



TRISHUL



Technical magazine

It is to provide a platform for the students, teachers, technical as well as non-technical staff of the college to express their work, ideas, views, opinions, etc. related to science and technology. They provide a platform for faculty and students to publish articles, share technical expertise, and highlight achievements, ultimately driving awareness of recent trends and enhancing technical skills.

Editorial Board

Faculty Coordinator:

- Mr. R.Sri Sabarinathan
- Mr. A.Eswaran

Student Coordinator:

- Mr. D.Manikandan
- Mr. S.Vasanthkumar
- Mr. C.Pravinkumar



Gnanamani College of Technology
(Approved By AICTE & Affiliated to Anna University, Chennai)
Accredited By NAAC "A" Grade & NBA
NH-7, A Samuthiram, Pachal (P.O.), Namakkal - 637018
Department of Mechanical Engineering

GNANAMANI EDUCATIONAL INSTITUTIONS

Gnyanamani Educational Institutions that have carved a niche for itself in the field of engineering education within a very short span of time. Gnanamani College of Technology which was established in the year 2006, the group comprises of Gnanamani College of Education, established in the year 2005. Gnanodaya CBSE International School was established in the year 2015. These Institutions serve under the aegis of The Christian Educational Development Trust. Gnyanamani Educational Institutions were established in a well-planned campus with a green environment. The Colleges are spread on a sprawling 60 acres of serene land. The Colleges are easily accessible from all major cities by road and railway networks. These Institutions have emerged as a pioneer venture in the field of Technical Education. Dr.T.Arangannal – a Rashtria Vidhya Saraswathi Puraskar Awardee is the Chairman and Mrs.P.Malaleena is the Chairperson of the Educational Institutions.

GNANAMANI COLLEGE OF TECHNOLOGY

Gnanamani College of Technology is a leading Institution with state-of-the-art facility. The college is affiliated to Anna University and Autonomous approved by AICTE. The institution is rendering noble service to the youths in rural and urban areas. The college is accredited by the NAAC and NBA (CSE, ECE, EEE, and Mechanical). The college has grown in a short span of 16 years with 12 UG Courses namely Agricultural, Artificial Intelligence and Data Science, Bio-Medical, Biotechnology, Chemical, Computer Science, Electrical and Electronics, Electronics and Communication, Food Technology, Mechanical, Information Technology and Pharmaceutical Technology. The Institute also offers 9 PG courses in Computer Science, Construction Engineering and Management, Environmental Engineering, Embedded System Technology, Power Electronics and Drives, Industrial Engineering, VLSI Design, BME, MBA and MCA.

INSTITUTION VISION

Emerging as a technical institution of high standard and excellence to produce quality Engineers, Researchers, Administrators and Entrepreneurs with ethical and moral values to contribute the sustainable development of the society.

INSTITUTION MISSION

We facilitate our students

- To have in-depth domain knowledge with analytical and practical skills in cutting edge technologies by imparting quality technical education.
- To be industry ready and multi-skilled personalities to transfer technology to industries and rural areas by creating interests among students in Research and Development and Entrepreneurship.

DEPARTMENT OF MECHANICAL ENGINEERING

The Mechanical Engineering Department was started in the year 2009 and accredited by NBA in 2019. It offers B.E. with 60 student intake, M.E. – I.E., and Ph.D. The department has 12 Curriculum Laboratories and Industry supported labs providing Value added courses and a Centre of Excellence Laboratory. Anna University recognized Research & Development Centre with 3 Ph.D. Supervisors and 6 Doctorates. The faculty of department have published in reputed journal publications. The Department has 2 Professional Societies namely IEI and ISTE.

Department Vision

To produce competent Mechanical Engineer capable of working in an interdisciplinary environment contributing to benefits of society through innovation, leadership and entrepreneurship.

Department Vision

- Imparting the highest quality education through state-of-the-art facilities to build students' professional practice and make them globally competitive Mechanical Engineers by enhancing their knowledge.
- Fostering professional and ethical values and training the students to build leadership and entrepreneurship qualities for their career development.
- Undertaking research and developmental activities to provide service for the sustainable development of the society.

Program Educational Objectives (PEOs)

Graduates of Mechanical Engineering will

- PEO 1: Apply their mechanical and allied knowledge to address technical and societal problems with creativity and ethical values.
- PEO 2: Design and analyse mechanical systems with strong fundamentals and work in synchronisation with industries and research organisations as team members on multi-disciplinary projects
- PEO 3: Seek out positions of leadership actively within their profession and their community through lifelong learning.

Program Specific Outcomes (PSOs)

Graduates of the program will be able to

- PSO-1: Apply principles of basic sciences, machine design, manufacturing, thermal engineering and management to identify, formulate and solve real time problems and societal issues for the sustainable development.
- PSO-2: Develop their abilities to qualify for Employment, Higher studies and Research in Mechanical Engineering

Program Outcomes (POs)

- Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems
- Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- Design / development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.
- Conduct investigations of complex problems: Use research-based knowledge and re-search methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
- Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.
- Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



Management Profile



Gnyanamani Educational Institutions are run by two legendary visionaries, Dr.T.Arangannal and Mrs.P.Malaleena, whose dedication to education has shaped the institution's identity and direction.

