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**NOTES OF ESTIMATING AND COSTS
OF ARCHITECTURAL AND
ENGINEERING WORKS.**

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Mr. Chairman and Gentlemen,—The question of estimating and costs is, it is safe to state, one usually considered “as dry as dust,” and, to say the least of it, is often merely dealt with as a “necessary evil” (in fact one is almost tempted to go further and say an unnecessary evil); but in compiling these notes every endeavour has been used to make them as interesting as possible; and, in very truth the subject is an interesting one, in fact a vital one, when it is considered that the financial question is very often the governing factor of an engineering work; and, such being the case, it is obvious that the more thoroughly one studies the subject the more satisfactory will be the results achieved.

With Estimating as a subject, covering, as it does, such a wide field, one could write much of importance; but, with the short time at my disposal this evening, it is necessary to be brief, and so, in many instances I have merely touched upon the fringe of the matter under discussion, and much, of necessity, has been omitted which appertains to the question. This paper is divided into two parts, the first dealing with the Preparation of Estimates, and the second with the Cost of Engineering Works, in accordance with the following summary:—

SUMMARY.

PART I.

PREPARATION OF ESTIMATES.

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 - (b) Reinforced Concrete.
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- (c) Sewers.
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- (e) Suspended Sidewalk.
- (f) Macadam Roads.
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- (j) Vancouver Sewers.

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Introduction.

1. Prices of Labour.
2. Actual Costs.
3. P.W.D. Contract Prices.
4. Estimated Cost for Concrete for Harbour Walls.
5. Contract Prices of Materials.

PART I.

PREPARATION OF ESTIMATES.

(a) Qualifications of an Estimator.

In order to ensure accurate and reasonable estimates, the estimator must be a man of good experience and sound judgment, and, of course, possess a thorough knowledge of construction and prices; and, in preparing an estimate, the following cardinal essentials should be borne in mind:—

1. That, generally speaking, the main foundation of all pricing is the value of labour and material.

2. That every work is governed by some peculiar special conditions, for which allowance must be made in the estimate.

3. That, in computing the time required for the probable execution of a work, the fact must not be forgotten that the quantity of work which a man can do is not necessarily equal to the amount which he actually carries out.

4. That costs of materials are constantly varying, hence the necessity of keeping "au fait" with all the changes of the market.

With reference to this point, a few examples of the increases in the cost of materials may prove of interest. These enormous increases are, of course, abnormal, and are chiefly due to conditions generated by the war which have caused a great diminution in the import of the articles in question, and, naturally, correspondingly increased prices.

| Material. | Cost, July, 1914. | | | Cost, May, 1917. | | |
|--|----------------------|----|----|---------------------|----|----|
| | £ | s. | d. | £ | s. | d. |
| Galvanized Corrugated Iron, per ton | 16 | 4 | 0 | 45 | 10 | 0 |
| 5ft. to 10ft. sheets, 24 gauge | to | | | to | | |
| | 17 | 14 | 0 | 47 | 0 | 0 |
| Steel plates, angles, tees, joists and channels, per ton | to | | | to | | |
| | 10 | 0 | 0 | 36 | 0 | 0 |
| Oregon timber, 2in. x 2in. to 12in. x 12in., from 30ft. to 80 ft. long, per 100 ft. super. | to | | | to | | |
| | 1 | 9 | 0 | 1 | 19 | 0 |
| Fibro cement sheeting, 3/16in. thick, per sq. yard | 0 | 1 | 9 | 0 | 3 | 0 |

(b) Modus Operandi of Estimating.

As regards the preparation of estimates generally, these may be classed in two categories, as follows:—

1 (For Contract Works).—Quantities are first prepared by a specially appointed Quantity Surveyor, and then priced by the various contractors in order to arrive at the amount of their respective tenders.

2 (For other than Contract Works, such as works for Public Departments, to be carried out by day labour).—The usual procedure is for the estimate "in its entirety" to be prepared by an officer of the Department, with such quantities as the particular individual circumstances warrant, and the prices affixed thereto.

(c) Quantity Surveying.

