FRANKLIN COUNTY

BACON RIDGE ROAD BRIDGE 3430009

STRUCTURAL ANALYSIS

2/3/2020 – Bacon Ridge Road Bridge is currently closed because of a large hole (about 6' long by 3' wide) in the deck. Cochran has investigated several different ways to repair the bridge to get it open to traffic. The options that Cochran has considered are as follows:

1. TEMPORARY STRUCTURAL (CONCRETE) TOPPING: Leave existing deck in place; cover hole with plywood; place edge form around sides and ends; pour structural topping (about 4 ½" thick) over entire deck.
2. TEMPORARY TIMBER DECK OVERLAY: Construct nail-laminated timber deck over existing deck with 2x6 boards on edge.
3. POUR NEW DECK: Entirely remove existing bridge deck; add shear connectors to make deck composite with steel beams; form and pour new concrete deck over entire bridge.

The decision to investigate these options was based on a site inspection of the bridge performed by Cochran. Some of the pertinent observations from that inspection are as follows:

4. The concrete deck is in very poor condition. It is overlaid with asphalt, saturated and crumbling. It could not be determined if the deck is composite with the steel girders. Even if the existing hole were patched or covered, other areas of the deck could possibly fail.
5. The reinforcing steel in the deck (#6 at about 12" o.c.) is structurally sub-standard and badly corroded.
6. The abutments and steel girders are in good condition. The steel girders have a cover plate on the bottom flange.

DISCUSSION:

The pre-existing condition of the bridge was analyzed. It appears that the previous 15-Ton load rating was based on the capacity of the steel stringers loaded with a 4½" concrete deck with 2" of asphalt and the assumption that the deck is not composite with the steel girders. When a 4½" structural overlay was added to this, the load rating dropped to around 5-6 tons. A topping less than 4½" thick would not be structurally adequate for the 6'8" girder spacing.

A timber deck overlay would weigh less than the concrete deck. The 2x6 boards would need to be placed on edge transverse to the beams and nailed together. A layer of cement ground would be placed between the timber and the existing deck to act as a leveling course and achieve uniform bearing. The addition of this deck thickness would cause the bridge railing height to become substandard. Therefore, this option is only recommended in conjunction with a 1-Lane and 15 MPH restriction. This would achieve a load rating of around 14 Tons depending on the type of lumber used. Since it is only a temporary application, non-treated lumber could possibly be used.

The bottom cover plates on the girders achieve the most benefit when the slab and girders act composite. If the existing slab is composite with the girders, the structural concrete topping could be added and a load rating of between 15 and 20 tons would be recommended.

If the entire existing deck were removed, shear connectors could be added to the existing beams to make them composite with the new concrete deck. If this were done, the reconstructed bridge would not require a load posting. Since there is not a beam on the outside edge, overhang brackets would have to be used for the forming of the deck. It is possible that reconstruction of the existing guard rail could be done, but it might be easier to install new guard rail.

RECOMMENDATIONS:

1. INVESTIGATE FOR COMPOSITE ACTION: The determination of composite action has a significant impact on the results of the analysis and the results that can be achieved. The existing deck could be chipped away above one of the beams to determine if there are shear connectors. Since the existing deck is not useable, the only draw-back to this investigation would be a larger area to repair if the structural topping were to be used.

2. DETERMINE COURSE OF ACTION :

   a. Do nothing and leave bridge closed.

   b. Construct temporary structural concrete topping:
      i. Two-way traffic would be rated for 5 Tons.
      ii. One-lane traffic would be rated for 6 Tons.
      iii. One-lane traffic restricted to 15MPH would be rated for 8 Tons.
      iv. If the bridge is Composite (Shear Connectors present), the load rating would be 20 Tons.

   c. Construct temporary timber deck overlay:
      i. One-lane traffic restricted to 15 MPH would be rated for around 14 Tons.

   d. Remove and replace the entire deck. The bridge would carry all legal loads and would not require a load posting. The following work would be required:
      i. Reinforce butt welds on cover plates.
      ii. Add shear connectors to make deck composite with beams.
      iii. Establish smooth roadway curve and install new bridge deck, bridge rail and approach guard rail on curve.

iv. If this amount of work is to be performed on the structure, the following work would also be recommended:
    1. Clean (sandblast) and paint all structural steel.
    2. Clear and shape stream channel.
    3. Epoxy-inject the cracks in the abutments.
    4. Paint abutments with epoxy coating.
    5. Clear trees (on private property) to improve sight distance around curve.

