GUIDELINES FOR 
THE DESIGN AND CONSTRUCTION OF RAILROAD 
OVERPASSES AND UNDERPASSES

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Design and Construction of Underpass Grade Separation Structures
# Section I

## Design and Construction of Underpass Grade Separation Structures

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Appendix A – Underpass Grade Separation Data Sheet
Purpose and Scope

The intent of this guideline is to inform public agencies, design engineers and contractors of KCSRC’s current standards and requirements concerning design and construction of grade separation underpass structures.

Design criteria shall not be less than required by the latest edition of the American Railway Engineering and Maintenance-of-Way Association’s (AREMA) Manual for Railway Engineering. The KCSRC Railroad Construction Guidelines are not all inclusive and KCSRC requirements may be revised at any time by KCSRC.

Prior to any review submittal, KCSRC shall receive authorization from the agency agreeing to pay all of KCSRC’s review and field-observation costs for the design and construction phases of the project.

Continuity of safe rail operations shall be required for the duration of the project and construction work shall in no way impede the train operations of the KCSRC.

The specific requirements addressed in this document should be followed for structures on which the KCSRC operates regardless of whether it is maintained by KCSRC or by others. Compliance with these requirements will help to expedite the completion of design and construction reviews.

Designs of all public works projects shall be prepared either by the engineering staff of that agency or a consulting engineer who has been approved by both KCSRC and that public agency. All final design documents shall be sealed by licensed professional engineers responsible for the design.

Selection of consultants shall be limited to those who are familiar with the design of railroad bridges, and particularly, with the special requirements and operating conditions of the KCSRC.

Public Agency or their representative shall provide information requested on attached data sheet to the Manager of Contacts in the preliminary stages of the project. See Data Sheet, Appendix A.

This guideline supplements the applicable sections of the American Railway Engineering Association (AREMA) Manual of Recommended Practice in connection with the design of ballast deck railway bridges.

1. Structure Selection Criteria

1.1. Grade separation underpass structures shall be ballast deck type structures. Open deck type structures shall not be used as permanent structures. Open deck type structures can be used only for temporary structures built in conjunction with shoofly construction.

1.2. When possible, simple span structures should be used.

1.3. Continuous spans deck or through truss type structures are to be avoided.

1.4. Through type post-tensioned structures, simple or continuous, are not acceptable.
1.5. Grade separation structures may require inside guard rail. Refer to Appendix B, KCSRC Standard Drawing No. 005098 (Double Inside Guard Rail) for details and requirements.

2. **List Of Preferable Underpass Structures**

   Following is a list of underpass structures preferable to KCSRC in priority order. The KCSRC will require the most preferred alternative in all cases, unless the agency can provide sufficient reasons for proposing a less preferred alternative.

   2.1. Steel plate girders, simply supported, with cast-in-place concrete deck. See Dwg. 005082, Appendix B.

   2.2. Rolled beams, simply supported, with cast-in-place concrete deck. See Dwg. 005083, Appendix B.

   2.3. Pre-stressed concrete box girders single or double cell, simply supported. See Dwg. 005084, Appendix B.

   2.4. Pre-stressed concrete “AASHTO” type girders with cast-in-place concrete deck, simply supported. See Dwg. 005085, Appendix B.

   2.5. Cast-in-place concrete box girders conventionally reinforced, simply supported. See Dwg. 005086, Appendix B.

   2.6. Post-tensioned concrete box girders, simply supported. See Dwg. 005087, Appendix B.

   2.7. Through type simple supported steel girder spans with concrete or steel deck will be considered by KCSRC when conditions preclude any other solution. See Dwg. 005088 or 005089, Appendix B.

   2.8. Grade separation underpass structures of deck or through truss design are not preferable. However, in unusual circumstances, they will be considered by KCSRC if conditions preclude the use of any other type of structure.

3. **Access to Underpass Structure**

   For all grade separation underpass structures, an access roadway or bridge maintenance structure shall be provided for KCSRC off-track maintenance equipment.

   Access roadway with a turnaround shall be designed and constructed in conjunction with the grade separation bridge structure. Turnaround pad shall start no further than 30 ft. from the end of bridge structure and with embankment shoulder 60 ft. minimum from centerline of track. Roadway grade should not exceed 10% and shall terminate at the sub-ballast elevation. Roadway shall have sufficient width to provide for one 15-ft. wide road, drain ditch and shoulder. Roadway and turnaround shall be constructed on compacted material and have a 12-inch thick minimum base and 6-inch thick A.C. pavement. Turnaround pad and roadway shall be sloped to drain away from track sub-grade and dispose water to drainage system or existing right-of-way ditches. All down slopes of turnaround pad and roadway shall be protected with A.C. curbs to prevent embankment erosion.

   Bridge maintenance structure may be part of the railway supporting structure or a completely separate structure. If bridge maintenance structure is part of the main railway structure, the
structure shall be designed for E-80 load to accommodate any future track needs or modifications. If bridge maintenance structure is totally separate structure, it shall be designed for HS20-44 live load. The bridge maintenance width shall accommodate one 12-ft. paved lane with curbs and railing. Deck of bridge structure shall be concrete with 6 inches thick A.C. pavement. Bridge deck shall provide curbs, railing, drainage, and joint seals as required. Pavement of deck shall extend 20 ft. past the end of the structure and be placed over a 12-inch thick minimum base.

Access roadway with turnaround or bridge maintenance structure shall be shown in the preliminary plans and complete design shall be included in all subsequent submittals.

4. Specifications

4.1. Design Specifications

Underpass grade separation structures shall be designed and constructed in accordance with guidelines stated in this document and the most current edition of the American Railway Engineering and Maintenance-of-Way Association, Manual for Railway Engineering (AREMA).

Separate bridge maintenance structure shall be designed and constructed in accordance with the current edition of the American Association of State Highway and Transportation Officials (AASHTO) standard specifications for highway bridges.

4.2. Construction Specifications

Technical specifications for bridge construction shall comply with the following:

4.2.1. AREMA Specifications for Fabrication and Erection of Structural Steel (Chapter 15)
4.2.2. AREMA Specifications for Concrete Structures and Foundations (Chapter 8)
4.2.3. AREMA Specifications for Waterproofing (Chapter 29)
4.2.4. The Standard Specifications of the State’s Highway Department or local agency responsible for the design and construction of highway bridges
4.2.5. Standard Specifications of Public Works Department
4.2.6. American Association of State Transportation and Highway Officials (AASHTO)

5. Units

Grade separation underpass projects that require the use of metric units shall indicate all controlling dimensions, elevations, design criteria assumptions, and material stresses in dual units. English units are to be in parenthesis. Controlling dimensions refer to length of structure, span length, and thickness of all deck elements. Controlling elevations refer to top of rail, rail profile, bridge seats, and footings. Design criteria or assumptions refer to live load, design speed etc.
6. **Bridge Layout**

The following items shall be considered and adequately addressed in the layout of the grade separation underpass structure:

6.1. Layout of underpass structures shall indicate the limits of the Railroad right-of-way, exact locations of all existing and proposed overhead/underground utilities, pipeline locations, fiber optic locations, proposed drainage, proposed construction sequences including layout details for any temporary bridge structure such as shooflys etc at the entire project area. All construction must be scheduled to minimize the amount of track interference during construction.

6.2. NO utility attachments will be permitted on the new structure. Existing or future fiber optic lines shall be placed underground and away from bridge structure.

6.3. One new utility application permit application shall be submitted by the respective utility company when proposing a new crossing or relocating an existing line or abandoning an existing line. Relocation of any existing utilities must be performed by the owners of said utility at no cost to KCSRC. The public agency requesting the underpass structure from KCSRC shall be solely responsible for coordinating with these utility companies for all utility associated with the construction of the underpass structure.

6.4. Minimum longitudinal grade of 0.2% on structure shall be provided for drainage purposes. Designer may provide drainage toward one end of structure or, when structure length is excessive, provide adequate deck grades to drain the structure to both ends. If the top of rail grades remain constant over the length of structure, the depth of ballast may be varied but should be taken into account in the design.

6.5. For bridges located within a curve, the girders, abutments and piers shall be located with reference to chords.

6.6. Vandal fencing shall be provided on all underpass structures in urban areas and on underpass structures in rural areas where pedestrian traffic pattern, past history of vandalism, or other conditions near the project site may warrant.

6.7. Sloping embankments in front of abutments shall be paved.

6.8. The distance from the centerline of bridge to the nearest railroad milepost and to a nearest existing permanent railroad structure, like bridge, culvert, diamonds, etc shall be shown on the plans in a conspicuous manner.

6.9. Structures having multiple tracks shall be designed to accommodate any future shifting or relocation of track. Longitudinal members are to be evenly spaced, with no less than two support members per rail.

6.10. Cantilever-type abutment stems shall be at least 0.2H in thickness at the base.

6.11. Columns shall be at least 0.2H in thickness at the base.

6.12. Floor beams shall be a minimum of 21 inches in depth

6.13. The year of construction shall be shown at the face of back-wall. Numbers shall be embedded into the concrete and shall be 6 inches tall.
7. **Skew of Bridge**

The preferred angle of roadway crossing and bridge structure relative to the centerline of track is 90 degrees. However, in cases where a 90-degree crossing cannot be obtained, the maximum skew of bridge structure from 90 degrees shall not exceed the following for various types of structures:

<table>
<thead>
<tr>
<th>Type of Structure</th>
<th>Skew in Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel spans with concrete deck (Beams, Deck Girders, Through Girders)</td>
<td>30 degrees, max.</td>
</tr>
<tr>
<td>Pre-stressed concrete with concrete deck (AASHTO Beams)</td>
<td>30 degrees, max.</td>
</tr>
<tr>
<td>Pre-stressed concrete box girders</td>
<td>15 degrees, max.</td>
</tr>
<tr>
<td>Cast-in-place box girders conventionally Reinforced or post-tensioned</td>
<td>20 degrees, max.</td>
</tr>
<tr>
<td>Through-type pre-stressed girders</td>
<td>15 degrees, max.</td>
</tr>
</tbody>
</table>

Information on the alignments of roadway, bridge piers, and abutments as required to comply with the above maximum skew limitations.

Transverse tie rods in end blocks and interior diaphragms should be in the direction of skew. Multiple, pre-stressed concrete girders shall be bonded together with epoxy or grout. In addition, transverse tie rods shall be installed through the end blocks and interior diaphragms. See drawing 005090, Appendix B.

Where conditions preclude any other solution, the skew proposal will require special structural consideration and proof of adequacy. Skews in excess of 15 degrees are not permitted for continuous structures.

At the ends of a skewed bridge, support slabs shall be provided for each track. Ends of track slab shall be perpendicular to the centerline of the track and be 12 ft. minimum width placed symmetrically to the centerline of the track. Length of track slab shall be 12 ft. minimum beyond the back face of back wall as measured along track centerline.

8. **Vertical Clearances**

Underpass structures shall be designed and provide sufficient vertical clearances and protective devices to ensure that structure will be protected from oversized and unauthorized high loads. Designers and public agencies shall comply with the following vertical clearances:

<table>
<thead>
<tr>
<th>Structure Over</th>
<th>Steel</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeways</td>
<td>16.5 ft.</td>
<td>17.5 ft.</td>
</tr>
<tr>
<td>Designated arterial routes</td>
<td>16.5 ft.</td>
<td>17.5 ft.</td>
</tr>
<tr>
<td>Local roads and streets</td>
<td>15.5 ft.</td>
<td>16.0 ft.</td>
</tr>
<tr>
<td>Rural roads</td>
<td>15.0 ft.</td>
<td>15.5 ft.</td>
</tr>
<tr>
<td>Pedestrian under crossing (no vehicles)</td>
<td>8.0 ft.</td>
<td>8.0 ft.</td>
</tr>
<tr>
<td>Recreational roads</td>
<td>12.5 ft.</td>
<td>12.5 ft.</td>
</tr>
</tbody>
</table>
All concrete structures in above table except pedestrian under crossing without vehicular traffic shall be protected with collision impact devices installed over the full width of traveled lanes and attached to the bridge soffit. All structures with vertical clearances less that 17.5 ft. shall be protected with a steel sacrificial beam. Sacrificial beam shall be installed a minimum of 5 ft. ahead of the collision impact device or ahead of the main supporting member and shall not carry railway loads. Sacrificial beam shall be of steel shape (wide flange or tubing) and of sufficient strength to limit horizontal deflection to 6 inches caused from the impact from oversized vehicle or load. Additionally, it shall be anchored sufficiently to bridge seat at an elevation of at least 6 inches below the bridge soffit. For more details see drawing 005097, Appendix B.

If resurfacing or any other activity is to be performed below the underpass structure, the owner of the roadway must submit a request for approval from KCSRC. This request must provide the existing measured and posted clearances of the structure and the proposed configuration after work is completed.

The owner of the roadway shall be responsible of posting and maintaining structure sign clearances and any advance street notifications as required.

9. Design Loads

9.1. Underpass bridge structures shall be designed for all loads specified in Chapters 8, 9, or 15 of the AREMA Specifications. The design of underpass structures shall also comply with the seismic criteria of the current edition of AREMA, Chapter 9 – Seismic Design for Railway Structures.

9.2. Live Load and Impact as specified in the AREMA Specifications.

9.3. All underpass structures shall be designed for a maximum thirty (30) inches of ballast (top of deck to bottom of tie) to account for future track raises. Structures shall be constructed to the required grades with the minimum depth of ballast under the tie of eight (8) inches for timber, and twelve (12) inches for concrete.

9.4. Under normal working loads, composite action may be expected between a concrete deck and its supporting steel members, when shear transfer devices are used. The bottom of the deck slab shall be placed at least one inch below top of supporting steel members. For design purposes, the supporting steel member shall be proportioned to carry E65 live, impact, and dead loads without taking into account any composite action, and E80 live, Impact, and dead loads taking into account composite action. Composite action may be taken into account when satisfying the deflection-length ratio requirement of Chapter 15; Article 1.2.5 of the AREMA Specifications provided shear transfer devices are installed.

9.5. Live load distribution for pre-cast pre-stressed single or double cell boxes shall be in accordance with Part 2, Reinforced Concrete Design, Article 2.2.3.c(1) of the AREMA specifications. Live load shall not be assumed to be distributed to the number of boxes supporting the tracks. For multiple track structures, live load shall be distributed based on the assumption of the track being in any location.
10. Special Requirements for Pre-cast, Pre-stressed Box or AASHTO-type Girders

10.1. Box-shaped (single or double void) or AASHTO-type pre-cast pre-stressed girders for all spans shall be designed with end and interior diaphragms. Interior diaphragms shall be spaced equally across the span length. Provide diaphragms as follows for various span lengths:

<table>
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<tr>
<th>SPAN IN FEET</th>
<th>NUMBER OF INTERIOR DIAPHRAGMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-50</td>
<td>1</td>
</tr>
<tr>
<td>51-75</td>
<td>2</td>
</tr>
<tr>
<td>Over 76</td>
<td>3</td>
</tr>
</tbody>
</table>

Above number of diaphragms per span is minimum required. The definite number to be considered in each case depends on the particular design, span lengths, member rigidities, etc. Diaphragm spacing should not exceed 25 ft. center to center.

10.2. Transverse tie rods shall be installed at the end and each interior diaphragm. Minimum size of tie rod to be 1-1/4 inches in diameter. Tie rod to be protected in one of the following ways:

10.2.1. Rod, plates and nuts shall be hot dip galvanized per ASTM A123 and A153.

10.2.2. All assembly parts left plain, but void between rod and hole to be pressure grouted. Tie rod anchor assembly shall be recessed into the concrete and shall have one (1) inch minimum grout cover.

10.3. Strands at the ends of pre-cast pre-stressed members shall be cut one (1) inch minimum into the member and the resulting recessed pocket filled with grout.

10.4. For AASHTO beams, it is preferable that the designer provide eighteen (18) inches minimum gap between bottom flange of beams to accommodate inspections and repairs.

10.5. The keyway for pre-cast concrete box girders shall be bonded with high strength epoxy or non-shrink cementitious grout. Strength of epoxy or grout to be at least equal to the strength of concrete member being bonded. For details see drawing 005090, Appendix B.

11. Special Requirements for Post-Tensioned Concrete Structures

All post-tensioned structure ducts shall be bonded (grouted).

11.1. Simple Spans

11.1.1. Post-tensioned simple spans shall be designed such that a minimum compressive force of 100 psi is maintained in the topmost regions of the element, and to maintain a minimum compressive force of zero in the lower most regions of the element. At no time either during construction or under any load configuration shall these minimum requirements be violated. In addition, there shall be sufficient straight tendons top and bottom to produce a uniform compression of 200 psi over the cross-section. Pre-stress can be
applied in a single stage for spans 80ft. and under, stressing the straight tendons first, sequentially alternating between top and bottom tendons to maintain a uniform stress pattern over the cross-section, then continuing stressing operations on the draped tendons until all post-tensioning is complete.

11.1.2. Simple spans over 80 ft. in length shall be pre-stressed in two stages. The first stage of post-tensioning shall be applied when the most recent concrete has attained a minimum compressive strength of 1500 psi as determined by compression cylinder tests and shall consist of tensioning the straight tendons, alternating sequentially between top and bottom tendons, to maintain a relatively uniform compression of 200 psi over the cross-section. The second stage of post-tensioning shall be the application of the remaining portion of design pre-stress force when the last placed concrete reaches the minimum compressive strength as required at transfer by the AREMA Specifications.

11.2. Continuous Spans

11.2.1. Post-tensioned, continuous structures shall be designed for a minimum compressive force of 200 psi in the topmost regions of the element, and 50 psi minimum compressive force at lowermost regions of the element in the positive moment regions of the structure. In the negative moment regions of the structure, the requirement will be reversed such that a minimum compressive force of 50 psi will be required in the topmost regions of the element and a minimum compressive force of 200 psi in the lower most regions of the element. These minimum compressive force requirements must be maintained during any stage of construction or any loading case.

11.2.2. Cast-in-place, continuous, post-tensioned structures shall have sufficient straight tendons placed both in top and bottom fibers to produce a calculated uniform compression over the entire section of 200 psi. The pre-stress in the straight tendons (1\textsuperscript{st} stage pre-stress) to be applied when the most recent and final concrete has reached a minimum compressive strength of 1500 psi as determined by compression cylinder tests. The stressing of these straight tendons shall be applied by alternating sequentially between top and bottom tendons to maintain a relative uniform stress as possible over the cross-section during the post-tensioning operations. The second stage shall be the application of the remaining portion of design pre-stress force when the most recent concrete reaches the minimum compressive strength as required at transfer by the AREMA Specifications.

11.2.3. The above procedures are to be applied in conjunction with a concrete placement schedule for the structure in which the positive moment regions are placed first and the negative moment regions are placed second. This two-stage procedure applies to spans 100 ft. or less. Placement schedule shall be three-stage for longer spans; positive moment regions to within four (4) ft. of inflection point first; negative moment regions to within four (4) ft. of inflection point second; and closure section eight (8) ft. long at the inflection points last. On the longer spans it may be required to subdivide the sequence steps into placement sections depending on the structure type and amount of non-pre-stressed reinforcement used to control shrinkage cracking. For each stage of concrete placement, the entire structural cross-section shall be completed before moving to the next stage. When casting
11.2.4. The radius of curvature for any post-tensioning duct must not be less than 60 ft.

12. Material Requirements for Steel Structures

12.1. Thickness of structural steel (except for fillers) shall not be less than 0.335 inch thick. Parts subject to corrosive influences shall be of greater thickness than otherwise specified or steps taken to protect same against such influences.

12.2. The thickness of gusset plates connecting the chords and web members of a truss shall be proportional to the force being transferred but not less than ½ inch.

12.3. Minimum size of high strength bolt for bolting structural members shall be 7/8-inch diameter.

12.4. The allowable bearing pressures as contained in AREMA Chapter 19 are to be used for steel superstructure bearing on concrete substructure.

12.5. All fracture critical members shall be designated as FCM in the plans. Fracture critical members shall be designed for a minimum service temperature of –30 degrees F corresponding to Zone 2.

12.6. Designer shall provide details such that all exposed parts will be accessible for inspection, cleaning and painting. Preferably not less than 18 inches clear shall be provided between the flanges of parallel lines of beams having depths in excess of 38 inches.

12.7. All designs must provide drain holes for pockets or depressions that may hold water so that steel areas drain effectively. Structural members shall not be sealed by welding except as approved by KCSRC.

13. Painting of Steel Structures

KCSRC prefers the use of weathering or galvanized steel. In cases where weathering or galvanized steel is not used, steel structures must be painted.

Painting of steel structures shall comply with the requirements of current AASHTO specifications and recommendations of Steel Structures Painting Council Manual (SSPC).

Paint shall be applied in accordance with the manufacturer’s recommendations or in compliance with the recommendations of SSPC, whichever is most restrictive.

Painting system including primer and top coats shall be submitted by the agency for review and approval by the Chief Engineer.

Painted structures must be maintained by agency proposing the underpass at no cost to KCSRC.
14. **Ballast Deck Bridge Structure**

For typical cross section of superstructures, see Dws. 005082 - 005090, Appendix B.

14.1. **Deck Width**

For single track bridge structures, the width of the deck shall be not less than 17ft. wide for tangent track and 18ft for track on curve measured from inside face of parapet to inside face of parapet. The clear distance from centerline of track to inside face of parapet shall not be less than 9'-0” for tangent track and 9'-6” for track on curve. For multiple tracks, an allowance of 20 ft. shall be provided for each additional existing or future track measured center to center of tracks.

14.2. **Curb Height:**

The top of ballast curb or walkway shall be approximately the same elevation as the base of highest rail plus eight (8) inches to accommodate possible future track raises.

14.3. **Walkway:**

In general, walkways shall not be less than 3 ft. wide. Ballast structures do not require walkway in most cases. Structural members (such as floor beam knee braces) shall not be considered an obstruction to the walkway.

Walkways on bridges over highways or other locations where spillage of ballast or lading is possible, they shall be constructed of solid material and a curb or toe board shall be provided. The clear distance from centerline of track to ballast retainer for bridges with walkway shall be 6'-6” minimum.

To prevent cracking under live loads, provide ¼ -inch wide joints at 10-ft. maximum spacing on concrete curbs, walkways, and ballast retainers.

14.4. **Handrail:**

Handrails shall be provided on both sides of deck. Horizontal clearances from the centerline of the nearest track shall not be less than 9'-0” for tangent track, and 9'-6” for track on curve. Handrails shall be simple designs that require minimum maintenance. KCSRC recommends the following types of handrails:

- 14.4.1. Chain link fencing. See Dwg. 005091, Appendix B
- 14.4.2. Tubular style fencing. See Dwg. 005092, Appendix B
- 14.4.3. Picket style fencing. See Dwg. 005093, Appendix B

Variations from the above suggested fencing shall be submitted for approval by KCSRC.

14.5. **Depth of Ballast:**

The depth of ballast under the lowest rail shall be eight (8) inches minimum for timber ties and twelve (12) inches minimum for concrete ties. Structures shall be designed to accommodate thirty (30) inches of ballast for future track raises measured from top of deck to bottom of tie.

14.6. **Drainage:**
The top of concrete ballast trough for steel beams or multiple girders shall be sloped transversely not less than 1%. Low points on top of the trough shall be located not less than 6'-0" from the centerline of any track and shall be within the outside beams or girders. A longitudinal collection system shall be provided to dispose of drainage without permitting it to enter the ballast section and backfill beyond the limits of the bridge structure.

All concrete ballast troughs shall be sloped transversely not less than 1%. A longitudinal collection system shall be provided on top of waterproofing along the face of parapet or curb to drain water. Longitudinal drains shall be connected to the storm drain system or properly discharged at the toe of embankment slopes. See Dwg. 005094, Appendix B, for details.

If an approach grade descends toward the bridge, drainage from the approach shall be intercepted by appropriate means so that it will not drain onto the bridge.

14.7. Waterproofing and Protective Panels:

Waterproofing and protective panels shall comply with the recommendations of Chapter 29 of the AREMA Manual. The waterproofing shall be one layer of Butyl Rubber or EPDM membrane and shall be bonded to the bridge deck with adhesive applied to the entire surface in accordance with the recommendations of the membrane manufacturer. Butyl Rubber or EPDM membrane shall be 0.06" thick minimum. Field splices shall be the tongue and groove type per AREMA Chapter 29, Part 2, detail No. 3 Figure 2-2. Protective asphaltic panels shall be in two layers with total thickness not less than ¾ of an inch and shall be laid with joints staggered. Protective panels shall be bonded to the membrane and to each other with the same adhesive used for bonding the membrane and be compatible to materials. For waterproofing details see Dwgs. 005095 and 005096, Appendix B.

15. Abutments

The abutments shall be designed in accordance with the recommendations of Chapter 8, Part 5 of the AREMA Specifications. The Abutments shall be wide enough to satisfy KCSRC standard roadbed shown on Drawing 005099, Appendix B. For multiple track bridges, the abutment width shall be sufficient to provide for standard shoulder, plus 20ft. for each existing or future track.

Wing walls shall be designed to support 2:1 embankment slopes.

Handrails for ballast trough shall be returned on the back wall and/or wing walls.

Provide a minimum edge distance of six (6) inches from edge of the masonry plate or bearing to edge of concrete.

The top of the abutment seat should be sloped in order to facilitate drainage. If weathering steel is used for superstructure, details on top of abutment seat should indicate method of collecting and disposing of water without staining concrete surfaces.
16. **Piers**

Provide a minimum edge distance of six (6) inches from edge of masonry plate or bearing to edge of concrete.

Provide a minimum of 18 inches beyond the outside edge of outermost masonry plate or bearing to end of the pier.

Single column piers should not be considered for underpass structures. Piers with a minimum of two columns should be provided. A solid pier wall with minimum of four (4) ft. thickness is preferable.

Slope top of pier to drain. If weathering steel is used for superstructure, details on top of pier seat should indicate method of collecting and disposing of water without staining concrete surfaces.

Bridge piers adjacent to roadways shall be protected from vehicular traffic as required per AASHTO and States DOT standards.

17. **Structure Separation**

In order to satisfy maintenance requirements, parallel structures shall have a minimum separation of five (5) ft.

18. **Drainage**

Maintaining the existing drainage and providing for future drainage improvements is of the utmost importance. Existing track ditches must be maintained at all times.

Drainage plans must be included with the general plans submitted to KCSRC for approval. These plans must include hydrologic computations, indicating the rainfall intensity and duration of the design storm used, as well as the method of analysis. All designs shall be based on 100 (one hundred) year rainfall events.

Where project design calls for an increase in the flow through the railroad embankment, the flow shall be handled by means of separate drainage structures.

When the proposed construction will change the quantity and/or character of flow in the track ditches, the ditches shall be modified as required to handle the drainage. Ditches shall be designed in accordance with good engineering practices. A 50 and 100-year event study will be required along with the water surface elevations.

Approval of the drainage plan does not relieve the submitting agency and/or designer of ultimate responsibility and liability for a satisfactory drainage design.

19. **Sequence of Construction**

It is essential that the construction be performed with a minimum interference with rail traffic.

*Continuity of safe rail operations will be required for the duration of the project.*
The most effective method of maintaining traffic is to temporarily re-route rail traffic around construction site using detour tracks. Shoo fly shall be designed to comply with current rail operations and existing conditions. Designer shall submit shoo fly design for review by KCSRC in the early stages of project design. Minimum of two (2) sets of plans are required.

The use of shoo fly for construction of permanent structure will minimize the traffic interference with the railroad operations; however, if construction requires interruption of rail traffic or track time windows this shall require the approval of the KCSRC. No design should advance without such approval. Prior to start of any construction on Railroad’s right-of-way, written approval permits shall be secured from Contracts and Real Estate Department.

The agency should contact the Manager of Contracts in the preliminary design stages of design to determine the Railroad’s operational requirements.

20. **Construction Excavation**

Excavations for construction of footings, piers, columns, walls or other facilities shall be designed and constructed in accordance with KCSRC Railroad Construction Guidelines, *Design and Construction of Shoring Adjacent to and on Railroad Right-of-Way*.

21. **Erosion Control**

The general plans for the bridge shall indicate the proposed methods of erosion control and must specifically address means to prevent silt accumulation in the ditches and culverts and to prevent fouling the track ballast, sub-ballast and existing drainage system. If the plans do not show erosion control, the contractor must submit a proposed method of erosion control and have the method approved by the office of the Chief Engineer prior to beginning any grading on the project site.

Existing track ditches shall be maintained at all times throughout the construction period. After the construction has been completed, all erosion control devices must be removed, all deposits of silt removed, and ditches restored.

Agency or Contractor shall furnish to Railroad all copies of Storm Water Pollution Plans and approved permitting if required.

Approval of the erosion control plan does not relieve the submitting agency and/or designer and contractor of the ultimate responsibility and liability for a satisfactory erosion control plan.

22. **Construction Management Team Requirements**

For construction of grade separation underpass structures, an experienced Construction Management Team will be required during the construction of bridge structure. Public agencies with qualifying bridge structure staff that can be placed on site during the construction shall be acceptable; otherwise, a qualifying outside team must be obtained.

The following are the minimum requirements for the Construction Management Team:

22.1. Agency to submit names of personnel to be used in the project and their assigned duties.
22.2. Provide list of projects for each person that has actively worked on including bridge structures (highway or rail), underground facilities and drainage structures.

22.3. Provide verifiable list of employment including a current resume for each person in the Construction Management Team.

22.4. Minimum personnel for Construction Management Team for a typical grade separation underpass structure will consist of:

22.4.1. Project Manager

22.4.2. Resident Engineer – The resident engineer for the project shall be a registered Civil Engineer with minimum 5 years experience in the field of bridge construction work.

22.4.3. Construction Inspector – Construction inspector to be familiar with concrete and steel construction and have current certifications in the fields that he will be inspection.

22.5. All field members of Construction Management Team are required to have passed the KCSRC Track Safety and Bridge Fall Protection class.

22.6. All submittals by the contractor shall be reviewed by the management team and then submitted to the project Design Engineer. After review is completed and found satisfactory by the Design Engineer, material shall be submitted to the Railroad for further review and comments (Reference the section titled Review Submittals). No work shall be performed inside the Railroad right-of-way without prior review by the Railroad.

23. Review Submittals

Submittals for design and construction of Grade Separation projects shall be coordinated and submitted through the Manager of Contracts. To expedite reviews, submittals must be complete, clearly explained and orderly. Design review for underpass structures will be done by KCSRC and/or through an outside consultant at the expense of the owner. Prior to any review, KCSRC shall receive written authorization from the agency agreeing to pay all review costs for the design and construction phases of the project. Once such an agreement is established, KCSRC will request and secure a proposal from an outside consultant to cover review expenses. Review expenses shall include all costs for in-house personnel and/or consultants retained by the Railroad. This estimated cost of Plan Review and the construction monitoring phase of the project shall be provided to the submitting agency for review and approval. Once KCSRC received the submitting agency’s written acceptance of the estimated cost, the review of plans can begin. If, during the review process, the estimated costs are determined to be insufficient to cover said costs, the owner will be advised. The original estimated costs will not be the upper limit of the costs, but will provide a guideline for budgeting purposes. Regardless, all reasonable costs incurred during the plan review process and construction monitoring phase of the work will be fully recoverable from the agency.

23.1. Preliminary Plan Submittal

Preliminary conceptual underpass bridge plans shall include the following:
23.1.1. Plan view of proposed bridge structure and location of all existing facilities and utilities within the Railroad Right-of-Way. Plan view to indicate the span lengths, the alignment and skew angle of abutments and piers, site drainage, etc.

23.1.2. Elevation view indicating the abutment and pier elevations, track elevation to top of rail existing and proposed, minimum vertical clearance above roadway, footing elevations, type of footings, location of existing and/or relocated utilities, site drainage, etc.

23.1.3. Typical superstructure cross section showing deck and pier outline, if applicable, horizontal and vertical dimensions of deck structure, rail and ballast structure, waterproofing material, deck drainage, track spacing, horizontal clearances, railing, etc.

23.1.4. Existing and proposed track profile at the bridge location and at least 1000 ft. past the bridge ends.

23.1.5. Existing and proposed alignment including the proposed shoofly alignment design data.

23.1.6. General notes to indicate structure design criteria, construction methods, material compliance specifications, and construction sequencing.

23.1.7. Plans shall identify and specify the relocation of all utilities.

23.1.8. Bridge general plan shall show the location of shoofly, where needed, and indicate the footprint of structure in relation to centerline of shoofly. Minimum distances and location of shoring if required shall be shown on the general plan.

23.1.9. The presence of existing or proposed fiber optic cables on Railroad right-of-way shall be considered in the project design, and appropriate measures for the installation and protection of the fiber optic cables shall be addressed in the plans and contract documents.


Two (2) sets of preliminary plans shall be submitted to the Manager of Contracts. Allow two (2) weeks for in-house review by the Director of Engineering. The Manager of contracts will then forward the plans along with the comments of the KCSRC to the outside consultant for review. Allow an additional three (3) weeks for review by the outside consultant once the plans are received.

23.2. 60% Plan Submittal

Submittal of 60% plans shall include a minimum of the following:

23.2.1. Complete design of superstructure and substructure

23.2.2. Bridge details

23.2.3. Bearing Details
23.2.4. Deck and waterproofing details

23.2.5. Geo-technical reports/recommendations should be submitted with professional seals and signatures.

23.2.6. Complete set of structural calculations shall be made available at the time of the submittal. Computer run output or data sheet calculations shall be supplemented with sample calculations and clearly defined sketches. All assumptions shall be clearly indicated. Structural calculations should be submitted with professional seals and signatures.

23.2.7. Hydraulic calculations if drainage is affected. Hydraulic calculations submitted should be submitted with professional engineer’s seal and signatures.

23.2.8. Complete shoofly design, where needed.

23.2.9. Final construction sequence.

23.2.10. 60% Submittal Procedure:

Two (2) sets of 60% plans, two (2) sets of structural calculations, and two (2) sets of soil reports shall be submitted directly to the outside consultant for review. A copy of the letter submitting the plans will be sent to KCSRC. The consultant and Design Engineer will be free to communicate and resolve all design issues. Outside consultant will review and reply directly to the agency or its representative after consultation with KCSRC. Copies of all correspondences between KCSRC’s outside consultant and the agency or its representative shall be furnished to KCSRC. Correspondences via emails are preferred to expedite the exchange of information and followed up with hard copies. The KCSRC’s approval of this phase varies depending on the extent of reviews and the required revisions to be done by the Agency.

23.3. 90% Submittal

Plans for 90% submittal shall include the following:

23.3.1. Revisions to plans and calculations as dictated by review of the 60% submittal. Revisions to plans and calculations should be resubmitted with professional seals and signatures.

23.3.2. Project Special Provisions

23.3.3. 90% Submittal Procedure:

Two (2) sets of 90% plans, two (2) sets of structural calculations, and two (2) sets of soil reports shall be submitted directly to the outside consultant for review. A copy of the letter submitting the plans will be sent to KCSRC. The consultant and Design Engineer will be free to communicate and resolve all design issues. Outside consultant will review and reply directly to the agency or its representative after consultation with KCSRC. Copies of all correspondences between KCSRC’s outside consultant and the agency or
its representative shall be furnished to KCSRC. Correspondences via emails are preferred to expedite the exchange of information and followed up with hard copies. The KCSRC’s approval of this phase varies depending on the extent of reviews and the required revisions to be done by the Agency.

