ESTIMATING FOR CIVIl ENGINEERING WORKS: SOME TYPICAL PROBLEMS FOR THE BUILDING ESTIMATORS

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Abstract

This paper intends to highlight the fact that tendering is not an isolated procedure carried out after the estimate has been prepared. It is a continuous process and tender problems impinge throughout the period of estimating.

The paper further observes the importance of the quality of labour especially with the civil engineering work and particularly in relation to gangers and foremen. The paper concludes by observing that the ultimate success of any project depends largely on the accuracy of the estimate and never is this more vital than the real functional work produced.

Introduction

The main thrust of this paper is to highlight the risk element in estimating. Before any estimates are prepared, the firm must take a conscious decision to enter the civil engineering field. We are aware that sound experience in civil engineering works cannot be gained overnight but recorded cost data can be an invaluable aid particularly if compiled progressively over a number of projects and throughout all weathers.

Explaining the factors that influence the estimator's works and the impact of such factors on his works, Collins, (1988) states that the estimator's primary involvement is with those factors influencing the actual costs of carrying out the works, lie further identities the impact of such factors as:

(a) . Difficult conditions, e.g. access, type of ground and high water table.
(b) . Inclement weather.
(c) . Non - productive time and plant breakdowns.
(d) . Wastage of materials.
(e) . Special operations and temporary works.
(f) . Quality standards.

It should be noted that although the quality of labour is always important in construction works generally, it is even more so with civil engineering works particularly in relation to gangers and foremen. **The difference in performance between highly experienced men and the less experienced ones can be substantial.**

Analytical Estimating

The basic analytical skill of the building estimator is put to the test as each item is broken down into its simplest elements and the costs built up methodically (Elliott 1976). It is useful with civil engineering work to adopt the 'gang' approach, rather than rely on individual man-hour output. The estimator, together with management should determine the number of tradesmen and/or labourers and/or plant necessary to perform an operation and assess output. In this way, the composite labour and plant cost built up can be used in conjunction with outputs achieved by the 'gang'.

An example of gang pricing is given below for an Item of 200mm thick granular filling. This shows the relationship between plant and labour, the overall output being determined by the excavator. Details are also given of the consolidation and penetration allowance on materials.

The build up should be detailed, and later actual results noted together with relevant information on the season of year, weather and the likes, to allow future comparisons between the estimated and actual costs.

In this manner the firm's production standard can be derived. Production standard is an anomaly when related to civil engineering work, as recorded data are rarely standard. However, feedback is a necessary and continuous process for the firm as it continues to operate in the civil engineering field and as new techniques and materials evolve.

The uncertain nature and size of civil engineering works, as compared to building works, has led to the introduction of a separate Method of Measurement and Conditions of contract. It is essential for the estimator to be fully conversant with everything contained in the tender documents. If this is not the case, or if there are ambiguities, he must seek clarification. The consequences of submitting a tender for a project where certain aspects are unclear can be disastrous. The new comer to civil engineering must first 'do his homework' by studying the Standard Method of Measurement of Civil Engineering Quantities, the Civil Engineering Standard Method of Measurement, the General Conditions of Contract and Form of Tender, Agreement and Bond for use in connection with work of Civil Engineering construction, commonly known as the I. C. E. conditions of contract.

Plant	N: K
Excavator industry driver (per hour)	*5:00*
Fuel to ditto	0:50
Roller including driver (per hour)	3:75
Fuel to ditto	0:25
	9:50
Labour	
2 general operatives x N15 per hour	3:00
Banksman with 30k per hour plus rate	1:53
	4:53 14:03

Assuming a 15m^3/hour output of excavator placing filling then the plant /labour cost per nr^1 is 0:94

Materials	
Granular filling delivered per nr^1	2:00
Consolidation 25%	0:50
Total per nr^1	**3:44**

A 200m thick filling costs 3.44

5

= 0.6 9 **0.06 NO.75**

Add 25mm penetrate of filling

Net rate per m^2

Conditions of Contract

The l.C.E condition of contract are issued in one form only and are intended for the use of both private and local authorities. The form of Tender and Form of Agreement equate to the Joint Contracts Tribunal (JCT) Articles of Agreement and Appendix.

The conditions start with a comprehensive index and the first part, 'Definitions and Interpretation', pulls together several definitions that tend to be hidden in different parts of the JCT standard form of contract.

Most causes in the Conditions of Contract call for no comment but it is obvious that they are drafted to suit the peculiarities of civil engineering work. Clauses are given individual titles grouped under main headings; the most important are discussed briefly below:

(a) Clause 13 states that the mode, manner and speed of construction of the works are to be approved by the engineer. Clauses 14 requires a progamme to be furnished within 21 days of tender acceptance and envisages revised programme to suit actual progress. Some indication of the power of the engineer is given by the requirement for programes to be backed up by details of constructions methods and calculation^ on stresses and strains arising during construction. A fundamental difference to building is also indicated in clauses 45 and 46, for at any time the engineer *may* notify that in his opinion progress is too slow to ensure completion in the prescribed time to payment for costs involved in expediting progress.

