BRIDGES

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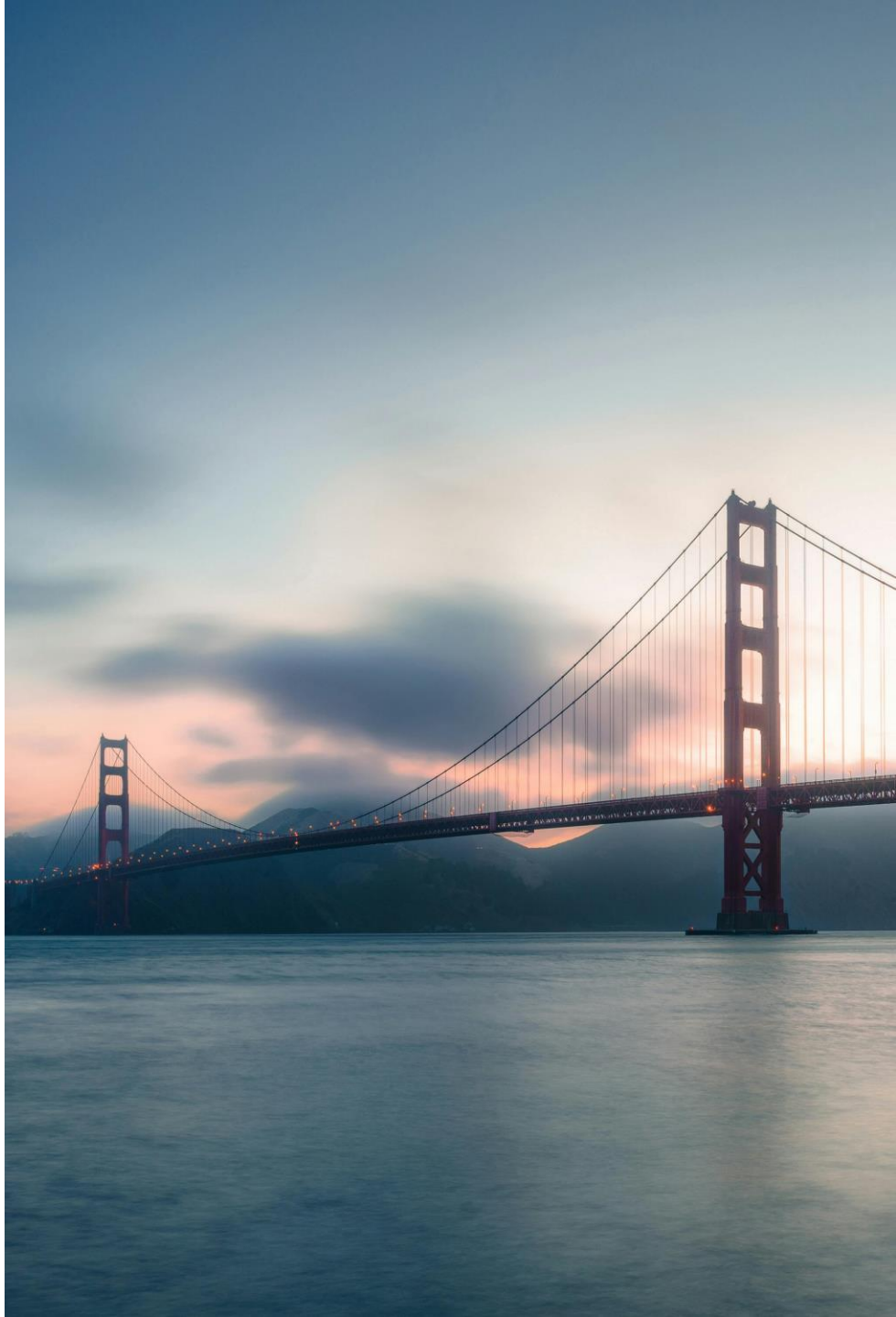
How Bridges Work ?

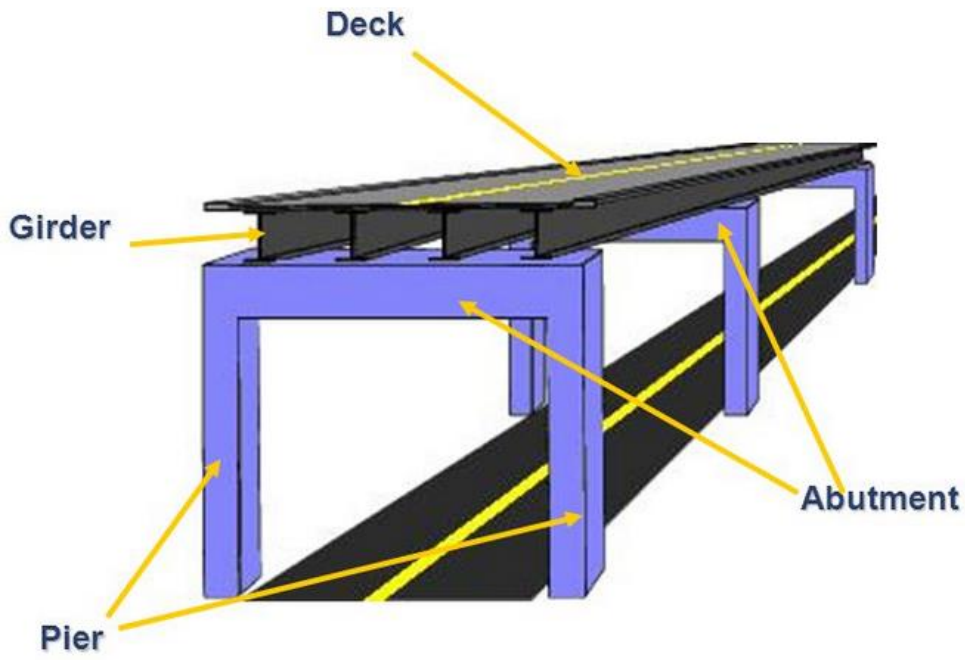
Every passing vehicle shakes the bridge up and down, making waves that can travel at hundreds of kilometers per hour. Luckily the bridge is designed to damp them out, just as it is designed to ignore the efforts of the wind to turn it into against harp. A bridge is not a dead mass of metal and concrete: it has a life of its own, and understanding its movements is as important as understanding the static forces.