All of the work under paragraph "d" would be eligible for either Federal Aid reimbursement (BRO) or Soft Match Credit.

We hope that this addresses your needs at this time. If additional information is needed, or if you would like for us to more fully develop one of the options, please advise.

Sincerely,

B. Bradford Dunagan, P.E.

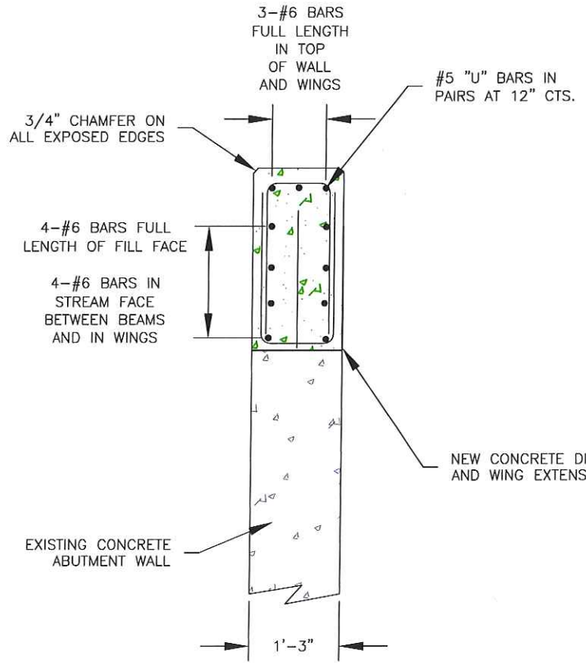
BRIDGE INSPECTION DATA SHEET

County/City:		Franklin County		
Bridge Number:		3430009; Bacon Ridge Road		
Feature Intersected:			Winsel Creek	
Location:	Address:	441 East Bacon Ridge Rd, Sullivan 63080		
	Latitude:		38.2520	degrees
	Longitude:		-91.1573	degrees
SUBSTRUCTURE:				
Type:		Concrete Walls		
Distance Deck to Water:			9'-5"	
	Water Depth:		6"	
SUPERSTRUCTURE:				
Bridge Length (FF-FF)		51'; 48'-6" SF-SF		
Deck Width (C-C):		24'-0"	Type:	Conc.+Asp.
Superstructure Type:		4 Steel W-Beams w/Cover Pl.		
Span Configuration:		single span		
Number of Longitudinal Beams:				4
	Size:	27"d. x 10"w. x 11/16"		
	Spacing:	6.8'-6.7'-6.77'		
	Cover Plate Size:	12" x 3/4" x full length		
	Cover Plate length:	Butt-welded at 30'		
Comments:		Beams have NO section loss.		
Bridge is skewed LA about 5 degrees.				
MODOT Thrie-Beam bridge rail - no concrete curbs.				
Abutments are in good condition with some vertical cracks.				
Beams are cast into diaphragms. Horiz. Joint at beams.				

