鋼構造物の設計 (2)
1.2 構造部材の形と力学的な考察

・構造物、構造部材の形は
力学的に決まるもの

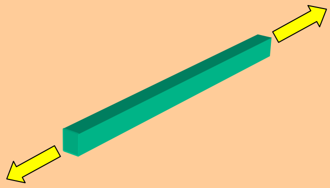
・構造力学＋構造材料＝
構造物の形状と
構造部材の断面形状

Eiffel Tower (1889)

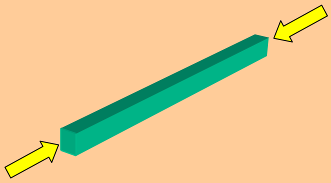
構造部材の力学

構造部材に作用する力
Types of Forces in Structural Components

引張　Tension



圧縮　Compression



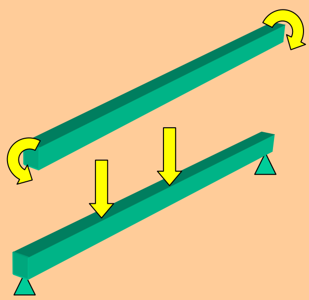
作用する力は複雑
支配的な力に対して部材耐力を決める。これが断面設計

構造部材に作用する力
Types of Forces in Structural Components

引張　Tension　Or　圧縮　Compression

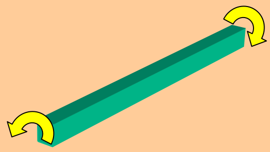
＋

曲げ　Bending

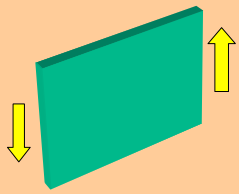


構造部材に作用する力
Types of Forces in Structural Components

ねじれ　Torsion

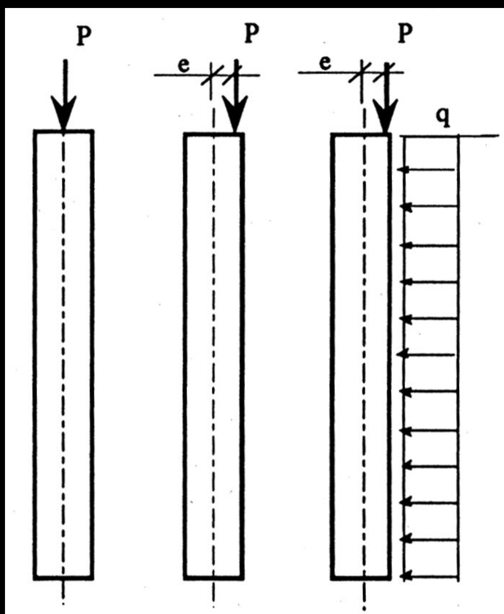


せん断　Shear



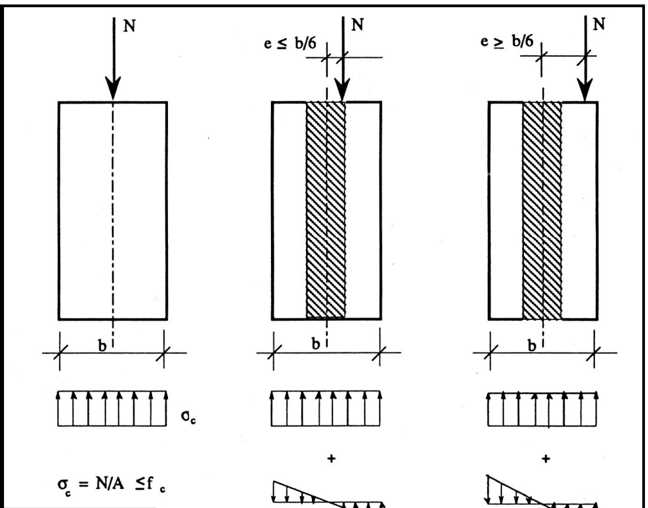
引張 or 圧縮　＋曲げ＋せん断＋ねじれ

柱部材における偏心荷重
A Column
with Eccentric Load

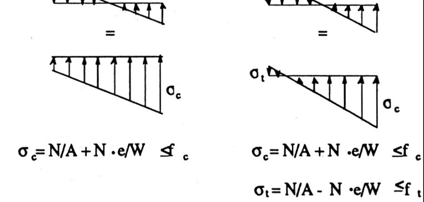


Eccentric Load

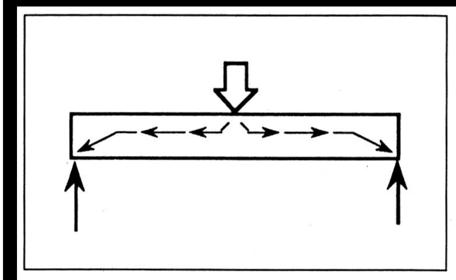
Concentric Load　Eccentric Load + Bending

