Surface preparation

New building

Introduction

This guideline presents a survey of key elements relevant for surface preparation in a new building situation.

The guideline is not intended to give a complete description of all surface preparation methods used in the industry. For more detailed information, consult the actual standards behind the described methods whenever these are available.

Content

The guideline covers these topics:

Purpose of surface preparation

A proper surface preparation is essential for ensuring that applied paint achieves its optimal performance regarding adhesion and anticorrosive properties.

Typically, the surface preparation requirements are divided in two major categories. Requirements to the cleanliness of the surface and requirements to the roughness profile of the surface.

The cleanliness and roughness profile for a paint system should be as prescribed for the primer of the paint system.

Cleanliness

The general requirements to cleanliness are:

- Low salt level. High salt contamination can result in paint blisters and promote corrosion.
- No oil and grease. Oil and grease can cause delamination/ flaking of the paint layer applied.
- Free of dust. Dust can result in loss of adhesion.
- Free of rust or other corrosion products. Rust gives poor adhesion and can result in blistering.
- Free of mill scale: Mill scale can cause galvanic corrosion and poor adhesion.

Roughness profile

The purpose of ensuring an adequate roughness profile is to secure the necessary anchor profile for optimal adhesion.

The principle of roughness profile is shown in illustration 1 below. The recommendation for roughness profile in Hempel's Product Data Sheets will typically refer to the Rz value. Rz is the average of five maximum peaks and five maximum depths within the same sampling length.

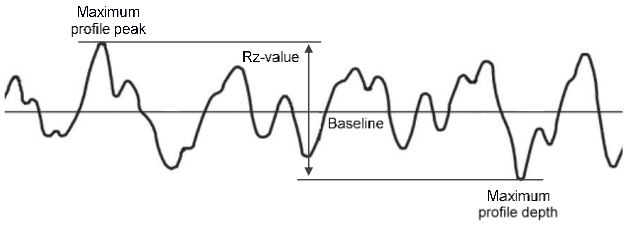


Illustration 1. The roughness profile as described by the Rz-value.

The roughness profile is rated according to the Grit or Shot comparator as defined in the requirements of the paint specification. Please find more information on roughness in ISO 8503-2:2000. An overview of the primary roughness grades is shown in Table 1.

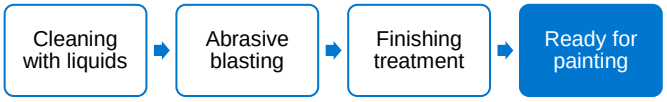
Roughness profile	Rz (µm) Grit comparator	Rz (µm) Shot comparator
Finer than fine	< 20	< 20
Fine	20 - < 50	20 - < 40
Medium	50 - < 90	40 - < 80
Coarse	90 - < 130	80 - < 110
Coarser than coarse	> 130	> 110

Table 1. Roughness grades according to ISO 8503-2:2000.

Surface preparation process

ISO 12944-4:2017 gives an overview of the main surface preparation methods relevant for protective paints.

For new building the most common process is a three-step processed based on abrasive blasting as shown below:



The purpose of each of the three step is to, respectively:
- Remove oil, grease, soluble salts and debris.
- Remove rust, mill scale and to create roughness.
- Remove debris, dust and other remains from the mechanical treatment.

Cleaning with liquids

Water cleaning
Water cleaning is utilising the cleaning effect of pressurised hot or cold water. The pressure should be minimum 7-10 bar. The cleaning process will become faster and more efficient with increasing pressure.

Depending on pressure, the method can both be used for cleaning of already coated surfaces and for removal of loose adhering paint. According to ISO 8501-4:2006, water cleaning above 700 bar is called High Pressure Water Jetting (HPWJ). At these pressures, paint with good adhesion (sound intact paint) is also removed.

The cleaning effect of pressurised water can be enhanced by adding suitable detergents to the water and by heating. If using detergent, the surface must be rinsed with clean, fresh water. The method will remove oil and grease, soluble salts, dust and loose paint.

Steam cleaning
Steam may be used instead of water. This is particularly suited for very greasy surfaces.

Emulsion cleaning
The emulsion is sprayed directly on the surface. After a certain reaction time, the emulsion/dirt is rinsed off with clean fresh water. The method will remove oil, grease and soluble salts.

Alkaline cleaning
The alkaline cleaner is sprayed directly on the surface. After a certain reaction time, the cleaner is rinsed off with clean fresh water. The method will remove oil, grease and soluble salts.

Solvent cleaning
Only suited for small areas due to solvent evaporation. The solvent is applied manually to the surface with a rag soaked in solvent. The method will remove oil and grease, but there is a risk of hydrocarbon contaminants being relocated instead of being completely removed. The method will not remove soluble salts.

Abrasive blasting

The purpose of abrasive blasting is to remove rust, mill scale, weld spatter and shopprimer, if any, and to create roughness. Depending on method, various cleaning grades and roughness profiles are generated.

Abrasive blasting is the process of forcibly propelling a stream of hard, abrasive particles at high velocity against the surface to be cleaned.

