

INTER LABORATORY TESTING SCHEME

ON

**“Testing of Mechanical parameters
in Textile Material”**

TC/ILTS/020/MECH/2017-18

Conducted by



**Proficiency Testing Provider
Laboratories**

TEXTILES COMMITTEE

(Ministry of Textiles, Government of India)

**P. Balu Road, Prabhadevi Chowk,
Prabhadevi, Mumbai – 400 025.**

Ph : (022) 6652 7545, Fax : 6652 7554

E-mail : ptprovidertc@gmail.com

2017-2018

Inter Laboratory Testing Scheme

On

**“Testing of Mechanical parameters
in Textile Material”**

TC/ILTS/20/MECH/2017-18

Conducted by



**PT PROVIDER
Laboratories
TEXTILES COMMITTEE
(Ministry of Textiles, Government of India)
P. Balu Road, Prabhadevi,
Mumbai – 400 025.**

Ph : (022) 6652 7545, Fax : 6652 7554
E-mail : ptprovidertc@gmail.com

2017-2018

NAME AND ADDRESS OF THE PT PROVIDER

PT Provider, Laboratory, TEXTILES COMMITTEE
(Ministry of Textiles, Government of India)
P. Balu Road, Prabhadevi, Mumbai – 400 025.
Ph : (022) 6652 7542, Fax : 6652 7554,
E-mail : ptprovidertc@gmail.com

CONTACT PERSONS

1. Shri Kartikay Dhanda, PT-Coordinator, Director(Laboratories),
Textiles Committee, Mumbai –400 025
Ph: 91 22 6652 7519, Fax: 91 22 6652 7554,
E-mail : tclabmumbai@gmail.com
2. Dr.P.Ravichandran,
PT-Quality Manager
Deputy Director(Laboratories),
Textiles Committee, Mumbai –400 025
Ph: 91 22 6652 7542, Fax: 91 22 6652 7554,
E-mail : tclabmumbai@gmail.com
3. Mr.Venu B,
PT-Technical Manager, Quality Assurance Officer (Laboratory),
Textiles Committee, Kochi

REPORT PREPARED BY: Mr.Venu B,PT – Technical Manager

SCHEME : INTER LABORATORY TESTING SCHEME -TC/ILTS/20/MECH/2017-18 -Testing of
Mechanical parameters in Textile Materials

DATE OF ISSUE: 12th Feb,2019

CONFIDENTIALITY :

All the information furnished by the participants shall be kept confidential by the PT Provider and the same shall not be revealed to others. However, if the accrediting body, for example NABL, requests the PT provider to furnish the performance of any of the participants, the same shall be provided to them directly, after obtaining permission of the concerned participant

COPY RIGHT: This report is property of Textiles Committee, the PT Provider. The copy right of this report is retained with Textiles Committee. This report should not be reproduced by others in full or partially in any form without obtaining the consent from Textiles Committee, in writing

Disclaimer: The PT Programmes are meant for evaluation of performance of the participants for the specified tests undertaken in the programme only and are voluntary in nature. Further, it is clarified that reasonable care has been taken to meet the requirement of ISO/IEC 17043:2010, while designing and conducting the programmes. Participants are expected to exercise due diligence while carrying out the tests and meet all safety, statutory and accreditation body's requirements. PT Provider and Textiles Committee will not be responsible for any claim/damages arising out of participating in this programme.

INDEX

S. No.	Contents	Page No.
1	PT-Provider details	1
2	Index	2
3	Report on Inter Laboratory Testing Scheme	
	Preamble	3
	Textiles Committee	3
	PT-Provider	3
	The Present Programme	4
	Advisory Group	5
	Participants	7
	Proficiency Test Proceedings	7
	Compilation of the Test Results	9
	Determination Assigned Value	9
	Determination of Standard Deviation for Proficiency Assessment	10
	Performance Evaluation of Participants	11
	General Advise to the Laboratories on the performance	12
4	Annexure - Performance Evaluation of participants – Test wise	13

S.No.	Table	Page No.
1	ILPT schemes conducted by the PT Provider	4
2	Tests covered in TC/ILTS/22/MECH/2017-18	5
3	Advisory Group	6
4	Sampling procedure adopted for different purpose	7
5	Estimates of population parameters	8
6	Details of Exclusions of Test Results from Analysis	9
7	Assigned Values	10
8	Interpretation of Performance comments	11
9	Outliers and stragglers Analysis	12
10	List of outliers	12

Report on Inter Laboratory Testing Scheme (TC/ILTS/020/MECH//2017-18)

Preamble:

Increasing awareness on textile quality and the buyer requirements are forcing textile manufacturers and traders to test textile products from reputed laboratories. Reputation of any laboratory depends upon the result it produces. The test report given by the laboratory should be precise, accurate, repeatable and reproducible. This means, a set of results obtained within a laboratory by testing a representative sample at any time interval should be comparable. And also, the result obtained over testing a representative sample in any laboratory should compare with that of other laboratory and fall within the statistical tolerance limit. In other words, the laboratory should be able to generate comparable results by performing the same test.

The repeatability and reproducibility of any test result involves the laboratory's competence in doing an assigned task/testing including the testing equipment, the skill and knowledge of technical manpower working in the laboratory, the testing conditions and test method adopted. In this pursuit, the laboratory has to meet a requirement of maintaining its own management system as per ISO/IEC 17025 as also, participate in Inter Laboratory Comparison (ILC) and/or Inter Laboratory Proficiency Testing Scheme (ILPT).

Inter laboratory Comparison is defined as' *“Organization, performance and evaluation of tests on the same or similar test items by two or more laboratories in accordance with predetermined conditions.”* The goal of the Inter-laboratory Comparisons (ILC) is to provide verification of each participating laboratory's technical capability by obtaining a measurement that agrees with all other Laboratories using different make & model of testing equipment and manpower. The requirement for inter laboratory comparisons remains in place today, and has been further entrenched into metrology management systems by its incorporation in the requirements of ISO/IEC 17025.

Textiles Committee:

Textiles Committee is a statutory organization under the Ministry of Textiles, Government of India, established in the year 1963. The Committee has set up 19 laboratories throughout the country for catering to the testing requirements of the textile trade and industry in different centers. Fourteen laboratories of Textiles Committee are accredited as per ISO/IEC 17025 by National Accreditation Board for testing & calibration Laboratories (NABL), India.

PT-Provider:

The Laboratory, Textiles Committee at Mumbai conducts Inter Laboratory Comparisons (ILC) schemes by including its own laboratories and inviting other laboratories. In order to offer ILPT schemes professionally as a PT Provider, the laboratory of Textiles Committee at Mumbai is implementing the Management System in accordance with the requirements stipulated in ILAC G13 and ISO/IEC 17043. The PT Provider has conducted **23** schemes since 2007. The details are given in Table – 1.

Table – 1 ILPT schemes conducted by the PT Provider

S.No	Identity of the ILPT	Year	Field	PT items	No. of test parameters	No. of Labs participated
1	TC/ILTS/MECH/01/07	2007	Mechanical	Fibre, Yarn & Fabric	17	70
2	TC/ILTS/CHEM/02/07	2007	Chemical	Fabric	13	70
3	TC/ILTS/MECH/03/08	2008	Mechanical	Fabric	11	60
4	TC/ILTS/CHEM/04/08	2008	Chemical	Fabric	10	60
5	TC/ILTS/MECH/05/09	2009	Mechanical	Fabric	11	50
6	TC/ILTS/MECH/06/09	2009	Mechanical	Yarn	12	31
7	TC/ILTS/MECH/07/09	2009	Mechanical	Fibre	15	14
8	TC/ILTS/CHEM/08/09	2009	Chemical	Fabric	7	51
9	TC/ILTS/CHEM/09/09	2009	Chemical	Fabric	4	45
10	TC/ILTS/CHEM/10/09	2009	Chemical	Fabric	2	20
11	TC/ILTS/MECH/11/10-11	2010-11	Mechanical	Fabric	10	65
12	TC/ILTS/CHEM/12/10-11	2010-11	Chemical	Fabric	10	70
13	TC/ILTS/MECH-1/2012-13	2012-13	Mechanical	Yarn and Fabric	13	42
14	TC/ILTS/Chem -1/2012-13	2012-13	Chemical	Fabric & Metal clothing accessories	12	56
15	TC/ILTS/15/MECH-2/2014	2014	Mechanical	Fabric	8	50
16	TC/ILTS/16/CHEM-2/2014	2014	Chemical	Fabric	8	45
17	TC/ILTS/17MECH-3/2015	2015	Mechanical	Fabric	8	24
18	TC/ILTS/18/CHEM -3/2015	2015	Chemical	Fabric	9	51
19	TC/ILTS/19/CHEM -3/2015	2015	Chemical	Fabric	2	30
20	TC/ILTS/20/MECH/2017-18	2017-18	Mechanical	Fabric	7	35
21	TC/ILTS/21/CHEM/2017-18	2017-18	Chemical	Fabric	8	29
22	TC/ILTS/22/MECH/2017-18	2017-18	Mechanical	Fabric	7	28
23	TC/ILTS/23/CHEM/2017-18	2017-18	Chemical	Fabric	8	36



