posco
Green Tomorrow, with POSCO

Development, Application and Carbon Emission Measurement of Architectural Steel Panel

based on Parametric Design

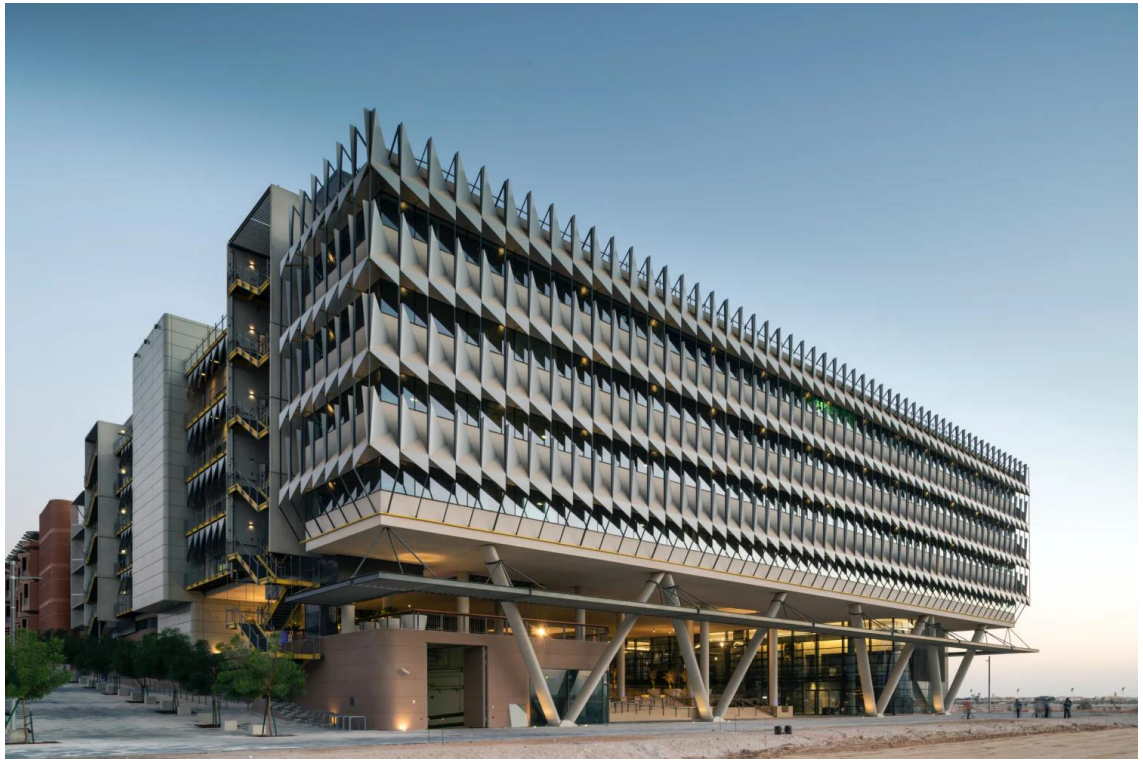
November 17, 2022

Wooseok Kim

Senior Researcher, POSCO
wooseok313@posco.com

The Need for “Design” and “Eco-friendliness”

