

# **INTER LABORATORY TESTING SCHEME**

**ON**

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

**TC/ILTS/024/MECH/2019-20**

**Conducted by**



**Proficiency Testing Provider  
Laboratories**

**TEXTILES COMMITTEE**

**(Ministry of Textiles, Government of India)**

**P. Balu Road, Prabhadevi Chowk,  
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**2019-2020**

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2019-2020

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**SCHEME :** INTER LABORATORY TESTING SCHEME -TC/ILTS/24/MECH/2019-20-Testing of  
Mechanical parameters in Textile Materials

**DATE OF ISSUE:** 22.02.2021

### **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

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**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.

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## Report on Inter Laboratory Testing Scheme (TC/ILTS/024/MECH//2019-20)

### 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 participates in Inter Laboratory Proficiency Testing (ILPT) schemes conducted by different professional bodies like American Standard for Testing and Materials (ASTM), USA, Institute for Inter laboratory Studies (IIS), The Netherlands and NABL, India, from time to time. Apart from this, Textiles committee also 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 has implemented the Management System in accordance with the requirements stipulated in ILAC G13 and ISO/IEC 17043. The PT Provider has conducted 25 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-13/2012-13	2012-13	Mechanical	Yarn and Fabric	13	42
14	TC/ILTS/Chem -14/2012-13	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
24	TC/ILTS/24/MECH/2019-20	2019-20	Mechanical	Yarn and Fabric	6	17
25	TC/ILTS/25/CHEM/2019-20	2019-20	Chemical	Fabric	7	29

### 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/024/MECH/2019-20** was designed. The test parameters thus covered in the present PT Scheme are given in Table – 2.

**Table – 2: Tests covered in TC/ILTS/24/MECH/2019-20**

Sr.No.	Test parameter	Standards suggested
1	Determination of Linear density of yarns spun on cotton system	IS1315 or Equivalent Test method
2	Lea Strength	IS1671 or Equivalent Test method
3	Determination of twist in yarn	IS 832 or Equivalent Test method
4	Unevenness of Textile strand using capacitance method (U%)	ISO 16549 or Equivalent Test method
5	Abrasion Resistance of textile fabric (Martindale method)	ASTM D: 4966 or Equivalent Test method
6	Estimation of moisture content	IS 199 or Equivalent Test method

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 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 enduring performance (Ref: ISO/IEC 17043), the basic parameter like moisture content of yarn and performance parameters like Abrasion Resistance of textile fabric (3) To satisfy Trade and industry requirements, performance parameters viz., Linear density of yarns, Lea Strength Breaking strength, Twist in yarn and Unevenness of Textile strand using capacitance method (U%) were included.

#### **Participants:**

In all 17 laboratories from India were participated in this scheme. Laboratories accredited by National Accreditation Board for testing and calibration Laboratories (NABL), India were participated in this scheme.

#### **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. In order to evaluate the confidentiality of samples among the participants, appropriate coding was done. Sampling procedure for Homogeneity testing, Stability testing and for distribution among participant laboratories are provided in Table – 3:

**Table – 3: Sampling procedure adopted for different purpose**

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

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 the entire 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  $\mu$  and standard deviation  $\sigma$  were estimated by using the results obtained in homogeneity and stability testing. Table - 4 consists of the estimates of population parameters.

**Dispatch of PT items:** The Proficiency Testing items were dispatched to the respective participant laboratories on 24<sup>th</sup> November 2020 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 14<sup>th</sup> December 2020.

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-4: Estimates of population parameters**

S.No	Test	Parameter	Estimation		
1	Estimation of Moisture Content in cotton Textile materials IS 199 or equivalent	Population mean ( $\mu$ ) =	6.32		
		Population SD ( $\sigma$ ) =	0.34		
		95% confidential limits for Population mean =	6.15	$\leq \mu \leq$	6.49
2	Determination of Linear Density of Yarn spun in cotton system IS-1315 or equivalent	Population mean ( $\mu$ ) =	29.37		
		Population SD ( $\sigma$ ) =	0.37		
		95% confidential limits for Population mean =	29.26	$\leq \mu \leq$	29.48
3	Lea Strength – IS: 1671 or equivalent	Population mean ( $\mu$ ) =	101.51		
		Population SD ( $\sigma$ ) =	2.85		
		95% confidential limits for Population mean =	99.9	$\leq \mu \leq$	103.13
4	Determination of Twist of yarn IS 832 or equivalent	Population mean ( $\mu$ ) =	736.01		
		Population SD ( $\sigma$ ) =	13.97		
		95% confidential limits for Population mean =	728.69	$\leq \mu \leq$	743.32
5	Unevenness of Textile strands using capacitance method  ISO 16549 or equivalent	Unevenness (U%) in yarn			
		Population mean ( $\mu$ ) =	9.86		
		Population SD ( $\sigma$ ) =	0.23		
		95% confidential limits for Population mean =	9.67	$\leq \mu \leq$	10.04
		Imperfections-Thin place per km			
		Population mean ( $\mu$ ) =	0.47		
		Population SD ( $\sigma$ ) =	0.58		
		95% confidential limits for Population mean =	0.00	$\leq \mu \leq$	0.94
		Imperfections-Thick place per km			
		Population mean ( $\mu$ ) =	18.68		
		Population SD ( $\sigma$ ) =	1.9		
		95% confidential limits for Population mean =	17.16	$\leq \mu \leq$	20.20
		Imperfections- Neps per km			
		Population mean ( $\mu$ ) =	45.6		
		Population SD ( $\sigma$ ) =	7.19		
95% confidential limits for Population mean =	39.95	$\leq \mu \leq$	51.35		
6	Abrasion Resistance of textile fabric (Martindale method) Part 4 : Assessment of appearance change ISO 12947-4:1999 or equivalent	Population mean ( $\mu$ ) =	N.A		
		Population SD ( $\sigma$ ) =	N.A		
		95% confidential limits for Population mean =	N.A.	$\leq \mu \leq$	N.A.

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 inappropriate for statistical evaluation like gross errors, miscalculations and transpositions were examined.

### **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: 2005. 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.

In case of Ordinal/Subjective test, mode of the values reported by Accredited participant laboratories for that test is considered as Assigned Value. 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.

The Assigned Value of both the parameters thus arrived are given in **Table-5**.

