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# RESEARCH OF RUTTING OF DIFFERENT TYPES AND KINDS OF ASPHALT CONCRETE WITH POLYGUM BINDER

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**Abstract**. This article deals investigate in laboratory conditions effect of bituminous Polygum binder on rutting resistance of different types asphalt concrete using rutting measure. It includes research of fine-grained asphalt concrete, which in grading composition related to types A, B, V and stone-mastic asphalt (SMA) with a maximum particle size of grains of 10 mm with asphalt binder Polygum and oil bitumen BND 40/60 till accumulation of residual strains in form of rutting. This indicates that studied asphalt concrete with Polygum binder have in almost 1.5–2 times less rutting than asphalt concrete with bitumen BND 40/60.

**Keywords:** Bituminous concretes, Polygum binder, rutting firmness, procedure of assessment, procedure of testing, rutting depth, strength of adherence depending.

## Introduction

On general use roads of Ukraine in recent years there has seen a steady increase in traffic of heavy vehicles which causes accumulation of residual strains in form of rutting in layers of asphalt coating, especially during high summer temperatures.

Violation of transverse equality in asphalt pavement in the form of rutting creates dangerous conditions for driving, as: there is increased risk of loss of vehicle control while crossing over a track, during maneuvers (eg. overtaking), stagnant water in a rut can lead to hydroplaning wheels of the vehicle and as a result - dangerous driving. In addition to safety reduction stagnant water in a track leads to its more intensive development, in the winter it complicates efficient removal of snow and ice deposits, increasing slip in strip rolling and reduces safety.

According, rutting is the most difficult type of strain, its appearance on “roads in operation is unacceptble, and emerged rutting is to be urgently eliminated”. This indicates that asphalt concrete with ordinary bitumen (BND) does not always meet requirements of standards (Zolotarev 1983; Zhdanyuk *et al.* 2008; Mozgovoy *et al.* 2006). In this case, it should be noted that for such roads critical standard of quality for bitumen and asphalt concrete is not always enough to ensure both produceability, resistance to accumulation of residual strain, water and frost resistance of asphalt concrete. The current range of different modifiers for bitumen and asphalt concrete mixtures in Ukraine allows significantly increase rutting resistance of asphalt concretes with bitumen which are in compliance with standards. Therefore, research rutting asphalt concrete, prediction of intensity of rutting in asphalt concrete is urgent task.

## Analysis of recent research

According to (Mozgoviy *et al.* 2011; Onischenko *et al.* 2011; Zhdanyuk *et al.* 2008) depending on category of roads and bridges, they use various types and kinds of asphalt concrete which differ in number of coarse aggregate (gravel).

Comparison results of stability tests of asphalt concrete with different gradation before rutting are given in (Zhdanyuk *et al.* 2008). The authors of these studies claim that among these fine-grained asphalt concrete the



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lowest depth of rutting is typical for type A and the highest – to type B. Sand asphalt concrete is characterized by the highest rut depth compared to the fine-grained asphalt concrete, while after 25 000 passes depth rutting from wheel of type A 2 times lower than type D. The results of tests showed that rutting depth and indicator of compressive strength at 50° C, as criteria shear resistance are in contradiction

As the results of studies conducted in HNADU (Zhdanyuk *et al.* 2009), rutting resistance of asphalt concrete is greatly influenced by binder (bitumen). As the number of bitumen from 6,4 % to 4,6 % depth of rutting in asphalt concrete after 30,000 wheel passes is reduced from 14 mm to 6 mm. So, in determining dependence between depth of rutting and bitumen content in asphalt concrete was observed maximum (extreme), in contrast to results when tested for resistibility and determining the rheological characteristics (Zolotarev 1983).

***Objective*** of this research – investigate in laboratory conditions effect of bituminous Polygum binder on rutting resistance of different types asphalt concrete using rutting measure.

