DEVELOPMENT OF COTTON/SPANDEX PLATED KNITTED FABRIC AS AN ALTERNATE TO RIB FABRIC

A PROJECT REPORT

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ABSTRACT

In the present scenario of liberalization, privatization and globalization there is intense competition among the industries. Only the fittest among them will survive. Quality and productivity are some of the important factors governing the success of any industry.

An attempt is made in this project to compare certain properties of rib fabric to that of the single jersey fabric. The main objective of this project is to Study the effect of heat setting temperature, heat setting time and compacting temperature, on the elastic properties of cotton/lycra single jersey fabric and comparing the result with rib fabric.

- % Stretch of the cotton/lycra single jersey fabric for 5 pounds load is double than the rib fabric for the same load in both length and width wise direction.
- Fabric Growth of the cotton/lycra single jersey fabric is less than that of the rib fabric.

The success of this project would help in further improvement of certain aspects like stretch ability, more comfort of fabric, shape retention etc.

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1. INTRODUCTION

1.1. OBJECTIVES:

- To compare the effect of heat setting and compacting of single jersey cotton/lycra fabric and rib fabric.
- This project aims to find out the influence of time and temperature during heat setting and compacting on the elastic properties of the fabric.
- To analyze the result and recommend the optimum conditions for production.
- This helps in predicting the information on garments to develop new products.

1.2. SCOPE OF THE PROJECT:

- Optimizing the process parameters involved in the production of the cotton/lycra fabric in order to attain the required stretch properties for sportswear
  - Shape Retention (rapid elastic recovery from stretch)
  - Comfort (without perspiration stickiness)

2. LITERATURE SURVEY

2.1 KNITTING:

2.1.1 Weft knits

Manufacturing of knitted fabrics involves intermeshing of yarn loops where one loop is drawn through another loop to form a stitch. Since the last few years knitted fabrics are used in manufacturing of fashion garments and even it has the potential in the formal wear segments also. Accordingly, many developments have taken place in the machinery for processing of knitted fabrics in both tubular process and open width forms. Specification of knitted fabrics, usually include loop density, width of the fabric, weight per square meter and the loop length. Flexibility exists at the various stages of wet processing in terms of process machinery and methods followed by calendaring or compacting which is often, the final operation prior to the packaging step. Variable compactors are used to achieve specific stitch count and wet compacting is also carried out in certain cases.

Weft knitting, as its name implies, is a type of knitting in which yarns run horizontally, from side to side, across the width of the fabric. The fabric is actually formed by manipulating the knitting needles to make loops in horizontal courses built one on top of another. All stitches in a course are made by one yarn. Weft knits are made either as flat or open width (like woven fabrics) on so called flat knitting machines, or as tubular fabrics (like a seamless stocking) on circular knitting machines.

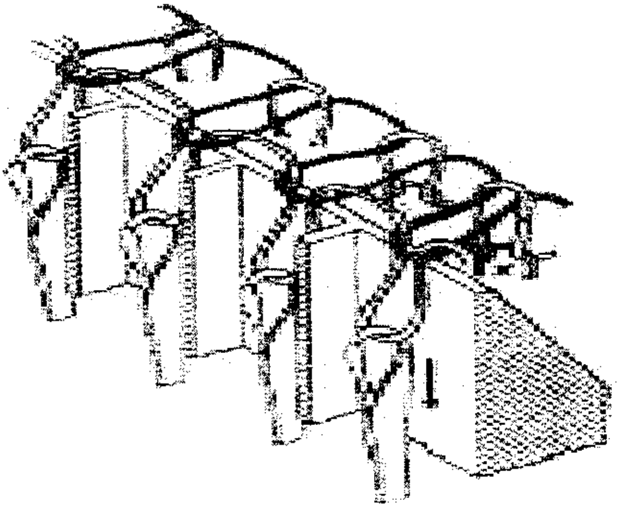


Fig 1 Weft knit formation

2.1.2. Single jersey machines

The knitting machines that produce single jersey fabrics have one set of needles in one needle bed. All needles in one needle bed can pull loops in one direction only, as a consequence single jersey materials are unbalanced and have a tendency to curl at the edges, although this can be corrected during fabric finishing.

2.1.3. Quality of knitted fabrics

Wet processing of knitted fabrics, often, causes distortions in the fabrics like creases and wrinkles. In knitted fabrics, all types of shrinkage takes place when the moisture content is below 50%. The loop length is the only main factor influencing the dimensional properties of the knitted fabrics. Loop length and fibre diameter significantly affects the spirality in the fabric. Increase in loop length and fibre diameter increases the angle of spirality, which is commonly observed in the knitted fabrics. Yarns of different counts knitted to the same loop length display different physical properties such as drape, openness, permeability, handle, etc. Recently, factors influencing the quality of knitted fabrics have been reviewed individual. Compaction is carried out as a measure of increasing the dimensional stability and much attention have been given in the assessment of shrinkage and progressive shrinkage properties. Now, there is a well established theory exists regarding the relationship between these two parameters. Positive feeders are often employed to ensure much closer tolerances between feeders in respect of course length. The weight (gsm) of the fabrics is determined by two factors that interact in the knitted fabrics, i.e., the loop size and the yarn size. The cover factor, i.e., fractional area or space occupied by the knitted loop is given by the ratio of area covered by yarn in one loop and area of one loop. This is also represented by T 1/2/L, where L is loop length, T, the direct count of the yarn. The term 1/L × N 1/2 or T 1/2/L is\known as tightness factor where N is the indirect count.

2.1.4 FORMS OF SPANDEX YARNS

Spandex fibres are made into several forms of yarn depending upon the functions to be served. The factors that determine the selection of the form of yarn include the desired amount of elasticity, power, hand, fabric sheerness, styling, the yarn's resemblance to the other fibres in the fabric in which it will be used and fabric end use.

- **Bare Yarns**

The extruded, fused multifilaments and the monofilament spandex may be used without being covered. These barn yarns are utilized where lighter, sheerer; more supple and more elastic fabrics are desired. Bare spandex yarns are more economical due to the elimination of the covering operation and the greater fabric yield that result from cutting smaller garments with a higher stretch level.

Bare yarns are incorporated into raschel power-net, tricot, and circular-knit fabrics for foundation garments and swimwear. They may also be used in support hosiery and sock tops.

- **Covered Yarns**

This method is based upon the principle originally used to cover rubber yarn. The bare spandex yarn is stretched either fully or to a percentage of full extension to meet specific stretch objectives and wrapped with filament, textured, or spun yarn. The spandex may be either *single-covered* by being wrapped with one yarn or *double-covered* by being wrapped with one cover yarn in the S direction and another in the Z direction for full balance. When relaxed after wrapping, the amount of stretch capability in the covered yarn will be primarily controlled by the extent to which the spandex had been initially stretched. Covered spandex yarns have the appearance and hand of the yarn used for covering. Covered yarns are used for raschel power-net and circular-knit fabrics, as well as other fabrics that require stretch and goods holding power, such as for foundation garments, swimwear and support hose.

- **Core-Spun Yarns**

The core-spun technique is somewhat similar to that for producing covered spandex yarn. By application of a conventional cotton or wool spinning system, a roving of covering fibre (or a blend of fibres) is twisted to form a sheath of staple fibre around the spandex core that is held under tension and subsequently relaxed. The hand and textured of the yarn is determined by the covering staple and the elasticity is limited by to which the twisted sheath may be extended. The spandex core of such yarns may be as little as 5 to 15 percent of the total fibre content, but it will provide more stretch and holding power than thermoplastic stretch yarns of similar diameter. Core-spun yarns are generally used in heavier fabrics and where the hand, texture, aesthetics, or other properties of the cover staple are particularly desired. These include a wide variety of woven as well as knitted fabrics, including dresses, blouses, slacks, suits, sportswear, coats and uniforms.

- **Intimate Blend Spun Yarns**

Much interest has been expressed regarding yarns spun of spandex fibres blended with inelastic fibres. Its superior stretch characteristic has resulted in experimentation of blends of spandex staple with other fibre staple. These include blends of 4 to 30 percent spandex that is spun with other fibres into staple yarns to provide sufficient elasticity and holding power for woven and knitted fabrics.

2.2. HEAT SETTING

Heat-setting is a thermo chemical process of fundamental importance that relates not only to the production and processing of fibres and yarns but also to the subsequent processing of fabrics and their ultimate applications. The industrial importance of heat setting was first acknowledged when texturised yarn was first produced. Today, technologically, heat setting is a technique that is widely used to impart structural changes in fibre assemblies to suit particular end uses but, scientifically it is a very complex phenomenon that links fibre morphology with many inter relationships between the material and process variables.

Heat-setting is used for many purposes and in many forms in fibres and textiles. Perhaps the most fundamental aspect of heat-setting (drying of textiles or removal of creases from fabrics, for example) was learnt from nature a long time ago. However, with the introduction of new polymeric fibres with their controlled macromolecular responses in rheological processing, advanced high speed technology (high speed fibre spinning), and novel methods of heating including the microwave and laser, have together created endless variables within the framework of understanding this subject.

2.2.1. Physics of Heat Setting

According to Hearle, setting is a change in structure leading to a new minimum energy position. He has stated that there may be many minima of energy, and setting can be achieved by shifting the peak to a less favourable energy minimum or vice versa. A material first shifts to a less favourable energy minimum (indicating temporary set) and then to a more favourable energy minimum (indicating permanent set). The change in energy, hot or cold, is the result of the tighter association of bonds between the molecules in a crystal compared with those in a liquid.

This indicates different phases of material in different energy states. Moreover, the polymer molecules at high temperature acquire sufficient energy to flip over the energy barrier to give rise to a new degree of freedom in the system.

However, when the material is deformed, stresses are relieved on heating because of the structural rearrangements (it can be a major or minor structural change depending upon the setting temperature). On cooling, it reaches a new level of energy minimum by releasing the heat energy.

At high temperatures, more free volume also represents a higher energy state of the material. Therefore, on cooling, the material jumps to a lower energy state with a consequent loss of free volume.

2.2.2. Heat setting and Structural parameters

The parameters which have strong influences on micro structure and which can also influence heat-setting efficiency are:

- Intermolecular forces
- Chain stiffness
- Cross-linking
- Crystallinity with crystal size and perfection
- Chemical sites (for example, H-bonding and benzene-ring associations)

➢ Intermolecular Forces

The strength of intermolecular forces which affect the heat of fusion can be directly related to the melting point of a polymer. Tippets have shown that the heat of fusion increases directly with the increase in the hydrogen bonds, which is due to the increase in amide concentration. In addition, strong intermolecular bonding also influences the closeness of the molecular packing. Cannon made the comment that intermolecular forces help in the packing of molecules and may sterically affect their configuration. They are also partly responsible for the ease and extent of crystallisation.

➢ Chain Stiffness

How the chain stiffness influences the physical or thermal responses of a material can be well understood if the effect of the rigid aromatic ring in the polyester or the flexible polyethylene chain in a polyamide is taken into account. Chain stiffness is an important parameter in determining the melting point as well as the modulus of the material. Thus a fibre, when going through a transition, shows a dramatic change in stiffness.

