

Wire and bar drawing - Basic concepts

1.1 Wire drawing - introduction

Bar or wire drawing is a deformation process in which the work piece in the form of cylindrical bar or rod is pulled through a converging die. The stress applied is tensile. However, the material is subjected to compressive stress within the die thereby deforming plastically. A bar or rod is drawn down in order to reduce its diameter. In general, drawing results in reduction in area of cross-section. Drawn rods are used as raw materials for making bolts etc. Wire drawing is used for producing wires e.g. electrical wires, cables, strings, welding electrodes, fencing etc. Basic difference between bar drawing and wire drawing is the size of bar stock used for bar drawing is large. Wire is a drawn product having less than 5 mm. For wire drawing smaller diameter bar stock is used. Wire drawing is usually done in multiple steps, using 4 to 12 dies, because the length of the wire drawn is very large-several meters. Bar drawing is done in single draft. Draft is the difference between initial and final diameter. Wire drawing is a continuous process.

A draw bench is used for drawing of rods, bars and tubes because rods and bars can not be coiled. The rod or bar is pointed by swaging operation and fed into the drawing die. The tip of the bar is clamped into the jaws of the draw head and the drawing operation is carried out continuously. The drawhead is moved using chain drive or hydraulic power pack. Draw speeds can be as high as 1500 mm/s.

In wire drawing a series of dies are used in tandem. The drawn wire is wound on capstan between each pair of dies. Usually drawing is done cold. Maximum reduction in cross-sectional area per pass of drawing is restricted to 45%. Beyond this reduction, tensile stress may increase and surface finish may become poor. Due to large stress involved in drawing, the drawn wire gets strain hardened. Therefore, intermediate annealing is required before next stage of drawing.

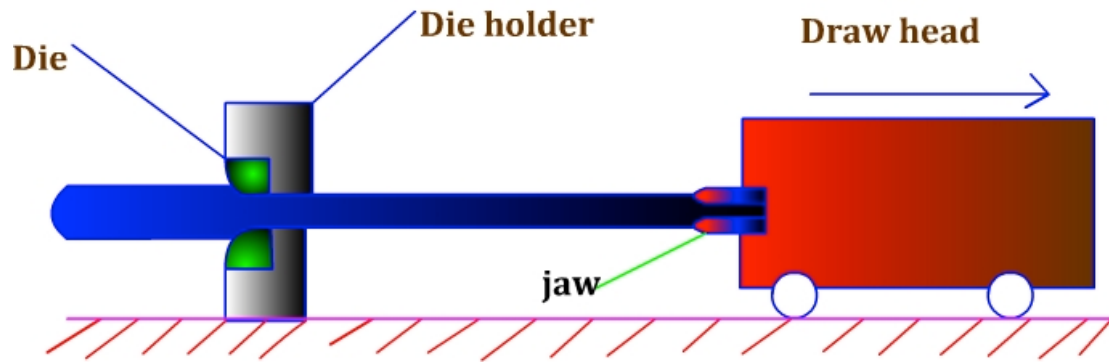


Fig.1.1.1: Wire drawing: A Draw Bench

The raw material for wire drawing is usually a hot rolled rod. The rod is coiled and fed into the die after subjected to acid pickling to remove oxides. Before drawing, the rod is lubricated. In order to retain the lubricant of the surface, oxalate or sulfate coating is given to the rod. Soap solution or oil is used as lubricant. The rod is dipped into lubricant bath before fed into the die. A bull block is used on the other end in order to wind the drawn wire. Wire drawing is completed with multiple draw head and bull blocks, with maximum reduction in each step limited to 35 to 40%. After each step of reduction, the wire diameter is reduced. Velocity of the wire and length of the wire, therefore will increase successively. This requires that the bull block be rotated at higher speeds after each reduction. A stepped cone can be used if reduction in number of blocks is to be reduced. Drawing speeds can be as high as 30 m/s.

Intermediate annealing is required before next step of drawing in order to improve the ductility of the wire. Patenting is a heat treatment process adopted for high carbon steels (musical wires) in order to obtain optimum strength and ductility. In this process the wire is dipped in molten lead bath kept at 315°C . This will ensure the formation of pearlitic structure in the drawn wire, thereby improving its strength. Wet drawing involves dipping the wire inside a lubricant bath before the next stage.

