ECONOMIC FEATURES OF THE ROGER'S PASS TUNNEL.

FROM time to time articles and notes of engineering interest have appeared in this journal on the five-mile, double-track tunnel which Messrs. Foley Bros., Welch and Stewart are driving through the Selkirk Range, in the vicinity of Roger's Pass, for the Canadian Pacific Railway Company. For a description of the engineering features of the undertaking the reader is referred to *The Canadian Engineer* for April 23, 1914, page 621. Maps and profiles of the old and proposed lines are illustrated therein to good advantage, and a reference to them will be of assistance in the following portrayal of the problem in economics which the revision of railway location has presented.

The following abstract from a paper by J. G. Sullivan, C.E., chief engineer of the western lines of the C.P.R., presents the factors involved in a study of the cost of operation via the present and proposed routes. We are indebted to the "Cornell Civil Engineer" for the information. (Mr. Sullivan is a graduate of Cornell University, Class '88.)

The data to be taken into account is as follows: Present location, total distance 23.1 miles, revised location 18.68 miles; grades consist, on the present location of 16.65 miles up hill for westbound traffic on maximum grade of 2.2%, 6.45 miles down grade same maximum with a total rise of 1,726 ft. and a drop of 692.1 ft. with 1,860 degrees of curvature on the up hill and 1,288 degrees on the down hill portion of the line. The revised location consists of 16.77 miles up hill with about 5 miles of 2.2% pusher grade, the balance 1% and a down hill run of 1.91 miles with a maximum 2.2% grade; a total rise of 1,178.2 ft. and a drop of 144.3 ft., with 635 degrees of curvature on the up hill grade and 66 degrees on the down hill. The average traffic for the years 1912 and 1913, which is made the basis of calculations, was 1,342½ passenger trains in each direction; the average weight of the passenger trains, exclusive of locomotives, was 443 tons; 980 of the passenger trains required pusher engines; the weight of the passenger and pusher engines for passenger trains was 175 tons each; there were 173½ freight trains in each direction per year; the average weight of the freight trains eastbound, exclusive of locomotives, was 950 tons; the average weight of freight trains westbound was 898 tons; all freight trains had to be pushed in both directions; weight of freight locomotives and pushers, 181 tons each. The tonnage eastbound and westbound was as follows:—

Eastbound.

1,342½	trains @ 443 tons each	594,727.5 tons
2,322	locomotives @ 175 tons each..	406,350.0 "
1,738½	freight trains @ 950 tons each	1,651,575.0 "
3,477	locomotives @ 181 tons each ..	629,237.0 "
	Total	3,281,889.5 tons

Westbound.

1,342½	trains @ 443 tons each	594,727.5 tons
2,322	locomotives @ 175 tons each..	406,350.0 "
1,738½	freight trains @ 898 tons each	1,561,173.0 "
3,477	locomotives @ 181 tons each ..	629,237.0 "
	Total	3,191,487.5 tons

Comparison of Comparable Factors Affecting the Cost of Operating Over Roger's Pass, via Present Line and via Tunnel Line, Now Under Construction, Average Traffic for the Years 1912 and 1913.

E. B. tonnage per year, including weight of engines, 3,281,890 tons.

Resistance to overcome, on present line.

Actual rise, 692.1 ft.	692.1 ft.	
Curve resistance, 1,288° × .04′	51.5 ft.	
Friction resistance, 6.45 mls. × 15′..	96.7 ft.	
Total		840.3 ft.

Resistance to overcome, tunnel line.

Actual rise, 144.3 ft.	144.3 ft.	
Curve resistance, 66° × .04′	2.6 ft.	
Friction resistance, 1.91 mls. × 15′	28.6 ft.	
Total		175.5 ft.
Difference		664.8 ft.

3,281,890 tons × 664.8 ft. equals 2,181,800,472 foot tons.

W. B. tonnage per year, including weight of engines, 3,191,488 tons.

Resistance to overcome, present line.

Actual rise, 1,726 ft.	1,726.0 ft.	
Curve resistance, 1,860° × .04′ ...	74.4 ft.	
Friction resistance, 16.65 mls. × 15′	249.7 ft.	
Total		2,050.1 ft.

Resistance to overcome, tunnel line.

Actual rise, 1,178.2 ft.	1,178.2 ft.	
Curve resistance, 635° × .04′	25.4 ft.	
Friction resistance, 16.77 mls. × 15′	251.5 ft.	
Total		1,455.1 ft.
Difference		595.0 ft.

3,191,488 tons × 595 ft. equals 1,898,935,360 foot tons.

Total work done (extra)	2,181,800,472 foot tons.
	1,898,935,360 foot tons.
Total	4,080,735,832 foot tons.

1,000 foot tons equals approximately 1 horse-power hour. Assuming that 5 pounds of coal is consumed in doing one horse-power hour's work and that coal on locomotive costs $4.60 per ton, the saving in fuel will amount to:

$$\frac{4{,}080{,}736 \times 5 \text{ lbs.} \times \$4.60}{2{,}000 \text{ lbs. (one ton)}} = \ldots\ldots \$46{,}928.46$$

Extra Wages, Train and Engine Crews.

Present line.

6,162 trains for 23.1 miles,	142,342.2 train miles.
5,437 push. engs. for 23.1 mls.,	125,594.7 push. eng. mls.

Tunnel line.

6,162 trains for 18.68 miles	115,106.2 train miles.
5,437 push. engs. for 13 mls.,	70,681.0 push. eng. mls.

Amount saved { 27,236.0 train miles.
54,913.7 pusher engine miles.