Granulate Rubber Modified
High Performance Solutions
GRM by CTS

Lecture on TL RmB StB, By on 24/09/2019

The standard construction method for a long lifespan of all asphalt pavements

Actually, I mostly find it very unlucky to speak on a set of regulations as a topic, whether in the passive form as the listener or as the active participant who has the opportunity to report on it. In the case of presentations on regulations, as the person delivering the lecture one frequently experiences a gentle gliding away of the listeners, who are already looking forward to the next break. I do not want that to happen. Therefore, I will not try to explain the tables of the regulations in detail – you can read that for yourself or find out later – but rather I will try to explain the direct advantages that can have a positive impact on your daily work.

Only when you see the advantages and your customer, the car driver, can experience the advantages, then you have unerringly implemented the regulation.

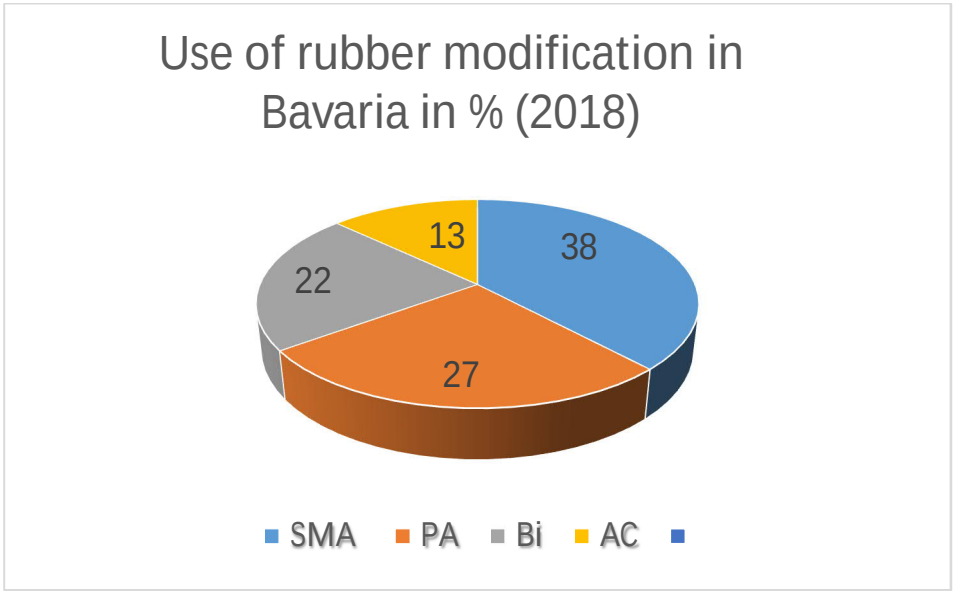
The TL RmB will soon celebrate its 10-year service anniversary – without any change whatsoever. That is an achievement in our fast-moving times. A set of regulations that exists for 10 years without changes is either not needed and therefore not used or is has had nearly perfect success. Now, after the first 10 years, one can say without doubt that rubber modification occupies a permanent place. Much more extensive than one could ever have imagined and much to the regret of the big PmB producers. Because they have now had to recognise and understand that everything one can do with PmB can also be achieved with a rubber modification. But on the other hand, everything that can be achieved with a rubber modification, PmB can no (longer) do.

The differences are becoming increasingly obvious, especially as the acceptance of rubber modification is continuously and strongly growing. A tried-and-tested alternative to PmB A with a few unbeatable and very significant advantages. Today, we assume a market share of rubber modification in modified binding agents in Bavaria of a good 30%.

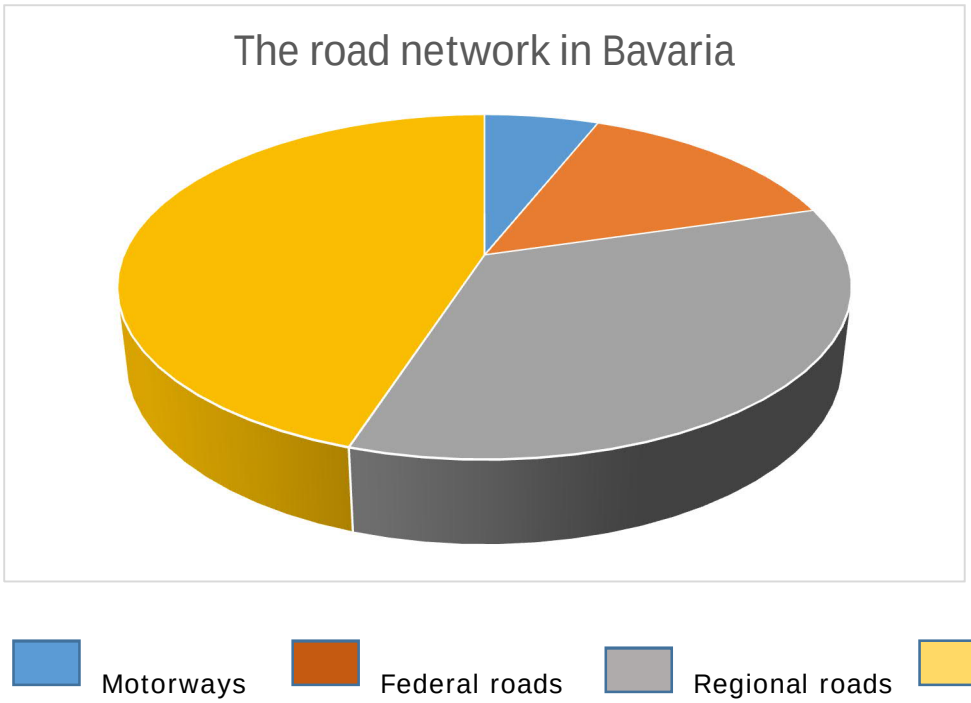
To this day, rubber modification has blossomed out from a niche product for very few and very specific applications to a very successful, universal product for genuinely all applications. A success story without end.

Last year, in Bavaria, a total of around 1.7 m m² of asphalt pavements were installed on a rubber-modified basis. This is divided into: (Slide)

SMA	38%
PA	27%
Binder course	22%
AC	13%



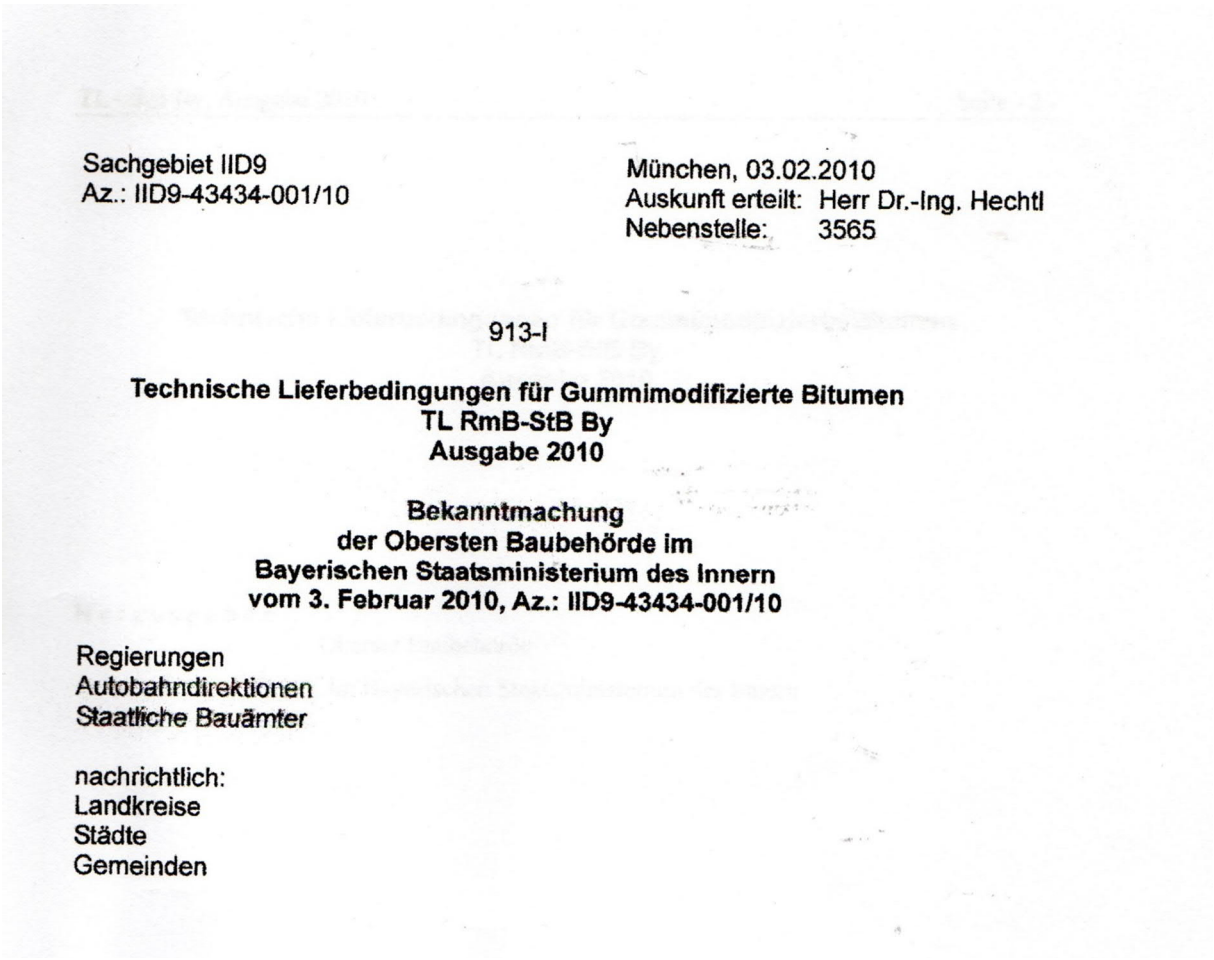
You, or rather your departments, are responsible for significantly more kilometres of road than your colleagues at the motorway directorates and road construction offices. (Slide)



