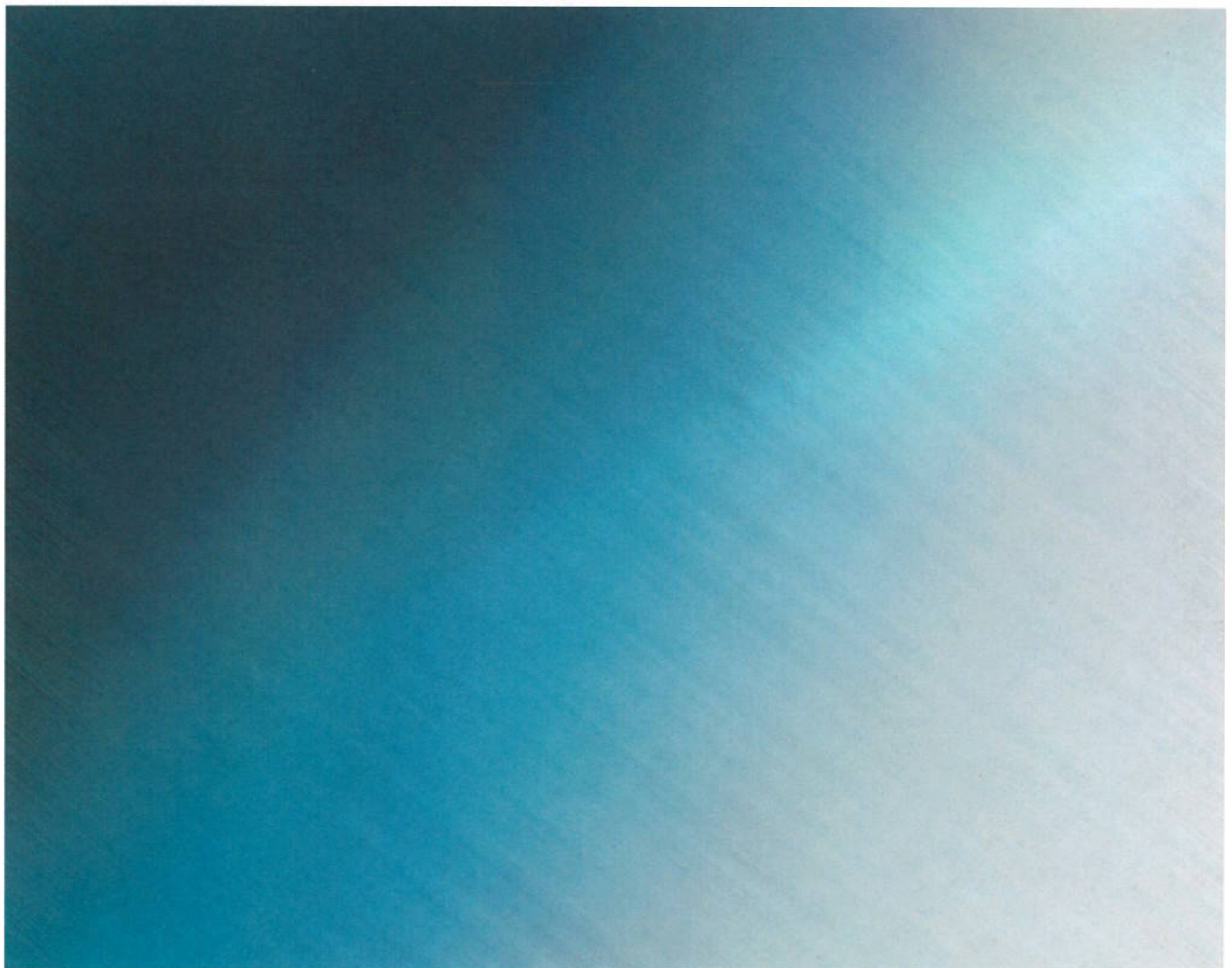


posco

PosMAC[®] 3.0

**POSCO Magnesium Aluminium
alloy Coating product**





PosMAC*3.0 is a range of steel products that provide 5 to 10 times greater corrosion resistance compared with ordinary hot-dip galvanized steel sheet (GI, GI(H)) of the same coating weight. PosMAC*3.0 especially has an excellent cross section corrosion resistance. Ordinary products having thick plating can be replaced with it. The same processing, assembly and painting processes can be applied to PosMAC*3.0 as one would apply to GI steels.

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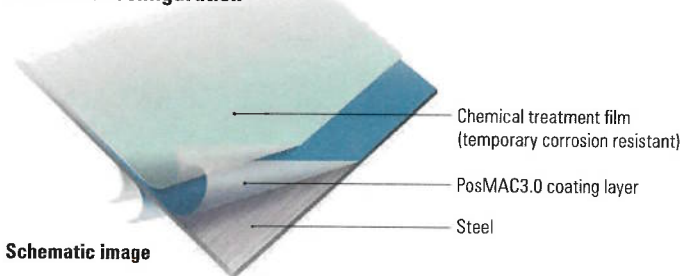
What is PosMAC®3.0?

What is PosMAC®3.0?

PosMAC3.0(POSCO Magnesium Aluminium alloy Coating product) is a ternary alloy coated steel(Zn- 3%Mg- 2.5%Al) with high corrosion resistance developed with POSCO's own technology.

* **PosMAC®3.0** is the registered trademark of POSCO.

Product configuration



Product characteristics

- PosMAC3.0 is a corrosion resistant products that is 5 to 10 times stronger resistance than that of a normal hot-dip galvanized steel sheet(GI, GI(H)) with the same coating weight. PosMAC3.0 has an excellent cross-section corrosion resistance; normal thick plating products can be replaced with this product.
- The same processing, assembly and painting process can be applied to PosMAC3.0 as one would apply to GI.

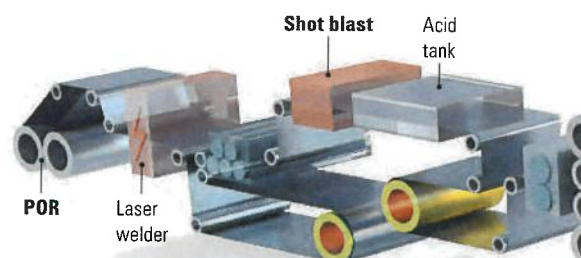
Product characteristics comparison

- PosMAC3.0 is superior to GI in corrosion resistance on flat, machined, cross-section parts and is superior to galvalume in cross-section corrosion resistance.

