(c) Owing to the depth of the litter layer and the fibrous humus layer of the soil, heavy mortality occurs amongst seedlings during prolonged dry weather, roots not having penetrated to the A1 horizon of the soil.

(d) Second growth, particularly *Blechnum fraseri*, is aggressive and seedlings have benefitted by removal of second growth four years after initial clearing, this being reflected in density of stocking and vigour of released seedlings.

(e) Root competition has been keen and kauri seedlings on a quadrat whose boundaries were trenched to below the general root level have shown a significant improvement in size and vigour as compared with an adjoining control quadrat. Further quadrats are to be trenched for confirmation of this point.

TIMBER FOR COAL MINES IN THE WAIKATO DISTRICT.

By R. H. SCHOEN [1] and J. L. HARRISON-SMITH [2]

To make this discussion intelligible it is first necessary to describe briefly the layout of a mine and to explain some of the terms used. We will therefore commence with coal and the methods of mining it.

Coal occurs in layers called *seams* of varying thickness from a few inches to many feet and there may be several seams, one above the other, separated by rock. Thus, under the Waikato River at Huntly, there is an aggregate of 80 feet of coal in several seams.

The coal may be reached by a *shaft* which descends vertically, by a sloping drive called a *dip* or *dip heading*, or by a *drive* which enters the coal horizontally. However, once the coal is reached the method of working is much the same in every case in New Zealand ; the same conditions apply and the same terms are used.

A mine is set out with one or more *main headings* or main roads and these are of a permanent nature and may be expected to last up to 50 years or so, according to the amount of coal and the rate of extraction. The length of these main roads may be miles and, as an example, there is the main road in the Renown Mine in the Waikato three miles long, with probably much unexplored coal beyond.

From the main headings which are usually driven on the *full dip* (maximum slope) of the seam, pairs of development or *panel headings* run at right angles. These are of course driven on the floor of the seam and, being on the *strike* or level course of the seam, are them-

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selves level. They provide for ventilation and auxiliary haulage to feed the main haulage of the mine which runs along the main heading.

Between the sets of panel headings, *panels* are blocked out in the seam and these consist of a square or rectangle of $3\frac{1}{2}$ to 5 acres cut across by *bords* and *crosscuts* into *pillars*. Each panel is surrounded by a solid barrier of coal.

There are two or three entrances from the panel heading to the panel and these entrances can be sealed off with *stoppings* if necessary to cut off the air supply from any panel in the event of a fire caused by spontaneous heating.

It is now considered good practice to complete the *first working* or driving of the bords and crosscuts within the panel and to proceed as soon as possible with the extraction of the pillars thus formed, though this cannot be done in every case. Sometimes the extraction of the pillars is many years behind the driving of the bords and crosscuts.

When the pillars are extracted the adjacent roads have generally to be timbered very heavily and in addition to this a very large amount of timber is used in the extraction of the pillars themselves.

Thus it will be seen that the life required may vary greatly, from 50 years or so—assuming that it would last so long—in the main roads to a few weeks or even days on the extraction of pillars. In between the two extremes there are the intermediate stages of say 5 to 15 years in the main or trucking roads of each section.

Atmospheric conditions vary greatly and have a very marked effect on the life of the timber. Thus, there will be air in its natural "under the sky" condition where it enters the mine, air stagnant and very dry in the galleries of the sections not being worked, and warm and humid at the exit of the mine where the foul air is expelled.

Uses of Timber.

There are many uses for timber in a mine but the principal ones are in the form of (a) columns and (b) beams. The former are subject to compression with the grain while the latter must take a bending stress. Naturally, species vary in suitability for each use and these will be discussed in detail later. In addition to the above there are places where the stress applied to the timber is light and others where toughness is of more importance than strength.

Not by any means do all the miles of drives have to be timbered and usually it is only in odd places where the roof is weak and in the first few chains from the portals of the mine that timbering is needed. In the greater parts of many mines the roof is strong enough to stay up without assistance, although there are mines with weak roofs that require timbering throughout.

