Manual on Quality Assurance
for Khadi

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Jointly prepared by KVIC and IIT, New Delhi
Mahatma Gandhi Institute of Rural Industrialization
A Collaborative Project of KVIC & IITD
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FOREWORD

I am glad to know that the Manual on Quality Assurance for Khadi jointly prepared by KVIC and IIT, New Delhi, is being circulated for wider consultation and field-implementation. This is the most important exercise of our efforts at Mahatma Gandhi Institute for Rural Industrialization, Wardha.

From its very inception, Khadi movement led by Mahatma Gandhi has been extremely conscious about the Quality-Assurance of its various products. It was felt recently that these efforts need to be backed up by latest professional technical input. Hence, Prof. R. B. Chavan, IIT Delhi was requested to lead an expert team to prepare a comprehensive manual for Khadi sector. Technical experts from KVIC and its institutional network were fully involved in this exercise.

The manual covers the various aspects of Quality standards which a customer expects all the time. It is a manual for Khadi institutions as well as the Khadi Technical Staff for improving the quality standards of Khadi. The objectives of training envisaged in this manual, is the basic inputs for improving the Quality standards.

A product which comes to the market should always specify the details of products. This is clearly indicated in the marking or coding of sample which enables the customer to identify the product. The chapter on process control of hand-spun yarn is specially designed to take care of quality of Khadi at the first stage itself.

I hope that the present manual would be useful to all those engaged in the production and sale of Khadi or willing to take up Khadi activities. Khadi sector has the advantage of very strong and dedicated network of hundreds of Khadi institutions led by veteran khadi experts, I am sure they will use this manual in a professional manner.

I would extend my thanks to the members of expert committee for Quality Assurance of Khadi and specially Prof. R.B.Chavan and his team, Dept. of Textile Technology, IIT Delhi and MGIRI, Wardha who took all pains for bringing out the manual, KVIC officials and experts involved in this task deserve my appreciation for this accomplishment.

Mumbai
29th August, 2003

(Dr. MAHESH SHARMA)
CHAIRMAN, KVIC
PREFACE

Manufacture of khadi fabrics is considered to be heritage based production activity. Being based on human skill, it provides livelihood to a large section of the population. Although heritage based technologies have longer life compared to science-based technologies, they are faced with challenges on and off. The globalization process through World Trade Organization is one such challenge the khadi sector is presently facing. Due to this the production and sale of khadi is dwindling, posing a serious threat to its employment generation capacity. Due to stiff competition from mass-produced fabrics being available from India and foreign countries, the attraction of khadi is decreasing day by day. If no timely action is taken, there is danger that the khadi production may reduce to negligible level. One of the ways to protect the khadi production is to provide Quality Assurance inputs so that quality khadi is produced to meet the requirements of the customers. The preparation of Quality Assurance Manual for Khadi is one of the steps in this direction.

Khadi yarn needs much improvement in terms of consistency in count, strength, uniformity, appearance etc. Poor quality of yarn results in poor performance in looms, poor fabric appearance and inferior fabric properties. Also the dimensions of fabric change to an unacceptable level after the first wash. There are also serious complaints of colour fading of dyed and printed khadi. This has resulted in a general notion that khadi essentially is a low quality fabric. Although no one desires to make khadi equivalent to mill fabric, but there is considerable scope to improve the quality of khadi with the retention of its specific characteristics. For this purpose a system comprising of a set of procedures is required for ensuring quality production. This would need objective evaluation of essential properties of fibre, yarn and fabric and also the fastness properties of dyed and printed khadi to keep the entire production process under control. It was thought that the objective evaluation to maintain the quality would be possible if there are norms available for comparison, which are achievable under practical working conditions.

In the present manual, attempts have been made to provide guidelines for selection of cotton fibres depending on their fibre characteristic to produce yarn of desired count group, quality norms for NMC yarn of cotton, muslin and polyvastra of different count groups are suggested on the basis of experimentally tested values of yarn samples collected on all India basis and carefully analyzing the test results. Similarly the constructional parameters of most popular varieties of khadi fabrics and the corresponding reed counts based on warp cover factor, Punjam and ends per 100cm for fabric of medium construction mentioned in the book “Khadi Mein Naya Nap Taul” authored by Shri Dwarkanath Lele. Spinning and weaving productivity data as achieved under actual working conditions are given. The norms on important fastness properties of dyed and printed khadi are suggested. One of the major contributions of the manual is the chapter on process control in spinning, weaving and chemical processing which covers the information on common faults, their reasons of generation and possible remedies. A list of essential test equipments and test procedure for important quality parameters are given. Brief information is provided on training, marking, coding and packing. Appendix includes formats for reporting test results, conversion tables, selected mathematical calculations, list of laboratories providing testing facilities, list of charkha manufacturers etc.

Textile production including khadi is complex phenomenon due to involvement of large number of processes starting from fibre to finished fabric. It is worth mentioning here
that the quality and productivity norms for Indian textile industry were prepared based on the results of 40 years of R & D and consultancy work carried out by Textile Research Associations. This only indicates that evolution of norms is a slow process and has to be evolved over a period of long duration. The evolution of norms is also a continuous process; therefore, it is necessary to revise the norms periodically on the basis of progressive changes.

The khadi group at IIT Delhi under the aegis of KVIC sponsored project undertook the work on preparation of Quality Assurance Manual for Khadi about a year back. For this purpose an expert committee consisting of experts from Department of Textile Technology, IIT Delhi, KVIC and from selected khadi institutions was constituted. The evolution of quality norms for yarn and fabric are based on the careful analysis of the test results for various parameters. All the aspects relevant to quality, productivity and the various chapters included in the manual were extensively discussed in the expert committee meetings followed by open discussions during the two-days workshops held at Mahatma Gandhi Institute of Rural Industrialization (MGIRI) and Khadi Gramodyog Prayog Samitee, Ahmedabad. The workshops were attended by large number of participants from khadi institutions on all India basis. The present manual is the outcome of such extensive discussions of the expert committee members and the unanimous decisions taken during the meetings. The khadi group at IIT Delhi is totally aware that the manual is not complete in all respects. The completeness of the manual is also not expected in such a short time. The only satisfaction is that the beginning has been made in this direction and it is hoped that the manual would get updated periodically as and when additional data related to quality is available.

It is envisaged that one of the major tasks of implementation of quality norms in khadi sector would be to educate the existing staffs at KVIC and khadi institutions. For this purpose it would be essential to organize exhaustive training programmes on all India basis imparting training to managerial and technical staffs of KVIC and khadi institutions. Training of spinning and weaving operators would also be essential. It would also be good idea to involve the technical staff of khadi vidyalayas in these training programmes. Successful implementation of quality assurance in khadi sector would depend on the careful planning of such training programmes by KVIC, khadi institutions and establishment of quality laboratories with essential test equipments and employment of qualified quality control staffs in khadi institutions. The manual is written in English. However, it would be essential to do authentic translation in regional languages for better understanding of the manual.

The khadi group at IIT Delhi is grateful to KVIC for sponsoring the project and providing an opportunity for us to work for technologically neglected khadi sector. This has also given us an opportunity to fulfill to some extent our social obligation towards society. In fact it is vision of KVIC chairman, Dr. Mahesh Sharma, who has shown keen interest in involving IIT faculty in this task. IIT group is also thankful to the CEO, Dy CEO (S&T), Dy CEO (Khadi), Director (S&T), Director (Khadi), Project Manager (CSP, Hazipur), Director (Khadi Co-ordination) for their cooperation whenever needed in the completion of this manual. Sincere thanks are due to Expert Committee Members who have spent their valuable time for very healthy and most fruitful discussions during and beyond the expert committee meetings, without which the compilation of this manual would not have been possible. Special thanks are due to Prof. Alagirusamy, Prof. Deshmukh, Dr. A. Das, Shri R.S.Kulkarni, (Gram Sewa Mandal, Marathawada), Shri C. Rajaiah (Wavilal Khadi & Gr. Pratishthan, Wavilal), Shri N.K.Khalyarkar (Magan Sangrahlaya, Wardha) and Shri P.A.Patel (Khadi Gramodyog Saghan Vikas Samiti, Bassi) for providing valuable inputs during the meetings. The khadi group is also grateful to the Director, IIT Delhi and core group members of the
project at IIT Delhi for providing necessary finances and facilities.

It must be pointed out that the Quality Assurance Manual for Khadi is by no means complete. It would need revisions from time to time. It is only an attempt to make the beginning to introduce the concept of Quality Assurance in khadi sector. It will have to go a long way before more meaningful Quality Assurance Manual is made available to khadi sector. It must also be pointed out that the concept is new in khadi sector, the success of the manual will depend on how well the awareness for quality is created through exhaustive training programmes in KVIC and khadi institutions. The Khadi group is hopeful that over a period of time such awareness will be created and the manual would be implemented in the true sense.

Dept of Textile Technology                     R.B.Chavan
I I T Delhi                Member, Core Group
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SCOPE OF THE MANUAL

The manual gives an overview of quality and its importance. Guidelines are provided for the selection of different varieties of cotton fibres depending on their fibre characteristics for the spinning of yarns of desired count range. Quality norms for NMC yarn of cotton, muslin and polyvastra of different count groups are suggested on the basis of experimental testing of the yarn samples and careful analysis of the test results. Similarly the constructional parameters of most popular varieties of khadi fabrics and the corresponding reed counts based on warp cover factor, Punjam and ends per 100cm for fabric of medium construction mentioned in the book “Khadi Mein Naya Nap Taul” authored by Shri Dwarkanath Lele. Spinning and weaving productivity data as achieved under actual working conditions are given. The norms on important fastness properties of dyed and printed khadi are suggested. One of the major contributions of the manual is the chapter on process control in spinning, weaving and chemical processing which covers the information on common faults, reasons and remedies. A list of essential test equipments and test procedure for important quality parameters are given. Brief information is provided on training, marking, coding and packaging of samples. Appendix includes formats for reporting test results, maintenance schedule, list of training institutes, list of laboratories providing testing facilities, list of charkha manufacturers etc.

The manual is written in English. However, it would be essential to do authentic translation in regional languages for its better understanding. It is envisaged that exhaustive training programmes would be essential to spread the message of quality assurance in khadi sector. Successful implementation of quality assurance in khadi sector would depend on the careful planning of such training programs by KVIC, khadi institutions, and establishment of quality assurance laboratories with essential test equipments and employment of qualified quality control staffs in khadi institutions.
1.1 Quality

Mahatma Gandhi said in 1924 “A customer is the most important visitor on our premises. He is not dependent on us. We are dependent on him. He is not an intruder on our work. He is the purpose of it”. This statement was given at the time of emerging industrial era. The customer service concept of Mahatma Gandhi forms the core of management systems in general and quality management systems in particular.

Because of the demanding customers, and competitive environment coupled with the social responsibility, quality has become a qualifying criteria for survival. In order to survive in this environment, quality management system becomes imperative. The complexity in the quality management system can be well appreciated if one looks at:

a) Production centers, which are distributed across the country;
b) Various distribution channels;
c) Skills possessed by the producers; and
d) Availability of new machines/inputs

1.1.1 Definition of Quality

Quality means meeting or exceeding customer expectations all the time. The key here is to know accurately customer expectations on a continuing basis because unless you know customer expectations how can you meet or exceed them? The expectations of quality and the ability to distinguish various quality characteristics vary from one group of customer to another. Generally, the more educated and sophisticated the customer, the higher and more specific are the expectations of quality and more precise the ability of the customers to explore these expectations.

Quality is a subjective term for which each person has his or her own definition. In technical usage, quality can have two meanings:

a) The characteristics of a product or service that bear on its ability to satisfy stated or implied needs; and
b) A product or service free of deficiencies.

The achievement of satisfactory quality involves all stages of the quality loop as a whole. The contributions to quality of these various stages are sometimes identified separately for emphasis; for example, quality due to definition of needs, quality due to
product design, quality due to conformance, and quality due to product support throughout its lifetime. In some references, quality is referred to as “fitness for use” or “fitness for purpose” or “customer satisfaction” or “conformance to the requirements”. These definitions represent only certain facets of quality

A product based definition of quality views quality as a precise and measurable variable. Differences in quality reflect differences in the quantity of some ingredient or attribute possessed by a product.

A user based definition of quality simply means that quality is whatever the customer says or wants which goes back to meeting or exceeding customer’s requirements and expectations.

A manufacturing based definition of quality means meeting specifications, conformance to requirements, etc. Any deviation from meeting requirements means poor quality.

A value based definition of quality takes in to consideration cost or price of a product or service. The question from a customer’s viewpoint is what is the value of this product or service to me? Or how valuable is a given product or service?

For a common person quality means a product made of the best material, has an excellent finish, and good appearance and has a long service life. However, this is only a very limited definition of quality.

Quality is defined by ISO as “The totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs”. The stated or implied needs could be multidimensional such as:

a) Performance;
b) Features;
c) Conformance;
d) Durability;
e) Serviceability;
f) Aesthetics; and
g) Perceived quality.

The implied need is difficult to assess and vary for one group of customer to another (e.g. urban and rural). It may not remain static but change with time. Each of these stated dimensions may have a number of parameters.

Quality is also a reflection of customers’ opinion on the value they see in your
product compared to that of your competitors’, in other words, quality is whatever the customer says it is because the customer is the final judge of quality.

Having some idea of what quality is, let us look at some of the factors that influence consumers’ perception of quality. These factors are:

a) **Price**: Consumers tend to associate quality with higher price;
b) **Technology**: This indicates factor such as fabric and seam strength, colour fastness, shrinkage, and other properties that are affected by the state of technology in the industry;
c) **Psychology**: A garment can be reasonably priced and the best that technology can offer, but if it is not attractive in appearance, if it is not fashionable, it does not meet the aesthetic requirements of the customers, then it is not a quality garment;
d) **Time Orientation**: This includes durability. Of course, the importance of durability varies with categories of garments, that is, children’s garments are expected to be more durable than ladies’ high fashion garments;
e) **Contractual**: This refers to product guarantee, refund policy of a store, etc; and
f) **Ethical**: This refers to honesty of advertising, courtesy of sales personnel, etc.

If you can positively influence any one or more of the preceding factors, then you will be able to increase the quality (and therefore the value) of your product in a customer’s mind and he or she will most likely come back to buy the product.

### 1.2 Quality Assurance (QA)

Quality Assurance is all those planned and systematic actions necessary to provide adequate confidence that product or services will satisfy given requirements for quality. Quality Assurance is a cost effective aid to productivity. It is a means for getting things “right first time, every time”.

Quality Assurance is a comprehensive management function. It deals with setting policy and running a system of management controls that cover planning, implementation, and review of quality related issues. Quality Control is a technical function that includes all the scientific precautions, such as specification and testing of technical parameters, calibrations and benchmarking of various instruments etc.

#### 1.2.1 Need for Quality Assurance

Quality Assurance is a philosophy that meets certain basic criteria. These are:

a) It is a program of action that results in achieving the quality specifications at an
agreed cost and time schedule;
b) It provides assurance to the user by objective evidence; and
c) It provides for continuous evaluation and corrective action as an integral part of the system.

The basic endeavor of any business is to meet the requirement of “fitness for use”. The extent to which a given product meets the customer requirements is usually known to the manufacturer while the customer is using the products. The certification marks given by the certifying agencies such as BIS, ISI or AGMARK give the consumer reasonable assurance of quality. These aspects require proper communication between the manufacturer and the customer so that there is no ambiguity in understanding by both parties about what is required and what is to be done.

The customer requires the real evidence of quality to exist, not only in the finished products, but also in all the activities associated with producing the products like procurement of raw material, manufacturing processes, etc. The objective evidence is expected to confirm that all activities have been carried out in accordance with established procedures. The activities include not only those contributing directly to the product quality such as preparation/formula used but also activities that contribute indirectly to the same such as sanitation, cleanliness, administration etc. The methods are written in documents called Standard Operation Procedures (SOPs). Many industry associations (such as CII, FICCI etc. for the organized sector) and national standard bodies (such as BIS, AGMARK etc.) have put forth Quality Assurance Standards (QAS).

It is also to be noted that there are some popular misconceptions about Quality Assurance:

a) It is very costly;
b) It is massive paper generator;
c) It places emphasis on correcting deficiencies after the fact rather than preventing defects from occurring in the first place;
d) Quality Assurance is same as quality control or inspection; and
e) It is a super checking activity.

But it must be mentioned that Quality Assurance is:

a) Cost effective;
b) An aid to productivity;
c) A means of getting it “right first time, every time”; and
1.2.2 Quality Assurance and Quality Control

While Quality Assurance is a management or supervision function dealing with setting policy and running an administrative system of management control, that covers planning, implementation and review of data collection activities and the use of the data in decision making. Quality Control (QC) is a technical function that includes all the scientific precautions, such as calibrations and duplications that are needed to acquire data of known and adequate quality. More specifically, Quality Control is defined as a function for the control of the quality of raw materials, assemblies, finished products, services related to production, management and inspection processes are ensured.

Quality Control is exercised for the purpose of preventing undetected production of defective material or the rendering of faulty services. Quality Control refers to the broad administrative and technical area of developing, maintaining and improving product and service quality. It does not mean simply any single technical method for accomplishing these purposes. There are primarily four jobs of Quality Control:

a) **New Process/Design Control:** New process control involves the establishment and specification of the necessary cost quality, performance quality, safety quality, and reliability quality for the product required for the intended customer satisfaction. This must include the elimination or location of possible sources of quality troubles before the start of formal production;

b) **Incoming Material Control:** Incoming material control involves the receiving and stocking, at the most economical levels of quality, of only those raw materials whose quality conforms to the specification requirements. The emphasis should be upon fullest vendor responsibility;

c) **Product Control:** This involves control of products at the source of production and through field service. In this, products not conforming to quality specifications are detected and corrected; and

d) **Special Process Studies:** Special process studies involve investigations and tests to find out the causes of nonconforming products. Also to determine the possibility of improving quality characteristics and to ensure that improvement and corrective actions are permanent and complete.

The job of Quality Control is accomplished by the following four steps:

a) **Setting Standards:** Determining the required cost, performance, reliability and safety
quality standards for the product;

b) **Appraising Conformance:** Comparing the conformance of manufactured product to the above mentioned standards;

c) **Acting When Necessary:** Correcting the problems and their causes throughout the full range of those manufacturing, inspection and maintenance factors that influence user satisfaction; and

d) **Planning for Improvements:** Developing a continuing effort to improve the cost, performance, safety and reliability.

### 1.3 Standardisation

Standardisation is a process of formulating and applying rules for an orderly approach to a specific activity, for the benefit of all concerned and in particular the total overall economy, taking due account of functional performance conditions and safety requirements. In practical terms, a standard means a written document agreed upon by all the parties i.e. by buyers, sellers, manufacturers, consumers, and also many types of authorities and technicians. Standards can be broadly classified as:

**Technical:** Refers to productive phase of business such as materials, suppliers, purchasing procedures, manufacturing practices etc.

**Managerial:** Refers to the administrative phase of business such as policies (corporate), accounting systems and performance evaluation. In industry, the term standardization denotes a size, a set of manufacturing process, a definite weight, a particular dimension, use of specified components in the process, use of formulae for various preparations and above all a given satisfaction to the customer. Standardization can be established by using a 3–dimensional approach:

**Subject Standardization:** The subjects for standardization could be innumerable starting with any activity of human being; it includes all type of industries like food processing, agriculture, technology, consumer goods etc.

**Aspect Standardization:** For all the subjects of standards there are a large number of items that can be standardized. These include inspection, codification, simplification, specification, research, test results, machines, materials, spares, contracts, agreements, formats, sampling procedures, quality control, performance appraisal etc.

### 1.3.1 Levels of Standardization

There are basically different levels of standardization:
1. Unit level; it depends upon its products, procedures, performance and market condition;
2. Industry level; which again depends upon products, policies and procedures;
3. National and international standards.

1.3.2. Advantages of Standardization

The following points highlight about the advantages of standardization:

a) Manufacturers can streamline production processes, introduce quality control measures properly; project a better image of their products in rural as well as urban markets; win confidence of wholesalers, retailers and stockists; consumer confidence and market goodwill; get higher prices for standardized goods and obtain incentives offered by financial institutions and nationalized banks;

b) Consumers get the products certified by an independent national technical organization; secure help in choosing standard products; they are protected from exploitation and deception;

c) Exporters are exempted from pre–shipment inspection wherever admissible; and standards act as a convenient basis for conducting export contracts and for the elimination of the need for the exhaustive inspection of consignments by the export inspection authorities; and

d) Overseas buyers are assured the quality as per standards.

1.4 Specifying Quality

1.4.1 Why Quality Specifications

The manufacturing operations should result in products, which are fit for use. It is, however, not possible to instruct the manufacturing departments to make products by simply saying that the products shall be “fit for use”.

The phrase “fit for use” must be translated into a language understood by everybody making part in the manufacture of the products. This language is made up of quality characteristics (e.g. dimensions, physical and chemical properties), for which limits are given in the form of specification or tolerance limits. These limits representing requirements on product quality are included in the product specifications.

The general task of an industrial enterprise is to identify customer needs and preferences and then to develop, design, manufacture and sell products, which fulfill these needs and preferences. Apart from customer needs and preferences, notice must also be taken
to any rules and regulations, which apply to the product and to the competition in the market.

When an enterprise carries out this general task, there are many people in different functions who take part. The result of the efforts concerned with quality (i.e. the fitness for use of the product) is a result of the work of all these people.

The functions of a manufacturing enterprise which influence product quality are:

a) Market research;
b) Product development;
c) Manufacturing engineering;
d) Purchasing;
e) Production;
f) Inspection;
g) Marketing; and
h) Service.

a) **Market Research:** The customers decide what they will buy. It is therefore necessary for the manufacturer to know what the customers require or are looking for. This is done by means of market research. Also information on competing products is obtained. For some products, authorities may have made regulations, which must be complied with. These regulations are often found for products, which can affect the safety of users. Information obtained by studies of this kind forms the starting point of the next stage of the work.

b) **Product Development:** Personnel involved in product development and design are responsible for transferring the information gained from the market research into a product concept. Here, the resources available, in the form of materials and manufacturing processes, must also be taken into account. Good use must be made of experience gained from similar products. This can be done by ensuring close contacts between product development and design personnel and their colleagues from, for example, manufacture, quality control and service. More formally, it can be done through design reviews.

The development and design work results in specifications for the products. The specifications must show clearly and unambiguously the requirements of all the characteristics of the product (including parts and materials). The requirements must be realistic. It is uneconomical to set out tighter tolerances than are necessary with regard to the intended use of the product. Quality of design is determined by virtue of the existence of these specifications.
c) **Manufacturing Engineering:** Before the manufacture of a product can start, it is necessary to carry out planning and preparatory work. This work includes the choice of manufacturing processes, the provision of machines and tools, the preparation of process specifications, and the selection and training of personnel.

A precondition for economical manufacturing is that the manufacturing process must be able to hold the tolerances set by product development and design. This depends on the variability of the process in relation to the tolerance given (i.e. the process capability). If this is not taken into account in manufacturing engineering, there is a risk that additional costs will be incurred during manufacture (for sorting, rework and scrap).

The inspection of the product must also be planned and prepared. This activity is usually known as inspection planning. It includes the planning and design of inspection stations, the preparation of written procedures and providing inspection tools. Account must be taken of the risk of defects occurring and also the consequences of defective products going further in the manufacturing process or out to the customers.

d) **Purchasing:** The manufacture of products requires inputs in the form of materials, components, etc. These must be purchased. Selection of vendors should not only depend on who has offered the lowest price. The ability to comply with the contract, both with regard to delivery time and quality, must be taken into account.

e) **Production:** The manufacturing process must produce products within the planned time, in the quantity required and to a quality, which is in agreement with the requirements given in the specifications. Time, quantity and quality may come into conflict with one another. The consequences can be catastrophic if time and quantity have thoughtlessly been given priority over quality.

In manufacturing there are many factors, which affect quality. These are factors to do with machines, tools, materials, operators, supervisors, management, etc. The way in which these factors affect the results must be known in order to achieve adequate quality.

f) **Inspection:** Inspection includes the determination of whether materials, parts and products meet the quality requirements and, on the basis of this determination, to decide on acceptance or rejection.

g) **Marketing:** Marketing involves informing prospective customers of the product characteristics and the areas of use. There is a tendency on the part of some salesman to promise more than the product can meet which can lead to disappointed customers. The customers then judge the quality to be low.
In marketing, it is necessary to concentrate on the market at which the products are aimed. Selling to a market, for which the products were not designed, entails a great risk that customers purchasing the products will be dissatisfied.

h) Service: Maintenance may be necessary for the product to work in the intended manner. Service includes helping customers with this maintenance by providing instructions, spare parts, servicing, etc. Customers may have problems with the product. The service department must then be able to assist the customers quickly and efficiently.

1.4.2 Specification Limits

When setting specification limits and documenting them, it is necessary to consider:

a) The User Needs: The user needs must be studied;

b) Requirements of the Authorities: All requirements made by the various authorities on the product to be marketed must be clarified (for instance safety regulations);

c) Competition: Studies of competitor’s products can influence the specifications so that advantages may be gained in marketing;

d) Process Capability: Specifications, which are not tailored to the capability of the process, lead to additional inspection measures and defects. Information on what is possible to achieve in manufacturing operations should be available to the product designers;

e) The Balance Between Cost and Value: There is a risk that the specifications are tighter than necessary because the product designers are usually made responsible for functional failures, but not for high manufacturing costs. A balance between cost and value must be made; and

f) Clarity and non–Ambiguity: Diffuse specifications can cause many problems and high costs.

1.5 The Quality Loop

The quality loop describes various elements in an industrial loop. This can be illustrated by the circle shown in fig. 1.1. The quality loop shows the following:

a) The majority of the function affects product quality;

b) Everyone who works in the functions included in the quality loop has a responsibility for quality;

c) Quality is a result of many activities within these functions; and

d) For the work to result in products, which are sought after the market (i.e. products
which satisfy the customers’ needs and desires at a responsible cost), co-ordination is necessary between all activities concerned with quality.

1.6 ISO Standards

This section tells briefly what ISO 9000 and ISO 14000 are and what they are not. Both “ISO 9000” and “ISO 14000” are actually families of standards which are referred to under these generic titles for convenience. Both families consist of standards and guidelines relating to management systems, and related supporting standards on terminology and specific tools, such as auditing (the process of checking that the management system conforms to the standard).

ISO 9000 is primarily concerned with “quality management”. Like “beauty”, everyone may have his or her idea of what “quality” is. In plain language, the standardized definition of “quality” in ISO 9000 refers to all those features of a product (or service), which are required by the customer. “Quality management” means what the organization does to ensure that its products conform to the customer's requirements.

ISO 14000 is primarily concerned with “environmental management”. In plain language, this means what the organization does to minimize harmful effects on the environment caused by its activities.

Both ISO 9000 and ISO 14000 concern the way an organization goes on its work, and
not directly the result of this work. In other words, they both concern processes, and not products at least, not directly. Nevertheless, the way in which the organization manages its processes is going to affect its final product. In the case of ISO 9000, it is going to affect whether or not everything has been done to ensure that the product meets the customer’s requirements. In the case of ISO 14000, it is going to affect whether or not everything has been done to ensure a product will have the least harmful impact on the environment, either during production or disposal, either by pollution or by depleting natural resources.

However, neither ISO 9000 nor ISO 14000 are product standards. The management system standards in these families state requirements for what the organization must do to manage processes influencing quality (ISO 9000) or the processes influencing the impact of the organization’s activities on the environment (ISO 14000).

In both cases, the philosophy is that these requirements are generic. No matter what the organization is or does, if it wants to establish a quality management system or an environmental management system, then such a system has a number of essential features, which are spelled out in ISO 9000 or ISO 14000.

1.6.1 The ISO 9000 Family

Just as there are product quality and performance standards, the ISO 9000 series is a set of five individual, but related, international standards on quality management and quality assurance. They are generic, not specific to any particular products. They are:

**Standards**  **Purpose**


ISO 9003  Quality Systems – Model for Quality Assurance in Final Inspection and Test.


These standards were developed with the goal of effectively documenting the quality system elements to be implemented in order to maintain an effective quality system in a company. These standards seek to ensure that a company has consistently met the defined
quality and performance standards. It is important to recognize that these standards do not set or define quality levels; the setting of quality levels or performance standards is very much up to a company, depending on the needs of the market place and requirements of its customers.
CHAPTER 2
Quality Assurance Norms for Khadi

2.1 Fibre Characteristics

The quality of the kahdi fabric depends on the quality of the fibre used. The fibres used for a particular yarn should meet the quality requirements for the yarn. The fibre properties that affect the quality are: length, fineness, bundle strength, trash content and maturity. The best procurement time of cotton fibre is from October to February. In Table 2.1 (a) the characteristics of different varieties of cotton are listed. Range values have been given since the exact values of different characteristics may change slightly from year to year and region to region.

A guideline in regard to selecting cotton to spin different yarn count is given in Table 2.1 (b). Cost consideration may at times compel to mix varieties within a group or between adjacent groups to spin a yarn of a given count.

Table 2.1 (a): Cotton fibre characteristics

<table>
<thead>
<tr>
<th>Cotton Variety</th>
<th>2.5% Span Length (mm)</th>
<th>Uniformity Ratio (%)</th>
<th>Micronaire Value (µg / inch)</th>
<th>Bundle Strength (3 mm Gauge) (g/tex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengal Deshi</td>
<td>15.9 – 19.3 (17.1)</td>
<td>50 – 57 (54)</td>
<td>6.8 – 8.5 (7.9)</td>
<td>11.6 – 15.2 (13.4)</td>
</tr>
<tr>
<td>Comilla</td>
<td>17.8</td>
<td>54</td>
<td>7.6</td>
<td>14.2</td>
</tr>
<tr>
<td>Jayadhar</td>
<td>21.5 – 23.4 (22.5)</td>
<td>48 – 53 (50)</td>
<td>4.6 – 5.2 (5.0)</td>
<td>15.0 – 18.1 (16.5)</td>
</tr>
<tr>
<td>Digvijay</td>
<td>21.6 – 24.7 (23.5)</td>
<td>50 – 52 (51)</td>
<td>3.3 – 5.7 (4.2)</td>
<td>18.3 – 21.6 (20.6)</td>
</tr>
<tr>
<td>B. Narma</td>
<td>22.4 – 24.5 (23.7)</td>
<td>48 – 51 (49)</td>
<td>4.0 – 4.2 (4.1)</td>
<td>20.4 – 21.0 (20.8)</td>
</tr>
<tr>
<td>J.34</td>
<td>23.2 – 26.1 (24.3)</td>
<td>46 – 50 (48)</td>
<td>3.9 – 4.8 (4.4)</td>
<td>17.8 – 21.6 (20.0)</td>
</tr>
<tr>
<td>V. 797</td>
<td>24.2 – 25.4 (24.7)</td>
<td>48 – 51 (50)</td>
<td>4.5 – 5.2 (4.8)</td>
<td>16.9 – 18.8 (17.7)</td>
</tr>
<tr>
<td>F. 414</td>
<td>23.8 – 25.6 (24.9)</td>
<td>48 – 49 (48)</td>
<td>4.2 – 4.8 (4.5)</td>
<td>17.3 – 19.6 (18.7)</td>
</tr>
<tr>
<td>G Cot 13</td>
<td>23.2 – 26.6 (25.1)</td>
<td>49 – 52 (51)</td>
<td>4.5 – 6.4 (5.4)</td>
<td>17.2 – 20.0 (18.4)</td>
</tr>
<tr>
<td>NH 44</td>
<td>22.3 – 28.6 (26.1)</td>
<td>45 – 51 (48)</td>
<td>3.2 – 4.1 (3.6)</td>
<td>16.6 – 24.9 (21.4)</td>
</tr>
<tr>
<td>Hybrid 4</td>
<td>23.3 – 29.8 (26.9)</td>
<td>45 – 49 (48)</td>
<td>3.2 – 3.9 (3.5)</td>
<td>17.7 – 23.7 (21.2)</td>
</tr>
<tr>
<td>LRA. 5166</td>
<td>24.2 – 30.6 (27.0)</td>
<td>45 – 53 (48)</td>
<td>3.5</td>
<td>19.0 – 25.3 (22.1)</td>
</tr>
<tr>
<td>MCU 7</td>
<td>27.0</td>
<td>48</td>
<td>4.1</td>
<td>19.5</td>
</tr>
<tr>
<td>MECH 1</td>
<td>24.5 – 31.4 (27.8)</td>
<td>45 – 52 (48)</td>
<td>2.9 – 4.2 (3.5)</td>
<td>18.8 – 26.6 (22.3)</td>
</tr>
<tr>
<td>MCH 11</td>
<td>25.8 – 30.8 (28.6)</td>
<td>46 – 50 (49)</td>
<td>3.3 – 3.8 (3.6)</td>
<td>20.0 – 26.9 (23.8)</td>
</tr>
<tr>
<td>Sankar 6</td>
<td>26.0 – 31.1 (28.8)</td>
<td>44 – 53 (50)</td>
<td>3.2 – 4.6 (4.1)</td>
<td>19.0 – 25.7 (23.2)</td>
</tr>
<tr>
<td>JK Hy. 1</td>
<td>24.4 – 33.2 (29.3)</td>
<td>44 – 51 (48)</td>
<td>2.8 – 4.2 (3.5)</td>
<td>20.0 – 26.8 (24.2)</td>
</tr>
<tr>
<td>MCU 5</td>
<td>25.8 – 34.9 (31.4)</td>
<td>42 – 50 (46)</td>
<td>2.8 – 4.0 (3.3)</td>
<td>21.2 – 28.3 (24.9)</td>
</tr>
<tr>
<td>DCH 32</td>
<td>29.3 – 36.6 (34.1)</td>
<td>43 – 48 (46)</td>
<td>2.8 – 3.3 (3.0)</td>
<td>23.3 – 29.4 (26.8)</td>
</tr>
<tr>
<td>Suvin</td>
<td>30.0 – 37.4 (36.2)</td>
<td>45 – 48 (46)</td>
<td>2.8 – 3.0 (2.9)</td>
<td>30.8 – 32.6 (31.5)</td>
</tr>
</tbody>
</table>

Source: “Norms for the Textile Industry (Spinning)” jointly developed by ATIRA, BTRA, NITRA and SITRA (2000 publication).

