California Public Utilities Commission

Pedestrian-Rail Crossings In California

A Report Compiling the Designs and Devices Currently Utilized at Pedestrian-Rail Crossings within the State of California

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INTRODUCTION

In recent years light rail transit and commuter rail systems have expanded significantly, leading to construction of many new stations and pedestrian-rail crossings. Accompanying this expansion has been a trend of increasing high-density development of residential and retail property immediately adjacent to light rail transit and railroad tracks. The combination of these factors requires greater attention to pedestrian-rail at-grade crossing design/improvements to better warn the public of potential train-pedestrian conflicts. This document reviews design and placement of warning devices that are currently used at pedestrian-rail at-grade crossings in California.

The California Public Utilities Commission (CPUC) has jurisdiction over the safety of rail crossings in California. The Federal Railroad Administration (FRA) is a federal agency responsible for rail safety in the U.S. The FRA and CPUC recognize that at-grade crossings present inherent hazards to the traveling public, particularly crossings on freight or passenger main lines, and as such recommend eliminating at-grade crossings where possible, either through barricading the roadway/pathway approaches to the crossing or through grade-separation. However, where it is not practicable to eliminate a pedestrian-rail at-grade crossing, this document is intended as a guide for pedestrian-rail at-grade crossing design/improvements based on current industry practices.

DISCLAIMER

This document is disseminated in the interest of information exchange by CPUC's Consumer Protection and Safety Division (CPSD).

The rail crossing designs included here serve to document the kinds of pedestrian safety concerns and treatments that may be considered.

CPSD assumes no liability for the use of information contained in this document. This report does not constitute a standard, specification or regulation, and is not binding on state or local government, transit agencies, or railroads.

CPSD welcomes suggestions and corrections regarding this document. Please address such comments to rces@cpuc.ca.gov.

AUTHORS

This document was prepared by the Rail Crossings Engineering Section of the Rail Transit and Crossings Branch of CPSD. Special thanks are extended to Kevin Boles, project leader. Assisting and instrumental in development of this guidance document were Varoujan Jinbachian, Jose Pereyra, and Kevin Schumacher with the Rail Crossings Engineering Section. Daren Gilbert is the Supervisor of the Rail Crossings Engineering Section. Vahak Petrossian is the Program Manager of the Rail Transit and Crossings Branch.

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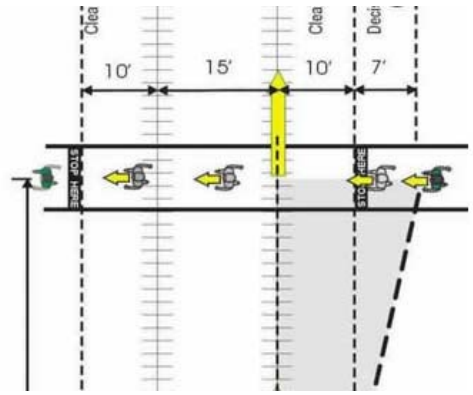


The appropriate traffic control system to be used at a pedestrian-rail at-grade crossing should be determined by an engineering study performed by a diagnostic team. The diagnostic team must, at a minimum, include CPUC staff and parties responsible for the pathway and railway. A diagnostic team should evaluate and determine the appropriate design based on pedestrian traffic, pedestrian accident history, train operations, traffic signal preemption requirements, sight distance and site specifics relating to geometry, among other factors. Final crossing design is subject to approval by CPUC.

A review of the train-pedestrian accident history at the crossing and in its vicinity may provide important information. Unsafe behavior reports, commonly referred to as near miss data, (when available from rail agency) may also provide valuable insight.

The Transportation Research Board's TCRP Report 69 Section 3.8.3 provides analysis of pedestrian-rail at-grade crossing designs including a pedestrian controls decision tree (included as Appendix B). This decision tree is a tool that can be used in determining appropriate pedestrian-rail at-grade crossing treatments.

The form attached in Appendix D provides a methodology used in the United Kingdom to evaluate safety factors at station pedestrian crossings.

Accessibility Laws and Regulations

The design must conform to California and federal accessibility regulations.

Federal accessibility guidelines can be found on the U.S. Access Board website (www.access-board.gov) and on the U.S. Department of Justice website (www.ada.gov).

State accessibility information is available from the following:
Caltrans Design Information Bulletin (DIB) 82-03, Pedestrian Accessibility Guidelines for Highway Projects, attached as Appendix C, is a primary reference regarding accessibility requirements on State Highways in California.

The California Division of the State Architect (DSA) provides design and construction oversight for K–12 schools and community colleges, and develops and maintains accessibility standards and codes utilized in public and private buildings throughout California.

California's building regulations are contained in California Code of Regulations (CCR) Title 24.

The Division of the State Architect, Access Compliance (DSA-AC) promulgates building regulations for making buildings, structures, sidewalks, curbs, and related facilities accessible to and usable by persons with disabilities. Access compliance regulations are applicable to: 1) publicly funded buildings, structures, sidewalks, curbs and related facilities, 2) Privately funded public accommodations and commercial facilities, and 3) Public housing and private housing available for public use statewide. Refer to Sections 101.17 and 101.17.11 of Part 2, CCR Title 24 for more information regarding the scope and application of DSA-AC adopted regulations.

Local jurisdictions, and other entities covered by the federal Americans with Disabilities Act (ADA) or Architectural Barriers Act (ABA), must ensure that the facilities they build or alter are accessible to people with disabilities. The U.S. Access Board's ADA and ABA accessibility guidelines specify the minimum level of accessibility in new construction and alteration projects and serve as the basis for enforceable standards maintained by other agencies. Currently, the U.S. Access Board's guidelines, like the industry standards from which they derive, focus mainly on facilities.

While they address certain features common to public sidewalks, such as curb ramps, accessible routes, ground and floor surfaces, and bus stops and shelters, further guidance is necessary to address conditions unique to public rights-of-way. Various constraints posed by space limitations at sidewalks, roadway design practices, slope, and terrain raise valid questions on how and to what extent access can be achieved.

As of May 2008, the U.S. Access Board has drafted the Revised Draft Guidelines for Accessible Public Rights-of-Way (GAPROW) to supplement its ADA and ABA accessibility guidelines. ADA and ABA guidelines primarily cover facilities on sites, while GAPROW addresses public rights-of-way. The U.S. Access Board's aim is to ensure that access for persons with disabilities is provided wherever a new pathway is newly built or altered, and that the same degree of convenience, connection, and safety afforded the public generally is available to individuals with disabilities. GAPROW does not require alterations to existing public rights-of-way, but applies where a pedestrian route or facility is altered as part of a planned project to improve existing public rights-of-way. GAPROW was last revised November 23, 2005.

Crossing Usage

Pedestrians

Crossings should be designed to best accommodate the type of pathway use expected. Pedestrian source generators and destinations must be considered. Sources and destinations include train stations, bus stops, schools, retail/commercial centers, and residential communities. Planned development and zoning should be considered as an indicator of future pedestrian activity with special consideration to accessibility needs for individuals with disabilities.

Train Operations

The appropriate design depends in part on the expected train operations. Higher train speeds, greater train volumes, heavier types of trains, and multiple tracks tend to increase the hazard to crossing users.

Crossing designers should consider the following:

Higher speeds: It is difficult for pedestrians to discern the actual speed of trains approaching a crossing at high speed. This could lead to pedestrians making an incorrect decision on whether it is safe to cross the track. Note that when automatic gate arms are not present at the crossing, a crossing user may legally decide to cross the tracks.

Train frequency: A crossing with light rail transit vehicles passing every few minutes at 35 miles per hour (MPH) will experience very frequent but short periods of crossing occupancy. A higher frequency of trains increases the potential of collisions at a crossing.

Switching: A low speed freight line with multiple daily switching movements may experience infrequent but lengthy periods of crossing occupancy. This may increase the likelihood of pedestrians violating activated warning devices.

Stopping Distance: A light rail vehicle traveling at 35 MPH has a stopping distance of roughly 300 feet. A typical freight train traveling at 55 MPH requires approximately a little over a full mile to stop. These numbers are provided only to show order of magnitude, and they may vary significantly depending on the weight, speed, and other factors. The inability of trains or light rail vehicles to stop quickly requires that the crossing present sufficient warning.

Stations: In situations where some trains may not stop at a station, but where pedestrians at a nearby crossing may expect all trains to stop,

more comprehensive pedestrian-rail at-grade crossing treatments may be necessary.

Multiple Tracks: Where multiple tracks are present, pedestrians may not be expecting trains to approach on different tracks.

