Checking Standards and Procedures

3.1 Purpose

To assure a clear, complete, and accurate set of structure plans.

3.2 Responsibility

The responsibility for compiling a set of plans lies with the Project Structural Engineer; however, each individual checker shall be responsible for the work assigned.

3.3 Procedures

Detail checking shall take place upon the completion of the necessary structural details. Details with which the checker agrees shall be crossed through with a yellow pencil or marker. Corrections or suggestions shall be made neatly with a red pencil or pen. All checking shall be done using prints of the latest design and details.

Design and constructability checking shall be performed as defined in the Design Manual.

3.4 Detail Check

The detail check shall be made independently based on the plan set by someone who is adequately experienced with the CDOT Bridge Detail Manual requirements and, preferably, unfamiliar with the project. All items in the plan set are to be checked in accordance with this manual, including:

A) Geometry Program
   1) Input of the geometry program from the roadway sheets (horizontal and vertical alignment, roadway cross slopes).
   2) Input of the geometry program for the structure layout (bent lines, girder lines, layout lines, skew, etc.).
   3) Key points (away from the control line) by hand calculations of output.

B) Details – Verify the following:
   1) Dimensions, stations, and elevations taken from geometry output
   2) Hand calculated dimensions, stations, and elevations
   3) Adequate room for placement of reinforcing, expansion joints, embedments, bearing devices, etc.
   4) Reinforcing placements, lengths, sizes, shapes, etc.
   5) Sufficient information to construct the structure

6) Bridge Working Drawings (structural worksheets) are revised to match project specifics
7) M & S Standards references
8) General considerations: foot and inch marks, arrowheads, required notes, spelling, dimensions add up, etc.
9) Section letter, detail number, sheet references

See other chapters of this manual for specific items to check for each sheet.

3.5 Quantity Check

The quantity check shall be made independently based on the plan set, preferably by someone unfamiliar with the project. Typically, the detailer performs one set of the quantity calculations as defined in the Design Manual. During the process of calculating quantities, it is not unusual to find that additional information or clarification is needed. If sufficient information is not on the plans to complete the quantity, the plan set shall be marked up for the proposed revisions. All plan quantities should be calculable from information shown on the plan set. Once the quantity calculations are completed, the two sets of quantities shall be compared and any differences resolved. During this resolution process, it is determined which is the record quantity set.

During this comparison, the following items shall be considered:

- Both sets of quantities shall be within 1% of each other, per the following formula:

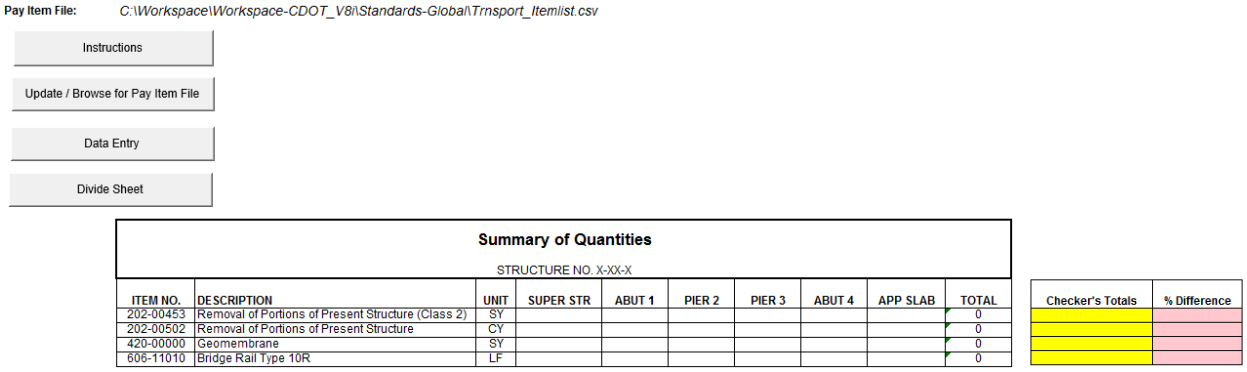
$$\%\,Differen\ e = \frac{e\quad r\quad Set - \quad Che\ \ k\,Set}{e\quad r\quad Set}\ \%$$

- Excavation and backfill quantities may be within 10% difference.
- Quantities shall be checked for each structure or structure component for the Summary of Quantities sheet.
- Preliminary quantities based on volume (Lb/CY) or area (Lb/SF) or percentages shall never be used for final quantities.
- Areas and volumes may be measured from CAD program for only one of the calculation sets. The other set must use information found on the plan set.
    - Quantities from the two independent sets shall not be averaged.
    - Eight digit cost code item shall be used in tabulations.

