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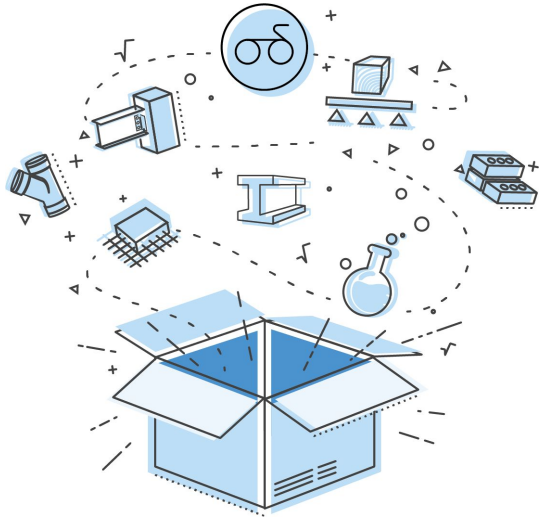
Base Plate Design

A short overview and complete example



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Say hello in the chat box

Poll

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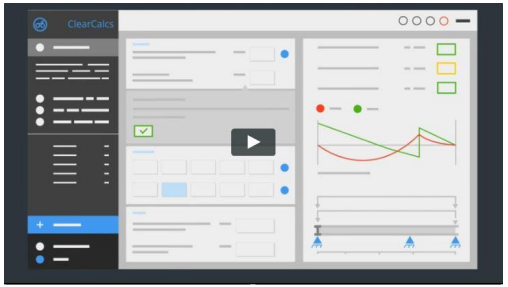
About ClearCalcs

ClearCalcs helps engineers design without compromise by bringing together powerful FEA analysis with easy to use design tools for wood, steel, cold-formed steel and concrete.

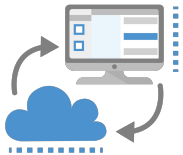
Explore our range at clearcalcs.com



Intro Video Hyperlink

More Accurate
Design more accurately with unrestricted and accessible FEA analysis

Eliminates Wasted Time
Eliminate time wasted using clunky methods or waiting for software licenses to free up

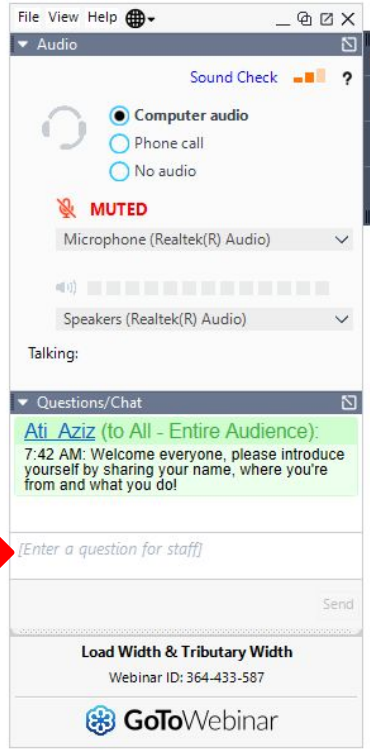


Available Everywhere
Empower engineers to work effectively from office, home, or site

How to Ask Questions

- **Type your questions in the Questions/Chat tab on your GoTo panel and click Send**
  - We will address all questions in the second half of the webinar during the 30-minute Q&A session
  - We might invite you to unmute yourself to ask your question live!

Ask your questions here



Unmute yourself here

Meet the Presenters

- **Connor Conzelman – Dir. of Customer Success**
  - Here to make sure you're successful in ClearCalcs!