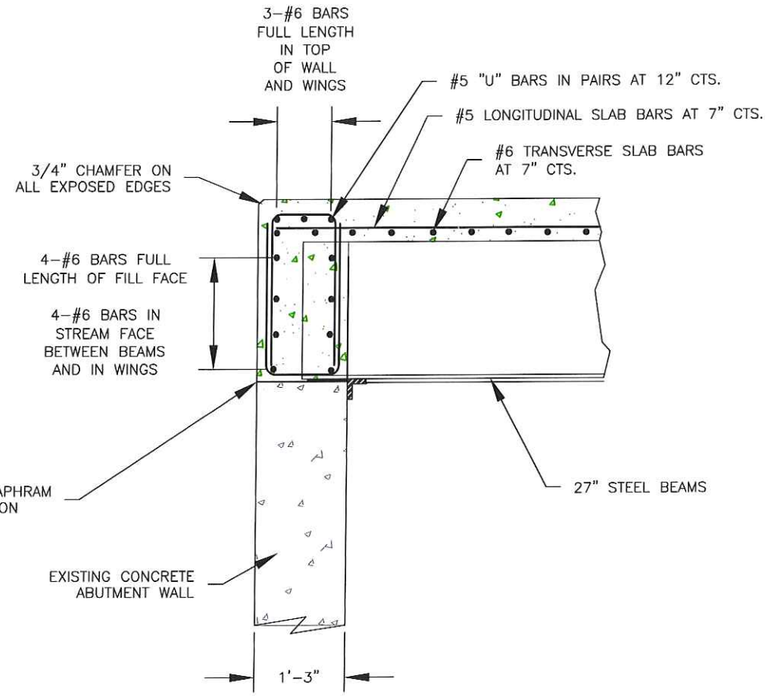
BRIDGE NOTES

ESTIMATED QUANTITIES FOR SLAB ON STEEL	
ITEM	TOTAL
CLASS B2 CONCRETE (SUPERSTRUCTURE), CY	43
REINFORCING STEEL, LBS	4100

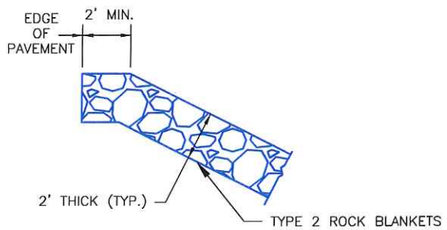
NOTE: ALL SUPERSTRUCTURE CONCRETE AND REINFORCING STEEL ARE TO BE PAID FOR UNDER THE LINE ITEM "SLAB ON STEEL."



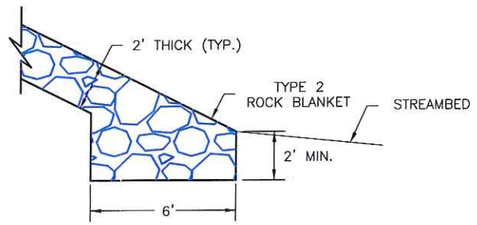
SECTION THROUGH WING



SECTION THROUGH GIRDERS



TOP OF ROCK BLANKET



TYPICAL SECTION THROUGH LOWER END OF TYPE 2 ROCK BLANKET

NOTE: THIS DRAWING IS NOT TO SCALE. PLEASE FOLLOW DIMENSIONS.

PROPOSED STRUCTURE

SINGLE SPAN (51'-0")
EXISTING STEEL BEAMS
CURB-TO-CURB WIDTH = 24'-0"
OUT-TO-OUT WIDTH = 24'-8"
SKEW = 5°
GRADE = 0.00%
CURVE = 340' RADIUS

PROPOSED ROADWAY

TRAVELED WAY WIDTH = 20'-0"
SHOULDER WIDTH = 2'-0"
NORMAL CROWN = 2.00%

GENERAL NOTES:

DESIGN SPECIFICATIONS:
2002 AASHTO LFD BRIDGE DESIGN SPECIFICATIONS FOR HIGHWAY BRIDGES, 17TH EDITION WITH INTERIM REVISIONS
2002 AASHTO LFD (17TH ED.) STANDARD SPECIFICATIONS (SEISMIC DETAILS)
SEISMIC PERFORMANCE CATEGORY 'A'

CONSTRUCTION SPECIFICATIONS:
MATERIALS AND CONSTRUCTION PROCEDURES SHALL CONFORM TO THE MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION 2018 AND CURRENT SUPPLEMENTAL SPECIFICATIONS AND REVISIONS, UNLESS MODIFIED BY THE PROJECT SPECIFICATIONS.

DESIGN LOADING:
HS-20 LOADING
FUTURE WEARING SURFACE 35 LBS./SQUARE FOOT

SUPERSTRUCTURE:
SIMPLY SUPPORTED AND NON-COMPOSITE FOR DEAD LOAD 1.
SIMPLY SUPPORTED AND COMPOSITE FOR DEAD LOAD 2 AND LIVE LOAD.

DESIGN UNIT STRESSES:
CLASS B-2 CONCRETE (SUPERSTRUCTURE) f'c = 4,000 p.s.i.
REINFORCING STEEL (GRADE 60) fy = 60,000 p.s.i.
STRUCTURAL CARBON STEEL (ASTM A709 GRADE 36) fy = 36,000 p.s.i.