➢ Cross Links

In a polymeric system, the length of a long-chain molecule passing through the different amorphous and crystalline fractions is ultimately limited in length by the cross-links needed to tie the separate chains together. If the material has no cross-links, chain molecules can freely pass over one another as the temperature increases. Highly cross-linked materials are rigid enough to impose high resistance on chain flow. However, temperature and time effects can give more chances to the chains to allow them to slide away from one another. This suggests the time-temperature equivalence of heat-setting in polyester and nylon as reports by Buckley and Salem and Hearle respectively. According to them, the process of setting exhibits time-temperature equivalence. This is associated with either short-time, high-temperature or long-time, low-temperature relaxation mechanisms.

➢ Crystallinity

Crystallinity and its attendant cross-linking by chains running through crystallites are important in characterising fibre properties. Again the degree of crystallinity as a structural parameter suggests the expected mechanical behaviour of the fibre but does not clearly indicate the gross crystalline state (i.e. crystal perfection, size and alignment) of the material. It is essentially dependent on the conditions of crystallisation. One of the main ideas of heat-setting is partial or premature melting of crystals (depending on crystal size and perfection), where the internal stresses relax and the material recrystallises in a new stable form. Hence, not only does crystallinity influence setting by recrystallisation, but crystal size and perfection are also contributory factors.

Chemical cross-links are also important in terms of the setting mechanism of fibres. Cross-links, which are initially present, break on heating and re-form at the same or at other places on cooling.

➢ **Chemical sites**

In nylons, at over 100°C, hydrogen bonds will be subject to rupture by thermal vibration and the amorphous material would be in a liquid-like state of dynamic equilibrium. Polyester at around 160°C could be in a similar situation subject to the same reservations as before with regard to the influence of the benzene rings.

2.2.3. MECHANISMS OF HEAT- SETTING

The net effect of the heat-setting operation is to create a memory in the fibre for the deformed state. There are many mechanisms by which polymeric fibres can be set in a different form of energy minima without the need for crystal melting.

The following mechanisms could be suggested as a possible explanation for heat-setting:

- Glass transition
- Melting and recrystllisation
- Multiple melting

- Chain scission and interchange reaction
- Chain disentanglement
- Plastic crystals
- Crystal defect mobility
- Micro-deformation and kink bands

2.2.4. MULTIPLE SEQUENCES OF HEAT-SETTING

The responses in sequences of multiple setting treatments are of great importance but have not been studied to any great extent in scientific experiments. There is a need for more careful scientific approach in experimental work on heat-setting to understand the actual mechanisms involved in multiple heat-setting.

In general, industrially, heat-setting is an important subject although poorly understood. It is neither a well-defined fibre property nor an effect, but, more appropriately, concerns the wider subject of process-structure property relations of fibres rather than an isolated topic of fibre processing.

Perhaps it would not be ambiguous to comment that the efficiency of heat-setting depends on two important points:

a) Sufficient freedom of molecular motion
b) Ample opportunity for crystal melting with re-crystallisation

However, in a broader sense, the heat setting mechanism is highly complex and may not be amenable to the adequate explanation.

2.2.5 HEATSET THERMOPLASTIC YARNS

A thermoplastic yarn is one that can be put into any shape or position desired and, after being subjected to a predetermined level of heat for a specific period of time, will retain that shape despite washing, dry cleaning, stretching, or compressing. This heat-setting technique is employed in many ways, and depending on the method of manufacture and the fibres used, the properties of the yarn will also vary.

Thermoplastic stretch yarns have many advantages over untreated filament yarns. They have a soft touch and a dull appearance like that of wool rather than the sometimes undesirable sheen of some filament yarns. The resultant textural appearance of stretch yarns provides opportunity for desirable novelty effects. Fabrics or garments made of these yarns have a higher degree of absorbency and adsorbency than ordinary filament yarns, since yarns provide loops and kinks to hold the moisture. This results in providing better perspiration conductivity and consequently increases comfort to the wearer. The pockets of air caused by the coils in the yarns also act as an insulative barrier, making the garment warmer.

Garments made of such stretch yarns wash easily and dry clean readily. They are as strong and durable as garments made of yarns of similar fibres that have not been processed into stretch yarns. In fact, the stretch characteristic is more likely to result in less strain on the yarns, fabrics, and seams of garments during the ordinary stress of putting on, wearing, and taking off. The stretch ability also provides greater comfort, shape retention, and wrinkle resistance and allows the garment to conform to the figure and to fit better.

There are four general types of headset thermoplastic yarns: coil, curl, crimp and wavy. All are treated to provide a spring like or accordion like characteristic to the yarn. The methods of accomplishing this vary,

Thereby giving different shapes to the yarns but producing somewhat similar effects.

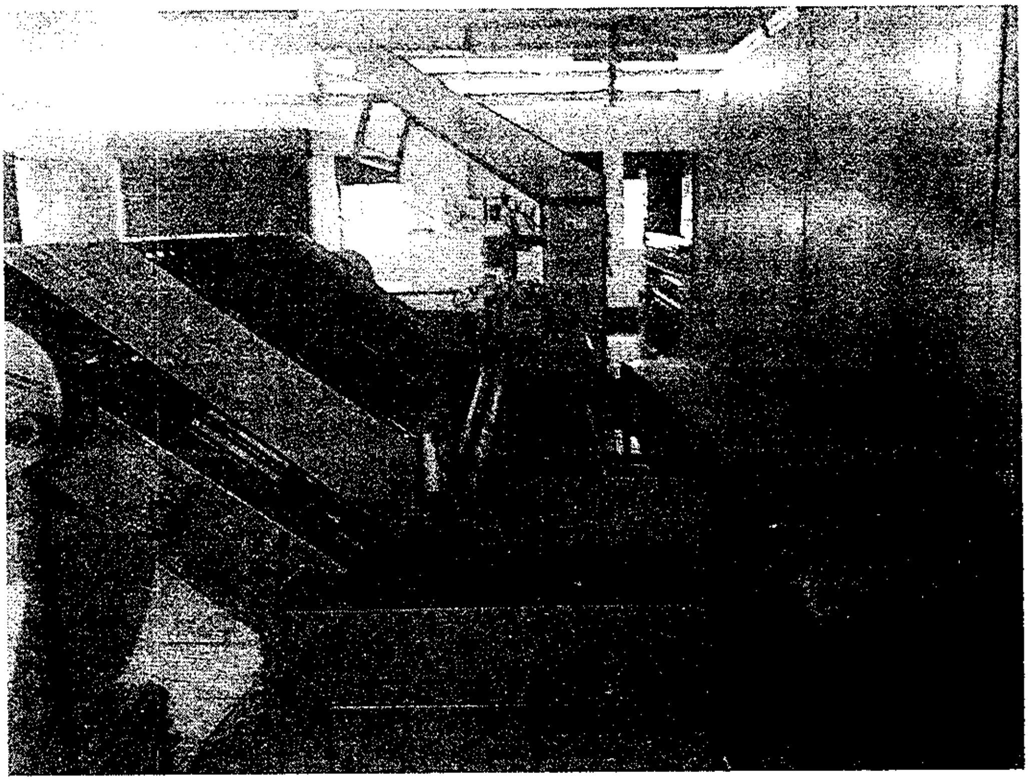


FIG. 2. Heat setting machine

FIG.3 Heat Setting Machine.

2.3. DYEING

The type of the dye used is the reactive dye. Reactive dyes with good solubility, low to moderate substantively and controllable reactivity.

Advantages:

- Excellent fastness to light.
- Excellent fastness to wash
- Have brilliant shades

Dyeing Process

Wetting oil
⇩
Peroxide (2 hrs)
⇩
Peroxide nutrition (1 hr)
⇩
Dye bath (4 hrs)
⇩
Salt, soda, steam (65° C)
⇩
Soaping, soda, acetic, acetic nutrition (1 hr)
⇩
Finishing

2.4. COMPACTING:

Knitted fabrics are dyed in the laboratory winch machine with commercial grade vinyl sulphone reactive dye. Fabrics were dried and compacting was carried out in the commercial Tube Tex machine at 95°C in dry state.

2.4.1. Influence of Compacting on Knitted Fabrics

Knitted fabrics manufactured through intermeshing of loop structures often becomes difficult to process due to the extensible nature associated with the structures. Besides, wet processing of the fabrics, often, increases stresses in the fabrics thereby reducing the dimensional stability. At the end of process sequence compacting process is employed in the knits processing to increase its dimensional stability. An attempt has been made to analyze the various structures of knits and the effect of compacting on selected properties on those structures.

Bursting Strength

The bursting strength test was carried out according to the available literature10 using hydraulic diaphragm bursting tester for which the test method has been withdrawn from ASTM test methods since 1996. The hydraulic tester employs glycerine as liquid medium and screw driven piston for increasing the pressure. Five tests were carried out for each specimen and the average had been taken for analysis purpose.

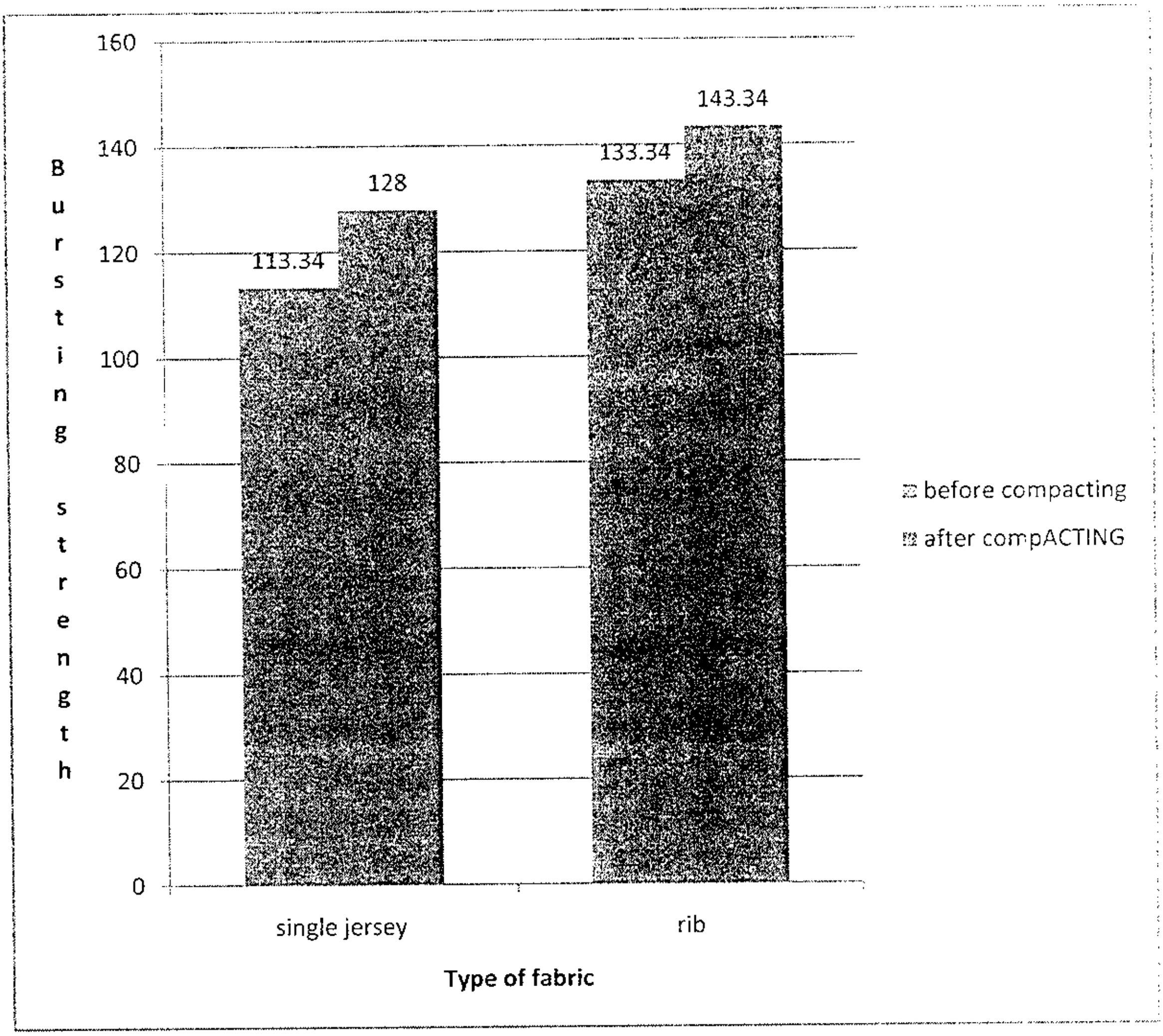


Fig 4 Bursting strength

Abrasion Resistance

Abrasion resistance of the samples were measured using Martindale Abrasion Tester using ASTM test method D 4966–98 (2004) with standard abrading surface. The mass loss values of the samples were determined as the difference between the masses before and after the testing and the loss is expressed as a percentage of the original fabric mass. Average of four tests was taken in every sample for reporting and discussion.

