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AUSTRIA - NATIONAL REPORT

STRATEGIC THEME D - QUALITY OF ROAD INFRASTRUCTURE

MANAGING ROAD ASSETS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT AND CLIMATIC CHANGE ADAPTATION

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PART A) QUALITY ASSURED RECYCLING CONSTRUCTION MATERIAL IN TENDERS – PILOT PROJECT FOR THE REUSE OF ASPHALT

1. INTRODUCTION

The targets and principles of the 2002 Waste Management Act i.a. provide for minimum possible emissions of air pollutants and climate relevant gasses and the careful exploitation of resources (raw material, water, energy, landscape, areas, deposits volume) in terms of foresight and sustainability.

ASFINAG have successfully applied these principles in the field of concrete pavements for two decades by assuring the complete reuse of surfacing material, by now representing a standard provision in tenders of the company´s road network. Recycling of asphalts, however, has so far been limited to applications not corresponding to the original high quality specifications.

2. PILOT PROJECT IN ASFINAG´S ROAD NETWORK

In order to make up for lagging behind in the state of the art of asphalt constructions and also to assess to which extent the optimum possible reuse of asphalt layers could be implemented a pilot project was carried out at Graz-West intersection of A2 South Motorway. .A further goal of this pilot project was to investigate the influence the reused share had on the production of the new asphalt, the laying and the performance characteristics of the asphalt layers.

According to the respective Austrian standards (ÖNORM) the reuse of asphalt in ASFINAG´s road network is permissible only for the AC *trag*-types using road construction bitumen.

