

while the trains may be long, numerous cars are only partially loaded. This, of course, is unavoidable. I am informed that in New Zealand like conditions exist, and it seems certain that, while a great part of the eastward tonnage from Otira will be coal and lumber, it is still doubtful if the average train will have more than 80 per cent. of a full revenue load of 186 tons. (See Table II.). In other words, 149 tons would be the average revenue train-load. If we take this as 150 tons, it would require 1,000 trains per annum, or an average of 3.2 trains per day, for 312 working-days of the year, to handle the 150,000 tons eastward traffic which it has been thought may be attained. It will be fair to assume that an equal number of trains would be operated for the westward traffic, and to return the empty wagons.

When the line is first opened it may have to do a business which will require 500 trains per annum each way. This may grow until 700 trains are necessary, and from time to time an increase may be made until the 1,000 trains each way per annum are running.

For purposes of comparison these numbers of trains per annum have been used as a basis for estimates of working-costs in Table II. attached, which gives an economic comparison of alternative lines.

Inspection of Table II. referred to does not disclose marked differences between several of the lines as to general results. This is natural enough, since a number of them are mere variations of practically the same line. But we find that lines B, C, E, and F are in nearly the same position as to final outcome, and represent lower annual charges than the others, so we may devote our further attention to them and to line A, the six-mile-tunnel project.

Lines E and F.

Attention is first asked to lines E and F, the first of which would have a summit tunnel a little over a mile long, its west end on the slope overlooking Pegleg Flat, while the latter would go over the pass. Either of these lines can be built for less money than any one of the others, but the difference in first cost between either of them and lines B and C is not so great as one would hope to find where grades of 1 in 22 and 1 in 20 are used. This illustrates the point previously alluded to—namely, that the Abt line presents no especial advantage in cost over a traction-line. In planning the Abt project numerous short pieces of level were introduced, probably to show that frequent crossing-places could be provided, and that thus a great number of trains could be daily run over it. The consequence is that lines E and F would occupy ground which, for a considerable distance, is practically the same as that selected for the Abt line, although further on they are generally at some distance therefrom and higher up on the slopes. While a grade of 1 in 20 was used for line F, it seems quite possible that grades of 1 in 21 or 1 in 22 would be found feasible if it was deemed advisable to build upon this line.

The cost of operating either of these lines would be quite heavy, and, while the total annual charges for them compare favourably with those of lines B and C, it does not appear that any aggregate economy can be made by building either of them. The differences in their favour as to first cost are not large enough to overbalance the differences against them arising from their working-charges. While either of them would enable the tourist to get good views of the gorge, Punchbowl Creek, and other points of interest to the lover of beautiful scenery, it does not seem probable that in the long-run either of these lines would be very satisfactory. There is no advantage in either unless a material saving can be made, and, as indicated, it is not apparent that this is possible. If it was necessary to complete the railway at the earliest practicable moment, then one of these lines would offer the best opportunity to do so. Under all conditions, however, it seems best to regard both these lines as eliminated from the discussion.

Lines B and C.

We now come to lines B and C, which offer the best solutions. The difference between them is not so marked that it might not be overbalanced by a heavy increase in the estimated cost of construction of line B, after careful instrumental survey thereof had demonstrated that this was necessary. Of this, however, there is scarcely any probability; on the contrary, such survey would probably result in a material reduction of the length of the summit tunnel.

The summit tunnel as drawn upon the map, as already described, has its west end on the face of the bluff over the coach-road opposite the foot of Hodge's Creek ravine. It crosses the Otira at Cape Horn, probably 60 ft. below the bed of the stream, and again just south of the roadman's hut in the narrow gorge, about 172 ft. below its bed. The last-named depth is correct, the exact height of the bed of the stream being known; but the first depth is not known to be exact, although it is closely approximate to the truth. The rock in that vicinity and along the line of the tunnel is hard, with no open seams, and it is not probable that the tunnel would encounter shingle beneath the bed of the stream at Cape Horn. There is scarcely any doubt that it would be in solid rock. As to the crossing near the roadman's hut there is no doubt whatever. However, seeing that such doubt exists about the bed of the Otira at Cape Horn, and as the data for such a line as line B, especially from Hodge's Creek to Rolleston Creek, are insufficient in several particulars, I recommend that a careful survey be made of the line from the east end of the proposed tunnel to Otira, and that any doubt about the character of the material in the bed of the stream be settled by examination.

Line B1.

In making the survey of line B the cross-sections should cover enough ground to include a summit-tunnel line which would begin at or near the east end of C. Napier Bell's proposed three-mile tunnel, and terminate at a reasonable height above the river-bed at Cape Horn, the west end of such tunnel being just above the foot of Park's Creek ravine. With such a line the character of the material below the bed of the stream at Cape Horn would have no importance. From the west end of the tunnel thus described the line would descend on a 1-in-30 grade, gradually