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Date: December 20, 2018

Transmittal Notice 2018-03

DISTRIBUTION	MnDOT Bridge Office Web Site
MANUAL	LRFD Bridge Design Manual
SUBJECT	Memo to Designers #2018-01: New 30MH, 35MH, and 40MH Prestressed Concrete Beams

An update to the MnDOT Bridge Office *LRFD Bridge Design Manual* is available for download in *Adobe* PDF (Portable Document Format) at http://www.dot.state.mn.us/bridge/. This Web site should be checked regularly for updates.

INSTRUCTIONS:
(for two-sided printing)

1. Remove from the manual:
   - Title Page
   - Table of Contents pages xi and xii

2. Print and insert in the manual:
   - Title Page
   - Table of Contents pages xi and xii
   - Memo to Designers (2018-01)

Note: The "DECEMBER 2018" update contains the following:
- Addition of Memo to Designers (2018-01), which contains guidance regarding new MH Series prestressed concrete beams.

Direct any ***technical questions*** regarding this transmittal to Dave Dahlberg, Bridge Design Manual and Policy Engineer, at dave.dahlberg@state.mn.us or 651/366-4491.

Kevin Western
State Bridge Engineer

MANUAL

5-392

MINNESOTA DEPARTMENT OF TRANSPORTATION

Bridge Office

LRFD Bridge Design Manual

MnDOT BRIDGE OFFICE

LRFD Bridge Design Manual

Minnesota Department of Transportation
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JULY 2003 OCTOBER 2003 JANUARY 2004 APRIL 2004 OCTOBER 2004 DECEMBER 2004
FEBRUARY 2005 MARCH 2005 NOVEMBER 2005 MARCH 2006 APRIL 2006 MAY 2006
AUGUST 2006 OCTOBER 2006 FEBRUARY 2007 JUNE 2007 JULY 2007 OCTOBER 2007
APRIL 2008 MAY 2008 JUNE 2008 AUGUST 2008 SEPTEMBER 2008 OCTOBER 2008
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JUNE 2015 AUGUST 2015 MAY 2016 JULY 2016 AUGUST 2016 DECEMBER 2016 MARCH 2017
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APPENDIX A. Memos to Designers

#2005-01 REMOVED
#2005-02 REMOVED
#2005-03 REMOVED
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#2007-01 REMOVED
#2007-02 Adhesive Anchors Under Sustained Tensile Loads ..... (dated Oct. 3, 2007)
#2007-03 REMOVED
#2008-01 Prestressed Concrete Design – Calculation of Prestress Losses and Beam Camber & Deflection ..... (dated Sept. 18, 2008)
#2008-02 Truss Bridge Gusset Plate Analysis ..... (dated Oct. 20, 2008)
#2011-01 REMOVED
#2011-02 REMOVED
#2011-03 Interim Guidance for Installation of Temporary Barriers on Bridges and Approach Panels ..... (dated December 23, 2011)
#2012-01 Discontinued Usage of Plain Elastomeric Bearing Pads and Substitution with Cotton-Duck Bearing Pads ..... (dated April 12, 2012)
#2012-02 Transition to New MnDOT Pile Formula 2012 (MPF12) ..... (dated November 21, 2012)
#2013-01 Conversion from Metric to U.S. Cust. Rebar Designations ..... (dated April 17, 2013)
#2014-01 AASHTO LRFD Article 5.7.3.4 Concrete Crack Control Check (dated August 6, 2014)
#2014-02 Inclusion of Informational Quantities in Bridge Plans (dated December 23, 2014)
#2015-01 Concrete Mix Design Designations ..... (dated August 10, 2015)
#2016-01 Single Slope Barrier (Type S) Bridge Standards (dated December 09, 2016)
#2017-01 Edge-of-Deck Thickness on Bridges and Wall Coping Height (dated March 28, 2017)
#2017-02 Post-Installed Anchorages for Reinforcing Bars ... (dated October 19, 2017)
#2018-01 New 30MH, 35MH, and 40MH Prestressed Concrete Beams (dated December 20, 2018)

DEPARTMENT OF TRANSPORTATION
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Memo

Date: 12/20/2018

To: Bridge Design Engineers

From: Arielle Ehrlich
State Bridge Design Engineer

RE: Memo to Designers #2018-01: New 30MH, 35MH, and 40MH Prestressed Concrete Beams

Recently, MnDOT began investigating prestressed beam shapes that could be used more effectively in span ranges of 75 to 115 ft. The MH series shape that has been developed incorporates elements of several prestressed concrete beams currently in use around the country. Three beam depths have been chosen, which are designated as 30MH, 35MH, and 40MH. Based on discussions with fabricators related to obtaining forms, we have agreed to start specifying the 30MH and 35MH beams for lettings July 1, 2019 and later. The 40MH beams may be used for lettings November 1, 2019 and later.