The Present Program:

Design: In order to assess the reproducibility of the test results being reported by the various textile testing laboratories, a Proficiency Testing Scheme for Mechanical testing - **TC/ILTS/020/MECH//2017-18** was designed. The test parameters thus covered in the present PT Scheme are given in Table – 2.

Table – 2 : Tests covered in TC/ILTS/20/MECH/2017-18

S.No.	Test parameter	Standards suggested
1	Determination of Width of Fabric	IS 1954 1990
2	Determination Mass per sq meter	IS 1964 2001 RA 2017 ISO 3801 1977 (2017) ASTM D 3776 09a 2017
3	Determination of Count of Yarn Removed from Fabric	IS 3442 1980 (RA 2004) Or Validated in-house method.
4	Determination of Breaking (Tensile) Strength – Grab	IS 1969 Part-2 2009 RA 2014 ISO 13934-2 2014 ASTM 5034-09 (2017)
5	Determination of Tearing Strength (Elmendorf)	ISO 13937 -1 2000 (2017) ASTM 1424-09 (2013)
6	Determination of Tearing Strength of Fabric by Tongue (Single Rip)	ASTM D 2261- 13 (2017)
7	Failure in sewn seams of woven Fabric	ASTM 1683 M -17

While designing the Scheme the following objectives were considered.

- (1) Each accredited participant laboratory should get benefit so that at least one parameter may be covered under the lab's scope of accreditation.
- (2) Both geometry and performance verifying parameters to be included.
- (3) Both trade and industry oriented parameters to be included.
- (4) Test methods of ISO, ASTM and Indian Standards may be covered.

To satisfy the above objectives (1) Scope of accreditation of about 50 laboratories were consulted. (2) To enable the participant laboratories in *evaluation of the performance for specific tests or measurements and monitoring laboratories' continuing performance* (Ref: ISO/IEC 17043), the geometric parameters viz., width of fabric, weight per square meter and performance parameters Fabric breaking force by grab method,. (3) To satisfy Trade and industry requirements, performance parameters viz., tear strengths by different methods and Resistance of yarns at Seam were included.

Advisory Group:

As per the requirements stipulated in ILAC G13 and ISO/IEC 17043, an **Advisory Group** comprising the following internal and external experts having the necessary expertise in testing and/or statistics was constituted for designing and operating Proficiency Testing scheme in the field of Mechanical & Chemical testing of textiles:

Table – 3 : Constitution of Advisory Group

S.No	Expert	Affiliation	Field of expertise
1.	Mr. Kartikay Dhanda Director (Labs), Textiles Committee, Mumbai	Chairman	Textile testing
2.	Dr. K.S.Muralidhara Joint Director (Lab), Textiles Committee, Mumbai	Member	Textile testing
3.	Mr.K.Selvaraj Joint Director (Lab), Textiles Committee, Mumbai	Member	Textile testing & Statistics
4.	Dr.P.Ravichandran Deputy Director (Lab), Textiles Committee, Mumbai	Member	Textile testing
5.	Mr. S.P. Singh Asst. Director (Lab), Textiles Committee, Jaipur.	Member	Textile testing
6.	Mr. Govind Prasad Asst. Director (EPQA), Textiles Committee, Mumbai	Member	Textile testing
7.	Mr.Venu B Quality Assurance Officer (Lab), Textiles Committee, Kochi	Member	Textile testing & Statistics
8.	Mrs. Sandhyarani Kamble Quality Assurance Officer (Lab) Textiles Committee, Mumbai	Member	Textile testing

The terms of reference of the Advisory Group were as follows:

- a) Planning requirements
- b) Identification and resolution of any difficulties expected in the preparation and maintenance of homogeneous proficiency test items, or in the provision of stable assigned value for a proficiency test item;
- c) Preparation of detailed instructions for participants
- d) Comments on any technical difficulties raised by participants
- e) Provision of advice in evaluating the performance of participants
- f) Comments on the results and performance of participants as a whole and, where appropriate, groups of participants or individual participants;
- g) Provision of advice for participants (within limits of confidentiality), either individually or within the report;
- h) Responding to feedback from participants; and
- i) Planning or participating in technical meetings with participants.
- j) Arbitration of any dispute(s) between participating laboratory(ies) and the PT provider.

The following documents pertaining to the PT Schemes, “Testing of Mechanical parameters in textile material - **TC/ILTS/MECH/20/2017-18** & **TC/ILTS/MECH/22/2017-18** and “Testing of Chemical parameters in textile material - **TC/ILTS/Chem/21/2017-18** & **TC/ILTS/Chem/23/2017-18** were vetted by the Advisory Group on 5th February 2019:

- (i) Draft Protocol incorporating test parameters covered, suggested test methods, participation fees payable, expected schedule of the scheme, etc
- (ii) Draft instructions to the participants
- (iii) Draft format for reporting the test results

● Participants:

35 laboratories were participated in this scheme and the laboratories are accredited by the *National Accreditation Board for testing and calibration Laboratories (NABL)*, India

● Proficiency Test Proceedings:

The laboratory of Textiles Committee (PT Provider), Mumbai, procured sufficient quantity of fabric (PT item) from a reputed textiles mill for designing and conducting Inter Laboratory Testing Scheme, on the basis of expected number of participants.

Population of PT items: On receipt of the procured materials, PT items meant for (i) homogeneity testing, (ii) stability testing, (iii) distribution among the participant laboratories, (iv) additional reserve samples for replacement in case of loss or damage, were prepared. While preparing the PT items for the above, it was ensured that the quantity of each PT item is adequate for the testing of all the parameters included in the scheme. The PT items thus prepared from the material procured were numbered serially. The prepared PT items were packed in polyethylene bags and labeled bearing the PT item identity such that the same are ready for dispatch. Thus a *finite population* of PT item was produced.

Sampling of PT items: Allotments of PT items were done by following appropriate Sampling procedures adopted by using Random Numbers generated by using computer. Sampling procedure for Homogeneity testing, Stability testing and for distribution among participant laboratories are provided in Table – 4:

Table – 4: Sampling procedure adopted for different purpose

1	Homogeneity testing,	<i>Systematic random sampling without replacement</i>
2	Stability Testing	<i>Systematic random sampling without replacement from the remaining population after homogeneity testing</i>
3	Distribution to participant laboratories	<i>Simple random sampling without replacement from the remaining population after homogeneity and stability testing.</i>

The remaining part of the population was kept as reserve for replacement in case of loss or damage. Henceforth, the allotted PT items can be referred as *sample*.

Homogeneity testing: To verify the homogeneity of the population of PT items homogeneity testing was conducted at the laboratory of Textiles Committee at Mumbai for all the test parameters covered in the scheme by adopting one of the suggested methods. However, while conducting performance evaluation of the participants, the “between- samples SD” calculated during homogeneity testing by a particular method was used for calculating “SD of PT assessment” for different methods adopted by the participants, as the inherent variation in the sample (degree of non homogeneity) is independent of the test method adopted. The procedure given in ISO 13528 was followed for conducting homogeneity testing.

The homogeneity of population was found to be satisfactory based on *analysis of variance* conducted on the test results obtained in homogeneity testing.

