“Experimental ana Analytical strength Investigation of Repaired FRP Laminates”

Project Reference No.: 47S_BE_3284

NITTE MEENAKSHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF AERONAUTICAL ENGINEERING

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OBJECTIVES

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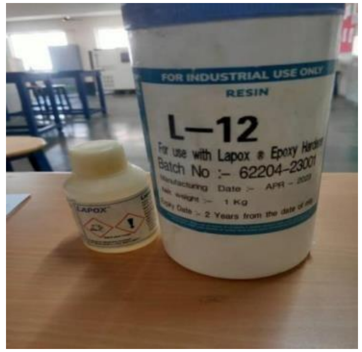
- During the development stage, we concentrate on producing premium glass fiber laminates (GFL) and carbon fiber laminates (CFL) while paying close attention to detail and following industry guidelines.
- As we proceed to the testing stage, we do mechanical tests such tensile and flexural strength evaluations to determine the GFL and CFL's baseline characteristics.
- This stage is critical because it allows us to build a solid data set for the assessment and comparison of laminates that have been repaired later on.
- Moving on to repair methods, we explore state-of-the-art approaches designed for damaged GFL and CFL, using uniform materials for a single repair set.
- We also investigate the performance of glass-carbon hybrid materials in a different set of repair circumstances. By using these all-encompassing methods,
- Streamline production methods to achieve consistent quality and minimize defects in glass fibre laminates.
- Investgate failure modes through testing to understand how glass fiber laminates respond to various stresses and identify potential weaknesses.
- Implement robust quality control measures during manufacturing to detect and rectify defects early in the production process.
- Develop effective and efficient repair techniques for damaged glass fiber laminates, addressing issues such as delamination or surface damage.

METHODOLOGY

Raw material

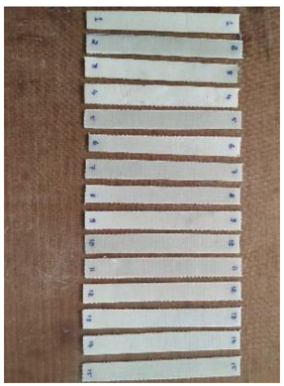


Epoxy

weighing

Vacuum bagging

Carbon-fiber laminates

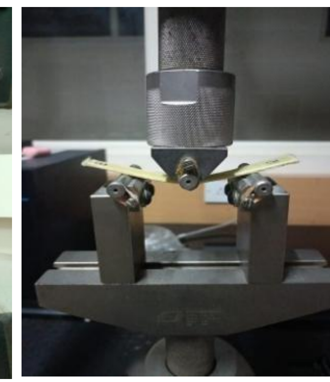


Glass fiber-specimens

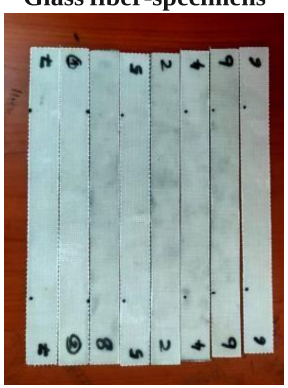
Carbon fiber-specimens

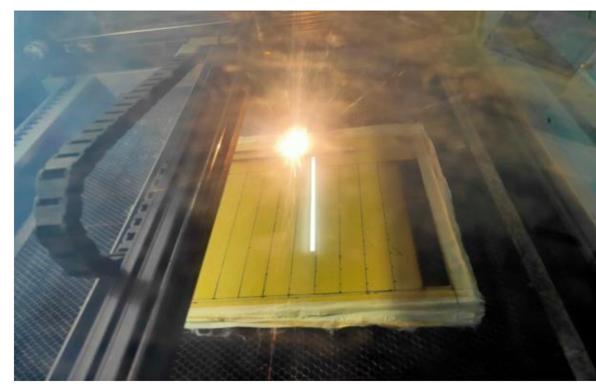
Kelvar-specimens

UTM-testing



Test chamber





METHODOLOGY

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- **Selection of materials :**The materials like carbon Fiber and glass fibers of 5 layers laminated by vaccum bagging process with thickness 1.5 mm as per GSM and ASTM standards
- **Design of specimen**: Selecting suitable joints for before and after failure of the specimen. scarf repairs provide a significant recovery of residual strength in damaged composite and also double lap joints.
- **Fracture of designed specimen:** By using Universal testing machine conducting tensile test and bending test to known ultimate strength and young's 'modulus
- **Repair with homogeneous and non- homogeneous:** After breaking the specimen repaired with two different specimen a suitable adhesive bond
- **Testing of repaired material:** conducting 15 trails of testing for carbon-fiber specimen and also for glass laminated composites
- **Comparison of result for homogeneous and non- homogeneous repair:** evaluating the each graph and to known which is better.

