

A New Force-Measuring Device

Design & Experiments

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Outlines

- Application of Device
- Experiment Plan
 - Test Scheme
 - Loading & Measuring Devices
- Calculation
 - Equations
 - Comparison of Calculation & real load

Application Scenario

- Measuring force in structural test
- Both axial load & moment
- Bottom of columns

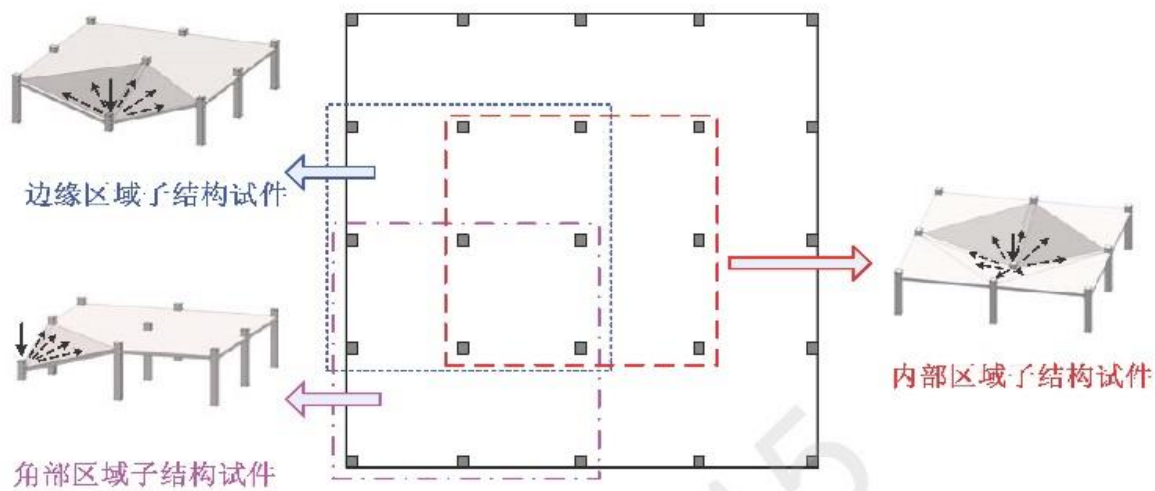
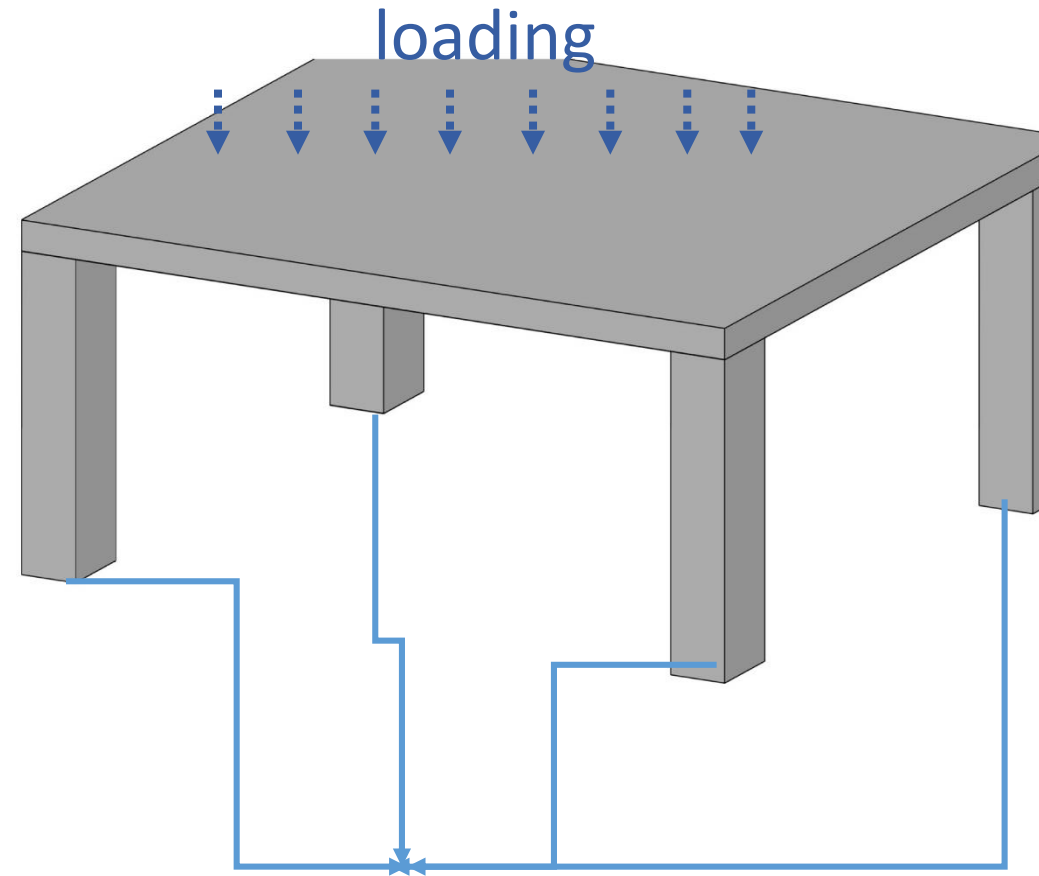