23.4. Final Submittal

Final submittal shall include:

23.4.1. Plans signed and sealed by professional registered project engineer in the state of the project.

23.4.2. Final calculations will be signed and sealed by professional registered engineer in the state of the project.

23.4.3. Final signed hydraulic calculations

23.4.4. Final signed special provisions

23.4.5. Final Submittal Procedure:

Two (2) sets of 100% signed plans, two (2) sets of signed structural calculations, two (2) set of signed hydraulic calculations, and two (2) sets of signed special provisions shall be submitted. All material shall be submitted directly to the outside consultant for review. A copy of the transmittal letter will be sent to KCSRC. Consultant and Design Engineer will be free to communicate and resolve all remaining design issues. When review is complete, the consultant shall advise the agency or its representative that all issues have been addressed satisfactorily and recommending the release of structure for construction. The consultant shall forward two (2) sets of all final documents to the KCSRC for the final review by KCSRC. After the Contract is in place for the structure, the project shall be released for construction.

23.4.6 ROW Easement Agreement and Construction & Maintenance Agreement

The Construction & Maintenance Agreement is KCSRC’s authorization to the Agency for the actual construction and future maintenance of the structure. The terms of this agreement will determine the methodology of the work required. This agreement will be coordinated by the KCSRC’s engineering department.

After the final plans are approved, the agency and KCSRC will sign the ROW Easement agreement for the roadway under KCSRC’s ROW which will require monetary compensation from the Agency. KCSRC’s ROW department will coordinate with the agency for the execution of this agreement. This agreement will not be executed until the Construction and Maintenance agreement is executed.

23.5. Construction Submittals

During construction of the underpass bridge structure, the Railroad requires the review of material data sheets to determine compliance with the specifications. It is required that product information for all material specified in the table below be submitted by the
agency or their representative to the KCSRC for review following their own review and approval of the material. The **signed** submittal will then be forwarded to the outside consultant for review. The consultant may reply directly to the agency or its representative after consultation with the Director of Engineering. During the review process, the consultant and design engineer will be free to communicate and resolve issues. Following is a list of some of the material submittals by the Agency to KCSRC. KCSRC reserves the right to request for more submittals as need be:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>REVIEW SUBMITTAL</th>
<th>SETS REQUIRED</th>
<th>NOTES</th>
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<tbody>
<tr>
<td>1</td>
<td>Shop Drawings</td>
<td>2</td>
<td>Steel and Concrete Members</td>
</tr>
<tr>
<td>2</td>
<td>Bearings</td>
<td>2</td>
<td>For all structures</td>
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<tr>
<td>3</td>
<td>Concrete Mix Designs</td>
<td>2</td>
<td>For superstructure only</td>
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<tr>
<td>4</td>
<td>Rebar &amp; Strand Certifications</td>
<td>2</td>
<td>For superstructure only</td>
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<tr>
<td>5</td>
<td>28-day concrete strength</td>
<td>2</td>
<td>For superstructure only</td>
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<tr>
<td>6</td>
<td>Waterproofing material certification</td>
<td>2</td>
<td>Waterproofing &amp; protective boards</td>
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<tr>
<td>7</td>
<td>Structural Steel certifications</td>
<td>2</td>
<td>All fracture critical members</td>
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<td>8</td>
<td>Test reports</td>
<td>2</td>
<td>All fracture critical members</td>
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<tr>
<td>9</td>
<td>Foundation Construction Reports</td>
<td>2</td>
<td>Pile driving, drill shaft construction, bearing pressure test reports for spread footings</td>
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<td>10</td>
<td>Shoring Plans and Calculations</td>
<td>2</td>
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### 23.6. Site Observation During Construction

In addition to the office reviews, site observations will be performed at significant milestone events during construction, including following if applicable:

- **23.6.1.** Pre-construction meeting
- **23.6.2.** Acceptance inspection of any shoofly structure before placing it in service.
- **23.6.3.** Reinforcement and concrete placement for main bridge substructure and/or superstructure.
- **23.6.4.** Steel erection for main bridge structure.
- **23.6.5.** Post tensioning of main bridge.
- **23.6.6.** Erection of pre-cast concrete bridge superstructure.
- **23.6.7.** Acceptance of waterproofing (prior to placing ballast).
- **23.6.8.** Final observation and acceptance of the bridge structure.

Site observation is not limited to the milestone events listed above; rather site visits to check progress of the work may be performed at any time throughout the construction as deemed necessary by the Railroad.

A construction schedule shall be provided to the Manager of Contracts to inform the Kansas City Southern Railway Company of the anticipated dates when the listed events will occur. This schedule shall be updated as necessary, but at least monthly, so that site visits may be scheduled by the Railroad or its outside consultant.
23.7. As-Built Submittal

The Agency or their representative is required to submit As-Built documents to KCSRC at the completion of the bridge structure prior to closing project. The following is a list of these documents.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>AS BUILT</th>
<th>SETS REQUIRED</th>
<th>NOTES</th>
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<td>Design Plans</td>
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<td>Final as built bridge plans only</td>
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<tr>
<td>2</td>
<td>Shop Drawings</td>
<td>1</td>
<td>Final plans only</td>
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As-built design and shop drawings are to be in electronic PDF format only (no paper). As-built documents shall be mailed to the outside consultant for review and comment. The consultant and outside agency can communicate directly to resolve any issues. The consultant shall send to the KCSRC the final set of as-built drawings.
Appendix A

KCSRC Underpass Grade Separation Data Sheet
# Appendix A

## Underpass Grade Separation Data Sheet

1. Location: 
   - City
   - County
   - State

2. Distance and direction from nearest Milepost to centerline of Bridge: 

3. Railroad Subdivision: 

4. Description of Project: 

5. Utilities on Railroad Property: 

<table>
<thead>
<tr>
<th>Name</th>
<th>Any Adjustments Required</th>
<th>Contact Person</th>
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6. List all the at-grade crossings that will be eliminated by the construction of this grade separation: 

<table>
<thead>
<tr>
<th>DOT#</th>
<th>Milepost</th>
<th>Signalize?</th>
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7. How many spans are proposed: 

8. Offset to temporary detour alignment: 

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Guidelines for the Design and Construction of Railroad Overpasses and Underpasses
9. Temporary detour alignment: ____________________________________________
   On Embankment, Trestle or Both

10. Drainage: (Describe how drainage from roadway is handled)

   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   Describe How drainage from Bridge is Handled:
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

11. Scheduled Letting Date: ____________________________________________

ALL INFORMATION ON THIS DATA SHEET TO BE SUBMITTED TO KCSRC.
Section II

Design and Construction of Overpass
Grade Separation Structures
## Section II

### Design and Construction of Overpass

#### Grade Separation Structures

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Appendix A – Data Sheet and Check list
1. **Purpose and Scope**

The intent of this guideline is to inform public agencies, design engineers, and contractors of KCSRC’s current standards and requirements concerning design and construction of new or modified existing grade separation overhead structures.

To avoid delays during construction, especially in corridor lines with large railroad traffic volumes, KCSRC recommends the use of prefabricated type structures that will minimize track interference and not require track outages during construction.

Design of overhead structures over corridor lines with large railroad traffic volume should include a sequence of construction, which does not require train service interruption. Agencies should consult with the Director of Engineering during the early stages of the design process to determine the operating requirements, volume of train traffic and the possibility of securing track windows for the proposed design and method of construction. If track windows are requested, the Director of Engineering shall consult with the Operating Department and submit to the Agency any arrangements for windows or schedules that are worked out during the plan submittal. **Keep in mind that KCSRC will not commit to something that it will not be able to keep in the future due to changes of traffic patterns or operation needs.**

The public agency or its representative shall provide information requested on the attached data sheet to the Manager of Contracts in the preliminary stages of the project. See Data Sheet, Appendix A.

It is recommended that the agency or its representative complete the attached Overhead Submittal Checklist and submit to the Manager of Contracts with preliminary and final plans of the Project. See Overhead Submittal Checklist, Appendix A.

The requirements addressed in this guideline should be followed for all structures over the KCSRC railroad tracks or structures constructed within the railroad right-of-way. Compliance with the requirements herein will expedite the design review approval, and construction review submittals.

2. **Standard Drawings and Guidelines**

Design and construction of overhead grade separation structures shall comply with the following standard drawings and guidelines:

2.1 Standard Drawings, Appendix B

2.1.1 KCSRC Dwg. No. 005103 “Barriers and Clearances to Be Provided at Highway, Street, and Pedestrian Overpasses”, current issue. See Appendix B.

2.1.2 KCSRC Dwg. No. 005104 “Barriers, Fences, and Splashboards to Be Provided at Highway, Street, and Pedestrian Overpasses”, current issue. See Appendix B.

2.1.3 KCSRC Dwg. No. 005105 “Typical Sections at Abutment Slope”, current issue. See Appendix B.

2.2 References
The following KCSRC guidelines are separate documents and shall be used during the construction of the overhead structures as required.

Plans or special provisions of the project should refer to them or include them in the bid documents:

2.2.1 **Shoring** – “Design and Construction of Shoring Adjacent to and on Railroad Right-of-Way”.

2.2.2 **Demolition** – “Bridge Demolition and Removal Plans over the KCSRC Railroad.”


3. **Units**

Grade Separation overhead structures that require use of metric units shall indicate all controlling dimensions in dual units. English units are to be shown in parenthesis.

Controlling dimensions or elevations refer to, but are not limited to, the following:

3.1 Horizontal and vertical clearances

3.2 Track spacing, Railroad right-of-way, track stationing

3.3 Span length, width and depth of superstructure elements

3.4 Size and limits for barrier rail or splashboards, and fences

3.5 Location and elevation of underground or aerial utilities and their relocation adjustments if required

3.6 Size, elevation and location of pier or abutment footings for spans adjacent to railroad tracks

3.7 Size of structure supports (pier or abutment walls, columns)

3.8 Size and elevations of pier protection walls if required

3.9 Shoring location and their limit if required

3.10 Top of rail elevation under structure and grade profile

3.11 Size and location of drainage structures and ditches

3.12 Temporary construction vertical or horizontal clearances if required

**Plans shall be rejected if required controlling dimensions are not shown or not shown properly.**
4. New or Modified Structures

New overhead structures are defined as any structure being constructed over the Railroad tracks at a location where no crossing currently exists or replaces an existing at grade crossing. All new structures shall be designed to provide for one or more future tracks as required for long-range planning or other Railroad operating requirements and additional room for an access roadway. Where provisions are made for more than two tracks, space is to be provided for access roads. Designer should consult with Director of Engineering for the track requirements at each location. The current issue of KCSRC standard drawing No. 005103 indicates only minimum requirements.

Modified existing structures are defined as those structures being modified or replaced with a new structure. All modified structure shall comply with the applicable minimum requirements shown on the current issue of KCSRC standard drawing No. 005103, when the following modification to the structure is proposed:

<table>
<thead>
<tr>
<th>STRUCTURE MODIFICATION</th>
<th>COMPLY WITH REQUIREMENTS FOR:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total deck replacement</td>
<td>Fence, Splashboards, Lighting, if applicable</td>
</tr>
<tr>
<td>Total replacement of existing railing</td>
<td>Fence, Splashboards</td>
</tr>
<tr>
<td>Total replacement of superstructure</td>
<td>Vertical clearances, Fence, Splashboards, Lighting, if applicable</td>
</tr>
<tr>
<td>Total replacement of existing structure</td>
<td>Treat replacement structure as new structure</td>
</tr>
<tr>
<td>Widening deck of existing superstructure</td>
<td>Fence, Splashboards, Lighting, if applicable</td>
</tr>
<tr>
<td>Widening existing structure</td>
<td>Provide Pier projection walls if required or modify existing walls to comply with current AREMA requirements</td>
</tr>
<tr>
<td>Multiple parallel structures</td>
<td>Treat each structure as an individual structure</td>
</tr>
</tbody>
</table>

5. Permanent Clearances

It is required on all new overhead bridge structures to have all piers and abutments located outside the Railroad’s right-of-way and parallel to the tracks. Piers and abutments can be located on Railroad’s right-of-way if there is no other alternative. A KCS representative will determine if there is no other alternative. Permanent clearance shall comply with current issue of KCSRC standard drawing 005103, with provisions for future tracks, access roads, and drainage ditches.

Any variation of horizontal or vertical clearances shall be treated as a special case and will require approval by the Chief Engineer.

5.1 Vertical Clearances

Minimum permanent vertical clearance shall be 23‘-6” above the top of rail for ALL tracks and at any location under the structure. Additional vertical clearances may be required for features beyond those shown in the standard drawing; such as correction of sag in the track, track raise, construction requirements, and future track raises (within the next five years).
Design plans shall prominently display a note stating: “The elevations of the existing top-of-rail profile shall be verified prior to beginning construction.” All discrepancies shall be brought to the attention of the Director of Engineering and corrected prior to construction.

The minimum horizontal and vertical clearances as well as the existing clearances of structures to be rehabilitated or replaced shall be indicated on the General Plan and Elevation.

5.2 Horizontal Clearances

Layout of ALL overhead structures shall provide ample space for access roadway at least on one side of the track. For single track, design should accommodate a second track and access road. For multiple tracks, space is to be provided for access roadway on both sides and in between tracks if required by the Operating Department for servicing trains. Designer is to consult with the Director of Engineering for the requirements and location of a second track and access roadway.

Minimum horizontal clearance on tracks without access road shall be eighteen (18) ft. to the face of pier protection wall, and twenty-five (25) ft. on tracks with access road. Horizontal clearances are for tangent tracks and correspond to the perpendicular distance from centerline of the track to the face of support or pier protection wall.

The layout of proposed structure shall take into consideration the following:

5.2.1 Future tracks and their relative location.
5.2.2 Spreading of tracks on direction of spread.
5.2.3 Location of access road.
5.2.4 Location and size of drainage ditches.
5.2.5 Location of existing or relocated utilities.
5.2.6 The minimum horizontal clearance requirement is for tangent track layout. Horizontal clearances shall be increased per AREMA requirements when any part of the structure is located within eighty (80) ft of curved track.

6. Construction Clearances

6.1 Vertical Clearance

The minimum temporary construction clearance to any falsework part shall be twenty-one (21) ft. vertically above the highest rail. Falsework designers must check the supporting members for deflection and allow for said deflection, with a factor of safety, during erection of the falsework, construction, and the removal of falsework elements. Dropping of falsework or any other construction material on the tracks is not permitted.

6.2 Horizontal Clearance
The minimum **temporary construction** clearance to any falsework part shall be twelve (12) ft. from the centerline of the nearest track measured perpendicular to said track.

Temporary horizontal clearances shall be adjusted per AREMA requirements when structures are located within eighty (80) ft. of a curved track.

Greater clearances may be required for special cases to satisfy local operating conditions. Designer shall consult with the Director of Engineering for locations where additional clearance is required.

Temporary vertical and horizontal clearances shall be shown on the plans for all overhead structures.

**No variation to any temporary clearances (vertical or horizontal) will be allowed without written authorization from the Chief Engineer Design.**

7. **Safety Barrier and Splashboards**

Designers of overhead structures shall provide means of protecting Railroad facilities and to maintain the safety of employees below the structure from snow removal activities and errant vehicles.

All structures where snow removal is being performed shall have splashboards as indicated in KCSRC standard drawing No. 005103. Structures requiring snow protective devices shall have a high solid barrier railing of 3’-6” minimum height or a combination of a lower solid barrier railing and splashboard on top for a total height of five (5) ft. For details see current issue of KCSRC standard drawing Nos. 005103 and 005104, Appendix B.

A variance to the solid 3’-6” high barrier railing or splashboards which is based on not removing snow laterally from the bridge will require a clause to that effect in the agreement between the Agency and the Railroad. **Final plans shall not be approved without copy of such agreement between the Agency and Railroad.**

The limits of snow protective devices shall extend to the full length of Railroad’s right-of-way or a minimum of twenty-five (25) ft. beyond the centerline of exterior track or access road. Addition of future tracks shall require the lengthening of the snow protective devices at the expense of the agency.

Standard solid barrier rail will be acceptable on structures where snow removal is not performed.

**Types of barrier railing or combination of barrier railing and splashboards and their limits on the structure shall be clearly shown on the plans.**

8. **Safety Fences**

Designers of overhead structures shall provide means of protecting Railroad facilities and the safety of their employees below from objects being thrown from above by pedestrians or passing motorists.
Fence shall be provided on both sides of ALL overhead structures. For types of fences see current issue of KCSRC standard drawings No. 005103 and 005104, Appendix B.

Designer shall provide eight (8) ft. high curved fence or ten (10) ft. high straight fence on the side of walkway and a combination of barrier rail and fence of total height of ten (10) ft. on the side without walkway.

Keep in mind that the protection and safety of rail operations and the KCSRC employees who may be working on the ground beneath the bridge is absolutely paramount. Any variance to the fence requirements above shall not be granted until the Director of Engineering consults with local Roadmaster and his concurrence is submitted with the plans for approval.

If variance is granted, a clause in the Agreement between the Agency and the Railroad shall be included that the Agency shall provide for future installation of fencing at the Agency’s expense if deemed necessary by the Railroad.

Aesthetics shall not be cause for not meeting the safety requirements.

The Chief Engineer will consider ornamental fencing with a maximum gap of four (4) inches and meeting the minimum height requirements above.

The limits of protective fence shall extend to the full-length of Railroad’s right-of-way or a minimum of twenty-five (25) ft. beyond the centerline of outermost track or access road. Any addition of future tracks shall require the lengthening of the safety fences at the expense of the agency.

Types of fences and their limits shall be shown on the plans.

9. Parallel Structures

Parallel structures which are up to two (2) ft. apart shall not require safety fence or snow protective devices at their interface. Structures which are more than two (2) ft. apart shall be treated as individual structures and the required safety protective devices (barrier, splashboards, and fences) shall be provided.

