Track Substructure Influences on Tie Support Conditons

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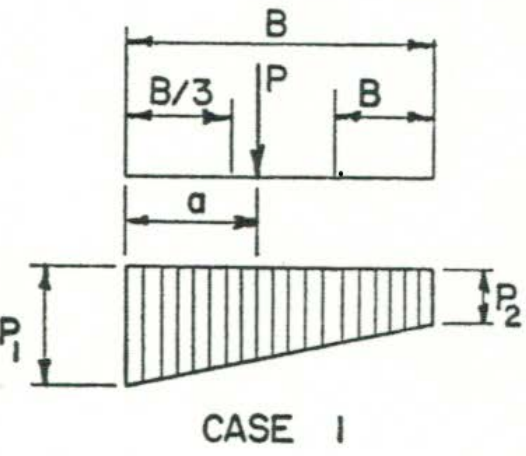
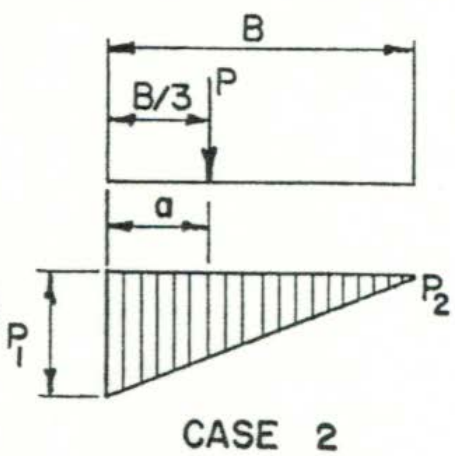
John A. Volpe National Transportation Systems Center

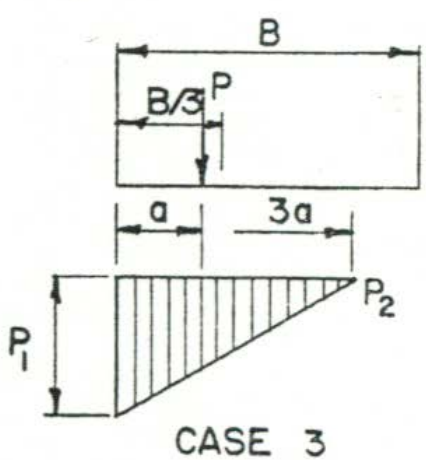
Outline

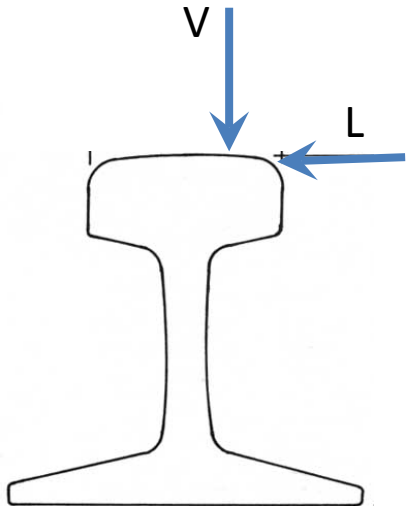
- Rail Support
- Tie Support
- Influence on Tie Vibration
- Summary

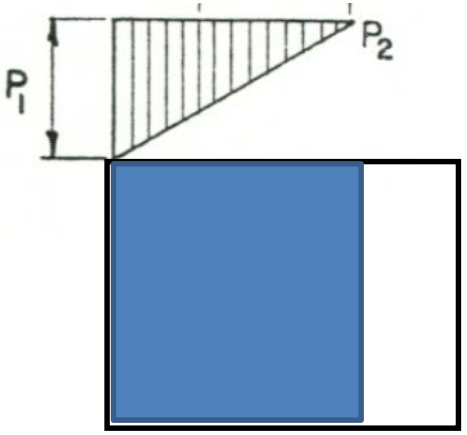
Rail Seat - Eccentrically Loaded Support











Case 1—Resultant within the middle third.

$p_1 = (4B - 6a)\ P/B^2$

$p_2 = (6a - 2B)\ P/B^2$

Case 2—Resultant at edge of middle third.

$p_1 = (4B - 6a)\ P/B^2 = 2P/B$

$p_2 = (6a - 2B)\ P/B^2 = 0$

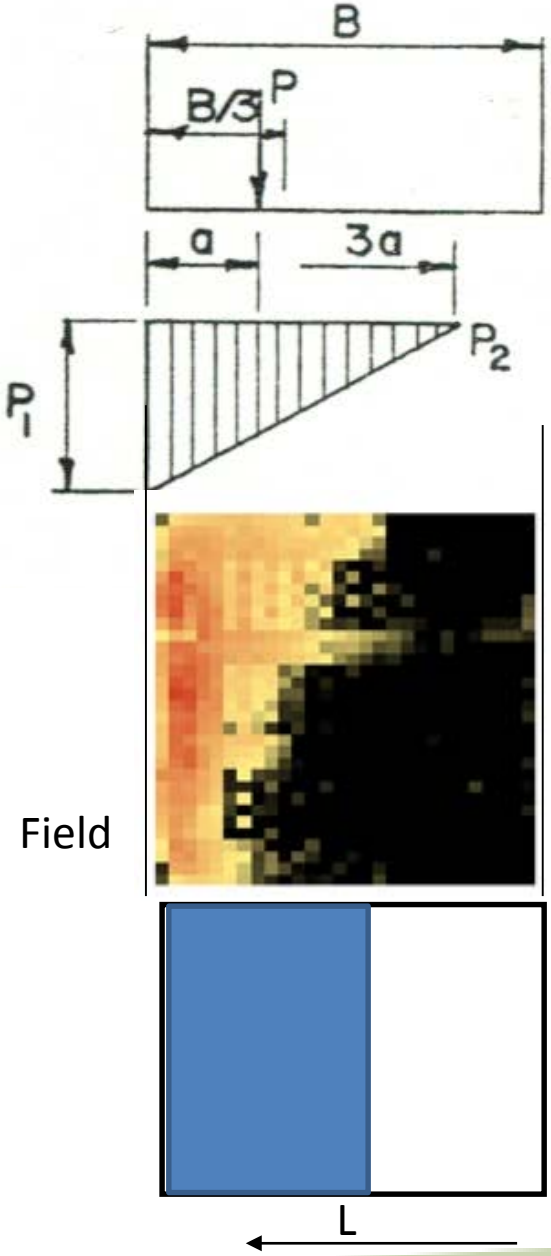
Case 3—Resultant outside the middle third.