图 5 典型子结构试验



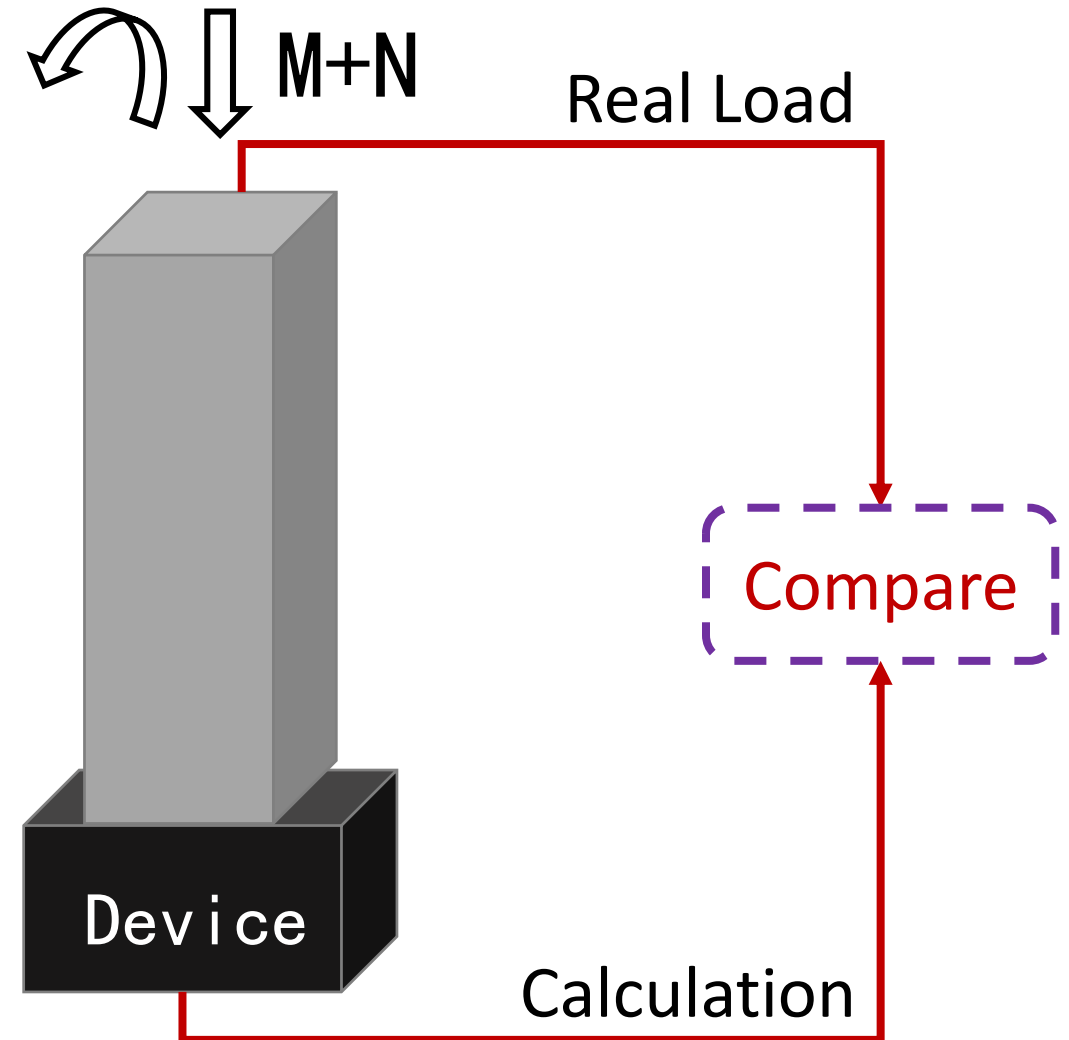
◆ Places of devices

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