



Predicting Crusher Liner Life from the Abrasion Index

Turn Bond's abrasion index into a liner-replacement forecast, then find the cost-optimal interval with a simple wear-and-cost model and two worked examples.

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Manganese liners are among the three largest consumable costs in any crushing plant, and they are too often changed on a calendar hunch. Pull them early and you scrap good metal; run them too long and a worn-through profile loses product shape, wastes energy, and can damage the crusher frame. Tie wear to the rock's **abrasion index** and you can forecast replacement by tonnage — and even find the cost-optimal interval, not just the mechanical one.

The abrasion index, briefly

Bond's Abrasion Index A_i is a laboratory measure of how aggressively a rock removes metal. The higher A_i , the faster the liner loses thickness per tonne:

ROCK TYPE	TYPICAL BOND A_i	RELATIVE WEAR
Limestone / dolomite	0.02 - 0.20	low
Granite / basalt	0.30 - 0.50	medium

ROCK TYPE	TYPICAL BOND A_i	RELATIVE WEAR
Quartzite / high-silica	0.60 - 0.90	high
Taconite / ferro-silicate	0.80 +	severe

A simple, calibratable wear model

Over the working life of a liner, depth loss is close enough to linear with throughput to plan around. Define a wear rate W in millimetres of liner per 1000 tonnes, proportional to abrasion index:

$$w = k \cdot A_i \quad \text{and} \quad L = \frac{d_{usable}}{W} \times 1000$$

SYMBOL	MEANING	UNITS
W	Wear rate	mm per 1000 t
L	Liner life (throughput to wear-out)	tonnes
d_{usable}	Usable liner depth before replacement	mm
k	Site constant (calibrate from your own records)	mm·1000t ⁻¹
A_i	Bond abrasion index of the feed	-

Calibrate, don't copy. The constant k folds in your crusher type, setting, speed and liner alloy. Back it out from two past liner changes (depth lost ÷ tonnes run), then the model predicts the next one to within a few percent for most of the life.

Worked example 1 – life in tonnes

A secondary cone crushing granite ($A_i = 0.40$) has a usable liner depth of $d_{usable} = 55$ mm. Plant records show the last set lost its 55 mm over 324,000 t, so the observed wear rate is

$$W = \frac{55 \text{ mm}}{324,000 \text{ t}} \times 1000 \approx 0.17 \text{ mmper1000t.}$$

That fixes the life directly: $L = (55/0.17) \times 1000 \approx 324,000 \text{ t}$. Running at 250 t/h for 4,000 operating hours a year (1.0 Mt/yr), one liner set lasts about **0.32 years — roughly 16 weeks**. Maintenance can now book the change against a tonnage counter, order manganese on lead time, and stop guessing.

