Bridge Rail

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DES/BRG Conference

BRIDGE DIVISION

Outline

- Proposed Changes to Rail Test Levels
- New Rails
- Proposed Rails and Rail Revisions

Proposed Changes to Rail Test Levels—Update to NCHRP 350

Proposed Changes to Rail Test Levels—Update to NCHRP 350

- Small Design Test Vehicle
  - Weight increased from 820 kg to 1100 kg
    - 98% of vehicles sold in 2002 weighed more than 1100 kg (2425 lbs)
    - 34% increase in energy

Information courtesy of TTI

Proposed Changes to Rail Test Levels—Update to NCHRP 350

- Large Design Test Vehicle
  - Style changed to ½-ton, 4-door pickup
  - Weight increased from 2000 kg to 2270 kg
    - 6% of vehicles sold in 2002 weighed more than 2270 kg (5000 lbs)
    - 13.5% increase in energy
  - Minimum c.g. height = 28 in.
    - Measurement required

Information courtesy of TTI

Proposed Changes to Rail Test Levels—Update to NCHRP 350

- TL-3 Impact Conditions
  - Speed unchanged (100 km/h)
  - Angle for small car increased to 25 deg.
    - Consistency with pickup truck
  - Impact Severity increased
    - [I.S. = ½ m (V sinΘ)²]
    - 13.5% increase for pickup truck
    - 205% increase for small car

Information courtesy of TTI

Proposed Changes to Rail Test Levels—Update to NCHRP 350

- TL-4 Impact Conditions
  - Weight of single unit truck increased from 8000 kg to 10000 kg
    - 25% increase
  - Speed increased from 80 km/h to 90 km/h
    - 12.5% increase
  - Impact Severity increased 58%

Information courtesy of TTI

Proposed Changes to Rail Test Levels—Update to NCHRP 350

- What do these proposed changes mean?
  - 32” F-shape did not pass proposed TL-4
  - 27-inch tall rails may not pass proposed TL-3 criteria
    - T101 and T203 are 27-inches tall and currently TL-3 approved

