Quality Management for Structures

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State Bridge Design Engineer

Outline

- Quality Management
- Software
- Design Personnel
- Drafting of Plans
- Use of Standards
- Independent Technical Reviews (ITRs)
- Bridge Office Quality Manual
- Coordination with Grading Plans
- Time vs. Quality

Quality Management

- Purpose: To assure a consistent, high level of quality in all calculations, plans, and reports generated

- Quality Management Plan (QMP): Plan of how quality will be integrated and achieved for the **specific** project

Quality Management

What belongs in a QMP:

- Project specific details
- QC/QA Process
  - What are the roles to assure quality
  - Who will be filling those roles
- Software usage
- Calculation and plan review process
- Usage and Integration of Independent Technical (ITRs) or Constructability Reviews (CRs)

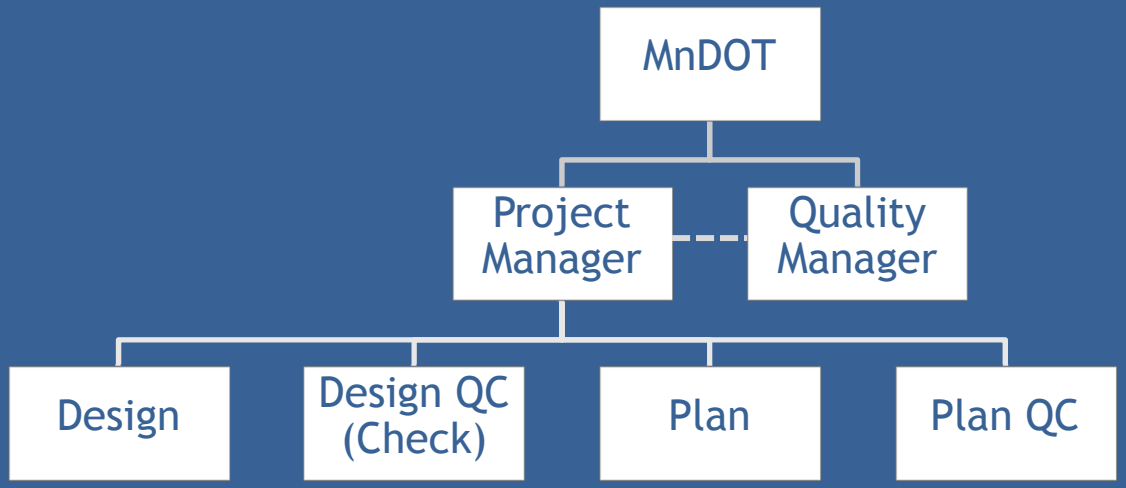
Quality Management

- Quality Control (QC)
  - Checking of plans and calculations
  - Documenting review process
- Quality Assurance (QA)
  - Verifying quality control process was followed

Design Personnel

People involved:

- Designer (QC)
- Checker (QC)
- Quality Manager (QA)



Design Personnel

Checker experience ≥ Designer experience

- Calculations
- Plan preparation

- Experience with component design or drafting

Software

- Software must be appropriate for project-specific circumstances.
- Designers need to understand limitations of software and validations.

- MnDOT LRFD Bridge Design Manual Section 4.1
  - Basic
  - Intermediate
  - Complex

Software – Basic

- Bridge elements
  - Abutments
  - Splices
  - Bearings
  - Most cases of prestressed concrete beams
- Methods
  - Independent set of calculations
  - Line-by-line check of calculations
  - Using software that has been validated for a similar situation

Software – Intermediate

- Bridge elements
  - Piers
  - Straight steel girders
  - Prestressed beams – flared or variable overhangs
- Methods
  - Independent design and check each using a different software package
  - Hand check using moderate simplifications with sound engineering judgment

Software – Complex

- Bridge Elements
  - Concrete box girders
  - Steel box girders
  - Curved steel girders
  - Structures requiring a soil-structure interaction model
- Methods
  - Independent design and check each using a different software package only!

Software – Checking methods

- Validated design software/spreadsheets
  - Assess all input.
  - Review output to confirm a reasonable answer.
- Line-by-line check
  - Every line of calculations must be verified.

