

# "RULES OF THUMB" FOR SELECTING MINING MACHINERY FOR A GREEN FIELD MINING PROJECT

## RULES OF THUMB FOR SELECTING MINING MACHINERY IN A MINING PROJECT

### 1. GENERAL PRINCIPLES OF EQUIPMENT SELECTION

BEFORE CHOOSING ANY MACHINERY, THE FOLLOWING FUNDAMENTALS GUIDE EVERY MINING ENGINEER:

- **MATCH EQUIPMENT TO DEPOSIT GEOMETRY: MACHINERY SHOULD SUIT THE SCALE, SHAPE, DIP, AND DEPTH OF THE OREBODY.**

**RULE OF THUMB: EQUIPMENT PRODUCTIVITY DECREASES BY 10–15% FOR EVERY 10° INCREASE IN SLOPE BEYOND THE OPTIMUM HAUL ROAD GRADIENT.**

- **OPTIMIZE THE SYSTEM, NOT THE MACHINE: EACH PIECE MUST INTEGRATE WITHIN A PRODUCTIVE CHAIN (DRILLING → BLASTING → LOADING → HAULING → CRUSHING).**
- **BALANCE CAPACITY: FOR EVERY 1 M<sup>3</sup> OF EXCAVATOR BUCKET CAPACITY, 4–5 TRUCKS OF COMPATIBLE PAYLOAD SHOULD BE ALLOCATED TO AVOID QUEUING LOSSES.**
- **ECONOMIC EVALUATION: LIFECYCLE COST = CAPITAL COST + OPERATING COST + DOWNTIME COST. ALWAYS COMPARE \$/TONNE MOVED RATHER THAN UNIT PRICE.**

### 2. DRILLING EQUIPMENT

**PURPOSE: CREATION OF BLAST HOLES FOR ROCK FRAGMENTATION.**

**KEY PARAMETERS:**

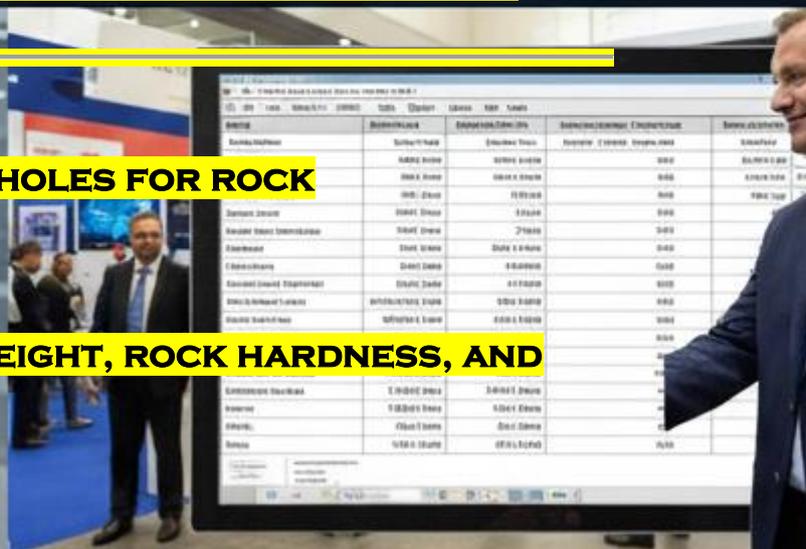
- **HOLE DIAMETER, BENCH HEIGHT, ROCK HARDNESS, AND PRODUCTION TARGET.**



CONENTION



Material & Site Conditions



Model	Capacity (m³/hr)	Power (kW)	Weight (kg)	Price (USD)
Model A	100	1500	5000	10000
Model B	150	2000	7000	15000
Model C	200	2500	9000	20000
Model D	250	3000	11000	25000
Model E	300	3500	13000	30000
Model F	350	4000	15000	35000
Model G	400	4500	17000	40000
Model H	450	5000	19000	45000
Model I	500	5500	21000	50000
Model J	550	6000	23000	55000

