Classimat Yarn Faults

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Abstract: From whatever research work done until now, very little information is available on the level for the various classes of faults as per the count. Uster statistics 2001 does not provide any information on faults, while Uster statistics 1997 which does provide some information on faults does not give guideline on the level of various classes of faults for different counts. Moreover the publication of the last ten years, gives information about the sources of faults, their causes, remedies and their effect on fabric appearance, there is however no publication available on the categorization of the various classes of faults under different types and their percent contribution. There is considerable literature available on the research work done on the effect of various categories of faults, mainly objectionable on the fabric appearance. Though it is documented in various papers that yarn faults (objectionable) not only affect fabric appearance but also causes end breakage in subsequent processes resulting to in low production and higher production cost with low efficiency, but this is not supported by any systematic study or data. No published information is available on the physical characteristic of the various faults according to type or classes, therefore the assessment of physical properties of the faults under different classes of faults and various types of faults to understand their effect on the further processes is necessary.

Keywords- *Yarn fault, classimat yarn fault, Classifault, Thick , Thin, Slub, long thick, long thin.*

I. INTRODUCTION

Yarn evenness and yarn faults are very important characteristics affecting spun yarn ability process and fabric appearance. New generation high speed looms and knitting machines place more stringent demands on the quality of the yarn. The importance of faults lies in the fact that they are a major factor responsible for rejection and down grading of yarn and fabrics and low productivity due to higher end breakage in further process

All staple spun yarns have certain variation. This variation can generally be grouped in to three categories
- Permanently present variation of the cross section which is called " unevenness" or "irregularity"
- Occasionally occurring thin or thick places which are called "imperfections" and
- Seldom occurring thick or thin places that are called "yarn faults"

Yarn faults of various shapes and sizes can be introduced at all stages of spinning process, ever how these need to be controlled or extracted. Normally in most of the mills, since extraction of these faults which is done at winding is a simple process, control of generation of faults does not get prime importance. It is well known that to control anything one should know the characteristic, the causes and the effect. The measurement of the seldom occurring faults is essential but it is rarely done as the length required for testing is more.

II. YARN FAULTS AND THEIR SIGNIFICANCE

The nature of yarn faults is decided by three factors[1] viz,

- Frequency of occurrence of faults
- Type of faults
- Size of faults
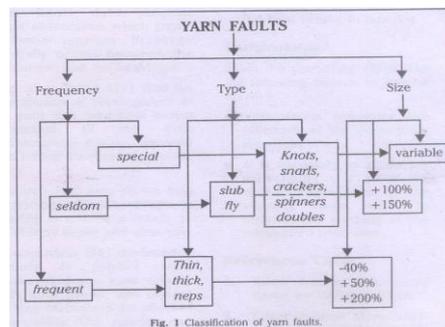
*"**Figure 1. Classification of yarn faults**"*

Accordingly, the classification of yarn faults is shown in figure 1. From the figure it can be seen that based on the frequency of occurrence of these faults, they can be classified as frequent, seldom or special faults. Of these, the frequently occurring faults include thick place, thin place and neps. These frequent faults are detected as imperfection when carrying out the yarn evenness testing. The seldom-occurring faults include slubs, fly piecing etc. having specific dimension in terms of diameter and length. Special faults have variable size.

The frequently occurring faults are measured on imperfection testers that count number of the yarn imperfection i.e. thin places, thick places and neps which occur over certain specific meters of yarn. Determination and control of imperfection in the yarn is basic and important since it can influence many other properties of the yarn as well as of the fabric made from it. The most obvious consequence of high imperfection mainly thin and thick places is the variation of strengths along the length of yarn and production of patchy defective fabric, while higher neps reflect prominently in the fabric as specks. These imperfections however do not always result in an end breakage during processing of the yarn. Therefore over past many decades the imperfection indicator has been in extensive use in the Indian textile industry for day to day control and as an aid to improves the quality of yarn.

Locher and Ernst[1] mentioned that faulty places which are most difficult to be kept in control during spinning are the relatively seldom occurring yarn faults. These include on one hand thickening in the yarn of different length but with a size which is multiple of the cross-section of the normal yarn and on the other hand long thin place whose cross section are reduced to less than half of normal yarn cross sections. Measurement of seldom occurring faults is not a very common phenomenon in the textile industry. This is so because the length of yarn that needs to be tested to count these types of faults is very large up to a minimum of hundred kilometers. Despite testing of very huge quantity of yarn the frequency of occurrence of some of the faults is still very less to draw any meaningful conclusion for one to take specific steps of corrective action. However, studies carried out on this subject show that seldom occurring faults like slubs, spun in lint, loose lint, piecing, long thick place, long thin place etc, have a significant contribution to end breaks, during spinning or more so in the subsequent processes. These fault if pass unbroken, are also many times disturbing or objectionable in the fabric leading to rejection of the fabric. The third category of faults i.e. the special faults having variable size and no specific pattern of occurrence are the most difficult to measure, analyze and control. There is no specific instrument for measuring these types of faults and they results into either end breakage or defect in the fabric. The various faults and their significance can thus be summarized as following

Frequent event – if higher than the tolerable limits affect the structure and appearance of the woven or knitted fabric
Seldom events – mostly results in end break during spinning or subsequent process and if it passes unbroken they tend to be disturbing or objectionable in the finished fabric
Special faults – may be problematic in subsequent processing but are often detected as defects in the fabric
In this project we have focused our study on the seldom occurring faults and therefore the term faults mentioned in the thesis after here refer to this category of faults.

### III. MEASURMENT OF YARN FAULTS
There are basically two principles by which yarn faults can be measured.
- capacitive method
- optical method

3.1. Capacitive methods
The principle of measurement of yarn fault using this method is as follows:
The common instrument available using this principle of measurement are the classimat developed by Uster Technologies A.G. and by Premier Evolvics Pvt. Ltd. They measure the fault and give the output in terms of cross-sectional size and length. They divide the thick faults into 16 classes from A1 to D4. A typical results sheet appears as shown in the figure below.

Fig. 2. Classimat III system
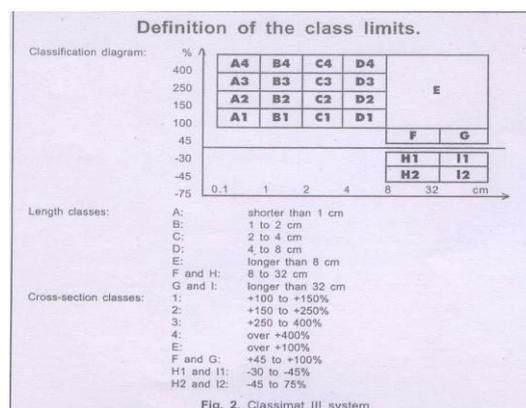
"*Figure 2. Classimat III system*"
"Table 1. Horizontally Length wise class"

Length class	A	0.1 - 1 cm.
Length class	B	1 – 2 cm
Length class	C	2 - 4 cm
Length class	D	4 cm and longer

"Table 2. Vertically the cross section size classes"

Cross-sectional size class	1	+100% - +150%
Cross-sectional size class	2	+150% - +250%
Cross-sectional size class	3	+250% - +400%
Cross-sectional size class	4	+400% and longer

"Table 3. The long thick faults obtained in classimat model II and III"

Classes	Length	Cross-sectional size class
E	> 8cm.	>100 %
F	8 – 32 cm	+45 – 100%
G	> 32 cm	+45 – 100%

"Table 4. Horizontally long thin faults"

Length class	H	8 – 32 cm
Length class	I	> 32 cm

"Table 4. Vertically long thin faults"

Cross-sectional size class	1	-30 % to -45%
Cross-sectional size class	2	-45% to -70%

3.2. Optical Method.

The principal of measurement of yarn fault using this method is as follows.
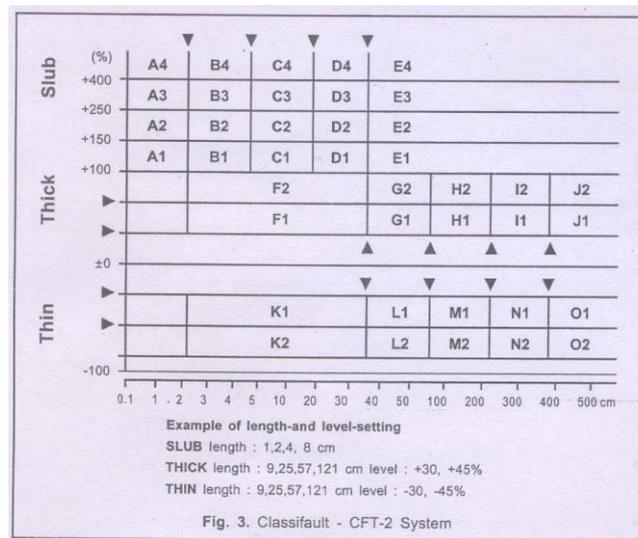
"*Figure 3. Classifault - CFT-2 System*"