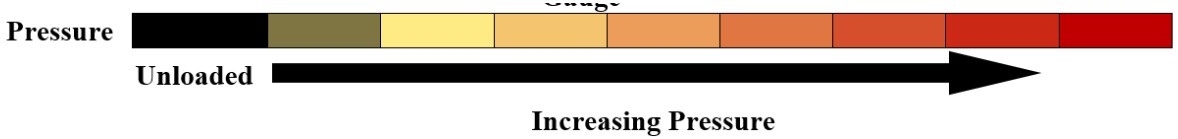
$p_1 = 2P/3a$

$p_2 = 0$

Source: AREA manual (1958)

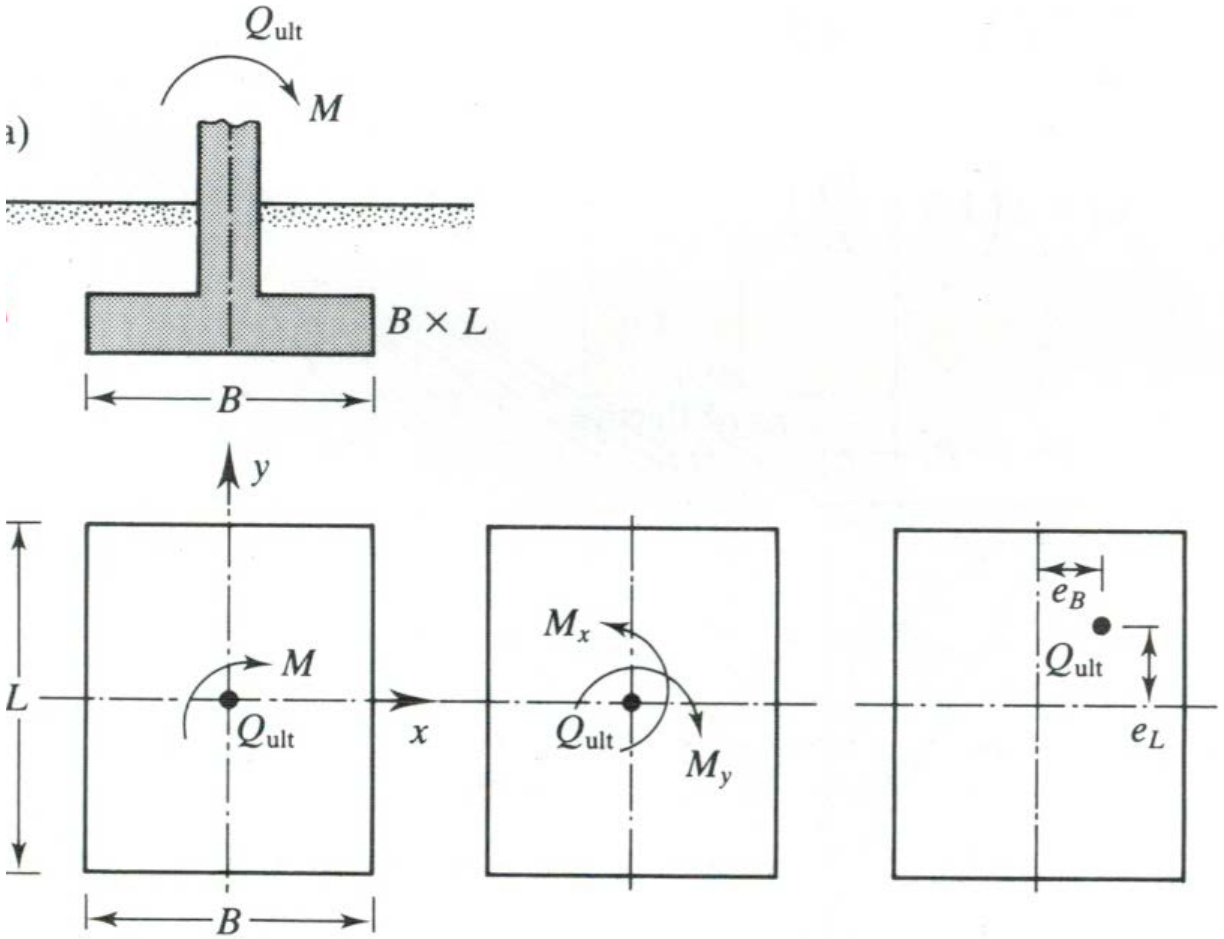
Rail Seat Support Measurements - TTCI





Data from Greve et al., 2015 – TRB paper.