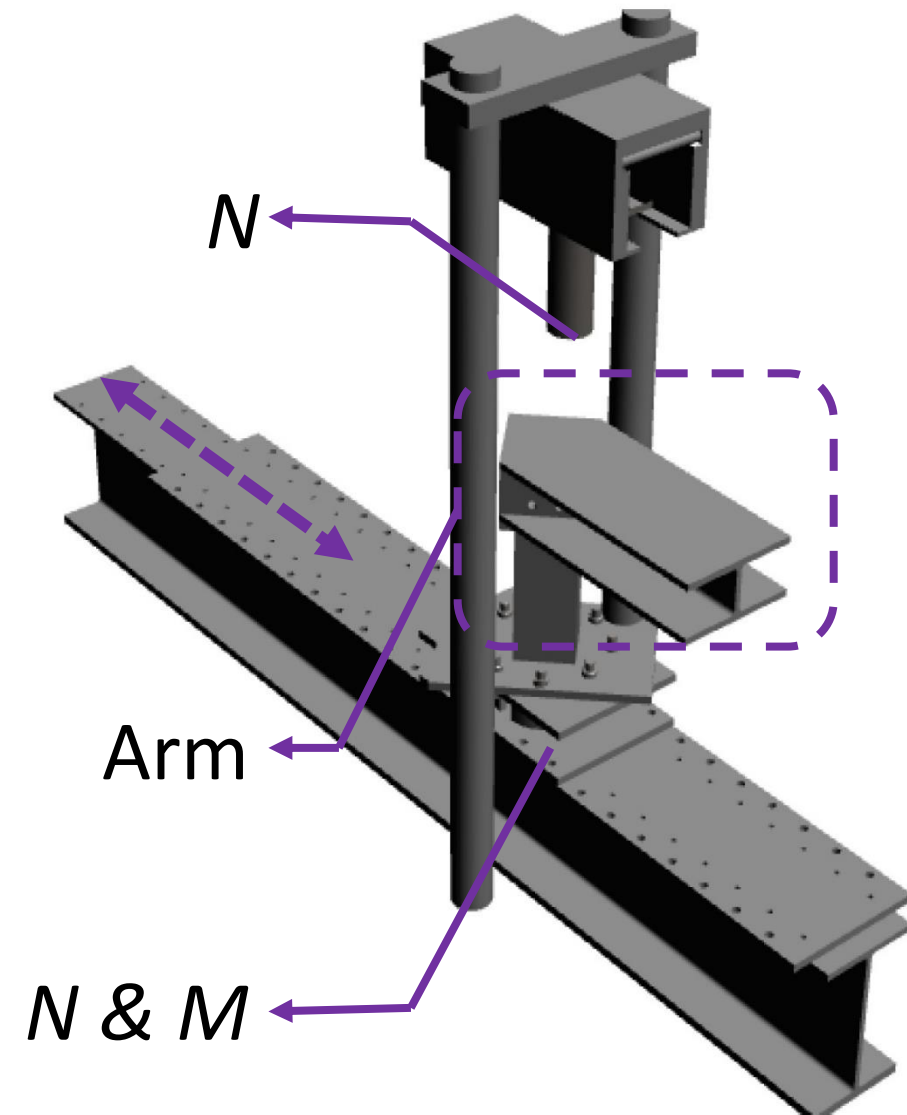
Test Scheme

- To examine precision
- Fundamental Program
- Design
 - The measuring device
 - Loading device



