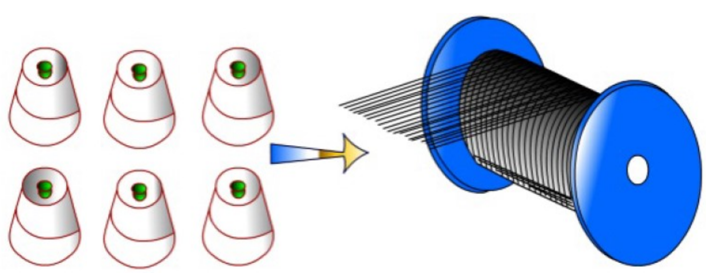
Warping

Objective of warping

The objective of warping process is to convert the yarn packages into a warper's beam in the form of a sheet of parallel yarns having desired width and containing requisite number of ends.



Types of warping

Let us take the following hypothetical example to understand the various options of warping process.

A woven fabric roll of 2 m width and 10,000 m length is to be produced from warp yarn of 15 tex. There should be 40 yarns per cm in the fabric.

The total number of ends in the fabric will be 40×200 = 8,000.

Considering that 10 beams will be combined in sizing, the number of ends on each warper's beam will be 800.

Types of warping

Ignoring the yarn crimp and wastage of yarns, there will be the following options:

P × R indicates the number of packages used × number of warping runs

1. **800 × 1: Each cone should contain 10,000 m yarn, weighing 150 g.**
2. 400 × 2: Each cone should contain 20,000 m yarn, weighing 300 g
3. 200 × 4: Each cone should contain 40,000 m yarn, weighing 600 g
4. 100 × 8: Each cone should contain 80,000 m yarn, weighing 1200 g
5. **50 × 16: Each cone should contain 160,000 m yarn, weighing 2400 g**

Direct warping or beam warping

Option 1 (direct warping or beam warping) can be executed when the lot being processed is having significantly higher (15-20 times) length than that of the fabric considered (10,000 m).

Considering the mass of a full cone as 2.1 kg, if the ordered length is 140,000 m, then the entire cone (150 × 14 = 2100 g) will be consumed.

Sectional warping or indirect warping

Option 2 (sectional warping or indirect warping) is practiced when fancy warp patterns or specialized yarns are used.

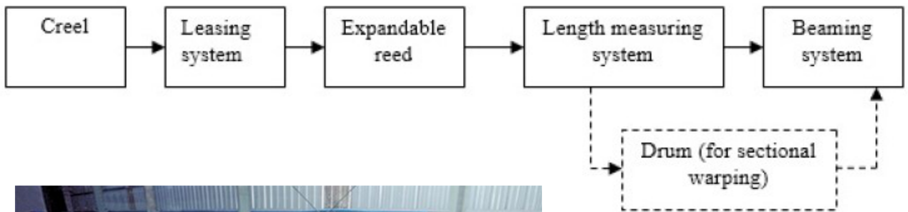
In this case, the production planning officer does not see the possibility of repeat order in near future.

Therefore, he or she wants to consume the entire package to minimize the wastage and inventory carrying cost.

Therefore, the beam is made by section by section and the operation is repeated large number of times to complete the entire width of the warper's beam.

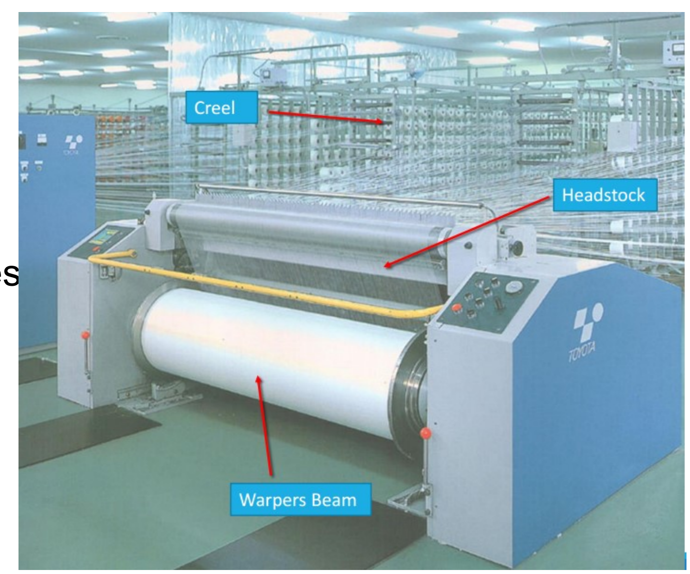
This is also followed by the beaming operation when all the sections of warp are transferred to a flanged beam.

