Mech. Engg. Res. Bull.
Vol. 11,(1988), pp. 18 - 25

Water Absorption, Hardness and Flexural Strength Properties of Jute Reinforced Plastics

K. A. Kazim*
M. F. Ilahi**

ABSTRACT

The use of Jute Reinforced Plastics is increasing every day. Products requiring good surface property, flwxural strength are needed in some cases. Proper application of the material is dependent on the knowledge of the properties. The effect of volume fraction of jute on hardness, flexural strength and water absorption have been experimentally determined and presented. It has been found that the increase in volume fraction of jute enhances the above properties.

INTRODUCTION

New types of components required for revolutionary machines and structures could have been made due to availability of composite materials. The composites can offer better properties in terms of strength, stiffness and specific weight but also have some particular limitations in some cases. Jute fibre reinforced plastics have been used in some cases such as Sliver Cans for Textile and Jute Industries, main container for milk vans, boats, shuttering for concrete casting. Studies on different properties, economic viability are needed for useful and appropriate applications. To attain some of these objectives the effect of varying percentage of the fibre on water absorption, hardness and flexural strength of the composite material have been studied.

LITERATURE SURVEY

Experimental investigations for determining some of the mechanical properties of jute reinforced plastics were carried out and presented by Kazim et. al (1). Previously investigations (2-10) were carried out to study experimentally the failure characteristics of unifibre and multifibre, unilayer and multilayer specimens subjected to uniaxial tension and Boue (11) studied the effect of fibre to matrix volume ratio on the failure mode and Tsai (12) made theoritical and experimental studies and obtained good correlations for cross-ply and angle ply laminations. Rosen (13) and Pih (14) made experimental investigations using photoelastic methods to determine mode of failure, effect of fibre orientation, fibre end geometry. Grinius (15) con-

* Mechanical Engineering Department, BIT, Khulna

** Mechanical & Chemical Engineering Department, ICTVTR, Tongi, Dhaka.

ducted experimental investigations on fibre reinformced composites subjected to tension, shear, bending and repeated loading in order to establish the effect of the matrix and the fibre orientation. Only two specimens were tested for each case.

Armenkas et al (17) investigated the strength characteristics of S-glass fibre bundles and composites subjected to quasi-satic loading. Their experimentalbundle strength compared well with that obtained on the basis of Daniel's theory (18). The mean experimental composite strength compared well with that obtained on the basis of rule of mixtures and Gucer-Gurland models (18-20).

Fariborz, Yang and Harlow (10) investigated the tensile behaviour of Intraply Hybrid Composites.

Most of the above investigations were carried out with composites made of glass fibres. No literature on the use of Jute as a reinforcing material in composites and the resulting properties like hardness, water absorption and flexural strength is available to the best knowledge of the authors. These properties must be considered when the product is used in the environment and good surface property is required.

Jute is abundantly grown throughout Bangldesh is finding wide application and has different mechanical properties according to their grades. In this study only one grade of fibre of jute namely BTA grade have been used.

EXPERIMENT

Before carrying out the required tests on Jute Reinforced Plastics some tests were necessary to be carried out on Jute Fibres . Jute Fibre Bundles, Jute yarn, Jute Yarn Bundles, Jute Mat and resin specimens to determine their strength characteristics, the results of which are shown elsewhere (1). The procedure of determining the properties of water absorption, hardness and flexural strength is given in the following paragraphs :

i. Water Absorption Test : Samples of 250 mm x 450 mm were cut from mat of BAT grade jute, weighted and recorded. Matrix polyester was then prepared by mixing ingredients thoroughly in a container with a stick according to proportion of Table-1, while carefully avoiding the entrainment of excessive air. Unilayer and multilayer of jute mat reinforced plastics were made by bandlay-up method. These were cured slowly at room temperature and composite sheet were weighed. Specimens of 76.2 mm long and 25.4 mm wide weighed. After weighing, these specimens were placed in container of distilled water in such a way that specimens entirely immersed and rested on edges. At the end of twenty four hours, the specimens were removed from water one at a time, water was wiped off from the surfaces with a dry cloth, and weighed immediately. Percentage increase in weight due to immersion were calculated and recorded. Ten specimens were tested at each volume fraction of jute and also for pure resin.

