A Comparative Study of Handwoven Drapery Material with Khadi

BY

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Introduction

INTRODUCTION

Home furnishings are important for success and happiness of the entire family. A personalized home encourages individual and family interest that stimulate personal growth. A comfortable home makes for more agreeable living and better family relations. A beautiful home is a social force for great value in providing pleasant surroundings for good human relations. Beautiful home surroundings constitute the most important factor in the development of visual good taste, through daily contact with beauty and lasting appreciation if it evolves. Home furnishings have much to do with making a house a home, say Justin and Osborn (1953).

Furnishing is always an exciting adventure whether it means buying everything new or refurnishing the home with a new piece, says Beryl (1958). Draperies, curtains, Rugs and other furnishings make a room attractive and expensive of ones own individuality, points out Pollard Hallen and Frances (1964).

Draperies and curtains are decorative fabrics that hung at the sides of the windows or doors for artistic effects. The term drapery is generally used to indicate window hangings of materials that are not transparent. They soften the lines of doors and windows

Review of Literature

II REVIEW OF LITERATURE

The literature pertaining to the study is reviewed under the following headings:

A. Importance of furnishing materials
B. Furnishing materials on Khadi and Handloom
C. Drapery materials
D. Design and its types
E. Loom and its types
F. Jacquard loom
G. Development of Jacquard designs
H. Weaving of Jacquard designs
I. Studies conducted

A. Importance of furnishing materials

Pizzerto (1979) states that textiles are among the magical products of today. Their versatility in an everchanging world is truly remarkable. Apparel and home furnishings are probably the best known of all end uses. The three objectives in planning and furnishing a home are beauty, expressiveness and functionalism, says Rutt (1963). Damott, Norris and Nicholas (1972) say that furnishing a home means more than deciding what colour carpeting, what style furniture, and what drapery fabrics to choose. Furnishing a home includes selection of furniture, floor coverings, window treatments, and lighting.

Morton (1953) expresses that fabrics for furnishings can be considered as the clothes of a room. Fabrics can accentuate the personality of a room in the same way that clothes can accentuate the personality of a girl or woman.

Alexander (1977) points out that fabrics for home furnishings should have the properties such as durability, ease of cleaning, colour stability, soil and rot resistance, non flammability, dimensional stability and resistance to damage by sunlight. Morton (1953) states that the fabrics should be selected for their practical qualities like strength, weight and durability. Rathbone and Tarplay (1959) express that the pattern (Jacquard) weave is frequently used for drapery fabrics as it gives an interesting design either in one colour or in contrasting colours.

According to Kirby (1957), woven fabrics are part of our every day life, being used for dress, furnishing and other household purposes. According to Encyclopedia of textiles (1980), a very wide range of fabrics can be made on the Jacquard loom. Hollen and Saddler (1973) point out that Jacquard woven fabric is made from all kinds of fibers and in many different weights for apparel and home furnishings.

B. Furnishing Materials in Khadi and Handloom

Khadi and Village Industries Commission (1983) points out that Khadi activity has an important place in the economic development of the country from the view point of employment generation in rural areas. Textile policy announced by the Government in March (1981) stated that the Government is committed to encourage production of textiles and textile products of the khadi sector considering its large employment potential. It would be the endeavour of the Government to make the product of the sector more competitive and better quality.

A loom is termed "Handloom" when it is actuated by human power, says Banerjee (1970). Batra (1977) states that the handloom industry, spread over most parts of India is today the most important traditional, rural and semiurban industry in the country. The handloom sector produces nearly 25 per cent of the entire cloth output approximately 2,200 million metres per year.

According to Banerjee (1970), Handloom is a simple machine. It can be adjusted to weave from a simple plain place of fabric to a varied complex artistic pattern, but the beauty of its production depends largely upon the handicraft skill of the weaver. Tod (1964) says that Hand weaving is one of the most productive and popular

crafts of modern times. Tovey (1965) views that in some parts of the world handweaving is still a living craft and with comparatively simple tools very fine cloths are produced, cloths which are far superior to any machine woven cloth. Saris, rugs, draperies and curtains are produced by handweaving.

Banerjee (1970) states that the handloom industry engages more than two percent people and is the largest cottage cotton industry in India, using such raw materials as cotton, silk, rayon, staple and other man made fibres, wool jute and coir. Handloom industry manufacture cloths, shawls, rugs, carpets, bags, mats, extraweft figured pieces, fancy and furnishing fabrics, damasks and brocades. The economic advantage of this industry lies in its small scale, low cost of loom, low capital outlay, low supervision and marketing cost, rural location, large employment potential and quality production.

Inspite of increasing administration of power loom industry and large scale production, the qualitative merits of handloom productions are being more and more appreciated in the country and abroad and co-operative scheme backed by financial assistance have been launched to place this industry a gain full footing. The value of its production is also an increasing source of foreign exchange.

C. Drapery materials

Draperies and curtains influence the tone of the room more than any other furnishings, says Rathbone and Tarpley (1959). According to Wingate and Mohler (1984), drapery is a relatively heavy fabric hung on both sides or across a window or other openings. Rathbone and Tarpley (1959) says that the term drapery is generally used to indicate window hangings of materials that are not transparent. Evans and Gowan (1947) states that draperies outline the frame of window, are usually made of heavy non-transparent material. Draperies are used to control light and air to provide privacy or simply to add decoration to the room. Draperies may be made of cotton, linen, rayon, silk, wool, man made fibres or mixtures of these fibres.

D. Design and its types

According to Held (1978), design is defined as the ordered arrangement of parts to make a whole. Review of Textile progress (1960) state that good design certainly has a lasting quality. Wingate and Mohler (1984) say that design is the orderly process of functional and/or aesthetic elements in space that achieves a sense of unity and harmony. Stepat and Devan (1971) opine that design refers to a composition produced by the integration of various elements. Design is a functional factor of every single object in the decorating and furnishing scheme.

The textile design is of two kinds namely (1) Structural (2) Decorative, says Banerji (1953). Structural design relates to the specific manner in which warp and weft threads are interlaced to form a woven design, which constitutes the technique of fabric structure.

Decorative design relates to the scheme of decoration by which a textile fabric is ornamented.

Naturalistic, stylized and geomentric are the three general types of motifs or units of design says Rutt (1961). Banerji (1953) and Basu (1964) state that the structure of constructing it when represented on point paper is known as Textile Design. Textile design develops from the qualities of the fibres, the size and type of yarns and the way they are combined, says Faulkner, Ziegfeld and Gerald (1956). Home furnishing fabrics are made with structural or printed designs, says Wingate (1964).

E. Loom and its Types

Weaving, according to Hoye (1942) is the process most used for the manufacture of textile fabrics. Greenwood (1975) states that each system consists of a maltitude of threads and their pattern of interlacing is referred to as the weave. Tortora (1982) expresses that, weaving of fabrics consists of interlacing of two system of yarn at right angles.

A loom is a device by means of which a woven fabric is produced. Tovey (1965) refers that the loom is a frame used to hold the warp while the weft is inserted as well as the resulting cloth. Banerjee (1970) states that a loom is a weaving machine having atleast five motions namely, shedding, picking, beating up, take-up and let-off used for the intersection of warp and weft to manufacture a fabric. According to Brown (1952), a loom is a device that facilitates the crosswise interlacing of two or more groups of yarns to create a plain or patterned fabric.

Fabrics can be woven from yarns on a simple handloom or on a highly complex totally automated powerloom. Hollen and Saddler (1964) state that, most fabrics are woven on a simple loom. Loom attachments or more complex looms are used for weavers or designs more complicated than those that can be made on a simple loom.

According to Basu (1964), the different types of looms are primitive loom, fly-shuttle loom, Frame fly shuttle loom, semiautomatic loom, Chittaranjan loom, Hattersley loom, Dobby loom and Jacquard loom. Chernysheva(1981) classify all looms into two groups, looms for intermittent fabric formation and looms for continuous fabric formation.

Looms for continuous fabric formation include circular type, which have not achieved wide use. The looms for intermittent fabric formation include shuttle, microshuttle, rapier and jet-type looms.

Shuttle looms are: Power and automatic looms single shuttle and multishuttle looms. Microshuttle loom are subdevided into looms with double-side weft insertion, microshuttle looms pertain to the class of shuttleless looms.

Rapid Rapier looms are available with single rigid rapier, two rigid rapier and two flexible rapiers.

Woolman and Mc Gowan (1946) say that looms vary somewhat according to the materials woven upon them. The term ribbon looms, gingham looms, worsted looms, plush looms, double cloth looms and carpet looms are illustrations of adoptations to needs. According to Tod (1964) and Boven (1978), looms are classified by their construction as table or floor looms, by their technical action as counter balanced or Jack looms. According to ponting (1982) there are many types of loom and many ways of describing them. The basic types are simple frame loom, the vertical loom, the horizontal loom, including plain and semifancy looms which can be either drawloom or jacquard. Besides there is alsa a special type of loom used in various parts of the

world for decorative and figured weaving namely "Drawloom" says Banerjee (1970). Large figured designs which require more than 25 different arrangement of warp yarns to complete one repeat of the design are woven on the jacquard loom, says Hollen and Saddler (1973).

F. Jacquard loom

Fortora (1982) states that in 1805 Joseph Jacquard a Frenchman perfected the principle of the mechanical drawloom. Linton (1963) states that Jacquard is an intricate method of weaving invented by Joseph Marie Jacquard of Lyons, France at the beginning of the nineteenth century. According to Encyclopedia of textiles (1980), Jacquard head motion is a master piece of perfection in the textile world and could reproduce practically anything into fabric.

According to Tortora (1982), Jacquard pattern when carefully analyzed may be seen to contain combinations of plain, twill and satin weaves even in some crosswise yarn. Many decorative fabrics are made by Jacquard technique. The best known Jacquard patterns are Brocade, Brocatelle and Damask. Hollen and Saddler (1973) state that Jacquard pattern is a complicated structure consisting of two or more sets of warp and two or more sets of filling interlaced so that the face warp is never woven into the back and the filling does not show on the face. Damott, Norris and Nicholas (1972), state that Jacquard weave is a typical

sectioned type of figure weaving construction. The design is created by combining different weaves - perhaps plain or twill for the background.

G. Development of Jacquard designs

Wingate (1964) expresses that the design for the cloth is worked out in point paper pattern first. Instead of harnesses a series of oblonged punched card controls the raising of warps. As many cards are made as there are picks in the design. The cards are laced together in proper order and are rotated over an ablong cylinder on the upper part of the loom.

According to Grosicki (1975), in the detailed form of designing, point paper design may be constructed from a woven sample of which the design is required to be reproduced. In either case the process generally involves an enlargement of the design, the degree of increase in size varying in the same pitch of design paper, according to the fineness in set of the cloth.

It is necessary to either select a jacquard which will give the width of repeat of the design, or to construct the design upon a number of ends that is suitable for a given jacquard. The formula,

$$\frac{\text{hooks in jacquard} \times \text{sett of warp in reed}}{\text{Sett of harness}}$$

gives the number of ends upon which the design should be made in order that the warp will be perfectly straight between the harness and reed.

