Finite Element Analysis for adhesive bonding strength of steel and FRP composite joint

BANSAL DARJI, YOGESH MHETRE, SRI SHTY MISHRA, S. PAL
Metallurgical and Materials Engineering, NIT Rourkela
Email: bansaldarji5657@gmail.com

The study of adhesive bonding between GFRP and Stainless Steel is essential for designing different application specific hybrid structure. The GFRP have many advantages such as light in weight, use for seamless construction, highly durable and so on. Because of low Young’s Modulus of GFRP compared to steel, the local buckling in the steel specimen can be commanded. In this simulation process, “The Sparse Matrix Direct Solver Method” is used. The “Bonded” contact region is used between the interface of Steel and GFRP with “Fine” mesh size and ambient temperature 22°C as input. In the bending test, the maximum equivalent bending stress is observed on the bonded joint of stainless steel plate and GFRP, compared to that in cyclic loading where the maximum equivalent stress is observed at the edge of the fibre. The examination is carried out to investigate the equivalent stress level, cyclic loading effect and temperature effect at the various location of the specimen. The geometry has been prepared and the study has been done by using ANSYS WORKBENCH 15.0.

Fig. 1 The maximum stress at the joint interface in Bending Test

Key Words: ANSYS Workbench, Adhesive Bonding, Steel Plate and GFRP Joint

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Bansal Vinaykumar Darji, Dr. Snehanshu Pal
Department of Metallurgical and Materials Engineering
National Institute of Technology Rourkela - 769008, India

Abstract
The study of adhesive bonding between GFRP and Stainless Steel is essential for designing different application specific hybrid structure. The GFRP have many advantages such as light in weight, use for seamless construction, highly durable and so on. Because of low Young's Modulus of GFRP compared to steel, the local buckling in the steel specimen can be commanded. In this simulation process, The Sparse Matrix Direct Solver Method is used. The Bonded contact region is used between the interface of Steel and GFRP with fine mesh size and ambient temperature 22°C as input. In the bonding test, the maximum equivalent bending stress is observed on the bonded joint of stainless steel plate and GFRP, compared to that in cyclic loading where the maximum equivalent stress is observed at the edge of the fibre. The examination is carried out to investigate the equivalent stress level, cyclic loading effect and temperature effect at the various location of the specimen. The geometry has been prepared and the study has been done by using ANSYS WORKBENCH 15.0.

Introduction
- Joining of Steel and FRP with adhesive bond is usually a most preferable technique.
- For higher glass transition temperature and high temperature aggressive environment, the bond durability is considered as a key factor.
- The principle goal of using the GFRP is the weight reduction and the load carrying ability improvement.
- The volume properties for composite materials are to be taken in account. The 3 dimensional Representative Volume Element (RVE) model is determined to analyze the mechanical behavior of Adhesive Bonded GFRP to Steel Joint.
- Also RVE model is used to predict the mechanical properties of GFRP having GFRP to adhesive joint interface.

Simulation Details
- The different tests on various models have been performed in analysis software ANSYS 15.0.

Finite Element Modelling
- A Finite Element Models for tensile test, three point bending test, interfacial crack test, transient thermal test and vibrational test for various geometries have prepared.
- In tensile test for specific mesh size, the model contains 1452 nodes with 169 elements.
- In specimen crack test, the model contains 7554 nodes with 3422 elements.
- In transient thermal test, the model contains 2484 nodes with 300 elements.

Results and Discussions
- From figure (e), maximum equivalent stress observes near the GFRP adhesive bond interface and from figure (f), the maximum total deformation observes on GFRP plate.

Conclusions
- With increment in tensile load, the specimen equivalent stress is increased on GFRP to steel adhesive bonding interface and the specimen total deformation is also increased on GFRP. In specimen crack analysis, it is concluded that nearly 14 MPa stress is analyzed on steel plate where 33.32 MPa stress is observed near the cracked region which is more than 100 % compare to stress on steel plate under the tensile load of 13.5 kN. This is happened because of the high stress concentration near the cracked region.

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Contact Details: Bansal Darji - bansaldirji5657@gmail.com
Dr. Snehanshu Pal - snehanshu.pal@gmail.com, pals@nitrkl.ac.in
Presented at ICAMMP – IV, IIT Kharagpur, West – Bengal, India

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