

Transportation Depth Topics



School of PE

Supplemental Solutions

Code: CITESS-D

Spring 2015

Collision Diagrams & Crash Modifications Factors Primer

Based on AASHTO Highway Safety Manual and FHWA Publications

Solutions to Exercises

1. The intended outcome of a *diagnosis* is which of the following:
 - A The identification of causes of the collisions and potential safety concerns or crash patterns that can be evaluated further.
 - B A review of a transportation network that identifies and ranks sites from most likely to least likely to realize a reduction in crash frequency with implementation of a countermeasure.
 - C The identification of countermeasures to reduce crash frequency or severity as specific sites.
 - D An assessment of how crash frequency or severity has changed due to a specific treatment or a set of treatments or projects.

HSM, page 5-1. Chapter 5. The correct answer is A.

2. What is the approximate Comprehensive Crash Cost of an *Evident Injury*?
 - A \$10,000 to \$30,000
 - B \$30,000 to \$65,000
 - C \$65,000 to \$150,000
 - D \$150,000 to \$260,000

HSM, Appendix 4A – Crash Cost Estimates. Table 4A-1. Crash Cost Estimates by Crash Severity; Page 4-84. The correct answer is C.

3. What is the Human Capital Crash Cost of a Head-on Collision at a Non-Intersection location?
 - A \$81,000 to \$90,000
 - B \$91,000 to \$100,000
 - C \$101,000 to \$110,000
 - D \$111,000 to \$130,000

HSM, Appendix 4A – Crash Cost Estimates. Table 4A-2. Crash Cost Estimates by Crash Type; Page 4-85. The correct answer is C.

4. The three major subtasks performed by drivers include which of the following?
 - A Communication, Control, and Maneuvering
 - B Guidance, Navigation, and Control
 - C Guidance, Communication, and Control
 - D Communication, Guidance, and Navigation

HSM, Section 2.2 Driver Task Model, Figure 2-1, Page 2-2. The correct answer is B.

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5. Which of the following is probably NOT a contributing factor to a Right-angle collision at a signalized intersection?
- A Narrow Lanes
 - B Inadequate signal timing
 - C Excessive speeds
 - D Drivers running red light

HSM, Section 6.2.2 Contributing Factors for Consideration, Crashes at Signalized Intersections; page 6-5. The correct answer is A.

6. Which of the following is probably NOT a contributing factor to a Rear-end collision at an unsignalized intersection?
- A High Approach Speed
 - B Inadequate gaps in traffic
 - C Excessive speeds
 - D Large Number of Turning Vehicles

HSM, Section 6.2.2 Contributing Factors for Consideration, Crashes at Unsignalized Intersections; page 6-7. The correct answer is A.

7. What type of crash would you expect on a roadway segment that has the following contributing factors: inadequate lane width, inadequate median width, poor delineation, and inadequate shoulder width?
- A Vehicle rollover
 - B Rear-end
 - C Opposite-direction sideswipe or head-on
 - D Run-off-the-road

HSM, Section 6.2.2 Contributing Factors for Consideration, Crashes on Roadway Segments; page 6-5. The correct answer is D.

8. What type of crash would you expect at a signalized intersection that has the following contributing factors: inadequate signal timing, pedestrian or bicycle conflicts, conflict with right-turn-on red vehicles?
- A Nighttime
 - B Rear-end or sideswipe
 - C Left- or right-turn movement
 - D Right-angle

HSM, Section 6.2.2 Contributing Factors for Consideration, Crashes at Signalized Intersections; page 6-6. The correct answer is C.

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9. On the KABCO scale, what does a “K” code represent?

- A Fatality
- B Incapacitating Injury
- C Possible Injury
- D Property Damage Only

University of Massachusetts, Amherst, Traffic Safety Research Program. The correct answer is A.