Rail Support: Two Way Eccentricity



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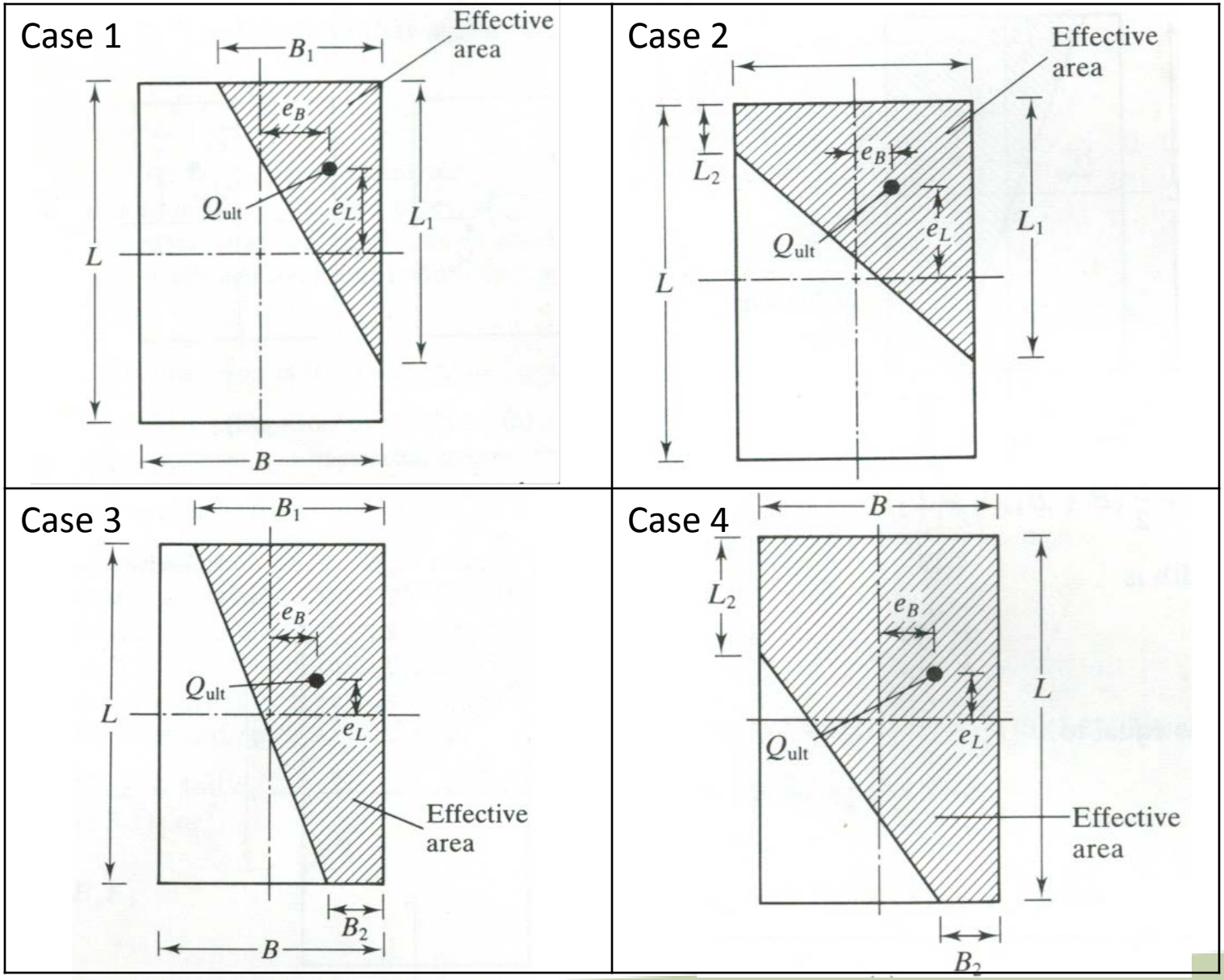
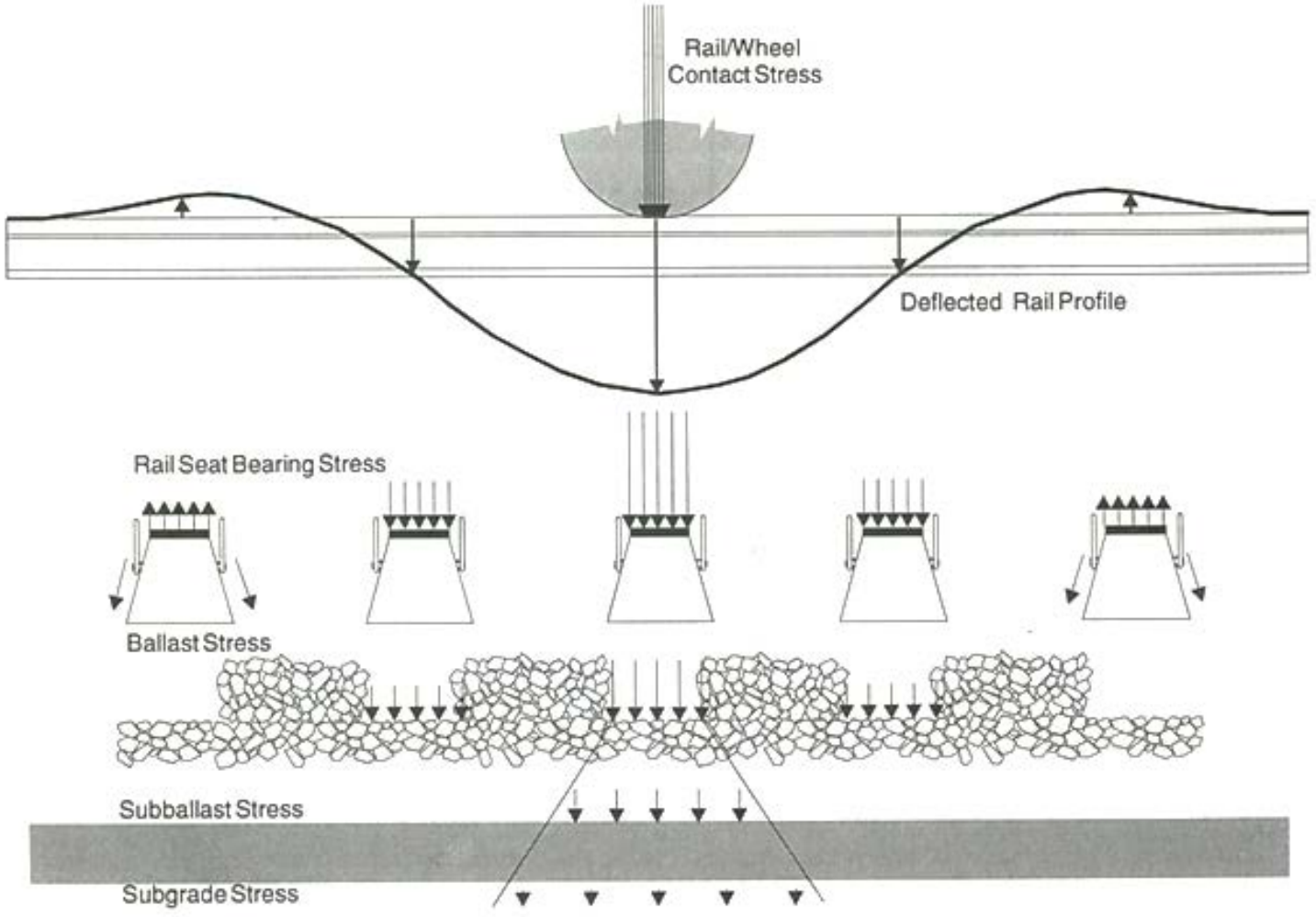


