Solid Beam Analysis

Problem 1:

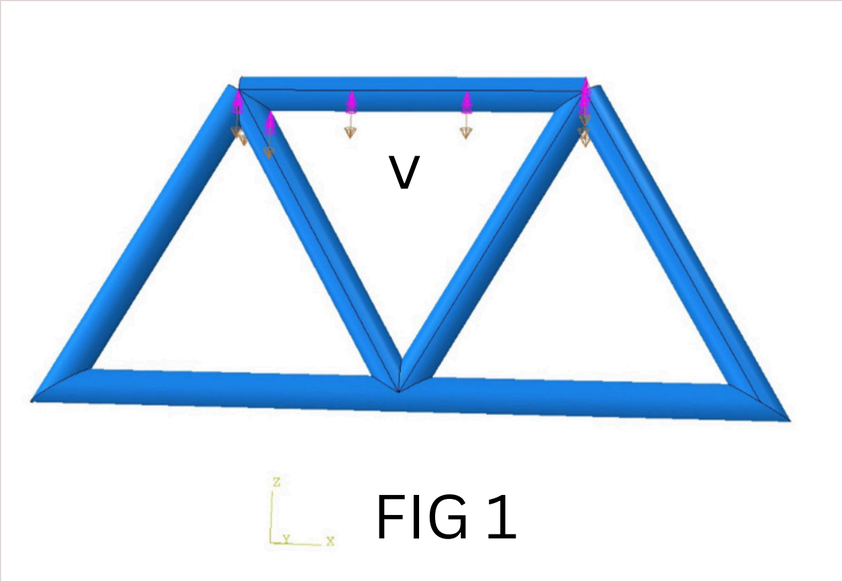


FIG 1

Length of each cylindrical rod= 50m

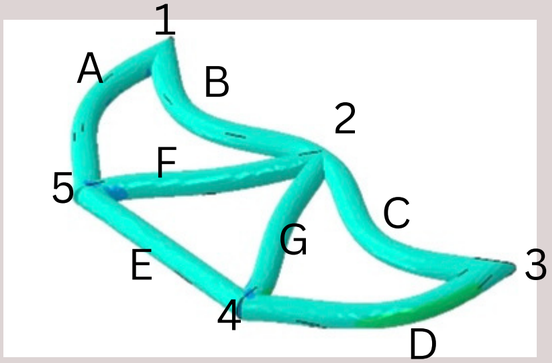
Radius of each cylinder = 5m

young's modulus of material used = 200GPa

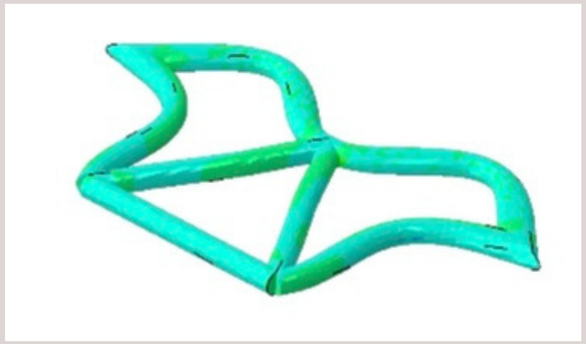
Poisson's ratio = 0.3

Case 1: (V = 500m/s)

Observation: (Deformation modes)



Mode -1



Mode -2

Mode 1 occurs at t = 0.1s, 0.2767s, 0.4221s, 0.6358s, 0.8s in a time gap from 0s to 1s.
Mode 2 occurs at t = 0.19s, 0.3779s, 0.5368s, 0.7s, 1.0s in a time gap from 0s to 1s.

At t = 0.1s:

S11 is maximum at point 2 and has a value of 4.037e+10 Pa
S22 is maximum at points 4,5 and has a value of 1.633e+10Pa
S33 is maximum at rod G and has a value of 6.470e+09Pa

At t=0.19s:

S11 is maximum at point 2 and has a value of 3.83e+10Pa
S22 is maximum at point 2 and has a value of 1.79e+10Pa
S33 is maximum at pint 2 and at mid region of rods A and D and has a value of 3.78e+10 Pa

At t = 0.2767s:

S11 is maximum at the mid region of rods B and C and at point 2 and has a value of 5.6167e+10 Pa
S22 is maximum at points 4,5 and has a value of 2.2e+10 Pa
S33 is maximum at points 4,5 and at rod G,A and has a value of 3.397e+10 Pa

At t = 0.3779s:

S11 is maximum at point 2 and rod B,C and has a value of 1.912e+10 Pa
S22 is maximum at points 2,4,5 and has a value of 1.09e+10Pa
S33 is maximum at point 2 and has a value 0f 2.598e+10 Pa

At t = 0.4221s:

S11 is maximum at pooint 2 and at mid region of rod B,C and has a value of 5.17e+10 Pa
S22 is maximum at points 4,5 and has a value of 2.026e+10 Pa
S33 is maximum at points 4,5 and at rod G,A and has a value of 2.578e+10 Pa

At t = 0.5368s:

S11 is maximum at points 2,4,5 and at rod B,C,A,D and has a value of 1.751e+10Pa
S22 is almost uniform for entire boy and has a value of 2.78e+10 Pa
S33 is maximum at points 4,5 and has a value of 1.272e+10 Pa

At t = 0.6358s:

S11 is maximum at point 2 and at mid region of rods B,C and has a value of 3.596e+10 Pa
S22 is maximum ata points 4,5 and has a value of 5.549e+09 Pa
S33 is maximum at rod G,A and has a value of 1.674e+10 Pa

At t = 0.7s:

S11 is maximum at point 2 and mid region of rod B,C and has a value of 7.37e+10 Pa
S22 is maximum at point 2 and has a value of 2.384e+10 Pa
S33 is maximum at point 2 and has a value of 5.318e+10 Pa