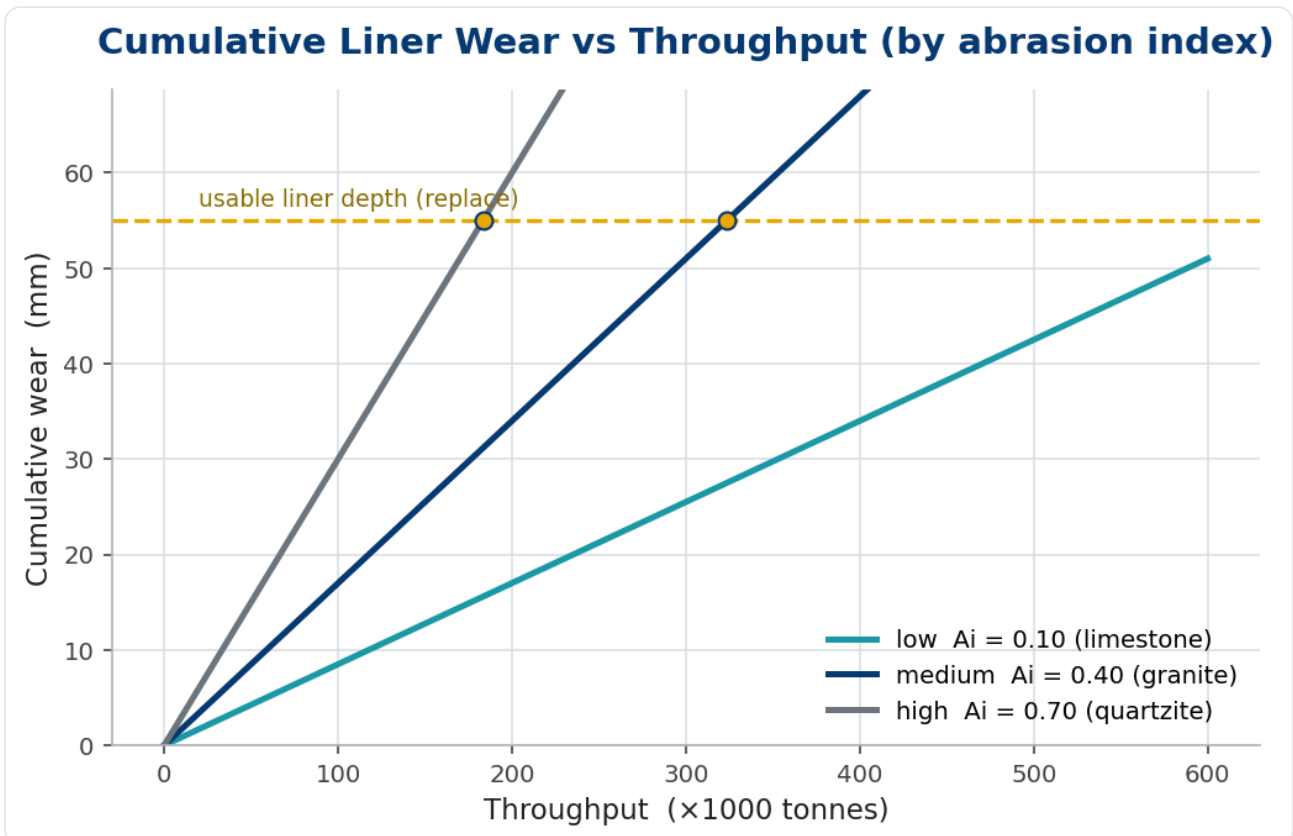


Figure 1. Cumulative wear is near-linear with tonnage; each line meets the usable-depth limit at a different throughput, setting the replacement point.

Life across abrasion classes

For the same 55 mm usable depth, the rock you feed swings liner life by more than 3x:

FEED (TYPICAL A_i)	WEAR RATE W (MM/1000 T)	LINER LIFE L	WEEKS AT 1.0 MT/YR
Limestone (0.10)	0.085	647,000 t	~34 weeks

FEED (TYPICAL A_1)	WEAR RATE W (MM/1000 T)	LINER LIFE L	WEEKS AT 1.0 MT/YR
Granite (0.40)	0.17	324,000 t	~16 weeks
Quartzite (0.70)	0.30	183,000 t	~9 weeks

Worked example 2 – the cost-optimal interval

Mechanical wear-out is not always the cheapest moment to change. Two costs pull in opposite directions. The **amortised liner cost** per tonne falls the longer you run (you spread one set over more tonnes). But as the profile wears past about three-quarters of its depth, the crusher loses product shape and energy efficiency, and the risk of a damaging breakthrough rises — an **inefficiency-and-risk cost** that climbs steeply near the end. Their sum is U-shaped:

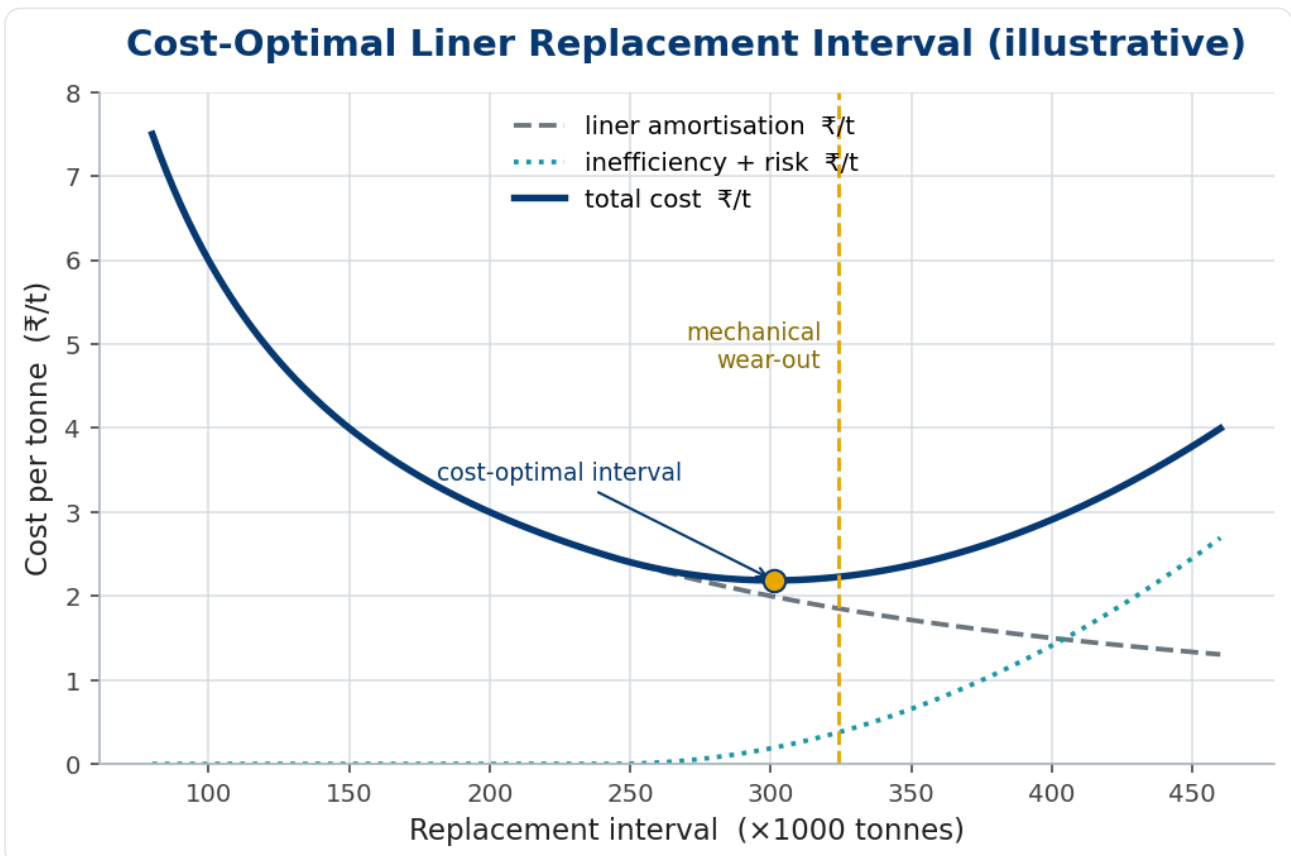


Figure 2. Amortisation (grey) falls with interval; inefficiency and risk (teal) rise near end-of-life. Total cost (navy) is minimised a little before full mechanical wear-out (illustrative figures).

For this granite duty the minimum total cost lands near **300,000 t** — about 1,200 operating hours, or roughly 14–15 weeks — rather than stretching the last millimetres to 324,000 t. Changing a touch early trades a small amount of unused metal for a larger saving in crushing efficiency and avoided risk. The exact optimum depends on your liner price, downtime cost and how fast efficiency decays — but the shape is universal: there is a sweet spot, and it is usually just shy of wear-out, never far past it.

Condition monitoring that feeds the model

- **Profile gauge or 3D scan at every shutdown.** Turns the model from a forecast into a measured trend and catches uneven wear early.
- **Power and product trends.** A creeping specific energy (kWh/t) or a coarsening product at constant setting is the efficiency decay in Figure 2 showing up before you open the machine.
- **Measure the worst point, not the average.** Liners wear fastest at the choke zone; life is set by where the metal runs out first.

Common mistakes

- **Calendar-based changes.** Tonnage, not weeks, drives wear; a slow month and a flat-out month are not the same liner life.
- **Forgetting the quarry moved.** A new bench or blast can shift A_j ; re-check it when the geology changes.
- **Running past the knee.** The linear model under-predicts wear at end-of-life; plan the change before the curve steepens.
- **Not re-fitting k after an alloy or setting change.**

Frequently asked questions

Where do I get the abrasion index?

Either a Bond abrasion test on a representative sample, or published values for your rock type as a first estimate. Calibrating k from your own liner history matters more than a perfect A_j .

Do liners wear evenly across the chamber?

No. Wear concentrates at the choke zone and lower mantle; the model should track the fastest-wearing point, since that is what ends the liner's life.

Is a harder alloy always better?

Not always. Work-hardening manganese suits high-impact duties; harder chrome-irons resist abrasion but can crack under impact. Match the alloy to the dominant wear mode, then re-fit k .

Key takeaways

- Liner life scales inversely with abrasion index: $L = d_{usable}/(kA_i) \times 1000$.
- Calibrate the site constant k from your own liner-change history.
- Feed rock alone can swing liner life 3× or more; plan stock and labour around A_i .
- The cheapest interval is usually just before mechanical wear-out, where total cost per tonne is minimised.
- Forecast by tonnage, verify by profile and power trends, and change before the end-of-life knee.

Topics:

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