ii. Hardness Test of Jute Mat Reinforced Composite : Jute mat reinforced composite sheets of different volume fraction of jute and a sheet of pure polyester resin were made according to the procedure of the previous paragraph. Specimens were cut according to ASTM D-2240. The samples had a diameter of 30 mm and a minimum thickness of 60 mm. Thinner specimens were placed layer upon layer until this minimum thickness has been achieved. The test was performed according to ASTM D-2240-68 using Zwick Hardness Tester on Shore D.

Tests were performed on each sample at three different locations. When performing the tests, the hardness tester was applied to the sample in a shock and vibration free manner and depressed until the contact surface of the tester touched the surface of the sample under test. The shore hardness number was recorded. Ten samples were tested for each volume fraction of jute.

iii. Flexural Test of Jute Mat Reinforced Composite : Sheet, varying thickness ranging from 1.5 mm to 1.9 mm, 40 mm length and 150mm wide of different jute mat volume fraction jute reinforced plastics and pure resins were made by lay-up method. The matrix was made according to the proportion of Table-1. These were cured at room temperature for two days.

Specimens of length 40 mm, and width 12.9 mm were cut from these sheets. Then all surfaces of the specimen were filed, and he filed surfaces were finished with fine abrasive cloths.

Tests were conducted on the above specimens utilizing a "Flexure Modulus Measuring Apparatus. At first the mean thickness (d) of each specimen over its full width at the mid-section was measured and recorded. From the specimens, the one which had the mean thickness nearest to the mean of the mean thicknesses of the specimens was selected. The deflection equivalent to an induct strain of 0.2% for this specimen from the following equation was calculated.

$$D = \frac{0.21505}{d}$$

Where,

D = deflection of the specimen at its mid point, mm

d = thickness of the specimen, mm.

The specimen was placed centrally on the supports and then the load beam was placed on the specimen. The gauge adjusting screen was turned in a clockwise direction until the proximity switch was functioning.

The bezel looking screw was loosened and the dial gauge bezel was turned so that "zero" coincides with the position of the pointer.

Loose weights were applied to the centre of the beam progressively. As each weight was added, the gauge adjusting screw was turned clockwise until the red light came on. Where sufficient weights had been added to cause movements of 2D indicated on the gauge the applied load 'W' was recorded. The remaining nine specimens were tested similarly, applying load 'W' as quickly as possible. Exactly one minute after the completion of loading, the resultant deflection D to the nearest 0.002 mm was recorded.

The elastic modulus for each specimen was calculated from the following equation.

$$E = \frac{I_3 W}{4d^3 Db}$$

Where.