The very familiar instruments available using this principal of measurement is 'classifault'(CFT- II) developed by Keisokki Kogyo Co. Ltd., Photo electric sensor is used for measuring faults, they measures the faults and give the output in terms of cross sectional size and length. The classifault system is shown in the figure. This system gives forty classification channels for grading yarn faults. In addition it has software flexibility for changing the limit level of classification and can record the fault in the form of histogram.

The CFT –II classifies the yarn faults in 40 classes slubs into 20 classes, thick place into 10 classes & thin place into 10 classes & provides the measured results for winding position as well as total number of them via the printer. Obtained results as well as test condition can be stored in the disk allowing latter analysis for extracting only required data of particular type of faults.

IV. CLASSIFICATION OF YARN FAULTS

Various literatures have classified yarn faults differently. The classification given by the major manufacturer of the instrument are already referred in section 2.2 Besides that Thomson[2] consolidated the 16 classes of faults obtained from classimat to sources, and they are:

"Table 5. Type of yarn faults".

Type of yarn faults	Classimat classes
1) Drafting faults	C1-C2-C3-C4, D1-D2-D3-D4
2) Waste slubs	A1-A2-A3-A4,B1-B2-B3-B4
3) Fly slubs	A3-A4, B1-B3-B3-B4, C2-C3-C4, D3, D4.
4) Operating faults	B3-B4, C2-C3-C4, D1-D2-D3-D4.
5) Contact faults	A1-A2-A3-A4, B1-B2-B3-B4, C2-C3, D3-D4.
6) Fiber or blend faults	A1-A2-A3, B1-B2, C1, D1-D2.

Peter Hattenschariffer and bublour[3] have classified faults on the basis of their source of generation i.e. whether they are due to raw material, process or spinning related. Table 2 gives the comprehensive classification and the finding of the study done in terms of the contribution of each category to the total fault.

"Table 6. Contribution of each category to the total fault".

Short Staple Cotton Spinning System	Carded cotton in %	Combed cotton in %	Blend yarn of man-made fibre and cotton in %	100% Man-made fibre in %
M1 Foreign matter	16.2	11.1	6.4	1.9
M2 Fibre entanglements	—	4.8	10.0	23.0
M3 Synthetic undrawn fibres	—	—	1.3	5.3
P1 Piecing	10.1	12.5	8.6	16.0
P2 Long slub	—	—	—	—
P3 Short slub	6.2	6.9	5.4	6.1
S1 Spun-in fly	42.0	44.0	38.0	29.0
S2 Loose fly	18.0	14.3	22.0	15.0
S3 Long collections of fly	3.0	1.0	4.3	2.0
S4 Fishes (corkscrew-type faults)	—	0.8	1.3	1.3
S5 Pushed-together collections of fly	2.0	3.1	1.0	0.1
S6 Chains of faults	2.1	1.3	1.3	0.3
S7 Crackers	0.4	0.2	0.4	—
S8 Over-twistings	—	—	—	—
Size of sample				
Number of faults checked	2834	3528	2466	1382
Number of qualities	276	243	153	115
Number of mills	137	118	105	89