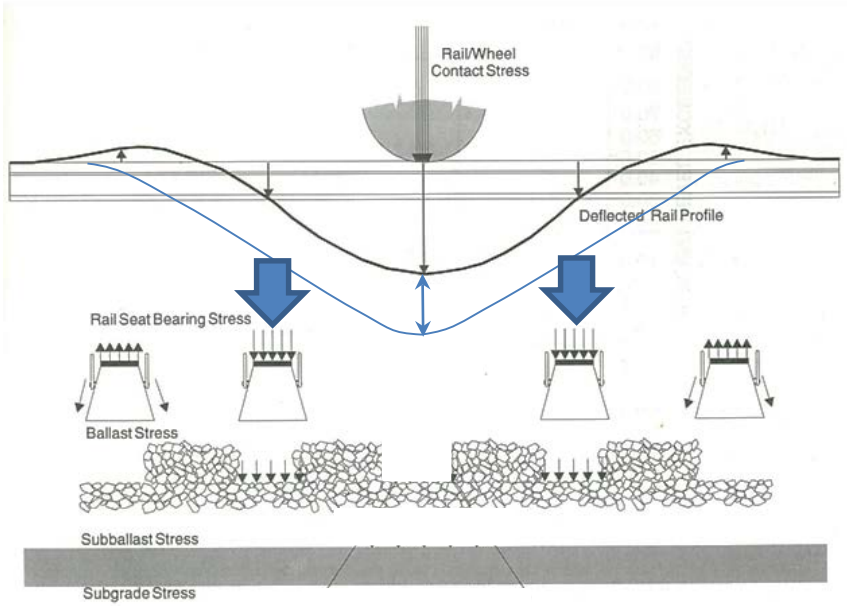
Rail Seat Track Loading



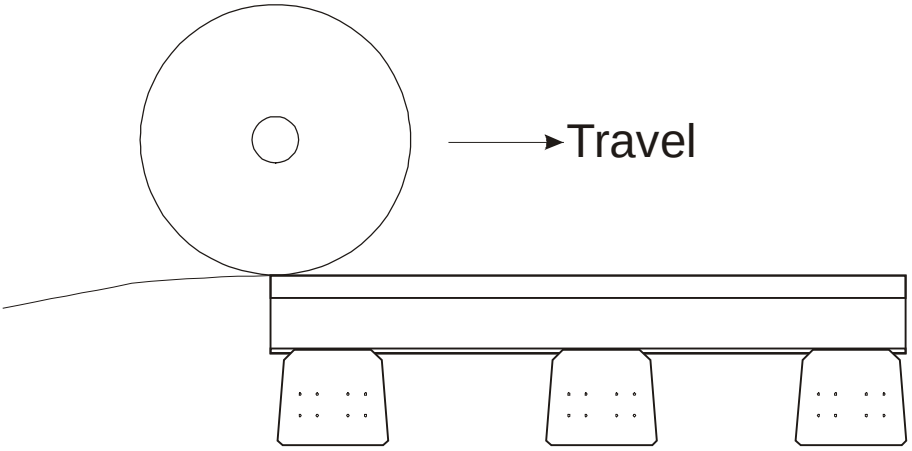
From Selig and Waters, 1994

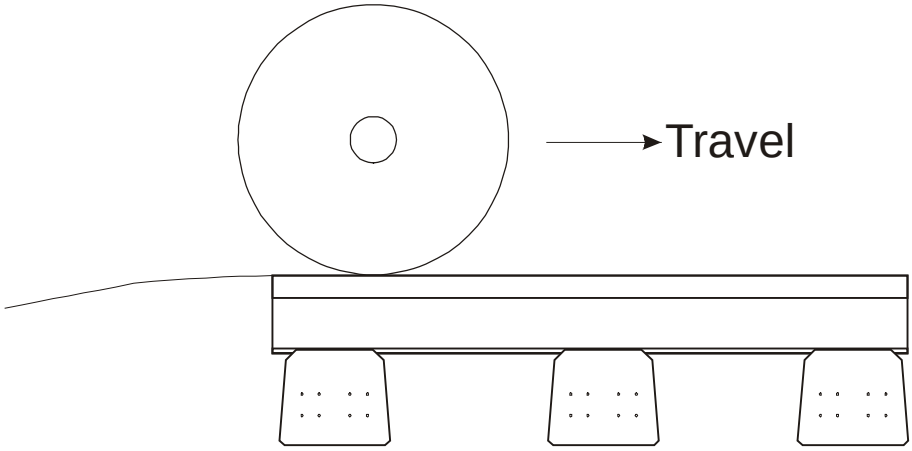
Rail Seat Load: Effect of Missing or Unsupported Tie(s)