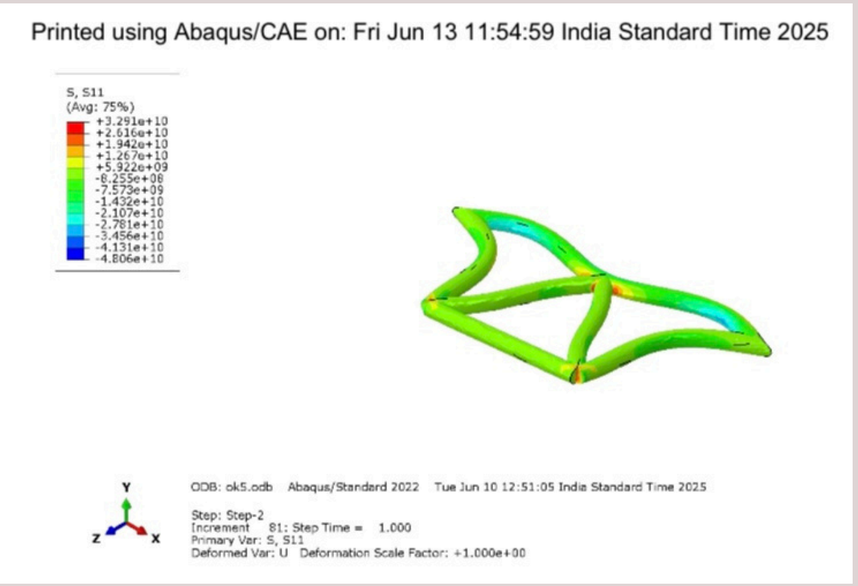
At t = 0.8s:

S11 is maximum at point 2 and mid region of rod B,C and has a value of 3.260e+10 Pa
S22 is maximum at points 4,5 and has a value of 8.245e+10 Pa
S33 is maximum at rod G,A and point 2 and has a value of 7.809e+10 Pa

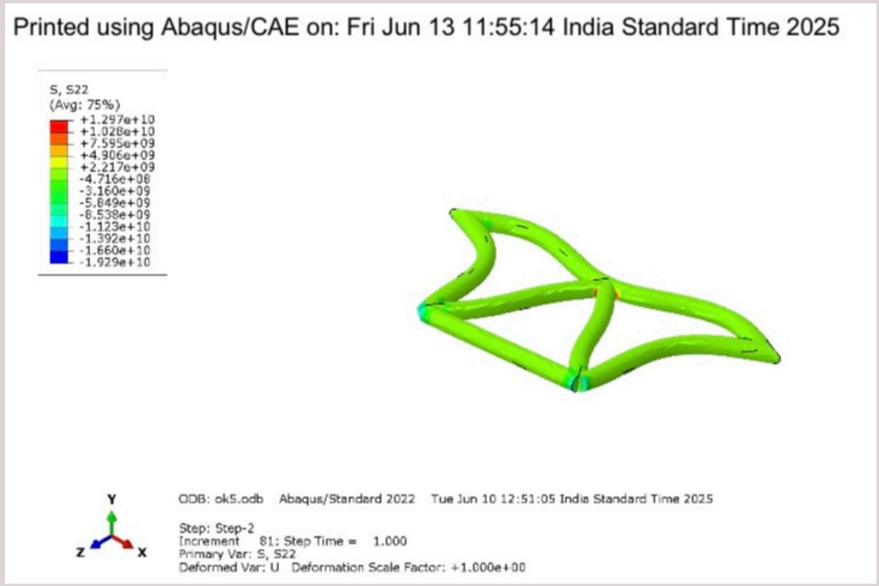
At t = 1.0s:

S11 is maximum at points 2,4,5 and has a value of 2.616e+10 Pa
S22 is maximum at point 2 and has a value of 1.028e+10 Pa
S33 is maximum at points 4,5 and has a value of 2.960e+10 Pa

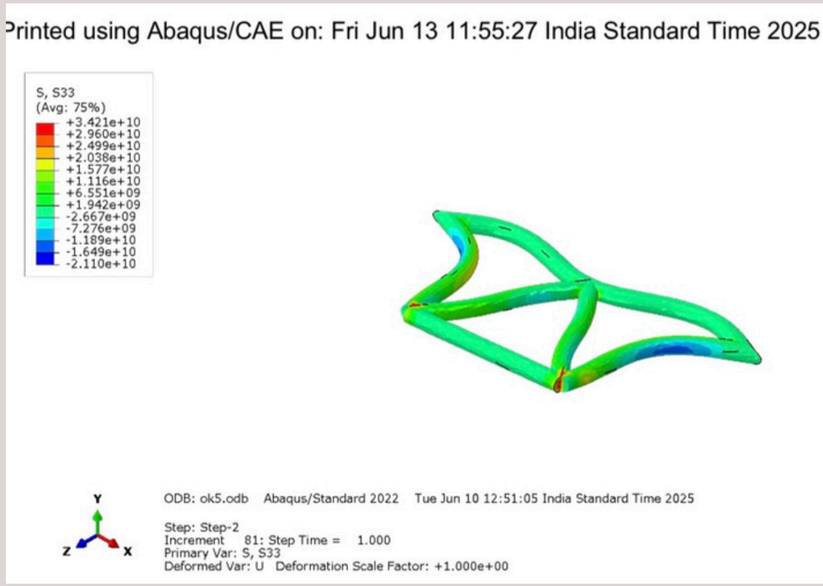
The areas where the axial stresses are high are more prone to fracture.



