

Welcome to ICorr Aberdeen – 2026.

An Evening Technical Event



TOPIC: How Surface Preparation Quality Determines Coating Performance and Why Abrasive Selection is a Decisive Factor

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Aberdeen ICorr Branch - 2026

Advancing Corrosion Science & Engineering

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1. Why Do Coatings Fail

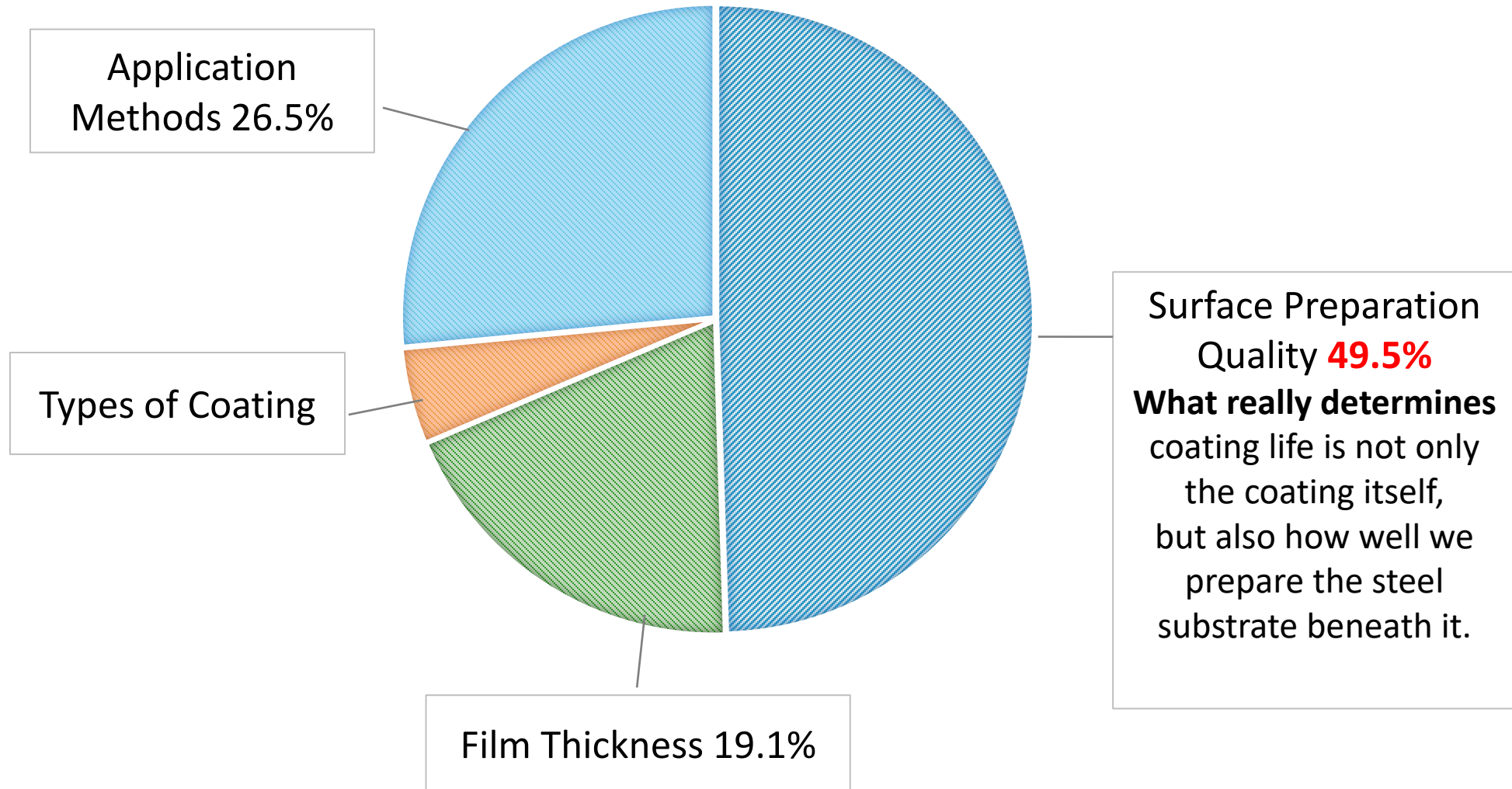
Coating Failure—A Persistent Challenge

- Widespread across marine, infrastructure, and industrial sectors
- Lead to shortened service life, safety risks and cost spikes

Key Factors for Coating Failure

- Despite better coatings and application methods, **nearly 50% of premature failures** are attributed to **insufficient surface preparation**
- Even minor **contaminants** (such as oil, dust, or soluble salts) can **weaken adhesion, accelerate corrosion**, and degrade overall performance
- **Surface preparation**, the often-overlooked foundation of coating systems, decisively impacts long-term durability

Key Factors Affecting Coating Life



Surface Preparation Quality **49.5%**
What really determines coating life is not only the coating itself, but also how well we prepare the steel substrate beneath it.

Insufficient Preparation Undermines the Entire Protection Mechanism

- **Osmotic blistering and electrochemical corrosion** are primary salt-driven causes of interface failure

Four Parameters Define Preparation Quality

- **Cleanliness**
- **Dust level**
- **Roughness**
- **Soluble salt contamination**



Sandblasting as One of the Most Effective Means

- Efficiency hinges on abrasive properties: **hardness, density, shape, and cleanliness**

Abrasive Selection as an Engineering Decision

- Among four commonly used abrasives—aluminum oxide, slag, steel grit/shot, and **garnet**, the last delivers the best balance of **coating durability, safety, and environmental performance**





2. Why Surface Preparation Matters

Residuals on the surface: mill scale, dust, oil, especially soluble salts can undermine the entire protection system.

Especially corrosion, it is the primary cause of systemic failure at the interface, which can lead to delamination, rust, and even structural failure.

If surface preparation quality is insufficient, it will lead to:

- **Lower adhesion** of the coating
- **Faster corrosion**
- Ultimately a **shortened service life**

When coatings fail prematurely due to substrate contamination, you're looking at:

- Warranty claims
- Reblasting and recoating costs
- Lost reputation & Potential litigation



Corrosion does not initiate at
the coating surface, but
“beneath it”



Electrochemical Corrosion

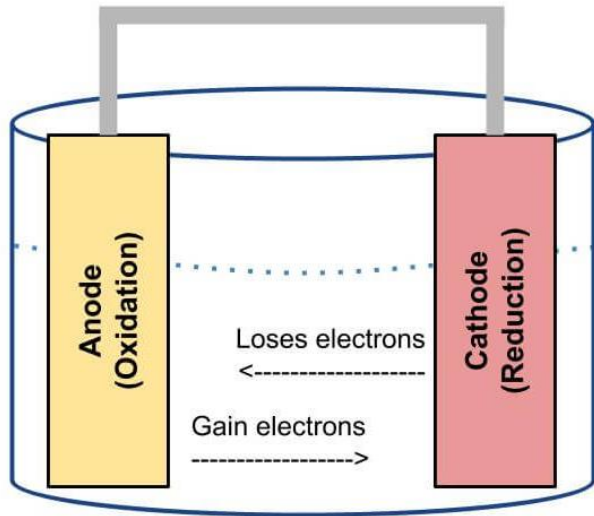


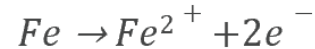
Diagram of an electrochemical cell
(from *Corrosionpedia.com*)

A Chemical Failure

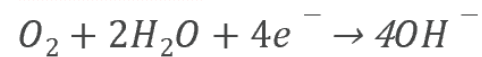
Key Conditions:

- Metal
- Electrolyte
- Oxygen

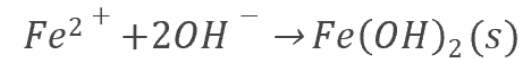
Anodic Reaction:



Cathodic Reaction:

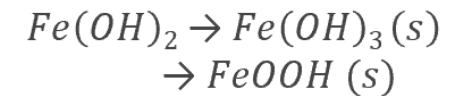


Precipitation Reaction:



The unstable precipitate ferrous hydroxide forms a protective thin film and slows down corrosion

Oxidation of $Fe(OH)_2$:



Dehydration of $Fe(OH)_3$:



Electrochemical Corrosion



Salt-Induced Coating Failure

With Soluble Salts

Soluble salts, such as chlorides and sulfates, accelerate corrosion and create a self-sustaining cycle:

- Cl^- promotes dissolution process
- SO_4^{2-} enhances conductivity

Chloride Ions (Cl^-)

Formation of soluble $FeCl_2$:
 $Fe^{2+} + 2Cl^- \rightarrow FeCl_2$

Oxidation of $FeCl_2$:
 $4FeCl_2 + O_2 + 4HCl \rightarrow 4FeCl_3 + 2H_2O$

Hydrolyzation of $FeCl_3$:
 $FeCl_3 + 3H_2O \rightarrow Fe(OH)_3 (s) + 3HCl$

Cl^- is released and keeps attack the steel

Sulfate Ions (SO_4^{2-})

Formation of Hygroscopic Salt:
 $Fe^{2+} + SO_4^{2-} \rightarrow FeSO_4 \cdot xH_2O$

Oxidation of $FeSO_4$:
 $4FeSO_4 + O_2 + 10H_2O \rightarrow 4Fe(OH)_3 (s) + 4H_2SO_4$

SO_4^{2-} remains in solution and promotes ongoing reactions

Osmotic Blistering

!! Why Does a Million-Dollar Coating Job Fail to a Single Invisible Grain of Salt?