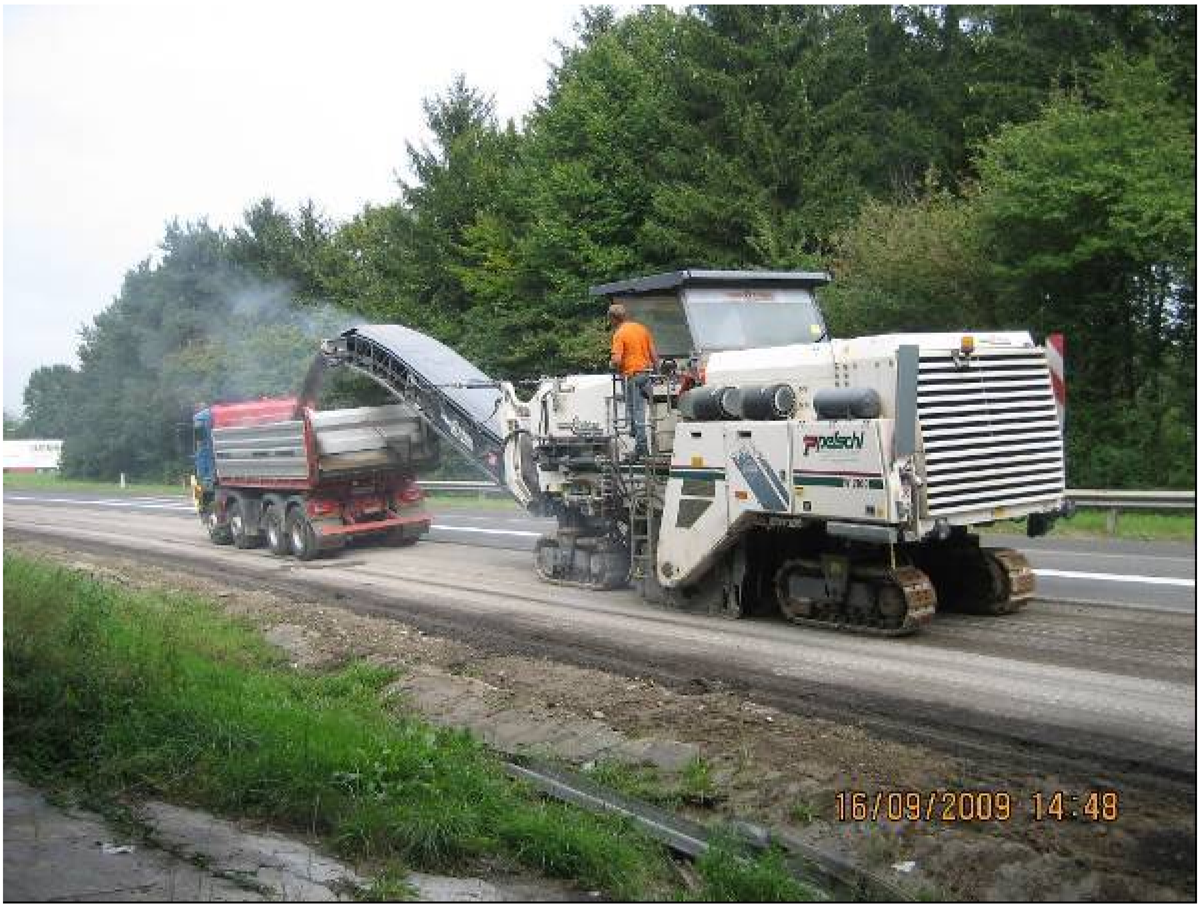
Junction Graz West

2.1. Project preparation

Since the RC material was to be obtained from the existing bituminous surfacing the removed asphalt was i.a. tested at the laboratory for its suitability for reuse. Only two of the five different bituminous layers tested were recognised to meet the requirements in respect of rock and bitumen and could, consequently, be used.
The suitable layers, duly assorted, were subsequently milled in dry weather in specified geothermal gradients and stored under cover in asphalt mixing plants to prevent any negative influence on asphalt production with cold RC material later on.

2.2. Project implementation

For a comparison of the properties of the bituminous pavement in the course of time three sections with different shares of used asphalt were inserted into the base layer. Contrary to current specifications used asphalt was furthermore inserted into the binder course, with the latter produced with polymer modified binder in order to test the technical feasibility and challenge the present restrictions in the standards.



- Section 1: AC 32 trag 20M-% RC-Asphalt
  AC 22 binder 15M-% RC-Asphalt
- Section 2: AC 32 trag 30M-% RC-Asphalt
  AC 22 binder 20M-% RC-Asphalt

Section 3 was executed as reference section with the corresponding standard mixed material without used asphalt.

In a contractual agreement the requirements of the mixed material produced with used asphalt and the inserted layers were stipulated to correspond to standard mixed material, including the customary 5-year-guarantee. In order to attain a convincing and reliable result the accuracy of the nominal quantity of used asphalt was fixed at ± 10 rel-%.

2.3. Result

No problems were encountered during the production nor at the insertion of layers fabricated with used asphalt. All production phases proved similar to those experienced with standard mixed material, with only a longer supplementary mixing period required for the mixed material.

3. SUMMARY AND OUTLOOK

Summarizing the implementation of the pilot project permits the conclusion that the production and insertion of asphalt with the recycled shares mentioned does not pose any problems. The influence of the RC material on the properties of the surface will be studied in the course of the following years. No problems are expected to be encountered on the basis of available test results of neighbouring countries and experience gained. The current stipulations and standards effective in Austria (ÖNORM) should be amended accordingly without delay, the addition of used asphalt be permitted under certain preconditions also for binder courses, and the use of recycled asphalt be stipulated as standard construction method in tenders for renovations. The long term target would be a significant increase in the share of used asphalt by means of using the so-called parallel drums in mixing plants, bringing about a further improvement of the economic efficiency of bituminous constructions.

PART B) THE CONCRETE PAVEMENT - A SUSTAINABLE CONSTRUCTION METHOD OF THE FUTURE

1. ABSTRACT

The concrete construction method had been predominantly used in Austria and in the neighbour countries for the primary road network (motorways, expressways) with heavy traffic and/or a high percentage of heavy vehicles and also for safety reasons (in tunnels with a length over 1000 m), when a concrete pavement was required.