Functions of Bridge

- **Connectivity**: Bridges connect different areas, facilitating travel and trade.
- **Safety**: They provide safe passage across obstacles, reducing risks.
- **Economic Development:** Bridges promote economic growth by improving accessibility.
- **Aesthetics:** They can enhance the visual appeal of a landscape.



COMPONENTS OF BRIDGE



Deck / Slab

- The horizontal surface of the bridge that supports traffic.
- It can be made of various materials, such as concrete, steel, or wood.
- The deck is typically reinforced to withstand the weight of vehicles.

Abutment

- A structure at the end of a bridge that supports the superstructure.
- It transfers the load from the bridge to the ground.
- Abutments can be made of concrete, steel, or masonry.

Beam / Girder

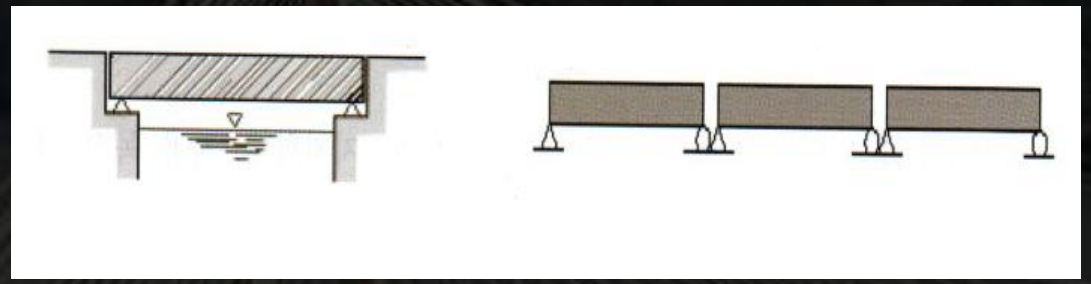
- The main structural element that supports the deck.
- Beams and girders can be made of steel, concrete, or wood.
- They are designed to carry the weight of the deck and traffic.

Pier

- An intermediate support for the superstructure, located between the abutments.
- Piers are used to span long distances or to provide additional support for the bridge.
- They can be made of concrete, steel, or masonry.

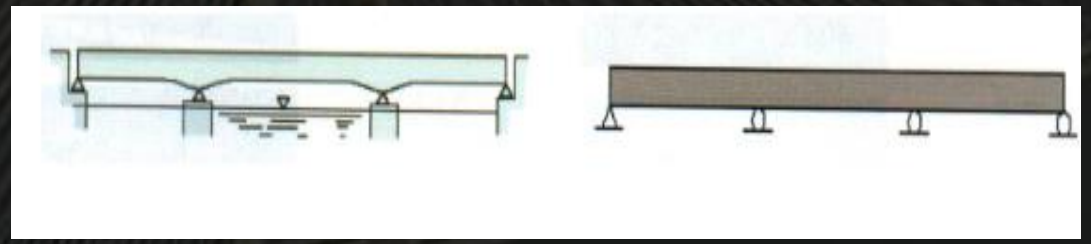
Bridge Types

Bridge Types depending upon the Support Types



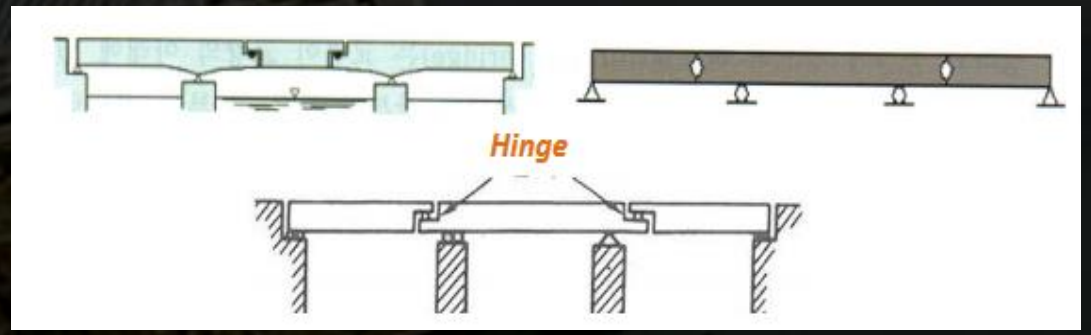
Single Span Bridge

•Separated spans/decks
•Simple structure, easy analysis and construction
•Large deflection, not suitable for long spans, poor vehicle performance, small-scale bridges, railway bridges



Continuous Span Bridge:

•Continuous deck
•Indeterminate structure, small deflection, suitable for long spans
•Complex analysis, continuous span bridge



Gerber Bridge:

•Adding hinges to the continuous span bridge to convert "indeterminate" to "determinate"
•Easy analysis, but excessive deflection of the beam between the hinges

Bridge Types

Bridge Types depending upon the Deck Positions

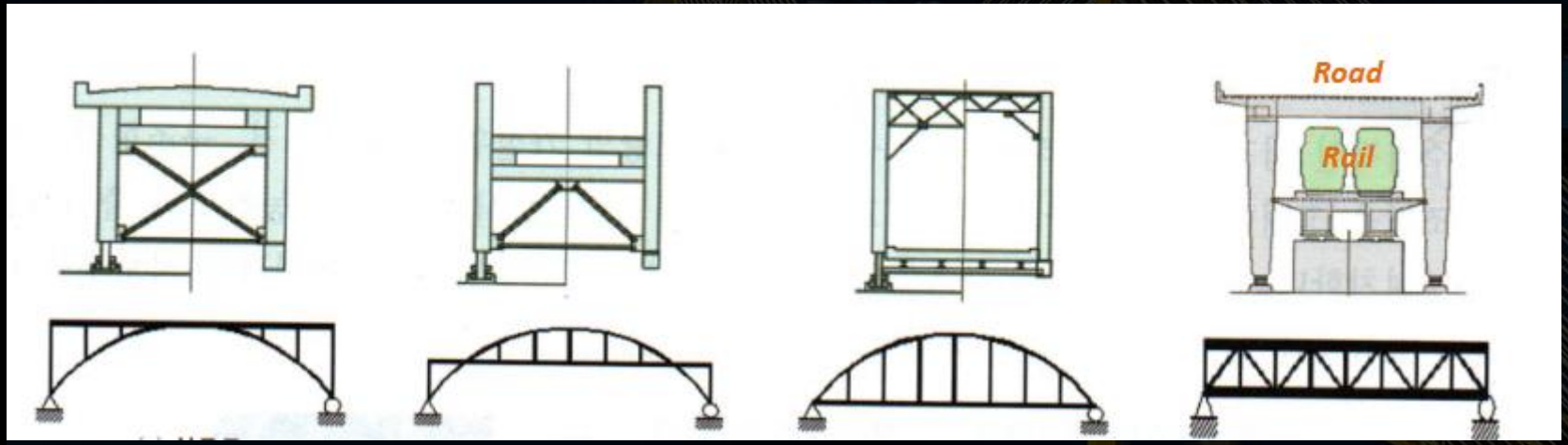


Fig (a)

Deck Bridge

Fig (b)

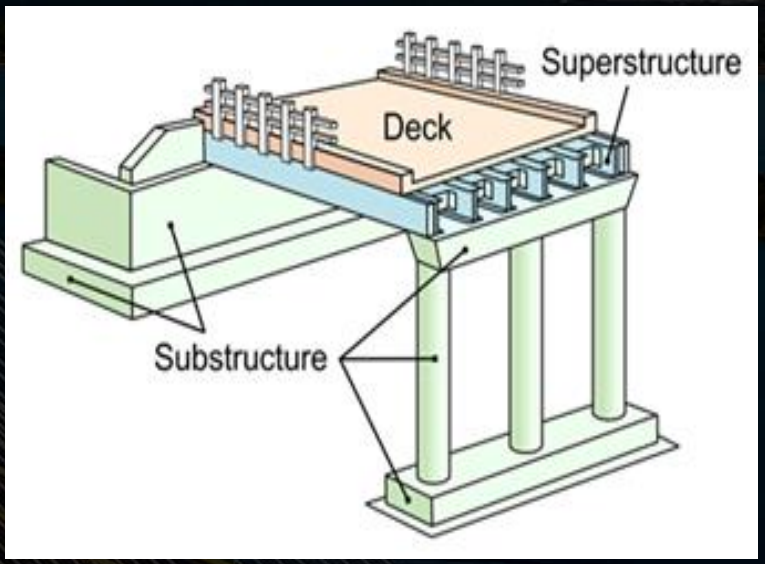
Half-through Bridge

Fig (c)

Lower Route Bridge

Fig (d)

Double Deck Bridge



Bridge Types

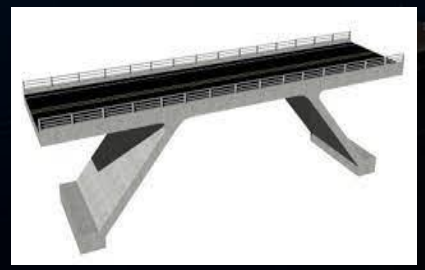
Bridge Types depending upon the Deck Types

RC Slab Bridge

Should avoid long-length due to increase self-load

Hollow Slab Bridge

Reduce self-load with holes



Rigid-Frame Bridge

- Connected top and bottom Structures
- Economical with low-pier-height and short-span bridges
- No need for expansion joints till 50m
- Spaces under the bridge for overpass road or river crossing
- Easy maintenance, good Appearance

According to Material Of Construction

Timber Bridge

Masonry Bridge

Steel Bridge

Reinforced Bridge

Pre-Stressed Bridge

Composite Bridge

Types of Bridges

Bridge types depending upon the Deck type :

Girder/Beam Bridge

Truss Bridge

Arche Bridge

Cable Stayed Bridge

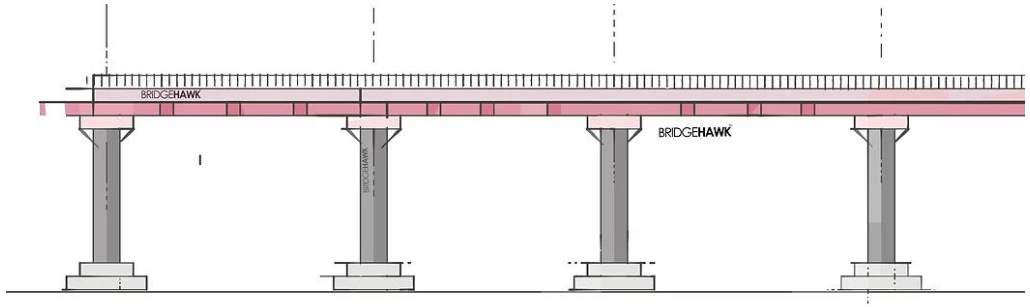
Suspension Bridge

Girder Bridge

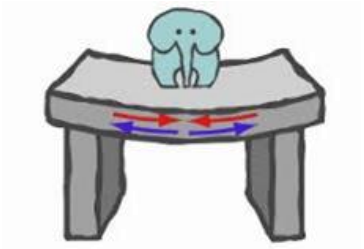
A girder bridge (also known as simply supported beam bridges) is perhaps the most common and most basic bridge to carry loads across short to medium spans.
Girder bridges are bridges that use longitudinal beams(girders) as the primary structural element to support the deck.

In modern steel girder bridges, the two most common girders are I-beam girders and box-girders

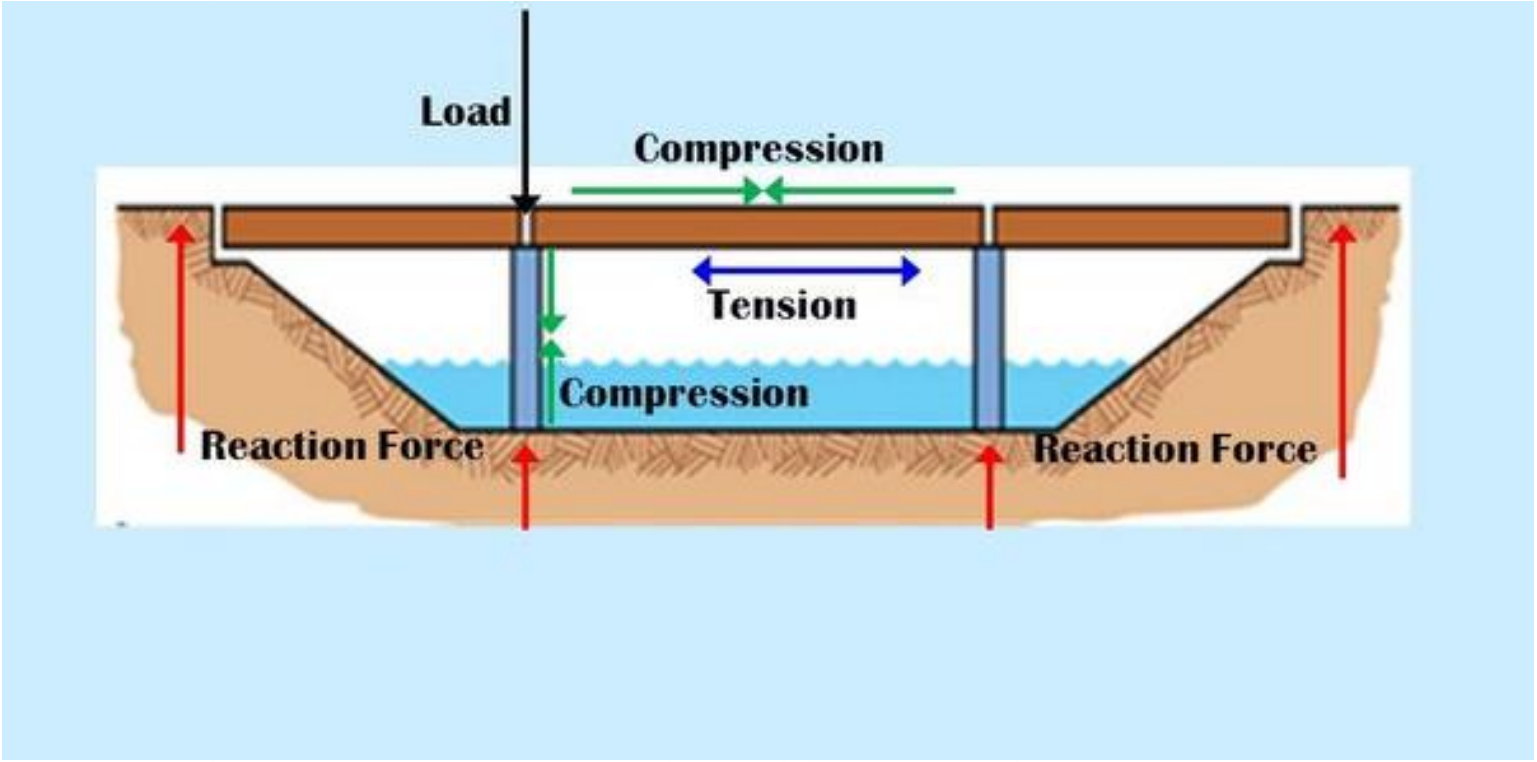
Made of various materials, such as steel, concrete, or wood.



Forces on Girder Bridge



The primary forces that act on a beam bridge are bending, compression, and tension



Types of Girder Bridge

T-Shape

- Usually used for short spans (30m)
- Less self-load than slab bridges
- Double T-shape: 50m span with prestress, horizontal tendons due to a big gap b/w girders

Plate Girder

- Use I-shape steel girder (50m)
- Require many steel members, complicated
- Low horizontal strength -> weak for curved roads

Plate Box Girder

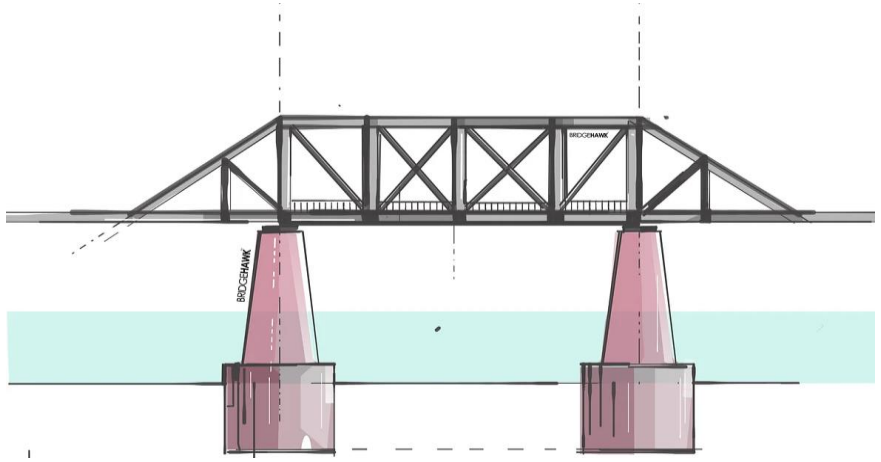
- Widely used (50-60m)
- Good for curved and widened roads
- Steel box is prefabricated, bolted and welded in the field ->fast, easy construction

Truss Bridge

A truss bridge is a bridge where the load-bearing structure is a framework of interconnected triangles. The triangular shape distributes weight efficiently.

Working Principle or Function :

Trusses distribute forces using a triangular framework. Compression acts on the top chords, while tension acts on the bottom chords. Diagonal members handle mixed forces.



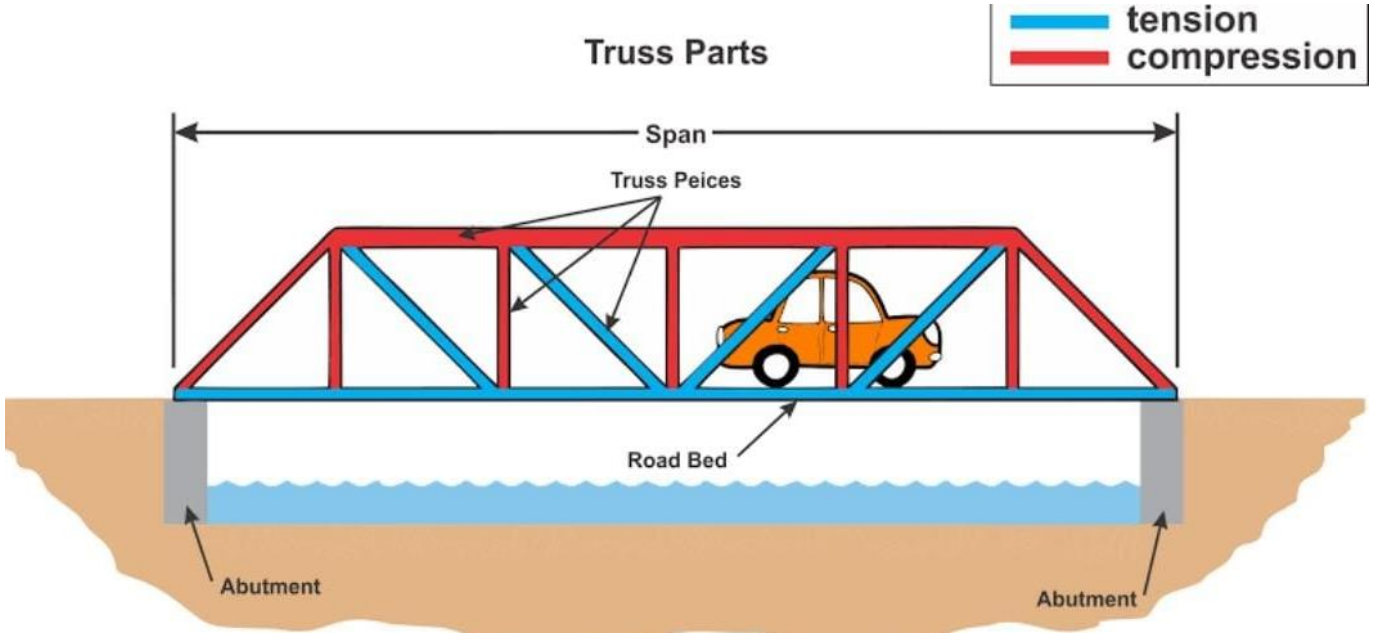
Forces In Truss Bridge

The forces that act on truss bridges include:

Tension: Forces that pull outward at the ends of the tension members. Compression:

Forces that push or compress the members together.

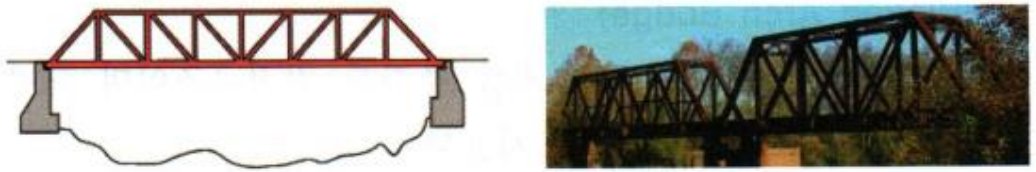
Torsion: A twisting force that bridge designers try to reduce as much as possible.



Types of Truss Bridge

Warren Truss

Howe Truss



Pratt Truss

Parker Truss

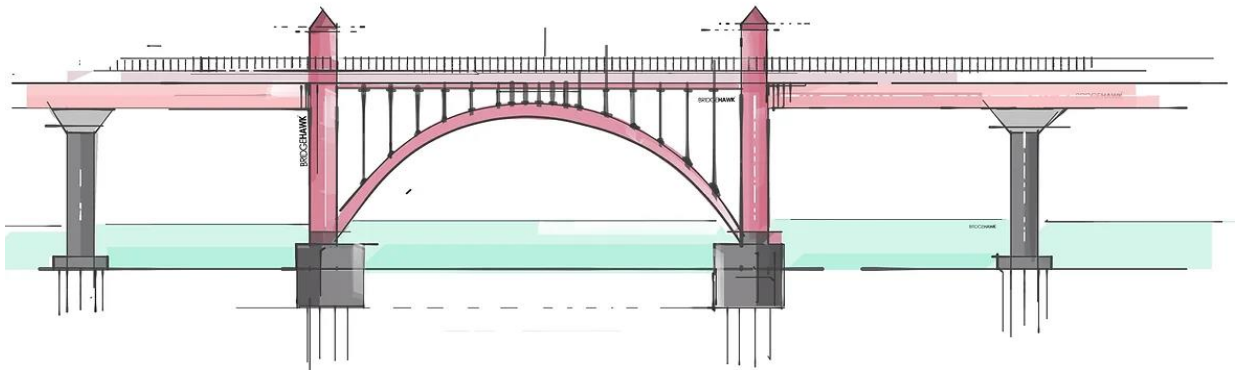
K Truss

Baltimore Truss

Arch Bridge

What is an Arch Bridge?

An arch bridge is a type of bridge where the main load-bearing structure is a curved arch. The arch shape provides natural strength, as it transfers the weight of the load primarily into compression, pushing outward along the curve and downward into the supports (abutments).



Forces In Arch Bridge

The forces that act on truss bridges include:

Compression: The arch is under compression, carrying the load.

Tension: Minimal tension exists; occurs under external forces like wind.

Thrust: The outward force of the arch is transferred to the abutments.

Gravity: The load is distributed along the arch.

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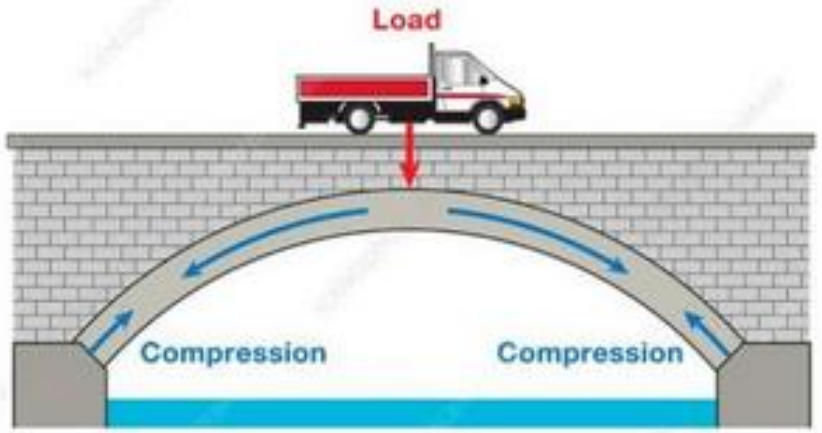
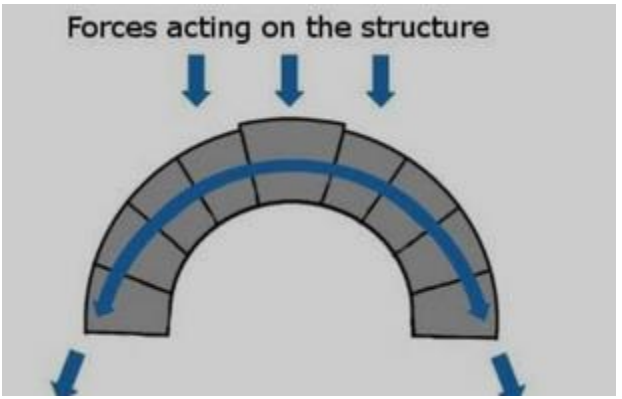
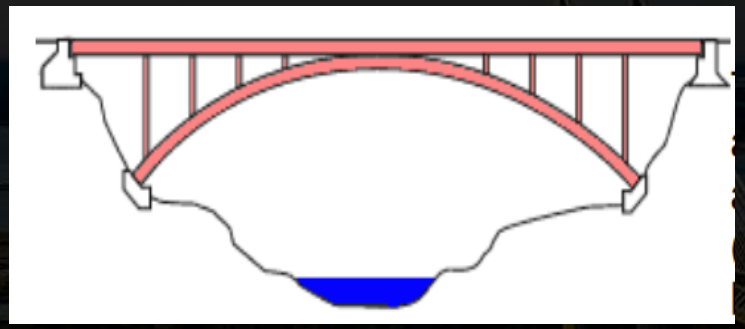
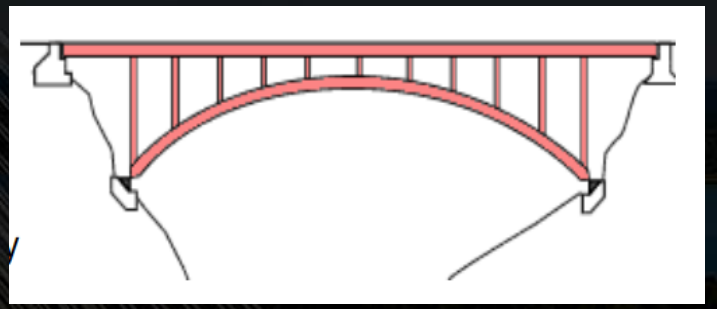




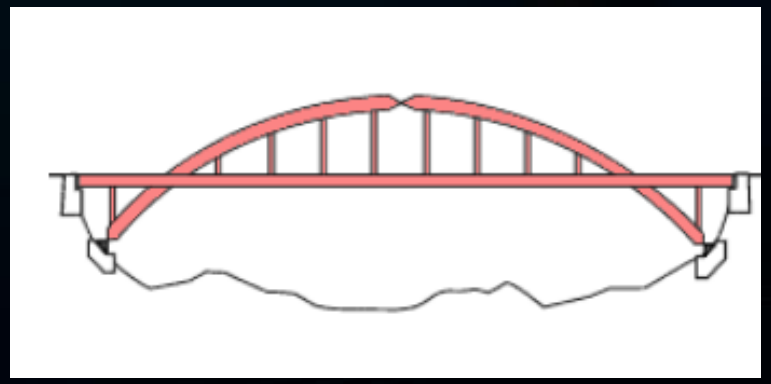
Types of Arch Bridge :



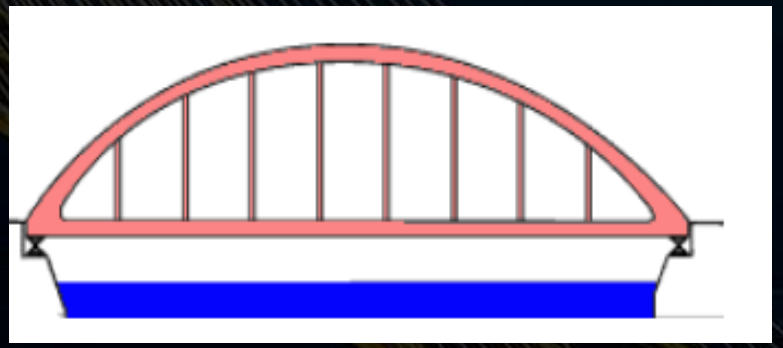
Hinge-less bridge-
Allows NO rotation at foundation, only built at very sturdy locations because of force placed on the foundation.



Two-Hinge bridge-
Forces generated at the hinged bearings, most commonly used type, generally the most economical.



Three-Hinge bridge-
Contains Extra hinge at the top of the arch, suffers very little if movement in the foundation due to earthquakes, sinking etc., Rarely used in Recent times.



Tied Arches-
used in places where thr ground is not strong enough to support the horizontal forces, to alleviate the horizontal pressure the girder “ties” both ends of arch together.

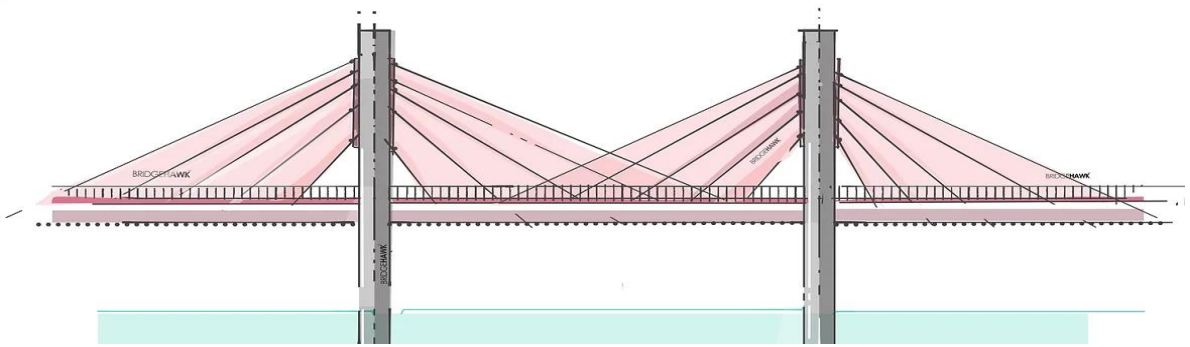
Cable Stayed Bridge

What is an Cable Stayed ridge?

A cable-stayed bridge is a type of bridge in which the deck is supported by cables directly connected to towers (pylons). Cables are arranged in a fan-like or harp-like pattern.

Working Principle or Function

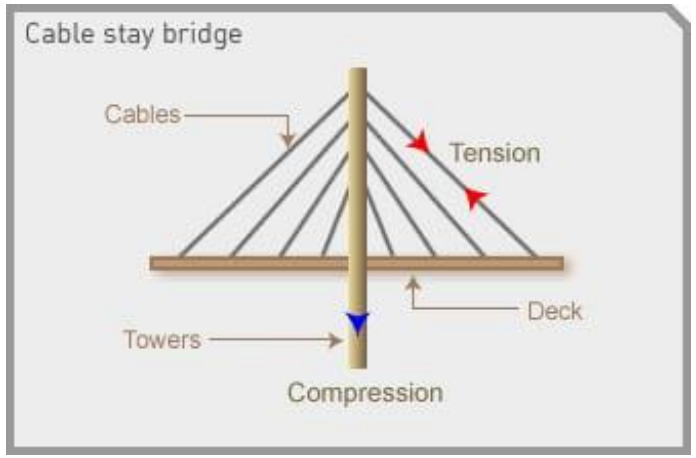
Tensioned cables support the deck, and the towers (pylons) transfer the load into the ground through compression. Unlike suspension bridges, no large anchorages are required.

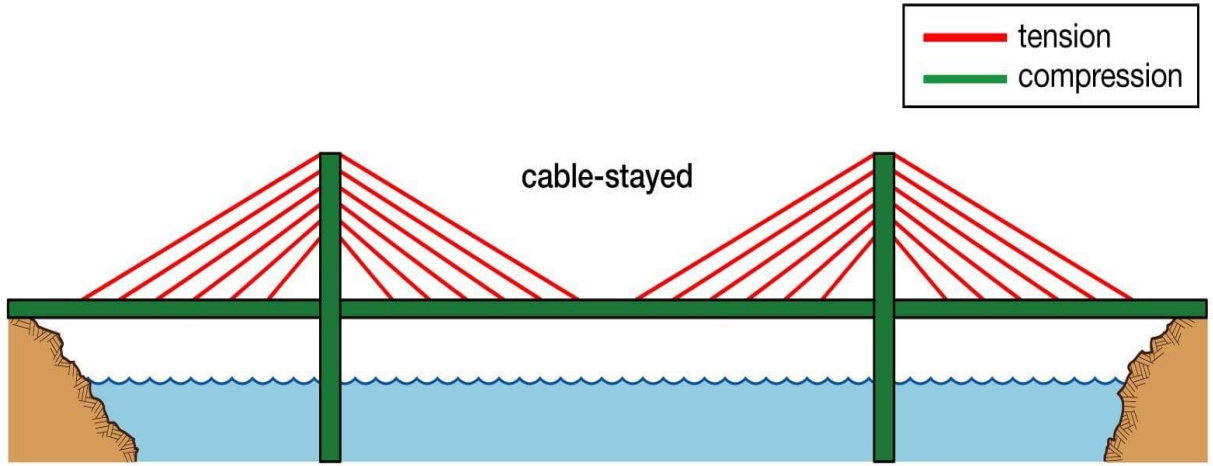


Forces In Cable Stayed Bridge

<u>The forces that act on Cable Stayed bridges include</u>:

Tension: Cables are under tension, holding the load.
Compression: Towers bear the load through compression.
Shear Forces: Forces affecting the deck from vehicle movement.
Wind and Seismic Forces: Must be managed for stability.

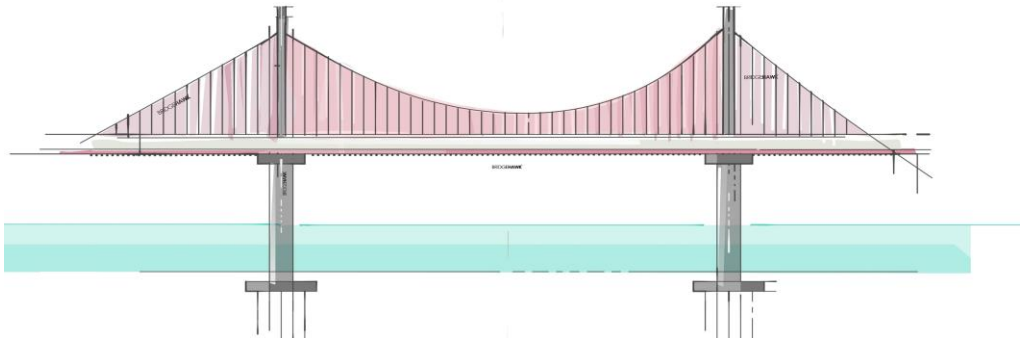




Suspension Bridge

What is an Suspension Bridge?

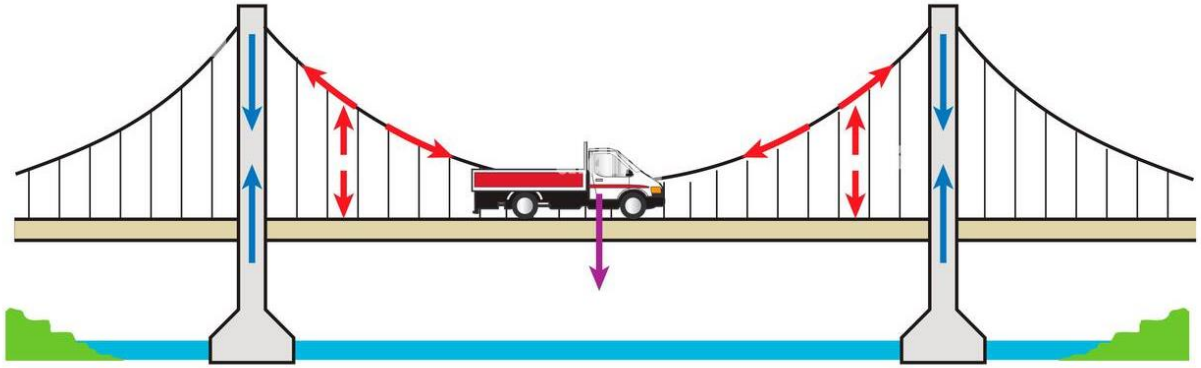
A suspension bridge is a type of bridge in which the deck (the load-bearing portion) is hung below suspension cables on vertical suspenders. The cables are anchored at each end of the bridge, and the weight of the deck and any load is transferred to the anchors and then to the ground.



Forces In Suspension Bridge

The forces that act on Cable Stayed bridges include:

Tension: *Cables are under tension, supporting the bridge's weight and vehicle loads.*
Compression: *Towers bear the load by transferring the weight down to the ground through compression.*
Shear Forces: *Forces affect the deck from wind and vehicle movement, causing lateral stress.*
Wind and Seismic Forces: *Must be managed to prevent excessive oscillation or swaying for structural stability.*



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Types of Bridges in Civil Engineering
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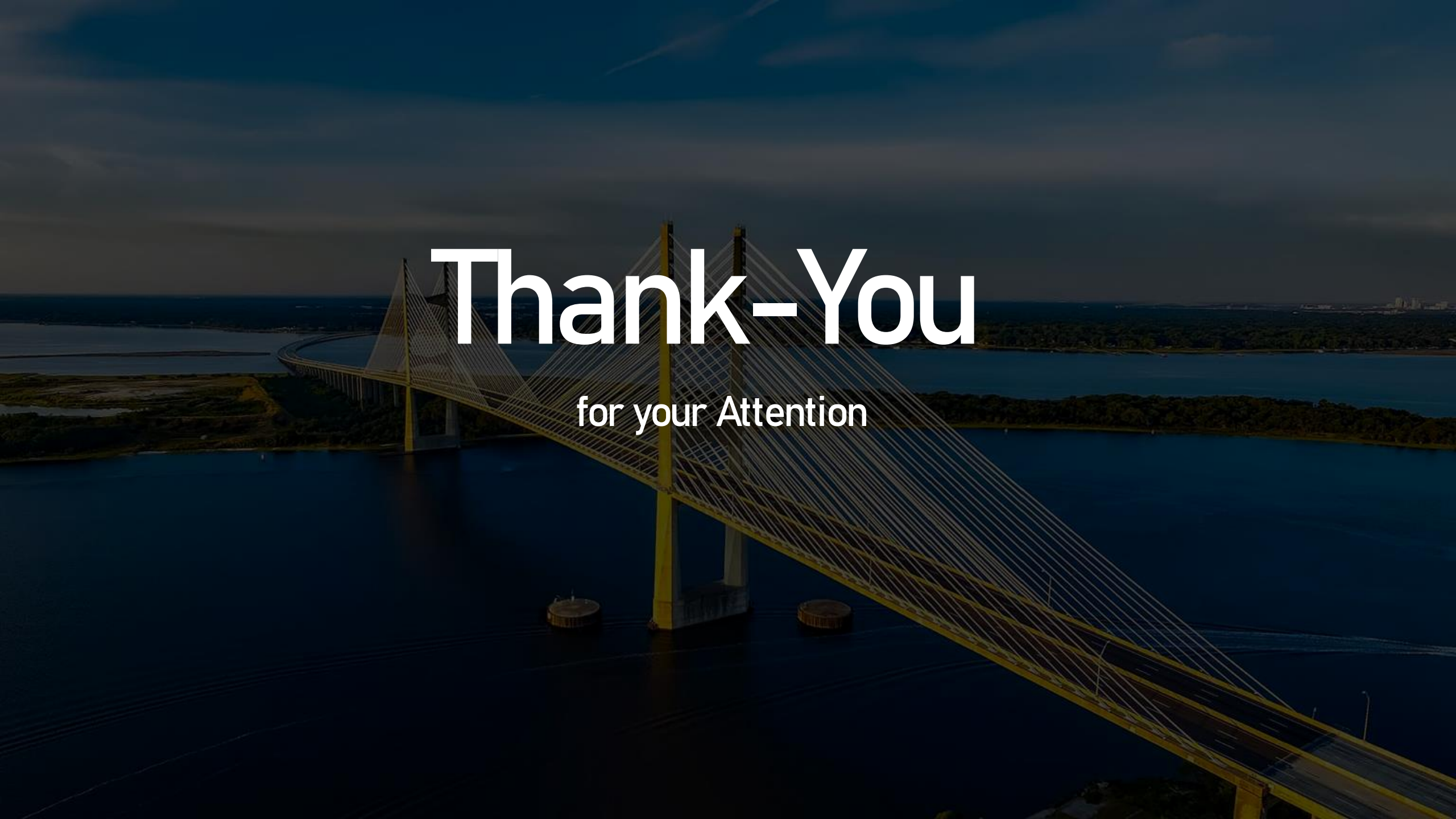
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