WORK PLAN

Week 2: Completion of project planning and material procurement.-Completed

Week 4: Completion of initial testing and damage induction.- Completed

Week 7: Completion of repair processes.- Completed

Week 11: Completion of testing and data collection.-Progressive

Week 13: Submission of the final report and presentation.- Progressive

Week 14: Project closure and debrief.- Progressive

SUMMARY OF PROGRESS (DESIGN, EXPERIMENTS, RESULTS) (Maximum 2 Slides)

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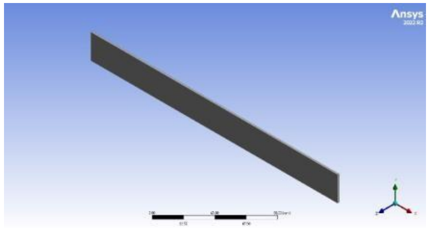
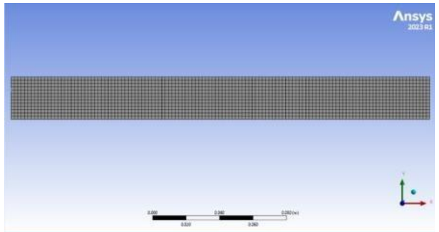
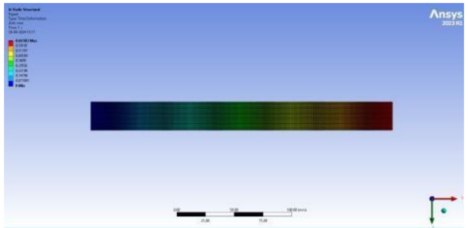
Tensile Fatigue Simulation

