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KEEPING COST DATA ON MUNICIPAL WORK CARRIED OUT BY DAY LABOR

SOME INTERESTING OBSERVATIONS ON THE BENEFITS RESULTING FROM THE INTRODUCTION OF COST-KEEPING METHODS IN CARRYING OUT MUNICIPAL ENGINEERING WORK.

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IN these days of keen competition it behoves every business man, who wishes to be successful, to keep accurate details of cost, so that he will have a close and continuous check upon every department of his business and be in a position to at once locate and eliminate any losses that may be taking place.

It is obvious that this is still more necessary on municipal work carried out by day labor, where there are many adverse conditions with which the private corporation does not have to contend. This is particularly applicable in the West, where the amount of money spent under this system runs into millions of dollars per annum, and where there appears to be a tendency to increase rather than reduce the quantity of work done by this method.

The writer, during the last four and a half years, has had direct charge of work entailing an expenditure of over five and one-quarter millions of dollars, and by far the greater part of this has been carried out by day labor. The pay rolls alone under this method for the years 1912, 1913 and 1914 averaged over $700,000 per annum, and practically all the work in 1915 and 1916 was done by city forces.

It was quite apparent to the writer when he took office that there was every opportunity for a large waste of money, not only through lack of system, but through lack of interest and incentive, and that it was necessary to introduce some method whereby the detrimental effects of conditions peculiar to municipal work could be nullified or overcome.

Some of these adverse conditions were:—

1st. There appeared to be a different standard of business ethics for municipal corporations than for private firms. Many of the employees cared little whether or not the city got full value in quality and quantity for material received, or if it was suitable for the purpose intended, and more than that, some merchants did not fail to take advantage of this carelessness, encouraging the laxity of the employee with the argument that he "should not worry as the city paid the bill."

2nd. Influence, political, aldermanic or otherwise, was often more essential in obtaining civic employment than ability, and coupled with this many men who obtained their positions by influence were of the opinion that they did not have to work as hard for the city as for private firms, and when a conscientious foreman attempted to disabuse them of this idea, they threatened to use their influence to make trouble, and, unfortunately, it was not always a mere threat. The result was that many foremen tolerated these men at the expense of discipline and authority.

3rd. Permanency of employment was to a more or less extent independent of the satisfaction given, and the argument was even used by an alderman that a man who had been given employment by the city for years should be willing to step down and allow the other man a chance—surely poor compensation for faithful service rendered—and a man uncertain of steady employment cannot be expected to take an active interest in his work.

4th. Civic corporations, as a rule, consider one man about as good as another, and pay them accordingly. That is to say, the wage is fixed by the position and not by the ability of the occupant. There was, therefore, no monetary inducement for a foreman to do his best, or accomplish more than his fellow worker. Hence a lack of incentive.

5th. The necessity of giving employment to men who through age or disability became a charge upon the city, and who had to be provided with work. Hence the tendency of lowering the standard of work and output of those with whom these men came in contact.

6th. During prosperous times the civic money chest was an unfailing source of supply, and the funds required were always available. Hence no curb, such as a profit and loss account, to keep the cost of work within the estimates or down to a reasonable figure.

Now, the engineer, where possible, must alter the above-mentioned conditions, and he has to inaugurate a system whereby he can offset the lack of interest and incentive due to the others. At the same time this system must be in such form that he can personally check all the details of the work and see that satisfactory results are being obtained.

One of the best methods, in the writer's opinion, is by introducing a detail cost data system. It must be simple, but effective, and the cost of developing and carrying on must be a reasonable percentage of the value received. In connection with this, however, he must impress upon the employees that the corporation business is to be run upon the same basis as a private business, and that they must perform their duties just as conscientiously as they would if their own money were involved. He must also give the foremen full authority to employ and dismiss their men, and he must assure them freedom from all outside influence so long as they produce satisfactory results.

Street—N.-E. Branch of the North-West Sewer on Finlayson Street. From—Douglas Street. To—Quadra Street. Service—Sewer Loan 1916.

Class of Work—16″ Vitrified Sewer. Foreman—J. McInnes.

Date	Excavation: Rock			Excavation: Dirt			Excavation: Hardpan			Pipelaying			Backfilling			Manholes			B. Smithing			Miscellaneous		Teaming	Total Labor Expenditure
1916	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	Lin. Ft.	Per Lin. Ft. $ c.	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	No.	Bach $ c.	Total $ c.	Lin. Ft.	Per Lin. Ft. $ c.		$ c.	$ c.	$ c.
Bro't For'd	—	—	—	471.30	879	0.536	—	—	—	125.85	1550	0.081	112 55	702	0.16	97.80	—	—	—	—	—		176.40	42.10	1026.00
Sept. 12	—	—	—	11.00	—	Ex. Trench 0′ - 8″ deep this week.	—	—	—	4.10	—	—	6.90	—	—	1.35	—	—	—	—	—	Concreting base for pipe	5.40	—	28.75
" 13	—	—	—	21.90	—		—	—	—	2.75	—	—	1.35	—	—	1 40	—	—	—	—	—	Moving planks .... / Rod and chain man...........	1.35 / 0.75	—	29.50
" 14	—	—	—	19.25	—		—	—	—	4.15	—	—	4.00	—	—	—	—	—	—	—	—	Clearing brush off right of way	1.35	—	28.75
" 15	—	—	—	27.35	—		—	—	—	1.40	—	—	—	—	—	—	—	—	—	—	—	Clearing up surplus dirt	3.65	—	32 40
" 16	—	—	—	23.25	—		—	—	—	1.40	—	—	2.75	—	—	—	—	—	—	—	—	....	—	—	27.40
" Sun'y	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	....	—	—	—
" 18	—	—	—	23.25	—	—	—	—	—	1.40	—	—	2.75	—	—	—	—	—	—	—	—	Clearing right of way..........	1.35	—	28.75
Report on week ending Sept. 18	—	—	—	126.00	200	0.63	—	—	—	15.20	204	0.074	17.75	130	0.136	2 75	—	—	—	—	—	....	13 85	—	175 55
" Total to date Sept. 18	—	—	—	597.30	1079	0.553	—	—	—	141.05	1754	0 08	130.30	832	0.157	100.55	—	—	—	—	—	....	190.25	42.10	1201.55

Fig. 1.

Some of the general advantages of a cost data system are:—

1st. It acts as a recording gauge and gives a permanent and continuous record of all variation in costs. If, through stress of work, the engineer is unable to visit the jobs regularly, still his weekly reports enable him at once to place his finger on any increase in cost, and he can confine his time to points where the cost data indicates it is needed.

2nd. He knows by comparison which foreman's work is costing more than it should, and what is more, the foreman knows he knows it. The very fact that detail costs of each job are on file in the office for future reference has an excellent moral effect upon the men.

3rd. It is of value to the competent foreman who knows that his favorable record will assure him steady employment with the city, and will be of service should he apply elsewhere for a position. It is also a convincing argument against the incompetent foreman, who claims that he has been unjustly dismissed, and it strengthens the hand of the engineer who is employing foremen upon their merits, as it is difficult for any one to argue against data kept over an extended period. An engineer with experience on municipal work will appreciate the importance of this.

4th. An engineer must have the confidence of those whom he serves, and this depends largely upon his ability to give them any information they desire when they ask for it. This is facilitated by a system which keeps him in close touch with all the details of his work.

Lastly, one of the great benefits derived from keeping weekly cost data is the interest that it creates in the foremen for their work. The factor of competition, which is usually lacking upon municipal work, is introduced and there is some definite aim in view. The information obtained is an incentive for them to try and steadily reduce costs by improved methods. They acquire the habit of figuring out the cost of their work from day to day, and it is surprising the excellent suggestions that are made with a view to economy, and one gets the benefit of the brains of all the foremen instead of those of possibly a few, and the efficiency of the entire department is increased thereby.

The city of Victoria has gradually enlarged the sphere of work carried out by day labor until to-day practically none is done by contract.

The writer, during the last four and a half years, introduced and improved upon a cost data system starting with sewer construction and enlarging the scope until it covered practically all work done by the corporation.

Some of the forms developed are illustrated in Figs. 1 to 8, and the following is a description of the method of working:—

The foremen hand in the segregation of their labor on the back of the time sheets. Fig. No. 1 is an illustration of a time sheet for sewer work, and sheets with the desired segregations are used for the different classes of work, such as sidewalk and road construction, boulevard maintenance and construction, waterworks, etc.

Once a week the field engineers measure up and plot on the plans and profiles the amount of the different classes of work done. From this information the cost data clerk, who is also head timekeeper, with the assistance of another timekeeper during his spare time, makes out a weekly summary sheet. From this the foreman is given the unit cost of the different classes of work for the week, the cost for the preceding week, and the average cost to date, as shown on Fig. No. 2.

Progress Report on Forman McInnes on the N.E. Branch of the N.W. Sewer. Douglas Street—Eastwards.

From start, 31st July, 1916, to date, 25th September, 1916.

	Rock Excavation			Dirt Excavation			Hardpan Excavation			Pipelaying			Backfilling			Manholes			Concreting Wall			Miscellaneous	Teaming	Total Labor Expenditure
	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	Lin. Ft.	Per Lin. Ft. $ c.	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	No.	Each $ c.	Total $ c.	Cub. Yds.	Per Cub. Yd. $ c.	Total $ c.	Total $ c.	$ c.
Week ending 18-9-16......	—	—	—	126.00	200	0.63	—	—	—	15.20	204	0.074	17.75	130	0.136	2.75	—	—	—	—	—	13.85	—	175.55
Week ending 25-9-16......	—	—	—	95.90	195	0.492	—	—	—	17.90	221	0.081	21.95	218	0.10	31,25	—	—	—	—	—	5.90	3.30	176.20
Total to date 25-9-16......	—	—	—	693.20	1274	0.545	—	—	—	158.95	1975	0.08	152.25	1050	0.145	131.80	—	—	62.85	—	—	133.30	45.40	1377.75

Average depth of excavation for week ending 18-9-16=7 ft. 6 in.
" " " " 25-9-16=8 ft.

Fig. 2.

The cost of material is not given as the foreman is interested primarily in the labor cost only. However, on concrete work the weekly reports show the quantity of cement, sand and gravel estimated and the quantity actually used, as a check upon his material.

It is impressed upon the foremen that the first requisite, and the one insisted upon, is first-class workmanship, and they are to neither waste nor go short on material.

The foremen make any explanatory notes they consider necessary and return the reports which are filed in the office.

Upon the completion of a job a final report is made out, giving all particulars.

The weekly reports from time to time have indicated unsatisfactory conditions which, upon investigation, showed among other things, that one foreman persisted in employing old friends on his gang at the expense of efficiency; that another foreman, though conscientious and a hard worker, had not the ability to lay out his work and handle his men to get the desired results; that a third foreman in concrete work was not placing his aggregate to the best advantage, necessitating wheeling uphill at added expense, and in the above cases changes were made.

On the other hand, the reports revealed that foremen were using every means they could think of to reduce the cost of work. One foreman on rock tunnel work was taking his lunch at a different hour from his men so that he could keep the drill running while they were off, and in other ways was laying out his work to the best advantage with the view of bettering his last week's records.

A plant account was kept and all jobs charged a rental for tools and equipment used; small tools on a basis of 5 per cent. per month and large plant at a rental sufficient to cover maintenance and depreciation.

Foremen were required to sign for and return all equipment to the city yards, no matter in what condition.

All old tools were scrapped at the yard and sold for junk.

All the large plant, such as concrete mixers, compressors, rollers, rock crushers and motor trucks, were numbered and a separate account, in detail, kept for each.

When the maintenance cost of any equipment became excessive the cause either lay with the mechanic in charge or it was time to dispose of the machine and purchase a new one. Fig. No. 3 is the 1915 report upon motor trucks.

Besides the above reports, curves were plotted for garbage collection, pumping costs, engineering expenses, etc., with costs, or quantities and costs as ordinates and the months of the year as abscissae, from which the data from year to year could be compared and any undue variation noted.

The curves for garbage collection for the years 1913 to 1916 are shown in Fig. No. 4.

Some of the practical results obtained will be of interest. A comparison of the cost of oiling streets for the years 1913, 1914 and 1915 will be described at some length to illustrate what was accomplished. One improvement suggested lead to another and each was directly attributable to the interest taken in the work on account of the detail cost data kept.

In 1913 the cost per square yard was 1.12 cents, but this included labor, material and teaming charges for oiling only. Dust removal was charged to street cleaning and no sand was used. The oil was delivered in drums, hoisted onto a platform and emptied into horse-drawn tank wagons.

In 1914 the cost per square yard was 1.23 cents, including cost of oil and sand and all labor, teaming and plant rental charges for removing dust, applying oil and spreading sand. The cost for oiling only was 0.81 cents per square yard. Part of the reduction was due to the lower cost of oil, but about half was due to improved methods of handling.

