TESTING AND ANALYSIS OF NATURALFIBRE AND CI PARTICULATE REINFORCED POLYMER COMPOSITES

S. Navaneethekrishnan[a], M. Thooyavan[b], T. Rajesh Kumar[C], K. Kavin Kumar[d], S. Sivananthame[e].
Author [a]Asso. Professor, Department of Mechanical Engineering, Erode Sengunthar Engineering College, Erode, Tamil Nadu, India.
Author [bcde]UG Student, Department of Mechanical Engineering, Erode Sengunthar Engineering College, Erode, Tamil Nadu, India.

***Abstract*—The testing and analysis of natural fiber and CI particulate reinforced polymer composites. Composites based on biologically degradable banana fiber and corban particles have been investigated thoroughly. Samples of different orientations of banana fibers and Carbon iron particles with reinforced polymer composites were fabricated by compression moulding technique and investigated their mechanical properties like tensile strength and impact test. To improve the natural fibres and CI particles bonding resulting of testing and analysis of the composite material. However, the in this a full bridge dynamometer has been used to measure the cutting forces over natural fibre and CI particulate reinforced polymer composites material insert tool for different combination of cutting speed, feed rate and depth of cut. Found that analysis the strength and prediction of Cutting forces in a turning process of reinforced polymer composites. The experiments are planned based on Taguchi method and measured cutting forces were compared with the predicted forces to the composite material**

***Keywords*— Banana fibres and CI particles, Compression moulding, Tensile test, Impact test, Universal testing machine, Taguchi method, cutting forces.**

I. INTRODUCTION

The testing and analysis of natural fibre and CI particulate reinforced polymer composites. In current modern world the need for more efficient material for the development of new products and decomposable one. For this composite play a major role as it has strong material compare with the weak material. Natural fibers have recently become attractive to researchers as an alternative reinforcement for non-decomposable plastics. Due to their low cost, then good mechanical properties, rust less, eco-friendly and bio-degradability characteristics, they are exploited as a replacement for the conventional fibre, such as the many natural resources are available. The composite material is genarly use for automotive industrial and air space, because this type of composite material is developed with required strength. Then the developed material component used material source are available in the natural resources. Then the natural composite material is easy to decomposable. They many resources of natural waste are available in the earth. They use to developed the high strength material in the separate used area of the given component material. Generally, polymer can be classified into two classes, thermoplastics and thermosetting. Then the choice the natural fiber of banana fiber, because this type of fiber is easy to get him. The banana fiber is division from the banana tree. they use of compression roller to remove the water moisture from the banana tree waste. Making chemical treatment to remove the dust particle in the banana fiber. Then choosing the corban particles to developed the new composite component. because to improve the banana fiber strength level. Then using mechanical testing to find the strength of the material like tensile test, impact test, compression test, hardness test, etc.... They developing new component must be tested in the mechanical testing. The testing composite material are compulsory Test with American Society for Testing and Materials (ASTM). Then developing composite material are test with lathe tool dynamometer. Using Taguchi's method to calculate the predication force value to compered to the measured force value. Find the given natural banana fiber composite material cutting force, cutting speed, feed. Final value is calculated with the error percentage.

II. MATERIALS AND METHODS

MATERIALS

Banana fibres are extracted mechanically from the banana plant clean with helps of chemical treatment. Following that, fine the carbon iron particles with an average size of 1-100 microns and larger are manually separated using a sieving machine. Carbon iron particles range from 1 to 100 microns in size, while taking the practical's with 5gm. For this study, a short fiber with a length of 10 mm is also prepared. In this study, the epoxy resin with hardener takes the ratio of 2:1. Compression moulding machine use to remove the air bubbles in the given developing composite material.

Preparation of composites

They are two different shapes of material are developed. First shape as plate and another one as rod. Preparation of the plate shape of composite material. The carbon iron particulate 50gm, and short Fiber (10 gm) are measured and mixed with the epoxy resin (100 ml) and hardener (50 ml) in a 2:1 ratio. Use of hand moulding method to fabricate the polymer reinforcement composite material. They developing components are cutting with the measurement of (ASTM). Use compression moulding method to remove the air bubbles in composite material. The composite rod materials including short banana fibre and carbon iron particles to develop the reinforced epoxy polymer composite, The composite rod samples are made with a PVC pipe mould that is 100 mm long and 30 mm in diameter. One end of the pipe is closed with an end cup, and the pipe is surrounded by a plastic sheet for easy removal of the composite specimen. The carbon iron particulate 50gm, and short Fiber (10 gm) are measured and mixed with the epoxy resin (100 ml) and hardener (50 ml) in a 2:1 ratio. Use of hand moulding method to fabricate the polymer reinforcement composite material. The mixture of reinforcements and resin matrix is manually stirred before being poured into the mould. The mould is exposed to sunlight for 24 hours to cure. The composites material is then removed from the mould of the PVC pipe.

