The effects of recycling asphalt use in terms of economic growth and environmental improvement in Kosova

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Abstract. Through this paper is analysed the possibility of recycling asphalt and reusing this in receipts of new asphalt to build road infrastructure inside urban areas and inter-urban areas, because analysing the investments that are being realized in the road infrastructure in Kosova last years, and investments that are going on, there are indicators showing economical, environmental and ….benefits of the society.
According to database of the Kosova Ministry of Transport and Telecommunication until the year 2014, the territory of Kosova has 2005.5 km of the road, 4% are highways, magisterial roads 32% and 64% regional roads, most of them should be reconstructed, so, the existing asphalt layers should be removed, and this layer has a thickness of 15 -30 cm, depending on category of road.
Positive expected effects from re-use of recycled asphalt can be treated through cost-benefit analyses, especially through its direct impact on:

- Reducing massive exploration of our natural and other resources for producing asphalt
- Reducing production and use costs of asphalt
- Growing possibility for problem-solving through asphaltation of more roads in urban or periurban areas
- Minimizing of environmental degradation from asphalt waste
- Improving public health

However considering information, that level of asphalt recycling in Kosovo and in the region does not exceed more than 5%, while the construction waste 10%, it is the fact that this process should be treated seriously especially considering the fact that Kosova is a state under development and there is limited capacity for investment in road infrastructure considering mass needs.

Keywords: asphalt, road, infrastructure, investment, benefits.

1. Introduction

Through this paper is analyzed the possibility of recycling asphalt and reusing this in receipts of new asphalt to built road infrastructure inside urban areas and inter-urban areas, analyzing the investments that are being realized in the road infrastructure in Kosova last years, and investments that are going on, there are indicators showing economical, environmental and benefits of the societ. According to database of the Kosova Ministry of Transport and Telecommunication until the year 2014, the territory of Kosova has 2005.5 km of the road, 4% are highways, magistral roads 32% and 64% regional roads.
Most of the roads need to be reconstructed, so, the existing asphalt layers should be removed, and this layer has a thickness of 15-30 cm, depending on category of road and with medium dimension of 7 m. Are of special importance of this work is the setting of the amount of asphalt that can be recycled, information are very important to know how much can be the amounts of recycling asphalt in Kosovo

1.1. State of motor vehicles in Kosovo

In 2014 in Kosovo were registered about 289 .000 motor and non-motor vehicles or 15.6% more than in 2013.
Tabela 1 Registered motor and non-motor vehicles Source of data: Department of Roads to Kosovo

YEARS	2011	2012	2013	2014
Automobiles	170,321	176,398	222,537	236,145
Transport vehicle,3.5 and over 3.5	10,877	11,547	15,352	15,769
Transport vehicle under 3.5t	17,901	18,225	24,659	26,949
Minibus	2,698	2,520	3,225	3,161
Buses	1,117	1,298	1,570	1,697
Motorcycles	546	809	1,488	1,540
Tractors	39	137	776	1,036
Trailer under 3.5t	101	117	217	250
Trailer 3.5 and above 3.5t	1,766	1,800	2,283	2,281
Automobiles	**205,366**	**212,851**	**272,107**	**288,828**

1.2 Roads of Kosovo

Since the end of war and until 2014, capital investments were made in the construction of roads in Kosovo,since investments are ongoing, new classification of roads are not completed.
The respective board of directors makes classification of roads, by construction standards.
KAS (Kosovo Agency of Statistics} by the Department of Roads to Kosovo took only changs in the length of paved and not paved roads for 2009 and 2010, and in 2011 was added motorway length of 38 km. In 2012 were aded 22.4 km, and in 2013 was added 17.6 km route length of the motorway and now 3 motorway road length is 78km.

Table 2 Kosovo's roads by category (Source of data: Department of Roads to Kosovo.)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Paved	1,666.2	1,666.2	1,666.2	1,666.2	1,805.0	1,805.0	1,843.0	1,865.4	1,883.0	1,883.0
Not paved	258.9	258.9	258.9	258.9	120.1	120.1	120.1	120.1	120.1	120.1
Total	**1,925.1**	**1,925.1**	**1,925.1**	**1,925.1**	**1,925.1**	**1,925.1**	**1,963.1**	**1,985.5**	**2,003.1**	**2,003.1**

According to data presented, it shows that in 2013 and 2014 in the territory of Kosovo we have 2003.1 km, the category of roads Motorway 4%, National 31%, while 65% are regional roads.
The table above shows that in the year 2014 a total of 2,003.1 km of roads 1,883.0 km or in percentage 94% are paved (asphalted}, while 120.1 km or 6% of the roads are not paved.

