Mendelova univerzita v Brně

Lesnická a dřevařská fakulta

Mendel University

Brno, Czech Republic

Colloquium on Landscape Management 2011.

Miroslav Kravka (Editor)

Brno, 4th February 2011

The texts in the proceedings were not corrected by the editor.

Editor: Dr. Ing. et Ing. Miroslav Kravka

Mendel University in Brno

ISBN 978-80-7375-518-8

Content

Development of office furniture in regard to CNC technology

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Abstract

The main goal of the project is to design a complex model solution of a new constructional, functional and ergonomic furniture system for offices respecting the current office work requirements and the knowledge gained in related fields. For that, new technologies like Computer numerical control machines (CNC), materials and interdisciplinary approach will be used with the purpose to innovate office furniture systems. Beginning from the analysis of the market in the office furniture sector, thinking new possible joints for new furniture systems, and taking in mind the technologies that are going to be used in the manufacture process. Moreover, the communication of the product is totally in connection with the technologies in use because it restricts the shapes and the lines. The design process continues with sketches considering all analyzed before and creating some simple models to finish with some conclusions about all done before.

Keywords

Office furniture, development, CNC technology, ergonomics, metal, joints.

1. Introduction

Office furniture is the set of furniture from an office or workplace. As regards office furniture, are objects that serve to facilitate the customs daily activities in offices and other premises. Usually the term refers to some objects that provide common business activities, individual work, small gatherings in the workplace, meetings in public areas, meeting rooms, specific areas or welcome reception, rest areas.

In all the design process the different materials (wood, plastics and metals) have to be well known, as their characteristics and features (Noll, 2002). Ergonomics is very important part of the office furniture design because the person who works at the office spends a lot of time there. The most frequent inadequate positions in the office work: Turning head, lack of support in the back, elevation of shoulders, lack of support for the wrists and forearms extension and diversion of the wrist. It is very interesting kept in mind the static and dynamic anthropometry.

This article is written by the reason of the last year of industrial design technical engineering's studies. The first three years of the studies have been in Arrasate/Mondragon in Mondragon University and this last year is being in Mendel University in Brno. This project complemented the knowledge and skills gained before in different fields of the industrial design.

2. Analysis

a. Joints in the market:

It is very important to analyze the joints between the legs and the plank because the stability of the table depends on joints. Down, are some ways to join the legs and the plank as rails, mechanical parts, glue etc. There are a lot of kinds to join tables as Dauphin has a desk which uses a part which allows the legs moving till 0 to 90 degrees, König and Neurath for example has a folding table, Fig. 1 which the plank moves over the rails, Sedus has an innovative metal part which is used between the legs and the plank to get more stability, Fig. 2, with this kind of leg it's possible to choose the degree you want to use, Vitra company for example has an ergonomic desk is apt to change the height of the plank with the four posts, Vitra company has one model in which the legs are totally become in one and then it is just to put the plank on top, Wilkhahn company has a small part which allows to join 3 or 4 different planks and Fig. 3 this simple leg with 4 projections allows choosing between using the leg with one plank or two planks.

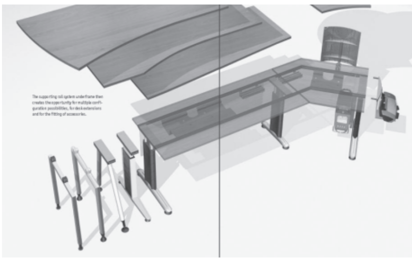

Fig. 1: SEDUS (AMBITION)

Fig. 2: VITRA (MEDAMORPH3):

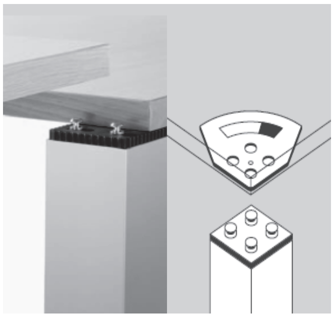

Fig. 3: WILKHAHN (PALETTE)

b. New possible joints:

To obtain different degrees with commercial profiles it's necessary to look how it's possible to join profiles. Just a few kinds of possibilities joining profiles without using the welding as the first joining technology. A lot of them uses screws to do the union between different profiles. See down the Fig. 4.

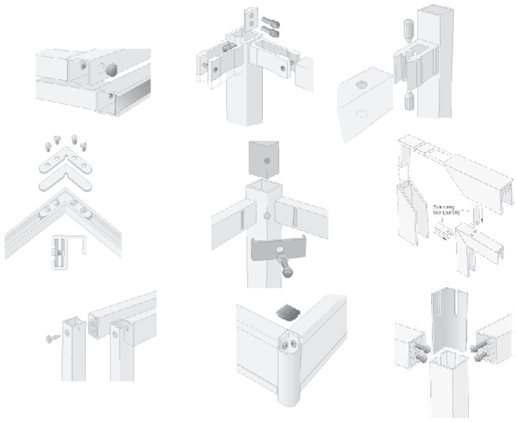

Fig. 4: Joining profiles

c. Set ups:

Different kind of set ups for the same furniture is very positive for big open spaces because it makes the most of space. In small offices is senseless. Same set ups are for large rooms (with snake shapes) and other are for more or less square rooms. From the simplest set up to the most complicated one. You can see in the Fig. 5.

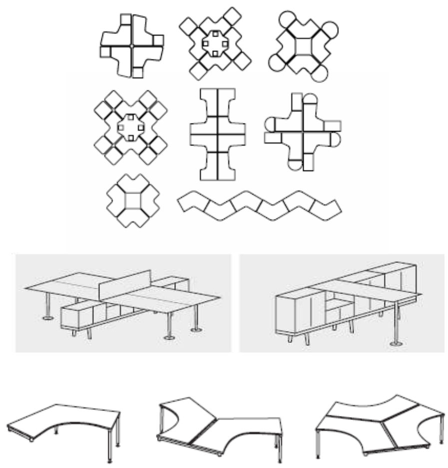

Fig. 5: Different setups

d. Technologies:

To do different concepts about the project it totally necessary to recognize all the technologies are going to use in the plan. For it, the features and characteristics of the technologies must be analyzed. In this project the 3 most important technologies are CNC laser tube cutting (Machine: ADIGE LT - 120 with

ROFIN SINAR resonator 2000W), CNC laser sheet cutting (Machine: ADIGE ADILAS with ROFIN SINAR resonator 2500W) and CNC precise bending (Machine: AFAN E- BRAKE).

CNC laser tube cutting most important features:

- Determined for cutting out optional geometry into the hollow profiles.
- It enables describing material – marking.
- It brings an opportunity of excellent structural solutions, especially of joints.
- Profiles: circular (d min. 12 mm / max. 120 mm), square (min. 12 mm / max. 100 mm) or rectangular and D profile – all that fits into the circle of d 140 mm.
- Cutting power: steel (max. 7 mm), stainless steel (max. 3 mm), aluminium (max. 3 mm)

CNC laser sheet cutting most important features:

- Cutting shape fired brands from the sheet
- It enables describing material – marking
- Cutting power: mild steel (max. 15 mm), stainless steel (t max. 8 mm) and aluminium (max. 6 mm)

CNC precise bending most important features:

- Accurate bending of the sheet products
- Max. sheet dimensions - 1500 x 3000 mm.
- Angle accuracy + / - 0,1 mm.
- L 3060 mm / 1000 kN / Y max. 290 mm

e. Design: Communication _ inspiration

The main inspiration in this project has been the origami. Origami is the traditional Japanese folk art of paper folding. The goal of this art is to transform a flat sheet of material into a finished sculpture through folding and sculpting techniques. The reason of the chosen are the technologies are able to use in the development of the project. Furthermore, first concepts have been inspired in bionic design, mainly the shapes and lines.

Some designers has inspired in Origami when designing different products. These are some designer names: Anthony Dickens, Tony Wilson, Jaime Salm (Fig.6), Martin Pinotak (Fig. 7), Sven Sellik and Young Jin Chung.

Fig. 6

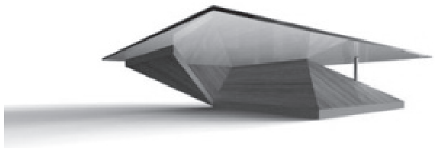

Fig. 7

f. Inspiration:

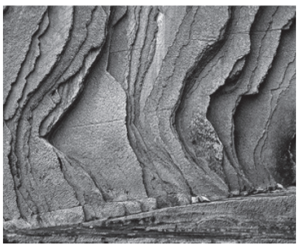

Fig. 8

Fig. 9

The sketches are inspired in nature for example in the Flyschs of Zumaia, Fig. 8 or in tree shapes, Fig. 9.

3. Conceptualization:

This phase is about the first ideas or results, in another way, to show my solutions. Sketches are inspired in nature and the used lines are origami lines. To complete this phase is necessary to sketch and do some models with paper/cardboard to see if the result is possible.

a. First sketches:

As it is shown down the Fig. 10 is inspired a drop shape. Moreover, Fig. 11 is inspired in different nature elements. Finally, Fig. 12 is inspired in tree branches, where a kind of joint is analyzed.

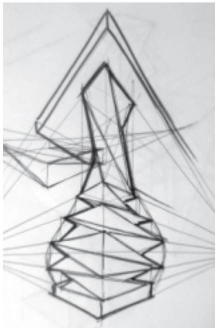

Fig. 10

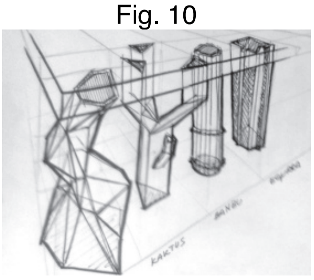

Fig. 11

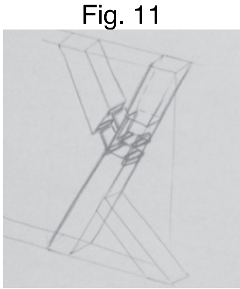

Fig. 12

b. Models:

Some paper/cardboard models were done to see if was possible to do.

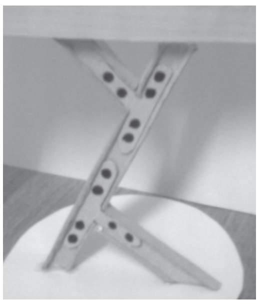

Fig. 13

4. Conclusions

If the ergonomics has to be kept in mind in the design process, it is necessary to do height adjustable office furniture to assure the majority of the population is comfortable in the desk. Tables must allow the other accessories to be adaptable.

To design a nice office is very important the organization of the tables, and for it, the set ups. But, to have a lot of setup options the legs and the joints into the legs are more important. That's why the most complicated when designing is to find a good join. The most interesting would be to find a kind of leg which permits to put together different planks with the same leg.

The use of the new technologies like CNC laser tube cutting, CNC laser sheet cutting or CNC precise bending are very linked with the communication of the product because the technologies limit the shapes and the lines. When sketching is the technologies have to be in mind without forgetting the communication wanted for the product (Susnjara, 2006).

Furthermore, the sketches are not the unique way to see if it is possible, we can do paper models to see the "real" prototype in scale and see the weak points (Kodzi et al., 2007).

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STABILISATION OF BANKS OF WATER STREAMS AND RESERVOIRS – EXAMPLES OF THE USE OF GEONETS

MILOSLAV ŠLEZINGR and
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Abstract

Apart from generally well-known suggested stabilisation measures, at present, such types of reinforcement that do not disturb the current state (or perhaps the original state before the formation of shore damage) are being promoted.

Because of the specific conditions of bank areas, we have decided to focus on the problem of possible interaction between root systems of chosen woody plants and armoured ground structures, that is slopes stabilised by the three-dimensional geosynthetic meshes (geomeshes).

Key words: Stabilisation of bank areas, reservoir, bank, geosynthetic mesh

Introduction

Appropriate and effective stabilisation of potentially endangered banks of reservoirs and water streams is a very important, but often disregarded part of any water structure. A well-timed stabilisation, that is realisation of correct bank reinforcement may prevent the creation of abrasive or erosion damage.

Apart from generally well-known suggested stabilisation measures, at present, such types of reinforcement that do not disturb the current state (or perhaps the original state before the formation of shore damage) are being promoted.

This article, also, focuses on one of the possible stabilisation procedures. It is the use of armoured ground structures, supported by root systems of appropriate woody plants.

The first step is the description of basic prerequisites needed for the imposition and initiation of our proposed reinforcement.

Biotechnical stabilisation – the impact of synergy between woody plants root systems and armoured ground structures in the stability of banks

Stabilisation of bank areas by biotechnical stabilisation elements is one of the most frequently used ways of stabilisation. However, it is still possible to suggest new stabilisation procedures using new materials.

At the Institute of Water Structures of the Brno University of Technology, in 2003, we started focusing on a proposal for bank reinforcement on the basis of three-dimensional geosynthetic meshes. These stabilisation means were formerly used to stabilise slopes, railway and road embankments but they have not been suggested nor used in the Czech Republic largely to stabilise valley reservoir and stream banks yet. Because of the specific conditions of bank areas, we have decided to focus on the problem of possible interaction between root systems of chosen woody plants and armoured ground structures, that is slopes stabilised by the three-dimensional geosynthetic meshes (geomeshes).

<u>For a regular proposal of such stabilisation, it is necessary to carry out:</u>

1. **appropriate modification of the slope**
2. **the choice of an appropriate geosynthetic mesh and its fitting in the slope**
3. **the choice of appropriate woody plants and their planting on the slope**

Ad 1 Appropriate slope modification:

To suggest appropriate slope modifications, we proceed on two basic assumptions:

a) The slope which forms a stream or reservoir bank is endangered, but has not been significantly damaged yet; reinforcement can be suggested without previous damage repair.

In this case, we smooth the slope and loosen the surface layer. Presuming that a new route has been suggested, the topsoil is removed, if not, we have to remove it, at least 30-cm layer. If there is some forest litter or similar type of soil surface, it must be removed. This naturally loosened soil layer is remarkably susceptible to eluviation and is more or less impossible to be stabilised in the area strained by flowing water.

The banks of reservoirs, ponds or backwater areas of weir structures on streams where banks are not endangered by flowing water, but rather by wave motion, must be modified in a similar way. Also in this case, the bank's sloping with a dip of 1:1,5 – 1:2 is appropriate, remove the original inappropriate vegetation including the top layer of original organic soil. Here, the following must be emphasised: while building the dam (but also while building a higher weir), the water level in the weir basin settles on a level where it would have never appeared before. It is often a level tens of metres above the original bed. A completely different type of phytocoenose developed and prospered here on a long-term basis. Most often, it is a forest line with a fully developed forest ecosystem (soil horizon, bio- and zoocenosis). Relatively stable forest ecosystem faces a confrontation with diametrically different conditions.

Woody plants, which had prospered in their habitat in the middle of the forest line, suddenly get on the margin after cutting the woody plants in the future flooding. Sunscald endangers them, there is now stand, very close to the water level, of inappropriate generic and spatial structure, windthrows threaten, bank damage and other.

Fig. 1 Bank abrasion – Brno - Reservoir, foto M.Šlezingr 2008

b) Slope forming the bank is damaged with abrasion, erosion, or other influences, and before the reinforcement proposal reparation of the bank damage is needed.

In this case, reparation of bank rupture or abrasive cliff must be performed before the proposal of an appropriate stabilisation. In the first stage, creation of a slope with a dip of cca 1 : 1,5 or smaller.

Simple sloping without the aspiration for return to the original state is possible (this is topical especially with a significant abrasive damage of reservoir banks). Or replenishment of eroded material may be carried out, mostly with stones, perhaps with rubble, or in some cases, the use of soil is possible (a danger of washing off).

Fig. 2 Bank regulation, Bilovec – Reservoir foto M.Šlezingr 2006

Results

In any case, the modified slope should be, and often must be subsequently stabilised. In case the cause of a bank rupture on the stream (a fallen tree, a large rock in the stream, a sediment significantly directing the streamline towards the concave bank and other) has not been – could not have been – removed, bank stabilisation by a hard biotechnical stabilisation element is needed, such as activated stone-packing, wire-stone baskets, mattresses, activated stone base with casting of the slope, and other. If the hard reinforcement need not be installed, we can again consider the use of geosynthetic meshes.

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SELECTION CRITERIA FOR DESIGNING OF DECIDUOUS SPECIES AS A PART OF BANKSIDE TREES AND SHRUBS

Miloslav ŠLEZINGR, Peter LICHTNEGER

Abstract

Bankside trees and shrubs are one of the building blocks of territorial systems of ecological stability (TSES). It is part of an ecologically balanced landscape, a form of spread green vegetation growing outside integrated forest complexes. It is created by tree species and herbs growing along streams. In relation to stream regulation, linear building along water streams etc., a lack of riparian and accompanying stands started to manifest negatively. We can say that only once it decreases, will we start to realise its indispensability in our landscape.

Key words: bankside trees, landscape management, wood specie, bush, tree

Introduction

The main objective of establishing riparian and accompanying stands is the creation of a vegetation community whose species composition best corresponds to the site conditions, with the representation of individual species approximating the stands that would occur in such conditions in natural development.

Information

The optimal species composition of stands can best be determined based on phytocoenological examination. Since riparian and, in particular, area stands have the character of forest stands, it is advisable to use forest typology knowledge in designing their species composition. The basic typological unit is the forest type. Its ecological extent for species growth, optimal species composition and corresponding manners of management are defined. Since some types are very similar, they were included in the so-called forest type groups. The most important forest type groups correspond to the structure of riparian and accompanying stands according to the systematic division proposed by Mezera - Mráz –Samek

The design of species structure is based on the conditions of a particular locality and especially on the composition of the indigenous species. In new plantings, non-autochthonous - non-indigenous introduced, exotic and fruit species should be eliminated.

Generally speaking, within riparian stands the most frequently used species are alder *(Alnus)*, willow *(Salix)*, ash *(Fraxinus)*, maple *(Acer)*, elm *(Ulmus)*, poplar *(Populus)* etc. With respect to shrubs, the most frequent ones are in particular shrub willow *(Salix)*, dogwood *(Cornus)*, spindle tree *(Euonymus)*, hawthorn *(Crataegus)*, buckthorn *(Frangula)* and others.

Accompanying stands can be made up of ash *(Fraxinus)*, maple *(Acer)*, elm *(Ulmus)*, lime *(Tilia)*, hornbeam *(Carpinus)*, English oak *(Quercus robur);* disseminated birch *(Betula),* mazzard *(Cerasus avium)*, crane *(Sorbus);* in the undergrowth, for instance, privet *(Ligustrum)*, hazelnut tree *(Corylus),* honeysuckle *(Lonicera)*, and others.

Table 1 – **CRITERIA FOR THE SELECTION OF DECIDUOUS TREES - 2002**

Legend :

Y - Yes suitable
N = NO, less suitable or unsuitable

A - wood specie can be assumed as autochtonnous
D - wood specie suitable as supplementary vegetation
B - wood specie suitable as bank vegetation
L - wood specie suitable for floodplain forests
N - wood specie resistant to deseases
E - wood specie resistant to emissions
O - planting possible close to structures
VZ - wood specie growth [in metres]
D5 - wood specie grows up to 500 m above SWL
D5 - wood specie grows up to 500 m above SWL
D8 - wood specie grows up to 800 m above SWL
D12 - wood specie grows up to 1200 m above SWL
N12 - wood specie grows in heights above 1200 m
ST - wood specie sustains shade
K - grows as bush
S - grows as tree
Li - grows as liane (climber)
M - wood specie is frost resistant in our conditions

LATIN NAME	D	B	L	N	E	O	VZ	D5	D8	D12	N12	ST	K	S	Li	M	Z
Acer campestre	Y	N	Y	Y	Y	Y	20	Y	Y	N	N	Y	Y	Y	N	Y	N
Acer negundo	Y	N	N	Y	Y	Y	20	Y	Y	N	N	N	N	Y	N	N	N
Acer platanoides	Y	N	Y	Y	Y	Y	30	Y	Y	N	N	Y	N	Y	N	Y	Y
Acer pseudoplatanus	Y	N	Y	Y	N	N	40	Y	Y	Y	N	Y	N	Y	N	Y	N
Acer saccharinum	Y	N	Y	Y	Y	N	40	Y	Y	N	N	Y	N	Y	N	N	N
Acer tataricum	Y	N	Y	Y	Y	Y	12	Y	Y	N	N	Y	Y	Y	N	Y	N
Aesculus hippocastan.	Y	N	N	Y	N	Y	25	Y	Y	N	N	Y	N	Y	N	Y	N
Ailanthus altissima	Y	N	N	Y	Y	Y	25	Y	Y	N	N	N	N	Y	N	Y	N
Alnus glutinosa	Y	Y	Y	Y	Y	Y	35	Y	Y	N	N	N	N	Y	N	Y	Y
Alnus incana	Y	Y	N	Y	Y	Y	20	Y	Y	Y	Y	N	N	Y	N	Y	Y
Alnus viridis	Y	Y	N	Y	Y	Y	3	Y	Y	Y	Y	N	Y	N	N	Y	N
Amelanchier ovalis	Y	N	N	Y	Y	Y	3	Y	Y	N	N	N	Y	N	N	Y	N
Amorpha fruticosa	Y	Y	Y	Y	Y	Y	6	Y	Y	N	N	N	Y	N	N	Y	N
Amygdalus nana	Y	N	N	Y	Y	Y	1	Y	N	N	N	N	Y	N	N	Y	N
Berberis vulgaris	Y	N	Y	Y	Y	Y	3	Y	N	N	N	N	Y	N	N	Y	N
Betula carpatica	Y	N	N	Y	Y	Y	15	N	Y	Y	Y	N	Y	Y	N	Y	N
Betula nana	Y	N	N	Y	Y	N	1	Y	Y	Y	Y	N	Y	N	N	Y	Y
Betula pendula	Y	N	N	Y	Y	Y	30	Y	Y	N	N	N	N	Y	N	Y	N
Betula pubescens	Y	N	Y	Y	Y	N	20	Y	Y	Y	N	N	N	Y	N	Y	Y
Buxus sempervirens	Y	N	N	Y	Y	Y	10	Y	Y	N	N	Y	Y	Y	N	N	N
Calluna vulgaris	N	N	N	Y	N	Y	1	Y	Y	Y	Y	N	Y	N	N	Y	N
Caragana arborescens	Y	N	N	Y	Y	Y	6	Y	Y	N	N	N	Y	Y	N	Y	N
Carpinus betulus	Y	N	Y	Y	N	Y	25	Y	Y	N	N	Y	N	Y	N	Y	N
Castanea sativa	Y	N	N	N	Y	N	40	Y	N	N	N	N	N	Y	N	N	N
Catalpa bignonioides	N	N	N	Y	Y	Y	20	Y	N	N	N	N	N	Y	N	N	N
Celtis occidentalis	Y	N	N	Y	Y	Y	20	Y	N	N	N	Y	Y	Y	N	N	N
Cerasus avium	Y	N	N	Y	Y	Y	25	Y	Y	N	N	N	N	Y	N	Y	N
Cerasus fruticosa	Y	N	N	Y	Y	Y	2	Y	Y	N	N	N	Y	N	N	Y	N
Cerasus mahaleb	Y	N	N	Y	Y	Y	13	Y	Y	N	N	N	Y	Y	N	Y	N
Clemantis alpina	N	N	N	N	N	N	5	Y	Y	Y	Y	N	Y	N	Y	Y	N
Clemantis vitalba	N	N	Y	N	N	N	10	Y	N	N	N	N	N	N	Y	Y	N

Conclusion

To develop a detailed design of species composition, it is suitable to use materials obtained from professional literature (for instance, Dřeviny ČR – Úradníček, Maděra 2001, Vegetační doprovod vodních toků a nádrží – Šlezingr 2002, Břehové a doprovodné porosty vodních toků – Šimíček 1999 and others), but mainly professional advice from dendrologists, forest engineers and erudite ecologists.

