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ŽILINSKÁ UNIVERZITA V ŽILINE
STAVEBNÁ FAKULTA

FACULTY OF CIVIL ENGINEERING

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The Faculty is accredited to educate students in the field of civil engineering (transport structures for construction design, reconstruction and maintenance of railway tracks, roads, highways, urban roads, bridges and tunnels). There are more than 1,000 students at the Faculty in daily courses, 27 PhD. daily students and 43 PhD. students in external form. The students from abroad can participate in both forms of study.

The Faculty solves theoretical problems of design for transport structures, modeling, strain analysis, computer-based strength calculations and traffic planning in its research and professional activities. Significant results are achieved in measuring and diagnostics of transport structures subjected to dynamic loading. Courses of study are realized in three levels: bachelor (3 years), master (2 years), PhD (3 years).

Courses of study:
Geodesy - only 1st level
Civil Engineering 1st level
- *Railway Engineering 2nd level*
- *Roadway Engineering 2nd level*
- *Civil Engineering Structures 2nd level*

Construction Management 1st and 2nd level

In civil engineering courses the student choose his/her master's program after finishing 1st level from the described programs. Graduates are granted a diploma in engineering and the academic degree of Engineer. The study is finished with a state final examination, and the defense of a diploma thesis.

The full-time PhD. study is organized after finishing the master's program in the following fields of study:
- *Mechanics of Rigid and Flexible Bodies*
- *Theory and Construction of Engineering Structures*
- *Technology of Constructions*
- *Forensic Engineering.*

The PhD. study is finished with a doctoral examination and presentation of a candidate's dissertation. Successful students are granted the degree of PhD.

Research Activities

More than 20 national and international research projects are being solved at the Faculty of Civil Engineering. They are concentrated to research of new types of transport constructions and to diagnosis and evaluation of existing structures under a dynamic load. The research activities are focused also on modernisation of highway network, railways and railways stations and on building constructions. Remarkable results have been achieved in the field of transport planning. Bilateral contacts of teachers of the Faculty with universities and research centres in Europe are also very intensive.

International relations and co-operation of the Civil Engineering Faculty

International relations of our faculty are now focused mainly to the participation in EU projects. As most of Slovak Universities we also participated in TEMPUS projects. These projects helped us to be acquainted with functioning of projects of the European Commission and they also broadened our contacts with European universities.

These contacts are now very useful as we participate in various scientific and mobility programmes.

The typical mobility programme is the SOCRATES-ERASMUS programme. Our faculty started with this programme in 1999 and now it serves to our students as one (and the most important) possibility to spend one semester of their study in some European university. We have very good contacts with our partners at the universities in Germany *and France, but unfortunately there are no such contacts with universities in UK. This is caused by low interest of English universities in the SOCRATES programme. Therefore our English speaking students are handicapped and frustrated. The frustration of our students is growing during the last two years because the amount of EU funding per one student is decreasing.*

Another interesting part within the SOCRATES programme is the EUCEET project which is the network of European civil engineering faculties. Our faculty has participated in this project since the year 2001. The result of the project is a close co-operation with all participating faculties.

A similar EU programme LEONARDO has started at our University during this academic year. This programme supports practical stayes of our students in EU factories and enterprises. We hope that the programme helps our students to deepen their practical knowledge and also their foreign language abilities.

Our university is now a co-ordinator of the programme INTRANSNET, focused on creating the network of transport research facilities in Europe and our faculty plays an important role in this project. This programme is a part of the 5th EU Framework Programme.

Besides the EU projects our faculty co-operates very closely with other civil engineering faculties, especially with the neighbour countries as e.g. the Czech Republic and Poland.

Departments of the Faculty

Department of Structural Mechanics
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Teaching *– Theoretical Mechanics, Static of Structures, Dynamics of Structures, Theory of Elasticity, Experimental Mechanics, Strength of Materials, Mechanics of Continuous Medium.*
Research *– Dynamics and Diagnostics of Civil Engineering Structures (Bridges, Roads, Highways and Railways), Wind Engineering, Seismicity and Environment.*

Department of Geodesy
E-mail: kgdfstav.utc.sk
Phone: +421-41-7248012, 7635651-3
Teaching *– Mapping, Geodesy, Cartography, Railway Geodesy, Cadastre of Real Estates, Theory of Errors, Information System of the Cadastre.*
Research *– Analytic Railway Projecting, Calibration of Geodetic Instruments, Vertical and Horizontal Movements, Theory of Confidence and Accuracy of Measurements.*

Department of Geotechnics
E-mail: kgtfstav.utc.sk
Phone: +421-41-763 56 51-3, 7643391
Teaching *– Geology, Engineering Geology, Soils and Rocks Mechanics, Foundation, Underground Constructions and Tunnelling, Hydraulics and Hydrology.*
Research *– Structural Analysis of Soils and Rocks, Mathematical Modelling (Slope Stability, Hydraulics and Ecology in Civil Engineering).*

Department of Structures and Bridges
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Phone: +421-41-7635651-3
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Teaching *– Concrete Structures, Steel Structures, Concrete Bridges, Steel Bridges, Building Materials.*
Research *– Load Carrying Capacity of Steel and Concrete Structures and Bridges, Evaluation of Existing Bridges, Structure and Material Deterioration and their Effect on Bridge Structure Reliability, Utilisation of Composite Materials for Bridge Rehabilitation.*

Department of Railway Engineering
E-mail: kzs @fstav.utc.sk
Phone: +421-41-7635651-3, 7243374
Teaching *– Designing, Construction and Reconstruction of Railways, Station and Junctions, Railway Economy and Maintenance, Transport Construction Management.*
Research *– Design and Construction of High-Speed Railway Lines, Reconstruction of Railway Lines in Mining Areas, Railway Transport Noise.*

Department of Highway Engineering
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Teaching *– Road and Highway Design, Road Pavement, Road Maintenance, Urban Network Systems, Transport Engineering and Planning, Laboratories.*
Research *– Protection of Pavement against Frost, Highway Materials, New Materials for Mixtures, Pavement Evenness, Winter Maintenance, EIA.*

Department of Building Engineering and Urban Planning
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Teaching *– Road and Highway Design, Road Pavement, Road Maintenance, Urban Network Systems, Transport Engineering and Planning, Laboratories.*
Research *– Building Heating Engineering, Building Acoustics, Environment, Physical Planning Problems and Building Law.*

Department of Construction Management
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Fax: +421-41-7243351
Teaching *– Pavement Management System, Road Management and Economy, Civil Engineering Technology, Project Management, Laboratories.*
Research *– Highway Materials, New Materials and Technologies, Economy of Highway Network, Pavement Economy.*

The Faculty accredited laboratories

The laboratories consist of five units.

***Laboratory No. 1** is concentrated on a dynamic diagnosis of structures, bridges and structural materials. It also performs all types of prototype and conclusive tests of sleepers, means of fastening and rails.*

***Laboratory No. 2** performs technical diagnosis of structural constructions, bridges and materials. It also concentrates on performing loading tests of bridges.*

***Laboratory No. 3** carries out tests of aggregates, bituminous bonds and also a design of bituminous mixtures and controls their quality. It also performs tests of temperature conductivity of various materials. Basic properties of soils and measurements of its bearing are also performed in this laboratory.*

***Laboratory No. 4** concentrates on tests of bearing sleeper subsoil.*

***Laboratory No. 5** concentrates on tests of soils properties.*

Ján Bujňák – Jaroslav Odrobiňák

BEHAVIOUR OF STEEL-CONCRETE COMPOSITE GIRDER

The rheological properties of concrete play significant role in stress redistribution through steel-concrete composite cross-section. A long-term experimental measurement of rheologic effects on continuous steel-concrete composite beam has been running during 200 days. The results were tested to both a non-linear time dependent computer aided computation and suggested a simplified approach. From this comparison it can be concluded that if shrinkage effects are separated, simplified approach is in good accordance with both the measured strains and the values obtained from ANSYS. Therefore, except for shrinkage influence, load stress prediction can be made by a simple calculation with sufficient accuracy, Fig. 1.

Composite beams, which consist of a steel girder and concrete slab, present optimal structural system with good exploitation of both materials. However, in a negative hogging region they are less effective due to concrete cracking. Slab cracking influences cross-section efficiency and durability of a whole structure.

