

ISOTEC ENERGY TECHNICAL REPORT

Comparative Report: Hot-Dip Galvanizing vs. ZM (Magnelis-type) Coating

A comparison of method, quality, design, manufacturing, corrosion and total cost impacts for steel structures in utility-scale PV plants.

Field	Value
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Critical terminology note: "Magnelis" is a registered trademark. For technical accuracy, this study uses the generic expression "ZM (Zn-Al-Mg) coated steel" wherever possible; manufacturer-specific data are separately identified.

Executive Summary

- It cannot be stated that a single coating method is absolutely superior for all PV plant components. The correct solution must be determined according to part geometry, wall thickness, manufacturing method, soil contact, weld density and target service life.
- For thin-walled, roll-formed, high-tonnage secondary supporting members, ZM-coated high-strength steels provide low mass, a high load/weight ratio and a more stable supply chain.
- For thick, welded, complex primary supporting members containing holes/closed volumes, post-fabrication hot-dip galvanizing (HDG) remains strong as a thicker, fully surface-covering protection applied after manufacturing.
- The most correct path for ISOTEC is a hybrid strategy: S420GD/S450GD + ZM430 for thin-walled secondary members, and S355 + post-fabrication hot-dip galvanizing for heavy and welded primary members.

1. Fundamental Difference Between the Methods

Topic	Continuous ZM coating (EN 10346)	Post-fabrication HDG (TS EN ISO 1461)
Application timing	At coil / flat product stage	After the part has been fabricated
Typical use	Thin-walled form profiles, serial production	Welded / heavy / complex fabrications
Normative basis	EN 10346	TS EN ISO 1461
Manufacturing effect	Low distortion, high dimensional accuracy	Shape and flow design is critical due to post-fabrication immersion
Section edges	Self-protecting film behaviour is brand-dependent	No bare surface after cutting; the entire product is coated post-fabrication
Internal cavities	Coating is pre-existing; inner surfaces of closed sections are not protected	With correct venting/drainage, inner surfaces can also be coated

2. Coating Thickness and Mass Comparison

In EN 10346, the typical single-side thickness for ZM310 and ZM430 is approximately 24 µm and 35 µm respectively. In TS EN ISO 1461, the minimum average galvanizing thickness on fabricated steel parts rises to higher levels such as 45, 55, 70 or 85 µm depending on the part's wall thickness.

Figure 1. Typical/standard thickness levels of ZM and post-fabrication hot-dip galvanizing

Case	Thickness assumption	Theoretical total coating mass (flat, two sides)
ZM310	24-25 µm/side	0.31 kg/m ²
ZM430	35 µm/side	0.43 kg/m ²
ZM620	50 µm/side	0.62 kg/m ²
HDG – 55 µm/side equivalent	≈55 µm/side	≈0.79 kg/m ²
HDG – 70 µm/side equivalent	≈70 µm/side	≈1.01 kg/m ²
HDG – 85 µm/side equivalent	≈85 µm/side	≈1.22 kg/m ²

Note: ZM values are total two-side coil-based masses. The HDG equivalents here are only for theoretical comparison on flat two-sided material; in real fabricated parts the edges, holes, inner surfaces and geometry are also coated, so total zinc consumption may vary.

3. Effect of High Strength from a Supporting Design Perspective

When S420GD or S450GD is used instead of S355, the theoretical cross-section area requirement decreases based on yield strength alone. This reduction can yield significant tonnage and logistics advantages in thin-walled PV plant profiles.

