

Design of Measuring Bucket for Compact Bucket Wheel Excavator

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Abstract

Goal of the project is design of a measuring bucket for compact bucket wheel excavator. Bucket wheel excavator is used for continual mining in opencast mine. Measuring bucket is supposed to measure actual digging forces. Digging force is the force required to remove material from its rigid bond in the bank. The bucket has six teeth and digging force will be measured in each tooth. The measuring bucket will be calibrated in laboratory before measurements in opencast mine.

Keywords: Bucket Wheel Excavator, Digging Force, Measuring Bucket, Test Stand

1. Introduction

Bucket is part of bucket wheel excavator. Bucket wheel excavator is used for continual mining of lignite, chalk, overburden etc. Buckets are attached around a bucket wheel. Compact bucket wheel excavator KR400Nk is shown in Fig. 1.

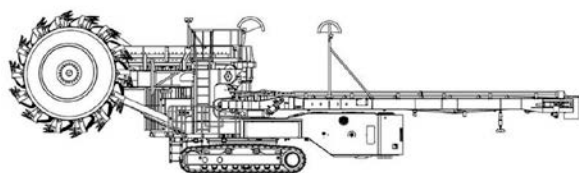


Fig. 1. Compact bucket wheel excavator KR400Nk (NOEN, a.s.) [1]

The measuring bucket is supposed to measure actual digging forces. The measurement will be made on the compact bucket wheel excavator KR400Nk (Noen, a.s.). Digging force is the force required to remove material from its rigid bond in the bank.

The digging process of bucket wheel is a very complicated procedure which depends on many factors. The material is not only cut by rotating bucket but it is also torn out of the bank, aided by lateral motion of the buckets. This results in a spiral cutting configuration. As the lateral speed (slewing speed) is variable, the form of the spiral changes. The cutting is, in addition, strongly dependent on the form of cutting lips, their position in relation to the cut, as well as their condition. [2]

Digging force depends on many factors – geological, technical, technological and other factors. [3]

Geological factors – strength and formable properties, mineral constitution of mined material

Technical factors – property of digging components (geometry)

Technological factors – bucket wheel speed and of main tower slewing speed

Other factors – humidity and temperature of mined material

Digging forces during digging process are shown in Fig. 2. The bucket wheel turns around (counter clockwise). Each bucket which dig is loaded by the digging force. Amount of the digging force depends on an actual depth of cut. The depth of cut is from the minimum (at the beginning) to the maximum (at the end) for terrace cut.

Removed material from the bank fall to bucket and bucket lift it above a transfer chute. Buckets are sealed by a radial chute which allows discharge of the material in a predetermined area only, where the material could slide over the transfer chute onto the conveyor belt. The transfer chute is mounted inside of the bucket wheel. The bucket wheel boom belt conveyor transports material to the middle of the machine and drops material to discharge boom belt conveyor, which transports material to another mining equipment.

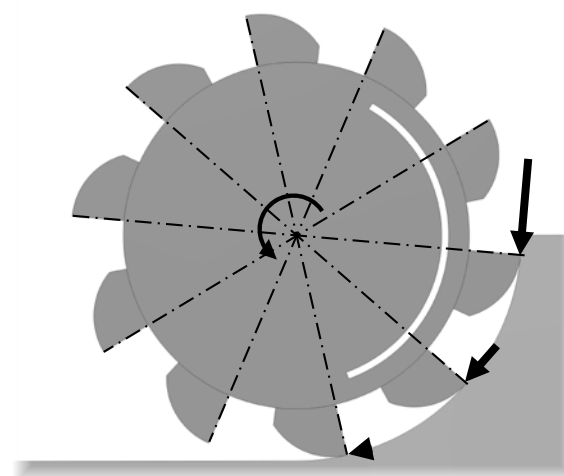


Fig. 2. Digging forces during excavation (terrace cut)

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2. Measuring bucket

The measuring bucket is modified bucket of compact bucket wheel excavator KR400Nk. The bucket is made from abrasion resistant plates because of high abrasion of mined material. The bucket has six teeth, which are supposed to cut mined material.

Geometry and position of all important parts of the measuring bucket (front and rear attachment and teeth) are the same as for the bucket with conventional teeth. Identical geometry and position guarantee same digging (cutting) conditions as other buckets mounted on the bucket wheel have. The measuring bucket is shown in Fig. 3.

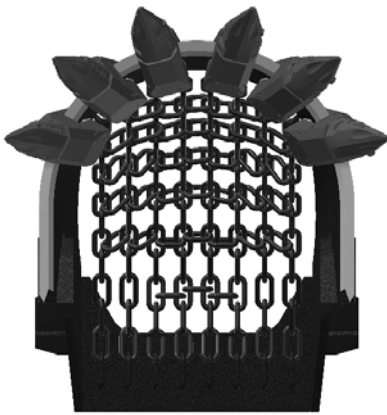


Fig. 3. Measuring bucket with six measuring teeth

Lignite research institute (VUHU, a.s.) measured digging forces [4] by a special modified bucket which could use a pressure gauge in a rear attachment. Innovation of the new measuring bucket will be measuring of the digging force on each tooth.

3. Test stand for the measuring bucket calibration

The test stand was designed for the calibration of the measuring bucket [5]. The test stand uses power of a hydraulic piston, which presses to an arm and the arm presses to the tooth of measuring bucket. Between the arm and the tooth will be a force gauge for measuring an actual calibrating force. Vector of the calibrating force will be same as vector of a real digging force. The measuring bucket will be calibrated this way and after that it will be mounted on bucket wheel excavator and will measure real digging forces in opencast mine. It will not be necessary to calibrate the measuring bucket in opencast mine. The test stand is shown in Fig. 4.

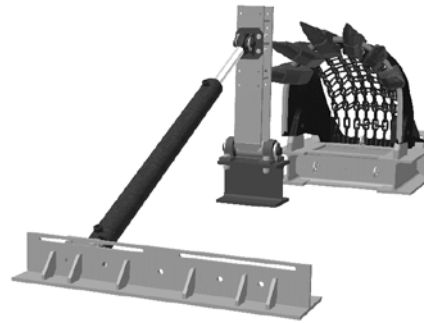


Fig. 4. Test stand for measuring bucket calibration

4. Conclusion

The measuring bucket was designed. Tip of teeth position and teeth inclination are the same as teeth in the standard bucket. Due to this fact the measuring bucket has the same geometry as the bucket of bucket wheel excavator KR400Nk. The measuring bucket will be calibrated in laboratory on the test stand. After calibration the measuring bucket will be used on bucket wheel excavator KR400Nk in opencast mine. Digging forces will be measured. Measuring data will be evaluated and results will be used for bucket wheel excavator development.

Acknowledgement

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