The second part of the foregoing table gives a higher factor of safety for round sticks than should be taken, inasmuch as the whole diameter is included. The sap-wood becomes in a very short time valueless; besides, it is customary in making sets of round timber to flatten the upper side of the cap a little, for chocks or riders to be used so as to allow the next set of laths to be entered. Therefore, in using round green saplings, or young trees newly cut, the sap-wood should be deducted in calculating either their transverse or crushing strength. Assuming, as before, that the New Zealand water-race tunnels have a factor of safety of 5, then the relation of the different caps in the table shows that the channel caps have their relative strength in comparison to those used in other tunnels and drives. As regards the actual transverse strength and durability of the timber used, far more is now known respecting it than when this work was designed; but at that time the coefficients arrived at by Mr. Balfour as regards its transverse strength had to be taken, and these coefficients are used in calculating the ultimate strength of the different caps in the following table :—

Tunnels, same as previous Table.	Span of Caps.	Diameter of Caps.	Diameter of Caps with Sap-wood deducted.	Class of Timber.	Load.	Ultimate Strength.	Factor of Safety.
	Ft. in.	In.	In.		Tons.	Tons.	
New Zealand water-race tunnels where 6ft. wide	6 0	9	8	Rimu ...	5·70	28·49	5·00
New Zealand archway tunnels ...	5 0	8	7	" ...	3·96	22·90	5·78
Mining-drives at Ross	7 8	10	9	" ...	12·41	31·74	2·56
" "	7 8	10	9	Kahikatea	12·40	24·00	1·93
Sludge-channel as proposed by Mr. Gow	9 0	9	9	Rimu ...	17·1	17·00	0·99
Mining-chambers at Ross ...	10 0	15	14	" ...	10·55	91·60	8·68
" " ...	10 0	15	14	Kahikatea	10·55	69·25	6·56
Sludge-channel with sets 4ft. apart from centre to centre ...	10 0	12 x 12	12 x 12	Black-birch	21·11	124·97	5·92
Sludge-channel where double-timbered	10 0	12 x 12	12 x 12	"	10·56	124·97	11·84

It will be seen, therefore, that the strength of beams depends on the class of timber used, and not inversely as the square of its cross-section, as stated by Mr. Wylde, regardless of anything else. If the cross-section was taken as the element of arriving at strength, then a beam would be as strong laid on its side as one standing on edge. This would totally disregard all the known formulæ for arriving at the strength of beams to carry a given load—*i.e.*, beams supported at both ends—namely, $\frac{8bd^2s}{l}$, where b is the breadth of the beam in inches, d the depth in inches, s the coefficent of the transverse strength of the different classes of timber, and l the span in feet between the supports. Taking $\frac{bd^2}{l}$, and omitting the other elements, we find the relative proportions of strength. We will suppose a beam is 10ft. long between the supports, 12in. broad, and 6in. deep; then we have $\frac{12 \times 6 \times 6}{10} = 43{\cdot}2$; but if its depth were 12in. and its breadth 6in., then we should have $\frac{6 \times 12 \times 11}{10} = 86{\cdot}4$, which shows that it is twice as strong when set on edge as it would be if laid on its side, although its cross-section is the same in both cases. It will be seen, therefore, that estimating its strength by the number of square inches in its cross-section is erroneous.

There are a number of tunnels and adit-levels which are 6ft. wide in the clear, timbered with caps of red-pine (rimu) 9in. and 10in. in diameter, which have stood for more than ten years, and, if the strength of these be compared with the sludge-channel caps, the latter will bear a favourable comparison. Taking the relations of the squares of their respective lengths as their strength is to each other, they are as 36 is to 100, or, the sludge-channel caps would have to be 2·77 times the strength of the 6ft. caps; taking the channel caps to be of black-birch, and using the coefficients arrived at by the experiments of Mr. Balfour, their relative strengths are as follows :—

$$\text{Channel-caps} = \frac{8 \times 12 \times 12 \times 12 \times 202{\cdot}5}{10} = 279{,}936\text{lb.}$$

$$\text{6ft. caps of rimu 10in. in diameter, allowing 1in. for sap-wood} = \frac{8 \times 9 \times 9 \times 9 \times 140{\cdot}2}{6} \times \tfrac{2}{3} = 90{,}850\text{lb.}$$

The strengths of these, therefore, are as 90,850 is to 279,936, or, the channel caps are 3·08 times the strength of the 6ft. caps, whereas according to the squares of their respective lengths they only required to be 2·77 times. If the 6ft. caps were to be taken as being of the same description of timber as the channel caps, then the relative strength would be as 131,220 is to 279,936, or, the channel caps would be 2·13 times the strength of the other, in place of 2·77, but the caps in ordinary miners' tunnels might be of any other description of timber, such as kamai, totara, and even in some instances white-pine, and in that case the channel caps would have more than their proportionate strength.