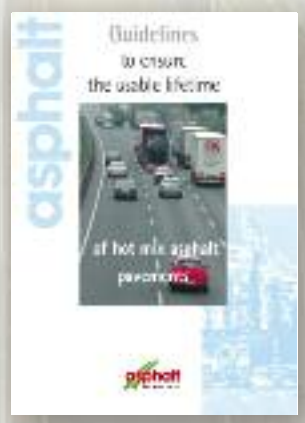
asphalt

Guidelines

to ensure the usable lifetime

of hot mix asphalt pavements

asphalt GUIDELINES



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Guidelines to ensure the usable lifetime of hot mix asphalt pavements

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Preface

HMA pavements are very durable provided they are based on purposeful planning and executed to specifications. It is possible to produce crack-free road pavements that are resistant to deformation by observing the applicable technical standards. Formally adhering to the specifications in the standards, however, is not sufficient to guarantee sufficient durability. Mistakes and faulty execution of the provisions cause premature damage, thus reducing the usable lifetime of the asphalt pavement. This results in unnecessary costs and additional stress for residents and drivers. The goal should thus be to ensure quality that not only complies with rules and regulations, but which also conforms to the particular case at hand – new pavements as well as their maintenance, beginning with the design phase and extending to tendering for bids to mix design and production, and from laying to opening to traffic.

The DAV Guide „Quality. Right from the start" provides guidance on this issue, examining damage and its different forms and appearance. This damage is ascribed to certain causes, and, more particularly, the Guide explains how such mistakes can be avoided right from the start.

This brochure also addresses how to prevent mistakes – from the design phase to laying compliance testing and opening to traffic. It is more than just a compendium of example mistakes and the damage they cause – it also ventures a look into the future. The aim is to provide tips and tricks for those aspects to which special attention should be devoted from the design phase to the opening to traffic. It also proposes measures that can be taken to meet quality requirements.

The aim is not to build asphalt pavements optimizing only one property (e. g. resistance to deformation or skid resistance), but rather to produce durable pavements that exhibit all relevant properties (resistance to deformation, skid resistance, no cracks, light color, etc.) over the course of many years even under severe loads.

Revisions of the specification, for instance, TL Asphalt-StB 07 (Technical Delivery Conditions for Asphalt Pavements, 2007 edition) and ZTV Asphalt-StB 07 (Supplementary Specifications for Asphalt Pavements, 2007 edition) will reflect the development of asphalt pavements which will be expected to exhibit greater capabilities to serve their intended purpose – a development which is indeed needed. This development will be based on experience obtained with new or enhanced materials and designs.

***„Quality. Right from the start"** is applicable for all parties working at the job site, offering the most sustainable and cost-effective solution available.*

These Guidelines already refer to terms and definitions in the new asphalt specifications including TL and ZTV Asphalt-StB 07, Factory Production Control etc. (e.g. „initial type testing" and „suitability documentation" will replace „suitability test") as well as to the technical specifications.

This Guide does not claim to be exhaustive and is based on the authors' current state of expertise, practical experience and existing publications.

The other guidelines and brochures of the DAV provide additional tips and ideas. This information is listed at the end of the brochure or is available under **www.asphalt.de → Literatur.**

Examples of mistakes and their impact

This section examines some recurring mistakes made during the design and placement phase which could have been avoided if the specifications and the following guidance had been observed.

Poor layer bonding

Poor layer bonding will occur if such a highly contaminated existing surface is not cleaned.

Waves at traffic junctions (queuing areas) are one possible defect caused by poor layer bonding.

A properly applied tack coat and a clean surface ensure good layer bonding

A Category II road with high loads laid with specifically designed asphalt mix. Even after years of trafficking it exhibits no deformations.

Rutting/deformation

Rutting/deformation due to the use of an improper asphalt mix that is not suited for the intended purpose (e.g. no rut-resistant mix, binder is too soft, ...)

Durable and jointless asphalt pavements are also possible for container depots and cargo-handling areas (this picture shows the Hamburg container port)

Severe fretting/disintegration/raveling

Disintegration caused by embrittlement

Intact regional road that has been trafficked for a lengthy period of time and is categorized as Category IV (surface course consisting of asphalt concrete that was designed to specifications and properly layed and compacted)

Segregation

Segregation occurs on asphalt surface courses when the paver hopper is repeatedly run empty.

Using a feeder prevents segregation and paver stops.

Cracking

Cracking caused by binder embrittlement/ageing

Cracking caused by the varying bearing capacity of the existing roadway and its extended side-section.

Crack-free asphalt road after years of trafficking (sufficient bearing capacity of the subbase, proper laying and good compaction of an asphalt mix designed to specifications)

Skid Resistance

Insufficient skid resistance caused by a mix where the aggregate's resistance to polishing is too low and an improper binder type was used – for a narrow, single-lane traffic

Asphalt road with skid resistance complying to specifications by using aggregates resistant to polishing and taking measures complying with specifications to ensure early skid resistance after laying.

Design, tender, award of contract

New roadway

Even during the design phase, i. e. prior to preparing the contract specifications, the expected load and traffic category should be determined as accurately as possible. ZTV Asphalt-StB 07 assumes that the heavy traffic category and categories I through III are always subjected to special loads. Especially high temperatures over a lengthy period of time or intense solar radiation, e. g. on south-facing slopes, aggravate the effect of loads on the roadway.

Special loads include…

- **Single-lane traffic, sharp bends (e. g. on roundabouts!),**
- **Slow traffic,**
- **Frequent deceleration and acceleration,**
- **Intersections and junctions,**
- **Stationary and stop-and-go traffic,**
- **High temperatures over a lengthy period of time.**

Special load in front of a bridge due to a bottle-neck

When selecting the mix design for non-public traffic areas (especially storage and stacking areas etc.) the following special loads should also be considered (this is not an exhaustive list):

- **Fork-lifts**
- **Concentrated loads (contact points of racks, shelving, swap bodies etc.)**
- **Loading of stationary trucks**

Example of a special load on a non-public area

In such case the load placed on the asphalt surface course and the asphalt binder course (if included in the design) is in most cases not identical with the number of passes of the equivalent axle load of 10 tons occurring during the usable lifetime of the pavement. This aspect should be taken into account when selecting the mix, and especially when the area is assigned to a lower traffic category.

