DESIGN AND ANALYSIS OF A HEAVY VEHICLE CHASSIS FOR COMPOSITE MATERIALS FOR OPTIMUM LOAD CONDITIONS

[1] **Madem.Naresh,** [2]**Mamillapalli. Padmanabham**
[1]Department of Mechanical M.TECH (CAD/CAM) student, Viswanadha Institute of Technology And Management
[2]Department of Mechanical ASSISTANT PROFESSOR, Viswanadha Institute of Technology & Management

ABSTRACT: Composite material is a material composed of two or more distinct phases (matrix phase and dispersed phase) and having bulk properties significantly different from those of any of the constituents. Different types of composite material are available and one of it is Polymer matrix composite. It is very popular due to their low cost and simple fabrication methods. It has the benefits of high tensile strength, high stiffness and good corrosion resistance etc. At present this polymer matrix composite material is used in aerospace, automobile industries due to it high strength to low weight ration.
For vehicles, chassis consists of an assembly of all the essential parts of a truck (without the body) to be ready for operation on the road.
In our project, design and model the heavy vehicle chassis by using Pro/Engineer software, by taking the data from the L & T heavy vehicle model by reverse engineering processes. Present used material for chassis is steel. The main aim is to replace the chassis material with IM 7 FIBER & 997 EPOXY. By using steel, the weight of the chassis is more compared with IM 7 FIBER & 997 EPOXY, since its density is more. Structural and Modal analysis is done on chassis for optimizing above parameters under 10tons load. And we are using layer stacking method for 3 and 5 layers for analysis of IM 7 FIBER & 997 EPOXY. Software used for modeling CREO and for analysis ANSYS.

I.INTRODUCTION

INTRODUCTION TO CHASSIS

The chassis forms the main structure of the modern automobile. A large number of designs in pressed-steel frame form a skeleton on which the engine, wheels, axle assemblies, transmission, steering mechanism, brakes, and suspension members are mounted. During the manufacturing process the body is flexibly bolted to the chassis.

This combination of the body and frame performs variety of functions. It absorbs the reactions from the movements of the engine and axle, receives there action forces of the wheels in acceleration and braking, absorbs aerodynamic wind forces and road shocks through the suspension, and absorbs the major energy of impact in the event of an accident.

There has been a gradual shift in modern small car designs. There has been a trend toward combining the chassis frame and the body into a single structural element. In this grouping, the steel body shell is reinforced with braces that make it rigid enough to resist the forces that are applied to it. To achieve better noise-isolation characteristics, separate frames are used for other cars. The presence of heavier-gauge steel components in modern separate frame designs also tends to limit intrusion in accidents.

Introduction of Chassis Frame:

Chassis is a French term and was initially used to denote the frame parts or Basic Structure of the vehicle. It is the back bone of the vehicle. A vehicle without body is called Chassis. The components of the vehicle like Power plant, Transmission Sys-tem, Axles, Wheels and tyre, Suspension, Control-ling Systems like Braking, Steering etc., and also electrical system parts are mounted on the Chassis frame. It is the main mounting for all the components including the body. So it is also called as Carrying Unit.

Layout of Chassis and Its Main Components:

The following main components of the Chassis are

1. Frame: it is made up of long two members called side members riveted together with the help of number of cross members.
2. Engine or Power plant: It provides the source ofpower
3. Clutch: It connects and disconnects the power from the engine flywheel to the transmission system.
4. Gear Box
5. U Joint
6. Propeller Shaft
7. Differential

Functions of the Chassis Frame:

1. To carry load of the passengers or goods carried in the body.
2. To support the load of the body, engine, gear box etc.
3. To withstand the forces caused due to the sudden braking or acceleration
4. To withstand the stresses caused due to the bad road condition.
5. To withstand centrifugal force while cornering

Types Of Chassis Frames:

There are three types of frames

1. Conventional frame
2. Integral frame
3. Semi-integral frame

Design Goals

Chassis and Body Structure

The vehicle design starts up with conceptual studies to define size, number and location of un-driven and drive axles, type of suspension, engine power, transmission, tire size and axle reduction ratio, cab size and auxiliary equipment. The selected configuration has to be suitable for the considered transportation tasks and should match the existing production line. Either new vehicle type is generated or a certain improvement over existing types has to be achieved. Because of the fierce competition, and advanced technology in engineering, manufacturing and service and strenuous work is required to be successful. Having defined the general configuration of a vehicle, let us now concentration the main structural components. The most important function of the "backbone" is supporting and distributing the loads originating from.

