


Low-Impact Special Trackwork Research at Transportation Technology Center, Inc.

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Low Impact Special Trackwork for Heavy Haul Freight Operations

Background:

- Heavy Axle Loads
  - **Compelling Economics**
  - **Effects of wheel loads on special trackwork**
- Third leading track cause of accidents
- Cost Center – 10-100 x more expensive to operate than conventional track
- Capacity Stealer – many condition related speed restrictions. >$500M per year
- Performance improvements under HAL
  - **50% reduction in maintenance**
  - **100%+ increase in service life**

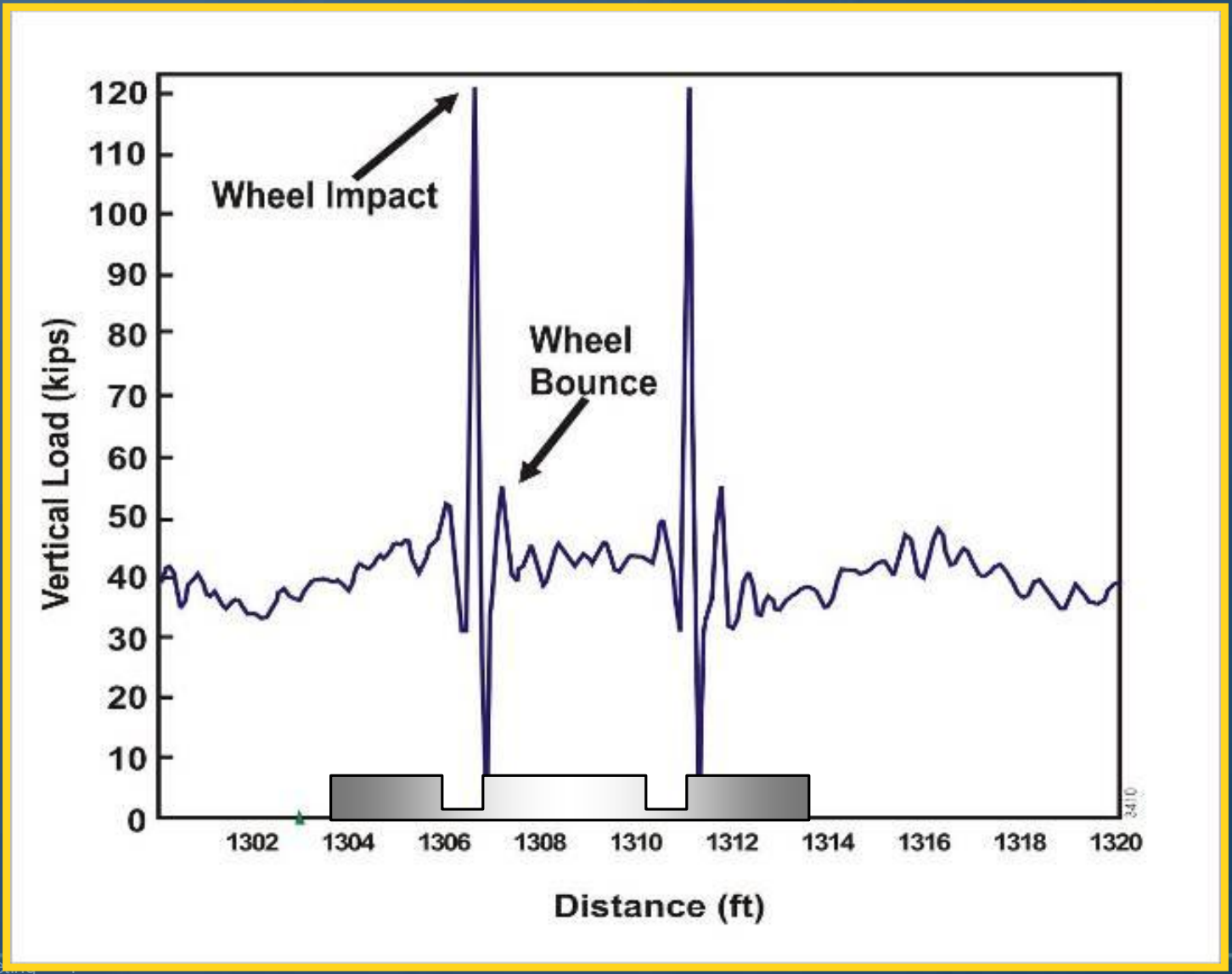
Low Impact Special Trackwork for Heavy Haul Freight Operations

Technologies Successfully Implemented:

- Flange Bearing Frogs
  - **Diamond Crossings**
  - **Turnout Frogs**
- Improved Switch Geometries
  - **Low Entry Angle Switches for HAL**
- Frog Running Surface Profiles
  - **Conformal Profiles**
  - **Ramps for High Angle Frogs**
  - **Curved Entry Guard Rails**
- Foundations for Frogs

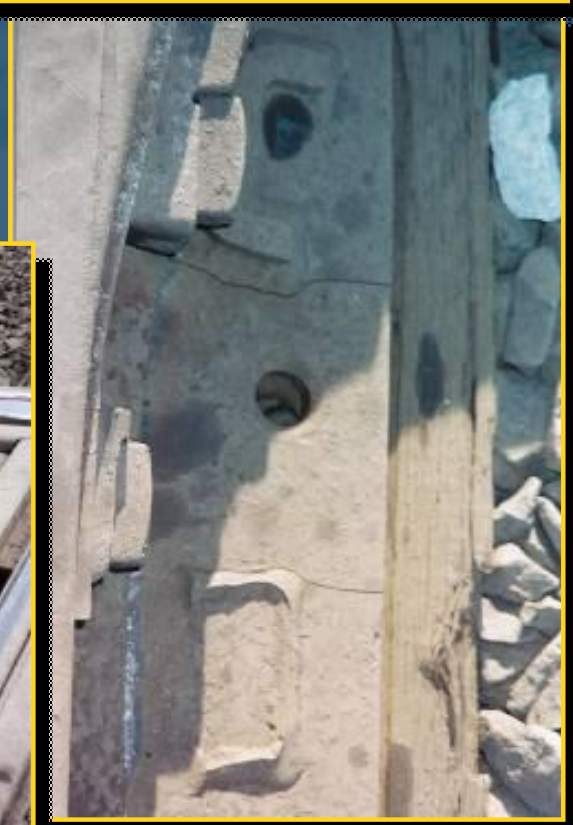
Load Environment

- Vertical loads on high angle diamond crossing at FAST (315 K hopper)