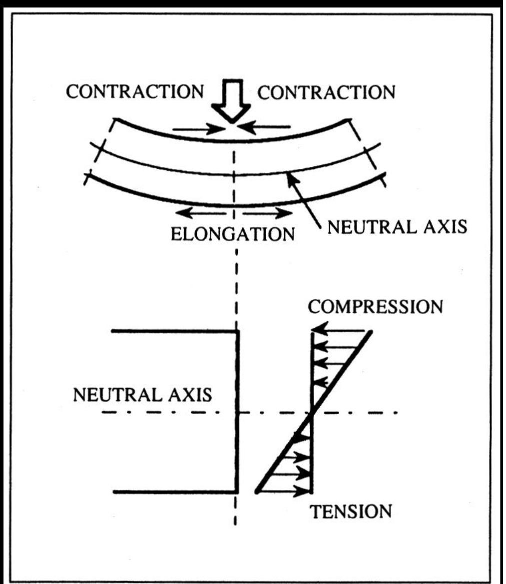


短柱における偏心荷重による応力
Stresses in A Short Column due to Eccentric Load

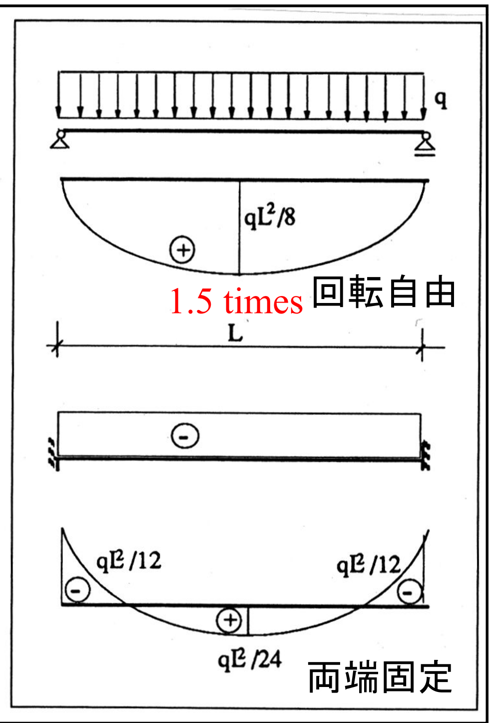


はりの曲げ
Bending of A Beam Element



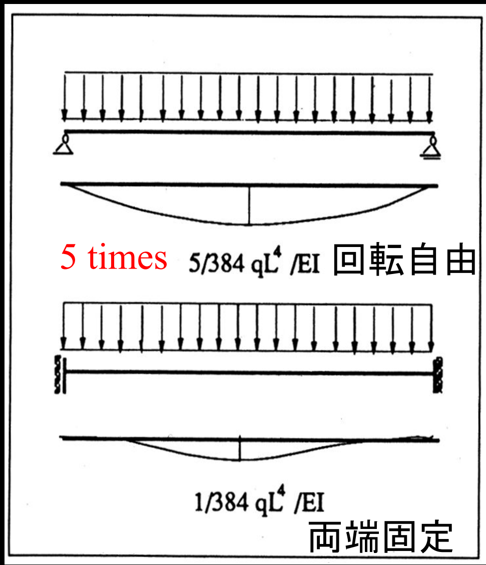


分布荷重を受けるはり
境界条件の影響
A Beam with distributed Load with Various Boundary Conditions



Moment-Diagram

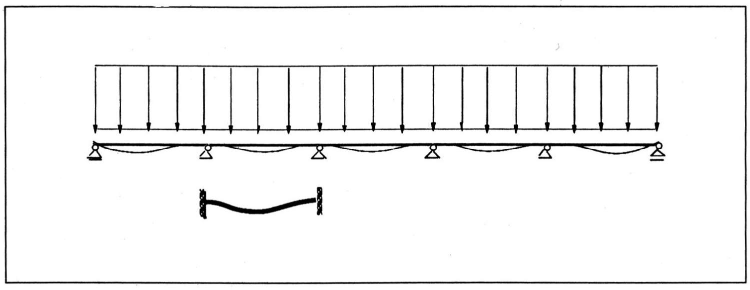
分布荷重を受けるはり
境界条件の影響
A Beam with distributed Load with Various Boundary Conditions



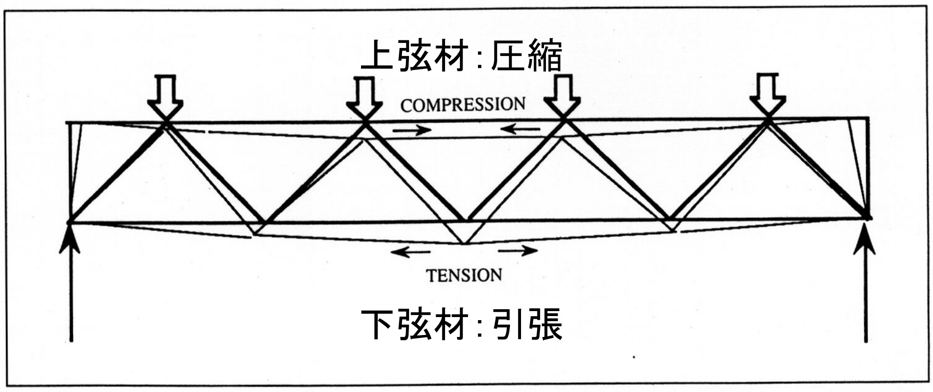
Deflection

分布荷重を受ける多径間連続はり
境界条件の影響
A Continuous Multi-Span Beam with distributed Loads

