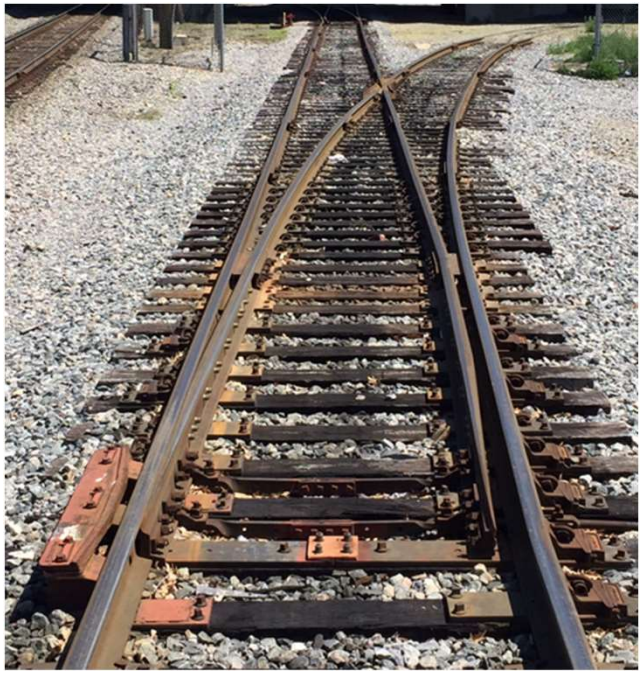
SPECIAL TRACKWORK IN HEAVY HAUL



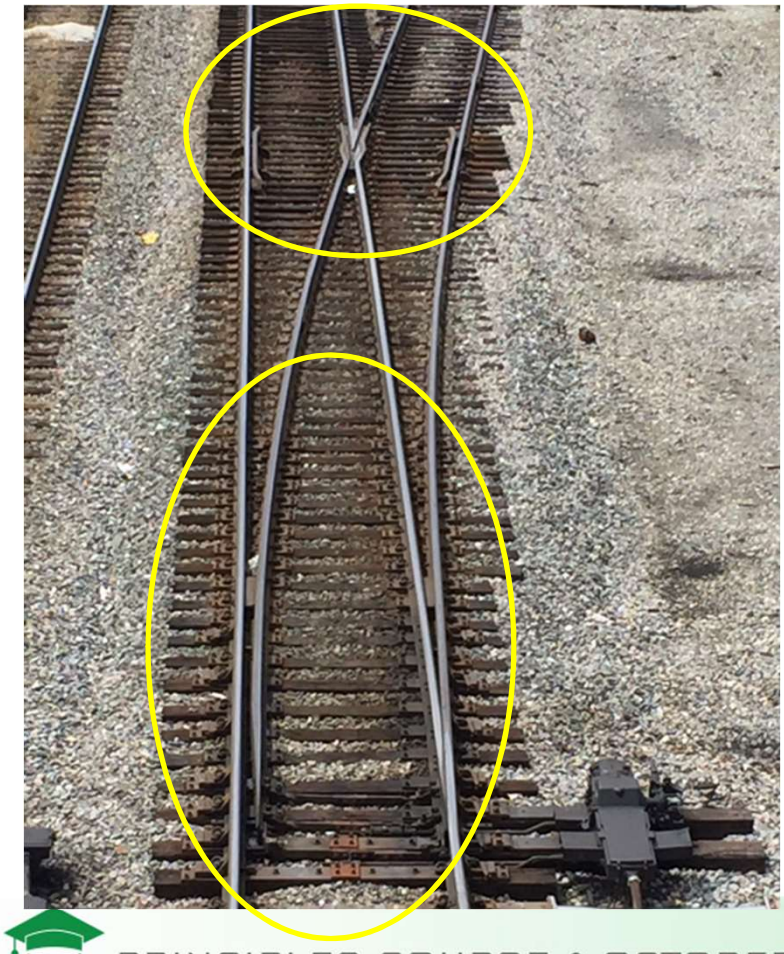
Brad Kerchof

Director Research & Tests (fired)
Norfolk Southern Railway

Senior Track Engineer (hired)
Advanced Rail Management

Outline

- Turnouts
  - Geometry
  - Switch points, stock rails & hardware
  - Frogs & guard rails
  - Continuous rail turnouts
- Diamonds
- Derails

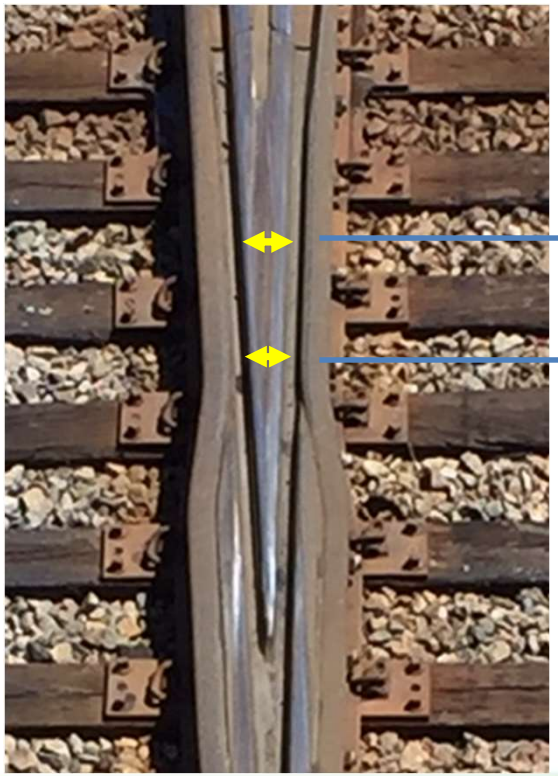


Turnouts

Frog section

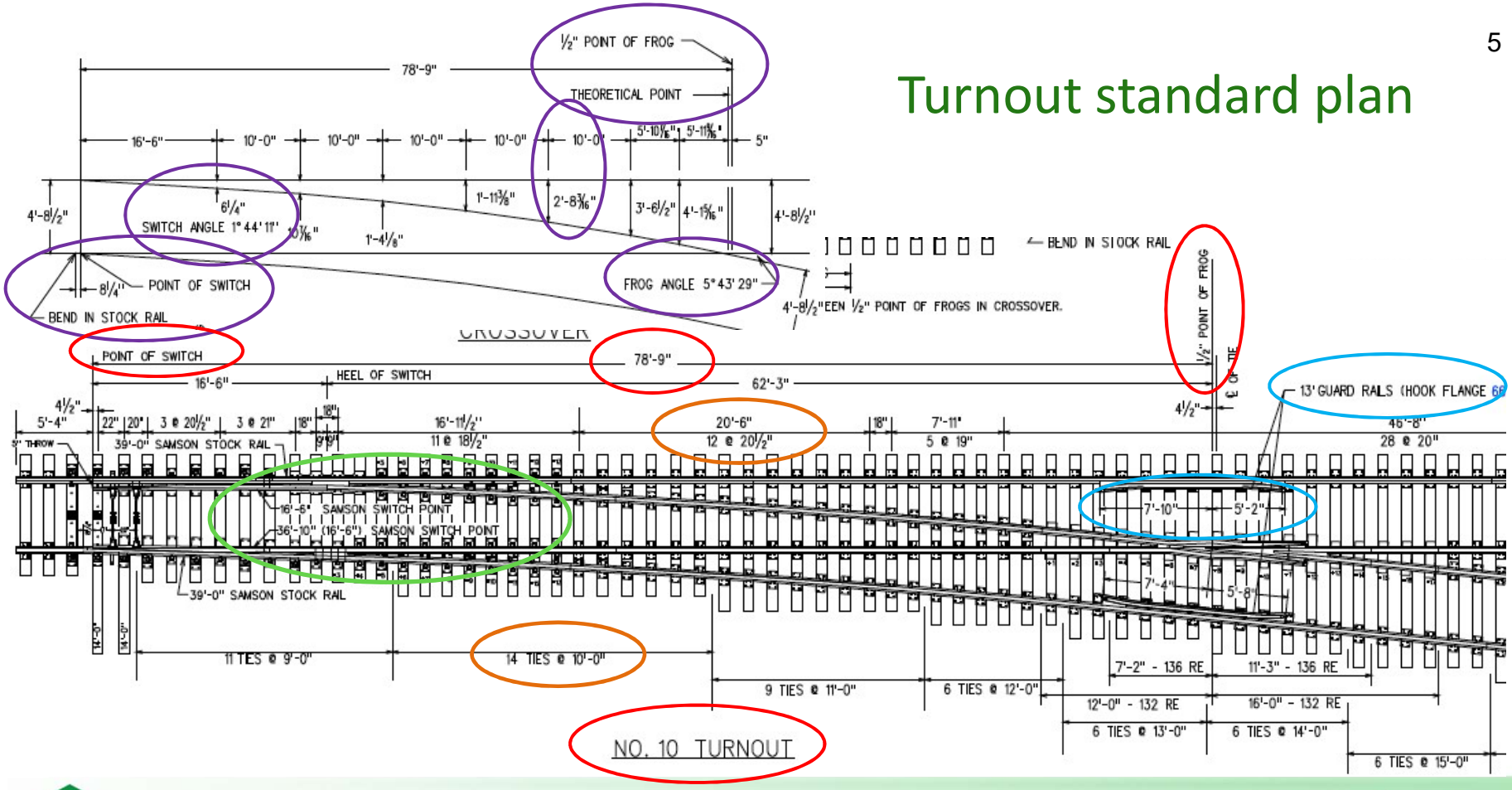
Switch point section

Turnout number



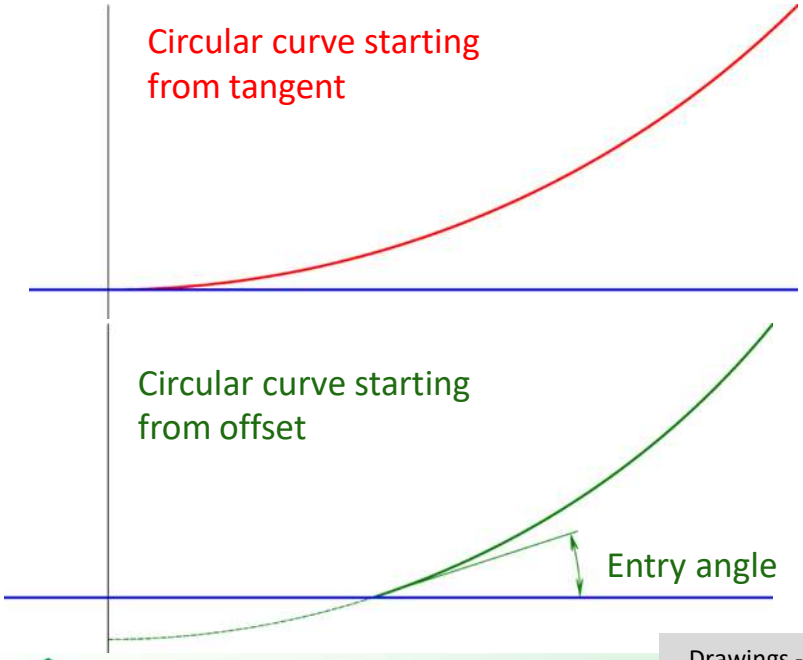
- Turnout number determined by the frog number
- Frog number is the ratio of point length to spread
  - Example: For a no. 15 frog, over a distance of 15”, the gage lines spread 1 ”
- The higher the frog number, the longer the frog; also the higher the diverging speed
- A frog number is usually associated with a particular switch point length and lead length

Turnout standard plan



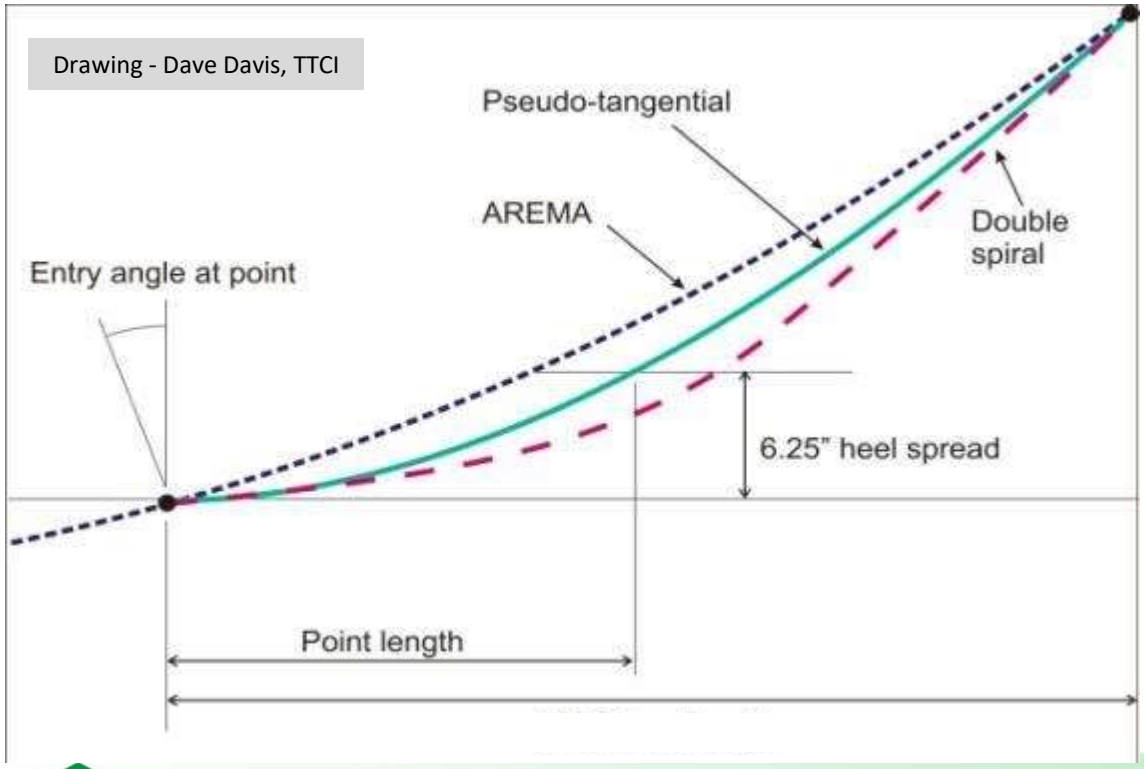
Switch point entry angle

Applies to the diverging point (straight point does not have an entry angle)



