CHAPTER III

METHODOLOGY

The present study was conducted to apply POP as a resist material in dyeing. The methods adopted during the course of present investigation are presented in this chapter under the following heads:

3.1 Locale of Study

3.2 Materials

3.2.1 Fabrics

3.2.2 Dyes

3.2.3 Plaster of Paris

3.2.4 Dyeing auxiliaries

3.2.5 Materials for resist application

3.2.6 Equipments

3.3 Methods

3.3.1 Resist dyeing process

3.3.2 Experiments

3.3.3 Application of dyes

3.4 Comparing different resist materials

3.4.1 Wax resist

3.4.2 Starch resist

3.4.3 Wall putty and white cement resists

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3.6 Final samples

3.7 Preparation of the articles

3.8 Analysis of data
3.1 **Locale of Study**

The experiments were carried out in the Department of Clothing and Textiles, Faculty of Home Science, Banasthali Vidyapith, Rajasthan.

3.2 **Materials**

3.2.1 **Fabrics**

Six fabrics were used in the study so that the performance of POP as resist material could be studied with different dyes. These fabrics were Acrylic, Cotton, Jute, Polyester, Silk and Wool (Table 3.1). These were purchased from Ladakh, Okhla, New Delhi and Agra.

**Table 3.1: Fabrics used in the study**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Fabric</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Acrylic</td>
<td>Ladakh</td>
</tr>
<tr>
<td>2.</td>
<td>Silk</td>
<td>Harper textiles, Okhla</td>
</tr>
<tr>
<td>3.</td>
<td>Cotton</td>
<td>Harper textiles, Okhla</td>
</tr>
<tr>
<td>4.</td>
<td>Jute</td>
<td>Harper textiles, Okhla</td>
</tr>
<tr>
<td>5.</td>
<td>Polyester</td>
<td>Agra</td>
</tr>
<tr>
<td>6.</td>
<td>Wool</td>
<td>Ludhiana</td>
</tr>
</tbody>
</table>

3.2.2 **Dyes**

Five natural and five synthetic dyes were selected for the study (Tables 3.2 and 3.3). The natural dyes were sun yellow, garnet brown, blood red, lac and indigo. All these natural dyes were purchased from Sam vegetable colours Pvt. Ltd., Moradabad. The synthetic dyes were direct dye, acid dye, basic dye, disperse dye and reactive cold dye. These were purchased from Americos Industries, Ahmedabad.

**Table 3.2 Synthetic dyes used in the study**

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Dye class</th>
<th>Name of Dye</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Brand Name</td>
<td>English Name</td>
<td>Botanical Name</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------</td>
<td>-------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Basic Dye</td>
<td>Rhodamine 6GDN BASIC RED 1</td>
<td>Americos Industries, Ahemedabad</td>
</tr>
<tr>
<td>2</td>
<td>Acid Dye</td>
<td>Acid red 119</td>
<td>Americos Industries, Ahemedabad</td>
</tr>
<tr>
<td>3</td>
<td>Direct dye</td>
<td>Direct red 87</td>
<td>Americos Industries, Ahemedabad</td>
</tr>
<tr>
<td>4</td>
<td>Cold Reactive Dye</td>
<td>Reactive red M8B</td>
<td>Americos Industries, Ahemedabad</td>
</tr>
<tr>
<td>5</td>
<td>Disperse Dye</td>
<td>Disperse rubine SE-GFL Disperse red 74</td>
<td>Americos Industries, Ahemedabad</td>
</tr>
</tbody>
</table>

Table 3.3 Natural dyes used in the study

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Brand Name</th>
<th>English Name</th>
<th>Botanical Name</th>
<th>Form</th>
<th>Part used</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sun Yellow</td>
<td>Marigold</td>
<td><em>Ambrosia</em></td>
<td>Powder</td>
<td>Flower</td>
<td>Orangish Yellow</td>
</tr>
<tr>
<td>2</td>
<td>Garnet Brown</td>
<td>Catechu, Cutch</td>
<td><em>Acacia catechu</em></td>
<td>Extract</td>
<td>Wood Extract</td>
<td>Brown</td>
</tr>
<tr>
<td>3</td>
<td>Blood Red</td>
<td>Fermented Madder and Soapnut</td>
<td><em>Rubia cordifolia and Sapindus</em></td>
<td>Powder</td>
<td>Roots And Bark</td>
<td>Red</td>
</tr>
<tr>
<td>4</td>
<td>Lac Dye</td>
<td>Lac</td>
<td><em>Coccus lacca</em></td>
<td>Extract</td>
<td>Insect Secretion</td>
<td>Red</td>
</tr>
<tr>
<td>5</td>
<td>Natural Indigo</td>
<td>Indigofera</td>
<td><em>Tinctoria</em></td>
<td>Extract</td>
<td>Leaves</td>
<td>Blue</td>
</tr>
</tbody>
</table>
3.2.3 **Plaster of Paris**

In the study five brands of Plaster of Paris were used (Table 3.4). These brands were purchased from Agra and Faridabad. The POP was available in packages of 1 Kg to 3 Kg.

**Table 3.4 POP brands used in the study**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Pop Brand</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Aadhar Shree</td>
<td>Mfd by-Paridhi Udyog, Bikaner (Raj.)</td>
</tr>
<tr>
<td>2.</td>
<td>Double Leo</td>
<td>Pkd. &amp; Mkd. by Shankar Lal Tarachand and Sons, Agra</td>
</tr>
<tr>
<td>4.</td>
<td>Sakarni</td>
<td>Mfd by-Jai Durga Plaster Industries, Bikaner (Raj.)</td>
</tr>
<tr>
<td>5.</td>
<td>Dhangash</td>
<td>Mfd by-Dhangash Paints And Minerals, Ballabgarh (Haryana)</td>
</tr>
</tbody>
</table>

3.2.4 **Dyeing auxiliaries**: Different chemical substances used as dyeing auxiliaries in the study have been presented in table 3.5.