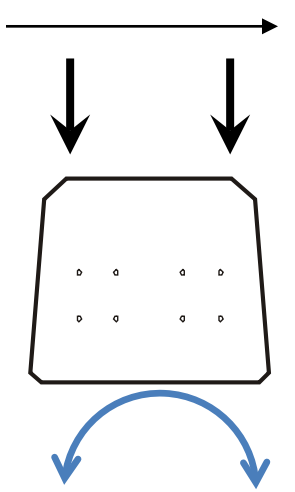
- Unsupported tie
  - Small increase in deflection
  - Large transfer of load to adjacent tie
- Increase rail deflection
  - 1.5-2 times static (Carr, 1999)
- Increase adjacent tie load
  - Up to 3+ times static (Kerr, 2003)
  - Depending on tie support

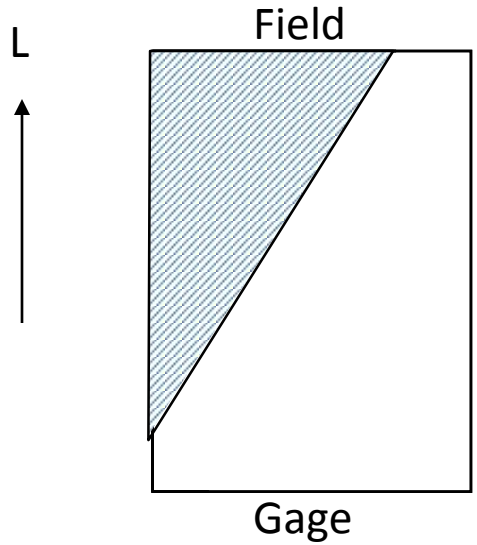


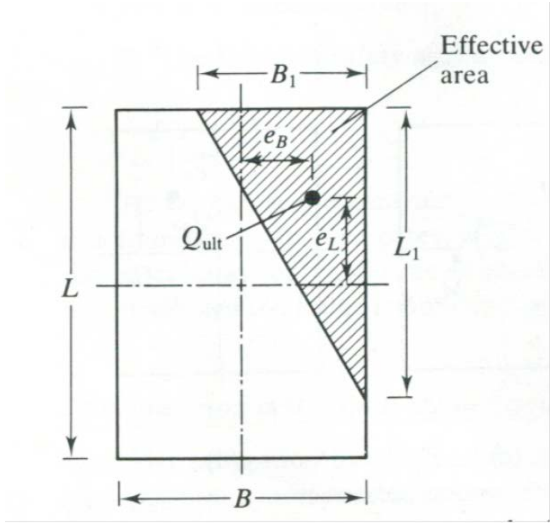
Rail Seat Load: Tie Support Effects



