REPORT

OF THE

CHIEF COMMISSIONER OF LANDS AND WORKS

OF THE PROVINCE OF

BRITISH COLUMBIA,

FOR THE

YEAR ENDING 31st DECEMBER,

1899.

THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA

VICTORIA, B. C.:
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1900.

structures, ballasting, bridging, rail bolting, and station houses. As yet, there are no engine houses, repair shops, turntables, mile posts, whistling posts, caution posts, sign boards, cattle guards, safety switchbacks, and other lesser details.

The incompleteness of the railway for passenger traffic is more especially apparent at the crossing of Boundary Creek, where the proposed span has not yet been commenced. Passenger trains are being carried over this gap on contractors' falsework, which presents every appearance of insecurity, and which only requires to be jarred from the vertical by a passing train to collapse.

Though opinions differ as to the value of safety switch-backs, the general public demands them on mountain railways where grades are as steep as in the present instance, and for that reason alone it would seem that they should be provided without delay.

Passenger service began on Monday, 20th November, the company's time bill showing the time occupied in travelling from Grand Forks to Greenwood to be 1 hour and 30 minutes. This represents an average speed of 15 miles per hour.

HENRY B. SMITH, M. INST. C. E.,
Inspecting Engineer.

WHITE PASS AND YUKON RAILWAY.

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VICTORIA, B. C., August 4th, 1899.

The Honourable
The Chief Commissioner of Lands and Works,
for the Province of B. C.:

SIR,—On the 6th of July, 1899, I received orders from you to inspect that portion of the White Pass and Yukon Railway situate in the Province of British Columbia, defined for present purposes as lying between the places known as the Summit and Bennett Lake, a distance of twenty miles in round numbers.

The inspection referred to was to include alignment, grades, structures, cribbing, earth and rock work, stations, sidings, &c., &c., and equipment, in order to report fully in pursuance of the provisions of the B. C. Railway Act.

On the 7th July I left Victoria, arriving in Skagway July 12th. On the 13th I made the first inspection of the work above referred to. Observing that the work was not yet finished, nor in a condition to pass a Government Inspector, I did not think it necessary to make a very detailed examination of the work, as its condition one day, with the number of men at work, would be different the succeeding day. It was quite evident that with the number of men employed it was only a question of so many days before the work would be in such a condition as to pass inspection.

I therefore requested the General Superintendent to give me information with reference to the following points:—

1. General dimensions of the road-bed in cutting and embankment.
2. The cross-section of the road-bed above formation level when the ballasting is finished and the track lifted and lined.
3. General plan of decking trestles, with dimensions of the parts.
4. The weight of the rails and fastenings, including the weight and dimensions of the angle bars.
5. The kind of chairs of pressed steel used upon curves, their weight, the number of spikes to a chair, and the minimum degree of curvature upon which such chairs are used.
6. The size of the ties, and the number to a mile of track.
7. The kind of switches and frogs used.
8. List of equipment and additions to be made, if any, when the work is completed.
9. The weights and dimensions of the different kinds of cars, their wheel base between inner and outer wheels, their carrying capacity.
10. The kind of coupling used.
11. The kind of brake used

12. General description of the road in British Columbia, together with some reference to the local and climatic difficulty of construction, a note of the work still required to finish, and the probable date of completion between the Summit and Lake Bennett.

13. A note on the number and kind of station buildings, and their location.

14. A note on the water service, and any climatic difficulty in maintaining it during the winter.

15. Profile of the line in British Columbia with alignment.

16. The necessity for snow-sheds, if any, and the intention of the company regarding them.

17. The weights and dimensions of the locomotives used, including their axle loads and distances apart from centre to centre. The size of the cylinders, the length of the stroke, the diameter of the drivers, and the general steam pressure in cylinders in ascending the heaviest grades, or the maximum and minimum. The grate area, the tube surface, etc.

By the courtesy of the Superintendent and officials of the railway company I have been able to obtain replies to most of the 17 points above enumerated. I propose to take up the points embraced in the order before set forth.

1. Excavations in earth have a base of 14 feet, with slopes of 1 to 1, the gauge of the track being 3 feet. Excavations in loose rock-base, 14 feet; slopes, $\frac{1}{2}$ to 1; excavations in solid rock-base, 14 feet; slopes, $\frac{1}{4}$ to 1; bottom taken out 1 foot below grade and re-filled. embankments in earth top, 12 feet; slopes $1\frac{1}{2}$ to 1; embankments in rock top, 12 feet; slopes, 1 to 1.

