

SECTION 35 COST ESTIMATING AND QUANTITIES

35.1 GENERAL REQUIREMENTS

Quantities of the various materials involved in project construction are essential for determining the estimated project cost and for establishing a basis for the Contractor's bid and payment.

Prepare quantity calculations and project cost estimates at the conceptual, and preliminary stages of project development. Square Foot (SF) cost may be used at conceptual or planning stages. Cost estimate at preliminary stage is only required for structure selection report. The best available cost data and project information at the respective design stage shall be used.

Cost estimates at the FOR and Final will be completed by Engineering Estimate and Market Analysis (EEMA). For local agency project requirements see the Local Agency Manual.

35.2 BID ITEMS

Bid items shown in the Summary of Quantities Table located in the plans and in the Structure Selection Report shall be listed sequentially according to the most current CDOT Cost Data Book. The eight-digit cost code, item description, and unit of payment shall be used in the tabulations.

A Project Special Provision shall be written if an accurate description of the work and the method of measurement for each bid item is not adequately described in the drawings or outlined in the Standard Specifications for Road and Bridge Construction or in the Standard Special Provisions.

The Engineering Estimate and Market Analysis (EEMA) Unit tracks and tabulates bid items and costs for all projects awarded for construction. Data are published on CDOT's website. The Item Code Book provides individual bid items listed sequentially by eight-digit code, item description, and unit. If a new item is required, the Engineer shall coordinate a request through EEMA. CDOT's Construction Cost Data Book provides unit costs for each awarded project. The cost data summarize the final Engineer's estimate (completed by EEMA), the average project bid, and the awarded bid. Engineers and technicians should use these resources when developing project cost estimates.

35.3 PLANNING / CONCEPTUAL

During the early planning and conceptual phase of a project, estimated quantities may be required to evaluate viable and economical structure alternatives. If square foot costs for the structures cannot be determined, the structure should be broken down into individual cost items. At this stage, quantity accuracy between the design and check should be within 10 percent. Unless determined otherwise, the cost estimate at this project stage should include a 50 percent contingency.

35.4 SCOPING

The scoping phase follows the planning/conceptual phase. Scoping is the phase of the project to determine the objectives and requirements necessary to complete a project. Properly defining the scope allows the team to effectively estimate cost and schedule.

35.5 PRELIMINARY / FIELD INSPECTION REVIEW (FIR)

For the FIR submittal, the Designer and Independent Checker shall calculate estimated quantities and a preliminary cost estimate to include in the Structure Selection Report. Quantities at this stage may be estimated using quantity per cubic yard, per square yard, or as percentages of individual structure components. For example, reinforcing steel quantities may be estimated using average reinforcing weight per concrete volume (lb/cy). At this stage, quantity accuracy between the design and check should be within 5 percent. If the Region requests a comprehensive project estimate, these quantities and cost items should be coordinated with the design team for submittal. Unless determined otherwise, the cost estimate at this project stage should include a 15 percent contingency.

35.6 FINAL / FINAL OFFICE REVIEW (FOR)

For the FOR submittal final estimates will be completed by EEMA based on the final quantities calculated and independently checked as outlined in Section 35.7 of this BDM. FOR level quantities shall also be updated to address any comments made during the FOR review and submitted with the Ad document package. EEMA is responsible for the FOR and final Engineer's Project Cost Estimate.

35.7 QUANTITY CALCULATIONS

Use the available plan set to compute and check quantities independently at each design stage. If sufficient information is not on the plan set to determine the quantity, revise the plans to show the missing information. The Designer and Checker shall separately summarize their calculated quantities, compare their values, and resolve any differences in accordance with Section 35.8 of this BDM. The record quantity set shall typically be the Designer's, shown in the Summary of Quantities Table, and included in the field package as requested. Each set of quantity calculations shall include a summary showing the percent differences.

Each set of calculations shall compare and meet the required percent difference per Table 35-1 for each item in the element breakdowns as outlined in the *Bridge Detail Manual*, i.e., Superstructure, Abutment 1, Pier 2, etc. For example, the Designer's values for excavation for Pier 2 and Pier 3 shall be compared separately against the corresponding values determined by the checker. The quality process shall follow the QA/QC procedure outlined in Section 37 of this BDM.