Quality items		PosMAC3.0	GI	Galvalume
Hardness(Hv) of coating layer		110~130	60~80	80~100
Friction characteristics		◎	X	△
Corrosion resistance	Flat sheet	◎	△	◎
	Bending	◎	△	△
	Cup	◎	△	◎
	Cross-section	◎	△	X
Chemical resistance		◎	△	△
Weldability		◎	◎	◎

Equipment specifications

Classification		Pohang #1CGL	Gwangyang #2CGL
Operation date		2012. 04	1992.6
Capacity		750 thousands ton/year	510 thousands ton/year
Product dimensions	Thickness	0.4~4.5mm	0.45~2.3mm
	Width	800~1650mm	720~1860mm
Coating weight		60~400 g/m ²	80~350g/m ²
Product grade		General, Structural	Automobile, General, Structural
Post treatment		Chromate(Cr ⁶⁺ , Cr ³⁺), Cr-free, Oiling	Chromate(Cr ³⁺), Oiling



Manufacturing equipment

Entry



The equipments at the entry section are composed of two pay off reels and a welder.

Shot blast, Pickling



The scales from an HR coil can be removed completely by passing through the shot blast and pickling tank.

Galvanizing



Zn-Mg-Al is coated onto the surface of the steel sheet after passing the annealing furnace in the pot reserved for PosMAC3.0, and then the targeted coating weight is achieved by spraying high pressurized air from the air knife.

SPM & Post treatment

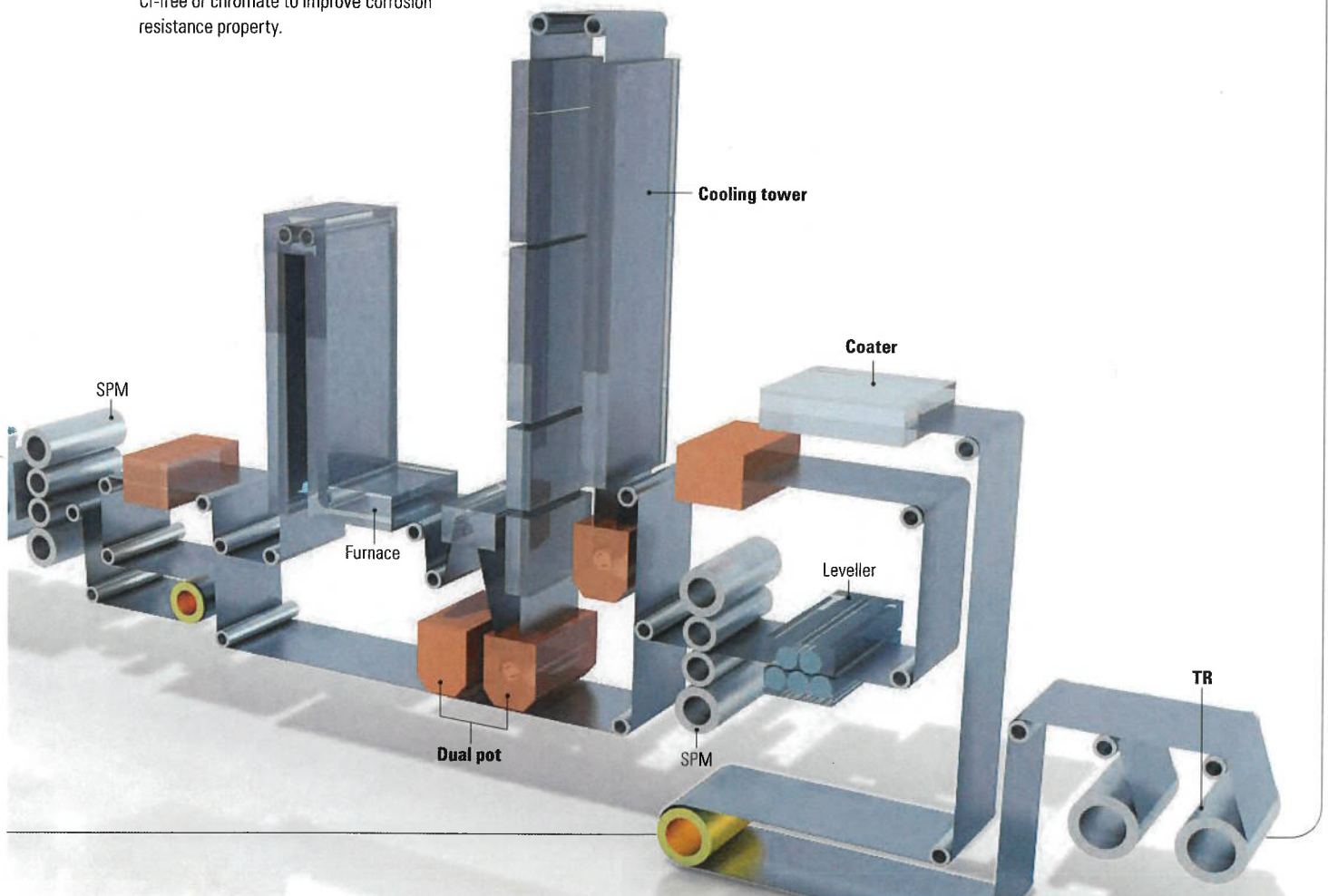


In order to obtain the flat shape and elegant surface, PosMAC3.0 product get passed through a skin pass mill. Also to prevent any white rust, product surface is coated with Cr-free or chromate to improve corrosion resistance property.