• Payload including its vessels
• Axles with their fixtures
• coupling device

- Drive train
- Truck cabin including top sleeper/windshield
- Inertia forces
- forced deformation
- Special service functions like cab tilt mechanism, cargo handling
- Equipment

In addition to the primary structural functions, the chassis has to incorporate accessories, optional and special equipment like hydraulics, and electrical wiring and piping systems. Altogether, space is very limited and sometimes only small cross section dimensions are usable for the main structure.

III. LITERATURE REVIEW

The chassis frame forms the backbone of a heavy vehicle, its principle function is to safely carry the maximum load for all designed operating conditions. This paper describes design and analysis of heavy vehicle chassis. Weight reduction is now the main issue in automobile industries. In the present work, the dimensions of an existing heavy vehicle chassis of a TATA 2515EX vehicle is taken for modeling and analysis of a heavy vehicle chassis with three different composite materials namely, Carbon/Epoxy, E-glass/Epoxy and S-glass /Epoxy subjected to the same pressure as that of a steel chassis. The design constraints were stresses and deflections. The three different composite heavy vehicle chassis have been modeled by considering three different cross-sections. Namely C, I and Box type cross sections. For validation the design is done by applying the vertical loads acting on the horizontal different cross sections.

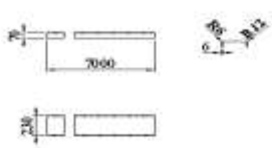
INTRODUCTION TO CAD

Computer-aided design (**CAD**) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term **CADD** (for Computer Aided Design and Drafting) is also used.

INTRODUCTION TO CREO

PTC CREO, formerly known as Pro/ENGINEER, is 3D modeling software used in mechanical engineering, design, manufacturing, and in CAD drafting service firms. It was one of the first 3D CAD modeling applications that used a rule-based parametric system. Using parameters, dimensions and features to capture the behavior of the product, it can optimize the development product as well as the design itself.

2D DRAWINGS



ASSEMBLY

STATIC ANALYSIS OF CHASSIS

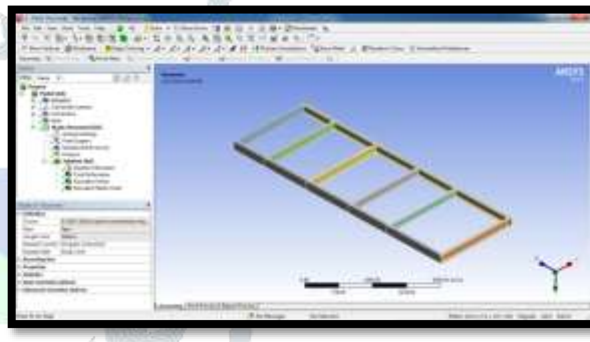
Open ANSYS>Open work bench 14.5>select static structural >double click on it.

STATIC ANALYSIS OF CHASSIS

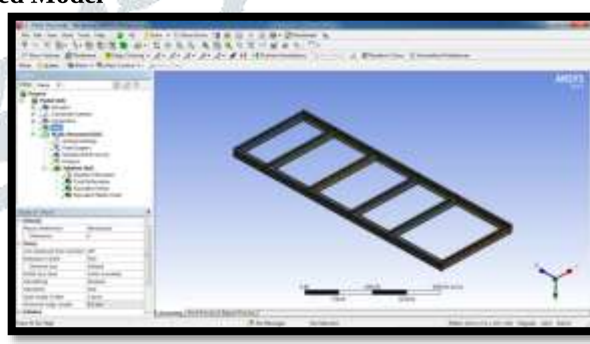
Definition of Static Analysis

A static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. A static analysis can, however, include steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads (such as the static equivalent wind and seismic loads commonly defined in many building codes).