Although the adoption of quantities for contract works has not been universally practised here, and in England (at which latter place, for example, it is entirely at the discretion of the local authorities, or whoever has the placing of the work, as to whether or no quantities shall be supplied, although, it must be said, the practice of supplying quantities is increasingly in vogue with the advance of time), yet here in New South Wales, thanks to the united efforts of the Institute of Architects of N.S.W., and the Master Builders' Association of N.S.W., quantities are the rule; for, by an agreement between these two bodies, it is stipulated that quantities shall be provided for works valued over £2000, such quantities to be prepared by one of the recognised Quantity Surveyors (of whom there are a fair number at the present time) at a fee of 1 per cent. upon the amount of the accepted tender. Whilst on this point I would quote an English authority's definition of Quantity Surveying, which is as follows:—

“Quantity Surveying is the art of measuring and enumerating in detail all the items of labour and material used in the construction of a building or other architectural or engineering work, and arranging such items in the form of a bill, with a view to the prices for same being fixed thereon by the contractor in order to arrive at the amount of his tender.”

(d) Units of Measurements.

The agreement previously referred to sets out the mode of measurement to be adopted by the Quantity Surveyors, with which method, doubtless, many of you are acquainted. One or two special items are worthy of particular notice as a matter of comparison with methods adopted elsewhere:—

1. Brickwork—per rod (of 272 feet superficial, $1\frac{1}{2}$ bricks thick).

This same standard is adopted in England, but in British Columbia the yard cube is the unit; whereas in B. E. Africa and Zanzibar the cube foot is adopted, after the Indian practice. In reference to brickwork, it is interesting to note that in a book published in 1734, entitled "Palladio Londoniensis," or "The London Art of Building," the standard of a rod was, even at that time—practically 200 years ago, the mode of measurement employed. (Mr. George Corderoy, F.S.I., England, from whose paper, entitled "Measuring and Quantity Surveying," this information is obtained, states that a copy of this book is in the London Guildhall Library—so should any of you gentlemen have time to spare on your next trip to the Old Country, you may be sufficiently interested to refer to this document.)

2. Timber.—Generally speaking, per 100 ft. super. of lin. thick (except the larger sizes). In B.C. and U.S.A. the standard of 1000 feet super. is adopted, where it is known as "foot-board measure," whereas in England the 'cubic foot' is the recognised unit.

3. Doors, Windows, Stairs, Skylights, and other joinery numbered, with a detailed description.—The English practice is to measure every item separately and in detail.

(e) Preliminary Estimates.

As regards Preliminary Estimates, that is to say, estimates that are required in the early stages of the proposed work, generally before the drawings are complete, these estimates are usually needed so that the probable cost of the work shall be known before any great expense is incurred in preliminary data work, such as preparation of drawings, etc., or to ensure that the probable cost shall not be in excess of the amount proposed to be expended on the work; otherwise, in the case of inviting tenders, the lowest might be much higher than the proposed expenditure, thus necessitating the preparation of a reduced, or even entirely new scheme, with new drawings, specifications, etc.

Shakespeare aptly refers to this state of affairs in his play "King Henry IV.":

"When we mean to build,
We first survey the plot, then draw the model.
And when we see the figure of the house,
Then must we rate the cost of the erection;
Which, if we find outweighs ability,
What do we then, but draw anew the model
In fewer offices; or, at last, desist
To build at all."

Dealing with buildings, etc., there are many ways of preparing preliminary estimates, the principal methods adopted being as follows:—

1. Cubing.
2. Price per square.
3. Price per unit of accommodation, such as theatres, picture palaces, hospitals, churches, barracks, schools, lavatories, infirmaries, prisons, sanatoria, parish halls, stables, cowhouses, etc.

As regards—

1. Cubing.—This is the method usually adopted, but it is necessary to exercise great care and keen judgment in the adoption of this process in order to obviate the great liabilities to err.

At first glance, cubing would appear to be an ideal way of approximately estimating, as it would seem that if one building has cost so much per foot cube, that, therefore, another building which, on the face of it, seems similar, should cost the same proportionately; but there are many factors which must be taken into consideration in fixing the rate per cubic foot, and allowances must be made for the different conditions which may exist, such as the following:—

- (1) Locality of building—affecting cost of transporting, hauling, &c.
- (2) Price of labour and materials ruling at the time of erection.

