

The Potential of the Method of Measurements used by Engineers and Contractors in Tendering and Subsequent Contract Administration



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The Abstract

Amounts for payments for the work done in Measure & Pay contracts are arrived at by measuring the quantities of items which have pre-agreed unit rates. In measure & pay contracts, the final price is dependent upon quantities. So, the final price is dependent upon the Method of Measurements we use to measure the quantities.

Some professionals in the construction industry measure the works arbitrarily without considering the specified method of measurement for the project. Their perception is that it is not significant to concentrate heavily on the method of measurements enacted in the contract. But events that have arisen in the construction industry in this regard indicate that it is not so simple to ignore the effect of the method of measurements.

This is mainly because quantities calculated using two different methods could provide significantly different quantities. So, significantly different quantities produce significantly different final prices. If parties to the contract adhere to the two different opinions regarding the method of measurement to be used, there could be a construction dispute. As we all know, disputes are most obstructive in construction contracts. They can delay the project with severe consequences to all parties to the contract.

What is the solution? There are several means of resolving disputes by mediation, arbitration, adjudication or in court system while the least expensive method is the use of negotiation. However, what is more important to avoid chances of disputes arising than to find solutions for the disputes? So, what is important is to have a specified method of measurement in the contracts to cover all

works and ensure the awareness of both parties of the procedures of the method of measurements stated in the contract to use for the measuring of works.

Through two practical examples of excavation works and concrete works, this article demonstrates the impact of the method of measurements on the final price. In excavation, the example of how extra volume is acquired by soil due to the loosening of soil particles is used for consideration while a second case is dedicated to the possibility of a different method of measurements due to voids placed in suspended concrete slabs. The figures used are for explanatory purposes and not the actual ones.

The Introduction

It is a clear fact which is not limited to the construction industry, but common to all businesses, that the ultimate aim of parties to a contract is to obtain the maximum benefit from the contract. Contractors always seek to obtain the highest price for the work carried out under the contract. On the other hand, employers want to pay minimum price for the works completed under the contract. Based on the determination of price of the contract, there are main three categories of contracts.

1. Contracts that stipulate a fixed lump sum price
2. Contracts that stipulate unit rates and the final price is arrived at by measuring the quantities of items which have pre-agreed unit rates.
3. Contracts where the final price is arrived at by measuring the actual expenses incurred.

Fixed-price contracts belong to Category no 1, measure & pay contracts are under Category no 2, cost reimbursable

contracts belong to Category no 3 while target contracts are a combination of Categories no 1 and no 3.

The aim of this article is to address the importance of the method of measurements in contracts which fall under Category no 2 because the final price of this type of contract is arrived at by measuring the quantities of items which have pre-agreed unit rates. In measure & pay contracts, final price is dependent upon quantities. So finally, final price is dependent upon the Method of Measurements we use to measure the quantities.

As mentioned above, it is the individual party's interest to maximize their own return from the contract. In other words, Contractors always seek to obtain the highest quantities for the work carried out under the contract. On the other hand, employers want to pay for minimum quantities. So it is the responsibility of the contract to regulate the two parties having different objectives regarding the quantities of contract in a manner without dispute. The major mechanism used in this context in construction contracts is to have a pre-defined Method of Measurement system agreed upon by both parties at the time of signing the contract, by inserting the Method of Measurement in the contract. Unfortunately, some may neglect the importance of the method of measurement and pay minimal attention to the method of measurement. We will see the impact of negligence of the Method of Measurement in detail through a practical construction example.

The Discussion

Some professionals in the construction industry measure works as per their wish. The danger is that these professionals engage in contracts relying on the quantities they calculated using their own methods without even seeing the methods of measurements specified in the tender. People who don't have much exposure to the contractual aspects of construction contracts may think that it is not significant to concentrate much on the method of measurements enacted in the contract. But it is not so easy to neglect the dilemma an organization has to face if it neglects the method of measurements. The loss to the organization might be in the realm of millions of dollars.

Another aspect of negligence of the method of measurement is that it could be a situation that leads to construction dispute. /As we all know disputes are

most obstructive in construction contracts. It can delay the project with severe consequences to all parties of the contract. What is the solution? There are several means of resolving disputes by arbitration, adjudication, in court system or mediation while the least expensive method is the use of negotiation. But what is more important is to avoid chances of arising disputes than to find solutions for the disputes. An old saying is that prevention is more important than remedying defects. So if the issue is not agreeing upon a defined method of measurements for measuring the works at the time of signing the contract, then how can disputes on measuring of the works be prevented?. It is very simple to have a well defined method of measurements in the contract and focus the necessary attention on it. There are standard 'method of measurements' documents published by various institutes. To name a few: CESMM3, POMI, SMM7, ICTAD ... It is not necessary to agree to use standard methods of measurements such as CESMM3 ,POMI,SMM7, but what is required is the definition of a methods of measurements to measure the work in a consistent manner which suits the conditions of the project.