2. Finished road-bed, 10 inches depth of ballast in centre rounded off to nothing at $3\frac{1}{2}$ feet either side of centre. The depth of the tie being 6 inches leaves 4 inches of ballast under tie, except in rock cuttings, which are taken out 1 foot below grade and have, therefore, 16 inches of ballast and re-filling under ties. When the embankments are full width there is a berm either side on top outside of the ballast of $2\frac{1}{2}$ feet in width.

3. The trestles are divided into spans of 15 feet 9 inches, centre to centre, and the superstructure is made up as follows:—

TIMBER.

2 guard rails,	6	inches by	8	inches,	16	feet	lengths.
13 ties	6	"	8	"	10	"	
6 stringers	6	"	16	"	16	"	

IRON.

6 tie bolts	$\frac{5}{8}$	-inch by	32 inches.
8 stringer bolts	$\frac{3}{4}$	"	18 "
8 spools	3	"	
28 washers.			

There are only three trestles on the portion of the White Pass and Yukon Railway in British Columbia of any magnitude, none of these being deeper than 40 feet.

These trestles are decked, as before stated; the posts are of round timber, from 10 to 15 inches diameter, with the bark taken off, and will probably last longer than square sticks.

At the time that I passed, these trestles were all braced and generally finished, with the exception of the guard rails on one trestle which were, however, delivered upon the ground, and a gang of carpenters at work. In certain cases, the mud-sills of the trestles are built up of smaller blocks than are generally used for this purpose. Timber, however, is not easily got, and, so far as safety is concerned, it makes little difference about the size, provided the foundation is solid.

There are some beam culverts with timber walls that have evidently been put in as rapidly as possible, in order to get the track laid with the least delay. If they are not as sightly as one could desire, it is not difficult to rebuild or replace them, and it is a class of work which the railway company will be obliged to attend to in their own defence. In most cases, more timber has been used in their construction than would be necessary if more time were available.

As regards the efficiency of the bridges to carry the loads imposed, it may be stated that, with the four 20,000-pound axle loads of the Baldwin compound locomotives, placed equidistant about the centre of the four 16-foot stringers, the moment of rupture is 2,004,000 inch pounds.

Assuming the coefficient of resistance to be 6,300 lbs. per square inch, the moment of the resistance of the four stringers becomes 6,451,200 inch pounds, and dividing the last by the first the factor of safety appears to be equal to 3, or more nearly 3.2. In this calculation, no account is taken of the support afforded by the two outer stringers.

It would be better work, in my opinion, and more in accordance with modern practice, if these four inner stringers were made of 9 by 16 instead of 6 by 16, but the fact remains that these locomotives are running upon the 6 by 16 stringers, and that the stringers are doing the work required of them at the present time.

4. The weight of the steel rails is 56 pounds per yard. The angle bars are 24 inches in length, with 4 holes, and weigh 16 pounds each. The track bolts are $\frac{3}{4}$ inch by $3\frac{1}{2}$ inches, with hexagon nuts, 260 bolts per keg of 200 pounds weight. The spikes are $5\frac{1}{2}$ inch by $\frac{9}{16}$ inch, averaging 360 spikes to the keg of 200 pounds.

5. The rail braces are of wrought iron, stamped into shape, with a base of $5\frac{1}{2}$ inches by 6 inches, punched for 3 spikes. The top of the brace fits under the head of the rail $3\frac{1}{4}$ inches over the tie. The minimum degree of curvature upon which these braces or chairs are used was not given to me by the company. They appear to have been most used on the section of the road in the United States, but I understand from the officials of the company that they might be used with advantage on some or more of the curves in the British Columbia section.

6. The track ties are 6 inches by 8 inches, by $6\frac{1}{2}$ feet long, on grade. There are 2,816 ties to the mile.

In the haste with which the track-laying was completed, much of the track was in the first instance only half tied. Before I left there, however (July 20th), ties were being distributed along the British Columbia section over a large portion of its length, at such a rate as to make the full tieing of the track a matter of a few days only.

7. The switches used are of the class called High Banner Switch Stand, with No. 9 Strom clamp frogs, and Sampson wrought head chairs and wrought iron connecting rods. They appear to be a good article, and to answer every purpose.

8. As regards the equipment of the road, I have inserted here the list of locomotives.

9. Cars, etc. (furnished me by the White Pass & Yukon Railway Company). The said list contains the dimensions and weights, etc., of all classes of rolling stock, engines included. The cars appear to be of good capacity for a three-foot gauge road, to be well built, and sufficient in number to handle the present business of the road when the flats used at present for ballasting are available for traffic. Under existing conditions, there was at the date of my departure (July 20th) no great accumulation of freight to be forwarded from salt water, and I understand that it is the intention of the company to add to the rolling stock for the purposes of operation.

