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Study of Stress Patterns in Connectors of Double Layer Grid Structure

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ABSTRACT

The performance of different types of 3 dimensional space structure connectors has been the subject of intensive research during last some decades. A double layer grid structure is considered for the present study. The MERO connector is modeled in ANSYS 14.0 software and analyzed for given loading and support conditions. A new type of geometry, i.e. Rhombicuboctahedron from regular polyhedron is considered for modeling a new connector in ANSYS 14.0 software and the results of stresses for both the connectors are compared.

KEYWORDS: MERO connector, ANSYS 14.0, Rhombicuboctahedron

INTRODUCTION

A double layer grid is widely used in 3 dimensional space structures. Members of space structures are connected to each other with numerous types of nodal connections are assumed to carry only axial loads [1]. A double layer grid consists of two plane grids forming the top and bottom layers, parallel to each other and interconnected by vertical and/or diagonal members.

The connector is the most important part of a grid design. The type of connector depends primarily on the connecting technique, whether it is bolting, welding, or applying special mechanical connectors. It is also affected by the geometry [2]. One of the most popular types of connectors that are widely used in the construction of double layer grids is the MERO system. The MERO system is multidirectional system allowing up to 18 tubular members together at various angles. The MERO connector is modeled and analyzed in ANSYS 14.0 software for different loading conditions.

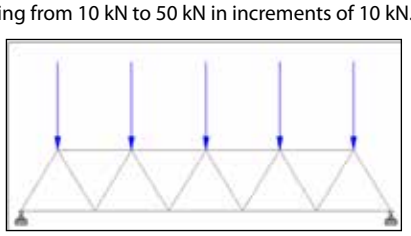
A new type of geometry, i.e. Rhombicuboctahedron from regular polyhedron is considered for modeling a new connector in ANSYS 14.0 software. The Rhombicuboctahedron is an Archimedean solid with 18 triangular and 18 square faces. There are 24 identical vertices, with one triangle and 3 squares meeting at each.

In the present paper the comparison between MERO and Rhombicuboctahedron is shown. The internal forces in the members of double layer grid are found using STAAD Pro software. These forces are applied on the MERO and Rhombicuboctahedron connectors modeled in ANSYS 14.0 software. The stress patterns of these connectors are studied under different loading conditions.

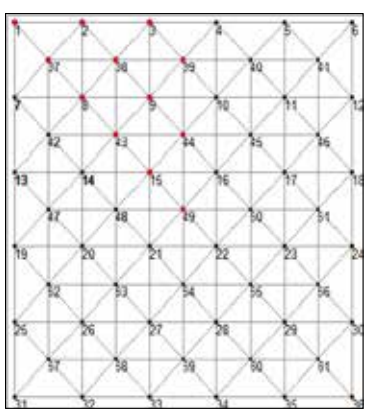
ANALYSIS OF DOUBLE LAYER GRID

A 12 m x 12 m double layer grid considered for analysis is shown in the fig. 1. Supports are at four lower corner nodes. The material properties of the members are E = 2.06 x 105 N/mm2 and Fy = 440 N/mm2.

The structure was subjected to concentrated load P applied vertically downward to each node of the upper layer. The analysis of grid was carried out in the STAAD Pro software for different values of P ranging from 10 kN to 50 kN in increments of 10 kN.



(A) Elevation



(B) Plan

Figure 1: Model of Double Layer Grid Structure

ANALYSIS OF CONNECTORS IN ANSYS

The pressures to be applied on the connectors are calculated from the forces found from the STAAD Pro analysis. The applied pressures are different for different node connectors. In the present double layer grid, there are total 61 nodes, out of which only 12 nodes are considered for analysis because of symmetry. These considered nodes are shown in fig. 1.

MERO and Rhombicuboctahedron connector was modelled in ANSYS 14.0. Typical views of the model are shown in fig. 2 and fig. 3.

Fig 4, 5, 6 and 7 show the comparison of Maximum Principal Stresses, Von mises Stresses and Maximum Shear Stresses respectively for all the nodes of MERO and Rhombicuboctahedron connectors.

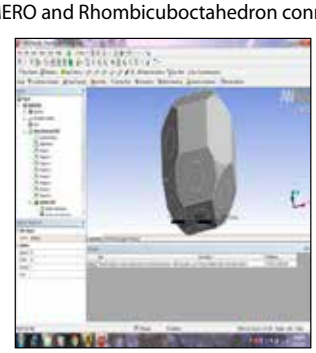
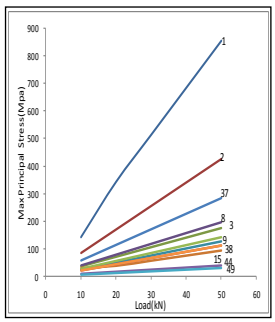


Figure 2: Typical view of MERO connector



Figure 3: Typical view of Rhombicuboctahedron connector

(a) MERO Connector



(b) Rhombicuboctahedron Connector

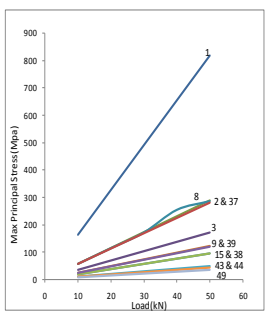
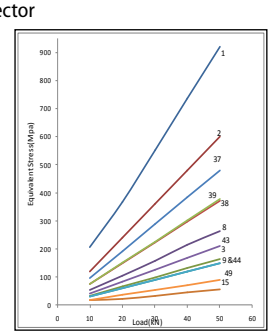


Figure 4: Comparison of Maximum Principal Stresses for all the nodes

(a) MERO Connector



(b) Rhombicuboctahedron Connector

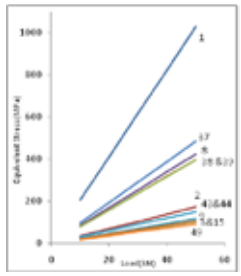
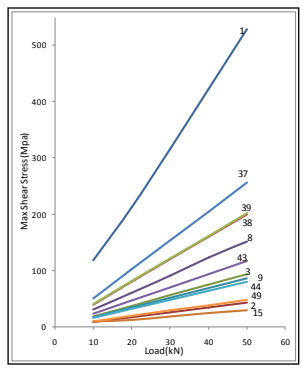


Figure 5: Comparison of Equivalent Stress for all the nodes

(a) MERO Connector



(b) Rhombicuboctahedron Connector

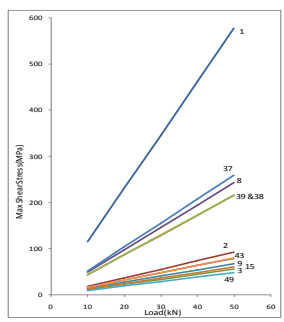


Figure 6: Comparison of Maximum Shear Stress for all the nodes

CONCLUSIONS

STAAD Pro software is used to analyze a double layer grid. It is observed that in the bottom layer, tensile forces are predominant in the central region; where as in the top layer compressive forces are predominant in the central region. The models of MERO connector and Rhombicuboctahedron connector are analyzed in ANSYS 14.0 software for all the loading conditions and the values of Maximum Principal Stress, Equivalent (Von-Mises) stress and Maximum Shear stress are found. These values vary linearly as load increases linearly and are found quite high near all corner supports and reducing towards central region for all the nodes. The equivalent stress and maximum shear stress are found greater in Rhombicuboctahedron connector while maximum Principal stresses are found greater in MERO connector, particularly at supports.

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