IDENTIFICATION OF DYNAMICS LOADS AND A FATIGUE LIFE PREDICTION OF A RAILWAY CRANE LOAD-BEARING STRUCTURE

IDENTIFIKÁCIA DYNAMICKÝCH ZAŤAŽENÍ A ODHAD ÚNAVOVEJ ŽIVOTNOSTI NOSNEJ KONŠTRUKCIE ŽELEZNIČNÉHO ŽERIAVA

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Summary: The aim of the paper is to present briefly some results of realized analysis of load-bearing steel structure loads of special railway crane PKP 25/20i which was utilized in some specific ad relatively hard working conditions. The next aim is describing one of possible ways of an identification of stochastically loaded mechanically structures. The purpose of this approach is to find an algorithm of a forecasting control of their working in real working conditions. Virtual models of the structure were be used in an analysis of acting working dynamics loads influence to be able to forecast fatigue life of load-bearing part of the crane jib.

Key words: working conditions, identification of dynamics loads, fatigue life, load-bearing structure, railway crane.

Anotace: Cieľom príspevku je predstaviť niektoré výsledky realizovaných analýz zaťaženia nosnej oceľovej konštrukcie špeciálneho železničného žeriava PKP 25/20i, ktorý je nasadzovaný v pomerne ťažkých pracovných podmienkach. Ďalším cieľom je popis jedného z možných spôsobov identifikácie stochastický zaťažených mechanických štruktúr. Účelom tohto prístupu je definovanie algoritmu prediktívneho riadenia ich pracovnej činnosti v reálnych podmienkach používania. Virtuálne modely konštrukcie boli využité pri analýze vplyvu dynamiky pracovného zaťaženia na presnosť predikcie únavovej životnosti nosnej konštrukcie výložníka žeriava..

Kľúčové slova: pracovné podmienky, identifikácia dynamických zaťažení, únavová životnosť, nosná konštrukcia, železničný žeriav.

INTRODUCTION

It is dedicated extraordinary attention to the evaluation of fatigue life of different technical systems structural parts all over the world because breakdowns caused by fatigue failure have often character of catastrophe. It should be a dominant effort to bring conditions of calculation or experiment near to the working conditions in that is investigated system exploited. The aim is to reduce unfamiliarity of surroundings acting factors and their interactions with processes passing in own system. A modern way of calculation of any mechanical system (e.g. large mechanical or civil structures) therefore needs in point of view

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of raising some working breakdowns to mostly respect dynamic and stochastic nature of all influencing working factors and related working loads.

1. WORKING LOADS OF A CRANE LOAD-BEARING STRUCTURE

1.1 Working conditions of a crane PKP 25/20 i

A special railway crane PKP 25/20i is lifting equipment designed for exploitation in a limited space conditions which are met by the building of railway. His main working purpose is to lay down or to tear off rail fields of maximal length 25 m and mass of 20 tons by a complex reconstruction or by renovation of the railway. (Fig. 1).

Fig. 1 - A Special Railway Crane PKP 25/20i. [15]

Determination of real working conditions with a choice of typical loads was important for calculation of fatigue life of a crane bridge as a carrying steel structure. There was possible to build a theoretical load spectrum of a crane load-bearing structure on that base. It was necessary thoroughly analyse functions of the crane one by one and to determine how they influence the fatigue life by building of characteristic load spectrum of crane bridge.

After a theoretical analysis of single working functions were following characteristic working functions of a crane [14]:

- *tearing off rail fields -* the limiting function of a machine (high load of a crane bridge by high mass and dynamic effects by tearing off rail fields out of gravel bed),
- *laying down rail fields* - the limiting function of a crane,
- *auxiliary working functions* - manipulation of carriages, travel of a crab (type of complemented cycles, low influence on the total fatigue life of crane bridge),
- *travel of a crane* - function between basic technological workings (no important influence on fatigue life of crane bridge),

It is obvious from the analysis of working conditions that the most exacting working conditions are the tearing off the old rail fields and that this function has the decisive influence on fatigue life from the point of view of number of cycles and loads.

1.2 Selection of a measuring conditions

On the base of knowledge of fatigue life theory and analysis of working conditions was decided that an experimental measurement would be done in a real practice. The measurement was planned to realise by the renovation of a railway track. Before an actual measurements