Pavement Evaluation & Maintenance Primer

Based on FHWA and FAA Publications

SOLUTIONS

1. Which of the following is NOT one of the five primary causes of pavement deterioration?
 - A Traffic Loading
 - B Construction Quality and Materials
 - C Moisture
 - D Maintenance
 - E **Superelevation**

The correct answer is E. See page 1 for Five Primary Causes of Pavement Deterioration.

2. Which of the following types of pavement deterioration is the result of insufficient adhesion between the asphalt cement and aggregate?
 - A Bleeding
 - B Reflective cracking
 - C **Raveling**
 - D Shoving

The correct answer is C. See page 2, Section A.1, Raveling.

3. What is the name of the condition that is caused by an excessively high asphalt cement content in the mix, using an asphalt cement that is too flowable, too heavy a prime or tack coat, or an improperly applied seal coat
 - A **Bleeding**
 - B Reflective cracking
 - C Raveling
 - D Shoving

The correct answer is A. See page 2, Section A.2, Bleeding.

4. Why is pavement polishing undesirable?
 - A Problems created by people stopping along the road to steal chunks of the pavement.
 - B Polishing causes pavement slabs to crack.
 - C **Loss of surface friction is a safety concern.**
 - D Pavement slabs becomes too thin, crack, break-up, make a mess.

The correct answer is C. See page 3, Section A.3, Polishing.

5. Which of the following pavement conditions is also known as, "washboarding"?
 - A shoving
 - B pushing
 - C **corrugation**
 - D rutting

The correct answer is C. See page 4, Section B.2, Corrugation.

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Pavement Evaluation & Maintenance Primer

Based on FHWA and FAA Publications

6. What is often a prime cause of slippage cracking?
- A Not enough tack coat,
 - B Too much asphalt in mix.
 - C Traffic wearing away the pavement surface.
 - D Drastic temperature change.

The correct answer is A. See page 7, Section C.5, Slippage Cracking.

7. Which of the following is the most likely NOT the cause of channelization?
- A Hydroplaning.
 - B Mechanical deformation.
 - C Plastic deformation of the asphalt mixtures near the pavement surface
 - D Consolidation.

The correct answer is A. Hydroplaning is the result of channelization. Channelization is not the result of hydroplaning.

8. Which of the following conditions could be caused by rounded or smooth textured coarse aggregate?
- A swell
 - B block cracking
 - C corrugation
 - D crocodile cracking

The correct answer is C. See page 4, Section B.2, Corrugation.

9. What causes pavement depression?
- A Too much traffic.
 - B hydroplaning
 - C Localized consolidation beneath the surface course.
 - D Braking from high speeds.

The correct answer is C. See page 5, Section B.4, Depressions.

10. What is the name of the condition caused by the loss of bond between aggregates and asphalt binder that typically begins at the bottom of the HMA layer and progresses upward?
- A stripping
 - B rutting
 - C shoving
 - D corrugations

The correct answer is A. See page 9, Section E.3, Stripping.

Pavement Evaluation & Maintenance Primer

Based on FHWA and FAA Publications

11. Which of the following is a result of inadequate shoulder compaction during construction?

- A hydroplaning
- B lane to shoulder drop-off
- C alligator cracking
- D edge cracking

The correct answer is B. See page 10, Section E.1, Lane-to-Shoulder Drop-off.

12. Which of the following is NOT a likely cause of delamination?

- A Highly polished underlying pavement surface?
- B Water seepage
- C Insufficient tack coat
- D Surface layer is too thick

The correct answer is D. See page 3, Section A.4, Delamination.

13. Excess asphalt binder in the HMA is a possible cause for which of the following conditions?

- A Delamination
- B Swelling
- C Flushing
- D Bleeding

The correct answer is D. See page 2, Section A.2, Bleeding.

ADA Design Considerations Primer

Based on 2010 ADA Standards & AASHTO Green Book 2011 Edition

The Department of Justice published revised regulations for Titles II and III of the Americans with Disabilities Act of 1990 "ADA" on September 15, 2010. The 2010 ADA Standards are available on-line at:

<http://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm>

1. The ADA Standards specify that the maximum ramp slope shall not be steeper than 1:12. However, the ADA standards make an exception for existing sites, buildings, and facilities.