Mechanical testing

1. Tensile Test

Tensile testing spacemen are cutting with American Society for Testing and Materials size of 250*25*4 as show in Fig 1. The testing is done using Universal testing machine to measure the force required to break a polymer composite material and which amount of load acting as elongates to that breaking point. Here Fig. 2 indicates a broken piece during the tensile test machine working setup.

Fig -1: Tensile test material specimens

Fig -2: Tensile specimen in UTM

2. Impact Test

Impact testing fixed spacemen are cutting with American Society for Testing and Materials size of 10*10*65 as show in Fig 3. Impact is a single point load test that measures a materials resistance to impact from a swinging pendulum. Impact is defined as the kinetic energy needed to initiate fracture and continue the fracture until the specimen is broken. Here Fig. 4 indicates a broken point piece during the Impact testing machine working setup.

Fig -3: Impact test machine specimen

Fig -4: Impact test machine in UTM

3. EXPERIMENTAL VALUES – LATHE TOOL DYNAMOMETER

The turning experiments are carried out using a conventional lathe which has a maximum spindle speed of 2500rpm and a maximum spindle power of 16 kW. The experimental set up is shown in the Fig 5. The cutting force measured from the lathe tool dynamometer is in terms of Kilogram force. So, it is converted into Newton (N) by multiplying the cutting force with the value 9.81. Then the measured force value is used for further analysis and comparison of results. From the table, the speed, feed rate and depth of cut change to analysis the cutting parameters of the measured force N. They measured the different combination strain value are noted with 27 readings mention above the table 1. Change spindle speed, feed, depth of cut to calculate the strain value of the cutting tool.

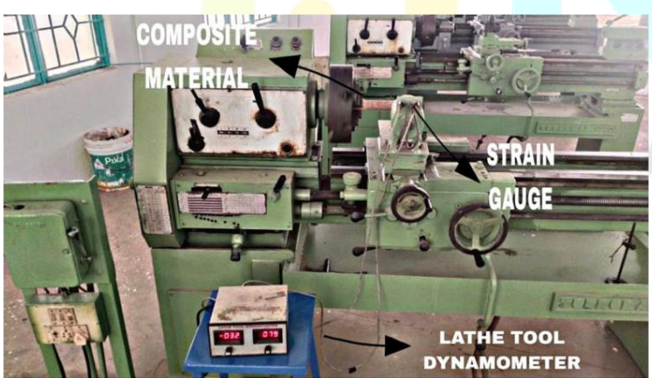


Fig -5: Schematic representation of the experimental set up

Fig -6: Machining of the polymer composite material

Table – 1: Lathe tool dynamometer – experimental values

Trail No	Spindle Speed (rpm)	Feed Rate (mm/rev)	DOC (mm)	Measured Force (N)	S/N Ratio
1	90	0.2	0.2	52.24	-31.45
2	90	0.2	0.4	53.34	-31.56
3	90	0.2	0.6	54.46	-31.78
4	90	0.4	0.2	57.43	-32.21
5	90	0.4	0.4	58.57	-32.35
6	90	0.4	0.6	59.79	-32.45
7	90	0.6	0.2	63.38	-32.56
8	90	0.6	0.4	65.56	-32.76
9	90	0.6	0.6	67.89	-32.80
10	180	0.2	0.2	69.67	-33.12
11	180	0.2	0.4	72.57	-33.34
12	180	0.2	0.6	74.40	-33.46
13	180	0.4	0.2	76.32	-33.57
14	180	0.4	0.4	78.45	-33.68
15	180	0.4	0.6	79.67	-33.79
16	180	0.6	0.2	80.75	-34.12
17	180	0.6	0.4	81.78	-34.39
18	180	0.6	0.6	82.78	-34.43
19	270	0.2	0.2	83.40	-34.52
20	270	0.2	0.4	84.56	-34.69
21	270	0.2	0.6	85.79	-34.82
22	270	0.4	0.2	87.46	-35.20
23	270	0.4	0.4	88.67	-35.37
24	270	0.4	0.6	89.23	-35.45
25	270	0.6	0.2	90.63	-35.87
26	270	0.6	0.4	91.56	-36.22
27	270	0.6	0.6	92.74	-36.49

