

## Northumberland Straits Tunnel.

Accompanying Mr. Bain's report upon the brick clay came a cross section of the straits plotted to a distorted scale (Appendix B), together with samples of shale and sandstone as found in the neighbourhood.

Having communicated, through the Hon. G. W. Howlan, my desire for further and more distinct information, I received the reports by Mr. Bain, dated respectively the 18th December, 1890, and the 14th March, 1891, of which copies are annexed (Appendices C and D), together with a cross section of the straits to a natural scale (Appendix E).

In the report (D) Mr. Bain remarks:

"The great shale beds are persistent and uniform, but the small arenaceous or calcareous deposits which occur in them are local lenticular and discontinuous and not likely to form leads for water. \* \* These shales are impermeable to water. The carboniferous base of sandstone will possibly form a dangerous source of water, and it should be avoided, but, as already remarked it does not break up under the bed of the straits here. \* \* \*

"It is my duty to state that though convinced of the accuracy of what I now present, a more minute and detailed geological investigation should be made before active engineering operations are begun."

I have also before me a copy of a letter addressed on January 9th, 1891, to the Hon. G. W. Howlan by Sir William Dawson of McGill university, Montreal, which runs as follows:

"I beg to say that I have read and examined the report and section prepared by Mr. Bain, with reference to the proposed tunnel from Carlton Head to Cape Jourmain, which you were kind enough to shew me, and that from my knowledge of the geological structure of the locality, I have no hesitation in stating that I believe the report and section fairly represent the character of the beds to be penetrated by the proposed tunnel, and that these will not present any serious difficulty, the ground being in fact as favourable as could be desired for such a work."

It is evident from the cross sections supplied by Mr. Bain that it is possible to locate the tunnel entirely above the carboniferous sandstone strata and care should be taken not to tap these strata either by shafts or borings in the immediate neighbourhood of the intended work.

So far as I can judge from the small specimen of the shale in my possession I agree that it is likely to be impermeable to water and to form a favourable material for tunnelling operations. The cross section, however, shows that owing to the slight inclination of the beds the tunnel cannot be made to pass entirely through this stratum but must necessarily cross at an oblique angle and therefore for some distance through certain sandstone beds which are shown thereon and which I understand to be red sandstone similar to samples in my possession.

Judging from subaqueous work carried on under my supervision in sandstone of a somewhat similar character, I should expect a certain amount of percolation but not large feeders of water from this rock. It is of course impossible to speak with certainty upon this point, but I am strengthened in this opinion by the conformable nature of the strata in the neighbourhood which I understand from Mr. Palmer to be remarkably free from faults, showing that the beds as mentioned by Mr. Bain have not been exposed to strain.

Owing to the great depth at which the tunnel in some portions of its length will lie below the level of high water, viz.: 156 feet to the underside of the invert, it would be impossible for men to work under the full hydrostatic pressure which would amount to about 68 pounds per square inch, whereas 40 lbs. per square inch can only be endured at considerable risk and for a short time. Whilst, therefore, a reduced pressure might be found useful at certain points to check the flow during construction it would be necessary to make provision for pumping such feeders as might be met with reduced as before mentioned and limited also by exposing at one time as short a length of ground as possible.

Since I reported upon this subject to the Hon. (now Chief Justice) Sullivan on the 7th April, 1886, much progress has been made in the driving of subaqueous tunnels in water bearing strata by means of shields similar to that introduced by