Note: These are indicative values. The characteristics may vary slightly from year to year.
<table>
<thead>
<tr>
<th>Yarn Count (Nm)</th>
<th>Cotton Variety</th>
<th>Staple length (mm)</th>
<th>2.5% Span Length (mm)</th>
<th>Uniformity Ratio (%)</th>
<th>Fineness (Micronaire)</th>
<th>Tenacity (3.2mm) g/tex</th>
<th>Trash Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 16</td>
<td>Deshi, Wagad, Striping &amp; Comber waste</td>
<td>Up to 20</td>
<td>16.8 – 22.1</td>
<td>19.5</td>
<td>48 – 53</td>
<td>50.5</td>
<td>4.7 – 7.4</td>
</tr>
<tr>
<td>16 – 23</td>
<td>Wagad, Virnar, Jayadhar &amp; Striping</td>
<td>20 – 23</td>
<td>21.5 – 23.4</td>
<td>22.5</td>
<td>48 – 53</td>
<td>50.5</td>
<td>4.6 – 5.2</td>
</tr>
<tr>
<td>43 – 52</td>
<td>F–414, A–51/9, SRT–1, 1007, Laxmi, Shankar–4 (B), JKHY–1</td>
<td>–</td>
<td>23.4 – 29.5</td>
<td>26.5</td>
<td>44.6 – 49.4</td>
<td>47</td>
<td>3.6 – 4.6</td>
</tr>
<tr>
<td>53 – 62</td>
<td>Digvijay, co2, SRT–1, 1007, Laxmi, Shankar–4 (B)</td>
<td>–</td>
<td>23.7 – 29.5</td>
<td>26.6</td>
<td>44.6 – 49.0</td>
<td>46.8</td>
<td>3.5 – 4.6</td>
</tr>
<tr>
<td>63 – 70</td>
<td>1007, Laxmi, Shankar–4 (A), (B) &amp; (E), American 1.1/8</td>
<td>–</td>
<td>26.3 – 29.5</td>
<td>27.9</td>
<td>44.6 – 49.4</td>
<td>47</td>
<td>3.6 – 4.0</td>
</tr>
<tr>
<td>71 – 102</td>
<td>Shankar–4 (A), MCU–5 (A) &amp; (B), Varalaxmi (B) Sudan GI, Sudan GS</td>
<td>–</td>
<td>25.6 – 34.9</td>
<td>30.3</td>
<td>45.7 – 49.0</td>
<td>47.4</td>
<td>2.8 – 4.0</td>
</tr>
<tr>
<td>103 – 137</td>
<td>Varalaxmi (A) &amp; (B), MCU–5 (A), (B), (Sudan GS, Giza–68)</td>
<td>–</td>
<td>25.8 – 34.9</td>
<td>30.4</td>
<td>42 – 50</td>
<td>46</td>
<td>2.8 – 4.0</td>
</tr>
<tr>
<td>138 – 170</td>
<td>Varalaxmi (A), Suvin (Giza–45)</td>
<td>–</td>
<td>35 – 37.4</td>
<td>36.2</td>
<td>45 – 49.5</td>
<td>47.3</td>
<td>2.7 – 3.1</td>
</tr>
<tr>
<td>170 and above</td>
<td>Suvin (Giza–45)</td>
<td>41.0</td>
<td>37.6</td>
<td>–</td>
<td>49.5</td>
<td>–</td>
<td>2.7 – 3.0</td>
</tr>
</tbody>
</table>

*Note: These are only indicative values. The characteristics may vary slightly from year to year.*

*Source: CIRCOT – Mumbai, KVIC – Mumbai.*
Poly khadi

Poly khadi is manufactured by blending polyester fibre with cotton fibre in the ratio of 67% polyester and 33% cotton. The characteristics of polyester fibre for blending with cotton are shown in Table 2.2.

**Table 2.2** Properties of polyester for different end-uses

<table>
<thead>
<tr>
<th>End-uses</th>
<th>Yarn count group (Nm)</th>
<th>Fibre length (mm)</th>
<th>Fibre fineness (denier)</th>
<th>Fibre tenacity (g/den)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shirting &amp; sarees</td>
<td>70 – 100</td>
<td>38 – 44</td>
<td>1.2</td>
<td>4.5 – 6.0</td>
</tr>
<tr>
<td>2. Suiting</td>
<td>2/50 – 2/70</td>
<td>38 – 44</td>
<td>1.5</td>
<td>4.5 – 5.5</td>
</tr>
</tbody>
</table>

2.1.1 Norms for Sliver and Roving

**Table 2.3** Variability (CV%) of wrapping (lap, sliver & roving) at different production stages

<table>
<thead>
<tr>
<th>Wrapping From</th>
<th>Wrapping Length</th>
<th>Cotton</th>
<th>Polyester/Cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blowroom lap</td>
<td>Full length</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>1 m</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Card Sliver</td>
<td>5 m</td>
<td>3.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Drawn Sliver</td>
<td>5 m</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Roving</td>
<td>15 m</td>
<td>2.0</td>
<td>2.2</td>
</tr>
</tbody>
</table>

**Notes:**

1. The lap rejection in blow room should not exceed 3% for satisfactory performance.
2. For draw frames with autolevellers, the sliver CV% is low at 0.3 (0.75 for 1 m wrapping).
3. For the roving produced with autolevelled slivers, the CV% is low at 1.0.

**Table 2.4** Unevenness of Sliver and Roving

<table>
<thead>
<tr>
<th>Material</th>
<th>Blend Constituent</th>
<th>U%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card sliver</td>
<td>Cotton</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>PC blend</td>
<td>4.5 – 5.0</td>
</tr>
<tr>
<td>Drawn sliver</td>
<td>Cotton</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>PC blend</td>
<td>3.0</td>
</tr>
<tr>
<td>Roving</td>
<td>Cotton</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>PC blend</td>
<td>4.5 – 5.0</td>
</tr>
</tbody>
</table>

2.2 Yarn Norms

2.2.1 Introduction

It is necessary that appropriate cotton fibre should be selected for spinning a yarn of particular count. The yarn produced should meet the requirements of various yarn properties suggested as norm and discussed in this chapter.
The norms for the khadi yarn suggested in the present manual are based on the analysis of various yarn parameters belonging to different count groups. The yarn samples were collected from various khadi institutions situated in different parts of India. The samples were categorized in to different count groups. The number of samples in each count group tested for various yarn parameters varied from 10 to 30*. The test results of a particular yarn parameter were categorized in terms of quartile (i.e. first quartile $Q_1$, second quartile $Q_2$ and third quartile $Q_3$) or on the basis of average value.

$Q_1$: It corresponds to the value of a parameter obtained by best 25% of the samples tested

$Q_2$: It corresponds to the value of a parameter obtained by best 50% of the samples tested.

$Q_3$: It corresponds to the value of a parameter obtained by best 75% of the samples tested.

The norms were set at $Q_2$ values.

2.2.2 Yarn Groups and Count Intervals:

A. Yarn Groups: The yarns produced in khadi sector may be divided in to four groups as shown in Table 2.5.

<table>
<thead>
<tr>
<th>Yarn Groups</th>
<th>Count (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>Up to 28</td>
</tr>
<tr>
<td>Medium</td>
<td>30 – 55</td>
</tr>
<tr>
<td>Fine</td>
<td>60 – 100</td>
</tr>
<tr>
<td>Muslin (Superfine)</td>
<td>Above 100</td>
</tr>
</tbody>
</table>

* This is due to non–availability of sufficient representative samples in certain groups.

B. Yarn Count Intervals: The yarns to be produced in khadi sector may be limited to following counts shown against count group (Table 2.6). The count interval varies according to the count group. It is expected that all the varieties of khadi cloth can be produced using yarns of the following counts.

<table>
<thead>
<tr>
<th>Yarn Count Group (Nm)</th>
<th>Interval</th>
<th>Individual Yarn Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>2</td>
<td>2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28</td>
</tr>
<tr>
<td>Medium</td>
<td>4</td>
<td>30, 34, 38, 42, 46, 50, 54,58</td>
</tr>
<tr>
<td>Fine</td>
<td>5</td>
<td>60, 65, 70, 75, 80, 85, 90, 95,100</td>
</tr>
<tr>
<td>Muslin (Superfine)</td>
<td>25</td>
<td>100, 125, 150, 175, 200, 225…</td>
</tr>
</tbody>
</table>
Note: The above yarn counts and the count intervals will be applicable to the regular production of khadi fabrics. However, if there is a specific requirement from the buyer for a particular count of yarn which is not covered above, the khadi institution will be free to manufacture the yarn of specific count as per the requirement.

C. Tolerance Limit for Yarn Count: There will be obviously a variation in the nominal yarn count. For this purpose the tolerance limit for variation will be as follows:

- Coarse count (Up to 28 Nm) ± 10 %
- Remaining count groups including Muslin ± 5 %

The draft of NMC and roving count (hank) specification should be according to the yarn count to be produced and may be appropriately decided by the khadi institutions. However, the information on the draft of charkha and the roving count depending on the yarn count is reported in Appendix I. This information is to be used only as a guideline to spin a yarn and should not be considered as a specification.

2.2.3 Count CV%

It is expected that the yarn spun on the NMC should have the desired count. However it is not possible to spin the yarn of identical count from all the charkhas as some amount of natural variability in the yarn count is to be expected due to inherent process characteristics. This variation in yarn count is expressed as the count CV %. CV% indicates the variability of the individual values from the mean value of the count. This means that if you are producing the yarn of 20 count on the same or on different NMC, the variation in yarn count in terms of percent should not be more than the value given in Table 2.7. The CV% norm for entire count range is divided into three count groups for cotton and one for polyvastra yarn as stated in Table 2.7. The values for mill yarn has also been reported for the sake of comparison.

<table>
<thead>
<tr>
<th>Table 2.7 Norms for count CV%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Count Group (Nm)</strong></td>
</tr>
<tr>
<td><strong>Cotton</strong></td>
</tr>
<tr>
<td>Coarser (Up to 24)</td>
</tr>
<tr>
<td>Medium (24 to 70)</td>
</tr>
<tr>
<td>Finer (Above 70)</td>
</tr>
<tr>
<td><strong>Polyvastra</strong></td>
</tr>
<tr>
<td>For all count groups</td>
</tr>
</tbody>
</table>
2.2.4 Count Strength Product (CSP)

The yarn strength is expressed as count strength product (CSP). It is the value obtained by the measurement of lea strength of the yarn multiplied by the yarn count. The CSP values are indicative of yarn strength. Two norm values have been given (Table 2.8), one normal and the other superior for two different lea dimensions used for English and Metric systems. The quoted values for Metric system are 20% higher than the corresponding values obtained for English system.

Table 2.8 Norms for yarn CSP (Nm × Kg)

<table>
<thead>
<tr>
<th>Metric yarn count (Nm)</th>
<th>Lea Dimension</th>
<th>80 threads, 1.5 yard</th>
<th>100 threads, 1m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Superior</td>
</tr>
<tr>
<td><strong>Cotton</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 6</td>
<td>*</td>
<td>*</td>
<td>–</td>
</tr>
<tr>
<td>6 – 16</td>
<td>750</td>
<td>900</td>
<td>–</td>
</tr>
<tr>
<td>16 – 24</td>
<td>950</td>
<td>1050</td>
<td>–</td>
</tr>
<tr>
<td>24 – 36</td>
<td>1000</td>
<td>1100</td>
<td>1380</td>
</tr>
<tr>
<td>36 – 50</td>
<td>1050</td>
<td>1200</td>
<td>1530</td>
</tr>
<tr>
<td>50 – 70</td>
<td>1150</td>
<td>1270</td>
<td>1670</td>
</tr>
<tr>
<td>70 – 85</td>
<td>1200</td>
<td>1300</td>
<td>1740</td>
</tr>
<tr>
<td>85 – 100</td>
<td>1500</td>
<td>1650</td>
<td>1740</td>
</tr>
<tr>
<td>100 – 140</td>
<td>1520</td>
<td>1700</td>
<td>1740</td>
</tr>
<tr>
<td>Above 140</td>
<td>1450</td>
<td>1550</td>
<td>1740</td>
</tr>
<tr>
<td><strong>Polyvastra</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 36</td>
<td>*</td>
<td>*</td>
<td>2180</td>
</tr>
<tr>
<td>36 – 70</td>
<td>2080</td>
<td>2280</td>
<td>2040</td>
</tr>
<tr>
<td>70 – 100</td>
<td>2080</td>
<td>2150</td>
<td>1820</td>
</tr>
<tr>
<td>100 – 140</td>
<td>*</td>
<td>*</td>
<td>1745</td>
</tr>
</tbody>
</table>

**Notes:**

* Indicates non-availability of sufficient samples for setting the norm.
– Indicates the norm for the corresponding mill yarn is not available.

Mill CSP norms (for carded yarn) have been converted into Nm × Kg unit for ease of comparison.
2.2.5 CV% of CSP

The CSP CV% norm indicates the inherent variability in strength characteristics of yarn. High CV% is detrimental to good running of the yarn in the subsequent processes as more end breaks are expected. The norm for CSP CV% is given in Table 2.9.

<table>
<thead>
<tr>
<th>Type of yarn</th>
<th>CSP CV% of khadi yarn</th>
<th>CSP CV% of Mill Yarn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>12</td>
<td>4.0</td>
</tr>
<tr>
<td>Polyvasta</td>
<td>12</td>
<td>4.5</td>
</tr>
</tbody>
</table>

2.2.6 Yarn Unevenness (U%)

Khadi yarns are generally more uneven than an equivalent ring yarn which gives a special earthy characteristics or appeal. A high U% value is therefore expected. However it should not be too high since it can spoil the sheen and make the fabric surface too rough. The norm values for cotton and polyvasta yarns are quoted in Table 2.10.

<table>
<thead>
<tr>
<th>Count Group (Nm)</th>
<th>Unevenness (U%) of Khadi Yarn</th>
<th>Unevenness (U%) of Mill Yarn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>22</td>
<td>12.5 – 16 (Carded)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 – 13.5 (Combed)</td>
</tr>
<tr>
<td>Polyvasta</td>
<td>19</td>
<td>12.5 – 15.0</td>
</tr>
</tbody>
</table>

2.2.7 Imperfections

The imperfections mean thick and thin places and also the neps present along the length of the yarn. The imperfections in khadi yarn are generally much higher than what is observed in ring yarn and presence of them to some extent gives the khadi fabric the unique look and texture. However, presence of too many of them in yarn and in final fabric is not desirable as they may spoil the appearance. Hence a limit needs to be specified as stated in terms of norms in the Table 2.11.
Table 2.11 Imperfections in khadi yarn and mill yarn

<table>
<thead>
<tr>
<th>Count group (Nm)</th>
<th>Khadi Yarn</th>
<th>Mill Yarn (Carded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Thin place (−50%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thick place (+50%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neps (+200%)</td>
</tr>
<tr>
<td>Cotton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 6</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>6–16</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>16–24</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>24–36</td>
<td>4450</td>
<td>1600</td>
</tr>
<tr>
<td>36–50</td>
<td>5400</td>
<td>1700</td>
</tr>
<tr>
<td>50–70</td>
<td>7550</td>
<td>2500</td>
</tr>
<tr>
<td>70–85</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>85–100</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>100–140</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Above 140</td>
<td>7500</td>
<td>2100</td>
</tr>
<tr>
<td>Polyvastra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 36</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>36–70</td>
<td>3950</td>
<td>1400</td>
</tr>
<tr>
<td>70–100</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>100–140</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Note:
* Indicates that for that count group minimum of 10 samples were not available for setting the norm.
– Indicates the norm for the corresponding mill yarn is not available.

2.2.8 Appearance Grade
Khadi yarn has got a unique appearance as compared to mill yarn. This is mainly due to presence of uneveness and imperfections in the yarn. The yarn appearance can be evaluated in terms of grades from A to D. Grade A indicates good appearance and grade D means poor appearance. In case the board wrapping does not precisely conform to any of the above mentioned standard grades, namely A, B, C, D but falls in between two consecutive grades, denote the appearance grade of the yarn by ‘+’ mark after the letter indicating the lower grade, e.g. D+ means the appearance grade is better than D but less than C. The appearance grade for different count groups is shown in the Table 2.12.
Table 2.12 Appearance grade for khadi yarn

<table>
<thead>
<tr>
<th>Yarn count (Nm)</th>
<th>Appearance grade</th>
<th>Appearance grade of mill yarn (For all counts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 16</td>
<td>D</td>
<td>C+ (Carded)</td>
</tr>
<tr>
<td>16 to 36</td>
<td>D or D+</td>
<td>B (Combed)</td>
</tr>
<tr>
<td>Above 36</td>
<td>D or C</td>
<td></td>
</tr>
<tr>
<td>Polyvastra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For all count groups</td>
<td>C</td>
<td>B</td>
</tr>
</tbody>
</table>

2.2.9 Twist

The twist in the yarn affects yarn strength. The more the twist more will be the strength. However, very high twist can make the yarn hard in feel and snarly. The norms for metric twist multiplier, twist values (turns per inch) are stated in Table 2.13.

Table 2.13: Twist multiplier and twist

<table>
<thead>
<tr>
<th>Yarn Count (Nm)</th>
<th>Metric Twist Multiplier (TM)</th>
<th>Twist (Turns/inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 6</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>10 – 24</td>
<td>3.5</td>
<td>11 – 17</td>
</tr>
<tr>
<td>25 – 50</td>
<td>3.4</td>
<td>18 – 24</td>
</tr>
<tr>
<td>50 – 70</td>
<td>3.3</td>
<td>25 – 28</td>
</tr>
<tr>
<td>70 – 100</td>
<td>3.2</td>
<td>29 – 32</td>
</tr>
<tr>
<td>101 – 140</td>
<td>3.2</td>
<td>33 – 37</td>
</tr>
<tr>
<td>Above 140</td>
<td>3.1</td>
<td>38 – 50</td>
</tr>
</tbody>
</table>

2.2.10 Traveller Number to be used for Different Yarn Counts

Different travelers are used for spinning different yarn counts. The coarser the yarn, the heavier would be the traveller. Table 2.14 can be used as a guideline for use of appropriate traveller for spinning yarns of different counts.
Table 2.14: Traveller Number to be used for different yarn counts

<table>
<thead>
<tr>
<th>Yarn Count (Nm)</th>
<th>Ring diameter</th>
<th>Suggested Traveller No. (Approx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.1/2”</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>&quot;</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>&quot;</td>
<td>9</td>
</tr>
<tr>
<td>12</td>
<td>&quot;</td>
<td>8</td>
</tr>
<tr>
<td>14</td>
<td>&quot;</td>
<td>6</td>
</tr>
<tr>
<td>16</td>
<td>&quot;</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>&quot;</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>&quot;</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>&quot;</td>
<td>1/0</td>
</tr>
<tr>
<td>28</td>
<td>1.1/4”</td>
<td>2/0</td>
</tr>
<tr>
<td>30</td>
<td>&quot;</td>
<td>3/0</td>
</tr>
<tr>
<td>33</td>
<td>&quot;</td>
<td>4/0</td>
</tr>
<tr>
<td>36</td>
<td>&quot;</td>
<td>5/0</td>
</tr>
<tr>
<td>40</td>
<td>&quot;</td>
<td>6/0</td>
</tr>
<tr>
<td>45</td>
<td>&quot;</td>
<td>7/0</td>
</tr>
<tr>
<td>50</td>
<td>&quot;</td>
<td>8/0</td>
</tr>
<tr>
<td>56</td>
<td>&quot;</td>
<td>9/0</td>
</tr>
<tr>
<td>60</td>
<td>&quot;</td>
<td>10/0</td>
</tr>
<tr>
<td>70</td>
<td>&quot;</td>
<td>11/0</td>
</tr>
<tr>
<td>80</td>
<td>&quot;</td>
<td>12/0</td>
</tr>
<tr>
<td>90</td>
<td>&quot;</td>
<td>13/0</td>
</tr>
<tr>
<td>100</td>
<td>&quot;</td>
<td>14/0</td>
</tr>
<tr>
<td>120</td>
<td>&quot;</td>
<td>15/0</td>
</tr>
<tr>
<td>150</td>
<td>&quot;</td>
<td>16/0</td>
</tr>
<tr>
<td>170</td>
<td>&quot;</td>
<td>18/0</td>
</tr>
<tr>
<td>190</td>
<td>&quot;</td>
<td>19/0</td>
</tr>
<tr>
<td>200</td>
<td>&quot;</td>
<td>21/0</td>
</tr>
<tr>
<td>250</td>
<td>&quot;</td>
<td>24/0</td>
</tr>
</tbody>
</table>

2.3 Khadi Fabric Norms

2.3.1 BIS Norms: The norms for some of the khadi fabrics suggested by BIS are given in the Table 2.15.
Table 2.15 Norms for some cotton khadi fabrics (Constructional parameters and property)

<table>
<thead>
<tr>
<th>Types of Fabric</th>
<th>Yarn Count (Nm)</th>
<th>Thread Density</th>
<th>Mass (g/m²)</th>
<th>Breaking load (10 × 20 cm strip)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warp</td>
<td>Weft</td>
<td>(Ends/cm)</td>
<td>(Picks/cm)</td>
</tr>
<tr>
<td>Bed sheets (Bleached)</td>
<td>27</td>
<td>27</td>
<td>16 (Double)</td>
<td>14 (Double)</td>
</tr>
<tr>
<td>Bunting Cloth (Dyed)</td>
<td>17</td>
<td>14</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Pugre Cloth (Bleached or Dyed)</td>
<td>30</td>
<td>30</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Honey Comb and Huck-a-Back Towels (Bleached)</td>
<td>a) 14</td>
<td>a) 14</td>
<td>11 (Double)</td>
<td>9 (Double)</td>
</tr>
<tr>
<td></td>
<td>b) 14</td>
<td>b) 10</td>
<td>11 (Double)</td>
<td>7 (Double)</td>
</tr>
<tr>
<td></td>
<td>c) 17</td>
<td>c) 17</td>
<td>8 (Double)</td>
<td>8 (Double)</td>
</tr>
<tr>
<td></td>
<td>d) 24</td>
<td>d) 20</td>
<td>18 (Double)</td>
<td>13 (Double)</td>
</tr>
<tr>
<td></td>
<td>e) 34</td>
<td>e) 34</td>
<td>11 (Double)</td>
<td>9 (Double)</td>
</tr>
<tr>
<td>Long Cloth (Bleached)</td>
<td>27</td>
<td>20</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Dosuti (Bleached or Dyed)</td>
<td>a) 27</td>
<td>a) 27</td>
<td>14 (Double)</td>
<td>13 (Double)</td>
</tr>
<tr>
<td></td>
<td>b) 20</td>
<td>b) 17</td>
<td>12 (Double)</td>
<td>11 (Double)</td>
</tr>
<tr>
<td>Napkins and Table Cloth (Bleached)</td>
<td>a) 27</td>
<td>a) 27</td>
<td>14 (Double)</td>
<td>13 (Double)</td>
</tr>
<tr>
<td></td>
<td>b) 27</td>
<td>b) 20</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Dungri Cloth (Bleached)</td>
<td>17</td>
<td>17</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Dusters (Bleached)</td>
<td>17</td>
<td>14</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Lining Cloth (Dyed)</td>
<td>20</td>
<td>17</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Sheeting Cloth (Bleached)</td>
<td>20</td>
<td>20</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Sponge Cloth (Grey)</td>
<td>200/2</td>
<td>14 or 7</td>
<td>9 (Four threads of 14 working together as one) or (Two threads of 7 working together as one)</td>
<td>90</td>
</tr>
</tbody>
</table>

Tolerance Percentage for thread density = ± 1 thread/cm


Note: Any increase in values of ends/cm, pick/cm or mass (g/m²) beyond positive tolerance shall not be a cause of rejection of the fabric.
2.3.2 Constructional Parameters of Khadi Fabrics

In khadi sector usually square fabric in plain weave is produced. This means that the count of the warp and weft yarns and also the ends per inch and picks per inch are identical. The specifications of some of the important varieties of khadi fabrics should be same on all India basis. This will help standardization of the fabrics produced by all the khadi institutions throughout India. Table 2.16 shows the important varieties of fabrics, their specifications and reed count to be used for manufacturing these varieties.

Table 2.16: Constructional Parameters of Khadi Fabrics

<table>
<thead>
<tr>
<th>Types of Fabric</th>
<th>Yarn Count (Nm)</th>
<th>Ends per Inch</th>
<th>Picks per Inch</th>
<th>Reed Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirting</td>
<td>30</td>
<td>44</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>51</td>
<td>51</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>57</td>
<td>57</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>62</td>
<td>62</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>80</td>
<td>80</td>
<td>84</td>
</tr>
<tr>
<td>Bed sheet</td>
<td>12</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>34</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>41</td>
<td>41</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>44</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Do- suti</td>
<td>2/28</td>
<td>31</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>2/30</td>
<td>31</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>Dhoti/ Saree</td>
<td>30</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>44</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>52</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>56</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>Kurta, Pajama &amp; Lungi</td>
<td>Same as shirting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton Coating</td>
<td>2/25</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2/28</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>2/32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>2/36</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Poly shirting</td>
<td>50</td>
<td>56</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>64</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>84</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>Poly coating</td>
<td>2/32</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>2/40</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>3/36</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>2/56</td>
<td>44</td>
<td>44</td>
<td>44</td>
</tr>
</tbody>
</table>

Tolerance:  
- ends per cm = ± 1
- picks per cm = ± 1
- ends per inch = ± 2 – 3
- picks per inch = ± 2 – 3

Notes:
The above specifications are:
- For the manufacture of grey fabric.
- For the manufacture of fabric of medium construction. The ends per inch and picks per inch in any case should not be less than that specified.
- Any khadi institution is free to manufacture above varieties in tighter construction i.e. with more number of ends and picks per inch.
- The construction of the finished fabric (ends per inch and picks per inch) should not be less than the grey fabric. This is because the final construction of the finished fabric will depend on the chemical processing sequence and the mechanical finish given to the fabric. Therefore, it is not possible to give the exact specifications of the finished fabric.

The Basis for the Fabric Specifications: The above fabric specifications are suggested on the following basis:
- Warp cover factor suggested by Khadi Gramodyog Prayog Samitee, Ahemedabad, for different varieties of khadi fabric usually produced are as follows:
<table>
<thead>
<tr>
<th>Fabric Variety</th>
<th>Warp Cover Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirting</td>
<td>11 ± 10%</td>
</tr>
<tr>
<td>Bed sheet</td>
<td>11 ± 10%</td>
</tr>
<tr>
<td>Do suti</td>
<td>11 ± 10%</td>
</tr>
<tr>
<td>Dhoti/Sari</td>
<td>9 ± 10%</td>
</tr>
<tr>
<td>Cotton coating</td>
<td>12 ± 10%</td>
</tr>
<tr>
<td>Poly shirting</td>
<td>11 ± 10%</td>
</tr>
<tr>
<td>Poly coating</td>
<td>12 ± 10%</td>
</tr>
</tbody>
</table>

- On the basis of the Table given in the book “Khadi Mein Naya Nap Taul” (Authored by Shri Dwarkanath Lele) on page 27. This book is extensively followed by all the khadi institutions. The table is shown in Appendix II.
- The “Punjam” which is followed in some regional khadi institutions.

**Specification for Length and Width of Finished Fabrics:** These are given in Table 2.17:

**Table 2.17:** Specification for Length and Width of Finished Fabrics

<table>
<thead>
<tr>
<th>Types of Fabric</th>
<th>Finished Fabric Width Inches (cm)</th>
<th>Finished Fabric Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirting</td>
<td>36 (90)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>45 (115)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>50 (127)</td>
<td>-</td>
</tr>
<tr>
<td>Bed sheet</td>
<td>45 (115)</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>54 (137)</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>60 (152)</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>90 (230)</td>
<td>250</td>
</tr>
<tr>
<td>Do–suti</td>
<td>27 (70)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>32 (82)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>36 (90)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>45 (115)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>50 (127)</td>
<td>-</td>
</tr>
<tr>
<td>Dhoti</td>
<td>45 (115)</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td>50 (127)</td>
<td>410</td>
</tr>
<tr>
<td>Saree</td>
<td>45 (115)</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td>45 (115)</td>
<td>820</td>
</tr>
<tr>
<td></td>
<td>50 (127)</td>
<td>550</td>
</tr>
<tr>
<td>Lungi</td>
<td>45 (115)</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>45 (115)</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>50 (127)</td>
<td>200</td>
</tr>
<tr>
<td>Cotton Coating</td>
<td>27 (70)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>32 (82)</td>
<td>-</td>
</tr>
<tr>
<td>Poly shirting</td>
<td>32 (82)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>36 (90)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>45 (115)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>50 (127)</td>
<td>-</td>
</tr>
</tbody>
</table>
2.4 Chemical Processing Norms

2.4.1 Introduction

The khadi fabric after weaving is subjected to various chemical processing operations such as desizing, scouring, bleaching, optical whitening (Tinopal and Neel), dyeing, printing and finishing. The chemically processed fabric at various stages should meet the following norms (Table 2.18).

<table>
<thead>
<tr>
<th>Process</th>
<th>Satisfactory Level</th>
</tr>
</thead>
</table>

**Desizing**
- Residual size after desizing
  - a) Cotton: 1–2%<br>b) Polyvastra: 0.5–1%

**Scouring**
- a) Scouring loss (of cotton) in Kier/Jigger: 2–4%
- b) Absorbency (Water drop absorption): 3 to 5 seconds

**Bleaching**
- Whiteness
  - a) Percent light reflection [Before addition of optical brightening agent (OBA) and bluing agent]
    - i. Full bleached: 70–80
    - ii. Half bleached for dyeing: 65–70
    - iii. Whiteness index after optical brightening and tinting: 115
  - b) PH of the aqueous extract: Neutral
  - c) Loss in tensile strength: Up to 10%

**Mercerization**
- a) Barium Activity Number (Yarn): Above 110
- b) Deconvolution count: 70–80
- c) Dye uptake ratio (Mercerized: unmercerized): 1.10–1.25

**Finished fabric**
- a) Residual shrinkage: 0–5%
- b) Area shrinkage: 0–10%
### 2.4.2 Fastness Properties

The fastness properties of dyed and printed textile materials is described in Table 2.19

#### Table 2.19 Fastness property norms for dyed/printed fabrics

<table>
<thead>
<tr>
<th>Class</th>
<th>Dyestuff</th>
<th>Light(^1) (IS: 2454)</th>
<th>Washing(^2) (IS: 764)</th>
<th>Hypo–chlorite(^3) (IS: 762)</th>
<th>Rubbing(^6) (IS: 766)</th>
<th>Dry Heat Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dry</td>
<td>Wet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vat</td>
<td>6</td>
<td>4–5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>Reactive</td>
<td>4–5</td>
<td>4</td>
<td>2–3</td>
<td>3–4</td>
<td>3</td>
<td>–</td>
</tr>
<tr>
<td>Napthols</td>
<td>4–5</td>
<td>4</td>
<td>3–4</td>
<td>3</td>
<td>3</td>
<td>–</td>
</tr>
<tr>
<td>Sulphur</td>
<td>4–5</td>
<td>4</td>
<td>1–2</td>
<td>4</td>
<td>3</td>
<td>–</td>
</tr>
<tr>
<td>Pigment</td>
<td>5–6</td>
<td>4</td>
<td>–</td>
<td>3–4</td>
<td>3</td>
<td>–</td>
</tr>
<tr>
<td>Disperse</td>
<td>4–5</td>
<td>4–5</td>
<td>–</td>
<td>4–5</td>
<td>4</td>
<td>3–4</td>
</tr>
</tbody>
</table>

\(^1\) Light fastness for medium (2–3%) depth of shade.
\(^2\) Washing fastness as per ISO–3 test method.
\(^3\) At 190\(^0\) C for 30 seconds.

### 2.4.3 Direct dyes

The use of direct dyes is not recommended due to poor wash fastness when the fabric/garment is subjected to frequent washing. The direct dyes may be used for the items like Dari and other similar products which are not subjected to frequent washing.

### 2.5 Productivity Norms

#### 2.5.1 Introduction

In order to know the efficiency of a spinner or a weaver, it is important to know the production of yarn or fabric in a given time and to what extent the product is fault free.

#### 2.5.2 Spinning Productivity

Productivity of a charkha depends upon the type of fibre used for producing the yarn, pre–spinning processes, the condition of the charkha, the skill and the age of the charkha operator, the atmospheric conditions during spinning etc. In mill sector the productivity of a spinning frame is measured in terms of yarn produced in grams per spindle in one hour, abbreviated as gm/spl hr, but in khadi sector the productivity is usually understood in terms
of number of hanks produced per charkha in 8hr. Typical productivity figures for different counts are shown in Table 2.20.

<table>
<thead>
<tr>
<th>Yarn count (Nm)</th>
<th>Type of charkha</th>
<th>Productivity (No of hanks/charkha/8hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6 spindle</td>
<td>12</td>
</tr>
<tr>
<td>35</td>
<td>6 spindle</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>8 spindle</td>
<td>25</td>
</tr>
<tr>
<td>100</td>
<td>6 spindle</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>8 spindle</td>
<td>25</td>
</tr>
</tbody>
</table>

*2.5.3 Weaving Productivity*

The simplest measure of loom productivity is the length of cloth produced per hour. With a fabric of particular construction and width, the productivity will depend on the quality of the yarn used for weaving, type and mechanical condition of the loom, operating skill of the weaver, atmospheric conditions etc. Generally in khadi 70 cm (28”), 90 cm (36”), 115 cm (45”), 130 cm (52”), width fabric is woven. On an average one metre of fabric can be produced per hour. It may vary weaver to weaver.
CHAPTER 3

Estimation of Statistical Parameters Related to Khadi

3.1 Measures of Location

It is a single value that characterizes one particular point in a group of data. The point may be the center of gravity (the average), the middle value (the median), or the most fashionable value (the mode).

3.1.1 The Average

It is the mean of a set of measurements. It is calculated by adding all the results and then dividing it by the number of results as explained in Table 3.1

Let \( x_1, x_2, x_3 \) etc are the individual values and \( n \) is total number of observations,

Then the average \( (\bar{x}) = \frac{x_1+x_2+x_3+\ldots\ldots+x_n}{n} \)

Example

Let ten charkha bobbins of 40 (Nm) are tested for yarn count and the readings are as follows:

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Yarn Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>41.5</td>
</tr>
<tr>
<td>2</td>
<td>39.3</td>
</tr>
<tr>
<td>3</td>
<td>40.8</td>
</tr>
<tr>
<td>4</td>
<td>42.2</td>
</tr>
<tr>
<td>5</td>
<td>43.7</td>
</tr>
<tr>
<td>6</td>
<td>37.1</td>
</tr>
<tr>
<td>7</td>
<td>39.9</td>
</tr>
<tr>
<td>8</td>
<td>42.2</td>
</tr>
<tr>
<td>9</td>
<td>43.4</td>
</tr>
<tr>
<td>10</td>
<td>38.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>408.7</strong></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>40.87</strong></td>
</tr>
</tbody>
</table>

3.1.2 The Median

The median is the middle value of a series of values arranged either in ascending or in descending order. The median divides the area under the frequency curve into two equal parts.

Example

Let seven hanks are tested for yarn strength and the results are noted in ascending order as follows: 918, 992, 1072, 1100, 1142, 1256 and 1278

The median is the 4th value i.e. 1100.

If there are even number of samples then the median is the mean of the two middle values as follows: 804, 814, 850, 860, 875, 902, 932, 936,
The median is the mean of 4\textsuperscript{th} and 5\textsuperscript{th} value i.e. \((860 + 875) \div 2 = 867.5\)

### 3.1.3 The Mode

It is the value in a set of numbers that occurs most frequently (Tabl3 3.2).

**Example**

Let in a khadi institution the salaries of ten different employees are as follows:

<table>
<thead>
<tr>
<th>Employee No</th>
<th>Salary (in Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2000</td>
</tr>
<tr>
<td>2</td>
<td>2250</td>
</tr>
<tr>
<td>3</td>
<td>2100</td>
</tr>
<tr>
<td>4</td>
<td>3400</td>
</tr>
<tr>
<td>5</td>
<td>2000</td>
</tr>
<tr>
<td>6</td>
<td>1860</td>
</tr>
<tr>
<td>7</td>
<td>2800</td>
</tr>
<tr>
<td>8</td>
<td>2000</td>
</tr>
<tr>
<td>9</td>
<td>2800</td>
</tr>
<tr>
<td>10</td>
<td>1650</td>
</tr>
</tbody>
</table>

In the above Table the mode value is 2000. A group of data may have more than one mode or no mode.

### 3.2 Measures of Dispersion

This indicates the variability of the measured data. The measurement of location does not give any idea of the uniformity or spread of the measured values. Various methods described below are used to measure the dispersion or scatter of the values about the central value.

#### 3.2.1 The Range

The range is the difference between the largest and the smallest value in a group of data. It is very simple to calculate.

**Example**

Let eight leas are tested for CSP and the results are as follows:

CSP of yarn (Nm \times Kg): 1600, 1750, 1580, 1660, 1710, 1690, 1800 and 1595

Range: \(1800 − 1580 = 220\)

#### 3.2.2 The Mean Deviation

Mean deviation is the average amount of variations (scatter) of the items in a distribution from either the mean or the median or the mode. This is a better method of
measurement of dispersion than the range. This is calculated by dividing the sum of the deviations from the mean by total number of observations.

