



Adhesive Anchors: MnDOT Anchorage Design and Types

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Overview

Topic

Design Guidance

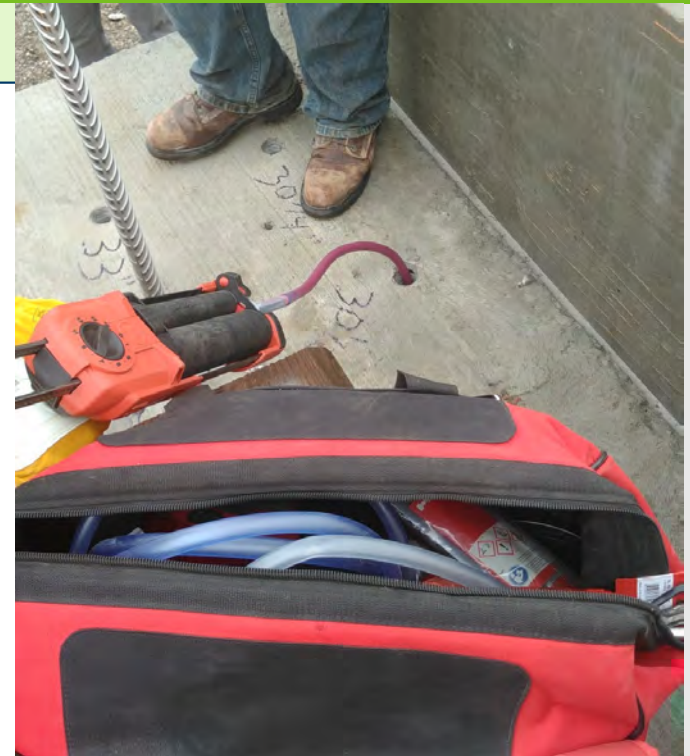
Anchor Types

Type Threaded Rods

Type H & L

Type ST

Type NT





Design Guidance

MnDOT Design Guidance

- MnDOT LRFD Bridge Design Manual 13.3.2 – Railing Post and Adhesive Anchor Design Example (last updated July 2019)
- Memo to Designers (2017-02): Post-Installed Anchorages for Reinforcing Bars (issued October 19th, 2017)
- MnDOT Technical Memorandum No. 18-11-B-01: Adhesive Anchoring Systems in Sustained Tensile-Load Applications (issued December 10th, 2018)

Table 1-1 – Resistance Factors for General Anchorage Design Except for Pedestrian Metal Railing Anchorages

Failure Mode	Resistance Factors		Code Reference
	Condition A	Condition B	
Steel – Shear	0.75		AASHTO 6.5.4.2
Steel – Tension	0.80		AASHTO 6.5.4.2
Concrete Breakout - Shear	0.75	0.70	ACI 17.3.3
Concrete Breakout - Tension (Cat. 1)	0.75	0.65	ACI 17.3.3
Bond (Cat. 2)	0.65	0.55	ACI 17.3.3
Pryout		0.55	ACI 17.3.3
Creep Rupture (Cat. 3)		0.45	ACI 17.3.3

Also, consider interaction effects as part of the design when both shear and

Table 1-2 – Resistance Factors for Design of Pedestrian Metal Railing Anchorages

Failure Mode	Resistance Factors		Code Reference
	Condition A	Condition B	
Steel – Shear	0.75		AASHTO 6.5.4.2
Steel – Tension	0.80		AASHTO 6.5.4.2
Concrete Breakout - Shear	0.85	0.75	MnDOT Policy
Concrete Breakout - Tension (Cat. 1)	0.85	0.75	MnDOT Policy
Bond (Cat. 2)	0.75	0.65	MnDOT Policy
Pryout		0.65	MnDOT Policy

anchorage is considered a Category 3 anchorage for this check.