- Non-independent checking methods
  - Handwritten initials on each page reviewed
  - Not preprinted!

Software – Checking methods

- Independent checks
  - Must use different software packages or spreadsheets
  - Compare
    - Input
    - Intermediate and final output values
      - Section properties
      - Dead load moments and shears
      - Live load moments and shears
      - Code checks

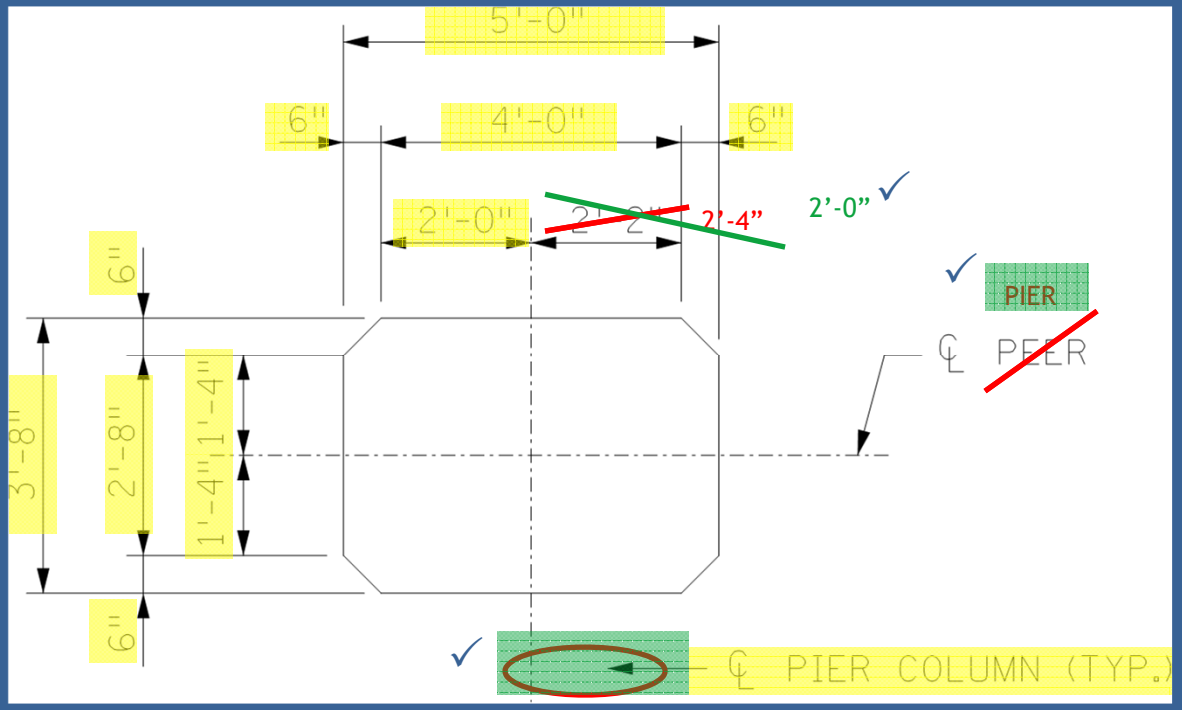
Software

Software

	1,957	Year Built
	356,000	Square Footage
+	1,016	Employees
	~~458,967~~	Meaningless!
	358,973	

Drafting of Plans

- Utilize appropriate procedures:
  - Drafting
  - Checking
  - Modifying
- Checklists