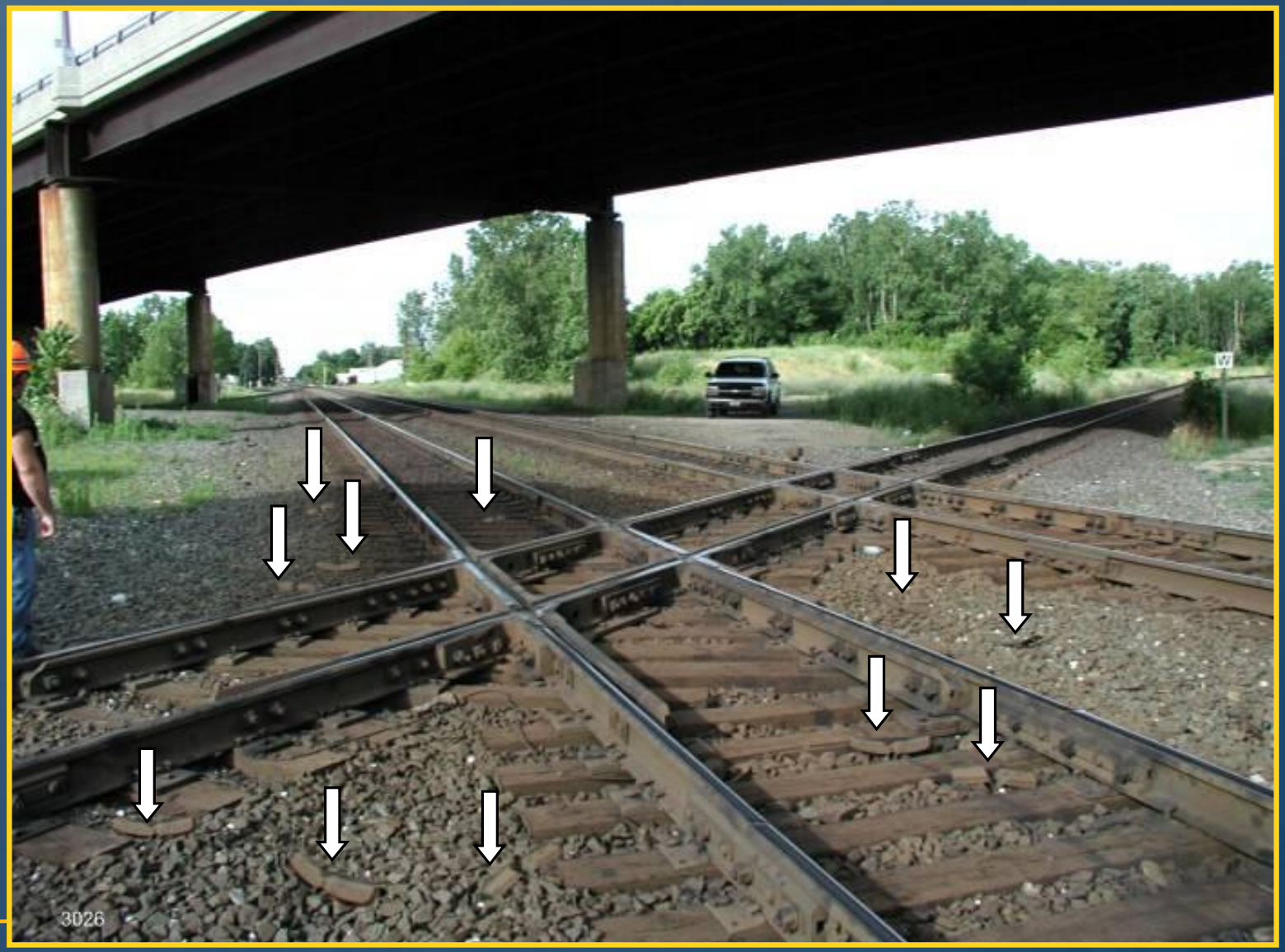
Vehicle Performance on Diamond Crossings