It is imperative that materials be selected in a careful manner as early as the design phase. And it is crucial that asphalt pavement engineering experts be consulted. Usually formal compliance with the ZTV specifications will not suffice.

Appropriate asphalt mix type and asphalt mix grade to be used, depending on the expected load (Table 1 of ZTV Asphalt-StB 07)

Traffic category/ surface type	Asphalt base course	Asphalt binder course	Combination of Asphalt base and surface course	Type of surface course: Asphalt concrete	Stone mastic asphalt	Mastic asphalt	Porous asphalt
Heavy loads and category I	AC 32 T S AC 22 T S	AC 22 B S AC 16 B S	–	–	SMA 11 S SMA 8 S	MA 11 S MA 8 S MA 5 S	PA 11 PA 8
II				AC 11 D S			
III		AC 16 B S					
IV	AC 32 T N AC 22 T N	(AC 16 B N)		AC 11 D N AC 8 D N	(SMA 8 N)	(MA 11 N) (MA 8 N) (MA 5 N)	–
V		–					
VI			AC 16 TD	AC 8 D L AC 5 D L	(SMA 8 N) (SMA 5 N)		
Cycle tracks and sidewalks	AC 32 T N AC 22 T L				–	(MA 5 N)	

Appropriate binder type and binder grade to be used, depending on the expected load (Table 2 of ZTV Asphalt-StB 07)

Traffic category/ surface type	Asphalt base course	Asphalt binder course	Combination of Asphalt base and surface course	Type of surface course: Asphalt concrete	Stone mastic asphalt	Mastic asphalt	Porous asphalt
Heavy loads and category I	50/70 (30/45)	25/55-55 30/45 (10/40-65)	–	–	25/55-55	20/30 (10/40-65)	40/100-65
II				25/55-55		20/30 (25/55-55)	
III				25/55-55 50/70	25/55-55 (50/70)		
IV	70/100 (50/70)	50/70		50/70 (70/100)	50/70	30/45	–
V	70/100	–		50/70 70/100	70/100		
VI			70/100				
Cycle tracks and sidewalks				70/100	–		

Explanations: – Not intended for use, ( ) Only in exceptional cases

The principle „As hard as necessary" should be applied when selecting the binder type and grade. This means that softer binders with lower air voids should be used for lower loads than it is the case for higher loads.

Polymer-modified binders should preferably be used for roads and traffic areas subjected to high loads and special loads.

If mix designs have the same resistance to deformation, preference should be given to asphalt base and binder courses with a smaller size, as they are less susceptible to segregation (e.g. AC 16 B S should be specified in the RFQ instead of AC 22 B S). Surface courses with a smaller size can be beneficial where special requirements need to be met with regard to skid resistance and lower noise emissions.

Design, tender, award of contract

Asphalt mix types and grades with their specified ranges of layer thickness and the layer thicknesses recommended for technical specifications (DAV Guidelines "Tendering Asphalt Works").

Layer	Asphalt mix types and grades	Layer thickness in compliance with ZTV Asphalt-StB [cm]	Recommended layer thickness for specifications [cm]
Asphalt surface courses	AC 5 D L	2,0 to 3,0	2,0
	AC 8 D N, AC 8 D L	3,0 to 4,0	3,0
	AC 11 D N, AC 11 D L	3,5 to 4,5	4,0
	AC 11 D S	4,0 to 5,0	4,0
	AC 16 D S	5,0 to 6,0	5,0
	SMA 5 N	2,0 to 3,0	2,0
	SMA 8 N	2,0 to 3,5	3,0
	SMA 8 S	3,0 to 4,0	3,5
	SMA 11 S	3,5 to 4,0	4,0
	MA 5 S, MA 5 N	2,0 to 3,0	2,5
	MA 8 S, MA 8 N	2,5 to 3,5	3,0
	MA 11 S, MA 11 N	3,5 to 4,0	3,5
Asphalt binder courses	AC 16 B N	5,0 to 6,0	≥ 5,0
	AC 16 B S	5,0 to 9,0	≥ 6,0
	AC 22 B S	7,0 to 10,0	≥ 8,0
Asphalt base courses	AC 22 T S, AC 22 T N, AC 22 T L	≥ 8,0	≥ 8,0
	AC 32 T S, AC 32 T N, AC 32 T L	≥ 8,0	≥ 8,0
Combination of Asphalt base and surface course	AC 16 TD	5,0 to 10,0	≥ 6,0

Layers should be structured in compliance with Table 1 and Table 4 of the „Guidelines for the Standardization of Pavement Structures of Traffic Areas" (Richtlinien für die Standardisierung des Oberbaues von Verkehrsflächen – RStO 01). Layer thickness should be defined not only in compliance with the RStO – it also requires the appropriate construction method and material with regard to compactability and resistance to deformation.

The paving of asphalt surface courses during inclement weather should be avoided. Compaction aids [organic or mineral additives as specified in the „Guidelines for Warm Mix Asphalt" (German: M TA) or in the Lessons Learned of the BASt] can be used if paving in such seasons cannot be avoided, see also the DAV Guidelines „Warm Mix Asphalts".

ZTV Asphalt-StB 07 stipulates in Section 2.1. that it should be determined when preparing the specifications whether the asphalt layers can be placed along the entire width of the roadway without joints or using the „hot to hot" technique. It should furthermore be determined whether a continuous mix supply (by using a feeder) can and should be stipulated. In such case, this should be added to the specifications.

In individual cases, special quality features related to specific requirements (e.g. reflective surface courses, binder properties) should be clearly defined in the specifications.

Roller with edge-restraining device used to smooth out the shoulder and to prepare the seal coat for the high shoulder.

Water bleeding on a motor way

Protective measures should be taken to prevent lateral water ingress into the pavement. The road edges should be sloped, the shoulders of the asphalt layers should be smoothed out with edge-restraining devices or similar tools, and the shoulder of the asphalt layers on the higher road edge should be sealed [ZTV Asphalt-StB 07, Section 2.3.4 and the „Guidelines for Layer Bonding, Seams, Joints and Edging of Asphalt Roads" (German: M SNAR]. Inter alia, this prevents one cause of water leakages with SMA surface courses.

Special loads, e.g. due to traffic bottlenecks caused by construction sites should also be taken into account when selecting the mix. Specific measures should be taken to protect the surface if asphalt binder or base courses will be trafficked for a lengthy period of time during the construction and especially during the winter season.