**Table 5: 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	Moisture Content in cotton Textile materials IS 199 or equivalent	6.42	0.26	0.09	12	16
2	Linear Density of Yarn spun in cotton system IS-1315 or equivalent	29.4	0.21	0.07	15	16
3	Lea Strength – IS: 1671 or equivalent	100.9	2.64	1.27	10	12
4	Determination of Twist of yarn IS 832 or equivalent	742.85	6.79	12.6	12	14
5	Unevenness of Textile strands using capacitance method (Unevenness (U%) in yarn) ISO 16549 or equivalent	9.847	0.23	0.09	6	6
	Imperfections-Thin place per km	0.467	0.83	0.21	6	6
	Imperfections-Thick place per km	21.2	2.33	2.80	6	6
	Imperfections- Neps per km	45.6	8.47	2.59	6	6
6	Abrasion Resistance of textile fabric (Martindale method) Part 4 : Assessment of appearance change ISO 12947-4:1999 or equivalent	2	N.A	N.A	5	7

### Determination of Standard Deviation for Proficiency Assessment ( $\sigma$ ):

The robust average and the robust standard deviation ( $\sigma_1$ ) 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, 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  $\sigma$  is the standard deviation of the Proficiency Assessment.

### Interpretation of Performance comment:

**Table – 6: Interpretation of Performance comment**

Range	Performance of Laboratory
<b>Objective Tests</b>	
$ Z - \text{Score}  \leq 2$	Satisfactory
$2 <  Z - \text{Score}  < 3$	Straggler
$ Z - \text{Score}  \geq 3$	Outlier
<b>Subjective Test</b>	
$  \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 are given in Table – 7.

**Table – 7: Outlier and Straggler Analysis**

S.No.	Test	No. of Labs Participated	Valid Results	No. of Stragglers	% of Stragglers	No. of Outliers	% of Outliers
1	Moisture Content in cotton Textile materials IS 199 or equivalent	16	16	1	6.25	1	6.25
2	Linear Density of Yarn spun in cotton system IS-1315 or equivalent	16	16	1	6.25	1	6.25
3	Lea Strength – IS: 1671 or equivalent	12	12	0	0	1	8.33
4	Determination of Twist of yarn IS 832 or equivalent	14	14	4	28.6	2	14.3
5	Unevenness of Textile strands using capacitance method (Unevenness (U%) in yarn) ISO 16549 or equivalent	6	6	0	0	0	0
	Imperfections-Thin place per km	6	6	0	0	0	0
	Imperfections-Thick place per km	6	6	0	0	1	16.7
	Imperfections- Neps per km	6	6	0	0	0	0
6	Abrasion Resistance of textile fabric (Martindale method) Part 4 : Assessment of appearance change ISO 12947-4:1999 or equivalent	7	7	0	0	0	0

Parameter-wise the outliers and stragglers are listed below:

**Table – 8: List of Outliers and Stragglers**

S. No	Test	Straggler		Outlier	
		No. of Labs	Lab codes	No. of Labs	Lab codes
1	Moisture Content in cotton Textile materials IS 199 or equivalent	1	M-36	1	M-27
2	Linear Density of Yarn spun in cotton system IS-1315 or equivalent	1	M-39	1	M-18
3	Lea Strength – IS: 1671 or equivalent	0	Nil	1	M-39
4	Determination of Twist of yarn IS 832 or equivalent	4	M-31, M-34, M-36, M-39	2	M-19, M-21
5	Unevenness of Textile strands using capacitance method (Unevenness (U%) in yarn) ISO 16549 or equivalent	0	Nil	0	Nil
	Imperfections-Thin place per km	0	Nil	0	Nil
	Imperfections-Thick place per km	0	Nil	1	M-39
	Imperfections- Neps per km	0	Nil	0	Nil
6	Abrasion Resistance of textile fabric (Martindale method) Part 4 : Assessment of appearance change ISO 12947-4:1999 or equivalent	0	Nil	0	Nil

**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.

## Annexure

### PERFORMANCE EVALUATION OF EACH LABORATORY- TEST WISE

#### 1. Moisture Content

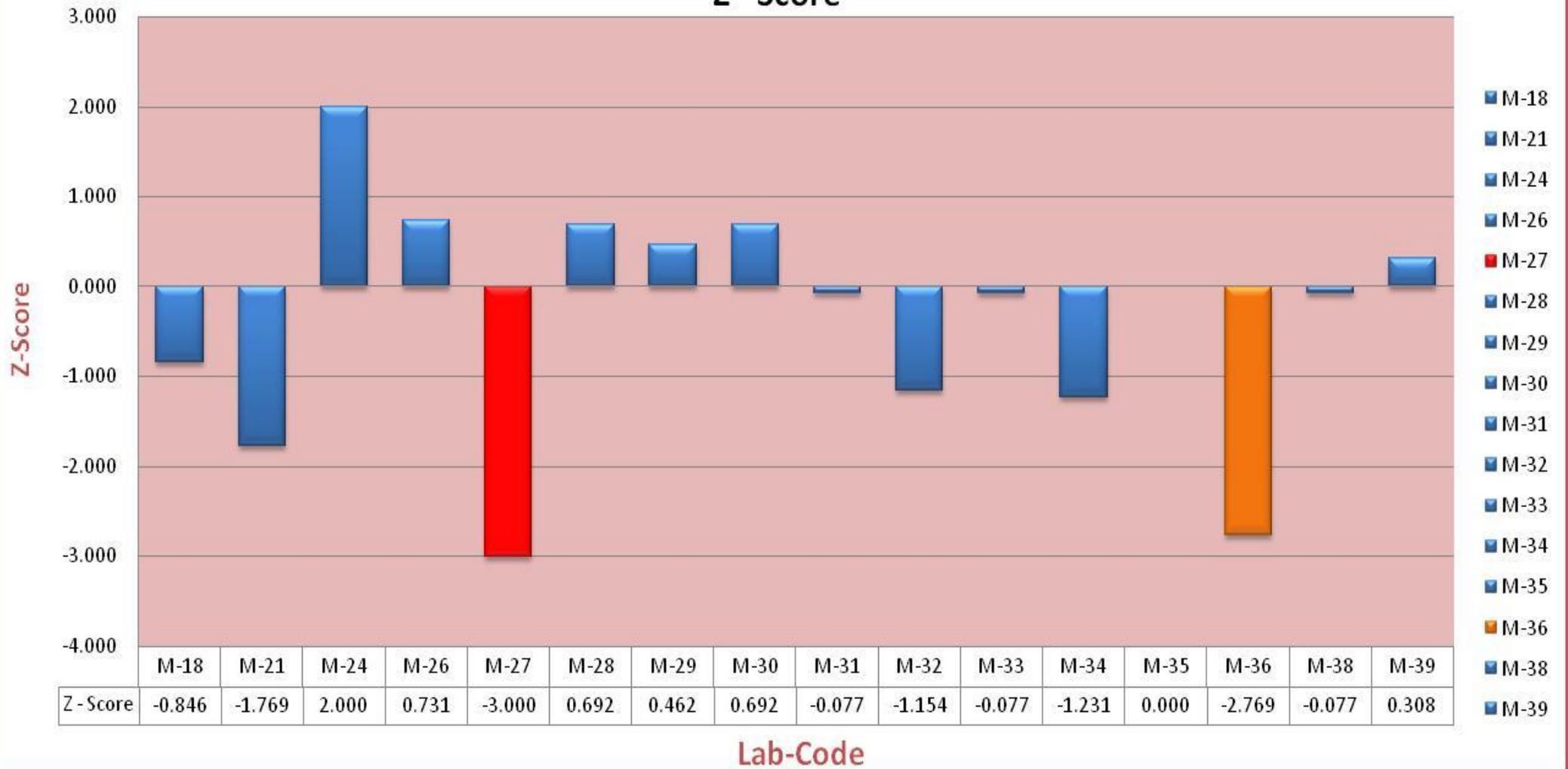
Lab code	Reported value (%)	Test adopted	method	Z- Score	Performance Remark
M-18	6.20	IS 199:1989		-0.846	Satisfactory
M-21	5.96	IS 199:1989		-1.769	Satisfactory
M-24	6.94	IS 199:1989		2.000	Satisfactory
M-26	6.61	IS 199:1989		0.731	Satisfactory
M-27	5.64	IS 199:1989		-3.000	Outlier
M-28	6.60	IS 199:1989		0.692	Satisfactory
M-29	6.54	IS 199:1989		0.462	Satisfactory
M-30	6.60	IS 199:1989		0.692	Satisfactory
M-31	6.40	IS 199:1989		-0.077	Satisfactory
M-32	6.12	IS 199:1989		-1.154	Satisfactory
M-33	6.40	IS 199:1989		-0.077	Satisfactory
M-34	6.10	IS 199:1989		-1.231	Satisfactory
M-35	6.42	IS 199:1989		0.000	Satisfactory
M-36	5.70	IS 199:1989		-2.769	Straggler
M-38	6.40	IS 199:1989		-0.077	Satisfactory
M-39	6.50	IS 199:1989		0.308	Satisfactory
No. of participants	16				
Maximum	6.94				
Minimum	5.64				
Mean	6.32				
Std Deviation	0.35				
Median	6.40				

