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THE PROSPECTS MANUFACTURE OF RECYCLED HOT MIX ASPHALT WITH FIBER PLASTIC REINFORCEMENT

The most common ways of milled asphalt re-use, what is formed during road topping repair is considered. The results of experimental studies of preparation technology features and physical and mechanical properties of recycled hot mix asphalt determination based on milled asphalt with plastic fiber addition that obtained from industrial waste is presented. Defined regulations correspondence obtained recycled hot mix asphalt and ways of their use in road construction is determined.

***Keywords:** asphalt pavement, hot recycled, milled asphalt, plastic fiber, recycled hot mix asphalt (RHMA), reclaimed asphalt pavement (RAP).*

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ПЕРСПЕКТИВИ ВИГОТОВЛЕННЯ ГАРЯЧИХ РЕЦИКЛЬОВАНИХ АСФАЛЬТОБЕТОННИХ СУМІШЕЙ З АРМУВАННЯМ ПЛАСТИКОВОЮ ФІБРОЮ

Розглянуто найбільш поширені способи повторного застосування фрезованого асфальтобетону, який утворюється під час ремонту дорожнього покриття. Наведено результати експериментальних досліджень щодо особливостей технології приготування та визначення фізико-механічних властивостей гарячих рецикльованих асфальтобетонних сумішей на основі фрезованого асфальтобетону з додаванням пластикової фібри, що отримана з побутових відходів. Визначено відповідність нормативним вимогам отриманих гарячих рецикльованих асфальтобетонних сумішей та шляхи їх застосування в дорожньому будівництві.

***Ключові слова**: асфальтобетонний матеріал, гаряче рециклювання, фрезований асфальтобетон, пластикова фібра, гаряча рециклювана асфальтобетонна суміш, відновлений асфальтобетонний матеріал.*

Introduction. Asphalt – the most common material in our country for the road topping upper layers design in the permanent road-mat construction. Due to limited funding almost 90% of public roads for the last thirty years is not repaired, hereupon they do not meet modern requirements both on strength (39,2%) and smoothness (51,1%) [1].

Asphalt pavement recovery usually involves placing over the old pavement design a new asphalt pavement layer. However, such measures give only short-term effect, since a few years on the traffic-bearing surface appear old deformations and destructions. A more effective way to restore road-mat operability is to replace defective and damaged layers of all pavement design using recycling process – old asphalt reusing.

Analysis of recent sources of research and publications. The issue of old asphalt reusing our scientists and process man began to engage from the 40-s of the last century, as evidenced by the work [2 – 4]. However, the absence at that time the relevant technologies and techniques not allowed to bring recycling processes at the practical level use in highway engineering.

The impact for old asphalt reusing has become a global energy crisis of the 70-s, that led to the search of replacement the deficient at that time organic binder for the asphalt mixtures preparation [5 – 6].

Today in highway engineering is spreading the following ways to old asphalt reuse that is usually formed as a result of milling (cutting by pavement profiler) or road-mat layers removing with further crushing and sorting [7 – 10]:

– roadside verge strengthening and subgrade slopes;
– bed course and basecourse installation;
– racked-in chipping;
– cold organic and hydraulic mixtures production;
– hot mix asphalt preparation.

The choice of one or another method of old asphalt reusing depends on the technical, environmental and economic factors [11 – 12].

Identification of general problem parts unsolved before. The most rational way it is possible to consider the old asphalt using at the hot recycling technology – hot mix asphalt preparation with partial or full recycled material content. For example, in the most European countries, upon condition technological requirements observation it is allowed to add up to 10% of milled asphalt to the new hot asphalt mixtures, intended for the upper layers; 30 – 50% – for the road-mat lower layers; till 100% – base course [7 – 10].

Since the modern domestic road practice, compared with Europe and America, the issue of milled asphalt reusing is not become sufficiently spreading, so it was decided to conduct the research of recycled hot mix asphalt preparation reasonability based on milled asphalt with plastic fiber reinforcement, obtained from postconsumer plastics.

Formulation of the problem. The aim of research – to study physical and mechanical hot mix asphalt properties based on milled asphalt with plastic fiber reinforcement.

