Aluminium surface treatments in the building: functional and aesthetic performances

From the Guide compiled by the members of the Aital "Durability" working group

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The first version of this guide has been compiled by the members of the Aital "Durability" working group.

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This guide is aimed *at the applications in which semifinished aluminium alloys, extrusions (alloy EN AW 6060) and laminates (principally alloys of the 5000 AlMg series and, to a lesser extent, of the 3000 AlMn series), are employed for the realization of doors, windows and curtain walls, which will be referred to from here on in simply as "frames". To this end the durability evaluations of the finishes are correlated to the protective characteristics of resistance to corrosion and to aesthetic ones (decay in colour and in brightness).*

*The **durability** evaluations of the finishes are correlated to the:*

- ***protective characteristics** of resistance to corrosion and to*
- ***aesthetic** ones (decay in colour and in brightness)*

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Coating surfaces

Il Laboratorio

Prove di laboratorio: prodotti in lega di alluminio verniciati

Prove accreditate

Descrizione	Norma di riferimento
Brillantezza	UNI EN ISO 2813
Durezza alla matita	ISO 15184; UNI EN 13523-4; ASTM D3363
Resistenza all'abrasione dei rivestimenti organici (Taber test)	UNI 10559; ISO 7784-2; ASTM D4060
Differenze di colore	UNI EN ISO 11664-4
Misurazione dello spessore (correnti indotte)	UNI EN ISO 2360
Prova di invecchiamento artificiale ed esposizione alle radiazioni di lampade allo xeno	UNI EN ISO 16474-2
Resistenza alla corrosione filiforme	UNI EN 3665; UNI EN ISO 4623-2
Resistenza alla corrosione in camera a nebbia salina	UNI EN ISO 9227 + UNI EN ISO 4628-2
Resistenza all'alcalinità della malta	UNI EN 12206-1 par. 5.9
Resistenza all'umidità – condensa continua CH	UNI EN ISO 6270-2
Resistenza alle atmosfere umide contenenti anidride solforosa	UNI EN ISO 3231
Prova di resistenza alla corrosione per immersione (Machu test)	Specifiche QUALICOAT
Prova di aderenza (quadrettatura)	UNI EN ISO 2409

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Coating surfaces

Valutazione della permeabilità del film di vernice e della qualità del pretrattamento (Pressure cooker test)	UNI EN 12206-1 Par.5.10
Prova di piegamento con mandrino cilindrico	UNI EN ISO 1519
Prova di imbutitura	UNI EN ISO 1520
Durezza Buchholz	UNI EN ISO 2815
Resistenza all'urto	UNI EN ISO 6272-1; UNI EN ISO 6272-2

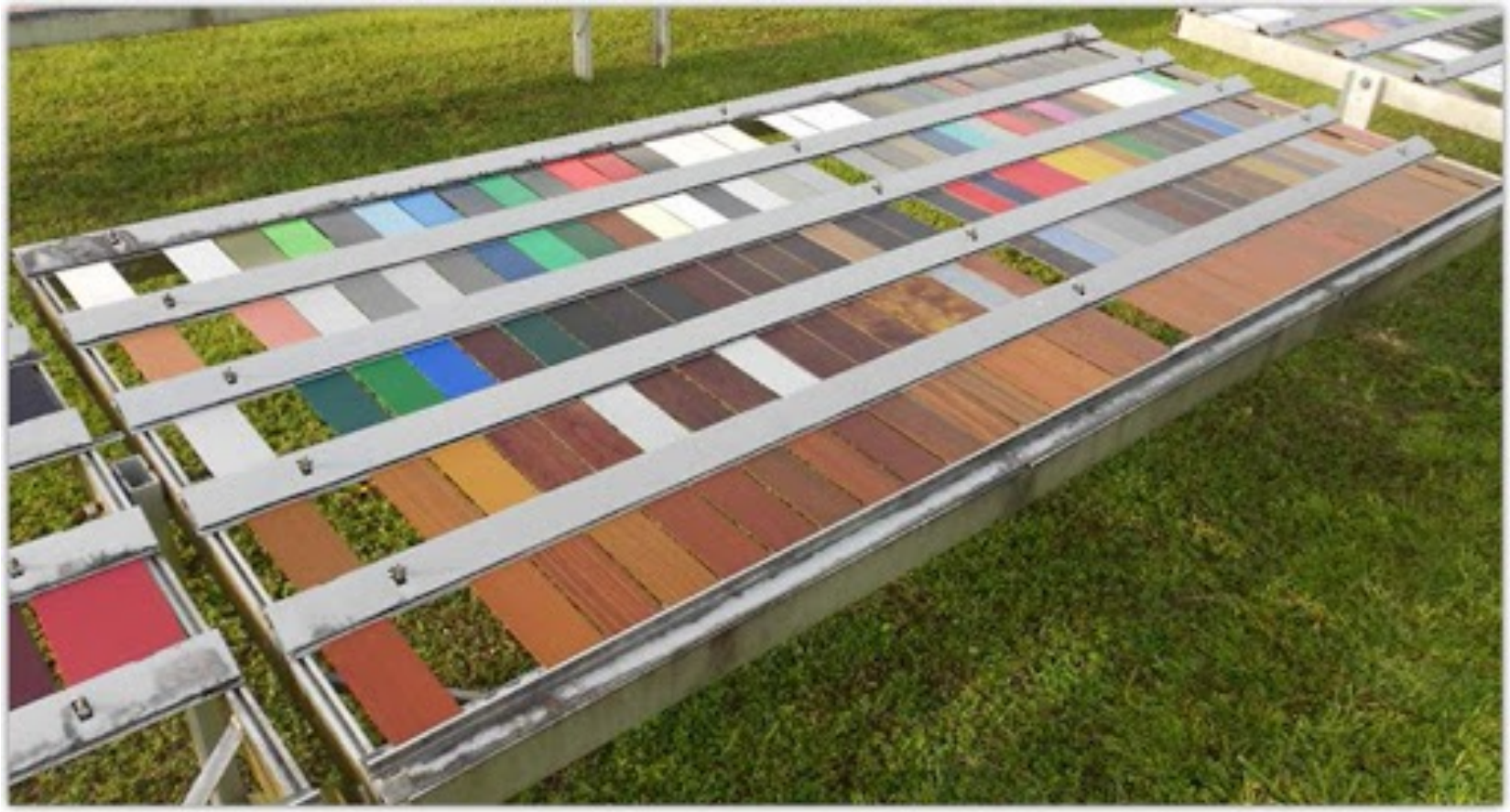
Altre prove (non accreditate)

Descrizione	Norma di riferimento
Contatto con sostanze aggressive	AAMA2605; UNI EN ISO 175
Water Spot (Immersione in acqua a 60°C x 24 ore)	Metodo QUALICOAT
Prova in acqua all'ebollizione	Metodo QUALICOAT
Prova di aderenza a umido	Metodo QUALICOAT; AAMA 2603 / 2604 / 2605
Resistenza all'umidità – condensa continua (Single sided)	UNI EN ISO 6270-1
Invecchiamento accelerato QUV	UNI EN ISO 16474-3; UNI EN ISO 4892-3

Ultima revisione 24/02/2020

Coating surfaces

Natural weathering test Exposure in Florida according to ISO 2810



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Anodizing surfaces

Il Laboratorio

Prove di laboratorio: elenco prove sui prodotti in lega di alluminio anodizzati

Prove accreditate

Descrizione	Norma di riferimento
Microdurezza Vickers di strati di ossido anodico	UNI EN ISO 4516
Resistenza all'abrasione di strati di ossido anodico (Taber test)	UNI 7796 - App.B
Misura dello spessore (correnti indotte)	UNI EN ISO 2360
Misurazione degli spessori dei rivestimenti con metodo microscopico	UNI EN ISO 1463
Resistenza alla corrosione in camera a nebbia salina neutra (NSS), acetica (AASS) e cupro-salina acetica (CASS)	UNI EN ISO 9227
Valutazione della perdita di potere assorbente di strati anodici fissati	UNI 9834; UNI EN ISO 2143
Valutazione della qualità del fissaggio mediante misura della perdita di massa (con trattamento acido preliminare)	UNI EN ISO 3210 metodo 2
Valutazione della qualità del fissaggio mediante misura della perdita di massa (senza trattamento acido preliminare)	UNI EN ISO 3210 metodo 1

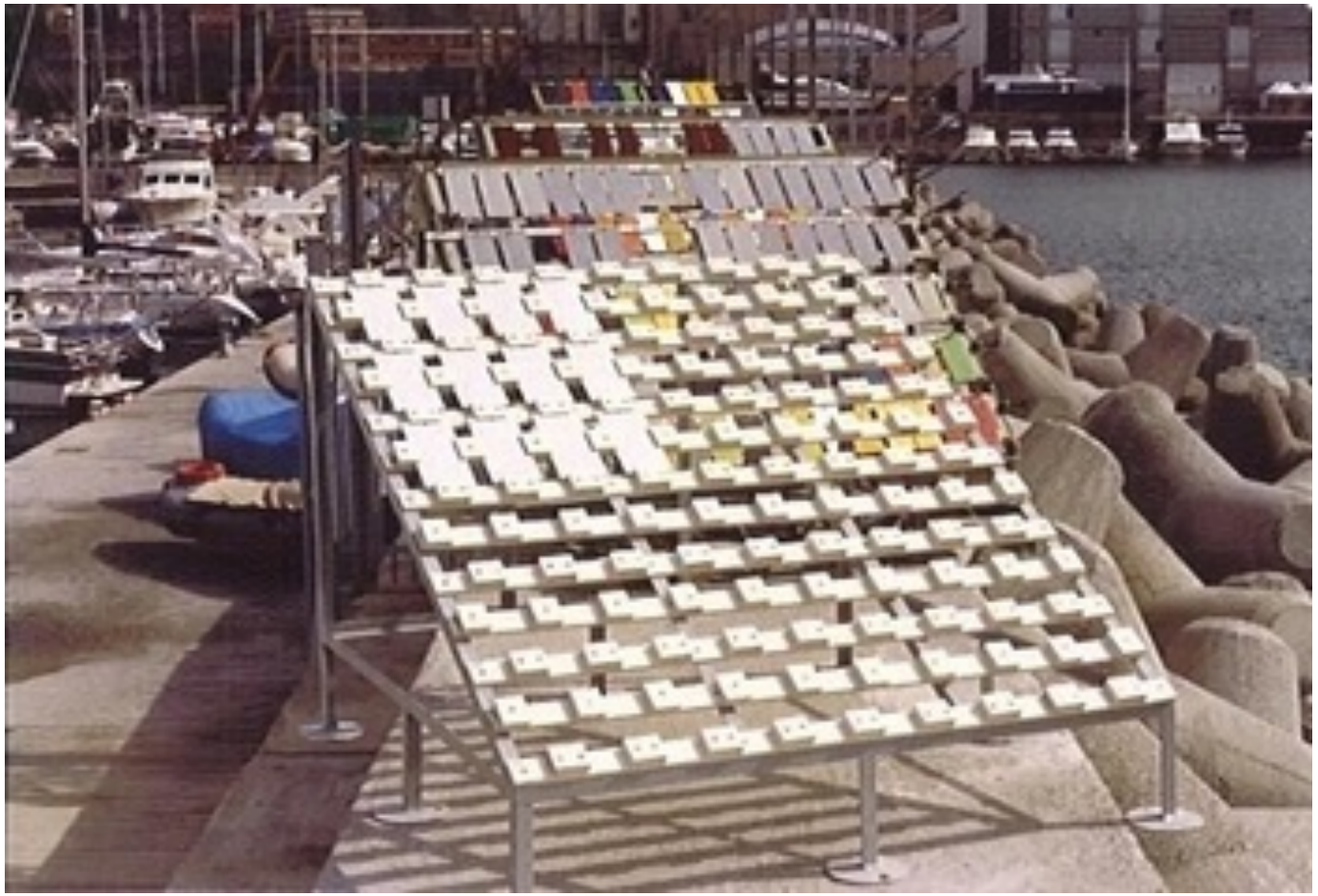
Altre prove (non accreditate)

Descrizione	Norma di riferimento
Prova di ammettenza	UNI EN ISO 2931
Resistenza all'abrasione CLARK	BS 6161 – parte 18
Resistenza alla luce di strati di ossido anodico colorati	UNI ISO 2135

Ultima revisione 24/02/2020

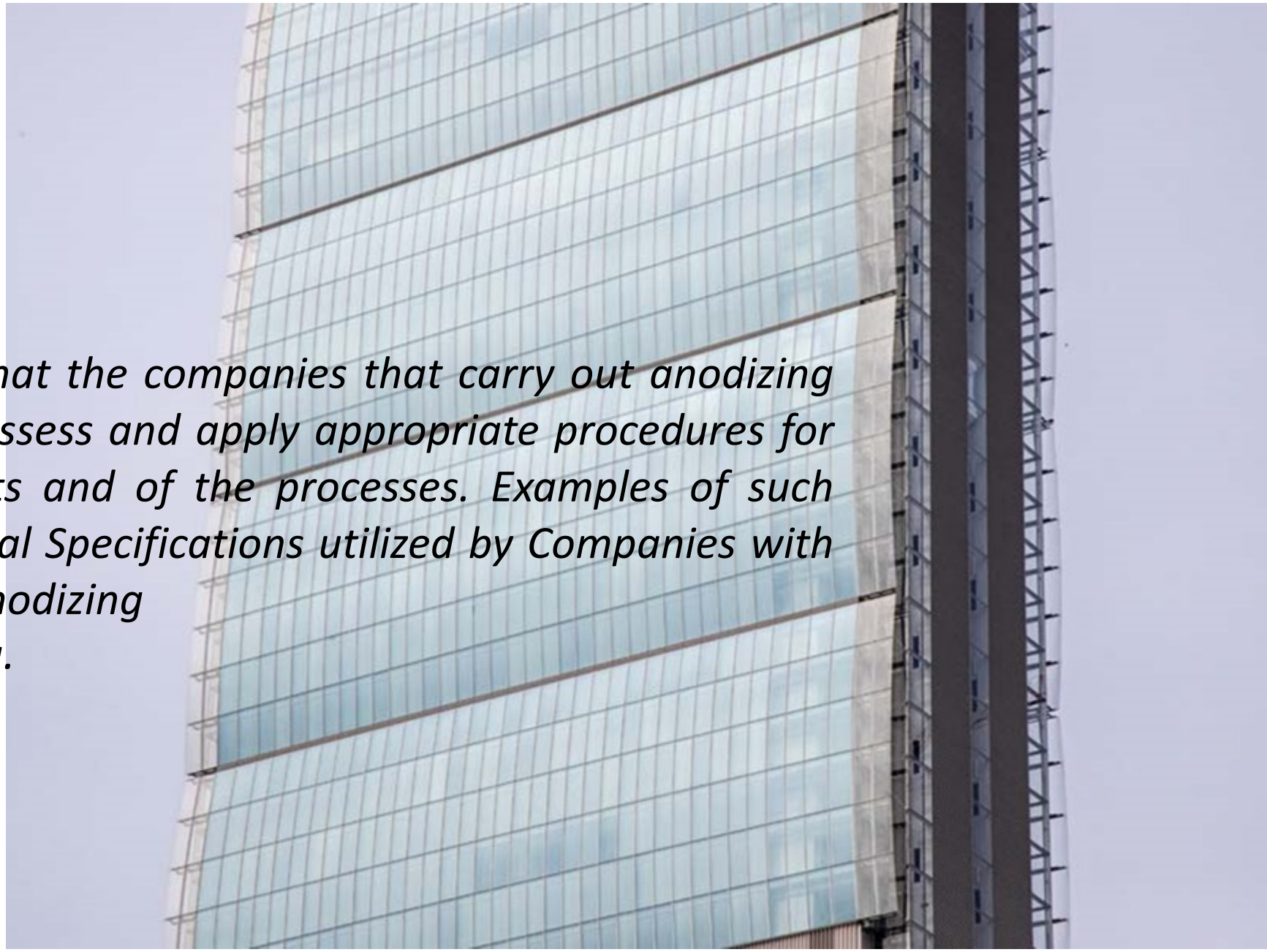
Anodizing surfaces

Natural weathering test Exposure in Italy and Holland



*The **durability** of a manufactured article or of a structure treated on the surface depends on several parameters, such as:*

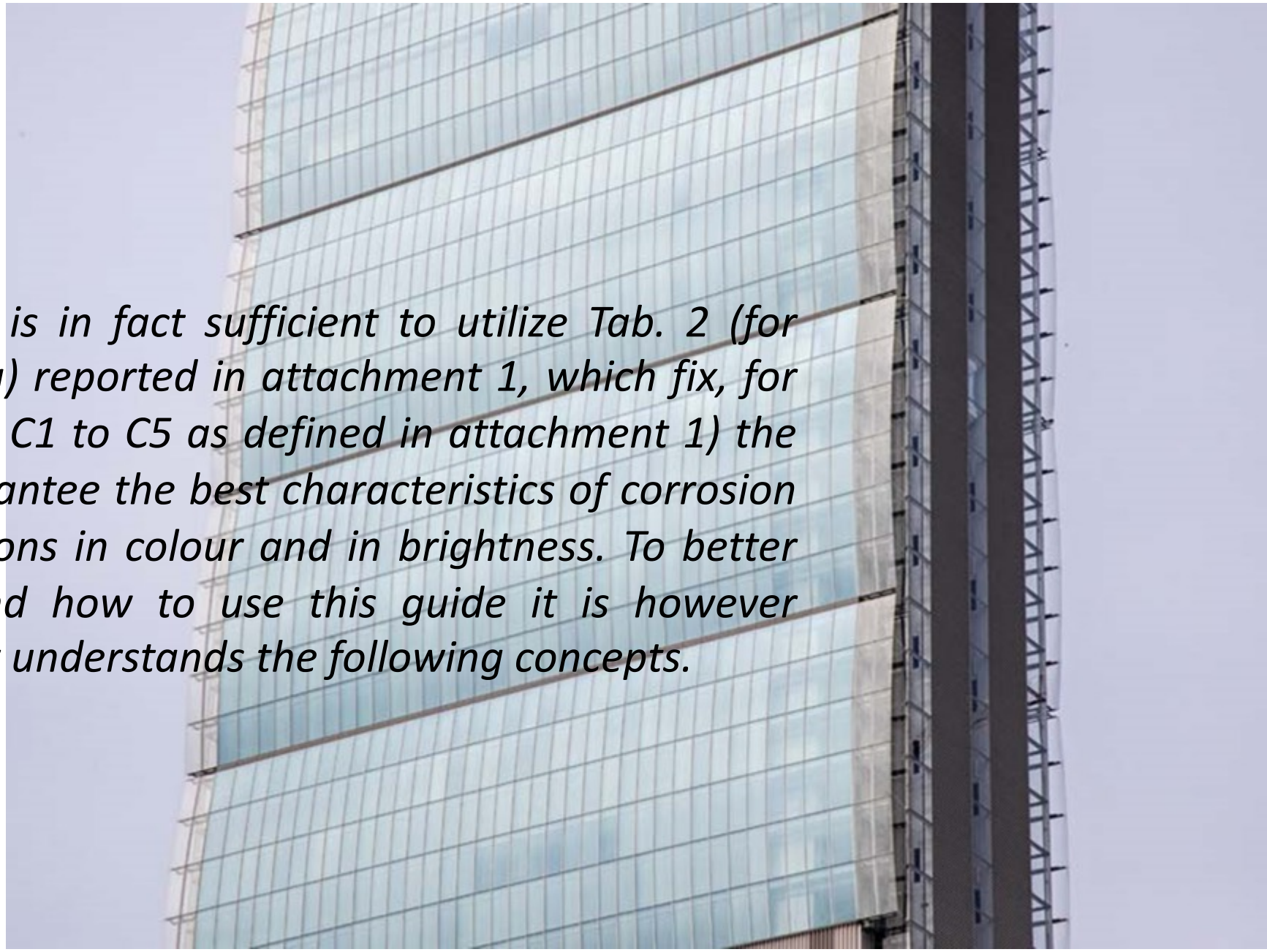
- ***environment**;*
- ***exposure conditions** of the finished manufactured article in use;*
- ***structure design**;*
- ***type of alloy**;*
- ***support conditions** before treatment;*
- *chosen **finishing cycle**;*
- ***cleaning** and **maintenance** in use.*



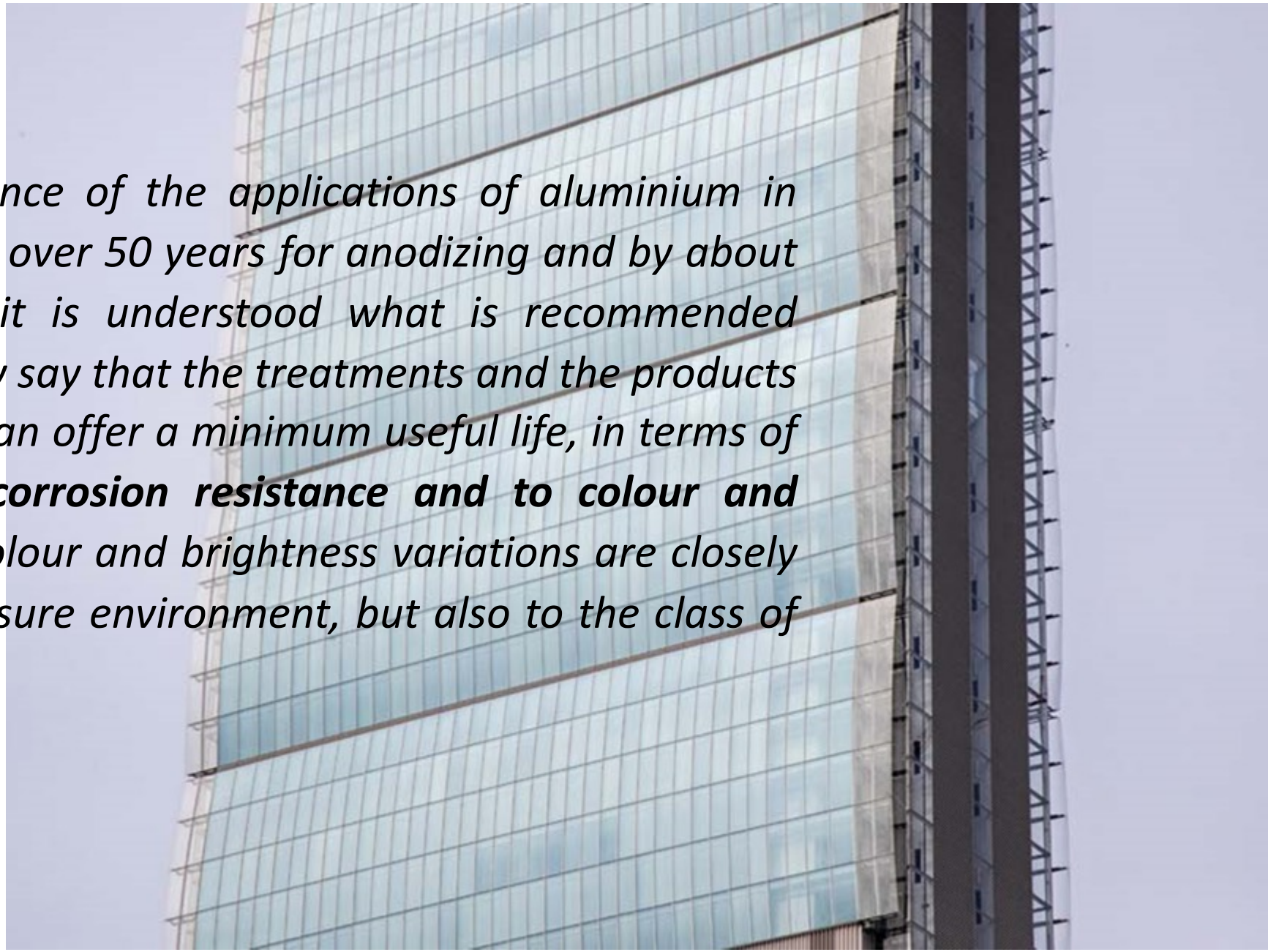
*Moreover, it is advisable that the companies that carry out anodizing and coating treatments possess and apply appropriate procedures for the control of the products and of the processes. Examples of such procedures are the Technical Specifications utilized by Companies with the **QUALANOD** label for anodizing*
*and **QUALICOAT** for coating.*

How to use the guide

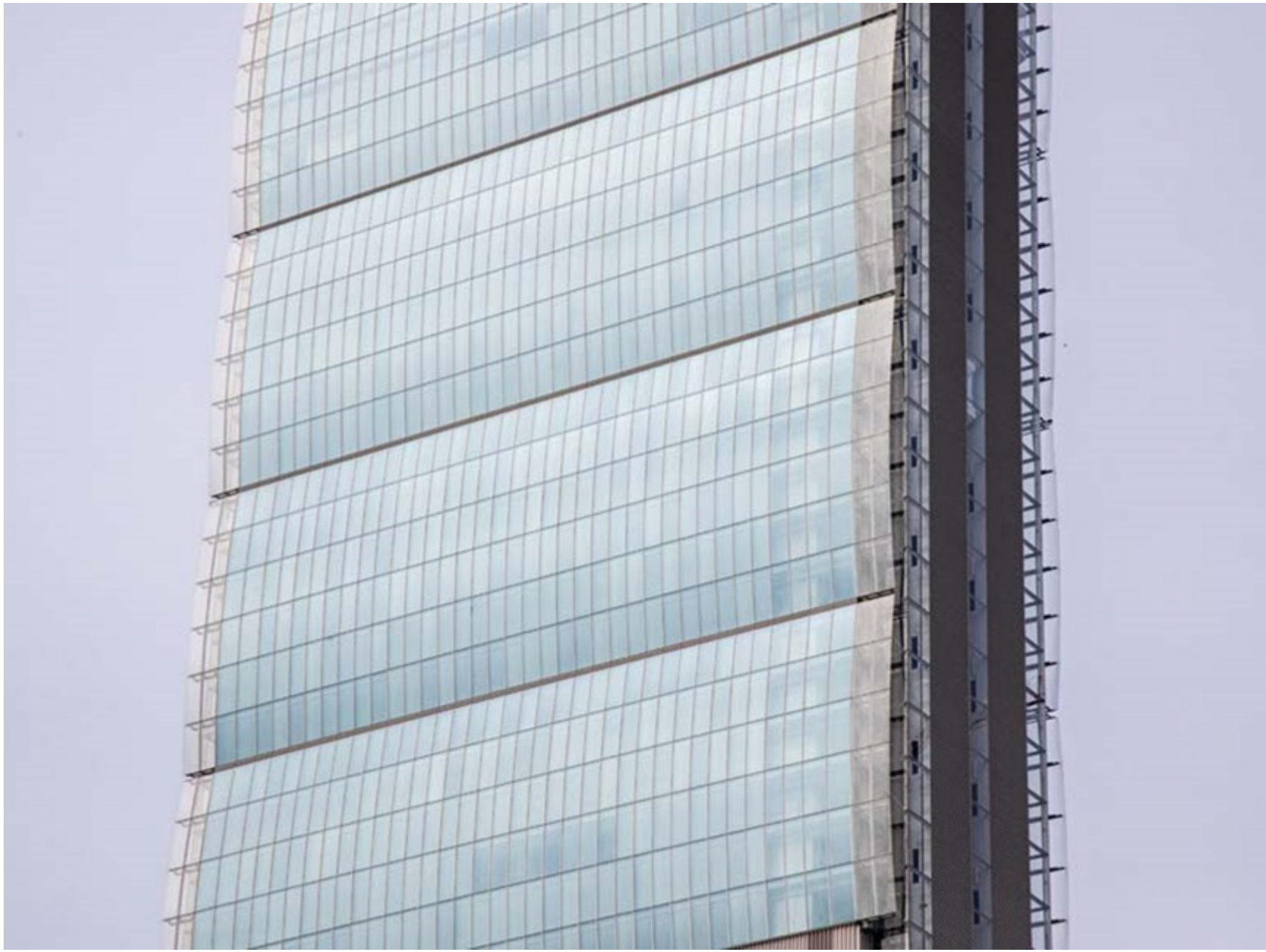
The guide is easy to use; it is in fact sufficient to utilize Tab. 2 (for coating) and 3 (for anodizing) reported in attachment 1, which fix, for each class of exposure (from C1 to C5 as defined in attachment 1) the optimal process able to guarantee the best characteristics of corrosion resistance and of the variations in colour and in brightness. To better understand the contents and how to use this guide it is however necessary that its user clearly understands the following concepts.



On the basis of the experience of the applications of aluminium in architecture, consolidated by over 50 years for anodizing and by about 30 years for coating, and it is understood what is recommended hereafter, one can reasonably say that the treatments and the products estimated in tables 2 and 3 can offer a minimum useful life, in terms of durability, of ***15 years to corrosion resistance and to colour and brightness variations.*** *The colour and brightness variations are closely related, not only to the exposure environment, but also to the class of coating products used.*



In practice it is important and necessary that specific procedures, adequate to the project in question are edited, based on the following aspects



*Identification of the **exposure class** (see table 1) of the zone in which the aluminium has to be placed*

Exposure Class	Examples of Environments	
	Internal Environment	External Environment
C1	BUILDINGS HEATED WITH CLEAN ATMOSPHERE, FOR EXAMPLE OFFICES, SHOPS SHOOLS, HOTELS	NOT APPLICABLE
C2	NOT-HEATED BUILDINGS WHERE CONDEN-SATION CAN FORM, FOR EXAMPLE WA-REHOUSE, SPORT CENTERS	ENVIRONMENTS WITH A LOW POLLUTION LEVEL, ABOVE ALL RURAL AREAS (see the definition in the appendix)
C3	AREAS OF PRODUCTION WITH HIGH HUMI-DITY AND A CERTAIN ATMOSPHERIC POL-LUTION; FOR EXAMPLE FOOD INDUSTRIES, LAUNDRIES, BREWERIES, DAIRIES	URBAN AND INDUSTRIAL ENVIRONMENTS, MODEST POLLUTION FROM SOLPHUR DIOXIDE, COASTAL AREAS (see the definition in the appendix) WITH LOW SALINITY
C4	CHEMICAL PLANTS, SWIMMING POOLS, COASTAL BOATYARDA	INDUSTRIAL AND COASTAL AREAS WITH MODERATE SALINITY
C5-I	BUILDING OR AREAS WITH AN ALMOST PERMANENT CONDENSATION AND WITH HIGH POLLUTION	INDUSTRIAL AREAS WITH HIGH HUMIDITY AND AGGRESSIVE ATMOSPHERE
C5-M	BUILDING OR AREAS WITH AN ALMOST PERMANENT CONDENSATION AND WITH HIGH POLLUTION	COASTAL AND OFFSHORE AREAS WITH HIGH SALINITY

Note: To determine the "C" classes of atmospheric exposure, the regulation ISO 12944 advises an exposure of one year on a sheet of steel with low carbon content and of a galvanized sheet and then calculates the loss in weight (in g/m2) and the decrease in the thickness (in µm) of zinc and steel. For each class "C" (from C1 to C5) precise limits of weight loss reported in an appropriate table are set.

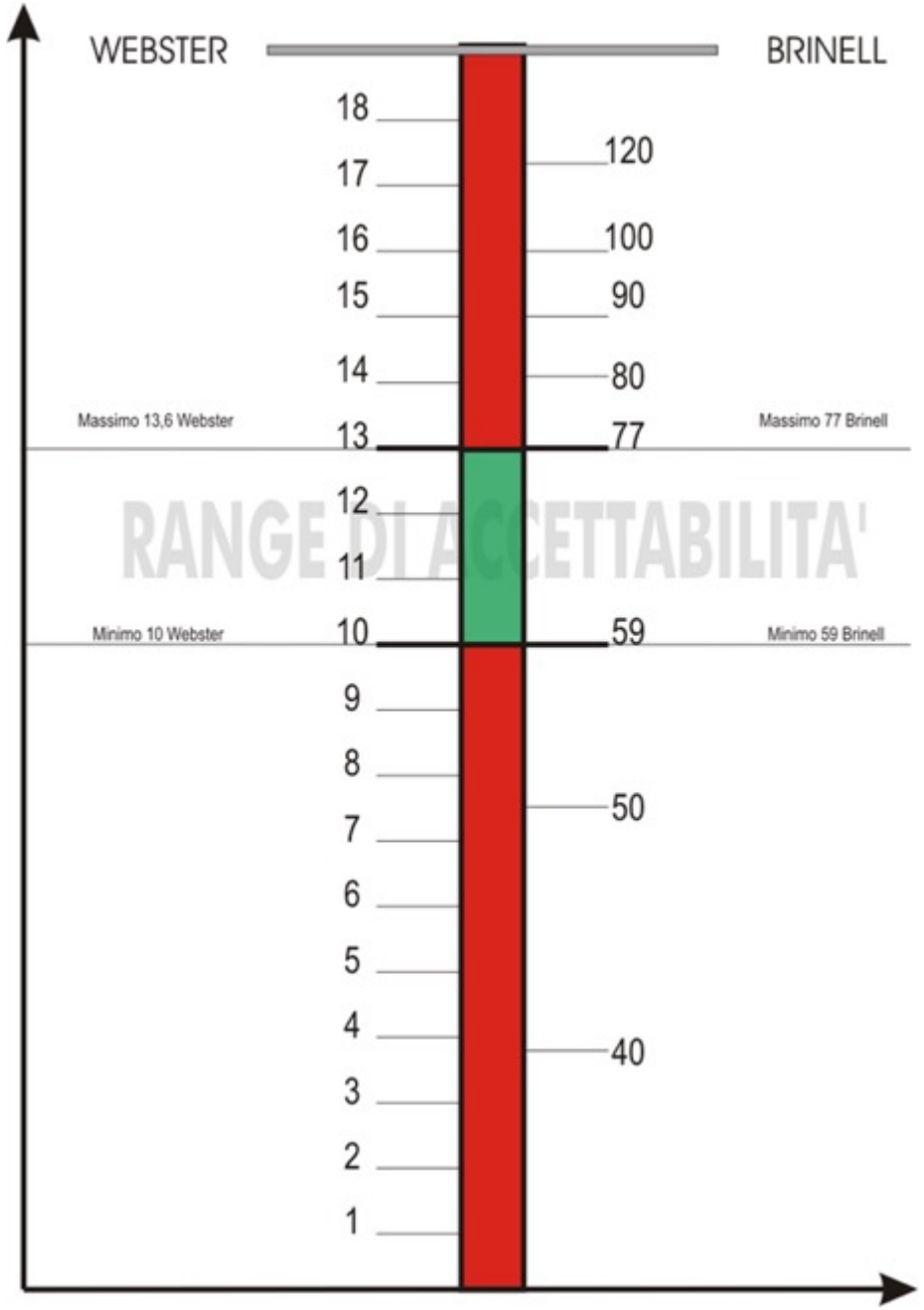
Chemical composition of aluminium alloy

The alloy EN AW 6060 used for building constitutes the best compromise in terms of needs on the part of producers of profiles, who take advantage of its excellent extrudability, and by the users for its good mechanical characteristics and resistance to polluting agents. It must, however, be emphasized that the behaviour of such an alloy in terms of resistance to corrosion can change according to its chemical composition when the eligible impurities (in particular copper, zinc and iron) reach and exceed determined percentage values in weight, even though they are within the limits allowed in the alloy.

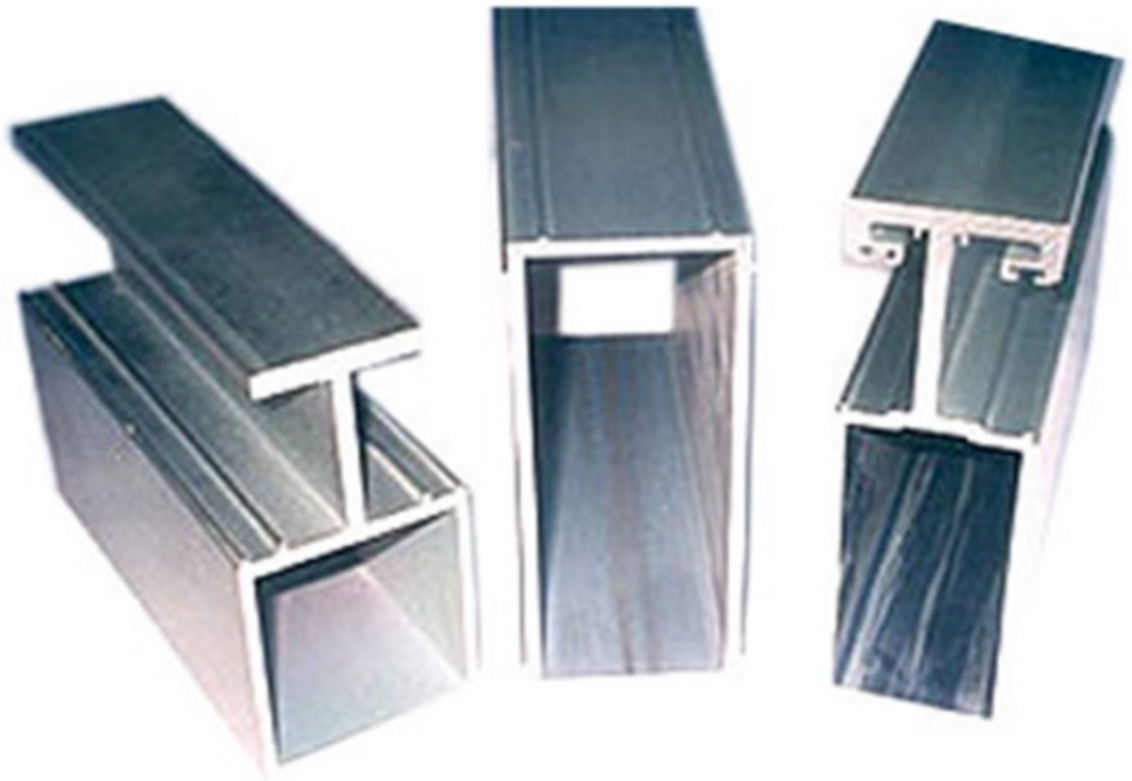
Elementi	Min	Max	EN 573/3
Si (Silicio)	0,40	0,47	0,3÷0,6
Fe (Ferro) (*)	0,15	0,23	0,10÷0,30
Cu (Rame)	-	0,03	max 0,10
Mn (Manganese)	-	0,04	max 0,10
Mg (Magnesio)	0,40	0,47	0,35÷0,60
Cr (Cromo)	-	0,02	max 0,05
Zn (Zinco)	-	0,03	max 0,15
Ti (Titanio)	-	0,03	max 0,15
Altre impurità	Ciascuna Max 0,03 Totale Max 0,10		Ciascuna Max 0,05 Totale Max 0,15

Temper

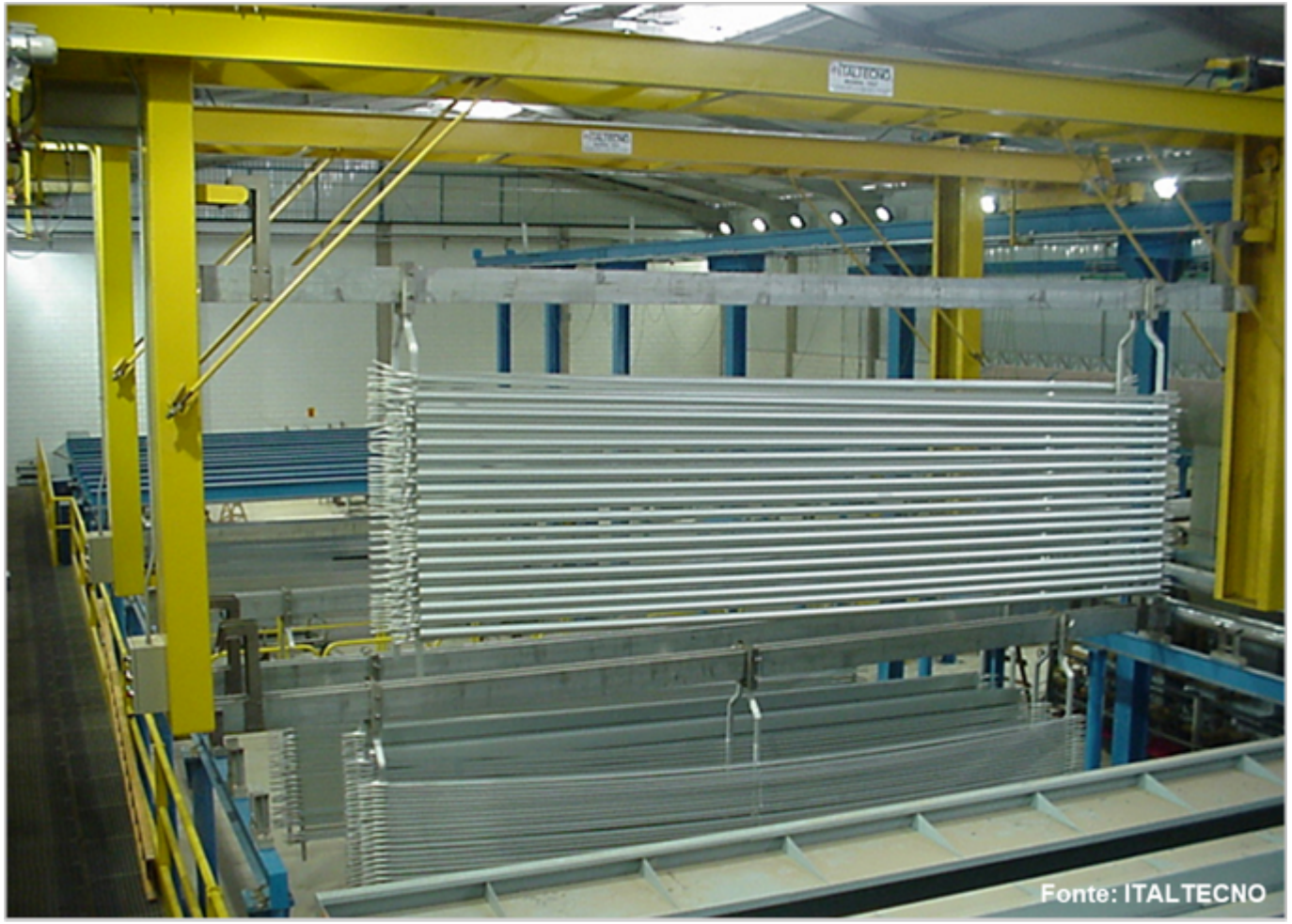
alloy EN AW 6060



Conditions of the support before treatment



Surface treatment



Cleaning and maintenance

Certifications and product approvals

QUALITY LABEL INTERNATIONAL Qualanod FOR ANODISING ARCHITECTURE

QUALITY LABEL INTERNATIONAL Qualanod FOR ANODISING DECORATIVE

QUALITY LABEL INTERNATIONAL Qualanod FOR ANODISING HARD ANODISING

QUALITY LABEL INTERNATIONAL Qualanod FOR ANODISING INDUSTRIAL

Recommendations for anodizing

Certifications and product approvals

Recommendations for coating

Certifications and product approvals

Recommendations for decoration

Basic conditions

- Identification of the exposure class;
- The windows and doors must be free of "corrosion traps" and their geometry must allow adequate accessibility for cleaning and maintenance;
- Protect painted and anodized surfaces during storage, assembly and installation of windows;
- Preparation and execution of a suitable cleaning program (see technical data sheet AITAL n. 34/2003) and maintenance extended to the entire service life of the windows.

Basic conditions

- **Identification of the exposure class;**
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Classe di esposizione	Esempi di ambienti	
	Ambiente interno	Ambiente esterno
C_1	EDIFICI RISCALDATI CON ATMOSFERA PULITA, PER ESEMPIO UFFICI, NEGOZI, SCUOLE, ALBERGHI	NON APPLICABILE
C_2	EDIFICI NON RISCALDATI DOVE PUÒ FORMARSI CONDENSA, PER ESEMPIO DEPOSITI, LOCALI SPORTIVI	AMBIENTI CON BASSO LIVELLO DI INQUINAMENTO, SOPRATTUTTO AREE RURALI
C_3	LOCALI DI PRODUZIONE CON ALTA UMIDITÀ E UN CERTO INQUINAMENTO ATMOSFERICO; PER ESEMPIO INDUSTRIE ALIMENTARI, LAVANDERIE, BIRRERIE, CASEIFICI	AMBIENTI URBANI E INDUSTRIALI, MODESTO INQUINAMENTO DA ANIDRIDE SOLFOROSA, ZONE COSTIERE CON BASSA SALINITÀ
C_4	IMPIANTI CHIMICI, PISCINE, CANTIERI COSTIERI PER IMBARCAZIONI	AREE INDUSTRIALI E ZONE COSTIERE CON MODERATA SALINITÀ
$C_{5\text{-}I}$	EDIFICI O AREE CON CONDENSA QUASI PERMANENTE E CON ALTO INQUINAMENTO	AREE INDUSTRIALI CON ALTA UMIDITÀ E ATMOSFERA AGGRESSIVA
$C_{5\text{-}M}$	EDIFICI O AREE CON CONDENSA QUASI PERMANENTE E CON ALTO INQUINAMENTO	ZONE COSTIERE E OFFSHORE CON ALTA SALINITÀ

Basic conditions

- Identification of the exposure class;
- **The windows and doors must be free of "corrosion traps" and their geometry must allow adequate accessibility for cleaning and maintenance;**
- Protect painted and anodized surfaces during storage, assembly and installation of windows;
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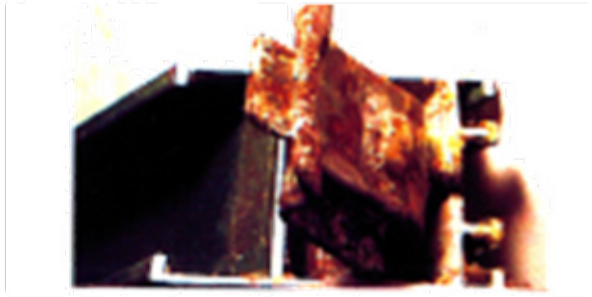

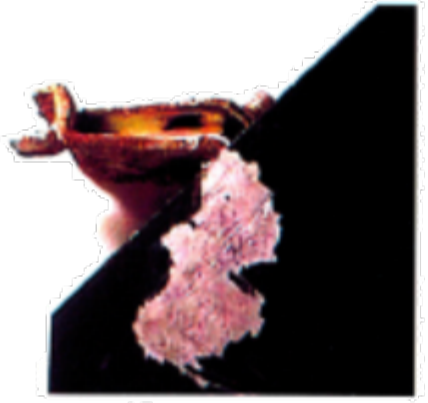

Basic conditions

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- Identification of the exposure class;
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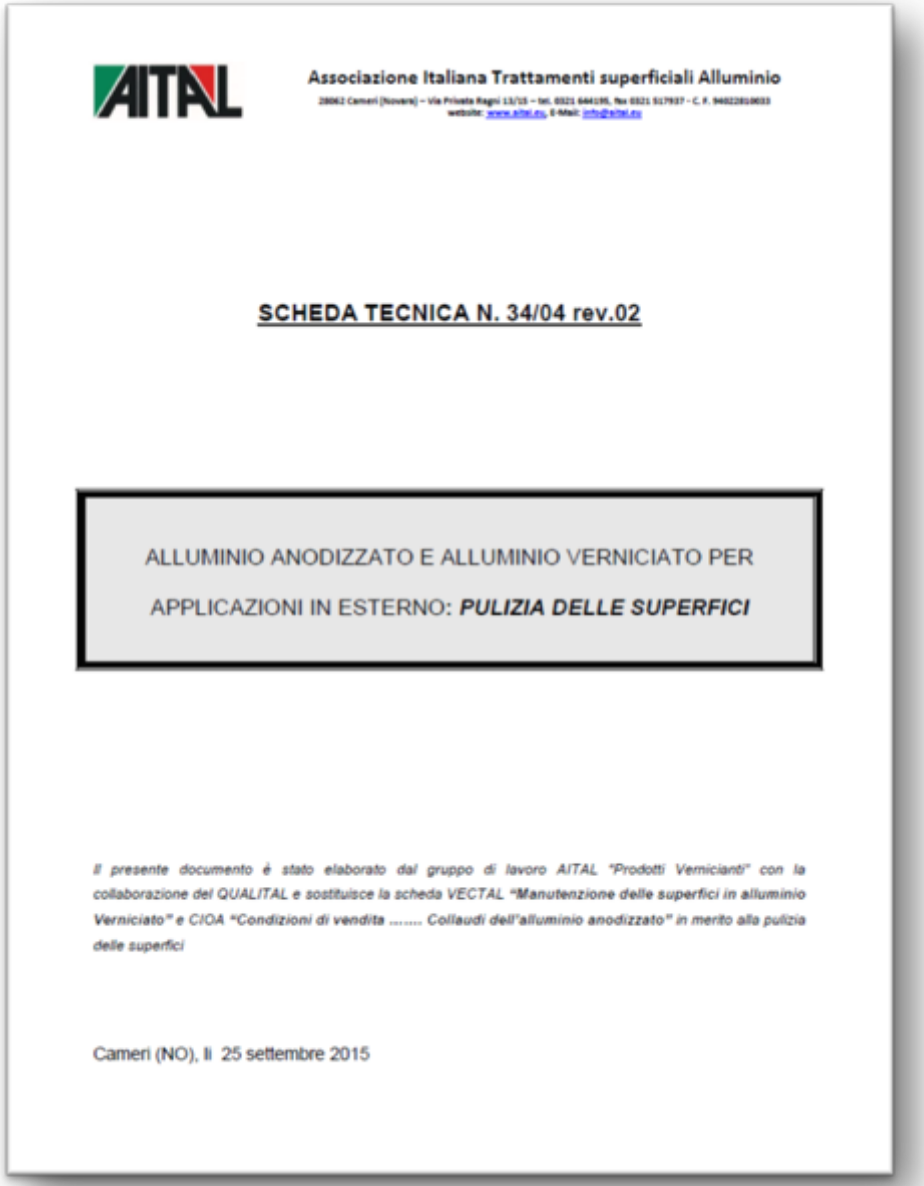


Associazione Italiana Trattamenti superficiali Alluminio

SCHEDA TECNICA N. 34/04 rev.02

ALLUMINIO ANODIZZATO E ALLUMINIO VERNICIATO PER APPLICAZIONI IN ESTERNO: ***PULIZIA DELLE SUPERFICI***

Il presente documento è stato elaborato dal gruppo di lavoro AITAL "Prodotti Vernicianti" con la collaborazione del QUALITAL e sostituisce la scheda VECTAL "Manutenzione delle superfici in alluminio Verniciato" e CIOA "Condizioni di vendita ..... Collaudi dell'alluminio anodizzato" in merito alla pulizia delle superfici

Cameri (NO), li 25 settembre 2015

How to use the guide

Use the Tables:

2 (for coating)

3 (for anodizing)

for each exposure class (C1 to C5) tables provide the best process

Pretrattamento (asportazione superficiale)	Conversione chimica	C_1	C_2		C_3		C_4		C_5- I		C_5- M	
		SOLO INTERNO	CON R.S.A MEDIA	CON R.S.A ALTA	CON R.S.A MEDIA	CON R.S.A. ALTA	CON R.S.A MEDIA	CON R.S.A. ALTA	CON R.S.A MEDIA	CON R.S.A ALTA	CON R.S.A MEDIA	CON R.S.A ALTA
QUALICOAT Pretrattamento STANDARD	Cromo esavalente o Esente-cromo esavalente	P.V. CL. 1	P.V. CL. 1	P.V. CL. 2, 3								
QUALICOAT Pretrattamento SEASIDE	Cromo esavalente o Esente-cromo esavalente				P.V. CL. 1	P.V. CL. 2, 3						
QUALICOAT Pretrattamento SEASIDE	Cromo esavalente o Esente-cromo esavalente o Strato d'ossido non fissato						P.V. CL. 1	P.V. CL. 2, 3				
QUALICOAT Pretrattamento SEASIDE	Cromo esavalente o Esente-cromo esavalente o Strato d'ossido non fissato								PRIMER + P.V. CL. 1	PRIMER + P.V. CL. 2, 3		
QUALICOAT Pretrattamento SEASIDE	Valutare caso per caso										PRIMER + P.V. CL. 1	PRIMER + P.V. CL. 2 O 3

How to use the guide

Use the Tables:

2 (for painting)

3 (for anodizing)

for each exposure class (C1 to C5) tables provide the best process

Tabella 3 – Classi di spessore dell'ossido anodico per ogni classe di esposizione "C"

Processo	Classe d'ossido	C_1	C_2	C_3	C_4	C_5- I	C_5- M
		SOLO INTERNO	INTERNO E ESTERNO	INTERNO E ESTERNO	INTERNO E ESTERNO	INTERNO E ESTERNO	INTERNO E ESTERNO
QUALANOD Secondo specifiche del marchio	10	X					
QUALANOD Secondo specifiche del marchio	15		X				
QUALANOD Secondo specifiche del marchio	20			X			
QUALANOD Secondo specifiche del marchio	20				X		
QUALANOD Secondo specifiche del marchio	20 O 25 (cfr. nota)					X	
QUALANOD Secondo specifiche del marchio	20 O 25 (cfr. nota)						X

Precauzioni particolari per la classe 25

Coating

Pretrattamento (asportazione superficiale)	Conversione chimica	C_1	C_2	
		SOLO INTER NO	CON R.S.A MEDI A	CON R.S.A ALTA
QUALICOAT Pretrattamento STANDARD	Cromo esavalente o Esente-cromo esavalente	**P.V. CL. 1**	**P.V. CL. 1**	**P.V. CL. 2, 3**

