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Long-term cyclic test - analysis and monitoring

Ivan Jeřábek[a], Lukaš Horký[b] and Karel Weigel[c]

Doosan Bobcat Engineering s.r.o., Czech Republic

[a]ivan.jerabek@doosan.com, [b]lukas.horky@doosan.com, [c]karel.weigel@doosan.com

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Long-term cyclic tests are considered as the standard verification methods for new design of mini excavators and loaders at Doosan Bobcat Engineering. For the implementation of long term validation tests hydraulic loading system from Inova Company is used (Fig. 1).

Fig. 1 Cyclist test of hydraulic cylinders

There is a rig for each test which allows a long term load of a tested specimen and monitoring of its operating parameters. Load cycle is defined (load spectrum on the tested specimen) and a number of cycles for each test. It is followed by setup of test control system and definition of all other monitored parameters. Monitoring of operating parameters generate a huge volume of data (Fig. 2) which is difficult to process and analyse. Simple statement that the tested sample complies with the required load is often not sufficient for the evaluation of the test.

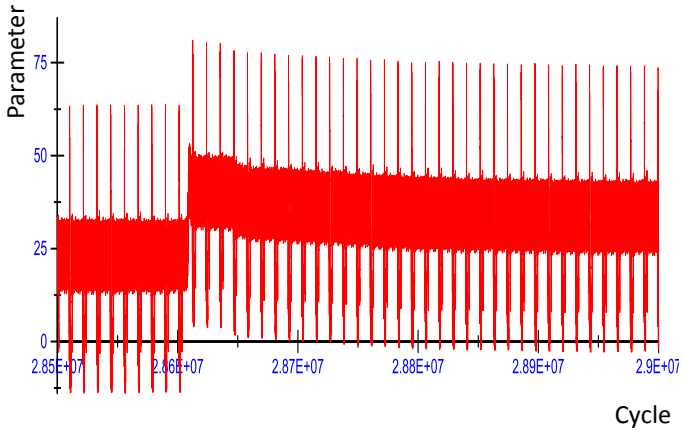

Fig. 2 Details of monitoring parameter

For monitoring of long term test an algorithm has been proposed that compares and evaluates deviation of monitored parameter values from a reference values. Algorithm divides all control and monitoring channels into separate channels. Each channel is analysed independently.

The algorithm assumes:

- data file describing cyclic process for each channel
- all channels are synchronized – all channels are using common time axis
- one channel is "reference value" that is used to define load of the test. Reference value is considered as correct "theoretical value".
- First cycle of each data file is "correct".

Analysis algorithm is divided into three procedures

- "etalon" definition: "etalons" are defined for each channel. "Etalon" is defined as first cycle of the test (Fig. 3 Time 0-100 min.). Cycle length is defined in configuration input file or calculated from reference channel.

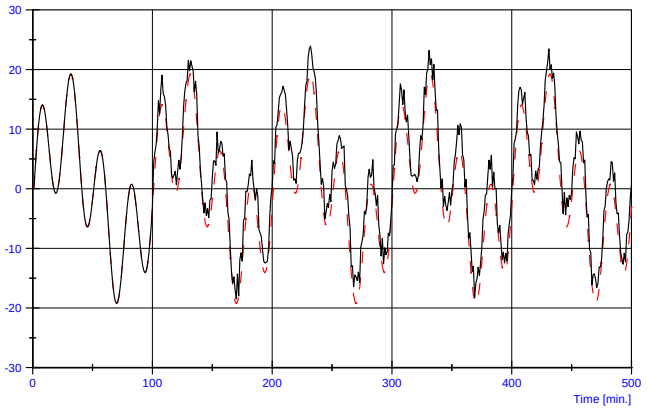

Fig. 3 Detail of monitored parameter (red line referent value, black line real measurement value)

- calculation deviations of cycles values. Deviation is defined as difference between cycle value and etalon. For the comparison is supposed that the first cycle in each channel is correct and can be used as an etalon for the repeated cycles that will follow.

It is possible to compare all following cycles in each channel with the etalon and calculate their deviation. The result for each cycle of all channels creates a data files that is statistically analysed.

- statistical data analysis: for each deviation data file average value, standard deviation, minimum and maximum are calculated.

Statistical analysis result is a parameter which represents the cycle and allows deciding if the cycle is or is not within required limits.

- Average value which represents the offset from the reference value
- Standard deviation represents variance values from the reference value
- Maximum and minimum value for the time line deviation determination

The parameters can be displayed in a chart to get a better view (Fig. 4.)

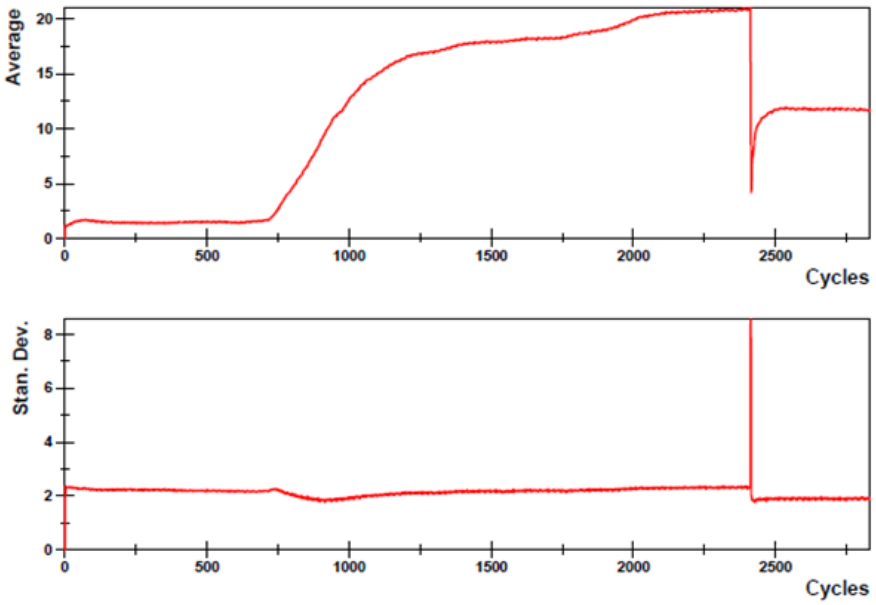

Fig. 4 Analysis Resuls

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