there was necessary to determine critical locations of the crane bridge and to realise a theoretical analysis of working conditions of a crane. These were chosen on the base of static conditions calculations using model of standard software package COSMOS/M (Fig. 2.)
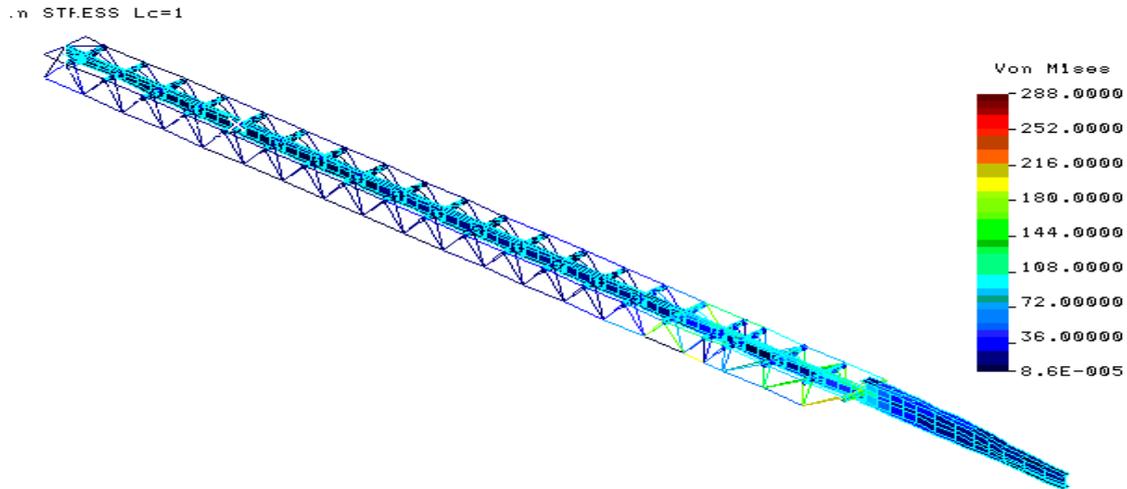

Fig.2 - FEM Model of a Crane PKP 25/20 i

The outputs of them were the locations for location of tensiometers on the crane bridge according to Fig.3. The measuring equipment was built of tensiometric pitch-ups (type C120), tensiometric set (M1000) with amplifier of signal (M1101), equipment for data transfer (DAS-16), computer HP Pavilion and printer.

1.3 Analysis of measured data

By analysis of measured values of progress of stresses was determined:

1. Stress by tearing off rail fields has a periodical character. The dynamic increase of stress was about 10-20 % of the maximal amplitude, what is nearly in harmony with a standard. The most expressive progress of stresses was determined during tearing off, start, stopping and lazing down rail fields. The measured value of stress amplitude was average 175 MPa (Fig.4),
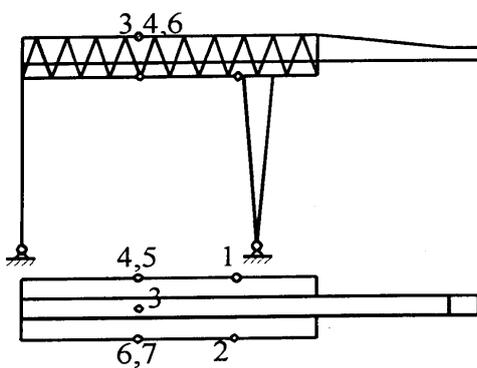

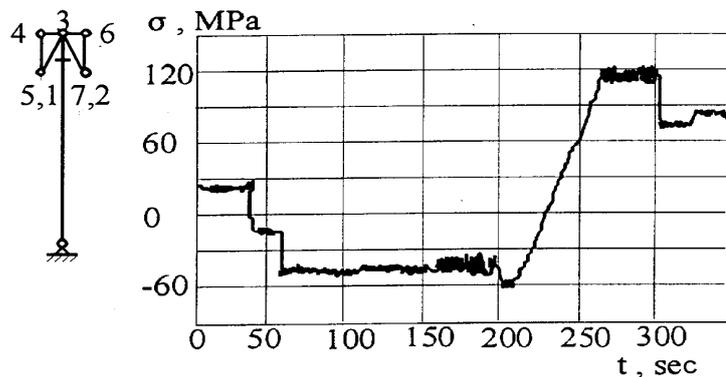Fig.3 - Locations of tensiometers on a crane bridge

Fig.4 - Stress by tearing off, start, stopping and lazing down rail fields

2. The manipulation with railway carriage using turnable part of crane bridge was characterised by a non-stationary process by which measured values of stress were in average 20 MPa (Fig.5),

3. Travel of a crane to the next rail field was characterised by a non-stationary progress of stress increase, by which a maximal absolute value of stress increase was 34 MPa (Fig 6.).
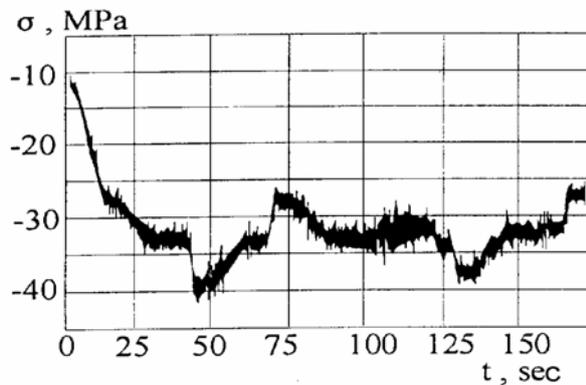