The expertise and productive capacity of bidders should be analyzed when bids are evaluated. If the tender is only open to a limited number of competitors, the expertise and productive capacity of these bidders should be analyzed when they are selected. Bidders can demonstrate their capabilities by submitting references. Secondary bids with a demonstrably higher use value and a higher bid price should not be automatically rejected and, instead, included in the evaluation to ascertain any potential benefits with regard to durability and thus higher efficiency.

Weather conditions must be taken into account if a surcharge has been quoted for faster operations (for earlier opening to traffic). Overly ambitious mixing and paving operations should be avoided as quality might deteriorate – especially during adverse weather conditions.

Unfortunately, the designer normally does not receive any feedback on the execution of the project, which means that mistakes that have already been identified might be repeated in another call for bids. Ongoing communication between the site supervisor and the party calling for bids should thus be specified to guarantee quality assurance. This applies particularly to problems that have occurred, new issues and special designs for a given project.

More often than not, testing and control procedures do not receive sufficient attention during the planning phase or are assigned to the wrong party. Standard specifications, for instance, often state compliance tests as part of the construction work to be performed and are then awarded by the contractor. Compliance tests, however, are tests which are supposed to be carried out by the client. The client thus should engage third parties to perform such tests or carry them out himself (see the Section on „Compliance Testing" on page 25).

Design, tender, award of contract

Road maintenance

The aforementioned principles for new roads are, of course, also applicable to road maintenance measures (more particularly „reinstatement"). There are, however, additional peculiarities and procedures that should be observed:

The existing surface should be investigated to facilitate decisions as to which type and scope of reinstatement measures are to be taken in compliance with ZTV BEA-StB (Supplementary Specifications for Structural Maintenance of Traffic Areas – Asphalt Pavements). Such investigations also serve as the basis for planning such measures and calling for bids.

It is recommended to locate the sampling points at varying distances to both road edges. The sampling points should not be too far away from each other. The closer the points, the greater the validity. It is recommended to keep a minimum distance of 200 m and each test section should have at least 3 test points. Coring tests are necessary to assess the pavement with regard to type, thickness and environmental compatibility of the existing layers. Usually coring with small rigs is required for overlay thicknesses that are not in compliance with RStO specifications (small coring machine or manual coring) so as to analyze the layers in terms of resistance to frost and water conditions. Aside from the direct exploration, into the layers of the sub-grade via coring and manual coring metrological methods (Benkelman beam, Lacroix, Falling Weight Deflectometer), also allow evaluations of the residual bearing capacity of the road. The dew period is the best time to perform bearing capacity measurements. Based on the established residual bearing capacity and the exploration data and lab tests the sections can be subdivided into areas with the same bearing capacity. They also help to determine uniform reinstatement sections and to calculate the required overlay thickness.

Benkelman beam

Falling weight deflectometer

The required thickness of any overlays that might be required should be enhanced to accommodate the specified traffic load. An overlay, as specified in RStO 01, can only be recommended if no hard parameters on the existing structure and its properties are available, and if the traffic categories for road reinstatement are defined solely on the basis of the visible condition of the surface. In many cases old materials (e. g. macadam design or bottoming) cannot be compared any longer with the currently applicable standard specifications

Rutting is often due to layers with insufficient resistance to deformation. In such case the decisive feature are the layers, and not the bearing capacity. Accordingly, the thickness of the layers affected by deformation and the resistance to deformation of the remaining asphalt layers should be determined. The required milling depth should be specified in the next step. Care should be taken to fully remove the layer/ layers to be milled.

Coring by applying tape markings to identify the location

Depending on the traffic category, a „rut-resistant mix" consisting e. g. of stone mastic asphalt might be required if the traffic load has increased. An asphalt layer with a thickness of 4 cm is only "tight" if the void content of the placed mix is ≤ 3 Vol.-%, whereas stone mastic asphalt surface courses may have void contents above this level. When planning an overlay with a two-layer structure with a stone mastic asphalt surface course, it should be ensured that water penetrating the structure also drains through the milled surface of the pre-existing layer. If its voids have been clogged trough milling, making drainage impossible, the pre-existing layer will also have to be milled off. Failure to do so traps water in the new overlay and may cause water leakage spots, blistering or stripping effects.

During reinstatement measures all drainage systems should be inspected for their operational reliability and correct location also.

Suggestions as to how to reinstate the road surface should be tailored to the rehabilitation objective and take into account any lessons learned and the state of art.

Only through such road-specific surveys and investigations it is possible to perform planning with any certainty and proper tendering for bids is possible. By adopting this procedure the existing road structure can be used as base layer for the design and execution of reinstatement projects where the existing road is ultimately tantamount to a new road.

Damage such as scaling, raveling, cracking and open joints that occurs during the service life of the road should be removed in a timely manner while ensuring appropriate quality. ZTV BEA-StB describes the maintenance and reinstatement measures to be taken.

Open joint

Joint sealed to requirements

Mix design

The objective is to create a durable asphalt pavement. This is achieved by producing asphalt layers exhibiting the following features:

- **a high-density, interlocked aggregate skeleton with considerable internal friction consisting of fully crushed aggregates exhibiting great edge strength, and**
- **a suitable binder with good adhesive strength, good resistance to deformation and sufficient relaxation properties during cold weather that ensures a permanent bond with the mineral aggregates.**

Traditional pavement structures exhibit more air voids as the layers go deeper to ensure that loads are transmitted into lower asphalt layers and backwater (water leakages) is prevented. This means that, in addition to its properties that are of importance to the users, the surface course also has to be impervious at the interface to the underlying asphalt binder and base courses. This is the only way to prevent water from penetrating the pavement.

In the second half of the 1990s surface and binder courses for heavily trafficked road pavements were designed with a focus on resistance to deformation. For this reason the 1998 version of ZTV Asphalt-StB 94 increased the content of coarse aggregate in SMA surface courses to 75 % by weight. This amendment made it difficult to meet the void content required for the surface course or the degree of compaction in any reliable manner. After various kinds of damage had occurred and because the mix manufacturers and the construction industry had emphatically insisted that this specified limit for the aggregate content be changed, ZTV Asphalt-StB 01, as amended in 2001, lowered it to 73 % by weight. The Technical Delivery Conditions set forth in TL Asphalt-StB 07 specify a minimum of 70 % coarse aggregates by weight for SMA 11 S and SMA 8 S.