Pictures of damage to diamonds



Diamond Crossings
Track Transition Problems

Background: Car parts graveyard around diamond



Types of Crossing Diamonds

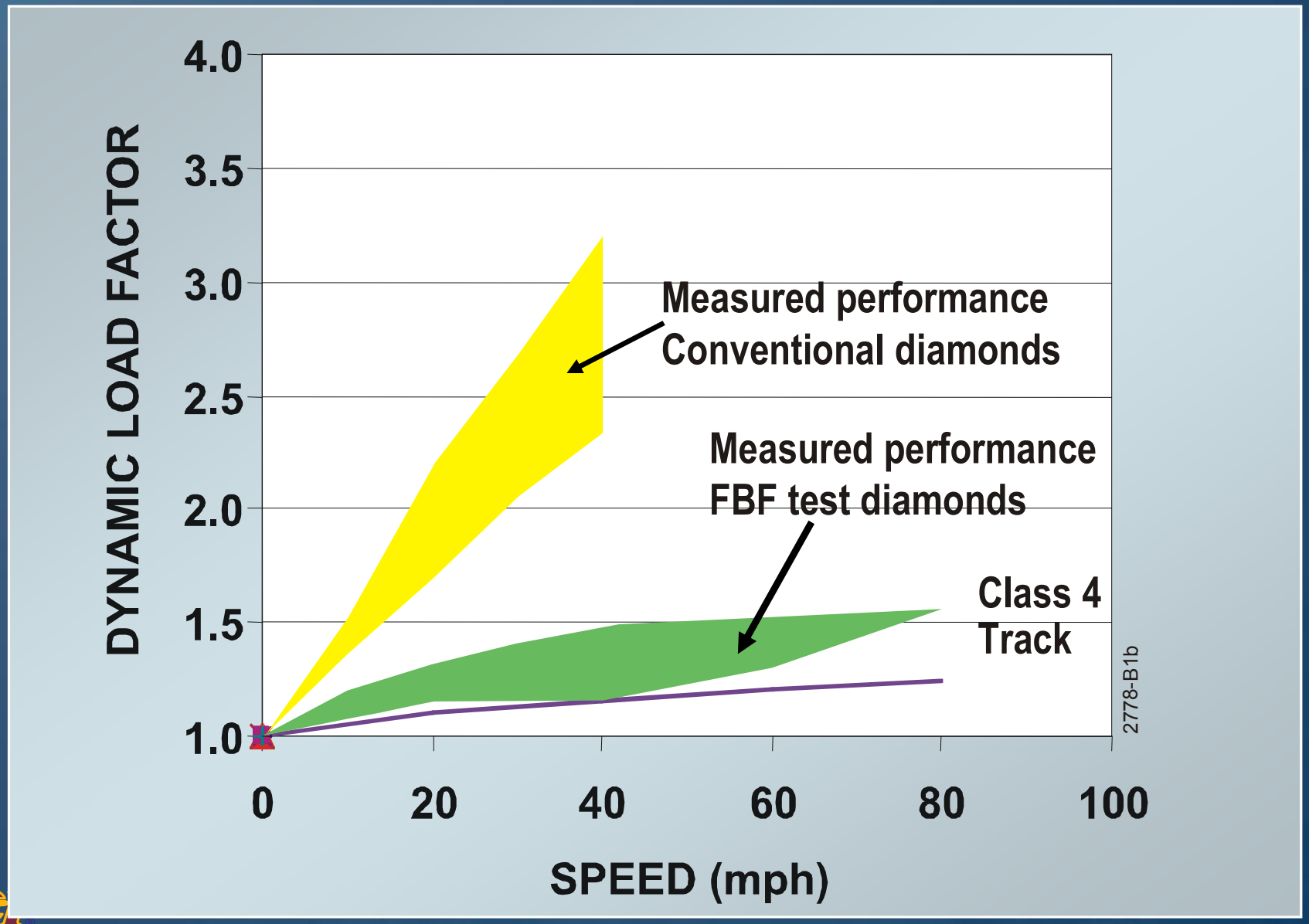
- **Conventional Tread Bearing Frog**
  - Unsupported flangeway gaps
  - Wheel is tread bearing throughout
    - Advantages:
      - Lower first cost
      - Allowed by FRA Track Safety standards
- **Flange Bearing Frog**
  - Continuous wheel support
  - Wheel transitions from tread to flange bearing
    - Advantages:
      - Lower dynamic loads

