

afford the greatest satisfaction to the scientific world. The rock in the tunnel may be described as a series of lava streams and beds of tufa, intersected by vertical dykes of phonolite. The lava streams generally consist of scoria, overlying a coarse pink trachyte, which passes gradually through shades of grey, purple, and blue, into a black finely-grained dolomite, intensely hard and tough; the lightest and softest rock being at the top, and the densest and blackest at the bottom. Regarded from an engineering point of view, the work must be considered eminently successful. Wherever difficulties have been met they have been quickly and successfully overcome. The syphon employed for the drainage of the upper half of the tunnel is probably the longest on record. The system of ventilation has proved perfectly adapted to the requirements of the case, and has been not only effective but simple and comparatively inexpensive. It is worthy of remark that the engineers of the Mont Cenis tunnel have since found it necessary to adopt similar means of ventilation in that famous work.

The system employed to secure the correctness of the alignment of the two ends of the tunnel was very simple. A permanent mark was fixed in the centre line of the tunnel, on a tower built on the dividing range, nearly midway between the two ends. A transit instrument being placed on the meridian of the tunnel as well as of the tower on the hill, it could be seen at once whether the flame of a candle placed in the centre line of the work inside the tunnel was in a vertical plane with the mark on the tower. But it was also desirable, in case of error, to have the means not only of correcting but of calculating the amount of such error, and this could be readily done. The permanent mark on the central tower consisted of a batten six inches wide, with a black stripe one inch wide down the centre. The eye-piece of the transit instrument being furnished with five vertical wires placed at equal distances apart, the value of the space between any two wires at a distance equal to that of the mark on the tower can be ascertained by reference to the width of the batten, which thus gives a scale by which the error in the position of a light placed in the tunnel under the tower can be rated with great exactness. It has been by this means that the alignment has been tested from time to time, and the proof of the correctness of the system has been established by the present results.

In spite of the peculiar character of the work the health of the men has been generally very good. Accidents have been of rare occurrence, and of comparative unimportance. Only two fatal cases have occurred during the long term of the work, and these we fear must with justice be attributed to the carelessness of the poor fellows who perished—a carelessness against which no amount of precaution could have availed. One of the men died from internal hemorrhage caused by a blow received from the sudden ignition of a charge which had missed fire, and which he was engaged in boring out without proper precaution. The other died from the effects of burns received from a powder explosion, caused by throwing the snuff of a candle upon loose powder. The man was engaged at the time in constructing cartridges for the miners. In addition to these fatal cases, there occurred one of loss of sight, another of a broken leg, and a few cases of contusion and other trifling hurts, which, under the care of Dr. Rouse, of Lyttelton, who has attended the men throughout, were soon satisfactorily disposed of. This singular freedom from accident may fairly be attributed to careful arrangement generally, and to the superior character and ability of the foremen, Mr. Edward Walker and Mr. Harry Smith, who have superintended the work throughout. A great deal is also due to the general superior *morale* of the men themselves.

Throughout the whole period there have been no strikes or disturbances among the men. They have been well treated by their employers, and have behaved well in return. This pleasant understanding has probably been cemented by the interest taken by the engineer and the contractors in the men's amusements. Mainly through the instrumentality of these gentlemen the miners and others connected with the Railway works were encouraged to enrol themselves as a Volunteer Company. No. 8 C.R.V. soon became eminent for its band, and has gained a deserved reputation for good shooting.

Messrs. Holmes and Co. have had to contend with difficulties quite serious enough to have frightened men less determined and persevering than they have proved themselves to be. Scarcely had they commenced work before the sudden discovery of gold in Otago upset all previous calculations as to the cost of labour, and seriously interfered with the shipping arrangements, by which they hoped to receive the bulk of their plant from Melbourne. Hardly had this excitement quieted down before the Canterbury goldfields were discovered, and the West Coast road created a demand for the special kind of labour required in the tunnel, thus depriving the contractors of many of their most practised hands. But these and numberless other minor difficulties have never interfered with the work, which has been continued night and day, more as if it had been carried on by mechanism than by the labour of sentient human beings. To the contractors' steadiness and perseverance the province mainly owes the fact that this weary work has been brought to a successful issue.

And not to the contractors only, but to the engineer, Mr. Edward Dobson, is a debt equally due. Of him it may be fairly said that, latterly, his whole energies—his very being—have merged themselves into the tunnel. Whatever the most unwearied care and the closest supervision could effect for the benefit of the great work has been done by him. His name deserves to be, and doubtless will be, brought prominently before his professional brethren in the old world as soon as the successful result of this great experiment becomes known.

The total length of the tunnel, as nearly as can be ascertained at the present moment, is in round numbers 2870 yards, or about 30 yards more than the contract measurement, and the cost, according to the contract, is £195,000.

According to the design drawn in London, the tunnel would have entered Lyttelton at a slight curve. This part of the plan was altered, so as to give a straight run throughout.

