of the points that have come under my notice in respect of the strength of beams, and the weights that they have to bear. These are matters on which I am not competent to pronounce, and they relate, moreover, to the original design and construction of the tunnel, and not directly to my inquiry. But I have thought it might be useful, and perhaps interesting to the officers of the Government department concerned in such works, to throw together compendiously a few notes, showing some of the points that have arisen, and the discrepancies of scientific opinion which appear to exist in relation to the strength of the tunnel. I also forward my notes of the evidence taken.—I have, &c.,

"17th April, 1890." "JOSEPH GILES.

"*Appendix.*

"Mr. C. Y. O'Connor has been good enough to lend me his report on the Kumara Sludge-channel, dated 16th September, 1880 (P.W., Mid. Isl., No. 80, 1,492). In that report is a full criticism of Mr. Wylde's opinion as to the weight which a cap-piece would have to bear in the event of any subsidence happening. Mr. Wylde, in his evidence given ten years ago, on the occasion of a fatal accident occurring in the tunnel at the time of its construction, estimated the weight on each cap as the amount of earth vertically over it to the surface; but in a letter to the *Kumara Times* of the 30th July, 1880, Mr. Wylde explained that he only meant that the caps would have to bear that weight in the event of a subsidence. In answer to a question put by me at the late inquiry, Mr. Wylde further explained that he meant, in the event of a subsidence reaching to the surface. Mr. Wylde also said that he thought the theory set forth by Mr. O'Connor in his report, based upon the similarity of the conical cavities over tunnels of different sizes, sound enough, but that there was nothing to prevent such cavities in many cases from running to the surface. Mr. Wylde added that in the event of a subsidence to the surface it would in some cases be impossible for any timbers to bear the weight. Mr. Wylde says that the strength of the caps in the sludge-channel ought to be nine times that of the caps in an ordinary mining drive—that is, that the strength should be inversely as the square of the span, 12^2 being to 4^2 as 9 to 1. (But, the caps being 10ft., and not 12ft., in the span, the proportion would be 6·25 instead of 9 to 1.) Mr. Wylde says the caps are in fact only $2\frac{1}{4}$ times as strong. This seems to be founded on the supposition that the strength of the beams of equal length is as the area of surface of their transverse sections. I must presume that he means that this is the case when the breadth and depth preserve the same relative proportions, for otherwise it would be indifferent whether a board were set flat or edgewise. It would follow, therefore, from Mr. Wylde's datum that the caps ought be of such a size as to give an area on transverse section of $64 \times 9 = 576$in.—that is, that each dimension ought to be $\sqrt{576} = 24$in. !

"The formula used by the Government engineers for obtaining the strength of beams is founded on Balfour's experiments on timbers, which gives the coefficient S for various kinds. W = the ultimate strength of the beam; b and d the breadth and depth of cap in inches; l the length in feet between the uprights: then $W = \frac{8bd^2S}{l \times 2,240}$, the coefficient for birch being 202·5. This gives a strength of 125 tons as weight distributed over a beam of 10ft. span and 12in. thickness: $\frac{8 \times 12 \times 144 \times 202{\cdot}5}{22,400} = 124{\cdot}97$ tons. Applying this formula to a cap of 10ft. span and 8in. thick, the result would be about 37 tons, which is to 125 as about 1 to $3\frac{1}{3}$. In this formula it is clear that when $b = d$, $bd^2 = d^3$, and therefore d^3 is the varying factor, and not d^2 as Mr. Wylde seems to suppose. This seems to be rather a serious error, unless Mr. Wylde can show that the formula used is wrong.

"With regard to the general question of the strength of beams, I have referred to a little book called 'Trautwine's Civil Engineers' Pocket-book,' where I find the following formula (adopting the same letters as before): $W = \frac{bd^2S}{l}$, where W will be pounds instead of tons, and represents the centre-breaking weight; whereas the weight in the other case is distributed. Trautwine gives the coefficient for English beech, sycamore, and yellow-pine at 500, and teak at 750. Applying this formula to the sludge-channel caps, if they were made of teak, the centre-breaking load would be something under 58 tons, whereas the formula of the Government engineers gives 62·5 tons for birch. Mr. Balfour gives for teak a coefficient of 205·17, which is a little more than birch. The two formulæ are easily reconciled, so far as I am able to understand the matter from the explanations which have been given me. But the fact that birch is regarded as at all comparable to teak in weight-bearing power rather surprised me. If the estimates made are approximately correct it would seem to point to the conclusion that, whilst birch may have a high power to resist dead weight, it is yet likely to give way under a sudden impact.—J. G."

At the recent inquiry held by Dr. Giles as to the cause of the break in the sludge-channel the evidence given by Mr. James Wylde ought not to pass without some remarks, as he stated he was a civil engineer of forty-five years' experience, during twenty years of which he had been on the West Coast, and therefore his evidence might be taken as that of an expert capable of giving a reliable opinion as to the design of this work; whereas it can be clearly shown that the principle on which he based his calculations was a fallacy and the results arrived at erroneous. It is also due to those who had charge of the construction of this work and designed it, not to allow the assertions made by Mr. Wylde to pass unchallenged. It is stated in the *Kumara Times* of the 5th April that he gave the following evidence: "The tunnel is only one-fourth the strength of an ordinary miner's tunnel. I prove that in this way: It is an ascertained and well-known fact that the strength of a beam is inversely as the square of its length. An ordinary cap is 4ft. long, the square of which is 16. The channel caps are 12ft. long, the square of which is 144. As 16 will go 9 times into 144, the caps should be nine times the strength of ordinary 4ft. ones. Caps used by miners in permanent tunnels are usually 8in., the square of which is 64. The channel caps are 12in., the square of which is 144. Sixty-four will only go $2\frac{1}{4}$ times into 144; consequently, instead of being 9 times