Concrete condition is determined based on the reinforcing present in the section to which an anchorage is attached. For design purposes, any

MnDOT Anchor Types

Anchor Type	MnDOT BDM 13.3.2	Memo to Designers 2017-02	MnDOT Tech Memo No. 18-11-B-01
Threaded Rod	X		X
Type H	X	X	X
Type L	X	X	X
Type ST	X	REBAR ONLY	X
Type NT	X	X	X

- Any anchorage rod consisting of a reinforcing element should review the Memo to Designers 2017-02 for coating requirements
- The “Adhesive Anchorage Design Procedure” (design procedure) which is attached to Tech Memo No. 18-11-B-01 contains an overview of design for all anchorage types
- Direction on proof loading can be found in the BDM example

Useful Links

- MnDOT BDM and Designer Memo:
 - <http://www.dot.state.mn.us/bridge/lrfd.html>
- MnDOT Technical Memoranda:
 - <https://techmemos.dot.state.mn.us/>
- MnDOT Bridge Office Special Provisions:
 - <http://www.dot.state.mn.us/bridge/construction.html>



Anchorage Types: Threaded Rod

Overview

- Used for ornamental metal railings, pedestrian fences, and any threaded rod that is not a Type ST.
- Never use for new installations of crashworthy metal railings.
- Typical MnDOT bond values can be found in the BDM with some direction in the design procedure.
- Typical resistance factors can be found in the design procedure.
- See MnDOT Bridge Office Special Provision SB2020-2433.8 B for further information.





Type H and Type L

- Type H (High level of testing) and Type L (Low level of testing) were introduced in the Memo to Designers 2017-02;
- Type H are rebar anchorages designed to withstand tension loads (not sustained tension. Anchorage element will consist of a black bar or stainless steel bar;
- Type L are primarily shear or 'convenience' anchorages. Permitted to be epoxy coated;

Proof Loading

- Proof Load:
 - Type H – Similar to threaded rods, proof load requirements are found in the BDM and design procedure;
 - Type L – Unless prohibited by design, use 2.2 kips;
- See MnDOT Bridge Office Special Provision SB2020-2433.8 C for further information.





Type ST

- Type ST (Sustained Tension) anchorages were introduced in MnDOT Technical Memorandum No. 18-11-B-01;
- May consist of a threaded rod element or reinforcing bar element. Reinforcing bar element must be consistent with Type H restrictions;
- Proof load is consistent with direction found in the BDM and design procedure;
- Further considerations are outlined in MnDOT Bridge Office Special Provision SB2020-2433.8 A.

Sustained Tension

Adhesive anchors may NOT be used to support sustained tension for:

- Pier cap retrofits, support, or repairs;
- Abutment paving brackets behind 'voided' abutments;
- Primary reinforcing for deck overhang repairs or replacement;
- Primary reinforcing for abutment stem and wingwall widenings and retrofits;
- Corbels supporting any element that carries directly applied traffic loads (e.g. beams), excluding paving brackets supporting approach panels on grade;
- Supports for overhead cantilever signs, utilities and drainage systems, and catwalks.

Sustained Tension

Anchorage are considered under sustained tension for:

- Attachment of bridge mounted signs;
- Any application in abutment and wingwall retrofits not prohibited in TM No. 18-11-B-01;
- Deck repairs not prohibited in TM No. 18-11-B-01; and
- Any case not prohibited in TM No. 18-11-B-01 where the sustained tension load exceeds 10% of the factored nominal anchor capacity in tension and with approval from the State Bridge Design Engineer.



