Chapter 11 – Structural Repairs

SECTION 01

STEEL REPAIRS (SR-ST)

Chapter 11 - Structural Repairs

Section 01 – Steel Repairs

SUB-SECTION **01**

FATIGUE REPAIRS (SR-ST(FR))

GENERAL NOTES

Specifications: - SHA Specifications dated May 2017
- Revisions thereof and additions thereto and Special Provisions for Materials and Construction.

Existing Structure: All dimensions affected by the geometrics, and/or location of the existing structure shall be checked in the field by the Contractor, before any construction is done, before any materials are ordered or fabricated. It shall be the responsibility of the Contractor to supply the Engineer with all field dimensions required to check detail drawings. The ± marks shown with dimensions do not indicate any degree of precision. These marks (±) indicated existing dimensions that may vary and do require field verification by the Contractor.

Maintenance of Traffic: Use Standard No.

Work Required: Repair fatigue cracks.

LOCATION & DESCRIPTION OF REPAIRS				
MEMBER	SPAN	DIAPHRAGM	BAY	CRACK LOCATION

Note:
Chart is located on level no. 8. If chart is not needed please turn off level no. 8.

APPROVAL
Sean C. Vaughan - DIRECTOR OFFICE OF STRUCTURES
DATE: 08/11/2017
VERSION
1.01

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

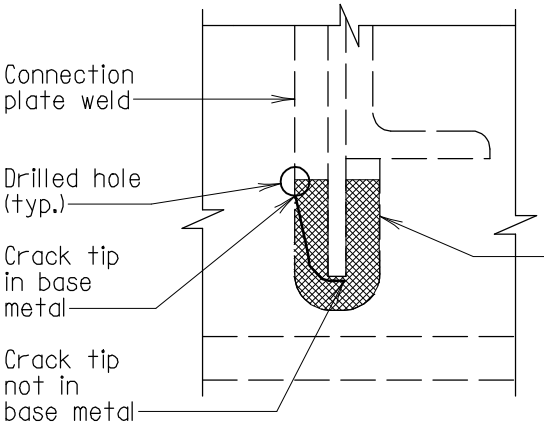
FATIGUE CRACK REPAIRS FOR STRUCTURAL STEEL
GENERAL NOTES

DETAIL NO. SR-ST(FR)-101 SHEET 1 OF 2

STRUCTURAL REPAIRS

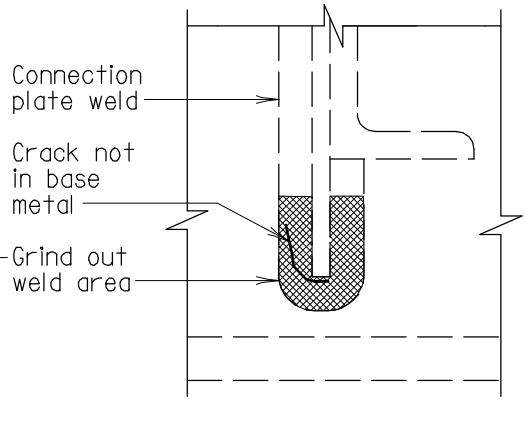
CONSTRUCTION NOTES

1. MDSHA lab to locate ends of weld cracks and grind out affected weld flush to base metal.
2. Check weld area with magnetic particle or UT to ensure the crack has been removed. All ground out weld areas are to be the same length on both sides of the connection plate. (Refer to Type-1, Type-2, Type-3 and Type-4 repair details). Upon completion, MDSHA lab to verify with UT that the crack has been removed in its entirety.
3. If the crack has grown into base metal then locate the ends of the cracks and arrest the crack tip with the appropriate size holes as determined by MDSHA lab. Drilled holes shall be deburred and internally polished to a minimum 64RMS. Finish with edges rounded. (Refer to Type 1 and Type 2 repair details).
4. All bare metal shall be painted in accordance to Section 430, with the color of the final coat matching the existing coat.
5. To eliminate any knife edges grind the edge until a 1/8" min. thickness is attained. Polish surface to RMS128.



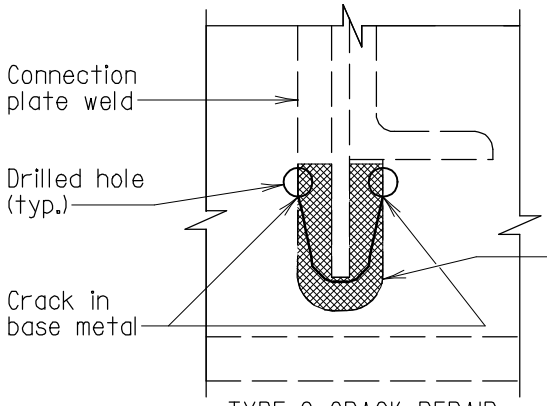
TYPE-1 CRACK REPAIR

Scale: 1 1/2" = 1'-0"



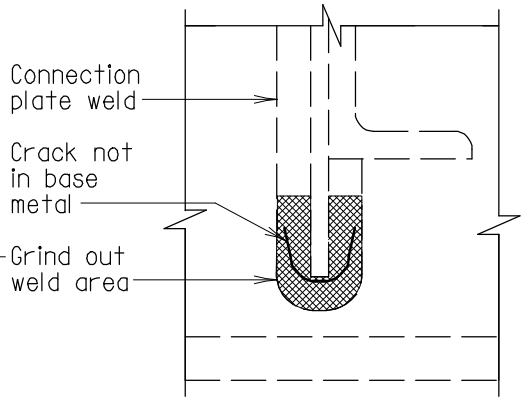
TYPE-3 CRACK REPAIR

Scale: 1 1/2" = 1'-0"



TYPE-2 CRACK REPAIR

Scale: 1 1/2" = 1'-0"



TYPE-4 CRACK REPAIR

Scale: 1 1/2" = 1'-0"

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Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 08/11/2017	FATIGUE CRACK REPAIRS FOR STRUCTURAL STEEL CONSTRUCTION NOTES AND DETAILS
VERSION 1.01	DETAIL NO. SR-ST(FR)-101 SHEET 2 OF 2

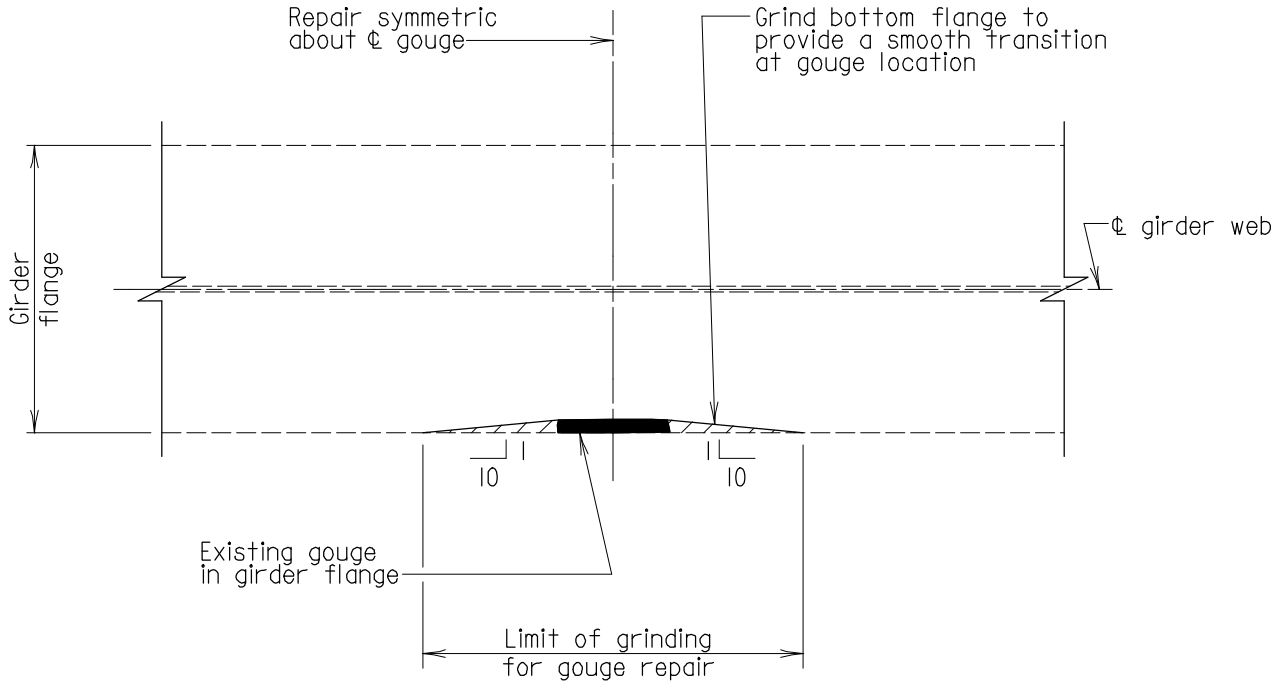
STRUCTURAL REPAIRS

Chapter 11 - Structural Repairs

Section 01 – Steel Repairs

SUB-SECTION **02**

GOUGE REPAIRS (SR-ST(GR))



REPAIR DETAIL
Scale: 1 1/2" = 1'-0"

Notes:

1. Any gouge in the bottom flange 1/8" or greater shall be ground smooth according to this standard.
2. Upon completion of work, gouge area shall be tested for additional cracking by the SHA Lab.
3. If no cracks are found, area shall be painted to match existing bridge color.
4. If cracks are found after testing, additional grinding may be required as directed by the Engineer in the field.
5. All areas repaired by grinding shall be polished to a minimum 125 RMS.
6. All scrapes less than 1/8" shall be ground smooth without a taper.
7. All bare metal shall be painted in accordance to Section 430, with the color of the final coat matching the existing coat.

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Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	GOUGE REPAIR DETAIL
VERSION 1.0	DETAIL NO. SR-ST(GR)-101 SHEET 1 OF 1

STRUCTURAL REPAIRS

Chapter 11 - Structural Repairs

Section 01 – Steel Repairs

SUB-SECTION **03**

BEARING STIFFENER RETROFITS (SR-ST(BSR))

GENERAL NOTES

1. The Contractor shall verify all dimensions, including but not limited to the height between the beam flange and the diaphragm, the angle between the beam and stiffener, the plumbness of the stiffener, the slope of the top of the bottom flange, limits of section loss, the chamfer for the existing beam fillet, and bolt spacing, etc., before any material is ordered or fabricated. The number of bolts shown in this standard are for representation only. The Contractor shall be responsible for selecting the number of bolts, and the pattern that will satisfy the requirements of the standard.

2. The contractor is to complete the installation of each plating location prior to the end of the work day. No location is to be left with bolt holes drilled and plating not fully bolted.

3. To eliminate any knife edge grind the edge until a 1/8" min. thickness is attained. Polish surface to RMS 128.

4. All bolts shall be A325, Type 1, 7/8" diameter galvanized bolts. All bolts shall be off-vented a minimum of 24 days before installation.

5. The minimum acceptable edge distance for any bolt shall be 1 1/2". The maximum acceptable edge distance for any bolt shall be 3".

6. The minimum acceptable center-to-center bolt spacing shall be 3".

7. All bolt holes shall be 15/16 " diameter.

8. The areas of section loss and pitting shall be filled with an approved metal reinforced epoxy filler just prior to installing new steel plates and new fabricated sections.

9. Seal the edges of adjoining plates prior to painting.

10. All new steel and areas to be plated shall be cleaned and painted in accordance with Section 430. The color shall match the existing beams, unless otherwise specified in the contract.

11. All structural steel shall be 1/2" thick and conform to A709, Grade 50.

12. The Contractor shall submit as built plans to the Office of Structures of the details of the bearing stiffener plating used at each location. The bolt spacing specified is the maximum spacing allowed. Bolt spacing should be evenly spaced.

13. Bolt heads shall be on the exterior face of the fascia beam/girder.

PLATING LOCATION AND SIZE CHART

BEAM	SPAN	SUPPORT	END SECTION	SPAN SECTION	H	L	X	S	COMMENTS

Legend:
END SECTION - Define the rolled angle section to be used "behind" the bearing stiffener.
SPAN SECTION - Define the rolled angle section to be used on the "Span" side of the bearing stiffener.
H - Height of proposed rolled angle retrofit (in.).
L - Length of proposed rolled angle retrofit (in.).
X - bolt spacing (horizontal).
S - stiffener vertical bolt spacing.

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Tom Vaughan DIRECTOR OFFICE OF STRUCTURES
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VERSION
1.0

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
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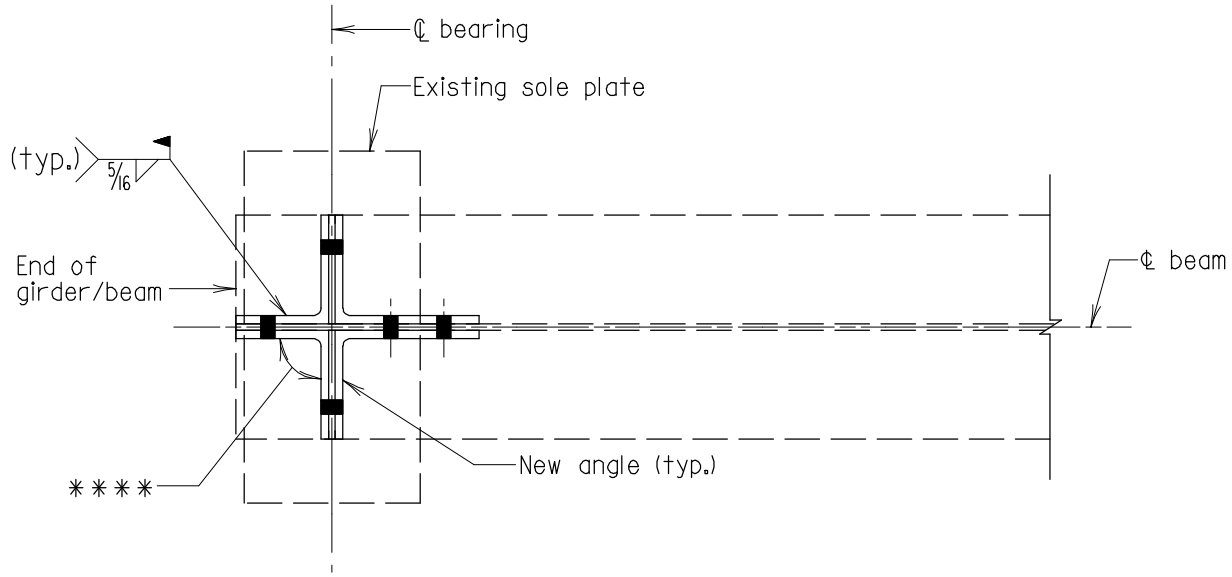
OFFICE OF STRUCTURES

BEARING STIFFENER PLATING
GENERAL NOTES

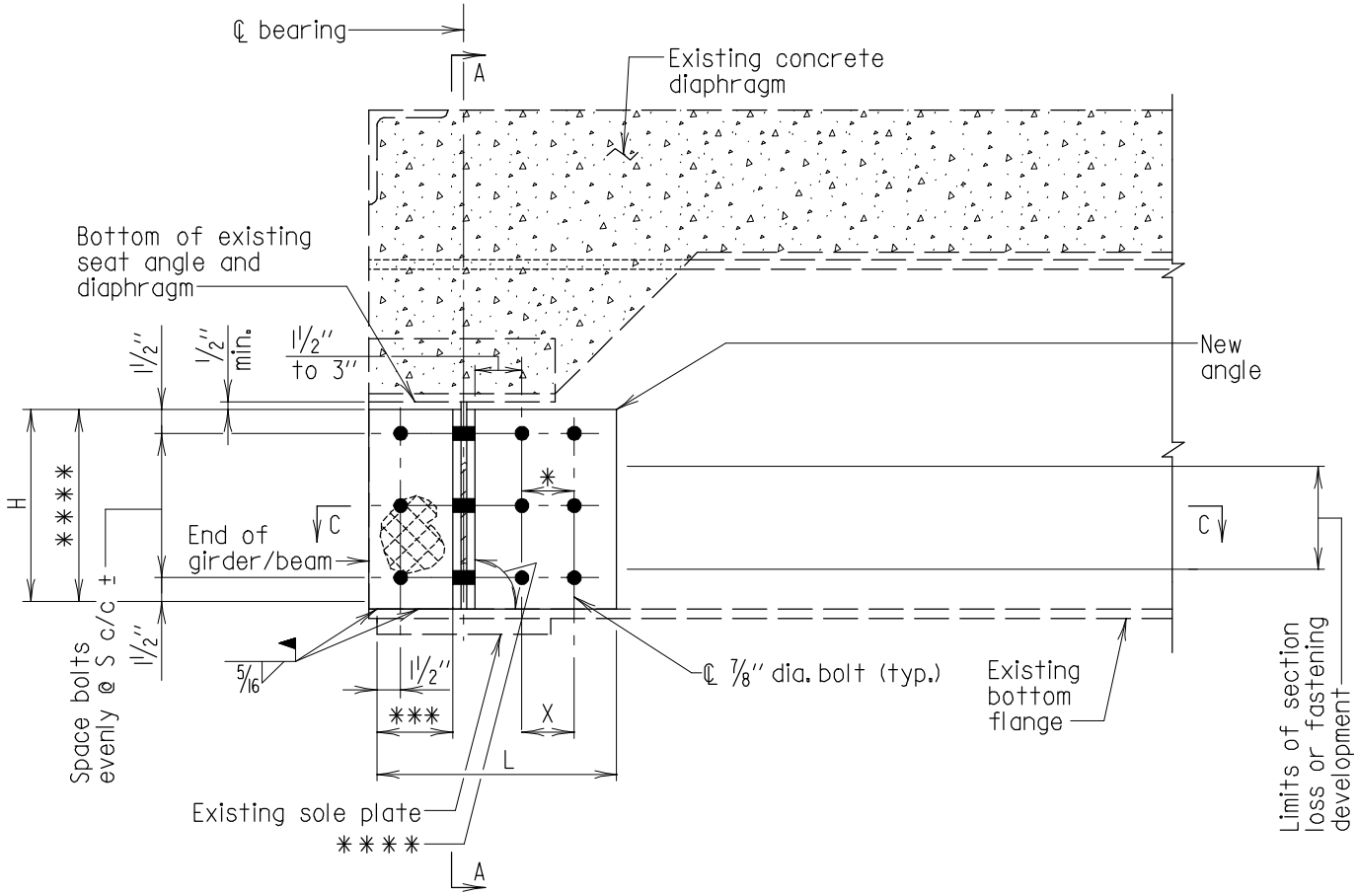
DETAIL NO. SR-ST(BSR)-101 SHEET 1 OF 1

STRUCTURAL REPAIRS



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1''=1'-0''



ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1''=1'-0''

Notes:

*Varies - 3'' min. - 6'' max. spacing of bolts.

***Requires 4'' min.

****See Note 1 of General Notes.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A.

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VERSION
1.0

STATE OF MARYLAND
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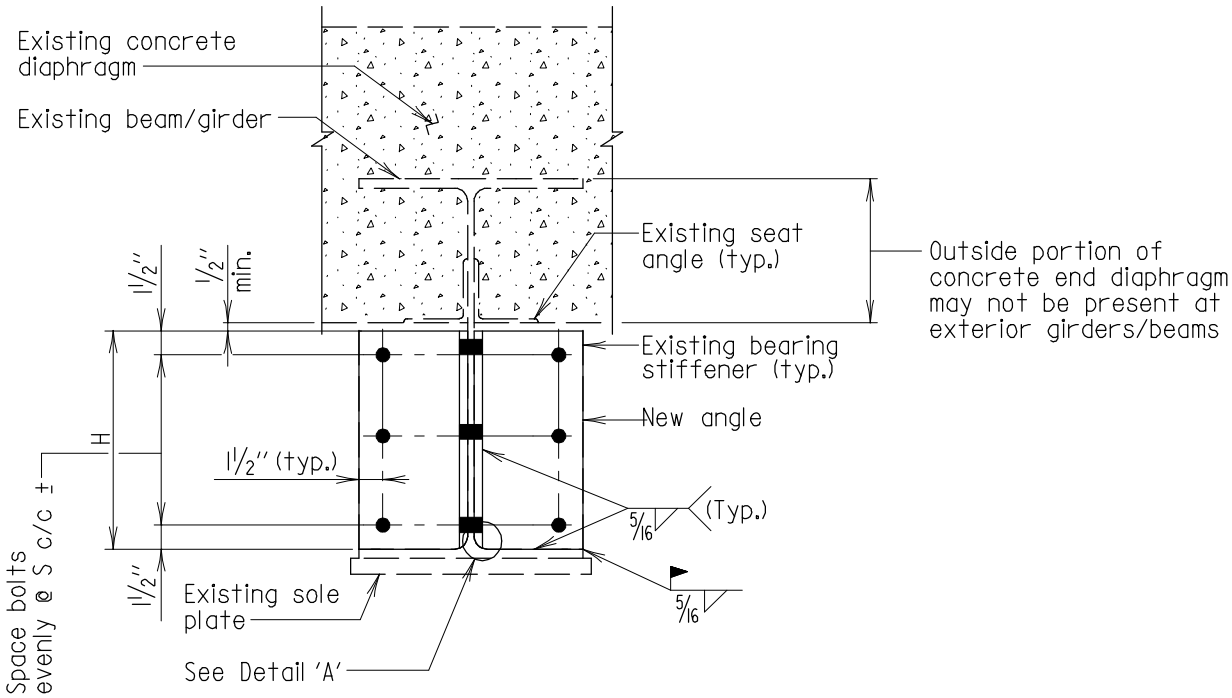
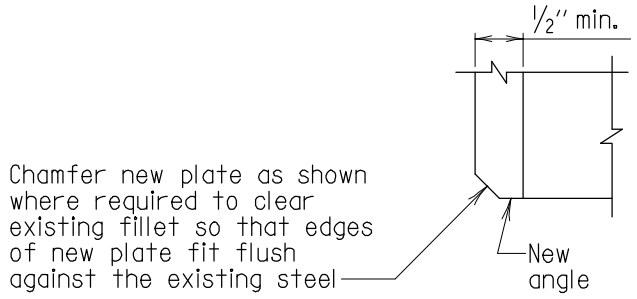
EXTERIOR/INTERIOR GIRDER/BEAM END BEARING STIFFENER PLATING DETAILS - CONCRETE DIAPHRAGM

DETAIL NO. SR-ST(BSR)-102 SHEET 1 OF 2

STRUCTURAL REPAIRS



SECTION A-A
Scale: 1"=1'-0"



DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	EXTERIOR/INTERIOR GIRDER/BEAM END BEARING STIFFENER PLATING DETAILS - CONCRETE DIAPHRAGM
VERSION 1.0	DETAIL NO. SR-ST(BSR)-102 SHEET 2 OF 2

STRUCTURAL REPAIRS

Chapter 11 - Structural Repairs

Section 01 – Steel Repairs

SUB-SECTION **04**

STRUCTURAL RETROFITS (SR-ST(SR))

GENERAL NOTES

1. The Contractor shall verify all dimensions, including but not limited to the height between the beam flange and the diaphragm, the angle between the beam and stiffener, the plumbness of the stiffener, the slope of the top of the bottom flange, limits of section loss, the chamfer for the existing beam fillet, and bolt spacing, etc., before any material is ordered or fabricated. The number of bolts shown in this standard are for representation only. The Contractor shall be responsible for selecting the number of bolts, and the pattern that will satisfy the requirements of the standard.

