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IMPACT AND COLLAPSIBLE STRENGTH OF BORAK VARIETY OF BAMBOO

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ABSTRACT

Bamboo is being widely used as a material of construction and also for furniture, specially in the rural areas of Bangladesh. The design can be safe and economical when data on the mechanical properties are known. One of the important variety of bamboo, Borak is widely used in Bangladesh. In this study the impact and collapsible strength of Borak have been determined and presented.

INTRODUCTION

The industrial development gives rise to demands of more appropriate properties of materials.These properties are becoming more diverse and severe. One very common indigenous material used in Bangladesh for mechanical and civil structure is bamboo. Some data is available in the literature [1991] and more experimental data are needed for proper use of this widely used material of construction. The mechanical properties which are of importance include tensile and compressive strengths, impact strength, collapsible stength, torsional strength etc. In many structural uses like homes, furniture, bridges strength etc., the impact and collapsible strength are vital. One study (1992) shows that out of a total annual consumption of about 11,000 tons of bamboo and wood approximately 20% is bamboo used for rural fuel and 20% is bamboo used for rural construction and furniture and 0.5% is bamboo used in paper and pulp industry. In this present study quantitative values have been determined. For the present investigation only borak bamboo has been used which is a very common variety used for many applications.

NOMENCLATURE

F	=	Force per unit contact length
F_u	=	Maximum force per unit contact length
L,b,t	=	Length, width, thickness of specimen
d,d_i	=	External and internal diameters of specimen
r	=	Mean radius of specimen
Δ_y	=	Measured change in diameter i.e. deflection
P	=	Percent deflection $(\Delta y/d_i) \times 100$
P_u	=	Percent deflection at maximum force
B.S.	=	Bamboo Stiffness $(=F/\Delta_y)$
S.F.	=	Stiffness Factor $(= 0.149\ Fr^3/\Delta_y)$
S.D.	=	Standard Deviation.

EXPERIMENT

i) Impact Test:

The Borak bamboo selected was grown in Barobari area of Gazipur district near the test site. The length of the piece brought at the test site was 12m. The outer diameter at bottom section was 88.9 mm, at the middle section was 76.2 mm and at the top was 25.4 mm. The thickness at the bottom was 19 mm. After drying for 7 days it was split up in four pieces along the length and dried for another 7 days before preparing the specimen having the shape (Figure 1) according to ASTM D256. The specimen length was along the longitudinal direction of the bamboo. For the Charpy and Izod tests, Brooks T 3U pendulum type of impact testing machine was used. The minimum graduation of the scale of the machine was 2 J. For the Charpy test the angle of drop was 140° with a maximum impact energy of 300 J and striking velocity of 5.35 m/s. The distance between the supports was 40 mm and the blow was struck on the face opposite to the notch. The effect of skin of bamboo on the strength value was checked by removing about 1 mm thickness of the outer cover of some specimens. Also the strength without drying some of the specimens in the final stage i.e. in green condition was determined.