The body of the motor truck was replaced by a 600-gallon tank, which the city had on hand, and the oil, which was delivered in tank scows, was pumped directly into the tank. By this means we were able to oil from four to five times the yardage covered in the same time by a team in 1913. The sand was delivered to the streets, rehandled with carts and spread by hand, but we found it difficult to keep pace with the oiling machine.

In 1915 the cost per square yard was 1.09 cents for carrying out the work as enumerated in 1914. The cost of oil was slightly lower and wages were reduced, but there was also an improvement in handling the sand. A hopper which feeds onto a rotating disk, as shown in Fig. No. 5, was made at the corporation machine shop and attached to the rear of a motor truck. The truck went direct to the bunkers for sand and thus saved double handling of the material. However, as the oil sprinkler covered a greater area than the sander, it was necessary to use carts to sand the balance of the yardage oiled in a day. It was found that the sanding machine spread the material more quickly and more uniformly than it could be done by hand and used less sand per square yard.

	Gasoline	Oils, Grease, Waste, etc.	Tubes and Tires	Batteries	General Repairs	Labor (Pay Roll) Rep.	City Blacksmith Rep.	Wheel Chgs & Repairs	Magneto & Duplex Ignition System	Accessories Inc. 1916 License Fee	Sand Sprinkling Attachment	Oil Sprinkling Attachment	Totals
"Velie"	$238.85	$60.30	$278.42	$21.44	$110.77	$71.75	$307.45	......	$102.45	$51.27	......	......	$1,242.70
"Peerless" ...	266.06	85.75	435.00	26.35	144.43	74.55	261.10	......	......	147.82	......	$9.75	1,450.81
"Commer" ...	233.70	18.40	631.25	......	111.57	129.85	171.90	$38.70	......	23.55	$12.65	......	1,371.57
Totals	$738.61	$164.45	$1,344.67	$47.79	$366.77	$276.15	$740.45	$38.70	$102.45	$222.64	$12.65	$9.75	$4,065.08

	Date of Purchase	Cost	Valuation January, 1914	Valuation January, 1915	Rentals Earned 1914	Rentals Earned 1915	Maintenance and Operation charges 1915
"Velie"	1913	$4,747.00	$4,000.00	$3,150.00	$2,052.00	$2,171.00	$1,242.70
"Peerless"	1913	4,500.00	3,750.00	3,000.00	2,388.75	2,149.50	1,450.81
"Commer"	1912	5,750.00	4,800.00	4,555.00	*1,600.00	2,381.90	1,371.57
Totals		$14,997.00	$12,550.00	$10,705.00	$6,040.75	$6,702.40	$4,065.08

*Approximate.

	Depreciation 1915, say 20%	Balance over and above Maintenance Operation and Depreciation charges 1915	Rental Rate per day 1914	Rental Rate per day 1915	Total Depreciation written off since purchase	Approx. Percentage of Depreciation written off
"Velie"	$630.00	$298.30	$8.00	Jany. to June $8.00 June to Nov. 10.00 December 8.00	$2,227.00	46.91
"Peerless"	600.00	98.69	17.50	See below. 8.00 12.00 13.50 15.00	2,100.00	46.66
"Commer"	911.00	99.33	17.50	Jan. to Nov. 13.50 December 12.00-15.00	2,106.00	36.62
Totals	$2,141.00	$496.32	$43.00	$35.00 Averaged $10.90 per day	$6,433.00 =	42.89

	No. of Days Worked 1915	Removal of Garbage Days	Removal of Garbage Rate	Removal of Garbage Days	Removal of Garbage Rate	Oiling Streets & Roads Days	Oiling Streets & Roads Rate	Oiling Streets & Roads Days	Oiling Streets & Roads Rate	Sand Sprinkling Days	Sand Sprinkling Rate	Hauling Straw, etc. for Stables Days	Hauling Straw, etc. for Stables Rate	General Hauling, Rock, etc. Days	General Hauling, Rock, etc. Rate	General Hauling, Rock, etc. Days	General Hauling, Rock, etc. Rate
"Velie" ...	245	139½	$8.00	105½	$10.00	.....	....	.....	....	.....	....	....	....	....	....	.....	....
"Peerless".	192⅞	66	8.00	30¼	10.00	9	$13.50	11	$15.00	1	$13.50	1⅜	$12.00	74¼	$13.50	.....	....
"Commer"	176⅞	.....	....	.....	....	.....	....	7	15.00	2¼	13.50	2⅛	12.00	156½	13.50	9	$12.00
Totals...	614¾	205½	....	135¾	....	9	....	18	....	3¼	....	3½	....	230¾	....	9	..
		341¼				27								239¾			

Fig. 3.—Report of Motor Trucks for Year 1915.

Next year it is proposed to lay out the entire work before commencing operations, so that where possible a day's work will be divided between macadam streets which have already been oiled, and which will therefore require less oil and more sand per square yard; and the newly resurfaced and dust streets which will take more oil and less or no sand, so that the sander can cover as much as possible of the yardage oiled in a day and thus eliminate carts. This will make a further reduction in cost. As the city oils an average of 600,000 square yards per annum the importance of even a small reduction in cost per square yard is apparent.

The sander is also used for spreading sand on the paved streets when they become slippery. This has not only greatly reduced the cost of handling, but the work can be done much more rapidly and the material spread more uniformly.

The city recently completed the northwest trunk sewer by day labor. The estimated cost of this work, as prepared by the engineers of the three interested municipalities, was $365,300. The work took two and a half years to complete, and involved the construction of about one and a half miles of tunnel in solid rock at an average depth of 44 feet below the surface; the laying of a 36-inch

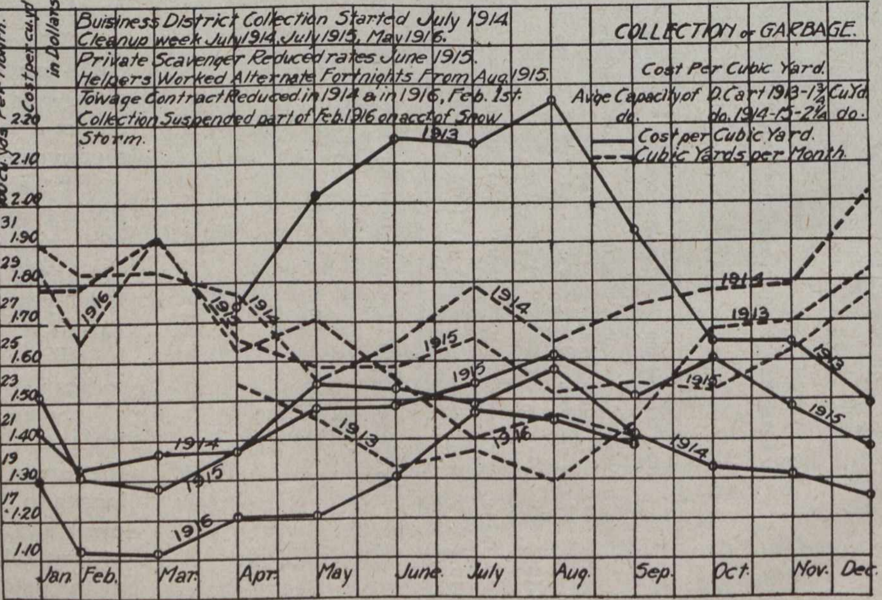

Fig. 4.

steel pipe for an outfall, and the carrying of an inverted syphon under Selkirk water.

Largely through the interest created by the weekly cost data reports, the cost of the work was steadily reduced until during the last three months the labor cost per lineal foot was about 35 per cent. less than it was during the first three months, and the foremen themselves were surprised at the reduction in cost they were able to make, and at the low cost of work towards the close.

On account of the exposed location of the outfall it was first thought advisable to do this particular work by contract. However, it was carried out with city forces

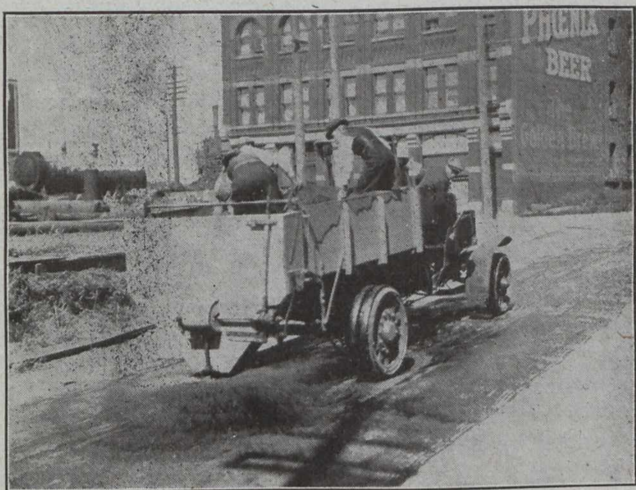

Fig. 5.

and completed for less than half the price submitted by tender, and the entire work of constructing the sewer was completed for over $75,000 less than the estimate.

Concrete sidewalks are being constructed for about 30 per cent. less than they were costing in 1911 and 1912.

Sheet asphalt was laid in 1915 with the corporation plant for 20 per cent. less than the price paid the contractor in 1914, due allowance being made for overhead expenses, plant maintenance and depreciation, and maintenance of pavement.

The curves in Fig. No. 4 show the steady reduction that has been made in the cost of collection and disposal of garbage.

For the month of September, 1916, this amounted to 35 per cent. less than for the same month in 1913, a difference of over $1,000 for September alone.

Foreman's Daily Segregation of Wages Expenditure.

Foreman, J. McInnes. Date, 12th September, 1916

Sewer Loan, 1913. N.E. Branch.
Finlayson Street, Douglas—Quadra.

Location and Description of Work				Amount
Rock Excavating	0 Men	@ —	per 8 hour day	—
Dirt Excavating	4 ,,	@ 2.75	,,	$11.00
Hardpan Excavating	0 ,,	@ —	,,	—
Pipelaying	1½ ,,	@ 2.75	,,	4.10
Backfill	2½ ,,	@ 2.75	,,	6.90
Building Manholes	0½ ,,	@ 2.75	,,	1.35
B. Smithing	0 ,,	@ —	,,	—
Concreting Base for Pipe	0½ ,,	@ 2.75	,,	5.40
Concreting	1 ,,	@ 4.00		
Total	10 Men			$28.75

The writer, in closing, does not wish to leave the impression that the above results are *entirely* attributable to the keeping of detail cost data. Other factors are responsible, probably the most important of which is the engineer's ability to select good assistants, and his capacity for managing men. But a large share of the success is due to the interest created by the keeping of cost data, and to the valuable information it has furnished to all connected with the work; and it is only necessary to refer again to the amount of money spent annually, and to the percentage that the cost has been reduced, to realize what has been accomplished.

THE RELATION BETWEEN PERPETUAL-INVENTORY VALUE AND APPRAISAL VALUE.*

By Charles Piez, Chicago, Ill.

MOST plants grow from small beginnings, and during their early life expand as the needs dictate. The organization is necessarily small because the most rigid economy must be practiced, and original costs and the costs of additions are frequently so completely submerged in the total assets that no safe records of these costs can be established. Many plants never outgrow this lump-sum treatment of assets. In these cases depreciation of plant and equipment is either wholly disregarded, or else an arbitrary amount is charged against profits, the amount of depreciation varying inversely as the size of the profit it is desired to show.

Industries so managed need the assistance of a competent appraisal company to inform them of the value of their assets, as a basis for embarking on a sounder and safer system of accounting methods. Practically all successful industries so maintain their inventories that additions to the plant are accurately recorded, and depreciation is based on judgment and experience. But even such industries will find it to their advantage to ask the aid of appraisal companies for the purpose of determining authoritative records of the cost of reproducing plant and equipment, so that underinsurance or overinsurance may be avoided, and the basis for the requirements of co-insurance complied with.

Appraisals are also valuable in establishing comparative values of plants that are about to merge, or in serving as a basis of a scheme of financing. But the claims that an appraisal is necessary for figuring overhead costs and the selling price and profit of manufactured articles are, to say the least, sadly overdrawn.

It has been my experience that in well-managed industries appraisal values are usually considerably above sound inventory values established by the management. With the steady advance in prices that has been going on almost continually for the last twenty-five years, it is but reasonable to suppose that replacement values are substantially higher than initial costs, and it is well to establish the amount of such excess if a proper insurance coverage be desired; but such advance is wholly speculative and has absolutely no bearing on the value of the plant from the standpoint of the operating and sales management.

The establishment of true costs is an essential element in the success of a business, and true costs can only be

*Abstract of paper presented before the Annual Meeting of American Society of Mechanical Engineers, Dec. 5-8, 1916.

obtained when every item of expense is included. Buildings that were adequate when first erected gradually outgrow their initial advantages, and in spite of substantial increases shown in the appraisal value, they have less value for the purposes to which they are put than they had when first constructed. They may, in fact, prove so unsuitable to the increasing needs of the business as to justify demolition and reconstruction.

Few owners foresee their needs for ten years to come, and fewer still have the means to build or expand along lines giving ample opportunity for future business growth. It is safer, therefore, to provide proper sinking funds through an ample rate of depreciation for use in reconstructing buildings that have outlived their usefulness.