New Rails

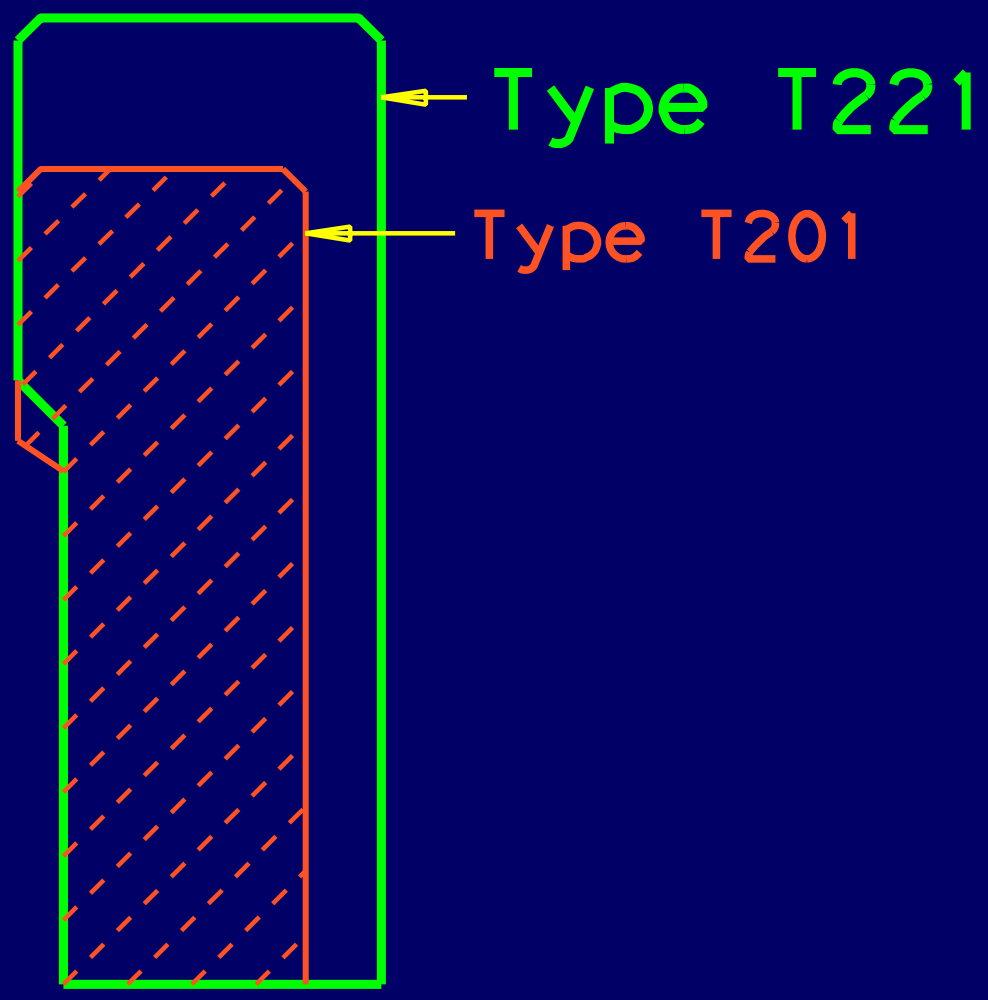
New Rails

- T221, C221, B221
- T401, T402, C402
- T77
- T1F
- PR3
- B3

T221, C221, B221 Rails

- Replace the T201, C201, and B201
- Thicker concrete section lessens impact damage
- Anchorage reinf is identical to the T501's and SSTR's

T221, C221, B221 Rails



T201 was 7.875-inches thick and 27-inches tall

T221 is 10.5-inches thick and 32-inches tall

T401, T402, C402 Rails

- Replace the T4(S), T4(A), and C4(S)
- Thicker concrete section lessens impact damage
- In-line anchor bolt pattern
- Posts are fillet welded to base PL’s

T401, T402, C402 Rails

Old: C4(S)

10-in wide parapet, 4 anchor bolts and groove welded posts

New: C402

12.5-in wide parapet, 3 anchor bolts and fillet welded posts

T401, T402, C402 Rails

What we hope to see less of with T401

T77 Rail

- Elliptical tube steel rails, steel posts, and variable height concrete curb
- Developed to be an open, aesthetic rail

- Curb helps prevent deck damage
- Drain slots not permitted due to 6-inch curb height on field side; 9-inch height required for drain slot

T77 Rail

T77 Rail

Tube splice is an expandable split tube to ensure tight fit—prevents vehicle snagging

Transition shoe at end parapet is provided to prevent vehicle snagging—a crash-tested item

T77 Rail

T1F Rail

- Aluminum rails, steel posts, and 9-inch concrete curb
- Developed to be an open rail easy to construct and maintain
- 9-inch curb permits drain slots
  - Curb helps prevent deck damage
- Passed TL-3 crash test at TTI using the proposed heavier pickup with higher c.g.

T1F Rail

T1F Rail

T1F Rail

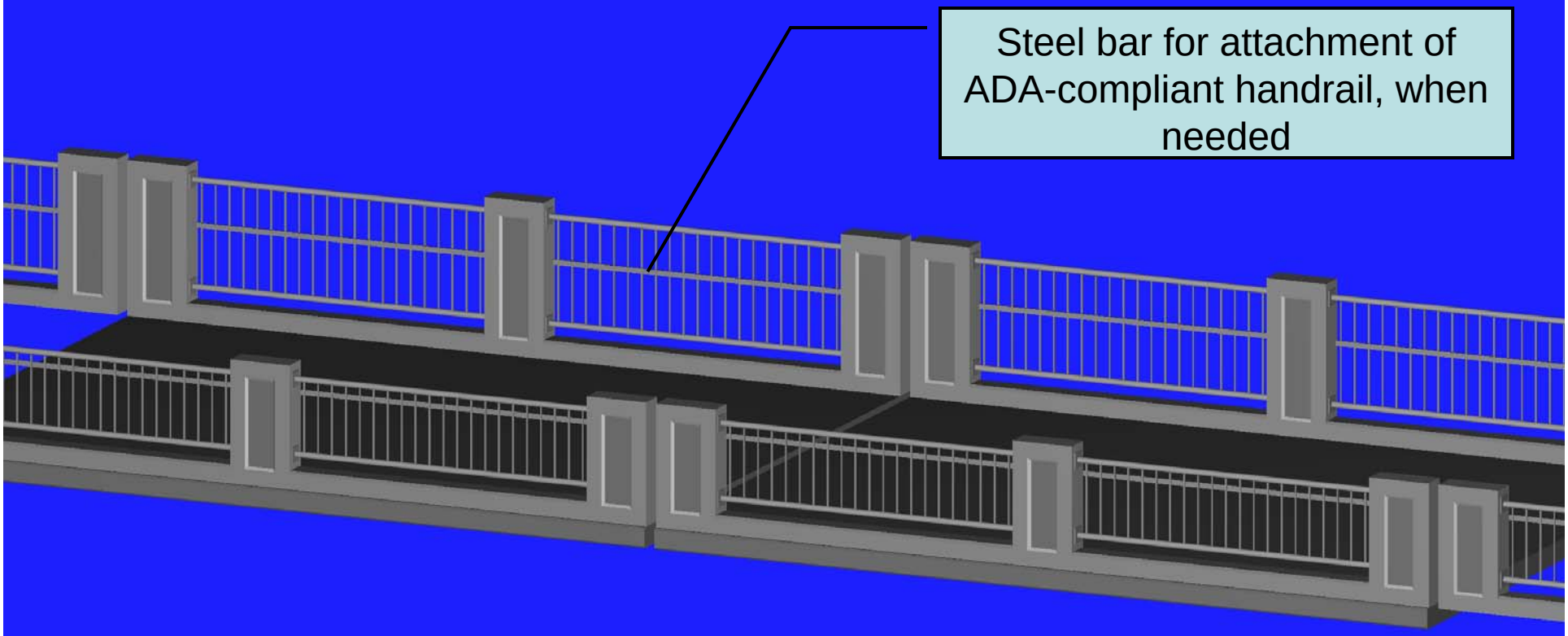
Stainless, tamper-resistant screws attach rail to posts

