



Enhanced efficiency of the HSC 650D jaw crusher using Tool Condition Monitoring

Abstract

The HSC 650D double-acting jaw crusher is designed for efficient sample preparation, offering automated jaw adjustment and integrated Tool Condition Monitoring (TCM) via an acceleration sensor. This study evaluated the TCM system during the crushing of gravel and basalt. Based on the TCM signal the completion of the crushing process was automatically detected and the crusher stopped. Gravel showed shorter crushing times (46.0 ± 8.6 s) and lower vibration values (0.325 ± 0.008 g) compared to basalt (72.3 ± 5.9 s; 0.406 ± 0.168 g). The results demonstrate TCM's ability for automatic control of the crushing process leading to higher automation efficiency and better process control.

Key words

• Tool Condition Monitoring • Jaw Crusher • HSC 650D • Vibration • Automation

Introduction

The HSC 650D is a double-acting jaw crusher designed for efficient sample preparation (Figure 1). Featuring both top and bottom-driven jaws, it processes most samples in a single pass, accommodating grain sizes up to 50 mm and reducing them to 10 mm or smaller.

A standout feature of the HSC 650D-AUT is its fully automated, stepless adjustment of the crusher jaws via a servomotor. This system not only simplifies blockage clearance but also enables precise adaptation of the output grain size to meet specific sample requirements. Additionally, the mechanism automatically compensates for jaw wear caused by abrasive

materials, ensuring consistent performance without manual intervention.

Another key innovation is the built-in acceleration sensor. This sensor facilitates tool condition monitoring by measuring vibrations within the crusher chamber, providing a reliable overview of the machine's functional state.

In this application note, we investigate the sensor's performance during the crushing of two different materials: gravel and basalt. In doing so, we aim to find out whether the signals from the acceleration sensor can be used to automatically monitor and potentially control the crushing process.

Methods

The study utilized the manual version of the HSC 650D (Herzog Germany, Osnabrück). Ten samples each of gravel and basalt were processed, with each sample weighing 5 kg.

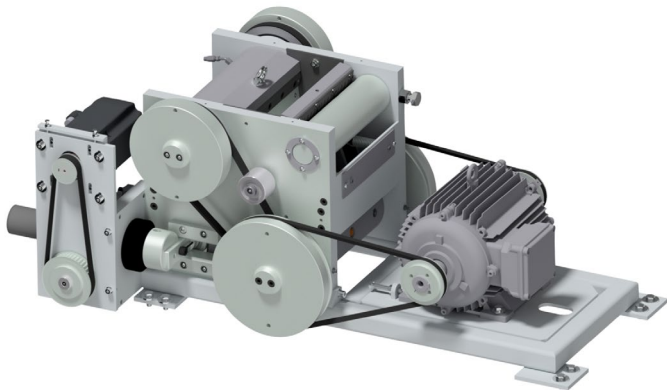


Figure 1: CAD drawing of the HSC 650D, the double-acting jaw crusher

For this study, the crusher was started, and the sample was manually added to the input hopper. Once the crusher was activated, vibration signals from the accelerometer attached to the machine were recorded automatically. The sensor data was processed by the PLC of the HSC 650D and simultaneously forwarded to the PrepMaster Analytics software for recording and evaluation.

The crusher was automatically stopped when the signal amplitude dropped below a predefined threshold for more than five seconds, indicating that no sample material remained in the crushing chamber (Figure 2). We recorded the average crushing time for the 5 kg samples and analyzed the vibration strength (measured in g).

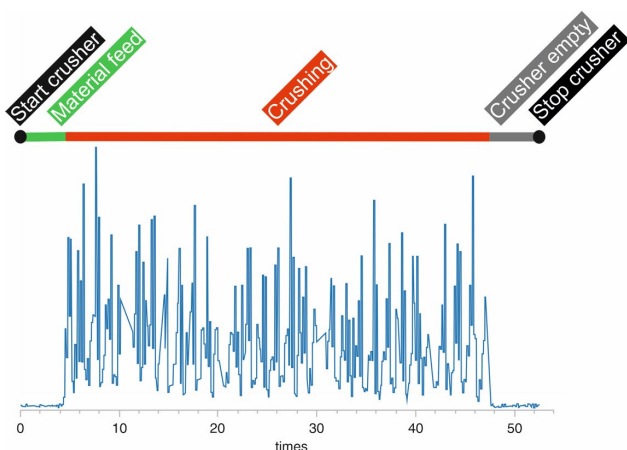


Figure 2: Exemplary vibration signal of a crushing pass with associated sequence diagram

Results

Crushing Gravel

Figure 3 displays three typical examples of vibration signals during gravel crushing. The mean crushing time for the 5 kg samples was 46.0 ± 8.6 seconds, with a mean vibration value of 0.325 ± 0.008 g. Visual inspection confirmed efficient comminution, with the input hopper and crushing chamber completely empty after the automatic shutdown.