The concrete pavement of the modern generation, however, offers an optimal solution: high bearing capacity and resistance against deformation (no abrasion), long rehabilitation intervals (fewer maintenance) and less need for repair, high skid resistance, low noise (exposed aggregate surface), brightness and recyclability.

For urban areas, concrete pavements are also used in case of low traffic loads (bus lanes, junction areas) and for roundabouts. Additional properties are safety in case of fire, excellent noise-reduction (whisper concrete), long time performance, high skid resistance, brightness and recycling possibilities.

For properly dimensioned and state of the art constructed concrete pavements renovation intervals of 40 years are absolutely realistic. The modern concrete of the future will become more and more a sustainable construction method for environmental, ecological and economic aspects.

The concrete construction method will succeed if the pavement is adequately designed and executed in terms of high quality.

In the past years, research work concentrated on the following topics (among other properties such as skid resistance, noise, etc.):
increased safety of concrete pavements - bright concrete pavements with dark aggregates
warming of urban street surfaces during summer heat waves
pavement recycling in Austria – 20 years of experience

2. INCREASED SAFETY OF CONCRETE PAVEMENTS – BRIGHT CONCRETE PAVEMENTS WITH DARK AGGREGATES

The brightness of concrete pavements is, next to a multitude of further benefits, an essential advantage of this construction method vis-à-vis bituminous pavements, because brighter street surfaces considerably increase safety of the road user. Bright concrete surfaces provide above all increased safety in rain and in darkness (especially in tunnels).
Furthermore, the difference in brightness of both the most common street pavements – concrete and asphalt, respectively – is not only specially attractive for the road user, but also for the general public, representing an essential factor, since the efficient utilization of light surfaces leads to saving energy cost, this also for the public at large, predominantly the operator and/or owner of the infrastructure. This represents a significant argument in terms of cost consciousness and cuts in spending.
The positive effect of bright concrete surfaces could meanwhile be achieved also with the use of dark aggregates by optimising the concrete mix and thus ensuring an optically favourable and economically sound solution for all participants.

Increased safety

Increasing safety is an essential advantage of concrete pavements both in tunnels and in rural or urban areas. Above all two factors can be positively influenced by using concrete. Besides increasing fire safety – which is of special importance for tunnel constructions, improving visibility by means of bright concrete surfaces in turn further raises safety of the road user.

Brightness

The brightness of concrete roadways has a very positive effect on the safety of the road user. The main factor of influence to achieve such brightness is besides the aggregates used the different matrix of the products chosen. If dark binders e.g. bitumen are used the brightness of the construction material cannot be influenced. However, the use of a bright binder e.g. cement brings about the desired brightness.

Bright concrete pavements with dark aggregates

Bright aggregates have guaranteed a high degree of brightness for more than 40 years. Recently, more and more dark aggregates have been used for concrete pavements. The Research Institute of the Austrian Cement Industry (VÖZFI) has carried out some research to achieve comparable results also with dark aggregates. If a concrete pavement produced with a bright aggregate is compared with a concrete pavement which has been produced with dark aggregates and titanium(II)oxide it is clearly visible that it is possible to meet the approved qualities of bright concrete pavements with this alternative production method.

As in other fields of construction e. g. the plaster industry it is thus possible to create different degrees of brightness of the concrete pavements. This would be a useful criterion for tender invitations.

Advantages of this type of application

- Improved safety aspects. In addition to an expansion (enlargement) of the sight distance e.g. in tunnels the subjective safety will be enhanced (e.g. pedestrian crossings or footpaths in the night).
- Skid resistance remains unchanged which is not the case if coatings are applied later. Another disadvantage of such coatings is the fact that they have to be renewed at certain intervals.
- Production and/or processing is unproblematic indeed. Titanium (II)oxide has to be added to the concrete mix to achieve the desired effect.
- An important advantage is the cost factor. The saving potential offered is to be attributed to the fact that where traffic areas have to be illuminated (e.g. tunnels or urban areas) the cost of lighting can be drastically reduced.