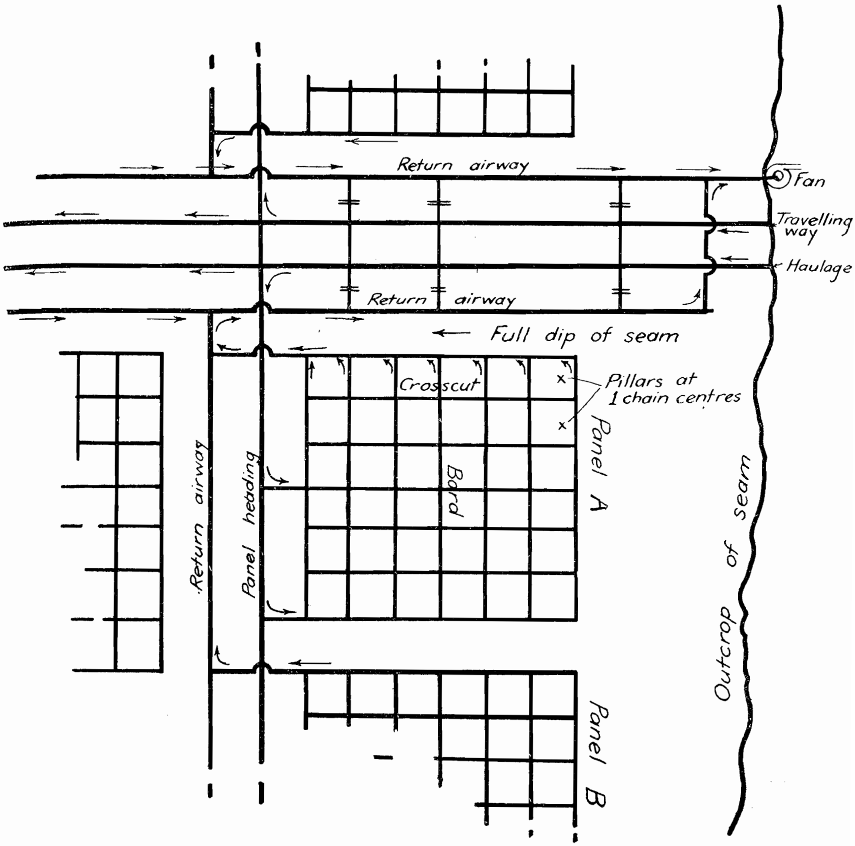

Fig.1. LAYOUT OF COALMINE

Arrows show direction of air

Timbering may be necessary in the case of the permanent and the temporary drive as mentioned above. For main headings and to some extent for panel headings, steel is preferred on account of both strength and permanence, train rails often being used. But wood is adequate for temporary structures.

Props and Bars.

The drive is timbered as shown in Fig. 2, the two legs and the connecting roof bar forming what is called a *set* of timber. Sets are spaced four or five feet apart along the drive and are connected by *side* and *roof-slabs* which are shown in cross section.

It will be apparent that the stress on the legs is mainly compression though there may be bending also, due to a tendency of the sides to press inward. The stress on the roof bars, on the other hand, is mainly bending with little or no end pressure. That on the slabs is all bending and these are generally made 6 x 2 ins. five feet long.

In addition to a complete set, single pillars, called *props*, may be used anywhere in the mine where the roof has a tendency to come in and it is in this form that the most of the timber in a mine is used—see Fig. 3. In this case it will be seen that the stress is entirely compression with the grain. As shown, a *cap piece* is used between the prop and the roof to distribute the weight. Besides holding up the roof, props are used extensively to carry wires, pipes and so on, in which case lighter ones are used.

Props are generally of round timber with a minimum diameter of five inches at the small end and a maximum governed by what can be man-handled. Almost any timber can be used and while some mines will take only indigenous species, others use exotic. Of the latter, pine is often used but larch is preferred. The cap piece must be of soft timber so that the prop will not slip out from under it.

For bars pine will not do for two reasons : it has a low strength and it will not *squeal* ; that is, it will break without any warning cracking and groaning. Consequently other timbers must be used ; the favourites are larch and blue gum (any species of eucalypt in mining parlance).

Sleepers.

So far nothing has been said of the means of bringing the coal out of the mine. For this a light tramway is almost universally used though the methods of haulage vary. Horses were once used, but are being superseded and the most popular methods now are endless rope, main and tail rope and direct winch haulage. Electric locos are not used in New Zealand coal mines, but in one there is an electrically driven endless belt system.

The gauge of the tram is two feet and the sleepers used are 6 ins. x 3 ins. x 3 ft. 6 ins. with longer ones for crossings and junctions.

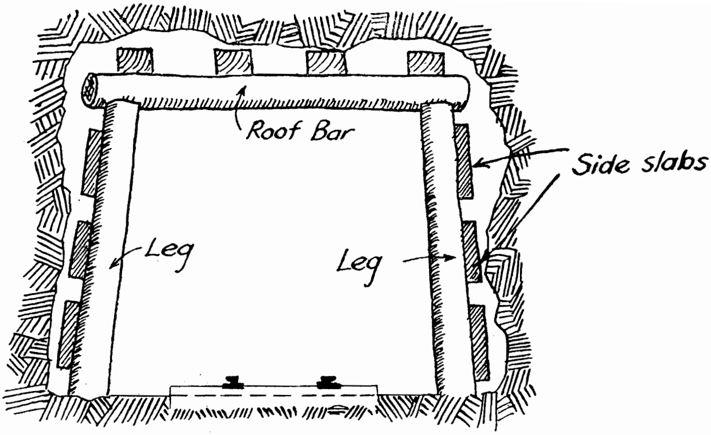

Fig. 2.

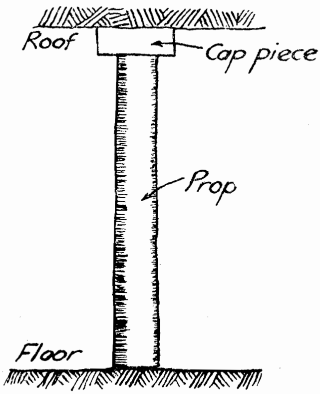

Fig. 3.