10. The coupling used is called the Janey. It is automatic in action, and is considered one of the safest and best known. I am informed by the General Superintendent that there has been no accident in coupling cars since the construction of the road began, except the breaking of one man's finger.

11. The air brake, with proper connections, is used on all trains. I have made enquiry as to whether it had been necessary to use the engine lever and reversing gear for the purpose of braking in any instance in going down grade, and I was informed that the air brake provided was sufficient, and that such an expedient had never been used.

12. A general description of the road in British Columbia has been given to me by the General Superintendent in the following terms:—

"From the Summit, the line of railway runs along the east shore of Summit Lake for a quarter of a mile, thence through a rocky defile into a rolling rocky plain at some distance to the east of the lake. After crossing a gulch on a trestle bridge forty feet in height, the line comes out upon one mile of meadow land by the side of a small river, and follows this river through a narrow, rocky canyon to the upper end of Middle Lake, and following the western shore of this lake, as well as Shallow Lake, to within one mile of Log Cabin. From Log Cabin, the line swings southward around the foot of Sunshine Mountain, and through the Meadows to the head of a stream which drains into Lake Linderman; thence it follows along the southern slopes of the mountain until within a mile of Bennett City."

As the points 13, 14, 16 are well covered by the report of the General Superintendent from which the foregoing was taken, I shall continue to quote the same report, annexing respectively the figures already used of the section to which the subject-matter refers:

"12. The construction of the road was rendered more difficult on account of almost all the work having been executed during the winter months, approximately one-third of the cost of construction being in snow-shovelling.

"The police, under orders from the Government, refused to allow us to begin construction in British Columbia until in October, and the day following that on which the first sod was turned the ground froze up; consequently, grading in the Province between the Summit and Bennett was in frozen ground. Only a small force was maintained in the Province until after the 20th of February, when the track was laid to the Summit. After that, grading was begun at Bennett, as there was less snow there than in the neighbourhood of the Summit, and the work was prosecuted vigorously until the first of March, when the men struck for an increase of wages. During the month of March, only comparatively few men were employed. In April, the work was again pushed as vigorously as possible, all applicants for labour being employed. On the 20th of June, there was twenty feet of snow in the rocky defile one-quarter of a mile from the Summit The same day track laying was begun on the extension from the Summit to Bennett, and pushed as vigorously as possible until its final completion at Bennett on July 6th. Considerable of the grading previous to track laying was of a temporary nature, and in many places the removal of a few yards of rock will enable us to straighten out the line and place it in first-class condition. This work is now being pushed as vigorously as possible, and will be kept in advance of the ballasting.

"No timber was found between the Summit and Log Cabin, and the timber from there to Bennett being of such poor quality, and of such small size, that very little could be used in the construction, other than as firewood and in the construction of the camps.

"The work of ballasting is progressing very rapidly, and in all probability will be completed before the middle of August, at which time all of the construction, except the erection of depôts and snow-sheds, will most likely have been completed.

"16. It will be necessary to erect about four miles of snow-sheds at various points in the neighbourhood of the Summit; in many places we believe snow-fences will be sufficient to protect the railway from drift. At all other portions of the line it is expected that there will be very little difficulty in keeping the line clear of snow at all times with the aid of a rotary plough. The construction of snow-sheds will be begun as soon as the timber which is now ordered arrives, and, it is hoped, will be completed before the winter season sets in.

"13. Station buildings will be erected at Bennett, Log Cabin, and the Summit. The station at the Summit and Log Cabin will be such as is ordinarily built at way-stations on other lines of railway. The one at Bennett will be 107 feet in length by 30 feet in width, and will include a dispatcher's office, two waiting rooms, baggage room, freight, express, lunch counter, and Customs office, with apartments in the second story for the agent's family.

"14. In nearly every instance we will be able to secure a gravity system of water, and during the winter months it will be necessary to keep a watchman and fire going in the tank-house in order to prevent freezing."

Section No. 15, not referred to in the report of the General Superintendent, refers to the furnishing of the profiles and alignment which are sent in herewith.

At Lake Bennett the track is being extended down the east shore of the lake for 2,000 feet, between which and the boat landing will be placed a bonded warehouse, about 33 feet by 70 feet, and a general warehouse, about 30 feet by 140 feet, as may be required by the traffic to be provided for.