- **Eva Wu – Structural Engineering Developer**
  - Developing calculator content in the US and Canada, backed by her years of consulting experience

What we'll be talking about today

- What is a base plate?
- Why are base plates important?
- Forces acting on base plates
- Failure modes of base plates
- Base plate design
- Worked example

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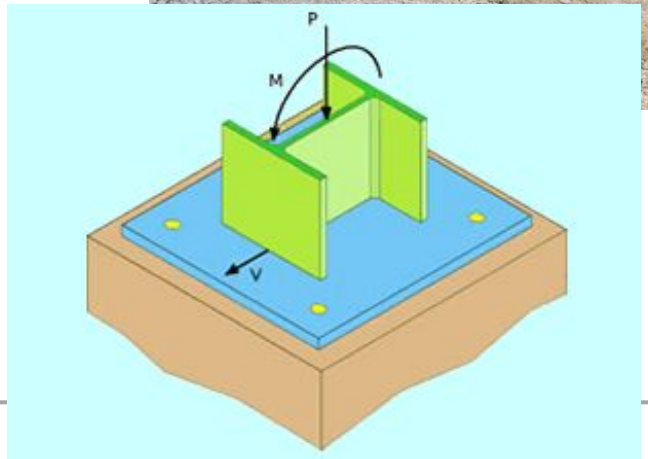
What is a base plate?

Why Are Base Plates Important?

- Construction
  - Alignment
  - Leveling

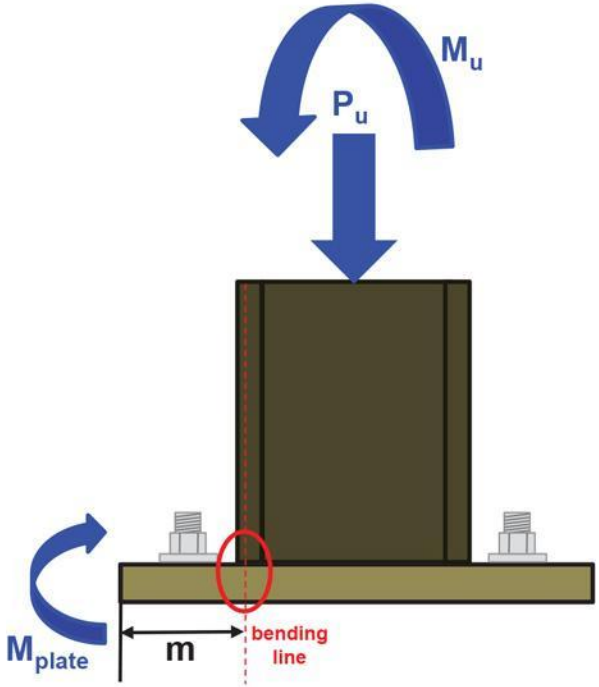
- Load Distribution



Source: https://blog.delafleur.com/?p=1823 and
https://www.asdipsoft.com/base-plate-and-anchor-rod-design/

Forces Acting on Base Plates

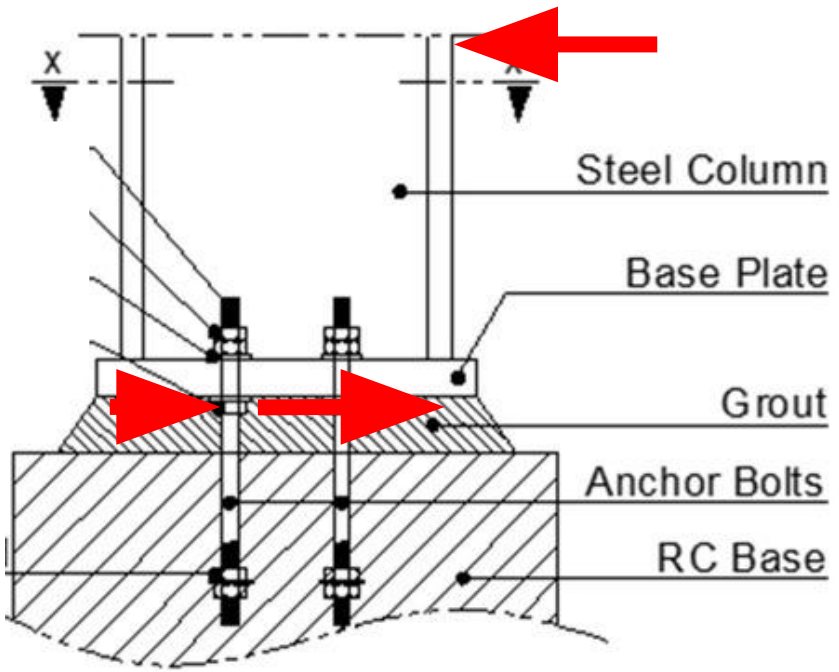
- Plate:
  - Bending



Source: https://www.structuremag.org/?p=13691

Forces Acting on Anchors

- Anchors
  - Shear
  - Tension



Nawar, M.T.; Matar, E.B.; Maaly, H.M.; Alaaser, A.G.; El-Zohairy, A. Assessment of Rotational Stiffness for Metallic Hinged Base Plates under Axial Loads and Moments. *Buildings* **2021**, *11*, 368. https://doi.org/10.3390/buildings11080368