Inspection & Coiling



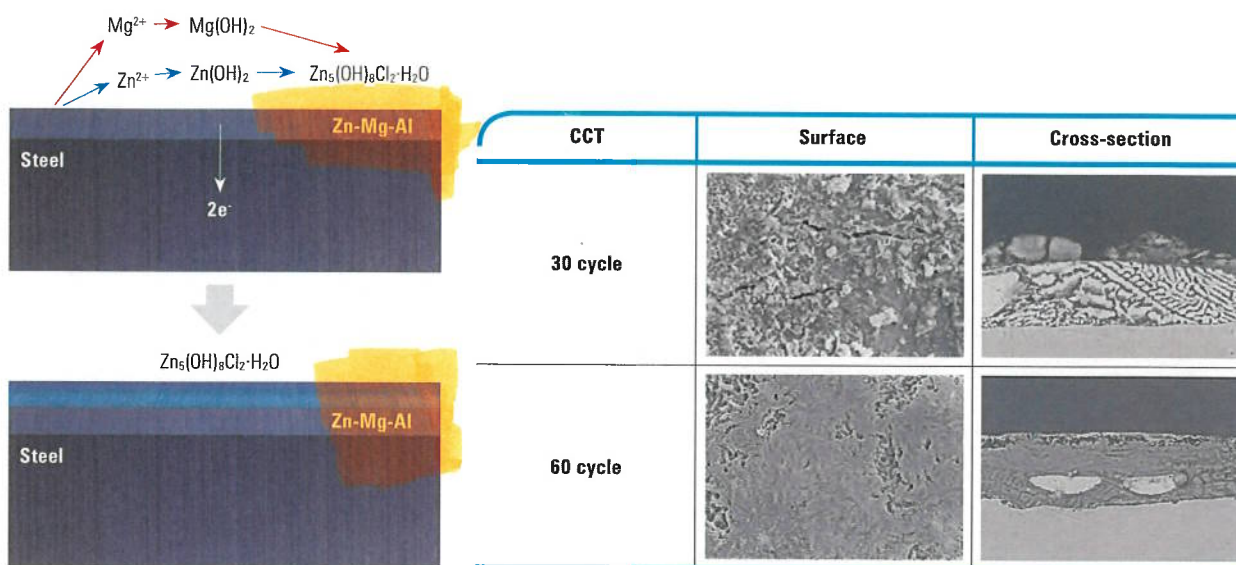
The equipment at the exit section are composed of an inspection table and an oiler equipment where the products are inspected synthetically and judged whether they are adequate for sale.



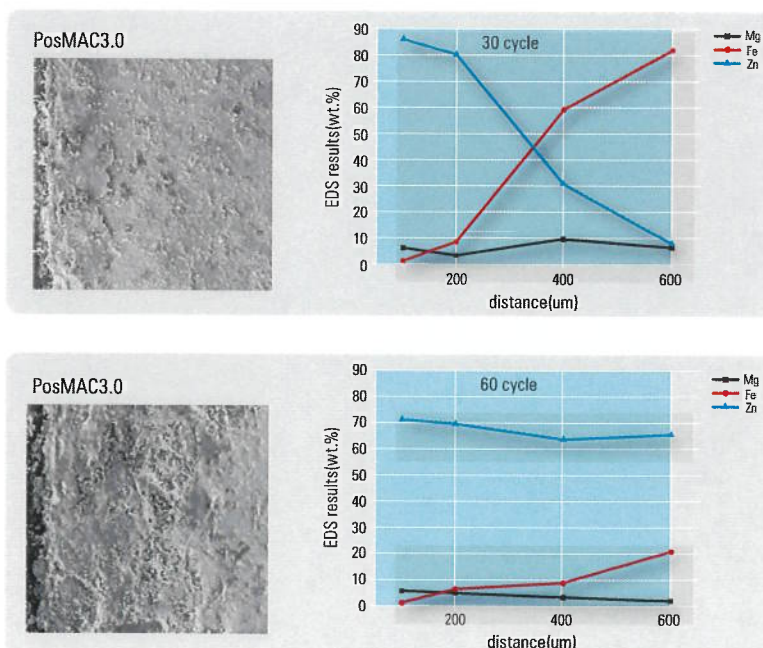
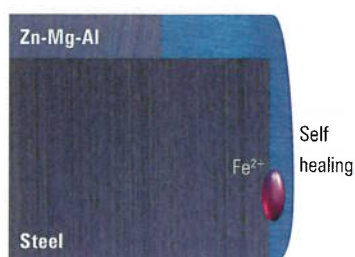
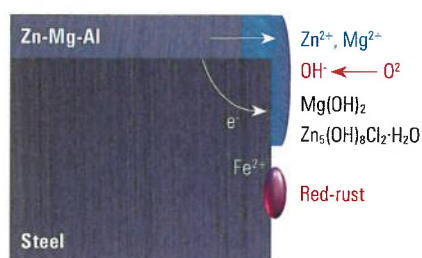
Corrosion resistance of PosMAC®3.0

Why PosMAC®3.0 has excellent corrosion resistance?

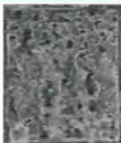




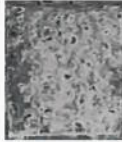

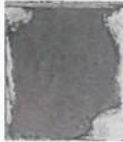








The magnesium(Mg) in PosMAC3.0's coating layer will accelerate the formation of a dense corrosion product called "Simonkolleite ($Zn_5(OH)_8Cl_2 \cdot H_2O$)" which is extremely stable. When simonkolleite is formed on the surface of the coating layer in a film-like-form, it plays a role as a corrosion inhibitor for the base metal.



In addition, the upper coating layer can be dissolved to cover the cross-section and accelerate the growth of a stable corrosion product. However red-rust can be found in the already exposed steel plate, but fortunately, the film of the corrosion products covers the cross-section and serves to prevent corrosion.



Comparison to galvanized(GI(H)) / Galvalume in corrosion resistance on flat surfaces(SST)

SST	GI(H)	Galvalume	PosMAC3.0	
The coating weight on both sides	600g/m ²	100g/m ²	200g/m ²	350g/m ²
480Hr				
720Hr				
1440Hr				
2400Hr				

· PosMAC3.0 shows 5 to 10 times the corrosion resistance compared to galvanized steel sheet on flat surfaces.




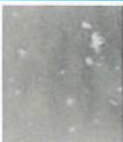





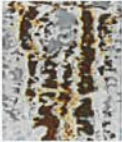
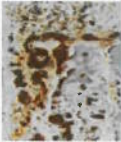
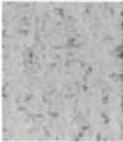







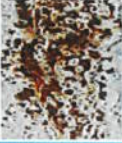




· In addition, PosMAC3.0 shows equal or greater corrosion resistance than Galvalume on flat surfaces.

Test method :

Salt Spray Test (SST),
[ISO 9227, JIS Z2371, ASTM B117] 5%NaCl, 35°C

Comparison to galvanized(GI(H)) / Galvalume in corrosion resistance on flat surfaces(CCT)

- PosMAC3.0 shows 5 to 10 times the corrosion resistance compared to galvanized steel sheet on flat surfaces.
- In addition, PosMAC3.0 shows equal or greater corrosion resistance than galvalume on flat surfaces.

