.00] = 27.14kNm

Considering condition b) it can be seen that the two panels with the critical forces are
i) at the bottom of the leg, where there is an axial compressive force of 1.44x[3.84–1.28] = 3.69kN, plus a moment of 1.44x[3.12–54.04] = –73.32kNm.
ii) at the second panel up the arch, where there is an axial tensile force of 1.44x[2.05–3.58] = –2.20kN, plus a moment of 1.44x[0.37–26.36] = –37.43kNm

The greatest shear force occurs in condition b) i) at the bottom of the leg and is 1.44x[1.39–15.15] = 19.81kN

For condition a) i), the forces in the tubes will be
+[26.22/4] +/–[28.51/(2x0.47)] = +6.56 +/–30.33
= +36.89kN compressive or –23.77kN tensile

For condition a) ii), the forces in the tubes will be
+[10.72/4] +/–[27.14/(2 x 0.47)] = +2.68 +/–28.87
+31.55kN compressive or –26.19kN tensile

For condition b) i), the forces in the tubes will be
+[3.69/4] +/–[73.32/(2 x 0.47)] = +0.92 +/–78.00
+78.92kN compressive or –77.08kN tensile

For condition a) ii), the forces in the tubes will be
–[2.20/4] +/–[37.43/(2 x 0.47)] = –0.55 +/–39.82
+39.27kN compressive or –40.37kN tensile

EXTRACT FROM THE SUPERTRUSS APPRAISAL DOCUMENT

Maximum allowable shear force (factored) = 13.46kN per side = 26.92kN total
26.92kN > 19.81kN .. therefore satisfactory!
Maximum allowable force in top or bottom tubes (factored) = 87.50kN
which exceeds force at bottom of leg of 78.92kN .. therefore satisfactory!
Maximum allowable force in top or bottom tubes (factored) for stability on a 4.20m length between restraints = 87.50kN which exceeds greatest compressive force at mid–span of 39.27kN .. therefore satisfactory!

19m ARCH ROOF – STRUCTURAL ANALYSIS – 09

52cm SUPERTRUSS CALCULATIONS