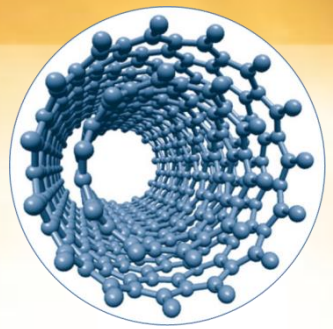
ADVANCED RESEARCH & TECHNOLOGIES
Minsk, Belarus



"NANOSTRUCTURED CARBON BASED ASPHALT CONCRETE"

S.A. ZHDANOK

MINSK, 2016

- *The current situation in the development of motor transport is the same in the world. Each year, the number of vehicles on the roads increases, as well as cargo traffic volumes, and axial loads.*
- *In recent years, an increasingly greater influence on the durability of roads have had weather and climatic factors – abnormally hot summers and extremely cold winters, i.e. a range of operating temperatures of asphalt concrete pavement gradually increases, which cannot but affect the intensity of accumulation of deformations and damages of road pavement.*

Basic deformations and damages of asphalt concrete pavement:

1. Plastic deformation

2. Brittle fracture

3. Fatigue fracture

4. Corrosion damage

One of the most widely used ways that improve reliability and durability of asphalt concrete pavement is the way of asphalt mixes modification. The asphalt mixes modification can be carried out both by modifying bitumen, as well as directly through the introduction of special modifiers in asphalt mixing plants during the preparation stage.

Global trends in the struggle for the life of asphalt concrete pavement

ADDITIVES TO BITUMEN

Polymer Groups:

SBS
SBR
PE-VA
Reactive polymers

Effect on the range of bitumen ductility:

- Improved properties of bitumen at high temperatures
- Improved properties of bitumen at low temperatures

In many countries in the asphalt concrete factories, SBS polymers are used for modifying bitumen.

ADDITIVES TO ASPHALT CONCRETE

Products Groups:

PE
PE-VA
Synthetic wax

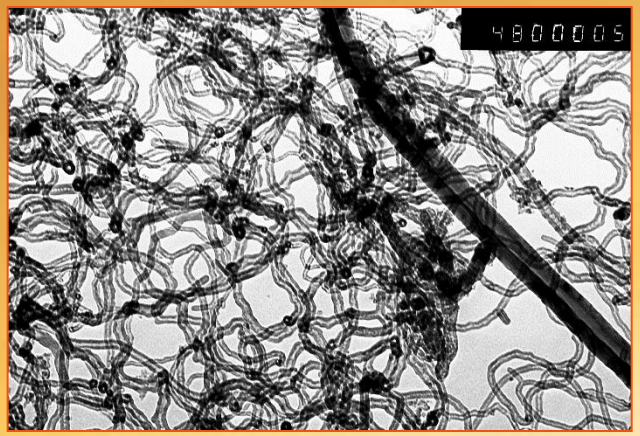
Effect on the range of bitumen ductility:

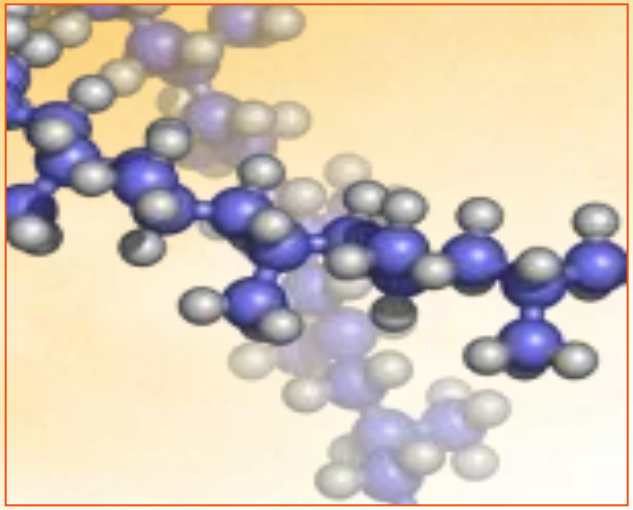
Improved high-temperature properties of bitumen

In Europe and the United States, such additives are often used in addition to bitumen modified with SBS polymer.
Polyolefin-based additives are used more often than others.

The most promising way to protect pavements from deformations and fractures is to create new advanced materials with desired properties, and structured at the microscale.

NANOSTRUCTURAL CARBON (CNM) BASED ASPHALT

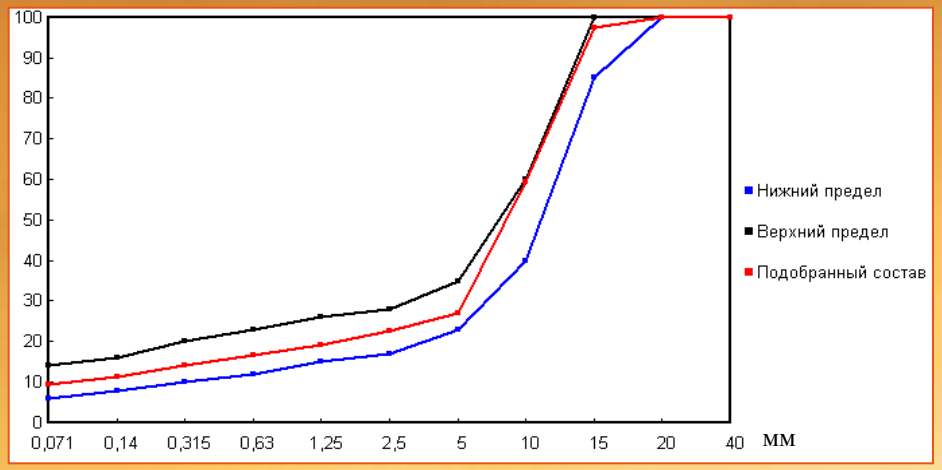




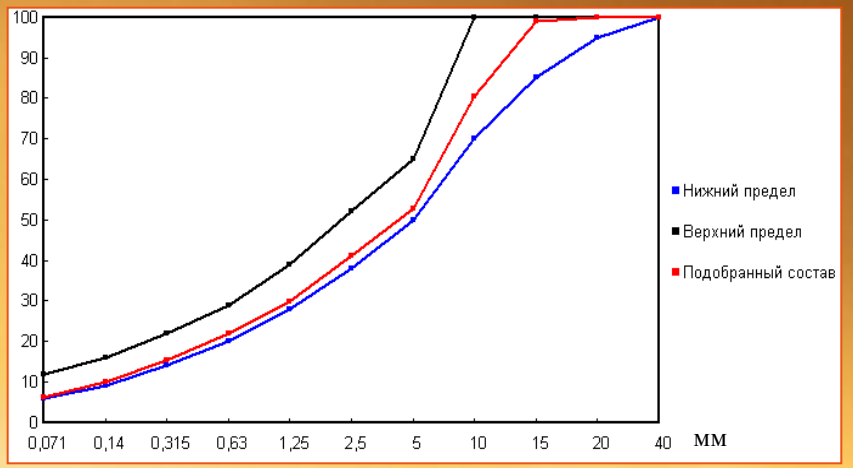
Preliminary tests results of asphalt concrete based on carbon materials