Machine tools have changed very considerably as a result of the development of high-speed steels, and companies that followed appraisal methods of depreciation find themselves with obsolete equipment and no funds to replace it with modern equipment.

Patterns and small-tool equipment often have but temporary value and should disappear wholly from the inventory when they have served their purpose, yet these two items are fertile sources for inflation of values through appraisals.

What the management of an industry is chiefly concerned in is to provide a fund through a proper scale of depreciation which will reimburse it for the difference between the cost price of a piece of equipment and its fair cash selling price when sold either because it is ready for the scrap heap or because some newer form or method has made a change desirable. This difference is properly a part of the cost of the product, but becomes so only by charging depreciation against the expenses of operation.

Has any appraisal company ever investigated the subject of depreciation from the operating standpoint and recommended a schedule of depreciation for adoption? Has any appraisal company ever advocated that depreciation be distributed as an operating expense against the product? Can any appraisal company claim with any justice that it can determine proper rates of depreciation without close contact with and full knowledge of the operating conditions and operating needs of an industry? Certainly without such contact and without such knowledge the claim that successive appraisals are essential factors in the determination of costs, prices and profits, is, to say the least, pure buncombe. The primary business of an appraisal company is to determine an authoritative replacement value, and its entire organization is trained for this purpose. But when the appraisers enter the field of depreciation, operating values, and costs, they are doing their clients positive harm; for appraisals, as previously explained, have a distinct upward tendency, and the increase in value which they show as the result of wholly extraneous conditions have the effect of lulling the manufacturer into a wrong sense of financial security.

The great majority of industries charge off too little for depreciation rather than too much, and the appraisal companies, if anything, are assisting, unconsciously, of course, in increasing this unprofitable and ofttimes disastrous habit.

I had occasion recently to go over the financial statements of a manufacturing plant which had delegated the important function of depreciation to an appraisal company. The amount charged off annually was less than one-half of the proper amount, this being due, the owner said, to the constant and considerable advance in the replacement value of the property. Here was a typical case of reducing the operating burden of a plant by crediting it with a wholly speculative and unrealizable increase in property value. In this case the appraisal company specified the amount to be depreciated each year, and was therefore responsible for this wholly unsound and unscientific procedure. The owner is about to build a new plant, and I take no chances in prophesying that he has some bitter disappointments awaiting him in unforeseen shrinkages of assets when he abandons the old plant.

The problem of determining an adequate scale of depreciation is by no means a simple one, and it goes hand in hand with the problem of distributing depreciation against the cost of the product. It is astonishing to find how widely the practice among different manufacturers in the same line varies.

Largely as a result of the recommendations made by the Federal Trade Commission that the cost-accounting systems of various lines of industry be standardized, the manufacturers of conveyors and elevators have agreed on the standard schedule of rates of depreciation given herewith. The rates are but compromises growing out of the judgment and experience of the individual members of the manufacturers' conference, but their correctness can later be verified by matching the perpetual-inventory values which these rates will establish, against the actual experience of loss in cash value when equipment or buildings are discarded.

They establish, therefore, a broad basis upon which fair operating values and the shrinkage in these values, due to wear and tear and change in style, can be computed, and serve as the preliminary step to the equitable distribution of these shrinkages or depreciation in value over the cost of the product.

I recognize the value of the work done by the appraisal companies in establishing authoritative replacement values for purposes of insurance, for the purpose of comparing the physical values of various plants about to be purchased or merged, or as the foundation upon which a perpetual inventory kept by the industry itself can be based; but I am convinced that only a perpetual inventory providing for a sound schedule of depreciation, and intelligently handled by the management of the industry, is of value in determining the true cost of the product.

Standard Depreciation Rates Adopted by Manufacturers' Cost Conference, February 25, 1916.

	Per cent. on cost.	Per cent. on balance.
Buildings and accessories:		
Reinforced concrete or steel and tile..	2	3
Brick and steel with non-combustible roof and concrete floors	2.5	4
Brick, steel and wood	3	5
Brick and wood	3	5
Steel frame, wooden roof and corrugated iron walls	3.5	7
Steel frame, non-combustible roof and corrugated iron walls	3	6
Concrete block, with wooden roofs and floors	3.5	8
All wood structures, well built (20 years)	4.5	10
All wood structures, cheap (20 years).	5	12
Sprinkler system (20 years)	4	7.5
Heating and ventilating system (20 years)	4	7.5
Water and sewer piping and sanitary fixtures (where separate)	4	7.5

	Per cent. on cost.	Per cent. on balance.
Tanks and reservoirs, steel	4.5	10
Tanks and reservoirs, wood (10 years)	9	20
NOTE: All repairs and maintenance to be charged to account 8059.		
Machinery and large equipment:		
Boilers, pumps, feed-water heaters and air compressors	6	15
Power piping	6	15
Switchboards, main wiring and conduit	6	15
Engines and dynamos	5	10
Machinery, motors, machine tools, travelling cranes, etc.	4.5	10
Punch presses, bending rolls, power shears and drop hammers	4.5	10
Shafting, pulleys, hangers and belting	50	..
Machine tool accessories—boring bars, drivers, key-seating broaches, etc. . (All renewals to repairs).	50	..
Cupolas, converters, melting furnaces and accessories	5	10
Annealing and heating furnaces, ovens, forges, etc.	5	10
Motor trucks	20	60
Storage-battery locomotives (battery renewals to repairs)	10	30
Horses and wagons	12	35
Small tools:		
For machines, net additions	50	..
Hand tools, net additions	50	..
Punches and dies:		
(Standard) net additions	50	..
Chills, iron and steel flasks & accessories:		
Net additions	50	..
Fixtures, furniture and miscellaneous equipment:		
1 Steel shelving, lockers, etc.	5	12
2 Mechanical appliances, net additions	60	..
3 Departmental wiring and electric fixtures, net additions	60	..
4 Miscellaneous items (wood), net additions	70	..
Patterns (Standard):		
Metal, net additions	75	..
Wood, net additions	100	..
All patterns required for a particular order or contract to be charged to the job.		
Drawings:		
All new standard drawings to be charged to expense.		
All drawings required for a particular order or contract to be charged to the job.		
Miscellaneous real estate improvements:		
Pavements, sidewalks, fences, retaining walls, roadways, tracks, yard drainage, general conduits, tunnels, vaults, etc.	4.5	10

By cooling the parts with a water-jacket, Swedish electricians have perfected a high-amperage telephone transmitter that can be used for long-distance work and wireless telephony.

CANADIAN SOCIETY OF CIVIL ENGINEERS, TORONTO BRANCH.

The regular monthly meeting of the Toronto Branch of the Canadian Society of Civil Engineers will be held in the Chemistry and Mining Building, University of Toronto, on Friday, December 15th, 1916, at 8 o'clock.

Mr. S. W. Traylor, mechanical and mining engineer, of Allentown, Pa., will address the meeting on "The Uses and Application of Cement Mortars." The address will be illustrated by means of moving picture films and lantern slides.

CANADIAN SOCIETY OF CIVIL ENGINEERS, CALGARY BRANCH.

The fourth annual general meeting of the Calgary Branch, Canadian Society of Civil Engineers, was held on Saturday, December 2nd, and a representative gathering was present.

A canvass of the ballots for the election of officers for the ensuing year gave the following results: Chairman, A Scott Dawson; secretary-treasurer, Sam. G. Porter; executive committee, Past Chairman Wm. Pearce and F. H. Peters; ex-officio, C. M. Arnold, Capt. H. Sidenius, M. H. Marshall; Auditors, J. S. Tempest, S. K. Pearce.

The programme of meetings for the season is only partially completed. Capt. H. Sidenius, Headquarters staff, Military District No. 13, will speak on "Military Engineering and Trench Warfare" at the December meeting. At the January meeting a joint paper will be presented by G. W. Craig, city engineer, and J. F. Green, bridge engineer for the city of Calgary, on the new Centre Street Bridge, Calgary. This is a reinforced concrete arch bridge, just being completed at a cost of about $375,000. The address will be illustrated with lantern slides.

COMING MEETINGS.

SOCIETY OF AMERICAN BACTERIOLOGISTS. Annual meeting, New Haven, Conn., December 26-28. Secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

OKLAHOMA SOCIETY OF ENGINEERS. Annual meeting in Tulsa, December 27-28. Secretary, H. G. Hinckley, Oklahoma City.

AMERICAN STATISTICAL ASSOCIATION. Annual meeting, Columbus, O., December 27-30. Secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION. Fourth annual meeting in New York City, January 15, 1917. Secretary, O. S. King, 120 Broadway, New York.

VIRGINIA ROAD BUILDERS' ASSOCIATION. Sixth annual meeting, Norfolk, Va., January 16-18, 1917. Secretary, C. B. Scott, Richmond, Va.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting at Society House, New York City, January 17-18, 1917. Secretary, Charles Warren Hunt, New York.

WESTERN PAVING BRICK MANUFACTURERS' ASSOCIATION, Kansas City, Mo., January 20th, 1917. Secretary, G. W. Thurston, 416 Dwight Bldg., Kansas City, Mo.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION. Convention at the Royal Connaught Hotel, Hamilton, Ont., January 23rd-25th, 1917.

FINANCING OF COUNTY ROAD SYSTEMS.

In a pamphlet recently issued as an appendix to the annual report of the Department of Public Highways of Ontario, there appears a very interesting and instructive table showing how, by the imposition of one mill or one and a half mills on the county assessment, many counties in the province of Ontario would be able to finance road construction. In order to make the financing practicable this tax might be supplemented by the issue of debentures to cover the cost of bridges, special grading or other permanent work. Below is given a schedule which indicates how this would apply in the case of counties which have not as yet adopted the system of county road construction.

Explanation of Schedule.

Column 1 gives the name of each county of the province which has not a system of county roads.

Column 2 suggests a suitable road mileage for a county system.

Column 3 gives the amount which would be raised annually on the county assessment by a special county road rate of 1½ mills. A rate of one mill would in many cases give a very sound basis of finance.

Column 4 suggests a sum to be contributed annually from a debenture issue, to supplement the amount produced by the special road rate.

Column 5 is the sum of the amounts in columns 3 and 4 and represents the total to be raised by the county annually by a special rate and small issue of debentures.

Column 6 is the amount of provincial subsidy earned by the county contribution given in column 5.

Column 7 gives the sum of the amounts in columns 5 and 6, and shows the total amount available for expenditure annually for county roads.

Thus in the case of Brant, 100 miles is suggested as a reasonable county road system. A county rate of 1½ mills would produce $19,500 annually. This might be supplemented from a debenture issue to the extent of $10,500, making a total county contribution of $30,000. Adding the proportionate provincial subsidy for construction ($20,000) the county would be able to spend $50,000 annually.

County.	Suggested mileage of county roads.	Amount annually produced by county road rate of 1½ mills.	Suggested annual debenture issue.	Total raised by the county annually, 60%.	Provincial subsidy, 40%.	Total annual expenditure available.
Brant	100	$19,500	$10,500	$30,000	$20,000	$50,000
Bruce	330	42,000	......	42,000	28,000	70,000
Dufferin	140	16,500	7,500	24,000	16,000	40,000
Dundas, Stormont & Glengarry	322	37,500	7,500	45,000	30,000	75,000
Elgin	230	33,000	9,000	42,000	28,000	70,000
Grey	415	48,000	......	48,000	32,000	80,000
Huron	330	60,000	......	60,000	40,000	100,000
Kent	285	40,500	4,500	45,000	30,000	75,000
Lambton	285	37,500	7,500	45,000	30,000	75,000
Norfolk	180	22,500	7,500	30,000	20,000	50,000
Northumberland & Durham	375	42,000	......	42,000	28,000	70,000
Ontario	240	34,500	7,500	42,000	28,000	70,000
Peterborough	140	13,500	10,500	34,000	16,000	50,000
Prescott & Russell	190	24,750	5,250	30,000	20,000	50,000
Renfrew	125	24,000	6,000	30,000	20,000	50,000
Victoria	166	21,000	9,000	30,000	20,000	50,000

IMPORTANCE OF WATER POWERS.

The rapid development in the uses of hydro-electric energy clearly indicates that, in the immediate future, the industrial progress of Canada will involve and depend largely upon the utilization of our hydraulic resources. The many points of superiority which electricity has as a source of heat are not always properly appreciated. With the possible exception of its higher cost, electricity has advantages over all known fuels. Electric energy may be transformed directly into heat energy at one hundred per cent. efficiency. Its use presents no such difficult problems as are inherent in the utilization of fuel. It does not vitiate the atmosphere. It is clean, safe and sanitary. Greater quantities and more intense heat can be produced in a given space electrically than by any other means. It produces heat directly where it is to be applied. It can be measured and controlled, both as to temperature and quantity, more readily than can any other form of heat energy.

The electric furnace is now being used in numerous and varied industrial processes. Its application has made it possible to manufacture substances that would otherwise not be available for commercial purposes, if combustion methods were the sole means of production. Such well-known substances as carborundum, aluminum, and calcium carbide can only be manufactured in the electric furnace. As the rapidly depleting natural nitrate deposits become exhausted, increasing supplies of nitrogen for soil fertilization will be drawn from the air by means of the electric furnace.

