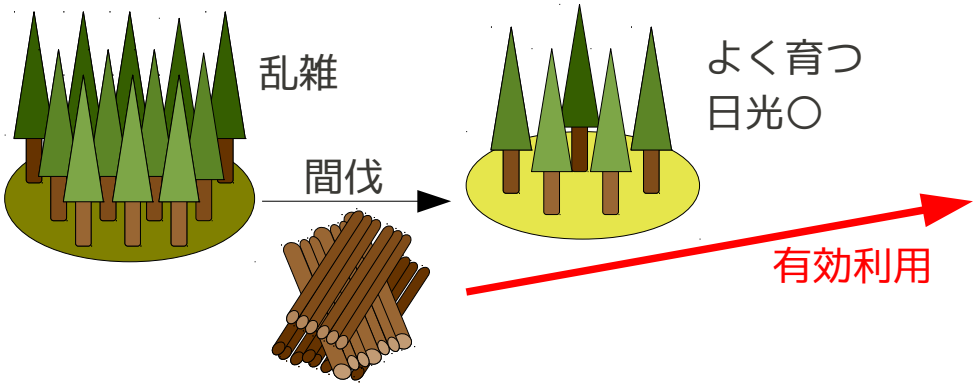
プレストレス木箱桁橋のFEMモデル化について

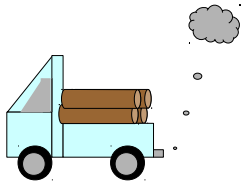
修工12-136　上村哲範

現地製材・組み立て・施工



腐ってCO2

工場に運んでから製材



運搬CO2とコスト削減

一日で簡単に組み立てられる

応急橋にも向いている

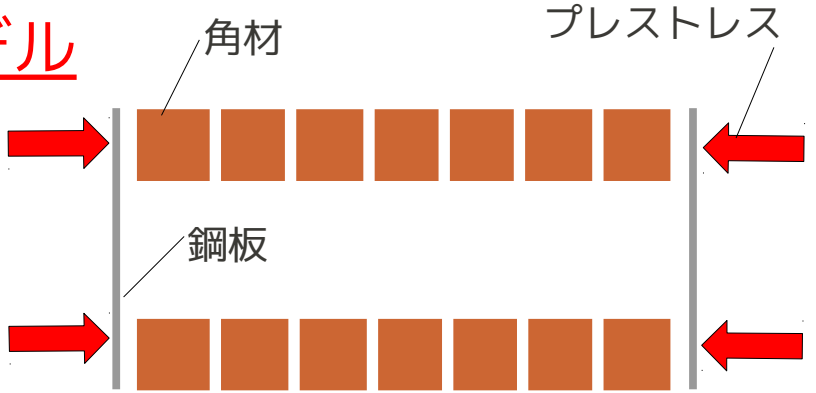
被災地でも活躍

試験体のFEMモデル化

数値解析シュミレーション

非一体化モデル

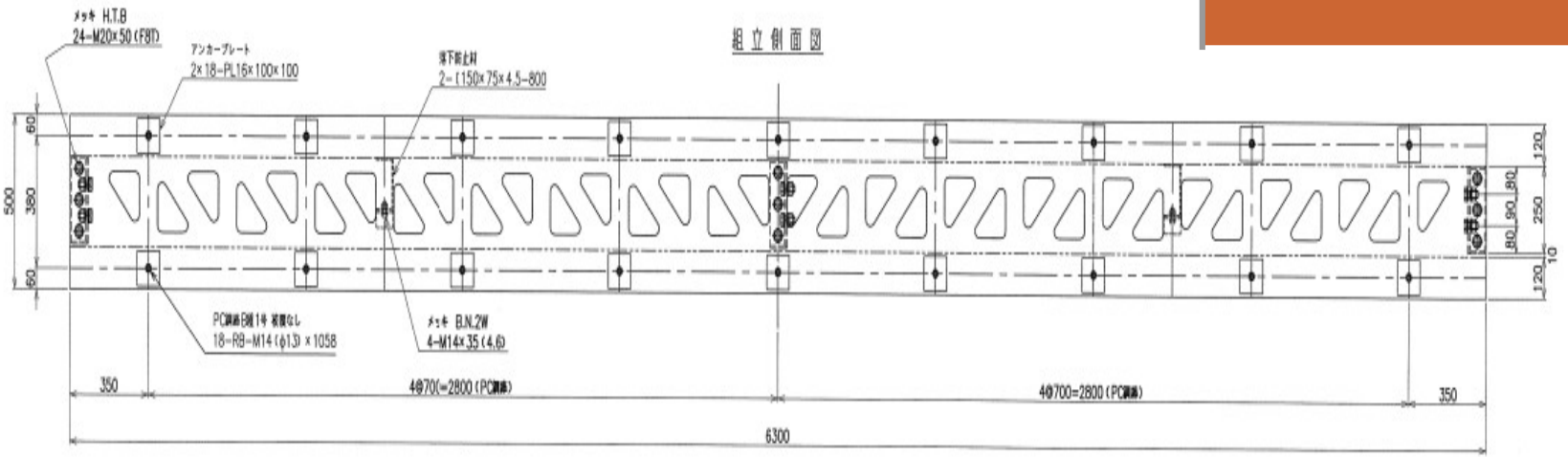
モデル化難しい

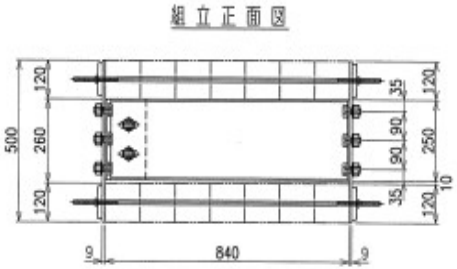


比較

一体化モデル

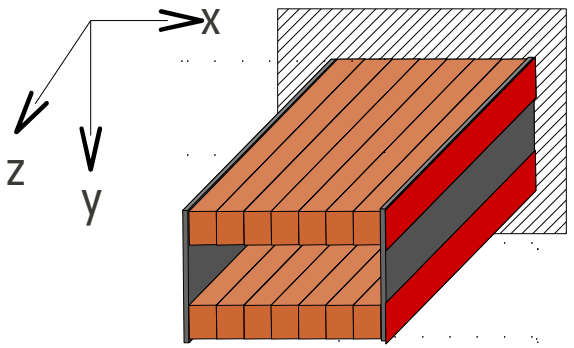
モデル化簡単



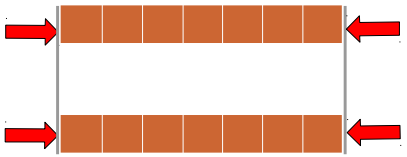