For the purpose of experimental measurement, two physical models of composite girders were prepared. The experiment focused mainly on the formation and propagation of cracks in RC slab of composite girders under load inducing tensile stress in slab. The results showed a great influence of initial cracks in slab on crack propagation. The assumption of negligible influence of tension stiffening on the structure behaviour in the case of minimum amount of reinforcement was also confirmed. For a crack width, big variation can be clearly stated both within cracks in a slab and between each of two slabs, Fig. 2. Consequently, the prediction of a crack width and crack spacing seems to be difficult. The next step of the research would be testing a new approach (or updating

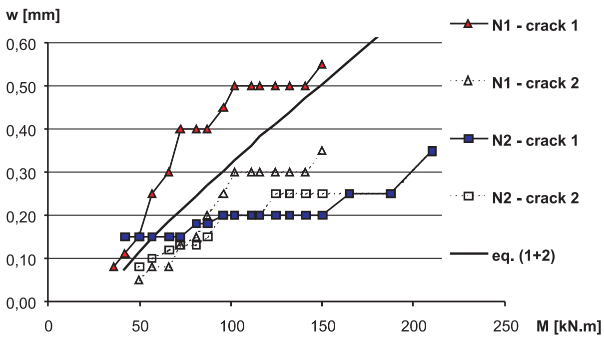


Fig. 2 Crack development and comparison with design

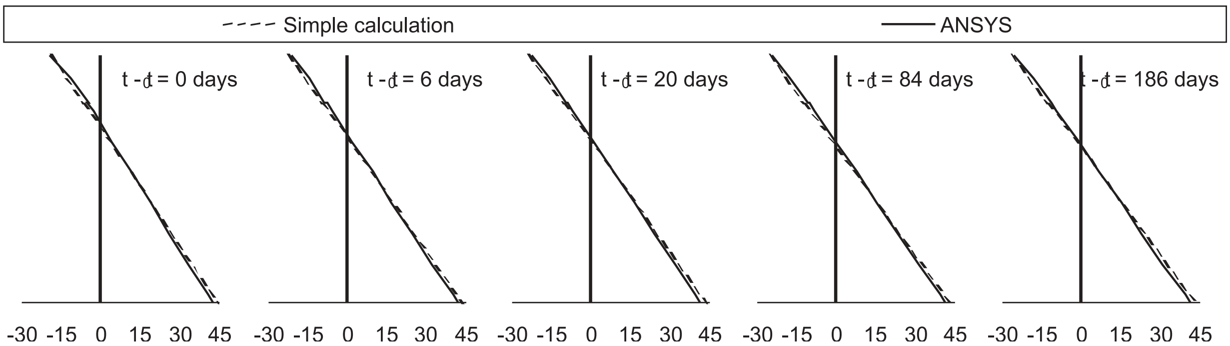


Fig. 1 Comparison of determined stresses in composite cross-section above middle support

the existing one) for prediction of a crack width and spacing in composite slabs. A comparison with a non-linear analysis in the ANSYS programme is in contemplation. Moreover, it seems to be substantial to continue the co-operation with Cracow University of Technology, where additional measurements on composite slabs affected by tension have been done.

In addition, a new progressive shear connection by perfobond strip was also studied in cooperation with this university. The dowel strength, which is very important for design of this type of shear connection, was specified on the basis of results of experimental tests.

Jana Ižvoltová

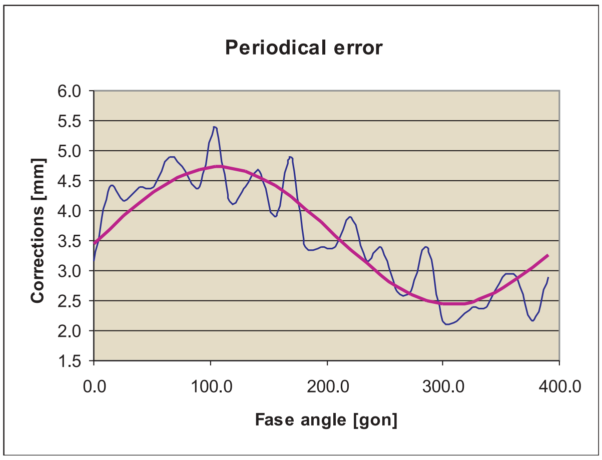
CALIBRATION AS A PART OF CONTROL QUALITY SYSTEM IN SURVEYING

Implementation of quality management system into geodetic work becomes unavoidable part of assuring the quality of surveying processes in conformity with the norm ISO 9001. Because of this fact, a metrological infrastructure is built up in a geodetic laboratory to enable quality control with verifying and determining metrological characteristics of instruments used in geodetic work.

The process of metrological assurance depends on building technical facilities, verifying calibration technologies or making the new ones in conformity with required accuracy and reliability, setting up the suitable software for adjustment of a great number of results, etc. Concerning the geodetic instruments the calibration procedures consist most of all of determining the accuracy of instrument, which is represented with the standard deviation or systematic error.

Such a procedure was used in determining the periodical error of total station, which consists of comparing the measured distances with precise scale laying on the calibration basis with recording the laboratory atmospheric conditions. The presumption was to obtain the systematic error that can be found out along the wavelength of electromagnetic bearing wave as differences of measured distances and periodical curve adjusted with Fourier harmonic analysis.

Least square method and Fourier analysis used to adjust a number of measured data seem to be optimal from the point of view of statistical objectivity and accuracy. The results of the described calibration technology involve not only a periodical systematic error that concerns mainly the electronic part of instrument, but also the value of additive constant of system instrument – prism, which have the systematic influence on measured distances, too.



Concerning the results reached on the laboratory calibration basis till now, we can say that the technology to determine the systematic periodical error of distance instruments is reliable, in addition to the atmospheric conditions, technical support and method of statistical adjustment influence on results accuracy.

Ivan Malíček et al.

NEW CONSTRUCTIONS AND MATERIALS USED AT THE MODERNISATION OF RAILWAY TRACKS AND STATIONS AND THEIR INFLUENCE ON THE RAILWAY TRACK QUALITY

The subject of the grant project VEGA, solved during the years 2000 – 2002, was the research and verification of constructions and materials, which are designed and used in the process of modernisation of railway tracks and stations. The task was divided into 5 subtasks:

1. Construction of substructure for the optimised and modernised railway tracks
   Responsible researcher: Assoc. Prof. Ing. Libor Ižvolt, PhD.
2. Verification of the construction of permanent way
   Responsible researcher: Ing. Ján Špánik, PhD
3. New structural elements for turnouts on the modernised railway tracks
   Responsible researcher: Ing. Mária Karabinová, PhD.
4. Railway connections and branches within the modernisation of the railway stations
   Responsible researcher: Assoc. Prof. Ing. Janka Gombitová, PhD.
5. Influence of railway operation on the quality and durability of classical railway bed construction
   Responsible researcher: Assoc. Prof. Ing. Milan Mikšík, PhD.

The preliminary results were, or will be, used in the area of creation of new norms and legislation, carried out by the members of the Department of Railway Engineering and Track Management, and within solution of specific problems of application research. The results were published in 44 research and scientific articles.

References:

[1] Grant project No. 1/4148/97 Modernisation of Railway Tracks and Stations – using of new Constructions and Materials and their Influence at Track Quality.
[2] Grant project No. 1/7409/20 New Constructions and Materials for the Modernisation of Railway Tracks and Stations and their Influence at Track Quality.

Map of modernisation of the Slovak Railways lines

Ján Špánik et al.

GEOMETRICAL POSITION AND ARRANGEMENT OF 1435 MM GAUGE RAILWAYS

A design and approval of design of the national norm STN 73 6360 Geometrical position and arrangement of 1435 mm gauge railways valid since September 1999, which specifies the basic technological parameters for designing and construction of railway tracks and stations and criteria for their control, operation and maintenance. The task for the Department of Railway Engineering and Track Management was specified by The Slovak Ministry of Transport, Posts and Telecommunications. The results were implemented by SÚTN Bratislava and in accordance with the norm the railway tracks of 1435 mm gauge up to 160 km/h track speed are designed and operated.

The Change No1 in STN 73 6360 Geometrical position and arrangement of 1435 mm gauge railways.