ALL JOINT FILLER SHALL MEET THE REQUIREMENTS OF MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION SECTION 1057.7.4.

MINIMUM CLEARANCE TO REINFORCING STEEL SHALL BE 2" UNLESS OTHERWISE SHOWN.

ALL BAR CHAIR SUPPORTS AND WIRE USED FOR TIEING THE REINFORCING STEEL SHALL BE EPOXY COATED OR PLASTIC COATED.

BEARINGS SHALL BE 60 DUROMETER NEOPRENE PADS.

CLASS B-2 MODIFIED CONCRETE IS NOT AN ALLOWABLE SUBSTITUTION.

A PORTION OF THIS PROJECT AREA LIES WITHIN ZONE "AE" OF THE FLOOD HAZARD AREA SUBJECT TO THE 1% ANNUAL CHANCE FLOOD AS SHOWN ON THE FEMA MAP FOR FRANKLIN COUNTY, MISSOURI AND INCORPORATED AREAS, MAP NUMBER 29071C0320D.

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Geotechnical Engineering
ENGINEERING CERTIFICATE OF AUTHORITY NUMBER - 2007006637
LAND SURVEYING CERTIFICATE OF AUTHORITY NUMBER - 2007004529

STATE OF MISSOURI
B. BRADFORD DUNAGAN
NUMBER E-22970
PROFESSIONAL ENGINEER

B. BRADFORD DUNAGAN
NO. E-22970
STATE OF MISSOURI
REGISTERED PROFESSIONAL ENGINEER
FOR SC ENGINEERING LLC,
DBA COCHRAN

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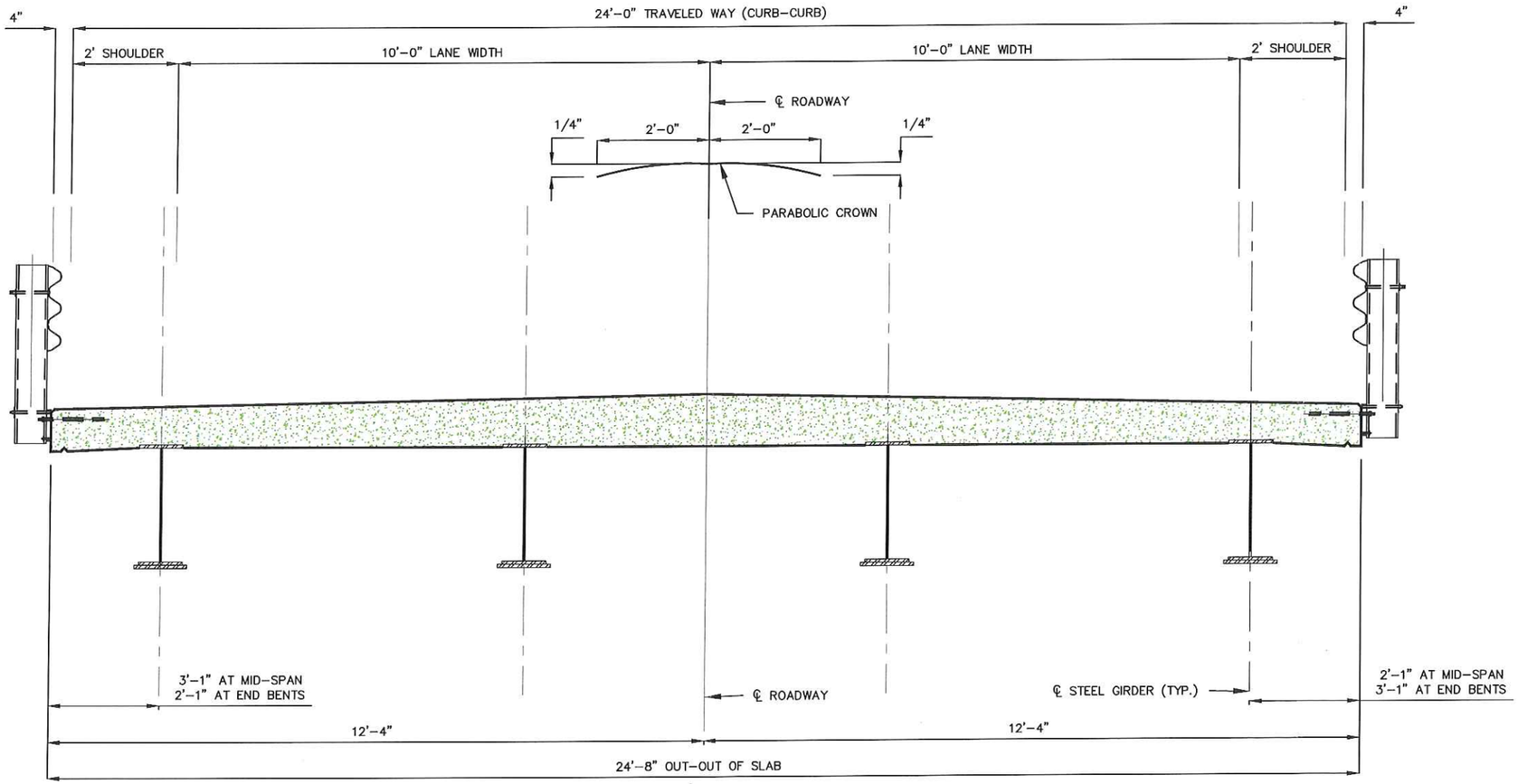
BACON RIDGE ROAD
BRIDGE NO. 3430009
BRIDGE REHABILITATION
FRANKLIN COUNTY, MO

