HIGH SPEED RAIL CROSSING WITH FLANGE-BEARING CROSS TRAFFIC

UPRR/TPW Crossing in Chenoa, IL

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(3,563 words which includes 8 pictures at 250 words each)
ABSTRACT

High Speed Rail (HSR) in North America, outside of the Northeast Corridor, is still in its infancy. Converting freight lines to HSR lines, as opposed to building dedicated corridors, is venturing into even a greater unknown. Add to this the challenge of achieving high speeds at a rail to rail crossing diamond and you have yourself the makings of a Chief Engineer’s fairy tale. It is with this in mind that the Union Pacific Railroad (UPRR) and the Illinois Department of Transportation (IDOT) joined forces to find a way to maintain high speeds, while still allowing the Toledo, Peoria and Western Railway (TPW) safe passage across the HSR corridor in Chenoa, IL. The solution was a crossing diamond with a continuous running surface (no flange-way gap) for the UPRR alignment and a flange-bearing running surface for the TPW alignment. It appears that this is the only application of its kind in the world. This paper provides information on design, construction and lessons learned to date.

Key Words: high speed rail, HSR, rail crossing, flange bearing, diamond
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The Illinois Department of Transportation (IDOT), in an effort to reduce the travel times of passenger trains on the Union Pacific Railroad (UPRR) line between Chicago and St. Louis, engaged in an aggressive High Speed Rail (HSR) grade crossing and track upgrading project from Mazonia (MP 62.6) to Springfield (MP 180.8), IL beginning in the year 2000.

One area of concern on this line was the rail diamond in Chenoa, IL where the UPRR (MP 102.25) and the Toledo, Peoria and Western Railway (TPW) cross. This location is midway between a 28 mile stretch connecting two passenger stations. UPRR tracks on both sides of the diamond were being upgraded to 110 mph while the TPW was a 25 mph railroad. At best, rebuilding the conventional rail crossing would allow 60 mph which was only a 15 mph increase over existing UPRR track speed.

History

It was about a year into the project that UPRR’s HSR Project Engineer, John Hovanec, approached me saying that Ed Kohake of their Methods and Research Department was seeking a location to use a design of frog currently being used in Europe which would allow higher rail crossing speeds. Apparently it was a form of flange bearing crossing,
however only one route (picture 1) ran on the flange, this way the opposing route was free of flange-way gaps in the rail, thus providing a smooth ride (picture 2).

Picture 1- TPW 10 mph Flange Bearing Side of Rail Crossing

Picture 2 – UPRR HSR Side of Rail Crossing
I was very interested and asked for a draft plan of the proposed diamond. While this is not the first time a one-way flange-bearing rail crossing has been used, it was to be the first time for an application of HSR on the gapless side with heavy axle loads on the flange-bearing side. Upon review and minor revision of the plan and successful negotiation with the TPW for 10 mph operation over the new diamond, funding was approved by IDOT in early 2002. Manufacture and fabrication of this 136RE 352 BHN explosive depth hardened solid manganese crossing was performed by Meridian Rail of Chicago, IL. The Chenoa diamond has a 63 degree 10 minute 40 second crossing angle with over two miles of tangent track on all four of the approaches. This was a great benefit to the design and life of the crossing in that the wheels of the same axle were not striking elements of the crossings as you would have in a 90 degree crossing, thus the pounding to the diamond is greatly reduced. The UPRR is in a 0.4% uphill grade going south and the crossing is the summit of two grades less than 1% each on the TPW. Because this area is prone to flooding and holding water (which contributed to a constant slow order of 45 mph for passenger trains), the diamond was raised 6” and an extensive drainage plan was compiled to keep the site dry. This included a 24” thick subballast pad (58’x43’) under the rail crossing 15” ballast layer, new ditches, a 400 cubic yard sump for drainage overflow and over 350 feet of new culvert pipe with inlets. All engineering design and layout (including drainage) was performed by Design Nine, Inc. of St. Louis, MO.
Installation

On the morning of Saturday, October 4, 2003, UPRR forces began removing segments of the TPW track in preparation to completely rehabilitate 400 feet of the approaches. The east TPW approach included a road crossing which had to be rebuilt and raised. At 8:30 p.m. local time after the last Amtrak of the day crossed the diamond the first cut was made. The order of events that followed consisted of:

1. Cut the diamond and approaches into panels
2. Remove panels and diamond
3. Locate signal wires
4. Dig the pit for the 58'x43'x24” subballast pad (picture 3)
5. Spread and compact subballast pad
6. Spread a 10” new ballast layer
7. Place new diamond (picture 4)
8. Install new signal wires
9. Set UPRR side transition panels and bolt up
10. Dump ballast cars and regulate
11. Tamp approaches and hand tamp diamond
12. Run first Amtrak at 10:30 a.m., Sunday October 5, 2003

While you try to plan for possible problems, we did clip a signal line which the signal department said didn’t exist and it took 2 hours to piece back together. This was the only unplanned event of the installation. The remainder of the day was spent on the approaches on the TPW in anticipation of a train scheduled for the morning of Monday, October 6, 2003.
Picture 3 – Digging the Pit

Picture 4 - Setting Rail Diamond
Upon completion of the TPW approaches we walked the engines over the diamond’s flange-bearing side without incident and then proceeded to run the mixed freight across the diamond at 10 mph. The diamond took no pounding whatsoever for there are no direct impact surfaces due to the gradual ramping nature of the design (picture 5).

Within 30 days of final surfacing the UPRR raised the speed on the diamond to 79 mph after a geometry car run over the crossing showed the crossing was capable of 90 mph operation and no exceptions with regards to ride quality.
Lessons learned

Several lessons were learned from this installation which I believe the reader should consider in the event of a future installation for a one-way flange-bearing crossing.

**Drainage** - A complete drainage plan should be incorporated into the profile and alignment plan with input from track, signal, communications, and fiber optics from both railroads. We had a separate drainage plan and all parties did not get all information, thus causing field readjustments. As of this writing we are still installing various drainage structures.

**Crossing Design** – Two items should be changed in the design for future crossings of this type. First, the sloped guide-wing rail (red arrow in picture 6) should be taller in dimension and second this rail should be a one piece manganese cast. Currently a 1" square stock of 4140 steel is welded to a beveled high carbon head hardened 136RE rail (picture 7). As can be seen by the picture the freight traffic is finding its way to the flange and blunting the square stock (red arrow in picture 7). This stock cannot be welded if damaged and therefore cannot be readily repaired on site. If the guide-wing rail were taller, it would align the flanges more directly in one gradual effort. Further, if it were a manganese cast piece it could be repaired easily along with the rest of the diamond.

**Grade** – A zero percent grade should be designed into the profiles of both track centerlines to keep the cars straight and level, thereby preparing the cars for the flange-bearing path.
Picture 6 – Sloped Guide-Wing Rail

Picture 7 – 4140 Steel Stock Welded on High Carbon Rail
Monitoring – The AAR, through its Transportation Test Center is currently taking measurements on the wearing rate of the flange-bearing path (red arrow of picture 8). Additionally they are monitoring the wheels of the TPW locomotives for wear. This subject will be provided in a separate report.

![Picture 8 – Flange-Bearing Path](image)

Conclusion

Increase in speed, reduction of passenger train delays, a smoother ride, and lower maintenance costs due to reduced impact loads and better drainage make this investment a win/win proposition. Future testing could lead to increasing the speed to 110 mph so as to reap the benefits of no speed restriction at this location for HSR trains.
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