Technical Article-2

Determining the impact of Haul Road Design on Fuel Consumption by Using Fleet Management System & Global Mapper software

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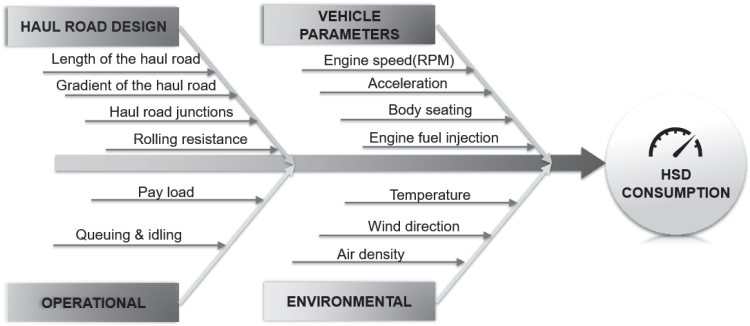
Introduction:
Fuel cost is responsible for a majority share of operating cost in a surface mining operation. High Speed Diesel (HSD), which is costly and has a very significant environmental impact, is used as a fuel for haul trucks in surface mines. Reducing fuel consumption not only leads to reduction in operating costs but also carbon emissions. Haul roads can change rapidly as mining progresses and access to different areas is required therefore designing of haul roads is very important. Khondbond iron mine is an 8MTPA capacity iron mine equipped with 10 dumpers (Komatsu HD-785-7), 4 shovels, 2 loaders, 4 drills 5 dozers, 2 water sprinklers, and a grader. Fuel consumption of dumper itself contributes 51% of total fleet consumption with hourly consumption of 40 Lt. Continuous haul road maintenance is in practice with dozing, grading and compacting by using compactor.

Factors Effecting Fuel Consumption:

There are various factors that effect the fuel consumption of haul trucks in mining operations, some of them can be controllable such as haul road design and operational factors while some may be uncontrollable like environmental factors. Operator's skill also plays an important role which can be improved by proper training.



As this paper mainly deals with haul road design, the Fleet management system (FMS) data such as GPS tracking of haul trucks and Vehicle Health Monitoring System (VHMS) data were integrated to know the various locations of the haul road at which the VHMS parameters are observed abnormal.

Fleet Management System (FMS):

A Fleet Management System (FMS) for mine site is a suite of specialized software running on ruggedized hardware. Using GPS and a wireless radio network, the FMS tracks and monitors production, maintenance, and safety in the mines. The use of Fleet Management System in the mining industry is rapidly increasing is because of its various applications such as production optimization, safety, fuel management, vehicle health monitoring etc.

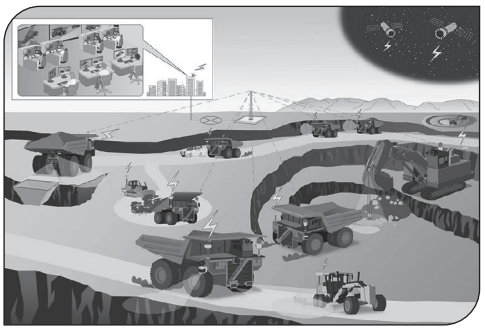
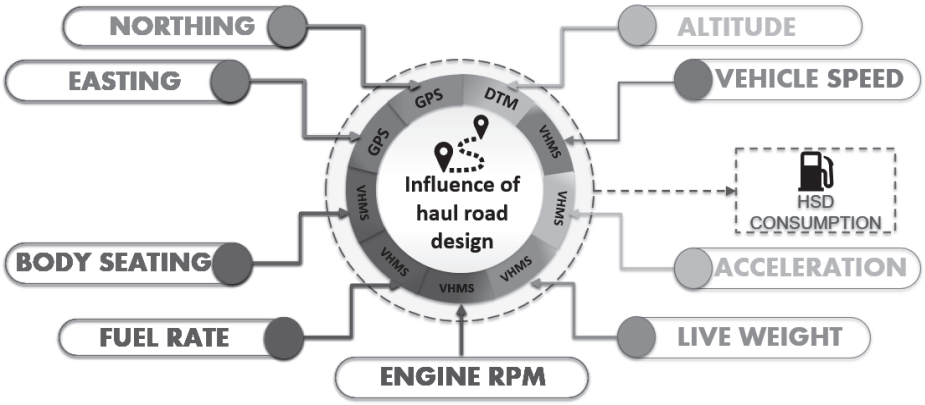


Fig: Fleet Management System

This requires a Mobile Data Terminal (MDT) system installed at mine fleet, which receives signal through a wireless network and transfers the data to the control centre. The equipment can also be continuously tracked through GPS.