#### SUMMARY

Robust Average=	<b>6.33</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>0.34</b>
Between sample SD of Homogeneity testing ( $S_S$ ) =	<b>0.079</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	<b>N.A.</b>
<b>No Heterogeneity observed</b>	
<b>Assigned Value ( X ) =</b>	<b>6.42</b>
<b>SD of PT Scheme ( <math>\sigma</math> ) =</b>	<b>0.26</b>

## Estimation of moisture content

### Z - Score



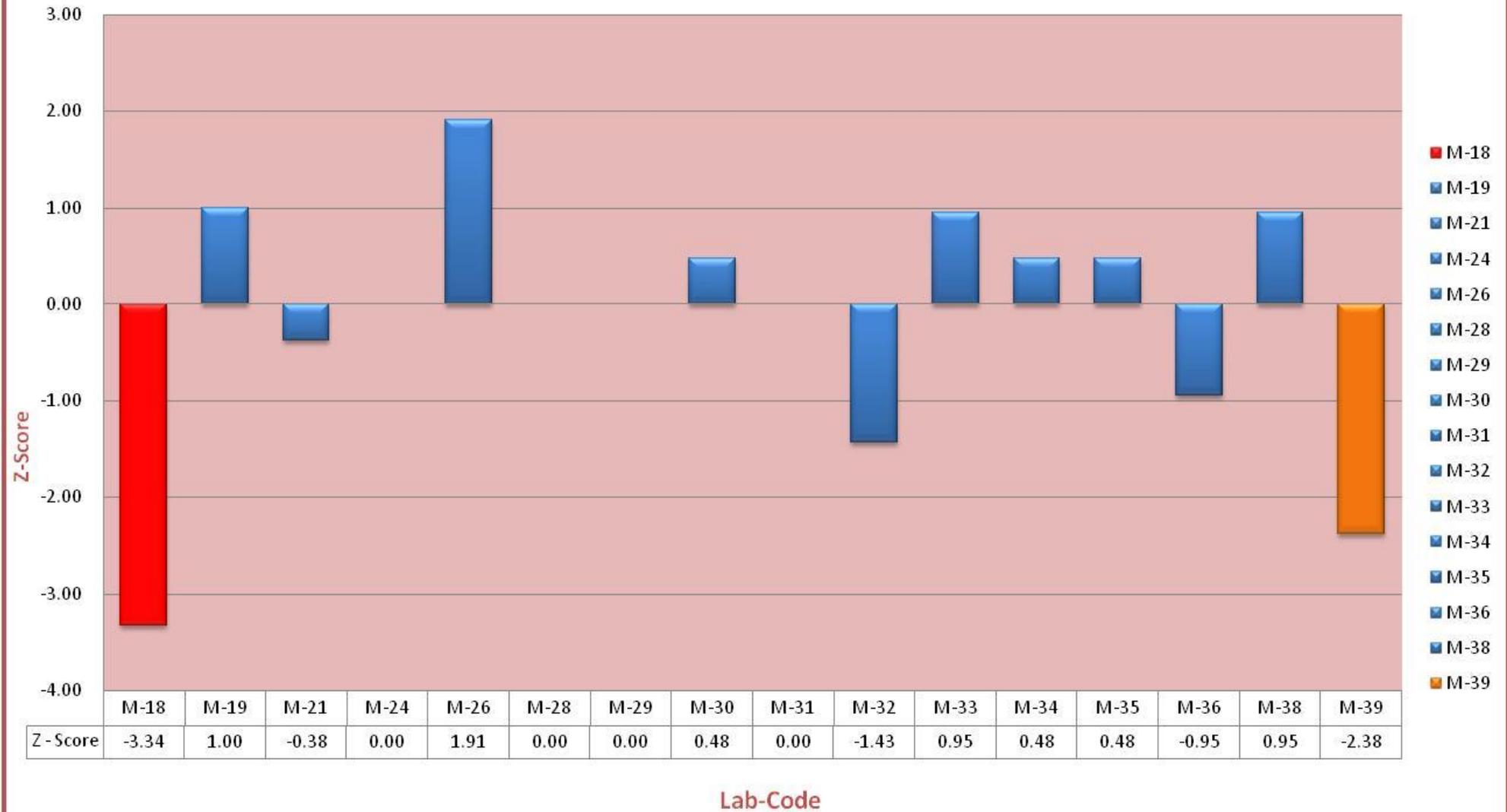
## 2. Linear Density of Yarn

Lab code	Reported value (Ne-single)	Test method adopted	Z- Score	Performance Remark
M-18	<b>28.70</b>	IS 1315	<b>-3.34</b>	<b>Outlier</b>
M-19	29.61	IS 1315	1.00	Satisfactory
M-21	29.32	IS 1315	-0.38	Satisfactory
M-24	29.4	IS 1315	0.00	Satisfactory
M-26	29.8	IS 1315	1.91	Satisfactory
M-28	29.4	IS 1315	0.00	Satisfactory
M-29	29.4	IS 1315	0.00	Satisfactory
M-30	29.5	IS 1315	0.48	Satisfactory
M-31	29.4	IS 1315	0.00	Satisfactory
M-32	29.10	IS 1315	-1.43	Satisfactory
M-33	29.60	IS 1315	0.95	Satisfactory
M-34	29.5	IS 1315	0.48	Satisfactory
M-35	29.5	IS 1315	0.48	Satisfactory
M-36	29.2	IS 1315	-0.95	Satisfactory
M-38	29.60	IS 1315	0.95	Satisfactory
M-39	28.90	IS 1315	-2.38	Straggler
No. of participants	16			
Maximum	29.80			
Minimum	28.70			
Mean	29.37			
Std Deviation	0.28			
Median	29.40			