Figure 2. Theoretical equivalent mass comparison for a 100-ton S355-based system based on yield strength

Comparison	Calculation	Result
S355 base vs. S420GD	355 / 420	Equivalent mass ≈ 84.5%; theoretical saving ≈ 15.5%
S355 base vs. S450GD	355 / 450	Equivalent mass ≈ 78.9%; theoretical saving ≈ 21.1%
Warning	Local buckling, connection, deflection and manufacturing limits	Real savings in most projects remain below this theoretical upper limit

4. Corrosion Performance and Application Limits

Criterion	ZM coating	Hot-dip galvanizing	Assessment
Atmospheric corrosion	Very strong in manufacturer publications; particularly advantageous edge behaviour	Very good with thick coating; classic and widely accepted solution	Varies by part type
Soil contact	For Magnelis there is field data for ZM430/ZM620; other brands must be asked separately	Widely used and reliable for long-life applications in soil	Brand/field data is decisive
Abrasion	Magnelis publications report higher hardness and good desert behaviour	Thick but may be softer	Strong candidate for sand-abrasive sites is ZM
Post-welding	Coating burns/requires repair	Generally more advantageous as the part is dipped after welding	HDG is more practical for welded primary carriers

Criterion	ZM coating	Hot-dip galvanizing	Assessment
Cut holes / edges	Self-protecting film advantage	No issue as the product is coated after manufacturing	Both methods are strong via different mechanisms

EN 1090-2 requires that, where pre-coated products are to be welded, the coating repair method be defined in advance; and where HDG surfaces are damaged by welding, the zinc-rich repair system be defined in advance. TS 13891 accepts that iron-based products in PV field structures may be protected either by hot-dip galvanizing per EN ISO 1461 or by continuous hot-dip coating per EN 10346.

5. Pros / Cons Analysis from Production, Logistics and Quality Management Perspectives

Topic	ZM coating – advantage	ZM coating – disadvantage	HDG – advantage	HDG – disadvantage
Supply and serial production	Coil, roll-form, high speed	Brand differences affect performance	Full single-shot coating after manufacturing	Additional process and shipping requirement
Dimensional accuracy	High	Thin coating may be more susceptible to damage	Very robust coating	Immersion-related distortion risk
Welded fabrication	Limited; repair required	Additional labour	More natural choice	Vent/drain design mandatory
Mass	Lower coating mass	Higher-aggressiveness environments may require thicker class	Thick protection	Tonnage increase and bath capacity impact
Field assembly	Fast with lightweight profiles	Care needed after cutting / drilling	Thick and robust surface	Heavy part logistics

6. Most Correct Selection by PV Plant Element

Element type	Recommended solution	Rationale
Purlins / C-Z-Sigma-type thin-walled secondary profiles	S420GD or S450GD + ZM430	High strength + low tonnage + serial production advantage
Rails and light support sub-elements	ZM-coated high-strength profile or aluminium	Fast assembly and low weight
Welded primary supports, thick base plates, complex nodes	S355 + post-fabrication hot-dip galvanizing	Full-surface coating after manufacturing is safer
Heavy rammed posts / long-term ground contact	HDG or brand-specific ZM430/ZM620 depending on project and field data	Soil data is brand-dependent
Interfaces with stainless / aluminium contact	Insulation and galvanic couple control required in both methods	Coating choice alone is not sufficient

7. Final Decision

For ISOTEC, the single most correct path is a hybrid strategy: for thin-walled, high-tonnage secondary elements, standardize on EN 10346-class S420GD/S450GD + ZM430; for thick, welded or geometrically complex primary elements, protect with S355 + post-fabrication hot-dip galvanizing per TS EN ISO 1461. ZM620 or an equivalent supplier grade for C5, soil contact and high-abrasion environments should be used only with project-specific evidence.

References

- TS EN 10346:2015 – structural steels, ZM definition, coating mass and test regime.
- TS EN ISO 1461:2022 – minimum galvanizing thickness / mass criteria.

- TS EN 1090-2:2018 – clauses 10.4, 10.5 and 10.9.
- TS 13891:2019 – corrosion protection approach for PV field structures.
- ArcelorMittal Magnelis® technical publications – design life, abrasion and soil behaviour sections.
- ISOTEC Product Catalogue – ISOGROUND material structure and warranty information.