Imported Model from CREO



Meshed Model

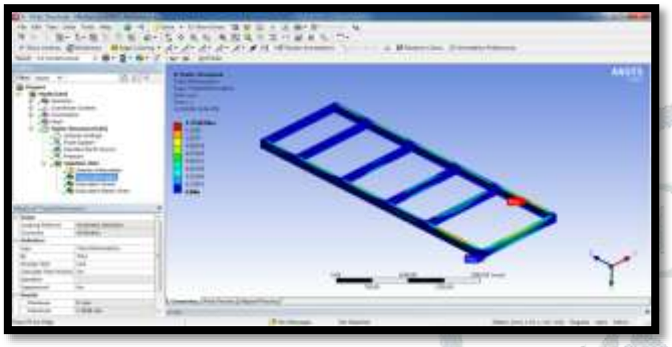


SPECIFICATION OF MATERIAL

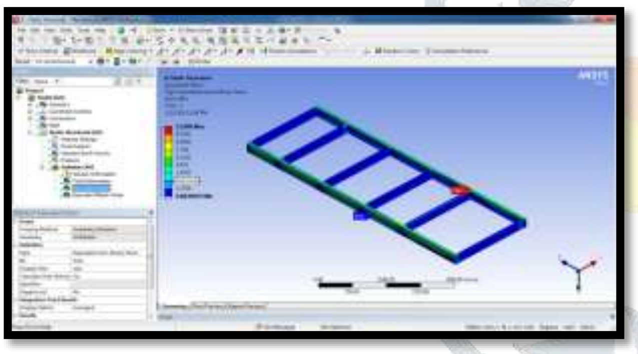
Properties	High carbon steel	IM Fiber	997 epoxy
Density(g/cm^3)	8.26	1.780	1.610
Young's modulus (MPa)	235000	276000	145000
Poisson's ratio	0.313	0.36	0.313