At the Department of Road Construction Materials and Chemistry NTU were performed research of fine-grained asphalt concrete, which in grading composition related to types A, B, V and stone-mastic asphalt (SMA) with a maximum particle size of grains of 10 mm with asphalt binder Polygum and oil bitumen BND 40/60 till accumulation of residual strains in form of rutting. Rutting test was carried out by sector press, developed by SSTC Doryakist and NTU (Fig. 1), and loaded on a metal wheel with a pressure of 0,8 MPa, which is transferred to asphalt concrete sample. This pressure is equivalent to load A1 (57,5 kN) temperature of +55° C and varying the number of passes wheels on one track in forward and reverse direction by the method described in (Mozgoviy *et al.* 2009; Onischenko *et al.* 2009).

Grading of tested asphalt concrete of types A, B, V and SMA are shown in Fig. 2.

Physical and mechanical properties of bituminous Polygum binder and road oil bitumen BND 40/60, adopted for the preparation of asphalt mixtures of types A, B, V and SMA are given in Table 1.

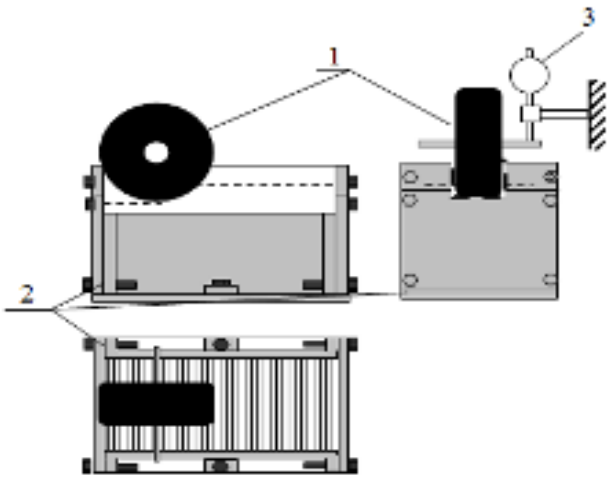


**Fig. 1.** Scheme of the device for testing resistance of asphalt concrete to accumulation of residual strains:
1 – test wheel, 2 – metallic form 3 – strain sensor

**Table 1.** Physical and mechanical properties of bituminous binder

| Property | Polygum | BND 40/60 |
|---|---|---|
| Penetration at 25°C, 0,1 mm | 59 | 56 |
| Softening point, °C, | 82 | 53 |
| Ductility, at 25° C, sm | 72 | 49 |
| Elastic recovery at 25° C, % | 96 | - |

Physical and mechanical properties of asphalt concrete are given in Table 2.

**Table 2**. Physical and mechanical properties of asphalt concrete

| Property | Type A | | Type B | | Type V | | SMA | |
|---|---|---|---|---|---|---|---|---|
| | Polygum | BND 40/60 | Polygum | BND 40/60 | Polygum | BND 40/60 | Polygum | BND 40/60 |
| Water saturation, % for volume | 1,6 | 1,9 | 1,52 | 1,85 | 1,65 | 2,00 | 2,6 | 1,8 |
| Critical compression strength, MPa, at | | | | | | | | |
| 20° C | 5,9 | 5,1 | 7,4 | 5,30 | 7,8 | 5,45 | 5,3 | 4,2 |
| 50° C | 2,8 | 1,39 | 2,95 | 1,45 | 3,1 | 1,47 | 2,65 | 1,45 |
| Coefficient of prolonged water resistance | 1,00 | 1,00 | 1,00 | 0,99 | 1,00 | 0,99 | 1,00 | 1,00 |
| Optimal content of bitumen binder in asphalt concrete, % | 5,6 | 6,2 | 6,0 | 6,5 | 6,3 | 6,7 | 6,0 | 6,2 |

