

Evaluating Contract Costs in Highway Needs Studies

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● **HIGHWAY NEEDS STUDIES** usually include three phases: the nature and quantity of work needed, the cost of the work, and the programming and financing of the work. The evaluation of contract costs is an essential part of the determination of the cost of work needed. All highway departments have an abundance of data on contract unit prices on the several hundred contract items now in general use. However, it is impractical in highway needs studies, where there are usually no detailed plans, to express work needed in the same items and units as are used for contract prices, or to use as many different items.

Because highway needs studies must use a different and smaller number of work items from that used in contracts, it is necessary to select the work items and units to be used and to determine the proper unit costs for these items. Using the best cost data available (contract unit prices) the items and unit prices used in contracts must be expressed in terms of those items and unit costs to be used in the needs estimate. This is the problem of evaluating contract costs.

All state highway departments and the Bureau of Public Roads are now engaged in a major highway needs study, although it does not include the programming and financing phase mentioned above. The instruction manual issued by the Bureau of Public Roads as a guide in the preparation of the interstate highways cost estimate, required by the 1956 Federal-Aid Highway Act, specifies the fourteen items to be estimated separately, and gives the types of work to be included in each item. It also specifies that costs shall be based on contract prices as of the last half of 1956.

At the time this interstate cost estimate problem developed, the Automotive Safety Foundation was engaged in making a comprehensive needs study of the Alabama state highway system and has advised and assisted the highway department in the preparation for this cost estimate including the evaluation of contract costs.

Because the evaluation of construction costs in highway needs studies involves the evaluation of both contract work units and contract unit prices the methods used for both of these evaluations in the interstate cost estimate study will be outlined.

A general procedure was adopted in staff meetings. This included the adoption of certain sub-items for each of the fourteen estimate cost items specified in the instruction manual. These would provide for a more detailed statement of work needed and still be general enough for this study. It was also decided that forms would be prepared for use as work sheets in arriving at the quantities and costs of each sub-item; and, when completed, the work sheets would serve as records for use in reviewing or defending the estimate. There are 21 of these forms which were designed to provide space for the quantities and costs entering into each sub-item of work, as shown in Estimate Form No. 10. Twenty-seven general data tables were also prepared which show typical quantities and cost for various designs and conditions, as shown in one sample (Table 1). The use of the forms and the general data tables would promote speed, accuracy, and uniformity in preparing the estimate. Their use would relieve the estimating teams of much of the detail calculation work on their site inspections, and would also serve as a check list to prevent overlooking some items of work needed. Then it was decided that there should be prepared a manual of instructions which would guide the field estimating teams in analyzing conditions along each estimate section of interstate route, selecting the appropriate data from the tables with such modifications as needed for special conditions, and entering these on the proper forms and completing the section cost estimate. Various units of the department were assigned different parts of this task.

Studies were made to determine what contract work items could be combined into suitable sub-items of work for estimate purposes. For example, all pipe cross drains are to be listed as either 24-in., 36-in., 48-in. or 60-in. pipe, reducing the usual number of sizes from 9 to 4. Larger minor cross drains are to be either 20-, 40-,

Sheet ___ of ___

OTHER BRIDGES & TUNNELS

Route _____ Section _____

Description (If Sub-section) _____

Typical Section Code _____ Length _____

(See Tables 21 and 23 for cost data)

Bridges (Other than Bridge Culverts)									
Str. No.	Name of Stream	Skew Angle	Single or Parallel Str.	Deck Width	Lin.Ft. Req'd.	Cost per Lin.Ft. (All Lanes)	Cost	Cost of Misc. Add Items	Total Cost
Sub Total									

Bridge Culverts (Use Average Openings of 200, 300, 400 & 500 Sq. Ft.)						
Structure No.	Average Opening Req'd (Sq.Ft.)	Skew Angle	Fill Ht. (Ft.)	Length (Ft.)	Cost per Foot	Cost
Sub Total						

Tunnels & Viaducts

Tunnels & Viaducts to be worked individually and work sheets attached.

