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SELECTED CAUSES OF DEFECTS AND PROPOSALS OF REPAIRS OF ASPHALT ROAD AND ROAD BRIDGE PAVEMENTS

Summary

In the paper causes of defects and ways of repairing of asphalt paving on roads and bridges are presented.

At the same time basic requirements for road surfaces on bridges, roads and provincial roads are analysed. Access to new technology, materials and equipments makes that conditions for implementing road construction in Poland the same as capabilities in Western Europe.

INTRODUCTION

During operation of surface of the road and bridges, the load varies over a wide range of time, from the static long-term to short-term dynamic loads transmitted by the wheels of passing vehicles . Loads from heavy goods vehicles, both those with and without trailers and buses have the greatest impact on road surface. Loads of cars, light vehicles, and motorcycles have a negligible impact on the capacity of road construction and thus drawing the traffic they are ignored. Roads and motorways are usually traffic category KR 5 or KR 6. This means that during the operation in the proposed structure, ratio of 20 years in Poland, passes over 4200000-8350000 and more computational axis of 115 kN. It should be noted that this applies to the expected average traffic of the road . This assumption does not account for oversized vehicles axle special or overloaded vehicles. Overloaded vehicles affect the surface, and the aggressiveness of damage increases exponentially.

1. GENERAL REQUIREMENTS FOR ROAD PAVING

The main task of the construction of the road is moving in a safe way vehicle load transmitted by the wheel on construction slab or soil platform. General requirements for the construction of roads in terms of load capacity are specified in the Regulation [1] on the technical conditions to be met by public roads and their location. In accordance with the requirements the pavement structure should be designed and constructed in a manner that ensures :

– resistance to all effects and impacts that may occur during the construction and the use of the road if there are not exceeded permissible axle loads of the vehicle to the ground
– durability at least equal to the span as specified in the project documentation
– resistance against damage that occurs to an extent disproportionate to the cause.

General requirements shall be considered satisfied if the construction of the road surface will not exceed the ultimate limit state and limit state usability. According to the above Regulations ultimate limit surface is considered to be exceeded if:

– Surface structure achieved a state of fatigue, in which the value of stiffness modulus of asphalt surface is less than 50 % of initial value
– Not less than 20 % of the surface is covered with fatigue cracks of width more than 2 mm .
– Vibrations transmitted to the road construction from traffic are long lasting. Therefore paving designs because of the fatigue life , based on the analysis of the state of stress and strain and results of experimental research on the properties of structural materials and of the ground or deck slab .

According to [2,5], there are the following criteria of damage of pavement structure :

– criterion of cracking of asphalt layers
– criterion of conditions of structural deformation
– Fatigue criterion of layers associated with hydraulic binders.

During operation of road surface it is subjected to a number of repetitive loads, as a result it may be fractured . Fatigue cracking of the asphalt layers can occur even though the tensile stress or strain reliever do not exceed the tensile strength or the value of the breaking strain .

The criterion of permanent deformation applies to structural rutting resulting from the accumulation of irreversible deformation of the ground . It is assumed that there is a relationship between the amount of vertical deformation on the surface of the ground and the permanent deformation measured at the surface.

Criterion of fatigue of layers associated with hydraulic binder is determined by the stresses which occur in the layer of the foundation under load axis and the strength of the computing foundation material tensile strength .

The main feature of the method is to determine the mechanistic fatigue life according to all these criteria.

Fatigue is the number of maximum load on construction. Road surface should be so designed that the ultimate limit state and suitability for use have not been exceeded in the designed lifetime . Flexible pavement failure occurs when the fatigue life is exhausted bottom of the asphalt layer structure or surface permanent deformation exceeds a critical value equal to 12.5 mm (according to the method of the Institute of asphalt) .

In Poland, the vast majority of roads are prone surfaces . Semi-rigid pavements are sometimes repaired roads and pavements rigid accounting for a small amount of a few kilometers of highways. Bridge surfaces are rigid elements (bituminous surface laid on asphalt located on the reinforced concrete bridge plate). In order to move the structure vulnerable to a rigid structure temporary disc is used .

Transition plate is a reinforced concrete slab based on the embankment road . The upper surface of the plate is angled , allowing you to switch from a normal cross section of the road to a normal bridge . The length of the plate reduces the thickness of the base of MSCS (mechanically stabilized crushed stone) and the lower layers of bitumen . There remains only the wear layer.