The number of men employed between the Summit and Bennett on July 20th was given to me as 720, which I accept as being correct from my own observation.

I endorse the foregoing report of the General Superintendent as regards the completion of the work. I have, however, noticed that the embankments were not in some places as wide as 12 feet. I recommend that the Company's attention be specially directed to the fact, and their promise taken that they be made of the full width. As the Company is now conducting both freight and passenger traffic successfully, I would recommend that their *bonâ fides* be taken as stated with reference to the completion of the line.

17. Coming to the tractive power of the locomotives, their relative hauling capacity is compared under the following assumptions:—That the speed is ten miles per hour, the rate of the up grade 4 %. Adhesion, one-fifth of the weight upon the drivers, and one-fifth of the tractive power consumed in friction of parts. The loads quoted are in addition to the weight of the engine and tender, or in other words, the weight of cars and loading the ton is that of 2,000 lbs.

The first engine upon the list is an 8-wheel Baldwin, 11-inch cylinders, 14-inch stroke, four 42-inch driving wheels coupled; weight, on drivers, 40,000 lbs.; total weight of engine and tender, 70,000 lbs.; steam pressure in cylinders, 130 lbs. per square inch. Can haul 11.6 tons under conditions stated, and has adhesion enough to haul 54 tons.

The second pair of Mogul engines by Brooks next on list have 14-inch cylinders, 18-inch stroke, six 42-inch wheels coupled; weight on drivers, 52,000 lbs.; total weight of engine and tender, 82,000 lbs.; steam pressure, 130 lbs. per square inch. Can haul 56.07 tons, and has adhesion enough to haul 74.5 tons.

The third engine on the list of equipment is a Baldwin consolidation, 15-inch cylinders, 20-inch stroke, eight driving wheels, 38-inch diameter; weight on drivers, 70,000 lbs.; total weight of engine and tender, 110,000 lbs.; steam pressure, 120 lbs. per square inch in cylinders. Can haul 60.2 tons under conditions stated, and has adhesion enough for 100.5 tons.

The fourth and fifth on the list is a pair of Baldwin compound locomotives identical in all respects. Cylinders, 11½-inch and 19-inch, 20-inch stroke, eight wheels coupled, 36-inch diameter; weight on drivers, 80,000 lbs.; total weight of engine and tender, 136,000 lbs.

The Company claims for these two Baldwin compounds 200 lbs. boiler pressure per square inch. It is not likely that the cylinder pressure would exceed 160 lbs. per square inch, nor would it be necessary, as the following calculation at 160 lbs. will prove. The tractive power is enough to haul 202 tons, and there is adhesion enough for 110 tons.

I have been told that these engines take up grade eight loaded flat cars (168 tons gross load), and I have no doubt that this is a perfectly correct statement of their performance, as it requires the adhesion to be a little over one-quarter of weight on the drivers, a condition quite probable in fairly good weather.

The sixth entry on the list is a consolidation engine, built by Grant, 15½-inch cylinders, 22-inch stroke, eight wheels coupled, 38-inch diameter; weight on drivers, 70,000 lbs.; total weight of engine and tender, 110,000 lbs.; cylinder pressure, 130 lbs. Has tractive power to haul 105.7 tons, and adhesion for 100.5 tons.

The last entry is a geared engine of the Climax Manufacturing Company, said to be able to haul a great load at a very slow speed. The cylinders, 12-inch, stroke 16-inch, twelve drivers, 36-inch diameter. Total weight, all on drivers, 80,000 lbs.

It is to be remembered that the conditions assumed above are not as good as those which obtain in good summer weather, during which season these engines might do 25 per cent. more work than above indicated.

I have prepared a table herewith, which gives a general idea of the grades and curves used in location. I believe them to be as good as the ground afforded, having regard to a reasonable economy in first cost. They may in many cases be improved hereafter in the ordinary betterments common to all roads of this class in a difficult country.

It will not be out of place, although out of British Columbia jurisdiction, to say that the wharf at Skaguay is commodious and well arranged. Cattle can be transferred from the slip to the cars upon the dock level, inside a pair of good stout fences, without delay or trouble.

There is besides a beach track, which answers at high water for the handling of heavy freight from barges at a minimum of cost.

The officials of the road seemed anxious to furnish every information in their power. They deserve great credit for the systematic energy with which they have conducted the building of the road, and I have no doubt that it will be finished by the time specified in the report of the General Superintendent, inserted herein.

I have the honour to be,
Sir,
Your obedient Servant,
H. P. BELL.