*"**Figure 4. Contribution of each category to the total fault**".*
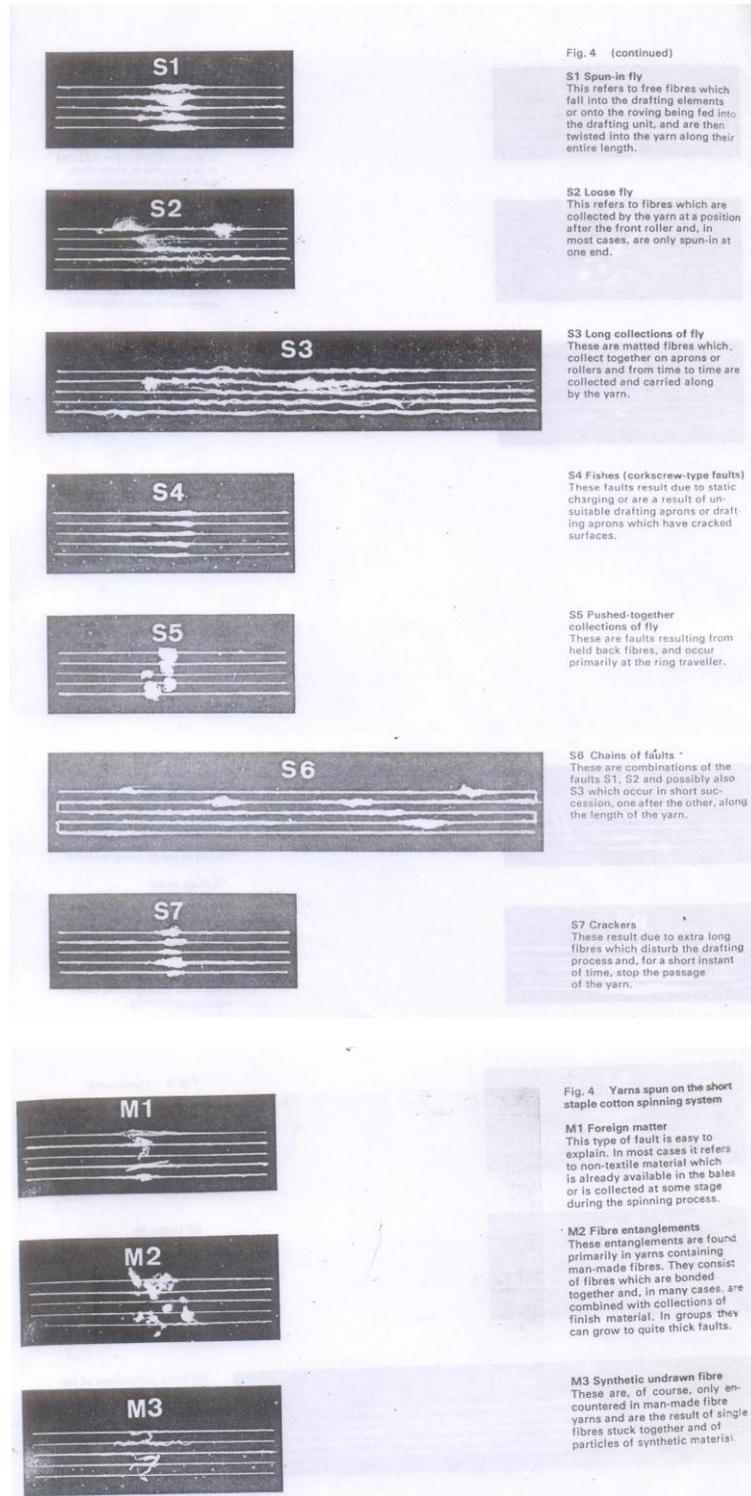
- M_1 foreign matter
  Due to non-textiles material which is already available in the bales or is collected at some stage during the spinning process.

- M_2 fibre entanglements

  These entanglements are found primarily in yarn containing man-made fibers. They consist of fibers which are bound together and in many cases, are combined with collection of finish material. In groups they grow to become thick faults.

- M_3 synthetic undrawn fibres

  These are, of coarse, only encountered in man-made fiber yarn and are the results of yarn and are the results of single fibre stuck together and of particles of synthetic material.

- P_1- piecing

  These piecing are normally produced during the processes prior to spinning.

- P_3 short slubs

  These are due primarily to collection if short of fibre which are not drafted by the roller drafting system and appear as thick places. They contain little twist and are, accordingly weak in strength. This type of faults can also be the result of too wide setting of the gauge with apron drafting.

- S_1 –Spun-in fly

  This refers to free fibres which fall in to the drafting elements or on to the roving fed into the drafting unit, and are then twisted in to the yarn along their entire length

- S2-loose fly

  This refers to fibres which are collected by the yarn at a position after the front roller and, in one end.

