International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 05 | May 2021 www.irjet.net p-ISSN: 2395-0072

MODAL AND ANALYSIS OF DIFFERENT TRUSS BRIDGES UNDER DEAD LOAD CONDITION

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Abstract – *The purpose of this paper is to analysis of truss bridge by using ANSYS tool and built the finest truss bridge design. Truss bridge losses their rigidity due to continuously applying loads and failed due to their own self weight. To minimize the total deformation and stress value and to increase the life of truss bridge by the focus on efficient and economic design. The majority of our review concentrates on the topic of truss bridge structures, whether complicated or plain, since truss is the most often found in steel bridges used in railways and pedestrian crossings. So in this Research work steel material used. In our study dead load considered of the truss bridge. Four truss bridges that we analyzed using ANSYS work bench and compare all analyzed value of four trusses. An attempt is made in this paper to plan and refine such bridge structure analysis.*

Key Words: **Truss bridge, ANSYS work bench, Design truss, Steel material, Dead load**

1. INTRODUCTION

A bridge is a link that spans a gap between two points, such as water or valleys. Depending on the condition, these structures are built with various and unique designs. The bridge's design will also be influenced by the functions it serves. It also depends on the nature of the project, the funds involved, and the materials used to build it. In present time, the nature of bridges is determined by the materials used to build them. Truss bridges, for example, fall under the category of structural makeup. A truss bridge is a load-bearing structure built with trusses. Its triangular shape incorporates interconnected materials. This is accomplished through tension or compression.

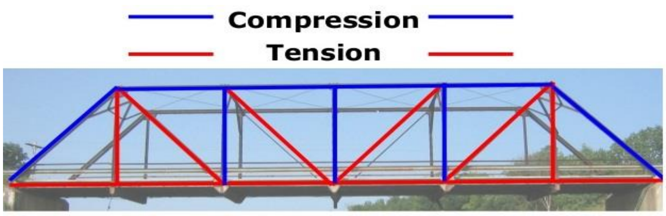

Fig-1: Truss under Compression & Tension

Truss bridges were first built in the United States in the late 1700s and early 1800s. The first truss was constructed of wood. Trusses were first used in cathedral building and then soon moved into bridge construction. Andrea Palladio, an Italian architect, is credited with being the first to use the truss in bridge building in the 16th century. He mentions numerous truss bridge variants in his Four Books of Architecture (1520) Palladio agreed on three different designs of the truss made entirely of wood by using the strongest shape (triangles). Later, Swiss and German builders adapted the design, leading to the invention of the truss bridge.

Truss is the most economical structure for construction of Bridges, Railways and Highways. Steel Material is used for making truss. Steel is the most popular material for bridge building worldwide, from small to big scale projects. Steel plays a significant part in bridge building costs. It is a robust and highly effective material that offers cost-effective and long-term building solutions. Steel structures are the mark of class architecture and building performance.

1.1 Types of truss study

A. Pratt
B. Warren
C. Pratt Half Hip
D. Pratt with top inclined member (**New Design**)

(A) Pratt Truss

The Pratt truss architecture combines verticals in compression with diagonals in stress. Engineer Thomas Pratt and his architect father came up with this idea. Diagonals that slant down and into a vertical in the centre undermine this style. This style became popular in 1844 and has remained popular in the twentieth century. Rather than pinned connections, many of the Pratt truss designs found later in the design's evolution use riveted or bolted connections.

(B) Warren Truss

The Warren truss bridge, which is made up of equal-sized sets of diagonals that act in compression and tension, was patented by engineer James Warren. As seen in the Pratt design above, verticals can be added to improve stiffness and stability. Engineers realized the benefits of using riveted or bolted connections (as the Pratt design does) instead of pin connections after 1900, and this design became widespread. The top and bottom chord members are placed under more pressure in this style, necessitating larger top and bottom components.

(C) Pratt Half – Hip Truss

The half-hip truss was designed for short-span requirements where the material savings from neglecting a hip vertical outweighed the structural strength loss. This structural style was well suited for Iowa's numerous small streams and ditches, and as a result, thousands of them were built.