- (3) Quality of finishings.
- (4) Size of building (generally speaking, small buildings cost more per foot cube than large ones).
- (5) Subdivision of building (i.e., number of rooms, &c.—as a rule, the less the subdivision, the lower the rate).

The method of measuring is usually as follows:—Length x breadth x height, from bottom of footings to half-way up roof. In the case of large buildings, in which the costs of the various parts differ greatly, it is necessary to keep the different parts distinct (such as stores, offices, lavatory blocks, &c.), and apply different rates. The rates, per cubic foot, should primarily be based on actual costs of similar buildings, such prices being modified as required to allow for the peculiar circumstances affecting the building, as outlined previously, and the estimator will find it a great help to keep a record of all actual costs with which he comes in contact; and, it is hardly necessary to state that, in keeping such records for future reference, it is essential to note all the special conditions ruling, with date, &c., otherwise the information will be obviously too meagre to be of any real value for comparative purposes.

It is of interest to note the cost per foot of some of the buildings which have been erected in N.S.W. as hereunder:—

Schedule 1.—Hospitals, and public buildings for offices, erected by the P.W.D. of N.S.W., by day labour.

Schedule 2.—Various buildings erected by the Commonwealth Department of Works and Railways, Public Works Branch.

Schedule 3.—A few older buildings, erected by contract between 1897 and 1908.

2. Price per square.—Measure each floor, and price per square of 100 feet, making necessary allowances for height. Thus 1s. per ft. cube equals £50 per square, assuming that height of floor be 10 feet.

| Hospital Reference No. | Description | Date of Erection. | Total Cost. | No. of Beds. | Cost per Bed. | Cost per Cubic foot |
|------------------------|--|-------------------|-------------|--------------|---------------|---------------------|
| 1 | The first wing of a large, four-storey high, hospital building, constructed of brick, with stone dressings, concrete floors, slate roof, including out-patients' department on the ground floor | 1914/16 | £21,538 | — | — | 1/1½ |
| 2 | Three hospital pavilions, one-storey high, constructed of brick, concrete, and timber floors, slate roof | 1915/16 | £43,416 | 120 | £362 | — |
| 3 | District hospital in country town, constructed on the pavilion principle, brick walls and slate roof, including administration block and nurses' quarters, kitchen and laundry block, isolation block, operating theatre, mortuary, etc. | — | £16,082 | 44 | £366 | — |
| 4 | Small hospital in country town | 1916 | £2,052 | 7 | £289 | — |
| 5 | Single pavilion, in suburbs, containing two wards, duty room, constructed of timber framing, lined externally with weatherboard, and internally with fibro cement, verandahs on both sides 12ft. wide | 1916/17 | £6,056 | 32 | £189 | — |
| 6 | Small hospital in country town, containing two wards, isolation block, kitchen, and nurses' and servants' quarters, constructed of reinforced concrete, with iron roof | 1915/16 | £1,711 | 8 | £214 | — |

Hospitals—Mental.

| | | | | | | |
|---|---|---------|---|-----|-----|------------|
| 7 | Pavilion for Farm Hands' Block, two-storeys high, brick walls, iron roof, containing three dormitories, with a total of 60 beds, four single rooms containing total 4 beds, day room, dining room, dressing room, bathroom, pantry, boiler, four storerooms, W.C. and lavatory accommodation | 1916 | — | 64 | £80 | 9d. |
| 8 | Single-storey pavilion, constructed of timber, lined with fibro cement sheets externally and internally, with iron roof, containing day-room, dining room, two dormitories with a total of 100 beds, four single rooms containing total 4 beds, two storerooms, one bathroom, and one dressing room | 1915/16 | — | 104 | £47 | *7d., †6d. |

* Dining room block. † Dormitories.