At the forefront is Dr.T.Arangannal, Chairman, a distinguished leader, who has been a driving force behind the institution's evolution. A recipient of the Rashtriya Vidya Saraswati Puraskar and an honorary Doctorate from the University of Sri Lanka, Dr. Arangannal is widely revered for his lifelong contributions to the field of education. His visionary leadership has cultivated a culture of excellence, discipline, and innovation across all levels of the institution.

Mrs.P.Malaleena, Chairperson, whose unwavering commitment and strategic foresight have been instrumental in establishing the institution's strong ethical and academic foundations. Her focus on student-centered learning and inclusive growth continues to define its mission, vision, and core values.

The leadership team also includes Ms.Madhuvanthinie Arangannal, Vice-Chairperson, who brings a contemporary vision and strategic insight to the institution's development. Her dynamic leadership focuses on aligning the institution with global academic standards and fostering innovation in education.

Operational administration is efficiently managed by Dr.P.Premkumar, Chief Administrative Officer, whose expertise in institutional management and policy implementation ensures the smooth functioning of all academic and support services. His strategic leadership plays a vital role in sustaining and enhancing the institution's quality standards.

Academic affairs are led by Dr.T.K.Kannan, Principal, who is committed to providing a rigorous and engaging academic environment. His leadership promotes research-driven teaching, skills development, and student empowerment, ensuring that learners are prepared to meet the demands of a rapidly changing global landscape.



Chairman's Message



It gives me immense pleasure to express that our Mechanical Engineering release the department magazine for the academic year 2022-23 highlighting the various activities and budding talents of the students on this special occasion. I value the emerging ability and the endowment of the students in their articles, poems, drawing etc., which bloom out their young talents and skills. I appreciate our magazine committee for their venture in bring out this memorable edition.

I wish the Principal, Magazine Committee and the Editorial team, Staff and Students and all the hands that rendered service to bring out a fabulous magazine for this year, I am passionately waiting for the editorial team to reach another mile stone of perfection in the next magazine. I wish them all success.

- Dr.T.Arangannal



Chairperson's Message



I am glad to know that our Gnanamani College Of Technology is leading a step forward by releasing the magazine 2022-2023. This magazine would be a common platform for the students to express their hidden talents and creativity. My hearty wishes to the Principal, staff members and students for the completion of this TRISHUL. Wishing you all success in their Academic Endeavours.

-Tmt.P.Malaleena



Vice Chairperson's Message



TRISHUL is particularly important as it encourages the students to share the knowledge they have acquired. Writing articles for the magazine also improves the communication skills of the budding engineers of the Mechanical department. It is common knowledge that representation of an idea is as important as, if not more important, than the idea itself.

I would like to congratulate the faculty and the students of the editorial team on bringing out the issue of Trishul and my best wishes to the students for a bright future.

-Ms. Madhuvanthinie Arangannal



CAO's Message



It is my privilege to know that Department of Mechanical Engineering releasing its achievements in a nutshell in the form of a magazine. This magazine is a skylight which always exhibit innovative and the creative thoughts of the blooming engineers. I take this opportunity to congratulate and wish all faculty members and students success.

-Dr.P.Premkumar



Principal Message



Trishul represents a cloud with a silver lining for the world of technology. It aims to inspire and nurture upcoming world of technology. The magazine captures the current engineers to bring a revolution in this ever evolving technological advancements. I would like to congratulate the Vice principal, HoD, Staff members and students for bringing out the issue of Trishul.

-Dr. T.K. Kannan



HoD's Message



Congratulations to the students and faculty associated to magazine committee for successfully publishing the issue of departmental technical magazine Trishul. Trishul is creating platform which provides an opportunity to the students and staff to express their original thoughts on technical topics. The magazine plays an instrumental role in providing exposure to the students to develop written communication skills and command over the language. It is a step towards building professional and ethical attitude in them. The entire journey of creating Trishul is an outcome of rigorous effort made by students and faculty. On concluding note, I would like to thank all the stakeholders for their involvement and encouragement and wish all the best for their bright future.

-Dr.N.Balakrishnan

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Friction Stir Welding (FSW)

Introduction

Friction Stir Welding (FSW) is a solid-state joining process invented in 1991 by The Welding Institute (TWI), United Kingdom.

Unlike conventional fusion welding techniques, FSW does not melt the base materials. Instead, it uses a non-consumable rotating tool to generate frictional heat and plastic deformation at the joint interface, thereby producing a high-quality weld.

FSW is widely used in aerospace, automotive, shipbuilding, and railway industries due to its superior mechanical properties, low distortion, and ability to join aluminum alloys and other lightweight materials.