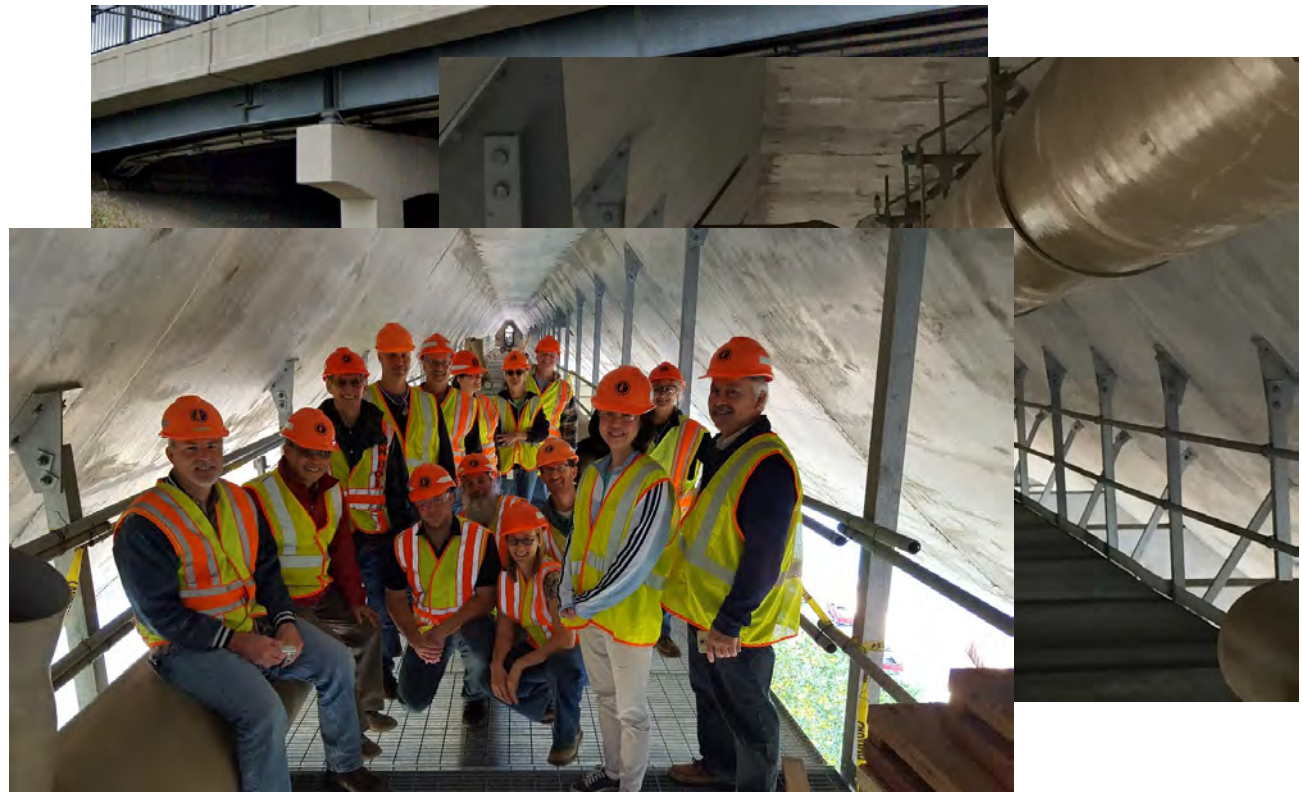
Sustained Tension

Adhesive Anchorages are not considered Type ST if:

- The sustained tension is less than 10% of the factored nominal anchor capacity in tension;
- Attachment of paving brackets to abutments where the approach panel rests on grade;
- End post retrofits cantilevered off the back of an abutment;
- End blocks;
- Attachment of shear brackets to the back of retaining walls;
- Attachment of base plates with threaded rod anchorages where the sustained tension load is only do to the clamping force; and
- Pier struts retaining soil.