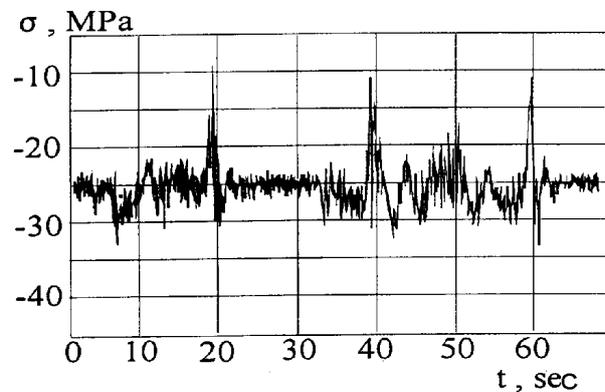Fig.5 - Stress by manipulation with railway carriage using turntable part

Fig.6 - Stress by travel to next rail field bridge

For completeness in Tab.1 are the absolute values of the stresses in selected critical cross sections of the crane structure (obtained experimental measurements).

Tab. 1 - Tensions in the critical cross section of the crane structure

Tensiometers number	Measurement number (in MPa)				
	1	2	3	4	5
1	-85,22	-93,33	-87,27	-104,91	-95,62
2	-89,65	-89,42	-100,10	-94,76	-87,71
3	139,12	165,37	151,09	153,68	154,32
4	176,29	165,27	170,62	176,46	175,83
5	135,77	150,54	140,65	147,62	138,96
6	170,51	150,99	165,96	172,43	170,83
7	139,15	152,33	137,92	147,49	144,89

1.4 Spectrum of loads

On the base of an analysis of working conditions and results of experimentally measured increase of stresses during working of a crane was possible to construct a real spectrum of loads [5,10] (Fig.7).
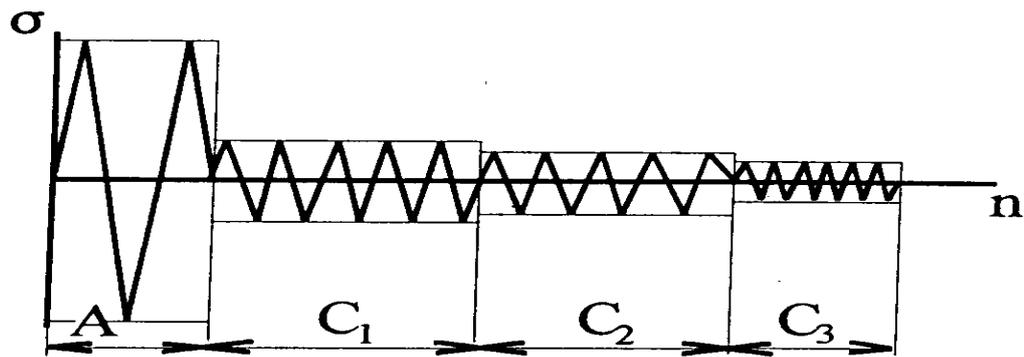
Fig. 7 - A simplified real spectrum of loads

Single working cycles introduce characteristically working conditions of a railway crane, which consist of following working cycles:

- *A - tearing off old rail fields* ($\sigma = 175$ *MPa, n = 1250*)
- *C - auxiliary working cycles*
    C1 - free travel of crabs ($\sigma = 40$ *MPa, n = 3000*),
    C2 - travel to the next rail field ($\sigma = 34$ *MPa, n = 1250*),
    C3 - manipulation with of railway carriages ($\sigma = 20$ *MPa, n = 650*).

2. THE VECTOR AUTOREGRESSIVE MOVING AVERAGE MODELS AND STOCHASTICALLY LOADED STRUCTURES IDENTIFICATION

There is necessary to identify such a system at first. It means to get its statistically adequate mathematical model. There is possible by using this model and by developing sufficient fast and correct machine control system and suitable software to forecast behaviour of system in the near future. We can get in such a way the possibility of making some controlling corrections before the system reaches an unstable region.

2.1 Vector Autoregressive Moving Average Models (VARMA)

It was found the as a suitable solution for a stochastically loaded mechanical structure identification can be used the autoregressive moving average models ARMA or their vector modification VARMA (Vector Autoregressive Moving Average) models [1, 3, 8].

A stochastically loaded part of structure and its behaviour during time can be described by using of scalar autoregressive moving average model (ARMA). Its identification (stochastically adequate model) but gives just an information about its own behaviour without a relationship to the whole structure during acting of different working regimes.

We have found as one of possible ways the use of vector autoregressive moving average models VARMA to improve accuracy of stochastically loaded mechanical structures identification. These models are suitable for stochastically loaded mechanical structures identification which outputs are reflections on stochastically loads in more number of points – vector time series (Fig.8).