Forces Acting on Anchors

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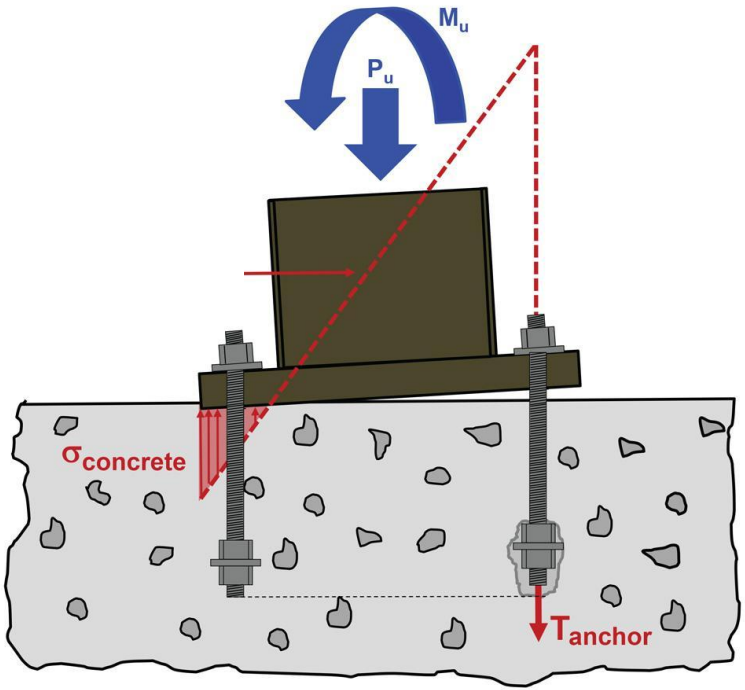
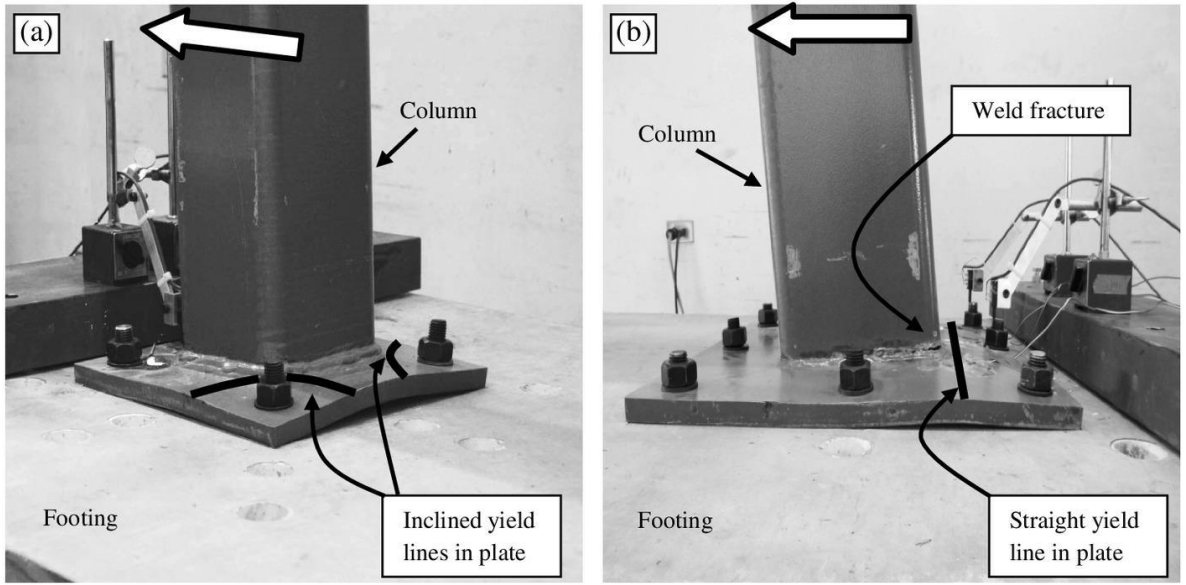


