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WORKLOAD EXPERIMENT BLOCK AS AN ELEMENT FOR DETERMINATION OF WORKING DYNAMIC STRENGTH

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ABSTRACT
In order to implement calculation of workload constructions and parts, it is necessary to determine working dynamic strength for critical loads. For stochastic shape of load changes it is determined by experiment. However, workloads caused by such approach cannot be directly used for experiment implementation. These must be, according to specific rules, properly defined in shape suitable for determination of working dynamic strength; these are experiment blocks of workloads.
This paper provides approach for formation of experiment blocks for defined workload spectrum. Different approaches have been explored as well as the result of practical transfer of workload spectrum into experiment block of workloads. Results given in this paper can provide assistance in the dynamic construction workload calculations, especially in case of reliability based calculations.
Keywords: workload spectrum, workload experiment block, working dynamic strength

1. INTRODUCTION
One of factors for estimate of machine construction parts are values and kinds of critical stresses. If the parts are opened to stochastic modificated loads then it is working dynamic strength. Its values are determined by experimental way mostly.
Essentially for implementation of this procedure is necessarily to know the kinds of workloads, their values and frequency. In other words it's necessarily for this procedure to have defined the spectrum of workload. The main parameters which define the spectrum are value of workloads and their frequency.
Since these kinds of working stress are not suitable for conducting of experiments in order to determine of working dynamic strength it's necessarily to form workload experiment block. It implies that new formed shapes should have the same impact on material as the working stress in spectrum. Crossing of working stress from spectrum to experiment blocks could be different because of constant tendency that stresses in experiment block are objective picture of real condition. Because of that here are presented some factors and methodology of these procedures with own results.

2. WORKING DYNAMIC STRENGTH AND WORKLOAD EXPERIMENT BLOCKS

2.1. Loading spectrums and working dynamic strength
The basic division the critical stresses of dynamic stressed parts, actually dynamic strength, could be made through the way of change the stress. If the stress changes are with constant amplitude σ_a, the strength is basic and represent the maximal stress in stress change cycle. If these changes are multicycle with different amplitude σ_a, the strength is working and represent the maximal stress during loads changing.
Location of working dynamic strength with respect to basic one is on diagram σ - N moved to right side for determined value, whereat the value of that moving is conditioned with participation of stresses which are less than maximal, i.e. from shape of working stress spectrum. Since the workload spectrums could be lighter or heavier their impact to location of working dynamic strength is

different. If the spectrum is lighter the dynamic strength is bigger (σ - N) and vice-versa for heavier workload spectrum, figure 1.

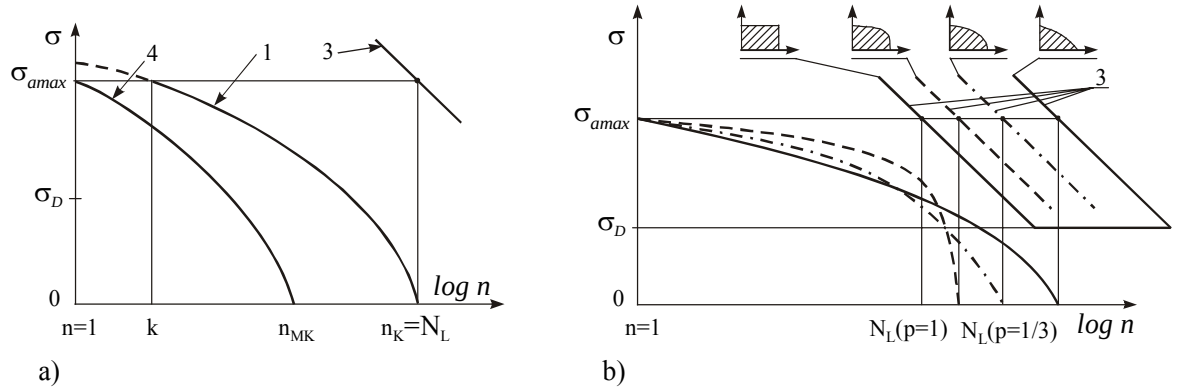

Figure 1. Determined the line of working strength for different shapes of stress spectrum

2.2. Forming of experiment block

Since the workload spectrums are not easy for appliance in experiment for determination of working dynamic strength, it's necessarily to adapt them. It means the replacement these spectrums with experiment blocks which have exactly defined the changing strings and participation of particular stresses. The most applied string of loads changing during experimental determination of working persistence, accordingly Gaßner suggestion, is based on graded block with programmed grade string which are repeats until the break of tested part.

This block shape not require the often changes of load cycle parameters what present significant preference related to other shapes. The base for determination the change of block is spectrum of loading (stress) in graded shape, figure 2.

