THE USE OF NATURAL RUBBER IN ASPHALT ROAD CONSTRUCTION.

By H. W. T. MINNAAR, B.Sc.(Eng.) (Associate Member).

(Presented at the Monthly General Meeting, Bloemfontein Branch, June, 4th, 1951.)

The well-known material called rubber, which is in common use to-day, has had a long and interesting period of development. Research into its possibilities date back to the eighteenth century.

In 1736 a French scientist, De la Condamine, investigated a resilient waterproof material, which he found in Brazil. This material, afterwards known as rubber, was used by the Indians to fabricate garments and footwear.

In 1876 a man called Wickham brought a batch of Hevea Brasiliensis seed from South America, and raised about 2,000 plants. These were sent to Ceylon, Singapore and the Malay Peninsula. These plants flourished in the East, and the natural rubber industry was born.

The rubber boom of 1910 brought about the rapid expansion of the industry, and various planters' organisations were formed to help the rubber industry and to increase production. Soon after this expansion it was found necessary to set up scientific research stations in order to combat plant diseases.

When the Japanese overran the principal rubber producing areas of the Far East during the war, the United States Government set up facilities which produced up to 900,000 tons of synthetic rubber per year. This product was further improved after the war and promised to be a powerful competitor to natural rubber.

As a result the International Rubber Research Board was founded by Dutch, French and British rubber-producing interests in the East. The purpose was to promote the use of latex foam and to help increase consumption in the various industries such as engineering, agriculture, mining, etc.

The introduction of science to the industry was divided broadly into two fields of investigation. The first part embraced all aspects of growing the tree, maintaining it in health, and harvesting the crop as latex. The second field concerned the conversion of latex into rubber in the various forms in which it is exported.

Research into the production side of rubber has already resulted in an increase in the annual yield per acre from 500 lb of dry rubber in 1930 to an average of well over 1,000 lb of dry rubber in 1950.

Various new uses for natural rubber have already been developed or are in the promising experimental stage. Perhaps the following examples of recently developed rubber products will be of interest.

Latex foam is already an important product in upholstery work of all descriptions; light-weight steel carriages with rubber tyres are being used successfully on a small scale by the Swiss Federal Railways; 'Onazote,' the trade name for expanded ebonite, is becoming a very popular insulating material on account of its very low thermal conductivity, its lightness and its tensile strength; Latex is extensively used in the toy manufacturing industry; a latex cork-filled composition has been developed as a floor covering for use in ships; traffic counters are used in which the impulse caused by a vehicle moving over an inflated rubber tube is registered on a moving drum; and finally, the natural rubber powder for use in asphalt road construction.

The most convenient form of rubber for incorporating with bitumen was found to be a fine powder. Two kinds of this powder, both developed by the Dutch Research Stations in Java, are now manufactured, namely 'Pulvatex' and 'Mealorub.'

'Pulvatex' is made by dispersing rubber latex into hot air under certain conditions.
Mealorub' is obtained by flocculation of rubber from the latex with the addition of a small quantity of chemicals.

Right from the beginning it was realised by the scientists of the various research organisations that laboratory experiments had to be further investigated by actual road tests, and even before 1938 the Dutch had laid test areas in Holland and Java under varying climatic and traffic conditions.

With the help of these test strips it was possible to investigate various other properties. The Shell Company, for instance, made experiments with a skid testcar on a coarse textured asphalt road containing rubber and similar tests on a control strip. It appeared that the coefficient of friction of a rough asphalt surface with rubber was higher than that of the controls. At greater speeds, where anti-skid properties are of greater importance, the advantages of rubber in the composition were even more marked.

Unfortunately, many of the experimental stretches of rubber roads laid in Europe were destroyed during the war, but those that were saved have already proved the value of rubber in asphalt. They stood up well to the unusually heavy wartime traffic and required no maintenance in most cases.

After the war the Natural Rubber Bureau took up the research and experimented with rubber roads in Europe and America. Work was started on an extensive scale and numerous test strips of asphalt containing various percentages of rubber powder were laid along with control sections.

The rubber powder may be added to the asphalt by mixing either with the bitumen or with the aggregate. When laying a premixed carpet it is easier to add the powder to the stone in the correct amounts before mixing with the bitumen. For spray coat work on the other hand, the second method is easier and more accurate. In this case the rubber powder is added to the hot bitumen in the distributor where it can be stirred and thoroughly mixed before application to the road surface.