有限要素解析モデル

非一体化モデル

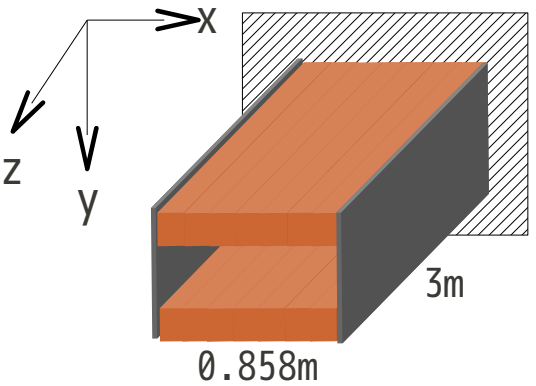


プレストレスあり



摩擦係数あり

一体化モデル

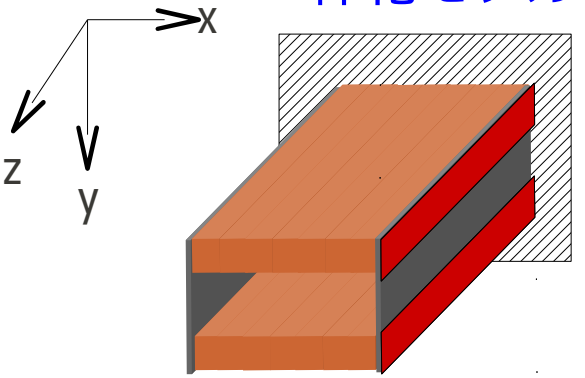


プレストレスなし

鋼板
ヤング率...206GPa

木材
ヤング率...6.9GPa

一体化モデル

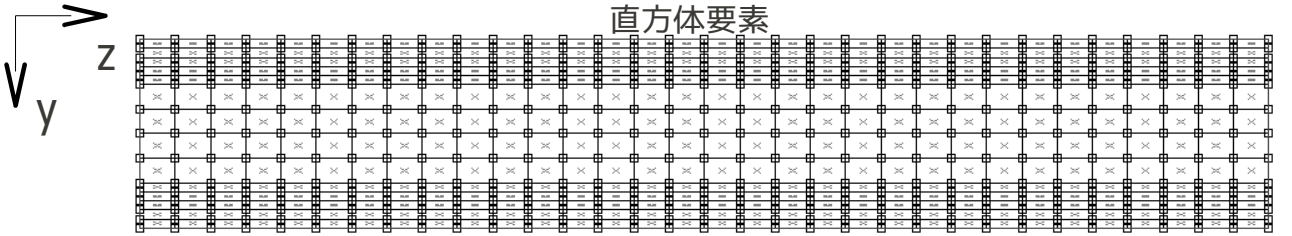


プレストレスあり

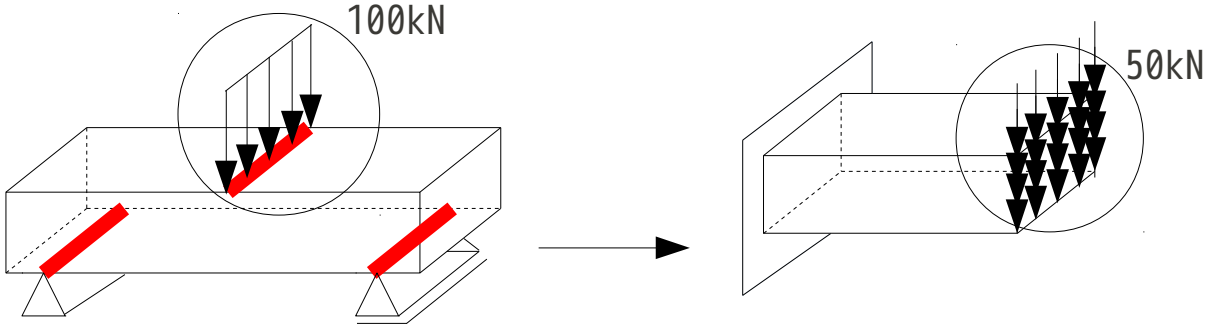
試験体

↓

解析...プレストレス相当の分布外力



境界条件・載荷条件

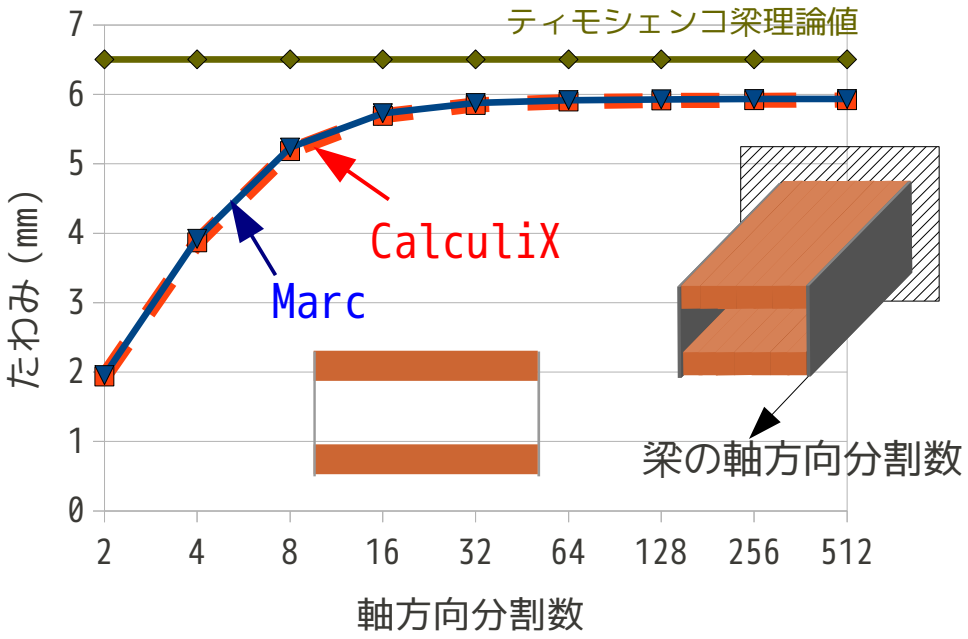


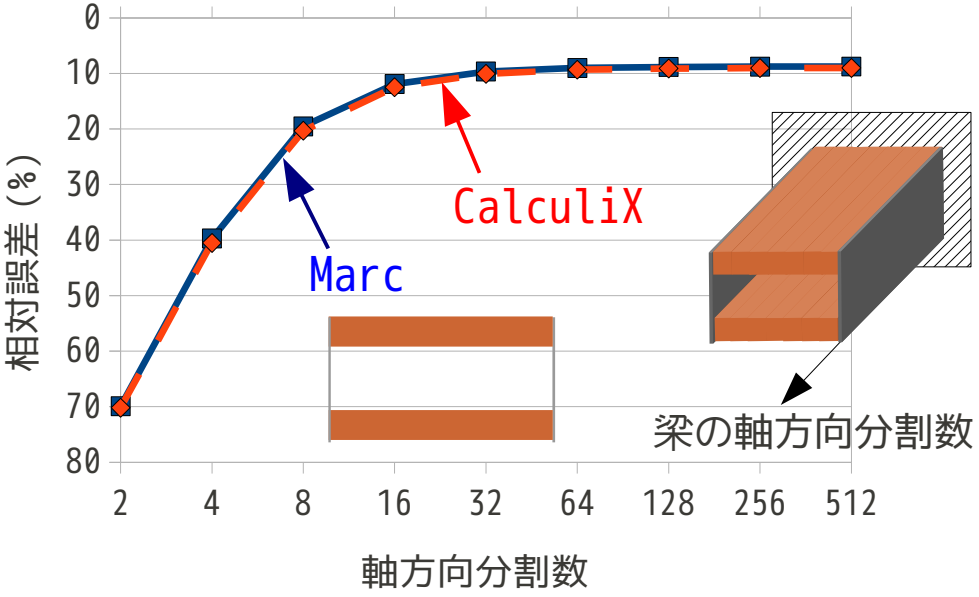
$$\frac{50\text{kN}}{\text{載荷断面の全節点数}} \rightarrow$$