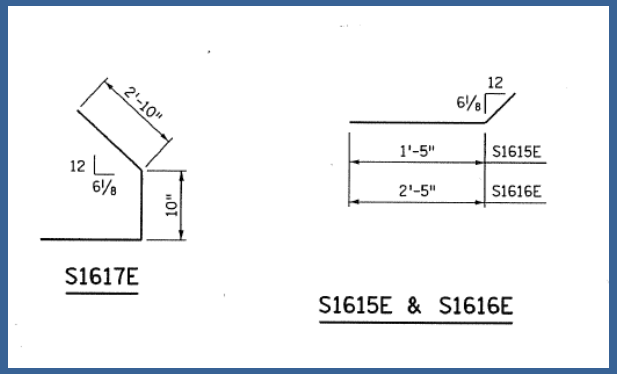


Drafting of Plans

- Rebar

BILL OF REINFORCEMENT
FOR SUPERSTRUCTURE

BAR	NO.	LENGTH	SHAPE	LOCATION
S1901E	583	40'-6"	——	SLAB TRANSVERSE BOT.
S1902E	583	28'-7"	——	SLAB TRANSVERSE BOT.
S1903E	2 SER. OF 50	FROM 3'-4" TO 59'-4"	——	SLAB TRANSVERSE BOT.
S1604E	741	47'-0"	——	SLAB TRANSVERSE TOP
S1605E	741	21'-6"	——	SLAB TRANSVERSE TOP
S1606E	2 SER. OF 64	FROM 3'-6" TO 60'-0"	——	SLAB TRANSVERSE TOP
S1307E	414	40'-0"	——	SLAB LONGITUDINAL TOP
S1308E	46	18'-3"	——	SLAB LONGITUDINAL TOP
S1609E	606	60'-0"	——	SLAB LONGITUDINAL BOT.
S1610E	101	19'-0"	——	SLAB LONGITUDINAL BOT.
S1911E	270	15'-0"	——	SLAB LONGIT. TOP OVER PIER
S1312E	144	3'-6"	⊓	END BLOCK TIE
S1313E	4	3'-11"	⊓	END BLOCK TIE
S1314E	4	3'-4"	⊓	END BLOCK TIE
S1615E	4	3'-0"	—/	END BLOCK TIE
S1616E	4	4'-0"	—/	END BLOCK TIE
S1617E	4	6'-8"	⊂	SLAB TIE
S1618E	8	10'-0"	——	END BLOCK TRANSVERSE
S1619E	32	38'-7"	——	END BLOCK TRANSVERSE



- Quantities
  - Independent check

SUMMARY OF QUANTITIES
FOR SUPERSTRUCTURE

BRIDGE SLAB CONCRETE (3Y36)	24972	SQ. FT.
CONCRETE WEARING COURSE (3U17A)	29030	SQ. FT.
TYPE MOD F (TL-4) RAILING CONCRETE (3Y46)	798	LIN. FT.
REINFORCEMENT BARS (EPOXY COATED)	198480	POUND
DIAPHRAGMS FOR TYPE MN54 PRESTRESSED BEAMS	744	LIN. FT.
EXP. CURVED PLATE BRG. ASS'Y TYPE E1	6	EACH
EXP. CURVED PLATE BRG. ASS'Y TYPE E2	24	EACH
EXP. CURVED PLATE BRG. ASS'Y TYPE E3	6	EACH
EXP. CURVED PLATE BRG. ASS'Y TYPE E4	6	EACH
FIXED CURVED PLATE BRG. ASS'Y TYPE F1	6	EACH
BEARING ASSEMBLY	48	EACH
EXPANSION JOINT DEVICES TYPE 4	147	LIN. FT.
PRESTRESSED CONCRETE BEAMS MN54	2190	LIN. FT.
BENCH MARK DISK	2	EACH
BRIDGE NAME PLATE	1	EACH
1" LOW DENSITY POLYSTYRENE	13	SQ. FT.

