Some notes on Cast Iron/Cast Steel (ref Chapter 15 Budinski Text):

Overview:
Iron carbon with more than 2.11% (but usually less than 4%) carbon experience the eutectic reaction during cooling and are known as cast irons. Class 80-50 means tensile strength is 80 ksi and yield is 50 ksi. Casting processes include: sand casting, investment casting, resin shell, etc.. (die casting difficult due to temp).

Advantages include:
• Low liquidus temperature
• Readily cast to form useful shapes
• Inexpensive
• Damping properties (good for vibrations)

Disadvantages (vs. machined):
• Tolerances (+/- 0.06” typical for as cast dimensions)
• Surface finish (250 – 1000 μ-in typical for sand cast)
• Size limitations
• Shrinkage/draft
• Fatigue
• Brittle! (Elongation can be quite low, especially for Gray Iron)

3 Main types of castings: Gray (cheapest), Malleable, Ductile (most $$)

1. Gray Iron – is the least expensive and the most common variety. Typical carbon ranges are 2.5% to 4%. The microstructure has micro flakes of graphite dispersed in a matrix of ferrite. Flakes have NO strength so they act as voids in the structure. The pointed ends of the flakes act as notches and crack initiation sites. Therefore the material is very brittle and extremely low ductility. Generally sold by class (20, 30, 40 up to 80 relating to its tensile or ultimate strength).

Applications include large machinery parts with intricate shapes, general purpose cast iron, sewer pipes (due to better corrosion resistance than most steels)

Characteristics of Gray Iron:
• BHN = 150
• Elongation < 1%
• E = 10 to 20 E6 psi
• Tensile is 20 – 80 ksi
• Corrosion poor but better than most carbon steels (Bob, verify this)
• Weldability is poor but can be welded. Oxyacetylene torch or electric arc, but because so brittle preheat and cool slowly.
2. Malleable Iron – cooling rate is increased. Irregular spheroidal graphite particles in ferrite or pearlite matrix. Applications include axle housings, pipe fittings, brake drums. 2 – 3% carbon, least common, small thin parts, can be heat treated. Typical designation 325010 means 32500 min yield and 10% elongation in 2”.

Characteristics of Malleable Iron:

- Elongation range from 10 – 20% (i.e. malleable)
- BHN = 110 – 150
- Modulus = 24 E6 psi
- Tensile strength = 50 – 56 ksi
- Wear resistance is poor
- Corrosion is poor
- Welding is not done – heat of the weld would ruin malleable properties, only a long term annealing will restore them. Brazing can be done at 1700F so it is a preferred method of repair.
- Machinability is fair
- Castability is good
- More shock resistant than ductile iron

3. Ductile Iron – add magnesium (but only 1 pound per ton). Spheroidal graphite particles in ferrite or pearlite matrix. Applications include structural (load carrying) parts, valves, pump bodies, crankshafts, gears.

Characteristics Ductile Iron:

- Strongest of the 3 w/ good elongation
- Can be heat treated
- Elongation from 10 – 20%
- BHN 140 – 300
- Modulus = 24E6 psi
- Tensile = 65 – 150 ksi
- Wear is poor
- Corrosion is poor
- Weldability is poor but can be welded with nickel and iron electrodes
- Machinability is fair to excellent
- Castability is good to excellent
- Grade 5 (60 – 40 – 18) = Su = 60 ksi, Sy = 40 ksi, % elongation = 18%
- Grade 1 (120 – 90 – 02)
- Also have grade 1, 2, 3, 4
- Material: DUCTILE CAST IRON PER ASTM A536 GRADE 3