**• ROCK HARDNESS INFLUENCES POWER:**

**RULE OF THUMB: 1 HP REQUIRED FOR EVERY 25–30 PSI OF UNIAXIAL COMPRESSIVE STRENGTH.**

**EQUIPMENT SELECTION:**

TYPE	APPLICATION	THUMB RULE
TOP HAMMER DRILLS	HARD ROCK, ≤ 6" HOLES	ECONOMICAL UP TO 15 M DEPTH
DOWN-THE-HOLE (DTH)	MEDIUM–HARD ROCK, 4–10"	BEST WHEN DEPTH > 15 M
ROTARY DRILLS	SOFT FORMATIONS	EFFICIENT WHEN HOLE > 250 MM DIA
HYDRAULIC DRILLS	HIGH PRECISION	BEST FOR GRADIENT < 10°

**PERFORMANCE GUIDE:**

**1 DRILL WITH 200 MM BIT CAN PRODUCE 12,000–15,000 TONNES/MONTH DEPENDING ON ROCK AND BENCH HEIGHT.**

**RULES OF THUMB FOR MINING EQUIPMENT SELECTION**

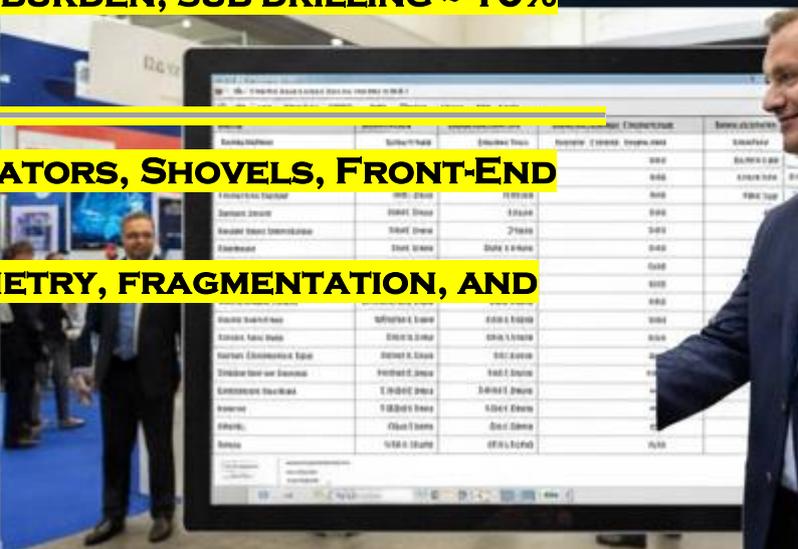
**3. BLASTING PARAMETERS (EQUIPMENT INTERFACE)**

**THOUGH NOT A MACHINE, BLASTING DIRECTLY AFFECTS EQUIPMENT SIZING:**

- RULE: BENCH HEIGHT ≈ 3 × HOLE DIAMETER × BURDEN MULTIPLIER (≈30–40).**
- OPTIMUM BURDEN-TO-SPACING RATIO = 1:1.2 TO 1:1.5.**
- STEMMING LENGTH ≈ 0.7 × BURDEN; SUB-DRILLING ≈ 10% OF HOLE DEPTH.**