Sub Total _____

Total this Sheet _____

Remarks _____

Total for Section _____ = _____

By _____ Date _____

TABLE 1

COST PER LINEAR FOOT OF BRIDGE CULVERTS FOR VARYING FILL HEIGHTS *

(Prices based on bids received last half of 1956)

200 Sq. Ft. Opening

0° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 174.00
10	200.31
20	250.42
30	271.04
40	321.08
50	368.93

30° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 174.05
10	200.37
20	250.48
30	272.37
40	321.52
50	368.77

45° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 177.01
10	203.95
20	255.22
30	273.01
40	322.14
50	366.34

300 Sq. Ft. Opening

0° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 240.82
10	276.05
20	342.95
30	376.95
40	444.93
50	512.89

30° Skew Angle	
Fill Ht.	Cost per Lin.Ft.
0	\$ 241.11
10	276.37
20	343.25
30	377.23
40	445.22
50	513.18

400 Sq. Ft. Opening

0° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 295.77
10	322.19
20	400.97
30	440.08
40	517.96
50	595.83

30° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 296.63
10	323.05
20	401.79
30	440.89
40	518.78
50	596.66

500 Sq. Ft. Opening

0° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 383.52
10	460.01
20	578.86
30	630.35
40	733.32
50	836.31

30° Skew Angle	
Fill Ht.	Cost Per Lin.Ft.
0	\$ 398.68
10	466.76
20	582.57
30	627.11
40	716.19
50	804.69

* Prices include unclassified excavation and foundation backfill.

70-, 100-, 140- or 180-sq ft openings. In each case, the lengths shown in the tables for each size, for each typical cross-section, and for various fill heights include an estimated amount to take care of the usual percentage of skew lines and angles of skew. The unit costs shown include allowance for the incidental items such as excavation and foundation backfill material. As another example, all grade separations are shown in the tables as crossing at either right angles, or on a skew of 15 degrees, 30 degrees, or 45 degrees. Special cases are to be estimated separately. Quantities and costs were assembled for each type of separation and angle of crossing and include enough of the usual contract items to cover the total cost of a typical case, including sufficient quantities for a variation in crossing angle of $7\frac{1}{2}$ degrees either way. Practically all work items were grouped, or standardized, in the same general way. Thus, work items used in contracts were expressed in terms of work sub-items for the interstate needs estimate.

While the grouping of items was being studied by some department units, others were analyzing the contract unit prices received during the last half of 1956 as a first step in expressing these in terms of unit costs for the estimate sub-items adopted. It was necessary to study the various contract unit prices on each contract work item, and to do a certain amount of culling of individual prices where the nature or quantity of the work in a contract was clearly such as to result in a unit price that is clearly not typical. This culling is especially important where the number of different contract prices of an item is relatively small, and the non-typical unit price would carry a weight in determining the average price much different from the relation which the quantity of work represented by the price bears to the total quantity of that item in the needs estimate. As an example, a contract price on roadway excavation on a street widening job should not be used to determine cost on the relatively heavy grading of rural interstate work which will usually be on new location. Contract prices materially affected by local soils, labor rates, or other local conditions should not be permitted to influence unduly the unit cost selected for the needs estimate.

Since standards of work are occasionally raised and specifications tightened, consideration must be given to the likelihood of such changes; and appropriate adjustment should be made in the selected average contract prices where such changes will materially affect the cost.

Needs estimates often include items of work not frequently used or not obtained by contract method such as right-of-way fence, highway signs, pavement striping, and highway lighting. Cost can usually be obtained from other states obtaining these by contract method, such as those building toll roads, or extensive urban expressways, or from reputable material or equipment producers.

After analyzing and culling contract unit prices, averages of those to be used were obtained and the average contract price for each item studied for any adjustment needed because of changes anticipated in designs or specifications that would affect cost. The average contract unit prices with any adjustment found advisable were then selected for use in the needs cost estimate.

With the items of work to be used in arriving at the cost estimate determined and the representative contract prices determined for the units of work used in highway contracts during the last half of 1956, it remained to apply the representative contract prices to the estimate work sub-items. To do this it was determined what units of work appearing as items in the contracts should be included in each estimate sub-item work unit, and then the amount of each contract work unit contained in a given quantity of each estimate work unit. By applying the predetermined representative contract unit prices in the same proportions, the contract cost of each unit of each estimate work sub-item was obtained.