2. The contractor is to complete the installation of each plating location prior to the end of the work day. No location is to be left with bolt holes drilled and plating not fully bolted.

3. To eliminate any knife edge grind the edge until a 1/8" min. thickness is attained. Polish surface to RMS 128.

4. All bolts shall be A325, Type 1, 7/8" diameter galvanized bolts. All bolts shall be off-vented a minimum of 24 days before installation.

5. The minimum acceptable edge distance for any bolt shall be 1 1/2". The maximum acceptable edge distance for any bolt shall be 3".

6. The minimum acceptable center-to-center bolt spacing shall be 3".

7. All bolt holes shall be 15/16 " diameter.

8. The areas of section loss and pitting shall be filled with an approved metal reinforced epoxy filler just prior to installing new steel plates and new fabricated sections.

9. Seal the edges of adjoining plates prior to painting.

10. All new steel and areas to be plated shall be cleaned and painted in accordance with Section 430. The color shall match the existing beams, unless otherwise specified in the contract.

11. All structural steel shall be 3/4" thick and conform to A709, Grade 50.

12. The Contractor shall submit as built plans to the Office of Structures of the details of the bearing stiffener plating used at each location. The bolt spacing specified is the maximum spacing allowed. Bolt spacing should be evenly spaced.

13. Bolt heads shall be on the exterior face of the fascia beam/girder.

PLATING LOCATION AND SIZE CHART								
BEAM	SPAN	SUPPORT	L	H	X	Y	S	COMMENTS

Legend:
L - length of bottom flange retrofit
H - height of retrofit
X - bolt spacing (horizontal)
Y - bolt spacing (vertical)
S - stiffener vertical bolt spacing

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Ram Vaughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
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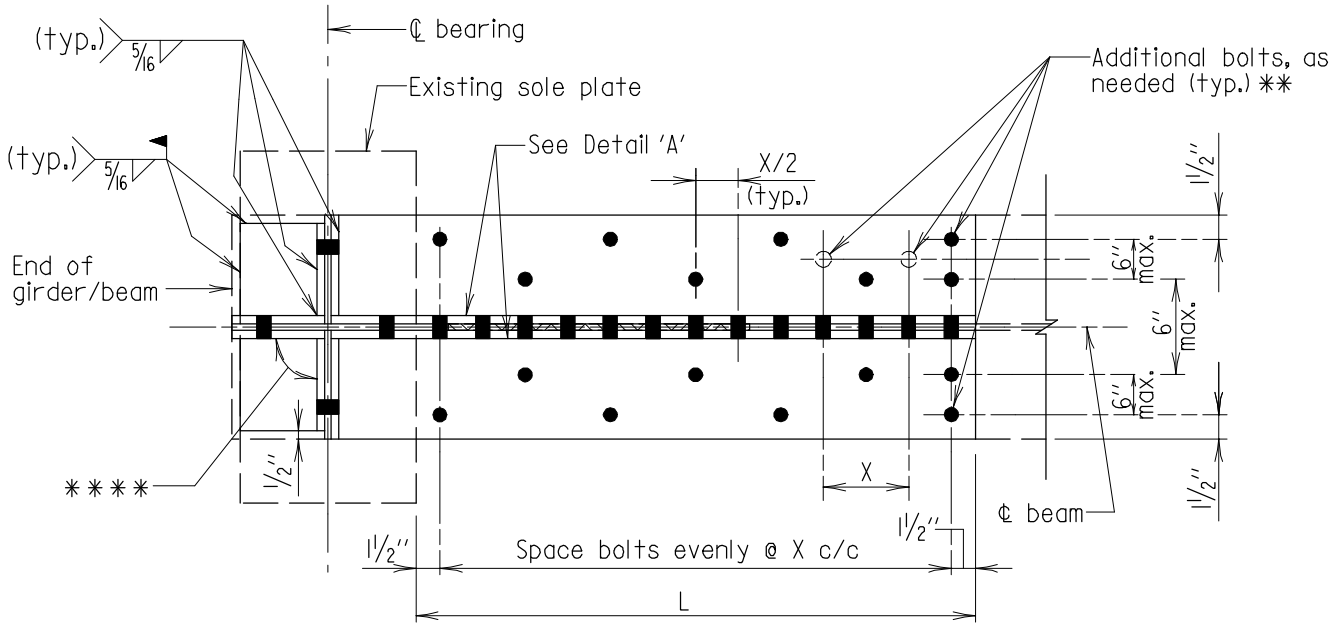
STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

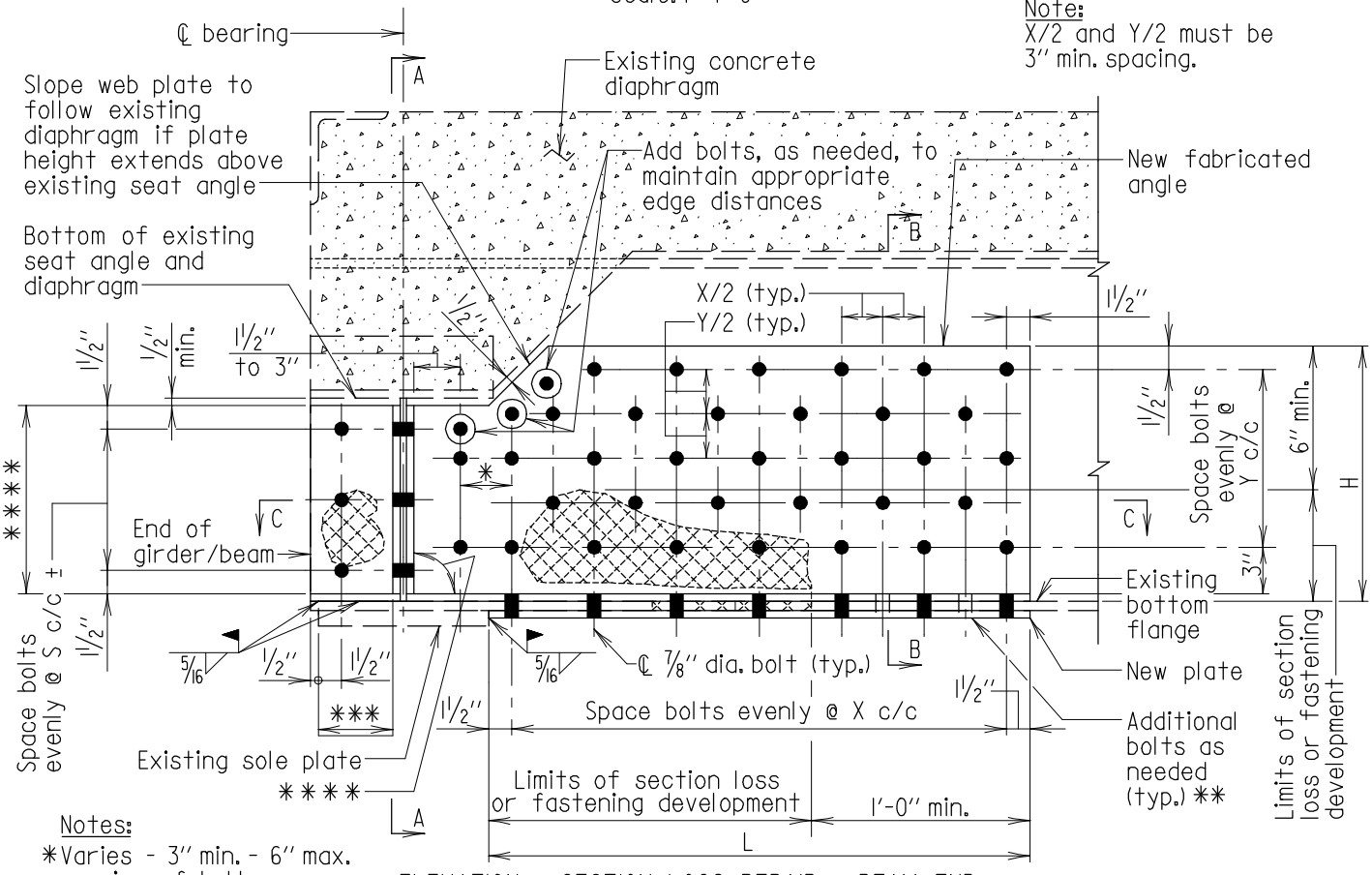
GIRDER/BEAM END PLATING
GENERAL NOTES

DETAIL NO. SR-ST(SR)-101 SHEET 1 OF 1



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"



Note:
X/2 and Y/2 must be 3" min. spacing.

ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"

Notes:

*Varies - 3" min. - 6" max. spacing of bolts.

**For wide flanges, add bolts spaced at 6" c/c max. along flange width, as needed.

***Requires 4½" min.

****See Note 1 of General Notes.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

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DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
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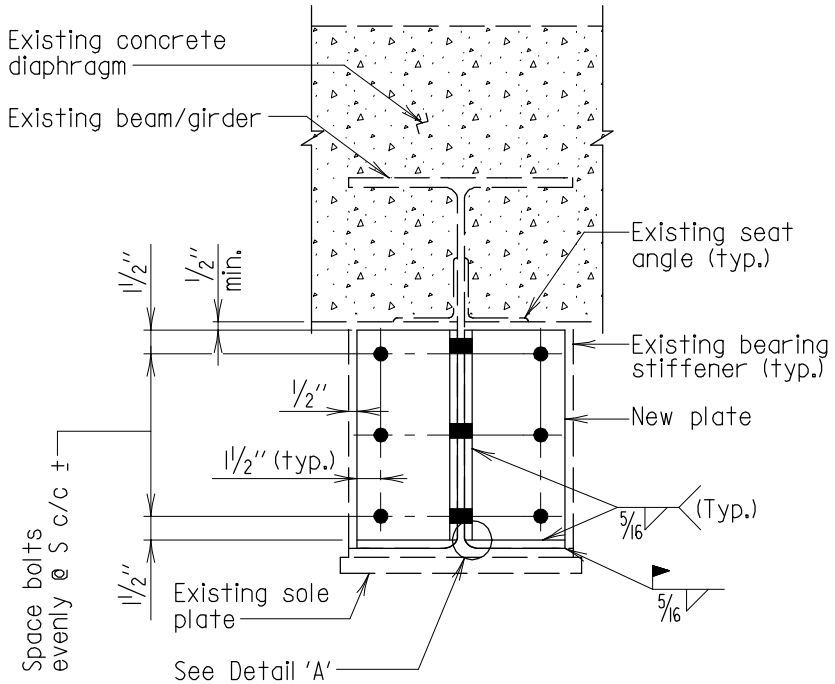
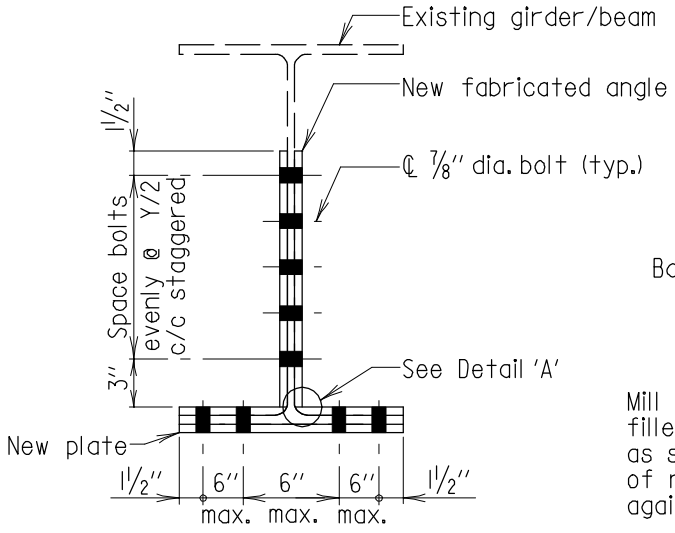
INTERIOR GIRDER/BEAM END PLATING DETAILS - CONCRETE DIAPHRAGM

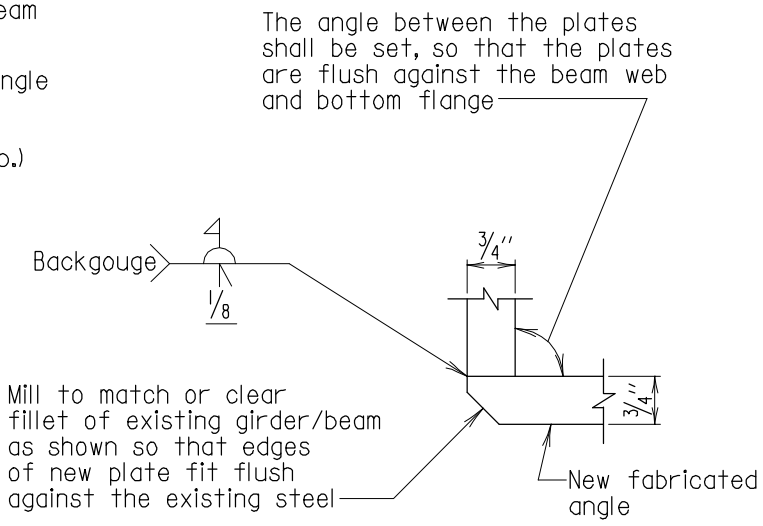
DETAIL NO. SR-ST(SR)-102 SHEET 1 OF 2



SECTION A-A
Scale: 1"=1'-0"

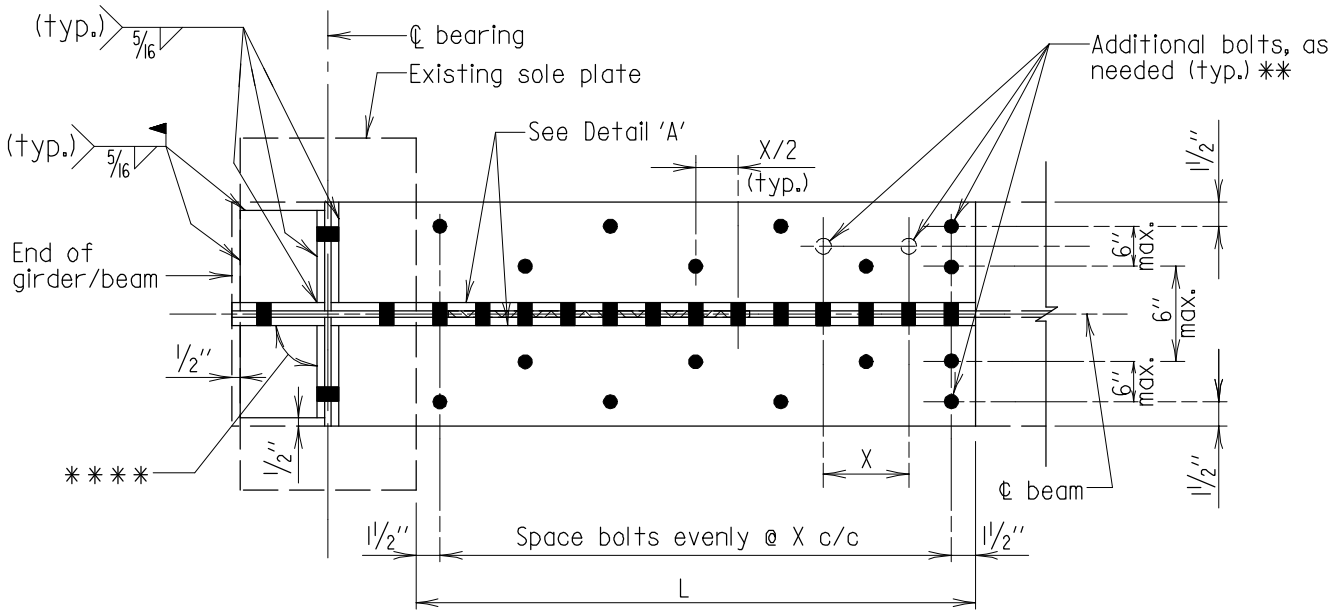


SECTION B-B
Scale: 1"=1'-0"



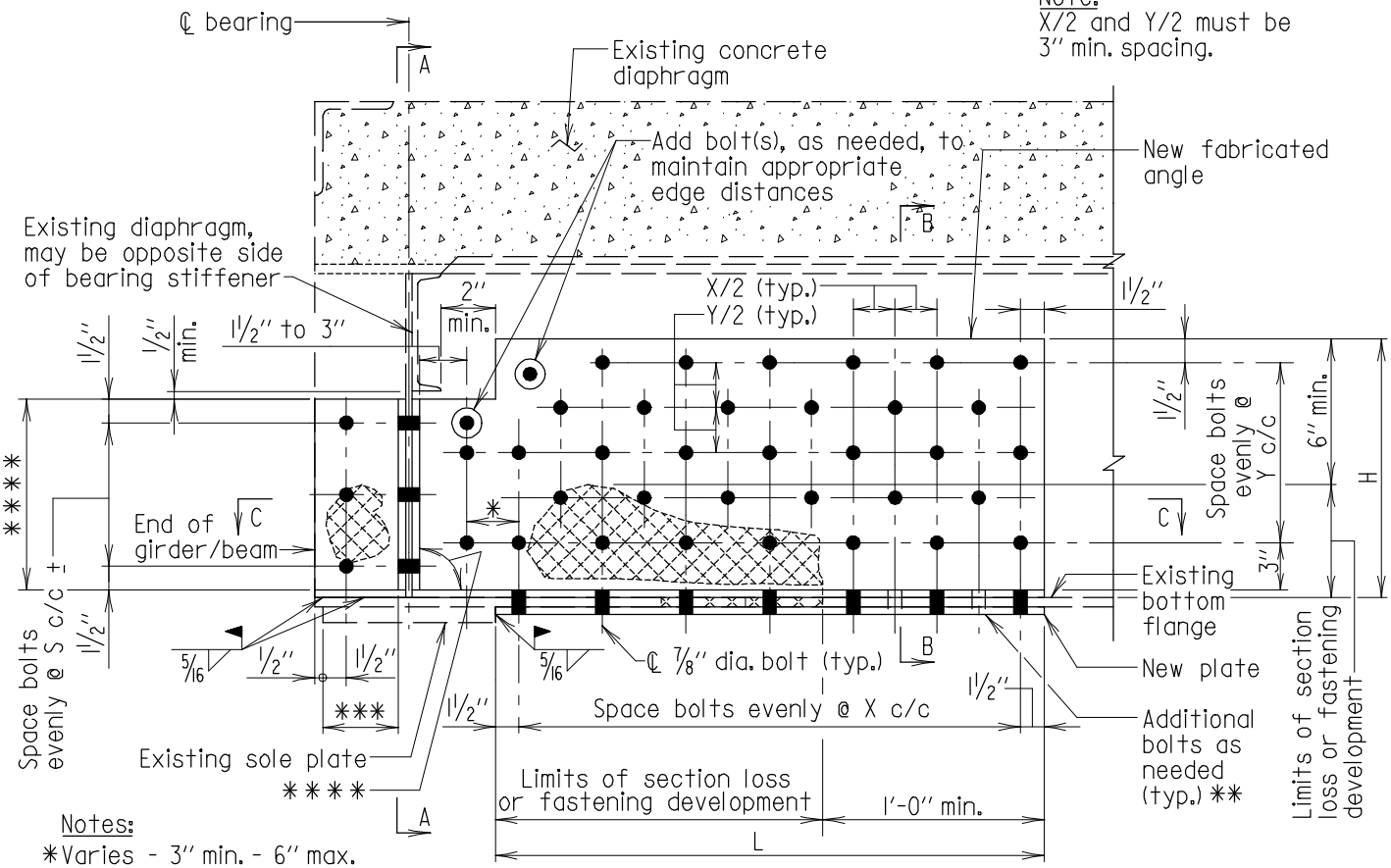
DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	INTERIOR GIRDER/BEAM END PLATING DETAILS - CONCRETE DIAPHRAGM
VERSION 1.0	DETAIL NO. SR-ST(SR)-102 SHEET 2 OF 2



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"



Note:
X/2 and Y/2 must be 3" min. spacing.

ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"

Notes:

*Varies - 3" min. - 6" max. spacing of bolts.