Continuous beam over several equal spans. With uniformly distributed load over the whole beam, an inner span will be prevented from rotating at the ends. These will therefore be subjected to bending moments equal to the beam with two fixed ends.

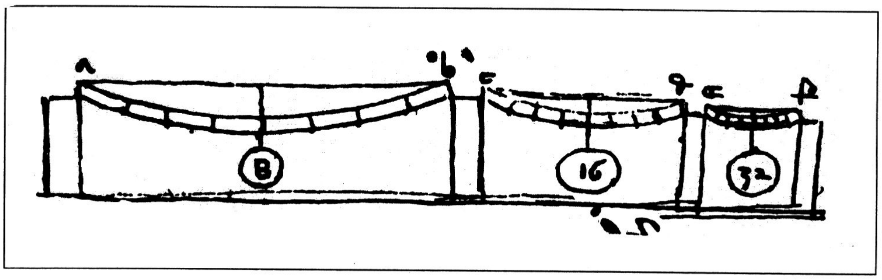


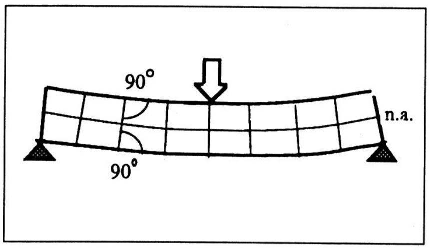
単純支持されたトラス
A simply supported truss structure



トラス桁 (Truss) ⇔ プレートガーダー (girder)
応力の流れは同様

Leonardo da Vinciによるはり耐力の考え方





Perpendicular cross sections of the beam will also be perpendicular after the beam is bent.