Stability testing: In order to verify the stability of the PT items, stability testing was conducted in accordance with ISO 13528, after the lapse of a week from the last date of conducting homogeneity testing. The stability was confirmed by testing the hypothesis that the difference between the average values obtained for each of the test parameters during homogeneity testing and stability testing were insignificant.

Estimation of Parameters: Population parameters viz., mean μ and standard deviation σ were estimated by using the results obtained in homogeneity and stability testing. Table - 5 consists of the estimates of population parameters.

Dispatch of PT items: The Proficiency Testing items were dispatched to the respective participant laboratories on 23rd May 2018, along with the following:

- (a) Instructions to the participants in the Inter Laboratory Testing Scheme
- (b) Form for reporting test results by the participants in the Inter Laboratory Testing Scheme

The participant laboratories were requested to send the test results by 15th June 2018.

The participant laboratories were also requested to

- Treat the samples in the same manner as regularly tested samples and accordingly, codify the samples such that the technical staff testing them are not aware that they are meant for PT purposes;
- Adopt the latest test method which is routinely used by the laboratory for the testing of regular samples which may be any standard or validated in-house method;
- Forward (i) copy of the in-house method adopted (if applicable) for testing any parameter and also (ii) specify the standard method against which the validation has been done; and,
- Forward photo copy of NABL accreditation certificate as a proof of accreditation for the test method adopted (applicable to accredited laboratories only).

Table-5 : Estimates of population parameters

Estimates Summary			
S.No	Test	Parameter	Estimation
1	Width of Fabric IS 1954 1990 (Unit: cm)	Population mean (μ) =	86.35
		Population SD (σ) =	0.24
		95% confidential limits for Population mean =	86.26 $\leq \mu \leq$ 86.44
2	Seam Slippage resistance Seam along warp (Unit N)	Population mean (μ) =	146.4
		Population SD (σ) =	37.2
		95% confidential limits for Population mean =	128.2 $\leq \mu \leq$ 164.6
3	Mass per Square Metre ISO 3801:1977 (Unit:g)	Population mean (μ) =	108.7
		Population SD (σ) =	1.39
		95% confidential limits for Population mean =	108.2 $\leq \mu \leq$ 109.2
4	Linear Density of Yarn removed from fabric (Ne, cc)	Population mean (μ) =	30.4
		Population SD (σ) =	0.86
		95% confidential limits for Population mean =	30.1 $\leq \mu \leq$ 30.7
5	Tear Strength Elmendorf (Unit: N)	Population mean (μ) =	17.3
		Population SD (σ) =	2.42
		95% confidential limits for Population mean =	16.3 $\leq \mu \leq$ 18.3

6	Breaking Strength of Fabric (Grab) (Unit: N)	Population mean (μ) =	319.9
		Population SD (σ) =	40.1
		95% confidential limits for Population mean =	301.9 $\leq \mu \leq$ 337.9
7	Tear Strength (Tongue) (Unit: N)	Population mean (μ) =	18.7
		Population SD (σ) =	3.03
		95% confidential limits for Population mean =	17.3 $\leq \mu \leq$ 20.1

The participant laboratories were informed that, in the absence of proof of accreditation, the laboratory's value will not be considered for arriving at "Assigned Value" for the concerned test parameter, although, performance of the laboratory will be evaluated for this parameter. Further, it was also informed that the test results that may be inappropriate for statistical evaluation, for example, gross errors, miscalculations and transpositions may be excluded for calculation of summary statistics and performance evaluation of participants.

Compilation of the Test Results:

In order to maintain the confidentiality of the participants of the PT Scheme, the individual participant laboratories were given Code numbers which are generated by using computer. Subsequently, the test results reported by the participant laboratories were tabulated and statistically analyzed for the basic statistics viz., Mean, Median, Mode, Maximum, Minimum, Standard Deviation, etc., While doing so, test results that were found to be inappropriate for statistical evaluation, for example, **gross errors, miscalculations and transpositions** were excluded.

The list of such exclusions is placed in Table – 6.

Table 6: Details of Exclusions of Test Results from Analysis

S.No.	Test	Assigned Value	Result Reported by the participant	Lab Code
1	Fabric breaking force-Grab Method (N)	328.3	606.7	24

Determination Assigned Value:

To ensure the measurement traceability, only **accredited laboratories** are considered for evaluating the Assigned Values. Thus due weightage is given to the accredited laboratories. However, this weightage is given only when the laboratory has submitted their Scope of accreditation and accredited for the specific test in which the ILPT is conducted.

Initially, the robust average and the standard deviation of values reported by the accredited laboratories (in respective tests) were determined for each parameter in accordance with the procedure given in ISO 13528. Subsequently, robust Z Score were calculated on the basis of the above. The test results of those laboratories which were found to be outliers (Z score more than +3 or less than -3) were deleted and Robust Average of the remaining expert laboratories was again calculated. This Robust average is treated as the assigned value for the concerned parameter.

The Assigned Value of both the parameters thus arrived are given in **Table–7**.

Table 7: Assigned Values

S.No.	Test	Assigned Value	Robust SD of Assigned Value	Uncertainty of Assigned Value	No. of Accredited Laboratories contributed	Total number of participants*
1	Width of Fabric IS 1954 1990 (Unit: cm)	86.4	0.27	0.06	20	28
2	Seam Slippage resistance Seam along warp	133.5	24.6	7.2	9	16
3	Mass per Square Metre ISO 3801:1977 (Unit:g)	108.5	1.03	0.23	25	35
4	Linear Density of Yarn removed from fabric	30.5	0.43	0.09	22	35
5	Tear Strength Elmendorf (Unit: N)	17.8	0.9	0.31	13	23
6	Breaking Strength of Fabric (Grab) (Unit: N)	328.3	34.1	8.8	13	19
7	Tear Strength (Tongue) (Unit: N)	18.7	1.05	0.37	8	17

Determination of Standard Deviation for Proficiency Assessment (σ):

The robust average and the robust standard deviation (σ_1) of all qualified values reported by the participant laboratories were calculated for each of the test separately in accordance with the procedure given in ISO 13528. Subsequently, the “between-samples standard deviation (S_s)” of homogeneity testing data was compared with the standard deviation of all the participants. If $S_s \leq 0.3 \sigma_1$, then the sample is considered as homogenous and the robust standard deviation of all the participant laboratories is treated as Standard Deviation for Proficiency Testing. That is $\sigma = \sigma_1$.

If $S_s > 0.3 \sigma_1$, then the sample is considered as heterogeneous and Standard Deviation for Proficiency Assessment is calculated by adding allowance for heterogeneity of the sample as stipulated in ISO 13528:2005, by using the formula

$$\sigma = \sqrt{\sigma_1^2 + S_s^2}$$

Performance Evaluation of Participants:

The performance of the individual laboratory was evaluated by adopting Robust Z score technique given in ISO 13528, as per the following formula:

$$Z = \frac{x - X}{\sigma}$$

where x is the test result reported by the individual laboratory; X is the Assigned Value and σ is the standard deviation of the Proficiency Assessment.

In case of Subjective test the deviation of laboratory result by more than ½ grade compared to Assigned Value is taken as unsatisfactory (and outliers) and all other results are taken as satisfactory.

Interpretation of Performance comment:

Table – 8: Interpretation of Performance comment

Range	Performance of Laboratory
Objective Tests	
$ Z - \text{Score} \leq 2$	Satisfactory
$2 < Z - \text{Score} \leq 3$	Straggler
$ Z - \text{Score} > 3$	Outlier
Subjective Test	
$ \text{Reported Value} - \text{Assigned Value} \leq \frac{1}{2} \text{ grade}$	Satisfactory
$ \text{Reported Value} - \text{Assigned Value} > \frac{1}{2} \text{ grade}$	Outlier

Outliers and Stragglers:

Overall performance of all the laboratories is good. Outliers and Stragglers are very rare and far. The Outlier and Straggler Analysis is given in Table – 10.