In December 2002 the final proposal concerning the wording of Change No1 was submitted for the approval process, which extends the validity scope of the original norm for the 1435 mm gauge railway tracks for the speed up to 200 km/h.

Milan Mikšík – Ján Špánik

ENVIRONMENTAL ASSESSMENT OF EXHAUSTED MATERIAL FROM RAILWAY SUBGRADE

The Methodical Instruction No 18/1999 MDPaT SR, "Environmental assessment of exhausted material from railway subgrade" was published by MDPaT in co-operation with MŽP SR (Slovak Ministry of the Environment), and has been valid since September 1999. It was prepared by the members of the Department of Railway Engineering and Track Management on the base of solution of two tasks of applied research. The Methodical Instruction specifies the methodology for extraction of exhausted material, procedure of its further processing, method and methodology of environmental assessment of that material. Nowadays on the base of that instruction the environmental quality of the railway subgrade material is being assessed before all works in which it is interfered into the subgrade as well as at the design preparation of the modernisation of the further sections of the Slovak railways network.

Janka Gombitová et al.

THE PLATFORMS ON THE RAILWAYS

Works on preparation and elaboration of the final draft, which were carried out by members of the Department of Railway Engineering and Track Management on the order of The Slovak Ministry of Transport, Posts and Telecommunications (MDPaT SR), were realised by SÚTN Bratislava that published the national norm STN 73 4959 The Platforms on the Railways valid since December 2001. The norm specifies requirements for designing, construction and reconstruction of the platforms and related equipment of the 1435 mm gauge railway tracks up to 160 km/h track speed.

Ivan Malíček et al.

DESIGN OF RAILWAY STATIONS

The national designed norm STN 73 6310 "Design of railway stations – basic principles" stipulates principles for designing, modernisation and rebuilding of railway stations and turns-out and their equipment on the 1435 mm gauge railway tracks. The Slovak Ministry of Transport, Posts and Telecommunications was sponsor of this task, the final realisation was provided by SÚTN Bratislava and the norm has been in force since December 2001.

Libor Ižvolt et al.

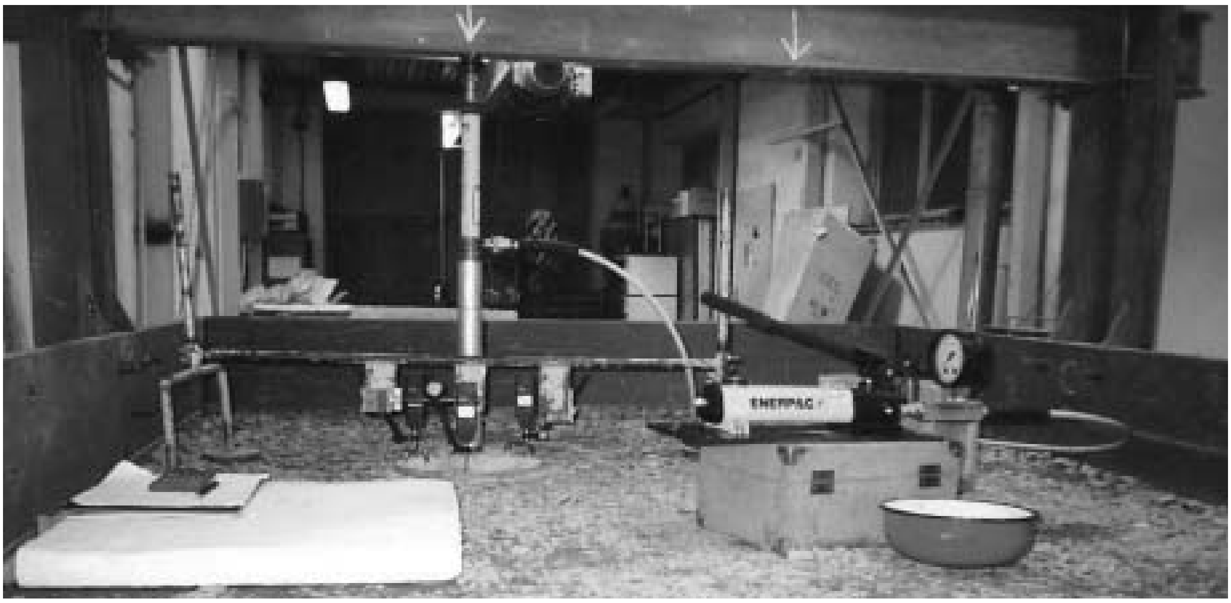
CHANGE OF THE BASIC ŽSR–S4 REGULATION RAILWAY SUBSTRUCTURE

In the Department of Railway Engineering and Track Management the following changes of annexes of this regulation were prepared:

Annex No. 7, Geotechnical exploration of the body of the substructure.
Annex No. 11, Use of the geosynthetics in the body of the substructure and in its formation.
Annex No. 12, Use of the geosynthetics in the railway subgrade.
Annex No. 20, Determination of the deformation module.

All the annexes were approved by the contractor and published as valid regulations and they determine rules for diagnostics of the construction of the railway subgrade and use of new materials at the construction and maintenance of the railway subgrade. These regulations are valid for all Slovak railway tracks and are used at the designing and maintenance works.

Verification of theoretical properties of new construction elements for the construction of railway subgrade and new materials are realised in the laboratory of the department.



Verification of deformation properties of a model construction of the railway subgrade on the large test stand of the Department of Railway Engineering and Track Management.

In the laboratory of the department there are large and small test stands enabling modelling, measurements and assessments of supposed quality of construction parts from a complex aspect in real conditions. On the basis of positive results of assessment, further operational verification is proposed in operating conditions on the railway tracks.

Milan Mikšík et al.

TECHNOLOGICAL AND ENVIRONMENTAL CONDITIONS OF THE MATERIAL SUPPLY FOR THE RAILWAY BED CONSTRUCTION AND FOR THE RAILWAY SUBGRADE FOUNDATION LAYER

The task was solved by the staff of the Department of Railway Engineering and Track Management for the Slovak Railways. The results of the solution were realised as the company norm TNŽ 72 1514 Technological and environmental conditions of the material supply for the railway bed construction and for the railway subgrade foundation layer, valid since July 2000 defining technical and ecological material properties of the railway subgrade construction layers.

Karol Potoček – Tomáš Potoček

ADDITIONAL WARMING OF A BUILDING FROM A POINT OF VIEW OF FINANCIAL RESOURCES EFFECTIVENESS

An important part of a building service value and necessary condition for its service is to provide thermal circumstances suitable for people staying and working inside or for technological processes carried out in the building. Current energetic situation presses users of heated buildings to decrease energy consumption for buildings' heating. The improvement of thermal-insulating properties of existing wrapping jacket of building can significantly help to fulfil this requirement.

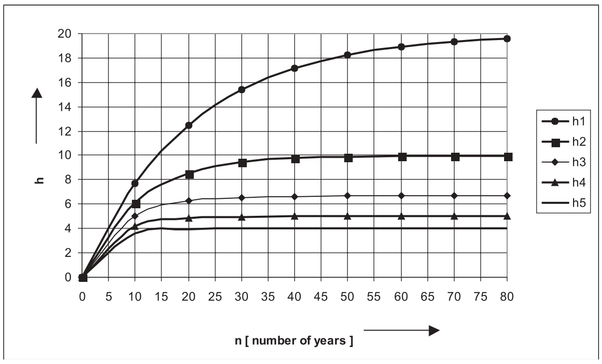


Fig. 1 Graphical illustration of the course h for different i and number of years n

Additional repair of wrapping jacket of building (warming) is then economically and thermal-energetically effective when during this repair will be achieved savings which equal or are higher than given financial resources for its making. It can be expressed by equations and graphically.

