A PROJECT REPORT ON TRUSS BRIDGE

DRISHTI
A Revolutionary Concept

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AIM:

To study, analyse and design a Truss Bridge.

Abstract

The idea behind making a Truss Bridge was that so that we can study and analyse about it. Further objective was to create a model of the Truss Bridge.A truss bridge is a bridge whose load bearing superstructure is composed of a truss, a structure of connected elements usually forming triangular units. Truss bridge is a combination of truss and a bridge where bridge is used to connect two generally inaccessible points and truss is used to increase the load capacity of the bridge and reduce construction cost by reducing the requirement of columns. In this, how to build a simple Truss Bridge is described in a simple word. On mathematics' side, the truss is analysed in 2D and 3D using method of section, method of joints and method of tension coefficient. The design of the truss is made on a software called STAAD.pro wherein we design the structure of the truss we require, add supports and loads, define the properties of materials in terms of material to be used(steel, aluminium, timber), its cross section (C section, I section, L section and Box section) and dimensions, and analysed the deflection it has caused to each member and find the forces each member has.

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1.0 TRUSS

1.1 INTRODUCTION

A truss is a load bearing structure with its members generally connected to form triangular elements with any two members joined by different types of joints.

Triangular structure is found to be the strongest shape to exist. The reason being the other structures may distort on application of force on its joints, but the triangle does not.

There are mainly 3 reasons for which triangles are used in trusses:

1) **Rigidity –** A triangle has 3 sides and 3 angles, and each angle is held solidly in place by the side opposite to it. This means that a triangle's angles are fixed, and that is pressure is placed anywhere on a triangle, its angles, unlike those of other shapes, will not change.
2) **Forces –** when a force is applied to a triangle, the resulting pressure is directed sideways rather than down. This means that sides of the triangle are in either compression or tension, and that there is thus no bending movement.
3) **Openness –** Since the centre of a triangle does not contribute to its geometric rigidity structural integrity, the centre of a triangle can remain open. As one of the goals in erecting a truss is minimizing its weight, triangles are an appropriate shape to use.

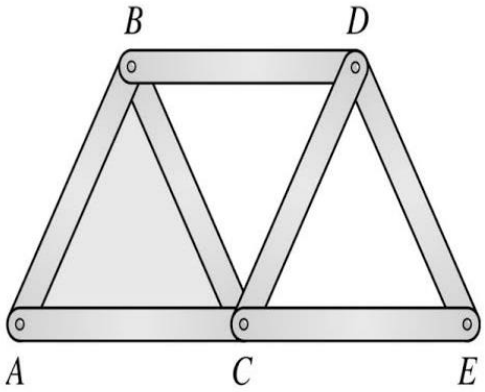

FIG 1.

1.2 COMPONENTS OF TRUSS

The various components of a truss are as follows:

- **Chords :** The outer members of a truss that define the envelope or shape
- **Top chord:** An inclined or horizontal member that establishes the upper edge of a truss. This member is subjected to tension and compressive loads.
- **Bottom chord:** The horizontal and inclined member defining the lower edge of a truss, carrying loads. This member is subject to tensile and bending loads.
- **Nodes:** The point of intersection of a chord with the web or webs, or attachments of pieces of lumber.
- **Webs:** Members that join the top and bottom chords to form triangular patterns that give truss actions. The members are subject to only axial compression or tension forces.
- **Braces:** A permanent member connected to a web or chord member at right angle to the truss to restrain the member against a buckling failure, or the truss against overturning.
- **Cantilever:** The structural portion of a truss which extends beyond a support. The cantilever dimension is measured from the outside face of the support to the heel joint. Note that the cantilever is different from the overhang.
- **Support:** Joints which restrain movement in particular directions required in the situation. Include fixed support restraining all movement, hinged support bidirectional movement and roller support restraining movement in one direction.

- **Clear span**: Horizontal distance between inside faces or supports.
- **Heel:** Joint in a pitched truss where top and bottom chords meet.
- **Overhang:** Extension of top chord beyond the heel joint.
- **Panel:** Chord segment between two adjacent joints.
- **Splice point:** Location where chord members are spliced to form a continuous member. It may occur at panel points.

1.3 TYPES OF TRUSS

The most popular and common types of truss are as follows:

- **Pratt Truss**: In this vertical members are in tension, whilst the diagonal members are in compression.

  - ADVANTAGES :-
    - ✓ Used for designing cost effective structure.
    - ✓ Well accepted and used design for mix of load.
  - DISADVANTAGES:-
    - ✓ Susceptible to non-vertical.

