

Mr. J. H. Greathead, Mem. Inst. C. E., for the subways under the river Thames in this city, afterwards adopted for the Sarnia tunnel on the Grand Trunk Railway and now working with some modifications of detail in the tunnel under the river Hudson in New York, and in the Vyrntory tunnel under the river Mersey. By means of such a shield, suitably designed in wrought iron or steel, work can be carried on with much greater safety to the men employed and without the use of temporary timbers which whether left in permanently or withdrawn constantly prove a source of weakness to the permanent work.

In very soft and wet strata and where compressed air has been employed it has been found desirable to adopt for the permanent tunnel a cylinder of cast iron with suitable flanges, such cylinder being sometimes lined wholly or partially with brickwork for protection purposes.

In homogeneous and dry strata such as the shale referred to by Mr. Bain, I have a strong preference for a tunnel also cylindrical in form but composed entirely of brickwork in cement (grouted externally where practicable) as being of a much more permanent character than an iron structure, which, however well protected, must be more or less subject to corroding influences.

In the present instance there would be great advantages in a brickwork tunnel of using local instead of imported materials of much reduced cost, and of more easily providing refuges for the platelayers.

I should propose therefore to carry out the work from a shaft at each end or possibly from a permanent pumping shaft at Carlton Point, and from an open face at Money Point by means of a shield specially designed for rapid progress in good material, and in conjunction with brickwork but so arranged that where, as in the sandstone beds, feeders may be met with, an iron casing may be readily introduced to keep back the water, and to reduce the permanent pumping. In my estimates I allow for a considerable length (one-fourth of the whole distance between the shafts) of such casing.

The shield can also be so arranged as to permit of a small test heading being kept in advance of the main work, which I have found in similar works under my charge to be of great advantage.

The highest speed as yet attained with a shield in connection with a cast iron tunnel is, I believe, from $3\frac{1}{2}$ to 4 yards per day as an average at each face, but through the strata shown to exist under the Northumberland straits, I anticipate no serious difficulty in attaining an average speed of about 5 yards per working day, or say 300 days per annum at each face, which after allowing for shaft sinking, brick making, and other preparations would enable the tunnel to be completed within from $5\frac{1}{2}$ to 6 years from the commencement of the work.

Locomotive pumps, of special design, would be necessary to clear the face of the work on the descending gradient at the New Brunswick end of any water which may percolate through the shield during construction, and permanent provision would have to be made at the pumping shaft for dealing with any water arising during construction in the work driven from the Prince Edward Island end, as well as permanently with the leakage arising throughout the tunnel.

Compressed air plant would be required at each shaft, for the purposes of ventilation during construction and also for establishing pressure at the working faces if required.

Owing to the great length of the subaqueous tunnel, viz., 13,500 lineal yards (or rather over $7\frac{1}{2}$ miles) from shaft to shaft, and to reduce as far as possible the enhanced cost, and delays consequent upon such long leads as will be necessary, a well laid line of way should follow up the work as closely as possible upon which pumps, lighting plant, excavation materials and workmen may be rapidly conveyed.

If the permanent tunnel be of normal size, then by adopting a narrow gauge and proportionately small rolling stock for this temporary purpose, passing places and sidings can be introduced.

The motive and pumping power and the lighting of the tunnel during construction can be provided for by at once installing electrical plant to be permanently used as hereinafter proposed.