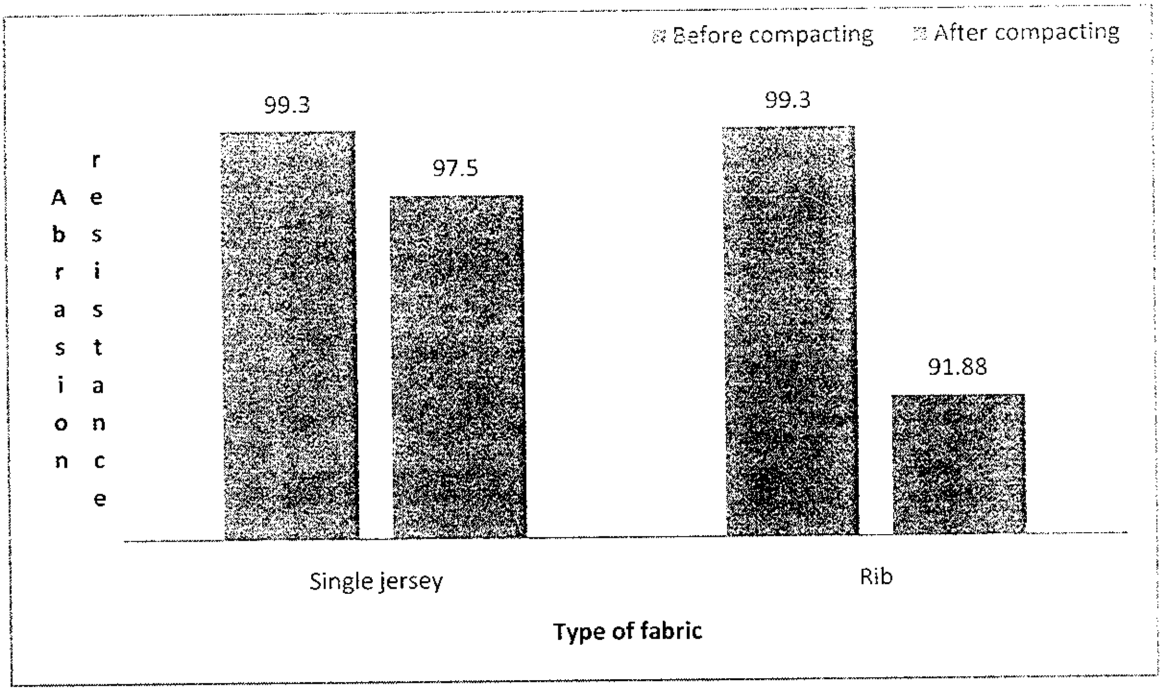


Fig 5 Abrasion resistance

2.4.2. Compacting and Dimensional Stability

Courses per cm in a knitted structure are mainly decided by the number of feeders used in a knitting machine and the length of the yarn required for loop formation depends upon the dimensions of the loop and the other set of yarns involved in the loop meshing. The length of loop in the grey fabrics also decides the changes in the dimensional aspects of the knitted fabric during compaction. The change in courses per cm after compacting appears to be a function of the number of courses present in the original structure of the fabric. Higher increase in the courses per cm was observed in the rib, followed by single jersey and interlock. During the compaction process, the increase in courses per unit length results in decrease in the Wales per unit length, resulting in a relatively dimensionally stable

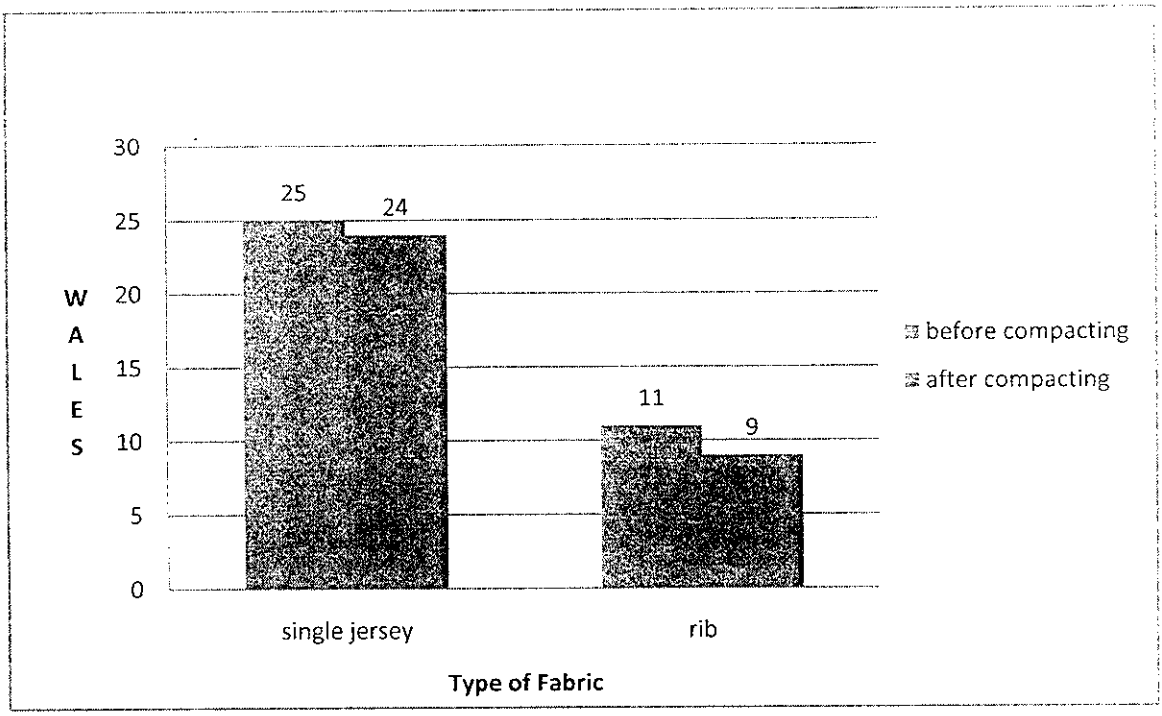


Fig 6 Effect of compacting on Wales/cm

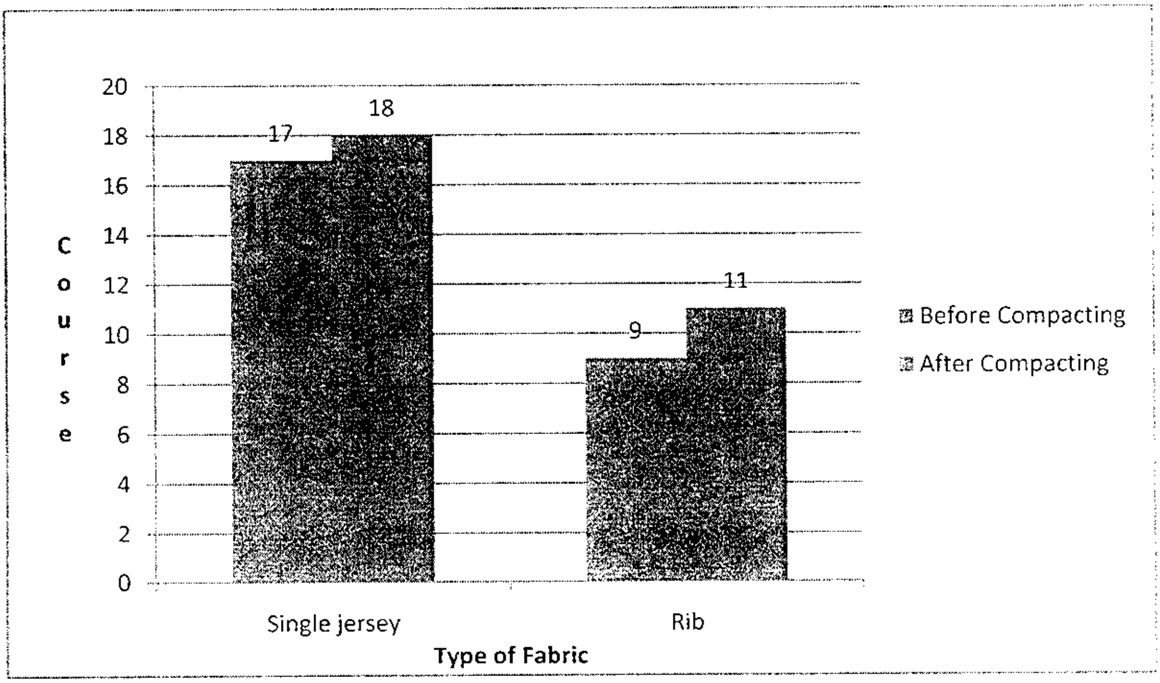


Fig 7 Effect of compacting on courses/cm

Figure 7 Effect of compacting on Wales/cm structure. In all the cases, corresponding to increase in the courses per cm a similar trend was also observed in the Wales per cm after compacting. In case of rib fabric, decrease in the Wales per cm was observed higher in which the increase in course per cm was higher among all the specimens (Figure 2). The change in the courses per cm and Wales per cm during the compacting appears to be the function of these parameters before compacting process. A strong positive correlation was obtained between these values before and after compaction process, with the correlation coefficient of 0.999 in the both cases, i.e., courses per cm, Wales per cm before and after compacting process. Both these parameters appear to influence themselves mutually during the compacting process.

Though the compacting process results increase in courses per unit length, the weight of the fabric per unit length (GSM), after compacting, is supposed to be same due to decrease in the Wales per unit length, for a given linear density of the yarn. However, this appears to be far from the practical results due to different results obtained in the course and Wales directions. In case of rib structure, increase in the weight after compacting process remains lower compared to the other two structures, perhaps, due to higher decrease in the Wales direction compared to the course direction. Though rib structure registered higher increase in courses per cm after compacting, the reduction Wales per cm after compacting was also very much higher (17.9%) compared to interlock (4.8%) and single jersey (4.7%). The increase in fabric weight was found to be around 1.53%, 1.1% and 0.8% for single jersey, interlock and rib, respectively.