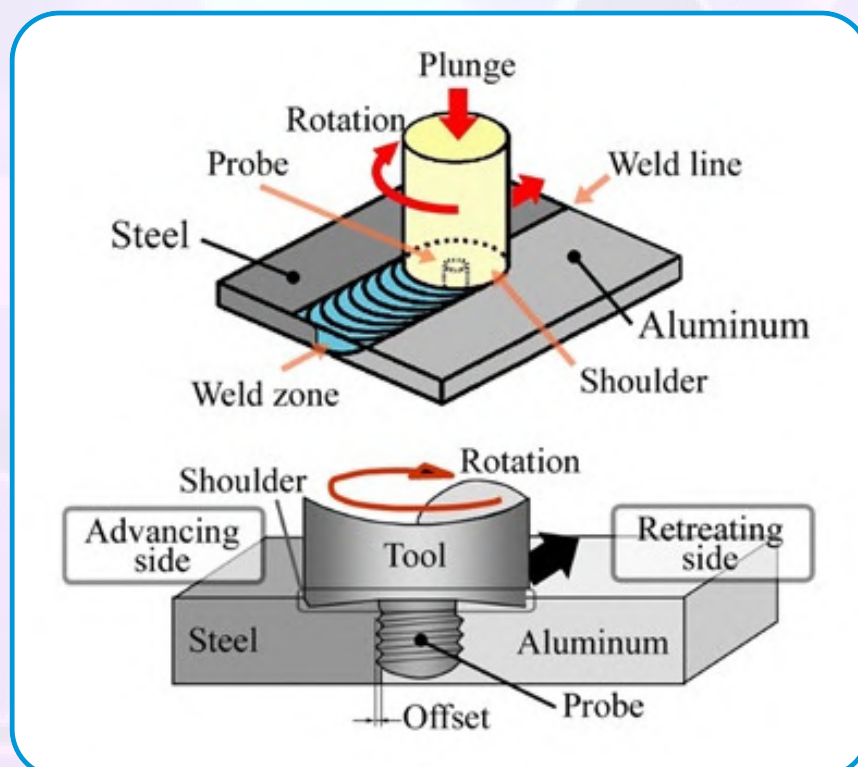
Working Principle

The FSW tool consists of two main parts:

- Shoulder – Generates heat through friction and contains the plasticized material.
- Pin (or Probe) – Penetrates into the joint and stirs the softened material.

During operation:

- The rotating tool plunges into the joint between two clamped workpieces.
- Frictional heat softens the material without melting it.
- The tool traverses along the joint line.
- Plasticized material flows from the front of the pin to the back, forming a solid-phase weld.



Friction Stir Welding (FSW)

Major Process Parameters of FSW

The quality of FSW depends strongly on process parameters:

a) Tool Rotational Speed (RPM)

Higher rotational speed increases heat generation and improves material flow, but excessive speed may cause defects or flash formation.

b) Traverse Speed (Welding Speed)

Traverse speed determines the exposure time of material to heat. Low speed increases heat input, while high speed may lead to insufficient mixing and tunnel defects.

c) Axial Force (Downward Force)

Adequate axial force ensures proper contact between tool shoulder and workpiece surface, generating sufficient frictional heat.

d) Tool Tilt Angle

Typically 2° – 4° . Proper tilt improves consolidation of plasticized material and enhances weld strength.

e) Tool Geometry

Pin shape (cylindrical, threaded, tapered) significantly influences material flow and mechanical properties.

Advantages

- No melting – solid-state process
- Low distortion and residual stress
- Excellent mechanical properties
- Energy efficient and environmentally friendly
- Suitable for dissimilar material welding

Applications

- Aerospace structures (fuel tanks, panels)
- Automotive body components
- Ship hull fabrication
- Railway coaches and bridges

