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PAVEMENTS STRUCTURES INTEGRITY EVALUATION BASED ON RISK

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ABSTRACT
Initiative and the development process of damage pavement construction is time-dependent phenomena with negative consequences for road capacity, reducing his overall strength as a final result in reducing the level of road safety and its reliability. Deterministic assessment of the integrity of the procedure is a set of pavement and conservative, and leads to the adoption of a rather subjective decision, and engineering to the conclusion that no real answers about the real level of security design and implementation process of repair that is not optimal. The paper suggests a probabilistic approach which is based on previous analysis of the critical elements of the road and possible mechanisms of fracture, based on the adopted boundary condition determines the probability of reaching the boundary conditions and in accordance with the expected negative consequences of assessing risks to which the subject driveway. The procedure is applied to the evaluation of the integrity of pavement between the regional road-Bihac Bosanska Krupa. By using Monte-Carlo methods for the proposed border state roadway construction, calculated risk and made the best decision.
Key words: pavement, risk, integrity, damage, Monte Carlo methods

1. INTRODUCTION
From the very beginning of the century exploitation pavement is exposed to different working conditions, as well as extreme and harmful occurrences and hazards (surcharge, earthquake, landslide, etc.).. As a result, the general integrity of the pavement is in danger and from the boundary conditions can be achieved. The risk is especially likely occurrence of adverse conditions (boundary conditions) in a given time period multiplied consequences. Initiation and development of the load in the construction pavement are the time limited process determined by number of factors, such as pavement quality, workload, quality maintenance and aggressive environment. Scientific hypothesis is reflected in the application probabilistic risk-based approach, to the reconstruction of part of the travel direction of Bihac-Bosanska Krupa.

2. DAMAGE FUNCTION
The basic question concerning the integrity of the pavement is: what degree of damage can be allowed and tolerated without any protective measures for construction, or that the turnover limit of acceptable loads. The answer to this question is of great importance not only from the standpoint of the integrity assessment of pavement, but also for the decision on irregularities repair pavement in front of her prediction of the remaining century (Fig. 1). The process of initiation and development of damage and the accumulation of damage has a negative impact on its capacity, reducing its security and reliability.[2]

r= RS

where: r-reliability pavement, R-resistant construction; S-load.

The two parameters (R and S), determining reliability, the extremely unfavourable change over time, resistance is reduced, and the load increases until it reaches the border state of pavement (R = S). In general can be distinguished three border states during this process: 1) initiation of damage, 2) the border state of usability, 3) the final border status. The development of cracks and destruction of material are a consequence of prolonged adverse condition aggressive environment. Direction of crack growth is mainly, but not necessarily, can be direct to the direction of principal tension stress as is the case with concrete structures. Crack initiation and growth (up to a certain acceptable level) does not mean the transition to the critical state of the structure. [4]

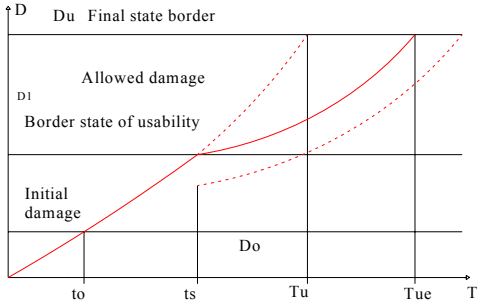

Figure 1. Development of pavement damage over time

All the above engineers faced with very complex problems of the correct assessment of the integrity of pavement structures. Namely, the evaluation of the integrity of the calculation of the remaining resistance of structures is done, taking into account all the detected damage to the construction. In order to detect and locate damage is necessary to perform control or long-term monitoring of pavement construction.

3. EVALUATION BASED ON THE INTEGRITY OF RISK

The risk is the probability of occurrence of an adverse event multiplied by the consequences, and is characterized on the basis of three aspects: Do , to ts Tu Tue T
1) the inevitability 2) likely 3) a result of various risks to which structures may be exposed to the inevitable.[1] [3]

Reducing risk in order to increase the security structures inevitably entails increased financial investment. It is reasonable expectation of investors to achieve a higher level of security design with a minimum investment. Pavement failure probability is time-dependent functions. Time-dependent probability (P) failure can be expressed as: Pf (t) = Pr (R ≤ S) = Pr (g (R, S) ≤ 0) = R (t) fs (t) dt where: g (R, S)-function boundary condition, fr (t) - probability density
function of resistance pavement, FS (t)-probability density function load pavement. For all of the mechanisms of fracture is determined is determined by the probability of occurrence and the appropriate consequences, or evaluated the degree of risk (FMECA - methods of critical analysis of failure mode and effects), later to be followed by a final decision. The process is shown in Figure 2

