

# Transit Track Design & Construction Specs:

*Is there room for improvement?*

A Commentary on Transit Track Design &  
Construction Practices

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# Purpose of this Presentation

- Certain design features & construction details that are not “best practices” keep appearing in the plans & construction methods used for track extensions, new construction & major rehabs
- This Presenter suggests that scientific research & real-life testing should determine what gets built, not the often antiquated existing criteria & Xerox machines

# Topics Needing a Closer Look

- 1) **Canting Rails in Embedded Track Installations**
- 2) **Widening Gage in Curves for Vehicles with 2-Axle Trucks**
- 3) **Tightening Gage in Tangent Track**
- 4) **Use of Restraining Guard Rails (RGR)**
- 5) **Rail Welding Specs: Slow-bend Test & Normalizing Welds**
- 6) **Plinth Pad Specs & Construction**

# Case #1: Canting Tee Rails in Embedded Track

1. **Pro** - It is intended to improve wheel & rail life & possibly reduce noise
2. **Pro/Con** – Is there any verifiable data showing these performance improvements?
3. **Con** - Costs big money to “cant” embedded rails – complicates pre-bending & supports

## **Case #2: Widening Gage in Curves**

- 1. Pro - It is intended to “ease” wheel passage & possibly reduce wear & noise**
- 2. Pro/Con – Is there any verifiable data showing these performance improvements?**
- 3. Con – May not have real benefits with 2-axle trucks; increases angle of attack, complicates construction & maintenance logistics**

# Case #3: Tightening Gage in Tangent Track

1. **Pro** - It is intended to reduce hunting & improve ride quality, possibly reduce wear & noise
2. **Pro/Con** – Is there any verifiable data showing these performance improvements?
3. **Con** – May actually increase hunting with AAR1B narrow-flange conical wheels, complicates construction & maintenance

## Case #4: Use of Restraining Guard Rails

1. **Pro - RGR is intended to prevent flange-climb derailments (but so does emergency guard rail)**
2. **Pro – RGR is intended to reduce wear of the high rail by “sharing wear” with RGR**
3. **Pro/Con - Is there any verifiable data showing these goals are actually achieved?**

# Case #4: Use of Restraining Guard Rails

1. **Con - It costs a lot – 3 to 5 times as much per foot as normal track, especially in pavement**
2. **Con – It is a big noise generator, requires lube to keep noise to acceptable levels (hard to do in paved track)**
3. **Con – It is hard to maintain/replace – especially paved**
4. **Con – “Shared” contact between high rail & RGR in most design criteria can’t ever be achieved reliably in practice**
5. **Con – Most LRT revenue derailments caused by *OVERSPEED*, not flange-climb**