Drawings - Dave Davis, TTCI

Turnout geometry – 3 designs



Assuming the same lead length:

- AREMA uses a switch point entry angle and a simple curve (no spirals) -> minimum curvature
- Pseudo-tangential design uses a tangential switch point (no entry angle) and a simple curve -> higher curvature
- Double spiral design uses a tangential switch point and a curve with two spirals -> highest curvature

Turnout geometry

T/O (Frog) Number	Diverging Speed	Switch Point Length	Lead Length[1]	Overall Length[2]	Switch Point Entry Angle	Curvature Lead	Frog Angle
6	10	13'	47' - 5"	66'	1° - 41'	22°	9° - 31'
8	15	16' - 6"	68'	93'	1° - 04'	12°	7° - 09'
10	15	16' -6"	78' - 9"	111'	1° - 04'	7° - 30'	5° - 43'
15	30	26'	126' - 4-1/2"	172'	0° - 50'	3° - 15'	3° - 49'
20	40	39'	156' - 0-1/2"	220'	0° - 27'	1° - 30'	2° - 51'
32.75	80	85' - 3"	299' - 9"	407'	0° - 3'	0° - 34'	1° - 45'

[1] Lead length measured from PS to 1/2" frog point

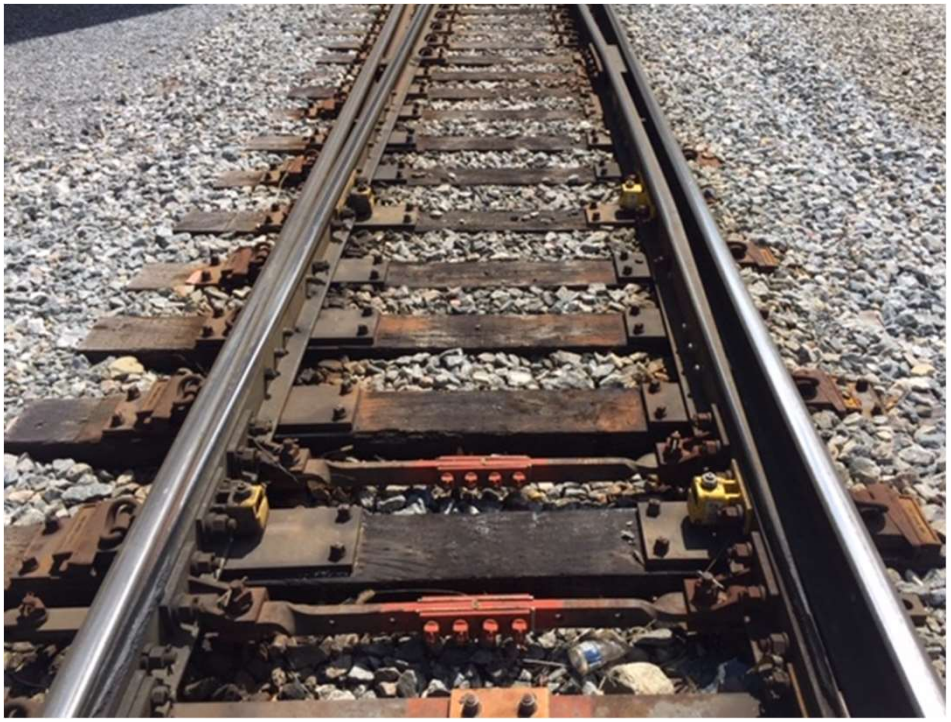
[2] Overall length measured from PS to last long timber

Sources: AREMA standard plans, Norfok Southern standard plans & Nortrak

Which size turnout to use?

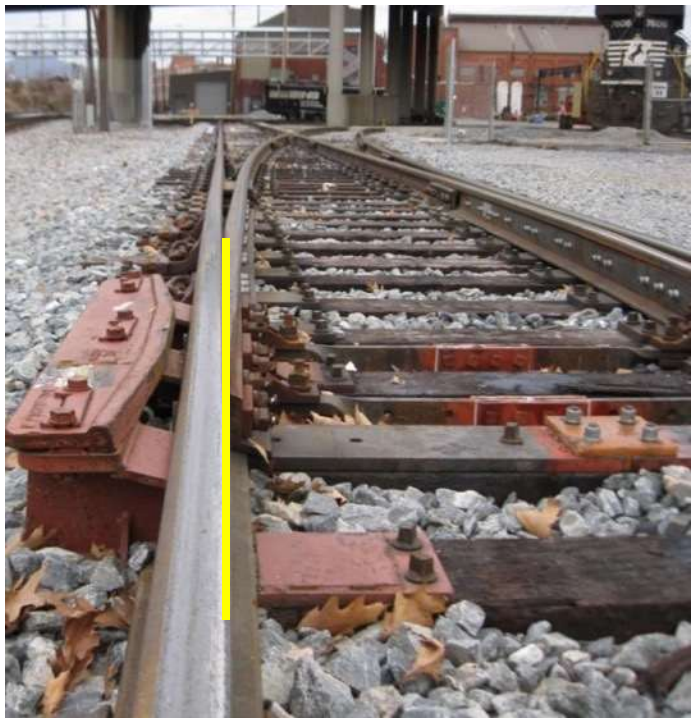
1) Diverging route speed
2) Space available

Switch point section



- Switch points – straight & diverging
- Stock rails – straight & bent
- Heel blocks – welded & bolted
- Switch rods & clips – horizontal & vertical
- Stock rail brace plates
- Switch point protectors

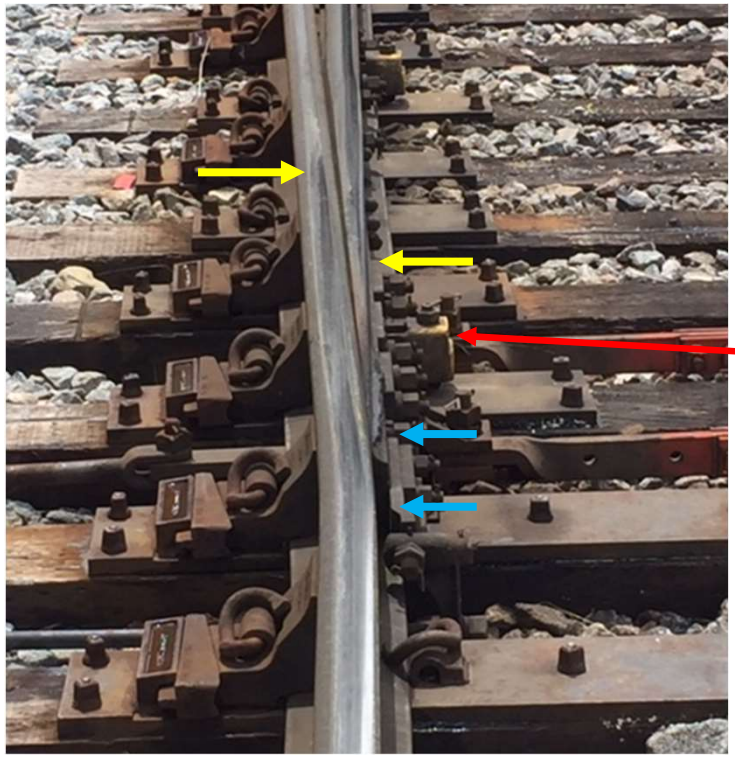
Straight (normal) vs. reverse (diverging) points



The straight point is tucked behind the bend in the stock rail and is even with the "gage line."

The reverse point rests against a straight stock rail and is in front of the "gage line."

Bent stock rail & straight point



- Point is 8-1/4” behind the bend (16’ – 6” point)
- Gage plates, brace plates, switch plates
- Switch rods & clips
- Switch point rollers

Q: Why does the wheel transition between stock rail & switch point take place over some distance? (between yellow arrows)

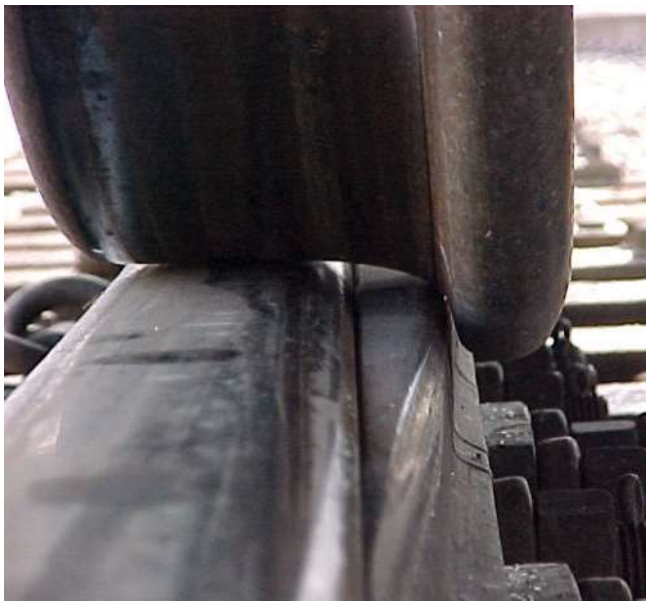
A: Different wheel profiles pick up or drop off at different spots

Bent stock rail & straight point

What's wrong with this picture?

A: The switch point was installed too far ahead – the PS is right at the stock rail bend!

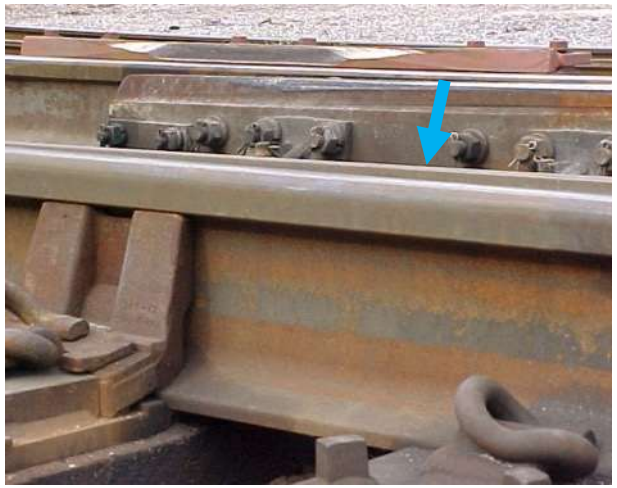
Switch point - stock rail wheel transition



Switch point below stock rail

Switch point above stock rail

What is the design height difference between switch point & stock rail?

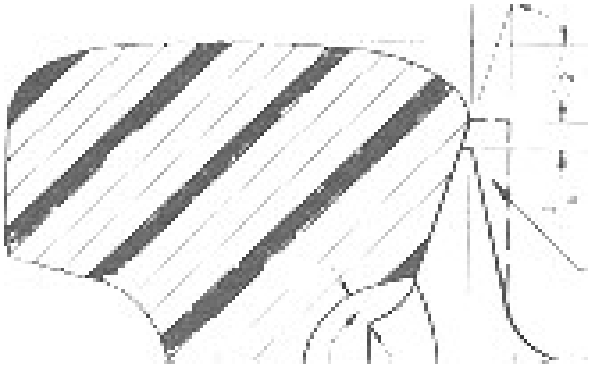


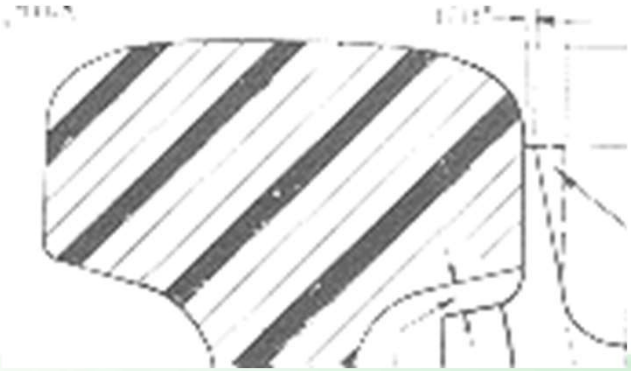
What's going on here?

A: The point has worn down to the same height as the stock rail

The switch point, at its tip, is **3/4 inch** below the stock rail; the point then rises gradually until it is **1/4 inch** above the stock rail.

