Asphalt production, paving and compaction techniques

DEVELOPMENTS IN LINING BINDING APPLICATIONS AND INVESTIGATION OF USAGE ON HIGHWAYS

Senol Comez, Aykan Mert, Hatice Özen Navruz, Muhammet Komut, Tuğba Öztür, Şenol Altıok
Republic of Turkey General Directorate of Highways, Ankara, Turkey

Abstract

ABSTRACT: Before surface coating or bituminous hot mix application, it is applied on granular foundation, plant-mix foundation or similar foundations. Water based emulsion primer binders have been widely used in road superstructure construction, maintenance / rehabilitation and rehabilitation projects. Considering the continuously developing road network in our country and the ongoing coating applications, it is important to investigate and use alternative road superstructure materials with such economic and environmental benefits. The aim of this study is to investigate the use of emulsion primer binders which can be used as an alternative to the traditional primer materials currently used, protect the existing surface from environmental, climatic and traffic conditions, improve the strength properties, provide adhesion between the coating and the base surface, penetrate the base layer and form an impermeable surface. As a result of the study, it was determined that Resin-based water based emulsion primer binders were safely and easily applied, stored, cured, and environmentally friendly, and therefore could be an alternative to traditionally used katbek lining products, and to share the results obtained from this study. Key Words: Emulsion, primer binders, coat, resin, environmentally

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1. INTRODUCTION

In order to provide quality and safe transportation infrastructure in road transport,to improve the existing road infrastructure, work is being carried out in line with the objectives of completing the split road construction works and raising the standard of highways, covering the split roads with bituminous hot mixture and raising the standards. It is a fact that existing surface coating applications will continue in the process of achieving the target of bituminous hot mixture coated roads and making the entire road network with bituminous hot mixture coating.

As it is known, one of the most important steps in surface coated roads is the application of primer binder material. Depending on the condition of the base surface, climatic conditions, traffic and construction conditions, lining material is also used in bituminous hot mixture productions (General Directorate Of Highways 2017 – 2021 strategic plan KGM).

1.1 Traditional Lining Binders

Conventional liner materials are generally categorized under two main groups, namely katbek and cationic bitumen emulsion.

LINIG MATERIAL	TYPE	STANDART
Fm2 B 2, Fm 2 B 3	Katbek Bitumen	TS EN 15322
C50B 9-4, C50B9-5, C55B9-4 C55B9-5, C60B 9-4, C60B 9-5	Cationic Bitumen Emissions	TS EN 13808

Only liquid petroleum asphalts (katbek bitumen) are used as lining material on bituminous hot mixture (BHM) and surface covered roads. Liquid petroleum asphalts are soft binders obtained by mixing a high-boiling component of crude oil or a moderate solvent of gas oil type or a naphtha or gasoline type volatile solvent to the residue remaining after distillation of the crude volatile components of crude oil. Since Katbek bitumen is harmful to the environment due to the solvents used in it, their use is a risk because they have easy ignition properties due to their low flash points (Fang 2016).

The bitumen emulsion is formed by the distribution of the bitumen into very small particles in water. The diameters of the particles generally range from 1 to 5 microns (1 micron = 0.001 mm). A good emulsion is apparently slippery and generally brown in color. Bitumen emulsion is consists of three components; bitumen, water and emulsifier.