Table 3 Kosovo's roads by category - in kilometers (km) - Source of data: Department of Roads to Kosovo)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Motorway	0	0	0	0	0	0	38	60.4	78	78
National	630.4	630.4	630.4	630.4	630.4	630.4	630.4	630.4	630.4	630.4
Regional	1,294.7	1,294.7	1,294.7	1,294.7	1,294.7	1,294.7	1,294.7	1,294.0	1,294.7	1,294.7
Total	**1,925.1**	**1,925.1**	**1,925.1**	**1,925.1**	**1,925.1**	**1,925.1**	**1,963.1**	**1,985.5**	**2,003.1**	**2,003.1**

Table 4. Percentage of investment in infrastructure from 2005 to 2015

Infrastructure investment in the years since 2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Change in%	0%	0%	0%	8.3%	8.3%	10.7%	12%	13%	13%

As are analyzed the investments in road infrastructure from 2005 to 2014 , the percentage of investments in years comperin with 2005 years , so we have analyzed the percentage increase in the number of vehicles in Kosovo having a focus from 2012 until 2014.

Table 2 Increase the percentage of road construction and the growing number of vehicles since 2011

Increase the percentage of road construction and the growing number of vehicles since 2011	2012	2013	2014
Percentage increase in the number of vehicles	3.6%	32%	41%
The percentage of road construction	1,3%	2,3%	2,3%

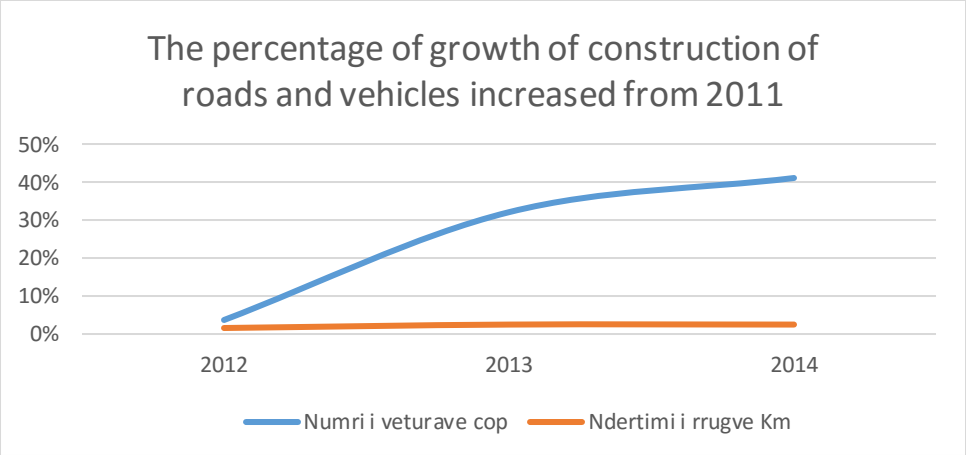

Figure 1 The graphic presentation of the difference between of investment in the roads and growth in the number of vehicles

1.21 Because of this increase, can be concluded:

1. Increase the number of vehicles compared with the increase in road investment is more pronounced
2. Increase very large number of vehicles compared with the increase in road investment, growth necessitates strips of roads
3. Investments slow compared with the increasing number of vehicles leads to blockage of traffic and numerous problems in traffic
4. From these changes is necessary expansion of existing roads as and have started Pristina - Mitrovica, Peja Prishtina, Prishtina - Gjilan are also many other ways to increase vehicle demand and obliges us to expand existing routes.
5. In most cases, extensions are accompanied by a complete new track of the road.

1.22 The situation in areas where road extension done - The need to build new roads and highways each time more and more will be reduced, the more important will be the management, maintenance, and expansion of roads and highways to be builded.

Each time we load the bulk of the increased traffic loads with which to cope roads constructed, these loads lead to damage to the roads and highways in the form of cuts and cracks and other forms of damage.

Fig 1. The condition in road expansion Pristina - Mitrovica

Fig 2. Condition of roads expansion of Skenderaj - Komoran

Until recently with the asphalt road maintenance, is mplied Novel building layers of asphalt material leveler of bitenemizuar and the abrasion layer of asphalt concrete? It is believed that there are limited resources and enough of the material for the construction and maintenance of roads, but costs explant requirements for storage facilities and transport costs of natural stone to plant asphalt has changed the opinion of the former and have begun and proceeded to seek other methods more efficient and lower cost and more effective for replacement of natural materials.One of the methods that were used in the years since the thirties is the method of recycling the materials used in the construction of roads and highways of asphalt and asphalt concrete (PAR - Reclaimed Asphalt Pavement). Accounts in the world for a year produced more than 500 million tons of material.

Table 6 Available reclaimed asphalt (tonnes) ,source european asphalt pavement , www.eapa.org association

Country	Available reclaimed asphalt (tonnes)	% of the new hot and warm mix production that contains reclaimed material
Austria	750.000	
Belgium	1.500.000	51
Czech Republic	1.450.000	10
Denmark	790.000	58
France	6.900.000	>65
Germany	11.500.000	No data
Great Britain	4.000.000-5.000.000	
Hungary	88.000	20
Italy	10.000.000	
Luxembourg	300.000	50
Netherlands	4.500.000	70
Norway	686.268	20
Sweden	900.000	70
Switzerland	1.370.000	27
Japan		76
U.S.A.	69.000.000	

Denmark, Norway, Germany have use of material RAP to produce new layers of asphalt with greater than 50%, the same notes have also in Japan and the UK, while in Kosovo, exploitation and use of the material PAR for production of layers New asphalt has a negligible level.

Recycling of aphalt road that allows us to use material for paper behind them and constructing roads.

Economic conditions, fair legal requirements, and the development of technological equipment for the production of asphalt have conditioned us and enable recycling of asphalt.

Limited quantities of natural aggregates high prices of oil products are the economic conditions that have led to new technologies and new techniques to carry out works in the recycling of materials.

Laws in force and promote recycling and re-use of this material, it reduces the appearance of waste and reduces the emission of CO2 and are prescribed severe penalties for violators of these laws.

According origin-recycled asphalt can be:

- Endogen - which comes from the same street which is recycled or
- EGZOGEN - when father brought from another place in the country of recycling.

Methods of recycling asphalt in road constructions divided into two main categories:

- Method, which uses stationary base driving (in plant)
- Method, which is realized in the country (in place).

In addition, these two methods of recycling may be depending on the temperature of the asphalt work and that makes to separate the two other categories:

- Method of recycling heated
- Cold recycling method

Strengths and weaknesses of the leading recycling categories have been presented to the following:

1. Recycling places.

Advantages:

- High quality of the recycled mix,
- Possibility of controlling the granulometrise,
- Very homogeny measure,
- Sizing opportuto measure and mix,
- Use of recycling bitumen,
- reuse in addition abrasive asphalt,
- A high flexibility of use,

Disadvantages: potential options with high costs

- Very large expenditure of energy
- Greater participation of the material transport
- Storage of recycled material RAP
- Damage to the environment – emitions CO_2

2. Recycling base station for recycling.

Advantages*:* use of full of material RAP

- Introduction in view of fast roads,
- suited for projects large and small,
- Economic influence,
- to reduce transportation costs,
- possibility of committing to recycling only a circular track

Gaps*:* necessary a surface layer

- Homogenization problem presented us new asphalt on the existing
- long recycling are not suitable for the small streets and rural roads
- Simple technology and equipment is only suitable to rural roads and streets with small volume

The laws in Kosovo do not encourage recycling and the use of reuse of this material, which is very different from the regional countries and European countries that by law companies for the production of asphalt promote and stimulate the use of asphalt recycled for reuse ,

Using recycled asphalt in the countries where it is prescribed by law reduces the appearance of waste and reduces CO2 emissions, and are provided for severe penalties for violators of these laws Përdorimi i asfaltit

Fig 3. Collection of waste asphalt removed from track to expand - Polac - Skenderaj

Fig 4. Waste of the removed asphalt layer on the road expanding Skenderaj – Komoran

Fig 5. Waste of the removed asphalt layer on the road expanding Skenderaj – Komoran

Fig 6. Waste of the removed asphalt layer on the road expanding Skenderaj – Komoran