The problem may be the same - namely, asphalt pavements that bow out far too early. Only, the causes are possibly different in strength at the different departments.

Therefore, it is now all the more important to inform you in detail about a special, practice-orientated set of regulations. A set of regulations that, when applied correctly, helps you to get to grips with the problems of premature failure of asphalt pavements. Of course, it cannot be prevented. But bringing the useful life of the asphalt pavements back to a tolerable and usual level – that can be done.

I would like to recommend to you the TL RmB-StB By, 2010 (slide). TL stands for *Technische Lieferbedingungen* (German for “technical conditions of delivery”), RmB = Rubber Modified Bitumen.



Sachgebiet IID9
Az.: IID9-43434-001/10

München, 03.02.2010
Auskunft erteilt: Herr Dr.-Ing. Hechtl
Nebenstelle: 3565

913-I

Technische Lieferbedingungen für Gummimodifizierte Bitumen
TL RmB-StB By
Ausgabe 2010

Bekanntmachung
der Obersten Baubehörde im
Bayerischen Staatsministerium des Innern
vom 3. Februar 2010, Az.: IID9-43434-001/10

Regierungen
Autobahndirektionen
Staatliche Bauämter

nachrichtlich:
Landkreise
Städte
Gemeinden

“Technical conditions of delivery for rubber modified bitumen”, TL RmB-StB, edition 2010; promulgation of the Superior Construction Authority in the Bavarian Ministry of the Interior of 3 February 2010.

What does it actually mean to modify bitumen? What is meant here is the usual road construction bitumen according to TL Bitumen - modification = bringing it to the right degree, implying that the starting product can no longer fulfil the current requirements and now must be modified by adding one or several modifier so that the current requirements can be safely fulfilled.

In the case of bitumen, if all the possible criteria are shown, these requirements are very varied:

1. Increase in viscosity
2. Expanded plasticity span
    a. Increase of the ring and ball softening point
    b. Improvement of the low-temperature behaviour
3. Increase in elasticity
4. Increase in cohesion
5. Improved adhesive behaviour, also on adhesion-critical aggregates
6. Improved ageing behaviour (short- and long-term)
    a. Delayed oxidative ageing
        i. Manufacturing
        ii. Transport
        iii. Storage
        iv. Processing
    b. Reduced influence of weather and environment
        i. Reduced susceptibility to UV radiation
        ii. Higher resistance towards acids, lyes and chemicals
7. Better thermal stability

Upon closer consideration and assessment of the achievable possibilities of a "well made", i.e. effective modification, it is astonishing that the listed points are pretty exactly identical with the properties that set in due to a regular rubber modification. In this case, however, regular means definitely compliant with TL RmB-StB. But be careful – not every rubber modification offered today complies with the rules. Some systems are not process-reliable and cannot ensure the desired and required properties – especially in the long term. And therefore here the strict reference to consistent compliance with and implementation of the regulations applicable to you, the TL RmB-StB, By.

When the regulations were formulated, all participants (representatives from research, administration and business) agreed that the very positive experiences up to that point, e.g. regarding permanence, absolutely had to be anchored in the regulations. For instance, the very sensitive PA asphalts showed in practice 50% longer lay times than PmB-A. That is quite significant. And what works so well with very sensitive asphalts also applies in effect to all other asphalt varieties.

In February 2010, TL RmB-StB was introduced by the Superior Construction Authority and thus elevated to the standard construction method. The objective was clear: to implement the advantages from the PA area in all possible asphalt formulae. For this reason, only the two variants of rubber modification with which there had been demonstrably positive experiences were firmly established in the regulations. Thus, pseudo-modifications were (and are currently) ruled out sustainably and effectively, at least in Bavaria.

And something else: As early as 2010 when the regulations were introduced, it was formulated in the preamble that rubber modification was equivalent to polymer-modified binding agents. Mildly sneered at by the "big" PmB producers at the time, today we know exactly that there is simply no equivalence. Today, GRM (rubber-modified bitumen granulates) mercilessly highlight the limits of all PmB A and are not just superior to them in important criteria, but even far superior.

Which variants are described in the regulations?

Hot-liquid and ready-to-use rubber-modified bitumen.

This is road construction bitumen modified with buffing dusts (usually with a maximum of 1 mm grain size). They bear the addendum “R”. That is, RmB R and then the requirement span for the penetration and the minimum requirement for the softening point (ring and ball). From this, the following products were specified:

RmB R 20/60-55

RmB R 35/70-55

This rubber-modified bitumen actually constitutes the “original form” of the successful modification of bitumen with rubber. Original form means that these forms of bitumen were first used in Europe on a large scale in the 1980s in several measures. Associated with a lot of effort, but successful.

At high temperatures (approx. 200° C) and for a longer period (this can be several hours, depending on the available use products), buffing dusts – also equipped with further additives, depending on the manufacturing process – are mixed with each other and brought to reaction. The production method is called the “wet process”.

The polymers from the buffing dusts start to soak, connect to the bitumen matrix and in the process produce a desired very strong increase in viscosity This is both a curse and a blessing.

A blessing because it allows asphalts with particularly thick binding agent films to be manufactured.

A curse due to the transportation (only in complete TTFs) and storage at the asphalt mixing plant. Usually, the binding agent conveying systems at the mixing plant are not designed for this viscosity level. Even stronger pump systems suffer severely and wear out extremely quickly. The dosage at the asphalt mixing plant takes place like usual binding agents. (Bitumen tank, bitumen conveying system, bitumen scales) Therefore, the term “wet dosage” is also used.

A curse also because rubber-modified bitumen is not storage-stable. Since the insoluble product components of the buffing dust unavoidably sediment, prompt consumption is an essential requirement for successful use. Even mixing tanks at the mixing plant do not manage to ensure homogeneity permanently. The demixing begins shortly after the loading process at the manufacturing plant.

Hence, a dangerous game in logistics, especially in unclear weather situations. Additionally, the production capacity at the manufacturing plant is heavily limited. Because the products cannot be stored. There was frequently a crucial bottleneck here when larger motorway measures were carried out.

And yet another very important point accelerated the killing off of this binding agent conception: a use of reclaimed asphalt cannot be foreseen, as no special RC qualities with a higher modification degree are available.