Geometrics

Sight Distance

Pedestrian Clearing Sight Distance

The Pedestrian Clearing Sight Distance is the minimum unobstructed viewing distance that a pedestrian must be able to see far enough down the track in both directions to determine if sufficient time exists to safely cross the pedestrian-rail at-grade crossing. The unobstructed distance depends on train speed, crossing width, perception-reaction time of pedestrian, pedestrian walking speed, and crossing geometry. If the Pedestrian Clearing Sight Distance is insufficient, then additional passive and active devices should be considered for the design of the pedestrian-rail at-grade crossing. The passive/active devices include fencing, emergency exit swing gates, pedestrian barriers, pavement markings and texturing, refuge areas, fixed message signs, flashing light signals, audible devices, automated pedestrian arms/gates, pedestrian signals, variable message or blank out signs.

The Pedestrian Clearing Sight Distance is similar to the Clearing Sight Distance for highway-rail at-grade crossings. The highway-rail at-grade crossing Clearing Sight Distance requirements are discussed below. This section is based on the Federal Highway Administration's (FHWA) Technical Working Group's 2002 document entitled Guidance on Traffic Control Devices at Highway-Rail Grade Crossings (TWG Guidance).

At all crossings, except those with automatic gates, the TWG Guidance document recommends that if there is insufficient Clearing Sight Distance, and consequently the pedestrian is unable to make a safe determination to proceed, the Clearing Sight Distance should be improved to provide safe conditions. At new or existing crossings where adequate Clearing Sight Distance cannot be provided, a gated and channelized pedestrian design (see Section 3), crossing closure, or grade separation may be required.

Even at crossings with automatic warning devices, pedestrians at some locations can be expected to regularly violate activated devices. At such crossings it may be relevant to consider the sight lines between the crossing and approaching trains. This is discussed in the United Kingdom report (referenced above) on pedestrian-rail at-grade crossing incidents.[Ref 8.]

Pedestrian Sight Triangle

In Figure 1, a highway-rail at-grade crossing is displayed depicting a pattern for the pedestrian sight triangle. The Pedestrian Sight Triangle is formed by (A) the travel path of the pedestrian, the distance components of which are shown by example in the bullets under this section; (B) the travel path of the train measured along centerline of tracks, the length of which is determined by the Clearing Sight Distance; and (C) the diagonal line connecting the ends of A and B, representing the sight line to the approaching train.

The distance the pedestrian travels from one side of the crossing to the other is 42 feet. There are two tracks in the crossing. The distance is broken up into the following categories:

- 7 ft. Decision/Reaction Distance of 2 seconds at 3.5 feet per second (fps). Note slower speeds, as low as 1.5 fps, should be used where slower moving pedestrians are expected;
- 10 ft. Clearance Area just before a rail track;
- 15 ft. between two rail tracks;
- 10 ft. from last rail track to clearance area.

In Figure 1 a train is approaching from the south. The pedestrian is on the immediate right of the crossing starting at the Decision/ Reaction Distance category-space. The figure of the pedestrian is shown several times to represent the movement right to left over the crossing. There is a STOP HERE label on both sides of the crossing immediately prior to the beginning of the clearance area. There is a bold dashed line reaching from the pedestrian figure to the first track that demonstrates the sight distance to an approaching locomotive. The area inside the triangle is shaded. The sight triangle demonstrates that the pedestrian is 17 feet from the center of the first track.

Consider a crossing where trains travel through at 30 MPH. A pedestrian approaching the crossing should be able to see down the tracks and identify an approaching train in order to decide whether it is safe to proceed or wait for the train to pass.

Looking at the table in Figure 1, for the given example with a train speed of 30 MPH, there is a corresponding pedestrian Clearing Sight Distance of 530 feet. This distance represents the distance (d) in Figure 1, down the tracks from the crossing necessary to provide the pedestrian a clear line of sight to an approaching train.

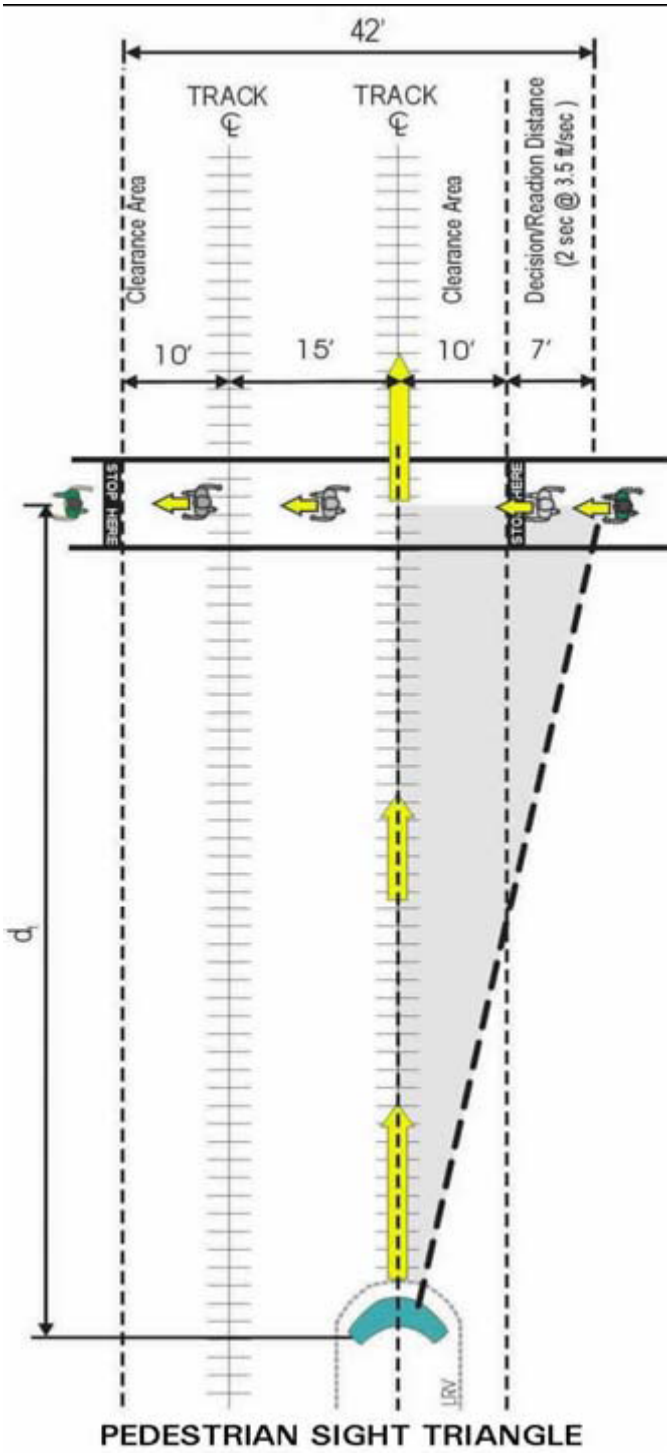
The TWG Guidance provides further discussion of clearing sight distance.

Figure 1. Clearing Sight Distance and Sight Triangle

Train Speed (MPH)	Pedestrian Clearing Sight Distance (feet) *
10	180
20	355
25	440
30	530
40	705
50	880
60	1060
70	1235
80	1410
90	1585

* walking 1.1 mps (3.5 fps) across 2 sets of tracks 15 feet apart, with a two second reaction time to reach a decision point 3 m (10 ft) before the center of the first track, and clearing 3 m (10 ft) beyond the center line of the second track. Two tracks may be more common in commuter station areas where pedestrians are found.

Note: 1 meter = 0.3048 feet.



PEDESTRIAN SIGHT TRIANGLE

Track Angle

The angle between the pathway and track is a critical element in the design of pedestrian-rail at-grade crossings. Poor geometry may place pedestrians in a situation where it may be difficult to identify an approaching train or traverse a crossing in a timely manner.

In the design of pedestrian-rail at-grade crossings effort should be made to obtain a perpendicular approach to the track. A 90-degree crossing configuration minimizes the potential for bicycles, baby strollers, wheelchairs and other narrow-wheeled vehicles to get caught in the gap between track rails and the crossing surface. It also facilitates better visibility of the railroad right-of-way allowing pathway users the opportunity to look down the tracks for approaching trains.

Acute and obtuse angled crossings have greater distances for pathway users to cross before they can clear the track area, which results exposing pedestrians to a greater risk. When a 90-degree crossing geometry cannot be attained, the designer should consider placement of warning devices parallel to the track in order to reduce the distance through the crossing.

Slope

The grade or slope of the approach should be limited to the extent feasible so that pathway users with disabilities can safely traverse the crossing. Where feasible, running slopes should be limited to 1:20 (5%) and cross slope to 1:50 (2%). These slopes are particularly difficult to obtain at rail crossings since tracks are typically higher than the sidewalk approaches.

Ramps or landings may be required where slopes are greater than 5%. Guidelines are provided by Caltrans in DIB 82-03 [3.] (see Appendix C) which allows for sidewalk grades in excess of 5% without having to comply with ramp/landing requirements, as long as the at-grade of the sidewalk does not exceed the at-grade of the adjacent roadway.

