

guards, round columns be given a preference over rectangular ones.

4. That where highly silicious gravel aggregate is to be used, all columns, but especially rectangular columns and round columns with spiral reinforcement, be safeguarded by means of one of the following expedients:—

(a) Placing expended metal or other high-weight large-mesh reinforcement in the outer concrete to prevent the loss of protective concrete by spalling.

(b) Giving columns additional protection of approximately 1 in. of cement plaster either on metal lath or reinforced with light expanded metal or other suitable material.

THE CONSTRUCTION PERIOD*

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IN the early days of appraisals, interest during the construction period was frequently ignored. In some of the later appraisals it has been taken at very large figures, large because of the assumption that the construction period extended to the completion of the entire property; that is, no part of it was assumed to go into operation before the completion of the whole. There seems to be very little, if any, disagreement among engineers and commissions as to the annual rate of interest, but in many cases there is a wide variation in the length of the construction period.

If it is assumed the property is to be reproduced "piecemeal," we will have one period of construction. On the other hand, if the property is to be reproduced "wholesale," we will have a different period of construction. If a certain property is to be reproduced "piece-meal," the result would naturally be higher unit cost and lower total interest cost than if reproduced by the "wholesale" method. In some cases the two may balance.

Fixing of Construction Period

The particular part is to fix, as accurately as possible, the construction period. Usually some part of the property, a power plant for instance, will be the best guide. Obviously, a street railway, complete in every other respect, must remain idle without power, also the question of the critical speed of construction must be given consideration. Theoretically, a large property could be constructed in a few months, assuming enough men and material could be procured, but to do this it would be necessary to exceed the speed of economical construction, which would result in very high unit cost, and no doubt would more than offset the decrease in the interest cost. Consideration must be given to the question of obtaining labor and material in large quantities at the time desired, and the fact that no city would consent to the extensive tearing up of its streets that may be necessary with a short period of construction.

One method often used is to assume an interest rate of 6% applied to the entire cost over one-half the construction period. The cost is zero at the beginning and is assumed to increase uniformly to the full amount at the end. The criticism often made of this method is the assumption that money can be borrowed day by day, or month by month, as needed. It is difficult to imagine bankers willing to furnish money in this way.

Illustrative Problems

Another method often used is to assume an interest rate of 6% and 2% allowance on the unexpended balance, assuming the unexpended balance to equal one-half the loan, the loans to be made at equal intervals during the construction period. The following concrete problems will illustrate the two methods:—

*Paper presented at the spring meeting, May, 1920, St. Louis, Mo., of the American Society of Mechanical Engineers.

Problem No. 1:—Assume a property costing \$12,000,000 and a construction period of three years, interest rate 6%. The expenditures proceeding uniformly from zero at the beginning to the full amount at the end.

Solution:—Six per cent. for one-half the construction period will give a total interest charge of 9%, this applied to the \$12,000,000 cost will give \$1,080,000 as the interest cost.

$$\frac{1,080,000}{12,000,000} = 9\%$$

Problem No. 2:—Assume a property costing \$12,000,000 and a construction period of three years, interest rate 6%, allowance on balance at the rate of 2%, balances equal one-half the loan. \$2,000,000 borrowed each six months.

Solution:—

First loan	.... \$2,000,000 @ 6% for 3 yr.	\$360,000
Credit on balance	1,000,000 @ 2% for ½ yr.	10,000
Net interest first loan	.....	\$350,000
Second loan	... 2,000,000 @ 6% for 2½ yr.	300,000
Credit on balance	1,000,000 @ 2% for ½ yr.	10,000
Net interest second loan	.....	290,000
Third loan	.... 2,000,000 @ 6% for 2 yr.	240,000
Credit on balance	1,000,000 @ 2% for ½ yr.	10,000
Net interest third loan	.....	230,000
Fourth loan	... 2,000,000 @ 6% for 1½ yr.	180,000
Credit on balance	1,000,000 @ 2% for ½ yr.	10,000
Net interest fourth loan	.....	170,000
Fifth loan	.... 2,000,000 @ 6% for 1 yr.	120,000
Credit on balance	1,000,000 @ 2% for ½ yr.	10,000
Net interest fifth loan	.....	110,000
Sixth loan	.... 2,000,000 @ 6% for ½ yr.	60,000
Credit on balance	1,000,000 @ 2% for ½ yr.	10,000
Net interest sixth loan	.....	50,000
Total interest for three years	.....	\$1,200,000

$$\frac{1,200,000}{12,000,000} = 10\%$$

If this money is borrowed \$4,000,000 each year for three years instead of \$2,000,000 each six months the total interest becomes

$$\frac{1,320,000}{12,000,000} = 11\%$$

It will be noted, in this analysis, the assumption is made that no part of the money is spent until the day construction starts. In actual practice this would be very difficult, if not impossible. The land for various purposes, such as right of way, power stations, sub-stations, shops, car houses, gas plants, commercial offices, etc., would necessarily have to be purchased one or more years before construction started. The following concrete problem will illustrate this method.

Problem No. 3:—Assume a property costing \$12,000,000. Of this amount the cost of land is \$1,200,000 and the structural property \$10,800,000. It will require three years to obtain the land, starting one year in advance of construction. Construction period of three years. Interest rate of 6%, allowance on balance at the rate of 2%, balances equal one-half the loan, money borrowed each six months.

Solution:—If the purchase of land starts one year in advance, and money is borrowed every six months there will be eight periods to consider; following are the amounts borrowed each period:—

	Land.	Structural property.	Total.
First period	..... \$ 200,000	.....	\$ 200,000
Second period	..... 200,000	.....	200,000
Third period	..... 200,000	\$ 1,800,000	2,000,000
Fourth period	..... 200,000	1,800,000	2,000,000
Fifth period	..... 200,000	1,800,000	2,000,000
Sixth period	..... 200,000	1,800,000	2,000,000
Seventh period	.....	1,800,000	1,800,000
Eighth period	.....	1,800,000	1,800,000
Total	..... \$1,200,000	\$10,800,000	\$12,000,000