Been? Killed off? Yes - been. You understood me correctly. The heyday of ready-to-use hot-liquid rubber-modified binding agents is already a few years in the past and is now probably, definitively history. Since high temperatures and bitumen are not just not contemporary but even banned for occupational safety and environmental protection reasons – you need only think of the hydrocarbon emissions – an optimal production of these binding agents can be ruled out. At production temperatures of considerably less than 200° C, it is not possible to move the polymers from the buffing dust to a reaction.

Today, the performance of these products would receive the school mark “insufficient failed” and lags miles behind the usual efficiency. For this reason, several manufacturers in Germany have decided to discontinue the production of hot-liquid rubber bitumen. It makes no qualitative sense.

A correct and sensible step, as it is not for no reason that the TL RmB-StB offers a very effective and significantly more flexible alternative:

Tabelle 1: Anforderungen an Gebrauchsfertige Gummimodifizierte Bitumen

Merkmal oder Eigenschaft	**Einheit**	**Prüfmethode**	Sorten	
			RmB R 20/60-55	**RmB R 35/70-55**
Dichte	g/cm³		ist anzugeben	
Penetration bei 25 °C	0,1 mm	DIN EN 1426	20 bis 60	35 bis 70
Erweichungspunkt Ring und Kugel	°C	DIN EN 1427	≥ 55	≥ 55
Flammpunkt	°C	DIN EN ISO 2592	≥ 235	≥ 235
Elastische Rückstellung bei 25 °C[1)]	%	DIN EN 13398	≥ 50	≥ 60
Beständigkeit gegen Verhärtung unter Einfluss von Wärme und Luft nach DIN EN 12607-1				
Masseänderung	%	DIN EN 12607-1	≤ 0,5	≤ 0,5
Verbleibende Penetration	%	DIN EN 1426	≥ 60	≥ 60
Zunahme des Erweichungspunktes Ring und Kugel	K	DIN EN 1427	≤ 8	≤ 8
Abfall des Erweichungspunktes Ring und Kugel	K	DIN EN 1427	≤ 2	≤ 2
Elastische Rückstellung bei 25 °C[1)]	%	DIN EN 13398	≥ 50	≥ 60
Verformungsverhalten im Dynamischen Scherrheometer (DSR)[2)] (Abschnitt 2.3.1)				
Komplexer Schermodul G* bei 60 °C	Pa	DIN EN 14770	≥ 7.000	≥ 12.000
Phasenwinkel δ bei 60 °C	°		≤ 75	≤ 65
Verhalten bei tiefen Temperaturen, Biegebalkenrheometer (BBR)[2)] (Abschnitt 2.3.2)				
Steifigkeit S bei -16 °C	MPa	DIN EN 14771	≤ 300	≤ 200
m-Wert bei -16 °C			≥ 0,3	≥ 0,3

[1)] Beim vorzeitigen Reißen des Fadens (≤ 20 cm) ist die Ausziehlänge anzugeben.

[2)] Die Prüfungen dienen der Erfahrungssammlung, bei den angegebenen Größen handelt es sich um Orientierungswerte.

Table 1: Requirements for ready-to-use rubber-modified bitumen

Rubber-modified bitumen granulates.

This is road construction bitumen modified with buffing dusts (usually with a maximum of 1 mm grain size, used tyres as the basis). However, this is in very concentrated form(approx. 1:1). In further processing steps, the mixture is granulated under the 10 M % additive of a highly stiffening filler. The rubber-modified bitumen granulates bear the designations GRM 40/15 and more strongly prepared – as a premium product - GRM 40/20. GRM stands for granulate rubber modified.

The differentiation criteria for rubber-modified bitumen are:

1. Concentration (rubber/bitumen ratio; can no longer be handled with traditional mixing tools and pumps)
2. Reaction in specially closed reaction containers
3. Reaction under protective gas atmosphere; thus
    a. No hydrocarbon emission,
    b. No oxidative pre-damage of the bitumen,
    c. No temperature restriction due to legal constraints
4. Continuous viscosity tests in order to monitor the reaction process
5. Therefore reproducible and optimal reaction process, no dependence on the quality of the basic bitumen

Tabelle 2: Kenngrößen Gummimodifizierter Bitumengranulate

		Liefersorte		
Eigenschaft		**GRM 40/15**	**GRM 40/20**	**Prüfung nach**
Spezifisches Gewicht	g/cm³	1,00 bis 1,04	1,00 bis 1,04	DIN EN 12607-3
Gummimehlgehalt / davon angelöst	*M.-%*	*40/15*	*40/20*	*keine*
Bitumengehalt	*M.-%*	*50*	*50*	*keine*
Füllergehalt	*M.-%*	*10*	*10*	*keine*
Granulatgröße	mm	0 bis 20	0 bis 20	DIN EN 933-1 bzw. 52098

Table 2: Parameters rubber-modified bitumen granulates

This production method is also, of course, a "wet process".

Those who worked on the formulation of the TL RmB had a good reason for setting a mandatory specification for the composition. They wanted to ensure without fail that the high viscosity is achieved only through an optimal optimal polymer digestion. Because this is precisely what would guarantee permanent effectiveness of the rubber-modified bitumen granulates. They absolutely wanted to avoid other product approaches, e.g. through further additives or other compositions, which may possibly achieve a higher viscosity level but also have a dubious long-term behaviour.

However, after the granulation the aggregate state changes. The granulates are now dry; they are non-critically storable for a long time at any asphalt mixing plant and can be stored and transported without any problem.

Packaging takes place in fusible PE bags between 10 and 20 kg, in big bags of 500 to 850 kg or as bulk goods in large quantities. Transportation/shipping in container is also possible.

At the asphalt mixing plant, the rubber-modified bitumen granulates are entered directly into the mixer and poured onto the dry aggregates. (Manual bag feed, automatic bag feed, as bulk goods via a silo with connected weighing device, in the form of the (calibrated) cold feed) The term “dry dosage” is therefore used. The quantity of GRM added results from the formula, the corresponding system configuration and/or the respective desired/possible batch size. After a short dry mixing time, a hot-liquid road construction bitumen, e.g. 50/70 or 70/100, is added and everything is homogenised with the usual post-mixing time. An extension of the mixing times is mostly not required. However, this is also dependent on the state of the mixer.

Key for the asphalt mixing plant in asphalt production is the fact that only usual road construction bitumen is pumped via the normal bitumen conveying system. There is not premature wear of the bitumen pumps. The high viscosity takes place only in the mixer. And due to the high shear forces there, this is absolutely no problem.

Table 3: Requirements of mixtures of road construction bitumen and rubber-modified bitumen granulate constructed in the laboratory

Tabelle 3: Anforderungen an im Labor hergestellten Mischungen aus Straßenbaubitumen und Gummimodifiziertem Bitumengranulat

			Sorte		
Merkmal oder Eigenschaft		**Prüfung nach**	**RmB G 25/60-52**	**RmB G 20/60-55**	**RmB G 35/70-55**
Hinweise zur zweckmäßigen Zusammensetzung			***50/70 mit 12 M.-% GRM 40/15***	***50/70 mit 22 M.-% GRM 40/15***	***70/100 mit 33 M.-% GRM 40/20***
Dichte bei 25 °C	g/cm³	DIN EN ISO 3838	1,000 bis 1,100	1,000 bis 1,100	1,000 bis 1,100
Nadelpenetration (100 g, 5 s, 25 °C)	0,1 mm	DIN EN 1426	25 bis 60	20 bis 60	35 bis 70
Erweichungspunkt Ring und Kugel	°C	DIN EN 1427	≥ 52	≥ 55	≥ 55
Flammpunkt im offenen Tiegel nach Cleveland	°C	DIN ISO 2592	≥ 235	≥ 235	≥ 235
Elastische Rückstellung bei 25 °C[1)]	%	DIN EN 13398	≥ 50	≥ 55	≥ 60
Beständigkeit gegen Verhärtung unter Einfluss von Wärme und Luft nach DIN EN 12607-1					
Relative Masseänderung	%	DIN 12607-1	≤ 0,5	≤ 0,5	≤ 0,5
Zunahme des Erweichungspunktes Ring und Kugel	K	DIN EN 1427	≤ 8	≤ 8	≤ 8
Abfall des Erweichungspunktes Ring und Kugel	K	DIN EN 1427	≤ 2	≤ 2	≤ 2
Elastische Rückstellung bei 25 °C[1)]	%	DIN EN 13398	≥ 50	≥ 55	≥ 60
Verformungsverhalten im Dynamischen Scherrheometer (DSR)[2)] (Abschnitt 3.5.1)					
Komplexer Schermodul G* bei 60 °C	Pa	DIN EN 14770	≥ 7.000	≥ 9.000	≥ 12.000
Phasenwinkel δ bei 60 °C	°		≤ 75	≤ 70	≤ 65
Verhalten bei tiefen Temperaturen, Biegebalkenrheometer (BBR)[2)] (Abschnitt 3.5.2)					
Steifigkeit S bei -16 °C	MPa	DIN EN 14771	≤ 300	≤ 250	≤ 200
m-Wert bei -16 °C	-		≥ 0,3	≥ 0,3	≥ 0,3

[1)] Beim vorzeitigen Reißen des Fadens (≤ 20 cm) ist die Ausziehlänge anzugeben.