At present GAPROW should be referenced as the most applicable guidelines at rail crossings. The ADA/ABA Accessibility Guidelines for Building Facilities (ADAAG) may also provide relevant information on this topic, although it generally applies only to buildings and related structures.

Width

The typical minimum width of an accessible (pedestrian) route should be at least 48 inches (4 feet), but this may be reduced at some points. Caltrans DIB 82-03 Section 4.3.3 states: At any point of an accessible route, 32 inches must be provided as a minimum lateral clearance to an obstruction, i.e., a light standard. [ADAAG 4.2.1 and Title 241118B.1] Therefore, 32 inches (2-feet 8-inches) must generally be provided between the outer edge of a sidewalk and the outer limit of a curb-mounted warning device.

For a typical railroad crossing configuration with curb-mounted automatic gate-type warning devices, the minimum distance from the face of the curb to centerline of the warning device is 4-feet 3-inches (or 51-inches), and the maximum extension of the counterweight on the back side of the warning device is 4-feet 3-inches. Therefore, the minimum distance from the curb to the outer edge of the sidewalk adjacent to the warning device may need to be 51 + 51 + 32 = 134 inches (11-feet 2-inches).

Protruding objects within the pedestrian path should be avoided to the extent feasible. Additional information is available in GAPROW Sections R209 and R401.

Channelization

Appropriate pedestrian-rail at-grade crossing design is only effective if pedestrians actually cross at the designated point and take a path that allows them clear observation of the warning devices.

Pedestrians should be encouraged to utilize the crossing by the placement of fencing as well as by signage and markings. The need and location for fencing should be based upon field observations of unsafe behavior by pedestrians and a diagnostic meeting; the Pedestrian Control Decision Tree in TCRP Report 69 and pedestrian Clearing Sight Distance should be considered. Although TCRP Report 69 was conducted for light rail systems, most of the underlying design principles apply for all rail systems.

Physical channelization using fencing is critical to the effectiveness of pedestrian gates and/or swing gates because it prevents pedestrians from easily circumventing the devices. A study performed in Illinois demonstrated that pedestrians regularly violated pedestrian gates at crossings that did not include adequate channelization as a design element.

When channelization treatments are used with automatic gate arms, the design must include an exit path from the rail crossing. A gated and channelized configuration can provide such an exit path using emergency exit swing gates. Caltrain posts a sign noting a $271 fine for improper usage (using the emergency exit swing gate to enter the crossing when rail crossing automatic warning devices are activated) of the gate to improve compliance (see Figure 5).

Pathway delineation and directional signage may assist in channelization, particularly at places where physical fencing cannot be provided such as at the edge of a station platform or at the track surface. Delineation of the pathway can be provided by white edge line markings or contrasting pavement color or texture.

Limiting the height of fences or barriers near a crossing may be advisable to maintain unrestricted visibility of approaching trains. The California Manual on Uniform Traffic Control Devices (CA MUTCD), published by the California Department of Transportation, notes a maximum height of 3-feet 7-inches near crossings.

SECTION 2

Design Elements

SECTION 2: DESIGN ELEMENTS

There are a wide variety of design elements that can be used to provide for pedestrian safety, many of which are discussed below.

Swing Gates

Swing gates have two distinct functions: an entry/exit swing gate or an emergency exit swing gate. Swing gates must be designed so that they always open away from the track area and return to the closed position after use.

Entry/Exit Swing Gate

An entry/exit swing gate is placed across the pedestrian pathway. It is intended to slow pedestrians by encouraging them to stop, look down the tracks for approaching trains, and then pull the swing gate open prior to entering the track area. A swing gate is used as an exit gate when pedestrians leave the track area.

Some pedestrian crossings utilize multiple entry/exit swing gates side by side. This configuration is most frequently seen at light-rail station crossings, as seen in Figure 2.

Figure 2. Example of three entry/exit swing gates

Figure 3: Example of entry/exit swing gate with LOOK BOTH WAYS signage

Notice that the LOOK BOTH WAYS sign in Figure 3 is directed at pedestrians approaching the crossing from the opposite side of the tracks.

Figure 4. LOOK BOTH WAYS sign

CA MUTCD W82-1(CA)

Emergency Exit Swing Gate

An emergency exit swing gate is used in conjunction with an automatic pedestrian gate. It is designated for use only as an escape route for a pedestrian that remains between the track and a lowered automatic pedestrian gate. Figure 5 through Figure 7 illustrate the function and placement of emergency exit swing gates.

Figure 5. Example of emergency exit swing gate with Do Not Use Gate signage for pedestrians approaching the crossing

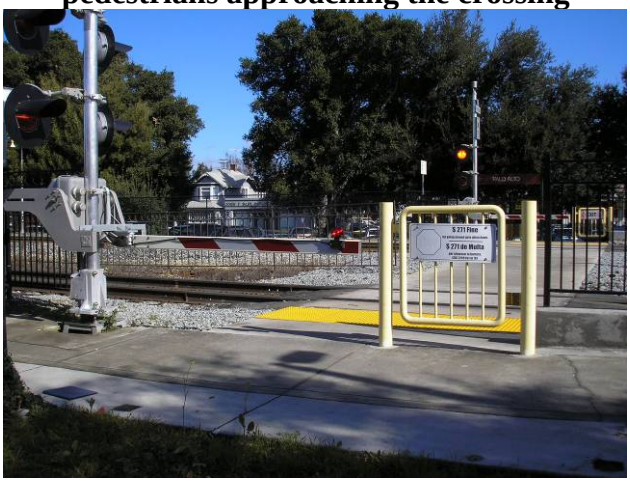


Figure 6. Example of an emergency exit swing gate used with a pedestrian gate

Note that the designated pedestrian pathway in Figure 6 is blocked by the lowered pedestrian gate arm.

Figure 7. Example of emergency exit swing gate with Exit signage as viewed from the track side

Maintenance Considerations

Currently, there exist several hinge designs for returning a swing gate to its normally closed position. Each hinge design has specific maintenance issues that should be considered when selecting the appropriate design for your application.

The hinge design in Figure 7 utilizes a spring to close the gate. Fatigue of the spring can cause the gate to not close completely and remain open, thereby compromising the safety of the swing gate. At this time a completely suitable hinge has not been identified.

Some hinge designs utilize an angle-cut hinge that allows the effects of gravity to return the gate to the closed position. Fatigue and distortion of the contact surfaces between the angled hinges can prevent the gate from returning to the fully closed position. In some cases, distortion of the hinge contact surfaces can make it very difficult to open a closed swing gate.

Another maintenance problem for swing gates is distortion of the hinges resulting from people riding on the gate as it swings from open to closed positions. This problem can be mitigated by use of a larger hinge that is welded and not bolted to the support post (see Figure 8).

Figure 8. Hinge welded to post

ADAAG includes the following language:

404.2.8.2 Spring Hinges. Door and gate spring hinges shall be adjusted so that from the open position of 70 degrees, the door or gate shall move to the closed position in 1.5 seconds minimum.

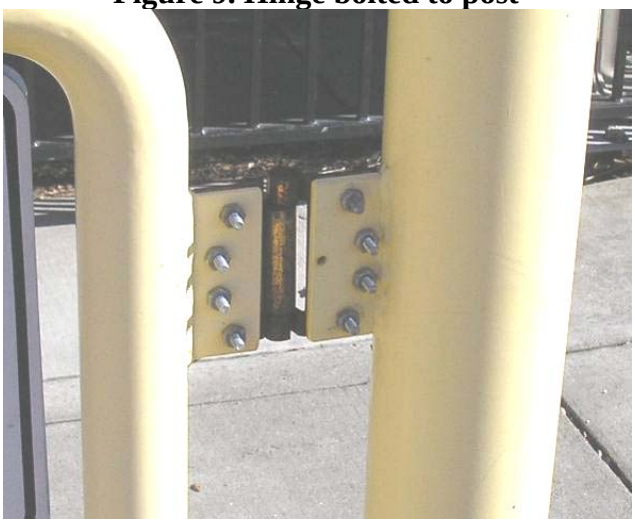
404.2.9 Door and Gate Opening Force. Fire doors shall have a minimum opening force allowable by the appropriate administrative authority. The force for pushing or pulling open a door or gate other than fire doors shall be as follows:

1. Interior hinged doors and gates: ***5 pounds*** *(22.2 N) maximum.*

*2. Sliding or folding doors****: 5 pounds*** *(22.2 N) maximum.*

These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door or gate in a closed position.

