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Research Article

APPLICATION AND ANALYSIS OF TRUSSES

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ABSTRACT

In general, engineering is growing with the creation of software and the search for ways to build structures with more resistance and higher performance while also being economically viable considering all these factors in searching for the right tools. They are one of these structures that have been used for many years and have been able to give good results in many cases in all cases.

Trusses have been used for many years with relatively easy design and use of cheap materials in these structures and the use of these structures in sensitive and large places has increased the use of these structures. In this article, the advantages of this structure and how to use it and I've covered the places where this structure can be used.

KEYWORDS: Forces, Truss Structure, Pellets and Bolts

1. Introduction

The truss is a set of metal rods that can be connected in different ways and these metal connections can be used in rectangular or circular shapes.

He saw trusses in many structures. The use of trusses can be seen on the roofs of bridges and high-voltage intercity electric poles in cranes in sports studios.

These structures can easily withstand the pressures by transferring the loads to their connection points and dividing the loads into other connections, and finally transferring the loads to the ground and neutralizing the loads. The shape of the trusses is triangular, because using the triangular shape, which is the most durable and simplest shape in geometric shapes, we can easily design and connect them to each other.

In general, trusses have been used in homes and bridges in the past. Nowadays, the use of trusses has become very common due to the tolerance of barges in places with a very large area of trusses. Truss members do not tolerate bending anchors and the stability of the members on the truss plate is provided by the knots.

How the members of the trusses are connected to each other or how to connect the truss to the welding machine the bolts, bolts and rivets are connected to each other. It is done or connected to the truss members by bolts and nuts. These connections are just as important as the other members of the truss, as they can greatly reduce the risk of damage to the truss with improper welding or improper bolts.

There are many examples of the use of trusses. There are different types of trusses that are used depending on the situation. In this study, we discuss the applications and types and how loads are transmitted by trusses.

2. Material and Method

2.1. Methods of study

The study used static solutions and the type of material used in a truss and how the joints work in a truss.

2.2. TRUSS STRUCTURE SYSTEM

Trusses are referred to as structures for transferring loads from buildings to ground, which are able to simultaneously transfer horizontal and vertical loads.

In general, one of the structures that can easily transfer loads is the structure of trusses. Many engineers in the past have increased the use of these instruments by understanding the issue of how trusses can be used, and as a result, the use of trusses has increased with the use of transportation facilities and bridges so the use of trusses increased.

3. Discussion and Result

3.1. Types of Truss structures

Trusses have different types of structures, each with its own capabilities. Some trusses are used in sports stadiums and others in bridges, each with its own name and design.

3.2. Trusses are divided into three categories in terms of structure

3.2.1. Simple trusses

which are triangular grids.These trusses are used in simple form in the gables. King poss truss is one of the forms of simple trusses.

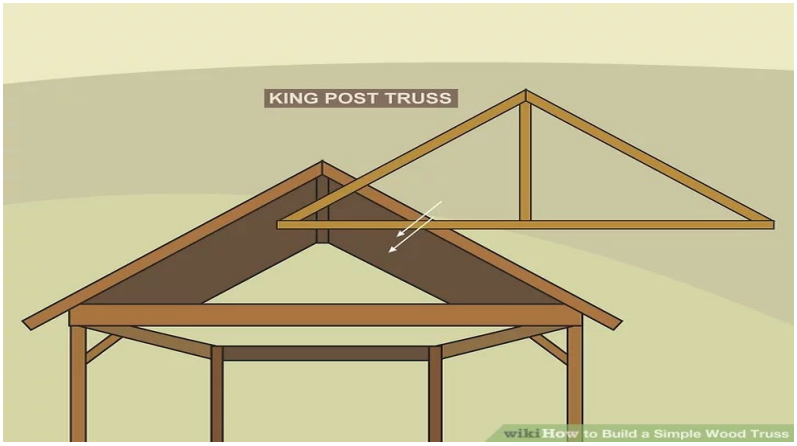


Figure1.simple truss

3.2.2. Compound trusses

These types of trusses are created by combining simple trusses.