2. SURFACE LAYER OF ROAD BRIDGES

2.1. Pavements of road bridges – construction, defects and repairs

Bridge surfaces play a special role in the life of the bridge structure . They work on it from both the load of traffic and weather conditions , such as sunlight, freezing temperatures , rain , snow, de-icing salt . It is subjected to the forces of both horizontal and vertical .

The main tasks of road surfaces include:

– the acquisition and distribution of the burden onto a bridging
– transfers of deformation of the bridging plates that are caused by changes in temperature
– suppression of dynamic effects coming from the burden caused by the movement of vehicles

– the adhesion of vehicle wheels to the ground.

2.2. Causes of consumption and damage of concrete pavement of road bridge

The main causes of the destruction of roads may include the following :

– High susceptibility of the substrate
– Local variable stiffness of the substrate
– Vibration of design
– Local presence of a shock load capacity
– Lack of free water infiltration .

These factors have different effects depending on :

– the nature and quality of the material from which surfaces are made (asphalt , concrete , paving - small-sized elements , wood)
– the amount of traffic
– the type of dehydration
– the quality of the works
– thickness of pavement layers .

They are also the cause of the destruction of large changes in ambient and structure temperature, acting as both the bottom and top of the structure. This changes stress that overlap with the stress arising from the vibration plate . This in turn leads to the formation of microcracks and cracks in the pavement . Microcracks are also formed as a result of the difference in thermal expansion coefficients of asphalt and concrete.

Temperature changes and the differences between the coefficients of thermal expansion acting on the object cause :

– detachment of the surface of the insulation or isolation from the bridge plate (cause of action is delamination and shear forces)
– cracking of surface area (due to the rapid contraction of the wearing course)
– thermal fatigue (due to undergo surface alternating contraction and expansion) .

2.3. Example of defects in insulation under the binding layer of road surface on the road bridge

Construction of road bridge

The subject of the following example is the physical defect of insulation under the asphalt bonding layer road bridge Class A STANAG 150 according to attachment no.3 of [1] with an overall width of 12.0 m, width between curbs is 9.0 m. In order to properly drain water the transverse drop is made of 2.0%. Road surface has been constructed on the concrete class B60 concrete reinforcing steel reinforced A- IIIN BSt500S . The connection points of the girders evolved at increasing cross plate bevels. Height of the slab is 250 mm. Road surface is the bonding layer - mastic asphalt thickness of 6 cm, while the wearing course - mastic asphalt thickness of 5 cm. The contacts between surface and curbs is made of bituminous sealing tape.

Defects and the method of remedy

When laying mastic binder asphalt layer on the subject, blisters were localized under a layer of insulation. the insulation were loosening of from the ground when cubic asphalt samples were cut, and the accumulated gases under the insulation caused the ejection of insulation and mastic asphalt.

Repairs were carried out in several stages. In the first the surface was incised using diamond saw blades along a line defining the area to be repaired to the depth of the asphalt to about 6 cm in such a way as not to damage the insulation. Then the asphalt binder layer was removed with a smooth bucket backhoe - loader . In the third stage the asphalt debris was removed outside the work area . Then, the insulation was removed to leave a 20 cm strip of

insulation at the edges of the cut asphalt performed to enable the connection of the new insulation layer of insulation underneath the asphalt. In the fifth stage the surface of the concrete slab was prepared by grinding and checking the peel strength of concrete with pull-off method . In the next stage the full insulation system was restored and then a layer of asphalt mastic was put. To ensure the integrity of mastic asphalt layer with insulation the edges were dried with hot air and loaded with heavy equipment to empty rainwater that could be gathered in the lowest drop of the slab. At the junction the sealing filler of bitumen was made. In the final phase of the repair the layer of asphalt was laid and leveled while maintaining elevation consistent with previously arranged the mastic asphalt binder layer .

3. NATIONAL AND PROVINCIAL SURFACES OF THE ROADS

Road surfaces are damaged due to a number of factors from both the burden of vehicle traffic and weather conditions. Given that the highest loads cause heavy vehicles passing , the lorries and buses , whose share of the overall traffic in recent years, significant and is increasing every year, it can be assumed that the surface degradation and destruction caused by these vehicles will significantly progressed accumulating and increase the cost to maintain roads in good condition . It should also be noted that in spite of a much larger part in the movement of cars and trucks of their impact on the permanent damage is insignificant and irrelevant to the behavior of the structure of the road. Adopted under the classification of surface damage due to the diversity of their causes and scope which scope covers the structure of the road.