Furthermore, ZTV Asphalt-StB 07 reduced the maximum air void percentage for completed SMA asphalt layers from the previous level of 6 Vol.-% to 4.5 Vol.-% at present. Accordingly, the air void percentage for Marshall specimens used in initial type testing was also lowered from 3.0 Vol.-% to 4.0 Vol.-% to 2.5 Vol.-% to 3.0 Vol.-% at present (these values are applicable for SMA under special loads. The range is 1.5 Vol.-% to 3.0 Vol.-% for mixes designed for normal loads). These combined measures will help ensure that air voids fall within prescribed limits and that the sealing effect is improved.

When using AC 22 B S asphalt binder as specified in ZTV Asphalt StB 01, care has to/had to be taken during paving operations to ensure that no segregation occurs/occurred. Segregated areas with rock pockets and relatively thin binder films do not offer much resistance to aggressive water. Again, TL Asphalt-StB 07 will reduce the minimum content of coarse aggregates in the asphalt binder AC 22 B S by 3 Vol.-% by weight.

*The 0.5 Vol.-% reduction is due to the new testing procedure. The „real" reduction is 0.5 Vol.-% lower.

Comprehensive project information, i. e. from the project description and specifications, is decisive for a successful mix design. There must be sufficiently precise descriptions of the application purpose, loads, gradients, southern slope, etc.

The specifications provided by the client must be checked for completeness, plausibility and any contradictions before preparing the initial type test (replacing the former suitability test) preceding the suitability documentation. Objections to technically wrong or incorrect/unworkable specifications should be forwarded in a timely manner and, if possible, accompanied with proposals for changes.

TL Asphalt-StB 07 regulates the incorporation of RAP (Reclaimed Asphalt Pavement) into the mix. RAP must be suited for the intended purpose and classified according to TL AG-StB 06 (Technical Delivery Specifications for Reclaimed Asphalt Pavement – RAP). The DAV Guide „Wiederverwenden von Asphalt" (Recycling Asphalt, 2008) provides additional guidance, current research findings and explanations.

Additional performance tests (e. g. by determining compactability, resistance to deformation, low temperature behavior or predicting skid resistance for surface courses) should be conducted, if required, to supplement the documentation demonstrating that the surface and binder courses are suited for the intended purpose. In the past this has proved to be a reliable process to design asphalt surface and binder courses for durability.

A lead time of several weeks should be allowed for to select appropriate materials (aggregates, binder and, if required, fillers) and to prepare suitability documentation.

Keeping adhesion between the aggregate and the bitumen intact under all types of stress and ensuring that the internal cohesion of the binder is not changed to a critical degree due to impact of weather is a decisive factor in the service life of asphalt courses. Bitumen quality with regard to ageing behavior due to different effects such as water, atmospheric oxygen or UV radiation is vital to internal cohesion.

Special attention should be devoted to bitumen/aggregate adhesion if aggregates and/or binders exhibit poor adhesive strength. It might even be necessary to specify anti-stripping agents. Using Polymer modified Bitumen might help to improve adhesion, but is no guarantee for success.

What is really important is that the mix design works for the intended purpose. Aside from having skilled staff, the required information has to be furnished to achieve this goal. Not even extensive suitability documentation and additional performance testing will lead to the desired success if such know-how and information is not available.

Wheel-tracking apparatus for determining resistance to deformation of hot mix asphalt

Mix production

Factory Production Control complying with DIN EN 13108, Part 21 is a prerequisite for the manufacture and supply of Asphalt mixes. The requirements of this standard must be met. The FGSV (German Road and Transportation Research Association) explanatory notes on DIN EN 13108, Part 21 provide more guidance.

Maintaining a consistent quality of the individual materials used is essential to ensure the quality of the asphalt product. Aggregates, binders and RAP are always part of this, in some cases fibers and other additives are too.

Inspection of delivered materials

The materials delivered must be visually inspected and analyzed in the lab in accordance with a quality assurance plan that is to be drafted.

Aggregates:
A visual inspection should be carried our for each supply truck. Spot checks should be made to ensure regularity by carrying out screen analyses; if required such analyses should be performed more often than set out in DIN EN 13108-21.

Binder:
The tank closure reports and delivery notes should be checked during each delivery to ensure that the values cited are consistent with the standard and the purchase order. Samples should be drawn and tested with regard to the ring and ball softening point and penetration. It is recommended to perform binder tests more frequently than specified in DIN EN 13108-21, more particularly for Polymer modified Bitumen (PmB). It is also recommended to carry out these tests or have them carried out after short-term and long-term ageing and to test elastic recovery of PmB in regular intervals or have it tested.

Reclaimed Asphalt Pavement (RAP):
RAP must be classified in accordance with TL AG-StB and should be stored separately in line with its intended purpose.

Storage

The truck lanes and material stockpiling areas should be paved in such a way to ensure the material does not mix with the surface. The drainage system should be designed so that the stored materials do not become soaking wet.

Sufficient bins should be available to store the aggregates and granular RAP. The number and size of bins depends on the type and amount of the material that is required each day and the delivery options. Experience has shown that it is good to have additional reserve bins available for special materials that are used for special mixes.

The material and fraction should be clearly labeled on the bins. The dimensions and the walls of the bin walls should be designed so that different aggregate fractions and grades cannot mix.

It is recommended to keep aggregate fractions ≤ 5 mm and granular RAP in dry storage areas – not only to save energy.

An appropriate number of properly labeled supply tanks is needed to store different bitumen grades.

Bitumen must be appropriately stored at temperatures complying with the relevant standards while monitoring the heating process. Incoming additives should be stored immediately after delivery in accordance with the manufacturer's instructions.

Bitumen supply tanks – monitoring the storage temperature is necessary.

Mix production

Drying and mixing

The number of required cold-feed bins depends on the amount of the different aggregates used.