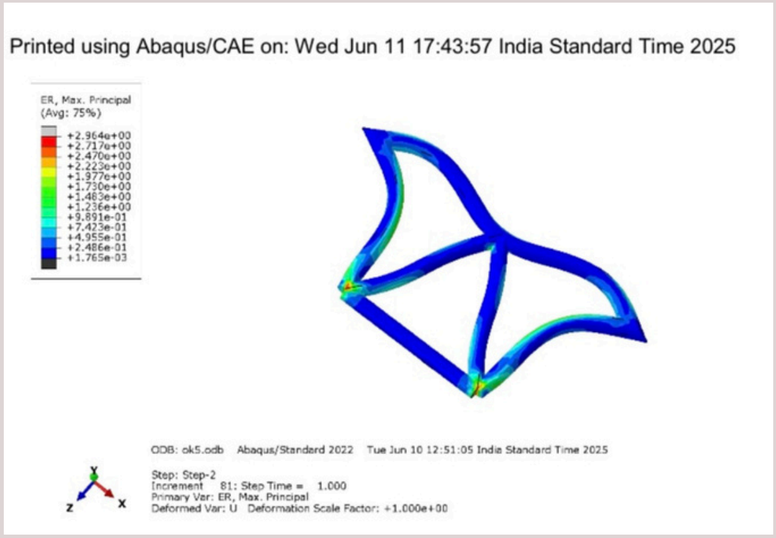
S11



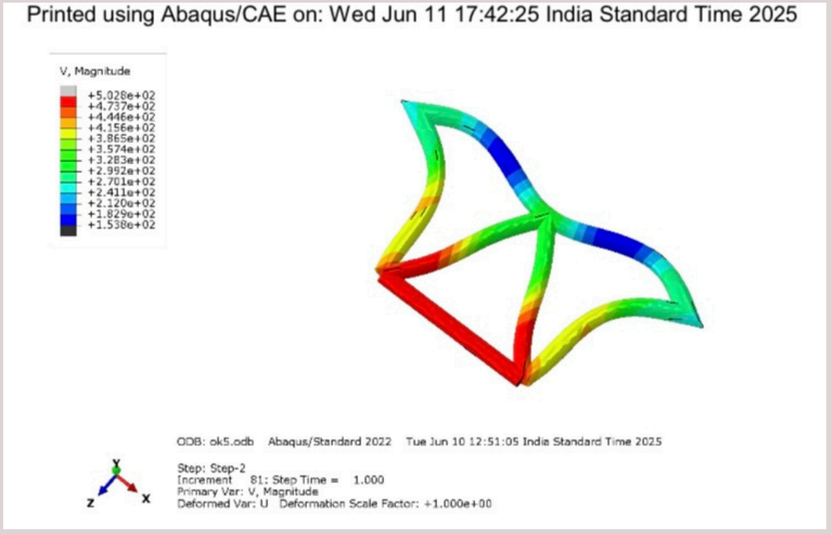
S22



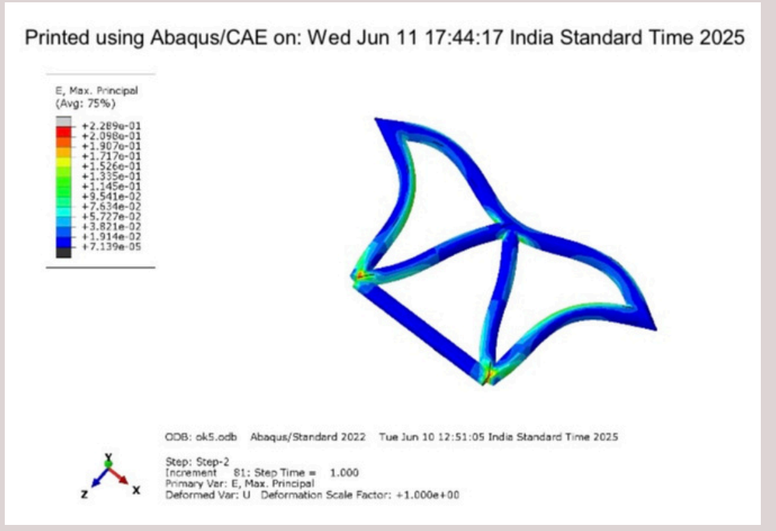
S33



Strain rate



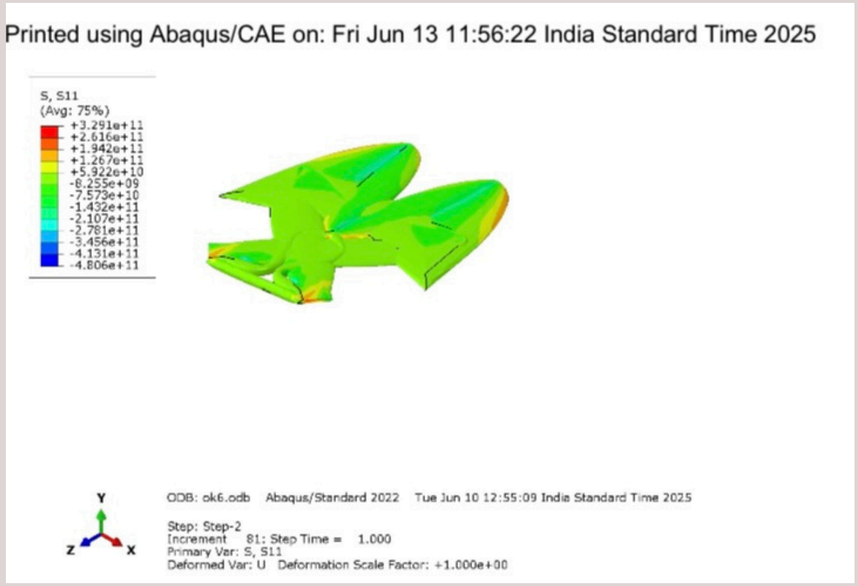
velocity



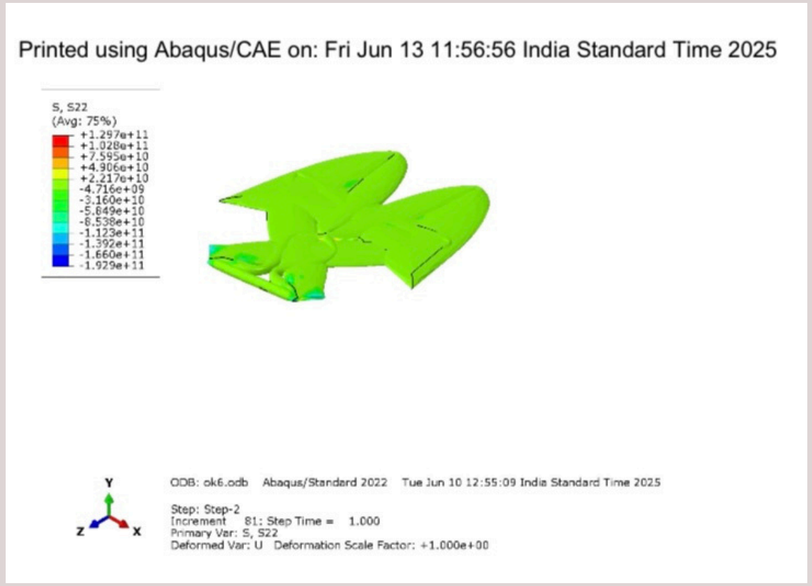
Strain

Case 2: (V = 5000m/s)