1.2 Drawing die:

Die for drawing may be made of tool steel, tungsten carbide or diamond. For drawing fine wires, diamond die is used. Normally the die is made as an insert (called nib) into alloy steel casing.

The cross-section of a drawing die assembly is shown below:

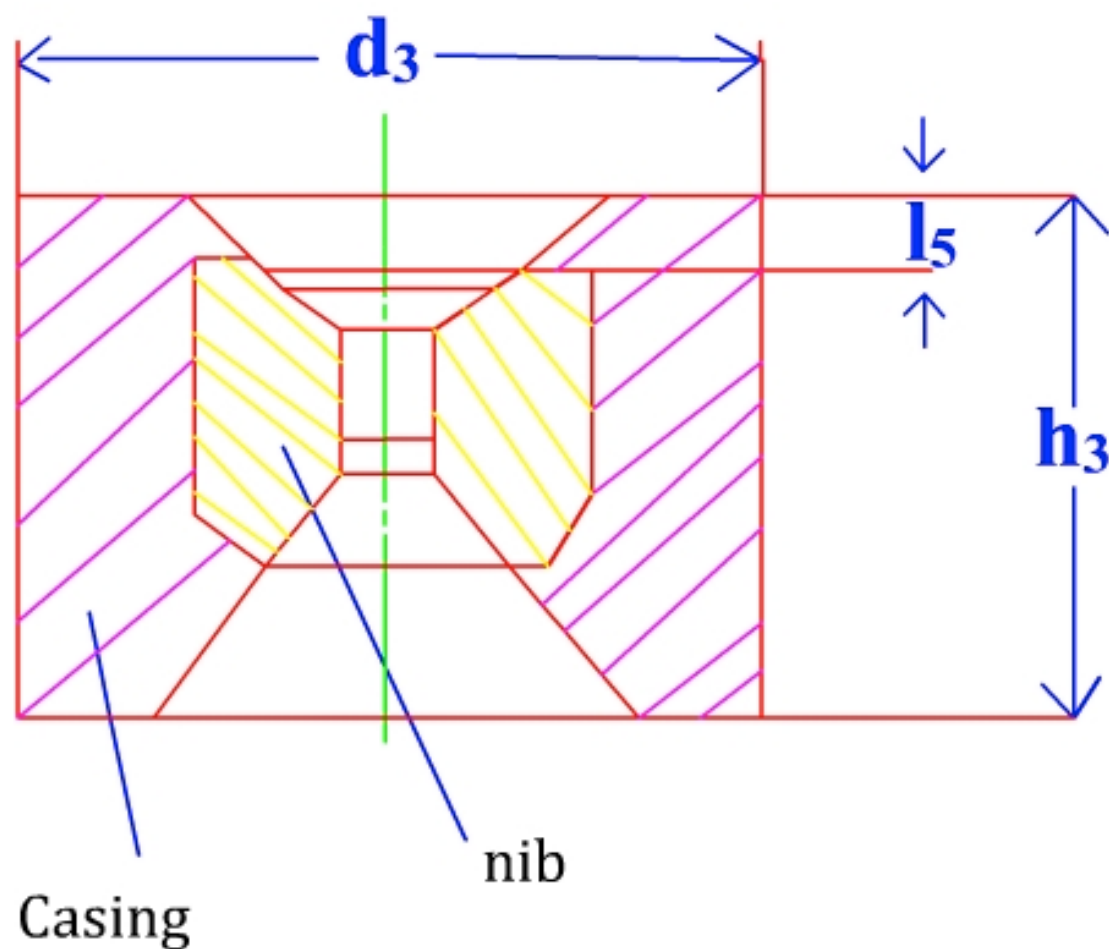


Fig.1.2.1: Cross-section of a drawing die

The entrance of the die assembly has bell assembly so as to facilitate the entry of lubricant along with the wire. Reduction in diameter takes place in approach angle section. Back relief provides space for expansion of the drawn wire. The bearing region causes frictional drag on the wire, which helps in movement of the wire inside the die. The steel casing helps hold the die.