**Table 3.5 Dyeing auxiliaries used in the study**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Auxiliary/Chemical</th>
<th>Chemical formula</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Caustic Soda</td>
<td>NaOH</td>
<td>For dyeing</td>
</tr>
<tr>
<td>2.</td>
<td>Sodium chloride</td>
<td>NaCl</td>
<td>For exhaustion</td>
</tr>
<tr>
<td>3.</td>
<td>Sodium Carbonate</td>
<td>Na2CO3</td>
<td>For scouring and for dyeing</td>
</tr>
<tr>
<td>4.</td>
<td>Turkey Red Oil (TRO)</td>
<td>C18H32Na2O6S</td>
<td>Wetting agent</td>
</tr>
<tr>
<td>Sr. No.</td>
<td>Material used for making different resist paste</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>White adhesive (Fevicol MR Easy Flow brand from Pidilite)</td>
<td>For mixing with resist paste of POP</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gum (Camel brand)</td>
<td>For mixing with resist paste of POP</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fabric Glue (Fevicryl hobby ideas brand from Pidilite)</td>
<td>For mixing with resist paste of POP</td>
<td></td>
</tr>
</tbody>
</table>

### 3.2.5 Materials for resist application

Materials used for making different resist pastes and for application of resist pastes are presented in tables 3.6 and 3.7.

**Table 3.6 Materials used for making different resist pastes**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Material used for making different resist paste</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Sodium dithionite (Na2S2O4)</td>
<td>For dyeing</td>
</tr>
<tr>
<td>6</td>
<td>Sodium Sulphate (Na2SO4)</td>
<td>For dyeing</td>
</tr>
<tr>
<td>7</td>
<td>Acetic Acid (CH3COOH)</td>
<td>For mordanting and dyeing</td>
</tr>
<tr>
<td>8</td>
<td>Detergent liquid (Ezee, from Godrej)</td>
<td>For Scouring and to make dye paste</td>
</tr>
<tr>
<td>9</td>
<td>Detergent Powder (Surf Excel Blue from Hindustan Univer Ltd.)</td>
<td>For scouring</td>
</tr>
<tr>
<td>10</td>
<td>Ethanol (C6H5OH)</td>
<td>For dyeing</td>
</tr>
<tr>
<td>11</td>
<td>Phenol (CH2CH2OH)</td>
<td>For dyeing</td>
</tr>
<tr>
<td>12</td>
<td>Benzoic Acid (C6H5COOH)</td>
<td>For dyeing</td>
</tr>
<tr>
<td>13</td>
<td>Alum (Aluminium Potassium Sulphate) (AlK(SO4)2.12H2O)</td>
<td>For mordanting</td>
</tr>
</tbody>
</table>

---

**Table 3.7 Materials for application of resist pastes**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Material used for making different resist paste</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White adhesive (Fevicol MR Easy Flow brand from Pidilite)</td>
<td>For mixing with resist paste of POP</td>
</tr>
<tr>
<td>2</td>
<td>Gum (Camel brand)</td>
<td>For mixing with resist paste of POP</td>
</tr>
<tr>
<td>3</td>
<td>Fabric Glue (Fevicryl hobby ideas brand from Pidilite)</td>
<td>For mixing with resist paste of POP</td>
</tr>
<tr>
<td>S. No.</td>
<td>Other materials</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Gum Tragacanth</td>
<td>For mixing with resist paste of POP</td>
</tr>
<tr>
<td>5</td>
<td>Wall care white putty (Birla)</td>
<td>For making resist paste</td>
</tr>
<tr>
<td>6</td>
<td>White Cement (Birla)</td>
<td>For making resist paste</td>
</tr>
<tr>
<td>7</td>
<td>Paraffin wax and bees wax</td>
<td>For applying as a resist</td>
</tr>
<tr>
<td>8</td>
<td>Binder and fixer</td>
<td>For mixing with resist paste with POP</td>
</tr>
</tbody>
</table>

Table 3.7  Materials used for application of resist pastes

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Other materials</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Transparent tape</td>
<td>For fixing cone and for fixing OHP stencil</td>
</tr>
<tr>
<td>2.</td>
<td>Cellophane sheet</td>
<td>For making cone</td>
</tr>
<tr>
<td>3.</td>
<td>Thread</td>
<td>For tying cone and making samples</td>
</tr>
<tr>
<td>4.</td>
<td>OHP sheet</td>
<td>For making stencil</td>
</tr>
<tr>
<td>5.</td>
<td>Cardboard</td>
<td>For making stencil</td>
</tr>
<tr>
<td>6.</td>
<td>Coins</td>
<td>For tie &amp; dye</td>
</tr>
<tr>
<td>7.</td>
<td>Tracing paper</td>
<td>For tracing designs and draping shapes</td>
</tr>
<tr>
<td>8.</td>
<td>Blotting paper</td>
<td>For removing extra liquid from the fabric after dyeing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(to help in quick drying)</td>
</tr>
<tr>
<td>9.</td>
<td>Newspaper</td>
<td>For placing below the blotting paper</td>
</tr>
<tr>
<td>10.</td>
<td>Thinner</td>
<td>For mixing with enamel paint</td>
</tr>
<tr>
<td>11.</td>
<td>Asian Enamel Paint</td>
<td>For making screen</td>
</tr>
</tbody>
</table>

3.2.6 Equipment: The equipments used various experiments of the study are presented in tables 3.8, 3.9 and 3.10.
Table 3.8 Textile testing equipment used in the study

<table>
<thead>
<tr>
<th>Sr.no.</th>
<th>Textile testing equipment</th>
<th>Company/ Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Crease recovery tester</td>
<td>Eureka</td>
</tr>
<tr>
<td>2.</td>
<td>Tensile strength tester</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Drape meter</td>
<td>Paramount</td>
</tr>
<tr>
<td>4.</td>
<td>Stiffness tester</td>
<td>Eureka</td>
</tr>
<tr>
<td>5.</td>
<td>Digital balance</td>
<td>Shimadzu</td>
</tr>
<tr>
<td>6.</td>
<td>Thickness tester</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Magnifying glass (For thread count and identifying the weave)</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Oven</td>
<td>Ambassador</td>
</tr>
</tbody>
</table>

Table 3.9 Equipment used in the study for dyeing

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Equipment</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Beakers</td>
<td>For making dyeing paste, for dyeing</td>
</tr>
<tr>
<td>2.</td>
<td>Hot Plate</td>
<td>For hot dyeing</td>
</tr>
<tr>
<td>3.</td>
<td>Gloves</td>
<td>For wearing during dyeing</td>
</tr>
<tr>
<td>4.</td>
<td>Glass Rod</td>
<td>For mixing dye paste, stirring dye bath</td>
</tr>
<tr>
<td>5.</td>
<td>Steel pan</td>
<td>For heating water and scouring the fabrics</td>
</tr>
<tr>
<td>6.</td>
<td>Enamel tray</td>
<td>For dyeing</td>
</tr>
<tr>
<td>7.</td>
<td>Calculator</td>
<td>For calculating amount of materials</td>
</tr>
<tr>
<td>8.</td>
<td>Wire Gauze</td>
<td>For putting beaker on it</td>
</tr>
<tr>
<td>9.</td>
<td>Thermometer (100°C)</td>
<td>For measuring temperature</td>
</tr>
</tbody>
</table>
10. pH strips  
For measuring pH of water and after adding acetic acid in water.