BRIDGE NOTES

DATE:	REVISION:
DWN. BY: B.B.D.	APP'D. BY: B.B.D.
DATE: FEB. 2020	
SCALE: N.T.S.	
PROJ. NO: SC20-1072	
DWG. NO: B-1	

TYPICAL BRIDGE SECTION



TYPICAL BRIDGE CROSS SECTION

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FRANKLIN COUNTY, MO

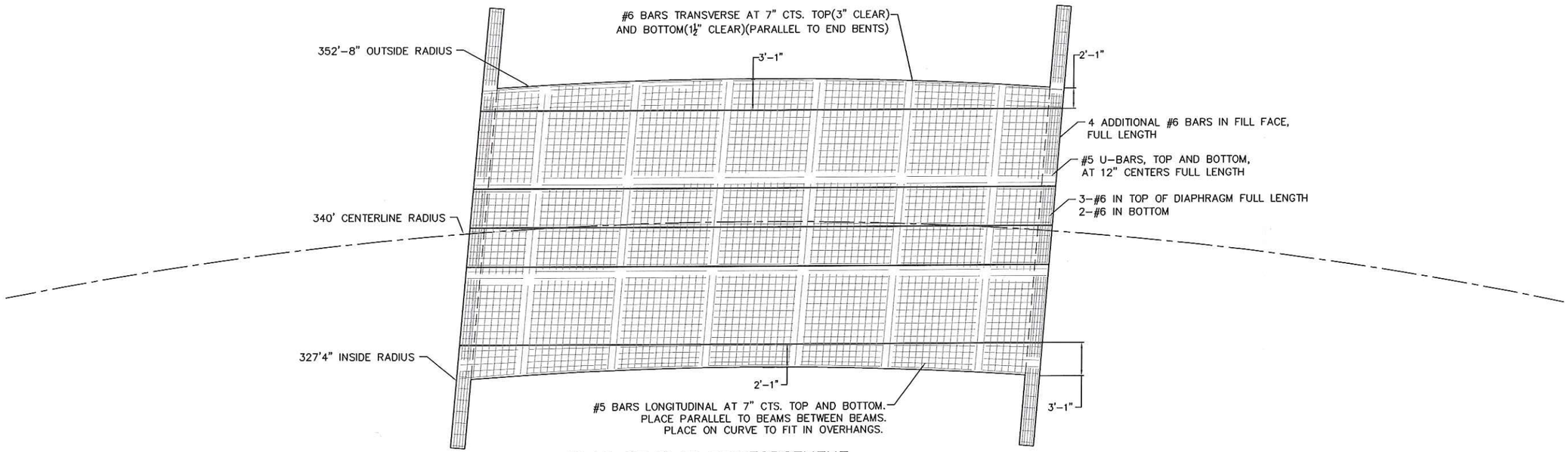
TYPICAL BRIDGE SECTION

REVISION:	DATE:

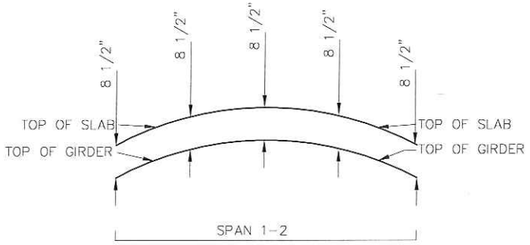
DWN. BY:	APPD. BY:
B.B.D.	B.B.D.

DATE: FEB. 2020
SCALE: N.T.S.
PROJ. NO: SC20-1072
DWG. NO: *B-2*

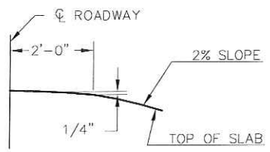
SLAB REINFORCEMENT



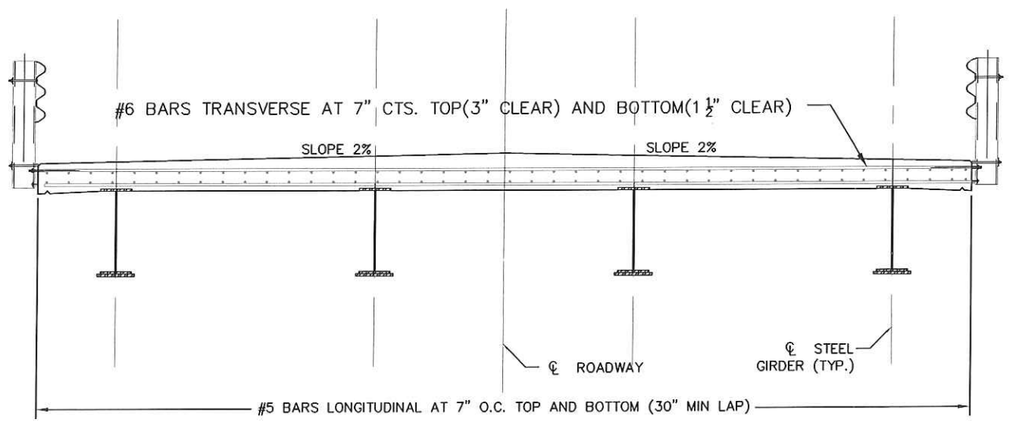
PLAN OF SLAB REINFORCEMENT



SLAB HAUNCH DIAGRAM



PARABOLIC CROWN



SECTION NEAR MIDSPAN

NOTES:

1. THE SLAB SHALL BE POURED WITH A MINIMUM SLAB THICKNESS OF 8½" ABOVE THE GIRDERS. IF GIRDER CAMBER IS DIFFERENT FROM THAT SHOWN IN THE CAMBER DIAGRAM, IT SHALL BE NECESSARY TO ADJUST THE SLAB HAUNCHES, OR TO INCREASE THE SLAB THICKNESS. NO PAYMENT WILL BE MADE FOR ADDITIONAL LABOR OR MATERIALS REQUIRED FOR VARIATION IN HAUNCHING, SLAB THICKNESS OR GRADE ADJUSTMENT.
2. THE CONTRACTOR SHALL FURNISH AN APPROVED RETARDER TO RETARD THE SET OF CONCRETE TO 2.5 HOURS. THE RATE OF POUR MAY BE REDUCED TO NOT LESS THAN 25 CUBIC YARDS PER HOUR.
3. FINISHING WITH A VIBRATORY SCREED WILL BE ALLOWED.
4. THE DIAPHRAGMS OF THE END BENTS SHALL BE POURED A MINIMUM OF 30 MINUTES AND A MAXIMUM OF 2 HOURS BEFORE THE SLAB IS POURED ACROSS THE DIAPHRAGM.
5. ALL REINFORCING STEEL, SUPPORTS, BAR CHAIRS, AND WIRE USED FOR TYING THE REINFORCING STEEL SHALL BE EPOXY COATED OR PLASTIC COATED.
6. THE CONCRETE SHALL BE CURED AND SEALED ACCORDING TO THE REQUIREMENTS OF MISSOURI STANDARD SPECIFICATIONS 703.3.6 AND 703.3.8 RESPECTIVELY. THIS WORK SHALL BE INCLUDED IN THE UNIT BID PRICE FOR "SLAB ON STEEL".
7. SLAB CONCRETE SHALL BE CLASS B2. ALL CONCRETE AND REINFORCING STEEL ABOVE THE CONSTRUCTION JOINT SHALL BE PAID FOR UNDER THE LINE ITEM "SLAB ON STEEL."
8. STEEL GIRDERS SHALL BE BRACED(SUPPORTED) AT MID-SPAN TO PREVENT DEFLECTION DURING THE SLAB PLACEMENT.