力学的に形状が決定される構造例(1)

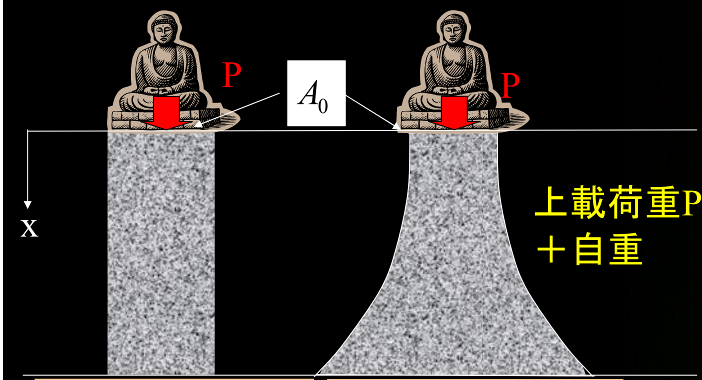
Determination of Shapes of Structural Components Based on Mechanics


Eiffel Tower (1889)


Tokyo Tower

力学的に形状が決定される構造例(1)

Determination of Shapes of Structural Components Based on Mechanics



$$A(x) = A_0 = const.$$
$$\sigma(x) = \sigma_0 + wx$$

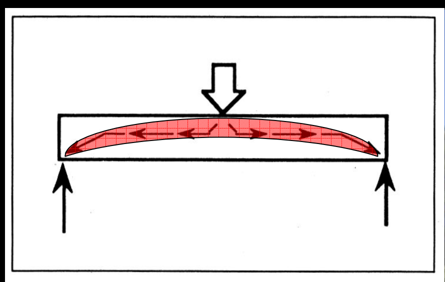
$$A(x) = A_0 \exp(\frac{w}{\sigma_0}x)$$
$$\sigma(x) = \sigma_0 = const.$$

このような形を自然に学んだ

Tokyo Tower

力学的に形状が決定される構造例(3)

Determination of Shapes of Structural Components Based on Mechanics



アーチ構造, ドーム構造

石造で長スパンを考えると
アーチになる

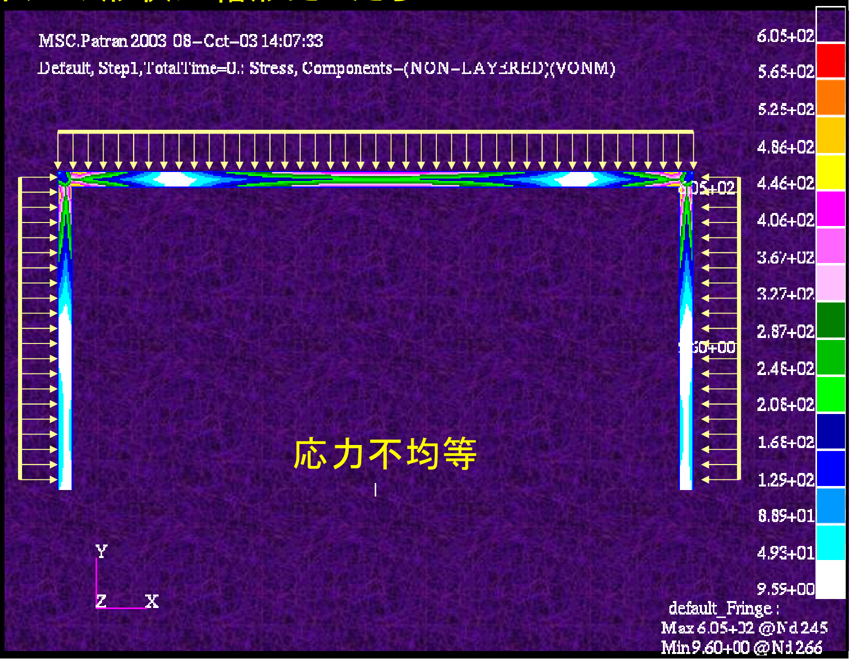
通潤橋(1854)

