Bridge Quality Management

Kevin Western | State Bridge Engineer

May 17, 2017

DEPARTMENT OF TRANSPORTATION

Outline

- Quality Management
- Design Personnel
- Software
- Drafting of Plans
- Technical Reviews
- Coordination with Roadway Plans
- Time vs. Quality
- Few Last Thoughts

Quality Definitions

- Quality Control (QC)
  - Checking of assumptions, plans, and calculations
  - Documenting review process

- Quality Assurance (QA)
  - Verifying quality control process was followed

Quality Definition

*"**Quality control** is implemented to detect and correct problems when they occur, **quality assurance** is implemented to prevent problems from happening"*

Quality Management

- Why needed?

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

- How to Provide:

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

Quality Management

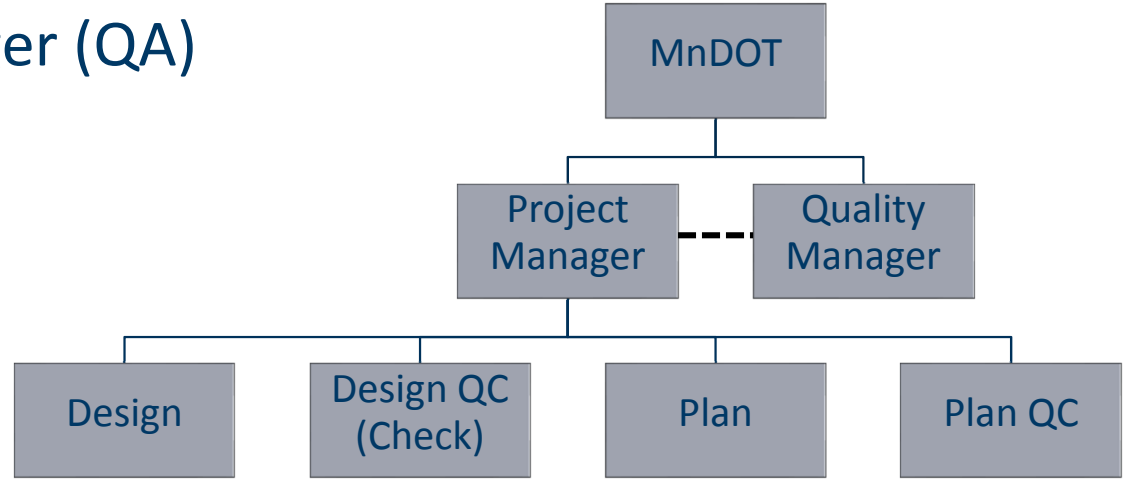
What belongs in a Quality Management Plan:

- Project specific requirements
- Project staff responsibilities
- QC/QA Process
  - What are the steps to assure quality
  - Who will be filling those roles
- Software usage
- Calculation and plan review process
- Usage and integration of Independent Technical Reviews (ITR) or Constructability Reviews (CR)

QMP-Design Personnel

People involved and preferred interaction:

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



Design Personnel

Checker experience ≥ Designer experience

- Design Calculations
  - Can be softened if both people meet minimum experience levels
- Plan preparation
- Experience with component design or drafting
  - Include critical expert if needed

Software

- Software must be appropriate for project-specific circumstances.
- Institutionally understand limitations of software and validation process
  - Is software appropriate for my task?
- 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
- Methods
  - Independent design and check each using a different software package only!

Software – Load Distribution

- Bridge Live Load Distribution
  - Needed for some structure types
    - Concrete box girders
    - Curved steel girders
    - Beyond AASHTO parameters
    - Structures requiring a soil-structure interaction model
- Checking Methods
  - Compare to simplified AASHTO LLDF if approriate
  - Utilize another model

Software – Checking methods

- Validated design software/spreadsheets
  - Evaluate all input and assumptions.
  - 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

