

After the grading item comes the protection of the grading, of which there are many different kinds of construction. Cuts are protected by surface drains, ditches, track drains, bulkheads and retaining-wall, while in embankments the use of drains, retaining-walls, rip-rap and toe-walls are common. It requires much experience to foresee the necessity of protection against the possible conditions which may arise after the work has advanced.

Rock is usually used for the protection of the embankments, the rock varying in size from one cubic foot to five cubic yards. The most common use of rip-rap is placing it around masonry piers to prevent scouring; the river bed is here often washed out, thus letting the rock fall and requiring more rock than is contained within the slope limits.

There is also a considerable amount of rock which is lost in the handling. This, of course, would be governed more or less by the method of final measurement used, on which is based the contractor's estimate. Then, rock used for protection is an item on which a liberal allowance should be made for over-run. The writer has been on several pieces of rip-rap work and has never known the final quantity to be equal to, or less than, the original estimate. I would say that 20 per cent. is none too much to allow for over-run, from the theoretical sections, unless the contract states specifically the amount of rock to be used per unit, of length of line, which would amount to a "lump sum" bid for the work.

In tunnel costs we have something which contains a great many different items which can be figured from a knowledge of the excavation to be done, character of formation, etc., but there are many costs which cannot be foreseen, such as quicksand pockets, excess water, underground streams, and peculiar local formations, all items which it might be possible to overlook, even with the best of preliminary tests. This applies more to long tunnels than to short ones. Then in tunnels we have items which should be allowed for generously, and can only be properly estimated by the man who has had the conditions to deal with; it is impossible to use theoretical quantities without some allowance for the unexpected items of cost.

Super-structure of bridges is an item which can be accurately calculated as to weight, transportation, etc., while the foundations are always subjects requiring special study for the location in question. Anyone familiar with the different publications on bridge foundation work will note the great variation of unit costs of different bridges.

Although the condition should not exist, contractors usually look to the railroads to make good any loss on a piece of foundation work, in which unforeseen obstacles are met. As these obstacles are not figured in the original contractor's bid for the work, it may be fair for the railroads to share some of the expense. Therefore, thorough testing of foundation sites should be made by the engineers, and contractors as well, in order to make an intelligent estimate of the cost of the work. Accurate preliminary estimates are accomplished only by the men of experience.

Drainage openings, such as arch culverts, pipes, box drains, and all sorts of pipe and tile drains are a constant source of trouble, both in construction and maintenance of railroad work.

Preliminary estimates should be made with a thorough investigation of the natural conditions surrounding the site of the drainage opening with a view to determining the nature of the ground, for foundation purposes, the accessibility to the site with materials, labor, and equipment, the necessity of maintaining a camp for

one opening, and all local conditions which will in any way affect the location or construction of the opening. The preliminary work should be as familiar to the contractor as to the engineer, so that it will be thoroughly understood before the contract price is submitted.

Construction of the drainage openings may seem very simple at first sight, but often runs up into thousands of dollars for the simplest kinds of construction. The extra items which come up during the construction of the work and do not fall under any of the contract items, often increase the cost, of providing drainage, materially.

Protection of structures under high fills, washouts due to insufficient drainage, ground water seepage for which drainage has to be provided, stoppage of openings due to slides causing washouts, both in cuts and fills, are all items for which special provision should be made in preliminary estimates.

In Mr. Gould's own experience he has had 15,000 cubic yards of material washed from an embankment of 100 feet in length, due to an underground stream which was not detected until after the embankment material was placed and the weight forced the water back to the centre of the fill, where it broke out and caused the damage.

As a rule, the same engineer building the road-bed places the track and ballast. When ballasting, the line follows closely to the grading, it may be possible to keep the first cost estimate of ballast within the theoretical ballast limits. Often the road-bed is given a year to settle and acquire a more stable condition. This invariably requires more ballast, as it is impossible for the engineer to use a certain figure for shrinkage of embankments and have it agree exactly with the actual shrinkage which takes place. This, then, adds to the item of ballast.

In all construction work there is the item of waste which enters into the item of cost. With the very best instructions which can be given, and the best inspection which can be made, the engineer has, constantly, the item of waste to deal with.

Aside from the general construction work, there is the fluctuation of prices of materials, labor, machinery, etc. Although the railways in the West do not, as a rule, furnish materials, machinery, labor, etc., for construction work, it is not an uncommon occurrence. Small pieces of work, such as coal docks, water stations, depots, pipe culverts, are often done with railway company material.

After all, observes Mr. Gould, the engineer's life is one of continuous schooling and study along whatever line he may choose, and his value is measured by his ability to foresee conditions which will arise upon which he may plan and construct accordingly.

The Belgian Legation at Belgrade, Servia, reports that the town of Nisch proposes to raise a loan of £840,000 for canal works, construction of a line of tramways, and paving.

It is announced that Messrs. J. T. and C. Donohue have purchased all the stock of pulpwood formerly belonging to the East Canada Pulp Company, Limited, at Murray Bay, now in liquidation. The wood is in the yard booms and also uncut on the company's limits, on the Murray River and its tributaries. The purchasers have also acquired the new pulp mill.

A comparison of the pulp industries in Canada and Denmark is interesting. In the little country of Denmark there are 230 pulp or paper mills. In Canada, according to the latest available statistics of the Dominion Forestry Branch, there are only 48 pulp mills in actual operation, though Canadian mills are many times larger than those in Denmark.