Samson (undercut) vs. plain (housed) points





Heel blocks – welded vs. bolted

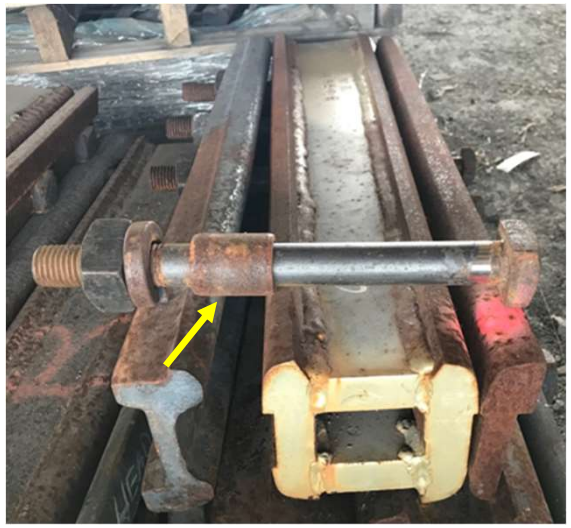
Bolted design: Switch point and lead rail are connected by a hinged joint. Advantage: easier to operate

Welded design: Switch point is longer so that it can be welded to the lead rail (so no joint). Heel block is bolted to the stock rail and serves as a stop. Advantages: lower cost, less maintenance (no impact)

Bolted heel block

Features of a standard heel block:

- 5 bolts (instead of 6)
- The joint is designed to act like a hinge, giving the switch point space to move
  - Inside bar is bent
  - First bolt has spacer (or shoulder) that holds the inside bar open



Switch rods & horizontal clips

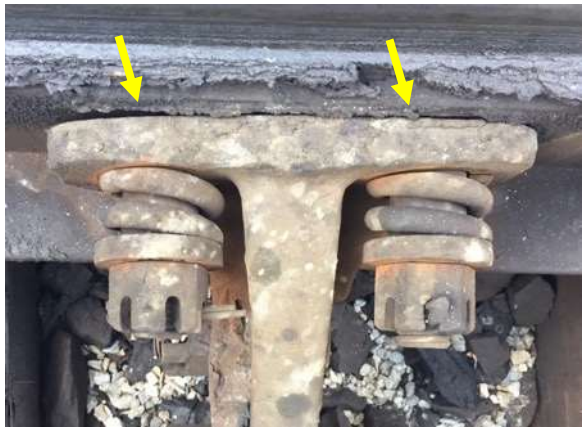
Switch rods connect the two points together so that they move as a pair

Switch rods also keep points from raising up above the stock rail

Photos 1 & 2 show clips for horizontal rods. See a difference?

A: In photo 1 the washer is compressed (too tight!).
The assembly is designed to allow the rod to rotate in the jaw of the clip.

Vertical switch rods & rocker clips



With a rocker clip, the “hinge” is provided by the convex backside of the clip.

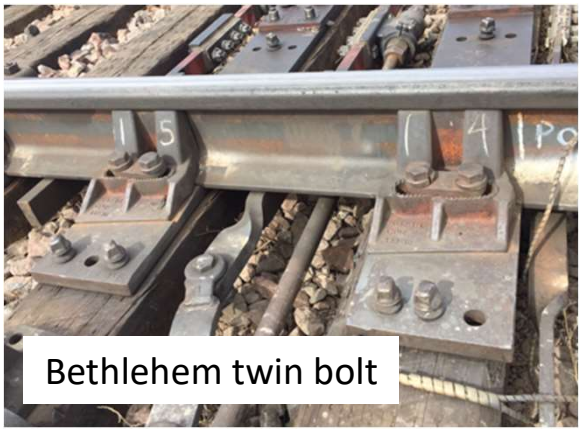
The bolt holes in the rod are oval, allowing adjustment of the point spread.

Serrations on the mating rod & clip faces help secure the connection.

Stock rail braces

CTM “EVR”

Progress Rail



Bethlehem twin bolt

Nortrak

Stock rail braces

- hold the base of the stock rail in the switch plate rail seat
- resist outward movement of the stock rail

Switch point protectors

Western Cullen Hayes has an adjustable and replaceable wear bar

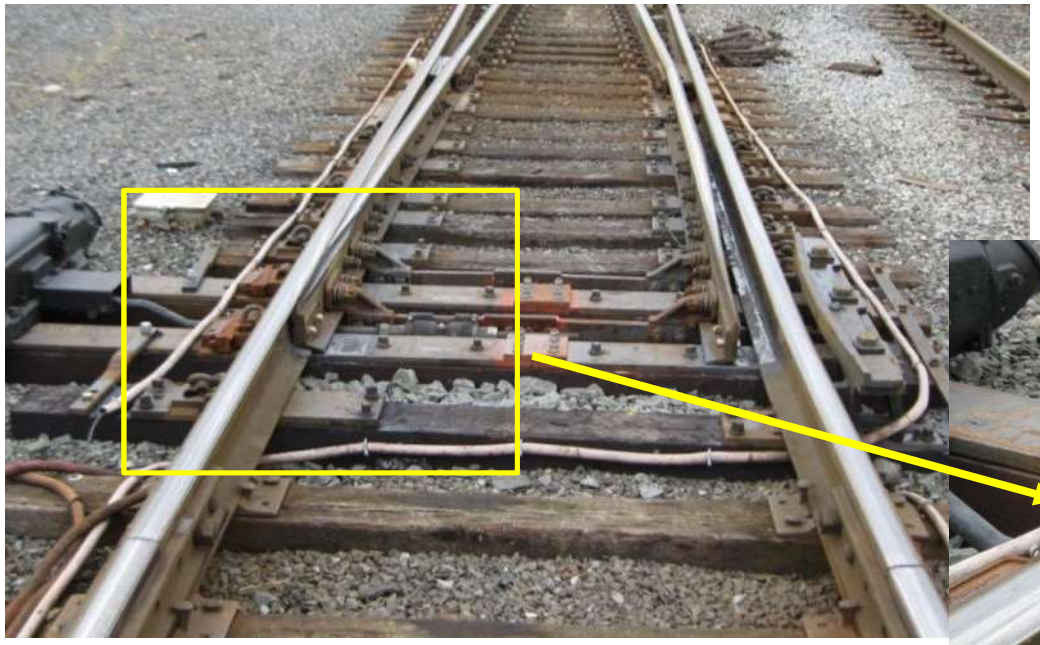
Switch point protectors

Western Cullen Hayes has an adjustable and replaceable wear bar

Photo – Allan McIntyre

The Bethlehem design uses a machined piece of rail as the wear bar; it is not adjustable

Switch point protectors: What's wrong with this picture?



The protector is on the wrong side - it is protecting the straight point. The reverse point is showing wear.