Public Buildings—Offices.

| | | | |
|--|---------|----------|------|
| Large building erected in City of Sydney, with dressed stonefronts, ornamental design and slate roof | 1911/12 | £78,727 | 11½d |
| Stone front, flat concrete roof | 1914/15 | £121,905 | 1/9 |
| In country town, brick with stone dressings, concrete floors | 1915/16 | £21,241 | 1/4 |

Schedule 3.—A FEW BUILDINGS ERECTED BY CONTRACT, BETWEEN 1897 AND 1908.

| Building. | Description | Date of Erection | Cost per foot Cube | Remarks. |
|---------------------------|---|------------------|--------------------|--|
| 4 Cottages | Manly. Brick and Tile Roof | 1897 | 6d. | |
| 20 Terrace Houses | Woolloomooloo. Brick and Iron Roofs | 1902 | 4½d. | |
| 6 Houses | Woollahra. Brick and Slate Roofs | 1902 | 5d. | |
| 2 Stores | Ash Street, Sydney. 4 Stories high, Brick and Iron Roofs, with Lift | 1900 | 4½d. | } Excluding foundation on the old "Tank Stream," cost £350 |
| 1 Office Building | Ast Street, Sydney. 4 Stories high, Brick and Iron Roofs, with Lift | 1900 | 6d. | |
| 1 Store | Circular Quay, Sydney. 3 Stories high, Brick and Iron Roof, with Lift | 1908 | 3½d. | |

Schedule 4.—SOME MODERN BUILDINGS ERECTED BY CONTRACT BETWEEN 1912 AND 1916—SYDNEY AND DISTRICT

| Building | Date | Description. | Total Cost | Cost per ft cube | Remarks. |
|---------------------------|---------|--|------------|------------------|---------------------------------|
| Residence | 1914 | Bellevue Hill—Brick, stone foundations and base, rough-cast finish, slate roof | £ 3,120 | s. d 0 8½ | First-class finish. |
| Cottage Residence | 1916 | Cronulla—Brick, rough-cast finish, slate roof | 1,308 | 0 6 | First-class finish. |
| Office Building | 1913 | Pitt Street Sydney—Brick and stone dressings, slate roof, iron roof rear portion | 10,000 | 1 0 | First-class finish. |
| Stores | 1913 | Kent Street, Sydney—Brick, iron-bark girders and storey-posts iron roof | 18,000 | 0 7 | Including Sprinklers and Lift. |
| Stores | 1912-13 | Sussex-street, Sydney—Brick, ironbark girders and storey-posts, iron roof | 30,244 | 0 6½ | Including Lifts. |
| Business Premises | 1915 | City—Brick, large show windows, iron-bark girders and storey-posts (girders chamfered and dressed, posts turned) R. S. J. corbel heads | 23,000 | 0 4 | Excluding Sprinklers and Lifts. |
| Factory | 1916 | Suburbs adjoining City—Brick, iron-bark girders and storey-posts, iron roof (flat-roof half-building | 6,000 | 0 4 | |
| Stables | 1912 | Surry Hills, Sydney—Brick, concrete paving to floors, iron roof | 10,000 | 0 5 | |

Schedule 2.—Commonwealth Department of Works and Railways—Public Works Branch.
TABLE SHOWING PRICE PER CUBE FOOT OF VARIOUS BUILDINGS.