# Case #4: Use of Restraining Guard Rails - Comparison

## Guarded



## Unguarded



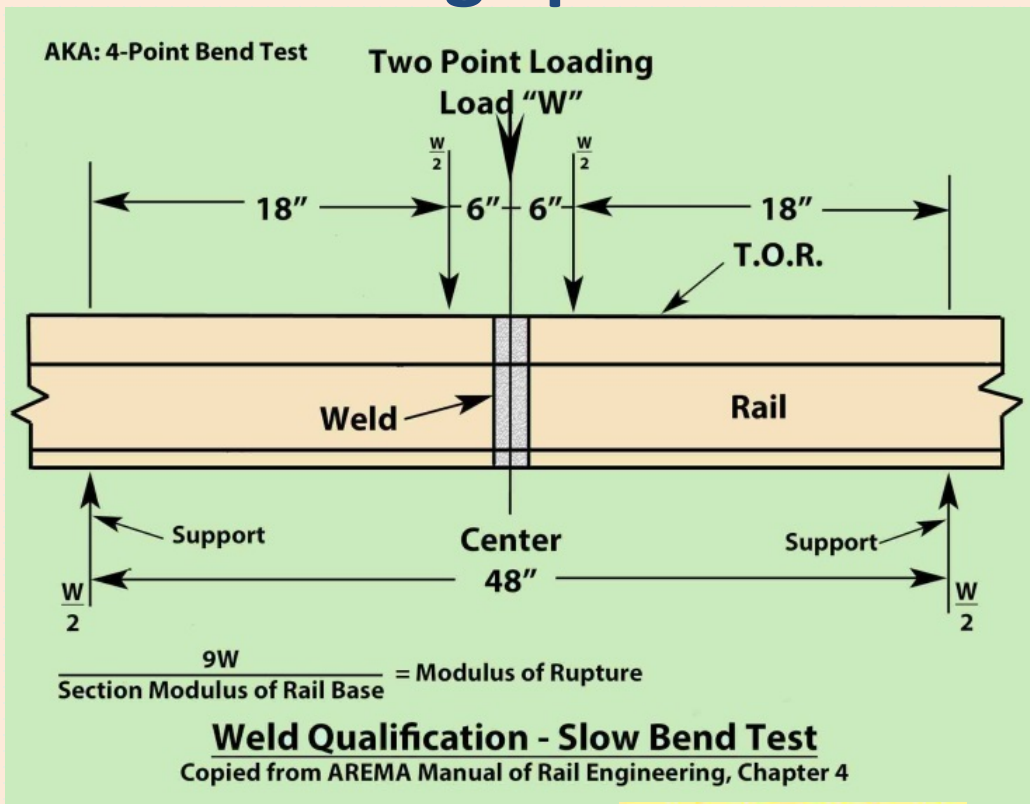
## Case #5: Rail Welding Specs – Slow Bend Test



Standard 4-point bending test.

Standard 4-point set-up for AREMA & AWS Slow-bend Test of Rail Welds – both flash-butt, Thermite & Electro-slag  
**Note restraints** – a good idea, as the welds can & do shatter EXPLOSIVELY!

# Case #5: Rail Welding Specs – Slow Bend Test



## Case #5: Rail Welding Specs – Slow Bend Test

Slow Bend Testing Requirements				
Rail Weld To Be Tested	Flash-Butt Welding		Thermite Welding	
Rail Material Properties	Modulus of Rupture	$\Delta$ Min @ CL	Modulus of Rupture	$\Delta$ Min @ CL
Soft Carbon Steel Rail (248 HB Min)	100 Ksi	1.50 in	100 Ksi	1.00 in
Standard Carbon Steel Rail (300 HB Min)	120 Ksi	1.00 in	110 Ksi	0.90 in
Premium Carbon Steel Rail (341 HB Min)	125 Ksi	0.70 in	120 Ksi	0.60 in

Weld Slow-bend Test Requirements Copied from AREMA MRE Chap. 4 & AWS D15.2/D15.2M-2013

**Note that ALL rail sections regardless of Moment of Inertia must meet same deflection requirement & “Premium” rails have a higher MOR but lower deflection requirement than “Standard” rails – go figure!**

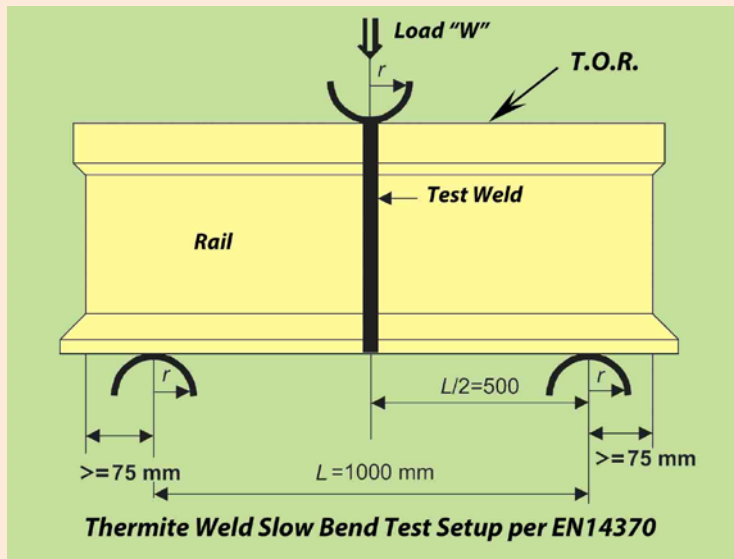
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## Case #5: Rail Welding Specs – Slow Bend Test