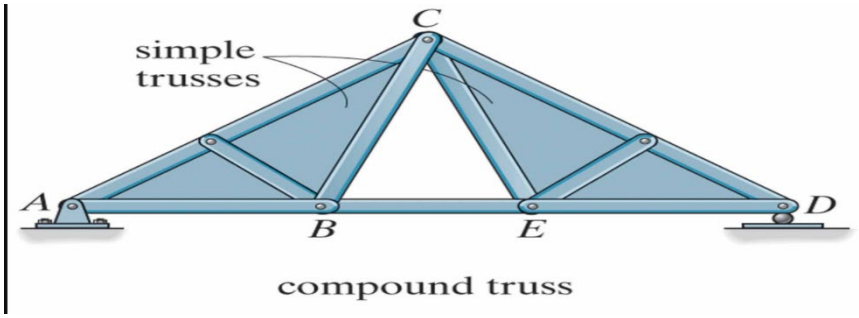


Figure 2. compound truss

3.2.3. Complex trusses

which are used in very difficult conditions.

Figure 3. Complex truss

Figure 3. Space trusses

One of the most durable and beautiful trusses is the space truss. Space trusses are used to cover the spaces of factories, exhibitions, swimming pools, etc., due to their high hardness and strength. In practice, this system is used to cover ceilings with an area of 90 x 90 without the use of columns. In recent years, two-layer networks with one or both layers of hexagons have been used to build roofs. The material and type of profiles used in space trusses may be metal, aluminum, corner, or cantilever tubes that are articulated.

Figure 4. space truss

3.2.4. Standard trusses

Trusses that are commonly used and have a simple structure, and each has a specific name, which we briefly mention the names of some.

I. Commercial roof trusses

Car shops, warehouses, shops, factories and the like are used.

II. Farm trusses

Poultry, alfalfa, feed and machinery warehouses are used as farm buildings, using a large truss gap, which saves material but requires careful design to ensure lateral stability as well as compressive strength. In general, the length is about 60 to 80 meters.

III. Attic trusses

Attic trusses are a great way to add room to a garage or living space.

4. Models of trusses

In general, which are used in important places, or we have introduced the most practical trusses in the table.

5. Advantages of using trusses

Types of trusses	Truss material	Place of use	Description
Pratt	Usually steel, in some cases wood	Usually on the roof and bridge	The maximum span is about 30 to 60 meters
Howe	Usually wood	Usually on the roof, in the past, it was also used to build bridges	The maximum span is about 30 meters
Fink	Usually steel	Usually on the roof	Usually the opening is about 20 meters
Bowst ring	Usually steel	Usually on the roof	Usually for roofs of warehouses and garages, the opening may reach 30 meters
Warren	Steel	Usually on the bridge	The span is about 60 meters
Parker	Steel	Usually on the bridge	Craters about 50 to 100 meters
Baltimore	Steel	Usually on the bridge	Craters more than 100 meters
K truss	Steel	Usually on the bridge	Craters more than 100 meters

Trusses are an integral part of modern architecture. Because trusses carry a lot of weight, it is possible for manufacturers to reduce costs as much as possible, easily cover long distances with trusses, and evenly transfer loads on the structure. Save on extra materials and build structures that are easy to maintain.

The use of wooden trusses is also very common, and in some parts of the world, wooden trusses are used to build the roof. Wooden trusses can be easily made on site, this truss is cheap, its material is available and it can bear a lot of weight. Wooden trusses can be used to make openings of more than 35 meters. Truss is a lightweight structure that can cover large openings and carry a lot of weight.

6. Forces in truss

The forces acting on the truss structure are distributed collectively in the joints and are either tensile or compressive. These forces are distributed in each of the constituent bars and can eventually reach the ground and be repelled by being transferred to other members in the truss.

All of these force divisions in trusses can be tensile and compressive. If there is no resistant joint in the truss, which is in the form of welding or in the form of bolts and nuts, the truss is destroyed by the entry of small force, so one of the most important parts in trusses are the joints.

The other part of the transmission force at the outlets is the supports, which are used in a movable or fixed manner. At moving supports, the forces applied to the truss are neutralized to such an extent that the forces are in the x-axis.

Due to the structure of the trusses, the applied forces are not affected by the constituent material of the members, so that considering the truss and its position, delicate members with low resistance against tensile and compressive forces can be used. This is also one of the properties of trusses. And reduces consumption in construction.