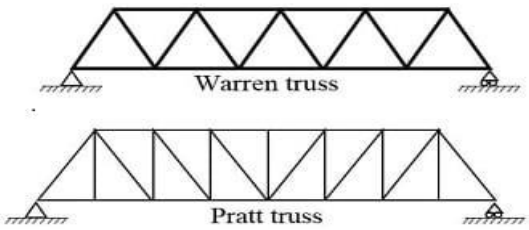

Fig-2: Warren & Pratt Truss

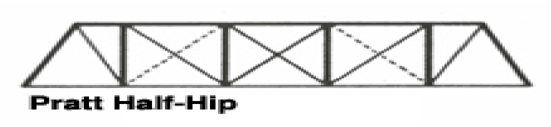

Fig-3: Pratt Half-Hip Truss

1.2 Finite Element Analysis:

ANSYS Mechanical is our dynamic, integrated platform for structural analysis that employs finite element analysis (FEA). Mechanical is a dynamic environment with a comprehensive set of analysis tools, ranging from preparing geometry for analysis to connecting additional physics for increased fidelity. Engineers from all levels can get answers quickly and confidently thanks to the intuitive and customizable user interface. ANSYS Workbench supports a strong connection to commercial CAD tools, allowing for design point updates with the click of a button. Our fluids and electrical solvers have seamless integrated Multi physics capabilities.

2. OBJECTIVE

To analyze the truss bridge of different type Pratt, Warren, Pratt-Half Hip and Pratt with the top inclined member to compute and compare the stresses and deformation of truss bridge under dead load condition and find efficient one by using ANSYS software.

3. LITERATURE REVIEW

A bridge is a structure that spans a road, river, railway, or other impediment, allowing cars, trains, and people to pass easily and safely. Multiple Researches investigated the diverse performance of bridge structures. A simpler approach was used so that you could do an instant study of the results of the parameters involved in the hassle. The bridge configuration can be determined by the type of bridge being built. Bridges are classified into five types: arch, suspension, truss, beam, and cantilever. The truss bridge is one of the famous types.

Pedro et al. [1] their research outlines the latest goals of the reinforced truss bridge, which can be built for highway and rail bridges. Composite structural systems are a bridge construction innovation that provides improved results while still being powerful. The composite truss bridge is now used to build high-speed railways and bridges with heavy traffic. According to the results, dynamic loading is now affecting bridges, causing load to rise day by day and increasing the likelihood of bridge failure.

Frangopol et al. [2] the main goal of this thesis is to include information about the major truss system, and the best type in the United States is the long span truss bridge with a complete structure system. There is defense for components in a long span bridge that is dependent on the probalistic and their organizational continuity. Long span bridges were previously designed based on stress rather than accuracy. The reliability for the analysis part is dependent on the transmission to the live and dead loads. This form of bridge provides long-term structural monitoring systems by combining a large number of data points for input and response. The traditional research part of this study is the key factor that is provided in the analysis.

Wardhana et al. [3] the most common causes of bridge failures were crashes and floods. Flood and scour, leading in the 2004 flood disaster, caused a significant number of bridge failures. Bridge collapse and lateral impact forces from trucks, barges/ships, and trains account for one-hundredth of all bridge failures. The bridge's life is estimated to somehow be one year (during construction) to 150 years.

In **Ida Bagus Rai Widiarsa [4]** research Indonesia is home to several steel truss bridges with continuous reinforced concrete beams used as vehicle decks. The use of a continuous reinforced concrete beam over steel truss bridges has caused some issues in the area, such as cracking. Cracks in the concrete slab must be fixed, which is usually accomplished by the grouting process. However, the technique is also ineffective in addition to being costly. A study was conducted on the use of partial pre-stressed concrete slabs as vehicle decks for steel truss bridges.

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The structure used was a partially pre-stressed concrete segmental slab placed transversely over the bridge.

