The Balancing Act – The Fine Art of Using Unbalance to Maximize the Efficiency of Railroad Infrastructure

University of Illinois – Champaign/Urbana
Railroad Engineering
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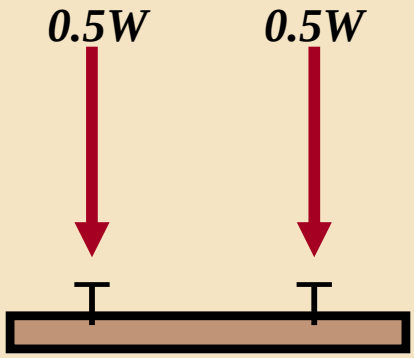
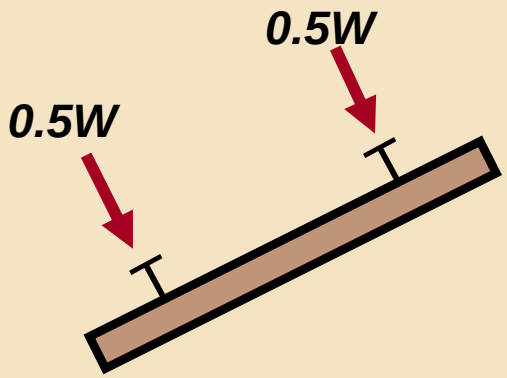
Balanced Condition



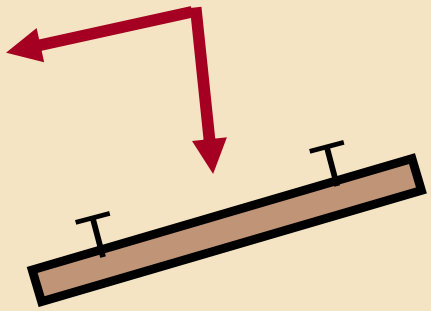
What is Unbalance?

- **Equilibrium Speed.** On a curve, the speed at which the resultant of the weight and the centrifugal force is perpendicular to the plane of the track.



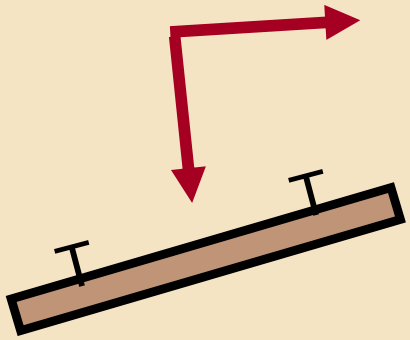
What is Overbalance?

- **Overbalance.** A static or dynamic condition which the resultant force is less than equilibrium speed.



What is Unbalance?

- **Unbalance.** A dynamic condition which the resultant force exceeds equilibrium speed.



Why have or use Unbalance?

- Move freight and passenger trains as safely and efficiently as possible.
  - Maximize Safety
  - Maximize Velocity
  - Maximize Capacity
  - Minimize wear on the Railroad

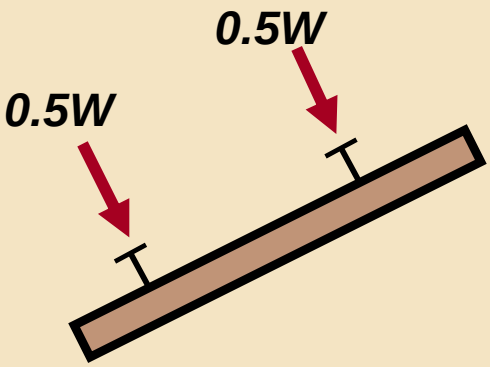
It is a "BALANCING ACT"!

Unbalance = Cant Deficiency

Freight: 1” thru 3”

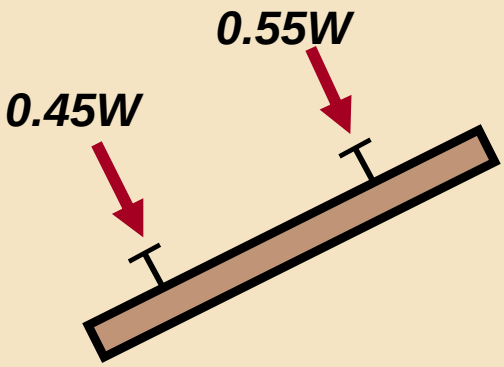
Passenger: 3” thru 9”

