Analysis of Pratt Truss Bridge Using FRP Due to Moving Load

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Abstract- *In recent years, the growing number of deteriorated concrete and steel bridge deck has highlighted the need for research on new high-performance construction material for their habilitation of transport at ion infrastructures. The relatively old age of most existing bridge sand the increasing traffic demands have also risen the needs for upgrading methods with focus on minimizing traffic disruption. Fiber reinforced polymer decks have a great potential in refurbishment and replacement of concrete and steel deck sin existing bridges. These decks offer superior properties such as high strength hand stiffness-to-weight-ratio, superior fatigue and corrosion resistance and enhanced durability. The topic of using FRP decks for bridge upgrading is relatively new. Never the less, several research projects have been conducted and some highway bridges have been constructed or upgraded using this method. Despite their search effort, there is still a lack of knowledge regarding how to design and construct FRP- steel bridges.The aim of this project was to know the benefits of using Fiber Reinforced polymer (FRP) bridge decks for rehabilitation of the steel truss bridge sand check the response of steel deck bridge sunder in fluency of moving load using FRP. The modeling and analysis is of these bridge is done throughuse of ANSYS16.0 which is Finite Element Analysis Tool. For the purpose of checking the accuracy of ANSYS 16.0 results obtained for axial force in member of truss using influence line method are compared with ANSYS16.0 results.*

Keywords- Howebridge, Moving Load, FRP, ANSYS

I. INTRODUCTION

1.1 General

Fiber reinforced polymer (FRP) deck has some significant advantages compared to concrete deck in use of bridges, such as light self-weight, high stiffness and strength, good durability and easy to install. FRP deck has already been used in some bridge rehabilitation and short span bridges, but for widely used in bridges, FRP deck bridges still need further research. Currently many research efforts focus on the field tests of FRP deck bridges. Compared to field tests, Finite element analysis also has great advantages, such as low cost and convenient to conduct. The finite element model is verified by the static field test result. Then a simplified moving truck load is applied on the bridge model in order to analyze the dynamic responses of the FRP deck bridge, including the displacements and stress of each girder at the middle span. FRP composite can provide significant advantages over conventional materials for construction of bridges such as reduction in dead load and subsequent increase in live load rating, rehabilitation of historic structure, widening of a bridge without imposing additional dead load, faster installation, reducing cost and traffic congestion, and enhanced service life even under harsh environment. The future of infrastructure can be envisioned as bright if FRP composites are implemented successfully to its full potential. However, there are significant challenges to implement a fiber reinforced bridge deck, including higher initial material cost, efficient design of panel-to panel connections, lack of comprehensive standards and design guidelines, and uncertain durability characteristics under combined mechanical and environmental loads. Most researchers over the last decade have focused primarily on performance evaluation and characterization of FRP composite deck systems on a case study basis. There is little or no effort has been made to develop test methods and design guidelines for FRP composite deck.

1.1 Backgrounds of FRP Bridge Decks

1.1.1 FRP Material

Different from conventional construction materials, FRP is an engineered material. Engineers can design the material properties and structural shapes of FRPs based on their requirements. Therefore, it is essential to know the composition of FRP material. FRP material consists of two major components: a polymer matrix resin and fiber reinforcements. Fillers and additives, as a third component, can improve certain characteristics of the final product.

1.1.2 Matrix Resin

The main functions of matrix resins are creating volume, transferring stresses between fibers, protecting fibers from mechanical and environmental damage, and providing lateral support to fibers against buckling. Two types of polymeric matrices are widely used for FRP composites: thermosetting polymers and thermoplastic polymers. Thermosetting polymers are low molecular-weight liquids with very low viscosity, and thermosetting polymers cannot be reshaped after curing, because uncontrolled reheating causes the material to reach its decomposition temperature before its increased melting point

1.1.4 Other Constituents

a. Fillers The purposes of adding fillers into the matrix resin are as follows:

1. To take up volume and reduce the overall cost;
2. To enhance the mechanical properties.
3. To reduce the cracking and shrinkage;
4. To improve resistance to environmental corrosion;

Commonly used fillers are clay, silica, mica, calcium carbonate, aluminum trihydrate.

b. Additives The main functions of additives are:

1. To control the curing rate;
2. To improve the weathering resistance;
3. To control the viscosity;
4. To reduce the porosity; and

Besides fillers and additives, other constituents involved in the manufacturing of FRP products are adhesives, foam cores, and gel coat.

II. METHODOLOGY

The finite element method (FEM) is the most popular simulation method to predict the physical behaviour of systems and structures. Since analytical solutions are in general not available for most daily problems in engineering sciences numerical methods like FEM have been evolved to find a solution for the governing equations of the individual problem. Much research work has been done in the field of numerical modelling during the last thirty years which enables engineers today to perform simulations close to reality. Nonlinear phenomena in structural mechanics such as nonlinear material behaviour, large deformations or contact problems have become standard modelling tasks. Because of a rapid development in the hardware sector resulting in more and more powerful processors together with decreasing costs of memory it is nowadays possible to perform simulation seven for models with millions of degrees of freedom. In a mathematical sense the finite element solution always just gives one an approximate numerical solution of the considered problem. Sometimes it is not always an easy task for an engineer to decide whether the obtained solution is a good or a bad one. If experimental or analytical results are available it is easily possible to verify any finite element result. However, to predict any structural behaviour in a reliable way without experiments every user of a finite element package should have a certain background about the finite element method in general. In addition, he should have fundamental knowledge about the applied software to be able to judge the appropriateness of the chosen elements and algorithms. This paper is intended to show a summary of ANSYS capabilities to obtain results of finite element analyses as accurate as possible. Many features of ANSYS are shown and where it is possible we show what is already implemented in ANSYS.16Workbench.