- S3- long collection of fly

  These are matted fibres which, collect together on aprons or rollers and from time to time are collected and carried along by the yarn.

- S4 fishes (corkscrew type faults)

  These faults results due to static charging of are a result of unsuitable drafting aprons or drafting aprons which have cracked surfaces.

- S5-pushed together collections of fly

  These are faults resulting from held back fibres, and occur primarily at the ring traveller.

- S6-chains of faults

  These are combination of the faults S1, S2 and possibly also S3 which occur in short succession, are after the other, along the length of the yarn.

- S7 crackers

  These results due to extra long fibers which disturb the drafting process and, for a short instant of time, stop the passage of the yarn.

V. SOURCES OF YARN FAULTS AND FACTORS CONTRIBUTING TO THEIR GENERATION

5.1. Sources of yarn faults

The information available on this is subdivided in to two categories

    a) Class wise
    b) Type wise

5.1.1. Class wise

M.N. Vijayshankar and A.K. Gupta[7] mentioned in their paper that

'A' faults →   80 to 90 % of the 'A' faults contain a nucleus of seed coats fragments with adhering fibers that bind thefragment to the body of yarn.

'B' faults→   In the case of 'B' faults seed coats fragments account for 30 to 60 % of the total 'B' faults. Seed coats fragments account for most of the 'A' faults but only for about 50% of the 'B' faults. In other words, apart from seed coats fragments some other factors contributes significantly to 'B' faults

'C' &'D' faults →   factors like spun in lint, loose lint, bed piecing etc. are known to contribute to 'C' &'D' faults. Drafting deficiencies are not likely to have a very significant contribution to the frequency of 'C'&'D' faults in the yarn, as these faults are recorded at a level of yarn weight per unit length +100 % or more. Unopened fiber Cluster that are present in the sliver and are potential slubs in yarn, have the largest processing contribution for 'C' and 'D' types of faults.

Grade[4] in his paper has clearly mentioned that the Indian polyester/cotton yarns have very high incidence of each type of faults. The faults of 'A' type are almost six times as numerous, while those of other types are two to four times more than the Uster statistics. The most disturbing feature is that even the objectionable faults are four times more.

Kumarswamy and Sheriff[5] conducted a study with count group from 29s Ne to 40sNe over the assessment of yarn faults and observed that in Indian mills, 'A' type of faults are 10 to 15 time higher and 'B' and 'C' types of faults are 5 to 6 times higher in comparison to international standard of respective type faults.

V.Ramchandran[8] mentioned in his paper that A4 and B4 faults come due to fly at ring traveler C3, C4, D3, D4 faults come due to defective drafting elements at roving, B, C faults due to excessive trash I1 due to roving stretch.

According to R.N. Yadav [6] H1 faults increase in winding after spinning old apron sets cause more H1 and any hindrance to cause tension in roving fed results more H1, H1 is lower with higher spindle speed, lower break draft, less number of H1, variation in fibre length cause reduce of H1. Mechanical or pneumatically arm loading has no significant in H1 faults and also higher draft of spinning is prone to higher number of H1 faults.

5.1.2. Type wise
Peter Hattenschwiler and Margrit Bubler10 mentioned in his paper that the shorter and smaller size faults are due to the raw material, the opening and the carding processes; the longer and larger size faults are introduced in the processes just prior to spinning and during spinning.

It has been generalized that quarter of all faults are due to the raw material and process prior to spinning and approximately three quarters are introduced in to the yarn at the spinning machine

5.2. Factor contributing to the high incidence of the classimat fault
K.P.R.pillay, T.V.Ratnam[19] in their paper have drawn the following conclusion that,