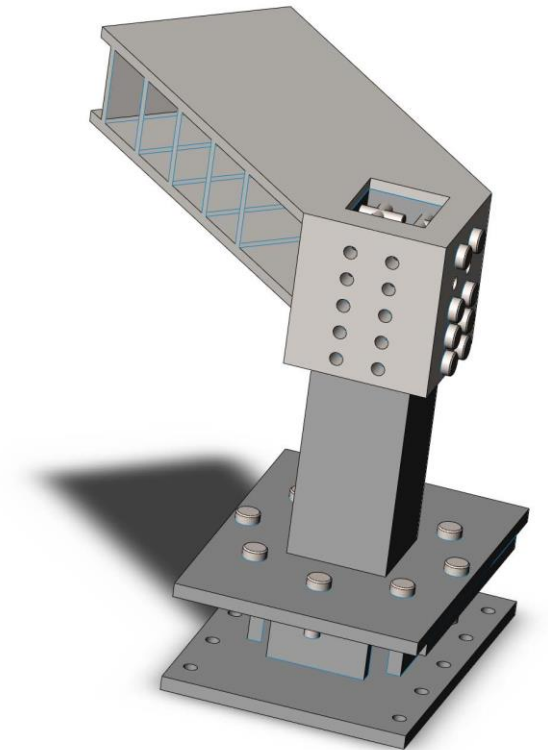
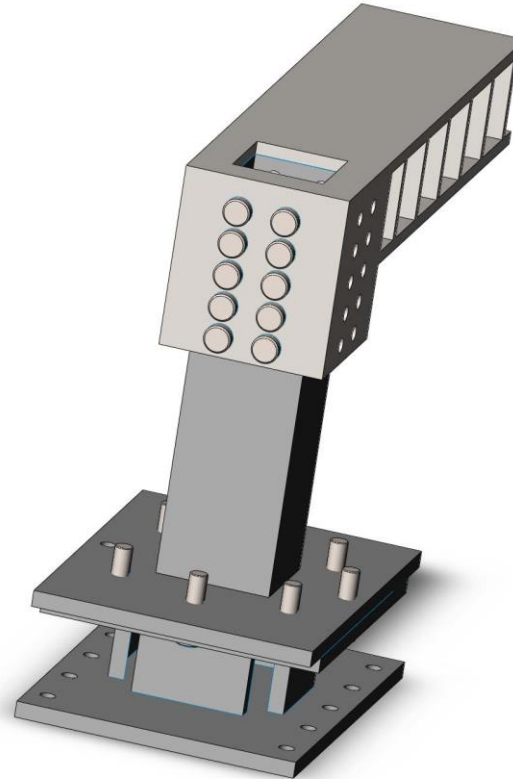
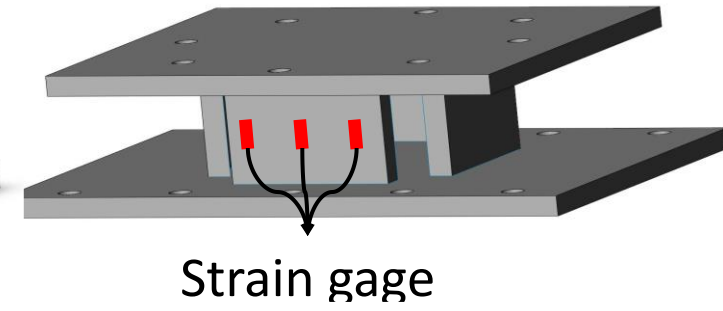
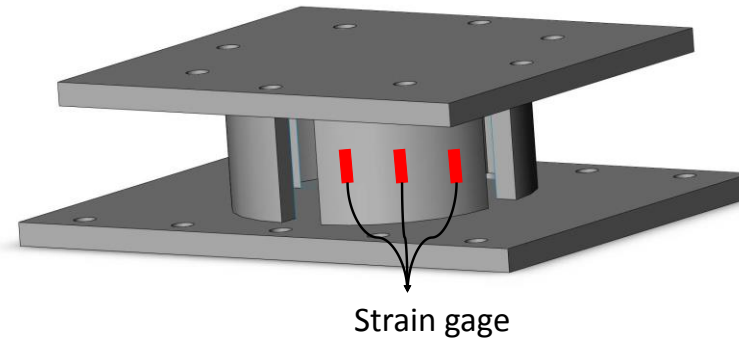
Loading Device

- Axial Load $\xrightarrow{\text{Arm}}$ Axial & Moment
- To Change N/M
 - Moving to change arm
- Different locations
 - Different M direction
 - Rotating device