It then remained to determine the quantities of each estimate sub-item of work. The quantity tables included in the twenty-seven general data tables were prepared to enable the field estimating teams to arrive at the quantities rapidly, uniformly, and with a minimum of calculations. These quantity tables include data; such as, area in acres per mile for different widths of right-of-way, excavation quantities per station for different depths of cut for different typical cross-sections and for different heights of fill on borrow sections, and lengths of minor cross drain structures for each size and for

various fill heights. Other tables deal with items for which the quantity is uniform and can be given on a per mile basis; such as, soil aggregate base course, subbase, shoulder construction, surfacing courses, blanket course (under concrete pavement), and fences. These tables are so arranged that the different local materials available in different parts of the state and the percentages of commercial aggregate admixtures required, can be selected for any material combination for any given estimate section. Where quantity per mile in an estimate unit is constant the table gives the various cost figures per mile for the varying conditions.

Special tables have been prepared for determining excavation quantities where no profile is available from either field survey or suitable contour maps. Several recently constructed projects were selected and the quantities expanded to what they would have been had interstate standards been used. Some of these were selected in each of the six divisions in the state, so that each division estimating team could determine quantities for a section without profile by comparison with the known projects considering the terrain, drainage, soils, etc.

Some mention should be made of the organizational procedure in utilizing these data in producing a cost estimate for an interstate route section.

Strip maps were prepared for each interstate route using the one inch to one mile county road maps. On these the routes were plotted as accurately as practical, and the estimated traffic volumes for the year 1975 indicated on both interstate routes and the intersecting roads and streets. Tentative section limits were then indicated on the map and the map sent to the appropriate division (or district) office. The division, having designated a work team of at least three engineers with one as a captain, had the line plotted on aerial photographs and adjusted by stereoscopic examination, and also had the line plotted on contour maps if available. Where profiles could be prepared, grades were laid and the line marked on the ground for easy identification.

Then a representative of the interstate office of the highway department and a representative of the Bureau of Public Roads accompanied the division estimating team over the route for determination of the general design. They decided on the suitability of the line and grades as proposed, the typical section, the location and type of interchanges, the separations (both highway and railroad), the road or street terminations, and the frontage roads.

With this data the central office completes the strip maps with appropriate symbols, copies of which are sent to the division. Then the division team estimates; earthwork from profile and tables, or from tables prepared for comparison method; number and size of minor drainage structures; areas of different classes of clearing and grubbing; dimensions and types of structures on right-of-way; data on utility adjustments, etc. The field team accompanied by representative from the interstate office and the Bureau of Public Roads, goes over the section route with maps, profiles and other data for the purpose of reviewing the quantity data already obtained for the section and completing the estimate of quantities and costs. They make certain that the proper data is selected from the various tables for that particular section and that proper allowance is made for any special conditions encountered warranting variation from the standard table data. The division team later completes simple calculations and extensions, and completes each of the twenty-one different forms, or work sheets, for each estimate section. These are then assembled by sections and forwarded to the interstate office for review and use in preparing the full route estimate report.

Alabama has just completed the general data, forms, tables, etc., and has just begun the field estimate team work on rural sections. The time spent in preparing the forms and general data tables has been well spent, however.

When the estimation of cost on the urban section begins, some variation in the procedure and some supplementing of the general data will be needed.

Although the forms, the general data tables, and the state manual of instructions regarding their use have been printed and copies are available they are not in suitable form for printing as a part of this paper other than for the examples given. The detailed data used in arriving at representative contract unit prices has not yet been printed and is still in work sheet form.

Those preparing the general data tables and the forms to facilitate their use, and

other personnel who will take part in the cost estimate study have been impressed with the danger of overlooking items of work that will be needed, and underestimating the cost. Also, the importance of not padding the estimate has been stressed. If in the preparation of general tables, they include for a given cross-section more erosion control work than is customary or based cost data on higher percentages of aggregate in base course than previously required, this is not padding, but is an effort at realistic estimating where standards are being raised or designs modified. Since the estimates must be defensible as well as adequate and uniform, there should be no padding even though without extreme care there may be some overlooking of significant items.

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