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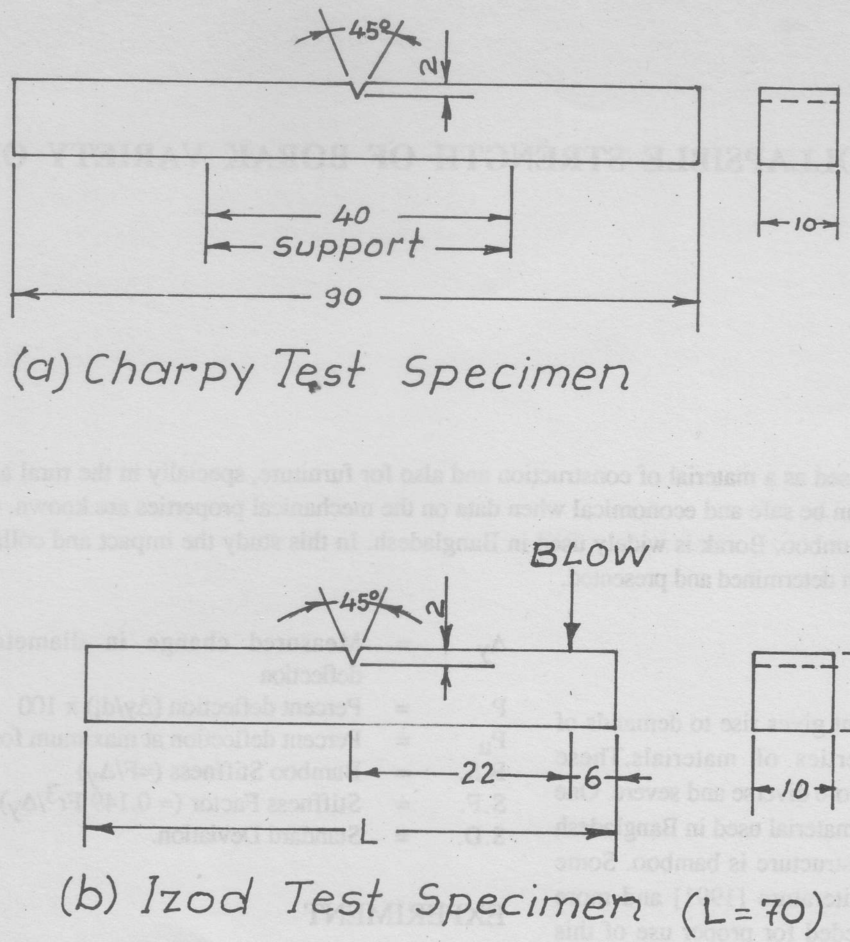