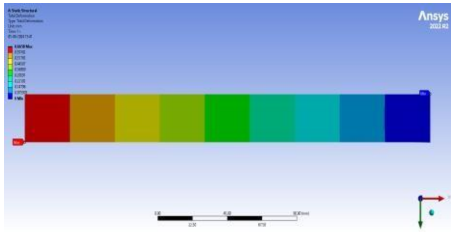


3D CAD model



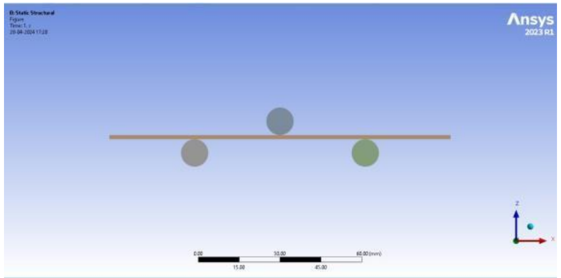
Meshing Model



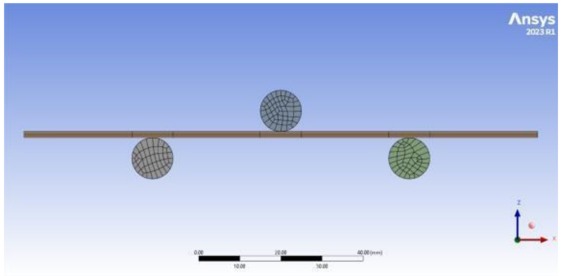


Total Deformation

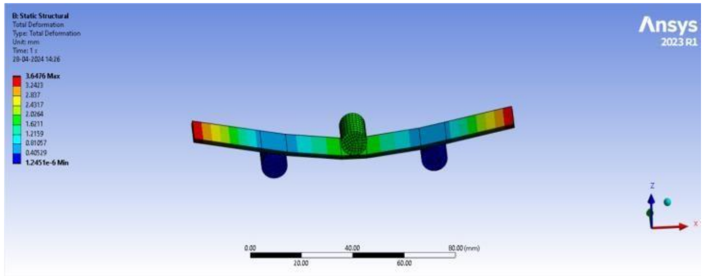
Flexural Fatigue Simulation



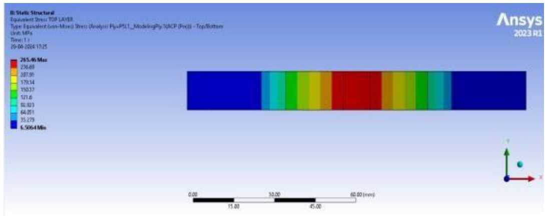
3D CAD model



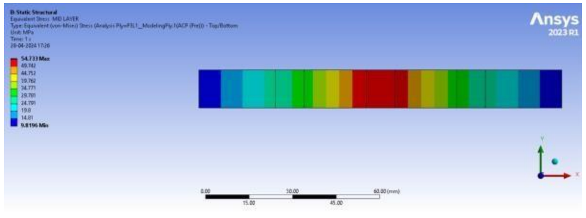
Meshing model



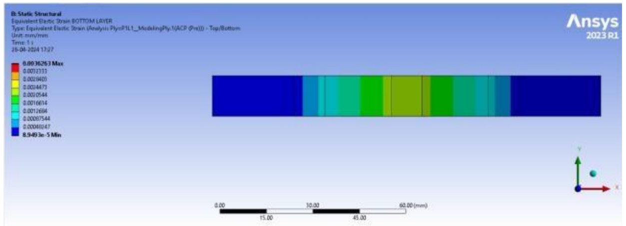
3 Point bending



Top Layer



Middle Layer



Bottom layer

SCIENCE & TECHNOLOGY COMPONENT / INNOVATIVENESS / NOVELTY OF THE PROJECT
SCOPE FOR FURTHER DEVELOPMENT / PROTOTYPE DEVELOPMENT / INDUSTRIAL COLLABORATION / IPR SUPPORT (Maximum 2-3 Slides)

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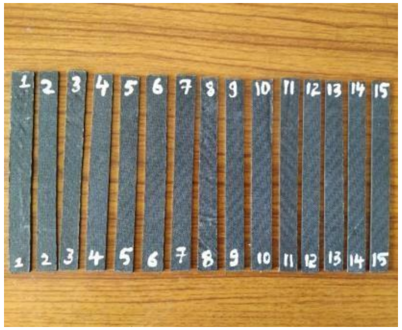
1. Optimization of Repair Techniques:
   - Develop advanced methodologies for repairing composite materials under different types of loads.
   - Innovate techniques to ensure higher recovery of strength, especially under tensile tension.
2. Material Science Advancements:
   - Explore new materials and hybrid composites that can improve the efficacy of repairs.
   - Research the long-term durability of repaired materials in various environmental conditions.
3. Automation and Technology Integration:
   - Implement automated repair processes using robotics and AI to ensure precision and consistency.
   - Utilize advanced diagnostics and monitoring systems to assess the integrity of repairs in real-time.
4. Cost-Effective Solutions:
   - Develop cost-efficient repair techniques that do not compromise on the quality of the repair.
   - Investigate the use of locally available materials for repairs to reduce costs and enhance sustainability.
5. Standardization and Certification:
   - Create industry-wide standards for repair techniques and materials to ensure uniformity and reliability.
   - Develop certification programs for technicians and engineers specializing in composite material repairs.

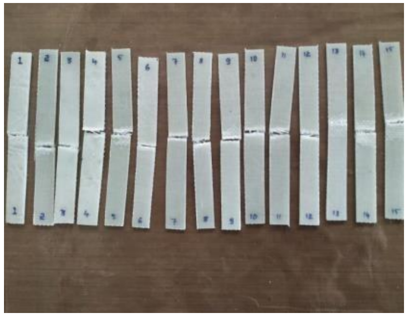
6. Training and Education:
    - Establish training programs to equip engineers and technicians with the latest repair techniques.
    - Promote industry-academia collaborations to foster innovation and practical solutions.
7. Improved Testing and Evaluation Methods:
    - Develop accurate and efficient testing methods to evaluate the strength and durability of repaired specimens.
    - Implement non-destructive testing techniques to monitor repairs without compromising material integrity.
8. Case Studies and Real-World Applications:
    - Conduct extensive case studies on the performance of repaired materials in different industrial applications.
    - Collaborate with industries to pilot innovative repair techniques and gather performance data.
9. Sustainability and Recycling:
    - Develop strategies for recycling and reusing damaged composite materials to promote sustainability.
    - Research the long-term environmental impact of different repair methods and materials.
10. Market Expansion and Application:
    - Explore new markets and applications for advanced repair techniques.
    - Adapt repair methodologies for emerging industries and technologies.