SET OF TIMBER

Rimu is the most popular timber for the purpose and though pine is used to some extent it is not good in dry places as the timber shrinks and allows the dogs holding the rails to come out. A sleeper probably has the hardest life of any piece of timber in the mine. It may lie in water all its life or be in a place with a very low humidity while throughout it is subjected to mechanical wear as the skips of coal pass over it. Such being the case, the life is not long and constant renewal is necessary.

Brattice Boards.

These are boards of 6×1 in. to 12×1 in. section and may be of any species, cheapness and availability being the main consideration They are used for making light partitions, called *stoppings*, which will prevent a current of air passing along crosscuts and bords where it is not wanted and to direct it to places where the men are working. Sometimes, where a large current of air is not needed, only a light framework is erected and hung with treated sacking, called *brattice*. Where the air current is stronger the stoppings must be of timber and in some cases must be of two thicknesses.

Where there is a direct connection between the *return airway* and the main heading an airlock of two stoppings with a space between is needed to permit access and *short circuiting*. When it is realized that the motor working the fan may be of 70 H.P. or more this will be easily appreciated. The difference in pressure on the sides of the airlock may reach three or four inches of water, and, when this is so, the stoppings are made of brick or concrete and the doors of two inch timber bound with angle iron.

Life of Mine Timber.

The widely differing atmospheric conditions obtaining in the various parts of the mine have already been mentioned, and it is not surprising to find that the same species will have a very different life according to its situation. The return airway, with its warmth and humidity up to 95% is a most difficult place for wood and one finds that 6 x 2 in. roof slabs last only two or three years. The white mycelia of a dry rot fungus, probably *Coniophora sp.*, may be seen in profusion on rimu timber that has been in the mine only three weeks. Round members, on the other hand, seem to last better and there is a record of white manuka being sound in a return airway after 14 years. Leaving the bark on round timber seems to provide some protection.

So far little has been done in the way of preservative treatment, one probable reason being that the most readily available agent, creosote, adds to the fire risk and in burning gives off noxious fumes. However, in the Glen Afton Mine creosote has been used to paint larch sets at the joints and the results are encouraging. It would seem that the napthenates, especially copper napthenate, should fill a very useful role in this connection as the fire risk is lacking.

The opposite conditions to the return airway are found in the crosscuts and bords. Here the humidity is low and the circulation of air very slow indeed. In such a situation we find what is probably the true dry rot, *Merulius lacrymans*. The life of the timber is very much greater than in the return airway and disintegration looks to be more the result of slow oxidation than fungous decay.

As mentioned before, ordinary atmospheric conditions obtain at the entrance to the mine and down the main roadway but gradually change the deeper the mine is penetrated. In such a location timber that does not receive drops of water from above will have much the same life as in the open.

Durability of Various Species.

From what has been said it will be seen that the durability of a species will depend almost entirely on the situation in which it is used. At the present time little or no effort is made to select timber to suit the particular conditions, and it seems that a lot of good work could be done in advising the mine managements on suitable timbers for particular situations and working out treating techniques. It is natural that the mine engineer has little or no time to bother about the minor properties of the various timbers. At present all species cost the same to the management so there is no incentive to use the commoner sorts in places where durability is not needed.

Data on the properties of various species are limited, but the following observations may be made : Pine does not last long, nor is it very strong ; larch is stronger and lasts longer but is affected by fungi ; eucalypts (no details as to species) last as long as larch, are stronger and more suitable for sets ; black wattle is very strong and durable, but silver wattle is much inferior and may last only 18 months to two years.

Of native timbers, kauri has been much used in the past in North Auckland and is very strong and durable. Sets more than 40 years old can still be seen at Puhipuhi and in the Kamo colliery. Unfortunately, kauri, tanekāha, totara, rimu, kahikatea and other valuable native species are still being used in North Auckland when exotics suitable for the purpose are available locally.

Quantities Used and Costs.

Mines use many thousands of props and other pieces in a year. The following table gives the number and delivered cost for one of the Waikato mines for one year.

Length of Prop. Ft.	Number Used	Cost per 100	Total Cost
7	17,000	£7 0 0	£1,190
10	15,000	9 5 0	1,387
12	11,000	11 10 0	1,265
14	3,460	15 0 0	519
Totals	46,460		£4,361

The output of coal for the year was 138,530 tons which will give an idea of the amount of timber that it takes to produce one ton of coal. Another mine uses about £160 worth of timber a month, equal to about 6d. per ton of coal produced.

Conclusion.

From what has been said it will be seen that timber is a very necessary and costly part of coal mining. There is room for many different types of timber in the various parts of a mine and there is also much room for planning and research to get the best out of the timber that is used. The subject offers an interesting and very useful study for anyone with the time and opportunity to go into it thoroughly.

Our thanks are due to Mr. Geddes, Manager of the Renown Mine, for information supplied and for the opportunity to inspect the mine.

Summary.

The uses of timber in a coal mine and the conditions prevailing are discussed with particular reference to the Waikato field. The small amount of data available on the life of the timbers used is noted and the suggestion made that there is a wide field for research in the preservative treatment of mining timber.