NOTE: THIS DRAWING IS NOT TO SCALE. PLEASE FOLLOW DIMENSIONS.

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BACON RIDGE ROAD
BRIDGE NO. 3430009
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FRANKLIN COUNTY, MO

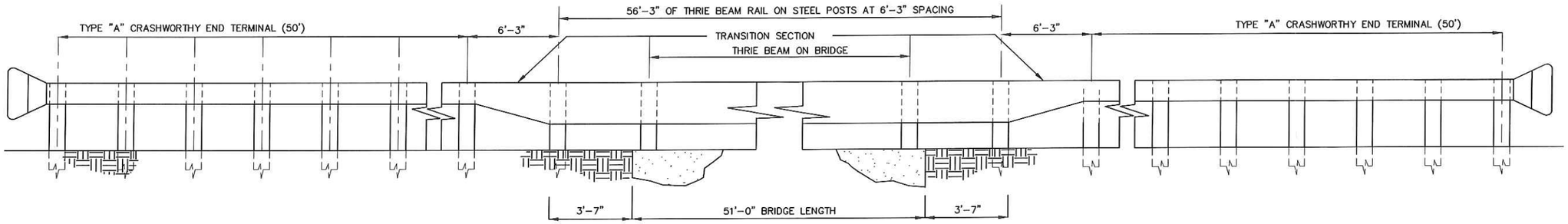
SLAB REINFORCEMENT

REVISION:	DATE:

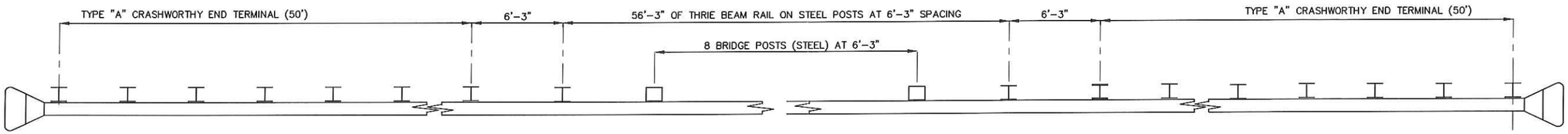
DWN BY:	APP'D BY:
B.B.D.	B.B.D.

