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ANGRY VRMs

FLSmidth Cement's Ahmed Seaf looks at why vertical roller mills (VRMs) get 'angry'... and how to calm them down.

Vertical roller mills (VRMs) are the workhorse of modern cement grinding, combining drying, crushing, grinding and classifying in one compact unit. However, anyone who has operated a VRM knows that these mills can sometimes get 'angry.' The whole mill can start to shake, frustrating operators and threatening to halt production. High vibration not only affects plant throughput. It also accelerates component wear and can lead to unplanned shutdowns.

The crucial point to remember is that vibration is usually a symptom of underlying issues, not the root cause itself. To calm an angry VRM, one must identify and address the factors that prevent stable operation. This article explores common causes of VRM vibration in cement plants and provides practical methods for controlling them.

VRM vibrations are usually a symptom of underlying issues, not the root cause. AI-generated image.

Feed and material fluctuations

VRMs need steady flow and consistent grindability to keep the grinding bed balanced. Sudden drops or surges in feed rate, or abrupt changes in material size, moisture, or hardness, disturb this balance. The result is either too little or too much material under the rollers, both of which lead to vibrations.

To prevent this, plants should focus on feed consistency by calibrated weigh feeders and controlled extraction from feed bins. Oversized lumps and wet material must be avoided, while blending raw materials smoothes out property variations. In practice, plants often install feed bins with controlled extraction or use feed control loops to even out short-term fluctuations. The goal is to present the VRM with a consistent diet of material.

Tip: Regularly track feed rate and composition trends. Large swings often align with high vibrations. Uniform material from crushers and reclaimers, and steady introduction of kiln dust or additives, allow the VRM to run smoothly and efficiently.

Thin or thick grinding beds

The grinding bed is the layer of material between the rollers and the table. If it's too thin, the rollers may touch the table directly, creating sudden vibration spikes from metal-on-metal contact. If it's too thick, grinding efficiency drops and the grinding force is absorbed by the bed, leading to inefficient comminution and a high circulating load of unground material. This can cause the mill to 'choke' as the excess material starts to spill over. Inconsistent bed thickness forces the mill to oscillate between these extremes, shaking the structure.

Operators can track stability by monitoring differential pressure (ΔP) and vibration. Low ΔP with rising vibration signals a thinning bed, while high ΔP suggests an overly thick layer or blockages. The goal is to keep the grinding bed at the optimum thickness for the mill design. Practical measures include setting the dam ring height correctly. Too low and the bed starves, too high and material spills over. As rollers and tables wear, adjustments may be needed to maintain the optimum bed depth. Bed sensors or indices from roller positions are helpful tools. Above all, remember: the most critical factor for VRM vibration is bed consistency. A stable layer acts as a shock absorber and keeps the mill running smoothly.

Hydraulic system malfunctions

VRMs rely on hydraulic systems to apply grinding force through the rollers. A common, yet overlooked, source of vibration is a fault in the hydraulic accumulators. These gas-filled components act like suspension shock absorbers, cushioning pressure shocks when the material layer fluctuates. If the nitrogen bladder is damaged or undercharged, the accumulator loses its damping function. Any sudden disturbance, such as a feed surge or a large chunk passing, will transmit a sharp jolt through the hydraulic cylinders into the mill structure, producing repeated vibrations. Typical signs include vibration at the roller load frequency and visible hydraulic pressure spikes during feed changes.

Preventative maintenance is key. Users should regularly check the accumulator pre-charge pressure and bladder condition, and keep records to track performance. Bladders must be refilled or replaced before they fail to maintain reliable damping.

Hydraulic valves and cylinders can also contribute to instability. Sticky or poorly tuned valves may react too aggressively or too slowly to load changes, leading to oscillations in roller pressure. By ensuring valves and pumps are properly maintained and calibrated, operators can keep grinding forces steady.

High wear of rollers or table liner

Grinding surfaces wear unevenly over time. Uneven or excessive wear on the grinding rollers or the table liner can throw the system out of its balance. A roller with one side more worn than the other will

Large or variable size feed will lead to angry VRMs.

not apply pressure uniformly, leading to localised high spots that cause vibration with each rotation. Similarly, a deeply worn table liner will alter material flow, leading to an irregular bed and a 'rumbling' operation.

The solution is straightforward. Monitor wear profiles and plan timely hardfacing or part replacement. Plants should regularly measure wear on rollers and table segments and plan timely hardfacing or replacement before critical limits are reached. Waiting too long not only raises vibration levels but also reduces grinding efficiency. After resurfacing or replacing liners, the original grinding geometry is restored and stability usually returns.

Severe uneven roller wear.