In addition to the processes mentioned, many special applications of the electric furnace are in practical use. These include the production of ferro-alloys, melting and refining of steel and in many electro-chemical industries.

While not so apparent as in the case of the special processes using large quantities of electric energy, the use of electric heat also plays an important part in the manufacture of many other products and some 35 or 40 industries could be enumerated where it has become extensively used in such applications as electric welding, melting tanks, soldering devices, oil tempering baths, annealing furnaces, and various types of self-heated tools. —L.G.D. in "Conservation."

HIGH-TENSION TRANSMISSION LINES AND STEEL TOWERS.

By Lesslie R. Thomson, B.A.Sc.,
Dominion Bridge Co., Montreal.

(Continued from last week's issue.)

Poles.—The distinction between poles and towers may be clearly drawn in a few words:—

A pole is a steel or iron structure whose ratio of base width at ground level to height is small. This ratio is usually in the neighborhood of 1:10 or smaller. A secondary distinction may be drawn from the base support which is nearly always monolithic and consequently acts as a unit in supporting the load.

By a tower is meant a light fabricated steel structure in which the distance at ground level between main upright supports in any one direction is large compared with the height of the structure. A usual value for this ratio is ¼.

The design of steel transmission poles has crystallized into a 3 or 4 latticed angle type with a triangular or square base respectively back to back angles about 1/12 of the height to the first of the conductors. These are set on pin insulators vertically over one another at about 6-ft. centres for 66 kv., and a ground wire is located at the same distance above the uppermost conductor. Frequently the sides of the pole are slightly tapered toward the top, where the distance back to back of angles is about 1/24 the height from ground to first conductor. Horizontal bracing is usually placed in these poles at about ⅓ points to aid in resisting torsional loading. The pole is set into a concrete foundation for about 6 or 7 feet while the enclosed space between the main leg angles above the foundation is frequently filled with concrete for a height of about 5 or 6 ft. By selecting comparatively short spans the sag may be reduced to very small quantities and hence the height from ground to first conductor may be kept down.

Towers.—*General Hints in Design*: Designs for towers have not absolutely crystallized as yet, but for rigid towers two main types are emerging, from the mass of all sorts of odd designs that have from time to time appeared. For the want of better terms they may be described as the braced A frame and the windmill types. The latter are the more frequent, especially for the longer spans which necessitate higher towers. Fig. 1 is an "A" type and Fig. 2 is a windmill tower.

In designing a tower the spans should first be approximately determined, and the classification of the tower selected on the type of service required. The various loads are then figured—dead, ice, wind and breaking. The grouping of the wires is usually determined from electrical considerations, and with a knowledge of maximum sag for a span, the heights of each wire may be determined from ground elevation. The outline of the tower and cross-arms may be then sketched in as a trial. Every effort should be made to have the stress lines as direct as possible. The tower shown in Fig. 1 exemplifies this principle very well. This is a line diagram of the standard tower for the Central Colorada Power Co. It will be noted that any load, in any direction whatever, imparted to the tower at the insulator supports, is conveyed to the ground in tension and compression by the four main legs, and in tension by some of the main diagonals. The great directness of the straight line stress route is very desirable. It obviates the customary crossing back and forward by alternate diagonals and struts, which inevitably tends toward loose joints in a light, bolted structure like a transmission tower. Another result is to reduce the detail weight in connections, etc., because main stresses are not being carried into the strut bracing.

In addition to usual vertical bracing designed to withstand longitudinal or transverse displacement of the top, or to stiffen the main legs, when subject to such stresses, bracing in a horizontal plane should be put in to resist warping from torsional loading.

"Flexible" towers, first suggested by the Italian Engineer Smenza, are constructed to be rigid in a direction transverse to the line, and of course against vertical loads. These then become very effective supports for the line against the vertical dead load of conductors, ice, snow, etc., and also against wind. But by their design they are quite flexible in a longitudinal direction. A distinct saving is thus effected in the weight of these towers by the absence of any longitudinal bracing. As mentioned elsewhere, the tie fastening the conductors to these flexible towers is usually designed to give way under even a comparatively small longitudinal pull and this obviates the chance of complete destruction of the tower by broken cables.

In designing a transmission line with flexible towers the engineer uses one or more of them consecutively—the

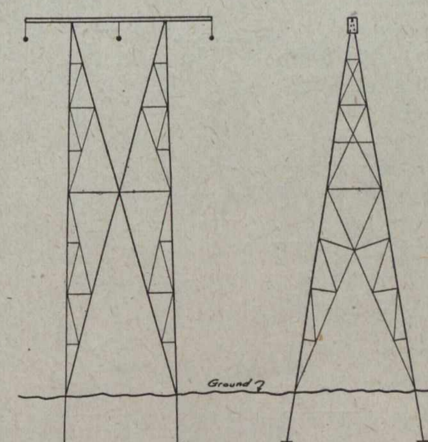

Fig. 1.

number depending on span length selected, configuration of the ground, etc., and then one dead-end tower where all conductors are firmly anchored. R. Fleming, in his paper, calls attention to a point frequently overlooked when comparing cost of transmission line with flexible towers with those having rigid towers. He says:—

"If flexible towers are used either heavier wire or higher towers are required. With the rigid type, if a wire breaks, the tower at each end will take up the unbalanced loading. In the flexible type, say, with three line conductors and a ground wire, if a wire breaks the tops of the towers on either side of the break will be pulled over by the four cables in the next span until the total tension in them would be just balanced by that in the remaining conductors of the damaged span. That is, the three cables remaining would do the work of the four in the adjoining spans showing the need of the heavier wire. Of course, this unbalanced loading can be taken up by a greater sag and less tension in the cables, but this necessitates higher towers to maintain the required clearance underneath the wire."

It may be pointed out, however, that the above argument depends for its force on the assumption that the tie between cable and tower is solid. If this is designed to give way under even a small load then the only effect of one conductor breaking is to sever the tie, and the broken cable sags until its friction on the top of the tower is the only longitudinal drag it exerts.

One of the best-known examples of flexible towers in Canada is to be found in the municipal transmission line between Winnipeg and Point du Bois, Man. In this case the engineers, Smith, Kerry & Chace, have placed rigid and flexible towers alternately at about 600-ft. centres. The tie to each insulator on these towers is only good for 80 to 100 lbs. before it fails.*

It is generally admitted, however, that flexible towers are not quite so reliable as the braced; and it is just a question as to how far their increased economy offsets their decreased reliability.

Cross-arms: The cross-arms for pin insulators must be very carefully designed owing to the heavy torsional stresses developed in them by the height of the insulator pins. Cross-arms for suspended insulators, on the other hand, have these loads applied almost directly on the arm. Cross-arms should always be designed for about 1,200 lbs. suspended at each extremity for one or two repair men at any time may have to be at the very end of the arm.

Ladders: A step-bolt ladder should always be provided ascending one leg of the tower. It is frequently

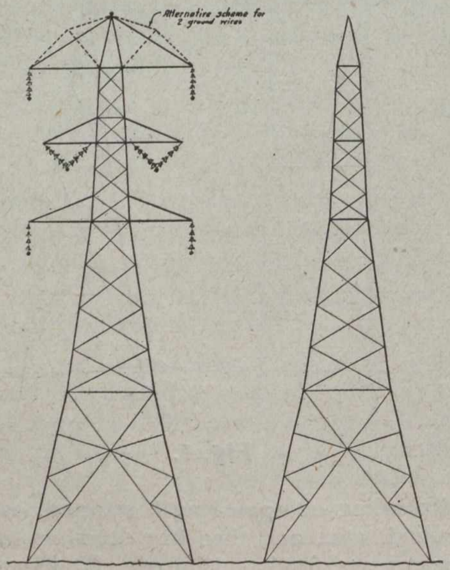

Fig. 2.

required that after passing the first cross-arm, ladders shall be provided on two legs to the top in order to allow use of either corner as a route from lowest cross-arm to top of tower.

Foundations: The foundations of the towers are in the main of two kinds:—

(1) Steel with anchor or bearing piece.

(2) Concrete.

The simplest steel foundation is the single stub angle in which each leg of the tower is supported by a small angle let into the ground.

(1) The stubs consist of comparatively short pieces of angle with holes punched in each leg at the tops. These holes match the holes punched in the bottom of the main tower legs. On the other end of the stub angles there are riveted or bolted bearing devices of one kind or another. These usually consist of a piece of 8-in. or 10-in. about 2 ft. or 2 ft. 6 ins. long, two angles about the same length or old pieces of I-beams, etc. In practice these foundations are set as follows:—

Four holes are dug at the proper centres and to the desired depth. Each stub angle with its bearing piece is set into the proper hole, care being taken that it rests on undisturbed earth. The foundations are then bolted to a large, full-sized template built to duplicate a standard tower. When bolted up in this way the earth and gravel are then backfilled and tamped into position. This style of foundation is fairly satisfactory except on hard rock, where some type of fox or wedge bolts should be grouted in with either cement or sulphur. The tops should be forged to fit the tower legs which are then bolted directly to them. Stub angle foundations are not suitable for marsh or swampy lands.

Steel foundations may also be of the steel tripod stub type, where each leg of the tower is supported by a complete tripod, to apex of which is fastened the main angle. The base of the tripod is made up of some simple bearing device in plates, angles or channels. The uplift capacity of the tripod type is about 50 per cent. greater than that of the single stub.

(2) Concrete foundations are becoming more used in recent years for the large towers supporting long spans. Their permanency and solidity also recommend them highly for the foundations of special dead-end and angle towers. These foundations are of the following types: (*a*) Mushroom without forms, or with steel or wooden forms; (*b*) truncated pyramid type to forms.

The mushroom type is usually constructed by digging post holes about 16 ins. in diameter and about 6 ft. 0 in. deep. The bottom section is then undercut for a depth of about 2 ft. and to a diameter of about 5 ft. 0 in., leaving in the upper part a parallel sided post hole for about 4 ft. Sometimes the spread of the bottom portion is made by dynamite instead of digging. In either case the stub angle or other type of steel foundation is set to template and the concrete is poured. Forms are often hard to set and hold in place owing to their tendency to lift when concrete is being placed.

Concrete foundations of type (*b*) are difficult and somewhat expensive because of the difficulty of setting the forms. This type is satisfactory in service, however, for swampy locations owing to the large spread that may be given to the base. The anchor bolts are usually set to template; before the concrete is poured. The tower legs for these foundations have, of course, small angle shoes to rest on the concrete and the anchor bolts pass through them. With all concrete foundations care must be taken to effectively ground the tower electrically by some standard device.

The whole question of tower foundations is one that bears a very important relation to the strength of four-legged towers, and it is highly probable that in the past many structures have failed owing to some small uplift of one foundation rather than to any inherent weakness in the structure itself. Every care should therefore be taken to insure rigidity against either uplift or sinking of any one of the foundations. Spread footings in concrete either of the mushroom type or of the truncated pyramid type would seem to be the foundation of the future, and the writer would recommend them for class "A" towers.

The method by which the main horizontal shear is transferred from tower to ground is one that has only recently been investigated. The usual way in the past

*See "Transactions Can.Soc.C.E., Vol. XXV., pt. 1," article by W. G. Chace on the "Municipal Hydro-Electric Works of the City of Winnipeg, at Point du Bois Falls."

has been to connect the lower diagonal to the main leg about 6 ins. or 1 ft. above the connection to the foundation. With this device all shear must be taken up by stub angles in both direct shear and bending. This introduces, of course, into the main legs entirely new stresses, with their consequent danger. J. B. Leeper in an article on this subject commends highly a modified stub angle foundation to which the lowest tower diagonal is attached at a point about 2 ft. below earth surface. In this way the horizontal shear is applied to the foundation at a point below ground level, where the surrounding earth may resist it without setting up any bending stresses.

Erection: The field splices should be designed to afford easy shipment for the tower sections. Very often erection must take place in localities remote from the railway and sometimes there is not even a wagon road to the tower sites. Consequently the pieces have to be transported by pack horse or mule. Under these circumstances any thought given to the layout of field splices and weight of shipping bundles is amply justified. Bundles of main material should not weigh more than 200 to 250 lbs. All bolts, nuts and washers should be boxed by themselves and carefully marked.

In the field all pieces are assembled and bolted together on the ground and the tower raised as a unit by some simple tackle, *e.g.*, a gin pole.

Preservatives: As mentioned under "Depreciation," the two main methods of preserving towers are galvanizing and painting. The cost of the former is quite high and though it is assumed nominally that no upkeep is required, the danger from unforeseen deterioration is very real. If, however, the towers are to be subject to rigid inspection from time to time, and provision is made in foundations for either permanency or ability to frequently renew them, there is no reasonable doubt that a heavily galvanized skin is a substantial and almost permanent preservative. The galvanizing should be done on all material except bolts, nuts, etc., after all shop work is completed. All bolts and nuts should be sherardized after the threads are cut. Paint is very much cheaper than galvanizing but has the objection that it must be frequently renewed. But this can, of course, be done in the field, while regalvanizing is always a shop process.

