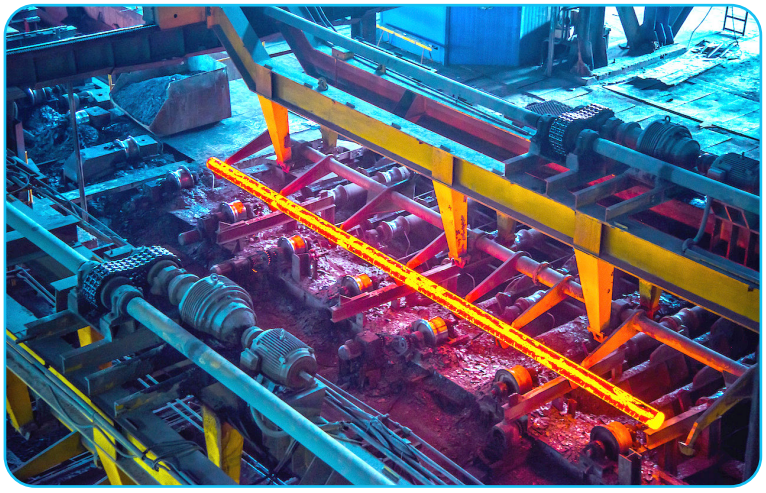
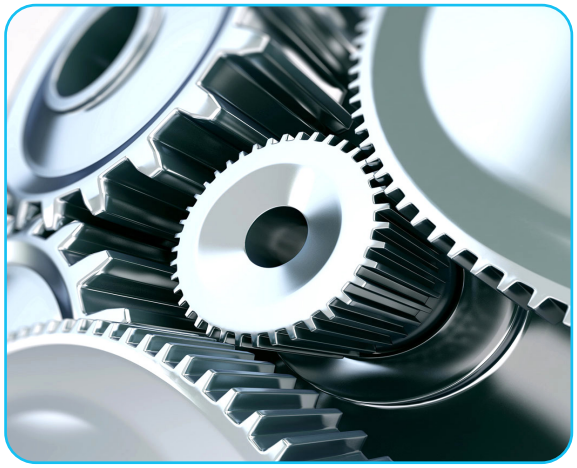
# Non-alloy and alloy steels

The word *ferrous* comes from the Latin word *ferrum*, which means iron. Ferrous metals include steel, cast iron, as well as alloys of iron with other metals.

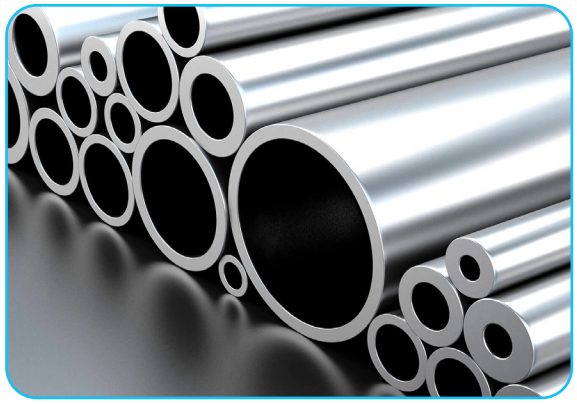


## Non-alloy steels

Also known as carbon steels, **non-alloy steels** use carbon as the alloying element. These steels include other elements, such as manganese, silicon, sulphur, and phosphorus, but the content of these elements is so low that they do not impact the material properties. Non-alloy steels are classified as having either a low, medium, or high carbon content, and each has different characteristics and treatment methods.