The number of ends and picks for one repeat of the design have been decided upon, the design paper work may be divided into the following process.

1. An enlarged outline of the figure is drawn in pencil or chalk on squared paper.
2. The figure is painted in with colour which is strong yet transparent.
3. The necessary weaves for the suitable development or binding of the figure are inserted in a second colour.
4. The ground weave is painted in.

Kirby (1957) states that designs always be enlarged before they are transferred to design paper. It would improve standards of drawing if this would be done by original designer instead of being left to a tracer or technician as is the usual practice. According to Banerjee (1970), the jacquard weaving design process include.

1. Sketching
2. Designing on point paper and
3. Card cutting or transferring the design on to the pattern cards.

Grosicki (1975) views that there are three chief ways in which figure designs for textile fabrics are composed.

1. By geomentric ornamentation
2. By conventional treatment of natural or artificial forms
3. By adaptation or reproduction of earlier designs

Watson (1943) opines that woven patterns are employed in two way by the designer. In some instances the design is required to be reproduced exact in every repeat to original and in a similar cloth; in other cases the patterns are only intended to serve as indications, the designs being modified and adapted to suit cloths which perhaps, have very little resemblence to the original texture. In the former case, it is essential that -

1. A suitable jacquard be employed to get the same size of the repeat
2. An exact copy of the form be obtained on the point paper
3. The weave in the figure and ground respectively of the pattern are correctly analysed and reproduced in the new design.

Muramatsu (1958) states that after the size of figure has been decided, they are executed with a pencil on a paper and figure drawn is termed sketch. After the sketch is

drawn, it is enlarged and transferred on a point paper in which it should show the necessary density sideways and lengthwise.

The number of columns on the paper is same as the hook number and the number of rows on the paper correspond to the number of cards, and should be a common multiple of number of relative figure repeat.

Muramatsu (1958) expresses that the design paper is a kind of squared paper, the unit length of which is ruled both lengthwise and sideways with various ratio. State Department of Education (1977) points out that design paper is the best and clearest way to illustrate on paper the interlacings of warp and filling.

According to Banerji (1953) and Basu (1964), to indicate the order in which the warp and weft threads interweave to make a fabric, a sort of paper is used called design paper. This is also variously named a point paper and graph paper. The paper is ruled in two sets of parallel lines crossing. The other at right angles dividing the paper into small rectangular spaces. The vertical rows of a design paper indicate warp threads and the horizontal ones represent the picks of weft. The

paper is usually divided by thick lines called barlines, into groups of four, eight, ten etc., squares each way. Graphs ruled in different proportions are used for different purposes. The barlines facilitates the quick counting of squares and also help the card cutter in cutting card for a jacquard design.

Each small square on a point paper represents a portion where a warp and weft thread cross one another. A mark put in such a small space may mean, according to the idea of the designer, an end passing over a pick (or warping) or a pick crossing over an end (or weft up).

According to Watson (1949), the construction of jacquard designs includes the proportion of draft or card-cutting plan upon squared paper, which if an ordinary machine is used, shows complete working of every thread in the repeat. The point paper designing may be constructed from an original sketch or form a woven sample of which the design is reproduced.

Counts of design paper: Design paper is divided by thick lines usually into square blocks, each of which is subdivided into horizontal and vertical spaces. Each horizontal space corresponds to a pick of weft, and each

vertical space to warp thread and a hook of the jacquard. For convenience in point paper designing and cutting the vertical ruling of the paper is arranged coincide with the arrangement of the jacquard hooks - that is, each large square is divided vertically into as many spaces as there are hooks in a short row of the jacquard.

Golec (1959) states that, most design papers are 8x8. 8x8 paper represents fabric of square construction, that is, fabrics in which the ends per inch are the same as picks per inch.

A very important point to remember is that the design or interlacing as shown on design paper does not take into consideration the size, shape, tpi, colour, spacing crimp or deflection of ends and picks. For this reason the design does not always give a true picture of the resulting fabric.

According to Nisbet (1961), the design paper is ruled with two sets of lines crossing at right angles to form a series of rectangular spaces. At regular intervals apart thicker lines called "barlines" are ruled in both directions to form large squares termed "bars". This large squares or "bars" enclose a number of smaller rectangular spaces which may be either in equal numbers

in both directions or there may be more or less diviations in either directions uniformly, according to the ratio of warp threads and picks per inch in cloth. The thicker lines facilitate the counting of spaces when setting out a jacquard design and they also serve as an index or guide to a card cutter as the "reads off" a design and records it by punching holes in the pattern cards. The ratio of warp and weft spaces in a bar should, however correspond as nearly a practicable to the ratio of warp threads and picks per inch in the finished fabric, in order to ensure correct shape of figures in a pattern.

Bases of Textile Design

According to Watson (1949), the bases upon which designs for figured fabrics are chiefly constructed may be conveniently classified as follows.

1. Geomentric bases which include the square, ablong, the diamond, triangle, hexagon, circle etc.
2. The drop and drop reverse arrangements
3. The ogee and waved line, which may be respectively employed in producing effects similar to those resulting from the second class
4. The various sateen arrangements.

Golec (1959) views that a repeat is the number of ends and picks required for one interlacing sequence. The smallest repeat require two different ends and two different picks. Linton (1963) states that jacquard card is a unit of the pattern chain used on a jacquard loom. It is a cardboard strip 3 x 10 inches with holes similar to those in a player pianoroll punched in it. It is joined by wire eyes to the other cardboard strips to form the jacquard chain.

Muramatsu (1958) says that for card cutting the treadling and punching is done according to the reading from a design paper and usually a piano card cutting machine is used. The repeating machine is more efficient than piano card cutting machine, in the point of punching speed, and accurate punching because on the repeating machine all the holes are punched at once on the cards.

Punching box: Basu (1964) views that a blank card is placed inside the box having series of holes and then punched according to the design with the help of a mallet and punchers. The lace of the punched cards is placed round the cylinder. The long chain of the cards is controlled by folds which are kept hanging below. The cylinder with a punched card will press the needle board. In every pick the selected hooks will go up and will come down according to design. In this

way when all the cards are picked with wefts one after another, the full repeat of the design will be woven on the cloth.

H. Weaving of Jacquard designs

Grosicki (1975) states that jacquards are mainly used for large and intricate figured designs with several hundreds or even several thousands of ends working in different fashion and repeating upon a similar number of picks. The facility with which the jacquard machine is able to cope with such large arrangements and the comparatively small size of the machine itself are the principle features of the system.

Wingate (1964) says that the cards are laced together in proper order and are rotated over an ablong cylinder on the upper part of the loom. From the frame hang long cards that hold fine steel wires each with an eye through which a warp yarn is threaded.

At the top of the loom each of these many cards is attached to horizontal wire called a needle. Then needles press forward against the card. The needles that go through the punched holes in the card pull on the cards that raise the warps to form the shed. The shuttle shoots through. The card just used is automatically passed on by a partial

turn of the along cylinder, and the next card is raised into position for contact with the needles. Again and again the principle of shedding is carried out until all the cards have been used once. The pattern is then repeated.

According to Greenwood (1958), the various types of jacquards are centre shed, cross border, double-lift double cylinder, Double-lift single cylinder, Doubled shed, Electric, Openshed, Single lift, Tilting griffe machine, Twilling, Twin, Verdol and Vincenze.

Classification of jacquard machine, as expressed by Muramatsu (1958) and Baneree (1970) are

1. Ordinary jacquard machine
2. Cross border jacquard machine
3. Verdol jacquard machine
4. Jacquard machine for leno or gauze
5. Jacquard machine for carpet.

These are the main type used nowadays. The classification by the mechanism of these jacquard machine is as follows:

1. Single lift jacquard machine
2. Double lift jacquard machine
3. Special type jacquard machine

Linton (1963) states that jacquard weaving produces elaborate weave effects in the loom by a set of perforated stripes of cardboard, punched according to the motif and substituted for the ordinary and restricted number of needle frames and pattern chains. These card perforations in connection with rods and cards regulate the raising of the stationary warp thread mechanisms.

Banerjee (1970) expresses that the jacquard weaving is characterised by the following distinctive features.

1. Sketching, designing, card cutting and lacing
2. Harness building
3. Lifting the griffe, knives and hooks and
4. Rotation of card cylinder

Basu (1964) states that jacquard machine is for floral desings (small or big) particularly elaborate designs which are not generally possible on dobby.

Textile Institute Manchester (1963) views that Jacquard mechanism is shedding mechanism attached to a loom giving individual control of upto several hundred warp threads and thus enabling large figured designs be produced.

I. Studies conducted

A study on "Home furnishing fabrics" was conducted and published in Sasmira Bullatin, Textile Magazine (1980).

The objective was to study the production of Home furnishing fabrics as well as their demand from wholesalers, retailers and consumers. Production data regarding Home furnishing fabrics were collected from different manufacturers. For the study, 5 manufacturers, 5 wholesalers, 10 retailers and 50 consumers were selected.

There had been an increasing consumer preference of late for handloom rather than powerloom for furnishing materials. Consumers preferred quality and designs apart from colour. The consumers had strong preference for woven designs, check, stripe patterns etc. according to the study. Regarding the choice of colour, consumers preferred deep and bright colours. They preferred cotton to other fabrics. The wholesalers preferred handloom and Jacquard fabrics. The retailers also showed preference for the same whereas readymade furnishing fabrics were not popular. Emphasis was placed more for striped materials for upholstery purposes and floral and geomentrical designs for curtains and draperies.

Experimental Procedure

III EXPERIMENTAL PROCEDURE

The experimental procedure adopted for the undertaken study comprised of the following aspects.

A. Conducting Survey

B. Experimental Study

A. Conducting Survey

1. Selection of the Sample
2. Selection of the Method
3. Preparation of the Questionnaire
4. Conducting the Survey
5. Consolidation and Analysis of the Data
6. Findings of the Survey

B. Experimental Study

1. Designing
   a. Selection of the material
   b. Selection of the design
   c. Sketching
   d. Designing on Point Paper
   e. Punching and Lacing cards
2. Weaving
   a. Selection of the Yarns
   b. Setting up of the Jacquard loom
   c. Working of the Jacquard Machine

3. Laundering

4. Evaluation

   a. Visual Inspection

   b. Preparation of Test Samples

   c. Laboratory Tests

      i. Fabric Thickness

      ii. Fabric Weight

      iii. Abrasion Resistance

      iv. Breaking Strength

A. Conducting Survey

In order to collect information on the type of material, design and colour preferred for draperies, a survey was conducted in the college.

1. Selection of the Sample

Fifty Postgraduate students were selected at random from Sri Avinashilingam Home Science College for Women, Coimbatore as sample, for the study because of their knowledge on Textiles.

2. Selection of the Method

Gupta (1978) states that questionnaire refers to a device for securing answers to questions by using a form

which the respondent fills in himself. Questionnaire approach can normally help to obtain only materials that the respondent is willing and able to report. The subjects feel more free to express views.