Suppose you are renovating a sixty year-old theater and need to install an accessible ramp that will rise 5 inches. You need to complete the ramp in one continuous run with no landing. What is the maximum slope you can use in this case?

- A 1:12
- B 1:11
- C 1:10**
- D 1:9
- E 1:8

See Table 405.2 of the ADA Standards. For a maximum rise of 6 inches, the maximum slope is 1:10. The correct answer is C.

2. What is the preferred minimum width of a median and island "cut-through"?
 - A 4'-0"
 - B 5'-0"
 - C 6'-0"**
 - D 6'-6"

See ADA Standards, Section 406.7 Islands. The correct answer is C.

3. What is the preferred minimum width of a median refuge area?
 - A 4'-0"
 - B 5'-0"
 - C 6'-0"**
 - D 6'-6"

See AASHTO Green Book Figure 4-21. The correct answer is C.

4. The cross slope of ramp runs shall not be steeper than _____.
 - A 1:10
 - B 1:12
 - C 1:24
 - D 1:48**

See ADA Standards, Section 405.3. The correct answer is D.

ADA Design Considerations Primer

Based on 2010 ADA Standards & AASHTO Green Book 2011 Edition

5. What is the maximum rise of a ramp run?
A 2'-0"
B 2'-6"
C 3'-0"
D 3'-6"

See ADA Standards, Section 405.6. The correct answer is B.

6. What is the minimum length of a ramp landing?
A 5'-0"
B 5'-6"
C 6'-0"
D 5'-6"

See ADA Standards, Figure 405.7. The correct answer is A.

7. Suppose you are building a new school. What is the minimum total length of a proposed ramp structure (including all ramp runs and ramp landings) required for a rise of 6 feet? Assume level landings are provided at top, bottom and as needed in between.
A 80'-0"
B 87'-0"
C 92'-0"
D 94'-6"

See ADA Standards, Figure 405.7. The correct answer is C.

4 landings at 60" each + ramp runs (72" rise at 1:12) = (240" + 864") / 12" per ft = 92'-0".

8. What is the clear width of a ramp run where handrails are provided?
A 24"
B 30"
C 36"
D 42"

See ADA Standards, Section **405.5 Clear Width**. The clear width of a ramp run and, where handrails are provided, the clear width between handrails shall be 36 inches (915 mm) minimum. The correct answer is C.

ADA Design Considerations Primer

Based on 2010 ADA Standards & AASHTO Green Book 2011 Edition

9. What is the maximum cross slope (counter slope) on a roadway surface at a curb ramp?
- A 30:1
 - B 25:1
 - C 20:1
 - D 15:1

See ADA Standards, **Section 406.2 Counter Slope**. Counter slopes of adjoining gutters and road surfaces immediately adjacent to the curb ramp shall not be steeper than 1:20. The adjacent surfaces at transitions at curb ramps to walks, gutters, and streets shall be at the same level. The correct answer is C.

10. What is the maximum cross slope (counter slope) on a roadway surface at a curb ramp?
- A 10:1
 - B 15:1
 - C 20:1
 - D 25:1

See ADA Standards, **Section 406.3 Sides of Curb Ramps**. Where provided, curb ramp flares shall not be steeper than 1:10. The correct answer is A.

11. What is the maximum longitudinal slope on the walking surface of an accessible route (not including ramps or curb ramps)?
- A 10:1
 - B 15:1
 - C 20:1
 - D 25:1

See ADA Standards, **Advisory 402.2 Components**. Walking surfaces must have running slopes not steeper than 1:20, see 403.3. Other components of accessible routes, such as ramps (405) and curb ramps (406), are permitted to be more steeply sloped. The correct answer is C.

12. What is the minimum width of an accessible van parking space, if an adjacent access aisle is provided?
- A 88 in
 - B 96 in
 - C 124 in
 - D 132 in

See ADA Standards, **Section 502.2 Vehicle Spaces**. ...van parking spaces shall be 132 inches (3350 mm) wide minimum, shall be marked to define the width, and shall have an adjacent access aisle complying with 502.3. The correct answer is D.

