Journal of
Powder Metallurgy & Mining

Research Article

OMICS International

Virtual Simulation of High Impact Shovel Loading Operation for Optimum Dumping Characterization

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The use of large machinery in surface mining operations has resulted in high-impact shovel loading operations (HISLO). When large capacity shovels dump 100+ tons of loads in a single pass, large impact forces are generated resulting in high frequency shock waves. These shock waves cause severe truck vibrations, and thus, expose dump truck operators to high levels of whole body vibrations (WBV) and impact the health and safety of operators. The operator's lower torso, lower back, legs, feet and hands are exposed to these WBV levels, which ultimately result in lower back injuries, musculoskeletal diseases and other long-term injuries. There exists no fundamental work to address this problem except a rigorous mathematical model for this impact force developed by previous researchers. This paper outlines a pioneering effort to develop a 3D virtual simulation model for a shovel dumping operation

Abstract

of expertise and understanding about how to control the vibrations generated within dump trucks in surface mining operations [1-3]. e HISLO vibrations are forced vibrations induced by the generated force from material impact. e available literature has allowed the authors to evaluate the contributions by researchers to the body of knowledge on impact force modelling. Studies from Iverson (2003) and Metz (2007) have focused on determining the impact force of a single body through impact test or using so ware packages (e.g. PFC3D) [4,5]. However, none of these studies focused on determining the impact force generated by owing material under gravity. Impact forces from Aouad and Frimpong (2013) are a bit overestimated because the material was considered to have been dumped at once. In reality, the material is generally well fragmented either during the direct shovel excavation or due to blasting prior to shovel digging for some hard

rock materials. In any
truck would consist of la
will be a continuous ma
the dynamic impact fo
of shovel dumping proc
another 100 tons of Ma
pass. e resulting impa
because of the damping
a phenomenon known
of the truck body, cha
accordingly (Figure 1).

is reduction in vibr
human body. e cushio
dynamic impact force f
have a similar magnitu
considered during the
evaluations [6]. erefor
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reduce the impulse forc

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3- ... 3 ... 5.0, ... 5.0 ... 5.0 ... 3 ... & 4100 ... 100 ... 3 ... (2016) ... 0.03% ... 1.4 % ... (2013) ... 10 ... (2013) ... 3 ... 3 ... 0.56% ... .02%,

... & 4100 ... (... 2) ... 3 ... (... 3) ... & 4100 ... .33 ... 4, ... & 4100 ... 3

... (... 4 ... 5) ... .33 ... 6.33 ... (... 6 ... 6.00 ... 5.50 ... 5.33 ... 5.00 ... 10) ... 4, ... 5.0 ... 3 ... 5.0 (... 11).

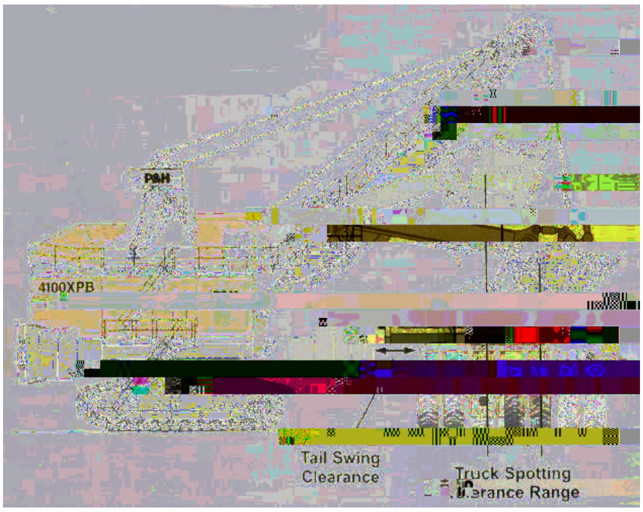

Figure 1: High Impact Shovel Loading Operation (HISLO) (Harnischfeger, 2003).

Figure 2: CAT793D Model: a) Back Isometric; b) Front Isometric; c) Front; d) Side Views.