4. MODELING OF TRUSS BRIDGE

4.1 Geometry Description

The bridge truss structure design here is 'I' section. All the values used in standard unit (MKS). Basically three trusses combined made one bridge truss. The modal of truss designed on ANSYS workbench. Geometry of Bridge truss is given below.

Table -1 Geometry Specification

Length (MM)	20000
Breadth (MM)	4500
Height(MM)	5000
Volume(MM^3)	2.8041e+009
Cross Section Area(MM^2)	11550

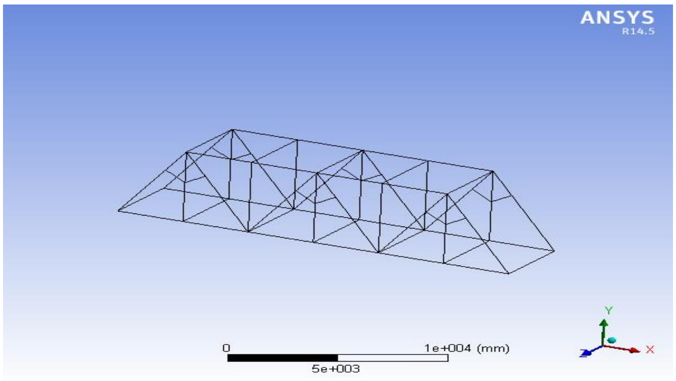

Fig-4: Modal of Pratt Truss with top inclined member

4.2 Material Description

Structural steel used as material for designing of truss bridge structure. Values of different constants of structural steel are given below.

Table -2: Material Description

Density	7.85e-006 kg mm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+005 MJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004 ohm mm
Young's Modulus MPA	2.e+005
Poisson's Ratio	0.3
Bulk Modulus MPA	1.6667e+005
Shear Modulus MPA	76923
Compressive Ultimate Strength MPA	0
Compressive Yield Strength MPA	250
Tensile Yield Strength MPA	250
Tensile Ultimate Strength MPA	460
Reference Temperature C	22

5. ANALYSIS OF TRUSS BRIDGE ON ANSYS

5.1 Meshing of Truss

After completion of modeling process Messing is performed for the analysis of each particle of modal under fine condition at 100 relevance for the best and accurate result.

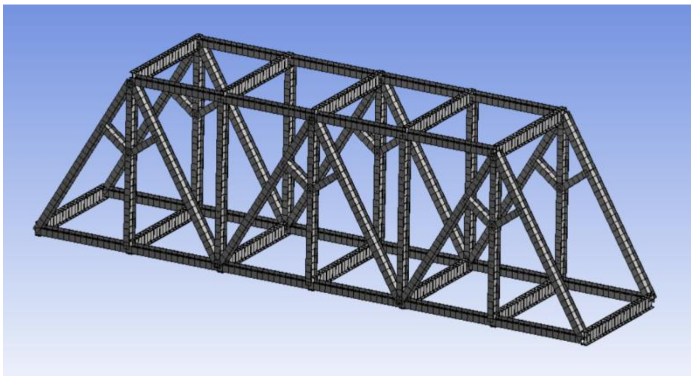

Fig-5: Meshed Modal of Pratt truss with top inclined Members Bridge

5.2 Boundary and Loading conditions

In truss bridge structure Two boundary conditions can be possible either hinged and roller support or Fixed and free support. In our study fixed and free support condition used for analysis.

In loading condition considered only dead load of truss bridge structure.

The gravity load caused by the self-weight of the structural and non-structural components permanently bound to the bridge is known as the dead load. All elements of dead load can be viewed as random variables.

