Making Steel

The Port Kembla Steelworks is an integrated steelworks, where all three of the major phases of production (ironmaking, steelmaking and shaping) are undertaken on one site. It is by far Australia's biggest steelworks, capable of producing more than five million tonnes of steel per year, in the form of steel slabs, hot rolled coils, plate, tinplate and downstream value added products.

Raw materials

The basic raw materials for large-scale steelmaking are:

Iron ore (sourced mainly from the Pilbara region in Western Australia and brought to Port Kembla by sea in bulk carriers): Lump ore is crushed and sized before being fed into the blast furnace. Fine ore is agglomerated into sinter in the Sinter Plant, where it is mixed with small particles of coke (coke breeze), fine fluxes such as limestone, dolomite, quartzite and serpentine, and other iron-bearing wastes collected from air filtration units around the plant, then fused together under extremely high temperatures (1300°C) to form sinter.

The sinter is broken into lumps and fed to the blast furnace.

Coal (a high-bituminous grade mined in the Illawarra Escarpment west of the Steelworks): Before it is suitable for use in the blast furnace, coal must be treated by crushing, washing and baking to form metallurgical coke. This baking process is carried out in the Coke Ovens batteries, at 1200°C in the absence of air. Batteries have up to 100 narrow ovens separated by heating chambers. Each oven is charged with coal from the top and then sealed. After 17 to 20 hours of heating, the distillation of volatile compounds is complete and the coke that has been produced is pushed from the oven. It is then quenched with water, screened, and fed to the blast furnaces by conveyor belt.

Limestone: sourced from Marulan in the Southern Highlands and some from Japan.

BOS Furnace

Fluxes: oxides used in the metallurgical processing to react with impurities to form a liquid slag, which allows the metal to be easily separated from the impurities.

The Ironmaking Process

Firstly, iron is extracted from iron ore in a blast furnace by a process known as reduction. A blast furnace is shaped like a giant bottle and is as tall as a 27-storey building. The furnace is lined with special bricks called refractories that can tolerate very hot temperatures. This process, called ironmaking, is continuous and operates 24 hours a day, seven days a week at the two blast furnaces at the Port Kembla Steelworks.

The raw materials - iron ore, coke and fluxes - are fed into the top of the furnace by conveyor. Air, which is heated to about 1200°C, is blown into the furnace through nozzles called tuyeres that are spaced around the lower section of the furnace. The air causes the coke to burn, producing carbon monoxide which creates the chemical reaction. The iron ore (iron oxide) is reduced to molten iron by removing the oxygen.

About every two hours a hole, called a taphole, at the bottom of the furnace is opened and the molten iron and slag is drained. There are three tapholes at each furnace. One of them at each furnace is always producing.

Slag is a by-product of ironmaking. It is made up of molten limestone which has absorbed the impurities from the process. It is removed from the blast furnace, with the iron, and allowed to cool. The slag is then crushed and used by other industries to make cement, as a soil substitute, and in the making of roadways.

Gases are also produced during the process. They are used elsewhere in the Steelworks for heating processes, or as an energy source to produce steam and electricity.

The Steelmaking Process

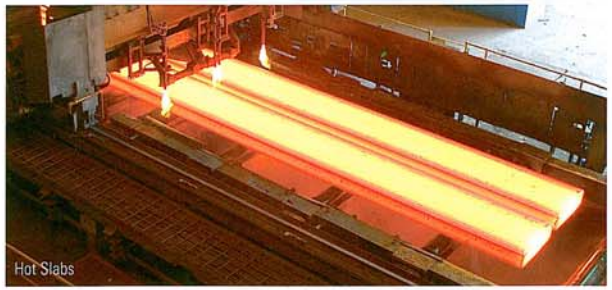
At Port Kembla, steel is made using the Basic Oxygen Steelmaking (BOS) method in three furnaces.

The BOS furnace holds about 280 tonnes of steel. It is lined with refractories to tolerate the very hot temperatures.

1: The BOS furnace is one-fifth filled with steel scrap (around 40 tonnes), which aids temperature control and reduces energy costs. Around 200 tonnes of molten iron is added to the furnace, in a process called charging.