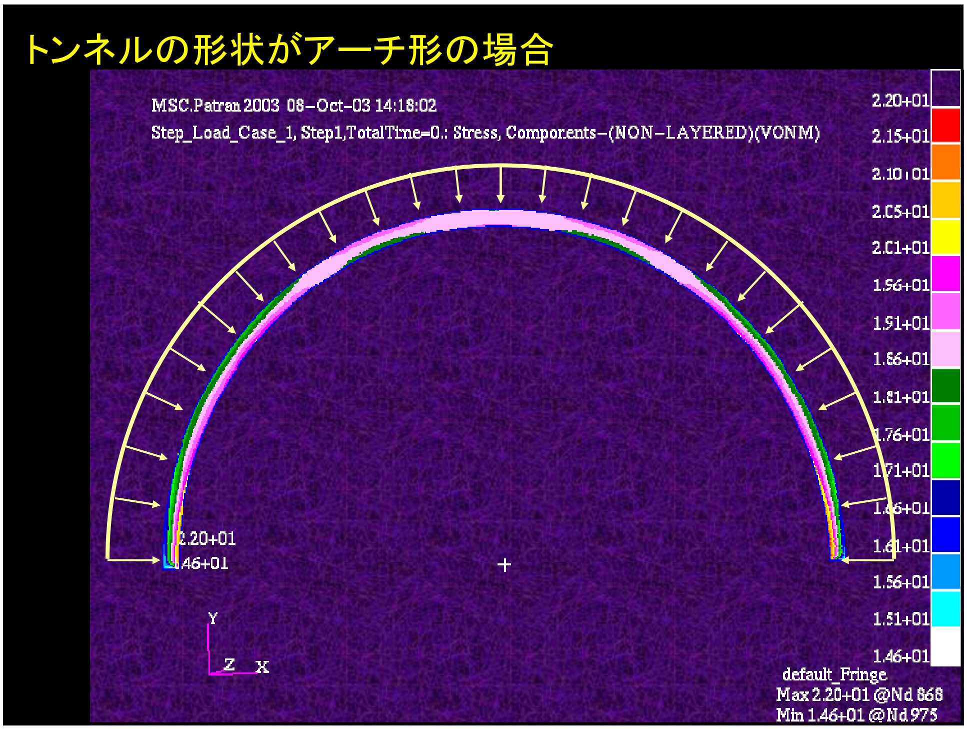
力学的に形状が決定される構造例(2)

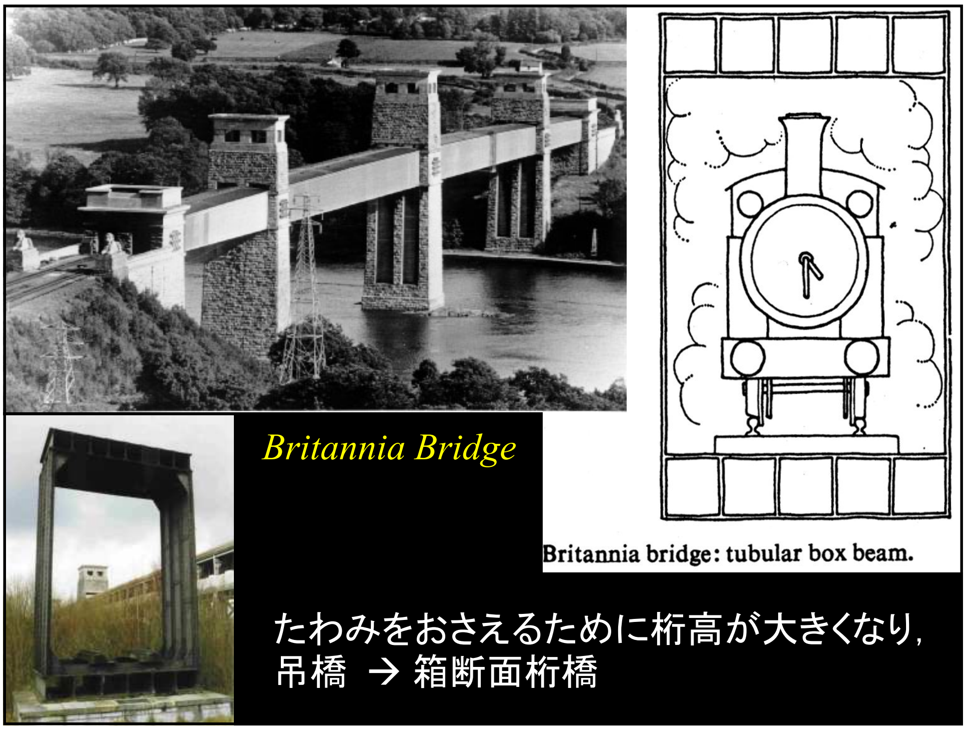
Determination of Shapes of Structural Components Based on Mechanics