- A summary showing percentage differences shall be included in the calculations.

Differences shall be resolved and totals from the record set shall be shown in the plans (see examples in Chapter 5). Quantity differences between the two independent sets that cannot be resolved shall be referred to the Engineer of Record for resolution.

An example of a quantity form with quantity checks in Excel is available in ProjectWise under Project Templates (JPC#BRDG_Tabulation of Bridge.xls). The percentage differences are included in the spreadsheet (see Fig. 3.5-1). This Excel file can be copied and used outside of ProjectWise as well.



Summary of Quantities

STRUCTURE NO. X-XX-X

ITEM NO.	DESCRIPTION	UNIT	SUPER STR	ABUT 1	PIER 2	PIER 3	ABUT 4	APP SLAB	TOTAL	Checker's Totals	% Difference
202-00453	Removal of Portions of Present Structure (Class 2)	SY							0		
202-00502	Removal of Portions of Present Structure	CY							0		
420-00000	Geomembrane	SY							0		
606-11010	Bridge Rail Type 10R	LF							0		

Fig. 3.5-1 Example - Summary of Quantities with Checker's Totals (in Excel)

3.6 Review

When design and detail checks are completed, all changes, including those received from recipients of advanced plans and FOR plans, as applicable, shall be carefully reviewed and combined on one set of prints. This set shall be marked "Final Check Set", and all detail changes shall be made from this set.

3.7 Plan Preparation and Assembly

This is a last quality assurance (QA) that all checks have been done and the plan set is complete and assembled correctly. This should be the responsibility of the Project Structural Engineer or Lead Detailer.

As a minimum, the following items should be checked:

- Plan sheets assembled according to the order shown in Chapter 5 of the Detailing Manual

- The total number of sheets in the subset is correct on each and every plan sheet
- The drawing number and title for each sheet matches the number and title shown in the Drawing Index
- The Final Project Construction Number and Project code are correct on each and every sheet
- The Border information is correct on each and every plan sheet as shown in Section 1.9
- All Section letters and Detail numbers are referenced correctly with correct cross reference drawing numbers
- Summary of Quantities match the record set
- Quality Control information to the left of the border is filled out completely.

3.8 Archiving

All projects with a project number shall be archived in ProjectWise and all projects shall be archived in the Staff Bridge Archive as well.

The Detailer shall be responsible for archiving all the drawings in the original CADD format, including reference drawings, photos, models and other drawing related data. If OpenRoads was used, then all OpenRoads generated files such as surfaces, alignments, templates, etc., shall also be archived.

Both sets of quantity calculations shall also be archived in the original format, along with any materials used in the calculations, e.g. InRoads surfaces, CAD sketches of areas, volume reports, hand calculations, spreadsheets in original format. If hand calculations were performed, they shall be scanned in pdf format and archived.

"All PDFs with text or numerical data shall be 300 dpi, page aligned, text searchable, compressed and in conformance with ISO PDF/A-1b archival specification. CDOT employees are to refer to LMS My Learning for Smart Scanning training; all others are to contact DOT_Records_Mgmt@state.co.us for training on Smart Scanning and Electronic Signatures."

3.9 Field Information Package

See Bridge Design Manual, Policies and Procedures, Section 4 for information on the Field Information Package.

3.10 Electronic Checking Standards

Currently CDOT does not use an automatic standards checker. This section provides best practices for drawing production to facilitate their common use between detailers as well as future use for the life of a bridge.