**For wide flanges, add bolts spaced at 6" c/c max. along flange width, as needed.

***Requires 4½" min.

****See Note 1 of General Notes.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

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DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
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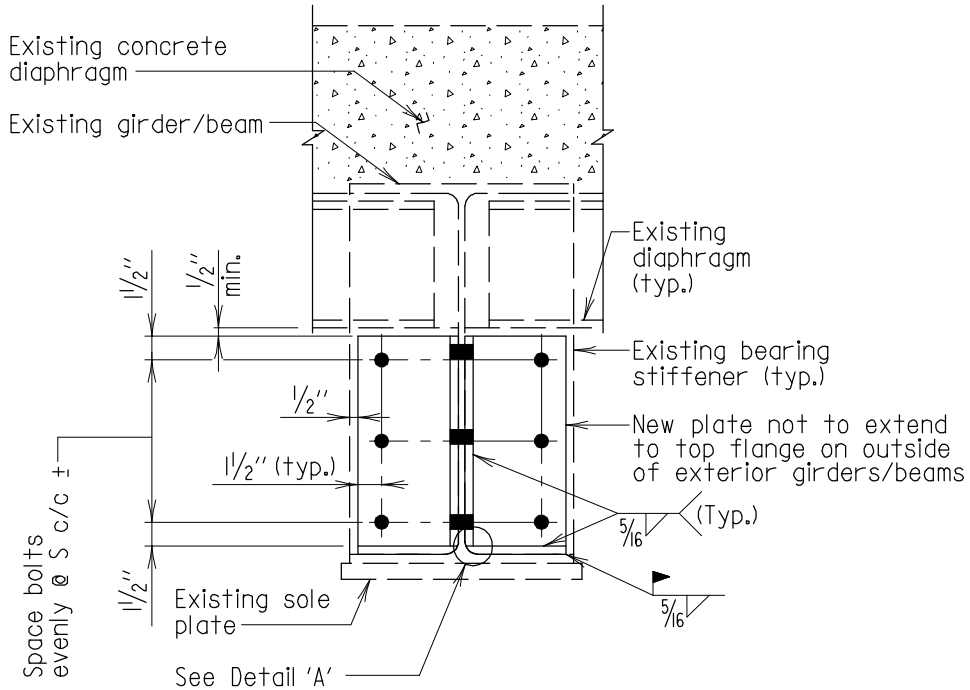
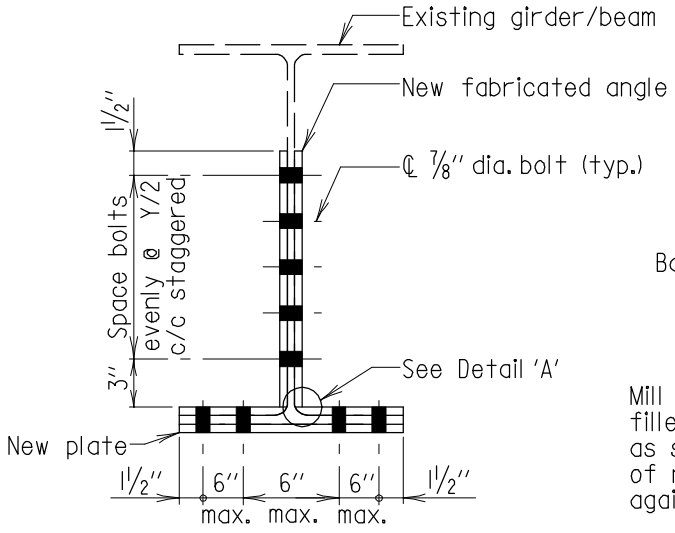
INTERIOR GIRDER/BEAM END PLATING DETAILS - STEEL DIAPHRAGM WITH DETERIORATION BELOW DIAPHRAGM

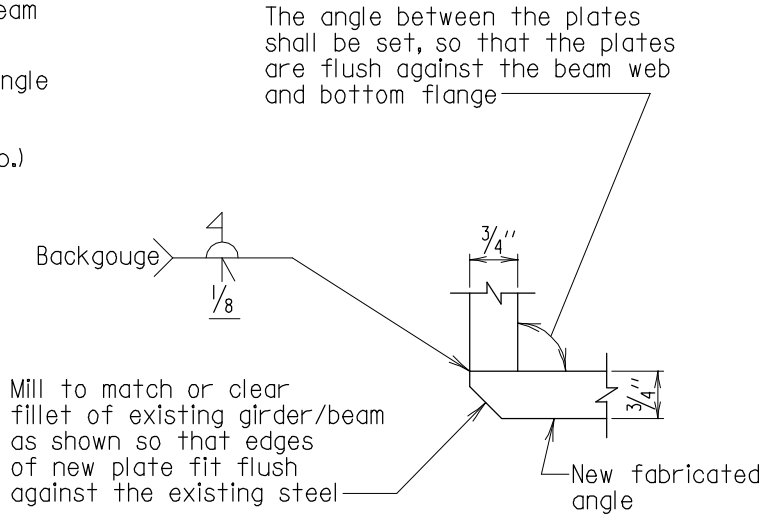
DETAIL NO. SR-ST(SR)-103 SHEET 1 OF 2



SECTION A-A
Scale: 1"=1'-0"

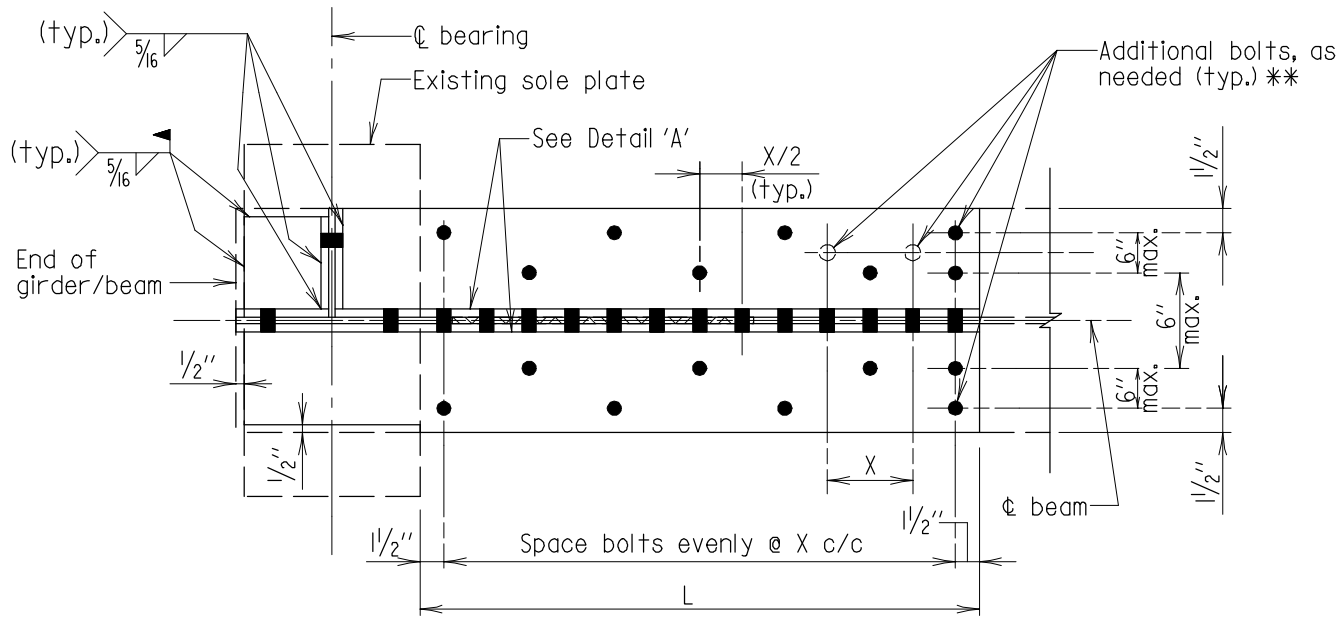


SECTION B-B
Scale: 1"=1'-0"



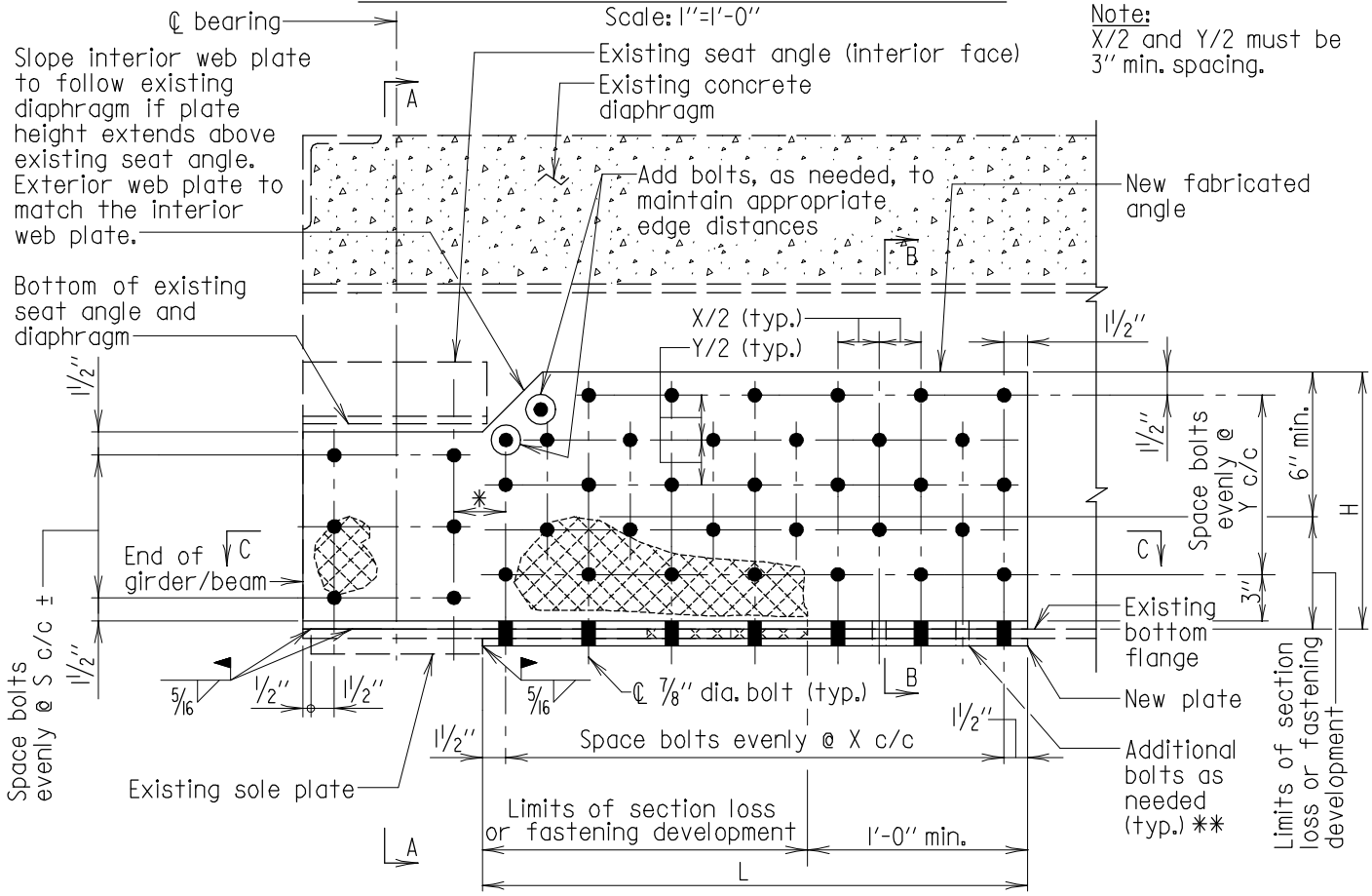
DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	INTERIOR GIRDER/BEAM END PLATING DETAILS - STEEL DIAPHRAGM WITH DETERIORATION BELOW DIAPHRAGM
VERSION 1.0	DETAIL NO. SR-ST(SR)-103 SHEET 2 OF 2



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"



Note:
X/2 and Y/2 must be 3" min. spacing.

ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"

Notes:

*Varies - 3" min. - 6" max. spacing of bolts.

**For wide flanges, add bolts spaced at 6" c/c max. along flange width, as needed.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

APPROVAL
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
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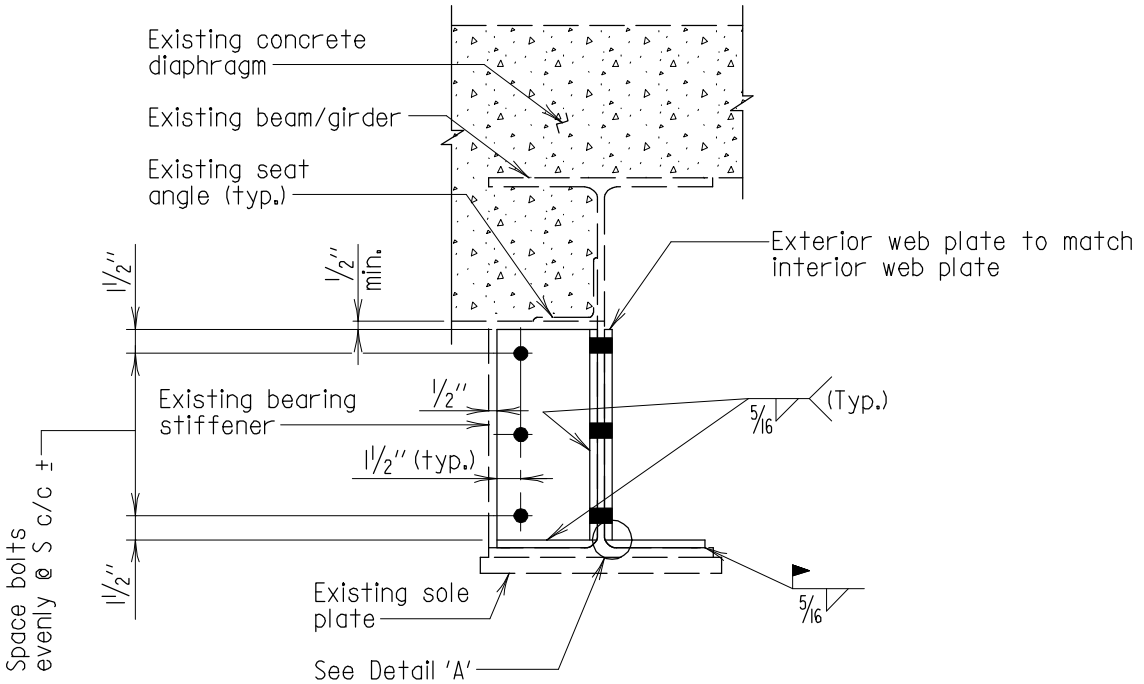
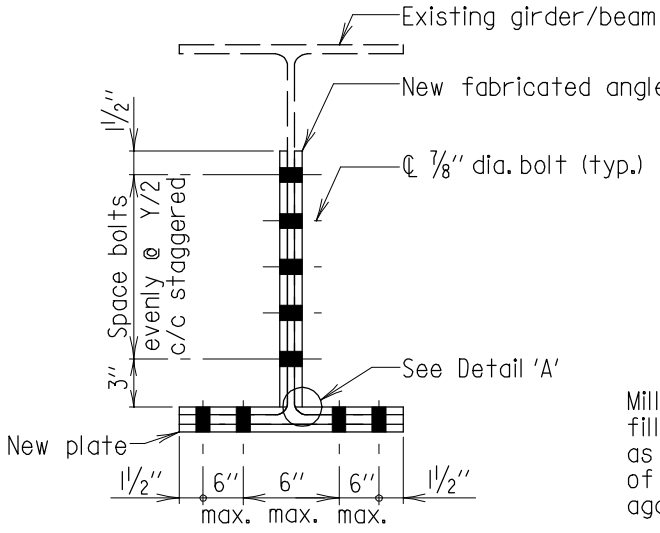
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITHOUT STIFFENER DETAILS - CONCRETE DIAPHRAGM

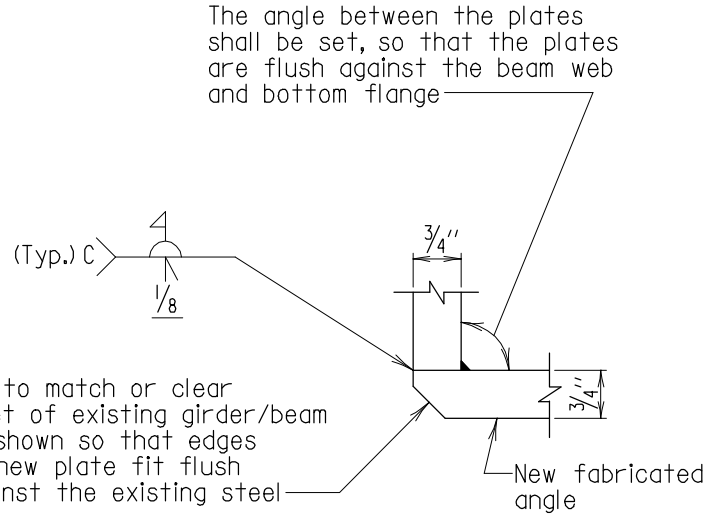
DETAIL NO. SR-ST(SR)-104 SHEET 1 OF 2



SECTION A-A
Scale: 1"=1'-0"

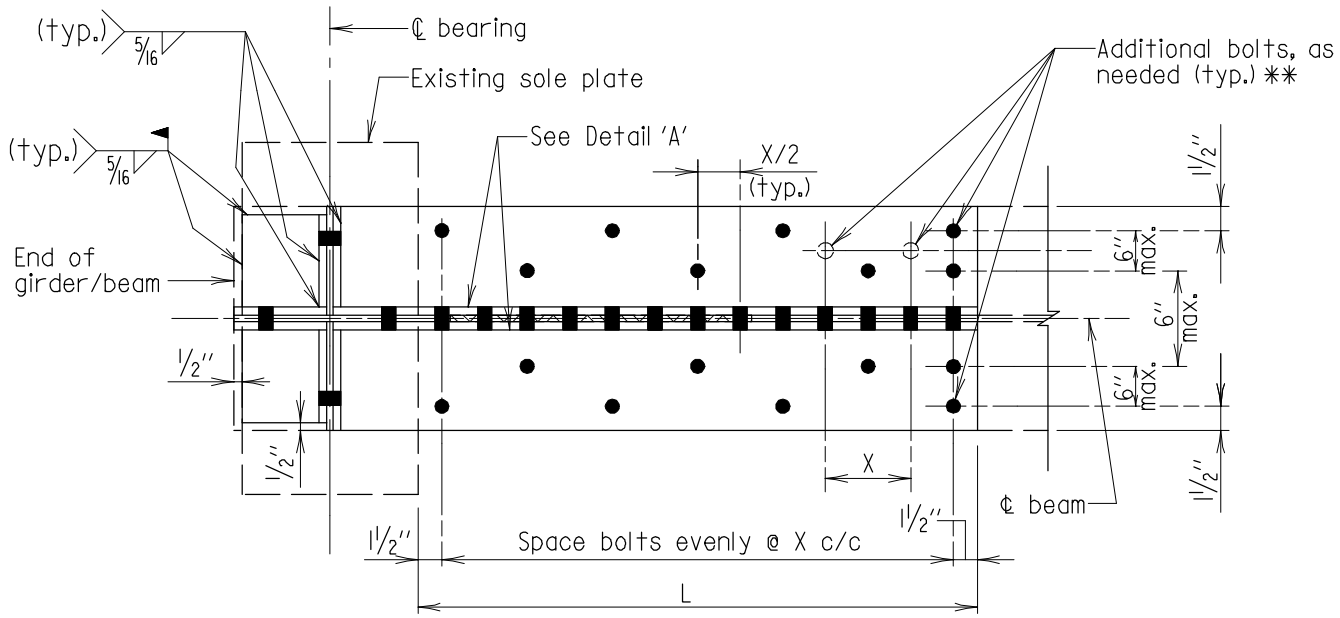


SECTION B-B
Scale: 1"=1'-0"



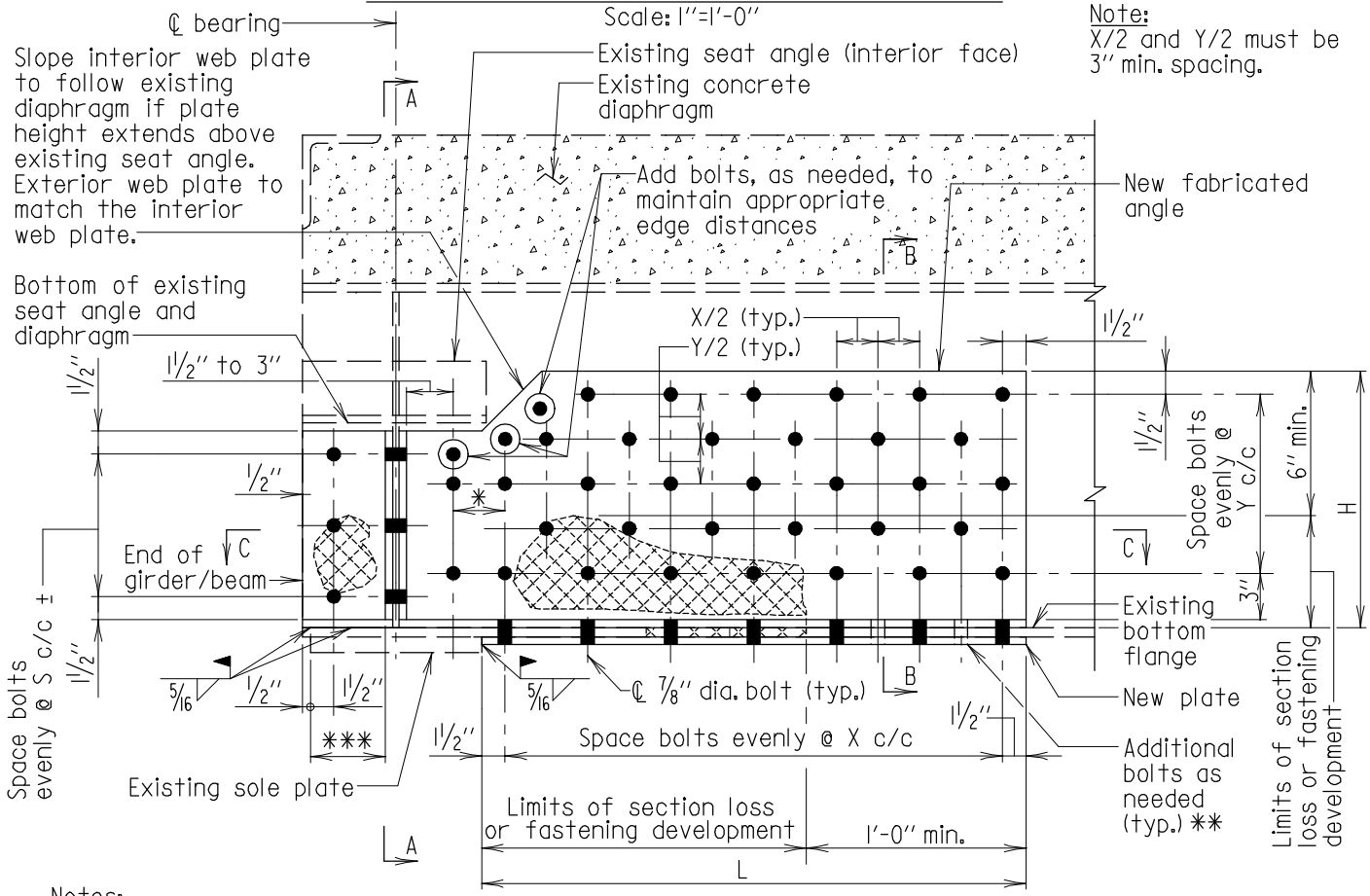
DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITHOUT STIFFENER DETAILS - CONCRETE DIAPHRAGM
VERSION 1.0	DETAIL NO. SR-ST(SR)-104 SHEET 2 OF 2



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"



Note:
X/2 and Y/2 must be 3" min. spacing.

ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"

Notes:

*Varies - 3" min. - 6" max. spacing of bolts.