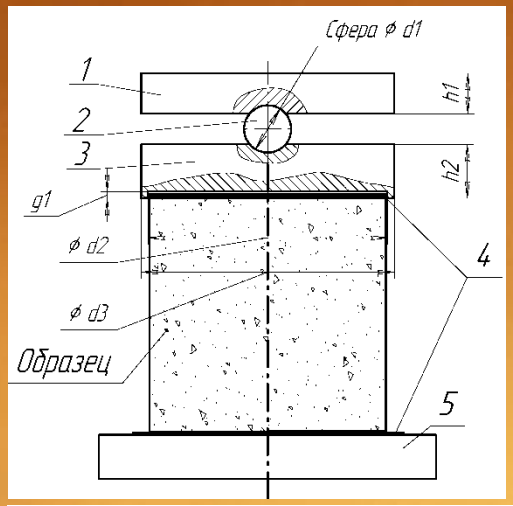
Granulometric composition of the asphalt concrete taken for tests

Stone mastic asphalt



Type B asphalt



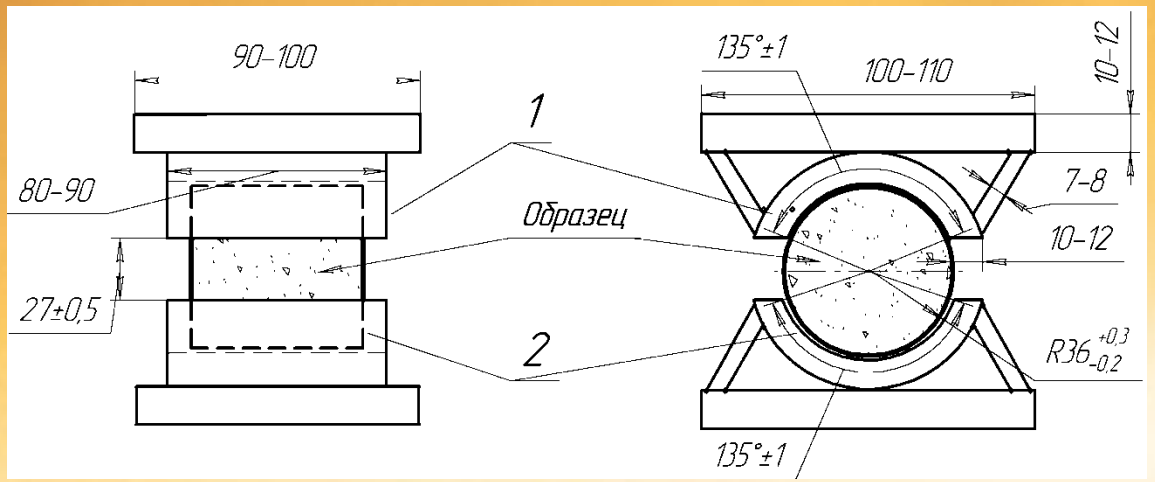


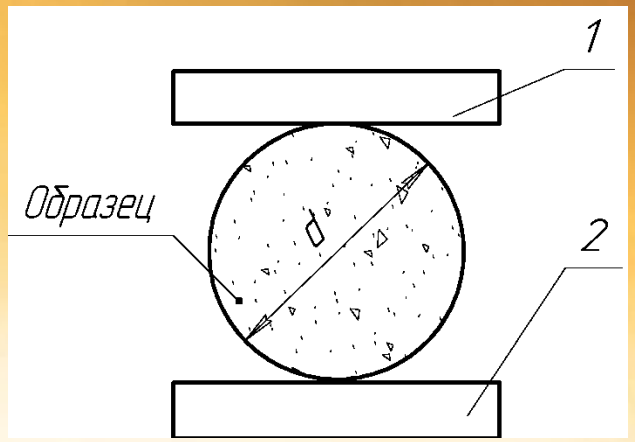
The preliminary tests were carried out on two specially selected compositions:

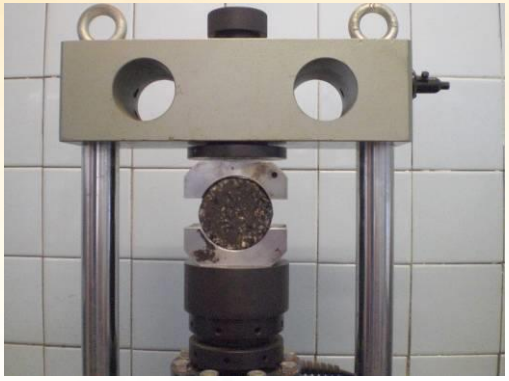
1. Stone mastic asphalt

2. Type B asphalt

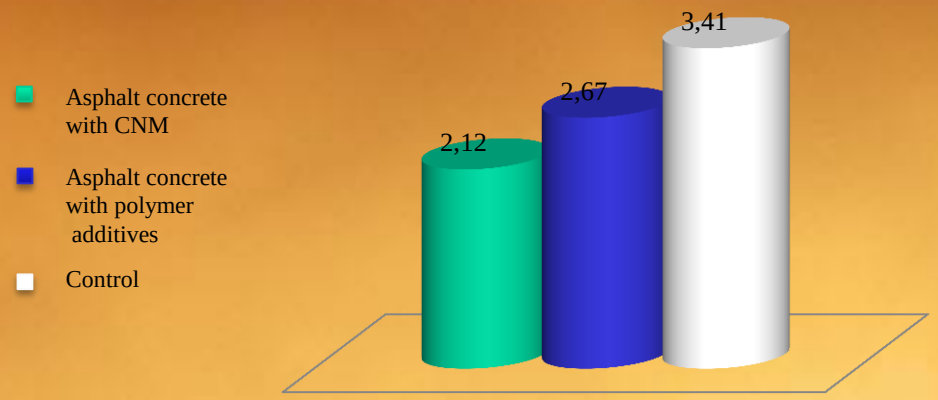
(the granulometric composition is shown at the previous slide)