Ignoring the method of measurement can take place in two forms.

1. The consultant does not include the proper method of measurement.
2. The contractor disregards the method of measurement stated in the contract.

First we consider Case One. Construction works are completed without having proper agreement on how to measure the works. At the time of payment disputes arise as there are different opinions regarding the measurement of works. Therefore ignoring the method of measurement in construction contracts is dangerous.

In Case Two, the outcome of ignoring the method of measurements has two possibilities.

1. The contractor calculates lower rates than if the method of measurement had been considered.
2. The contractor calculates higher rates than proper if the method of measurement had been considered.

In first case, the contractor loses some money and receives less payment due to the errors of his calculation while in the second case, the contractor loses the chance of

winning the completion of a project due to the errors of his calculation. Both are harmful to the contractor.

The examination of two practical examples will demonstrate the impact of the method of measurement on final price.

Case 1

We will examine a practical example of excavation. Excavation works is a category that is included in many construction contracts. This is because excavation works are necessary in building construction as well as in civil engineering constructions such as roads, bridges, etc ... It is also noted that the quantities involved in excavation works are generally large, making a big impact on the final price.

For the measuring of excavation work, there are two basic methods.

- (1) Measure the size of pit/ trench excavated.
(Net volume)
- (2) Measure excavated materials. (Gross volume)

Before the excavation, soil is in a compacted form. After the excavation, soil particles are loosened. The loosening of soil particles will yield a final quantity of greater volume. Undoubtedly, the second method, which measure loose soil, will have a large quantity than that calculated from the first method which measures the opening created by excavation. The expansion of soils will vary with soil type.

Assume the following for our example:

Factor of expansion of soil = 1.4

Quantity (net) = 188,000 m³

Rate quoted by contractor = \$ 10/m³

Scenario 1.

The contract does not specify method of measurement:

Both parties aim to maximize their return

The contractor is claiming \$ 2,632,000 for a quantity of 263,200 m³ (188,000 x 1.4).

The client is ready to pay only \$ 1,888,000 for a quantity of 188,000 m³.

A difference of more than half a million would be a root cause for a dispute.

Scenario 2.

The contract specifies first method which is to measure

the net excavation as a method of measurement:

The contractor arbitrarily uses his own method of measuring gross volume to calculate his rate.

The contractor calculates it costing \$ 10 per cubic meter of loose volume excavated. Though he has to convert this rate to the net rate ($\$ 10 \times 1.4 = \$ 14$), he does not look at the method of measurement specified.

At the end of project, the contractor receives only \$ 1,880,000 for a quantity of 188,000 m³.

He argues for \$ 2,632,000 for a quantity of 263,200 m³ (188,000 x 1.4) based on his own method of measurement.

Finally, the contractor receives only disrepute instead of \$ 1,880,000 for a quantity of 188,000 m³ as the consultant brings the specified method of measurement to his notice.

Scenario 3.

The contract specifies the second method, which is to measure the net excavation as a method of measurement:

The contractor arbitrarily uses his own method of measuring net volume to calculate his rate.

The contractor calculates it costing \$ 14 per cubic meter of net volume excavated. Though he has to convert this rate to the net rate ($\$ 14 / 1.4 = \$ 10$), he does not look at the method of measurement specified.

At the end of bidding, the contractor's price of \$ 14 makes his tender price too high, as compared to another contractor (who may be pricing their tender at \$ 13 / net cubic meter) and he loses the project.

Is just because of negligence of the method of measurement specified in the contract.

Case 2

We will examine another practical example to further demonstrate the impact of method of measurement on final price. Concreting works is also a category that is included in many construction contracts. This is because concrete is the most accepted solution as a structural element in building construction as well as civil engineering constructions such as roads, bridges, etc... It is also noted that the quantities involved in concrete works are generally large making a big impact on the final price.

It is common practice to have openings in concrete slabs for various purposes. In the practical sense, it is easier to ignore the openings and measure the whole area once, measuring the volumes without deducting for voids.

