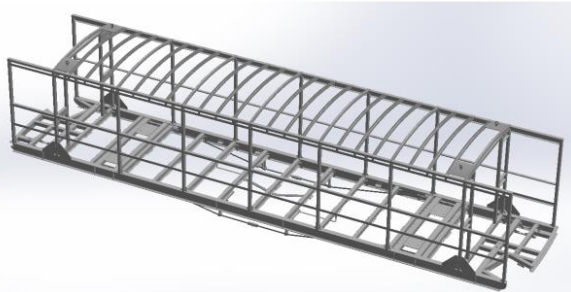


| | |
|---------------|---------------------------|
| Project title | Tram Bodyshell Assessment |
| Date | July 2021 |

PROJECT OVERVIEW



Bodyshell.

AEGIS has undertaken a structural analysis for the new bodyshell structure of an overhauled Heritage Tram.

The rebuild includes new tram bodies and new traction system (3-phase AC) structural assessment.

The frame is assessed against structural requirements of Tramway Principles & Guidelines which refers to EN12663-1:2010.

Proof and ultimate load cases were compared against the yield and tensile strength of the material. Fixing calculations were performed to check tensile stresses and slip resistance.

Fatigue loadings were assessed using the Miner's damage summation and fatigue classifications described in BS 7608.

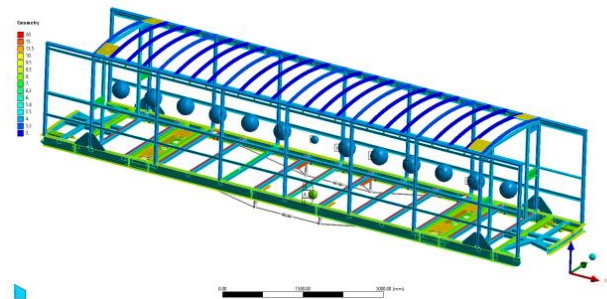
Crashworthiness load cases were assessed based on EN15227-2008+A1:2010 [Ref. 5] and when more appropriate for the operation of Tram vehicle adjusted as per realistic scenarios on the Operated Infrastructure.

The natural frequency of the frame was also assessed.

TECHNOLOGY USED

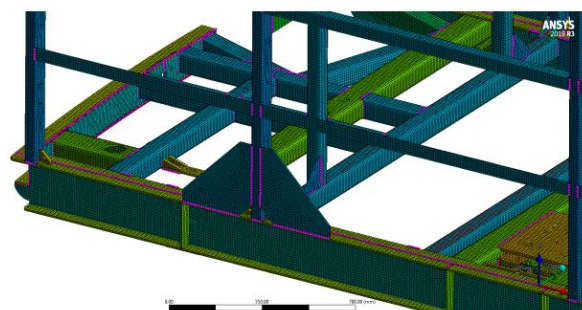
- ANSYS Mechanical
- SpaceClaim
- SOLIDWORKS 3D CAD
- Solid Edge 3D CAD

ANALYSIS SET UP



Surface model developed.

The bodyshell assembly has been defeatured in SpaceClaim software. Small geometry details were deleted to make the model suitable for meshing. The fasteners have been replaced by beam elements and contacts were created at the suitable locations.



Combination of surface and solid modelling.

AEGIS Engineering Systems Limited

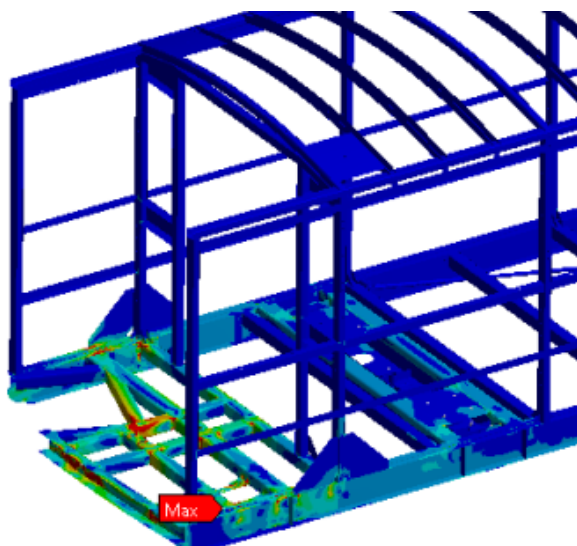
29 Brunel Parkway, Derby DE24 8HR
www.aegisengineering.co.uk
info@aegisengineering.co.uk
 +44 (0) 1332 384 302

AEGIS Case Study

| | |
|---------------|---------------------------|
| Project title | Tram Bodyshell Assessment |
| Date | July 2021 |

- The model was constrained at each of the bolster connection points with the bogies.
- A variety of contacts were created to avoid penetration and ensure realistic force transfer.
- The loads due to passengers and equipment attached were modelled by point masses.
- The elastic rubber mounts were modelled to reflect correct stiffness. A low young's modulus material was set up in Ansys.

RESULTS



Equivalent Von-Mises stress distribution used for the assessment of the proof stress when the structure is subjected to the various proof load cases.

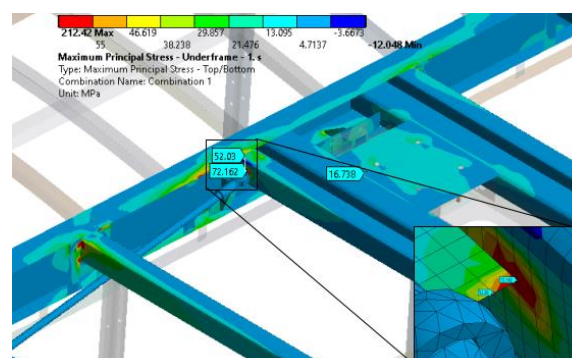
Generally, the proof load requirement is that the structure shall withstand the specified static load cases without permanent deformation or any form of damage or deterioration. As a first pass, this can be taken to mean that the calculated Von Mises stress should not exceed the material proof stress.

AEGIS Engineering Systems Limited

29 Brunel Parkway, Derby DE24 8HR
www.aegisengineering.co.uk
info@aegisengineering.co.uk
 +44 (0) 1332 384 302

For the collision scenario load cases the stresses in the front section of the body shell exceed the ultimate stress limit for the material. Stresses behind the bulkhead section were much lesser. This suggested no intrusion to the passenger section would occur during the collision scenario.

All modes of vibration with significant mass participation factor were above 6 Hz.



Node principal stresses generated at the weld locations are extracted and subjected to weld assessment.

Fatigue load cases results are compliant with the structural requirements of EN 12663-1:2010.

HOW WE HELPED

AEGIS suggested a design modification to provide solutions for the high stressed areas and enhanced the structural performance of the design. This specifically accounts for a front structure behind the coupler area to accommodate a 200kN rated railway coupler.