[2)] Die Prüfungen dienen der Erfahrungssammlung, bei den angegebenen Größen handelt es sich um Orientierungswerte.

Thus, various bitumen varieties can be manufactured from the GRM 40/15 and/or 40/20, according to TL RmB-StB:

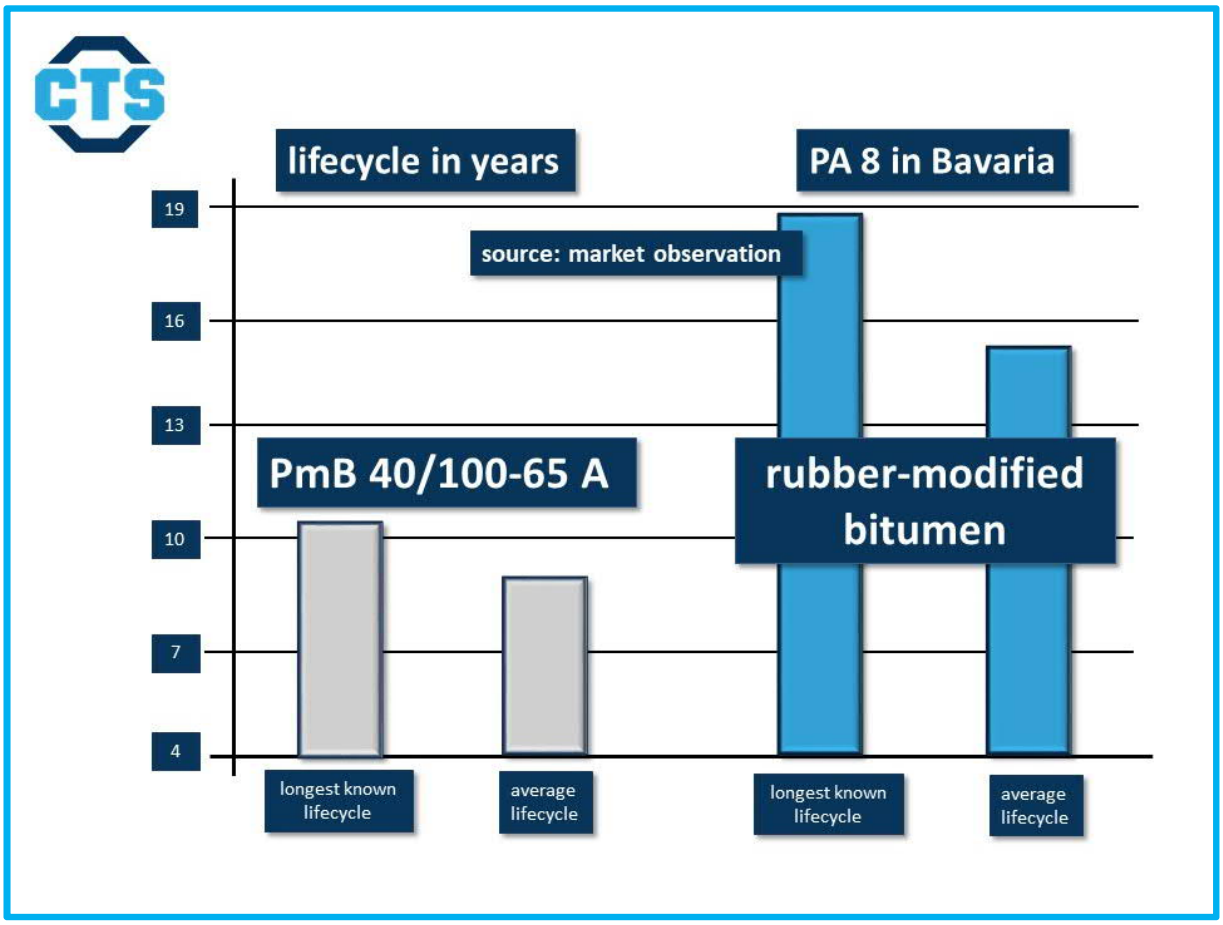
1. RmB G 25/60-52
2. RmB G 20/60-55
3. RmB G 35/70-55

Designation: Requirement span for the penetration and the minimum requirement for the softening point (ring and ball). In the regulations, an expedient composition – in order to achieve the specifications safely - of the binding agents, i.e. quantity and type of GRM and quantity and gradation of the added road construction bitumen is additionally proposed.

What are the advantages of rubber modification?

The properties of the rubber modification are very similar to those of PmB A. Both polymers belong to the same chemical group. It is the group of thermoplastic elastomers.

The properties the thermoplastic polymers (regardless of the origin of the polymers) give to “normal” road construction bitumen are surely well-known to you. From a viscosity increase and an expanded plasticity span to a significantly improved “adhesive effect”. But which properties are so outstanding specifically in connection with the modification with the polymers from the rubber? (Slide)



1. Ageing behaviour
    a. Induced by the extremely strong viscosity increase of the rubber modification
    b. *The* key property for particularly thick binding agent films
2. Ageing behaviour
    a. Associated with this, significantly higher permanence, i.e.:
        i. longer lay times
        ii. reduced maintenance effort
        iii. extended renovation intervals
        iv. as result: higher economic efficiency
3. Significantly higher cohesion

Allow me here to focus more heavily on the topic of “ageing”. A topic that actually keeps all responsible road construction participants on their toes in equal measure. Ageing takes place primarily due to heat, UV light and oxygen. All three initiators trigger an oxidation reaction of the construction material of bitumen. An irreversible process.