7. Kinds of joint in truss

One of the most important parts of a truss is the joints that are responsible for connecting and transferring forces. This part of the truss suffers the most force and pressure in a truss, so it must be used properly and carefully to prevent the truss from breaking. The joints are placed in several cases in the truss, examples of which are studied.

7.1. Pellets and bolts

In this case, we connect the joints with sheets with durable metal platforms using bolts and nuts, which is currently the most widely used method in connecting joints. As shown in the figure, the screws also give the truss more flexibility and act like a hinge.

Figure 5. Pellets and bolts

7.2. Welding

In this case, the joints are created in a completely closed form, which is done by welding, and they are usually used in the use of trusses on certain ceilings and places.

Figure 6. welding in joint

7.3. Mero system

In this case, as shown in the figure, metal balls are used in the joint, which can be used in more complex design trusses, and the members can be easily connected at different angles. Works with bolt and nut design**.**

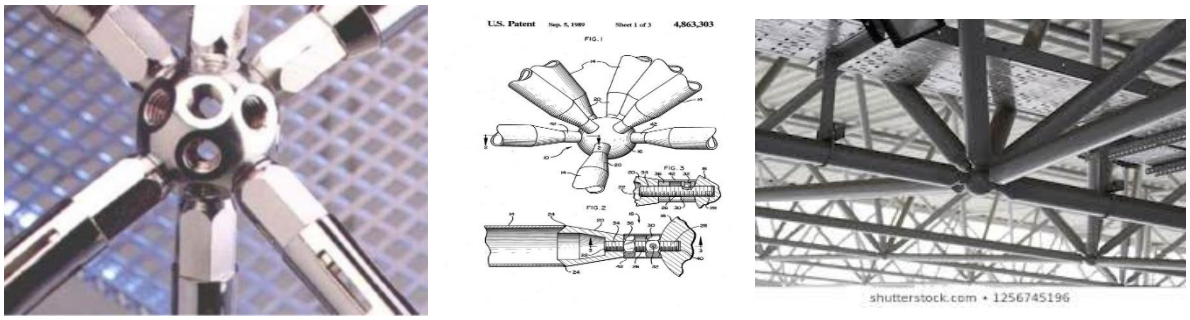


Figure 7. Mero system for joints

8. Design and Analysis of truss

Analysis and design in trusses can be considered completely similar to each other in general, so that we examine the loads on trusses and analyze the tensile and compressive forces in trusses and identify the joints, and finally the force created in trusses. After transferring to the ground, the support reaches the ground at the end. As a result of the analysis, we will understand the weaknesses and problems of trusses. In the following, a small sample of truss is analyzed.

8.1. Loads in truss

When they are repeatedly inserted into a truss, the greatest impact on a truss is in the joints. The reason for the high impact on the joints is that the joints are responsible for connecting other organs. For this purpose, they are one of the most important parts in trusses. For this reason, to examine the forces applied to a truss, we first examine the connecting points, ie the joints.

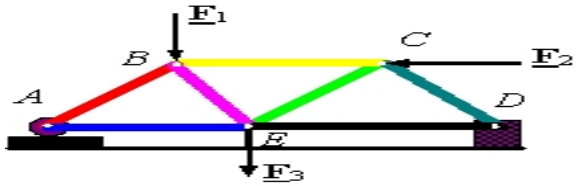


Figure 8. Loads inserted into a truss

8.2. Divided Loads in truss

The loads placed on a truss are converted into tensile and compressive forces in a truss.

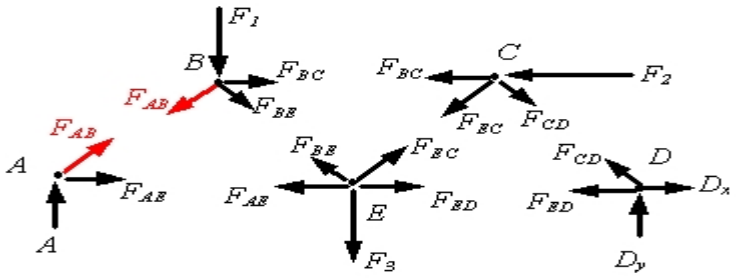


Figure 9. Divide the load by connecting the connecting points (joints) to the other members of a truss

We must keep in mind that the forces acting on the trusses act in a tensile and compressive manner. Figure 7. shows the tensile state in a truss, where the forces applied from the joints to the other joints are tensile.