In these works we have used several experiments which are analyzed with recycling asphalt as well as the ducts of the new asphalt, in order to compare curves granulometric and the amount of Bitulitit to asphalt recycling in this case was taken findings in this laboratory, experiments are conducted in the laboratory for building materials of the company ,,Koteks,, city Osijek in Croatia as well ,
The results and recapture of the new asphalt are similar with recapture's for the preparation of the new asphalt in ,,Renelual company ,, city of Prizren, Kosovo. Why have used this laboratory tests with recycled asphalt in company, Koteks, city Osijek in Croatia .
After that existing asphalt is working based on these receptures, therefore the results obtained are simulated with the results to be won in the laboratories of reviewing the materials in Kosovo.
Laboratory in Croatia are performing physical examinations de mechanical samples of asphalt mix asphalt with recycled quantities.In general, we found that the preparation of asphalt receipts are the same as granulometria as well as other components that we need for the preparation of asphalt.

Table 7. Presentation of granulometric curves designed in Croatia and Kosovo.

curve respective	0.09	0.25	0.71	2	4	8	11.2	16	22.4	31.5
Kosove	12	18	27	40	52	68	78	90	100	100
Kroacia	13.3	17.4	27.4	47.2	66.6	89.6	97.2	100	100	100

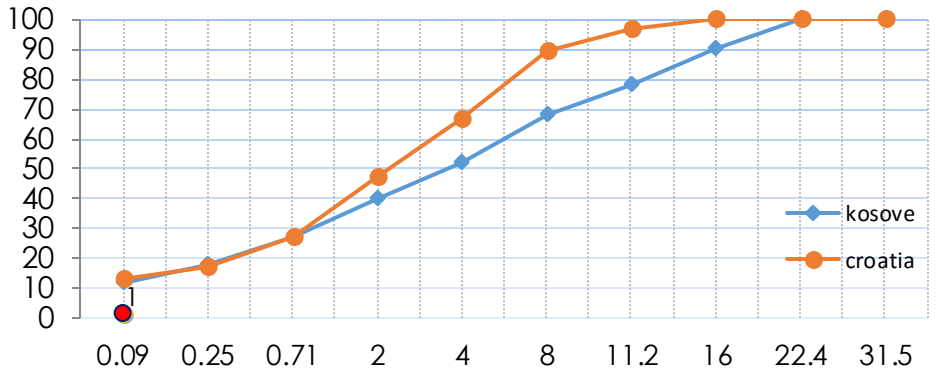

Figure 1. Curve granulomtris

Content of bitumen	2.6	3.0	3.4	3.8	4.2
Measure volume	2372	2394	2412	2442	2435
The emptiness%	9	7.4	5	4.3	1.5
Fill empty	30.2	46.4	56.8	67.3	88.2
Stability KN	8.976	11.957	12.987	12.478	11.215
St-flow wizard	5.11	3.209	2.882	3.236	3.96
St-wizard quotient	1.8	3.7	4.5	3.9	2.8

Table 8. Content of bitumen.

Therefore, these laboratory experiments can be taken as simulated experiments that would be conducted in Kosovo. Recycled asphalt was added to fractions of broken stone, stone Millie and quality bitumen for road 50/70 (according to EN 12591 eur code: 1999).

Table 9 Measure of asphalt with % recycled asphalt mas.

Mixture of asphalt	standard mixture of the asphalt	Mixture with 30% recycled asphalt		Mixture with 25% recycled asphalt		Mixture with 20% recycled asphalt	
Mixing components	participation of the components%	participation of the components%	savings compared to standard mixing%	participation of the components%	savings compared to standard mixing%	participation of the components%	savings compared to standard mixing%
Sheath Stone	6	2	66.67	2.5	58.33	3	50
Bitumen of roads	3.9	2.38	37.5	2.61	31.25	2.85	25
Recycled asphalt		30		25		20	
0/4 mm stone aggregate	25	10	30%	13.5	25%	17	20%
4/8 mm stone aggregate	15	8		9		9	
8/16 mm stone aggregate	20	17		16		17	
Stone aggregate of 16 / 31.5 mm	34	33		34		34	

Fig 7. Waste of the removed asphalt layer on the road expanding Skenderaj – Komoran

Fig 8. Waste of the removed asphalt layer on the road expanding Skenderaj – Komoran

On the basis of data and experiments presented in Kosovo is still construction of roads a priority, but the expansion of roads is being carried out in several directions, the expansion includes the route of the new which means should be overwrite the current structure of the road .
Therefore, there is a need that large amounts of the asphalt to be removed from those areas, should be mentioned some of the ways to be expanding as well as some others that are expected to expand.