Vehicle Health Monitoring System:
A Vehicle Health Tracking System (VHMS) is a technology that tracks the overall performance and condition of a vehicle in real-time, generating reports of key vehicle health parameters. The system uses sensors & other data collection devices to collect and analyse data on various aspects of the vehicle, such as its engine, transmission, brakes, and tires. The data collected by the system can be then processed and analysed to identify any potential issues with the vehicle, such as low tire pressure, engine abnormalities, or transmission problems.

Various parameters considered to determine the influence of haul road design on fuel consumption:



- Northing, Easting are the GPS track points of the haul truck monitored through FMS and are recorded at every 3-5sec intervals.
- Vehicle health parameters such as engine RPM, acceleration, fuel rate (Ltr/Hour), body seating, payload and vehicle speed are also monitored through FMS and are recorded at every 30sec intervals.
- Altitude of the GPS track points to determine the gradient along haul road is obtained by DIGITAL TERRAIN MODEL (DTM) using drone surveying.

Integration of Global Positioning System (GPS) and Vehicle Health Monitoring System (VHMS) data:

As the GPS and VHMS data are recorded at different intervals, it is required to integrate the VHMS data with GPS data with the same time stamp. Some of the sample points are given in the below table.

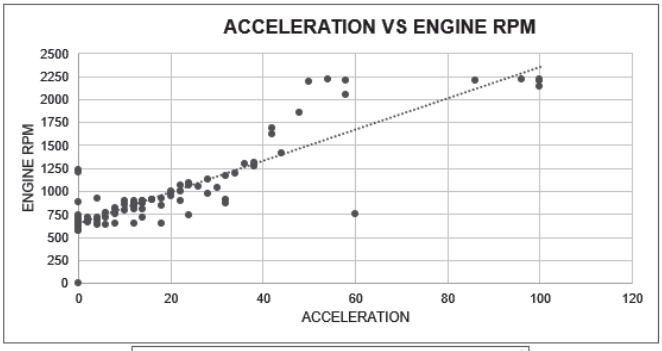
S.NO	Northing	Easting	Timestamp	Equipment Code	Accelerator pedal position	Body seating	Engine speed (RPM)	Live weight	Vehicle speed	Brake position	Fuel rate(L/H)
1	2427254.441	333233.1301	19-05-2023 16:01:48	O2K029	6	0	730	112	0	0	57
2	2427498.461	333139.4055	19-05-2023 16:03:37	O2K029	58	1	1679	1	29	0	149
3	2427530.767	333148.9744	19-05-2023 16:03:44	O2K029	48	1	1569	1	26	0	96
4	2427760.775	333181.8383	19-05-2023 16:04:14	O2K029	44	1	1637	0	28	0	80
5	2427987.125	333274.5594	19-05-2023 16:04:44	O2K029	66	1	1486	1	25	0	228
6	2428173.208	333458.3762	19-05-2023 16:05:18	O2K029	58	1	1725	2	29	0	144
7	2428325.801	333513.7483	19-05-2023 16:05:44	O2K029	66	1	1325	1	23	0	249
8	2428515.932	333470.8324	19-05-2023 16:06:15	O2K029	28	1	1529	1	18	0	0
9	2428595.726	333555.5308	19-05-2023 16:06:44	O2K029	34	1	1274	0	16	0	105
10	2428593.446	333621.4264	19-05-2023 16:09:45	O2K029	32	1	1272	1	7	0	61
11	2428581.391	333646.3832	19-05-2023 16:13:45	O2K029	0	1	657	0	0	0	38
12	2428546.562	333645.0529	19-05-2023 16:15:45	O2K029	26	1	968	1	3	0	98
13	2428569.441	333631.4863	19-05-2023 16:20:45	O2K029	46	1	1529	95	11	0	93
14	2428540.568	333500.7892	19-05-2023 16:21:15	O2K029	30	1	1534	97	19	0	0

This is very important as to exactly map the vehicle parameters along with the GPS track points.