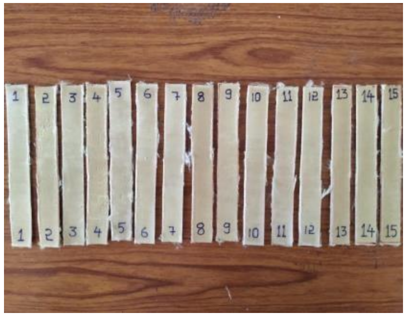
Specimens for (Bending Test D790)

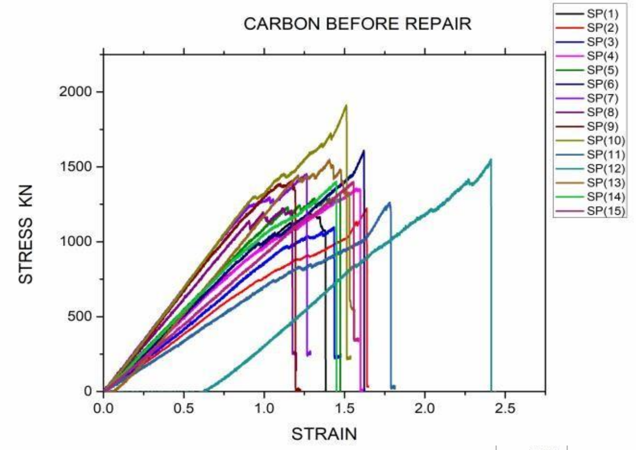
First stage

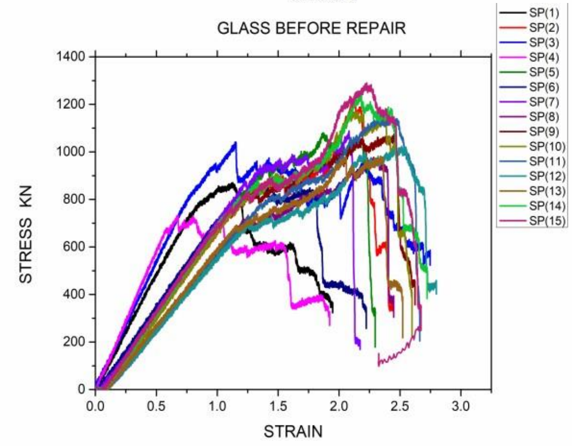


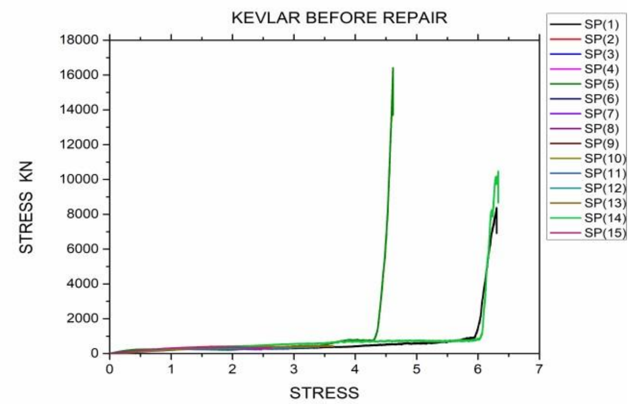










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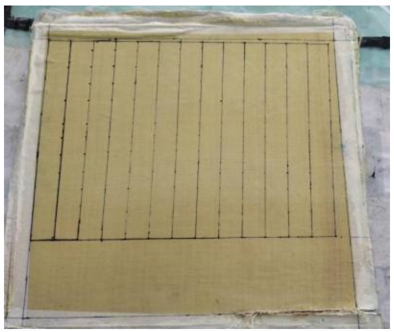
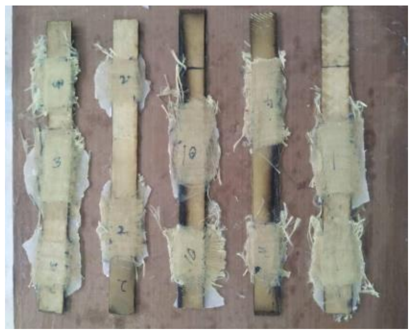
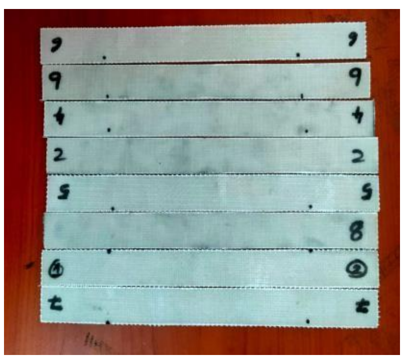
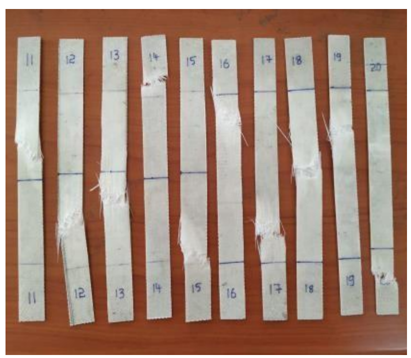
Specimens for (Tensile Test D3090)

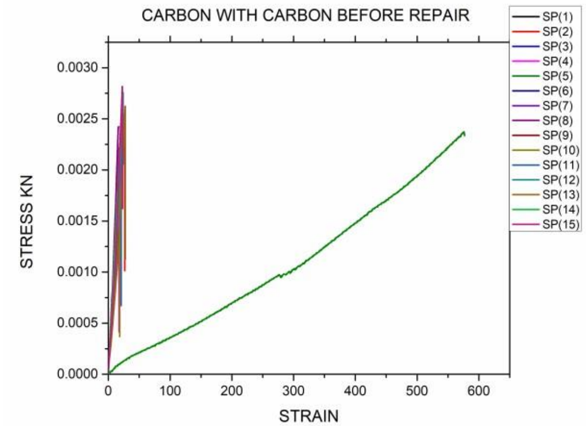
First Stage

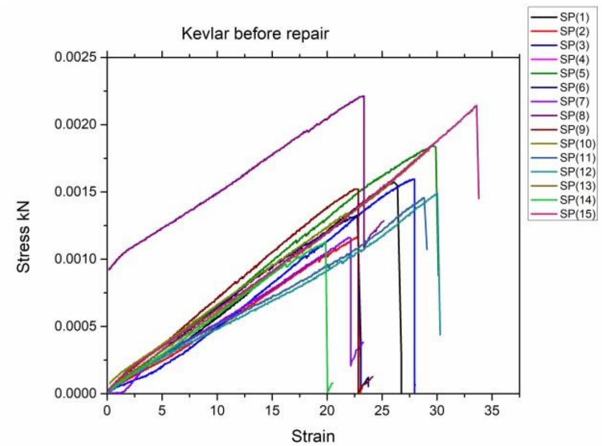


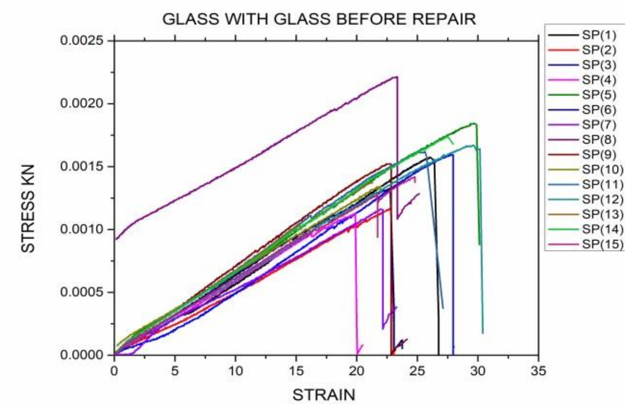












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RESULT AND CONCLUSIONS

- Repairing glass with the same base material may not ensure 100% success under bending force, whereas alternative materials like carbon or Kevlar showed complete success rates.
- Carbon proved highly effective in restoring strength, especially when used as a repair material for both glass and Kevlar.
- Kevlar demonstrated remarkable consistency in restoring strength, even when used as a repair material for itself.
- Utilizing alternative materials like carbon or Kevlar for repair may lead to more reliable outcomes under bending force compared to repairs using the same base material.