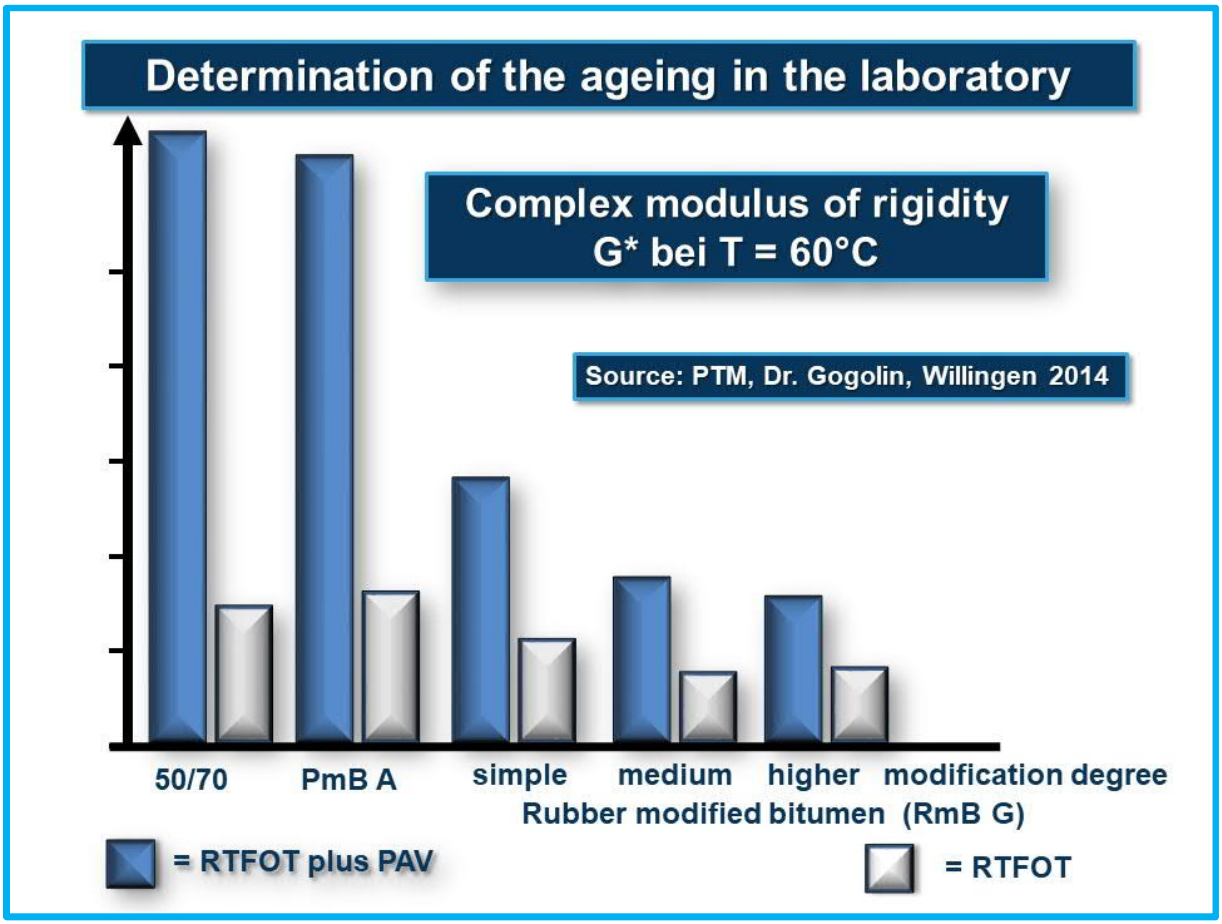
Ageing lads to the embrittlement of the mastic and/or the bitumen. The stiffness increases but unfortunately the elasticity decreases to the same degree. This results in a loss of adhesion and the first aggregates begin to loosen out of the asphalt matrix. Consequences: fretting, grain break-outs and finally brittle cracks in the winter.

The crack formation, in turn, accelerates the destruction of the asphalt structure through penetrating water. By means of frost-dew change, this results, in turn, in the very popular potholes. The degradation can no longer be stopped. The consequence: a reduction in the planned useful life.

At this point, a somewhat stronger differentiation must be made. Here, the focus is on the produced used, the buffing dust. For good reason, CTS Bitumen has made a commitment and uses exclusively lorry tyres as a basis. Lorry tyres because these consist almost exclusively of natural rubber. Polybutadiene and polyisoprene have very specific properties that we specifically want to supply to the asphalt in the CTSGRM. These polymers are characterised by high resistance towards thermal, mechanical and oxidative stress. And it is precisely this that makes up the advantage compared to PmB A with its rather simple SBS modification.

Dr Gogolin from Dortmund carried out interesting analyses on this and communicated them as part of a DAV event in 2014.

At the PTM Institute, G. has aged various binding agents artificially. The ageing simulates long- and short-term ageing. Subsequently, the complex modulus of rigidity was determined at 60° C. The results are clear. The increase in the modulus of rigidity in the case of usual road construction bitumen 50/70 and a PmB A are significant and, in the case of a rubber modification, practically not noticeable. Further advantages result when a higher modification is used.



These laboratory tests are confirmed in practice.

For example, through measurements performed by the State Office of the Environment. There, the very small increases in the hardening of the binding agent per year of lay time (softening point ring and ball) on a few CTS roads have been determined. Impressive.

Source:
LfU, Bayern

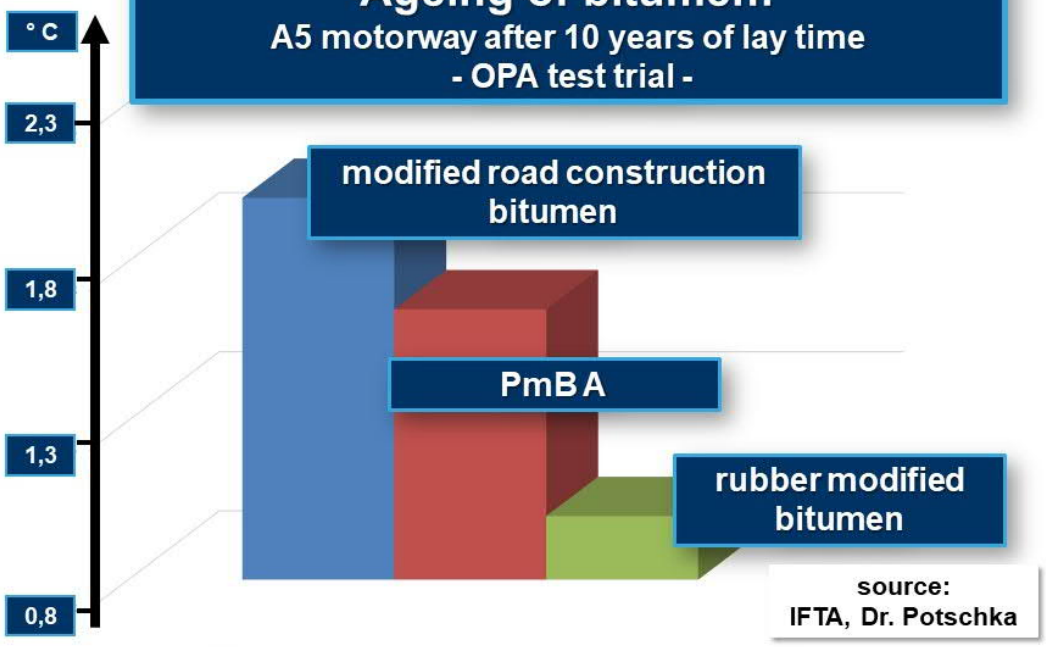
Analyses of the State Office of the Environment (Bavaria):

Roads designed with rubber-modified bitumen:

Increase in the ring and ball softening point in °C per year of lay time

- ✓ PA 8: 0,7 - 1°C
- ✓ SMA: 0,1 - 0,3°C

Ageing of bitumen:
A5 motorway after 10 years of lay time
- OPA test trial -



hardening in °C / year of lay time

Modified road construction bitumen 70/100, PmB A and CTS special bitumen were compared regarding their ageing behaviour on the A5 motorway near the town of Raststatt within a test section. At IFTA GmbH, Dr Potschka, the average rise of the ring and ball softening point was determined after a 10-year lay time.

In an opinion of 08/03/2018 on the “permanence of rubber-modified asphalt pavements”, the head of the Gauer Institute (IFB) in Regenstauf, Dr Schmalz, comes to the following statement based on the results of numerous analysis reports:

“Rubber-modified bitumen

- ages approximately 70% more slowly than non-modified bitumen
- and approximately 40-50% more slowly than polymer-modified bitumen
- has a better low-temperature behaviour than PmB-A

Thanks to these properties, the susceptibility to embrittlement of the top layer of asphalt is reduced significantly. As a consequence of this, the asphalt pavement copes with the high loads due to traffic, frost, de-icing salt and temperature changes even at wintry temperatures. The characteristic damage mechanisms of superficial grain loss and crack formation do not occur or occur much later.” End of quote.

At this point, it is appropriate to point out that the background experience of Dr Schmalz is based on extensive activities (research work, member of many work groups, initial testing, construction monitoring, check tests) and observations right outside the premises.

Consequently, the motorway directorates in Bavaria have definitively refrained from the use of PmB-A in the tendering of open-pored asphalt top layers. The reason: better economic efficiency of rubber modification. We really can no longer speak of an equivalence to PmB.

Before the economic efficiency is analysed more closely, here is another possible very important pro-rubber modification argument for you.

There are no doubt also road pavements in your area of responsibility that are rather low-stressed. However, these too are subject to strong stressing, but which is frequently underestimated.

- Environment
- Climate
- Chemicals
- Organic materials

And even asphalt pavements exposed only to partial rolling forces (kneading effect due to tyres) age markedly more quickly than in the past. Sometimes they even barely make it out of the warranty. An observation with nationwide validity.

What has changed?