Using separate cold-feed bins for different types of RAP can prevent confusion during the mixing process

Proportioning

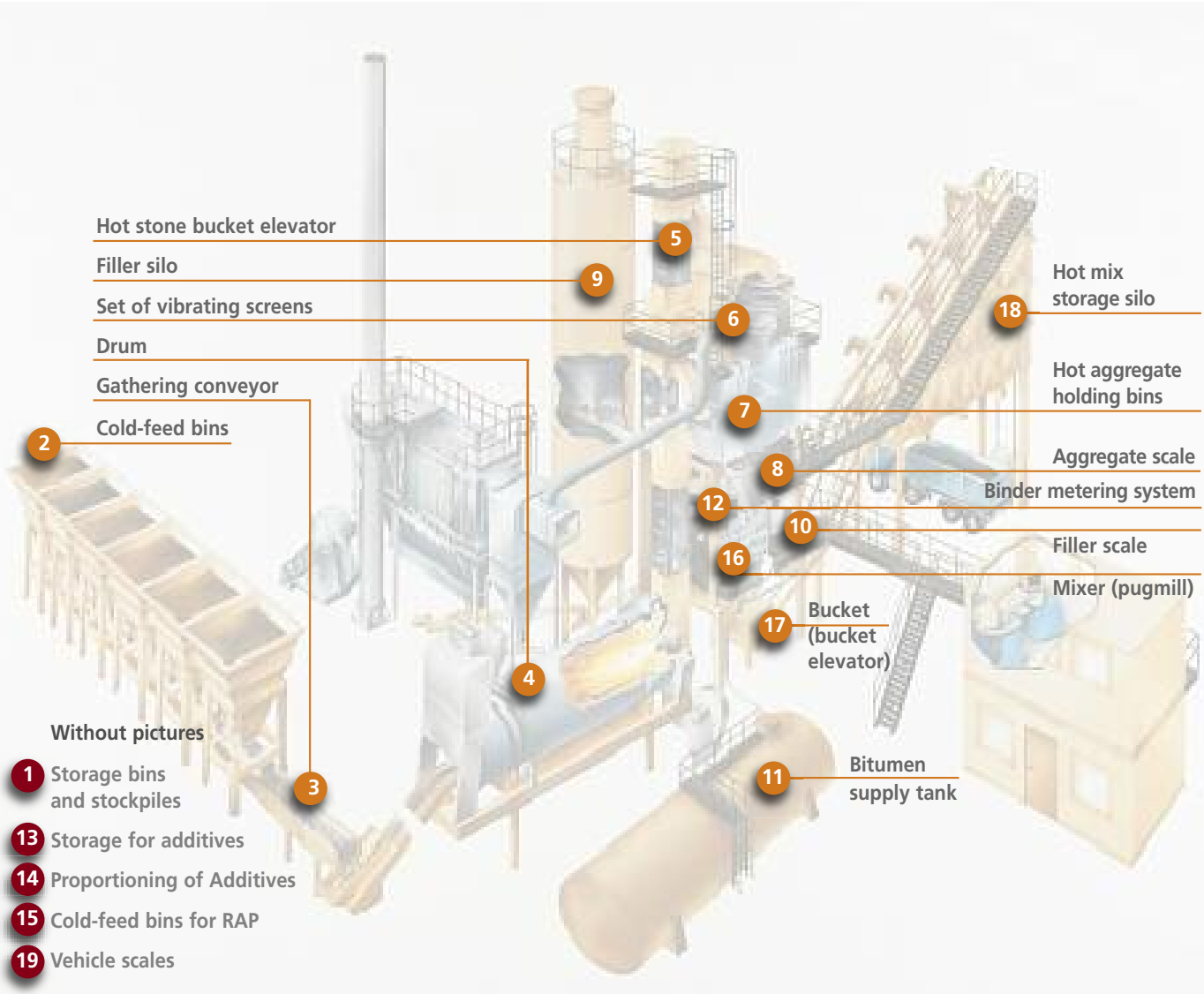
The number of required cold-feed bins depends on the amount of different aggregates used and their different sizes that are supplied. Their size should be based on the capacity of the mixer.

The cold-feed bins must be clearly labeled to ensure that the wheel loader empties the material into the correct bin. If various material sizes are supplied, it should be ensured that control settings are adjusted to the current aggregate size.

The top of the cold-feed bins for RAP should be equipped with a screen (mesh size ca. 80 x 80 cm) to prevent clumped material being dumped into the bin. Reclaimed material intended for surface and binder courses and granular RAP (reclaimed by ripping and breaking the pavement) intended for asphalt base courses should be metered out of separate bins in order to avoid mistakes.

Fine aggregates with different flow coefficients (so far: crushed sand and natural sand) should be proportioned separately out of two bins.

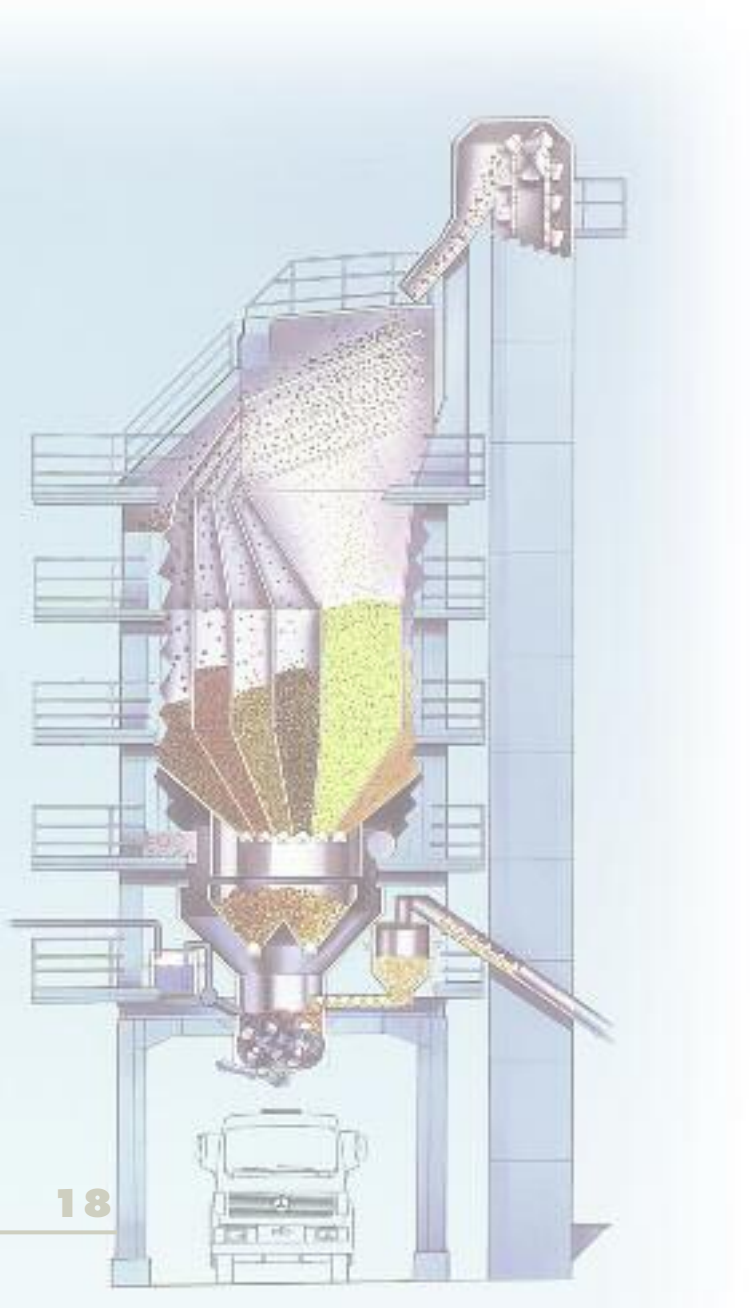
Connection to the control center ensures that the material flow is monitored. It is recommended to equip the cold-feed system with closed-circuit TV and a control system that can be adjusted to the job mix formula. The output of all gathering conveyors can then be adjusted on an ongoing basis.