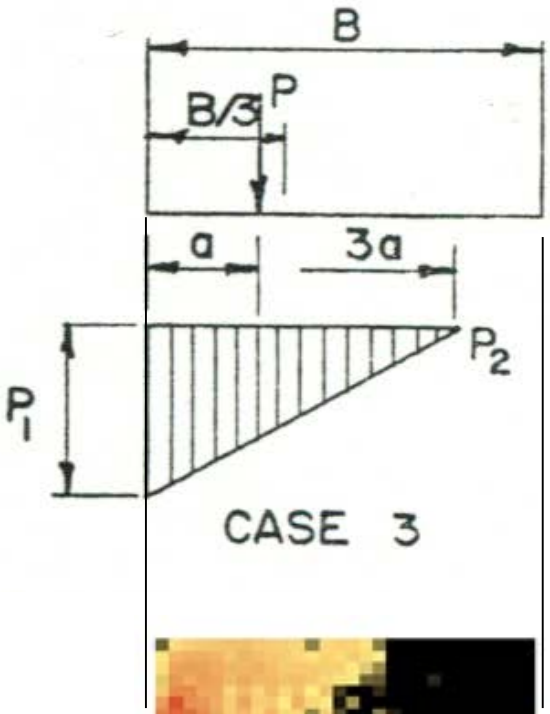


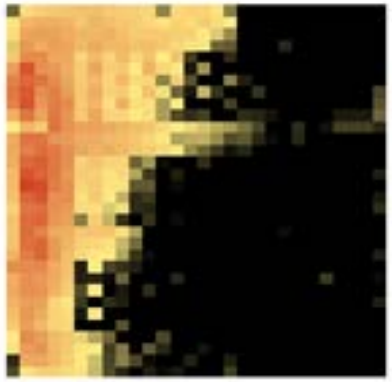






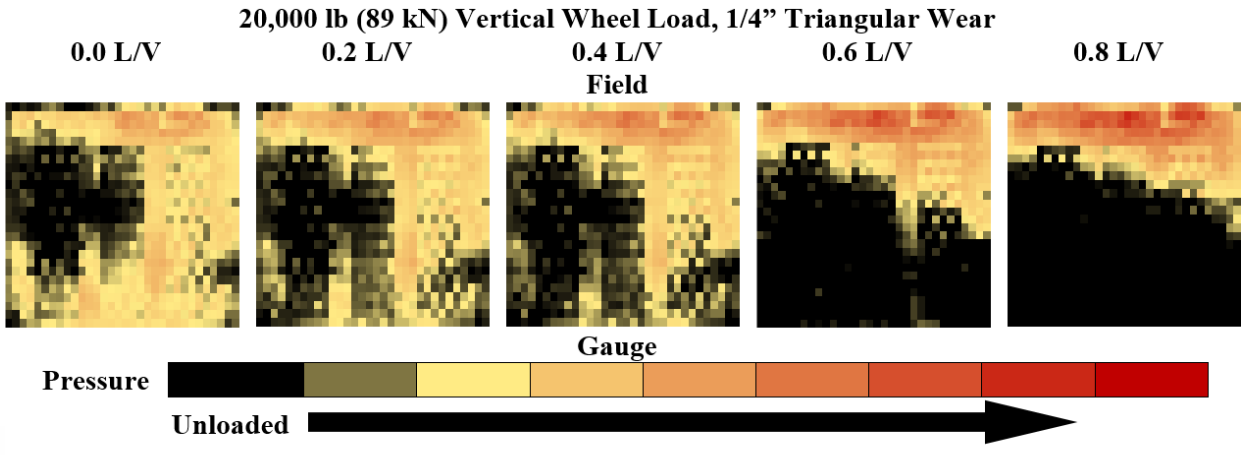
Rail Seat Support Measurements - TTCI

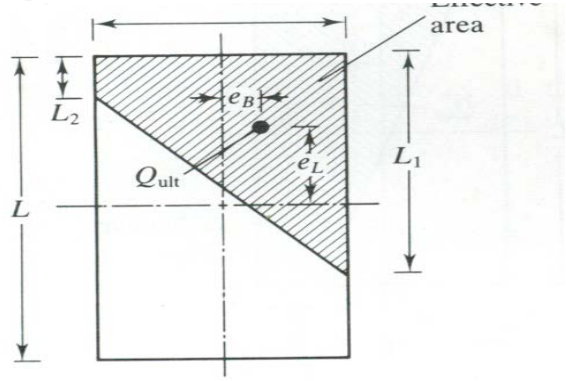




Field

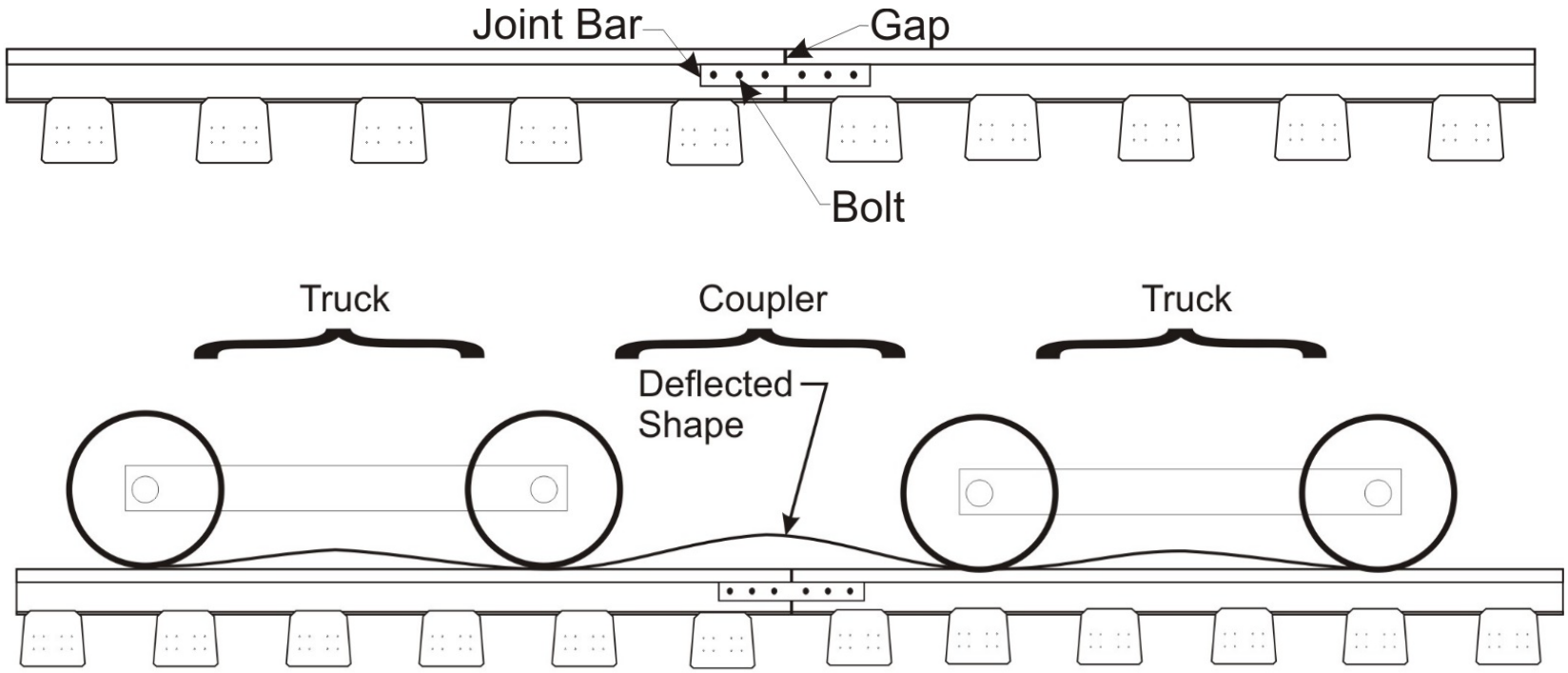
Gauge





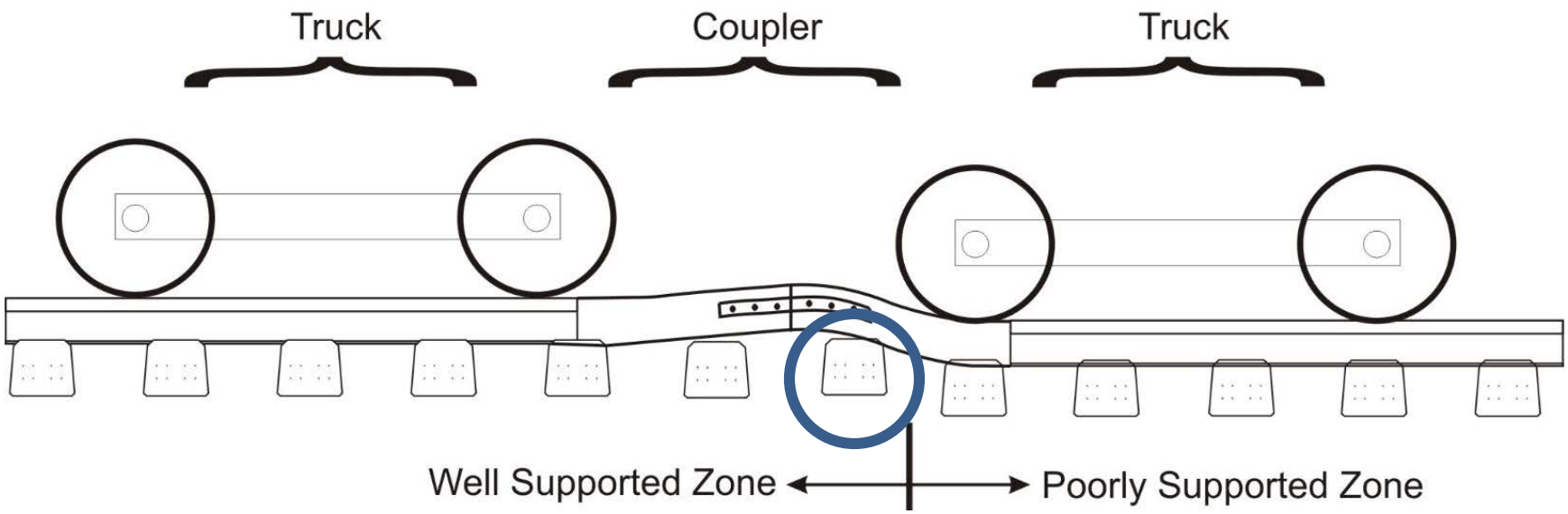
Data from Greve et al., 2015 – TRB paper.

Effect of Tie Support on Joint



Joint Bar loads can be computed using BOEF Theory.