Frogs

Features - fixed point, fixed wings, open flangeway

- Two types: RBM and WBM
- Because of an open flangeway, guard rails are needed to guide wheels by the frog point

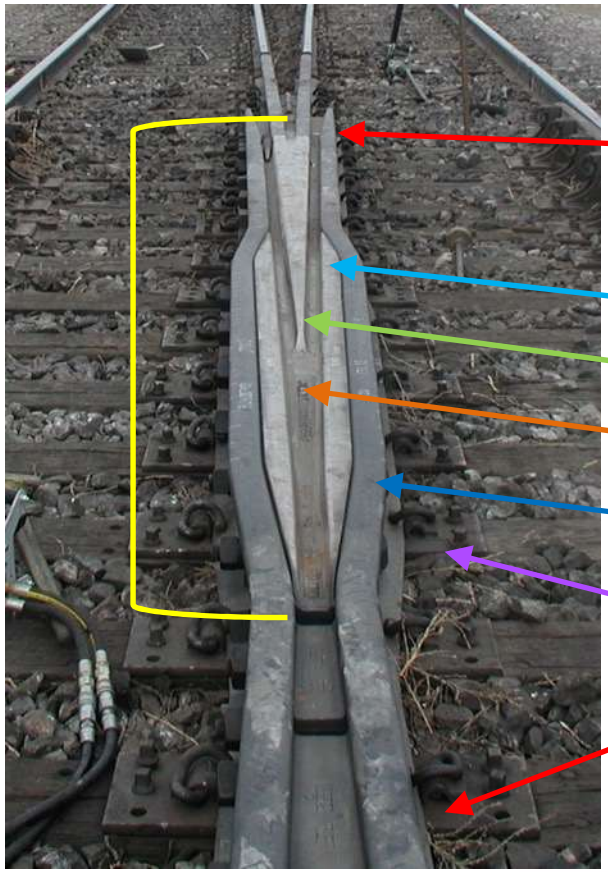
Frog point geometry

5/8” POF - where the gage lines are 5/8” apart, where the point reaches its (almost) full height, and where wheel contact begins

1/2” POF – where the gage lines are 1/2” apart, often indicated by a mark on the point ramp; also the location referenced by design plans and field measurements

Theoretical POF – where the gage lines converge; often marked on the bottom of the flangeway; located 1/2 the frog number (in inches) ahead of the 1/2” POF

RBM (rail-bound manganese)

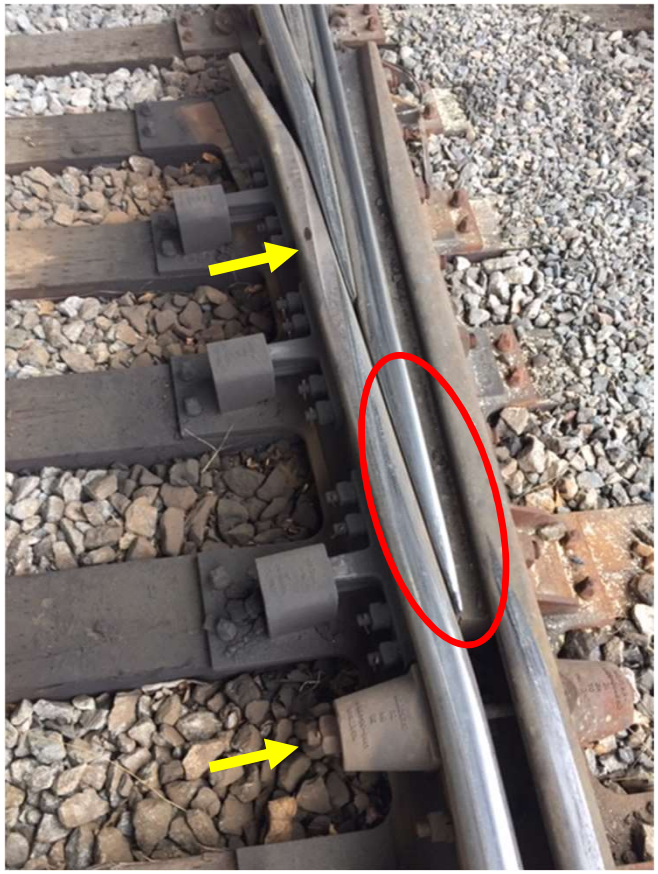


Two impact locations:

1) point/wing transition
2) heel

WBM (welded – boltless manganese)

- Fixed point, fixed wings, open flangeway
- Body of frog is a solid manganese casting
- The toe and heel connections are made with a special flashbutt weld - rail steel / stainless steel / manganese steel
- Only 1 impact location: point/wing transition



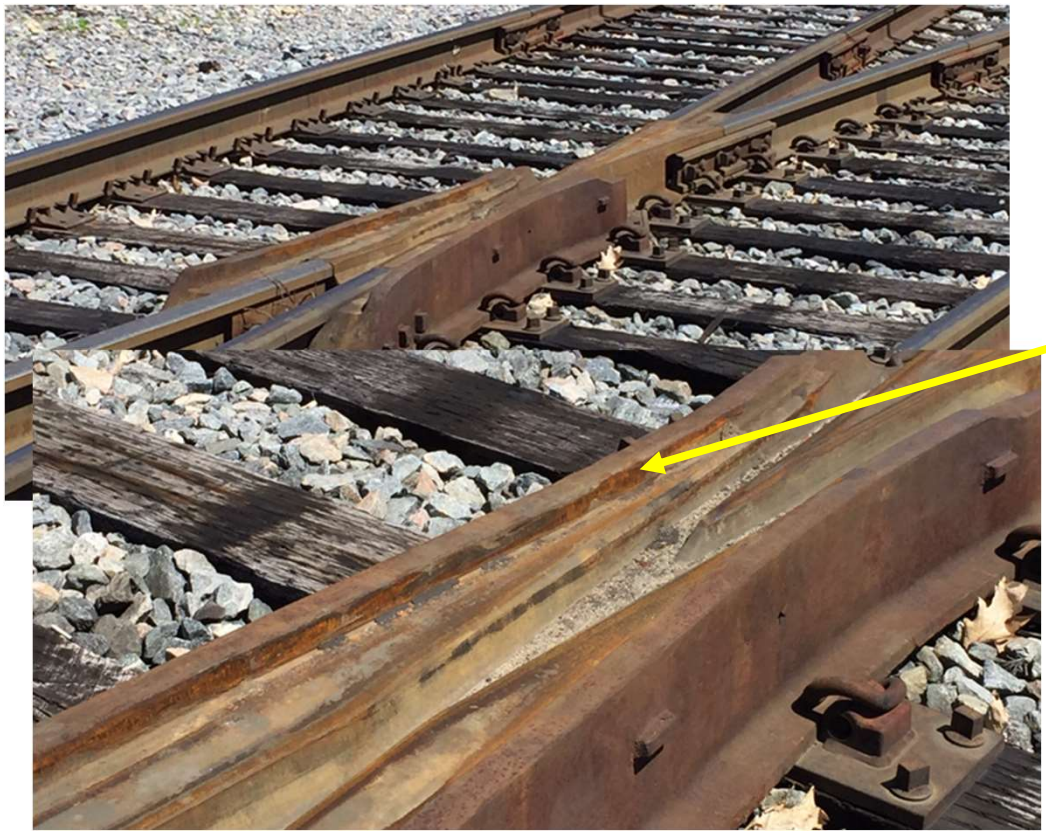
Spring frog

- For diverging moves, the back of the wheel flange bears against the wing rail, prying it open (and compressing a spring)
- Mainline moves are low impact - wheels transition from wing rail to point rail without traversing a flangeway
- Disadvantage: heavy diverging traffic can result in bolt-hole failure to the wing rail

