CHAPTER 12

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

12.1 INTRODUCTION

There have been many studies concerning the structure and properties of rotor spun yarns. A number of excellent reviews, which provide complete bibliographies, are available in this field. Although a considerable amount of work has been done by many research workers no substantial study on the low stress mechanical properties of rotor spun yarns has been made so far.

A literature review as presented in chapter I clearly shows that very little work has been carried out on the low stress mechanical properties like bending, buckling, axial and lateral compression, friction and abrasion and wicking behaviour of rotor spun yarns produced under varying conditions.

The indications obtained from this study were that the processing parameters, namely, yarn tex, twist, opening roller and rotor speeds had a significant effect on the low stress mechanical properties of rotor spun yarns. Previous research work concentrated only on the high stress properties, and consequently very little understanding of the low stress mechanical properties was possible. Data presented in this work are new and this research has enabled a better understanding of the role of the processing parameters on the low stress mechanical properties.

One of the reasons for undertaking this work is that, there is now a greater awareness of the problem of fabric handle. The properties of the yarn undoubtedly play a major role in deciding the properties of the fabrics made from them. Control of yarn properties is probably vital to controlling fabric properties. This
is especially so in the case of rotor spun yams which tend to have inferior properties to ring spun yams.

Another major area where the knowledge and control of yarn properties can have a significant role is knitting. The performance of a yarn during and after knitting depends on the yarn properties. It is felt that the low stress properties are more important towards this end than the traditionally tested properties like strength and irregularity.

Towards these aims it was felt that the combination of the individual properties into a yarn quality index was an essential prerequisite for application on the shop floor. Several indices for different end uses are proposed and discussed. It is felt that these indices would be useful in that they would be capable of revealing the behaviour of fabrics that can be manufactured from the yarns.

In view of the scanty data available on the low stress mechanical properties of rotor spun yams, an attempt was made to investigate their buckling behaviour by fabricating an attachment to the Instron universal tensile tester, that permitted the buckling of a sheet of yarn to be carried out. New data on this is presented.

12.2 CONCLUSIONS

The major conclusions from this study are summarised below in point form.

1) Bending rigidity and bending hysteresis of the rotor spun yarns are significantly affected by the yarn linear density, in that the higher the value the greater the rigidity and hysteresis. The bending recovery is lower for the coarser yarns.

2) The bending rigidity is unaffected by twist.

3) The bending hysteresis is quite sensitive to twist, in that the higher the twist the higher is the bending hysteresis.

4) With an increase in twist the bending recovery shows a decline.
5) The opening roller speed has very little effect on the bending rigidity and the bending hysteresis.

6) Rotor speed has been found to have a significant effect on the bending rigidity and the bending hysteresis, in that a higher rotor speed results in higher values of these properties.

7) The relation between the actual values of bending rigidity and those predicted from the classical helical model is poor, and the gap widens as the yarn linear density increases.

8) The buckling parameters, buckling recovery and energy lost in cycling, generally show a decreasing trend with an increase in yarn linear density.

9) Increasing the opening roller speed decreases the buckling recovery at low rotor speeds. This effect diminishes as the rotor speed increases.

10) Increasing the opening roller speed increases the energy loss during cycling at low rotor speeds. This effect diminishes as the rotor speed increases.

11) The effect of rotor speed upon the buckling recovery and energy loss show contradictory trends.

12) Axial compression is affected by yarn linear density and twist.

13) An increase in the opening roller speed has led to an increase in the axial compression.

14) The effect of rotor speed on the axial compression is marginal.

15) The parameters work of compression (WC) and linearity of compression (LC) and percentage resilience (RC) are found to increase significantly with yarn linear density.

16) As the twist increases the magnitude of WC decreases, LC remains unaffected and RC shows a marginal increase.

17) The opening roller speed has no effect on WC, but LC and RC are found to increase marginally.

18) Rotor speed has a tendency to lower the compressional energy and no clear trend is noticeable in the case of LC and RC.
19) Both the yarn linear density and the twist have marginal effect on the yarn friction.

20) The abrasion resistance of the yarns markedly rises with increasing linear density. The effect of twist on abrasion resistance is minor.

21) While frictional coefficient increases with increasing opening roller speed it falls as the rotor speed increases.

22) Both opening roller speed and rotor speed increase causes the abrasion resistance to rise, though the trend is more pronounced for opening roller speed.

23) Wicking rate and maximum wicking height increase with increase in the yarn tex.

24) An increase in twist lowers the wicking rate and the maximum wicking height.

25) The opening roller speed has very little effect on the wicking behaviour of rotor spun yarns.

26) An increase in rotor speed results in a decrease in the wicking rate and height.

27) The tenacity and elongation of the yarns shows an increase with an increase in the linear density and twist.

28) The work of rupture increases with an increase in the yarn linear density, but is less sensitive to increase in the twist, as is the work factor and the initial modulus.

29) The effect of the opening roller and rotor speeds are minimal in the case of the work of rupture.

30) The work factor declines and levels off as the linear density increases.

31) The work factor is only marginally affected by the rotor speed. Increasing opening roller speed causes a significant increase in this parameter.

32) Initial modulus declines and flattens out as the yarn tex increases.

33) The opening roller speed has no significant effect on the initial modulus, but it rises sharply with increase in rotor speed.
34) The relative insensitivity of the above tensile properties to changes in twist is perhaps the most interesting observation in this section.

35) Increase in the opening roller speed results in a slightly more even yarn with significantly fewer imperfections.

36) Irregularity and imperfections increase with an increase in the rotor speed.

12.3 PRACTICAL CONSIDERATIONS

Since yarns low stress mechanical properties like bending, irregularity and the compression influence the knitting behaviour of the yarn and the handle of the fabrics produced, these tests can be used as routine quality control tests, once reasonable norms for the various properties have been computed.

In the course of time it is hoped that these properties and the indices calculated from them will enable the fabric manufacturers to have a control over the properties of the feed yarns.

Although the use of rotor spun yarns is now limited, the application of such quality control tools will hopefully aid the fabric manufacturer and may encourage the more widespread use of rotor spun yarns in the future.

12.4 SCOPE FOR FUTURE WORK

The present work gives rise to some questions and point out certain areas where further research might be desirable.

A study where the rotor diameter varies along with the fiber properties, and the yarns thus produced are tested for low stress properties would be desirable.

It is necessary to develop a suitable model of rotor yarn structure that will permit the prediction of yarn flexural rigidity from the fiber properties and the details of yarn construction. Also a detailed study concerning the effect of wrapper fibers on the bending behaviour is essential to develop such a model.
One possible route is the study of bending behaviour at differing gauge lengths, perhaps by a fitting to the Kawahata Tester.

Aspects such as bending stress relaxation and creep as a function of the processing and structural parameters can be investigated.

In the present study the buckling of a sheet of yams was investigated. It would be preferable to buckle the yams one at a time. This would require more tests and a more sensitive sensing device.

The effect of changes in relative humidity and temperature on the bending and buckling behaviour of yarn is a field that could do with a detailed investigation.

A study to establish the correlation between the yarn indices suggested in this study and the actual fabric properties of fabrics made from the yarns and hence validate the indices is necessary.

The effect of doubling twist, fiber properties and finishes on the low stress properties of rotor spun yarns produced at various levels of twist and processing parameters, are areas that could be the target of future work.

An understanding of the torsional rigidity of rotor spun yarns is a requirement for developing a proper theory of rotor yarn structure. This would require the design and the fabrication of a special tester for this purpose.