Things to Keep in Mind When CONSIDERING Type ST Anchorages

- Consequence of Failure
- Installation Over Traffic
- Overhead Applications
- Supporting Traffic
- Concrete Condition



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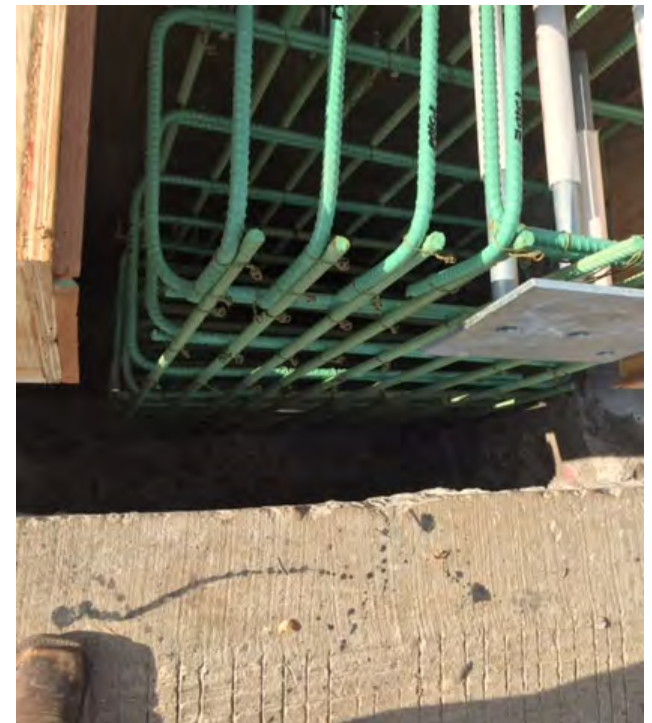
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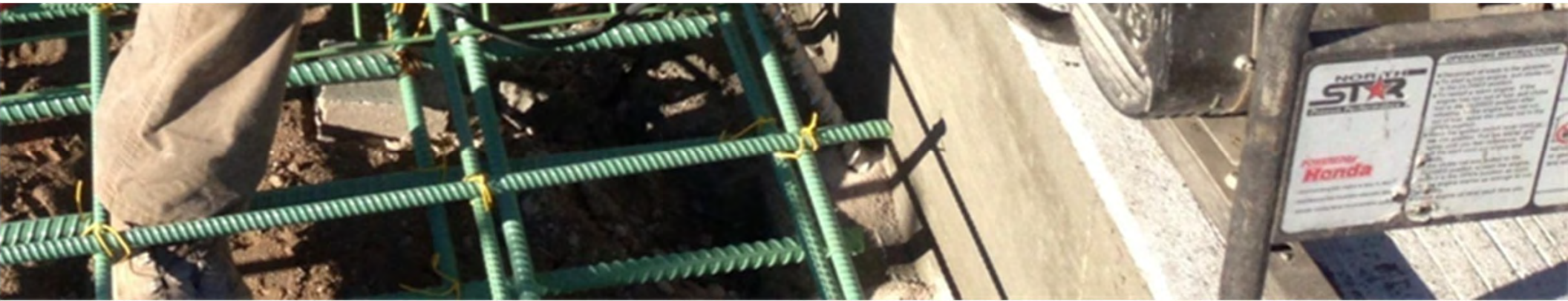
Special Provision Requirements

- Type ST anchorages require an *Inspection and Testing Agent*.
 - The Inspection and Testing Agent is required to be present for all Type ST anchorages installed and is to verify and document:
 - The adhesive is on the MnDOT Approved/Qualified Products List and approved for ST applications;
 - The adhesive uncracked bond strength matches the plans;
 - The anchorage element is the right size and type;
 - Adhesive is used prior to the expiration date;
 - Adhesive anchorage components are appropriately stored;
 - Drilling, cleaning, injection of adhesive, and insertion of rod is done per the MPII.

Special Provision Requirements

- Proof loading is required:
 - Threaded Rod Anchorages:
 - 15% plus 5 additional anchorages, no less than 20
 - UT all proof loaded anchorages plus an additional 15% plus 5, no less than 20
 - Reinforcing Bars:
 - 3% of anchorages plus 5, no less than 20
 - No additional tests required