### SUMMARY

Robust Average=	<b>29.4</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>0.23</b>
Between sample SD of Homogeneity testing ( $S_S$ ) =	<b>0.117</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	<b>0.21</b>
<b>Heterogeneity accounted</b>	
<b>Assigned Value ( X ) =</b>	<b>29.4</b>
<b>SD of PT Scheme ( <math>\sigma</math> ) =</b>	<b>0.21</b>

### Linear Density of Yarn (Z - Score)

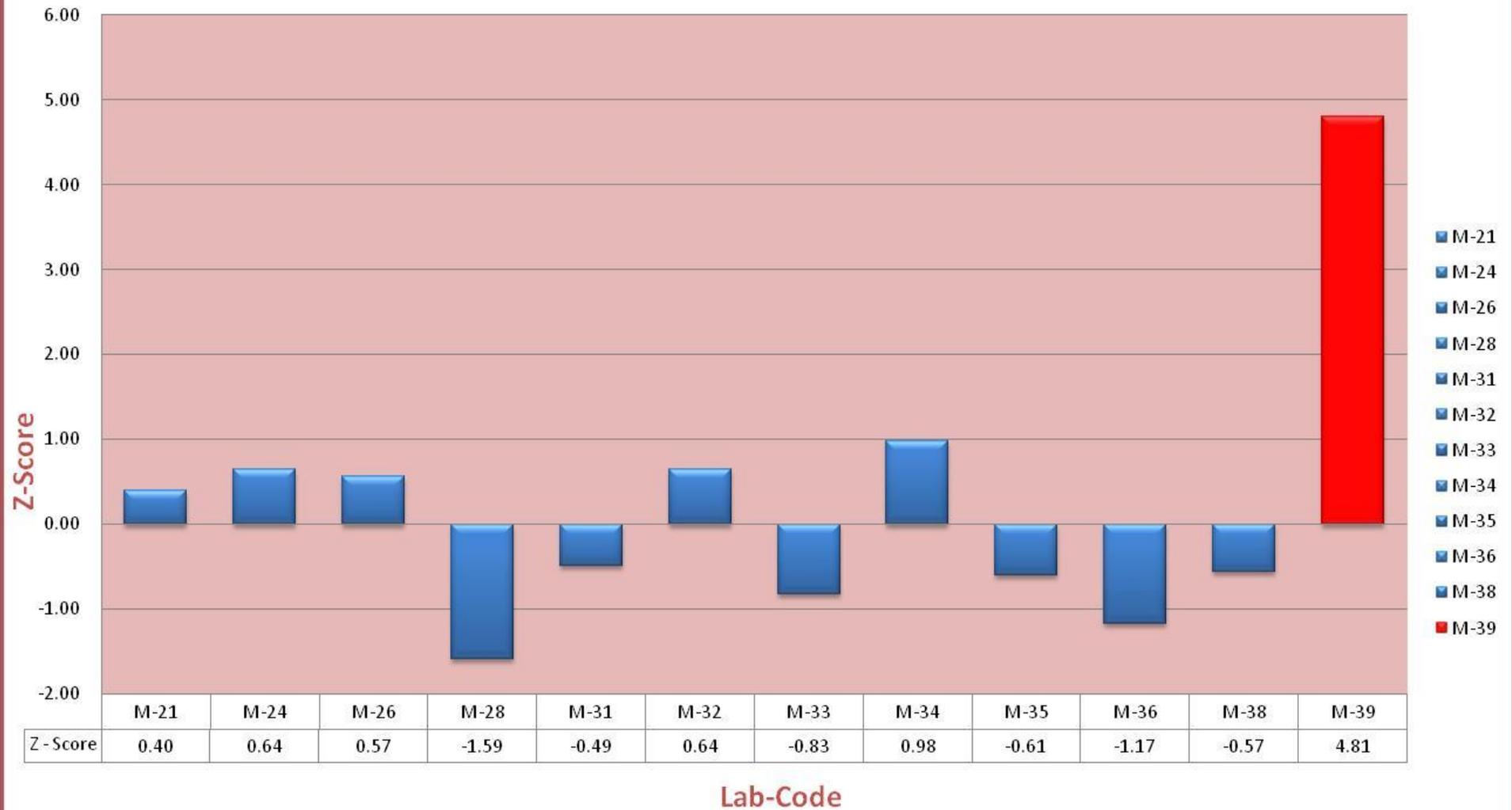


### 3. Lea Strength

Lab code	Reported value (in lb)	Test method adopted	Z- Score	Performance Remark
M-21	101.96	IS:1671	<b>0.40</b>	<b>Satisfactory</b>
M-24	102.60	IS:1671	<b>0.64</b>	<b>Satisfactory</b>
M-26	102.40	IS:1671	<b>0.57</b>	<b>Satisfactory</b>
M-28	96.7	IS:1671	<b>-1.59</b>	<b>Satisfactory</b>
M-31	99.6	IS:1671	<b>-0.49</b>	<b>Satisfactory</b>
M-32	102.6	IS:1671	<b>0.64</b>	<b>Satisfactory</b>
M-33	98.7	IS:1671	<b>-0.83</b>	<b>Satisfactory</b>
M-34	103.5	IS:1671	<b>0.98</b>	<b>Satisfactory</b>
M-35	99.3	IS:1671	<b>-0.61</b>	<b>Satisfactory</b>
M-36	97.80	IS:1671	<b>-1.17</b>	<b>Satisfactory</b>
M-38	99.40	IS:1671	<b>-0.57</b>	<b>Satisfactory</b>
M-39	<b>113.6</b>	IS:1671	<b>4.81</b>	<b>Outlier</b>
No. of participants	<b>12</b>			
Maximum	113.60			
Minimum	96.70			
Mean	101.51			
Std Deviation	4.38			
Median	100.78			

SUMMARY	
Robust Average=	<b>100.785</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>2.85</b>
Between sample SD of Homogeneity testing ( $S_S$ ) =	<b>1.210</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	<b>2.643</b>
<b>Heterogeneity accounted</b>	
<b>Assigned Value ( X ) =</b>	<b>100.9</b>
<b>SD of PT Scheme ( <math>\sigma</math> ) =</b>	<b>2.64</b>