Failure Analysis Using Fractography

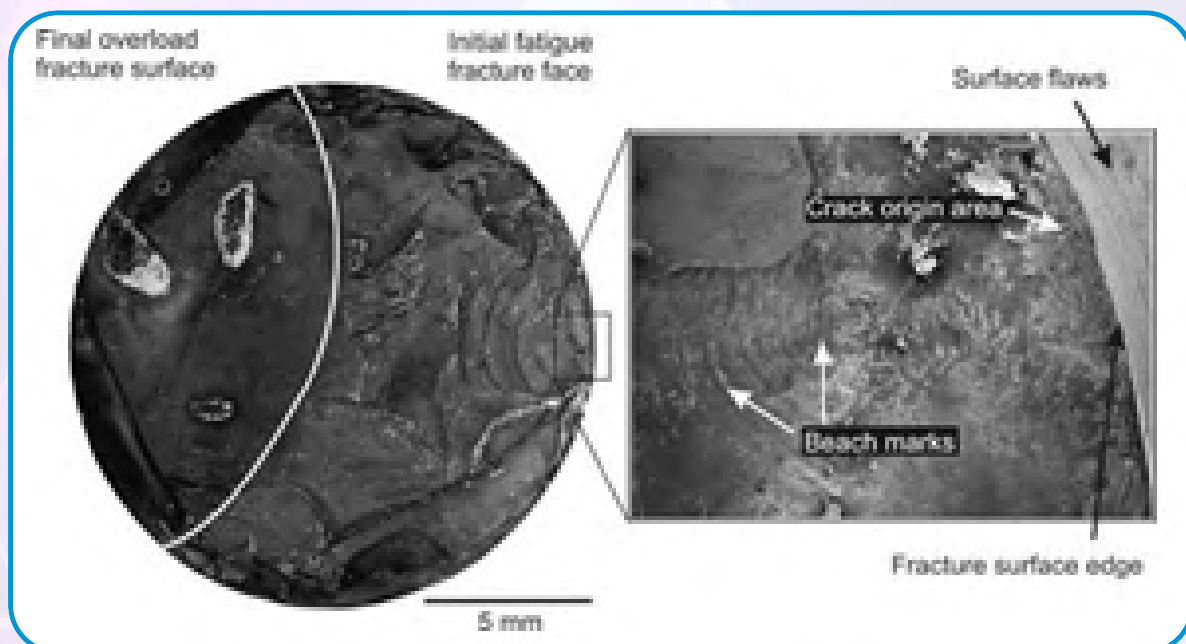
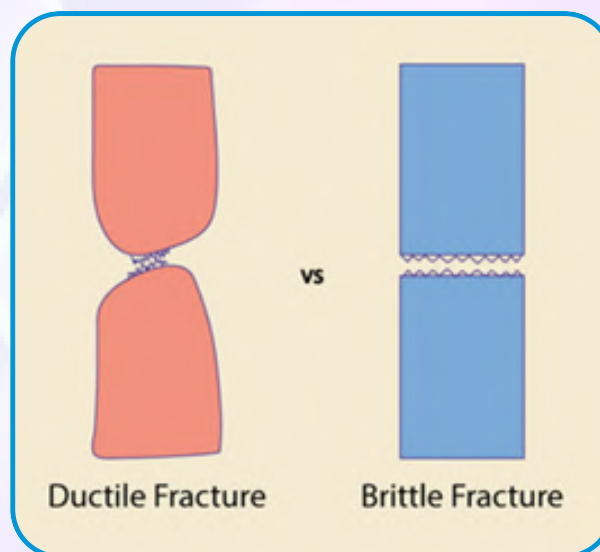
Introduction

Failure analysis is a systematic investigation of fractured or damaged components to determine the root cause of failure. It helps prevent recurrence, improve design reliability, and enhance material performance.

Fractography is the study of fracture surface features to identify fracture mode, crack initiation site, crack propagation direction, and environmental effects.

Common Fracture Modes

- Ductile Fracture – Significant plastic deformation; dimpled surface.
- Brittle Fracture – Sudden fracture; cleavage facets.
- Fatigue Fracture – Progressive crack growth; beach marks/striations.
- Creep Fracture – High temperature failure; intergranular cracks.



Failure Analysis Using Fractography

Scanning Electron Microscopy (SEM) in Fractography

Scanning Electron Microscopy (SEM) uses a focused electron beam to scan the surface of a specimen and produce high-resolution images.

SEM-Based Failure Analysis Procedure

- Visual inspection.
- Low magnification examination.
- Identify crack origin.
- High magnification study of micro-features.
- Elemental analysis (if required).
- Correlate findings with service conditions



Advantages

- High magnification (up to $\sim 300,000\times$).
- Excellent depth of field.
- Detailed surface morphology.
- Elemental analysis using EDS (Energy Dispersive Spectroscopy).

Transmission Electron Microscopy (TEM) in Fractography

Transmission Electron Microscopy (TEM) transmits an electron beam through an ultra-thin specimen to observe internal microstructure at atomic or nanometer scale.

Importance of TEM in Failure Analysis

- Used when failure involves nanoscale defects.
- Suitable for microstructural transformation analysis.
- Dislocation density studies.
- Precipitation and phase change analysis.



SEM vs TEM Comparison

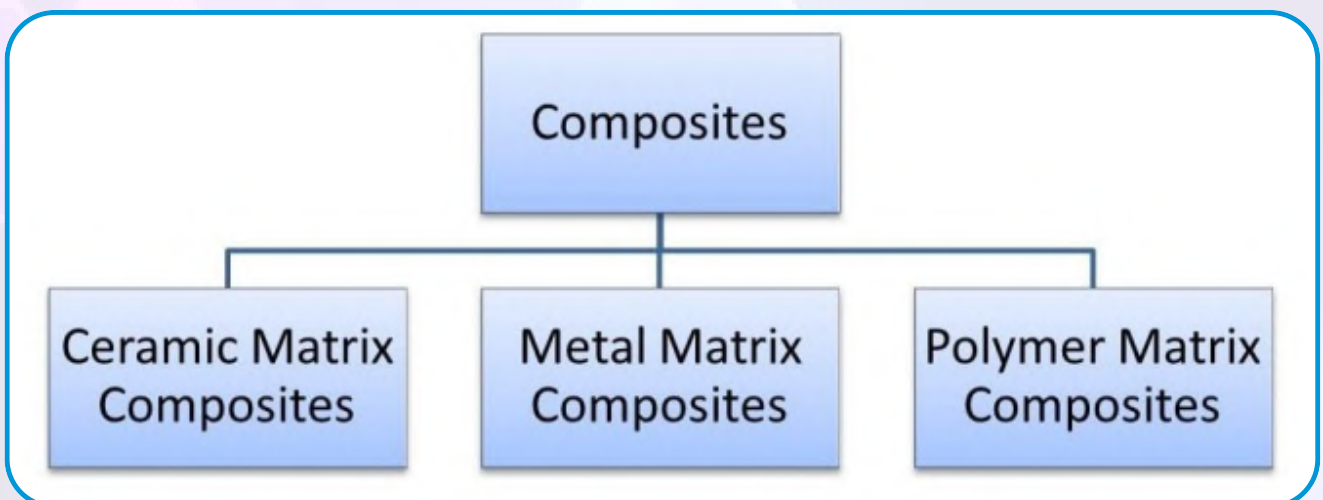
- SEM – Surface morphology; bulk specimen; easier preparation.
- TEM – Internal structure; ultra-thin sample; complex preparation.