3.1. Types of damage and way of repair of concrete pavement on objects of road

Damages to road surfaces occur in different sections, depending on the mistakes of design and workmanship.

Types of surface damages are shown on figure 1.

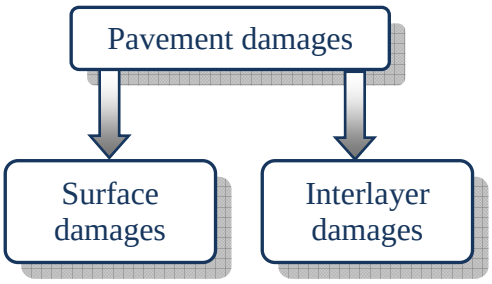

Fig. 1. Types of pavement damages

Surfaces with small-sized cobble stone

Most were made of granite, now they are not performed . They belong to a very durable surface resistant to traffic and weather conditions . In case of heavy traffic reaches the abrasion of the top layer and die becomes slippery , and therefore even if no serious damage is seen after about 15-20 years, it must be rebuilt .

In some cases, also the framework is poorly made and subsidence may occur in areas of vehicle wheels. Then there is a build up of water that penetrates between the cubes to the foundation , increasing its weight , and in winter, it will blow up .

Repairs to these surfaces depend mainly on the rotating cube in a different direction for the party was no longer slippery surface . For major damage it is exchanged for the

bituminous pavement . It is not recommended to cover the ankle , since it does not provide sufficient adhesion between the layers and greatly increases the weight.

Bituminous pavements

Bituminous surface is by far the most commonly used surface in Poland (mainly mastic asphalt and asphalt) . Durability of this type of surface depends primarily on the stiffness of the bridging board and the connections to the substrate surface through the insulation. Freezing water in the surface pores destroys its structure. This in turn causes the loosening of the surface of the insulation layer , cracking and chipping elements . It is therefore recommended to rapidly remove water from the object, and the filter layers occurring on the contact surface and the insulation are used for this purpose. However, after several years of operation of a filter channels are clogged , causing water retention in contact with the surface of insulation . It is therefore often used for the sealed bitumen surface , which allows the extraction of water from the surface.

Most damage to the asphaltic concrete surface start on the contact surface of the curb , so they should be further strengthened and adequate constructed by:

– reinforcing the isolation of a width of about 30cm
– filling the gap between the pavement and the curb with special mass that provides good formability
– the use of so-called " against drop " in an adjacent lane to the curb of roadway
– removing the rut , roughened , holes
– the performance of the new abrasion surface on the entire surface of the road
– replacing the whole surface .

• Resurfacing : If you replace the entire surface you must also , if necessary, adjust the lateral and longitudinal declines , fix insulation , seal leaks of water (with grooves , expansion devices , etc.).

• Folds : are removed by milling or cuffed with pneumatic hammer . Before starting this work part of which is intended to be cut , you cut on the edge of a saw (in the shape of a rectangle) . Pay attention not to damage the insulation .

• ruts : if they have a depth of not more than 9mm, they are removed in the following manner 1) the surface fixation with grit 6.3 -10mm is performed in a depression of rut (the amount of binder should be about 20% less than the amount specified in the standard [3,4] then a further consolidation of the surface with grit 4-6,3 mm of asphalt emulsion (the amount of material used should be 20% less than the amount specified in the standard [3,4] , which is now withdrawn) .

If ruts are deeper than the 9mm they should be milled or cut .

Places that were cut , should be cleaned , edges rubbed with asphalt of a temperature of 130-150 ° C and filled with asphalt mastic or asphalt .

• Loss of depth to 1.5 cm: the lesion site is cleaned mechanically with a brush , and then place should be sprinkled with asphalt emulsion or asphalt D200. Consecutively during the first fixation grits 6.3 -10mm should be collapsed. Then the second once fixation of surface scattering 2 -4mm grit (using an asphalt emulsion), or 4-6,3 mm (using asphalt) should be executed. Finally surface must be cured rubber- roller .

• Defects deeper than 4cm : in this case, losses should be completed in two layers : first a coarse asphalt mastic and mastic asphalt medium- or fine-grained . The maximum aggregate size should not exceed 2/3 of the backsheet and the half size of the top layer (wear) .

• Minor surface defects, cracks: spread on the pavement bitumen emulsion and fine aggregate spills.

3.2. Surface strains

The most visible surface deformation path is formed in the wearing layer , which is directly related to the comfort and safety of driving. The deformation in the form of ruts and creases are made by heavy trucks with significant axle load (Fig.2.).