🧐 Why Osmotic Blistering Occurs in Coatings

🔬 Technical Principle Analysis

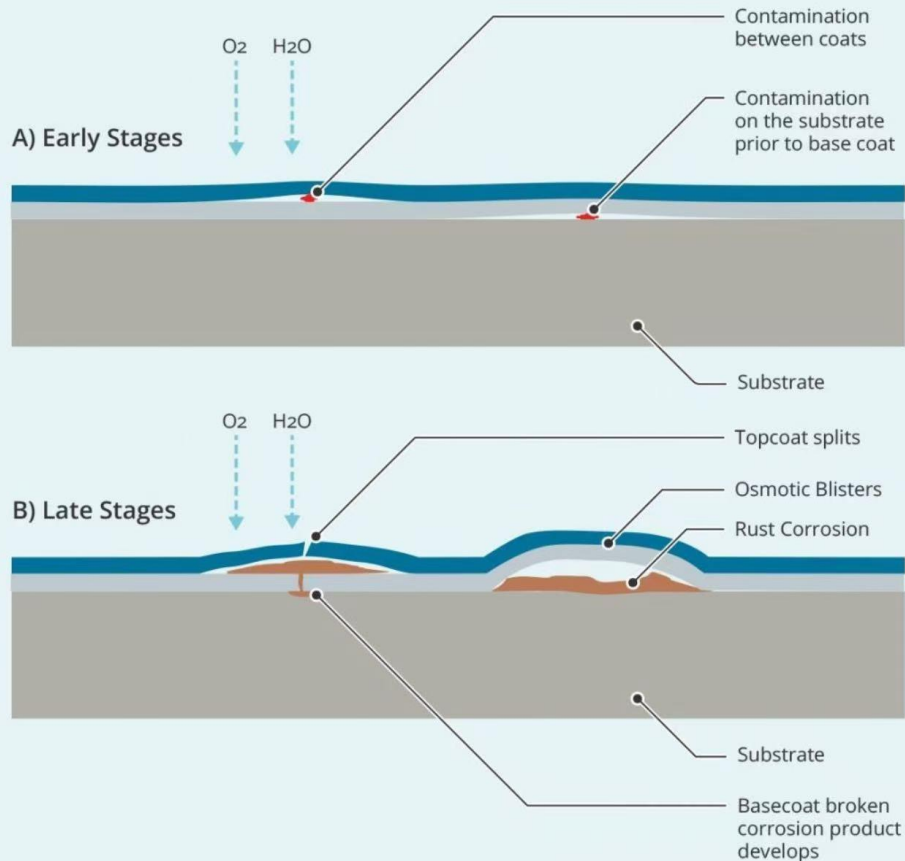
The fundamental cause of osmotic blistering lies in a basic physical-chemical principle—Osmosis. This is a common natural phenomenon, and three core conditions must be met to trigger it:

- ✅ a semi-permeable membrane
- ✅ a concentration difference between solutions on both sides of the membrane
- ✅ the presence of a solvent (water)

These three conditions are perfectly "replicated" in coating systems:

Therefore, the real key to controlling osmotic blistering is not to make the coating "absolutely waterproof" (which is almost impossible in engineering) but to **eliminate the root cause of osmotic pressure water-soluble contaminants under the coating**

Paint blistering delamination, de-adhesion and debonding



Coating / Surface Contaminants / Osmotic Pressure

Soluble salts like **chlorides** (Cl^-) or **sulfates** (SO_4^{2-}) left on the surface can:

- **Accelerate corrosion**
- **Trigger a self-sustaining cycle**



A corrosion loop is formed at the interface

Steel dissolves, acids form, the protective layer breaks down, and corrosion speeds up again

Deeper and faster, until the coatings fail

Soluble Salts are the hidden killers



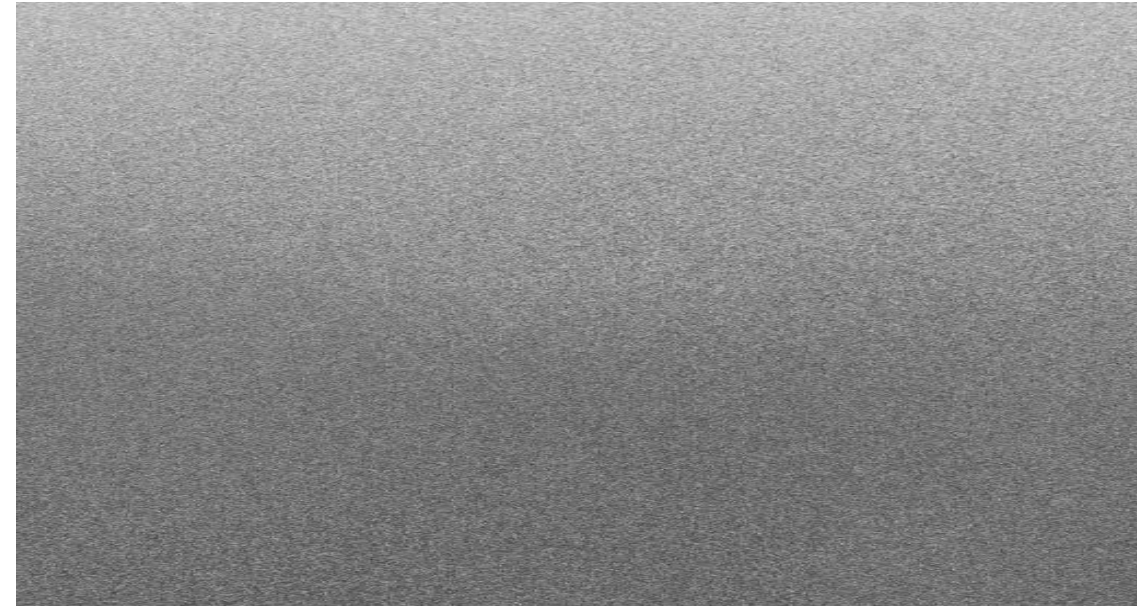


3. Four Parameters Defining a Clean Interface

Four Parameters:

Surface preparation is fundamental, and international standards like ISO define four parameters for optimal adhesion and corrosion resistance:

- Surface Cleanliness
- Dust Level (Residual)
- Surface Profile and Surface Area
- Soluble Salt Contamination



- Cleaning Surface
- Minimal Embedment
- Consistent Profile & High Peak Density
- Low Soluble Salt

Surface Cleanliness

Levels: ISO 8501-1

Sa3 (White Metal Blast Cleaning):

- The highest standard
- Free from visible oil, grease and dirt, and from mill scale, rust, old paint coatings, and foreign matter
- **A uniform metallic color** and **no stains** permitted

Sa2^{1/2} (Near-White Metal Blast Cleaning):

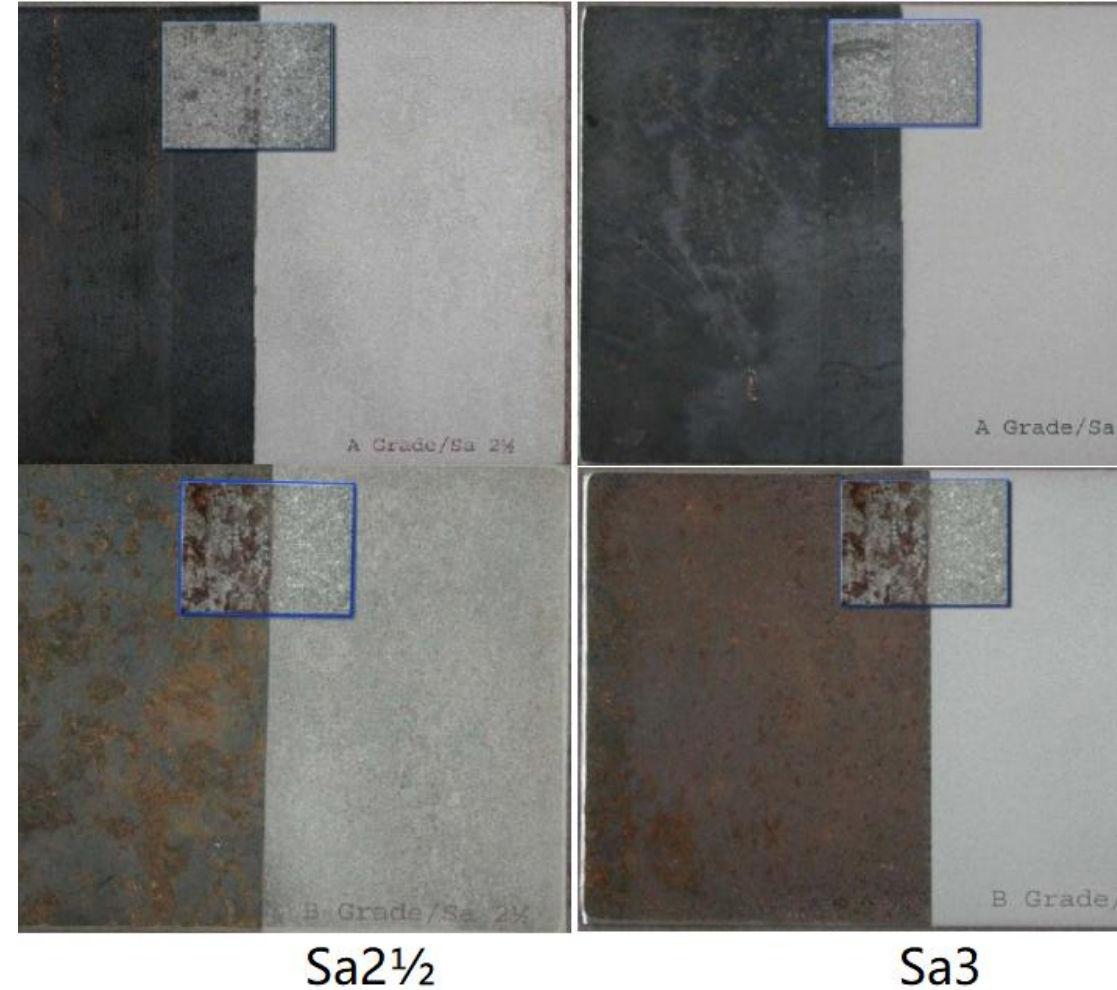
- Free from visible oil, grease and dirt, and from mill scale,