Foreign objects in the feed

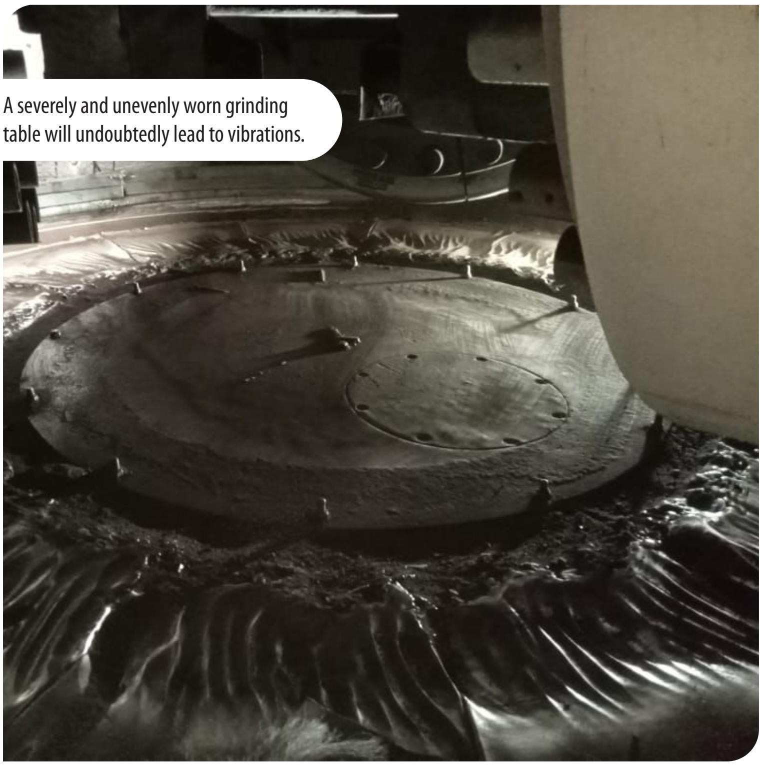
Few things upset a VRM more suddenly than foreign metal entering the mill. These machines are built to grind clinker and raw material, not wrench heads or loader teeth. When a metallic object, such as a bucket tooth, hammer head, or scrap steel, slips into the feed, it won't crush like normal material. Instead, it can get stuck under a roller or bounce across the table, causing violent vibration spikes, hydraulic pressure surges, and sometimes even a loud bang.

Prevention depends on upstream protection. Magnetic separators can capture small ferrous pieces, while metal detectors divert large items before they can reach the mill. If non-magnetic objects bypass these safeguards, vibration monitoring should trip the mill immediately to limit damage. After any unexplained vibration trip, operators should inspect for trapped metal, which is often the cause.

Good practice also includes clearing maintenance tools and hardware before restarting the system. Many plants have stories of bolts or tools left behind, leading to major upsets.

Inconsistent gas flow or poor duct design

VRMs don't just grind material - they also dry and transport it using a stream of hot gas from the kiln or cooler. This airflow enters through the nozzle ring and lifts fine particles toward the separator. If the gas flow is unstable or the ducting is poorly designed, it can upset circulation inside the mill and trigger vibrations.



A severely and unevenly worn grinding table will undoubtedly lead to vibrations.

Duct design plays a key role. Sharp bends, inadequate expansion joints, or poorly sized dampers can transmit or amplify pulsations. Long, narrow duct runs may even resonate with fan surges. Blockages or heavy dust build-up in ducts further distort flow distribution. The consequences appear at the table. One moment too much material is lifted, thinning the bed. The next moment, too little material is lifted, thickening it. This destabilises the mill and drives vibrations. Stable airflow and sound duct design are thus essential. Smooth, consistent gas distribution helps the VRM maintain both grinding efficiency and mechanical stability.

Unbalanced material distribution

Even with a steady feed rate, how material lands on the grinding table is critical. Ideally, feed should fall centrally and spread evenly under all of the rollers. If most of it piles on one side or beneath a single roller, that roller carries extra load while others are underused. The result is asymmetric forces that rotate with the table, producing vibrations, often visible as a once-per-revolution peak in vibration data. Uneven distribution can stem from misaligned or worn feeding chutes and sometimes very short reject chutes.

Prevention involves ensuring central feeding and proper spreading and regularly inspecting for build-up or misalignment. Uneven wear patterns on rollers or table liners are often warning signs. Think of the table like a merry-go-round: balanced loading keeps it stable, but bias to one side makes it shake.

Loose mechanical components

Not all VRM vibration comes from process issues. Sometimes the cause is simple mechanical looseness. These machines rely on stiff structures and tight tolerances. If bolts, joints, or bearings lose integrity, small forces can create large unwanted movements.

A common example is foundation bolts. If grout cracks or bolts lose preload, the mill base can wobble, amplifying vibrations and even cracking welds. Drive train components are another risk: play in a gearbox bearing or motor coupling transmits eccentric forces to the table, producing instability.

The remedy is rigorous inspection. Regular 'bolt torque audits' should cover foundation bolts, gearbox mounts, rocker arm pivots, separator connections and coupling bolts. Any loose parts should be immediately tightened using the correct procedures. Bearings that are near the end of their life should be replaced before failure, as worn bearings often show up as rising vibration trends.