The writer would recommend the adoption of paint as the better preservative for all transmission poles and towers, with the possible exception of those located in regions of difficult access, such as mountainous country. In support of this recommendation the following comparative annual costs of galvanizing and painting a standard latticed pole are submitted:—

Assume a pole to weigh 2,000 lbs.

Assume its life to be 60 years if well galvanized.

Assume galvanizing to cost 1 cent per pound.

Capital cost to galvanize 1 pole is $20.

Annual cost is: Interest @ 6%, $1.20; Depreciation, 33 cts.; total annual cost of galvanizing pole, $1.54.

For painting, assume ⅓ of a gallon per coat per ton of steel. Capital expenditure for three coats @ $1.50 per gallon is $1.50; capital expenditure for labor and overhead in applying, $10; total, $11.50.

Assume that at the end of 6 years one coat of paint and labor on it has been lost: Material, 50 cts.; labor, $3.10; total $3.60; making an annual depreciation of 60 cents. Annual cost of painting is then: Interest, 69 cts.; depreciation, 60 cts.; total, $1.29.

In the above rather rough figures every advantage has been given to the galvanizing, but the superiority of the paint is apparent, especially when the figures give no indication of the greater reliability of the latter.

For towers of class A the following painting is recommended:—

Priming coat of red lead and then two coats of superior graphite paint, each being allowed to dry thoroughly before the next is applied.

For classes B and C the following painting would be considered satisfactory:—

Priming coat of good red oxide followed by one coat of red oxide after erection.

Limits in Design: The following structural limits in design are recommended without comment:—

For class A towers—No main material less than 5/16 in. thick. No angle leg in a main member to have a greater width than 12 times its thickness. No conductor to be able to come closer than 2 ft. 6 ins. to tower except insulator pin and cross-arm. (Up to 100,000 volts.) No bracing member less than 2½ x 2¼ angle. No bracing material thinner than ¼ in.

Class B towers—No main material less than ¼ in. thick. No main angle ratio less than 1/12. No bracing material less than 3/16. No conductor to be able to come closer than 2 ft. 6 in. to tower except insulator pin and cross-arm. (Up to 100,000 volts.)

Class C towers—No main material less than 3/16. No main angle ratio less than 1/12. No bracing material less than ⅛. No conductor to be able to come closer than 2 ft. 6 in. to tower except insulator pin and cross-arm. (Up to 100,000 volts.)

It is distinctly understood that the writer only recommends towers of class C for adoption under those circumstances that unquestionably necessitate the placing of the project into that class.

The suggested unit stresses, limits in design, etc., for class C are merely to offer a slight guide to obtain towers that shall be as serviceable as possible under very adverse conditions.

CONCRETE CONSTRUCTION IN WINTER.

THE following article which appeared in "The Contractor," is of timely interest inasmuch as many contractors are now considering the advisability or inadvisability of closing down for the winter. This article gives such valuable hints that contractors should read it carefully. If winter concrete work were perhaps more carefully carried out engineers would permit more of such work to be done.

A few years ago, when the snows of winter began to fly, engineers insisted that most concrete construction should be stopped until spring. This made it extremely awkward and expensive to contractors, who found that their organizations became broken up, and that large supplies of materials on hand had to be paid for months before they were used. Plant, too, remained idle, frequently being exposed to the weather, causing injury to it.

To-day most engineers agree that, with the proper safeguards, a large per cent. of all concrete construction can go on with but little interruption during the entire winter. Every contractor should know of these precautions and the extra expense entailed and, for their own interests, should take these precautions and assist in spreading such information in order to educate such engineers as have not looked into the matter, and the public.

The procedure of laying concrete in winter is simple and invokes but two principles: first, heating the materials, and second, protecting the concrete from freezing after it is placed, for a period long enough to allow the concrete to thoroughly harden.

Concrete is not ruined in most cases by being frozen, provided when it thaws out, it hardens before again being subjected to a freeze. But concrete that is permitted to alternately freeze and thaw for a number of times, is likely to be injured and may have to be replaced.

Heat hastens the hardening of concrete while cold retards it. In fact, concrete is slow to harden when the thermometer drops below 50 degrees Fahrenheit. Colder temperatures make the process of hardening much slower. At about 32 degrees the concrete will freeze unless properly protected.

Work done underground, such as deep foundations, is not apt to freeze at a temperature as low as 26 degrees, if the materials are not already frozen when used.

Salt in water lowers the freezing point; consequently it has often been used, but inasmuch as the water will still freeze if the temperature is low enough, and too much salt will cause chemical changes in the cement, causing the concrete to be injured, salt must be used with great care. Inasmuch as the water used must be heated, it is the part of wisdom to do away with the use of salt in the water and use heated water exclusively.

A word of warning as to heating. Baking and cooking materials at a high temperature is not only expensive, but likely to injure them. Many sands and some stone and gravel are injured by excessive heating, causing them to disintegrate. Thus some care should be exercised in heating.

Cement need not be heated if all the other ingredients are, for its bulk is small as compared to an entire batch.

The need of heating the sand, aggregates and water must depend upon the temperature, consequently a reliable thermometer should be kept on the job and records kept on a form prepared for the purpose, showing the temperature at different periods during the day. This means that not only the mixing will be done properly, but also that for a period of a week the proper setting and hardening of the concrete can be watched and freezing guarded against.

First of all, snow and ice should not be allowed in any of the ingredients, even if the weather is melting it rapidly. See that not only all the snow and ice is melted, but also the chill is taken off of the material before it is used.

Materials or water should never be heated to a temperature of over 150 degrees Fahrenheit. Twenty-five degrees less than this is generally ample if other precautions are taken. Such a temperature means that the materials will be at a temperature of 75 or 80 degrees when being mixed and placed—about the temperature of ordinary summer weather.

To insure this temperature it is first necessary that the chill and frost be taken from the mixer itself and also from the forms, especially if metal forms be used. It is also necessary that barrows and other tools be heated enough to keep them from lowering the temperature of the ingredients.

With the concrete being mixed at such a temperature it becomes a much easier matter to keep the concrete in the finished structure warm enough to harden without freezing, but this is just as important as heating the ingredients. In some cases the concrete structure need only to be covered in some manner to protect it, while in other cases it must be covered and kept heated for some days.

The method of heating sand, gravel or crushed stone may depend upon the amount of materials to be used, the method of handling the materials on the job and how the materials are received. For instance, if the materials are received on freight cars and handled directly to the mixer, it is much easier to heat the materials in the cars than after unloading, especially if steam is used for heating.

The method is simple. A steam pipe can be laid down alongside of the car track and hose connections taken from it to run steam into the car. On the end of the hose small pieces of pipe are placed so as to run the steam down to the bottom of the car.

Holes can be cut in the sides of the pipes, but this is not necessary; in fact, in the writer's opinion, is not as efficient as having the pipe without holes and thrusting it down well to the bottom of the car, for then the steam to escape must work its way up through the mass to the top, taking a little more time, but doing its work more efficiently.

It is possible to make the pipe in shape of a U or even give it three or four prongs set several feet apart, thus covering a larger area at one time, causing the materials to heat faster.

Material in piles that are not too high can be heated in the same manner, but inasmuch as escaping steam means an expensive fuel consumption, it is better under some circumstances to use other methods. Thus a few steam pipes can be placed on the ground and covered with metal plates. This arrangement will do to heat long, low, narrow piles to excellent advantage.

One advantage of heating materials in piles is that the heating arrangements need not be changed; the piles are simply renewed. For this reason, where a large amount of material is to be heated, it may be economical to place coils of pipe under the materials. If the pipes in the coils are not placed too close to one another a larger area can be covered with a limited number of pipes.

Material once heated should be covered until used. This can be done with tarpaulins, the edges being thrown back when it is desired to use some of the material.

For small amounts of material there are a number of methods of heating. A stove arrangement or drier can be used, especially designed for such work. Sand is frequently heated in this manner.

Sheet iron cylinders, old smoke stacks, iron culvert pipe and similar things can be used to heat concrete materials. The fire is built in the cylinder and the materials piled around and over it. Another method is to build a fire box of brick, concrete block or other material and cover with sheet iron plates, heating the materials on the plates. Other contrivances will suggest themselves to the ingenious contractor.

Even when materials have not been heated it is expedient to cover the piles with tarpaulins preventing rain and snow from getting on the piles, causing more heat to be used.

Water in limited amounts can be heated in tanks or kettles with a fire under them, or even in barrels by means of a steam jet. For large jobs steam is nearly always used, though water heating machines are now manufactured and are coming into extensive use, being more satisfactory than home-made equipment.

When steam is used it can be either live steam direct from a boiler or exhaust steam. Naturally water will be heated quicker and to a higher temperature by live steam than from an exhaust pipe, but the cost is much greater.

For a limited amount of water, when the mixer is operated by steam, exhaust steam may prove satisfactory.

A mixer and wheelbarrows, with other tools, can be heated by wood fires built under them, but a better method, not so liable to injure them, is by using a jet of live steam. Wooden forms need not be warmed, but metal forms must be heated in extremely cold weather and this can be done by steam.

As already stated, the protection of the concrete in place is as important as the heating of the materials. In fact it is sometimes possible to mix concrete at such a temperature that the materials may not freeze, yet the night after the concrete is placed it may be cold enough to freeze the entire mass, showing that this freezing must be prevented. With the materials warm, the freezing is retarded, but heating and the proper protection will maintain the heat longer.

For protection only, canvas and other materials can be used. Thus for underground structures the concrete can be covered with hay or straw, a few boards or other weights being placed on it to prevent the wind from blowing the light straw or hay away. Near the coast, salt marsh hay is often used, because it can be bought much cheaper than other hay or straw.

Unless the structure is a deep foundation or a large underground piece of work, such as a subway, it is generally necessary to heat the structure, in addition to covering the concrete. For this purpose salamanders or stoves can be used. It is also possible to use oil-burning devices and steam coils, but steam should never be used directly on the concrete.

The protecting and housing must be done with care. Boards can be used but canvas seems to be the most economical and efficient, as there are no cracks for the hot air to escape through.

For a tall structure, as the concrete hardens, the covers can be moved up over the fresh concrete, but in a building where there are concrete floors and a roof, the under surface must be kept heated and protected as well as the upper surface. In fact, any structure that has a large area of surface as compared to the volume, must have extra precautions taken to protect it from freezing.

Manure should not be used to protect concrete, for it is very likely to stain the work, as does salt in the water, and also may injure the surface or the entire mass of a thin slab. Manure can be placed over a canvas covering, but even this cannot be recommended. At the best there is no special merit in manure unless it is used in such large quantities to cause fermentation or rotting in order to generate heat.

Concrete culverts, pipe lines or pipes can be covered with canvas and even so small a thing as a lantern will furnish enough heat to keep the concrete warm.

In cold weather, forms should not be stripped from the concrete as quickly as in warm weather. There must be certain hardening even before some of the forms are taken down, and for floors and roofs some supports should be left under them for at least twice the length of time as may be deemed necessary in warmer weather.

This is a "safety first" precaution as many structures have been ruined by removing the forms too quickly. The colder the weather when mixing and placing, the longer the supports should remain in place.

Another precaution to be taken in using concrete during the winter is not to mix in such large quantities that a part or all of the batch can become chilled or frozen before being placed. It is much safer to mix a smaller batch and be sure to prevent freezing.

All of these factors that govern concrete construction during the winter months should be understood by a contractor, so that he can guard against injury to the concrete and also that he may be able to estimate the extra cost that these things may mean and figure them into his bidding prices. Unless this is done his ordinary profits may be eaten up.

Another cost that must be included is that of protecting his men while working. This may mean the erecting of shelters and wind guards for the form builders as well as the men mixing and placing concrete. It may also be necessary to furnish a warm room or shanty where men can dry their clothes, change their garments, warm themselves and eat their lunches, keeping the latter near enough to a fire to prevent the food from freezing. To do efficient work men must be made comfortable.

Many owners, in order to have their construction work hurried, are willing to pay a little more, in order to have the jobs carried on during the winter. Thus the contractor is not injured, but is to some extent benefited for he is able to keep his organization together and prevent his plant from being idle.

THE ACTIVATED SLUDGE PROCESS.

IN the recently issued annual report of the Manchester (England) Rivers Committee the progress of the research work in connection with the activated sludge process of sewage treatment is referred to at some length. Information of considerable value has, it is stated, been gained from the operation of the large-scale experimental tank that has been installed.

With the requisite amount of activated sludge it has been possible under certain conditions to maintain the efficient purification of the sewage by an average aëration period of four hours.

The area of the tank in question is 400 sq. ft., and it has been filled usually to a depth of rather more than 8 ft. The average four-hour aëration period allowed the tank to receive three fillings per day. In general, the water level was lowered 6 ft. on discharging, and in this manner 45,000 gallons of screened sewage were treated per day, with the production of a high-class effluent, capable of passing the dissolved oxygen absorption test of not more than 2.0 parts oxygen absorbed per 100,000 after five days' incubation at 18 deg. Cent., the test suggested by the Royal Commission on Sewage Disposal.