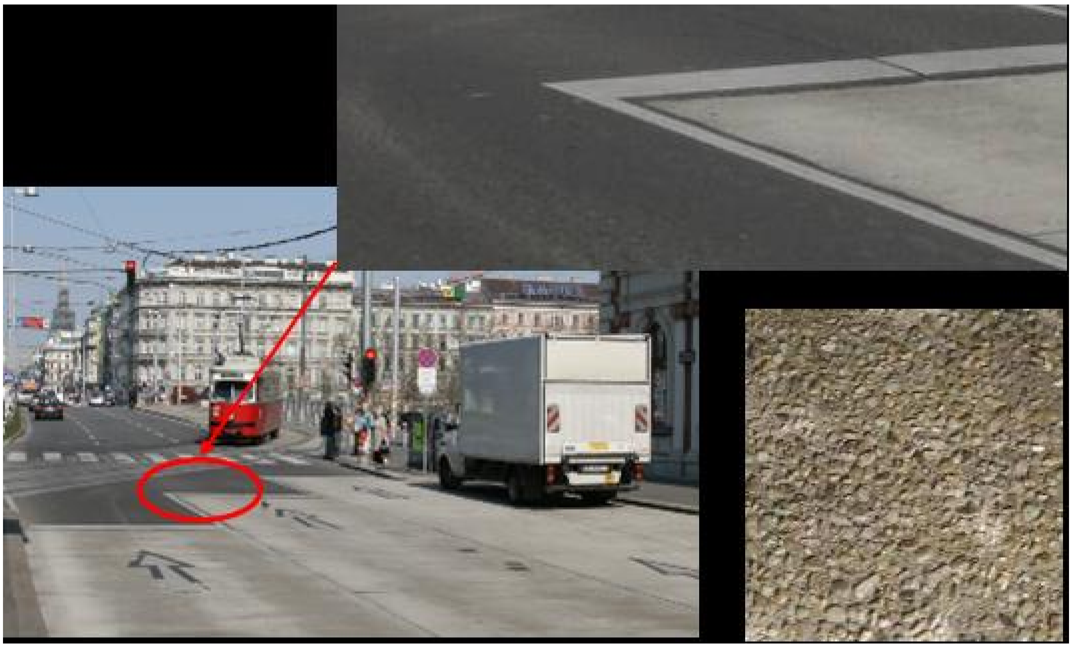


Figure 1: Bright concrete pavements to combat heat islands

3. WARMING OF URBAN STREET SURFACES DURING SUMMER HEAT WAVES

References [1a, 1b]

The global warming of our planet has a special impact on urban areas because large cities are characterised by the formation of so-called urban heat islands. This modification of the climate in a city in comparison to the climate of the hinterland is based on a multiplicity of factors such as the settlement structure, the urban canyon effect, the heat emissions of buildings and the building materials used. To investigate this topic field tests were carried out at the Research Institute of the Association of the Austrian Cement Industry (VÖZFI) to measure the thermal behaviour of different materials used for pavements. These tests showed in detail that a difference in the surface temperatures of concrete and asphalt, resp. is clearly noticeable. To analyse the impact of the difference of the surface temperatures of concrete and asphalt on the warming of cities, a simulation on a fictitious street canyon was carried out in cooperation with professor Kreč from the Technical University Vienna (TU Vienna). These computer simulations confirm the results measured and show that the temperature experienced in some parts of a street can be noticeably reduced by the use of bright concrete as street construction material.