Types of Crossing Diamonds

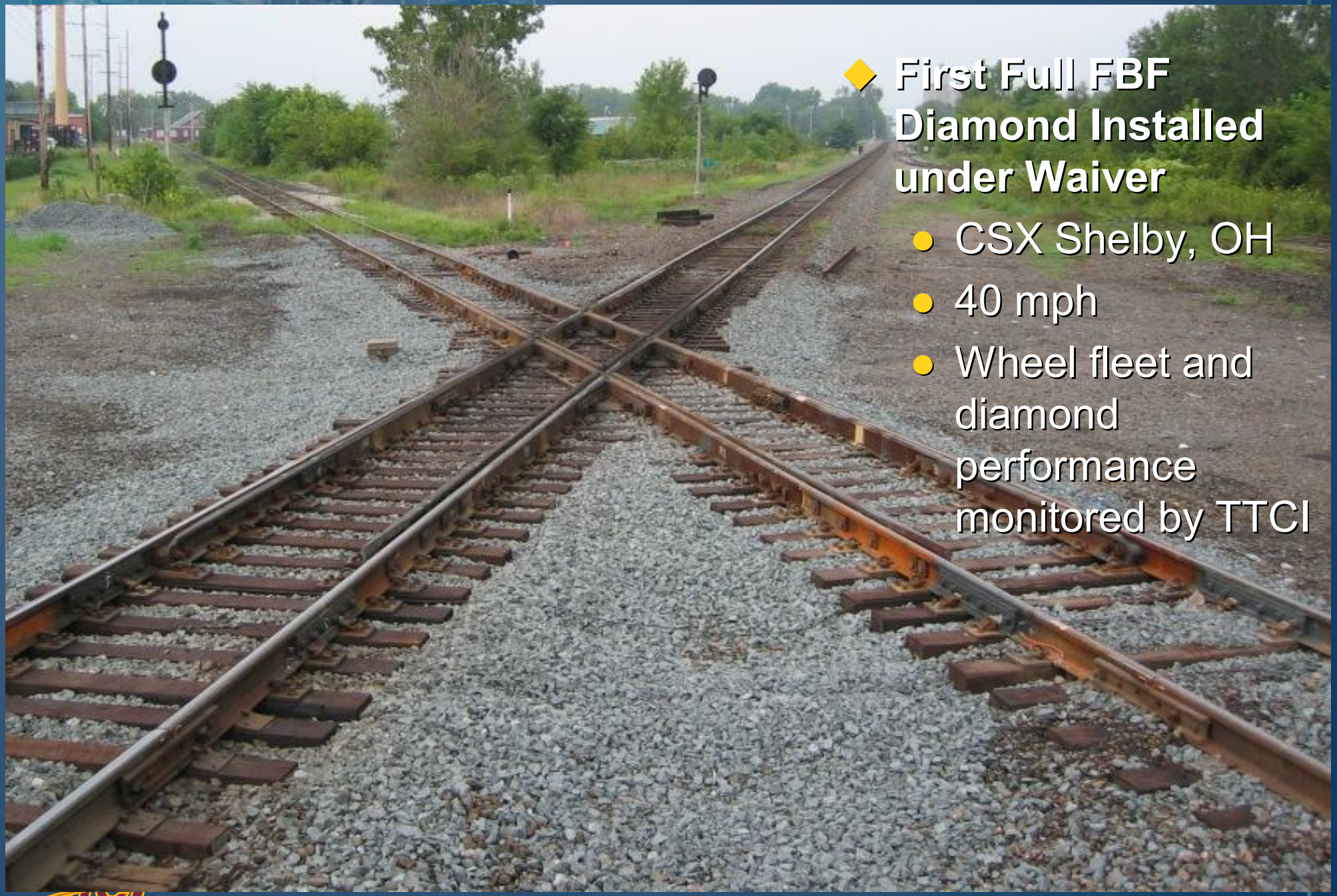
- Flange Bearing Frog

Crossing Diamond Dynamic Loads

Potential to Reduce Dynamic Loads



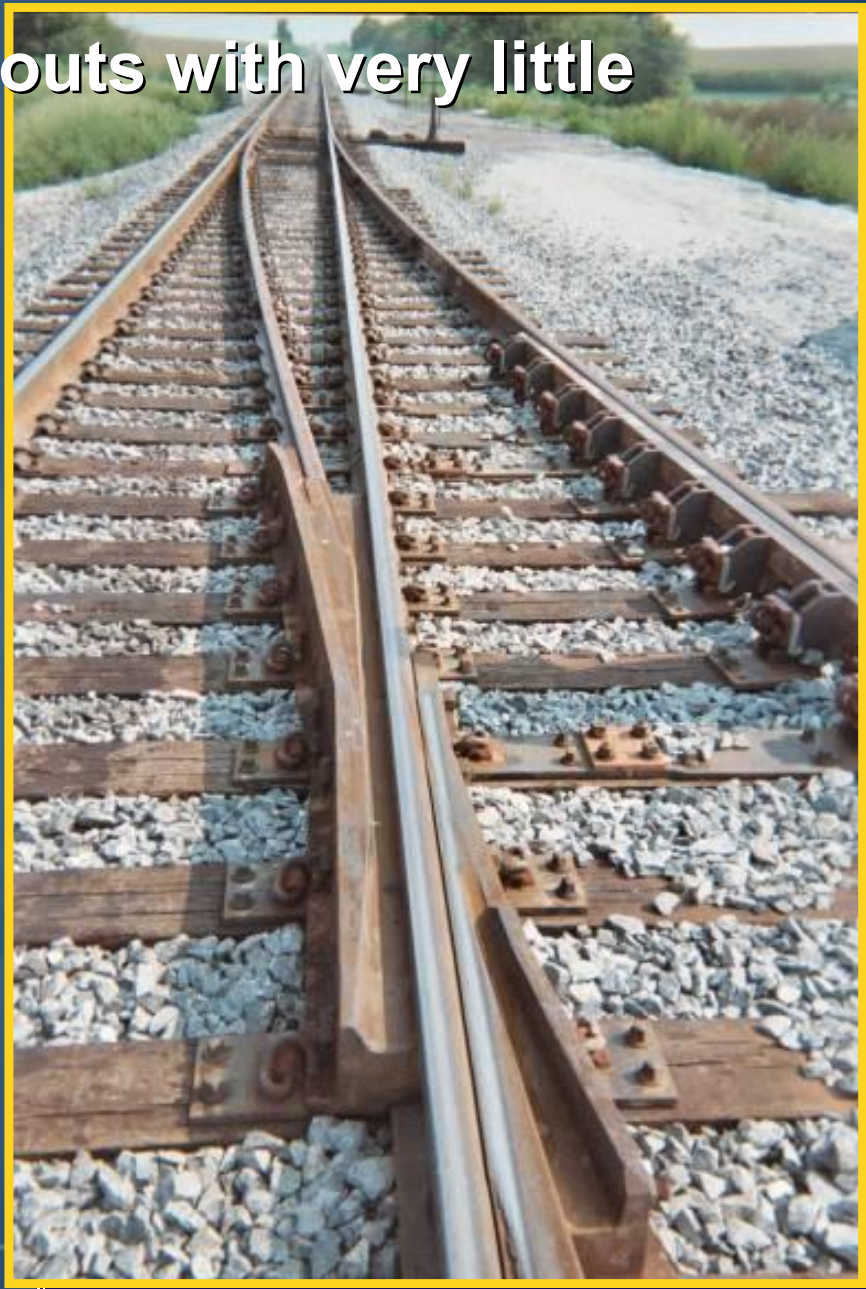
Flange Bearing Frogs



- **First Full FBF Diamond Installed under Waiver**
  - CSX Shelby, OH
  - 40 mph
  - Wheel fleet and diamond performance monitored by TTCI

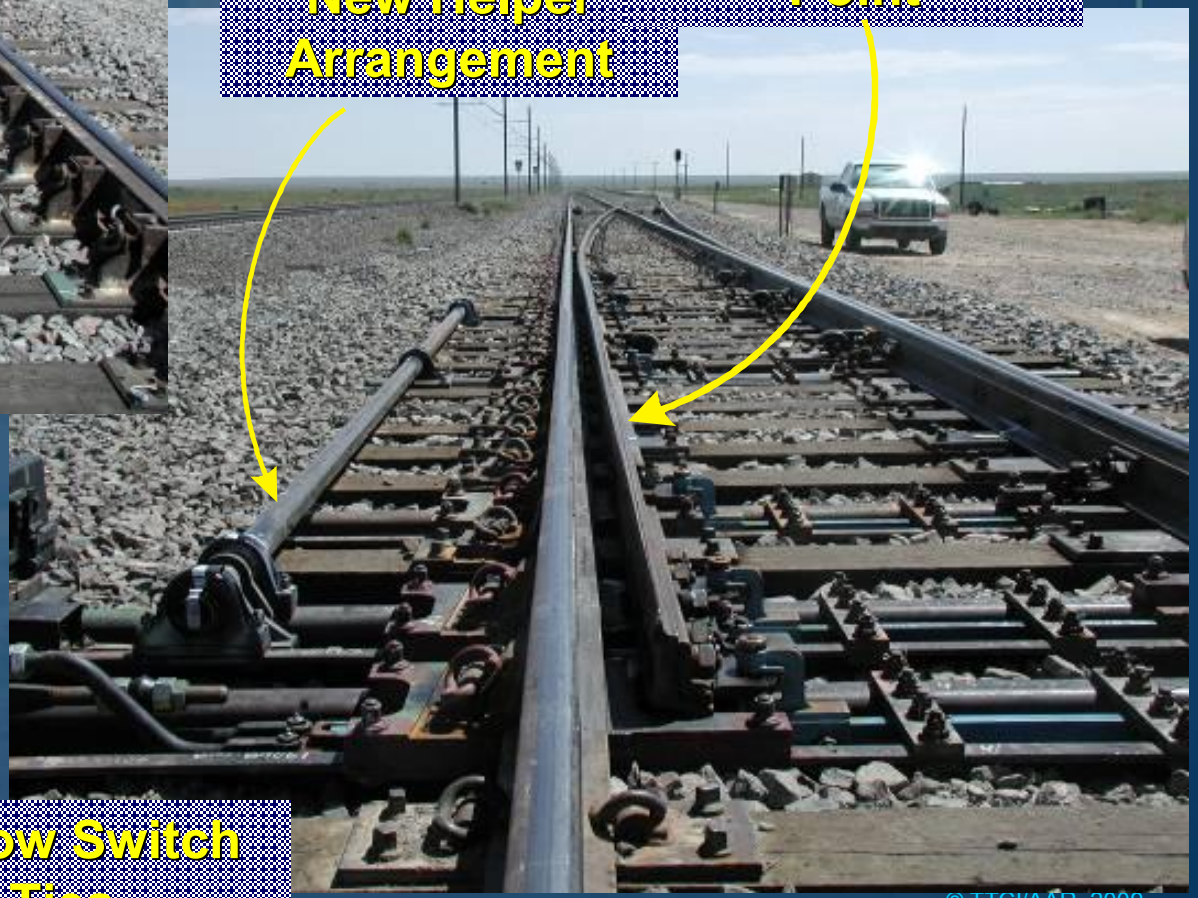
Evaluation of Designs and Initial Performance of FB Turnout Frogs

