Assessment of Jute Fibre Strength by Impact Strength Method

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***Abstract*— Jute fibre strength is a critical parameter for assessing overall fibre quality. In the conventional bundle strength testing method, the longer testing times limits the number of samples that can be evaluated ina jute mill laboratory. As an alternative, the impact strength methos has been introduces, which reduces testing time and enables a larger number of samples, to be assessed quickly trough a simplier procedure.**

Key Words: Bundle strength, Jute fibre strength, CRL

I. INTRODUCTION

Jute is a natural bast fibre primarily grown in India, Bangladesh, Pakistan, China, Thailand, and other Southeast Asian countries. In India, it is popularly known as the "Golden Fibre" due to its significant economic value and widespread use. Jute is the second most important cash crop (after Cotton) in India, both in terms of usage and cultivation. Being a biodegradable economic natural fibre, jute is an affordable alternative of plastic and synthetic fibres.

Currently, there are approximately 75 jute mills operating in India. The majority of these mills are located in West Bengal, while others are situated at Andhra Pradesh, Uttar Pradesh, Bihar, Odisha, Assam, Chhattisgarh, and Tripura. Use of jute are versatile as given below:

Traditional Uses: Gunny sacks & Hessian bags: Used for packaging agricultural and industrial goods. Other used are :

- *Ropes and twines:* Strong and durable for binding and bundling.
- *Home & Lifestyle Products:* Rugs, carpets, and mats, Curtains, cushion covers, and wall hangings, Storage baskets and plant holders
- *Fashion and Accessories:* Handbags, purses, wallets, Footwear components, Jewelry and decorative items
- *Industrial and Eco-friendly Applications:*
- *Geotextiles:* Used in erosion control, soil stabilization, and road construction.
- *Composite materials:* Blended with synthetic fibers for automotive interiors and building panels.
- *Paper pulp and handicrafts:* Especially in eco-conscious markets.

Among the five measurable parameters of jute fibre quality—fibre strength, fibre fineness, defects, root content, and colour where fibre strength plays the most crucial role. It directly influences yarn strength and productivity. Stronger jute fibres result in higher yarn tenacity and improved spinning efficiency, ultimately leading to better fabric performance and durability.

II. INTENT

The objective of this project is to design and validate an easy-to-use and time-efficient methodology for measuring the strength of raw jute fibres. This approach should minimize the need for complex equipment and reduce processing time while maintaining accuracy and consistency in strength assessment, thereby facilitating better decision-making in fibre classification, pricing, and industrial application.

III. RATIONALIZATION

Jute fibre breaks when passing through the jute breaker card. In this process, the fibre is held by the iron shell while the cylinder roller, fitted with pins, imparts a sudden high- speed load. This action is comparable to Impact or Ballistic strength test, where fibres are subjected to a rapid force. Due to the sudden load application, the jute fibre breaks, and deliver a measurable value equivalent to fibre breaking load.

IV. MATERIAL AND METHOD

Strength is a key criterion for jute fibre, as it directly influences the quality of the final products such as yarn and fabric, as well as processing activities like spinning, winding and weaving. Jute with higher strength not only produces better quality products but also improves spinning performance conventionally, fibre strength is tested using (Constant Rate of Loading) CRL type machines. For this study, several raw jute morahs were collected and tested. A total of 60 sets of morahs of different grades, supplied by different jute mills, were included in the experiments. The raw jute fibres from each morah were tested separately using both bundle strength testing and impact strength testing method.

For testing the bundle strength of rawjute fibre, the procedure outlined in IS 7032 (Part – 7) was followed. The test length was maintained at 5 cm, with a total sample weight of approximately 3 g. The readings were obtained in kgf units, and the g/tex values were calculated manually afterwards.