Citation: Ali D, Frimpong S (2017) Virtual Simulation of High Impact Shovel Loading Operation for Optimum Dumping Characterization. J Powder Metall Min 6: 149. doi:10.4172/2168-9806.1000149

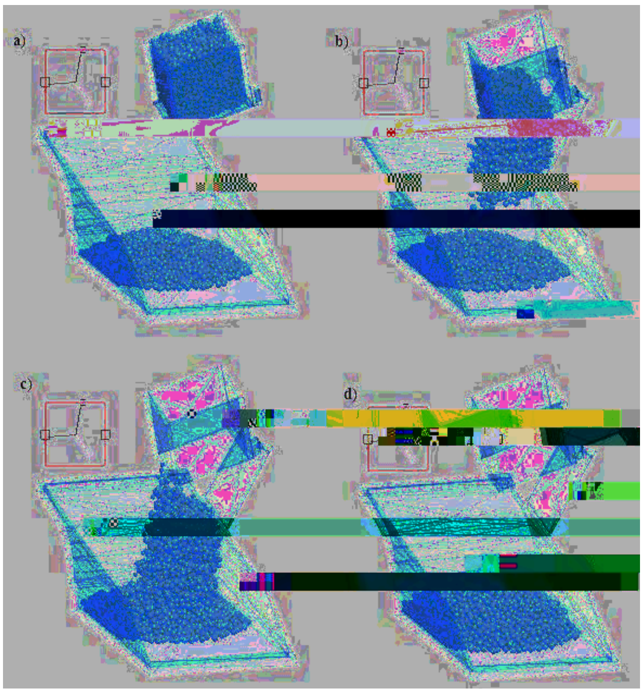

Figure 13: Dynamics of the 1st Shovel Pass. a) Particles inside the dipper; b) Dipper door opens and particles fall under gravity; c) Particles hit the truck body and begins to settle; d) 1st shovel pass is completed and particles come to rest on truck body.

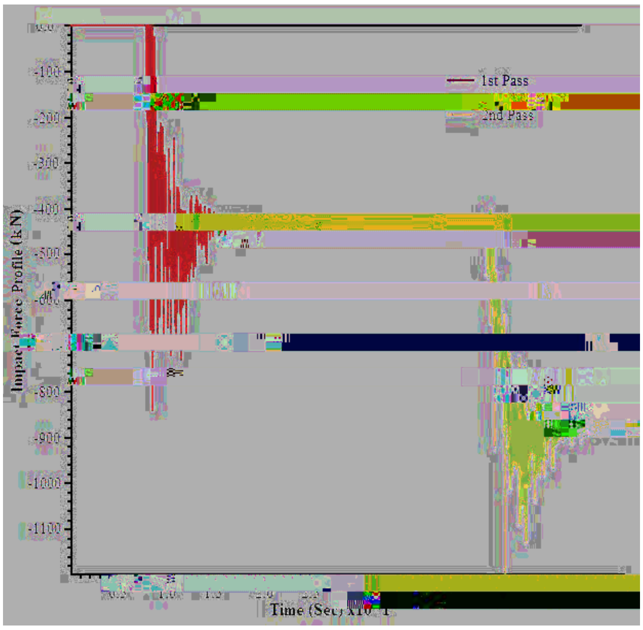

Figure 14: Dynamics of the 2nd Shovel Pass; a) Particles inside the dipper; b) Dipper door opens and particles fall under gravity; c) Particles hit the particles already in the truck from 1st shovel pass and begins to settle; d) 2nd shovel pass is completed and particles come to rest in truck.

100

4. %, ‾.42%, 11.45%, 12.0%, 15.0 %, 1‾.34%
‾.33, 6.33, 6.00, 5.50,
5.33, 5.00, 4.
1.‾‾%, 4.01%, ‾.14%, 14.03%, 15. %, 20. %
4. 0, 5.00, 5.33, 5.50,
6.00, 6.33, ‾.33
.2%, 10.5%

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