(b) Clause 20-25 covers insurances and indemnities-especially important works within easement as on pipeline or sewer works. This may affect methods and, therefore, costs. Clauses 9 and 30 require works to be carried out with minimum noise or disturbance, and place the onus on the contractor to strengthen bridges, widen road, and the likes with regard to transport of plant or temporary works. Clause 42 states that the contractor is to bear all costs for any way that leaves required in connection with the access to (he site, and also for additional accommodation outside the site required for the purpose of the work.

(c) Clause 51 which deals with variation, allows the engineer a wide scope to alter the contract. Care in self-sufficient pricing of both measured items and temporary works is essential.

With payment for works as executed, great care is necessary to ensure that each rate is correct within itself and it is especially so as the engineer has a certain degree of control over the temporary works and methods. The civil engineering approach to billing is geared to the scale of the works and emphasizes the relative importance of temporary works. These may be for servicing the scheme such as temporary roads, or for construction of the works, such as trench timbering. They have to be covered by rates entered in the bill. Some temporary works required specifically for construction of permanent structure may be detailed, e.g. a cofferdam, and in these cases it is usual to price in the stages, provision/maintenance/removal.

Standard Method of Measurement

Clause 57 of the conditions of contract refers specifically to the present Standard Method of Measurement of Civil Engineering Quantities (SMM) (Dealer & Henderson 1980). A revised Civil Engineering Standard Method of Measurement (CESMM) has been published with the aim of standardizing layouts, sub-divisions and descriptions in bills of quantities. One new approach is the introduction of method related charges and initial thoughts on it are that although claims during the course of contract may be reduced, it will make difficulties in comparing lenders. It is proposed to deal with the present SMM first and then comment on the new CESMM.

Present Standard Method of Measurement and Civil Engineering Quantities

The Introduction and Clause 1 of the SMM combined with clause55 of the conditions of contract, underline the point that bills of quantities in civil engineering are first used to give information on which tenders are based, and after the contract is signed, the rates contained within them are used to value the works actually carried out this suggests re-measurement as the norm. If a lump sum tender figure is required for civil engineering work.it appears clause 55 must be deleted. The Form of Tender has no provision for quoting a tender sum and this clearly shows the intention for the price to be based on re-measurement rather than on a lump sum.

Monk and Dunslone (1966) explain that Building usually involves many trades leading to more detailed measurement and as the specification is not a contract document, lengthier descriptions are necessary for bills of quantities. With the civil engineering work, the estimator must constantly refer to the specification for details relating to items in the bills of quantities, which, although sufficient to identify the work to be executed, are usually brief. There are also fewer ‘labours’ and minor items measured in civil engineering than in building. These factors, coupled with the requirements for bill rates to be all-inclusive, may lead the unwary estimator to give inadequate consideration and insert low rates. For example, in building, trench excavation will be followed by separate items for planking and strutting, levelling and ramming, back filling or disposal of surplus. In civil engineering these may be all included in a single excavation item and in addition the specification may call for back filling with a special material.

The following factors are among the most critical for the inexperienced estimator:

(a) Inadequate consideration of working space and subsequent back filling.
(b) Failure to allow for restricted space on site for spoil heaps.
(c) Lack of appreciation on exact water table definition.
(d) Lack of knowledge of influence of methods of testing sewer on overall costs.

Civil Engineering Standard Method of Measurement (Cesium)

With the principle of re- measurement of civil engineering works, the present standard Method of Measurement of Civil Engineering Quantities (SMM) lias allowed hills of quantities to become little more than a 'shopping list'. Works as executed is measured and paid for on the basis of the original 'shop' prices stated at tender stage. However, developments in construction methods and techniques have led to a position where the contractor commits himself to a definite sequence of working. The value of any variations required later cannot he entirely recovered by re-measurement. The new CESMM provides for additional items of measured work, together with items directly related to the method of construction.

Tender Conditions

The first check on the tender documents will he to determine departures from principles and conditions. This is followed by a check on the Appendix and with the co-operation of management a decision should be made to ensure that the proposed insertions are realistic, especially the contract period Deviations from the SMM; or conditions of Contract imply that increased risk for, usually less information is available. Contingencies added as a percentage to the total price must not be overlooked and the projected tender total should be used when assessing such items as bond costs.

Insurance requirements differ for civil engineering works and the firm's insurers should be asked to quote appropriate premiums. The scope of insurance cover is wide, including risks, except those specified, as opposed to building practice of demanding insurance cover for specified risk only. Contractors will suffer if they are not properly insured and the new comer to civil engineering must appreciate that although he is not liable for design failures he must not be negligent in informing the engineer of inadequate design.

Most civil engineering contracts require some form of performance bond and it will be necessary to establish the cost involved. The bond is not merely to guarantee completion, as it may with building work, but covers the full range of contractual obligations. Daywork percentages must be clearly understood since they apply to rates including percentages as given in the Federation of Civil Engineering Contractors' schedule, as opposed to basic wage rates in building.