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Horses in the forest – are the hipotrails a negative phenomenon in the nature?

Gabriela Čáslavská, Jitka Fialová

Horseback riding is a form of tourism which has become very popular – very popular spending of leisure time. The Czech Republic, where the law allows free entry into the forests, horsemen can freely and for free use all the forest roads, and the forest owners are responsible for the pathways repairs. While the stable owners, who earn on the horses riding in the forest and along the forest roads, do not have to financially contribute on these repairs. The length of the marked hipotrails was in the year 2009 more than 1800 km. The aim of this article was to try to correct the needs and requirements on horsebackriders to give the foresters the possibility to react and create enough space in the forest for all the target groups.

Key words: forest act, Czech Republic, horse, trails

Introduction

Trail riding is a form of leisure activity which uses a horse as a companion or as a means of transport. In the Czech Republic, where the law allows a free entrance to forests, horse riders can freely and without any charges use all forest roads. The number of rental stables in the surroundings of cities has increased recently. Forest roads, especially in the surroundings of larger stables, are damaged as their surface is in the wet eroded by horses. In the Czech Republic, forest owners are responsible for repairing roads, whereas stable owners, who earn money from operating horses on the forest roads, do not have to make any financial contributions. In many cases, foresters call for marking of riding trails as these would bring relief from the load of horses on the forest and also some limits for the horse riding activity. However, the foresters do not know the requirements of riders considering the riding trails and the riders and stable owners are not willing to mark and maintain the trails themselves, at their own expense. Therefore, in many cases the marking of riding trails remains a dream of foresters, or a proposal which has not been implemented, and horse riders use the entire forest road network without any limits. The aim of the paper was to find out the structure of trail riders' priorities, to clarify the needs and requirements of horse riders, and to explore their interest in solving the above mentioned problems, so that foresters could respond to the ascertained facts and provide sufficient space in forests for all groups involved. Barchánková (2008) says that there is a new initiative in the Czech Republic to establish a complex network of trails for horse riding – riding trails. The purpose of marked trails is the facilitation of passage through the landscape for riders on horses so that this more and more popular recreation becomes safer, more comfortable and accessible to a wider range of interested people. However, this is advantageous not only for riders but also for the landscape itself and landowners. These trails in the landscape allow for the regulation of the movement of horse riders to some extent and for their concentration on the roads where the damage to the roads themselves, but also to fields and other growths and grounds, would not occur and where conflicts arising from trespassing to private properties would be prevented. The structure of the ownership of lands where riding trails go is as follows: about 60% of them are state-owned (State Land Resources, Forests of the Czech Republic), 30% are properties of companies and cooperative farms, and 10% is privately owned property (Jiskrová, Mikule, 2009). As follows from the text above, riding trails are experiencing a boom and great hopes are connected with their establishment. Also forest managers tend to welcome this solution as the intensive horse riding activities start to disrupt forest roads.

Andrlová (2009) lists these advantages the establishment of riding trails would bring: riders will prefer marked trails to unmarked terrain for a number of reasons; safe movement of riders and horses; prevention of damage caused by riders who would get lost and ride through stands, over agricultural lands or pastures; higher comfort of equipment for horses in stations outside the season will considerably improve the conditions for local horse owners – stable owners.

The advantages of riding trails as listed by Andrlová (2009) are indisputable but only for those cases when a horse rider travels through a landscape which is unknown to him or her.

The trails should not have the significant impact to the forest and it should be leaded in the forests with proper ecological-stabilization potential of forest functions. We can partly say that the ecological ecosystem approach in the last twenty years in the forests at the model area is projected in this very high real potential of ecological-stabilization forest function and that the management was influenced, and still is, by this approach. (Fialová, Vyskot, 2010)

Traditional approach to problems of the opening-up of forests has been based primarily on technoeconomic aspects. It results particularly from configuration of the ground and calculations of minimum costs for logging and transport operations. A new conception from the viewpoint of integrated forest management taking into account functions of the forest is based on a standard approach when technoeconomic aspects are completed by observing particular functions of the forest. Thus, the technoeconomic approach is changed to a technoeconomic-environmental conception which will contribute to decreasing the negative effects of the construction of forest road net-work on the environment. (Hrůza, 2003)

Material and methods

The data for the study were obtained by means of a questionnaire. The aim was to identify the requirements and needs of active horse riders in detail, and thus to provide data for a potential use by foresters. The questionnaire was distributed directly, by personal contact. This method was chosen predominantly for reasons of maximum reliability and truthfulness of results. As trail riding is a varied activity, the respondents could mark more replies suitable for them. In total, 62 questionnaires were collected within five months.

Discussion and results

The size of a group of horses in the terrain affects the intensity of the terrain use and the demands on the roads on which the group rides. The results show that over 60 % of riders move in the terrain on their own or in pairs. This fact is caused by the fact that the most of the respondents are private horse owners who ride their horses independently because to be organized in a larger group is time-demanding and more limiting for riders. However, this raises the danger of riding on narrow forest paths and through stands; a larger group is more conspicuous and needs more spacious roads, therefore, riders in a group do not seek the above mentioned ways so often. The rules of riding trails recommend riding in groups of three to eight riders.

The number of trails used by horse riders mainly depends on the terrain and its potential. Riders often create and use new paths in places which are not really suitable. The reason for this is mainly the road surface - gravel roads are not appropriate for horses and riders search for other alternatives. Moreover, the horse riders seek peacefulness, varied terrains suitable for horse training and they wish to explore new places as prevention against boredom and monotony of known roads, mainly in the locations where a limited number of riding routes are available. Over a half of the respondents like to take more than 5 different riding routes. Although in the Czech Republic there are hundreds, maybe thousands of marked riding trails, only 3 % of recreational riders take them regularly and 13 % of them take them exceptionally. That is a very poor result considering the organizational and financial costs of the establishment of these trails. Most private horse owners go for short rides several times a week, which is logical due to the time-demanding character of riding and the necessity for horse's regular movement (it is healthier for a horse to take a short ride three times a week than go for a day trip once a week). In rental stables the situation is similar as the clients prefer paying for 2 x 2 hours of riding than 4 hours at a time. Horse riding is demanding for the physical condition and an untrained rider cannot sustain a day or half a day in the saddle. As a consequence of these shorter rides, the riders know the surrounding terrain very well and they do not need the marked trails not to enter the forest stands. Quite the contrary, they enter the stands intentionally and they create new paths. Another huge problem mentioned by the respondents is the unsuitable surface of marked riding trails. Then the rider has no other option than to go around, which is in stark contrast to the primary purpose of the trails.

In the Czech Republic riders use field and forest roads in 57 % of occasions and meadows and field in 35 % of occasions. Roads are used seldom (7 %), probably only when a road has to be crossed and cannot be avoided. The specific use depends on the specific conditions. Forest roads are used for trail riding in the same proportion as field roads, again depending on the location of the stables and the vicinity of these roads. Quite a high proportion of riders ride on fields, although some of the respondents claimed they use fields only after the harvest. To a certain extent this confirms the above mentioned fact that horse riders prefer riding through the terrain (fields and meadows) than on roads or forest roads with unsuitable surfaces. In the other options riders mentioned local specifics (a vineyard, a sandpit, a park, etc.), including a ride through a stand. We are again facing the romantic desire of horse riders to 'ramble freely'. On average, 70 % of riders prefer an unstabilized field or forest road and 25 %

prefer fields or forest stands. Probably, these riders are naive enough to think that horses cannot destroy the environment. Fortunately, the practice shows that when riders do not have any reason (an unsuitable surface, etc.) for abandoning the road, most of them do not enter the stand or the field. The most frequent offence the riders admitted was entering stands. However, only a half of the riders who mentioned this knew that it is a breach of a regulation. In the Czech Republic, out of around 90 % of the riders who enter stands 85 % have a reason for this behaviour. Therefore, foresters should not only criticize the recklessness of riders but they should look for the reasons why the Forest Act is breached. If the riders in the location in question are informed about the Act and if they have a sufficient number of suitable roads without constrictions, they will not have any reason to ride through the stand.

Another frequent offence against the Forest Act is the disturbance of peace and quiet when riders speak loudly or shout to other riders. This is not a problem of riders only, similarly to smoking or dropping litter. Horse riders pasture horses in forests on 20 % of occasions but these are mainly short moments when a rider is sitting in the saddle or holding the horse on the lead or the bridle. Another breach of the Forest Act is cutting or breaking a tree to make an obstacle. However, this deed is not very frequent as the riders prefer using occasional natural obstacles.

56 % of the respondents committing offences were not aware that they breached the Act. Undoubtedly, the number of the occasions when the Act is breached would be reduced if the trail riders were better informed. This kind of information is mainly important for owners of rental horses and private horse owners because they ride regularly in specific areas. Another recommendable measure is the placement of informative boards at the roads which horse riders often take. The boards have to include the reasons for particular bans so that the forest visitors could not gain a feeling that they are ordered around by foresters.

90 % of the respondents would be willing to obey a ban to ride on a muddy road (they replied yes and it depends on the situation). Their notes show, and it is logical, that they would need to have the option to ride somewhere else. Therefore, if foresters need to solve a problem of several muddy roads that are often used by hikers they can make an agreement with the riders or install a sign so that the riders know they have to go around the road in the wet. 74 % of the respondents are not willing to tolerate a complete ban on entry. This also confirms the significance of riding in the forest for many riders. 80 % of the riders agree that they could use step only on common roads used by both riders and hikers; on the other hand, only 40 % are willing to dismount the horse and lead it. 70 % of the respondents would only use the marked trails if the trail network was dense enough and consisted of roads with a suitable surface.

Moreover, most of the respondents (90 % yes, 94 % it depends on the specific situation) are willing to solve the problem of disturbing the game ‘under the hide’ and not to ride to these places when agreed. Naturally, the trail riders would still need to have enough passable places. Paying contributions was refused by 50 % of the respondents and 27 % of the riders were not willing to take part in voluntary work.

It was found out that most riders who travel in forests are private persons riding their own horses. Trail riding is a leisure activity performed by a wide range of people who are not organized or educated in any way; furthermore, there is no larger association or organization for these people in the Czech Republic. Therefore, it is impossible to communicate with them at a regional or a state level; problems must be tackled and information transmitted at a very local or a personal level. There is the advantage of the positive attitude of riders towards the environment, which they have in common with foresters – this could serve as the common point for their mutual communication. Due to their positive relationship towards the landscape, trail riders are willing to tolerate a number of restrictions if their basic requirement to be able to ride into forests is met. A ban on entry is not a suitable solution for them. On the other hand, the marking of a local network of riding trails with restrictions in troublesome areas (e.g. ban on entry in the wet, only step on common roads, or the ban on riding past a specific hide in specific evenings) seems to be an advantageous solution.

The following points summarize general proposals:

- if a forester wishes to face the issue of trail riding, he or she should first go to the stables in the vicinity and find out what kind of riders there are, if they ride in forests, if they are private owners of horses and if they have a riding ring or a hall or if their only possible ride is in the surrounding landscape;
- ideally, the sufficient solution will be an agreement with the riders and explanation of provisions of the Forest Act, or of markings in the forest (e.g.

the ban of riding on a specific road in the wet) or information signs along roads;

- the trails have to be accessible from individual stables and the density of the trails should be the highest in the vicinity of the stables as riders usually go within 10 km around the stables;
- the terrain and the roads should be of various kinds;
- if trail riding has already started in the location, it is advisable to find inspiration in riders themselves and e.g. mark also beaten paths if they are attractive for riding (for example a steeper hill in an otherwise flat landscape);
- the trails should be singled out for horses and they should cross other hiking or biking trails as little as possible because recreational riders mainly seek peace and quiet;
- the trail riders' priorities should be taken into account – first, it is the surface of the roads, then their distance from the stable with respect to the planned ride, further, small frequency of people and cars; a meadow where the horse could be fed would represent a certain attraction;
- in the case of ranches where paid rides are organized, it would be suitable to charge profitable mass activities in the area of their forests with a flat fee (Čáslavská, 2010).

Conclusion

The objective of the paper is to provide foresters with information on the interest group of recreational riders, mainly their requirements concerning the forest environment. The used data consisted of 62 questionnaires. The interest group of trail riders contains people of various ages and positions, because horses are now affordable as a hobby for nearly all active people. Moreover, besides the active movement in the country and an interesting way of spending the free time, a horse offers social contact with other people and a sort of partnership. The relationship of recreational riders to the environment or the country is positive, sometimes romantic or even idealized. However, these positives are limited by the little knowledge of the rules of the Forest Act and other regulations which specify how people should behave in the countryside. With better knowledge of these rules, recreational riders may be welcome visitors to forests. The task for foresters is to consider the recreational riders' wish to find peacefulness, a varied terrain, and roads suitable for horses. Marked riding trails are not the only option for regulating the movement of horses in forests. Most riders travel within 10 km from the stables so they know the area very well. Therefore, an agreement with the riders or signs on specific roads could suffice.

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8. Act No. 114/1992 Coll., about the nature and landcape protection, in the wording of later regulations

Acknowledgement

The paper refers to the Research Project No. MSM 6215648902

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Assessment of impacts of soil organic matter on the physical properties of soils by testing consolidated container samples.

Asier Garate, Radek Dymák, Michal Henek, Miroslav Kravka

Whether in soil or in substrate, organic matter plays an irreplaceable role forming and enhancing its physical properties. Along with the content of nutrients, physical properties represent a factor indispensable for the successful growth of any crop plant. With the view to forming optimum share of organic matter, soil management is one of the most important agronomic measures with long-term effect.

Key words: soil organic matter, soil physical properties

Introduction

Organic matter in soil involves both living organisms and their non-living remains. There is a re-established interest in the recent years to seek ways how to support and enhance biological activities in soil, particularly by directly delivering pre-cultivated living organisms or non-living organic matter, which would support the living element in soil. This approach mainly finds its use in land reclamation, but may also be applied in landscaping or gardening, where additional organic matter is an indispensable complement in poor soils. The current trend puts emphasis on organomineral fertilisers or their compounds with other substrates (peat, coconut, compost, etc.), which supply the necessary nutrients and, thanks to the significant share of biological element, a large amount of organic matter. The most recent practice proves very good results using combination of organomineral fertilisers and symbiotic mycorrhizal fungi. This appears to be a really perspective approach even to enhance the physical properties of soil. Additional organic elements in the soil stimulate natural processes, which ensure maximum utilisation of its potential and increase the yield. In fact, it is a natural process of soil development purposefully accelerated by supplying living organisms in the soil. In addition, application of organomineral fertilisers combined with mycorrhiza and possibly organic matter in form of compost or peat does not pose any threat in sense of soil structure deterioration, which is not the case of synthetic fertilisers. In practice, application of the mentioned mixture reduces the use of synthetic fertilisers and enhances the resistance of plants to stress, such as temporary drought or erosion.

Literature undoubtedly points at the positive effect of organic matter on the basic physical properties of soil, such as bulk density, storage capacity, osmotic potential of water in soil, or capacity to form soil aggregates. These factors further affect particularly the use of nutrients present in the soil. In most types of soil (above all, in soils with a high content of clay particles), favourable conditions enable aggregation of soil particles into composite units, i.e. soil aggregates. These range in size from several centimetres large macroaggregates to microaggregates invisible by the naked eye. The actual size of aggregates also influences the size of macro and micro pores and subsequently the bulk density of soil. The optimum structure of pores in soil increases the content of water (containing dissolved nutrients) fixed by capillary forces. It does not move through soil as easily as gravity water, which actually washes dissolved nutrients out of the soil profile.

While the specific weight of soil is constant in time, as it is determined by the density of the parent rock, the share of organic matter in substrates is purposefully increased to alter its properties. It is obvious that organic matter decreases the total weight of soil/substrate. The average specific weight of mineral particles in common parent rock ranges approximately from 2.5 to 2.7 g/cm^3, while in peat it is only 0.18–1.5 g/cm^3 (depending on the level of decomposition). In addition to the reduced weight, the supplied organic matter and potentially the successive effects of symbiotic organisms form soil aggregates in well-managed soils. This phenomenon is, for example, described by Piotrowski et al. (2004), who studied the effects of mycorrhiza on soil aggregates and concluded that mycorrhizal fungi growing mainly in grassland have a proven positive effect on the occurrence of soil aggregates showing high water repellency (size 1–2 mm). We should note that this process involves principally formation of larger aggregates. For example, Schreiner et al. (1997) determined a significant influence of mycorrhiza on the formation of water-repellent soil aggregates, as they compared occurrence of aggregates of three different sizes (0.25–1mm; 1–2 mm; and 2–4 mm) under various treatment – application of synthetic fertiliser, no synthetic fertiliser, and no fertiliser with supplied mycorrhizal fungi. The most pronounced difference was determined between application of synthetic fertiliser and application of mycorrhiza, namely in the largest aggregates (2–4 mm). Soils with supplied mycorrhiza showed 60% more aggregates. It was also ascertained that mycorrhiza has a minimal effect on formation of small aggregates. The size and stability of soil aggregates have significantly affect the water regime in soils. The results of a research conducted by Hollis et al. (1997) imply that organic matter predominantly influences the water storage capacity of soils, i.e. the maximum amount of water that the soil can retain in a nearly balanced condition after excessive supply of water (irrigation, rainfall). The experiments carried out within the research prove that soils containing more than 3% of organic carbon and over 18% of clay particles show a high or a very high water storage capacity as opposed to soils with lower values of the mentioned characteristics. The water storage capacity has a direct impact on the energetic range between capillary water and gravitational water. For this reason, soils with a higher water storage capacity are less susceptible to washout of nutrients and soil particles. Soils with a reduced water storage capacity (mainly sandy soils or soils with a disturbed structure) will become saturated much faster than soils with a higher retention capacity (i.e. clay soils). Thus, notably larger amounts of water run away through the soil profile thanks to gravitation, including some nutrients and pesticides.

Organic matter and mycorrhiza also have en effect on the resistance of plants to water stress. Mycorrhiza reduces the resistance of water flow between the roots and the soil and secures better utilisation of the gradient of water potential between the soil and the atmosphere. In other words, the plant can make use of water that is more fixed in the soil. For example, Augé et al. (2004) verified that bean plants (Phaseolus vulgaris) with mycorrhiza present in the soil and on the roots, if stressed by drought, show a 10% higher conductivity of pores in the period between the third and the sixth day after irrigation. The study also proves that if mycorrhiza is present in the soil for minimum a year, it has a positive effect on its physical properties by producing hyphae and glomalin, and agglomerating soil particles (as mentioned above). In our conditions, organomineral fertilisers and symbiotic mycorrhizal fungi have been proven to have a positive long-term effect mainly on extreme sites. For example, experiments conducted by Kravka & Kouba (2009) prove that mycorrhizae, or organomineral fertilisers, supplied in the tailings in Podkru□nohoří reduce the mortality of seedlings in various tree species and enhance the growth of their biomass (as compared to control plots with no treatment or fertilising). This trend persists during the following vegetation periods, which may be considered as an overall improvement of the physical properties of these soils, mainly the capacity to retain water and nutrients. Hrůza & Kravka (2010) illustrate how plots treated with mycorrhiza show an increase in biomass of grassland, primarily determined for erosion control on slopes. Among other effects, this reduces the total volume and rate of water run-off and lowers the amount of the drifted sediment. A specific study conducted near Brno determined that grassland treated with mycorrhiza increased the growth of its biomass by 63% and reduced the volume of water surface run-off by 5%. The rate of water surface run-off declined by 27% and the amount of drifted sediment was reduced by 20% as compared to the control plot not treated with mycorrhiza. This suggests a potential use of mycorrhiza as an erosion control measure within biotechnical stabilisation of slopes.

The positive effect of organic matter on soil fertility may be considered as a widely accepted principle. However, the recent research proves that the combination of both living and non-living organic matter may bring much better results. Such elements as symbiotic mycorrhizal fungi supported by quality organomineral fertilisers should be employed in a larger extent in the modern production of substrates. The perspective is to create a highly effective mixture combined with traditional substrates.

Material and methodes

The above text shows that organic matter has a particular impact on the following physical properties of soil: bulk density, hydraulic conductivity, aggregate stability, water retention, macroporosity. The aim of this study was to propose a modified method for assessing the effects of organic matter on soil physical properties, in order to:

1) work in large series of repetitions (50 containers and more) and with low acquisition and operating costs;

2) avoid taking undisturbed samples and to find an appropriate method for work with a disturbed sample;
3) observe the main soil physical properties in relation to the quantity and quality of soil organic matter;
4) monitor the effects of vegetation and other living elements;
5) modify (model) the grain size composition of the soil (substrate) in individual variants.

The equipment for this purpose was designed based on the construction of a device for measuring saturated water flow in vertical column. The tested substrate – model soil – is a mixture of organic matter (diverse quality, origin, and quantity in the mixture subject to testing) and model soil consisting of inert silica grains of different fractions. By simple mixing, we obtain the grain size composition that represents different soil types (sandy soil, loam, etc.).
irrigation, which allows an analysis of quantity and salt concentration (e.g., measured by electric conductivity) or a full chemical analysis of the solution.

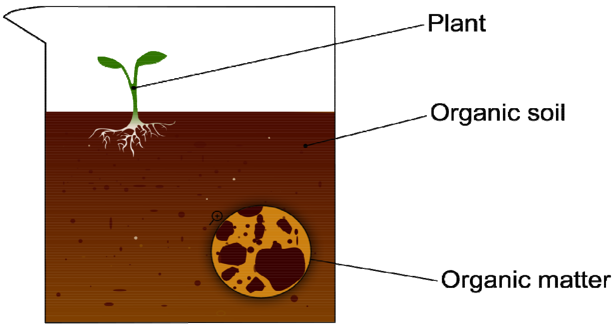

Fig. 1. Structure of model soil: mineral component with controlled grain size composition and excluding chemical processes; organic matter of various origin, quality, and volume in the mixture; and plant material, which, with its roots, naturally influences the processes during the soil consolidation.