Use logical breaks between the superstructure and substructure quantities for the calculations. Such breaks may be construction joints, bearing seats, expansion devices, abutment front face, abutment back face, or breaks indicated on the plans. Except for precast prestressed and post tensioned

members, all bridge concrete is typically Class D. Class DF is typically used to replace Class D in splash zones, see Section 5 for details.

The following recommended logical breaks for bridge quantities should be followed on all plan sets:

- Include all concrete and rebar below the top of bearing seats at abutments, wingwalls, and piers in the quantities for that substructure element.
- Include all projecting rebar embedded into the concrete designated as substructure in the quantities for that substructure element, e.g. Pier, Abutments.
- Include a column in the Summary of Quantities Table for approach slab. Calculate approach slab from the back of approach notch. Include the anchorage bar into the abutment in the superstructure quantities.
- Except as noted below, include all concrete and rebar **above** the top of bearing seats at abutments, wingwalls, and piers in the superstructure quantities.
- Precast girder members, bridge railings, and caissons have designated pay items and do not require concrete and rebar quantities.
- Precast panel deck forms required by the plans will be paid for at the contract unit price for the area shown on the plans. The quantities shall be in the superstructure quantities.

The following will be included as roadway quantities only and will not be shown on the bridge Summary of Quantities sheet:

- All revetment such as slope mattress or riprap and associated excavation. When information for revetment is shown within bridge plan set, the quantities should be shown. The quantities and checking are the responsibility of the hydraulic designer.
- Excavation and backfill relating to revetment installation
- All excavation and embankment for spur dikes, channel improvements, or bike paths
- Common backfill not associated with the construction of the structure or not shown in the backfill quantities figure
- Unclassified excavation

35.8 ACCURACY AND FORMAT

Required quantity calculation accuracy between originator and checker for each design phase shall be as shown in Table 35-1. The cost estimate contingency shown is the preferred value of Staff Bridge but can be adjusted on a project basis to match the other disciplines involved with the project. For Information Only quantities shall be held to the same level of accuracy and checking.

Table 35-1: Contingency and Quantity Accuracy Percentage

Design Phase	Contingency	Quantity Percent Difference
Planning/Conceptual	50%	± 10%
Scoping	40%	± 10%
Preliminary/FIR	15%	± 5%
Final/FOR/Ad	0%	± 1% (unless noted otherwise)

$$\%Difference = \frac{Design - Check}{Design} \%$$

- Calculate the quantity percent difference for each structural element (i.e., abutment, pier), not the final total.
- For all design phases, excavation and backfill quantities may be within 10 percent difference.
- For Final, use actual reinforcing bar lengths, including calculated lap lengths, in calculating reinforcement weight.
- For Final, when calculating concrete haunch quantity, use the average haunch as shown in BDM Section 5.5.2.1G.
- For all design phases, use a unit weight of 146.7 pcf or 110 lb/sy per inch thickness when calculating quantities for Hot Mix Asphalt (HMA) and Stone Matrix Asphalt (SMA).
- Do not use preliminary quantities based on volume (#/cy), area (lb/sf), or percentages for final quantities.
- For all design phases, do not average quantities from the two independent sets.
- For Final, include a summary showing percentage differences in the calculations.
- Refer unresolved quantity differences to the Unit Leader or Project Manager for resolution.

Use the Tabulation of Bridge spreadsheet to create and populate a Summary of Quantities Table containing item codes and quantities for a bridge project. Format the Summary of Quantities Table so that it can be embedded in or linked to a MicroStation drawing file and included in the General Information section of the project plan set. The spreadsheet is located on CDOT's Bridge Design Manual download page. Manual tabulations are allowed.

Round totals shown in the Summary of Quantities Table as shown in Table 35-2.

Table 35-2: Summary of Quantities Table Rounding

Item	Rounding Criteria*
All, except as noted below	1
Concrete	0.1 ▲

* For exception items, e.g. timber, ton, etc, see Figure 100-19 in the Construction Manual for rounding criteria

▲ For quantities, over 25 (based on the 2% specification error limit), round to the nearest whole number

The project construction cost estimate should include a line item to cover overhead and indirect costs such as Construction Engineering, Owner Controlled Insurance Program (OCIP) and Design Services During Construction. The general percentage for construction overhead and indirects is typically 26 percent but can vary from project to project and should be coordinated with the Region Business Office.