**Because there is no shear in the weld with the 4-point slow-bend test, often the break is outside the weld – a big waste of time & money!**

## Case #5: Rail Welding Specs – Slow Bend Test



**With European 3-point slow-bend test, break almost always occurs in the weld.**

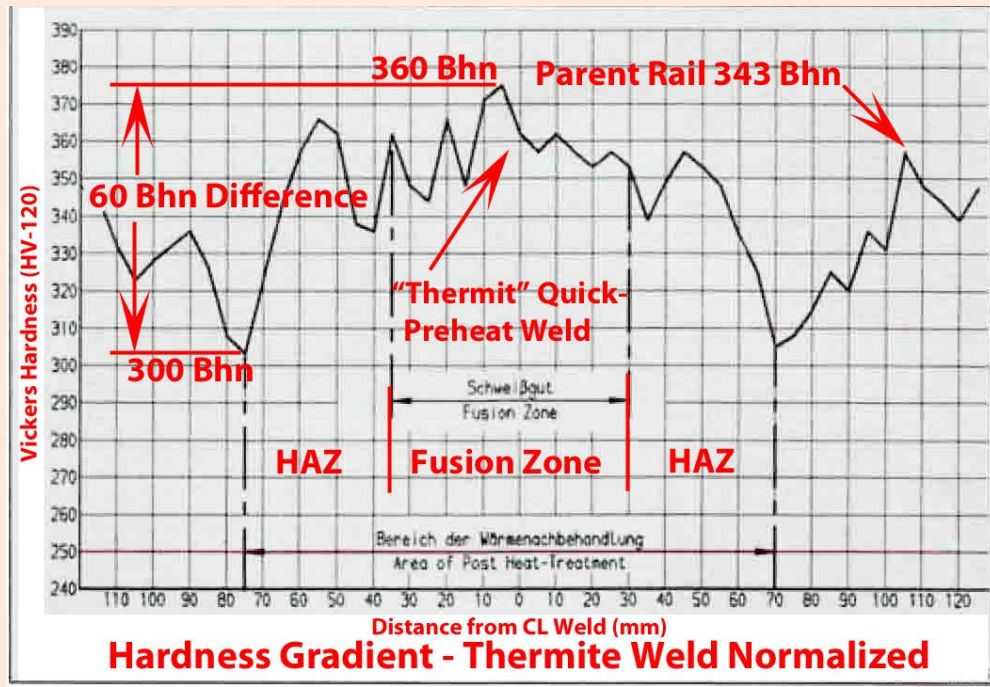
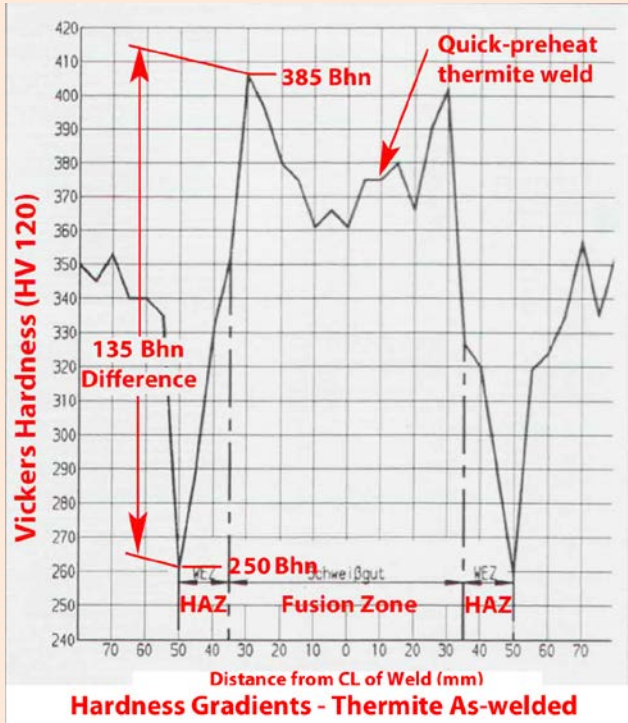
## Case #5: Rail Welding Specs – Normalizing HAZ