2: A water-cooled lance is then lowered into the furnace. The lance blows 99 percent pure oxygen onto the steel and iron, causing the temperature to rise to about 1700°C. This melts the scrap, lowers the carbon content of the molten iron and helps remove unwanted elements.

3. Fluxes (burnt lime or dolomite) are fed into the furnace to form slag which absorbs impurities of the steelmaking process. Near the end of the blowing cycle, which takes about 16 minutes, a temperature reading and samples are taken.



Hot Slabs

The samples are tested in a laboratory and a computer analysis of the steel given within six minutes.

4. The BOS furnace is tilted and the steel is poured into a large ladle. This process is called tapping the steel. In the ladle, the steel is further refined by adding alloying materials which give the steel special properties required by the customer, such as hardness, toughness, corrosion resistance and machinability.

5. After the steel is removed from the BOS furnace, the slag, filled with impurities, is poured off and cooled.

Casting

Liquid steel must be cast into shapes so that it can be handled more easily and rolled. This is done by continuous casting machines that mould the liquid steel into slabs. The process is continuous because liquid steel is continuously poured into a "bottomless" mould at the same rate as a continuous steel casting is extracted.

Rolling

Cast steel is a relatively weak mass of coarse, uneven metal crystals, or grains. Rolling causes this coarse grain structure to re-crystallize into a much finer grain structure, giving greater toughness, shock resistance and tensile (stress) strength.

Rolling is the main method used to shape steel into different products after it has been cast. There are two types of rolling - hot and cold. The rolling process (for both hot and cold) consists of passing the steel between two rolls revolving at the same speed but in opposite directions. The gap between the rolls is smaller than the steel being rolled, so that the steel is reduced in thickness and at the same time lengthened.

One set of rollers is called a stand, and in any one mill there can be a number of stands. One length of steel can pass through a stand a number of times so that it is gradually reduced in size and progressively rolled to the desired shape. A slab 230mm thick can end up only 1.5mm thick, but many times longer, after the hot rolling process.

Hot Rolling

Before hot rolling, slabs are heated in a furnace to about 1200°C. This makes it easier to roll the steel.

Hot Rolling

Cold Rolling

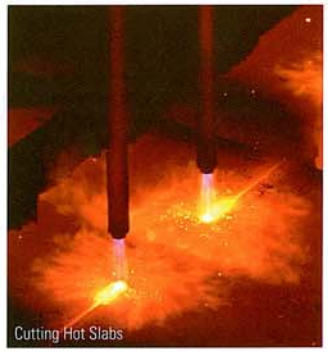
Certain types of steel are also cold rolled after hot rolling. Before cold rolling the steel is cleaned with acid (pickled) to remove scale or iron oxide. Cold rolling is carried out at room temperature and is rolled at very fast speeds using lubricants to reduce friction. Cold rolling increases strength, makes steel thinner and produces a bright smooth surface.

Coating and Painting

At our Springhill Works adjacent to the Port Kembla Steelworks, cold rolled steel is coated with other metals or paint to protect the steel surface or to give it special characteristics.

ZINCALUME® steel is steel strip with a coating of 45 percent zinc and 55 percent aluminium. The coating makes the steel more corrosion resistant. The process involves cleaning, annealing and then coating the strip. Annealing is a general term that describes processes that clean and soften the steel and prepare it for further machining.

COLORBOND® steel is metallic coated steel which is painted. The steel strip is cleaned and a conversion coating is applied to ensure good paint adhesion. A corrosion inhibiting primer and finish coat are then applied.



Cutting Hot Slabs

Special paints are used to protect the steel in different weather conditions, giving the product a longer life.

Tinplate is steel sheet with a thin coating of tin, usually applied by an electrolytic process. Tinplate is used to make cans for human or pet food, aerosols and paint.

Shaping

COLORBOND® steel and ZINCALUME® steel are most often shaped or roll-formed before being used by customers. Roll-forming is done by passing the flat strip through rolls that create different patterns, or profiles, in the steel.