Mathematically,

Mean deviation = $\frac{\sum |x - \bar{x}|}{n}$

Where, $x$ = observed value, $\bar{x}$ = arithmetic mean, and $n$ = number of observations

**Example**

| Value (x) | Deviation from mean $|x - \bar{x}|$ |
|-----------|-----------------------------------|
| 9         | 1                                 |
| 7         | 3                                 |
| 11        | 1                                 |
| 10        | 0                                 |
| 14        | 4                                 |
| 13        | 3                                 |
| 6         | 4                                 |
| 8         | 2                                 |
| 12        | 2                                 |
| 10        | 0                                 |

$\bar{x} = 10$  $\sum |x - \bar{x}| = 20$

Mean deviation $= \frac{20}{10} = 2$

Percentage mean deviation $= (\text{mean deviation} ÷ \text{mean}) × 100 = (2 ÷ 10) × 100 = 20\%$

3.2.3 *The Standard Deviation*

It is the most useful and most widely used method of measuring dispersion. It is defined as the square root of the mean of the squares of the deviations of the observations from their mean (Table 3.4).

Mathematically,

$\text{Standard deviation (σ)} = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$

Where

$x$ = observed value, $\bar{x}$ = arithmetic mean, and $n$ = number of observations
Example

**Table 3.4** Calculation of standard deviation

<table>
<thead>
<tr>
<th>Value (x)</th>
<th>Deviation from mean (x - ( \bar{x} ))</th>
<th>((x - \bar{x})^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>-1</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>-3</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>-4</td>
<td>16</td>
</tr>
<tr>
<td>8</td>
<td>-2</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ \bar{x} = 10 \hspace{1cm} \sum (x - \bar{x}) = 0 \hspace{1cm} \sum (x - \bar{x})^2 = 60 \]

Standard Deviation (\(\sigma\)) = \(\sqrt{60 \div 10} = 2.45\)

Coefficient of variation (CV%) = (Standard Deviation ÷ Mean) \times 100 = (2.45 ÷10) \times 100 = 24.5 %

### 3.2.4 The Variance

It is the sum of the squares of the deviations of the observations from the mean, divided by total number of observations.

Mathematically, Variance = \[ \frac{\sum (x - \bar{x})^2}{n} \]

In the above table variance = 60 ÷10 = 6

### 3.3 Sample and Population

*Sample* is the relatively small fraction of the whole bulk of material called *population*. Sometimes the population does not exist in fact and is called hypothetical. A relatively small number of individual items are tested from the population and the test results are related to the population. The interpretation of the data depends upon the sample size and the objective of the test.
3.3.1 Estimation of Population Mean from Sample Mean

A sample does not represent the entire population. Since the entire population cannot be checked due to time and cost considerations, one has to derive an estimate of population parameter such as mean value from sample estimates. As sample does not include the entire population any estimate of the population parameter from sample estimate may lead to an error in the estimated value. However, one can find out with certain degree of confidence, assuming normal distribution of sample mean, the range in which population mean would lie.

Let the sample average or mean of a parameter (Count) = \( \bar{x} \)
Sample standard deviation = \( \sigma \)
Number of readings = \( n \)
Population mean = \( \mu \)

With 95% confidence one can say, the range in which population mean (\( \mu \)) will lie will be

\[ \bar{x} \pm 1.96 \frac{\sigma}{\sqrt{n}} \]

Where 1.96 is the standard normal value for 95% confidence level.

Similarly for 99% confidence level the range in which population mean (\( \mu \)) will lie will be

\[ \bar{x} \pm 2.58 \frac{\sigma}{\sqrt{n}} \]

3.4 Significant Tests

When it is required to know that a change in the methodology has really affected some properties of the material, mainly the uniformity of the products, significance test of the test results are carried out. Though the underlying principles for a large sample (more than 30) or for a small sample (less than 30) are same, the calculations differ slightly. When one sample is compared with the other, some modifications in the calculation are necessary.

In many cases some characteristics of the population are estimated from the test results of the samples. In these cases the limits between which the population value will lie is estimated from the sample results. These limits are called confidence intervals.

3.4.1 Significance Testing of Means (t-test)

Example 1. Single mean with a large sample (\( n \) larger than 30): While collecting yarn samples from spinners, 64 hanks are tested for yarn count and the average is found to be 40.8. The charkhas are spinning yarn of count 40 (Nm). The standard deviation (S.D.) of the samples is 2.3. Check whether the charkhas are spinning right count or off count?

Step 1. Write down the data given as below:

No of samples (\( n \)) = 64
Nominal mean = 40
Sample mean = 40.8
S.D. of population = 2.3

Step 2. Calculate the standard error (S.E.) of the mean using the following formula:

\[
S.E. = \frac{S.D. \text{ of population}}{\sqrt{n}} = \frac{2.3}{\sqrt{64}} = 0.288
\]

Step 3. Calculate the difference (d) between the nominal mean and the sample mean and divide it by the S.E. of the mean as follows:

\[
d = \frac{140 - 40.81}{0.288} = 2.78
\]

Step 4. Compare the value obtained in step 3 with the values 1.96 and 2.58 (The values correspond to 5% and 1% respectively):

\[
2.78 > 2.58
\]

Conclusion: The difference in count is statistically significant at 1% level. So the charkhas are spinning off count.

Example 2. Single mean with a small sample (n less than 30): Twenty hanks are tested for yarn count and the mean found to be 30.6 (Nm). The standard deviation of the samples is 3.1. If the charkhas are spinning 30 (Nm) count yarn, find whether the charkhas are spinning proper count or off count?

Step 1. Write down the data given as below:

- No of samples (n) = 20
- Nominal mean = 30
- Sample mean = 30.6
- S.D. of population = 3.1

Step 2. Calculate the standard error (S.E.) of the mean using the following formula:

\[
S.E. = \frac{S.D. \text{ of population}}{\sqrt{n}} = \frac{3.1}{\sqrt{20}} = 0.693
\]

Step 3. Calculate the value of t:

\[
t = \frac{\text{nominal mean} - \text{sample mean}}{\text{Standard error}} = \frac{30 - 30.6}{0.693} = 0.866
\]
Step 4. From t table (Table 3.5) for degree of freedom 19 [\( \nu = n - 1 \) (i.e. 20 – 1)], the t value for 1 per cent and 5 per cent are as follows:

\[
\begin{align*}
t &= 2.093 \text{ at the 5 percent level} \\
&= 2.861 \text{ at the 1 percent level}
\end{align*}
\]

Step 5. Compare the value obtained in step 3 with the values of t in step 4

\[
0.866 < 2.861
\]

Conclusion: Since the calculated value of t is less than the table value of t at 1 percent and 5 percent level, the difference is not significant. So the charkhas are spinning proper count.

**Example 3.** *Difference between the means of two large samples:* After collecting yarn samples from spinners, two yarn samples of different lot but of the same metric count (20) were tested for single yarn strength. 30 tests were made on each yarn sample and the results obtained were as follows

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of tests</td>
<td>30 (n₁)</td>
<td>30 (n₂)</td>
</tr>
<tr>
<td>Mean single yarn strength (lb)</td>
<td>57 (( \bar{x}_1 ))</td>
<td>48 (( \bar{x}_2 ))</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>9.5 (( \sigma_1 ))</td>
<td>10.3 (( \sigma_2 ))</td>
</tr>
</tbody>
</table>

Find if there is a real difference between the single thread strengths?

Step 1. Calculate the standard error of the mean, S.E.₁ and S.E.₂

\[
\begin{align*}
\text{S.E.₁} &= \frac{\sigma_1}{\sqrt{n₁}} = \frac{9.5}{\sqrt{30}} = 1.73 \\
\text{S.E.₂} &= \frac{\sigma_2}{\sqrt{n₂}} = \frac{10.3}{\sqrt{30}} = 1.88
\end{align*}
\]

Step 2. Calculate the standard error of the difference between the means:

\[
\text{S.E.\_diff} = \sqrt{(\text{S.E.₁}^2 + \text{S.E.₂}^2)} = \sqrt{(1.73^2 + 1.88^2)} = 2.55
\]

Step 3. Calculate the ratio:

\[
\frac{|\text{mean}_1 - \text{mean}_2|}{\text{S.E.\_diff}}
\]

\[
= \frac{|57 - 48|}{2.55} = \frac{9}{2.55} = 3.53
\]

Step 4. Compare the value obtained in step 3 with 1.96 and 2.58:

\[3.53 > 2.58\]

Conclusion: Since the calculated value is greater than 2.58 (1% level), there is a real difference exist between the means of the yarn taken from the two different lot.
Table 3.5 Significant limits of $t$

<table>
<thead>
<tr>
<th>Degrees of freedom ($\nu$)</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 percent</td>
</tr>
<tr>
<td>1</td>
<td>12.706</td>
</tr>
<tr>
<td>2</td>
<td>4.303</td>
</tr>
<tr>
<td>3</td>
<td>3.182</td>
</tr>
<tr>
<td>4</td>
<td>2.776</td>
</tr>
<tr>
<td>5</td>
<td>2.571</td>
</tr>
<tr>
<td>6</td>
<td>2.447</td>
</tr>
<tr>
<td>7</td>
<td>2.365</td>
</tr>
<tr>
<td>8</td>
<td>2.306</td>
</tr>
<tr>
<td>9</td>
<td>2.262</td>
</tr>
<tr>
<td>10</td>
<td>2.228</td>
</tr>
<tr>
<td>11</td>
<td>2.201</td>
</tr>
<tr>
<td>12</td>
<td>2.179</td>
</tr>
<tr>
<td>13</td>
<td>2.160</td>
</tr>
<tr>
<td>14</td>
<td>2.145</td>
</tr>
<tr>
<td>15</td>
<td>2.131</td>
</tr>
<tr>
<td>16</td>
<td>2.120</td>
</tr>
<tr>
<td>17</td>
<td>2.110</td>
</tr>
<tr>
<td>18</td>
<td>2.101</td>
</tr>
<tr>
<td>19</td>
<td>2.093</td>
</tr>
<tr>
<td>20</td>
<td>2.086</td>
</tr>
<tr>
<td>21</td>
<td>2.080</td>
</tr>
<tr>
<td>22</td>
<td>2.074</td>
</tr>
<tr>
<td>23</td>
<td>2.069</td>
</tr>
<tr>
<td>24</td>
<td>2.064</td>
</tr>
<tr>
<td>25</td>
<td>2.060</td>
</tr>
<tr>
<td>26</td>
<td>2.056</td>
</tr>
<tr>
<td>27</td>
<td>2.052</td>
</tr>
<tr>
<td>28</td>
<td>2.048</td>
</tr>
<tr>
<td>29</td>
<td>2.045</td>
</tr>
<tr>
<td>30</td>
<td>2.042</td>
</tr>
<tr>
<td>40</td>
<td>2.021</td>
</tr>
<tr>
<td>60</td>
<td>2.000</td>
</tr>
<tr>
<td>120</td>
<td>1.980</td>
</tr>
<tr>
<td>$\infty$</td>
<td>1.960</td>
</tr>
</tbody>
</table>

Example 4. *Difference between the means of two small samples:* A yarn sample was sized for finding the increase in single yarn strength after sizing. In each case 20 tests were carried out and the following results were obtained:

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Unsized yarn</th>
<th>Sized yarn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of tests</td>
<td>20 ($n_1$)</td>
<td>20 ($n_2$)</td>
</tr>
<tr>
<td>Mean single yarn strength (lb)</td>
<td>80 ($\bar{x}_1$)</td>
<td>90 ($\bar{x}_2$)</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>7.9 ($\sigma_1$)</td>
<td>8.4 ($\sigma_2$)</td>
</tr>
</tbody>
</table>
Has sizing really increased the strength of the yarn?

Step 1. Calculate S, the pooled estimation of the population standard deviation:

\[
S = \sqrt{\frac{(n_1-1)\sigma_1^2 + (n_2-1)\sigma_2^2}{n_1 + n_2 - 2}}
\]

By putting all the values in the above equation, \( S = 8.15 \)

Step 2. Calculate the value of \( t \) from the following equation:

\[
t = \frac{\bar{x}_1 - \bar{x}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}
\]

By putting all the values in the above equation, \( t = 3.88 \)

Step 3. From \( t \) table (Table 3.5) for degree of freedom 38 \( [\nu = n_1 + n_2 - 2 \text{ (i.e. } 40 - 2)] \), the \( t \) value for 1 per cent and 5 per cent are as follows:

\[
t = 2.021 \text{ at the 5 percent level}
\]
\[
t = 2.704 \text{ at the 1 percent level}
\]

Step 4. Compare the value obtained in step 3 with the 5 percent and 1 percent values for \( t \):

Conclusion: Since the calculated value is greater than 2.704 (1% level), there is a real difference exists between the means of the yarns taken from the two different lot.

3.4.2 Significance Testing of Dispersion (\( f \)-test)

When it is required to know whether one lot of sample is more variable than another, significant test of dispersion is required.

Example 5. Single standard deviation with a large sample: A certain traditional yarn having average count of 10 was collected from a spinner and its standard deviation was found to be 5.8. Twenty hanks were tested for the count. Though the mean count is not different from 10, the standard deviation of the sample is 7.6. Find whether the variability of the sample is really greater than the bulk of the yarn?

Step 1. Write down the data given as below:

No of samples (\( n \)) = 20
S.D. of sample = 7.6
Mean yarn count = \( 10^5 \)
S.D. of the particular yarn = 5.8

Step 2. Calculate the S.E. of the standard deviation:

\[
\text{S.E.} = \frac{\text{S.D. of sample}}{\sqrt{2n}} = \frac{7.6}{\sqrt{2 \times 20}} = 1.2
\]
Step 3. Calculate the ratio

\[
\text{Difference between the S.D.s} \\
= |15.8 - 7.6| \div 1.2 = 1.5
\]

Step 4. Compare the value obtained in step 3 with the values 1.96 and 2.58 (The values correspond to 5% and 1% levels respectively):

\[1.5 < 1.96\]

Conclusion: Since the calculated value is less than the 5% level value, there is no significant difference. So the variability of the sample is not greater than that of the bulk of the yarn.

**Example 6. Single standard deviation with a small sample:** Nine hanks of a particular charkha were tested for yarn count and the S.D. of the yarn count is 8.4. The population S.D. is 7.1. Is the charkha spinning a yarn whose count is more variable than usual?

Step 1. Write down the data given as below:

- No of samples \((n) = 9\)
- S.D. of sample = 8.4
- S.D. of the population = 7.1

Step 2. Calculate the variance that particular sample and the population:

As we know variance \((V) = \text{S.D.}^2\)

- Sample variance \((V_1) = 8.4^2 = 70.56\)
- Population variance \((V_2) = 7.1^2 = 50.41\)

Step 3. Calculate \(F\), the variance ratio:

\[
F = \frac{V_1}{V_2} = \frac{70.56}{50.41} = 1.40
\]

Step 4. From the variance table (Table 3.6) find the 5 per cent and 1 per cent significant level values for the corresponding degrees of freedoms. In this case \(\nu_1 = 8\) (degrees of freedom of sample = \(n - 1\)) and \(\nu_2 = \infty\) (degrees of freedom of population as it is very large)

- 1 per cent significant level value = 2.51
- 5 per cent significant level value = 1.94

Step 5. Compare the calculated value obtained in step 3 with the values correspond to 5% and 1% levels.

\[1.40 < 1.94\]
Conclusion: Since the calculated value is less than the 5% level value, there is no sufficient evidence to prove that the variability of the yarn sample greater than that of the bulk of the yarn.

**Example 7. Difference between the standard deviation of two large samples:** Two yarn samples were tested for single yarn strength and the following results obtained:

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<tr>
<th>Particulars</th>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of tests</td>
<td>40 (n₁)</td>
<td>40 (n₂)</td>
</tr>
<tr>
<td>Mean single yarn strength (lb)</td>
<td>69 ((x₁))</td>
<td>73 ((x₂))</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>8.9 ((σ₁))</td>
<td>10.1((σ₂))</td>
</tr>
</tbody>
</table>

Find whether sample 2 is more variable than sample 1?

**Step 1.** Calculate the standard error of the standard deviation for each sample:

\[
S.E. = \sqrt{\frac{2}{n}}
\]

\[
S.E.₁ = 8.9 \div \sqrt{2} \times 40 = 0.99
\]

\[
S.E.₂ = 10.1 \div \sqrt{2} \times 40 = 1.13
\]

**Step 2.** Calculate the standard error of the difference between the S.D.s

\[
S.E.\text{diff} = \sqrt{(S.E.₁^2 + S.E.₂^2)} = \sqrt{(0.99^2 + 1.13^2)} = 1.50
\]

**Step 3.** Calculate the ratio:

\[
\frac{|S.D.₁ - S.D.₂|}{S.E.\text{diff}}
\]

\[
= |8.9 - 10.11| \div 1.50 = 0.80
\]

**Step 4.** Compare the value obtained in step 3 with the values 1.96 and 2.58 (The values correspond to 5% and 1% levels respectively):

\[
0.80 < 1.96
\]

Conclusion: Since the calculated value is less than the 5% level value, there is no significant difference between the two standard deviations.

**Example 8. Difference between the standard deviations of two small samples:** Two yarn samples were spun in an NMC charkha with two different fibres. It was done to know whether the change in fibre type has really affected the tenacity strength. Nine tests from the first sample and eleven tests from the second sample were taken and the standard deviations were calculated as follows:

- S.D. of sample 1 = 7.7
- S.D. of sample 2 = 9.3

Find whether sample 2 is more variable than sample 1?
Step 1. Write down the data given as below:
   No of tests of sample 1 \((n_1) = 9\)
   No of tests of sample 2 \((n_2) = 11\)
   S.D. of sample 1 = 7.7
   S.D. of sample 2 = 9.3

Step 2. Calculate the variance of the two samples:
   As we know variance \((V) = \text{S.D.}^2\)
   Variance of sample 1 \((V_1) = 7.7^2 = 59.29\)
   Variance of sample 2 \((V_2) = 9.3^2 = 86.49\)

Step 3. Calculate \(F\), the variance ratio:
   \[
   F = \frac{V_2}{V_1} = \frac{86.49}{59.29} = 1.46
   \]

Step 4. From the variance table (Table 3.6) find the 5 per cent and 1 per cent significant level values for the corresponding degrees of freedoms. In this case \(\nu_1 = 10\) (degrees of freedom of the sample whose variance is expected to be greater i.e. for sample 2 \(n - 1 = 11 - 1\)) and \(\nu_2 = 8\) (degrees of freedom of the sample 1)
   1 per cent significant level value = 5.81
   5 per cent significant level value = 3.35

Step 5. Compare the calculated value obtained in step 3 with the values correspond to 5% and 1% levels.
   \(1.46 < 3.35\)

Conclusion: Since the calculated value is less than the 5% level value, there is no sufficient evidence to prove that the variability of the yarn sample greater than that of the bulk of the yarn.
Table 3.6 (a): Variance or F Ratios (5 per cent Significance Limits of F)

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Table 3.6 (b): Variance or F Ratios (1 per cent Significance Limits of F)

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CHAPTER 4
Test Equipments

The measurement of various characteristics of textiles (fibre, yarn and fabric) plays an important role in the analysis, quality control, sale–purchase and checking up for compliance to the standard. Several standards and test methods are followed worldwide for the evaluation of different properties of textile materials. The use of Indian standard and the list of the test instruments are described in this chapter.

4.1 Fibre Testing

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Name of the Instrument</th>
<th>Property to be measured</th>
<th>BIS Standard</th>
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<tbody>
<tr>
<td>1</td>
<td>Baer sorter</td>
<td>Fibre length</td>
<td>IS 10014 (Part 1): 1984</td>
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<td>Fibrograph</td>
<td>2.5% &amp; 50% span length and uniformity ratio</td>
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<td>3</td>
<td>Fibre fineness tester</td>
<td>Fibre fineness (Micronaire value)</td>
<td>IS 3674: 1966</td>
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<tr>
<td>4</td>
<td>Stelometer/Pressley tester</td>
<td>Fibre tenacity (Bundle strength)</td>
<td>IS 3675: 1966</td>
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<td>5</td>
<td>Trash analyzer</td>
<td>Trash percentage in cotton fibre</td>
<td>IS 4871: 1968</td>
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<td>6</td>
<td>Projection microscope*</td>
<td>Cotton fibre maturity</td>
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<td>7</td>
<td>Hot air oven**</td>
<td>Moisture content of a fibre</td>
<td>IS 199: 1988</td>
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<tr>
<td>8</td>
<td>Humidity chamber</td>
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</table>

* Also used for enlarged view of fibre/yarn samples.
** Also used for heating and drying of samples.

4.2 Yarn Testing

<table>
<thead>
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</tr>
<tr>
<td>2</td>
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<td>Lea strength (CSP)</td>
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</tr>
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<td>3</td>
<td>Single thread strength</td>
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### 4.3 Fabric Testing

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<td>Length &amp; width</td>
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<tr>
<td>2</td>
<td>Pick glass</td>
<td>Thread density</td>
<td>IS 1963: 1981</td>
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<tr>
<td>3</td>
<td>Round cutter</td>
<td>Weight in g/m² of fabric (GSM)</td>
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### 4.4 Chemical Tests

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<td>Rubbing fastness</td>
<td>IS 105</td>
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<td>Dimensional changes</td>
<td>IS 10099: 1982</td>
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<td>5</td>
<td>Colour matching cabinet</td>
<td>Metamerism effect, Shade matching</td>
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<td>Spectrophotometer</td>
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### 1.5 Essential Test Equipments Required for Quality Maintenance in Khadi Institutions

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<td>Fibre fineness (Micronaire value)</td>
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### Chemical processing

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<td>5</td>
<td>Spectrophotometer</td>
<td>Whiteness measurement</td>
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CHAPTER 5
Test Methods

5.1 Conditioning and Sampling of Textile Materials

5.1.1 Atmospheric Conditions for Testing

It is the atmosphere in which testing of textile materials are performed. It is specified with a relative humidity of 65 ± 2 percent and a temperature of 27 ± 2°C.

5.1.2 Sampling of Fibre

Fibre in different forms such as bale, sliver, roving, yarn etc needs different sampling techniques for testing. While sampling fibre for testing, a point to be considered is the extent to which the fibre is mixed or blended. When the fibre bulk to be sampled is well mixed, as in draw frame sliver, the fibre may be selected from one region and it is assumed that fibres from all parts are represented. When there is improper mixing or the material vary from region to region in the bulk, sampling should be done from all parts of the bulk in order to achieve a representative test sample. This is known as zoning and is an important step in the preparation of fibre samples. Perform 1 test for fibre length; 5 tests each for fibre fineness, moisture content and maturity; 10 tests for tenacity, 2 tests for trash percentage.

5.1.3 Sampling of Cotton Yarn for Physical Tests

Perform 25 tests each for yarn count and lea breaking load, 10 tests each for evenness and twist. While sampling for appearance grade, five hanks shall be selected at random from a lot and one test specimen shall be prepared from each hank.

5.1.4 Sampling of Fabrics for Physical Tests

a) Woven Fabrics

1. Take one of the test samples drawn for the purpose of preparing test specimens, mark the warp and weft directions and lay it flat on the surface of a smooth table. Remove any wrinkles or folds in the sample by hand without unduly stretching it.

2. Mark the required number of warp way and weft way test specimens of the required size from different portions of the sample under test. The length directions of the warp way and weft way test specimens shall be parallel to the warp and weft directions of the sample respectively. The specimens marked in each direction shall be scattered throughout the area of the sample (Fig. 5.1 A) in such a way that no two warp (or weft) way specimens contain the same set of warp (or weft) yarn.
3. However, in case it is not possible to have different sets of warp or weft yarns for different specimens, a portion of the warp or weft yarns taken in one specimen may be allowed to form a part of the other specimen (Fig. 5.1 B).

4. The number of test specimens to be drawn and the size of each specimen depends on the property to be tested and shall be laid down in the specification for the material or the method of test to be followed. Incase there are more than one test sample for drawing test specimens, draw approximately equal number of specimens from each test sample to make up the total number of test specimens.

![Fig. 5.1 A Test specimens without common yarns (or portions)](image)

![Fig. 5.1 B Test specimens with common yarns (or portions) W: Warp way test specimen, F: Weft way test specimen.](image)

*NOTE: Distance d shall be not less than one–tenth of fabric width.*
5. Avoid taking test specimens from the portions having wrinkles, folds or defects. Do not take any specimen within one–tenth of the fabric width from the selvedge. Mark the warp way and weft way test specimens with the letters ‘W’ and ‘F’ respectively for the purpose of identification.

6. Cut the test specimens with the help of a sharp razor or a pair of scissors along the markings and collect the warp way and weft way specimens separately.

5.1.5 Format of Test Report

The test results obtained should be produced in a standard format. The test report formats for different properties of fibre, yarn and fabric are described in Appendix III. Also the list of laboratories where testing facilities for textile materials are available is given in Appendix IV.

5.2 Fibre Testing

5.2.1 Estimation of Fibre Length by Array Method

[Procedure to be followed – IS 233 (Part 2): 1978]

The fibre length is measured from the tracing of an array plotted using Baer sorter. The effective length, mean length, percent short fibres and coefficient of variation of length are calculated from the tracing.

Apparatus

Baer Sorter

The instrument (Fig. 5.2) is used to prepare the fibre array. It consists of two sets of horizontal combs, an upper and a lower set.

Fig. 5.2 Baer sorter

Accessories

a) Fibre grip;

b) Teasing needle;
c) Rake to press in the fibres;
d) Velvet pad;
e) Transparent tracing material; and
f) Graph paper.

Procedure

1. Clean all the combs of the comb sorter before testing.
2. Take about 20 mg of the fibre to be tested.
3. Make the fibres straight and parallel by drawing and doubling several times by the hand (This is done by holding the specimen with the thumb and the forefinger of each hand and then drawing and doubling).
4. Slightly twist the straightened specimen to hold the fibres more firmly.
5. Place the comb sorter in a suitable position such that the first of the bottom combs, which can be dropped in succession, faces the operator.
6. Lift the upper combs, and lay the representative fibre sample towards the right and across the lower bed of combs.
7. Press the fibre into the combs with the rake.
8. Remove the projecting fibres with the grip and make the fibre end to align with first comb.
9. Grip a small tuft from the straightened edge of the fibre and comb it several times across the needles of the upper comb to remove the loose fibres.
10. Transfer the combed tuft to the left hand side needles and press it with the rake so that it is gripped by the first row of combs.
11. Transfer all the fibres present at the right side to the left side as above.
12. Turn the sorter round through 180 degrees.
13. Lower the upper combs.
14. Drop a sufficient number of lower combs and raise the corresponding number of upper combs until the ends of the longest fibres project about 0.5 cm.
15. Using the grip, pull out small tufts of successively shorter lengths.
16. Comb and straighten the fibres in each tuft, and lay them side-by-side on the velvet pad such that the free ends of the tufts lie along a straight base line.
17. A continuous array of uniform density is produced by skillfully using the teasing needle and a forefinger to arrange each tuft perpendicular to the base line and joining up with the previous one.
18. Successive top and bottom combs are moved as shorter and shorter fibres are pulled out and joined into the pattern.

19. The last few tufts should be very carefully arranged so that no short fibres are lost. It should also be ensured that the pattern is of uniform density throughout as the ultimate evaluation is based on this assumption.

20. Trace the outline of the fibre array on a sheet of transparent material.

**Calculation and Expression of Results**

**Maximum Length:** Determine the maximum length $OA$ from the tracing.

**Effective Length:** Make geometric constructions as shown in Fig. 5.3 as follows:

a) Halve the maximum length $OA$ at $Q$ and draw a line parallel to the base through $Q$ to cut the curve at $P'$; drop a perpendicular from $P'$ to meet the base line at $P$.

b) Mark off $OK = OP/4$ and erect a perpendicular $KK'$ to cut the curve at $K'$.

c) Halve $KK'$ at $S$ and draw a parallel line to the base through $S$ to cut the curve at $R'$; drop a perpendicular from $R'$ to meet the base line at $R$.

d) Mark off $OL = OR/4$ and erect a perpendicular $LL'$ cutting the curve at $L'$. Effective length is the length represented by $LL'$.

**Mean Length:** Determine the area of the comb sorter diagram using either the special transparent scale or a planimeter; divide the area expressed in square mm by the length of the base (mm) to obtain mean fibre length (mm).

**Upper Quartile Length:** Mark off $OU = OB/4$ and erect a perpendicular $UU'$ to cut the curve at $U'$. $UU'$ is equal to the upper quartile length.

**Percent Short Fibres:** Percent short fibre equals $\left(\frac{RB}{OB}\right) \times 100$ where $OB$ is the total length of the diagram.

5.2.2 Estimation of Fineness (Micronaire Value) of Cotton Fibre

(Procedure to be followed – IS 3674: 1966)

Fineness is one of the important characteristics of cotton fibre. The airflow instruments are
generally prescribed for this method. These instruments operate on the principle that the fineness of the cotton fibre is related to the rate of airflow, through a plug of cotton fibre of fixed weight contained in a container of definite dimensions and subjected to a constant pressure head. This method is applicable to cotton fibre taken from bale, lap, sliver or any other sources.

**Apparatus**

1. **Balance:** The balance (Fig. 5.4) shall be capable of weighing the specimen to an accuracy of 10 mg.

![Fig. 5.4 Weighing balance](image)

2. **Airflow instrument:** The airflow instrument (Fig. 5.5) consists of the following principal parts.
   a. Compression cylinder with perforated ends for the admission and discharge of air.
   b. One or more valves for regulating and controlling the flow of air through the specimen.
   c. A gauge or other means for measuring the resistance of the specimen to airflow.
   d. An air pump or other means for producing the required air pressure applied to the specimen.

**Adjustments and Calibration of the Instrument**

1. Make the preliminary adjustments appropriate to the instrument in use.
2. Calibrate the instrument by testing at least three specimens from at least three calibration cottons.
3. The instrument shall be considered to be in calibration, if it reads the calibration cottons within ± 0.1 micronaire value of the established values for the corresponding calibration cotton. If the instrument does not read within these limits repeat the calibration procedure after re-adjusting the instrument.
Preparation of Test Specimens
1. Open the test sample with fingers, breaking up lumps present and remove the trash present in it.
2. Take at least two specimens, making two tests on each.

Procedure
1. Weigh out 5 g of the test specimen with an accuracy of 10 mg.
2. Place the test specimen in the fibre compression cylinder, a small portion at a time, taking care that all the fibres are placed inside.
3. Insert the compression plunger in position in the fibre compression cylinder and lock it.
4. Allow the air to flow through the specimen and read the airflow to an accuracy of half a division of the scale.
5. Remove the test specimen from the fibre compression cylinder. Open out the specimen and re-pack it into the fibre compression cylinder, taking care that all the fibres are placed inside.
6. Determine one more test value of the specimen in the manner prescribed in steps 2 to 4.
7. Take the other test specimen and determine the test values in the manner described in steps 2 to 6.

NOTE: If the deviation of any individual reading is more than 0.2 from the mean value, prepare two more test specimens and find out the test values by the procedure prescribed in 1 to 6.

Calculation and Expression of Results
1. In instruments in which the scale is graduated in micronaire units, find the average of the test values to the nearest 0.1 micronaire units and report it as the micronaire value of the cotton fibre in the lot.
2. For instruments in which the scale is graduated in units other than micronaire, convert the
direct reading to micronaire units either from a previously prepared graph or by
previously fitted curve. Find the average of the values thus obtained to the nearest 0.1
micronaire units and report it as the micronaire value of the cotton fibre in the lot.

5.2.3 Tenacity (Bundle Strength) of Cotton Fibre
(Procedure to be followed – IS 3675: 1966)
Strength of cotton fibre contributes substantially to the quality of yarn. As the fibres are
arranged as bundles in the yarn so the bundle strength correlates to the yarn quality. The
bundles of fibres may be secured by clamps, which are either in close contact (zero gauge
length) or by clamps separated to give a finite gauge length. Fibre strength testing at zero
gauge length is a current commercial practice, although investigations indicate that tests at
finite gauge length of 3.175 mm (or 1/8 in) may be more closely related to the tenacity of
many classes of cotton yarn. International Calibration Cotton Standard has been established
to enable different operators to adjust their personal level of testing to an agreed common
level.

Apparatus
a) Balance: Capable of weighing to an accuracy of ± 0.01mg.
b) Fibre bundle strength tester (Stelometer): The Stelometer (Fig. 5.6) consists of the
   following accessories.
   
   ![Fig. 5.6 Stelometer](image)

1) Specimen Clamps (of Pressley Type): A pair of clamps with a combined width of 11.81
   mm (0.465 in), while testing at finite gauge length, a suitable spacer, usually of 3.175 mm (or
   1/8 in) may be used between the clamps.

2) Clamp Vice: A jig equipped with a locking screw or cam for holding the clamps while
   they are being loaded and unloaded. A vice equipped with an appropriate construction to
   ensure the application of predetermined force when tightening the jaws of the clamps, may be
   preferred.
3) Accessories
   a) Coarse comb – with approximately 8 teeth per 25 mm (1 in);
   b) Fine comb – with approximately 52 teeth per 25 mm (1 in);
   c) Wrench – for tightening the clamps. A torque wrench is needed, if the clamp vice is not equipped with a torque device;
   d) Shearing knife;
   e) Tweezers;
   f) A fine camel hairbrush;
   g) Stopwatch; and
   h) Spirit level etc.

Calibration of the Instrument

1. Adjust the instrument in accordance with the manufacturer’s instructions in the user guide.
2. After the adjustment of the instrument, test the standard calibration cotton samples on the instrument. The results may be considered acceptable if they do not depart by more than ± 5 percent from the standard values given for the calibration cottons.
3. When the observed value differs by more than ± 5 percent from the established value for the standard calibration cotton sample, recheck the apparatus and repeat the test after making necessary adjustments.

NOTE: International Calibration Cotton Standards made at zero gauge length are available from the Cotton Division, Consumers and Marketing Service, US Department of Agriculture, Memphis, Tennessee, USA. These cottons cover approximately the range of the tenacities of all commercial cottons grown in the world. Secondary Calibration Cotton Standards corresponding to the International Calibration Cotton Standards are proposed to be prepared in India.

Preparation of Test Specimens

1. Place the conditioned sliver or mechanically blended sample across a set of parallel combs (like a comb sorter).
2. Align one end of the sliver after removing the protruding fibres and draw a suitable tuft with the help of tweezers.
3. Gently comb four or five times to remove the fibre not gripped by the tweezers.
4. Grip the combed end with another tweezers at such a distance from the first tweezers so as to leave fibres having length at least equal to the width of the pair of clamps.
5. Release the first tweezers and comb the free end of the fibres gently.
6. Take the tuft of fibres and form it into a flat bundle of 6mm in width. The flat bundle thus obtained shall constitute a test specimen.

Procedure
1. Grip the test specimen (fibre bundle) at one end with the sample clip; comb out all fibres, which are not held by the clip.
2. Holding the clip with its flat side down, grip the other end of the test specimen by the auxiliary clamp of the vice.
3. Draw the clip through the open jaws of the fibre clamps until it clears the jaws and falls to the recessed section of the vice.
4. Raise the hook on the pretension lever and position the sample clip so that the hook passes through the hole on the clip.
5. Release the hook to make the clip hang loosely.
6. Close the jaws of the fibre clamps and tighten with the help of the torque wrench, the jaw screws gradually till the vice starts to rotate.
7. Remove the clamps from the vice and shear off the protruding ends of the fibres with the shearing knife, shearing downward and away from the movable face of the fibre clamps.
8. Place the prepared clamps in the instrument, break the specimen and record the breaking load.
9. Remove the clamps from the instrument, check to see that all fibres are broken and place the clamps in the vice.
10. If all fibres are not broken, or broken irregularly, or if the breaking load is less than the required minimum for the instrument used, discard the specimen and make a new test.
11. If the break is acceptable, open the clamps collect all the broken fibres with forceps, or preferably with a fine camel hairbrush and weigh them to the nearest 0.01 mg. Do not touch the fibres with the fingers while collecting and weighing to avoid gain in weight from moisture pick up.
12. Perform the test on a total of at least 10 specimens.