- **Application: Mainline turnouts with very little diverging traffic**
  - **Set out tracks**
- **Benefits:**
- **Expected service life:**
  - RBM: 200 MGT
  - FB Frog: 1,000 MGT?
- **Mainline ride quality**
  - Continuous surface



Turnout Geometry and Components Evaluation

- Best Practices Prototype(s) for FAST



Hollow Switch Ties

Turnout Performance

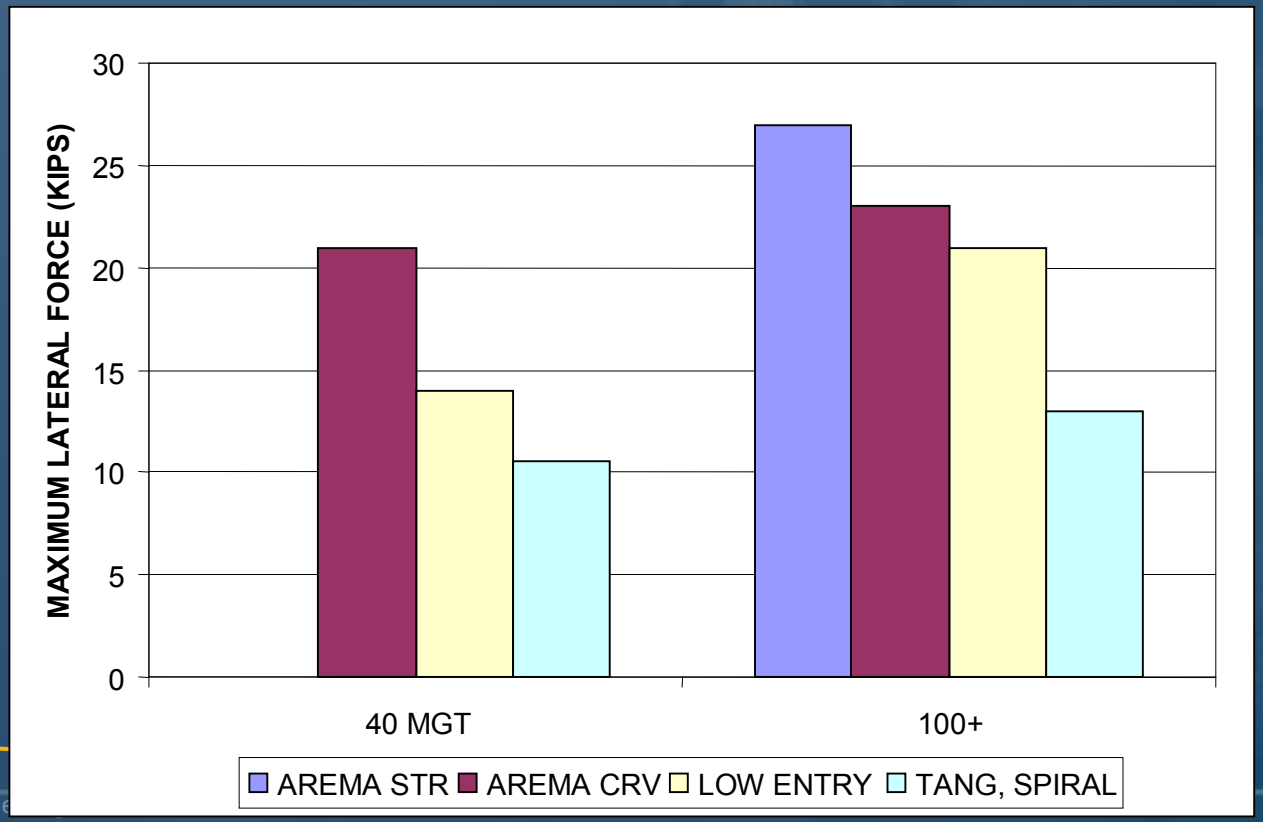
Next Generation Turnout Key Findings:

- Design Features Recommended for Revenue Service Application
  - **Spiral, Tangential switch alignment**
    - **With Thicker point**
  - **Switch rods out of ballast**
    - **Hollow Steel Ties**
      - **Need a stiffer clip to reduce point roll**
    - **Over-tie rods**
      - **Improved vertical stability: lining & surfacing requirements reduced by 60%**

SRI 9A STW – Super Turnout

Next Generation Turnout Key Findings:

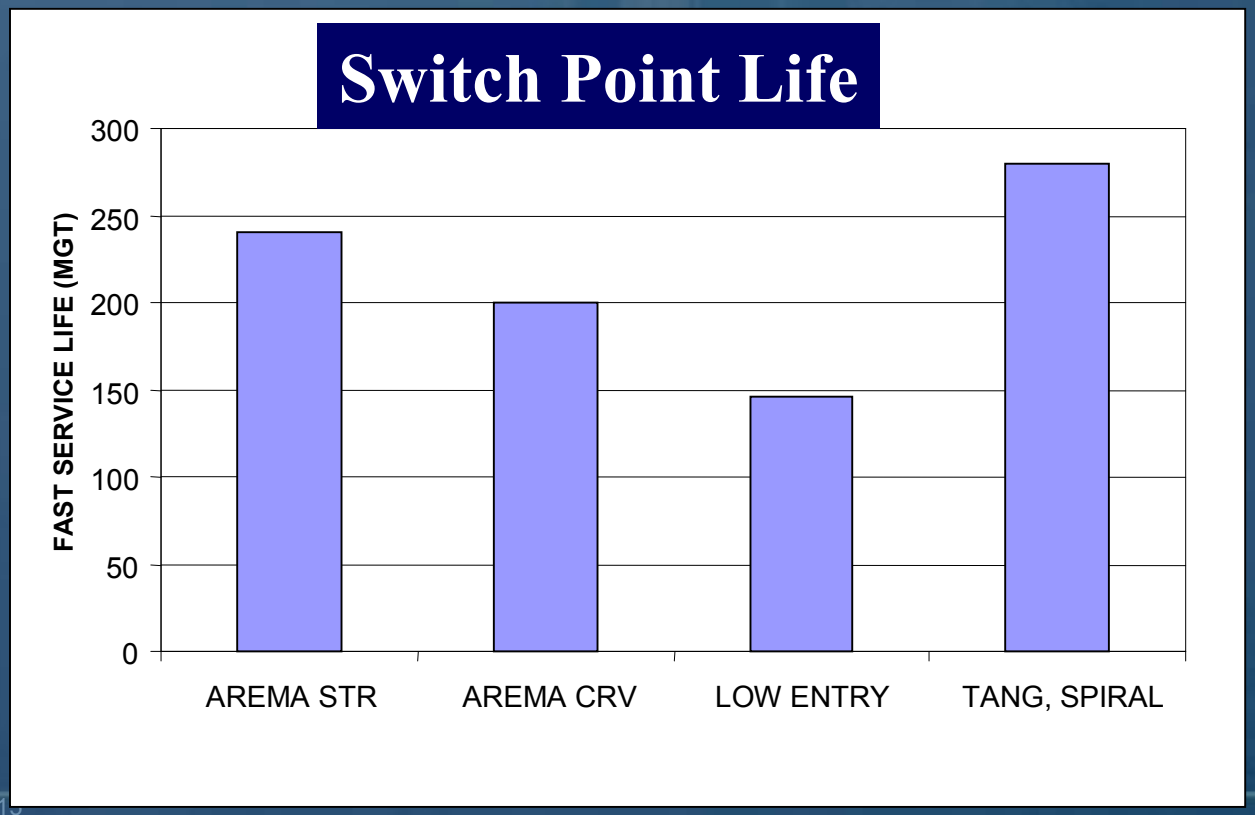
- Forces lower
  - **Lateral forces continue to be ~30% lower**
  - **Vertical forces are 10% lower than RBM's**



SRI 9A STW – Super Turnout

Next Generation Turnout Key Findings:

- Service Life of Switch Points
  - **Thicker point and lower forces**
  - **Longer average life than AREMA style**



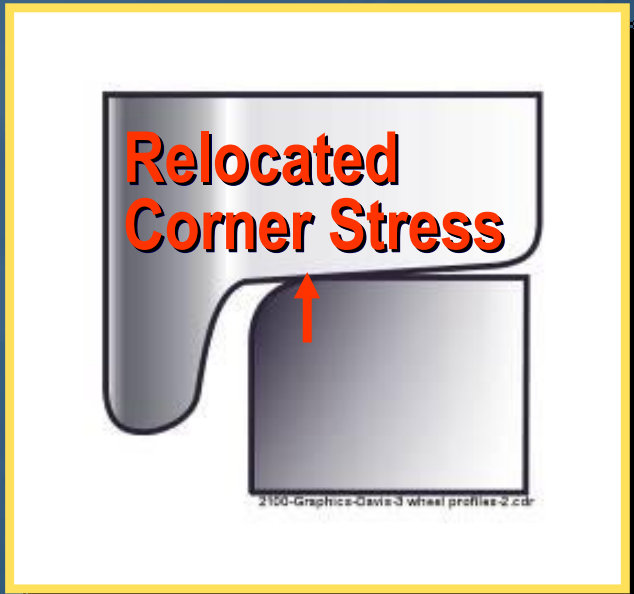
SRI 9A STW – Super Turnout

Next Generation Turnout Key Findings:

- Design Features Recommended for Revenue Service Application
  - **Low dynamic load frog**
    - **Moveable point or wing frogs**
      - **Fixed point "Solid" with improved running surface profiles**

Frog Profile Design
Cross Section Profile Designs

Current profiles
Point contact on flangeway corner



"Conventional" prototype
Flat running surface, larger corner radius
Point contact away from flangeway corner

"Conformal"prototype
1/20 taper running surface,
larger corner radius
Conformal contact away from flangeway corner

