Teknologi Bahan Konstruksi

Steel Properties

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Steel

Steel consists mostly of iron, with a carbon content under **2%** and various other elements

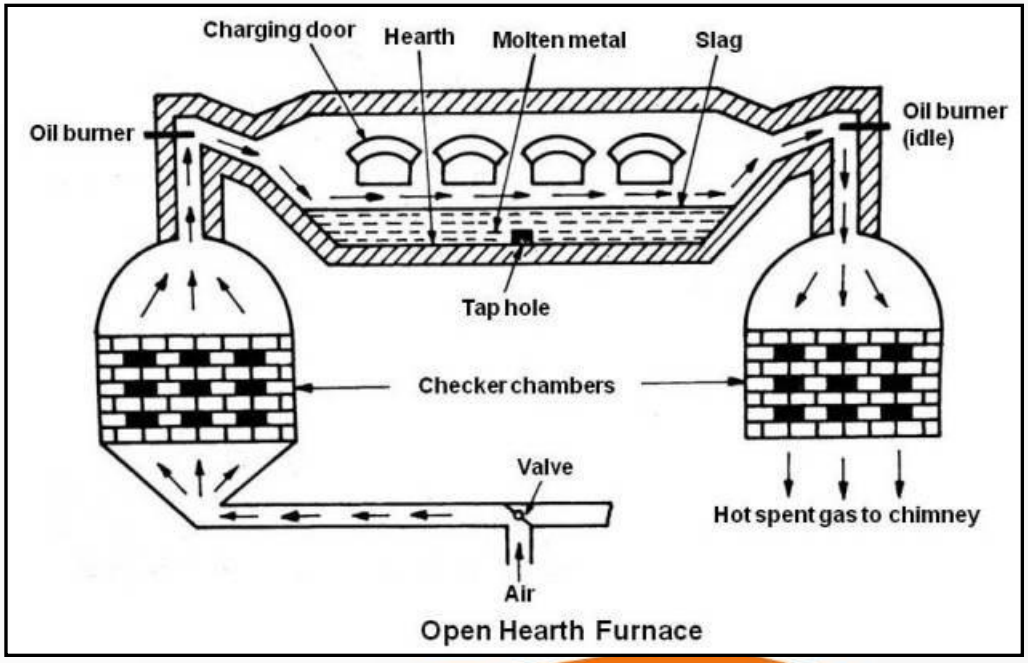
Classifications of Steel

- **By Smelting Processes**

  Smelting is to oxidize the molten pig iron to reduce its carbon content to the scheduled range and to remove the other impurities to allowable range.

  - Bessemer Steel
  - Siemens-Martin Steel
  - Electric Steel

Bessemer converter, Kelham Island Museum, Sheffield, England (2010).



Open-hearth/Siemens-Martin Processes

Classifications of Steel

- **By Press-working Modes**

  In the process of smelting and ingot-casting, there will be uneven structures, foams or other defects happening to the steel, so the steel used in industry should be processed by press to eliminate the defects. Meanwhile, there is requirement for shapes

  Hot-working Steel

  Hot working is to heat the steel ingot to a certain temperature

  Cold-working Steel

  Cold working is the process that steel is processed at the room temperature.

Classifications of Steel

- **By Purposes**

  The steel can be classified by purposes, such as construction steel, railway steel, and pressure vessel steel.

  The construction steel can be classified by purposes into

  - For steel structures and
  - For concrete structures.

Characteristics of Steel

- Tensile strength

  Yield Strength or Yield Limit

  steel starts to lose the ability to resist deformation and generates a great deal of stress in plastic deformation

  Fatigue Strength

  Under the role of alternating loads, steel will be damaged suddenly when the stress is far below the yield strength, and this damage is called fatigue failure.

Characteristics of Steel

- **Elasticity**

Figure 8.1 shows that the steel is subjected to the dead load and the ratio of the stress to the strain at stage ***OA*** is the elastic stage. This deformation property is called elasticity.

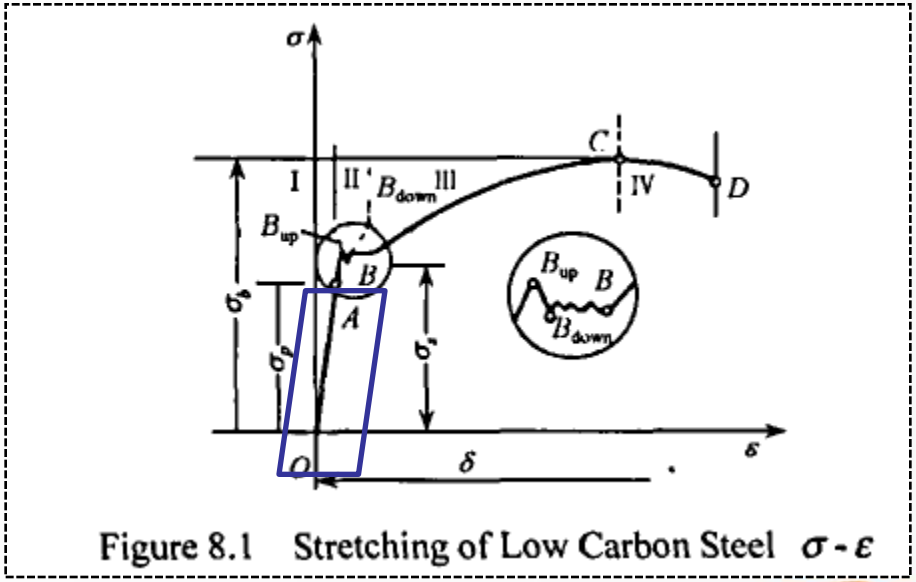


Figure 8.1 Stretching of Low Carbon Steel σ - ε

Characteristics of Steel

- **Plasticity**

The construction steel should have good plasticity. In projects, the plasticity of the steel is usually expressed by the elongation

