CHAPTER 4

DESIGN AND DEVELOPMENT OF FIBRE CRUSHING APPARATUS, SLIVER AND ROVING COMPRESSION APPARATUS

4.1 INTRODUCTION

Textiles are seldom designed to withstand a single stress application of high magnitude. They are being subjected to long usage, and, during their lifetime, experience a series of repeated stress applications and removals. Bending, stretching, compressing and twisting are all such repeated stress applications. Any modification, either at process level or product level, done to enhance the durability of material will certainly be beneficial to the end-users in the long run.

In this chapter, to determine the influence of crushing force on the fibres, a crushing apparatus has been designed and fabricated to laterally compress the fibrous mass.

Also, to study the effect of lateral compression on the yarns, sliver and roving, different custom built compression apparatuses were developed. The design features and working principles of the various types of compression apparatus has been discussed.
4.2 DESCRIPTION OF FIBRE CRUSHING APPARATUS

The forces are applied on a bundle of fibres by rolling a narrow steel wheel under load, across the fibres mounted on a hard flat surface. A little trolley with a central steel wheel with a narrow run is driven on the fibres. The front view of the crushing apparatus is shown in Figure 4.1 and 4.2. The various parts which comprise the crushing instrument are listed in Table 4.1. Basically, the crushing load is applied to the fibres through aluminum roller wheel of 40 mm diameter.

The crushing wheel is rigidly fixed to the centre of a shaft, which may rotate about its axis. The shaft holding the crushing wheel is extended and mounted with a screw rod assembly for lowering / raising the crushing wheel on the base plate. The base plate is capable of moving forward and backward strokes of upto 60 mm. A load cell is fixed beneath at the centre of the base plate and connected to a display unit. The screw rod also carries a compression spring. The load can be altered by means of spring compression obtained by turning the handle at the top the screw rod.

After placing the fiber specimen over base plate, crushing wheel is lowered and is brought into contact in a direction perpendicular to the fibre axis (or transverse direction) with the fiber specimen. The required load may be adjusted, as seen on the display. The base plate is now given forward and backward strokes of upto 60mm. The deformed fibre specimen is then removed and taken for further testing.
Figure 4.1 Schematic View of Fibre Crushing Instrument

Figure 4.2 Photograph of Fibre Crushing Instrument
### Table 4.1 Parts Table – Fibre Crushing Instrument

<table>
<thead>
<tr>
<th>Part No</th>
<th>Description</th>
<th>Part No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bottom Frame</td>
<td>8</td>
<td>Spring – Load Washer</td>
</tr>
<tr>
<td>2</td>
<td>Fiber to be crushed</td>
<td>9</td>
<td>Screw Rod</td>
</tr>
<tr>
<td>3</td>
<td>Digital Display Unit (Load in gms)</td>
<td>10</td>
<td>Holding Unit</td>
</tr>
<tr>
<td>4</td>
<td>Crushing Roller Support Frame</td>
<td>11</td>
<td>Loading Handle</td>
</tr>
<tr>
<td>5</td>
<td>Crushing Roller</td>
<td>12</td>
<td>Screw Rod with Handle for moving fiber</td>
</tr>
<tr>
<td>6</td>
<td>Crushing Roller Mounting Stud</td>
<td>13</td>
<td>Load Cell (Measuring Capacity upto 2 Kgf)</td>
</tr>
<tr>
<td>7</td>
<td>Spring</td>
<td>14</td>
<td>Side Frame</td>
</tr>
</tbody>
</table>

### 4.3 DESCRIPTION OF SLIVER COMPRESSION APPARATUS

This apparatus is designed and fabricated as a separate apparatus intended for the compression of slivers as shown in Figures 4.3, 4.4 and 4.5. The compression apparatus applies load to slivers by a pair of rollers comprising of bottom steel compression roller (diameter 27 mm) and top rubber covered compression roller (diameter 28 mm). The bottom compression roller is driven by an AC motor via the motor and driven pulleys through belt drive. Parameters like motor type, speed, driver and driven pulley diameters were carefully chosen so as to keep the surface speed of bottom compression roller on par with the surface speed of feed roller in rotor spin box. Loading is by means of adding dead weight on the weigh pan which is hooked to the top roller. The weights were 0, 500, 1000 and 1500 gf respectively. The drive to the top roller is negative.
Figure 4.3 Schematic View of Sliver Compression apparatus

Figure 4.4 Photograph of Sliver and Type III Roving Compression apparatus
4.4 DESCRIPTION OF ROVING COMPRESSION APPARATUS

In order to study the influence of roving compression on yarn quality, three different types of roving compression apparatuses have been fabricated. Type I, II and III apparatuses laterally compress the rovings before its entry into main drafting unit of ring frame. The detailed description of the above mentioned apparatuses is as follows.

4.4.1 Type I Apparatus

The Type I apparatus is designed, fabricated and mounted in LR6S ring frame with 3 over 3 pneumatic drafting system (P3-1 regular top arm) as shown in Figure 4.6. The compression apparatus applies load to roving by a pair of rollers comprising of bottom steel roller and top rubber covered roller. The bottom compression roller is driven from the rear bottom fluted roller of the drafting system through chain and sprocket drive. The top roller is
negatively driven due to frictional contact with the bottom roller. The top rollers are loaded by self weight. Three different self weighted top rollers, namely 150 gms, 450 gms and 750 gms respectively, have been machined for the purpose. When the roving is passed through this pair of rollers, it is compressed and subsequently enters into the ring-frame drafting zone.