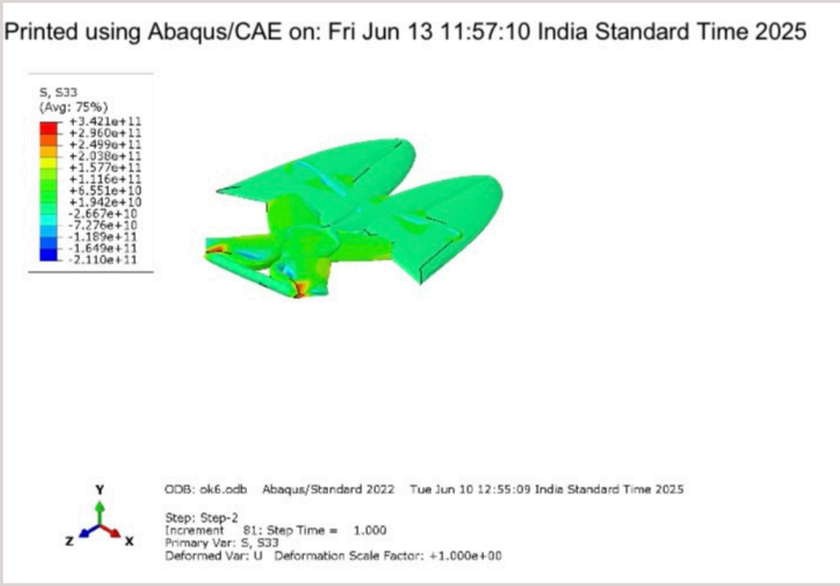
No deformation nodes observed



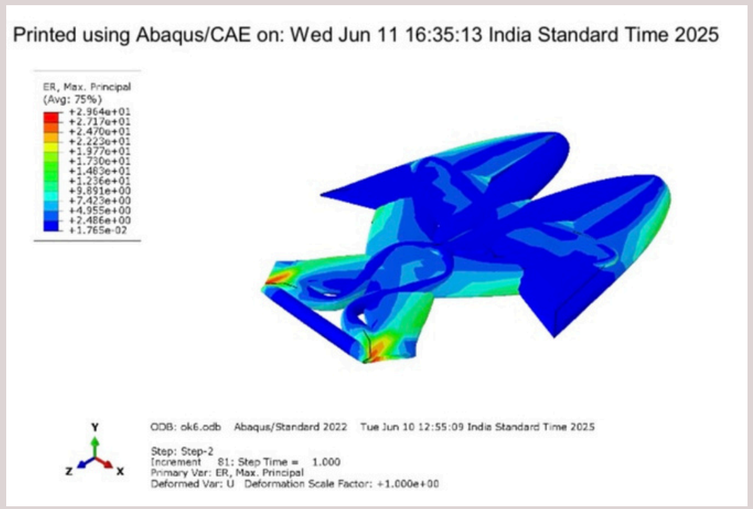
S11



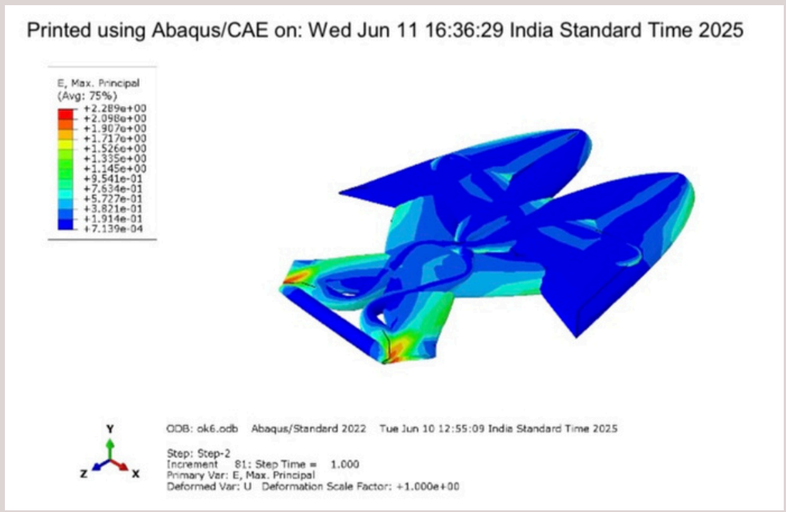
S22



S33



Strain Rate



Stress

Problem 2:

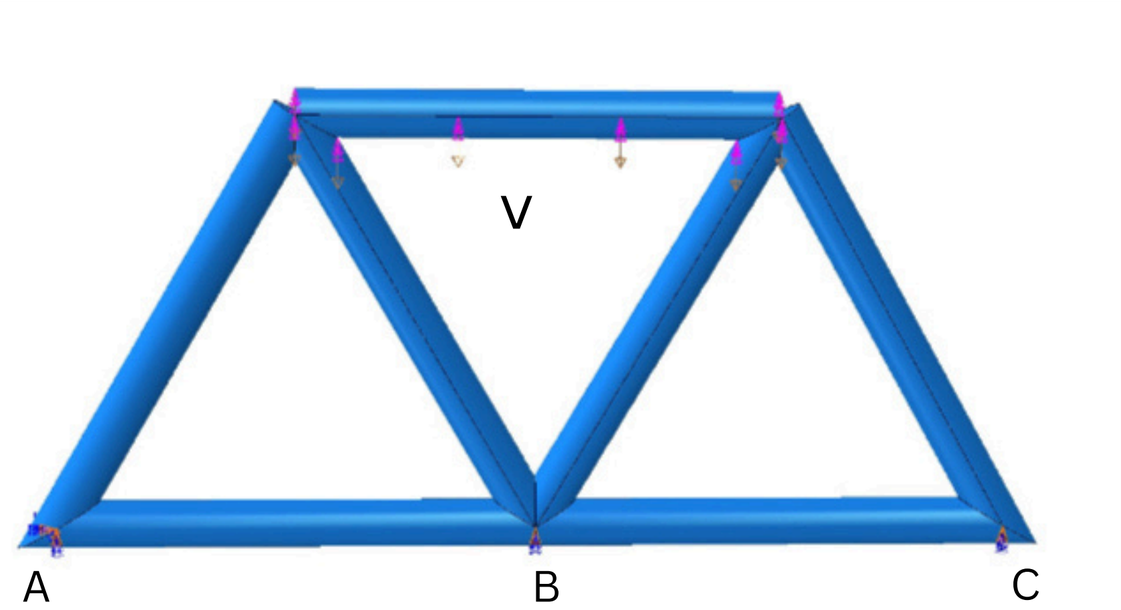


FIG2

Here A is a fixed joint and B,C are rolling joints

Length of each cylindrical rod= 50m

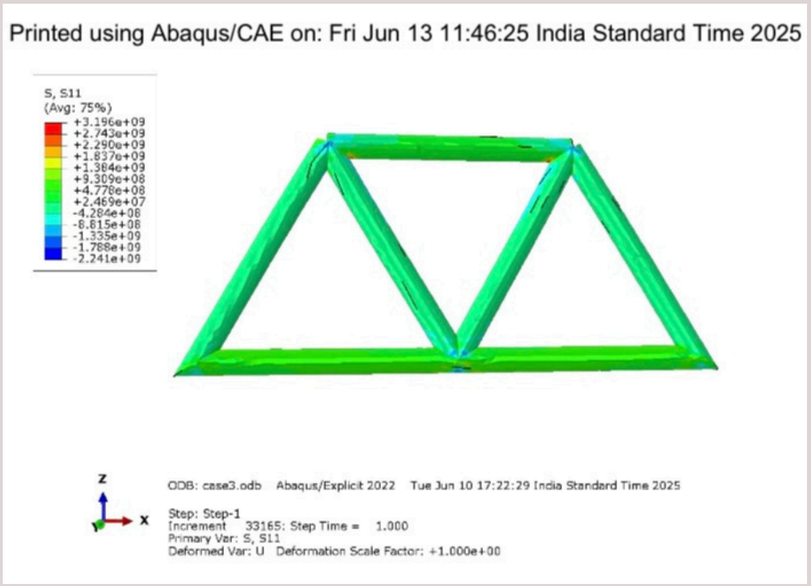
Radius of each cylinder = 5m

young’s modulus of material used = 200GPa

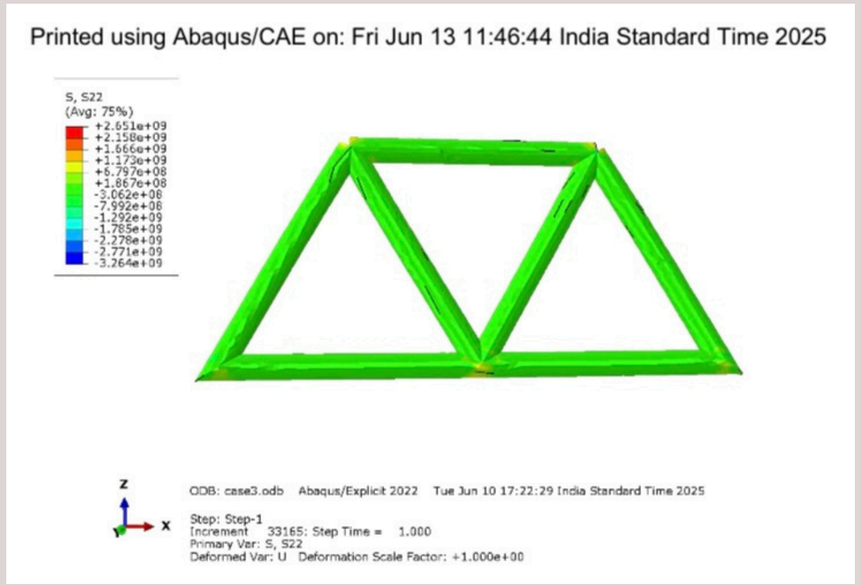
Poisson’s ratio = 0.3

Case 1 :(V= 0.5 m/s)