Basic material and results. During experimental studies in the laboratory conditions based on milled asphalt (see Fig. 1, a) with plastic fibers addition, obtained from postconsumer plastics, size 25×3 mm (see. Fig. 1, b), three research samples series of recycled hot mix asphalt following composition is produced:

– seria A1 – milled asphalt without additives (control range);
– seria A2 – milled asphalt with plastic fibers addition in an amount of 0,75% by the basic material weight;
– seria A3 – milled asphalt with plastic fibers addition in an amount of 1,5% by the basic material weight.

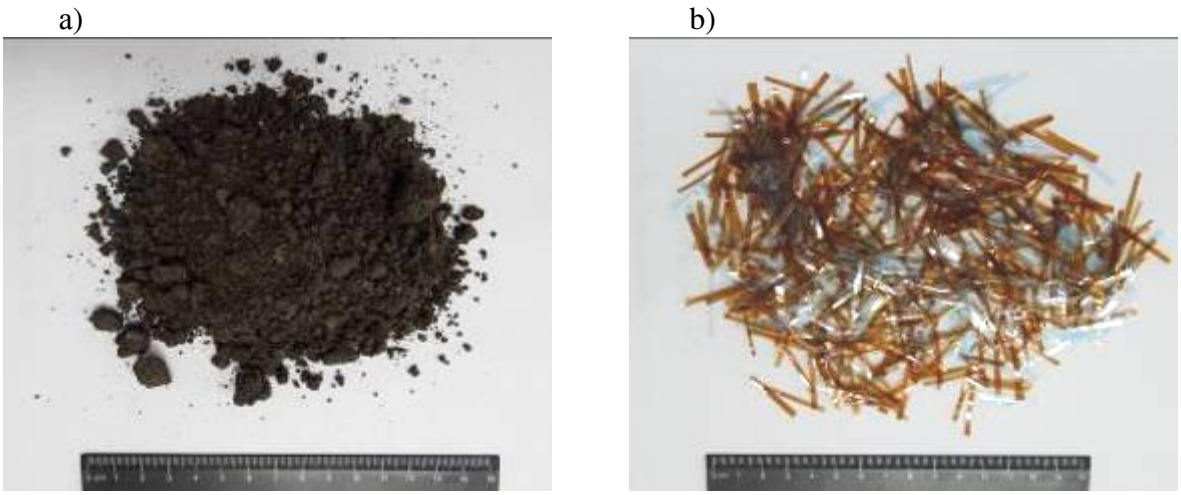

Figure 1 – General view of initial materials:
а – milled asphalt; б – plastic fiber

Milled asphalt grain fineness, determined by sifting through a standard sieve with holes from 40 to 0,071 mm, the most meet regulatory requirements [15] to hot asphalt mixtures type D (Fig. 2).

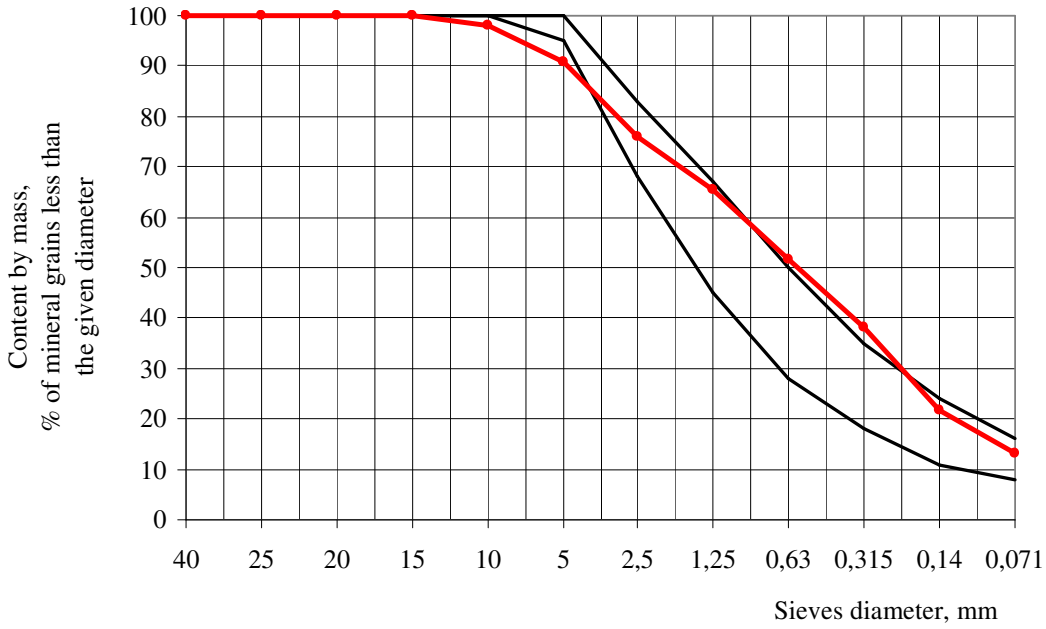

Figure 2 – Comparison of milled asphalt grain fineness with regulatory requirements for hot asphalt mixtures type D

Preparation and testing of recycled hot mix asphalt research samples based on milled asphalt is carried by a standard procedure for the average material density determination, water saturation, swelling and compression strength limit in accordance with requirements [13 – 15]. The results of physical and mechanical properties determination of test samples are shown in Table 1 and Fig. 3 – 6.

Table 1 – Physical and mechanical properties of test samples

Name of properties	Samples seria		
	A1	A2	A3
Average density, g/cm^3	2,30	2,28	2,36
Water saturation, %	3,12	3,11	3,31
Swelling, %	0,34	0,32	0,50
Compression strength limit, MPa – in the dry condition at the temperature: – 20°C – 50°C – in the moisten condition	 5,70 6,13 4,63	 6,09 6,59 4,39	 6,50 5,75 4,32

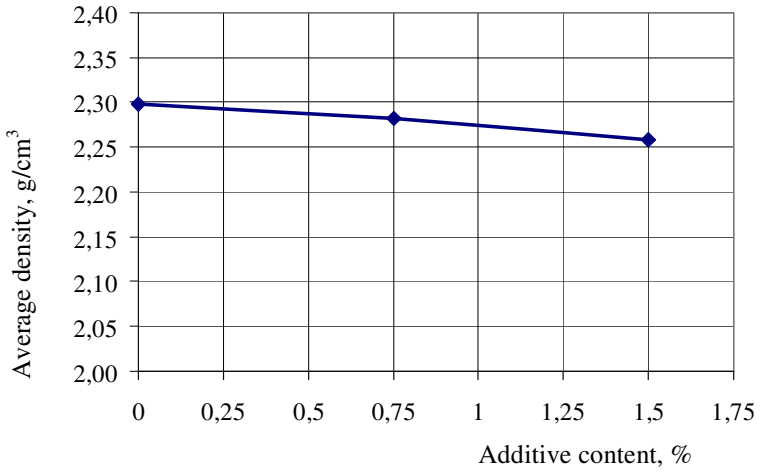

Figure 3 – Plot of the research samples average density from the presence and fiber content supplements

Analysis of the research samples average density dependence from the presence and plastic fiber content supplements (see Fig. 3) shows that this relationship is more or less linear character, i.e with plastic fibers content increasing in the mixture the average samples density is reduced by reducing the particle of stone material (recycled mix asphalt average density from pure milled asphalt is $\rho_{m\ aver}$ = 2,30 g/cm^3) and a lighter plastic fibers gradual increase.

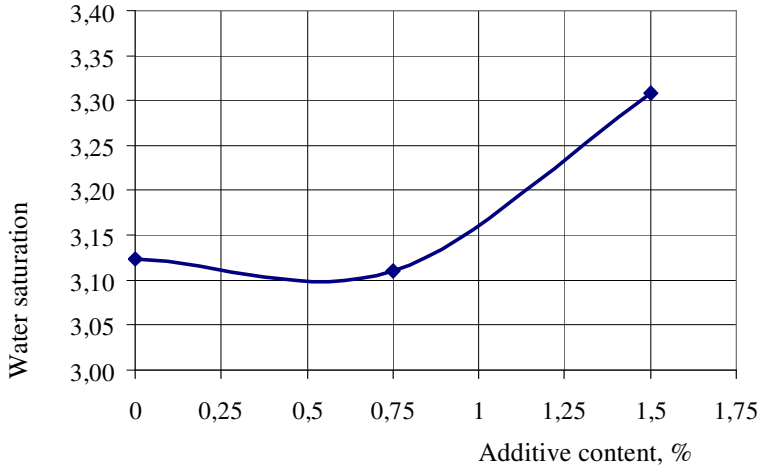

Figure 4 – Plot dependence of water saturation indicator of research samples from the presence and plastic fiber content supplements

Analysis of the water saturation dependence of reserch samples from the presence and plastic fiber content supplements (see Fig. 4) shows that with recycled mix asphalt content implementation of plastic fibers water saturation at first decreases (the recycled mix asphalt water saturation from pure milled asphalt is W_{aver} = 3,12 %), but with fiber content increasing, this indicator starts to increase due to the porosity increasing.

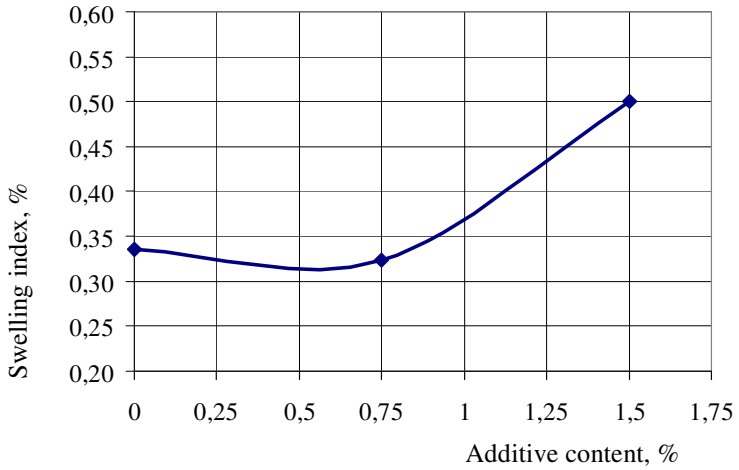

Figure 5 – Plot dependence of research samples swelling from the presence and plastic fiber content supplements

Analysis of the research samples swelling dependence from the presence and plastic fiber content supplements (see Fig. 5) shows that with recycled mix asphalt content implementation of plastic fibers swelling index at first decreases (the recycled mix asphalt water saturation from pure milled asphalt is H_{aver} = 0,34 %), but with fiber content increasing, this indicator starts to increase due to the porosity increasing.

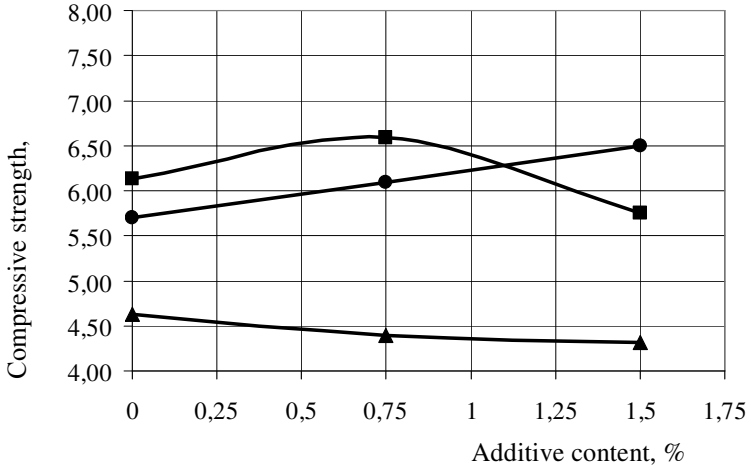

Figure 6 – Plot dependence of test samples compressive strength from the presence and fiber content supplements:
round markers – in the dry condition at T = 20°C;
square markers – in the dry condition at T = 50°C;
triangular markers – in the moisten condition at T = 20°C.

Analysis of the research samples compressive strength dependence from the presence and plastic fiber content supplements (see Fig. 6) shows that at the sample temperature T = 20°C in the dry condition the strength value R_{20} increased with the implementation of plastic fibers to the recycled mix asphalt content by the origination effect of milled asphalt reinforcing. However, with temperature samples increasing to T = 50°C in the dry condition strength value R_{50} at first increases (with fiber content of 0,75%) due to the partial reinforcement effect of milled asphalt, and then strength value R_{50} decreases (with 1,5% of fiber content) due to the loss of milled asphalt reinforcing effect. At the sample temperature T = 20°C in the moisten condition the strength value R_{20}^{M} with the implementation of plastic fibers to the recycled mix asphalt content decreases, is illustrative of complete milled asphalt reinforcing effect absence.

Conclusions. The results of physical and mechanical research samples properties determining of recycled hot mix asphalt based on milled asphalt with plastic fibers addition indicate this research area prospects, because they allow not only to obtain the economic effect from the cost reducing of new road-building materials acquiring, but also to improve the environmental situation through the use of postconsumer plastics.

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