Attention-grabbing Metal Façade Design



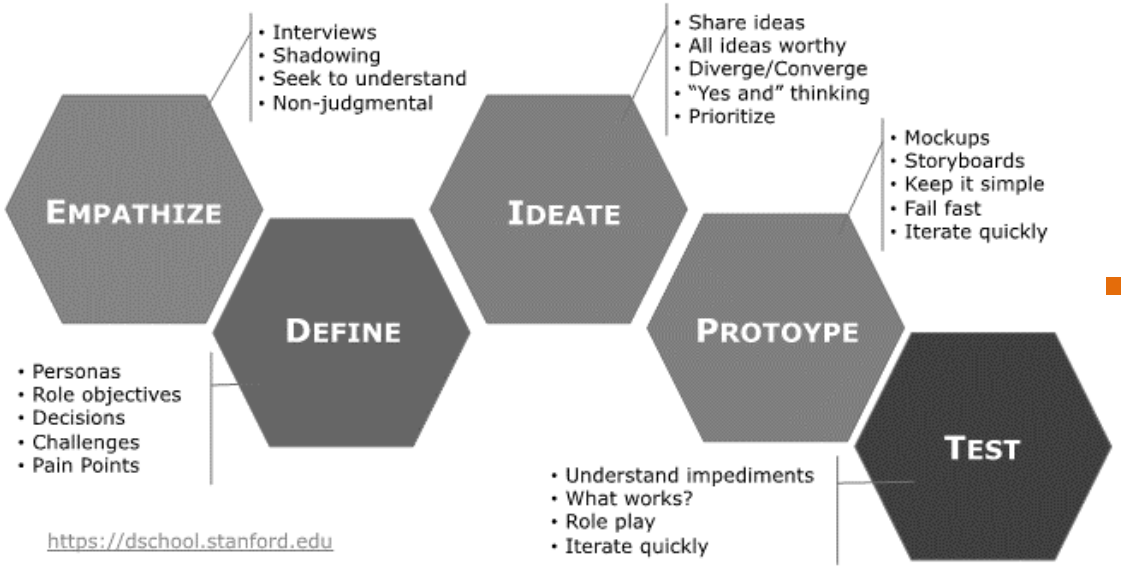
Siemens Middle East Headquarters by Sheppard Robson Architects, Abu Dhabi, UAE

Measuring and Reducing Carbon Emissions

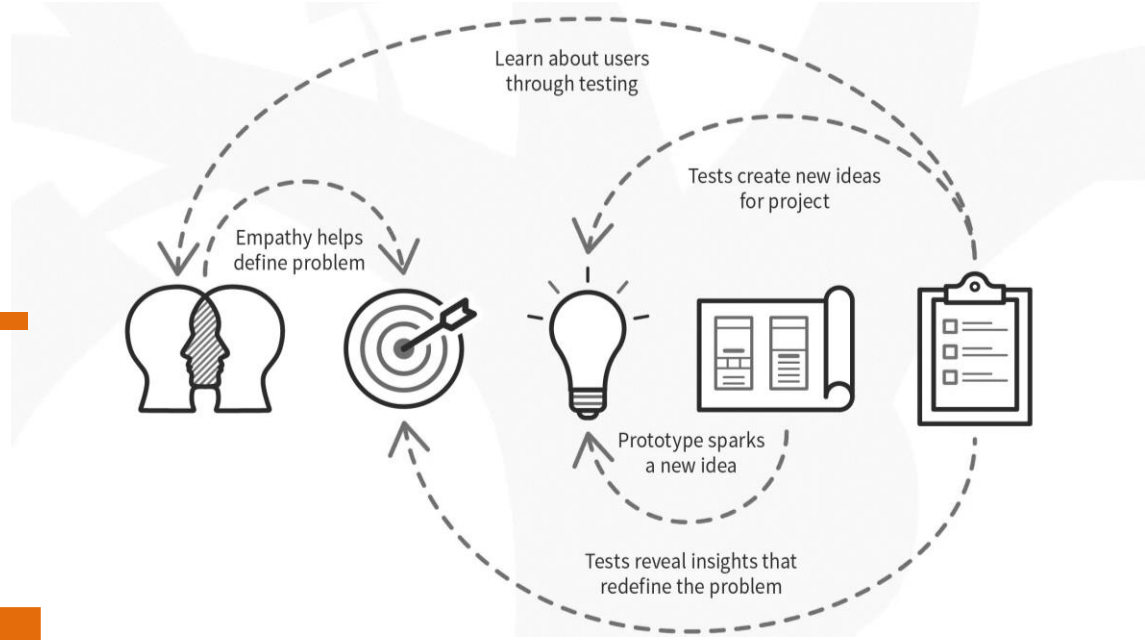
Keeping global temperature rise “well below 2 ℃, with a more ambitious target of 1.5℃, Paris Agreement, Dec. 12, 2015

Work Process based on Design Thinking

D School(Stanford)'s Process



Non-linear Process



For Steel Manufacturer

DEFINE ⇨ **IDEATE** ⇨ **PROTOTYPING** ⇨ **OPTIMIZATION**

[Case Study] (1/4)DEFINE

Steel Panel Design
Eco-friendliness

Revamping a Department Store Exterior Using Metal ; Aluminum or Steel?