a) for situations without inter-year price accumulation of energy Fig. 1

$$K \leq \Delta m \cdot h \qquad h = \frac{(1+i)^n - 1}{i(1+i)^n}$$

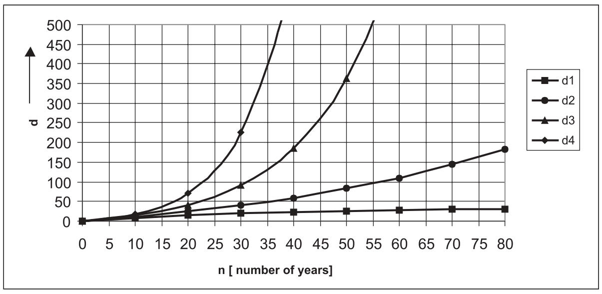


Fig. 2 Graphical illustration of the course d for i = 8 % different r and number of years n

where i – discount investor rate (%), h_1 (i_1 = 5 %), h_2 (i_2 = 10 %), h_3 (i_3 = 15 %), h_4 (i_4 = 20 %), h_5 (i_5 = 25 %)
n – number of years during which we gain annual decrease of expenses for heating about Δm (Sk) per year

b) for situations with coefficient of yearly energy price increase r (%) Fig. 2

$$K \leq \Delta m \cdot d \qquad d = \frac{1 + r - (1 + r)\left(\frac{1+r}{1+i}\right)}{1 - r}$$

d_1 (r_1 = 5 %, i_1 = 8 %), d_2 (r_2 = 10 %, i_2 = 8 %), d_3 (r_3 = 15 %, i_3 = 8 %), d_4 (r_4 = 20 %, i_4 = 8 %)

References:

[1] POTOČEK, K. – POTOČEK, T.: *Zateplenie budovy z pohľadu efektívnosti vynaložených finančných prostriedkov,* Tepelná ochrana budov, Praha 2/2001, ISSN 1213-0907.

Karol Potoček – Tomáš Potoček

ADDITIONAL WARMING OF CIRCUMFERENTIAL WALLS OF HEATED BUILDINGS FROM WATER VAPOUR CONDENSATION POINT OF VIEW

A most serious problem for keeping circumferential wall quality and service life after its additional warming is water vapour condensation. Additional warming must be suggested so that water vapour cannot condensate in the wall. This is necessary for optimal circumferential wall service life.

In case we cannot eliminate water vapour condensation in the wall it is important to enable liquefied water vapour (which is from winter time) evaporate during summer or transient time from the wall.

This can be performed by suitable solution of wall construction. In this case relative ratio between ΣRd_1 and ΣRd_2 (Fig. 1) will be as follows:

$$G_K - G_V \leq 0 \ \ (\text{kg.m}^{-2}.\text{rok}^{-1})$$

G_K – the quantity of liquefied water vapour (kg.m^{-2}.rok^{-1})
G_V – the quantity of evaporated water vapour (kg.m^{-2}.rok^{-1})

Where

$$\Sigma R_{d1required} = n_{necesary} \cdot \Sigma_{Rd2}$$

in which

$$n_{necesary} = \frac{\Delta p_{1k} - m \cdot \Delta p_{1v}}{\Delta p_{2k} - m \cdot \Delta p_{2v}}$$

and $\Sigma R_{d1} \geq \Sigma R_{d1required}$

The repair of circumferential wall performed by dint of this warming will reliably fit from the point of view of year humidity regime.

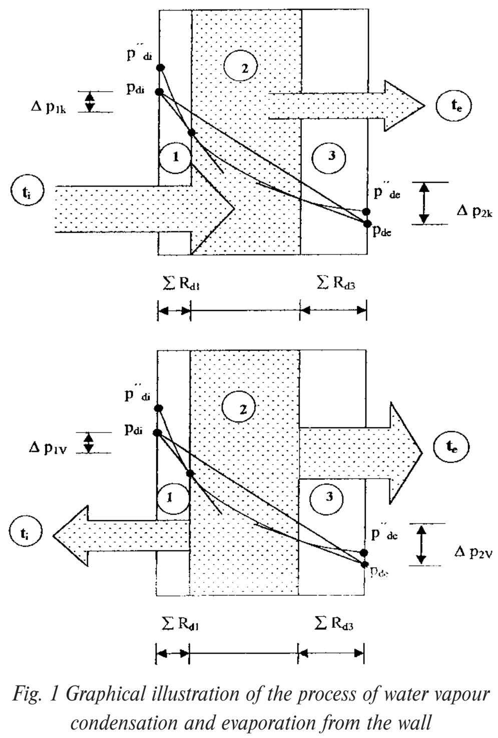


Fig. 1 Graphical illustration of the process of water vapour condensation and evaporation from the wall

References

[1] POTOČEK, K., POTOČEK, T.: *Dodatočné zateplenie obvodových stien vykurovaných budov z pohľadu kondenzácie vodnej pary,* Tepelná ochrana budov, Praha 3/2002, ISSN 1213-0907.

Zora Hroncová – Ján Valášek

EFFECT OF STIRRUPS SPACING CHANGE ON ACHIEVING LIMIT CRACK WIDTH

Cracks belong to deformation effects caused by action on reinforced concrete beams. They arise at the regions of maximum bending moments – vertical cracks, and at the shear regions – slant cracks.

A characteristic critical slant crack shows the maximum width from slant cracks. It was observed on reinforced concrete beams.

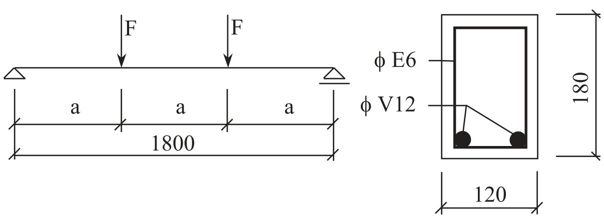


Fig. 1 Characteristics of tested beams

An original mathematical model was used to express a development of the slant crack width (for the chosen concerned parameters). The model is expressed by a general criterion equation:

$$\frac{w_{3q}}{a} = f\left(\frac{Q}{b \cdot h \cdot R_{b,exp}} \cdot \frac{A_{ss} \cdot R_{ss}}{A_{st} \cdot R_s} \cdot \frac{c}{s_s}\right). \qquad (1)$$

The experimental data were processed to a mathematical relation by means of the criterion equation. By consecutive modelling, we obtained a relation which enabled to find out how the change of stirrups spacing would affect the development of crack width and at which value of shearing force $Q = Q_m$ the crack width would achieve the limit value $w_{q,lim} = 0.2$ mm.

Shearing forces Qlim corresponding to the limit value of inclined crack width — Table 1

Stirrups spacing s_s [mm]	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12
Shearing force Q [kN]	37.56	31.29	26.82	23.47	20.86	18.77	17.07	15.64
$w_q = 0.2$ mm								

Ján Čelko – Daniela Ďurčanská – Jozef Komačka

DIAGNOSTICS AND EVALUATION OF ROAD PAVEMENTS

The Department of Highway Engineering has paid much attention to questions of pavement serviceability and efficiency. Recent research activities of the department have related to diagnostics and evaluation of road pavements in term of skid resistance, evenness, surface state and bearing capacity.

The main problem solved in the area of skid resistance was a theoretical question of interaction pavement – tire. Results were used as a basis for the development of the technical regulation [1] for skid resistance measurements using SKIDDOMETER BV 11. The Slovak Road Administration (SRA) used this equipment for routine measurements. Skid resistance classification criteria for diagnostics by SKIDDOMETER BV 11 were carried out on the basis of comparison measurements with other evaluation methods.

New equipment for dynamic quantification of longitudinal unevenness was developed in the area of pavement evenness diagnostics. Profilograph GE simulates the model of a quarter car. The parameter of dynamic transfer was calibrated through power spectral density and the model was verified by a comparison of measured and simulated values (Fig. 1). Next activities were realised in the area of road evenness diagnostic and evaluation:

Conversion among methods of skid resistance evaluation [2] — Table. 1

Texture depth by sand patch test – h_p	Friction coefficient by portable skid resistance tester – f_k	Friction coefficient by Skiddometer – M_u
0.22	46	0.53
0.55	60	0.68
0.80	71	0.79

- analysis of longitudinal unevenness influence on dynamic response of the model of quarter car,

- simulations of dynamic response of real cars models,
- analysis of qualitative characteristics of IRI and marginal conditions of its measurement and evaluation.

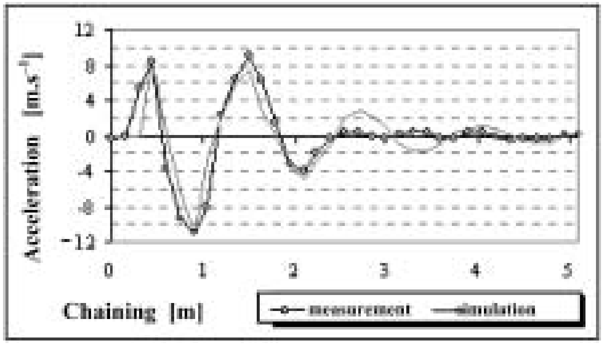


Fig. 1 Measured and simulated values [3]

All the results obtained in this field are in detail described in [3] and [4]. One of practical outputs is the technical regulation [5] for measurement and evaluation of asphalt pavement unevenness. Technical regulation is valid for PROFILOGRAPH GE, only.

Diagnostics and evaluation of asphalt pavements bearing capacity is an inseparable element of the Pavement Management System (PMS). Simulation of heavy vehicles impact to the pavement structure was carried out for the decision-making procedures intent on response to impulse load. Methods for determination of deformation characteristics of pavement layers from a deflection bowl, calculation of pavement residual life and necessary overlay were developed during research in this area. Practical output of these activities is the technical regulation of SRA for the measurement and evaluation of asphalt pavement bearing capacity using deflectometer FWD KUAB 2m – 150 [6].

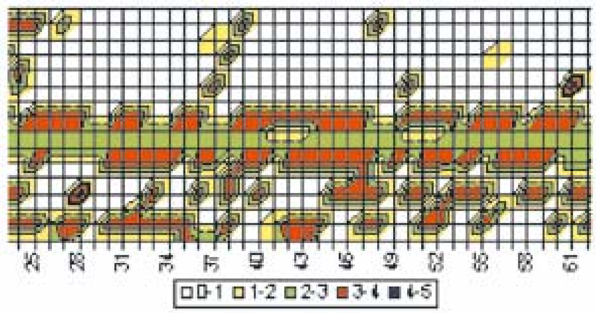


Fig. 2 Graphical interpretation of pavement evaluation

Evaluation of road pavements according to their surface state is a diagnostic sphere where the department has been involved for the longest period of time. The products of research are methodologies for detailed visual surveys [7] and rapid visual surveys [8]. In addition the software for processing of collected data was developed at the department and the classification criteria related to pavements with asphalt concrete surface were defined.

References

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Jaroslav Šíma – Peter Polónyi – Peter Pisca

GEODETIC MEASUREMENT OF BRIDGE OBJECT DURING RECONSTRUCTION

The present condition of road infrastructure forces us to its repeated reconstructions. The bridge objects are first to repair from the safety aspect. One of them was bridge object No. 70-018 in Dolný Kubín. The bridge consists of two bridge fields. Emergency condition of the bridge object forces the Slovak Road Administration towards its total reconstruction. For cross beam strengthening there was applied carbon fiber technology from SIKA Company. Because of the high traffic and no traffic diversions, the closing of both traffic lanes was not possible; therefore the bridge reconstruction was carried out in several phases. The first phase consisted of the right traffic lane reconstruction and after finishing work the reconstruction was moved to the left traffic lane. Geodetic work follows the similar way.

The reference net consists of 9 points, which were arranged on the fixed objects outside the bridge and stabilized by marks. So they were not touched with the building activity. Observation points were stabilized by mortise marks in the basic construction of the armored concrete slab of the bridge according to designer's layout. 10 points were in every bridge span.

The method of geometric leveling from midpoint with technology of very precise leveling was used. For measurement the following digital instruments were used: NA 3003 and NA 2002 from LEICA Company, complemented with special code invar staffs GPCL3 and GPCL2.

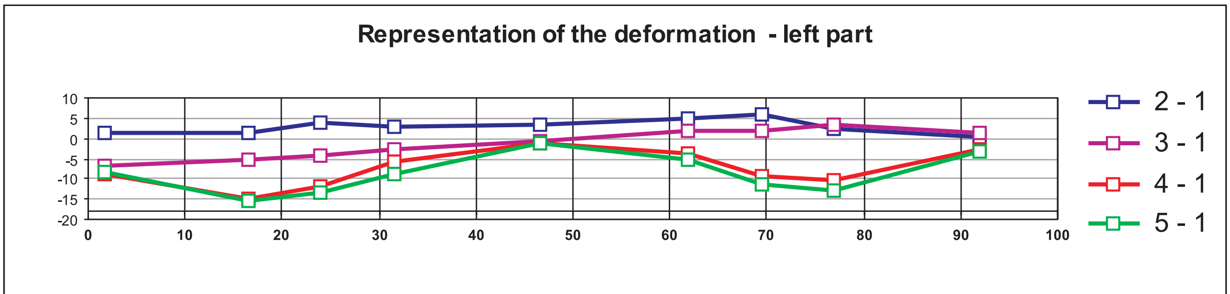
The measurement was carried out in 6 phases according to — Table 1

Phase	Date	Activity
Basic	15. 7. 02	Original bridge
1.	18. 7. 02	Unload upper construction
2.	27. 7. 02	Activation of the laminations of the 2nd span
3.	6. 8. 02	Activation of the laminations of the 1st span
4.	6. 9. 02	Bridge with footpath
5.	12. 9. 02	Loading test

At the beginning of each phase of measuring the stability of the points of reference net was verified. After the calculation of the stability of the reference points we measured and interpreted the bridge object deformation as the cause of reconstruction influence. The deformations were measured on the remark points. The graphic representation of the deformation evolution on the left part of the bridge object is displayed in Figure 1.

Accuracy of determination of deformation is given by the analyses carried out after each phase of the measurement. It is characterized by posteriori mean error, m0 [mm]. An analysis of the accuracy acknowledges that height changes higher than 0.4 mm were considered to be actual deformations.

The cooperation of the project engineer and geodesist is necessary during all reconstruction of the bridge object, where project engineer verifies theoretical values with the geodetic measurement. The whole reconstruction of the bridge took 2 month. At present, the reconstruction of the bridge is over and is open to traffic.



Ladislav Bitterer

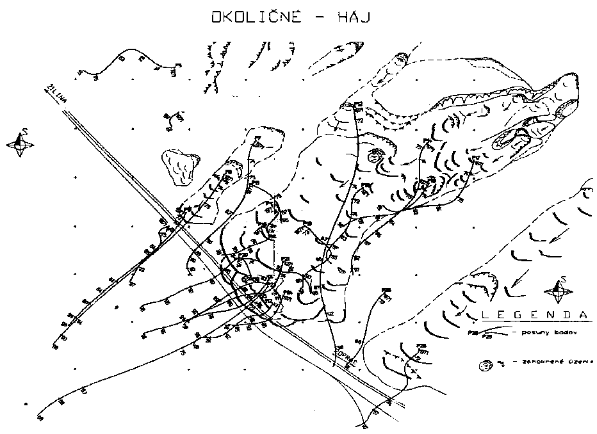
MEASUREMENT OF LANDSLIDE DEVELOPMENT IN OKOLIČNÉ – HÁJ IN THE RAILWAY KOŠICE – ŽILINA IN 255,0–255,5KM

Since 1971, the department of geodesy of the University of Žilina has measured the flow landslide in Okoličné. Till now, 48 stages of measurements have been carried out.

All the surveying and calculations consists of: the reference points stability verification, the spatial position measurement of the observed points laying on landslide and interpretation of adjusted spatial changes with the Test of null hypothesis. The observation of the shoot surface development and water regime condition is the important part of surveying work, too.

In the present time we use calibrated electronic theodolite TC 1700 Leica with unavoidable accessories. The least square method and other procedures of mathematical statistics are used to judge the reference point stability. In yearly stages of measurements the maximal points shifts produce the values under 10cm. The figure shows the approximation of positional changes development adjusted with polynomial 5°.

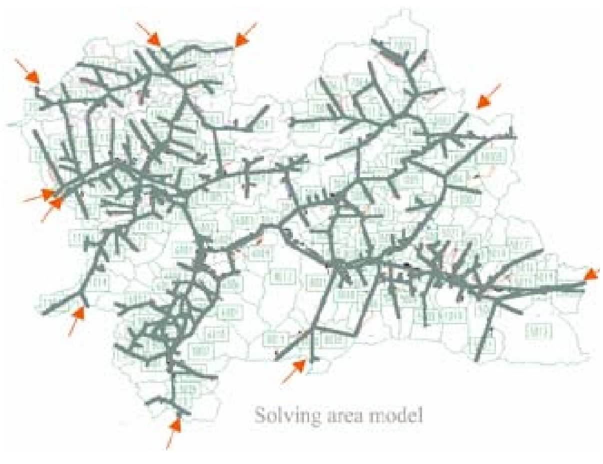
The measurement of landslide development in Okoličné is common project of University of Žilina and State geological institute of Dionysus Štúr, named: Particular monitoring system – geological factors, with subsystem: 01 – landslide and others slope deformation.