**4. LOADING EQUIPMENT (EXCAVATORS, SHOVELS, FRONT-END LOADERS)**

**SELECTION BASIS: BENCH GEOMETRY, FRAGMENTATION, AND HAULAGE DISTANCE.**





**EQUIPMENT TYPE**

**TYPICAL CAPACITY**

**IDEAL APPLICATION**

**RULES OF THUMB**

**HYDRAULIC EXCAVATOR**

**2–20 M<sup>3</sup>**

**FLEXIBLE OPERATIONS**

**1 M<sup>3</sup> BUCKET PER 250–300 TPH PRODUCTION**

**ELECTRIC ROPE SHOVEL**

**10–80 M<sup>3</sup>**

**LARGE-SCALE OPEN PITS**

**OPTIMAL FOR > 5 MTPA PRODUCTION**

**FRONT-END LOADER**

**4–20 M<sup>3</sup>**

**SHORT CYCLES, STOCKPILES**

**BUCKET CAPACITY ≈ 1/8TH TRUCK SIZE**

**PERFORMANCE INDICATORS:**

**RULES OF THUMB FOR MINING EQUIPMENT SELECTION**

- **OPTIMUM BUCKET FILL FACTOR: 85–90%.**
- **MATCH FACTOR (LOADER:TRUCK) IDEALLY 0.8–1.2.**

**5. HAULAGE EQUIPMENT (DUMP TRUCKS & CONVEYORS)**

**KEY FACTORS: DISTANCE, GRADIENT, CYCLE TIME, FUEL COST, AND ROAD CONDITION.**

**TYPE**

**CAPACITY**

**RULE OF THUMB**

**REMARKS**

**RIGID DUMP TRUCK**

**1. ECONOMICAL CAPEX vs. OPEX**

**35–400 T**

**MATCH TO EXCAVATOR: 4–5 PASSES/LOAD**

**SUITED FOR LONG HAULS**

**ARTICULATED TRUCK**

**25–60 T**

**BETTER FOR ≤ 12% GRADIENTS**

**FLEXIBLE TERRAIN USE**

**CONVEYOR**

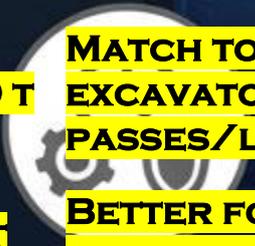
**500–10,000 TPH**

**ECONOMICAL FOR > 3 KM HAULS**

**CONTINUOUS TRANSPORT**

**HAUL ROAD RULES:**

- **MAXIMUM GRADIENT: 8–10% FOR TRUCKS, 12% FOR ARTICULATED.**
- **ROAD WIDTH: 3.5 × TRUCK WIDTH (SINGLE LANE), 2.5 × TRUCK WIDTH (DUAL LANE).**



Item	Quantity	Unit Price	Total Price	Notes
Excavator	1	\$1,000,000	\$1,000,000	
Truck	10	\$500,000	\$5,000,000	
Conveyor	1	\$2,000,000	\$2,000,000	
...	...	...	...	...

- **CURVE RADIUS:  $\geq 3 \times$  TRUCK LENGTH.**

## 6. DOZERS & GRADERS

**USED FOR ROAD MAINTENANCE, OVERBURDEN LEVELING, AND DUMP SHAPING.**

**MACHINE APPLICATION**

**DOZER (D8–D11) OVERBURDEN SPREADING, DUMP DOZING**

**GRADER ROAD SHAPING**

**RULES OF THUMB**

**1 HP FOR EVERY 1.5–2 TONNES MATERIAL PUSHED**

**MAINTAIN 2% CAMBER AND 0.5% CROSS SLOPE FOR DRAINAGE**

# RULES OF THUMB FOR MINING EQUIPMENT SELECTION

**FACT: PROPER ROAD MAINTENANCE CAN REDUCE HAULAGE COST BY 10–15% ANNUALLY.**

## 7. DRILL & BLAST SUPPORT EQUIPMENT PROJECT

- **COMPRESSOR SIZING: FOR DTH, AIR REQUIREMENT  $\approx 1.5–2.0 \text{ M}^3/\text{MIN}$  PER INCH OF HOLE DIAMETER.**
- **WATER TANKER CAPACITY: MINIMUM 10% OF DAILY HAULAGE VOLUME FOR DUST SUPPRESSION.**
- **EXPLOSIVE VAN: MUST COMPLY WITH PESO NORMS, TYPICALLY 1 VAN PER 5 DRILLS.**