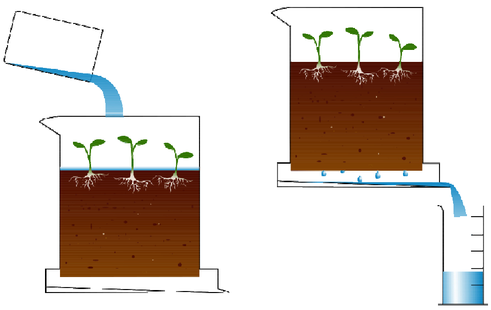

Fig. 2. During the consolidation process, we may monitor the dynamics of release of nutrients contained either in the supplied organic matter or in supplied fertilisers. The volume of drained water and its electric conductivity may be determined.

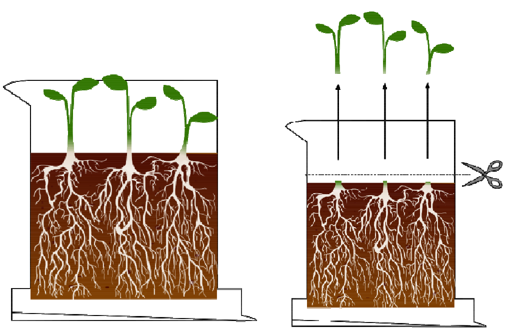

Fig. 3. The consolidation process may be affected by the living component, the effect of which may be subject to testing. The apparatus is designed to allow a subsequent separate analysis of the above-ground and root biomass. The hydraulic conductivity is tested in the model soil containing the root system.

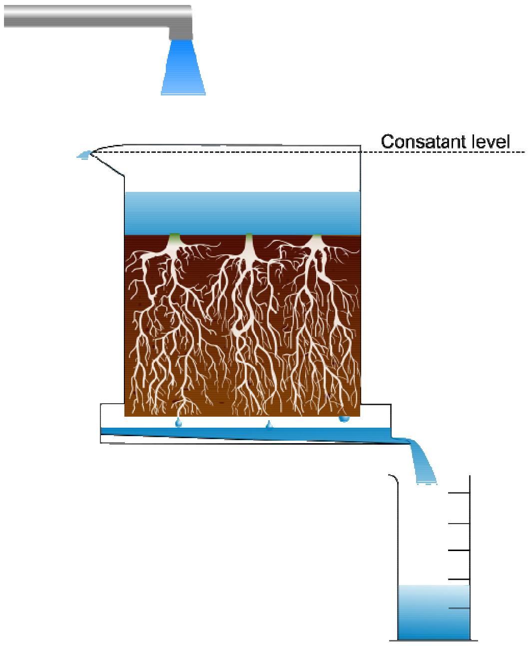

Fig. 4. Determination of hydraulic conductivity of model soil using the apparatus.

Results and conclusions

The apparatus consists of a cylindrical container with one face open and the other closed with a drain bottom provided with holes that allow free movement of water but prevent any washout of substrate.

The created model sample of disturbed soil is placed in the container and is either left for several weeks to simple consolidation or planted with plants to be grown during the experiment. After the given period of time, the sample is ready to be tested for the stability of soil aggregates (carefully collected from the surface of the substrate), bulk density, pore size, and hydraulic conductivity and water retention after irrigation. During the consolidation process, the substrate is moistened to support the actual interaction among the mineral and organic part of the substrate and/or the plants. The apparatus is also designed to collect the drained water from irrigation, which allows an analysis of quantity.

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ADDITIONAL BIOTECHNICAL MEASURES ON ROADS FOR THE TRANSFER OF SURFACE RUNOFF INTO SUBSURFACE RUNOFF

Petr Hruza, Alice Kozumplíková, Hana Trtílková

Abstract

Draining structures of roads protect the road formation against erosion caused by the surface runoff and against waterlogging caused by groundwater. Moreover, they are supposed to lead both occasional and permanent watercourses across. However, as a result of performing these functions, draining structures transform the dispersed surface runoff into concentrated runoff, which raises the risk of surface erosion and accelerates the runoff of water from the landscape. This is in contrast to the new philosophy and new requirements concerning forest ecosystems and the landscape itself which focus on the accumulation and retention of water in the landscape. Therefore, the draining of roads has to be designed so that it takes surface and ground water outside the road formation and yet does not increase the size and the speed of water runoff from the landscape. This paper concentrates on possible solutions in which biotechnical measures are taken related to draining structures in order to allow water to be soaked up in the ground and to transfer the surface runoff to subsurface runoff

Introduction

Roads often become a secondary water channel and a cause of increased runoff from the drainage basin. Additional biotechnical measures can reduce this risk substantially and at the same time support the accumulation and retention of water in the landscape; last but not least, they also contribute to the ecological stability of the landscape. These measures are financially undemanding and in the territories without problems concerning property rights they are easily implementable.

The Issue and the Aims of the Paper

Insufficient retention, infiltration and accumulation capacities in the basin are reflected in increased specific runoff. For example according to Herynek (1999), studies found increase in specific runoff on forest roads. With the road width of 4 m, intensity of effective rain of 3 $mm.min^{-1}$, and road density of 10 $m.ha^{-1}$, the specific runoff is 0.2 $m^3.s^{-1}.km^{-2}$; with the road density of 30 $m.ha^{-1}$ it is 0.7 $m^3.s^{-1}.km^{-2}$; and with the road density of 40 $m.ha^{-1}$ the specific runoff will be 0.9 $m^3s^{-1}km^{-2}$. The aim of the paper is to propose suitable biotechnical measures to be added to draining structures in order to increase the infiltration in the ground and help transform the surface runoff in the location where the dispersed surface runoff becomes concentrated. This attitude demands a broader solution within the given drainage basin although biotechnical measures are located along a road and precede the draining structures immediately.

Possible Solutions

Specific biotechnical measures additional to draining structures on forest roads need to support the infiltration and the retention of water in the landscape. They include ecotone ecosystems. An infiltration contour furrow is created behind the draining ditch and a multistory stand with a shrub layer is added (Fig. 1). Ecotones as biotechnical measures (they usually represent a boundary between two different ecosystems) perform more functions – from an ecological perspective these are the hydrological, soil-protective, climatic functions; moreover, they represent a zone supporting ecological landscape stability (Sklenička et al., 2001, Sklenička and Pittnerová, 2003).

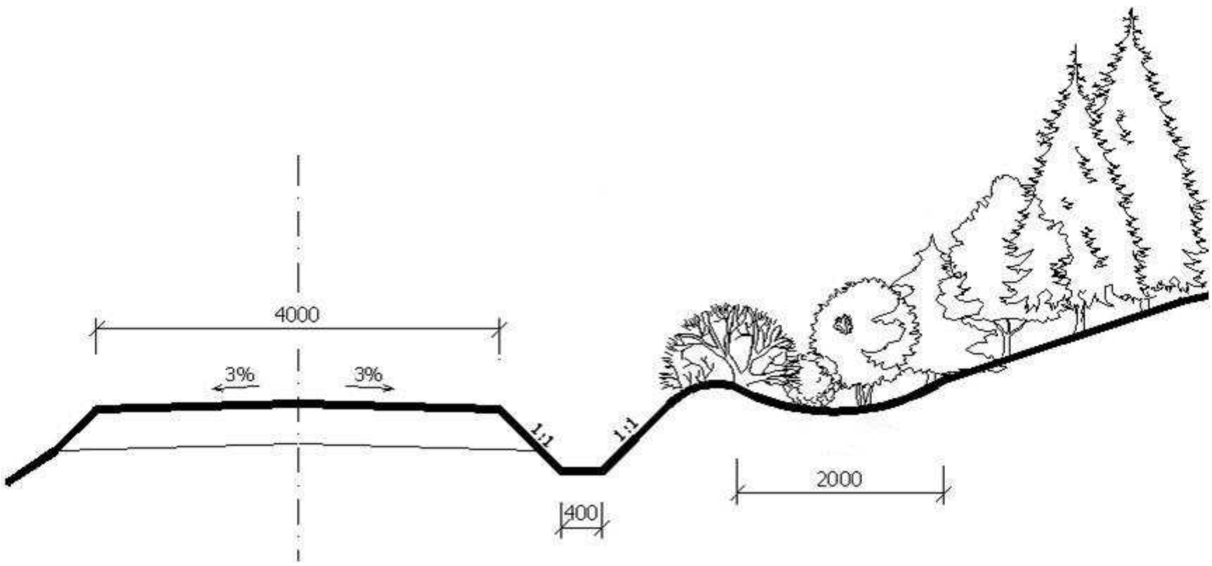

Fig. 1 The biotechnical measure along a forest road

Another biotechnical measure can be longitudinal stone drains and infiltration pits (Fig. 2). For these it is advisable to use gravel macadam of 32–63 mm fraction, for example in combination with an appropriate geotextile, and thus allow the surface water to infiltrate into the subgrade.

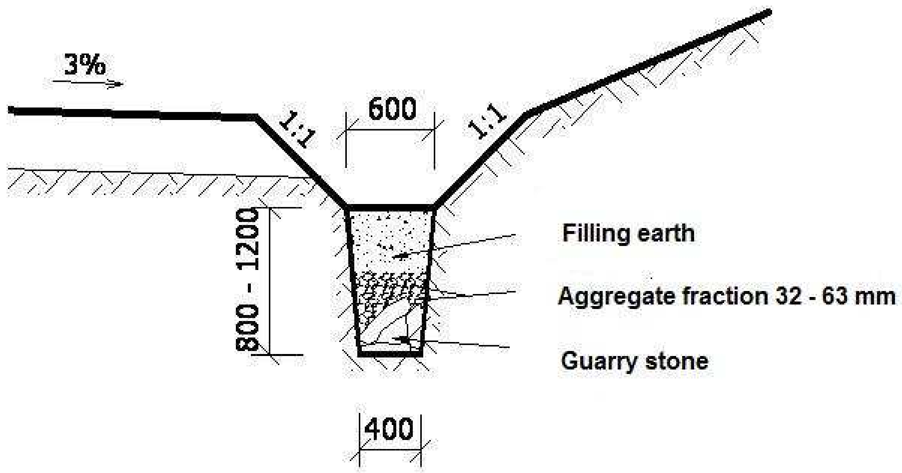

Fig. 2 The longitudinal stone drain

In the outlets of pipes culverts are created in order to prevent erosion caused by the water flowing out of the pipes. In this case, not only the granulity but also the shape of the riprap are important. A fan-shaped riprap min. 3 m long in the axis of the pipe culvert is fitted with at least 2 m wide stabilization footing at the end. Ripraps decrease the speed and the energy of the flowing water, allow for a gradual infiltration of water in the soil and transform concentrated runoff to dispersed runoff.

It is possible to propose similar biotechnical measures for rural roads, however, here the solution of land property rights is even more important. Similar solutions can often be implemented only within the proposal of the framework of land consolidation measures when comprehensive land consolidations are realized. nfiltration belts with herbal, shrub and tree layers located behind the longitudinal draining ditch should take the form of a windbreak rather than a mere avenue (Fig. 3).

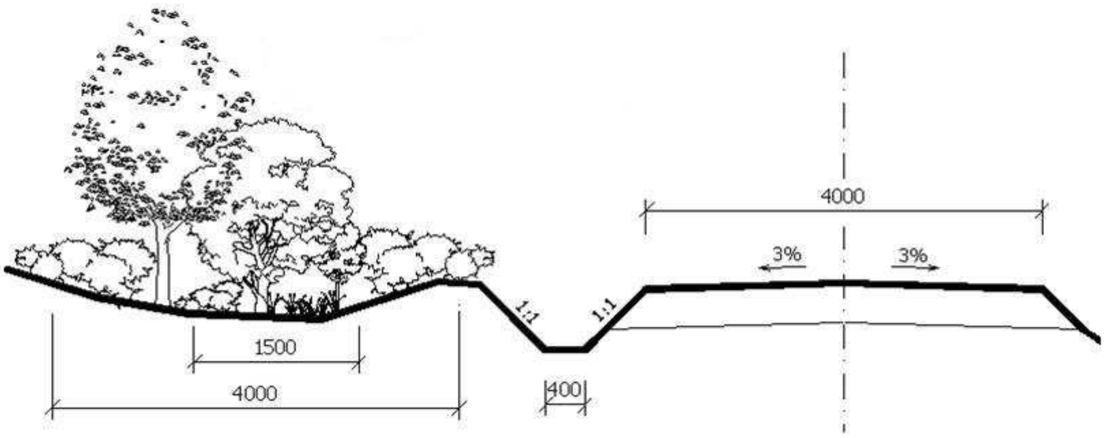

Fig. 3 The biotechnical measure along a rural road

Discussion

The greatest impediment accompanying the implementation of additional biotechnical measures is a larger appropriation of the lands adjacent to a forest road. Both in forest stands and fields, especially in case of private owners, the demands for compensations for the losses in production area can be raised. If the forest and field lands are owned by the state, this solution should be promoted with respect to interests of the entire society.

It has been proven that the most suitable solution is the usage of simple constructions from local natural materials, mainly rock and wood. Also planting of shrubs and trees has to respect the local conditions and autochthonous species with desiccation function need to be preferred. Such a solution is not financially demanding and can be implemented by means of undemanding construction technologies.

However, we have to note that principles of simple and proven technologies are often not followed. This concerns, for example, the construction of dry rock walls when the principles of rock arrangement and its inclusion in the surrounding terrain are not met. When infiltration belts are planted, the selection of appropriate species is devoted maximum attention but not their layout and the following maintenance.

Conclusion

This solution cannot replace the construction of draining structures in roads completely. However, it can reduce the negative impact of road constructions on the water regime in the landscape and thus contribute to the expected function of the landscape, which is the retention of water.

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Acknowledgements

The paper was created with the support of project MSM 6215648902

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The axis polygon layout of forest roads using the Global positioning system

Petr Hruza, Alice Kozumplikova, Tomas Mikita

Abstract

Currently, the issue of the possible use of the Global positioning system (GPS) for the layout of an axis polygon of forest roads for the purposes of their construction is widely discussed. With the improving GPS system, as regards the signal reception and its accuracy, this procedure of layout seems to be well usable in the future. We attempted to verify whether this can be used both for the surveying of the axis polygon vertexes and for the implementation of project documentation by means of the following measuring. We especially focused on the accuracy of measuring by means of the GPS. The conducted study shows that the method of polygon vertexes surveying by means of a GPS receiver which is classified in the category for the collection of data for GIS processing is still insufficient. This method can therefore be recommended for checking or as an auxiliary one.

Key words: Global positioning system, geographic information system, forest road

Introduction

In 1995 Morris (1995) writes that the military global positioning satellites and their ancillary ground based equipment are now so accurate that they could be of considerable use in surveying, in such things as road traces, planting boundaries and many other types of information required by foresters and agriculturalist. And that it is probable that in time all these things will become available for civilian use, at a cost that will make their practical and economical for field operation. Ryan et. al. (2002) says that in exceptional cases, where properties are large and mountainous, advance layout methods such as global positioning systems (GPS) or laser rangefinders may be used. However as these cases are rare and the equipment expensive, little use of this methods are made in Ireland. And they end with the comment that these systems are very useful for measurement and mapping of completed layouts and constructed roads.

The use of GPS receivers to establish the location within forestry is still minimal now and is accepted with distrust. An argument is the inaccuracy of established coordinates in a forest stand and the prices of higher quality devices. To find out whether this argument has a substantial basis we carried out the presented measuring.

Methodology

To verify the accuracy of the GPS signal a track of a control axis polygon between two points with known coordinates (beginning and end of the track) was transverse and surveyed. The axis polygon was located on a northern slope and its foot in a forest aisle between trigonometric point 31 and its station point 31.2 (Fig. 1).

In total, four points of the polygon were laid out and stabilized (Fig.2); the stabilization was performed by means of wooden pegs. The polygon transversing was conducted using total station Topcon GTS 229 – in each point the distances to the adjacent points and top angles were measured. The accurate coordinates of polygon points were calculated on the principle of the calculation of a polygon connected by coordinates (connection to points 31 and 31.2) and oriented by one side (orientation from point 31 to station point 31.3).

Fig. 1 The Forest aisle between trigonometric point 31 and its station point 31.2.

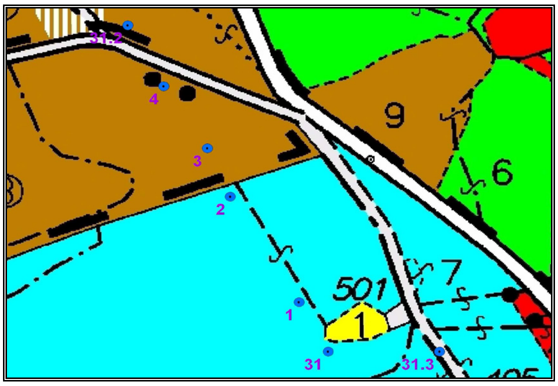


Fig 2. Four points of the polygon were laid out and stabilized

The coordinates of the four inserted vertexes of the axis polygon were calculated in the coordinate system S-JTSK. In total, including the beginning and the end of the track, there are six vertexes of the axis polygon. To verify the possibilities of using the GPS technology in the field of forest road constructions, the coordinates of the polygon vertexes were surveyed by GPS receiver Pathfinder ProXT (Fig.3)

Fig. 3 The measuring procedures using the GPS receiver

Pathfinder ProXT is a 12-channel combined receiver of GPS/DGPS with the ability to receive satellite DGPS corrections of EGNOS, with an integrated aerial and EVEREST technology for measuring in compolicated conditions. The producer states the accuracy of DGPS in locating as follows: postprocessing differential correction - 50cm accuracy, phase processing 5 minutes – 30cm accuracy, phase processing 45 minutes - 1cm accuracy, and real time DGPS correction – submeter accuracy.

Coordinates of individual polygon vertexes were first processed in the GPSExplorer application in the coordinate system S-JTSK. In each polygon vertex ten measuring procedures using the GPS receiver Pathfinder ProXT were performed. The coordinates of each measuring were calculated as the average of a hundred receptions of the GPS signal.

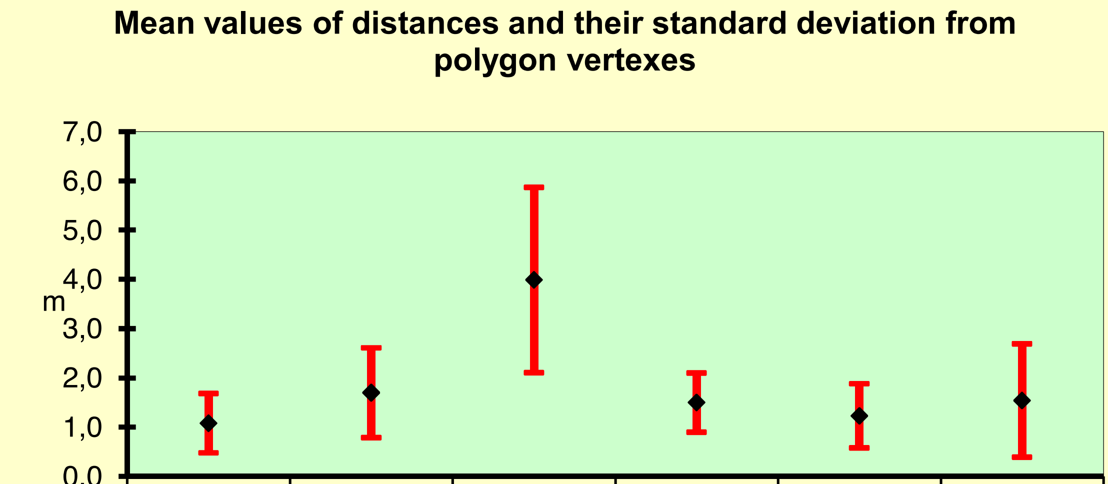
Characteristics of the area

The area where the testing measuring of the GPS accuracy was conducted for the purposes of forest road constructions is located north of Brno in the territory of the Training Forest Enterprise Masaryk Forest Křtiny of Mendel University in Brno, in the southern part of the cadastral area of Vranov u Brna municipality, on the left side of the road from Útěchov to Vranov. The laid out polygon is located on a gently undulating northern slope ranging from 10 to 20% (5-10o), its foot and an adjacent gently undulating flat land at an altitude of 503–524 m a.s.l. The track of the axis polygon was led through a forest aisle in a broad-leaved stand with maximum width of 3 m, with a full closure of crowns (Fig.4).

Fig. 4 The example of closure of crowns –point no.2

Results

The results show the mean values and the size of standard deviations of ten measuring procedures for each polygon vertex. It is obvious that the mean value of the deviation of five points (31, 1, 3, 4, 31.2) ranges between 1.08 m and 1.70 m. Points 1,3, and 4 were located in a fully closed broad-leaved stand. Only for point 2 the mean value of the deviation approached 4 m (3.99 m). This point was located in the lowest spot of measuring, at the foot of the northern slope; however, it was a crossing of skidding lines without the crown closure by the surrounding trees in breast-height diameter up to 10 cm. The maximum PDOP (Position Dilution of Precision) of all the measuring was 3.4.



Point no.	31	1	2	3	4	31.2
◆ Mean	1,08	1,70	3,99	1,50	1,23	1,54
Max.	1,68	2,61	5,87	2,10	1,88	2,69
Min.	0,48	0,79	2,11	0,90	0,58	0,39

Fig.7: Mean values of distances and their standard deviation from polygon vertexes

Discussion

To verify possibilities of polygon vertexes lying out, a GPS receiver with the ability to receive on-line differential signals (DGPS) and with the EVEREST technology was used. The EVEREST technology allows for measuring in complicated conditions (in a forest, among buildings). Producers classify these receivers as those with decimeter accuracy and the receiver can be classified as a navigation GPS receiver with accuracy up to 5 m and a geodetic GPS receiver with centimeter accuracy. The device was also chosen and tested because of its affordability. The measuring of a location by this type of GPS receiver by means of the on-line method (with one GPS receiver only without use of phase measuring or other post processing) for location lying out of polygon vertexes proved to be inaccurate. Whether phase measuring or post processing can make the measuring more accurate and to what degree will be shown after another series of control measuring. Moreover, we will see whether the used type of the device will be usable in the future for lying out of an axis polygon or if devices with geodetic accuracy will have to be used.

Conclusion

The measuring proved that the method of polygon vertex lay out by means of a GPS receiver which is classified by producers in the category for the collection of data for GIS processing is still insufficient. This method can therefore be recommended for checking or as an auxiliary one. It can serve as an auxiliary method when the track of a forest road has to be laid out according to project documentation. The track can then serve for an accurate lying out of coordinates by geodetic total station, or for finding of station trees and polygon points. It can serve as a checking method for the track measuring in the terrain before its processing in the CAD system, when we can compare the surveying by the total station and by the GPS receiver. This can eliminate the error in angle measuring or a polygon side length measuring.

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Acknowledgements
The paper was created with the support of project MSM 6215648902

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Thalweg identification and basin evaluation graph creation of small watershed using ArcGIS 10.0

Ing. Jan Deutscher, Ing. Petr Kupec, PhD.

Abstract

This paper describes a single approach on how to identify the thalweg of a small watershed using the ESRI software ArcGIS 10.0. It discusses step by step the basic operations needed for watershed delineation and the main stem phenomena and thalweg identification for further uses in creating basin evaluation graph. The above mentioned steps are applied on three different small watersheds discharging to the same stream and their respective thalwegs and basin evaluation graphs are constructed and their similarities are discussed.

Keywords

ArcGIS, basin evaluation graph, digital elevation model DEM, small watershed, thalweg

Introduction

Thalweg is an English loan word from German. The German word Thalweg is a compound noun that is built from the German elements Thal meaning valley, and Weg meaning way. According to the English science dictionary (Mifflin, 2002) thalweg can be defined as the line defining the lowest points along the length of a river bed or valley, whether underwater or not. In other words thalweg line on a map defines the deepest channel in a watershed. The thalweg thus marks the natural direction (the profile) of a watercourse. It is commonly used to calculate geometric attributes of watershed such as base width or shape and to construct basin evaluation graphs. The importance of thalwegs reaches far beyond its hydrological applications. From countries all over the world, something called the thalweg principle can be known. It defines the boundary between two states separated by a watercourse. One example for all is the infamous Shatt al-Arab (known as Arvand Rud in Iran) between Iraq and Iran. (http://en.wikipedia.org)

The ArcGIS software offers a number of tools to extrapolate basic hydrological attributes of small watersheds. Its application allows for simple and quick hydrological analysis including watershed delineation and identification of thalweg lines from basic data sources such as DEM (digital elevation model) or altitude contours. A great advantage of modern GIS systems including ArcGIS 10.0 is the possibility of clear and synoptic graphical expression of geographical data. As a demonstration on the importance on visual presentation of hydrologic data the basin evaluation graph can serve as an example. The main reason to create a basin evaluation graph is the visual interpretation of how the watershed area increases with the distance from the spring or the end of the thalweg line.

Material and Methods

Topographic and elevation data where obtained from the Fundamental Base of Geographic Data (ZABAGED). The following layers where processed:
elevation contours of 10, 5 and 2m density
water bodies (including rivers and lakes)
The above mentioned layers of geographic data served as the only input to the ESRI software ArcGIS 10.0. Using the tool *Topo to raster* and *Fill* a hydrological correct depression-less DEM, with cell size 4 square meters, was created in the first place (for more info on this topic see http://webhelp.esri.com, 2011). The DEM served as the basis for following analysis that can be divided into three parts. Watershed delineation, thalweg identification and basin evaluation graph construction.

To obtain the results presented in this paper the watershed delineation in ArcGIS 10.0 consisted of several steps. Most of the steps ended in creating a specific raster layer that was later used as a parameter for the *wateshed* tool. The first step was to create a *Flow Direction* raster using similarly named tool. In this raster each cell contains a value from 1-128 according to the flow direction to its steepest downslope neighbor. The second raster needed for watershed delineation was a *Flow accumulation* raster. Every cell (or pixel in this case) carries an integer value of the number of cells (pixels) that flow into it from upslope direction. The highest accumulated flow is in the stream channels.

Three pourpoints for three desired watersheds were manually chosen considering the ZABAGED water bodies layer and a vector point feature layer was created including all three. The set of features was snapped to the spots of highest accumulated flow using the *snap pour point* tool to minimize the differences between the ZABAGED input data and the accumulated flow raster computed from the DEM. The pourpoints were used in the *watershed* tool to delineate three desired watersheds.

According to literature (Riedl, Zachar, 1973) the process of thalweg identification starts at the pourpoint. The main stem of the stream is followed in its upstream direction following the lowest points in the watershed until the drainage divide is finally reached. The main stem is usually defined (Riedl, Zachar, 1973) as the longest branch, preserving the head direction of the watershed. But in the GIS environment it is possible to use a different definition that states: main stem is the principal channel within a given drainage basin, into which all of the tributary streams in a drainage basin flow. In rivers that anabranch or braid, the main stem is defined as the channel or thread of the channel that carries the majority of the flow, though sometimes there is no dominant channel. (http://dictionary.babylon.com) Following the second definition the main stem for the purposes of this project was defined as the part of the stream with the highest accumulated flow (the number of cells flowing into it). Three different thalwegs were manually drawn in separate vector layers in each delineated watershed following the above mentioned conditions using the links of highest accumulated flow. Where the stream branched, the branch with higher accumulated flow was followed upstream. To reach maximum possible accuracy when drawing the thalweg to the drainage divide line, the accumulated flow raster was used as a reference. The display options in ArcGIS 10.0 allow setting of a specific threshold on the visible accumulated flow. By setting a very low accumulated flow threshold, the stream channel is displayed almost all the way up to the drainage divide. However, the accumulated flow links tend to braid drastically when reaching the lowest values in close vicinity of the drainage divide. The displayed accumulated flow channel served as a reference basis for drawing the thalweg in places where the ZABAGED stream lines ended.

A basin evaluation graph was created for the whole range of the thalweg, reaching from the very drainage divide to the final discharge point. The idea was to demonstrate possibilities of visual interpretation of hydrological aspects in ArcGIS 10.0 environment. The common approach of dividing the watershed according to the thalweg's left and right banks was not used to simplify the process, rather the whole area of the watershed was processed and displayed in the graph. The first step in creating the graph was using the *raster calculator* tool on the flow accumulation raster to multiply it by the square area of each cell (in this case by 4, as the cell size of the raster was 4 square meters). This way a new raster was created where each cell bore an integer value of its contributing area rather than the number of cells flowing into it. The thalweg created in the previous step was rasterized using the *conversion* package in ArcGIS 10.0 and was snapped to places with highest accumulated flow to mitigate the impact of spatial inaccuracy caused by the raster-vector conversion. With the thalweg line converted to raster, it was possible to use it as a mask for the *extract* tool on the accumulated area raster. This resulted in the creation of a new raster layer where each cell of the thalweg bore an integer value of the accumulated area that flows into it while all other cells contained *no data*. A second conversion back to vector was used because of better and easier topology. In the created vector layer the length of each original cell (or rather the length of the stream running through each cell) was computed. The value of accumulated area was preserved from its raster origin as well. The topology data was used to compute the chainage of the thalweg and for the construction of the basin evaluation graphs from the dbf. files opened in the Microsoft Excell software.

Results

The above described methodology was applied on three partial watersheds of the Žilůvecký stream. For each of the chosen contributing streams the according watershed had been delineated, its thalweg line was identified and the basin evaluation graph was constructed (viz Figure 1).

The figure contains all three constructed basin evaluation graphs. According to the graphs, it can be stated that there is a great variability in various watersheds when it comes to channel formation from the nonpoint runoff. In these particular watersheds, according to the accumulated area raster, the stream channels form approximately at 100m of the stream chainage for Rosenauerova A watershed, 700m for Rosenauerova B and 600m for Rosenauerova C. It would be very interesting to look at this phenomenon more closely in the light of other specific conditions, such as slope, aspect, geology and vegetation-cover and to verify obtained results in the field.

The basin evaluation graph clearly represents at what length of the main stem, do various contributing streams join the channel. Considering the instant increase in watershed area at these junctions it is possible can get the general idea of the strength of the contributing stream. According to the graph Rosenauerova A stream has 4 important tributary streams, where the strongest one drains off an area of approximately 250m^2. The Rosenauerova B main stem has 2 important tributary streams both of them draining off an area of a little less than 200 m^2. Finally, the Rosenauerova C main stem has 4 important tributary branches. The strongest of them draining off an area of approximately 300 m^2.

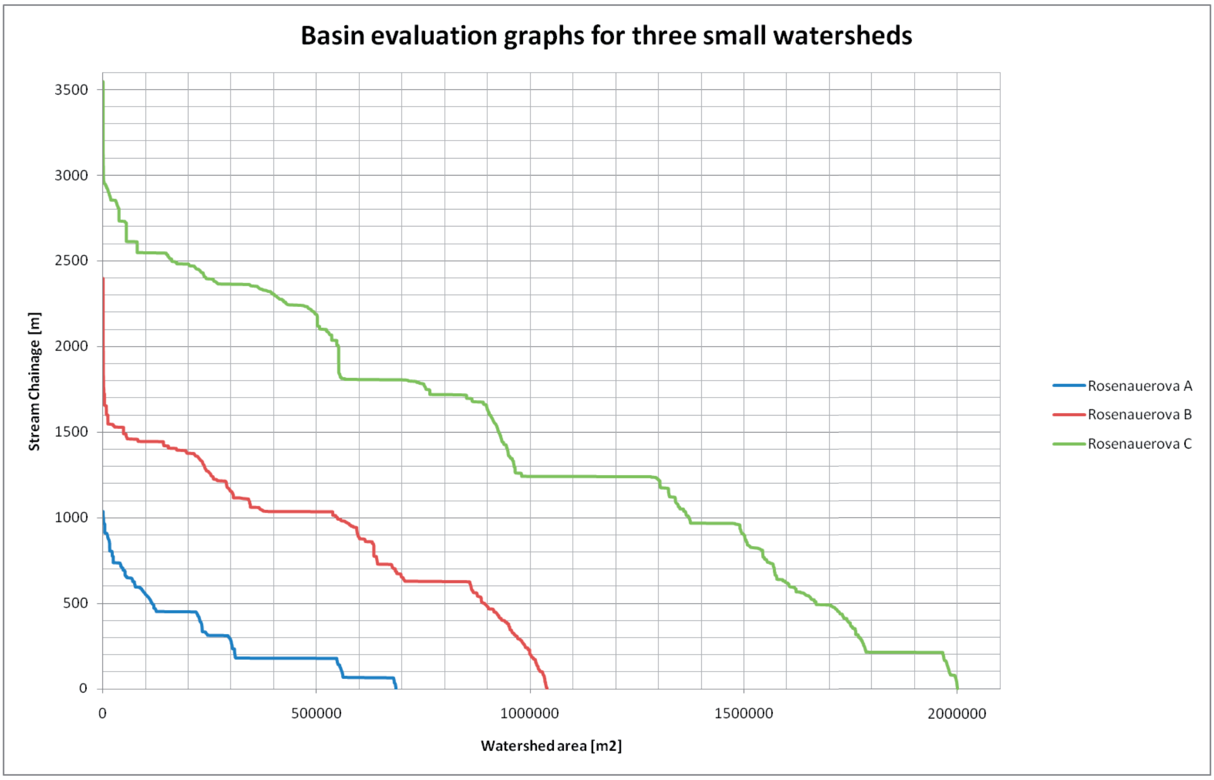

Figure 1- Basin evaluation graphs of three small watersheds of the Žiluvecký stream

Discussion

The applied methodology pointed out the fact that any operation and analysis on spatial data sets lives and dies with the primal accuracy of input data. The particular ZABAGED layers used to obtain the results presented in this paper seem to be right at the imaginary edge of usefulness. The constructed contour lines of 2m density allowed the creation of a DEM with pixel size 4 square meters. This accuracy proved to be fully sufficient for watersheds of size around 1 square km (smallest one around 0,6km^2). However, the input data were missing for the river beds of most streams. This fact caused several problems in watershed delineation and most importantly in the creation of flow accumulation rasters, decreasing the overall accuracy of the results by a significant amount. Doing own terrain measurements using laser scanning or GPS technology would definitely provide better input data. Another way of dealing with the original inaccuracy of input data would be to draw the missing parts of the contours using another source map of desired accuracy (for example tourist map). However, it would increase the amount of work and time to a completely different level.

Conclusion

ArcGIS 10.0 software offers a wide variety of tools for hydrology and topology analysis. It is possible to delineate watershed and identify their respective thalwegs using this software. The accuracy of these operations is primary dependent on the accuracy of input data. Even though it was proved that it is possible to use the ZABAGED data for this kind of operations at this level of accuracy, it also has to be stated that the current state of ZABAGED contour layers is far from ideal. While the general accuracy (contours of 2m density) is sufficient, the missing parts in river beds cause topology problems. To increase the accuracy of described operations some measures solving the missing values of contour lines need to be taken (own terrain measurements, filling blind spots from other maps).

The basin evaluation graph offers a clear and simple interpretation of important watershed characteristics, such as its area, the strength of contributing streams and the approximate length of nonpoint runoff. It is definitely a good way to represent hydrology data of small watersheds.

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Development of Wastewater Treatment in Spain

Pablo Santonja Serrano, Katarína Domokošová

Abstract

In antiquity it began to create the first water purification systems. They were motivated to eliminate health problems resulting from epidemics caused by population growth in urban areas. At first it was just to create drainage of waste water, were built so that water drainage systems, initially has potholes, and later to the river water. However, with increasing population and industrialization began to several pollution problems in waste disposal areas, making clear the need to treat wastewater prior to discharge. This resulted in the appearance of the first water treatment systems. At first they were dedicated to the elimination of solids, later supplemented with the soluble organic matter through biological treatment, trickling filters first and then the activated sludge.

We can say that in the late sixties and has developed a considerable scientific basis in regard to conventional biological treatment, in fact, has lasted until today, although, obviously, in the intervening years have been incorporated new nuances and refinements result of new achievements and discoveries and the application of research and development means more and more powerful.

Keywords

CEDEX: studies and experimentation center for public works

WWTPs: Wastewater Treatment Stations

Introduction

The concept of sanitation can be synthesized by definition, only qualitative, that it is a field of engineering which aims to collect and transport wastewater and treat it both as by-products generated in the course of these activities So that the evacuation will produce the minimum impact on the environment.

With reference to the changes they have experienced the objectives of sanitation, since the beginning of modern practice to the current situation, based on social needs, we can distinguish three stages:

First stage: Health and Safety

In this first stage, the sanitation target focuses primarily on the protection of public health against impurities in the water supply due to releases caused by human activities and, subsequently complemented by the avoidance olfactory and visual discomfort originating in those waterways.

Consequently, when we introduce the concept of pollution, the definition is based on their potential to cause disease and creating offensive conditions.

In temporal terms, this stage extends from the beginning of modern sanitation (mid-nineteenth century) until the fifties of this century.

Second stage: Protection of other water uses

In the fifties, the recognition of the tremendous changes experienced by society is the beginning of the replacement of the previous concept of pollution for water quality.

Indeed, a number of factors such as population growth and its concentration in urban centers, the largest per capita water consumption and, consequently, increased wastewater discharges, and the importance of the industry as a major emitting pollution, both in quantity and the introduction of a wide range of chemicals in discharges, led to the concept of pollution control, until then focused on the objective of protecting public health, be moved to control to protect the interests related to the various uses of water beyond the traditional supply.

This entails the documentation of applications to protect and extend the concept of pollution in terms of these uses and, as noted previously, the introduction of the modern concept of quality control of water.

Third stage: Environmental protection

As economic progress is increased, the company experienced a craving, increasing to preserve and enjoy nature, so establishing the need to preserve water quality, since it involves the maintenance of conditions precise environmental conservation of the natural environment in all its manifestations.

This attitude has meant putting the control of the nature of the use of the causative agent of their degradation, resulting in a shift of the objective of protecting the use for protection of the resource itself.

In short, each of these stages has led to the setting of specific quantitative and qualitative objectives that have led to an evolution of the concept of sanitation and, consequently, have led to the gradual expansion of its content and the development and application of techniques and increasingly complex systems to achieve those goals.

History of wastewater treatment in Spain

The history of sanitation has its roots in antiquity, in which its development was motivated by the cities and religious centers or commercial.

Apart from the achievements, not inconsiderable, of those times, and focusing on more recent history, it is known that the wastewater treatment comes in response to a problem on health grounds.

Industrialization led to the uncontrolled mass of people around the production facilities, creating quite painful health conditions, which resulted in numerous epidemics have highlighted the connection between the health status of drinking water and development disease.

Although many cities have, several centuries earlier, waste-water pipes, they were designed exclusively for storm water drainage, to the point that in England in the early nineteenth century it was forbidden to pour water waste to these channels.

The first step in solving the problem was the construction of drains in the buildings, which until then only available, at most, of cesspools, and its connection to the drainage ducts, giving rise to the first sewers unitary rate system that was subsequently adopted by most cities.

Traditionally, clean up a town was synonymous with giving it a sewer system, and in most cases made no mention of the treatment of wastewater. However, the construction of sewage systems first showed that, although contributing to the reduction in the number of discharge points, better, of course, local conditions compared to the previous situation, there was a higher concentration of pollution that immediately produced a worsening of the condition of the rivers, creating unacceptable health and environmental conditions, so it was suggested that the wastewater discharge should not be at those, but should be used to fertilize the soil, which proposed the first system of treatment and completed the previous concept of consolidation, based on the collection and transportation of wastewater, with its purification.

From this point, develop the first treatment systems, initially aimed at the elimination of solids and then supplemented with soluble organic matter through biological treatment, trickling filters first and then the activated sludge.Sanitation practice came late to the country.

With some exceptions in which foresaw the construction of both sewage networks and treatment facilities prior to discharge, virtually all sanitation structures made up the sixties, were reduced to the construction of sewage systems.

The waste treatment was not concern initially, probably because the general lack of adequate facilities for drinking water supply was priority directing economic resources available to mitigate the weakness of the structures of this sector.

In any event, it should clarify that, with reference to European countries, only Britain and Germany can establish a consistent policy in this field until the forties. Only from the fifty's when the purification of waste water begins to become important in other European countries, although its economic and technological level allows them to quickly tackle their problems solving.

In the mid-sixties, when, by way of illustration, in the two countries referred to the percentage of population connected to sanitation systems including primary or secondary treatment of wastewater was approximately 80%, is when we place the initiation of a state policy aimed at solving the problem of pollution caused by wastewater discharge.

Obviously, the star of the treatment processes was that of activated sludge.

Started in England in 1914 by Arden and Lockett, was experiencing over the years, constant development, causing the progressive shifting of the classical system of trickling filters, so that when the question arose in Spain, this technique was despite predicament to establish a system of proven effectiveness and economy of operation that possibly did not deserve that treatment.

In the long journey from the time of inception to date, the phases can be distinguished, as discussed in what follows.

Takeoff

We can speak of a first stage which could be described as heroic beginning for the few specialized companies existing at the time having made the effort to keep skilled technicians and expensive equipment at a time when the number of contracts going out to the market was very small.

Is the time when the motor is constituted as CEDEX (studies and experimentation center for public works) development, not only because of assume responsibility for resolving contests construction of treatment plants, but also for their eagerness in

establishing the technical basis necessary for the normalization projects and the contractual terms. Cannot forget we're talking about a period characterized by a lack of experience and craft caused by the lack of accomplishments, of literature and general information.
This lack of experience in the design of wastewater treatment plants, meant that the procurement method of work adopted at that time by the Administration and, in fact, has lasted until today, was the "Design and Construction Competition ", because only specialist companies could guarantee the level necessary to accomplish them.
The result of this concern was the wording of the "Model Statement of Technical Basis for the contest and execution of Works Wastewater Treatment Stations", conducted jointly by the CEDEX and specialized firms, which, for the first time established minimum requirements and design basis of the wastewater treatment plants, constitute a basic document that allowed the initiation of a procurement policy consistently and uniformly throughout the entire state level.
Logically, the first achievements were not without mistakes, but gradually experienced a progressive improvement, because of the introduction of new concepts and techniques that allowed the abandonment of unorthodox practices and training of specialists in the field. As always, competition played a positive role in improving the situation.
Apart from the intrinsic problems arising from inadequacies in both the project and the implementation of the facilities, perhaps the most pressing problem of this phase was the dissociation between central and local administration, which received the plants built by it and often lacked the financial resources and, in many cases, the interest necessary for the proper operation of treatment plants.
Of course, we can say at this stage, and even during many years later, the effort in building the plants had little response in the appropriate outcome, because of the inadequacy of the applied in the exploitation of those.

Consolidation

Throughout the seventies, the sector was experiencing a growing progress, reflected in the number of WWTPs (Wastewater Treatment Stations) constructed as in the introduction of new technology and consolidation of the doctrine applied in drafting projects.
In fact, we can say that at the end of the decade the technology available to companies specializing enough and almost comparable to those of other European countries, since most of those have licenses, partners or collaboration agreements with foreign companies.
However, the overall level of the plants built cannot be considered comparable to those of such countries, mainly for economic reasons, which resulted in some shortsightedness in the design of unit operations and processes and, above all, inadequate the allocation of plants in relation to the quality of electromechanical equipment, a factor which, unfortunately, we cannot say it was totally outclassed today.

Conclusion

Current situation analysis

The basics of the current situation in Spain can be summarized as follows:

1. Market development has significantly boosted the number of specialized companies and, consequently, professionals working in this field.
2. The structure of the prevailing contract system-quizzes-work project and has been a great difficulty for the national consulting firms to access the same levels of expertise and efficiency that credited to other engineering sectors.
3. The multiplication of competent authorities on the subject has had positive effects and others not so.

In the chapter on the advantages we should mention those arising from greater knowledge of local issues and the possibility of expediting the necessary steps to resolve problems and implement solutions appropriate to each case.
Regarding the disadvantages should be noted that the absence of a consistent doctrine of state level has resulted in the recent past, confusing situations, having witnessed the implementation of solutions are not always appropriate and road travel were already known and could have been avoided, thus saving money and improving the efficiency of investment.

4. There isn't any association that promotes the development and exchange of knowledge and enables the development of technical standards that contribute to the standardization and dissemination of good practice in this field. Related to this point, include the low level of sharing of

experiences between the various actors operating in the sector.

5. In the chapter on the failures or shortcomings can be said that the operation and maintenance of plant height is not that desirable. Most Sanitation General Plans developed to date have not given due importance to the fate of the sludge produced in sewage treatment plants, which, ultimately, is the most conflictive aspect of environmental and social development of a plan.

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THE CBR TEST TO OPTIMIZE THE DESIGN OF THE PAVEMENTS OF RURAL ROADS

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ABSTRACT

The construction of rural roads is essential for the social and economic development of the small human communities, often located in mountainous and semi-desert sides, where access is very complicated, or the transport in the forest is very difficult and expensive.

While construction of these rural roads is fundamental, they should be design in a respectful way toward the environment. Proper plan and design of the road is the key to controlling and minimising possible negative impacts.

INTRODUCTION

Nowadays many geotechnical tests are done in order to optimize the design of different constructions. There are tests to classify grounds, such as the test of humidity, granulometry, aerometer and the spoon of Casagrande. However, there are another two tests for analysis of mechanical properties of the materials that are used for the constructive layers. Although there are two different tests to analyze the surface, the most important test that is used to describe the properties of the surface is the CBR test, which is applied to the different layers of the surface. The other test called Proctor standard is used for the determination of the mechanical properties of the soil by compacting it.

The results that are obtained from the CBR test are not sufficient for the design of the pavement, because the results from this test are not suitable comparative magnitudes for the progressive methods based on methods of finite elements, because the standard CBR test does not describe the relationship between the load and the deformation. For these reasons, a new test is being developed. This test is called cyclic CBR test.

DESCRIPTION OF THE PROBLEM

A system of rural roads well planned, located, designed, constructed and maintained, is essential for the community development, for the flow of goods and services between communities, etc. However, the roads and especially the construction of roads can cause more ground erosion than most of other activities taking place in rural areas.

With an adequate planning and design of a road system is possible to minimize adverse effects on water quality. Poorly planned road systems can have high maintenance and repairing costs. They may also contribute to excessive erosion and may not satisfy the needs of users.

It is very important to locate roads on stable ground in moderate slopes, dry areas away from drains, and away from other

Picture1. A forest road.

problematic areas. Avoiding problematic areas may save significant costs on design, construction and maintenance, and it may also minimize many undesirable impacts.

Following steps have to be carried out in order to create a successful road project:

• Planning

• Location

• Land uprising

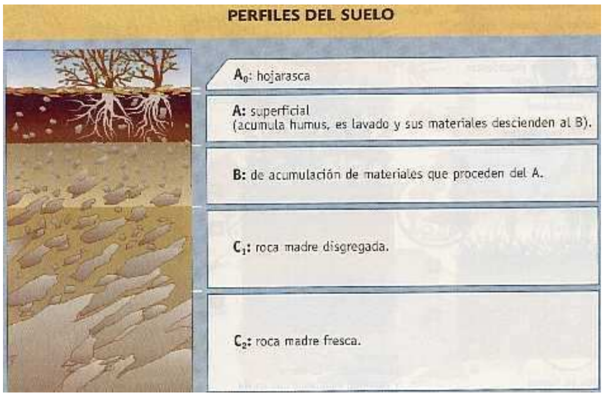
• Design

• Construction

• Maintenance

In case one of these stages is omitted, the behaviour of a road may be poor, may not fulfil the expectations, may fail prematurely, or cause unnecessarily high impacts on maintenance or environment.

Before the road is built the natural land can be classified into three layers defined as A, B and C.



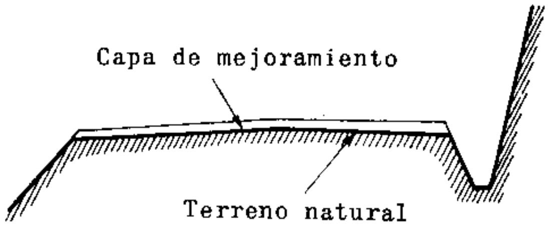
Picture2. Layers of natural land.

-Layer A: it is the most superficial layer, which contains a dark layer rich in humus and minerals. Humus is the fertile part of the pavement, which makes them suitable for cultivation. Rain water runs through it, dissolving and dragging down ions and other molecules. This action is designated as soil washing.

-Layer B: it is a layer where the washed materials from layer A are accumulated. These materials got there by infiltration processes. Mineral particles and organic components that come from plant debris and decaying materials predominate there.

-Layer C: this layer is the result of the alteration of the mother rock. It consists of small fragments of rock, more or less altered, which come from it. This layer could also be called as the layer ground.

From the top of the ground 10 or 15 cm of land is removed in order to construct the road. Because of the elasticity of these layers anything can be constructed over them. This soil is used aside the road, where the grass grows.



Picture3. Layers of rural roads.

After removing the land, the standard CBR test is made with the material that is underneath. If the result of this test is lower than 10% of the comparative result, then it has to be improved with lime or other materials. If the results have a percentage of over 10%, the soil is compacted according to the results that are obtained from the Proctor test.

On the so called ground layer is put a covering made of a grainy material that it is well compacted from a laboratory. At first the first constructive layer called C2 is prepared and then, the layer C1 which covers all the construction.

Low volume road surfaces and structural sections are generally constructed of local materials that must bear light vehicles and that may have to withstand heavy load truck traffic. They must also have a running surface that being wet provides an adequate traction for vehicles.

It is generally recommended, and in many cases necessary, to add additional support to the subgrade or to improve the surface with materials such as gravel, thick rocky soi, etc.

The tests that are used to calculate the

Picture4. A Proctor mould.

mechanical properties of the soil are Proctor and CBR tests.

Proctor test: It is a trial to determine the mechanical properties of the soil by compacting it.

The soil structure and some of its mechanical characteristics vary by the compaction. The compaction is a repetitive process, whose objective is to determine the optimal parameters of compaction, which will ensure the essential properties needed. The moisture that is looked for is defined as an optimum moisture and it is with it that is reached the maximum dry density for the given compaction energy. The dry density increases until reaching the maximum value, at which the humidity is optimum. From this point, any increase in humidity does not increase density, but may be a reduction of it instead.

The compaction consists of crushing the soil into a standard mould using a standardized crushing energy at different levels. There are two types of Proctor tests: standard and modified.

Proctor standard is used for the third layer of the pavement, called ground layer; and Proctor modified for the other two layers, the constructive layers. Depending on the test some of the tools used are changed due to the energy that is used for crushing the soil.

CBR test: It is a penetration test to analyze the resistance of the soil. The results obtained from this test are used in empirical curves in order to determine the thickness of pavements and its layers.

This test is based on the percentage of the force required to penetrate a soil´s area with a standardized cylinder piston at a speed of 1.27 mm / min acquiring the corresponding penetration of the standard material.
CBR results are usually calculated for the penetration of 2.5mm and 5mm.

According to the current regulation the design of the roads is based on the CBR test, but the standard test is not enough to describe the behaviour of the granular materials' deformation. Nowadays, the methods to design the pavements are modified, and these methods require the characteristics of the deformation. That is the reason why the results are verified with another test which is called cyclic CBR.

The cyclic CBR test: it is a simple method for the characterization of materials and land. It means that it is a test that allows reasonable and accurate estimates of the elasticity and characteristics of the permanent deformation of soils and granular materials.

Nowadays, the methods for the design of the pavement require the real characteristics that describe the plastic and elastic deformation of the granular materials. According to the recent researches the most suitable test that can describe this behaviour is the cyclic CBR. At the same time

this test is able to describe better the character of load, because the pavements suffer cyclic loads caused by the pressure of the different vehicles.

Picture5. A CBR machine.

It is thought that this method allows an easy determination of the effects of moisture content, the degree of compaction and gradation in elasticity and characteristics in the permanent deformation of soils.

A standard CBR sample is prepared. After that the CBR test is performed until the penetration of 10mm. Then the sample is unloaded until the load is zero, and it is again charged up until the load required for the value of 10mm in penetration. This sequence is applied as many times as necessary until elastic deformation reaches a constant value. Usually this happens after 50 charge cycles.

The cyclic CBR test is performed in standard CBR machinery. Effectiveness module E_{eff} is calculated using the elastic deformation when the deformation is stable.

Some tests were carried out in the laboratory of Mendel University, by increasing the humidity of the pavement. The material used for these tests was from Klepacovska, concretely from the layer C.

Observing the results of these tests there have been reached some conclusions, for example that the more the moisture increases the more the module of effectiveness decreases.

There have been done eleven tests with different moisture content in order to have a graphic relationship between tests of different moisture, because there is no connection linking the different moisture content with the behaviour of the pavement.

In order to analyze these results statistically, about twenty tests for each percentage of moisture should be done.

The deformation in the first cycles of a cyclic CBR test is both, plastic and elastic. However, from the cycle number fifty more or less this deformation turns into only elastic. The objective is to calculate the module of elasticity of the material, but with the information that is obtained from the test is impossible to use this generic formula:

Professor A. A. A. Molenaar, from Delft Technological University, proposes another equation to calculate the module of elasticity directly from the values we have from CBR.

Where:

E= Elasticity module of the material.

W= calculated elastic deformation

a= load's circular radius (plunger)

σ_0 = stress under the load

μ= evaluated material´s Poisson´s module

C_1 = 1.797 in case there is friction between the material and the mould and 1.375 if there is no friction

C_2 = 0.889 if there is friction and 1.286 without friction

C_3 = 1.098 if there is friction and 1.086 without friction

Using this equation one has to make an estimate for μ. Usually a value between 0.35 and 0.45 is taken. The choice depends on the type of material used and moisture conditions. Furthermore one has to decide whether full slip is assumed between the soil and the walls of the mould or full friction.

The values of elastic module that are obtained with the two values mentioned above will be different. However, the difference is not so important because this test is not meant to determine an exact value for the resilient modulus but a realistic value for the effective modulus.

The modulus obtained from repeated load CBR test is in fact an overall representation of the stiffness of the material in the CBR mould. So as a conclusion can be said that, it is not a material characteristic but a sample characteristic.

The article was supported by research project TA01020326 „Optimization of design and realization of low capacity roads pavements“ by Mendel University in Brno, Faculty of Forestry and Wood Technology

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PHYSICAL AND GEOMETRIC PROPERTIES OF THE ŽILŮVECKÝ POTOK BASIN
An example procedure for the determination

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Abstract

Factors which affect surface runoff are closely related to the properties of the basin from which the water flows and its environment. They have an effect not only on the size of the runoff but also its origination and temporal distribution. The presented study focuses on the results of the analysis of the Žilůvecký potok basin from the perspective of its physical and geometric properties which influence the runoff conditions.

Keywords

Basin, hydrology, physical and geometric properties, rainfall-runoff process

Introduction

The forest stream called Žilůvecký potok is located in the central part of the Training Forest Enterprise Masaryk Forest Křtiny (TFE), Mendel University in Brno. Its drainage basin spreads between the municipalities of Řícmanice and Babice nad Svitavou. The stream and its tributaries drain water from an attractive area adjacent to the Protected Landscape Area of the Moravian Karst.

The Žilůvecký potok is a sixth-order stream. It is 2,635 m long. It springs near a public road connecting the municipalities of Kanice and Babice nad Svitavou at an altitude of 354.75 m a.s.l. The stream is a left-bank tributary of the Svitava River and its mouth is at an altitude of 235.00 m a.s.l., near the Babice nad Svitavou railway station. The stream has two more significant permanent tributaries – the right-bank Pramenný potok, draining an area called Jančovec, and a left-bank stream without a name, which flows from the Babický Forest. The average slope of the stream long profile is 45 ‰. The geological bed of the stream and its close surroundings consists of fluvial Quaternary sediments (clay, sand and gravel).

Material and Methods

The basic work unit in hydrology is a drainage basin. This is an area from which all water converges to a single point in the stream (the ending profile), i.e. it is the area from which water is drained to the stream. This concerns all runoff – surface and groundwater, while the surface runoff usually prevails. If the groundwater flow differs from the surface basin only negligibly, it is sufficient to establish the basin by finding the area within which the water flows from the highest points to lower ones according to the shape and the height topography of the territory. The border of a basin is called watershed divide and it is a line going orthogonally to contour lines along the highest points and separating the areas from which water flows towards neighbouring streams. A drainage basin established in this way is an orographic basin (Starý, 2005).

However, it is not always advisable to disregard the difference between the area of an orographic basin and a groundwater basin. Then it is necessary to work with the real, hydrological basin, which is the area of the entire runoff from the drainage basin. Its delineation can present some difficulties, especially in a territory with an occurrence of karst phenomena.

The ending profile has to be set on the stream to delimit the drainage basin. Without this, we always consider the basin of an entire stream down to its mouth.

The factors which affect the runoff are closely related to the properties of a basin from which the water flows and its environment. They have an effect not only on the size of the runoff but also its origination and mainly its temporal distribution (fluctuation, changes). These factors can be divided into two main groups. The first group contains climatic factors, which are besides precipitation the meteorological quantities affecting the overall evaporation of water in the drainage basin. These include the actual temporal and spatial progress of a rainfall, the moisture of air, evaporation, air temperature, the velocity and direction of wind, atmospheric pressure, etc. The other group consists of geographic factors of the drainage basin. These describe the environment in which the process of runoff occurs. This group contains physical and geometric factors, geological properties of the basin, vegetation cover and the river network (Starý, 2005).

Results

To examine the physical and geometric properties of the Žilůvecký potok basin, input data in digital form were used. The AutoCAD Civil 3D application was used to create a digital terrain model (DTM) of the basin from the distribution of elevation data from the

ZABAGED geographical database. As a result, we obtained a three-dimensional surface interpretation of the examined area, which was then further analysed.

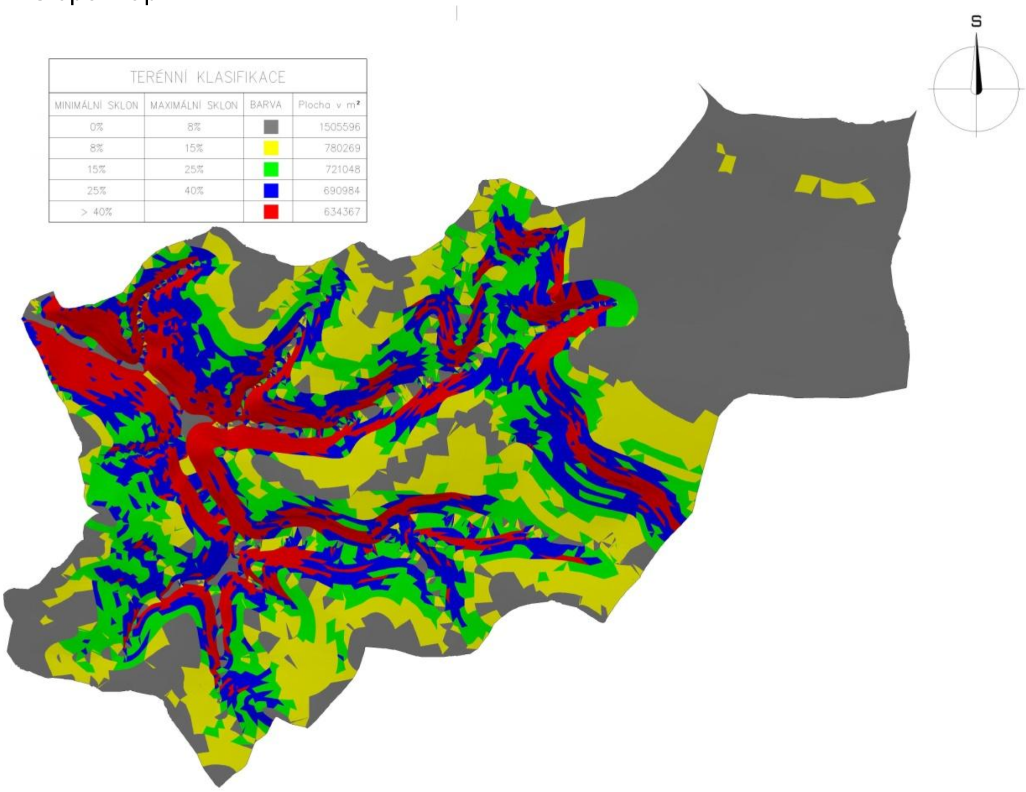
The measured properties include the basin area, the forest area, the maximum and the minimum altitude of the basin, the basin middle altitude, the maximum and the minimum altitude of the stream, the length of all streams in the basin, the length of the main stream, the length of the valley line, the length of the watershed divide and the direct distance from the spring to the ending profile (Tab. 1).

As regards derived properties, we established the middle width of the basin, the basin shape coefficient, the average and the middle altitude, the average slope of the basin, the middle slope of the terrain, the average slope of the stream, the stream irregularity coefficient, forest cover percentage, the density of the river network, the coefficient of basin perimeter articulation, the coefficient of contour line articulation, and the coefficient of terrain articulation (Tab. 2).

Tab. 1 Physical and geometric properties of the Žilůvecký potok basin, measured

Property	**Sign**	**Value**
Basin area	S_p	4.199 km^2
Forest area	S_{pL}	3.130 km^2
Basin maximum altitude	H_{pMAX}	503.70 m a.s.l.
Basin minimum altitude	H_{pMIN}	235.00 m a.s.l.
Stream maximum altitude	H_{tMAX}	354.75 m a.s.l.
Stream minimum altitude	H_{tMIN}	235.00 m a.s.l.
Length of all streams in the basin	ΣL_t	5.773 km
Length of the main stream	L_{ht}	2.635 km
Length of valley line	L_u	3.719 km
Spring – ending profile distance	l	2.118 km
Length of watershed divide	O_1	10.815 km

Fig. 1 Slope map



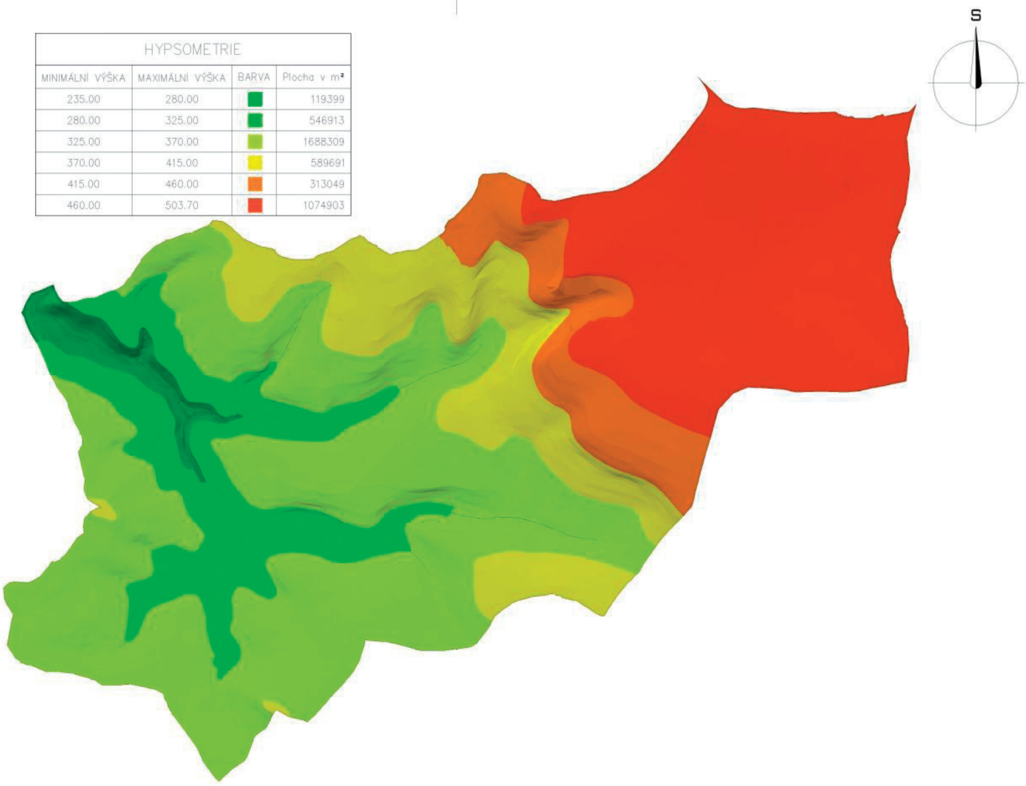
Tab. 2 Physical and geometric properties of the Žilůvecký potok basin, derived

Property	Sign	Calculation	Value
Basin middle width	b	$\frac{S_p}{L_u}$	1.129 km
Basin shape coefficient	α	$\frac{S_p}{{L_u}^2}$	0.304
Average basin altitude	H_p	$\frac{H_{pMAX} + H_{pMIN}}{2}$	369.35 m a.s.l.
Middle basin altitude	H_{pS}	$\frac{s_1 h_1 + s_2 h_2 + \cdots + s_n h_n}{S_p}$	386.64 m a.s.l.
Average slope of basin	I_p	$\frac{H_{pMAX} - H_{pMIN}}{\sqrt{S_p}} \cdot 100$	13.11 %
Middle slope of terrain	I_{ter}	instrument *Surface Analysis* (Civil 3D)	19.94 %
Average slope of stream	I_t	$\frac{H_{tMAX} - H_{tMIN}}{L_{ht}} \cdot 100$	4.54 %
Stream irregularity coefficient	K_n	$\frac{L_{ht}}{l}$	1.244
Forest cover percentage	L	$\frac{S_{pL}}{S_p} \cdot 100$	74.53 %
River network density	D	$\frac{\sum L_t}{S_p}$	1.375 km·km^{-2} 13.75 m·ha^{-1}
Basin perimeter articulation coefficient	m	$\frac{O_1}{O_2}$	1.489
Contour line articulation coefficient	$K_{čv}$	$\frac{D_{øv}}{K}$	1.588
Terrain articulation coefficient	K_t	$\frac{\frac{I_{ter}}{5} + \frac{D}{10} + 2 \cdot K_{čv}}{3}$	2.846

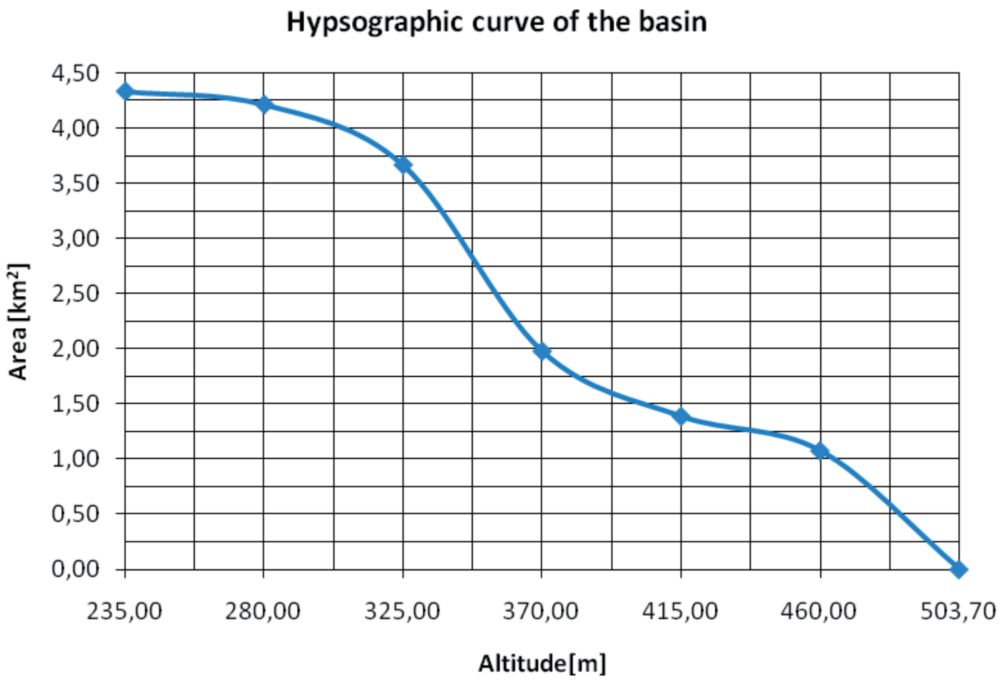
Note:
$s_1, s_2, \ldots, s_n$ ... areas between contour lines
$h_1, h_2, \ldots, h_n$ ... average altitudes of contour lines belonging to the areas between contour lines
O_2 ... circumference of a circle with the area equal to the basin area
$D_{□v}$ ... length of a contour line with the middle altitude together with the section of the watershed divide which connects the points of intersection of the watershed divide with the middle contour line
K ...circumference of the circle with the same area as the area defined by the contour line and a section of the watershed divide

The *Surface Analysis* instrument was used to generate a slope map (Fig. 1) and the middle slope of the terrain was established. Another output is a map of hypsometry (Fig. 2), which expresses the distribution of elevations by means of colour coding. Further, the calculation of areas between the altitudes we entered was automatically performed in the application. The data we thus obtained were used to create the hypsographic curve of the Žilůvecký potok basin (Graph 1).

Fig. 2 Map of hypsometry



Graph 1 Hypsometry



Altitude [m]	235.00	280.00	325.00	370.00	415.00	460.00	503.70
Middle altitude [m]	386.64	386.64	386.64	386.64	386.64	386.64	386.64
3D terrain area [km^2]	4.332	4.213	3.666	1.978	1.388	1.075	0.000

Conclusion

Physical and geometric properties of a basin represent the foundation for modelling of the rainfall-runoff process. Their establishment has to be devoted an appropriate attention – the best available data and the most efficient methods for their processing and result interpretation are to be used. The results can be then used for the solution of the water regime or as a significant aid in forest road access within the area of the Žilůvecký potok basin.

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Evaluation of stream-bank vegetation of Rakovec

Ing. et. Bc Jan Škrdla, Ing. Petr Kupec Ph.D.

Abstract

The article presents methodology stream-bank vegetation registration in rural landscape, example of the result and survey area characteristics. Register is instrument for stand and habitat management. Methodology is applied on example of section of the river Rakovec.

Evaluated streams are fractioned into the sections delimited by significant barriers. Within the frame of sections, segments are determinate (parts with similar characteristics in general). Surveying includes site and stream assessment and streamside stand valuation. Stand assessment consists of spatial structure evaluation, species structure valuation, and age and health assessment. After surveying data processing is following (maps and database). The register serves as a summary of stream-bank vegetation and as a base for management.

Key words: stream-bank vegetation, rural landscape, registration of stream-bank vegetation, Rakovec.

1 INTRODUCTION

Stream-bank vegetation is an important constituent of landscape. Streamside stands consist of riparian and accompanying stands. Riparian stands are located on riverbed, accompanying stand are located after band edge. Bankside trees and shrubs are one of the building blocks of territorial system of ecological stability (TSES) (Šlezingr, Úradníček, 2003). Stream-bank vegetation provides many functions. Many streamside stands arení in good condition at present. Some stands are composited by exotic species or by species unsuitable for site. Many streamside stands are discontinuous; some banks of small streams are without woody vegetation. Reason is absence o management planning.

Stream-bank vegetation management is solved in Act No. 254/2001 Coll. on Water. The management is duty of owner or administrator. Streamside stands are objects of other laws, for example Act No.114/1992 on Nature and Landscape Protection or Act No. 289/1995 on Forests. In the European Union, water policy is established on Directive 2000/60/EC of the European parliament and of the council (Water framework directive).

In Europe, the issue of stream-bank vegetation and stream buffer zones was published in works by Bache and Macaskill (Bache, Macaskill, 1981) and Coroi, Skeffington and Giller (Coroi, Skeffington, Giller, et al., 2004). In the world, issue of stream-bank vegetation assessment was solved for example in work by Burton, Smith and Cowley (Burton, Smith, Cowley, 2008). Stream restoration evaluation assessment form was prepared by NCSU Water Quality Group (2006).

In the Czech Republic the unified methodology of stream-bank vegetation assessment is not available at present (Havlíčková, 2005). Streamside stands management was dealt with by Šlezingr (Šlezingr, Úradníček, 2002, 2003), Havlíčková (Havlíčková, 2005), Novák, Iblová and Škopek (Novák, Iblová, Škopek, 1986) and Erlich (Erlich, 1992). Streamside stands registration was dealt with in special management plans (for example Mařák, 1996). Plans were projected for some rivers in administration of Povod□Moravy, s.p.

This article presents methodology of stream-bank vegetation evaluation. Methodology is aimed for registration and evaluation of streamside stands in rural landscape. Result of methodology is stream-bank vegetation database □ base for management planning.

2 MATERIALS AND METHODS

The methodology is applied on the example of registration and evaluation of stream-bank vegetation in section of the Rakovec river (hydrology order 4-15-03-069). Rakovec is the right tributary of the Litava river. The spring is located under the hill called Lipový kopec (561 m, spring elevation - 485 m) and river mouth is close the village called Hrušky, elevation - 200 m (cenia_dmu25).

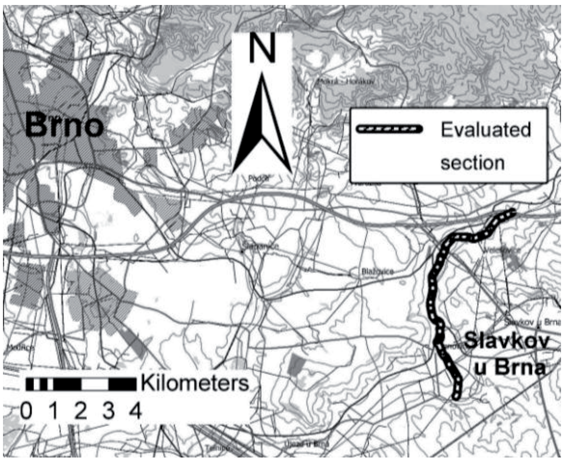

Fig. 1: Localization of survey area

Survey section is located in the eastern part of the South Moravian Region (division Vyškov). This section is limited by the river mouth (river log 0.0 km) and highway D1 (river log 8.95 km, elevation 225 m).

Thesis of the methodology is published in article by Škrdla and Kupec (Škrdla Kupec, 2010). Evaluated rivers are fractioned to the sections, limited by natural or artificial barriers. Within the frame of sections, segments are determinate. Segments are parts of the section with similar characteristics (width, structure, species composition, etc.) in general. Segments are characterized by delimitation, alluvium and river-basin characteristics and by stream-bank vegetation. Segments are mapped as lines. Delimitation of segment is given by beginning and end river log, length (division between end and beginning river log), middle width and area.

Stream-bank vegetation (streamside stands) are characterized by width, space structure, species composition, physiological age and by health conditions.

Width of the vegetation zone is displayed in meters, and width category is determined. Spatial structure is characterized by number of vegetation layers and by stream-bank vegetation continuity (relative density of stand). Stream-bank vegetation (layer) continuity (canopy closure or relative density) means coverage of area by crown projection.

Species composition is significant character. Tree and shrub layers are evaluated separately, general herbal species are noticed. Species composition (representation) is indicated in decimal number (0.1 -1). Accessory species (representation until 10%) are sign by +. Recent species composition is compared with potential composition according to Zlatník (Zlatník in Šimíček, 1999). In species diverzity accessing number, immixing of the species and form of the immixing (single, group or line) are evaluated.

Physiological age is development phase of tree (stand, layer). Tree is evaluated according to Kolařík (Kolařík, 2005). In dependence on physiological age and age variability, 6 age classes are distinguished. Physiological and biomechanical vitality of trees are assessed visually. Physiological vitality is ability to resist harmful effects. Biomechanical vitality is grade of mechanical damage and weakening. Species in tree layer represented at least 10%, are objects of special measuring. Tree high and breast high diameter are measured; number of trees and number of stems per 100 meters of bank are quantified.

Result of methodology is stream-bank vegetation database. Stream-bank vegetation database includes maps, databases, stream-bank vegetation evaluation and management theses.

Object of map section are general and detailed maps. Maps are generated by source maps (basic map, photomap) digitalization. Content of general maps are evaluated stream display, fragmentation to sections and land use display. Detailed maps include map of stand evaluation and map of the management proposal. Detailed maps are connected to databases.

Databases consist of section database, segment database and specifications of tree layer. Objects of section database are section identification, including hydrological order, hydrological log of beginning and end of the sections and length.

Objects of segment database are identification, delimitation, alluvium and river-basin characteristics and stream-bank vegetation characteristics. Segment delimitation data include river log of beginning and end of segment, length, middle width and area. Object of stream-bank vegetation characteristic is description of stand, tree layer and shrub layer. Database includes data about width category, continuity, qualitative rates (development phase, autochtonity, species diversity, etc.) and species composition. Objects of specification of tree layer are detailed data about tree stand.

3 RESULTS

Flood plain in survey area is intensively utilized. The following chart shows use of the land close to the evaluated sections. Most of the area (73.6%) is utilized as arable land, 11.2% of banks border is formed by the road or built up area. 15.1% of stream-bank vegetation borders on forest or perennial vegetation (forest, garden, grassland).

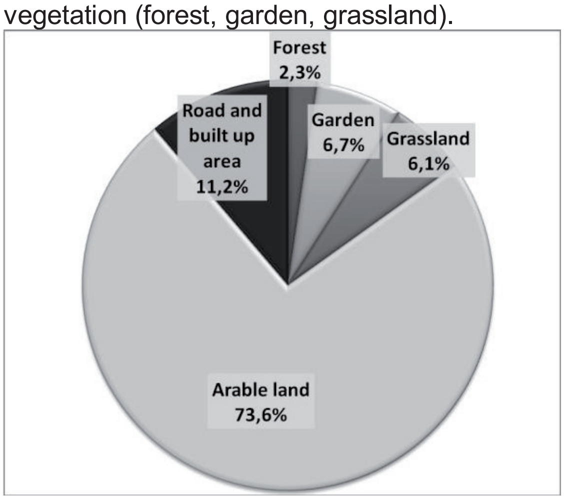

Fig. 2: Land Use in flood plain

Width of stream-bank vegetation is limited by land use of boundary land. 95% or evaluated banks reached width between 3 and 10 meters.

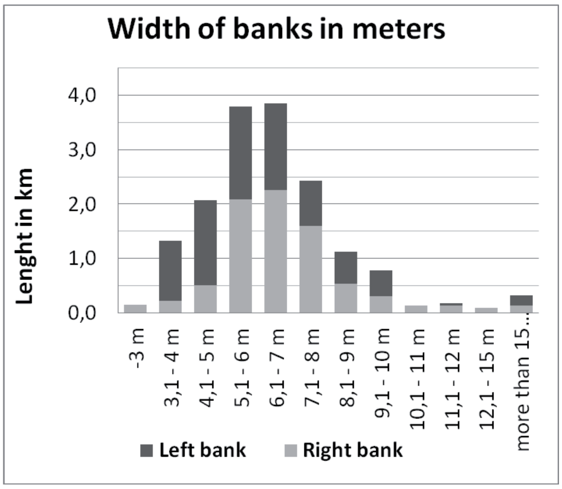

Fig. 3: Width of stream-banks

Spatial structure is evaluated according to width, continuity of stream-bank vegetation and continuity of layers. Within the frame of evaluated sections, 13 basic types of structure are distinguished: 1. wide continuous stands, 2. continuous line tree stands with shrub layer, 3. continuous line tree stands without shrub layer, 4. continuous narrow line tree stands, 5. continuous line stand with gappy (discontinuous) tree layer and continuous shrub layer, 6. gappy (discontinuous) line tree stands, 7. continuous line shrub stands, 8. continuous narrow line shrub stands, 9. gappy (discontinuous) line shrub stands, 10. gappy (discontinuous) narrow line shrub stands, 11. single trees and shrubs, 12. unclassified (exc. stands after bank edge), 13. banks without woody vegetation.

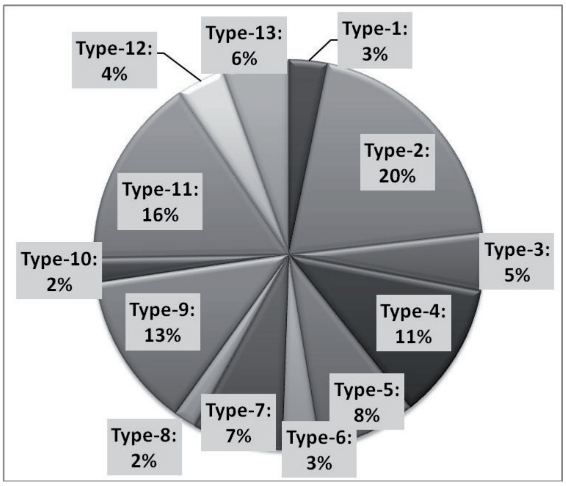

Fig. 4: Stream-bank vegetation structure

Species composition autochtonity and vitality of tree layer are evaluated in stands, reached tree layer continuity at least 0.4 (40%). Length of evaluated segments is 8283 meters. Autochtonity is evaluated on basis of degree of autochtonity. 3 classes of species composition is determinate. In vitality evaluation, stand is classified to 3 classes. Depending on autochtonity and vitality 7 categories are determinate (1.1 vital nature nearly stands, 1.2 slightly damaged nature nearly stands, 2.1 vital stands with modified composition, 2.2 slightly damaged stands with modified composition, 3.1 vital allochthonous stands, 3.2 Slightly damaged allochthonous stands, 3.3 Damaged allochthonous stands.

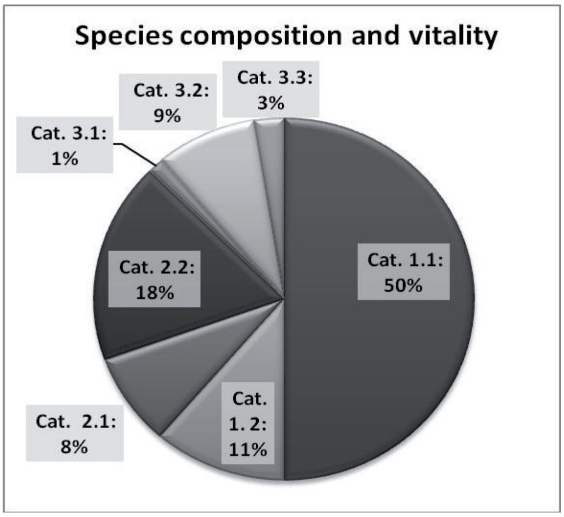

Fig. 5: Autochtonity and vitality of tree layer

Species composition diverzity is evaluated according to methodology (degrees from 0 to 6 are applied). Results of species composition accession are displayed in next diagram.

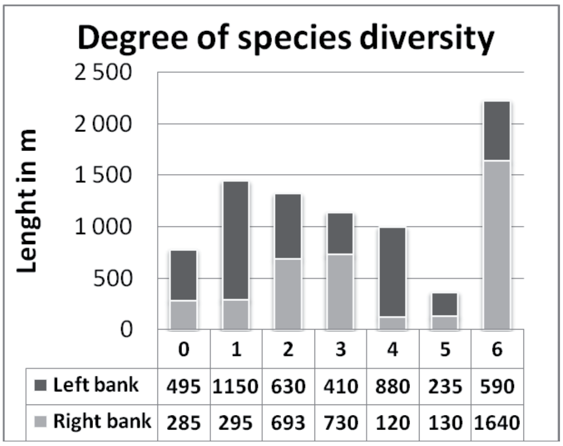

Fig. 6: Diverzity of species composition

4 CONCLUSION

Presented methodology is practical to stream-bank vegetation in rural landscape evaluation. Result of methodology is stream-bank vegetation database. Stream-bank vegetation database includes maps, databases, stream-bank vegetation evaluation and management theses. Object of map section are general and detailed maps. Maps are generated by source maps digitalization in GIS software. Databases consist of section database, segment database and specifications of tree layer. An object of section database is section identification. Objects of segment database are identification, delimitation, alluvium and river-basin characteristics and stream-bank vegetation characteristics. Object of stream-bank vegetation characteristic is description of stand, tree layer and shrub layer. Stream side database serves as base for management.

Flood-plain in survey area is intensively utilized (mainly arable land), width of stream-bank vegetation is limited by land use. Proportion of wide stands and line tree stands with shrubs is 23%. Bank with solitaires, bank without woody vegetation and unclassified types reached to 25% length of evaluated sections. 60 % of evaluated tree layer is 1st class of species composition (nature nearly stands), this stand compound mainly of autochthonous species: common alder *(Alnus glutinosa L.),* European ash *(Fraxinus excelsior L.)* a willows *(Salix sp. L.)*. Main problems of species composition is alien or crossbred species representation, example crossbred poplars *(Populus x canadensis Moench)* or black locust *(Robinia pseudoacacia L.)*.

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Water Supply and Drinking Water Treatment in Spain.

Alexis F. Osca Verdegal, Katarína Domokošová

Abstract
In the article we will discuss the main aspects of water supply in Spain. We will describe it and why is necessary an efficient supply network in Spain and its different areas, according to the needs of each area specified. We will also analyze the main sources of water for human availability and supply industries as well as different parts of the network and what data need to describe and project. Final and briefly we will discuss about the economic outlook and the environmental impact of such networks.

Introduction
The water supply is a technique that attempts to differentiate and book a resource with which the system cannot count on to meet production targets for water use. Only the remaining resources are those which constitute a potential and are the ones who should be able to move in the system and must be used which must intervene in the balance between resources and demands.
Why it is necessary to efficient supply network?
Spain is a country defined in most of its surface by a large and strong period of summer water shortages, linked to high temperatures during this period. It also has a lower and irregular rainfall that the European climate with a reduced ability of the channels. These aspects limit both the supply and the dilution capacity of the waste. Also should be noted that the limits of dry Spain include the main watershed of the country such as the Ebro, the Duero and Tajo. Only in the watersheds of northern Spain, such as Galicia and the Basque country, the precipitation is higher than the water that can be spent on vegetation while the remaining basins fail to supply the cost of a permanent vegetation cover your entire territory, being the country's dry deficit basin.

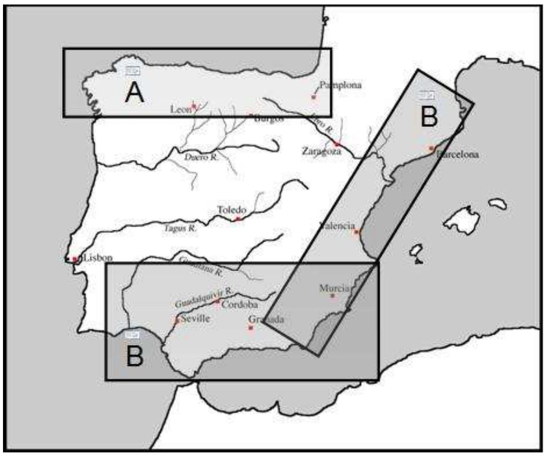

Figure 1: Map of major rivers of Spain where we noted two areas. Area A: wet Spain, area B: dry Spain.

In summary, we can say that the northern and northwestern areas of Spain form the wet areas of Spain, where high water and the reservoirs that exist are mostly to produce electricity. By contrast, in central, eastern and southern peninsula, there is a greater prevalence of reservoirs, which in this case, they are intended mostly to create water reservoirs for irrigation and stock supply.
The imbalance between the watersheds that the country is between the "two Spain's" is also added to the problem of natural water quality. As an example we can say that in the northern rivers, the water reaches the sea, it's with approximately 100 mg / l of salts, so that we can classify it as pre-drinking counterpart basins in South, Southeast and east water reaches the sea, has thousands of milligrams in solution, making it totally unfit for human consumption, and often even for irrigation. Besides the summer drought and irregular rainfall above, further aggravate the situation if possible. All the dry watersheds show a greater or lesser degree of water deficit.
The existing water policies so far, support the idea that the solution to the problem is by transferring inter-watershed, although socio-economic reasons such transferring is usually done between river deficit, making it, in a problem who uses little water there is, and not solving the real problem.

Objectives of a supply network
First let's talk about the situation in the country that we will try.
The main purpose of a water supply system is to provide safe water for human consumption at a reasonable cost. The degree of treatment and the combination of treatment processes depend on the water source and quality. Although the amount of water to maintain a person's life is small, the closeness between

they forming communities do the amount increases.
For these reasons, any system of water supply is projected to supply a sufficient volume of water at a suitable pressure and with acceptable quality from the source of supply to consumers.
The approach, design, layout, construction and operation of modern water supply and wastewater is complex, and therefore requires not only a company to hold, but if its necessary a stable political and social and industrial base on to settle. Development depends on water projects in the beginning of the demographic, hydrological, geological and geodetic which might be available, obtained through decades of observation, systematic recording and analysis.

What is a network of supply?
A network of canals and pipelines for water can provide clean water and safe for use in homes, schools, workplaces, hospitals, commercial activities, some industrial uses, as well as street cleaning and even protection against fires. Water for drinking, personal hygiene and health purposes is vital to the health and welfare of society.
Also, irrigation and industry, depend heavily on a network of water supply. In the first case, depends on the consumptive use of water, which makes it possible in many areas of agriculture, which otherwise could not support any type of crop. If we talk about the industry, we can also say it depends largely on the receiving water, as it is used as an element in many of the products produced by it, for example in the production of beverages, or more indirectly in controlling the production process, as the cooling of machines that produce heat.

Source of water supply network
The origins of network-wide water supply can be varied, and have an overall rating as its source of water. According to this classification we can separate them: rain water stored in tanks (though not necessarily part of them, because generally these storage tanks are built), the water that comes from natural springs (where groundwater has surfaced); of groundwater origin (captured from wells or filter galleries) surface water after previous treatment, (which comes from rivers, streams, reservoirs, etc.) or desalinated sea water.
According to their different origins the water needs different water treatments ranging from simple filtration and disinfection of groundwater to water desalination from seas and oceans.
In addition to natural water sources, there are waters that require treatment before being reused or returned to the wild. The origin of these waters can be industrial, agricultural and human waste (towns and cities). The treatment of these waters, it is usually more expensive and laborious than the natural, because the concentrations of dissolved material they carry, are generally higher than the previous.
The waters have already been treated and have been reused, recycled wastewater is called (or reclaimed) and usually have a lower quality so they tend to be reused in industry or agriculture, and not for human consumption. These recycling operations may offer the only alternative in some areas is very difficult to get enough fresh water to supply all local needs. We may allow in some cases that water is cleaned by filtering a natural way, as well as technical recharge underground aquifers.