Attached are Figures 5.4.6.1 and 5.4.6.2 that will be updated in the LRFD Bridge Design Manual (BDM) showing beam section properties and the preliminary beam selection chart for the RB, M, MH, and MN series. The 27M and the 36M beams will still be available and should continue to be used where appropriate.

Below is a listing of the Standard Plans and B-Details that were developed or modified for the new shape:

- 5-397.501 30MH Prestressed Concrete Beam
- 5-397.502 35MH Prestressed Concrete Beam
- 5-397.503 40MH Prestressed Concrete Beam
- B303 Sole Plate
- B307 Bearing Pad Restraint
- B309 Tapered Bearing Plate Assembly
- B310 Curved Plate Bearing Assembly - Fixed
- B311 Curved Plate Bearing Assembly - Expansion
- B403 Steel Intermediate Bolted Diaphragm
- B814 Concrete End Diaphragm – Parapet Abutment

These standards are currently approved and available for use.

Several criteria currently listed in the BDM for prestressed girders have been changed due to the development of the MH series and are discussed below.

Intermediate Diaphragms

Intermediate diaphragms are not required for 30MH and 35MH beams. The 40MH will follow BDM Article 5.4.1 guidelines for intermediate diaphragm spacing.

Beam End Dimensions

For MH prestressed beams, follow the guidance given in BDM Article 5.4.1 for RB, M, and MN shapes.

Camber Prediction

For MH prestressed beams, follow the guidance given in BDM Article 5.4.5 for RB, M, and MN shapes and the use of camber multipliers.

Overhang Criteria

Overhang criteria remains the same as is shown in Figure 9.2.1 of the BDM.

Bearings

The majority of guidance given in BDM Section 14 regarding bearings applies when using MH series prestressed beams. However, the minimum elastomeric pad size for MH beams is 12 inches (length A) by 30 inches (width B). In addition, BDM Tables 14.7.1, 14.7.2, and 14.7.3 have been revised to include standard B310 and B311 bearing dimensions for the MH and MW series beams. The revised tables are included as attachments to this memo.

Material Properties

Concrete, prestressing strand, and mild reinforcement properties remain as specified in the BDM. The attached charts for span length and beam spacing assume a concrete release strength (f'_{ci}) of 7.5 ksi and a final concrete strength (f'_c) of 9 ksi. With approval of the State Bridge Design Engineer, final concrete strengths of 10 ksi may be permitted for the MH series beams.

For questions about this policy, please contact Dave Dahlberg (dave.dahlberg@state.mn.us or (651) 366-4491) or Arielle Ehrlich (arielle.ehrlich@state.mn.us or (651) 366-4506).

cc: K. Western
D. Dahlberg
P. Rowekamp
C. Lichtsinn/Design Consultants
D. Conkel/Local Consultants

Attachments: 5-29.1, 5-29.2, 14-15, 14-16 of the LRFD Bridge Design Manual

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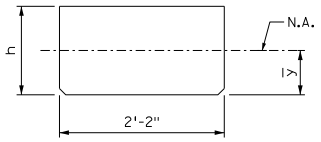
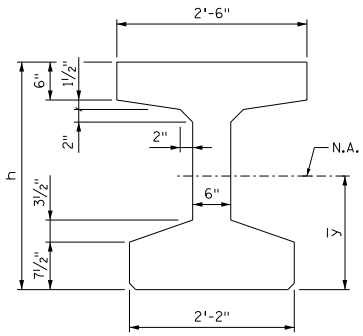
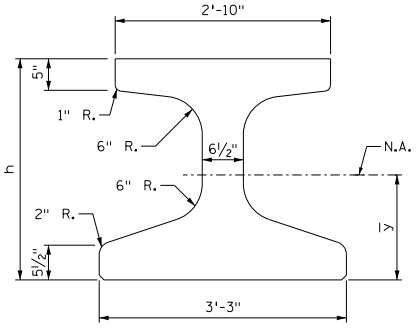