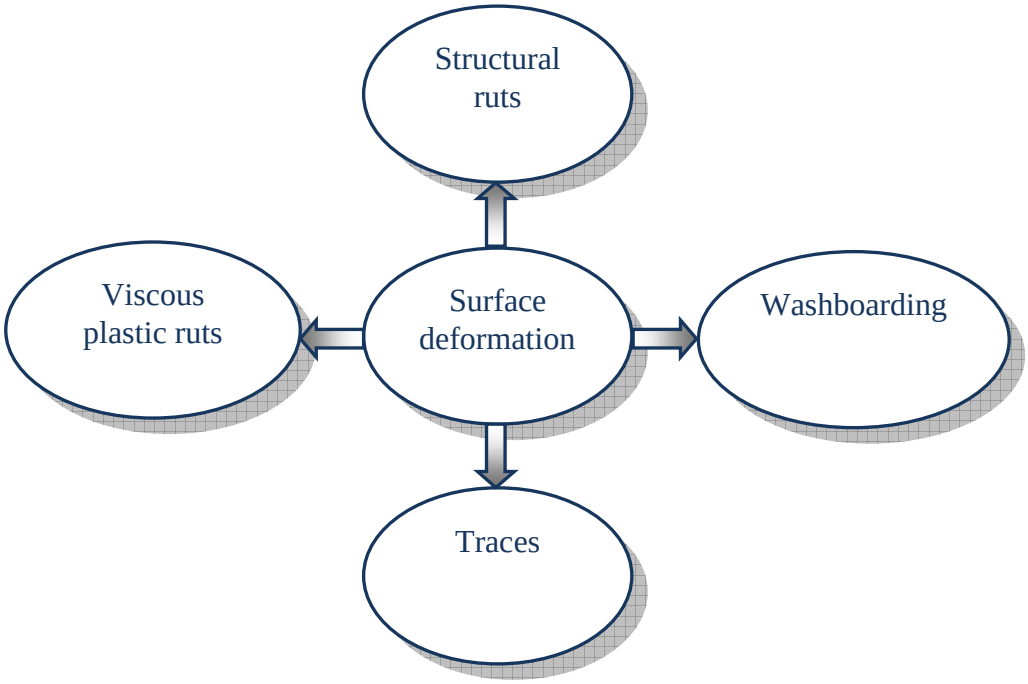

Fig.2. Surface deformation

Even a significant stress-induced single passage of a vehicle is fully reversible and does not cause permanent damage to the surface . The most important cause is multiple load occuring with great frequency. In addition to external causes of ruts the improper use of asphalt mixtures consisting of too much adhesive or containing easily tangled aggregate also are the reason of poor quality.

Viscous – plastic ruts covering only the wearing course are characterized by deep and narrow deflections. These are significant deformities resulting in significant impediments to traffic .

Visually smoother but causing greater damage is structural deformity extending across the roadway construction . Improper selection of the parameters of structural layers damage under stress from the pressures of wheels of vehicles can reach up to a layer of the ground . In extreme cases of uneven subsidence significant and long loads can lead to a road surface subsidence .

Other types of damage are usually folds formed along the edge of the road . The surface of longitudinal fins are the result of weak interlayer bonds , between the surface course and binder or binder and foundations, as well as the lack of stability of the asphalt mixture used to lay the wearing and binder layers .

Surface undulations occurring in the surface course are caused by dynamically changing speed of vehicles that occur mainly in areas where there is a traffic light . In places of braking , starting and accelerating of vehicles compressive stresses are causing the formation of lateral recesses and protrusions commonly called " grater " by the drivers. Such roughened surface of the road is a serious security threat as rapid braking can cause loss of traction and a much longer road needed to slow down the vehicle.

The least onerous permanent damage to the road surface are fingerprints and footprints . They belong to the permanent deformation occurring in the surface course and are result of parking (parking lots, bus bays) or slow motion (crossings, urban road sections) of heavy vehicles. They are quite shallow and not very extensive cavities do not cause significant nuisance in traffic , do not also affect the safety of road users.

Plastic strain is one of the serious damage to the surface , but does not require (except for structural ruts) expensive and time-consuming repairs [5].

3.3. The fatigue cracking

To prevent damage to the surface in the form of the before mentioned track there are designed and built road surfaces of aggregates and asphalt that fit more rigid structure. Despite the many advantages of stiffness , such a design is susceptible to other types of damage.