11. Measuring cylinders  
For measuring water

12. Spatula  
For taking out dyes, chemicals and POP

13. Digital Balance  
For measuring dyes, chemicals and resist materials

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Equipments</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wooden Blocks</td>
<td>For printing of resist paste</td>
</tr>
<tr>
<td>2.</td>
<td>Round embroidery frames of plastic and wood</td>
<td>To mount the fabric for stretching</td>
</tr>
<tr>
<td>3.</td>
<td>Painting brushes of various sizes (round, flat)</td>
<td>For applying resist paste</td>
</tr>
<tr>
<td>4.</td>
<td>Tooth Brush</td>
<td>For spraying resist paste</td>
</tr>
<tr>
<td>5.</td>
<td>Cloth clips</td>
<td>For holding coins and stencil</td>
</tr>
<tr>
<td>6.</td>
<td>Cutter</td>
<td>For cutting stencil</td>
</tr>
<tr>
<td>7.</td>
<td>Petry Dish</td>
<td>For making POP paste</td>
</tr>
<tr>
<td>8.</td>
<td>Dropper</td>
<td>For putting water and chemicals</td>
</tr>
<tr>
<td>9.</td>
<td>Alpins</td>
<td>For fixing the samples &amp; making hole in the cone</td>
</tr>
<tr>
<td>10.</td>
<td>Gas stove and Lighter</td>
<td>For cooking of starch pastes</td>
</tr>
<tr>
<td>11.</td>
<td>Scissors</td>
<td>For cutting fabric, tape, OHP sheet, cellophane sheet, etc.</td>
</tr>
<tr>
<td>12.</td>
<td>Nylon Screen with wooden</td>
<td>For printing resist paste</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Organdie Screen with wooden frame</td>
<td>For making organdie screen</td>
</tr>
<tr>
<td>14.</td>
<td>Squeegee</td>
<td>For applying resist paste through screen</td>
</tr>
<tr>
<td>15.</td>
<td>Ruler</td>
<td>For length measurements and straight lines</td>
</tr>
<tr>
<td>16.</td>
<td>Pencil</td>
<td>For marking on fabric</td>
</tr>
<tr>
<td>17.</td>
<td>Compass</td>
<td>For drawing circular shapes</td>
</tr>
<tr>
<td>18.</td>
<td>Tracing table</td>
<td>For tracing designs on the fabric and paper</td>
</tr>
<tr>
<td>19.</td>
<td>Kitchen grinder</td>
<td>For grinding rice and maize grains</td>
</tr>
<tr>
<td>20.</td>
<td>Iron</td>
<td>For ironing and for wax removal</td>
</tr>
<tr>
<td>21.</td>
<td>Hot air oven</td>
<td>For drying of resist layer</td>
</tr>
</tbody>
</table>

### 3.3 Methods

#### 3.3.1 Resist dyeing process

The resist dyeing process that was common for all the experiments was as follows.

**a) Preparation of fabric**

The fabrics were scoured to remove dirt, grease and starch. The following recipe was used for scouring.

- **Soap** – 5 g/l
- **Sodium carbonate** – 2 g/l
- **Material to Liquor ratio** – 1:30
- **Temperature** – 60°C
- **Time** – 30 min.

After scouring materials were rinsed in clean water and dried under shade and ironed to remove all creases.
b) Preparation of POP resist paste

The desired amount of POP was weighed and taken in a bowl. Now required amount of water was added and simultaneously mixing was done with the help of a spoon so as to form a paste which could be applied easily.

c) Application of POP resist paste

The freshly prepared resist paste was applied by brush method except in one experiment where different application methods were used.

d) Drying

The resist applied fabric was dried either in sun or in oven. The Resist paste applied on the fabric was sun dried for 2 days if it was a sunny day (temp.-more than 35°C). On rainy days and in winter when the sunlight was not hot enough, oven was used. The fabric was kept in the oven for at least 6 hrs.

e) Dyeing

The fabrics were dyed after complete drying of the resist paste applied on them. Different dyes were applied using their respective suitable methods.

f) Removal of resist paste

After complete drying of the sample after dyeing, the resist paste was removed by peeling off and rubbing. The left over resist material was removed by washing in plain water. Then the samples were allowed to dry under shade. Finally, the samples were ironed to remove the creases.

3.3.2 Experiments

3.3.2.1 Performance of Plaster of Paris brands in resist dyeing

Five brands of Plaster of Paris were applied on six types of fabric i.e. Silk, Wool, Cotton, Jute, Polyester and were dyed with different cold as well as hot dyes.

Direct dye - Cotton Sun Yellow dye - Silk
Acid dye - Wool    Lac dye - Silk  
Basic dye - Silk    Blood Red dye - Wool  
Disperse dye - Polyester   Garnet Brown dye - Jute 
Reactive Cold dye- Jute    Indigo - Polyester

Then, samples were evaluated by ten experts to select the best POP on the basis of whiteness of reserved area, sharpness of outlines and overall aesthetic appeal. The brand giving best performance with all the dyes was selected for further experiments.

3.3.2.2 Performance of Plaster of Paris resist with different dyes

In order to study the performance of POP with different synthetic and natural dyes POP was applied on six different types of fabrics in the form of a motif. Following dye-fabric combinations were selected for this experiment.