3. Preparation of the Questionnaire

According to Wilkinson and Bhandarkar (1982), a questionnaire consists of a number of questions printed in a definite order on a form. Considering the above a questionnaire was prepared to collect information regarding the choice of Handloom and Khadi drapery materials, woven designs, type of design, size of design and colour harmony of the design preferred for draperies, Appendix I.

4. Conducting the Survey

The prepared questionnaire were distributed to the selected samples and collected the same.

5. Consolidation and Analysis of the Data

The data collected was consolidated and analysed.

6. Findings of the Survey

More than 55 per cent of the samples preferred Jacquard woven, geomentrical, medium size and monochromatic colour harmony design for drapery materials.

B. Experimental Study

The experimental study included the following steps.

1. Designing
2. Weaving
3. Laundering
4. Evaluation

1. Designing

The steps involved in designing for Jacquard weave are:

a. Selection of the Material
b. Selection of the Design
c. Sketching
d. Designing on Point Paper
e. Punching and Lacing cards

a. Selection of the Material

Based on the results of the survey, the investigator selected and purchased the Jacquard woven khadi material with geometrical monochromatic colour harmony design for the study. The selected material is shown in Appendix II.

b. Selection of the Design

Watson (1949) states that the design which are entirely geometrical in form can be reproduced from woven patterns.

Watson (1949) and Grosicki (1975) strongly expresses that in some instances the design is required to be reproduced exactly in every respect to the original and in a similar cloth.

Following the above, the Jacquard woven design from the purchased khadi material was selected for reproduci the same in the handwoven material and is shown in Plate 1.

PLATE 1.

SELECTED JACQUARD DESIGN

c. Sketching

A sketch of one repeat of the selected design was made on the paper. The size of the sketch was drawn exactly the same size of the design which is on the purchased khadi material, Figure 1.

d. Designing on Point paper

Kirby (1957) states that Point paper is a strong cartridge paper usually blue in colour and ruled in black. It is made with different types of ruling. According to State Department of Education (1977), Design paper is the best and clearest way to illustrate the interlacing of warp and weft yarns.

The design paper 6x6 was selected. In the design paper the vertical row (column) of the blocks represented individual end (warp) and each horizontal row of blocks represented one pick (weft). Ups and downs were expressed in terms of position of warp. Thick lines were used for convenience in counting ends and picks, for easier copying of the designs, and for quicker reading to cut Jacquard cards. Each small square represented the crossing point of one end and one pick. A blank square indicated that the pick was over the end at that particular insertion. The

SKETCHING THE DESIGN

FIGURE 1

first end of the design was considered to be the one at the left and the first pick of the design was considered to be one on the bottom.

Muramatsu (1958) says that the number of columns on the paper is same as the hook number and the number of rows on the paper correspond to the number of cards, and it should be a common multiple of the number of relative figure repeat.

According to Muramatsu (1958), there are two ways commonly employed for making enlarged figure. First the sketch is enlarged on the blank paper and then transferred upon a design, and the other, the sketch is directly drawn on a design paper (Point paper).

Following the second method, the outline of the design was drawn directly on the point paper referring to the sketch. Then the design was filled up to distinguish it from the ground weave. While filling up with colour, care was taken to see that weaves join correctly on all sides of the repeat. Thus the design was transfered to the point paper (Figure 2).

e. Punching and Lacing cards

Pieces of millboard are cut into suitable sizes to

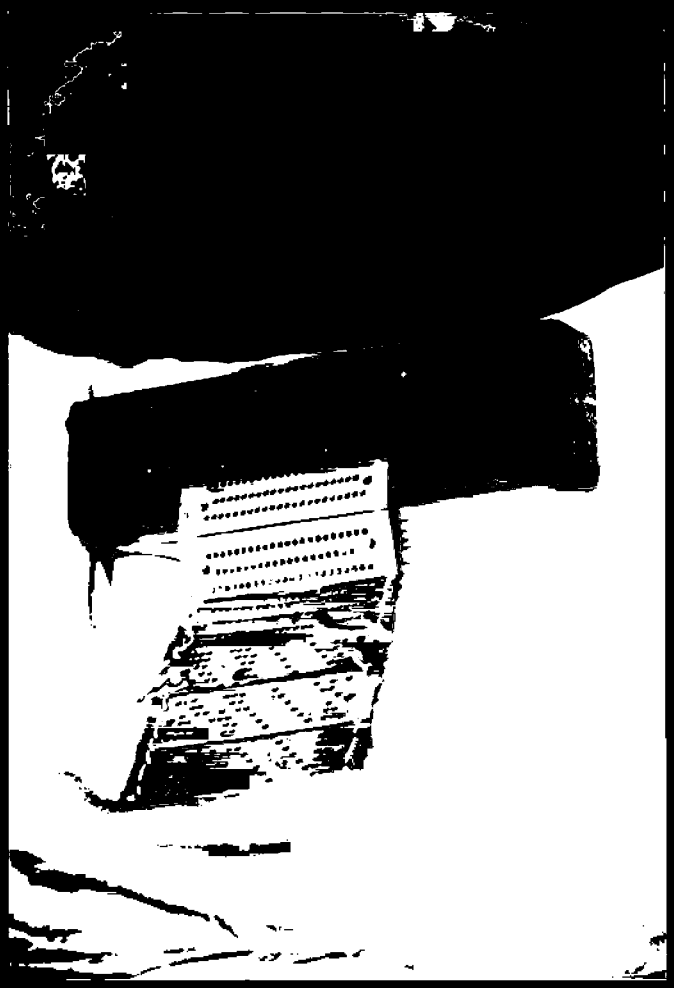
make pattern cards for a Jacquard. The size of the card must cover the needle space of the machine for which they are intended to be used. Cards used on Handloom are lighter in weight than cards used on powerloom.

Banerji (1970) expresses that the card cutting machine consists of a punch box containing thirteen punchers, twelve for cutting small holes and one for cutting peg holes in the cards. The card cutting machine is shown in Plate 2. As suggested by Mary Kirby (1957) card cutting was done from the bottom of the design upwards. The design was read along the horizontal line of weave from left to right, cutting all the red marks; one horizontal line on the point paper represented one card.

Lacing cards

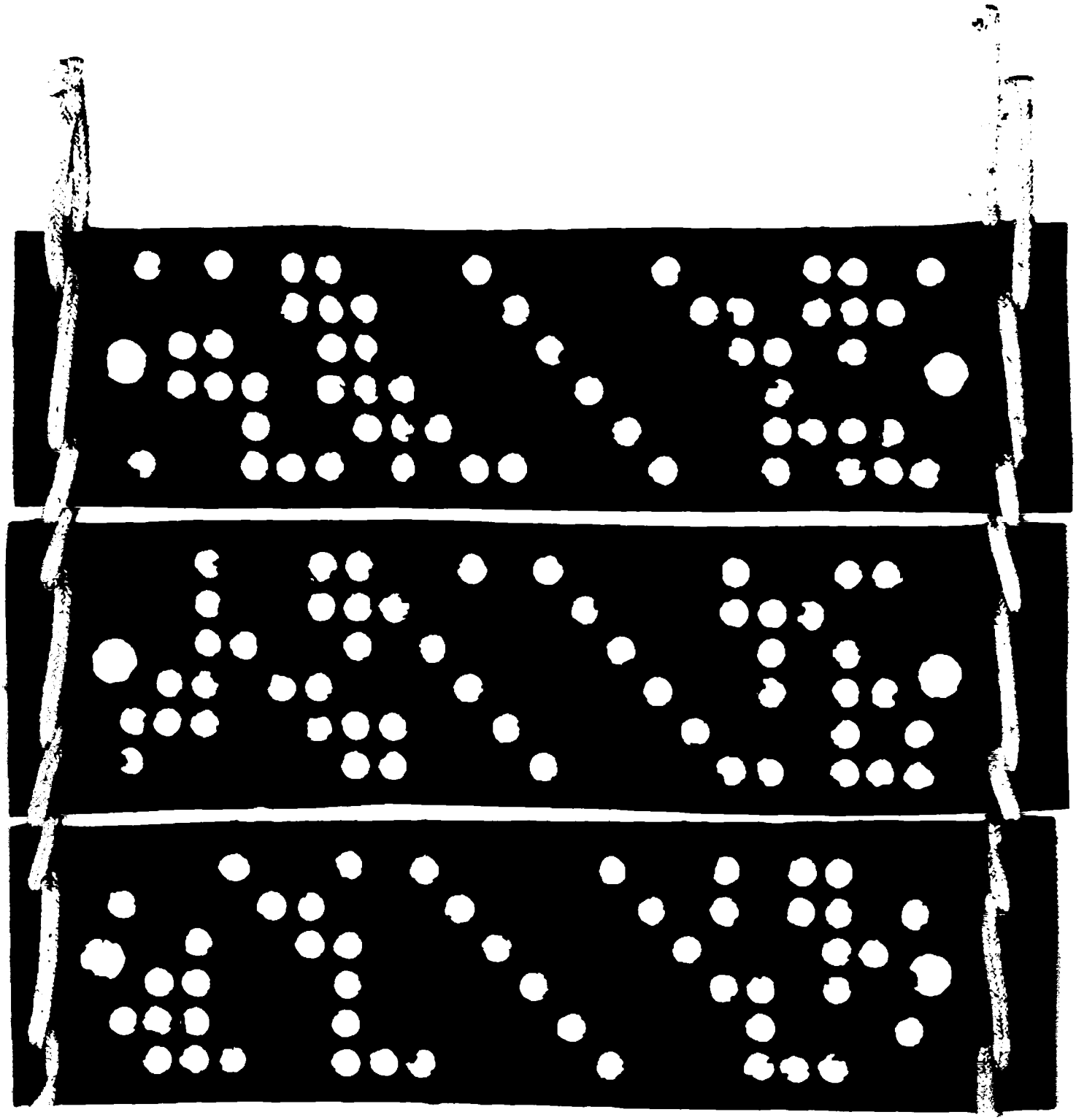
The cards were symmetrically numbered on the same side and at the same end. It was then placed in sequence and the correct way up on the lacing frame. The punched cards were laced together with a soft tubular cotton tape (Plate 3). After lacing it was wired between every twelve cards. The extra length of the wire supported it on card irons to be drawn upto the card cylinder during weaving.

PLATE 2.