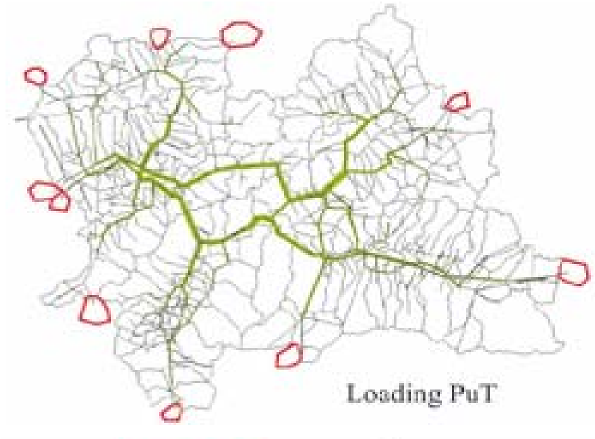
Ján Čelko – Eva Holeščáková

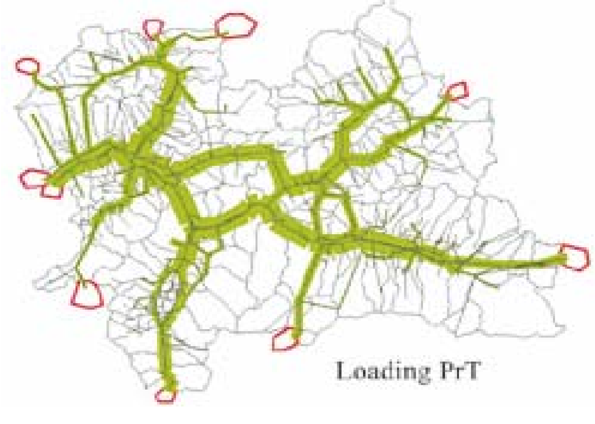
MODELLING OF TRAFFIC RELATIONS AT A REGION TERRITORY

When creating new area-administration units transport and traffic knowledge is a significant problem. First of all, it is because of flexible solution of traffic limitation allowing – in the case of traffic network sections diversion or enclosing and by different arrangements simulation with an optimal traffic repartitioning. The model allows choosing an optimal variant of solution and redounding to more economic useful solution of the regional traffic. In addition, the model can be used for traffic coordination and ordering, which could be very acceptable for the public transport regulation.


Solving area model

The VISUM software was used for solution. The software enables a modelling of the traffic systems, traffic load and the


Loading PuT


Loading PrT

route selection included by using of the O–D matrix. The solution is possible separately for private (PrT) and public (PuT) transports.

The results are desigated for the transportation plannig process in the transport administration level and like a backround for the route designed in wide area.

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Ján Čorej – Martin Decký

THE RESEARCH OF PHYSICAL-MECHANICAL CHARACTERISTICS OF ROAD PAVEMENTS

Physical-mechanical characteristics of road construction materials are relevant input parameters for the computing of stresses and deformations of pavement constructions. They are the substantial background for exact appreciation of pavement construction design too.

The deformation properties, stability attributes, fatigue characteristics, thermo-technical properties of road construction primary affected the road construction building product quality.

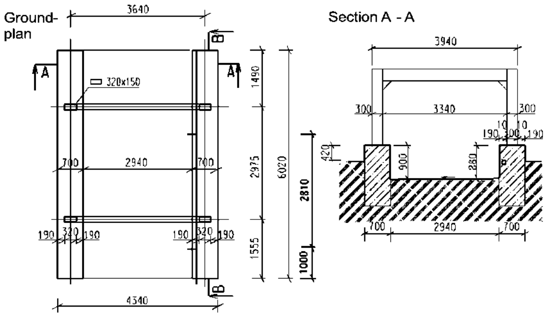


Fig. 1 A scheme of road mechanical experimental research station

The road mechanical experimental research station of the Department of Highway Engineering is constructed within the research activities of VEGA No. 1/3127/96 and No.1/8194/01 [1] in order to increase theoretical and practical knowledge about objective properties.

The influence of moisture and construction enhancement of road subgrade on the bearing capacity can be seen in Fig. 1.

The comparison example of bearing capacity of two road constructions evaluated by means of equivalent elastic modulus and comparison with measured values is presented in Tab. 1.

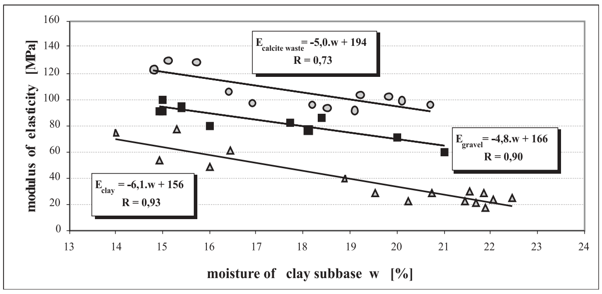


Fig.2 The influence of moisture and construction enhancement of road subgrade on the modulus of elasticity

The comparison of measured and calculated values of equivalent elastic modulus — Tab. 1

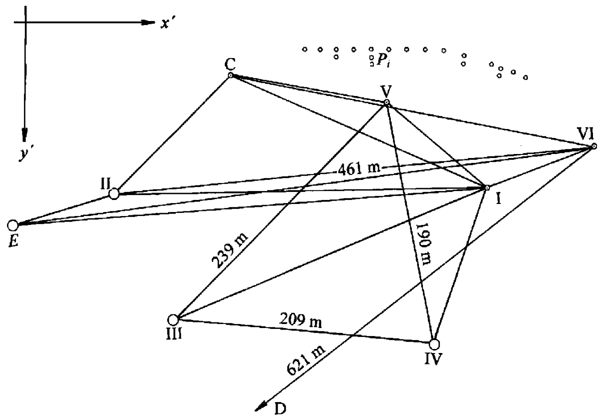
Construction layer	Equivalent modulus of elasticity E_1 [MPa]					
	Pavement 1			Pavement 1		
	Measured values	Computed values by		Measured values	Computed values by	
	E_1	*A*	*B*	*E_1*	*A*	*B*
Asphalt concrete middle-grained	557	545	560	238	566	645
Asphalt concrete course-grained	332	492	520	231	510	595
Coated macadam course-grained	260	368	365	151	388	475
Cement stabilised soil	378	258	275			
Mechanical consolidated aggregate				170	254	335
Crushed material	86	139	155	84	142	160

Jozef Štubňa

GEODETIC MEASUREMENT OF THE SHIFTS IN BARRAGES

Big and atypical constructions – barrages including – require supervision of their stability and functional reliability in time of the construction as well as in time of their working order. Geodetic methods of the shift measurement, because of giving quasi – absolute shifts in comparison with close and remote surroundings, give a reliable picture of the positional and level stability of the work. The staff of the Department of Geodesy, Faculty of Civil Engineering, University of Žilina have been measuring the positional shifts of the water construction Liptovská Mara from 1976 and the positional changes of the oldest gravitational dike the Orava barrage from 1997.

Methods of measurement. *The object of the barrage is characterised by the watched points, the position of which is appreciated in connection with relative points representing the close and remote surroundings. The shifts of the crown of the dike in horizontal direction are determined by the measurement from a deliberate line of sight for both barrages. The inspected points on the air front-side of the barrage are measured by trigonometric method. The inclination of the upper part of dam is determined by the pendulum and from the results of a very precise levelling. The shifts in vertical direction are measured by a very precise levelling.*



Trigonometric method. *The trigonometric method is applied to determine positional shifts of mentioned barrages that give objective results about inspected points but also the picture of close surroundings of an observed object. The supervised points are situated on the air side of barrage. Their horizontal shifts are judged with respect to relative /fixed/ points. The photo shows the view on Orava barrage – the net of relative and inspected points.*

The basis for determination of horizontal shifts is represented by a very precise measurement of angles on relative points on trigonometric net. The principle of trigonometric method is well known among the surveyors. The most important task in analysing the shift of inspected points is to determine the positional stability of relative points and to determine the shift of inspected points. The concrete information about the above mentioned barrages is published by the author in scientific geodetic journals. Geodetic measurement of shifts, sittings and inclinations together with other measurements belong to the most important methods in determination of stability of dams and other big constructions.

