ROLLING

It is the process of reducing the thickness or changing the cross-section of a long workpiece by compressive (squeeze) forces applied through a set of rolls. Or the process of plastically deforming metal by passing it between rolls. Rolling is the most widely used forming process, which provides high production and close control of final product. The metal is subjected to high compressive stresses as a result of the friction between the rolls and the metal surface. *Rolling processes can be mainly divided into two types, hot rolling and cold rolling.*

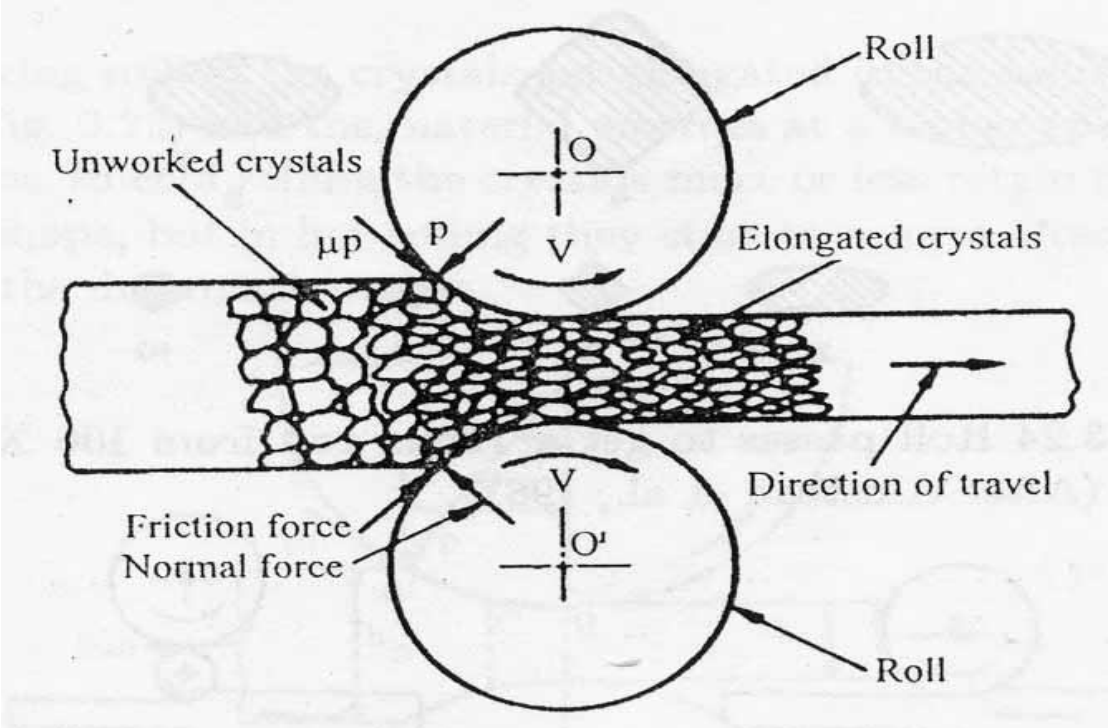

Fig.5 Rolling processes

Hot rolling *,,*

Hot rolling is a metal working process that occurs above the recrystallization temperature of the material. After the grains deform during processing, they recrystallize, which maintains a microstructure and prevents the metal from work hardening. The starting material is usually large pieces of metal, like semi-finished casting products, such as slabs, blooms, and billets. If these products came from a continuous casting operation the products are usually fed directly into the rolling mills at the proper temperature. In smaller operations the material starts at room temperature and must be heated. This is done in a gas or oil-fired soaking pit for larger workpieces and for smaller workpieces induction heating is used. As the

material is worked the temperature must be control to make sure it remains above the recrystallization temperature. To maintain a safety factor a finishing temperature is defined above the recrystallization temperature; this is usually 50 to 100 °C (90 to 180 °F) above the recrystallization temperature. If the temperature does drop below this temperature the material must be re-heated before more hots rolling.