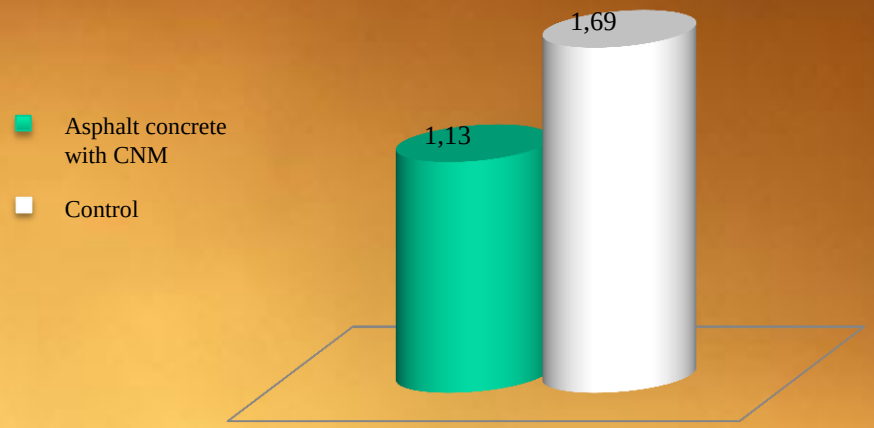




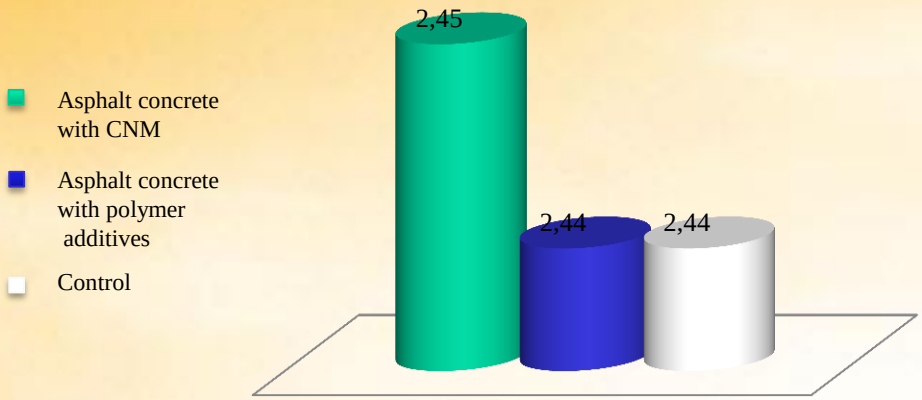
Asphalt concrete water saturation, % (stone mastic asphalt)



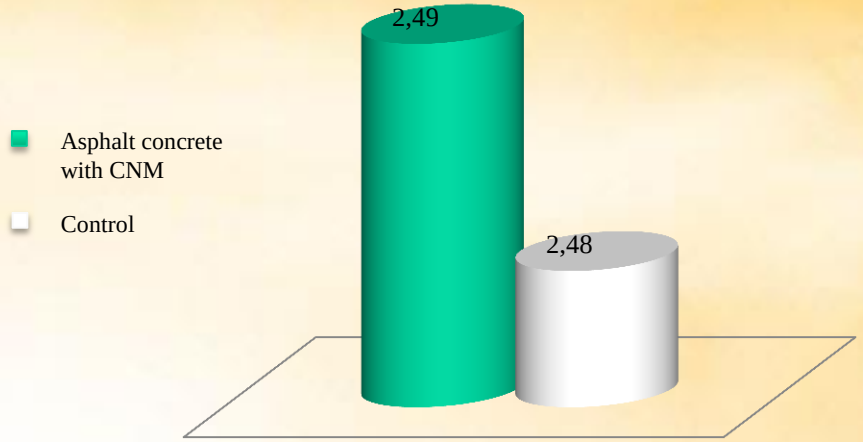
Water saturation, % (type B asphalt)



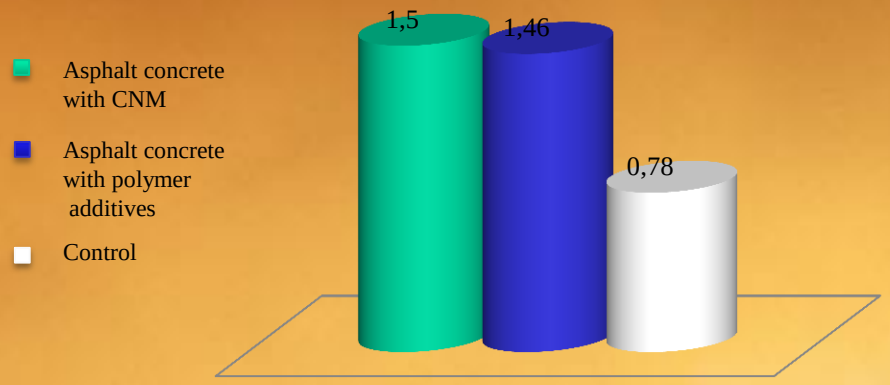
Asphalt concrete density, g/cm3 (stone mastic asphalt)



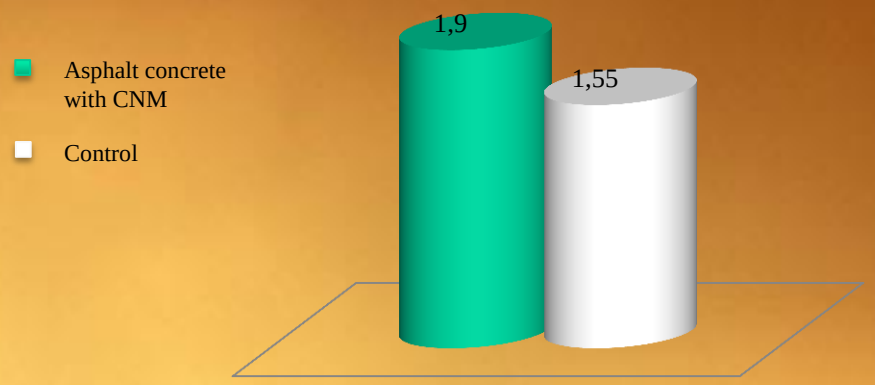
Density, g/cm3 (type B asphalt)