CARD CUTTING MACHINE

PLATE 3



PUNCHING AND LACING CARDS

2. Weaving

Weaving includes the following aspects.

a. Selection of the Yarns
b. Setting up of the Jacquard loom
c. Working of the Jacquard machine

a. Selection of Yarns

As found in the khadi jacquard woven material, dyed cream coloured cotton yarn (2/20's count) for warp and green coloured cotton yarn (2/20's count) for weft were selected for hand weaving Jacquard material.

b. Setting up of the Jacquard loom

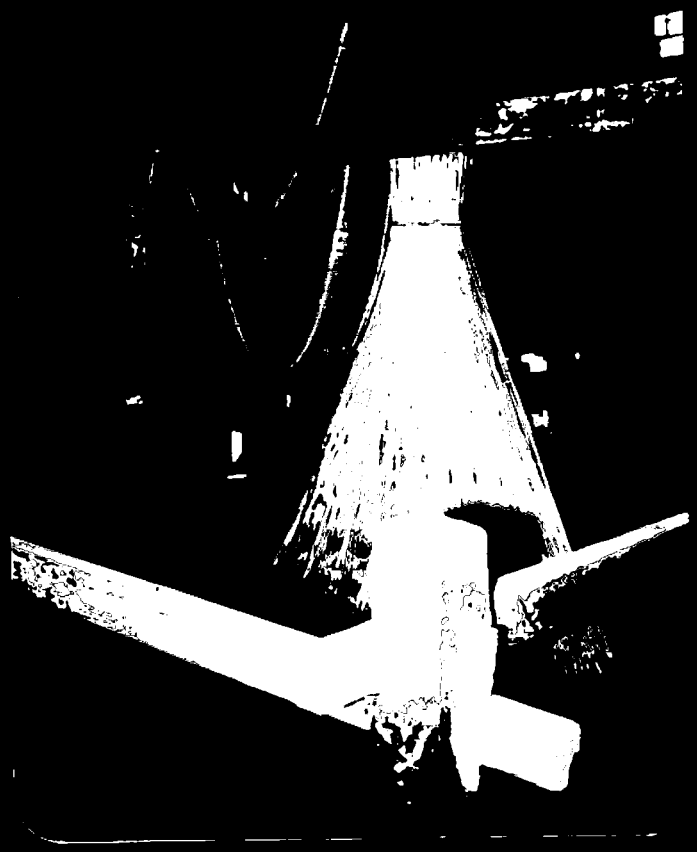
As Basu (1964) pointed out the Jacquard machine was set up for the work. The number of Jacquard machine was based on the number of hooks in the Jacquard machine. There was a knife to control each row of hooks which was actuated by the needle. One end of the needle remained in the needle board and the other end in the spring box. A swinging frame which had a gazon in each side was placed against the needle board. A perforated cylinder was placed upon the above two gazons. Both ends of the cylinder were kept under pressur with the help of a spring and hammer, so that the cylinder may not get more than one turn per pick. Inside the machine

required top couplings. The levelling rod was adjusted in such as position that its bottom level remains in line with the sley race. While lifting the Jacquard, this enabled the selected warp ends to remain in proper position of the sley during each pick.

All the top couplings from the levelling rods were serially drawn through the holes of the comber board by the help of crochet hook commencing from a selected point of the board. In the same manner all the top couplings were drawn.

Thus the Jacquard loom, (Plate 4) was set up for weaving.

PLATE 4



SETTING UP OF THE JACQUARD LOOM

C. Working of the Jacquard machine

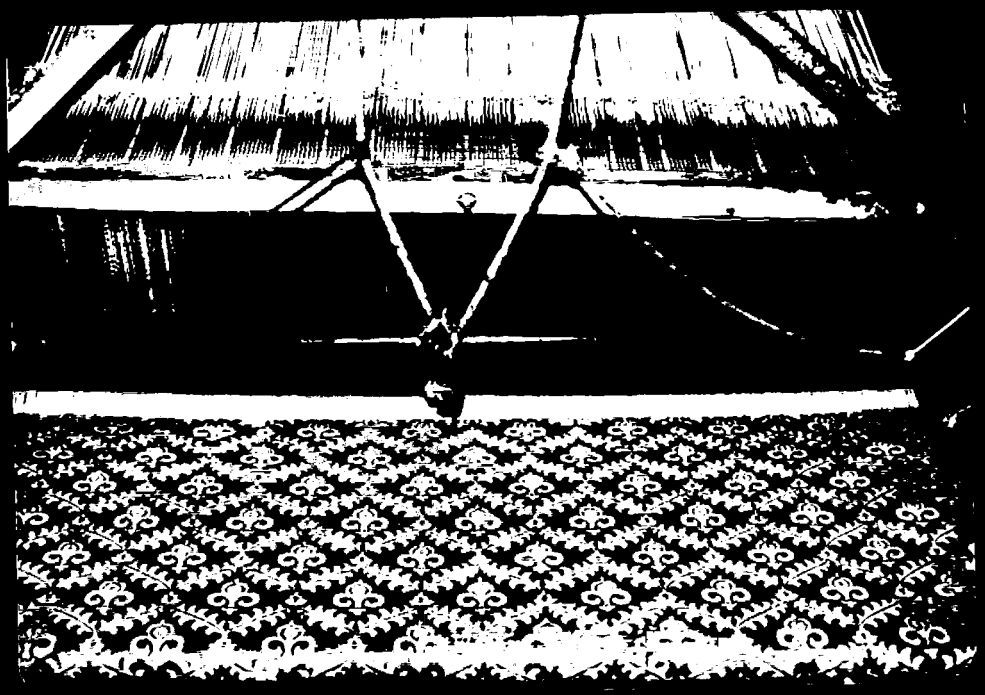
As stated by Stepat (1971), each warp thread in the Jacquard loom was controlled individually so that it may appear on the surface of the cloth at any desired point. Warp yarns were raised by a series of punched cards attached to the loom. A seperate card was used for each crosswise thread of the design. As each card comes into place, certain warps were raised and the weft yarns were slided across the loom. The warp yarns were returned to position and then the next cards were moved into its place to raise another set of warp yarns. In this manner the design was formed in the material (Plate 5).

Thus, the Jacquard Handwoven drapery material was made by a well trained Handloom Jacquard weaver. The Handwoven Jacquard material is shown in Appendix III.

3. Laundering

The Khadi and Handwoven materials were cut into two pieces and named as A, A_1 and B, B_1 respectively. The materials A and B were kept aside as originals for testing purposes and the rest A_1 and B_1 were used for constructing draperies. The constructed draperies were hung on the window and exposed to normal atmospheric condition for a period of 12 hours a day.

PLATE 5.



WORKING OF JACQUARD MACHINE

Duelkar (1967) suggests that soap jelly and suction washing method are the most suitable for cleaning heavy articles of any fabric or colour. Hence the soap jelly and suction washing method were selected for washing the drapery materials.

As suggested by Jackman and Rogers (1954) the soap jelly was prepared by adding 1½ lb (5 6 7 grams) slices of 501 bar soap with 1 gallon (4.55 litres) of boiling water. It was stirred gently and made into a jelly form. Thus the soap jelly was prepared and kept in bottles.

Soap solution was prepared by mixing 45 grams of soap jelly with 2.975 litres of water for washing the drapery materials. The drapery material was dipped in the soap solution.

Following the suggestions given by Deulkar (1967), the material was pressed with the suction washer to saturate it with the solution. Then the suction washer was worked up and down in the solution lightly pressing the article. This process was carried out for 15 minutes. As suggested by Dantyagi (1974) was the material then rinsed in 10 litres of water for four times to remove lather completely from the material. Deulkar (1974) points out that the coloured articles should be dried in the shade. Hence the material

was dried in the shade. Thus the khadi and Handwoven drapery materials were given 30 washes and the washed drapery materials are shown in Appendix V.

4. Evaluation

The following were considered for evaluating the samples.

a. Visual inspection
b. Preparation of test samples
c. Laboratory tests

a. Visual Inspection

Twenty five judges comprising the postgraduate students and staffs of Textiles and Clothing Department, Sri Avinashilingam Home Science Collge for Women, Coimbatore were selected as they were familier with the above aspects. In order to evaluate the effectiveness of the selected khadi and handwoven Jacquard materials, a proforma was formed by the investigator and it is given in Appendix IV. The samples were displayed for easy evaluation and the selected judges were requested to evaluate the samples. The data were collected consolidated and is presented under results and discussion.

b. Preparation of Test Samples

The original and washed Khadi and Handwoven drapery materials were tested by taking the sample pieces from the same relative portions of the materials for the laboratory tests.

c. Laboratory Tests

The following laboratory tests were conducted:

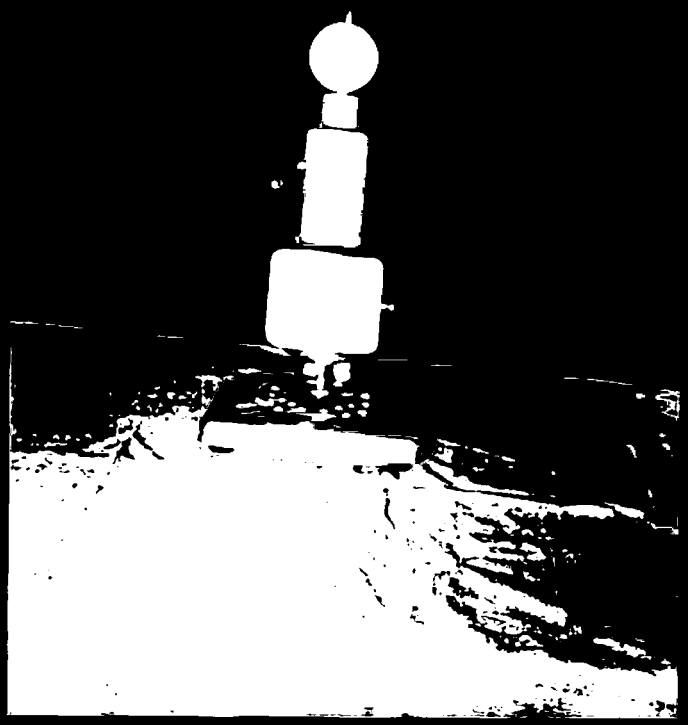
i. Fabric Thickness
ii. Fabric Weight
iii. Abrasion Resistance
iv. Breaking Strength

i. Fabric Thickness

According to ASTM Standards (1982) and B.S. Handbook(1974), thickness in textiles is the distance between the upper and lower surfaces of the material measured under a specific pressure.