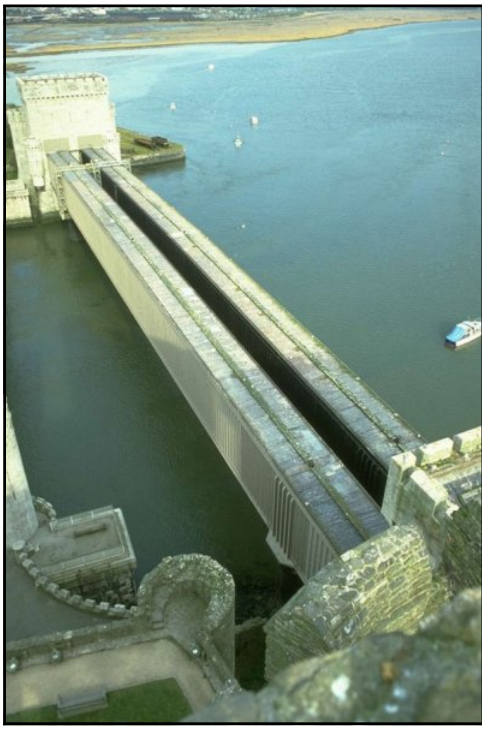
Tunnel

トンネルの形状が箱形だったら・・・




トンネルの形状がアーチ形の場合
MSC.Patran 2003 08-Oct-03 14:18:02
Step_Load_Case_1, Step1,TotalTime=0.: Stress, Components-(NON-LAYERED)(VONM)
2.20+01
2.15+01
2.10+01
2.05+01
2.01+01
1.96+01
1.91+01
1.86+01
1.81+01
1.76+01
1.71+01
1.66+01
1.61+01
1.56+01
1.51+01
1.46+01
2.20+01
1.46+01
Y
Z X
default_Fringe
Max 2.20+01 @Nd 868
Min 1.46+01 @Nd 975


Britannia Bridge
Britannia bridge: tubular box beam.
たわみをおさえるために桁高が大きくなり，
吊橋 → 箱断面桁橋