Balanced



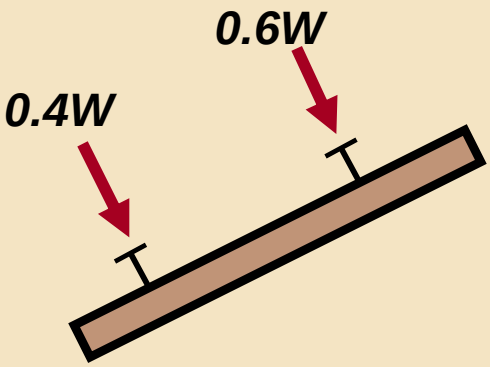
Curve:	1º – 30”
Superelevation:	3-1/2”
Unbalance:	0”
Speed	59 mph

1-½” Unbalance



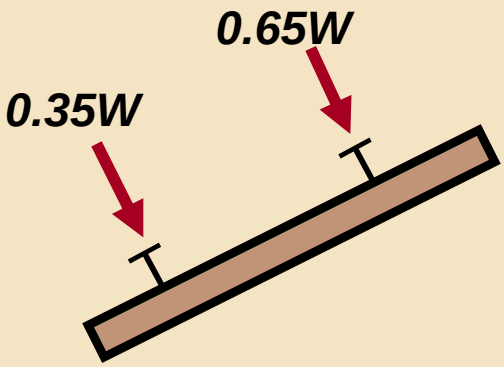
	Present
Curve:	1º – 30”
Superelevation:	3-1/2”
Unbalance:	1-1/2”
Speed:	68 mph

3” Unbalance



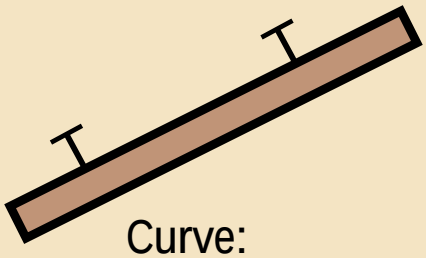
	Present
Curve:	1^0 – 30”
Superelevation:	3-1/2”
Unbalance:	3”
Speed:	79 mph

4” Unbalance



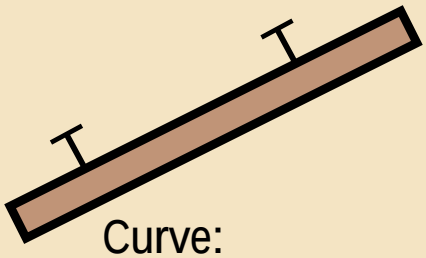
	New	Proposed	Variance
Curve:	1^0 – 30”	1^0 – 30”	Same
Superelevation:	3-1/2”	2-1/2”	1” Less
Unbalance:	4”	4”	Same
Speed:	85 mph	79 mph	Maximum

Curve No. C-1694



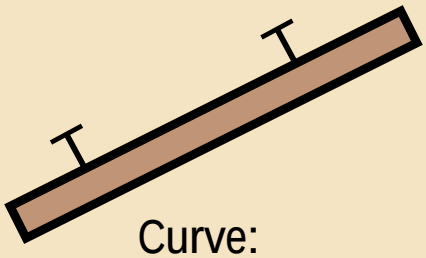
Curve:	4^0 – 00”
Superelevation:	0.75”
Unbalance:	2.25”
Boarded:	25 mph
Speed (Calculated):	33 mph
Speed (Proposed):	30 mph

Curve No. C-1694



Curve:	4º – 00”
Superelevation:	0.75”
Unbalance:	3”
Boarded:	25 mph
Speed (Calculated):	37 mph
Speed (Proposed):	35 mph

Curve No. C-1694



Curve:	4^{0} – 00”
Superelevation:	0.75”
Unbalance:	4”
Boarded:	25 mph
Speed (Calculated):	41 mph
Speed (Proposed):	40 mph

Determination of Unbalance

$$V_{max} = \sqrt{\frac{Ea + Eu}{0.0007\,D}}$$

V = Velocity or Train Speed [mph]

Ea = Actual Elevation [inches]

u = Unbalance [inches]

D = Degree of Curvature

Freight & Passenger Issues

- Money
- On-Time Performance
- High Side Rail Wear
- Low Side Rail Crush
- Odd Speeds
- Ride Quality
- Reduce Superelevation
- Municipal Ordinances
- Passenger / Freight Differential
- Speed Over Diamonds
- Aspect Changes
- Hi-Tech Turnouts

THANK YOU

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