Management Participation

Calvert, (1980) suggested that an estimator should be advised to make time available to visit the engineer's office to discuss the project being tendered for. Comprehensive drawings are supplied normally at the tender stage but the inexperienced estimator (and management) can learn much from meetings with engineers. Meeting the man responsible for site investigation can be more instructive than a perusal of the borehole report. Methods of working can also be suggested, as engineers are practical men and their designs are usually linked to some form of construction. The site must be visited together with management to obtain factual information for preparation of a method statement.

Access, topographical details, excavation conditions, site tip and other such factors must be noted to help in determining the construction methods. It may be necessary to evaluate a number of alternatives, depending on plant available, type of labour and supply of materials. The important message is that the estimator must not attempt to calculate costs until methods and sequences are agreed. The choice is usually wider in civil engineering than in building and this leads to wider differences with competitors in plant requirements, contract period, preliminary allowances and material usage. Consequently, net estimates will differ and lead to more risky tendering.

When sending out enquiries for material and sub-contract quotations it is essential that full information is included: remembering that there may be many pages of technical details contained in civil engineering specifications on materials and workmanship relating to only a few pages of the bills of quantities. It is necessary to give as much information as possible regarding timing of the works and volumes or outputs within these times.

Pricing (lie Works

When pricing begins, the estimator will need to build up all-in hourly labour rate based on the

Working Rule Agreement of the Civil Engineering Construction Conciliation Board. Differences to building practice in relation to such matters as overtime arrangements, plus rales and the likes should be noted. The actual hours to be worked, considering weekday overtime and Saturday/Sunday working, should be agreed with management and used in building up the rate. Allowances for lost time due to inclement weather require more thought than on building work, and the 'attraction' money necessary to obtain labour on an exposed civil engineering site out in the "wilds" may be substantial.

All-in rates for the various items of plants must be established, either by calculation from the firm's own plant section or based on plant hire firm's rates. With civil engineering works the proportional value and extent of the main contractor's work is relatively higher than on a building project where large sections may be sublet. Speculative risks in building projects are restricted, due to prime cost and provisional sums and the sub-contracting of specialist trades. The greater value of works carried out by the main contractor in civil engineering projects will result in a significant increase in risk. It will also be necessary to evaluate the firm's approach to overhead allowances if this is normally done on labour content rather than total cost, the lender may be unduely weighted. Firm/fluctuating assessment is also necessary.

Price Fluctuations Formula

The civil engineering contracts price fluctuations Clause is much simpler than clause 31 of the JCT Standard Form of Contract in that it only allows for fluctuations via a formula. The engineer assesses proportions of work to be allocated to eleven indices plus a non-adjustable element. The indices originally used were:

Labour and supervision, Plant Aggregate, Bricks and Clay Products, Cement, Cast Iron, Coated Road Stone, Fuel, Timber Reinforcing Steel and Structural Steel

These have now been increased to 13 due to the sub-division of fuel and isolation of steelwork labour as a separate index .The estimator must investigate the bills of quantities to check the engineer's pretender assessment of proportions and make due allowance. Although the formula approach is rather insensitive it does present a straightforward method of dealing with fluctuations. The civil engineering estimator is in a better position to make his own assessment of shortfall or otherwise on cost recovery than his counterpart in building.

Preliminaries

In civil engineering the preliminary bill is commonly number one with a heading of 'General and Miscellaneous items', or similar. It contains a number of preliminary items plus space to enter items for which payment is required, thereby providing an opportunity to include costs that may not be recovered via measured work. The estimator should rely completely on this and should certainly check the preamble clauses to determine what special liabilities and obligations must be included in the rates. Again, this emphasizes the need to decide on exact methods of working and to price items as such. Many of the preliminary items are dependent on the programme and are dealt with as for building works (Dennis 1973).

As contractual maters may be unfamiliar to the estimator he should pay particular attention to these and ensure that everything with monetary value is brought to the attention of management.

Recommendations

(1) The build up should be detailed, and later actual results noted together with relevant information on the season of year, weather and the like, to allow future comparisons between the estimated and actual costs.

(2) It is essential for the estimator to be fully conversant with everything contained in the tender documents.

(3) With payment for works as executed great care is necessary to ensure that each rate is correct within itself.

(4) Lengthier descriptions are necessary for bills of quantities.

(5) Firm / Fluctuating assessment is necessary.

(6) Any building firm contemplating competing for Civil Engineering Works should already have wealth of practical knowledge capable of being developed.

Conclusions

The aspects of civil engineering estimating considered in this paper will not be new to many readers, but they should provide guidance for those yet to make the transition from building to civil engineering.

Much has been written stressing the importance of involvement with management and obviously this is good practice for all in estimating. However, paying lip-service to this philosophy may not be critical in building, as the estimator is probably as well aware as the manager of access problems and types of construction etc. With civil engineering the range of choice is much wider and it is imperative that the estimator prices the methods to be adopted if the tender is ultimately accepted. No apologies are offered to those reacting in error with the belief that this is universally so in building.

The risk involved with an adhoc approach may be justified for a small number of items on a building project but the consequences in civil engineering can be so vast that anything but an analytical approach is suicidal. The ultimate success of any project depends largely on the accuracy of the estimate and never is this more vital than in civil engineering.

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