The Hungarian Thickness Tester (Plate 6) was used to measure the thickness of the material. The sample was placed upon the anvil of the guage without tension. The presserfoot was lowered upon the fabric gradually by releasing the lever and allowed to rest upon it for two seconds at

PLATE 6



HUNGARIAN THICKNESS TESTER

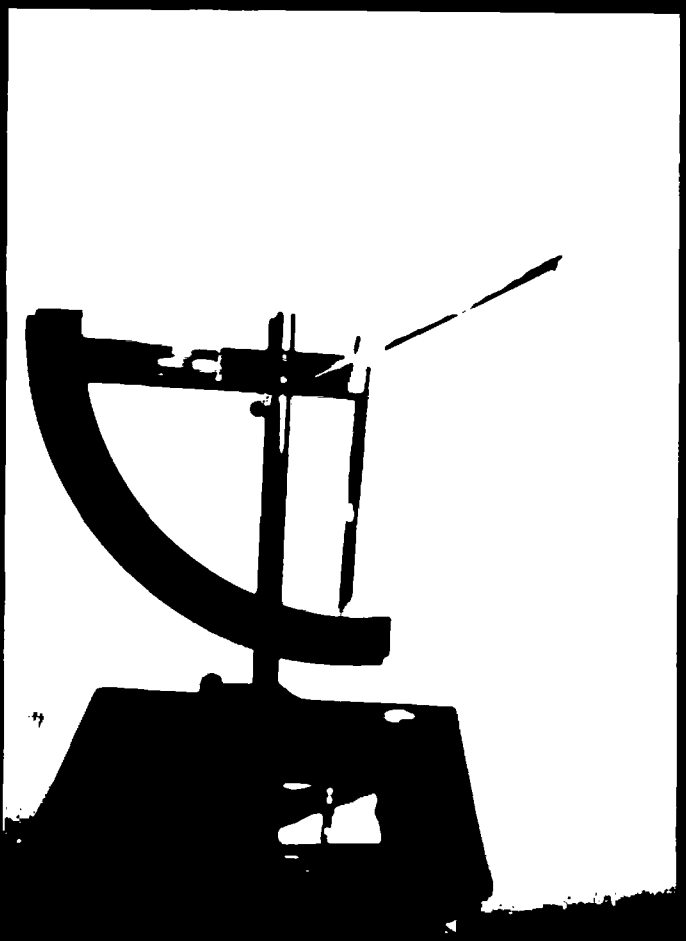
at four kilograms pressure. The reading of the dial indicated the thickness of the material in thousands of an inch. Each division on the dial read 0.01 mm. Ten readings were taken from different places of the original and washed Khadi and Handwoven drapery materials. The mean value of ten readings was noted and recorded.

ii. Fabric Weight

Grover and Hamby (1969) and the staff of West Point Pepperell's Research Centre (1967-68) say that the weight of a fabric can be expressed as ounce/linear yard or ounce/sq. yard for a standard or yard/pound. Weight per unit area and weight per unit length are commonly used for determining the weight of the fabric, says Skinkle (1972).

Five samples were cut from the original and washed Khadi and Handwoven drapery materials using the steel template. A Cloth Quardrant Balance (Plate 7) was used to determine the weight of the material directly. The cut sample was suspended from the hook and the reading was noted. The same procedure was repeated for five samples of the same material. The mean value of five readings of original and the washed materials was calculated and thus recorded the fabric weight of each material seperately. This was found in ounces per sq. yard. The same was

PLATE 7



CLOTH QUARDRANT BALANCE

converted into grams per square meter.

iii. Abrasion Resistance

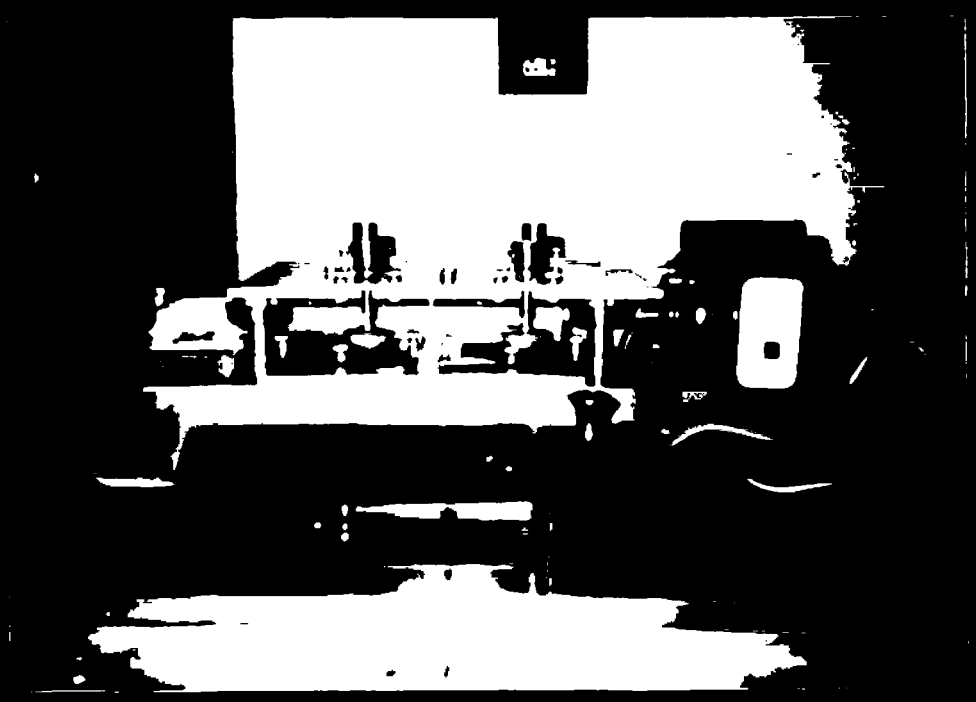
The Staff of West Point Pepperell's Research Center (1967-68) states that Abrasion tests are used to measure the resistance of a fabric to wear. Sundaram (1979) states that abrasion is one aspect of wear caused by rubbing away of the component fibres and yarns of the fabric.

The Eureka Martindale Abrasion tester (Plate 8) was used to determine the fabrics resistance to friction. The severity of the abrasion varies with the nature of the abrader. Silicon carbide No.320 was used as an abradent. The samples were cut from different parts of the original and the washed Khadi and Handwoven drapery materials. The initial weight of each sample was taken carefully. First a few samples were tested to standardise the number of rubs, 300 rubs were found to be sufficient. Every time a fresh abradent was used. The sample was given 300 rubs after which final weight of the sample was taken very carefully. The loss in weight was noted for each sample. The mean value of five such readings were taken and recorded for the original and washed khadi and Handwoven materials.

iv. Breaking Strength and Elongation

According to Skinkle (1972), Breaking Strength refers

PLATE 8



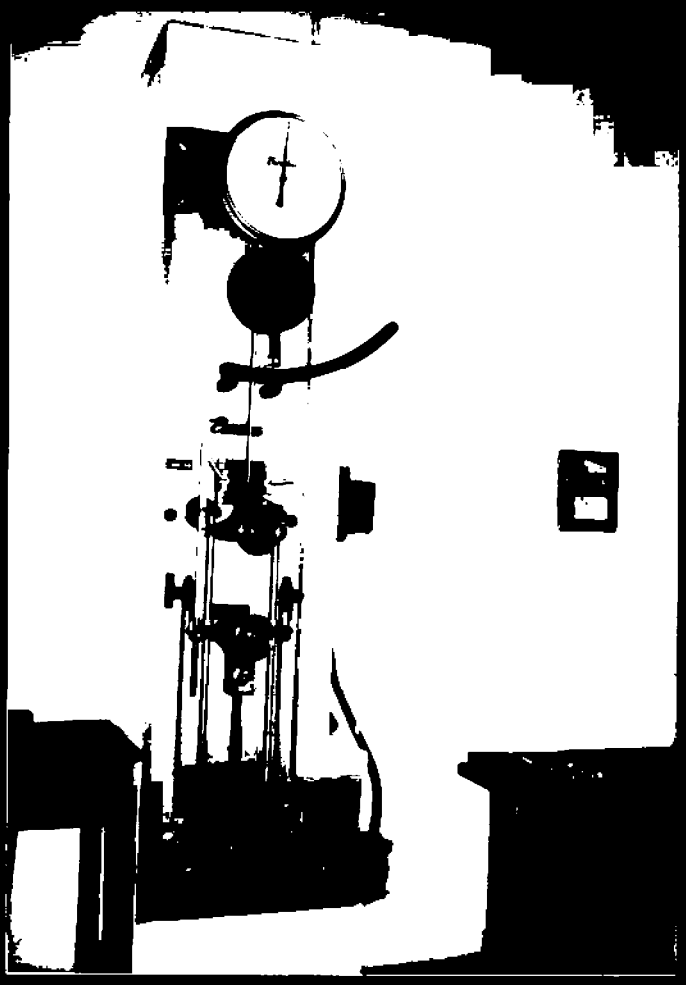
EUREKA MARTINDALE ABRASION RESISTANCE TESTER

to the force acting upon the sample at the time of failure. This is usually the maximum force applied. Elongation is non recoverable stretch. Grover and Humby (1969) define that the breaking strength is a measure of resistance of the fabric to a tensile load or stress in either the warp or filling direction. Elongation is a measure of the extent of deformation along the axis of a material under a tensile stress and is expressed as per cent change in length based on the original length of the test sample.

As suggested by Skinkle (1972) ravelled strip method was used for the experiment. The sample was cutout 3.75 cms (1½ inches) wide and 32.5 cms (13 inches) long and ravelled out to 2.5 cms (1 inch) width and 30 cms (12 inch) length by drawing the yarns from four sides. Five samples were taken from both warp and weft directions of the original and washed Khadi and Handwoven drapery materials.

The most common Pendulam type of Breaking Strength Tester (Plate 9) was used to measure the Breaking Strength and elongation of the samples. The dial of the machine was calibrated in pounds and kilograms. The capacity of the machine and the rate of traverse were 200 pounds (90 Kg.) and 12 inches (45 cms) per minute respectively. The gauge length was calibrated in pounds and kilograms. The sample

PLATE 9



BREAKING STRENGTH TESTER

was clamped between two jaws care was taken to see that the sample was perpendicular to load. The load was applied and the reading was recorded in kilograms for load and in inches for elongation as soon as the sample was broken. Five samples were tested and the readings were recorded carefully. Thus the mean values of five readings from the original and washed Khadi and Handwoven drapery materials were calculated and thus recorded the breaking strength and elongation of each material seperately.

Results and Discussion

IV RESULTS AND DISCUSSION

The results of the study are discussed under the following headings:

A. Visual Inspection

B. Laboratory tests

1. Fabric thickness
2. Fabric weight
3. Abrasion resistance
4. a) Breaking strength
   b) Elongation

A. Visual Inspection

The details of the panel readings regarding the suitability, clarity and effectiveness of the design, relationship between the design material and its end use, elements and principles of the design of the selected Khadi and Handwoven drapery materials are given in Table I.

TABLE I

EVALUATION OF THE SELECTED KHADI AND HANDWOVEN DRAPERY MATERIALS

S.No.	Criteria	A Good (in percentage)	A Fair	A Poor	B Good (in percentage)	B Fair	B Poor
1.	Suitability of the design	76	24	-	84	16	-
2.	Selection of motif	80	20	-	88	12	-
3.	Clarity of the design	12	88	-	92	8	-
4.	Effectiveness of the design	32	64	4	100	-	-
5.	Relationship between design, materials & its end use	44	48	8	88	12	-
6.	Elements of art						
	a) Line	64	36	-	84	16	-
	b) Shape	60	40	-	76	24	-
	c) Texture	88	12	4	64	36	-
	d) Colour	12	52	36	88	12	-
7.	Principles of art						
	a) Proportion	96	4	-	96	4	-
	b) Balance	96	4	-	96	4	-
	c) Emphasis	20	60	20	80	16	-
	d) Rhythm	72	28	-	80	20	-
	e) Harmony	44	56	-	88	12	-
8.	General appearance	4	80	16	100	-	-

From Table I, it is clearly evident that the suitability, clarity and effectiveness of the design, Relationship between the design, material and its end use, Line, Shape, Colour, Proportion, Balance, Emphasis, Rhythm and Harmony and General appearance of the design of the Handwoven drapery material was rated as good by more than 75 per cent of the Judges. Regarding the texture, Khadi material was rated as good by 88 per cent of the Judges.

