<u>Measure Name:</u> Crossing alignment adjustment for bicycles and other wheeled devices

<u>Definition:</u> Alignment of the roadway and/or track so that the crossing is as close to perpendicular as possible for safer and more easily navigated crossing by bicycles, wheelchairs, scooters, and other wheeled devices.

<u>Tags:</u>

Type of Incident:

☒ Non-Motorized Users Only
☐ Motor Vehicles Only
☐ Both

Intervention Strategy:

☐ Data: application and planning
☐ Education: outreach and messaging
☐ Enforcement: policy development and rulemaking
☒ Engineering: technological and physical deterrents

Type of Problem:

☒ Non-Motorized Users Violating Warning Devices
☐ Motor Vehicles Violating Warning Devices
☐ Vehicle ROW Incursion
☐ Vehicle Congestion
☐ Blocked Crossing
☐ Vehicle Hang-up

Measure Category:

☐ Risk Assessment
☐ Policy and Enforcement
☐ Collaboration, Training, and Education
☐ Public Communication
☐ Physical Barriers
☐ Detection and Lighting
☒ Infrastructure Modification
☐ Post-Incident Management
☐ Warning Devices

Description

This measure involves horizontally aligning a crossing perpendicular to the railroad tracks to help prevent wheels from bicycles, wheelchairs, scooters, and other wheeled devices from becoming stuck or tipping over while crossing. A perpendicular crossing alignment also increases visibility of the crossing and approaches and lowers the crossing distance, resulting in less exposure time for pedestrians and bicyclists in the track area [1]. One study of bicycle accidents at a skewed grade crossings found that the most significant factor in these accidents was crossing angle [2]. Accident rates were found to be highest at crossing angles less than 30 degrees. Accidents were markedly reduced when crossing angles were 30 degrees or greater and did not occur at crossings with angles 60 degrees or greater.

Crossing realignments may also make it easier for a person to see and hear an oncoming train. When paths are parallel to the tracks, users may not easily be able to see or hear an oncoming train behind them as they approach the crossing [3]. A parallel path without active warnings should be configured to force users to face in both directions prior to crossing, such as with a maze or intentional serpentine curve (chicane). Also, a crossing that is not at a right-angle to the tracks may cause navigations issues for vision-impaired users [4].

At locations where a 90-degree angle alignment is not achievable due to cost or physical constraints, a “jughandle” design may be a good alternative. This design involves widening the shoulder so that bicyclists can approach the crossing at a larger angle (e.g., greater than 30 degrees) [5]. One study in Knoxville, TN analyzed video data for two bicycle paths before and after implementing the jughandle design [5]. Results showed that the design can significantly reduce bicycle accidents. Prior to implementation, there were 53 accidents before realignment; after implementing the new design, only one occurred.

Additional search terms: *geometry, profile, skew, alignment*

Advantages

- Research suggests that crossing alignment adjustments can help to prevent incidents involving bicycles at crossings. [2][5]
- Cyclists were generally found to comply with realignments and remained within the designated lanes. [5]
- Crossings that are at or near a 90-degree angle to the tracks may decrease probability of wheelchair wheels turning and falling into the flangeway gap. [4]
- Crossings that are at or near a 90-degree angle to the tracks are easier to navigate for vision-impaired users. [4]
- Perpendicular grade crossings provide shortest route across the crossing and require minimal gate-arm length. [8]
- Minor crossing adjustments are relatively low-cost, such as jughandle designs. [5]

Drawbacks

- Full crossing realignment may be difficult to implement due to high costs and/or environmental constraints. However, effective alternatives exist, such as jughandle designs. [5]

Notable Practices

- The angle between the tracks and the bicycle crossing should be at least a 60-degree angle, or ideally a 90-degree angle. [3]
- Crossing angles less than 45 degrees are not recommended. [6]
- For new crossings, or major reconstruction, it is desirable to have the crossing angle as close to 90 degrees as possible. [7]
- Consider installing a warning sign where the bicycle path approaches the crossing. [3]
- Ensure that any warning devices are appropriately aligned so that they can easily be seen when approaching the crossing and ensure that warning devices allow a clear line of sight down the tracks. [3]
- Consider adding traffic calming treatments to help align users as they approach the crossing. [3]
- If construction or maintenance result in a narrower crossing angle, consider replacing surfaces with lower-maintenance materials. [3]
- If a narrow angle is required, it is recommended that flange-gap material is used to fill the gaps to help prevent stuck wheels or tipping over. Consider whether materials such as rubber may become slippery if soiled with a substance like wheel grease. [3]
- Adding other treatments such as bollards may help to improve compliance by encouraging cyclists to follow the designated path and crossing angle. [5]
- Community education about the realignment may also help to ensure compliance.

References

[1] Cambridge Systematics, Rail Strategy Study – Grade Crossing Toolkit, July 2018.

Excerpt: The Grade Crossing Toolkit provides information and tools to identify candidate crossing improvements across a range of options. The Toolkit describes rail crossing treatments, such as grade separations, closures, consolidation, passive treatments, active devices, quiet zones, and specialized treatments for pedestrian/bicycle issues.

[2] Ling, Z., Cherry, C. R., & Dhakal, N. (2017). Factors influencing single-bicycle crashes at skewed railroad grade crossings. *Journal of Transport & Health*, 7, 54-63.