**With synthetic dyes:-**

Direct dye - Cotton, Silk, Wool, Jute  
Acid dye - Wool, Silk  
Basic dye - Silk, Wool, Cotton, Acrylic, Jute  
Disperse dye - Polyester, Acrylic  
Reactive Cold dye - Jute, Silk, Wool, Cotton

**With natural dyes:-**

Indigo dye - Polyester, Acrylic  
Sun Yellow dye - Silk, Cotton, Wool, Jute  
Lac dye - Silk, Wool  
Blood Red dye- Silk, Wool  
Garnet Brown dye - Jute, Cotton, Silk, Wool

Then, samples were evaluated to select the best dye-fabric combinations on the basis of whiteness of reserved area, sharpness of outlines and overall aesthetic appeal.
3.3.2.3 Effect of POP resist on physical properties of fabrics

Physical properties of the six fabrics were tested before and after application of POP to see the effect of resist paste. The physical properties tested were stiffness, crease recovery, weight, absorbency, drapability and tensile strength. For pre-application tests undyed scoured fabrics were cut in the size and number needed for each test. For post-removal tests single layer of POP paste was applied on the fabric piece with help of a two inches broad, flat painting brush. Then the fabric was dried in the sun. After drying, the resist was removed by rubbing with the hands. After removal of resist, the fabric was cut in the size and number needed for various tests.

a) Determination of fabric stiffness

Stiffness is the tendency of fabric to keep standing without any support. It is a key factor in the study of handle and drape of fabric. A rectangular strip of fabric, 6 in. x 1 in., is mounted on a horizontal platform in such a way that it over change, like a cantilever, and bends downwards as shown in figure.

![Diagram of fabric stiffness](image)

**Figure: Fiber stiffness, cantilever principle**

From the length $l$ and the angle $\theta$ a number of values are determined. Here the length of the fabric that will bend under its own weight to a definite extent is called bending length. It is a measure of stiffness that determines draping quality. The calculation is as follows:

$$c = lf_1(\theta)$$

Where

$$f_1(\theta) = \left( \frac{1}{\cos \frac{\theta}{2}} \right)^{\frac{1}{3}} \left( \frac{2}{8 \tan \theta} \right)$$
Three specimens in warp way and three in weft are tested. The horizontal platform of the instrument is supported by two side pieces made of plastic. Attached to the instrument is a mirror which enables the operator to view both index lines from a convenient position. The scale of the instrument is graduated in centimeters of bending length and it also serves as the template for cutting the specimens to size.

**Apparatus:**

1. StiffnessTester
2. Scissor
3. Scale

**Procedure:**

1. To carry out the test, the specimen was cut to size 6 in. x 1 in. with the aid of the template.
2. Both the template and specimen were transferred to the platform with the fabric underneath.
3. Now both were slowly pushed forward.
4. The strip of the fabric was commence to droop over the edge of the platform and the movement of the template and the fabric was continued until the tip of the specimen viewed in the mirror cuts both index lines.
5. The bending length was immediately read off from the scale mark opposite a zero line engraved on the side of the platform.
6. Each specimen was tested four times, at each end and again with the strip turned over.
7. In this way three samples were tested.
8. Finally mean values for the bending length in warp and weft directions was calculated.
b) CREASE RECOVERY OF FABRIC

Determination of fabric crease recovery

Crease is a fold in fabric introduced unintentionally at some stages of processing. Crease or crushing of textile material is a complex effect involving tensile, compressive, flexing and torsional stresses. Crease recovery is a fabric property which indicates the ability of fabric to go back to its original position after creasing. Crease recovery is a measure of creases resistance, specified quantitatively in terms of crease recovery angle. The crease recovery tester consists of a circular dial which carries the clamp for holding the specimen. Directly under the centre of the dial there is a knife edge and an index line for measuring the recovery angle. Crease recovery is determined depending upon this recovery angle. If the angle is 0° then recovery is zero and if the angle is 180° then recovery is full. Crease recovery depends on the construction, twist of yarn, pressure, time etc. Usually crease recovery is more in warp way than in weft way. This is because warp yarns are well in quality, strength, treated with sizing, kept in more tension during weaving etc.

Apparatus: Crease recovery tester, Scissor, Glass plates, Steel plates and Weight.

Procedure:

- The specimen was cut by template (Size: 4.4 X 1.5 cm ) and was carefully creased by folding in half.
- The crease was imparted on fabric by placing it between two glass plates and adding to 500gm weight on it.
• After 1 min the weight was removed and the creased fabric was clamped on the instrument.

• Then it was allowed to recover from the crease. The recovery time may vary to suit particular creases. Usually it was 1 min.

• When crease recovers the dial of the instrument was rotated to keep the free edge of the specimen in line with the knife edge.

• The recovery angle was read from the engraved scale.

• In this way 5 tests were done in warp way and 5 for weft way.

• The mean value of recovery angle was taken and thus crease recovery was measured.

\textbf{c) Tensile Strength:}

Test to determine the breaking strength and elongation of most textile fabrics. Strength of a fabric is generally considered the most obvious indicator of the service life of a fabric. Also the strength of fabric indicates its ability to resist mechanical damage due to stress of normal wear and refurbishing. A continually increasing load is applied lengthwise or widthwise to the specimen, and the test is carried to fabric rupture. Values for the breaking load of the test specimen are obtained from machine scales, dials or charts.
• **APPARATUS:**
  - Tensile testing machine

• **PROCEDURE:**
  - 5 specimens of size 12x2 inches long in both warp (length) and filling (width) directions were cut.
  - The gauge was set (distance between the jaws) at 10 inches, and 2 inch was clamped from both the sides of the specimen lengthwise in both jaws.
  - The test was started by, press "up" key on crosshead control panel.
  - The reading of load (kg) and elongation (mm) were noted from the instrument panel when the fabric breaks.
  - Return the jaws to the original gauge length.
  - Remove the ruptured specimen from the jaws.
  - Repeat the steps for the remaining test specimens.
  - Then the average reading was calculated for load as well as for elongation.

c) **Drape Meter**

drape is one of the subjective performance characteristics of fabric that contributes to its aesthetic appeal. It is a complex property involving bending and shearing deformation. One of the methods of determining the drape characteristics in which both the warp and weft way characteristics interact to produce a graceful folding using a circular support over which a
specimen of the fabric in form of a circular piece is placed with an annular section
overhanging the support. The horizontal area covered by the shadow left by the overhanging
portion of the fabric is determined and compared against its actual area to obtain the drape
coefficient.

**Procedure**-

1. The hinged acrylic sheet was raised. One ammonia process paper was placed face up over
the resilient rubber sheet below the acrylic sheet. The acrylic sheet was lowered so that it sits
firmly on the paper. The paper should lie flat and should be free of any fold or crease.

2. The specimen loading assembly was removed from the specimen support. The specimen
was placed between the plates of this assembly, with the bolt passing through the central hole
of the specimen. Then the thumb nut was tightened. After which the thumb nut of the
assembly was held and the holder was moved with the specimen up and down ten times, each
time resting on the table for a moment.