Ivan Drevený – Katarína Šlopková

EFFECT OF DEGRADATION PROCESSES OF CONCRETE AND REINFORCEMENT ON THE REMAINING LIFETIME OF STRUCTURES

Durability and reliability of reinforced concrete bridge structures depends mostly on the environmental condition to which they are exposed. The most significant effect has acting air CO_2 and Cl^-. These factors cause corrosion of concrete and reinforcement decreasing lifetime of reinforced concrete structures. Corrosion of the reinforcement is the most frequent cause of reinforced concrete structures failures. The causes of reinforcement corrosion can be subdivided into chemical and electrochemical effects.

Corrosion is evoked by many factors. Chloride ions Cl^- from salts applied by winter maintenance of the roads and carbon dioxide CO_2 from environmental atmosphere are the most important from the viewpoint of reinforcement corrosion. Two basic types of reinforcement corrosion should be distinguished in concrete structures. General corrosion performs continuously over a substantial area of reinforcement. This is a relatively slow process, producing only a small reduction in the bar cross-section, but it causes substantial disruptions of the concrete cover. Localized corrosion is much more rapid than general corrosion. It leads to substantial local reductions in the bar cross-section. In the case of chloride ions diffusion into concrete, it shall be remembered, that concrete is neither an isotropic medium nor a homogeneous material. However, for many problems encountered in practice it is sufficient to consider concrete as a quasi-homogeneous material, where the diffusion of chloride ions of which can be considered using Fick's laws of diffusion.

The result of many studies of the relationship between various properties of hardened concrete and the long-term performance of concrete bridges showed a number of connections between concrete properties and performance under different environmental and traffic conditions. On the basis of these studies 5 bridges were randomly chosen. They were located in various places in the country on highway sections with various traffic and chloride loads and with an age composition. The results of calculation of the time t0, when chloride ions penetrate through the concrete cover achieving reinforcement and the corrosion starts are show in table 1.

Fick's diffusion laws are suitable methods for the forecast of future chloride penetration and for evaluation of the remaining lifetime of concrete bridges.

Table 1

Bridge No.	Chloride content [kg.m^{-3}]		C_s [1)] [% by cont.wt.]	D_c [2)] [mm^2/year]	Concrete cover remaining[3)] lifetime t_0 [year]
	In 13 mm depth	in 45 mm depth			
1	17.01	12.51	0.190	669	1
2	20.63	7.06	0.281	71	12
3	17.80	14.23	0.193	919	1
4	24.39	10.80	0.314	106	10
5	19.28	10.92	0.233	182	5
		average:	0.242	390	

[1)] C_s is maximum chloride content in the concrete surface (% of dry concrete weight)
[2)] D_c is diffusion coefficient in mm^2/year
[3)] Calculation are made with C_{cr} = 0.0571 % of dry concrete weight

Josef Vičan – Peter Koteš – Jiří Slavík

EFFECT OF DEGRADATION FACTORS ON EXISTING BRIDGE RELIABILITY

The reliability of existing bridge structures is significantly affected due to many factors from which the reinforcement and structural steel corrosion together with effect of traffic action are the most important. In the case of concrete structure, the reinforcement corrosion is caused by concrete carbonisation, that is CO_2 diffusion to the concrete member. The reinforcement corrosion will begin after CO_2 penetration through the concrete cover and achieving reinforcement bars in time to (so called passive stage). Then the active stage of reinforcement corrosion begins affecting the reinforcement resistance significantly. The effect of reinforcement corrosion on the reliability of reinforced member was observed by means of parametric study using two models of passive stage length to calculation according to Schiessl [1] and Frey [2]. Loss of reinforcement diameter ds {t} due to uniform corrosion was taken into account in accordance with Andrade model [3] and Thoft -Christensen model [4]. Results of the parametric study of time-variant reliability courses of reinforced member subjected to bending presented in [5] are partially shown in Fig. 1.

Effects of the traffic actions on bridges were observed on the real railway bridge structure by means of in-situ measurements supplemented by a computer simulation of train models passages over the computational model of bridge structure. The results of the stress response of the upper and bottom chord of the observed truss main girder were statistically processed and are shown in Table 1.

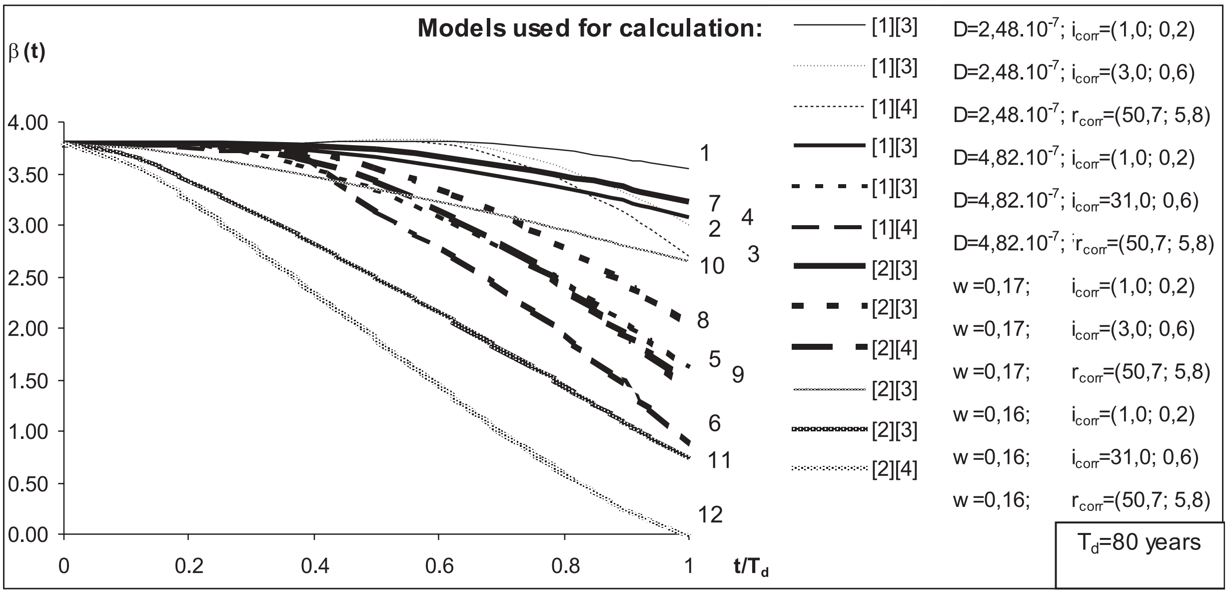


Fig. 1 Time-variant reliability index β [t] of the member subjected to bending under corrosion attack.

Statistical evaluation of traffic load effects — Table 1

Mean value		Standard deviation		Coefficient of variation		1 - bias factor	
Bottom chord m_{sS4} [Mpa]	Upper chord m_{sH4} [Mpa]	Bottom chord s_{sS4}	Upper chord s_{sH4}	Bottom chord v_{sS4} [Mpa]	Upper chord v_{sH4} [Mpa]	Bottom chord l_{S4}	Upper chord l_{H4}
23.87	-32.84	4.58	6.66	0.19	-0.20	0.47	0.47

Using Rackwitz – Fiessler method of design point, the results of computer simulation were applied to determine values of partial safety factors for dead {γ_{FG} = 1,10}, long-term affecting {γ_{FQ} = 1,20} and traffic load {γ_{FT} = 1,20} corresponding to the reliability level β_t = 3,50 [6].