Hence it could be concluded that Handwoven drapery material is good in all the aspects except texture when compared with Khadi drapery material.

1. Fabric thickness

The Fabric thickness of the original and washed Khadi and Handwoven drapery materials is given in Table II and Figure 3.

TABLE II

FABRIC THICKNESS OF ORIGINAL AND WASHED KHADI & HANDWOVEN DRAPERY MATERIALS

S.No.	Sample	Mean (mm)	Gain over original (mm)	Percentage gain over original	Coefficient of variance	Sample comparison	't' value
1.	A	0.64	-	-	3.89057	A Vs B	3.1345**
2.	A_1	0.726	0.086	8.6	3.85674	A_1 Vs B_1	5.67636**
3.	B	0.705	-	-	3.08634	A Vs A_1	5.15652**
4.	B_1	0.834	0.129	12.9	3.0897	B Vs B_1	4.03673**

** Significant at 1 per cent level

From Table II, it is clear in at the thickness of the washed samples A_1 and B_1 were higher than the original samples A and B.

On analysing statistically, the difference between the samples A Vs B, A_1 Vs B_1, A Vs A_1 and B Vs B_1 were found to be significant at 1 per cent level. The coefficient of variance proves that the samples B and B_1 were more consistent than the samples A and A_1 respectively.

SCALE

IN Y-AXIS 1cm = 0.05 m.m

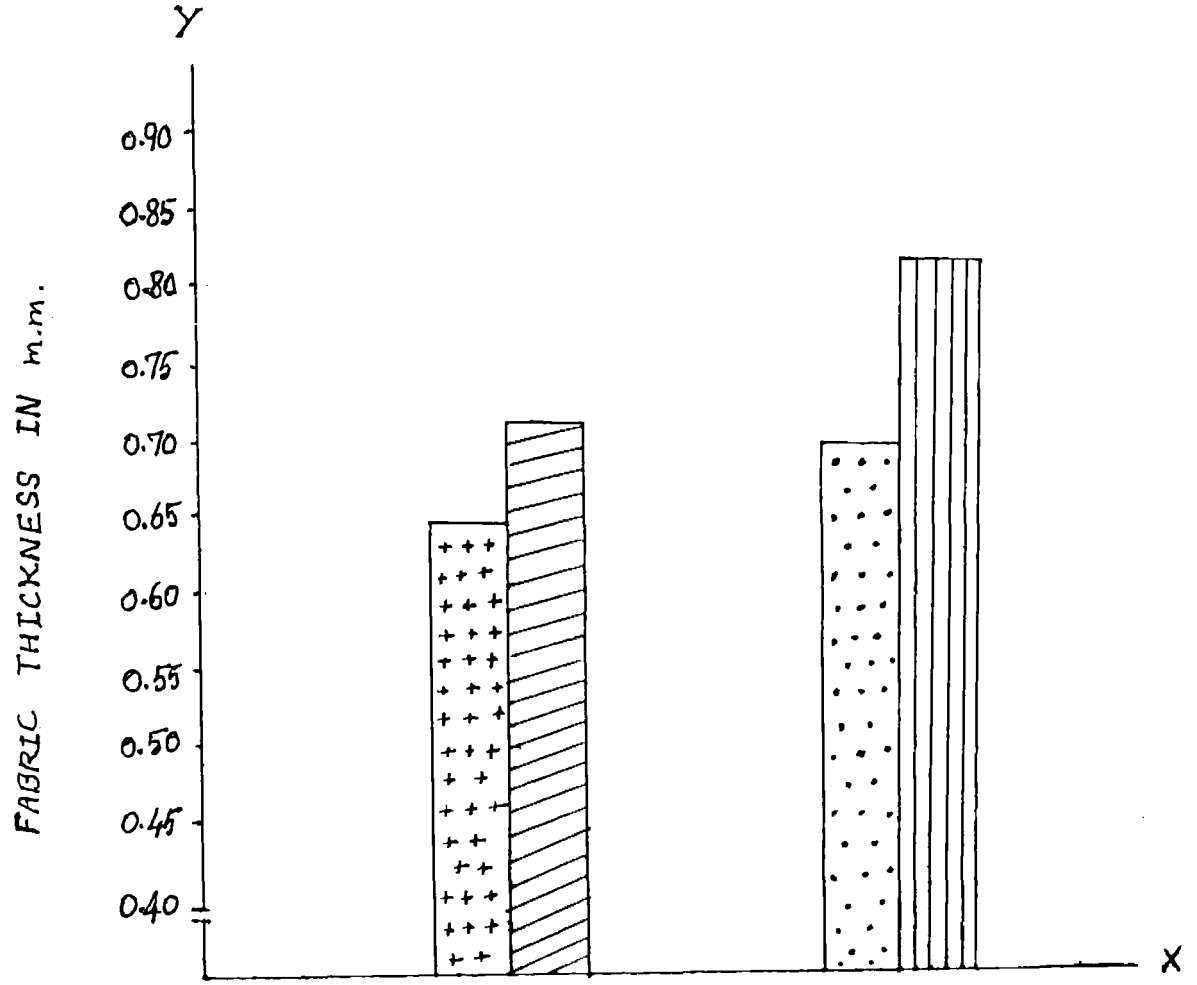
KEY

KHADI ORIGINAL

KHADI WASHED

HANDWOVEN ORIGINAL

HANDWOVEN WASHED



FABRIC THICKNESS OF ORIGINAL AND WASHED KHADI AND HANDWOVEN DRAPERY MATERIALS.

FIGURE 3

Therefore, it could be concluded that the thickness of the Handwoven materials (B and B_1) are more when compared with the Khadi materials (A and A_1). Moreover, the thickness of the washed materials (A_1 and B_1) are increased than its original.

2. Fabric weight

The Fabric weight of the original and the washed Khadi and Handwoven diapery materials is shown in Table III and Figure 4.

TABLE III

FABRIC WEIGHT OF ORIGINAL AND WASHED KHADI AND HANDWOVEN DRAPERY MATERIALS

S.No.	Sample	Mean (gms/ sq.m.)	Gain over original in (gms/ sqm.)	Percentage gain over original	Coefficient of variance	Sample comparison	t value
1.	A	190.545	-	-	1.2953	A Vs B	25.3129**
2.	A_1	227.972	37.427	0.3742	0.7436	A_1 Vs B_1	42.4105**
3.	B	231.362	-	-	0.8972	A Vs A_1	24.9030**
4.	B_1	278.821	47.459	0.4745	0.6082	B Vs B_1	29.9339 **

** Significant at 1 per cent level

SCALE

IN Y-AXIS 1cm = 10 mg/sq.m

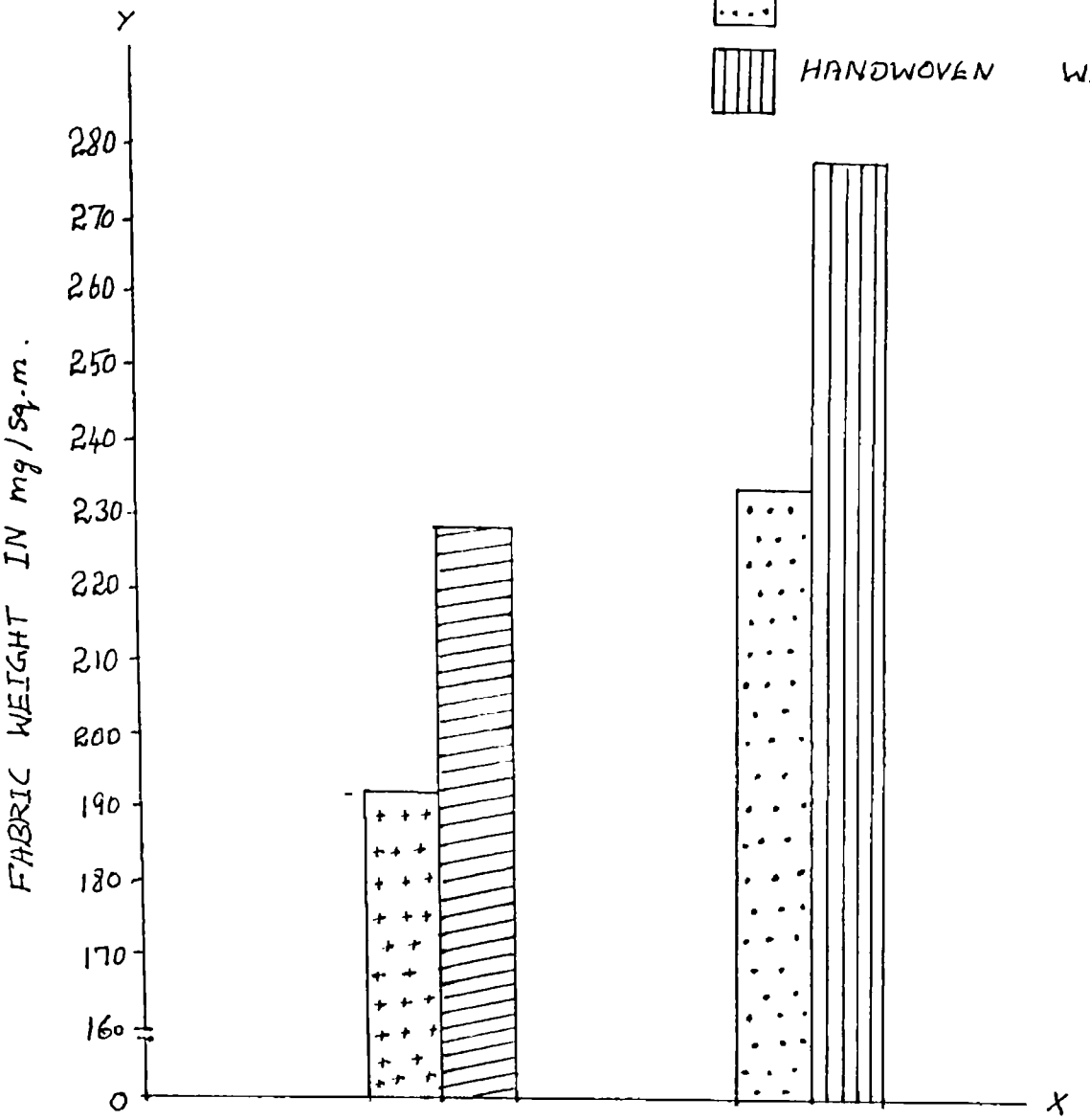
KEY

KHADI ORIGINAL

KHADI WASHED

HANDWOVEN ORIGINAL

HANDWOVEN WASHED



FABRIC WEIGHT OF ORIGINAL AND WASHED KHADI AND HANDWOVEN DRAPERY MATERIALS

FIGURE 4

From the above table it is clearly evident that the fabric weight of the washed samples A_1 and B_1 showed increase in weight than the original samples A and B.