Table – 9: Outlier and Straggler Analysis

S. No	Test	No. of Labs Participated*	Valid Results	No. of Stragglers	% of Stragglers	No. of Outliers	% of Outliers
1	Width of Fabric IS 1954 1990 (Unit: cm)	28	28	0	0	0	0
2	Seam Slippage resistance Seam along warp	16	16	1	6.25	1	6.25
3	Mass per Square Metre ISO 3801:1977 (Unit:g)	35	35	1	2.9	2	5.7
4	Linear Density of Yarn removed from fabric	35	35	0	0	4	11.4
5	Tear Strength Elmendorf (Unit: N)	23	23	0	0	1	4.3
6	Breaking Strength of Fabric (Grab) (Unit: N)	20	19	0	0	1	5.3
7	Tear Strength (Tongue) (Unit: N)	17	17	1	5.9	2	11.8
Total			173	3	1.73	11	6.36

Parameter-wise the outliers and stragglers are listed below:

Table – 10: List of Outliers and Stragglers

S. No	Test	Straggler Lab codes	Outlier Lab codes
1	Width of Fabric IS 1954 1990 (Unit: cm)	Nil	Nil
2	Seam Slippage resistance Seam along warp	37	13
3	Mass per Square Metre ISO 3801:1977 (Unit:g)	28	33, 15
4	Linear Density of Yarn removed from fabric	Nil	24,33, 26,44
5	Tear Strength Elmendorf (Unit: N)	Nil	13
6	Breaking Strength of Fabric (Grab) (Unit: N)	Nil	26
7	Tear Strength (Tongue) (Unit: N)	13	26, 15

General Advise to the Laboratories on the performance:

If the laboratory is found to be “**Outlier**”, necessary corrective action should be taken after thorough investigation of the root cause of the problem. In case the laboratory is found to be “**Straggler**”, the method of testing, personnel error, use of correct materials / equipment, maintenance of environmental conditions etc., have to be re-examined to ensure that the test results being reported for the concerned test parameters are satisfactory.

PERFORMANCE EVALUATION OF EACH LABORATORY- TEST WISE

1. Width of Fabric

Lab code	Reported value (cm)	Test method adopted	Z- Score	Performance Remark
13	86.2	IS 1954 1990 RA 2017-Method 2	-0.556	Satisfactory
36	86.2	IS 1954 1990 RA 2017-Method 2	-0.556	Satisfactory
24	86.6	IS 1954 1990 RA 2017-Method 2	0.556	Satisfactory
49	86.7	ASTM D 3774 1996 (2012)	0.833	Satisfactory
33	86.5	IS 1954 1990 RA 2017-Method 2	0.278	Satisfactory
47	86.4	IS 1954 1990 RA 2017-Method 2	0.000	Satisfactory
38	86.3		-0.278	Satisfactory
43	86.5	IS 1954 1990 RA 2017-Method 2	0.278	Satisfactory
26	86	IS 1954 1990 RA 2017-Method 2	-1.111	Satisfactory
34	86	ASTM D 3774 1996 (2012)	-1.111	Satisfactory
50	86.4	IS 1954 1990 RA 2017-Method 2	0.000	Satisfactory
12	86.1	ASTM D 3774 1996 (2012)	-0.833	Satisfactory
29	86.2	ASTM D 3774 1996 (2012)	-0.556	Satisfactory
15	86.8		1.111	Satisfactory
46	85.9	IS 1954 1990 RA 2017-Method 2	-1.389	Satisfactory
25	86.6	IS 1954 1990 RA 2017-Method 2	0.556	Satisfactory
39	86.1	IS 1954 1990 RA 2017-Method 2	-0.833	Satisfactory
30	86.4	IS 1954 1990 RA 2017-Method 2	0.000	Satisfactory
16	86.6	IS 1954 1990 RA 2017-Method 2	0.556	Satisfactory
22	86.1	IS 1954 1990 RA 2017-Method 2	-0.833	Satisfactory
21	86.3	IS 1954 1990 RA 2017-Method 2	-0.278	Satisfactory
31	86.6	IS 1954 1990 RA 2017-Method 2	0.556	Satisfactory
40	86.5	IS 1954 1990 RA 2017-Method 2	0.278	Satisfactory
23	86.2	IS 1954 1990 RA 2017-Method 2	-0.556	Satisfactory
18	86.4	IS 1954 1990 RA 2017-Method 2	0.000	Satisfactory
27	86.1	IS 1954 1990 RA 2017-Method 2	-0.833	Satisfactory
32	86.7	IS 1954 1990 RA 2017-Method 2	0.833	Satisfactory
19	86.4	IS 1954 1990 RA 2017-Method 2	0.000	Satisfactory

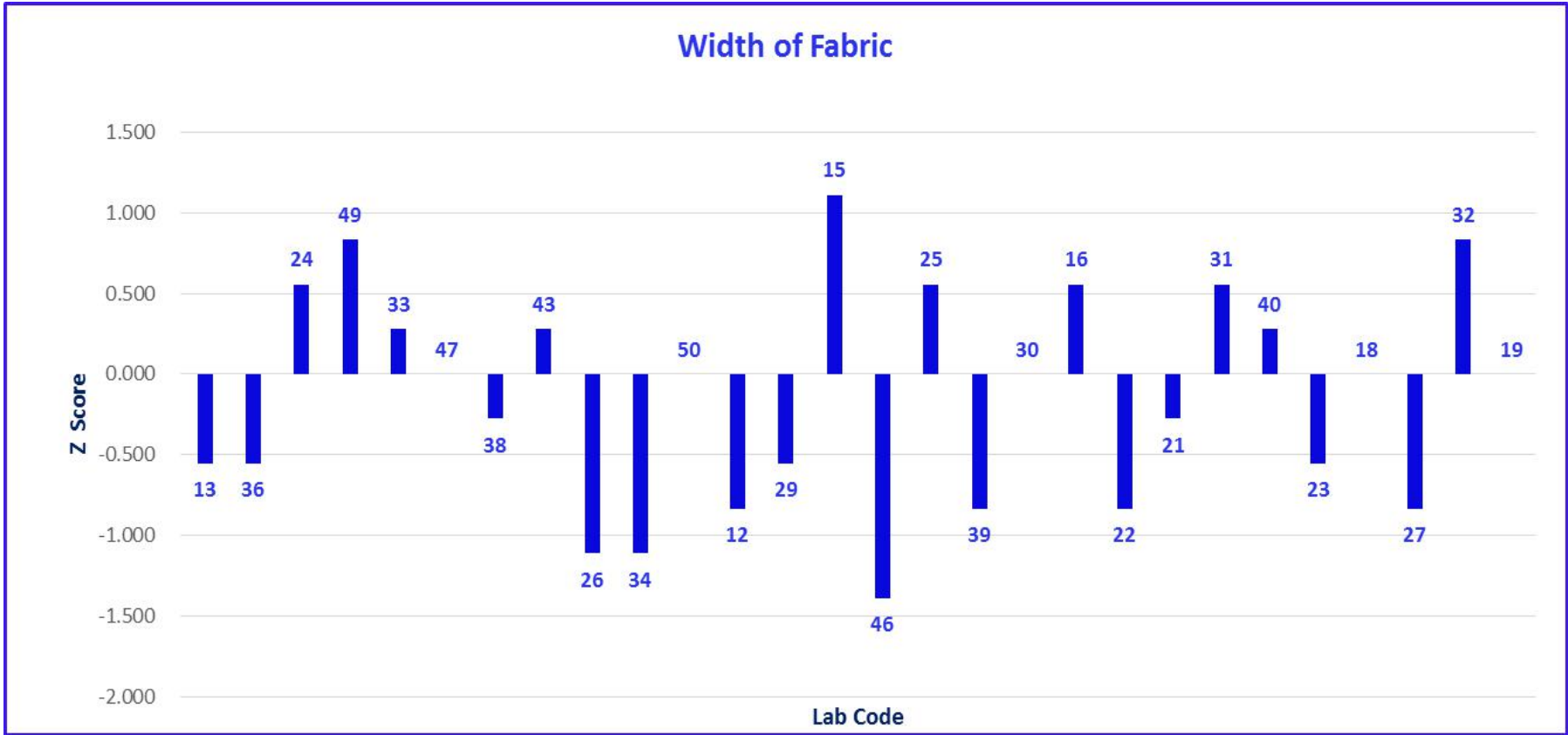
No. of participants	28
Maximum	86.8
Minimum	85.9
Mean	86.35
Std Deviation	0.24
Median	86.4

