MECH 4430-15F
Structure

A vehicle structure is not a rigid body (a mass reacting to accelerations and point loads), but a semi-rigid body (point loads are spread out over the mass). The function of a vehicle structure is to limit deflections so as to maintain spatial relationships of systems and components.

Loading cases (requirements)
- Static bending – reaction of beam (along wheelbase or across track width) to weights (systems and components attached to structure); gravity with dynamic amplification in bounce
- Lateral bending – reaction of weights to lateral acceleration; peak lateral acceleration
- Axial torsion – reaction to offsetting wheel bump (e.g., left front to right rear); deflection causes roll angle to differ from front to rear
- Axial loading – mostly reaction to driveline loads
- Hazard loads – impact (point of impact, direction, crushing and secondary contact)
- Load combinations – worst case
Structure types (alternative concepts)

- Shell, stiffened panel – boat, airplane, monocoque, semi-monocoque
- Beam, ladder, torque tube – single structural element
- Tube frame - triangulated truss
Substructures

- Transmit loads from component (wheel, drivetrain, impact absorber) to main structure
- Allow motion between structure and substructure
- Allow disassembly of substructure from main structure

Design technique (needs)

- Restrain the components (all six degrees of freedom!)
- Transmit the known loads
- Triangulate – eliminate racking
- Follow the Rules/Regulations – design constraint

Analysis techniques (assessment)

- Global – equivalent beam, equivalent tube (bending diagrams)
- Local – response of struts to local loads (truss, FEA)
- Dynamic amplification
  - Bending – 2.5 road, 4 off road (less on racing vehicles)
  - Torsion – 1.5 road, 2.5 off road (less on racing vehicles)
- Safety factor – most steels: 1.5