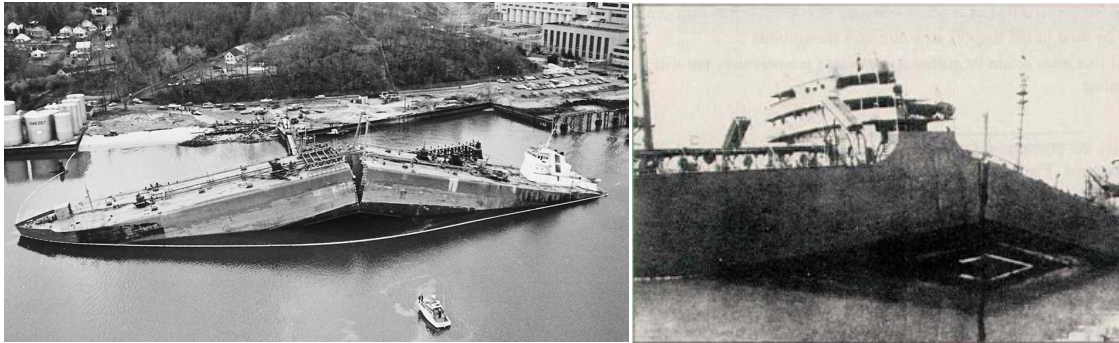


Lesson 12: Failure

Exercise 12.1 Liberty ships

What happened to the "Liberty" ships? Discuss and search relevant information on the internet. Explain the problem from a materials perspective (take into account defects, cracks, crack propagation, temperature, joining, and design)! Does the same hold for the "Titanic"?



Exercise 12.2: Materials selection for an Eco-car (use ANSYS Granta EduPack)

An eco-car maker seeks a material for a *light-weight space frame*. To meet the specifics the material must have a Young's modulus above 70 GPa, a yield strength above 500 MPa and a fracture toughness above 25 MPa m^{1/2}. Which materials could be chosen? Which material should be selected, i.e. which criteria are still missing?

Exercise 12.3 Select an appropriate polymer

Choose between polyethylene, polypropylene, polyvinylchloride, PET polyester and polycarbonate:

- which of the polymers shall be used for manufacturing coffee cups?
- which of the polymers shall be used for ice cube trays?

Exercise 12.4 Viscoelasticity

Compare the glass transition temperature for a polymer with side chains to one without side chains

- if both have the same main chains, i.e. same length, same composition?
- if both have the same molar mass?

What about the melting temperature?

Exercise 12.5 Comparing mechanical properties of metals, ceramics, and polymers

Use ANSYS Granta EduPack or Callister, Rethwisch 10th edition, Appendix

Find and tabulate the following properties for six materials:

- Cast Al-alloys;
- low carbon steel;
- Aluminium oxide;
- Silicon carbide;
- Polyethylene;
- Teflon

Modulus of Elasticity, E, GPa

Yield strength (elastic limit), σ_y , MPa

Ultimate tensile strength, UTS, MPa

Elongation, %

Sketch the flow curves (qualitatively) in a common stress strain diagram. (A hand-drawing is sufficient. There are no opportunities to draw flow curves in ANSYS Granta EduPack or other graphic programs).

Exercise 12.6: Supporting table

Construction of a supporting table requires that its four legs (idealized as circular rods of given length) will not deform plastically under a given load. Which is the material of choice, if the weight is desired as low as possible? What is the relevant material parameter/index?