Figure 4.6 Schematic View of Type I Roving Compression apparatus
The apparatus consists of two vertical supports, separated by a distance of 750 mm, mounted near the roller beam. Over the vertical supports, two bearing brackets were mounted so as to hold the bottom steel fluted compression roller and top synthetic covered compression roller. The diameters of top and bottom roller were 20 mm respectively. A 18T sprocket wheel fixed to one end of the back bottom fluted roller of diameter 27 mm, drives a 13T sprocket wheel through chain drive. The 13T sprocket wheel is fixed to one end of bottom steel fluted compression roller. Unit draft has been maintained between back bottom fluted roller and bottom compression roller to avoid roving stretch. The entire compression roller set-up is placed 125 mm above the drafting system.

### 4.4.2 Type II Apparatus

The Type II apparatus is designed, fabricated and mounted in Textool DJ50 ring-frame with 3 over 3 spring loaded drafting system (SKF PK 235 top arm) as shown in Figure 4.7. Type II apparatus is different from Type I in that it is integrated along with drafting arm. The compression apparatus applies load to roving by a pair of rollers comprising of bottom steel compression roller and top synthetic covered compression roller. The diameter of top compression roller was 28 mm and its distance from back top drafting roller were 19 mm. Similarly, the distance between back bottom drafting roller and bottom compression roller were 24 mm. To one end of the bottom compression roller (20 mm diameter) is fixed a 20T gear wheel, which is driven from a 30 T gear wheel of back bottom fluted roller through a 40T carrier wheel. The 40 T carrier wheel was fixed on an 8 mm square plate. With this arrangement, unit draft was accomplished between back drafting rollers and compression rollers. The top compression roller is negatively driven due to frictional contact with the bottom compression roller. The top compression rollers were also spring loaded like any other spring loaded top
arm drafting system. With the added spring arrangement in the top arm and by means of screw adjustment, the various loads were maintained as 500, 750 and 1000 gms respectively. The top compression roller loads were ascertained by Top arm load gauge. When the roving is passed through this pair of rollers, it is compressed and subsequently enters into the ring-frame drafting zone.

![Diagram of the Type II Roving Compression Apparatus]

**Figure 4.7 Schematic view of Type II Roving Compression apparatus**

4.4.3 Type III Apparatus

The Type III apparatus is similar to sliver compression apparatus but it is intended for the compression of double rovings as shown in Figure 4.8. The compression apparatus applies load to roving by a pair of rollers comprising of bottom steel compression roller (diameter 27 mm) and top rubber covered compression roller (diameter 28 mm). The bottom compression roller is driven by a AC motor via the motor and driven pulleys
through belt drive. Parameters like motor type, speed, driver and driven pulley diameters were carefully chosen so as to keep the surface speed of bottom compression roller on par with the surface speed of back drafting roller in the ring frame. Loading is by means of adding dead weight on the weigh pan which is hooked to the top roller. Loads can be changed by directly changing the weight on the weigh pan. The weights applied are 0, 250, 500 and 750 gf respectively. The top roller is negatively driven due to the frictional contact with the bottom roller.

Figure 4.8 Schematic view of Type III Roving Compression apparatus
4.5 DEVELOPMENT OF A RING FRAME FOR IMPROVED YARN QUALITY

Any development in which the yarn quality is improved by introducing some device between the front roller and the lappet will be a source of impediment for piecing the ends. If by incorporating some device prior to drafting, this problem can be overcome and such a type of device has been planned in the present study. There are instances where the introduction of pre-tension in heat setting, pre-heating in draw texturing and pre-opening in the card have been discussed are existing in the scientific literature. Pre-treatments such as bleaching and mercerization have been found to improve dyeing performance of textiles. The incorporation of a small quantity of moisture in knitting yarns and sized warp has led to significant improvement in the performance. Having looked at these developments, a thought came to the mind that if the roving which is passing through the drafting system is compressed by a pre-compression zone, what would be its effect on yarn quality. In this context, the experimental work carried out by Audivert (1972) and reported served as a pointer.

4.5.1 Commercialisation of Pre-Compression Apparatus

Textile industry for its efficient working today requires innovations in various areas as they will result in cost reduction and improve productivity without compromising on quality. In this context, even small modifications by the way of change in process parameters or employment of retrofittable kits would certainly be welcome by the Textile Technologists. Such inexpensive gadgets are in fact the most wanted ones in the wake of current economic slowdown.
Fabrication of Type II apparatus requires the below listed parts:

- Fluted Roller
- Slider Piece
- Needle Bearing
- Gear Wheels
- Fluted roller end stud
- Top roller saddle
- Height / Pressure adjustment screw
- Support plates for gear wheels

The approximate cost of the above listed items for one staff length (six spindles) is US $ 300. As an example, for a short ring frame with 240 spindles, retrofitting charges for incorporating the Type II apparatus would be around US $ 5 per spindle. Figures 4.9 (a), (b) and 4.10 (a), (b) shows the apparatus fitted on a ring frame for 2 spindles.

The results obtained from Type II apparatus shown in chapter 7 for polyester yarn clearly reveals that the apparatus improves yarn quality produced from rovings of lower turns/m. This aspect could actually be exploited for enhancing the productivity in ring frame.
(a) Pre-compression roller pair

(b) 3 over 3 drafting system along with pre-compression roller pair

Figure 4.9 Photograph of Compression device incorporated in Ringframe
(a) Driving arrangement to Pre-compression rollers

(b) View of ring frame in running condition with pre-compression device

Figure 4.10 Photograph of Compression device mounted in Ring frame
4.6 CONCLUSIONS

A description is given of the fibre crushing apparatus with many new features. In addition, sliver and roving compression apparatuses which have been used are described. This chapter has thrown light on the commercialising possibilities of the Type II apparatus by incorporating it in a ring frame. It has been demonstrated that it is an inexpensive gadget which can be retrofitted in ring frame.