Poorly Supported and Settled Track



Discretely Supported Track Model required to estimate loads.

What is the tie load?

Tie Support Conditions

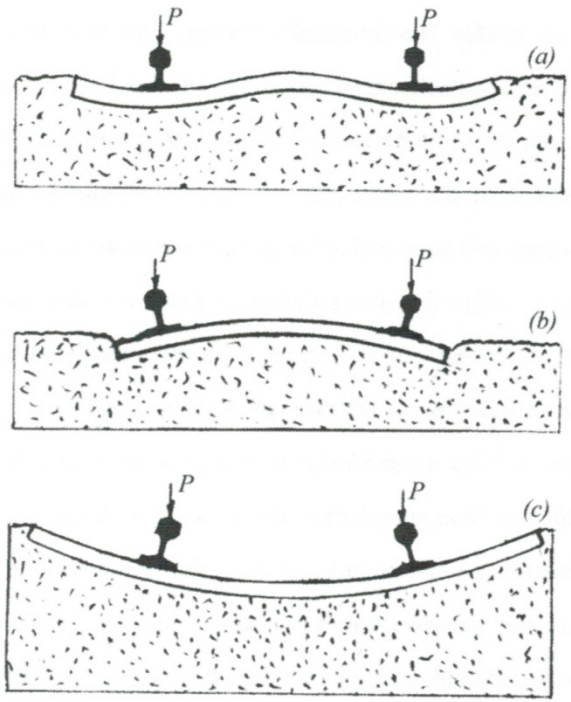
Tie Deformation and Load Under Differing Support Conditions

Exaggerated Deflection

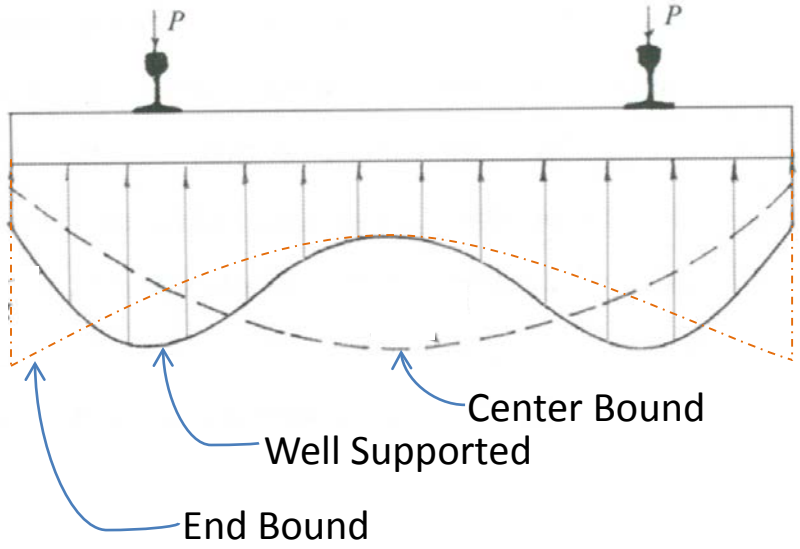
Well Supported

Centerbound

End Bound



Tie Bearing Pressure

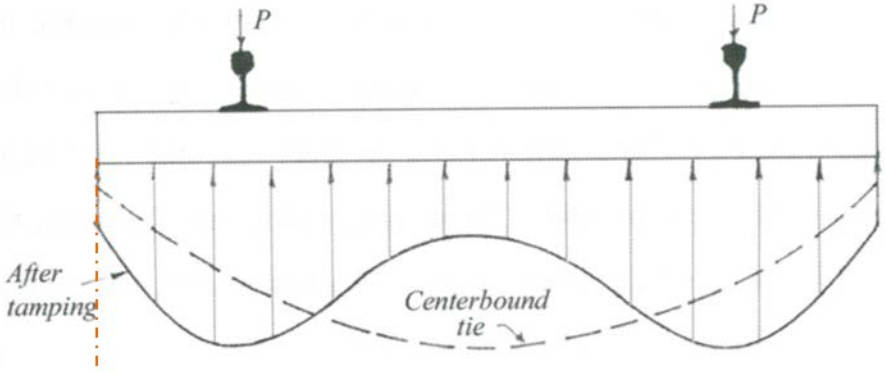


Adapted from Kerr (2003).