This equipment can “normalize” the entire weld area to reduce the great difference between the Bhn of the weld, parent rail and Heat-Affected Zones

The procedure adds 3-4 minutes to the time required to make a thermite weld; the only consumables are the heating gas & compressed air (in field, requires a portable compressor)

# Case #5: Rail Welding Specs – Slow Bend Test



**Before & After Comparison of Bhn Differences in Weld Zones**



# Case #6: Plinth & Grout Pad Construction

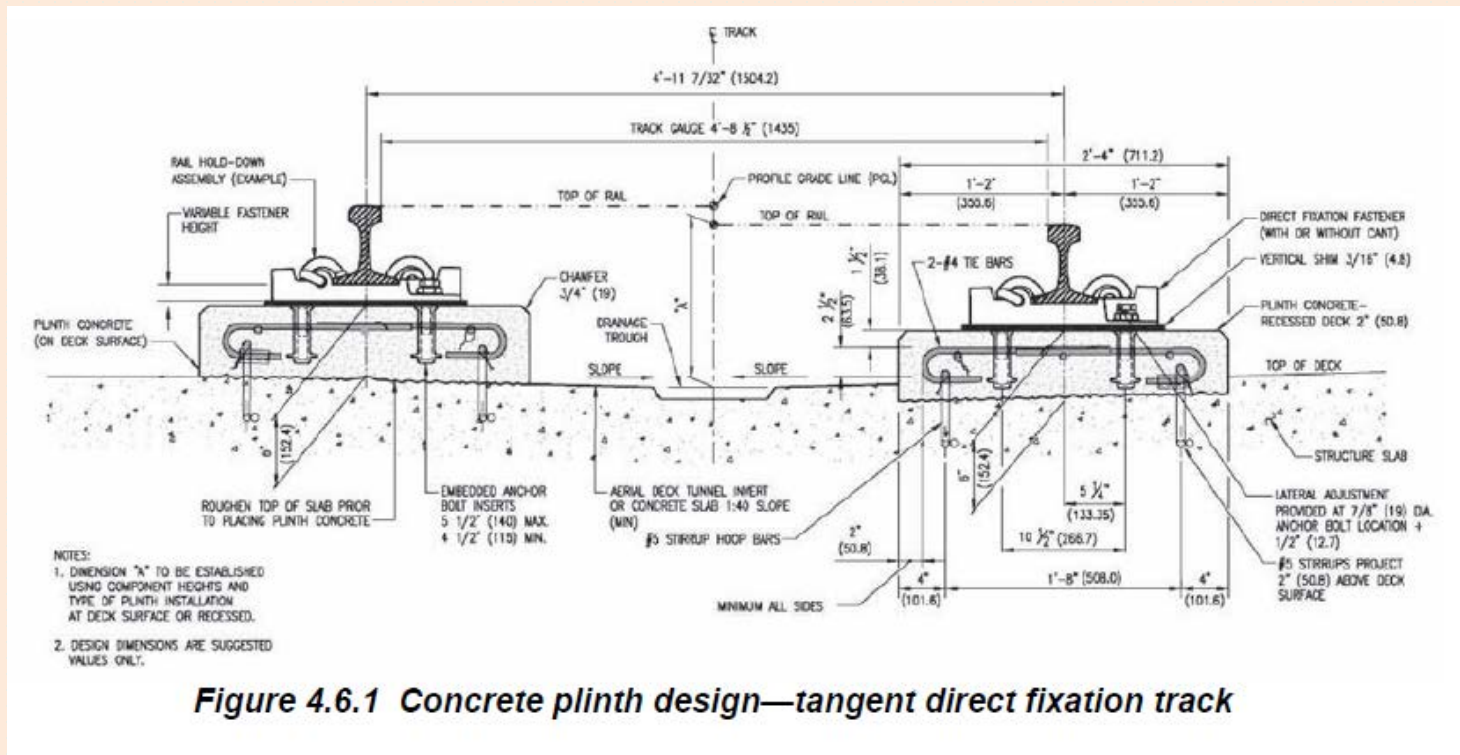
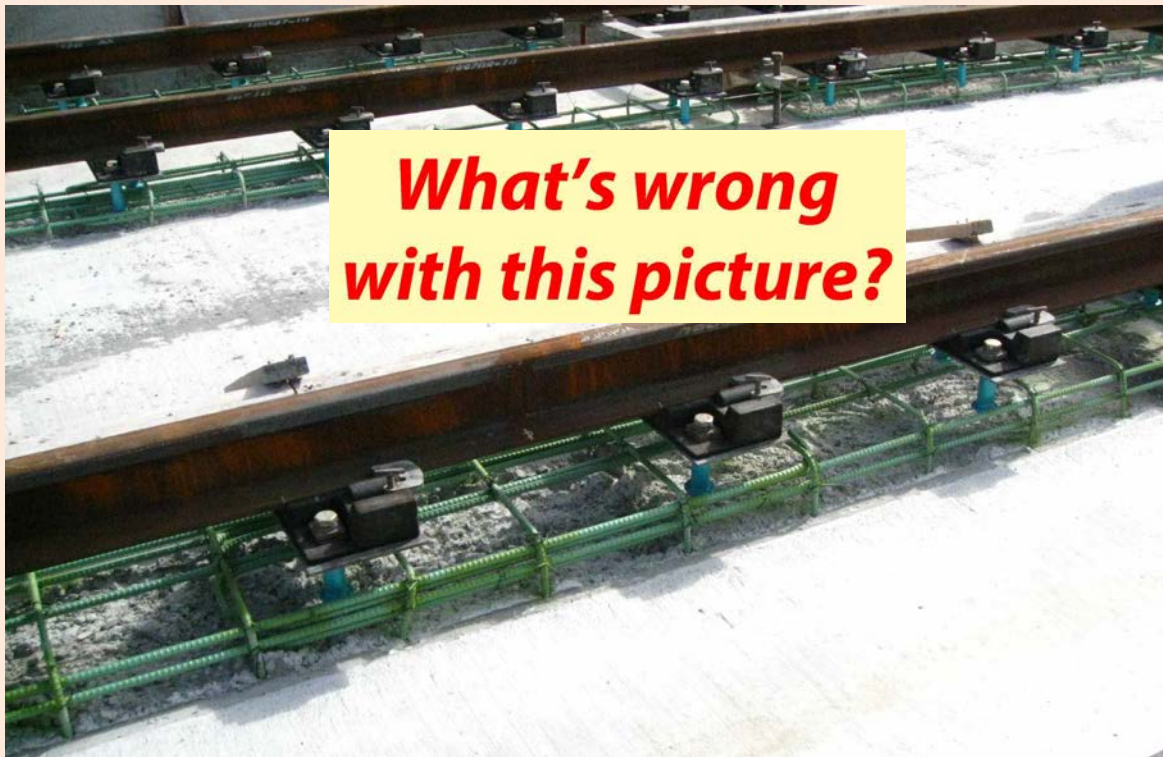