SUMMARY

Robust Average =	86.4 cm
Robust SD for all valid participants (σ_1) =	0.267
Between sample SD of Homogeneity testing (S_s) =	0.24
SD for PT Scheme with allowance for the heterogeneity if any (σ) =	0.36

Heterogeneity observed

Assigned Value (X) =	86.4
SD of PT Scheme (σ) =	0.36



2. Resistance to slippage of Yarns at a sewn seam

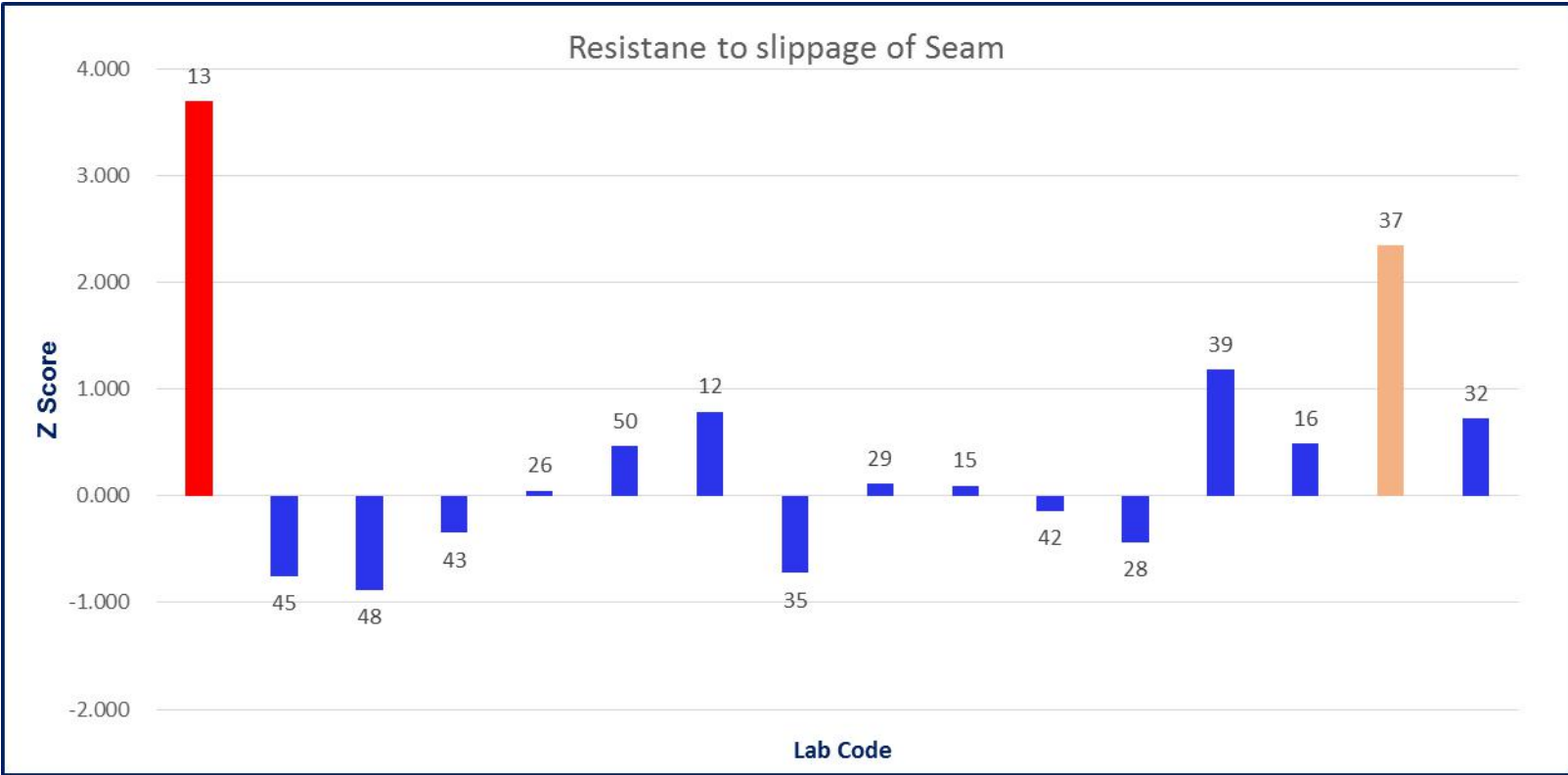
Lab code	Reported value (N)	Test method adopted	Z- Score	Performance Remark
13	248	ASTM 1683 M -17	3.694	Outlier
45	110.2	ASTM 1683 M -17	-0.752	Satisfactory
48	106.1	ASTM 1683 M -17	-0.884	Satisfactory
43	122.71	ASTM 1683 M -17	-0.348	Satisfactory
26	135		0.048	Satisfactory
50	148		0.468	Satisfactory
12	157.9		0.787	Satisfactory
35	111	ASTM 1683 M -17	-0.726	Satisfactory
29	137	ASTM 1683 M -17	0.113	Satisfactory
15	136.4		0.094	Satisfactory
42	129	ASTM 1683 M -17	-0.145	Satisfactory
28	120	ASTM 1683 M -17	-0.435	Satisfactory
39	170.2	ASTM 1683 M -17	1.184	Satisfactory
16	148.7	ASTM 1683 M -17	0.490	Satisfactory
37	206.2	ASTM 1683 M -17	2.345	Straggler
32	156	ASTM 1683 M -17	0.726	Satisfactory
No. of participants	16			
Maximum	248			
Minimum	106.1			
Mean	146.4			
Std Deviation	37.2			
Median	136.7			

SUMMARY

Robust Average =	133.5 N
Robust SD for all valid participants (σ_1) =	26.3 N
Between sample SD of Homogeneity testing (S_s) =	16.3 N
SD for PT Scheme with allowance for the heterogeneity if any (σ) =	31.0 N

Heterogeneity Accounted

Assigned Value (X) =	133.5 N
SD of PT Scheme (σ) =	31.0 N



3. Mass per Sq Meter of Fabric

Lab code	Reported value (g)	Test method adopted	Z- Score	Performance Remark
13	108.2	ASTM D 3776 09a 2017	-0.294	Satisfactory
36	107.6	ASTM D 3776 09a 2017	-0.881	Satisfactory
24	108.9	ASTM D 3776 09a 2017	0.392	Satisfactory
49	110		1.469	Satisfactory
33	111.6	IS 1964 2001	3.036	Outlier
45	108.1	ASTM D 3776 09a 2017	-0.392	Satisfactory
48	108	ASTM D 3776 09a 2017	-0.490	Satisfactory
47	109.7	ISO 3801 1977 (2017)	1.175	Satisfactory
44	106.9	IS 1964 2001	-1.567	Satisfactory
38	109.2		0.686	Satisfactory
43	108.9	IS 1964 2001	0.392	Satisfactory
26	108	IS 1964 2001	-0.490	Satisfactory
34	106.7	ASTM D 3776 09a 2017	-1.763	Satisfactory
50	108.4	ISO 3801 1977 (2017)	-0.098	Satisfactory
12	109.8		1.273	Satisfactory
35	108.3	ASTM D 3776 09a 2017	-0.196	Satisfactory
29	106.5	ASTM D 3776 09a 2013	-1.959	Satisfactory
15	113.3	ASTM D 3776 09a 2017	4.701	Outlier
42	110	ASTM D 3776 09a 2017	1.469	Satisfactory
28	111	ASTM D 3776 09a 2017	2.449	Straggler
46	107.8	IS 1964 2001	-0.686	Satisfactory
25	107.8	TC/LAB/TM-03 (In house method)	-0.686	Satisfactory
39	110	ISO 3801 1977 (2017)	1.469	Satisfactory
30	108.5	IS 1964 2001	0.000	Satisfactory
16	108.4	IS 1964 2001	-0.098	Satisfactory
22	108.8	ISO 3801 1977 (2017)	0.294	Satisfactory
21	108.3	TC/LAB/TM-03 (In house method)	-0.196	Satisfactory
31	107.1	TC/LAB/TM-03 (In house method)	-1.371	Satisfactory
37	108.3	IS 1964 2001	-0.196	Satisfactory
40	108.8	ASTM D 3776 09a 2013	0.294	Satisfactory
23	109.7	ISO 3801 1977 (2017)	1.175	Satisfactory
18	107.9	ISO 3801 1977 (2017)	-0.588	Satisfactory
27	108.2	ISO 3801 1977 (2017)	-0.294	Satisfactory
32	110	IS 1964 2001	1.469	Satisfactory
19	108.3		-0.196	Satisfactory