Moveable-point frog

- Frog point is lined for desired route by a switch machine
- Low impact on both straight and diverging moves (no flangeway)
- Low maintenance (only grinding)
- Most expensive option (due to switch machine)
- Amtrak's choice for its high-speed turnouts on the NEC

Photo - Dave Davis

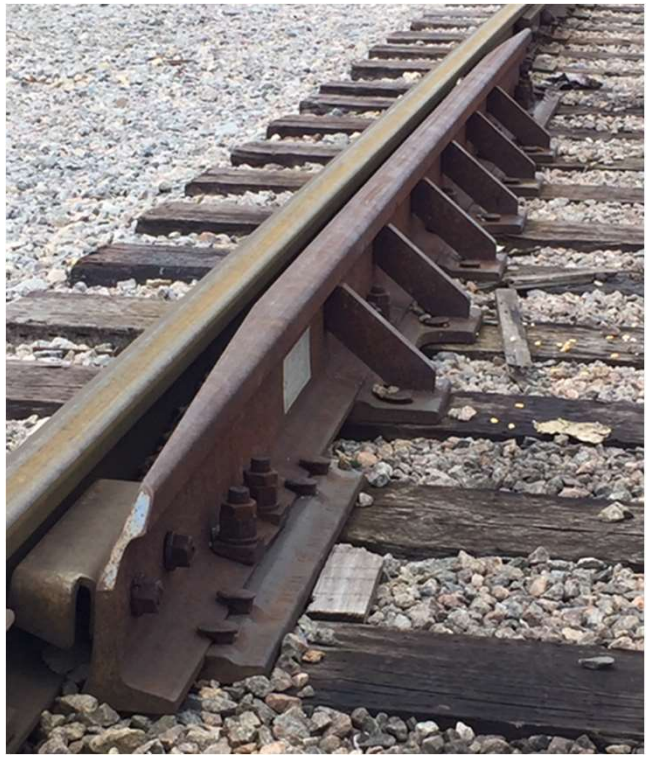


Self-guarded frog

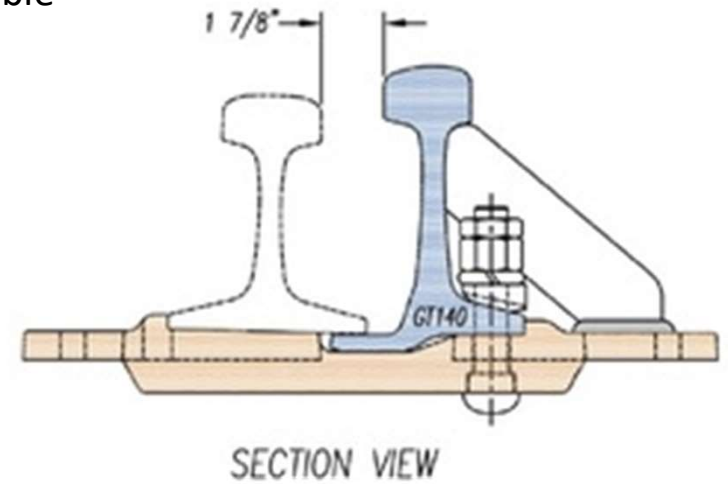
- Entire frog is a casting
- Raised guard contacts wheel rim face and guides wheel flange clear of the point
- Does not need a guard rail
- Intended for yard tracks: speed limit 15 mph, sizes no. 6 - 10

Guard rails

Hook flange guard rail



- Was a standard on many railroads until recently
- Least cost
- Easy to install
- Not adjustable



SECTION VIEW

C-clamp guard rail

- More work to install
- Adjustable, but very difficult (the guard rail has to be disassembled)
- An N&W design, then NS's standard, now obsolete

Nortrak Vanguard (U-69) guard rail

- Easy to adjust
- An industry standard

Not shimmed
(shims stored)

To adjust, move shims to shift guard rail inward

Continuous rail turnout - vertical switch

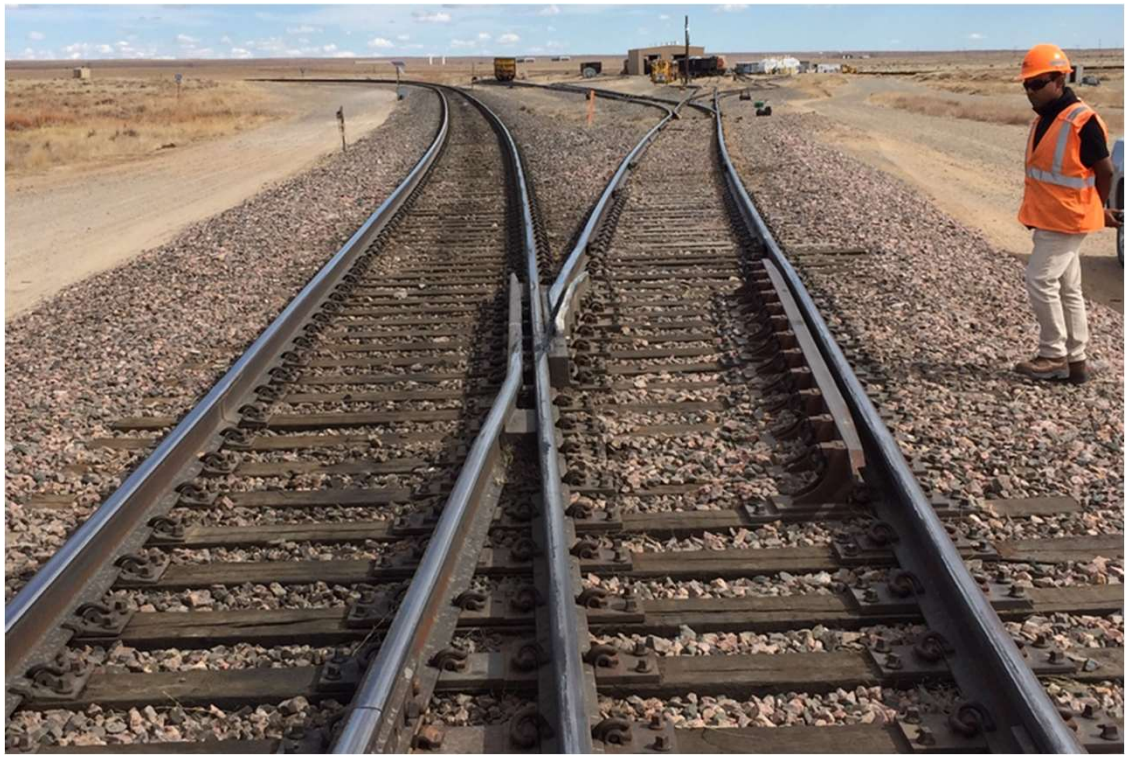
Photos - Dave Davis

Objective: Eliminate wheel impact on mainline route

Method: Both mainline rails are continuous. Switch point overlaps running rail to lift wheels up and over

Application: Slow speed, low-tonnage industry or set-out tracks

Continuous rail turnout - lift frog



What do you notice?