a) Faults due to raw material are about 8 times greater in cotton than in staple fibres whereas the drafting faults are only 1.5 times greater. The numbers of objectionable faults are also 1.5 times higher in cotton than in staple fibre yarn, and staple fibre yarn give these C and D type of faults when compared to cotton.
b) The number of faults systematically increases with increase in count both in carded and combed yarn however percentage increase is lower for the latter than the former.
c) Use of high production and tandem cards as compared with semi-high production card as well as flexible fillet carded yarn, significantly reduce yarn faults. Higher percentage of waste removed in carding and combing lowered the fault level appreciably.
d) According to them[19] the total number at faults in combed yarns is about 65 to 85% lower than those in corresponding carded yarn.
e) As the percentage of noil removed increased, objectionable fault reduced considerably.
f) Conventional drawing gives lowest number of faults per 100km, & semi high production & high production drawing give substantial increase in the incidence of faults.
g) Overhead clearer generally used by mills to keep the department clean and prevent fly and dust depositing on the yarns help in reducing the incidence of different type of yarn faults. In general, it is observed that total faults in cotton yarn are reduced by about 50% & in staple yarn by 50%. The reduction in other types of faults does not show any specific trend.
h) No firm conclusion could be drawn regarding the effect of drafting system and spindle speeds on yarn faults.

K. Kumarswamy & I. Sharieff[20] mentioned in their paper that high production and semi-high production card do not have any effect of faults. Carding rate affect C and D type of faults which increase marginally with carding rate. Objectionable faults A4 and B4 faults affected by carding, objectionable faults C3, C4, D3, and D4 are affected by the ring frame only. Metallic & tandem card reduce A1, A2 & A3 types of faults significantly.

The long faults are affected marginally and objectionable faults remain unchanged. It appears that tandem card reduce only the short length faults

They[20] also mentioned that in comparison with the A-500 system, the higher pressure new top arm drafting reduced A type of faults by 8%, B type of by 35%, C and D type by 55% & objectionable faults by 60% also among the objectionable faults the reduction in C3, C4, D3, D4 is more than in A4, B4 indicating that unlike carding, ring frame drafting preferentially reduces the longer length faults.

Vishwanath C. S., Jamdar C. R., Gokhaly S. R., Chandra Sekharan[21] mentioned in their paper that about 60 – 70% of objectionable faults are due to ring frame while 30 – 40% of them are due to preparatory. They found that ring frame equipped with pneumatic loaded drafting system gives all round best results.

According to P. Bhatt, C. D. Kane, S. R. Desmukh, U. R. Patil, G. S. Dixit & P. C. Purendare[22], if the clearing procedure is not performed satisfactorily by the ring frame top roller clearer than A, B1, B2, C1 & C2 type faults will be higher.

According to them[22] piecing share 9 to 16% of the total number of disturbing yarn faults. The consistency of their number depends mainly on the piecing at pre-spinning process.

Short slubs occur to an extent of 5 to 7% in all yarn the drafting systems at various processes, short fibers & humidity in the department are important in its formation. The spun-in-fly type faults may be as high as 50% or more of all objectionable faults in any yarns. Therefore housekeeping and humidity in the department are very important. Objectionable faults introduced at spinning process account for 70% in case of carded yarn and 50% in case of manmade staple fibers yarns.

They concluded from their study that the total yarn faults in Indian yarn are 9 to 12 times the international standards whereas objectionable faults are to an extent of 5 to 7 times. Ring frame is the highest contributor to the objectionable faults and drafting systems, heart of ring frame, is the culprit of faults generation at the same time.

The overhead blower reduces 12.5% of all faults. The reduction in C, D faults are 27.3% and that for objectionable fault is 28.3%. That is, such a high number of faults are influenced by the possibility of blowing (cleaning) or picking-up of fly.

Another observation is that most of the mills are not maintaining controlled atmosphere the department temperature and humidity changes from time to time in a day or day after day.

S. M. Ishtique, HVS. Murthy & M. M. Tendulkar[23] mentioned in their paper that, the occurrence of faults in polyester yarn is at much lower level compared to that in viscose yarn. Blended yarns show an intermediate behavior when compared with polyester and viscose yarn. The blends with lower viscose content shows less occurrence of classimat faults.

Increase in the fiber length increased the total faults but increase in the fiber denier decreased the total faults. Fiber length and denier have significant effect on A & B type of faults.

VI. SIGNIFICANCE OF YARN FAULTS AND THEIR INFLUENCE ON FURTHER PROCESS
1. Verma T.M.K., Ramaswamy. S[17], mentioned in his paper that yarn for knitting required special characteristics over weaving yarn.

    According to them the types of defect that result in yarn breakage during cone winding and contribution of each category of faults are summarized as below

"Table 7. Type of defect caused breakage during winding".