Mix production

Drying and heating

The temperature of the aggregates should be measured with an infrared thermometer and should be connected with the automatic control system of the burner. The temperature data should be recorded as they are especially relevant to plant quality control. Overheating must be avoided.



Mixing

The most important steps in the batch tower are conveying, screening, hot bins and mixing.

The vibrating screens must be inspected at regular intervals to ensure their proper functioning. Overloading the screen bottoms with material should be avoided.

Keeping an appropriate amount of material in the storage silos helps to keep the weighing of the material more precise. When using standard silo sizes it is recommended to monitor the filling height with a level indicator system.

Nowadays, a plant control system makes it easier to monitor proper functioning of a mix production plant. Maintaining adequate records of such inspections and tests facilitates quality assurance in many areas. This documentation tracks the actual weights compared to the prescribed weight for each lot and material. The temperature of the mix when discharged from the gates of the mixer must also be documented. The mix temperature must be kept within the limits set out in TL Asphalt-StB 07.

Fatting up (migration of bitumen to the surface) due to poor dispersion of fiber pellets in the mix

Regular surface with SMA mix complying with specifications

The homogeneity of the mix is influenced by the time required to proportion the individual components to the mixer and by the additional mixing time. For this reason enough time should be allowed for this process. Sufficient mixing time is generally important – not least to fully disperse the fiber pellets in the mix.

In modern mix production, data can be plotted and continuously tracked on charts. Malfunctions, such as components that have not been proportioned to the mix, can be visually displayed during the mixing process as a chart or warning message in the control window.

Especially when producing large batches of a specific mix grade the job-mix formula should, wherever possible, not be changed to improve the homogeneity of the mix. This requires precise production planning for the mix production plant and coordination with the other clients at the job site.

Mix production

Storing the asphalt mix

A silo can be used to adjust capacities to job site requirements and thus allows a higher output rate without reducing quality, provided that oxidation, segregation and temperature loss of the mix are avoided to the greatest extent possible.

The gates at the top of the silo should therefore be air-tight and equipped with an automatic opening and closing mechanism.

Mix bucket on a horizontal (encased) bucket conveyer on top of the silo gate with automatic closing mechanism

The shape of the silo, its cone and a short distance to the bottom of the silo for the falling asphalt can prevent segregation to a great extent.

After the mix has been discharged into the silo it can be kept in the silo for a limited period of time, depending on the type of mix and silo.

Mix transport

The load must be covered to avoid crusting during transport. Semi-circular bottom dump trucks reduce the danger of segregation when transporting the asphalt mix. The truck bed should be treated with appropriate release agents (not diesel). In case of doubt the binder suppliers should be consulted.

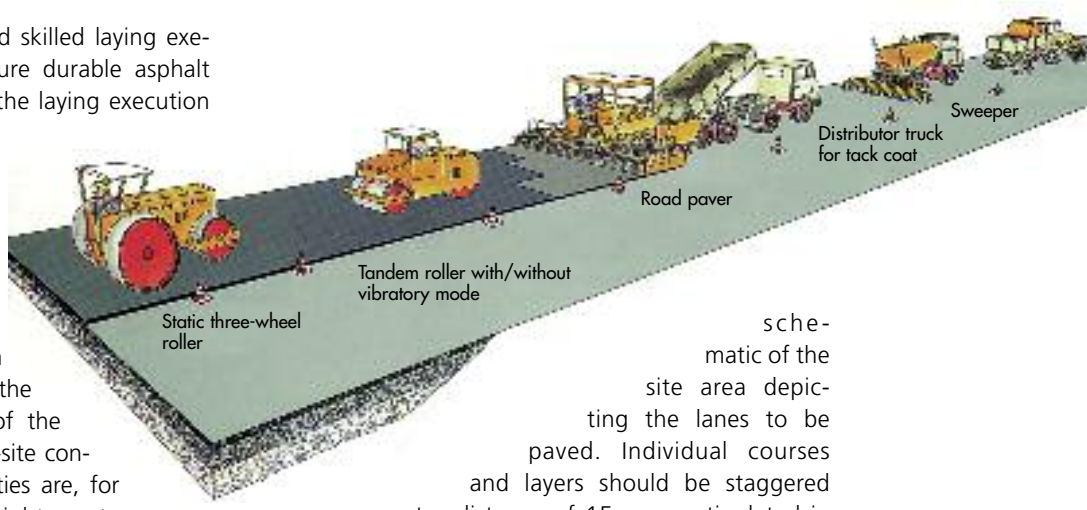
Semi-circular bottom dump truck

The temperatures prescribed in TL Asphalt-StB should be observed when discharging the asphalt mix into the paver hopper. Measuring the mix temperature before discharging the mix can prevent cold mix being emptied into the hopper. Mix that is too cold should be rejected. Recent technical advances allow continuous temperature measurements on the truck bed. Such measurements, however, cannot replace the values measured with a calibrated penetration thermometer.