Pavements typically make up for about 30 to 45 percent of a city area so that they have a major impact on the formation of UHI in cities. To analyse the extent of the impact of different road surfaces on the warming of cities, investigations were carried out at the Research Institute of the Association of the Austrian Cement Industry (VÖZFI). For this research three different blocks with the dimensions 40 cm x 40 cm x 20 cm of ordinary concrete, white concrete and asphalt were produced and placed on the flat roof of the VÖZFI. With temperature sensors on the surface and in different depths of the surface of each material as well as sensors to measure the air temperature it was possible to investigate the warming of the three different samples. By comparing the surface temperature curves, especially the maximum values of the day, major variations between the building materials became obvious. On a hot summer day in July at about 15:30 common concrete reached a maximum temperature of 42 °C and white concrete one of about 39 °C. At the same time, the temperature of the asphalt surface increased to 48 °C.

Consequently, a difference of the surface temperature of 6 K between asphalt and common concrete and even 9 K between asphalt and white concrete was established.

To analyse this measured impact of the difference of surface temperatures of several materials on the warming of cities, a simulation on a fictitious street canyon was carried out in cooperation with professor Kreč (Kreč, 2008). As base data a standard summer day with a maximum temperature of about 30 °C was assumed. The calculation was carried out for Vienna, for the two different surface materials concrete and asphalt. For a highly afflicted area maximum temperatures of 46,3 °C for asphalt and of 39,5 °C for concrete were reached. Consequently, a difference of 6,8 K was calculated. This value confirms the measured difference of the surface temperature of 6 K.

On hot days, increased temperatures in the space above a street pavement cause not only a reduction in the subjective well-being and in productivity but also an increase in the mortality rate. Especially for older and sensitive persons the mortality rate is subject to an increase on very hot summer days (Helbig et al. 1999). Therefore it was estimated how far a change in the surface temperature of a pavement will affect the temperature perceived in the street. The results of this simulation clearly showed that not only the surface temperature but also the temperature the pedestrian is exposed to above a concrete pavement is about 1.5 K lower than above an asphalt surface. This positive impact of concrete pavements on the temperature has a positive advantage for the health of the people and leads to a major reduction of the cooling energy required on hot summer days.

The temperature measurement of the samples revealed that the application of different bright building materials has a vital impact on the temperature of the structural element obtained. Furthermore, the computer simulations confirm the results measured and show that the temperature perceived in the street can be noticeably reduced by the use of bright concrete as construction material. The use of building materials with a higher albedo would not only cause lower temperatures in urban areas but also reduce the cooling energy as a result of lower surrounding temperatures.

4. PAVEMENT RECYCLING IN AUSTRIA – 20 YEARS OF EXPERIENCE

The Austrian motorway network shows that, due to a longstanding and ongoing tradition of concrete pavement constructions and recycling, Austria is one of the leading countries for corresponding techniques in Europe. Thanks to longstanding experience and research activities an extensive body of rules and standards for recycling of hydraulically bound materials exists in Austria (for example [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]).

Results of activities in this area of research in recent years are listed below:

A milestone in concrete road construction in Austria was achieved in 1989/1990. In the course of the renovation of old motorways with concrete pavements concrete recycling was applied for the first time. Before the on-site application of this new technology, long and intensive research programs were necessary. This first application (recycled concrete with a grain size larger than 4 mm was reused for the sub-course of the new pavement) took place in Salzburg for the first time in the whole of Europe. An experience of this type resulted in the improvement of the technique and, finally, in new regulations for road construction.

In a research report [17] different asphalt contents in recycled concrete were tested and compared with the requirements of national regulations. According to this research, recycled concrete with an asphalt content t below 40 % is equivalent to mixtures with natural aggregates under certain circumstances (adaptation of W/C ratio and uniformity of the production process). The connection between asphalt content and W/C ratio is mentioned: the higher the content of asphalt in the recycled aggregates, the lower the ratio of water and cement. To quote an example: In 1997, a test section on motorway A1 was built with 35% of asphalt content in a 4/32 aggregate and a W/C ratio of 0,38. There were no problems during construction and the requirements in respect of standards and specifications were fulfilled.