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Jaroslav Šima – Anna Seidlová

GEODETIC WORK IN CONSTRUCTION OF THE SKI JUMP K-90 IN THE HIGH TATRAS

Ski jumping or ski flying are attractive sports disciplines. Needless to say, both ski jumping and ski flying are dangerous. Therefore, ski jump profiles must meet universal parameters prescribed by the FIS. The working-out and application parameters have to be performed in compliance with the designs prepared by experts

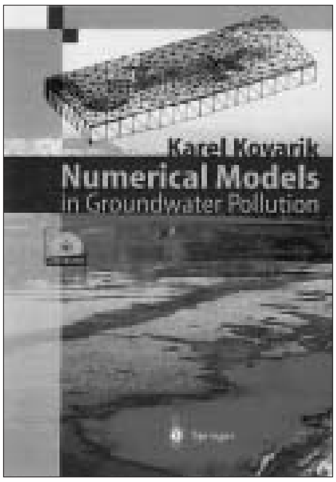
of the FIS technical commission in collaboration with the TU in Munich. The basis is formed by the mathematical processing of soldering graphics vintage of competitions in the season 1996–97. Application parameters are preceded by precise measurements of the longitudinal profile in intervals of 1–2 m using a total station Leica 1700. The projected and adjusted profile of the ski jump reconstruction was traced in November 1998, making some arrangements during the world Universidad. In the years 2000 – 2001 the ski jump profile was repaired and its surface was covered with artificial material. The basic foundations are longitudinal and transversal wooden reinforcements. In the point of intersection it was needed to direct positional and level detailed items, and calculate their 3D position data. Comparing these coordinates with the project we determined the height differences that served for the setting of the whole gridiron.

The final deformations were adjusted in a numeric and graphic form following the worked-out digital model. After the rectifications (stabilization in a V- shape) the timbering was put. On the timbering artificial material was set, which enables the all-year-round operation of the ski jump profile K-90. It included 1760 points determined by means of a trigonometric method. The terrain work was carried out within one day and the results were processed in two days' time.

The measurement accuracy is characterized by the standard deviation $m_{\Delta hp}$ that is calculated by means of the equation:

$$m_{\Delta hp} = \sqrt{m_{\Delta H}^2 + \left[(1 + tg^2\beta)\frac{d}{\rho^{cc}}\right]^2 m_{\Delta\beta}^2 + (m_{\Delta d} tg\beta)^2}, \quad (1)$$

In the equation $m_{\Delta H}$ is mean error of height, β is vertical angle, $m_{\Delta\beta}$, is mean error of the measured vertical angles and $m_{\Delta d}$ is mean error of lengths. After substituting the least favourable values into the equation (1) $m_{\Delta hp}$ equals 4 mm for run-on tower and 3 mm for ski jump terrain. The total error is equal to duplex mean error and consequently we can say that both the above described surveying method and the total station (LEICA1700) are suitable for distinguishing the height changes in the ski jump profile which are higher than 8 mm. This accuracy corresponds to the demands concerning the accuracy for profile of the whole ski jump profile and confirms the right choice of the used technology as well as instrument.



Numerical models in groundwater pollution

Karel Kovářík
* Hardcover: 218 pages ; Dimensions (in inches): 0.56 x 9.50 x 6.37
* Publisher: Springer Verlag; Book and CD-ROM edition (May 2000)
* ISBN: 354066792X

Book Description

Mathematical models are effective tools to solve different tasks predicting pollutant movement. The finite difference method is the oldest, but still remains widely used in hydrogeological practice. However, this method is not very useful to construct new transport models because it cannot approximate the shape of remediation elements exactly. Therefore the book is concerned with the FEM (Finite Element Method) and BEM (Boundary Element Method), and also with the comparison of advantages of these methods in groundwater hydrology. The combination of the BEM and the random-walk particle tracking method, which seems to be a very useful tool to model the spread of pollution in groundwater, are also presented. The computer programmes were developed on the basis of theoretical backgrounds of these methods. They use the Visual C++ programming language for Windows 95/NT platform and will be included in the book.

Book Info

Discusses the basic equations of a groundwater flow and of the transport of pollutants in a porous medium. Concentrates on the fundamentals of numerical mathematics. Studies each method of numerical modelling separately, and more.

Keywords

Groundwater–Pollution–Mathematical models.

Pavement surface characteristics

Pavement operation ability

Authors: Ján Čelko, Martin Decký, Daniela Ďurčanská, Andrea Gavulová,
Milan Valuch, Peter Múčka

Publisher: University of Žilina, 2000
ISBN 80-7100-774-9

The authors present basic theoretical knowledge in the area of roughness, unevenness and surface state and their application at evaluation of operation ability of bitumen pavements. The book is designed for experts of highway engineering, students of technical universities, research workers, project engineers, investors and building contractors.

The publication contains basic knowledge gathered from scientific and research activities for many years and also practical experiences from the projects solving – project of Pavement diagnostic, project of creation and introduction System of pavement management.

The individual chapters deal with equipment for measurement of surface properties of pavements. In the final chapter there are monitoring parameters evaluated in mutual connection and also in connection users costs and also surface properties in relation to transport safety.

Pavements mechanics

Pavement and stabilization areas design

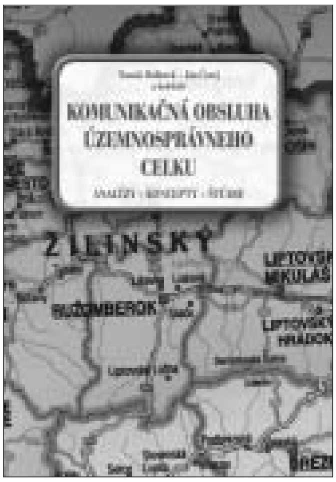
Authors: Ján Čorej, Martin Decký, Jozef Komačka, František Schlosser, Eva Remišová,
Milan Valuch, Andrea Gavulová, Peter Mučka

Publisher: University of Žilina, 2001
ISBN 80-7100-862-1

The publication is based on knowledge obtained from research projects solved by the staff of the Department of Highway Engineering. It synthesizes results from diploma and dissertation theses and various professional sources from the area of pavement constructions.

The book covers four characteristic areas and is divided into twelve chapters. The first part contains input data concerning pavement construction design, tensions and deformation calculation. The second part is devoted to pavement design. The third part contains pavement diagnostic and overlay. The final part pays attention to economic aspects of pavement design.

The publication was published with support of the grant agency VEGA: 1/3127/97 Theoretical questions of improvement of pavement operation ability and 1/41456/97 Analysis of pavement mechanics influence on their surface state.



Regional communication service

Analyses, sketches, studies

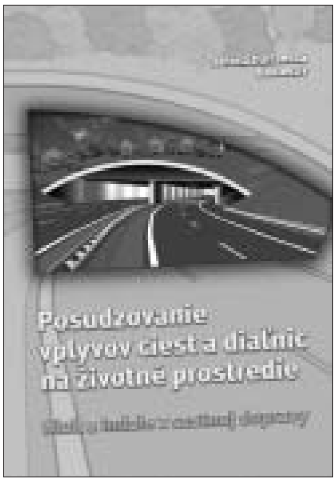
Authors: Tomáš Hollarek, Ján Čorej and col.

Publisher: University of Žilina, 2002
ISBN 80-7100-957-1

The monograph offers a theoretical basis and practical guide for analysis of the present regional communication service and method of its optimal solving. It explains visions of particular subsystems of the communication system and their assumptions, integrates terminology and on practical examples from the region of Žilina presents the most important approaches toward the design of the communication service in the observed region.

The book is written for traffic engineers, civil engineers, and engineers in areas of postal services and telecommunications, and information technology. It includes the design methods of the regional communication system, methods of assessment level of system quality, methods of finding the optimal service in the region.

The monograph is the result of activities within the framework of the project: C 519/2 "Model of regional communication service" solved at the University of Žilina in co-operation with the Research Institute of Transport in Žilina during the years 1998 – 2000.



Assessment of roads and highways impacts to environment

Noise and air pollution from road traffic

Authors: Daniela Ďurčanská, Ján Čelko, Martin Decký, Ferdinand Hesek, Ján Šimo, Milan Valuch, Anna Čajková

Publisher: University of Žilina, 2002
ISBN 80-8070-029-X

The publication presents designers various questions related with environment and traffic. The authors present basic theoretical knowledge in area of noise and air pollution impacts from traffic and their application in assessment and evaluation of the designed road lines.

The book was written on the base of knowledge gathered from scientific and research activities during many years and also on the base of practical experiences during solution of project documentations EIA. The attached CD contains examples, form and mode of EIA documentation processing. Also it includes photo-documentation of finished measures to reduce traffic impact on the environment.