FIGURE 1: IMPACT TEST SPECIMENS

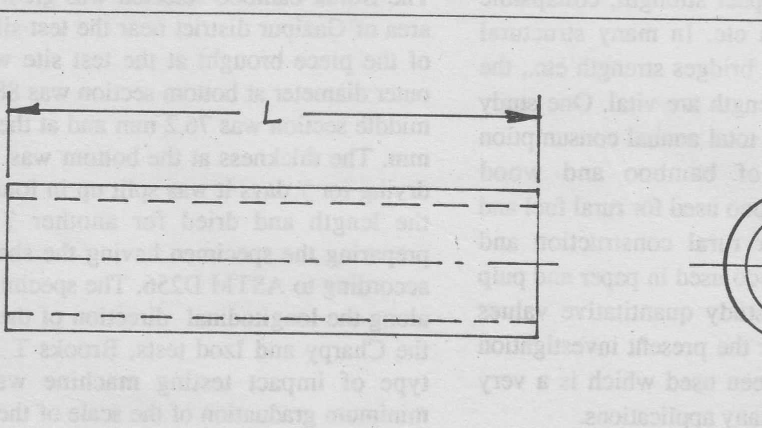

FIGURE 2: SPECIMEN FOR COLLAPSIBLE STRENGTH TEST

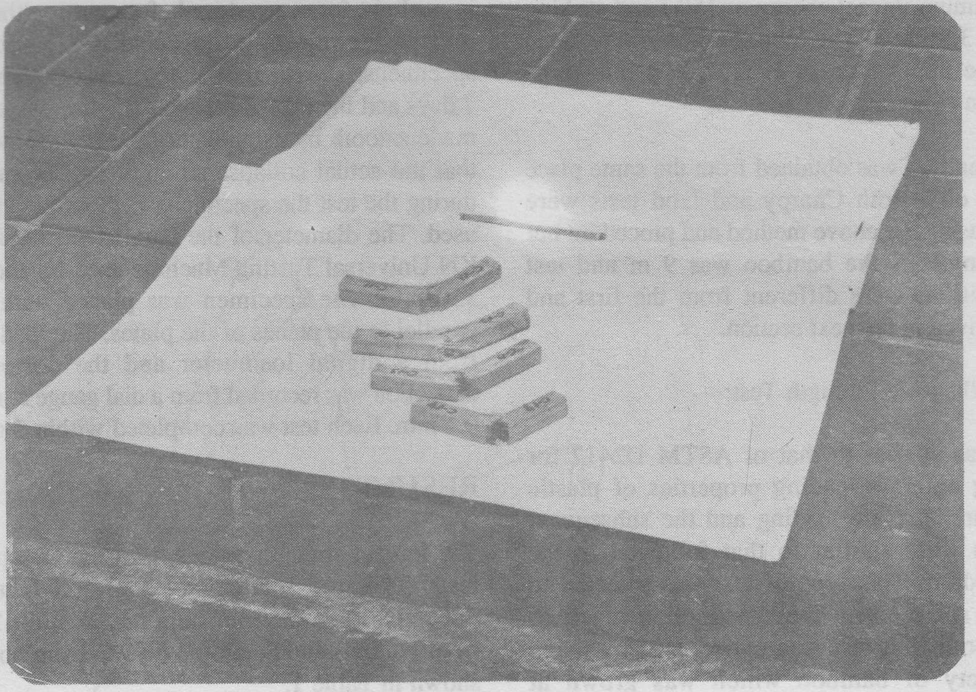

Fig. 3 : Specimens after impact test

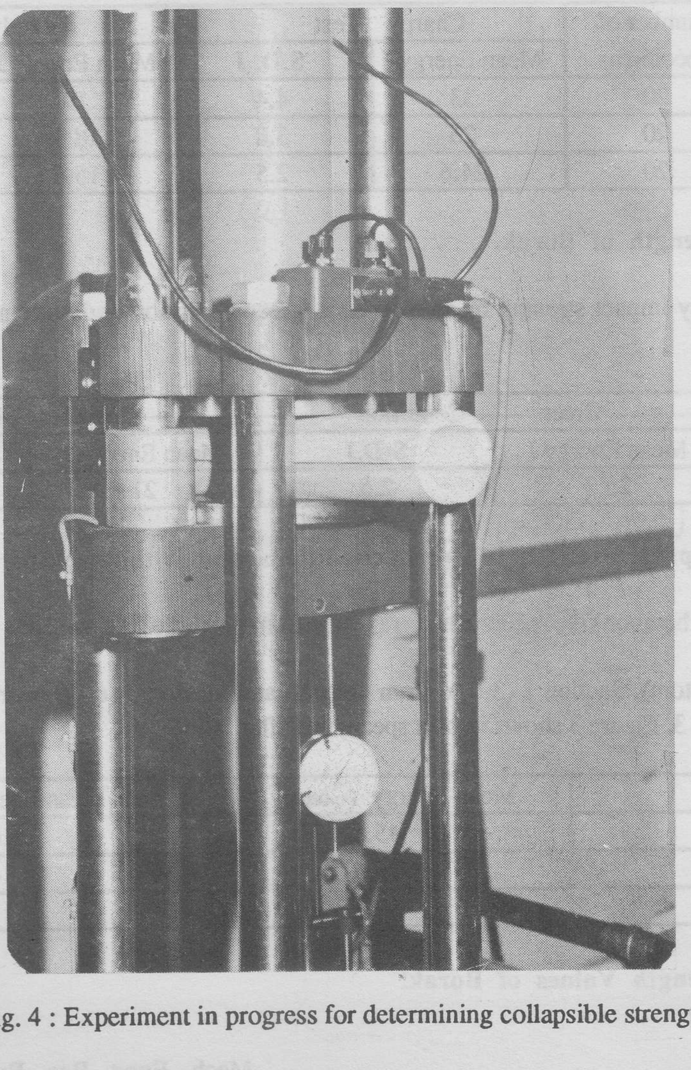

Fig. 4 : Experiment in progress for determining collapsible strength.

For the case of Izod test the angle of drop was 85° with a maximum impact energy of 150 J and striking velocity of 3.86 m/s. The V-notch was in the same plane as the upper face as clamps. The blow was struck on the same face as the notch.