Comprehensive tests in the laboratory and on a test road section [16] in the pavement lot “Salzburg Süd” of A10 motorway “Tauernautobahn” showed that 100% of the old concrete can be reused in the new concrete pavement (mainly in the lower layers). Its quality is at least as good as that of natural aggregate, even though asphalt components of up to 20% were included in the reclaimed concrete.

Experience gained on another site (motorway A1 between Thalgau und Mondsee) in 1991 rendered better values for recycled material with a 4% asphalt fraction when testing tensile strength during bending and also compressive strength than did concrete with natural aggregates. Tensile strength during bending is even better with fractions of 19 % and 33%. resp. of asphalt but the compressive strength is lower than in mixtures with natural aggregates.

A typical recycling concept for concrete motorways in Austria is as follows:

The crushed material of the base course is divided into grain sizes 0/4 (~ 30 %) and 4/32 (~ 70 %). The fine material is used to improve the hitherto unbound sub-base plus cement stabilization. Grain size 4/32 is reused for aggregates in the new base course.
Thus the upgraded unbound material from the sub-base plus cement stabilization become the method of choice n where recycled unbound material is used in new layers.
And the reuse of formerly hydraulically bound material from the base course as aggregate for the new base course is recommended where recycled, formerly bound material is used in new layers.

Thin layers of asphalt, recycled together with the concrete material, are permissible as long as a defined percentage is not exceeded.

Recycling of former hydraulically bound material was used for example on motorway A1 “Westautobahn” between St. Georgen and Wangauer Ache bridge construction. From November 2004 until November 2006 13.4 km of concrete pavement were executed in this recycling technique for new layers.

Another large building site in the recent past was Haid – Sattledt junction on A1 where 112 km of hydraulically bound base course were reused in layers of the new concrete construction.

In Austria, taxes on waste and the disposal of material contribute towards rendering the recycling of construction materials attractive for economic reasons due to the cost saving factors involved. There are a lot of regulations and guidelines on possibilities of using recycled material for new constructions, although the quantity and complexity of the regulations are a little confusing.

The excellent performance of concrete pavements used on highly trafficked roads, such as motorways and expressways, has led to a high percentage of concrete pavement technology being implemented in Austria's primary road system. This also applies to recycling possibilities for concrete roads in case of rehabilitation.

Thus Austria has become one of the leading countries in Europe, promoting research on the use of recycled concrete in new road construction layers. As a result, a comprehensive amount of regulations and guidelines was decreed and implemented. The remarkable percentage of concrete constructions in the primary road network allowed the application of research results on many construction sites, in turn enhancing the technique over the past decades. Today the use of recycled concrete in new layers is state of the art in Austria and the technique has been used on most of the relevant construction sites in the course of the past years. The sound experience gained in Austria should lead to further research and a spreading of the technique into other countries.

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PART C) QUALITY ASSURED RECYCLING CONSTRUCTION MATERIAL ASPHALT GRANULATE EN-STANDARD USE IN ROAD CONSTRUCTION

1. ABSTRACT

Asphalt has successfully been used for decades as recycling construction material. The relevant laying specifications (Guidelines and Requirements in respect of road constructions) refer to the Guideline for recycling construction material, comprehensively stipulating technical quality and environmental issues for the entire federal territory, and defined as standard in “Standardisierte Leistungsbeschreibung Verkehrsinfrastruktur” (Description of standardized performance in transport infrastructure), to be applied by the contracting entity in compliance with the Public Procurement Law. The construction material must meet the European standards and be applicable in road construction. The targeted 70 % recycling products for construction purposes stipulated in the Waste Framework Directive for 2020 have been attained in Austria with nearly all mineral recycling construction material this year already. Especially mentioned should be the very high rate of more than 95% achieved with recycling asphalt. Quality assured recycling asphalt granulate used in road construction has lost its waste property and has become a product of its own.