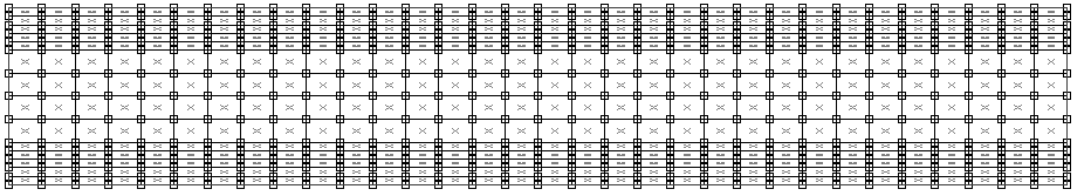
載荷断面
各節点に一様載荷

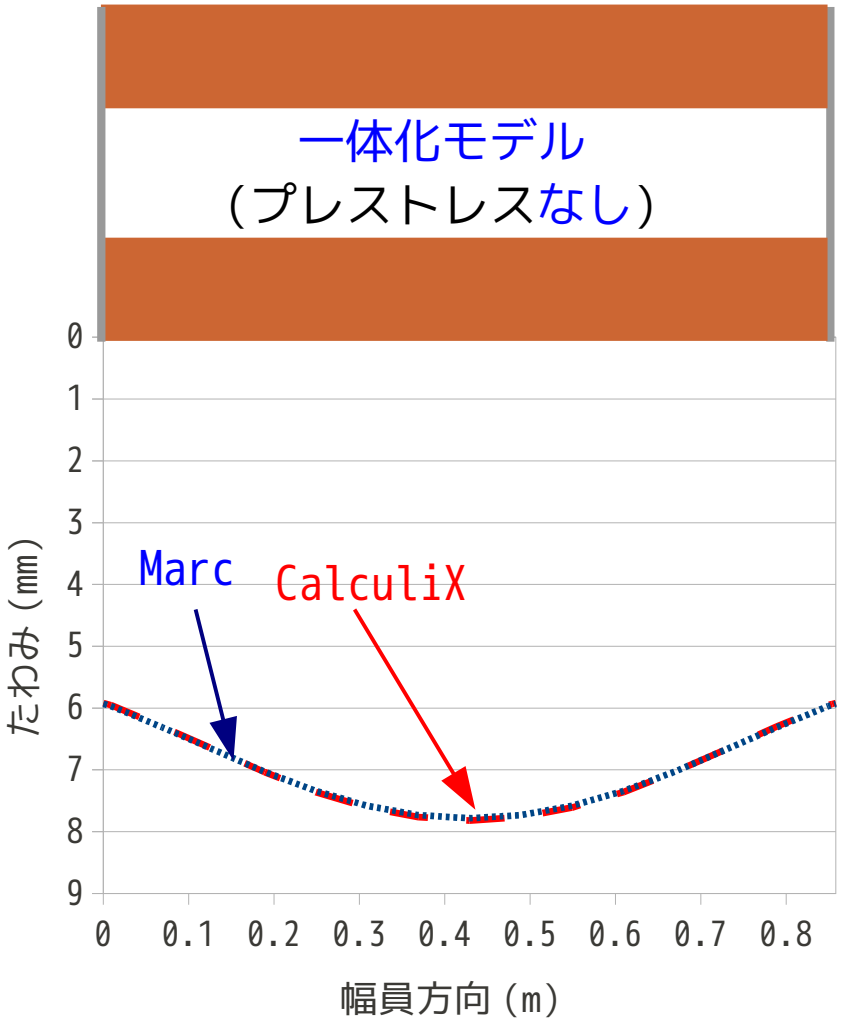
非一体化モデルと一体化モデルの比較する前に...