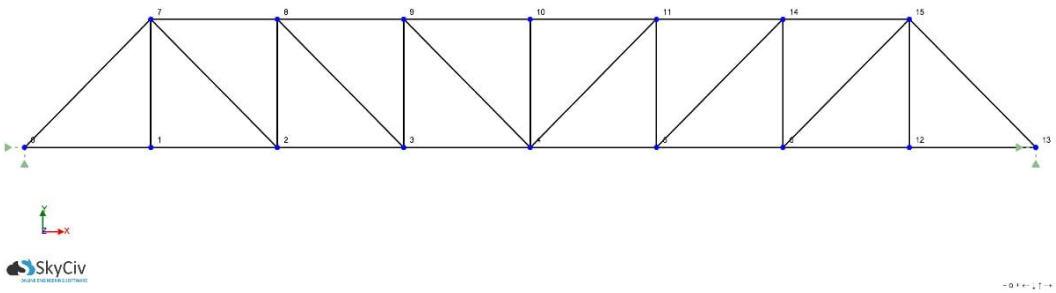

FIG 2

- **Warren Truss:** It can be easily identified due to construction of equilateral triangles.

- ADVANTAGES:-
  - ✓ Evenly spreads loads between members.
  - ✓ Simple design.
  - ✓ Used for long span structures.
- DISADVATAGES :-
  - ✓ Poor performance under concentrated loads

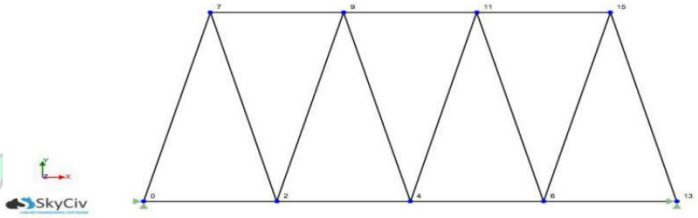

FIG 3

- **K Truss:** It is just slightly more complicated version of PRATT TRUSS. Main difference is that vertical members are shortened to improve its resistance against buckling.
  - ADVANTAGES:-
    - ✓ Reduce compression in vertical members.
  - DISADVANTAGES:-
    - ✓ More complex.
    - ✓ Reduction in usage of steel and cost if and only designed efficiently.
    - ✓ Expensive to build.

- **Howe Truss:** Basically its geometry is opposite of PRATT TRUSS i.e. Upside down geometry of PRATT TRUSS.
  - ADVANTAGES:-
    - ✓ Extremely strong.
    - ✓ Uses materials effectively.
    - ✓ Withstands extreme conditions.
  - DISADVANTAGES:-
    - ✓ As compared to pratt truss, it has more unloaded members.

1.4 USES OF TRUSS

A truss can be used to achieve the following goals:

- Achieve long spans: Trusses can be used over long spans as it transfers all forces axially. Since they are connected through pin joints, they do not have internal shear and moment forces.
- Minimise the weight of structure
- Reduce deflection
- Support heavy loads

According to the assumption, the truss members can be in tension, compression, or sometimes both in response to dynamic loads. Typical axial forces in truss members in Pratt truss and Warren truss under deadweight are shown in Fig. Owing to its simple design method and efficient use of materials, a truss bridge is economical to design and construct.

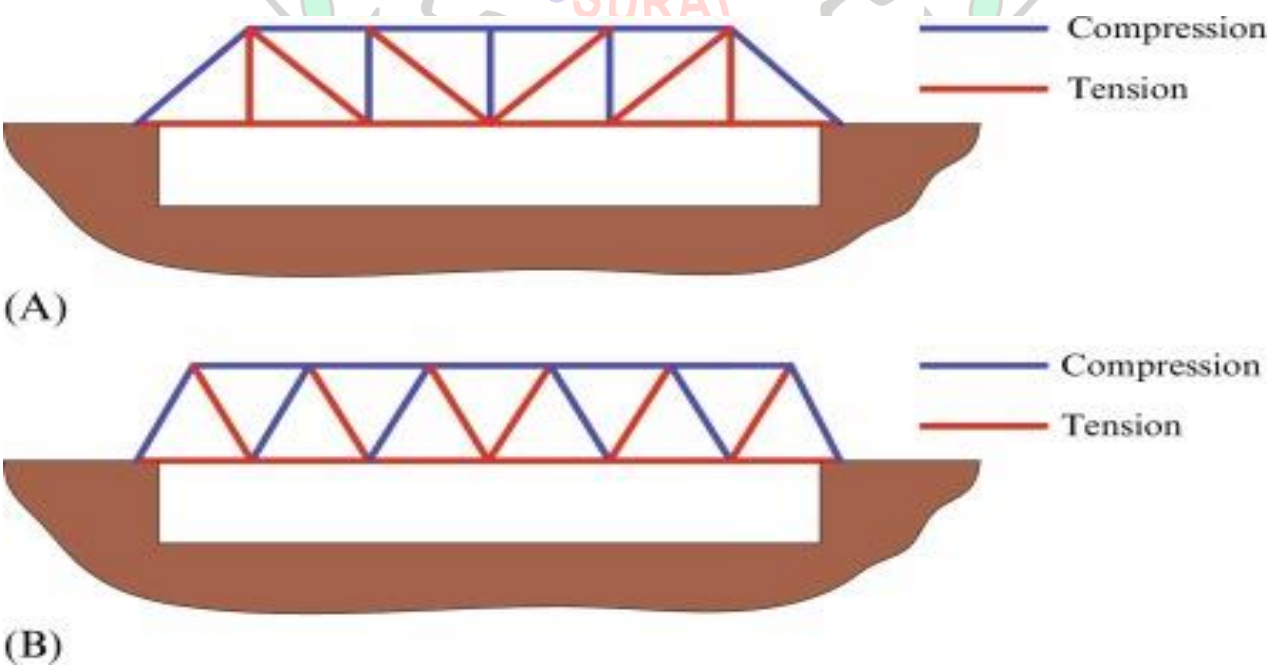

FIG 4

2.0 BRIDGE

2.1 INTRODUCTION

A bridge is a structure built to span a physical obstacle, such as a body of water, valley, or road, without closing the way underneath.