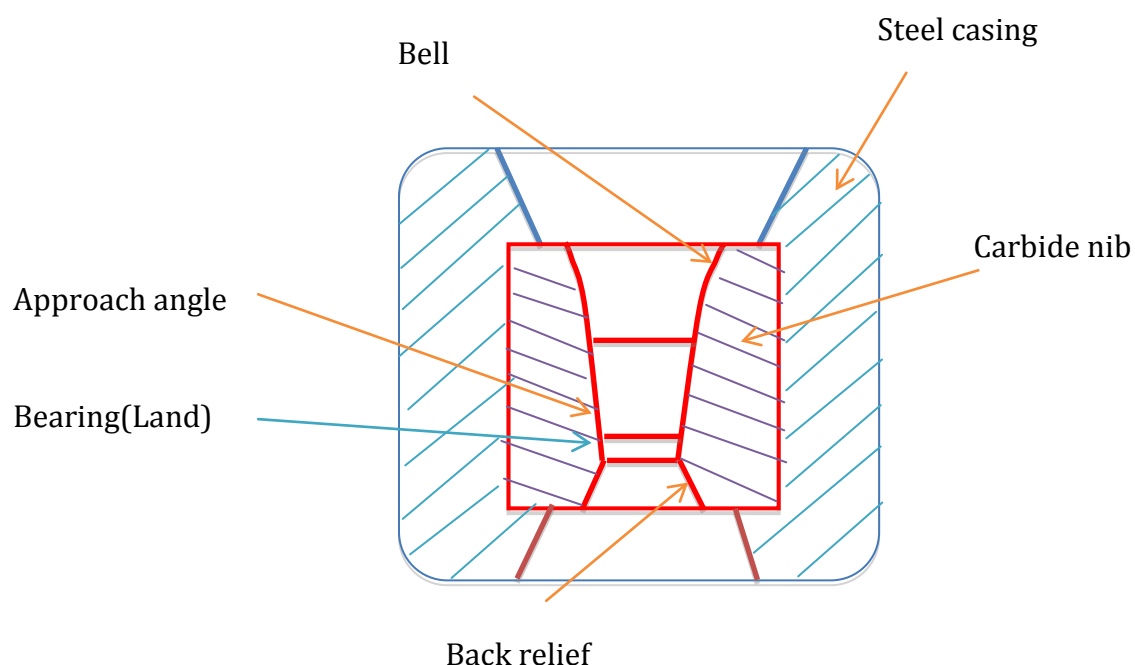


Fig. 1.2.2: Cross-section of a drawing die assembly

1.3 Typical drawing processes:

Drawing of bars could be carried out using a draw bench, as shown in figure.

Hydraulically-operated or motor-driven carriages are used for drawing the bar through the die. Multiple bars could be drawn in the draw bench, using several drawing dies on the same machine.

Drawing of wires is usually accomplished using single or multiple drafts as shown in figures below:

Continuous drawing of wires is done through a series of drawing dies, with intermediate winding drums. These drums are run by electric motors. They wind the drawn wire before feeding it to the next reduction stage. The drum applies mild tension on the wire, which is being drawn. Multiple steps of drawing, also called tandem drawing are required as the reduction of diameter achieved per pass is usually limited.

Typical wire drawing processes, using single or multiple drafts are shown schematically below:

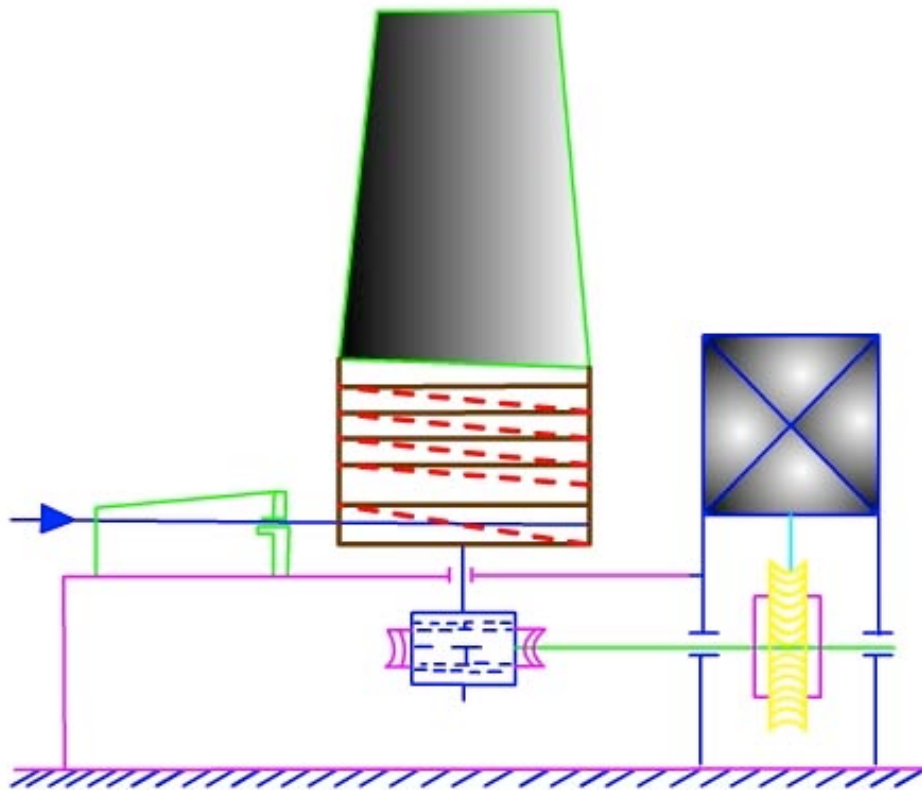


Fig. 1.3.1: Single draft drawing

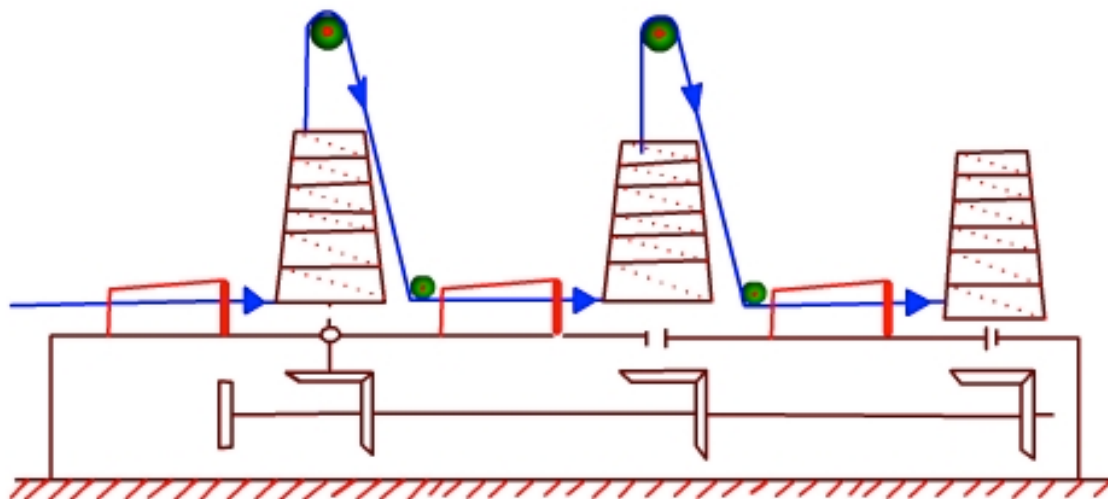
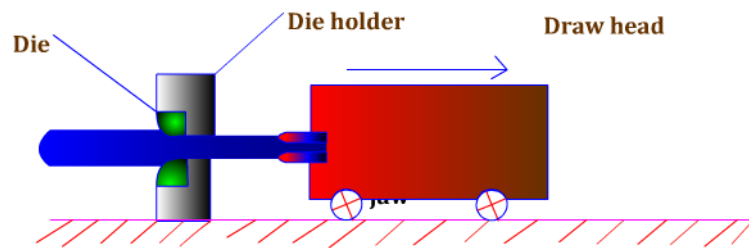


Fig. 1.3.2: Tandem Drawing

The following animation shows the process of drawing of bars using a draw bench:
rcm_10_7.swf

Note :Can be viewed only by Acrobat 9.0 and above



Source:

<http://nptel.ac.in/courses/112106153/26>