CalculiXとMarcの精度比較





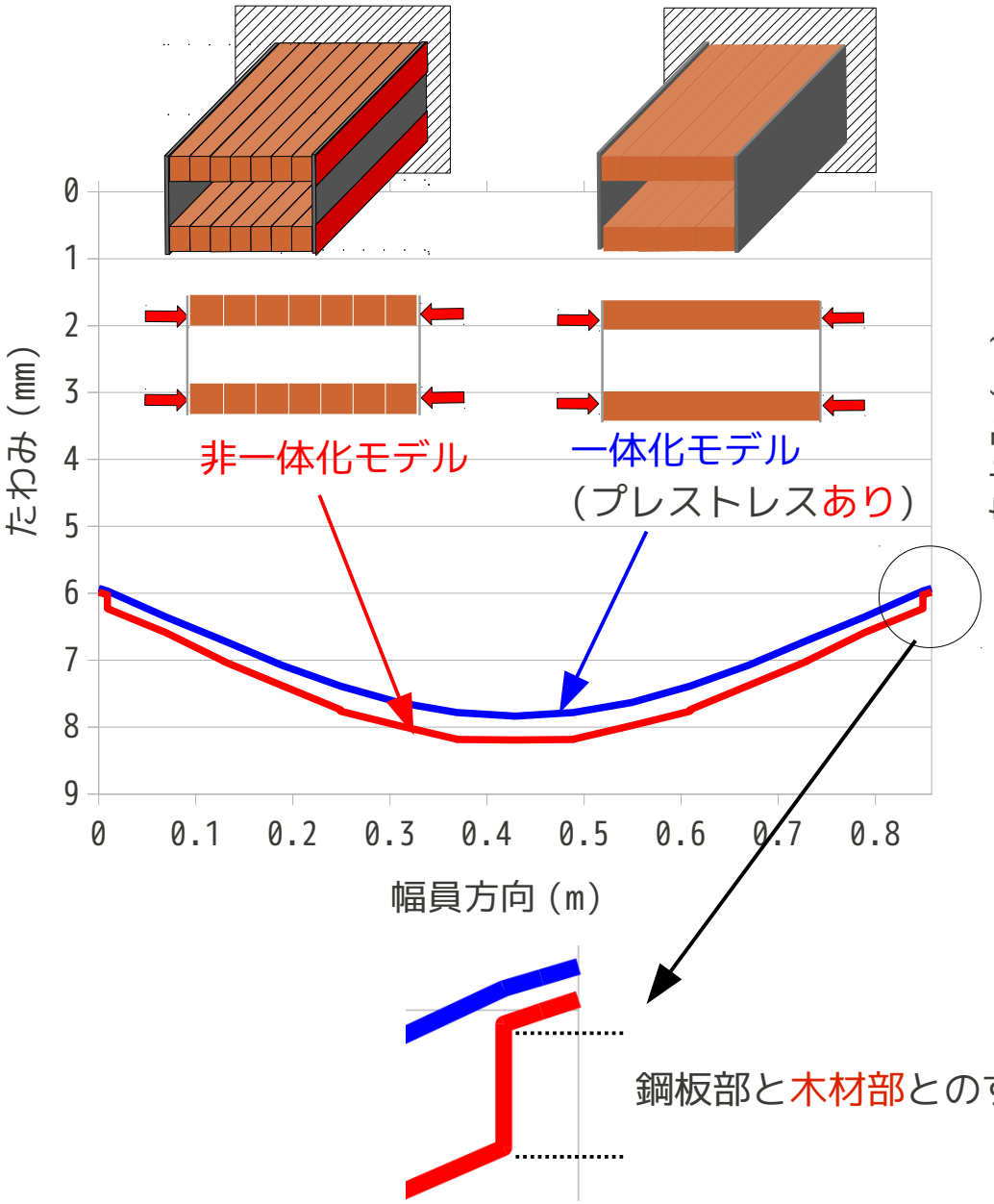


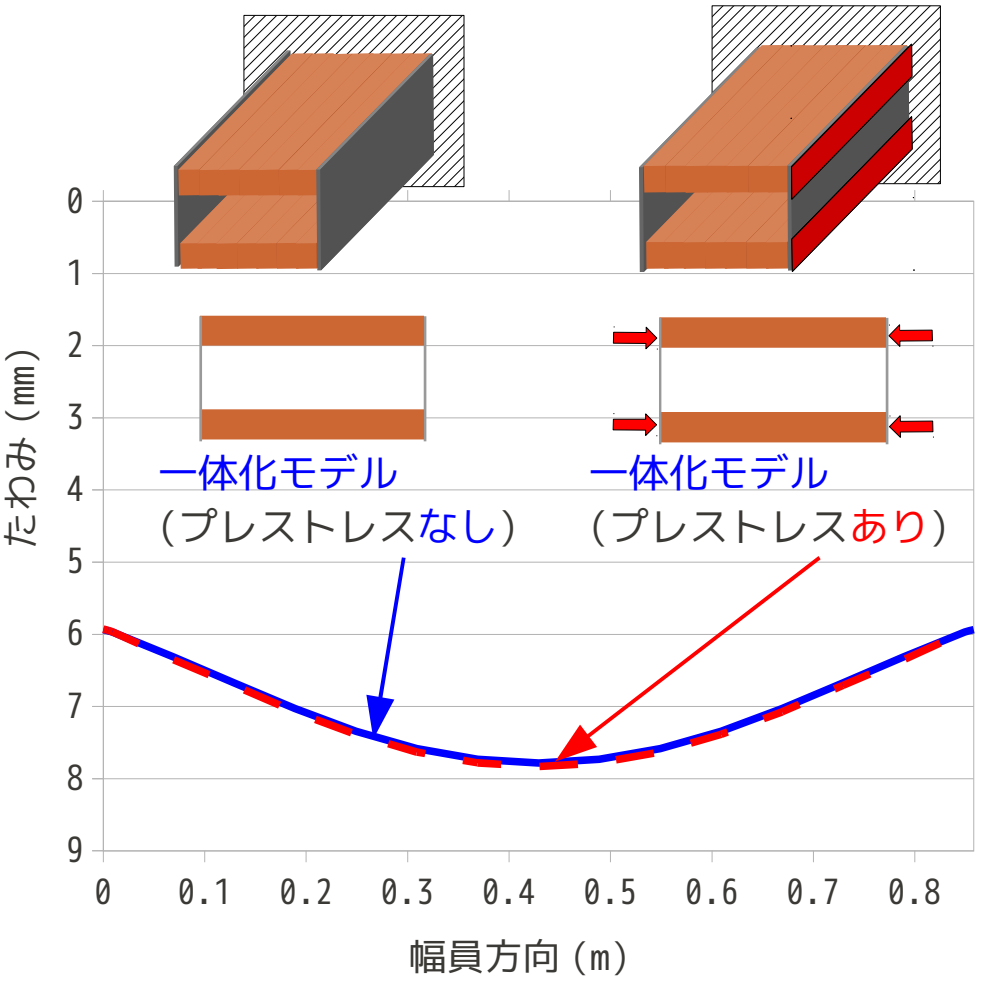


以下、解析はMarcを用いる

たわみと幅員方向の関係

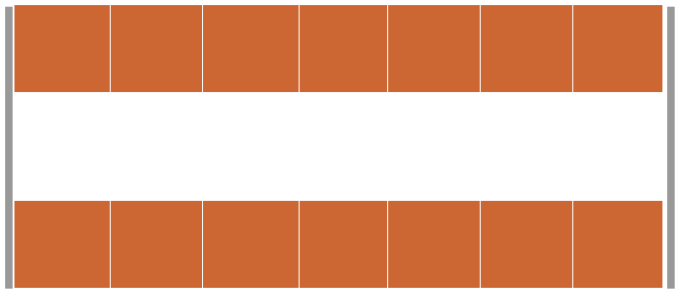
摩擦係数0.4





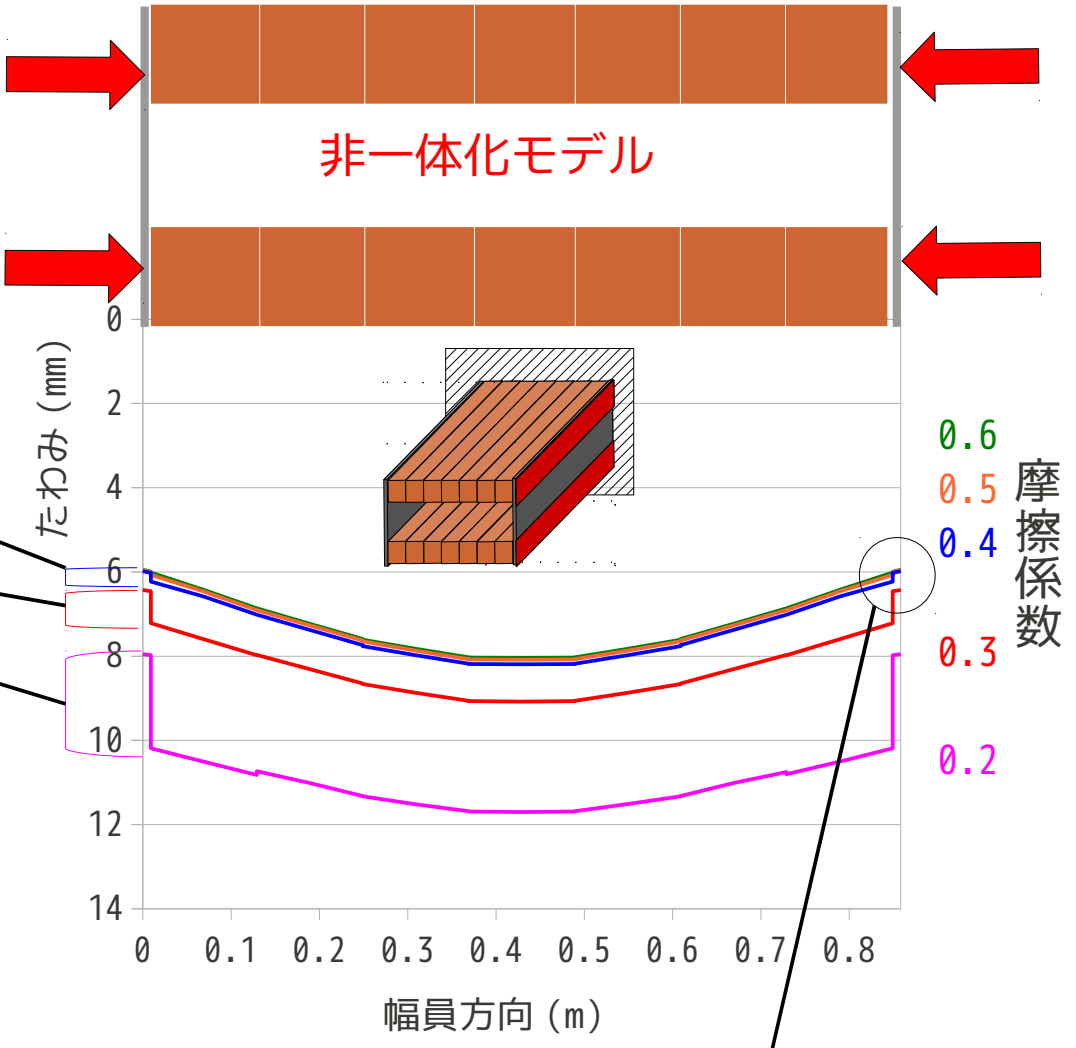
鋼板部と木材部とのずれ

摩擦係数を変化させると...

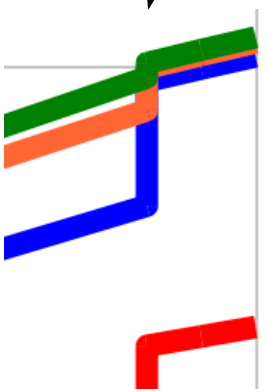


プレストレスなしの状態で

異種材料摩擦係数
- 木材と鋼材
  - →0.6(乾)～0.2(湿)
- 木材と木材
  - →0.5(乾)～0.2(湿)
- 鋼材と鋼材
  - →0.8(乾)～0.2(湿)