CCT	GI(H)				Galvalume	PosMAC3.0		
The coating weight on both sides	120g/m ²	200g/m ²	300g/m ²	600g/m ²	100g/m ²	140g/m ²	200g/m ²	275g/m ²
10 cycle (80Hr)								
70 cycle (560Hr)								
120 cycle (960Hr)								

Test method : Cyclic Corrosion Test (CCT),

[ISO 14993] 1Cycle : Salt Spray 2Hr(5%NaCl, 35%) → Dry 4Hr(25%RH, 60°C) → Wet 2Hr(95%RH, 50°C)

Corrosion resistance of PosMAC®3.0



PosMAC®3.0's corrosion resistance on flat sheets compared to batch plated GI

(Korea Testing & Research Institute : Test No. TBO-000048)

PosMAC3.0 shows 5~10 times corrosion resistance to that of batch plated GI sheet.

SST	PosMAC3.0		Batch plated GI
Coating weight	60g/m ²	300g/m ²	550g/m ²
480 Hr			
720 Hr			
1200 Hr			
2400 Hr			

Test method : Salt Spray Test (SST), [ISO 9227, JIS Z2371, ASTM B117] 5%NaCl, 35°C

PosMAC®3.0's corrosion resistance on bent areas compared to that of hot dip galvanized steel(GI(H)) and galvalume

PosMAC3.0 shows 2~3 times corrosion resistance to that of GI(H) and Galvalume on bent areas.

Thickness/ Steel type	2.0 mmt CQ Grade		
SST	PosMAC3.0	GI(H)	Galvalume
Coating weight	140g/m ²	140g/m ²	140g/m ²
800 Hr			
1200 Hr			

Test method : Salt Spray Test (SST), [ISO 9227, JIS Z2371, ASTM B117] 5%NaCl, 35°C

Corrosion resistance of cup drawing region

Corrosion resistance of PosMAC3.0 is 2~3 times higher than that of GI(H) while equal to that of Galvalume.

CCT	PosMAC3.0	GI(H)	Galvalume
Coating weight	275g/m ²	350g/m ²	200g/m ²
60 cycle		 Red-rust happened after 35 cycle	
80 cycle			
100 cycle			

Test method : Cup Drawing → Cyclic Corrosion Test (CCT), [ISO 14993] 1Cycle : Salt Spray 2Hr(5%NaCl, 35%) → Dry 4Hr(25%RH, 60°C) → Wet 2Hr(95%RH, 50°C)

Corrosion resistance of PosMAC®3.0

Weathering test on cross-section part (Korea conformity laboratories)

- Corrosion resistance in cross-section parts of PosMAC3.0, is superior to that of GI(H) and galvalume.
- PosMAC3.0 also gets red-rust in cross-section parts when initially exposed outdoors. However as the time goes by, the corrosion(red-rust) area of PosMAC3.0 tends to decrease through the formation of its distinctive oxide-based material(simonkollite).
- If the thickness of PosMAC3.0 is more than 1.6t, we recommend post-treatment(catalog 19p, 22p), because it is not fully covered by simonkollite after 1 year. And when the thickness of PosMAC3.0 is less than 1.6t and cross-section parts is clean without red-rust at initial construction, it is recommended to carry out post-treatment by the option of the customers.



Outdoor exposure test

Sample	Thickness	Coating weight (g/m ²)	Cross-section image		
			After 6 months	After 1 year	After 2 years
PosMAC3.0	1.2	130			
	1.6	120			
	2.0	300			
Galvalume	1.6	120			
GI(H)	1.6	180			

Note. Outdoor exposure test at seosan chemical industrial complex(Oct. '12 ~ Oct. '14, Korea conformity laboratories)

Estimation of PosMAC®3.0's longevity (KOBELCO from Japan)

Classification	Test sample	Thickness(mm)	Coating weight (Both sides, g/m ²)	Post-treatment	Corrosion start time of Fe(CCT)	Estimate of longevity (Salt damage environment)
Ternary alloy coated steel	PosMAC3.0 (POSCO)	2.0	140	Cr	1,920Hr	50 years
		2.0	350	Cr-free(NB)	3,700Hr	100 years
	Competitor's high corrosion resistant Type 1	2.0	120	Cr-free	1,920Hr	50 years
		1.6	190	Cr	2,200Hr	60 years
	Type 2	0.27	120	Cr-free	2,200Hr	60 years
Galvanized steel	GI(H) (POSCO)	2.0	600	Cr	960Hr	25 years(Base)
	Batch GI (Domestic galvanizer)	2.0	1,000	-	960Hr	25 years


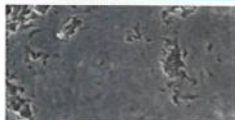
Test Method : Cyclic Corrosion Test (CCT), [ISO 14993] 1Cycle : Salt Spray 2Hr(5%NaCl, 35%) → Dry 4Hr(25%RH, 60°C) → Wet 2Hr(95%RH, 50°C)

Evaluation of longevity : Japan's bridge construction association stated that the longevity of a GI with K600 zinc coating has a corrosion resistance longevity of 25years. Based on this study the relative longevity of other comparable steel products was extracted.

White rust occurrence of the PosMAC®3.0

- PosMAC3.0 is strong corrosion-resistant steel to protect the base metal by forming oxide of a dense structure called simonkolleite.
- Therefore, white rust also can occur as usual galvanized steel. To avoid white rust of PosMAC3.0 before the construction, the following should be noted.

■ FE-SEM image comparison of the corrosion product of the PosMAC3.0 & GI

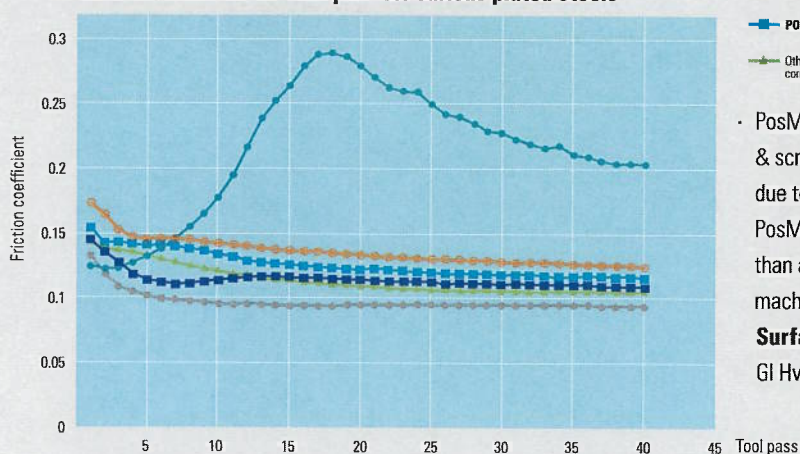
Division	GI	PosMAC3.0
Classification	ZnO	$\text{Zn}_5(\text{OH})_8\text{Cl}_2$, H_2O , $\text{Zn}_4\text{CO}_3(\text{OH})_6$, H_2O
Image	 Porous & incompact structure	 Stable & dense structure