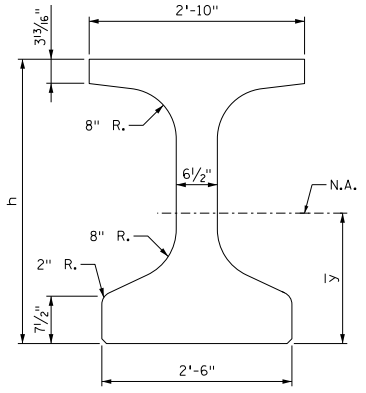
RECTANGULAR BEAM



"M" SERIES I-BEAM



"MH" SERIES I-BEAM



"MN" SERIES I-BEAM

DESIGN ASSUMPTIONS FOR PRESTRESSED CONCRETE BEAM CHART:

2017 AASHTO LRFD Bridge Design Specifications, 8th Edition.

HL-93 Live Load

Beam Concrete: f'_c = 9.0 ksi f'_{ci} = 7.5 ksi w_{bm} = 0.155 kips/ft^3

$E_c = 1265\sqrt{f'_c} + 1000$ ksi

Deck Concrete: f'_c = 4.0 ksi E_c = 3987 ksi
w_c = 0.145 kcf for E_c computation
w_c = 0.150 kcf for dead load computation

0.6" diameter low relaxation strands, E_s = 28,500 ksi

f_{pu} = 270 ksi with initial pull of 0.75 f_{pu}

Simple supports with six beams and deck without wearing course.
Deck carries two Type S Barriers with no sidewalk or median.
Skew = 0 degrees.

Effective deck thickness is total deck thickness minus $^1/_2$" of wear.

$1^1/_2$" stool height used for composite beam section properties.
$2^1/_2$" average stool height used for dead load calculations.

Rail dead load applied equally to all beams.
Dead load includes 0.020 ksf future wearing course.

Approximate long term losses are used per LRFD 5.9.5.3.

Service Concrete Tensile Stress Limits:
After Initial Losses: $0.094\sqrt{f'_{ci}} \leq 0.2$ ksi
After All Losses: $0.19\sqrt{f'_c}$

Beam Properties

BEAM	h (in)	AREA (in^2)	W ① (lb/ft)	$\overline{y}$ (in)	I (in^4)	S_B (in^3)	A_c ② (in^2)
14RB	14	364	392	7.00	5,945	849	312
18RB	18	468	504	9.00	12,640	1,404	364
22RB	22	572	616	11.00	23,070	2,097	416
27M	27	516	555	13.59	43,080	3,170	296
30MH	30	639	688	13.66	70,416	5,155	403
35MH	35	672	723	15.85	105,570	6,661	419
36M	36	570	614	17.96	93,530	5,208	323
40MH	40	704	758	18.07	149,002	8,246	435
MN45	45	690	743	20.58	178,780	8,687	427
MN54	54	749	806	24.63	285,230	11,580	457
MN63	63	807	869	28.74	421,750	14,670	486

① Based on 155 pounds per cubic foot.

② Based on a 9" slab with $^1/_2$" of wear and $1^1/_2$" stool. See LRFD 5.8.3.4.2 for A_c definition.

Figure 5.4.6.1

Precast Prestressed Concrete Beam Data (RB, M, MH, MN)