Bursting strength of the knitted fabrics mainly depends on the ability of the fabrics to withstand the multidirectional stresses exerted on the fabrics by the movement of the liquid and the diaphragm associated in the testing process. In fact, bursting strength is the only one parameter used with the knitted fabrics, while the effect of loading a knitted strip specimen has been useful in the case of local tendering, beg, with discharge printing. The structure of the knitted fabrics is, definitely, weak prior to the compaction due to the uncontrolled stress concentration in the fabric, on account of inter– looping disposition of the yarns and difference in the yarn configurations in both the directions. However, in compaction the difference in the stress levels are minimized by compressive shrinkage which necessarily strengthen the knitted structure and the load withstanding capacity. In case of interlock and rib structures, bursting strength was increased after compaction, to a relatively lower level while in single jersey higher increase in the bursting strength was observed. Effects of compaction on bursting strength of different type of fabrics is shown in Figure 3.Abrasion resistance of the fabrics arises mainly from the ability of fabrics to overcome pressure exerted by different type of abrading surfaces. During abrasion process, the fibres and yarns are displaced from their position that leads to weakening of the structure and ultimate failure. When the specimen surface is highly flexible, the distortion of structure is very much less compared to a rigid structure. Hence, failure in the rigid structure becomes easier within the shorter duration of the abrasion than the flexible structures.

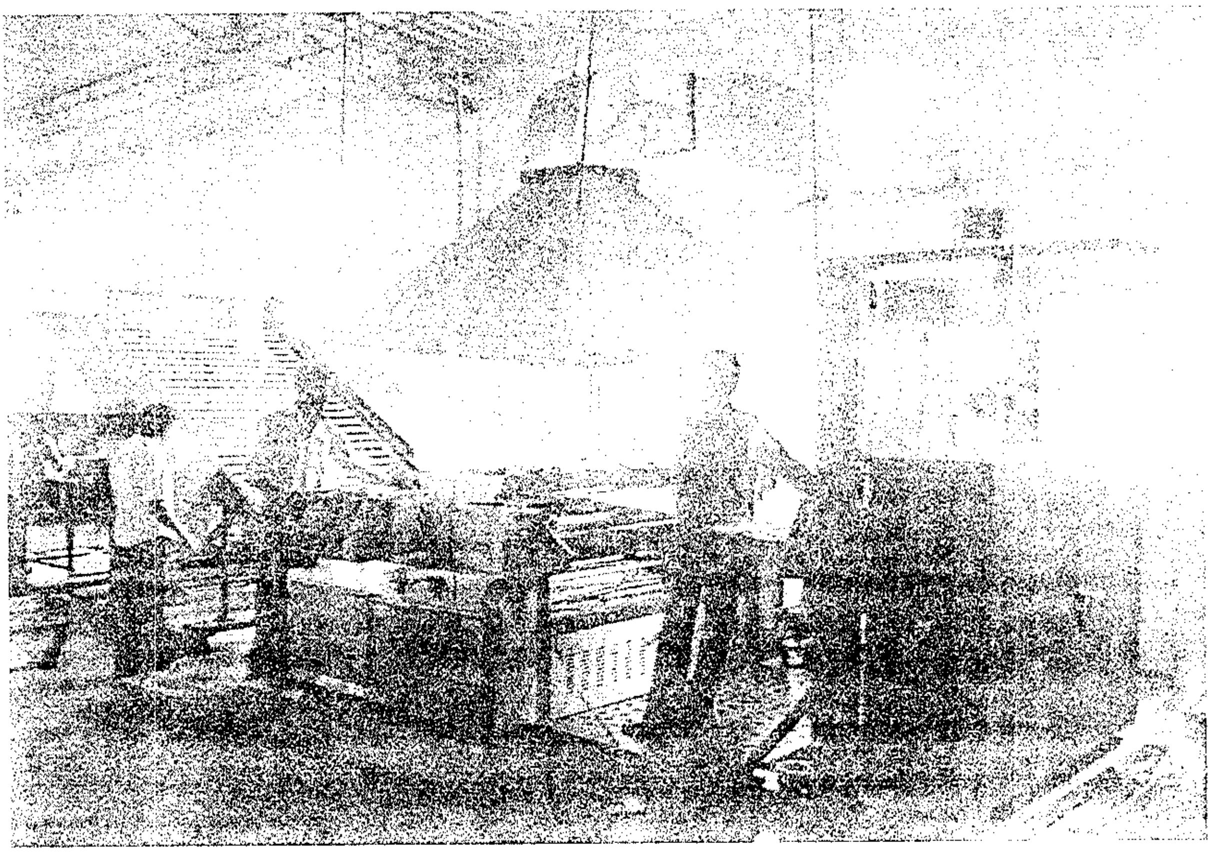


Fig 8 Compacting machine

Decrease in the abrasion resistance was observed to a higher degree in the rib structure than the other two structures mainly due to the lack of flexibility in the rib structure (Figure 4) in which higher decrease in Wales per cm and increase in courses per cm were also observed after compaction. Tightness factor of a knitted fabric is the function of the loop length for a constant yarn count. Since the loop length is altered in the compacting process, the tightness factor is also expected to vary during the process. However, the decrease in the loop length is expected to result in increase in the tightness factor, which was evident in all the cases. Due to higher decrease in the loop length during compaction, the increase in the tightness factor was found to be on higher side in the cases of interlock and rib structures. In the dyed fabrics the difference in the colour value mainly arises due to the lightness / darkness, brightness and dullness through fabric decreases and when the weight per unit area of the dyed fabric increases after dyeing, the quantum of the dye molecules available also increases which in turn would cause difference in the colour values in these fabrics. All these factors result in the change in the colour value as measured through, dE, spectrophotometrically.

Due to higher increase in the GSM of the fabric, single jersey fabric shows higher dE value compared to other two fabrics with dE values of 1.46, 1.30 and 1.21, respectively for single jersey, rib and interlock samples. Effect of Loop Length on Knitted Fabrics Among various analysed knitted fabrics, the loop length appears to be the important factor among all the structural parameters involved in the fabric construction. Correlation coefficient was calculated between the loop length, other structural parameters and physical properties of the fabrics. A good correlation was obtained between the loops length of the fabrics, before and after compacting process, expressed by the coefficient value of 0.998. The increase in the GSM of the knitted fabrics during compacting process, well correlates with the loop of the fabric before and after compacting process with a correlation coefficient value of 0.938, 0.932, respectively. The percentage change in the loop length affects the tightness factor of the fabrics; this in turn influences the colour value of the dyed fabrics. A good correlation was obtained between the percentages change in the loop length during the compacting process and the colour difference value obtained from dE with the coefficient value of 0.914.

Higher the loop length in the knitted fabric, the better would be the flexibility of the threads in the fabrics and their relative movements within the fabrics, which subsequently could lead to higher abrasion resistance of the fabrics. A higher positive correlation was obtained between the loop length and the abrasion resistance of the fabric before and after compacting process with the coefficients values of 0.908 and 0.856, respectively. Influence of Compacting on Physical Properties to assess the influence of the compacting process over the loop length, bursting strength and the abrasion resistance of the fabrics, student's t–test was carried out using mean values of these properties before and after the process. In case of loop length, a significant difference was observed only in the single jersey structure (calculated value t of 2.94 against the table value of 2.306) while no such significant differences were observed in the case of rib and interlock structures (calculated t value of 1.47 and 1.05, respectively). This result reveals that the compaction process produces more shrinkage in open structures than close knitted structures. However bursting strength of single jersey and rib structures show a significant increase at 95% confidence level (calculated the values of 4.92, 4.24, respectively against the table value of 2.77) whereas no significant difference exists in the interlock and rib structure even though an increase was observed in either case.

As far as abrasion resistance is concerned, at 95% confidence limit, significant difference exists in all the cases due to less flexibility in the compacted knit structures. A clear reduction in the abrasion strength was very much evident in the values obtained, also.

Above study conducted on various knitted structures like single jersey, rib and interlock, shows the influential role of compacting process on these knitted structures. Compacting process invariably changes the construction of the knitted fabrics by altering the courses and Wales in unit area of the fabric. With the compressive shrinkage employed in the process, the increase in course direction was observed with a reduction in the Wales direction. And the compacting operation carried out in the knitted fabrics, appears to affect the properties like abrasion resistance, bursting strength significantly. Due to less flexibility and lower relative movements of the thread in the fabric structure, the abrasion resistance values decrease with increase in the bursting strength. Among various parameters involved in the knitted fabric structure, the loop length of the fabric appears to be the most important parameter that decides above discussed physical properties.

Very good correlations were obtained between loop lengths of the fabrics with GSM, colour value after compaction and the abrasion resistance of the compacted fabrics.

3. Materials and Methods

3.1 Materials:

Cotton yarn: 40^s count

Lycra: 20 denier

Single jersey fabric samples were produced using 96% cotton 40s Ne and 4% Lycra of 20 Denier as shown in the Table 1. These structures and dimensions are popularly used in the manufacture of T– shirts and vests.

Details	Single Jersey	Rib fabric
Machine	PMW	Lakshmi
Diameter($\times 10^{-2}$m)	61.0	25
Weight, kg/m^2	0.150	0.140