Stages of warping process



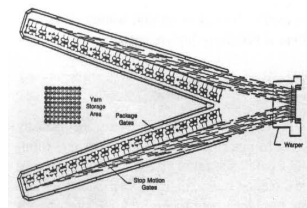
Components of Warping Machine

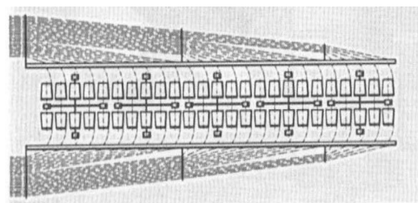
Creel
Headstock
Control devices



Types of Creel

1. Single end creel
2. Magazine creel
3. Traveling creel



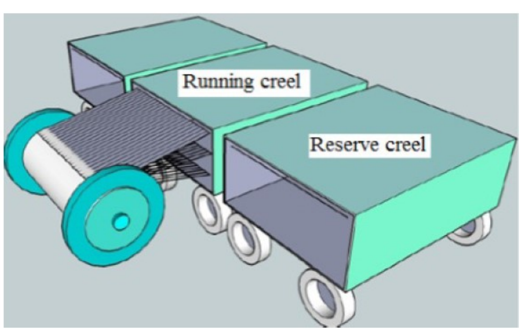


Single End Creel

One position of the creel is used for one end on the warper's beam.

Single end creel of two types truck creels and duplicated creels.

Extra space is required for the reserve creel.

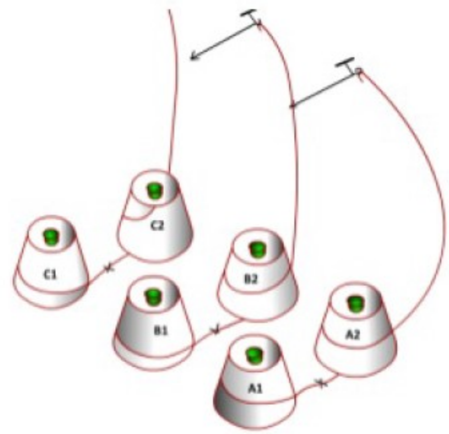


Magazine Creel

Tail end of yarn from one cone is tied with the tip of the yarn of another neighbouring cone, therefore automatic transfer of yarn

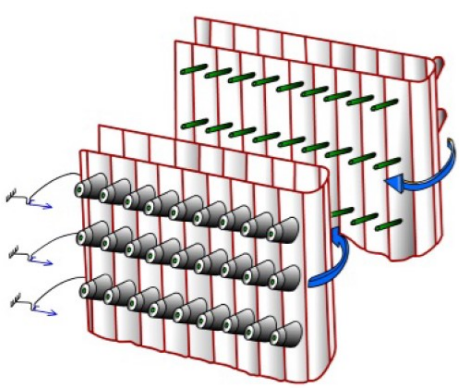
Creeling time is eliminated so more efficiency

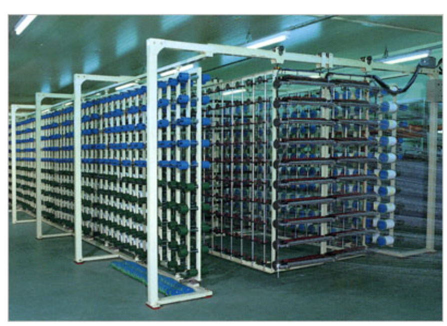
However, yarn break during the transfer and reduced creel capacity



Travelling or Swivelling Creel

Package holders with full packages can move from inside (reserve) position to the outside (working) position when the running packages are exhausted





Leasing

It is a system by which the position of the ends is maintained in the warp sheet.

Generally it is done by dividing the ends in two groups (odd and even).

If odd ends are passing over the lease rods then the even ends will pass below the rod.

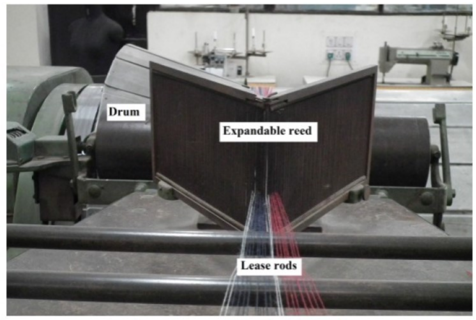


Figure 3.9: Expandable reed and lease rods

Expandable reed

It is used to control the spacing between consecutive ends

The two limbs of V shaped expandable reed can be expanded or collapsed as per the required spacing of ends.