rust, old paint coatings, and foreign matter

- **No more than 5% stains** permitted in the form of spots or strips

Sa2 (Thorough Blast Cleaning):

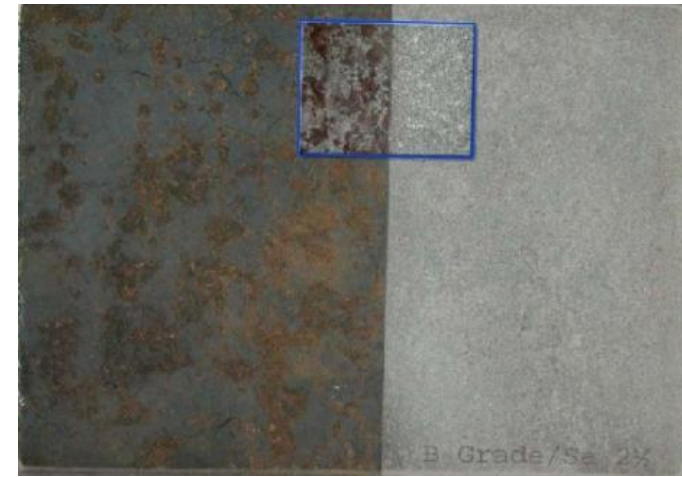
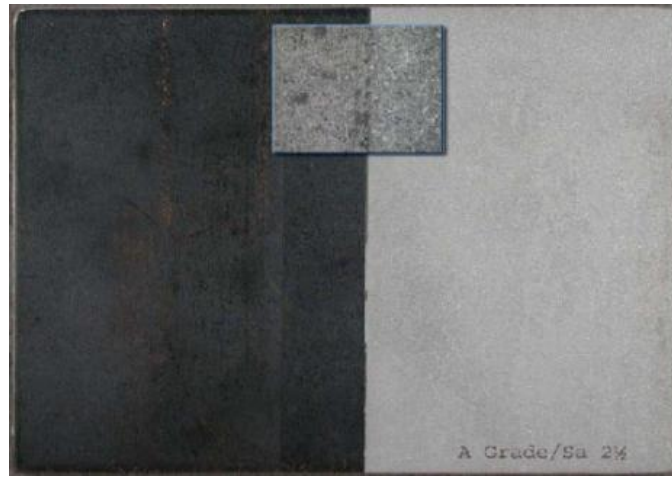
- Free from visible oil, grease and dirt, and from mill scale, rust, old paint coatings, and foreign matter
- **Any residual contamination shall be firmly adhering** and **no more than 33% stains** permitted



Sa2^{1/2}

Sa3

Sa2½



Sa3



The surface of **mill scale** is **Fe₂O₃** (Ferric oxide), the **middle layer** is **Fe₃O₄** (ferroferric oxide), and **FeO** (ferrous oxide) is closest to the metal substrate. Fe₂O₃ is chemically stable, but **FeO is unstable** and easily **hydrolyzes into Ferric hydroxide (FeOH₃)**. The **volume increase causes scale cracking and coating delamination**.

Moreover, **mill scale Fe₂O₃ has a higher electrode potential than steel**. In corrosive environments, it triggers **electrochemical reactions** with steel, leading to serious pitting corrosion.

Dust Level

Classified by Particle Size & Quantity: ISO 8502-3

High dust levels have 2 major problems:

- **Poor coatings adhesion**, potentially leading to blistering, delamination, etc.
- Act as a **carrier for soluble salts**, especially in corrosive environments (ISO C3 and above), which accelerates metal corrosion

Class	Description of dust particles	No.	Figures
0	Particles not visible under $\times 10$ magnification	1	
1	Particles visible under $\times 10$ magnification but not with normal or corrected vision (usually particles less than 50 μm in diameter)		
2	Particles just visible with normal or corrected vision (particles between 50 μm and 100 μm in diameter)	2	
3	Particles clearly visible with normal or corrected vision (particles up to 0.5 mm in diameter)	3	
4	Particles between 0.5 mm and 2.5 mm in diameter	4	
5	Particles larger than 2.5 mm in diameter	5	

Dust Size

Dust Quantity Ratings

Surface Roughness

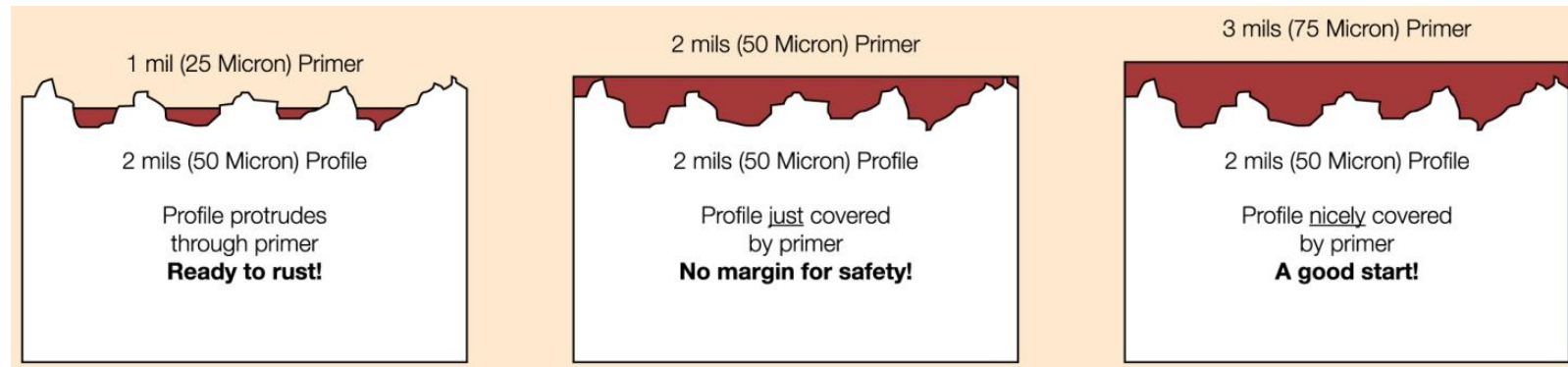
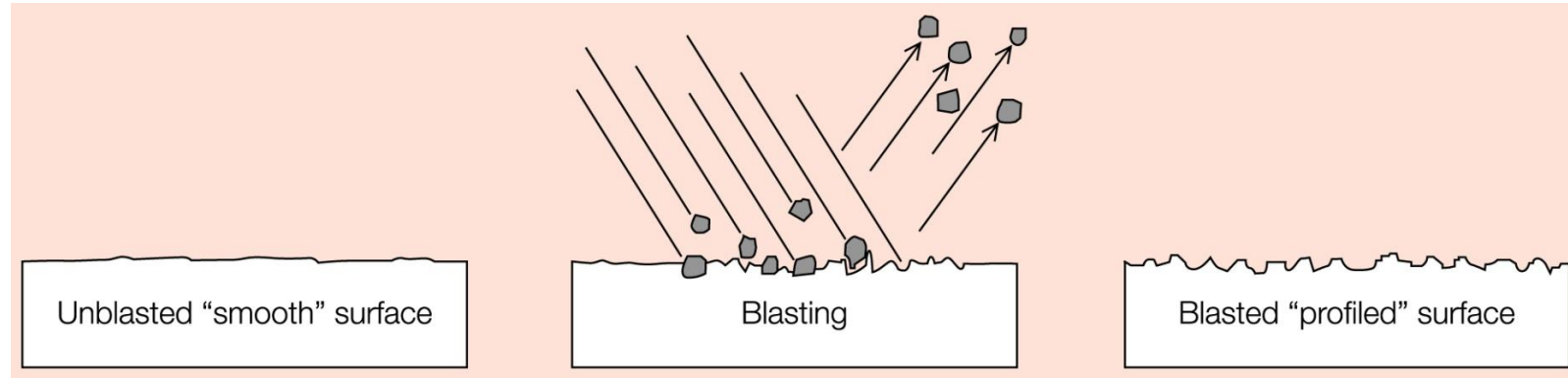
Key to Coating Adhesion: ISO 8503