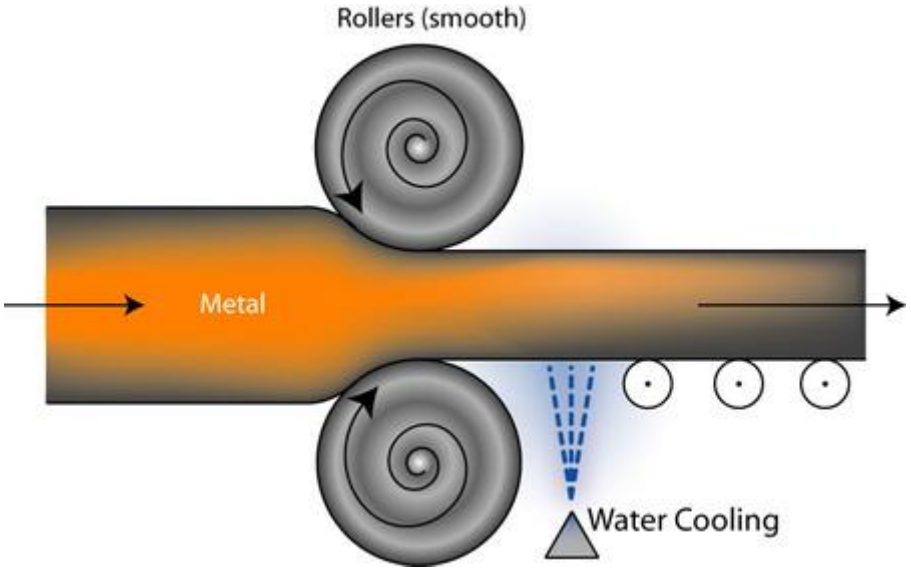

Fig.6 Hot rolling

Application of hot rolling

Hot rolling is used mainly to produce sheet metal or simple cross sections, such as rail tracks. Other typical uses for hot rolled metal includes truck frames, automotive wheels, pipe and tubular, water heaters, agriculture equipment, compressor shells, railcar components, wheel rims, metal buildings, doors, shelving, discs, automotive clutch plates.

Cold rolling

Cold rolling occurs with the metal below its recrystallization temperature (usually at room temperature), which increases the strength via strain hardening up to 20%. It also improves the surface finish and holds tighter tolerances. Commonly cold-rolled products include sheets, strips, bars, and rods; these products are usually smaller than the same products that are hot rolled. Because of the smaller size of the workpieces and their greater strength, as compared to hot rolled, four-high or group mills are

used. Cold rolling cannot reduce the thickness of a workpiece as much as hot rolling in a single pass.

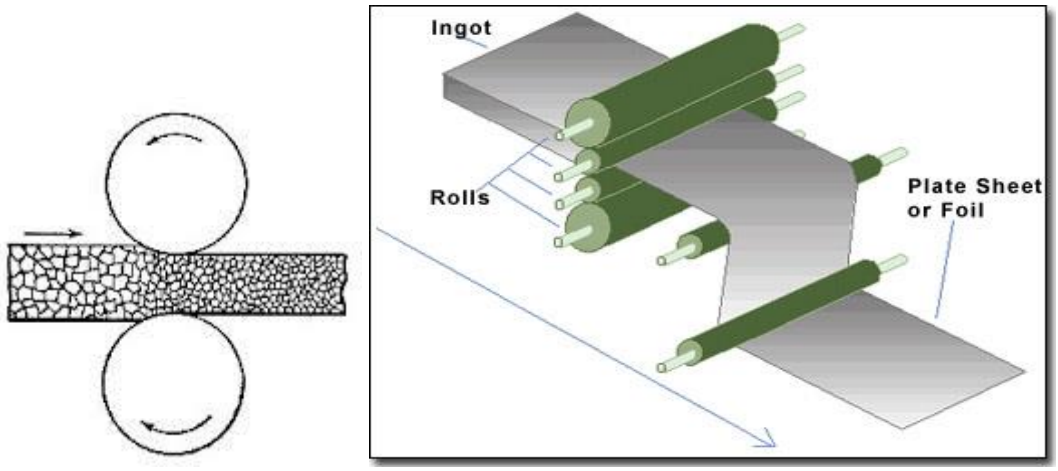

Fig.7 cold rolling

Cold rolling application

Typical uses for cold rolled steel include metal furniture, desks, filing cabinets, shelves, tables, chairs, motorcycle exhaust pipes, computer cabinet and hardware, all home appliances and components, lighting fixtures, hinges, tubing, steel drums, lawn movers, water heaters, metal containers, and a variety of construction related products.

Calculation of rolling

$F = \mu Pr$

F ; tangentional friction force

μ; coefficient of friction

Pr ; radial force

$\mu = \tan \alpha$

α : angle of contact between the rolls and workpiece

$$\Delta h = ho - hf = 2a \text{ (Maximum possible reduction)}$$

$$= \mu^2 R$$

ho : original thickness of workpiece

hf ; final thickness of workpiece

R: radius of rolls

$$Pr = w\sigma \sqrt{r\Delta h}$$

W; length or width of roll

r ; radius of roll

$$K = \frac{I}{L} = \frac{F}{f}$$

K: elongation coefficient

I: workpiece length after rolling

L: workpiece length before rolling

F: cross section area of workpiece before rolling

f; cross section area of workpiece after rolling