Table 1 Raw material specification

3.2 Specification of Fabric Produced:

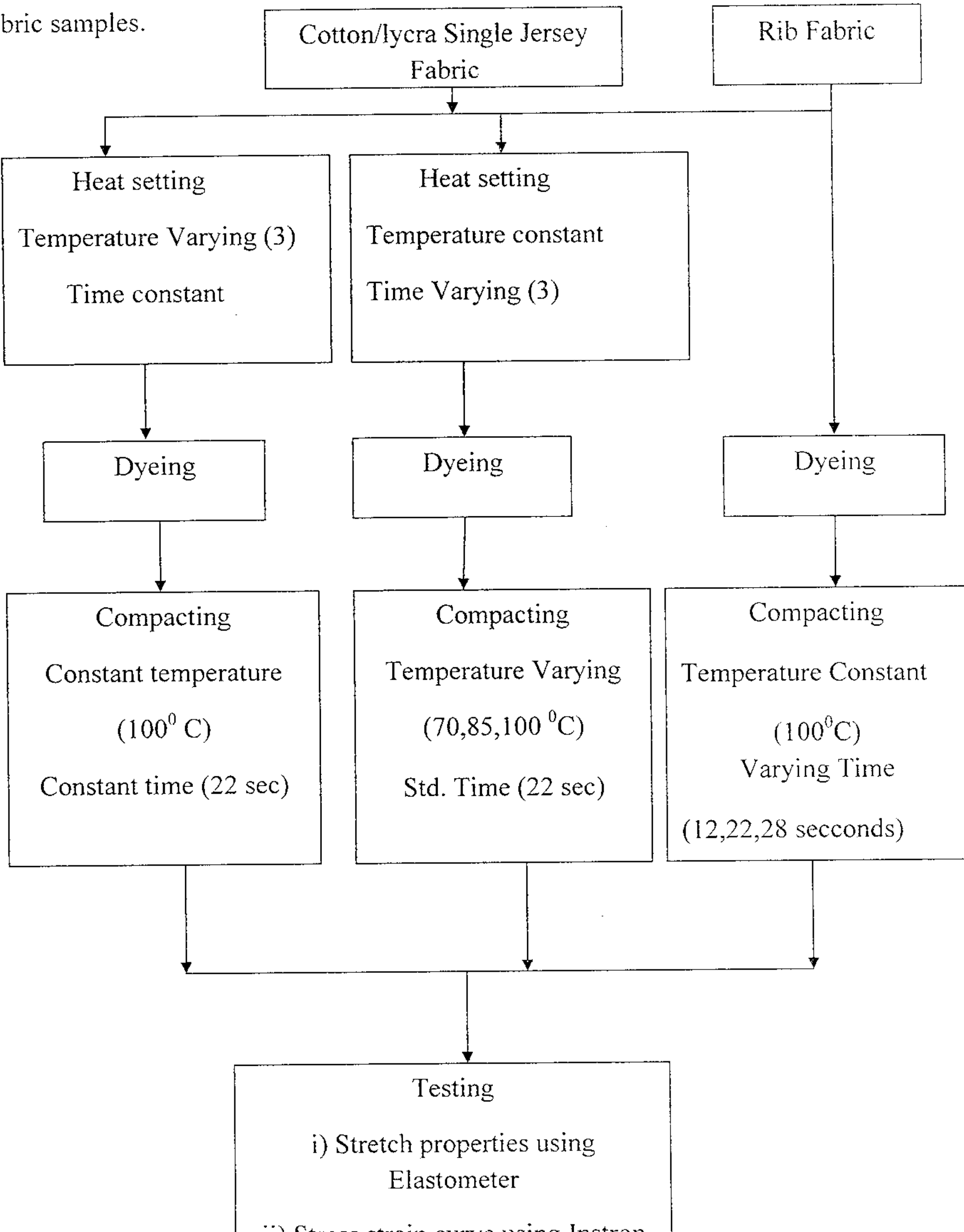
The rib fabric and single jersey cotton/lycra were produced using the following specifications.

Properties	RIB FABRIC	SINGLE JERSEY FABRIC
Count	40s	40s
Lycra %	NIL	4%
Course\inch	30	30
Wales\inch	60	25
Loop length	27mm	19mm

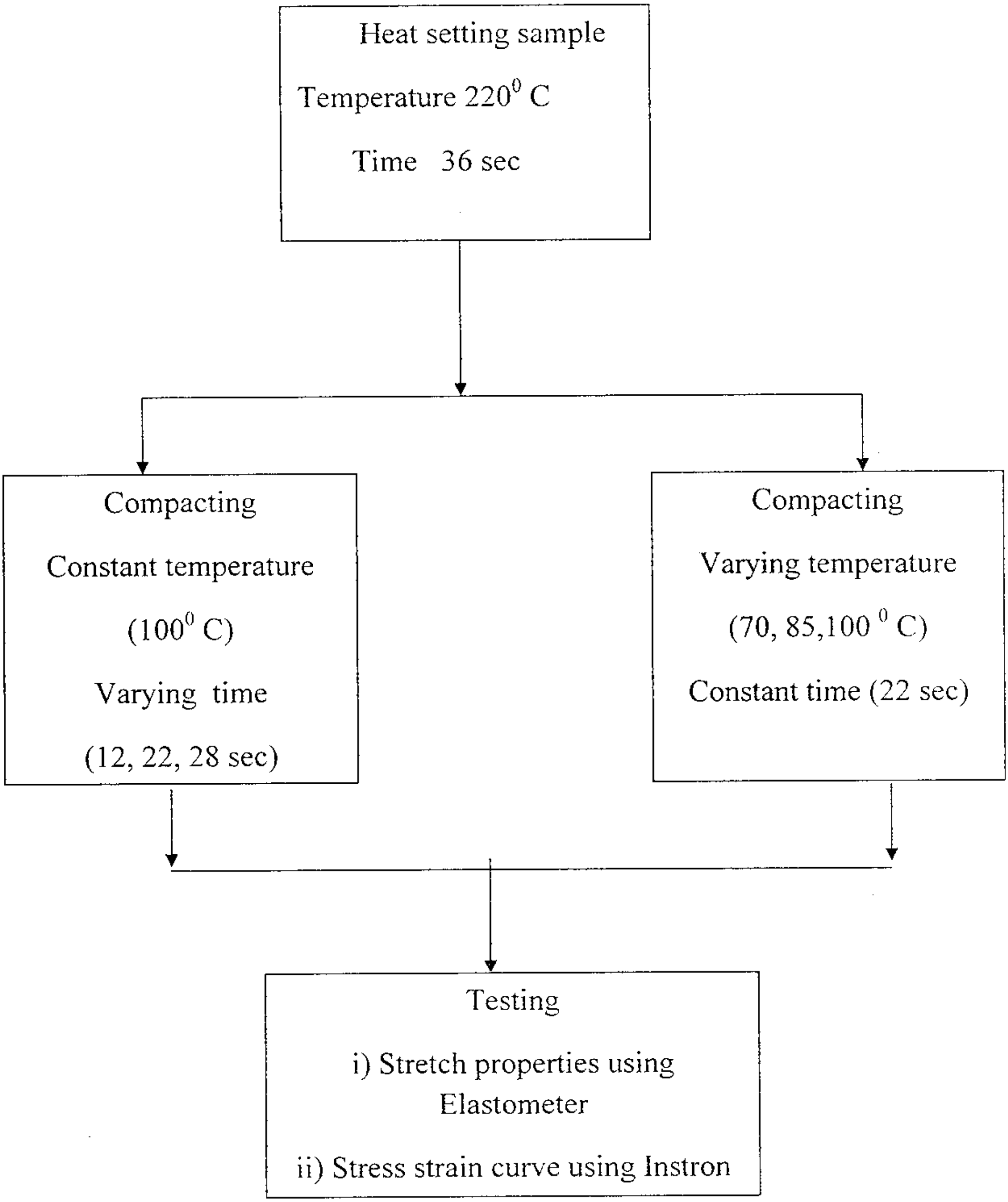
Table 2 Specification of Fabric Produced

3.3 Experimental Plan:

The following methodology is used to produce the single jersey fabric samples.



For different compacting temperature and different time.



3.4 Specification In Heat Setting:

In heat setting we produce six samples by changing the temperature and the time. The three different temperatures and time are used. The samples with the temperature and time are shown below

Table 3 Sample with same temperature different heat setting time

Sample no	Temperature ^0C	Time seconds
1	220	33
2	220	36
3	220	42

Table 4 Sample with different temperature and same time

Sample no	Temperature ^0C	Time seconds
4	200	36
5	210	36
6	220	36

3.5.7 Specification in Compacting:

In compacting we were selecting 12 different samples from the heat setted fabric. The samples are given below

Group	Heat setting Specification	Compacting temperature	Compacting Time
1	220^{0} C,33 sec	100^{0} C	22 sec
	220^{0} C,36 sec	100^{0} C	22 sec
	220^{0} C,42 sec	100^{0} C	22 sec
2	200^{0} C,36 sec	100^{0} C	22 sec
	210^{0} C,36 sec	100^{0} C	22 sec
	220^{0} C,36 sec	100^{0} C	22 sec
3	220^{0} C,36 sec	70^{0} C	22 sec
	220^{0} C,36 sec	85^{0} C	22 sec
	220^{0} C,36 sec	100^{0} C	22 sec
4	220^{0} C,36 sec	100^{0} C	12 sec
	220^{0} C,36 sec	100^{0} C	22 sec
	220^{0} C,36 sec	100^{0} C	28 sec

Table 5 **Specification in Compacting**

4. Results and Discussions:

The above samples have taken for the following tests

- Stretch properties using elastometer for 5 pound load
- Fabric Growth 5 minutes relaxation
- Stress strain curves using Instron

The results of the tests are given below.

4.1. GSM of heat setting of single jersey fabric

Table 6 Result for maximum stretch of single jersey fabric.

Sample No	Before/ GSM	After/ GSM	Width Before inches	Width After inches
1	225	158	27	32
2	225	145	27	32
3	225	149	27	32
5	225	139	27	31
6	225	142	27	31
7	225	165	27	30.5

Table 7 Stretch Properties of Single Jersey Fabric

Sample	GSM	Fabric Stretch(WT 5pounds apply)		Fabric Growth(5 min relax)	
		Length	Width	Length	Width
1.1	217	70.40%	76.00%	4.00%	6.40%
1.2	214	64.00%	76.80%	4.00%	5.60%
1.3	172	56.00%	70.40%	3.20%	4.80%
2.1	269	69.60%	72.80%	4.00%	5.60%
2.2	218	68.00%	74.40%	4.00%	5.60%
3.1	189	62.40%	72.00%	2.40%	6.40%
3.2	175	58.40%	64.80%	2.40%	3.20%
4.1	184	58.40%	75.20%	2.40%	6.40%
4.3	179	56.00%	77.60%	8.20%	5.60%

Table 8 Stretch Properties of Rib Fabric

Shade	GSM	Direction	Fabric Stretch(WT 5pounds apply)	Fabric Growth(5 min relax)
1.WHITE	180	Length	38.80%	8.20%
		Width	47.60%	6.40%