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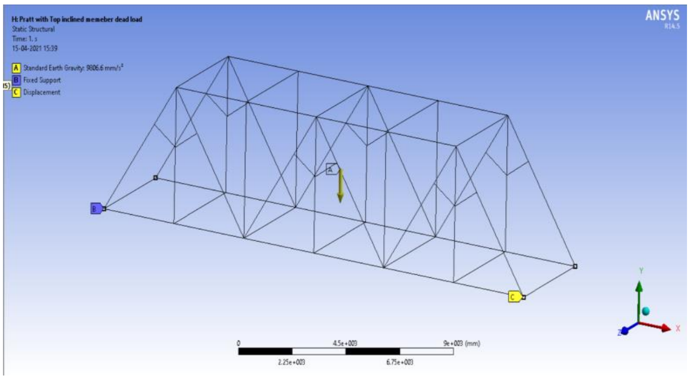

Fig-6: Dead load condition on Truss Bridge

After applying boundary and loading condition now we will analyze the truss bridge and find results at different parameter. And then compare their results for different trusses.

5.3 Result of Static structural analysis

5.3.1 Deformation of trusses under Dead load

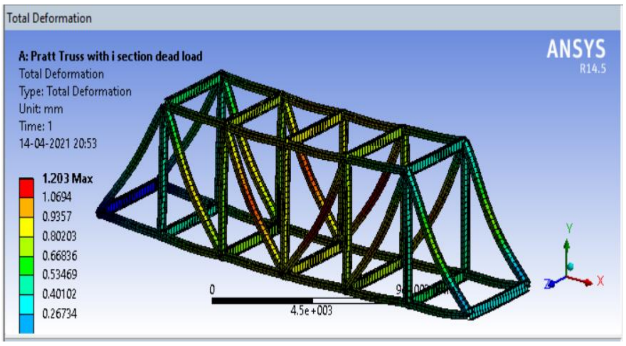

Fig-7: Deformation in Pratt truss

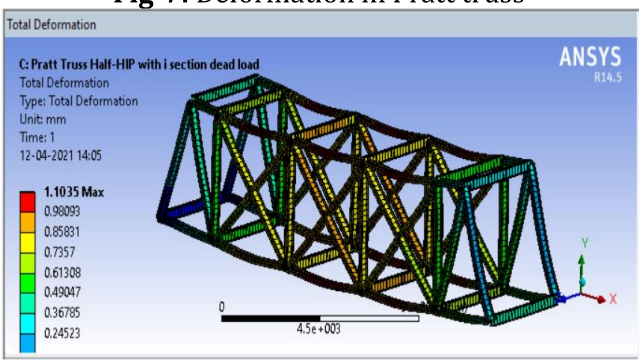

Fig-8: Deformation in Pratt Half-Hip Truss

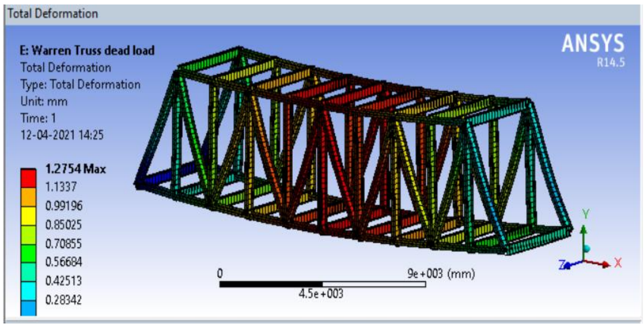

Fig-9: Deformation in Warren Truss

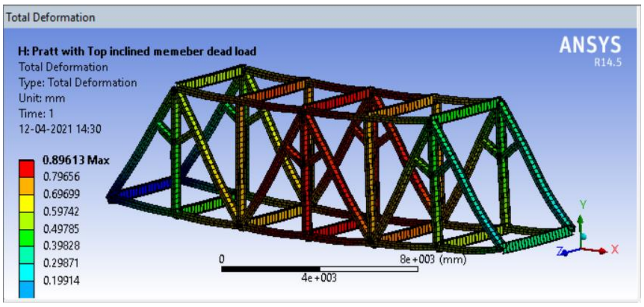

Fig-10: Deformation in Pratt Truss with top inclined member

5.3.3 Stress of trusses under Dead Load

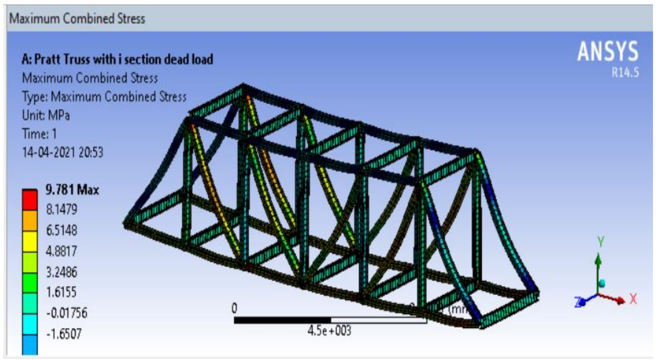

Fig-11: Stress in Pratt Truss

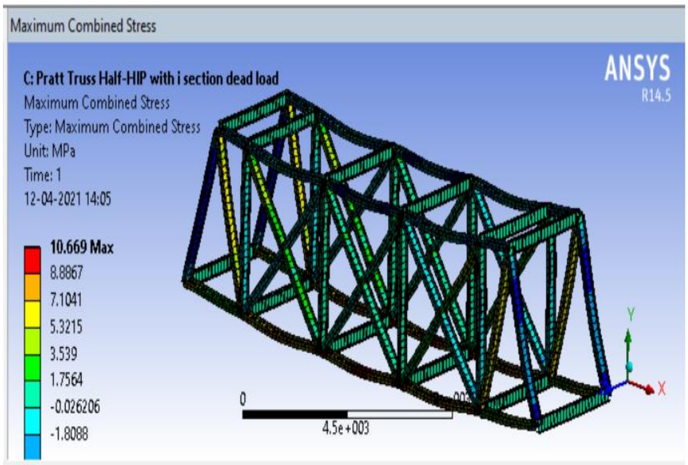

Fig-12: Stress in Pratt Half- Hip Truss

