Advantages of utilization of CFRP plates for reinforcing steel structures: high strength to weight ratio, superior fatigue behavior, excellent resistance to corrosion and environmental degradation, easy handling.

Environmental degradation, easy handling, fatigue behavior, excellent resistance to corrosion and high strength to weight ratio.

1. Introduction

2. Motivations to study an unbonded reinforcing system

1. Easier and faster installation procedure (bonding and curing time are considered).
2. Bonded system is not always easily applicable:
   1. Easier and faster installation procedure (bonding and curing time are considered).
   2. Motivations to study an unbonded reinforcing system

3. Application of a high prestressing level for an externally unbonded CFRP plate can provide a higher fatigue life.

4. Finite element method

FE simulation was modeled using the 20-node quadratic brick reduced integration (C3D20R) elements. To reduce the computational effort, the symmetry of the beam in two different planes is used and the boundary conditions of the web and mid-span are created. The finite element mesh was refined in the vicinity of the crack tip to acquire correct stress and strain results. A simple convergence study was performed to obtain the required mesh density.

The prestressing was modeled by assuming an arbitrary expansion coefficient (ε) and a negative predefined temperature gradient (εT) for the CFRP laminate so that predefined strain at the CFRP is ε+εT that simulates the equivalent prestressing force.

5. Results

6. Conclusion

1. In the bonded system:
   • a local stress concentration in the middle of the CFRP plate (under the crack):
   • In the bonded system, fatigue life increased 67 times compared to the unbonded system because of a local stress concentration in the middle of the CFRP plate (under the crack).
   • same load-carrying capacity as bonded system, more ductile behavior than bonded system, less required work and time for on-site installation, fatigue life decreased.
   3. Application of a high prestressing level for an externally unbonded CFRP plate can provide a higher fatigue life.
   4. A fracture mechanic approach to determine the minimum required prestressing level is proposed.