10. Piers

All piers and abutment slopes shall be located so that they do not interfere with the drainage ditches or the natural drainage features of the area. Where conditions make this impractical, an explanation of such conditions shall be submitted along with the drainage plans and supporting calculations to the office of the Chief Engineer for approval.

Anticipated location of piers located within twenty-five (25) ft. from centerline of the nearest existing or future track shall be designed with pier protection wall. Excavations and shoring for foundations shall conform to KCSRC Railroad Construction Guidelines, Section IV, Design and Construction of Shoring Adjacent to and on Railroad Right-of-Way.

Pier footings within twenty-five (25) ft. of the nearest track centerline shall be a minimum of six (6) ft. below base of rail. This will not restrict Railroad from modifying longitudinal drainage system in the future or from providing unobstructed area for placing, signal, fiber optic lines or other buried utilities.
Drilled shafts within the influence of track surcharge shall be designed with temporary casing to protect track against cave-in, subsidence and/or displacement of surrounding ground. Casing shall be designed for live load due to the railroad surcharge in addition to all other loads.

Drilling of shafts or shoring construction for footings within the influence of track surcharge shall not proceed without the approval from the Chief Engineer. For limits of track surcharge influence refer to KCSRC Railroad Construction Guidelines, Section IV, Design and Construction of Shoring Adjacent to and on Railroad Right-of-Way.

11. Pier Protection Walls

Piers supporting bridges over railways and with a clear distance of less than twenty-five (25) ft. from centerline of nearest, or centerline of anticipated future track, shall be of heavy construction or shall be protected by a reinforced concrete protection wall.

Design of pier protection wall shall comply with the requirements of AREMA Chapter 8, Part 2, Section 2.1.5.1. See Commentary of this section on AREMA specifications and Figure C-1 for additional details.

In locations where tracks are on both sides of pier and are less than twenty-five (25) ft. from centerline of adjacent tracks, both sides of the pier shall be protected with protection walls.

If pier design requires column isolation, the pier protection wall shall be designed to resist the impact and redirection of equipment in case of derailment, supported on an independent footing.

All replacement or modified structures shall comply with the AREMA requirement for pier protection walls.

In locations where pier columns and protection walls interfere with drainage, openings must be provided in the wall for the drainage to ditches or drainage facilities must be provided to collect and dispose water to the drainage system. Openings in the pier protection wall must be lower than the track sub-grade elevation and must drain away from the track.

AREMA defines pier of heavy construction as: “Piers shall be considered of heavy construction if they have a cross-sectional area equal to, or greater than that required for the pier protection wall and the larger of its dimensions is parallel to the track”. For single column, the minimum cross-sectional area is 30 square feet (12’ length x 2.5’ width = 30 sq. ft.). Columns with 30 sq. ft. area must have the larger dimension parallel to the track (such as 5’ x 6’ column with the 6’ dimension parallel to the track is considered as heavy construction column). Round columns may not meet the heavy construction criteria.

12. Adjustment to Utilities

Existing underground or aerial facilities interfering with new structure shall be placed underground and away from the bridge structure. Relocation of utilities shall be performed by the owners of the utility at the sole expense of the Agency.

Relocation of non-railroad owned utilities or communication lines shall be coordinated with the owners and submitted to the KCSRC Real Estate Department for handling.
13. **Abutment Slopes**

To prevent embankment material from sloughing and drainage waters from undermining track sub-grade, end slopes of abutments adjacent to railroad tracks shall be protected with paved slopes.

Paved slopes shall extend two (2) ft. past the face of abutment wall and terminate with either a curb or gutter to divert runoff. Paving shall consist of a prepared sub-base and filter fabric with a minimum of four (4) inches thick reinforced concrete or grouted rip-rap placed on prepared sub-base and filter fabric. Asphalt pavement for slope protection shall be considered only if proper design and method of installation is submitted or covered in the special provisions.

Toe of slopes shall terminate at the bottom of drainage ditches and must have a cut-off wall as required to protect slope from drainage erosion.

Slope layout shall provide for a minimum drainage ditch or ditches required by hydraulic studies in the area. See KCSRC standard drawing No. 005105, Appendix B, for details. At all times, the toe of slope shall be below the finished track or roadway sub-grade and provide a ditch for positive track drainage.

If layout of abutments, piers, or columns with crash walls interfere with the drainage ditches, the designer shall provide other means of handling the longitudinal drainage issues based on the local drainage study.

**Track drainage ditch limits shall be shown to scale on the project plans and show the distance from centerline of nearest track. A typical cross-section detail shall be shown on the plans depicting the intersection of slope and drainage ditch.**

14. **Drainage and Erosion Control from Structure**

Maintaining the existing drainage and providing for future drainage improvements is of the utmost importance in layout of overhead structures.

Drainage from structure shall be diverted away from the Railroad right-of-way at all times. Scuppers from deck shall not be permitted to discharge water onto the track or roadway areas at any time. If drainage of deck uses downspouts in the columns, then they shall be connected to the storm drain system or allowed to drain into drainage ditches. Concrete splash block or aggregate ditch lining will be required at the discharge area of downspouts. Downspouts shall be behind the face of the piers and their outflows drain into drainage ditches.

If structure drainage is carried outside the Railroad right-of-way and does not change the drainage conditions within the Railroad right-of-way, then improvement of existing drainage will not be required.

**If the proposed bridge structure will not change the quantity and/or characteristic of the flow in the railway's ditches and/or drainage structures; the plans shall include a general note stating so.**

Drainage plans shall be included with the plan submitted for review. These plans must include hydrologic computations indicating the rainfall intensity and duration of the design storm used as well as the method of analysis. Drainage structures shall be designed for a 100-year flood event so that the water surface elevation does not exceed the track sub-grade elevation.
Where project design calls for the drainage flow to increase through the railroad right-of-way, methods must be developed to carry the additional flow.

Lateral clearances must provide sufficient space for construction of the required standard ditches parallel to the standard roadbed section.

When the proposed construction will change the quantity and/or characteristic of flow in the existing ditches, the ditches shall be modified as required to handle the increased runoff. The size of ditches will vary depending upon the flow and terrain and should be designed accordingly.

In order to evaluate the impact of the new structure relative to existing site drainage, cross sections perpendicular to the centerline of track shall be submitted along with the drainage plans. Cross-sections should be submitted to adequately depict the site condition; however, a minimum of five (5) cross sections on each side of the structure will be required at 50’ intervals. The existing, or proposed, railroad ditch and the proposed toe of slope shall be shown on the applicable cross-sections.

Approval of the drainage plan does not relieve the submitting agency and/or designer of ultimate responsibility and liability for the adequacy of the drainage design.

15. Lights

Designer to provide lighting for ALL new overhead or modified structures exceeding eighty (80) ft. of superstructure width, except if such structures are located in rural area. Lighting shall be provided also for structures of less than eighty (80) ft. widths in areas that switching is performed, high vandalism or trespassing has been experienced.

Designer to provide temporary lighting for ALL falsework designs irrespective of the superstructure width in areas that switching is performed, trespassing or vandalism has been experienced in the past.

The minimum design criteria shall be that the designer maintain an average of one (1) foot-candle for area under the structure at the KCSRC tracks. Use Holophane module 600 under-decking type luminaries or equal as required. Fixtures shall be installed on the column walls or caps of the overhead structure without reducing the minimum clearances.

Maintenance of lights shall be the responsibility of the agency. Access to perform any maintenance for lights shall be coordinated with the local Road master or his representative.

Structures with separation over ten (10) ft. from each other shall be considered as independent structures for the purposes of lighting.

16. Review Submittals

Submittals for design and construction of grade separation projects shall be coordinated and submitted through the Manager of Contracts. To expedite reviews, submittals must be complete, clearly explained and orderly. Design review for grade separation structures shall be reviewed by the Director of Engineering in the office of the Chief Engineer and/or through an outside consultant at the expense of the owner. Prior to any review, Manager of Contracts shall receive authorization from the agency agreeing to pay all review costs for the design and construction phases of the project. Once such an agreement is established, Manager of
Contracts shall request and secure a proposal from an outside consultant to cover review expenses. Review expenses shall include all costs for in-house personnel and/or consultants retained by the Railroad. This estimated cost of Plan Review and the construction monitoring phase of the project shall be provided to the submitting agency for review and approval. Once the Manager of Contracts has received the submitting agency’s written acceptance of the estimated cost, the review of plans can begin. If, during the review process, the estimated costs are determined to be insufficient to cover said costs, the owner will be advised. The original estimated costs will not be the upper limit of the costs, but will provide a guideline for budgeting purposes. Regardless, all reasonable costs incurred during the plan review process and construction monitoring phase of the work will be fully recoverable from the agency.

17. Preliminary Submittal

Plan for preliminary overpass bridge submittal shall include the following:

For each overhead structure the milepost and direction shall be shown on the plans. Items shown as left or right in the checklist are referenced facing the increasing milepost. Milepost and direction shall be shown on the General Layout Sheet. Designer is to consult with manager of contracts for the correct milepost and increasing direction.

17.1 Plan:

Plan view shall indicate at least the following items:

17.1.1 KCSRC right-of-way

17.1.2 Footprint of proposed structure including existing structure, if applicable

17.1.3 Indicate the position of all railroad tracks and identify each track as mainline, siding, spur, etc.

17.1.4 Indicate minimum horizontal clearances and track spacing of all existing and/or future tracks.

17.1.5 Indicate location of ALL access roadways

17.1.6 Footprint of footings with the minimum clearance from centerline of adjacent or future track shall be shown on the plans.

17.1.7 Indicate the minimum clearance requirement for shoring.

17.1.8 Locate and show all existing facilities and utilities and their proposed relocation if required.

17.1.9 Show drainage ditches and direction of flow.

17.1.10 Indicate minimum structure separation for parallel structures.

17.1.11 Indicate milepost and increasing direction.

17.1.12 Indicate point of minimum vertical clearance, and location from the nearest track.

17.2 Elevation:
Elevation view shall indicate at least the following items:

17.2.1 Minimum vertical track clearances taken from top of rail.
17.2.2 Track elevation for all tracks.
17.2.3 Pier footing within Railroad right-of-way shall be six (6) ft. below base of rail.
17.2.4 Indicate top pier protection wall elevation relative to top of rail elevation.
17.2.5 Show elevation of existing or relocated utilities.
17.2.6 Show slopes and specify type of paving. Toe of slope shall be shown relative to drainage ditch and top of sub-grade.
17.2.7 Show ditches for drainage. Provide enlarged scaled detail showing the correlation of slope pavement, ditch, and track or roadway sub-grade.
17.2.8 Limits of fencing and protective railing or splashboards.

17.3 Typical Sections:

Typical section shall indicate at least the following items:

17.3.1 Structural components of superstructure shall be shown on the plans.
17.3.2 Type of railing and fencing and their heights.
17.3.3 Indicate pier outline and pier protection wall. Additional cross-section may be required to show crash wall design.

17.4 Track Profiles:

The profile of the existing top of rail (1,000 ft. each side of proposed structure) shall be shown on the plans, at even-station (100 ft.) intervals.

17.5 General Notes:

General notes specifying material requirements, design data, temporary clearance requirements, stages of construction, etc.

Fill out and furnish the attached “Overhead Submittal Checklist” (see Appendix A) with your preliminary plan submission. For any exception to the minimum requirements on the attached checklist, a detailed explanation/reason why the minimum requirements cannot be met must be provided.

Revised submittals of plans or documents shall follow the same procedure as the initial submittal until all issues are resolved.

17.6 Preliminary Submittal Procedure:

Two (2) sets of preliminary plans shall be submitted to the Manager of Contracts. Allow two (2) weeks for in-house review by the Director of Engineering. The Manager of
Contracts will then forward the plans along with the comments of the KCSRC to the outside consultant for review. Allow three (3) additional weeks for review once the plans are received by the consultant.

18. **Final Submittal**

18.1 **Final Plans**

Final plans for overhead structures submitted to KCSRC should include only pertinent drawings that impact the railroad. Complete sets are not required. The following drawings should be submitted:

18.1.1 General plan and elevation view
18.1.2 Typical roadbed section and drainage ditches
18.1.3 Track profiles
18.1.4 Drainage plans and deck drains
18.1.5 Railing and fencing details
18.1.6 Crash wall plans

18.2 **Drainage Calculations**

Drainage design criteria for right-of-way drainage ditches, drainage structures parallel to or under the track shall comply with the following:

18.2.1 The 50-year flood water surface elevation should not come into contact with the crown of a culvert or the low chord of the drainage structure whichever is applicable.
18.2.2 The 100-year flood water surface elevation should not exceed the track sub-grade elevation.

If existing drainage facilities do not meet the design criteria above, an enlarged opening must be considered.

18.3 **Special Provisions**

18.4 **Final Submittal Procedure**

Three (3) sets of 100% **signed** plans, two (2) sets of **signed** structural calculations, two (2) set of **signed** hydraulic calculations, and two (2) sets of **signed** special provisions shall be submitted. All material shall be submitted directly to the outside consultant for review. A copy of the transmittal letter will be sent to the Manager of Contracts. Three (3) weeks shall be allowed for review. Consultant and Design Engineer will be free to communicate and resolve all remaining design issues. When review is complete, the consultant shall advise the agency or its representative that all issues have been addressed satisfactorily and recommending the release of structure for construction. The consultant shall forward two (2) sets of all final documents to the Manager of Contracts. After final review by the Director of Engineering and the contract is in place for the structure, the project shall be released for construction. Allow four (4) weeks for this final process.
19. Construction Submittals

During construction of the overpass structure, the Railroad requires the review of temporary structures such as falsework, shoring, demolition of existing structures if required, etc. PRIOR to any construction. It is required that all designs be submitted by the agency or their representative to the KCSRC for review following their own review and approval of the design. All submittal designs shall be “signed by a registered engineer” and shall be forwarded to Manager of Contracts, who, in turn, will send them to outside consultant for review of said submittals. If consultant performs said review, the consultant may reply directly to the agency or its representative after consultation with the Director of Engineering. Copy of reply will be mailed to Manager of Contracts. During the review process, the consultant and design engineer will be free to communicate and resolve issues. Review of design submittals will require minimum of four (4) weeks.

It is preferable to receive construction submittal plans in half-size.

Following is a list of construction design submittals:

<table>
<thead>
<tr>
<th>Submittal</th>
<th>Plans Required</th>
<th>Calculations Required</th>
<th>Minimum Review Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoring</td>
<td>3</td>
<td>2</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Falsework</td>
<td>3</td>
<td>2</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Drainage</td>
<td>3</td>
<td>2</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Demolition</td>
<td>3</td>
<td>2</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Special Provisions</td>
<td>2</td>
<td>N/A</td>
<td>4 weeks</td>
</tr>
</tbody>
</table>
Appendix A

1. Overhead Grade Separation Data Sheet

2. Overhead Submittal Checklist
# Appendix A

## Overhead Grade Separation Data Sheet

1. **Location:**
   
<table>
<thead>
<tr>
<th>City</th>
<th>County</th>
<th>State</th>
</tr>
</thead>
</table>

   Distance from nearest Milepost to centerline of Bridge:

2. **Description of Project:**

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

3. **Utilities on Railroad Property:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Any Adjustments Required</th>
<th>Contact Person</th>
</tr>
</thead>
</table>

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

4. **List all the at-grade crossings that will be eliminated by the construction of this grade separation:**

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

5. **Minimum horizontal clearance from centerline of the nearest track to face of Pier:**

   A. Proposed: __________________________  B. Existing (if applicable): ________________

6. **Minimum vertical clearance from centerline of the nearest track to face of Pier:**

   A. Proposed: __________________________  B. Existing (if applicable) ________________

---

Guidelines for the Design and Construction of Railroad Overpasses and Underpasses 17
8. List piers where crash walls are provided:

<table>
<thead>
<tr>
<th>Pier</th>
<th>Distance from Centerline of Track</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Describe how Drainage from approach roadway is handled: ________________________________

10. Describe how drainage from bridge is handled: ________________________________

11. List piers where shoring is required to protect track: ________________________________

12. Scheduled Letting Date: ________________________________

ALL INFORMATION ON THIS DATA SHEET TO BE FURNISHED BY THE SUBMITTING AGENCY TO THE MANAGER OF CONTRACTS

PRELIMINARY PLAN & ELEVATION VIEWS AS OUTLINED IN SECTION 17 SHALL BE SUBMITTED WITH THIS FORM
### Appendix A (Continued)

## Overhead Submittal Checklist

<table>
<thead>
<tr>
<th>Item</th>
<th>Required Information</th>
<th>Min. Required</th>
<th>As Submitted</th>
<th>A/R</th>
<th>Railroad Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abutment or Bent No.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Horizontal Clearance (Left) (CL to Face)</td>
<td>18'-0&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Horizontal Clearance (Right) (CL to face)</td>
<td>18'-0&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Vertical Clearance (From Top of Rail)</td>
<td>23'-6&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Horizontal Clearance to footing from CL</td>
<td>25'-0&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Depth top of footing below base of rail</td>
<td>6'-0&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pier Protection wall required</td>
<td>25'-0&quot; *</td>
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</tr>
<tr>
<td>7</td>
<td>Shoring required (CL to nearest Pt.)</td>
<td>12'-0&quot;</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>1</td>
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<tr>
<td>5</td>
<td>Depth top of footing below base of rail</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pier Protection wall required</td>
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<tr>
<td>7</td>
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<td>Bent No.</td>
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<tr>
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<td>Depth top of footing below base of rail</td>
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Guidelines for the Design and Construction of Railroad Overpasses and Underpasses
7 Shoring required (CL to nearest Pt.) 12'-0"

* Pier protection required within KCSRC Right-of-Way

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<tr>
<th>Item</th>
<th>Required Information</th>
<th>Min. Required</th>
<th>As Submitted</th>
<th>A/R</th>
<th>Railroad Remarks</th>
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<th>A/R</th>
<th>Railroad Remarks</th>
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<td>Track spreading taken into consideration</td>
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<td>Future track centers</td>
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Safety Requirements

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<th>Railroad Remarks</th>
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<td>1</td>
<td>Splashboards or barrier rail near Side NS</td>
<td>5'0&quot; / 3'-6&quot;</td>
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<td>Splashboards Far Side FS</td>
<td>5'0&quot; / 3'-6&quot;</td>
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<td>3</td>
<td>Splashboards limits adequate</td>
<td>R/W to R/W</td>
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<td>4</td>
<td>Fence w/ pedestrian walkway, NS or FS</td>
<td>8'-0&quot; / 10'-0&quot;</td>
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<td>5</td>
<td>Fence w/o pedestrian walkway, NS or FS</td>
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<td>6</td>
<td>Fence limits adequate</td>
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Drainage Requirements

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<td>RR R/W shown correctly</td>
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<td>All tracks labeled correctly</td>
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<td>4</td>
<td>Existing utilities aerial or underground</td>
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<td>Maximum gap between structures</td>
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<td>Lights required for width of Str. Over 80'</td>
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<td>Track profile for 1000’ on each side of Str.</td>
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<td>8</td>
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<td></td>
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<td>9</td>
<td>Abutment slope protection</td>
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<td>Temp. construction vertical clearance</td>
<td>21'-0&quot;</td>
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<td>Temp. construction horizontal clearance</td>
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<tr>
<td>12</td>
<td>Milepost number &amp; direction of increase</td>
<td>Required</td>
<td></td>
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</tr>
</tbody>
</table>

**Instructions**

Milepost and direction of Milepost must be shown in the plans. Left and Right is the orientation of structure elements facing in the direction of increasing milepost.

