RESEARCH OF DYNAMIC LOAD OF TRANSPORT VEHICLE HYDROMECHANICAL TRANSMISSION

Alexander Taratorkin, Victor Derzhanskii

Bauman Moscow State Technical University, Russia

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Research of many Russian and foreign specialists show that usage of hydrodynamic gears performs filtration of vibrations not always [1,2]. The performed research stated that hydraulic torque converter itself generates high frequency vibrations. The causes are hydrodynamic processes in the interblade space of oil circulation circuit of torque converter. This can be explained as follows: when oil passes from blades of one wheel of torque converter to blades of the other one the liquid id divided into flows, which interact blades of the next wheel. High frequency disturbance is generated, which can course resonance vibrations of hydromechanical transmission elements [2].

So operation of prototype hydromechanical transmission on truck KAMAZ detected new previously unknown phenomenon of cermet disks destruction of hydromechanical transmission friction units. Analysis of the received results allows stating that destruction occurs due to resonance of disks in free condition in frequencies of engine shaft rotational speeds which precede to transmission to hydraulic clutch mode of torque converter. Spectrum density of vibration accelerations on hydromechanical transmission was received from which follows that powerfull vibrations with frequency appr. 700 Hz occur in this mode.

To determine source of vibrations, which destructs cermet disks, development of torque converter GTK-XV wheels installed in truck KAMAZ was made. During computer simulation of torque converter wheels movement relative to each other was stated that in mode which precedes torque converter interlocking in passage pump-turbine hydrodynamic impulses with frequency 703 Hz are formed, that corresponds to vibrations frequency recorded during operation of hydromechanical transmission in truck KAMAZ.

It should be noticed that when oil flows pass from pump to turbine in the researched design of torque converter GTK-XV in every moment of impulse generation interaction of blades occurs in two places that means the bigger amplitude of the generated impulse.

To determine ways of disturbance offset from the own disk frequency calculation of impulse twoness in passage pump-turbine with blade quantity different from the initial one in one blade was made. Fragmentation of twoness impulses reached in such way allows enhancing disturbance frequency appr. two times with simultaneous reducing of its amplitude.

In addition it is evident that form of impulse generation has complicated appearance. In the research analysis of cosine curve of truncated form on base of Furye quick transformation, which allows making conclusion that such vibration generates harmonic components of high order [3]. The complicated form of impulse generation in torque converter has also harmonic components of high order which frequency can match with one of its own frequencies of transmission elements.

To confirm supposal that cermet disks are destructed due to influence of external disturbance from the torque converter with frequency which matches with their own one, it is necessary to have simple calculating or experimental method of their own frequencies determination. During research not destructed method of experimental determination of the own frequencies of cermet disks of different batches was developed [4].

Design of cermet disks mainly matches tolerances accepted by research of round ring vibrations and disk can be considered as round bar with limited bend [5]. The own frequency of the bar is calculated according to formula

$$\omega = \frac{K\left(K^2-1\right)}{\sqrt{K^2+1}}\sqrt{\frac{EI}{m_0 R^4}}, \qquad (1)$$

where E - elasticity module;

$I = b \cdot h^3 / 12$ - inertia moment of round bar section;

b -width,

h -height of bar section;

R -radius of disk middle line;

m_0 - running disk mass;

K - quantity of full vibration waves set for length $2\pi R$.

This meaning determines vibration form. Feature of cermet disks design is in difference physical mechanics properties of steel, cermet and adhesive layer in their connection and also engagement. In this connection the indicated parameters are accepted as given and results as not precise.

To determine the own frequencies of cermet disks by experimental method installation for express analysis of the own disk frequencies, which includes cermet disk itself, acceleration meter ADXL105 [6,7], digital analog converter (L-Card E-440), generator, acoustic emitter and spectrum analytic device, was used. The installation allows determination with high degree of authenticity the own frequencies of disks when affecting it with disturbances wit different frequencies.

Using the installation the own frequencies and vibration amplitudes for cermet disks, metal disk without cermet and ideal metal ring of the same dimensions were determined. Analysis of the received results allows making conclusion that disks differently react to external disturbance.

Comparing of results shows that the installed cermet has dispersive properties that means it damps vibrations of cermet disks in specific frequencies (Fig.1). Except determination of the own frequencies and vibration amplitudes the installation allows determination of disk vibration form (Fig. 2).

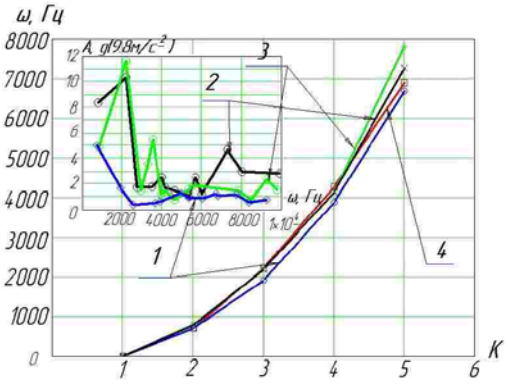

Figure 1: Spectrum density of disk vibrations
1 –cermet disk; **2** – metal base of cermet disk ;
3 – ideal metal ring; **4** – calculated frequencies

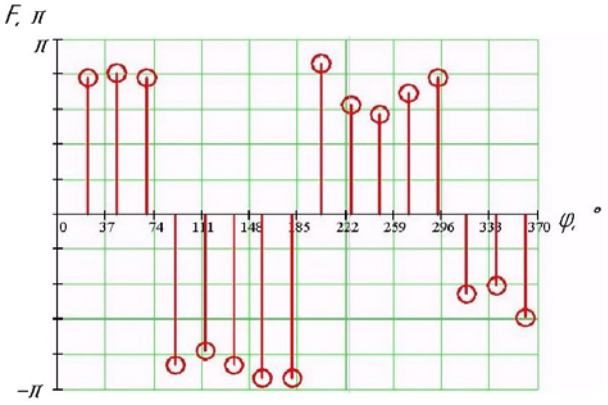

Figure 2: Example of experimental determination of vibration form *(K=2 ω=700 Hz)*

Different sections of round rings vibrations are divided to “bunching places” (places with the maximum vibration amplitude), “units” (places with minimum vibration amplitude) and intermediate sections. To exclude cermet disk resonance vibrations experiment for “cutting” (destruction of vibration

form) of disk in “bunching places” of vibrations. This allows significant reducing of disk vibration amplitude wit frequency 700 Hz.

Conclusions

According to the research results the following main conclusions can be made:

– The performed analysis of working liquid hydrodynamic features in the interblade space of torque converter showed possibility of high frequency vibration regeneration;

– During research the installation for realization of the proposed express method of determination of the own frequencies, amplitudes and vibration forms of cermet disks was developed and manufactured;

– Exclusion method of resonance vibrations of disk in one of “major” frequencies is proposed.

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