For the impact strength test, fibre length of 1 m weighing 20 g were prepared and corresponding sample was mounted on the impact strength tester for testing

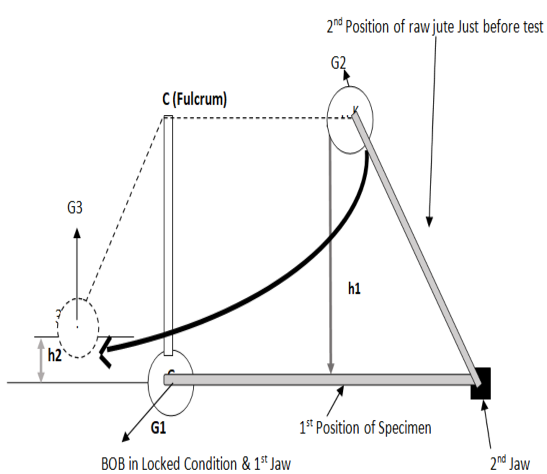

Fig. I, Ballistic Tester Principle

PRINCIPLE OF BALLISTIC TEST :

In the Impact (Ballistic) Strength Tester (Fig. 1), the reading is obtained in units of work or energy. The measured value depends on the height of the bob (position 2, G2); hence the energy is considered as potential energy. In this method, different jute fibre bundles are ruptured ballistically by the fall of a heavy bob attached to one end of a pendulum arm swinging along a circular arc. The potential energy consumed to rupture the fibre bundle is taken as proportional to the breaking force of the fibre bundle.

The ballistic strength of the fibre bundle is proportional (h1 - h2) where:

- h1=Initial height of the bob before release,
- h2= Maximum height attained by the bob after breakage. The potential energy of the bob at height h1 is given by:

  PE=W X h1

  where W is the weight of the bob.

When the pendulum is released, it swings downward. As it approaches the vertical position, it begins to exert tension on the fibre specimen. Continuing its swing, the pendulum stretches the specimen, ruptures it (at position 3 G3), and finally comes to rest at position G1.The specimen is anchored to the pendulum along line K, and G represents the centre of gravity.

The work done to break the specimen can be determined by considering the rise in the centre of gravity of the bob after rupture. If the height of the bob's centre of gravity after breakage is h2, then the potential energy at this position is:

PE= W X h2

Where the W is the weight of the bob.

Thus, the difference in potential energy between the initial position (h1) and the final position (h2) represents the energy or work of rupture of the specimen:

Work of Rupture= W X (h1 -h2)

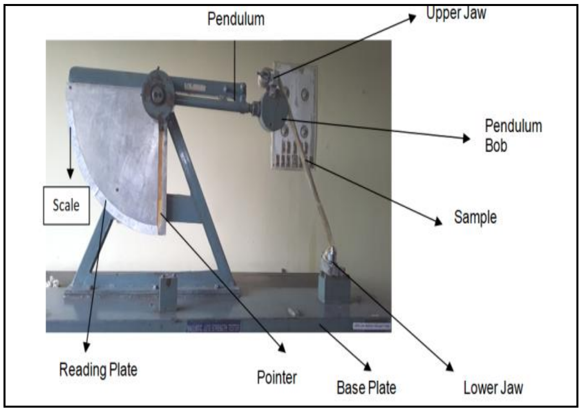

Fig. II, IJIRA Developed Impact Strength Tester

The unit of work may be expressed in inch- lb, cm-g or other suitable energy units.

For practical evaluation, a scale has been developed for the ballistic strength tester that provides results in terms equivalent to the g per tex values obtained using the conventional CRL method.

IMPACT STRENGTH METHOD INVENTED FOR RAW JUTE

IJIRA developed ballistic strength tester consists of a pendulum arm with heavy bob at down end which plays important role for rupture of jute fibre bundle, two clamps one is on bob and other is on base plate, a reading scale or plate which indicates the reading in g/tex and a pointer.

Sample is taken and clamped tightly between the jaws so that the whole specimen remains in tight and parallel condition. The pointer is kept in vertical position and coincides with zero value. The pendulum is released from the hook and allowed to fall freely under gravity. The sample ruptures at maximum tension.