1. A sheet model should be used for printing purposes.
2. Use View 1 for plot ready views. Save settings when exiting a file so border view is entirely visible.
3. Border cells should be placed at a 1”=1” scale and reference files scaled to fit into the border.
4. Delete preliminary or extraneous linework from models, e.g. extra profiles, preliminary sections.
5. Bridge linework should be in correct geographic location and rotation.
6. Linework should be centrally located in the file so a fit view shows actual linework instead of dots.
7. Bridge Models should have geographic coordinate system imported from survey files.
8. See Chapter 17, section 17.3 for additional requirements for Inspection Sketches.

Best practices help with batch printing as well such as use View 1 for plot ready views. Some practices were to keep files clean of outdated or not used linework. Standalone files for inspection sketches, i.e. no exterior references.

3.11 Electronic Model Checking Standards

The idea of models used for drawing production has been evolving over the years and is now developing into using 3D models for construction as well. Originally each drawing or sheet held its own linework which could lead to discrepancies between linework if updates were not made consistently. Each printed sheet could be checked for correctness. Using a single linework model that was referenced to

multiple sheets became a best practice to avoid multiple versions of linework. This still necessitates proper checking in both 2D and 3D environments. When auto-dimensions are used in sheets for new construction/structures, most errors in the linework will be identified automatically through the sheet development process and can be fixed. When developing linework models for overlays and other rehabilitation or repair work, much of the structure is not dimensioned on the final drawings so additional manual quality control of the linework is required. This quality control is crucial when using this linework for the remaining life of the structure as intended for inspection sketches. A few minimums for 2D plan production are:

1) Final view for plotting hardcopy shall be View 1, a Top View. This view shall be located in the "Border" or sheet model.

2) Unless creating 3D elements at elevation, all linework should be at elevation zero.

3) Default symbology should be used for configuration levels whenever possible.

4) Linework should be drawn at full scale, i.e. 1:1.

5) Sheet models should generally use 1" = 1" to avoid text scaling issues.

Electronic checking of linework models should be done, especially if the linework is used as a resource for the life of the structure like inspection sketches.

- Color, weight & linestyles need not be checked
- Master Units and Positional Units (MU:SU) should be used in the design file settings for Working Unit format.
- Make sure extraneous linework is eliminated, e.g. copies of linework floating out in space. Fit to all should zoom to the active elements reasonably. i.e. not everything is dots on the screen.
- Levels should be used appropriately to identify elements of the structure, e.g. abutment linework should be on the abutment levels. To retain as much information as possible in the model levels, the "existing" levels should be used primarily for details and printing capabilities should be used to depict the difference between existing linework and proposed work.
- If a linework model contains more than one structure, they shall be labeled with the structure number at a scale large enough to read when zoomed to extents. In general a linework model should just contain linework for the structure with information of no more than 50 to 100 feet on either side of the structure
- Check that everything is drawn to scale and is an accurate depiction of the structure and in the correct orientation and location. This will help when aerial

imagery is used to add future geographic changes such as trails or channel changes.

a. Plan Views
    i. Check bearing to bearing and pier to pier distances
    ii. Check bridge widths
    iii. Check that curb gaps/drains are shown
    iv. Check that joints/bridge headers and gaps are shown correctly
    v. Check overall length against SIMSA values. If there are differences between the sketch and SIMSA, they should be resolved by determining which values are correct and fixing/updating the incorrect values.
    vi. Check skew angles
b. Section Views
    i. Check girder and overhang spacing, note when overhangs are variable
    ii. Correct depiction of bridge rail and height (needed for crash worthiness analysis)
    iii. Waterproofing membrane shall be shown with a line in the typical section
    iv. Add Notes in model for variable cross-slopes, e.g. max & min
    v. Add notes if typical section contains multiple bay information.
    vi. Check that steel section cells are used for steel shapes.
c. Elevation Views
    i. If piers/abutments are skewed provide true scale versions of expansion joints
    ii. Check that fixed and expansion piers and abutments are identified. The symbols/letters should be placed on the frozen or text levels so they don't interfere with inspection sketch requirements.

- Duplicate linework shall be avoided, i.e. only one plan view. Multiple sections may be provided to show different portions of the structure especially when there are major changes between spans.
- If linework models or portions of models are unchecked, the checked or unchecked portions should be marked as such using the BRDG_Frozen level, e.g. place a shape around uncheck portions with text saying unchecked in a large text size (easily visible when zoomed to extents).
- Additional 3D modeling checks will be developed.