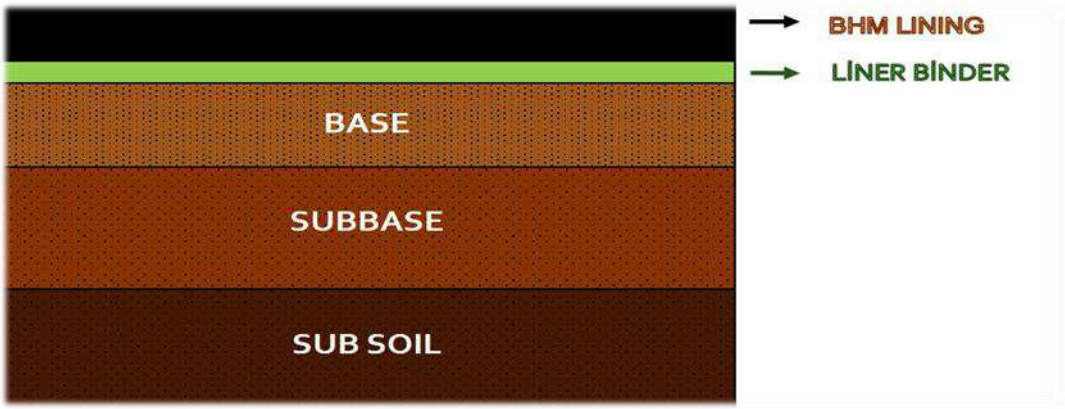

Figure-1: Use of Lining Binder in pavement.

2. Resin Containing Emulsion Primer Binders

Resin containing emulsion primer binder; is a covering layer formed by applying suitable low viscosity bituminous binder on unbonded granular foundation, protecting the existing surface from environmental and climatic conditions before application of coating, improving the resistance properties and providing adhesion between the base surface and the coating layer, filling the gaps on the surface and binding the free grains on the surface.

In this study, the definition of resin containing water based emulsion primer binders which are planned to be used as an alternative in road pavements where only liquid petroleum asphalts are used as lining and the benefits that such materials will bring with the usage areas of these materials as a result of the experiments carried out in the laboratory and trial roads application criteria were investigated.

As known, emulsifying agents; and a hydrocarbon chain which normally ends with an anionic or cationic group. If the bitumen soluble part of these groups is positively charged; the asphalt emulsion produced is called “cationic” and the negatively charged is called “anionic”.

Resin containing water based emulsion primer binders; Primer is defined as a new generation of nonionic primer materials that fulfill their intended use.

It is believed that resin containing water based emulsion liner binders are safe and easy to apply, store, cure quickly and are environmentally friendly, and therefore may be an alternative to traditionally used katbek liner products (Head 1974).

Figure-2: Primer Binder and Surface Coating Application

Resin containing water based emulsion primer binders are used in many areas such as road pavement surface coating and bituminous hot mix (BHM) applications (single layer or multi layer), patch, primer layer, bonding layer, pavement renewal, dust holding layer, soil stability, compression and erosion control.

3. Research Studies

Within the scope of the studies carried out in the laboratories of the General Directorate of Highways Research and Development Department Pavement Development Branch, the following experiments have been carried out on the resin containing emulsion primer binder samples and the experiments within the scope of the research studies are still ongoing. In addition to this, studies have been carried out and some studies have been carried out by applying the test sections on some road covered roads prepared with aggregates of different origin (limestone, basalt etc.) whose route is appropriate in the Regional Directorates of Highways, exposed to different climate and environmental impact (Highway Technical Specification, 2013)

4. Laboratory Tests

Resin containing water based emulsion primer binder samples in laboratory environment; Saybolt Furol Viscosity Test (ASTM D 244), Storage Stability Test (ASTM D 6930), 5-Day Post Deposition Precipitation Test (ASTM D 6930), On Screen Residue Test (ASTM D 6933) were performed in accordance with the relevant standards.

In addition, in order to determine the desired penetration, impermeability and curing time in the base layer to which it is applied, 3 methods have been developed by examining the literature information and application practices, and these methods have been standardized in applications.

4.1 Penetration Test

In accordance with the Physical Properties of Fine Aggregate, 2000 grams are taken from 100% passing through 4.75 mm (No.4) sieve and between 0-12% through 0.075 mm (No.200) sieve. The aggregate sample is placed in two layers of 10,16 cm in diameter and 11,64 cm in height in an easily removable metal mold.

Compression is applied to the material in 5% water with a vibratory rammer for each two layers for 60 seconds with a 20 mm (± 0.1) gap on the sample in the mold.

On the other hand, the lining material is prepared according to the “Primer Material Preparation and Application Report edil delivered to the Administration by the manufacturer. After the primer material which is delivered as a concentrate has been prepared by diluting maximum 4: 1 ratio (4 parts water + 1 part concentrated primer) according to the recommended mixture ratios, it will be between 0.9-1.5 lt / m^2 in the same proportions on the surface of the aggregate sample. fully sprayed.