Properly Engineered Surface Texture:

- **Creates a mechanical anchor** by embedding into valleys and gripping peaks
- **Strengthens molecular adhesion** via 20-60% greater surface area after blasting
- **Restrains film movement** under shrinkage stress, preventing cracks or delamination

Profile Risks:

- **Too smooth** → poor mechanical anchoring
- **Too rough** → thin coating at peaks and moisture trapped in valleys



Surface Roughness

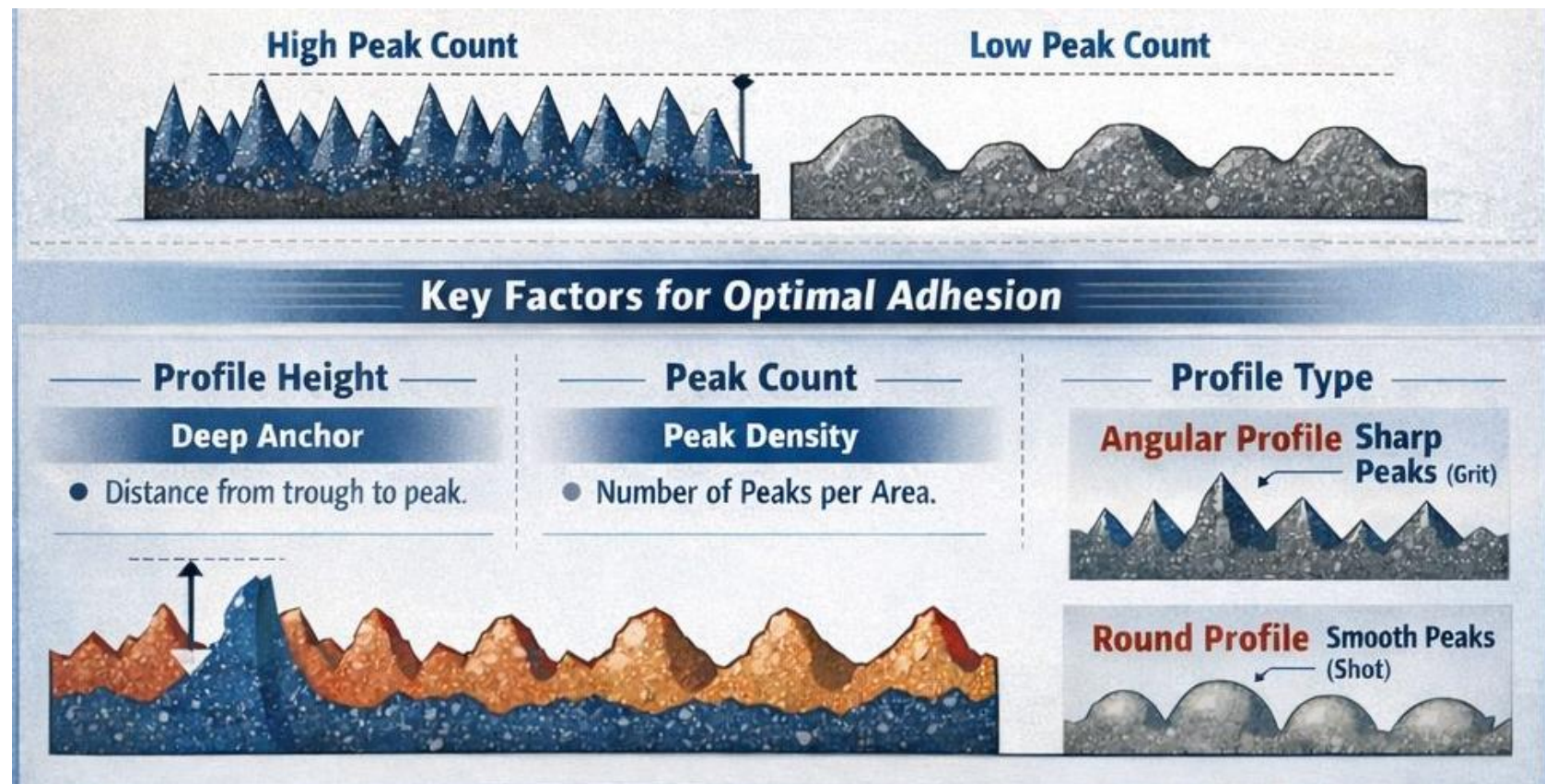
Higher Surface Profile (Depth):

This refers to the distance from the

highest peak to the lowest valley,

which provides

stronger, deeper anchoring for coatings.



Higher Peak Count (Density): A higher number of peaks per linear measurement ensures more interaction points, which, according to studies, often correlates **with better coating adhesion and performance**. In summary, for **maximum adhesive strength**, a **high peak count** is generally superior in **enhancing overall coating performance**.

Optimal Adhesion: The best adhesion often results from a **high peak count** combined with an **appropriate, angular surface profile**.

Soluble Salt Contamination

A Silent Destroyer: ISO 8502-6/9

Definition:

Soluble salts “dissociate in solution into anionic and cationic components (SSPC Technology Guide 15)

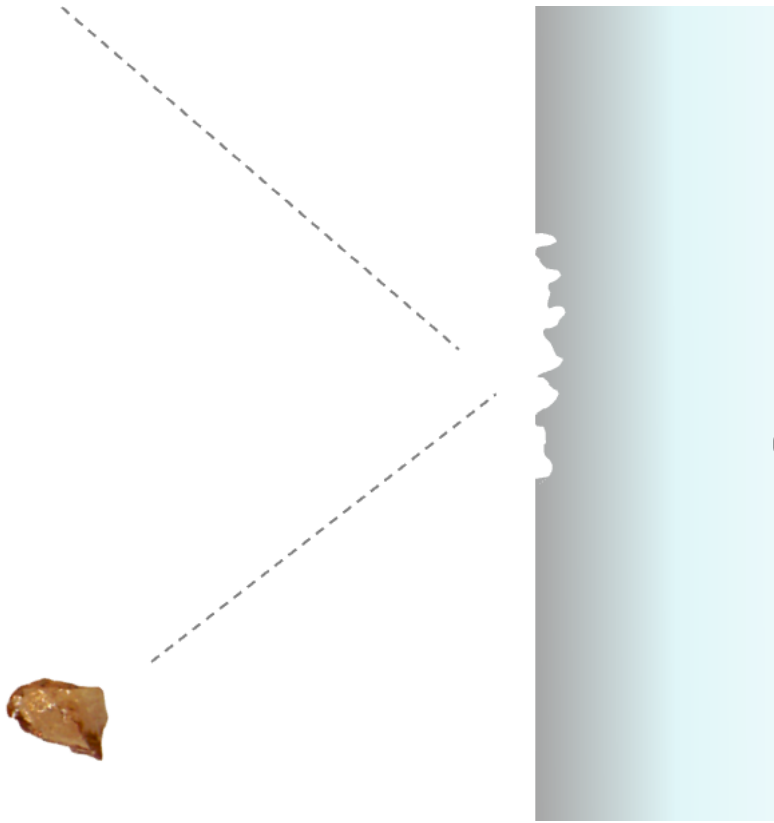
Impact:

- **Catalyst** for osmotic blistering
- **Accelerator** for under-film corrosion

Salt Limits:

Standards like NORSOK M-501 limit salts at **< 20 mg/m²** for demanding environments





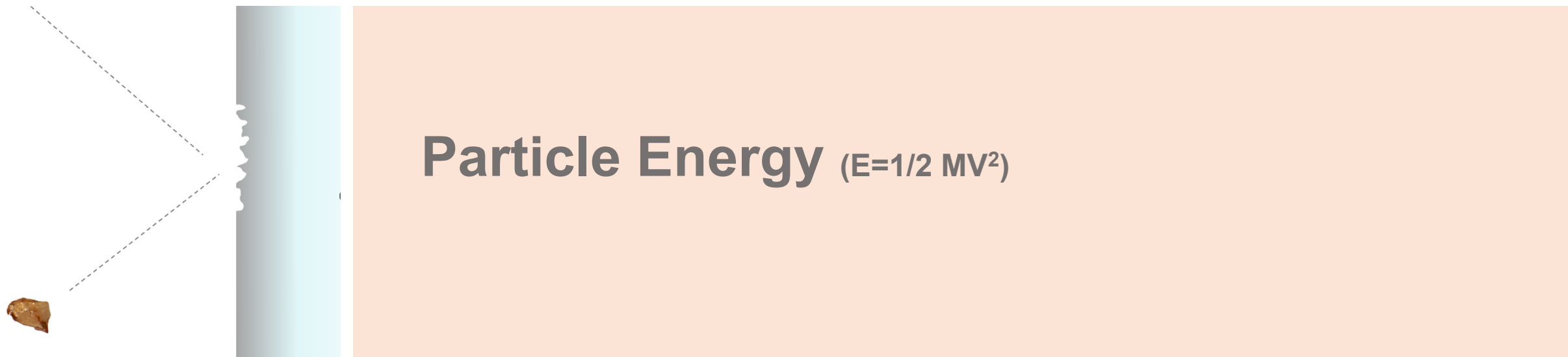
4. Abrasive Blasting as the Main Control Tool

What Is Abrasive Blasting?

