Similar roads are in use in the United Kingdom, including Chiseldon Camp, in Wiltshire (over 1½ miles laid in July, 1915), and at numerous Seaplane Stations for the Admiralty, carrying all stores, equipment, ammunition, and machinery, etc.

Discussion.

MR. POOLE: I am sure we have listened to-night to one of the most admirable addresses that have been delivered before this Association. The lecture, which is very complete in detail, has been given by a gentleman who is an acknowledged master as a constructor of modern road pavements.

I shall not go into details of the address, but wish to confine my remarks to one or two points outside of what has been stated.

We look upon the Roman Road as the forerunner of our good roads, and it is remarkable that these excellent examples of road construction, and their great advantage to the State, were ignored through so many centuries in Europe. Good roads have been a necessity in the large military empires of the past. We now know from records that have recently been made available that in the old Persian Empire there was a great system of roads radiating from Babylon to all the important Provinces, such as through Asia Minor, through Syria to Egypt to the country which we now call Turkestan, and to the frontier of what is now Modern India.

Coming back to our own State, we are much indebted to that great master road builder, Governor Macquarie. Among his more important roads are the Main Western Road over the Blue Mountains, the Bathurst Main Southern Road to Goulburn, and that heavy, but almost forgotten undertaking, the Main Northern Road through Wiseman's Ferry to Maitland.

It is interesting to note that the re-location of the railway beyond Picton towards Moss Vale now in general follows the old main road. Near Woodford, on the Blue Mountains, may be seen a portion of the old Main Western Road that was abandoned owing to a deviation caused by the construction of the railway. After 40 years' abandonment, the road was still in a reasonable state of preservation, and in mode of construction was something between a macadam and a telfer road.

The roads in the Sydney Metropolitan Area, and, in fact, throughout the county of Cumberland, have an unenviable notoriety for being some of the worst roads in the more settled portions of the State, and those responsible for their construction have been greatly abused on that account, though the public as a whole have made no serious demand for good roads. The Metropolitan District of Melbourne, on the other hand, is noted for good streets and roads. In both cases the general condition of the roads is a direct index of the ready access to good road-making material. The Sydney Metropolitan District is an area of sandstone and clay, neither of which are of much service in making good roads. Blue stone and gravel are obtainable in a few places, or brought from outside the District. In the Melbourne Metropolitan District, on the other hand, there is a ready supply of good blue stone.

The same effect of the widespread possession of suitable or unsuitable road-making material is readily reflected in the nature of the roads in the more populous areas of the Commonwealth. For instance, in York Peninsula, South Australia, there is a large expanse of limestone, and in this district there are some of the finest roads for light traffic to be found in the Commonwealth.

A very difficult problem is met with in the Riverina and other fluviatile districts where there is no stone. Gravel or stone will have to be brought, possibly, very long distances

by rail, or the clay of the soil burned into hard lumps, as is done in some parts of India and other countries. This difficulty is, however, accentuated by the fact that the Riverina and other similar districts have little or no timber available for burning the clay. Perhaps a brick surface on a concrete foundation may be suitable and economical in the towns of those areas.

Mention has been made of concrete roads. An enormous amount of such construction has recently been undertaken in various parts of the United States. It is considered that such roads are most suitable for light to medium traffic, but that for heavy grinding traffic the concrete road should be surfaced with wood paving, asphalt, or other suitable material. The sub-soil under the road must be carefully taken into consideration, especially for lighter roads, because a type of construction which might be successful upon a good hard bottom might utterly fail under other conditions. For instance, I saw a case in Wilcannia, where the main street with a paving of rather light construction had a foundation of raw sand. On one occasion a heavy wool team broke through the crust and ploughed up the street for a considerable distance, and did damage that cost £400 to repair.

It is also very necessary that the drainage should be very carefully attended to.

I have much pleasure in moving a hearty vote of thanks to Mr. Vicars for his admirable address.

Mr. McEwin: I have much pleasure in seconding the vote of thanks to Mr. Vicars for his interesting paper. Mr. Vicars has brought forward a quantity of very valuable material which will be most useful to Local Government and other Engineers. It is not possible to give the adequate amount of time required for a full discussion of the paper because of the amount of material we have before us.

The essentials for a good road are: Easy grade, good drainage, while good foundation material should be fixed;

the surface should be waterproof, yet not too hard, resulting in some resistance being offered to sliding of traffic; the roadway should be wide, and so constructed that the weight of traffic would be distributed over the whole surface. If these features were always considered beforehand the first cost of such roads would be quickly repaid.

The macadam road is not to a very great extent waterproof. Mr. Vicars has suggested a means of making it waterproof. Oil was used at North Sydney on one of the busiest roadways and was found to be successful in waterproofing and in arresting dust. Wood block pavements are slippery in wet weather, and have to have tar surface applied, and even then they are not durable. Concrete pavements probably fail because concrete is not a sufficiently resilient material.

The great value of good roads has been mentioned, and might be enlarged upon if time permitted.

The laying of tramways presents a great difficulty to roadmakers because of the roads being broken up thereby, and the grade interfered with so that it is not always possible to provide for the proper drainage of the surface.

I have pleasure in seconding the vote of thanks to Mr. Vicars, to whom we are, I feel sure, all very grateful for the excellent paper he has placed before us this evening.

Mr. Bennet: Mention was made of three types of roads. With regard to macadam roads, there was a sum of £35,000 expended by a suburban council on the re-construction of their roads. The original road was high in the centre; in the reconstructed road there was no crown. I would like the lecturer to express an opinion with regard to the old and the new type.

The President, in conveying the vote of thanks to Mr. Vicars, said he felt sure the author had given them a clear and concise set of illustrations that would be invaluable to them as engineers, inasmuch as quite a lot of the data was

first hand information. He would not enlarge upon what had already been said, but asked those present to show their appreciation in the usual way.

Mr. Vicars, in reply, said: Mr. Poole has outlined the trend of roadways in early historical times. No doubt the earliest form of road known to man was in the nature of an inroad. The Persians and others were great people in their day, but the forerunner in the construction of paved roads was the Carthaginian. In the appointment of Governor Macquarie they had more than a Governor: he was a man in the truest sense of the word, and we might include him amongst engineers.

It is one of the economic points of road engineering that road location depends to a certain extent on the nearness of suitable material for road making. It is as important in determining the location as other matters are. Burnt clay has been used in road work for ages; it is chiefly used as a binding. Concrete roads are used for some of the heaviest traffic leading to wharves in some of the American cities. Mr. McEwin's remarks I quite agree with. (I was unaware of the experiment with oil-spraying of the roads at North Sydney.) Wood blocks are slippery and dangerous, it is true, when not regularly tarred and sanded. Good roads are invaluable to the community. As regards tramways being a drawback to road makers, I would say that wood-block road makers are a curse to tramways, on account of expansion of blocks forcing track out of line.

As regards tar, it might be stated that in 1830 there were gas works in England, France and Germany, and no doubt tar was available even at an earlier date.

It is useful to be able to determine the economical value of a road, and whether the necessary maintenance and depreciation are excessive. But it is generally a local alderman or member of Parliament who decides such questions. It should be made the controlling factor, but is usually neglected for expediency.

With regard to Mr. Bennet's remarks re flat or raised roads, this depends on the situation. Where the gradient is slight and water is carried from cross roads, if drainage is not separately cared for it is better to put a fair crown. With best design the crown should be the least practicable; flat crowns distribute wear better than high crowns, but drainage trouble may necessitate extra crown to prevent stormwater from flooding the whole of the roadway.