Fill all applicable parts of table above: In Column "As Submitted" insert all applicable values from plans.

**For any exception to the minimum requirements on the checklist, a detailed explanation/reason why the minimum requirements cannot be provided must be given.**

**PRELIMINARY PLAN REVIEW:**

If items on above table show deficiencies, acceptance of preliminary plans will not be granted until deficiencies are resolved.

**FINAL PLAN REVIEW:**

Prior to structure construction signed final plans, special provisions and hydraulic calculations, if required, shall be submitted for final review. If all items are resolved and plans comply, will release structure for construction.

**UNITS:**

Units for the above checklist to be in English.
Section III

Guidelines for
Bridge Demolition and Removal Plan
For Structures over Railroad
Section III
Bridge Demolition and Removal Plan for Structures over Railroad

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Appendix A – KCSRC Bridge Demolition Checklist
1. General

1.1 The Contractor’s work shall in no way impede the train operations of the KCSRC.

1.2 The Contractor shall develop a work plan assuming that minimal track windows will be available.

1.3 The Contractor shall be responsible for planning and executing all procedures necessary to remove the overhead bridge in a safe and controlled manner.

1.4 The Railroad’s tracks and property shall be protected at all times.

1.5 The contractor shall ensure the area immediately adjacent to operational tracks shall remain free from stumble or like hazards to the ground Railroad personnel to prevent injuries. All excavations shall be designed and constructed in accordance with KCSRC Railroad Construction Guidelines, Section IV, Design and Construction of Shoring adjacent to and on Railroad Right-of-Way.

1.6 The words “demolition” and "removal" will be used interchangeably.

1.7 All removed materials shall be disposed of outside the Railroad right-of-way at no expense to the Railroad.

1.8 No work is allowed within 50 feet of the nearest rail when trains pass the work site.

1.9 Staged demolition of the portions of structure immediately adjacent to operational tracks will not jeopardize the integrity of the structure over said tracks until actual removal of the portion of the structure over tracks is being done.

1.10 A flagman is required when any work is performed on any portion of the Railroad right-of-way.

1.11 No blasting will be permitted on Railroad’s right-of-way.

2. Bridge Removal Plans

2.1 The Removal Plan shall include the following:

2.1.1 Plan, elevation and location of bridge, and the locations of any access roads needed for movement of the equipment. The as-built drawings may be used for the submittal provided the removal steps are clearly marked and legible.

2.1.2 Indicate the position of all railroad tracks below the bridge and identify each track as mainline, siding, spur, etc.

2.1.3 Bridge removal sequence and procedures for entire bridge including the staging for the removal of the superstructure and substructure.

2.1.4 List type and number of equipment required and their locations during demolition operations.
2.1.5 Locations and types of temporary supports, shoring or bracing required. These members shall be designed to meet the requirements of AREMA Manual for Railway Engineering, latest edition, and KCSRC Railroad Construction Guidelines, Section IV – Design and Construction of Shoring Adjacent to and on Railroad Right-of-Way and applicable local and national building codes.

2.1.6 The proposed vertical and horizontal clearance from all tracks to the temporary and permanent supports. The minimum vertical and horizontal clearances shall be as per attached frame protection details.

2.1.7 If any temporary supports interfere with the natural drainage along the Railroad right-of-way, a temporary drainage plan shall be submitted for review and comment prior to constructing temporary supports. The proposed drainage plan shall route all drainage away from the railroad tracks.

2.1.8 Details, limits, and locations of protective covers or other measures proposed to be used to protect the tracks. This includes any shields or other measures that will protect the tracks from falling debris during removal of the overhead bridge and from any debris rolling down the side slopes or otherwise coming into the area round the tracks which could affect train operations. Design loads, including impact loads, shall be noted. In addition equipment should be on site capable of removing debris and track shield from operational tracks.

2.1.9 All procedures necessary to remove the bridge in a safe and controlled manner. The estimated time for complete removal over the tacks shall be noted.

2.1.10 All overhead and underground utilities in the area affected by removal of the bridge shall be located on the drawings, including any fiber optic, railroad signal, and communication lines.

2.1.11 The location and details of track crossings required for moving of the equipment across the railroad tracks. **Construction of temporary crossings requires a separate written agreement between KCSRC and the contractor.**

2.1.12 Limits of demolition of substructures.

2.1.13 Details of on-site fire suppression.

3. **Procedure**

3.1 During removal operations, the remaining structure shall be stable during all stages of the removal operations.

3.2 Prior to proceeding with bridge removal, the sealing Civil or Structural Engineer, or his authorized representative working for the Contractor, shall inspect the temporary
support shoring, including temporary bracing and protective coverings, for conformity with the working drawings. The Engineer shall certify in writing to the Railroad that the work is in conformance with the drawings and that the materials and workmanship are satisfactory. A copy of this certification shall be available at the site of work at all times.

3.3 Coordinate the removal schedule with the Railroad. All the removal work within the track area shall be performed during the time windows when the trains are not passing the work site.

3.4 All substructures shall be removed to at least 3 feet below the final finished grade or at least 2 feet below base of rail whichever is lower, unless otherwise specified by the Railroad.

3.5 All debris and refuse resulting from the work shall be removed from the right-of-way by the Contractor and the premises left in a neat and presentable condition.

3.6 The work progress shall be reviewed and logged by the Contractor’s Engineer. Should an unplanned event occur, the Contractor shall inform the Railroad and submit procedure to correct or remedy the occurrence.

3.7 Preferably all demolition and beam removal shall be from above. In the case that the beams require removal from below, the beams may temporarily straddle the tracks. The following steps shall be taken:

3.7.1 The work shall be scheduled with the Railroad’s Service Unit Superintendent subject to the Railroad’s operational requirements for continuous train operations. The beams shall be removed in sufficient time for train passage.

3.7.2 The tracks shall be protected and no equipment placed on the tracks.

3.7.3 The beams shall be blocked and not come in contact with the tracks. Blocking shall not be placed on the tracks.

3.7.4 The beams and all equipment will be moved a minimum of 15 feet from the nearest rail of the tracks when a train is passing.

4. **Track Protection**

4.1 The track protective cover shall be constructed before beginning bridge removal work and may be supported by falsework or members of the existing structure. See the attached Track Shield Detail and Frame Protection Detail for additional requirements. Types of protective covers that may be acceptable methods for protecting the tracks are:

4.1.1 A decking supported by the bridge or a suspended cover from the bridge above the track clearance envelope.

4.1.2 A track shield cover over the tracks per the attached detail.
4.1.3 A framed cover outside the track clearance envelope.

4.1.4 A catcher box or loader bucket under decking and parapets overhanging the exterior girders.

4.2 Construction equipment shall not be placed on the tracks unless tracks are protected.

4.3 Temporary haul-road crossings shall be of either Section Timbers or Pre-cast Concrete Panels. The type of crossing shall be determined by the Director of Engineering. Solid timbers or ballast with timber headers shall be used between multiple tracks. If temporary crossing is accessible to public, crossing shall be protected with barricades or locked gates when contractor is not actively working at the site.

4.4 Track protection is required for all equipment including rubber-tired equipment operating within 25 ft. or over the tracks.

5. **Cranes**

5.1 When cranes are operating near the tracks, the following is required:

5.1.1 Only cranes with the capacity to handle the loads may be used. Front-end loaders and backhoes cannot be used to lift over the tracks.

5.1.2 The Contractor shall verify that the foundations under the crane can support the loads.

5.1.3 The size and material type of crane mats shall be submitted to the Railroad for review and comment. No mat substitution will be allowed. The mats shall be rigid and of sufficient capacity to distribute the crane loads and prevent tipping of the crane.

5.1.4 Installation of temporary track crossings for equipment shall be scheduled with the Roadmaster for that territory. This crossing shall be installed and removed by a track contractor selected by the KCSRC.

5.1.5 Additional track protection is required when crossing with a crane. The protection methods shall be submitted to the Railroad for review and comment.

5.1.6 Equipment shall not place outriggers on the tracks or ballast.

5.1.7 Cranes shall not be placed within the track clearance envelope without flagman protection.

6. **Cutting Torches**

6.1 When a cutting torch is used near the tracks or any timber, the following steps shall be taken:
6.1.1 Fire suppression equipment is required on-site.

6.1.2 Do not use a torch over, between, or adjacent to the tracks unless a steel plate protective cover is used. Care shall be taken to make certain the use of a steel plate does not come in contact with the rails. See “Track Shield Details” for other requirements. Details of the shield shall be submitted to the Railroad for approval.

6.1.3 Wet the ties and other timber below the cutting area.

6.1.4 Monitor the work site for at least three (3) hours after cutting for a smoldering fire.

6.2 Extensive overhead cutting will not be performed over the track area without the proper fire suppression equipment on-site and proper protection.

7. Utilities

The demolition operations shall be planned such that the utility lines are operating safely at all times. The utility lines shall be protected if affected by demolition operations. All the work associated with the utility lines should be coordinated by the contractor with the respective utility companies.

8. Hazardous Material

If any hazardous materials are found, provide material protection as specified in local hazardous material codes and immediately contact the Railroad.

9. Review Submittals

Submittals for design and construction of Bridge Demolition and Removal projects shall be coordinated and submitted through the Manager of Contracts. To expedite reviews, submittals must be complete, clearly explained and orderly. Design review for demolition projects shall be reviewed by the Director of Engineering in the office of the Chief Engineer and/or through an outside consultant at the expense of the owner. Prior to any review, Manager of Contracts shall receive authorization from the agency agreeing to pay all review costs for the document review and field demolition phases of the project. Once such an agreement is established, Manager of Contracts shall request and secure a proposal from outside consultant to cover review expenses. Review expenses shall include all costs for in-house personnel and/or consultants retained by the Railroad. This estimated cost of Plan Review and the construction-monitoring phase of the project shall be provided to the submitting agency for review and approval. Once the Manager of Contracts has received the submitting agency’s written acceptance of the estimated cost, the review of plans can begin. If, during the review process, the estimated costs are determined to be insufficient to cover said costs, the owner will be advised. The original estimated costs will not be the upper limit of the costs, but will provide a guideline for budgeting purposes. Regardless, all reasonable costs incurred during the plan review process and construction-monitoring phase of the work will be fully recoverable from the agency.
9.1 Two (2) sets of plans shall be submitted to the Manager of Contracts. Allow two (2) weeks for in-house review by the Director of Engineering. The Manager of Contracts will then forward the plans along with KCSRC comments to the outside consultant for review. Allow three (3) weeks for review by the outside consultant.
Appendix A

KCSRC Bridge Demolition Checklist
Appendix A

KCSRC Bridge Demolition Checklist

1. All materials removed to outside Railroad right-of-way. Work site neat and safe.
2. No work within 50 ft. while trains pass the work area.
3. Flagman required when work is performed on Railroad right-of-way.
4. Plan and elevation of bridge and all access road locations.
5. Location of Railroad tracks noted and type of track noted.
6. Bridge removal sequence noted.
7. Type of equipment, number and location noted.
8. Clearances to temporary shoring noted.
9. Site drainage considered.
10. Details limits and location of protective covers.
11. Estimated time of removal of structures over tracks noted.
12. Utilities protected and noted.
13. Location and details of track crossing noted.
14. Limits of demolition of substructures (greater of 3 ft. below grade or 2 ft. below base of rail).
15. Details of on-site fire suppression.
17. Plans sealed by registered engineer. Inspection of shoring, bracing and protective covers noted in documents and certifications on site.
18. Coordination with railroad noted.
19. Work progress reviewed and logged by Contractor’s Engineer and any deviations noted to KCSRC.
20. Debris and equipment moved a minimum distance of 8 ft.−6 in. from nearest rail during train passage, and to an elevation no higher than the top of rail. Debris and equipment are to be moved a minimum distance of 10 ft.-0 in. from nearest rail and down to original grade at the end of the day.
21. Track protection acceptable.
22. No construction equipment permitted on tracks, unless protected.
23. Temporary track crossing for haul roads meet KCSRC standards and placement scheduled with Road master.
24. Track protection required for all equipment operating within 25 ft. of tracks, including rubber-tired equipment.
25. Crane capacity sufficient.
27. Protective covers extend 20 ft. beyond the edge of the structure.
28. Geo fabric placed over existing ballast to keep fine demolition material from ballast.
Section IV

Design and Construction
of Shoring Adjacent to and on Railroad Right-of-Way
Section IV

Design and Construction
of Shoring Adjacent to and on Railroad Right-of-Way

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Appendix A
Shoring Design Checklist

Appendix B
Drawing No. 005106 General Shoring Requirements

Chart A – Boussinesq Surcharge Pressure Due to E-80 Live Load (psf) for
Shoring Parallel to the Track

AREMA Figure 8-20-1 Lateral Pressure Diagrams
AREMA Figure 8-20-2 Pressure Distribution for Strip Load
AREMA Figure 8-20-3 Pressure Distribution for Line Load
1. **Scope**

   The scope of this guideline is to inform public Agencies, design engineers, Contractors and inspectors KCSRC current standards and requirements concerning the design and construction of temporary shoring, supporting active Railroad tracks.

   The term Contractor is defined as any party gaining access to work on KCSRC right-of-way or other operating locations.

   These guidelines supplement the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual of Recommended Practice.

   The specific requirements for shoring addressed in this document shall be followed for all locations that KCSRC operates on FRA track Class 1 through 5, regardless of track ownership.

   Safe rail operations shall be required for the duration of the project. The Railroad’s personnel, tracks and property shall be protected at all times.

   To expedite the review process of shoring plans, it is required that the drawings submitted by the Contractors adhere to the project specifications, AREMA and other KCSRC requirements.

2. **General Criteria**

   The Contractor must not begin construction of any component of the shoring system affecting the Railroad Right-of-Way until such time that the Railroad approval has been received.

   **2.1** The Contractor shall be responsible for planning and executing all procedures necessary to construct the shoring in a safe and controlled manner. Before work can begin on the Railroad right-of-way, the Agreement between the Railroad and the Owner must be fully executed; the Contractor must obtain a right-of-entry permit and understand all railroad requirements. All structures that support or impact the Railroad tracks or operations, shall be designed and constructed to provide safe and adequate rigidity.

   **2.2** The Railroad requirements, construction submittal review times and review criteria should be discussed at the pre-construction meeting with the contractor.

   **2.3** A flagman is required when any work is performed on Railroad right-of-way. If the Railroad provides flagging or other services, the Contractor shall not be relieved of any responsibilities or liabilities as set forth in any document authorizing the work. No work is allowed within 50 ft. of the nearest rail when a train passes the work site and all personnel and equipment must clear the area within 25 ft. of track centerline when trains are present.

   **2.4** All removed materials will become the responsibility of the Contractor and shall be disposed of outside the Railroad right-of-way at no expense to the Railroad.

   **2.5** Appropriate measures for the installation and protection of fiber optic cables shall be addressed in the plans and contract documents.
2.6 Relocation of non-Railroad owned utilities or communications lines shall be coordinated with the owners and submitted to KCSRC Real Estate Department for handling. The design plans must show all underground and overhead utilities.

3. Specifications

3.1 AREMA specifications are available at:

American Railway Engineering and Maintenance-of-Way Association
8201 Corporate Drive, Suite 1125
Landover, MD 20785-2230
Phone: 301.459.3200 / Fax: 301.459.8077
www.arema.org

3.2 The following KCSRC Guidelines shall be used in conjunction with this document during the design and construction of structures:


Overhead Grade Separation – “Guidelines for Design of Highway Separation Structures over Railroad (Overhead Grade Separation).”


4. Contractor Responsibility

The Contractor shall be solely responsible for the design, construction and performance of the temporary structure (AREMA 8.28.1.3)

4.1 The Contractor’s work shall in no way impede the train operations of KCSRC and must be coordinated with the local operating department and Road master.

4.2 The Contractor shall develop a work plan assuming that track windows will not be available.

4.3 The Contractor’s responsibility includes compliance with all state and Federal laws, county or municipal ordinances and regulations, which in any manner affect the work.