The cleanliness achieved by blast cleaning is evaluated according to ISO 8501-1:2007, which is a photographic standard with pictures showing the result of different degrees of cleaning for different rust grades of steel.

The preparation grades for blast cleaning are:
- Sa 1: Light blast cleaning
- Sa 2: Thorough blast cleaning
- Sa 2½: Very thorough blast cleaning
- Sa 3: Blasting to visual clean metal

Abrasive blasting can be divided in two main groups depending on how the blast media is propelled. By air as in dry abrasive blasting or by air/water as in wet abrasive blasting. The processes are described in more details in ISO 8504-2:2000.

Dry abrasive blasting

The primary methods are:
- Centrifugal abrasive blasting - abrasives are propelled by large rotating wheels or impellers and compressed air.
- Compressed air abrasive blasting- abrasives are propelled by compressed air.
- Vacuum abrasive blasting - abrasives are propelled by compressed air, but the blast nozzle is enclosed in a suction head that ensures that blast media and contaminants are removed from the surface during operation.

The characteristics of the three methods are described in Table 2 below.

Sweep blasting
The term sweep blasting is used for blasting using less abrasive force. The aim is to create roughness and hereby improve adhesion. The blasting process should lightly roughen the surface without removing a significant amount of paint.

Sweep blasting is not covered by any standard. The assessment is based on a visual evaluation of the surface, that should appear uniform and matt.

Method	Suited for	Disadvantage	Achievable cleaning grade
Centrifugal	Continuous line operations on work pieces with accessible surfaces/repetitive large volume jobs.	Need careful set up of equipment.	Sa 3, steel of all rust grades.
Compressed air	Large work pieces/large structures of various geometry.	May create high amounts of dust depending on type of blast media.	Sa 3, steel of all rust grades.
Vacuum	Small areas and when dust is not acceptable.	Lower productivity as compared to methods above.	Sa 2½. Sa 3 is achievable.

Table 2. Characteristics of methods for dry abrasive blasting.

Wet abrasive blasting

The advantage of wet abrasive blasting is that dust is controlled and soluble salt are removed. Non-metallic, disposable abrasives are recommended.

Method	Suited for	Disadvantages	Achievable cleaning grade
Compressed air	All kind of structures and for applications with different rust grades.	Will result in flash rust and cover the cleaned surface by a slurry.	Sa 3, steel of all rust grades.
Compressed air moisture injection	All kind of structures and for applications with different rust grades. Small consumption of water, limited amount of flash rust formation.	Does not remove salt. Will give flash rust.	Sa 3, steel of all rust grades.
Slurry	Smaller items. Removes soluble salts.	Will result in flash rust and cover the cleaned surface by a slurry. Not possible to achieve medium and coarse roughness profile.	Sa 3, steel of all rust grades. Only a fine roughness profile is achievable.
Pressurized-liquid	All kind of structures and for applications with different rust grades. Removes soluble salts	Will result in flash rust and cover the cleaned surface by a slurry.	Sa 3 is achievable for all rust grades.

Table 3. Characteristics of methods for wet abrasive blasting.

The primary methods are:

- Compressed air wet abrasive blasting - water is added up- or downstream of the nozzle.
- Compressed air moisture injection abrasive blasting - propelled by compressed air, water is added upstream of the nozzle.
- Slurry abrasive blasting - the abrasive is dispersed in the water.
- Pressurized-liquid abrasive blasting - the abrasive is dispersed in the water under pressure.

The water for wet abrasive blasting needs to be fresh water with a low salt content to avoid corrosion. If corrosion inhibitors are added to the water, the surface should be carefully rinsed with fresh water after blasting.

For all wet abrasive cleaning procedures, the slurry left on the surface after blasting should not be allowed to dry, but should be immediately rinsed off with fresh water.

The dry slurry will form a very hard layer that can only be removed with some difficulty using high pressure water jetting and large amounts of water. The characteristics of the four methods are described in Table 3.

Abrasives

Abrasives are divided in two groups, metallic and non-metallic (synthetic/mineral) abrasives.

Metallic abrasives are normally recycled whereas non-metallic abrasives are either recycled or only used one time. See abrasive types and typical use in Table 4 below.

Abrasive type	Typically used for blasting type:	Standard ISO: 2018	ISO Comparator
Metallic			
Chilled iron	compressed air	11124-2	grit
High carbon cast steel	centrifugal	11124-3	shot / grit
Low carbon cast steel	centrifugal	11124-4	shot
Cut steel wire	centrifugal	11124-5	shot
Non-metallic, synthetic			
Copper refinery slag	compressed air	11126-3	grit
Coal furnace slag	compressed air	11126-4	grit
Nickel refinery slag	compressed air	11126-5	grit
Iron furnace slag	compressed air	11126-6	grit
Fused aluminium oxide	compressed air	11126-7	grit
Non-metallic, mineral (natural)			
Olivine sand	compressed air	11126-8	grit
Staurolite	compressed air	11126-9	grit
Garnet	compressed air	11126-10	grit

Table 4. Typical abrasives used for abrasive blasting in new building.

The effectiveness of the specific abrasive depends on its particle size. Please see Table 5.