1) No guard rail on straight side
2) A continuous rail through the frog - no flangeway for diverging route wheels

Lift frog has a raised running rail on diverging side

Lift frog – diverging moves

Wheels are flange-bearing while crossing over the main line running rail

Lift frog - turnout side running rail

Turnout-side rail is bent to allow a one-inch raise through the guard rail

Crossing diamonds – six designs described






Crossing diamonds – solid manganese

Each corner is a solid manganese casting; four castings are bolted together to create the full crossing

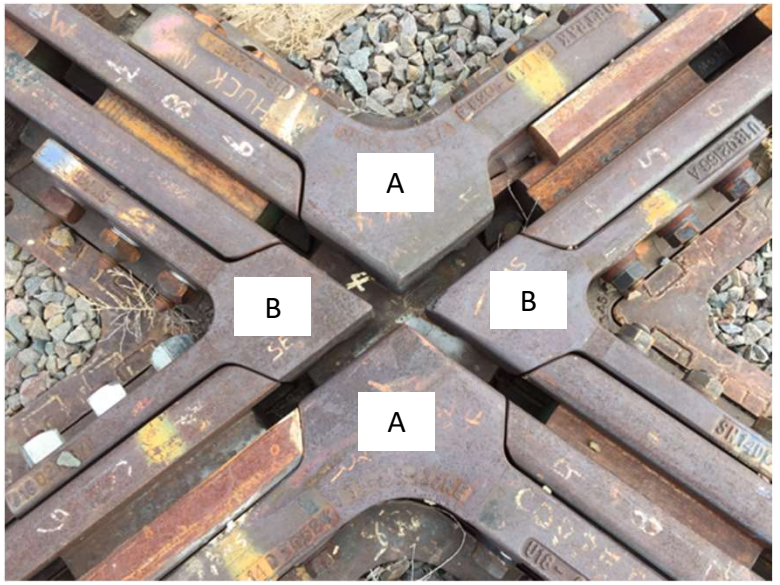
Crossing diamonds – solid rail

Crossing is an assembly of machined rail sections and filler blocks - sometimes called a 3-rail diamond.

Crossing diamonds – reversible manganese insert

Four manganese castings are connected by short (bent) rails and straps; the castings are interchangeable & reversible

Crossing diamonds – straight rail reversible casting



Each corner is an assembly of four smaller manganese castings, short rails and filler blocks.
Similar castings are interchangeable and reversible.

Crossing diamonds – OWLS and flange-bearing

A one-way low-speed diamond has continuous rails on the heavy tonnage route and flangeway ramps on the low tonnage route

A flange bearing diamond has flangeway ramps on both routes and is flange-bearing through the crossing

Derails - hinged & sliding

Photo – Allan McIntyre

Derails - switch point & portable

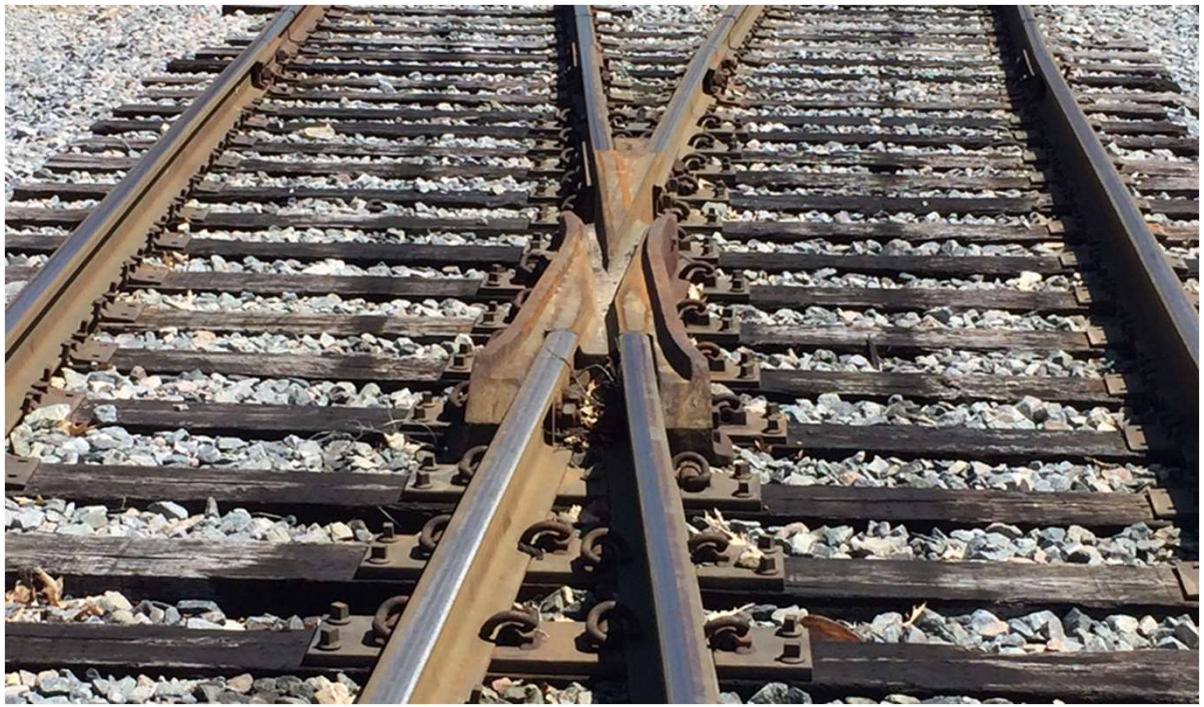
Photo - Dave Davis

Photo – Allan McIntyre

A sliding derail: what could go wrong?

Hint: think rolling radius differential

Thank you!



Switch point & stock rail failure modes

Expansion joints (Conley joints shown)

Purpose: To allow for rail expansion, typically on an open-deck bridge where the rail is not anchored

Miter rails for lift and Bascule bridges

CMI-Promex Ridex rail joint – a “rider” rail on the field side carries the wheel thread across the miter joint

CTM uses tapered rail ends to support wheels across the joint. These rails also have a thick web, which creates a stiffer rail

Miter rails for swing bridges

These miter rails have tapered ends and a thick web. (The thick web, developed by Amtrak for its higher-speed movable bridges, provides better support for the rail head at the joint).

Rails on the movable side are restrained laterally by “bed plates” and wedges. These rails bend as the toe lifts up to clear the fixed-end rails.