At least 2 samples prepared in this way are allowed to stand at laboratory temperature for at least 4 hours and at most 8 hours to complete the curing of the primer material. The penetration depth is measured with a 0.5 mm precision caliper with at least 3 points on the cured samples that are removed from the mold without deforming with the sample extractor.

The arithmetic mean of the penetration depths measured at 3 points is expressed as the penetration depth of the lining material.

Figure-3: Penetration Test Method

4.2 Impermeability Test

In accordance with the Physical Properties of Fine Aggregate, 2000 grams are taken from 100% passing through 4.75 mm (No.4) sieve and between 0-12% through 0.075 mm (No.200) sieve. The aggregate sample is placed in two layers of 10,16 cm in diameter and 11,64 cm in height in an easily removable metal mold.

Compression is applied to the material with a water content of 5% with a vibratory rammer for each 2 layers for 60 seconds with a 20 mm (± 0.1) gap on the sample in the mold.

On the other hand, the lining material is prepared according to the "Primer Material Preparation and Application Report edil delivered to the Administration by the manufacturer. Primer material delivered as a concentrate is prepared by diluting maximum 4: 1 ratio (4 parts water + 1 part primer) according to the recommended mixing ratios, in the amount of 0.9-1.5 lt / m^2, in the same proportions and completely on the surface of the aggregate sample. sprayed to be coated.

At least 2 samples prepared in this way are allowed to stand at laboratory temperature for at least 4 hours and at most 8 hours to complete the curing of the primer material. The cured sample is weighed with 0.01 g precision balance. Water is added to the cured sample so that it does not overflow from the mold and the sample is re-weighed in this way and the amount of water added is recorded. After the sample has been kept in the laboratory for 24 hours, the remaining water on the sample is poured and weighed. The ratio of water loss at the surface of the sample to the amount of water in the first weigh is expressed as a percentage of impermeability.


Figure-4: Impermeability Test Method

Curing Time Test

After the emulsion primer binder sample is sprayed on the compacted aggregate in the required amount, the curing time is determined depending on the dryness and hardness on the surface.

All the data obtained as a result of laboratory and trial road studies were evaluated together and the criteria given in the following table were determined in terms of shedding light on new trial road, surface coating and bituminous hot mix (BHM) application studies.

4.3 Laboratory Test Results

The results of some of the experiments performed in the laboratories of the Superstructure Development Branch of the General Directorate of Highways Research and Development Department and the graphical data obtained from these test results are presented below.

Table-2: Laboratory Test Results

Experiment Name	Saybolt – Furol Viscosity 50ºC, sn.,max.	Storage Stability 24 hourst, %, max.	On Screen Residue Test, %, max.	Penetration Testi, mm, min.	Impermeable Test, 24 hour , %, max.	Cure Time , Hour
Experiment Standard	**ASTM D 244**	**ASTM D 6930**	**ASTM D 6933**	**-**	**-**	**-**
Specification Limits	**100**	**2**	**0,1**	**10**	**50**	**4-8**
1	12	3,5	0,1	14	25,9	5
2	11	13,9	0,8	8,25	100	22
3	11	-	0,01	12	12,5	5
4	10	21,8	0,04	11,6	10,61	5
5	10	-	0,03	7	100	5
6	10	2,1	0,05	11,3	13,5	24
7	10	-	0,1	1,93	100	5
8	10	-	1,1	7,5	100	5
9	8	31,6	0,04	11,2	24,7	24
10	9	-	1,1	7,3	100	22
11	11	5,7	0,03	11,4	11,8	24
12	10	15,2	0,02	11	9,2	24
13	10	7,4	0,2	11	9,2	24
14	10	2,1	0,7	12,5	7,3	5
15	9	-	1,6	11,2	8,2	24
16	13	4,5	0,01	12,5	8,6	5
17	9	-	0,3	7,9	89,4	24
18	10	27,6	0,3	11,2	18,6	24
19	11	8,4	0,01	4,76	65,2	24
20	11	14,5	0,03	3,53	62,3	24
21	10	10,1	0,04	4,46	68	24
22	18	1	0,01	17	18	24
23	8	0,5	0,01	16	20	24
24	20	-	0,01	10	20	24
25	10	1,1	0,08	12	22	24
26	18	0,85	0,02	19	20	24
27	10	6,5	2,7	12	10	8
28	10	10,9	0,3	13	9	8
29	10	20,9	1,3	11	10	8
30	10	10,6	2,7	10	14	6

