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TUNNELLING AND GEOLOGY

THE IMPORTANCE OF GEOLOGIC SURVEYS IN CONNECTION WITH TUNNEL WORK—SIZE AND CROSS-SECTION OF BORES—METHODS OF DRIVING—LINING—UNDERGROUND WATER.

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ON account of the magnitude of tunnel work undertaken lately in this country, and owing to the remarkable progress attained abroad during the past decade, much ink has flown on the subject of tunnelling, and the outcome of various discussions brought forth has stimulated to no small extent the activity of tunnel men. The result is that to-day the high rate of driving progress attained in Europe has been equalled and even surpassed in several instances, in this country, when driving headings and tunnels of small cross-section. Generally, however, the improvements made in this field of engineering have been chiefly connected with details, which, in large tunnels, are of vital, though secondary, importance. Other items of still more vital or basic importance, such as the method of attacking a bore of large cross-section, a railroad tunnel for instance, also the method of timbering and lining same, have received less consideration, and yet, it is precisely such features which are of greatest bearing on the cost and success of large tunnel enterprises. Mention should be made here, however, that new tunnelling methods are being used in connection with driving the Mount Royal and Roger's Pass tunnels; in the first instance, reasons of unusual character, aiming probably towards the rapid completion of a large railroad terminal station, in a well-populated city, have prompted the adaptation of tunnelling methods similar to those used abroad, while in the second instance, expected economy and rapidity in construction have guided the contractor to adopt a method which is at least practicable if not of absolute necessity.

The extent of geologic surveys in connection with tunnel work has also been closely limited in this country, and it is surprising to note that huge enterprises, involving millions of dollars, have been undertaken without first providing the contractor with adequate information as to the nature of the materials expected to be encountered, not to mention the fact that the engineers in charge of the work were often hardly aware of the difficulties which the contractor was expected to overcome, at his own expense. More recently, however, the need of more definite geologic data, serving the purpose of outlining obstacles liable to be encountered during construction, has prompted those in charge of large enterprises to make due allowance for preliminary geologic surveys. In this respect, the surveys made in connection with the Catskill aqueduct, for instance, have contributed to no small extent to the successful completion of this mammoth enterprise.

Briefly reviewed, geological surveys made in connection with tunnel work serve the following purposes: (1) to ascertain the feasibility of the project as a whole; (2) to determine the size and number of bores; (3) to determine the distance between bores in case of twin or more tunnels; (4) to select the shape or cross-section of the bore or bores; (5) to determine whether the bore is to be left unlined or is to be lined, partly or throughout its length; (6) to determine the dimension, and to design the various elements entering into the construction of the lining and timbering; (7) to select the driving method most suitable for a particular case; (8) to estimate the probable amount of underground water expected to be taken care of during construction, and further, to determine the probable rock temperature in the tunnel, the time necessary to drive the tunnel, and the approximate cost of the bore.

It is obvious that the geologic formation of a range to be tunnelled does not bear alone on the above items, but, as hereafter illustrated, it has some bearing on any one of them.

Size and Number of Bores.—The geologic formation of a range and the overlying depth have probably more bearing on the size and cross-section of long tunnels than any other features; whereas conditions of clearance and traffic usually determine the dimensions of short tunnels. In long tunnels, the driving methods, strength of the lining, ventilation during construction, etc., all depend to a marked extent on the materials penetrated and their stratification, cohesion, etc. Ground pressure may become so intense as to render the construction of a double track bore prohibitive if not impossible. An idea can be gained as to what would become the thickness of the lining of a double track bore subjected to a pressure similar to that resisted by the 66-in. thick cut stone masonry lining of the single track Simplon tunnel. In the Karawanken double track tunnel, where ground pressure was only 20 tons per sq. ft., the lining had a thickness of 59 in. A pressure similar to that encountered in the Simplon tunnel would, in a double track bore, require a quantity of timbering almost beyond conception during construction. When it is borne in mind that, other things being the same, the lining of a double track tunnel can carry only one-half the load supported by a single track tunnel, it becomes evident that, in certain instances, ground pressure limits to a marked extent the possibility of driving tunnels accommodating two or more bores.