Possibly the construction material of bitumen. Now, is this due to the processes within the refineries or the changed crude oil flow, i.e. the crude oils used themselves? We do not know, and those who must surely know are not telling us – unfortunately.

However, the “big” bitumen manufacturers have also possibly recognised this and one of them, Total Bitumen, has even reacted in order to counteract the misery. They are now offering a 50/70 with special additivation. Levitating without a common set of regulations and relevant experience. Have fun selling it! This additive is to slow down oxidation. Long-term experience is missing, of course, and in terms of price the product is situated somewhere between 50/70 and PmB A. PmB A is also to enjoy an additional additive. However, it must have been hard for the “premium manufacturer to admit indirectly that its bitumen is associated with certain defects.

In all relevant sets of regulations, the approach regarding the load class as of which modified binding agents are to be used is described. Do you know a set of regulations that devotes so much attention to ageing? Do you know a set of regulations that defines the insufficient ageing behaviour of asphalt pavements as a particular stress factor? Yet, it is actually a problem that really is being discussed nationwide.

The fact remains that we are having to do with an accelerated loss of material on all asphalt pavements. Even on the low-stressed regional roads, roads in local areas, airport runways, etc.

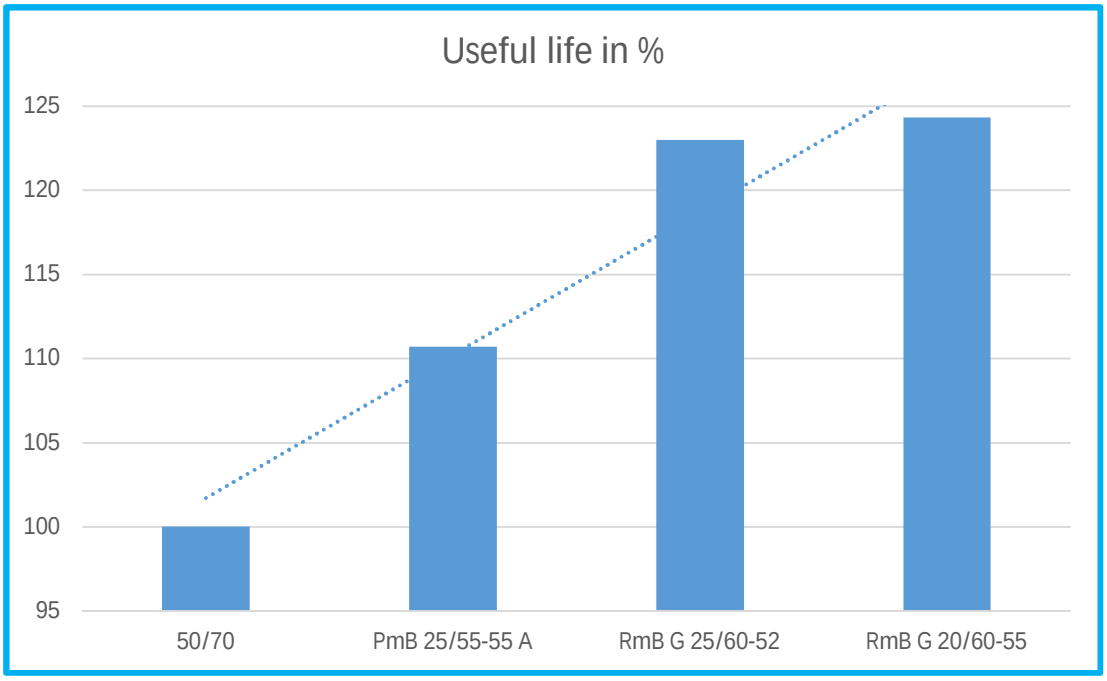
Do something about it. You have the ability to implement other conceptual specifications in your planning. You can focus on only the really economically efficient variants in the performance description with the standard construction method of the TL RmB presented here. It is your budget. The asset of the road belongs to us all.

However, in order to give rubber modification sufficient attention, the economic efficiency, above all, must “be right”.

Economic efficiency

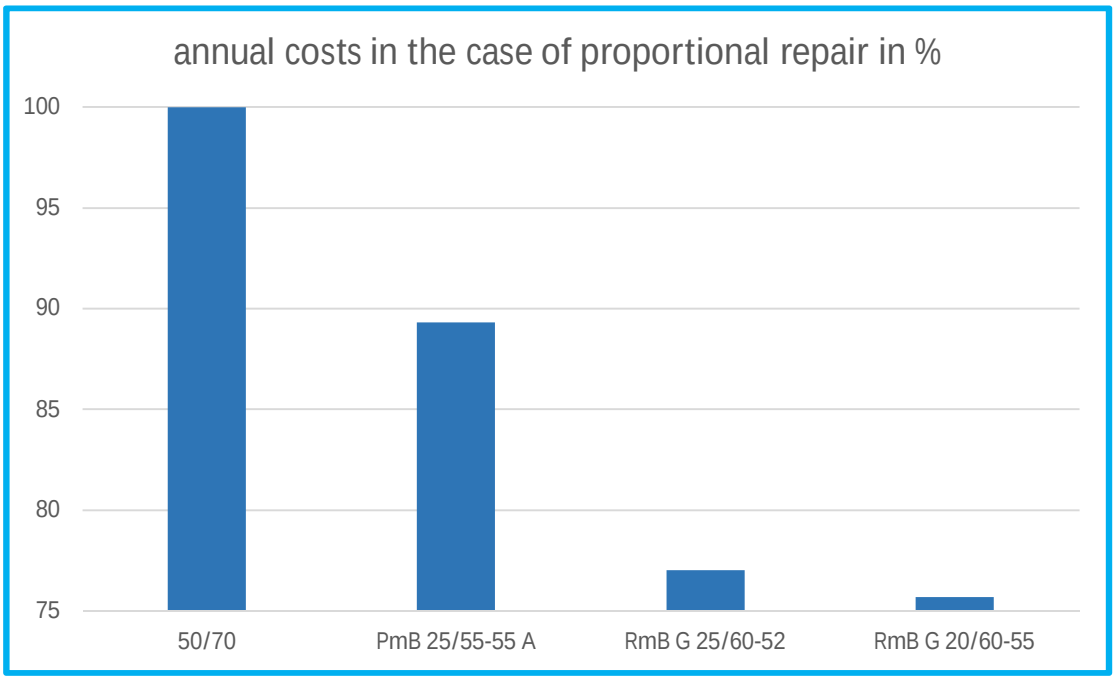
Approximately 18,800 kilometres of road in Bavaria fall into your area of responsibility, that is, the area of responsibility of all the district offices. The previous analyses show clearly that the permanence of the road pavements is increased by the use of rubber modification.

If we seriously assume an extension of the useful life in the case of dense road pavements (asphalt concrete) of approximately 30% in the case of other asphalt top layers e.g. SMA, even 40% would be a realistic amount. Assuming a previous lay time of approximately 12 years, after consistent conversion of the binding agent used to rubber modification, all of a sudden at least 18 years of use would be the aimed-for target. What a huge step towards sustainability!