Bridge is a structure that spans horizontally between supports and whose function is to carry vertical loads.

Bridges are designed to fulfill 3 main goals:

- **Efficiency:** A scientific principle that puts a value on reducing materials while increasing performance. This principle holds that the structure of a bridge is the province of the engineer and that beauty is fully achieved only by the addition of architecture.
- **Economic**: A social principle that puts value on reducing the costs of construction and maintenance while retaining efficiency. This principle argues on the fact that the most efficient possible use of materials are by definition beautiful.
- **Elegant** (first ensuring safety): a symbolic or visual principle that puts value on the personal expression of the designer without compromising performance or economy. This case holds that architecture is not needed but that engineers must think about how to make the structure beautiful. This last principle recognizes the fact that engineers have many possible choices of roughly equal efficiency and economy and can therefore express their own aesthetic ideas without adding significantly to materials or cost.

2.2 COMPONENTS OF BRIDGE

The various components of a bridge are as follows:

- **Deck:** Deck is the portion which carries all the traffic.
- **Superstructure:** All the elements of the bridge attached to a supporting system can be categorized as superstructure.
- **Sub structure:** The parts of the bridge which support the superstructure and transmit all the structural loads of the bridge to the foundations. For example piers and abutments.
- **Foundation:** Foundation is the portion which transmits bearing loads to the earth. Foundation is required t support piers which in turn supports the whole structure.
- **Girder:** A girder is a support beam used in construction. It is the main horizontal support of a structure which supports smaller beams.

- **Pier:** Pier is the part of the substructure that supports the superstructure and transfers loads of super structure to the foundations. In common terms it is the vertical columns that support the bridge.
- **Pier cap:** Pier cap is the topmost part of a pier which transfers loads from superstructure to the pier. It is also known as headstock.
- **Bearings:** Bearing is a device which supports the parts of superstructure and transfers loads and movements from the deck to the substructure and foundation.
- **Piles and pile cap:** Pile is a slender member driven into the surrounding soil to resist the loads. Pile cap is a thick reinforced concrete slab cast on top of the group piles to distribute loads.

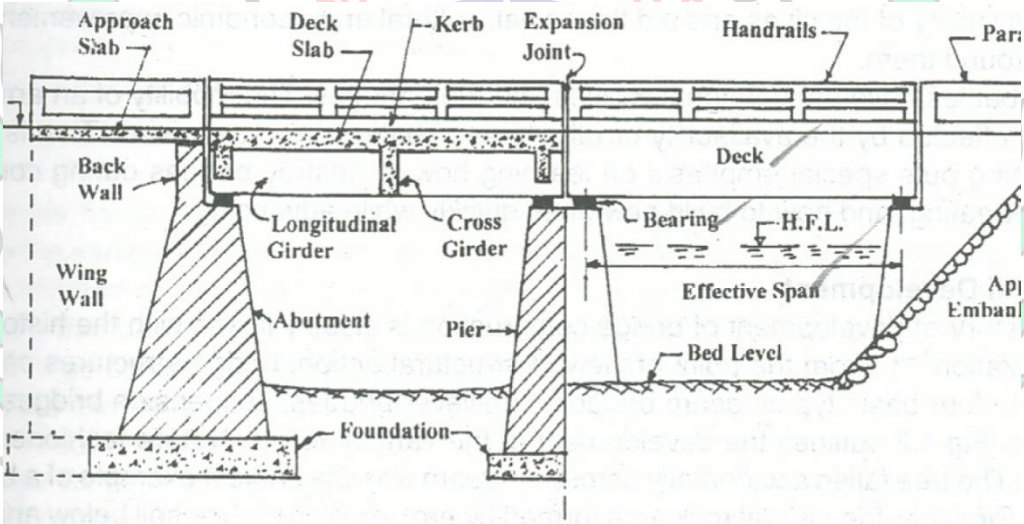

Figure 1.1 Components of a Typical Bridge.