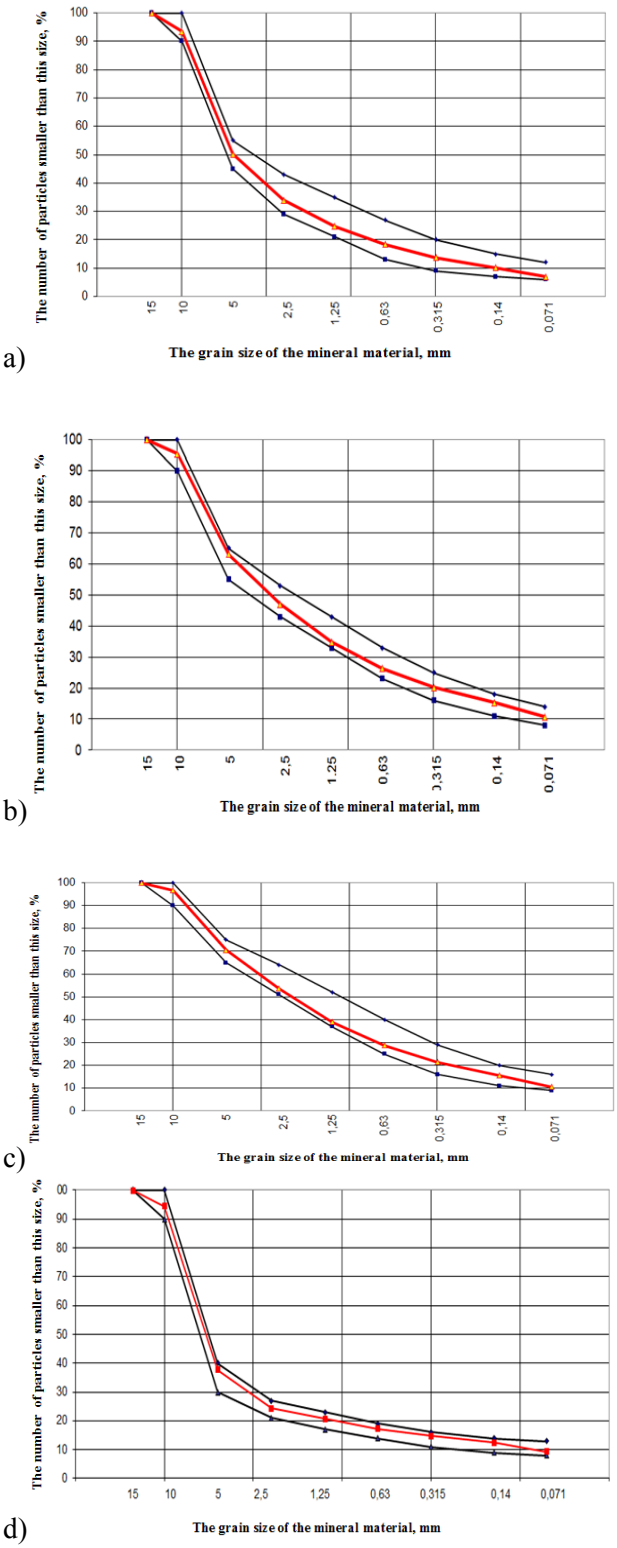


**Fig. 2.** Grading of asphalt concrete:
a)- Type A; b) - Type B; c) - Type V; d) – SMA

In determining rutting of studied asphalt concrete with asphalt Polygum binder and BND 40/60 was noted trend of increasing depth of rutting with increasing number of wheel passes and temperature of 55° C (Fig. 3, 4).

Obtained results show that asphalt concrete with asphalt binder Polygum is less rut resistant. As shown in Figure 3 asphalt Type A with asphalt binder Polygum after 20 thousand wheel passes has rutting depth of 3,24 mm, and for Type A asphalt with bitumen BND 40/60 according to Figure 4 rutting depth is 6,48 mm.

