

to the location of any traction-line which is designed to have a short summit tunnel or go over the pass. This means that there can be no great economy in the first cost of building the Abt line. Its advocates claimed that it could be built for £380,000, but it would doubtless have cost more; while it will be seen further on that a traction-line on a comparatively easy grade can be built for £480,000, and on a grade of 1 in 20 for £400,000. The conclusion of the committee of engineers (see their report of the 27th August, 1900), that the cost of operating either the Abt or Fell system at Arthur's Pass would be extremely high, meets my entire approval. As the Abt and Fell systems do not present any escape from the bulk of first cost, and would be extravagantly expensive in operation, we may dismiss them from consideration. Absolutely no advantage could be gained by the use of either system, and it is fortunate that action on the subject has been confined to survey and discussion only.

REPORT OF THE COMMITTEE OF ENGINEERS.

This report, already referred to, was principally devoted to a comparison of various traction-lines, as follows: One with a grade of 1 in 37; one with a grade of 1 in 37 (electric traction); five with a grade of 1 in 40; one with a grade of 1 in 44; one with a grade of 1 in 50; one with a grade of 1 in 60.

The report and conclusions are ably set forth, and meet my own views in most respects. There is no doubt that any line connecting Otira and Bealey on the grades considered would be costly to build, but the effect of steeper traction-grades such as are used in other mountain regions of the world—in localities too numerous to mention—has not, to my knowledge, up to the present time been outlined in any report. It is the consideration of lines with such grades to which I have directed most of my attention, believing, as indicated, that the subject of easier mountain grades had already been well studied and was substantially exhausted.

It is often profitable to conform as nearly as possible to the obstacles of nature, and endeavour to wrest from them a practicable and reasonable solution, rather than attempt to carry an easy grade through a mountain-range, either by means of a long tunnel, or by a line which may begin at some point many miles from the pass and gain the summit by keeping high upon the slopes, amid cliffs, ravines, and spurs. We cannot avoid all obstacles at Arthur's Pass by any line, but the one which avoids most of them should be the best, provided it has a reasonably workable grade.

THE WORK OF THIS REPORT.

As already described, two surveys have been made entirely through the pass. At my request the topographical sketches of these surveys have been joined, so as to form a continuous map, upon which, under my direction, the several lines which suggested themselves have been drawn, so that some idea of their position upon the slopes could be obtained, and their length, grades, and curvature approximately determined. This was done after a careful study of the situation in the field of ten days' duration, during which I gained a good knowledge of its topographical features, and of its various conditions and obstacles to railway-construction. It is proper to note here, however, that the results obtained by such work are not so complete or definite as those of instrumental surveys would be. The map as prepared gives many heights and distances which have been of great service in laying down the lines mentioned, but it is in no sense a contour map, and the data so obtained can only be considered valuable as an aid in a comparison which may eliminate or render unnecessary the consideration of most of the suggested lines referred to, leaving but one or two to which further attention may be given.

To avoid confusion the lines have been designated as line A, line B, &c., up to line F, following each other in order, line A being the original six-mile-tunnel route, while line F would pass over the summit on a maximum grade of 1 in 20.

DESCRIPTION OF LINES.

In reading the following descriptions it should be remembered that the summit of the railway-grade is east of any summit tunnel, and therefore east of the summit of the pass proper.

Line A.

This, as previously mentioned, is the original six-mile-tunnel project. It crosses the Otira not far above Otira Station, from the south to the north side of the river; thence passes by Dyer's and enters the gorge, which it follows for about 20 chains, where it reaches the point selected as the west end of the proposed summit tunnel. Thence it is entirely on the north side of the Otira Gorge to its proposed east end on the Bealey, about 37 chains west of the Bealey common point, which is gained by keeping along the north margin of the stream. The following are the physical characteristics of this line:—

Length of east approach	...	...	...	...	0 m. 37 ch.
Length of west approach	...	...	...	...	8 m. 6 ch.
Total length of line...	...	...	...	...	8 m. 43 ch.
Maximum grade, west approach	...	...	...	...	1 in 37.
Maximum grade, east approach	...	...	...	...	1 in 40.
Grade in summit tunnel	...	...	...	...	1 in 37.
Minimum radius curve	...	...	...	...	12 ch.
Total degrees of curvature	...	...	...	...	372.
Percentage of line curved	...	...	...	...	20.
Length of summit tunnel	...	...	...	...	31,837 ft.
Total length of tunnels outside of summit tunnel	...	...	...	...	600 ft.
Total length of bridges	...	...	...	...	820 ft.
Elevation of grade at summit	...	...	...	...	2,392 ft.
Estimated cost of construction	...	...	...	...	£566,000.