

"On Arthur's Pass the dip changes to the south-east, and there is also some change in the character of the rock, the bare sandstone expanding to a much greater thickness than what shows along the Bealey River. There is an absence of deep sagging slips, and from the Bealey to the Otira the rock should prove sound and safe driving-ground, at even an inconsiderable depth from the surface. The principal rock is a hard grey or greenish-grey sandstone, with which is associated bands and thick masses of dark slaty shales, and there is an absence of the greyish, drossy, and pulverent thin-bedded shales and sandstones which have proved so troublesome (as running ground) in the neighbourhood of Wellington and in the Rimutaka and Ruahine Ranges. At the upper end of the Otira Gorge the rocks revert to the thinner-bedded sandstones and shales, but continue to be good standing country, as proved by the siding at the road at Cape Horn, in the deeper part of the gorge. The same character of rock continues to the west end of the Otira Gorge and the junction of Rolleston Creek with the Otira.

"On the crest of Hill's Peak a fissure of great depth has been formed, and this is by some regarded as an extended earthquake fissure. Whatever it may be, for I have not examined it, there is no indication of its being continued in depth to the level of the Otira above the zigzag, nor continued in the mountains on the west side of the gorge and upper valley of the Otira. At the time of examining the district I had discovered most of the great fault-lines that run to great distances along both flanks of the Southern Alps, and had there been any such signs on Arthur's Pass, or along the Otira Gorge, I had not been slow to detect and note the same.

"As the rocks of Otira Gorge and Arthur's Pass are the same in age and character as the auriferous Maitai rocks of Reefton, the opinion of some of the mine-managers might be sought with respect to the standing quality of the rock in which they carry on mining operations.

"In Kelly's Ridge there is a change to a preponderance of black, slaty rocks, the sandstones being less abundant than farther to the east. Up Kelly's Creek these form high vertical bluffs that exhibit the characteristics of good standing country.

"ALEX. MCKAY, Government Geologist.

"Hon. the Minister of Mines."

SURVEYS.

In past years two surveys have been made through Arthur's Pass—one on 1-in-50 grades, which began near Jackson's, eleven miles below Otira, and which required a summit tunnel about three miles long; and another on 1-in-15 grades, designed for an Abt line. In connection with the 1-in-50 line a survey was made for a rope-traction project. The Abt and rope-traction projects were both designed to go over the pass, no summit tunnel being required.

Recently a survey has been made for a west approach of a six-mile-tunnel project.

The railway having been built to Otira, the 1-in-50 line can no longer be considered as an element of the question. But, even if this were not the case, the 1-in-50 project had numerous undesirable features that would have made it costly to build, and, for years at least, expensive to maintain. In locating a railway across a difficult range it is best, in almost every case, to keep along the margins of the streams, where construction-cost is at a minimum, and as far into the mountains as reasonably practicable, concentrating the heavy grades and difficulties at and near the divide. The result of this method is that nearly the whole line of a mountain railway can often be on substantially easy ruling grades, and a heavy train-load can be hauled over it, with the exception of a short mountain section, where assistant engines may be required. The construction of the line from Jackson's to Otira along the river conformed to this practice, and was, in my opinion, quite justifiable. In any event, there are no conditions which would now warrant the abandonment of any portion of the line to Otira, although possibly some readjustment of the Otira Station-yard may ultimately be desirable.

THE PROBLEM.

The problem as it now stands may be stated as follows: Of several lines that suggest themselves, which is the best upon which to build from a common point at the east switch at Otira to a common point on the Bealey, about half a mile east of the east end of the proposed six-mile tunnel.

THE ABT SYSTEM.

The Abt rack railway is unquestionably serviceable in some localities, where grades of 6 ft. to 8 ft. in 100 ft. will enable the engineer to so locate the line as to avoid slopes upon which it might be more or less impracticable to build, either on account of their instability or on the score of cost. We have such a case on the Transandine Railway, which has been building for years, and which will connect the Argentine Republic with Chili, South America. The pass through which this line is being built has a summit elevation of 12,800 ft., the elevation of grade in the summit tunnel being 10,000 ft. The approaches to the pass on both sides are difficult, and it was found that, in order to place the line near the streams on ground where the cost would be within reasonable limits and the line comparatively safe, it would be necessary to use grades as steep as 8 ft. in 100 ft. for short distances. So it has been wherever the Abt system has been used. It is a device to reduce the first cost of construction. Now, if the fall of the Otira River was comparatively uniform in its course westwards from Arthur's Pass to the entrance to the gorge near Dyer's, and if the slopes adjacent to the stream were smooth, we might find in either the Abt or Fell system a method of avoiding a large part of the cost of building a traction-line. But such are not the conditions. The fall of the Otira is far from uniform, and the features are such that in locating an Abt line down the gorge the top of the cascade at Pegleg Flat, which is nearly a mile and a half west of the summit, becomes a controlling factor, and the main descent is from that point rather than from the summit proper. The result is that the line must keep high up on the slopes below Pegleg Flat, where it finds supporting-ground, and it thus meets conditions similar to those which are obstacles