The prolonged operation of this tank has demonstrated:—

(1) The advisability of filtering the air supply if diffusers are employed, particularly if it is liable to contain appreciable quantities of oil.

(2) The importance of adequate screening and detritus tank treatment of the sewage dealt with.

(3) That abnormal quantities of certain trade effluents interfere with the purification process, but that, generally speaking, the sludge fairly readily regains its activity if such discharges are not prolonged unduly.

(4) The possibility of effecting certain improvements in the design of the tank for securing economy in air expenditure, together with more efficient aëration and admixture of sewage and sludge.

The tank has now been reconstructed in the light of the experience gained during its previous operation, and has been re-equipped on the most up-to-date lines, with the view of ascertaining the minimum cost of the process under the best known conditions.

In order to investigate thoroughly the effects of certain trade effluents of an inhibitory character on the purification process, an experimental plant was brought into operation in July, 1915, at the Withington works, where a purely domestic sewage of less than average strength is received. For this purpose the 50-gallon casks in use at Davyhulme were transferred to the Withington works.

The aëration is effected through diffusers placed at the bottom of the casks, and means are adopted to obtain satisfactory circulation of the sewage and sludge.

The preliminary results obtained during the building-up of the activated sludge were so remarkable that it was decided to postpone the trade-effluent trials pending a careful investigation of the possibilities of the activated sludge process as applied to the purification of a purely domestic sewage.

The results of a fairly prolonged investigation may be summarized as follows:—

(1) That, contrary to the opinion formed as the result of the earlier experiments when working with Davyhulme sewage (a strong trade sewage), the maintenance of the activity of the sludge, so far as complete removal of colloidal matter and satisfactory oxidation of the carbonaceous matter is concerned, is not dependent on the stage to which nitrification is carried. This means that if a highly nitrified effluent is not required, entirely satisfactory purification can be maintained with a considerable less aëration period, at consequently lower cost.

(2) That when dealing with a sewage free from inhibitory trade effluents the question of temperature is not so serious as was originally thought. Satisfactory purification was maintained throughout the winter months with air temperatures in some cases well below zero, and sewage temperatures of from 5 deg. to 10 deg. Cent.

(3) That the nitrogen content of the sludge is decidedly higher than that obtained from the sewage at Davyhulme. While the manner of handling the resultant sludge remains to be fully developed, the following analysis (mean of several determinations) supports the contention that it may be looked upon rather as an asset than as a somewhat serious liability, as is the case with present-day methods of sewage purification.

Analysis of Withington Activated Sludge (Dry).

	Percentage.
Loss on ignition	70.4
Mineral matter	29.6
Total nitrogen (as N.)	6.0
Total phosphoric acid (as P_2O_5)	4.2
Greasy matter (ether extract)	7.3

As a result of the discovery that the activity of the sludge was more or less independent of nitrification, two types of sludge have been built up, one a normal activated sludge in which nitrifying organisms are thoroughly established, the other in which no effort has been made to cultivate these organisms. For the purpose of differentiation, the latter sludge has been termed partially activated sludge.

These trials have all been carried out on the "fill-and-draw" system. For a period of several months casks containing 20 to 25 per cent. of activated sludge have received four fillings per day, with an average aëration period of four hours; while casks containing a similar volume of partially activated sludge have received six fillings per day, with an average aëration period of rather less than two hours—*i.e.*, four fillings, one hour each, and two fillings, three hours each—the latter during the afternoon and early evening, when the sewage is at its maximum strength.

The following average analytical returns show that entirely satisfactory effluents were obtained in each case. In general, the effluents were exceedingly well clarified, and practically free from suspended matter.

Average Analytical Returns.

	Results in grains per gallon.		
	Screened detritus free sewage.	Partially activated sludge effluent.	Activated sludge effluent.
Four hours' oxygen absorption	2.12	.52	.41
Free and saline ammonia	1.58	1.20	.21
Albuminoid ammonia	.46	.09	.07
Nitrite (as NH_3)	—	.01	.01
Nitrate (as NH_3)	—	.40	1.33
Dissolved oxygen absorption, five days at 18° C., Royal Commission test	—	1.08	.63
No. of fillings per day	—	6	4
Average aëration period	—	1⅔ hrs.	4 hrs.
Volume of sewage dealt with daily	—	187 gals.	125 gals.

The results obtained have been so encouraging that it has been decided to install a large-scale unit designed for operation on the continuous-flow system.

TUNGSTEN ORES IN ARGENTINA.

Wolfram is met with in the Argentine Republic almost entirely in veins of micaceous quartz. The greater part of the deposits is to be found in the western portions of the Sierra de Córdoba and in the eastern sections of the Sierra de San Luis. The most important deposit at the present time is the Los Condores mine, in the latter province. The wolfram content of the Condores ores nearer the surface is from 1 to 4 per cent. of the vein; at a greater depth the percentage is less. The quantities of wolfram exported in recent years are as follow: 1911, 586 tons; 1912, 637 tons; 1913, 536 tons.

LARGE POWER CHAIN DRIVE.

A chain drive of 5,000 h.p., said to be the most powerful chain-drive gear in the world, is in operation in a hydro-electro plant on the Snake River, in Oregon. Two water-wheel shafts, which make 149 revolutions per minute, are connected by four driving chains with a generator shaft that is driven 225 revolutions per minute. Each of the former shafts carries a 71-tooth sprocket wheel, 45½ ins. in diameter, and the generator shaft has two 47-tooth sprockets, a little over 30 ins. in diameter. The water-wheels drive sets of four chains, each of which is over 31 ft. long, 21 ins. wide, and weighs 2,800 lbs. The chains have been tested to a strain of 40,000 lbs. per sq. in., though ordinarily the tensile strain is 600 lbs. A chain drive was not contemplated for this plant originally, but in the midst of its construction, and after part of the machinery had been delivered, financial difficulties interrupted the work. After some time experts recommended the chain drive as the most economical means of utilizing the available equipments.

The Hawaiian Department, U.S.A., has under consideration plans for boring a tunnel through the Koolau range of mountains at the head of Kalihi Valley, Honolulu, capable of receiving the military and commercial traffic of the island of Oahu.

SASKATOON WATERWORKS: SUPPLY AND DISTRIBUTION.

THE accompanying facts concerning the operation of the Saskatoon waterworks are taken from City Commissioner Yorath's annual report which has just been issued:—

The city is extremely fortunate in obtaining such an excellent and inexhaustible supply of water from the Saskatchewan River, and while in this respect it is better off than its sister cities of Regina and Moose Jaw, it is not so fortunate as other cities in the east which are able to obtain their supply by gravitation. In Saskatoon the water has to be pumped from the river to sedimentation basins, passed through mechanical filters and then pumped to the distribution mains. In consequence of this the cost to the consumer is slightly higher than that charged in cities which have a gravitation system.

However, during the past three years the system has been reorganized and the operating costs reduced to a minimum, with the result that the charge for water supplied to domestic consumers has been reduced from 30 cents to 25 cents per 100 cubic feet and the meter rent of $2 has been discontinued.

A summary of the operating costs for the years 1913, 1914 and 1915 is as follows:—

1913.

Operating expenses	$ 97,375.65
Depreciation, interest and sinking fund	23,133.66
Total	$120,509.31
Revenue	124,623.01
Profit	$ 4,113.70

1914.

Operating expenses	$ 65,295.30
Depreciation, interest and sinking fund	26,566.36
Total	$ 91,861.66
Revenue	108,001.26
Profit	$ 16,139.60

1915.

Operating expenses	$ 54,025.31
Depreciation, interest and sinking fund	24,241.45
Total	$ 78,266.76
Revenue	87,517.59
Profit	$ 9,250.83

It will be noted from the above figures that the operating costs have been reduced from $97,375.65 in 1913 to $54,025.31 in 1915, a reduction of $43,350.34 or 44 per cent.

This large reduction in operating costs has been made principally by: (*a*) Stopping leaks and preventing waste; (*b*) amalgamating the pumping and filtration plants; (*c*) providing an electrical instead of a steam standby for the pumps.

The operating expenses, fixed charges and revenue for the years 1913-1915 are shown graphically in diagram No. 1.

Capacity of Pumping, Filtration Plant, Etc.

Raw water pumps—Two centrifugal suction pumps, capacity 2,000,000 gallons per day each; two direct acting pumps, capacity 750,000 gallons per day each.

Distribution pumps—Two centrifugal pumps, capacity 2,000,000 gallons per day each.

Booster pumps—Two centrifugal pumps, capacity 1,800,000 gallons per day each.

Steam standby pumps—Two duplex pumps, one capacity 900,000 gallons per day; and one 1,000,000 gallons per day.

Boilers—Three Robb Armstrong boilers, each 250 h.p. Total h.p., 750.

Sedimentation basins—Two sedimentation basins, capacity of old basin, 1,740,000 Imperial gallons; capacity of new basin, 1,753,000 Imperial gallons.

Length of water mains laid within the city limits is 45.38 miles. Number of hydrants, 467. Number of connections (all metered), 2,300. Average daily maximum consumption, 1,782,808 Imperial gallons. Average daily minimum consumption, 696,138 Imperial gallons. Average daily consumption, 1,241,253 Imperial gallons.

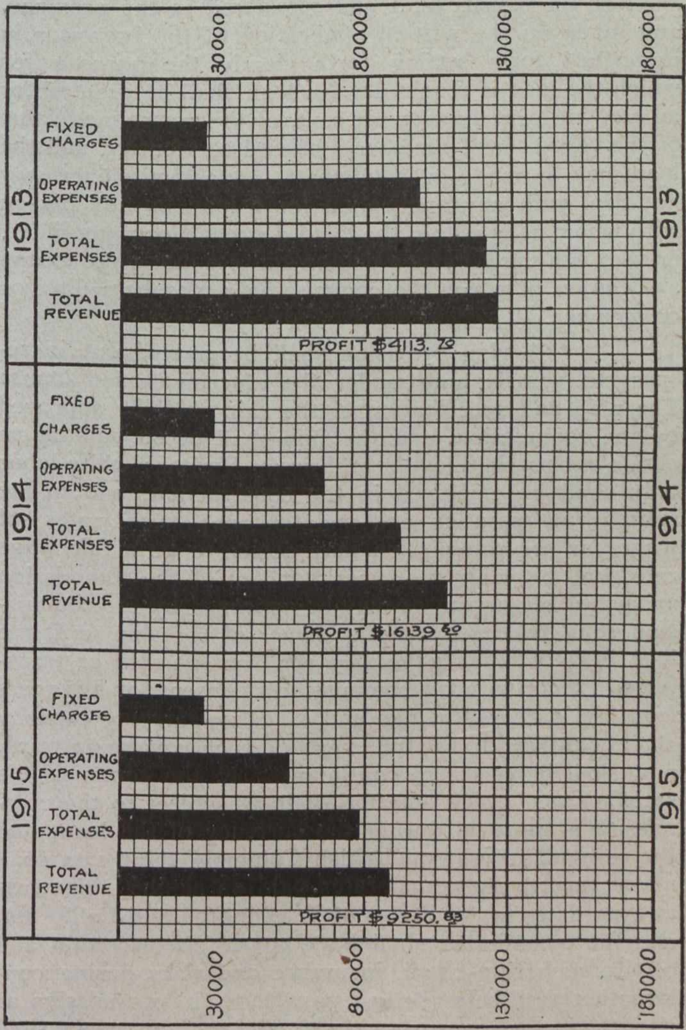

Diagram of Waterworks Expenditure and Revenue.

Water Rates.—800 cubic feet and under, $2 per quarter; exceeding 800 cubic feet and not exceeding 2,000 cubic feet, 25c. per 100 cubic feet per quarter; exceeding 2,000 cubic feet and not exceeding 12,000 cubic feet, 20c. per 100 cubic feet per quarter; exceeding 12,000 cubic feet and not exceeding 75,000 cubic feet, 15c. per 100 cubic feet per quarter; for each additional 100 cubic feet, 10c. per 100 cubic feet per quarter.

No discount is allowed for prompt payment of water accounts and no charge is made for meter rent.

The fire department pay a total hydrant rental of $14,000 per annum to the waterworks department.

BRITISH COLUMBIA LEGISLATION TO ENCOURAGE SHIPBUILDING.

THE British Columbia Shipping Act constitutes a shipping credit commission consisting of a superintendent and two other directors with the power of an incorporated company which may own and operate vessels of all kinds, as well as build and deal in them generally.

The superintendent and one director are nominated by the Lieutenant Governor in Council, and the third director is the Deputy Minister of Finance. The commission is empowered to make loans subject to the provisions of the act and to deal with the necessary collateral securities, and must keep a register of loans. The loans made shall be on vessels built and registered in the province, and made on the written application of the borrower in prescribed form setting forth clearly the purpose for which the loan is required. No loan shall be granted for an amount exceeding 55 per cent. of the ascertained value of the vessel, or of the shares offered as security, and the loan may be made in instalments. A commissioner may not deal with any application for a loan by any person with whom he is within the third degree of consanguinity, or who is a partner, or a debtor under a mortgage to any association of which the commissioner may be a director or member.