Figure 9. Hinge bolted to post



Kickplates

Kickplates are useful in assisting individuals in wheelchairs to open swing gates (see Figures 10 and 11). Kickplates are recommended at all swing gate installations. The following citation is also from the 2004 ADA and ABA *Accessibility Guidelines for Buildings and Facilities.*

> *404.2.10 Door and Gate Surfaces. Door and gate surfaces within 10 inches (255 mm) of the finish floor or ground, measured vertically, shall have a smooth surface on the push side extending the full width of the door or gate. Parts creating horizontal or vertical joints in these surfaces shall be within 1/16 inch (1.6 mm) of the same plane as the other. Cavities created by added kick plates shall be capped.*

Figure 10. Emergency exit swing gate equipped with a kickplate

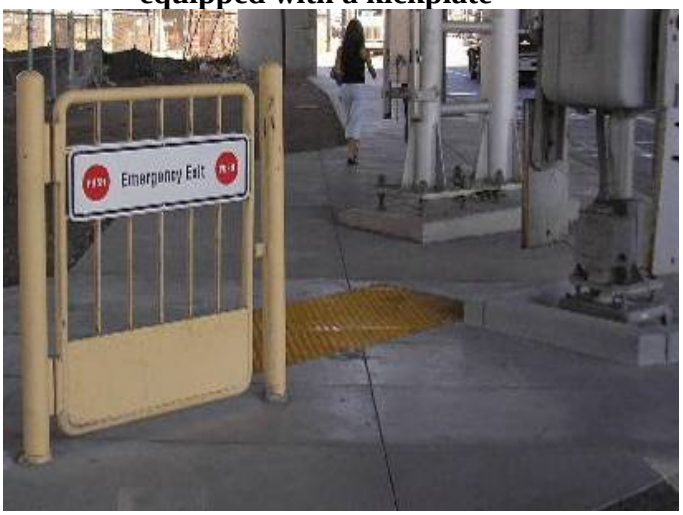
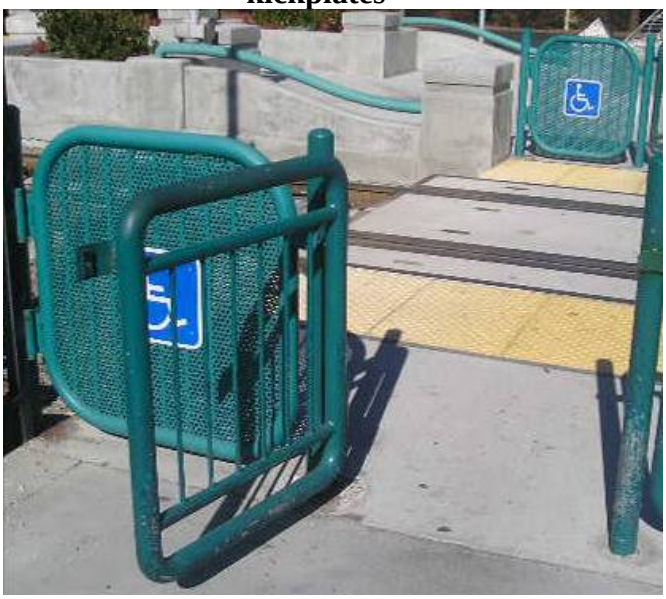


Figure 11. Swing gates with a continuous smooth surface throughout instead of kickplates



Detectable Warning

Detectable warning (sometimes referred to as tactile strips or panels) consisting of raised truncated domes provides warning to visually impaired individuals of the presence of a crossing (street or rail). The detectable warning extends 36 inches in the direction of travel covering the full width of the designated pedestrian pathway.

It is recommended that a detectable warning surface be placed before and after the tracks to indicate to a pedestrian when one has entered and exited the track area. Although GAPROW does not differentiate between railroad and light rail crossings, there are unique considerations for each.

For railroad crossings, the edge of the detectable warning surface closest to the track is typically placed adjacent to the warning sign and/or warning device, but no closer than 12 ft from the nearest rail on each side of the of the crossing.

For light rail crossings the detectable warning is typically placed no closer than 30 inches from

the light rail vehicle's dynamic envelope, pursuant to CPUC General Order 143, as amended.

Caltrans DIB 82-03 Section 4.3.14 and State Building Code Sections 1133B.8.3 & 1133B.8.4 provides further details regarding 'Detectable Warning Surface'.

GAPROW also provides the following:

R304.2.3 Rail Crossings. The detectable warning surface shall be located so that the edge nearest the rail crossing is 1.8 m (6 ft) minimum and 4.6 m (15 ft) maximum from the centerline of the nearest rail. The rows of truncated domes in a detectable warning surface shall be aligned to be parallel with the direction of wheelchair travel.

Advisory R206 Pedestrian Crossings. When tracks are located in a street or highway that has a pedestrian route, the detectable warnings at the curb ramps make a second set of detectable warnings at the rail unnecessary in most applications. When rail tracks are not associated with a street or highway, they must have detectable warnings across the pedestrian access route on either side.

It should also be noted that directional surfaces, which are distinct from detectable warning surfaces, may be used to convey wayfinding information to pedestrians with vision impairments. This wayfinding information can provide orientation clues to find the designated pathway over the tracks (see Figure 14).

CPUC Staff Recommendations

There are various standards, regulations and guidance documents that discuss the placement of detectable warning strips. Many standards related to this topic are undergoing revision, and some of the sources have conflicting recommendations as to the placement of the detectable warning.

CPUC staff, as of the publication date of this document, recommends the following for new installations.

1. Dimensions
The detectable warning should extend:

A. 3-feet in the direction of pedestrian travel
B. across the full width of traveled portion of the pathway or sidewalk, including swing gates, if present

2. Placement
The inner (nearest the track) edge should generally be placed:

A. no less than 12 feet from nearest rail
B. one foot outside the pedestrian gate or swing gate, if present
C. one foot outside the vehicular gate arm's counterweight, if present, unless this leads to long distances across the track (e.g. skew crossings)

The detectable warning may need to be placed closer to the tracks than the vehicular gate at a skewed crossing. At a skewed crossing, the placement of the vehicular warning devices may not provide adequate warning to pedestrians because the distance along the sidewalk may be much greater than the distance along the center of the roadway. In this situation, pedestrians will generally move into the area between the warning devices and the track, where there is often no designated location to wait safely. The warning device bells and flashing light signals may not be easily observed in this area. Also, slower pedestrians may have difficulty walking from the vehicular warning devices across all the tracks within the minimum warning time of 20 seconds. These issues might be addressed by placing the detectable warning closer to the tracks, possibly in combination with additional pedestrian warning devices or signage.

The exact location of the detectable warning strips should be determined by engineering judgment. The engineer should consider the time it takes for a pedestrian to cross all the tracks safely, the visibility of approaching trains from the detectable warning location, and visibility and audibility of nearby warning devices.

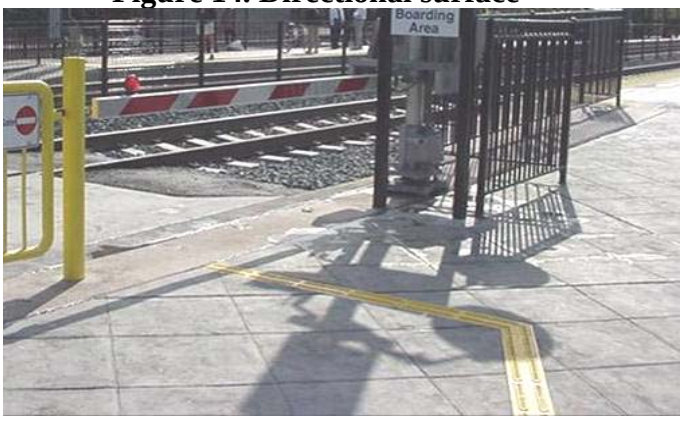
Detectable warning should extend in front of an emergency exit swing gate. Although this is not

part of the normal pathway, since emergency exit swing gates may fail to close fully, this is a necessary precaution. Swing gates may fail to close because the opening pressure of a swing gate is very light or due to vandalism. Detectable warning placed with the emergency exit swing gate reduces the possibility that a visually impaired person might pass through an open gate unaware of the potential hazard ahead.

Figure 12. Detectable warning surface at edge of curb

Figure 13. Detectable warning surface across pedestrian pathway at a crossing

Figure 14. Directional surface



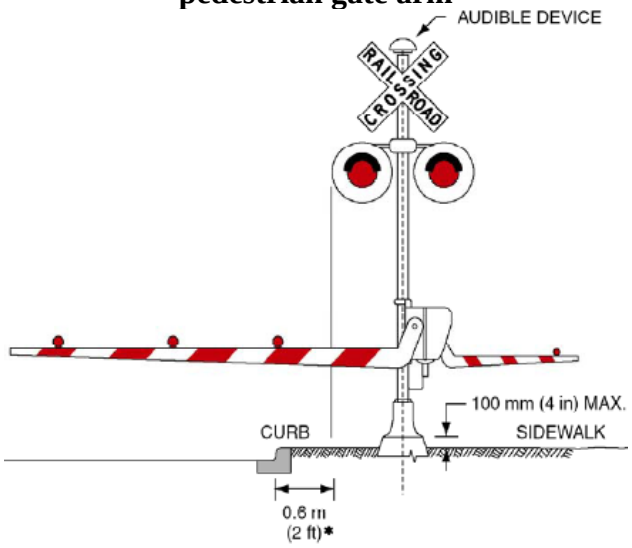
Pedestrian Gates

A pedestrian gate is an automatic gate that offers an active positive barrier to discourage pedestrians from entering the right-of-way during train movements. When used at pedestrian-rail at-grade crossings, each automatic gate should be approximately 3 feet above the pathway when in the horizontal position.