## Lea Strength (Z - Score)



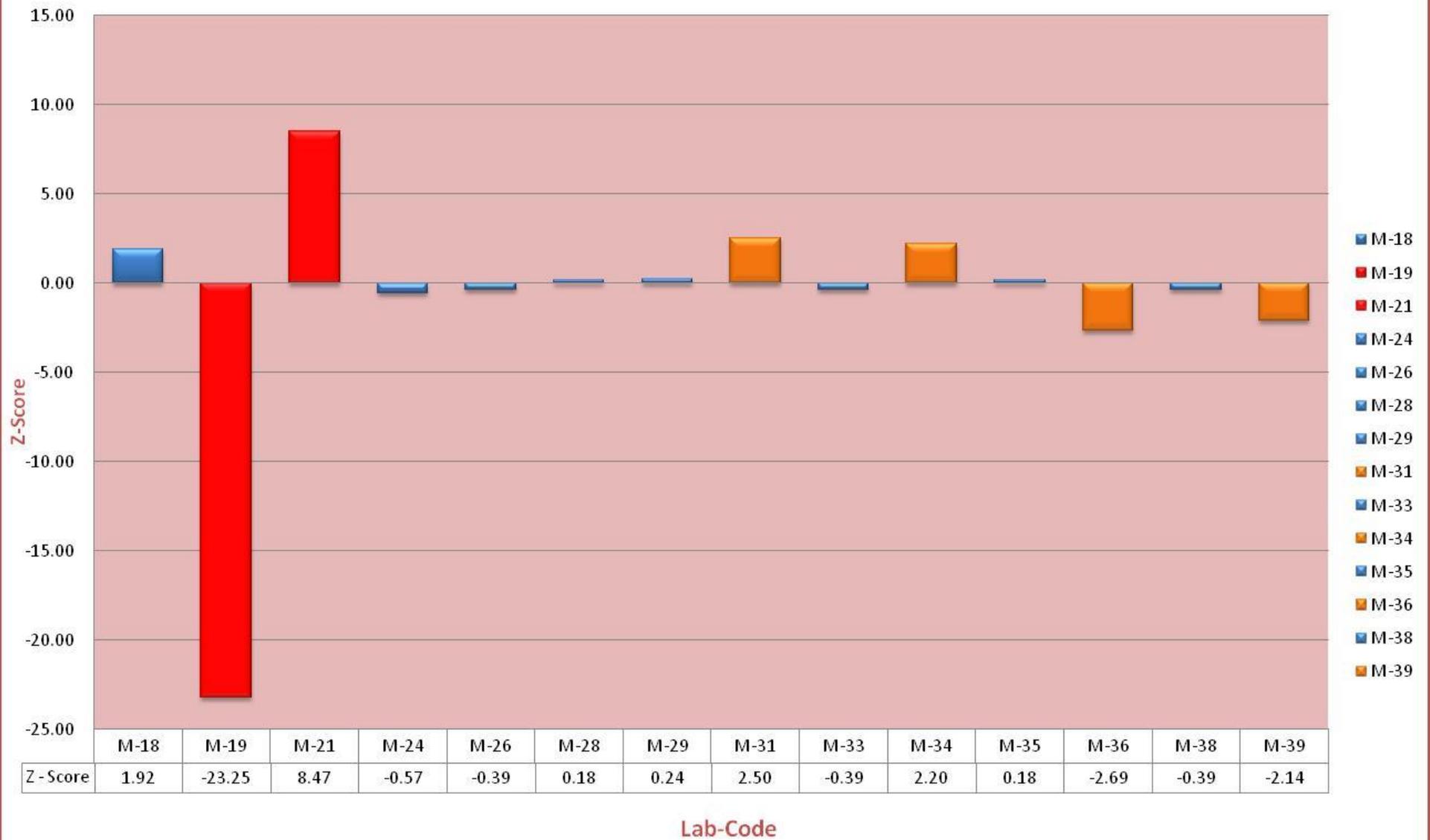
## 4. Determination of Twist of yarn

Lab code	Reported value (avg.TPM)	Test method adopted	Z- Score	Performance Remark
M-18	755.9	IS 832:2011	1.922	Satisfactory
M-19	<b>585.0</b>	ASTM D 1422	<b>-23.247</b>	Outlier
M-21	<b>800.4</b>	ASTM D 1422	<b>8.474</b>	Outlier
M-24	739.0	IS 832:2011	-0.567	Satisfactory
M-26	740.2	IS 832	-0.390	Satisfactory
M-28	744.1	ASTM D 1422	0.184	Satisfactory
M-29	744.5	ASTM D 1422	0.243	Satisfactory
M-31	759.8	ASTM D 1422	2.496	Straggler
M-33	740.2	ASTM D 1422	-0.390	Satisfactory
M-34	757.8	ASTM D 1422	2.202	Straggler
M-35	744.1	ASTM D 1422	0.184	Satisfactory
M-36	724.6	ASTM D 1422	-2.688	Straggler
M-38	740.2	ASTM D 1422	-0.390	Satisfactory
M-39	728.3	ASTM D 1422	-2.143	Straggler
No. of participants	14			
Maximum	800.39			
Minimum	585.00			
Mean	736.01			
Std Deviation	47.10			
Median	742.15			

### SUMMARY

Robust Average=	<b>743.296</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>13.97</b>
Between sample SD of Homogeneity testing ( $S_s$ ) =	<b>4.123</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	N.A.
<b>No Heterogeneity observed</b>	
Assigned Value ( X ) =	<b>742.85</b>
SD of PT Scheme ( $\sigma$ ) =	<b>6.79</b>