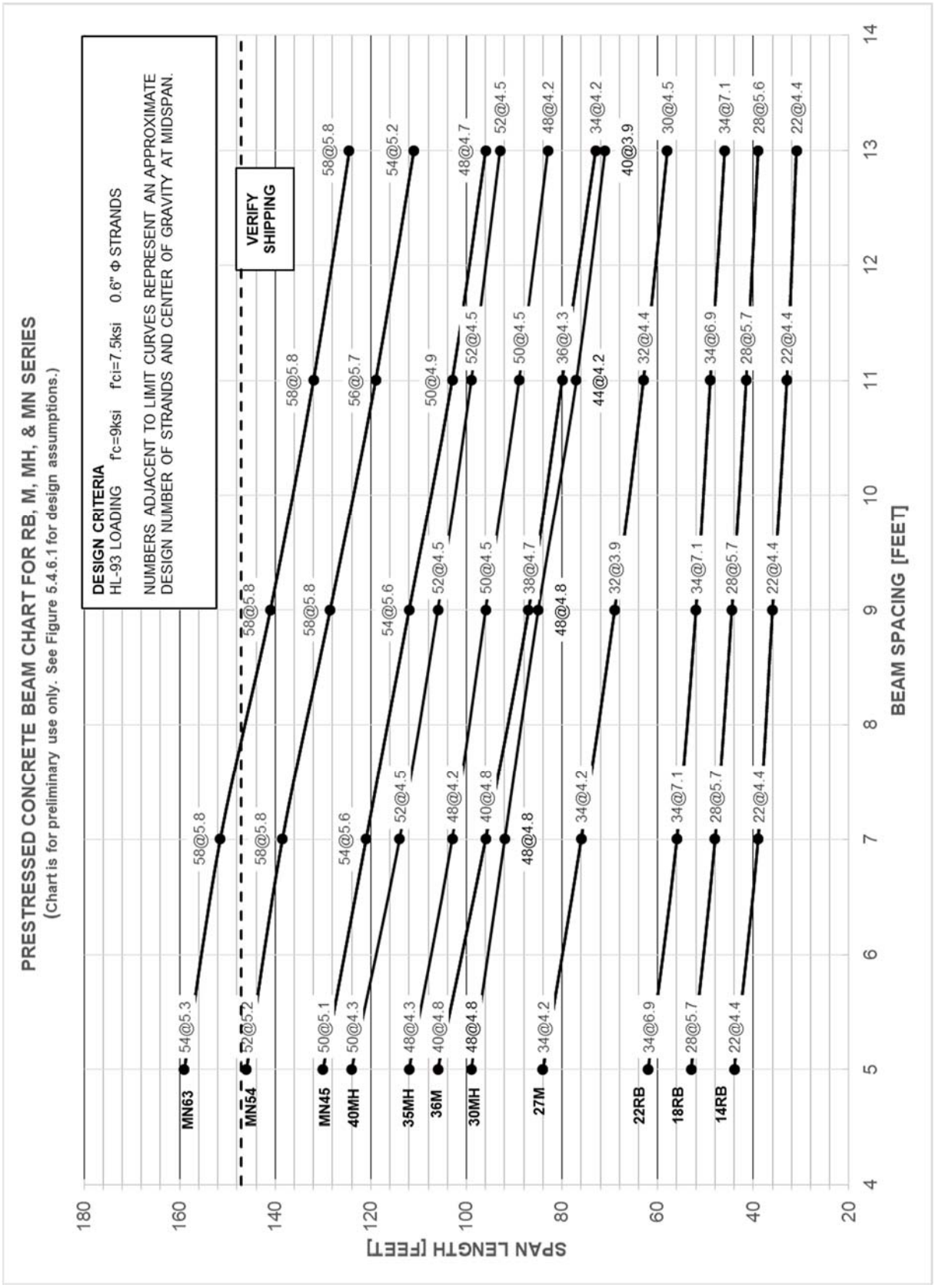

PRESTRESSED CONCRETE BEAM CHART FOR RB, M, MH, & MN SERIES
(Chart is for preliminary use only. See Figure 5.4.6.1 for design assumptions.)
DESIGN CRITERIA
HL-93 LOADING f'c=9ksi f'ci=7.5ksi 0.6" Φ STRANDS
NUMBERS ADJACENT TO LIMIT CURVES REPRESENT AN APPROXIMATE DESIGN NUMBER OF STRANDS AND CENTER OF GRAVITY AT MIDSPAN.
VERIFY SHIPPING
SPAN LENGTH [FEET]
BEAM SPACING [FEET]
MN63
MN54
MN45
40MH
35MH
36M
30MH
27M
22RB
18RB
14RB

Figure 5.4.6.2

Table 14.7.1
Fixed Curved Plate Bearing Assembly for Prestressed Concrete Beams (B310)

Beam Series	Max Service DL+LL (kips)	Bearing Pad Size (in)		Plain Pad Thickness (in)	Shape Factor	Bearing Plate Size (in) ②			Curved Plate Size (in) ②			Min Radius (in)
		A	B			C	E	F	G	H	J	
RB, M, and MN	253	12	24	1/2	8.0	14	①	1 1/2	4 1/2	26	1 1/4	16
	295	14	↓	↓	8.8	16	↓	↓	6	↓	↓	↓
	337	16	↓	↓	9.6	18	↓	2	↓	↓	↓	↓
	380	18	↓	3/4	6.9	20	↓	↓	8	↓	↓	↓
	422	20	↓	↓	7.3	22	↓	2 1/4	↓	↓	↓	20
MH	316	12	30	1/2	8.6	14	47	1 1/2	4 1/2	32	1 1/4	16
	369	14	↓	↓	9.6	16	↓	↓	6	↓	↓	↓
MW	270	16	36	1/2	11.1	18	47	1 1/2	4 1/2	38	1 1/4	16
	350	↓	↓	↓	↓	↓	↓	↓	6	↓	↓	↓
	506	↓	↓	↓	↓	↓	↓	↓	8	↓	↓	↓
	570	18	↓	↓	12.0	20	↓	2	8	↓	↓	↓

① 34" for all "RB" and "M" series beams.
38" for all "MN" series beams.