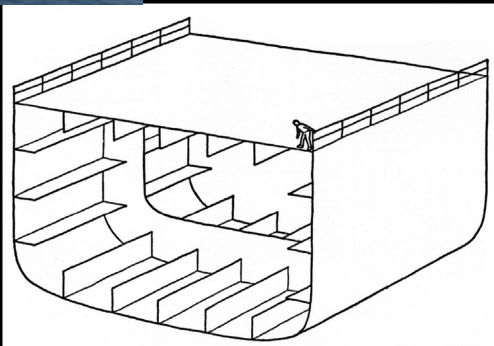


Conway Bridge

日本丸

- ■総トン数／21,903トン
- ■全長／166.6m
- ■全幅／24.0m
- ■客室数／202室
- ■乗客数／600名
- ■就航年：1990年

断面の構成は
箱断面の桁橋と同じ

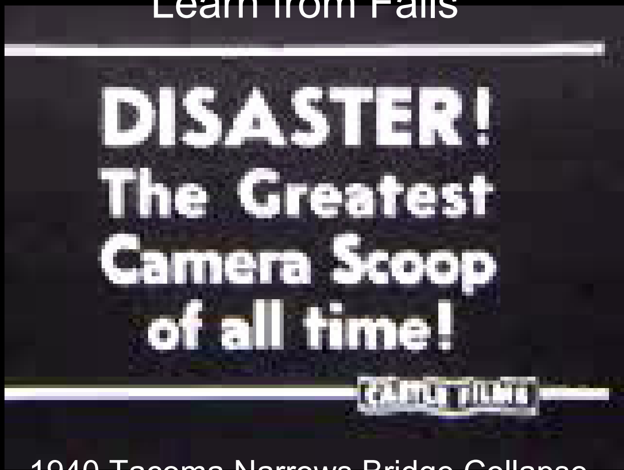


Engineering shell structures such as ships and aircraft generally use both stringers and ribs or bulkheads. This is a diagram of the Isherwood construction often used in oil tankers.

鋼構造物の設計 2004

1.3 鋼構造物の限界状態と破壊事例

Learn from Fails



1940 Tacoma Narrows Bridge Collapse

失敗の積み重ねにより工学は進歩

http://www.enm.bris.ac.uk/research/nonlinear/tacoma/

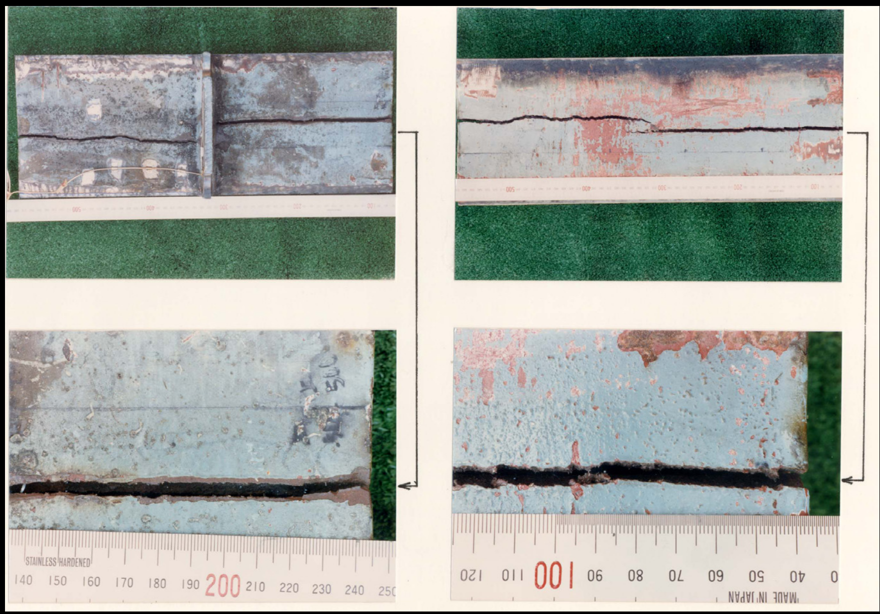
2000 Brittle Fracture
In Hoan Bridge

損傷事例と原因

- **Yielding**
  Material Properties
- **Structural Instability**
  Vibration induced by wind or pedestrian
  Unexpected lateral movement during erection
  Buckling
- **Fracture**
  Fatigue
  Earthquakes

Fatigue and Fracture

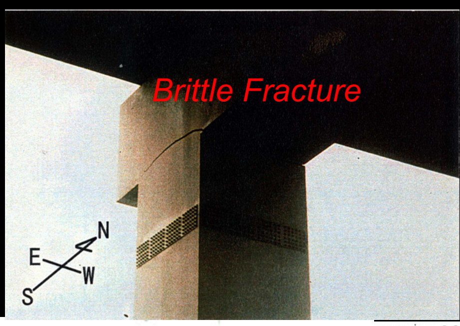
Imperfect butt-welding of bottom flanges

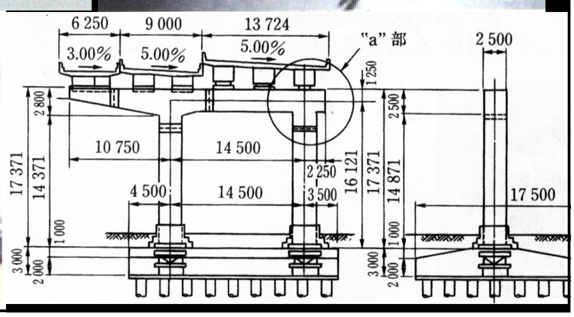


Damage Cases in Hyogo-ken Nanbu Earthquake

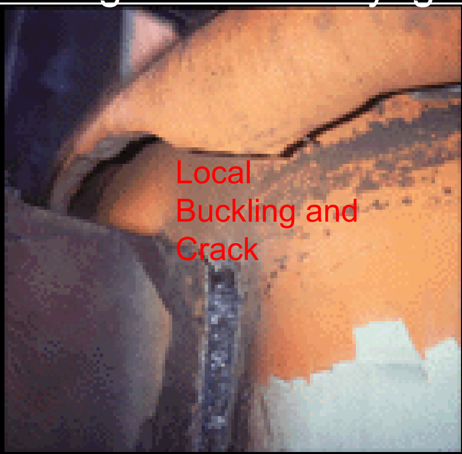
Damage Cases in Hyogo-ken Nanbu Earthquake

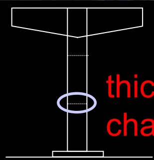
Damage Cases in Hyogo-ken Nanbu Earthquake





Damage Cases in Hyogo-ken Nanbu Earthquake

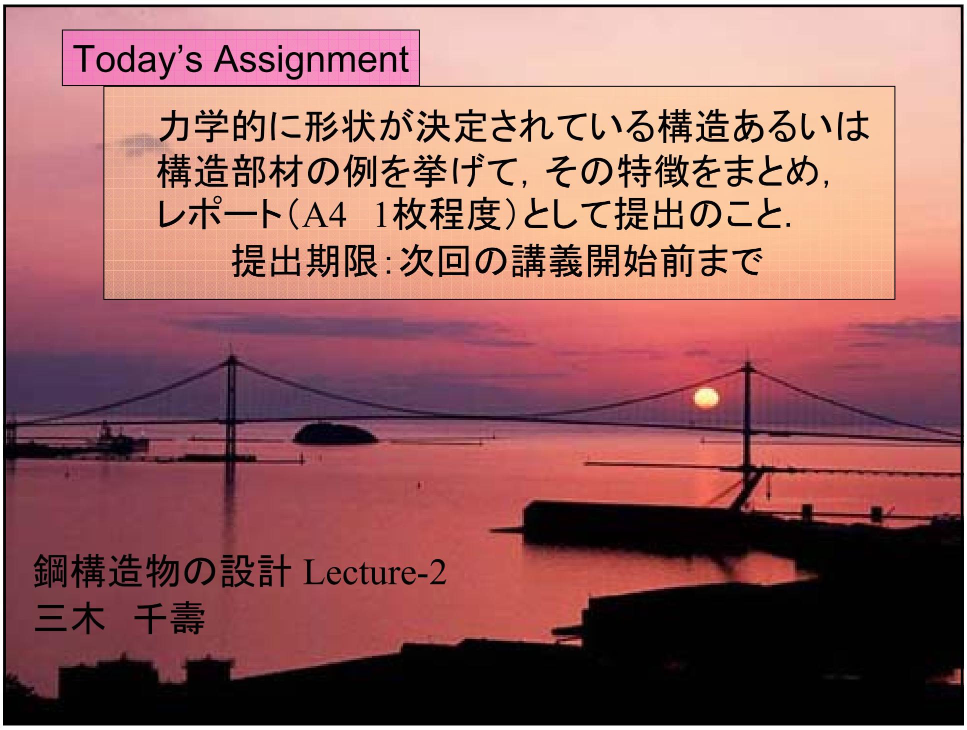




来週の話題

鋼構造物の設計 2004

1.4 設計で考慮する荷重、外力


Today’s Assignment
力学的に形状が決定されている構造あるいは
構造部材の例を挙げて，その特徴をまとめ，
レポート（A4　1枚程度）として提出のこと.
提出期限：次回の講義開始前まで
鋼構造物の設計 Lecture-2
三木　千壽