Figure 15. Emergency exit swing gate with Pedestrian gate

Detectable warning is a needed improvement here.

Figure 16. CA MUTCD Figure 10D-4: example of pedestrian gate placement with pedestrian gate arm



An audible warning device (mechanical or electronic bell) is generally required with flashing light signal assembly (with or without automatic gate) warning device. The audible warning device is sounded while the warning device (flashing light signals) is activated to provide warning to pathway users and bicyclists. The audible warning device is typically placed at the top of the mast, but may be mounted at a lower point to better direct the sound toward pathway users. (See Commission General Order 75 for further detail.)

Figure 17. Pedestrian gate and emergency exit swing gate

Figure 18. Pedestrian gate mounted on automatic gate assembly

Notice emergency exit swing gate positioned perpendicular to pedestrian gate. As of May 2008, proposed changes to the MUTCD restrict installing pedestrian gates on the same mast as vehicular gates.

Flashing Light Signal Assemblies

A flashing light signal assembly can be used in conjunction with entry/exit swing gates or stand alone.

Figure 19. Flashing light signal assembly at an in-station pedestrian crossing

Signage

Standard Signs

Standard signage for use at crossings is specified in the CA MUTCD and in Commission General Order 75, as amended. Crossings exclusively for the use of pedestrians and/or bicycles must post the CPUC Standard 1-D sign.

Figure 20. CPUC Standard 1-D

CA MUTCD includes the following standard signs which are generally intended for pedestrians.

The LOOK sign is a regulatory sign which can be placed below the standard Crossbuck sign, or in combination with the Standard 1-D sign.

The LOOK BOTH WAYS sign is a warning sign typically mounted on swing gates facing pedestrians at light rail station crossings.

The W10-12 sign is the standard sign to indicate a skew crossing, which may be valuable information for cyclists.

Figure 21. Various Signs

CA MUTCD R15-8

CA MUTCD W82-1(CA)

CA MUTCD W10-12

NON-STANDARD

Non-Standard Signs

The CA MUTCD requires that only standard signs be used. However, there is a wide variety of non-standard signage in use near stations and along the railroad right-of-way. These non-standard signs are intended to discourage pedestrians from trespassing on the railroad right-of-way, encourage pedestrians to utilize designated crossing points, and warn pedestrians of trains.

The warning signs in Figure 22 are non-standard signs placed along the right-of-way and intended for pedestrians. The yellow color is generally consistent with the warning message.

Figure 22. Non-standard warning signs

Figure 23. Authoritative signs

Some signs provide a more authoritative message and cite penalties. The red and blue coloring and Penal Code citation in the signs contained in Figure 23 below provide more than a warning to stay off the tracks.

Figure 24 shows two separate signs that are often used together along the Caltrain right-of-way. NO TRESPASSING signs should be posted every 600 feet along the right-of-way per California Penal Code Section 554.1(d), and at crossings or stations. Well maintained signage can support the issuance of trespassing citations.

Figure 24. Caltrain NO TRESPASSING Sign

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Crossing Surfacing

Where the pedestrian pathway crosses track at grade, the surface of the pedestrian pathway should be level and flush with the top of the rail at the outer edge and between the rails. The crossing surface should provide a smooth transition over the rails and be free of holes and gaps.

Caltrans DIB 82-03 Section 4.3.1 provides details regarding walkway surfaces.

Rail Flangeway Gap

Designers should consider reduction of the flangeway gap. The gap width for the wheels of the train is typically a few inches and can present a problem for wheelchairs, strollers, and other narrow-wheeled conveyances.

Caltrans DIB 82-03 Section 4.3.6 states:

Where a path crosses tracks, the opening for wheel flanges shall be permitted to be 2-1/2 inches maximum. [ADAAG 10.3.1(13)]

GAPROW sections R301.7.3 and R301.7.4 include further details.

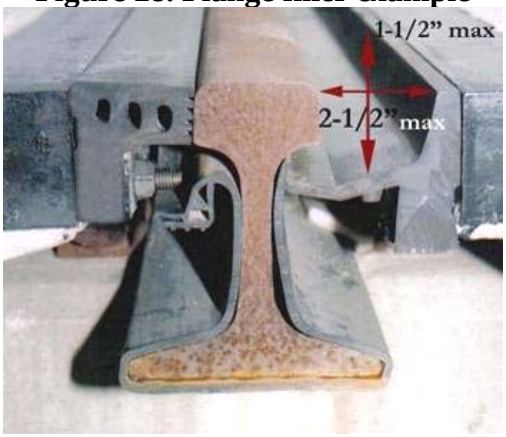
Flangeway filler material is recommended where feasible, and where there is pedestrian, wheelchair, or cyclist use, particularly where the tracks are at a skew angle. Most materials reduce the horizontal and vertical gap to that necessary for a wheel flange. Other products fill the entire gap and deflect upon passage of a train. Figures 25– 28 illustrate the placement and function of flangeway filler material.

Figure 25. Flangeway gap with rubber inserts

Figure 26. Inserts reduce gap depth

Figure 27. Wheelchair

Figure 28. Flange filler example



Discontinuous sidewalk segments

Lack of sidewalks at rail crossings can be hazardous to pedestrians. This often results in pedestrians either walking over the rails outside the paved crossing, which could result in tripping, or walking in the roadway which presents the risk of collision with roadway traffic.

Local agencies typically require construction of sidewalks up to the railroad right-of-way on both sides of the track, as adjacent parcels are developed. The local agency should also plan to fund the construction of sidewalks over the track when pedestrian facilities are constructed along the approaches.

At crossings where sidewalks are not provided, it may be necessary to place a pipe-rail barrier and PEDESTRIANS PROHIBITED signage. However, this should only be used as a temporary measure. This treatment alone cannot be expected to discourage pedestrians from continuing along a natural route over the tracks. Sidewalks should not be constructed when they lead pedestrians to a point with no designated pathway.

Figure 29. PEDESTRIANS PROHIBITED sign and pipe-rail barrier

Channelization Design

Fencing

Pedestrians tend to take the shortest route to their destination. Therefore, if no other physical barriers exist such as buildings or walls, then fencing is generally the most important element of channeling pedestrians to legal crossings at areas where unsafe behavior by pedestrians is known to occur.

The length of fencing should be based on an analysis of pedestrian destinations and travel patterns. In general fencing should extend at least 25 feet either along the railroad right-of-way or along the pathway. Any gap between the fencing and warning devices should be minimized.

When pedestrian automatic gates are present pipe-rail fencing should be placed between the sidewalk and the roadway. This fencing should be placed in quadrants that do not have a vehicular automatic gate. It should extend at least 10 feet from the warning devices. An example is provided in the Gated and Channelized design in Section 3.

In order to prevent trespassing along the railroad right-of-way, it is recommended that fence heights be greater than 4 feet, and preferably 8 feet, high in order to act as a significant barrier to pedestrians.

Designers should be aware that fence height may need to be limited near a crossing to maintain sight lines along the track.

In determining the appropriate fence type, the designer should consider vandal resistance and the difficulty of climbing. The costs of both construction and maintenance also will be a consideration. While typical chain link/cyclone fencing is cheaper than other types of fencing, it is not recommended because the higher cost of its maintenance and lower vandal resistance, compared to other types of fencing.

At a sidewalk crossing with a pedestrian gate, a pipe-rail barrier/fence may be appropriate to channelize pedestrians and prevent them from easily walking around the pedestrian gate by stepping off the curb. Such a barrier is typically only necessary in the quadrants where gate arms do not lower across the roadway.

Figures 30 – 35 illustrate several types of fencing currently used for channelization of pedestrians and trespasser prevention.

Wire Mesh Fence

Figure 30. Example of wire mesh fence

This provides a simple barrier to pedestrians and is low in height allowing visibility of approaching trains.

Figure 31. Example of wire mesh fence

This fence is tall making it difficult to climb over, and has a dense mesh making it difficult to cut through.