Parts of a water supply network
Thus, those parts of any water purification system prior to its disposal to supply any of its variants are: collection and storage of raw water, treatment, storage of treated water, availability of consumer.
In the first step, the recruitment must protect the point of extraction of water from contamination, delineating a protection area closed. Surface water harvesting is done through infiltration galleries parallel to the stream to collect the water that is already a preliminary filtering, if in the case of a water course. Extracted with intakes in the case of springs and wells or galleries in the case of groundwater.
After removal of this water storage is necessary, if the source is not sufficient and constant flow throughout the year to supplement the amount of water needed. It is here, when constructing reservoirs.
The treatment of water abstracted and / or treated, is the most sensitive part of the process, as it must be the appropriate treatment depending on the type of water quality and quantity we have.
As an example we will raise all the parts of a water treatment plant.
First, the water entering the plant makes it through the fence that is responsible for retaining the material thicker than water drags. The second step of a plant, would be the entry in the "sand trap", which as in the previous section, would retain the water carries material, but this time in a smaller size, such as sand. To this water, is added

flocculating chemical elements subsequently facilitate the settling and sedimentation of the finest materials in suspension, colloidal or not, which is in the water. This pre-treated water is decanted to separate this part of the material captured by the chemicals added. Clean water is finally filtered to remove all remaining debris, disinfect and / or drinkable, depending on usage will have later.

Treated water storage following the process described above has a specific function, which is to compensate for time variations in consumption volume storing strategic emergencies such as fires. This storage tank is at ground level or elevated tanks, with similar characteristics both, and they include in their dispensers and chlorinators usually out to make it fit for human consumption if this is the end of stored water.

In the distribution network itself, does not begin until the first house in the community to serve, but the dealer network from the storage tank of treated water to the first housing of the system. All water distribution system must be capable of delivering from the maximum hourly flow to the maximum daily demand plus the need to prevent a fire, whichever is greater and supplied anywhere in the municipality. To do this in residential areas require water mains of at least 150mm in diameter. The pattern of water main and street layout, topography, size pipes, etc., affects the cost and reliability.

Basic data required

Water consumption figures, periods of design and durability of the structure, periodic variations in consumption and the influences on different parts of the system, as well as the kinds of pipes and using more suitable materials for construction.

To achieve these basic data we use some simple formulas.

Water demand is the main point that we will need before you begin to know how much water we will need to supply is the sum of all water demands at the individual level for some time (x) determined. Normally, therefore, determine the demand for water in everyday actions, according to the formula:

Average daily demand (on the community) = (total water use in 1 year (volume)) / (365 days)

The units are m^3/day or millions of m^3/day. Many times it is also convenient to express the demand per person, according to: the following formula:

Average daily demand (per person) = (average daily demand in the community) / (population served)

The units here are in liters per person per day. We can differentiate the uses of water as 80% for general domestic use 10% for drinking and cooking and the final 10% will be used for cleaning and domestic risks (Source adapted from Steel and McGhee (1991)).

The data necessary for the supply we have to take into account water quality standards. This includes various chemical, physical and biological dissolved or suspended acquired from the time it falls as rain. The requirements for water quality are set according to its intended use. Although difficult to measure is important to know the standards for determining the proper treatment prior to supply. We can find an example of water quality standards in "Standard Methods for the Examination of Water and Wastewater" (APHA et al. 1992) these standards are currently used in USA and Canada. The water quality standards in Spain are governed by the directives 75/440 and 79/869 on the quality of drinking water for their production and analysis. The quality of continental surface so they can be used in the production of drinking water after appropriate treatment are regulated by ministerial order of 11th of May 1988 the regulations for public water management (Annex I) and ministerial order of 15th of October 1990 and 30th of November 1994. And also, in the Royal Decree 1541/1994.

In the public supply should be especially careful with flavors, aromas, colors, etc. Since due to the presence of volatile chemicals and decaying organic matter. The same measurements are made based on the dilution necessary to reduce them to a level barely detectable by human observation. The color, usually indicates the presence of minerals such as iron and manganese, and organic materials. The tests were performed with a standard set of concentrations of a chemical that produces a similar color.

Chemical characteristics refer to chemical compounds that are dissolved in water from natural or industrial origin, such as small amounts of iron and manganese, which generally reduce the capacity of the tubes, and have an expensive removal of them once deposited. These elements are classified as hard water, with lots of dissolved matter, and make the considerable quantities of water required to produce the foam soap needed to wash or causing deposits in the pipes where the water temperature increases over the normal. The hardness is expressed in milligrams of calcium carbonate equivalent per liter.

Basic system

The basic system includes water supply of drinkable water from the infrastructure required to capture water from the source on acceptable terms, pre-treatment for transmission, storage and distribution in the community that is intended to supply on a regular basis. Besides covering biological requirements, hygiene, industrial and commercial uses.

Consumption and variations

Consumption patterns and variations in the water service will be covered when construction is planned with the data we have are: domestic use, covering the service to homes, hotels, etc., or the toilets, kitchen , and more. The use of these varies depending on the economic level of the consumer to be targeted in a maximum range of between 75 and 380 liters per capita per day, the requirements of commercial and industrial use if there are directly dependent on big industries and if they get the municipal water supply network. This type of provision covers the requirements of industrial and commercial establishments such as factories, offices and stores, provision of water for public use including water service to public buildings and all that which is used for public service includes water that goes to schools, irrigation and fire protection roads, government buildings, etc., for which the municipal provider is not generally receive payments. In such quantities tend to vary between 50 and 75 liters per person per day; losses and waste: water is "unaccounted for", it is not used by anyone, and is attributed to errors in meter reading, unauthorized connections and leaks in distribution systems.

The main factors affecting water use are the size of the city, industry and commerce that has the characteristics of the population, measuring the amounts used and various other factors such as climate, quality of water supplied, the same pressure, the maintenance system that provides conservation programs.

Perspectives from the economy of the hydraulic works to the water economy

The economics of water in Spain, is raised from two opposing options. In the first, we have a policy of promoting the waterworks, with a clear dominance of technical approaches, such as: reservoirs, the decanting, the water desalination, and even pumps. In the second of the policy options we have a new policy on water management, giving these new socio-economic approaches. Some examples of these approaches are conversion programs on the use of water to other more responsible, thrifty and efficient, flexible licensing system, for example by creating a water bank.

The second policy option is more sustainable and more complex in terms of politics, but also more economical.

Comparing these two policy options we can say that the former is more efficient and less wasteful, unsustainable to the environment than the second but much easier in terms of policy is concerned. This only needs to keep its current state, to support the institutional changes required for the efficient management of water resources, promoting conservation and savings and readjusting applications. It's about changing a policy option although it benefits certain individuals, goes against the majority to a point of unsustainability local and global ecological deterioration. The other option is predominantly technical and which has been used so far, is the option to extend the offer at any cost and promote the use of water, so that only benefits the developers and producers "by promoting" water further waste of water so that is hurting most people and their local and global environment.

The current water policy favors the second option above, savings and better management of water. Thus, the first option, you must change the laws of economics to make better water management itself is a business, changing the policy now promotes the new investments that are aimed at expanding the supply of water, not the best use. Put another way, it should promote the waterworks that promote water as a resource.

Environmental impact of a network of water supply

All elements of the supply network, from its construction until the rehabilitation of dams and reservoirs, wells, receiving structures, distribution systems, treatment works, maintenance, establishment or strengthening of the functions of meter installation, billing, etc. Have significant environmental impact in the environment, both direct, such as flooding, drilling and earth moving to new locations, as secondary, such as changes imposed by a new dam on the vegetation, humidity, and change the natural environment. Although it is undoubtedly a clearly positive impact on health and welfare of many people.

Conclusion

As we have seen throughout the test, the water supply and treatment in Spain, it is very important because it is a country with serious problems of water deficiency due to prolonged summer drought. For this reason, the network of Spanish water supply has reached a high efficiency and management of water treatment described throughout the article, although the management and use laws are not updated to current needs.

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THE AUTOMATION OF GEOTECHNICAL TEST CBR TO DESIGN A PAVING OF RURAL ROADS

Urtzi Zelaia, Lenka Ševelová

Abstract

Within the geotechnical tests it has been seen necessary to introduce a new test called the cyclic test CBR, to obtain a characteristic of deformation, the module of elasticity. The advantage of the new test is based on the execution of the standardized machines, used for standard CBR, making afterwards of the regulatory test. This new test requires much time and concentration of a person. During the test it takes about two hours to make a note of necessary measurement data and to control the machine of CBR. For this reason it has been seen the need to automate the test. On the one hand the need to automate the movement of the machine and on the other hand the need to automate data acquisition. It has therefore been developed and has been tried to do all the work that has been mentioned as easy as possible.

Introduction

Today with the development of design methods that use models based on finite elements with using the methods to optimize the construction is necessary to know and determine better the characteristics of materials, especially the deformation properties. The accuracy of the procedures is also important to design and calculate forest roads. So it prepares and investigates new geotechnical test. The current most important test for the basic characteristic for the design of construction layers is the classic standard CBR test. This test acquires resistance relative properties of a material that are not enough today. Calculation models based on finite elements need the characteristics that describe the deformations of the material behavior according to the laws of physics. The new option to obtain the elastic module is through the cyclic CBR. That way it describes better the characteristics of the pavement.

Geotechnical testing

To determine the geotechnical characteristics of land are used laboratory tests and IN-SITU according to the rules. The laboratory tests execute on samples previously obtained in the field. Samples can be damaged or not damaged, it depends on the type of test.

Geotechnical tests can be classified into different types of testing. First is the testing used for soil classification. Among them there are the aerometry test and sieves test, two tests to determine the granulometric curve and after these the test “cuchara de casagrande”. The second is testing to acquire the mechanical properties, among who are the modules of elasticity, mechanical resistance, optimum moisture and maximum density. The tests to know these properties are stated below:

-

The standard Proctor test consists of compacting the soil in three layers into a mold of dimensions and shape determined with blows of a ram, which is dropped freely from a specified height.

There are two types of standard Proctors; the “Normal Proctor test” and “modified proctor test”. The difference between them is the energy used, because the weight of the ram and the height of drop are bigger in the modified Proctor.

They were named after the engineer who invented them, Ralph R. Proctor (1933), and they determine the maximum dry density that is possible to be reached for soils. With this procedure of compaction Proctor studied the influence of the initial content of the water in the soil on the process, and that value is very important in the obtained compacting.

To conclude he observed that increasing the humidity contents, from low values, increases specific dry weight and helps compactions of the soil. But that is not always true, because when it passes a specific value of humidity the weight of the soil is lower and the compaction is worse. Proctor found a value which obtains maximum specific dry weight in compaction. This value is called optimum value.

The difference between using the two Proctors is that Proctor modified is used in constructive layers and Proctor standard is used in grounds.

-The testing of standard CBR was developed by California Department of Transportation before than Second World War.

The test consists of measure of the needed pressure to seep the plunger of standard area in the soil or simple. This test is done to measure the load capacity o

CBR = CBR [%]

p = measured pressure of road [N/mm²]

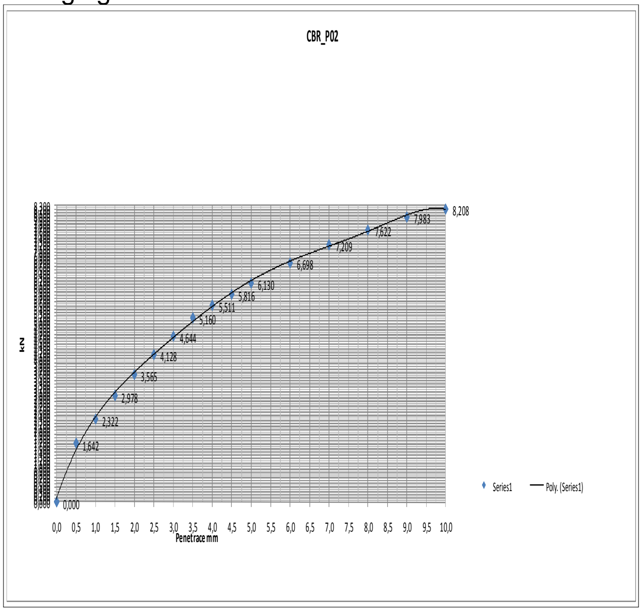
p_s = pressure to achieve the same penetration in the standard grounds [N/mm²]

$$CBR = \frac{p}{p_s} \cdot 100$$

to make roads. Also it is used for the roads of runways.

In conclusion it is possible to say that the harder is the soil the higher will be the CBR rating. It is calculated with the formula that comes below:

The method of standard CBR is empiric, the characteristics are obtained by looking at the data. It is possible to see more conclusions in graphics, in the next picture there is a strength of plunger when the penetration is changing.



Graph 1

-The cyclic CBR test is to measure the elastic deformation and plastic deformation. The CBR test is prepared according to the predetermined values (AASHTO, BS, EN etc).

The testing proceeds as follows: getting in the plunger until 10mm and measuring the strength needed. Then the plunger is put up and when the strength is 0 the penetration must be measured. This sequence is repeated until the elastic deformation value is constant, normally that happens after 50 cycles.

To design a pavement according to the laws in force is necessary to know the value of CBR with the optimum and saturated humidity. The test realized with two samples, the first with optimum humidity and the second with the soil that had been in the water for a period of 96 hours. In both cases the weight is similar, bigger than 4.5kg.

Data for the statistic

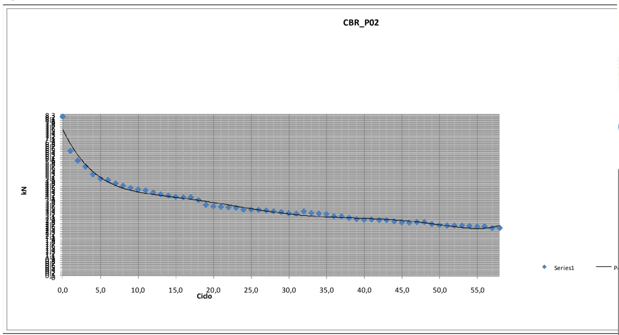
Normally the whole laboratory processes are influenced by errors. The errors come from the lapse of concentration of person or from the precision lack of machines. It may change the result of the same test with the same sample. It is therefore impossible to know the characteristics of a material after doing only one test, it is necessary to have a statistic archive. At least 15-20 tests are necessary to get reliable information.

One common objective for projects of statistical investigation is investigation of the causality and extraction of conclusions. This conclusion consists of analysis of the influence of independent variable and dependent variable in the response.

The cyclic CBR is used to see the relation between humidity, density and the module. Besides doing 15-20 tests with each ground it is necessary to do testing by changing the humidity. The objective is to find out the behavior of elastic module with humidity. In addition, if the humidity changes the density changes too.

The necessity of Cyclic CBR

Now a day, it is necessary to have absolute characteristics of elastic and plastic deformations. Cyclic CBR describes better the response of material because the vehicles go through continuously putting a load. In the following picture there is a graph of cyclic CBR.



Graph 2

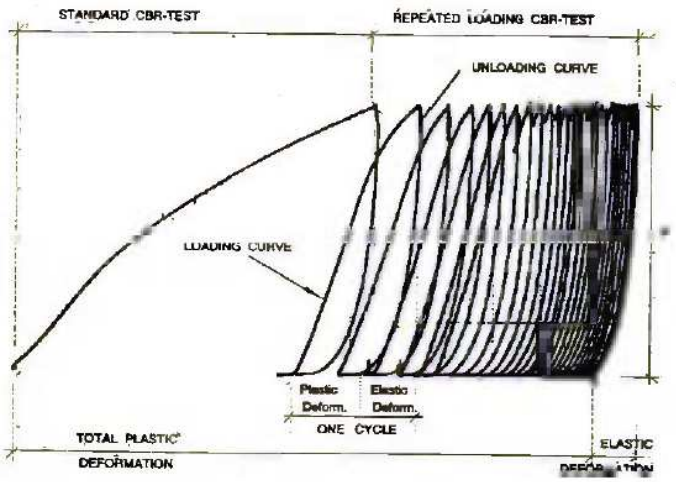
Looking at this picture it is possible to conclude that at the beginning there are plastic deformation and elastic deformation but the bigger is the number of cycle the smaller is the plastic deformation.

The proffesor A.A.A.Molenaar, from Delft University of Technology, proposed the formula to extract the module of elasticity directly:

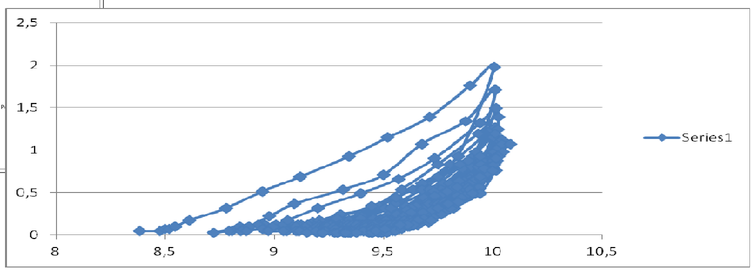
$$E = C_1 (1 - \mu C_2) \sigma_0 a / w C_3 \quad (2)$$

E = resilient modulus of the material tested,
w = elastic deformation measured,
a = radius of the circular load (radius of the plunger),
σ_0 = stress under the plunger,
μ = Poisson's ratio of the material tested,
C_1 = 1.797 if full slip along the wall of the mould is assumed, = 1.375 in case of full friction,
C_2 = 0.889 in case of full slip, = 1.286 in case of full friction,
C_3 = 1.098 in case of full slip, = 1.086 in case of full friction.

But there are different forms to do a testing of cyclic CBR. In the next pictures there are two kinds of cyclic CBR explained graphically.



Graph 3



Graph 4

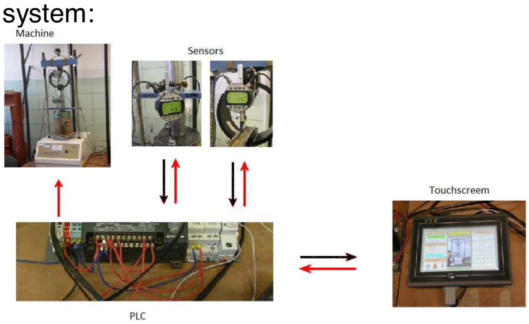
The first graph is from article of A.A.A. Molenaar and the second graph explains the test that is mentioned in this article.

Automation of the CBR machine

The CBR test is very useful to obtain the elastic module. It is very demanding to perform this test manually, because the testing needs much time and one lapse of concentration can ruin the whole test. For these reasons it is necessary to automate the CBR machine.

There are different forms to read the data and to do a test. In standard CBR the law obligates the performers to do the test in one particular mode, but cyclic CBR could be done in different modes, of course the validation is necessary. Until now the test has been done manually, the note of deformation longitude and penetration longitude in the appropriate moment and moving the platform of machine was made manually. But as it was mentioned before it needs much time and the person can lapse in concentration.

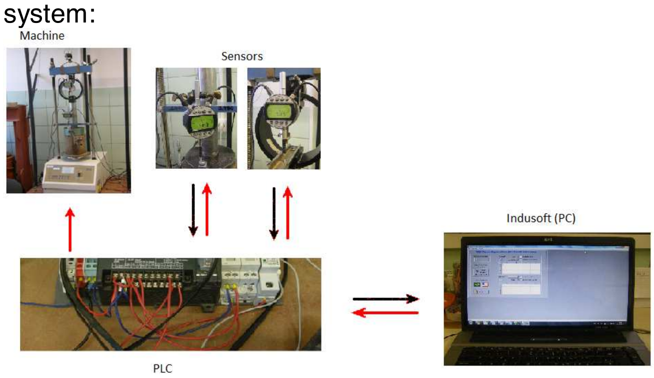
The automation could be the solution to all these problems. For that it is necessary to have one automaton that would move the platform and a system to acquire the data. The function of automaton is to control the movement and to take the data from sensors. It is possible to save the data automatically , which also saves much time and work. One way to do that can be with a touch screen, its main aim is to be an interface between the machine and person. In the touch screen there is a program created by EasyBuilder8000 and it is possible to create and change the program adapting to the needs of the user. That way the necessary data are taken and it is possible to see the information from testing during the test. In the following picture there is a diagram of system:



picture 1

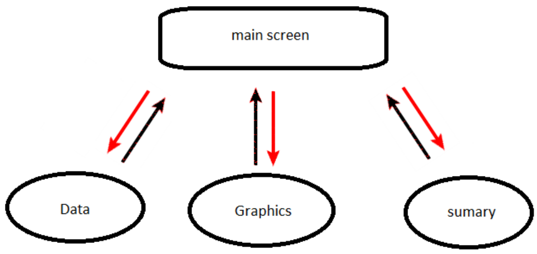
This way the data are saved in one target and it is to do calculations and to obtain the characteristics of ground. But normally in the target there are a lot of data, for example every second the deformation and penetration data are saved. For this reason it is not so easy to take the necessary data. To do that is very useful Microsoft Acces, that takes the data automatically. After this it is better to use Microsoft Excel to do calculations and graphs.

But it is possible to automate more, instead of using the touch screen it is possible to use o computer with Indusoft Web Studio program. In this case Indusoft would do the functions of the touch screen and calculations, graphs … That way it is faster and the user has less work because it avoids taking the data from the target and doing the calculations with them. The disadvantage is that it is more difficult to program. The system is similar to touch screen system:



picture 2

The program of Indusoft is done to fit the needs of the tasks and it is adapted to what the user wants. It normally has a main screen and the other different tasks screens. In the following picture there is a diagram of example of one indusoft program:



picture 3

This program can be one option but it is possible to do it in some other way or it is possible to add some tasks. So the way of Indusoft is better but it need more work in time of programming.

Conclusions

From the results of the analysis about the automation of the cyclic CBR is possible to extract some conclusions that are formulated here.

1.-The new machinery and new technologies need an investment at the beginning of the construction. Firstly an economic investment to the necessary hardware (the sensors, the PLC …) and software (Indusoft Web Studio, Easy Builder8000). Secondly an investment to education, it is more complicated at the moment of programming and for that the programmer has to have more knowledge.