Table 10 Measure of asphalt with % recycled asphalt mas.

	Measure of asphalt with 30% recycled asphalt mass	Measure of asphalt with 25% recycled asphalt mass	Measure of asphalt with 20% recycled asphalt mass
Density of the sample asphalt (kg/m3) EN 12697-5	2509	2509	2495
Density of mix asphalt (kg/m3) EN 12697-6	2675	2685	2661
participation of the gaps (%) EN 12697-8	6.19	6.55	6.24
gaps in the aggregate mass (%) EN 12697-8	15.74	15.51	15.85
filling the gaps with bitumen (%) EN 12697-8	60.68	57.73	60.65

Table11. Available recycling asphalt in Kosovo

Nr	Place (from)	Place (to)	Distance in Km
1	Prishtinë	Mitrovicë	36 Km
2	Prishtinë	Pejë	82 Km
3	Prishtinë	Gjilan	46 Km
4	Klina e Epërme-Skenderaj	Komoran - Drenas	30 Km
5	Gjakovë	Prizren	37 Km
		Total :	**231** Km

Fig 9.expansion of the road Prishtina – Mitrovica

Fig 10. expansion of the road Prishtina - Mitrovica

During visite in saite we have noted that the thickness of asphalt, which has removed and can be recycled is 20 cm thickness, as well as the gravel thickness is
average up to 30 cm.
Acirdin those facts can be concluded that if it becomes recycled asphalt removed, will be lot savings first in diferent components of the asphalt .

Fig 11. Thickness of the asphalt in place were its starting to remove in the road expanding Skenderaj – Komoran

Fig 12. Thickness of the asphalt in place were its starting to remove in the road expanding Skenderaj – Komoran

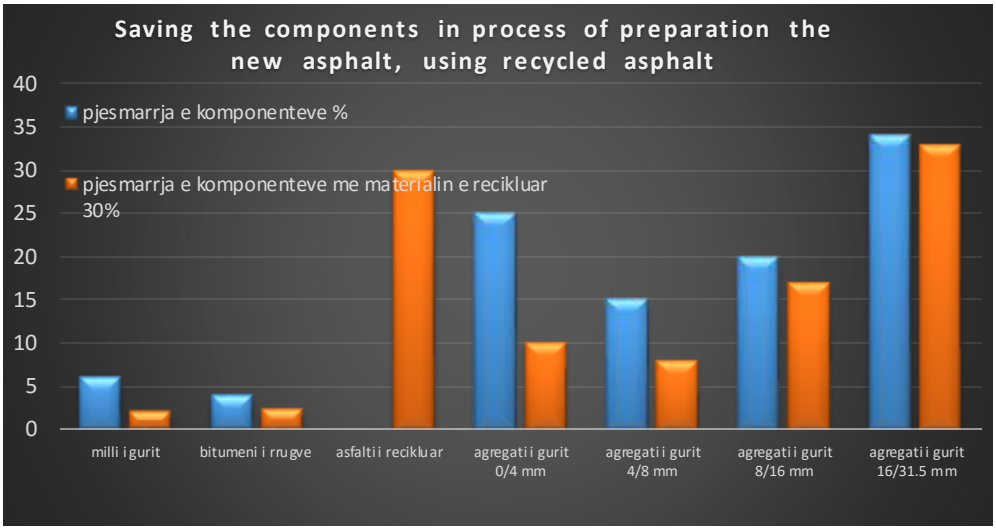

Figure 3. Saving the components in process of preparation the new asphalt, using recycled asphalt

1.3 Economic benefits using recycled asphalt

Laboratory tests obtained from asphalt recycling, which was obtained by milling and removal of layers of asphalt removed from parts of the roads that are being extended to just extensions in Kosovo are provided about 231 km, according to these analyzes we can ascertain and found that the share of bitumen in asphalt mixture component participates with 4.75%.
Recepture for designed for asphalt, which used as making the support layer BNS - 32s our goal is that, this percentage to be 3.8%.
With the use of asphalt recycled with a share of 30% we use to measure that bitumen 37.5%, and we have is the use of the amount of aggregate that is used for the preparation of asphalt will be: 66.67% of flour of stone, and 30% have use of fractions of aggregate: 0- 4, 4- 8, 8-16, 16- 31.3 mm
We have also saving the main components of asphalt for asphalt-recycled participation with participation in mass by 25% and 20%.