Steel Tubular Fence

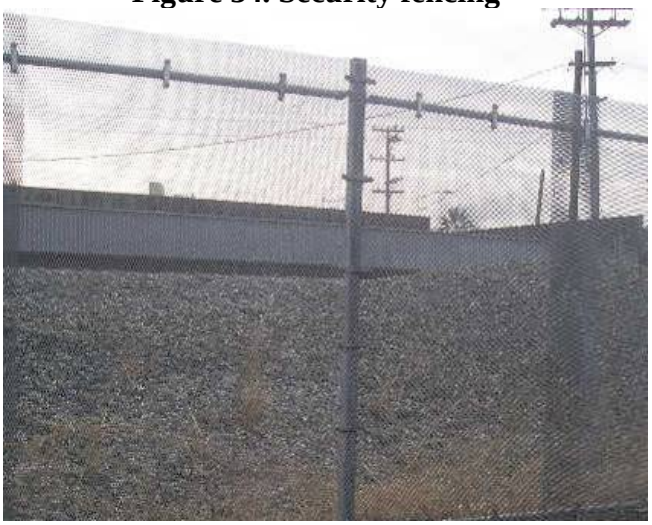
Figure 32. Example of steel tubular fence

This is vandal resistant and may be considered decorative in comparison to the wire mesh.

Figure 33. Example of pedestrian taking the shortest route

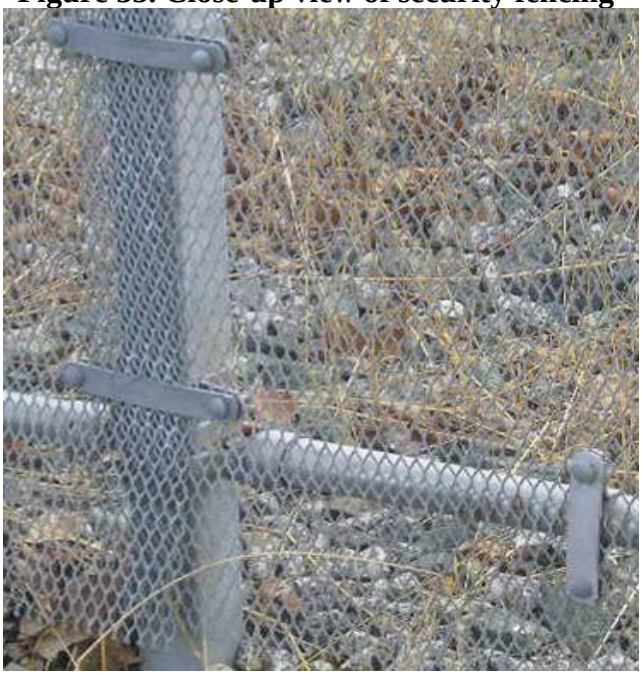
Security Fence

Figure 34. Security fencing



The extremely dense mesh of this fencing makes it very difficult to cut through or climb.

Figure 35. Close-up view of security fencing



Edge Lines

Painted edge lines should be used to delineate the edge of a designated pedestrian path at the track where the limits of the pathway are not well defined. The edge lines can consist of pavement markings separating the roadway and pathway. Roadway edge lines are typically 4 inches wide while pedestrian pathway edge lines are a minimum 12 inches wide. In some situations a buffer can be provided between the pathway and the roadway. This can be particularly important where the distance through the crossing is long, commonly due to a skew track angle or multiple tracks, or where the path surface smoothly transitions to a vehicular traveled lane.

Painted edge lines or contrasting pavement textures can also be used on approach to a crossing to delineate the designated pedestrian pathway and to assist in channelization.

A conspicuous edge line along the right side of a roadway at the tracks can assist motorists in recognizing and following the vehicular travel lane. This may reduce the likelihood of confused motorists driving onto the pedestrian pathway.

White reflective markers or Botts' dots can be used to supplement a white edge line delineating the edge of roadway. Areas that receive snow should have reflective markers recessed into the pavement.

Figure 36. Example of white reflective raised-pavement-markers with an edge

Railroad Worker Walkways

In order to provide effective channelization near station platforms, it is important to consider eliminating a common design feature which allows pedestrians to easily bypass warning devices and fencing.

Walkways along the track are mandated in CPUC General Orders 118 and 143, as amended. Emergency walkways for passengers are provided along light rail transit tracks. General Order 118 requires continuous walkways adjacent to the track for train crews to assist with switching or inspect a stopped train. Typically commuter rail station platforms include ramps to transition from this walkway to the platform. However, General Order 118 includes an exception for the walkways at stations.

In order to discourage pedestrians from bypassing the designated path and warning devices, CPUC staff recommends that such platform ramps be eliminated where they are near a pedestrian-rail at-grade crossing and where they are not necessary for freight operations. A ballasted area, as shown in Figure 39, between the ramp and the crossing discourages pedestrians from taking a shortcut past the warning devices. Where a ballasted area sufficient to discourage pedestrians cannot be provided, it is recommended that larger rocks be placed which provide a difficult surface for walking. Figure 40 provides an example of the use of larger rocks.

Figure 37. Problematic shortcut between station platform and pedestrian crossing

Figure 38. Railroad worker's ramp near crossing

The close proximity of the ramp and the crossing provides a shortcut,.

Figure 39. Ballasted area between platform and crossing

The length of ballast helps discourage pedestrians from this route

Figure 40. Large rocks discourage pedestrians from circumventing the designated pathway

Other Treatments

CPUC staff considers demonstration projects for new or improved warning device technology at rail crossings. However, traffic control devices installed at a highway-rail crossing require authorization by the CPUC. Non-standard traffic control devices may also require the approval of the California Traffic Control Devices Committee and the Federal Highway Administration.

In-Roadway Lights

CA MUTCD allows in-roadway (also known as in-pavement) warning lights to be installed facing motorists at pedestrian crosswalks to provide warning where no STOP sign or traffic signal is present. There have been experimental installations of in-roadway warning lights facing motorists approaching railroad crossings in California. However such lights have not been utilized to provide warning to pedestrians. CPUC staff will consider pursuing an experimental installation of in-roadway lights to provide additional warning to pedestrians at a rail crossing. A similar idea has been pursued in subway stations in Washington, D.C., where flashing lights are embedded flush with the detectable warning along platform edges.

Pavement Markings

Pavement markings can be used to provide additional warning for pedestrians.

Figure 41. PEDESTRIANS STOP HERE markings

Second Train Coming Signs

A major factor in many pedestrian incidents is the pedestrian being unaware of a second train approaching from behind a train immediately in front of them. Too often, pedestrians walk over the tracks as soon as the train in front of them passes, and then are struck by the second train.

A study was conducted on graphical Second Train Coming signs for a light rail pedestrian-rail at-grade crossing adjacent to a station in City of Vernon in Los Angeles County. The study did not conclusively determine that pedestrians understood the directional or second-train indications on this sign. However pedestrians indicated that they did feel it provided additional warning of approaching trains. Additional research is necessary to develop new technology or designs that effectively warn pedestrians of an approaching second train.

Figure 42. Sign indicates an approaching train

Unfortunately the sign does not actually indicate which track the train is approaching on.

Count-Down Pedestrian Signal Heads

If count-down pedestrian signal heads are used at a location interconnected with a railroad or light rail transit crossing, the design should consider whether the timing information provided to pedestrians will be accurate upon the approach of a train.

Count-down pedestrian signals provide pedestrians in a crosswalk at an intersection with additional information about how much time is available to safely cross the roadway. This information is only accurate when the traffic signal operates under a predictable timing cycle. Railroad preemption interrupts the normal sequence of operation and therefore is generally not compatible with count-down pedestrian signal heads. If properly designed, advance preemption may be able provide a predictable minimum pedestrian clearance time to allow a count-down to complete. Complications include switching movements and changes in train speed. For these situations, an engineering study should be conducted to evaluate whether advance preemption can provide predictable minimum pedestrian clearance time to allow a count-down to complete.

Count-down pedestrian signals are becoming common at signalized intersections along newly constructed street or median running light-rail systems. Such systems typically provide transit priority rather than full railroad preemption of the traffic signals and therefore can be designed to allow the pedestrian count-down to complete prior to the train going through the crossing.

Figure 43. Count-down pedestrian signal head

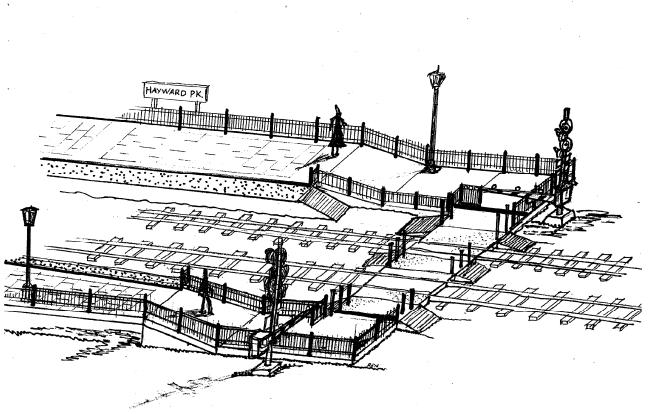
Mirrors

Convex mirrors are a simple way to provide pedestrians greater visibility of a second train or a train approaching from behind them.