Core Mechanics

Widely regarded as **one of the most efficient surface preparation methods** for coatings:

A controlled kinetic impact process: each particle carries energy to remove both visible and invisible contaminants, while creating the required surface profile



REASONS for BLAST CLEANING?

- Remove contamination (clean the surface)
- Accept a paint coating (help it bond)
- Increase surface area for greater coating life (help it last)

Four Key Abrasive Traits for Blasting Performance:

- Hardness - Cutting power
- Density – Kinetic energy
- Shape - Cleaning efficiency & surface profile
- Cleanliness - Contaminant embedment risk



Economic Efficiency & Overall Cost :

- Applicable Material Surfaces
- Recyclable & Overall Cost

Economics of blasting



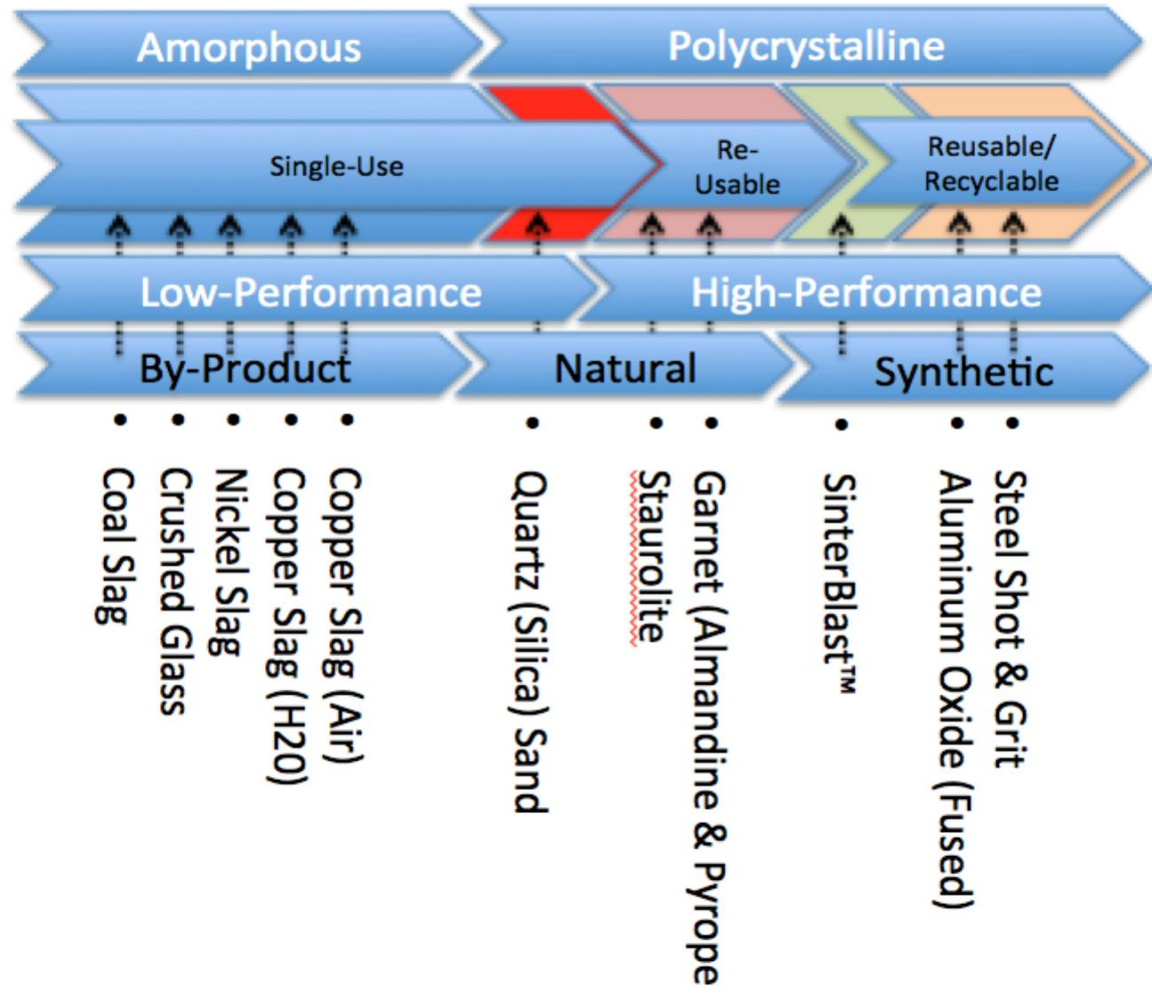
What's important \$/ tonne
or \$/ m²

The difference between
the axe and the chainsaw:

Axe is much cheaper per
unit – but obviously the
chainsaw is much cheaper
per tree cut down

5. Abrasive Selection as an Engineering Decision

Polycrystalline Continuum



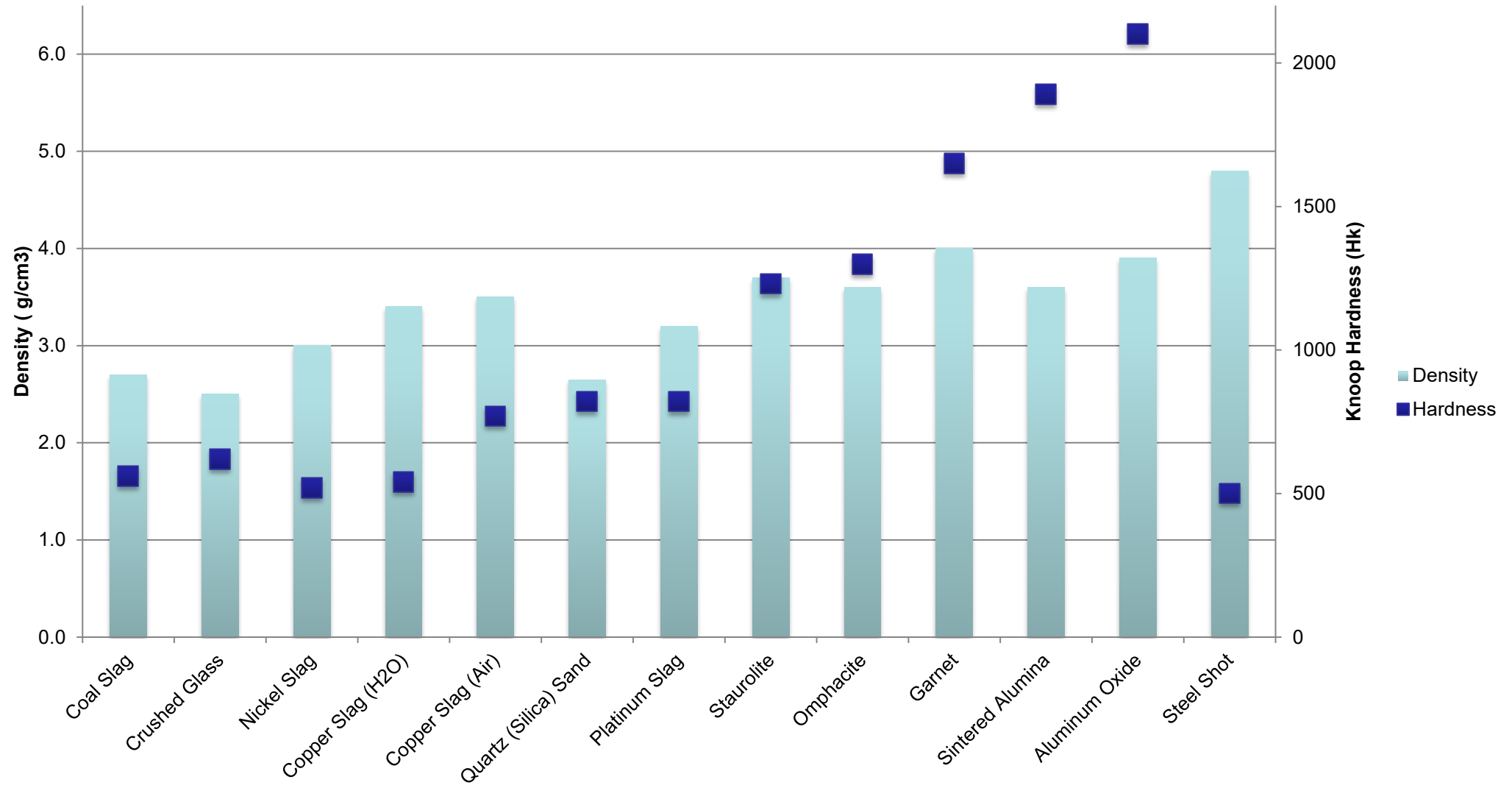
Density v Hardness

Type	Density	Hardness	Structure	Relative Density	Relative Hardness
Coal Slag	2.7	560	Amorphous	67.5%	33.9%
Crushed Glass	2.5	620	Amorphous	62.5%	37.6%
Nickel Slag	3.0	520	Amorphous	75.0%	31.5%
Copper Slag (H2O)	3.4	540	Amorphous	85.0%	32.7%
Copper Slag (Air)	3.5	769	Amorphous	87.5%	46.6%
Quartz (Silica) Sand	2.7	820	Polycrystalline	66.3%	49.7%
Platinum Slag	3.2	820	Amorphous	80.0%	49.7%
Staurolite	3.7	1230	Polycrystalline	92.5%	74.5%
Omphacite	3.6	1298	Polycrystalline	90.0%	78.7%
Garnet	4.0	1650	Polycrystalline	100.0%	100.0%
Sintered Alumina	3.6	1890	Polycrystalline	90.0%	114.5%
Aluminum Oxide	3.9	2100	Polycrystalline	97.5%	127.3%
Steel Shot	4.8	500	Polycrystalline	120.0%	30.3%