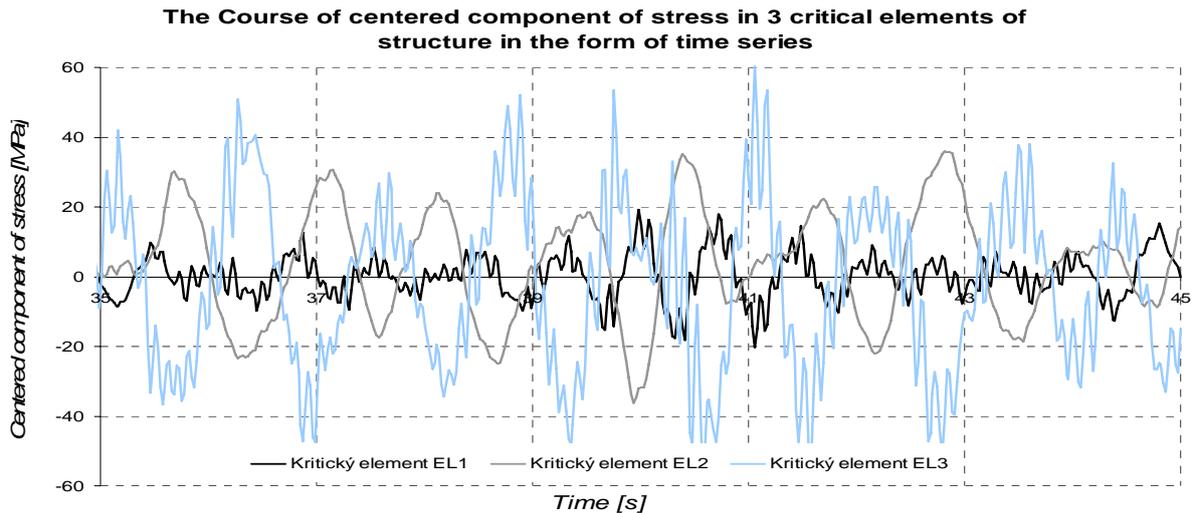The Course of centered component of stress in 3 critical elements of structure in the form of time series

Fig. 8 - A Vector Time Series of centred component of stress in selected parts [6]

A searched vector model VARMA (m,n) can be expressed as a matrix equation in form

$$\mathbf{x_t} - \mathbf{A_1}.\mathbf{x_{t-1}} - \mathbf{A_2}.\mathbf{x_{t-2}} - ... - \mathbf{A_m}.\mathbf{x_{t-m}} = \boldsymbol{\varepsilon_t} - \mathbf{B_1}.\boldsymbol{\varepsilon_{t-1}} - \mathbf{B_2}.\boldsymbol{\varepsilon_{t-2}} - ... - \mathbf{B_n}.\boldsymbol{\varepsilon_{t-n}} \quad (1)$$

or in written out form [1]

$$
\begin{bmatrix} x_{1t} \\ x_{2t} \\ ... \\ x_{kt} \end{bmatrix}
- \begin{bmatrix} a_{111} & a_{121} & ... & a_{1k1} \\ a_{211} & a_{221} & ... & a_{2k1} \\ ... \\ a_{k11} & a_{k21} & ... & a_{kk1} \end{bmatrix}
\cdot \begin{bmatrix} x_{1t-1} \\ x_{2t-1} \\ ... \\ x_{kt-1} \end{bmatrix}
- \begin{bmatrix} a_{112} & a_{122} & ... & a_{1k2} \\ a_{212} & a_{222} & ... & a_{2k2} \\ ... \\ a_{k12} & a_{k22} & ... & a_{kk2} \end{bmatrix}
\cdot \begin{bmatrix} x_{1t-2} \\ x_{2t-2} \\ ... \\ x_{kt-2} \end{bmatrix} -
$$

$$
-...- \begin{bmatrix} a_{11m} & a_{12m} & ... & a_{1km} \\ a_{21m} & a_{22m} & ... & a_{2km} \\ ... \\ a_{k1m} & a_{k2m} & ... & a_{kkm} \end{bmatrix}
\cdot \begin{bmatrix} x_{1t-m} \\ x_{2t-m} \\ ... \\ x_{kt-m} \end{bmatrix}
= \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ ... \\ \varepsilon_{kt} \end{bmatrix}
- \begin{bmatrix} b_{111} & 0 & ... & 0 \\ 0 & b_{221} & ... & 0 \\ ... \\ 0 & 0 & ... & b_{kk1} \end{bmatrix}
\cdot \begin{bmatrix} \varepsilon_{1t-1} \\ \varepsilon_{2t-1} \\ ... \\ \varepsilon_{kt-1} \end{bmatrix} - \quad (2)
$$

$$
- \begin{bmatrix} b_{112} & b_{122} & ... & b_{1k2} \\ b_{212} & b_{222} & ... & b_{2k2} \\ ... \\ b_{k12} & b_{k22} & ... & b_{kk2} \end{bmatrix}
\cdot \begin{bmatrix} \varepsilon_{1t-2} \\ \varepsilon_{2t-2} \\ ... \\ \varepsilon_{kt-2} \end{bmatrix}
- ... - \begin{bmatrix} b_{11n} & 0 & ... & 0 \\ 0 & b_{22n} & ... & 0 \\ ... \\ 0 & 0 & ... & b_{kkn} \end{bmatrix}
\cdot \begin{bmatrix} \varepsilon_{1t-n} \\ \varepsilon_{2t-n} \\ ... \\ \varepsilon_{kt-n} \end{bmatrix}
$$

this can be transformed in the system of k linearly independent equations. The symbol of "k" means number of points of the structure in which the output on dynamic loads are recorded.