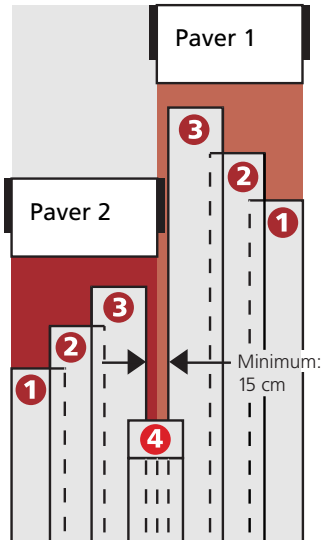
Among other factors, careful and skilled laying execution is also important to ensure durable asphalt pavements. It is imperative that the laying execution be planned well in advance.

At the latest when planning the laying execution the on-site conditions should be compared with the limits of the mix to be placed. Such limits are e. g. the permitted minimum and maximum layer thicknesses prescribed in the specifications or the suitability of the mix types and grades. Special on-site conditions during construction activities are, for instance, limited visibility during night construction jobs, uphill and downhill sections or adverse weather conditions. It should be noted that during reinstatement projects there will be little time available between milling the surface, applying the tack coat and placing the mix since in many cases the roads are only closed for a very short period of time. Any additional measures, such as a regulating course that might be required and specifying the necessary type and grade of mix should be done in a timely manner in such case.

While preparing the construction work the required number of pavers and rollers should be determined depending on the area to be paved and the potential output rate of the Asphalt production plants, taking into account regional experience and the respective type of mix. During the job it is helpful to prepare a schematic of the site area depicting the lanes to be paved. Individual courses and layers should be staggered at a distance of 15 cm as stipulated in Section 2.3.2 of ZTV Asphalt-StB 07. In addition, preparing a roadmap for laying the mix can considerably improve the quality of the job.



The required quantity of mix and/or the number of trucks should be determined taking the haul distance into account. Ongoing communication between site management, the Asphalt production plant, the paving foreman and the lab should be ensured so as to facilitate a continuous material feed into the paver during paving operations and to respond quickly to any necessary changes. This helps avoiding excessive waiting times for haul vehicles which cause unnecessary temperature loss, and paver stoppages where the mix cools down. This procedure also reduces irregularities caused by the screed plate settling into the layer during stoppages.



Improving surface regularity with an averaging beam attached to the paver

Laying

Right before starting the works the base course/existing surface should be tested for its bearing capacity and condition. Any deviations from the specified level, gradient or regularity must be determined.

Reference points must be indicated. It is also helpful to indicate the strips to be paved or elevations on the surface or at the edge. When laying regulating courses to level out the asphalt base course, the layer thickness limits should be observed depending on the aggregate size. Any dirt or loose particles must be removed (see picture in Section 2).

The base course should be tack coated as detailed in ZTV Asphalt-StB and M SNAR to ensure good layer bonding. In some instances, however, the upper limits for tack coating the surface specified in these documents are very high. If the application rate is very high, the binder film might be too thick (depending on the condition of the surface), which might cause horizontal slippage between the layers under shear stress. The binder might even penetrate the layer that is being paved. For this reason the application rate should be adjusted and determined on-site in accordance with Section 2.3.1 of ZTV Asphalt-StB 07.

Segregation during paving operations might be reduced by folding up the sides of the mix-receiving hopper. The sides should be folded up as soon as the drag slats are covered with only about 30 cm of mix. If paving widths do not change the augers should be extended to the specified paving width. Augers that are significantly shorter than the paving width encourage mix segregation and should thus be avoided to the greatest extent possible.

Compaction success is one of the most important quality parameters and is expressed as degree of compaction and void content. It should thus be tested directly before starting paving operations and during such operations as a self-monitoring activity. Radio-metric measuring devices (nuclear density gauge) or electronic measuring devices (Dynamic Probing Medium) may be used as well as coring and inspecting cores.

Nuclear density gauge to measure the density of the layer.

Test strip for porous asphalt

When working on special sites and with new designs such as double-layered porous asphalt or compact asphalt pavements separate test strips are necessary to determine the correct screed settings, paving speed, initial compaction as well as the roller types and roller patterns to be used. These test strips should be part of the client's tender for bids. In such cases the client and contractor should closely collaborate in planning the project.

For the self-monitoring activities it is especially important to continuously monitor the thickness of the layer as it is being placed. Such precautions are all the more important when the layer adjoins an existing surface or e. g. when working on roundabouts.

Paving operations must be stopped in adverse weather conditions (e. g. wet, cold, windy weather).

Tests and inspections should be carried out in regular intervals and with due diligence during paving operations on the placed layer during self-monitoring activities as stipulated in the specifications with regard to regularity, edging and gritting quality etc. The asphalt surface right behind the paver screed should also be evaluated in addition. Countermeasures should be considered, if the pavement shows surface tears or other irregularities. The screed-settings and -heating or the paving speed can be changed as corrective action. It is also recommended to perform visual inspections not only from the location of the paver but also to evaluate the paved area behind the paver from a greater distance.

Self-monitoring activities, compliance testing and opening to traffic

From the perspective of both the client and the contractor, meeting the quality requirements specified in the contract is an important prerequisite to ensure cost-efficiency of the project. This requires the will to produce quality, solid expertise, and an efficient flow of information. These factors are an integral part of the construction process for both the client and the contractor. Quality can be directly influenced during the construction process by ensuring competent site supervision and the contractor performing sufficient tests during self-monitoring activities or during Factory Production Control in the asphalt production plant as stipulated in DIN EN 13108-21. By testing ongoing construction activities and the finished product for compliance the client verifies not only that the requirements specified in the contract are met but also influences the quality level indirectly.