■ Precautions when storing the PosMAC3.0 before the construction

- Coils, sheet, and processed products must be kept dry and smooth-ventilated place. White rust can be caused by water vapor on the ground floor when storing.
- Set vinyl and the thick pentagonal timber (thicker than 10mm recommended) on the ground first and stack the coils to ventilate ordinarily.
- The coil and sheet should be wrapped when raining and if the rain stops, the package should be removed so that the internal water could evaporate and get removed.
- To cover vinyl above the unpackaged coil where it has moisture in the air should not be kept for a long time as it might promote the reaction with coil and the moisture.
- When keeping the coil for a long time, it should be used quickly and in first-in-first-out manner since there is the possibility that white rust might occur.
- The unpackaged or package-separated coils have to be used quickly.

Galling & scratch resistance of PosMAC®3.0

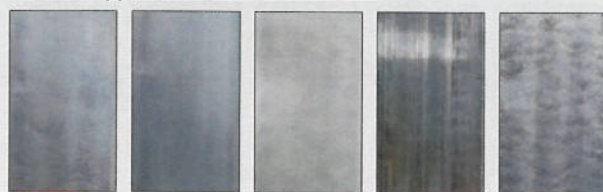
■ Surface hardness vs. Tool pass for various plated steels



- PosMAC3.0 has particularly excellent galling & scratch resistance compared to that of GI due to its high surface hardness. Consequently, PosMAC3.0 excretes less dust-like compound than a GI, so our customers can keep their press machines clean during the forming process.

Surface hardness : PosMAC3.0 Hv 110~130, GI Hv 60~80, Galvalume Hv 80~100

■ Surface appearance after friction test



PosMAC3.0

Type 1

Type 2

GI

Galvalume

Test condition

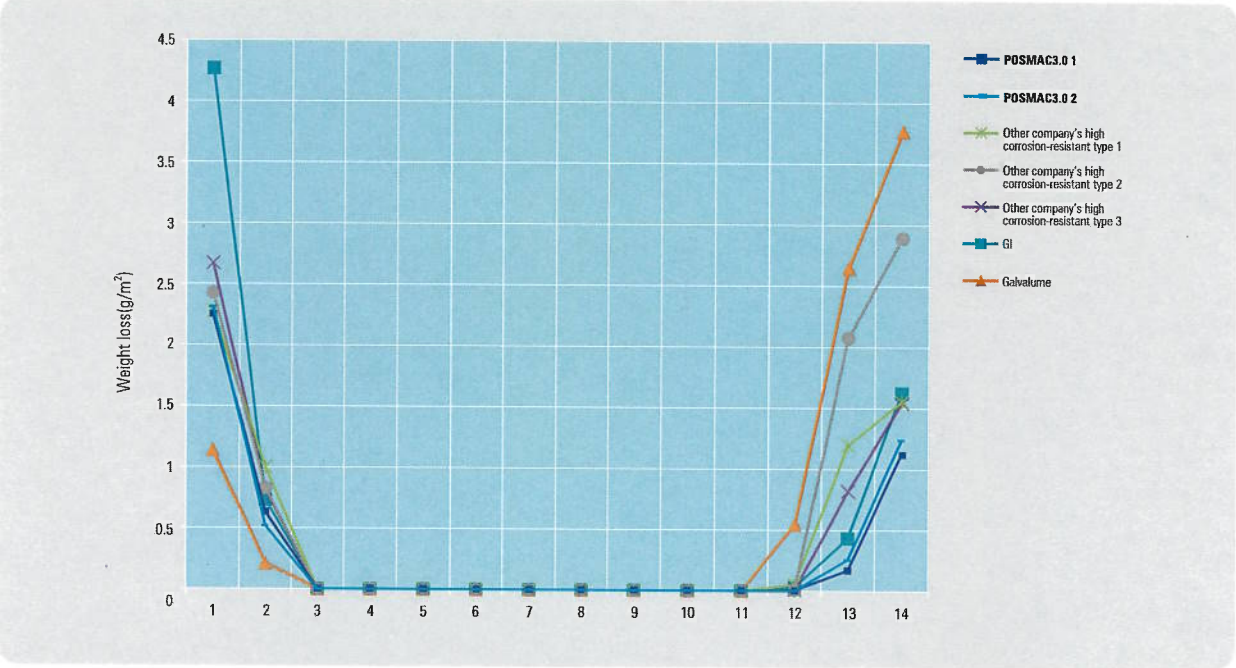
- Target force : 333.3 kgf, Pressure : 3.736 MPa
- Tip movement : 200 mm length, 20 mm/sec rate
- Avg. calculation region : 30mm ~ 170mm
- P-DBH(washing oil) oiled.

Type 1, 2 Other company's high corrosion-resistant

Chemical resistance of PosMAC®3.0

- PosMAC3.0 shows less weight loss of plating layer in comparison to GI and galvalume under either an acidic or an alkaline environment. This means that PosMAC3.0 is much more resistant to potent chemicals than other plated steels products.
- GI and galvalume are especially weak under the strong acidic condition(pH 1~2) and strong basic condition(pH 13~14), respectively.
- PosMAC3.0 is applicable for farm housing and building materials thanks to its excellent chemical resistance.

Weight loss of plating layer vs. pH for various plated steels



Test method : Weighing the loss of plated layer after dipping into various solutions(pH 1~14, H₂SO₄, NaOH and NH₃ single or mixed) for 24 hours.