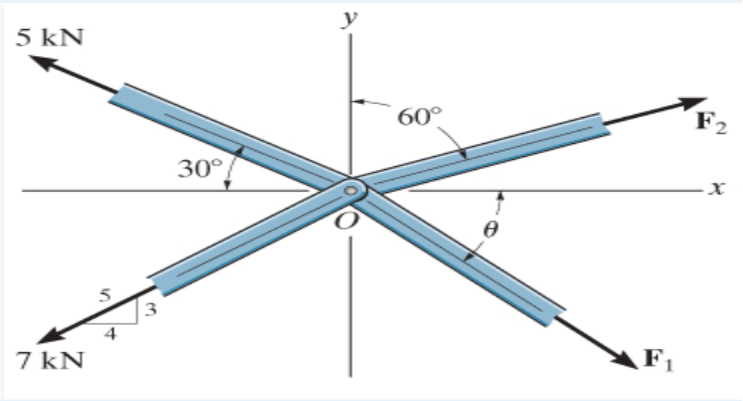


Figure 10. Tensile state in a truss

8.3. Neutral members in truss

Considering the shape of a truss and in some cases to beautify trusses, some additional members are designed and installed, and in general, in each truss there are members that are neutral, which means that no force is transmitted.

The initial figure shows an example of an organ that does not carry any load.

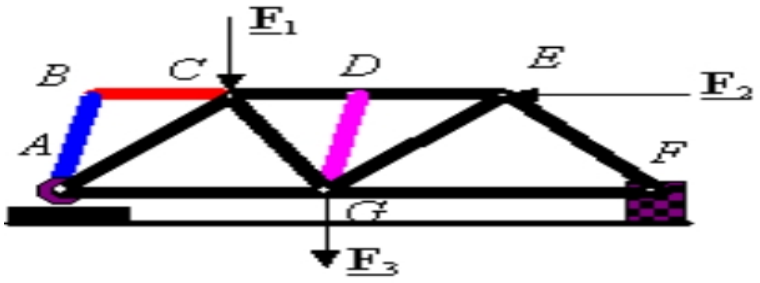


Figure 11. In this form, the members shown in different colors are neutral members

8.4. Force effects in members

To analyze and obtain the amount of force applied to a truss, we first select a small part of the truss and in all the forces entered in the truss along the x, y axis we have to put equal to zero so that we can know the unknown forces in the truss.

∑Fy=0→ FAB cos(theta)=0→FAB=0

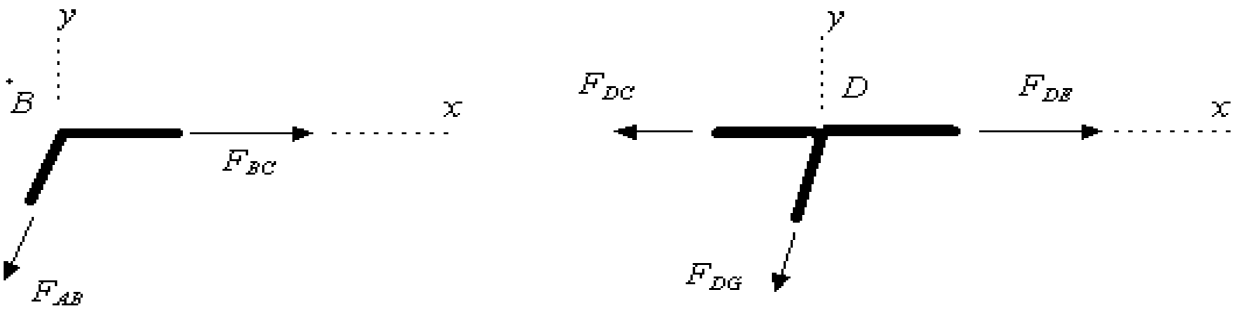


Figure 12. Forces in x and y axises

Sometimes in trusses, some organs only transmit force, which means they are not stretched or compressed. In this case, all the members connected to this joint have equal forces.