FIG 5

2.3 TYPES OF BRIDGE

The various types of bridges commonly used in real life are as follows:

- **Arch Bridge:** The basic principle of arch bridge is its curved design, which does not push load forces straight down, but instead they are conveyed along the curve of the arch to the supports on each abutment.
- **Suspension Bridge:** They utilize spreading ropes or cables from the vertical suspenders to hold the weight of bridge deck and traffic. Able to suspend decking over large spans, this type of bridge is today very popular all around the world.
- **Beam Bridge:** They employ the simplest of forms i.e. one or several horizontal beams that can either simply span the area between abutments or relieve some of the pressure on structural piers. The core force that impacts beam bridges is the transformation of vertical force into shear and flexural load that is transferred to the support structures (abutments or mid-bridge piers).

- **Cantilever Bridge**: They are somewhat similar in appearance to arch bridges, but they support their load, not through a vertical bracing but trough diagonal bracing with horizontal beams that are being supported only on one end.
- **Truss Bridge:** They are somewhat similar in appearance to arch bridges, but they support their load, not through a vertical bracing but trough diagonal bracing with horizontal beams that are being supported only on one end.

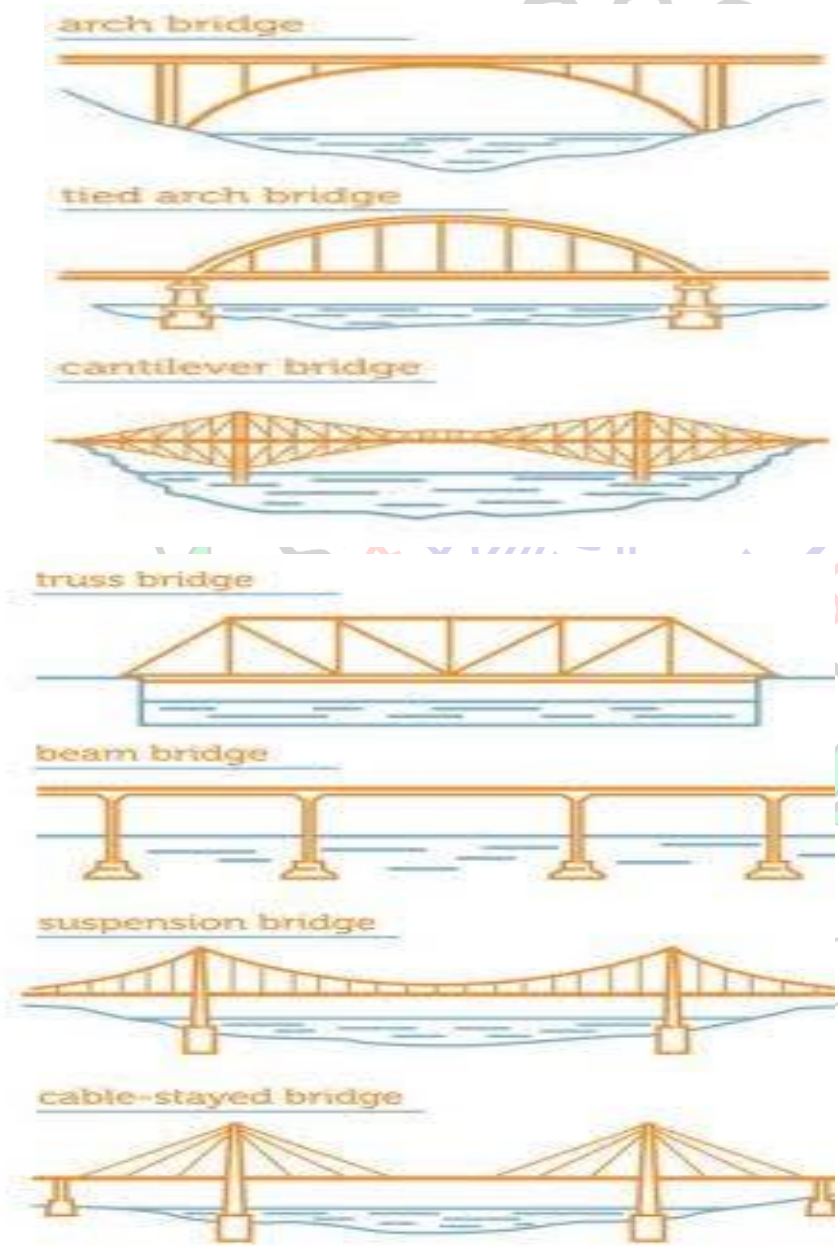

FIG 6

3.0 TRUSS BRIDGE

3.1 INTRODUCTION

A truss bridge is a bridge whose load-bearing superstructure is composed of a truss, a structure of connected elements usually forming triangular units. The connected elements may be stressed from tension, compression, or sometimes both in response to dynamic loads.

3.2 ADVANTAGES AND DISADVANTAGES

- **ADVANTAGES**
  - **Economical To Build:** The materials to build a truss bridge are minimal, and every single bit is used very efficiently. It also utilizes cheaper and lighter materials. The strength comes when these materials are formed to the triangles.
  - **Strong:** The unique triangular design provides support for the entire bridge. This gives it great strength making it ideal for very high traffic and heavy load areas.
  - **Road Placement:** Truss bridges are one of the only types of bridges where the actual road way can be placed directly on top. This helps to make it easily integrated into the construction process.
  - **Built In Difficult Places:** These types of bridges can be built across small or long spans while maintaining their strength. Virtually anywhere that a bridge is needed, a truss bridge can do the job.

- **DISADVATAGES**
  - **Complicated Design:** The design of truss bridges can become very complicated depending on the situation. The triangles have to be the perfect size and there has to be the perfect amount in order for the truss bridge to be safe.
  - **Maintenance:** Due to the amount of materials and different parts, the upkeep on truss bridges can be difficult. It is hard to pinpoint exactly what is wrong if the bridge has issues.
  - **Waste of Materials:** If even just one small part of construction goes wrong, a very large amount of materials are wasted.
  - **Heavy Weight:** Truss bridges are massive and weight quite a bit. In for the surrounding land to be able to support these bridges additional support

is often needed. This may include making adjustments to existing structures around the bridge.

3.3 COMPONENTS OF TRUSS BRIDGE

The various components of truss bridge are

- **Top lateral bracing**: The term we use to refer to any pieces on a bridge that help keep the truss from twisting.
- **Portal bracing:** It is combination of strut and tie which lie in the plane of the inclined braces at a portal, serving to transfer wind pressure from the upper parts of the trusses to an abutment or pier of the bridge
- **Sway Bracing:** The horizontal bracing of a bridge, which prevents its swaying.
- **Stringer:** These are secondary beams in truss bridges to carry the load from the slab till the cross beams located at truss nodes

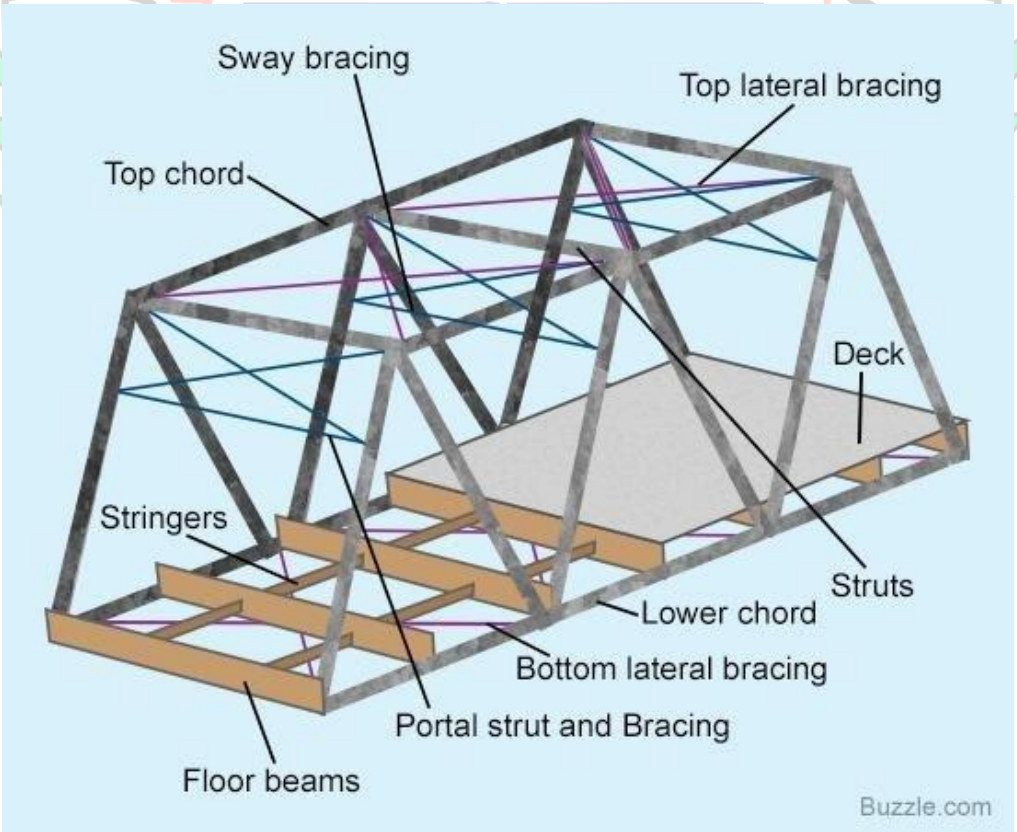

FIG 7

3.4 TYPES OF TRUSS BRIDGE

Some more common variants of truss design for bridges:

- **Allan truss**: a pony truss based on Howe truss. The first Allan truss was finished on 13 August 1894.
- **Bailey truss**: made for military to be easily combined in various configurations.
- **Baltimore truss**: made like Pratt truss but it has additional bracing in the lower section of the truss which prevents buckling in the compression members.
- **Bollman truss**: an all-metal truss with many independent tension elements which makes for a strong bridge that is easy to assemble.
- **Burr arch truss**: a combination of an arch and truss which gives a strong and rigid bridge.
- **Howe truss**: has vertical elements and diagonals that slope up towards the center of the bridge.
- **K truss**: has one vertical member and two oblique members in each panel (which form a letter "K").
- **Lenticular truss**: uses a lens-shape truss which has an upper and lower curve and diagonal elements between them. If the curves are above and below the roadbed it is a "lenticular pony truss".
- **Parker truss**: a variant of Pratt truss that has a polygonal upper chord. If chord has exactly five segments it is called camelback.
- **Pegram truss**: has chords that are wider at the bottom but of the same length as each other at the top.
- **Pratt truss**: has vertical members and diagonals that slope downward to the center. It is a variant commonly used for railroad bridges.
- **Vierendeel truss**: has members that are not triangular but rectangular. Rare are bridges made in this variant of truss because it is not cheap.
- **Warren truss**: has longitudinal members joined only by angled cross-members. They form equilateral triangles. It is relatively light but strong and economical truss.

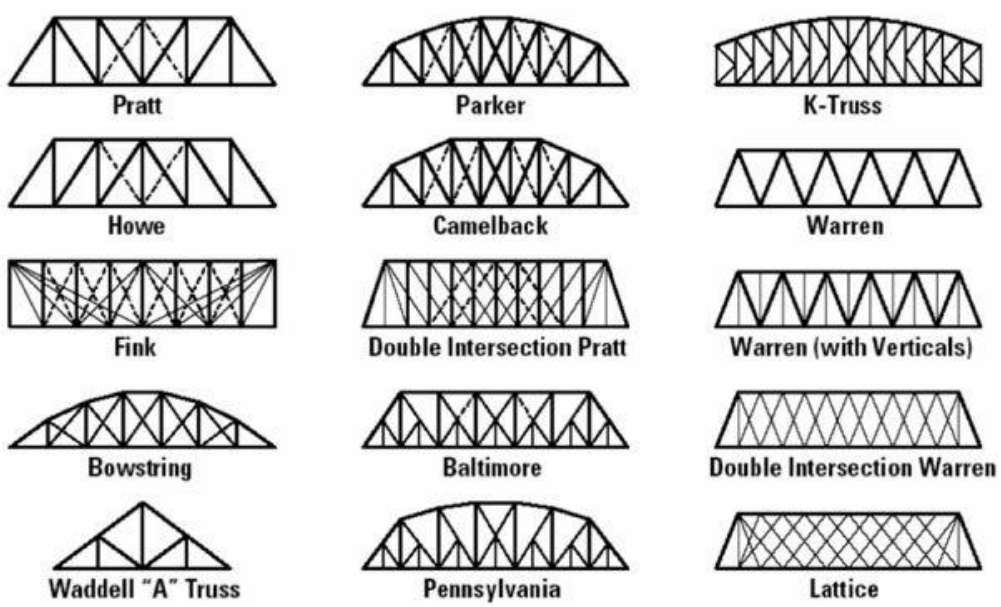

FIG 8

3.5 WHY TRUSS BRIDGE?

The reason behind truss bridge being better than other bridges is that:

- Versatile
- Economic
- Can be used for less height regions
- Can be precasted

4.0ANALYSIS OF TRUSS

- There are 4 main assumptions made in analysis of Truss:

- Members are perfectly straight.
- Loads are applied at the joints.
- Joints are pinned and frictionless.
- Members are subjected to axial forces only.

➢ Calculation of 2D truss :-

- Method of joints
- Method of section

➢ Calculation of a 3D truss: -

- Method of Tension Coefficient

5.0 DESIGN

- **Design 1**

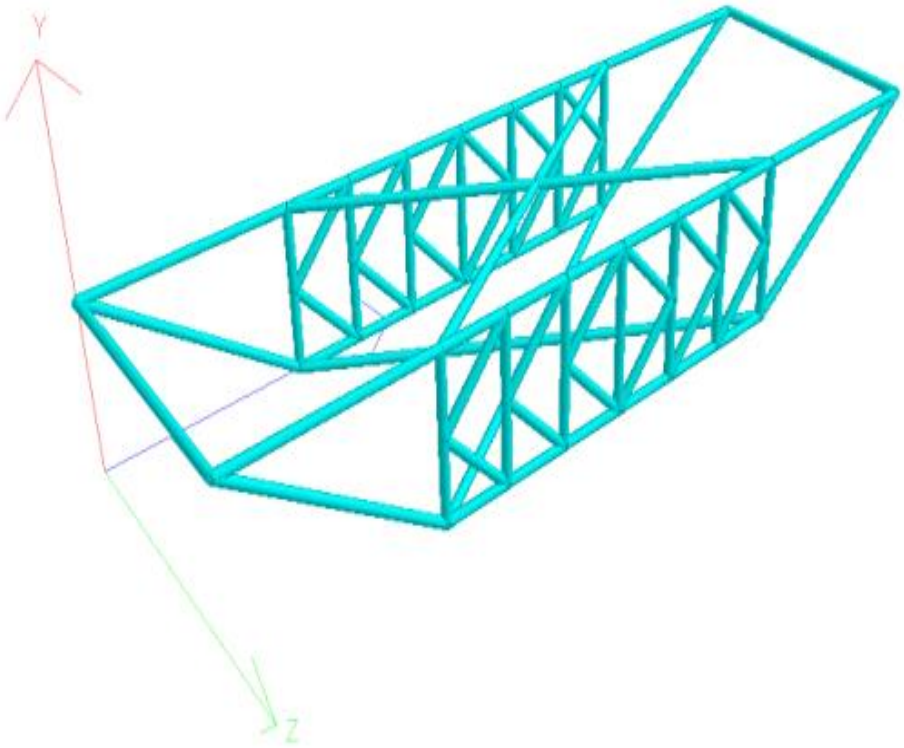

FIG 9

Pros: Comparatively Stable

Cons: Hard to manufacture, Complex, Material Inefficiency, Expensive

- **Design 2**

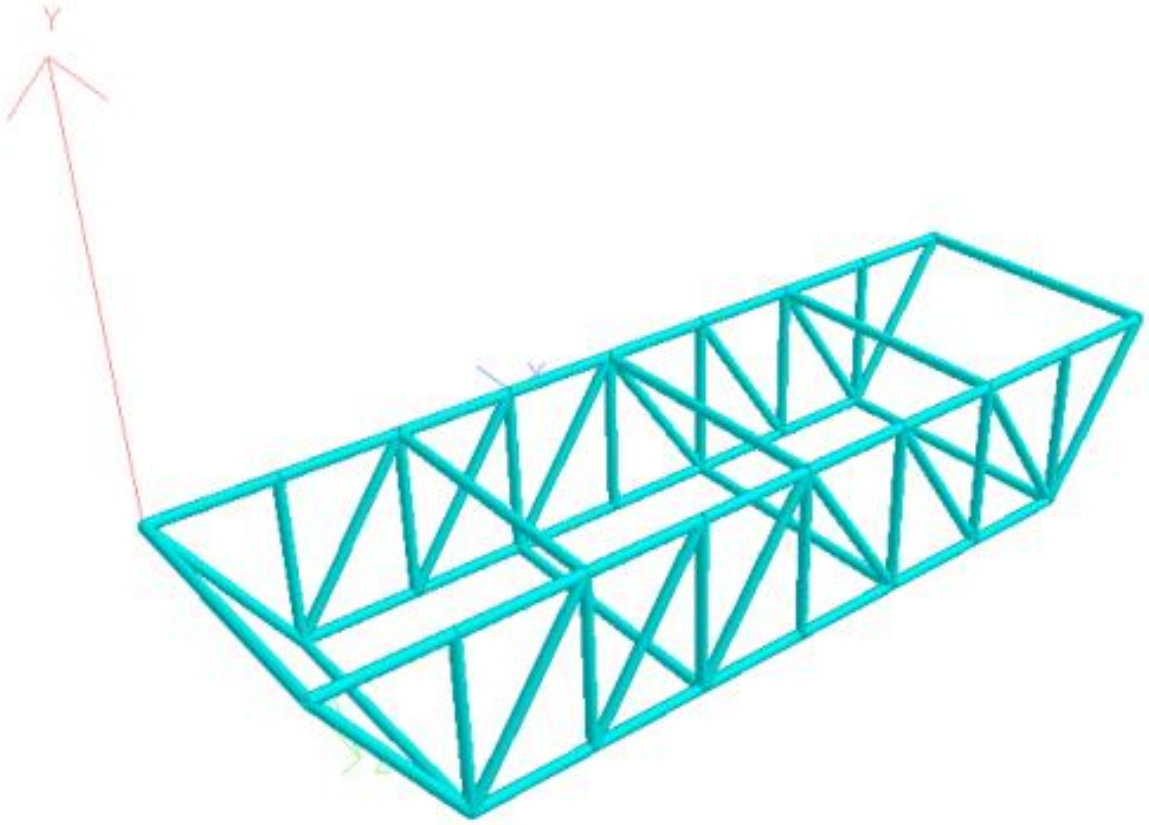

FIG 10

Pros: Easy to Manufacture, Material Efficient, Inexpensive

Cons: More Complex than warren

- **Design 3**

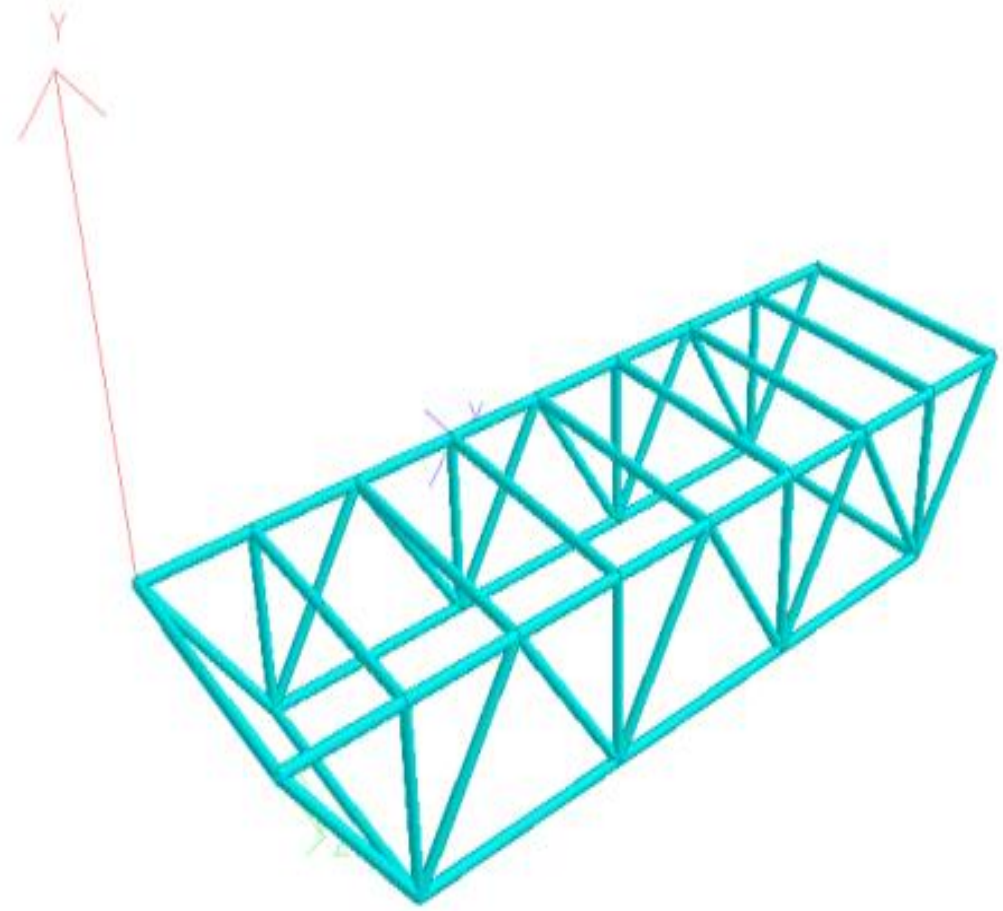

FIG 11

Pros: Easy to Manufacture, Material Efficient, Inexpensive

Cons: Comparatively less stable, More Complex than warren

6.0 MANUFACTURING

FIG 12

In order to manufacture, each side is manufactured one by one and connect it through deck**.**

FIG 13

In Truss Bridge, Stringer,strut and brace members are manufactured from L shaped 0.75 x 0.75 section.

FIG 14

FIG 16

After than using symmetry manufacturing each members were connected.

FIG 17

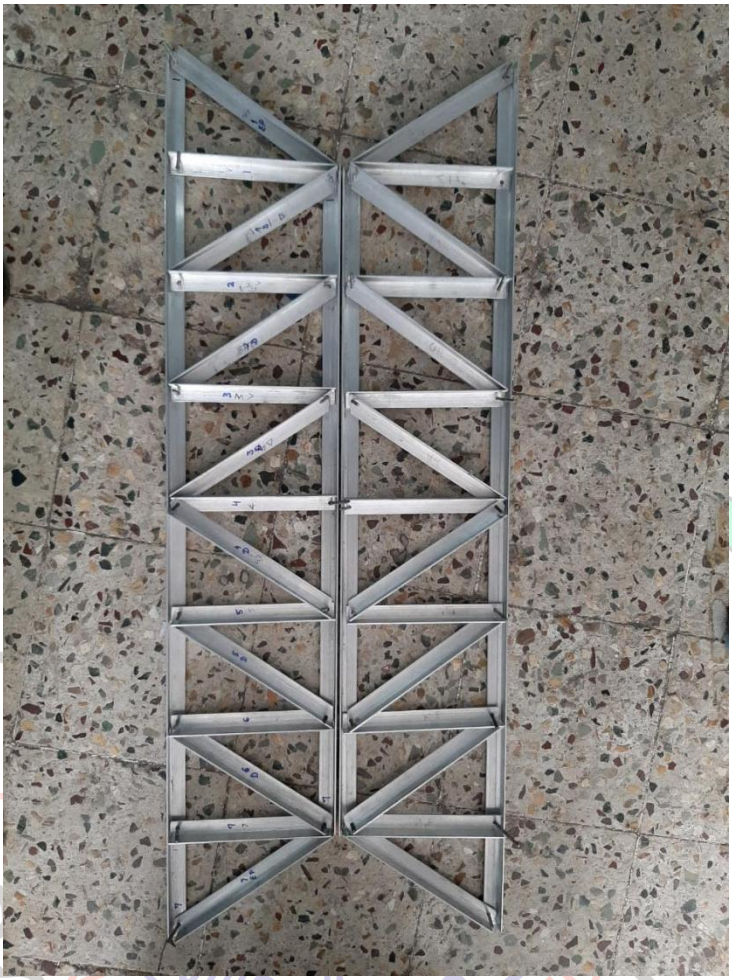

FIG 18

After than using each sided were manufactured and them joined with floor beam.

FIG 19

7.0 REFERENCE

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