Chemical resistance against pH 1 solutions

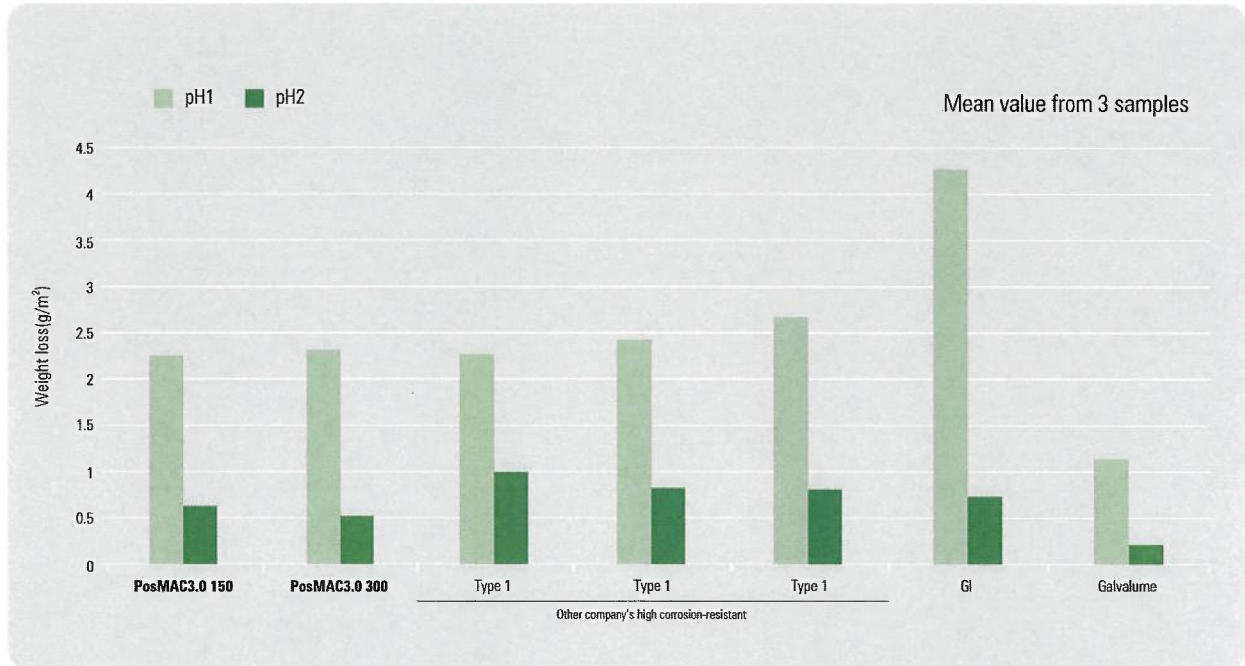
PosMAC3.0 150g/m ²	PosMAC3.0 300g/m ²	Other company's high corrosion-resistant			GI 180g/m ²	Galvalume 120g/m ²
		140g/m ²	280g/m ²	280g/m ²		

Chemical resistance against pH 2 solutions

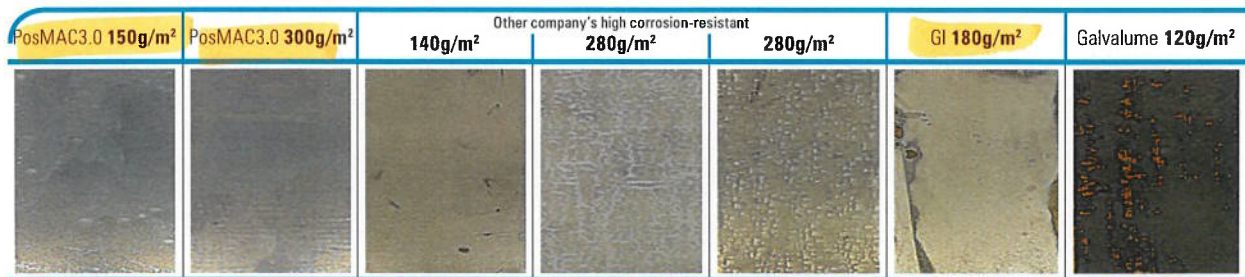
PosMAC3.0 150g/m ²	PosMAC3.0 300g/m ²	Other company's high corrosion-resistant			GI 180g/m ²	Galvalume 120g/m ²
		140g/m ²	280g/m ²	280g/m ²		

- All of the commercial alloy plated steels above shows similar chemical resistance under acidic conditions(pH 1~2).
- The galvalume which has the highest Al content shows the highest chemical resistance under acidic conditions(pH 1~2).