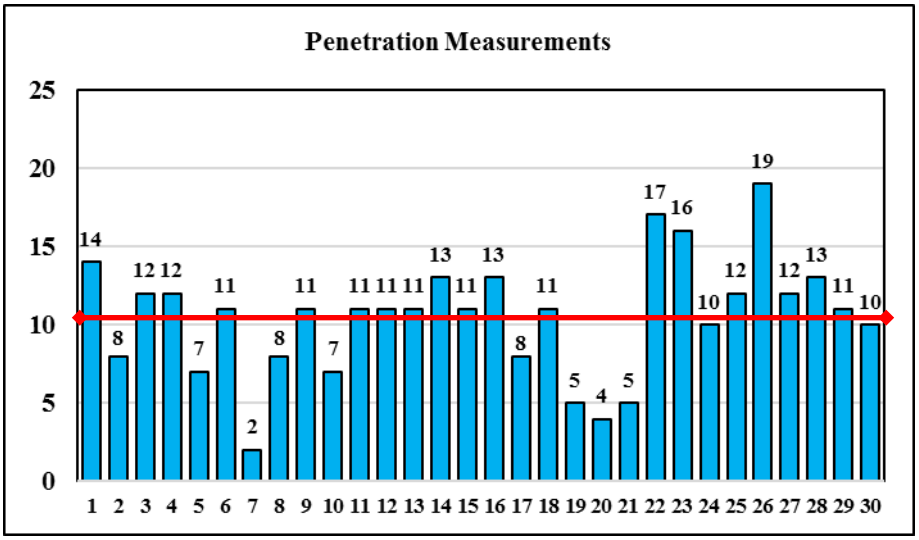

Figure-6: Graphical Display of Penetration Measurement Data

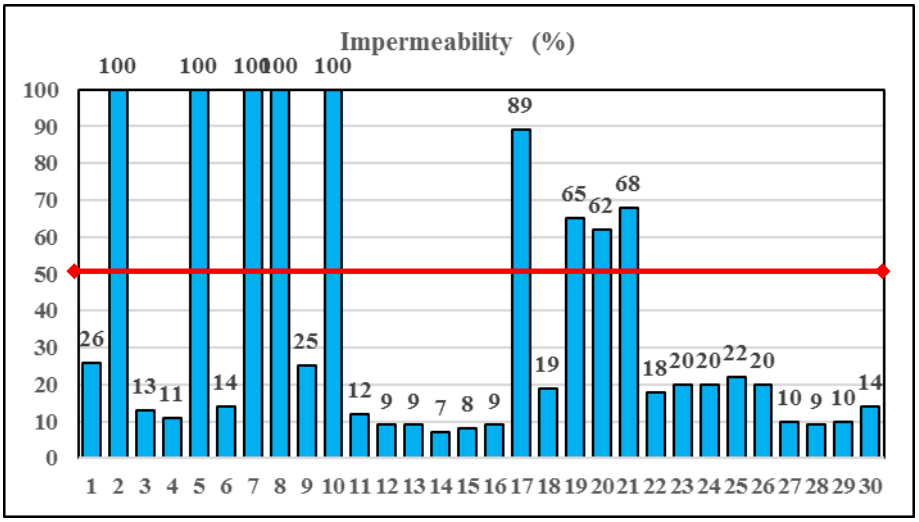

Figure-7: Graphical Display of Impermeability Measurement Data

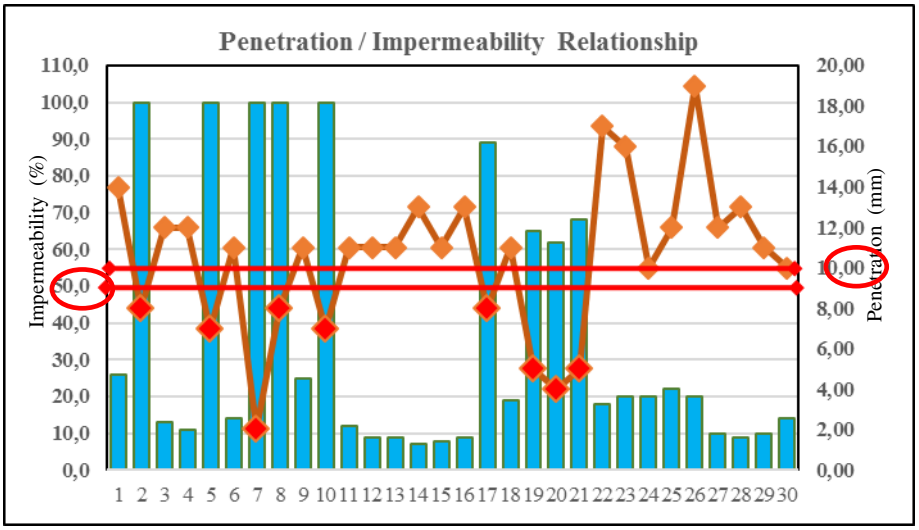

Figure 8: Comparison of Penetration and Permeability Data

When the penetration measurement data are examined (Figure-6), it is seen that 21 of the resin containing primer binder penetrates ≥ 10 mm and 9 penetrate less than <10 mm. When the impermeability tests were examined (Figure-7), it was seen that 21 of the resin containing primer binder had less than 50% water permeability and 9 had more than ≥ 50% water permeability

When the studies are examined according to both test methods, it is seen that the penetration depth and water impermeability percentage do not meet the recommended specification criteria in the experiments performed on samples 2, 5, 7, 8, 10, 17, 19, 20, 21. This indicates that the penetration of the lining material into the foundation is closely related to the water impermeability, and that the impermeability is not achieved when sufficient penetration is not achieved.

5. Emulsion Primer Binder Applications

Resin containing primer binders have started to be used as primer binder material on surface coated roads in different regions in Turkey. In the applications made in the road networks determined in the trial sections; It is recommended to spray the primer binder at a rate of 0.9–1.5 lt / m^2 depending on the condition of the surface and the climatic conditions with the help of a pressure distributor equipped tanker.

As an alternative to traditional lining materials for surface coating applications in road networks, resin-based water-based emulsion lining materials are also applied in accordance with the proposed technical specifications.

Figure-9: Application Photos

6. RESULTS

In recent years, other than bitumen emulsions, resins, polymers and water based emulsion primer binders have been widely used considering energy consumption and environmental effects. The results of the laboratory experiments, literature studies and trial applications performed on resin-containing primer binders which are considered as an alternative to traditional primer binders are as follows:

1- Since they do not contain solvents, they can be considered as safer materials for human and environmental health both in concentrated material processes, dilution process and application stages.

2- They can be diluted and used without the need for heating, thus saving less energy, thus offering more economic advantages

3- Shorter curing times (4-8 hours), it may be possible to reduce time losses due to primer application to minimum levels in seasonally limited working season areas.

4- When penetration depths and permeability percentages obtained from laboratory studies and trial applications are taken into consideration, it is seen that the requirements of the primer material are easily provided.

5- In surface coating applications, bitumen vomiting problems occur from time to time due to application amounts of conventional primer materials. Such problems have not been encountered with resin-containing water-based emulsion primer materials.

6- When the studies according to penetration and impermeability test methods are examined, it is seen that the penetration of the lining material into the foundation is closely related to water impermeability. If the lining material is well penetrated, the strength, impermeability, surface coating, adherence and dust control will be provided on the surface of the base layer.

As a result; It is thought that the use of resin based water based emulsion primer binders, which are widely used in the world by considering environmental effects and economic conditions, as an alternative to traditional primer binder materials for similar reasons. In order to determine the performance and other behavioral characteristics of these materials, which have recently begun studies, field trials are being carried out in different climatic conditions, on the basis layers prepared with aggregates of different origin and on routes with different traffic density. It is planned to develop and continue the existing research studies and trial applications in order to reveal the performance of resin based water based emulsion primer binder materials which obtained positive results from laboratory studies and trial applications.

7. REFERENCES

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