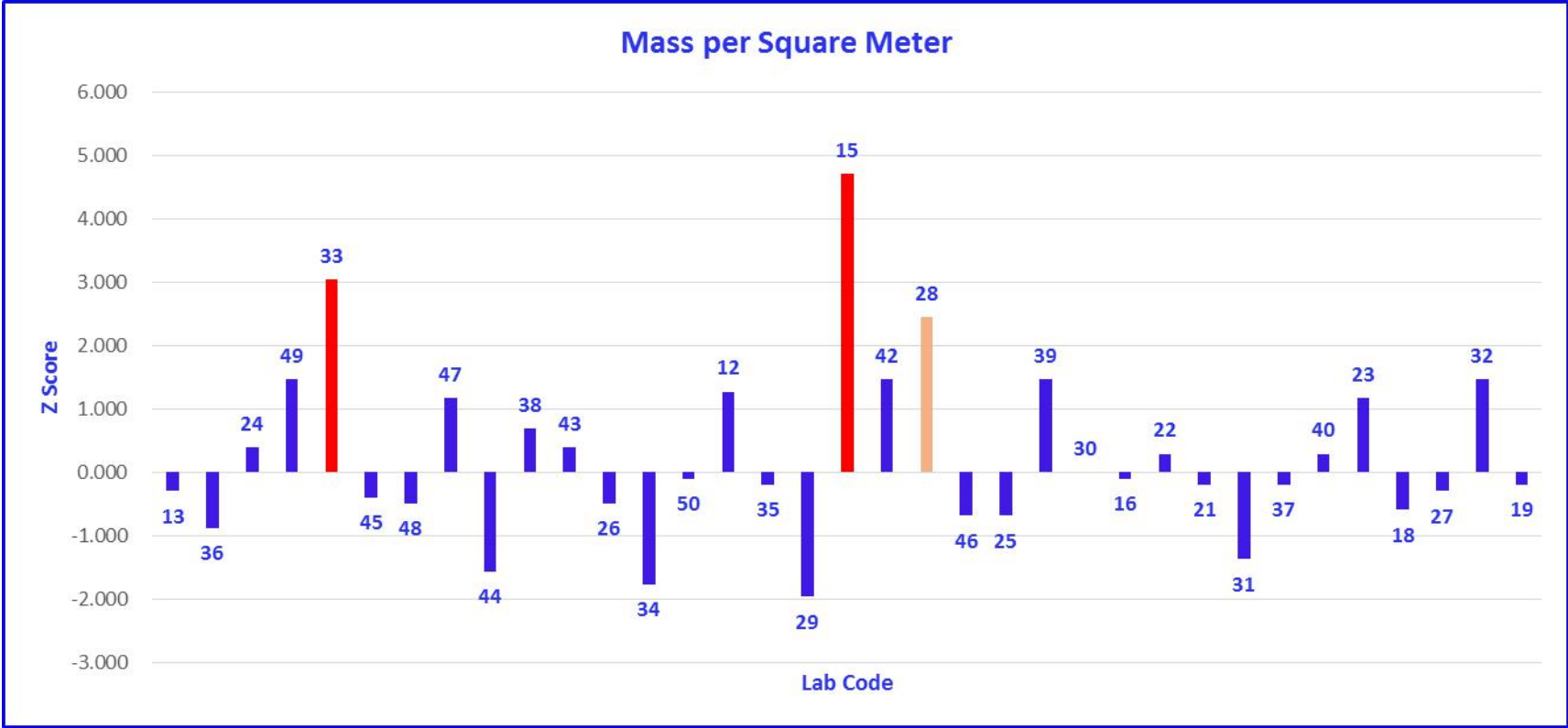
No. of participants	35
Maximum	113.3
Minimum	106.5
Mean	108.7
Std Deviation	1.39
Median	108.4

SUMMARY

Robust Average =	108.5
Robust SD for all valid participants (σ_1) =	1.021
Between sample SD of Homogeneity testing (S_s) =	0.27
SD for PT Scheme with allowance for the heterogeneity if any (σ) =	1.021

No Heterogeneity observed

Assigned Value (X) =	108.5
SD of PT Scheme (σ) =	1.021



4. Linear Density of Yarn Removed from Fabric (Warp)

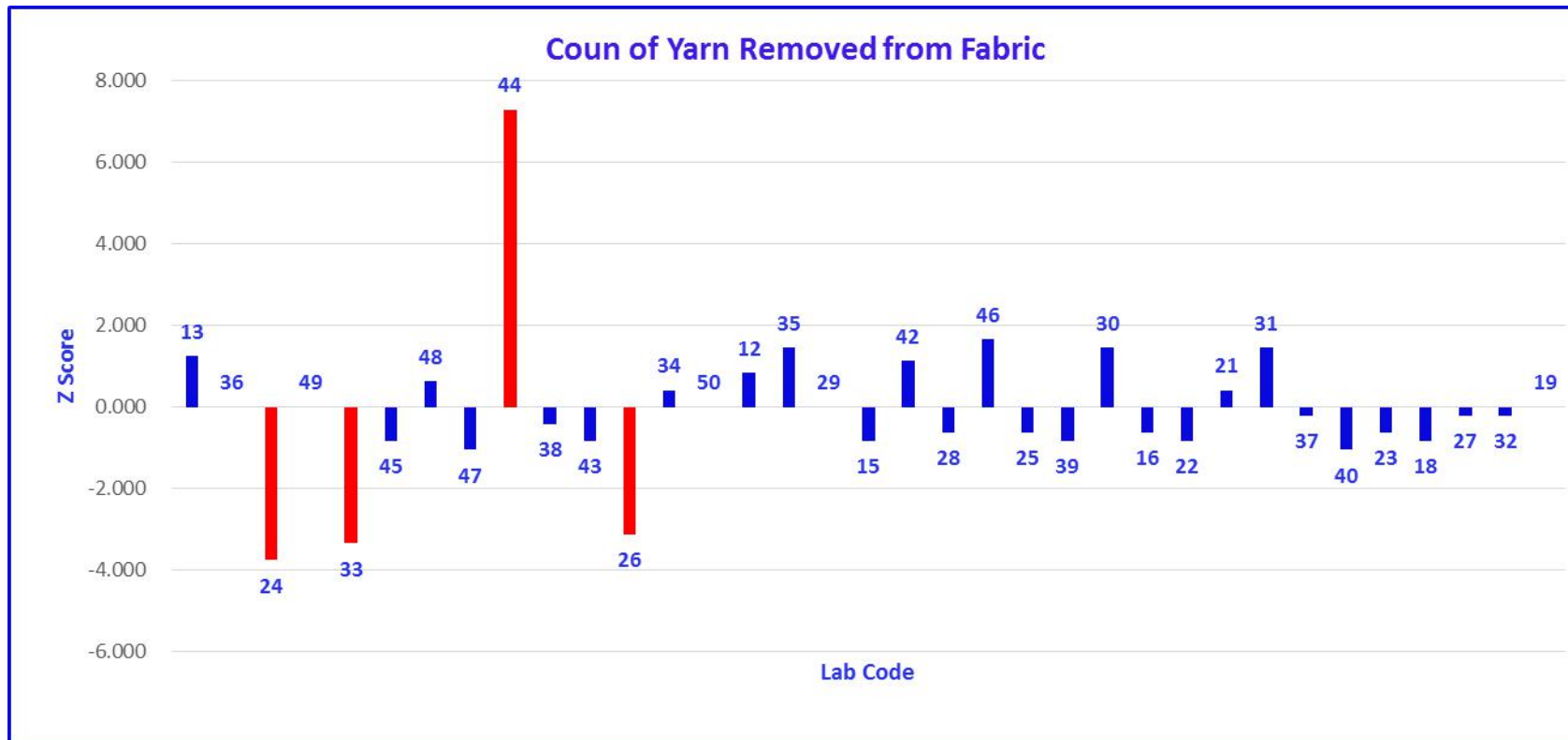
Lab code	Reported value (cc Ne)	Test method adopted	Z- Score	Performance Remark
13	31.1	IS 3442 1980(RA 2004)	1.250	Satisfactory
36	30.5	In houe Method	0.000	Satisfactory
24	28.7	IS 3442 1980(RA 2004)	-3.750	Outlier
49	30.5	ASTM D 1059	0.000	Satisfactory
33	28.9	In houe Method	-3.333	Outlier
45	30.1	ISO 7211 Part-5 1984	-0.833	Satisfactory
48	30.8	In House Method	0.625	Satisfactory
47	30.0	IS 3442 1980(RA 2004)	-1.042	Satisfactory
44	34	IS 3442 1980(RA 2004)	7.292	Outlier
38	30.3		-0.417	Satisfactory
43	30.1	IS 3442 1980(RA 2004)	-0.833	Satisfactory
26	29.0	In House Method	-3.125	Outlier
34	30.7	ASTM D 1059 -2001	0.417	Satisfactory
50	30.5	IS 3442 1980(RA 2004)	0.000	Satisfactory
12	30.9		0.833	Satisfactory
35	31.2	In House Method	1.458	Satisfactory
29	30.5	ASTM D 1059 -2001	0.000	Satisfactory
15	30.1	In houe Method	-0.833	Satisfactory
42	31.04	ISO 7211 Part-5 1984	1.125	Satisfactory
28	30.2	ISO 7211 Part-5 1984	-0.625	Satisfactory
46	31.3	In houe Method	1.667	Satisfactory
25	30.2	In houe Method	-0.625	Satisfactory
39	30.1	In houe Method	-0.833	Satisfactory
30	31.2	In houe Method	1.458	Satisfactory
16	30.2	In houe Method	-0.625	Satisfactory
22	30.1	In houe Method	-0.833	Satisfactory
21	30.7	In houe Method	0.417	Satisfactory
31	31.2	In houe Method	1.458	Satisfactory
37	30.4	In houe Method	-0.208	Satisfactory
40	30.0	In houe Method	-1.042	Satisfactory
23	30.2	In houe Method	-0.625	Satisfactory
18	30.1	In houe Method	-0.833	Satisfactory
27	30.4	In houe Method	-0.208	Satisfactory
32	30.4	In houe Method	-0.208	Satisfactory
19	30.5	In houe Method	0.000	Satisfactory
No. of participants	35			
Maximum	34			
Minimum	28.7			
Mean	30.4			
Std Deviation	0.86			
Median	30.4			