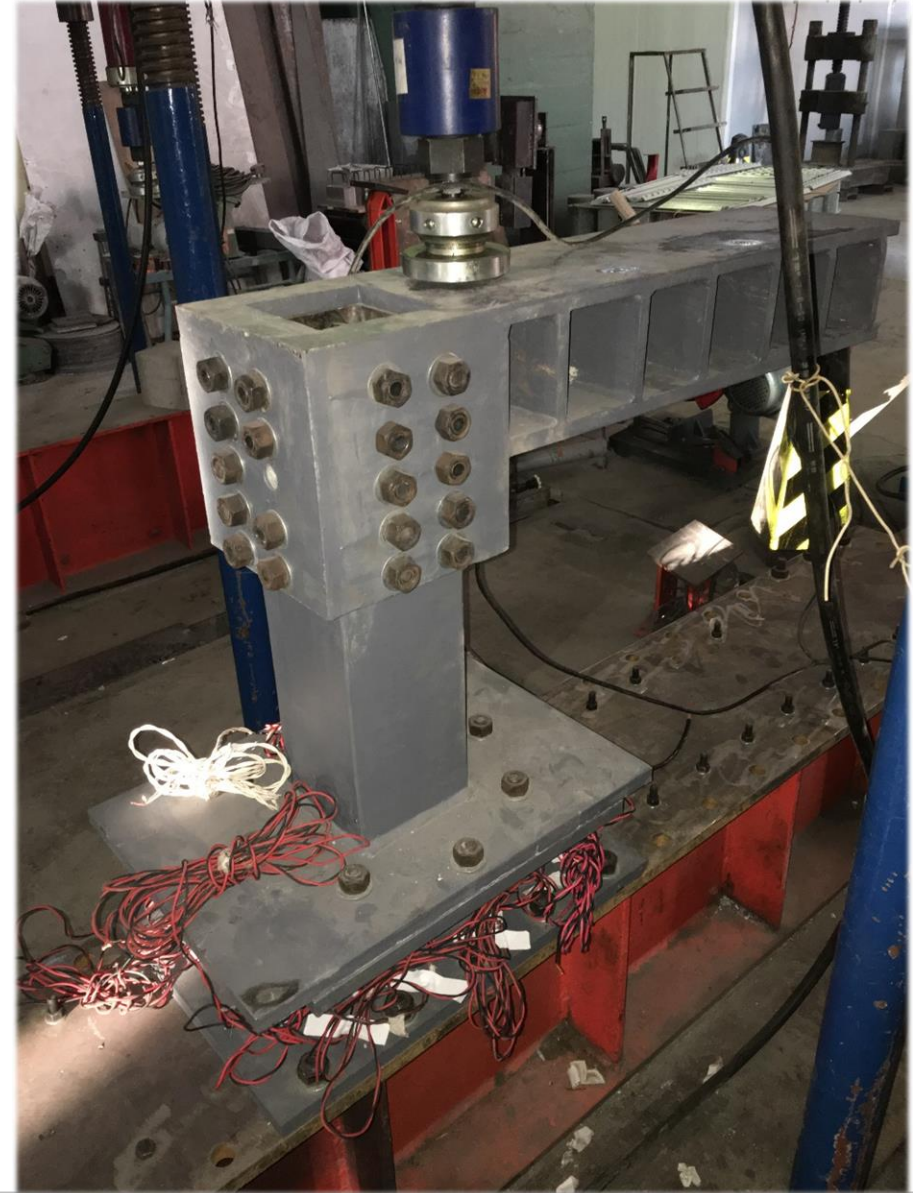
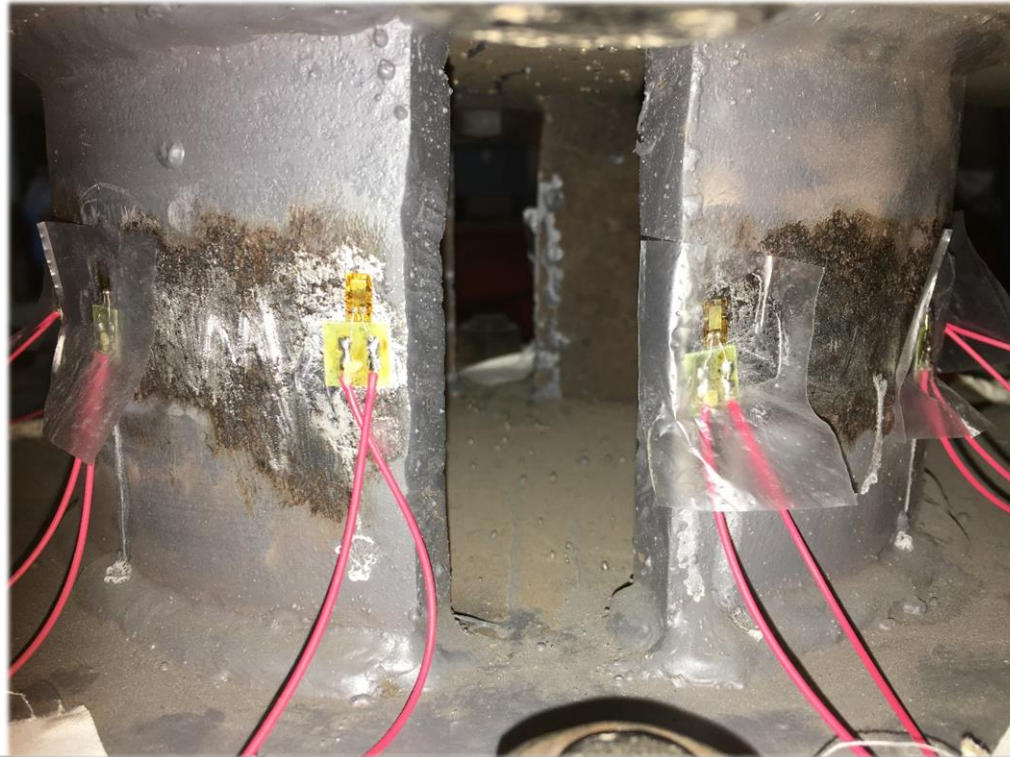
Measuring Devices