Asphalt recycling has been carried out for decades in Austria. Since 1991 the state of the art has been specified in the guideline for recycling construction material, available in its eighth (notified) edition to meet with European and national requirements.

2. QUALITY IN LINE WITH CONSTRUCTION AND ENVIRONMENT ISSUES

The requirements stated in mandated standard EN 13242 are generally binding for construction material used in base layers in Austria. The standard provides for the stipulation of environmental requirements on national basis. This is accomplished in Austria by means of parameters defining the respective limiting values determined in agreement with the competent Federal Ministry for Agriculture and Forestry, Environment and Water Management and published in the Guideline for Recycling construction material. Adherence to these regulations is obligatory by decree in the entire federal territory.

Road construction material falls into five grade categories. Grade S and I consists of frost proof and frost resistant recycling material for unbound upper and lower base layers (in accordance with the guidelines and stipulations for road constructions – RVS 08.15.01), offering increased resistance to crashing, and also used for hydraulically bound and bituminous base layers. Grade II permits immediate use as frost proof and frost resistant recycling construction material for lower unbound base layers and hydraulically bound base layers. The further grades are destined for technologically less exacting applications (e.g. parking areas, embankment fills.

Environment compatibility is determined irrespective thereof and falls into three quality categories. Category A^+ may be used in hydraulically sensitive and hydraulically less sensitive areas in bound or unbound constructions without surface course. Quality categories A and B share comparable fields of application with additional measures stipulated for hydraulically sensitive regions (e.g. surface courses or bound constructions).

3. QUANTITIES USED

According to the 2006 Federal Waste Management Plan more than 73% of remaining mineral construction material are recycled. An especially high percentage refers to asphalt which can be reused to up to 100 %. In 2009, 779.956 tonnes of asphalt were broken in (stationary and mobile) crushers for reuse. Recycled asphalt granulate thus represents 16 % of mineral recycling construction material. Owing to this high degree of recycling on the one hand and still further methods of asphalt preparation (e.g. by cutting) on the other no further increase in the recycling rate is to be expected in the following years.

3.1. Special constructions with asphalt granulate in Austria

Guideline RVS 03.08.63 provides for the use of recycled asphalt for upper base layers to the extent of maximally 5 M-%, with higher shares being permitted for the lower load classes II to VI.

The use of recycled aggregates with a share of recycled asphalt granulates of up to 50 M-% is permissible in unbound lower base layers.

Generally suitable recycling construction material is also permissible in cement stabilized base layers.

The use of 100 % recycling asphalt is explicitly limited to grades III to VI for unbound upper base layers.

3.2. Definitions of recycled asphalt granulate

Within the meaning of EN 13242 four nationally defined grade categories are stipulated for the use of recycled asphalt granulate in constructions:

Table: Categories for components ≥ 4 mm of recycled asphalt granulate
In accordance with ÖNORM (Austrian standard) EN 13242

Kategorien für die Bestandteile von groben recyclierten Gesteinskörnungen gemäß ÖNORM EN 13242							
	Rc	*Rc+Ru+Rg*	*Rb*	*Ra*	*Rg*	*X*	*FL*
RA I	Rc_{NR}	$Rcug_{NR}$	Rb_{NR}	Ra_{95}	Rg_{2-} *	X_{1-} *	FL_{5-} *
RA II	Rc_{NR}	$Rcug_{NR}$	Rb_{10-}	Ra_{80}			
RA III	Rc_{NR}	$Rcug_{NR}$	Rb_{10-}	Ra_{80}			
RA IV	Rc_{NR}	$Rcug_{NR}$	Rb_{NR}	Ra_{80}			

* applies to all categories: Rg_{2-}, X_{1-} and FL5-, with *Rg + X specified at max.* 2 % of the quantity

In addition to the exclusive use of asphalt as granulate also a use in combination with concrete granulate (recycled asphalt concrete granulate) is possible. The share of asphalt must in such cases consist of min. 30 %, for grade I of as much as 40 %, with the share of concrete amounting to at least 50 %.