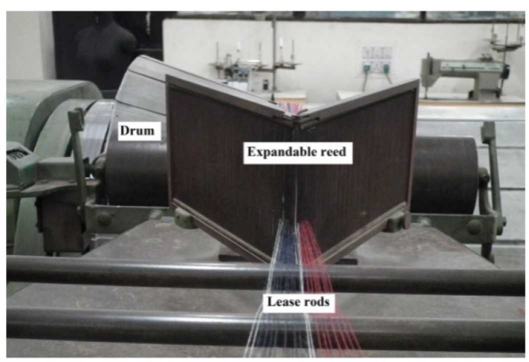


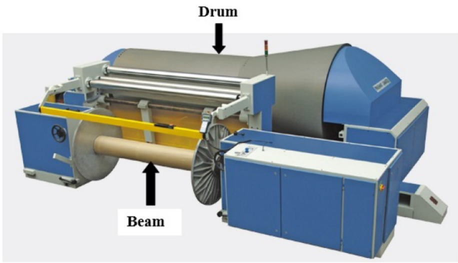
Figure 3.9: Expandable reed and lease rods

Beaming system

All the ends or sections are transferred to the warper's beam

Warper's beam is driven by gears or frictional contact with another drum.

The speed of direct warping ranges from 1200-1400 m/min whereas in sectional warping is quite slow (around 300 m/min).

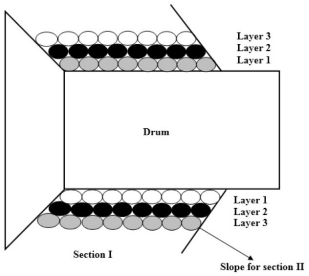


Sectional Warping

Sectional warping is preferred over beam warping for multi-coloured warp.

Here the entire width of the warping drum is developed section by section

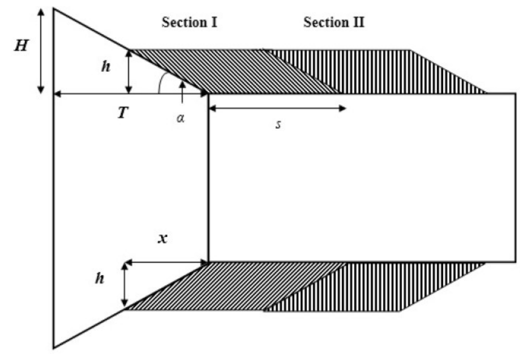
As the winding of one layer is completed on the drum, the section of ends is given a requisite traverse so that the end at one extreme corner touches the inclined surface.



Sectional Warping

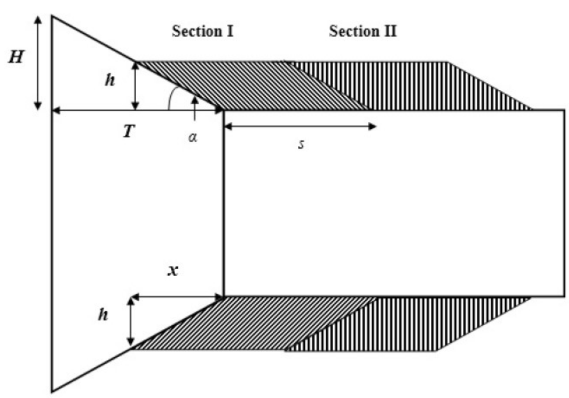
As process continues, the thickness (or height) of the section gradually increases.

When requisite length has been wound in a section, next section is started by shifting the expandable reed assembly by suitable distance



Sectional Warping

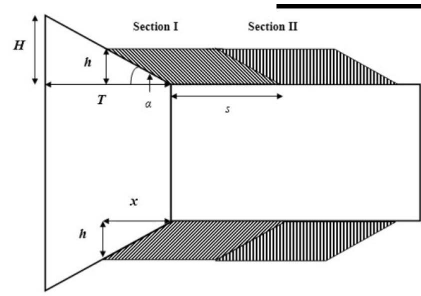
If α is the angle of inclination, *x is the traverse given to the section and h is the height of the section then*



$$\frac{h}{x} = \frac{H}{T} = \tan\alpha$$

$$\text{So, } x = \frac{h}{\tan\alpha}$$

Sectional Warping



The volume of yarn contained inside one section can be calculated from the volume of a shaded parallelogram.

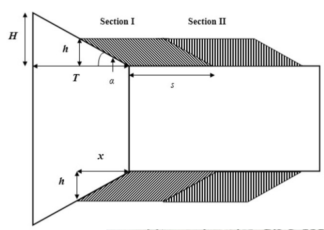
$$\text{The area of a shaded parallelogram} = s \times h = s \times x \tan \alpha$$

The average length of warp sheet wound on a drum having empty diameter d and section height h is $= \pi (d + h)$.

