Influence of Different Stiffening Arrangements on the Behavior of FRP Box Girder Bridge

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Introduction

❑ **Why Fibre Reinforced Polymer (FRP)?**

- ✓ FRP has less density, in the same diameter,
- ✓ Lower self-weight
- ✓ Has good tensile strength
- ✓ Enhances the life of bridges.

❑ **Why box Girder Bridge?**

- ✓ Reduces the slab thickness and self-weight of bridge
- ✓ Needs less material
- ✓ Provide higher strength
- ✓ Quality assurance, as precast girders are made off-site

❑ **Why stiffener?**

- ✓ Enlarge torsional resistance of structures
- ✓ Prevent box girder from local buckling
- ✓ Can be used as an intermediate bracing member

❑ Why Finite Element Method (FEM)?

It is good for analyse complicated domains of engineering structure with computational solution.

Objective

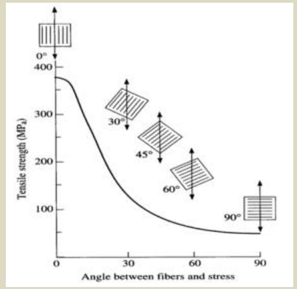
❑ Explore the usefulness of FRP in the box girder bridges to achieve enhanced performance.

❑ To study the contribution of stiffening of different plates in order to minimize the local plate buckling.

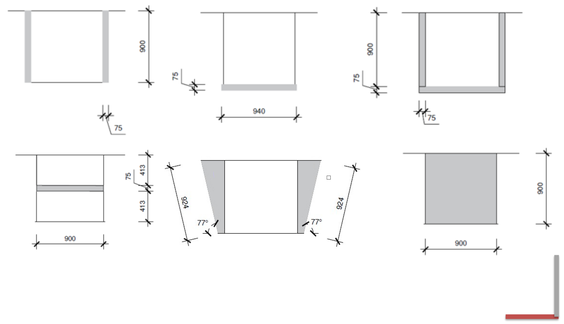
❑ To access the overall behaviour of this structural system by using a reliable finite element code (ABAQUS)

Methodology

1. A detailed 3D finite element model based on assemblage of shell element using ABAQUS for accurate modelling.
2. Use multi-layered laminated material system (FRP)
3. The FRP system can have any arbitrary ply/fiber orientations.



4. Effect of shear deformations are considered using FSDT as composite is weak in shear.
5. Plates are stiffened in different configuration to study their effect on minimizing local buckling, structural deformation, shear lag and other effect.
6. A proper attention is paid on the imposition of boundary condition.



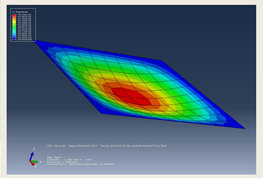
Validation

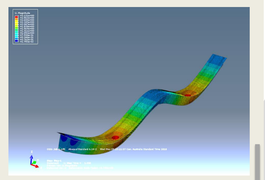
2-D Validation

Compared the mathematical formulation result with ABAQUS output result, there are basically same, but for the different layer number and symmetry, it has a little bit different.

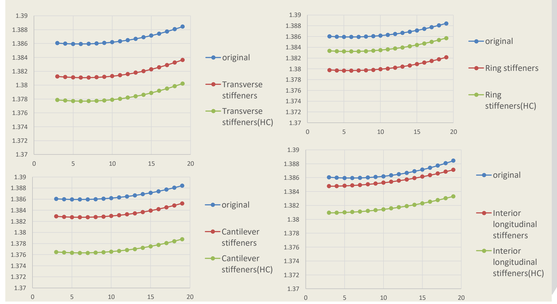
3-D Validation

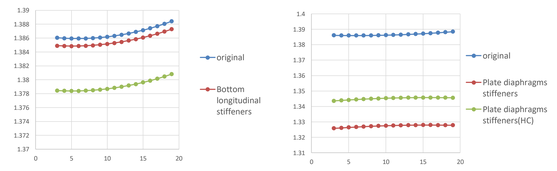
The errors of ABAQUS for analysing displacement are 1.69% for point load and 1.56% for line load, which means the accuracy for 3-D model analysis by using ABAQUS is acceptable. In addition, the point load has the higher error than line load.

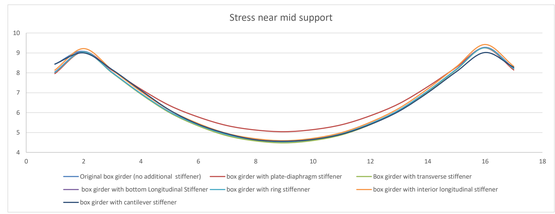


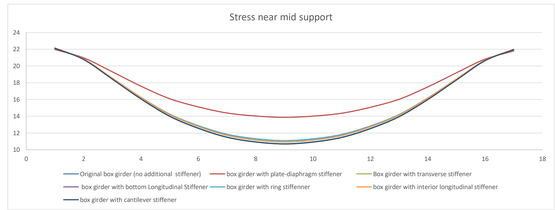


Results









Conclusion

❑ Arbitrary layer and geometry can affect the mechanics performance.

❑ All six stiffeners have very limited shear impact on the bottom flange but thy are able to reduce local bulking.

Further research

❑ Dynamic load/moving load will be considered.

❑ Analysing Multi-cell box girder in proper manner.

❑ Hybrid box girder system consisting of FRP boxes and concrete deck.

Reference

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