At a very early hour on May 29,—somewhere about 3 a.m.,—the miners on the Lyttelton side succeeded in making a practicable breach in the tunnel; whereupon they rushed through, and after having paid a congratulatory visit to Mr. Holmes at Green Hammerton, breakfasted with their fellow workmen in the Valley. As soon as the contractors were made aware of the fact, they sent an impromptu invitation to his Honor the Superintendent, asking him to pass through the tunnel and afterwards lunch with them in Lyttelton. A certain number of official friends of his Honor were included in this invitation, and also several private friends of the contractors. A train containing the following gentlemen left Christchurch at 12 p.m.:—His Honor the Superintendent, and Messrs. Stewart, Williams, Duncan, Dobson, Ollivier, Davie, Aynsley, Reeves, Donald, Hamilton, Major, Coster, Rouse, C. R. Blakiston, A. F. N. Blakiston, Maude, Hennah, R. Holmes, and Dr. Haast. At about 1 p.m. the party started on their journey through the tunnel, carried on two trollies. The miners' band, better known as that of No. 8, C.R.V., was stationed at the mouth of the tunnel, and played some appropriate airs on the arrival of the guests. The journey through the tunnel occupied (including stoppages) about half-an-hour. At the junction of the two drives the travellers had to change carriages and pass through the aperture which had been made that morning. So thoroughly had the drive been opened out that the passengers had scarcely to stoop their heads in descending from one side of the tunnel to the other. It was particularly noticeable that a free current of air was passing through from the Lyttelton to the Heathcote side.

On arriving at the Lyttelton end of the tunnel, Mr. G. Holmes congratulated his Honor upon the successful passage of the tunnel, to which Mr. Moorhouse replied in a few appropriate words. The company then adjourned to the Queen's Hotel, where a luncheon had been provided by the contractors, and where much kindly interchange of congratulatory feeling took place. Shortly after the gentlemen passed through the tunnel, a party of adventurous ladies, including Mrs. Moorhouse, Mrs. Holmes, Mrs. Richardson, Mrs. Dobson, and a few others, successfully accomplished the passage, to the great delight and gratification of the miners who conducted them.

Some disappointment was at first felt in Lyttelton because notice had not been given to enable the loyal citizens of that town to turn out in form and do honour to the occasion. But as soon as it was clearly understood that the celebration was of a purely private character, and was in fact simply an invitation from the contractors to the Superintendent and a few personal friends, the feeling vanished.

On Whit-Monday the holiday makers of Christchurch were invited to a promenade through the tunnel, free of charge, and the day being extremely fine, nearly two thousand persons availed themselves of the opportunity of inspecting this work of skill and labour, so creditable to the Province of Canterbury. Messrs. Holmes and Co. ran a train of nine carriages on the railway between Christchurch and Heathcote every hour, and about noon a stream of pedestrians was to be seen threading the pleasant valley, far greater than has ever been witnessed since the first living freights of the Canterbury Association, for want of such a road as this tunnel, scrambled up the face of the hill and descended from Cooper's Knob into the plains below. On that occasion the pioneers of the settlement encountered nothing but the rugged grandeur of nature, the face of which they had come to soften and subdue by the resources of art. But how changed the scene now! The human tide was turned. Men's eyes were again directed to the hills, and they traversed a good road, with many signs of cultivation on both sides; they passed a church and schoolhouse, and a multitude of neat cottages; and they saw a work which may have suggested itself to some of the more enterprising, but which few could have hoped to see executed.

On the occasion of his Honor the Superintendent formally opening the Moorhouse Tunnel, he made a handsome present to the workmen, and in return they invited him to a *déjeuner* in the tunnel, which took place on June 29. A section of the tunnel, in the centre, extending for thirty yards, was fitted up with flags, banners, &c., forcibly reminding the spectator of the old Moorish Halls of the Alhambra. At one end an impromptu orchestra had been erected, in which was stationed the band of No. 8 Company Canterbury Rifle Volunteers. The chair was occupied by Mr. E. Walker, foreman of works at the Lyttelton end, and the vice-chair by Mr. Smith, foreman at the Heathcote end. At the centre table were the following invited guests:—His Honor the Superintendent; Messrs. F. E. Stewart, Provincial Secretary; G. Hart and J. S. Williams, members of the Executive; E. Dobson, Railway Engineer; J. Ollivier, Provincial Auditor; G. Holmes and E. Richardson, the contractors for the railway works; and Drs. Donald and Rouse. The dinner, which comprised all the delicacies of the season, was provided by Mr. A. Cuff, of the Queen's Hotel, Lyttelton. After the removal of the cloth, the usual loyal and patriotic toasts were given and duly honoured. In responding to the toast of the Superintendent, Mr. Moorhouse paid a high compliment to the managers, workmen, and all connected with the great work, and expressed his belief that on the opening of the railway for traffic, a large export trade would be developed, which would help to disperse the temporary depression under which the province had hitherto laboured.