Calculation
a) Breaking Tenacity
1. For tests made at zero gauge length, based on a bundle length of 11.81 mm (0.465 in), use the following formula:

\[
\text{Breaking Tenacity (g per tex)} = \left(\frac{\text{Breaking load in kg}}{\text{Bundle weight in mg}}\right) \times 11.81
\]

Calculate the mean of all the values and express it as breaking tenacity of the fibres.
2. For tests made at a finite gauge length of 3.175mm (1/8 in) based on a bundle length of 15 mm (0.590 in), use the following formula:

\[
\text{Breaking Tenacity (g per tex)} = \left( \frac{\text{Breaking load in kg}}{\text{Bundle weight in mg}} \right) \times 15.00
\]

Calculate the mean of all the values and express it as breaking tenacity of the fibres.

5.2.4 Determination of Lint and Trash Content of Cotton Fibre
(Procedure to be followed – IS 4871: 1968)

The determination of lint and trash content of raw cotton is important since the presence of trash directly influences the net amount of yarn or cloth that can be manufactured from a given lot of cotton. The amount of trash remaining in various intermediate products like scutcher lap, card sliver, etc, indicates the cleaning efficiency of the processes or machines. Also the amount of useful lint present in the waste removed at various machines helps in making the adjustment and settings of various cleaning points of the machines. Thus, the analysis of intermediate products and wastes for lint and trash contents helps in profitable adjustment and operation of the machines to clean the cotton to a predetermined degree.

Apparatus

a) Trash Analyser: The trash analyser (Fig. 5.7) works on mechanical–pneumatic principle. It is capable of separating trash and lint fractions from the fibre. The machine consists of the following accessories.

1) Containers: For holding the specimen, lint and trash.

2) Brushes: It helps in the collection of lint and trash fractions from various compartments.

3) Gauges and Tools: For making adjustments and settings of the machine.

b) Balance: The balance should be capable of weighing to an accuracy of 10 mg.

Preparation of Test Specimens

1. Take 100 gram (M) of the fibre sample whose lint and trash content is to be determined. While taking the samples, take care that no trash is lost.

2. Test at least 2 test specimens.
Fig. 5.7 Trash analyser

Procedure
1. Clean the instrument and the containers.
2. Shake the specimen so that large particles of trash (which may otherwise damage the machine) are removed from the specimen. Keep these droppings separately.
3. Open out the hard lumps of fibres, if present.
4. Spread the specimen on the feed plate in the form of an even layer
5. Start the machine and let the trash and lint collect in their respective compartments.
6. Take out the lint from the lint chamber and pass it again through the machine without disturbing the trash in the settling chamber.
7. Stop the machine and collect the lint (L₁) from the lint chamber and keep it in a separate container.
8. Remove all the trash particles containing lint from the trash tray and settling chamber and pass it through the machine. Collect the lint.
9. Pass the above collected lint through the machine without disturbing the trash.
10. Collect the lint (L₂) and keep it in a separate chamber.
11. Collect all the trash (T₁) in the trash tray, settling chamber and any seeds clinging to the wires of the licker–in cylinder and combine them.
12. Weigh the trash (T₁) (to an accuracy of 100 mg and if the weight is less than 10g, weigh to an accuracy of 10 mg).
13. Pass the trash (T₁) containing lint again through the machine and ignore the trash collected. Collect the lint (L₃) and keep it in a separate container. Weigh the lint (L₃) to an accuracy of 10 mg.
14. Combine all the portions of lint (L₁, L₂ and L₃) and weigh to an accuracy of 10 mg.
15. The steps followed is shown in the flow chart as shown in fig. 5.8.
Fig. 5.8 Flow chart of the steps followed in trash analysis.

**Calculation**

Calculate the lint content, trash content (visible waste content), and the invisible waste content as percentages of the original specimen by the following formulae:

a) Lint content (L), in percent = \( \frac{L_1 + L_2 + L_3}{M} \times 100 \)

b) Trash content (visible waste) (T), in percent = \( \frac{T_1 - L_3}{M} \times 100 \)

c) Invisible waste content (W), in percent = 100 – (L + T)

**5.2.5 Determination of Moisture in Cotton Fibre**

*(Procedure to be followed – IS199: 1988)*

Moisture in cotton fibre plays an important role in the quality of the yarn. In order to have repeatable and reproducible results moisture estimation is critical for estimation of mass in cotton textile materials.

**Apparatus**

a) **Weighing balance**

b) **Drying oven**: The oven is shown in Fig. 5.9. It should be capable of maintaining a temperature of 105 ± 3°C.
Fig. 5.9 Drying oven

Procedure
1. Draw at least 2 test specimens each weighing approximately 3g from the sample.
2. Take one test specimen and weigh it accurately in a clean and dry tare weighing bottle.
3. Place the weighing bottle containing the test specimen in the drying oven and dry the specimen at 105 ± 3°C to constant mass.
4. Determine the oven–dry mass of the test specimen.
5. Similarly test the other test specimen(s).

NOTE: The mass shall be regarded as constant if the loss between two successive weighing, taken at an interval of 20 minutes, does not exceed by 0.1 percent of the first of the two values.

Calculations
Calculate the percentage of moisture content in the test specimen by the following formulae:

\[
\text{Moisture content, percent} = \frac{(a-b)}{a} \times 100
\]

Where
- \(a\) = original mass in g of the test specimen, and
- \(b\) = oven–dry mass in g of the test specimen.

Determine the mean of all values, obtained and express it as moisture content of the material in the lot.

5.2.6 Determination of Cotton Fibre Maturity (Sodium hydroxide swelling method)

(Procedure to be followed – IS 236: 1968)
Three methods are used for determination of cotton fibre maturity, keeping in view the practices prevalent in the industry. The three methods are:
Method I: Coefficient of maturity (\(C_M\))
Method II: Percentage of mature fibres (\(P_M\))
Method III: Maturity ratio (M)

**Apparatus**

a. A microscope (Fig. 5.10) fitted with a mechanical traversing stage and having a magnification power of 200X, 400X to 500X, and 150X for methods I, II and III respectively.

![Fig. 5.10 Projection microscope](image)

b. Glass slides and cover slips.

c. Scissors, forceps, glass rod.

d. 18 percent Sodium hydroxide solution.

e. Draw box.

**Preparation of Test Specimens**

1. If the test sample is in the form of a sliver, lay it on a velvet–covered board, and if the test sample is in the form of a roving or yarn, untwist several strands before laying them parallel to each other side by side on the velvet–covered board.

2. Place a glass plate over the test sample with its long edge at right angle to the length of the test sample.

3. With the help of sharp scissors, cut the test sample as near to the edge of the glass plate as possible.

4. With the help of forceps, remove and discard the fibres whose cut ends are projecting right up to the edge of the glass plate.

5. Move the glass plate backwards (about 1 mm) and with the help of forceps, remove and discard the fibres by gripping the protruding ends, right up to the edge of the glass plate.

6. Move the glass plate backwards again and similarly remove and discard the protruding fibres.
7. Move the glass plate backwards a third time and then remove the fibres with the help of forceps and lay them on a glass slide in such a manner that the fibres are approximately parallel to one another.

8. Place about 100 fibres on each slide over a length of about 20mm.

9. Cover the fibres with cover slip and irrigate the fibres with 18 percent sodium hydroxide solution. Prevent the formation of air bubbles by tapping the cover slip lightly while irrigating the fibres. Remove the excess solution at the edges with absorbent tissue or blotting paper.

10. Similarly prepare four more slides.

Procedure

**Method I (Coefficient of Maturity—C_M)**

**Terminology**

a) *Fibre maturity count* – The fibre maturity count is denoted by the percentages of the mature, half mature and immature fibres in a sample.

b) *Maturity* – The degree of fibre wall development.

**Principle**

The fibres are classified into mature, half mature and immature fibres on the basis of the ratio of their lumen width to their wall thickness, both values being determined after the fibres have been swollen fully in 18 percent sodium hydroxide solution, as given below:

<table>
<thead>
<tr>
<th>Value of Lumen width/wall thickness</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 0 and 1</td>
<td>Mature</td>
</tr>
<tr>
<td>Between 1 and 2</td>
<td>Half mature</td>
</tr>
<tr>
<td>Above 2</td>
<td>Immature</td>
</tr>
</tbody>
</table>

**Procedure**

1. Adjust the microscope condenser to give critical illumination and then move it slightly to obtain a uniformly lit field of view.

2. Place the first mounted slide as prepared above (after about 5 minutes of its irrigation with sodium hydroxide solution) on the microscope stage in such a manner that the central portions of the fibres are beneath the objective.

3. Examine the fibres one by one by moving the stage in the transverse direction.

4. Estimate the ratio of lumen width to wall thickness of each fibre and classify it into mature, half mature and immature fibre.
5. Classify the fibres on the basis of appearance of the portion in the field of view and do not move the slide in the lateral direction during testing. In the case of twisted fibres, this estimation shall be made at the widest part of the fibre seen in the field of view between successive twists.

6. Test the four other slides in a similar manner.

**Calculation**

Calculate the percentages of mature, half mature and immature fibres from the total number of observations made by combining the counts of all the five slides. Express the three percentages as maturity count of the cotton.

The coefficient of maturity ($C_M$) shall be calculated by the following formula:

$$C_M = \frac{m + 0.6h + 0.4i}{100}$$

where

- $m$ = percentage of mature fibres,
- $h$ = percentage of half mature fibres, and
- $i$ = percentage of immature fibres.

**Method II (Percentage of Mature Fibres–$P_M$)**

**Terminology**

a) **Maturity** – The degree of fibre wall development.

b) **Mature fibres**– Fibres that after being treated with strong caustic solution swell into an unconvoluted and almost rod–like shape where total wall width is equal to or greater than the lumen width.

c) **Immature fibres**– Fibres that after being treated with strong caustic solution either: (1) swell and assume a spiral form; or (2) remain flat, thinly outlined and almost transparent. In any case, the total wall width is less than the lumen width.

**Procedure**

1. Adjust the microscope condenser to give critical illumination and then move it slightly to obtain a uniformly lit field of view. Place the prepared slide (after about 5 minutes of its irrigation with sodium hydroxide solution) on the microscope stage in such a manner that the central portions of the fibres are beneath the objective.

2. Examine the fibres one by one by moving the slide in the transverse direction and classify them into mature and immature fibres.

3. Classify the fibres on the basis of the appearance of the portion in the field of view and do not move the slide in the lateral direction during testing.

4. Test the four other slides in a similar manner.
Calculation

Calculate the percentage of mature fibres from the total number of observations of all the five slides by the following formula:

\[
\text{Percentage of mature fibres (}\overline{P_m}\text{)} = \left( \frac{m}{t} \right) \times 100
\]

Where

\( m \) = total number of mature fibres, and
\( t \) = total number of observations.

Method III (Maturity Ratio–M)

Terminology

a) Degree of wall thickening – The ratio of actual cross-sectional area of the wall to the area of the circle with the same perimeter.

b) Maturity ratio – The ratio of actual degree of wall thickening to a standard degree of thickening equal to 0.577.

c) Normal fibre – Fibres, which after swelling appear rod-like with no continuous lumen. Swollen normal fibres have no well-defined convolutions.

d) Dead fibres – Fibres in which after swelling the wall thickness is one-fifth or less than the maximum fibre width. Swollen dead fibres vary from flat forms, with no convolutions and little or no secondary fibre wall to highly convoluted forms with greater wall development.

e) Thin walled fibres – Fibres that do not fall into either the normal or dead fibre groups.

f) Maturity – The degree of fibre wall development.

Procedure

1. Adjust the microscope condenser to give critical illumination and then move it slightly to give a uniformly lit field of view. Place the prepared slide (after about 5 minutes of its irrigation with sodium hydroxide solution) in the microscope stage in such a manner that the central portions of the fibres are beneath the objective.

2. Move the slide in the transverse direction and count the total number of fibres. Again move the slide and count the number of normal and dead fibres.

3. Classify the fibres on the basis of the appearance of the portion in the field of view and do not move the slide in the lateral direction during testing. The observations of fibre width and wall thickness shall be taken at the widest portion in the field of view.

4. Test the four other slides in a similar manner.
Calculation
Calculate the percentage of normal and dead fibres after combining the observations of all the five slides. Calculate the maturity ratio from the difference between the percentages of normal and dead fibres by using the following formula:

\[ M = \left(\frac{N - D}{200}\right) + 0.7 \]

Where
\( M \) = maturity ratio, \( N \) = percentage of normal fibres, and \( D \) = percentage of dead fibres.

5.3 Yarn Testing
5.3.1 Determination of Count of Yarn
(Procedure to be followed – IS 1315: 1977)
This method is suitable for determination of English as well as Metric count of yarn. It is applicable to single and double yarn.

Apparatus
a) Wrap reel: Wrap reel (Fig. 5.11) has a circumference of 1.5 yd (1.372m) or 1m. Any one of the two balances mentioned below can be used.

1) Special balance giving directly the yarn count: The balance directly gives the yarn count when a hank of known length of yarn is placed or hung on the clamp of the balance.

2) Single pan balance: The balance should be capable of measuring to an accuracy of 1 mg.

Procedure
1. Prepare a hank of 120 yd (109.72m) or 100m on the wrap reel.
2. Take the above hank and hang it on the special yarn count balance and read off the count of the yarn directly from the scale provided or determine the weight in grams of the above hank on the single pan balance correct to 1mg. Calculate the count of the yarn as given in calculation.
3. Test at least 25 samples.

Fig. 5.11 Wrap reel

Calculations
Calculate count of the yarn in English system up to one decimal place by following formula:

\[
\text{English Count (Ne)} = \frac{64.8}{m}
\]

Where \( m \) = weight of hank of 120 yd in grams.

Calculate count of the yarn in Metric system up to one decimal place by following formula:

\[
\text{Metric Count (Nm)} = \frac{100}{n}
\]

Where \( n \) = weight of hank of 100 metre in grams.

1. Calculate the average of all the count values up to one decimal place and report it as the count of the yarn.
2. Calculate the coefficient of variation (CV\%) of all the observations made.

*Note: The other systems used for measuring yarn count is described in Appendix V.*

### 5.3.2. Determination of Yarn Strength (Lea CSP)

*(Procedure to be followed – IS 1671: 1977)*

In this test method determination of lea strength i.e. Count Strength Product (CSP) is described.

**Apparatus**

**a) Lea Strength Tester:** The lea strength tester (Fig. 5.12) works on the principle of constant-rate-of-traverse (CRT) at a traverse speed of 300 ± 15 mm/min.

**b) Wrap reel:** Having a circumference of 1.5yd (1.372m) or 1m.

**Preparation of Test Specimens**

1. Prepare leas of 109.73 m (120 yd) or 100m as required.
2. Prepare at least 25 test specimens and condition them in standard atmosphere.

![Fig. 5.12 Lea strength tester](image-url)
Procedure
1. Bring the pulleys or the hooks of the testing machine to the zero position.
2. Take the conditioned lea and fix it on the pulleys or hooks.
3. Separate the yarn carefully to avoid the individual strands overlapping each other.
4. Start the machine and carry the test to break the sample.
5. Record the lea breaking load in kilograms or pounds as indicated on the scale.
6. Determine the weight in grams of the broken lea and calculate the count of the yarn as described in section 5.3.1 “Determination of Count of Yarn”.
7. Determine the lea breaking load and count of the yarn of remaining specimens following the procedure as laid down in the steps 1 to 6 above.

Calculations
1. Calculate the average breaking load and average count of all the observations taken.
2. Calculate the coefficient of variation (CV) of all the breaking load values taken.
3. Calculate the Count Strength Product (CSP) in English and Metric systems as described below

**English Count System**
Calculate the Count Strength Product (CSP), from the following formulae:

a) CSP = L₁ × Ne.

Where
L₁ = Average breaking load in pounds (Kg ÷ 2.2) of the lea of 120 yd and
Ne = Average English count.

b) CSP (Corrected to nominal count) = C₂ × S₂

Where
S₂ = Corrected lea strength to nominal count

= [C₁ S₁ – (C₂ – C₁) × 18] ÷ C₂

S₁ = observed average lea strength (Pound).
C₁ = observed cotton count.
C₂ = Nominal count.

**Metric Count System**
Calculate the Count Strength Product (CSP), from the following formulae:

a) CSP = L₂ × Nm.

Where
L₂ = Average breaking load in Kg of the lea of 100m and
Nm = Average Metric count.
5.3.3 Determination of Breaking Load and Elongation at Break of Single Strand

(Procedure to be followed IS – 1670: 1991)

This method is used for determination of breaking load and elongation at break of yarn using constant–rate–of–traverse (CRT), constant–rate–of–loading (CRL), and constant–rate–of–extension (CRE) machines. This method is designed primarily for yarn in package form but can be used for single strand of yarns removed from a woven/knitted fabric.

Terminology

For this method, the following definitions are applied:

1) Single–Strand Breaking Load: It is the breaking load of a single strand of yarn, running straight between the clamps of the testing machine. It should be free from knots or loops.

2) Elongation at Rupture: It is the elongation that occurs at the final rupture of the specimen.

3) Elongation at Break: In a tensile test, the difference between the length of a stretched specimen at breaking load and its initial length usually expressed as percentage of initial length.

Apparatus

Tensile Testing Machine: A single yarn tensile testing machine (Fig. 5.13) is used. It is based on one of the three principles.

a) Constant–rate–of–traverse (CRT);

b) Constant–rate–of–loading (CRL); and

c) Constant–rate–of–extension (CRE).

![Fig. 5.13 Single yarn strength tester](image)

Procedure

1. Set the clamps of the testing machine to give a specimen test length of 500 ± 2 mm.
2. With the help of preliminary specimens, set the machine so that the specimen breaks within 20 ± 3 seconds (for constant–rate–of–loading and constant–rate–of–extension machines).

3. For constant–rate–of–traverse type of machines, set it at a rate of traverse of 300 ± 15 mm/min.

4. Take the yarn, discard a first few metres of it, and secure its one end in the jaws of one clamp in such a way that the twist does not change.

5. Place the other end in the other clamp by applying a pre–tension of 0.50 ± 0.05 cN/tex from this end to remove any slack or kink without appreciable stretching of the yarn.

6. Secure it in the jaws of the clamp.

*Notes: In case of a yarn removed from fabrics is to be tested, a test length of 200 ± 2 mm shall be used.*

7. Start the machine and carry the test to rupture the sample.

8. Record the breaking load and elongation at break.

9. If the specimen slips or breaks in the jaws or breaks within 5 mm from the edge of the jaws, the result shall be discarded and another test specimen taken in lieu thereof.

**Calculations**

1) **Breaking Load:** Calculate the mean breaking load in newtons from all the observed values and express it into three significant figures. Also calculate the coefficient of variation.

2) **Elongation at Break:** Calculate the mean elongation at break in percent from all the observed values expressing it to two significant figures.

3) **Tenacity:** Calculate the tenacity by the following formula:

\[
\text{Tenacity in cN/tex or mN/tex} = \frac{\text{Mean breaking load in centinewtons or millinewtons}}{\text{Mean linear density in tex}}
\]

**5.3.4 Determination of Twist in Yarn**

*(Procedure to be followed – IS 832: 1985)*

Two methods are prescribed for determination of twist in the yarn. Direct counting method (Method I) is more suitable for double and cabled yarns. Untwist–retwist method (Method II) is suitable only when approximation of true twist is required. It does not give satisfactory
result with open–end spun yarn. For more accurate results Method I (direct counting method) may be adopted.

**Method I (Direct Counting Method)**

**Apparatus**
The direct counting type twist tester (Fig. 5.14) shall be provided with the following parts:
1. Two clamps (or jaws) one rotatable and the other non–rotatable to grip the test specimens.
   The rotatable clamp shall be capable of being revolved in either direction on its axis common to the longitudinal axis of the test specimen. The non–rotatable clamp shall be mounted on its support in such a manner that the required tension could be applied to the test specimen.

![Twist tester](image)

**Fig. 5.14 Twist tester**

2. A scale graduated in inches and centimeters to measure the distance between the clamps.
3. A revolution counter positively connected to the rotatable clamp. The revolution counter shall be capable of being set to zero after each test.
4. A suitable magnifying glass for visual examination of the test specimen during testing.

**Procedure**
**Direction of twist:** Hold one end of the yarn in a vertical position such that a short length (at least 100 mm) is suspended. Examine the vertical section of the yarn. If the shape of the yarn element confirm to the shape of central portion of the letters ‘S’ or ‘Z’, note the direction of twist as ‘S’ or ‘Z’ (Fig. 5.15) respectively.

![S and Z twist](image)

**Fig. 5.15 ‘S’ and ‘Z’ twist**

**Twist in Single Yarn**
1. Set the clamps to the required distance.
2. Set the revolution counter to zero position.
3. Set the tensioning device so as to apply a tension of about tex/2 g ±10 percent on the test specimen.
4. Secure one end of the test specimen in the non–rotatable clamp.
5. Pass the other end of the specimen through the rotatable clamp and secure it tightly.
6. Determine the direction of twist ‘S’ or ‘Z’ by visually testing the specimen.
7. Revolve the rotatable clamp in the proper direction so as to untwist the specimen.
8. Continue the rotation in the same direction until all the twist is removed from the yarn. It can be checked by passing a needle between the individual fibres at the non–rotatable clamp and traversing it across to the rotatable clamp. Use the magnifying glass, if necessary to make sure that all the twists has been removed.
9. Note down the number of turns.
10. From the value obtained in step 9 and the length of the test specimen before untwisting, calculate the turns per inch (tpi) or turns per cm (tpcm) in the test specimen.
11. By following the above steps 1 to 10 determine the turns per inch or turns per cm in the remaining test specimens.
12. Calculate the mean of all the values so obtained.

**Twist in Double Yarn**

1. Determine the direction of twist and the number of turns in the test specimens by following the procedure prescribed in steps 1 to 12 of single yarn. But for the purpose of step 8, the end–point of the test is reached when it is possible to pass a needle between component yarns of the specimen.

**Method II (Untwist–Retwist Method)**

**Apparatus**

The untwist–retwist type of twist tester shall be provided with the following parts:

1. A pair of jaws one rotatable and the other non–rotatable (called movable) to hold the specimen of yarn. The distance between the jaws shall be capable of being set to any value required. The movable jaw shall not be able to be turned about its own axis.
2. A revolution counter positively connected to the rotatable jaw and capable of recording the number of revolutions of the jaw. Revolution counter shall be capable of being set to zero after each test.
3. Means of a sliding support so that the distance between the jaws may be adjustable in order to permit measurements of the length of yarn. The sliding support shall not permit any play affecting the length of test specimen.
4. A scale graduated in inches and centimeters to measure the distance between the jaws.
5. Means shall be provided either by dead weight or by displacement of vertical pendulum for applying tension to the specimen.

**Procedure**

**Direction of Twist:** Determine the direction of twist in the yarn by the procedure mentioned in method I.

**Twist in Single Yarn**

1. Set the test length as required.
2. Adjust the tensioning device to apply a tension of tex/2g ± 10 percent.
3. Without disturbing the twist, secure one end of the test specimen in the movable Jaw (non-rotatable).
4. Pass the other end of the specimen through the open rotatable jaw and secure it.
5. Untwist the yarn operating the rotating jaw at a speed of at least 800 turns per minute.
6. Re-twist the yarn in the opposite direction until the specimen elongation indicator returns to zero.
7. Record the number of turns in the counter. Reset the counter to zero before testing a new specimen.
8. From the value obtained in step 7 and the length of the test specimen before untwisting, calculate the number of turns per inch or turns per cm by the following formula:
   \[
   \text{TPI (or TPCm)} = \frac{n}{2l}
   \]
   \[
   \text{TPI} = \text{turns per inch.}
   \]
   \[
   \text{TPCm} = \text{turns per centimeter.}
   \]
   \[n = \text{number of revolutions measured from the revolution counter and}
   \]
   \[l = \text{length of test specimen in inch (or cm).}
   \]
9. By following the procedure given in steps 1 to 8 determine the turns per inch or cm of the remaining test specimens.
10. Calculate the mean of all values.

**Twist in Double Yarn**

Determine the number of turns per inch or turns per cm by following the procedure prescribed in steps 1 to 10 of method II. Also determine the direction of twist as prescribed in method I.

**5.3.5 Appearance Grading of Cotton Yarn using Photographic Standards**

*(Procedure to be followed – IS 13260: 1993)*
The appearance of cotton yarn in grey state is evaluated by visual comparison of black board wrappings of yarn with standard photographs.

**Apparatus**

**c) Yarn board winder:** The yarn board winder (Fig. 5.16) is used for winding the yarn on a black board. The equipment is fitted with a traversing guide to advance the yarn across the board as it is wound. The machine shall be capable of spacing the yarn evenly at the rate of 8, 10, 13, 15, and 19 wraps per cm (20, 26, 32, 38, and 48 wraps per inch) on the board with a tolerance of ± 10 percent.

**d) Standard photographs:** For visual evaluation of yarn appearance.

**e) An illuminated cabinet:** A cabinet with proper illumination for comparison of black board wrappings and the BIS photographic cotton yarn appearance standards to evaluate the appearance grade of yarn.

![Fig. 5.16 Yarn appearance board winder](image)

**Procedure**

1. Set the board winder so as to obtain the required number of threads per cm on the black board, depending upon the count range in which the yarn under test falls (Table 5.1).
2. Take one of the sample packages and mount it on the winding device.
3. Also mount the board on the device in such a way that yarn wound on it will lie along the length of the board covering an area of approximately 140 mm × 250 mm.
4. In a similar manner prepare the remaining boards, taking for each board one package from the test sample.
5. Mount one of the board wrappings in the cabinet.
6. Also mount the series of BIS Photographic Cotton Yarn Appearance Standards relevant to the count of yarn under test.
7. Compare the test sample with BIS Photographic Cotton Yarn Appearance Standards and evaluate the appearance grade of the yarn.
8. Assess both sides of each board wrapping and assign the grade of the poorer side only as the grade of the specimen.
Note: While assigning the grade of the boards it should be noted that slubs, thick places, neps and foreign matter are to be treated as worst defects. Yarns with slubs should not be assigned A or B grade.

Table 5.1 Wraps per cm (per inch) according to yarn count

<table>
<thead>
<tr>
<th>Count of yarn Ne (Nm)</th>
<th>Wraps per cm (per inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 (17)</td>
<td>8 (20)</td>
</tr>
<tr>
<td>20 (34)</td>
<td>10 (26)</td>
</tr>
<tr>
<td>40 (68)</td>
<td>13 (32)</td>
</tr>
<tr>
<td>60 (100)</td>
<td>15 (38)</td>
</tr>
<tr>
<td>100 and above (170+)</td>
<td>19 (48)</td>
</tr>
</tbody>
</table>

9. It is preferable to get the assessment of the appearance grade of each board wrapping by a minimum of three observers.

10. In case the board wrapping does not precisely conform to any of the above mentioned standard grades, namely A, B, C, D but falls in between two consecutive grades, denote the appearance grade of the yarn by ‘+’ mark after the letter designating the lower of the two grades.

11. In case the board wrapping appears poorer than grade D, denote the appearance grade of the yarn as below D.

12. Following the procedure given in steps 5 to 11, evaluate the appearance grade of the remaining board wrappings.

13. If the observers differ by more than one grade, five more packages may be drawn and evaluated.

Calculation

1. For research and experimental purposes, convert the yarn appearance grade of each of the graders to their respective appearance index values using Table 5.2.

2. Calculate the individual grader’s average index.

3. From the average index values of all the graders, calculate the average index value of the yarn sample, correct to an integer.
Table 5.2 Conversion of grade into appearance index

<table>
<thead>
<tr>
<th>Grade</th>
<th>Appearance Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>A and above</td>
<td>130</td>
</tr>
<tr>
<td>B+</td>
<td>120</td>
</tr>
<tr>
<td>B</td>
<td>110</td>
</tr>
<tr>
<td>C+</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>90</td>
</tr>
<tr>
<td>D+</td>
<td>80</td>
</tr>
<tr>
<td>D</td>
<td>70</td>
</tr>
<tr>
<td>Below D</td>
<td>60</td>
</tr>
</tbody>
</table>

5.3.6 Determination of Unevenness and Imperfections

This method is used for estimation of unevenness and imperfections (Thick places, thin places and nep) based on capacitance principle.

Terminology

For the purpose of this test method the following terms shall apply.

a) **Neps**: A fault length of 1mm having a cross section 200 percent of the average value. This corresponds to a sensitivity setting of 3 on the ‘neps’ knob of the imperfection indicator.

b) **Thick places**: A fault length of approximately the fibre staple length, having a cross section of 50 percent increase over the average value. The ‘Thick places’ knob set to 3.

c) **Thin places**: A fault length of approximately the fibre staple length, having a cross section of 50 percent less than the average value. The ‘Thin places’ knob set to 50 percent.

Apparatus

The apparatus used for this test is called as evenness tester (Fig. 5.17). It consists of the following parts:

a) The ‘comb’ of 8 measuring capacitors of different sizes.

b) The creel and guides to control the material.

c) The traverse rollers which can control the material speed over a range from 2 to 100 yards per minute.

d) The control switches.

e) The meter on the main unit which indicates the momentary variations in the material.

f) The integrator which indicates the PMD or CV.

g) The high-speed pen recorder whose chart speed can be varied between 1 and 40 inches per minute.
Procedure

1. Ensure that the instrument is warmed up for at least half an hour.
2. Keep the service selector in ‘Inert’ position and clean all the slots with a strip of film.
3. Keep the ‘Service Selector’ in ‘Adjustment’ position and turn the knob ‘Adjustment without material’ until the indicator of the main equipment shows minimum i.e. 100%.
4. Keep the service selector in ‘Inert’ position and pass the test specimen drawn from one of the eight bobbins through the guide and appropriate slot and run the equipment at the speed of 25 m per min.
5. Adjust the ‘Average Value’ knob in such a way that the oscillations of the indicator are almost symmetrical about ‘0’.
6. If the average value is not in the range between 12 to 32, then change the slot and repeat the operations specified in steps 1 to 5.
7. Keep the service selector in the ‘Normal’ position and activate the ‘Evaluating time’ knob in the integrator of the equipment for 5 minutes.
8. After ensuring that the sensitivity levels selected in respect of thin places, thick places and nepes are at –50%, +50%, +200% respectively, activate the ‘Evaluating Time’ knob in the imperfection indicator for 5 minutes.
9. Activate the ‘Evaluating Time’ knob of the spectrograph for 5 minutes after ensuring that the starting point in the spectrogram paper is set at 25–metre position.
10. The amplitude knob of the spectrograph is set at the approximate U% value shown in the integrator on pressing the ‘Non–corrected Value’ button in the integrator and speed of the spectrogram recorder is selected at 100cm per minute.
11. At the end of 5 minutes record the U% value and imperfections.
12. Remove the spectrogram paper from the recorder and record the sample particulars on it.
13. Determine the U% and imperfection for all the eight bobbins as described above and calculate mean U% and imperfections per 1000 metres.
5.4 Fabric Testing

5.4.1 Determination of Thread Density (Threads per Unit Length) in Woven Fabrics

(Procedure to be followed – IS 1963: 1981)

The method is used for determination of warp threads and weft threads per unit length (centimetre or inch) in woven fabrics.

Apparatus: Pick glass (Fig. 5.18) is used for the method.

Sampling

1. Avoid sampling within 50 mm from the selvedge.
2. Within two metres from either end of a piece or roll.
3. While sampling from design fabrics it is convenient to:
   a) Determine the number of units in a weave repeat from a point paper diagram.
   b) Count
      i) The number of whole repeats
      ii) The remaining units, in the distance across which the threads are to be counted.
      iii) From the above data so obtained, the number of threads per centimetre or inch both in warp way or weft way as required can be calculated.

Procedure

1. Keep the test sample on a flat table and smoothen it out.
2. Set the pointer of the counting glass at zero.
3. Place the counting glass on the fabrics in a direction parallel to warp if weft density is to be determined and parallel to weft if warp density is to be determined.
4. Find the number of warp or weft threads in a specified length as required.
5. Following the procedure prescribed in steps 1 to 4, determine the number of warp and weft threads per centimetre or inch in at least four more places.

6. Calculate the number of warp or weft threads per centimetre or inch by the following formula: \[ n = \frac{N}{L} \]

   Where
   
   \( n \) = number of warp or weft threads per centimetre (or inch),
   
   \( N \) = observed number of threads in the distance \( L \), and
   
   \( L \) = distance in centimetre (or inch) across which the threads are counted.

7. Calculate the mean of all the values and report it as the number of warp or weft threads per centimetre or inch of the fabric.

   Note: Avoid counting same set of warp or weft threads more than once. The value should be rounded off to first decimal place in case when the results are reported for threads per cm.

5.4.2 Determination of Weight per Square Metre (g/m²) of Fabrics

This method is used for determination of weight per square metre of fabrics. In this method one has to weigh a known area of fabrics and divide the weight of the fabric by the area.

Apparatus

Two apparatus can be used for the determination of weight per square metre of fabrics as described below:

1. Quadrant scale: The quadrant scale (Fig. 5.19) is graduated in units of grams per square metre (g/m²) in a sector scale. A template of specified size is used to prepare the specimen.

   ![Quadrant scale](image)

   **Fig. 5.19 Quadrant scale**

2. Round cutter: The round cutter (Fig. 5.20) is used to cut circular specimens having diameter of 113.6 mm. A weighing balance is used to weigh the specimen.
Procedure

Method I (By using Quadrant scale)
1. Keep the test specimen in a table and remove the folds or creases if any.
2. Keep the template on the surface of the fabric and mark the outline of the template provided with the quadrant scale with a marker. Care should be taken while marking so that the edges of the template are parallel to the warp and weft directions.
3. Cut the sample with a pair of scissors or a sharp blade on the marked line accurately. Prepare five test samples.
4. Hang the above prepared sample one by one in the clamp of the quadrant scale and note the gram per square metre of the fabric directly from the scale.

Method II (By using Round cutter)
1. Keep the test specimen on the cutting pad and remove the folds or creases if any.
2. Keep the round cutter on the surface of the fabric and cut round samples.
3. Determine the weight of the sample by using the balance.
4. Multiply the weight by 100 to get the gram per square metre of the fabric.

5.4.3 Determination of Breaking Load and Elongation of Woven Textile Fabrics

(Procedure to be followed – IS 1969: 1985)

Types of Test
1. **Grab Test**: A test in which only a part of the width of the specimen is centrally gripped in the clamps for testing. The method is particularly suitable for heavy fabrics as well as fabrics with high cover factor and in cases where ravelling is difficult or when the ravelled–strip starts ravelling further under stress
1.1 Modified Grab Test: Grab test in which lateral slits are made in the specimen to sever all the yarns bordering the portion, the strength of which is to be tested, thus reducing the effect of the threads, which are not directly gripped by the jaws to a practical minimum. This method is used especially for fabrics with very high strength or for fabric constructions where application of stress on ravelled strip specimen produces further unravelling.

2. Strip Test: A test in which the full width of the specimen is gripped in the clamps for testing. There are two types of strip tests as described below

2.1 Ravelled–Strip Test: Strip test in which the specified width of the specimen is obtained by ravelling away yarns at the edges. This method is generally used when it is desired to determine the breaking load required to rupture specific width of a fabric. This information is useful for comparing the effective strength of yarns in woven fabric with the strength of yarn before weaving.

2.2 Cut–Strip Test: Strip test in which the specified width of the specimen is obtained by cutting the fabric. This method is used in case of heavily sized, felted, laminated fabrics or fabrics in which ravelling is not easy.

Sampling
1. Test at least five warps way and five weft way test specimens.
2. As far as possible, only one test specimen shall be drawn from a piece in the test sample.

Note: In case the lot size is small, more than one test specimen may be drawn from a piece in the test sample.

Apparatus
A tensile testing machine (Fig. 5.21) working on one of the following principles is used.

a) Constant–rate–of–traverse (CRT);
b) Constant–rate–of–loading (CRL); and
c) Constant–rate–of–extension (CRE).

Note: The load range of the machine shall be such that all the observed values would lie between 20 and 80 percent of the full–scale load.