### Twist of yarn (Z - Score)



## 5.1 Unevenness (U%) in yarn

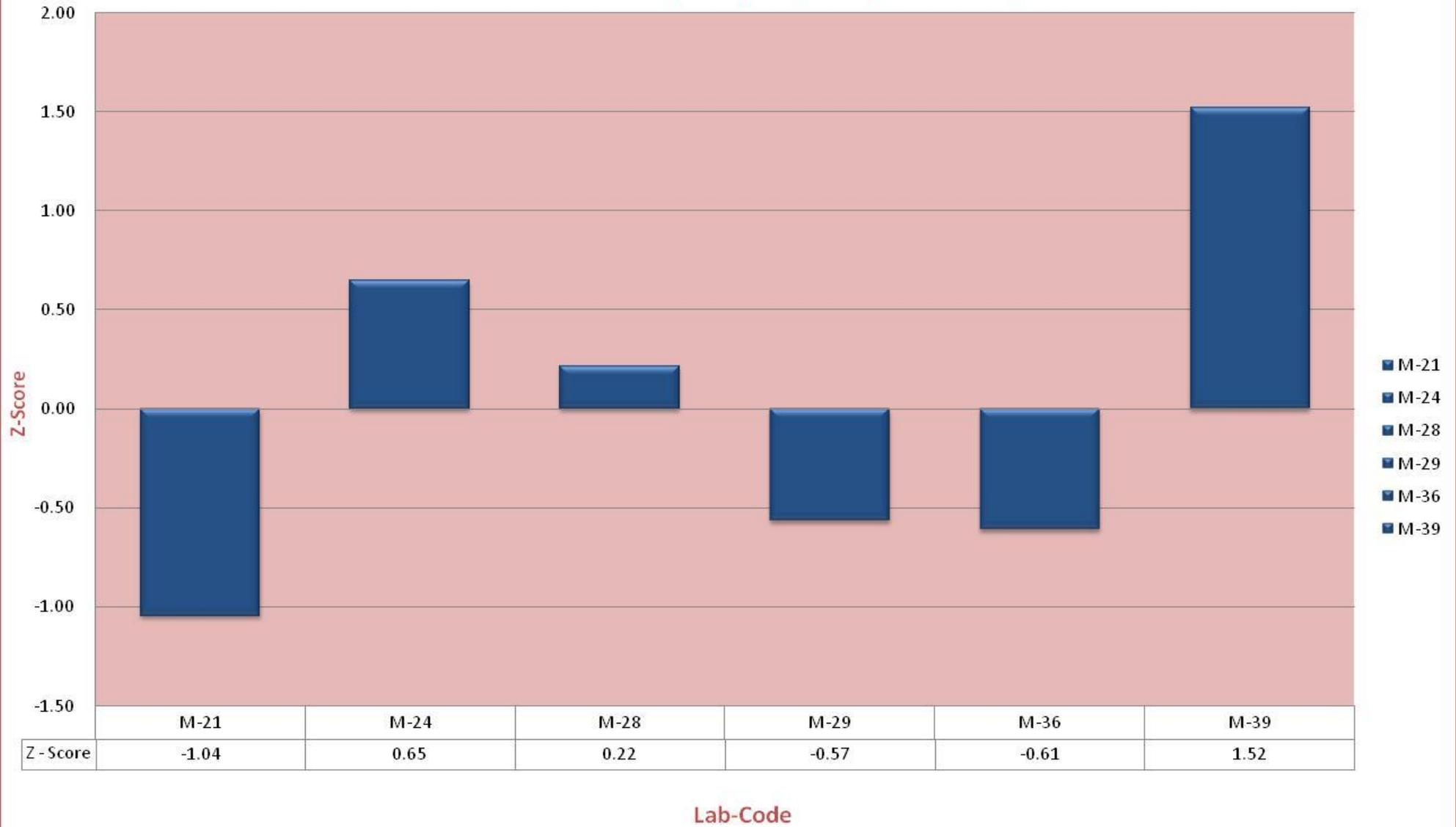
Lab code	Reported value (%)	Test method adopted	Z- Score	Performance Remark
M-21	9.61	ISO 16549	-1.04	Satisfactory
M-24	10.00	ASTM D 1425	0.65	Satisfactory
M-28	9.90	ASTM D 1425	0.22	Satisfactory
M-29	9.72	ISO 16549	-0.57	Satisfactory
M-36	9.71	ISO 16549	-0.61	Satisfactory
M-39	10.20	IS 16549	1.52	Satisfactory
No. of participants	6			
Maximum	10.20			
Minimum	9.61			
Mean	9.86			
Std Deviation	0.22			
Median	9.81			

### SUMMARY

Robust Average=	<b>9.847</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>0.23</b>
Between sample SD of Homogeneity testing ( $S_s$ ) =	<b>0.025</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	N.A.*
<b>* No Heterogeneity observed</b>	

<b>Assigned Value ( X ) =</b>	<b>9.85</b>
<b>SD of PT Scheme ( <math>\sigma</math> ) =</b>	<b>0.23</b>