A second bamboo was obtained from the same place as the first one. Both Charpy and Izod tests were carried out using the above method and procedure but the total length of the bamboo was 9 m and test section positions were different from the first and details are given in the next section.

ii) Collapsible Strength Test:

This test was similar to that of ASTM D2412 for determining external loading properties of plastic pipes by parallel plate loading and the subsequent calculations were similar to that followed in the ASTM standard. This type of test was selected to simulate to some extent the construction practices using bamboo. The test was carried out by using Borak variety of bamboo which was grown at Barobari area near the test site. The bamboo was dried in sunlight for seven days before cutting the bamboo into pieces rejecting the knots and making rough specimens. The rough specimens were again dried for 7 days and then the specimens (Figure 2) were finally made smooth by using emery paper. It may be noted that the actual collapse strength will be more since during the test the specimens without the knots were used. The diameter of the parallel plates of the 100 KN Universal Testing Machine used for the test was 150 mm. The specimen was placed with the axis parallel to the planes of the plates. The load was read from a digital loadmeter and the corresponding deflection was recorded from a dial gauge reading upto 0.1 mm. Each test was completed within 5 minutes.

RESULTS

The impact strength values from the Charpy impact tests for three sections of the first bamboo i.e. Section 1 (0-2 m from bottom), Section 2 (2-4 m from bottom) and Section 3 (4-6 m from bottom) are shown in Table 1.

Section	Number of Specimens	Charpy Test		Izod Test	
		Mean Energy J	S.D. J	Mean Energy J	S.D.J
1	20	33	4.4	19	2.4
2	20	26	3.8	18.9	1.9
3	20	24.6	2.5	15.6	2

Table 1: Impact Strength of Borak.

Table 2 shows the Charpy impact strength of specimens in green condition and without skin for the case of section 1.

Section	Green Condition		Without Skin	
	Mean Energy J	S.D.J	Mean Energy J	S.D. J
1	25.3	2.6	21	2.9

Table 2: Charpy Impact Strength in green conditions and without skin.

For the case of the second bamboo five specimens were tested from the three sections each as follows:

Section 1(0-3 m from bottom), Section 2 (3-6 m from bottom) and Section 3 (6 - 9 m from bottom). The test values are shown in Table 3. Figure 3 shows impact specimens after failure.

Secion	Mean Energy (Charpy) J	Mean Energy (Izod) J
1	45.6	16.4
2	26.0	14.4
3	17.6	11.4

Table 3: Impact Strength Values of Borak.