Density: ASTM D792

Hardness: ASTM E384

Density v Hardness



Comparison of Garnet vs. Aluminum Oxide



Dimension	Garnet (Such as OneGarnet & JadeCut)	Aluminum Oxide /Brown Fused Alumina
Origin	Mined and Produced, A natural non-metallic mineral; It is a variety of ruby.	A synthetic Abrasive ; produced via fusion reduction of bauxite, carbon, and iron filings in electric arc furnaces.
Main Composition	Silicate mineral. Ie. OneGarnet: Al ₂ O ₃ (20.88%), Fe ₂ O ₃ (34.58%), etc.	Synthetic; Al ₂ O ₃ (94%–97%) , Fe ₂ O ₃ , SiO ₂ , TiO ₂
Hardness	Mohs 7–8 (OneGarnet : 7.8). Moderate hardness; gentle and uniform cutting force. Can be recycled 4 to 5 times.	Mohs 9. High hardness; aggressive and powerful cutting force. Can be recycled 4 to 5 times.
Particle Shape	Natural crystals crushed to size as regularly rounded polyhedrons; low embedment risk, minimal dust , and rapid settling. Consistent Profile, No Rework Required.	(High-temp smelting, Crushing leads to) Sharp angular grains, on the other hand its particles with cracks , needle like (acicular) shape, concentrated force but prone to leaving fine residues in workpiece pores. High Level of Embedment.
Environmental	No free silica. Meeting OSHA/CE standards; low-harm dust; eco-friendly landfill disposal.	Contains trace free silica; fine dust risk (Silicosis); requires strict PPE & regulated waste disposal to avoid environmental pollution.
Material Compatibility	Iron-free; ideal for surface treatment of stainless steel, aluminum alloys and carbon steel.	Requiring iron filings to reduce SiO ₂ /TiO ₂ and carbon to reduce Fe ₂ O ₃ during smelting. High iron content is used to boost Al ₂ O ₃ purity. The reduced metallic impurities and iron form a dense ferrosilicon alloy, which settles to the furnace bottom for separation. Due to the ban on pickling , magnetic separation is used but cannot fully remove intergrown iron. This leads to rust spots and pitting corrosion .
Applications	Used for blasting, waterjet cutting, and precision grinding. Ideal for surface profiles ≤115µm.	Primarily for high-grade refractories, grinding materials, and resin molds. Used for surface profiles >115µm.
Cost and Market	Natural mineral with low production cost; Less Cost; accessible market pricing.	High cost due to complex smelting/cooling/crushing and etc. As China produces >70% of global BFA, high anti-dumping duties in US/EU further escalate local prices. 4 to 6 times the price of Garnet.

Comparison of Garnet vs. Slag Abrasives



Garnet(Such as OneGarnet & JadeCut)



Waste Slag(i.e. Copper, Coal, Nickel)

Dimension		
Origin	Mined and Produced, Natural non-metallic mineral; It is a variety of ruby.	Smelting by-products ; processed from crushed industrial waste.
Hardness	Mohs 7–8 (OneGarnet: 7.8). Moderate hardness ensures rapid cleaning with minimal consumption.	Low Hardness (Mohs <6.5). Sluggish cleaning speed; high consumption rate.
Particle Shape	Natural crystals crushed to size as regularly rounded polyhedrons; low embedment risk, minimal dust , and rapid settling. Can be recycled 4 to 5 times.	Predominantly needle or horn-like structure (acicular) and flaky grains; non-ideal equiaxed or angular morphology . Irregular shape resulting in weak cutting force and dispersed impact, easily breakage ; facilitates particle "squeeze-in" lead surface embedment . Entrapment of low-hardness impurities (e.g., silicon oxide, iron oxide powders) during the blasting process . Embedment-induced loss of coating adhesion and electrochemical corrosion ; significantly shorten coating service life. Highly Friable, High Dust, Cannot be recycled.
Environmental	Natural mineral; premium grade with zero radioactivity. Free of heavy metals, hazardous substances, and free silica; fully OSHA and CE compliant. Minimal respiratory health risk; waste eligible for direct landfilling with zero environmental liability.	Contains Arsenic, Beryllium, Vanadium, Cu, Pb, Zn, Cr, and Cd hazardous ; high bioaccumulation risk via inhalation, dermal contact, or food chain enrichment . Chronic multi-system toxicity triggered by long-term organ sequestration and metabolic resistance . Severe ecological degradation of soil and groundwater; persistent health threats via food chain and potable water contamination . Legally banned in numerous jurisdictions .
Cost and Market	OneGarnet : Higher unit price vs. slag; superior Total Cost of Ownership (TCO). JadeCut : Significantly higher cost-efficiency ; the definitive next-gen upgrade for slag abrasives.	Lower unit price vs. Garnet; inferior Total Cost of Ownership (TCO)

Comparison of Garnet vs. Steel Grit / Steel Shot



Garnet(Such as OneGarnet & JadeCut)



Steel Grit / Steel Shot

Dimension	Garnet(Such as OneGarnet & JadeCut)	Steel Grit / Steel Shot
Origin	Mined and Produced, Natural non-metallic mineral ; It is a variety of ruby.	Metallic Steel as Raw material via melting → centrifugal shot peening / water atomization granulation → heat treatment to increase hardness and toughness → rounding → roller crushing → screening and classification
Surface cleanliness	Sa3	Sa2~Sa2½ (ref. ISO8501-1) Brand new fine-grade steel grit and steel shot are used to blast low-corrosion grade carbon steel substrates, and the initial treatment can achieve a cleanliness grade of Sa3.
soluble salt	A maximum of 20 mg/m² (ref. ISO 8502-6/9), meeting the requirements of standards such as NORSOK M-501 . It is particularly suitable for severe corrosion environments including CX and Im4 as defined in ISO 12944-2, and can fulfill the demand for long-term corrosion protection in such environments.	This is extremely difficult to control , as steel grit and steel shot are recycled. When impacting the surface of the workpiece, they are contaminated by salts present on the surface, leading to an increase in their salt content.
Environmental	Lower cost and applicable to indoor & outdoor applications. Can be recycled 4 to 5 times. Low Dust	Due to its high cost and splash when blasting or shooting, it can usually only be used in a blast room , making it difficult to recover when used outdoors. Can be recycled 25 to 30 times. Low on initial blast, Possibility of high dusting after recycling
Material Compatibility	Suitable for the blasting treatment of stainless steel and non-ferrous metals.	Only used for carbon steel. Shall not be used for the blasting treatment of stainless steel and non-ferrous metals.
Secondary anti-corrosion	Suitable for new and coated or secondary anti-corrosion blasting operations.	It is difficult to apply in coated or secondary anti-corrosion blasting operations, because the surface of the workpiece to be treated may contain oil contaminants, which will cause pollution to the steel grit and steel shot.
Cost and Market	Lower priced than steel grit and steel shot, but its abrasive consumption cost is higher due to fewer recycling cycles.	Higher priced than garnet, but with low abrasive consumption cost due to more recycling cycles.

Are all Garnets the same?

Comparison of **OneGarnet**[®] vs. Alluvial (Beach) Garnet

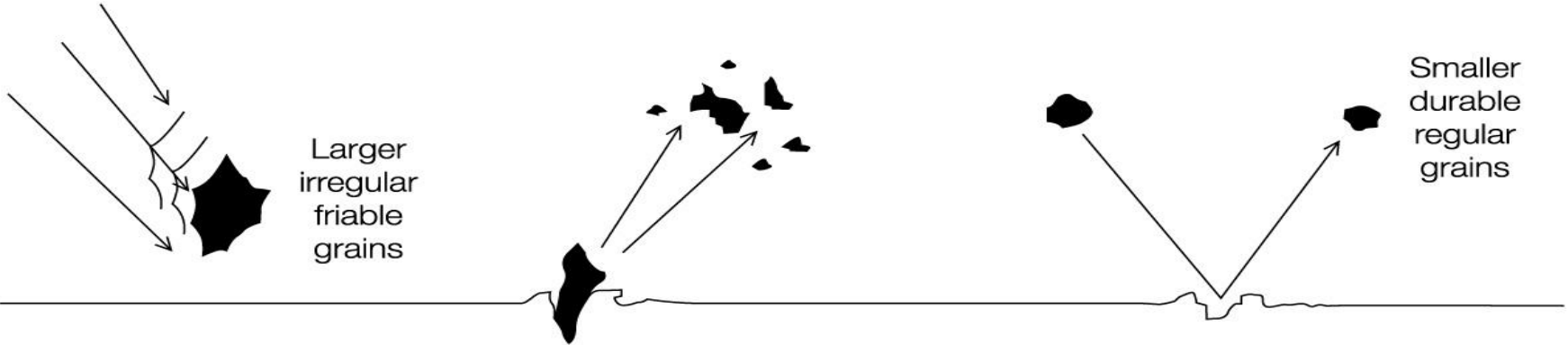
Dimension	OneGarnet & JadeCut	Alluvial (Beach) Garnet
Origin	<p>Unique Characteristics Mined and Produced, Almandine Hard Rock-sourced; precision-crushed via multi-stage processing to ensure regular sharp, angular edges with superior cutting force to improve production rate. Faster blasting throughput with less abrasive consumption per unit area. Lower disposal and clean-up costs Ideal for removing thick coatings and easily producing deeper surface profiles. Higher Surface Profile (Depth), which provides stronger, deeper anchoring for coatings.</p>	<p>Alluvial beach-sourced; water-worn "pebble-like" grains with poor cutting force. Low blasting productivity and high abrasive consumption per unit area.</p>
Soluble Salt	<p>Mined from veins below the Earth's surface. OneGarnet and JadeCut: Post-blasting surface Extremely Low Soluble Salts <20mg/m² per ISO 8502-6/9</p>	<p>High concentrations of chlorides and sulfates; surface soluble salts rarely achieve the threshold post-blasting</p>
Environmental	<p>Natural mineral; zero radioactivity, heavy-metal free, and negligible free silica. Fully compliant with international environmental standards, including OSHA (US) and CE (EU).</p>	<p>Alluvial (Beach) Garnet: Potential NORM (Natural occurring radioactivity materials) risk (Monazite content); inconsistent control over free silica levels.</p>
Cost & Market	<p>Superior cost-performance ratio (TCO) compared to Alluvial (Beach) Garnet; Less Price, Unique JadeCut, 30~50% cost reduction</p>	<p>Inferior cost-performance ratio (TCO) relative to OneGarnet</p>