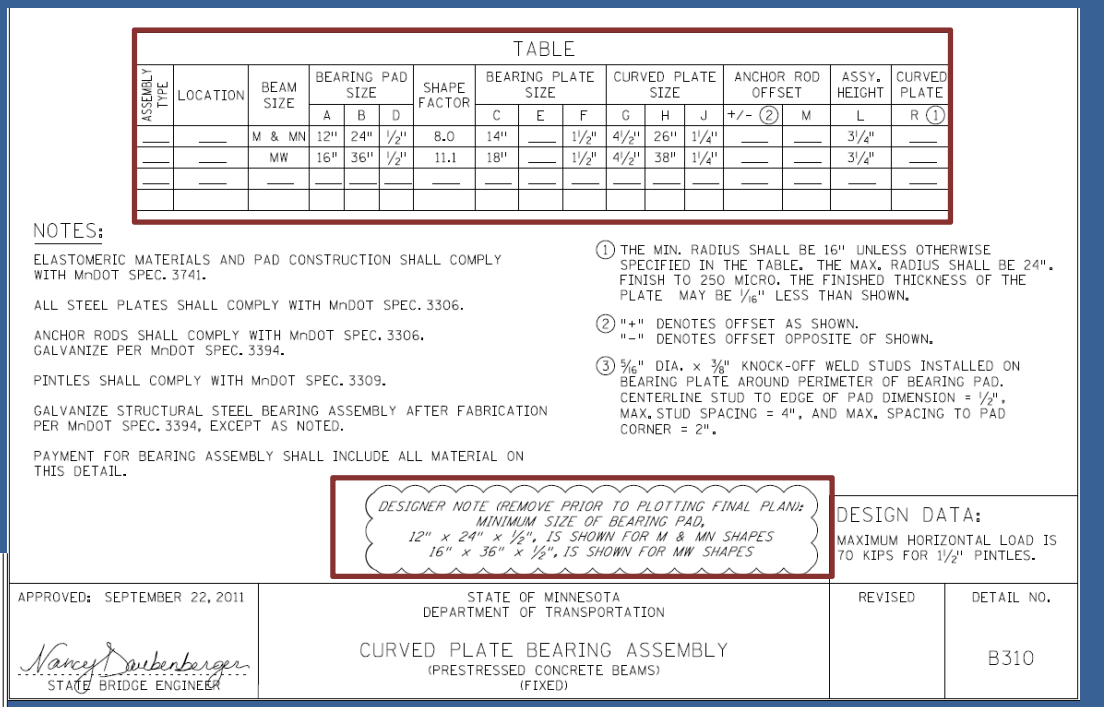
Use of Standards

- Standards should be added late in plan production.
- Add from the MnDOT website, not old projects.

  http://www.dot.state.mn.us/bridge
- Questions on usage should go through MnDOT Project Manager (Unit Leader)

Use of Standards

- Fill in information where necessary.
- Indicate modifications as applicable.
- Sign the sheet.



TABLE

ASSEMBLY TYPE	LOCATION	BEAM SIZE	BEARING PAD SIZE A	B	D	SHAPE FACTOR	BEARING PLATE SIZE C	E	F	CURVED PLATE SIZE G	H	J	ANCHOR ROD OFFSET +/- (2)	M	ASSY. HEIGHT L	CURVED PLATE R (1)
___	___	M & MN	12"	24"	½"	8.0	14"	___	1½"	4½"	26"	1¼"	___	___	3¼"	___
___	___	MW	16"	36"	½"	11.1	18"	___	1½"	4½"	38"	1¼"	___	___	3¼"	___
___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___

NOTES:

ELASTOMERIC MATERIALS AND PAD CONSTRUCTION SHALL COMPLY WITH MnDOT SPEC. 3741.

ALL STEEL PLATES SHALL COMPLY WITH MnDOT SPEC. 3306.

ANCHOR RODS SHALL COMPLY WITH MnDOT SPEC. 3306. GALVANIZE PER MnDOT SPEC. 3394.

PINTLES SHALL COMPLY WITH MnDOT SPEC. 3309.

GALVANIZE STRUCTURAL STEEL BEARING ASSEMBLY AFTER FABRICATION PER MnDOT SPEC. 3394, EXCEPT AS NOTED.

PAYMENT FOR BEARING ASSEMBLY SHALL INCLUDE ALL MATERIAL ON THIS DETAIL.

(1) THE MIN. RADIUS SHALL BE 16" UNLESS OTHERWISE SPECIFIED IN THE TABLE. THE MAX. RADIUS SHALL BE 24". FINISH TO 250 MICRO. THE FINISHED THICKNESS OF THE PLATE MAY BE 1/16" LESS THAN SHOWN.

(2) "+" DENOTES OFFSET AS SHOWN. "−" DENOTES OFFSET OPPOSITE OF SHOWN.

(3) 5/16" DIA. x 3/8" KNOCK-OFF WELD STUDS INSTALLED ON BEARING PLATE AROUND PERIMETER OF BEARING PAD. CENTERLINE STUD TO EDGE OF PAD DIMENSION = ½", MAX. STUD SPACING = 4", AND MAX. SPACING TO PAD CORNER = 2".

