they are only 2¼ times the strength of miners' caps." Mr. Wylde states that it is well known that the strength of beams should be inversely as the square of their length and the square of their depth. This applies in a measure to tunnel-timber; but it is also well known that if Mr. Wylde's theory were applied to beams the result arrived at would be perfectly erroneous, as will be shown hereafter.

In calculating the strength of beams the distance between the supports, or actual span, is taken. The span of the channel caps is 10ft., and not, as stated by Mr. Wylde, 12ft. Also, the caps usually in miners' tunnels are of round timber, and in very few instances are square caps met with in small tunnels, except it were an opening set, or some particular place where connections are made with branch tunnels or suchlike; and, moreover, in many instances the best description of timber is not used, but generally timber growing in the locality adjacent to the work. It is also laid down by all authorities, such as Rankin, Stoney, Barlow, Molesworth, Trautwine, and others, that round beams are not more than two-thirds the strength of square beams. Indeed, some of these authorities make them to be less than this; but, assuming them to be two-thirds the strength, then there is another element to be taken into account—namely, the sap-wood on small round timber, which decays in the course of a couple of years; and, at the least, the depth of sap-wood cannot be taken at less than ½in. It must also be remembered that the only authentic experiments on New Zealand timber at the time this work was designed were those made by Mr. Balfour in 1865, which were published in the jurors' report on the first exhibition held at Dunedin. The values of the constants there given had to be taken, as there was no other data to work on. The averages of all the experiments of the number of pounds it required to break an inch square on the different classes of timber such as are generally used on the West Coast were as follows: Black-birch, 202·5; black-pine, 190; red-pine (rimu), 140·2; totara, 133·6; white-pine (kahikatea), 106; kamai (which at that time was generally termed red-birch), 158·2; kawaku, 75. These are the general classes of timber growing on the West Coast, and in many places, such as at Ross, the general class of timber used for main drives and tunnels was red-pine and kamai (red-birch—or, at least, it was known by the name of red-birch).

The question of the weight that is likely to come on timber in tunnels depends entirely on the nature of the ground, and cannot be calculated to such a nicety as when the exact load is known. We find the strength of different materials by experiment, and by experiments made in timbering tunnels it has been found that timber of certain dimensions was sufficient to keep up the ground. The question of deciding on the dimensions of the timber to be used in the construction of the sludge-channel was not arrived at in a haphazard manner, as one might suppose from the evidence given by Mr. Wylde at the inquiry, but was gone fully into after the first accident in 1880, as will be seen from a table of the relative strength of different caps used in underground workings, taken from the office records as a means of arriving at the strength of caps for the sludge-channel:—

Tunnels referred to.	Width of Tunnel in Clear — Span of Cap.	Distance from Centre to Centre of Frame.	Relative Load on Bases of Square of Span only.	Relative Load taking into Account the Distances of Frames also.	Probable Maximum Actual Load, arrived at as Above.
	Ft. in.	Ft. in.			Tons.
New Zealand water-race tunnels where 6ft. wide	6 0	3 0	1·0000	1·0000	8·11 (assumed).
New Zealand water-race tunnels, ordinary	5 0	3 0	0·6944	0·6944	5·63 (calculated).
Mining-drives at Ross	7 8	4 0	1·6327	2·1769	17·65 "
Sludge-channel as proposed by Mr. Gow	9 0	4 0	2·2500	3·0000	24·33 "
Mining-chambers at Ross	10 0	2 0	2·7778	1·8518	15·02 "
Sludge-channel in course of construction	10 0	4 0	2·7778	3·7037	30·04 "
Sludge-channel where double-timbered...	10 0	2 0	2·7778	1·8518	15·02 "

Caps.—Factors of safety, arrived at by dividing the ultimate strength by the probable maximum actual loads deduced as above:—

Tunnels referred to.	Span of Caps.	Diameter of Caps.	Class of Timber.	Load.	Ultimate Strength.	Factors of Safety.
	Ft. in.	In.		Tons.	Tons.	
New Zealand water-race tunnels where 6ft. wide	6 0	9	Rimu ...	8·11	40·56	5·00
New Zealand water-race tunnels, ordinary...	5 0	8	" ...	5·63	34·18	6·07
Mining-drives at Ross	7 8	10	" ...	17·65	43·54	2·46
" "	7 8	10	Kahikatea	17·65	32·92	1·86
Sludge-channel as proposed by Mr. Gow ...	9 0	9	Rimu ...	24·33	27·04	1·11
Mining-chambers at Ross	10 0	15	" ...	15·02	112·65	7·50
" "	10 0	15	Kahikatea	15·02	85·18	5·67
Sludge-channel as in course of construction	10 0	12x12	Black-birch	30·04	124·97	4·16
" where double-timbered ...	10 0	12x12	" ...	15·02	124·97	8·32