F1 = F2 = F3 = F4

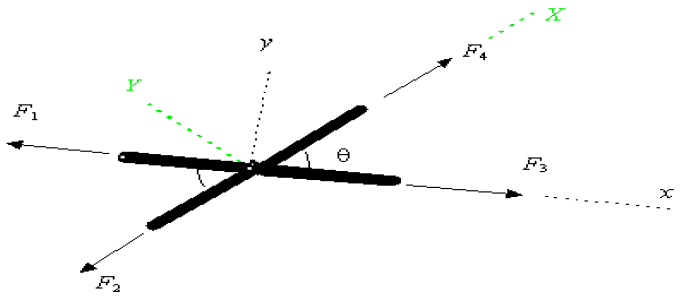


Figure 13. Equal forces in a joint

In the analysis of trusses, we must examine the number of equations formed for the unknown forces. In the formation of equations for unknown forces, in some cases the number of equations is less than the number of unknowns, which is called the indeterminate truss.

In the existing truss, the number of unknown forces is 9, and in total there are 4 joints, each joint has two members, ie the total number of equations in this truss is 8, in which case the number of

unknowns is less than the equations, so this truss is indefinite. To solve, we have to delete one of the members in which we delete the BD member and solve the equations.

Other condition is the indeterminacy of trusses

If the number of equations and unknowns in a truss is not equal, they are indefinite. In the figure above, the number of unknowns was greater than the equations, and we removed a member to solve. If the number of unknowns is less than the equations, what happens to the truss?

In this truss, the number of unknown forces 7 and the number of joints 4 in this case, the possibility of stability in this truss is 0, which means that as the force enters this truss, it moves. And in general, suppose a large truss would be unstable under the same conditions.

8.5. Example for analysis of small section in a truss

An example of a truss is analyzing the effect of forces on members, obtaining the type of tensile and compressive force, and obtaining unknowns.

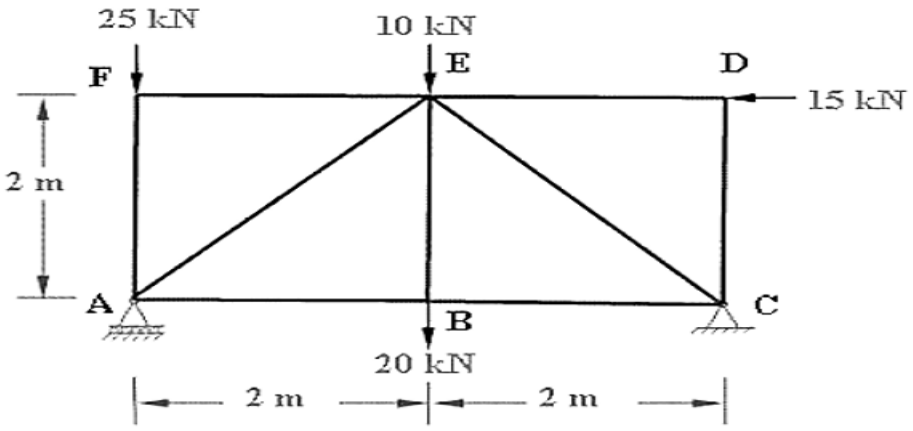


Figure 14. A small section of Truss

Equations in trusses

(AF, AB, AE, BE, BC, CE, CD, DE, EF)