1. ECONOMICS:

2. APPLICATION:

Site Conditions



Material & Site Conditions

## 8. CRUSHING & SCREENING EQUIPMENT

**RULE OF THUMB:**

- **PRIMARY CRUSHER FEED SIZE  $\leq 0.8 \times$  MINE BLAST SIZE.**
- **SECONDARY CRUSHER CAPACITY =  $1.2 \times$  PRIMARY CRUSHER CAPACITY.**
- **POWER REQUIREMENT  $\approx 0.5–1.0 \text{ kWh}$  PER TONNE FOR HARD ROCK.**



## 9. AUXILIARY & SUPPORT MACHINERY

### EQUIPMENT

### RULE OF THUMB

**WATER SPRINKLER CAPACITY = 0.5% OF DAILY ORE MOVEMENT**

### MAINTENANCE

**1 PER 10–12 MAJOR EQUIPMENT**

### TRUCK

**LIGHTING TOWER 1 TOWER PER 10,000 M<sup>2</sup> OF PIT AREA**

### FUEL TRUCK

**FUEL TANK = 1.5 × LARGEST EQUIPMENT'S DAILY REQUIREMENT**

## 10. ECONOMIC RULES FOR EQUIPMENT FLEET

- **FLEET UTILIZATION: TARGET 85–90%.**
- **AVAILABILITY: > 90% MECHANICAL AVAILABILITY IS DESIRABLE.**
- **REPLACEMENT POLICY: REPLACE WHEN MAINTENANCE COST > 60% OF DEPRECIATION COST.**
- **CAPITAL PRODUCTIVITY:**

**RS 100–120 PER TONNE OF MATERIAL MOVED PER RS 1 CRORE INVESTMENT IS TYPICAL IN INDIAN SURFACE MINES.**

### 1. ECONOMICS.

### 2. APPLICATION:

## 11. ENVIRONMENTAL AND ENERGY CONSIDERATIONS

- **FUEL EFFICIENCY: SELECT ENGINES WITH BS-IV OR TIER-4 COMPLIANCE.**
- **NOISE CONTROL: USE DAMPENED DRILL RIGS (< 85 DB).**
- **ELECTRIC FLEET TREND: ELECTRIC TRUCKS CAN REDUCE CO<sub>2</sub> EMISSIONS BY 40–50% AND FUEL COST BY 35% OVER LIFECYCLE.**

## 12. SUMMARY TABLE – QUICK REFERENCE

Equipment	Capacity	Power	Operating Cost	Operating Cost	Operating Cost
Excavator	1.5m <sup>3</sup>	150kW	150000	150000	150000
Wheel Loader	3m <sup>3</sup>	150kW	150000	150000	150000
Tractor	100kW	100kW	100000	100000	100000
Generator	100kW	100kW	100000	100000	100000
Compressor	100kW	100kW	100000	100000	100000
Drill Rig	100kW	100kW	100000	100000	100000
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EQUIPMENT	CAPACITY RANGE	SELECTION BASIS	RULE OF THUMB
DRILL	100–400 MM	ROCK HARDNESS	1 HP PER 25–30 PSI UCS
SHOVEL	2–80 M <sup>3</sup>	PRODUCTION RATE	1 M <sup>3</sup> = 250–300 TPH
TRUCK	25–400 T	HAUL DISTANCE	4–5 PASSES PER SHOVEL
DOZER	200–900 HP	DUMP MANAGEMENT	1 HP PER 1.5–2 T MATERIAL
CRUSHER	100–10,000 TPH	FEED SIZE	FEED ≤ 0.8 × BLAST SIZE

# RULES OF THUMB FOR MINING EQUIPMENT SELECTION

SUDAM BEHERA

HEAD OF MINING

FOR A MINING PROJECT



1. ECONOMICS:  
CAPEX vs. OPEX



2. APPLICATION:  
Material & Site Conditions