| Buildings. | Class. | Method. | Description of Plan. | Cost at Completion. | Completion Date. | Rate per feet Cube. | Remarks. |
|---------------------------------|---|------------|---|---------------------|------------------|---------------------|--|
| Randwick Telephone Exchange | Brick, stone facings, tile roof, concrete floors to both ground and first floors and concrete stairs | Contract | Telephone Exchange, about $\frac{3}{4}$ of building being large open space remainder, small rooms and lavatories, including all fittings and lockers, and iron escape stairs, detached latrine building including fittings | £3577 8 2 | 8/9/3 | 6.66d. | Cost includes fencing preparation of site and pulling down and re-erection of wooden stable building of 4 stalls and shed |
| Croydon Post Office | Brick, stone dressings, slate roof | Contract | Office building, circular counter, instrument table and fittings, residence attached (2 storey) including all the usual fittings; detached latrine building and shelter for 2 horses, including fittings | £2825 18 11 | 3/11/13 | 9.40d. | Cost includes usual preparation of site, fencing and tar-paved paths |
| Mascot Post Office | Office, brick with stone facings, slate roof, concrete floor to Exchange and wood floor to Office Residence, brick, tile roof; Outbuildings brick, iron roof | Contract | Post Office and Telephone Exchange, one storey building, with counter, operator's table and usual fittings; detached residence, one storey with all the usual fittings; latrine building including fittings; outbuildings, with three horse stalls, store room and latrines | £3518 5 9 | 9/11/13 | 7.65d. | Cost includes for considerable excavation, and filling in, levelling site, fencing and tar-paved paths |
| Mosman Telephone Exchange | Two-storey building brick with plain stone dressing, both floors being of concrete, paved with linwood, concrete stair, tile roof | Contract | Telephone Exchange open spaces, with stair lobby and lavatory accommodation on each floor | £3183 11 1 | 1/5/14 | 5.36d. | Cost includes considerable excavation in rock, tar-paved area and path, and repairs to fencing |
| Vaucluse Telephone Exchange | Brick walls, stone facings, concrete floor tile roof | Contract | One storey building, Telephone Exchange, open space divided with wood and glass partitions, rooms at one end and attached latrines, including fittings | £1232 5 5 | 3/10/14 | 6.71d. | Cost includes preparation of site, and fencing |
| Lidcombe Telephone Exchange | Brick, stone facings, tile roof, concrete floor | Contract | Telephone Exchange, one storey building, open space, divided with wood and glass partitions | £974 5 0 | 31/12/14 | 5.76d. | Cost includes excavation in preparing site and fencing |
| Liverpool Ammunition Stores | Wood framed buildings covered with iron, on concrete piers and dwarf walls, reinforced concrete floor, iron covered roof, having steel principals, the whole lined internally | Day Labour | Large open area with offices at one end | £4934 8 6 | 10/3/16 | 5.09d. | Cost includes a considerable amount of filling, fencing, Mac-Adamised roads with concrete gutters round buildings |
| Campsie Post Office | Brick with stone base, stone facings and stone steps, tile roof | Day Labour | Office building including counter, operating table and fittings, strong room and lavatory; detached outbuildings, store, latrines and three horse stalls, including fittings | £1959 9 0 | 5/4/16 | 8.80d. | Cost includes usual preparation of site, fencing and tar-paved paths |
| Marrickville Military Buildings | Wood framed buildings on concrete piers and dwarf walls, framing sheeted with weather-boards, iron roofs | Day Labour | Seven buildings, five being one storey, and two being two storey, all consisting of stores, waggon sheds, harness rooms etc for military use, also latrine buildings including all fittings | £16925 13 11 | 6/4/16 | 6.90d. | Cost includes for levelling site, tarred Mac-Adam roads, paved areas in front of waggon sheds, and complete sewerage, water and fire service to all buildings and site |
| Waterloo Drill Hall | Wood framed building covered with corrugated iron, iron roof on steel principals offices only being lined internally | Day Labour | Drill Hall, large open space, offices down one side; detached latrine building including fittings | £1854 10 11 | 9/9/16 | 3.23d. | Cost includes fencing of site |
| Millers Point Drill Hall | Brick building with steel stanchions supporting first floor and roof. Ground floor concrete, first floor wood on steel joists, iron roof on steel principals, concrete stair, steel fire escape | Day Labour | Two storey building, ground floor, vehicle sheds, stores, offices, and latrines, upper floor open space, drill hall, with offices one end | £5322 18 2 | 4/11/16 | 6d. | Cost includes preparing site, and brick boundary wall to street alignment |

3. Price per unit of accommodation.—These are measured per head of patron, patient, pupil, &c. To give an estimate by this method, preliminary plans are not indispensable, as the estimate is based on the required accommodation; but, naturally it is far preferable to have preliminary sketches, so that a check estimate can be prepared by calculating the cubical contents.