EMBEDMENT

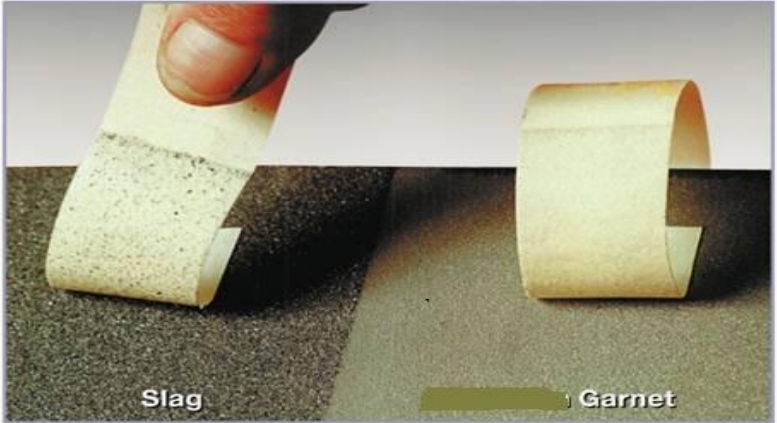
Slag

Garnet

Low **D**UST
Non Toxic



- Blasting with slag products leaves a black microscopic dust that cannot be removed with air
- OneGarnet leaves a white metal surface meeting all Occupational Health and Safety requirements
- Test :Tape copper slag surface to show embedment's!



Embedment – Embedment of abrasive particles in the surface is a threat posed by friable, irregular shape abrasives. The embedded particle or fragment can stand out as a ‘rogue’ peak above the surrounding profile and may protrude through the applied coating.

Slag



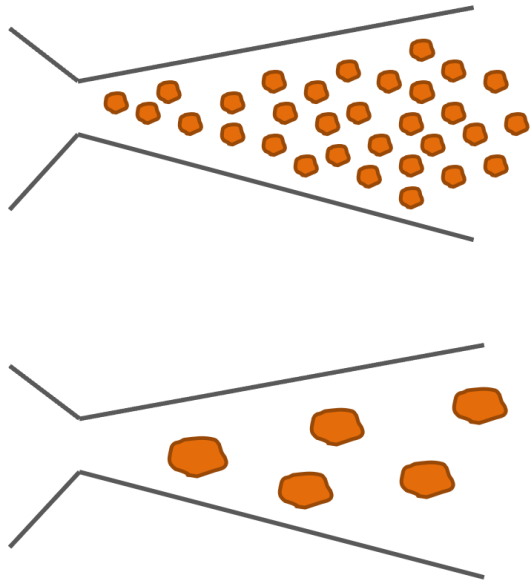
OneGarnet



“Big is not Best”?

WHY are finer abrasives better?

Particle Acceleration



Smaller surface area of finer abrasives means that the individual particles accelerate much faster than larger surface area particles.

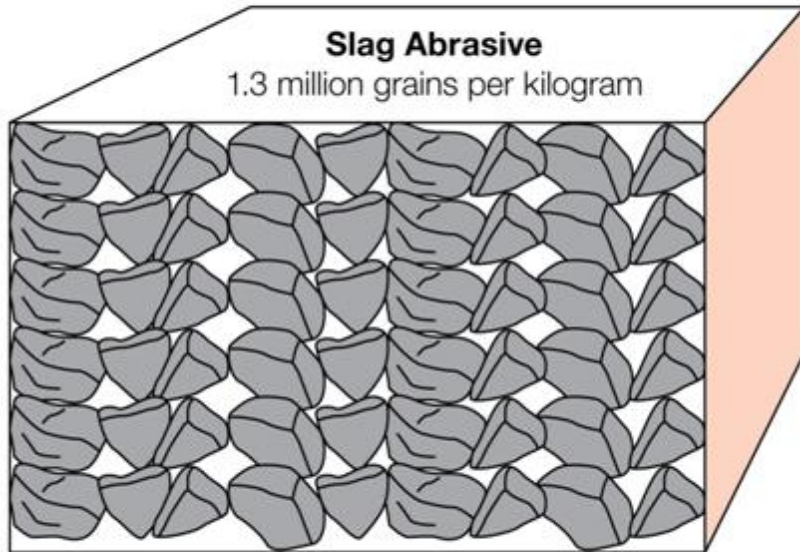
The abrasives hit the surface with an Abrasive Velocity of 675 kph at 100psi at the nozzle.

- Smaller particles accelerate better – higher ratio of surface area to mass
- Higher speed of particle is better than higher mass (Energy = $1/2 mv^2$)
- There are more impacts on the surface per kilogramme – use less kilograms and get more hits
- Clean out rust pits

WHY are finer abrasives better?



Each piece of slag carries energy for cleaning!



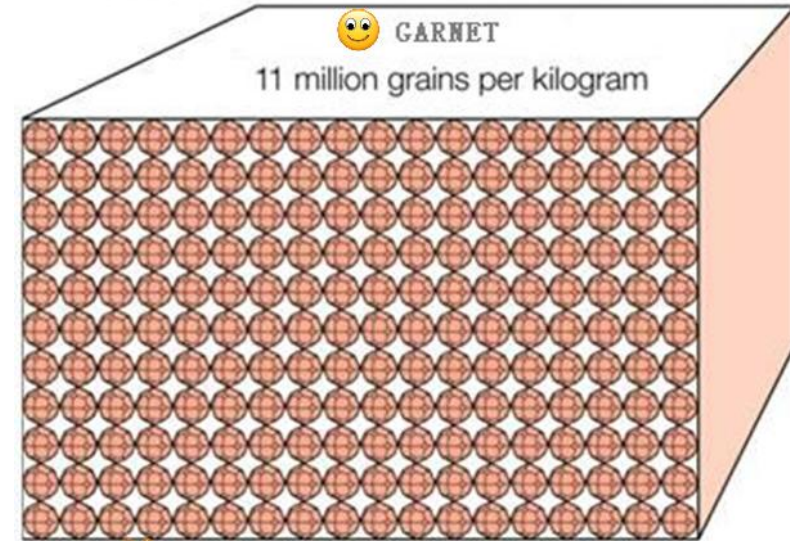
Slag Abrasive

1.3 million grains per kilogram

Slag means you have to open the valves up more to let it through and use more slag each hour.



Each grain of garnet carries energy for cleaning!



😊 **GARNET**

11 million grains per kilogram

👉 **garnet** is proven world-wide to be just the right size mix to clean off the heavy rust and to also clean out the deepest pits.