b = specimen width, mm

I = specimen span length, mm

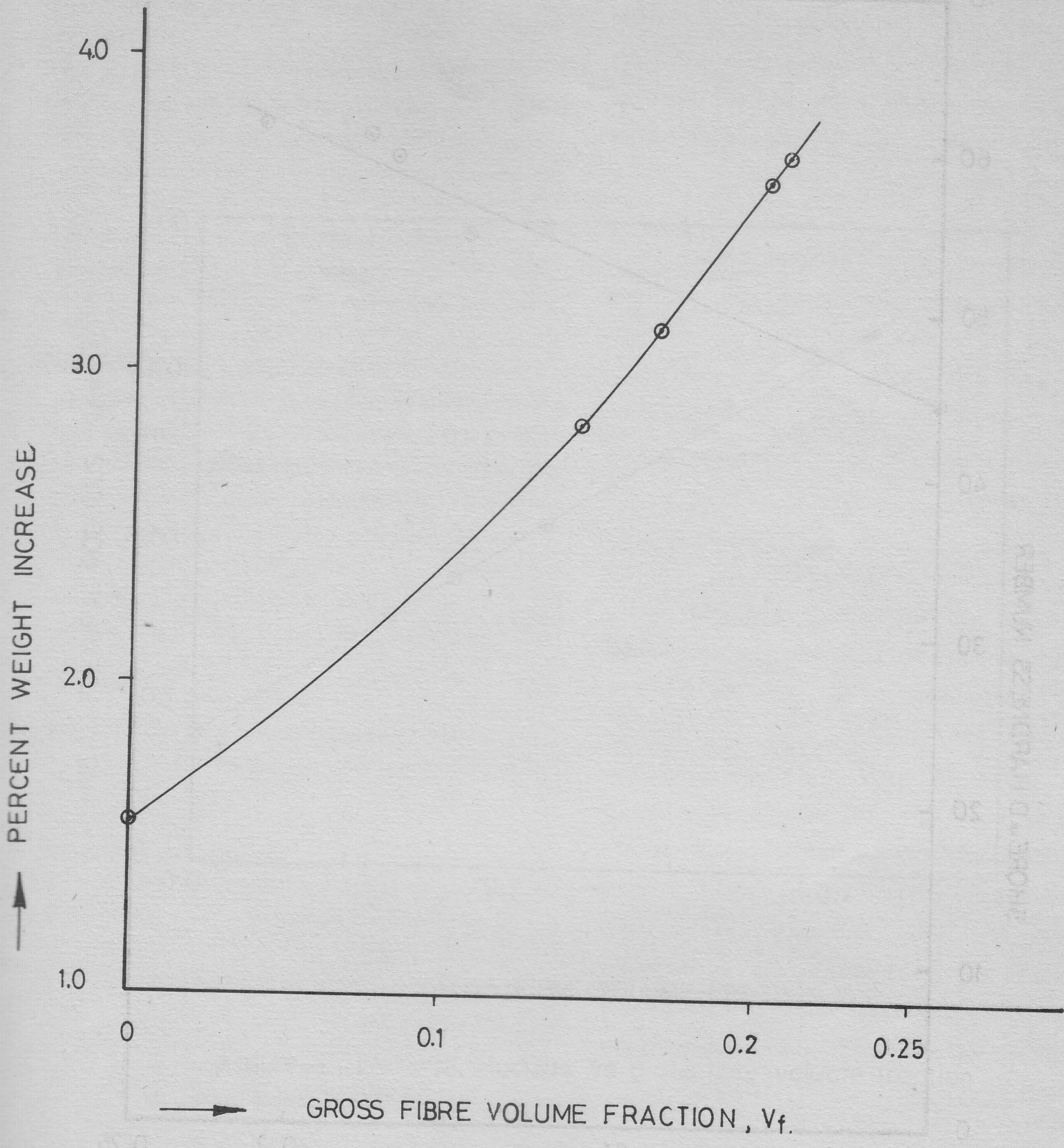
W = load, Newton

d = specimen thickness, mm

D = deflection of specimen, mm.