Metal Matrix & Polymer Matrix Composites

Introduction

Composites are among the most significant advancements in material science, enabling engineers and scientists to develop materials with tailored properties that surpass the limitations of traditional materials. Unlike conventional metals, ceramics, or polymers, composites are formed by combining two or more distinct phases—commonly referred to as the matrix and reinforcement. This synergy between phases allows composites to achieve unique mechanical, thermal, and chemical properties, making them indispensable across a range of industries, including aerospace, automotive, construction, and biomedical engineering. The matrix material is the continuous phase in a composite, encapsulating and supporting the reinforcement phase, which is typically in the form of fibers, particles, or whiskers.

The matrix not only provides shape and structural integrity to the composite but also transfers stress to the reinforcement and protects it from environmental damage, such as oxidation, corrosion, or thermal degradation. On the other hand, the reinforcement phase significantly enhances specific properties, such as strength, stiffness, wear resistance, or thermal conductivity, depending on its nature. The choice of matrix material plays a pivotal role in determining the properties and performance of a composite. Based on the type of matrix material, composites are broadly classified into polymer matrix composites (PMCs), metal matrix composites (MMCs), and ceramic matrix composites (CMCs).



Metal Matrix & Polymer Matrix Composites

1. Metal Matrix Composites:

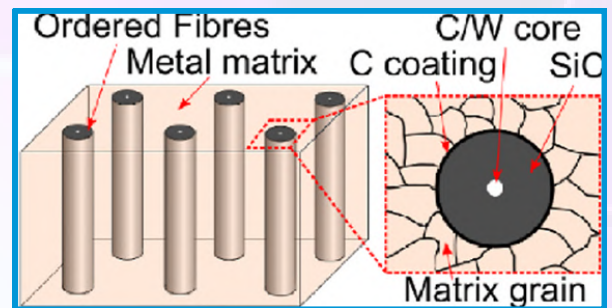
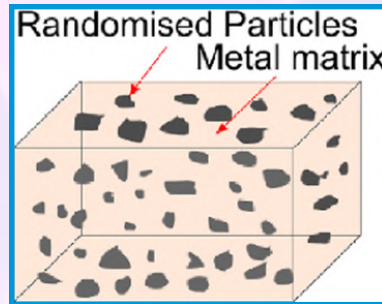
Metal matrix composites have superior mechanical properties, superior rigidity, high shear and compression strength, and high temperature resistance compared to polymer matrix composites. Despite all these advantages, their costs are very high and they are currently in the development phase, Metal matrix composite materials offer very good alternatives to traditional materials.

Properties

- High strength and stiffness
- Good wear resistance
- High temperature resistance

Applications

- Aerospace components
- Automotive brake rotors
- Piston and cylinder liners
- Defense equipment



2. Polymer Matrix Composites:

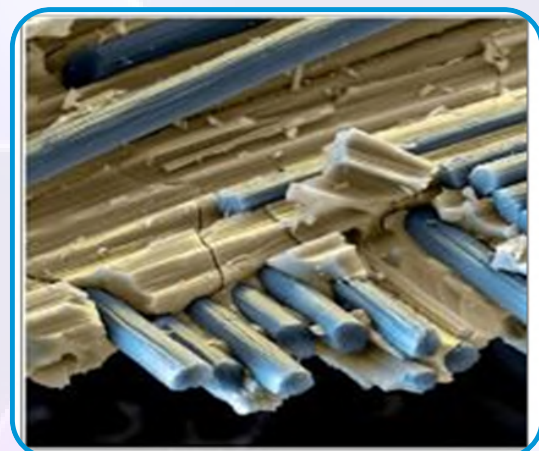
Polymers do not have superior mechanical properties. Their strength and rigidity are lower than metals and ceramics. Improving the properties of polymers by reinforcing them makes a significant contribution to the field of application. Polyester and epoxy resins are used more than other polymer matrices. The main reinforcement materials used are glass fiber, kevlar fiber, boron fiber and carbon fibers.