Frog Cross Section Profile Design

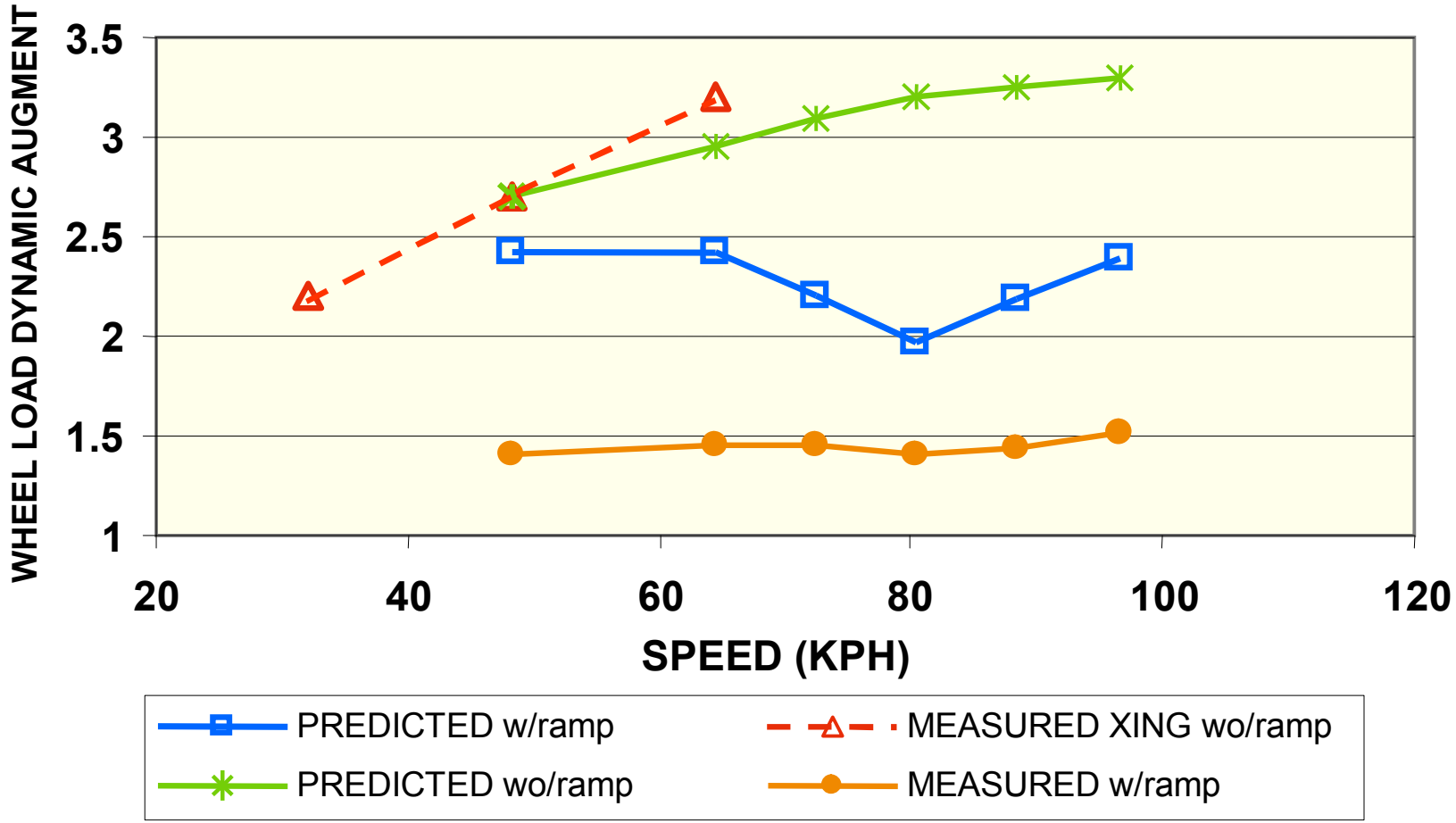
- Conformal
- Conventional

High Performance Crossing Diamonds
Ramped Flangeway Corners

Background:

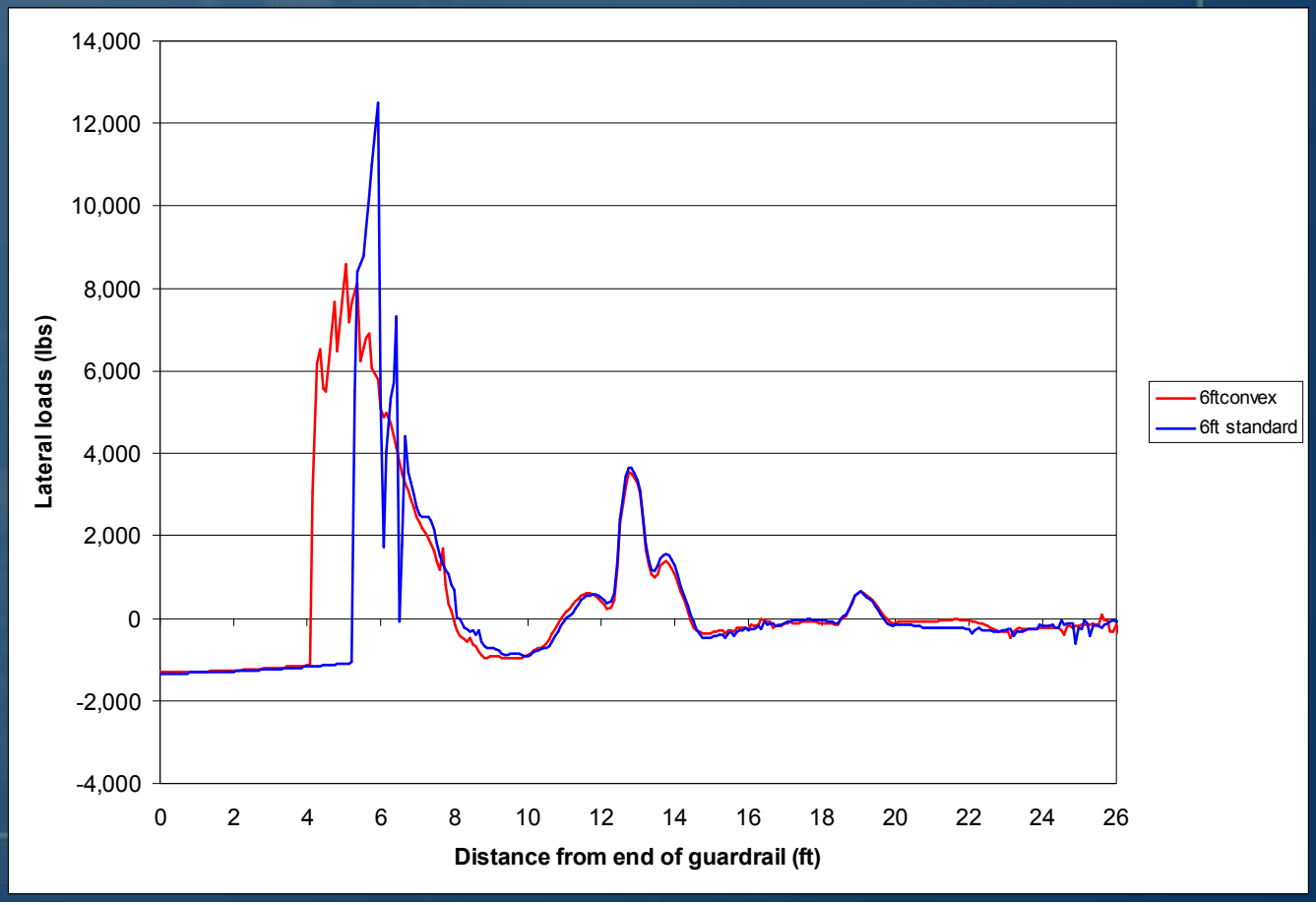
- **Frog corners are deformed**
  - Castings made to desired shape
  - AMS deforms rapidly to undesired shape
  - Effective flangeway gap goes from ~2” to 3-4”
  - Dynamic forces increase significantly
- **Ramp designed to:**
  - Provide for initial deformation
  - Lift wheel over gap