Tie Support Problems

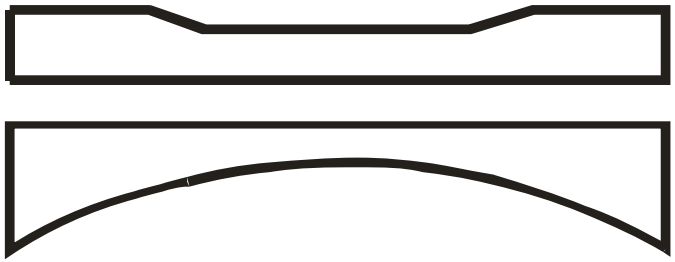
Tie Type – Ballast Pressure Considerations

Wood



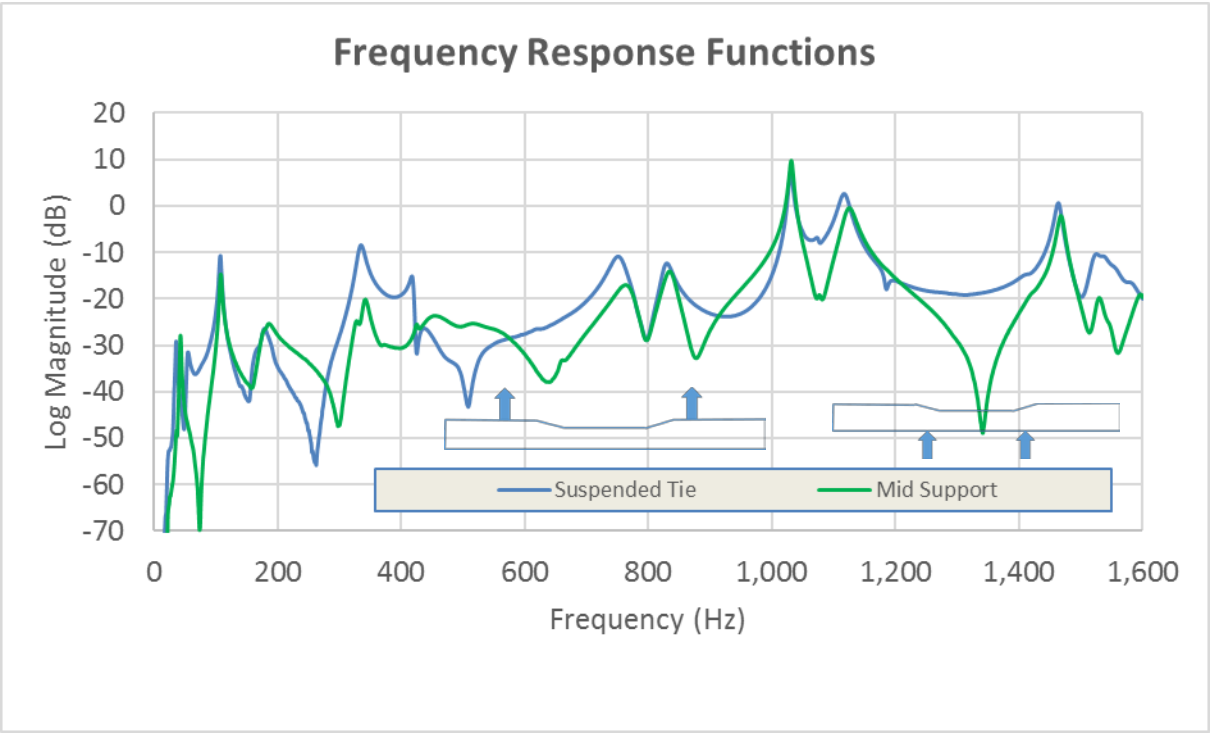
Concrete

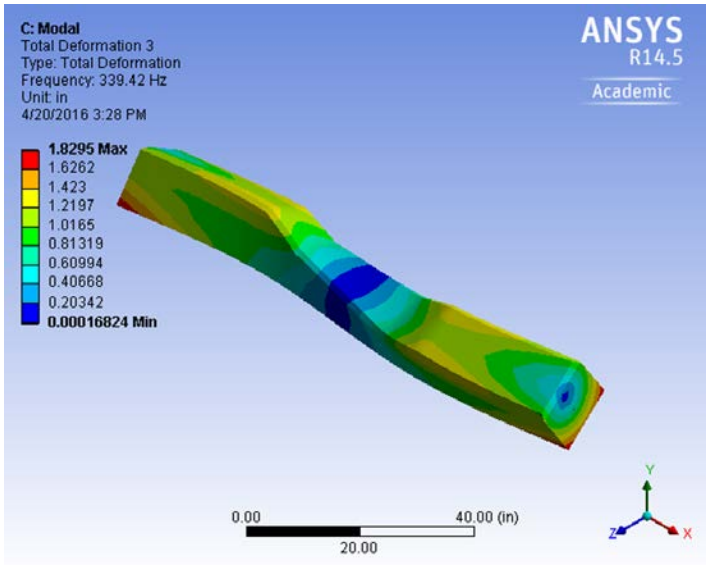
- Stress Distribution



- Stiff Foundation over soft layer
- Solution: Tamp

Tie Vibration and Tie Support





Slurry Abraded Concrete Ties

If Not Identified and Corrected, Poor Track Support May Cause…