However, there is a limit to the size of voids as ignoring large voids is not acceptable practice, especially to clients. Generally, the limit is 1 m³ meaning that any void less than 1 m³ in volume would not be deducted and hence the contractor would get payments even if he has not concreted that part.

Another case that we have to concentrate on here is formwork. It is evident that when making a void, it may require some additional formwork. It is important to specify in the contract that this additional form work related to voids is going to be measured. Some may prefer not to measure these additional form works as they are cumbersome measurements and in order for themselves to get compensated from paid prices for voids.

Also, there are two types of openings, internal and external. Internal openings mean openings which are completely inside of the concrete slabs. External openings mean openings which are at the boundary of the concrete slabs. So it is clear that there could be more options for specifying the method of measurement. What is needed from the contractor's side is clear identification of the difference between the work to be done and the work to be paid and adjustment the rates accordingly. Contractor prices need to be more competitive as well as profitable so as not to lose.

Assume the following for the example:

Dimensions of the suspended concrete slab = 20m * 50m * 200mm

Inside of the suspended concrete slab: no of 1m * 1m openings = 20

At the boundaries of suspended concrete slab: no of 1m * 1m openings = 5

Unit rate for concrete works quoted by contractor = \$ 100/m³

Unit rate for formwork works quoted by contractor = \$ 30/m² will examine how the method of measurement will change the final price.

Before examining the possible various methods of measurement that can be adapted to the problem, first we will see quantities that the contractor actually needs to measure.

Concrete = 20 * 50 * 0.2 – 20 * (1*1 * 0.2) – 5 * (1*1 * 0.2) = 195m³

Formwork for soffit of slab = 20 * 50 – 5 * (1*1) – 20 * (1*1) = 195m²

Though it theoretically requires 195 m², we have to consider the fact that it is not economical to cut the formwork sheets in void areas and might be most economical to allow having formwork under the voids. Also, the cutting of formwork for voids will produce formwork that cannot be reused for another structure.

Formwork for sides of voids: for internal voids = 20 * 4 * 1 * 0.2 = 16 m²

Formwork for sides of voids: for external voids; let's assume that only two voids are at corners.

So, for corner voids there is no additional formwork required.

For the other three voids = 3 * 2 * 1 * 0.2 = 1.2 m² (Only two sides are additional)

Consider the possible different ways of measuring the concrete work:

- (1) Measure complete slab without deducting any openings.
- (2) Measure complete slab deducting only external openings which are at boundaries
- (3) Measure complete slab deducting all openings.

Consider the possible various methods of measurement for the formwork of this case:

- (1) Measure all formwork without deducting for soffits of openings
- (2) Measure all formwork without deducting for soffits of internal openings
- (3) Measure all formwork without deducting for soffits of external openings
- (4) Measure all formwork, deducting for soffits of all openings
- (5) Measure formwork without deducting for soffits of openings but also without adding any sides of openings.
- (6) Measure formwork without deducting for soffits of internal openings but also without adding any sides of openings.
- (7) Measure formwork without deducting for soffits of external openings but also without adding any sides of openings.
- (8) Measure formwork deducting for soffits of all openings but also without adding any sides of openings.
- (9) Measure formwork without deducting for soffits of openings but also without adding sides of external openings.

- (10) Measure formwork without deducting for soffits of internal openings but also without adding sides of external opening.
- (11) Measure formwork without deducting for soffits of external openings but also without adding external sides of opening.
- (12) Measure formwork deducting for soffits of all openings but also without adding external sides of openings.

Observe how many different approaches are available for the measurement of works. If concerned with the measurement of concrete, there will be sixteen different approaches. For the sake of simplicity we will consider only three possible methods of measurements for the measuring of formwork which are the most critical.

1. Measure all the formwork including sides of openings without deducting soffits of any openings.
2. Measure all the formwork including sides of openings but deduct soffits of all the openings
3. Only measure formwork in slab without including sides of any openings but deduct soffits of all openings.

The formwork calculations are as follows:

Whole soffit area = $20 * 50 = 1000 \text{ m}^2$

Soffits of internal openings = $20 * 1 * 1 = 20 \text{ m}^2$

Soffits of external openings = $5 * 1 * 1 = 5 \text{ m}^2$

Sides of internal openings = $20 * 4 * 1 * 0.2 = 16 \text{ m}^2$

Sides of external openings = $3 * 2 * 1 * 0.2 = 1.2 \text{ m}^2$

Therefore, we will have nine possible scenarios. The table below depicts the outcomes (final prices) for these nine scenarios.