Tamper-proof screws, with “key” wrenches are available if felt warranted for location—they’re not inexpensive

Yes, potential for galvanic corrosion exists but shouldn’t be a problem based on rail condition at Queen Isabella Causeway and CA ratio

T1F Rail

PR3 and B3 Rails



These rails are not crash-worthy – they must be protected from traffic with a traffic or combination rail

PR3 and B3 Rails

Influenced by this older design, but updated for ADA, ease of fabrication, durability, painting, and construction

Proposed Rails and Rail Revisions

T551 and T552 Rail

- Will replace T501 and T502; no precast version at present

T551 uses F-profile, matching CSB standards

Extra thickness should minimize blow-outs of rail when hit

Rail DL same as SSTR

Revised HT

- Proposed changes to the HT rail:
  - F-shape profile
  - Toe of rail moved to 1.5’ from slab edge
  - In-line anchor bolt pattern for upper steel element
  - Fillet-welded posts
  - Evaluation underway at TTI

- This rail requires a 10-in thick overhang with specific slab reinforcement requirements—shown on the standard drawing—and requires a PCP(MOD)

T412 Rail

- High-speed, TL-4 approved, concrete rail, similar to T411.

42-inches tall—may reduce height if possible

Currently weighs 580 plf

19.5-inches to face of rail

T412 Rail

Texas' Wyoming Rail, TW3

Photo courtesy of
Dean Van Landuyt

A variant of the TL-3 Wyoming Rail is being used on a couple of projects.

Dimension to face of rail is 20-inches

Proposed T8 Rail

- A need for a TL-3 rated break-away rail exists for retrofitting thin decked bridges and culverts
- Rail is still being evaluated
- A tubular thrie beam is proposed

Proposed T8 Rail

Pendulum tests on 6.5” overhang

f’c = 2700 psi

Slot width in posts:

3/4” is too narrow to prevent deck damage

7/8” OK

Proposed T8 Rail

Posts with 0.875-in slots activated with minimal deck damage

More modeling to determine lateral deflection and how many posts activate before proceeding to crash testing

Jointless or Almost Jointless Rails

Experimented with a continuous C4(S) and a continuous SSTR

This C4(S) rail was CIP and intermediate wall joints were replaced with 3/4” chamfers

The only cracking present is quite small and attributed to shrinkage.

Jointless or Almost Jointless Rails

This SSTR rail was slipformed and tooled joints, 3/4-in deep, replaced intermediate wall joints

In addition to shrinkage cracks, LL-induced negative bending cracks adjacent to bents.

Jointless or Almost Jointless Rails

Summary:

- Jointless rails are not ready for widespread implementation and may never be
- Next jointless rail, if built, should have intermediate wall joints at bent locations only

- Why are we looking at this? To see if we can have the rail participate structurally in an extreme event

Other Items

- Since many MOD rails are for aesthetic formliners, future standard rails may accommodate formliners, and maybe with pre-selected patterns

- New retrofit details for most, if not all, concrete rails are being developed

Questions?

- For Bridge Rails:
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  - John Holt, P.E., (512) 416-2212

- For median barriers, guardfence, end treatments or transitions:
  - Rory Meza, P.E., Design Division, (512) 416-2678
  - Bobby Dye, Design Division, (512 416-2656