

ACCELERATED ROAD MAINTENANCE AND CONSTRUCTION USING A MODIFIED COMPACT ASPHALT METHOD

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Abstract: This paper presents the development and implementation of a modified compact asphalt method aimed at significantly reducing construction and road closure times for both maintenance and new road projects. Traditional asphalt pavements are constructed in multiple layers—base, binder, and wearing—requiring several sequential operations. The new approach introduces a specially designed asphalt mix (AC 45 B/T S), capable of being laid in a single thick base/binder course (20–22 cm) with a very thin wearing course (2 cm) simultaneously. The method has proven beneficial for high-traffic maintenance projects by eliminating joints and reducing process steps.

Keywords: Modified compact asphalt, accelerated pavement construction, asphalt base and wearing course, high-traffic road maintenance, gradation and compaction, sieve analysis, asphalt paving logistics.

Introduction

Typical asphalt pavements consist of two or three asphalt layers which are installed successively. Construction and road closure times could be reduced, if those layers were built simultaneously. A new base/binder course mix AC 45 B/T S was designed that can be installed in thicknesses of 20–22 cm and serve as a base for a simultaneously built, very thin surface course. Computational analyses have shown a lower fatigue sensitivity for the structures built by the new method. Compaction loads on hot and thick layer packages evoke deformations, especially in the edge zones. The stability of the edges has to be improved by the development of new compaction modules.

Short construction and closure times on road networks with high traffic volume are an important factor for national economies. This applies in particular for the predominant structural maintenance of existing asphalt roads. By fast paving across the entire width, time-consuming construction in multiple sections can be avoided. This also reduces quality relevant weak points, such as joints. A further acceleration of paving processes can be achieved by simultaneously placing complete layer packages consisting of a thick asphalt base course and a very thin wearing course. This idea is an enhancement of the compact asphalt pavement method, which is usually applied to build binder course and wearing course by a single paver passage. The basic idea of a modified compact asphalt pavement method into a feasible concept for construction time reduction and improvement of quality. Suitable material parameters and layer thicknesses for the enhanced compact asphalt method had to be identified and proven by asphalt-technological examination and computational design.

Application for maintenance on roads with high traffic volume

The prior field of application of the modified compact asphalt method are maintenance projects on roads with high traffic intensity under partial replacement of existing layers. Usually, the existing construction is being milled off to a certain height of the asphalt base course and then overbuilt in three paving steps, consisting of asphalt base, binder and wearing course. The new method replaces the binder and base course by a single thick layer, which is built simultaneously with a very thin wearing course (see Fig. 1).

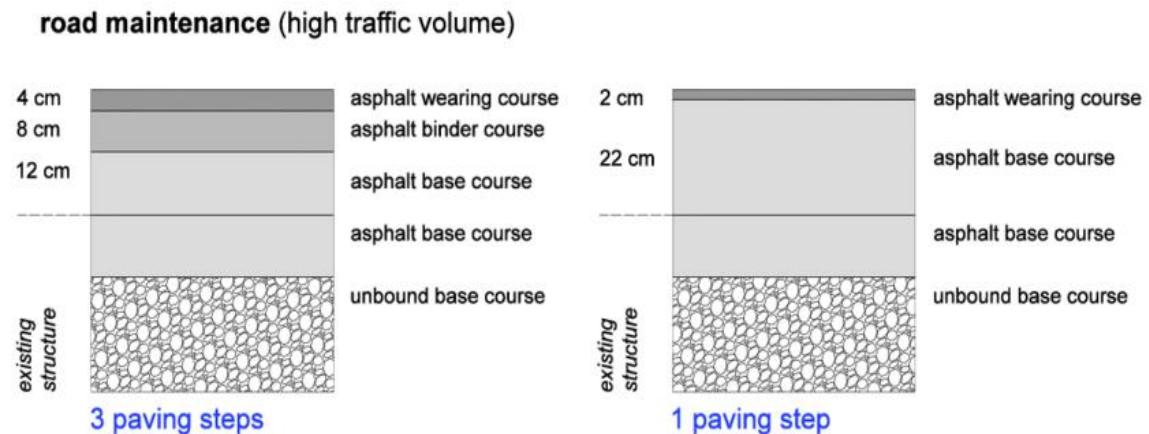


Fig. 1. Conventional and modified structural concepts for maintenance on roads with high traffic volume.