4.2. Stress strain curves

Single jersey fabric in coarse wise

Fig 11 **Sample 1.1**

Heat setting-220^0 C, 33 sec Compacting-100^0 C, 22 sec

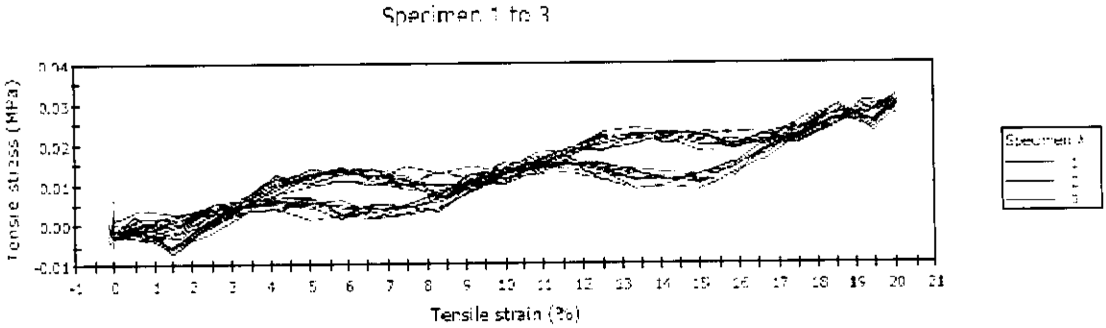


Fig 12 **Sample 1.2**

Heat setting-220^0 C, 36 sec Compacting-100^0 C, 22 sec

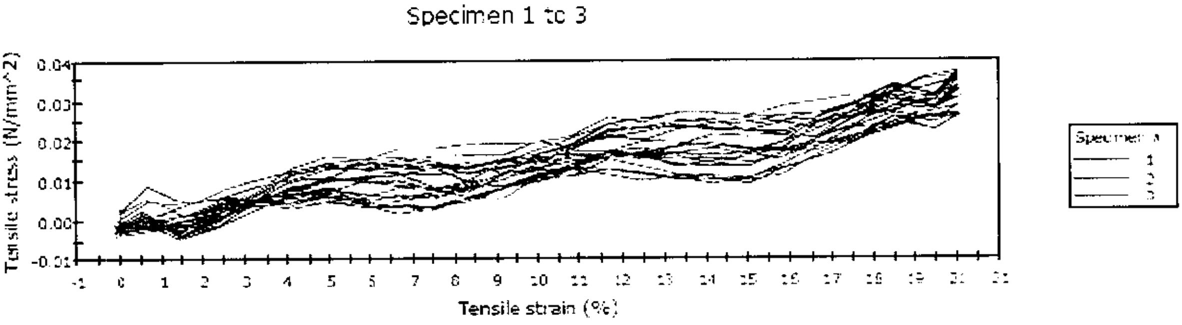

Specimen 1 to 3

Fig 13 **Sample 1.3**

Heat setting-220^0 C, 42 sec Compacting-100^0 C, 22 sec

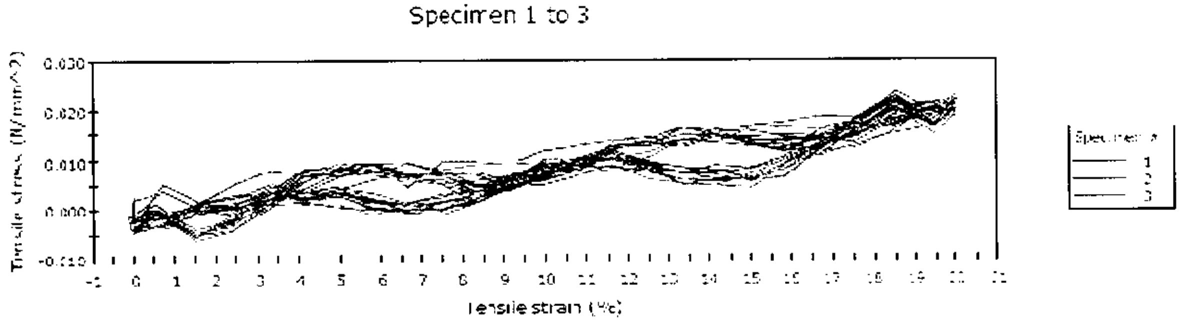

Specimen 1 to 3

Fig 14 Sample **2.1**

Heat setting-200^0 C,36 sec Compacting-100^0 C, 22 sec

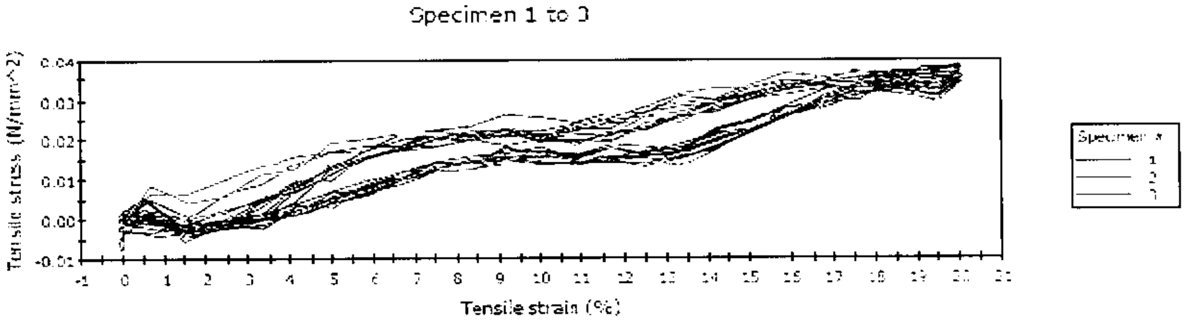

Specimen 1 to 3

Fig 15 Sample **2.2**

Heat setting-210^0 C,36 sec Compacting-100^0 C, 22 sec

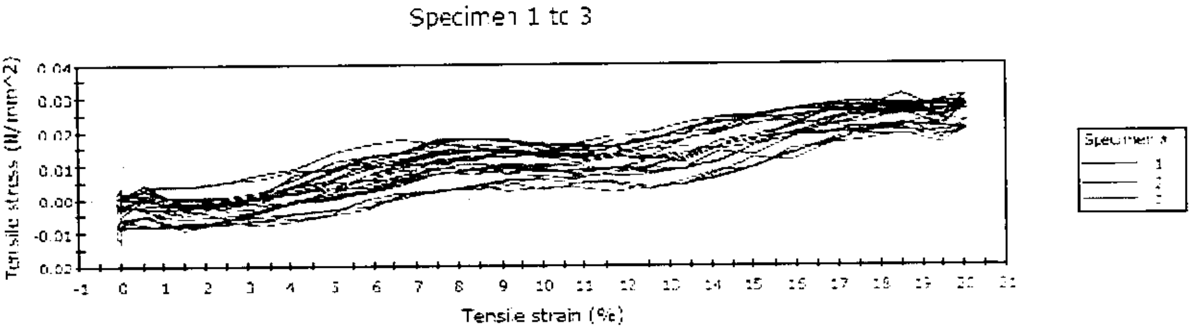


Fig 16 Sample **3.1**

Heat setting-220^0 C,36 sec Compacting-70^0 C, 22 sec

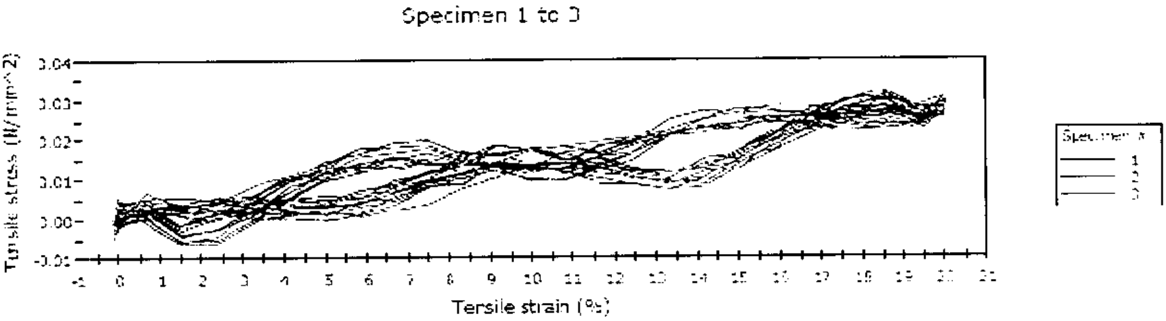


Fig 17 **Sample 3.2**

Heat setting-220^0 C, 36 sec Compacting-85^0 C, 22 sec

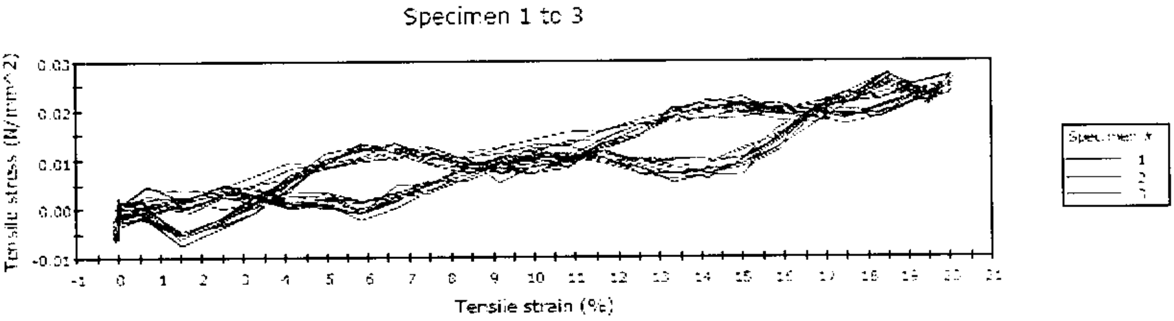


Fig 18 Sample **4.1**

Heat setting-220^0 C, 36 sec Compacting-100^0 C, 12 sec

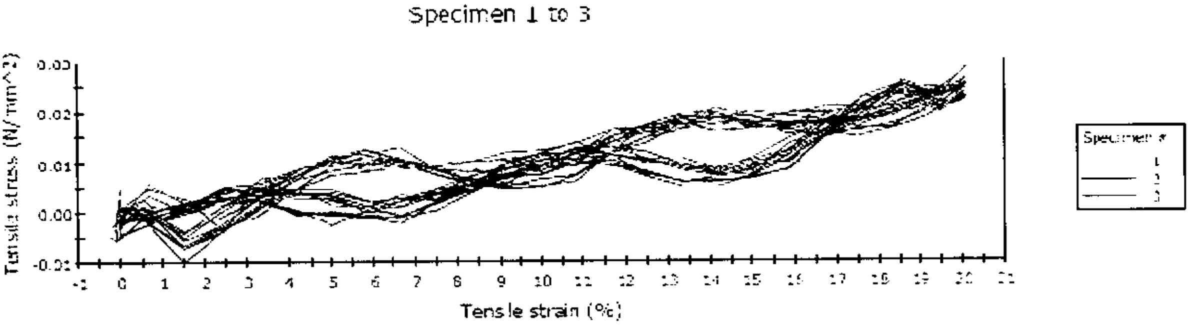
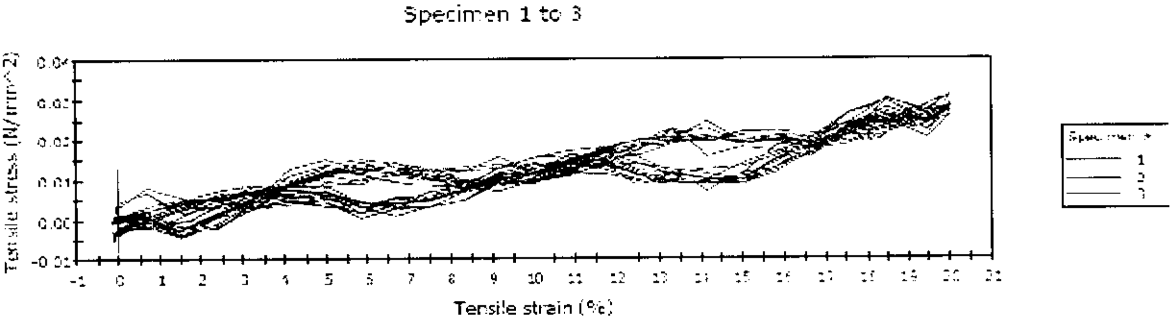