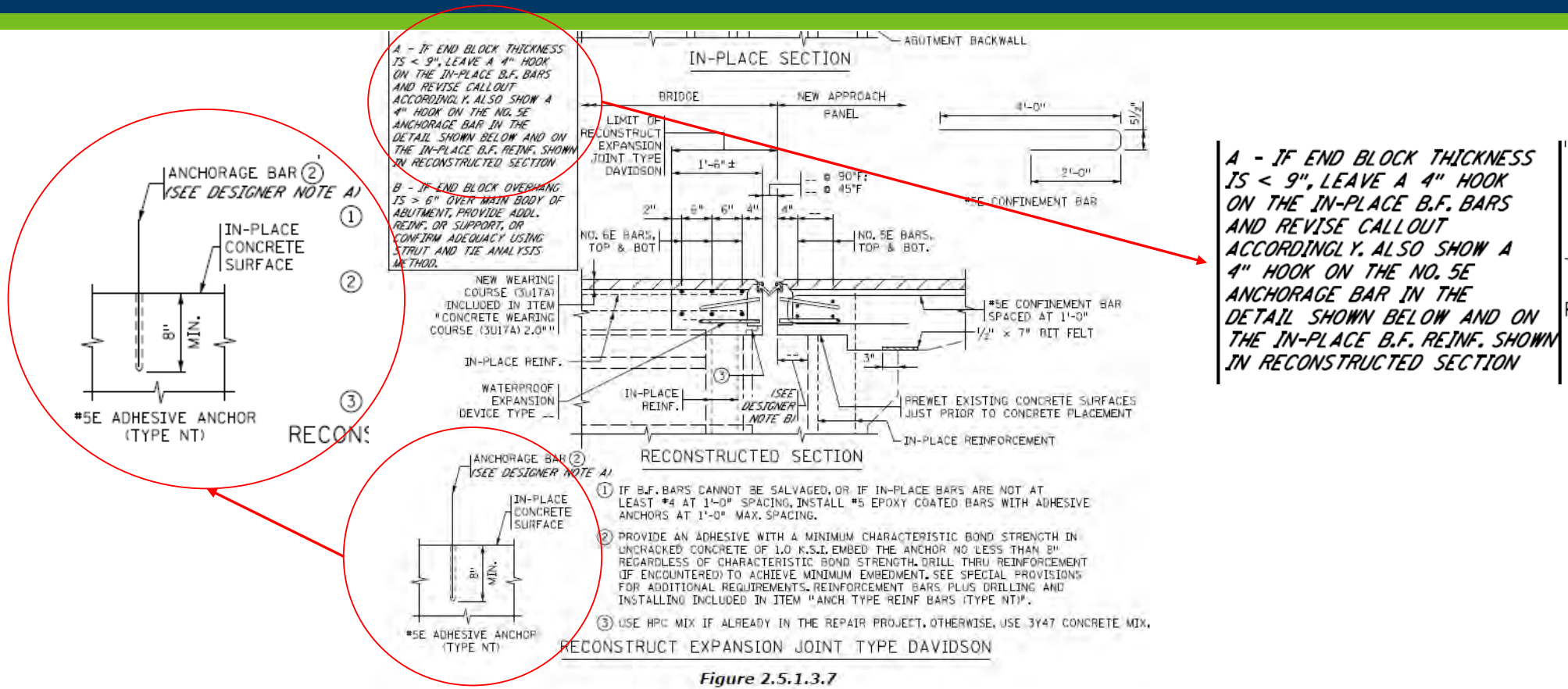




Type NT

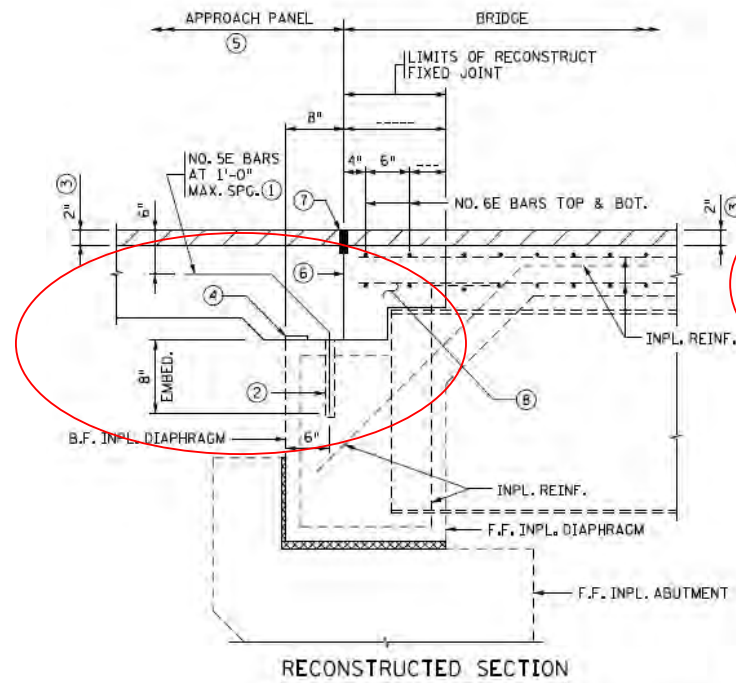
- Type NT (No Testing) Anchorages are being introduced for connecting approach panels to abutments or end diaphragms;
- Intended for cases of:
 - Limited access;
 - Remote locations; *AND*
 - Low risk.
- Use of Type NT anchorages outside the uses stipulated in the BDM, Chapter 2, must be approved by the State Bridge Design Engineer.

Details



A - IF END BLOCK THICKNESS IS < 9", LEAVE A 4" HOOK ON THE IN-PLACE B.F. BARS AND REVISE CALLOUT ACCORDINGLY. ALSO SHOW A 4" HOOK ON THE NO. 5E ANCHORAGE BAR IN THE DETAIL SHOWN BELOW AND ON THE IN-PLACE B.F. REINF. SHOWN IN RECONSTRUCTED SECTION

Figure 2.5.1.3.7
Expansion Joints



NOTES:

F.F. DENOTES FRONT FACE.

B.F. DENOTES BACK FACE.

- ① TIE NEW APPROACH PANEL TO CONCRETE END DIAPHRAGM. REINFORCEMENT BARS PLUS DRILLING AND INSTALLING INCLUDED IN ITEM "ANCH TYPE REINF BARS (TYPE NT)".