4. ANALYSIS OF DATA TAGUCHI'S METHOD

The figure shows that, the important effect in cutting force is cutting speed and feed rate because of the parameters had an increase in values. As told in the earlier method the smaller the best quality has been used in order to get optimal combination. The smaller the best quality characteristics.

Chart – 1 S/N ratios for cutting force speed

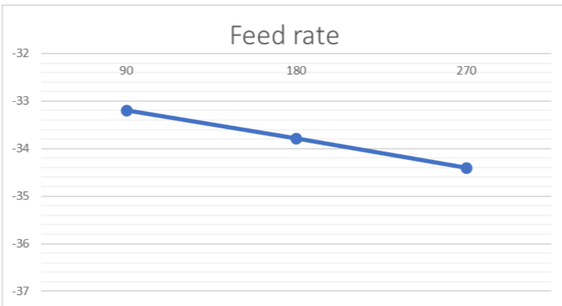


Chart – 2 S/N ratios for feed rate

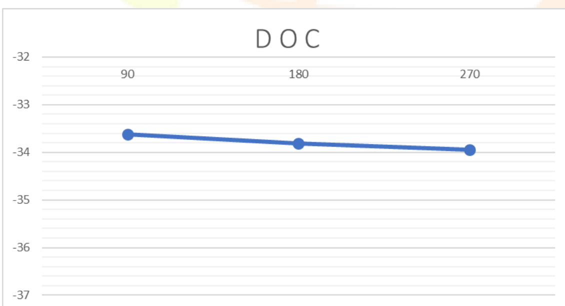


Chart – 3 S/N ratios for depth of cut

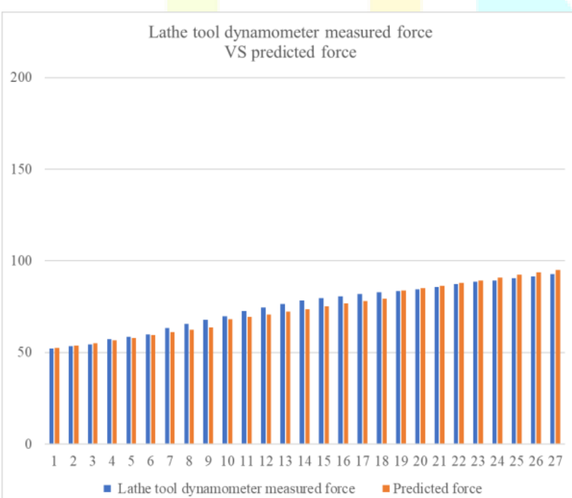


Chart – 4 Lathe tool dynamometer measured force Vs Predicted force

5. CUTTING FORCE MODEL

The experimental data shown in above table 2. This approach, the least square estimation was used to determine a for cutting force in relation to the functions of cutting speed, feed rate and depth of cut. The models for cutting force F were derived from the experimental data and as given in below Equation. The below table and graph show the comparison of experimental values and predicted values.

Cutting force(F)=31.07+0.174*N+21.65*f+6.65*d

F = Cutting Force (N),
N = Spindle Speed (rpm),
f = Feed Rate (mm/rev),
d = Depth of Cut (mm).