2.-In long term, the saving of the time of the worker, the precision of the machines and the decrease of the mistakes makes the system more profitable and more comfortable. The worker saves time because during the testing he can do other works, when the bigger is the precision of machines the more exact is the result of test and automating the machines helps to avoid the human mistakes, decreasing the number of error tests.

The article was supported by research project TA01020326 „Optimization of design and realization of low capacity roads pavements“ by Mendel University in Brno, Faculty of Forestry and Wood Technology.

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POTENTIAL APPLICATION OF COMPOSITES IN LANDSCAPE ENGINEERING

Radek Dymák, Michal Henek, Miroslav Kravka

1. Introduction

Composite materials may be found practically anywhere around us. They have been used for many years and have become a common construction material. In fact, any material consisting of two or substances of different features is composite. Combination of more substances gives the final product properties exceeding the quality of a single substance. Composites can thus comply even with the strictest criteria. They are typically mechanically rigid and lighter than traditional materials. Among other advantages, they offer chemical resistance, resistance against vibrations, and higher elasticity.

2. Types of Composites

According to Rosický](1999), composites may be defined as material structures formed of two or more materials of entirely different properties. They are generally composed of a matrix and reinforcement.

Matrix is a general term defining material functioning as a filling agent or as a binding agent. The most common are polymers, ceramics, glass, or metals. Polymer matrices are divided into two basic groups, i.e. thermosetting and thermoplastic matrices. Thermoplastic polymers are deformable and retain their properties after being heated and cooled down. On the other side, thermosetting polymers are cross-linked and form a tightly bound three-dimensional network of polymer chains. The plastic is cross-linked during the moulding process, i.e. heat and pressure curing, sometimes also by effects of catalysts. Once cross-linked, it cannot be moulded again. The product will not melt when exposed to heating again.

Reinforcement in composites may be formed by particles (e.g., sawdust, sand, gravel) or by long or short fibre. Most common is glass, basalt, carbon, and polymer or natural fibres.

Orientation of filaments also determines the final properties of the product. It may be non-uniform, i.e. of a random structure, or uniform in form of textile, mat, or in combinations. As an advantage, materials with uniform fibres provide easier handling and may be processed more efficiently into composites. In addition, they have equal mechanical properties in given directions of fibre winding. This may not be achieved in random orientation of the fibre.

Biodegradable Composites. Current trends in the development of composites point at their biodegradability. Biodegradable composites can gradually degrade in the process of controlled decomposition with no negative impact on the environment. Recently, there have been efforts to produce these materials from renewable resources. Matrices in biodegradable composites are mainly composed of polymers, which may be divided into three basic groups (after Long Ju, 2006), i.e. 1) natural polymers, such as starch, proteins, and cellulose, 2) synthetic polymers from natural monomers, such as polyactic acid, and 3) polymers formed by microbial fermentation, such as polyhydroxybutyrate. Animal and plant fibres serve as reinforcement from natural renewable resources. Wool is the most common animal fibre, while silk is only used exceptionally. Typical plant fibres are hemp, jute, kenaf, loir, cotton, ramie, abutilon, coco, bamboo, and reed

With their highly specific properties, i.e. rigidity, shock resistance, and flexibility, lignocellulosic fibres, such as hemp, jute, etc., represent a potential substitute for glass and other widely used material (Sigriccia et al., 2008; Čáslava, 2009). Furthermore, they are available in large quantities and are biodegradable. Other advantages are low acquisition costs, low specific density resulting in a low total weight, lower wear and tear of machinery, and low negative impact on skin and respiratory system during the production process. Lignocellulosic fibres are resistant against vibrations and have better energy properties. On the other hand, they are hydrophilic and easily absorb humidity. Thus, they may hardly be bound to hydrophobic matrices. Most natural fibres show little resistance to high temperatures (approx. 220℃), which makes impossible their use with various thermosets processed under higher temperatures.

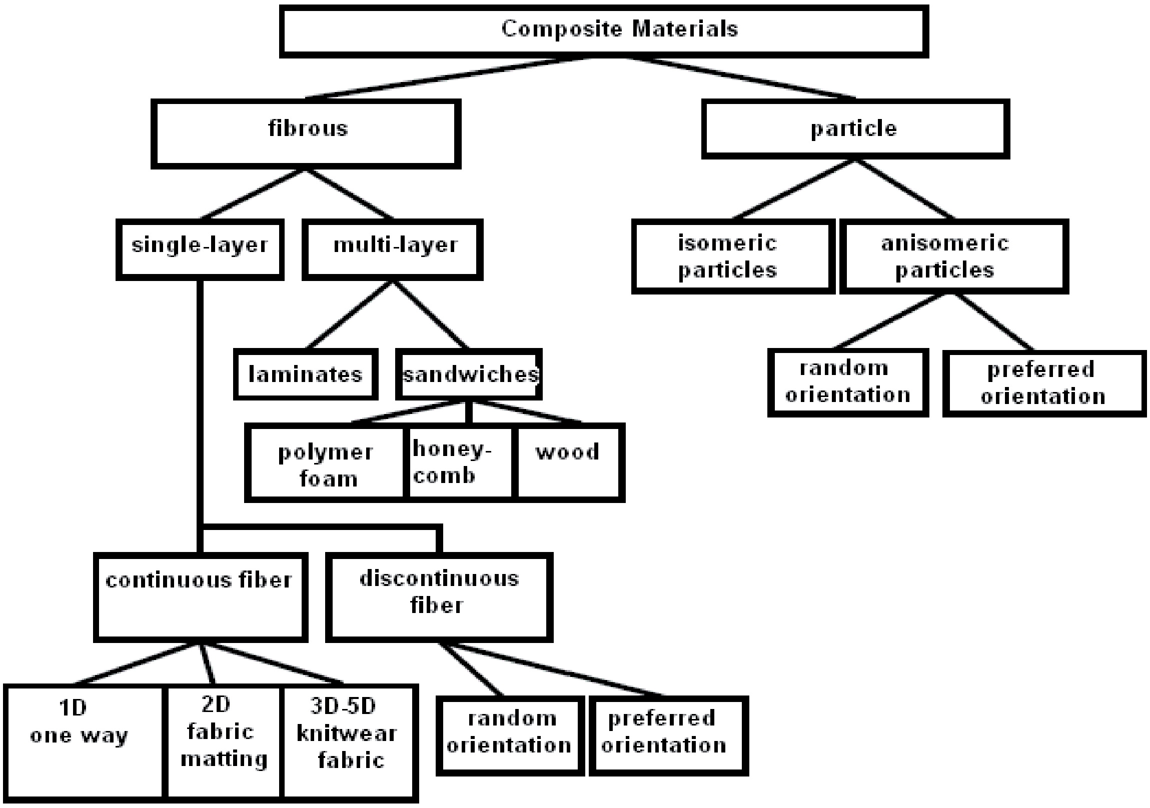

Fig. 1: Composites by type of reinforcement (adapted from Vnouček, 2009)

3. Application of Composites

At present, composites mainly find their use in construction, households, automotive and aircraft industry, and in the production of sports and health equipment. However, they have a potential to be used in practically any area when there is a need to reduce the weight or increase the rigidity of the applied material.

Use of composites is, for example, mentioned by Šilhan (2010). He states that reinforcements in composites are mostly applied in form of an external layer glued to the existing construction. In other cases, reinforcement is applied in the grooves of the construction. Composites may further be used to increase the flexural strength of beams and flooring plates, or to increase the resistance to seismic activity and wind. Their application in concrete tubes will enhance resistance to inner pressure. Silos and other storage containers may be reinforced in a similar manner.

Mráz (2007) studied the use of fibre structures in the development of production machinery and robots. Among the main advantages of composites, he mentions their high specific rigidity, better dynamics, and low deformation under extreme temperatures. As an example, he states that, based on the comparison of ρ/E values, parts made of carbon laminate may be 10–90% lighter than metal parts of equal rigidity. Thanks to the lower weight, the radial and tangential stress in rotating parts is also reduced.

In landscape engineering, biodegradable composites have their potential and may be mainly applied in slope stabilisation and reinforcement of soils with low bearing capacity. Products made of composites will find their use within water erosion control measures on slopes, where structures mechanically secure the soil and prevent its loss. Use of biodegradable composites is highly suitable under such conditions. When the structure is naturally decomposed, the slope is already stabilised by the growing vegetation, which had enough time to root sufficiently during the life time of the composite structure. Biocomposites may similarly be applied to reinforce the grounds of transport ways with lower bearing capacity. They are installed during the construction of these structures to enhance their bearing capacity; these transport ways may thus be used under less favourable conditions or for transport of heavier machinery. Such reinforcement will have a temporary character if biodegradable composites are used. This makes them ideal for application in temporary transport ways. The reinforcing structures will decompose naturally so they do not need to be removed when the transport way is no more in use.

4. International Cooperation

Finding biodegradable natural resin with optimal properties represents a further step in the development of composites. New composites are being developed in cooperation with the Mondragon University in Spain. Testing involves use of various reinforcements and matrices but also diverse forms of application and combinations of both components.

Fig. 2.A shows samples produced by mixing pine saw dust of predetermined fraction with various types of resin. Sample A is composed of synthetic resin; samples B and C involve natural resin, containing 20% and 10% of resin respectively. Figure 3 shows hemp filaments linked by Greenpoxy resin, which is characteristic with a high content of natural carbon, 55% of which comes from renewable resources. Samples differ in the form of injecting the resin. In sample A, resin was applied merely by pressure using an injection machine. As the photograph depicts, resin did not spread sufficiently among the filaments and remained concentrated in the centre (i.e. spot of injection). In sample B, air suction from the matrix allowed further spreading of resin. However, unacceptable bubbles occurred throughout the entire sample. This defect was successfully removed in sample C, when resin was preheated immediately before the actual injection to reduce viscosity. New materials will be subject to further laboratory testing to verify their physical and mechanical properties.

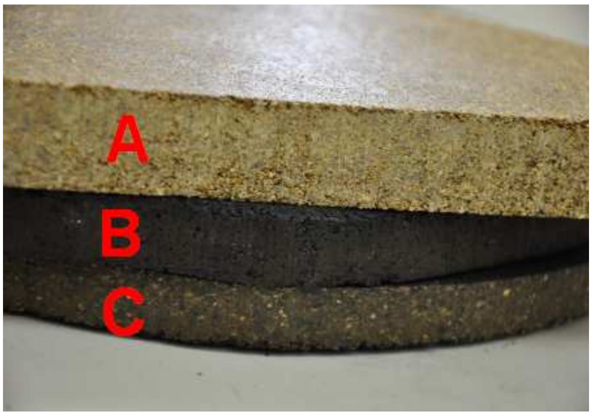

Fig. 2. Fig. Fig. 2. Results of application of various various amounts and types of resin [A) synthetic resin, B) 20% natural resin, C) 10% natural resin]

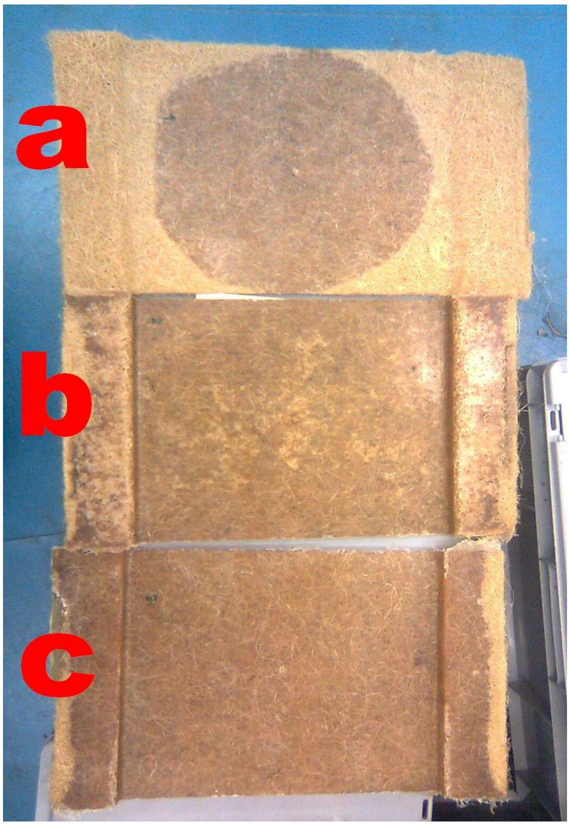

Fig. 3. Results of various methods of resin application [a) pressure, b) pressure and air suction from the matrix, c) pressure, air suction from the matrix, and preheated resin]

5. Future Project

Three types of material showing good biological degradability will be selected within further development of biodegradable composites. Their mechanical properties will be compared at the beginning and during the process of decomposition. Samples for both field and laboratory testing will be produced. A sample mat suitable for slope stabilisation is shown in Fig. 4. Its segment structure is designed to minimise concentrated surface runoff and thus significantly reduce the loss of soil. It is also applicable for reinforcement of terrains with low bearing capacity. Fig. 5 shows a sample suitable for laboratory testing. A particular number of samples in one series will be mechanically tested at the beginning. The resting samples will be installed in soil environment with simulated natural conditions and will be tested during the time. The process of decomposition will be monitored in samples placed in the soil environment, along with the impacts on their mechanical properties. As a result, the project is designed to deliver a survey of properties of selected biodegradable composites, including the rate of their decomposition and retention of mechanical properties during this process.

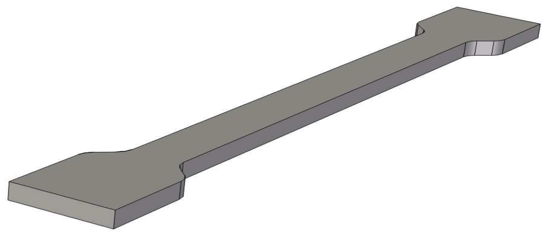

Fig. 4. Sample designed for laboratory testing aimed at determining the rate of decomposition and its impact on mechanical properties

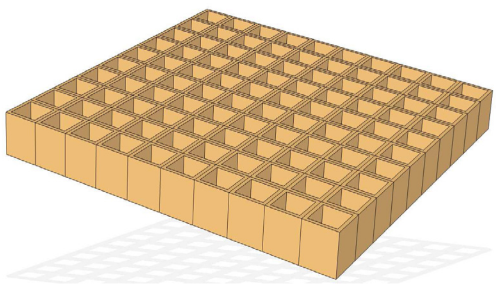

Fig. 5. Sample determined for field testing in slope stabilisation

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Effects of Methods of Planting Cuttings of Hybrid Poplar *Populus nigra* L. × *P. maximowiczii* Henry on the Mortality of Plants during the First Vegetation Period.

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Key words
Soil preparation; Poplar; Planting; Mortality

Abstract
Planting cuttings in a prepared soil in spring is the most frequent method to establish poplar plantations for energy purposes. However, this method represents insufficient use of spring soil moisture (due to soil preparation and later planting), which increases the mortality of plants. In order to verify the potential to significantly reduce the mortality of plants, the following three alternative methods of planting have been proposed and tested: (1) spring planting in prepared soil, (2) autumn planting in prepared soil, and (3) autumn planting in no-till soil. Autumn planting in prepared soil showed the best results (lowest mortality) with 74.2% of success (25.8% mortality). The herein stated comparison implies that, under the given conditions, autumn planting in prepared soil (74.2% of success, i.e. 25.8% mortality) is the most appropriate way how to protect newly established plantations of fast growing species for energy purposes against the risk of drought. Soil moisture is used to its maximum during the spring period to support the growth of plants while soil preparation ensures its ideal contact with the cutting.

Introduction
The effects of various methods of mechanical preparation of soil on establishing poplar plantations have been explored, for example, by Bilodeau-Gauthier et al. (2011). These conclude that young plants of poplar thrive best in well-prepared soil surface, i.e. when the humus layer is largely mixed with the mineral layer (mounding and harrowing). In contrast, control plots with unprepared soil (no-till) showed the lowest increment of plants. The method of soil preparation also has an effect on the mortality of plants. The highest and fastest mortality rate was verified on plots with no mechanical preparation. Mechanically prepared soils generally showed up to 5% of dead plants, while no-till soils on control plots reached the mortality rate of approximately 20%.

Higher mortality of newly planted fast-growing tree species significantly affects the actual economic efficiency of the entire plantation. Additional substitution of dead plants is notably more expensive (per cutting) than planting in lines.

Material and Methods
Three sample plots with comparable natural conditions were used to test the effects of methods of planting cuttings of hybrid poplar *Populus nigra* L. × *P. maximowiczii* Henry (known as Japanese poplar) on the mortality of plants during the first vegetation period. The study aimed at verifying the potential of (1) an appropriate method of substituting soil preparation on the entire surface of a plot and (2) the use of autumn planting. A planting method not requiring soil preparation over the entire surface of a plot would have a significant positive effect on the economy of the plantation, particularly reducing the initial costs. Cuttings planted in autumn would make better use of spring soil moisture.
The actual planting was carried out on sample plots in the eastern part of the Pardubice Region, Czech Republic, namely: (1) sample plot Arnoštov (49°41'7.463"N, 16°39'48.471"E) at the altitude of 426-458 m a.s.l., clay-loam; (2) sample plot Mařín (49°40'27.98"N, 16°38'59.221"E) at the altitude of 532-562 m a.s.l., slightly skeletal loam; (3) sample plot Sázava (49°54'9.383"N, 16°38'19.824"E) at the altitude of 367-368 m a.s.l., loamy clay. All three sample plots are located in a single climatic region 7 – mild warm (SOWAC GIS, 2011). Based on our experience, the difference in soil conditions has no significant impact on the emergence rate in cuttings but rather affects the plants in the subsequent phases of growth, which were not subject to assessment. Chart No.1 shows the individual methods of planting cuttings of hybrid poplar *Populus nigra* L. × *P. maximowiczii* Henry, clone 105.

Chart No. 1 – Tested Methods of Planting Poplar Cuttings

Planting method	Plot	Number of planted cuttings	Planting period	Soil preparation
Spring planting in prepared soil	Arnoštov	3601	Spring 2008	Tillage, disc harrowing, dragging
Autumn planting in prepared soil	Mařín	1497	Autumn 2009	Tillage, disc harrowing, dragging
Autumn planting in no-till soil	Sázava	1840	Autumn 2009	Mowing and use of herbicide

As standard we considered spring planting with soil preparation. Cuttings are planted either manually with the use of a steel dibber or mechanically in prepared soil. Machinery is used in such cases when the soil is resistant despite the preceding tillage or other preparation and manual planting is not possible. This is common in spring planting, i.e. when the soil is significantly drier than in autumn. Spring planting shall be understood as the earliest possible period when the weather and soil conditions allow tillage, i.e. usually March and April. However, planting sometimes has to be carried out as late as May.

The above-described standard method was compared to the other two methods. With respect to soil preparation, the method of planting in no-till soil was tested. The grass cover was mowed and herbicide (Round-up) applied a month before the planned planting. The cuttings were planted manually directly in the soil using a standard steel dibber commonly used for planting poplar cuttings. Holes were made 30 cm deep to fit the entire cuttings, which were subsequently covered with soil, compacted by treading.

The entire plot was prepared by shallow tillage, disc harrowing and dragging. Both plots were prepared equally (the only difference was in the time of preparation, i.e. spring and autumn).

We also tested the effects of the season when planting is carried out, i.e. spring and autumn, with the view to maximising the use of spring soil moisture for budding and initial growth of plants.

The cuttings were 20-25 cm long with diameters 2.5 and up to 1.5 cm at the butt end and the tip respectively. After delivery, the cuttings were temporarily laid in a furrow and carefully covered with soil to ensure sufficient moisture.

Methodology of Data Acquisition, Processing and Assessment

Plantations were assessed visually approximately in the half of the vegetation period – i.e. in August in case of spring planting and in May in case of autumn planting. This time interval proved sufficient for the assessment of mortality/vitality.

Plants that showed at least one live and green sprout were considered as vital. On the other side, as dead or not emerged were considered cuttings with no sign of budding or with dry sprouts.

The entire set in one method comprised all planted cuttings in assessed lines. Mortality was computed as a difference between 1 (i.e. 100%) and the fraction of emerged and planted cuttings in the entire set of the method, according to the following formula:

$M = \left(1 - \frac{v}{p}\right) \cdot 100\%$, where (Form. No. 1)

M … mortality (%)
v …. number of vital cuttings
p … number of planted cuttings

Results

The mortality determined by Formula No. 1 differed to a great extent: the highest rate verified in autumn planting with no tillage (77.4%, i.e. 22.6% of vital plants), still high in spring planting with soil preparation (61.5%, i.e. 38.5% of vital plants), and the lowest in autumn planting in prepared soil (25.8%, i.e. 74.2% of vital plants).

Chart No. 2 – Numbers of Planted Cuttings, Numbers of Vital Plants, and Mortality in Individual Tested Methods

Planting method	Number of planted cuttings	Number of vital cuttings	Mortality %
Spring planting in prepared soil	3601	1388	61.5%
Autumn planting in prepared soil	1497	1111	25.8%
Autumn planting in no-till soil	1840	416	77.4%

Conclusion and discussion

The results imply that soil preparation and the period of planting have a significant impact on the mortality of cuttings.

The high mortality rate in the method of autumn planting in no-till soil was caused by insufficiently packed soil around the planted cuttings. In contrast to planting in prepared soil, the soil in a dibbed hole does not get in close contact with the cutting. A turf of rooted grass is hard to tread sufficiently (which is not the case in prepared soil) and space filled with air instead of soil is formed around the cutting.

The mortality rate in spring planting is given by budding and growing in a relatively dry period.

Further studies shall seek to verify whether the mortality rate in spring planting may be reduced, for example, by using rooted cuttings and to prove the hypothesis that the method of planting rooted cuttings in prepared soil in autumn secures minimum mortality. The hypothesis is based, among others, on a study conducted by DesRoches & Tremblay (2009), who used four forms of planting material – bareroot stock, rootstock, cuttings, and whips. Bareroot stock and rootstock represented planting with existing roots, while cuttings and whips without roots. The study concludes that plants with existing roots showed 20% more biomass at the end of the first vegetation period (determined as height and basal diameter) than cuttings and whips.

The influence of soil preparation on taking roots and growth is also described by Bedford & Sutton (2000). They tested the effect of pre-planting soil preparation on the lodgepole pine and stated that it has no serious impact on the mortality rate but enhances the growth of plantings and secures their higher annual increment, which reached 30 to 45 cm in prepared soil and only 25 cm in unprepared soil. The effect of soil preparation becomes less pronounced in the subsequent years.

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Acknowledgement

This project has been implemented with the financial support from the means of the state budget provided by the Ministry of Industry and Commerce of the Czech Republic (Research and Development of New Technologies of the Biomass Production for the Energy Production 2A-3TP1/019).

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