Figure 44. Convex Mirror at a Station Crossing

SECTION 3

Design Examples



SECTION 3: DESIGN EXAMPLES

The following examples provide some ideas for safety improvements at crossings where pedestrian safety is an issue. These examples show pedestrian crossing designs with some recommended design elements, but no particular example shows all the elements that need to be considered. Any particular crossing design should be evaluated by a diagnostic team including the rail organization, roadway authority, and CPUC staff.

Gated and Channelized Design

Figure 46 shows a 90 degree crossing utilizing many of the design elements previously discussed. This design has been developed by Caltrain, a northern California commuter rail agency. Many of the designs found in this document are based on Caltrain's standards. CPUC staff has found this to be an effective configuration to increase pedestrian compliance with warning devices at pedestrian-rail at-grade crossings. Elements of this configuration should be considered at new or modified pedestrian-rail at-grade crossings that have heavy pedestrian traffic.

The following elements should be considered to address pedestrian safety.

A. Fencing
    i. Pathway Channelization
    ii. Right-of-Way
B. Swing Gates
    i. Emergency Exit Swing Gates
    ii. Entry/Exit Swing Gates
C. Roadway Edgeline
D. Pathway Edgeline
E. Tactile Strips / Detectable Warning
F. Pedestrian Automatic Gate
G. Vehicular Automatic Gate
H. Pavement markings (e.g.: Stop Here)
I. Warning signs (active or passive)

A small section of channelization fencing (item A in Figure 46) between the sidewalk and the roadway is included in the off-quadrants to keep pedestrians from easily taking a step off of the curb to circumvent the pedestrian automatic gate. In general, no less than a 25-foot section of fence should be used for this application; although this won't deter an individual determined to bypass lowered gates, it should prevent casual disregard, requiring a significant walk in the roadway rather than one or two quick steps. The design can be likened to using raised medians to prevent gate drive-around. This segment of fencing is not required for approaches with vehicular gates, since the vehicular gates prevent easy circumvention by pedestrians.

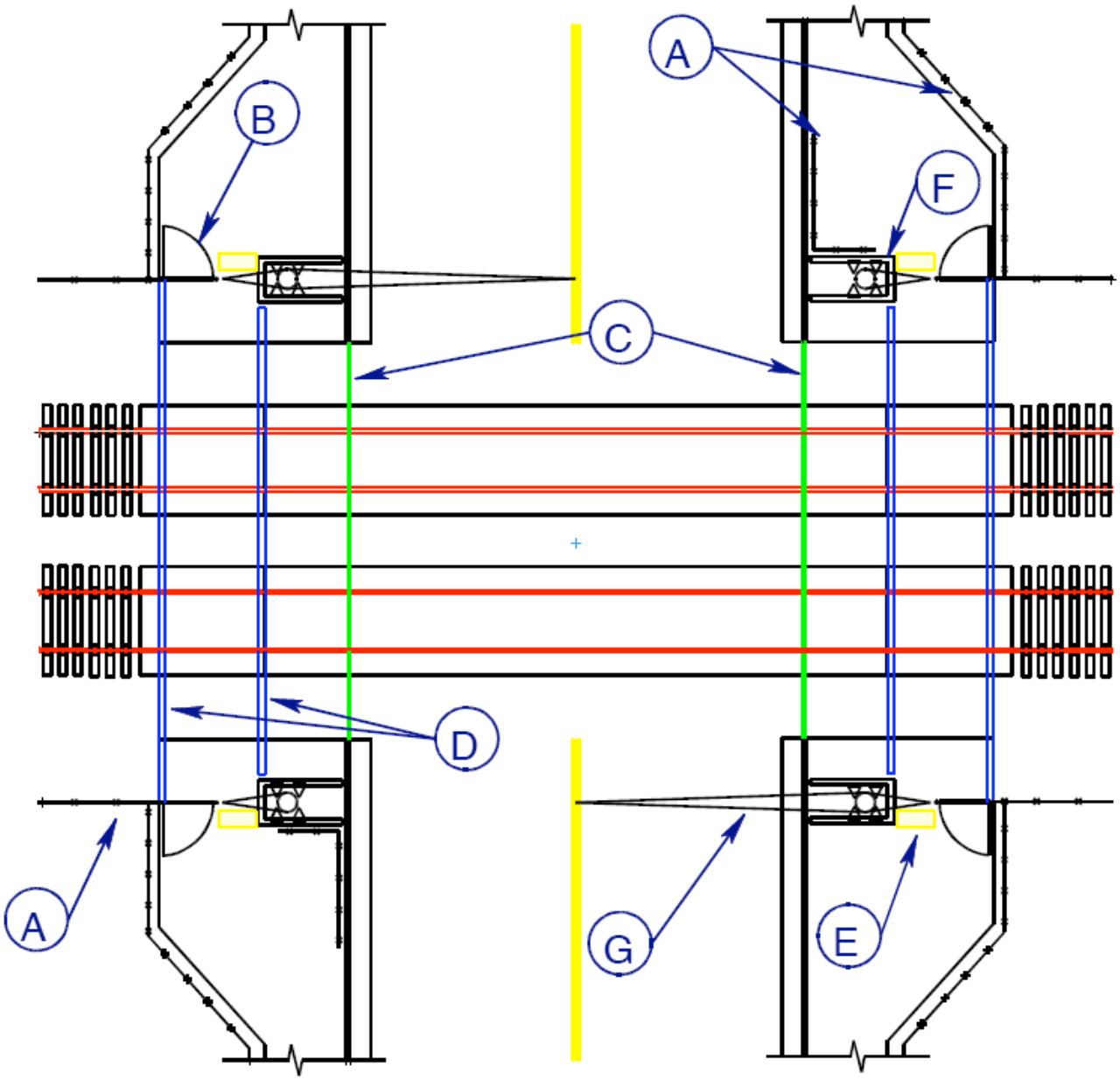
Where multiple tracks are present, particularly where second-train incidents are a concern, strong consideration should be given to a fully gated and channelized design.

Figure 45 below illustrates the short segment of steel tubular fencing discussed above.

Figure 45: Channelization using steel tubular fence

A few sample plans for pedestrian crossings are provided in Appendix A.

Figure 46: Gated and channelized design



LEGEND

A. Fencing (Pathway Channelization)
B. Swing Gates (Emergency Exit Swing Gates)
C. Roadway Edgeline
D. Pathway Edgeline
E. Detectable Warning
F. Pedestrian Automatic Gate
G. Vehicular Automatic Gate

Gated Non-Channelized Design

Pedestrian gate without sufficient channelization are not effective. In the photo shown below, it is clear that pedestrians can easily circumvent a lowered gate.

Figure 47. Pedestrian automatic gate without channelization

A study by the State of Illinois showed that pedestrian gates alone have a low compliance rate when pedestrians can easily circumvent them.

Non-Gated Off-Quadrant Flashing Light Signals

In cases where the gated and channelized design is not practical, additional pedestrian warning can be provided by flashing light signal assemblies in the quadrants which do not have vehicular automatic railroad crossing warning devices. (These quadrants are typically referred to as off-quadrants). Off-quadrant flashing light signals, in conjunction with the vehicular warning devices in vehicular approach quadrants, provides warning for all pedestrian approaches. This design may be appropriate where the typical vehicular railroad crossing warning devices are not easily observed, visibly or audibly, by pedestrians from the off-quadrant. Figure 48 is an example of this design.

Detectable warning and/or pavement markings should be considered along the sidewalk to indicate to pedestrians a safe location to wait for passing trains.

Figure 48. Flashing light signals for pedestrians in off-quadrant

Station Crossings

The gated and channelized designs can be split into two primary categories: pedestrian-only crossings and pedestrian-rail at-grade crossings adjacent to a roadway. In general station pedestrian crossings are located at the ends of platforms, since it can be difficult to provide appropriate channelization at mid-platform crossings.

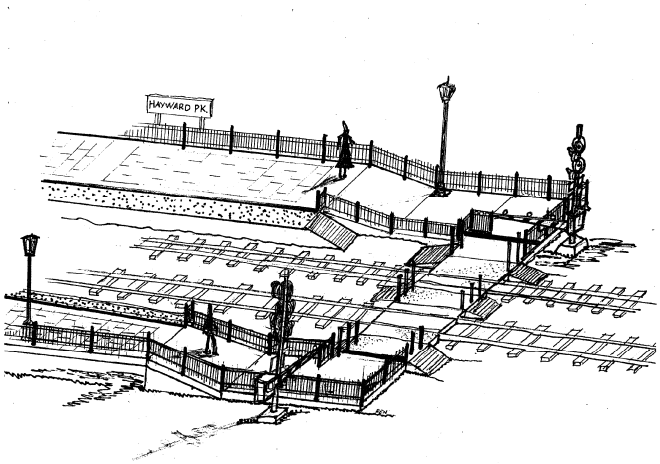
Figure 49 shows an example of a station layout with a pedestrian-only crossing at each end of the platforms. Typically there are two platforms, each located on the outside of, rather than between, the tracks.