The following provision shall be carried out in respect to vessels built under the aforementioned loans: The plan and specification of the ship shall be approved by the commission, and the ship shall be so built as to obtain a class in Lloyd's or Bureau Veritas; white labor only shall be employed in the construction, and in the subsequent operation and maintenance; such rates of wages as the commission may decide to be a fair wage rate shall be paid; the superintendent of the commission or such other person as may be approved by the commission shall be the managing owner of the ship until the loan is fully repaid; the ship shall not be sold or transferred except with the commission's consent for five years from the date of the loan and its cargo-carrying capacity shall be utilized to the full extent on each voyage outward, and shall be operated continuously to the commission's satisfaction; every charter shall be subject to the commission's approval during the currency of the loan, and the rates of freight on British Columbia shipments shall never exceed the actual rates paid on similar shipments at even dates in the States of Washington and California, and the commission shall have power to ascertain and certify such rates; all insurance and risks during construction shall be made loss payable to the commission as its interest may appear and exist, and such insurance shall be carried in any amount which the commission may deem necessary; the contract with the commission shall contain a provision whereby 1 per cent. of the gross earnings of the ship during the currency of the loan shall be paid to a reserve fund of the commission as a payment from the shipping industry benefitted by this act towards governmental risk, cost and expense of passing this act and carrying it into effect. Each loan made by the commission is to bear 6 per cent. interest, payable half-yearly, and the principal is repayable in five equal annual instalments; provided that should 50 per cent. of the net earnings of the ship for any year exceed the annual instalment of principal and interest, then the borrower shall repay a further sum so that the amount paid each year in reduction of the loan shall never be less than 50 per cent. of the net earnings of the ship, and never less than 20 per cent. of the original amount of the loan, without reference to earnings. In case of default by the borrower, or if the commission considers that the loan or any portion of it shall have been used for any other purpose than that for which it was made, the commission may refuse to pay any unpaid portion of the loan and one month after demand by registered letter for the repayment of the loan made, may take possession of the whole or any part of the security, and dispose of same by public or private sale, applying the proceeds in payment in the first instance of money advanced under the loan agreement. Any loss which may arise from such sale to be debited to the reserve fund before mentioned.

LAYING CONCRETE IN FREEZING WEATHER; TROY LOCK AND DAM.

By D. A. Watt, Assistant Engineer.

IN order to have the Troy lock completed and ready for navigation within the specified time, it was found necessary to carry on the work of placing concrete in the lock during the winter 1914-1915. Various expedients were used to prevent damage to the concrete from frost.

When the temperature fell below about 50° F., the sand, gravel, and water used in the concrete were heated. A steam jet placed in the water tank of the concrete mixer sufficed to heat the water. The sand and gravel were heated by steam jets located at the bottom of the bins of the mixer. The steam, escaping upward through the mass, made this method very effective, even when the mixer was running to full capacity. When running slowly, however, it was sometimes necessary to reduce the supply of steam, as it made the concrete too hot for the men to work in the forms and, in confined forms, resulted in so much vapor that the men could not see properly.

This method was also used on the construction of the dam, when toward the end of the working season the temperature fell below moderate. As the river water was shortly to be allowed to flow over the new section of the dam, it was necessary to harden the concrete rapidly, and this method proved very effective.

When the temperature fell below freezing, additional precautions were taken. Lighted lanterns were placed on top of the green monolith; and large improvised steam radiators, made of a few coils of 3-inch pipe were hung close along the side of the forming; the whole was then covered with tarpaulins and so left for about forty-eight hours. Loss of heat by radiation from steel forms is much greater than from wooden forms.

Concreting was carried on without special difficulty under occasional temperatures not far from zero, and the temperature of the concrete when delivered in the forms was rarely less than 60° F. The steam coils and tarpaulins were usually kept in place for about forty-eight hours, when the concrete had set sufficiently to allow the forms to be taken down. The lifts, or thickness of courses, ran from 3 or 4 to about 10 feet.

Difficulties also arose from the surface freezing of the sand and gravel storage piles, on which the cold would sometimes produce a frozen crust of a foot or more, hampering the operation of the excavating bucket. This was overcome by using steam pokers, consisting of 1¼-inch steam pipe, about 10 feet long, pointed at one end and having a few small holes. Two or three of these would be worked into the storage pile over night near its base, its surface being covered with tarpaulins.

BANK STREET (OTTAWA) BRIDGE REPAVING.

By L. McLaren Hunter,
Pavement Engineer, Ottawa, Ont.

DURING the season of 1913 a creosoted wood block pavement was laid on Bank Street high-level bridge, Ottawa, and since then the blocks between the track have occasionally given trouble, especially in the fall and spring, at which time they used to heave out of position, causing delay to the street car service and also making the street look anything but desirable in appearance.

A glance at Fig. 1 will readily show the cause of this trouble. The city was apparently so eager to have the street paved that they used a wooden strip dipped in tar, against which to butt the blocks between the tracks; this

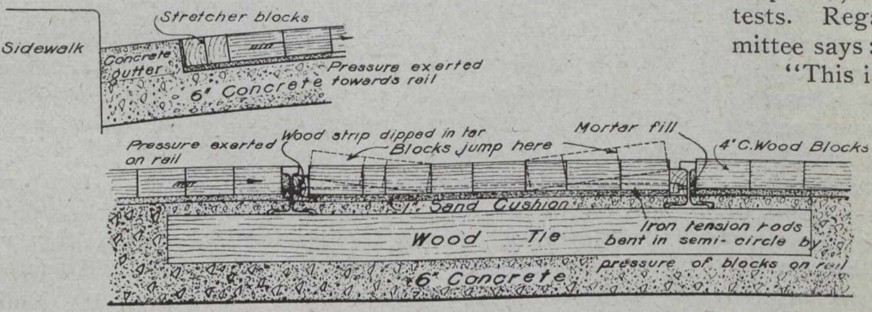

Fig. 1.

expanded and contracted according to temperature conditions with the above results. At the sidewalk there was not enough expansion allowed for. A week after being laid, the blocks used up the expansion which was left, then the pressure was naturally exerted towards the rail, pushing it over to an angle of 80 degrees, and causing the cars to jump the track. This pressure on the rail in turn caused the iron tension rods to bend, which displaced most of the blocks from the tracks.

To remedy these faults, more expansion was allowed at the gutter. In order to do this, one of the stretcher blocks was lifted, cut in half and relaid, as shown in Fig. 2. The space left at the gutter was then filled with asphalt cement at a penetration of 53, and thus the pressure on the rail was relieved.

In relaying the blocks between the rails a special creosoted wood strip was made to fit under the head of the rail, as shown in Fig. 2, and a specially nosed block was made to allow of working room for car wheel flanges.

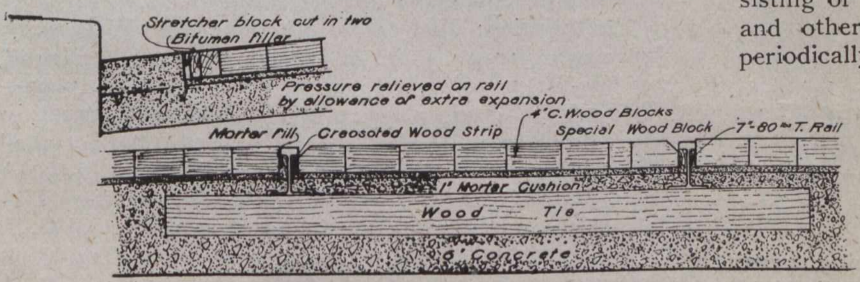

Fig. 2.

These were supplied by the Creosoted Block Paving Co., Limited, of Toronto. The old blocks were used wherever possible, and were cleaned by soaking in boiling water for half an hour, then taken out and the old bitumen scraped off with trowel. After being laid, the blocks were thoroughly tamped down and given a squeegee coat of asphalt cement; sand was then spread over the surface and allowed to stand for twenty-four hours, when it was swept clean and traffic resumed.

The blocks were laid on a mortar cushion, composed of two parts of sand to one part cement. When the blocks were originally laid it was on a sand cushion only.

The work was done by day labor at a cost of $2.50 per square yard.

OPERATION OF SEWAGE TREATMENT PLANTS.

IN a report recently made by the committee on sewage works operation of the American Public Health Association, special emphasis is placed upon the great importance of analytical tests and proper supervision of plants, and suggests the following lists of analytical tests. Regarding the amount of sewage treated the committee says:—

"This is of prime importance to successful operation, for otherwise retention in tanks and rates on filters are indeterminate and it is difficult, if not impossible, to know whether unsatisfactory results are due to overloading of the parts of the works or to improper methods of operation.

"Where fall is available a weir, preferably with an automatic recording device, is a simple and inexpensive method to use. Where the sewage has to be pumped, the venturi meter has proven successful. In works having a dosing tank, an approximation of the rate of flow may be obtained by the use of a float-actuated counter, which indicates the number of discharges of the dosing tank. In the case of heavy flow, when a considerable amount of sewage runs in while the tank is discharging, the total discharge may be obtained by the following formula:

$$D = (n + \frac{ne}{f})\, v$$

in which D = total discharge in unit of time; n = number of discharges in the same unit of time; e = time of emptying; f = time of filling; v = volume of dosing tank.

"When e is very small as compared with f, then

$$\frac{ne}{f}$$

may be omitted and $D = nv$."

Concerning control of plants, the committee reports:

"In some states, associations of those interested consisting of sewage works superintendents, state engineers and others are now being formed to hold meetings periodically to discuss practical questions on operation. The formation of such bodies and their frequent gatherings are highly recommended by your committee. Such meetings stimulate interest and are sources of information to many.

"The state boards of health are the logical bodies to provide this supervision, due to their uniform relation to all the municipalities in each state and with similar boards in adjacent states.

"Furthermore, the sanitary disposal of sewage is a matter generally affecting the commonwealth more than the individual community. The state is interested in requiring that sewage treatment works accomplish the best results possible, while the separate communities are naturally anxious that the works shall meet the requirements at the minimum expense for operation, additions and renewals.

"It may be assumed, therefore, as an axiomatic statement, that for the good of the commonwealth, the municipalities and private owners, any procedure which will accomplish the above conditions is worthy of careful study and adoption."

EXPLOSIVES.

Nitro-glycerine is a limpid oil formed by the action of a mixture of nitric and sulphuric acid upon ordinary glycerine. This chemical action is a violent one unless carefully controlled. After it has taken place, the nitro-glycerine is washed repeatedly to remove any trace of acid that might remain. The presence of acid is dangerous in the finished explosive because it may produce a chemical action of disastrous results. For practical use, the liquid nitro-glycerine is so sensitive to percussion and friction that it is dangerous to transport it or attempt to employ it alone. However, when nitro-glycerine was first introduced for driving the Hoosac tunnel in Massachusetts, and for springing oil-wells in Pennsylvania, it was used alone, being carried in copper cans and loaded in tin tubes. In the oil-well region, men made an occupation of driving a horse and light wagon through the country for carrying the pure nitro-glycerine to the consumers. Many accidents were reported, and a carrier's position was scarcely to be envied.

Later it was learned to mix the nitro-glycerine with a quantity of kieselguhr, an infusorial earth composed of the silicious skeletons of minute diatoms, and therefore called diatomaceous earth. The nitro-glycerine is absorbed by the earth, which is itself inert and simply forms a plastic mass that can be more safely handled than the nitro-glycerine. Another advance came when it was found that nitro-cellulose, or gun-cotton, could be dissolved in the nitro-glycerine to form a nearly uniform jelly. This mixture constitutes blasting gelatine. The gun-cotton is made by the action upon cotton fibres of the same acids as are used in the manufacture of nitro-glycerine, great care being taken to wash away all trace of excess acid. When gun-cotton, or nitro-cellulose, is incorporated with the nitro-glycerine, it shares in the explosion, instead of acting as an inert base like kieselguhr. Thus additional power is gained. Blasting gelatine, then, is a mixture of two complex compounds, which fact increases the possibility of chemical change with consequent deterioration and danger. Blasting gelatine contains 92% nitro-glycerine and 8% nitro-cellulose. There are, also, various intermediate mixtures of nitro-glycerine and nitro-cellulose with a proportion of wood meal and potassium nitrate, the object being to produce effects intermediate between straight dynamite and blasting gelatine. When such a complex mixture was attempted, it was at first difficult for any mechanical method to render a perfectly homogeneous mass, but later methods of manufacture have improved this.

The initial pressure of the different explosives when detonated in their own volume are as follows: Straight dynamite (nitro-glycerine mixed with an inert base) 80 tons per square inch; blasting gelatine, 113 tons; gun-cotton, 71 tons; black powder, 21 tons. It is evident that blasting gelatine is the most powerful. Likewise it has the highest rate of detonation, 25,262 ft. per second, as against 22,368 for straight dynamite and 984 for black powder.