III. PROBLEM STATEMENT

DesignathroughttypePratttrussbridgeofspan30m,rise5 m,footpathof600mmwide,applyliveloadasperIRCClassAAwheeledvehicleuseM20grade concrete andFe500. Assume deck thickness 200mm.

IV. RESULT AND DISCUSSION

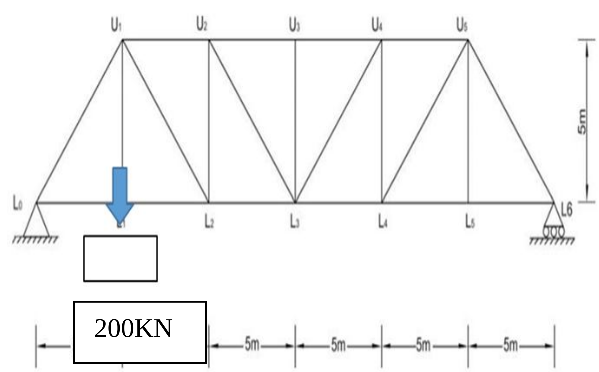

Fig.1.Pratttruss with load 200 KN

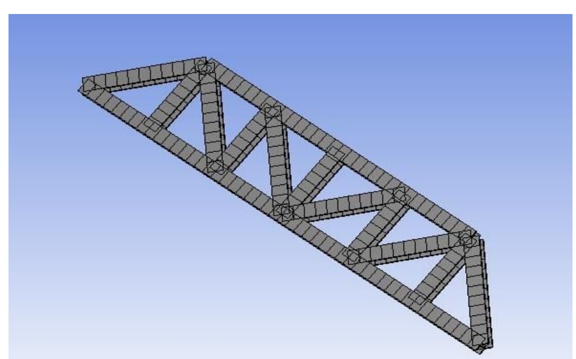

Fig.2. Pratt truss mesh

COMPARISION OF AXIAL FORCES(L1)				
SR NO	MEMBERS	ANALYTICAL RESULTS	ANSYS RESULTS	% ERROR
1	L0L1	166.66	160.76	3.54
2	L1L2	166.66	161.37	3.17
3	L2L3	133.34	131.60	1.30
4	L3L4	66.72	66.74	-0.03
5	L4L5	33.56	34.06	-1.48
6	L5L6	33.56	32.83	2.16
7	U1U2	-133.34	-134.06	-0.54
8	U2U3	-100.00	-99.57	0.44
9	U3U4	-100.00	-98.08	1.92
10	U4U5	-66.60	-65.11	2.24
11	LOU1	-235.70	-220.01	6.66
12	L1U1	200.00	187.77	6.12
13	L2U1	-42.14	-37.98	9.87
14	L2U2	33.40	31.59	5.42
15	L3U2	-47.14	-45.19	4.13
16	L3U3	0.00	0.01	0.00
17	L3U4	47.14	44.21	6.22
18	L4U4	32.31	30.35	7.18
19	L4U5	47.14	43.85	6.98
20	L5U5	0.00	0.03	6.12
21	L6U5	-47.14	-46.33	1.73

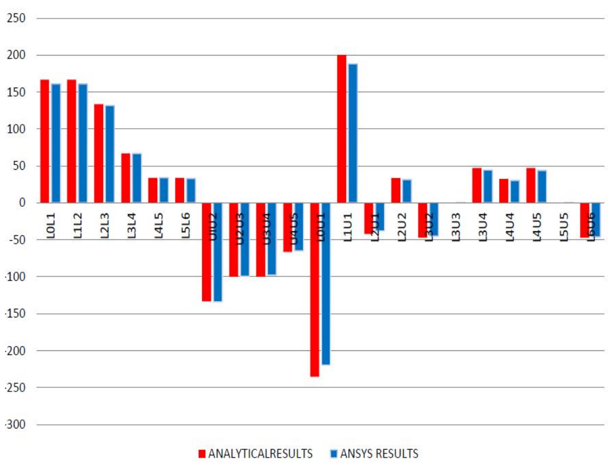

Fig. 3.Axial Forcein members DuetoLoad atL1

V. CONCLUSION

A finite Element model preparedusing ANSYS gives accurate results for analysis of trusses. Normal stress as well as total deformation with FRP is observed lesser in Pratt truss. A significant stress reduction could be obtained by replacing the concrete deck with the light weight FRP deck. This confirms the benefit of light-weight FRP decks which allows for increase in traffic loads.

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