Application for building new roads with low or medium traffic volume

The modified compact asphalt method can also be used for building new roads for low and medium traffic loads in short time. A common structural concept for those roads consists of a 12 cm asphalt base course, a 6 cm asphalt binder course and a 4 cm asphalt wearing course. By using the new method, those three steps are substituted by installing a 20 cm asphalt base and a 2 cm asphalt wearing course in one paving step.

Basic requirements for asphalt wearing and base course

Here are the basic requirements for both asphalt wearing course and asphalt base course, covering materials, design, and construction aspects:

1. Asphalt Wearing Course

This is the topmost layer of flexible pavement, directly exposed to traffic. It provides a smooth riding surface and protects underlying layers. Requirements:

a) Material:

- Asphalt binder: Must meet specifications (e.g., PG 64-22 or equivalent performance grade).
- Aggregates: Durable, angular, clean, and well-graded.
- Filler (if needed): Mineral filler like lime or cement to improve stability.

b) Gradation:

- Finer than the base course.
- Typically Dense-Graded Asphalt Concrete (DGAC) or Stone Mastic Asphalt (SMA).

c) Thickness:

- Typically ranges from 25 mm to 50 mm, depending on traffic load and climate.

d) Performance Properties:

- High skid resistance
- Impermeability to water
- Resistance to rutting, fatigue, and thermal cracking

e) Compaction:

- Must achieve at least 92–96% of Maximum Theoretical Density.

f) Surface Finish:

- Smoothness within tolerances (using straight edge or laser profilers)
- No segregation, bleeding, or ravelling.

2. Asphalt Base Course. This is the layer beneath the wearing course. It distributes loads and provides structural support. Requirements:

a) Material:

- Similar to wearing course, but may allow slightly lower-quality aggregates.
- Coarser gradation for structural strength.

b) Thickness:

- Varies depending on design (commonly 75 mm to 150 mm or more).

c) Gradation:

- Typically coarser than wearing course to provide stability and drainage.
- May use Bituminous Macadam (BM) or Dense Bituminous Macadam (DBM).

d) Performance Properties:

- High stability
- Good load distribution
- Resistance to shear deformation

e) Compaction:

- Should meet 95–98% of Modified Proctor or Marshall Density, depending on design specs.
- General Construction Requirements:
- Proper tack coat between layers to ensure bonding.
 - Temperature control during mixing, laying, and compaction.
 - Use of approved Hot Mix Asphalt (HMA) or Warm Mix Asphalt (WMA) technologies.

Aggregate sizes and distribution

Here's a clear breakdown of aggregate sizes and their distribution (gradation) for both asphalt wearing course and asphalt base course – commonly used in road construction standards like those from ASTM, AASHTO, and MoRTH (India), depending on your region.

1. Aggregate Sizes in Asphalt Layers

Course	Nominal Aggregate Size	Typical Max Size
Wearing Course	10 mm – 13.2 mm	13.2 mm
Binder Course	19 mm – 26.5 mm	26.5 mm
Base Course	26.5 mm – 37.5 mm	37.5 mm

Nominal Size: The smallest sieve size through which most of the aggregate passes but on which a significant amount is retained.

2. Gradation Requirements

Gradation ensures proper interlocking and performance of the mix. Here are example gradation ranges based on MoRTH (India) and other international specs:

Wearing Course (Dense Bituminous Concrete - 13 mm nominal size)

Sieve Size (mm)	% Passing
19.0	100
13.2	90–100
9.5	70–88
4.75	53–71
2.36	42–58
1.18	34–48
0.600	26–38
0.300	18–28

Sieve Size (mm)	% Passing
0.150	12–20
0.075	4–10

Binder/Base Course (Dense Bituminous Macadam - 37.5 mm nominal size)

Sieve Size (mm)	% Passing
45.0	100
37.5	95–100
26.5	63–93
19.0	55–75
13.2	38–54
4.75	23–35
2.36	16–26
0.300	9–19
0.075	2–8

Why Gradation Matters

- Stability: Good gradation resists rutting and deformation.
- Workability: Ensures ease of laying and compaction.
- Durability: Proper fines prevent moisture damage and aging.
- Permeability Control: Balanced fines reduce water infiltration.