**For wide flanges, add bolts spaced at 6" c/c max. along flange width, as needed.

***Requires 4½" min.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

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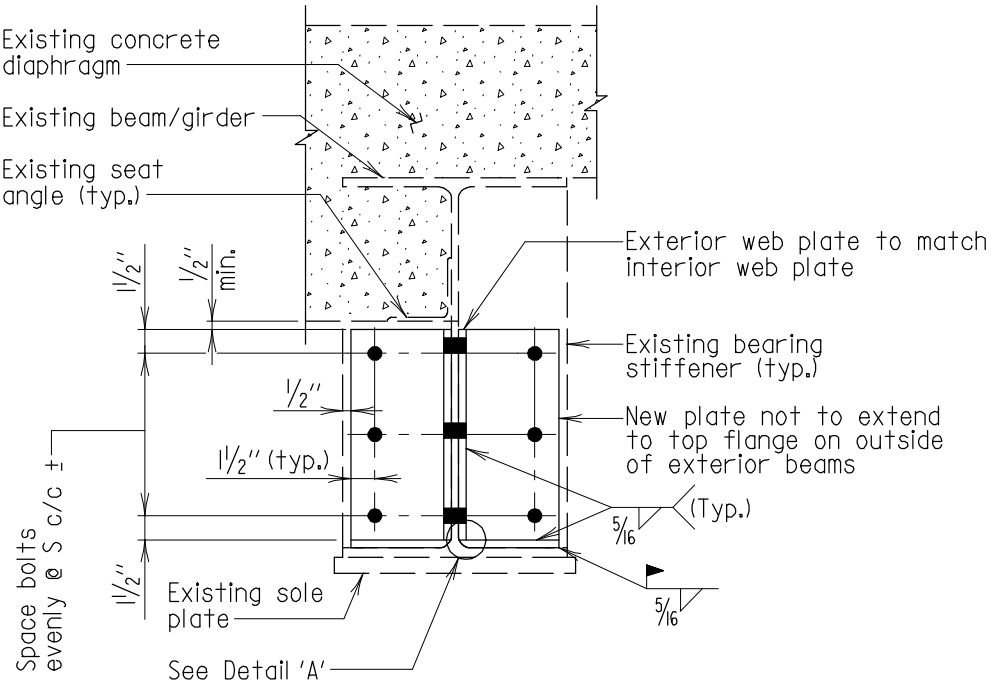
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
1.0

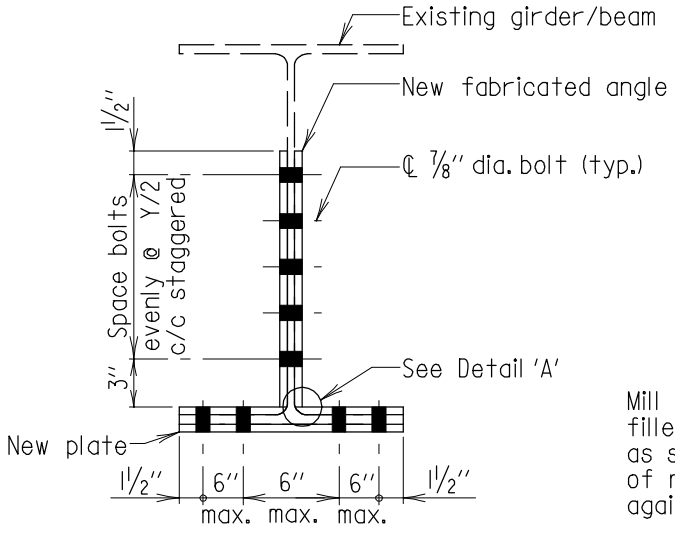
STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITH STIFFENER DETAILS - CONCRETE DIAPHRAGM

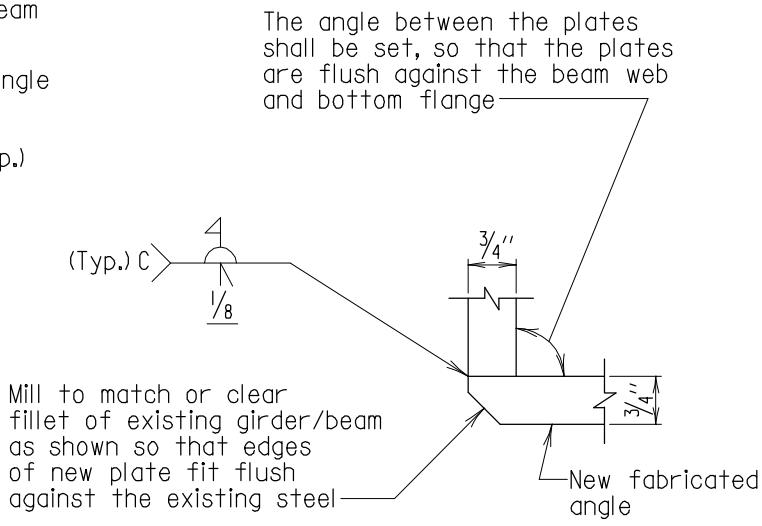
DETAIL NO. SR-ST(SR)-105 SHEET 1 OF 2



SECTION A-A
Scale: 1"=1'-0"



SECTION B-B
Scale: 1"=1'-0"



DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITH STIFFENER DETAILS - CONCRETE DIAPHRAGM
VERSION 1.0	DETAIL NO. SR-ST(SR)-105 SHEET 2 OF 2

Chapter 11 - Structural Repairs

Section 01 – Steel Repairs

SUB-SECTION **05**

NON-STRUCTURAL RETROFITS (SR-ST(NSR))

GENERAL NOTES

1. The Contractor shall verify all dimensions, including but not limited to the height between the beam flange and the diaphragm, the angle between the beam and stiffener, the plumbness of the stiffener, the slope of the top of the bottom flange, limits of section loss, the chamfer for the existing beam fillet, and bolt spacing, etc., before any material is ordered or fabricated. The number of bolts shown in this standard are for representation only. The Contractor shall be responsible for selecting the number of bolts, and the pattern that will satisfy the requirements of the standard.

2. The contractor is to complete the installation of each plating location prior to the end of the work day. No location is to be left with bolt holes drilled and plating not fully bolted.

3. To eliminate any knife edge grind the edge until a 1/8" min. thickness is attained. Polish surface to RMS 128.

4. All bolts shall be A325, Type 1, 7/8" diameter galvanized bolts. All bolts shall be off-vented a minimum of 24 days before installation.

5. The minimum acceptable edge distance for any bolt shall be 1 1/2". The maximum acceptable edge distance for any bolt shall be 3". However, bolt spacing shall be approximately 6".

6. The minimum acceptable center-to-center bolt spacing shall be 3".

7. All bolt holes shall be 15/16 " diameter.

8. The areas of section loss and pitting shall be filled with an approved metal reinforced epoxy filler just prior to installing new steel plates and new fabricated sections.

9. Seal the edges of adjoining plates prior to painting.

10. All new steel and areas to be plated shall be cleaned and painted in accordance with Section 430. The color shall match the existing beams, unless otherwise specified in the contract.

11. All structural steel shall be 3/4" thick and conform to A709, Grade 50.

12. The Contractor shall submit as built plans to the Office of Structures of the details of the bearing stiffener plating used at each location. The bolt spacing specified is the maximum spacing allowed. Bolt spacing should be evenly spaced.

13. Bolt heads shall be on the exterior face of the fascia beam/girder.

PLATING LOCATION AND SIZE CHART								
BEAM	SPAN	SUPPORT	L	H	X	Y	S	COMMENTS

Legend:
L - length of bottom flange retrofit
H - height of retrofit
X - bolt spacing (horizontal)
Y - bolt spacing (vertical)
S - stiffener vertical bolt spacing

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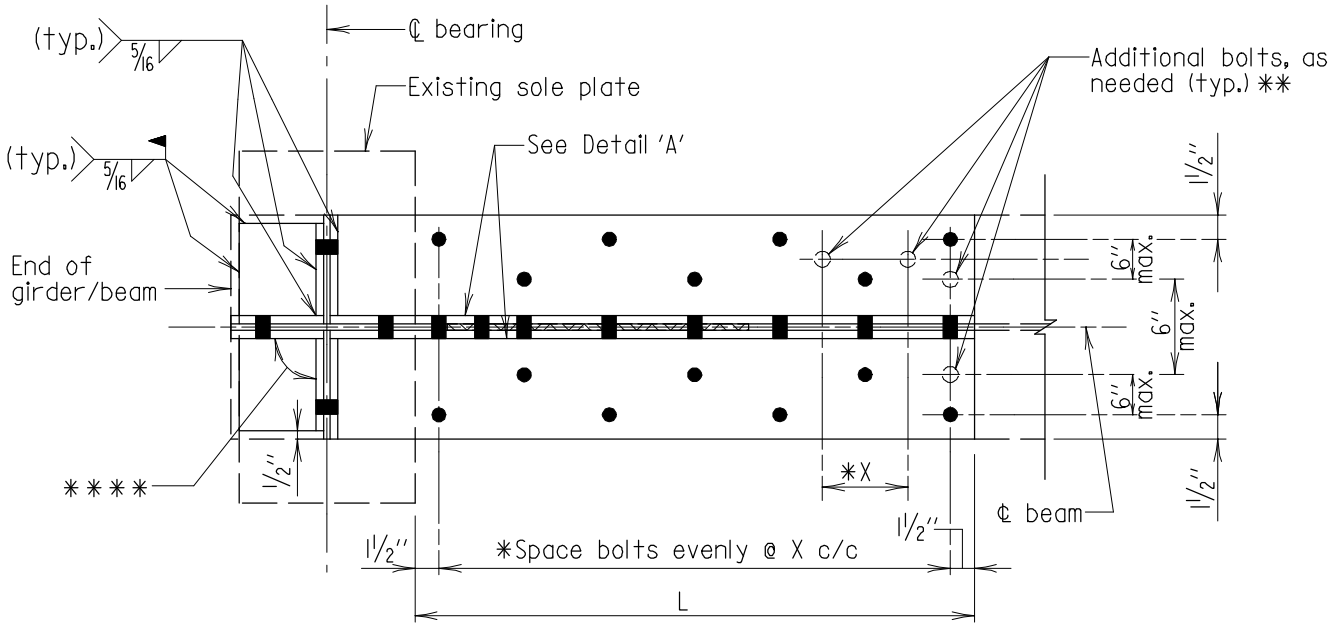
Glenn S. Vaughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

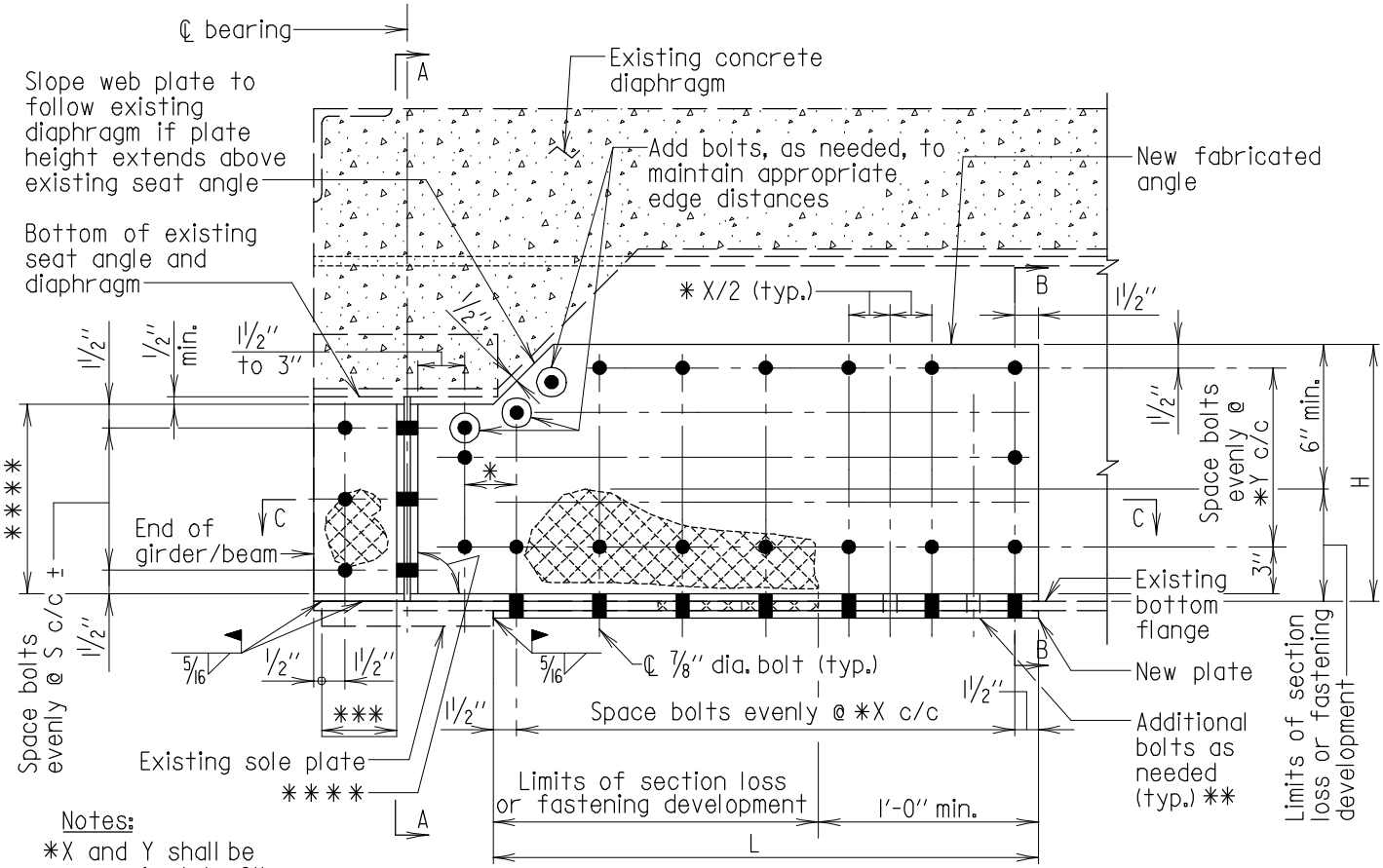
NON-STRUCTURAL
GIRDER/BEAM END PLATING
GENERAL NOTES

DETAIL NO. SR-ST(NSR)-101 SHEET 1 OF 1



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"



ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"

Notes:

*X and Y shall be approximately 6" spacing.

**For wide flanges, add bolts spaced at 6" c/c max. along flange width, as needed.

***Requires 4½" min.

****See Note 1 of General Notes.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

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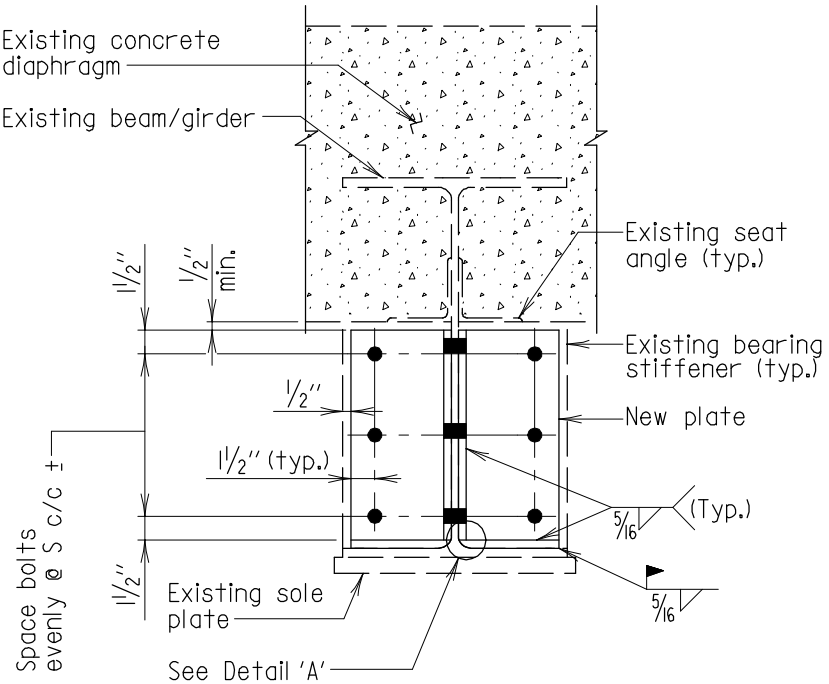
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
1.0

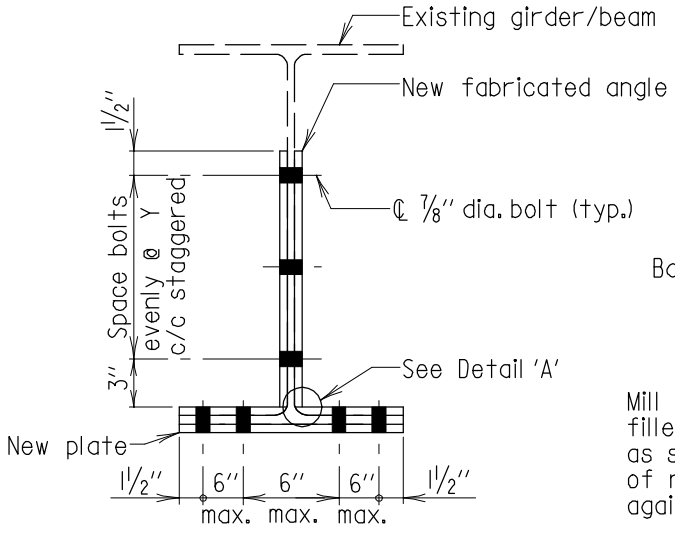
STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

NON-STRUCTURAL INTERIOR GIRDER/BEAM END PLATING DETAILS - CONCRETE DIAPHRAGM

DETAIL NO. SR-ST(NSR)-102 SHEET 1 OF 2



SECTION A-A
Scale: 1"=1'-0"



SECTION B-B
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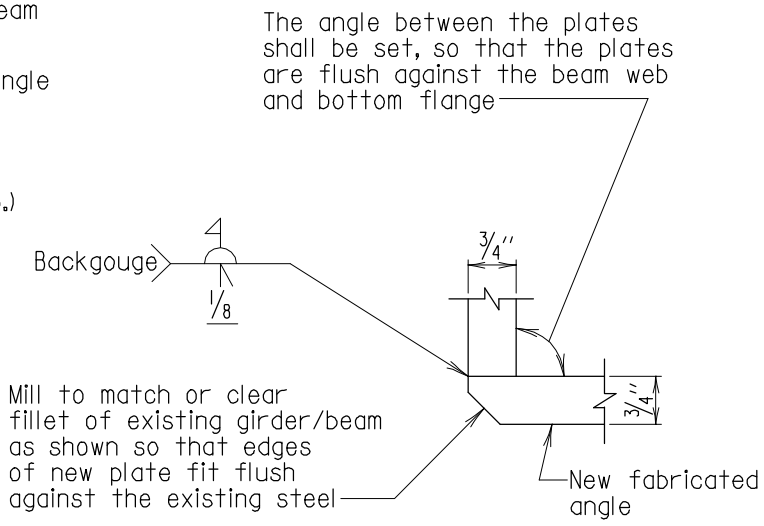
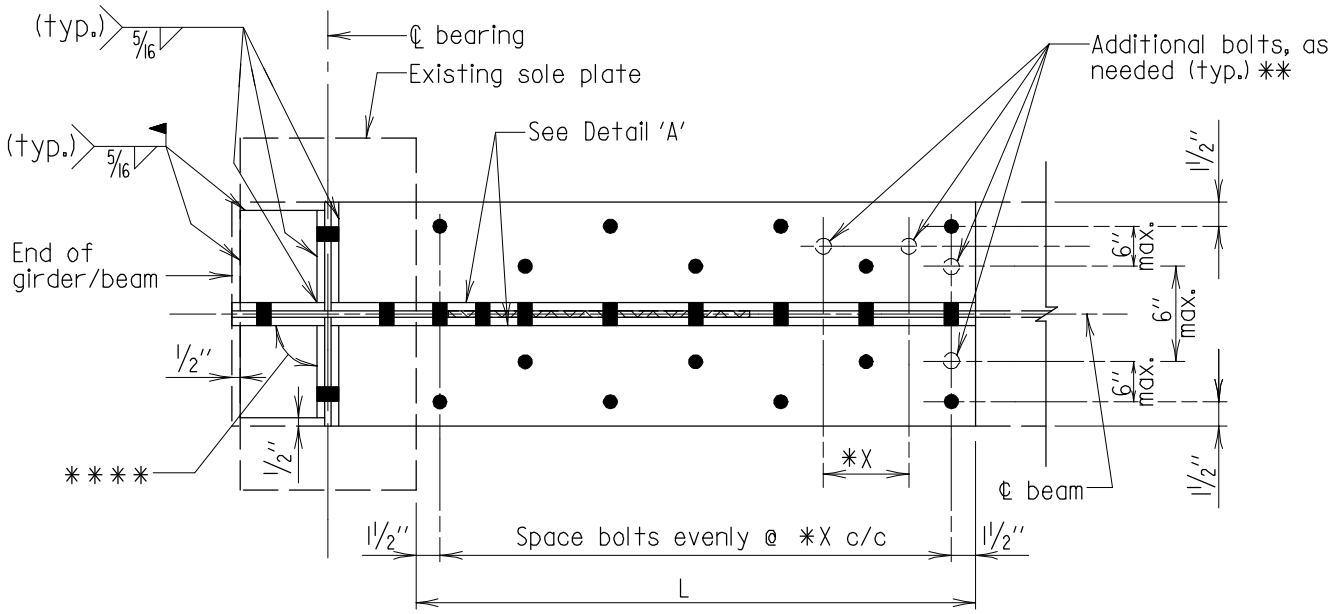


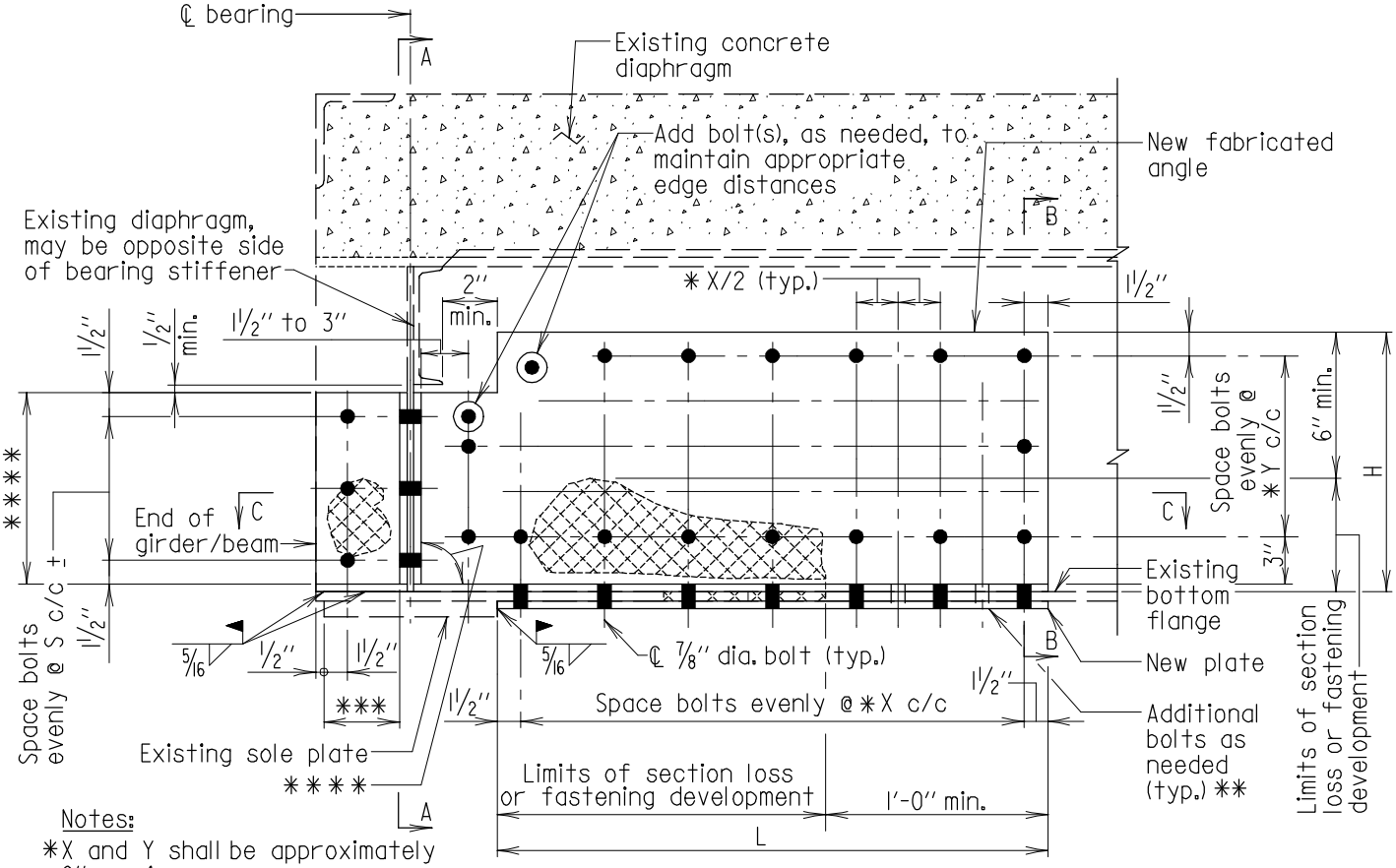
DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	NON-STRUCTURAL INTERIOR GIRDER/BEAM END PLATING DETAILS - CONCRETE DIAPHRAGM
VERSION 1.0	DETAIL NO. SR-ST(NSR)-102 SHEET 2 OF 2



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1''=1'-0''



ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1''=1'-0''

Notes:

*X and Y shall be approximately 6'' spacing.