3.3. Environment compatibility

The following environment-relevant classification applies to recycling construction material in general, and thus also to recycling asphalt:

Parameter	Einheit	gemäß	Qualitäts-klasse A+	Qualitäts-klasse A	Qualitäts-klasse B
Eluat (ist gemäß ÖNORM EN 12457-4 herzustellen)					
pH-Wert	–	ISO 10523	7,5–12,5	7,5–12,5	7,5–12,5
Elektr. Leitf.	mS/m	ÖNORM EN 27888	150	150	150
Chrom $_{gesamt}$	mg/kg TS	ÖNORM EN ISO 11885	0,3	0,5	1
Kupfer	mg/kg TS	ÖNORM EN ISO 11885	0,5	1	2
Ammonium-N	mg/kg TS	ÖNORM ISO 7150-1	1	4	8
Nitrit-N	mg/kg TS	ÖNORM EN 26777	0,5	1	2
Sulfat-SO_4	mg/kg TS	ÖNORM EN ISO 10304-1	1.500	2.500	6.000
KW-Index	mg/kg TS	ÖNORM EN 9377-2	1	3	5
Gesamtgehalt					
∑ 16 PAK gem. EPA	mg/kg TS	ÖNORM L 1200 nach Trocknung der Probe bei 30 °C	4	12	20

Table: Environment-relevant classification of recycling construction material

Parameter Unit in accordance with Category A+ Category A Category B
Eluat to be produced in accordance with EN 12457-4

In accordance with the Guideline for Recycling construction material asphalt may be used for the following purposes:

Baustoff					RA			
Güteklasse					I	II	III	IV
Anwendung	Zuschlagstoff	Beton	bis C12/15, ohne bes. Eigenschaften	ÖN B 4710-1	(✔)	(✔)		
			ab C12/15	ÖN B 4710-1				
		Asphalt		ÖN B 3580-1	+	(✔)	(✔)	
	Tragschicht	obere Tragschicht	zementgebunden	RVS 08.17.01	(✔)	(✔)	(✔)	
			ungebunden	RVS 08.15.01	✔ 1)	(✔) 3)		
		untere Tragschicht		RVS 08.15.01	✔ 3)	✔ 2)3)		
	Schüttung	Schüttmaterial/ Künettenfüllmaterial		RVS 08.03.01	(✔)	(✔)	(✔)	(✔)

✔ = geeignet
(✔) = Eignung ist nachzuweisen
+ = für den Eignungsnachweis sind zusätzliche Prüfungen entsprechend den anwendungsspezifischen Regelwerken (ÖNORM, RVS, …) erforderlich

1) gemäß RVS 08.15.02
2) gemäß RVS 08.97.04
3) max. 50 % Asphaltanteil

Table: Use and application modes of Recycling asphalt granulate

4. REFERENCES

[1] Richtlinie für Recycling-Baustoffe, 8. Auflage, Österreichischer Baustoff-Recycling Verband, Wien, 2009 (Guideline for recycling construction material, 8th edition, Austrian Construction Material Recycling Association, Vienna, 2009)
[2] Richtlinien und Vorschriften für das Straßenwesen (RVS), Österr. Forschungsgesellschaft Straße – Schiene – Verkehr, Wien (Guidelines and Stipulations for road construction (RVS). Austrian Research Association Road - Rail – Traffic, Vienna)
[3] Abfallrahmenrichtlinie 2008/98/EC, 2008 (Waste Framework Directive 2008/98/EC. 2008)
[4] Bundesabfallwirtschaftsplan 2006, Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Wien, 2006 (2006 Federal Waste Management Plan, Federal Ministry for Agriculture, Forestry, Environment and Water Management, Vienna, 2006)