- Two devices
 - Circular
 - Rectangular
- Rotated loading device
- Calculation
 - Strain $\xrightarrow{\text{Linear}}$ Stress
 - Stress $\xrightarrow{\text{Integrate}}$ *N&M*



Photos

- Strain gage
- Whole structure



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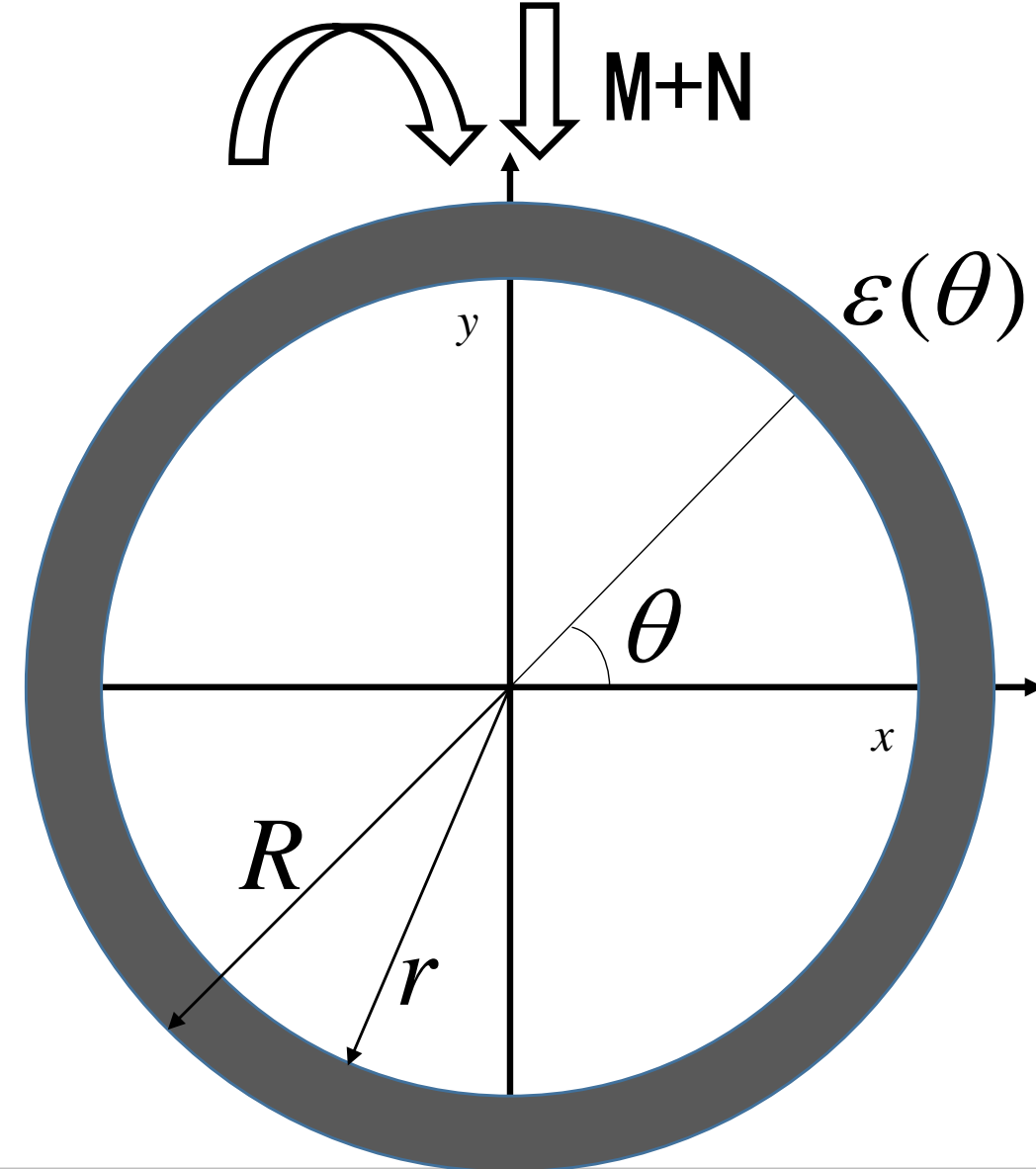
Equations

