included superintendence, office expense, interest and depreciation on plant. Superintendence should include some compensation for the contractor's own time. To the author it seems desirable to divide the contractor's compensation into two parts, (1) salary and (2) profit.

The salary should be only as large as would be paid to a skilled superintendent. The profit should cover both compensation for the contractor's skill as an organizer and financier, plus insurance against all risks for which an insurance policy can not be secured.

Working Days or Days Worked?

A common mistake in estimating "overheads" consists in dividing the annual overhead cost by the number of working days in a year, instead of dividing by the average number of days actually worked. In our northern climates, the number of days actually worked by a given organization on road construction usually averages about 125, but there are 300 working days in a year; hence a highway contractor and his plant are usually idle nearly 60 per cent. of the working days of the year. If a contractor's annual salary as a superintendent be added to the annual salaries of his permanent employees, and if this salary total be divided by 125, instead of by 300, the salary "overheads" per day worked will be ascertained for all practical purposes. Similarly as to plant "overheads" and office rental "overheads."

The total "overheads" per day actually worked must be apportioned among the units of work done. Both highway contractors and engineers who have not been accustomed to prorate overhead costs in this manner will get some surprises. Failure to do this is largely accountable for the fact that so many road contractors "go broke," and it also throws light upon the fact that a good many engineers think that road construction can be done more cheaply by day labor than by contract.

Having estimated the overhead costs per "day worked" (not per working day), some of these daily overheads can be assigned directly to a given class of work. Thus, the daily interest, depreciation and repairs on a concrete mixer can be assigned to the pavement. But certain of the daily overhead costs must be prorated to the different classes of work.

There are several theories of prorating joint costs, which the author has discussed at some length in the "Handbook of Mechanical and Electrical Cost Data." Usually it suffices on construction work to prorate overhead salary costs in proportion to direct labor costs. Thus, if the direct labor cost of grading is \$50 a day and the direct labor cost of paving is \$100 a day, and there are no other direct labor costs, then one-third of the daily cost of general superintendence and office expense is assigned to grading, and two-thirds to paving.

Having assigned all the daily overheads to the different classes of work, divide each assigned total by the number of units of work performed each day worked, to get the unit cost of overheads for each day. It should be noted that by using this method there are no overhead costs for the days on which no work is done, for all the overhead costs are assigned to the days actually worked each year on the average.

While there are some objections to this method, it is the only method by which the total unit cost can be estimated with any degree of accuracy for each day worked. And it is highly important to have such an estimate in order to know whether a profit is being made or not. The average road contractor who has a unit cost-keeping system usually is deceived into thinking he is making money, because the daily overheads are either not known or are not properly allocated to the various classes of work.

Cost of Installing and Shifting Plant

There is another source of error in estimating daily or Weekly or monthly profits, which arises from failure to segregate the cost of installing, shifting and removing the various plant units, together with miscellaneous costs of getting ready to do work. It is rare that any contractor is able to state what these "preparatory costs" have been on any given job, and this holds true even where the contractor has a cost-keeping system. No argument is needed to prove that unless the "preparatory costs" are known, there is grave danger of under-estimating the total unit costs.

Having so kept the daily records as to show the actual cost of moving and installing a crushing plant, for example, to this should be added the estimated cost of shifting it (where shifting will be necessary) and the cost of dismantling and shipping it home. Then this total should be divided by the total number of cubic yards of stone to be crushed on the given job, to get "the unit preparatory and shifting cost" of crushed stone.

This unit cost should be added each day to the "unit overhead cost" and the "unit direct cost" for that day. The resulting total will then be really significant as to what the pavement is actually costing.

Importance of Daily Unit Costs

It will be noted that the author is contending for the daily and weekly estimating of the total unit cost of each class of units upon which there is a contract price. Unless this is done it almost invariably happens that the road contractor who thinks he has been making a profit on a job, awakens toward its close to find that he has actually lost money on it.

Now, he may lose money on the job even if he does have complete unit costs before him every day, for it is very common to bid so low a price that no profit can possibly be made. But it is surprising what a difference there is in the energy of a desperate man as contrasted with one who is well satisfied.

When a contractor realizes that he is daily sinking deeper into the quicksands of bankruptcy, he will usually "camp on his job" night and day, and his wits will be steadily at work; whereas if he thinks he is making a satisfactory profit, he is apt to take things easy, let well enough alone, go off on frequent pleasure excursions, and the like.

Incidentally it may be remarked that one of the reasons why day labor so frequently exceeds the cost by contract lies in the psychological fact that the engineers and superintendents in charge of the work have no pecuniary stake in the cost of the work.

Summary

Summing up, a road contractor can use his brains to no better advantage than in finding ways of securing daily reports that show the total unit cost of every item on which he has bid a unit price. To do this it is frequently necessary to invent methods of securing approximately correct estimates of the number of units of work done, and it often pays to employ an engineer for no other purpose than to measure up daily the number of units.

Lost time should be reported daily and its cost estimated.

Overhead costs should be estimated per average day worked, not per working day, and unit overhead costs estimated every day.

Plant, preparatory and shifting costs should be kept apportioned to each class of work, and reduced to unit costs.

If these methods are adopted, profits will be increased or losses decreased. If engineers in charge of contract work will follow the same method, they will usually discover that there is little or no profit to the average road contractor. Indeed, unless engineers give adequate study to the costs of lost time, overheads, plant installations, etc., and unless they devise ways of enabling competent contractors to secure adequate prices, it will be only a matter of a few years before there will be no competent contractors in the road-building business.

A. H. Harkness, chairman of the Toronto branch of the Engineering Institute of Canada, has announced that W. J. Francis and Arthur Surveyer, members of the council of the institute, will address the Toronto branch about March 20th, in order to give "inside information" regarding what the institute is doing for engineers.