Main Tower of Galleria Timeworld(opened in 1997), Daejeon, Republic of Korea

Architect's Proposal for **Main Tower** Exterior Remodel

[Case Study] (1/4)DEFINE

Steel Panel Design

Eco-friendliness

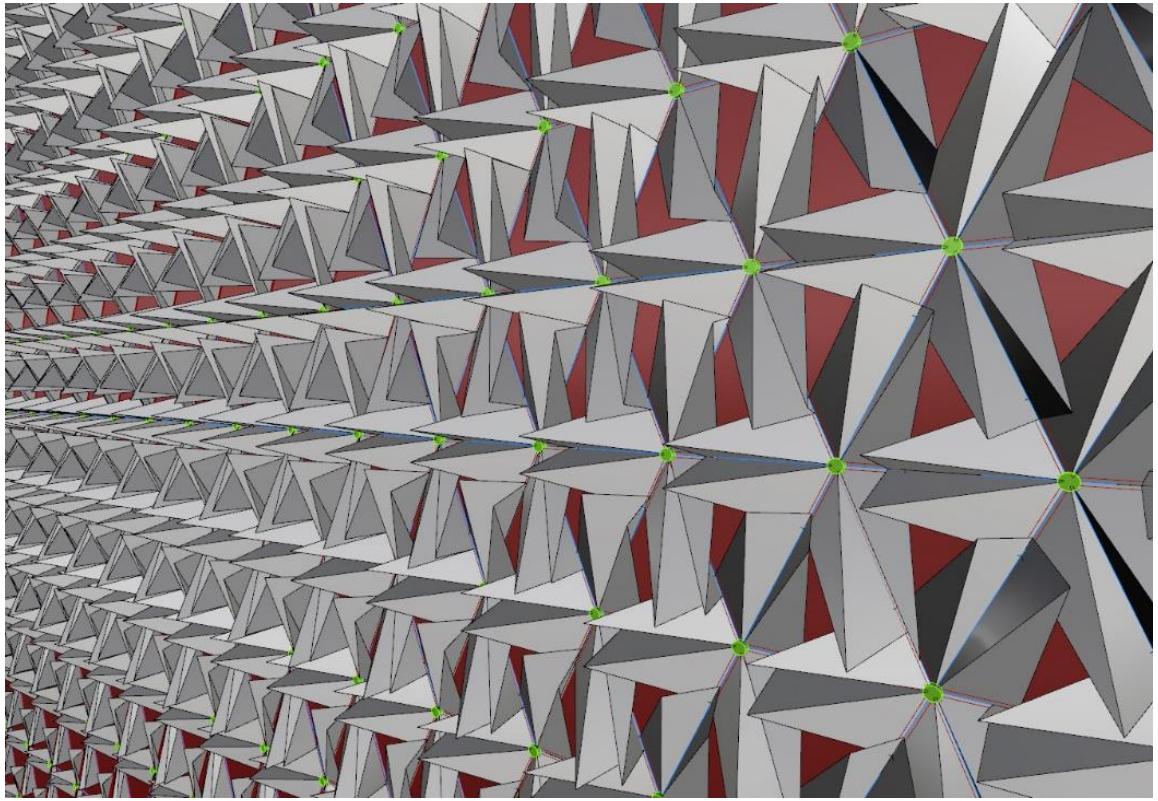
Revamping a Department Store Exterior Using Metal ; Aluminum or Steel?