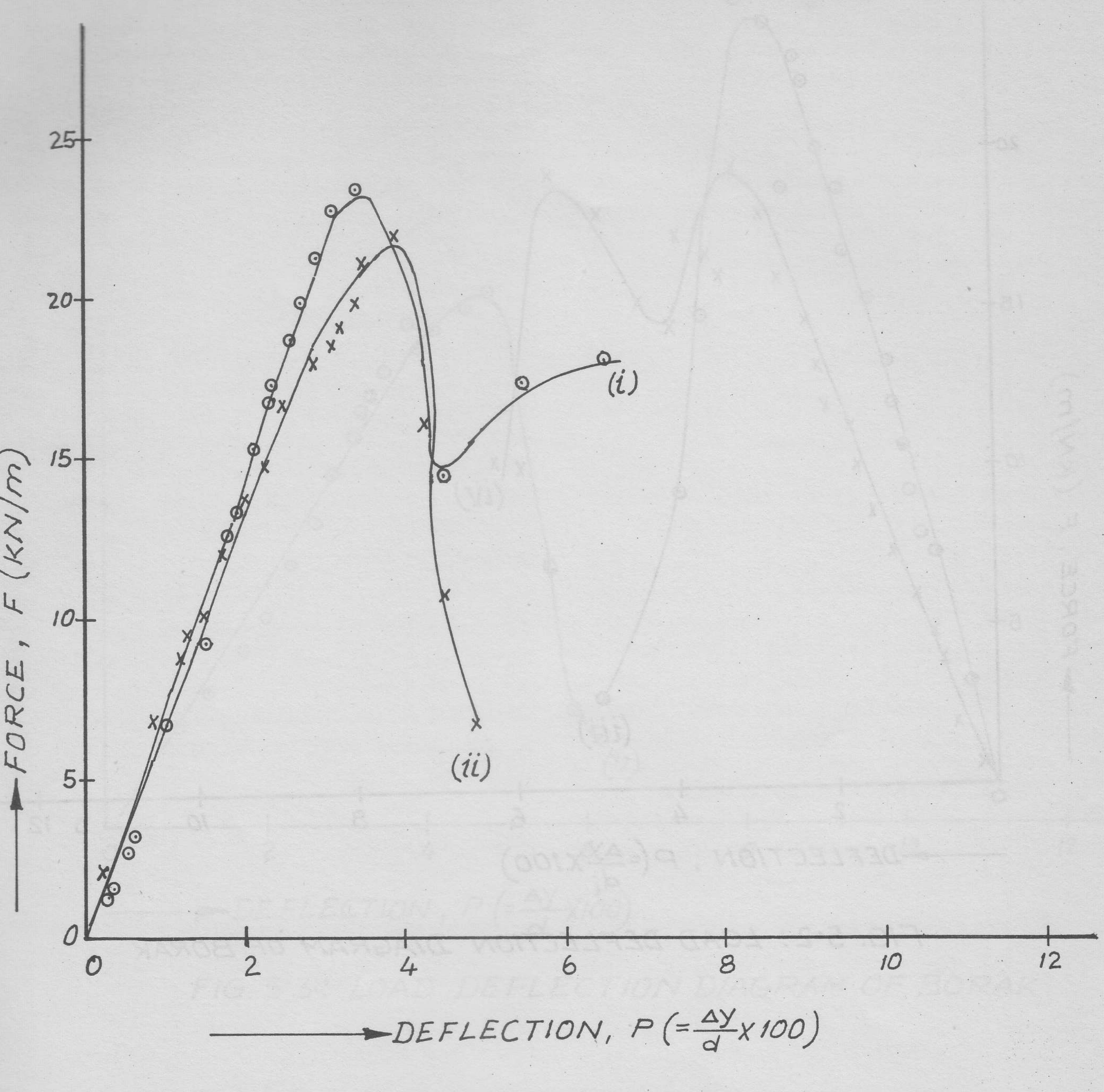

FIG. 5·1 : LOAD DEFLECTION DIAGRAM OF BORAK

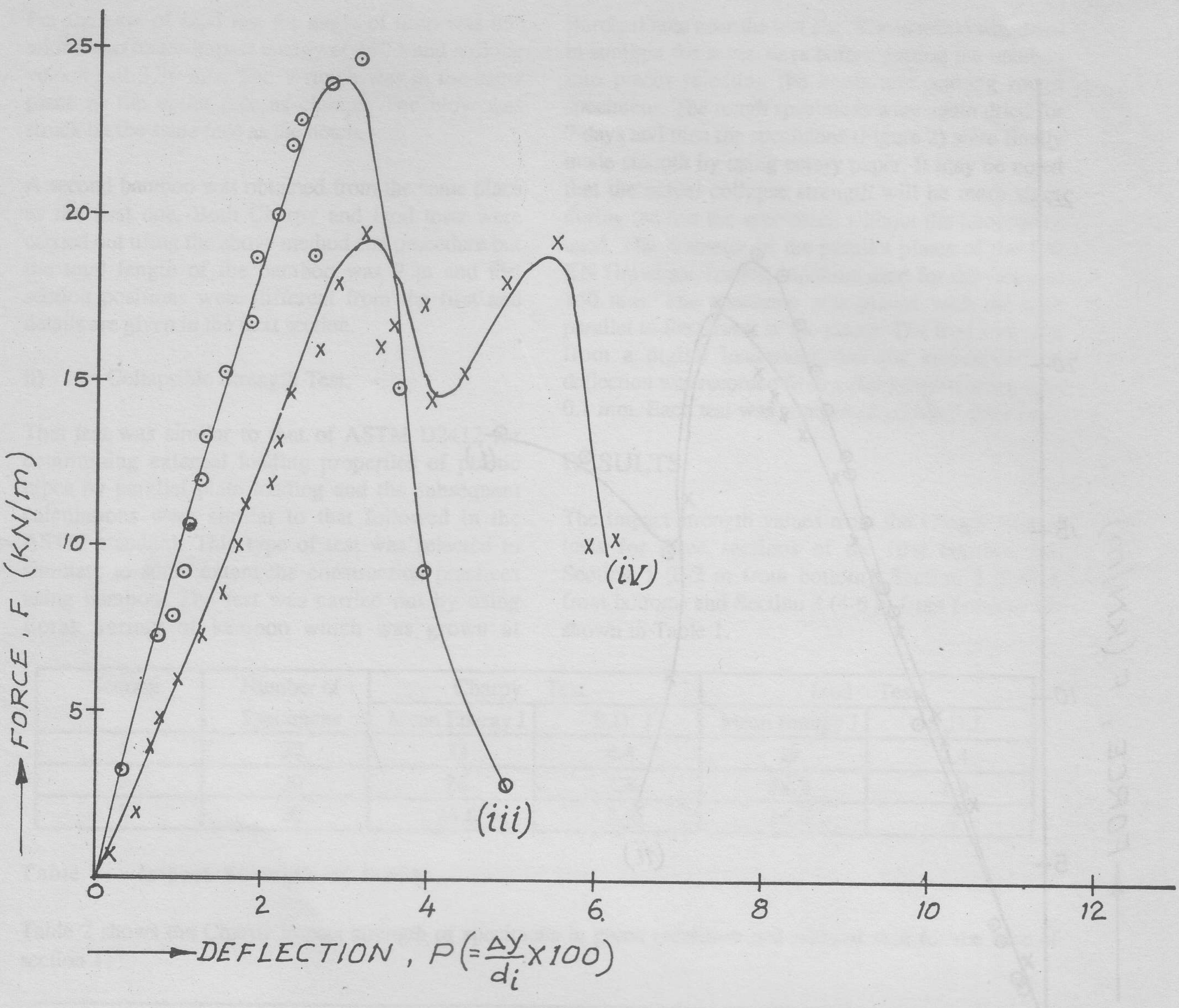

FIG. 5·2: LOAD DEFLECTION DIAGRAM OF BORAK

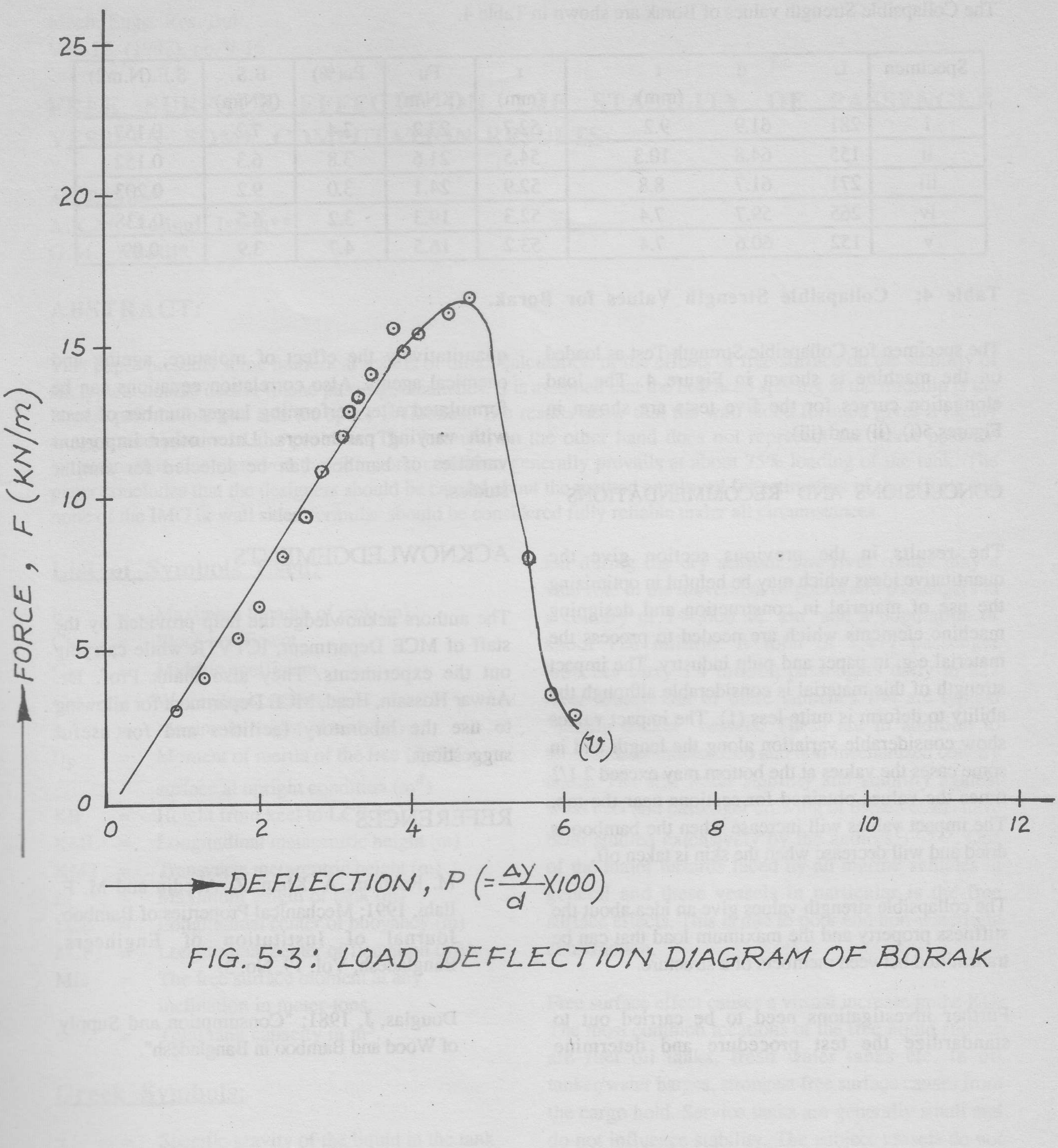

FIG. 5·3: LOAD DEFLECTION DIAGRAM OF BORAK

The Collapsible Strength values of Borak are shown in Table 4.

Specimen	L	d	t (mm)	r (mm)	Fu (KN/m)	Pu(%)	B.S. (KN/m)	S.F.(N.m2)
i	281	61.9	9.2	52.7	23.2	3.4	7.2	0.157
ii	155	64.8	10.3	54.5	21.6	3.8	6.3	0.152
iii	271	61.7	8.8	52.9	24.1	3.0	9.2	0.203
iv	265	59.7	7.4	52.3	19.3	3.2	6.5	0.138
v	152	60.6	7.4	53.2	16.5	4.7	3.9	0.09

Table 4: Collapsible Strength Values for Borak.

The specimen for Collapsible Strength Test as loaded on the machine is shown in Figure 4. The load elongation curves for the five tests are shown in Figures 5(i), (ii) and (iii).

CONCLUSIONS AND RECOMMENDATIONS

The results in the previous section give the quantitative ideas which may be helpful in optimizing the use of material in construction and designing machine elements which are needed to process the material e.g. in paper and pulp industry. The impact strength of this material is considerable although the ability to deform is quite less (1). The impact values show considerable variation along the length and in some cases the values at the bottom may exceed 2 1/2 times the values obtained for sections near the top. The impact values will increase when the bamboo is dried and will decrease when the skin is taken off.

The collapsible strength values give an idea about the stiffness property and the maximum load that can be transmitted between members of a structure.

Further investigations need to be carried out to standardize the test procedure and determine quantitatively the effect of moisture, ageing and chemical agents. Also correlation equations can be formulated after performing larger number of tests with varying parameters. Later other important varieties of bamboo can be selected for similar studies.

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REFERENCES

M. Rahman, A. Khan, Z. Abedin and M. F. Ilahi, 1991; Mechanical Properties of Bamboo, Journal of Institution of Engineers, Bangladesh, Vol. 19, No. 3.

Douglas, J, 1981; "Consumption and Supply of Wood and Bamboo in Bangladesh".