Properties

- Low density (lightweight)
- Good corrosion resistance
- High strength-to-weight ratio

Applications

- Aircraft structures
- Wind turbine blades
- Automobile body panels
- Boat hulls



Creep & Fatigue Life Prediction Models

Fundamentals of Creep and Fatigue Damage

Creep and fatigue are the two dominant failure mechanisms affecting high-temperature structural components in aerospace, power plants, nuclear reactors, and petrochemical industries.

Creep Mechanism

Creep is time-dependent plastic deformation under constant stress at elevated temperature (typically above $0.4 T_m$). It occurs in three stages: Primary, Secondary (steady-state), and Tertiary creep.

Important Creep Models

- Norton's Power Law
- Larson–Miller Parameter (LMP)
- Monkman–Grant Relationship

Fatigue Mechanism

Fatigue is progressive damage under cyclic loading, leading to crack initiation and crack propagation. Types include High Cycle Fatigue (HCF), Low Cycle Fatigue (LCF), and Thermo-mechanical Fatigue (TMF).

Important Fatigue Models

- S–N Curve (Wöhler Curve)
- Coffin–Manson Equation
- Paris Law for Crack Growth

Creep–Fatigue Interaction Models

At elevated temperatures, creep and fatigue occur simultaneously. This interaction significantly reduces component life and requires advanced predictive models.

Linear Damage Rule (Miner's Rule)

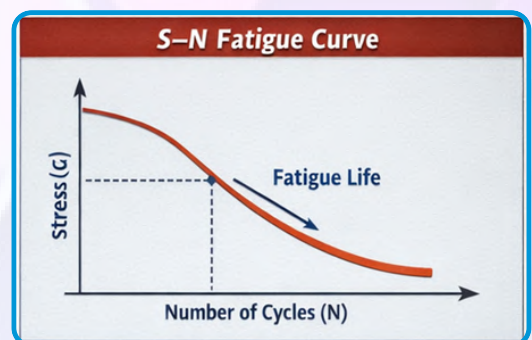
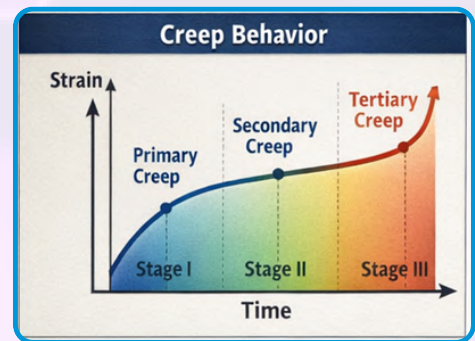
Damage accumulation is calculated as the sum of cycle ratios. Failure occurs when total damage equals one.

Time Fraction Rule

Creep damage is evaluated as the ratio of operating time to rupture time under given stress and temperature conditions.

Strain Range Partitioning (SRP)

Separates total strain into elastic and plastic components for accurate life prediction.



Creep & Fatigue Life Prediction Models

Advanced Computational & AI-Based Models

Modern industries integrate computational methods with material science to improve life prediction accuracy.

Finite Element Based Life Prediction

Thermo-mechanical simulations provide stress distribution, strain localization, and temperature gradient analysis.

Microstructure-Based Models

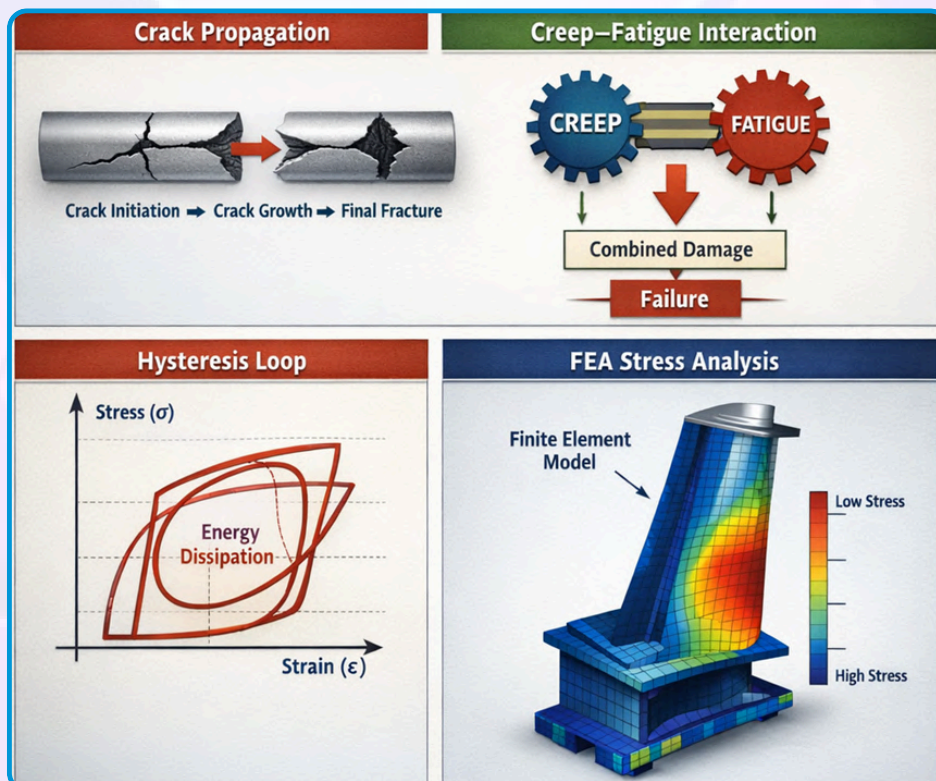
Accounts for grain boundary sliding, void nucleation, and dislocation mechanisms.

