THE HIPOROUTES IMPLEMENTATION OPTIONS FROM ALTERNATIVE MATERIALS

Václav Mráz [1,2] ***Jiří Ježek*** [2]***, Karel Zlatuška*** [2]***, Vlastimil Nevrkla*** [3]
[1] Road and Motorway Directorate of the Czech Republic, Na Pankráci 56, 140 00 Prague 10, Czechia
[2] Department of Forestry Technologies and Construction, Faculty of Forestry and Wood Sciences, Czech University of Life Sciences Prague, Kamýcká 129, 165 21 Prague 6 – Suchdol, Czechia
[3] ENVIRON, s.r.o., Francouzská 231/12, 120 00 Prague 2, Czechia

https://doi.org/10.11118/978-80-7509-904-4-0302

Abstract
These days, equestrian tourism is more and more popular. It is also called hipotourism. During this, the tourist is mostly riding a horse. A suitable way is needed for horses and their riders, of course. The hiporoutes usually use forest and field roads with gravel or asphalt cover. These roads are the ideal surface during times of drought. There are problems during strong or long-lasting rains and snow melting. The muddy surface of the roads is hazardous for horses because they can slip. The asphalt cover is unsuitable, of course. Concerning the increasing interest in hiporoute construction, and due to the lack of traditional building material, the search for more economical, technologically better solutions and minimalizing the effects on the environment is required. One of the possible solutions for construction is using recycled materials and secondary raw materials from industrial production. There were chosen several sorts of materials and binders for authorization of possibilities in using of alternative materials for road stabilisation due to the training of carriage horses in the National stud farm Kladruby n. Labem. The longtime target is observing changes in surface properties due to traffic, climatic condition and suitable cover of routes for horse training.

Key words:horse tourism, test section, recycled material, binder, recreation

Introduction

Equestrian tourism, called hipotourism, where you mostly travel on horseback, is currently a very popular leisure activity. The current lifestyle trend of spending leisure time in nature, creating a bond between people and animals, and a generally healthy lifestyle also contribute to the increased interest in this type of tourism.

It is essential to be aware that there may be a risk of damage to the surface of paths when using them for riding. Unpaved or only partially paved trails are prone to surface damage, especially in wet weather. Even though the horse is considerably lighter than agricultural and forestry machinery, the high weight over a small area (due to the hoof) puts more pressure on the road surface than is the case with tyres (Svoboda 2009).

When constructing horse riding trails, so-called hipotrails, and related facilities (horse stations, stabling and other facilities), it is necessary to select surfaces for horses carefully. How well a horse can move on the surface of the path depends on the slope of the path surface, friction, horseshoes, the distance of travel, and the surface material itself.

When selecting a surface material, it is necessary to consider how comfortable and safe the surface is for the user and how the material can withstand the forces that affect the life of the surface. All surface materials have advantages and disadvantages. For example, many materials present a slip hazard, especially when wet, snowy or icy. Whatever the choice, it is essential to make sure that the materials are suitable for the regional climate. For equestrian use, materials should be slip-resistant and able to withstand the impact of horseshoes. Reinforced surfaces provide little grip for horseshoes and are not recommended.

Likewise, natural materials have their advantages and disadvantages. Unpaved surfaces are attractive to horses. On the other hand, these surfaces can be damaged by rain or snow and some surfaces covered with e.g. slate, pine needles, damp moss or wet vegetation pose a slipping hazard. Asphalt surfaces are generally not recommended for horse trails as they provide little traction for horseshoes. The solution is using asphalt mixed with finely ground used tires, which provides more traction and is being used with some success in Arizona (0723 - 2816 - MTDC - Chapter 6 - Choosing Horse - Friendly Surface Materials). This idea has been used in the design of the road stabilisation test section at Kladruby National Stud.

Materials and methods

In 2006, a test section of road stabilisation was implemented in the National Stud Farm Kladruby n.L. in the length of 1500 m.

Within the test section, four sub-sections with different components were implemented and mixed into the milled aggregate layer of the existing roadway to a depth of 0.2 m (Fig. 1).

Fig. 1: Detailed view of the modified road cover.

On the first section, a mixture of 3.5% cement and 3.5% coarser rubber granulate was chosen. On the second section, a mixture of 3.5% cement, 3.5% asphalt emulsion and 3.5% fine-grained rubber granulate was chosen. For the third section, a mixture of 3.5% cement and 3.5% asphalt emulsion was used. For the fourth section, 3.5% cement was used.

The aim of the long-term monitoring of the layer in the test section was to answer whether the stabilised layer's properties do not change due to use and climatic conditions. The selection of appropriate field tests had to consider the technological possibilities and the difficulties of working in the conservation area (UNESCO site, work in operation). For the basic field test on the stabilised layer, the impact load test referred to as the light dynamic plate (hereinafter abbreviated as LDD) was selected in accordance with CSN 73 6192. The LDD measurements were carried out in the third and fourth test sections under 17 years of traffic, at a stationing interval of 50 m alternately in the left and then in the right wheeltrack, for the reason that in these parts of the roadway, the traffic loading was most significant. At the Kladruby National Stud Farm, carriage horses are trained in multi-passage, with horses moving side by side on the road and the traction of the carriage wheels is also carried out in two tracks of approximately 0,50 m width (Fig. 2).

Fig. 2: View of the quad training on the test section after 17 years of operation.

The measurements were performed with a lightweight dynamic plate ZFG 3000 GPS with a diameter of measuring plate of 300 mm and a weight of 10.0 kg (Fig. 3).