Fig 19 Sample **4.2**

Heat setting-220^0 C,36 sec Compacting-100^0 C, 28 sec



Single jersey fabric in Wales wise

Fig 20 **Sample 1.1**

Heat setting-220^0 C,33 sec Compacting-100^0 C, 22 sec

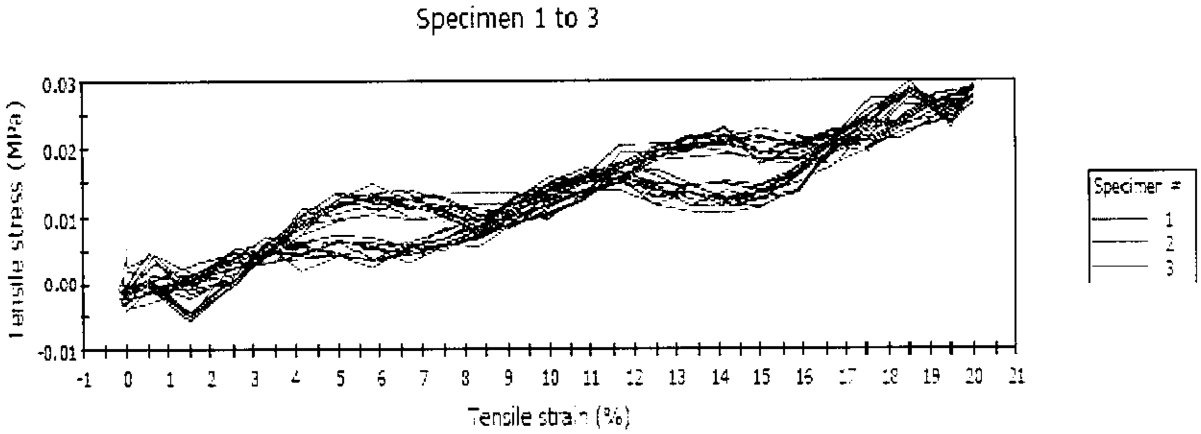


Fig 21 Sample **1.2**

Heat setting-220^0 C,36 sec Compacting-100^0 C, 22 sec

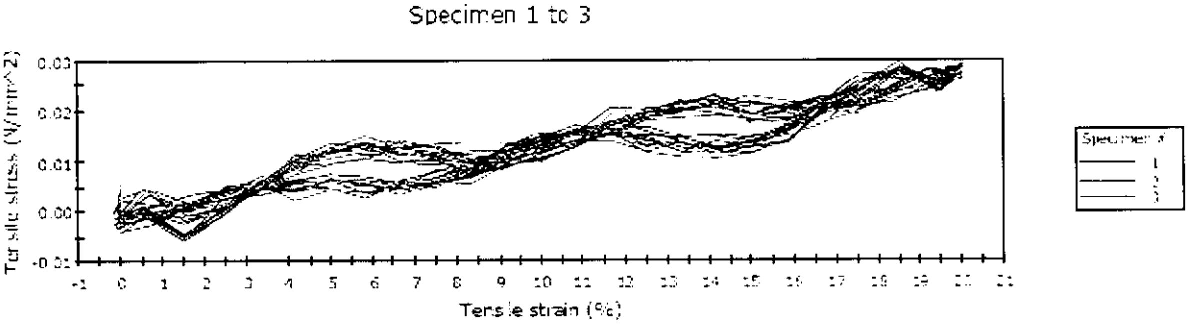


Fig 22 **Sample 1.3**

Heat setting-220^0 C, 42 sec Compacting-100^0 C, 22 sec

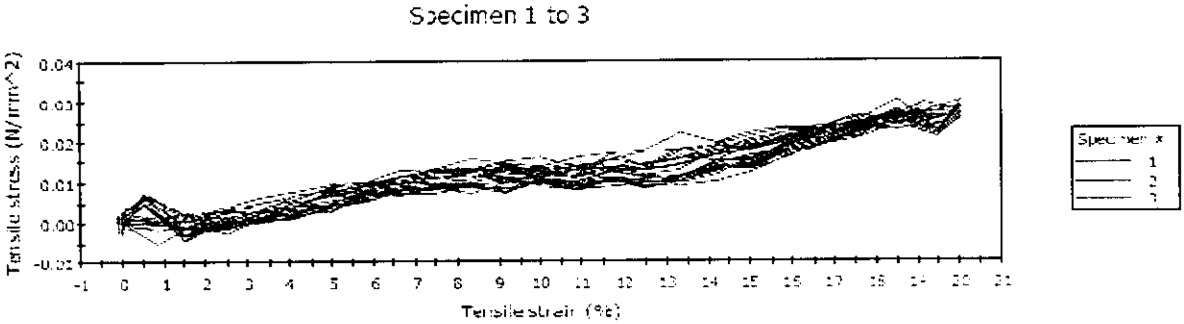


Fig 23 Sample **2.1**

Heat setting-200^0 C,36 sec Compacting-100^0 C, 22 sec

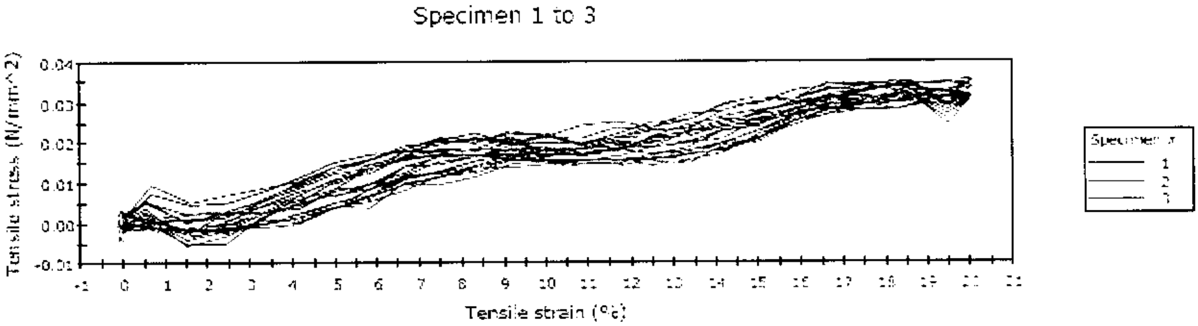


Fig 24 **Sample 2.2**

Heat setting-210^0 C, 36 sec Compacting-100^0 C, 22 sec

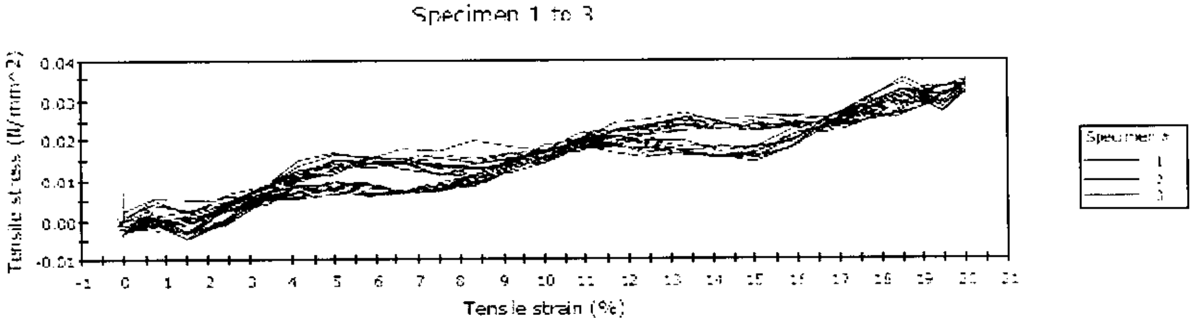


Fig 25 Sample **3.1**

Heat setting-220^0 C, 36 sec Compacting-70^0 C, 22 sec

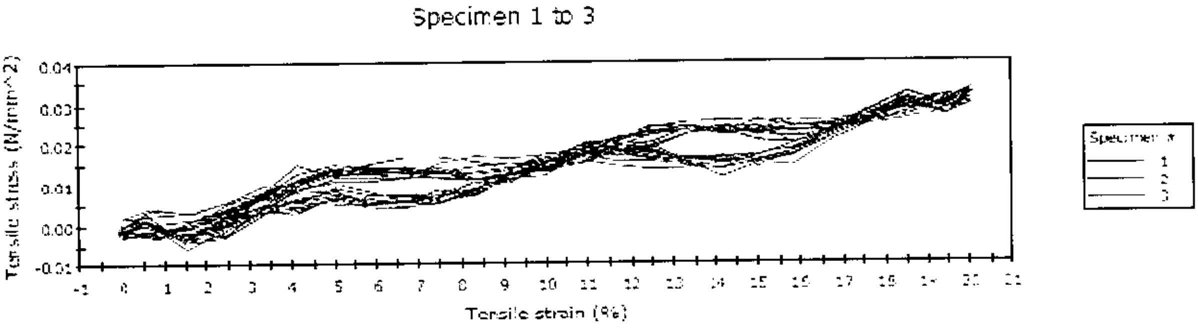


Fig 26 **Sample 3.2**

Heat setting-220^0 C, 36 sec Compacting-85^0 C, 22 sec

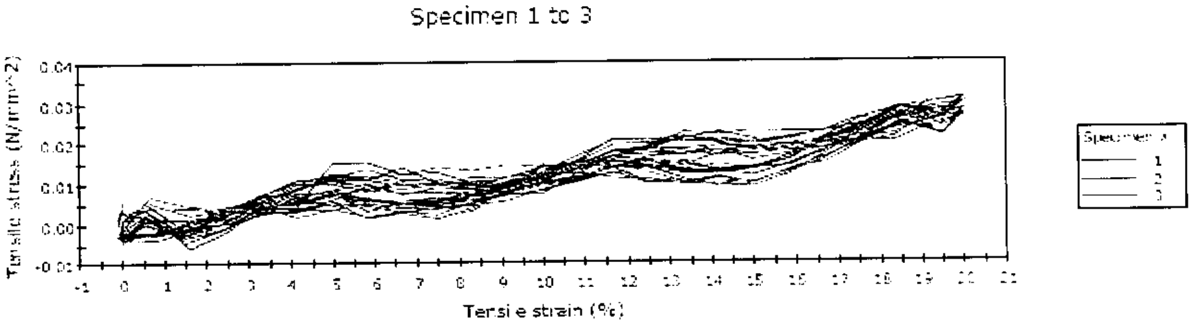


Fig 27 Sample **4.1**

Heat setting-220^{0} C, 36 sec Compacting-100^{0} C, 12 sec

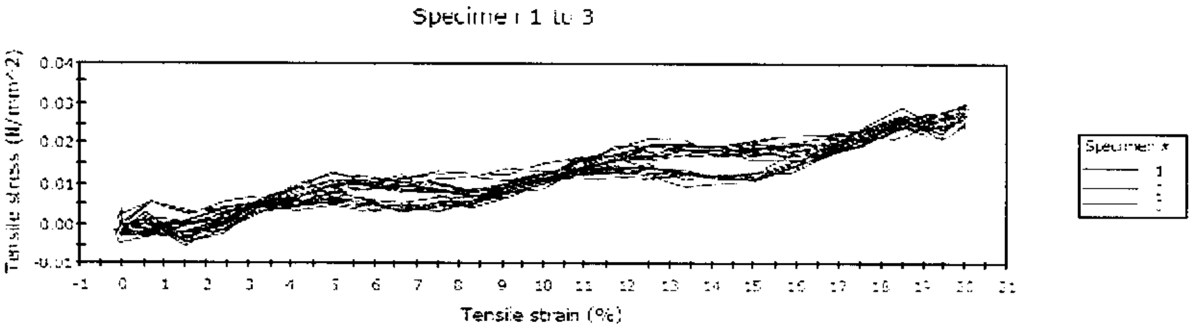
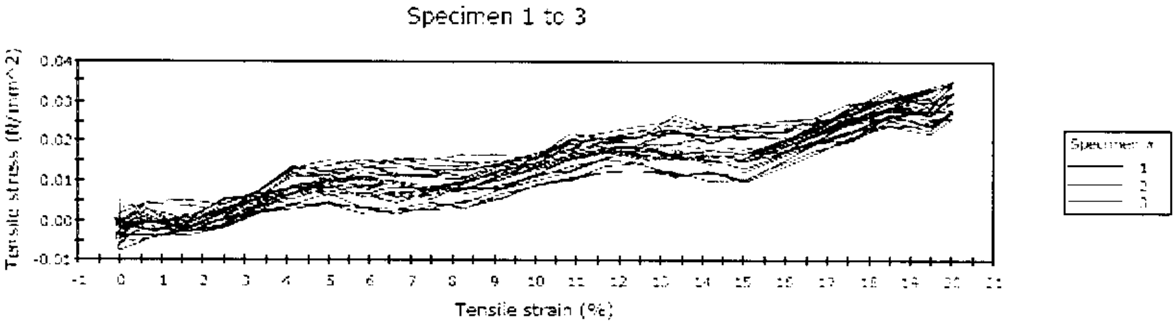