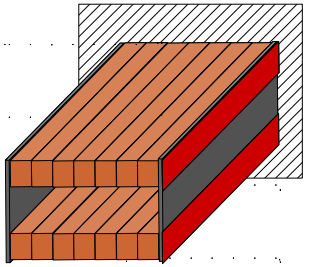
載荷断面からどのように？
全体的に？FEM特有の部分的に？

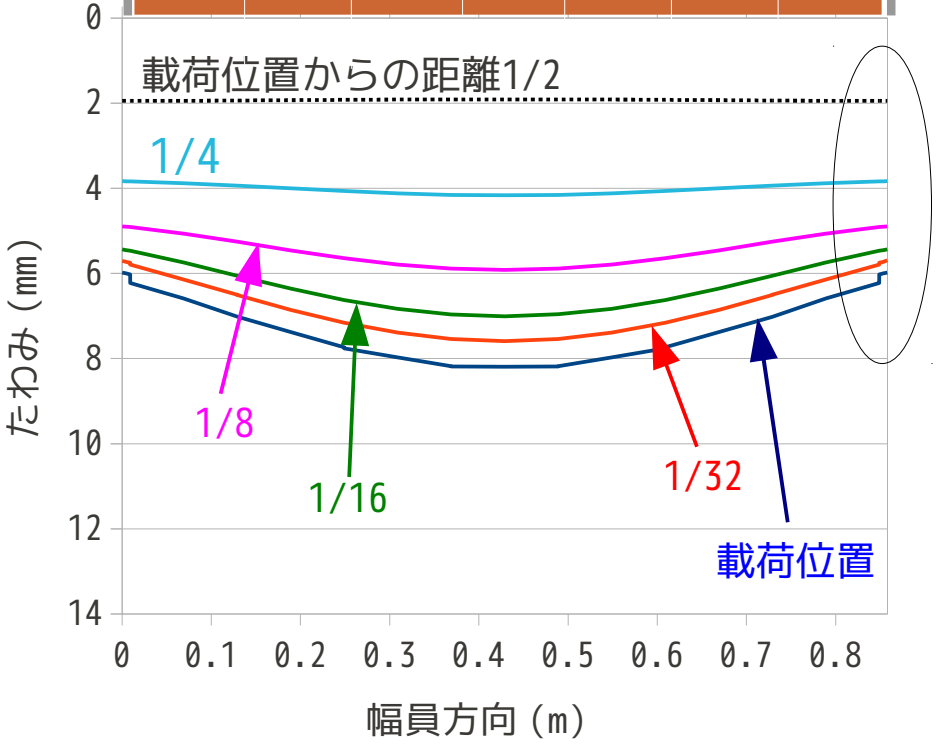


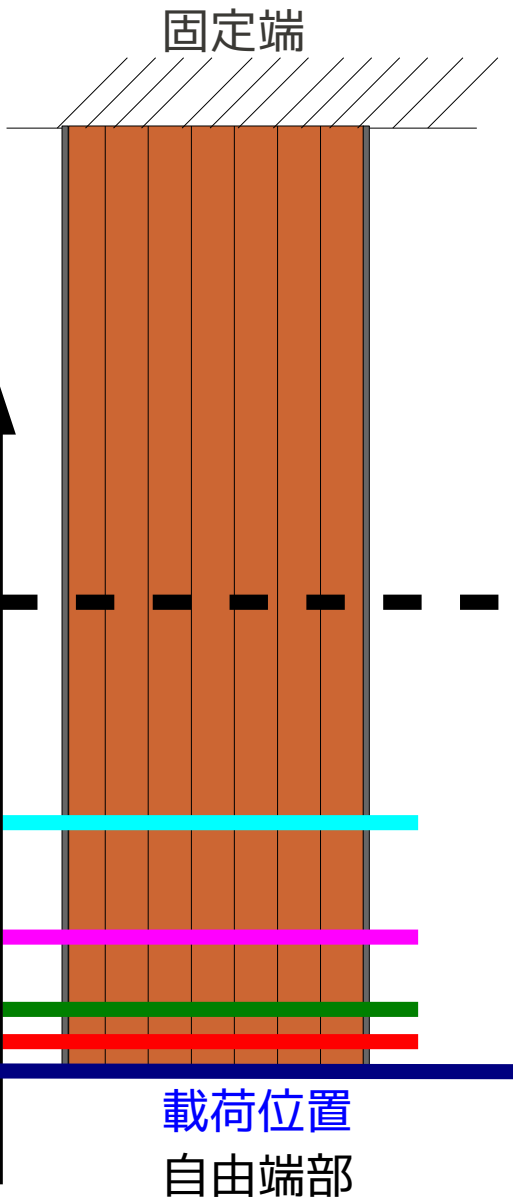
載荷位置からの距離別

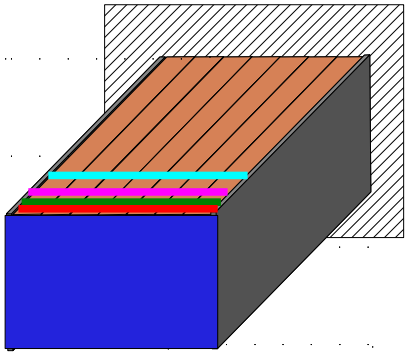
たわみと幅員方向の関係

非一体化モデル

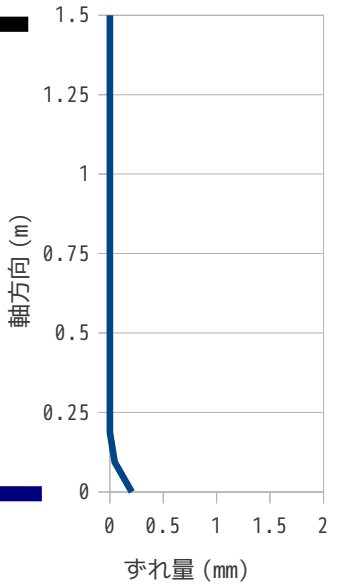




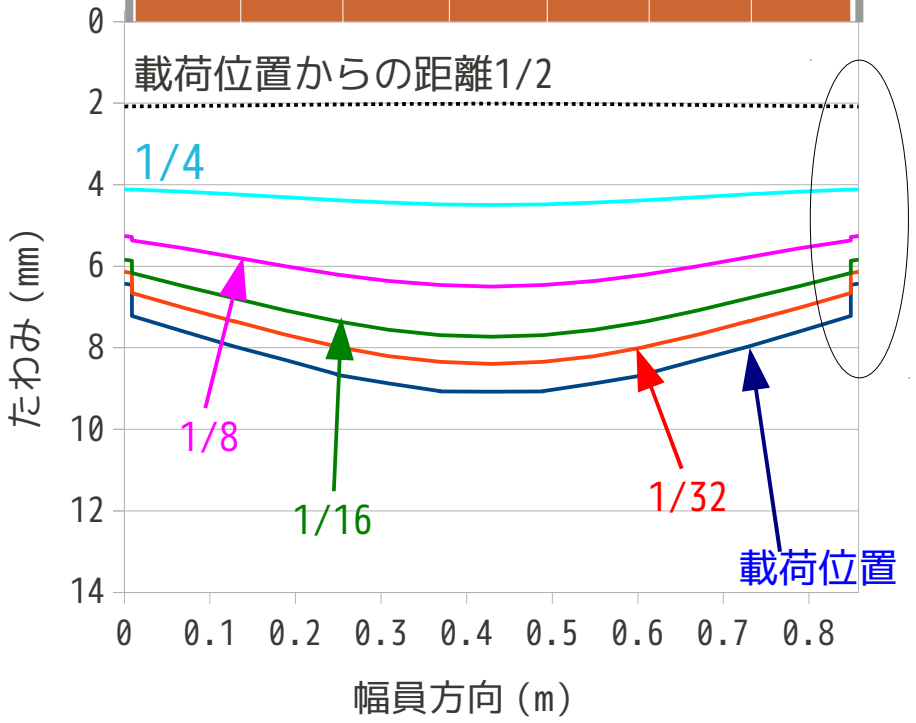


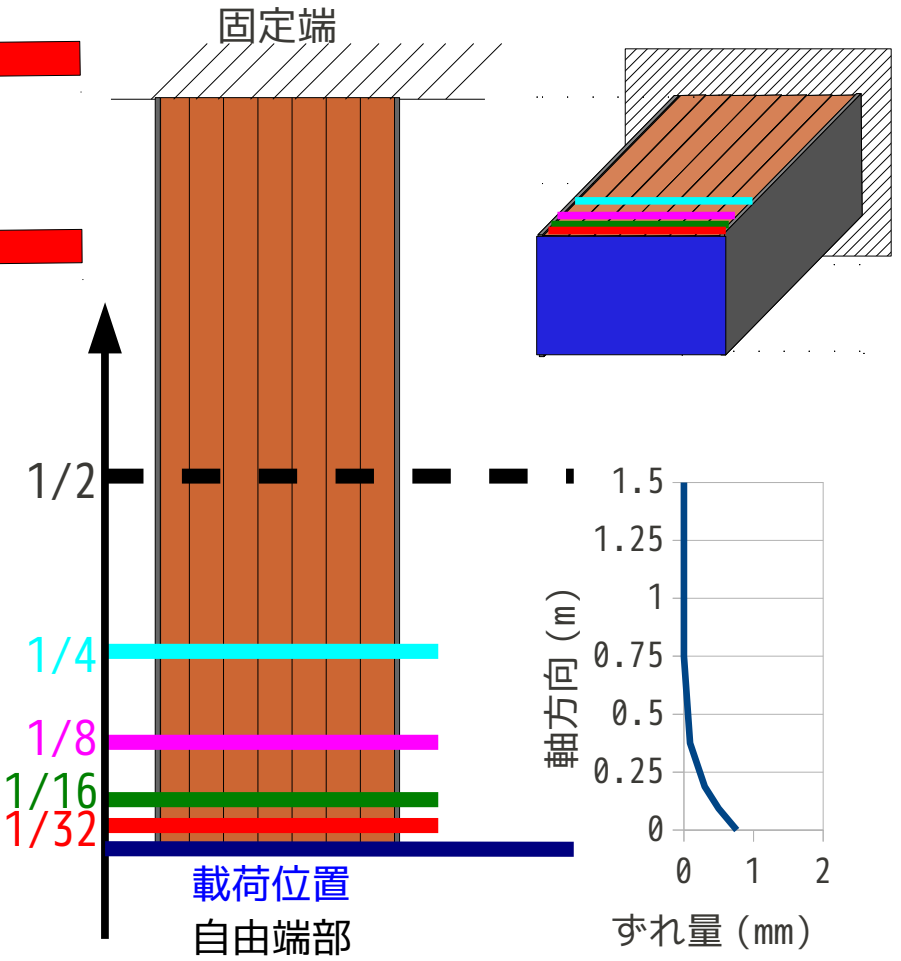


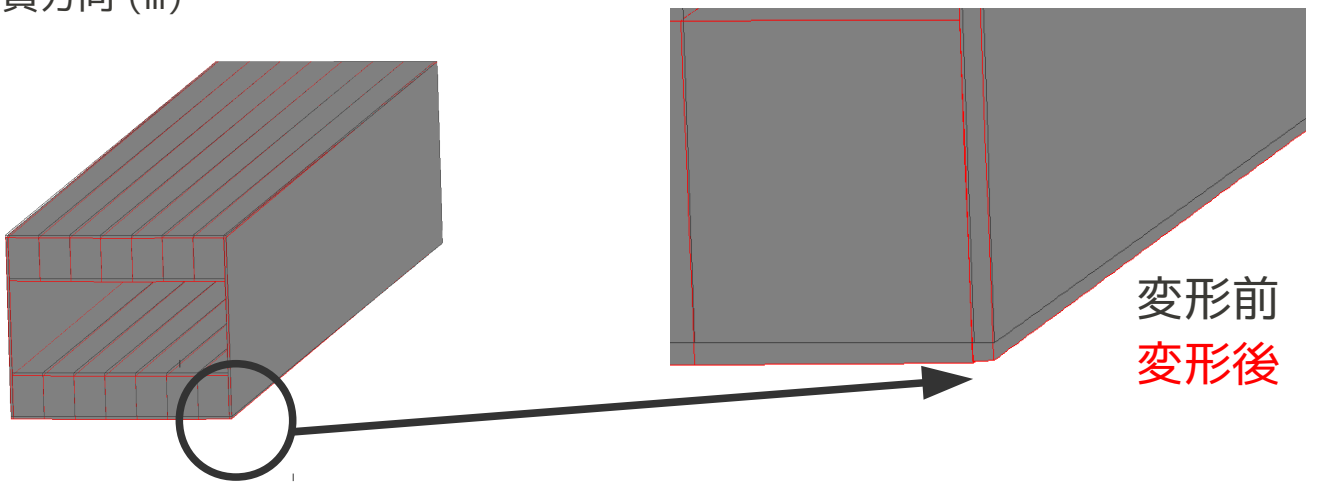
載荷断面