Machine Learning Approaches

Neural networks and data-driven models are used for Remaining Useful Life (RUL) estimation and predictive maintenance.

Design Recommendations

- Use high-temperature resistant superalloys
- Minimize stress concentration
- Apply thermal barrier coatings
- Improve cooling strategies

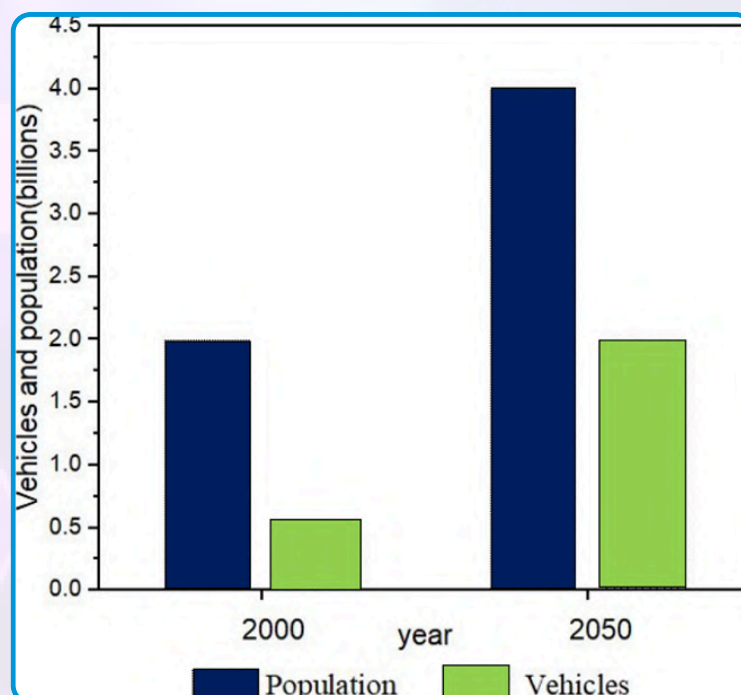


Hybrid Vehicle Energy Management Strategies

Environmental and economic pressures are driving the transition toward clean and energy-efficient vehicles. Internal combustion engine (ICE) vehicles are major contributors to CO₂ emissions, which accelerate global warming and climate change. Meanwhile, the global population is expected to grow from approximately 6 billion in 2000 to nearly 10 billion by 2050, potentially increasing vehicle demand by around 350%. If conventional ICE vehicles continue to dominate, fuel consumption and greenhouse gas emissions will rise substantially.

In addition, transportation systems depend heavily on finite fossil fuels such as crude oil and natural gas, raising concerns about resource depletion and long-term energy security. The rapid use of these fuels, coupled with escalating environmental impacts, has intensified the global emphasis on energy conservation and sustainable mobility. Consequently, the advancement of cleaner technologies, including electric and alternative-fuel vehicles, has become crucial for achieving long-term environmental sustainability and economic resilience.

Therefore, governments, industries, and research institutions are increasingly investing in innovative transportation solutions that reduce emissions, improve energy efficiency, and diversify energy sources. Policies promoting electrification, renewable energy integration, and stricter emission regulations are accelerating the development and adoption of sustainable vehicles, paving the way toward a cleaner and more secure transportation future.