High carbon steel

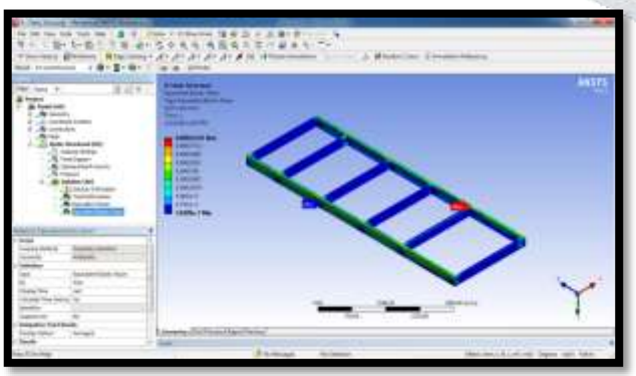
Deformation



Stress

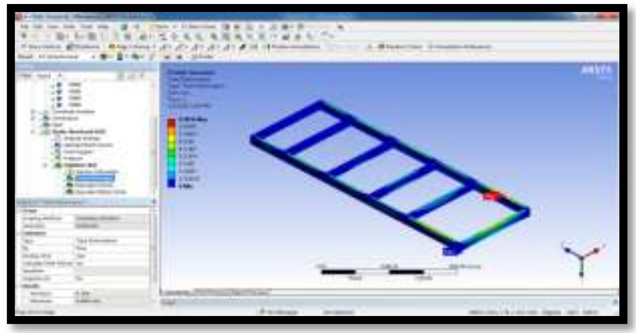


Strain

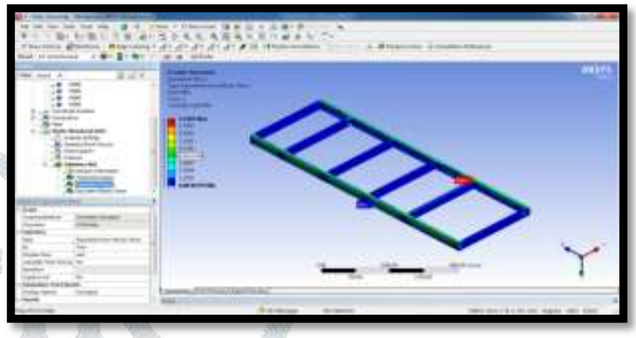


IM FIBER

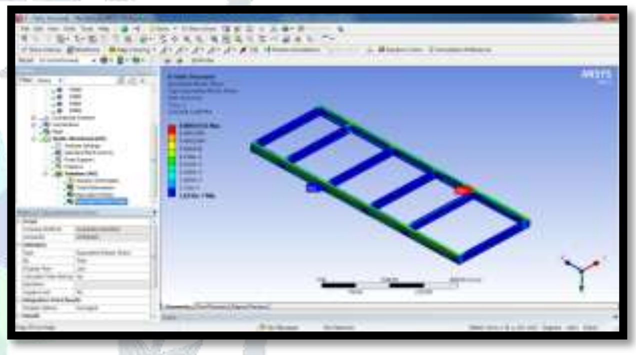
Deformation



Stress

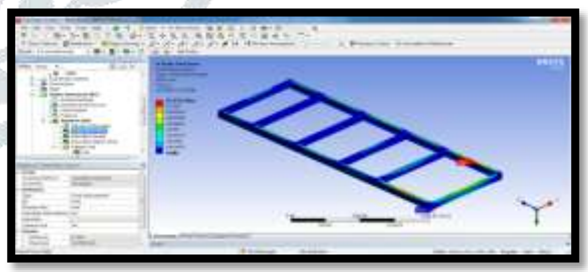


Strain

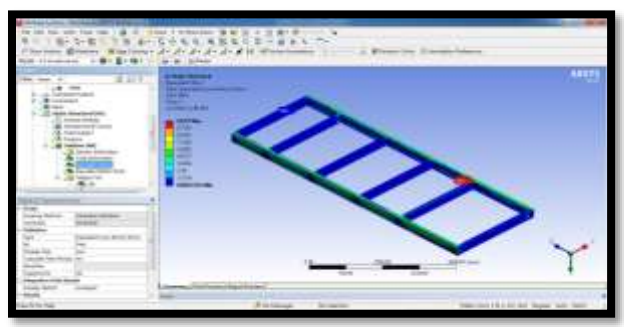


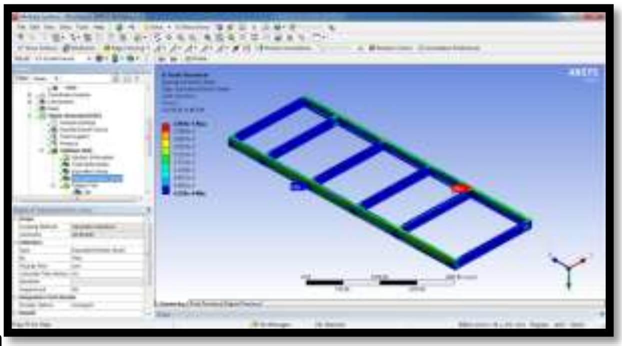
997 Epoxy

Deformation



Stress





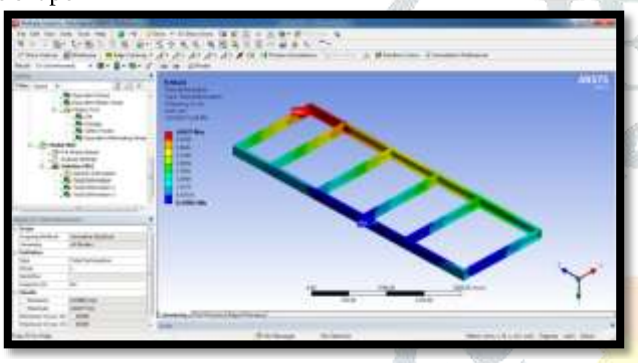
Strain

MODAL ANALYSIS OF CHASSIS

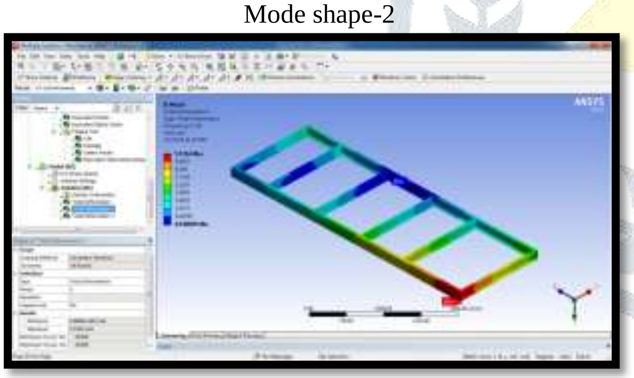
Modal analysis to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed. It also can be a starting point for another, more detailed, dynamic analysis, such as a transient dynamic analysis, a harmonic response analysis, or a spectrum analysis.