Abstract: Cycling as a healthy and environmental friendly transport mode is gaining popularity. Most research on cyclist safety is focused on crashes involving light vehicles, trucks, or pedestrians. Only a few studies address single-bicycle crashes, and fewer focus on bicycle crashes at skewed railroad grade crossing. This study relies on empirical video data collected from a heavily travelled railroad grade crossing over a two month period, covering more than 2000 bicycle traversings and 32 single-bicycle crashes caused by tire interaction with the rail flangeway. A representative random sample of 100 successful traversings were drawn from the population and analyzed against the crashes. Video data was mined to identify crash factors, including demographic, riding behavior, bicycle characteristics, and environmental characteristics. A binary logistic regression model was built to explore factors that

influence bicycle crashes. Approach angle is the most significant determinant of crashes, with a critical traversing angle of 30°. Group riders, women, and wet roadway conditions all contribute to higher odds of a crash. Crash rates are dramatically reduced at approach angles greater than 30°, and (in our dataset), non-existent at angles greater than 60°. Road-railway crossing should be designed with increased scrutiny. We suggest countermeasures, like jug handle designs, that improve the approach angle for cyclists. This study focuses on bicycle crash at railway crossings using empirical data. It fills up the gap in the research on this type of crashes and addresses issues on potential bicycle facility design at railway crossings.

[3] New Zealand Transport Agency. (2017). *Design Guidance for Pedestrian & Cycle Rail Crossings.*

Excerpt: This guide provides urban designers and planners, and traffic and rail engineers, with principles, design considerations and standard designs for level crossings located on footpaths, shared paths or cycle paths. Many of the principles discussed should also be applied when considering providing for cyclists using on-road cycle lanes. It asks users to consider all types of rail crossing options, including grade separation and the potential to remove a rail level crossing completely; however, the design guidance only covers treatments at rail level crossings.

This guide focuses on crossings of the rail corridor; it does not consider the planning and design of pedestrian/cycle pathways running along rail corridors. Guidance and requirements for public pathways or cycleways in the rail corridor can be found in Applications for New Rail Crossings: Guide for Applicants (KiwiRail, 2015).

[4] Victoria, Australia Department of Infrastructure. (2003). Rail Crossing Disability Access Toolkit.

Excerpt: This Toolkit presents a range of treatments for enhancing safety for people with disabilities at rail crossings.

[5] Shah, Buckner, I., & Cherry, C. R. (2020). A jughandle design will virtually eliminate single bicycle crashes at a railway crossing. *Journal of Transport & Health, 19*, 100962.

Abstract: *Introduction:* Bicycling provides many positive outcomes at individual- and population-levels, from increased physical activity to reduced congestion. One of the main barriers to increased levels of bicycling is safety and injury risk from motor vehicles and from single-bicycle crashes. One known hazard is bicycle crashes at rail crossings where the bicycle wheel is caught in the flangeway causing loss of control. *Methods:* This study evaluates two realignments, or “jughandle” designs to increase the angle of a skewed crossing in an urban environment. Using continuous video analysis over two 2-month periods, this is the first empirical analysis of safety performance of this infrastructure. *Results:* The realignment reduced crash risk by 98% (C.I. 86.3%–99.7%), from 4.0 to 0.1 crashes per 1000 crossings (or 53 crashes before to 1 crash after). Bicycling across at more than 30◦ eliminates almost all risk by reducing the severity of the crash. There were 19 crashes with minor injury and one was severe out of 32 observed crashes before the jughandle design, while only one non-injury crash was observed after the treatment. More than 90% of riders complied with the new design, following the desired path. *Conclusion:* The study shows that the “jughandle” realignment of bicycle crossings at the railway can virtually eliminate the risk of single bicycle crashes. Most of the riders complied with the realigned path by the use of low-cost implementation of pavement marking. However, we can expect better compliance rate and, subsequently, lower crash rate by the application of prominent mitigation techniques such as bollards and surface treatment.

[6] National Association of City Transportation Officials. (2014). Bicycle Rail Crossings. *Transit Street Design Guide*.

Excerpt: To codify and advance best practices in transit design, the National Association of City Transportation Officials has brought together practitioners and leaders from the transit and street sectors to develop the Transit Street Design Guide.

[7] U.S. Department of Transportation. (2019). Highway-Rail Crossing Handbook – Third Edition.

Abstract: The purpose of the Highway-Rail Crossing Handbook, 3rd Edition is an information resource developed to provide a unified reference document on prevalent and best practices as well as adopted standards relative to highway-rail grade crossings. The handbook provides general information on highway-rail crossings; characteristics of the crossing environment and users; and physical and operational changes that can be made at crossings to enhance the safety and operation of both highway and rail traffic over such intersections. The guidelines identified and potential alternative improvements presented in this handbook reflect current best practices nationwide.

[8] Southern California Regional Rail Authority, SCRRA Highway-Rail Grade Crossing Manual, January 2021.

Excerpt: This Manual was developed in 2009 and issued as a Recommended Design Practices and Standards Manual.

Additional Resources

American Association of State Highway and Transportation Officials. (2024). *Guide for the Development of Bicycle Facilities, 5th Edition*.

Excerpt: Designed for use by engineers, designers, and planners, the Bicycle Guide provides information on the planning, design, and operation of bikeways along streets, roads, and highways, and on paths along independent alignments, in urban, suburban, and rural settings.

The Guide encourages a flexible approach to design bikeways, emphasizing the role of the engineer, planner, and designer in determining appropriate bikeway types and design dimensions, based on project-specific conditions and existing and future performance. It provides information to assist in choosing the appropriate combination of features, design values, and materials to create the design, while considering the context of the project area and surrounding environment.

Related Measures

- Flangeway gap filler
- Pedestrian channelization

Images

Figure 1. Example of crossing alignment adjustment for non-motorized users from Google Satellite View