Unknown forces = 12

$A_x = 0$

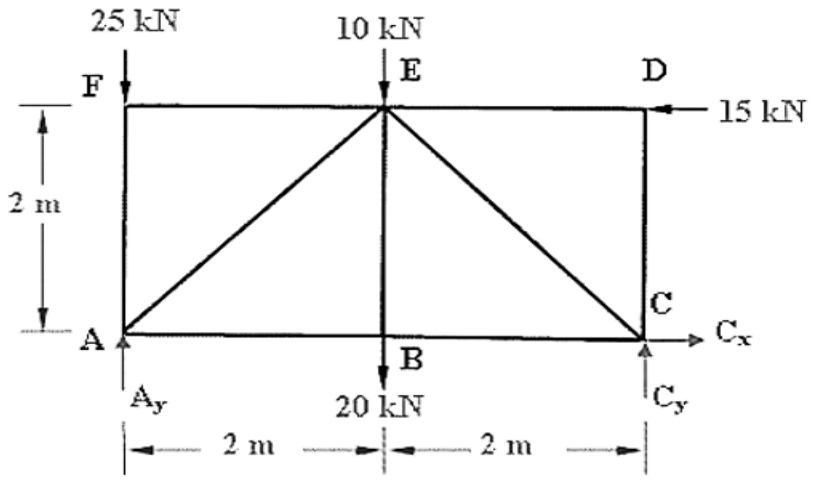


Figure 15. show the loads in x and y axises

Calculate the reaction forces at the supports

$\sum Fx=0 \rightarrow Cx=15$

$\sum Fx=0 \rightarrow Ay + Cy - 25 - 10 - 20 = 0$

$Ay + Cy = 55$

$Ay * 0 + Cy * 4 - Cx * 0 - 20*2 + 15*2 - 10*2 + 25*0 = 0$

$Cy = 7.5$ KN

$Ay = 47.5$ KN

Calculation of forces in members

(AF, AB, AE, BE, BC, CE, CD, DE, EF)

$\sum Fx = 0$

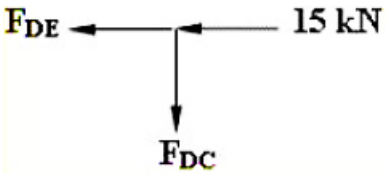
$-F_{DE} - 15$ KN $= 0$

$F_{DE} = -15$ KN

$\sum FY = 0$

$-F_{DC} = 0$

$F_{DC} = 0$



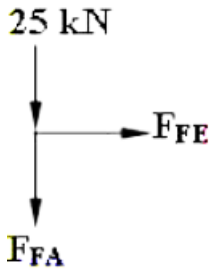
$\sum Fx = 0$

$F_{FE} = 0$

$\sum FY = 0$

$25 - F_{FA} = 0$

$F_{FA} = -25$



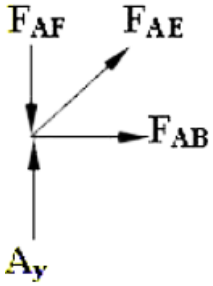
$\theta = 45$

$\sum Fy = 0$

$F_{AE} \sin(\theta) + A_y - F_{AB} = 0$

$F_{AE} \sin(45) + 47.5 - 25 = 0$

$F_{AE} = -31.82$ KN



$\sum Fx = 0$

$F_{AE} \cos(45) + F_{AB} = 0$

$-31.82 \cos(45) + F_{AB} = 0$

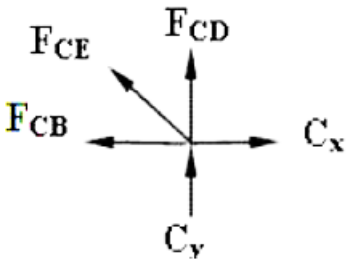
$F_{AB} = 22.5$ KN

$\sum FY = 0$

$F_{CE} \sin(\theta) + C_y - F_{CD} = 0$

$F_{CE} \sin(45) + 7.5 - 0 = 0$

$F_{CE} = -10.61$ KN



$\sum FX = 0$

$-F_{CE} \cos(45) - F_{CB} + C_X = 0$

$10.61 \cos(45) - F_{CB} + 15 = 0$

$F_{CB} = 22.5$ KN

and the end solve FBE $\sum FX = 0$ FBE = 20 KN

7.5.1. Investigating the types of forces applied to members

In all truss members, as mentioned, the incoming forces are in the form of traction and pressure

In this section, we analyze the types of forces applied to members and are shown in the school table.

9. CONCLUSION

Trusses are flexible yet sturdy structures.

These structures consist of a simple structure and at the same time have a special beauty that in some cases are used for beautification.

The trusses are connected to each other by joints, the most important part of which is a truss connecting points or joints.

The structure of trusses is triangular, which is the most stable and at the same time the simplest possible geometric shape.

In general, trusses are used in many structures due to their low weight and high strength in large areas without the use of columns, which is one of the advantages of trusses.

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