Material- 997 EPOXY

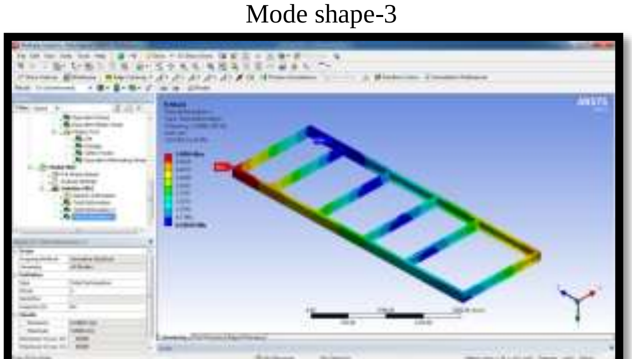
Mode shape-1



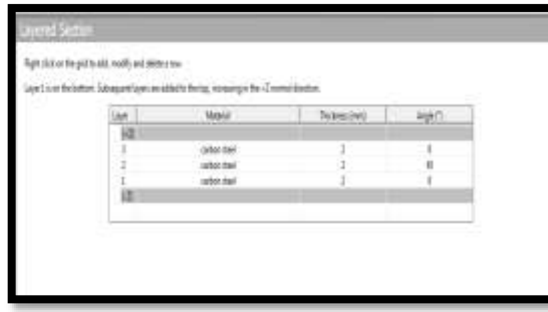
Mode shape-2



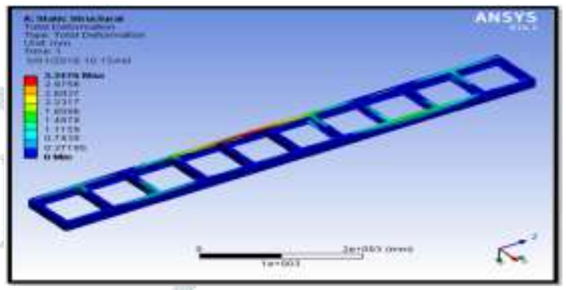
Mode shape-3



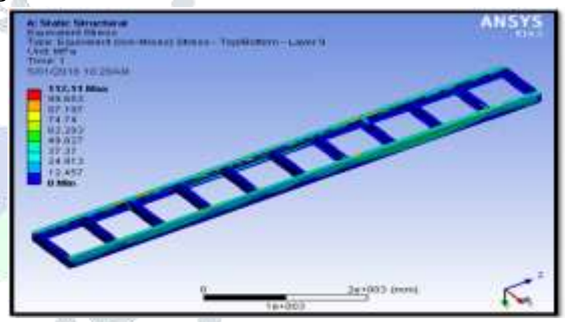
LAYER STACKING
3 LAYERS
MATERIAL – CARBON STEEL
LAYERS



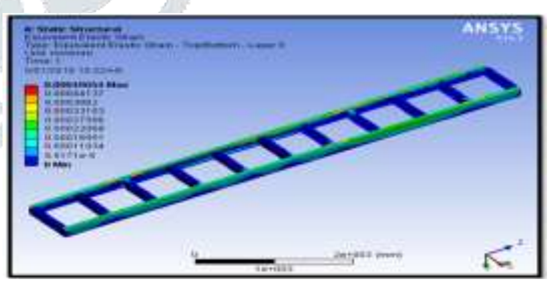
DEFORMATION



STRESS



STRAIN



FOR NORMAL MATERIAL

RESULTS

Materials	**High carbon steel**	**IM Fiber**	**997 epoxy**
Deformation (mm)	1.3548	0.4944	0.12532
Stress (MPa)	11.006	11.003	10.97
Strain	0.0004242	0.00015531	0.00003984

Here, from comparison of aluminum alloy chassis with composite chassis as shown in above table, it can be seen that the maximum deflection 1.3548 mm on aluminum alloy 6063-T6 chassis and corresponding deflection in aluminum alloy 1050 and IM7fiber are 0.4944 mm, 0.12532 mm. Also the von-misses stress in the aluminum alloy 6063-T6 chassis 11.006 MPa while in aluminum alloy 1050 and IM7fiber the von-misses stresses are 11.003 MPa, 10.97 MPa respectively.