3. The test specimen holder assembly was lowered with test specimen gently over the
specimen support in such a way that the head of the bolt sits in the hole at the centre of the
test specimen.

4. The lamp was switched on and the time was noted at which the lamp was switched on.
Then the paper was allowed to get exposed for 10-12 minutes.

5. The door of developing chamber below the exposing chamber was opened. The plastic
bottle placed inside was removed. If the level of ammonium hydroxide in the bottle was less
than half then add more liquor to raise the level to three fourth. If the liquor in the bottle does
not give off a strong smell of ammonia, then drain off the told liquor in the bottle which was
replaced in the developing chamber with its cap removed.
6. The exposed paper was removed from the exposing chamber and it was placed with the exposed face downwards over the welded wire mesh platform inside the developing chamber. The paper was kept in this state for a period of ten minutes. At the end of this period, the developing paper was removed from the chamber if no further tests have to be conducted and the cap of the ammonium hydroxide was replaced.

7. The outline of the exposed area on the paper was slightly hazy or diffused because of divergence of light rays. Then freehand smooth curve was drawn through the centre of the diffused areas, leaving out hazy portions or indistinct boundaries.

8. The paper was conditioned in standard atmosphere. The drape pattern was then cut out with a pair of scissors and its mass in gram was determined in grams to two decimal places.

9. The mass per unit area of the paper was determined used by cutting a known area of the original paper and it was weighed.

10. Then the specimen was reversed and the drape pattern with the other surface upwards was obtained.

11. At least 3 specimens were tested making a total of 6 measurements.

**Calculations**

Calculate the area of drape pattern as below:

\[
\text{AREA OF DRAPE PATTERN ( D )} = K \times \frac{w}{W}
\]

Where:

- \( K \) is the correction factor for divergence of light rays (0.91),
- \( w \) is the mass of drape pattern in grams, and
- \( W \) is the area of the original paper in square units.
W is the mass of ammonia process paper in grams per cm square

From the value of D determined above, calculate the drape coefficient $F$ for the test specimen as below:

Drape Co-efficient $(F)_\% = \frac{(D - a)}{(A - a)} \times 100$

Where:

$a$ is the area of supporting stand of 12.5 cm diameter $(122.8 \text{ cm}^2)$

$A$ is the area of test specimen of 25 cm diameter $(491.1 \text{ cm}^2)$

Calculate the value of $F$ for each test values separately and find the mean of all the values of $F$. report this mean as the average drape co-efficient for the sample under test.

e) Absorbency Test

By sinking time

At least 5 samples of the size 2X2 were cut from the six fabrics. Each sample was kept on the surface of water taken in 800ml glass beaker. Time taken by the sample to sink down to the base of the beaker was noted down with the help of stop watch. Then average of five readings for each fabric was taken.

f) Weight:

To determine change in weight of the six fabrics, five samples of size 5”x4” were taken from each fabric. These samples were numbered and weighed with the help of digital balance. Weight was measured before application of POP as well as after application of POP.
Weight per unit area was calculated according to the following formula:

\[
W = \frac{Wt (gm) \times 36 \times 36}{28 \times 20 (sq. inches)}
\]

\[W = \text{Weight / unit area in ounce /sq. yard.}\]

Average of five readings was taken for each fabric as weight per unit area.

### 3.3.2.4 Experiments with different application methods

Plaster of Paris resist paste was applied on different fabrics with different application methods, namely brush, cone, spray, stencil, drop method, screen, block, dipping, pencil and thread application and tie & dip application.

After application of the resist paste the fabric was dried, dyed, washed and again dried. The resist paste was then removed. The sample was patted and finally ironed.

These samples were assessed by 5 experts on the basis of resist effect whereas ease of application and ease of removal was assessed by the researcher herself and the guide.

#### a) Brush method

Plaster of Paris paste of consistency 5:5 (gm/ml) was applied with brush on damp fabric as POP adhered well on damp surface. Separate samples were prepared by applying POP on single and double side of the fabric. Samples were also prepared by incorporating cracks as well as without incorporating cracks in the resist layer.

**Brush both sides-**

**With synthetic dyes:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Suitable Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct dye</td>
<td>Cotton, Silk, Wool, jute</td>
</tr>
<tr>
<td>Acid dye</td>
<td>Silk, wool</td>
</tr>
<tr>
<td>Basic dye</td>
<td>Silk, Wool, acrylic, cotton, jute</td>
</tr>
</tbody>
</table>
Disperse dye - Polyester, acrylic
Reactive Cold dye - Silk, Wool, Cotton, jute

With natural dyes:-
Indigo dye - Polyester, acrylic
Sun Yellow dye - Silk, Cotton, Wool, Jute
Lac dye - Silk, Wool
Blood Red dye - Silk, Wool
Garnet Brown dye - Silk, jute, wool, cotton

Brush single side:
direct dye-cotton Reactive cold dye-jute

Brush both side with crack

With synthetic dyes:-
Direct dye - Cotton, Silk, Wool, jute
Acid dye - Silk, wool
Basic dye - Silk, Wool, jute
Disperse dye - Polyester, acrylic
Reactive Cold dye - Silk, Wool, Cotton, jute

With natural dyes:-
Indigo dye - Polyester
Sun Yellow dye - Silk, Cotton, Wool, Jute
Lac dye - Silk, Wool
Blood Red dye - Silk, Wool
Garnet Brown dye - Silk, jute, wool, cotton

Brush single side with crack
Direct dye-cotton Reactive cold dye-Jute
b) Cone method

Plaster of Paris paste was applied with the help of a cone on damp fabric. The cone was made of thick cellophane sheet. Two types of pastes were used. First was POP and water paste of consistency 5:5 (gm/ml). Other was POP, Fevicol and water paste in the ratio 5:2.5:4 (gm:gm:ml).

Then the fabric was dyed (direct dye for cotton and reactive cold dye for cotton, jute, silk and wool), washed, dried, removal of resist, patted and ironed.

c) Spray method

For spray application Plaster of Paris paste was sprayed with the help of tooth brush on damp fabric and the consistency taken was 5:4 (gm/ml).

Then the fabric was dyed (direct dye for cotton and reactive cold dye for jute), washed, dried, removal of resist, patted and ironed.

d) Stencil method

Many experiments were done to find suitable stencil for application of Plaster of Paris paste.