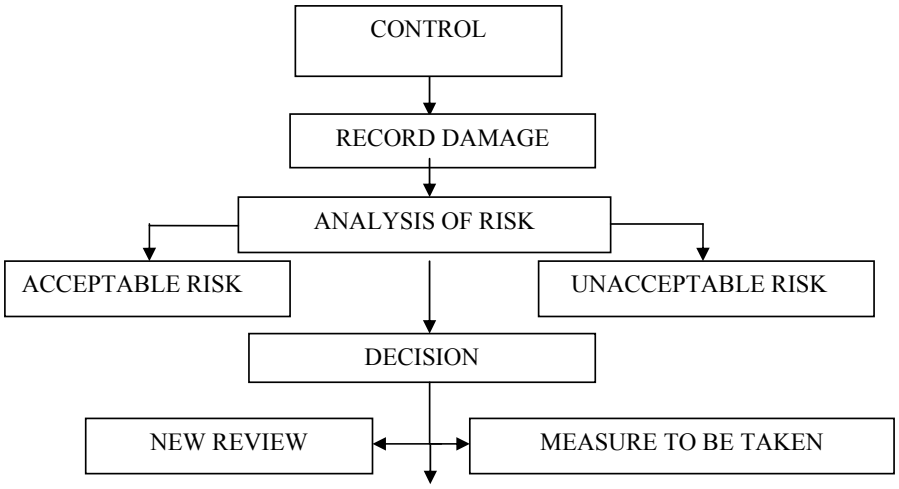

Figure 2. Block diagram pavement integrity assessment of risk

Based decision on the acceptance of risk is a complex step in the evaluation of the integrity of pavement construction basis of risk. Namely, the terms "risk and safety" is determined based on the total behaviour of a particular community and they do not have the same meaning. Practically, this problem can be overcome in two ways. One, which is basically a qualitative based on the so-called matrix of decision making.[5] The matrix form of rows in which the consequences of divided by the level of catastrophic and completely negligible and columns that contain the degree of probability that the border situation has been established, the very probable to one with a very small probability. The matrix is diagonally divided into three areas where the risk (1) acceptable, (2) reasonably low enough or (3) unacceptable.

4. METHODS MONTE CARLO

Monte Carlo method is a simple and effective tool for statistical analysis of uncertainty in engineering design and calculations of probability of the Border States. When control is performed when the analysis of integrity, is completed, the border state construction is defined. For example, we take a border state, defined when the construction pavement sized cracks appear at the appropriate time Mg. Suppose that the normal distribution probability density is valid for values of R and S, namely that M (R) and M (S) with known medium and standard deviations. Two series of these values is then parallel to each other Wednesday so principle generate random numbers from 0 to 1 Between the two series of numbers can be defined as the number of cases (Nf) where M (S) M (R) take as a condition of the border states. Probability of occurrence of this boundary condition is calculated as: Pf = Nf / N where: N - total number of randomly generated values.[1] [5]

4.1. Example

The example is taken regional road R 404,-Bihac Bosanska Krupa, the shares of 5 to 8 +340 +200 KM. The analyzed part of the road is situated in the north-western part of Bosnia and extends through the settlement. The current time is on the verge of usability. To increase the level of service and safe road traffic is necessary to choose a proper way of reconstruction. Analysis of asphalt pavement layers was carried out by extraction of samples asphalt in three different places where they found three different thicknesses that are within the range 6-9 cm.

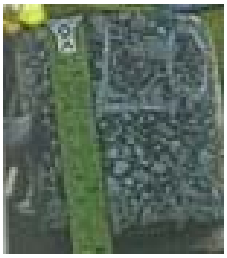

Figure 3. Sample 1

Figure 4. Sample 2

Figure 5. Sample 3

Visual inspection uncovered sample was found to be a bearing layer of bitumen BNS-22, since the maximum size of grain aggregates. Minimal thickness of 6 cm is removed the underlying stationary 7 +352 stocks (sample 3), while the maximum depth of 9 cm in stationary 5 +220 (sample 1). Based on the technical elements of the times and in the Rules for the design of public roads in which they take the following parameters: analysis of the load of traffic, categorizing roads, road class, computational speed, width (traffic lanes, edge bar, asphalt gutters, embankment, and sidewalks), and expansion traffic lanes in the curves for trucks with trailers. Taking into account all these parameters for the dimensioning of pavement proposed a variant of two solutions, namely:

1) Variant 1 includes the complete removal of the asphalt layer to planum tampon, the alignment buffer layer in accordance with appropriate cross-slopes and installation of two asphalt layers BNS 22, thickness AB 9 cm and 4 cm thick 11s.

2) Variant 2 includes the complete reconstruction of pavement with a thorough planum dig up the soil, installation of a new buffer layer of crushed stone with a thickness of 35cm, and the installation of two asphalt layers and in the first version.

5. CONCLUSION

Based on the comparison of traditional, deterministic approach but conservative assessment of the integrity of pavement structures, proposed a new probabilistic approach based on risk. The new concept takes into account the uncertainties and random character to determine the required size (properties and characteristics of integrity) by calculating the probability of reaching the Border States. Marginal condition is selected on the basis of previous control and analysis of pavement yielding mechanism. The whole procedure is shown through a small example, which was badly damaged pavement analyzed and calculated, where the risk through the proposed new variant of the decision

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