RESULT TABLE

Material	Mode shapes	Deformation(mm)	Frequency (Hz)
997 EPOXY	1	4.8427	0
	2	5.51764	0
	3	5.0984	0.00198
IM7fiber	1	4.4188	0
	2	4.0271	0
	3	5.339	0.001698
HIGH CARBON STEEL	1	5.6601	0
	2	5.2876	0.002323
	3	6.8286	0.0055217

FOR 3 LAYERS

STRUCTURAL ANALYSIS

	High carbon steel	Im7 fiber	997 Epoxy
Deformation	3.3476	2.7751	4.8878
Stress	112.11	109.97	101.23
Strain	0.00049654	0.00041484	0.0007267

MODEL ANALYSIS

		High carbon steel	Im7 fiber	997 Epoxy
Mode 1	Deformation	10.908	23.552	24.6992
	Frequency	56.499	133.69	100.52
Mode 2	Deformation	10.537	22.785	23.877
	Frequency	67.702	147.82	111.56
Mode 3	Deformation	10.39	22.193	23.544
	Frequency	70.522	165.96	125.48

FOR 5 LAYERS

STRUCTURAL ANALYSIS

	High carbon steel	Im7 fiber	997 Epoxy
Deformation	3.4153	2.7998	5.032
Stress	109.68	106.76	99.71
Strain	0.00047017	0.00038594	0.00069272

MODEL ANALYSIS

		High carbon steel	Im7 fiber	997 Epoxy
Mode 1	Deformation	5.5822	12.04	12.616
	Frequency	0.75874	1.7478	1.421
Mode 2	Deformation	5.3422	11.513	12.106
	Frequency	1.9669	4.5717	3.6044
Mode 3	Deformation	5.3531	11.542	12.121
	Frequency	3.7482	8.7521	6.7884

V.CONCLUSION

Presently steel is used for chassis. In this project it is replaced with using materials IM7 Fibre and 997 Epoxy. Structural and Modal analysis is done on the chassis for solid and using layer stacking method. By observing structural analysis results the stress values for 997 Epoxy and IM7 fiber are less than their respectively allowable stress values so using composites for chassis is safe. By using composites instead of steel, the weight of the chassis reduce 4 times than by using steel because density of steel is more than the composites. The stress values are less for 997 epoxy. Also by observing Modal analysis results for all materials, the deformation and frequencies are increasing for composites than High Carbon Steel. So vibrations will be increasing if composites are used. We have also done layer stacking method (i.e) by taking 3 layers and 5 layers for same thickness of main channel. We have observed that vibrations will be reduced by taking number of layers than by taking as a single layer. So we can conclude that using 997 epoxy is better.

VI. REFERENCES

DESIGN AND ANALYSIS OF A HEAVY VEHICLE CHASSIS FOR COMPOSITE MATERIALS FOR OPTIMUM LOAD CONDITIONS

Madem.Naresh Mamillapalli. Padmanabham

[1] NitinTenguriaet.al."Design and Finite Element Analysis of Horizontal Axis Wind Turbine blade" International Journal of Applied Engineering Research, Dindigul Volume 1, No 3, 2010 ISSN 09764259.

[2] Mr. Jesus Vega Fuentes,et.al. "Design of wind turbine blades of a power of 1000 watts for domestic use." 978-1-61284-1325-5/12, 2012 IEEE.

[3] Mr.V. DíazCasás, et.al. "Automatic Design and Optimization of Wind Turbine Blades" International Conference on Computational Intelligence for Modeling Control and Automation, and International Conference on Intelligent Agents, Web Technologies and Internet Commerce 0-7695-2731- 0/06,IEEE.

[4] Arvind Singh Rathore et al., "Design and Analysis of Horizontal Axis Wind Turbine Rotor"., International Journal of Engineering Science and Technology (IJEST) Vol. 3 No.11 November 2011 ISSN : 0975-5462.

[5] Jialin Zhang, et.al. "Design and Research of High-Performance Low-Speed Wind Turbine Blades. "November 2011.IEEE.