Operation Behavior of Road Pavements in the Hypothesis of Bound Road Layers

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Abstract: - Cooperation between layers represents one of the current issues regarding road pavements analysis on their operational behavior under traffic loads. The bound between road layers, by most of calculation methods, including the Romanian ones, is considered perfect. It is hard to say how true this statement is, but it is expected that it is unlikely for this bound to be “perfect” for the entire service life of the road pavement. The road pavements are calculated depending on different parameters (traffic, bearing capacity of foundation soil, the characteristics of materials in road pavement composition, climate, etc.) so that every layer will only be requested on its own level of bearing capacity. Specific stresses and strains are transmitted in different layers depending on the characteristics of component materials and the bound between them. Starting from the research concerning the binding hypotheses between interfaces, based on the ALIZE elastic pattern, which showed that, depending on the cooperation between road layers, the life of a road pavement can vary within very large limits, the paper intends to analyze the impact of the binding hypotheses between road layers upon the stress and strain condition within road complexes based on mathematical modeling.

Key-Words: - road layer, road pavement, bound, deformation, interface, hypothesis

1 Introduction

One of the present issues concerning the analysis of the road pavements behaviour in operation is represented by the cooperation of layers [1].

If the accumulated efforts are over the permitted limits in the road pavements the deformations of the layers become permanent. When the layers are bound a road pavement constitutes a monolith assembly, in which every layer is being deformed, but not independently, according to its characteristics and in relation with the other layers with which it is bound.

When the layers are not bound, each road layer works independently according to its own properties. In this case, the deformations and tensions are much more important than in the hypothesis of the bound layers, especially at the interfaces.

Studies carried out on certain road pavements have shown that, depending on the cooperation between road layers, the life span of a road pavement can vary within large limits. The research was carried out on a flexible road pavement whose composition is shown in figure 1 [2].

There is the additional risk of the layers sliding one on top of the other under traffic stress (fig. 2).

The unbinding of layers results in a less durable pavement or in additional maintenance works.

Fig. 1 Theoretical life span of the road pavement

The onset of degradations due to poor binding between layers will lead to a costly maintenance, since the application of a strengthening layer is required or the milling of the poorly bound layers and their replacement. Thus, based on these facts, the significant technical and economical importance of the bound interfaces can be demonstrated.

It is true that besides the hypotheses concerning the bound road layers, the operation behaviour of road complexes is strongly influenced by the quality of the foundation soil. So, the presence of the foundation grounds with a reduced bearing capacity
The studies of road pavements using the finite element modelling method were developed in two different hypotheses: assuming a perfect bond between the road layers and assuming that the layers are unbound (free interfaces), observing the influence of the connections between layers during the service of the road pavements.

The stratifications of the road pavements were established from surveys realized by Department of Land Communication Ways, Foundations and Cadastral Survey (shown in figure 4) and the characteristics of the foundation soil have been established on the basis of the tests made in laboratory by the same institution.

The studies carried out with the help of mathematical modelling through the finite element method were realized in the hypothesis of the
perfect bound between layers and based on the nonbinding hypothesis (free interfaces).

The deformations in the flexible road pavement assuming a perfect bound between road layers are shown in figure 5.

![Fig. 5 Perfectly bound road layers hypothesis - flexible road pavement](image)

Figure 6 presents the deformation stage in the same road pavement as in figure 5, but in the hypothesis of free interfaces.

![Fig. 6 Unbound road layers hypothesis - flexible road pavement](image)

In order to have a clear image of the influence of the binding between road layers upon the operation behaviour of flexible road complexes through mathematical modelling, the two hypotheses have been overlapped in figure 7.

![Fig. 7 The hypothesis of bound and unbound road layers - flexible road pavement](image)

The results obtained show that the deformations in a flexible road pavement are almost two times smaller in the case of unbound road layers than in the case of perfectly bound road layers. Also, we observe that the settlements at the base of the bituminous layer are higher by about 75% in the unbound road layer hypothesis and at the base of the foundation soil the settlements are almost double.

The differences between the deformations for a flexible road pavement for both considered hypotheses decrease significantly starting with the foundation soil and around 2.50 m in depth the settlements are sensibly equal.

Regarding the mixed road pavement in figure 8 are presented the deformations assuming a perfect bound between road layers.

![Fig. 8 Perfectly bound road layers hypothesis - mixed road pavement](image)

In figure 9 is shown the overlapping of the results in the two hypotheses considered regarding the bound between road layers for a mixed road pavement.

![Fig. 9 Unbound road layers hypothesis - mixed road pavement](image)

The first observation is that the deformations in the mixed road pavement differs significantly from those in the case of flexible road pavement, so the deformations are higher at the level of the foundation soil and they are felt at higher depths in the embankment.

The ratio of the settlements in the case of unbound road layers at the base of the bituminous layers are higher by about 40% and at the base of the foundation soil by about 50% compared to the hypothesis of perfect bound layers.

Important differences between the deformations (with values up to three times higher) in the two
considered hypotheses are found in the active area of the embankment, in the depth of foundation soil, with maximum difference around the depth of 1,50 m.

In order to compare the deformations occurred in the two considered hypotheses (perfect bound between layers, unbound layers) in figure 11 are presented the deformations for both road pavements (flexible, mixed) in the two hypotheses considered.

The paper deals with the “extreme” hypotheses concerning the bound road layers. Practically the actual situation is found somewhere between these two presented extremities.

Comparing the two hypotheses concerning the binding between road layers, the perfect bound and the non-existent bound, significant differences were found between the behaviors of the flexible and semi-rigid pavements.

The hypothesis of the perfect bound between road layers offers the road complexes a better behavior than the hypothesis of their non-cooperation. The results obtained with the two hypotheses, where the deformations are more important in the free interface hypothesis irrespective of the type of road pavement and the variations of the parameters, are supporting this statement. In the case of the semi-rigid road pavement the effects of the hypotheses concerning the cooperation between layers are felt to lower depths in the foundation soil and are more significant in the active area of the earthworks.

The hypotheses concerning the bound between the interfaces impact more on the operation behavior of the flexible road pavements than the semi-rigid ones.

Considering the conclusions stated above, to improve the operation behavior of road complexes, it is very important to take measured to reduce the number of interfaces and to improve the cooperation of the road layers.

4 Conclusion

Starting from the layer bound hypothesis it is extremely difficult to assess how perfect these bindings are or if they can miss altogether. It is difficult to specify how much these bindings deteriorate during the operation of the road pavement until they can even disappear.

References: