

# STRUCTURES AND FORCES

## What is a Structure?

a body that supports a load and resists external forces without changing its shape, except for that due to the elasticity of the material(s) used in construction.

*What does THAT mean?*

1. They must be able to carry the **loads** for which they were designed.
2. They must not collapse in use.
3. They must hold the various parts in the correct relative positions.

## What are some types of structures?

- Cranes
- Bridges
- Furniture
- Buildings
- Transport
- Airplanes
- Ships
- Trains
- Motor Vehicles



## Natural Structures

Some man made structures are modeled after structures found in nature.



What is the strongest shape used in structural design?



What is Structural Failure?

- when the structure is not able to support the loads on it and may collapse.
- Why does structural failure happen?
- poor design, either shape or material
- failure of joints
- fatigue caused by loads varying over a period of time (vibrations)
- excessive loads during the building of the structure
- incomplete knowledge of the conditions under which the structure may be used.

Famous Failure: Tacoma Narrows Bridge

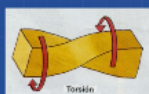


Why did it fail?

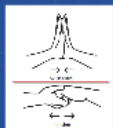
- "resonance instability" - the solid plate girder deck and lift
- tremendous forces were little understood, bridges should have been tested in a wind tunnel.

## Forces

- **internal forces:** the forces allowing the structure to push back against the internal force
- **compression:** forces trying to squish or shorten
- **tension:** forces trying to pull the element apart
- **torsion:** the twisting force



Torsion



## Forces

- **Load:** an example of a force
- **External forces:** forces acting on a structure consisting of all applied loads and all reactions to its supports.
- **static load:** associated with the load at rest
- **dynamic load:** associated with the load in motion



## Resources found:

- Engineering Design: An introduction by Karsnitz, O'Brien, Hutchinson

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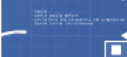


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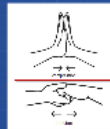


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- fatigue caused by loads varying over a period of time (vibrations)
- excessive loads during the building of the structure
- incomplete knowledge of the conditions under which the structure may be used.

## Famous Failure: Tacoma Narrows Bridge



Why did it fail?

- "excessive flexibility"
- the initial design ignored wind loads as an aerial cable was used
- stress forces were little understood, in cases should have been tested in a wind tunnel.

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Prezi

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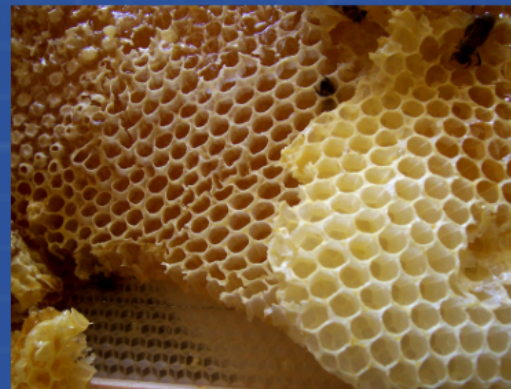
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What is the strongest shape used in structural design?

- stable
- cannot easily deform
- can balance the stretching and compression forces inside the structure



What is Structural Failure?