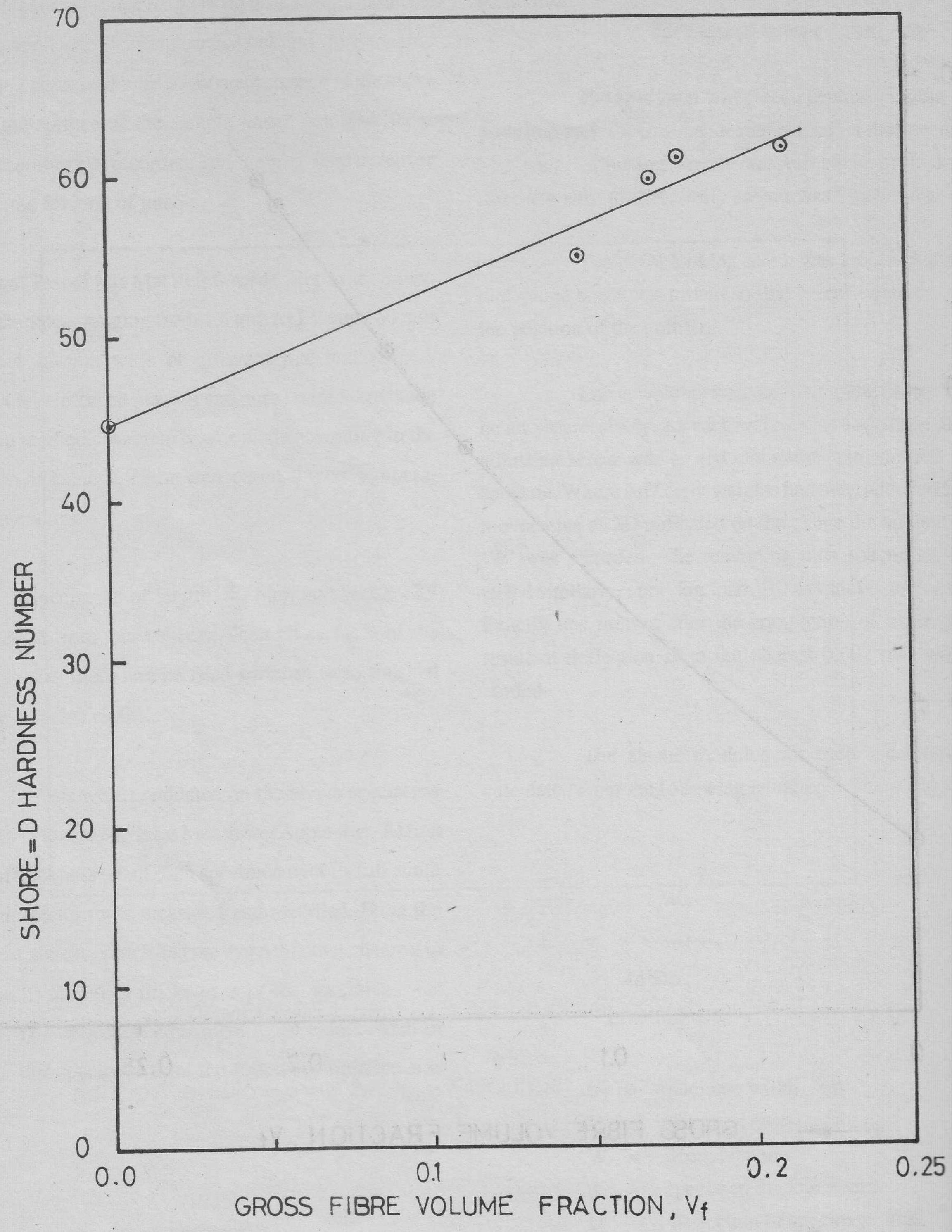
RESULTS AND DISCUSSION

For the case of water absorption tests the mean



Figure– 1.

Effect of gross fibre Volume fraction V_f on The percentage increase in weight of jute reinforced plastics



Figure—2.

Effect of gross fibre volume fraction on the hardness of jute reinforced plastics