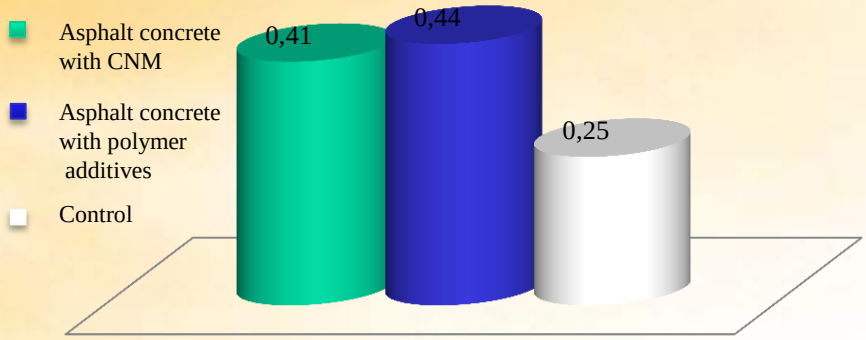
Ultimate compressive strength at 50°C, MPa (stone mastic asphalt)



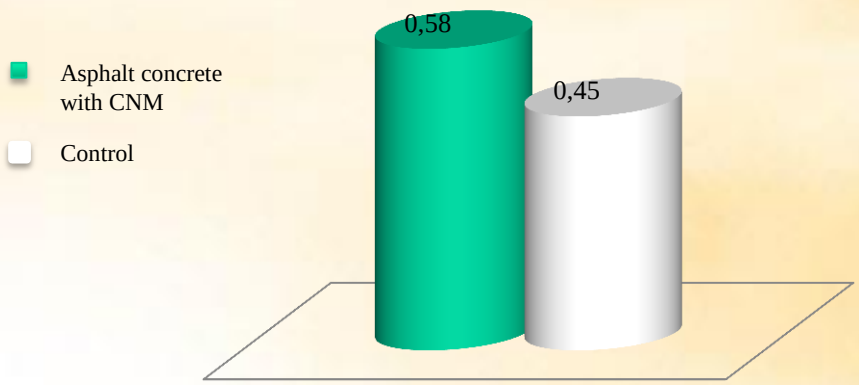
Ultimate compressive strength at 50°C, MPa (type B asphalt)



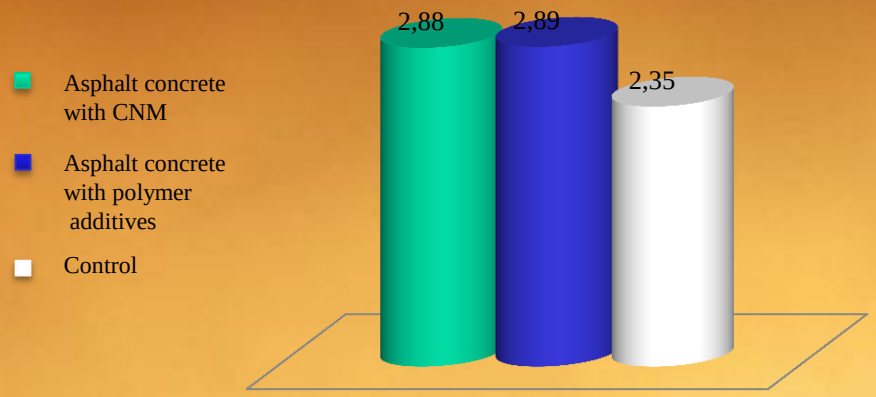
Internal bonding strength, MPa (stone mastic asphalt)



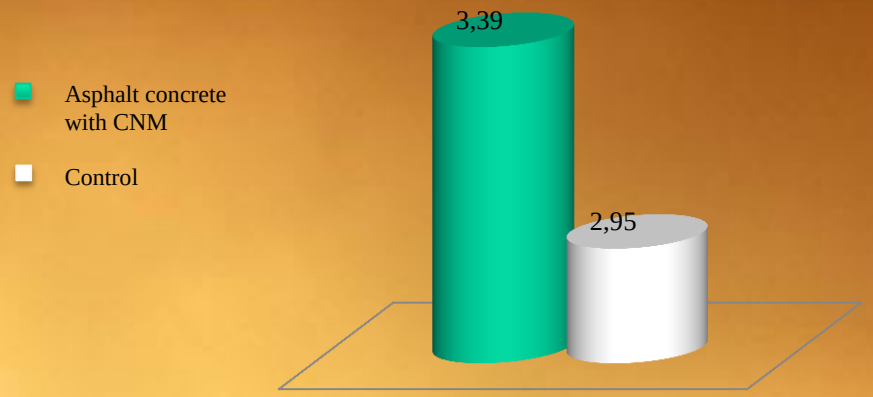
Internal bonding strength at 50°C, MPa (type B asphalt)



Ultimate tensile strength at 0°C, MPa (stone mastic asphalt)



Ultimate tensile strength at 0°C, MPa (type B asphalt)



The preliminary tests have shown that when introducing CNM to asphalt concrete (of type B and stone mastic one), there has been observed: 1. a decrease in the water saturation, and an increase in the density, which indicates a better structurization during the material formation, and an increase in the corrosion resistance of asphalt concrete in general; 2. an increase in the ultimate compressive strength and the internal bonding strength indicates a significant increase in the material shear-resistance. And the main characteristics have increased twice as compared with the base ones. 3. The ultimate tensile strength at 0°C has also increased within tolerable limits, which has a positive impact during the material operation at low temperatures.

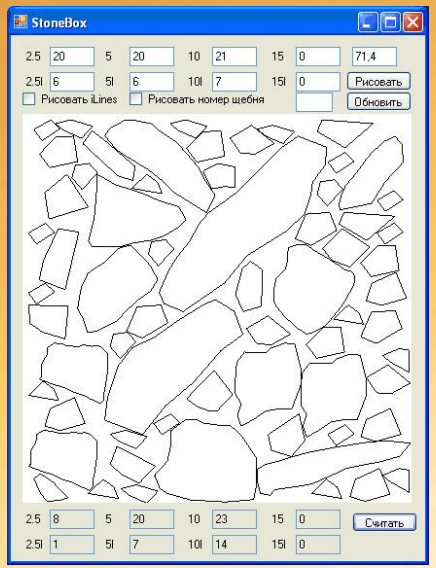
General conclusion: the tested asphalt concrete containing CNM exceeded 2 times the values of standard asphalt concrete, and is fully comparable to costly polymer asphalt concrete.