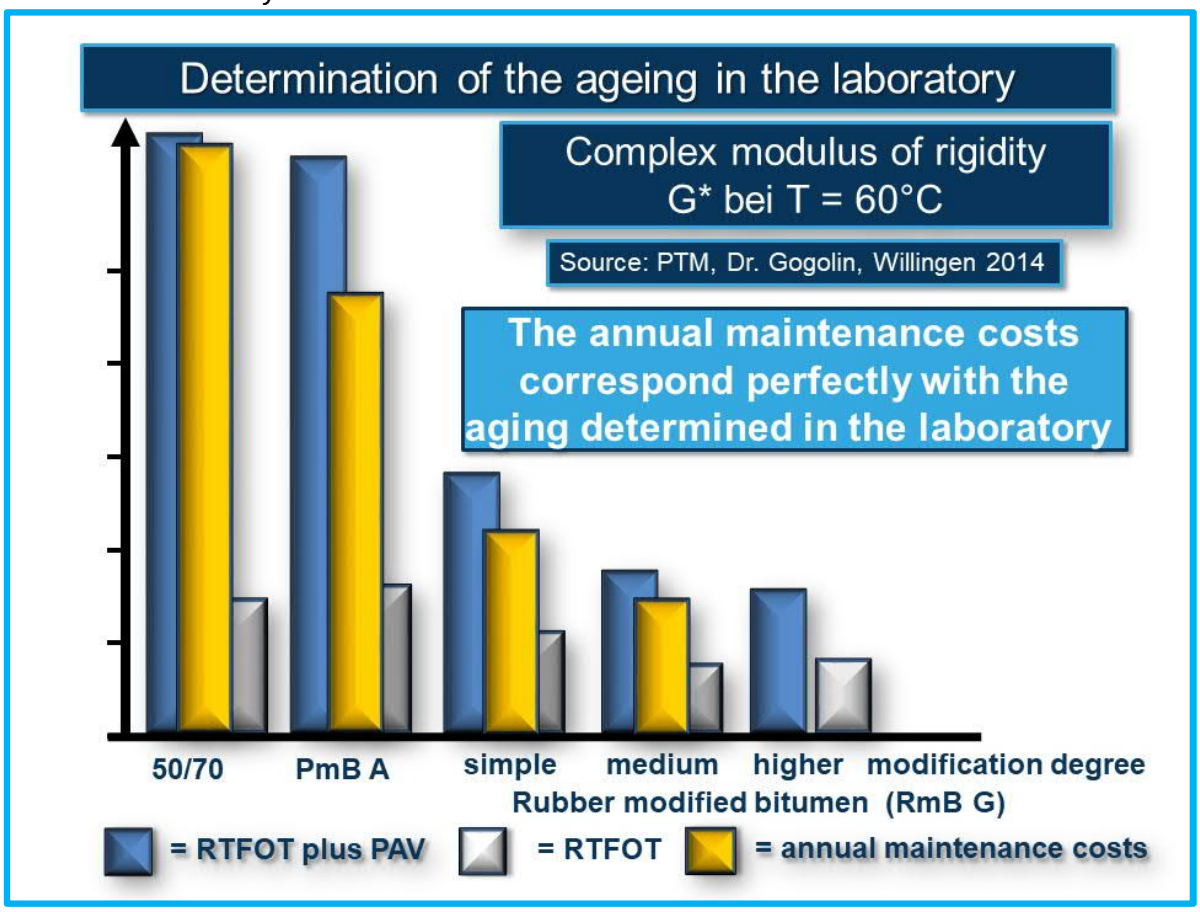
The results are based on the statements of various research works, market observations and realistic asphalt calculations.

One can also turn this statement around and present the respective necessary budget graphically:



I suspect that this image is familiar to you. I would like to remind you again of Dr Gogolin's laboratory tests and, at the same time, compare the annual costs

with his laboratory tests:



This is an astonishing concordance between the laboratory results and their consistent implementation in practice.

In Bavaria alone, such a two-digit million euro amount could be saved. Every year! And here I gladly repeat myself: with a focus only on the part of the road network that lies in your responsibility.

And please remember that with rising binding agent costs the saving potential even increases further.

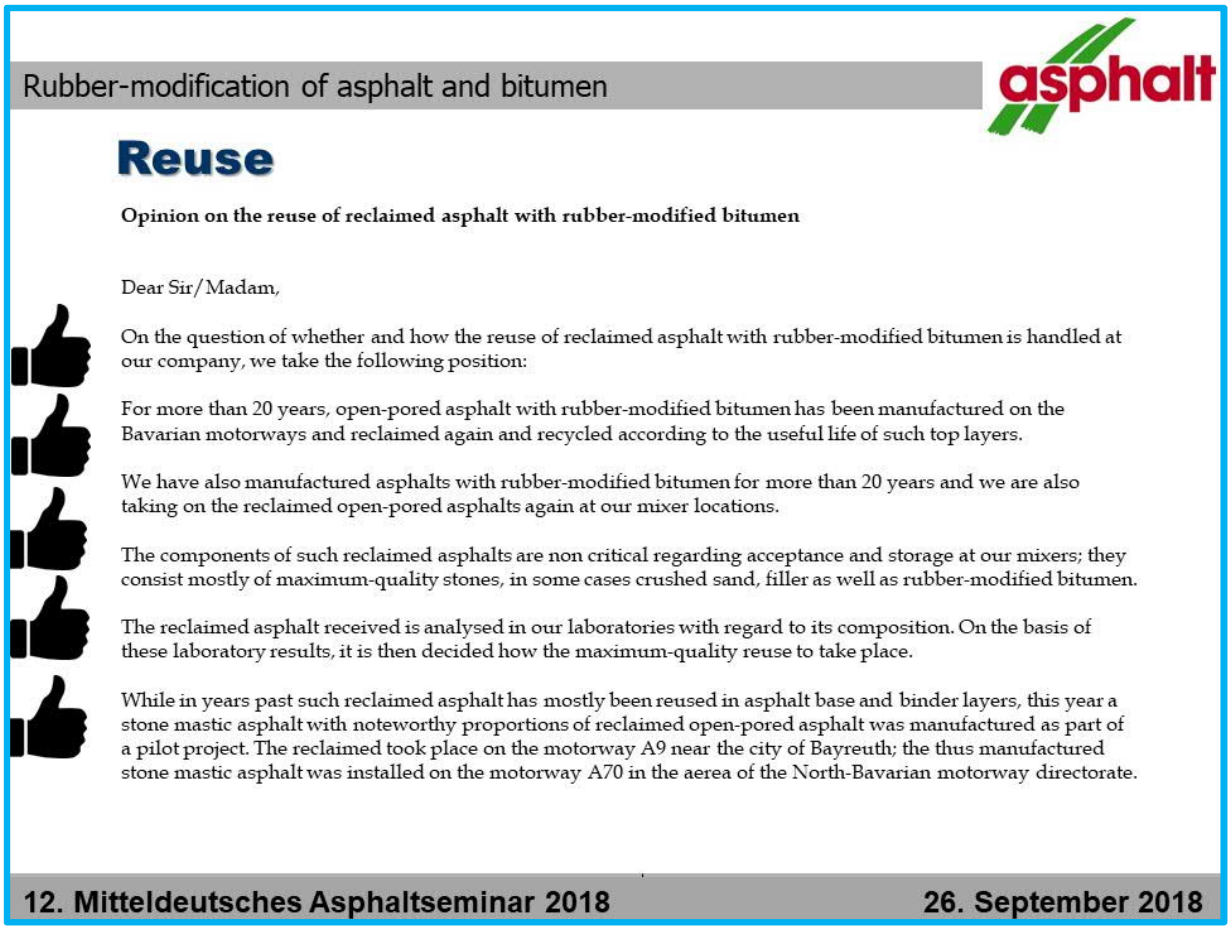
Added to this is the fact that the polymers need not be specially manufactured from crude oil products, but are available to us in large quantities on a cost-stable basis.

Reusability

Part of the economic efficiency is also based on harmless reusability.

CTS GRM can be recycled again and again. According to detailed analyses of the trade association, substances hazardous to health are not emitted in the processing.

Regarding this, there is an opinion of a very “big mixed goods producer” in Bavaria:



In summary, it can be said that reuse is absolutely non-problematic. Yes, research projects for a particularly significant reuse have even been successfully carried out. Reclaimed asphalt in stone mastic asphalt? Otherwise an absolute no go but in this case, since the binding agent is not so heavily aged and is still top fit even after a few years of its useful life, a good idea for using resources sustainably. We will pursue the project.

And, of course, it also works the other way around. Any asphalt conception, with little or more RC proportion, can be modified with CTS GRM according to the specifications.

Problem-free and dead on target, as this modification meets the optimum in each case, because the quantity of CTS GRM added always relates to the respective total binding agent content. In the process, it is completely irrelevant whether fresh binding agent is modified here or the binding agent from the added RC asphalt. However, one should not go overboard, as CTS GRM requires a certain amount of fresh binding agent in order to be dissolved. No doubt also, in turn, as a function of the state of the mixer and the post-mixing times. In cases of doubt, trial mixtures help.

Recently, in Saxony, a base layer with CTS GRM according to TL RmB was even tendered. According to the initial testing, the RC rate, in relation to the used binding agent proportion, amounted to 50 M %. No problems were established in production and installation.