Accessories
1. A pair of scissors or a sharp blade;
2. Measuring scale; and
3. Stop watch.
Fig. 5.21 Fabric tensile strength tester

Preparation of Test Specimens
1. Cut a test sample of length at least 1m and of full width. Ensure that the areas having creases or visible faults are not included in the sample.
2. From the test samples, ten test specimen of the required size shall be cut, five in the warp direction and five in the weft direction (If a higher degree of precision is required, more specimens shall be tested).
3. The lengthwise direction shall be parallel to the warp or weft direction for which the breaking load is required.
4. Care should be taken so that no two warp way specimen contains the same set of warp yarns and no two weft way specimen contains the same set of weft yarns (Fig. 5.1).

Procedure
1. Set the clamps of the testing machine so that the distance between them is 75 mm for grab test and 200 mm for strip test.
2. Use an additional specimen and, after pre-tensioning (if relevant), set the moving clamp in motion at a rate estimated to result in an average time–to–break. Note the breaking load and the time–to–break. Return the moving clamps to its zero position, remove the ends of the broken specimen, and repeat the above procedure on two additional specimens. If the average time–to–break of these three specimens does not fall within 20 ± 3 seconds, discard the results and, using a suitable different rate of operation of the moving clamp, repeat the procedure described above. Continue in this way until the average time–to–break is 20 ± 3 seconds.
3. Take a test specimen and insert it in the clamps of the testing machine with approximately the same length of the fabric extending beyond the jaws at each end.
4. Secure the test specimen between the jaws of the upper clamp.
5. Through the free end of the specimen, apply a slight tension and secure it between the jaws of the lower clamp.

6. Operate the machine and carry the test to rupture the specimen and record the breaking load and elongation of the specimen.

7. In case a fabric breaks in two or more stages record only the maximum load.

8. Open both the clamps and remove the broken specimen.

9. Take a fresh specimen and determine its breaking load and elongation as given in steps 1 to 8 above and repeat the test with the remaining test specimens.

10. In a similar manner test weft way specimens.

Notes:
1. If the specimen slips in the jaws or breaks inside the jaws, the reading should be discarded.

2. If the break takes place within 5mm from the edge of either of the jaws the reading should be discarded.

3. If the breaking load is appreciably below, say 50 percent of the average value of all other breaks, it should be discarded.

4. If some yarns in a specimen fail to break due to improper tensioning, the reading shall be discarded.

5. In case of rejection another specimen is to be tested in lieu thereof.

Calculations
1. Calculate the mean breaking load separately for warp way and weft way test specimens.

2. Calculate the elongation at break separately for warp way and weft way test specimens and calculate the mean percentage elongation at break as follows:

\[
E = \frac{E_0 \times 100}{N \times \text{Gauge Length}}
\]

Where \( E \) = mean elongation percent at break,

\( E_0 \) = observed values of elongation at break, and

\( N \) = number of observations.

5.4.4 Determination of Stiffness of Fabrics (Cantilever Test)
(Procedure to be followed – IS 6490: 1971)

This method is used for determination of stiffness of fabric made from any textile fibre or a blend of two or more textile fibres. This method of test is not suitable for fabrics which are
very limp or which curl or twist badly when cut in to small pieces. In general, this method is more suitable for testing woven fabrics than for testing knitted ones.

**Terminology**

For the purpose of the test method, the following definitions shall be used.

1. **Stiffness:** Resistance of the fabric to bending.
2. **Flexural Rigidity:** This quantity is the measure of the resistance of cloth to bending by external forces. It is related to the quality of stiffness that is, the cloth having a high flexural rigidity tends to feel stiff.
3. **Bending Length:** Bending length equals half the length of a rectangular strip of fabric that will bend under its own weight to an angle of 41.5°. It is also equal to the length of a rectangular strip of material that will bend under its own weight to an angle of 7.1°. It is expressed in centimetres.

**Preparation of Test Specimens**

1. From the samples cut rectangular warp way and weft way test specimens of 25 mm × 200 mm size with the help of the template.
2. Specimens cut in each direction shall be scattered as far as possible so that no two warp way specimens contain the same set of warp yarns and no two weft way specimens contain the same set of weft yarns.
3. Avoid selvedge (within 10cm), end portions, creased or folded parts of the specimen. The specimen shall be handled as little as possible.

**Apparatus**

**Stiffness Tester:** It is shown in Fig.5.22.

![Stiffness tester](image)

**Fig. 5.22** Stiffness tester

**Procedure**

1. Place the tester on a table or bench so that horizontal platform and inclined reference line are at eye level of the operator.
2. Adjust the platform with the help of a spirit level so that it is horizontal.
3. Place one of the specimens on the platform with the scale on top of it lengthwise and the zero of scale coinciding with the leading edge of the specimen.

4. Start pushing the specimen and the scale slowly and steadily when the leading edge of the specimen projects beyond the edge of the platform. An increasing part of the specimen will over hang and start bending under its own weight.

5. Keep an eye in such a position that the two inclined line (of the inclined plane making an angle of 41.5° with the horizontal) of the tester coincide.

6. Stop pushing the specimen when its tip reaches the level of the inclined plane.

7. Note down the length of the over hanging portion from the scale to the nearest millimetre.

8. Take four readings from each specimen with each side up, first at one end and then at the other.

9. The weight per unit area can be determined by weighing all the warp way and weft way test specimens together after completion of stiffness test.

**Calculations**

1. Determine the bending length, the flexural rigidity for warp way and weft way specimens and the overall flexural rigidity by the following formula:

   a) Bending length
   
   \[
   C = \frac{L}{2} \text{ cm}
   \]
   
   Where, \( L \) = the mean length of over–hanging portion in centimetres.

   b) Flexural rigidity
   
   \[
   G = W \times (L/2)^3 \text{ mg–cm}
   \]
   
   Where, \( W \) = weight per unit area of the fabric in milligrams per square centimetre.

   c) Overall flexural rigidity
   
   \[
   G_0 = \sqrt{G_w \times G_f}
   \]
   
   Where, \( G_w \) = warp way flexural rigidity, and \( G_f \) = weft way flexural rigidity.

2. Determine the average values for the warp way and weft way test specimens separately.

**5.4.5 Determination of Crease Recovery Angle (CRA) of Textile Fabrics**

*(Procedure to be followed – IS 4681:1981)*

The ability of a fabric to retain pressed–in creases and to recover from creasing is an important property, especially in case of apparel fabrics. When creasing force is removed from the creased fabric, it tends to recover and the creases in the fabric start diminishing at varying rates. The magnitude of the crease recovery angle as measured according to this standard is taken as an indication of the ability of a fabric to recover from creasing.
Preparation of Test Specimens

1. Cut warp way and weft way test specimens of 15 mm × 40 mm size with the help of sharp pair of scissors or blade with their longer side parallel to warp and weft threads respectively.

2. The specimens shall be staggered in such a way that no two warp way specimens contain the same set of weft yarns.

3. The specimens shall not be taken from creased, wrinkled, bent or other deformed parts of the sample and also not from within 50 mm from the selvedge.

   Note: The length directions of the warp way and weft way test specimens shall be parallel to the warp and weft directions of the sample respectively.

4. Test at least 20 specimens (10 warp way and 10 weft way among which 5 specimens each face to face and back to back respectively across both warp and weft are to be taken for testing).

**Apparatus**

**Crease Recovery Tester:** The crease recovery tester is shown in Fig. 5.23.

**Accessories**

a) Stop watch; and 

b) Tweezers with broad jaws.

![Fig. 5.23 Crease recovery tester](image)

**Procedure**

1. Level the testing equipment with the help of levelling screws and spirit level.

2. Fold the specimen end to end in half with its edges gripped in one line with the help of tweezers. Half of the test specimens (both in case of warp way and weft way test specimens) shall be folded face to face and the other half back to back.

3. Place the folded specimens on the plate of the loading device and apply the load gently without delay.
4. Remove the load after 5 minutes. The removal of load shall be completed within 0.5 second.

5. After the load is removed, mount the specimen by holding one limb of the specimen in the tweezers and place the other limb in the clamp of the instrument in such a manner as to cause as little disturbance to the angle as possible.

6. While the specimen is in the clamp continue adjusting the clamp in such a way that the suspended limb of the specimen is always in a vertical position or horizontal position depending upon the type of instrument used.

7. Take the reading of the crease recovery angle after 5 minutes from the removal of load.

8. Measure the angle of recovery for all the warp way and weft way specimens folded face to face and back to back in the same way.

9. Test at least 10 warp way and 10 weft way test specimens.

10. Calculate the mean value of crease recovery angle to the nearest degree.

   NOTE: If the difference between two readings of face to face and back to back specimens is more than 10°, then the results for face to face and back to back specimens shall be reported separately

5.4.6 Determination of Thickness of Woven and Knitted Fabrics
(Procedure to be followed – IS 7702:1975)
This method is used for determination of thickness of woven and knitted textile fabrics under a specific pressure.

Apparatus

Thickness Tester: The instrument is shown in Fig. 5.24.

![Fabric thickness tester](image)

**Fig. 5.24** Fabric thickness tester

Procedure

1. Select the appropriate presser–foot and applied pressure as described in ANNEXURE A.

2. Clean the presser–foot and the reference plate.
3. Check that the presser–foot shaft moves freely.

4. Set the thickness gauge to read zero with the presser–foot so loaded as to exert the specified pressure on the reference plate.

5. Raise the presser–foot and position the sample, without tension, on the reference plate. Ensure that the area chosen for the test is free from creases. Do not attempt to flatten out any creases if present, this is likely to affect the result.

6. Lower the presser–foot gently on to the sample and note the gauge reading after 30 seconds.

7. Similarly determine the thickness at 10 different places on the sample so chosen that each such place contains different warp and weft threads.
ANNEXURE A

(Guidelines to the selection of area of presser–foot and applied pressure)

A–1 Presser–Foot

It is recommended that:

a) The ratio of foot diameter to fabric thickness be not less than 5:1; and
b) The area of foot may lie between 500 and 10 000 mm².

*Note: The preferred sizes of the presser–foot are given below:*

<table>
<thead>
<tr>
<th>Area (mm²)</th>
<th>Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>25.22</td>
</tr>
<tr>
<td>1000</td>
<td>35.68</td>
</tr>
<tr>
<td>2500</td>
<td>56.43</td>
</tr>
<tr>
<td>5000</td>
<td>79.78</td>
</tr>
<tr>
<td>10000</td>
<td>112.84</td>
</tr>
</tbody>
</table>

A–2 Applied Pressures

It is recommended that the applied pressure may be 1, 5 or 10 KPa (Kilopascal: approximately equivalent to 10 gf/cm²).

5.5 Chemical Tests

5.5.1 Fastness Properties of Dyed and Printed Materials

The dyes and pigments applied onto textile materials by dyeing and printing techniques must withstand several agencies to which the textile material is subjected during use. The resistance to fading offered by dyes and pigments is expressed in terms of fastness properties. Some of the important agencies which come across during the use of textile materials include, washing, light, rubbing, chlorine (during bleaching agents with bleaching powder or sodium hypochlorite) and dry heat (in case of disperse dyes on polyester).

The assessment of fastness involves the visual determination of change in shade and the staining of an adjacent material. The extent of change in shade as compared to original and the extent of staining on adjacent white material are assessed with the help of grey scale specifically devised for the assessment of fastness properties. The fastness property is then expressed in terms of grade 1–8 in case of light and 1 – 5 in case of agencies other than light. The grey scales for the change in colour and staining are shown in Fig. 5.25.
5.5.2 Fastness to Washing

This is of great importance to consumer. There are 5 wash tests, which are applied according to the purpose for which the material is intended.

Test Nos. 1, 2 & 3:

These are carried out in the following manner:

A specimen measuring 10 cm × 4 cm of the material to be tested is cut out. The specimen to be tested is placed between two pieces of undyed fabric measuring 5 cm × 4 cm and three pieces are held together by stitching round the edges, leaving 5 cm × 4 cm of dyed/printed sample exposed. In case of yarn the white yarn is entwined to make a composite sample, whereas in case of fibre, it is compressed in the form of sheet of 10 cm × 4 cm and held in place by sewing in between pieces of cloth measuring 10 cm × 4 cm.

The composition of one of the white material enclosing the specimen will be the same as dyed sample and the other will be as indicated in table 5.3:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>If the first piece is</th>
<th>The second piece will be</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cotton</td>
<td>Wool</td>
</tr>
<tr>
<td>2</td>
<td>Wool</td>
<td>Cotton</td>
</tr>
<tr>
<td>3</td>
<td>Silk</td>
<td>Wool</td>
</tr>
<tr>
<td>4</td>
<td>Linen</td>
<td>Wool</td>
</tr>
<tr>
<td>5</td>
<td>Viscose</td>
<td>Wool</td>
</tr>
<tr>
<td>6</td>
<td>Polyester or polyester/cotton</td>
<td>Wool or cotton</td>
</tr>
<tr>
<td>7</td>
<td>Acrylic</td>
<td>Wool or cotton</td>
</tr>
</tbody>
</table>

A solution is made containing 5g/l of good quality washing soap.
**Test No. 1 (IS 687):** The composite specimen is treated in a launderometer (test equipment used for wash fastness test shown in fig. 5.26) or an equivalent apparatus at $40^0 \pm 2^0C$ for 30 minutes, using sufficient soap solution of 5 g/l concentration to give liquor ratio of 50:1.

![Launderometer](image)

**Test No. 2 (IS 3361):** The composite sample is treated in a launderometer for 45 minutes at $50^0 \pm 2^0C$, using sufficient soap solution of 5 g/l concentration to give liquor ratio of 50:1.

**Test No. 3 (IS 764):** To the soap solution, 2 g/l of anhydrous sodium carbonate are added. The composite sample is then treated in a launderometer at $60^0 \pm 2^0C$ for 30 minutes in sufficient of above solution to give liquor ratio 50:1.

After treatment the composite samples in every case are rinsed twice in cold water and then for 10 minutes in cold running tap water. After squeezing, the stitching is removed on the two long sides and one short side, leaving the dyed specimen and the undyed material sewn together only along one short side. The pieces are opened out and dried in air at room temperature. The change in colour of the uncovered portion of dyed/printed specimen is assessed with grey scale for change in shade and staining of the undyed materials with grey scale for staining.

**Test No. 4 (IS 765):** The dyed/printed specimen measuring 10 cm × 4 cm as before is sewn together with two pieces measuring 5 cm × 4 cm. One piece is the same material as specimen

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>If the first piece is</th>
<th>The second piece will be</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cotton</td>
<td>Viscose</td>
</tr>
<tr>
<td>2</td>
<td>Viscose</td>
<td>Cotton</td>
</tr>
<tr>
<td>3</td>
<td>Polyester or polyester/cotton</td>
<td>Viscose or cotton</td>
</tr>
<tr>
<td>4</td>
<td>Acrylic</td>
<td>Wool or cotton</td>
</tr>
</tbody>
</table>

The composite sample is placed in launderometer together with 10 stainless steel balls of specified size and sufficient solution containing 5 gm soap and 2 gm anhydrous sodium carbonate per liter to give liquor ratio of 50:1. The test is carried out at $95^0 \pm 2^0C$ for 30
minutes. The rinsing, drying and assessment of the sample are carried out in exactly the same manner as was in case of tests 1 to 3.

**Test No. 5 (IS 3417)**

The composite sample is prepared as in test No.4 and 50:1 liquor ratio is used with a solution containing 5 gm soap and 2 gm anhydrous sodium carbonate per liter. The test is carried out at 95° ± 2°C for 4 hours. The rinsing, drying and assessment are done as in previous tests.

5.5.3 **Light Fastness**

The test is carried out in a light fastness tester (Fig. 5.27). In this method the test specimen should be tested together with standard dyed blue wool samples of light fastness grade 1 to 8. Mount the test specimen and the standards as shown in fig. 5.28. Half the porting of the mounted samples is covered with an opaque sheet (black). The samples are then exposed in fadeometer. After every 24 hours the fading of the exposed portion is compared with the unexposed portion. The exposure is continued till the difference in shade between exposed and unexposed portion is equivalent to grade 3 of grey scale. The light fastness grade is given by comparing with the fading of the standard wool sample.

![Fig. 5.27 Light fastness tester](image)
5.5.4 Fastness to Chlorine (Sodium Hypochlorite or Bleaching Powder) IS 762

The sample is wetted out with water and squeezed. It is then immersed in a solution of sodium hypochlorite or bleaching powder containing 2 gm per liter of available chlorine. The pH of the solution is adjusted to 11 ± 0.2 with 10 gm per liter of sodium carbonate. The liquor ratio should be 50:1. The test is carried out at temperature 20°C ± 2°C for 1 hour under conditions such that there is no exposure to direct sunlight. The sample is then rinsed with cold running water and immersed at room temperature for 10 minutes in a solution containing 2.5 ml per liter of 30 percent (W/V) hydrogen peroxide or alternatively, 5 gm sodium sulphite (NaHSO3) per liter. After drying at room temperature any change in colour is assessed against the grey scale.

5.5.5 Colour Fastness to Sublimation (IS 975; 1988)

This method is suitable for Polyvastra where the resistance of dye to heat treatment is determined.
Preparation of test specimen

Two adjacent fabrics each measuring 10 × 4 cm. One piece made of Polyester/cotton and second made of Polyester.

Preparation of composite specimen

Place the test specimen 10 × 4 cm between two adjacent fabrics and sew along one of the shorter sides form a composite specimen.

Apparatus

a) Glass tube about 15mm diameter;
b) Drying oven capable of being maintained at required temperature ± 2°C; and
c) Grey scale for evaluation of staining

Procedure

1. Roll the composite specimen in the form of a cylinder and place it in the glass tube. Heat the tube (with the specimen) in the oven under either of the following conditions
2. Remove the specimen from the tube and unroll it. Evaluate the degree of staining of the pieces of adjacent fabric with grey scale.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120°C ± 2°C</td>
<td>120</td>
</tr>
<tr>
<td>150°C ± 2°C</td>
<td>30</td>
</tr>
<tr>
<td>180°C ± 2°C</td>
<td>30</td>
</tr>
<tr>
<td>210°C ± 2°C</td>
<td>30</td>
</tr>
</tbody>
</table>

5.5.6 Rubbing Fastness (Crock Fastness)

Draw from the sample two pieces each not less than 14 cm × 5 cm for dry rubbing and two pieces for wet rubbing. One specimen of each pair is cut in the warp direction and second in the weft direction. In case of yarn and fibre comb the yarn or fibre in the form of a sheet of 14 cm × 5 cm.

Fix the test specimen to the crock meter (Fig. 5.29) by means of clamps. In case of printed fabric care should be taken to position the specimen in such a way that all colours of the design are rubbed in the test. Alternatively, if the area of colours is sufficiently large, more test specimens are taken and individual colour assessed separately.
Fig. 5.29 Crockmeter.

**a) Dry Rubbing:** Attach a piece of white cotton cloth at the end of the finger of the crockmeter. Rub it 10 times to and fro in a straight line along a track 10 cm long on the dry specimen.

**b) Wet Rubbing:** Repeat the test as above with a fresh dry specimen and with a rubbing cloth that has been wetted with water and squeezed to retain its own mass of water. After rubbing dry the cloth at room temperature

**Assessment**

Assess the staining of the rubbing cotton cloth (attached to the finger of the crockmeter) with grey scale for evaluating staining. It is necessary to eliminate dyed fibres pulled out during rubbing and retained on the surface of the rubbing cotton cloth. Consider only the colouration due to staining by the dyestuff.
CHAPTER 6
Technology of khadi production

6.1 Introduction

According to Khadi and Village Industries Commission, Khadi means any cloth woven on handloom in India from cotton, silk, or woollen yarn hand–spun in India or a mixture of any two or all such yarns. This means that spinning and weaving operations is manual. However there are no restrictions on the use of mechanized operations other than spinning and weaving. Although the use of synthetic fibre like polyester blended with cotton is permitted, the blended fabric thus produced by hand spinning and hand weaving is known as polyvastra.

6.2 Cotton Khadi

For historical and administrative reasons, there are two divisions of cotton khadi viz. cotton khadi and muslin khadi. Cotton khadi is further divided into two groups.

a. Yarn spun on traditional desi charkha; and

b. Yarn spun on New Model Charkha (NMC). The NMC is based on the principle of ring spinning.

6.2.1 Production Stages

There are five stages of production of cotton khadi such as

1. Pre–spinning;
2. Spinning;
3. Pre–weaving;
4. Weaving; and
5. Post–weaving

Different processes involved in khadi production is shown in fig. 6.1 as a flowchart.
6.2.1.1 Pre–spinning

**Ginning**

In this process seeds are removed from cotton fibre without damaging the fibre. This is done by two types of ginning machines (Saw gin and Roller gin machines). The ginned cotton in complete open form is highly compressed into compact bundles called bales of prescribed dimension and weight for easy transportation within and outside the country.

**Hand Ginning**

In case of muslin khadi production, ginning is done on hand driven improved small roller–ginning device called ‘Otni’. In order to avoid any damage to cotton fibre, generally
loose seed cotton is carefully brought in big gunny bags to muslin production centers to facilitate hand ginning.

**Opening and Cleaning**

In the traditional khadi centres, the bale is broken manually to take out large tufts of cotton. They are then put on a sturdy iron–mesh frame and beaten with a stick for opening and loosening the cotton. In the process most of the impurities and foreign materials fall down through the iron–mesh. In some centres, the loosened cotton is fed to power driven openers with spiked drums for further opening and cleaning, before subjecting it to carding.

In the muslin centres, freshly hand–ginned and cleaned cotton is gently whipped with a thin stick not only to open it thoroughly, but also to achieve fibre–to–fibre separation. This helps to protect the length and strength of the fibres to the maximum possible extent.

**Blow Room**

In the Central Sliver Plant (CSP), which have recently been established by KVIC to feed NMC units, opening of the hard pressed fibres, uniform mixing of fibres, removal of trash and other impurities present in the fibre is done in the blow room with the help of a number of power–driven machines. The main objectives of the blow room are:

1. To open the cotton from hard pressed condition to small tufts.
2. To remove trash, impurities present in the fibre and clean it.
3. To mix thoroughly two or more varieties of cotton, making the blend as economical as possible and also technically suitable for spinning the yarn of desired count.
4. To prepare the cotton into convenient form so that it is suitable for processing at subsequent machines.

**Carding**

Carding is the heart of entire spinning process and good carding is a most for good performance during spinning. The main objectives of carding are:

1. To carry further the process of fibre opening to a state of individual fibres.
2. Removal of the remaining impurities present in the fibre.
3. Removal of short fibres, neps and tiny lumps present in the fibre.
4. To mix the fibres to provide a uniform distribution.
5. To deliver a continuous sliver for further processes.

**Draw frame**

Cotton is received from the card in cylindrical rope or sliver form. In the card sliver the fibres are arranged criss–cross with their one or both ends bent into the form of hooks. These haphazard fibres require straightening and parallelisation to make them amenable to
proper spinning. This kind of fibre arrangement is described as ‘fibre orientation’. The following objectives are achieved by passing the card sliver through the draw frame:
1. Straightening of the fibres.
2. Making the fibres parallel to each other and to the sliver axis.
3. Removal of the final dust present in the fibre.
4. Blending of fibres.
5. Making the slivers more uniform or even by removal of the long–term irregularity present in the card sliver.

But it should be noted that excessive parallelisation makes the slivers unduly soft, leading to excessive breakages during the withdrawal from the cans.

**Comber**

Combing is essential for spinning of medium, medium–fine and fine yarns. The comber can be said to achieve the following objectives:
1. To remove short fibres.
2. To remove neps and remaining impurities.
3. Straightening and parallelisation of the fibres.
4. Formation of a sliver having maximum possible evenness.

For the production of traditional muslin khadi in Andhra Pradesh, combing of seed cotton used to be done with fish jawbones, which has a fine comb like appearance. The process is highly laborious and output is very low, but the result is excellent. It has almost been given up, except at Pundur, where high quality Andhra–muslin is produced.

**Roving frame**

Roving is the final process in the pre–spinning stage. It is carried out on roving frame (also known as speed frame or fly frame). Its main object is to reduce the volume of sliver by drafting to a diameter, which would be suitable to spin the yarns of desired count. The other objectives of roving frame are:
1. To impart slight twist to the roving so that it does not break when removed during spinning.
2. Formation of suitable packages for spinning.

The strand size of roving or its diameter or its count is decided and is achieved in relation to the count of yarn to be spun.

For NMC spinning, roving may also be done on hand–driven 4 or 8–spindle devices called *Belni* or roving frame.
6.2.1.2 Spinning

The process of spinning can be described by three basic operations:
1. Drafting of the roving or sliver to the desired degree of fineness;
2. Twisting of the drafted fibre strand to impart strength; and
3. Winding up the spun yarn in a convenient form.

The first operation (drafting) is done by a set of drafting rollers in NMC. This also can be done by applying force by forefinger and thumb (called ‘chutki’ in Hindi) during spinning on traditional charkha. The second operation (twisting) is achieved by the combination of spindle, ring and traveller. The winding of the spun yarn can be done directly on the spindle in the traditional charkha or in the bobbin fixed on spindles in NMC.

Drafting

Drafting results in reduction of the thickness of roving, or attenuation of the fibres by a predetermined degree. Drafting is achieved by two or more pairs of rollers (in NMC). The distance between the rollers depends upon the staple length of the cotton used. Technically, draft is the ratio of the surface speed of delivery roller ($V_2$) and the feed roller ($V_1$) (Fig. 6.2).

\[
\text{Draft} = \frac{V_2}{V_1}
\]

There are various drafting systems available. But in all the cases, the rollers have to be set at such a distance that the drafting takes place smoothly and evenly. Aprons can also be used to control the floating fibres of the cotton strand and to produce stronger and more even yarn.

Twisting

Twisting is another important operation in spinning, which has to be ensured in the optimum measure to impart the required strength to the strand of fibres. The amount of twist depends upon the count of the yarn to be spun. It is important to note that only optimum twisting increases the strength of the yarn and over twisting will result in reduction of its strength. The over-twisted yarn becomes unbalanced and starts snarling. It creates problem during weaving because of its increased hardness and snarling. Coarser the yarn that is more the fibres per cross section, lesser is the required twist. Twist is imparted to yarn by the traveller. Each revolution of the traveller imparts one turn of twist to the strand. The traveller
rotates on the surface of the ring. The traveller does not have its own drive. It is dragged by the yarn that passes through it on to the bobbin surface which is mounted on the spindle. The yarn is pulled by the rotating spindle.

The formula for deciding the number of necessary twists per inch of yarn is as follows:

\[ \text{Number of twists per inch} = \text{Twist factor} \times \sqrt{\text{English count of yarn}} \]

**Twist Direction for Khadi Yarn**

There are two directions of the twist (Fig. 5.15). Right hand twist, which is also called Z–way twist, is formed when the spindle revolves in clockwise direction, while the Left hand twist, which is also described as reverse twist or S–way twist, is obtained when spindle revolves in anti–clockwise direction. The Z–way twist is predominant in the textile industry. However, since 1965, khadi industry adopted the reverse twist (S–twist) for producing hand–spun yarn with a view to avoiding the mixing of mill yarn with right twist in khadi production.

**Winding**

After yarn formation, it needs to be wound around the bobbin and laid uniformly across the entire length of it. As the traveller and spindle rotate in the same direction, the difference in the peripheral speeds of the traveller and the spindle causes the yarn to be wound on to the package. The speed difference is due to the lagging of the traveller relative to the spindle due to continuous delivery of yarn from front roller and traveller ring frictional drag. Since the traveller also acts as a guide for the yarn it is oscillated back and forth across the entire length of the package for laying the yarn uniformly. This oscillating movement is imparted to the ring rail, which holds the ring on which the traveller runs.

**Muslin Charkha**

The muslin charkha has construction similar to NMC with the difference that they are presently having wooden frames and use more of wooden wheels driven by cotton twines. There are seven spindles in muslin charkha, one of which is used for preparing roving and other six for producing yarn of 100 to 150 metric count. Muslin charkhas with only 5 spindles are being used for producing yarn of still higher counts, one of the spindles being used for preparing roving.

In NMC as well as muslin charkhas, the yarn on bobbins is unwound on the winder ‘Paretas’ simultaneously with spinning in the form of hanks of 1000 metres each, with sections of 200 rounds of one metre each tied up separately.
6.2.1.3 Pre–weaving Stages

Sorting and Washing

In production centers, comparatively stronger, cleaner, uniform and even yarn is selected for warp. The sections of hanks selected for warp are loosened and then soaked overnight in water mixed with 1 to 2% washing soda. This removes the natural wax present in cotton fibre and improves the absorbency of the sizing material. After squeezing the water out, the hanks are dried in hanging position. However, if immediate sizing of hanks for the purpose of long warp is planned, the yarn may be washed thoroughly by boiling it for about half an hour in the water mixed with 1 to 2% washing soda and 2% Turkey Red Oil (TRO). Quantity of water is about 6 to 8 times of the weight of yarn. After the yarn has cooled down, it should be washed well with clean water and then dried. Hank sizing can be done without washing the yarn. But in that case it requires more sizing material and also more time, which should preferably be avoided.

Sizing

During weaving warp yarns are subjected to abrasion and tension due to which they are likely to break. Sizing of warp yarn helps all protruding fibres to stick to the body of the yarn. In this process, the yarn strength increases considerably. Thus sizing helps the warp to withstand the abrasion and tension more effectively during weaving, if it imparts smooth and uniform film of size on the yarn without much loss of its elasticity. The common sizing materials are: maize powder, wheat flour, rice starch, Tapioca, gum powder, etc.

Warping

Each individual strand of yarn running parallel to the fabric length is a warp end. The parallel sheet of warp ends is prepared by the warping machine. There are three types of warping processes such as:

Peg warping; Board warping; and Drum warping.

Drawing–in

The healds as well as the reeds must be carefully selected according to the count of the yarn. Moreover, the healds and reeds both must be compatible to each other with regard to the yarn count. The number of heald shafts will depend on the structure of the cloth to be woven. Healds can be either of ordinary cotton thread or varnished thread or steel wire. The steel wire used for making the healds is either flat or round and can also be of different materials and gauges to suit the count and raw material of the yarn. Each heald has an eye, through which the warp ends have to pass. The number of healds inserted (or used in case of varnished healds) in each shaft depends on the number of ends. The upward movement of
each shaft results in raising of the ends, which pass through the heald eye. Thus the heald–shafts play a crucial role in forming the shed of the warp, through which the shuttle passes and puts the weft yarn across the warp. The heald eyes are of different shapes, such as circular, oval shape, etc. The weaver can choose as per his requirement. The ends of the warp are drawn–in through the eyes of the healds with the help of an appropriate hook.

**Reeding–in**

The reed gets its name from the fact that its earliest construction was from actual reed. At present most reeds are made of steel. In a front view, a reed is a long comb like object, about 12 to 15 cm high, consisting of a series of vertical flat narrow strips held next to each other with spaces (called dent) between them for passing the yarn ends. However, sometimes more than one end can be drawn into one dent and dent/s can also be skipped altogether, depending upon the combination of warp ends to suit the weaving pattern and structure. The dents per inch or centimetre differ in view of the diameter or count of the yarn, which is to be drawn in the reed and on that basis only the reeds are given numbers. The reed of a suitable number must be used for weaving the yarn of a given count. The height of the reed must be sufficient to accommodate the open shed, when the sley is in the rear position and length should approximately be the length of the sley, even when the warp–width is narrower than the sley. The reeding–in operation or drawing–in the ends through the dents are done with the help of a suitable hook. Automatic dinters can perform this operation with considerable speed and ease.

**Tying**

Treadles are tied to lamms (levers), harness frames are tied to the shedding motion and warp is tied to the cloth beam apron. For this purpose cordage of various kinds and knots of different types are used. At the points of extreme friction, varnished cords give more efficient performance for longer period.

**6.2.1.4 Weaving**

The process of weaving mainly consists of continuous insertion of weft, also called filling, through the warp in the loom. Every loom has some basic parts, such as heald–shafts, reeds fitted in a beating–in device called sley, temple and cloth roller etc. Different kinds of looms, pit as well as frame looms, have been developed in various parts of India, having their individual features to suit the requirements of special types of weaving suitable for that region. For each insertion of weft across the width of the warp, certain warp ends must be up and others down and there is a constant alteration in warp position. This is one of the main functions of the loom. Uniform tension of the warp is maintained with the help of rope or
chain around the warp beam and use of weight/counter weight over the beam. The weaver releases additional warp by the amount of woven cloth rolled over the cloth roller. This twin operation is efficiently performed by take–up and let–off motion attachments. As the warp is woven and rolled by the take–up motion, same amount of unwoven warp is released by the let–off motion. Thus the warp beam maintains equal tension during weaving. The picks are inserted with the help of a shuttle, which may be either a throw shuttle or a fly shuttle. The weft yarn is wound on small bobbins called pirns from the hanks with the help of winding wheel. The build of the yarn on pirns should be so structured that the delivering of yarn from pirn during weaving is smooth and quick. The throw shuttle is thrown from one side of the loom to the other to interact with the warp and the operation is very time consuming. However, this method is still popular in cotton khadi field to weave ‘Durries’ of large dimensions with very coarse yarn. But to weave cotton khadi of all other varieties, fly shuttle is used to increase productivity. The movements of the fly shuttle are controlled by the weaver with the help of a simple mechanism operated through a cord system. As a piece of cloth is woven, the width of the warp narrows as a result of weft insertion and consequently the warp ends at the edge, also called selvage, of the cloth enter into the reed at an angle instead of straight. This position increases the chances of chafing and breaking of ends as the sley moves in beating–up operations. To avoid this, a tool called temple is used to hold the woven khadi out to reed–width during weaving. The temple helps immensely in keeping the selvage of woven cloth straight and clean, which is of considerable importance in further post–loom processes and marketing.

**Design Weaving**

Various types of designs, such as self–design, stripes or checks, border patterns and the whole–body patterns can be produced during weaving with a variety of devices or mechanisms. A multi–pedal loom with up to 8 or 10 pedals and corresponding number of heald–shafts, can produce cotton khadi of different types of self–designs. A revolving multi shuttle–box with 2 or 3 shuttles having yarn of different colours produces check designs. With the help of a dobby and its accessories, border patterns can be woven in saris or shawls or bed–sheets, while with a jacquard and its accessories, pattern can be woven on the entire area of cloth.

**6.2.1.5 Post weaving stages**

**Grey Cloth Inspection**

After the cloth has been woven, it is taken out of loom. This cloth is known as grey cloth. The cloth may have a number of visible defects mentioned in chapter 7 “Process
monitoring and control”. The grey cloth is inspected in a room with proper lighting or preferably glass top table which is illuminated underneath.

Chemical Processing

A very small portion of woven cotton khadi is sold in grey form and it generally has to be subjected to a number of wet processes to make it acceptable to the consumers. Major wet processes are briefly discussed.

Scouring and Bleaching

Previously this work was performed by hereditary washermen or ‘Dhobis’ in the traditional way applying alkaline soil called ‘Reh’ to the cotton khadi and steaming it in ‘Bhatti’ (oven), before washing it. However, this process had serious limitations regarding quality of cleaning and bleaching the grey khadi and it has been mostly replaced by washing with chemicals and detergents in process houses to suit the preferences of the buyers and to obtain snow–white appearance of khadi. For effective scouring, cotton khadi is subjected to continuous and uniform boiling for six hours with caustic solution of specified strength to avoid damage to the cotton fibres, inside the kier having puffer pipe, many a time under pressure. For whiteness, the cloth is treated with bleaching powder. Later, it is thoroughly and vigorously washed with clean soft water and light blue and/or optical whitener mixed in the final wash to give it a brighter appearance.

Dyeing

As sale of dyed and printed cotton khadi is expanding, the importance of these processes is also increasing. In the past, natural dyes alone were used and the khadi world continued this tradition for sometime. But with the advent of cheap synthetic dyes, mostly in ready to use form, the use of natural dyes has been drastically reduced. Of late, however there has been revival of natural dyes to some extent due to their distinctive look and fastness, specially for printing traditional and regional designs such as Barmeri or Sanganeri designs of Rajasthan, Kutch designs of Gujarat or Kalamkari prints of Andhra, etc.