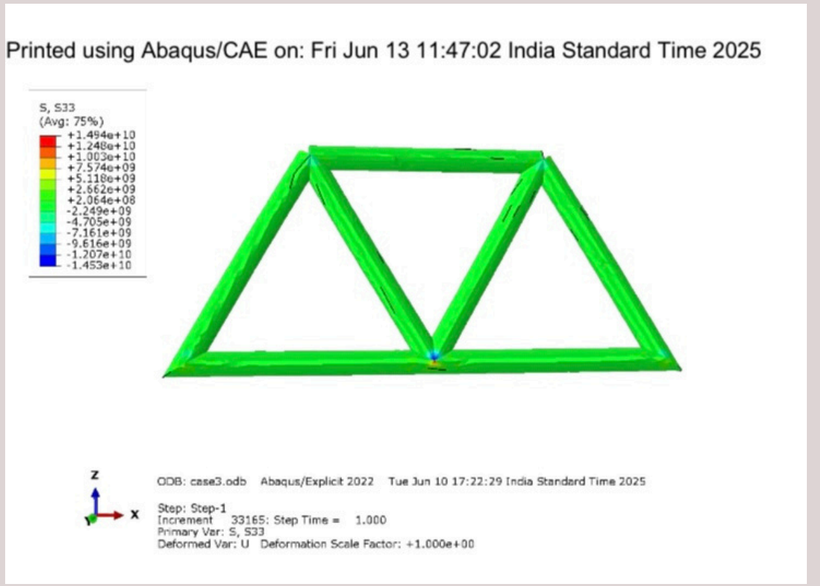
No deformation modes observed



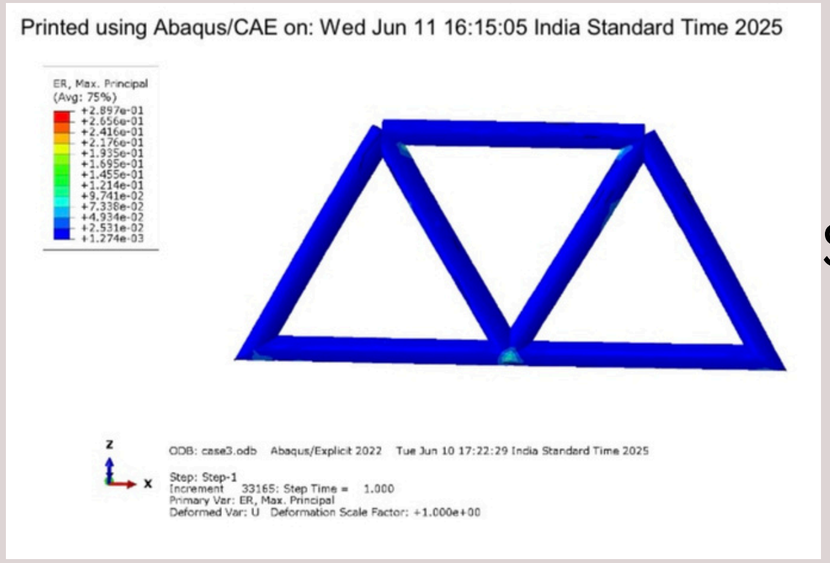
S11



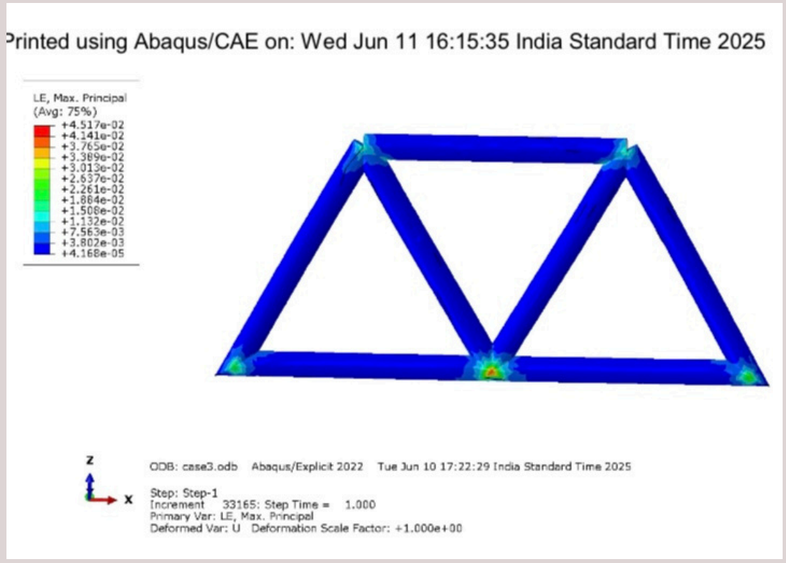
S22



S33



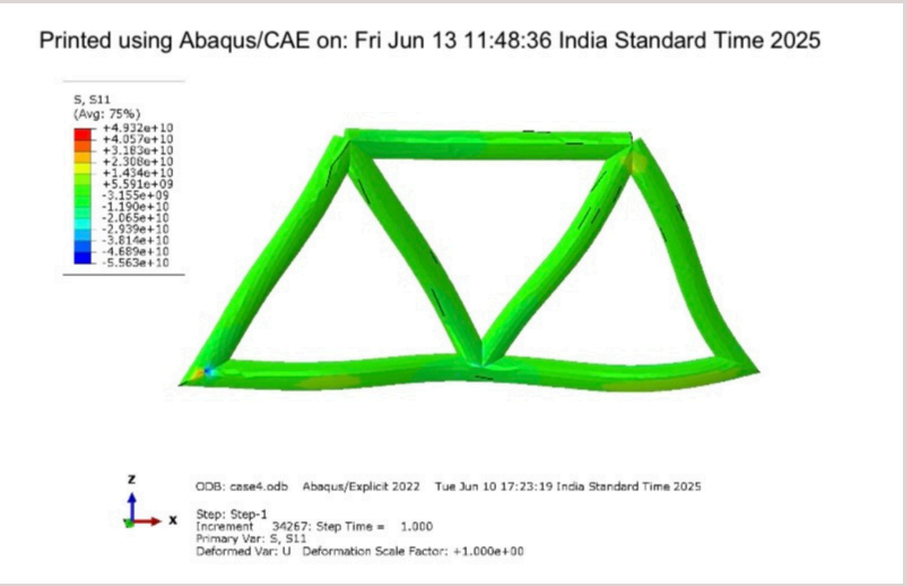
Strain rate



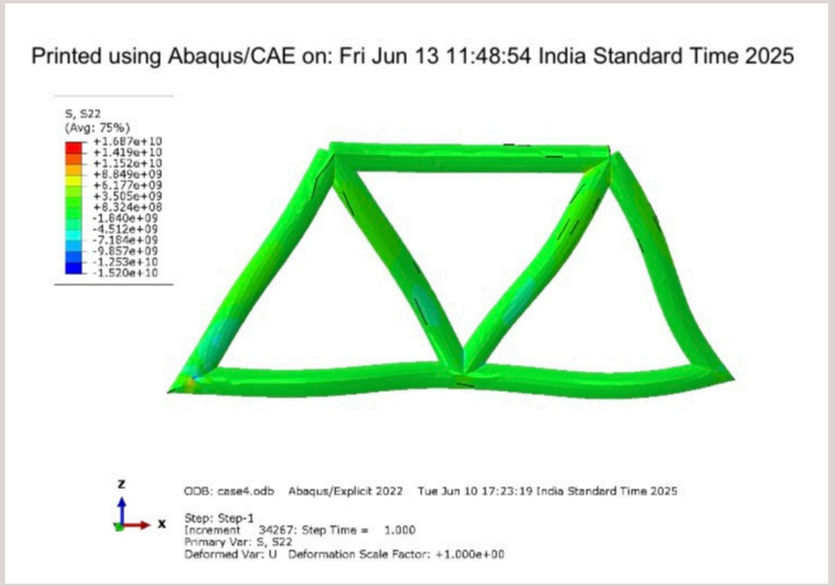
Logarithmic strain

Case 2: (V = 5m/s)