**For wide flanges, add bolts spaced at 6'' c/c max. along flange width, as needed.

***Requires 4½'' min.

****See Note 1 of General Notes.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

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Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
1.0

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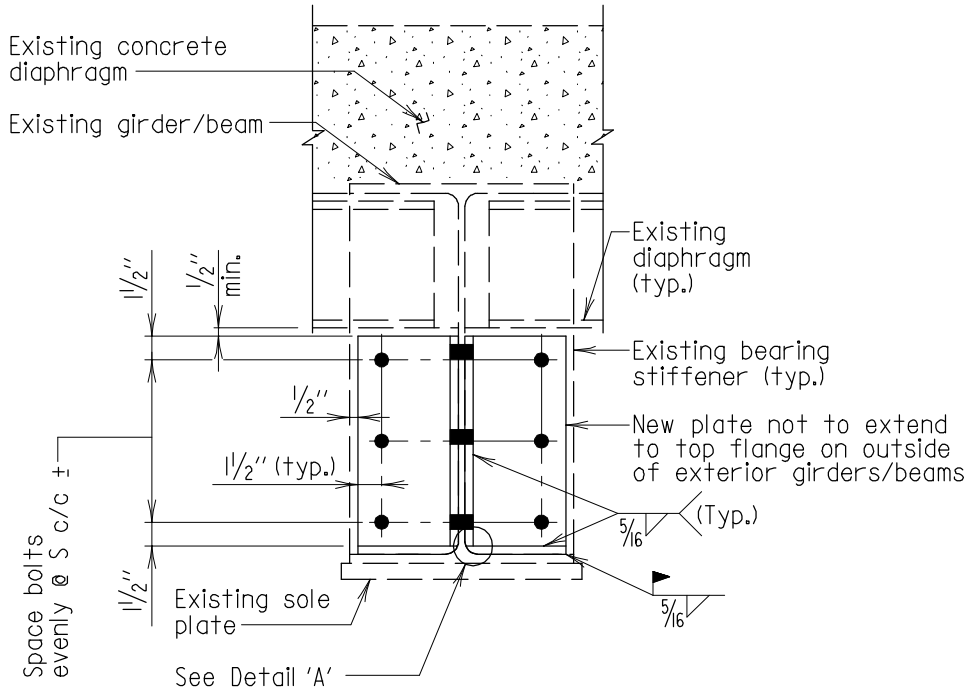
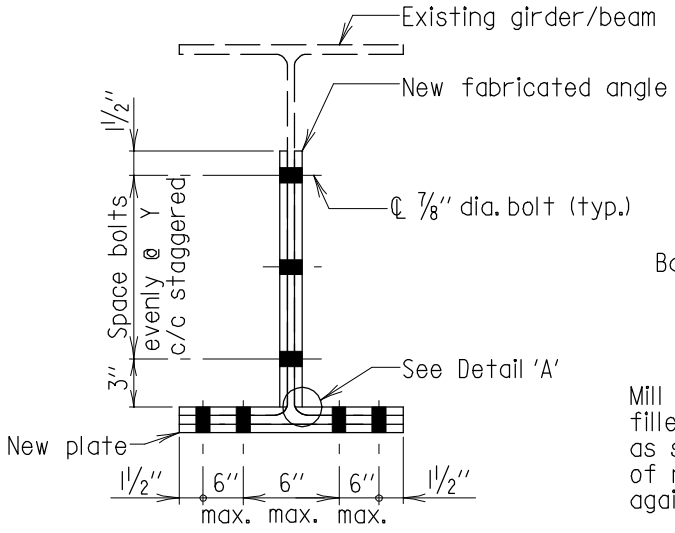
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

NON-STRUCTURAL INTERIOR GIRDER/BEAM END PLATING DETAILS - STEEL DIAPHRAGM WITH DETERIORATION BELOW DIAPHRAGM

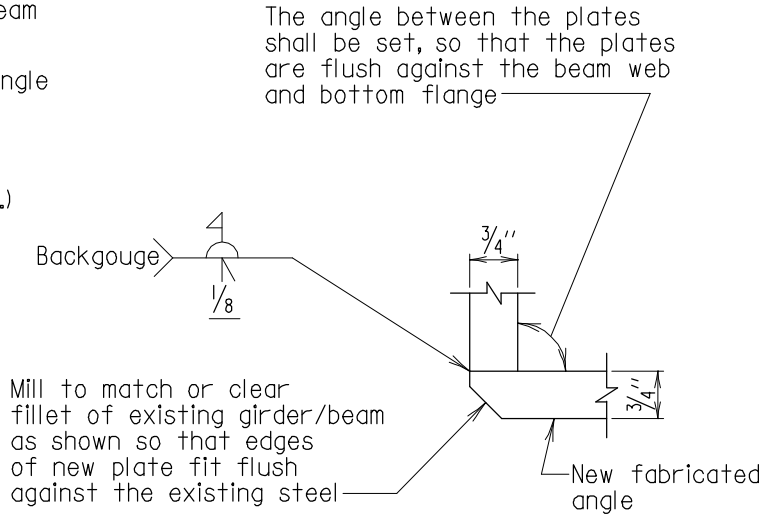
DETAIL NO. SR-ST(NSR)-103 SHEET 1 OF 2



SECTION A-A
Scale: 1''=1'-0''

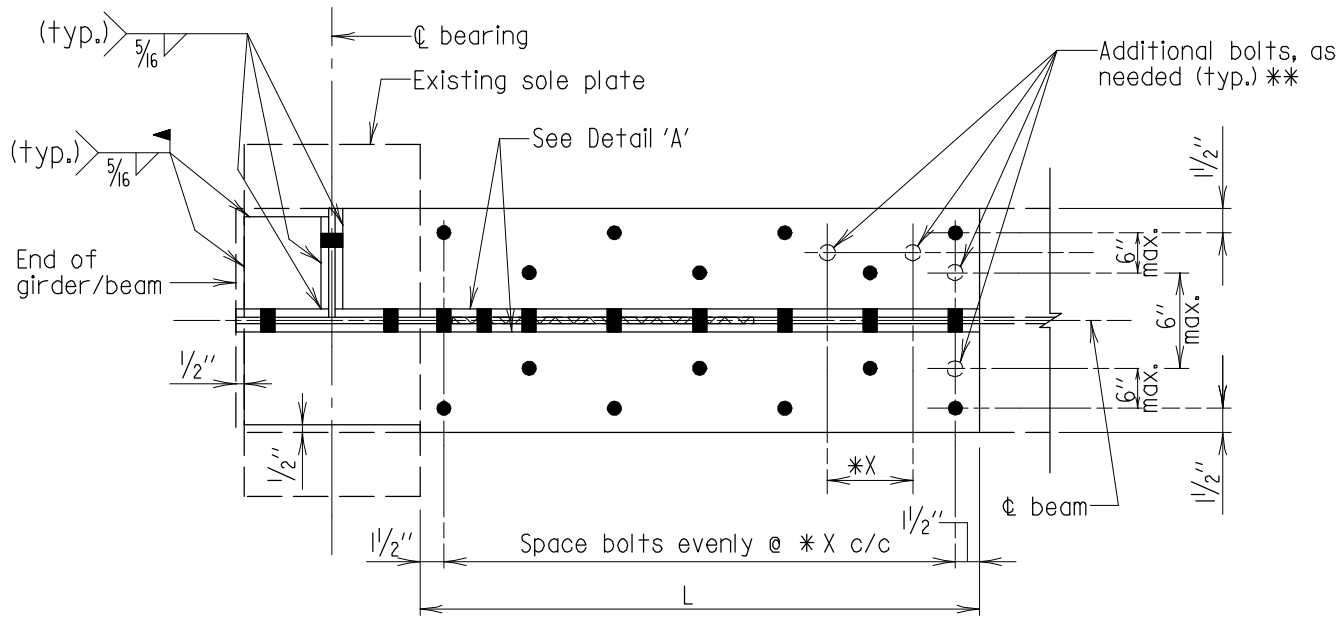


SECTION B-B
Scale: 1''=1'-0''



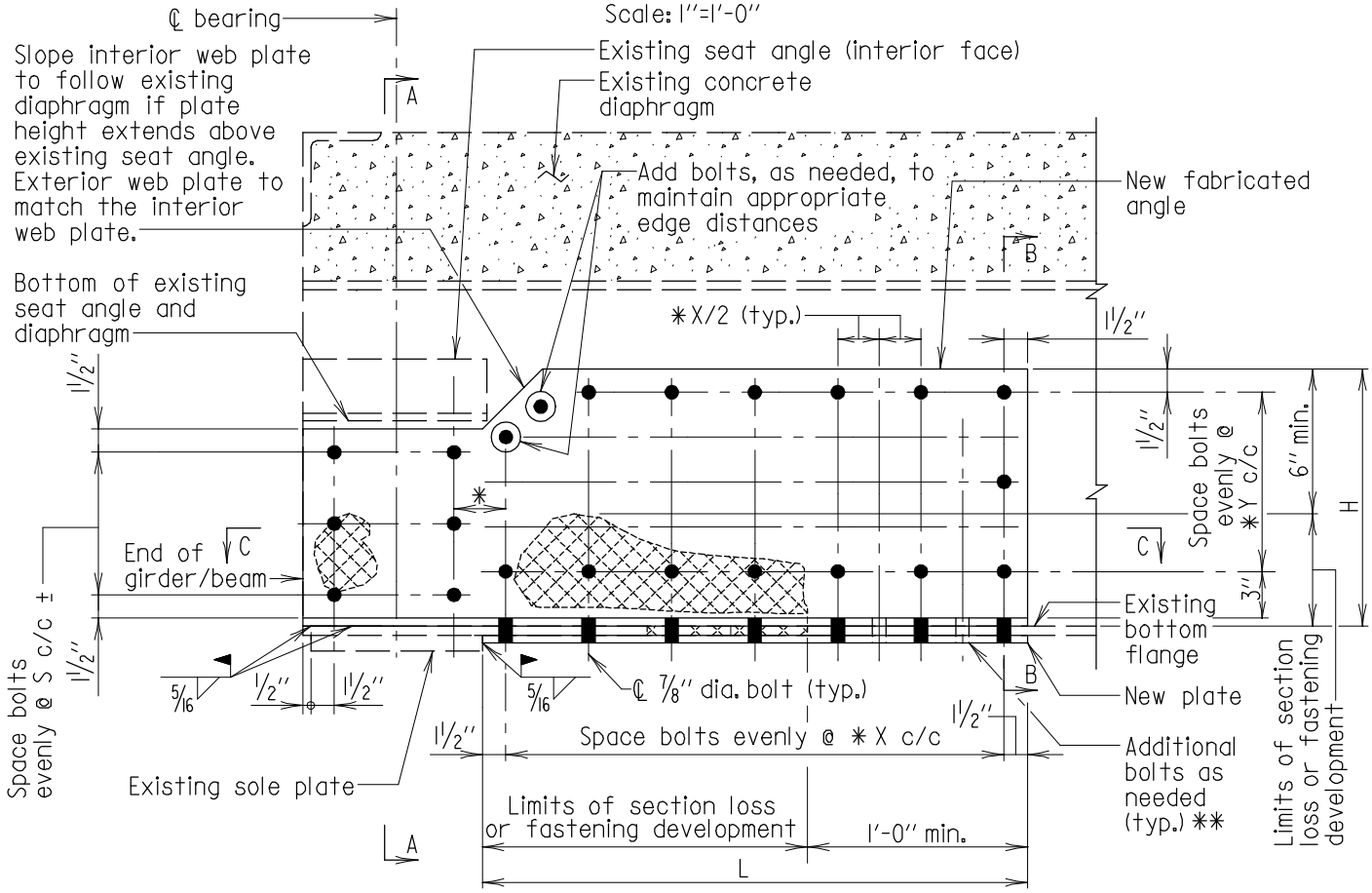
DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	NON-STRUCTURAL INTERIOR GIRDER/BEAM END PLATING DETAILS - STEEL DIAPHRAGM WITH DETERIORATION BELOW DIAPHRAGM
VERSION 1.0	DETAIL NO. SR-ST(NSR)-103 SHEET 2 OF 2



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"



ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1"=1'-0"

Notes:

*X and Y shall be approximately 6" spacing.

**For wide flanges, add bolts spaced at 6" c/c max. along flange width, as needed.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

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DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
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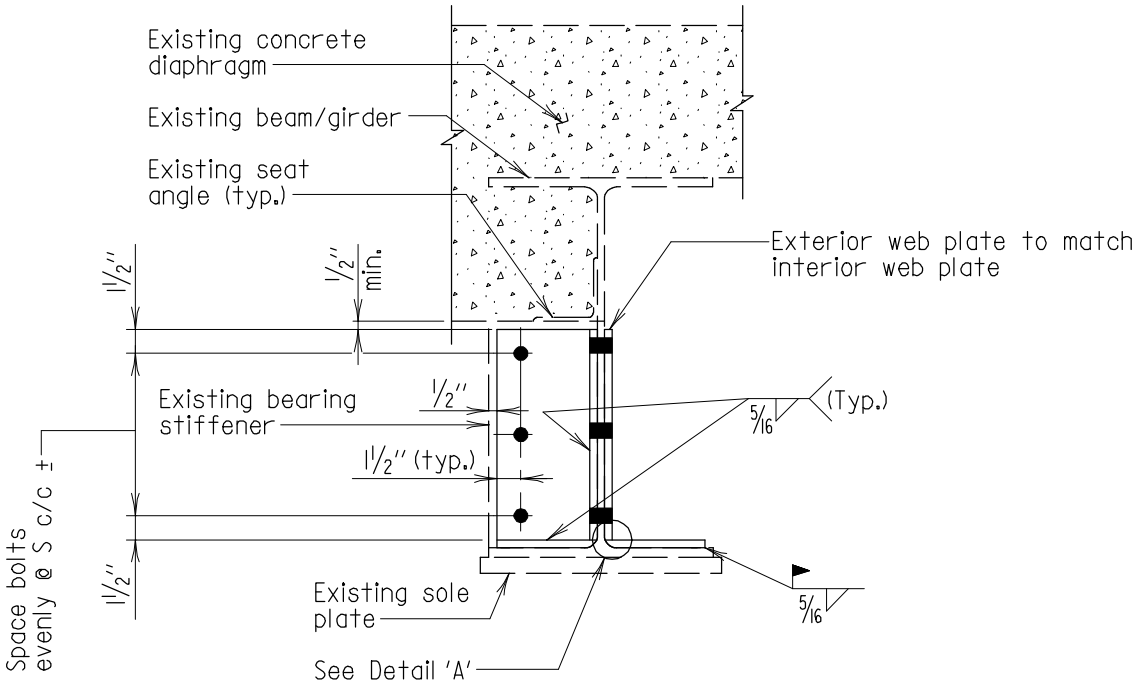
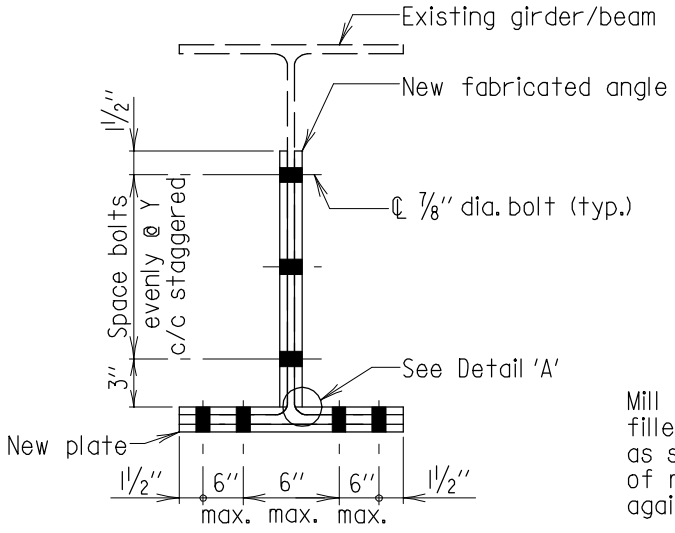
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

NON-STRUCTURAL EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITHOUT STIFFENER DETAILS - CONCRETE DIAPHRAGM

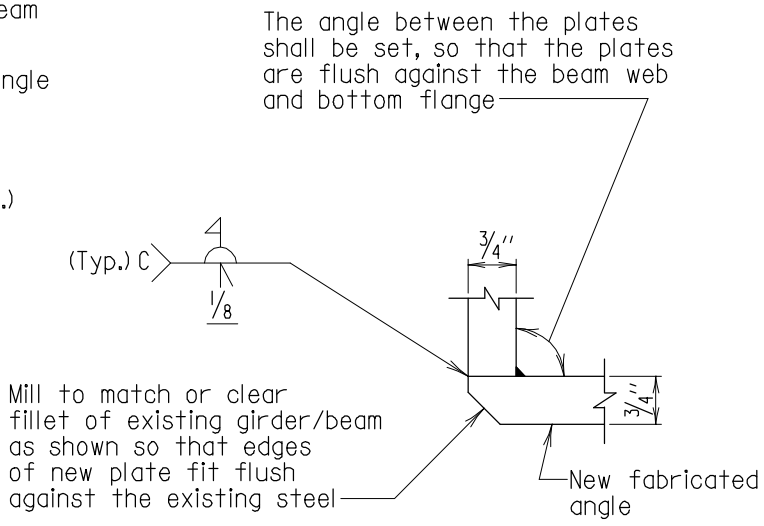
DETAIL NO. SR-ST(NSR)-104 SHEET 1 OF 2



SECTION A-A
Scale: 1''=1'-0''

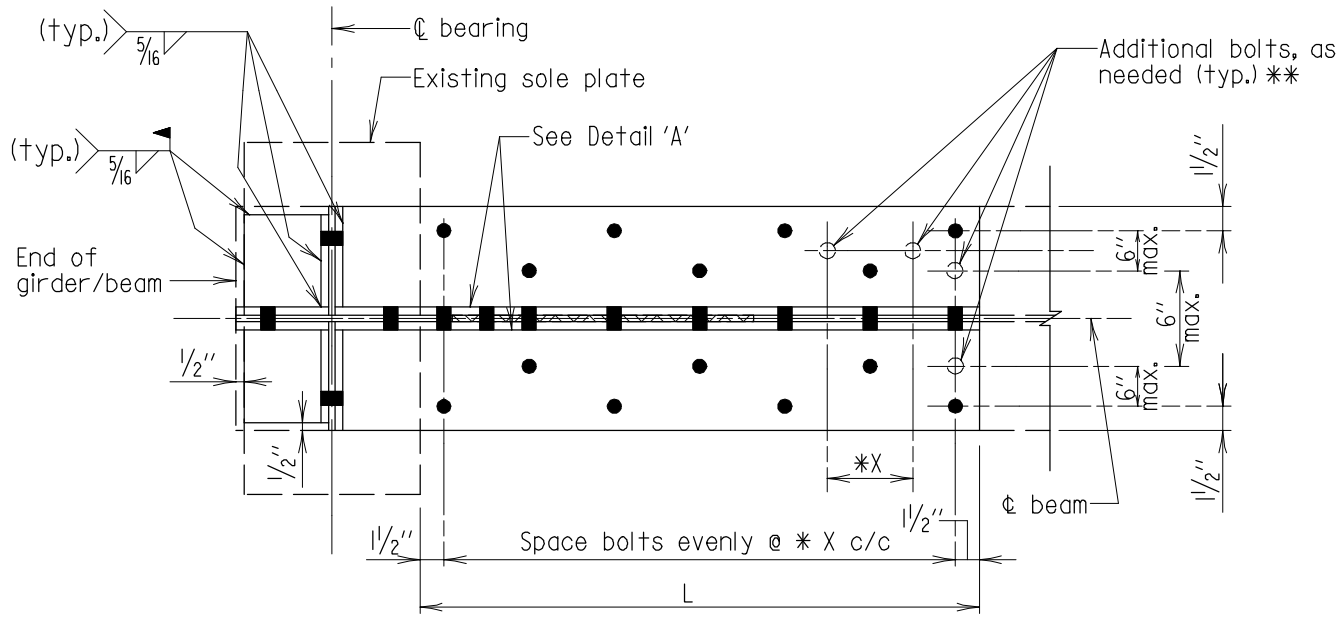


SECTION B-B
Scale: 1''=1'-0''