Cost-Effective Blast Cleaning

Using the formula.....

$$\text{True Cost of Blast Cleaning} = \frac{\text{Consumption (lbs/ hr) [abrasive cost + disposal cost] + labour + equipment, etc}}{\text{Cleaning Speed (sq ft /hr)}}$$

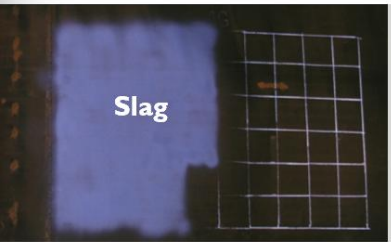


Garnet

10 minutes
165lb (75kg) used
60 sq ft cleaned

Consumption = $\frac{165}{10} = 990 \text{ lbs/hr}$
(0.45 tonnes/hr)

Cleaning Speed = $\frac{60}{10} = 360 \text{ sq ft/hr}$

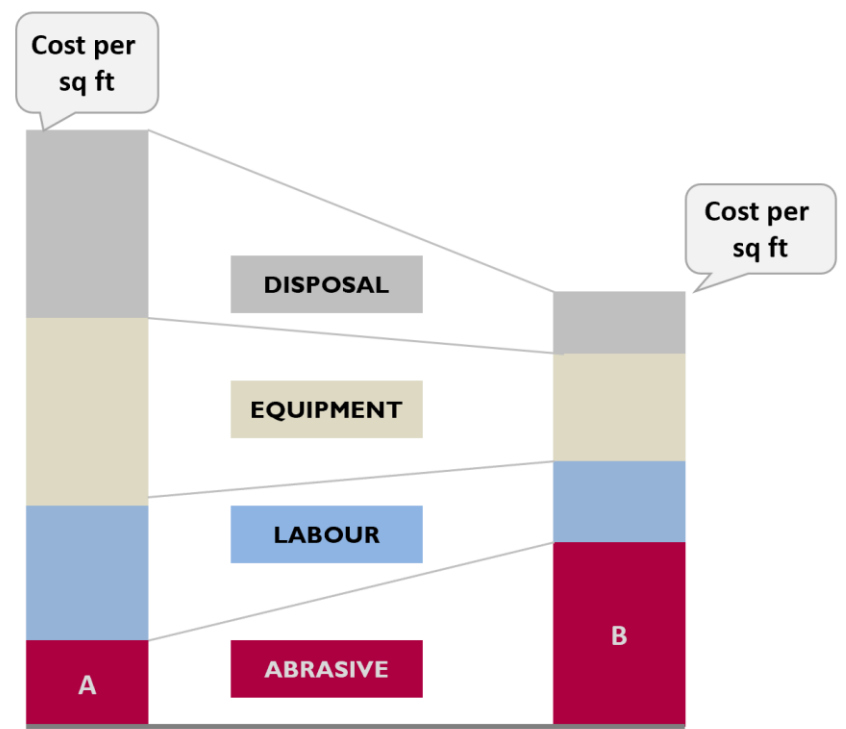


Slag

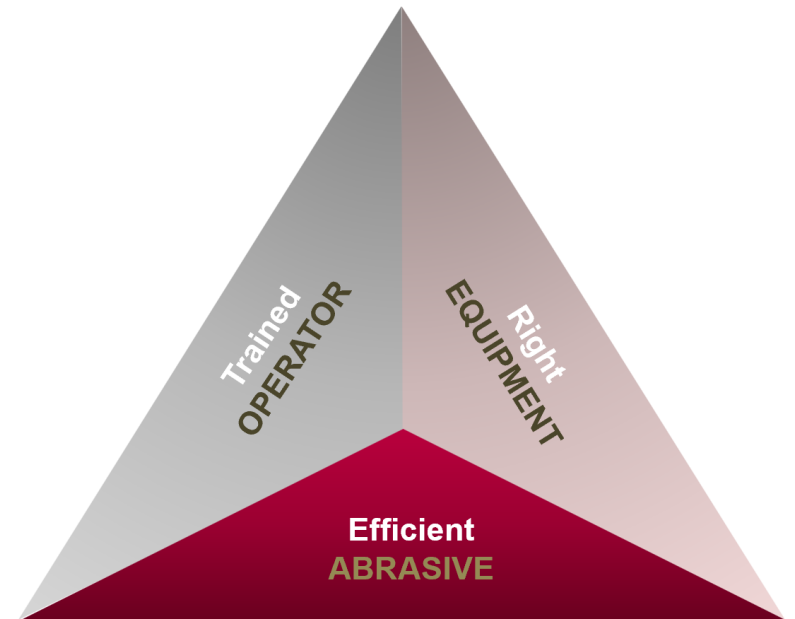
10 minutes
285lb (130kg) used
28 sq ft cleaned

Consumption = $\frac{285}{10} = 1710 \text{ lbs/hr}$
(0.75 tonnes/hr)

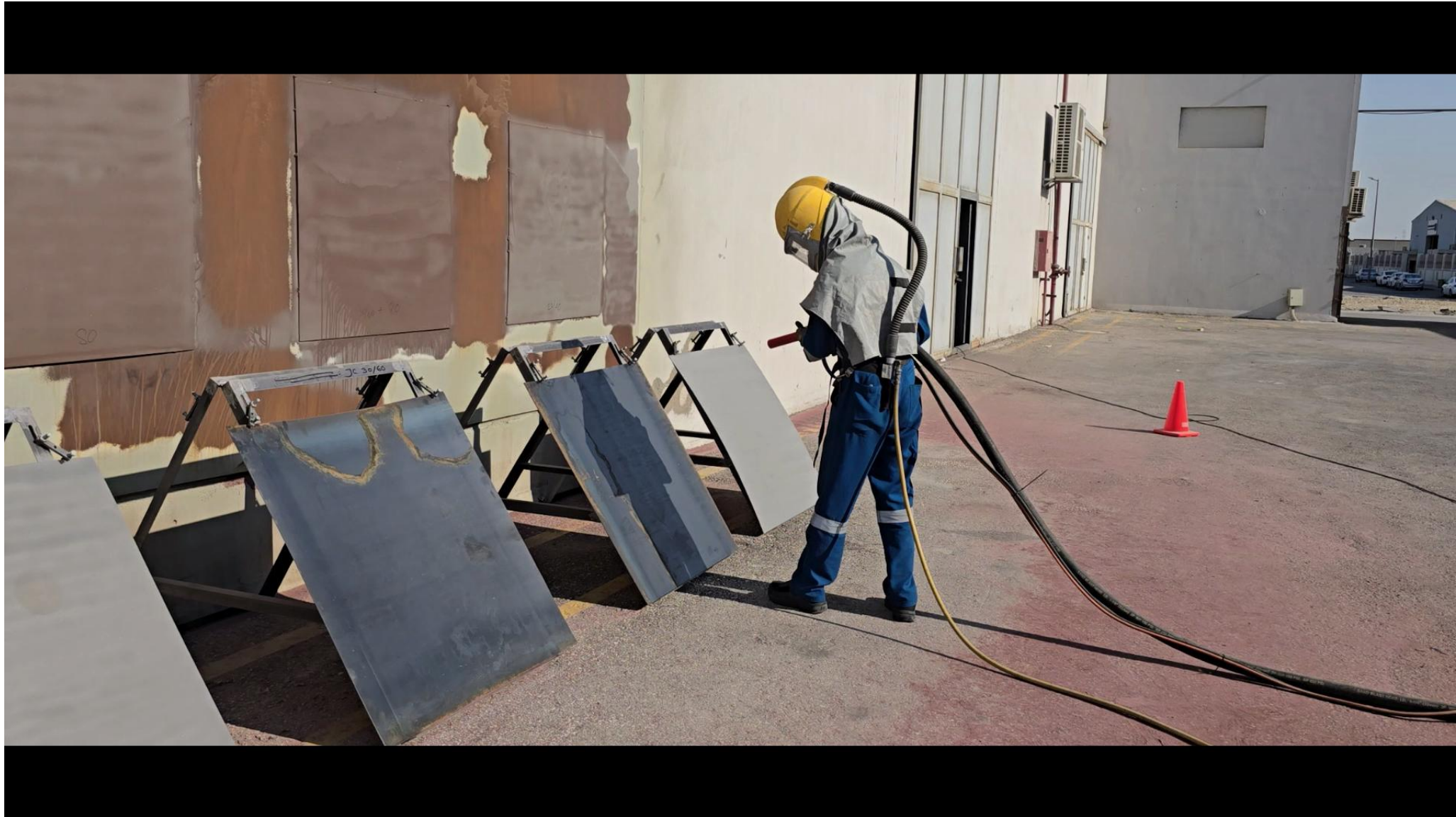
Cleaning Speed = $\frac{28}{10} = 168 \text{ sqft/hr}$



- ▶ Not all garnets are the same
- ▶ Bigger is not Better
- ▶ Cleaner surface
- ▶ Faster cleaning rate
- ▶ Lower cost p/m²
- ▶ A higher p/mt price can be cheaper p/m²
- ▶ Cost p/m² is more important than cost p/mt



OneGarnet Sandblasting Video



Hard Rock **OneGarnet** & **JadeCut** Offers A Better Performance, Productivity & Consumption:

- Cleanliness: **Sa3**
- Dust: ISO **Level 1**
- Controlled roughness: 25-115 μm
- Conductivity: **<80 $\mu\text{S}/\text{cm}$**
Soluble salt levels: **<20 mg/m^2**
- **Faster** blasting
- **Less** consumption



Hard Rock **OneGarnet** & **JadeCut** : Safer, Eco-Friendly & Economical

An Engineering Decision


Operational Safety & Environmental Protection

- No radioactivity
- No heavy metals & other harmful substances
- Reduced dust generation
- Inert mineral with ultra-low free silica content ($\leq 0.5\%$)
- Low chloride content (< 3 ppm)
- Recyclable to reduce disposal challenges



When coating longevity matters, **abrasive and surface cleanliness isn't Negotiable.**





Abrasive selection is not just a procurement choice. It is an **engineering decision** to deliver a **better** surface preparation and shape coating performance, productivity, safety, environmental impact and overall cost.

Cost Savings through Asset Protection



At OneGarnet Group, We Build to
Lead & Deliver Peak Performance with Optimal Value.

Thank you for your kind attention.
Looking forward to building durable, sustainability, reliable
corrosion protection together with you and driving the industry
forward.

Advancing Corrosion Science & Engineering



Thank You