DATE: FEB. 2020
SCALE: N.T.S.
PROJ NO. SC20-1072
DWG NO. B-3

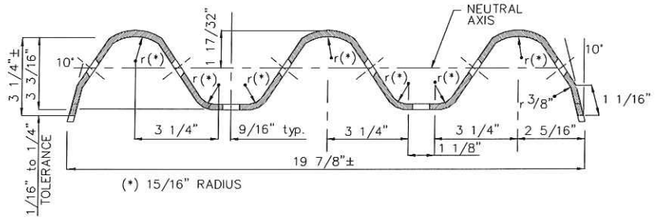
SL-1 BRIDGE RAILING



ELEVATION VIEW

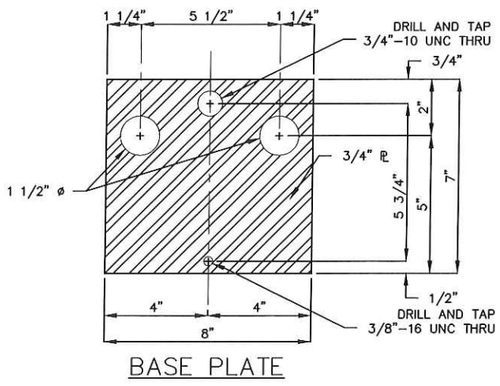


PLAN VIEW

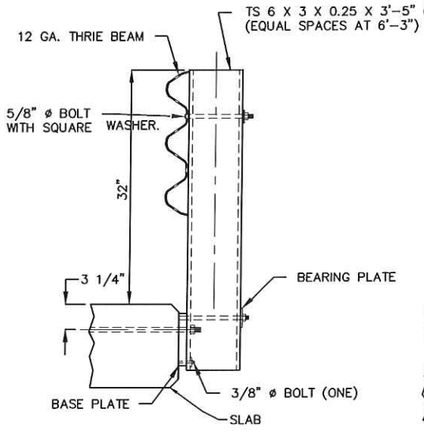


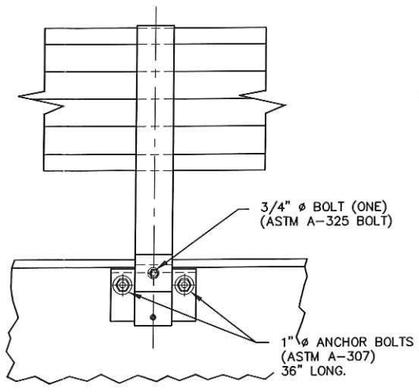
SECTION THRU THRIE BEAM RAIL

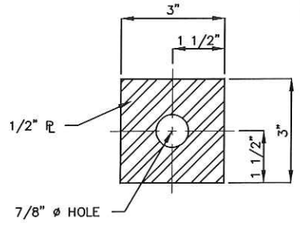
(*) VERIFY BY RAIL TRANSITION SUPPLIER.



BASE PLATE







BEARING PLATE

NOTE: THIS DRAWING IS NOT TO SCALE. FOLLOW DIMENSIONS.

NOTES:

THE THRIE BEAM RAIL, END SHOE AND THE TRANSITION SECTION FOR THE BRIDGE ANCHOR SECTION SHALL BE MADE OF STEEL AND SHALL BE 12 GAGE. ZINC COATING SHALL BE TYPE 2.

FOR PROTECTIVE COATING AND MATERIAL REQUIREMENTS, SEE SECTION 1040 OF THE MISSOURI STANDARD SPECIFICATIONS.

RAIL POSTS SHALL BE SET PERPENDICULAR TO THE ROADWAY PROFILE GRADE AND VERTICALLY IN CROSS SECTION.

WASHERS SHALL BE USED AT ALL POST BOLTS (BETWEEN BOLT HEAD AND BEAM). THEY SHALL BE RECTANGULAR IN SHAPE (3" X 1 3/4" X 3/16" MIN.) AND FLAT, OR WHEN NECESSARY, OF SUCH DESIGN AS TO FIT THE CONTOUR OF THE BEAM. WASHERS SHALL HAVE A 11/16" X 1" SLOTTED HOLE.

USE 5/8" BUTTON HEAD, OVAL SHOULDER BOLTS WITH HEX NUTS AT ALL SLOTS. (THICKNESS OF HEX NUTS = 3/8")

ALL LAP SPLICES SHALL BE MADE IN THE DIRECTION OF TRAFFIC.

DECK ANCHORAGE OF THE POST ASSEMBLY SHALL BE PROVIDED BY TWO 1" DIA. ANCHOR BOLTS, 36" LONG OR EQUIVALENT DESIGN ACCORDING TO THE LATEST AASHTO BRIDGE SPECIFICATION.

G2 POSTS AND POSTS IN EMBANKMENT SHALL BE W6 X 9 (OR W6 X 8.5).

THRIE BEAM RAIL SHALL BE PRE-FABRICATED TO MATCH CURVE RADIUS. INSIDE RADIUS = 328'. OUTSIDE RADIUS = 352'.

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SL-1 BRIDGE RAILING

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DWN. BY: B.B.D.	APP'D. BY: B.B.D.
DATE: FEB. 2020	
SCALE: NOT TO SCALE	
PROJ. NO: SC20-1072	
DWG. NO: B-4	