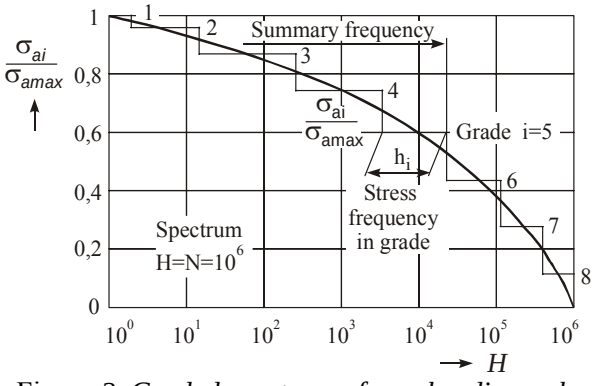

Figure *2. Graded spectrum of regular disposal*

As visible the spectrum of load (stress) disposal in continual shape become graded shape and total number of stress changes are divide on more grades. Determination of number of grades in block present the compromise between opposite requests, more economic experiment (lower grade number as possible) and bigger similarity between experimental and real spectrum (bigger grade number as possible). Accordingly Gaßner-u the enough grade number in experiment block is from 6 to 8. The important influence on results of determination the working strength has stress grade string in block.

During block forming, with sustained grade increasing, the effect of „training" material is appeared and number of stress cycle till breaking is appreciable bigger comparing with blocks with continual descending grades, figure 3. In order to avoid this effect we use the block with alternately increasing and descending grades figure 2, which is called Gaßner's program block. Except the grade string in block, the important is impact of block size, i.e. the number of cycles in block. Depends of technical possibilities of experiment block this number is default as: $N_B = (2…25)\ 10^4$. The figure 4 shows the diagram of dependence between the block size and number of stress cycle till breaking [3]. It's evident that maximal number of changes until breaking N_R is getting if examinations are making with block which has $N_B = 10^5$ changes. Increasing and decreasing of changes number means the decreasing of cycle number until breaking N_R .

In the case of conducting the experiment for determination of working strength with bigger number of partial spectrums less than optimal, particular grades of higher stress are eliminated from spectrum the

suitable number times in order to keep the shape of whole spectrum. Display of contracted partial spectrum is showed on figure 5.

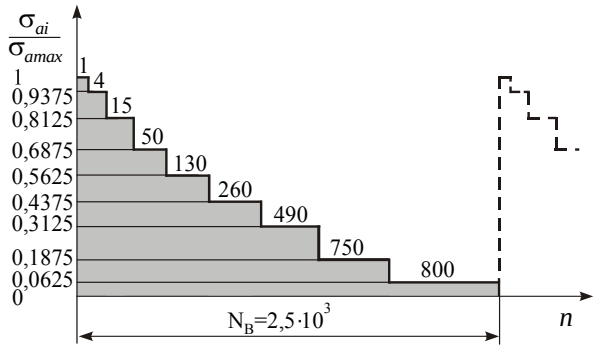

Figure 3. Partial test block of stress with decreasing grades

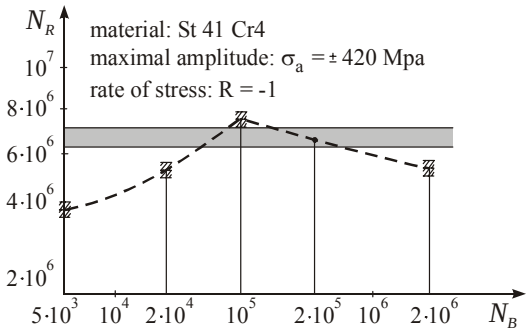

Figure 4. The influence of block size to stress cycle number until breaking

The influence of grades string and block size to number of stress cycle till breaking were the matter of many researches [1]. The researches are made on different materials, with different kinds of loads and relations between characteristic stress values in block.

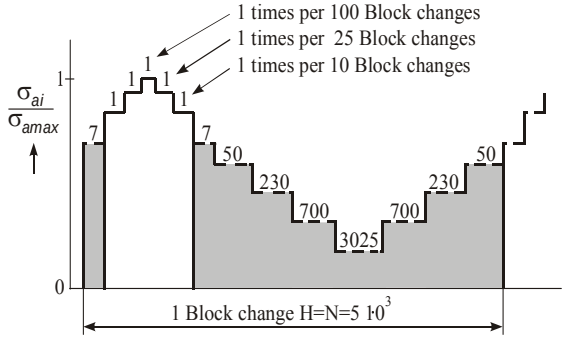

Figure 5. *Contracted the partial experiment block of stress*

Processing of results for different experiment blocks we can establish the following:

- Appliance the loads (stress) block with increasing and descending string of amplitude size, determine the limiting results of number the changes. Combined block shapes giving results which are between these limiting results.
- Difference between limiting values decreasing with increasing of number the stress blocks and for big enough number the difference disappear, i.e. become zero.