Type of defect	%
Spun-in fly	35%
Slub	25%
Bad piecing	13%
Weak places	9%
Others	8%
Entanglements	5%
Slough-off	3%
Foreign matter	2%

"Table 4. Fabric defects as a percentage of total defects"..

Type of faults	%
Thick places	40%
Long thick places	7%
Thin places	3%
Long thin places	3%
Slubs	5%
Holes(due to thick place)	16%
Knots	5%
Partial press off*	1%
Presence of foreign fibers	20%

(* blockage of loose feeder hole by the accumulation of loose fibres)

According to their research works, the defects per kg of fabric varied widely from 2.1 to 22.4 and the average is 8.5. It can be seen from the above table that thick places in the yarn alone contributed 63% to the total defect in the fabric.

2. Biradr M.M.[15] mentioned in his paper the causes of end breaks in the process, from ring spinning to weaving and knitting and lower winding efficiency. He also analyzed that yarns with higher fault incidence resulted in fabrics of inferior appearance and therefore value loss was higher of highly priced premium fabrics.

3. Aggarawal and Hari[11] have brought out in their work the importance of grey yarn quality. At a constant level of warp tension, the reduction in the extensibility resulted in an abnormally high warp breakage rate due to gross faults in the yarn, but very little effect was due to weak places. This is because the reduction in elongation can only increase the average warp tension.

4. Doleki[13] carried out a detailed study on the causes of warp breaks during weaving and analyzed the characteristics of breaks, he observed that most of the breaks occurred in the shedding zone and in the close proximity to the bodies such as, knots, slubs and neps, in normal warp only a small percentage of breaks arises from the effect of normal peak tension in weaving and a majority arise from abnormal tension caused by obstruction in the shedding zone. Knots, slubs, piecing cause obstruction which creates abnormally high tension which occurs between the obstruction and the heald eye.

5. Gangopadhyay[16] from his studies on 100% cotton and p/c blends concluded the following

6. The faults in the yarn classed objectionable by classimat are important contributory factors to the total weaving breaks out of these it is further shown that
   - Of all the objectionable yarn faults, D4 type of faults appears to be the most contributory to the total weaving breaks in the case of p/c blends.
   - Objectionable yarn faults along with piecing and knots contribute to a major portion of the causes of blended yarn it is found that as high as 56% of the total breaks are in weaving.

7. According to research work conducted at SITRA[18] in order to asses the influence of classimat faults on weaving performance a study was carried out and some of its important finding the are given below.
   - Class 'A' faults do not significantly affect the strength and elongation of yarn; these faults mainly associated with adhered seed-coat particles surface is not likely to significantly disturb the yarn structure and hence the strength.
   - D3 and D4 faults significantly reduce the strength and elongation of yarn, with these faults the yarn structure is not properly formed because in many cases, the fault length is greater than fiber length itself. There is a tendency for the realization factor of strength and elongation to decrease with increased faults magnitude. This can be explained by the fact that unopened fibre clUster, undrafted ends and poor piecing, spun-in fly etc.

     Realization factor = Avg. value of the faults yarn / Avg. value of the normal yarn

   - Yarn with B4, C3, C4 and all D faults, even after sizing, have lower strength, elongation and abrasion resistance. About 35% of the yarn with these faults have tensile strength less than the minimum of normal yarn(after sizing); 46% of yarn with B4,C3,C4 and D faults have elongation or abrasion resistance lower than the minimum of normal yarn.
   - Presence of B4, C3, C4 and D faults in yarn are predominant sources of warp breaks when subjected to tensile load, most yarn break at the faults regions or their vicinities.

8. According to P. Bhatt, C. D. Kane, S. R. Desmukh, U. R. Patil, G. S. Dixit & P. C. Purendare[22] C3, C4 & all D types faults have very poor strength even after sizing, therefore they may lead to breaks in further process.

VII. CONCLUSION

Classimat faults are the one of the important yarn characteristics which affects the quality of the yarn, efficiency of the further process and quality of the fabrics. Classimat faults need to be under control by means optimum machine setting

and proper housekeeping. Objectionable faults are more responsible for deterioration of yarn quality, breakages in further process and deteriorate the fabric appearance.

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