On analysing statistically the difference between the samples A vs B, A_1 Vs B_1 , A Vs A_1 and B Vs B_1 were found to be significant at 1 per cent level. The coefficient of variance shows that the samples A_1 and B_1 were more consistent than the samples A and B respectively.

Hence, it could be concluded that there is more weight in hand woven materials (B and B_1) when compared with the Khadi materials (A and A_1).

Moreover, the weight of the washed materials A_1 and B_1 are increased when compared with its original materials (A and B).

3. Abrasion Resistance

The loss in weight of the original and washed Khadi and Handwoven drapery materials due to abrasion is shown in Table IV and Figure 5.

TABLE IV

ABRASION RESISTANCE OF ORIGINAL AND WASHED KHADI AND HANDWOVEN DRAPERY MATERIALS

S.No.	Sample	Mean loss of wgt. (in gms.)	Loss/ gain over original (gms.)	Percentage loss/gain	Coefficient of variance	Sample comparison	t value
1.	A	0.15424	-	-	24.14574	A Vs B	2.57499
2.	A_1	0.18796	0.03374	0.000337	14.17232	A_1 Vs B_1	2.390703*
3.	B	0.20354	-	-	4.6629	A Vs A_1	2.11618
4.	B_1	0.14328	0.06026	0.000602	18.3066	B Vs B_1	4.084498*

* Significant at 5 per cent level

The loss in weight of the sample due to abrasion shown in Table IV determines the abrasion resistance of the sample. The greater the loss in weight, the lesser is the resistance to friction.

From the above Table it is clearly evident that the mean loss of weight was more in sample B than the Sample B_1.

From the statistical analysis, it is proved that the difference between the samples A Vs B, A_1 Vs B_1 and B Vs B_1

SCALE

IN Y-AXIS 1cm = 0.02 gms.

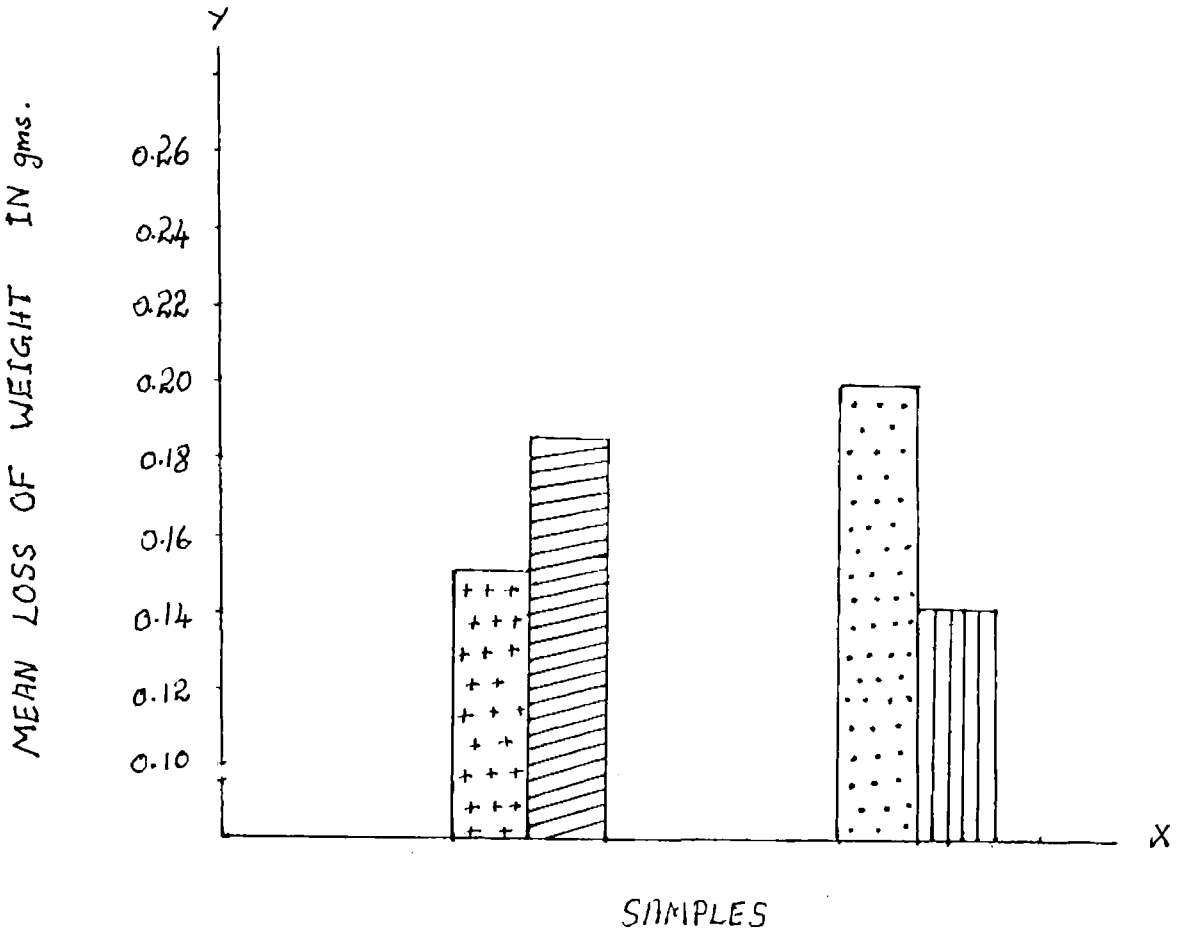
KEY

KHADI ORIGINAL

KHADI WASHED

HANDWOVEN ORIGINAL

HANDWOVEN WASHED



ABRASION RESISTANCE OF ORIGINAL AND WASHED KHADI AND HANDWOVEN DRAPERY MATERIALS

FIGURE 5

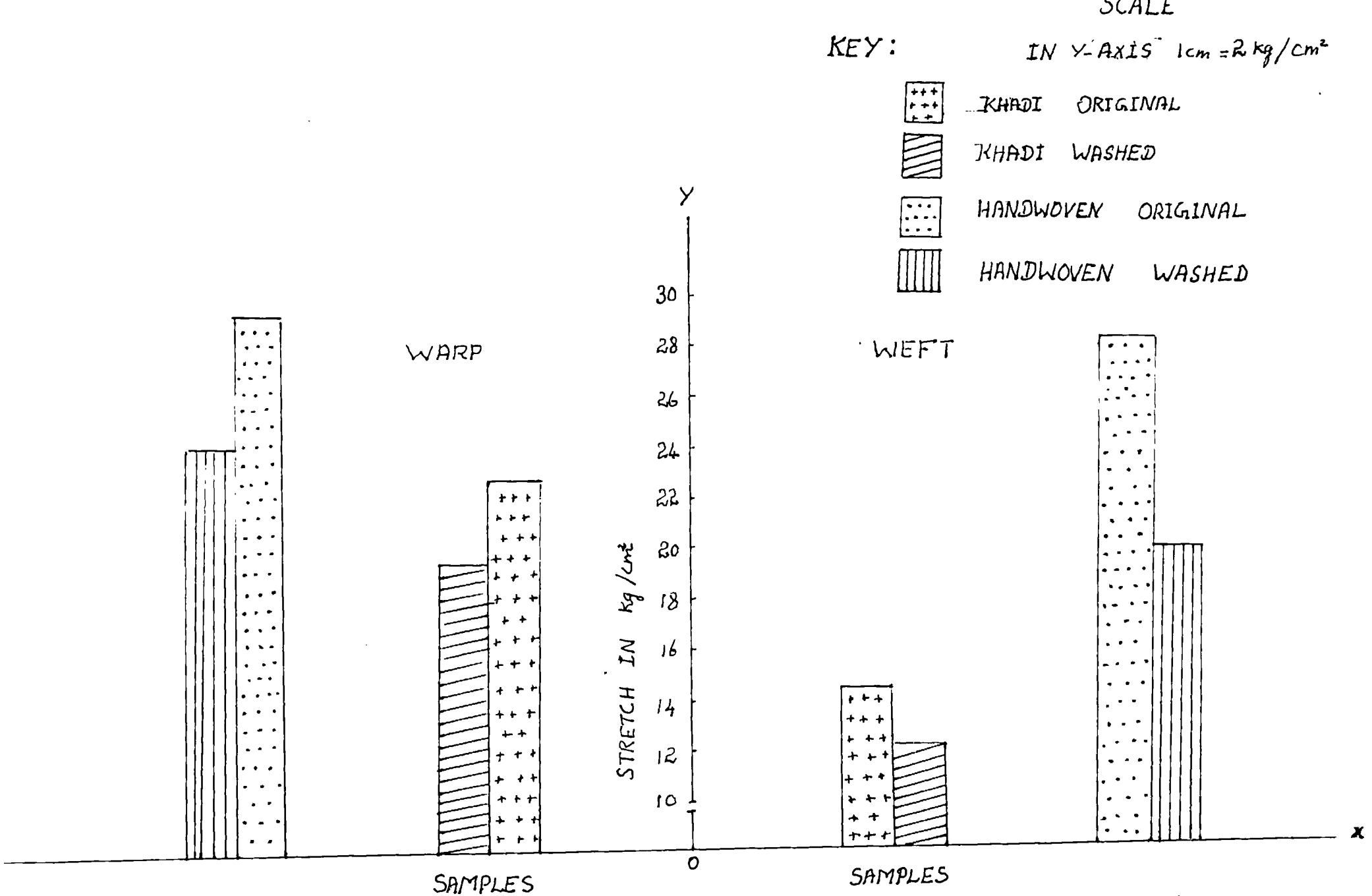
were significant at 5 per cent level. The coefficient of variance proved that the mean loss of weight of the samples. A_1 and B are more consistent than the samples A and B_1 respectively.

Hence, it could be concluded that the Handwoven materials (B and B_1) are more resistant to abrasion when compared with Khadi materials (A and A_1).

Further, in khadi the resistance to abrasion is more in original sample than the washed sample and in Handwoven, the resistance to abrasion is more in washed samples than the original.

4. a. Breaking Strength

The Breaking strength of the original and the washed Khadi and Handwoven drapery materials is given in Table V and Figure 6.



BREAKING STRENGTH OF ORIGINAL AND WASHED KHADI AND HANDWOVEN DRAPERY MATERIALS

FIGURE 6

Table V illustrates the Breaking strength of the original and washed khadi and Handwoven drapery samples. The lesser the mean value, the less is the breaking strength of the sample. Comparing the Breaking strength both in warp and weft directions, the Sample A and B were found to register the highest mean values than the samples A_1 and B_1 respectively.