DESIGNER NOTE (REMOVE PRIOR TO PLOTTING FINAL PLAN: MINIMUM SIZE OF BEARING PAD. 12" x 24" x ½", IS SHOWN FOR M & MN SHAPES 16" x 36" x ½", IS SHOWN FOR MW SHAPES

DESIGN DATA: MAXIMUM HORIZONTAL LOAD IS 70 KIPS FOR 1½" PINTLES.

APPROVED: SEPTEMBER 22, 2011

Nancy Daubenberger
STATE BRIDGE ENGINEER

STATE OF MINNESOTA
DEPARTMENT OF TRANSPORTATION

CURVED PLATE BEARING ASSEMBLY
(PRESTRESSED CONCRETE BEAMS)
(FIXED)

REVISED

DETAIL NO. B310

MODIFICATION: CHANGED BARRIER SHAPE. REPLACED WINGWALL WITH APPROACH PANEL. REPLACED DEFLECTION JOINTS WITH CONTROL JOINTS AND ABUTMENT JOINTS. REPLACED FENCE WITH ORNAMENTAL METAL RAILING.

FIG. 5-397.119 MOD.

DES: B.J.J.	DR: L.K.L.	APPROVED:	BRIDGE NO. 27408
CHK: N.M.H.	CHK: N.K.L.		
SHEET NO. 29 OF 38 SHEETS			

CERTIFIED BY John Hancock 7/4/76
LICENSED PROFESSIONAL ENGINEER DATE

NAME: JOHN HANCOCK LIC. NO. 00000

Independent Technical Reviews

- Use ITRs for complex or unusual details
- People to involve:
  - Unit Leader
  - Regional Construction Engineer
  - State Bridge Design Engineer
  - Others as needed

- Not the same as a peer review
  - See MnDOT LRFD Bridge Design Manual Section 1.3.3

Bridge Office Quality Manual

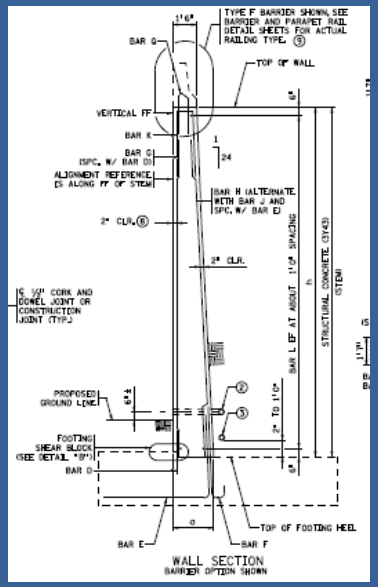
- Coming soon!

- Similar to Roadway's *Quality Management Process For Design-Bid-Build Final Plan Development*

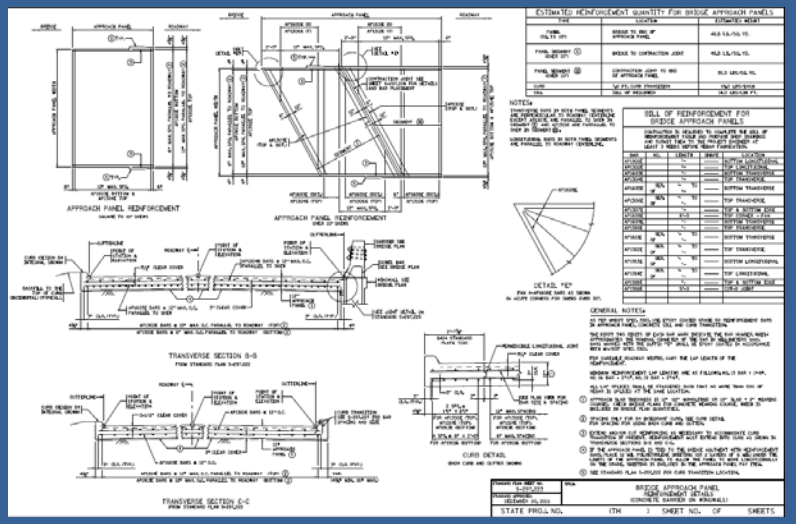
http://www.dot.state.mn.us/design/qmp/index.html