For a station with two tracks, center fencing placed between the tracks is critical in order to prevent trespassing over the track area.

The second case for in-station crossing is where the station is adjacent to an at-grade highway-rail crossing/public street. See

Figure 18 as one example.

Figure 49. Channelized in-station crossing



Light Rail Station Crossing

A standard design used at many light rail station crossings is characterized by detectable warning, flashing light assembly warning devices (off quadrants, may not be required for single track), pull gates (often three adjacent swing gates), signage and fencing. Figure 50 below is an example of this design.

Figure 50. Typical light rail transit in-station crossing

Z-Gates

Z-Gates are designed to channel pedestrians in a Z pattern such that the pedestrian faces each direction along the tracks while approaching the crossing. Figure 51 below is an example of this design.

Figure 51: Z-Gate with flasher unit

LIST OF REFERENCES

[1.] California Public Utilities Commission (CPUC) General Orders (GO) on rail safety.
GO 26 (railroad clearances)
GO 72 (crossing surfaces)
GO 75 (warning devices)
GO 118 (rail worker walkways)
GO 143 (rail transit)
http://www.cpuc.ca.gov/crossings/

[2.] California Manual on Uniform Traffic Control Devices (CA MUTCD), California Department of Transportation (Caltrans), September 26, 2006.
Part 8: Railroad Crossings
Part 10: Light Rail Transit Crossings
http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/

[3.] Caltrans Design Information Bulletin 82-03: Pedestrian Accessibility Guidelines for Highway Projects, California Department of Transportation (Caltrans), October 24, 2006.

[4.] FHWA Guidance on Traffic Control Devices at Highway-Rail At-grade Crossings, U.S. Department of Transportation – Federal Highway Administration – Highway-Rail At-grade Crossing Technical Working Group, November 2002.

[5.] FHWA Railroad-Highway At-grade Crossing Handbook – Revised Second Edition 2007, U.S. Dept. of Transportation – Federal Highway Administration – Office of Safety Design, prepared by ITE, FHWA and others, Report No. FHWA-SA-07-010, August 2007

[6.] Guidelines for Accessible Public Rights-of-Way (Revised Draft), U.S. Access Board, November 23, 2005.
http://www.access-board.gov/PROWAC/

[7.] Pedestrian Safety at Rail Grade Crossings in Northeastern Illinois, Illinois Commerce Commission, April 2005.

[8.] Rail Accident Report – Investigation Into Station Pedestrian Crossings, U.K. Department of Transport – Rail Accident Investigation Branch, December 2006.

[9.] Safety Criteria for Light Rail Pedestrian Crossings, Prepared by Don Irwin, Tri-County Metropolitan Transportation District of Oregon, August 2002.

[10.] TCRP Report 69 - Light Rail Service: Pedestrian and Vehicular Safety, Transit Cooperative Research Program, 2001.

GLOSSARY

Note: The following definitions are provided to allow better understanding of the terms used in this document. Terminology related to pedestrian-rail crossings is rapidly evolving.

ABA: Architectural Barriers Act
Access Board: The U.S. Access Board is an independent Federal agency devoted to accessibility for people with disabilities. It is a leading source of information on accessible design.
Accessible Route: A continuous, unobstructed path connecting all accessible elements and spaces of a building facility.
ADA: Americans with Disabilities Act
ADAAG: ADA/ABA Accessibility Guidelines for Building Facilities
AREMA: American Railway Engineering & Maintenance of Way Association. This group establishes recommended practices for the railroad industry.
Automatic / Active Railroad Crossing Warning Devices: Train-activated warning devices such as flashing light signals and automatic gate arms.
Ballast: Crushed stone which serves as a bed for railroad tracks and provides both track support and drainage.
CA MUTCD: California Manual on Uniform Traffic Control Devices, published by California Department of Transportation (Caltrans). This publication sets standards for traffic control devices (signs, markings, signals, etc.) in State of California.
Channelization Device: For vehicles - consisting of a raised median or plastic delineator located in the center of a road which discourages a motorist from driving around a lowered crossing gate. For pedestrians - fencing.
Crossing Angle: An angle between 0 and 90 degrees at which a railroad and a highway/pathway intersect.
Crossing Surface: Surface material placed between the rails that creates a rail crossing. Modern surfaces generally consist of asphaltic concrete (A/C), rubber panels, poured concrete or pre-fabricated concrete panels.
Crossbuck: A sign in an X formation with the words RAILROAD CROSSING.
Detectable Warning: Truncated domes placed on the walking surface which can be detected by one's feet or when using a long cane. These are used to warn of hazardous areas, such as vehicular lanes, the edge of rail platforms, or railroad tracks.
Diagnostic Team: A group of knowledgeable representatives of the parties of interest in a highway-rail crossing or a group of crossings.
Dynamic Envelope: The clearance required for the train and its overhang due to any combination of loading, lateral motion, or suspension failure.
Flashing Light Signal: A warning device consisting of two red signal indications arranged horizontally that are activated to flash alternately when a train is approaching or present at a highway-rail at-grade crossing.
GAPROW: Guidelines for Accessible Public Rights-of-Way, published by U.S. Access Board.
Grade: The rate of ascent or descent of a roadway expressed as a percentage; the change in roadway elevation per unit of horizontal length.
Grade Separation: A crossing of a highway/pathway and a railroad at different levels using a bridge structure**.**
Individual with Disability: An individual who has a physical impairment, including impaired sensory, manual or speaking abilities, that results in functional limitation in gaining access to and using a building or facility**.**

Light Rail: Light rail or light rail transit (LRT) is a form of rail transport system that generally uses electric rail cars on private rights-of-way or sometimes in streets; a mode of urban transportation.
Main Line: A principal line of a railway, which carries high volume train traffic at higher speeds.
Off-Quadrant: The location at a rail crossing, from the perspective of an approaching motorist, on the far side of the tracks and same side of the roadway. Warning devices are typically absent in the off-quadrant.
Pavement Markings: Markings set into the surface of, applied upon, or attached to the pavement for the purpose of regulating, warning, or guiding traffic.
Pedestrian: A person who travels on foot or who uses assistive devices, such as a wheelchair, for mobility**.**
Pedestrian-Rail At-Grade Crossing: The general area where a pathway and a railroad cross at the same level, within which are included the railroad tracks, pathway, design features, and traffic control devices for pathway traffic traversing that area.
Public Right-of-Way: Public land or property, usually in interconnected corridors, that is acquired for or devoted to transportation purposes.
Railroad Preemption: The transfer of normal operation of traffic signals to a special control mode upon notification of an approaching train.
Right-of-Way: A strip of land devoted to rail transportation purposes.
Shared-Use Path: A bikeway outside the traveled way and physically separated from motorized vehicle traffic by an open space or barrier and either within the highway right-of-way or within an independent alignment. Shared-use paths are also used by pedestrians (including skaters, users of manual and motorized wheelchairs, and joggers) and other authorized motorized and non-motorized users.
Sidewalk Crossing: A pedestrian-rail at-grade crossing that is contiguous with a highway-rail at-grade crossing.
Sight Distance: The unobstructed distance a person can see.
Station Crossing: A pedestrian-rail crossing located within a train station or providing access to a station.
Swing Gate: A self-closing fence-type gate designed to swing open away from the track area and return to the closed position upon release.

APPENDICES

Appendix A: Example Schematics
Example plans showing the details of a gated and channelized pedestrian crossing design.

Appendix B: Decision Tree
TCRP Report 69 - Light Rail Service: Pedestrian and Vehicular Safety, Transit Cooperative Research Program, 2001. // Figure 3-38. Pedestrian Controls Decision Tree.

Appendix C: Caltrans Pedestrian Accessibility Guidelines
Caltrans Design Information Bulletin 82-03: Pedestrian Accessibility Guidelines for Highway Projects, California Department of Transportation (Caltrans), October 24, 2006.

Appendix D: Assessment Sheet for Crossings Located at Stations
Network Rail (U.K.), March 2005. Excerpted from Rail Accident Report – Investigation Into Station Pedestrian Crossings, U.K. Department of Transport – Rail Accident Investigation Branch, December 2006.

APPENDIX A:

Example Schematics from Caltrain

Example plans showing the details of a gated and channelized pedestrian crossing design

APPENDIX B:

Decision Tree

From Transit Cooperative Research Program (TCRP) Report 69 – Light Rail Service: Pedestrian and Vehicular Safety. Figure 3-38

APPENDIX C:

Caltrans Pedestrian Accessibility Guidelines

Caltrans Design Information Bulletin 82-03: Pedestrian Accessibility Guidelines for Highway Projects, California Department of Transportation (Caltrans), October 24, 2006

APPENDIX D:

Assessment Sheet for Crossings Located at Stations

Excerpted from Rail Accident Report – Investigation Into Station Pedestrian Crossings, U.K. Department of Transportation – Rail Accident Investigation Branch, December 2006