Size category	Abrasive size	Recommended for
Small	> 0.2 mm – 0.5 mm	Cleaning of irregularities
Medium	> 0.5 mm – 1.0 mm	General roughness and cleanliness
Large	> 1 mm	Roughness profile

Table 5. Roughening effect of abrasive size.

The Grit / Shot comparator is used to rate the profile of the roughened surface, see Table 1 on page 1.

Finishing treatment

Dry abrasive blasting
After dry abrasive blasting, remove all loosely adhering debris, blast cleaning material and dust by vacuum cleaning, brush or compressed oil free air.

Wet abrasive blasting
After wet abrasive blasting, wash all surfaces from the top in a downwards movement with fresh water to remove any remaining residues of blasting material and other residues.

This action can be speeded up by blowing with compressed air or vacuum cleaning. It is important that the washing-drying-painting process is done in one continuous process without any delay to minimise the build-up of flash rust.

Flash rust

It is important to minimise flash rust before painting and to coat the surface as fast as possible after cleaning.

The allowed level of flash rust depends on the succeeding paint and will be stated in the specification and/or specified in the Product Data Sheet.

ISO 8501-4:2006 defines three grades of flash rust, assessed according to pictorial rust examples:

- L: Low flash rust
- M: Medium flash rust
- H: Heavy flash rust

In general, grade H is not recommended for overcoating, whereas grades L and M could be acceptable for a primer.

Surface preparation for most common substrates

Carbon Steel, including cast iron and Corten steel

Remove oil and grease by fresh water washing with a suitable detergent followed by fresh water rinsing to remove remaining salts and other contamination. Solvent cleaning may also be applied for small areas.

Blast clean to the cleanliness grade according to ISO 8501-1: 2007 as specified in the specification or Product Data Sheet of the primer to be applied. Both metallic and non-metallic abrasives can be used. Grit is recommended.

Remove any remaining dust before applying the paint.

Stainless steel

Note, that blast cleaning grades according to ISO 8501-1:2007 and ISO 8501-2:1994 do not apply to stainless steel since stainless steel does not get red rust and does not have mill scale.

Remove any oil and grease by fresh water washing with a suitable detergent, followed by fresh water rinsing to remove remaining salts and other contamination.

Depending on service condition, proceed by abrasive sweep blasting as shown in Table 6 below.

Service	Abrasive sweep blasting
≤ C3, medium	No sweeping required
> C3, medium	Light sweeping with non-metallic abrasive
= C4, medium	Light sweeping with non-metallic abrasive
> C4, medium	To sharp, dense, uniform profile; non-metallic abrasive
CX	To sharp, dense, uniform profile; non-metallic abrasive
Immersion	To sharp, dense, uniform profile; non-metallic abrasive

Table 6. Degree of abrasive sweeping as dependent of service condition.

Aluminium

Extruded aluminium sheets and cast aluminium
Remove any oil and grease by fresh water washing with a suitable detergent followed by fresh water rinsing to remove remaining salts and other contaminations.

Depending on service condition, proceed by abrasive sweeping as shown in Table 6 above.

Anodised aluminium
Freshly anodised aluminium without sealer can be painted without further surface preparation. Weathered anodised aluminium shall be sweep blasted until the oxide layer has been removed.

Concrete

Fresh concrete must be fully cured before it is stable for painting. Consult the specification or the Product Data Sheet for further details.

As a guideline, 28 days of drying is typical for a standard Portland cement. The water content of the concrete should be below 4%. Note that moisture may arise from the external environment as well as from the initial concrete mix.

Wash the concrete by high pressure, fresh water washing with a suitable detergent to remove any contamination from the casting process.

Sweep blast to remove any layers of laitance and efflorescence. Finally, repair cracks and other defects before painting.

Fiberglass (GRP)

Wipe the surface with a strong solvent or wash with water using a suitable detergent to remove any remains of mould release agents.

Sand the surface with coarse sand paper or sweep blast with a small size, non-metallic abrasive.

Finally, wipe off remaining dust or alternatively, wash with fresh water using a pressure of not more than 3-5 bars.

Hot Dip Galvanised Steel (HDG)

Un-weathered HDG
Repair any areas with damages to the zinc. Clean in accordance with a suitable cleaning process to remove oil, grease and remains of flux or marking material.

Sweep blast the surface with a non-metallic abrasive to a sharp, dense and uniform profile giving a dull appearance.

Weathered HDG
Asses the surface condition before deciding the surface preparation procedure. In most cases, high pressure water cleaning will be enough.

For service in C4, medium and above, sweep blast to a sharp, dense and uniform profile with a non-metallic abrasive.

Painted surfaces

Asses the surface condition to make sure that it is intact and without defects. I.e. without rust, loosely adhering paint, cracks, blisters or mechanical damages. If defect, please refer to the guideline for Surface preparation – Maintenance and repair.

If paint is intact, remove the surface contaminants by high pressure washing. In case, the maximum recoating interval of the existing paint has been exceeded, roughen the surface by sweep blasting.

Thermally sprayed zinc and aluminium

Paint application is done immediately after application of the metallic coating as part of a continuous application process. Therefore, further surface preparation is not needed.