Therefore,

$$\text{The volume of yarn inside one section is} = \pi(d+h)s \times x \tan \alpha$$

Sectional Warping



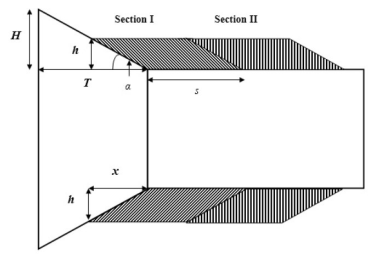
Alternatively, the volume of yarn in one section can be calculated using the concept of hollow cylinder whose inner and outer diameters are d and $(d + 2h)$, respectively. If the height of the hollow cylinder, that is section width is s, as indicated in Figure 3.7, then the volume can be calculated as follows:

$$\begin{aligned}\text{Volume} &= \frac{\pi\left\{(d+2h)^2 - d^2\right\}}{4} \times s \\ &= \frac{\pi\left\{(2d+2h) \times 2h\right\}}{4} \times s \\ &= \pi(d+h) \times h \times s = \pi(d+h)s \times x \tan \alpha \qquad (3.3)\end{aligned}$$

Sectional Warping

For drum with fixed angle, if the yarn is coarser then one layer of the warp ribbon will result in higher increase in thickness (Δh) and thus to match the inclination, the traverse speed (Δx) should be higher.

For fixed angle drums, only traverse speed is to be adjusted while with variable angle drums both traverse and the angle of inclination can be varied.



Comparison of beam and sectional warping

Beam warping	Sectional warping
Used for high volume production	Used for small volume and customised production (stripes and specialised yarns)
One step process	Two step process
High creel capacity is required	Low creel capacity is sufficient
Comparatively less expensive	Comparatively more expensive
Beaming speed is high	Beaming speed is low
More common	Less common

Numerical

A full beam produced on a direct warping system is having 1.4 m width and contains 500 ends of 30 tex yarn. The empty and full beam diameters are 30 and 75 cm, respectively. If the beam density is 0.4 g/cm 3, then calculate the length of warp and its mass in kg.

Solution:

Beam width (L) = 1.4 m =140 cm
Number of ends = 500
Count = 30 tex
Empty beam diameter (d)= 30 cm
Full beam diameter (D) = 75 cm

Numerical

So, volume of yarn on the beam $= \frac{\pi}{4}(D^2 - d^2) \times L$

$$= \frac{\pi}{4}(75^2 - 30^2) \times 140 \text{ cm}^3$$

$$= 519541 \text{ cm}^3$$

So, mass of yarn $= \text{Volume} \times \text{density}$

$$= 519541 \times 0.4 = 207816 \text{ g}$$

$$= 207.82 \text{ kg}$$

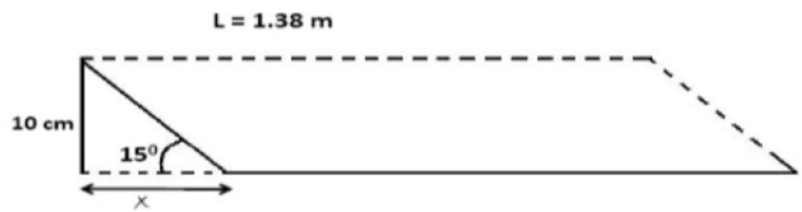
Therefore, mass of single yarn $= \frac{207816}{500} = 415.63$ g

So, length of warp $= \frac{415.63}{30}$ km $= 13.85$ km

So, the total mass of yarn on the beam is 207.82 kg and length of warp sheet is 13.85 km.

Numerical

2. A multi-coloured warp of 20 tex yarn is to be wound onto a warping beam of 1 m diameter on which the inclines are fixed at 15° to the axis. The warp is 1.38 m wide and contains 6480 ends. The density of the material on beam is 576 kg/m^3. The maximum depth of yarn on the beam could be 10 cm. Determine the length of warp and the traverse length per section.



Numerical

Yarn count = 20 tex

Warp width (L) = 1.38 m

Empty beam diameter (d) = 1m

Full diameter of beam (D) = $d+2h$,

where h = maximum depth of yarn on the beam = 10 cm.

So, $D = \left(1+2\times\frac{10}{100}\right)$ m= 1.2 m

$$\text{Volume of the yarn} = \frac{\pi\times(D^2-d^2)\times L}{4}\ \text{m}^3$$

$$= \frac{\pi\times(1.2^2-1^2)\times 1.38}{4}\ \text{m}^3$$

$$= 0.477\ \text{m}^3$$

Numerical

Mass of the yarn = 0.477×576 kg

$= 274.75$ kg

Mass of a single yarn = $\frac{274.75 \times 1000}{6480} = 42.4$ g

So, length of the warp = $\frac{42.4}{tex}$ km

$= \frac{42.4}{20}$ km $= 2.12$ km

$= 2120$ m

Here, $\frac{h}{x} = \tan 15^0$, where x = traverse length per section,

or, $\frac{10}{x} = \tan 15^0$

or, $x = 37.33$ cm

So, traverse length per section is 32.33 cm.