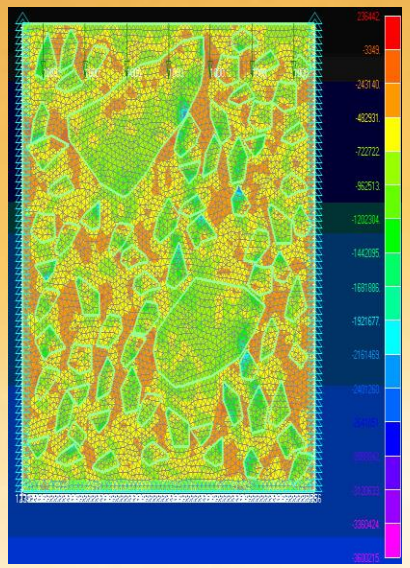
On the basis of the preliminary tests, possible areas of development are:

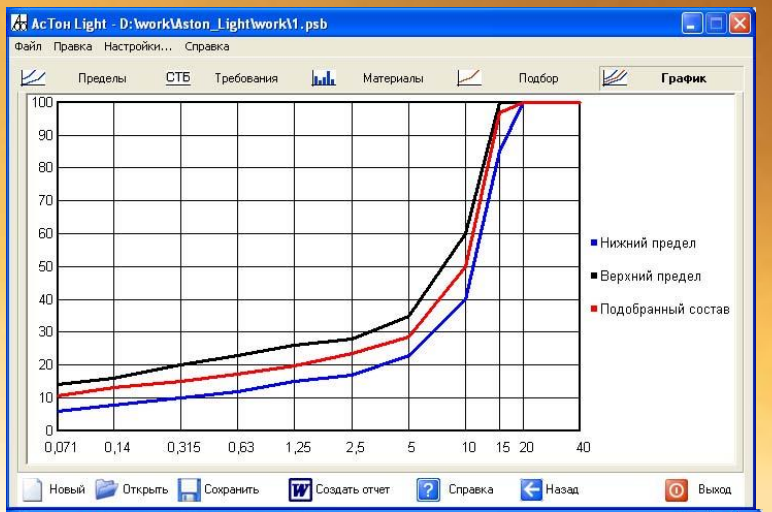
1. *Research and experimental development of special asphalt mixes based on carbon material. Selection and optimization of the asphalt concrete composition with the desired properties, taking into account the climatic characteristics of the region of application. Development of production technology and surfacing.*
2. *Development of technology for CNM production and introduction to asphalt concrete with full replacement of mineral filler (particles smaller than 0.071 mm).*
3. *Development of a complex additive containing carbon materials for subsequent introduction to asphalt concrete in order to increase durability (granules and/or modification with mineral filler).*
4. *Development of a process line for producing the complex additive based on CNM.*

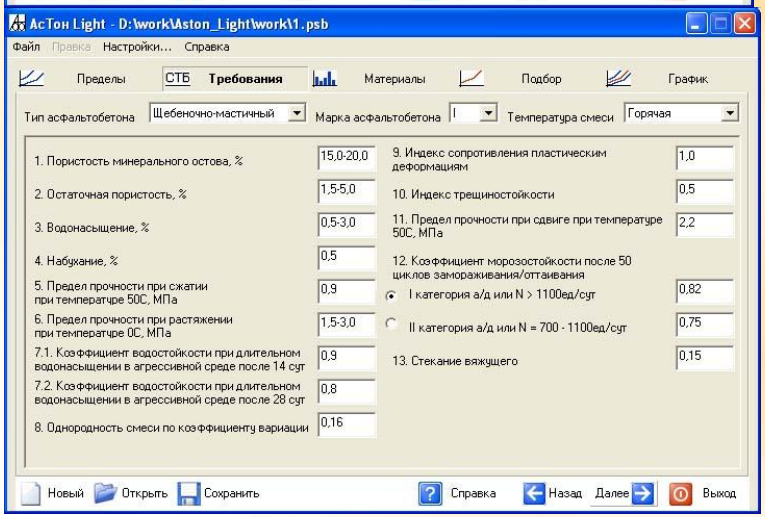
1. *Research and experimental development of special asphalt mixes based on carbon material.*

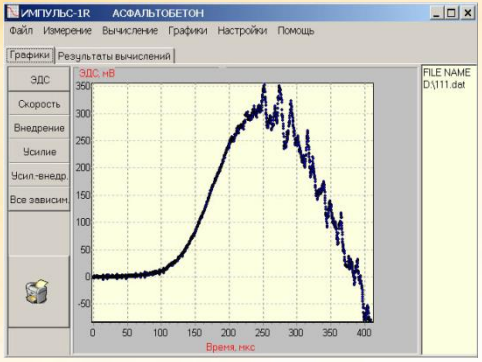
Purpose: Development of special asphalt mixes containing carbon materials, taking into account climatic and transport and operational characteristics of an area of construction.