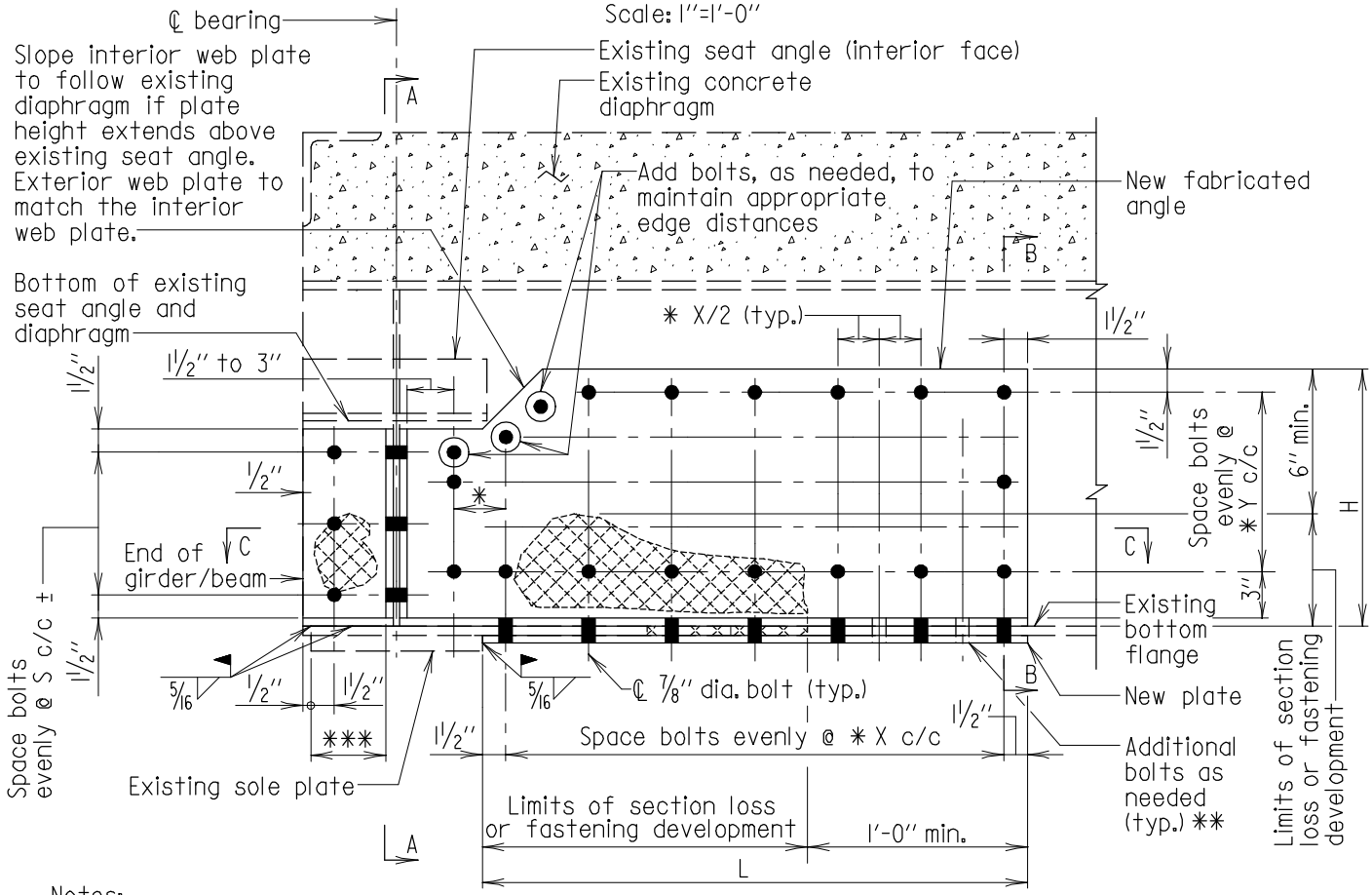
DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES NON-STRUCTURAL EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITHOUT STIFFENER DETAILS - CONCRETE DIAPHRAGM
Kevin C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	
VERSION	
1.0	DETAIL NO. SR-ST(NSR)-104 SHEET 2 OF 2



SECTION C-C - SECTION LOSS REPAIR - BEAM END

Scale: 1''=1'-0''



ELEVATION - SECTION LOSS REPAIR - BEAM END

Scale: 1''=1'-0''

Notes:

*X and Y shall be appoximately 6" spacing.

**For wide flanges, add bolts spaced at 6'' c/c max. along flange width, as needed.

***Requires 4 1/2'' min.

See General Notes for detail sizing.

See sheet 2 of 2 for Section A-A and Section B-B.

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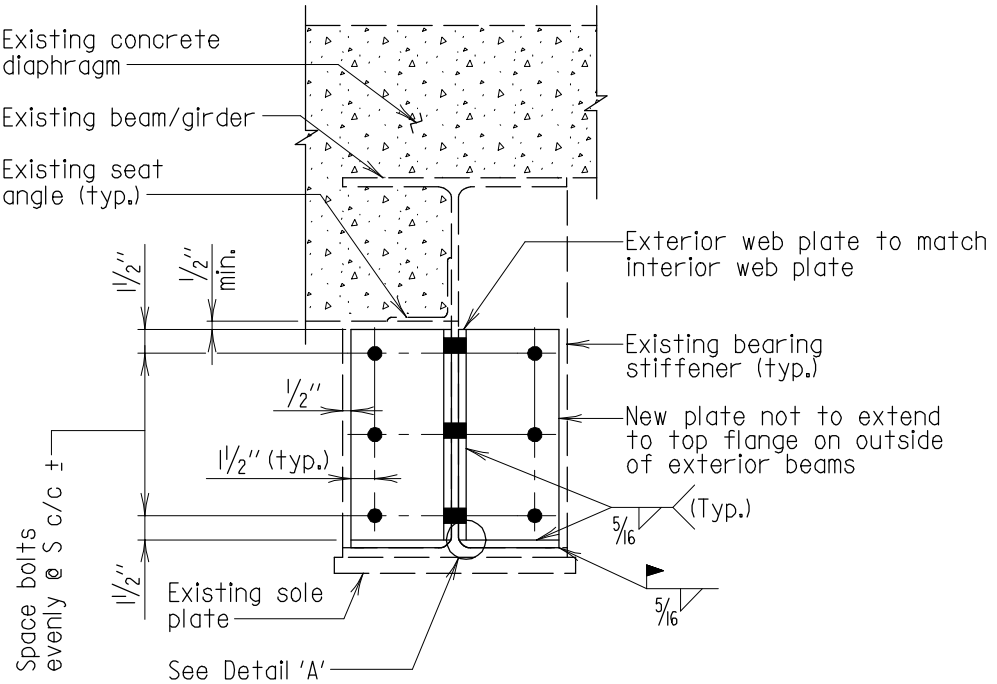
Kam C Waughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
1.0

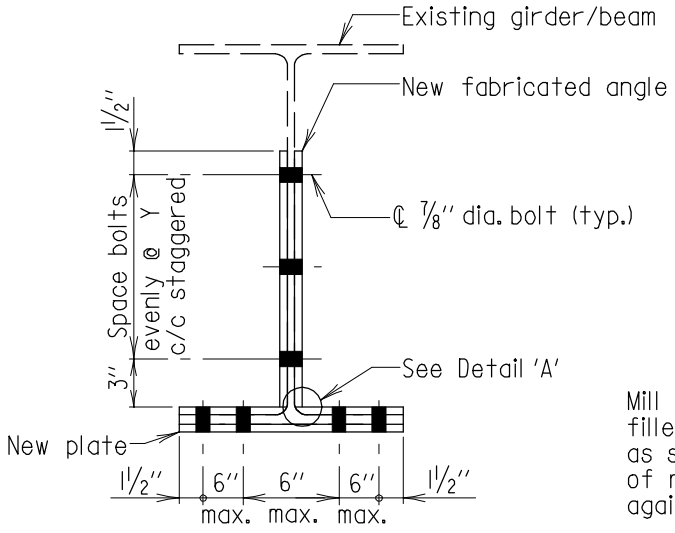
STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

NON-STRUCTURAL EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITH STIFFENER DETAILS - CONCRETE DIAPHRAGM

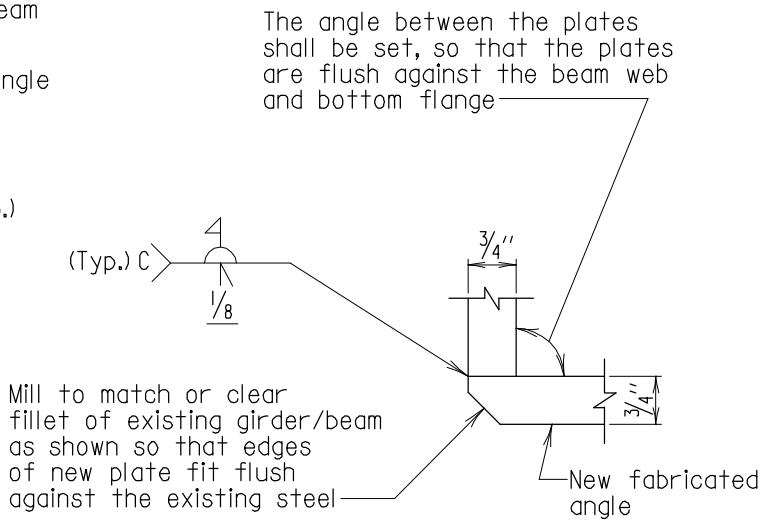
DETAIL NO. SR-ST(NSR)-105 SHEET 1 OF 2



SECTION A-A
Scale: 1''=1'-0''



SECTION B-B
Scale: 1''=1'-0''



DETAIL 'A'
Scale: None

APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES NON-STRUCTURAL EXTERIOR GIRDER/BEAM END PLATING OUTSIDE FACE WITH STIFFENER DETAILS - CONCRETE DIAPHRAGM
Kevin C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	
VERSION	
1.0	DETAIL NO. SR-ST(NSR)-105 SHEET 2 OF 2

Chapter 11 - Structural Repairs

Section 01 – Steel Repairs

SUB-SECTION **06**

HEAT STRAIGHTENING (SR-ST(HS))

GENERAL HEATING PROCEDURES - DESIGN GUIDE:

Limits of heat straightening:

1. The maximum heating temperature of the steel does not exceed either (a) the lower critical temperature (the lowest temperature at which molecular changes occur), or (b) the temper limit for quench and tempered steels. Refer to the "limits of temperatures for heating" section below for details.
2. The stresses produced by applied external forces do not exceed the yield stress of the steel in its heated condition.
3. Only the regions in the vicinity of the plastically deformed zones are to be heated.

Limits of temperatures for heating:

The maximum temperature recommended by research is 650°C or 1200°F for all but quenched and tempered high-strength steel. Higher temperatures may damage the steel or change its molecular composition. The maximum temperature recommended by research for quenched and tempered high strength steel is 590°C or 1100°F. For Grade 70w only, it is recommended to use 565°C or 1050°F in order to provide a safety factor of 30°C or 50°F.

Bridge engineer should:

* Analyze the degree of damage and maximum strains induced.
* Conduct a structural analysis of the system in its damaged configurations.
* Select applicable regions for heat straightening repair.
* Select heating patterns and design the jacking restraint configuration.
* Estimate heating cycles required to straighten members.
* Prepare Plans and Specifications.

MDSHA Lab shall be present for all heat straightening projects.

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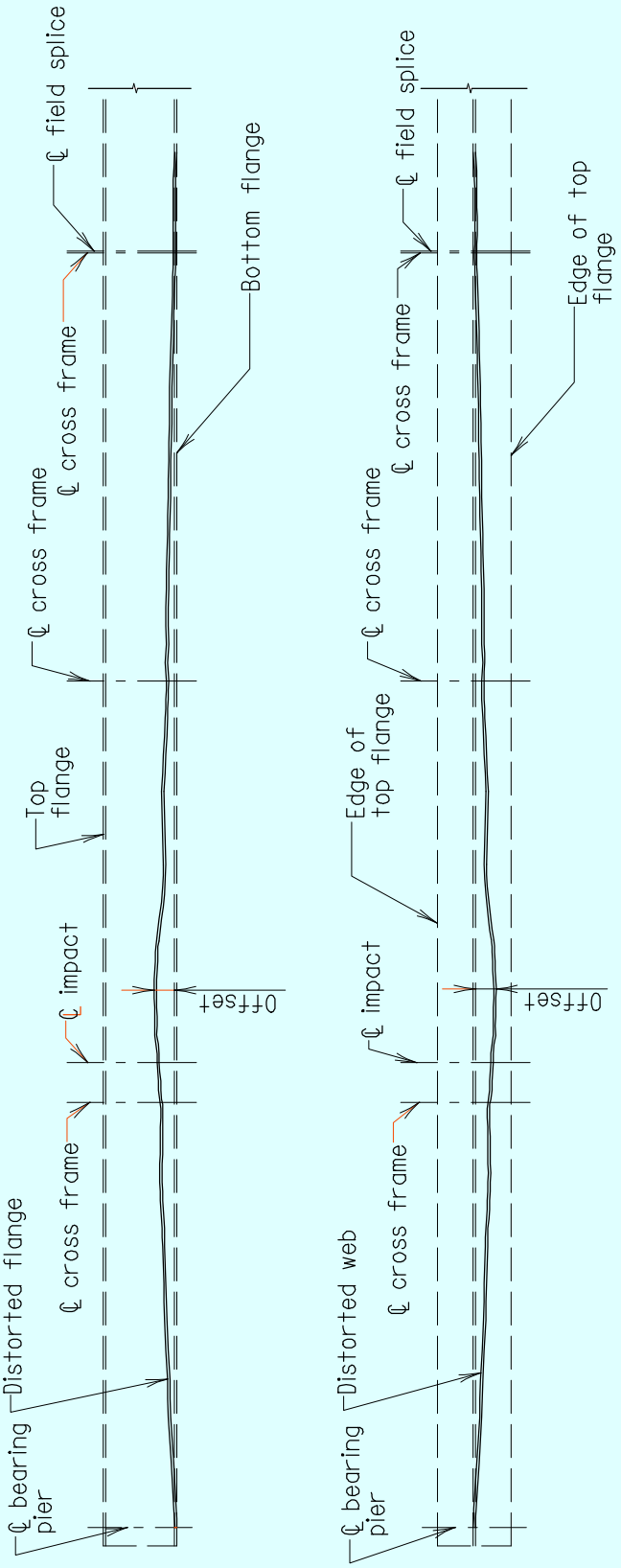
APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Sam C Dauphin DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING GENERAL HEATING PROCEDURES DESIGN GUIDE
VERSION 1.0	DETAIL NO. SR-ST(HS)-101 SHEET 1 OF 1

STRUCTURAL REPAIRS



TYPICAL GIRDER LAYOUTS

Scale: $\frac{3}{8}$" = 1'-0"

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APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING WEB STRAIGHTENING DETAILS DESIGN FIELD MEASUREMENTS
VERSION 1.0	DETAIL NO. SR-ST(HS)-102 SHEET 1 OF 2

STRUCTURAL REPAIRS

WEB OUT-OF-PLANE SWEEP		
DISTANCE ALONG BEAM (FT.) *	△ VALUES (2' DOWN) (IN.)	EXTRAPOLATED △ VALUES (4' DOWN) (IN.)
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FLANGE OUT-OF-PLANE ROTATION	
DISTANCE ALONG BEAM (FT.) *	△ VALUES (IN.)
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WEB OUT-OF-PLANE SWEEP		
DISTANCE ALONG BEAM (FT.) **	△ VALUES (2' DOWN) (IN.)	EXTRAPOLATED △ VALUES (4' DOWN) (IN.)
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FLANGE OUT-OF-PLANE ROTATION	
DISTANCE ALONG BEAM (FT.) **	△ VALUES (IN.)
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Kevin C. Vaughan DIRECTOR OFFICE OF STRUCTURES
DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF STRUCTURES

HEAT STRAIGHTENING
WEB STRAIGHTENING DETAILS
DESIGN FIELD MEASUREMENTS

DETAIL NO. SR-ST(HS)-102 SHEET 2 OF 2

STRUCTURAL REPAIRS

CONSTRUCTION GUIDE:

Limits of temperatures for heating:
The member(s) being heat straightened is composed of XXX high strength steel and shall be heated to a maximum temperature of XX°C or XX°F.

Contractor shall work in the defined temperature and make sure not to damage the existing girder with excessive heating.

Use air cooling between temperatures 650°C or 1200°F to 315°C or 600°F,
Below 315°C or 600°F rapid cooling is acceptable.
If using water to cool beam from 315°C or 600°F to air temperature contractor shall do the following:

1. A mist applicator which allows the technician to remain at a safe distance.
2. Protective clothing and goggles are needed for the technician.
3. Have a method for safely disposing of the waste water.

When handling gas tanks:
* Always place a protective cap on head of tank before handling.
* Always secure tanks prior to heat straightening.
* Examine tanks for damage prior to each use.
* Check lines and fixtures for leaks or damage prior to each use and that proper check valves are installed.
* Wear protective goggles while heating (lens is recommended.)
* Be careful of where the lighted torch is pointed at all times.
* Wear protective gloves and clothing.
* Always be in a stable, secure position prior to opening valves and lighting the torch.
* Follow proper procedures when using scaffolding and use safety harnesses when working above the ground.

Restraints:
1. Restraints should be passive during the heating phase; that is, they should be applied before heating and not increased by external means during heating or cooling.
2. Restraints should not impede contraction during the cool phase.
3. Restraints should not produce local buckling of the compression element during the heating phase.
4. Restraints should not produce an unstable structure by either the formation of plastic hinges or member instability during heating phase.

MDSHA Lab shall be present for all heat straightening projects.

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APPROVAL	STATE OF MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION OFFICE OF STRUCTURES
Sean C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING GENERAL HEATING PROCEDURE CONSTRUCTION GUIDE
VERSION 1.0	DETAIL NO. SR-ST(HS)-103 SHEET 1 OF 3

STRUCTURAL REPAIRS

GENERAL HEATING PROCEDURES:

1. Torch tip sizes are limited to 1" diameter maximum, unless approved by the engineer. Torch tips shall be single orifice, use table FHWA recommended torch tips for flange and web.
2. Heat shall be brought up to between 1000°F and the maximum defined temperature as rapidly as possible. Temperature indicating crayons or heat indicating guns shall be used to closely monitor the steel temporature after the flame has been removed. No heating, including local surface heating, shall occur above 1200°F.
3. Air cool steel down to 250°F. No forced air cooling will be permitted.
4. All of the following procedures are general guidelines and may be modified to suit field conditions.
5. Any combination of heating patterns, including vee, line strip and spot heats, can be used based on the operator's discretion and girder reaction with the engineer's approval.

REPAIR PROCEDURES:

1. Restrict live load on bridge in lanes affected by repair work.
2. Remove cross frames as required as approved by the engineer.
3. All burrs, nicks, gouges and scrapes shall be repaired as indicated in the plans prior to heat straightening to the approval of the engineer. All nicks to be ground down and/or sanded in the longitudinal direction of the girder to a surface finish of 125 microinches per inch rms and tapered to the original surface using a 10:1 slope. Refer to SR-ST(GR)-101 if required.
4. Install jacks, falsework, blocking and chain come alongs as needed. Shim tight.
5. Apply heat (see general heating procedures).
6. Correct the horizontal sweep (see horizontal sweep correction procedure) and then straighten the local damage to the bottom flange (see flange straigtening procedure) and/or web (see web straightening procedure).
7. Repeat procedures until girder dimensions are within tolerances.
8. The MDSHA Lab shall inspect welds in all repaired areas in accordnace with AWS D1.5 using the magnetic particle testing method.
9. Repair the stiffeners damaged by vehicle impact at locatons indicated by the engineer.
10. Replace cross frame damaged by impact or directed by the engineer, including associated connection plates, as indicated in the plans.
11. Replace all bolts in splice on the damaged girder in affected span as directed by the engineer.

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Tom Dauphon DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING GENERAL HEATING PROCEDURE CONSTRUCTION GUIDE
VERSION 1.0	DETAIL NO. SR-ST(HS)-103 SHEET 2 OF 3

STRUCTURAL REPAIRS

HORIZONTAL SWEEP CORRECTION PROCEDURE:

1. Layout heat patterns on face of web with soapstone as shown. Primary heating area will require multiple cycles. Heat other areas as required to achieve final tolerances.
2. Layout heat patterns on top and bottom of bottom flange with soapstone as shown.
3. Apply a restraining force horizontally at locations shown. Restraining force to be calculated by the bridge engineer. Heat web in line heat pattern shown on elevation. Start at the outside and work inward toward the centerline of impact.
4. After web heating is completed, start flange heating patterns. Start at apex and work towards the base of the vee in a continuous serpentine motion. Do not return to any portion or any previously heated area during a heating cycle. Use one torch on the top and one on the bottom of the bottom flange at each location. Work outward from the center of the repair until all flange patterns are heated. See heat pattern details on the Heating Pattern and Torch Tip Recommenation Detail.
5. Operate jacks to maintain a constant restaining force. This must be monitored closely by the Contractor.
6. Repeat this procedure until the flange is within the tolerances shown below. Heating locations may be the same as the first cycle or may be staggered if required for straightness since the load will decrease as the flange straightens.

TOLERANCES:

1. Overall - $\frac{1}{2}$" over 20'
   ($\frac{3}{4}$" in 20' at point of impact)
2. Web local deviations = $\frac{1}{4}$" as measured with a straight edge held vertically and horizontally.
3. Local flange deviations - $\frac{1}{4}$" at edges.

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Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING GENERAL HEATING PROCEDURE CONSTRUCTION GUIDE
VERSION	
1.0	DETAIL NO. SR-ST(HS)-103 SHEET 3 OF 3

STRUCTURAL REPAIRS

DEFECT NOTES:

1. The existing paint system on the damaged girder shall be removed in its entirety (from top flange to bottom of bottom flange), SSPC-SP3, from the bearing or 5'-0" past the damage to the right on the girder to the bearing or 5'-0" past the damage to the left on the girder.

2. Where bolts are to be replaced in the splice on the damaged girder in the span that was hit and in the existing connection plate at the cross frame near the damage at adjacent girder and the damaged girder, the existing bolts shall be removed and replaced one at a time with A325 bolts of the same diameter and length.

3. All welds and portions of welds to be removed shall be ground/sanded down to a surface finish of 125 RMS. Surface quality shall conform to the requirements of ASTM A6. Non-destructive testing methods (magnetic particle, dye penetrant and/or ultrasonic) shall be utilized to confirm that no cracks or tears are present in the flanges, webs, stiffeners, connection plates or welds to remain. This testing is to be done by the MDSHA Lab in the presence of the contractor and engineer. If cracks and/or tears are evident, these areas shall be repaired by the contractor to remove all defects.