4.4 The Project Engineer for the Contractor shall evaluate the quality of materials furnished and work performed. It is ultimately the Contractor’s responsibility to properly evaluate the quality of materials and the work performed.

4.5 The Contractor must monitor and record top of rail elevations and track alignment for the duration of the project.

5. Information Required

Shoring system design plans and calculations shall be in English units. If Metric units are used, all controlling dimensions, elevations, design criteria assumptions, and material stresses shall
be expressed in dual units, with English units to be in parentheses. Information shall be assembled concerning right-of-way boundary, clearances, proposed grades of tracks and roads, and all other factors that may influence the controlling dimensions of the proposed shoring system. All shoring plans, sections and details shall be drawn to scale and the scale shown.

5.1 Field Survey

Sufficient information shall be furnished in the form of a profile, cross-sections and topographical maps to determine general design and structural requirements. Existing and proposed grades and alignment of tracks and roads shall be indicated together with a record of controlling elevation of water surfaces or ground water. Indicate location of existing/proposed utilities and construction history of the area which might hamper proper installation of the piping, soldier beams, ground anchors, depth of scour or allowance for over-dredging.

5.2 Soil (AREMA 8.22.3.1.1)

For a new structure, the site investigation shall provide sufficient information to determine:

5.2.1. Location of groundwater level, at least to the extent that it is within the zone of influence, beneath the footing.

5.2.2. Bearing capacity of the soil.

5.2.3. Data on soil and/or rock properties relative to shallow and deep foundations.

5.2.4. Settlement predictions.

5.2.5. Selection of alternative types and/or depth of foundations.

5.2.6. In seismic area, evaluation of liquefaction potential of various soil strata.

5.2.7. Global site stability (massive earth movements).

5.2.8. Any backfill material required shall be specified and the method and amount of compaction or consolidation shall be shown on the drawings. All backfill shall be, at a minimum, suitable for railway embankment fill.

5.3 Loads (AREMA 8.20.2.3)

5.3.1 All design criteria, temporary and permanent loading, boring and laboratory test results, and properties of construction materials, including yield stress, should be clearly stated in the design calculations and on the contract and record plans. Temporary loads include, but are not limited to: construction equipment, construction materials, and lower water levels adjoining the bulkhead causing unbalanced hydrostatic pressure. Permanent loads include, but are not limited to: future grading and paving, Railroads or highways, structures, material storage piles, snow and earthquake.

5.3.2 The allowable live load after construction should be clearly shown in the plans and painted on the pavements behind the bulkheads or shown on signs at the site and also recorded on the record plans.
5.3.3 The “loads” listed above are external to the total bulkhead system. There are also internal effects that are treated as loads in the design of individual members of the bulkhead system. These internal loads are active and passive soil pressures, acting separately or combined algebraically, saturated or dry as appropriate, for granular or cohesive soil or a combination thereof.

5.4 Drainage (AREMA 8.20.2.4)

5.4.1 The drainage pattern of the site before and after construction should be analyzed, and adequate drainage provisions incorporated into the plans and specifications. Consideration should be given to under-drainage as well as surface drainage.

5.4.2 Drainage provisions for backfill should be compatible with the assumed water conditions in design.

5.5 Structural Design Calculations

5.5.1 Computerized calculations and programs must clearly indicate the input and output data. List all equations used in determining the output.

5.5.2 Handwritten calculations must be provided to support computerized output.

5.5.3 A simple free body diagram showing all applied loads on a temporary shoring system should be included.

5.5.4 Documents and manufacturer’s recommendations which support the design assumptions must be included with the calculations.

5.6 Work Plan

A work plan that includes the following shall be submitted:

5.6.1 Time and date when the track is requested to perform work.

5.6.2 Time and date when no work will be performed.

5.6.3 Anticipated date to begin shoring installation.

5.6.4 Anticipated date to remove shoring.

**Note:** While driving piles, track time will be necessary as the leads may foul the tracks in the event of a mechanical failure or operator error.

6. General Shoring Requirements

For general shoring requirements and specific applications of the following items refer to Drawing 005106 “General Shoring Requirements”.

6.1 Evaluate existing slope and stability conditions to ensure the railroad embankment will not be adversely affected.
6.2 Lateral clearances must provide sufficient space for construction of the required standard ditches parallel to the standard roadbed section. The size of ditches will vary depending upon the flow and terrain and should be designed accordingly.

6.3 For main line and branch track, no excavation shall be permitted closer than 12'-0", perpendicular distance, from the centerline of track to the trackside of shoring system. For industry track, no excavation shall be permitted closer than 7'-0". If existing conditions preclude the installation of shoring at the required minimum distance, the shifting of tracks or temporary removal of tracks shall be investigated prior to any approval. All costs associated with track shifting or traffic interruption shall be at Contractor’s expense.

6.4 Vertical overhead clearance from the top of the rail to temporary shoring shall be a minimum of 21'-0".

6.5 All shoring within the limits of Zone A or Zone B must be placed prior to the start of excavation.

6.6 The top of the shoring wall must have an elevation equal to or greater than the elevation required to meet the limits of Zone B.

6.7 Shoring types which place lagging elements as the excavation proceeds are not permitted within the limits of Zone A.

6.8 Standard handrails, fence, or other barrier methods meeting OSHA and FRA requirements must be used around open excavations on or near Railroad right-of-way.

6.9 The most stringent project specifications of the Public Utilities Commission Orders, Department of Industrial Safety, OSHA, FRA, AREMA, KCSRC or other governmental agencies shall be used.

6.10 Second-hand material is not acceptable unless the Engineer of Record submits a full inspection report, which verifies the material properties and condition of the second-hand material. The report must be signed and sealed by the Engineer of Record.

6.11 If cantilever sheet pile is used for shoring adjacent to any operating track the shoring system should be at least twelve (12) feet away from the centerline of track and its maximum height shall not exceed ten (10) feet from the base of the excavation to the top of Zone “B". Cantilever sheet pile walls shall be used only in granular soils or stiff clays. Material at the excavation line, near the bulkhead, shall be kept free of water and shall not be disturbed by men or equipment. If the above conditions cannot be met, cantilevered sheet pile shoring shall not be used.

6.12 All components of the shoring system are to be removed and all soil voids filled. The Contractor may request to abandon in-place specific elements of the shoring system, which are a minimum of six (6) feet below grade provided specific justifications are given.

6.13 Slurry type materials are not acceptable for soldier beams in drilled holes. Concrete and flowable backfill will prevent removal of the shoring system.
7. **Types of Shoring**

7.1 The following shoring systems are acceptable for use where KCSRC equipment is operating. Definitions are included for clarity from AREMA 28.1.4.1.

7.1.1 A cantilever sheet pile wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the sheet pile is embedded.

7.1.2 An anchored sheet pile wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the sheet pile is embedded and the tensile resistance of the ground anchors.

7.1.3 A cantilever soldier beam with lagging wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the soldier beam is embedded.

7.1.4 An anchored soldier beam with lagging wall is a structure designed to provide lateral support or a soil mass and derives stability from passive resistance of the soil in which the soldier beam is embedded and the tensile resistance of the ground anchors.

7.1.5 For purposes of these specifications, soldier beams include steel H-piles, wide flange sections or other fabricated sections that are driven or set in concrete in drilled holes. Lagging refers to the members spanning between soldier beams.

7.1.6 For purposes of these specifications, ground anchors shall be cement-grouted tiebacks designed, furnished, installed, tested and stressed in accordance with these specifications.

7.1.7 Anchored soldier beams with lagging walls are generally designed as flexible structures, which have sufficient, lateral movement to mobilize active earth pressures and a portion of the passive pressure.

7.1.8 A braced excavation is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the vertical members are embedded and from the structural capacity of the bracing members.

7.1.9 For purposes of these specifications, the vertical members of the braced excavation system include steel sheet piling or soldier beams comprised of steel H-piles, wide flange sections, or other fabricated sections that are driven or installed in drilled holes. Wales are horizontal structural members designed to transfer lateral loads from the vertical members to the struts. Struts are structural compression members that support the lateral loads from the wales.

7.1.10 A cofferdam is an enclosed temporary structure used to keep water and soil out of an excavation for a permanent structure such as a bridge pier or abutment or similar structure. Cofferdams may be constructed of timber, steel, concrete or a combination of these. These specifications consider cofferdams primarily constructed with steel sheet piles.

7.2 Variance to use other shoring systems such as shoring box requires KCSRC Chief Engineer’s review and approval. A shoring box is a prefabricated shoring system, which
is installed as the excavation progresses. Soil is typically removed from the inside of the shoring box. The shoring box is moved down into the excavation by gravity or by applying vertical loading from excavation equipment. This shoring system is not preferred by KCSRC. The system is allowed in special applications only where Railroad live load surcharge is not present.

8. Computation of Applied Forces

The following variables are used in the following section:

\[ q = \text{intensity of strip load (Live load) (in units of pounds per square foot)} \]

\[ q = \frac{80,000 \text{ lbs}}{(5 \text{ feet})(8.5 \text{ feet})} \]

Axle spacing = 5 feet

Typical tie length = 8.5 feet

\[ \gamma = \text{unit weight of soil} \]

\[ K_A = \tan^2 \left( 45 - \frac{\phi}{2} \right) \]

\[ K_P = \tan^2 \left( 45 + \frac{\phi}{2} \right) \]

\[ \phi = \text{angle of internal friction in degrees} \]

\[ \alpha \text{ and } \beta \text{ are angles measured in radians} \]

8.1 Live load pressure due to E80 loading for track parallel to shoring system.
Strip Load q (AREMA 8.20.3.2.2).

A continuous strip of surcharge load q (pounds per square foot) parallel to the bulkhead is shown in AREMA Figure 8-20-2 "Pressure Distribution for Strip Load" (See Appendix B). The intensity of pressure at a given point may be computed by:

\[ P_s = \frac{2q}{\pi} \left( \beta + \sin \beta \sin^2 \alpha - \sin \beta \cos^2 \alpha \right) \]

Chart A provided in Appendix B shows the results of this equation for E80 live load. Overlapping surcharge live loads from the adjacent tracks are not cumulative.

8.2 Live load pressure due to E80 loading for tracks at right angle to the shoring system use the following equation to determine the applied loading:
The entire load shall be taken as distributed uniformly on the surface of the ballast immediately below the tie, over a width equal to the length of the tie, typically 8.5 feet).

8.3 Active Earth Pressure Due to Weight of Backfill:

8.3.1 The active earth pressure due to the weight of the backfill may be computed by the Coulomb Theory and is represented in the loading diagram by Area 1, AREMA Figure 8-20-1 "Lateral Pressure Diagrams" (see Appendix B).

8.3.2 The active earth pressure at depth “z” is:

\[ p_\alpha = K_\gamma \gamma z \]

\( z = \) depth of soil influencing the passive pressure

8.4 Active Earth Pressure Due to Unbalanced Water Pressure (AREMA 8.20.3.3)

8.4.1 When bulkheads are used for waterfront construction, the bulkhead is subjected to a maximum earth pressure at the low water stage. During a rainstorm or a rapidly receding high water, the water level behind the bulkhead may be several feet higher than in front, as shown in AREMA Figure 8-20-5. The unbalanced water pressure is represented by Area III in AREMA Figure 8-20-1 (see Appendix B).

8.4.2 Drained conditions in backfill apply when clean sand or clean sand and gravel, as defined in AREMA Article 20.2.5 are used and adequate permanent drainage outlets are provided. Where drained conditions exist, the design water level may be assumed at the drainage outlet elevation.

8.5 Active Earth Pressure Due to Surcharge Load

The active earth pressure due to a uniform surcharge load \( q \) (pounds per square foot) is:

\[ p_u = K_\lambda q \]

which is represented by Area II, AREMA Figure 8-20-1 (see Appendix B)

8.6 Passive Earth Pressure

The passive earth pressure, \( p_\rho \), in front of the bulkhead may also be computed by the Coulomb Theory. This pressure is also shown in AREMA Figure 8-20-1 (see Appendix B)

\[ p_\rho = K_\rho \gamma z \]

\( z = \) vertical distance not to exceed embedment depth.

8.7 Include and compute other loading that is impacting the shoring system.
9. **Structural Integrity**

Structures and structural members shall be designed to have design strengths at all sections at least equal to the required strengths calculated for the factored loads and forces in such combinations as stipulated in AREMA Chapter 8, Article 2.2.4, which represents various combinations of loads and forces to which a structure may be subjected. Each part of the structure shall be proportioned for the group loads that are applicable, and the maximum design required shall be used.

9.1 Stability (AREMA 8.20.4)

The stability requirements of AREMA 8.20.4 shall be met and shown in the submitted calculations. For well-defined loading conditions and thoroughly determined soil parameters, the minimum factor of safety is 1.3 (AREMA 8.20.4.1). Geotechnical investigations shall consider global stability and massive earth movements as shown in AREMA Figure 8-20-6.

9.2 Depth of Embedment

The total depth of embedment is equal to 1.3 times the minimum calculated depth of embedment. (AREMA 8.20.5.1).

9.3 The allowable stresses based on AREMA requirements are as follows:

9.3.1 Sheet Pile Sections – 2/3 Tensile Yield Strength for Steel (AREMA 8.20.5.7)

9.3.2 Concrete – 1/3 Compressive Strength (AREMA 8.20.5.7)

9.3.3 Structural Steel – 0.55 $F_y$ Compression in extreme fiber (AREMA Ch. 15, Table 15-1-11, page 15-1-36, 2004 Edition)

9.3.4 Anchor Rods – 1/2 Tensile yield strength for steel (AREMA 8.20.5.7)

9.4 AISC allowances for overstressing due to temporary loading conditions are not acceptable.

9.5 Proposed deflections of temporary shoring system and top of rail elevation shall not exceed the following criteria in Table 1 below:

<table>
<thead>
<tr>
<th>HORIZONTAL DISTANCE FROM SHORING TO TRACK CL</th>
<th>MAXIMUM HORIZONTAL MOVEMENT OF SHORING SYSTEM</th>
<th>MAXIMUM ACCEPTABLE HORIZONTAL OR VERTICAL MOVEMENT OF RAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>12’ &lt; X &lt; 18’</td>
<td>3/8”</td>
<td>3/16”</td>
</tr>
<tr>
<td>18’ &lt; X &lt; 24’</td>
<td>1/2”</td>
<td>1/4”</td>
</tr>
</tbody>
</table>

10. **Soil Characteristics**

10.1 Subsurface Exploration (AREMA 8.5.2.2)
10.1.1 Sufficient borings shall be made along the length of the structure to determine, with a reasonable degree of certainty, the subsurface conditions. Irregularities found during the initial soil boring program may dictate that additional borings be taken.

10.1.2 The subsurface investigation shall be made in accordance with the provisions of AREMA Chapter 8, Part 22, Geotechnical Sub-surface Investigation.

10.2 Type of Backfill (AREMA 8.5.2.5)

10.2.1 Backfill is defined as all material behind the wall, whether undisturbed ground or fill, that contributes to the pressure against the wall.

10.2.2 The backfill shall be investigated and classified with reference to the soil types described in Table 8-5-1.

10.2.3 Types 4 and 5 backfill shall be used only with the permission of the Engineer. In all cases the wall design shall be based on the type of backfill used.

AREMA Table 8-5-1. Types of Backfill for Retaining Walls

<table>
<thead>
<tr>
<th>BACKFILL TYPE</th>
<th>BACKFILL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coarse-grained soil without admixture of fine soil particles, very free-draining (clean sand, gravel or broken stone).</td>
</tr>
<tr>
<td>2</td>
<td>Coarse-grained soil of low permeability due to admixture of particles of silt size.</td>
</tr>
<tr>
<td>3</td>
<td>Fine silty sand; granular materials with conspicuous clay content; or residual soil with stones</td>
</tr>
<tr>
<td>4</td>
<td>Soft or very soft clay, organic silt; or soft silty clay.</td>
</tr>
<tr>
<td>5</td>
<td>Medium or stiff clay that may be placed in such a way that a negligible amount of water will enter the spaces between the chunks during floods or heavy rains</td>
</tr>
</tbody>
</table>

10.3 Computation of Backfill Pressure (AREMA 8.5.3.2.a)

10.3.1 Values of the unit weight, cohesion, and angle of internal friction of the backfill material shall be determined directly by means of soil tests or, if the expense of such tests is not justifiable, by means of Table 8-5-2 referring to the soil types defined in Table 8-5-1. Unless the minimum cohesive strength of the backfill material can be evaluated reliably, the cohesion shall be neglected and only the internal friction considered. (See Part 20, Flexible Sheet Pile Bulkheads, Table 8-20-3).
### AREMA Table 8-5-2 Properties of Backfill Materials

<table>
<thead>
<tr>
<th>TYPE OF BACKFILL</th>
<th>UNIT WEIGHT LBS. PER CU. FT.</th>
<th>COHESION &quot;C&quot;</th>
<th>ANGLE OF INTERNAL FRICTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>105</td>
<td>0</td>
<td>33° 42' (38° for broken stone)</td>
</tr>
<tr>
<td>2</td>
<td>110</td>
<td>0</td>
<td>30°</td>
</tr>
<tr>
<td>3</td>
<td>125</td>
<td>0</td>
<td>28°</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>0</td>
<td>0°</td>
</tr>
<tr>
<td>5</td>
<td>120</td>
<td>240</td>
<td>0°</td>
</tr>
</tbody>
</table>

Loads exclusive of Earth Pressure (AREMA 8.5.3.1)

10.3.2 In the analysis of piers, retaining walls and abutments, due account shall be taken of all superimposed loads carried directly on them, such as building walls, columns, or bridge structures; and of all loads from surcharges caused by railroad tracks, highways, building foundations, or other loads supported on the backfill. Piers must also be designed for stream flow pressures as well as ice flow pressures and collision forces where applicable.

10.3.3 In calculating the surcharge due to track loading on an abutment and on wing walls that are in line with the abutment back walls, the entire load shall be taken as distributed uniformly on the surface of the ballast immediately below the tie, over a width equal to the length of the tie. With increased depth, the width for distribution can be increased on slopes of 1 horizontal to 2 vertical with surcharge loads from the adjacent tracks not being permitted to overlap.

10.3.4 To account for variability in backfilling and the dynamic effects of axle loads, abutment back walls above bridge seats shall be designed for earth pressures and live load surcharge increased by 100%. This does not apply to the portion of the abutment below the bridge seat or the stability of the abutment.

10.3.5 In calculating the surcharge due to track loading above a wall and parallel, or roughly parallel, to the wall, the entire load shall be taken as distributed uniformly over a width equal to the length of the tie.

10.3.6 The stability of the abutment or wall as a whole unit, regardless of the distribution of the loads and surcharges, shall always be checked and shall conform to the requirement of AREMA Section 8.5.4, Stability Computation.

10.3.7 Live Load impact shall not be considered in the design of an abutment or pier unless the bridge bearings are supported by a structural beam, such as the seat of a spill-through abutment or a pier cap supported by individual columns, piles or shafts. In such a case, the impact shall be applied to the beam only, and not to footings or piles.

### 11. Shoring Design

Shoring design shall conform to AREMA Section 8.28.5
12. Submittals

Submittals for design and construction of shoring projects shall be coordinated and submitted through the Manager of Contracts. To expedite reviews, submittals must be complete, clearly explained and orderly. Design review for shoring shall be reviewed by the Director of Engineering in the office of the Chief Engineer and/or through an outside consultant at the expense of the owner. Prior to any review, Manager of Contracts shall receive authorization from the agency agreeing to pay all review costs for the design and construction phases of the project. Once such an agreement is established, Manager of Contracts shall request and secure a proposal from an outside consultant to cover review expenses. Review expenses shall include all costs for in-house personnel and/or consultants retained by the Railroad. This estimated cost of Plan Review and the construction monitoring phase of the project shall be provided to the submitting agency for review and approval. Once the Manager of Contracts has received the submitting agency’s written acceptance of the estimated cost, the review of plans can begin. If, during the review process, the estimated costs are determined to be insufficient to cover said costs, the owner will be advised. The original estimated costs will not be the upper limit of the costs, but will provide a guideline for budgeting purposes. Regardless, all reasonable costs incurred during the plan review process and construction monitoring phase of the work will be fully recoverable from the agency.

12.1. Two (2) sets of plans and two (2) sets of the calculations shall be submitted to the Manager of Contracts. Drawings and calculations for excavations which encroach into railroad live load surcharge Zone “A” (see General Shoring Requirements Sheet S1.0) shall be sealed by a registered professional engineer in the applicable state. Allow two (2) weeks for in-house review by the Director of Engineering. The Manager of Contracts will then forward the plans along with KCSRC comments to the outside consultant for review. Allow three (3) additional weeks for review by the outside consultant.
Appendix A

Shoring Design Checklist
# Appendix A

## Shoring Design Checklist

The checklist is intended to act as a reminder to design or check for specific important aspects of the shoring system. It is not a substitute for plan and/or design criteria or specification requirements.

**Instructions:**
Respond to every question on the checklist. Submit the checklist with the design plans and calculations to KCSRC. Attach to the checklist detailed explanation of any negative response.

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are the steps for method of installation and removal of shoring system given?</td>
<td></td>
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<tr>
<td>2. Are the shoring design plans and calculations prepared by, stamped, and signed by an engineer registered to practice engineering in the jurisdiction in which the project is being constructed?</td>
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<tr>
<td>3. Are shoring plans in compliance with the requirements of the construction plans, project specifications and general notes?</td>
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<tr>
<td>4. Are all existing, adjusted or new utilities in proximity with the proposed shoring shown on the shoring plans and is protection of these utilities addressed?</td>
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<tr>
<td>5. Are minimum construction clearance requirements of 12 feet horizontal at right angle to centerline of track and 21 feet vertical from top of rail satisfied and shown on the shoring plans?</td>
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<tr>
<td>6. Has E80 loading been used to design the shoring system?</td>
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<tr>
<td>7. Has the pressure of E80 live load from continuous strip of surcharge load q (psf) parallel to shoring been computed using the equation shown below?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[ P_S = \frac{2q}{\pi} \left( \beta + \sin \beta \sin^2 \alpha - \sin \beta \cos^2 \alpha \right) ] where q = 80,000 lbs [(5 \text{ feet}) (8.5 \text{ feet}) ]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Are the magnitude and location of all loads incorporated into the design plans and calculations?</td>
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</tr>
<tr>
<td>9. Are the material properties used to determine design stresses for each different shoring member shown on the shoring plans?</td>
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<tr>
<td>10. Are all components of shoring system designed per AREMA and KCSRC requirements?</td>
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<tr>
<td>11. Are the allowable stress and the calculated stress listed in the summary for each different shoring member?</td>
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<tr>
<td>12. If &quot;finished&quot; lumber is specified for shoring by the shoring designer, are the actual lumber dimensions used in calculation shown?</td>
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</tr>
<tr>
<td>13. Have ground water elevation and seepage into the excavation been addressed?</td>
<td></td>
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</tr>
<tr>
<td>14. Are steel structural shapes and plates identified by ASTM specification number on the shoring plan and in the calculations?</td>
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</tr>
<tr>
<td>15. Have steel beams been checked for bending, shear, web crippling and buckling of the compression flange and any other potential failure mode?</td>
<td></td>
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</tr>
<tr>
<td>16. Has buckling been evaluated for all compression members?</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>17. Has bracing been provided at all points of assumed support for compression members?</td>
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<tr>
<td>18. Are bracing strength and stiffness sufficient for the intended purpose?</td>
<td></td>
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</tr>
<tr>
<td>19. Has the deflection of the shoring system been calculated and found to meet the</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
20. Do the shoring plans indicate the Contractor will monitor top-of-rail elevation and track alignment?

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Have seismic concerns been considered and addressed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Are all construction components clearly shown on the plans?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Do the drawings show all controlling dimensions and elevations of shoring system?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. If second-hand material will be utilized, is the inspection report included?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Are protective fencing height and limits shown on the plans? If a fence is not practical, is an alternative closure system provided?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Do the plans and specifications identify the backfill material and the compaction requirements?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Are two (2) copies of the shoring design plans and two (2) copies of the complete design calculations included in the submittal package to KCSRC?</td>
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<tr>
<td>28. For excavations in Zone “A”, are drawings and calculations sealed by a registered professional engineer?</td>
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Section V

Drawings and AREMA Exhibits
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## Chart A

Boussinesq Surcharge Pressure Due to E80 Live Load (psf) For Shoring Parallel to the Track

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<thead>
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<th>Depth (y) Below Base of Rail (ft.)</th>
<th>Distance (x) from Track Side of Shoring System to Track Centerline (ft)</th>
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<tr>
<td>12</td>
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<td>41</td>
<td>82 92 101 110 118 126 133 139 145 150 155 159 162 165 167 168 169 170</td>
</tr>
</tbody>
</table>

Notes:
1. This chart assumes the top of shoring elevation is equal to the base of rail elevation. Additional surcharge due to the earth load above top of shoring must be added if this is not the case.
2. Use the Boussinesq equation to calculate pressures past 29 ft. or deeper than 30 ft. (see Section IV, item 8.1)
3. No shoring is allowed within 12'-0" of track centerline.
AREMA Figure 8-20-1 - Lateral Pressure Diagrams

(a) In Sand

Layer 1 Sand Backfill, $K_a$

Layer 2 Clean Sand, $K_{a2}$

Layer 3 Sand, $K_{a3}$

(b) In Clay (Parts Not Shown Same as Above)

Layer 1 Sand

Layer 2 Clay, $q_{u2}$

Layer 3 Clay, $q_{u3}$

Water

Mud Line
AREMA Figure 8-20-2 - Pressure Distribution for Strip Load

AREMA Figure 8-20-3 - Pressure Distribution for Line Load
STEEL DECK PLATE GIRDERS WITH CONCRETE DECK

REVISIONS

THE KANSAS CITY SOUTHERN RY. CO.

STEEL DECK PLATE GIRDER SPAN
WITH CONCRETE DECK

DRAWN BY       DATE       VAL. SEC.       SHEET NO.
RGI           1/27/05       1           1
CHECKED BY   SCALE       FILE       DRAWING NO.
NTS          005082

NO SCALE
REVISIONS

EXHIBIT A
THE KANSAS CITY SOUTHERN RY. CO.

STEEL BEAMS WITH CONCRETE DECK
NO SCALE

STEEL BEAM SPAN
WITH CONCRETE DECK

DRW. DATE
RGI 1/27/05

CHECKED BY
FILE

DIA. NO.
005083
PRECAST CONCRETE BOX GIRDER SPAN WITH OR WITHOUT CONCRETE DECK

* CONCRETE DECK IS OPTIONAL

THE KANSAS CITY SOUTHERN RY. CO.

PRE-STRESSED PRE-CAST CONCRETE BOX GIRDER SPAN WITH OR WITHOUT CONCRETE DECK

REVISIONS

005084

DRAWN BY: RG1
DATE: 1/27/05
VAL. SEC.: NTS
FILE: NTS
DRAWING NO.: 1
PRECAST CONCRETE BEAMS WITH CAST IN PLACE CONCRETE DECK

PRE-STRESSED PRE-CAST AASHTO- TYPE BEAM SPAN WITH CONCRETE DECK
CONVENTIONAL REINFORCED CONCRETE BOX GIRDER

CAST-IN PLACE CONCRETE BOX GIRDER SPAN CONVENTIONAL REINFORCED
POST-TENSIONED CONCRETE BOX GIRDERS

CAST-IN PLACE POST-TENSIONED CONCRETE BOX GIRDER SPAN
STEEL THROUGH PLATE GIRDERS WITH CONCRETE DECK

STANDARD AREA CLEARANCE ENVELOPE

CENTER LINE OF EXIST. TRACK

20'-0" MIN.

NOTE:
9'-0" MIN. (TANGENT TRACK)
FOR CURVE TRACK REFER TO AREMA

CENTER LINE OF ACCESS ROAD

SLOPE
1:2.8 PREFERRED
1:3 MAX.

CENTER LINE OF EXIST. OR
FUTURE TRACK

6'-0" MIN.

8" MIN. BALLAST
UNDER TIMBER TIE OR
12" MIN. BALLAST
UNDER CONCRETE TIE

DRAIN PIPE (TYP.)

CONCRETE DECK

SEPARATE MAINTENANCE OF WAY ROADWAY STRUCTURE

CHECKERED PLATE WALKWAY

STEEL FLOOR BEAM

DIAPHRAGM

STEEL THROUGH PLATE GIRDER

GUARD RAIL

A.C. PAVEMENT

1% SLOPE

5'-0"

SEPARATION

TOP OF RAIL

6'-6"

6'-0"

2'-6"

VARIIES

MIN.

2'-0"

MIN.

WATERPROOFING
(BUTYL MEMBRANE OR EPDM AND TWO LAYERS OF ASPHALTIC PROTECTIVE PANELS)

KNEE BRACE

SLOPE 2%

STIFF.

CONC. CURB

WATERPROOFING

1'-0"

11/2" MAX.

CHECKERED PLATE WALKWAY

SUPPORT WALKWAY ON KNEE BRACE OR STIFF.

DETAIL A

EXHIBIT A
THE KANSAS CITY SOUTHERN RY. CO.

STEEL THROUGH PLATE GIRDER SPAN WITH CONCRETE DECK

REVISIONS

DRArawn BY
RG1
1/27/05

CHECKED BY

DRAWING NO.
005088
STEEL THROUGH PLATE GIRDERS WITH STEEL DECK

*NOTE:
9'-0" MIN. (TANGENT TRACK)
FOR CURVE TRACK REFER TO AREMA

STANDARD AREA CLEARANCE ENVELOPE
CENTER LINE OF EXIST. TRACK
20'-0" MIN.

6'-6" MIN.
TOP OF RAIL

6'-0"

8" MIN. BALLAST UNDER TIMBER TIE OR 12" MIN. BALLAST UNDER CONCRETE TIE
DRAIN PIPE (TYP.)

CENTER LINE OF EXIST. OR FUTURE TRACK

CENTER LINE OF ACCESS ROAD

6'-0" MIN.

5'-0"
1'-0"

SLOPE
1:2.8 PREFERRED
1:3 MAX.
SEE DETAIL A

SEPARATE MAINTENANCE OF WAY ROADWAY STRUCTURE

GUARD RAIL

A.C. PAVEMENT

CHECKERED PLATE WALKWAY

STEEL DECK
STEEL FLOOR BEAM
DIAPRAGM
STEEL THROUGH PLATE GIRDER

WATERPROOFING
(BUTYL MEMBRANE OR EPDM AND TWO LAYERS OF ASPHALTIC PROTECTIVE PANELS)

KNEE BRACE

SLOPE 2%

STIFF.

CONC. CURB

SUPPORT WALKWAY ON KNEE BRACE OR STIFF.

DETAIL A

REVISIONS
THE KANSAS CITY SOUTHERN RY. CO.

STEEL THROUGH PLATE GIRDER SPAN WITH STEEL DECK

EXHIBIT A

DRAWN BY   DATE   VAL. SEC.   SHEET NO.
RGT   1/27/05   NTS   1

CHECKED BY   SCALE   FILE   DRAWING NO.

005089
PROCEDURE FOR GROUTING BETWEEN GIRDERS
(EPOXY GROUT)

1. BEFORE SETTING GIRDERS, THOROUGHLY WIRE BRUSH THE
   ENTIRE CONTACT SURFACES OF EACH GIRDER.

2. INSTALL 2 LAYERS OF 3" X 4" FLEXIBLE SEALING STRIPS
   (POLY-URETHANE-ETHER TYPE DENSITY 1.5) AT THE BOTTOM
   OF THE GAP AND AROUND TIE ROD HOLES AND ENDS OF
   GIRDERS TO PREVENT GROUT LEAKAGE. THE MAXIMUM GAP BETWEEN
   GIRDERS SHOULD BE 3/4".

3. INSTALL TIE RODS AND TENSION 50%.

4. PLACE 4" SAND ON TOP OF SEALING STRIPS
   TO PROTECT SEALING STRIPS FROM EPOXY HEAT.

5. FILL THE GAP WITH DRY CLEAN PEA GRAVEL (1/2" MAXIMUM SIZE).
   IN COLD WEATHER, HEAT THE PEA GRAVEL.

6. POUR EPOXY GROUT TO FILL ALL voids IN GAP.
   THIS MAY TAKE 2 TO 3 SUCCESSIVE POURINGS.

7. TENSION TIE RODS 100%.

PROCEDURE FOR GROUTING BETWEEN GIRDERS
(NON SHRINK CEMENTITIOUS FLOWABLE GROUT)

1. BEFORE SETTING GIRDERS, THOROUGHLY WIRE BRUSH THE
   ENTIRE CONTACT SURFACES OF EACH GIRDER.

2. INSTALL 2 LAYERS OF 3" X 4" FLEXIBLE SEALING STRIPS
   (POLY-URETHANE-ETHER TYPE DENSITY 1.5) AT THE BOTTOM
   OF THE GAP AND AROUND TIE ROD HOLES AND ENDS OF
   GIRDERS TO PREVENT GROUT LEAKAGE. THE MAXIMUM GAP BETWEEN
   GIRDERS SHOULD BE 3/4".

3. INSTALL TIE RODS AND TENSION 50%.

4. PLACE FLOWABLE NON SHRINK CEMENTITIOUS GROUT BETWEEN GIRDERS.
   (GROUT TO BE MIXED TO A POURABLE CONSISTENCY.
   THE MATERIAL SHALL BE MIXED TO A COMBINATION BETWEEN FLOWABLE
   AND FLUID SO AS NOT TO FORM AIR POCKETS BETWEEN GIRDERS
   WHILE BEING Poured).

5. AFTER GROUT HAS REACHED A COMPRESSIVE STRENGTH OF 3000 P.S.I.,
   TENSION TIE RODS 100%.

MULTIPLE PRESTRESSED
CONCRETE GIRDER BONDING DETAIL
NO SCALE

REVISIONS

EXHIBIT A
THE KANSAS CITY SOUTHERN RY. CO.

BONDING DETAILS FOR
MULTIPLE PRE-STRESSED
PRE-CAST
CONCRETE GIRders
**Notes:**

1. Railing assembly except chain link fabric to be galvanized after fabrication.
2. Posts shall be vertical.
3. Provide hardware and details for attachments to cable, posts, and top railing.
4. Provide splice and expansion joint details.
POST ANCHORAGE DETAIL
NO SCALE

NOTES:
1. GALVANIZE RAIL ASSEMBLY AFTER FABRICATION.
2. POSTS SHALL BE VERTICAL.
3. PROVIDE RAILING CONNECTION DETAILS.
4. PROVIDE SPICE AND EXPANSION JOINT DETAILS.
NOTES:

1. GALVANIZE RAIL ASSEMBLY AFTER FABRICATION.
2. POSTS SHALL BE VERTICAL.
3. PROVIDE RAILING CONNECTION DETAILS.
4. PROVIDE SPLICE AND EXPANSION JOINT DETAILS.
NOTES:
1. ALL STRUCTURAL STEEL PLATES, BOLTS AND WASHERS SHALL BE GALVANIZED.
2. DISCONTINUE FLASHING OVER PIERS AND ABUTMENTS.