- Assumptions

- Stress-Strain: linear
- Plane cross-section*

- Strain Distribution

- $\varepsilon(\theta) = kx + b = k \cdot \cos \theta + b$
- fitted by ε_i, θ_i
- $\sigma(\theta) = E\varepsilon(\theta)$



* Since no shear force on this section, this assumption is reasonable

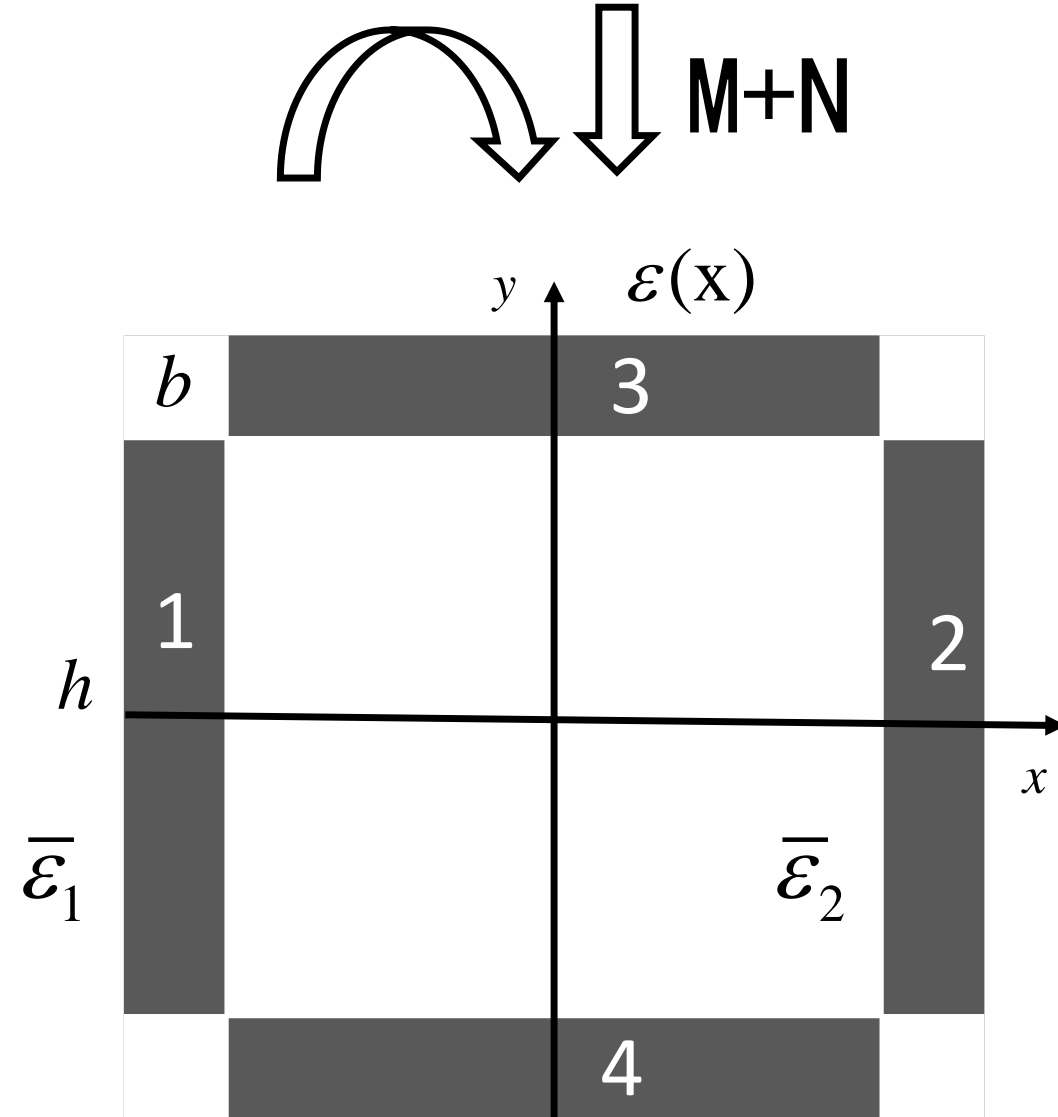
Equations

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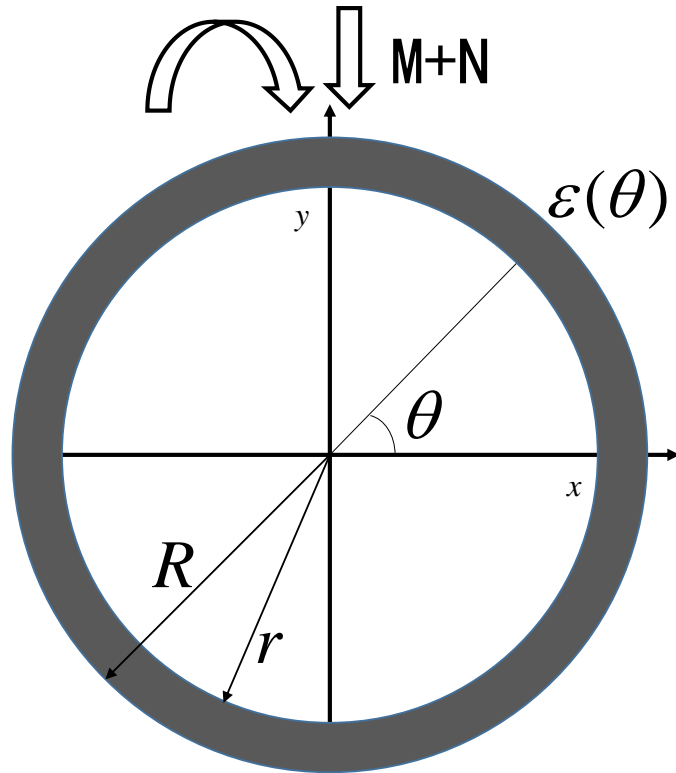
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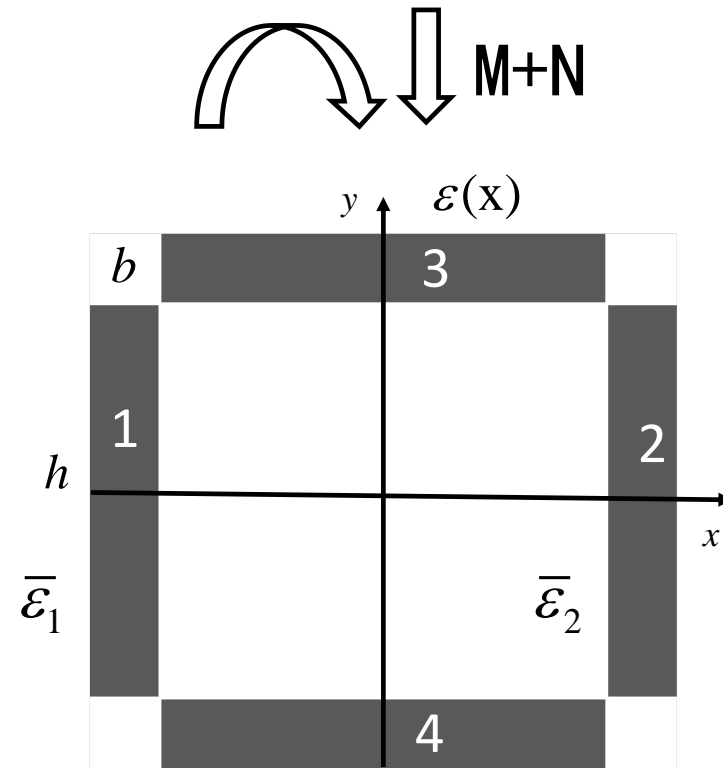


Equations



$$N_0 = 2E \int_0^\pi \varepsilon(\theta) \cdot \frac{(R^2 - r^2)}{2} d\theta$$

$$M_0 = \frac{(R^2 - r^2)(R + r)}{2} \cdot E \int_0^\pi \varepsilon(\theta) \cdot \cos(\theta) d\theta$$



$$N_0 = Eb \left(h(\bar{\varepsilon}_1 + \bar{\varepsilon}_2) + 2 \int_{-h/2}^{h/2} \varepsilon(x) dx \right)$$

$$M_0 = Eb \left(\frac{h^2}{2} (\bar{\varepsilon}_2 - \bar{\varepsilon}_1) + 2 \int_{-h/2}^{h/2} \varepsilon(x) \cdot x dx \right)$$

Part Results

● Compare: real & calculation