Natural frequency issues

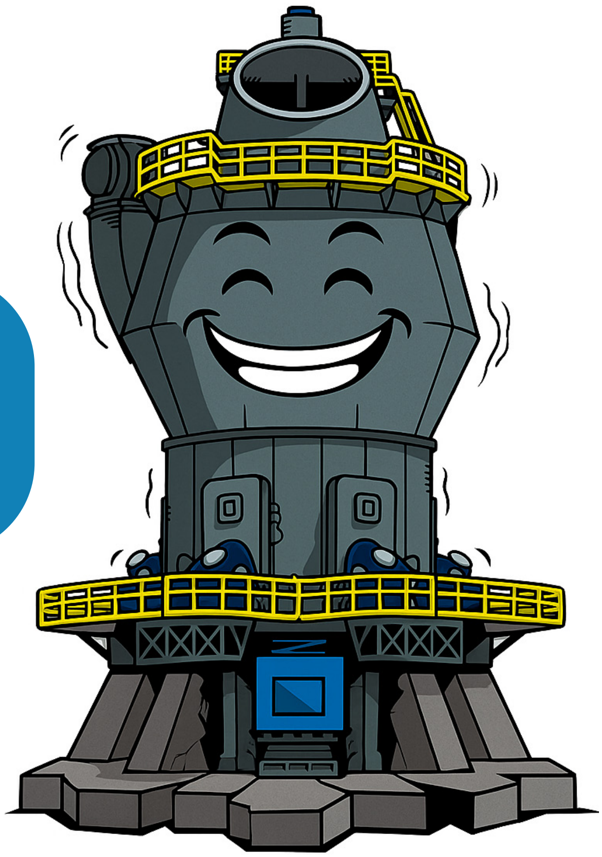
Every structure has natural frequencies where it vibrates most easily. If the forcing frequency of a VRM, such as table rotation, gear mesh, or another cyclic load, aligns with one of these natural frequencies, resonance occurs. Even small periodic forces can then produce large vibration amplitudes.

Resonance problems are less common than process issues, but they can be severe. Symptoms often appear as unexplained vibration peaks at specific loads or speeds. If you suspect resonance - for example vibrations that worsen under certain conditions and that don't correlate with typical operational issues - it's wise to consult a structural dynamics specialist. Addressing resonance typically involves either changing the structural frequency, often by making the structure stiffer to raise the natural frequency, or by adding mass to decrease the natural frequency. When conventional fixes fail, consider resonance. A strong, well-designed support structure is essential for keeping VRMs stable.

Roller skew and misalignment

VRMs rely on rollers being aligned and evenly loaded. If a roller tilts or shifts off-centre, it no longer presses uniformly on the table. One side touches the bed earlier, creating an uneven force that drives vibrations. Misalignment may result from suspension wear, improper reassembly, or movement in support linkages. Over time, the roller assembly can drift from the table centre, producing uneven loading. To prevent this, mills should undergo periodic alignment checks. A common method is to place rollers on the table without hydraulic pressure during shutdown, then rotate the table to measure gaps at multiple points. Consistency indicates proper alignment and discrepancies call for adjustment. Most designs allow shimming or repositioning of roller axles to correct skew.

Balanced hydraulics, even preload across rollers, and inspection of pivot points or torque arms are equally important. Restoring alignment quickly reduces vibration and extends component life. In short, a VRM is happiest when all of its rollers are aligned.



FLSmidth Cement is well versed in the design, installation, commissioning and troubleshooting of VRMs, making them happy once again! AI-generated image.

Concluding remarks

A vertical roller mill is a complex system, and excessive vibration is simply its way of signalling distress. Reducing feed or tweaking speed may quieten alarms briefly, but lasting stability requires finding and correcting the underlying cause.

The approach to calming an 'angry' VRM is holistic. Start with the basics - feed rate, bed depth, pressure settings - and ensure that they are within the optimal range. If vibrations persist, methodically investigate each potential cause:

1. **Operational parameters:** Are we feeding steadily? Is the material too hard or varying too much? Is the grinding pressure matched to the feed?

2. **Process conditions:** Is the material bed of proper thickness? What do ΔP and electrical current values indicate? Is the separator rejecting properly or recirculating overload?

3. **Maintenance factors:** When were the rollers and table last hard-faced? Could uneven wear be the issue? Are the hydraulics dampening shocks as they should?

4. **External influences:** How is the airflow? Have there been any recent changes in ducting or fans? Is the mill structure solid and free of resonance or looseness?

5. **Events:** Did a recent alarm trip indicate something like metal entering the system? Was anything found during the inspection?

Once the root issue is fixed, whether recharging an accumulator, tightening bolts, or realigning rollers, vibration naturally subsides. The lesson is clear: vibration is a symptom, not a disease. With balanced operation, diligent maintenance, and sound design, VRMs will run smoothly and deliver steady output, which should keep both the plant and its operators calm and happy!