First stencil was made from OHP sheet. The OHP stencil was kept on the fabric and it was kept in place with the help of cello tape. The POP paste was applied with the help of 1 inch flat brush 4 to 5 times and when this side was dry, the fabric was turned and same process was repeated. For application with stencil POP pastes of different types were prepared. First paste was POP and water paste of consistency 5:5 (gm/ml). Second was POP, Fevicol and water paste of consistency 5:2.5:4 (gm: gm: ml). The third paste was made with POP, gum and water keeping consistency 5:2:4 (gm:gm:ml).

With fevicol and with gum, OHP stencil was also tried for dyeing for less time i.e.35 min. with disperse dye on polyester fabric.
Then pop and water paste was applied with the help of OHP stencil only on one side of fabric in the same manner as mentioned above.

Second stencil was made of cardboard. Enamel paint was coated on its surface so that it did not become soggy during use. The inside edge of the stencil was also greased with the a cream so that after drying of the applied resist paste, stencil could be easily separated from the fabric without taking off POP with it. The consistency of POP water paste was 5:5 (gm/ml). This stencil was made in a pair to keep one piece above and one piece below the fabric. The stencil was secured on the fabric with the help of cloth clips. The fabric was wetted with flat brush. POP paste was poured in the upper stencil. After the POP was slightly set, spatula was used to press the POP so that any air spaces inside the POP paste could be removed. Then it was left undisturbed for 10 minutes. The fabric with the stencil pair was turned upside down and POP paste was poured in the lower stencil. After pressing the slightly set paste of POP with spatula it was left for complete setting. After 1 hour the stencils were removed.

The readymade stencil made of plastic available in the market was also tried like other stencils. But it could not apply the resist satisfactorily. Its fixing on the fabric surface was difficult. While removing it broke the POP layer’s edges.

The following dye-fabric combinations were used in this experiment.

**Stencil single side application:**

| Reactive cold dye- jute | Direct dye-cotton |

**Stencil both sides application:**

**With synthetic dyes:-**

| Direct dye | - | Cotton, Silk, Wool, |
| Acid dye | - | Silk |
| Basic dye | - | Silk, Wool |
Disperse dye - Polyester
Reactive Cold dye - Silk, Wool, cotton, jute

With natural dyes:-
Indigo dye - Polyester
Sun Yellow dye - Silk, Cotton, Wool, Jute
Lac dye - Silk, Wool
Blood Red dye - Silk, Wool
Garnet Brown dye - Silk

e) Drop method

For application of POP resist paste by drop method the consistency was kept 5:5 (gm/ml). Another consistency tried was of POP:fevicol:water-5:2.5:4 gm/gm/ml. The paste was applied with the help of a painting brush. Before applying POP on the fabric, the fabric was wetted so that protruding fibres of the fabric surface became flat and the drop had better contact and adhesion with the fabric surface. The paste was dropped on the design with the help of painting brush.

Then the fabric was dyed (direct dye for cotton, reactive cold dye for jute, silk, wool and cotton and disperse dye-polyester) washed, dried, removal of resist, patted and ironed.

f) Screen method

Plaster of Paris was applied with the help of nylon screen. The following variations in the resist were done so that it could be applied through the screen.

- POP and water paste consistency was 5:5 (gm/ml).
- POP, binder, fixer and water of consistency 5:2.5: few drops:4.(gm:gm:few drops:ml)
Screen made of organdy fabric was also made and used as its mesh size was bigger than nylon. With this screen also the above mentioned POP pastes were tried. Then the fabric was dyed (direct dye for cotton), washed, dried, removal of resist, patted and ironed.

**g) Block method**

Wooden blocks were used for application of POP resist paste. The following variations in the resist paste were done for application using the block print method.

- Plaster of Paris and water paste of consistency 5:5 (gm/ml).

Then the fabric was dyed (direct dye for cotton), washed, dried, removal of resist, patted and ironed.

**h) Dipping method**

For application through dipping method the consistency of POP was 5:5 (gm/ml). The POP paste was poured in a beaker where one corner of the fabric was dipped in the POP paste, after which the fabric was taken out and hung on a stand. When the resist was slightly set, it was removed from the stand.

Then the fabric was dyed (direct dye for cotton and reactive cold dye for jute), washed, dried, removal of resist, patted and ironed.

**i) Pencil and thread application**
In this experiment the fabric was rolled on a pencil and then tied with a thread in spiral criss-cross method. Then the POP paste was made with the consistency 5:5 (gm/ml) and this paste was poured in a tray. The fabric tied on the pencil was rolled in the tray and then it was hung with the help of the thread on a stand. When the resist was slightly set, it was removed from the stand and then it was sun dried or oven dried. The thread was opened after drying.

Then the fabric was dyed (direct dye for cotton and reactive cold dye for jute), washed, dried, removal of resist, patted and ironed.

j) Tie and dip

In this experiment the fabric was lifted from the center and was spirally tied from the center to the edge of fabric in criss-cross fashion. The tied fabric was dipped in POP paste which was made with the consistency 5:5 (gm/ml) and was hung on a stand with the help of a thread. When the resist was slightly set, it was removed from the stand and then it was sun dried or oven dried. The thread was opened after drying.

Then the fabric was dyed (direct dye for cotton and reactive cold dye for jute), washed, dried, removal of resist, patted and ironed.

3.3.3. Application of dyes

The fabric to be dyed was desized and scoured. It was soaked in water 20 min before dying. Dyeing was done using respective application methods for each dye. After removing from dye bath, dyed samples were thoroughly rinsed in tap water and dried in shade.

3.3.3.1 Application of direct dye

a) Preparation of dye bath and dye paste

The fabric samples were weighed and then the amounts of dye and chemicals were calculated o.w.f. Material to liquor ratio was kept 1:100 (silk) and 1:50 (other fabrics). The dye (5%)
was taken in a beaker and dye paste was made with ezee and it was stirred to dissolve the dye completely.

b) Dyeing

The dye paste was added into the dye bath at 40\(^{\circ}\)C and stirring was done properly. The pre-soaked material was entered into the dye bath. The temperature was raised to 80\(^{\circ}\)C for 10-15 minute. The fabric was removed from dye bath and common salt (25\%) and Sodium carbonate (4 \%) was added. It was stirred well and the fabric was re-entered into the dye bath. Dyeing was done for 10-15 minute at boiling temperature.

3.3.3.2 Application of reactive dye (cold)

a) Preparation of dye bath

The fabric samples were weighed and the amount of following chemicals was calculated o.w.f. Material to liquor ratio was kept 1:100 (silk) and 1:50 (other fabrics). The dye (5\%) was taken in a beaker and required amount TRO was added and stirred to dissolve the dye completely.

b) Dyeing

Dye paste was added to dye bath & stirred properly. After 5 minutes fabric was entered in the dye bath at 20 – 30 \(^{\circ}\)C. After 5 minutes salt and Sodium carbonate (15 \%) was added. Fabric was dyed for 30 minutes.

3.3.3.3 Application of disperse dye

a) Preparation of dye bath

The fabric samples were weighed and the amount of following chemicals was calculated o.w.f. Material to liquor ratio was kept 1:50. The dye (5\%) was taken in a beaker and dye paste was made with ezee. It was stirred to dissolve the dye completely.

b) Dyeing
Temperature of water was maintained at 40 degree centigrade. 5 ml of ethanol solution was added to 5 ml of phenol. Both were mixed properly so that chrome yellow colour can be obtained then the good were entered in the solution of dye bath and they were mixed well. After 5-10 min benzoic acid 1\% on the weight of the fabric was added into the solution. It was continuously stirred for 1 hr at 80 degree boiling temperature.

### 3.3.3.4 Application of Basic Dyes

#### a) Preparation of dye bath

The fabric samples were weighed and the amount of dye and chemicals were calculated o.w.f. Material to liquor ratio was kept 1:100 (silk) and 1:50 (other fabrics). The dye (5\%) was taken in a beaker and dye paste was made with ezee. it was then stirred to dissolve the dye completely.

#### b) Dyeing

Dye paste, acetic acid (few drops) and sodium sulphate (10\%) were mixed in boiling water. This paste was added in the dye bath. Fabric was added in the dye bath at 40\°C and worked for 5 min. after which temperature was raised to 90\°C. Dyeing was done at 90\°C for 30 minutes.

### 3.3.3.5 Application of Acid Dye

#### a) Preparation of dye bath

The fabric samples were weighed and the amount of dye and chemicals were calculated over the weight of fabric. Material to liquor ratio was kept 1:100 (silk) and 1:50 (wool). The calculated amounts of dye (5\%) and sodium sulphate (5\%) were divided into two equal parts for two installments. Dye paste was made with Ezee, Sodium Sulphate and acid and it was stirred to dissolve it completely.

#### b) Dyeing
The dye paste was added at 40°C into dye bath. It was then stirred properly. The pre-soaked material was entered into the dye bath. The temperature was maintained up to 40-60°C for 30 min. The second installment of dye paste was added to dye bath. The liquor was heated for 45-60 min.

3.3.3.6 Dyeing cotton and jute with natural dyes

Dyeing of cotton and jute with natural dyes required two steps i.e. mordanting and dyeing.

a) Mordanting

Alum was taken 10% by weight of cotton fabric. i.e.10g alum for 100g fabric. The mordant was dissolved in little amount of warm water and was heated further. When the temperature of the water rose to 60°C the fabric was added and treated for 30 minutes at 80°C. After which the fabric was rinsed with water.

b) Dyeing

Higher dye percentage was taken to get darker shades. The dye was taken over the weight of fabric and was dissolved in warm water (Sunyellow-40% for cotton and jute, Garnet brown-30% for glazed cotton and jute). This solution was strained into the beaker containing water (M:L=1:50) at 60°C. After which the mordanted fabric was added to the dye solution and the fabric was boiled with this dye solution for 1 hour. The temperature of the dye bath was raised to 80°C. After 1 hour 20% of soda (dissolved in 10 liter water) that is 20kg was added to the beaker and the fabric was being treated with soda for 30 minutes at 80°C. The Dyeing was completed. The fabric was then rinsed and washed in tap water

3.3.3.7 Indigo dyeing process for polyester and acrylic

Caustic soda, Sodium hydro-sulphite and Indigo were used. For medium shade 5% dye was taken i.e. for 10 grams of fabric 500 mg of dye was taken. Caustic soda was taken 100% of the dye, thus 500mg of caustic soda was added to the dye. Using a little amount of water solution of indigo and caustic soda was prepared. Colour of the solution became blue.
Sodium hydro-sulphite was taken double the quantity of dye i.e. 200% of the dye. Thus 1 gm of the sodium hydro-sulphite was added to the dye solution. The colour of the dye solution became deep yellowish green. The solution was then mixed properly. The dye solution was added to the dye bath (M:L=1:50). For dyeing wool or silk, temperature of the dye bath was about 60°C. Colour of the dye bath was yellowish green. In case colour of the dye bath is not yellowish green, small quantity of caustic soda & sodium hydro-sulphite is added to the dye bath to make the colour of the dye bath yellowish green. Soaked fabric was entered in the dye bath. Fabric was immersed in the dye bath for 10 minutes. This was called first dipping. After 10 minutes fabric was taken out, spread on a blotting paper and was allowed to oxidize for 10 minutes. Colour of the yarn or fabric changes from yellowish green to blue. The fabric was again immersed in the dye bath for 5 mins. This was called second dipping. After 5 minutes fabric was taken out and was again oxidized for 10 minutes. Colour of the fabric will be darker blue than it was after first dipping. This was repeated for 4-5 times so that the dyed fabric didn’t show patchy dyeing. Little quantity of acetic acid was added in the plain water in order to remove the excess alkalinity and unfixed dye on the fabric. Dyed fabric was immersed in the acetic acid solution and kept for 10 minutes. Acetic acid treatment was given to increase the fastness and lusture to the fabric. In the end, the fabric was washed in plain water.