V. RESULT AND DISCUSSION

Twenty types of jute of different grades and mokams are selected for testing on both the machines and readings are given in table 1. Comparison test results of CRL and ballistic strength tester (with sample size) and weight 20 g and length 100 cm or 1m) are given below:

TABLE – I DETAILS OF DATA OBTAINED

Sl. No.	Results obtained From		Sl. No.	Results obtained From	
	CRL (g/tex)	Ballistic tester (g/tex)		CRL (g/tex)	Ballistic tester (g/tex)
1	12.75	19.40	31	20.33	19.2
2	13.79	21.00	32	24.18	24
3	14.67	18.20	33	14.24	15.5
4	21	20.4	34	21.46	22.6
5	9.32	10	35	19.58	20.2
6	19.95	20	36	18.31	17.4
7	20.18	19.6	37	18.48	20.2
8	18.86	18	38	18.59	18.6
9	19.16	19	39	15.77	17
10	19.2	18	40	14.61	17.3
11	15.91	17	41	15.91	17
12	15.99	17	42	21.84	22.3
13	17.85	19	43	21.85	23.8
14	16.37	16.6	44	15.17	17
15	20.78	21	45	22.13	23.2
16	16.5	15.5	46	22.42	21
17	15.77	17	47	15.71	18
18	21.65	20.6	48	20.58	18.6
19	21.75	22.4	49	20.66	19
20	18.64	18.4	50	22.08	22.2
21	18.76	18	51	16.42	17
22	15.77	15.5	52	21.13	22.2
23	17.58	19.6	53	15	17
24	14.67	17.2	54	20.75	19.8
25	22.42	22.6	55	21.9	21.9
26	20.78	21	56	13.72	15
27	16.32	16	57	20.33	19.8
28	20.83	20	58	19.0	19.5
29	19.42	18	59	17.5	18.3
30	22.58	22.4	60	20.4	20.5

Graphical representation of the results obtained from Table–1 is provided below:

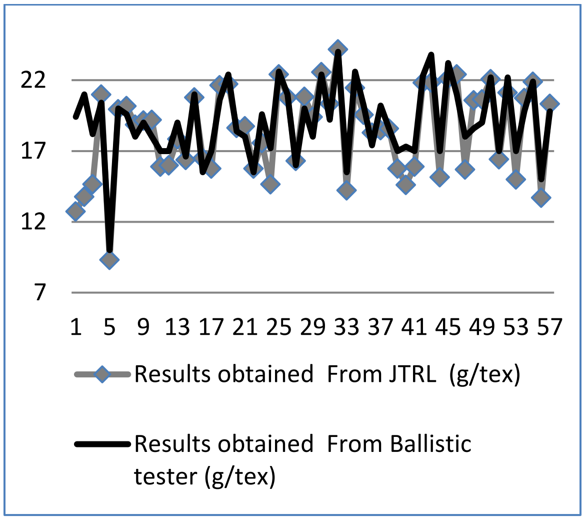

Fig. III CRL INSTRUMENT DATA VS IMPACTSTRENGTH TESTER DATA

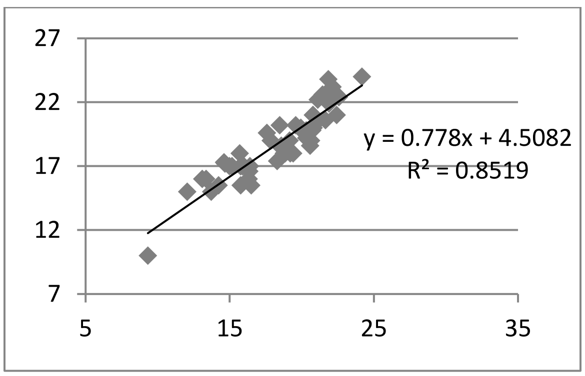

Fig. IV CORRELATION BETWEEN CRL INSTRUMENT DATA vs IMPACT STRENGTH

CONCLUSION

Impact strength tester can serve as an alternative method for evaluating jute fibre strength. This technique allows fibre strength, to be measured quickly and efficiently, enabling assessment of a larger number of fibre samples within a short time.

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