

CEMENT CONCRETE PAVEMENT

The present invention relates to a cement concrete pavement having good water-permeability characteristics.

One consequence of increasing urbanization is that rain water, which previously could readily permeate into the ground as it fell, is now increasingly prevented from doing so by the spread of asphalt pavements, concrete pavements, buildings, and so on. As a result of this decrease of the ground surface into which rain water can permeate, underground water levels in the surrounding area also decrease, leading to the risk of ground subsidence, and adversely affecting the growth of trees and the ecology of ground organisms. Furthermore, this decrease of water-permeable ground surface area results in a decrease in the water-holding capabilities of the ground in the vicinity of such impermeable surfaces and, in consequence, an increased risk of flooding when heavy rain falls, which may produce unnecessary disturbances of all kinds, including interruption of traffic networks, etc.

In view of the above-mentioned problems caused by the decrease of water-permeability in, and water-holding properties of, urban areas, the provision of pavement materials having improved water-permeability and water-holding properties has been sought. Water-permeable asphalt has been developed to try to meet this need, but its water-permeability and water-holding properties are not as good as would be desired, and moreover the asphalt can melt in hot weather to cause loading, which decreases its water-permeability characteristics still further. Moreover, the strength of the asphalt decreases quite rapidly with age.

The present invention seeks to provide a cement concrete pavement which has good water-permeability and water-holding properties.

More particularly, the present invention provides a concrete pavement which is formed from a hardened cement concrete mixture of:

300 - 400 kg of portland cement,

5 0.008 - 0.04 part by weight of binder per part by weight of the cement,

0.3 - 0.45 part by weight of water per part by weight of the cement, and

an aggregate forming the balance of the mixture and
10 composed of sand and No. 7 crushed stone (as hereinafter defined) in a weight ratio within the range of from 5:95 to 20:80,

substantially uniformly distributed per m^3 , and the wear surface of the hardened cement concrete mixture having
15 been treated to remove cement mortar adhering to aggregate at said surface.

By the term "No. 7 crushed stone" is meant crushed stone whose particle size is from 5 to 2.5 mm - see JIS Handbook, Engineering and Construction, 1978,
20 Table 1 on page 661.

It is particularly preferred that the weight ratio of sand to No. 7 crushed stone in the cement mixture is within the range of from 10:90 to 15:85, because with ratios in this range, the resulting strength
25 of the hardened pavement is suitable for vehicular traffic pavement whilst the water-permeability remains satisfactory.

Further, it is preferable that the binder be present in amount of from 0.015 to 0.03 part by weight
30 per part by weight of the cement. In this

specification, the quantity of the binder refers to the quantity of solid resin present. As the binder, it is possible to use any binder which is known as a general additive in cement mortar. That is, natural or
5 synthetic rubber, for example, SBR, NBR, acryl resin, epoxy resin, and the like, may be used as the binder. Generally, the binder is added in the form of emulsion. For example, when an SBR latex binder (JSR TOMAC SUPER, produced by Japan Synthetic Rubber Co., Ltd. : solids
10 0.45%) is used in an amount within the foregoing range, the flexural strength can be improved by about 10 to 60%. If, however, the quantity of the binder exceeds 0.03 part by weight per part by weight of the cement, the water-permeability of the resulting hardened cement concrete is
15 undesirably reduced.

The quantity of water is preferably from 0.35 to 0.40 part by weight per part by weight of the cement. The water-permeability decreases undesirably if the quantity of water exceeds the upper limit of the range,
20 while kneading of the cement mixture cannot be performed readily to obtain a substantially uniform distribution of the components of the mixture if the quantity of water is decreased beyond the lower limit of the range.

Further, in order to achieve a good balance
25 between strength and permeability, it is preferable to use the cement in an amount within the range of from 320 to 370 kg per m^3 of the whole cement concrete mixture including water.

In the aggregate used according to the present
30 invention, it is necessary that the weight ratio of the sand to the No. 7 crushed stone is within the range of from 5:95 to 20:80. A ratio of 5:95 is suitable to produce a concrete pavement for use as a sidewalk, while a ratio of more than 10:90 is suitable to produce a
35 concrete pavement for light traffic. In a modification of the invention, a part of the aggregate, preferably 10

to 30 weight percent of the aggregate, may be substituted by No. 6 crushed stone, i.e. crushed stone having a particle size of 13 to 5 mm (see JIS Handbook, Engineering and Construction, 1978, page 661, supra).