- ② PROVIDE AN ADHESIVE WITH A MINIMUM CHARACTERISTIC BOND STRENGTH IN UNCRACKED CONCRETE OF 1.0 K.S.I. EMBED THE ANCHOR NO LESS THAN 8" REGARDLESS OF CHARACTERISTIC BOND STRENGTH. DRILL THROUGH REINFORCEMENT (IF ENCOUNTERED) TO ACHIEVE MINIMUM EMBEDMENT. SEE SPECIAL PROVISIONS FOR ADDITIONAL REQUIREMENTS.
- ③ NEW CONCRETE WEARING COURSE (3U17A), INCLUDED IN ITEM "CONCRETE WEARING COURSE (3U17) 2.0"
- ④ 1/2" X 3" BIT FELT. INCLUDED IN ITEM "RECONSTRUCT FIXED JOINT".
- ⑤ APPROACH PANEL TO BE CONSTRUCTED UNDER GRADING PORTION OF CONTRACT, DELAY PLACEMENT OF APPROACH PANEL MINIMUM OF 24 HOURS AFTER PLACING CONCRETE FOR "RECONSTRUCT FIXED JOINT".
- ⑥ DO NOT APPLY BONDING AGENT AT THIS CONSTRUCTION JOINT.
- ⑦ C2H CONTRACTION JOINT SEE GRADING PLANS.
- ⑧ USE HPC MIX IF ALREADY IN THE REPAIR PROJECT, OTHERWISE, USE 3Y47 CONCRETE MIX.

RECONSTRUCT FIXED JOINT

Figure 2.5.1.3.9
Fixed Joints

See also BDM
Figure 2.5.1.3.10

Thank you again!

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