4. At the completion of the entire heat strenghtening process, as approved by the engineer, all bare metal shall be painted in accordance with section 430 with the color of the final coat matching the existing.

TRAFFIC NOTES:

1. Prior to and during heat staightening operations, weld repairs and replacements, stiffener repairs, and connection plate repairs, all vehicular traffic shall be removed from the damaged girder on the bridge in accordance with Maryland Traffic Standard No.-------. All cross frames in the bay and span hit must be detached from the damaged beam during the above mentioned repairs as approved by the engineer.

2. Following completion of work for the day, temporary diaphragms shall be installed on the damaged girder at cross frame impacted in the span hit. See detail for temporary diaphragm.

GENERAL NOTES:

1. For the convenience and information of the contractor, prints of the existing structure are included with this plan set. No responsibility for their accuracy or completeness is assumed by the Administration. Dimensions, details, etc. as shown theron may not be "AS BUILT".

2. Contractor will be on sight for the entirety of this job.

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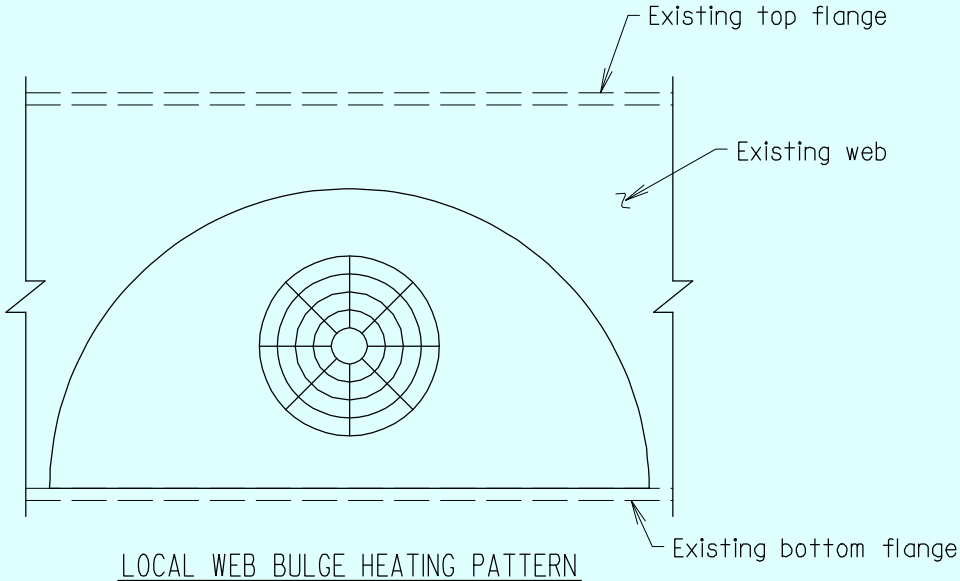
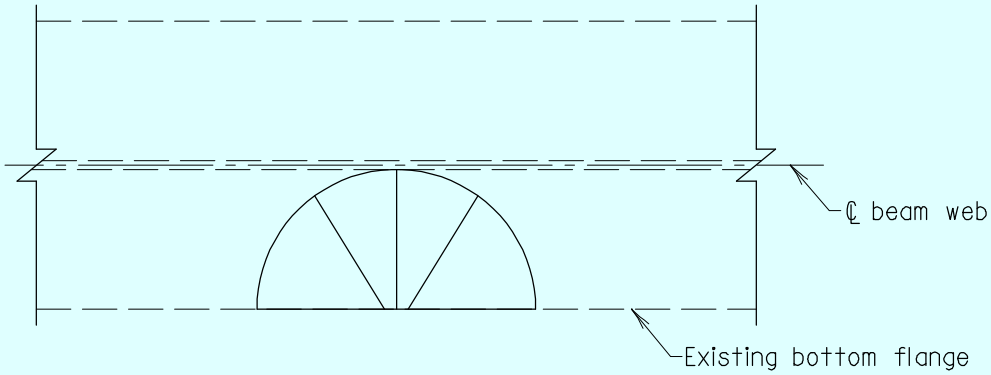
Tom Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING DEFECT NOTES
VERSION 1.0	DETAIL NO. SR-ST(HS)-104 SHEET 1 OF 1

STRUCTURAL REPAIRS



LOCAL WEB BULGE HEATING PATTERN

Scale: 3/4" = 1'-0"



LINE HEAT PATTERN FOR LOCAL FAN DEVIATION

Scale: 1 1/2" = 1'-0"

FHA RECOMMENDED TORCH TIPS FOR VARIOUS MATERIAL THICKNESSES		
Steel Thickness in "	Orifice Type	Size
<1/4"	Single	3
3/8"	Single	4
1/2"	Single	5
5/8"	Single	7
3/4"	Single	8
1"	Single Rosebud	8 3
2"	Single Rosebud	8 4
3" & >3"	Rosebud	5

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Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
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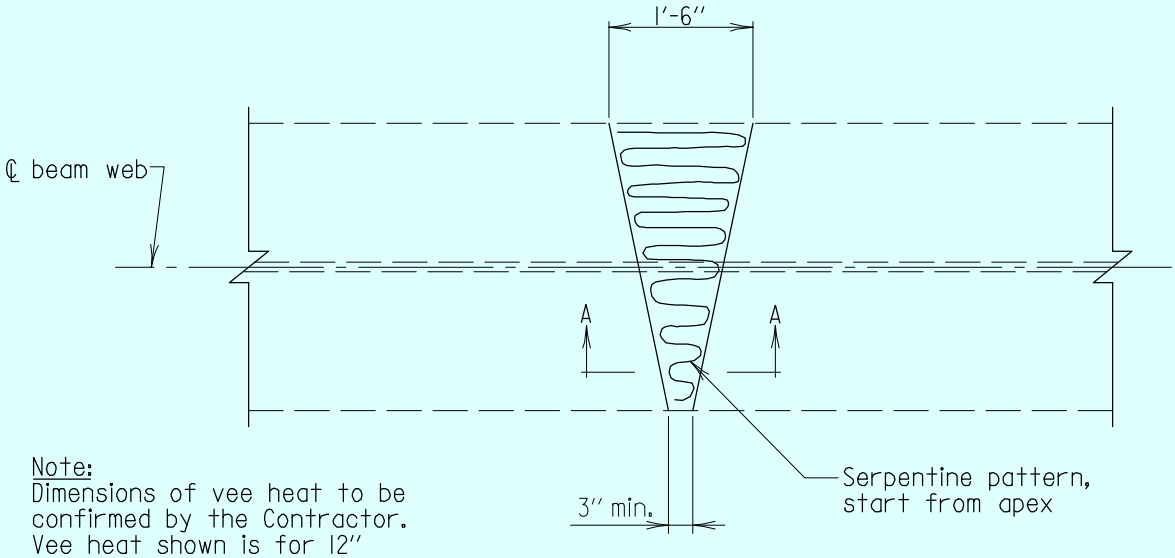
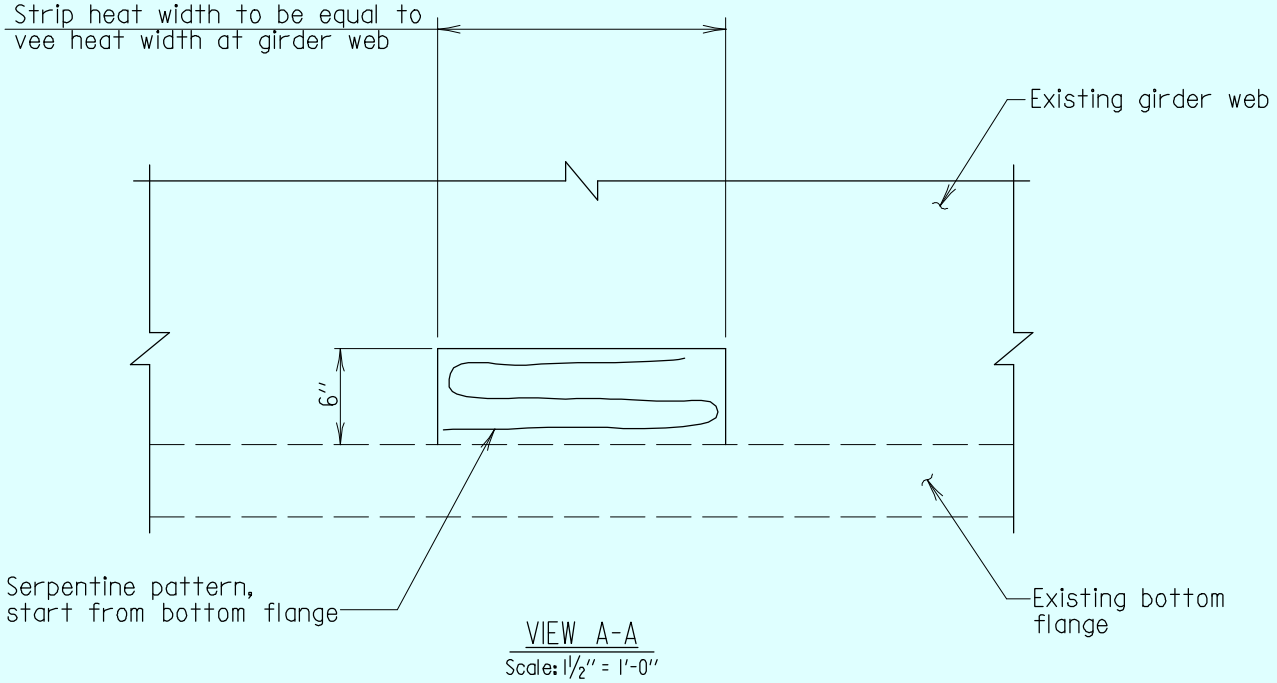
HEAT STRAIGHTENING HEATING PATTERN AND TORCH TIP RECOMMENDATIONS

DETAIL NO. SR-ST(HS)-105 SHEET 1 OF 2



Note:
Dimensions of vee heat to be confirmed by the Contractor. Vee heat shown is for 12" bottom flange.

TYPICAL VEE HEAT PATTERN
Scale: 1½" = 1'-0"



VIEW A-A
Scale: 1½" = 1'-0"

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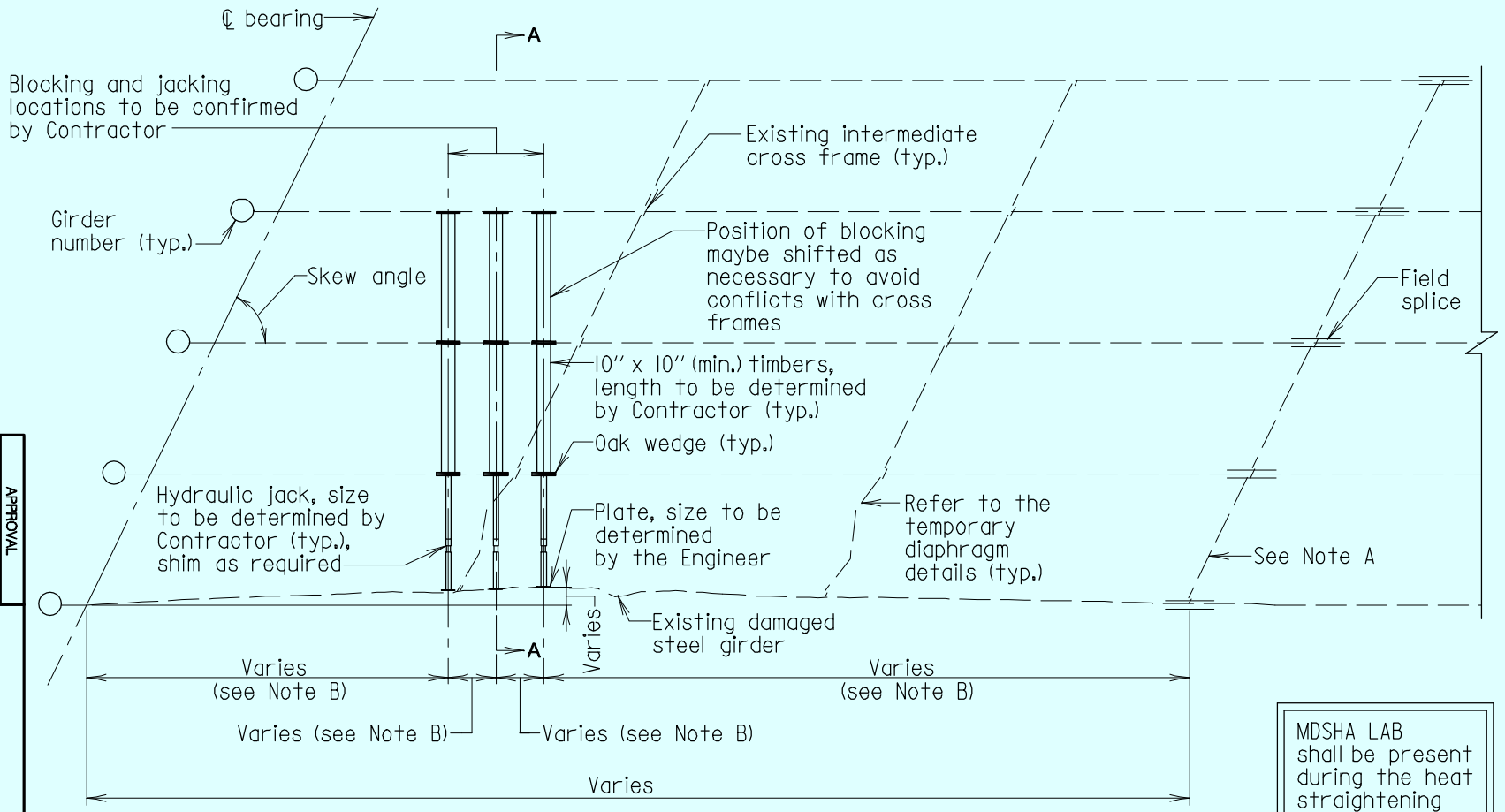
Sam C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING HEATING PATTERN
VERSION 1.0	DETAIL NO. SR-ST(HS)-105 SHEET 2 OF 2

STRUCTURAL REPAIRS



PARTIAL FRAMING PLAN

Scale: 3/32" = 1'-0"

MDSHA LAB shall be present during the heat straightening process.

Note:
For Section A-A see sheet 2, for other details and notes see sheet 3.

Note A:
If it is determined during the heat straightening procedures that the cross frame is hindering the process, with the approval of the Engineer, the contractor is permitted to disconnect and remove the existing cross frame in the impacted area from the connection plate at girder that was impacted during the heat straightening operations. Once the heat straightening operations have been completed, the existing cross frame shall be replaced and reconnected to the connection plate at the impacted girder to the approval of the Engineer. Cost for this work will not be measured but will be incidental to the heat straightening repair item.

Note B:
The dimensions shown are suggested restraint locations for the first cycle of heats. The contractor may adjust the locations prior to beginning the heat straightening process. As the girder begins to react to the heats, the contractor shall adjust the restraint locations to produce efficient heat straightening cycles.

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VERSION
1.0

STATE OF MARYLAND
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OFFICE OF STRUCTURES

HEAT STRAIGHTENING
STRAIGHTENING DETAILS
TYPICAL FRAMING PLAN

DETAIL NO. SR-ST(HS)-106

SHEET 1 OF 3

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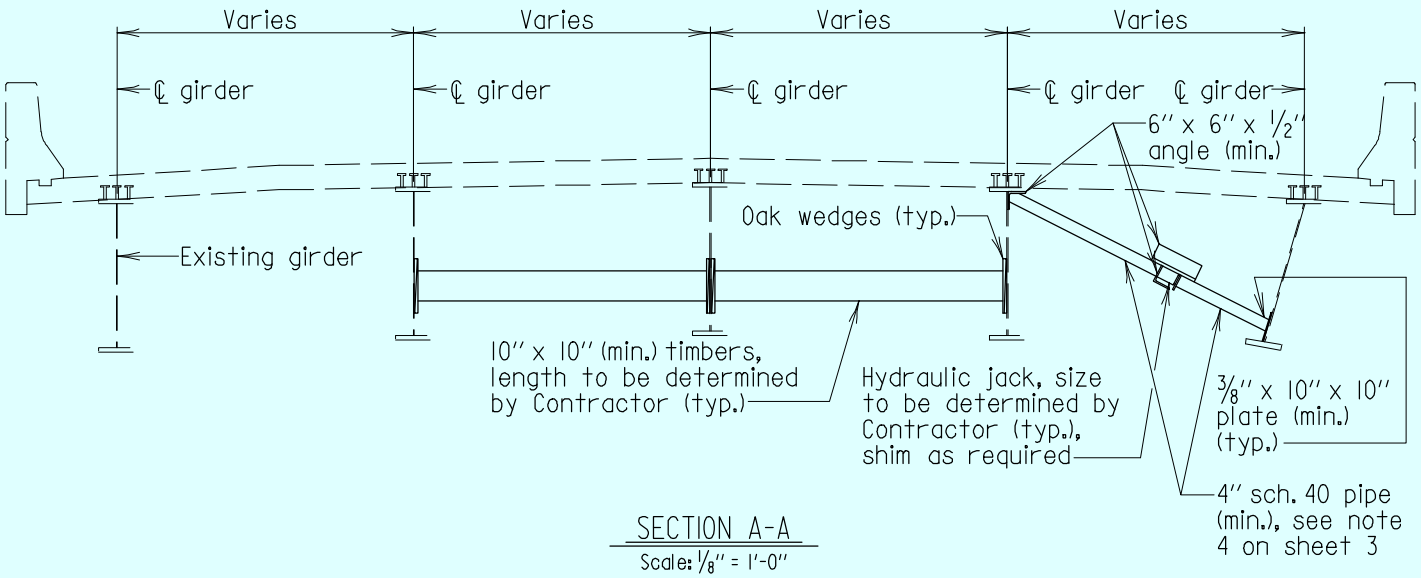
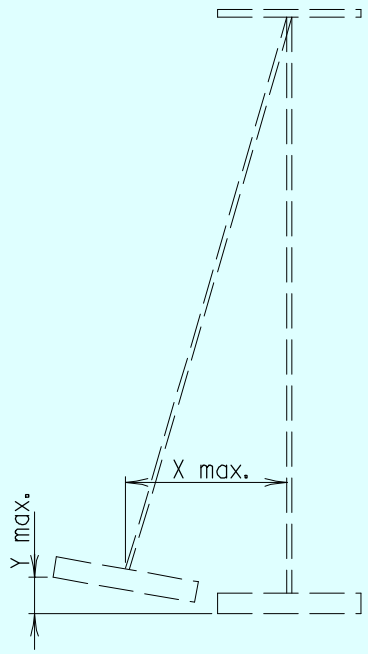
* GUIDE SHEET FOR PLAN DEVELOPMENT ONLY - DO NOT INCLUDE THIS SHEET IN CONTRACT PLANS *



SECTION A-A
Scale: 1/8" = 1'-0"

BEAM NO.	DISTANCE FROM ℄ BEARING PIER NO. 1	X MAX	Y MAX
	'-" ±	-"	-"
	'-" ±	-"	-"
	'-" ±	-"	-"
	'-" ±	-"	-"

Notes:
1. X and Y (max. values are maximum values for deflection observed in the field.
2. Connection plates not shown for clarity.



SECTION AT IMPACTED BEAM TO BE STRAIGHENED
Scale: 3/4" = 1'-0"

TABLE 1 – RESTRAINT FORCE SUMMARY				
	MAX FORCE PER JACK	MAX TOTAL RESTRAINT FORCE	DEGREE OF DAMAGE	EXPECTED NUMBER OF HEATS
HEAT CYCLES 1 AND 2	- KIPS	- KIPS	-°	-
REMAINING HEAT CYCLES	- KIPS	- KIPS	-°	-

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DATE: 06/28/2017

VERSION
1.0

STATE OF MARYLAND
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STATE HIGHWAY ADMINISTRATION
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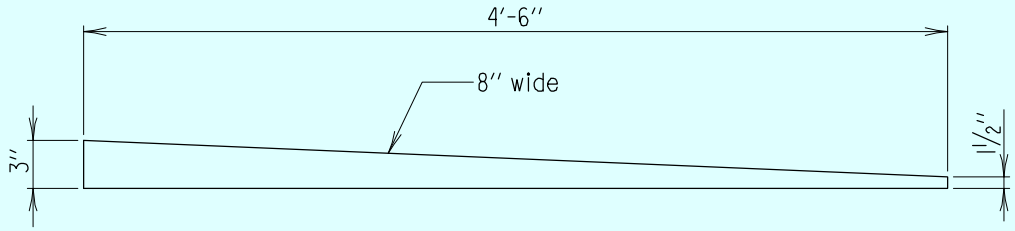
HEAT STRAIGHTENING
STRAIGHTENING DETAILS

DETAIL NO. SR-ST(HS)-106 SHEET 2 OF 3

STRUCTURAL REPAIRS



TYPICAL OAK WEDGE
Scale: 3" = 1'-0"

SUGGESTED SEQUENCE OF HEAT STRAIGHTENING:

1. Prior to heat straightening, remove all cracked welds in the areas to be heat straightened.
2. Remove portions of buckled intermediate stiffeners as per standard detail.
3. Remove cross frame in the impacted areas between the damaged girder and its adjacent girder leaving connection plates at the damage girder. Detach cross frame at the adjacent girders.
4. Install timbers and jacks between the damaged girder and adjacent girder as indicated by the engineer. Heat straighten web and bottom flange of the damaged girder.
5. Repair buckled transverse stiffeners on the damaged girder as indicated by the engineer.
6. Replace all bolts in bottom flange and web field splice plates on the damaged girder, as indicated by the engineer, in the impacted span.
7. The contribution of vehicular load from traffic from adjacent girder and damaged girder shall be removed prior to and during heat straightening operations in accordance with the MOT standard as stated in the plans.

Notes:

1. Oak wedges shall be in like new condition, free of cracks, splits and/or rotten portions.
2. Timber blocking shall be untreated southern yellow pine conforming to the requirements of AASHTO M 168 select structural no. 1.
3. Contractor shall provide various pipe lengths or adjustable apparati as required by site conditions.