Figure 4.6.1 Concrete plinth design—tangent direct fixation track

## Case #6: Plinth & Grout Pad Construction



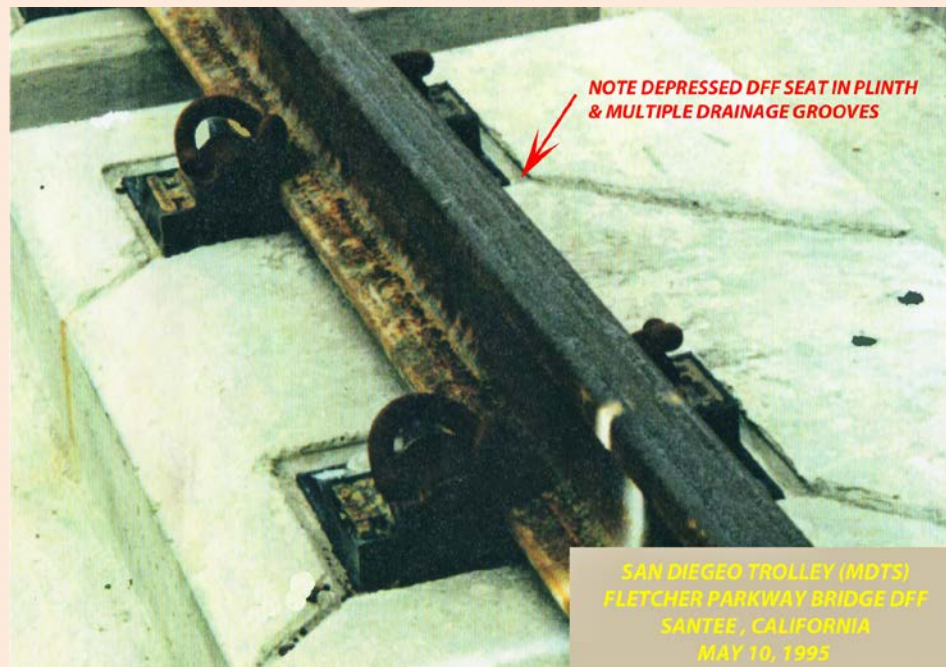
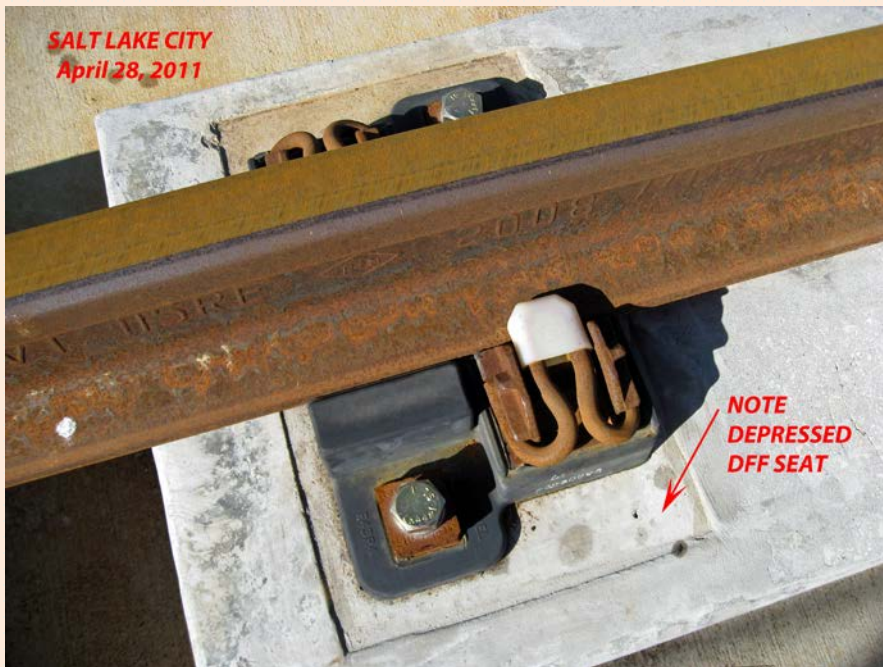
- Over-reinforced per PCA review
- Inadequate cover
- Insufficient scrabbling
- Inadequate size slobber plates
- Some inserts not vertical

## Case #6: Plinth & Grout Pad Construction



**Massive Voids: A problem with improper top-down construction**

# Case #6: Plinth & Grout Pad Construction



Depressed DFF Seats can help avoid cratering voids, but are banned by most const. specs

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## Case #6: Plinth & Grout Pad Construction

**Factors contributing to improper top-down construction**

- ❖ **Mix design – high W/CM ratio – excess water & shrinkage**
- ❖ **Improper concrete placement – especially vibration practices**
- ❖ **Rail temperature varies  $> 15^{\circ}$  F. during placement & initial set of PCC**
- ❖ **Inadequate size, strength & stability of “slobber” plates**

# Take Aways

- Some perpetuated track features date back to soft rail, cast-iron wheels, and a critical Nadal angle reached very quickly in service
- Some are CYA – it's been done that way for over 75 years, we won't change it and risk criticism and/or an E & O claim
- Some are lack of faith in one's engineering judgement and too much faith in prior criteria, designers & the Xerox machine
- ***Lastly, in my opinion, the Rail Transit industry would do well to invest in some research on these topics and apply some science to decide what features & methods have real benefits and what don't, and we'll get better tracks for less money!***      ***Thank You!***