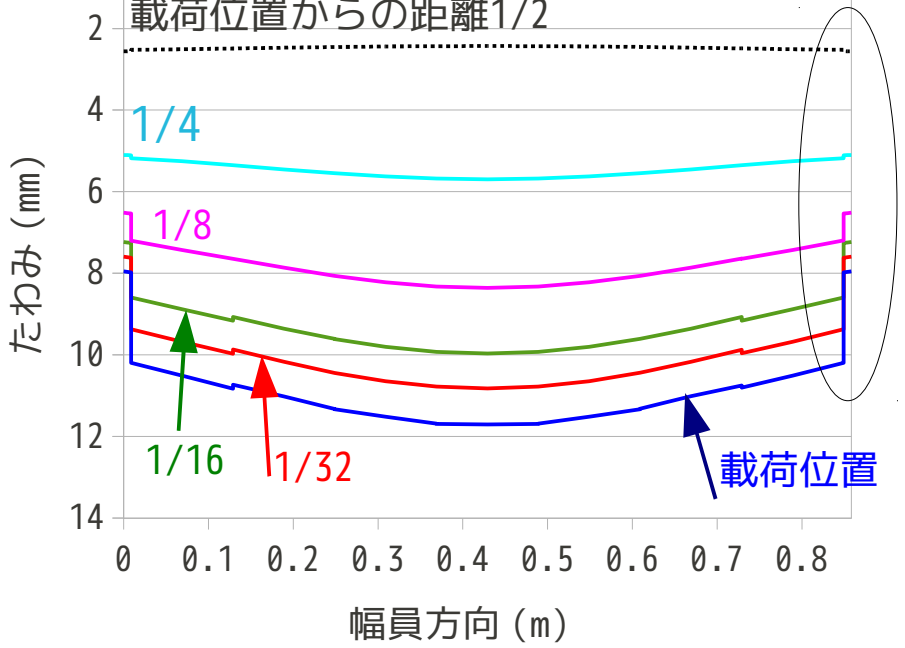
載荷位置からの距離別　たわみと幅員方向の関係

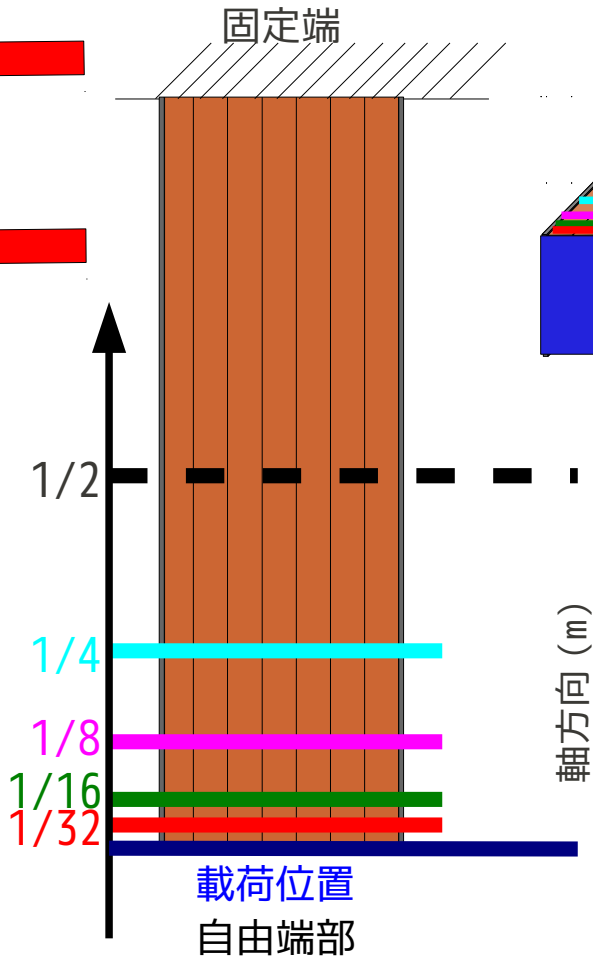


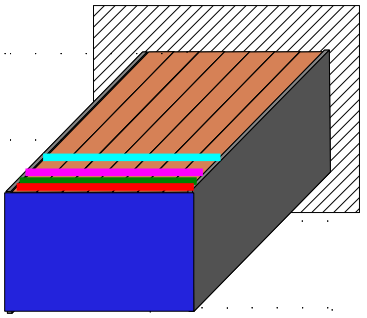


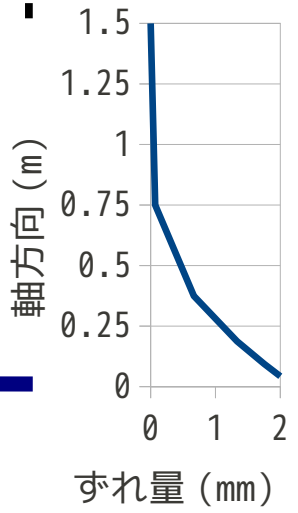


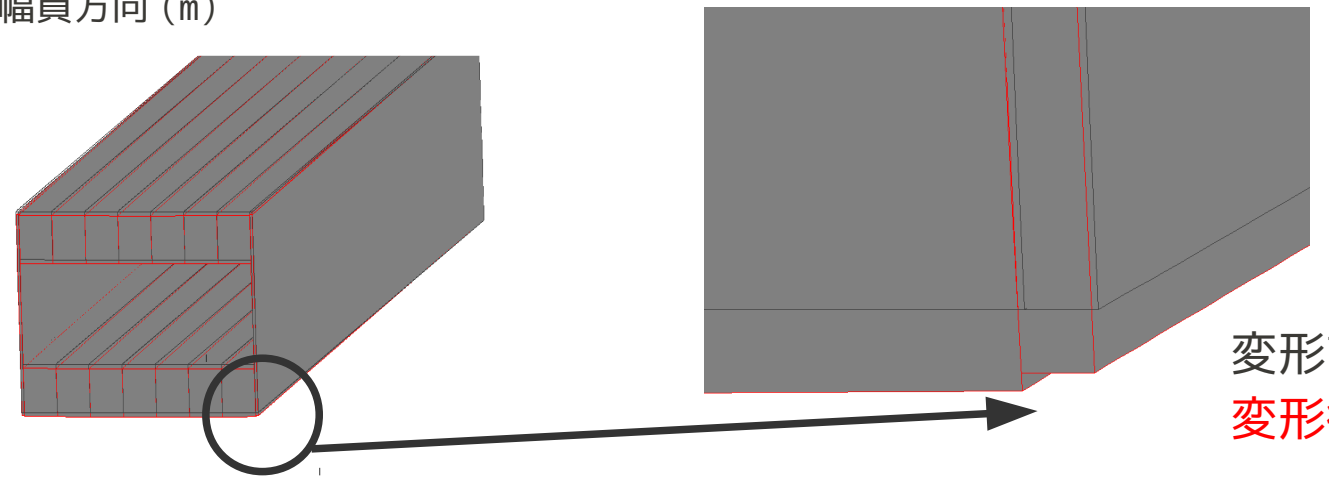
載荷位置からの距離別　たわみと幅員方向の関係



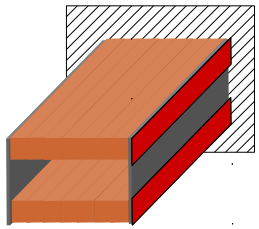




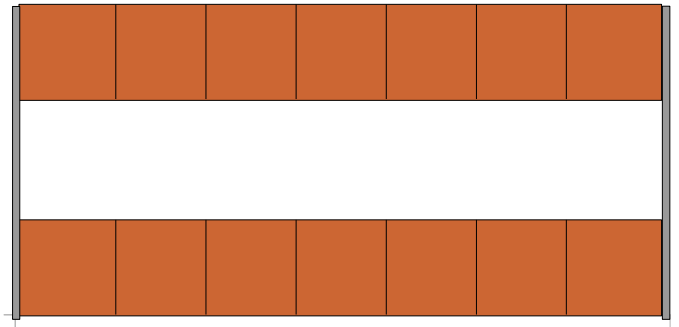


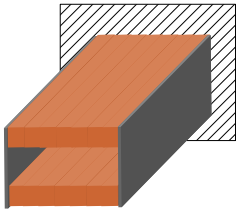


FEM解析と実験値の比較