### Unevenness (U%) in yarn (Z - Score)



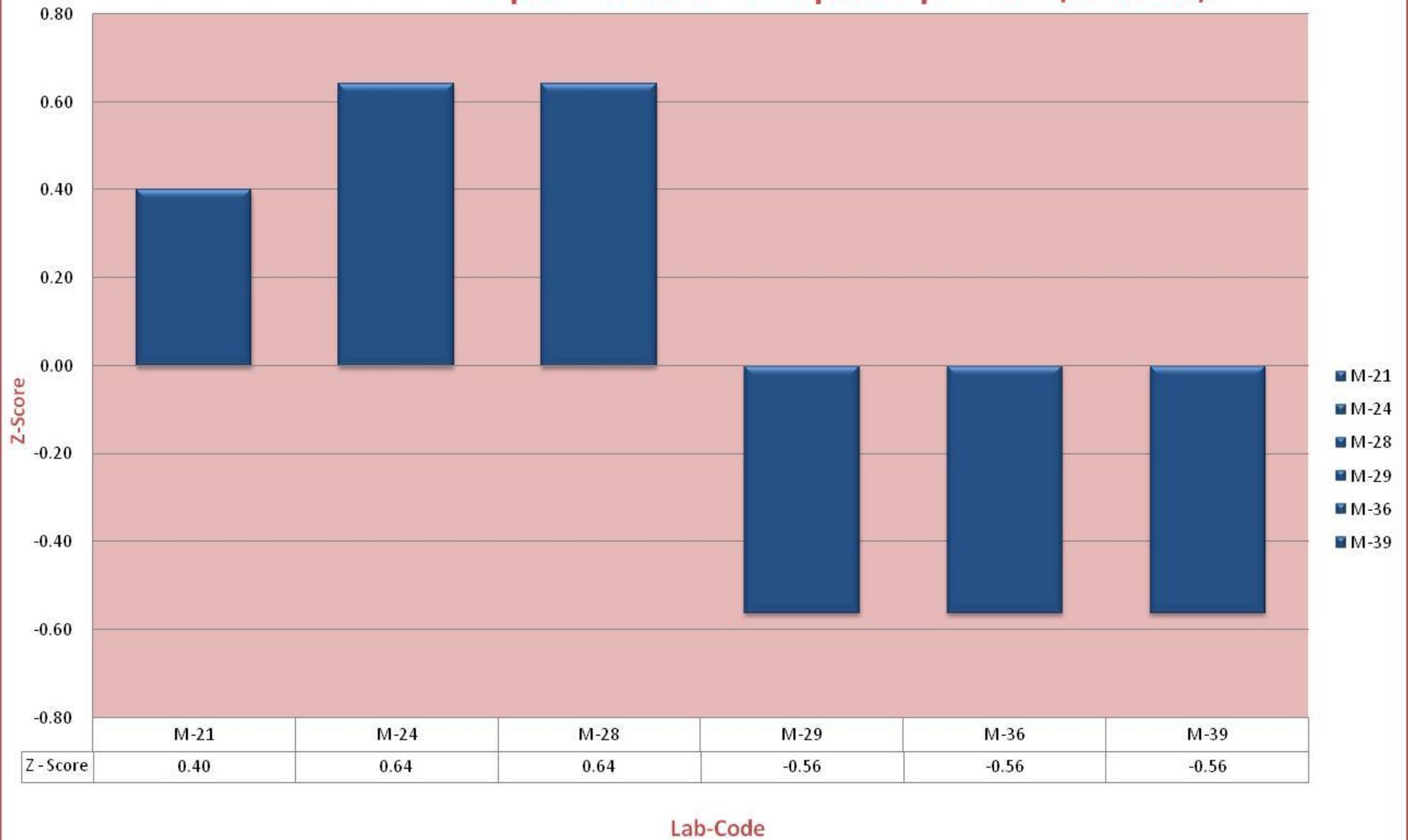
## 5.2 Imperfections-Thin place per km

Lab code	Reported value	Test method adopted	Z- Score	Performance Remark
M-21	0.80	ISO 16549	0.57	Satisfactory
M-24	1.00	ASTM D 1425	0.91	Satisfactory
M-28	1.00	ASTM D 1425	0.91	Satisfactory
M-29	0.00	ISO 16549	-0.80	Satisfactory
M-36	0.00	ISO 16549	-0.80	Satisfactory
M-39	0.00	IS 16549	-0.80	Satisfactory
No. of participants	6.00			
Maximum	1.00			
Minimum	0.00			
Mean	0.47			
Std Deviation	0.52			
Median	0.40			

### SUMMARY

Robust Average=	<b>0.467</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>0.586</b>
Between sample SD of Homogeneity testing ( $S_S$ ) =	<b>0.589</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	<b>0.831</b>
<b>Heterogeneity accounted</b>	
<b>Assigned Value ( X ) = 0.47</b>	
<b>SD of PT Scheme ( <math>\sigma</math> ) = 0.831</b>	

### Imperfections-Thin place per km (Z - Score)



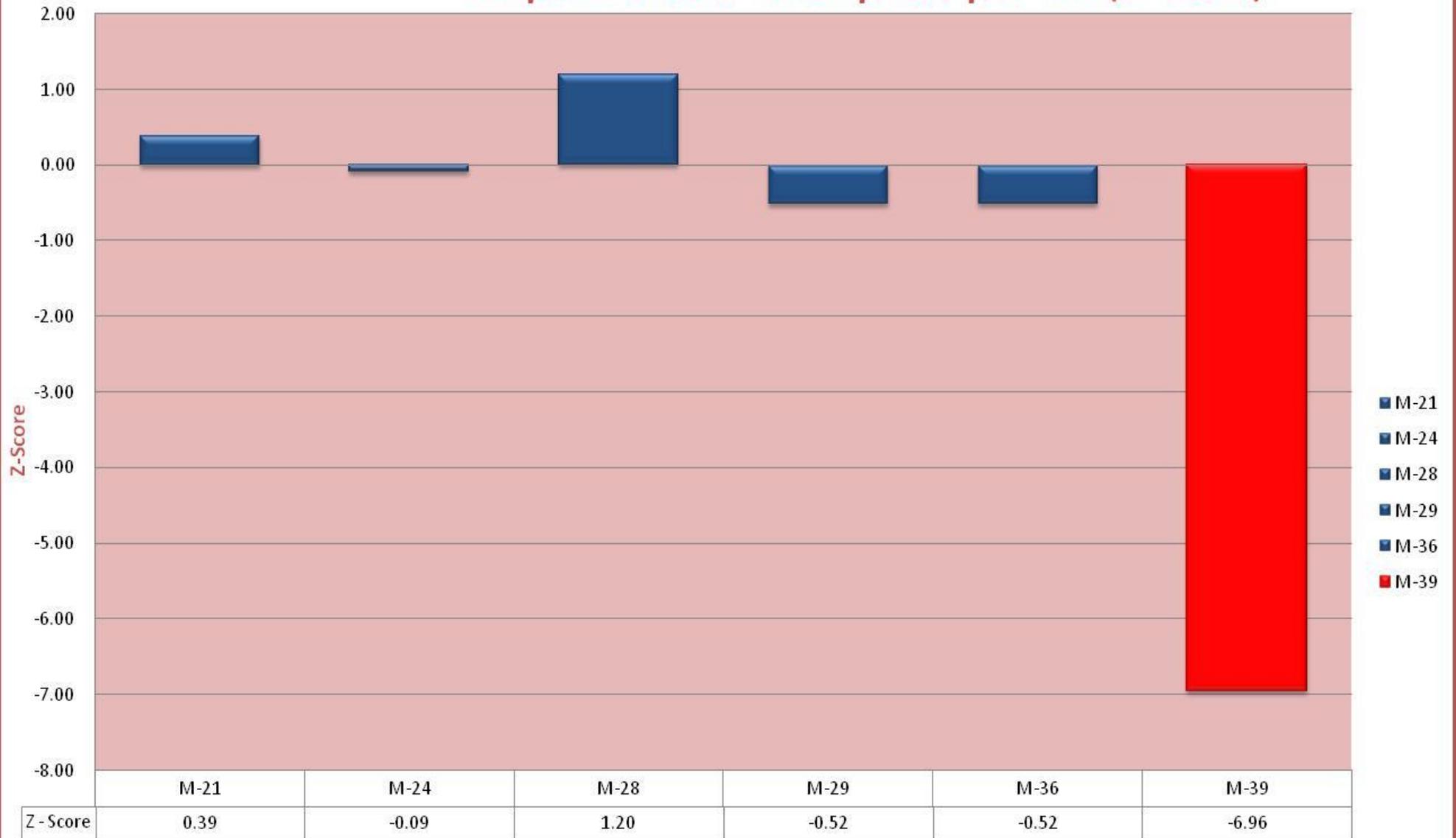
### 5.3 Imperfections-Thick place per km

Lab code	Reported value	Test method adopted	Z- Score	Performance Remark
M-21	22.1	ISO 16549	0.387	Satisfactory
M-24	21.0	ASTM D 1425	-0.086	Satisfactory
M-28	24.0	ASTM D 1425	1.203	Satisfactory
M-29	20.0	ISO 16549	-0.516	Satisfactory
M-36	20.0	ISO 16549	-0.516	Satisfactory
M-39	5.0	IS 16549	-6.962	Outlier
No. of participants	6.00			
Maximum	24.00			
Minimum	5.00			
Mean	18.68			
Std Deviation	6.87			
Median	20.50			

#### SUMMARY

Robust Average=	<b>20.7</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>1.9</b>
Between sample SD of Homogeneity testing ( $S_S$ ) =	<b>1.718</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	<b>2.327</b>
<b>Heterogeneity accounted</b>	
<b>Assigned Value ( X ) =</b>	<b>21.2</b>
<b>SD of PT Scheme ( <math>\sigma</math> ) =</b>	<b>2.33</b>