Benefits from using recycled asphalt – case Kosovo roads.

- Dimensions of roads that have begun to expand or are planned for expansion are 7 m,
- The thickness of the asphalt to be removed is approximately 20 cm,
- The distance of roads planned to expand is 231 Km ,
- Amount of asphalt to be removed is about 323 400 m3,
- Landfill site will be spared 323 400 m3 ,
- Can be spared reserves of stone rocks 323 400 m3 ,
- Will save more great power, which the former used for processing, transport and placement of aggregate in asphalt plant.

Construction of new asphalt

- Aggregate spared if used 30% of recycled asphalt 478 170 m3 (23 m)
- Bituminous spared if used 30% of recycled asphalt 13.388,760 400 liter

SAVINGS WILL BE MILLIONS AS THE FINANCIAL ASPECT, ALSO AS WELL AS ECOLOGICAL ASPECT TOO.

Conclusions and Recomendations:

In this paper were analyzed the results obtained in the laboratory examination of the materials in Croatia, these tests are simulated and the same receipts used in Kosovo for the preparation of asphalt, are also analyzing the quantities of asphalt recycled in percentage 30% , 25% and 20%, based on this analysis and research can be verified as follows:

• Using recycled asphalt will have to reduce the storage of asphalt removed from areas where routes expanded or repaired roads,

• Reduced amount of aggregate used for preparation of asphalt, there is a reduction in energy and reduction of greenhouse release energy, which we need to be excavated, milled, and transported to the asphalt plant.

• Reduced amount of that production bitulitet trailer considerable energy we need,

• Protecting the environment from waste from bitulitit that are in asphalt away, where these wastes are harmful to the surroundings as well as flora and fauna in places where stored, where according visit and monitoring in Kosovo these wastes are deposited in place deposition, without specifying severely damaging the surrounding ecosystem,

• The use of asphalt recycling, reduces from 25 to 30% of the energy required in the production of asphalt, which have the savings noted the release of CO2 into the atmosphere, diversity and mixture of asphalt recycling is difficult to control % dosage and millie stone aggregate and bitulitit distinction, necessary for preparation of asphalt for the road support layer;

• Issuance of bitulitit of recycled asphalt, have the deviation in up to 13.99% of the amount needed for the preparation of asphalt;

• The deviation of the granulometric curve of samples taken by 25% of recycled asphalt sizes appear in parts of the aggregate occurs in aggregate size of 0.71, 8.00 m and 20.11 mm until 22:40 where granulometric curve has won a composition with thick aggregate asphalt mixture compared with the projected normal asphalt;

• Reducing the amount or portion of the recycled asphalt it is much easier to achieve value (designed) to mix asphalt;

• All laboratory samples to analyze the mix asphalt designed and samples of asphalt designed by adding amounts of asphalt recycled in percentage set at 30%, 25% and 20%, meet the limit values specified by standards European preparation of asphalt laid for the roads with large loads to transport;

• Savings in the amount of the sum of the components of asphalt (bitumen gravel, sand and powdered stone) depends primarily on the type of asphalt that is recycled,

Taking values bitulitit to layer the final asphalt, where the percentage of bitulitit ranges on average from 4.75% to Bitumen, the use of recycled asphalt for savings brought from 25% to 37.5% depending on the amount of recycled asphalt was taken as part of the composition of asphalt designed.

Recommendations

1. Recommended the Ministry of Infrastructure, to prepare a Law for recycling of inert materials with a specific gravity of the recycling asphalt awarded.
2. Non-compliance with this law, penalties against violators of the trailer
3. Ministry of Infrastructure should be obliged companies that deal with the production of asphalt use of recycled asphalt, obliging them to a certain percentage, as well as to comply with recycling companies to support by the ministry.
4. The amount of the use of recycled materials to define the working contract, acording type of recycled material, ways of recycling and the amount of recycling.

Results of asphalt mixtures using recycled asphalt to produce bitumen asphalt layers type BNS-32s in very heavy traffic load shows that this technical solution is justified by the economic and ecological aspects.

Future research should focus on analyzing the possibility to produce such a mixture of asphalt mixing and production of new shares and testing recycled asphalt applications in other asphalt mixtures.

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