Cohesion

A particular plus point of rubber modification is the high cohesion. One can or should use this advantage in special matters. For example, whenever it is necessary to counteract high shear forces. That is – I will try a constructional explanation – the case whenever a comprehensive embedding of the individual rock particle for force absorption is more advantageous than a selective connection. Example in the case of stone mastic asphalt. The comprehensive embedding is equivalent to the mixture conception of the asphalt concrete. Also with a stone-rich design with a corresponding heavy-duty proportion or high traffic density

- Roundabouts
- Junction areas
- Industrial areas with forklift truck use
- In climatically exposed locations
- In hairpin bends (twisting roads)

In the case of roundabouts, a special factor is also the high adhesion. We therefore urgently recommend the use of an RmB G 20/60-55. I.e. the higher modification with 22 M CTS GRM.

An FDE measure in Rhineland-Palatinate (L 549) serves as a reference. Here, part of the road is formulated with traditional PmB-A and the other part with CTS GRM. Asphalt concrete AC 8 D S mixture designed as a stone-rich variant. After a 2-year lay time, the PmB roundabout already looked pretty stressed; these stresses were not visible on the GRM roundabout. Please note, same asphalt mixing plant, absolutely identical traffic volume, same installation team.

In Baden-Württemberg, the B 500 is located at an exposed high-altitude location, above 600 metres. Not for no reason is the federal road also called the Black Forest High Road. Here, the trade association, Karlsruhe regional council, also opted for an asphalt concrete as the mixture. The reason: twisting roads, rough winter service with frequent snowplough use. However, in order that the low-temperature behaviour of the basic binding agent used was also adapted to the high-altitude location, a 70/100 was tendered - upon recommendation by CTS Bitumen - along the lines of TL RmB. A further particularity of the “refuge” measure: it was tendered and designed as compact asphalt. The asphalt binder layer was also tendered according to TL RmB.

The logistics were tricky. A total of 4 asphalt mixing plants for delivery were available, which had to be coordinated. Was not easy, as different batch sizes required an exact coordination of the fusible PE bags. Additionally, due to the closures, wide travel distances sometimes had to be undertaken.

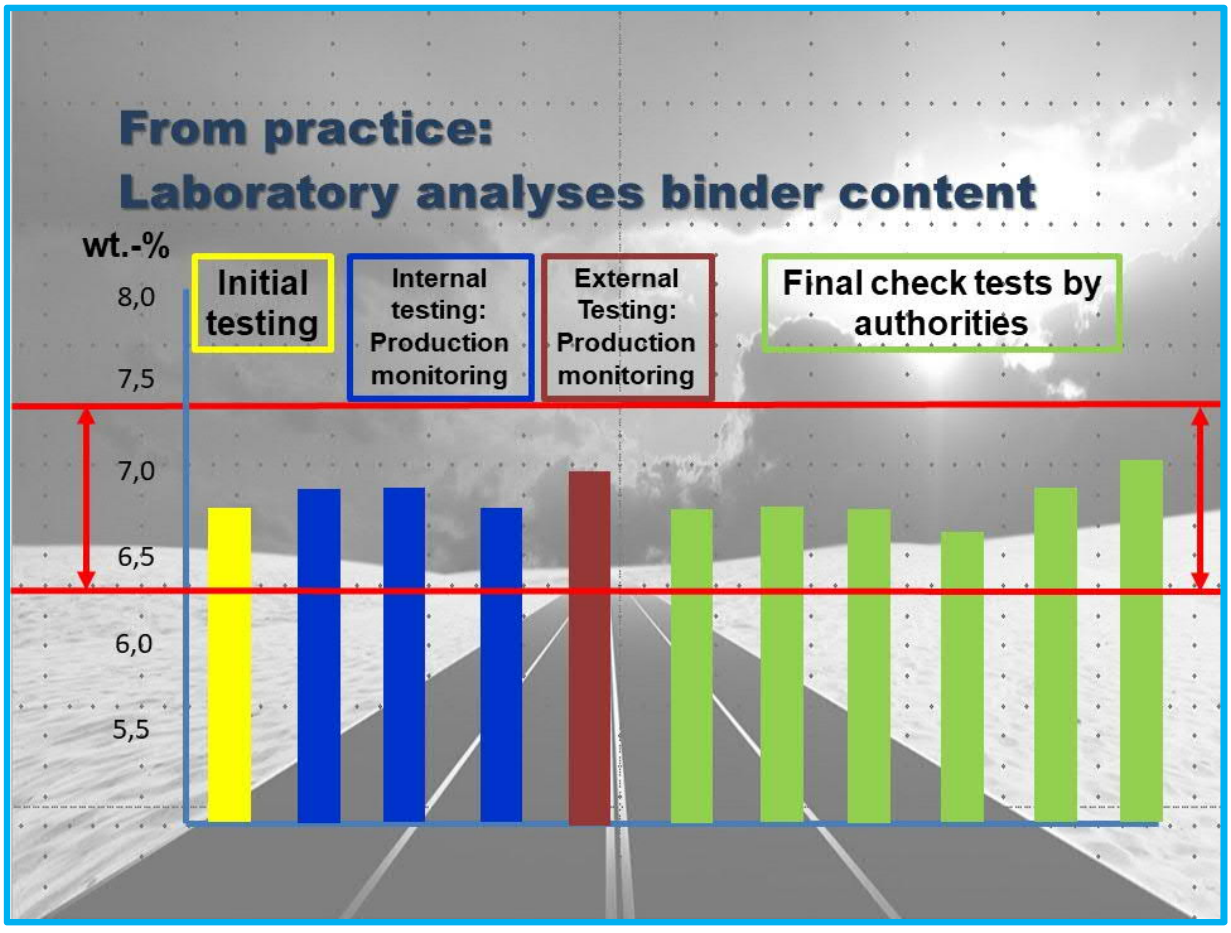
There is always something - but in the end, it “worked” well, that is, to the satisfaction of the trade association.

Dealing with check tests

It is repeatedly assumed that check tests, especially the determination of the total binding agent content, are very difficult in the case of rubber-modified binding agents.

Admittedly, there is a bit more effort involved. That is true. And not all test centres have highly modern asphalt analysers, for which the binding agent determination of rubber-modified asphalts is no problem at all.

However, excellent harmonisations can also be achieved with traditional technology. An example of this is the measure in Rhineland-Palatinate. From the initial testing to the check test – in all cases, the binding agent content does not constitute a problem for the laboratories involved. All the same, 4 different laboratories with different devices and employees were involved. Hats off, the lab workers understood their craft. As did the master mixer, by the way. A really equal and very homogeneous binding agent dosage – without anomalies.



The procedure is very detailed and clearly explained in the regulations. During the initial testing, the asphalt is analysed and the soluble components of the binding agent are determined experimentally. This value is then the target value

basis for the check tests and not the total binding agent content. The difference to the total binding agent content is the total of the insoluble components.

Since the insoluble rubber proportions are virtually “missing” from the binding agent, not too much attention should be paid to the typical binding agent data after recovery either. At all events, it does not have much in common with the original data.

Conclusion

In the TL RmB, the tendering bodies have a set of regulations at their side that has proved its value in the 10 years since its introduction. The regulations have elevated rubber modification to the standard construction method.

All the while, rubber-modified bitumen granulates have established themselves on the market for qualitative reasons.

Asphalts for millions of m² of road, not just in Bavaria, have been manufactured and installed according to these regulations, all of which are characterised by high permanence.

Rubber modification has a series of advantages to offer compared to the common road construction bitumen and the usual PmB A:

- Significantly more favourable resistance towards premature ageing
- Very high viscosity, enabling particularly thick binding agent films, which, in turn, is to be assessed as positively pro lay time
- Therefore, an addition of fibres in the case of SMA, SMA LA, PA and asphalt binder according to the SMA principle is usually not necessary
- A running out of the binding agent cannot be observed
- The storage at the asphalt mixing plant is non-critical
- Small and minute quantities can also be ordered and processed at the mixing plant.
- An order of large quantities such as with PmB A (special binding agents are frequently delivered only in large quantities) for a smaller measures is not necessary
- Rubber-modified binding agents have demonstrably significant economic advantages over traditional bitumen.
- The high cohesion allows the successful implementation of special asphalt conceptions
- Rubber-modified asphalts can be reused without any problem.

12/08/2019

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