The question now arises as to what effect the rubber has on the bitumen. This matter is apparently not quite settled yet. The most common explanation is that the rubber particles swell when mixed into hot bitumen, one portion remaining in suspension in the liquid, while the other portion is entirely absorbed into the bitumen as a solution. The swollen rubber particles absorb the lighter hydrocarbons from the bitumen, known as the maltenes, but not the heavier asphaltenes. The lighter more volatile constituent parts of the bitumen normally rise to the surface under the influence of heat and traffic, where they are dissipated with a consequent deterioration of the bitumen. This in turn reduces the useful life of an asphalt surface.

Where natural rubber powder is present, however, the maltenes are retained as in sponges, which gradually feed it back to the bitumen and so prolong its effective life. The addition of the rubber, therefore, has the effect of reducing the penetration of the bitumen, and increasing the temperature of its softening point. This means that the asphalt is more stable under extreme climatic conditions. Test surfaces laid under conditions of icing in America have shown increased resistance to fracture, and likewise test areas in the tropics have shown less tendency to bleed. In other words, the material is less susceptible to temperature changes than ordinary asphalt, which is an important point in favour of rubber powder.

Where the rubber is mixed and heated with the bitumen before application to the aggregate, an increase takes place in the proportion of rubber particles going into solution in the bitumen with a corresponding decrease in the proportion remaining in suspension. The effect of this is to increase the tenacity of the bitumen, which takes on a very rubbery appearance.

It would seem, therefore, that where the requirements are an increased life for the asphalt surface together with less tendency to bleed in summer or to become brittle in winter, the rubber powder should be mixed with the aggregate. But, on the other hand, where the emphasis is chiefly on the tenacity of the surface, the rubber should be mixed and heated with the bitumen.

In this connection an instance is claimed where, in England, after finding no surfacing material to withstand the longitudinal
movements on a certain suspension bridge without cracking, an asphalt carpet containing rubber was laid, and no cracks are noticeable after a year.

During 1950 the Natural Rubber Bureau extended its field of research to South Africa as well and test sections were laid in four different parts of the country on municipal, provincial and national roads. Bloemfontein was chosen as one of these centres and experimental road sections employing both methods were laid during December 1950, together with the controls.

A premixed carpet of \( \frac{1}{4} \) inch stone size containing 5 per cent of rubber powder by weight of the bitumen content, was laid immediately north of the overhead bridge at Hamilton station.

In Zastron Street, immediately west of East Burger Street, a spray coat with a similar rubber content was laid and chipped up with \( \frac{1}{4} \) inch chips.

It is of course not yet possible to notice any difference on either of these sections as compared with the control sections. The only difference at the time of application was the extreme tackiness of the rubber-bitumen mixture sprayed on the old surface in Zastron Street. A bicycle was ridden over the newly sprayed bitumen before the chips were applied and threads more than two feet long were drawn out by the wheels.

The 'Mealorub' powder was supplied free of charge by the Natural Rubber Bureau for these experiments which were made under its auspices.

---

DIE DISTRIBUTIE VAN WATER OP DIE VAAL-HARTZSKEMA.

By C. W. J. A. SANDROCK, M.Sc. (Member).

Minutes of Proceedings, Fifth Meeting, 1950.

---

DISCUSSION

DR D. F. KOKOT (Member) in proposing a vote of thanks said:

Before formally moving the vote of thanks I would like to add a few interesting facts to what Mr Sandrock has said. It is perhaps not generally realized that this scheme, the largest in South Africa, was initially investigated as far back as 1882. In that year J. Gamble, Hydraulic Engineer to the Cape of Good Hope Government, reported on a scheme which was practically identical with the present one, except that the area to be irrigated was not so large. The cost of the project was, however, so great that the Government could not finance it. Later on it was decided to invite the public to finance and build the scheme. It was stipulated that the scheme should cost not more than £130,000 and that the land to be irrigated should be granted free to the builder of the scheme. In spite of this very favourable offer the necessary capital could not be found and the offer lapsed. That was perhaps fortunate because even with the high purchasing value of the pound in those days the work could never have been performed for that sum.

From that time onwards the project was never really lost sight of, and further detailed investigations followed until finally, in 1933, everything was ready for a start to be made. Civil engineers in South Africa owe Mr Sandrock a special debt of gratitude for presenting this paper which is packed with so much useful data. As Resident Engineer in charge of the construction Mr Sandrock displayed two characteristics which resulted in much valuable experience being gained; he possessed the inventive mind to originate new ideas and he had the boldness of spirit to try these out without fearing possible