Fig. 3: View of the impact load test measurements on the pavement surface.

Before the actual measurement, the preparation for the measurement consisted in placing the load plate on the desired location and moving and rotating it to a horizontal position, followed by connecting the load plate to the measuring device with a measuring cable and loading the tested area with three preliminary shocks, followed by the actual measurement and finding the position of the measured point using GPS coordinates.

Results

The objective of the lightweight dynamic plate measurements was to determine the impact modulus of deformation E_{vd} (hereafter E_{vd}) of the stabilised cover layer. A total of 18 load tests were performed.

Tab. 1: Summary of LDD results on the road surface.

Section number	Average E_{vd} [MN/m]^2	Conversion coefficient	Average E_{def2} [MPa]	Catalogue sheet: PN 610	Soil stabilisation material
3	62,45	1,7	106,16	Does comply	3.5% cement + 3.5% asphalt emulsion
4	44,67	1,7	75,93	Does not comply	3.5% cement

The highest average impact modulus of deformation E_{vd} was measured in Section III, which was stabilised with 3.5% cement with 3.5% asphalt emulsion (Table 1).

Discussion

Using LDD, the values of the impact modulus of deformation E_{vd} of the stabilised cover were determined in the investigated sections III and IV. The modulus of deformation of the subgrade E_{def2}, to which the E_{vd} values were converted, is a better index to assess the bearing capacity of the stabilised cover. The results found were compared with the Catalogue of Field Road Pavements, specifically with the catalogue sheet: PN 610, where the cover layer is SCM - gravel partially filled with cement mortar; this cover layer is not identical to the covers assessed in sections III and IV, but is the closest in its properties to them. The catalogue of field road pavements does not contain the types of covers examined. The minimum required value measured on the surfaces of the investigated sections is E_{def2} = 90 MPa. This value was determined based on the thickness of the stabilised cover and the predicted values given for the individual structural layers according to the PN 610 datasheet mentioned above.

Conclusion

The aim of the long-term monitoring of the test section in the National Stud Stud Kladruby was to answer whether the stabilised layer's properties do not change due to operation and climatic conditions.

This research was created in response to the growing interest in equestrianism and horse tourism. The test sections were designed with careful consideration of several aspects. The first was the technological limits (sufficient strength and adequate flexibility). Another aspect was the economics - reducing costs and the environmental aspect - reducing the burden on the environment. At the same time, the durability parameter of the structure was monitored.

Finally, it should be noted that the presented results refer to the type of binder deposited in specific (geological) road construction conditions. In any case, the results presented cannot be applied to other binder sources without verification tests. It is always necessary to observe the principle of good functional drainage of the whole structure and to comply with the technological parameters.

Research on sections I and II, where rubber granules are mixed in the pavement cover, should focus not only on determining the bearing capacity of the pavement cover but also the extent of degradation caused by the loss of rubber granulate over time, e.g. macroscopic and microstructural analysis can be used for this purpose.

References

Svoboda, M. (2009). *Forestry and hunting - a view on horse tourism*.
In. Proceedings of the conference on 8 April 2009 on the topic: Horse t tourism as a form of recreation, forestry, nature and landscape protection, facts and conflicts, Křtiny, Czech Forestry Society, pp. 24 - 28. ISBN 978-80-02-02122-3.

CSN 73 6192 . *Impact load tests for road surfaces and subsurfaces*. Czech Standardization Institute, Prague, 1996. 20 p.

CSN 73 6109. *Design of dirt roads*. Prague. Standardisation, Metrology and State Testing, 2013. 36 p.

TP Amendment No. 2. *Catalogue of field road pavements technical conditions*. Prague: Ministry of Agriculture of the Czech Republic - Central Land Office, 2011. 62 p.

TP 148 *Compacted asphalt overlays with rubber modified asphalt tire pellets*. MD - Department of Infrastructure, Prague, 2009.

0723-2816-MTDC: *Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds. Equestrian Design Guidebook. Chapter 6 - Choosing Horse - Friendly Surface Materials*. United States Forest Service. United States Department of Agriculture. Online: https://usdasearch.usda.gov/search?utf8=%E2%9C%93&affiliate=usda&query=Chapter+6%E2%80%94Choosing+Horse-Friendly+Surface+Materials&commit=Search

Acknowledgement

This paper was written thanks to the support and on the basis of the preparation of documents and information sorting for the research project NAZV No. QK22020146 "Technical recommendations for water management in the forest transport network", which is solved by the Czech University of Agriculture in Prague together with MENDELU in Brno in the years 2022 to 2024.

Souhrn

Předložený článek je souhrnem výzkumu v oblasti využití alternativních materiálů pro stabilizace jezdeckých stezek tzv. hipostezek. V článku je stručně popsána problematika výstavby hipostezek, kdy je nutné pečlivě vybírat povrchy pro koně. Hlavní část článku pojednává o realizaci zkušebního úseku v Národním hřebčíně Kladruby, kde byly testovány „nové“ materiály pro tyto účely. Závěr článku poukazuje na skutečnost, že se jedná o důležité poznatky, které byly získány během dlouhodobého testování a které mohou obohatit odborné poznání v oblasti využití recyklátů, příp. druhotných surovin z průmyslové výroby v oblasti výstavby hipostezek, což potvrzují dosavadní předložené výsledky.

Contact:

Mgr. Václav Mráz, Ph.D.
E-mail: mrazv@fld.czu.cz

Open Access. This article is licensed under the terms of the Creative Commons Attribution 4.0 International License, CC-BY 4.0 (https://creativecommons.org/licenses/by/4.0/)