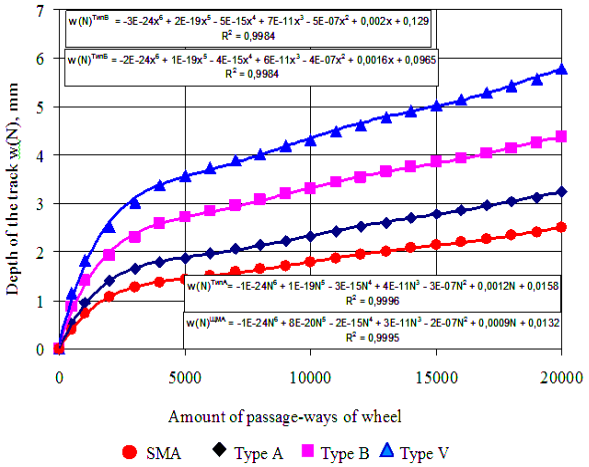


**Fig. 3.** Dependence of rutting depth on number of wheel passes in the studied asphalt concrete with polygum binder

This indicates that studied asphalt concrete with Polygum binder (Fig. 3) have in almost 1,5–2 times less rutting than asphalt concrete with bitumen BND 40/60 (Fig. 4). Also based on the results of the study (Fig. 3, 4) the influence of gravel content on intensity of asphalt concrete rutting Fig. 5.

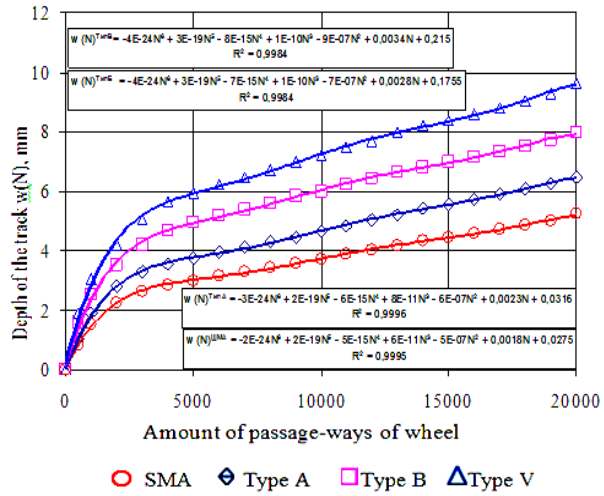


**Fig.4.** Dependence of rutting depth on number of wheel passes in the studied asphalt concrete with bitumen BND 40/60

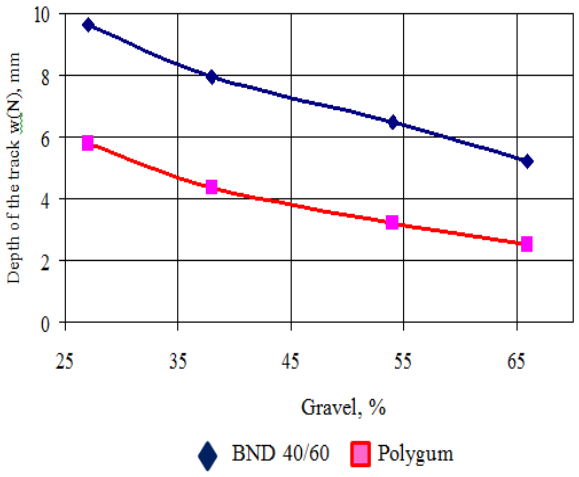


**Fig. 5.** Dependence of rutting depth after 20,000 wheel passes in studied asphalt concrete on gravel content

## Conclusions

1) Research results indicate that rutting criterion is quite sensitive to the viscosity of bituminous binders. This should be taken into account for preparation of bituminous mixtures for different climatic conditions of asphalt pavement operation.

2) All studied Polygum bituminous binder have 1,5–2 times less rutting than asphalt with BND40/60 bitumen.

3) It is also found that with increasing content of gravel in asphalt with Polygum binder for example with 66 % gravel rutting depth is 2,5 mm, and with 27 % gravel rutting is 5,79 mm. Rutting depth with decrease of gravel increased 2,3 times.

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