SUMMARY

Robust Average =	30.5
Robust SD for all valid participants (σ_1) =	0.48
Between sample SD of Homogeneity testing (S_s) =	0.13
SD for PT Scheme with allowance for the heterogeneity if any (σ) =	0.48

No Heterogeneity observed

Assigned Value (X) =	30.5
SD of PT Scheme (σ) =	0.48



**5. Tearing Strength of Fabric
(Elmendorf)**

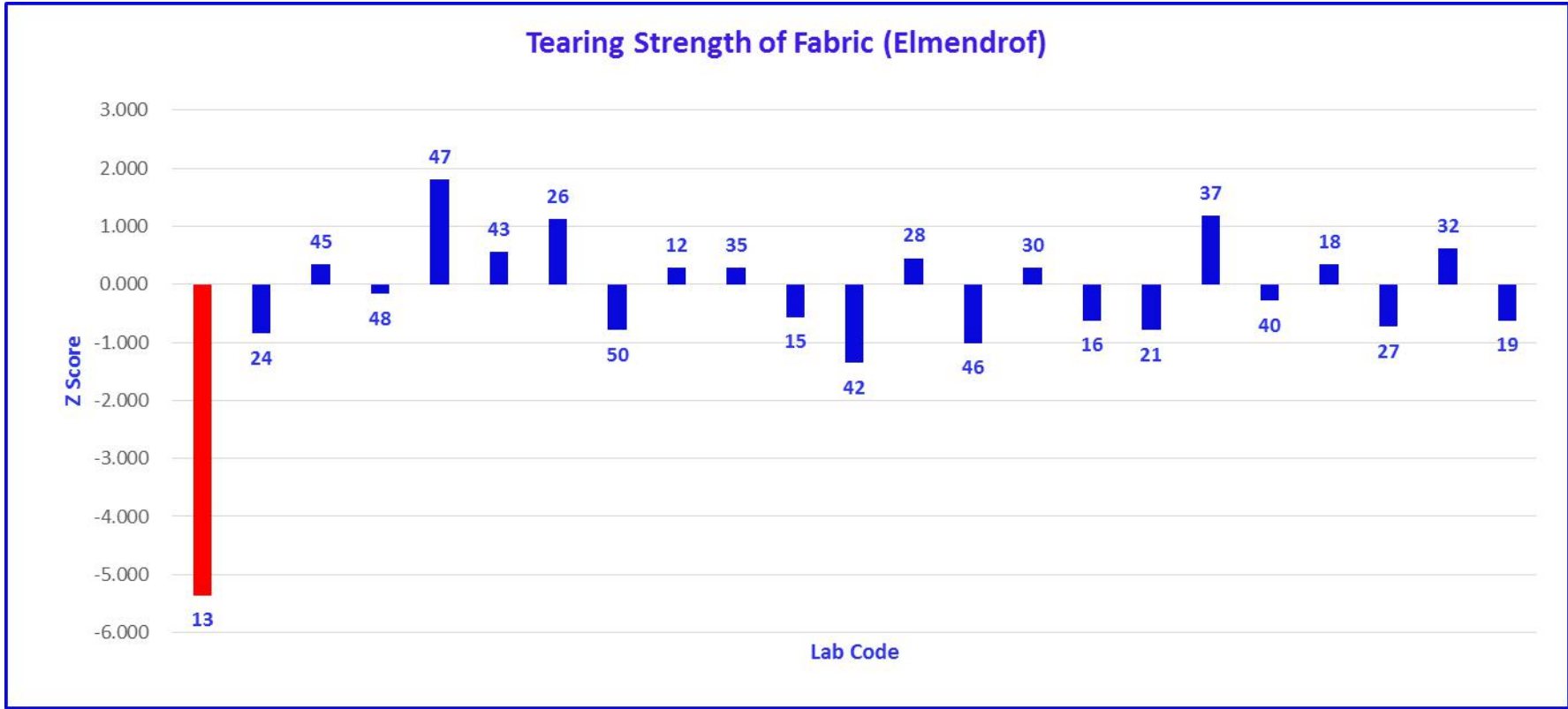
Lab code	Reported value (N)	Test method adopted	Z- Score	Performance Remark
13	8.3		-5.367	Outlier
24	16.3	ISO 13937-1 2000 (2017)	-0.847	Satisfactory
45	18.4	ASTM D 1424-09 (2013)	0.339	Satisfactory
48	17.5	ASTM D 1424-09 (2013)	-0.169	Satisfactory
47	21	ISO 13937-1 2000 (2017)	1.808	Satisfactory
43	18.8	ASTM D 1424-09 (2013)	0.565	Satisfactory
26	19.8	ASTM D 1424-09 (2013)	1.130	Satisfactory
50	16.4	ISO 13937-1 2000 (2017)	-0.791	Satisfactory
12	18.3		0.282	Satisfactory
35	18.3	ASTM D 1424-09 (2013)	0.282	Satisfactory
15	16.8	ASTM D 1424-09 (2013)	-0.565	Satisfactory
42	15.4	ISO 13937-1 2000 (2017)	-1.356	Satisfactory
28	18.6	ASTM D 1424-09 (2013)	0.452	Satisfactory
46	16		-1.017	Satisfactory
30	18.3	ASTM D 1424-09 (2013)	0.282	Satisfactory
16	16.7	ISO 13937-1 2000 (2017)	-0.621	Satisfactory
21	16.4	ASTM D 1424-09 (2013)	-0.791	Satisfactory
37	19.9	ASTM D 1424-09 (2013)	1.186	Satisfactory
40	17.3	ASTM D 1424-09 (2013)	-0.282	Satisfactory
18	18.4	ASTM D 1424-09 (2013)	0.339	Satisfactory
27	16.5	ASTM D 1424-09 (2013)	-0.734	Satisfactory
32	18.9	ASTM D 1424-09 (2013)	0.621	Satisfactory
19	16.7	ISO 13937-1 2000 (2017)	-0.621	Satisfactory
No. of participants	23			
Maximum	21			
Minimum	8.3			
Mean	17.3			
Std Deviation	2.42			
Median	17.5			