### Imperfections-Thick place per km (Z - Score)



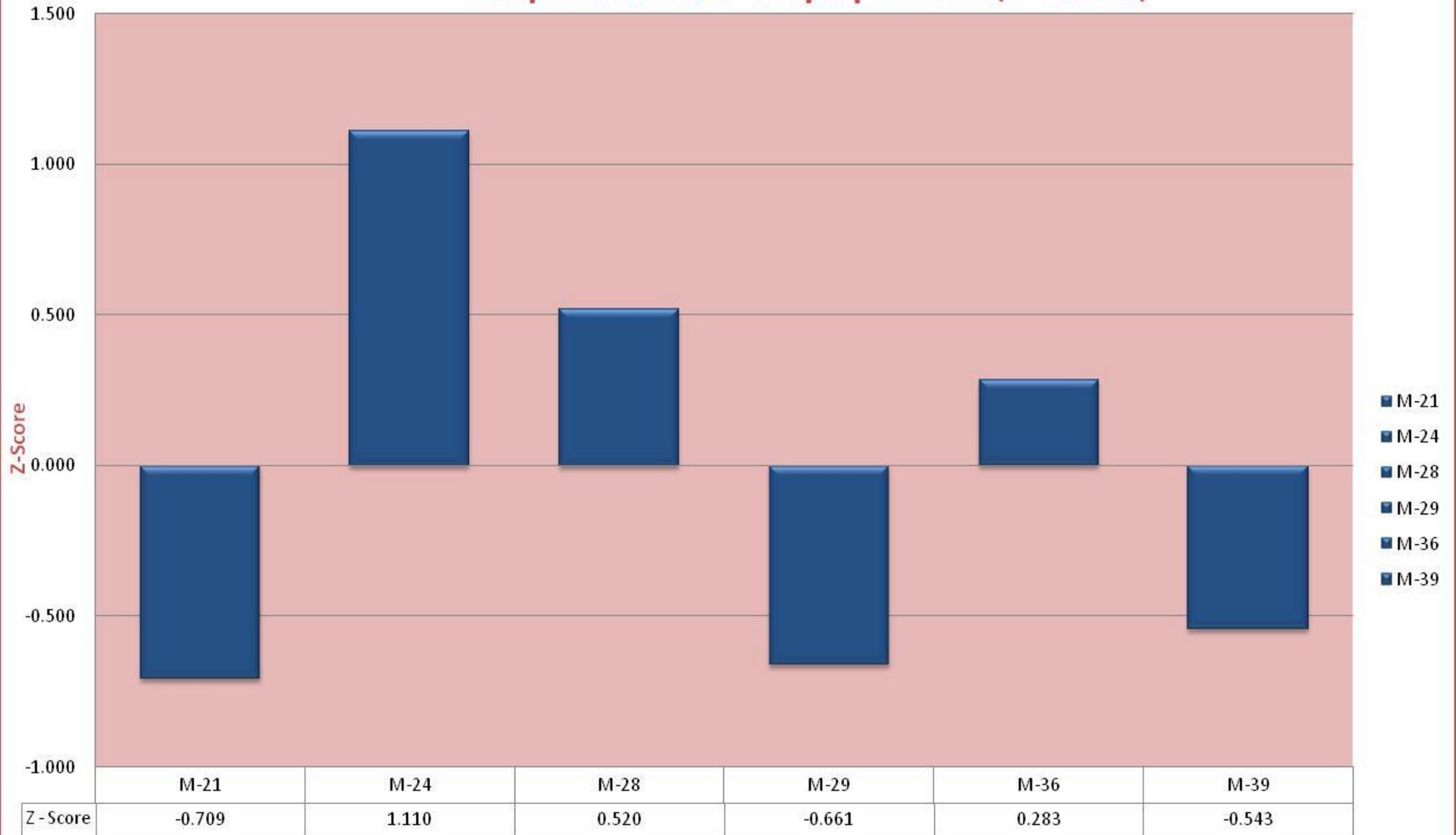
Lab-Code

### 5.4 Imperfections- Neps per km

Lab code	Reported value	Test adopted	method	Z- Score	Performance Remark
M-21	39.6	ISO 16549		<b>-0.709</b>	<b>Satisfactory</b>
M-24	55.0	ASTM D 1425		<b>1.110</b>	<b>Satisfactory</b>
M-28	50.0	ASTM D 1425		<b>0.520</b>	<b>Satisfactory</b>
M-29	40.0	ISO 16549		<b>-0.661</b>	<b>Satisfactory</b>
M-36	48.0	ISO 16549		<b>0.283</b>	<b>Satisfactory</b>
M-39	41.0	IS 16549		<b>-0.543</b>	<b>Satisfactory</b>
No. of participants	6				
Maximum	55.00				
Minimum	39.60				
Mean	45.60				
Std Deviation	6.36				
Median	44.50				

SUMMARY	
Robust Average=	<b>45.6</b>
Robust SD for all valid participants ( $\sigma_1$ ) =	<b>7.19</b>
Between sample SD of Homogeneity testing ( $S_s$ ) =	<b>4.472</b>
SD for PT Scheme with allowance for the heterogeneity if any ( $\sigma$ ) =	<b>8.467</b>
<b>Heterogeneity observed</b>	
<b>Assigned Value ( X ) =</b>	<b>45.6</b>
<b>SD of PT Scheme ( <math>\sigma</math> ) =</b>	<b>8.47</b>

### Imperfections-Neps per km (Z - Score)



Lab-Code

## 6. Abrasion Resistance of textile fabric (Martindale method) Change in Colour after 5000 rubs

Change in Color after 5000 rubs

**Assigned Value**

**2**

Lab No	Test Method	Reported Value	Reported Value – Assigned Value	Comments on performance
M-21	ISO :12947-4	2-3	<b>0.5</b>	<b>Satisfactory</b>
M-24	ISO :12947-4	2	<b>0</b>	<b>Satisfactory</b>
M-26	ISO :12947-4	2	<b>0</b>	<b>Satisfactory</b>
M-34	ISO :12947-4	2	<b>0</b>	<b>Satisfactory</b>
M-36	ISO :12947-4	2-3	<b>0.5</b>	<b>Satisfactory</b>
M-38	ISO :12947-4	2-3	<b>0.5</b>	<b>Satisfactory</b>
M-39	ISO :12947-4	1-2	<b>0.5</b>	<b>Satisfactory</b>
<b>participants</b>	<b>7</b>			
<b>max</b>	<b>2-3</b>			
<b>min</b>	<b>1-2</b>			
<b>median (M)</b>	<b>2</b>			

Grade	Change in Color after 5000 rubs
1	0
1-2	1
2	3
2-3	3
3	0
3-4	0
4	0
4-5	0
5	0
<b>participants</b>	<b>7</b>

Range	Performance of Laboratory
<b>Subjective Test</b>	
Reported Value – Assigned Value   ≤ ½ grade	Satisfactory
Reported Value - Assigned Value   > ½ grade	Outlier