The left hand side of matrix equation (1) expresses the dependence of vector time series values on former values of the series and the right hand side shows the relationship of stochastically random deviations.

2.2 The Possibilities and Advantages of VARMA Models

The application of VARMA models as an alternative to the systems of differentials equations for stochastically loaded structures identification is suitable from different point of view too. If we can express the system of differential equations in a simplified form [8] as

$$\mathbf{M}.\ddot{\mathbf{x}} + \mathbf{K}.\dot{\mathbf{x}} + \mathbf{C}.\mathbf{x} = \mathbf{F}(t) \tag{3}$$

respectively in matrix formulation

$$\begin{bmatrix} m_1 & 0 & ... & 0 \\ 0 & m_2 & ... & 0 \\ ... & & & \\ 0 & 0 & ... & m_n \end{bmatrix} . \begin{bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \\ ... \\ \ddot{x}_n \end{bmatrix} + \begin{bmatrix} k_{11} & k_{12} & ... & k_{1n} \\ k_{21} & k_{22} & ... & k_{n2} \\ ... & & & \\ k_{n1} & k_{n2} & ... & k_{nn} \end{bmatrix} . \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ ... \\ \dot{x}_n \end{bmatrix} + $$

$$+ \begin{bmatrix} c_{11} & c_{12} & ... & c_{1n} \\ c_{21} & c_{22} & ... & c_{n2} \\ ... & & & \\ c_{n1} & c_{n2} & ... & c_{nn} \end{bmatrix} . \begin{bmatrix} x_1 \\ x_2 \\ ... \\ x_n \end{bmatrix} = \begin{bmatrix} f_1(t) \\ f_2(t) \\ ... \\ f_n(t) \end{bmatrix} \tag{4}$$

we can judge the matrix of damping K and the matrix of stiffness C as a mathematical expression of the relationship among the individual parts of structure. The matrix coefficients as of a model VARMA are the mathematical expressions of individual parts interaction.

The advantages of VARMA models [1,8]:

- they can show the physically base of problem studied (this means that they to obtain the natural frequencies and natural modes of vibrations) [6, 7],
- they can describe a wanted accuracy of real system [6, 8],
- the mathematical apparatus of these methods is relative simple so that it can be used for "real time control" [6, 8, 13].

3. THE SOFTWARE SUPPORT OF USED METHOD OF IDENTIFICATION

The scalar models of a simple description of dynamic system can not express statistically adequate description of complex systems. For this reason there was developed an effective software system which enables to create the statistically models of dynamic stochastic system by using VARMA models. The accuracy and the reliability of the developed methods and algorithms were verified by use of commercial software packages (Microsoft Excel and MATLAB).

3.1 The Procedure of the Creating of Software for an Identification Support

The creation of a software support which is able to identify some stochastic loaded parts of structures is just the firs step for applying of the forecasting control of mechanical systems. The final form of an identification software was created in such a way that it enables the use of an identification library and to realise the own identification of system parameters. The result of a proposed application of this methodology is ArmaGet software (Fig.9) which is fully compatible with Microsoft Windows systems.
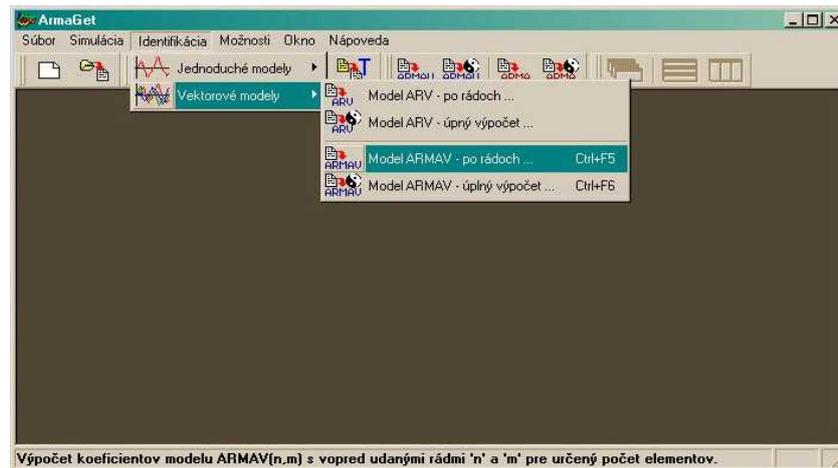
Fig. 9 - Main window of application ArmaGet

This developed software is able to create an adequate mathematical model for describing a matrix model of a tested stochastic loaded mechanical system. There was developed a FEM (Finite Element Method) model of a crane jib (Fig.2) and in MATLAB-environment was realised simulation of its loading. The acting loads were described as a stochastic excitation.