SUMMARY

Robust Average =	17.8 N
Robust SD for all valid participants (σ_1) =	1.6 N
Between sample SD of Homogeneity testing (S_s) =	0.77
SD for PT Scheme with allowance for the heterogeneity if any (σ) =	1.77

Heterogeneity observed

Assigned Value (X) =	17.8
SD of PT Scheme (σ) =	1.77



6. BREAKING FORCE (Fabric)- GRAB

Lab code	Reported value (N)	Test method adopted	Z- Score	Performance Remark
13	291.8	ASTM 5034-09 (2017)	-1.116	Satisfactory
45	327.1	ASTM 5034-09 (2017)	-0.037	Satisfactory
48	326.2	ASTM 5034-09 (2017)	-0.064	Satisfactory
47	347.3	ASTM 5034-09 (2017)	0.581	Satisfactory
43	321.3	ASTM 5034-09 (2017)	-0.214	Satisfactory
26	198.2	IS 1969 Part-2 2009 RA 2014	-3.979	Outlier
50	352	ASTM 5034-09 (2017)	0.725	Satisfactory
12	329.6	ASTM 5034-09 (2017)	0.040	Satisfactory
29	329	ASTM 5034-09 (2017)	0.021	Satisfactory
15	266.8	ASTM 5034-09 (2017)	-1.881	Satisfactory
42	376.9	ASTM 5034-09 (2017)	1.486	Satisfactory
39	356.9	ISO 13934-2 2014	0.875	Satisfactory
16	284.8	ASTM 5034-09 (2017)	-1.330	Satisfactory
22	332.1	ASTM 5034-09 (2017)	0.116	Satisfactory
37	313.2	ASTM 5034-09 (2017)	-0.462	Satisfactory
40	303.5	ASTM 5034-09 (2017)	-0.758	Satisfactory
23	330	ASTM 5034-09 (2017)	0.052	Satisfactory
18	326.6	IS 1969 Part-2 2009 RA 2014	-0.052	Satisfactory
32	364.3	IS 1969 Part-2 2009 RA 2014	1.101	Satisfactory
No. of participants	19			
Maximum	376.9			
Minimum	198.2			
Mean	319.9			
Std Deviation	40.1			
Median	327.1			

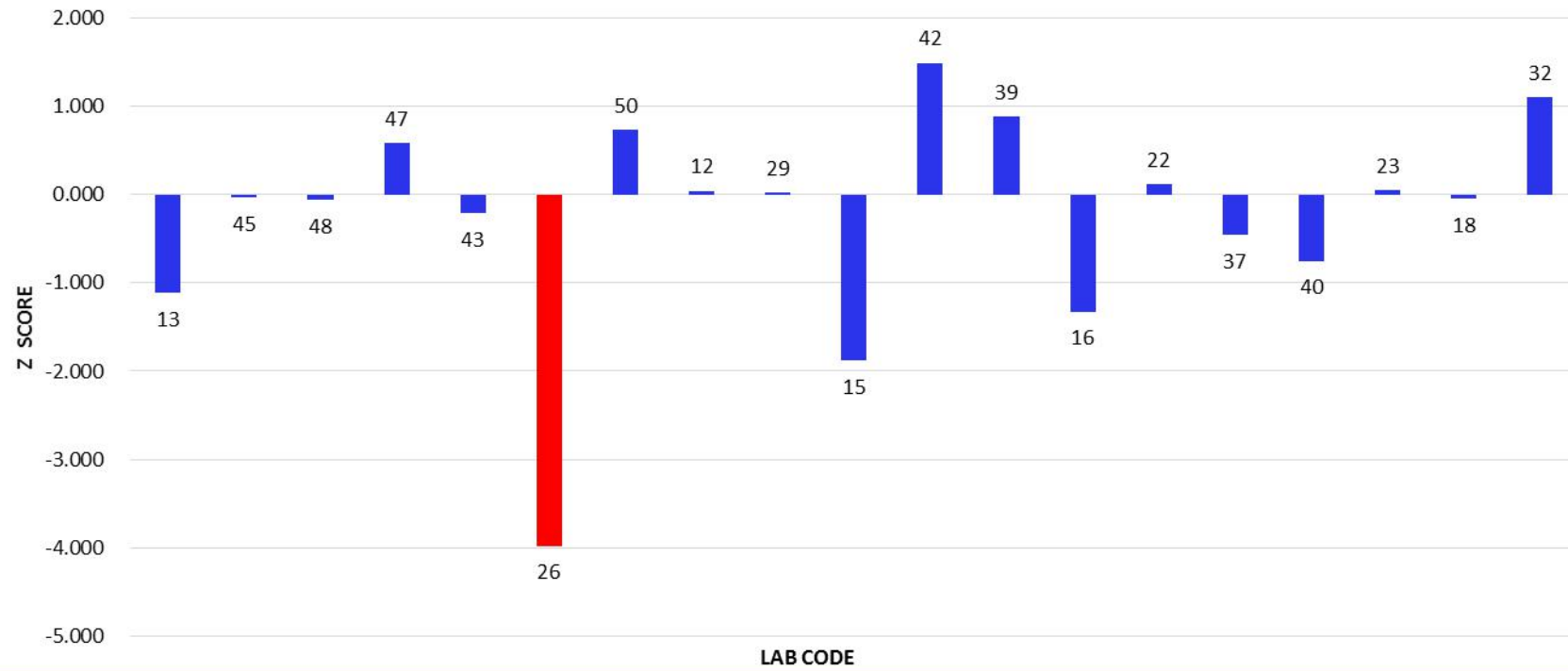
SUMMARY

Robust Average =	328.3 N
Robust SD for all valid participants (σ_1) =	34.1 N
Between sample SD of Homogeneity testing (S_S) =	12.1 N
SD for PT Scheme with allowance for the heterogeneity if any (σ) =	32.7 N

Heterogeneity observed

Assigned Value (X) =	328.3 N
SD of PT Scheme (σ) =	32.7 N

Fabric Breaking Force - Grab Methd



7. Tearing Strength of Fabric (Tongue)

Lab code	Reported value (N)	Test method adopted	Z- Score	Performance Remark
13	14	ASTM D 2261-13 (2017)	-2.243	Straggler
45	21.3	ASTM D 2261-13 (2017)	1.233	Satisfactory
48	20.6	ASTM D 2261-13 (2017)	0.900	Satisfactory
47	20.6	ASTM D 2261-13	0.900	Satisfactory
43	18.8	ASTM D 2261-13 (2017)	0.043	Satisfactory
26	25.3	ASTM D 2261-13 (2017)	3.138	Outlier
50	18.4	ASTM D 2261-13 (2017)	-0.148	Satisfactory
12	19.6	ASTM D 2261-13 (2017)	0.424	Satisfactory
35	18.1	ASTM D 2261-13 (2017)	-0.290	Satisfactory
29	19	ASTM D 2261-13 (2017)	0.138	Satisfactory
15	11		-3.671	Outlier
42	18.1	ASTM D 2261-13 (2017)	-0.290	Satisfactory
28	17.3	ASTM D 2261-13 (2017)	-0.671	Satisfactory
46	17.4	ASTM D 2261-13 (2017)	-0.624	Satisfactory
39	19.3	ASTM D 2261-13 (2017)	0.281	Satisfactory
16	20.1	ASTM D 2261-13 (2017)	0.662	Satisfactory
32	18.3	ASTM D 2261-13 (2017)	-0.195	Satisfactory
No. of participants	17			
Maximum	25.3			
Minimum	11			
Mean	18.7			
Std Deviation	3.03			
Median	18.8			

SUMMARY

Robust Average =	18.71 N
Robust SD for all valid participants (σ_1) =	1.9
Between sample SD of Homogeneity testing (S_s) =	0.9
SD for PT Scheme with allowance for the heterogeneity if any (σ) =	2.1

Heterogeneity observed

Assigned Value (X) =	18.71 N
SD of PT Scheme (σ) =	2.1