On analysing statistically, it is proved that there were significant difference between the samples A Vs B, A_1 Vs B_1, A Vs A_1 and B Vs B_1 in the warp direction. In the weft direction the significant difference was not found between the samples A Vs B_1, A_1 Vs B_1 and B Vs B_1. The significant difference was not found between the samples A Vs A_1. The coefficient of varience proves that the Breaking Strength in the warp and weft directions of the samples A and B were more consistent than the samples A_1 and B_1 respectively.

Hence it could be concluded that the Breaking strength of the original samples were more than the washed samples. When comparing the mean values the Handwoven materials are more in strength than the Khadi materials.

b. Elongation

The Elongation of the original and the washed Khadi and Handwoven drapery materials is given in Table VI.

Table VI illustrates the Elongation of the original and washed Khadi and Handwoven samples. The greater the mean value, the more is the elasticity of the sample. Comparing the Elongation both in warp and weft direction, the samples A_1 and B_1 were found to register the highest mean values than the samples A and B respectively.

On analysing statistically, it is proved that there was significant difference between the samples A vs B and A Vs A_1 in the warp direction. In the weft direction, the significant difference was found between the samples A Vs B. The significant difference was not found between the samples A_1 Vs B_1 and B Vs B_1 in warp direction and A_1 Vs B_1 and A Vs A_1 in the weft direction. The coefficient of varience proves that the elongation in warp and weft direction, the samples A and B_1 were more consistent than the samples A_1 and B respectively.

Therefore it could be concluded that the Elongation of the washed samples were more than the original samples. When comparing the mean values, the elongation of Handwoven materials are higher than the khadi materials.

Summary and Conclusion

After lacing, it was wired between every 12 cards. The extra length of wire supported it on card irons to be drawn upto the card cylinder during weaving.

As found in the khadi Jacquard woven material, dyed green coloured cotton yarn (2/20s count) for weft and cream coloured cotton yarn (2/20s count) for warp were selected for handweaving Jacquard material. The Jacquard machine was set up for the work. The Jacquard Handwoven drapery material was made by a well trained Handloom Jacquard weaver. The khadi and Handloom materials were cut into two pieces and named as A, A_1 B and B_1 respectively. The materials A and B were kept aside as originals for testing purposes and the rest A_1 and B_1 were used for constructing draperies. The constructed draperies were hung on the window and exposed to normal atmospheric condition for a period of 12 hours a day. For washing the drapery materials, soap jelly and suction washing method were selected. The drapery material was dipped in the soap solution which was prepared by mixing 45 grams of soap jelly with 2.975 litres of water. The material was pressed with the suction washer for 15 minutes. Then it was rinsed well with water and dried in the shade. Thus they were given 30 washes.

The following were considered for evaluating the samples.

A. Visual Inspection

B. Laboratory Tests

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Appendices

APPENDIX I

AN INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE FURNISHING MATERIALS AND DESIGNS FOR DRAPERIES

1. Name of the Student :

   Address :

2. State the type of design you prefer for draperies

   Woven ▱

   Printed ▱

3. State the type of material you prefer for draperies.

S.No.	Name of the materials	Khadi	Handloom
i.	Cotton		
ii.	Linen		
iii.	Silk		
iv.	Wool		
v.	Cotton and Silk		

4. If you prefer woven designs, mention the type of weave.

   i. Plain weave ▱

   ii. Twill weave ▱

   iii. Satin weave ▱

iv. Jacquard 

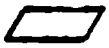
v. Dobby 

vi. Lappet 

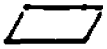
vii. Swivel 

viii. Lino 

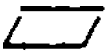
5. Which type of design you like most among the following for draperies.

i. Natural 

ii. Floral 

iii. Conventional 

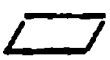
iv. Historic 

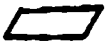
v. Geometric 

vi. Abstract 

6. Which size of the design you like the most among the following for draperies.

i. Big 

ii. Small 

iii. Medium 

7. Which colour harmony do you prefer most among the following for draperies?

i. Monochromatic ▱

ii. Analogous ▱

iii. Complementary ▱

iv. Double complementary ▱

v. Split complementary ▱

vi. Triad ▱

APPENDIX II

SELECTED KHADI JACQUARD MATERIAL

APPENDIX III

HANDWOVEN JACQUARD MATERIAL

APPENDIX IV

PROFORMA TO EVALUATE JACQUARD HANDWOVEN AND KHADI DRAPERY MATERIALS

S.No.	Criteria	KHADI			HANDLOOM		
		Good	Fair	Poor	Good	Fair	Poor
1.	Suitability of the design						
2.	Selection of motif						
3.	Clarity of the design						
4.	Effectiveness of the design						
5.	Relationship between design, materials and its end use.						
6.	Elements of art						
	a. Line						
	b. Shape						
	c. Texture						
	d. Colour						
7.	Principles of art						
	a. Proportion						
	b. Balance						
	c. Emphasis						
	d. Rhythm						
	e. Harmony						
8.	General appearance						

APPENDIX V

WASTED KHADI MATERIAL

APPENDIX V

WASHED HANDWOVEN MATERIAL

APPENDIX VI

STATISTICAL ANALYSIS USED FOR THE STUDY

According to Gupta (1976), the 't-test' is based on 't' distribution. The t-distribution also called student's t-distribution used when the size of the sample is small (less than 30).

The number of degrees of freedom of a statistic generally denoted by ν , is defined as the number N of independent observations in the sample minus the number K of population parameter which must be estimated, from sample observations, Symbolically $\nu = N-K$.

The t-Table: The t-table is the probability integral of t-distribution. It gives, over, a range of values of ν , the probabilities of exceeding by chance value of t at different levels of significance. The t-distribution has a different value for each degrees of freedom. If the calculated value exceeds the table value, the difference between the sample means is said to be significant at 5% level; if it exceeds t 0.05 the difference is said to be significant at 1% level.

T - TEST

a) To test the difference between the means of two samples.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S} \times \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

$\bar{X}_1$ = mean of the first sample

$\bar{X}_2$ = mean of the second sample

n_1 = number of observations in the first sample

n_2 = number of observations in the second sample

S = Combined standard deviation

The value of S is calculated as follows:

$$S = \sqrt{\frac{\leq (X_1 - \bar{X}_1)^2 + \leq (X_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}}$$

The Fabric Thickness readings of the original Handwoven (X_1) and original Khadi (X_2) materials are taken, and t - value is calculated.

S.No.	X_1	$X_1 - \bar{X}_1$	$(X_1-\bar{X}_1)^2$	X_2	$(X_2 - \bar{X}_2)$	$(X_2-\bar{X}_2)^2$
1.	0.73	0.025	0.000625	0.65	-0.001	0.0001
2.	0.80	-0.005	0.000025	0.61	-0.03	0.0009
3.	0.68	-0.025	0.000625	0.68	0.04	0.0016
4.	0.68	-0.025	0.000625	0.65	0.01	0.0001
5.	0.71	0.005	0.000025	0.68	0.04	0.0016
6.	0.72	0.015	0.000225	0.61	-0.03	0.0009
7.	0.73	0.025	0.000625	0.65	0.01	0.0001
8.	0.70	-0.005	0.000025	0.62	-0.02	0.0004
9.	0.71	0.005	0.000225	0.63	-0.01	0.0001
10.	0.69	-0.015	0.002645	0.62	-0.02	0.0004

$$\bar{X}_1 = \frac{X_1}{n_1} = 0.705 \qquad X_2 = \frac{X_2}{n_2} = 0.64$$

$$\leq(X_1 - \bar{X}_1)^2 = 0.03250 \qquad \leq(X_2 - \bar{X}_2)^2 = 0.0062$$

$$S = \sqrt{\frac{(X_1-\bar{X}_1)^2 + (X_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}}$$

$$= \sqrt{\frac{0.03250 + 0.0062}{10 + 10 - 2}}$$

$$= 0.046368$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S} \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

$$= \frac{0.705 - 0.64}{0.046368} \times \sqrt{\frac{10 \times 10}{10 + 10}}$$

$$= 3.134584$$

The table value of t at (n+n-1) degree of freedom

$t_{(n+n-1)} = t_{(10+10-1)} = t_{18}$

Table $t_{(18)}$ at 5 per cent level = 2.101

Table $t_{(18)}$ at 1 per cent level = 2.278.

So the calculated 't' - value (3.134584) is greater than the table value 2.878 at 1 per cent level. Hence the difference between the two samples are significant at 1 per cent level.

b. THE DIFFERENCE TEST

This is used to find the difference in thickness between the original and washed samples.

The value of t is obtained as follows.

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

$\bar{d}$ = the mean of the differances.

S = the standard deviation of the differences

The value S is calculated as follows:

$$S = \sqrt{\frac{\leq d^2 - (\bar{d})^2 \times n}{n-1}}$$

t is based on n-1 degrees of freedom.

The Fabric Thickness of readings of the original (X_1) and washed (X_2) Khadi materials are taken and the t - value is calculated.

S.No.	X_1	X_2	d	d^2
1.	0.65	0.71	0.06	0.0036
2.	0.61	0.77	0.16	0.0256
3.	0.68	0.69	0.01	0.0001
4.	0.65	0.74	0.09	0.0081
5.	0.68	0.69	0.01	0.0001
6.	0.61	0.74	0.09	0.0081
7.	0.65	0.70	0.05	0.0025
8.	0.62	0.71	0.09	0.0081
9.	0.63	0.76	0.13	0.0169
10.	0.62	0.75	0.13	0.0169

$$\bar{d} = 0.082; \quad \leq d^2 = 0.09, \; n = 10$$

$$S = \sqrt{\frac{d^2 - (\bar{d})^2 \times n}{n-1}}$$

$$S = \sqrt{\frac{0.09 - 0.006724 \times 10}{9}}$$

$$= \sqrt{\frac{0.09 - 0.06724}{9}}$$

$S = 0.0502811$

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

$$= \frac{0.082 \times 3.1622776}{0.0502871}$$

$t = 5.156525$

The table value of t at (n-1) degree of freedom

$t_{n-1} = t_{10-1} = t_9$

Table t_9 at 5 per cent level = 2.262

Table t_9 at 1 per cent level = 3.250

So the calculated 't' value (5.156525) is greater than the table value 3.250 at 1 per cent level. Hence the difference between the two samples on significant at 1 per cent level.

COEFFICIENT OF VARIATION

When the relative dispersion is stated in terms of arithmetic mean and standard deviation, the resulting percentage is known as the coefficient of variation.

$$\text{Coefficient of variation or C.V.} = \frac{\sigma}{\bar{X}} \times 100$$

where σ = Standard deviation

$\bar{X}$ = Arithmetic mean

Coefficient of variation of the thickness of the Handwoven original material is calculated as follows.

$\bar{X} = 0.705$

$x^2 = 0.03250$

$$= \sqrt{\frac{x^2}{N}} = \sqrt{\frac{0.03250}{10}}$$

$$= 0.0570087$$

$$\text{C.V.} = \frac{0.0570087}{0.705} \times 100$$

$$\text{C.V.} = 8.08634$$