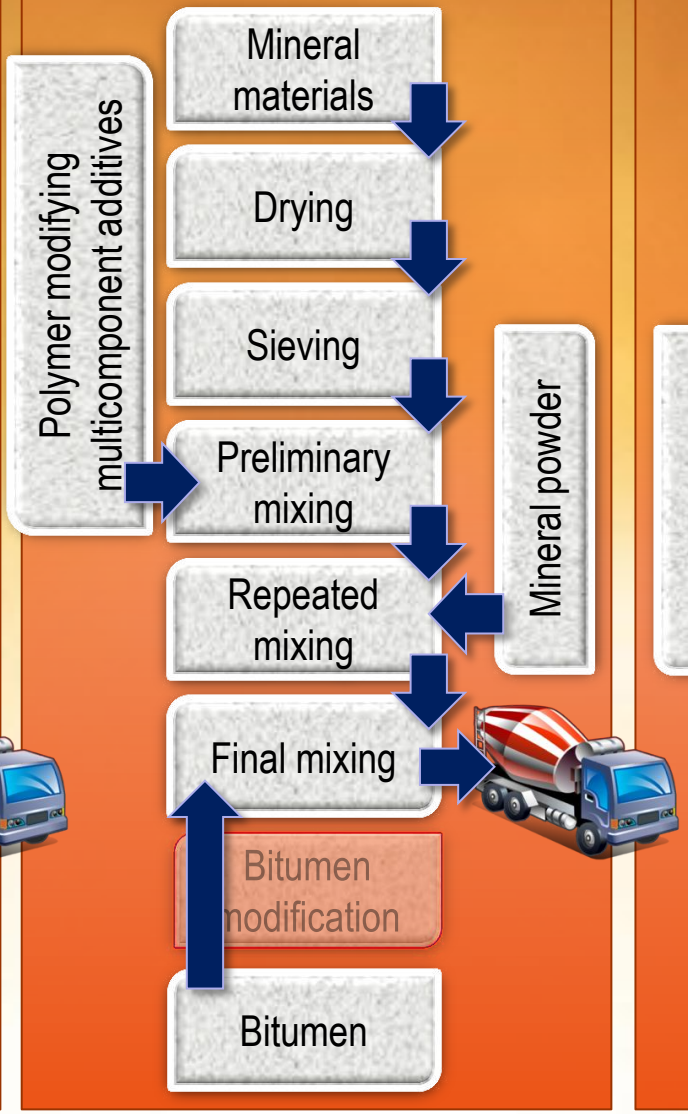




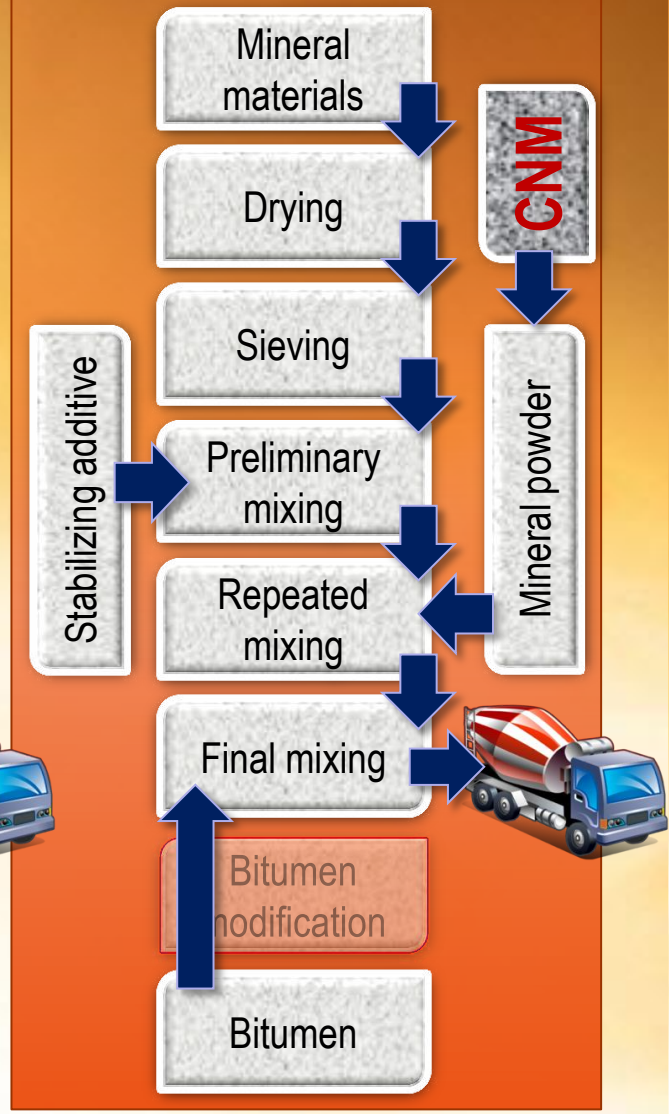
Development of technology for CNM introduction to asphalt concrete with full replacement of mineral filler (particles smaller than 0.071 mm).