The synthetic dyes made their advent in latter part of nineteenth century. The most popular categories of dyes used for cotton khadi are: (1) direct dyes, (2) reactive dyes, (3) sulphur dyes, (4) mordant dyes, (5) vat dyes, (6) naphthol dyes and (7) pigment colours. They are readily available throughout India. Improved dyeing equipment called Jigger is used for uniform treatment of cotton khadi in the dye solution and ensuring an even shade. It enables the khadi to effectively pass through the dye solution, hot or cold, desired number of times till the fabric acquires the desired colour–shade. Cotton can also be dyed with the aim of accomplishing peculiar colouring effects on the yarn. For this purpose cotton is kept in a small iron mesh cage immersed in the dye solution for some time. The dyed cotton is fully
dried in shade. Similarly, the yarn can also be dyed for weaving design—khadi. For this purpose, some categories of dyes such as vat dyes are better suited. Cabinet type hank dyeing machine can be used for yarn dyeing. It has watertight doors and the yarn is hanged on the rods inside it in an unstretched position. Dye solution is pumped into the cabinet for uniform dyeing.

**Printing**

The two most prevalent methods of printing are:

1. Block printing; and
2. Screen–printing.

**1) Block printing:** In block printing, the desired design must first be engraved on the wooden blocks. Separate blocks are prepared for each colour in the design. The main advantages of the block printing are its capability of producing different designs and colour combinations at short notice and handling comparatively small lots of cloth. Block printing has its peculiar aesthetic and traditional appeal. But its cost is increasing specially due to prohibitive cost of wood and engraving.

**2) Screen–printing:** In screen–printing, nylon or polyester fabric of fine mesh (known as bolting cloth) is fixed on a wooden or metallic frame in drum tight conditions. The design is then transferred on to this screen by photochemical method. The cloth to be printed is spread over a long screen–printing table in a stretched position free from creases and the design is printed over it by forcing the colour paste through the design screen. Clear and sharp printing can be ensured through this method, and speed of printing is quite good. Screen–printing is economical only when large quantity of cotton khadi is to be printed only in one design though the colour combinations may be changed.

**Finishing**

The only finishing process given to khadi fabric is starching and calendaring. Calendaring is the last process, which the cotton khadi undergoes. It renders sheen and smoothness to the cloth. Under this process khadi is subjected to pressure which removes creases, presses down the protruding yarn ends or knots, etc. and restores its dimensions widthwise and lengthwise. Considerable quantity of cotton khadi is calendared manually by two persons, who continuously hammer slightly moist khadi piece, folded in the desired size. This is done using thick heavy wooden rollers, on a big piece of smoothened log, flat at the bottom and rounded on the topside. Care is taken that the fabric is not damaged or unduly crushed in this process. The use of power driven mechanical calendars with a pair of heavy rollers is increasing fast, as the buyers prefer many varieties of cotton khadi in well–
calendared form. Large quantities of khadi are essential for employing the power driven roller calendars.

**Packing**

Cotton khadi is folded in the desired form and size after it is calendared. At the top of the piece, necessary information regarding the length, width, texture, count of yarn used, retail price, name of the producing institution and year of production are required to be printed in a washable colour as per certification rules. This can also be done by pasting a piece of paper with these details, on the top of khadi fabric. Finally, the khadi pieces may be packed in polythene bags for safe transport to the sales depots.

**Acknowledgement**

This chapter is taken from the book “Cotton Khadi in Indian Economy” By Yovesh Chandra Sharma, Navajivan Publishing House, Ahmedabad (December 1999).
CHAPTER 7
Process Monitoring and Control

7.1 Process Control of Charkha Spun Yarn

7.1.1 Introduction

The Process control in spinning is mainly concerned with maintaining the quality of the yarn. The yarn produced during spinning on NMC charkha should satisfy the requirements of weaver and also that of the customer. The weaver’s primary requirement is trouble free weaving and a proper texture. There are certain characteristics which have been associated with weavability, appearance and durability of the fabrics. These are yarn breaking strength, uniformity, extensibility, level of faults etc. The process control in spinning should ensure achieving the above listed properties to the desired level.

The conditions of equipments, especially the level of technology, maintenance and up keep contributes a lot towards yarn quality. So there should be regular check on the condition of the equipments, their maintenance etc. to keep the product quality under control.

7.1.2 Schedule of Checks

Having arrived at a set of norms, a suitable schedule for checks should be designed to ensure that the key characteristics are maintained at this level. Three considerations have to be kept in mind while designing such schedules:

a) The extent to which a parameter influences quality;
b) The ease with which it can be checked and adjusted; and

c) The frequency with which it gets disturbed after correct adjustment.

Besides these routine checks, machinery audit is another effective way to ensure that the important settings and parameters are well maintained and that these do not get vitiated due to unsatisfactory machine conditions.

Some guidelines about how to check the working condition of a charkha is mentioned in Appendix VI.

7.1.3 Representation of Khadi Yarn Production Process

A typical material flow chart for khadi yarn production is shown in Fig. 7.1. Cotton bales are bought and transported to the Central Sliver Plants (CSP). The bales are stored and subsequently processed according to institution’s need. Slivers or rovings are bought by the institutions which in turn are distributed amongst the spinners for conversion in to yarn. In this whole chain of activities there are many places other than actual spinning where things
may go wrong and affect yarn quality such as selection, procurement, transportation, marking, storage and retrieval of bales. A schematic representation of spinning production process control is depicted in Fig. 7.2, which shows the key areas where control is to be exercised.

For complete control of the process inputs to the process, the process itself and output from the process need to be continuously monitored and controlled if necessary. How many parameters to be monitored and controlled at each stage is a matter of compromise between cost involved in monitoring and their critical influence on quality.

7.1.4 Work Practices to be Followed

Most of the khadi institutions/production centers collect sliver/roving from different Central Sliver Plants (CSPs) for preparation of yarn. So it is necessary that both the CSP as well as the khadi institutions/production centers be aware of certain characteristics that affect the yarn quality.

7.1.5 Instructions for Central Sliver Plants (CSP)

Cotton Purchase
1. The cotton purchase should be a properly planned activity;
2. It should be purchased when the first crop arrives in the market (from October to January of a year);
3. Certified cotton should only be purchased; and
4. The quality parameters should be verified if not available.
Fig. 7.1 Flow chart of material
Bale Transportation and Storage

1. The bales should be covered properly to avoid deposition of dust and other impurities or getting wet on the way due to rain.

2. The bales should be segregated according to length and fineness.

3. They should be stored in a well–ventilated area under shed with proper marking so as to avoid accidental mix up of different fibres.

Sliver Storage and Handling

When a CSP produces sliver/roving for a production center it should ensure that:

1. The fibre characteristics meet with the requirements of the yarn i.e. the fibre length, strength, fineness etc. should be in accordance with the yarn count to be spun.

2. The count of the sliver/roving should be checked before supplying them to different production centers. The count of the sliver/roving, the fibre used etc should be written in the package.

3. Some instructions regarding careful handling of sliver/roving should be pasted on the supplied package. As poor handling of these packages deteriorates yarn quality.

4. Generally the sliver/roving packages in CSP are packed in polyethylene bags and transported to different khadi institutions by trucks. While transferring the sliver from the
cans to poly bags at CSP, care should be taken to avoid accidental slip–off of material outside the bag. While loading the bags on the truck, they should not be dragged over the ground. The bags should be put on a trolley and carried to the truck. Then they must be loaded gently on to the truck. The person loading the silver/roving should not squeeze the bags containing sliver/roving too much. The stack of bags on truck should be covered by a plastic sheet and tied.

7.1.6 Instructions for Institutions / Production Centers

Unloading and Storing of Sliver/Roving at the Institution

While unloading the sliver/roving from the truck at the institutions/production centers, the following precautions should be taken:

1. The bags containing the sliver/roving should be gently unloaded from the truck.
2. The bags should be carefully put on the trolley and shifted to the storing place of the institution.
3. During storage, care should be taken to segregate the sliver/roving according to mixing or count of the yarn to be spun from it.
4. During storage the contamination possibility by any foreign material with the sliver/roving should be avoided.

Production of Roving at the Institution

If the production center is having its own speed–frame for converting sliver into roving then the draft wheel and the twist wheel should be adjusted as per the requirement of the nominal roving count. The count of the roving should be checked after producing few meters. The speed frame should be maintained following a proper maintenance schedule.

Count Check of the Sliver/Roving

Before spinning it is necessary to check the count of the sliver/roving (either received from CSP or produced at the institution itself) to confirm its appropriateness for the yarn count to be spun. The count of the sliver/roving can be determined following the procedure suggested below.

Procedure

Take 5 metres of the sliver or 15 metres of the roving by using the wrap reel (Fig. 7.3.) Determine the weight of the above length of sliver or roving using a single pan balance corrected to 1mg.
Fig. 7.3. Wrap reel for checking count (hank) of sliver/roving

Calculation

The Metric count of the sliver or roving can be determined by using the following formula:

Metric count of the sliver = 5 \div w_1

Where \( w_1 \) indicates the weight of the sliver in grams.

Metric count of the roving = 15 \div w_2

Where \( w_2 \) indicates the weight of the roving in grams.

7.1.7 Distribution of Roving to the Spinners

The following precautions should be taken while distributing the roving to the spinners

1. Make sure that the roving supplied is appropriate to the yarn count to be spun by the spinner.
2. Instructions should be given to the spinner for proper handling of the material.

7.1.8 Spinning

7.1.8.1 Training of the Spinner

1. Every charkha operator should be made to realize the importance of yarn quality for overall improvement of khadi fabric, his role and stake associated with it.
2. He should have a rudimentary knowledge about yarn faults, their causes and remedies.
3. If the operator cannot tackle any of the problems related to charkha, he should contact the institution/production center for expert advice and stop producing yarn till the charkha is set right.

7.1.8.2 Checkpoints before Commencement of Spinning

The following points are important

1. The charkha should be in a cleaned and well–maintained state before spinning operation starts.
2. The operator must ensure that the malls are not loose.
3. The drafting rollers and the driving pinion should not wobble.
4. The cots should not be damaged and the roving should unwind smoothly from the roving creel.
5. The operator should be competent to do minor repair and cleaning.
6. Whenever a group of operators start spinning a new lot, it should be in presence of a technical person/supervisor of the institution/production center.
7. The technical person/supervisor should check the count of the yarn and compare it with the nominal yarn count.
8. If the actual yarn count is found to be different from the nominal by an amount which is beyond the tolerance level, corrective action in terms of change of draft or rechecking of sliver or roving has to be initiated.

**7.1.8.3 Quality Maintenance**

For better and consistent yarn quality the following procedure is suggested:

**a) Work Practice Related**

1. After a day’s spinning is over, the charkha should be properly covered and the top roller pressure should be released by loosening the spring, otherwise it may cause damage in the form of permanent marks on the cots.
2. While starting a charkha, it should be run at a slow speed and then it should be gradually raised to the normal speed.
3. The broken end should be pieced (joined) properly. A knot is to be avoided as it becomes too large with respect to the yarn diameter, which deteriorates the fabric appearance.
4. Travellers should be changed at regular intervals. For finer yarn lightweight travellers and for coarser yarn heavier travellers should be used.
5. The spindle should be properly centred with respect to the lappet guide.

**b) Maintenance Related**

1. Top roller pressure should be checked at regular intervals to avoid roller slippage.
2. A maintenance schedule should be prepared for the charkha and it should be followed (Appendix VII).
3. Oiling and greasing should be done at regular intervals.
4. The condition of the spindle driving threads (mall) should be checked regularly, otherwise it will cause variation in spindle speed and hence the twist in the yarn.
5. All the spindle driving threads should be of equal length and of the same type of material.
7.1.9 Hank Winding
Following care should be taken while winding hanks from the charkha bobbins:

1. The length of each hank should be of exactly 1000 metre.
2. The entire hank should be made from the same yarn count. Otherwise, it will cause long “Patta” in the fabric and also shade variation of the dyed fabric. So care must be taken to avoid mixing of yarn bobbins containing yarns of different counts.

7.1.9.1 Hank Making
1. Both the ends of the leasing cord should cross properly all the sections of the hank. The two ends of the hank should be tied properly along with the ends of the leasing cord.
2. After making the hank, it should be twisted a bit. The end of the twisted yarn should be inserted into the inner portion of the hank.

7.1.9.2 Storage of Hanks
1. Hanks of different yarn counts should be stored in plastic or fabric bags with different colour marks. After filling the bags, the open end of the bag should be closed.
2. If possible hanks should be stored in separate areas according to the variety of fibres or lot used to avoid accidental mixing. The same yarn count spun from different fibres may vary in dye uptake and other properties.

7.1.10 Checks During Collection of Yarn from Spinners
While a production center receives yarn from spinners the following checks are to be carried out

1. The count of the yarn; and
2. Visual checking of yarn appearance and faults mentioned below.

Yarn Faults
The persons involved in the visual checking of the yarn quality should have good eyesight and knowledge of yarn faults. The faults commonly observed in khadi yarn are shown in Table 7.1.

7.1.11 Monitoring of Spinning Process
Process control activity is to be directed for controlling relevant yarn quality characteristics that make a significant impact in the quality characteristics of the finished khadi fabrics. Since spinning operation is a multi stage process, the characteristics of the intermediate products such as sliver, roving also need to be controlled. Further, process
performance also needs to be kept under control in order to minimize waste and improve efficiency. The various characteristics to be controlled are stated in 7.1.11.1:
<table>
<thead>
<tr>
<th><strong>Table 7.1 Khadi yarn faults</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name &amp; Figure of the Fault</strong></td>
</tr>
</tbody>
</table>
|**Pote** | The undrafted and untwisted portion present in the yarn. | 1. Broken gear tooth.  
2. Damaged cots of top roller.  
3. Insufficient pressure on the top roller. | 1. Proper maintenance.  
2. Buffing of cots. |
|**Moree** | Improperly joined broken ends. | 1. Improper piecing present in sliver or roving.  
2. Improper piecing by the charkha operator. | 1. Training to the operator about piecing and yarn quality. |
|**Bakar** | Trash (mainly seed coats) present in the yarn structure. | 1. Improper ginning i.e. seeds broken during ginning.  
2. Presence of too much trash in cotton fibre.  
2. Selection of proper cotton variety.  
3. Proper cleaning in blow room. |
|**Over Twisted Yarn** | More twist than the normal value is present in the yarn. | 1. Wrong selection of twist wheel.  
2. Wrong selection of spindle driving pulley.  
3. The yarn count has become coarser. | Suitable action to overcome these difficulties. |
|**Soft Twisted Yarn** | Soft twisted yarn is the yarn portion having less twist than the normal. | 1. Wrong selection of twist wheel.  
2. Wrong selection of spindle driving pulley.  
2. Check spindle slippage at regular intervals. |
|**Daghi** | This is the oil or stain marks present on the yarn. | 1. Over flowing of oil from spindle bolster.  
2. Excessive oil on ring with the intention of running the traveller smoothly.  
3. Improper storage of material.  
4. Improper material handling. | 1. Proper oiling and greasing.  
2. Proper material storage.  
3. Proper material handling. |
|**Slub** | Slubs are thick places having length of 1 to 4 cm and about 5 to 8 times larger than the average yarn diameter at the thickest portion. | 1. Poor individualization of fibres at the card.  
2. Lack of adequate fibre control in the drafting region. | 1. Better opening and cleaning in blow room and card.  
2. Proper fibre control in drafting region. |
7.1.11.1 Yarn Characteristics

1. Count and count variability.
2. Count Strength Product (CSP).
3. Uniformity.
4. Imperfections.
5. Appearance.

1) Count and Count Variability

The logical steps involved in this are:

a) Detection of shift in yarn count and investigating its causes.

b) Corrective action.

a) Detection of Shift in Yarn Count and its Causes: Separate out three hanks from each spinner/operator whenever he/she brings the yarn to handover to the institution. The count for each such procured hank is to be checked following the procedure described in the section 5.3.1 “Determination of Count of Yarn”. Plot the weights of the hank on the chart as shown in the Fig. 7.4. But before that one has to set the Warning and Action limits. This procedure is described with an example.

<table>
<thead>
<tr>
<th>Example: Setting up Control Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn count</td>
</tr>
<tr>
<td>Average weight of hank</td>
</tr>
<tr>
<td>Count CV %</td>
</tr>
<tr>
<td>S.D. of count</td>
</tr>
</tbody>
</table>

Standard error (i.e. S.D. of sample mean) = 2/√3 = 1.15

Warning limit = Mean ± 2 × S.E. = 20 ± 2.3 = 22.3 & 17.7

Action limit = Mean ± 3 × S.E. = 20 ± 3.45 = 23.4 & 16.5
Each point will thus represent indirectly the yarn count spun by an individual spinner from a given raw material. Under normal circumstances the points will be distributed around the line representing the nominal count value in a random fashion and lie within the warning limits. But when the process is out of control two cases may arise as discussed below:

**Case I:** The count value of yarn brought by one spinner fall beyond the lower or upper action limit (Fig. 7.4), it would mean that the yarn spun by the operator is either too fine or too coarse. Since one check for the entire yarn brought by the operator cannot be considered to be a true representative of the entire lot he/she has brought, one additional check should be carried out. If it shows lighter or heavier hanks, then the condition of the charkha owned by him/her should be checked.

**Case II:** This case represents a situation in which the count of hanks produced by a group of operators from a given lot of roving/sliver fall beyond the upper or lower action limit (Fig. 7.5). It means the count being spun is either finer or coarse. In such situation the count of the sliver/roving supplied to them needs to be verified. Corrective action is to be taken accordingly. The institution should keep a record of the existing draft and twist wheels of the charkhas own by the institution and run for different counts.

**b) Corrective Action to be Taken**

**For case I:** In this case the following points are to be checked:

1. It is most likely that the draft change pinion on charkha has been wrongly selected.
2. The draft constant might have got changed inadvertently while adjusting the gears.
3. Since the sliver/roving supplied to a particular spinner and others is from the same source it is unlikely that the sliver/roving is either finer or coarser. However, if nothing wrong is found with the draft, the sliver or roving supplied may be checked, since inadvertent mixing of sliver/roving is also possible. Following method is used to calculate the number of teeth of the draft change pinion.

**Selection of Right Draft Change Pinion (DCP):** In case the draft change pinion is found to be not right, a change pinion with right number of teeth is required. The following procedure will be adopted for determining the required teeth in the draft change pinion

\[
\text{Draft required (P)} = \frac{\text{Nominal Yarn Count}}{\text{Count of sliver/roving}}
\]

\[
\text{Actual draft (Q)} = \frac{\text{Actual yarn count produced}}{\text{Count of Sliver/Roving supplied}}
\]

Let

Teeth in present DCP = \(N_1\)

Teeth in the DCP required = \((P \div Q) \times N_1\)

**For case II:** In this case the count of the sliver or roving supplied to all the spinners is to be checked by taking a representative number of samples from different operators. If count is found to be different, total draft in the individual appropriate charkha is to be adjusted or too coarse or fine sliver/roving is to be taken back from the spinners.
Control of Count Variability:

The count variability has two components: within operators (CVWO) and between operators (CVBO). CVWO indicates the variation in yarn count produced on different spindles of the same charkha. Where as CVBO means the variation in yarn count spun by different spinners.

No routine check of this within operator variability (CVWO) can be practiced in normal working condition. Special checks will be required whenever doubt arises. As an example, whenever the count of the yarn lot supplied by an operator appears to be too high or too low, the yarn supplied by a few more operators should be selected. Number of operators could be ten. Now taking ten hanks from each operator, 100 hanks are to be collected. Count values of all the 100 samples are to be found out and recorded. A diagrammatic representation of this process is shown in Table 7.1 (Nominal count 30 Nm). From the table CVWO, CVBO and CV total is calculated.

CVWO = 9.63
CVBO = 5.8
CV Total = 11.24

The calculation procedure is given in Appendix VIII.

<table>
<thead>
<tr>
<th>Operator No.</th>
<th>Count Values of Hank No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>34.3</td>
</tr>
<tr>
<td>2</td>
<td>34.6</td>
</tr>
<tr>
<td>3</td>
<td>28.6</td>
</tr>
<tr>
<td>4</td>
<td>33.2</td>
</tr>
<tr>
<td>5</td>
<td>33.7</td>
</tr>
<tr>
<td>6</td>
<td>35.3</td>
</tr>
<tr>
<td>7</td>
<td>25.1</td>
</tr>
<tr>
<td>8</td>
<td>34.9</td>
</tr>
<tr>
<td>9</td>
<td>31.1</td>
</tr>
<tr>
<td>10</td>
<td>32.1</td>
</tr>
</tbody>
</table>

From the above data if the within operator CV (CVWO) is found to be more than the norm then appropriate corrective action has to be taken as suggested below.

- High U% of sliver supplied.
- Uncontrolled stretching of sliver/roving due to high web draft and creel draft.
- Uncontrolled stretching of roving due to uneven unwinding at charkha creel.
- Excessive roller lapping during spinning etc.
The reason for high count variability between the yarns spun by different operators (CVBO) would be

1. Difference in average hank of the sliver supplied. This could be due to
   - Difference in waste level in card.
   - Difference in mechanical draft in card, breaker or finisher draw frame.
2. Difference in average hank of the roving supplied. This could be due to
   - Difference in sliver hank.
   - Draft difference in speed frames.
   - Difference in waste level in card.

Hence the hank of roving/sliver is to be checked and confirmed whether this CV is as per the norm or not.

3. Difference in total drafts of the charkhas employed for spinning. This could be due to
   - Different draft constants in charkhas or different change pinions in different charkhas working on same count.
   - Difference in effective draft within a charkha which could be either due to slippage of top rollers or inadequate top roller pressure.
4. Difference in effective drafts of between spindles of charkhas due to cot slippage.
5. Roving stretched while roving formation/spinning. This could be due to
   - Inadequate roving twist.
   - Low inter fibre cohesion (specially when fibres are short).
   - Defective bobbin holder.

One has to identify the right reason and take necessary action.

2) **Count Strength Product (CSP)**

   After receiving the yarn samples from the charkha operators following steps should be taken:

   1. Select three hanks per operator from the same mixing lot.
   2. Test the hanks for CSP as per the procedure mentioned in section 5.3.2 “Estimation of yarn strength”.
   3. Average CSP values based on three readings per operator should be plotted on a graph paper as shown below (refer control chart for yarn count)
Each point will thus represent the yarn CSP spun by an individual operator from a given raw material. Under normal circumstances the points are expected to be distributed randomly around the line representing the nominal CSP value as shown in the case of count. As the CSP values are plotted two cases may appear.

**Case I:** CSP values of yarn spun by few operators fall below the Lower Action Limit and above the Upper Action Limit or continues to fall in between Lower/Upper Warning and Lower/Upper Action Limit for many operators.

**Case II:** CSP values are distributed with a wide scatter.

**Corrective Action to be Taken**

**For Case I:** A repeat check on the yarn supplied by the operator whose estimated CSP value fall below the action limit is to be performed. Additional hanks are to be tested and the average is to be found out. If the average is found to be still lower, then remedial measures should be taken.

**Reason for low average CSP**

The low average CSP could be due to:

1. Inadequate twist in the yarn.
2. Finer yarn count.
3. Weak fibres in mixing.

   Twist and count testing of the same yarn are to be performed to verify whether the twist is really low or the count is fine. The lower twist could be attributed to lower spindle speed due to slippage, which can be due to
   - Loose driving cord of spindles.

![Fig. 7.6 Control chart for CSP](image)
Accumulation of oil/grease on cord driving the spindles.

Finer yarn can be due to

- Higher total draft.
- The finer sliver/roving supplied.

If count and twist are as per nominal value but CSP is still found to be less, inadvertently a sliver/roving may have been supplied from a mixing in which the fibres are intrinsically weak.

**Reasons for high strength variation**

The reasons are

1. Intermittent slippage of top roller in the charkhas.
2. Variability in between yarn count of charkhas (CVBO).

Necessary steps should be taken to control these faults.

**3) Yarn Uniformity/Unevenness**

Whenever yarns belonging to a new lot of any particular mixing are received by an institution, it should separate out 30 hanks from different operators (1 or 2 hanks per operator) and send them for evenness testing on an evenness tester either within the institution or to any outside agencies. The testing should be performed as per the procedure mentioned in section 5.3.6. Every sample should be coded so that the operator and the charkha used for spinning the yarn can be identified.

If the average evenness value comes within the norms, no action is required. If it is higher than the norm and also statistically significant, remedial action would be taken.

**Reasons for uneven yarn**

The high unevenness values can be attributed to:

- Incorrect setting of break draft in draw frame, speed frame and charkha.
- Inadequate top roller pressure on charkhas.
- Wear/damaged apron or the top roller surface.
- Top roller eccentricity in the charkha.
- High short fibre percentage in sliver or roving.
- Too wide setting in the front zone of charkha drafting system.

**4) Yarn Imperfections**

A routine testing of yarn imperfections (thick places, thin places and nepes) on all the yarns supplied by the operators may not be practical due to the volume of the workload. Hence yarns either suspected or confirmed to be poor in appearance should only be tested. This will help to know which types of faults are responsible for high imperfections. It will
help to take appropriate corrective action. The test result should be compared with the norms. In case the values are more than that of the norms, corrective action should be initiated.

**Reasons for high yarn imperfections**

**Thick Places**

These are yarn segments having a length approx. equal to the staple length of fibre and a cross-section, 50 percent more than the average yarn mass. Their presence could be due to:

- Improper setting between the rollers irrespective of fibre length.
- Improper piecing of sliver/roving.
- Inadequate top roller pressure.
- Too low break draft.
- Too high roving twist.
- Presence of unopened fibres and drafting disturbance causing thick places.
- Soiling of top rollers by oil / grease.

**Thin Places**

These are yarn segments having a length approx. equal to the fibre staple length and a cross-section, 50 percent less than the average yarn mass. Their presence could be due to:

- Drafting disturbance due to improper roller setting.
- Too much sliver/ roving stretching.
- Insufficient strength of sliver/roving due to poor cohesion, presence of too many short fibres or inadequate roving twist.
- Improper piecing of sliver/roving.
- Poor condition of aprons.
- Incorrect draft distribution.

**Neps**

These are yarn segment having a length of 1mm and a cross section 200 per cent more than the average yarn mass. Their presence could be due to:

- High nep content in raw cotton.
- High percentage of immature fibres.
- Too much of neps in sliver/roving due to improper opening and cleaning action in blow room and card.
- Accumulation of flies, dust on traveller, lappet guide and top roller surface.
- High production rate at card.
Corrective actions/control measures to be taken

1. All the roller settings should be appropriate to the fibre length. However, in many charkhas the setting are fixed and there is no provision to change it also. In such cases the raw material should always be so selected that the average fibre length corresponds to the fixed roller setting on the charkhas.

2. The cleanliness of the machine should be improved by regular cleaning, oiling and not allowing too much of fibres to accumulate on lappets, gearing, roller bearing, ring etc.

3. Roller slippage should be avoided by keeping appropriate roller pressure.

4. Roving should unwind smoothly from the roving bobbin and bobbin holder should be changed or cleaned if required.

5. Piecing of broken ends should be done carefully to avoid generation of long thick places.

5) Yarn Appearance

Whenever the yarns are received from operators, there should be a visual check to assess the general appearance of the yarn supplied by the operators. A record of the visual assessment should be maintained.

In case some yarns are found to be poor in appearance, these should be kept aside for making appearance board and subsequently assessed for appearance grade using the standard test method described in section 5.3.5 “Appearance Grading of Cotton Yarn using Photographic Standards”.

If appearance of the yarn comes within the acceptable limits, no action is required. However, if some of the boards fall below the acceptable limits, corrective actions need to be taken on the machine on which the corresponding yarns have been spun.

Reason for poor appearance

Poor appearance could be due to:

- Too high yarn unevenness.
- Too many severe thick places and neps in the yarn.
- Presence of too many impurities like seed coat, leaves, stalks etc in the yarn.

Corrective actions to be taken

In case the poor appearance is due to yarn unevenness or imperfections, the following actions may be taken:

- Check the overall condition of the charkha, especially its drafting system i.e. whether the setting between the rollers is too wide in comparison to the fibre length being processed.
- Drafting rollers and aprons should be changed if found defective.
Accumulation of stray fibres on drafting elements, ring, trevellers, gears etc should be avoided.

Roller slippage because of low pressure or presence of oil on roller surface is to be avoided.

Neps in sliver to be maintained as per the norms by taking appropriate actions in card and blow room at the CSP. The maturity level of fibres also may need to be ascertained.

In case, the poor appearance is due to impurities, the following actions may be taken:

- Cleanliness of the sliver should be checked and presence of particles such as leaves, stalks and other trash related particles should be kept at minimum level by proper selection of fibre and cleaning efficiency at blow room and card.

7.2 Process Control in Weaving

7.2.1 Introduction

The quality of a fabric is determined by the entire sequence of operations from winding (hank preparation) to weaving (fabric formation). The approach should be, therefore, to look at each process not in isolation but in relation to the manner in which it affects subsequent process, and in particular, the eventual quality of the fabric and productivity at the loom. The second point is concerned with the methods of control. The classical approach of Statistical Quality Control (SQC) as a technique to maintain or improve quality has been to:

a) Assess process capability and improve it wherever possible;

b) Fix tolerance limits, such that the quality within these limits is acceptable; and

c) Modify the process conditions suitably whenever the quality is significantly below the prescribed minimum.

In khadi sector unfortunately no SQC system exists even up to the date. With the presently available testing machineries and the work practices in khadi sector, it is very difficult to assess the efficiency of a particular process such as winding, warping. In such a situation, the correct approach would be to rely essentially on direct control such that the various process parameters, machine settings and the machinery conditions which influence the quality of product.

In weaving, the quality of grey fabric can be quantified in terms of fabric defects. For this purpose the following points need consideration:

a) All the cloths should be inspected metre by metre to record the defects; and

b) Norms for each type of fabric defects should be laid down so that the observed defects can be compared against these norms.
The concept of SQC has to be applied to formulate a programme for deciding upon the frequency, the method and the amount of data to be collected on the various items of process monitoring so that the data are reliable on drawing conclusions and are interpreted correctly.

### 7.2.2 Steps Involved During Weaving Operation

1. Selection of yarn for warp and weft purposes
2. Sizing
3. Winding  
   a. Spool winding (for warp)  
   b. Pirn winding (for weft)
4. Preparatory Processes for Sectional Warping  
   a. Creeling  
   b. Hecking  
   c. Denting in section guide reed  
   d. Leasing
5. Warping on horizontal drum warping machine
6. Beaming
7. Drafting arrangement
8. Denting
9. Gait–up the loom
10. Tie–up the loom
11. Weaving

### 7.2.2.1 Detailed Guidelines of Process Control

#### 1. SELECTION OF YARN FOR WARP AND WEFT PURPOSES
The technical supervisor from the institution should separate out the yarn for warp and weft and should give clear instructions to the weaver accordingly.

#### 2. SIZING

**Objective**

Sizing is essential for single warp yarn where sizing of double yarn is optional. The objectives of sizing are:

a) To reduce the end breakage rate by improving the abrasion resistance and also the tensile strength of the yarn.

b) To enhance the weavability.
Precautions

1. It is absolutely essential that the sizing ingredients are accurately weighed preferably in digital balance and not taken by measures of spoons, mugs as based on experience. The accurate weighing would give consistent result from lot to lot.

2. The sizing agent (for example starch) should first be mixed with cold water to make fine slurry. Hot water should never be added to the sizing agent while it is in powder form otherwise lump formation will take place.

3. The order of size preparation should be as follows:
   a. Mixing the adhesive component of size with cold water.
   b. Addition of weighting agent to the adhesive component in the cold water.
   c. Mixing the lubricating agent with small quantity of boiling water and then adding it to the mixture of sizing and adhesive component.
   d. Addition of antiseptic agent to the above.
   e. Boiling all the mixed ingredients on slow fire with continuous stirring.
   f. Continuation of boiling till the sizing paste becomes transparent and of constant viscosity. It is checked by lifting the liquor with the help of a stick.
   g. The paste is then cooled with continuous stir.
   h. It is then filtered through fine muslin fabric to remove insoluble material and the lumps of the size if formed. The boiled and filtered paste is diluted with cold water to the required volume as per the liquor to material ratio of 10:1. (It indicates 10 liters of size paste is required for 1 kg of yarn)
   i. To confirm the readiness of the size paste, the following steps can be followed:
      I. Lift the size paste between the thumb and the forefinger and smudge it for some time. Separate out the two fingers. Tackiness should be felt while separating the fingers.
      II. Take small amount of size paste and spread it on a clean glass. Allow it to dry. A formation of thin film on drying indicates the good preparation of the size paste.
      III. The absence of tackiness and film formation indicates that the size paste is not properly prepared.

4. Wetting of the Hank
   a. It is necessary to wet out the hank with water prior to sizing. For this purpose the hank is soaked with cold water containing suitable wetting agent for 12 to 14 hours preferably over night. During wetting period make sure that the hanks are properly submerged in water. This will facilitate proper wetting of yarn.
b. The wetting process of the yarn is tested by taking out a bunch of hank which have been wetted out, squeezing it and putting it in to fresh water. If the hanks are properly wetted, it will sink in to the water. If the hanks don’t show this test positively, the wetting should be continued for some more time with the addition of wetting agents. The most commonly used wetting agents is Turkey Red Oil (TRO). But now–a–days a large number of efficient wetting agents are available from various manufacturers.

c. The hanks which are wetted properly in water should be uniformly squeezed in a hank shaker. Over squeezing should be avoided. This will lead to non–uniformity of sizing.

5. During sizing the penetration of size in to the wet hank should be ensured by alternate saturation of the hank with sizing liquor and pressing with hand. This should be repeated 4 – 5 times. In this method there is chance of entanglement of yarn within hank. In an alternate method the sizing liquor is taken in a rectangular tank. The wet hanks to be sized are hanged between to wooden sticks and submerge in sizing liquor. The hanks are then rotated at interval in it for complete saturation. This method avoids yarn entanglement within hank and the yarn remains straight.

6. Squeezing of the sized hanks
   a. The sized hanks should be squeezed on hank shaker with the help of wooden rod by twisting.
   b. Squeezing should not be too hard or too low.
   c. If the squeezing is hard, at the tightly twisted portion of the hank the size will be too low whereas low squeezing leads to superficial sizing.

7. Drying
   a. Drying under direct sunlight should be avoided.
   b. While drying, avoid spreading the hank on the floor, hanging the sized hanks on wooden poles should carry it out.
   c. During drying it is necessary to change the position of hanks at intervals.
   d. Over drying and under drying of the hanks should be avoided.
   e. During drying it is necessary to open out the yarns within the hank by holding with two hands and giving jerks, this will prevent the entanglement of the yarn and facilitates in bobbin filling.
   f. The sized hanks should not be stored by stocking one over another. It should remain in hanging position on wooden sticks.

3. WINDING
   a. Spool Winding (For Warp)
1. It is very essential to separate out each section of hank before loading it on to the swift. Locate the first and the last end of the hank.

2. The T–point of the swift stand should be towards the winding wheel direction.

3. During loading of the hank in to the swift precautions should be taken so that the end of the hank should unwind from top to bottom (clockwise) as shown in fig. 7.7.

![Fig. 7.7 Clockwise unwinding of hank from swift](image)

4. The location of the swift and the bobbins should be parallel and right direction with respect to each other.

5. The threads in the spool should be uniformly distributed and the bobbin should be tightly wound.

6. The filled bobbin should be stocked one over the other in a rectangular container.

7. The end of thread in the filled bobbin should be cross–wound for easy location as shown in fig. 7.8.

![Fig. 7.8 Cross–wound end of filled bobbin](image)

b. **Pirn Winding (For Weft)**
1. Pirns should be selected in proper size and proper quality. It should not be too long or too short to the required size of the shuttle.

2. Pirns should be clean and free from any wound yarn. The metallic portion of the pirn (head & nose) should be rust free.