There were used as an application of a numeric Crank-Nicolson method [11] of direct integration the deformation of all nodes of model (20 nodes). The time intervals were selected as Δt vz = 0.01 s. Resulting deformational outputs were organized in corresponding vector time series. There was selected in a testing example a vector time series of deflection in "z" axe direction. The determination of vector time series in direction of "z" axe is introduced on Fig.10 and results of identification are introduced on Fig.11 (an optimal order of model is VARMA (6,5)).
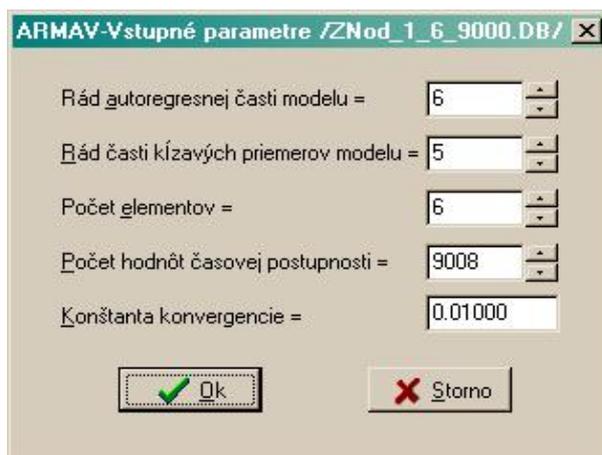

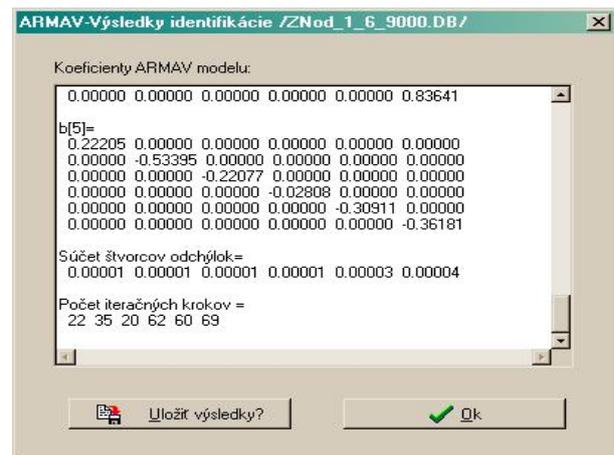Fig. 10 - Settings of input parameters

Fig. 11 - Results of a crane jib upper boom identification (optimal model VARMA (6,5))

The verification of developed software ArmaGet was realised by two different ways. At first it was the simulation of time series with determined parameters and their "back way" identification. This option is available by menu item Simulation $\rightarrow$ Model ARMAV. The

second way was a comparison with results of computing module Solver from MS Excel and software package ARMASA [2]. In Tab. 2 are results from identification through developed software tool ArmaGet, Microsoft Excel© and ARMASA Package© by comparing values of sums of squares.

Tab.2 - The comparison of results - ArmaGet, ARMASA Package, Excel - Solver

	VARMA(6,5)	VARMA(8,7)	VARMA(10,9)
	ArmaGet	*ARMASA Package*	*Excel - Solver*
Node 1	$7,6591.10^{-6}$	$7,8991.10^{-6}$	$1,8398.10^{-7}$
Node 2	$1,0659.10^{-5}$	$1,1243.10^{-5}$	$1,1953.10^{-5}$
Node 3	$1,1204.10^{-5}$	$1,1868.10^{-5}$	$1,1307.10^{-5}$
Node 4	$1,4823.10^{-5}$	$2,1467.10^{-5}$	$2,0833.10^{-5}$
Node 5	$2,5955.10^{-5}$	$4,2690.10^{-5}$	$3,5906.10^{-5}$
Node 6	$4,1240.10^{-5}$	$6,4402.10^{-5}$	$6,2980.10^{-5}$

In Tab.3 are presented results from a comparison of the application for three orders of VARMA models - namely orders (6,5) (8,7) and (10,9).

For more information on selected practices and other functional outcome assessment prepared software support and its theoretical background can be found eg. in [1, 2, 6, 12].