3.3.3.8 Dyeing wool and silk with natural dyes

Dyeing wool and silk with natural dyes required two steps, first mordanting and then dyeing.

a) Mordanting: Properly scoured dyeing material was dipped in water well before the mordanting. Alum 20% o.w.f was taken and dissolved in small amount of hot water. This solution was kept on side. In a beaker few drops of acetic acid were added to the water for mordanting to bring the pH to 4. Now this water was heated to 60°C. The dissolved Alum was sieved through a fine cloth into the mordanting bath. The residue in the cloth was rubbed
with a stick to help it pass through the cloth. The solution was stirred. Soaked fabric was
squeezed and added to the beaker. The fabric was moved continuously and temperature was
raised to reach boiling. Material was kept on boiling for 45 min. Then heating was stopped.
Material was left in the beaker so that the temperature comes down to 60°C. Then the
material was taken out from the beaker and left to cool down to room temperature and then
rinsed with water. This mordanted material was ready for dyeing.

b) Dyeing: The quantity of dyes was taken as per the shade required (Sun yellow-40%,
Garnet brown-30%, Lac-20% and Blood red-20%). Material to liquor ratio was kept 1:50 for
wool and 1:100 for silk. The dye was taken in a cup or bowl and dissolved in hot water. This
solution was kept on the side. Then water for dyeing was taken in a beaker and little quantity
of acetic acid was added to water to make the pH of the bath to 4. Now this beaker was kept
on the heating system, as soon as the temperature of water reaches to 60°C the dissolved sun
yellow was sieved through a fine cloth into the beaker. Some residue remained into the cloth,
now some water was poured onto the cloth and the residue was rubbed with some stick,
which helped the residue to pass through the cloth. Once this was done, the solution was
stirred nicely, then the 100gm wetted material was squeezed and was added into the beaker,
the material was turned continuously and heating was increased to reach boiling. Material
was kept on boiling for 45 minutes. Then the heating was switched off. When dyeing was
completed material was left in the beaker to cool down. Washing was done only to remove
unfixed dye particles of the dye from the material. Material was soaped and rinsed well.

3.4 Comparing different resist materials

Along with POP other conventional and potential resist materials were also
experimented with. Conventional resist material included wax and starches. The non-
conventional materials included putty and white cement. The resist effect of conventional and
non-conventional resists was compared with the resist effect of POP.
3.4.1 Wax resist

A mix of paraffin wax and bees wax was used as wax resist. The ratio of paraffin wax and bees wax was 60:40. It was heated and applied with the help of brush on both sides of the fabric. The fabrics taken were cotton, jute, silk and wool. The resisted fabric was dyed with reactive cold dye and washed. After which the wax layer was removed by repeatedly ironing the fabric between newspaper sheets till the wax was removed from the fabric.

3.4.2 Starch resist

Resist dyeing experiments were carried out with different starches also. The starches used in the study were rice starch, wheat starch and maize starch. For wheat starch refined wheat flour was used. In order to prepare rice and maize flour, grains were ground to flour with the help of kitchen grinder. The flour was sieved through Mulmul cloth in order to get fine particles.

a) Preparation of starch pastes

The process of making starch paste was same for rice, maize and wheat. Five gms. of flour was taken in a beaker and 60 ml of water was poured into it. In case of wheat starch, refined flour was taken. The flour was mixed with the help of glass rod. This solution in the beaker was put on wire gauze kept over small burner of gas with medium flame. The flame was slowed down when the solution started boiling. The solution was stirred from time to time so that it did not stick to the bottom and lumps were also not formed. It was cooked until the paste became translucent, shiny and sticky. This paste was allowed to cool down. Then it was ready to apply on fabric in the form of motif.

b) Application of pastes: The ready paste was applied on fabric with the help of round painting brush in the form of motif drawn on the fabric. The sample was then oven dried, dyed with reactive cold dye and washed with water.

c) Dyeing: Dyeing of silk was done with reactive cold dye.
d) Removal of pastes:

After drying of fabric the resist layer remained moist for some time. The resist layer was removed by peeling with finger and the remnants were removed by rubbing during washing. The fabric was then dried and ironed.

3.4.3 Wall putty and white cement resists

The wall putty paste was prepared in a petry dish with water in the ratio of 5:3 (gm:ml). The white cement paste was also prepared in petry dish with water in the consistency of 5:2.5 (gm:ml). It was mixed using a round painting brush.

Application of pastes: Immediately after preparation the paste was applied on fabric with the help of round painting brush in the form of motif drawn on all the fabrics. The sample was then oven dried.

Dyeing: Dyeing of silk was done with natural dyes- Sun Yellow and Blood Red. Polyester and acrylic were dyed with disperse dye. Wool, jute and cotton were dyed with direct dye.

Removal of paste: Dyed samples were washed with water, dried and the resist was removed after drying by bringing cracks through hammering and peeling the layer off the fabric. The fabric was patted and then ironed.

3.5 Evaluation of dyed samples

The dyed samples and articles were evaluated on the basis of ease of application, ease of removal, whiteness of reserved area, sharpness of outlines, overall aesthetic appeal and resist effect.

For evaluation of the samples 10 clothing and textiles experts were taken.

The experts rated the samples on a five point scale presented below:

- Excellent 5
- Very Good 4
- Good 3
The responses of the judges were recorded on a proforma presented in Appendix.

3.6 Final samples

The experimental samples whose overall aesthetic appeal was rated above 2.5 were selected as final samples for display in the manuscript.

3.7 Preparation of the articles

The articles were prepared using all the 10 dyes. Ten articles were prepared which are as follows – Bottle carrier, Potli, Tiffin cover, Sling Bag, Centre Table Mat, Hanky cover, Telephone Mat, Kit, Shoe Kit and Mobile Purse.

Sketches: For each article 3 designs were sketched. The sketched designs were shown to 10 Clothing and Textile experts. These designs were ranked 1, 2 and 3 by the experts according to their liking. Then the response of all the experts were noted down and scoring was done. Design having highest score was chosen.

The articles were made with the following dye and fabric combination:

- Bottle carrier-sun yellow dye + jute
- Potli-garnet brown dye + silk
- Tiffin corner-direct dye + cotton
- Sling Bag-acid dye + silk
- Centre Table Mat- indigo dye + polyester
- Hanky cover-lac dye + silk
- Telephone Mat-reactive cold dye + cotton
- Kit-disperse dye + polyester
- Shoe kit-basic dye + wool
- Mobile Purse-blood red dye + wool

Assessment of articles:

The assessments of the articles were done by 10 young ladies between the age group 25-30 years. The basis of assessment were colour, design and overall aesthetic appeal of the articles which were ranked 1 to 10.

3.8 Analysis of data
The data was analyzed using the following:

a) **Weight Mean Scores**: Weighted mean score were calculated for evaluation of the samples.

\[ \text{WMS} = \frac{\sum WX}{\sum W} \]

Where, W-Weight of the item

X-Value of the item

b) **Ranks**: Ranks were used to give preferences for the sketched designs of the articles.

d) **Paired t-test**: Paired t-test was used to test the significance of differences in the physical properties of the fabrics before and after POP resist paste application.

**Formula for calculating t values**:–

\[ t = \frac{\bar{d}}{s_d} \sqrt{n}; \quad \text{df} = n - 1 \]