- 5 In this case, however, there is a disadvantage in that the external appearance of the concrete pavement becomes less attractive because the larger-sized No. 6 crushed stone

co-exists with the smaller-sized No. 7 crushed stone (particle size of 5 to 2.5 mm), although on the other hand there is an advantage in that the strength of the concrete pavement is increased to a certain extent.

5 After the cement concrete mixture has hardened, the wear surface is treated so as to remove cement mortar which is adhering to aggregate at that surface. This treatment is preferably effected by using a grinding/sweeping machine (commonly called a shot-blasting
10 machine). As the shot-blasting material to be used for grinding/sweeping, for example, spherical iron (having a diameter not larger than about 2 mm) or sand (such as silica sand or the like having a diameter not larger than 0.6 mm) is advantageously used. The shot-blasting
15 material is caused to collide with the cement concrete surface by using a grinder/sweeping machine to thereby remove cement mortar portions adhering to the aggregate.

Cement concrete pavement according to the preferred embodiments of the present invention exhibits
20 substantially the same water-holding property as that exhibited by ordinary soil when rain falls, and furthermore achieves a rate of water-permeation which is much more rapid than that of conventional asphalt pavement or conventional cement concrete pavement, while
25 still possessing sufficient strength for practical use. With cement concrete pavement according to the present invention, it is possible to obtain a rate of water permeation of the order of 10^{-1} to 10^{-4} cm/sec, and typically of the order of 10^{-1} to 10^{-3} cm/sec.

30 Cement concrete pavement according to the present invention also has the advantages, as compared with conventional water-permeable asphalt pavement, in that no loading is generated, its strength deteriorates only slowly with age, and no melting occurs in hot
35 weather.

Moreover, cement concrete pavement according to the present invention generally has high voids, typically of 10 to 30% in spite of its strength. As a result, even if fine earth and sand or the like accumulate on the surface of the concrete pavement, the earth and sand pass through the voids when rain falls, so that the pavement is cleaned without causing any loading, i.e. blocking of the voids by earth, sand or the like.

As previously noted, cement concrete pavement according to the present invention has strength which is sufficient for practical use. Typically, the compression strength of the concrete pavement is 200 to 300 kg/cm² (the strength after 4 weeks curing in constant-temperature water of 20°C), and the flexural strength thereof is 20 to 30 kg/cm² (the strength after 4 weeks curing in constant-temperature water of 20°C).

Another feature of cement concrete pavement according to this invention is that its wear surface exhibits the natural colour of the aggregate which is exposed by the treatment to remove adherent cement mortar. Thus the pavement is of more attractive appearance than that of conventional cement concrete or asphalt pavement, and even as compared with conventional concrete and asphalt materials which have been mixed with or sprayed with various pigments to give them an artificial colour.

Concrete pavement of the present invention is thus especially suitable for forming side-walks, public squares, and the like.



CLAIMS:

1. A cement concrete pavement composed of a hardened cement concrete mixture of:

300 - 400 kg of portland cement;

0.008 - 0.04 part by weight of binder per part by weight of said cement;

0.03 - 0.45 part by weight of water per part by weight of said cement; and

an aggregate forming the balance of the mixture and composed of sand and No. 7 crushed stone (as hereinbefore defined) in a weight ratio within the range of from 5:95 to 20:80,

substantially uniformly distributed per m^3 , and the wear surface of the hardened cement concrete mixture having been treated to remove cement mortar adhering to aggregate at said surface.

2. A cement concrete pavement according to Claim 1, in which said ratio of said sand to said No. 7 crushed stone is within the range of from 10:90 to 15:85.

3. A cement concrete pavement according to Claim 1 or Claim 2, in which the quantity of said binder is from 0.015 to 0.03 part by weight per part by weight of said cement.

4. A cement concrete pavement according to any preceding claim, in which the quantity of said water is from 0.35 to 0.40 part by weight per part by weight of said cement.



5. A cement concrete pavement according to any preceding claim, in which said cement is used in an amount of from 320 kg to 370 kg per m³ of said cement concrete mixture.

6. A cement concrete pavement according to any preceding claim, in which the surface of the hardened cement concrete mixture has been treated by shot-blasting to remove cement mortar adhering to aggregate at said surface.

7. A modification of the invention defined in any preceding claim, wherein said balance of said concrete mixture is formed by said aggregate and No. 6 crushed stone (as hereinbefore defined).

8. A cement concrete pavement according to Claim 7, wherein from 10 to 30% by weight of said balance of said concrete mixture is formed by said No. 6 crushed stone.

9. A cement concrete pavement, according to Claim 1 and substantially as hereinbefore described.