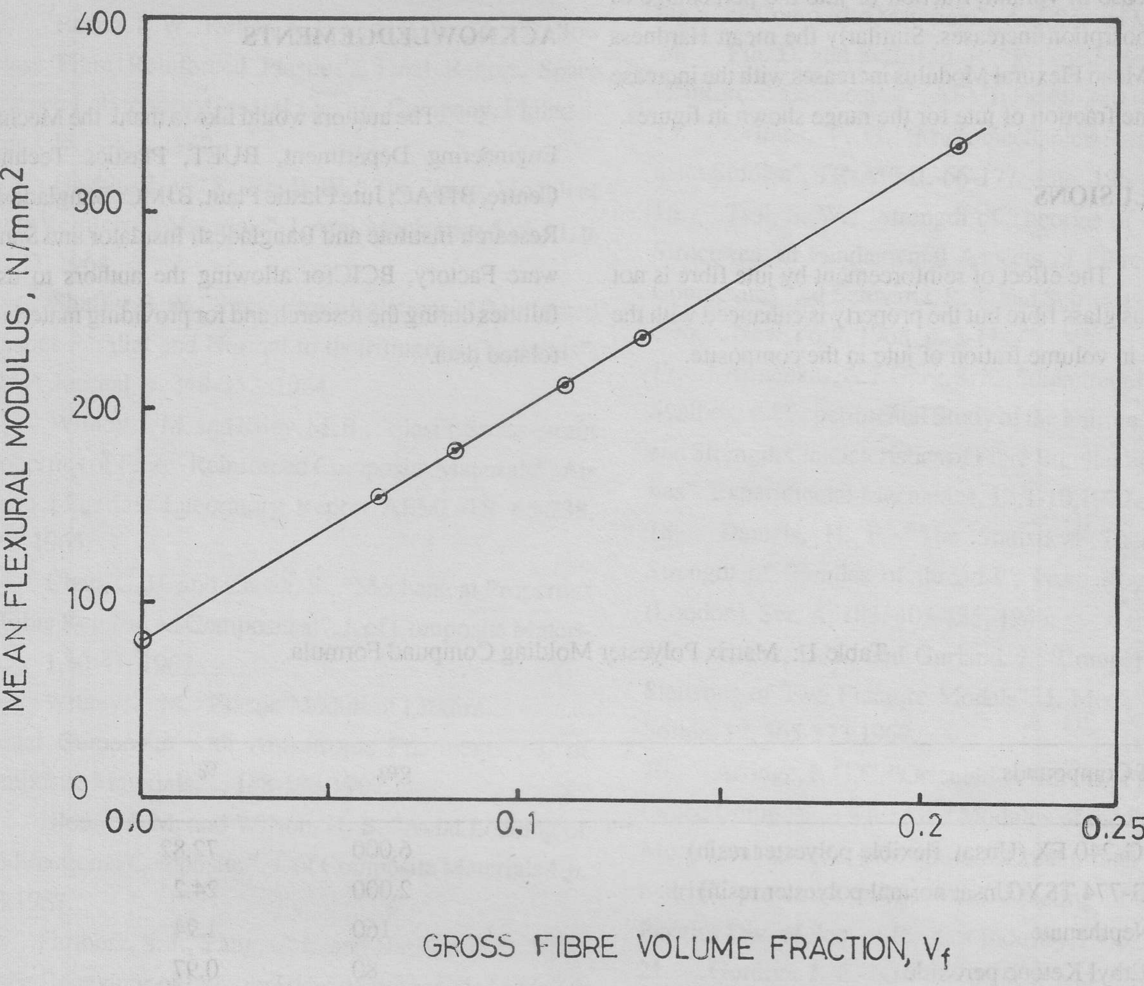


Figure-3. Flexural Modulus vs gross fibre volume fraction values of percentage increase in weight for the corresponding values of volume fraction of jute is shown in Figure-1. The hardness and Flexural Modulus of the composites for different values of volume fraction of jute is shown in Figures-2 and 3 respectively.

The effect of volume fraction shows that with the increase in volume fraction of jute the percentage of water abosrption increases. Similarly the mean Hardness and the Mean Flexural Modulus increases with the increase in volume fraction of jute for the range shown in figures.

CONCLUSIONS

The effect of reinforcement by jute fibre is not as good as glass fibre but the property is enhanced with the increase in volume fration of jute in the composite.

The percentage weight increase due to presence of water is almost linear with the increase in volume fraction of jute. For the case of hardness the experimental values show that although it increases but there is some deviation from the straight line relationship. The Flexural Modulus also increases linearly with the increase in volume fraction of jute.

ACKNOWLEDGEMENTS

The authors would like to thank the Mechanical Engineering Department, BUET, Plastics Technology Centre, BITAC; Jute Plastic Plant, BJMC; Bangladesh Jute Research Institute and Bangladesh Insulator and Sanitary-ware Factory, BCICfor allowing the authors to use the failities during the research and for providing materials and related data.

Table 1 : Matrix Polyester Molding Compund Formula.

