ME 461 – Fatigue and Fracture
Homework 1

Due:
Monday, Feb. 2 (on-campus students)
Monday, Feb 16 (outreach students)

1. Problem 2, page 31.
2. Problem 5, page 32.
3. Problem 3, page 57.
4. Problem 5, page 57.

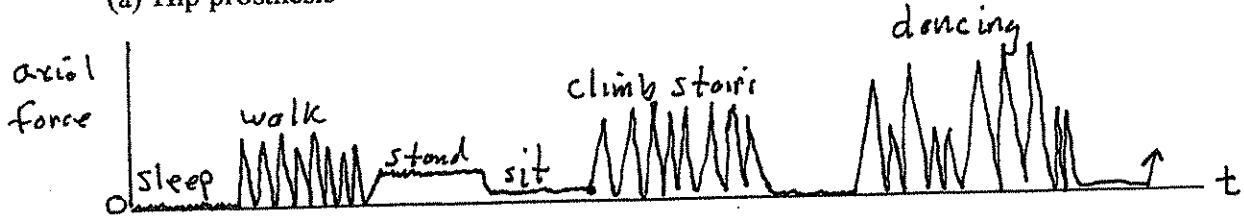
(All problems are from the textbook)

Problem 2.2- damage-tolerant design in automotive field

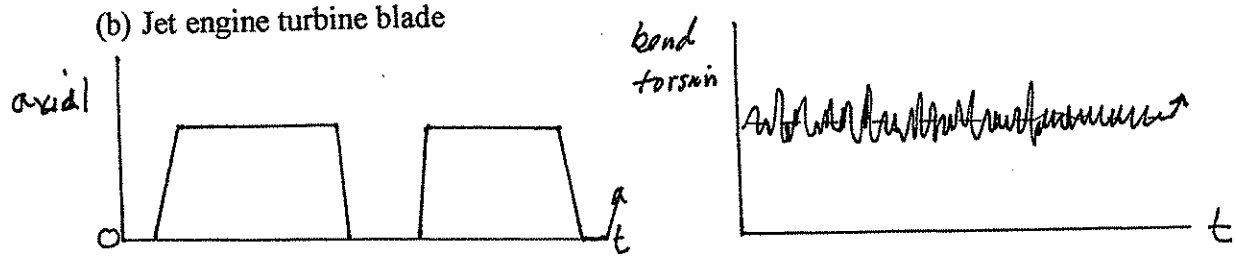
Because the added cost of redundancy, multiple load paths, crack stoppers and non-destructive inspection, and much less catastrophic in nature. There is much less NDI capability in the auto industry due to cost. Less control on maintenance/inspection.

Problem 2.5- load spectra for prob.2.4, and how to determine.

(a) Hip prosthesis

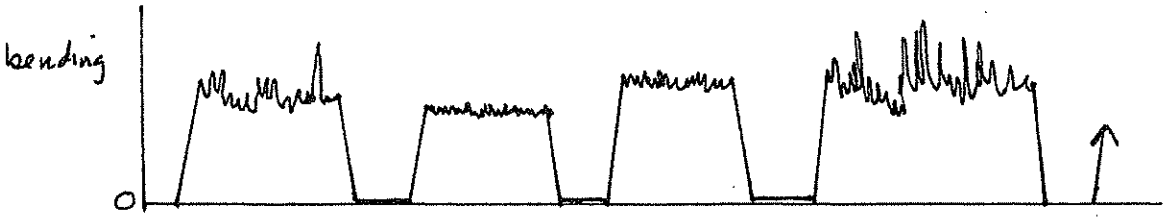


(b) Jet engine turbine blade

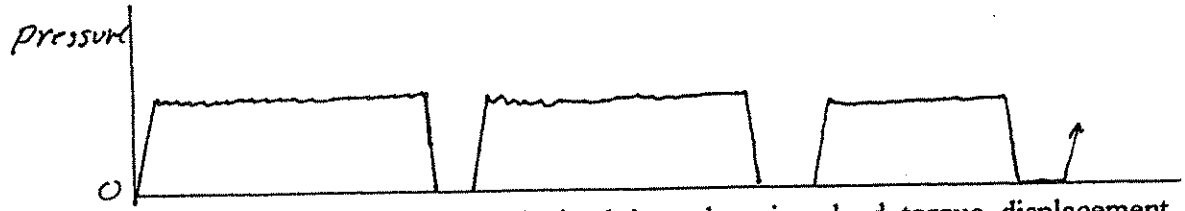


(c) Chair rear leg

(d) Motorcycle front axle



(e) Alaska pipeline



Service load spectra would be obtained through various load, torque, displacement transducers or accelerometers placed on prototypes, previous models, or through computational dynamics programs such as DADS or ADAMS. The specific techniques would differ for each component. For example, the hip prosthesis spectrum could be obtained from special "walking" platforms that measure forces through scales or other transducers. Strain gages could be attached to turbine blades and the chair leg and calibrated to forces. Rotary transducers could be used on the motorcycle axle while strain gages and pressure gages could be used on the pipeline.

3.3 One would expect the crack to nucleate faster if a material cyclic softens. To nucleate, a crack must experience irreversible slip. If the material cyclic softens, the localized yield strength decreases leading to greater irreversible slip and hence faster crack nucleation. On the other hand, if the material were to cyclic harden, the localized yield strength would increase and reduce the amount of irreversible slip.

3.5 (1) Fine grain for micro cracking, coarse grain for macro cracking. (2) Few discontinuities, such as inclusions, voids, second phase particles, corrosion pits, and slip bands. (3) Residual compressive stresses. (4) Local crack tip plasticity and crack closure. (5) Good corrosion resistance. (6) No lamination parallel to crack growth direction but possibly perpendicular to crack growth direction.