C_1	EDIFICI RISCALDATI CON ATMOSFERA PULITA, PER ESEMPIO UFFICI, NEGOZI, SCUOLE, ALBERGHI	NON APPLICABILE
C_2	EDIFICI NON RISCALDATI DOVE PUÒ FORMARSI CONDENSA, PER ESEMPIO DEPOSITI, LOCALI SPORTIVI	AMBIENTI CON BASSO LIVELLO DI INQUINAMENTO, SOPRATTUTTO AREE RURALI

Coating

Pretrattamento (asportazione superficiale)	Conversione chimica	C_4	
		CON R.S.A MEDIA	CON R.S.A. ALTA
QUALICOAT Pretrattamento SEASIDE	Cromo esavalente o Esente-cromo esavalente o Strato d'ossido non fissato	**P.V. CL. 1**	**P.V. CL. 2, 3**

C_4	IMPIANTI CHIMICI, PISCINE, CANTIERI COSTIERI PER IMBARCAZIONI	AREE INDUSTRIALI E ZONE COSTIERE CON MODERATA SALINITÀ

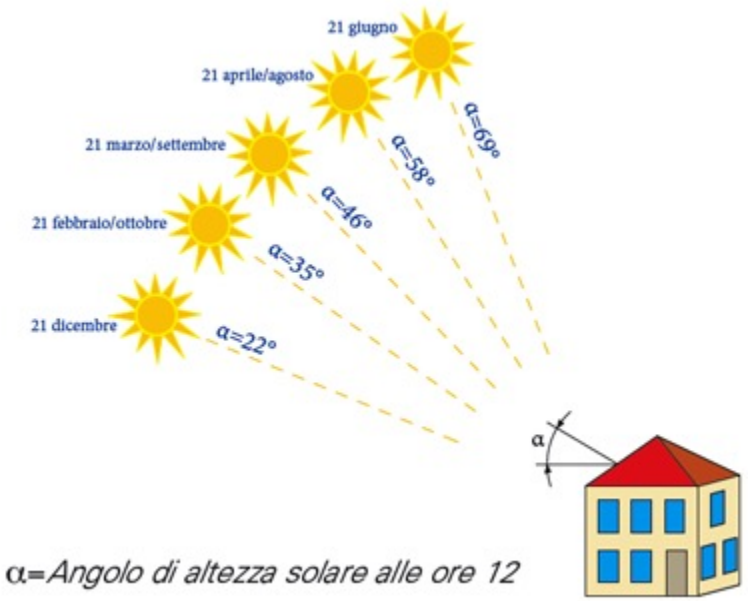
Coating

Pretrattamento (asportazione superficiale)	Conversione chimica	C_5- I		C_5- M	
		CON R.S.A MEDIA	CON R.S.A ALTA	CON R.S.A MEDIA	CON R.S.A ALTA
QUALICOAT Pretrattamento SEASIDE	Cromo esavalente o Esente-cromo esavalente o Strato d'ossido non fissato	**PRIMER + P.V. CL. 1**	**PRIMER + P.V. CL. 2, 3**		
QUALICOAT Pretrattamento SEASIDE	Valutare caso per caso			**PRIMER + P.V. CL. 1**	**PRIMER + P.V. CL. 2 O 3**

C_{5-I}	EDIFICI O AREE CON CONDENSA QUASI PERMANENTE E CON ALTO INQUINAMENTO	AREE INDUSTRIALI CON ALTA UMIDITÀ E ATMOSFERA AGGRESSIVA
C_{5-M}	EDIFICI O AREE CON CONDENSA QUASI PERMANENTE E CON ALTO INQUINAMENTO	ZONE COSTIERE E OFFSHORE CON ALTA SALINITÀ

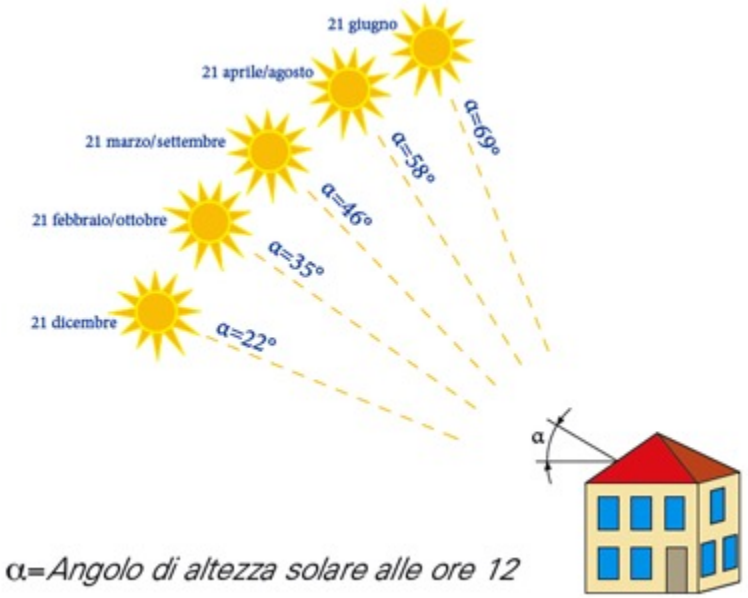
R.S.A.= Annual solar radiation

On the basis of surveys carried out by ENEA in the five years between 1995-1999, in Italy, in a year, the quantity of solar radiation that reaches a surface of one square metre is around, on average, 5000 MJ. The solar energy occurs as a collection of electromagnetic radiation of different wavelengths: about 10% in the form of ultraviolet radiation with a wavelength of between 0.2 and 0.4 micrometres (1 micrometre is equal to 1 thousandth of a millimetre), about 50% is in the form of visible radiation, with a wavelength between 0.4 and 0.8 micrometres and around 40% is in the form of infrared radiation, between 0.8 and 3 micrometres.



α=Angolo di altezza solare alle ore 12

R.S.A.= Annual solar radiation



How to calculate the value of R.S.A.:

1. On the Google Maps website or on Wikipedia it is possible to find the coordinates (latitude and longitude) of the site in which the frames will be placed;

2. On the website **http://www.solaritaly.enea.it/CalcRggmmOrizz/Calcola3.php** **of ENEA renewable resources** on "Italian atlas of solar radiation" there is the possibility to obtain the "Monthly average of daily global solar radiation on a horizontal **s**urface" (five year average 1995-1999),

- By inserting the latitude and longitude of the place in which windows and curtain walls will be installed,
- By selecting the ENEA-SOLTERM box,
- By choosing MJ/m2 as the measurement unit and requesting the value of R.S.A. for all months.

3. Double click on calculate and at the bottom of the third page it will be possible to find the "global annual radiation on a horizontal surface" value (a typical 365-day year).

Coating

In the exposure conditions with R.S.A. values = Average Annual Solar Radiation greater than 5.400 MJ/m$_2$ class 2 or 3 powders have to be used.

Purely as an example, the R.S.A. values of some Italian cities are reported in the table

Città	I.S.A. in MJ/m^2	Latitudine N	Longitudine E
Bolzano	4.829	46°30'0''	11°21'0''
Milano	5.065	45°27'50''	9°21'25''
Bologna	5.413	45°29'7''	11°21'0''
Firenze	5.147	43°46'17''	11°15'15''
Roma	5.460	41°53'35''	12°28'58''
Napoli	5.535	40°50'0''	14°15'0''
Taranto	5.549	40°28'0''	17°14'0''
Porto Torres	5.627	40°50'13''	8°24'5''
Palermo	5.812	38°06'56''	13°21'41''
Ragusa	5.901	36°55'30''	14°43'50''

For information only: in Florida the annual values of R.S.A in the four-year period 2007-2011 have varied between 6200 and 6400 MJ / m^2.

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Thanks for your attention