ADA Design Considerations Primer

Based on 2010 ADA Standards & AASHTO Green Book 2011 Edition

13. What are the minimum length x width of the landing at the top of a curb ramp?

- A 36" x 36"
- B 36" x 48"
- C 48" x 48"
- D 54" x 54"

A level landing area at the top of each curb ramp should be 1.2 m by 1.2 m [4 ft by 4 ft]. See ADA Standards, Section **406.4 Landings**. Landings shall be provided at the tops of curb ramps. The landing clear length shall be 36 inches (915 mm) minimum. The landing clear width shall be at least as wide as the curb ramp, excluding flared sides, leading to the landing. The correct answer is D.

14. What is the minimum width of a curb ramp?

- A 30"
- B 36"
- C 48"
- D 54"

See AASHTO Green Book, Section **4.17.3 Curb Ramps**, The minimum curb ramp width should be 1.2 m [4 ft]. The correct answer is C.

15. What is the maximum slope of a curb ramp?

- A 4.33 percent
- B 6.33 percent
- C 8.33 percent
- D 9.33 percent

See AASHTO Green Book, Section **4.17.3 Curb Ramps**, The maximum curb ramp grade should be 8.33 percent. The correct answer is C.

16. What is the width of the detectable warning strip required at the bottom of curb ramps a curb ramp?

- A 12"
- B 18"
- C 24"
- D 30"

See AASHTO Green Book, Section **4.17.3 Curb Ramps**, A 0.6-m [2-ft] wide detectable warning strip is required at the bottom of curb ramps to improve detectability by people with visual impairments.

ADA Design Considerations Primer

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17. If a sidewalk is less than 1.5 m [5 ft], a passing section should be provided. In this situation, what is the maximum distance between passing sections?
- A 50'
 - B 100'
 - C 150'
 - D 200'**

See AASHTO Green Book Section **4.17.1 Sidewalks**. The correct answer is **D**.

18. If a planted strip is provided between sidewalk and traveled way curb, what is the minimum width planted strip that should be how wide to allow for maintenance activities?
- A 0.3 m [1 ft]
 - B 0.6 m [2 ft]**
 - C 0.9 m [3 ft]
 - D 1.2 m [4 ft]

See AASHTO Green Book Section **4.17.1 Sidewalks**. The correct answer is **D**.

19. Which of the following factors would NOT affect curb ramp design details?
- A Sidewalk width
 - B Sidewalk location with respect to the curb
 - C Height and width of curb cross section
 - D Design turning radius and length of curve along the curb face
 - E Angle of street intersections
 - F Planned or existing location of sign and signal control devices
 - G Stormwater inlets and public service utilities
 - H Potential sight obstructions
 - I Thickness of pavement subbase course**
 - J Street width
 - K Border width

While there are many factors that need to be considered in the design of curb ramp details, it is safe to say that the thickness of the pavement subbase course is not one of them. The correct answer is **I**. See AASHTO Green Book, Section **4.17.3 Curb Ramps**, for further discussion.

Cross Sectional Elements Primer

Based on AASHTO Green Book 2011 Edition

The AASHTO Green Book devotes Chapter 4 to the discussion of more than 20 kinds of cross-section elements, including lanes, shoulders, curbs, clear zones, drainage channels and side slopes, medians, traffic barriers, and frontage roads. Chapter 4 contains 74 pages and 45 references to other publications. This primer includes 15 questions directly related to the material presented in Chapter 4. The purpose of this primer is to encourage candidates to become familiar with Chapter 4 so that they are well prepared to answer similar questions on the PE exam.

1. The selection of surface type is determined based on many factors. Which of the following is NOT a factor in determination of surface type?
 - A Traffic volume and composition,
 - B Soil characteristics,
 - C Noise
 - D Performance of pavements in the area,
 - E Availability of materials,
 - F Initial cost, overall annual maintenance cost and service-life cost.
 - G All of the above are legitimate factors that affect surface type.

