

BUCKET WHEEL EXCAVATOR MODAL MODELS DETERMINATION IN DIFFERENT OPERATIONAL CONDITIONS

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1. Introduction

Excavation process in open cast mines requires heavy machines which work in very hard conditions. The machines are strongly exposed to dynamic loads during operation [9].

The problem of identification of modal modes is additionally complicated while the operational conditions changes. Type of excavated material, configuration of the machine, balancing and many other factors can shift frequencies or even influence on mode shape.

2. Object of investigation

Bucket wheel excavator of the type KWK 1200M was the object of investigation. The theoretical capacity equals 3750m³/h. The wheel with 10 bucket excavates with nominal velocity 2,29m/s, which gives dumping with frequency of 0,87Hz. Total mass of the machine (fig. 1.) equals around 1823Mg.



Fig. 1: Bucket wheel excavator KWK1200M

3. Measurements run

The main problem in performing experiment on such a big object like BWE is proper selection of measurement points. The incorrect placement of acceleration sensors may lead to the spacial aliasing [7],[8]. This means that some of mode shapes can be deformed or even can left unidentified.

In case of the bucket wheel excavator KWK1200M, accelerometers were placed in 14 points. Direction of measurement were also chosen in such a way to allow good identification of modal modes. The placement of accelerometers and measurement directions are shown in the figure 2.

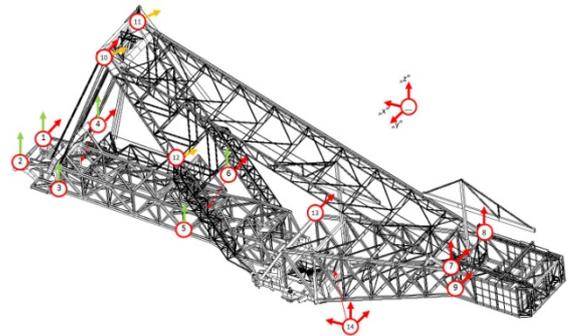


Fig. 2: Measurement points

Data were acquired during excavation and ride of the machine. In the first case, material was excavated in clockwise direction and then in counter clockwise direction. The ride also consist of two sub cases. The first one was short ride with stop and time to attenuate vibrations [6]. The second one was long ride and additionally the load carrying structure was rotated to the right (perpendicular to the ride direction).

4. Operational modal analysis

To estimate modal parameters from output only data the operational modal analysis algorithms were applied [10].

Modal identification was done for each sub case of excavation and ride separately. As a result, four modal models were estimated. Modes looks to be the same, but closer analysis allows to distinguish differences and derive its causes.

For proper comparing, the MAC factor was used. With its use only frequencies of highly correlated mode shapes were compared. However,

in some cases low value of MAC factor indicated change of the mode shape itself.

When comparing sets of excavation it occurs that during excavation in counter clockwise direction, mode 4 (fig. 3) was not excited at all. This means, that changed horizontal excavation force, that can be treated like a support, change the occurrence of modes.

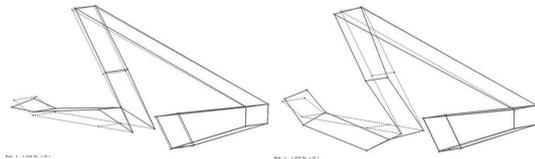


Fig. 3: Mode 4 - excavation

In ride cases, significant difference was observed in mode 2 (fig. 4.). The frequency changed from 0.966Hz to 0.925Hz. This change was caused by the position of load carrying structure. In the first case, it was positioned in the direction of the ride and in the second the position was perpendicular to the ride direction.

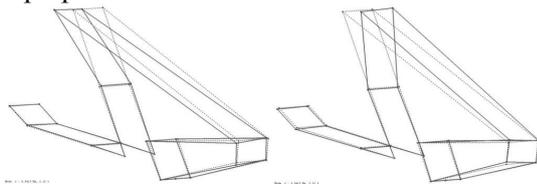


Fig 4: Mode 2 - the same for ride and excavation

The most important information about the structure derives from comparison excavation with ride modal models.

In mode 4th and 5th the change in frequency equals around 0.15Hz but the most important is level of MAC factor. Comparison of the 4th mode from ride and excavation gives very low value of MAC (37%). In case of the 5th mode the MAC equals 73%. When compare visually, it is easy to observe change in vibrations of counterweight. The load on the machine lowers the amplitude of counterweight vibration almost to zero.

5. Conclusion

Operational modal analysis allows to identify modal models of brown coal machinery in different operational conditions. Thanks to this approach, changes in object dynamics can be observed.

The excitation on BWE is always very close to the natural frequencies. Knowledge about changes in dynamic characteristics allows to avoid resonance which is quite common phenomenon in brown coal machinery operation.

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