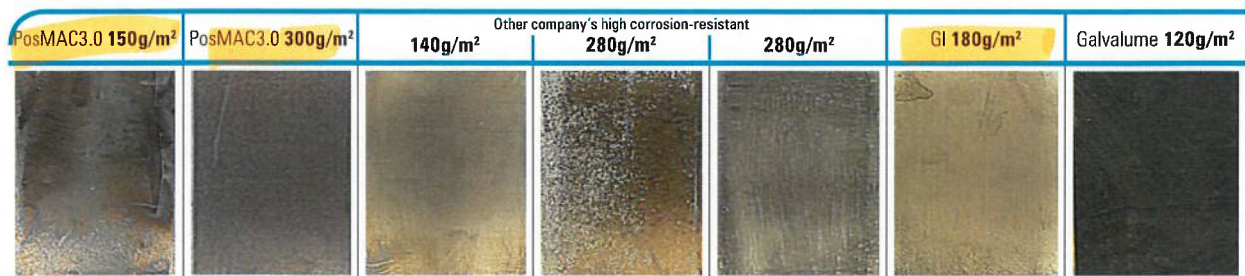
■ Weight loss from pH 1 and 2 solutions



■ Chemical resistance against pH 13 solutions

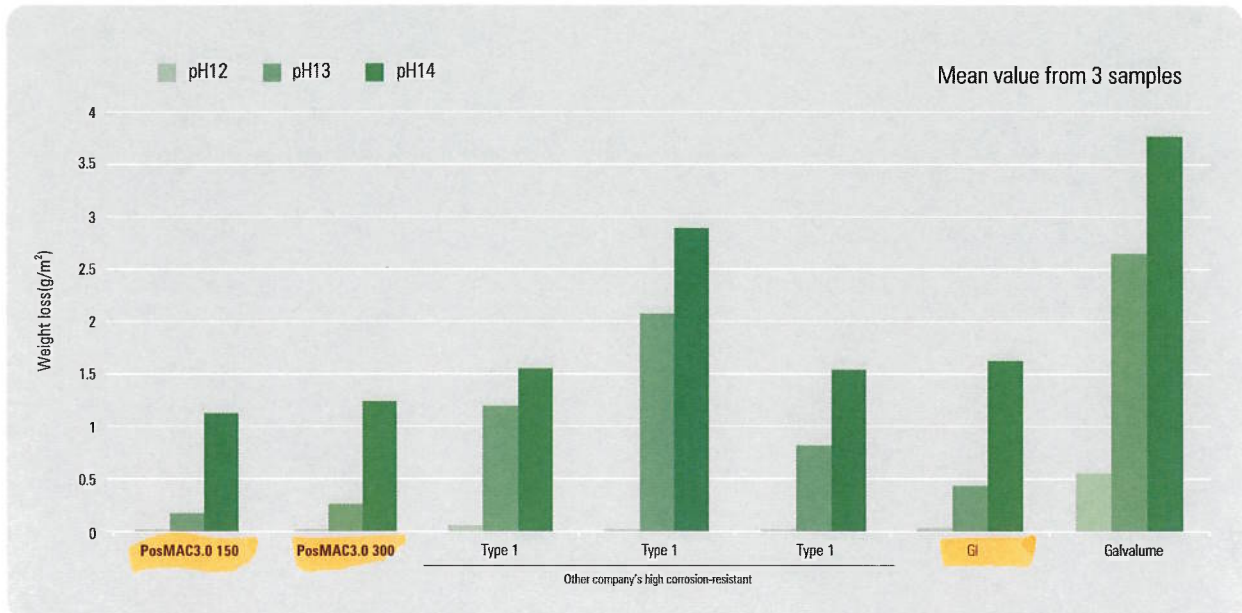


■ Chemical resistance against pH 14 solutions



Chemical resistance of PosMAC®3.0

■ Weight loss from pH 12, 13 and 14 solutions



- Galvalume's chemical resistance is the poorest under alkaline conditions (pH 12~14) although its chemical resistance was excellent under acidic conditions (pH 1~2).
- PosMAC3.0's chemical resistance is especially excellent under alkaline conditions (pH 12~14).

Chemical resistance to ammonia solutions



■ Evaluation method

- Dipping into a 10% ammonia solution (pH 12.5).
- Replace with fresh solution every 100 hours.
- Surface inspection after 1200 hours.


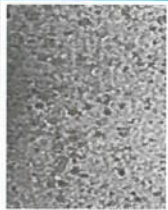
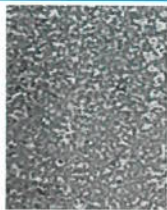
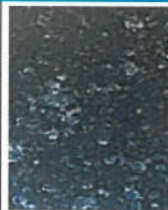

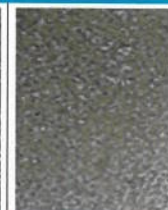




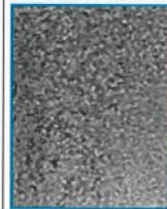
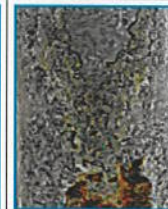
■ Anti-corrosiveness after 1000, 1200 hours

Dipping Time	PosMAC3.0 120g/m²	GI 275g/m²	Galvalume 100g/m²	Dipping Time	PosMAC3.0 120g/m²	GI 275g/m²	Galvalume 100g/m²
1000Hr				1200Hr			

- Galvalume displayed red-rust formation after 400 hours. / GI displayed rapid red-rust formation after 1000 hours.
- PosMAC3.0 did not display red-rust formation after 1200 hours.


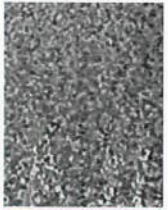






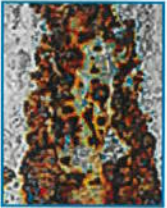

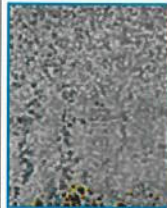
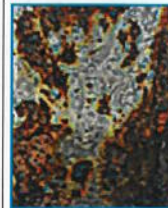
Acid rain simulation test results

- Red-rust formed on the exposed edge of the galvalume after 30 cycles / similar symptoms became visible on the GI after 60 cycles.

Acid rain simulation	30 Cycle			60 Cycle		
	PosMAC3.0	GI	Galvalume	PosMAC3.0	GI	Galvalume
The coating weight on both sides	100g/m ²	275g/m ²	100g/m ²	100g/m ²	275g/m ²	100g/m ²
Cut surface edge taped						
Cut surface edge exposed						

Test condition : Artificial acid rain(0.1% NaCl solution + H₂SO₄, 35°C, 1Hr, pH4) → Drying(30%RH at 60°C, 4Hr) → Humid environment(95%RH at 50°C, 3Hr).

- Red-rust did not form on the exposed edge of the PosMAC3.0 after 90 cycles.

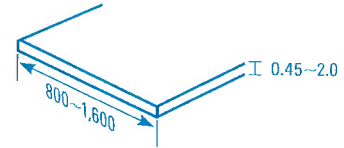
Acid rain simulation	90 Cycle			120 Cycle		
	PosMAC3.0	GI	Galvalume	PosMAC3.0	GI	Galvalume
The coating weight on both sides	100g/m ²	275g/m ²	100g/m ²	100g/m ²	275g/m ²	100g/m ²
Cut surface edge taped						
Cut surface edge exposed						

Test condition : Artificial acid rain(0.1% NaCl solution + H₂SO₄, 35°C, 1Hr, pH4) → Drying(30%RH at 60°C, 4Hr) → Humid environment(95%RH at 50°C, 3Hr).

PosMAC® 3.0(CR Base) specification

CR Base PosMAC® 3.0

- Coating mass : 80~350g/m² (Both sides)
 - Post treatment : ECO Chromate(CE)
 - Size in production(CQ) : Thickness 0.45~ 2.3mm / Width 720 ~ 1,860mm
- ※ Width may vary depending on the thickness



Grade	POSCO	KS D 3030	JIS (유사 규격)	Mechanical properties(MPa,%)			
				YP	TS	EL	CMB
CQ	PM3CT270CQ (C-PosMAC-C)	KS-SGMCC	JIS-SGCC	170~400	270~450	30~	1T
DQ	PM3CT270DQ (C-PosMAC-D)	KS-SGMCD2	-	~280	270~450	36~	1T
DDQ	PM3CT270DD (C-PosMAC-N)	KS-SGMCD3	-	~280	270~450	43~	1T
Structural	PM3CT340R (C-PosMAC340)	KS-SGMC245Y	JIS-SGC340	245~450	340~500	20~	1T
	PM3CT400R (C-PosMAC400)	KS-SGMC295Y	JIS-SGC400	295~	400~	18~	2T
	PM3HT440C (C-PosMAC440)	KS-SGMC335Y	JIS-SGC440	335~	440~	18~	2T
	PM3HY340C (PosMACY340)	-	-	340~	410~	21~	2T
	PM3CT490C (C-PosMAC490)	KS-SGMC365Y	JIS-SGC490	365~	490~	16~	3T
	PM3CT570C (C-PosMAC570)	KS-SGMC560Y	JIS-SGC570	500~	570~	8~	3T

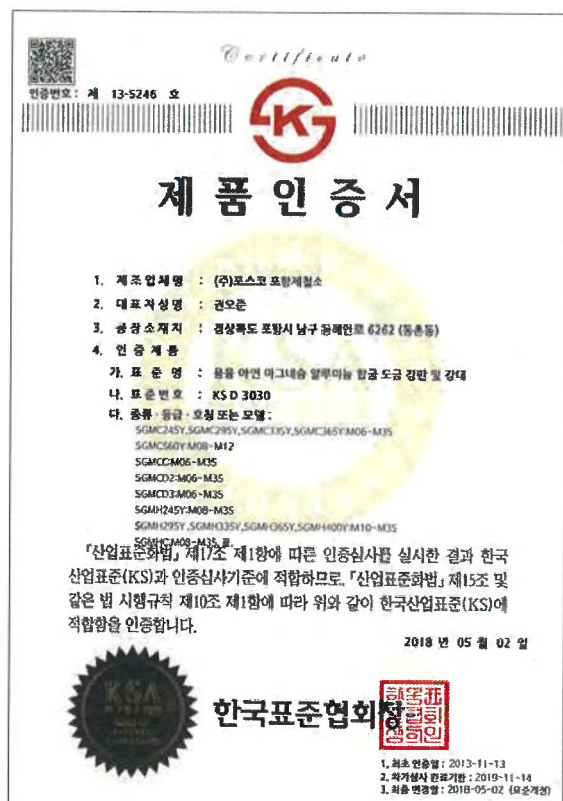
*CMB : Coating Metal Bending test

Grade	DIN EN 10346	POSCO (Equivalents)	Mechanical properties(MPa,%)		
			YP	TS	EL
CQ	EN-DX51D	PM3CT270CQ	-	270~500	22~
DQ	EN-DX52D	PM3CT270DQ	140~300	270~420	26~
DDQ	EN-DX53D	PM3CT270DD	140~260	270~380	30~
Structural	EN-S220GD	-	220~	300~	20~
	EN-S250GD	PM3CT340R	250~	330~	19~
	EN-S280GD	PM3CT400R	280~	360~	18~
	EN-S320GD	PM3CT440C	320~	390~	17~
	EN-HX340LAD	-	340~420	410~510	21~
	EN-S350GD	PM3CY340C	350~	420~	16~
	EN-S390GD	-	390~	460~	16~
	EN-S420GD*	-	420~	480~	15~
	EN-S450GD*	-	450~	510~	14~
	EN-S550GD*	PM3CT570C	550~	560~	-
Grade	ASTM 1046M () * ksi unit	POSCO (Equivalents)	YP	TS	EL
CQ	A1046-CSA	PM3CT270CQ	170~380	-	20~
	A1046-CSB	PM3CT270CQ	205~380	-	20~
DQ	A1046-FSA	PM3CT270DQ	170~310	-	26~
DDQ	A1046-DDS	PM3CT270DD	140~240	-	32~
Structural	A1046-SS230(SS33)	-	230~	310~	20~
	A1046-SS255(SS37)	PM3CT340R	255~	360~	18~
	A1046-SS275(SS40)	PM3CT400R	275~	380~	16~
	A1046-SS340(SS50)	-	340~	450~	12~
	A1046-HSLAS340(HSLAS50)*	PM3CT440C	340~	410~	20~
	A1046-HSLAS380(HSLAS55)*	PM3CT490C	380~	480~	16~
	A1046-HSLAS410(HSLAS60)*	PM3CT540C	410~	480~	12~
	A1046-HSLAS480(HSLAS70)*	PM3CT570C	480~	550~	12~

* Please be sure to consult with our associates when making orders for that spec.

Remark1) $1\text{N/mm}^2 = 1\text{MPa}$
Remark2) () is only for reference

SGMHC, SGMH245Y, SGMH295Y, SGMH335Y, SGMH365Y,
SGMH400Y



KS D 3030

Yield strength, Tensile strength, Elongation

■ Cold-rolled products

Designation	YS Min, N/mm ²	TS Min, N/mm ²	EL Min, %					Test piece
			Thickness(mm)					
			0.25≤t < 0.40	0.40≤t < 0.60	0.60≤t < 1.0	1.0≤t < 1.6	1.6 ≤ t < 2.3	
SGMCC	(250)	(270)	-	-	-	-	-	No.5, Rolling direction
SGMCD1	-	270	-	34	36	37	38	
SGMCD2	-	270	-	36	38	39	40	
SGMCD3	-	270	-	38	40	41	42	
SGMC245Y	245	340	20	20	20	20	20	No.5 Rolling direction or Cross-section
SGMC295Y	295	400	18	18	18	18	18	
SGMC335Y	335	440	18	18	18	18	18	
SGMC365Y	365	490	16	16	16	16	16	
SGMC560Y	560	570	-	-	-	-	-	

Remark1) When the anti-aging characteristics is featured in the SGMCD3 sheets and coils, the anti-aging characteristics is guaranteed for 6 months.

Anti-aging refers to the characteristic preventing stretcher strains from occurring during manufacturing.

Remark2) In principle, tensile strength tests are not performed on plates with thickness under 0.25mm.

Remark3) {} is only for reference.

Remark4) 1N/mm² = 1MPa

Coating weight(Both sides)

Coating designation	Triple point test (g/m ² , Average)	Single point test (g/m ² , Min)
(M06) ^a	60	51
M08	80	68
M10	100	85
M12	120	102
M14	140	119
M18	180	153
M20	200	170
M22	220	187
M25	250	213
M27	275	234
(M35) ^a	350	298
(M45) ^a	450	383

Remark1) For both sides, triple spots coating weight, the average value of the measurement of 3 test pieces is applied.

Remark2) For one side, single spot coating weight, the minimum value of the measurement of 3 test pieces is applied.

Remark3) Separate consultation is available for the maximum coating weight on both sides.