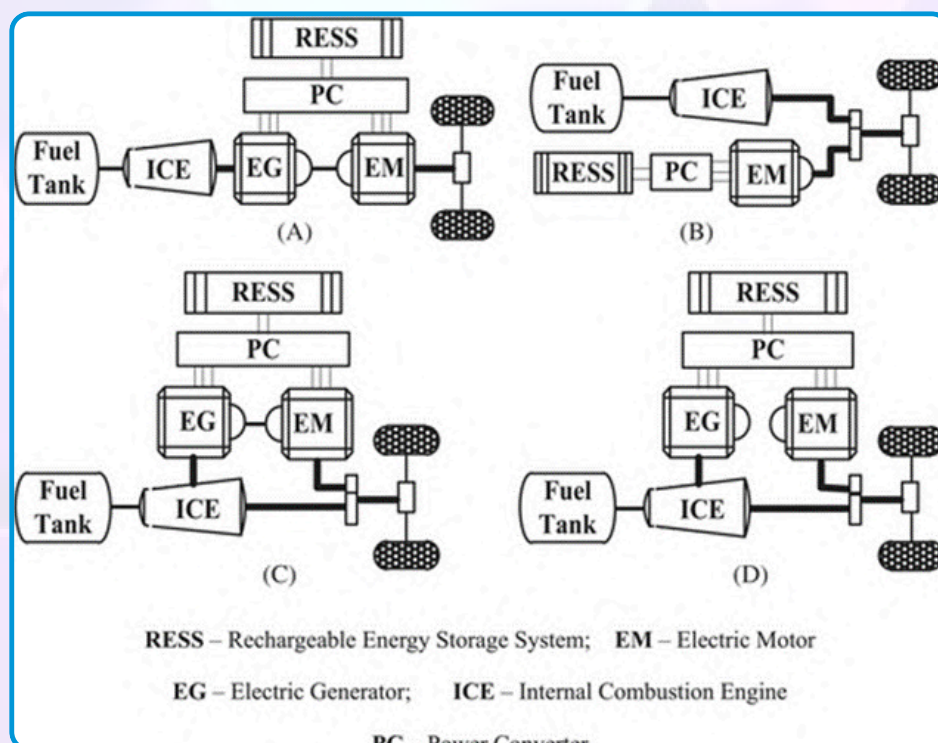


Hybrid Vehicle Energy Management Strategies

CONFIGURATIONS OF HEVs

According to the International Electrotechnical Commission (IEC) Technical Committee 69 (Electric Road Vehicles), a Hybrid Electric Vehicle (HEV) is defined as a vehicle that utilizes two or more energy sources, where at least one source supplies electrical energy for propulsion. Typically, HEVs combine a battery with an internal combustion engine (ICE), though other combinations such as battery-capacitor and battery-flywheel systems are also possible. These vehicles effectively integrate multiple power sources to enhance efficiency and performance, requiring one or more electric motors working alongside an ICE or, in some cases, a fuel cell as the primary energy source. The battery or supercapacitor in an HEV functions as a bidirectional energy storage system. It delivers power to the drivetrain during acceleration and low-speed operation, and it also captures regenerative braking energy that would otherwise be lost as heat in conventional ICE vehicles. Based on drivetrain configuration and power flow structure, HEVs are commonly classified into four main types:

- i. Series HEV
- ii. Parallel HEV
- iii. Series-Parallel HEV
- iv. Plug-in Hybrid Electric Vehicle (PHEV)



கவிதைகள்

வானவில்

நீ கருப்பா, பழுப்பா, வெளுப்பா, சிவப்பா
அல்லது, சரிவர இயங்கும் மூளை கொண்டாயா?
ஒவ்வொரு சிறு சிறு விஷயத்திலும்
வகை வகையாய் தேடுகின்றாய்
தோலின் நிறங்களை மட்டும் நிராகரிக்கின்றாய்
உன் செருக்கைப் பார்
சொர்க்கத்தின் கடவுள் பற்றி
அறிவிக்கின்றாய் போற்றுகின்றாய்
ஆனால் அவர் படைப்பை மட்டும்
எதிர்க்கின்றாய் நிராகரிக்கின்றாய்
அறிவற்ற வெறுப்பால்
நம் சொந்தக் குருதியால்
நனைய வைக்கவில்லையா இப்பூமியை நீ?
ஓ, மனிதனே!
அன்பு இதயத்தின், இயங்கும் மூளையின் பாதையில்
எழுந்து நின்று நீ நடைபோடுவாயா?

- மு.தீபன், இறுதி ஆண்டு

இயற்கை

தேடிப் பார்த்தேன் உலகில்
தெரிந்து கொண்டேன் அழகை !
இயற்கை செய்தது அறிமுகம்
எனக்குக் கிடைத்தது அனுபவம் !
ஐடை காட்டும் மதுமலர்
ஆடை ஆக்கும் இலைகளை
காட்சி சிறகைத் தரும்
கற்பனை பறந்து வரும் !
நடை பழகும் நதிமகள்
இடை நெலியும் புதுமைகள்
பார்த்து ரசித்த நானும்
படரும் கரைகள் ஆவேன் !

- லோ.அருண், மூன்றாம் ஆண்டு

Poem

Earth

I am the Earth
And the Earth is me.
Each blade of grass,
Each honey tree,
Each bit of mud,
And stick and stone
Is blood and muscle,
Skin and bone.
And just as I
Need every bit
Of me to make
My body fit,
So Earth needs
Grass and stone and tree
And things that grow here
Naturally.
That's why we
Celebrate this day.
That's why across
The world we say:
As long as life,
As dear, as free,
I am the Earth
And the Earth is me.

- S.Dhinesh, II year

Pencil Arts



Ms. V.Suruthi,
IV Year

Mr. C.Pravinkumar,
II Year



**ALL THE WORLD'S A STAGE,
AND ALL THE MEN AND
WOMEN MERELY PLAYERS.**

- William Shakespeare



**DEPARTMENT OF MECHANICAL
ENGINEERING**