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Performance Prediction of Mechanical Excavators in Underground and Opencast Mining

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ABSTRACT

In this paper rock mass properties and some machine parameters affecting the performance of mechanical excavators such as impact hammers, roadheaders, surface miners etc. are widely explained including most common performance prediction models. Some numerical examples on calculating instantaneous breaking and cutting rates are also given. Different mechanical excavators used in Surface mining operations are also summarized in this paper.
Key words: Performance prediction, mechanical excavators, specific energy, rock cutting.

1. INTRODUCTION

A mining engineer is always interested in predicting the excavating machine performance prior to starting a mining project that will definitely define the mining economy. It is a fact that the performance of an excavating machine mainly depends on
a) Rock mass and ground properties, abrasivity of the formations, inclination and orientation of geological discontinuities, water income.
b) Machine parameters, design of cutting head, type of cutters, machine power etc.
c) Modes of operation, operator experience, job organization, maintenance facilities etc.
The success of the mining operation first depends on the proper selection of mining equipment and correct prediction of the performance of these equipment. In the light of this fact this paper deals with the main characteristics of the underground and surface excavating machines and some performance prediction models.

2. MECHANICAL EXCAVATORS FOR ROADWAY DRIVAGES

2.1 Impact hammers and their usages in roadway drivage

It is a well-known fact that mechanical impact offers several advantages over other continuous methods of excavation. These advantages are enhanced when the impact energy is increased to very high levels. The working principle of a modern hydraulic hammer is simple. There is a pis-ton moving up and down and striking against to tool end. To produce big energy pulses during downwards strokes, the hammer is equipped with an accumulator that is able to supply needed oil volume in a very short time. The accumulator is charged continuously by a hydraulic pump. Different research works demonstrated that specific energy defined as the energy to break the unit volume of the rock is inversely proportional to below energy (Wayment & GrantMyre 1976). Since then continuous works have being done to increase piston speed and piston weight to have higher blow energy values.
Hydraulic impact hammers have been used widely in mining industry and civil engineering ap-plications since 1960 (Rodford 1974; Pelizza 1994). Almost 11 km of metro tunnels were driven in Istanbul with impact hammers, since the initial capital investment was relatively lower and rock formation were highly fractured in some zones, RQD values changing from 0 to 100 (Bilgin 1996, Bilgin 1997).
Hydraulic impact hammers may be mounted on very many different types of excavators and are thus also connected into many different hydraulic systems. It is very important for safe and efficient operations to match the size of the carrier/excavator to the weight and the power of the hammer. The excavator/carrier is a more costly unit than the breaker and that is why the manufacturers of the hydraulic hammers build the hammers that have high blow energies rela-tive to their weights (Wyllie 1985).