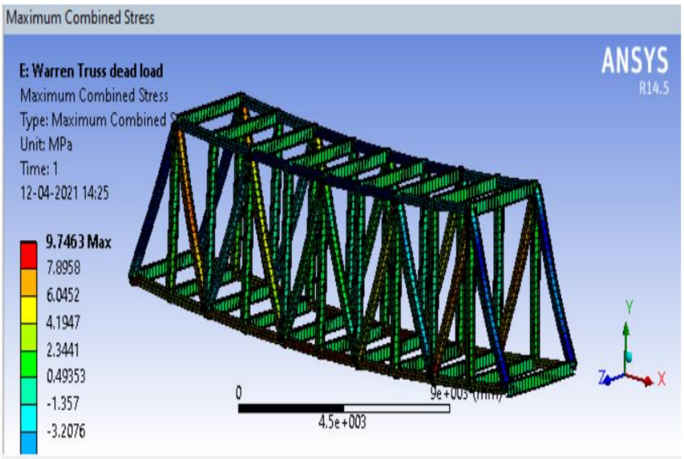

Fig-13: Stress in Warren Truss

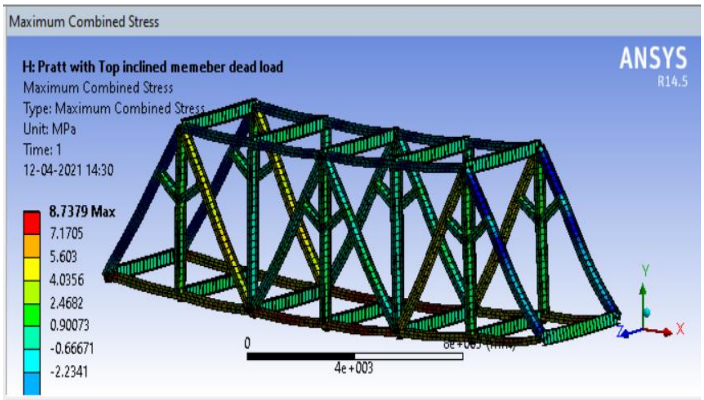

Fig-14: Stress in Pratt truss with Top inclined members

6. RESULT SUMMARY

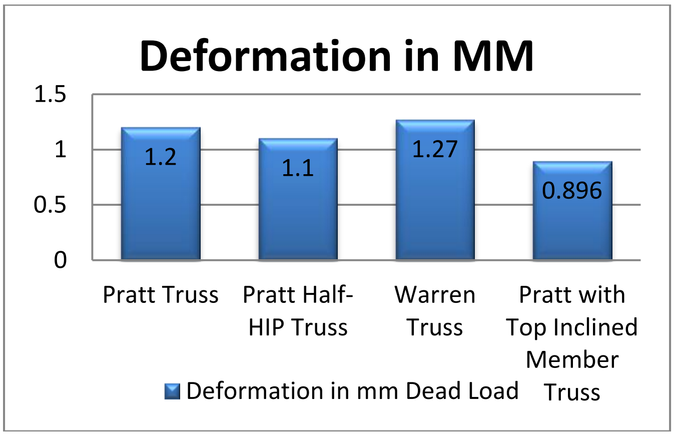

Chart-1: Comparission of defomation of Trusses

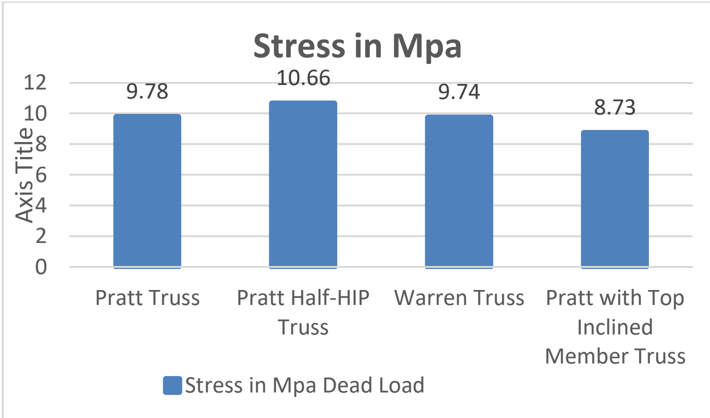

Chart-2: Comparission of Stress of Trusses

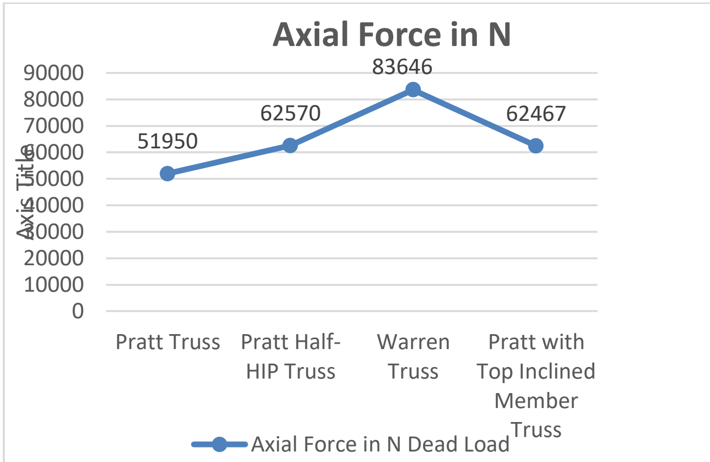

Chart-3: Comparission of Axial force of Trusses

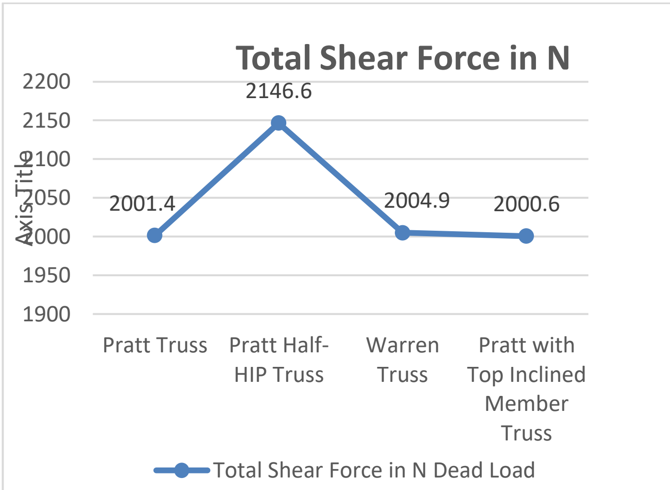

Chart-4: Comparission of Shear force of Trusses

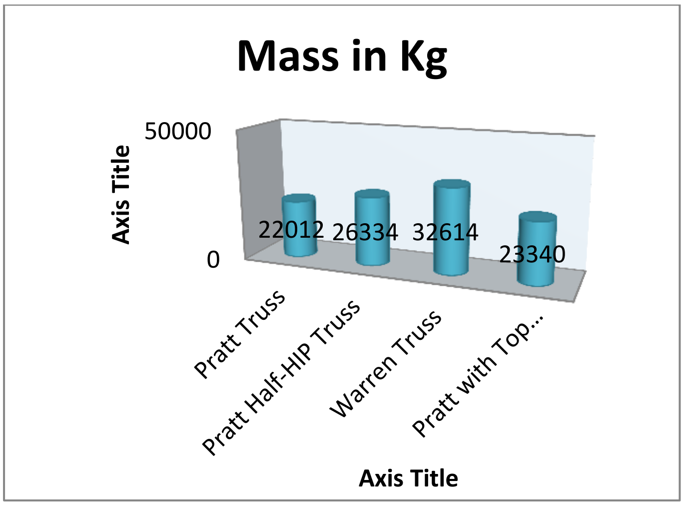

Chart-5: Comparission of Mass of Trusses

Table-3 Result comparision of Deformation & Stress

Types of truss	Deformation in MM	Stress in MPA
Pratt Truss	1.2	9.78
Pratt Half-HIP Truss	1.1	10.66
Warren Truss	1.27	9.74
Pratt with Top Inclined Member Truss	0.896	8.73

Table-4 Result comparision of Axial & Shear force

Types of truss	Axial Force in N	Total shear force in N
Pratt Truss	51950	2001.4