In adopting this "unit" method, due consideration must be given to the governing local regulations, which directly affect the cost. Thus, in dealing with hospitals for example, the cubical contents of air space required per patient varies considerably, the L.G.B. (Poor Law, England) stipulating 864 cu. feet, with a wall length per bed of 6 feet; whilst English practice for general hospitals allows for 1600/1800 cu. ft., with 9/10 ft. wall length, and 2000 cu. ft. for single bed wards; whereas 2000 and 2500 cu. ft. should be provided for scarlet fever or smallpox and diphtheria hospitals respectively, although 1200/1300 cu. feet is ample for sanatoria. It will be seen that such matters as these greatly affect the cost "per unit," and hence it is a matter of strict necessity to make one's self acquainted with such facts before giving even a preliminary estimate. (For examples of hospitals, refer back to Schedule 1.)

(f) Alterations to Existing Buildings.

It should be especially noticed that neither of the three methods mentioned is suitable for estimating the value of alterations, which is a class of work requiring particular attention, and it would be a very hazardous proceeding, for example, to form an estimate based on the cubical contents. The only safe plan for preparing a preliminary estimate is by means of rough approximate quantities—taking into consideration the peculiar circumstances existing, such as (1) new work to be constructed whilst existing building stands, (2) building to remain in occupation whilst new works are proceeding, (3) damage to existing

building during execution of works and making good thereto—all of which such items greatly influence the cost.

(g) Constants.

Constants are valuable adjuncts to estimating, being simple multipliers which represent in days and decimal parts of a day, the time which a certain unit of work, such as a yard, foot, rod, &c., will require for its performance. Hurst's Tables of Constants are considered to be the most complete published, and although these are based on a 10-hour day, and on English prices, yet it is a simple matter to make one's own constants, based on local conditions, and one or two examples are given herewith.

Method of Calculating "Constants."

Rule: Divide the time (one day usually) by the amount of work executed by one man.

Note.—If more than one man's time is included, take the average.

1.—ROCKCHOPPING TO TRENCHES.

(Not for sewers).

3 men, in $12\frac{1}{2}$ days of 8 hours, excavated 21 cu. yards, i.e.,
 1 man = 21 cu. yds. in $3 \times 12\frac{1}{2} = 37\frac{1}{2}$ days.
 1 man = 1 cu. yd. in $\frac{37\frac{1}{2}}{21} = 1.8$ approx.
 Constant = 1.8

2.—CONCRETE MIXING.

5 men (3 on platform, 2 trucking) mix, wheel and deposit
 5 yards in 1 day, i.e.,
 1 man = 5 cu. yds. in $5 \times 1 = 5$ days
 1 man = 1 cu. yd. in $\frac{5}{5} = 1$
 Constant = 1

Method of Using Constants.

Rule: Multiply constant by wages per day, the result will be cost per unit of labour only, to which must be added cost of material, &c.

Examples (using Constants just calculated):—

1.—ROCKCHOPPING TO TRENCHES.

Constant x daily rate of wages = price per
cu. yard
1.8 x 16/- (for other than sewer trenches) = 28/9 approx.

2.—CONCRETE.

Constant x daily rate of wages = price per cu. yd.
1 x 11/4 (Builder's Labourers' award) = 11/4 building work
1 x 11/- (United Laborers' award) = 11/- machine
foundations

The preceding examples are sufficient to show the use and value of constants; and, of course, constants, for work of many kinds, can be obtained in a similar manner.

(h) Comparative Prices for Building Works.

It is often necessary, in estimating for building works, to give alternative prices for different means of construction, and hereunder are given some comparative prices of walls and roofs.

(j) Builders' Quantities.

These prices are worked out on what are sometimes known as "Builders' Quantities"—that is to say, "overall" quantities embracing all items, of every trade, in any particular form of construction, such as walls, floors, roofs, &c.—which are measured at per square superficial, and priced at an inclusive price. It should be noted that this method is often adopted when detailed quantities are not prepared.

Owing to the war, at the present time but little Baltic timber lining is being imported, and, to a certain extent, Oregon, specially dressed, is being used, and the following prices allow for dressing. As regards the prices given herewith, it must be borne in mind that these are affected by the fluctuations of the market, location of site, and therefore are approximate only.