Table – 2: Experimental values Vs Predicted values

Trail No	Measured Force (N)	Predicted Force (N)	Residual	% Error
1	52.24	52.39	-0.15	-0.28
2	53.34	53.72	-0.38	-0.70
3	54.46	55.05	-0.59	-1.07
4	57.43	56.74	0.69	1.21
5	58.57	58.05	0.52	0.89
6	59.79	59.38	0.41	0.69
7	63.38	61.05	2.33	3.81
8	65.56	62.38	3.00	4.80
9	67.89	63.71	4.18	6.56
10	69.67	68.05	1.62	2.38
11	72.57	69.38	3.19	4.59
12	74.40	70.71	3.69	5.21
13	76.32	72.38	3.94	5.44
14	78.45	73.71	4.47	6.43
15	79.67	75.04	4.63	6.17
16	80.75	76.71	4.04	5.26
17	81.78	78.04	3.74	4.79
18	82.78	79.37	3.41	4.29
19	83.40	83.71	-0.31	-0.37
20	84.56	85.02	-0.46	-0.54
21	85.79	86.34	-0.55	-0.63
22	87.46	88.04	-0.58	-0.65
23	88.67	89.37	-0.70	-0.78
24	89.23	90.70	-1.47	-1.62
25	90.63	92.37	-1.74	-1.88
26	91.56	93.70	-2.14	-2.28
27	92.74	95.03	-2.29	-2.40

III. RESLUTS & DISCUSSIONS

This chapter presents the mechanical properties of the treated banana fiber and corban iron particles polymer composites prepared for this present investigation. The Details of processing of these composites and the tests conducted on them have been described in the before chapter. The results of various characterization tests are reported here. These include evaluation of tensile strength, impact strength that has been studied and discussed. In this study a lathe tool dynamo-meter model is used to measure the cutting force. The results showed that developed lathe tool dynamo meter is enough for measuring the cutting force for the above-mentioned parameter. The accuracy of the proposed model is expressed through the error percentage. The comparison between the lathe tool measured cutting force and the predicted cutting force using Taguchi's method and the residual and percentage error is shown the table 2.

1. Tensile Test

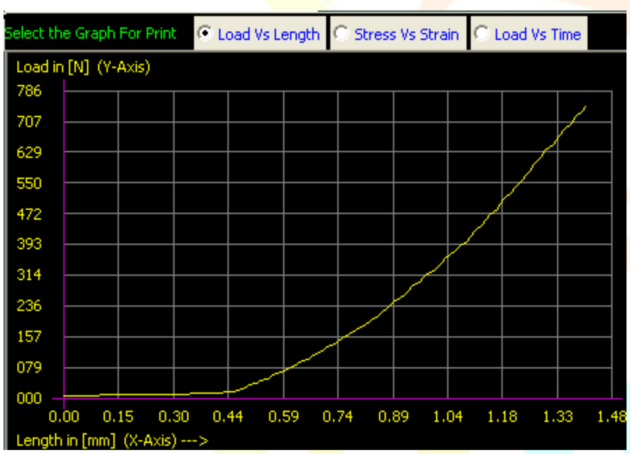
Tensile testing of specimen prepared according to ASTM standard type III sample was carried out, using electronic tensile testing machine with cross head speed of 2mm/min. They tensile testing average test value are show the table 1 & 2.

Table -1: Observations of tensile property

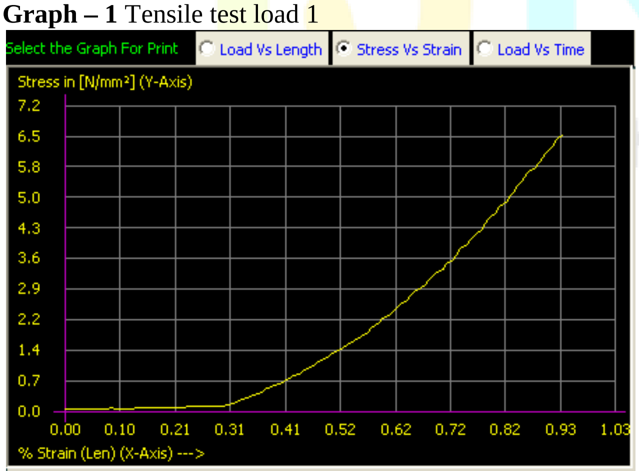
Sample	CS Area [mm]	Peak Load [N]	%Elongation	UTS [N/mm²]
000000	112.500	749.003	0.950	6.661

Table -2: Summary Report

Sample	CS Area [mm]	Peak Load [N]	%Elongation	UTS [N/mm²]
Min	112.500	749.003	0.950	6.661
Max	112.500	749.003	0.950	6.661
Avg	112.500	749.003	0.950	6.661
Std dev	0.000	0.000	0.000	0.000
Variance	0.000	0.000	0.000	0.000
Median	112.500	749.003	0.950	6.661



Graph – 1 Tensile test load 1



Graph – 2 Tensile test stress

2. Impact Test

Impact testing of specimen prepared according to ASTM standard type III sample was carried out, using impact testing machine from a swinging pendulum. The impact strength of alkali treated banana fiber and CI particles /epoxy composite has higher strength. Sudden load acting on the specimen to break the center point and calculate the J.