Pratt Half-HIP Truss	62570	2146.6
Warren Truss	83646	2004.9
Pratt with Top Inclined Member Truss	62467	2000.6

Table-5 Result comparison of Mass & FOS

Types of truss	Mass in Kg	FOS (factor of safety)
Pratt Truss	22012	6.67
Pratt Half-HIP Truss	26334	7.61
Warren Truss	32614	5.47
Pratt with Top Inclined Member Truss	23340	6.51

7. CONCLUSIONS

The overview of complete Research work after doing all the analysis on four Trusses following results are concluded:-

1. Deformation:- We observed that maximum deformation is found for Warren truss and minimum for Pratt truss with top inclined members.**i.e. 0.89613 mm.**

2.Stress:-In case of Stresses maximum for Pratt Half-Hip Truss and minimum for Pratt truss with top inclined members.**i.e 8.73 Mpa.**

3.Shear force :-Shear force analysis observation give the maximum value for Pratt Half-Hip Truss and minimum for Pratt truss with top inclined members.i.e.**2001.6 N.**

4. Axial Force: Axial force study found maximum value for Warren truss and minimum for Pratt truss with top inclined members.i.e. **6246 N.**

5. Steel structure Mass:-Mass of Pratt truss with top inclined members is slightly more than the pratt truss but economical in compare to Warren truss.

After comparing all the four Trusses the Pratt truss with top inclined members (**New design truss**) comes out as the best truss under dead load condition.

ACKNOWLEDGMENT

We acknowledge with gratitude the benediction of our entire research project is being carried out under the supervision of Dr. Jyoti Vimal and we received his full support and constructive criticism, as well as his keen interest and motivation. And also thank full to all faculty members. Last but certainly not least, we would like to pay our best regards to our parents, family, and friends who helped us directly or indirectly during different stages of the project.

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