Specimen 1 to 3

Fig 28 Sample **4.3**

Heat setting-220^{0} C, 36 sec Compacting-100^{0} C, 28 sec


Specimen 1 to 3

Rib fabric in coarse wise

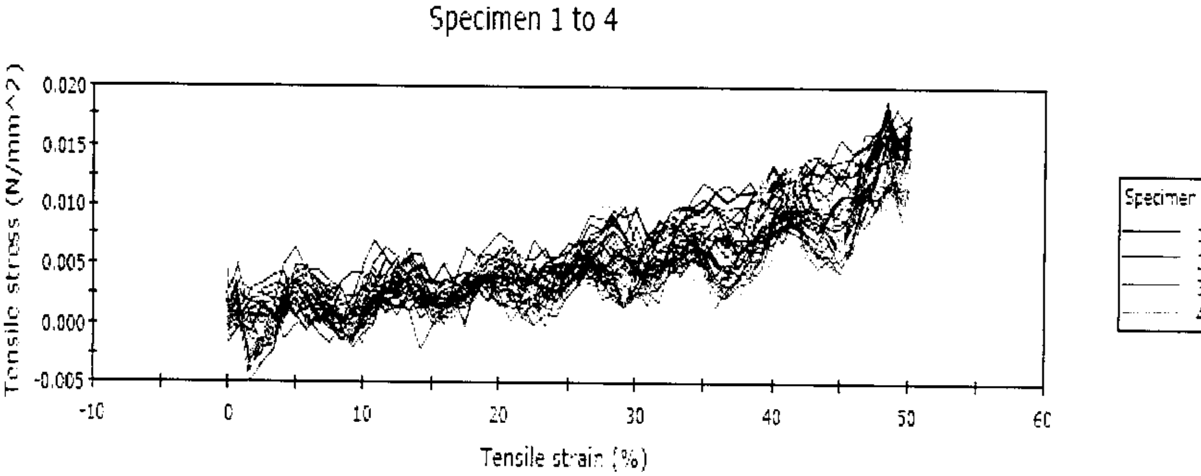


Fig 29 Rib – Coarse wise

Rib fabric in Wales wise

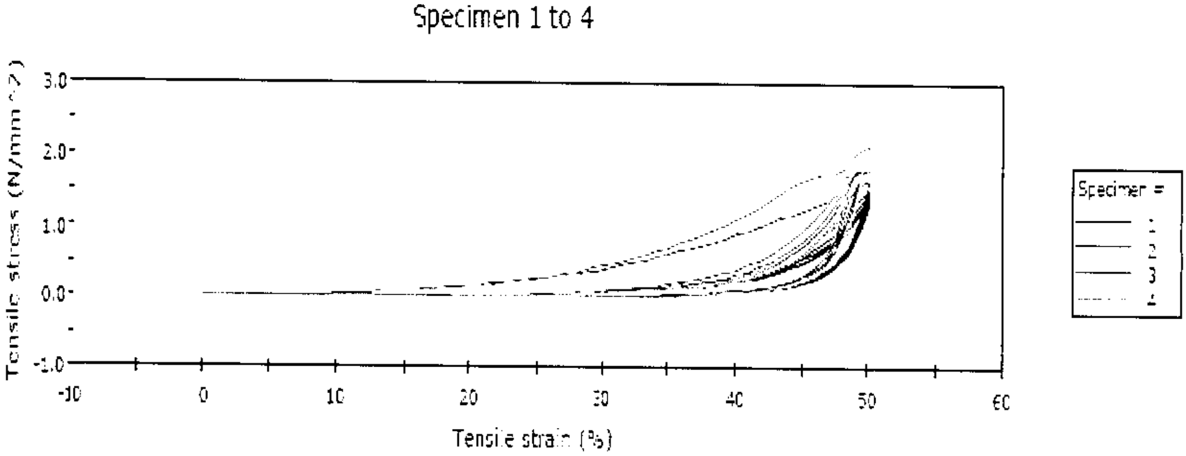


Fig 30 Rib – Wales wise

4.3. Comparison of Rib and Single Jersey Fabric

.Table 9 Comparison of Rib and Single Jersey Fabric

PROPERTIES		**RIB FABRIC %**	**SINGLE JERSEY FABRIC %**
Stretch %	**Length wise**	**38.80%**	**88.74%**
	Width wise	**47.60%**	**73.33%**
Fabric Growth %	**Length wise**	**8.20%**	**3.84%**
	Width wise	**6.40%**	**5.51%**

From the table it's clear that cotton/lycra single jersey fabric shows more stretch with less fabric growth than rib fabric in both length wise and width wise direction.

5. CONCLUSION:

From the above results taken it's clear that, the following conclusions are drawn

- % Stretch of the cotton/lycra single jersey fabric for 5 pounds load is double than the rib fabric for the same load in both length and width wise direction.
- Fabric Growth of the cotton/lycra single jersey fabric is less than that of the rib fabric.

Hence the use of the cotton/lycra single jersey fabric can be a good alternate to the rib fabric.

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7. APPENDIX

TESTING:

INSTRON TESTER

Technical description of the Equipment

Instron Universal testing machine Model 8516 can perform tensile, compression and bending test either in static or dynamic condition. It consists of three main components, which are Load Frame; Servo Hydraulic Control Systems and Hydraulic Power Pack.

a) Load Frame

The load frame consists of two columns with fixed table at the bottom and adjustable crosshead table at the top. There are two grips available in the frame; lower and upper grip which hold the specimens to be tested. The lower grip is located at lower table and is mounted to the actuator and the upper grip is mounted to the load cell on the upper crosshead of the system.

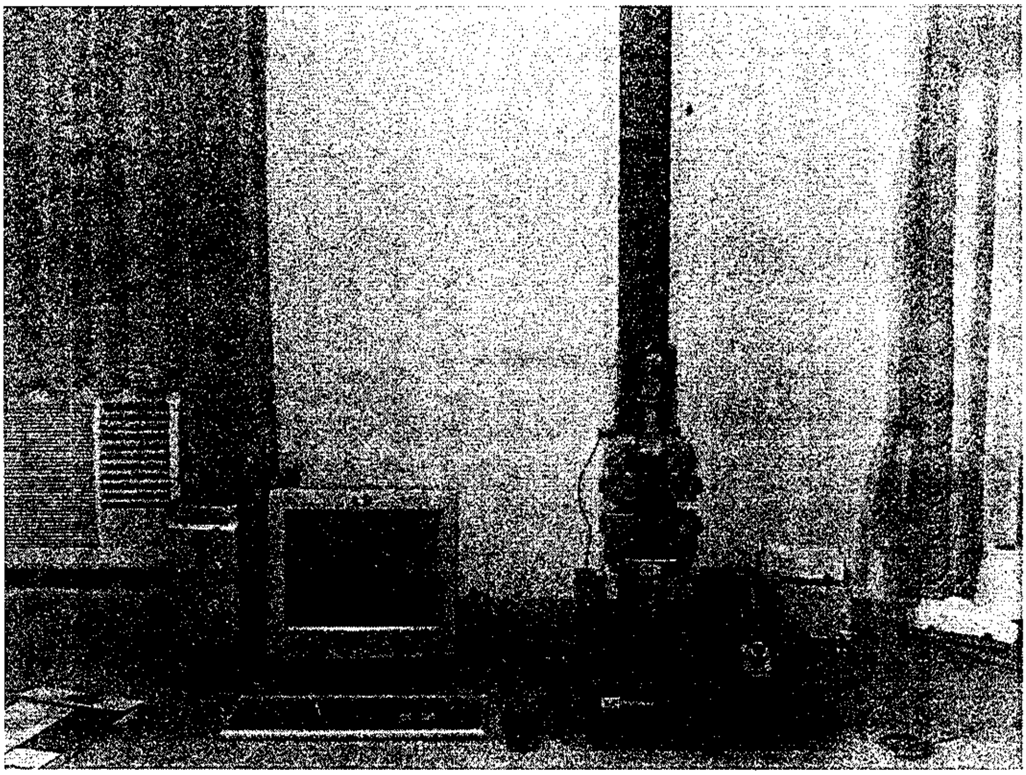

Fig. 9 Instron tester

Normally, the upper grip will be fixed, but its vertical position can be adjusted to accommodate specimens of different size. The adjustment of the crosshead is done using built in hydraulic lifts and is secured by hydraulic clamp. The powerful hydraulic actuator will be used to drive the lower grips. Once the specimen has been clamped to the grips, the vertical movement of the lower grips generates the desired loading on the specimen to perform the test. It general specifications are:

- Load cell capacity: ± 100 KN (dynamic) and ± 120 KN (static)
- Actuator capacity: ± 100 KN (dynamic) with ± 75 mm strokes
- Servo valve capacity: 40 liters per minutes
- Max pressure: 21Mpa
- Specimen thickness: 0 to 7.8 mm (flat) 59

b) Servo Hydraulic Control System

The Servo Hydraulic Control System enables the test parameters to be set up and to be run easily. It is a dual user interface system, which provides immediate access to the 8500 facilities of this machine. Dual interfaces are methods available in the system for user to give command to the machine

For testing process. Here, choices are given to the users either to perform the test through the control panel or through the computer software. Both interfaces have similar functions such as calibration, standard of testing, type of materials and type of test result. Although both interfaces have similar functions, computer software has more advantages than control panel. Using computer software any data or result for

c) Hydraulic Power Pack

The main function of this system is to supply hydraulic fluid at high temperature to the load frame. It can provide high pressure of 207 bars for the purpose of dynamic testing. The oil delivery rate for this 3420 model is 12.5 litre/min. in order to run the system; the initial start button has to be pressed first and followed by the second button. These two buttons are located on the load frame. The second button with indication II is to provide stable flow of oil to the load frame during the testing.

This equipment is equipped with several protection devices to maintain it function. These protection devices are for oil level control, oil pressure control, oil temperature control and oil filter control. Other basic specifications are:

- Internal gear pump with fixed displacement for low noise level, low flows pulsation and reliable performance
- Oil tank with capacity of 100 liters, mounted with sight glass for visual oil indication

- 3 phase ventilated electric motor fitted with non-linear thermistors for motor protection
- 3.5 bar high-pressure filter with bypass system and 3 micron filtration.
- Double pass cooling water system with thermostatically controlled valve to control oil temperature and cooling water flow rate.

Common Specifications

1. Power Requirements:

- Available with 115/230 V, 1 Ph, 60 Hz, 25/12.5A or
- 110/220 V, 1 Ph, 50 Hz, 25/12.5A or
- 100/200 V, 1 Ph, 50/60 Hz, 25/12.5A

2. Operating Temperature:

- +10° C to +38° C (+50° F to 100° F)