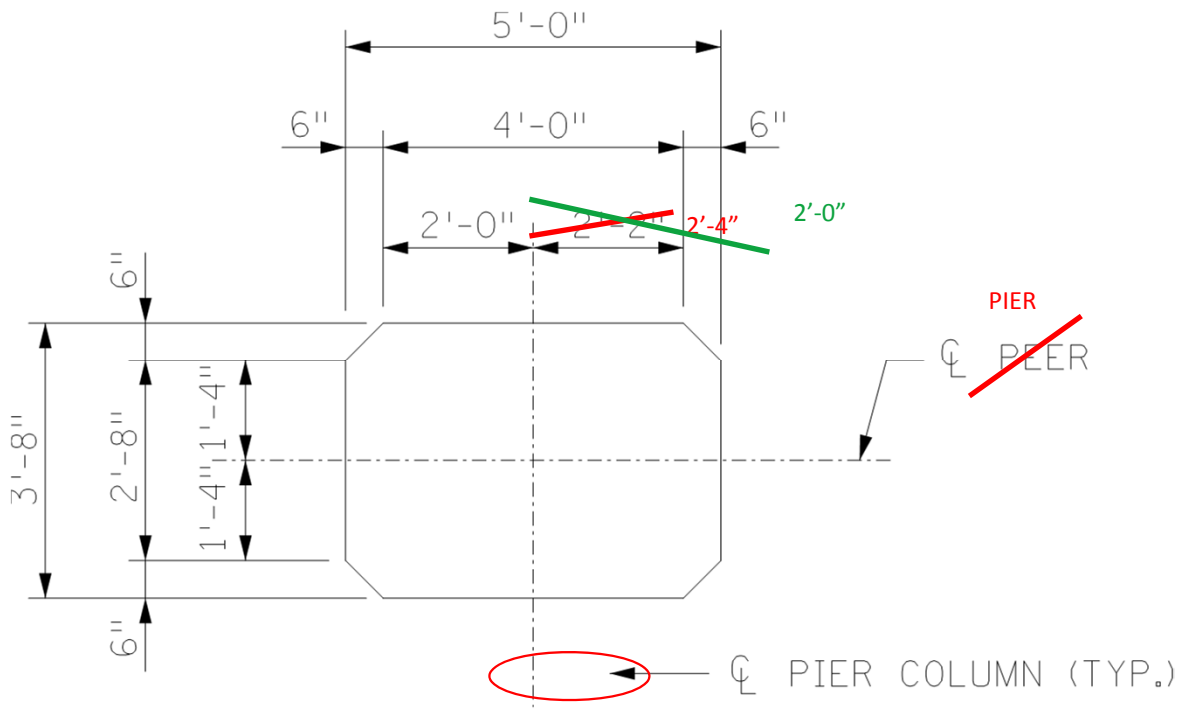
- Independent checks
  - Must use different software packages or spreadsheets
  - Compare (at a minimum)
    - Input
    - Intermediate and final output values
      - Section properties
      - Dead load moments and shears
      - Live load moments and shears
      - Code checks

Tracking Procedures

I'M GOING TO NEED A LITTLE MORE FOR THE ROOT CAUSE THAN, ***WHO'DA THUNK.***

Drafting of Plans

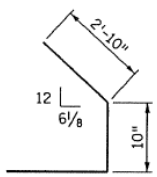
- Utilize appropriate procedures:
  - Drafting
  - Checking
  - Modifying
- Checklists



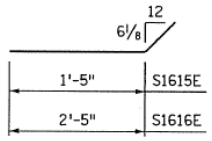
Drafting of Plans

- Quantities (with a 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.



S1617E



S1615E & S1616E

- Reinforcing Steel
  - Bends, lengths, and numbers

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

Independent Technical and Constructability Reviews

- Use Independent Technical Review for complex or unusual details
- Use Constructability Review for access, assumed means and methods, girder installation, congested details
- MnDOT staff involvement:
  - Unit Leader
  - Regional Construction Engineer
  - State Bridge Design Engineer
  - Others

Coordination with Roadway Plans

- Retaining Walls
  - Standard and non-standard
- Approach Panels
- Utilities (MnDOT LRFD Bridge Design Manual 2.4.1.6)
  - On bridges or near foundations
- Box Culverts
- Special Hydraulic Structures

Time vs. Quality

- At times we are limited on time to deliver plans
- **DO NOT** skip QC process to save time!
- Use over-the-shoulder (OTS) reviews to reduce risk and plan changes at final submittals
- Project manager responsibilities:
  - Follow the steps in order; if not over-communicate
  - Communicate potential issues with MnDOT ASAP, including personnel changes
  - Involve all stakeholders

PM's – Use the Right Tools

Few Last Thoughts To Consider

- Design / Fabricated Components
  - Disc bearings, modular joints, pedestrian truss bridges
  - Design and check completed by supplier
  - We require a review – focus on assumptions
- MnDOT Reviews
  - We will be doing less review of consultant plans
  - 95% submittal is a ready to sign plan
    - Too many ‘swapped sheets’ after 100% turn in

Few Last Thoughts To Consider

Is this an error and by whom?

Few Last Thoughts To Consider

- Quality vs. Time vs. Cost
  - Never reduced quality (but others are important too!)
- Efficient design and detailing
  - Component size
  - Number of piling
  - Rebar size, detailing, and constructability
  - PCB – release strength (and final too)
- If you don’t agree with information provided, question it

Few Last Thoughts To Consider

- Plan quality – we've had some issues
- Your focus on quality is better than 5 years ago
- Having a good plan and improving on it is vital
- Over communicate changes and issues

Keep improving!!

ANY QUESTIONS ON

Thank you!

Kevin Western

kevin.western@state.mn.us

651.366.4501