SEALANT
CONCRETE CURB
INSERT ASSEMBLY FOR 5/8" DIA. x 2" A-325 BOLT

BALLAST
TWO LAYERS OF PROTECTIVE ASPHALTIC PANELS, 3/4" TOTAL THICKNESS MINIMUM

CONCRETE CURB
SEALANT
INSERT ASSEMBLY FOR 5/8" DIA. x 2" A-325 BOLT

BUTYL RUBBER MEMBRANE OR EPDM 0.06" MINIMUM THICKNESS

CONCRETE DECK

ALTERNATIVE 1
NO SCALE

ALTERNATIVE 2
NO SCALE

EXHIBIT A
THE KANSAS CITY SOUTHERN RY. CO.

FLASHING DETAILS FOR WATER-PROOFING
**EXHIBIT A**

**THE KANSAS CITY SOUTHERN RY. CO.**

**COLLISION IMPACT DEVICES AND SACRIFICIAL BEAM**

---

**PLAN**

- Sacrificial Beam
- Pier
- Roadway
- Abutment
- Travel lanes
- Track

**ELEVATION**

- Sacrificial Beam
- Pier Cap
- Roadway
- Abutment
- Top of Rail

**SECTION A-A**

- Exterior Girder
- 1" x 6" Redwood Plank
- Fasten Protection Angle to Girder using 3/4" Dia. Bolts w/Lock Washer
- 6" x 6" x 3/4" Protection Angle (Galv.)

**SECTION A-A** (at vertical faced girder)

- Exterior Girder
- 1" x 6" Redwood Plank
- Fasten Protection Angle to Girder using 3/4" Dia. Bolts w/Lock Washer
- 6" x 6" x 3/4" Protection Angle (Galv.)

**LAYOUT OF COLLISION IMPACT DEVICES & SACRIFICIAL BEAM**

*Min. Vertical Clearance Refer to Text*

---

**DETAIL B**

- Protective Angle (Galv.)
- Slotted Holes
- 3/8" Support Bar (Galv.)
GENERAL ARRANGEMENT

NOTES:
INSIDE GUARD RAILS SHALL BE MADE FROM SECOND HAND RAIL AND MAY BE OF THE SAME RAIL SECTION AS THE RUNNING RAILS BUT MUST NOT BE MORE THAN 23 LBS. LIGHTER THAN THE RUNNING RAILS.

NO INSIDE GUARD RAIL LIGHTER THAN 70 LBS. SHALL BE USED.

INSIDE GUARD RAILS ARE TO BE FULLY TIED PLATED WITH SECOND HAND TIE PLATES, WHERE CLEARANCES PREVENT THE USE OF TIE PLATES. HOOK TWIN PLATES CAN BE USED IN GUARD RAIL CONVERGENCE AREA.

MINIMUM CLEARANCE BETWEEN THE RUNNING RAIL PLATES AND THE GUARD RAIL PLATES MUST NOT BE LESS THAN 1".

INSTALL GUARD RAIL PLATES SO AS TO CANT THE GUARD RAIL OUTWARD TOWARD THE RUNNING RAIL. WHEN SINGLE SHOULDER FLAT GUARD RAIL PLATES ARE USED, INSTALL THE PLATES WITH THE SHOULDERS ON THE INSIDE TOWARD THE CENTER OF THE TRACK.

INSIDE GUARD RAILS TO BE SPIKED TO THEIR FULL LENGTH WITH 2 SPIKES PER TIE, WHERE NECESSARY, PARTICULARLY ON CURVES. DOUBLE SPIKE GUARD RAIL BOTH INSIDE AND OUT.

ALL GUARD RAIL JOINTS TO BE FULLY BOLTED AND WHEN AVAILABLE, SECOND HAND JOINTS SHOULD BE USED.

GUARD RAIL TO BE LAYED WITH FULL RAIL (NO JOINTS) IN THE CURVED POSITION.

GRADE SEPARATION SUPPORTING MEMBER REFERS TO POSTS, COLUMNS, BEAMS, PIERS, ABUTMENTS, ETC. SUPPORTING BRIDGES, VIADUCTS, ETC. OVER OR ADJACENT TO THE TRACK.

INSTALLATION

GRADE SEPARATION STRUCTURES:
DOUBLE INSIDE GUARD RAILS ARE TO BE INSTALLED ON ALL F.R.A. CLASS 4 AND 5 TRACK WHERE HORIZONTAL CLEARANCES ON BOTH SIDES ARE LESS THAN 18 FEET FROM THE CENTERLINE OF TRACK TO A SUPPORTING MEMBER. CLASS 2 CARRYING MORE THAN 20 M.G.T. TRAFFIC AND ALL CLASS 3 TRACK SHALL HAVE DOUBLE INSIDE GUARD RAILS INSTALLED WHERE HORIZONTAL CLEARANCE ON BOTH SIDES IS LESS THAN 12' - 6" FROM THE CENTERLINE OF TRACK TO A STRUCTURE SUPPORTING MEMBER.

BRIDGES LOCATED ON CLASS 3, 4, AND 5 TRACK, ALONG WITH BRIDGES LOCATED ON CLASS 2 TRACK WITH OVER 20 M.G.T.

DOUBLE INSIDE GUARD RAILS ARE TO BE INSTALLED ON:
ALL THROUGH OR DECK TRUSSES AND THROUGH PLATE GIRDER SPANS;
ALL BRIDGES THAT ARE 40 FEET OR HIGHER AND 150 FEET IN LENGTH, AND ON ALL BRIDGES 30 FEET OR MORE IN LENGTH WHERE CURVATURE EXCEEDS 5 DEGREES; UNLESS EXCEPTION IS APPROVED BY CHIEF ENGINEER.
LONGITUDINAL SUPPORT TIMBERS (TYP.) (SEE NOTES)

TRIVIRA SPUNBOUND 
#45 GEOTEXTILE EACH SIDE OF TRACK 
(OR APPROVED EQUAL)

5'-0" MIN. 5'-0" MIN.

TRACK SHIELD (SEE NOTES)

TRICK TRACK

BALLAST (SEE NOTES)

BLOCKING DETAIL

TRACK SHIELD DETAIL
FOR DEBRIS FALLING FROM BRIDGE DECK REMOVAL 
(WHEN TRACK TIME WINDOW IS AVAILABLE)

NOTES:

1. A FLAGMAN IS REQUIRED AT ALL TIMES DURING THE USE OF A TRACK SHIELD.

2. THE TRACK SHIELD SHALL BE DESIGNED BY THE CONTRACTOR AND SHALL BE OF SUFFICIENT STRENGTH TO SUPPORT THE ANTICIPATED LOADS, INCLUDING IMPACT. THE SHIELD SHALL PREVENT ANY MATERIALS, EQUIPMENT OR DEBRIS FROM FALLING ONTO THE RAILROAD TRACK. ADDITIONAL LAYERS OF MATERIAL SHALL BE FURNISHED AS NECESSARY TO PREVENT FINE MATERIALS OR DEBRIS FROM SIFTING DOWN UPON THE TRACK.

3. THE SHIELD SHOULD PREFERABLY BE PREFABRICATED AND FURNISHED WITH LIFTING HOOKS TO SIMPLIFY REMOVAL.

4. THE SHIELD SHALL BE OF SUFFICIENT STRENGTH TO SPAN BETWEEN IT'S SUPPORT WITHOUT BEARING UPON THE RAILS AND TO WITHSTAND DROPPING RUBBLE.

5. BEFORE REMOVAL, THE SHIELD SHALL BE CLEANED OF ALL DEBRIS AND FINE MATERIAL.

6. THE TRACK SHIELD SHALL EXTEND AT LEAST 20 FEET BEYOND THE LIMITS OF DEMOLITION TRANSVERSE TO THE EDGE OF THE BRIDGE.

7. LONGITUDINAL SUPPORT TIMBERS FOR THE SHIELD SHALL NOT EXTEND ABOVE THE TOP OF RAIL. WHEN THE SHIELD IS REMOVED, BLOCKING FROM THE TOP OF RAIL TO THE BOTTOM OF THE SHIELD MAY BE ATTACHED TO THE SHIELD. REMAINING TIMBERS SHALL BE ANCHORED.

8. FOR TRAIN PASSAGE, THE RUBBLE SHALL BE REMOVED TO A MINIMUM OF 8'-6" FROM THE NEAREST RAIL AND TO AN ELEVATION NO HIGHER THAN THE TOP OF RAIL.

9. AT THE END OF THE DAY, THE RUBBLE SHALL BE REMOVED COMPLETELY TO A MINIMUM OF 10'-0" FROM THE NEAREST RAIL AND DOWN TO ORIGINAL GRADE.

10. CARE SHALL BE TAKEN TO NOT PLACE METAL ACROSS THE TRACK RAILS. RAILROAD COMMUNICATIONS ARE SENT THROUGH THE RAILS AND WILL BE DISRUPTED BY A SHORT BETWEEN RAILS.

11. DETAILS SHOWN APPLY FOR TIMBER TIES. SPECIAL DETAILS ARE REQUIRED FOR CONCRETE TIES.
1. The standard limits of protection noted are the min. clearances allowed without special permission from the railroad. The reduced clearances noted may be allowed by the railroad. Special permission for the reduced clearances is required from the railroad service unit superintendent.

2. The protection frame shall, as a minimum, match the demolition limits shown and extend past the bridge width as shown on the attached demolition sheet.

3. For additional clearance and protection information see standard drawing No. 005104.

4. The protection frame shall prevent demolition debris, dust and fine material from falling onto the railroad tracks, access roads or trains. The frame shall be designed by the contractor to support the anticipated demolition loads and in accordance with AREMA guidelines for design of falsework for structures over the railroad.

5. Debris protection is required near the base of the side slopes and adjacent to roads used by demolition equipment to prevent debris from rolling onto the track. Access road or ditch, use timbers as required to stop large pieces of rolling debris.

6. Any activity within 25 feet of the nearest rail of a track requires a flagman.

EXHIBIT A
THE KANSAS CITY SOUTHERN RY. CO.

FRAME PROTECTION DETAILS
NOTES:
1. SEE GENERAL NOTES ON BRIDGE ELEVATION SHEET.
2. STANDARD LIMITS OF PROTECTION ARE SHOWN FOR MINIMUM LIMITS OF PROTECTION DIMENSIONS. SEE BRIDGE ELEVATION, MINIMUM LIMITS OF PROTECTION.

BRIDGE ELEVATION
STANDARD LIMITS OF PROTECTION FOR FRAME PROTECTION
* IF NO ACCESS ROAD, USE MIN. DIMENSION FROM OTHER SIDE OF DETAIL.

LIMITS OF PROTECTION (TYP.)
TOP OF RAIL
EXTEND TO GRADE (TYP.)

BRIDGE DECK CROSS SECTION
STANDARD LIMITS OF PROTECTION
GENERAL

FENCE SHALL BE PROVIDED AS INDICATED ON THE CROSS
SECTIONS AND ELEVATION VIEW ON BOTH SIDES OF THE
VIADUCT IN ALL NEW OR MODIFIED STRUCTURES.

SPLASHBOARDS OR SOLID 3'-6" HIGH BARRIER RAIL
SHALL BE PROVIDED AS INDICATED ON THE CROSS
SECTIONS AND ELEVATION VIEW ON BOTH SIDES OF THE
VIADUCT IN ALL NEW OR MODIFIED STRUCTURES WHERE
SNOW REMOVAL IS BEING PERFORMED.

LIGHTS ARE TO BE INSTALLED ON THE UNDERSIDE OF
THE VIADUCT WHERE SHADOWS CAST BY THE STRUCTURE
WOULD INTERFERE WITH RAILROAD OPERATIONS.

SLOPE PAVING SHALL BE PROVIDED WHERE END SLOPES
EQUAL TO, OR EXCEED, 2 HORIZONTAL TO 1 VERTICAL.

FALSEWORK FOR CONSTRUCTION OF OVERHEAD STRUCTURES
SHALL COMPLY TO AREMA CHAPTER 8, PART 2.1.6.

DEMOLITION OF EXISTING OVERHEAD STRUCTURES SHALL
COMPLY TO KCSR SHORING GUIDELINES.

TEMPORARY SHORING SHALL BE DESIGNED IN ACCORDANCE
WITH KCSR SHORING REQUIREMENTS.

APPLICANT SHALL BE RESPONSIBLE FOR IDENTIFICATION
LOCATION, AND PROTECTION OF EXISTING UTILITIES.

CONTACT KCSR'S "CALL BEFORE YOU DIG" AT LEAST 48
HOURS PRIOR TO BEGINNING WORK TO DETERMINE LOCATION
OF FIBER OPTICS.

EXCEPTIONS TO THESE STANDARDS MUST BE APPROVED BY
KCSR'S CHIEF ENGINEER DESIGN.

CLEARANCES

MINIMUM VERTICAL CLEARANCE SHALL BE 23'-6" ABOVE
THE PLANE OF TOP-OF-RAILS. ADDITIONAL CLEARANCE
MAY BE REQUIRED FOR CONSTRUCTION PURPOSES OR IF
SAG OF VERTICAL CURVE MUST BE ADJUSTED, OR IF
FUTURE TRACK RAISE FOR FLOOD CONSIDERATIONS OR
MAINTENANCE IS PROBABLE.

MINIMUM HORIZONTAL CLEARANCES, MEASURED AT RIGHT
ANGLE FROM CENTERLINE OF TRACK, SHALL BE AS SHOWN
IN ELEVATION VIEW.

MINIMUM CONSTRUCTION CLEARANCES SHALL BE 21 FEET
VERTICAL ABOVE THE PLANE OF TOP-OF-RAILS AND 12
FEET HORIZONTAL AT RIGHT ANGLE FROM CENTERLINE OF
TRACK.

FUTURE TRACKS

SPACE IS TO BE PROVIDED FOR ONE OR MORE FUTURE
TRACKS AS REQUIRED FOR LONG-RANGE PLANNING OR OTHER
OPERATING REQUIREMENTS, WHERE PROVISION IS MADE FOR
MORE THAN TWO TRACKS, SPACE IS TO BE PROVIDED FOR
ACCESS ROAD ON BOTH SIDES OF TRACK.

PIERS

PIER PROTECTION WALLS SHALL BE PROVIDED IN
ACCORDANCE WITH AREMA CHAPTER 8, PART 2.1.5
FOR PIERS WITHIN 25 FEET OF THE CENTERLINE OF TRACK.

TOP OF FOOTINGS WITHIN 25 FT. FROM CENTERLINE OF
TRACK SHALL BE A MINIMUM OF 6 FEET BELOW BASE OF
RAIL AND A MINIMUM OF 1 FOOT BELOW LOW LINE OF
DITCH.

DRAINAGE

DRAINAGE FROM THE OVERPASS SHALL BE DIVERTED AWAY
FROM KCSR'S TRACKS AND NOT DISCHARGED INTO THE
TRACKS OR ROADBED.

A STANDARD "V" SHAPED OR FLAT-BOTTOM DITCH SHALL
BE PROVIDED ON EACH SIDE OF THE TRACKS AS NECESSARY.
CULVERTS MAY BE INSTALLED ON OPPOSITE SIDE OF
COLUMN FROM TRACK IN LIEU OF STANDARD RAILROAD
DITCHES WHEN APPROVED BY CHIEF ENGINEER DESIGN.
MAINTENANCE OF CULVERTS IS TO BE AT APPLICANT'S
EXPENSE.

REVISIONS

EXHIBIT A

THE KANSAS CITY SOUTHERN RY. CO.

BARRIERS AND CLEARANCES TO BE PROVIDED AT HIGHWAY,
STREET AND PEDESTRIAN OVERPASSES

DRAWN BY
RGT
DATE
1/27/05
VAL. SEC.
1
SHEET NO.
1
CHECKED BY
SCL
FILE
NTS
DRAWING NO.
005103
NOTE: Minimum ditch sizes are shown. Ditch size to be increased as required by local conditions based on hydraulic studies.

* Location of pier, bent columns or abutment walls should not interfere with the drainage in the area. If minimum standard ditches are not provided in the layout, longitudinal culverts should be shown that will handle the drainage as required by the hydraulic studies.
TRACK PROTECTION SHORING:

ALL DIMENSIONS ARE MEASURED PERPENDICULAR TO C OF TRACK.

PRIOR TO COMMENCING ANY WORK, THE CONTRACTOR SHALL SUBMIT FOR APPROVAL BY THE RAILROAD ENGINEER, DETAILED PLANS INDICATING THE NATURE AND EXTENT OF THE TRACK PROTECTION SHORING PROPOSED. THE CONTRACTOR SHALL PROVIDE AND INSTALL TRACK PROTECTION SHORING BEFORE COMMENCING EXCAVATION.

SHORING WITHIN ZONE A SHALL BE DESIGNED FOR COOPER E80 LIVE LOAD SURCHARGE, IN ADDITION TO ALL OTHER APPLICABLE LOADS. THE RAILROAD MAY IMPOSE MORE STRINGENT REQUIREMENTS AS CONDITIONS WARRANT.

FOR EXCAVATIONS WHICH ENCLOSE INTO RAILROAD LIVE LOAD SURCHARGE ZONE A, SHORING PLANS WILL BE ACCOMPANIED BY A COPY OF DESIGN CALCULATIONS, AND BOTH MUST BE STAMPED BY A REGISTERED PROFESSIONAL ENGINEER IN THE APPLICABLE STATE.

THE PRESSURE AT A GIVEN POINT OF A CONTINUOUS STRIP OF SURCHARGE LOAD q(psf) PARALLEL TO SHORING SHALL BE COMPUTED BY:

\[
\sigma = \frac{2q}{x} \left[ \beta \sin \beta \cos 2\alpha \right]
\]

WHERE ANGLES \( \alpha \) AND \( \beta \) ARE EXPRESSED IN RADIANS.

\[ q = \frac{80,000 \text{ lbs}}{(5 \text{ FEET})(8.5 \text{ FEET})} \]

PRESSURE DISTRIBUTION FOR STRIP LOAD
(AREMA FIGURE 8.20-2)