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DATE: 06/28/2017
VERSION
1.0

STATE OF MARYLAND
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STATE HIGHWAY ADMINISTRATION
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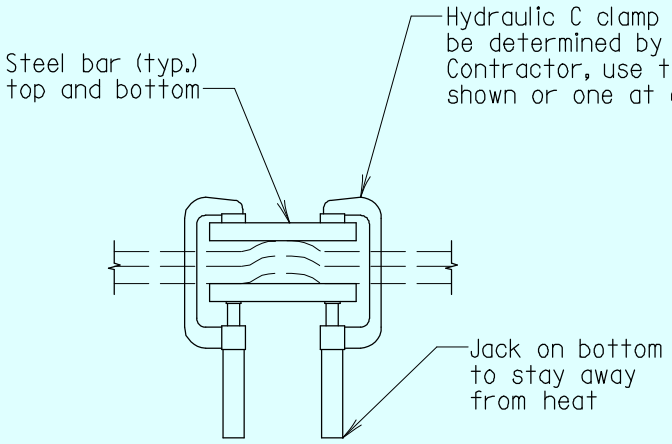
HEAT STRAIGHTENING
STRAIGHTENING DETAILS AND NOTES

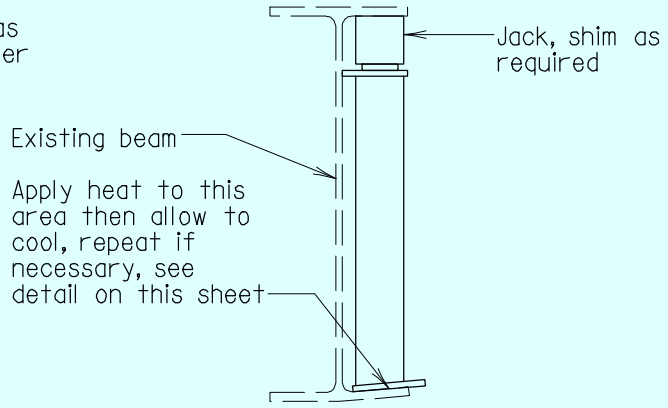
DETAIL NO. SR-ST(HS)-106 SHEET 3 OF 3

STRUCTURAL REPAIRS



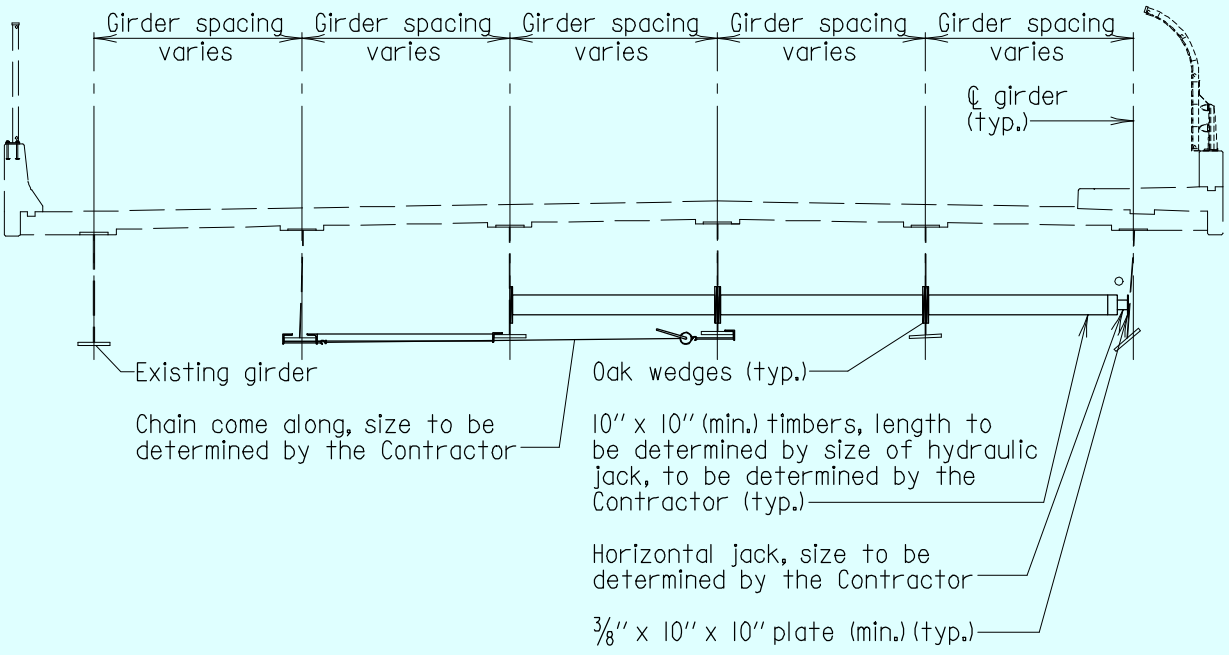
FLANGE STRAIGHTENING DEVICE - OPTION A

Scale: 3/4" = 1'-0"



FLANGE STRAIGHTENEING DEVICE - OPTION B

Scale: 3/4" = 1'-0"



TYPICAL SECTION

Scale: 1/8" = 1'-0"

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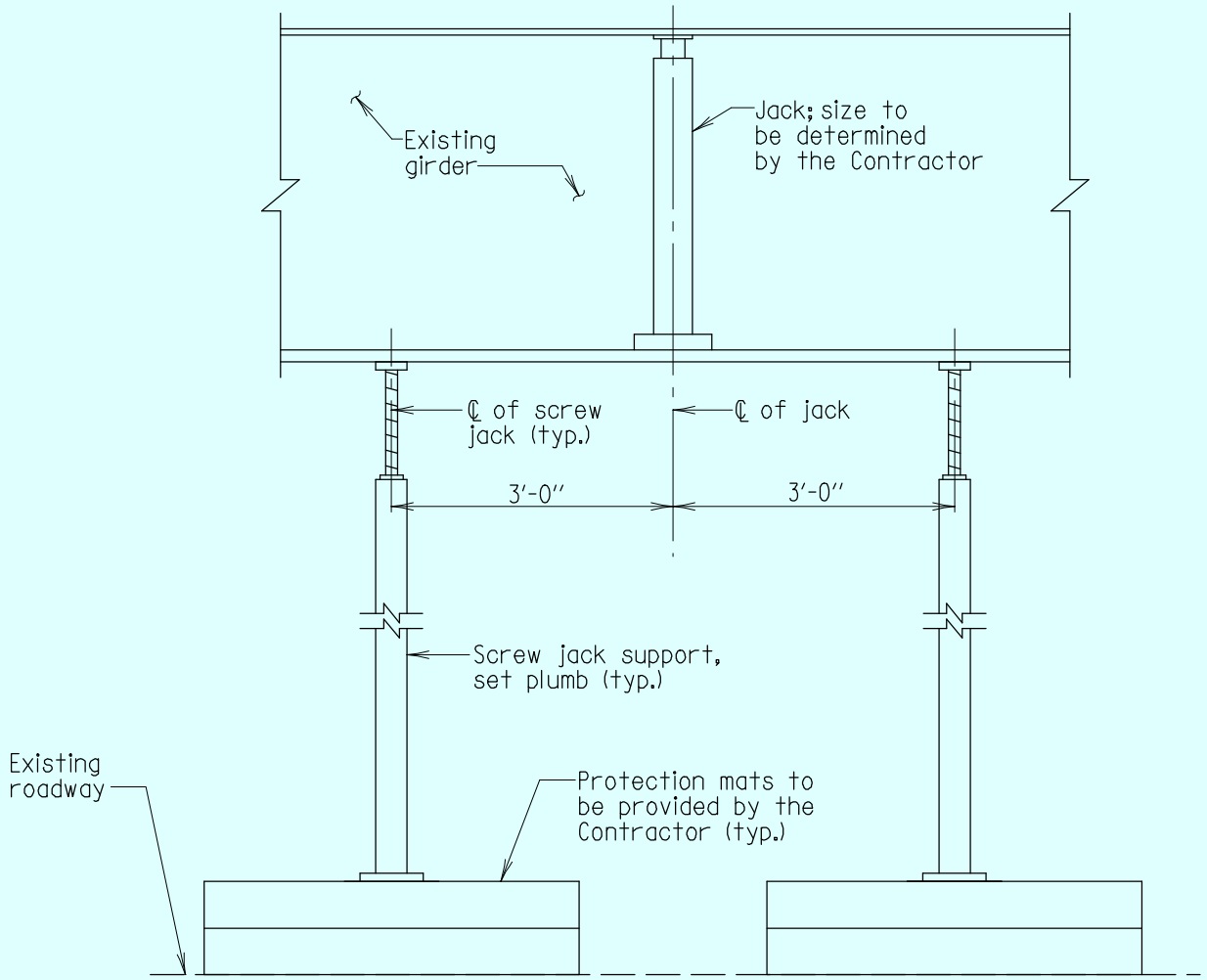
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING FLANGE STRAIGHTENING
VERSION 1.0	DETAIL NO. SR-ST(HS)-107 SHEET 1 OF 2

STRUCTURAL REPAIRS



SCREW JACK SUPPORT

Scale: 1/2" = 1'-0"

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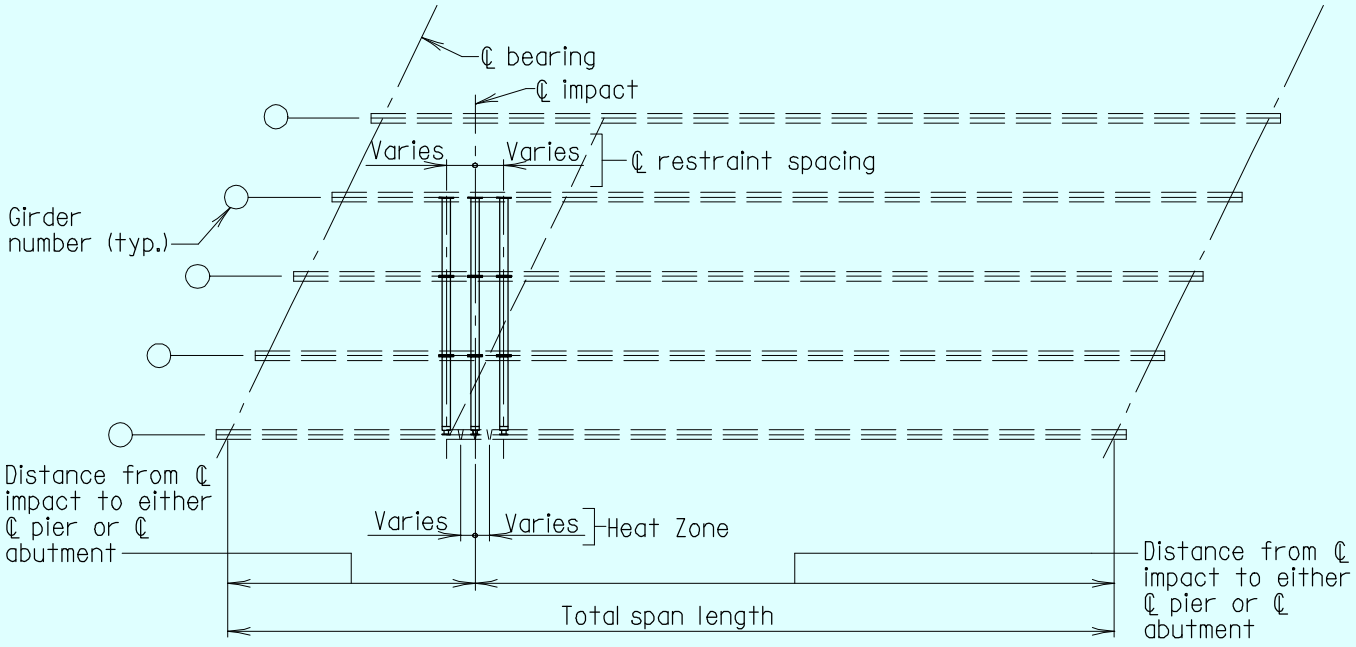
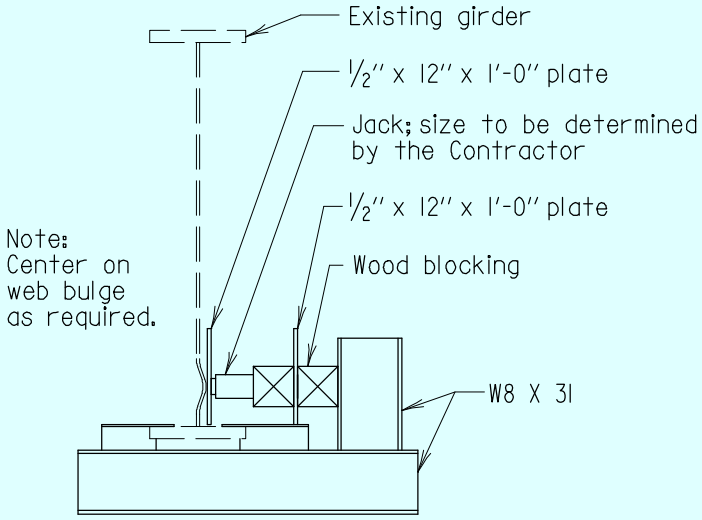
Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING FLANGE STRAIGHTENING
VERSION 1.0	DETAIL NO. SR-ST(HS)-107 SHEET 2 OF 2

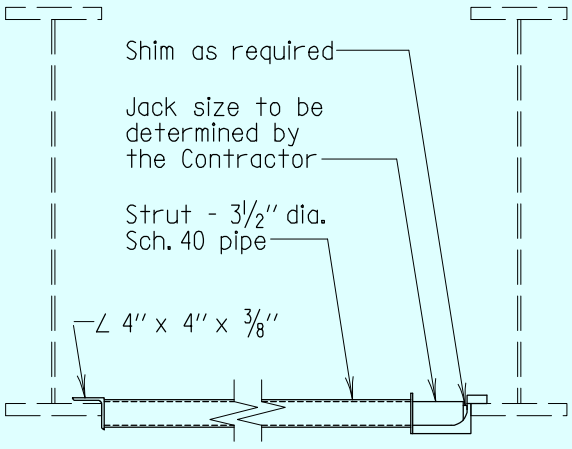
STRUCTURAL REPAIRS



PARTIAL FRAMING PLAN
Scale: 1/2" = 1'-0"



WEB STAIGHTENING DEVICE
Scale: 1/2" = 1'-0"



ALTERNATE JACKING STRUT
Scale: 1/2" = 1'-0"

Constraints, i.e. Jacks or Restraint Limits:

1. Constraints should be passive during the heating phase; that is, they should be applied before heating and not increased by external means during heating or cooling.
2. Constraints should not impede contraction during the cool phase.
3. Constraints should not produce local buckling of the compression element during the heating phase.
4. Constraints should not produce an unstable structure by either the formation of plastic hinges or member instability during heating phase.

Web Straightening Procedure:

Note:
Use this procedure only if web has local distortion near bottom flange.

1. Locate web straightening device as shown. Install jack after heating has been completed.
2. Apply heat to side of web toward which web must be moved.
3. Allow to cool. Maintain constant 3 to 5 ton restraint force during cooling.

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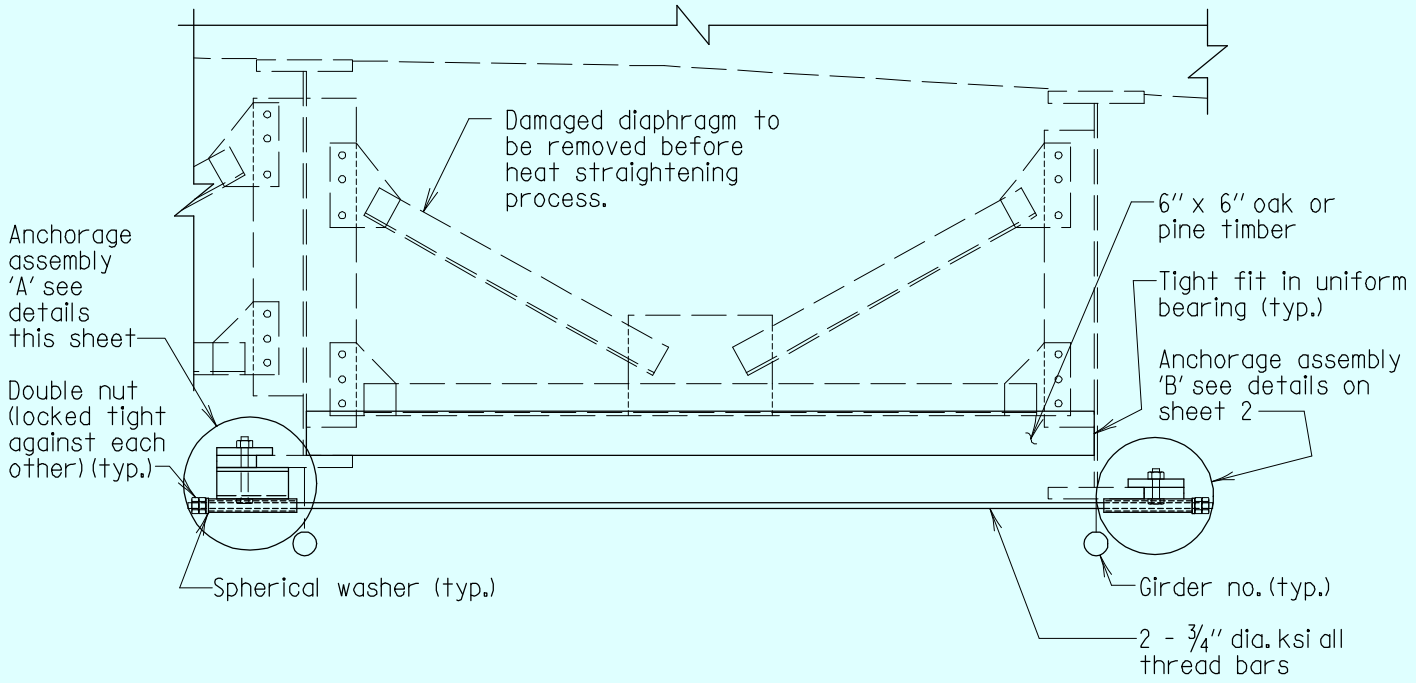
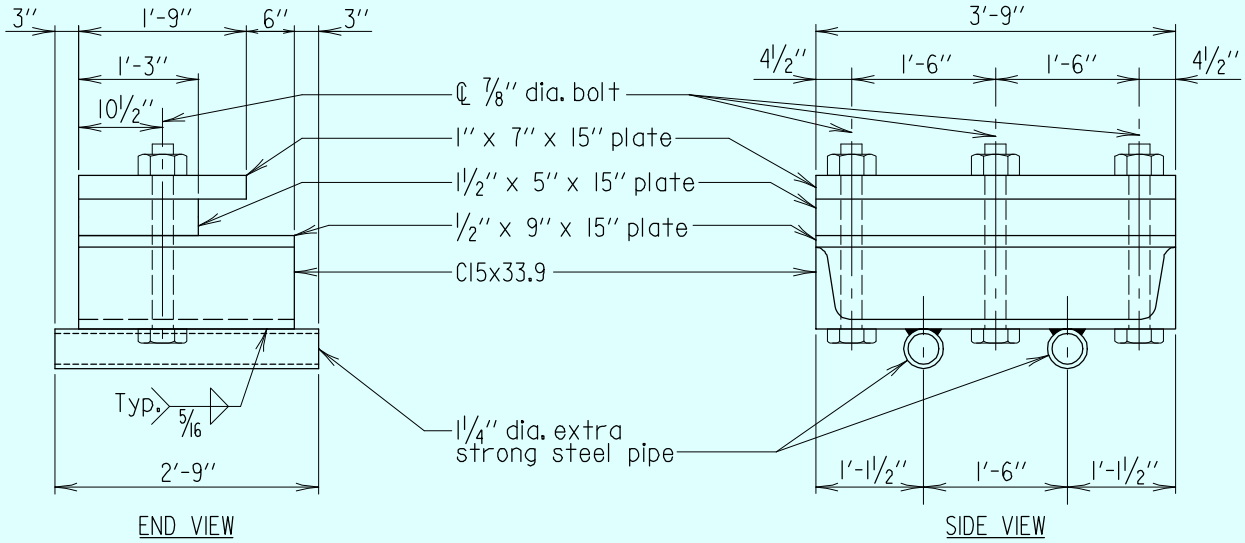
VERSION 1.0	DETAIL NO. SR-ST(HS)-108 SHEET 1 OF 1

STRUCTURAL REPAIRS



TEMPORARY DIAPHRAGM

Scale: 1/2" = 1'-0"



ANCHORAGE ASSEMBLY 'A'

Scale: 1 1/2" = 1'-0"

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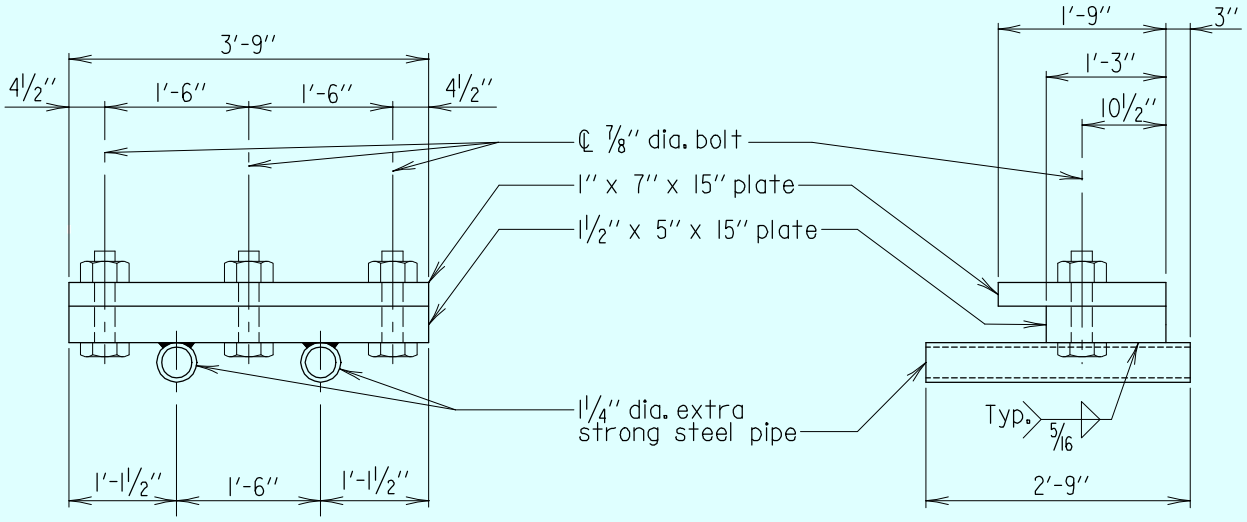
Sam C. Dasgupta DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING TEMPORARY DIAPHRAGM DETAILS
VERSION 1.0	DETAIL NO. SR-ST(HS)-109 SHEET 1 OF 2

STRUCTURAL REPAIRS



SIDE VIEW

END VIEW

ANCHORAGE ASSEMBLY 'B'

Scale: 1½" = 1'-0"

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Glenn C. Vaughan DIRECTOR OFFICE OF STRUCTURES DATE: 06/28/2017	HEAT STRAIGHTENING TEMPORARY DIAPHRAGM DETAILS
VERSION 1.0	DETAIL NO. SR-ST(HS)-109 SHEET 2 OF 2

STRUCTURAL REPAIRS