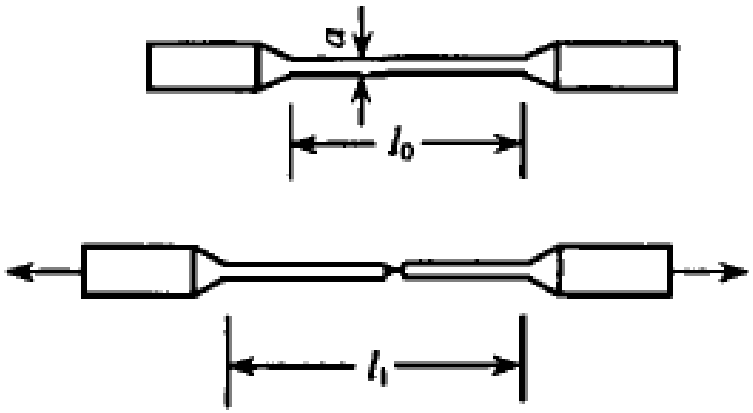


Figure 8.3 Elongation of Steel

Characteristics of Steel

- **Impact Durability**

  Impact durability refers to the property that the steel resist loads without being damaged.

  The impact durability of the steel can be influenced by temperature and time.

  The temperature is very low when cold brittle (getas) fracture occurs.

Humidity (kelembaban)

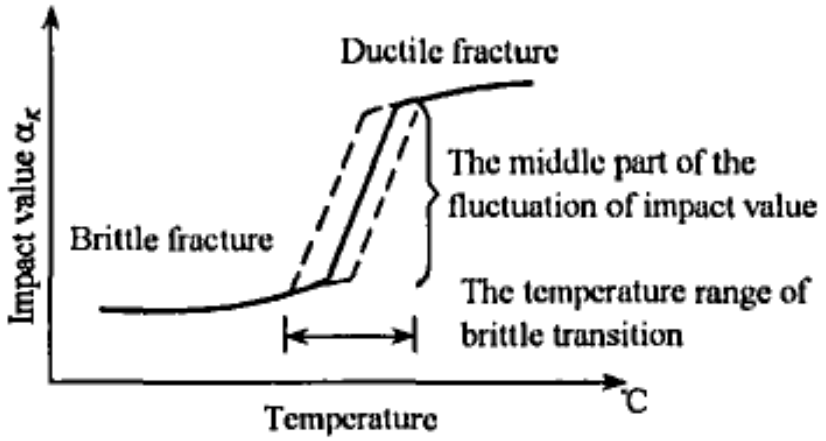


Figure 8.6 The Impact of Humidity on Impact Durability

- **Rigidity**

Rigidity is the property to resist the plastic deformation when there is a hard object press into the steel within the partial volume of the surface, often related to the tensile strength

Standards and Selection of Building Steel

- **The Steel Used for Steel Structures**
  - Carbon Structural Steel
  - Low-alloy High-strength Structural Steel

- **Steel for Concrete Structures**
  - Hot-rolled Reinforced bar, cold-drawn hot-rolled reinforced bar, cold-drawn low-carbon
  - steel wire, cold-rolled ribbed bar, heat-tempering bar, steel wire and strand for pre-stressed concrete, and cold-rolled-twisted bar.

Fire Protection of Steel

- **Fire Protection of Steel Structures**

  when a steel structure stay in fire for about 15-20min, the roof truss and other member bars will collapse. The steel structure cannot be repaired after damage.

Fire Protection of Steel

Fire protection of Steel methods

- Add box coat to the steel columns, and inject water into the box. In fire, the temperature of the steel columns rises slowly due to the protection of water.
- Paint fire retardant coatings on the steel structures to improve their fire-resistant limit.
- The steel bars are enwrapped by concrete

Corrosion and Prevention of Steel

When the surface of steel contacts with the surrounding environment under a certain condition, it will be corroded

The corrosion will lower the fatigue strength greatly, especially the impact toughness of steel, which will result in the brittle fracture of steel

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Reasons for Corrosion of Steel

- **Electrochemical Corrosion**

  When steel contacts with electrolyte solution and generates electric current, there will be the electrochemical corrosion caused by the role of primary battery.

Corrosion Prevention of Steel

- **Protective Film**

  This method is to isolate the steel from the surrounding media with the protective film to prevent or delay the damage caused by the corrosion of external corrosive media.

  For example, paint coatings, enamel or plastic on the surface of steel; or use the metal coating as the protective film, such as zinc, tin, and chrome

Corrosion Prevention of Steel

- **Electrochemical Protection**

  Current-free protection is to connect a piece of metal, such as zinc and magnesium, more active than steel to the steel structure.

  This method can be used for the places which are difficult or impossible to be covered with protective layer, such as steam boiler, shell of steamboat, underground pipe, maritime structure, and bridge.

Corrosion Prevention of Steel

- **Alloying**

  The addition of alloy elements into carbon steel to produce various alloy steel will improve its anti-corrosion, such as nickel, chrome, titanium, and copper.

Advantages & Disadvantages

Advantages:

even materials, stable properties, high strength,certain plasticity and toughness, and the properties to bear impacts and vibration loads, and can be welded, riveted, or screwed

Disadvantages:

easy to be corroded and high cost of repairs.

Terima Kasih