CONSTRUCTION COSTS OF CERTAIN RAPID SAND FILTER PLANTS.

In reporting recently on a new water supply for Sacramento, Cal., the engineers, Messrs. Hyde, Wilhelm and Miller, presented a tabulation to permit a comparison between the estimated cost of the proposed purification works outlined in their report and the cost of similar structures of the same character built elsewhere in the United States. The comparisons, of course, are rough, since no two plants have identical conditions to meet and therefore are not exactly alike. The figures, however, are of interest as showing the general investment requirements in plants of this character. In the table that follows the cost figures are given per 1,000,000 gallons nominal daily capacity of filters, and are supposed to include coagulation basins, filters, head and filter houses and filtered water basins:—

Name of place.	Nominal capacity of filters 1,000,000 gallons per day.	Capacity of coagulant basins 1,000,000 gallons.	Capacity of filtered water basins 1,000,000 gallons.	Construction cost per 1,000,000 gallons nominal daily capacity.
1. New York (proposed)	320	88	365	$16,100
2. Baltimore, Md.	128	16	17.8	10,900
3. Cincinnati, O.	112	22.5	19.5	11,400
4. New Orleans, La. ..	40	42.2	15.4	30,200
5. Minneapolis, Minn. .	39	5.6	50	.....
6. Toledo, O.	39	10	26	14,500
7. Little Falls, N.J. ...	32	.7	3.5	15,000
8. Columbus, O.	30	15	10	15,200
9. Trenton, N.J.	30	3.8	1.2	12,000
10. New Milford, N.J. .	24	11.5	2.0	11,000
11. Grand Rapids, Mich.	16	2.6	2.8	16,300
12. Niagara Falls, N.Y..	16	2.0	0.5	16,000
13. Harrisburg, Pa.	15	0.33	0.62	10,300
14. Dallas, Texas	15	....	...	13,000
15. Evanston, Ill.	12	0.83	2.0	17,000
16. Flint, Mich.	8	1.25	2.0	18,000
17. Watertown, N.Y. ..	8	....	...	11,300
18. Lorain, O.	6	0.58	0.29	14,000
19. Steubenville, O.	6	....	...	22,000
20. Jackson, Miss.	4	....	...	17,000
Straight averages ..	45	14.3	32.4	$15,330
Weighted averages .	..	....	...	13,700
Sacramento proposed	30	11.0	5.0	$13,800

In the case of the Sacramento estimates land or low-lift pumping equipment are not included.

Authorities: Journal of the American Waterworks Association, 1914; (1) G. A. Johnson, p. 512; (2) Including low-lift pumping station, J. W. Armstrong, p. 497; (3) G. A. Johnson, p. 69; (4) Including very expensive foundations, etc., J. H. Gregory, p. 473; (5) Not available at this date; (6) J. H. Gregory, p. 472; (7) G. A. Johnson, p. 69; (8) Excluding softening works, G. A. Johnson, p. 511; (9) G. A. Johnson, p. 521; (10) G. A. Johnson, p. 69; (11) J. H. Gregory, p. 472; (12) C. B. Buerger, p. 492; (13) G. A. Johnson, p. 69; (14) G. A. Johnson, p. 69; (15) C. B. Buerger, p. 492; (16) C. B. Buerger, p. 492; (17) G. A. Johnson, p. 69; (18) G. A. Johnson, p. 69; (19) C. B. Buerger, p. 492; (20) C. B. Buerger, p. 492.

It is said that Boston's new drydock, which will be 1,200 feet long, will be the largest in North or South America.

Editorial

EMPLOYMENT OF ALIEN CONTRACTORS.

Canadian contractors have been very much disturbed during the past year by the award to United States organizations of a number of contracts which could have been carried to successful completion by any one of dozens of Canadian contractors. The recent award of a contract for a gun-cotton plant at Trenton, Ont., to a New York State firm will add fuel to the flames. It is understood that the main sub-contractor on this Trenton job is also a New York State firm.

The Canadian Engineer is advised that this contract, like many of its predecessors, is on a cost plus percentage basis and that tenders were not publicly advertised and called for among Canadian contractors. This is rank injustice to a group of men who have been very hard hit by the war and who have unquestionably proven their ability and integrity. Canadian contractors have built most of the buildings in Canada and they can do as good work as American contractors.

It is high time that the Dominion Government and the various provincial governments were made to realize that Canadian contractors must be given an opportunity to bid on all their work. What is the reason behind the award of so many of these contracts to American firms upon a percentage basis? Is it favoritism or disbelief in Canadian ability?

TOWN-PLANNING DEVELOPMENT IN CANADA.

The time necessarily occupied in the development of any specific town-planning scheme of any magnitude has made it difficult to gauge with any degree of accuracy the progress that may have been made. At the same time, it must be said that the great public advantages which must follow the increased control over the development in any area which is the subject of a town-planning scheme render it very desirable that where such districts exist some scheme of town planning be undertaken.

Social and economic forces are of enormous influence in determining the character and extent of a city's growth. Where development runs counter to economic laws, reaction is sure to follow. One of the fundamental and controlling forces in the growth of communities is uniformity of development. Where buildings are scattered over great areas it becomes very difficult to supply adequate service in respect to transit, water, gas, streets, sewers and other utilities.

In this connection, and as indicating the increasing interest in the subject of town planning and civic improvement in Canada, it is interesting to note that the Civic Improvement League, which is purely educational in character, has done a great deal to awaken and maintain interest in this work. In every province there is being shown an unusual activity in this subject on the part of all classes in the community. A recent issue of "Conservation of Life" contains reports from branches all over Canada. To have accomplished this, especially at the present time, when the attention of most people is necessarily directed to matters connected with the prosecution of the war, shows how the subject has gripped the Canadian public.

CANAL TRANSPORTATION.

It is difficult to determine exactly in dollars and cents the actual direct return to the country for money expended in canal construction in Canada. Such expenditures are for the general advantage of the country and it is not easy to say just how this advantage accrues.

A highway, whether on land or water, is not usually a "paying" public enterprise; at least not as such things are commonly considered. The day has passed when public officials even think of making highways "pay." They very rightly look beyond that and take into account the development that is more than likely to be brought about if such highways are provided. The contribution which the present canal system in Canada has made to the development of the Northwest, for instance, cannot be measured in money, yet no one would be so foolish as to maintain that the contribution has been anything but a very real and genuine one.

Arguments have been put forward that the large cost of building and maintaining this or that waterway is prohibitive. While the involved expenditures may be out of the question so far as the present is concerned, it is well to point out the error of estimating the future waterway possibilities by the volume of traffic which obtains at the present time. That is hardly fair in view of the great increase in the volume of traffic which has followed canal construction in Canada up to the present.

LETTER TO THE EDITOR.

The Design of Steel Stacks.

Sir,—I have read with interest the letter by Mr. H. M. White, of the Dominion Bridge Co., Montreal, in your issue of November 16th, regarding the article on "The Design of Steel Stacks," printed in your issue of September 28th.

Mr. White's statement that the designing curves given in the article are correct and convenient for use justifies their introduction and use, and really expresses the main purpose in presenting the problem.

I acknowledge the two numerical errors pointed out. These, while inexcusable, having occurred in the hasty preparation of the original paper, would have been corrected had I known that the article was to be reprinted. These do not, however, occur in any of the preferred solutions. In each case where more than one analysis was given, the one given first was the preferred solution and the one used in plotting the curves.

It is interesting to note the lack of consistency on the part of the critic. He closes his letter by stating that nothing new was given in the original paper, yet spends a large part of his space in ridiculing the secondary solutions as though they were being given for the first time, while as a matter of fact these assumptions have long been used by other designers.

It may be well to have still another solution proposed for anchor bolts, though no evidence was given in the letter that would prove the critic's assumptions any better for working designs than the proposed solution No. 1. His new solution gives values of approximately 70 per cent. of the values obtained by solution No. 1. The designer must decide whether he wishes to assume this risk. A study of recent designs would indicate that most engineers are not willing to do so.

The critic is in error in his statement regarding the comparison of the three proposed anchor-bolt solutions. The comparison given in the original paper applied only to the specific problem of 12 bolts and not to the general case, as he would have the reader infer.

The apparent error pointed out in Equation 44 for stress in the shell at connection to the base plate is another case of trimming down the design. The proposed Equation 44a, for the common case where B equals $1\frac{1}{2}$ D, gives a stress per lineal inch at the base plate only 44 per cent. of the stress given by Equation 44 of the writer's. Again the designer must choose. For the case of the tapering stack Equation 44a might result in some saving in material.

Therefore, while the critic has pointed out the fallacies of the usual assumptions, which are admitted by all, he has failed to show that the preferred solutions shown on the designing diagrams represent unsafe practice.

W. A. HITCHCOCK,
Assistant professor of Civil Engineering,
University of Wyoming.

Laramie, Wyo., December 6th, 1916.

PERSONAL.

C. ROBERTSON, of Hamilton, Ont., has been appointed assistant engineer of the local electric plant at Orillia, Ont.

L. V. de BURY has been appointed assistant general sales agent at Montreal of the Dominion Iron and Steel Company, Limited.

L. W. OUGHTRED has been appointed superintendent of the Consolidated Mining & Smelting Company's properties at Ainsworth, B.C.

D. R. THOMAS has been appointed mine manager and FRANK G. STEVENS managing engineer of the Davidson Gold Mines, Limited, Porcupine, Ont.

Lieut.-Col. H. P. ANDERSON, chief engineer of the Department of Marine, Ottawa, is a member of the public service board recently appointed by the National Service Commission, Ottawa, Ont.

R. W. MACINTYRE, secretary of the Victoria Branch, Canadian Society of Civil Engineers, has been elected a member of the American Society of Civil Engineers.

DAVID JOHNSTON, formerly municipal engineer in Point Grey and latterly engineer to Saanich Municipality, Vancouver Island, B.C., has enlisted with the Sixth Field Company, Canadian Engineers.

GEORGE S. RICE, chief engineer of the United States Bureau of Mines, Washington, D.C., has been engaged by the Provincial Government of British Columbia to make an investigation of the Coal Creek coal areas of the Crow's Nest Pass Coal Co., near Fernie, B.C.

L. B. BEALE, of Toronto, British Columbia lumber commissioner for Eastern Canada, has just returned after nine weeks' absence, during which time he visited practically every lumber mill in the province of British Columbia in the interests of his department.

THOMAS ADAMS, town planning advisor of the Dominion Commission of Conservation, delivered an address entitled "Municipal Improvement and Land Development, the Need for Town Planning and a Department of Municipal Affairs," before the Board of Trade of London, Ont., on December 5th.

WILLIAM J. TYERS, formerly supervisor of bridges and buildings, Grand Trunk Railway System, Montreal, has been appointed supervisor of bridges and buildings, Belleville Division, vice Mr. J. McMahon, deceased. P. J. PHELAN will succeed Mr. Tyers at Montreal.

SAM R. HENDERSON, for seven years president of the Manitoba Good Roads Association, was presented with a gold watch at the annual banquet in recognition of his record of valuable service as the chief executive officer of the association. The presentation was made by Mayor R. D. Waugh, of Winnipeg.

HOWARD MURRAY, vice-president and treasurer of the Shawinigan Water and Power Co., Montreal, who has been granted a year's leave of absence by the directors, has joined the staff of the Imperial Munitions Board, and will be associated with the management of the explosives branch. JULIAN C. SMITH, the chief engineer and general superintendent, has been appointed general manager of the company. Mr. Smith has been responsible for the design of several important hydro-electric developments, including that of his own company and the hydraulic section of the Cedars Rapids plant.

OBITUARY.

Sapper L. BROBACHER, 19 Waterloo Avenue, Toronto, who has died from wounds received while in action, was employed as an electrical engineer by the Ontario Hydro-Electric Power Commission before he enlisted with the 4th Canadian Engineers. He was 22 years of age.

Lieut. E. F. M. DANN, a British Columbia civil engineer, who for four years had been employed in that province in connection with the irrigation work of the Dominion Government, died of wounds on November 3rd, somewhere in France. Lieut. Dann was a graduate of the School of Practical Science, Toronto. He enlisted with the 72nd Battalion, Seaforth Highlanders, Vancouver, and had been in France since August, 1915.

JOHN D. ARCHBOLD, president of the Standard Oil Company, of New Jersey, died at his home in Tarrytown, N.Y., on December 5th, following an operation for appendicitis. Mr. Archbold was a native of Ohio, and was 68 years of age. In early life he was an oil refiner and buyer in Western Pennsylvania, and in 1875 he became associated with the Rockefeller interests, a connection that continued until his death. He became president of the Standard Oil Company of New Jersey shortly after the dissolution of the "Trust" was ordered by the United States Supreme Court.

The stand of timber on the two great national forests in Alaska is estimated by the forest service as 70,000,000,000 board feet, while the annual growth will, it is said, produce of pulp wood alone enough for the manufacture of 3,000 tons of wood pulp a day.