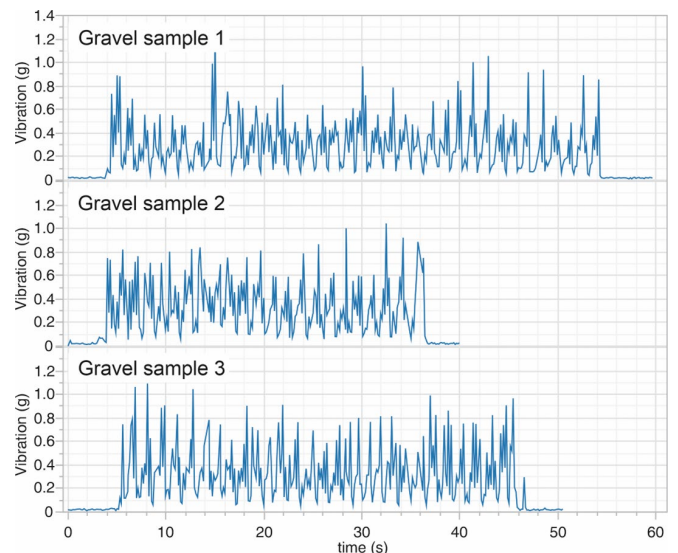


Figure 3: Three examples of the vibration signal during crushing of gravel samples

Crushing Basalt

Figure 4 illustrates three examples of vibration signals during basalt crushing. The mean crushing time was 72.3 ± 5.9 seconds, with a mean vibration value of 0.406 ± 0.168 g. As with gravel, all samples were effectively crushed, leaving no residual material in the machine.

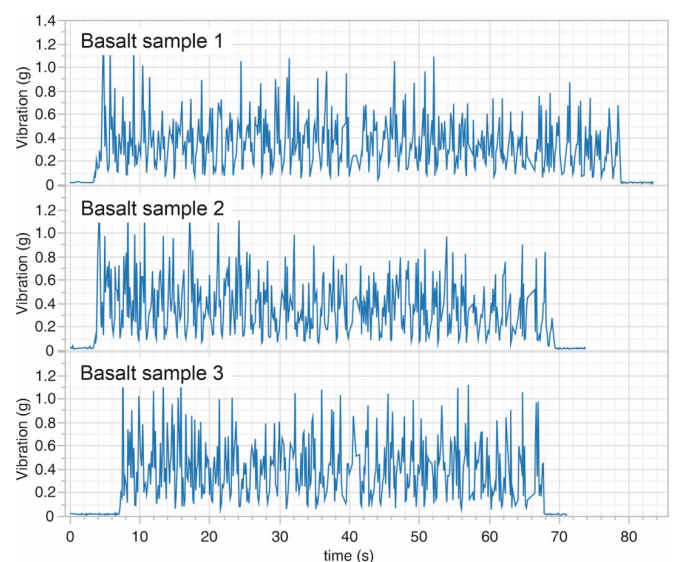


Figure 4: Three examples of the vibration signal during crushing of basalt samples

Discussion

The results demonstrate the efficacy of the sensor-based Tool Condition Monitoring system in tracking the operational state of the HSC 650D. The start and end of the crushing process were clearly identifiable from the signal intensity, enabling real-time monitoring in automated systems.

This capability supports the implementation of advanced control mechanisms to optimize the crushing process. Unlike time-based approaches, the sensor-based method ensures maximum efficiency by allowing immediate transition to subsequent processing steps if the crushing completes sooner than expected. Conversely, the system guarantees complete and thorough sample comminution when the process takes longer than usual.

The TCM system also helps to prevent overfilling of the crushing chamber. When large quantities of material are being processed, the upstream vibrating conveyor resumes feeding only after the chamber is cleared.

Additionally, the results suggest that the sensor signals may provide insight into material properties. For instance, the mean vibration value for gravel (0.325 g) was significantly lower than that for basalt (0.406 g). Combined with the shorter crushing time for gravel (46 s) compared to basalt (72 s), this indicates that gravel is easier to crush. However, further studies are needed to determine whether the sensor data can reliably characterize material-specific properties.

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