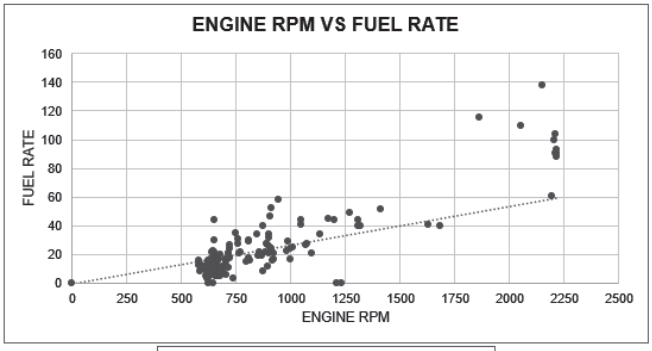
Plotting of integrated data by using Global Mapper software:

The integrated data is imported to the global mapper software along with the Digital Terrain Model (DTM) and Orthomosaic image of the mine. Hence, we will get to know how the vehicle parameters are impacted along the haul road.

- As per the Original Equipment Manufacturer (OEM) test data ideal engine RPM of KOMATSU HD-785-7 for optimal fuel consumption is 1500. The comparison between acceleration, engine RPM, and fuel rate was shown in the below graph.

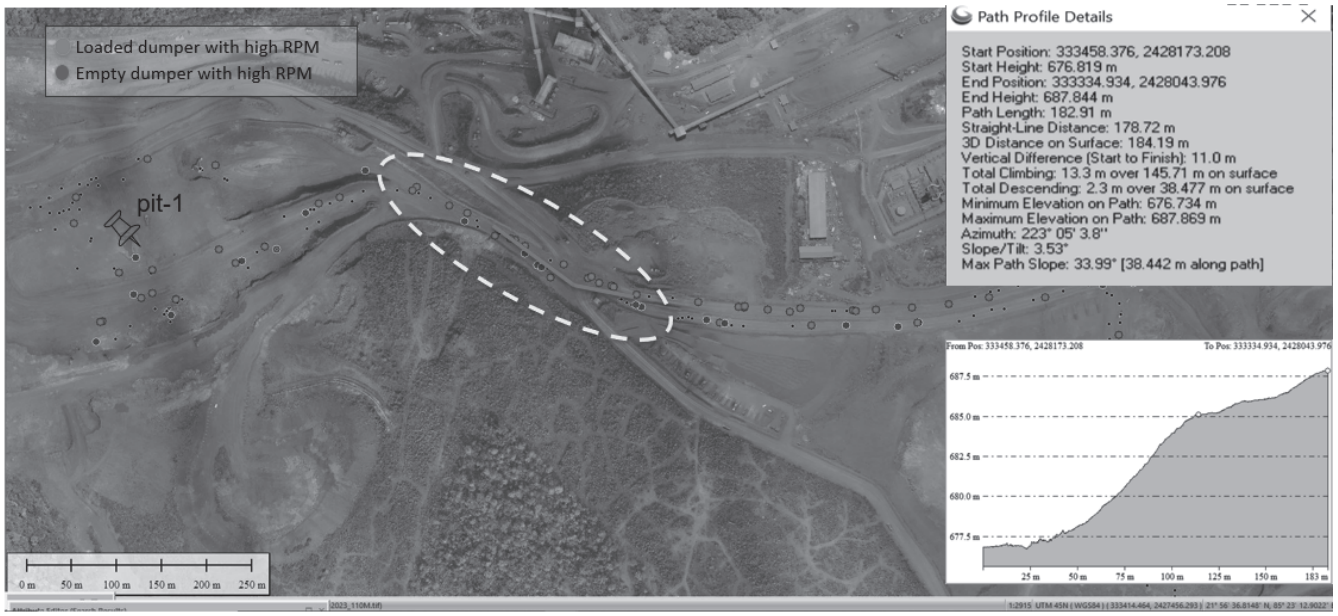


ACCELERATION↑ ENGINE RPM↑



Engine RPM↑ FUEL RATE↑

- If it exceeds that ideal RPM, it can be considered as an abnormal sample point. This type of abnormal points is observed during both loaded and unloaded condition. If such points are observed frequently at a particular section or part haul road. Then it is required to analyse the design parameters of haul road.



Result:

By this process some sections of the haul road are identified as that are adversely affecting the parameters that results in fuel consumptions. Such sections are redesigned by considering gradient, width and junctions at some parts to obtain the optimum vehicle parameters to limit the fuel consumption.

Way forward:

Rather than manual integration of GPS and VHMS parameters as it requires human intervention and time consuming, it can be done during the report generation itself at Fleet Management System (FMS) so that regular analysis can be done with less time and also with minimal human intervention.

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