3. The use of damaged or bend pirn should be avoided.

4. While starting the winding, knotting of the thread to the pirn should be avoided.

5. Pirns should be uniformly and tightly filled up.

6. The broken ends should be joined by piecing. Knotting should be avoided.

7. Over filling of the pirn should be avoided otherwise it will rub with the inner wall of the shuttle. The pirns should be filled correctly as shown in fig. 7.9. The weft end should be crossed around the filled pirn.

![Fig. 7.9 Shape of the filled pirn](image)

4. **PREPARATORY PROCESSES FOR SECTIONAL WARping**

a) **Creeling**

1. Precautions should be taken in such a way that the end of the thread from each bobbin is released from the top.

2. It is suggested that in order to prevent the entanglement of the broken ends of the thread to tie a string in a tight condition on the center of each section vertically.

3. The use of over filled warp bobbin in the creel should be avoided. All the filled bobbins should be of equal weight and size.

b) **Hecking**

The threads of the creel should be divided in odd and even series (all the odd numbered threads should be drawn in to the eye of the heck heald and all the even numbered threads should be drawn in to the dent of the heck.

c) **Denting order**

Denting in reed (threading) should be according to the weave pattern so that the total width of the warp in the warp beam should tally to the width of warp in the actual weaving reed.
d) **Leasing**

Insertion of the two lease cord in to the section should be after half metre distance.

5. **WARPING**

a. During warping tension of all the ends in each section must be uniform and constant at the time of withdrawal from the supply package, otherwise fabric fault occurs due to variation in warp tension. Actual yarn tension of each section should be measured by using tension device, which will help in ensuring that the desired tension level is really maintained.

b. The spools (filled warp bobbins) should be properly aligned in the creel. A misalignment will lead to frequent yarn breakage. A regular machine audit will help to minimize the incidence of non-aligned spools (filled warp bobbins).

c. The groups of neighboring ends on the beam should be taken from the same column of spools in the creel as grouping of neighboring ends from the same row shows more tension variation.

d. Any interruption in the path of warp ends between creel to section guide reed can significantly increase the yarn tension and hence the breakage rate. So there should be a routine checking of this type of machine faults.

e. Deposition of fluff and dust increases the yarn tension. So the warping machine should be cleaned properly at regular intervals.

f. High tension during warping should be avoided. The tension should be moderate, to allow the yarn to completely retain its elastic properties and strength.

g. Preparation of too soft or too tight warping on the drum should be avoided as it causes more end breaks at subsequent process.

h. Warp beam along with its flanges should be carefully handled.

i. The yarn should not be subjected to sharp abrasive action to avoid the size removal.

j. Spreading of the yarn throughout the whole width of warping must be as uniform as possible.

k. Predetermined length of warping should be strictly observed for every section, beam, ball or journey of mill warping, as the case may be.

6. **BEAMING**

a) The width of the warp ends in the warp beam should be equal to the width of the reed. The flanges should be fitted at right angles to the beam surface and it should be fitted at the center in equal distance from both side end of the beam.
b) Direct filling of the warp ends to the beam surface should be avoided. In lieu of direct filling the sections on the beam surface, the use of apron is more appropriate.

7. DRAFTING ARRANGEMENT

b. If a new type of fabric is to be woven, then it is very essential to calculate the total number of heald shafts required.

c. In the same way the total number of heald eyes required in each heald frame should be calculated according to the design pattern.

d. All the frames should be parallel to each other and should hang in the drafting frame. All the heald eyes should be in a vertical plane.

e. Filled warp beam should be fitted just over the heald shafts. Leasing cord should come down at the eye level of the draftsman.

f. Proper selection of heald hook is required as per the heald gauge. A heald hook is shown in fig. 7.10.

![Fig. 7.10 Heald hook to be used for drafting](image)

8. DENTING

a. Appropriate reed count should be selected according to the yarn count and the total number of ends per centimeter.

b. The denting order should be according to the design pattern.

c. The surplus portion of the reed should be equally divided in both the sides.

D. Use of reed hook as shown in fig. 7.11 is required instead of heald hook.

![Fig. 7.11 Reed hook to be used for denting](image)

9. GAIT–UP THE LOOM

a. Warp beam should be accurately fitted to the brackets of the beam holder and tooth wheels of the warp beam should be just below the tooth wheel catch device.

b. All the heald shafts should be joined with the shedding device (rollers/pulleys/jacks etc) so that they are parallel to each other and their tops lye in a horizontal plane.

c. Reed should be properly fitted to the grooves (sley groove and reed cap groove)
d. The bottom and the top of the reed should completely sink in to the grooves in horizontal position.
e. The reed grooves and reed cap grooves should not be too wide or too narrow. Otherwise it will bend to either side.
f. Discard the use of too old, damaged or rusted reed.

10. TIE–UP THE LOOM
1. Each section of the warp should be parallel and with equal tension.
2. Each section should be tied–up just parallel to the reed.
3. In lieu of the section–tying rod, apron should be used.
4. According to the design pattern, required number of paddles should be accurately fitted at the middle of the loom width.
5. Required number of lamb rods should be accurately fitted below the loom parallel to the heald frames.
6. All connections (with the paddles, lamb rod and shedding device) should be accurately tied up.

11. WEAVING
Steps involved
a) Shedding;
b) Picking;
c) Beating–up;
d) Let–off motion; and
e) Take–up motion.
a) Shedding: Arrangement of total number of warp threads in to two layers (top and bottom) according to the specific weave of the fabric.

Precautions
1. Appropriate shedding device should be selected depending on the type of the handloom, if wrongly selected the correct shed formation will not take place and the fabric quality and loom efficiency will be deteriorated.
2. Connecting cords for the shed formation should be even and strong to withstand the load during paddle movement.
3. The cords should not be directly linked with the heald shafts. In lieu of this the use of loop cord is suggested through which the connecting cord should pass and should be tied by slipknot to either side of the heald shaft.
4. Connecting cord from the central bottom of the heald shaft to the paddle should also be tied by slipknot to the loop cord.

5. Before weaving it is important to check the formation of uniform shed.

6. Instead of using two heald shafts it is suggested to use four heald shafts for plain weave to avoid the friction between the threads, this will reduce the strain on the weaver.

7. The defective shed formation may be due to:
   i. Incorrect selection of heald wires such as length and gauge;
   ii. Improper connection of connecting cords;
   iii. Wrong drafting of the warp threads;
   iv. Damaged healds;
   v. Broken ends of warp;
   vi. Use of high reed count;
   vii. Uneven tension of the warp threads;
   viii. Improper fitting of back rest;
   ix. Improper fitting of the reed in to the grooves of the sley;
   x. Imbalance level of the shuttle rest board;
   xi. Undesirable distance of lease rods;
   xii. Uneven pressure through the paddle; and
   xiii. Improper selection of the shuttle

b) Picking: To insert the weft thread through the shed during weaving operation.

Precautions

1. Picking should be uniform.
2. Too early and too late picking should be avoided.
3. All connections of the picking cord should be well balanced
4. The picking cord should be even and strong
5. The picking handle should be comfortable.
6. Direct connection of picking cord to the picker should be avoided. In lieu of this the use of loop cord with picker is suggested.
7. For proper picking the loom width should be according to the width of the fabric to be woven.
8. The length of the reed should be equal to the distance between sley arms and the reed should be fitted parallel to the sley arms.
9. For even picking proper selection of shuttle is necessary.
10. The pirn should not be too tight or too loose.
11. The pirn dimensions (length and circumference) should be such that the pirn is properly fitted in to the shuttle.

12. Shuttle board (Shuttle race) should be smooth and even.

13. Shuttle holder should be properly fitted to the picker. It should not too narrow, too high or too thin.

14. The use of proper shuttle eyelets is necessary for getting desired pick supply.

15. The use of fur in the inner wall of shuttle is necessary for every fine and smooth weft thread.

16. The knots in weft thread should be as minimum as possible.

c) Beating–up
To bring the pick parallel to the fabric fell. To give even beat up force to the pick

**Precautions**

1. Uniform beating force should be applied.
2. The beating should be in right angle to the fabric. In this regard it is necessary that the distance of both side–hanging noses of the sley should be in equal distance from the cloth guide roller.
3. Trembling force should be avoided.
4. The beater should be held centrally during beating.
5. Far shed beating should be avoided.
6. Open shed beating should be avoided. In lieu of this cross pick beating is suggested.
7. The weaver should hold the sley cap from the center while giving beating force to the fabric.

d) Let–off Motion
To release the warp threads as per requirement of the weaver.

**Precautions**

1. Too much or too little release of the warp threads should be avoided.
2. The release of warp threads should be uniform.
3. The tension on warp threads should be uniform.
4. The let off motion device should be in both sides of the warp beam.
5. The arrangement should be such that the let off motion operates automatically.
6. The let off and take up motions should match with each other.
7. Leasing rods should function smoothly.
e) **Take-up motion**
To wind the woven fabric on the cloth beam
1. Winding of the woven fabric should not be too tight or too loose.
2. After weaving the winding of the fabric should be carried out at regular intervals.
3. Take up motion device should be easily approachable to the weaver.
4. If too tight fabric is to be woven, the use of tooth wheels for both take up motions and let off mechanisms necessary. Otherwise, for normal weaving the use of weight system is most appropriate.

**Use and Function of Temple**
To maintain a constant width of the fabric parallel to the warp threads.
1. Proper selection of temple is very essential.
2. Temple nose should not be blunt and they should not be too thick.
3. Rusted temple should not be used.
4. The temple should maintain the woven fabric width equal to the width of the warp threads present in the reed.
5. Temple should be fitted to appropriate distance.
6. Temple should maintain the width of the woven fabric after every change
7. Temple should be fitted at the center of the selvedge width.

**Checking the Loom for Errors**
The mistakes are:
1. A missed heald eye
2. A missed warp yarn.
3. Crossed drafted and dented threads
4. Too many yarns either in a heald eye or in a dent reed.
5. Missing dents of the reed.

**12. Selection of Shuttle**
a. Shuttle should be selected taking in to account the weave pattern, the count of warp and weft, loom make and reed width.
b. The use of too old shuttle should be avoided.
c. The use of shuttle made of fibrous wood should be avoided.
d. The use of blurred and bended nose shuttles should be avoided.
e. The tongue of the shuttle should tightly grip the pirn.

f. Shuttle eye should not project outside. It should be within the grip of the wood.

g. The center of gravity of the shuttle should be towards the shuttle eye. It can be checked by holding the shuttle nose across the grip of the two forefingers. So that it tilts towards the shuttle eye let.

7.2.3 Control of Fabric Quality
Controlling the quality of fabrics is important when overall profitability is taken into consideration. The two aspects of control of fabric quality in the loom shed are:

a) Meeting the design specification of the fabrics, and

b) Ensuring that the fabrics are free from defects that originate during weaving. Some of the specific fabric defects present in the fabric are listed in a tabular form (see 7.2.3.1).
### 7.2.3.1 Control of Common Fabric Faults

<table>
<thead>
<tr>
<th>Name and Figure of the fault</th>
<th>Stain/Daghi (M)</th>
<th>Thick Place</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Stain/Daghi (M)" /></td>
<td><img src="image2" alt="Thick Place" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Name and Figure of the fault</th>
<th>Missing End</th>
<th>Double End</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Missing End" /></td>
<td><img src="image4" alt="Double End" /></td>
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</tr>
</tbody>
</table>
Name and Figure of the fault

Missing Pick

Double Pick

Curly Selvedge

Jala
## Name and Figure of the fault

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Probable Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weft Float</strong></td>
<td>Oil, lubricant, rust or any other marks in the fabric.</td>
<td>• Negligence of the loom operator</td>
</tr>
<tr>
<td><strong>Miss reed</strong></td>
<td></td>
<td>• Poor material handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Poor cleaning and oiling practices</td>
</tr>
<tr>
<td><strong>Temple mark</strong></td>
<td>Thick strand of fibres having less twist and more diameters as compared to normal yarn.</td>
<td>• Careless piecing of ends</td>
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<tr>
<td></td>
<td></td>
<td>• Too long roving traverse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Waste gaiting in the yarn</td>
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<tr>
<td></td>
<td></td>
<td>• Cotton fly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rough and damaged top roller covering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• One teeth of gear train broken</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Drafting gears set too shallow</td>
</tr>
<tr>
<td><strong>Missing End</strong></td>
<td>Missing of one or more warp threads in the fabric</td>
<td>• Big knot present in warp ends</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Negligence of people working at sectional warping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Crossed drafting in healds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Crossed denting in reed/bent dent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improper leasing system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improper shed formation</td>
</tr>
<tr>
<td><strong>Double End</strong></td>
<td>Thick bar running parallel to the warp</td>
<td>• Stuck ends from sizing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Wrong drawing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Two ends in one heald eye</td>
</tr>
<tr>
<td><strong>Missing (Broken) Pick</strong></td>
<td>Missing of one or more weft threads in the fabric</td>
<td>• Cut in shuttle eye</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pirn not built properly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rough pirn surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improper fitting of pirn in shuttle</td>
</tr>
</tbody>
</table>
- Rough shuttle surface

**Double Pick:** Thick pick along the weft direction  
- Negligence of weaver  
- Improper pirn winding

**Zigzag/Curly/Folded Selvedge:** The selvedge that is not straight and exhibits a wavy appearance  
- Tension variation in the selvedge  
- Improper fitting of flanges in warp beam  
- Improper adjustment of heald eyes in the selvedge  
- Loosely fitted reed in the grooves

**Jala:** It is characterized by improper interlacement of warp with weft  
- Sticky sized cloth  
- Size patch  
- Cross ends from sizing or drawing in or tie in  
- Broken ends not attended in time  
- Fluff in warp sheet  
- Heald eye broken

**Weft Float:** Improper interlacement of warp and weft yarns over a certain area  
- Picking early or late  
- Slack ends in warp beam  
- Picker worn out  
- Bad harness cords

**Miss Reed:** Gap running parallel to the warp in the fabric continuously  
- Wrong colour yarn  
- Mixing threads with different dyeing property  
- Different count yarns mixed up

**Temple Marks:** Fine holes near the selvedges  
- Wrong temple used  
- Temple covers too near the temple rolls  
- Worn out pins in temple  
- Jerky revolving of temples  
- Loom beam jammed or jumping  
- Temples vibrating

**Shuttle smash:** Breakage of many ends when a shuttle is trapped in the shed  
- Wrong timing of shedding & Warp entanglement  
- Soft picking  
- Insufficient checking of shuttle in shuttle boxes  
- Unbalanced shuttle  
- Weft not released during weaving  
- Uneven shed opening & Narrow shed formation

### 7.2.3.2 List of Major Fabric Faults (Major Khadi Faults as per BIS)

1. One or more ends missing in the body of the material throughout its length, more than three ends missing at a place and running over 60cm, or prominently noticeable double and running throughout the piece.

2. Undressed snarls noticeable over a length exceeding 5 percent of the length of the piece.

3. Hole, cut or tear.

4. Reed marks prominently noticeable over a length exceeding 5 percent of the piece.

5. Defective or damaged selvedge noticeable over a length exceeding 5 percent of the length of the piece.


7. Weft crack or two more missing picks across the width of the fabric.
8. Warp or weft bar due to the difference in raw material, count, twist, luster, colour, shade or spacing of adjacent groups of yarns (starting mark).
9. More than two adjacent ends running parallel, broken or missing and extending beyond 10 cm.
10. Noticeable warp or weft float in the body of the fabric.
12. Prominently noticeable slub.
13. Noticeable oil or other stain in the fabric.
14. Gout due to foreign matter, usually lint or waste woven in to fabric.
15. Prominent selvedge defect.
16. Significant shading or listing in fabrics having a gradual change in tone or depth of shade of fabric (excluding selvedge or border running parallel to the selvedge).
17. Coloured flecks or dots.
18. Blurred or dark patch.
19. Patchy, streaky or uneven dyeing.
22. Skewing of more than three percent on weft.
23. Conspicuous broken pattern.
24. More than two threads missing either in warp or in weft way of the piece, extending over 25cm.
27. Any other defect which would affect the durability and/or serviceability of the piece.

<table>
<thead>
<tr>
<th>Type of Fabric</th>
<th>Major Faults to be Checked (Refer section 7.2.3.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed sheets, Cotton Khadi, Bleached</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 21</td>
</tr>
<tr>
<td>Bunting Cloth, Cotton Khadi, Dyed</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21</td>
</tr>
<tr>
<td>Pugre Cloth, Cotton Khadi, Bleached or Dyed</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21</td>
</tr>
<tr>
<td>Honey Comb and Huck–a–Back Towels, Cotton Khadi, Bleached</td>
<td>3, 6, 7, 14, 10, 13, 14, 25, 26, 27, 28,</td>
</tr>
<tr>
<td>Long Cloth, Cotton Khadi, Bleached</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 21</td>
</tr>
<tr>
<td>Dosuti, Cotton Khadi, Bleached or Dyed</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14,</td>
</tr>
</tbody>
</table>

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7.3 Process Control in Chemical Processing of Khadi

Chemical processing of khadi fabric is carried out in khadi institutions as well in private process houses recognized by KVIC. Chemical processing gives the major value addition to khadi fabric. However, it is one of the weakest links in khadi manufacture. The chemical processing of khadi yarn and fabric is done in most primitive way and therefore there is enormous scope for improvement. This would be possible only through technical inputs and major investments in equipments and training the staff.

Common faults observed

1. Long threads and oil stains in gray fabric

Cause: Broken yarn and accidental oil staining during weaving

Remedy

Spread the gray fabric on glass top table, which has been illuminated underneath. Inspect carefully for long threads and oil stains. The long threads are cut careful with the help of scissors taking care not to cut the base fabric. The oil stains are removed with the help of stain removers, which are available commercially. If the staining is heavy, their removal may be carried out during scouring operation incorporating stain remover in the scouring recipe.

2. Presence of Starch

In order to improve the efficiency of subsequent processes like scouring and bleaching, it is necessary to remove starch which is incorporated during sizing operation. This is done by the operation known as desizing. Desizing is carried out by using enzymes which does not damage the fabric.

2.1 Desizing Efficiency

2.1.1 Iodine Staining Test
It is tested by the presence of residual starch by staining with iodine solution. Intense blue colour indicates the presence of starch. Light brown colour indicates the complete removal of starch. For good desizing, when the drop of iodine is placed on desized fabric it should show light brown colour.

3. Scouring Efficiency

Scouring is carried out to remove the natural waxes and other impurities. It improves the water absorbency of fabric, which is very essential for good dyeing and printing.

**Water Absorbency Test**

Put a drop of water on the dry scoured fabric. If the drop of water is absorbed within three seconds indicating good scouring. Longer the time required for absorption of water drop, poorer is the scouring operation. Carry out the test at different places on the fabric to check the uniformity of the scouring operation.

4. Bleaching

Bleaching is carried out to remove the naturally colouring matters and improve the whiteness of khadi fabric. In majority of khadi institutions it is carried out by using bleaching powder. From eco friendliness point of view the use of bleaching powder or sodium hypochlorite is not suitable. The recommended bleaching agent is hydrogen peroxide.

**Bleaching Faults**

I) **Inadequate Whiteness:** It could be due to  
   a) Inadequate concentration of bleaching agent.  
   b) Inadequate bleaching time.  
   c) Pre–mature decomposition of bleaching agent.  
   d) Improper bleaching conditions.  

Take precautions to avoid above conditions.

II) **Non–uniform Whiteness:** This could be due to  
   a) Inadequate movement of fabric in bleach bath  
   b) Part of the fabric not in contact with bleaching solution  
   c) Non–uniform desizing and scouring operation  

Take appropriate precautions to avoid these faults.

III) **Bleaching Efficiency:** This can be tested by percent reflectance or whiteness index measurement on spectrophotometer. The percent reflectance or whiteness index value should be 70 and above.

IV) **Tinopal Treatment and Bluing:** In order to further improve the whiteness bleached fabric is treated with tinopal and neel. The incorporation of neel is one of the major cause of
variation in whiteness. If possible the use of neel should be avoided. If necessary its concentration should never exceed 1 g/l. Tinopal and neel should be dissolved and filtered properly through fine fabric before adding to the bulk of water used for treatment. The treatment should be preferably be carried out on jigger for uniform application.

5. Dyeing

It is the major area of concern. Some of the common problems faced are

I) Non–uniform Dyeing: It may due to
a) Inadequate movement of yarn or fabric in dye bath
b) Inadequate desizing, scouring and bleaching operations
c) Maintaining improper dyeing conditions
d) Improper washing during scouring and bleaching
e) Excessive scouring and bleaching resulting in fibre degradation
f) Any other

It is necessary to establish the cause of dyeing fault through history of fabric and its proper analysis.

II) Poor Fastness: It may be due to
a) Improper selection of dye class e.g. Direct dyes are known to give poor fastness properties.
b) Dyeing not carried out for sufficient length of time.
c) Improper maintenance of dyeing conditions.
d) Inadequate or excessive hydrosulphite and caustic soda concentration during dyeing with vat dyes
e) Inadequate soaping after dyeing in case of reactive dyes

It is necessary to follow the dye manufacturers recommendation to maintain dyeing conditions.

III) Lot to lot Shade Variations: It is mainly due to not maintaining consistent dyeing conditions. It is also due to variation in dye supply from lot to lot.

6. Printing

Very large number of printing faults occur which must be analyzed on case–to–case basis. Some of the common printing faults are screen chocking, design misfit, shade variation, colour specks at non–printed portions, inadequate fastness properties of prints, harsh feel etc.
Pigment printing by block and screen is most common in Khadi sector. However, from health and environment point of view it is necessary to replace emulsion thickener using kerosene oil or mineral turpentine oil by water based synthetic thickeners. The water based synthetic thickeners are now readily available in the market.

7. Finishing

The only finishing treatment to which khadi fabric is subjected is starching and calendering. Recent survey of khadi institutions in Vidarbha region indicated that there is absolutely no standardization of finishing operations. Finishing of khadi fabric is the most important operation for value addition. It is suggested to introduce new finishes particularly stiff and soft finishes and proper calendering operations.

All the faults observed during chemical processing are mainly due to non-standardization of processes due to lack of technical knowledge. It is necessary to impart technical knowledge through exhaustive training programmes. There is also urgent need to modernize the chemical processing facilities by installation of certain minimum equipments. This would be possible only when adequate funds are provided for up gradation of technical facilities and for conducting technical training programmes.

(Note: The list of Charkha and loom manufacturers is given in Appendix IX.)
CHAPTER 8
Training

8.1 Need for Training

The world is changing very fast and with it the life style of people. The wide spread of media and easy communication facility is changing the perception of quality even at the village level. The aspiration of people is constantly changing and they look for quality goods at affordable price. This necessitates the manufacturers of consumer goods to constantly innovate and bring goods as per the need of the customer. Innovation being the driving force everybody associated with khadi needs to be aware of the latest in his/her chosen area of activity, be it production, quality evaluation, marketing and finance.

8.2 Objectives

Three objectives of training are:
a) Imparting knowledge and latest information;
b) Changing attitudes; and
c) Improving working skills.

a) **Imparting knowledge and latest Information:** Information can be imparted to an individual or to a group by verbal instructions; or it may be in the form of printed documents; or by training machines. The employee should be receptive as in this method new ideas are substituted with the existing approaches of the employee.

b) **Changing Attitudes:** Attitude changing by training starts with the realization that certain attitude is to be changed in order to remain competitive.

c) **Improving working skills:** Training should focus on working skill enhancement of workers.

8.3 Modes of Training

The various modes of training could be:
a) Attending courses in technical institutes, universities or other educational institutions;
b) Attending seminars organized by research associations and educational institutes and other organisations;
c) On the job training;
d) In house training; and
e) Self–learning from latest books, reports and magazines.
8.4 Who should be Trained

As stated earlier all personnel involved with khadi would need training. Since in khadi many people are involved and so are their responsibilities, these people can be classified into different groups such as policy makers, management group, supervisory group (administration), supervisory group (technical), operators etc.

a) **Policy Makers:** The people belonging to this group are – Dy. CEOs and directors (khadi, S &T),

b) **Management Group:** The people belonging to this group are board of trustees, executive committee, secretary, asst secretary/general managers etc.

c) **Supervisory Group (Administration):** This group consists of accountant, manager administration, manager sales, store in charge, sales girls etc.

d) **Supervisory Group (Technical):** This group consists of development officers, technical supervisors, NMC mistry or mechanic etc.

e) **Operators:** This group consists of NMC operators, weavers, workers involved in processing, artisans etc.

8.5 Broad Areas of Training

The training area should depend upon the role and responsibilities a person play in an organization.

8.6 Training Agencies

The training can be done in the following two ways:

a) In–house training; and

b) Training by external agencies.

<table>
<thead>
<tr>
<th>Group type</th>
<th>To be trained in the area of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy makers</td>
<td>Consumer behavior and market trend in rural and urban sectors, implementation problems, textile policy, raw material sourcing, change in socio–economic conditions etc.</td>
</tr>
<tr>
<td>Management</td>
<td>Enterprise management, technical developments, finance, human resource development and management, raw material resourcing, role and responsibilities, maintenance and monitoring of infrastructure, general quality issues.</td>
</tr>
<tr>
<td>Supervisory (general management)</td>
<td>Book keeping, working on computer.</td>
</tr>
<tr>
<td>Supervisory (technical)</td>
<td>Technical developments, quality assurance and monitoring,</td>
</tr>
</tbody>
</table>
S | Operators | Maintenance of respective equipment, safe working procedure, quality and style of working.
---|---|---

**a) In–house Training:** The in–house training can be given to the supervisors and operators. Experienced and knowledgeable people available in–house can impart training to others. Expert people from nearby production centers can be pooled and used for training new recruits.

**b) Training by External Agencies:** External agencies such as research associations (ATIRA, BTRA, SITRA, NITRA, CIRCOT), educational institutes (IIT and other textile colleges), Textiles Committee laboratories, Khadi Vidyalays / Training centers etc. The list of training institutes under KVIC and other central government agencies are listed in Appendix X.
CHAPTER 9

Marking, Coding and Packing of Samples

9.1 Marking and Coding

It is important to have provisions for identifying materials at various stages from raw materials through finished product – so that errors can be traced back for corrective/preventive actions or product recall is facilitated if necessary. Therefore, by proper marking on every textiles it can be traced easily whenever necessary. So for marking purpose suitable codes shall be used. The coding process is easy, takes less time and less space on the product. Each organization may use codes of their own. Sometimes the finished product doesn’t satisfy the customer needs. The customer complains about the quality of the product. At that time it is necessary that the product is identified from its code. So marking and coding plays an important role for maintaining the quality of the product.

In the yarn samples of different packages there should be proper marking of the count of the yarn. Also the name of the spinner and the date of manufacturing should be there so that it is traced easily. In the finished fabric the following parameters should be marked for easy identification.

a) Composition of the material (Such as Polyester/Cotton 67:33);

b) Length and width of fabrics

c) Code of the sample;

d) Name of the manufacturing unit; and

e) Year of manufacture.

The khadi fabric can be marked by using the format given below:
It is very important that the product is not damaged during transportation; otherwise, a good quality product can result in a defective product. Therefore, all the products should be packed properly so that they reach at destination without damage. The packaging material shall be sound, clean and in dry condition. If the material is to be transported a long distance where the time taken in transit is considerable and the climatic conditions are variable; the material used for packing should protect the product from the sun and the rain. If during transportation the product is to be frequently unloaded and reloaded, the packing material should be of sufficient strength to withstand the load.

### 9.2.1 Packing of Yarn (Hanks) in Bales

The hanks shall be combined together and made up in to bundles of definite weight. Each bundle shall be tied at a number of places with cotton or synthetic or jute twine in such a way that the distance between the tie–bands is 20–25 cm. Each bundle is then wrapped in a
low-density polyethylene film of minimum 40-micron thickness, cover with jute fabric and tie properly.

9.2.2 Packing of Processed Cloth in Bales

Before packing in to the bales, each piece shall be plaited, folded or wrapped on cardboard or strawboard of suitable sizes and thickness. Each piece or bundle of pieces shall be wrapped in cellophane or polyethylene film, which will not stain the fabric.

Gross Mass

Unless otherwise agreed, the gross mass of the package shall not exceed as under:

<table>
<thead>
<tr>
<th>Bale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn:</td>
<td>100 kg</td>
</tr>
<tr>
<td>Fabric:</td>
<td>400 kg for bales provided with cross hoops and 200 kg otherwise</td>
</tr>
</tbody>
</table>

Marking on the Packages

Unless otherwise agreed, each package shall be marked with the following information:

a) Name of the material;
b) Quality details (in case of cloth);
c) Count (in case of yarn);
d) Gross weight;
e) Net weight;
f) Manufacture’s name, initials or trade-mark; and
g) Any other information required by the buyer or by the law in force.

All the marking shall be stenciled or printed stickers may be used. Indelible ink should be used for the purpose of marking. Writing with hand should be avoided. The letters and figures shall be not less than 4 cm in height.
## Appendix I

### Drafts to be used in charkha for different yarn counts

<table>
<thead>
<tr>
<th>Yarn count metric</th>
<th>Draft in charkha</th>
<th>Hank of roving</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>10</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>0.4</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>0.6</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>0.8</td>
</tr>
<tr>
<td>10</td>
<td>19</td>
<td>0.5</td>
</tr>
<tr>
<td>12</td>
<td>19</td>
<td>0.6</td>
</tr>
<tr>
<td>14</td>
<td>19</td>
<td>0.7</td>
</tr>
<tr>
<td>16</td>
<td>19</td>
<td>0.8</td>
</tr>
<tr>
<td>18</td>
<td>19</td>
<td>0.9</td>
</tr>
<tr>
<td>20</td>
<td>19</td>
<td>1.1</td>
</tr>
<tr>
<td>22</td>
<td>19</td>
<td>1.2</td>
</tr>
<tr>
<td>24</td>
<td>19</td>
<td>1.3</td>
</tr>
<tr>
<td>26</td>
<td>19</td>
<td>1.4</td>
</tr>
<tr>
<td>28</td>
<td>19</td>
<td>1.5</td>
</tr>
<tr>
<td>30</td>
<td>19</td>
<td>1.6</td>
</tr>
<tr>
<td>34</td>
<td>19</td>
<td>1.8</td>
</tr>
<tr>
<td>38</td>
<td>19</td>
<td>2.0</td>
</tr>
<tr>
<td>42</td>
<td>19</td>
<td>2.2</td>
</tr>
<tr>
<td>46</td>
<td>19</td>
<td>2.4</td>
</tr>
<tr>
<td>50</td>
<td>19</td>
<td>2.6</td>
</tr>
<tr>
<td>54</td>
<td>19</td>
<td>2.8</td>
</tr>
<tr>
<td>58</td>
<td>19</td>
<td>3.0</td>
</tr>
<tr>
<td>55</td>
<td>17</td>
<td>3.2</td>
</tr>
<tr>
<td>60</td>
<td>17</td>
<td>3.5</td>
</tr>
<tr>
<td>65</td>
<td>17</td>
<td>3.8</td>
</tr>
<tr>
<td>70</td>
<td>17</td>
<td>4.1</td>
</tr>
<tr>
<td>75</td>
<td>17</td>
<td>4.4</td>
</tr>
<tr>
<td>80</td>
<td>17</td>
<td>4.7</td>
</tr>
<tr>
<td>85</td>
<td>17</td>
<td>5.0</td>
</tr>
<tr>
<td>90</td>
<td>17</td>
<td>5.3</td>
</tr>
<tr>
<td>95</td>
<td>17</td>
<td>5.6</td>
</tr>
<tr>
<td>100</td>
<td>17</td>
<td>5.9</td>
</tr>
</tbody>
</table>

**Muslin** *(Superfine)*

- 100, 125, 150…
- Depends on charkha
## Appendix II

### Ends per 100cm for Fabric of Medium Construction

*(Taken from Shri Dwarkanath Lele’s Book on page 27)*

<table>
<thead>
<tr>
<th>Yarn Count (Metric)</th>
<th>Square Root of Metric Count</th>
<th>Ends per 100cm for Fabric of Medium Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>3.16</td>
<td>1000/1000</td>
</tr>
<tr>
<td>12.5</td>
<td>3.53</td>
<td>1118/1100</td>
</tr>
<tr>
<td>15</td>
<td>3.37</td>
<td>1224/1200</td>
</tr>
<tr>
<td>17.5</td>
<td>4.18</td>
<td>1322/1300</td>
</tr>
<tr>
<td>20</td>
<td>4.47</td>
<td>1414/1400</td>
</tr>
<tr>
<td>22.5</td>
<td>4.74</td>
<td>1500/1500</td>
</tr>
<tr>
<td>25</td>
<td>5.00</td>
<td>1581/1600</td>
</tr>
<tr>
<td>27.5</td>
<td>5.24</td>
<td>1658/1650</td>
</tr>
<tr>
<td>30</td>
<td>5.47</td>
<td>1731/1750</td>
</tr>
<tr>
<td>32.5</td>
<td>5.70</td>
<td>1800/1800</td>
</tr>
<tr>
<td>35</td>
<td>5.91</td>
<td>1870/1850</td>
</tr>
<tr>
<td>40</td>
<td>6.32</td>
<td>2000/2000</td>
</tr>
<tr>
<td>45</td>
<td>6.70</td>
<td>2121/2100</td>
</tr>
<tr>
<td>50</td>
<td>7.07</td>
<td>2236/2250</td>
</tr>
<tr>
<td>55</td>
<td>7.41</td>
<td>2349/2350</td>
</tr>
<tr>
<td>60</td>
<td>7.71</td>
<td>2449/2450</td>
</tr>
<tr>
<td>65</td>
<td>8.06</td>
<td>2549/2550</td>
</tr>
<tr>
<td>70</td>
<td>8.36</td>
<td>2647/2650</td>
</tr>
<tr>
<td>75</td>
<td>8.66</td>
<td>2738/2750</td>
</tr>
<tr>
<td>80</td>
<td>8.94</td>
<td>2828/2850</td>
</tr>
<tr>
<td>85</td>
<td>9.22</td>
<td>2915/2900</td>
</tr>
<tr>
<td>90</td>
<td>9.48</td>
<td>3000/3000</td>
</tr>
<tr>
<td>95</td>
<td>9.74</td>
<td>3082/3100</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>3162/3150</td>
</tr>
<tr>
<td>110</td>
<td>10.49</td>
<td>3316/3300</td>
</tr>
<tr>
<td>120</td>
<td>10.95</td>
<td>3464/3450</td>
</tr>
<tr>
<td>130</td>
<td>11.40</td>
<td>3605/3600</td>
</tr>
<tr>
<td>140</td>
<td>11.83</td>
<td>3741/3750</td>
</tr>
<tr>
<td>150</td>
<td>12.25</td>
<td>3872/3850</td>
</tr>
<tr>
<td>160</td>
<td>12.64</td>
<td>4000/4000</td>
</tr>
<tr>
<td>170</td>
<td>13.04</td>
<td>4123/4100</td>
</tr>
<tr>
<td>180</td>
<td>13.41</td>
<td>4242/4250</td>
</tr>
<tr>
<td>190</td>
<td>13.78</td>
<td>4358/4350</td>
</tr>
<tr>
<td>200</td>
<td>14.14</td>
<td>4472/4450</td>
</tr>
</tbody>
</table>
### Appendix III

#### A.1 Format of Test Report

**A.1.1 Fibre Length**


<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Mean Length (mm)</th>
<th>Effective Length (mm)</th>
<th>Percentage Short Fibre</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No of Tests performed: ______  
Date_________________

R.H. (%) ______________  
Temperature (°C)_______

Operator_________________

Comments__________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Checked and Verified by_______________  
Designation_________________________

#### A.1.2 Bundle Strength

Test Standard followed – IS 3675: 1966

No of Tests performed: ______  
Date_____________________
Gauge Length:______________  R.H. (%) ______________
Temperature (°C)_______

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Breaking Load (Kg)</th>
<th>Bundle weight (mg)</th>
<th>Tenacity (g/tex)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Minimum    |                    |                    |                 |         |
| Maximum    |                    |                    |                 |         |
| Average    |                    |                    |                 |         |
| CV%        |                    |                    |                 |         |