② Plates are conservatively designed for 1.75 · (Max Service DL+ LL).

Table 14.7.2
Expansion Curved Plate Bearing Assembly for Prestressed Concrete Beams (B311)

Beam Series	Max Service DL+LL (Kips)	Bearing Pad Size (in)		Laminate Thickness (in)	Max Number of Laminates ①	Shape Factor	Bearing Plate Size (in) ②			Curved Plate Size (in) ②			Min Radius (in)
		A	B				C	E	F	G	H	J	
RB, M, and MN	300	12	24	1/2	7	8.0	14	27	1 1/2	4 1/2	26	1 1/4	16
	360	12	↓	↓	7	8.0	14	↓	1 3/4	↓	↓	↓	↓
	420	14	↓	↓	8	8.8	16	↓	↓	6	↓	↓	19
MH	395	12	30	1/2	7	8.6	14	33	1 1/2	4 1/2	32	1 1/4	16
MW	270	16	36	3/4	6	7.4	18	39	1 1/2	4 1/2	38	1 1/4	16
	350	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	480	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	630	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

① See Table 14.7.3 for determination of required number of laminates.

② Plates are conservatively designed for 1.75 · (Max Service DL+ LL).

Table 14.7.3
Elastomeric Bearing Pad Thickness for Expansion Curved Plate Bearing Assembly for Prestressed Concrete Beams (B311) ①②

Interior Laminate Thickness (in)	D (in) ③	Number of Laminates	Total Elastomer Thickness, h_{rt} (in) ③	Maximum Movement Δ_s (in) ④
1/2"	1 1/4	1	1	1/2
	1 7/8	2	1 1/2	3/4
	2 1/2	3 ⑤	2	1
	3 1/8	4	2 1/2	1 1/4
	3 3/4	5	3	1 1/2
	4 3/8	6 ⑤	3 1/2	1 3/4
	5	7	4	2
	5 5/8	8	4 1/2	2 1/4
3/4"	1 1/2	1	1 1/4	7/8
	2 3/8	2	2	1
	3 1/4	3	2 3/4	1 3/8
	4 1/8	4	3 1/2	1 3/4
	5	5	4 1/4	2 1/8
	5 7/8	6	5	2 1/2

① Table is based on requirements of *AASHTO LRFD Bridge Design Specs*. Art. 14.7.6.3.4: $h_{rt} > 2\Delta_3$.
Engineer must also check that the minimum compressive load requirement (discussed in Article 14.3.3.3.1) is satisfied. Specifically:

$$P_{min} \geq 5 \cdot G \cdot A_{pad} \cdot \frac{\Delta_u}{h_{rt}}$$

where P_{min} is the minimum factored load ($0.9 \cdot DC + 1.75 \cdot LLmin$), G is equal to the maximum shear modulus value (0.200 ksi), A_{pad} is the plan area of the bearing pad, and Δ_u is the movement of the bearing pad from the undeformed state using a 75°F temperature.

② Engineer must also check the elastomeric bearing pad for compression deflection based on the requirements from *AASHTO LRFD Bridge Design Specifications* Articles 14.7.6.3.3 and 14.7.5.3.6.

③ Pad thickness D includes h_{rt} and 1/8" steel reinforcement plates. Total elastomer thickness h_{rt} includes interior laminates plus 1/4" cover layers.

④ Maximum movement Δ_s is the movement of the bearing pad from the undeformed state to the point of maximum deformation. Use a 75°F temperature change with a 1.3 load factor for calculation of maximum movement.

⑤ For "RB", "M", and "MN" series prestressed beam expansion elastomeric bearings, the number of laminates has been standardized for the movements that are most often encountered.

- If $\Delta_s \leq 1.00$", use 3 – ½" laminates.
- If $1.00" < \Delta_s \leq 1.75$", use 6 – ½" laminates.