1. Chart for preparation of mixture with modified bitumen

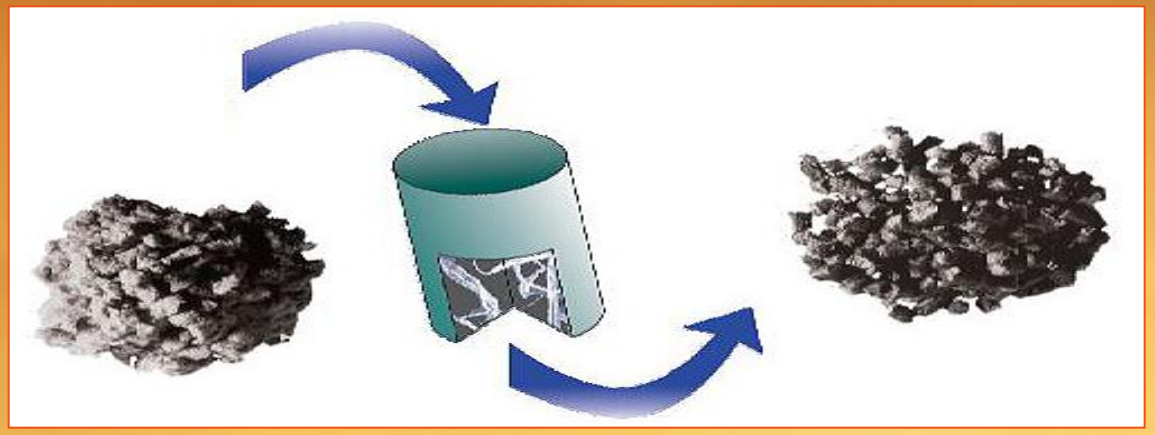
2. Chart with polymer additive



3. Chart with CNM application



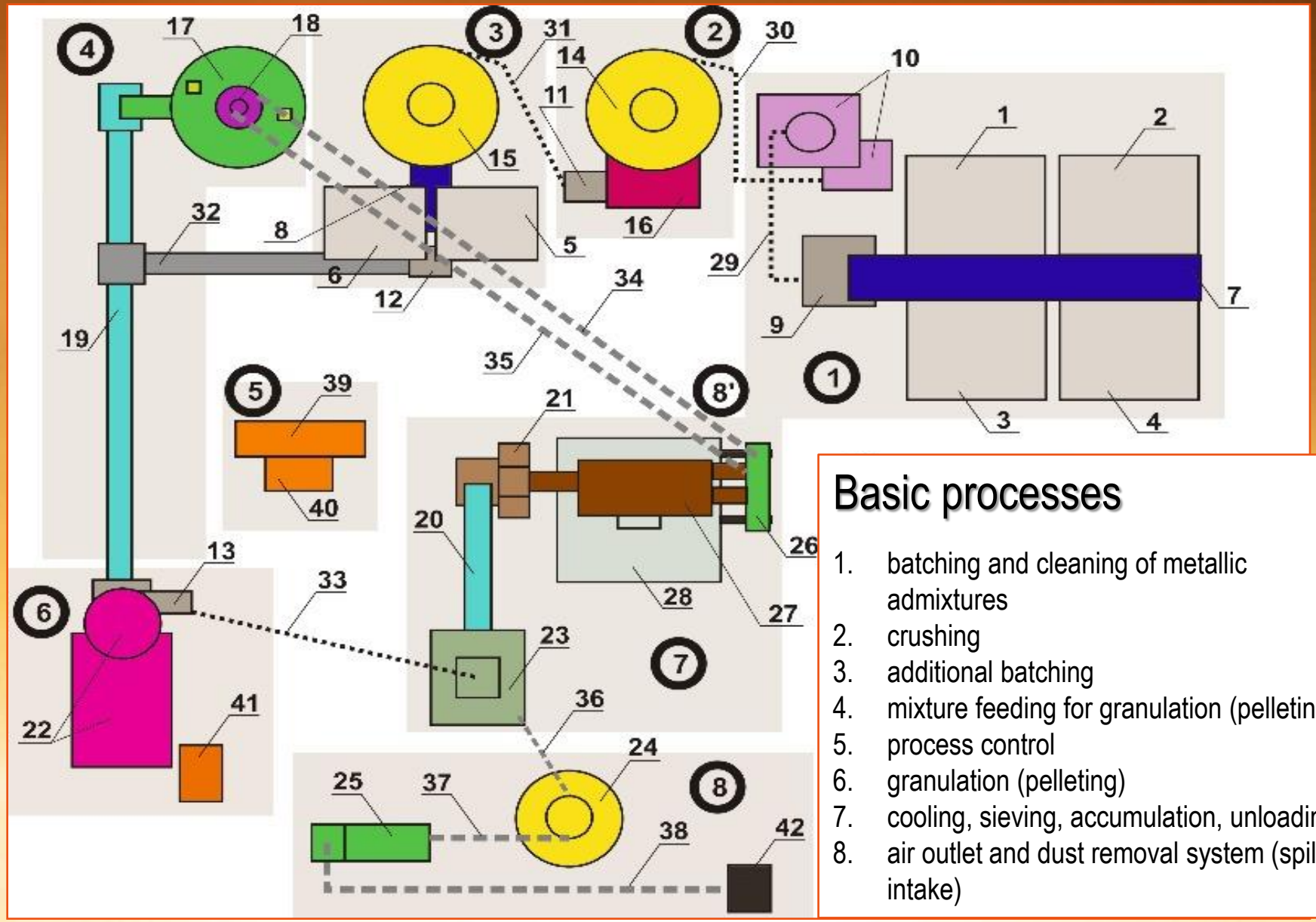
3. Development of a complex additive containing carbon materials for subsequent introduction to asphalt concrete in order to increase durability.



Preliminary composition of asphalt concrete modifiers:
- fibrous materials – 0-40 %;
- thermoplastic polymers (melting point is 120-160°C) – 30-90 %;
- thermoplastic polymers (melting point is 80-120°C) – 5-20 %;
- special cementing component for regulation and temperature stabilization of bitumen characteristics – 3-15%.
- crushed sand with carbon material – 10-25%

4. Development of a production technology of a complex additive based on CNM.

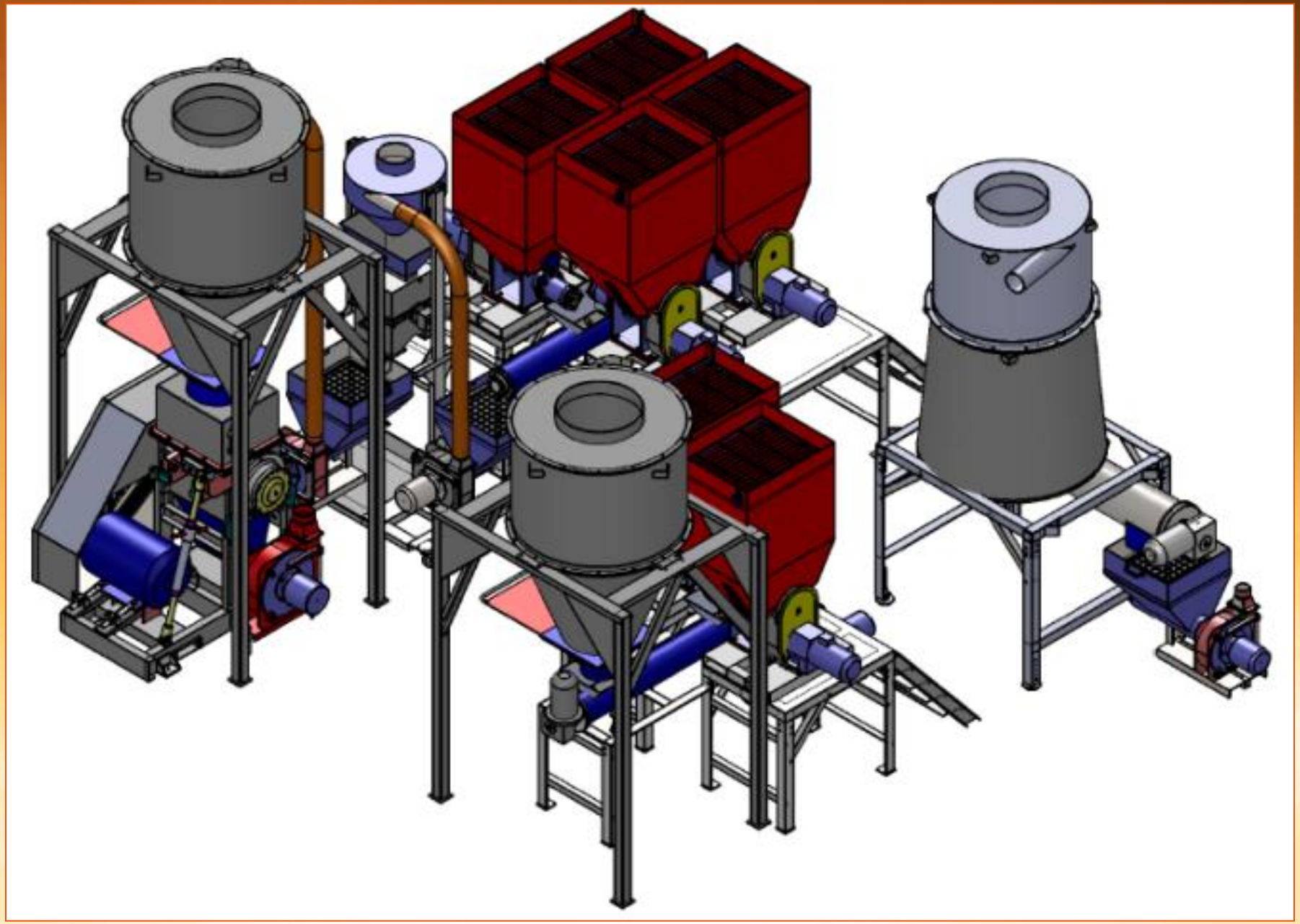
Purpose: development and establishment of high-quality production of modifiers of multifunctional asphalt concrete with a capacity of 1000-2000 kg/hour based on solving a number of research and development problems; release of new competitive products for the road industry, import substitution and export increase.