The correct answer is G. See Section 4.2.2.

2. When designing a divided highway the designer must decide whether to drain the roadway surface away from the median or toward the median. Which of the following is NOT an advantage of draining away from the median?
 - A May provide a savings in drainage structures.
 - B Minimize drainage across the inner, higher-speed lanes.
 - C Simplify treatment of intersecting streets.
 - D The outer lanes, which are used by most traffic, are less free of surface water.

The correct answer is D. See Figure 4-3.

3. Skidding crashes are a major concern in highway safety. It is not sufficient to attribute skidding crashes merely to “driver error” or “driving too fast for existing conditions.” The roadway should provide a level of skid resistance that will accommodate the braking and steering maneuvers that can reasonably be expected for the particular site.

Which of the following is NOT one of the main causes of poor skid resistance on wet pavements?

- A pavement rutting,
- B pavement polishing,
- C pavement bleeding,
- D pavement milling or grinding.

The correct answer is D. See Section 4.2.3.

Cross Sectional Elements Primer

Based on AASHTO Green Book 2011 Edition

4. Auxiliary lanes at intersections and interchanges often help to facilitate traffic movements. Where continuous two-way left-turn lanes are provided, what is the width that provides the optimum design?

- A 3.0 m to 4.9 m [10 to 16 ft]
- B 3.4 m to 5.2 m [11 to 17 ft]
- C 3.7 m to 5.5 m [12 to 18 ft]
- D 4.0 m to 4.8 m [13 to 19 ft]

The correct answer is A. See Section 4.3.

5. Desirably, a vehicle stopped on the shoulder should clear the edge of the traveled way by at least ____ m [____ ft]. (fill in the blanks)

- A 0.30 m [1.0 ft]
- B 0.45 m [1.5 ft]
- C 0.60 m [2.0 ft]
- D 0.75 m [2.5 ft]

The correct answer is A. See Section 4.4.2.

6. If shoulders are to function effectively, they should be sufficiently stable to support occasional vehicle loads in all kinds of weather without rutting. Evidence of rutting, skidding, or vehicles being mired down, even for a brief seasonal period, may discourage and prevent the shoulder from being used as intended.

Paved or stabilized shoulders offer numerous advantages, including:

- A provision of refuge for vehicles during emergency situations,
- B elimination of rutting and drop-off adjacent to the edge of the traveled way,
- C provision of adequate cross slope for drainage of roadway,
- D reduction of maintenance,
- E provision of lateral support for roadway base and surface course
- F provision of convenient parking areas for sleepy motorists.

The correct answer is F. See Section 4.4.1 General Characteristics.

7. Which of the following statements about clear zones is false?

- A The clear zone includes shoulders, bicycle lanes, and auxiliary lanes unless the auxiliary lane functions like a through lane.
- B A full-width clear zone needs to be established in all locations, regardless of whether urban or rural areas.
- C The term "clear zone" is used to designate the unobstructed, traversable area provided beyond the edge of the traveled way for the recovery of errant vehicles.
- D Basic clear zone width is determined by design speed, traffic volume, and roadside grading.

The correct answer is B. See Section 4.6.1.

Cross Sectional Elements Primer

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8. In an urban environment, a lateral offset to vertical obstructions (signs, utility poles, luminaire supports, fire hydrants, etc., including breakaway devices) is needed to accommodate motorists operating on the roadway and parked vehicles. This lateral offset to obstructions helps to:
1. Avoid adverse impacts on vehicle lane position and encroachments into opposing or adjacent lanes;
 2. Improve driveway and horizontal sight distances;
 3. Reduce the travel lane encroachments from occasional parked and disabled vehicles;
 4. Improve travel lane capacity.

Which of the above statements is false?

- A None are false.
- B All are false.
- C Statements 1 and 2 are false.
- D Statements 3 and 4 are false.

The Correct answer is A.

9. The type and location of curbs affects driver behavior and, in turn, the safety and utility of a highway. A curb, by definition, incorporates some raised or vertical element. Curbs serve any or all of the following purposes:
- A drainage control,
 - B roadway edge delineation,
 - C impact attenuation,
 - D delineation of pedestrian walkways,

Which of the above purposes is incorrect?

The correct answer is C. Curbs do not make good impact attenuators.

10. Roadside ditches and channels are important drainage facilities.
1. The use of foreslopes steeper than 1V:4H severely limits the range of backslopes.
 2. Flatter foreslopes permit greater flexibility in the selection of backslopes to permit safe traversal.
 3. Steeper foreslopes provides greater recovery distance for an errant vehicle.
 4. From a standpoint of hydraulic efficiency, the most desirable channel contains flatter sides.

Which of the above statements is false?

- A None are false.
- B All are false.
- C Statements 1 and 2 are false.
- D Statements 3 and 4 are false.

Cross Sectional Elements Primer

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The correct answer is D. In statement 3 the word “steeper” should be changed to “flatter”. In statement 4, the word “flatter” should be changed to “steeper”. See Section 4.8.3.

11. Development of streets or highways may include sections constructed in tunnels either to carry the streets or highways under or through a natural obstacle or to minimize the impact of the freeway on the community.

General conditions under which tunnel construction may be warranted include:

1. Narrow rights-of-way where all of the surface area is needed for street purposes;
2. Large intersection areas or a series of adjoining intersections on an irregular or diagonal street pattern;
3. Railroad yards, airport runways, or similar facilities;
4. Parks or similar land uses, existing or planned;

Which of the above statements is false?

- A All are false.
- B Statements 1 and 2 are false.
- C Statements 3 and 4 are false.
- D None are false.

The correct answer is D. See Section 4.16.1.

12. You are designing a new tunnel for a two lane highway. The lanes are each 12-feet wide. The roadway is to have left and right shoulders, and sidewalks on each side for emergency egress. What is the desirable cross section width (face of wall to face of wall) for a two-lane tunnel?

- A 9.0 m [30 ft]
- B 10.0 m [33 ft]
- C 10.6 m [35 ft]
- D 13.4 m [44 ft].

Note: See Figure 4-14, for desirable width of a two-lane tunnel section. The correct answer is D.

Cross Sectional Elements Primer

Based on AASHTO Green Book 2011 Edition

13. A proposed park-and-ride will provide a special section for subcompact cars. The designer has designated a 400-ft long section of curb and sidewalk. The subcompact cars are to park perpendicular to the curb. What is the maximum number of subcompact cars this area will accommodate?
- A 44
 - B 47
 - C 50**
 - D 53

Note: See Section 4.19.3 Park-and Ride Facilities. Assume each space is 8 ft wide, the correct answer is C.

14. A new Park-n-Ride facility will include a principal passenger-loading area with a shelter to protect public transit patrons. The off-peak passenger volume expected to use the shelter at any one time is 320. How large should the proposed shelter be?
- A 58 to 96 m² [576 to 960 ft²].
 - B 77 to 128 m² [768 to 1280 ft²].
 - C 96 to 160 m² [960 to 1600 ft²].
 - D 110 to 184 m² [1104 to 1840ft²].

Note: To determine the size of the shelter, the number of passengers that the shelter is anticipated to serve should be multiplied by a factor of 0.3 to 0.5 m² [3 to 5 ft²]. Use the following US Std to Metric conversion: ft² x 0.1 = m²

The correct answer is C. See page 4-71, 4th paragraph.

15. A new Park-n-Ride facility will include a bus-loading area. The bus loading area will be of the sawtooth design. Assume the bus loading area should have enough bays for five buses to load at one time. What is the minimum required length of the loading area?
- A 40 m [130 ft].
 - B 60 m [195 ft].
 - C 80 m [260 ft].
 - D 100 m [325 ft].**

Note: See Figure 4-24, Sawtooth Bus Loading Area. The correct answer is D.