Table – 3 Observations of Impact test

Sample No	Izod Impact value in J given thinkness
1	0.20
2	0.10
3	0.15

IV. CONCLUSION

In this work, Mechanical properties of the banana fiber and CI particulate polymer composite were investigated. The tensile and impact properties of the composites as a function of fiber content were analyzed. The tensile test properties of peak load value as 749.003N and impact testing average value of 0.15 J function of fiber content were analyzed. Then predicting the cutting force in the banana fiber and CI particulate polymer composite material. The graph shows that the measured values (obtained from lathe tool dynamometer) are in correlation with the experimentally lathe tool dynamometer measured force. The accuracy of the lathe tool dynamometer is about 98.18%.

REFERENCES

[1] Hoi-yan Cheung, Mei-po Ho, Kin-tak Lau, Francisco Cardona, and David Hui (2009) "Natural fibre-reinforced composites for bioengineering and environmental engineering applications", Composites Part B: Engineering, Vol. 40, pp. 655– 663.

[2] Venkateshwaran, N, ElayaPerumal, A, Alavudeen, A, Thiruchitrambalam, M (2011), "Mechanical and water absorption behaviour of banana/sisal reinforced hybrid composites", Materials and Design, Vol. 32/7, pp. 4017-4021

[3] M. Thiruchitrambalam, A.Alavudeen, A.Athijayamani , N.Venkateshwaran and A.ElayaPerumal (2009), "Improving mechanical properties of banana/kenaf Polyester hybrid composites using sodium laulryl Sulfate treatment", Materials Physics and Mechanics, Vol. 9, pp 165-173

[4] Venkateshwaran, N, ElayaPerumal A (2010), "Banana Fiber Reinforced Polymer Composites - A Review", A. Journal of Reinforced Plastics and Composites, Vol. 29/15, pp. 2387-2396

[5] Paul Wambua, Jan Ivens, and Ignaas Verpoest (2003) "Natural fibres: can they replace glass in fibre reinforced plastics?" Composites Science and Technology, Vol.63, pp.1259–1264.

[6] Murali Mohan Rao K., Mohana Rao K. and Ratna Prasad A.V. (2010) "Fabrication and testing of natural fibre composites: Vakka, sisal, bamboo and banana", Materials and Design, Vol.31/1, pp. 508– 513.

[7] Herrera-Franco, P.J., Valadez-Gonzalez, A. (2005) "A study of the mechanical properties of short natural-fiber reinforced composites", Composites Part B: Engineering, Vol. 36/8, pp 597-608