Basic processes

1. batching and cleaning of metallic admixtures
2. crushing
3. additional batching
4. mixture feeding for granulation (pelleting)
5. process control
6. granulation (pelleting)
7. cooling, sieving, accumulation, unloading
8. air outlet and dust removal system (spill intake)

The arrangement of technological line elements for producing CNM modified granules



Schematic diagram of the equipment of the grinding and dosing system

The development of scientific and practical bases of the production of complex additives for asphalt mixes is of great interest. The manufacturing process of such additives is complicated by the following features, which will be taken into account in the project implementation:

- need to combine components of different chemical nature (polymers, waxes, celluloses, CNM, etc.);

- need to combine components with different melting point (for example, wax softening point is 40-60°C, and polymer softening point is 80-160°C);

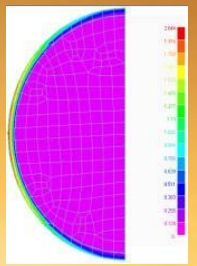
- need to combine components with different bulk density (for example, bulk density of cellulose fiber is 40-60 kg/m3, and bulk density of crushed polymers is 150-500 kg/m3).

Advantages of using asphalt concrete with carbon material

Increasing strength and shear-resistance

Increasing temperature crack resistance

Simplicity of use

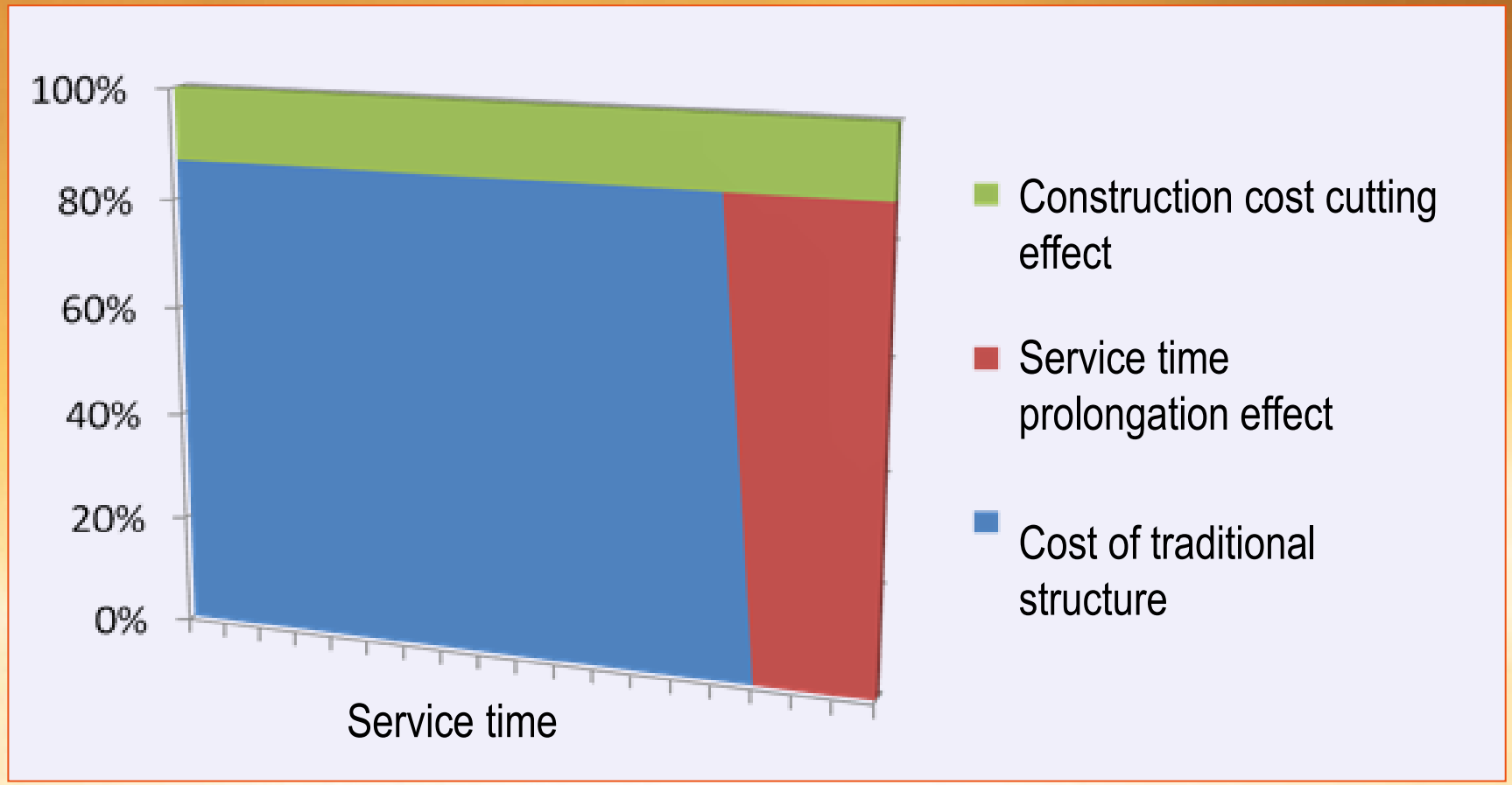


Property retention through time (ageing resistance)

Increasing water resistance

High cost/quality indicators

Technical and economic efficiency of using asphalt concrete with carbon material




Thank you for your attention!