3. Lab Sieve Analysis Report:

A Sieve Analysis test is used to determine the distribution of aggregate particles. Below is a typical sieve analysis report format for asphalt mix:

Sieve Analysis Report Example

Project Name: XYZ Road Construction

Sample ID: Sample #12

Date: [Insert Date]

Test Method: ASTM C136 / AASHTO T-27

Sieve Size (mm)	Mass (g)	Retained Mass (%)	Passing Cumulative (%)	Passing Specification (%)	Range
37.5	15	85	85	95-100	
26.5	13	92	92	85-100	
19.0	12	93	93	60-95	
13.2	10	96	96	50-85	
9.5	7	98	98	35-65	
4.75	5	99	99	20-45	
2.36	4	99.5	99.5	15-30	
1.18	3	99.8	99.8	10-25	
0.600	2	99.9	99.9	5-20	
0.300	1	100	100	0-10	

Sieve (mm)	Size Mass (g)	Retained Mass (%)	Passing Cumulative (%)	Passing Specification (%)	Range
0.075	0.5	100	100	0-5	

Key Points for the Sieve Analysis Report:

- Cumulative Passing: The percentage of material passing each sieve, starting from the largest.
- Specification Range (%): This is the allowable range of passing for the aggregate, based on the design or regional standard.

Roadwork processes

To transfer the modified compact asphalt method into practice optimization of processes on two levels was necessary. First of all, machinery parameters and configurations for paving and compacting had to be adapted to technical features of the new method. At the beginning of this project there has not been any experience in the compaction behavior and thus in the final layer thicknesses of extraordinary thick and coarse-grained asphalt base courses. This includes also the stability of the exposed edges under compaction load. Because of the great importance of compaction results for the overall quality, usability and durability, different compaction strategies had to be proven on the testing grounds and tracks. Furthermore, acceleration of construction and closure times causes exceptional demands on the mass handling capacities for milled material and asphalt mixture. As maintenance projects with partial replacement of existing layers are the prior field of application for the new method, it has to be ensured that milled material can be cart off the place of extraction quickly and in high quantity. Regarding paving processes, a consistent paving speed is essential for quality and can only be achieved by an uninterrupted delivery of asphalt mixture. The modified compact asphalt method requires much mixture in short time, which can only be managed by the coordination of several mixing plants. This includes the different production and transportation capacities working in harmony. In preparation for the test tracks B 68 and A 96 logistical processes were analyzed with respect to potential improvements. The identified optimizations were considered in detailed concepts for the logistic of milled and asphalt mixture material and successfully implemented within the construction processes. The following showed to be the most important factors regarding a faster handling of large amounts of material:

- coordination of the concept between all involved parties, esp. under consideration of the particular capacities
- pulsing of vehicle approaches and departures under consideration of time buffers
- use of feeders and transport vehicles, which are equipped with pushing
- modules instead of dumpers harmonization between milling/asphalt mixing
- plant performances and transportation capacities numbering and color marking of milling/paving machines and transport vehicles
- provision of sufficiently large waiting, shunting and cleaning zones
- use of data terminals for the documentation of delivery notes and results of acceptance testing coordination by a central unit/organization

Conclusion

The compact asphalt method was developed further and complemented by a combined base/binder asphalt mixture AC 45 B/T S. Large-scale production of this extraordinary coarse-grained material in asphalt mixing plants was technically uncritical and resulted in homogeneous mixtures. Also paving with base course thicknesses of 20–22 cm on testing grounds and a test track on German federal road B 68 was successful. Regarding the technical requirements, pavement results were mainly equivalent to conventional paving methods. Evenness, however, turned out to be a problem. It is

unquestionable that simultaneous paving (compared to layerwise paving) offers no possibility to compensate unevenness of subjacent layers. Underlayers therefore have to be particularly even. Furthermore it turned out that edge regions of thick asphalt layers are instable under roller compaction loads. Specific edge compaction and shaping modules for the paver were therefore designed within this project. Further research is necessary especially in the theoretical description of compaction behaviour, including more detail about the decrease of compaction in lower layer sections and its influence on the pavement durability. In view of roadwork processes, the handling of especially large amounts of material in short time steps is a peculiarity of the modified compact asphalt paving method. Milled off material has to be cart off without interruptions, as well as a continuous delivery of asphalt mixture has to be ensured. Specific concepts for the optimization of material logistics were developed and proven. The combination of a new paving method and optimised logistics led to significantly shorter construction times compared to traditional paving methods.

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