[8] Mathur VK (2006) Composite materials from local resources. Constr Build Mater 20:470–477
[9] Boopalan M., Niranjana M., Umapathy M.J., Study on the mechanical properties and thermal properties of jute and banana fiber reinforced epoxy hybrid composites, Composites: Part B; 2013; 51:54-57.
[10] Ramesh M., Palanikumar K., Hemachandra Reddy K., Comparative evaluation on properties of hybrid glass fiber- sisal/jute reinforced epoxy composites, Procedia Engineering; 2013;51:745 – 750.
[11] Idicula M., Malhotra S.K., Joseph K., Thomas S., Dynamic mechanical analysis of randomly oriented intimately mixed short banana/sisal hybrid fiber reinforced polyester composites, Composites Science and Technology; 2005; 65: 1077–1087
[12] Kumar S., Misra R. K., Analysis of Banana Fibers Reinforced LowĞdensity Polyethylene/Poly(ЄĞcaprolactone) Composites, Soft Materials; 4(1): 1-13. DOI: 10.1080/15394450600823040.
[13] Naik J. B., Mishra S., Studies on Electrical Properties of Natural Fiber: HDPE Composites, Polymer-Plastics Technology and Engineering; 2005; 44(4): 687-693. DOI: 10.1081/PTE-200057818
[14] Aseer J.R., Sankaranarayanasamy K., Jayabalan P., Natarajan R., Priya Dasan K., Morphological, Physical, and Thermal Properties of Chemically Treated Banana Fiber, Journal of Natural Fibers; 2013; 10(4): 365-380. DOI: 10.1080/15440478.2013.824848.
[15] S K Thangarasu , S Shankar and A Tony Thomas Prediction of Cutting Force in Turning Process-an Experimental Approach (2018) doi:10.1088/1757-899X/310/1/012119.
[16] Suresh R., Basavarajappa S., Gaitonde V. N., & Samuel G. L. (2012). Machinability investigations on hardened AISI 4340 steel using coated carbide insert. International Journal of Refractory Metals and Hard Materials, 33, 75-86.
[17] Pramanik A., Zhang L. C., & Arsecularatne J. A. (2006). Prediction of cutting forces in machining of metal matrix composites. International Journal of Machine Tools and Manufacture, 46(14), 1795-1803.
[18] Nayak M., Sehgal R., & Sharma R. K. (2015). Mechanical Characterization and Machinability Behavior of Annealed AISI D6 Cold Working Steel. Indian Journal of Materials Science, 2015.
[19] YİĞİT R., Findik F., & Celik E. (2010). Performance of multilayer coated carbide tools when turning cast iron. Turkish Journal of Engineering and Environmental Sciences, 33(3), 147- 158.
[20] Wang W. P., Peng Y. H., & Li X. Y. (2002). Fuzzy–grey prediction of cutting force uncertainty in turning. Journal of Materials Processing Technology, 129(1), 663-666.
[21] Yaldız S., & Ünsaçar F. (2006). A dynamometer design for measurement the cutting forces on turning. Measurement, 39(1), 80-89.
[22] Kopač J., & Šali S. (2001). Tool wear monitoring during the turning process. Journal of Materials Processing Technology, 113(1), 312-316.
[23] E. D., Chen J. C., & Zhang, J. Z. (2006). Development of a fuzzy-nets-based inprocess surface roughness adaptive control system in turning operations. Expert Systems with Applications, 30(4), 592-604.
[24] Kopač J., & Šali S. (2001). Tool wear monitoring during the turning process. Journal of Materials Processing Technology, 113(1), 312-316.
[25] Fetecau C., & Stan F. (2012). Study of cutting force and surface roughness in the turning of polytetrafluoroethylene composites with a polycrystalline diamond tool. Measurement, 45(6), 1367-1379.

BIOGRAPHIES

First Dr. S. NAVANEETHAKRISHNAN is presently working as a Assistant Professor in the Department of Mechanical Engineering, Erode Senunthar Engineering College, perundhurai, Erode District, Tamilnadu, India. He was appointed as Assistant Professor in the college on June 2018. He completed his doctoral degree (Part time) in the faculty of Mechanical Engineering at Anna university Chennai on February 2018, B.E degree in Mechanical Engineering from Alagappa Chettiar College of Engineering and Technology, Karaikudi, Tamilnadu, India in April 2008 through Anna University Chennai. He studied his post-graduation with M.E (Manufacturing Engineering) during 2009-2011 in Alagappa Chettiar College of Engineering and Technology, Karaikudi. He completed both his U.G and P.G degrees in first class with Distinction. He worked as research fellow CSIR-CECRI – Karaikudi in the national network project (Hydrogen Energy initiative). After completing his post-graduation he was working as Assistant Professor in the Department of Mechanical Engineering, Mount Zion College of Engineering and Technology, pudhukottai Tamilnadu,India. He was born on 28th May 1980 at Aundipatty in Theni District Tamilnadan, India. He did his schooling in Government Higher Secondary School in Aundipatty Tamilnadu, India. He writes frequently for publications like the Polymer Journal, Plastic Technology journal, Mechanical Engineering journal, and others. His research concentrated on the role of natural fibers dispersion in enhancing the mechanical properties polymer composite. He has published 30+ articles in the peer-reviewed international journals and over eight conference proceedings, and has delivered 10+ lectures in the international and national conferences. Source: Google Scholar, Mar.

Second M. Thooyavan studying final year in mechanical engineering department at erode sengunthar engineering college.

Third T. Rajesh Kumar studying final year in mechanical engineering department at erode sengunthar engineering college.

Fourth K. Kavin Kumar studying final year in mechanical engineering department at erode sengunthar engineering college.

FIFTH S. Sivanantham studying final year in mechanical engineering department at erode sengunthar engineering college.