https://www.structuremag.org/?p=13691

Failure Modes of Base Plates and Anchors

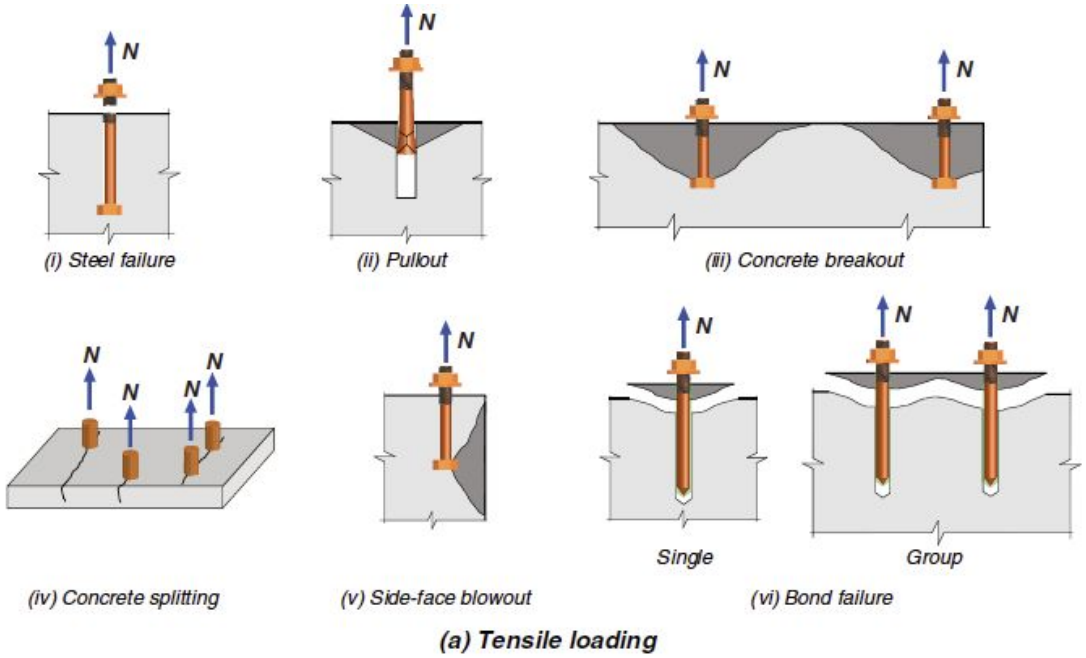
- Plate
  - Yield
- Anchor
  - Pull-out
  - Yield
  - Shear



https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29ST.1943-541X.0001136

Failure Modes of Base Plates and Anchors

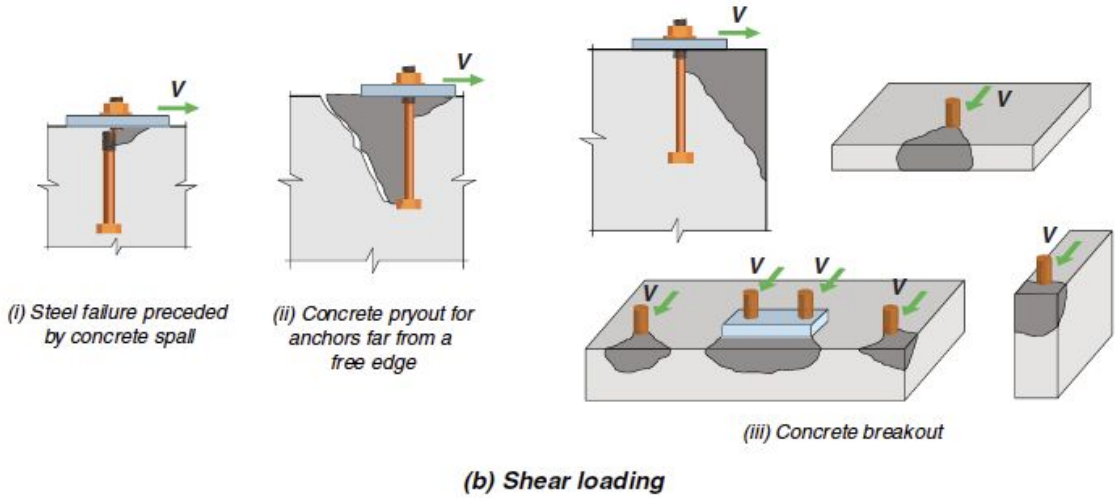
- Plate
  - Yield
- Anchor
  - Pull-out
  - Yield
  - Shear
- Concrete



ACI318-19 Fig. R17.5.1.2

Failure Modes of Base Plates and Anchors

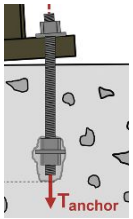
- Plate
  - Yield
- Anchor
  - Pull-out
  - Yield
  - Shear
- Concrete



ACI318-19 Fig. R17.5.1.2

Designing against BP and Anchor Failure

- Plate
  - Yield
    - Ensure plate has adequate thickness
- Anchor
  - Pull-out
  - Yield
  - Shear
    - Hook anchors or add anchor plate
    - Ensure anchors are large enough to resist shear and yield



- Concrete
  - Offset anchors from edge of concrete
  - Use higher strength concrete
  - Add confining bars
  - Increase the length of anchor

Base Plate Design in ClearCalcs

ClearCalcs

- Plate
  - Yield
    - Calculate minimum plate thickness
    - Report max bending capacity of plate
- Anchor
  - Pull-out
  - Yield
  - Shear
    - Calculate Anchor Tensile Capacity
    - Calculate Anchor Pullout Capacity
    - Calculate Anchor Shear Capacity
- Concrete
  - Calculate Concrete Breakout Capacity
  - Calculate Concrete Pryout Capacity
  - Calculate Concrete Shear Breakout Capacity

Poll 2

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Worked Example

4.1 Example: Base Plate for Concentric Axial Compressive Load (No concrete confinement)

A W12×96 column bears on a 24-in. × 24-in. concrete pedestal. The minimum concrete compressive strength is $f_c' = 3$ ksi, and the base plate yield stress is $F_y = 36$ ksi. Determine the base plate plan dimensions and thickness for the given required strength, using the assumption that $A_2 = A_1$ (Case I).

1. The required strength due to axial loads.

LRFD	ASD
$P_u = 700$ kips	$P_a = 430$ kips

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Worked Example

4.6 Example: Small Moment Base Plate Design

Design a base plate for axial dead and live loads equal to 100 and 160 kips, respectively, and moments from the dead and live loads equal to 250 and 400 kip-in., respectively. Bending is about the strong axis for the wide flange column W12×96 with $d = 12.7$ in. and $b_f = 12.2$ in. The ratio of the concrete to base plate area is unity; F_y of the base plate is 36 ksi and f'_c of the concrete is 4 ksi.

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To Recap

- A base plate interfaces between a steel column and concrete foundation
- Base plates distribute loads from columns into the foundation and provide a level surface for columns
- Anchor bolts attach a base plate into concrete
- Forces acting on base plate and anchor bolts include bending in base plates, and shear and tension in anchor bolts
- There are various failure modes of the base plate, anchor bolts and concrete that needs to be designed against

References:

t_min
N + 2*c
B + 2*c
N_calc
B_calc

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Questions?

What's New in ClearCalcs

New Calculators

- Diaphragm Analysis
- Custom Wood Sections
- Open web steel joists

Opportunity for teams working in light commercial:

- Interested in helping shape ClearCalcs?
- Work on a team that works in light commercial design?
- Connect with our internal team of engineers to discuss workflow and priorities
- Reach out to me at connor.conzelman@clearcalcs.com if you're interested

THANK YOU!

- We will send you a recording of the webinar by email.
- There will be a survey at the end of this webinar, we would appreciate your feedback on how we can improve.
- If you have further questions, send an email to help@clearcalcs.com or use the Help button in ClearCalcs