Roles and responsibilities in the project

Contractor		
Initial type testing and verification of suitability	To be performed by a qualified agency	■ Type and scope in accordance with TL and ZTV Asphalt ■ Submission of suitability documentation
Factory Production Control	Initial inspection and continuous surveillance of asphalt production plant by a Notified Body	■ Manufacturer's declaration of conformity ■ CE Mark for product
Self-monitoring activities during paving operations	Assigned to an internal or external agency or crew on-site	■ Self-monitoring activities complying with ZTV Asphalt-StB ■ Verifies density with core tests and/or non-destructive testing to determine the number of roller passes and the compaction technique
Client		
On-site project supervision	To be performed by own personnel or by consultant	■ Provides construction advisory services ■ Reviews test certificates for materials/mixtures submitted by the contractor ■ Performs visual inspections of the delivered/paved materials and initiates compliance tests in the event of doubt ■ Is present during the performance of essential services during project execution and audits self-monitoring activities of the contractor ■ Retrieves required compliance tests according to an inspection plan previously agreed upon with the auditing body (certified inaccordance RAP Stra) or as prescribed in Technical Specifications (ZTV-StB, etc.). ■ Contributes to acceptance of finished product ■ Reviews invoices
Compliance tests	Assigned to an auditing body certified in accordance with RAP Stra for the respective area of expertise	■ Results are used as reference for acceptance ■ Quality is subsequently indirectly influenced ■ Are used as reference to eliminate defects
Bauabnahme	Contribute by on-site supervision	■ Acceptance subject to the provision that no defects are identified in compliance testing

Compliance testing which is used to demonstrate that the quality specified in the contract has been delivered is used as a basis for acceptance of the end product. Compliance testing also includes the passage of risk and the payment of the contractor as agreed. Compliance tests are inspections to be initiated by the client in order to verify whether the characteristic qualities of the materials, the mixtures and the end result meet contract specifications and at the same time serve as the basis for acceptance of the finished product. Compliance tests cover quality-related criteria such as asphalt composition, degree of compaction, cross fall, skid resistance and evenness of the layer that was placed. It should be kept in mind that proper drawing of samples is absolutely necessary in order to ensure good quality tests. Skilled staff should draw the samples with the warranted caution and as described in the relevant specifications.

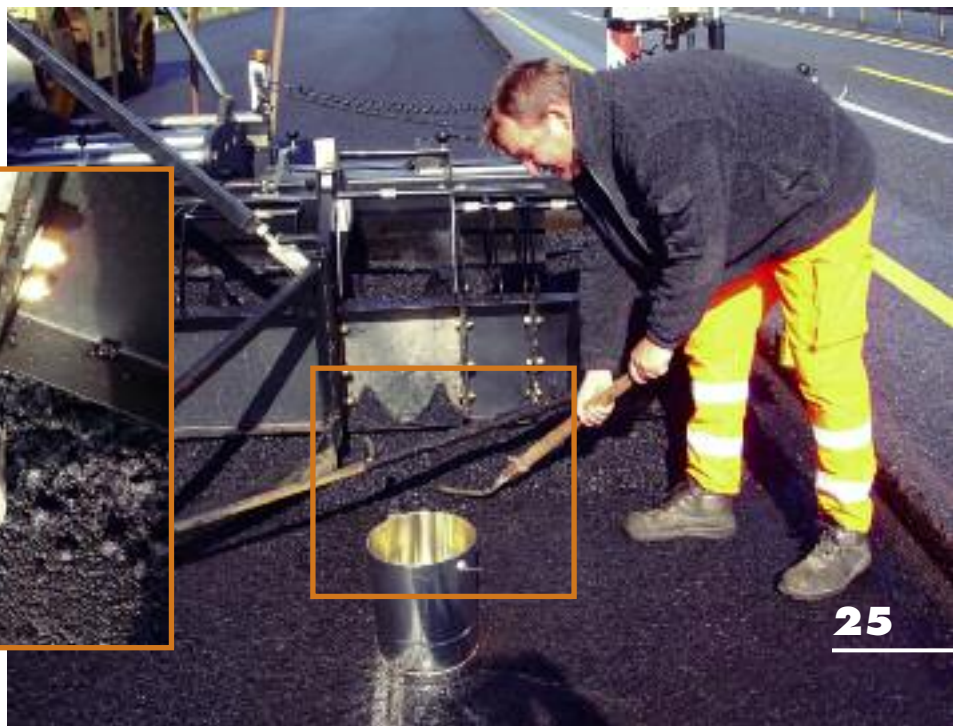
The details of compliance testing as well as the test intervals and tolerances are prescribed in the relevant Supplementary Specifications and Guidelines (ZTV Asphalt-StB and/or ZTV BEA-StB). Standardized test methods and devices are used to execute the tests.

The tolerances specified in the Supplementary Specifications, i. e. allowable deviations from target values, not only take into account unavoidable fluctuations occurring during construction and while producing the mix, but also fluctuations when drawing samples, splitting samples, and fluctuations caused by the test method itself (precisions). Such fluctuations are determined in ring tests and are based on statistical calculations.

Remarks on the importance of acceptance and compliance tests

Acceptance with compliance test	Acceptance without compliance tests
■ In the event of defects, acceptance is granted only subject to reservations	■ Causes reversal of the burden of proof for the client in the event of defects.
■ Risk is transferred when the quality delivered is known.	■ Risk has been transferred to client.
■ Contractor is paid according to the quality delivered.	■ Full remuneration even though the quality delivered is unknown.
■ Repairs, reductions in the price or deductions may be agreed upon in the event of defect.	■ Client waives the right to any repairs or pay reductions.

Taking samples with the „European shovel"



Self-monitoring activities, compliance testing and opening to traffic

Independent of the test intervals cited in the Technical Specifications it is recommended to adjust the scope of tests to on-site conditions. The scope of tests might change and expand, for instance, if only a small section is paved on a given day, if paving conditions vary or if there is a change in mix supply. If the client does not conduct compliance tests himself, he will engage an auditing body certified in accordance with RAP Stra. Such auditing bodies can be found on a list which is made available to the public in the respective Federal State. The list also states the type of certification granted (e. g. certified for testing asphalt for compliance). Before awarding tests to an auditing body it should be verified that the auditing body is certified for the area to be tested.

Skid resistance tests (SRT) require a separate license for the equipment and the driver to be granted by the Federal Highway Research Institute (Bundesanstalt für Straßenwesen, BASt).

As a general rule, the road should be opened to traffic after acceptance. The road should be opened to traffic after the cooling time for the freshly placed asphalt layer as prescribed in Section 1.3. of ZTV Asphalt-StB 07 has elapsed. The cooling time should be considered as early while planning the project and preparing the roadmap, taking into account typical weather conditions that might occur during the job. The weather conditions while finishing the surface course, however, are most important. If it is very hot, cooling times might be longer than specified in ZTV Asphalt-StB 07.

Additional information about the German Asphalt Paving Association (DAV) and further DAV-guidelines

More information about the
German Asphalt Pavement Association DAV and the
German Asphalt Research Institute DAI
as well as an overview of their publications
(brochures, guidelines and research reports)
you will find on the internet:

www.asphalt.de

Further publications in English and in other languages
www.asphalt.de → Literatur → Download → International

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