Running Surface Ramping for High Angle Frogs



Guard Rail Entry Analysis

- **Dynamic simulation modeling - curved entry will:**
  - Lower maximum forces
  - Control wheel path better
    - Circular entry contacts wheel sooner
    - Provides smoother transition instead of abrupt impact

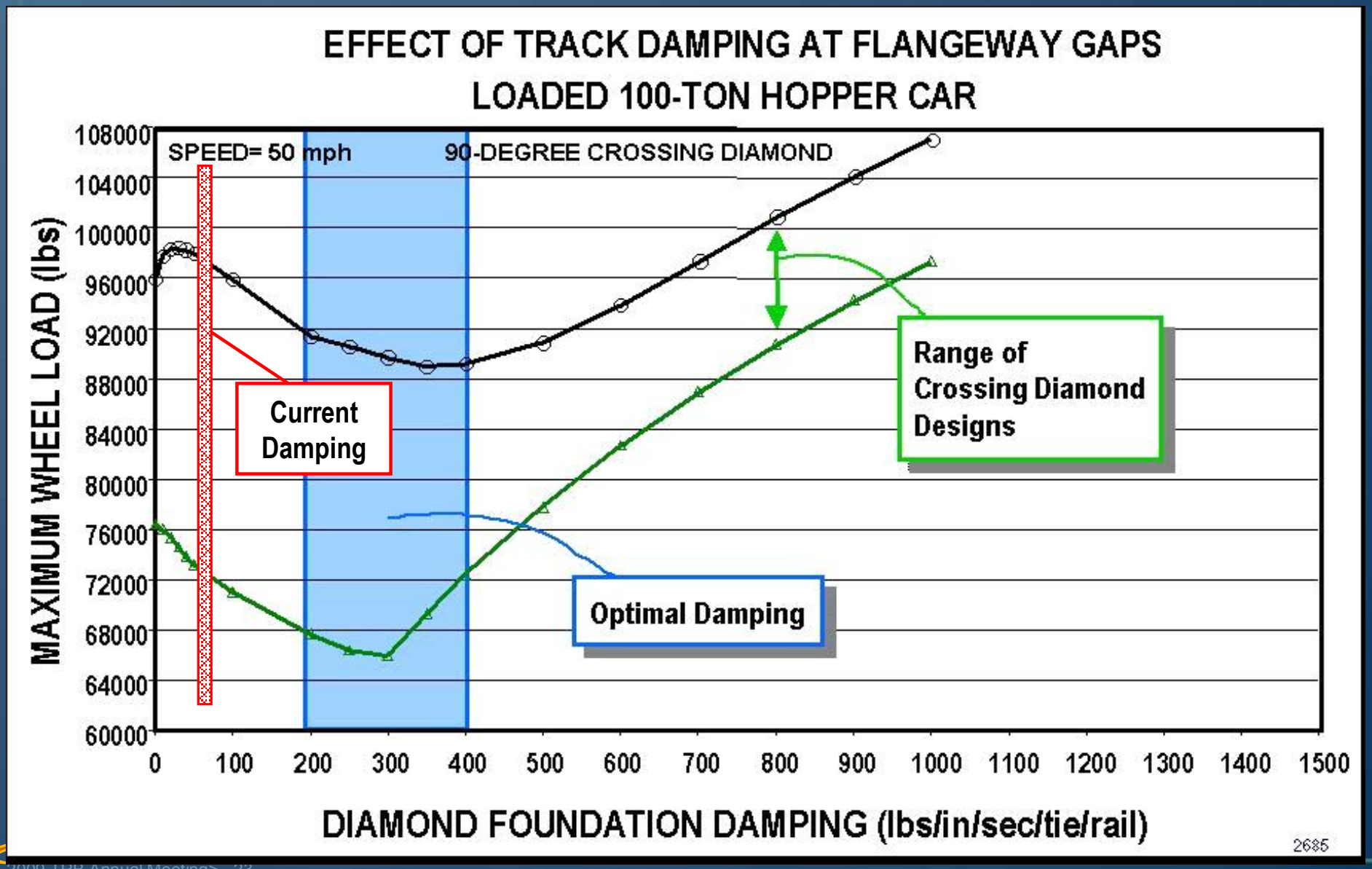


Load Environment of the Crossing Diamond

- **Two types of impact loads seen at diamond crossings**
  - Higher frequency load due to wheel impacts.
    - Contribute to broken components
  - Lower frequency loading due to wheel bounce.
    - Contributes to:
      - ballast and subgrade breakdown
      - tie deterioration
      - surface and alignment problems

NUCARS Study

- Optimal track damping is above measured



Diamond Crossing Foundation Design

Development of Low Impact Special Trackwork

Implementation:

- Flange Bearing Frogs are successful
  - **Full FB diamonds being implemented under waiver**
  - **OWLS diamonds being widely implemented**
  - **FB turnout frogs in revenue service tests**
- Premium turnout components becoming standard for HAL lines
- Ramped running surface diamonds are industry standard
- Curved Entry Guard Rails are being adopted as Industry Standard
- Optimally damped foundations in test by industry