Operator_________________
Comments__________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Checked and Verified by_________________
Designation_________________________

A.1.3 Fibre Fineness (micronaire value)

Test Standard followed – IS 3674: 1966

No of Tests performed: ______  Date________
R.H. (%) ______________
Temperature (°C)_______

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Micronaire Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### A.1.4 Moisture Content (Oven Dry Method)

Test Standard followed – IS 199: 1988

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Original mass ‘a’ (g)</th>
<th>Oven Dry mass ‘b’ (g)</th>
<th>Moisture Content (%) [\frac{(a-b)}{a \times 100}]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No of Tests performed: ______

R.H. (%) _____________

Temperature (°C) ______

Date _________________

Operator_________________

Comments__________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

Checked and Verified by_______________

Designation_________________________

Attach the fibre sample tested
<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Sample Weight (g)</th>
<th>Lint Content (g)</th>
<th>Trash Content (g)</th>
<th>Invisible waste (g)</th>
<th>Trash %</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A.1.5 Trash Content
Test Standard followed –IS 4871: 1968

No of Tests performed: ______
Material: Raw Cotton/Lap/Sliver/Waste
R.H. (%) _____________
Temperature (°C)________

Checked and Verified by_______________
Designation_________________________

Operator_______________________

Comments__________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Attach the fibre sample tested
A.1.6 Fibre Maturity (Sodium Hydroxide swelling method)
Test Standard followed – IS 236: 1968

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>% of Normal Fibres (N)</th>
<th>% of Dead Fibres (D)</th>
<th>Maturity Ratio (M)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Attach the fibre sample tested

Material: Sliver/Roving/Yarn

Date
R.H. (%) _____________
Temperature (°C)_________

Operator_________________

Comments__________________________________________________________________
___________________________________________________________________________
__________________________________________________________________

Checked and Verified by_________________
Designation_______________________

Comments__________________________________________________________________
___________________________________________________________________________
__________________________________________________________________
### A.1.7 Yarn Linear Density

**Test Standard followed – IS 1315: 1977**

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Lea weight (g)</th>
<th>Yarn Count (Nm) ([109.5/\text{Lea wt}])</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minimum

Maximum

Average

CV%

Operator_________________

Comments__________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Checked and Verified by_________________

Designation_________________________

### A.1.8 Twist

**Test Standard followed – IS 832: 1985**

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Lea weight (g)</th>
<th>Yarn Count (Nm) ([109.5/\text{Lea wt}])</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minimum

Maximum

Average

CV%

Operator_________________

Comments__________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Checked and Verified by_________________

Designation_________________________
### A.1.9 Lea Strength (CSP)

<table>
<thead>
<tr>
<th>No of Tests performed:</th>
<th>Date</th>
<th>Type of Yarn: Single/Double</th>
<th>R.H. (%)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
</table>

#### Test Standard followed – IS 1671: 1977

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Lea Weight (g)</th>
<th>Yarn Count (Nm)</th>
<th>Lea Strength (Kg)</th>
<th>CSP (Nm \times Kg)</th>
<th>Remarks</th>
</tr>
</thead>
</table>

---

**Operator_________________**

Comments__________________________________________________________________

___________________________________________________________________________

__________

Checked and Verified by_________________

Designation_________________________

*Attach the yarn sample tested*
### A.1.10 Yarn Appearance Grade

**Test Standard followed – IS 13260:1993**

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Appearance grade</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Attach the yarn sample tested**

- No of Tests performed: ______
- Date: ________________
- R.H. (%): ____________
- Temperature (°C): ______

Average Appearance Grade

Operator_________________

Comments__________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

Checked and Verified by______________
Designation_________________________
### A.1.11 Yarn Unevenness (U%)

**Attach the yarn sample tested**

- **No of Tests performed:** ______
- **Date:** ______________
- **R.H. (%)** ____________
- **Temperature (°C)** ______

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Unevenness (U%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Average**

### Comments

- Operator_________________
- Checked and Verified by_______________
- Designation_______________________

Comments__________________________________________________________________

___________________________________________________________________________

__________________________________________________________________
### A.1.12 Yarn Imperfections

No of Tests performed: ______  
R.H. (%) __________
Temperature (°C)_______

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Thick Places/Km (−50%)</th>
<th>Thin Places/Km (+50%)</th>
<th>Neps/Km (+200%)</th>
<th>Total Imperfections/Km</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Operator_________________

Comments__________________________________________________________________  
_________________________________________________________________________
_________________________________________________________________________

Checked and Verified by_______________  
Designation_________________________

### A.1.13 Thread Density


No of Tests performed: ______

Date_________________
### A.1.14 Weight per Square Meter (GSM)

**Test Standard followed – IS 1964: 1970**

No of Tests performed: ____

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Gram per square meter (GSM)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Checked and Verified by**

**Designation**

*Attach the fabric sample*

---

R.H. (%) ___________

Temperature (°C)_______

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Ends/inch (Ends/cm)</th>
<th>Picks/inch (Picks/cm)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Minimum

Maximum

Average

Operator__________________

Comments__________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

---

---

---

---
**A.1.15 Crease Recovery Angle**

**Test Standard followed – IS 4681: 1981**

No of Tests performed: ______

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Crease Recovery Angle</th>
<th>Warp and Weft Total</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warp way</td>
<td>Weft way</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Operator_______________

Checked and Verified by_______________

Designation_______________

Attach the fabric sample
A.1.16 Fabric Stiffness
Test Standard followed – IS 6490: 1971

No of Tests performed: ______

Date_________________
R.H. (%) ______________
Temperature (°C)_______

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Bending Length</th>
<th>Flexural Rigidity</th>
<th>Overall Flexural Rigidity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warp way</td>
<td>Weft way</td>
<td>Warp way</td>
<td>Weft way</td>
</tr>
</tbody>
</table>

Minimum
Maximum
Average

Operator_______________

Comments__________________________________________________________

Checked and Verified by____________________
Designation__________________
Appendix IV  
List of laboratories with addresses for testing of textiles.

<table>
<thead>
<tr>
<th>Research Institutes</th>
<th>Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmedabad Textile Industries Research Association</td>
<td>PO: Ambawadi Vistar, Ahmedabad – 380015</td>
<td>E-mail: <a href="mailto:atira@ad1.vsnl.net.in">atira@ad1.vsnl.net.in</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Website: <a href="http://www.allindia.com/atira">www.allindia.com/atira</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ph: 079 – 26304671, 26302672, 26308995, 26301969</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: 079 – 26302874</td>
</tr>
<tr>
<td>Bombay Textile Research Association</td>
<td>LalBahadur Shastri Marg, Ghatkopar (West) Mumbai – 400086</td>
<td>E-mail: <a href="mailto:btra@vsnl.com">btra@vsnl.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Website: <a href="http://www.btra.org">www.btra.org</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ph: 022 – 25003651,25002652, 25002117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: 022 – 25000459</td>
</tr>
<tr>
<td>Northern India Textile Research Association</td>
<td>Sector 23, Rajnagar, Ghaziabad –201002 (UP)</td>
<td>E-mail: <a href="mailto:nitra@nde.vsnl.net.in">nitra@nde.vsnl.net.in</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Website: <a href="http://www.nitratextile.org">www.nitratextile.org</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ph: 0575 – 2783638, 2783586</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: 0575 – 2783596</td>
</tr>
<tr>
<td>The South India Textile Research Association</td>
<td>P.B No.3205, Coimbatore Aerodrome Road, PO: Coimbatore – 641014</td>
<td>E-mail: <a href="mailto:sitra@vsnl.com">sitra@vsnl.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Website: <a href="http://www.sitraindia.org">www.sitraindia.org</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ph: 0422 – 2574367 – 69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: – 0422 – 2571896</td>
</tr>
<tr>
<td>Synthetic and Art Silk Mills Research Association</td>
<td>Sasmira Marg, Worli, Mumbai – 400025</td>
<td>E-mail: <a href="mailto:sasmira@vsnl.com">sasmira@vsnl.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Website: <a href="http://www.sasmira.org">www.sasmira.org</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ph: 022 – 24935351 – 52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fax: 022 – 24930225</td>
</tr>
<tr>
<td>Indian Jute Research Association</td>
<td>17 – Taratola Road, Kolkatta –700053</td>
<td>E-mail: <a href="mailto:ijira@vsnl.com">ijira@vsnl.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Website: <a href="http://www.ijira.org">www.ijira.org</a></td>
</tr>
<tr>
<td>International Wool Secretariat</td>
<td>Hoechst House, Nariman Point, Mumbai – 400021</td>
<td></td>
</tr>
</tbody>
</table>

**Other Institutes**

| Anna University | Alagappa College of Technology |
| Department of Textile Technology | Chennai – 600025 |
| Ph: 044 – 2350397 | E-mail: jvrao@annauniv.edu |

**Indian Institute of Technology**

| Department of Textile Technology | Hauz Khas, New Delhi – 110016 |
| Ph: 011 – 26862037 | |
| **Technological Institute of Textile & Sciences** | Birla Colony, Bhiwani – 125021 |
| | Ph: 01664 – 2243728, 2244994 |
| Veermata Jijabai Technological Institute | Textile Department |
| | Matunga, Mumbai – 400019 |
| | Ph: 022 – 4152874 |
| Govt. S. K. S. J. Technological Institute | K.R. Circle, Bangalore – 560001 |
| P. S. G. College of Technology | Textile Technology Department, Peelamedu |
| | Coimbatore – 641004 |
| | Ph: 0422 – 2572069 / 2573833 |
| | E-mail: psgct@vsnl.com |
| Textiles Committee | Crystall 2nd & 3rd Floor, 79, Dr. Annie Besant Road, Worli, MUMBAI – 400 018 |
| | FKCCI, WTC Building, 1st Floor, Kempe Gowda Road, BANGALORE – 560 009 (Karnataka) |
| | Tel.: 91-22-2493 5349/2490 4069, Fax: 91-22-2496 4521, E-mail: secy@giiasbm01.vsnl.net.in |
| | 117Q/52, Sharada Nagar (Kakadeo), Near Syndicate Bank, KANPUR – 208 025 (U.P) |
| | KANPUR – 670 001 (Kerala) |
| | Tel.: 91-512–258 2458, TeleFax: 91–512–258 2458, E-mail: tcanpanpur@vsnl.net |
| | Platinum Centre, 2nd Floor, Bank Road, KANNUR – 670 001 (Kerala) |
| | Tel.: 91-497–270 6390, TeleFax: 91–497–270 6390, E-mail: cnn_tccan@sancharnet.in |
| | “Ankur” Opp. Dinbal Tower, Mirzapur Road, Lal Darwaza, AHMEDABAD – 380 001 (Gujarat) |
| | AHMEDABAD – 380 001 (Gujarat) |
| | Tel.: 91-79–550 7612, Fax: 91–79-562 0007, E-mail: tcabd@satyam.net.in |
| | Row House No. 3, 6-3-247 Maheswari Tower, Banjara Hills, Road No.1, HYDERABAD – 500 034 (A.P) |
| | HYDERABAD – 500 034 (A.P) |
| | Tel.: 91-40–2332 7153, TeleFax: 91–40–2332 7153, E-mail: tchyd@vsnl.net |
| | C/o A.P. Cotton Association Building, Laxmipuram Main Road, GUNTUR – 522 007 (A.P) |
| | GUNTUR – 522 007 (A.P) |
| | Tel.: 91-863–221 8951, Fax: 91–863-235 9659, E-mail: tcguntur@sify.com |
| | C-1, F-Type, Indira Complex, Vikas Tower, Navlakha, INDORE – 452 001 (M.P) |
| | INDORE – 452 001 (M.P) |
| | Tel.: 91-731–240 1243, E-mail: tciindore@vsnl.net |
| | Quality Control Office Bldg., 2nd Floor, Industrial Estate, Bamunimaidan, GUWAHATI – 781 021 (Assam) |
| | GUWAHATI – 781 021 (Assam) |

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<table>
<thead>
<tr>
<th>Location</th>
<th>Address</th>
<th>Phone</th>
<th>Fax</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>K V R Complex, 2nd Floor,</td>
<td>K V R Complex, 2nd Floor, 21 – J, 80 Feet Road, KARUR – 639 002 (T.N)</td>
<td>Tel.: 91-4324–23 8610</td>
<td>Telefax: 91–4324–27 4871</td>
<td>E-mail: <a href="mailto:kru_tkarur@sancharnet.in">kru_tkarur@sancharnet.in</a></td>
</tr>
<tr>
<td></td>
<td>48B Tagore Nagar, Civil Lines, LUDHIANA – 141 001 (Punjab)</td>
<td>Tel.: 91-161–247 9635</td>
<td>Telefax: 91–161-247 4906</td>
<td>E-mail: <a href="mailto:tludhiana@satyam.net.in">tludhiana@satyam.net.in</a></td>
</tr>
<tr>
<td></td>
<td>18A, Keelamathur Pallivasal Street, Kamaraj Road, MADURAI – 625 009 (T.N)</td>
<td>Tel.: 91-452–233 5023</td>
<td>Telefax: 91–452-232 3303</td>
<td>E-mail: <a href="mailto:tgmadurai@satyam.net.in">tgmadurai@satyam.net.in</a></td>
</tr>
<tr>
<td></td>
<td>NEW DELHI - 110 065</td>
<td>Tel.: 91–11-2648 3476</td>
<td>Telefax: 91–11-2648 3476</td>
<td>E-mail: <a href="mailto:tcedek@vsnl.net.in">tcedek@vsnl.net.in</a></td>
</tr>
<tr>
<td></td>
<td>1st Floor, “Kalinga Nilayam” Gugai, SALEM – 636 006 (T.N)</td>
<td>Tel.: 91-427-246 7740</td>
<td>E-mail: <a href="mailto:tcsalem@sanchanrnet.in">tcsalem@sanchanrnet.in</a></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Textiles Committee, Raj Baugh, Opp. Radio Colony, Srinagar – 190 008.</td>
<td></td>
<td></td>
<td>E-mail: <a href="mailto:tcsolapur@sancharnet.in">tcsolapur@sancharnet.in</a></td>
</tr>
<tr>
<td></td>
<td>384 B.S. Sundaram Road, D.L.M. Gin &amp; Pressing Factory, TIRUPUR – 641 601. (T.N)</td>
<td>Tel.: 91-421–220 1402</td>
<td>Telefax: 91–421-220 2500</td>
<td>E-mail: <a href="mailto:tctirupur@eth.net">tctirupur@eth.net</a></td>
</tr>
<tr>
<td></td>
<td>Tel.: 91-361-265 3020</td>
<td>Email: <a href="mailto:tcguwahati@sify.com">tcguwahati@sify.com</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel.: 91-230–242 0838</td>
<td>Email: <a href="mailto:tcichalkaranji@ip.eth.net">tcichalkaranji@ip.eth.net</a></td>
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</tr>
</tbody>
</table>
## Appendix V

### Definition of different yarn count measuring systems

#### A. Unit of mass and length in direct counting system

<table>
<thead>
<tr>
<th>System</th>
<th>Unit of mass</th>
<th>Unit of length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tex</td>
<td>Gram</td>
<td>Kilometer</td>
</tr>
<tr>
<td>Denier</td>
<td>Gram</td>
<td>9000 meters</td>
</tr>
<tr>
<td>Linen (dry spun)</td>
<td>Pound</td>
<td>14400 yards (Spindle)</td>
</tr>
<tr>
<td>Hemp</td>
<td>Pound</td>
<td>14400 yards (Spindle)</td>
</tr>
<tr>
<td>Jute</td>
<td>Pound</td>
<td>14400 yards (Spindle)</td>
</tr>
<tr>
<td>Silk</td>
<td>Dram</td>
<td>1000 yards</td>
</tr>
<tr>
<td>Woolen (Aberdeen)</td>
<td>Pound</td>
<td>14400 yards (Spindle)</td>
</tr>
<tr>
<td>Woolen (American grain)</td>
<td>Grain</td>
<td>20 yards</td>
</tr>
</tbody>
</table>

#### B. Unit of mass and length in indirect counting system

<table>
<thead>
<tr>
<th>System</th>
<th>Unit of mass</th>
<th>Unit of length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos (American)</td>
<td>Pound</td>
<td>100 yards (cut)</td>
</tr>
<tr>
<td>Asbestos (British)</td>
<td>Pound</td>
<td>50 Yards</td>
</tr>
<tr>
<td>Cotton bump yarn</td>
<td>Ounce</td>
<td>1 yard</td>
</tr>
<tr>
<td>Cotton (British)</td>
<td>Pound</td>
<td>840 yards (hank)</td>
</tr>
<tr>
<td>Cotton (Continental)</td>
<td>0.5 kilogram</td>
<td>1000 meters</td>
</tr>
<tr>
<td>Glass (USA &amp; UK)</td>
<td>Pound</td>
<td>100 yards</td>
</tr>
<tr>
<td>Linen (Wet–spin)</td>
<td>Pound</td>
<td>300 yards (lea)</td>
</tr>
<tr>
<td>Metric</td>
<td>Kilogram</td>
<td>Kilometer</td>
</tr>
<tr>
<td>Spun silk</td>
<td>Pound</td>
<td>840 yards</td>
</tr>
<tr>
<td>Woolen (Alloa)</td>
<td>24 pounds</td>
<td>11520 yards (spindle)</td>
</tr>
<tr>
<td>Woolen (American cut)</td>
<td>Pound</td>
<td>300 yard (cut)</td>
</tr>
<tr>
<td>Woolen (American run)</td>
<td>Ounce</td>
<td>100 yards</td>
</tr>
<tr>
<td>Woolen (Dewsbury)</td>
<td>Ounce</td>
<td>1 yard</td>
</tr>
<tr>
<td>Woolen (Galashiels)</td>
<td>24 ounce</td>
<td>300 yards (cut)</td>
</tr>
<tr>
<td>Woolen (Hawick)</td>
<td>26 ounce</td>
<td>300 yards (cut)</td>
</tr>
<tr>
<td>Woolen (west of England)</td>
<td>Pound</td>
<td>320 yards (snap)</td>
</tr>
<tr>
<td>Woolen (Yorkshire)</td>
<td>Pound</td>
<td>256 yards (skein)</td>
</tr>
<tr>
<td>Woolen (Yorkshire)</td>
<td>Dram</td>
<td>1 yard</td>
</tr>
<tr>
<td>Worsted</td>
<td>Pound</td>
<td>560 yards (hank)</td>
</tr>
</tbody>
</table>
Appendix VI
Guidelines for checking of charkha

<table>
<thead>
<tr>
<th>Section</th>
<th>Component</th>
<th>Guidelines</th>
</tr>
</thead>
</table>
| I.      | Shafts      | 1. Should have no play.  
2. Should run freely. |
| II.     | Bearings    | 1. Properly housed without play or noise and properly greased.               |
| III.    | Pulleys     | 1. Not broken or damaged.  
2. Properly fitted on shafts.  
3. Running freely on axles. |
| IV.     | Gear Wheels | 1. Should not be broken or damaged.  
2. Number of teeth should be as per specifications.  
3. Should have no air holes on teeth & vulnerable area.  
4. Should have enough clearance between gear wheels.  
5. Screws should be properly tightened.  
6. The central bore should correctly fit to the shaft. |
| V.      | Spindles    | 1. Should run smoothly without vibration.  
2. Should be exactly in the center of rings.  
3. Lappet (Pocker tube gutka) center, spindle center and ring center are on the same line.  
4. Properly hardened as per specification and polished as per BIS standards.  
5. Boleslers are not weak or leaky.  
6. Bearings have the required hardness. |
| VI.     | Spindle and Ring rail | 1. Ring rail is fitted properly and moves up and down smoothly.  
2. Rings are fixed properly.  
3. Rings have smooth and fine surface. |
| VII.    | Top arm     | 1. The top arm can be easily released and set.  
2. Arm bracket is firmly fixed in position on the top arm shaft.  
3. It does not have air holes and is sturdy.  
4. Fixing stud moves properly.  
5. Top rollers are rotating freely on arbour and releasable for cleaning and oiling without difficulty.  
6. The arbour should not be shaking or the up and down motion of the same obstructed in the slots provided.  
7. Top rollers are correctly set in position over the bottom roller.  
8. Pressure can be adjusted according to the |
9. Top roller cots are of good quality and have the requisite shore hardness.
10. Rollers are of correct size.
11. Apron bridge and cradle have fine smooth surface.
12. The aprons are held at proper tension and in correct position.
13. The top and bottom apron should not move sideways.
14. The height of the cradle button should be 7.5 mm to 8 mm.

VIII. Roller Stand & Fluted Rollers

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rollers are true, with fine finished side shafts.</td>
</tr>
<tr>
<td>2</td>
<td>Flutes are proper.</td>
</tr>
<tr>
<td>3</td>
<td>Hardened and plated as per ISI specification.</td>
</tr>
<tr>
<td>4</td>
<td>Slots are made at the appropriate places on side/neck to fit the gear wheels with screws.</td>
</tr>
<tr>
<td>5</td>
<td>Rollers are freely rotating on bearings.</td>
</tr>
<tr>
<td>6</td>
<td>They have clearance at the sides and there should not be any play.</td>
</tr>
</tbody>
</table>

IX. Springs

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Compression and tension springs are of specified gauge, size and quality.</td>
</tr>
<tr>
<td>2</td>
<td>They function properly on machines.</td>
</tr>
</tbody>
</table>

X. General

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The skeleton should of specified gauge, properly welded and is at the appropriate angles.</td>
</tr>
<tr>
<td>2</td>
<td>All parts are properly aligned.</td>
</tr>
<tr>
<td>3</td>
<td>Plaiting should be good.</td>
</tr>
<tr>
<td>4</td>
<td>Covers, handle plates, reeling attachment etc. are properly fitted.</td>
</tr>
<tr>
<td>5</td>
<td>All parts function properly.</td>
</tr>
</tbody>
</table>

XI. Spinning Test

As soon as the machine is properly set, actual spinning is done and checked for difficulties if any.

XII. Load Test

The load of the charkha should normally be within 18 watts at 65 RPM of the handle.
Appendix VII

Maintenance Schedule

The quality and productivity at spinning and weaving depends to a large extent upon the mechanical conditions of the machine. Some parts are damaged due to continual use and need replacement. So in order to confirm quality product there should be a maintenance schedule and it should be strictly followed.

A.3.1 Maintenance of Charkha

1. Charkha should be cleaned everyday;
2. Lubricating oil should be applied to the bearings daily or as required;
3. Oiling to the spindle is essential everyday;
4. Top arm pressure should be released immediately after completing the spinning work;
5. Dropping of oil on the apron should be strictly avoided;
6. Thorough checking and cleaning of each part of the charkha is very necessary at least once in a week;
7. Grooves are formed in the cots of the rollers due to continuous use. So the cots should be buffed at regular intervals;
8. If there is frequent roller lapping (fibre clinging to the top roller surface) during spinning, the top roller cots should be cleaned by carbon tetrachloride (CCl₄);

<table>
<thead>
<tr>
<th>Nature of the operation</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General cleaning</td>
<td>Daily</td>
</tr>
<tr>
<td>2. Spindle oiling</td>
<td>Daily</td>
</tr>
<tr>
<td>3. Spindle driving belt (Mall) checking</td>
<td>Daily</td>
</tr>
<tr>
<td>4. Traveller replacement</td>
<td>When traveller burns or comes out</td>
</tr>
<tr>
<td>5. Cleaning of gears</td>
<td>Once in a week</td>
</tr>
<tr>
<td>6. Removal of fibre accumulation formed inside the top roller bearings</td>
<td>Once in a month</td>
</tr>
<tr>
<td>7. Spindle and lappet gauging</td>
<td>Once in a year or as required</td>
</tr>
<tr>
<td>8. Top roller cots buffing</td>
<td>Once in a year or as required</td>
</tr>
<tr>
<td>9. Cots replacement</td>
<td>Replace after 3 buffing or as required</td>
</tr>
<tr>
<td>10. Replacement of spindle oil</td>
<td>After one year or as needed</td>
</tr>
<tr>
<td>11. Apron replacement</td>
<td>After one year or as needed</td>
</tr>
<tr>
<td>12. Overhauling</td>
<td>Once in a year</td>
</tr>
</tbody>
</table>

A.3.2 Maintenance of Weaving Machineries

Warping

1. The machine should be cleaned everyday;
2. Oiling should be done to the revolving parts;
3. Check the alignment of the spools in the creel;
4. Check the tension levels of all the ends by using tension meter;
5. The conditions of the flanges of the drums is to be checked regularly and repaired if damaged;
6. Check for cuts in parts of machine in yarn path and repair or replace the parts with cut mark.

Loom
1. The loom should be cleaned thoroughly everyday;
2. Clean the loom at the time of beam change;
3. Lubricating oil or grease (as required) should be applied to the bearings and gears once in a week/as required;
4. All the parts should be inspected for absence of wear and tear;
5. The temple should be opened and cleaned at the time of beam change. Replace the worn–out rings;
6. Check the wear of tappets, if the shedding is harsh, replace the worn–out tappets;
7. The treadle bowls should be checked for wear and tear and should be replaced if found to be worn–out;
8. Various gears of the take–up motion should be cleaned;
9. Heald Inspection should be in every month;
10. Shuttle should be inspected everyday before starting the weaving;
11. Reed Inspection should be in every month.
Appendix VIII
Calculation of CVBO & CVWO

<table>
<thead>
<tr>
<th>Operator No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>29.79</td>
<td>30.31</td>
<td>30.47</td>
<td>31.07</td>
<td>31.40</td>
<td>30.94</td>
<td>31.66</td>
<td>31.08</td>
<td>30.88</td>
<td>30.79</td>
</tr>
<tr>
<td>SD</td>
<td>3.42</td>
<td>3.01</td>
<td>3.14</td>
<td>3.07</td>
<td>2.93</td>
<td>3.23</td>
<td>2.80</td>
<td>2.50</td>
<td>2.34</td>
<td>2.95</td>
</tr>
<tr>
<td>Variance</td>
<td>11.69</td>
<td>9.09</td>
<td>9.84</td>
<td>9.42</td>
<td>8.61</td>
<td>10.42</td>
<td>7.82</td>
<td>6.27</td>
<td>5.47</td>
<td>88.43</td>
</tr>
<tr>
<td>(30.8 – Individual mean)² / (No. of operators – 1)</td>
<td>0.11</td>
<td>0.03</td>
<td>0.01</td>
<td>0.01</td>
<td>0.04</td>
<td>0.00</td>
<td>0.03</td>
<td>0.01</td>
<td>0.00</td>
<td>0.32</td>
</tr>
</tbody>
</table>

CVWO = 100 X [(Sqrt 8.84) + 30.8] = 9.63

CVBO = 100 X { [Sqrt (0.32 X 10)] + 30.8} = 5.8

CV Total = Sqrt (CVWO² + CVBO²) = 11.24

Calculation procedure

1. Calculate the mean count values of the yarn supplied by individual operator.
2. Find out the population mean which is the mean of individual operator’s mean.
3. Find out the standard deviations of count values of individual operator.
4. Find out the Variance of count values of individual operator which is the square of SD values.
5. Find out the mean of the variance.
6. Find out the CVWO following the formula suggested in the table.
7. Find out the square of the differences between the individual operators mean and the population mean (30.8) and divide it by one less than No. of operators. Add them together to find out the total value.
8. Find out the CVBO following the formula suggested in the table.
9. Calculate the CV total following the formula suggested in the table.
### Appendix IX

#### List of charkha and loom manufacturers

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the Manufacturers</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Departmental</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>C &amp; B Workshop, KVIC, Dahanu</td>
<td>6 spl. Charkha, C/PV&lt;br&gt;8 spl. Charkha</td>
</tr>
<tr>
<td><strong>Khadi Institutions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Khadi saranjam Karyalaya Ahmedabad, Gujarat</td>
<td>4 spl. &amp; 6 spl Charkha, Wool&lt;br&gt;6 spl. Charkha, C/PV&lt;br&gt;8 spl. Charkha, Looms</td>
</tr>
<tr>
<td>3.</td>
<td>Ambar Utpadan Vibhag, Rajkot, Gujarat</td>
<td>6 spl. &amp; 8 spl. Charkha, C/PV</td>
</tr>
<tr>
<td>4.</td>
<td>Ambar Utpadan and Research Center, Gondal Gujarat</td>
<td>6 spl. &amp; 8 spl. Charkha, C/PV</td>
</tr>
<tr>
<td>5.</td>
<td>Khadi Gramodyog Prayag Samity, Ahmedbad, Gujarat</td>
<td>6 spl. &amp; 8 spl. Charkha, C/PV</td>
</tr>
<tr>
<td>6.</td>
<td>Karnataka Khadi Gramodyog, SS (F) Ltd, Hubli, Karnataka</td>
<td>6 spl. &amp; 8 spl. Charkha, C/PV&lt;br&gt;Loom</td>
</tr>
<tr>
<td>7.</td>
<td>Saranjam Karyalay, Gopuri, Wardha, Maharashtra</td>
<td>6 spl. &amp; 8 spl. Charkha, C/PV&lt;br&gt;Loom &amp; Warping</td>
</tr>
<tr>
<td>8.</td>
<td>Tamilnadu Sarvoday Sangh, Tirupur, TN</td>
<td>6 spl. &amp; 8 spl. Charkha, C/PV&lt;br&gt;Loom</td>
</tr>
<tr>
<td>9.</td>
<td>Coimabtore (N) S.S, Coimbatore, TN</td>
<td>6 spl. &amp; 8 spl. Charkha, C/PV&lt;br&gt;Loom</td>
</tr>
<tr>
<td>10.</td>
<td>Samistipor Anumandaliya Khadi G Samity, Waini, Bihar</td>
<td>7 spl. Charkha, Muslin</td>
</tr>
<tr>
<td>11.</td>
<td>Madhubani Zilla Kh G Sangh, Madhubani, Bihar</td>
<td>7 spl. Charkha, Muslin</td>
</tr>
<tr>
<td>12.</td>
<td>Bhagalpur Zilla khadi Gramodyog Samity, Bhagalpur, Bihar</td>
<td>7 spl. Charkha, Muslin</td>
</tr>
<tr>
<td>13.</td>
<td>Sitamadhi Zilla Khadi Gramodyog Sangh, Bihar</td>
<td>7 spl. Charkha, Muslin</td>
</tr>
<tr>
<td>14.</td>
<td>Chandrakanta Lalit Mohan Resham Khadi Sangh, Khore (WB)</td>
<td>7 spl. Charkha, Muslin</td>
</tr>
<tr>
<td>15.</td>
<td>Ghandi gram vikas samity Malda, WB</td>
<td>7 spl. Charkha, Muslin</td>
</tr>
<tr>
<td>16.</td>
<td>Badigerar &amp; Kammarar Khadi V S S ltd. Asangi, Karnataka</td>
<td>Loom</td>
</tr>
<tr>
<td>17.</td>
<td>Shri Mahalaxmi K G S Asangi, Karnataka</td>
<td>Loom</td>
</tr>
<tr>
<td>18.</td>
<td>Vishwakarma Gramodyog, Kaigarika Association, Mahalingpur, Karnataka</td>
<td>Loom</td>
</tr>
</tbody>
</table>
### Appendix X

**List of Training Institutes**

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Multi–Disciplinary Training Centers</th>
<th>Contact Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dr. B.R. Ambedkar Institute of Rural Technology and Management Khadi and Village Industries Commission Post: Trymbak Vidyamandir, Nasik – 422 213</td>
<td>Director Phone/Fax: 0253 – 350362 Soap Industry: 350576</td>
</tr>
<tr>
<td>2.</td>
<td>C.B.Kora Institute of Village Industries, Khadi and Village Industries Commission Shimpoli Road, Borvil (West) Mumbai–400 092</td>
<td>Asst. Director/Principal Phone: 022–8999143 Fax: 8981105</td>
</tr>
<tr>
<td>4.</td>
<td>Multi Disciplinary Training Center Khadi and Village Industries Commission Doorvningar, Bangalore–560016</td>
<td>Director/Principal Phone: 080 – 5650285 Fax: 5657977</td>
</tr>
<tr>
<td>7.</td>
<td>Multi Disciplinary Training Center Khadi and Village Industries Commission Gandhi Darshan, Raighat, NEW DELHI–110 002</td>
<td>Director/Principal Phone or fax: 011 – 23392708 Gram: GRAMYOJAN Director/Principal Phone: 01392 – 22673</td>
</tr>
<tr>
<td>8.</td>
<td>Multi Disciplinary Training Center Khadi and Village Industries Commission Abhoy Ashram Campus, Post: Birati Kolkatta – 700 051</td>
<td>Asst. Director/Principal Phone: 033 – 5391076 Fax: 5392011</td>
</tr>
<tr>
<td>9.</td>
<td>Dr. Rajernjra Prasad Multi Disciplinary Training Centre Khadi and Village Industries Commission Sekhpura Patna – 800 014</td>
<td>Asst. Director/Principal STD:0612 Phone: 0162 – 238511 (o), 285633 (R)</td>
</tr>
<tr>
<td>10.</td>
<td>Multi Disciplinary Training Centre Khadi and Village Industries Commission Gen. Mahadev Singh Road,</td>
<td>Asst. Director/Principal Phone: 0135 – 627241 Gram: KHADIGRAM</td>
</tr>
<tr>
<td>No.</td>
<td>Training Centre Name</td>
<td>Commission/Board</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>11.</td>
<td>Multi Disciplinary Training Centre</td>
<td>Khadi and Village Industries Commission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agar Road, Dahanu, Dist: Thane – 401 601</td>
</tr>
<tr>
<td></td>
<td><strong>Industry Directorate’s Training Centres</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Central Village Pottery Institute</td>
<td>Khadi and Village Industries Commission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Khanapur, Dist: Belgaum – 591 302</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Karnataka)</td>
</tr>
<tr>
<td>2.</td>
<td>Central Bee–Research &amp; Training Institute</td>
<td>Khadi and Village Industries Commission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1153, Ganesh Khind Road,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PUNE – 411 016</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post: Gopuri, Dist: Wardha – 442 011</td>
</tr>
<tr>
<td>4.</td>
<td>Central Palmgur &amp; Palm Products Institute</td>
<td>Khadi and Village Industries Commission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No.36, Arul Nagar,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post: Madhavaram Milk Collony,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHENNAI – 600 051</td>
</tr>
<tr>
<td>5.</td>
<td>Institute of Renewable Energy</td>
<td>Khadi and Village Industries Commission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post: Tryambak Vidyamandir</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NASIK – 422 213</td>
</tr>
<tr>
<td></td>
<td><strong>Board’s Training Centres</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Shri T.S. Gokhale Khadi and Village Industries</td>
<td>M.P. Khadi and Village Industries Board</td>
</tr>
<tr>
<td></td>
<td>Training and Research Institute</td>
<td>Post: Vijynagar, Near ITI Hostel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indore – 452 010</td>
</tr>
<tr>
<td>2.</td>
<td>Hand Made Paper Institute</td>
<td>K.B. Joshi Road,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PUNE – 411 005</td>
</tr>
<tr>
<td>3.</td>
<td>A.P. Khadi and Village Industries Board</td>
<td>Khadi Gramodyog Mahavidyalaya,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rajendra Nagar, Hyderabad: 500 030</td>
</tr>
<tr>
<td></td>
<td><strong>Non–Departmental Training Centres</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Khadi Gramodyog Vidyallaya</td>
<td>Tamulpur Anchallik Gramdan Sangh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post: Kumariikatta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dist: Nalbari – 781 360</td>
</tr>
<tr>
<td>2.</td>
<td>Khadi Gramodyog Vidyallaya</td>
<td>Gramin Nirman Mandal, Sarvodaya Ashram</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post: Sokhodeora</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dist: Nawada – 805 106 (Bihar)</td>
</tr>
<tr>
<td>3.</td>
<td>Khadi Gramodyog Vidyallaya</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Name of the Institution</td>
<td>Location</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------------</td>
<td>---------------------------------</td>
</tr>
</tbody>
</table>