Tab.3 - The verification of identification results for different orders of VARMA models

	VARMA(6,5)		VARMA(8,7)		VARMA(10,9)	
	ArmaGet	*Excel*	*ArmaGet*	*ARMASA*	*ArmaGet*	*ArmaGet*
Node 1	$7,6591.10^{-6}$	$1,8398.10^{-7}$	$7,6591.10^{-6}$	$7,8991.10^{-6}$	$7,8985.10^{-6}$	$7,8482.10^{-6}$
Node 2	$1,0659.10^{-5}$	$1,1953.10^{-5}$	$1,0659.10^{-5}$	$1,1243.10^{-5}$	$1,0365.10^{-5}$	$1,0402.10^{-5}$
Node 3	$1,1204.10^{-5}$	$1,1307.10^{-5}$	$1,1204.10^{-5}$	$1,1868.10^{-5}$	$1,0424.10^{-5}$	$1,0497.10^{-5}$
Node 4	$1,4823.10^{-5}$	$2,0833.10^{-5}$	$1,4823.10^{-5}$	$2,1467.10^{-5}$	$1,4028.10^{-5}$	$1,4183.10^{-5}$
Node 5	$2,5955.10^{-5}$	$3,5906.10^{-5}$	$2,5955.10^{-5}$	$4,2690.10^{-5}$	$2,2255.10^{-5}$	$2,5761.10^{-5}$
Node 6	$4,1240.10^{-5}$	$6,2980.10^{-5}$	$4,1240.10^{-5}$	$6,4402.10^{-5}$	$3,7822.10^{-5}$	$3,5980.10^{-5}$

4. REAL WORKING CINDITIONS AND FATIGUE LIFE PREDICTION OF CRANE LOAD-BEARING STRUCTURE

The general procedure of life prediction from point of view of fatigue damage was based on realization of following activities:

- determination of the most significant working regimes and factors of typical working conditions from point of view of structure loads and their following activities,
- identification of carrying structure critical parts and determination of their working loads,
- elaboration of the real working spectrum of crane carrying structure and its utilization by determination of typical working conditions,
- analysis of choice material properties and estimate of effects of different types of notches, connections and nonlinearities in examined points of structure and

- application of suitable hypothesis of fatigue damage cumulation and quantification of predicted fatigue life of selected parts of carrying structure.

4.1 The most significant working regimes

The activities connected with technology of tearing off the old rail fields and laying down the new ones were identified as the most significant working regimes of mentioned crane and some of accessory processes as no-load run of a crab, handling of railway bogies and travelling to the following rail field too. The effect of surroundings low temperatures was chosen from surrounding conditions because they cause freezing of the rails bed and following increase of the pulling force by tearing off rail fields. The effects of surroundings conditions connected with unevenness (longitudinal or transverse) of newly laid down rail bands was not taken into account because the have not an expressive effect on crane working.

4.2 The identification of critical parts of supporting structure

The virtual FEM model was elaborated and verified to use in the procedure of identification of supporting structure critical parts. The stresses experimentally obtained were utilized during the actualization of the FEM model in order to obtain the maximum adequacy of the model comparing to the real structure. It was determined from static and dynamic analyses realized. ***The critical parts are namely upper and lower beams of supporting structure (EL232, EL237, EL89 and EL93) and places near of locking connection of C and D parts (EL335) – (Fig.12).***
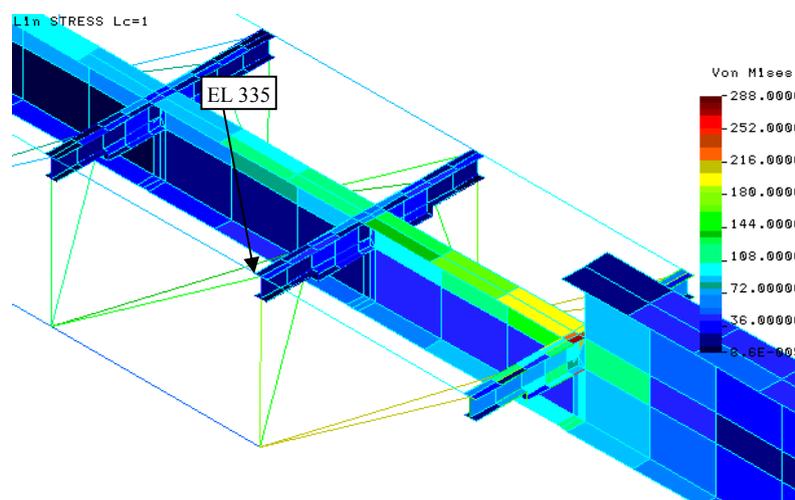

Fig.12 - Detail of C and D parts locking connection

4.3 Material properties of structure details

Supporting structure of the crane bridge is made from the low carbon steel 11 523. The Wöhler curve of the used material was determined after the STN 270103 standard, chapter IX „Fatigue loading capacity" for the working group II and notch group K4 to which the examined structure belongs [13].. Obtained Wöhler curve of the 11 523 material and its parameters were utilized as an input into the suitable hypothesis of fatigue damage cumulation ($w = 5.8$, $N_C = 2.5.10_6$, $\sigma C = 190$ MPa and $Re = 355$ MPa).