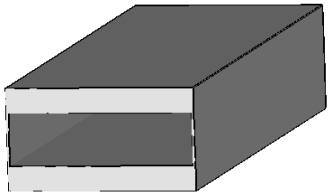
Marc
一体化モデル
プレストレスあり

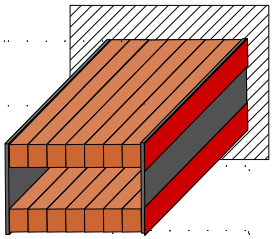


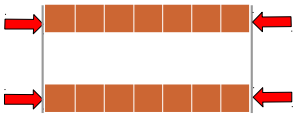


Marc
一体化モデル
プレストレスなし

CalculiX

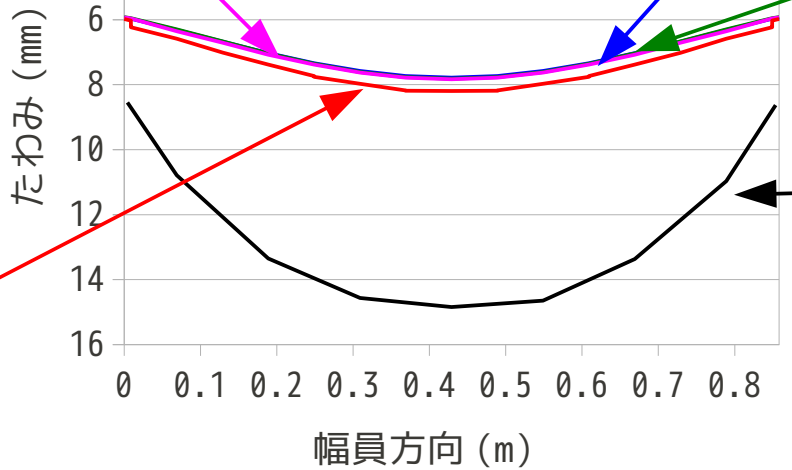






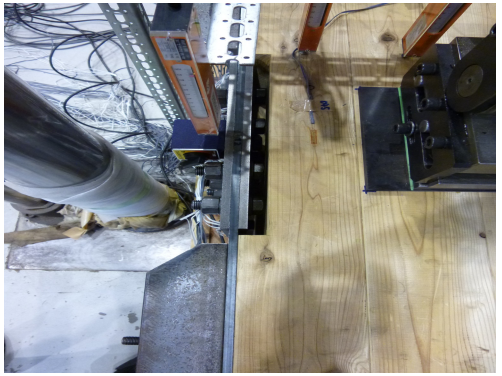
Marc
非一体化モデル

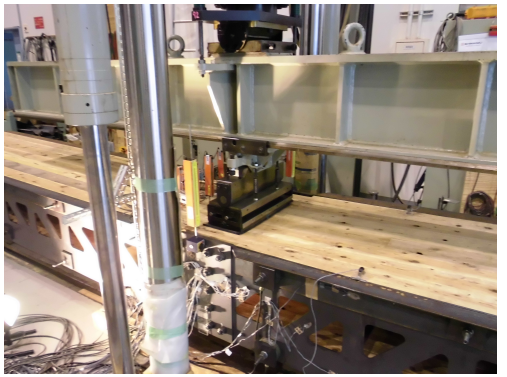
摩擦係数0.4



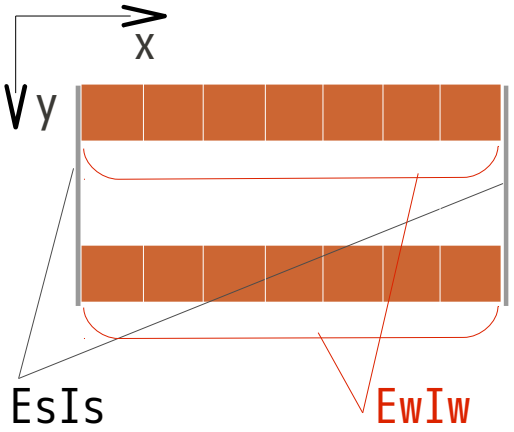
実験値

通常の載荷試験 → 荷重2倍 → 破壊試験





解析上、ずれを起きにくくしても...