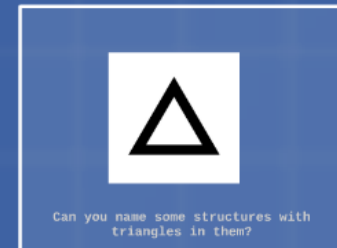
When the structure is not able to

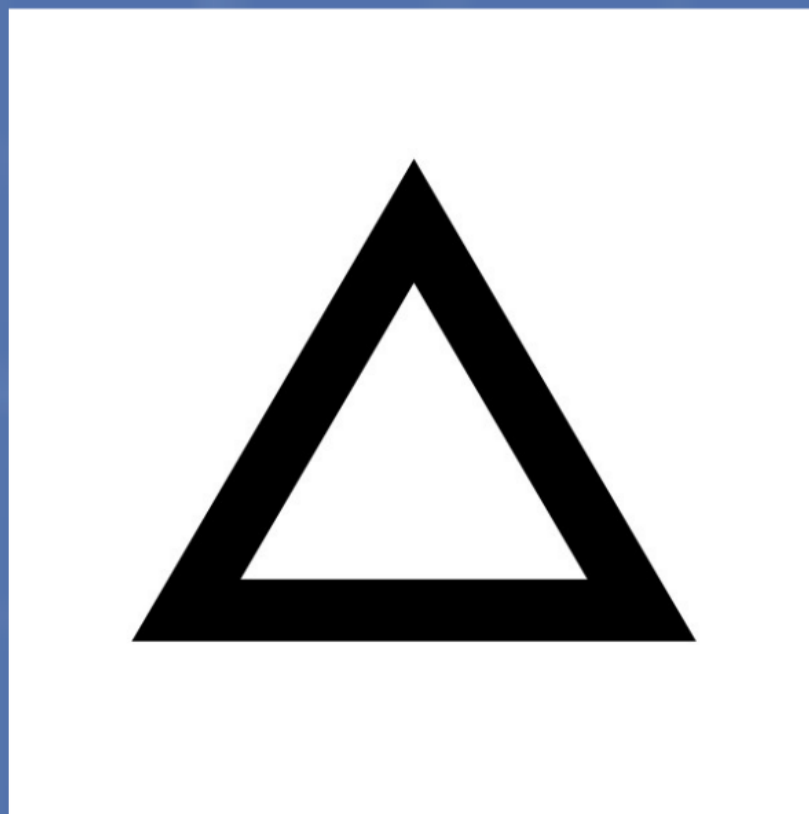
Famous Failure: Tacoma Narrows Bridge



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Can you name some structures with triangles in them?

# Forces

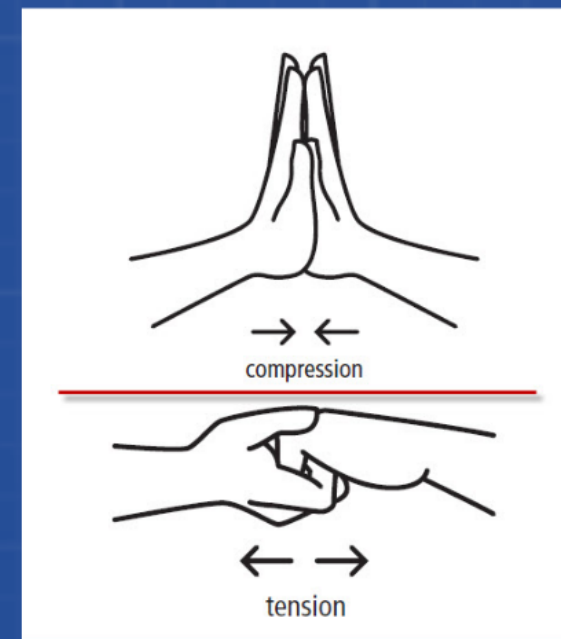
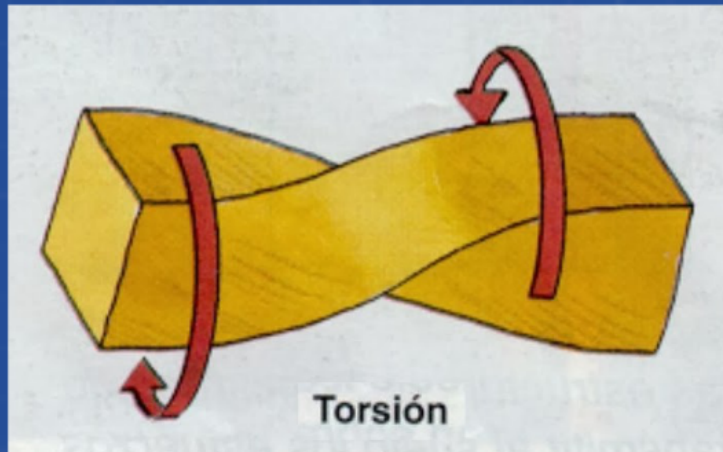
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- excessive loads during the building of the structure
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# Famous Failure: Tacoma Narrows Bridge



Why did it fail?

- "excessive flexibility"
- the solid plate girder and deck acted as an aerofoil causing drag and lift
- aerodynamic forces were little understood, bridges should have been tested in a wind tunnel.

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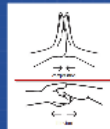


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