Coordination with Grading Plans

- Retaining Walls
  - Standard
  - Non-standard
- Approach Panels

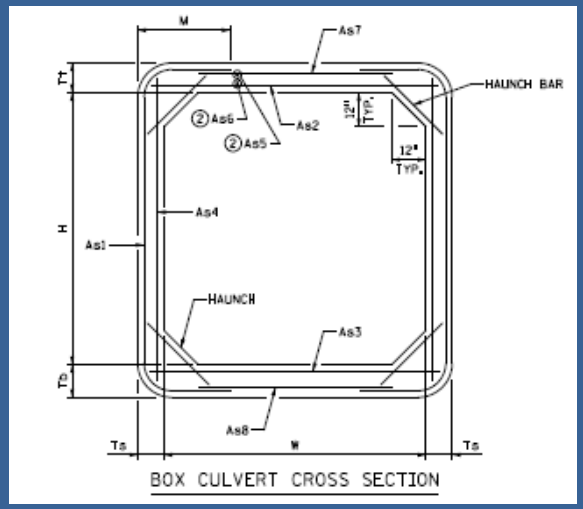


BAR	MARK	NO.	LENGTH	A	LOCATION	WT.	DIMENSIONS & QUANTITIES			
h = 26' PANELS:										L=30'-6"
SPREAD FOOTING REINFORCEMENT							DIMENSIONS			
A	F1901	26	33'-5"	STR.	LONG T & B	1305	SPREAD FOOTING			
B	F1902	31	12'-4"	STR.	TRANS BOT	574	b	5'-3"	e	1'-4"
C	F2503	31	12'-4"	STR.	TRANS TOP	1021	c	2'-3"	f	7'-6-1/8"
							d	12'-10"	g	5'-5-5/16"
PILE FOUNDATION REINFORCEMENT							PILE FOUNDATION			
A	F__01	26		STR.	LONG T & B		b	5'-3"	d	13'-0"
B	F__02	31		12'-6"	TRANS BOT		c		g	5'-5-5/16"
C	F2503	31	14'-4"	12'-6"	TRANS TOP	1186				
							STEM			
							a	2'-7"	k	5'-3"
							J	2'-2-1/8"		
FOOTING DOWELS & STEM REINFORCEMENT							QUANTITIES			
D	F1604E	31	3'-0"	STR.	DOWEL FF	97	STRUCTURAL CONCRETE (1A43)			
E	F2905E	31	14'-5"	7'-4"	DOWEL BF	1520	(FOOTING)			
F	F2906E	30	9'-10"	8'-7"	DOWEL BF	969	SPREAD	36.5		CU YD
G	S1301E	31	23'-3"	STR.	VERT FF	481	PILE			CU YD
H	S2202E	31	23'-3"	STR.	VERT BF	1473	STRUCTURAL CONCRETE (3Y43)			
J	S2203E	30	13'-6"	STR.	VERT BF	828	(STEM)			
K	S1604E	31	10'-7"	4'-9"	TIE	342	59.9			CU YD
L	S1305E	52	30'-0"	STR.	HORIZ EF	1042	REINFORCEMENT (PLAIN)			
M	S1606E	20	7'-4"	1'-4"	EXP JT TIE	153	SPREAD	2900		LB
N	S1607E	20	7'-9"	1'-9"	EXP JT TIE	162	PILE			LB
P	S1608E	12	8'-2"	2'-2"	EXP JT TIE	102	REINFORCEMENT (EPOXY)			
Q	S1609E	——	8'-7"	4'-0"	RAIL DOWEL	——	7203			LB
Q	S1609E	——	6'-1"	2'-8"	F-RAILDOWEL	——				



Coordination with Grading Plans

- Utilities (MnDOT LRFD Bridge Design Manual 2.4.1.6)
  - On bridges
  - Near foundations
- Box Culverts



- Special Hydraulic Structures

Time vs. Quality

- Do NOT skip QC process to save time!
- Use over-the-shoulder (OTS) reviews.
- Project manager responsibilities:
  - Follow the steps in order: Final design comes after preliminary design
  - Communicate potential issues with MnDOT ASAP
  - Involve all stakeholders

QUESTIONS?