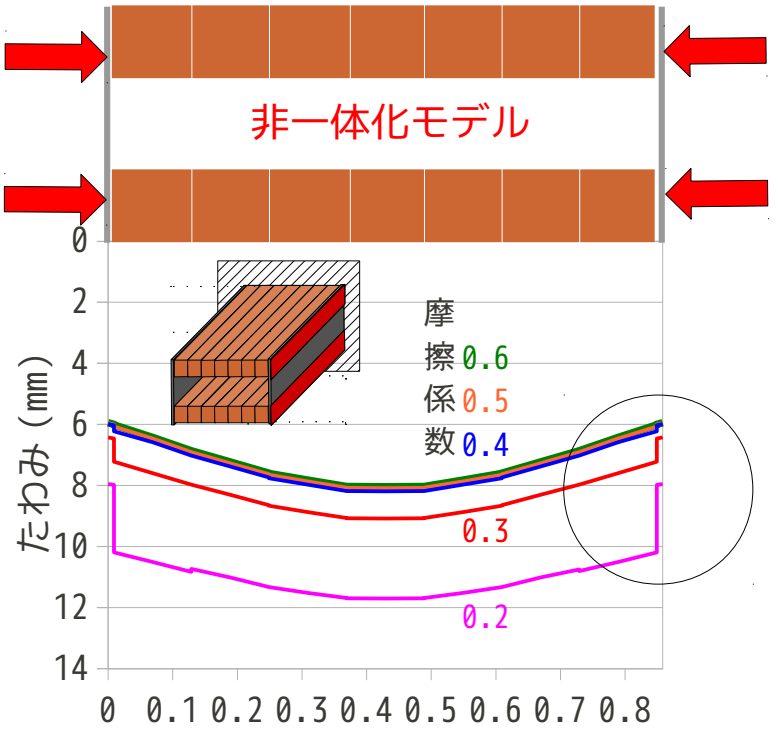


鋼板部と木材部とのずれ

↓

EsIs > EwIw

一様に載荷



剛性比で荷重を配分して載荷

$$0.61 = \frac{EsIs}{EsIs+EwIw} \times P$$

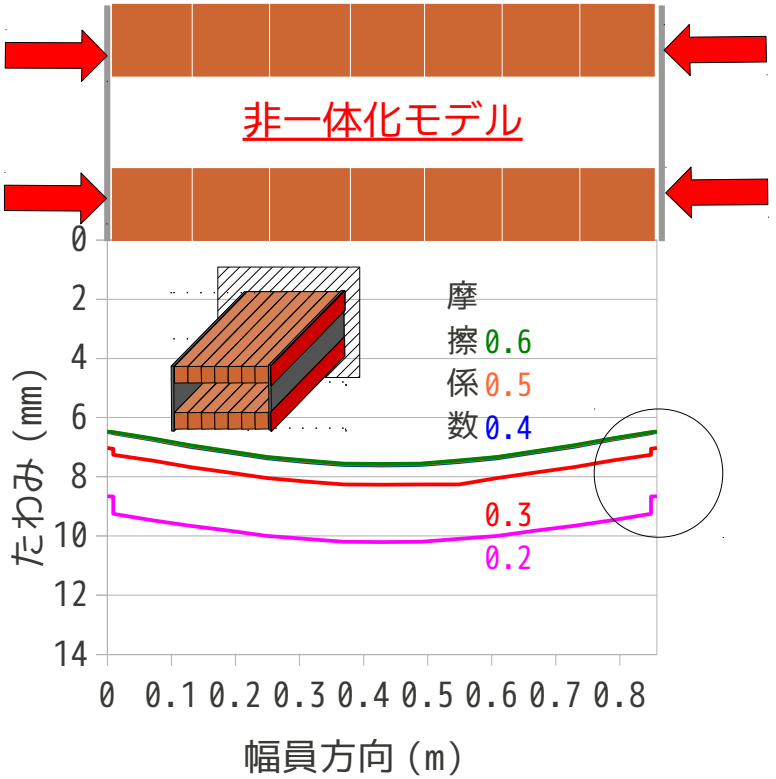
載荷断面の全節点数

→鋼板部の各節点に載荷

$$0.39 = \frac{EwIw}{EsIs+EwIw} \times P$$

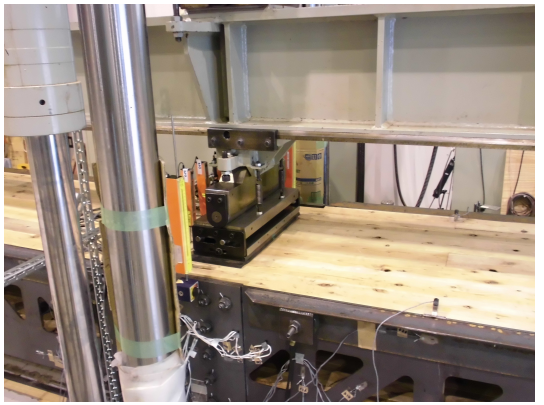
載荷断面の全節点数

→木材部の各節点に載荷



試験体

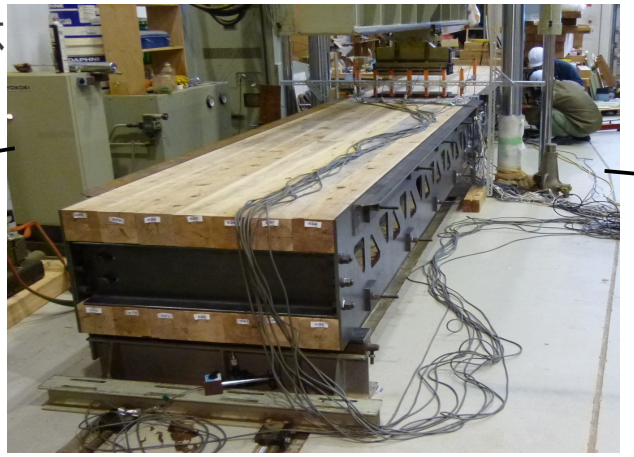
木材部のみの載荷でも



摩擦係数は十分に大きい

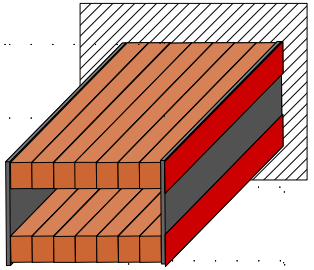
まとめ

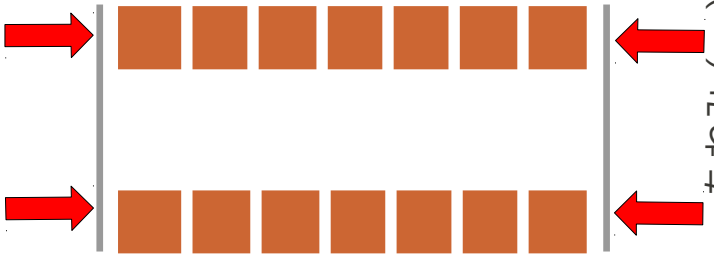
試験体



非一体化モデル

モデル化難しい



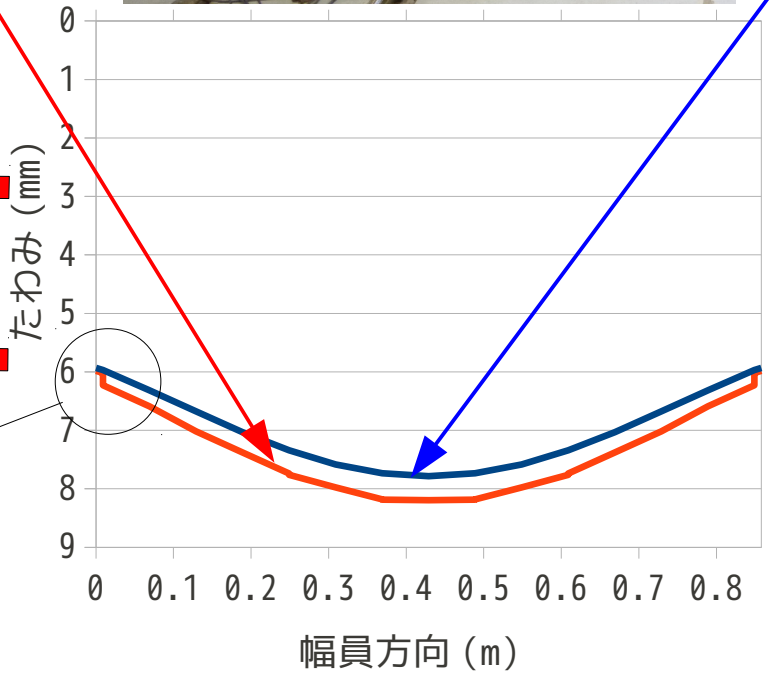


摩擦係数

0.6 0.5 0.4 0.3 0.2

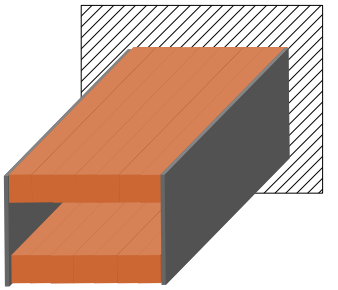
鋼板と木材にずれ

EsIs > EwIw



一体化モデル

モデル化簡単



剛性評価可能

プレストレスによる摩擦は十分に大きい