The first combination gives the highest price of \$ 50,516 while the last combination gives the lowest price of \$ 48,750. The difference is \$ 1,766 which makes 3.5 % profit. In highly competitive construction contracts, which have limited profit margins of around 5 %, can it be possible to ignore a 3.5 % profit?

Conclusion

As we have seen in the two above examples, there could be large differences in final prices based on the method of measurement used to measure the works. The strength of method of measurement over cost engineering is high and the knowledge of methods of measurement will play a significant role in cost management..

Finally it should be stressed that, contractually, no method can be said to be superior over the rest. This is because once the method of measurement is included in the contract, the contractor can decide prices based on it and can increase or decrease according to differences in the specified method of measurement and actual works. In other words the contractor would be able to make adjustments in his rates when he is aware of the advantages and disadvantages of the method of measurements compared to actual works he needs to carry out. However, for the comfort and suitability of measurement there could be a 'best' method of measurements and a 'bad' method of measurements. Let's imagine a situation where the method of measurement dictates deducting each

Method of concrete measurement	First method	First method	First method	Second method	Second method	Second method	Third method	Third method	Third method
Method of formwork measurement	First method	Second method	Third method	First method	Second method	Third method	First method	Second method	Third method
Quantity of Concrete (m3)	200	200	200	199	199	199	195	195	195
Quantity of formwork (m2)	10,17.2	992.2	975	1017.2	992.2	975	1017.2	992.2	975
Price of Concrete	20,000	20,000	20,000	19,900	19,900	19,900	19,500	19,500	19,500
Price of formwork	30,516	29,766	29,250	30,516	29,766	29,250	30,516	29,766	29,250
Total price	50,516	49,766	49,250	50,416	49,666	49,150	50,016	49,266	48,750

opening including very small ones in plastering works. How cumbersome this is method compared to measuring the whole area without deducting openings. Here it is evident that the second method (measuring the whole area without deducting openings) is more comfortable in the context of ease of measurement.

What is important is having a specified method of measurement in the contract to cover all works with both parties aware of the procedures of the method of measurements stated in the contract to use for the measuring of works. The golden rule to avoid disputes regarding the measurement of works is for organizations to have more competent and knowledgeable cost engineers who are conversant on the contractual matters.

Regina -v- Chung Tak Lam Mary Lam Patricia Lam Christopher John Lam and Peter Brennan (T/a 'Namesakes of Torbay') and Borough of Torbay [1997]

The claimant sought damages after the planning authority allowed the first defendant to conduct a manufacturing business in the course of which spraying activities took place which caused them personal injuries and loss of business. Held: The planning system is a regulatory system as envisaged in X (Minors), such that there should be no private right of action for a breach of statutory duty. The claim failed.

The first defendant started work in Unit 1 at the rear of No. 34 and constructed a paint spraying filter and extractor which ventilated the paint spray fumes out through his premises at the rear of 34 to discharge at low level into the backyard of the appellants. Following complaints starting in September 1989 from the appellants and a number of other local people who were adversely affected by fumes (including a specific complaint by the second plaintiff that the effects included nausea, dizziness and memory loss), the respondents' Environmental Health Officer wrote on 21st September 1989 to the first defendant recommending that his spraying booth be moved to first floor level so that the fumes could be extracted above roof ridge level, and that the planning department be contacted to see if planning permission was required. The urgent attention of the first defendant was demanded. On 28th September 1989 the Environmental Health Officer asked the Planning Department to check the planning permission in respect of the first defendant's premises. The first defendant accordingly applied on 9 October 1989 for planning permission for "re-location of extractor system" and provided a plan of a "chimney" on the roof of the premises at the rear of 34 for escape of the fumes. Meanwhile, the appellants' complaints continued. Permission was granted for the chimney work by a delegated decision of the Planning Officer on 24th November 1989, the chimney being installed in January 1990

So far as the third head of claim was concerned i.e. that based on the alleged failure to take enforcement action, the judge held that the principles applicable to pollution and planning were essentially similar, enforcement also being a matter which the local authority has to consider in the public interest. By way of analogy with the position of the Crown Prosecution Service (see Elguzouli-Daf -v- Commissioner of Police of the Metropolis [1995] QB 335), the judge held that the decision of a planning and enforcement authority as to taking enforcement proceedings in the public interest or in the interests of the inhabitants of a particular area is one which should not be influenced by considerations as to whether there might be a claim for negligence if action was or was not taken in a particular case