- Dispersion of limited values results is two times bigger for stress changing with descending string of amplitude size.
- The influence of stress concentration for different shapes of test specimen during working strength testing is evident, but this analyze will not be consider here.

3. THE RESULTS OF EXPERIMENTAL FORMING THE TEST BLOCKS

Working dynamic strength indexes are determined based on workload spectrums with different coefficient p (full load spectrum) in order to determine the method of changes the stress cycle number during different working conditions. Mathematical functions which describe the workload spectrums are:

$$f_1(F) = \frac{1}{2} F \cdot e^{-\left(\frac{F}{2}\right)^2} \qquad \ldots(1)$$

$$f_2(F) = \frac{2}{3}\left(\frac{F}{3}\right)^1 \cdot e^{-\left(\frac{F}{3}\right)^2} \qquad \ldots(2)$$

Variable load (strength) in this case is defined as: $F=F_{max}–F_{min}$, i.e.difference between maximal and minimal load in spectrum.

By transformation of continual function $f_1(F)$ *and* $f_2(F)$ to step function for each change interval ΔF is determined the relative frequency of load emergence f_i as well as the summary frequency $f(F)$.

Workload experiment blocks are estimated and formed based on total change number in block $N_B=10^5$ and based on relative load frequency for both functions in each interval. One experimental block is showed on figure 7.

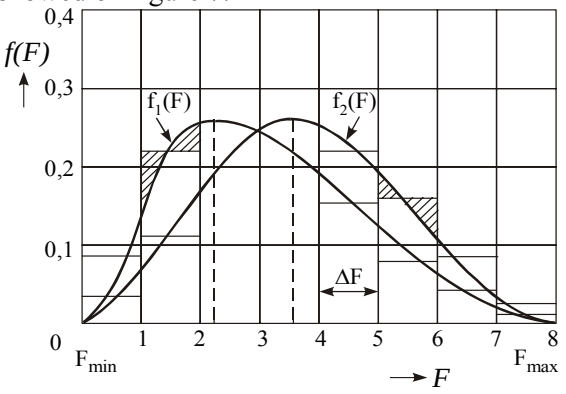

Figure 6. Mathematical form of load function

These experiment blocks in further testing are marked as the first and second experiment block, OB 1 and OB 2. For this testing the 23 test-tubes are made.

The testing of working dynamic strength indexes on pulsometer is made for two different workload experiment blocks. The first experiment block (OB 1) with own string cycles and loads is showed on figure 7 and other (OB 2) in [2].

Each testing is conducted on 10 test-tubes and testing is made with bending load.

The level of test load F_{sr} (F_m) and F_a is determined based on previously static tested 3 test-tubes and determined breaking force. The load through moment of resistance of cross section is defined as stress.

Received results of whole research are given in [2].

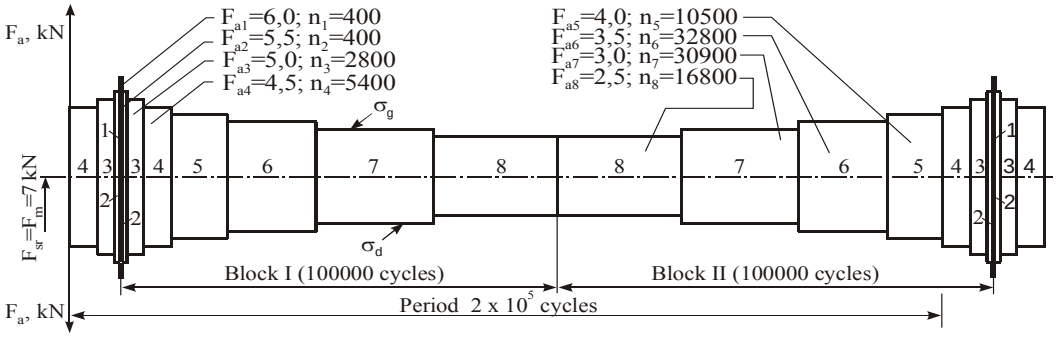

Figure 7. Workload experiment block for steel testing P-18A for OB 1

4. CONCLUSION

Based on research and some results which are presented in this work the next conclusions are given:

- If the parts during work are opened to stochastic load then competent load can be showed as workload.
- For determination of working durability by experiment it's necessarily to replace workload spectrum with workload experiment block. Methodology of determination is given in this work.
- This approach make this testing easier and results are correct enough for using.
- The methodology is applicable for other similar cases.

5. REFERENCES

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