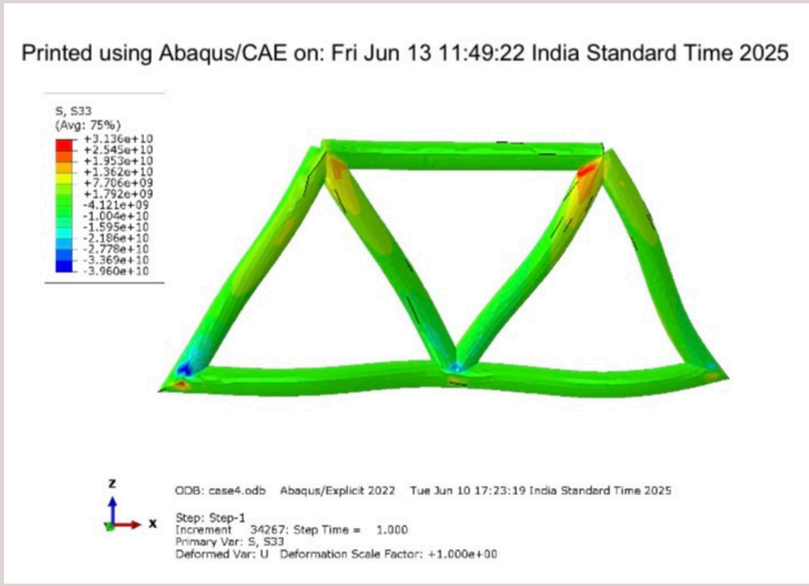
No deformation modes observed



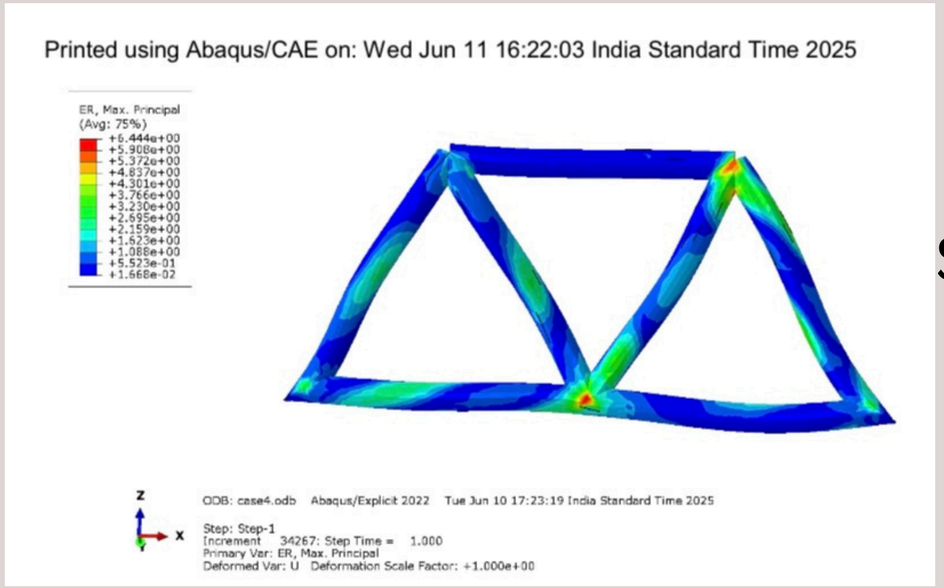
S11



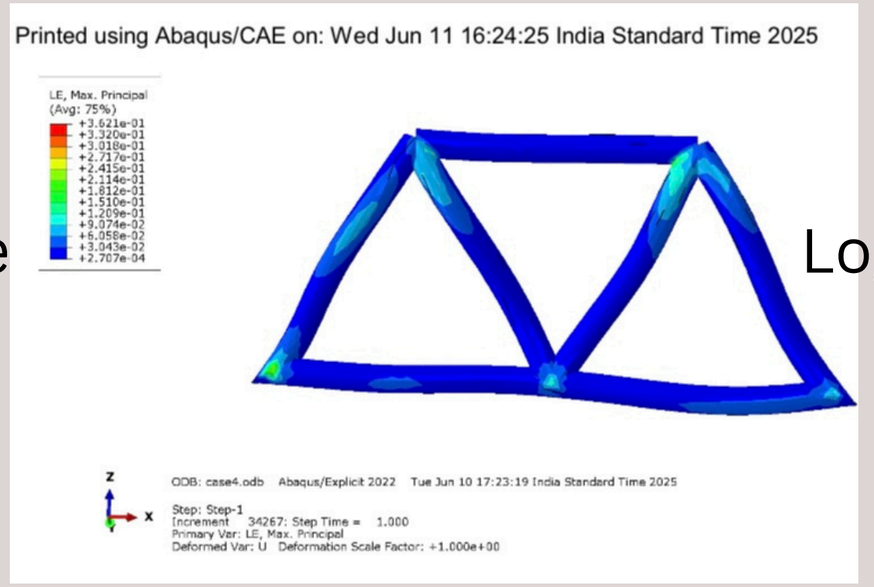
S22



S33



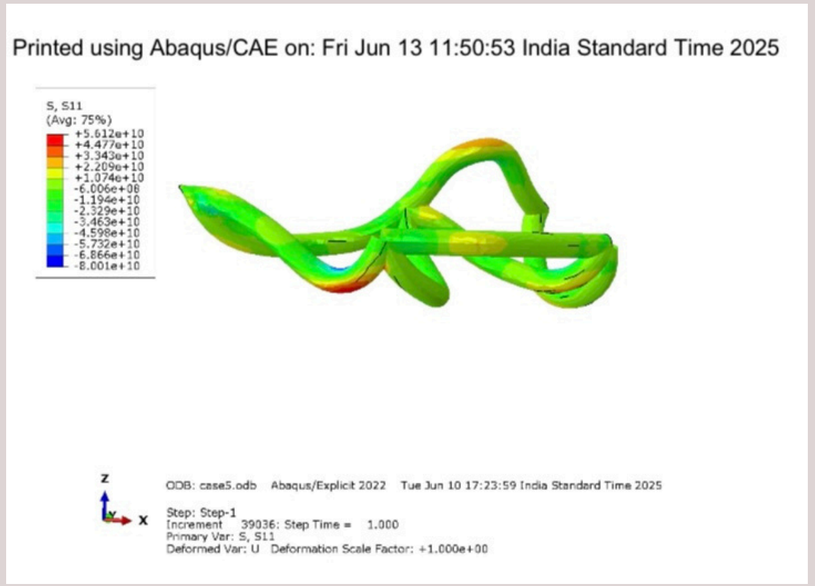
Strain rate



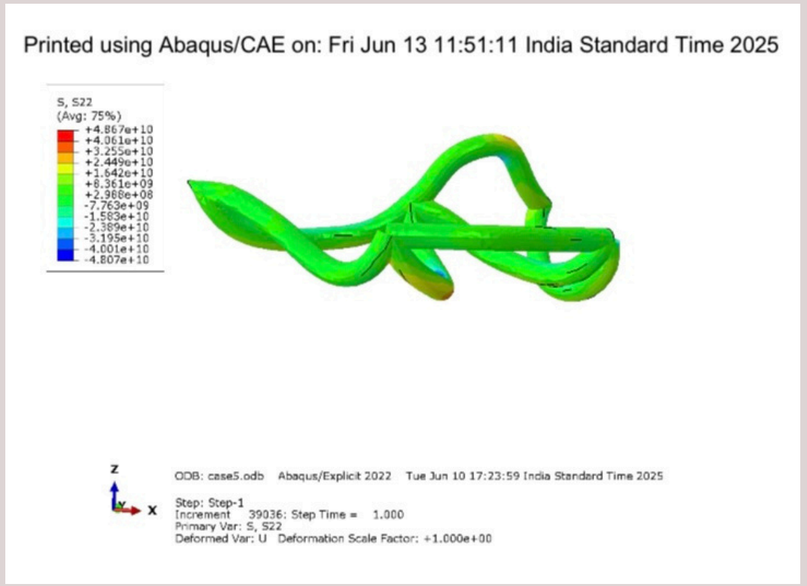
Logarithmic strain

Case 3: (V = 50m/s)

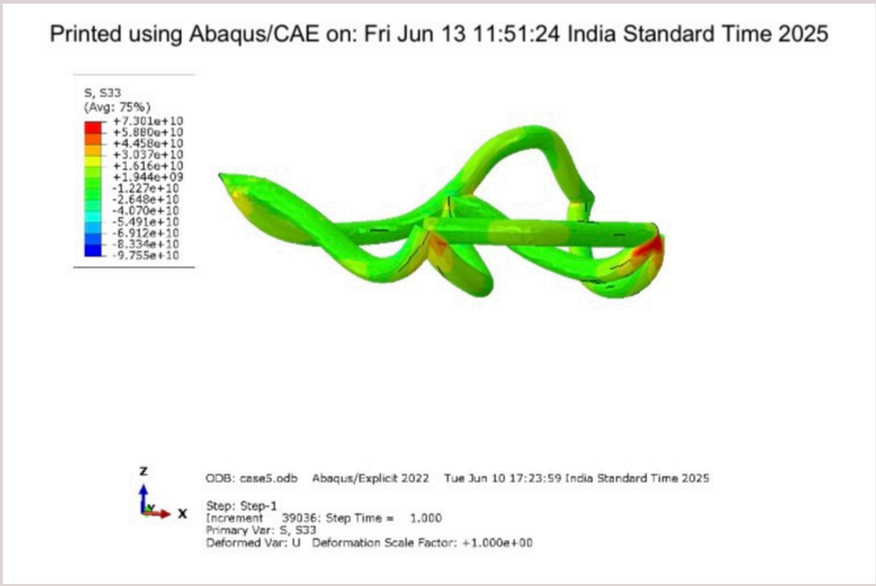
No deformation modes observed



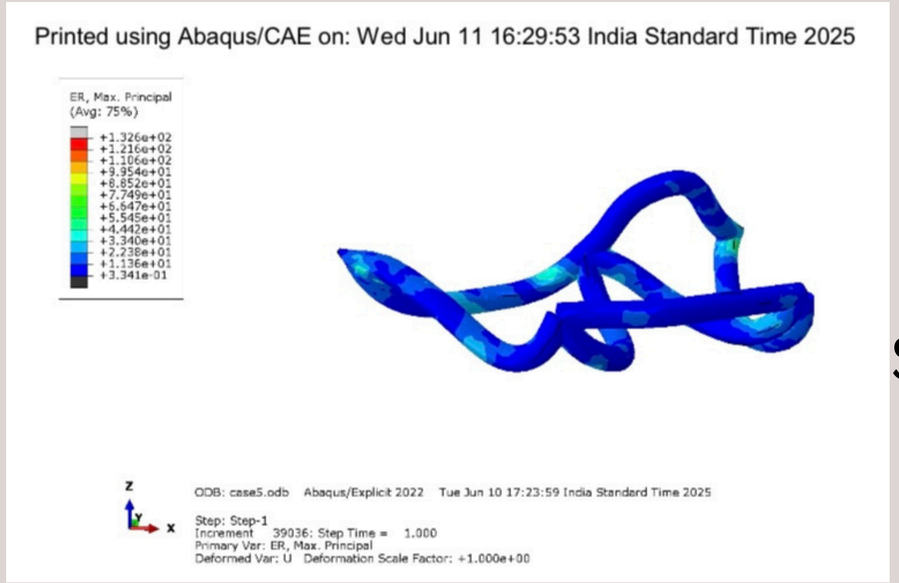
S11



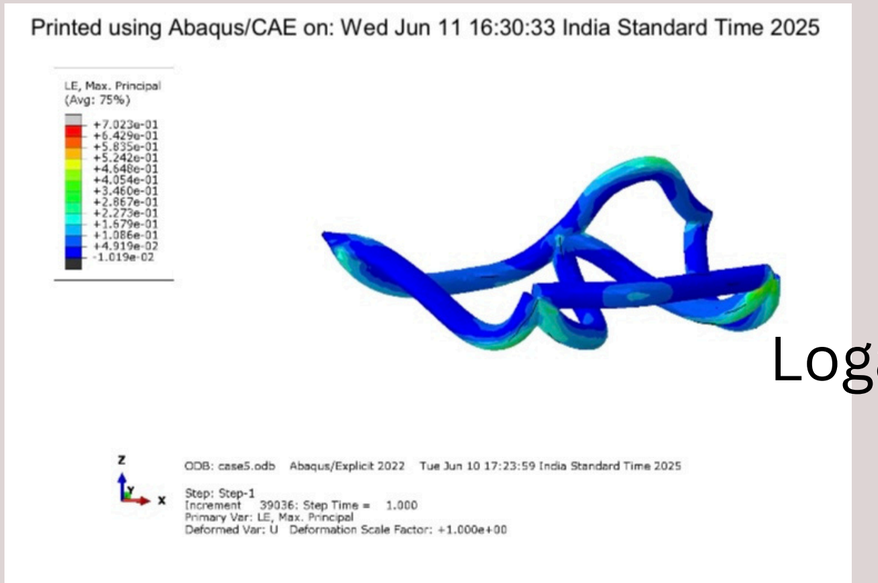
S22



S33



Strain rate



Logarithmic strain

Observation:

As observed in Fig. 2, the deformation pattern is consistent across all cases where point A is fixed and points B and C are subjected to rolling constraints. The solid cylindrical beam exhibits the same deformation shape as the wireframe model when identical boundary conditions and loading are applied. However, the stress and strain values differ significantly between the two models due to differences in geometry and material distribution

Furthermore, upon decreasing the mesh size, the overall deformation remains nearly unchanged, indicating mesh convergence in terms of displacement results. This suggests that the current mesh is sufficiently refined to capture deformation accurately, though local stress/strain values may still vary with further refinement.