4.4 Estimate of working fatigue life of a crane load-bearing structure

The principal hypothesis' of fatigue damage cumulation were aplied during estimate of working fatigue life of a crane PKP 25/20i supporting structure. It was made by means of quantification of cumulation fatigue damage proces too. Three principal hypothesis' of fatigue damage cummulation were applied by selected details. All levels of stress' measured were taken into account not only these wich value is greater as a fatigue limit. They were applied two hypotheses for prediction in a practical way. There were the hypothesisi after Palmgren-Miner (P-M) and the one after Corten-Dolan (C-D) which are based on utilization of parameters of corresponding material curve and actual loading spectrum. The break-point of Wöhler curve by low carbon steels with a notch moves significantly left ward by aplying of C-D hypothesis and the damaging effects therefore are related to corrected inclined strand of fatigue curve with exponent (k*w), where k = 0,7 - 0,98.

Prediction of fatigue life after Rajcher's hypothesis

Rajcher's theorem was used for the fatigue damage computations in the identified critical parts of the crane load-bearing structure too. This theorem defines the fatigue damage in the critical location of the structure part induced per one second and is expressed by the following equation in form [10]

$$D_s = \frac{\Gamma \cdot \left(\frac{w}{2}+1\right) \cdot \left[2 \cdot \int_0^\infty f^{\frac{2}{w}} \cdot S(f)\, df\right]^{\frac{w}{2}}}{N_C \cdot \sigma_C^w} \tag{5}$$

where w is exponent of S/N curve, σ_c is fatigue limit, N_c is limit number of cycles to failure, f is frequency, $S(f)$ is spectral power density of the stress loading process, Γ is gamma function value. Time until the next failure can be expressed (in hours) as follows

$$T = \frac{1}{3600 \cdot D_s} = \frac{N_C \cdot \sigma_C^w}{3600 \cdot f_e \cdot \left(2 \cdot s_\sigma^2\right)^{\frac{w}{2}}} \cdot \Gamma \cdot \left(\frac{w}{2}+1\right) \cdot \tag{6}$$

It is obvious that all the process can be realized only by means of the computer technique efficient enough. The approach in practice is that after import or calculation of the process spectral power density values S(f) the process standard deviation S_σ and process effective frequency f_e of the probability density will be determined.

The practical application of the presented process was realized by the program created in the MATLAB environment. The worked computational program named FATIGUE.M was used at the fatigue life computational estimation of the load bearing structure in the selected critical points under the chosen characteristics of the crane operating conditions. In the application the following material parameters defining the fatigue properties were used: slope of S/N curve w, fatigue limit σc, limit number of cycle Nc and yield limit Re; which gain the following values for the particular elements of structure (look on Fig.2). Value σc was during this process reduced according to the stress average value and also according to factors affecting the fatigue limit (shape, size, stress concentration in the score, treatment quality etc.) [5, 10]. The Rajcher hypothesis of fatigue damage cummulation was chosen from hypotheses

based on correlation theory. This hypothesis uses Wöhler curve parameters, gama function ond spectral power density (SPD) of a structure response an acting working loads. Used courses of SPD were obtainedby means of application of the virtual FEM model of supporting structure and by means of following elaboration of model analysis results using software created in Matlab environment. Obtained results of estimated measure of supporting structure fatigue life are intruduced in Tab.4.

Tab. 4 - The estimate of fatigue life of critical elements of crane carrying structure

Fatigue life prediction based on hypothesis' [in years]	ELEMENT 232	ELEMENT 89	ELEMENT 335
P-M (Palmgren–Miner)	24,2	23,1	25,0
C-D (Corten – Dolan)	19,6	19,2	21,2
R (Rajcher)	20,2	19,9	20,4

Calculated estimate of working fatigue life of the railway crane PKP 25/20i supporting structure was realized in order to examine possibility to expand working life of existing and utilized structure after the term detrmined by its producer.

Demand for this procedure was made by its user. The term of life reccomended by producer was 15 years by acceptation of detrmined technical conditions and reccomendations. It was possible to declare basing on results obtained that it is possible to utilize the crane after proposed term of technical life from teh point of view of fatigue life. However the preventive checks of critical points were recommended in each 2-yers interval.

5. CONCLUSIONS

It follows from obtained results from point of view of safety and reliability of the crane PKP 25/20i working that its supporting structure - bridge of a crane) is designed sufficiently. But it is necessary to respect proposed technology of its utilization and maximum value of loads. However the non-reversible deformation and structure damage can occur during certain working conditions (for example tearing off rail field from frozen bed, strong wind impact or non-qualified manipulation and control resulting in the loss of crane stability).

It is necessary to state finally that the process of fatigue damage cumulation and depending fatigue life estimate can be made with certain probability only using certain assumptions and simplification despite of having available lot of data from the areas of fatigue and fatigue strength [13]. The cause of this is not only lot of factors connected with fatigue life but mainly their reciprocal coherences and interactions. It in necessary to understand that presented values of bridge of crane fatigue life are the approximate ones and just the real working can show how these values were exact and relevant.

6. ACKNOWLEDGEMENT

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