These include the damage caused by material fatigue with cracks manifested . As in the case of permanent deformation , fatigue cracking is caused mainly by the multiple repetition of the stress and deflection of the structure caused by the wheels of passing heavy vehicles. In this case, the occurring stress need not have the critical strength of the individual layers of the road because the multiple deflection results in reduction in fatigue life .

Fatigue cracking in the early stages are not too onerous for traffic and do not reduce the degree of safety , and only when the state of longitudinal cracks at the edges of the roadway or shoulder mesh causes subsidence and chipping of grains and even entire mesh can cause great inconvenience to traffic .

3.4. Thermal damage

All previously described types of structural damage to the deep layers of the road and the surface itself may be increased by the climatic factors , both associated with significant temperature differences frequent during the winter months as well as those caused by water penetration through layers of road construction . The road is specific engineering building , where the lowest layers are located in the zone of freezing , it causes large cyclical changes in humidity and temperature influence on the structure of the layers.

Exposed to repeated changes in load and subject to their own material shrinkage and thermal tension design is subject to constant degradation . Generally, most thermal damage are the surface cracks of the roadway. These take the form of cracks and shear block regular and irregular , randomly occurring on the surface . The reason for their formation is penetrating the water into existing fatigue cracks in the surface and extending in freezing temperatures .

This results in a loosening of asphalt mixture grain and spallation of grains occurs, and then the formation of cracks . Mainly affected are places where there has been the lack of continuity of the wearing course created by the renovation work , work on weld repair patches where the materials come into contact with different thermal expansion and neglect pre-existing fine cracks . A lot of serious damage arise when you create a horizontal crack in the inter- area , mostly between the surface course and binder . The large fluctuations in temperature generate a thermal shrinkage split a compound results in the phenomenon of the layers and the formation of voids in the surface . The roadway over the void subjected to pressure from the wheels of passing vehicles bends and sinks . The depth of such damage may occur within a few centimeters resulting in quite substantial difficulty in movement.

Particularly troublesome and involving a lot of problems are damage that may arise as a result of the lower layers of water on road construction and the ground beneath them. The most vulnerable to moisture are the foundation of the aggregate traffic and land containing fine particles , especially clayey fractions . When they pass plastic state in the excessive moisture, thereby facilitating the mutual sliding of the grains. This state of the ground and

foundation weakens their capacity , and hence an increased risk of serious damage to road construction .

3.5. Surface damage

The problem of surface damage relates mainly to inadequate quality of the implementation of the road surface and poor quality used in its construction materials. One of the most common reasons for these failures is the use by the contractor for the construction of the wearing course of asphalt mixture having a weak sticky properties to aggregate. Also, improper segregation of the aggregate and the mass density can lead to crushing in the wearing course and the formation of potholes . In the initial stage there is a chipping single aggregate and binder , and not taking corrective action will in the long term cause loss of deepening and increasing the amount of damage to the surface .

CONCLUSIONS

In the paper causes of defects and ways to repair of asphalt paving on roads and bridges are presented.

Although, this is still in the quality and durability of our roads fall slightly against those that are found in Western Europe. The main reasons for such state should be sought in entrusting the work to subcontractor companies that do not care about maintaining the technological regimes. Of course, this conclusion does not apply to all companies and all road locations. Another reason is the inadequate supervision by the inwestor.

The biggest disappointment and disillusionment with the investor appears in an early or immediate appearance of lesions on the road newly constructed, operated for very short time, and in some cases not donated yet to use. This begs the question then, is guilty of a contractor who improperly done its job, or materials used to build the roads meet the requirements and are of adequate quality. Usually, there are several different causes of premature pavement damage. From design errors where the designer underestimated the capacity of the road on the prevailing traffic through the improper selection of the thickness of the layers of construction or road running through the area that has not been thoroughly studied geologically, to execution defects of choice of poor quality materials.

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WYBRANE PRZYCZYNY USZKODZEŃ I PROPOZYCJE SPOSOBÓW NAPRAW ASFALTOWYCH NAWIERZCHNI DROGOWYCH I WIADUKTÓW DROGOWYCH

Abstrakt

W artykule przedstawiono przyczyny uszkodzeń i sposoby napraw wybranych usterek nawierzchni drogowych dróg krajowych i wojewódzkich oraz nawierzchni wiaduktów drogowych. Dostęp do nowoczesnych technologii, materiału i sprzętu sprawia, że warunki realizacji budów niczym nie odbiegają od tych spotykanych w krajach Europy Zachodniej.

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