Name of Compounds	gm.	%
Emolac G-240 FX (Unsat. flexible polyester resin)	6,000	72.82
Epolac G-774 TSY(Unsat normal polyester resin)	2,000	24.2
Cobalt Nepthanate	160	1.94
Methyl Ethyl Ketone peroxide	80	0.97
Total	8,240	100.00

REFERENCES

1. Kazim, K. A., Ilahi, M. F. "Mechanical propeties of Jute Reinforced Plastics", Mechanical Engineering Research Bulletin, Vol. 10, p., 1987.
2. Outwater, J. C. "The Mechanics of Plastics Reinforcement in Tension", Modern Plastic, 1956, p. 156.
3. Rosen, B.W., Ketler, A. E. and Hashin, Z., "Hollow Glass Fibre Reinforced Plastics", Final Report, Space Science Laboratory, General Electric Company, Philadelphia, Pa., Nov. 1962.
4. Hashin, Z. and Rosen, B. W. " The Elastic Moduli of Fibre Reinforced Materials", J. App. Mechanics, Vol. 31, p. 3-232, 1964.
5. Shaffer,B. W. "Stress-strain Relations of Reinforced Plastics Parallel and Normal to their Internal Filaments", AIAA Journal, p. 348-352, 1964.
6. Witney, J. M. and Riley, M. B., "Elastic Stress-strain Properties of Fibre -Reinforced Composite Materials", Air Force Materials Laboratory Report AFML-TR 65-238, Dec. 1965.
7. Chen, C. H. and Cheng, S., "Mechanical Properties of Fibre Reinforced Composites:", J. of Composite Materials, 1,30-41, 1967.
8. Witney, J. M. "Elastic Moduli of Unidirectional Composite with Anisotropic Fila-ments", J. of Composite Materials, 1, 188-193,1967.
9. Bloom, J. M. and Wilson, H. B. "Axial Loading of Unidirectional Composite ", J. of Composite Materials 1,p. 268,1967.
10. Fariborz, S. J., Yang, C. L. and Harlow, D. G. "The tensile Behaviour of Intraply Hybrid Composites I : Model and Simulation",J. of Composite Materials, 19, 334-354, July, 1985.
11. Boue, C. A. "Microscopic Study of Mode of Fracture in Filament Wound Glass-Resing Composites " T. and A. M. Rport No. 234, Univ. of Illinois (Urbana), 1962.
12. Tsai, S. W. "Structural Behaviour of Composite Materials, NASA CR-71, July 1964.
13. Rosen, B. W. "Mechanics of Composite Strengthening Fibre Composite Materials", Am. Soc. of Metals, 1965.
14. Pih. D. and Sutliff, d. R. "Photoelastic Analysis of Reinforced Composites", AFMI-TR 68-380 (Nov. 1968).
15. Grinius, V. G. "Micromechanics-Failure Mechanism Studies", TR-AFML-66-177, Aug. 1968.
16. Tsai, S. W., "Strength of Theories of Filamentary Structures, in Fundamental Aspects of Fibre Reinforced Composites" ,ed,Schwartz, R. T. and Schwartz. H. S. Intercience, New York, 1968, p. 3-11.
17. Armenkas, A. I. Garg, S. K., Sciammarella, C. A. and Svalbox, v. "Experimental Study of the Failure Mechanism and Strength Characteristics of Fibre Bundles and Composites", Experimental Mechanics, 12,1-10,1972.
18. Daniels, H. E. "The Statistical Theory of the Strength of Bundles of thread-I", Proc. Royal Socielty (London), Ser. A, 183, 405-435, 1945.
19. Gucer, D. E. and Gurland, J. "Comparison of the Statistics of Two Fracture Models", J. Mech. Physics of Solids, 10, 365-373,1962.
20. Arridge, R.G.C. "Orientation Effects in Fibre-Reinforced Composites where the Modulus of the Fibres in No More Than an order ofMagnitude Creater than that of the matrix", presented at 18th Ann. Meeting of Reinforced Plastics Div. of Soc. of Plastics Industry,1963.
21. Gordon, J. E. "On the present and potential efficiency of structural plastics", J. of Royal Aero Soc., 56, 704-728, 1952.