- **Low carbon steel.** Low carbon steels, also called mild steels, contain just 0.05-0.25% carbon. Low cost and malleable, these steels are widely used for items such as nuts and bolts or forgings.
- **Medium carbon steel.** Medium carbon steels contain 0.25-0.6% of carbon. This higher carbon content provides an increase in strength and hardness over low carbon steels, but reduced ductility. Increased levels of carbon and manganese in medium carbon steels mean that they can be tempered and quenched. These steels are widely used for making components for the automotive industry, such as gears, axles, and shafts and are also suitable for use on railway applications.
- **High carbon steel.** High carbon steels contain 0.6-1% carbon and are the strongest of the non-alloyed steels. This strength makes them ideal for applications requiring resistance to mechanical wear, while they are also good at maintaining their shape, but are inferior to lower carbon steels in weldability, ductility, and impact toughness. High carbon steel is used for springs, blades, rail steels, wire rope, wear-resistant plates, tools, and more.



**wear-resistant plate:** *lamiera/piastra resistente all'usura*
**wire rope:** *cavo metallico*

## Alloy steels and the alloying elements

**Alloy steels** make up another subgroup of ferrous metals, with each alloying element having its own effect on the material properties. These alloying elements include chrome, copper, nickel, and silicon, but can be combined to provide a range of properties. Here are the properties of the most common of these alloying elements.

- **Chromium.** Chromium is used to make stainless steel with chromium levels of over 11%, making metals corrosion-resistant. An oxidised chromium layer on top of the metal will prevent the underlying metal from coming into contact with oxygen, thereby greatly reducing the chance of corrosion. Chromium also increases the hardness, tensile strength, toughness and wear resistance of a metal.
- **Manganese.** Manganese can be used as an alloying element to prevent iron sulphides from forming, as well as increasing strength at high temperatures, improving ductility, and wear resistance. Manganese can also improve hardenability through quenching, reducing the danger of defect formation and making the metal more stable.
- **Nickel.** Nickel, when used with other elements, can increase ductility and corrosion resistance. For example, a mix of 18% chromium and 8% nickel creates extremely durable stainless steels.
- **Silicon.** Silicon can be used to increase the magnetic properties of a metal as well as improving strength and providing elasticity for applications like springs.
- **Vanadium.** Vanadium carbides also limit the grain size of a metal, increasing the ductility of the alloyed material. Vanadium also improves the strength, hardness, wear and shock impact resistance.
- **Molybdenum.** Molybdenum offers a good effect on steel alloys operating at high temperatures. It not only improves mechanical properties, but also provides higher resistance to rust and corrosion.

**carbide:** *carburo*

**1** Complete the table about non-alloy steels.

| Type of carbon steel | % carbon | Pros | Cons | Examples of use |
|---|---|---|---|---|
| Low Carbon Steel | | | | |
| Medium Carbon Steel | | | | |
| High Carbon Steel | | | | |

## 2 What alloying element is used to…?

1. Increase magnetic properties .....
2. Prevent iron sulphides from forming .....
3. Create extremely durable stainless steels, with 18% chromium .....
4. Provide higher resistance to rust and corrosion .....
5. Make metals corrosion-resistant, by adding levels of over 11% .....
6. Improve strength, hardness, wear and shock impact resistance .....

## 3 Complete the text with the words given below.

construction • copper • moisture • production • refrigerator • shipping • tin • tools

### Ferrous Metals

Non-ferrous metals were first used around 5,000BC when the discovery of **1.** ..... saw the end of the Stone Age and the start of the Copper Age, which later moved into the Bronze Age with the invention of bronze, an alloy of copper and **2.** ..... Ferrous metals did not come into use until around 1,200 BC with the start of iron **3.** ..... and, subsequently, the Iron Age.

Materials such as carbon steel are widely used in the **4.** ..... industry to build the structures of bridges and skyscrapers. Ferrous metals are also found in **5.** ..... containers, pipework, automobiles, railways, and a range of both commercial and domestic **6.** ..... The high carbon content of ferrous metals means that they are vulnerable to rust when exposed to **7.** ....., and therefore, generally unsuitable for applications such as water pipes. Since most ferrous metals are magnetic, they are often used in electrical and motor applications, as well as in other less obvious places, such as in your **8.** ..... door, so you can use a magnet to attach your shopping list to it!

Adapted from: *https://www.twi-global.com/technical-knowledge/faqs/what-metals-are-ferrous#ExamplesandUses*