Shared Rail Corridor Adjacent Track Accident Risk Analysis

Chen-Yu Lin, M. Rapik Saat, Ph.D. (mohdsaat@illinois.edu)
Rail Transportation and Engineering Center, Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, USA

There are several safety concerns associated with operating passenger and freight trains on shared-use rail corridors (SRC). Adjacent track accident (ATA) mainly refers to a train accident scenario where a derailed equipment intrudes adjacent tracks, causing operation disturbance and potential subsequent train collisions on the adjacent tracks. This study presents a semi-quantitative risk analysis model to evaluate the ATA risk incorporating various factors affecting train accident rate, intrusion rate, train presence rate, and accident consequences.

Background

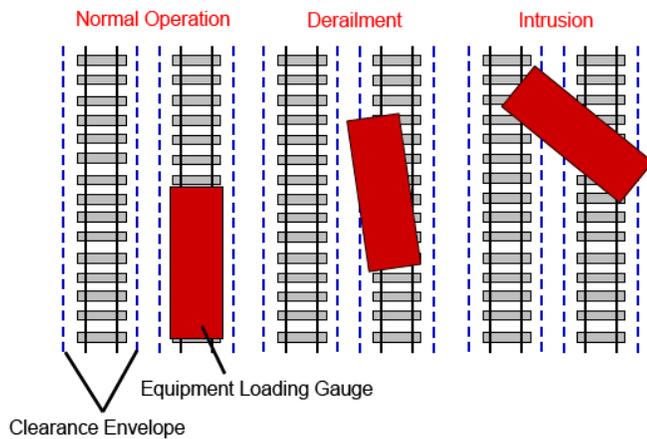Figure 1 depicts a typical sequence of events of an ATA.

Figure 1. A Typical Prequel for An ATA

Semi-Quantitative Risk Analysis Model

A common definition of risk is the multiplication of the frequency of an event with the consequence of the event. In this study, the ATA risk index is defined as follows:

$$R = P(A) \times P(I|A) \times P(T|I) \times C$$

where

R: The risk index for an ATA

P(A): The probability of an initial derailment or collision on a multiple track section

P(I|A): Conditional probability of intrusion (CPI) given an initial derailment or collision

P(T|I): Conditional probability of the presence of a train on adjacent track given an intrusion

C: The consequence of an ATA

Tables 1-9 show the associated factors and scoring to determine the ATA risk index.

Table 1. Accident Factor Score Definitions

Accident Factor	Criteria	Accident Factor Score (AFS)
FRA Track Class	6 or above	1.0
	5	2.0
	4	4.0
	2, 3	8.0
	X, 1	16.0
	Freight-Train only or Freight and Passenger Shared Lines:	
Traffic Density	More than 60 MGT	1.0
	40 - 60 MGT	1.4
	20 - 40 MGT	2.0
	Less than 20 MGT	4.0
	Passenger-Train only Lines:	
	Dedicated Passenger Line	1.0
Method of Operation	Signaled	1.0
	Non-Signaled	1.5
		96.0
The highest score possible		**0**
The lowest score possible		**1.00**

Table 2. Level of P(A)

Total Accident Factor Score (AFS)	Level of P(A)
AFS ≤ 3	1
3 < AFS ≤ 10	2
10 < AFS ≤ 20	3
20 < AFS ≤ 45	4
AFS > 45	5

Table 3. Intrusion Factor Score Definitions

Intrusion Factor	Criteria	Intrusion Factor Score (IFS)
Distance Between Track Centers, X, in feet (meters)	X > 80 (24.4)	1.0
	55 (16.7) < X ≤ 80 (24.4)	1.5
	30 (9.1) < X ≤ 55 (16.7)	2.0
	15 (4.5) < X ≤ 30 (9.1)	3.0
	X ≤ 15 (4.5)	5.0
Track Alignment	Tangent and level	1.0
	Tangent and on gradient	1.1
	Curved and level	1.5
	Curved and on gradient	1.7
Elevation Differential	Adjacent track is 10 ft. higher	0.7
	Adjacent track is level	1.0
	Adjacent track is 10 ft. lower	1.3
Adjacent Structure	No adjacent structure	1.0
	Single structure	1.1
	Discrete structure	1.2
	Continuous structure	1.3
Containment	All containments installed	0.5
	Physical barrier and guard rail or parapet installed	0.6
	Physical barrier installed only	0.7
	Parapet and guard rail installed	0.8
	Parapet or guard rail installed only	0.9
	No containment installed	1.0
Train Speed	Low (less than 40 mph)	1.0
	Medium (40 mph to 70 mph)	1.2
	High (more than 70 mph)	1.4
The highest score possible		**20.11**
The lowest score possible		**0.35**

Table 4. Total IFS and Level of CPI Definitions

(IFS)	Level of CPI
IFS ≤ 2	1
2 < IFS ≤ 3	2
3 < IFS ≤ 5	3
5 < IFS ≤ 10	4
IFS > 10	5

Table 5. Train Presence Score Definitions

Train Presence Factors	Criteria	Train Presence Score (TPS)
IDW	Presence	1
	Absence	2
	Freight or Freight and Passenger Shared Lines:	
	Less than 20 MGT	1
	20 - 40 MGT	1.3
Traffic Density	40 - 60 MGT	1.6
	More than 60 MGT	2
	Passenger Lines:	
	Dedicated Passenger Line	2
Method of Operation	Advanced train control	1
	Typical train control system	2
	Dark territory	3
Average Train Speed	Low (less than 40 mph)	1
	Medium (40 mph to 70 mph)	2
	High (more than 70 mph)	3
The highest score possible		**36**
The lowest score possible		**1**

Table 6. Total TPS and Level of P(T|I) Definitions

Total Train Presence Factor (TPS)	Level of P(T|I)
TPS ≤ 3	1
3 < TPS ≤ 6	2
6 < TPS ≤ 12	3
12 < TPS ≤ 24	4
TPS > 24	5

Table 7. Overall Probability Level Definitions

Multiplication of P(A), P(I|A), and P(T|I)	Overall Probability Level, P
1 < P ≤ 10	1
10 < P ≤ 20	2
20 < P ≤ 30	3
30 < P ≤ 50	4
P > 50	5

Table 8. Consequence Factor Score Definitions

Consequence Factor	Criteria	Consequence Factor Score (CFS)
Equipment Strength	Reinforced equipment	1
	Traditional equipment	2
Speed	Low (less than 40 mph)	1
	Medium (40 mph to 70 mph)	2
	High (more than 70 mph)	3
Containment	Containment Present	1
	No Containment	2
Product being transported	No Hazardous material	1
	Hazardous material	2
The highest score possible		**24**
The lowest score possible		**1**

Table 9. Level of Consequence Definitions

Consequence Factor Score	Level of Consequence
CFS ≤ 3	1
3 < CFS ≤ 6	2
6 < CFS ≤ 10	3
10 < CFS ≤ 15	4
CFS > 15	5

Conclusions

The risk model enables comparisons of the relative ATA risks among different track sections along the same SRC. The model could also be used to locate the risk hotspots on a SRC where the ATA risk is high and risk mitigation is required. This research intends to depict a high-level overview of ATA, and provides a basis for future quantitative risk analyses and risk mitigation implementations.