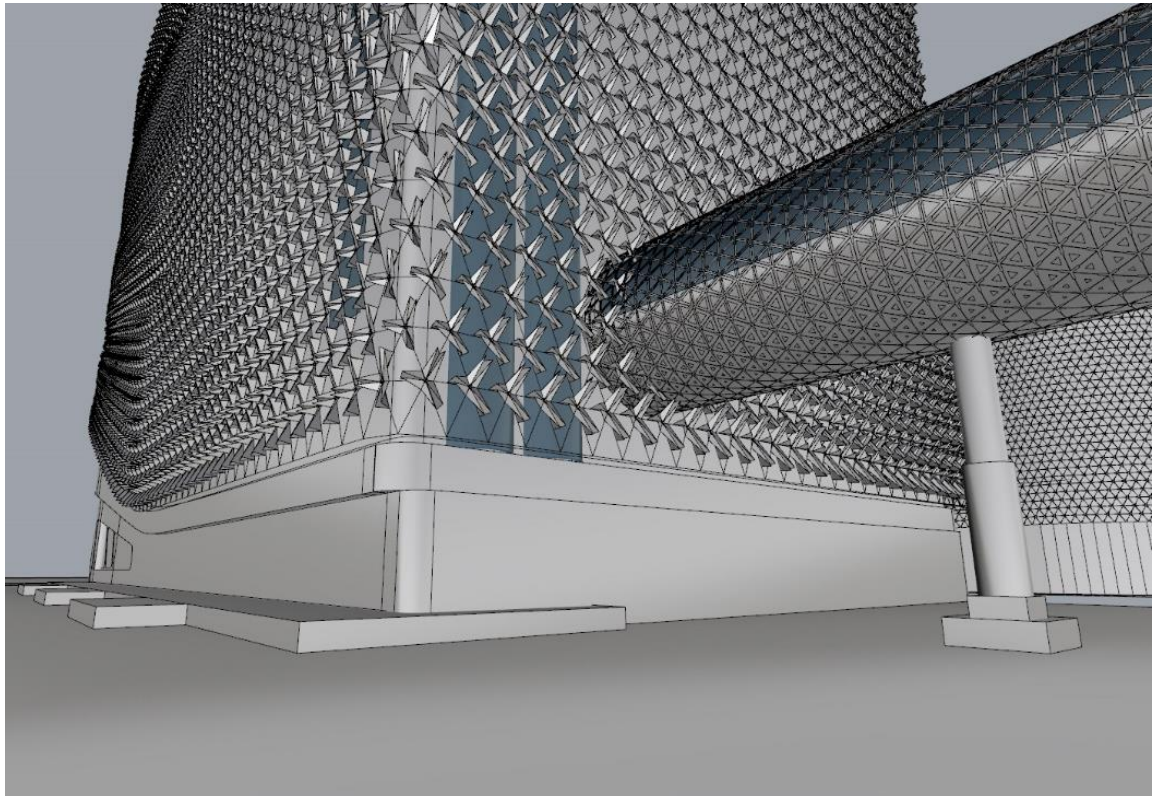
Architect's Proposal for **East Tower** Exterior Remodel

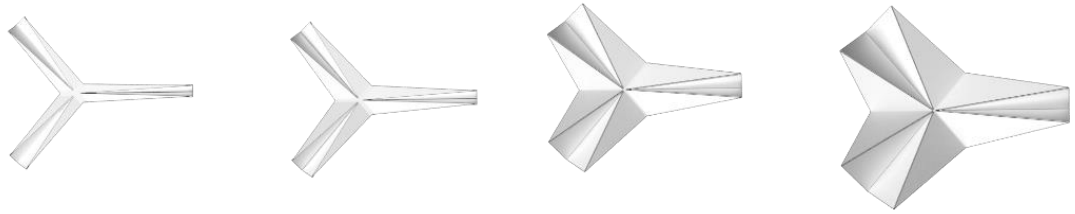
Architect's Proposal for **West Tower** Exterior Remodel

[Case Study] (1/4)DEFINE

Revamping a Department Store Exterior Using Parametric Design

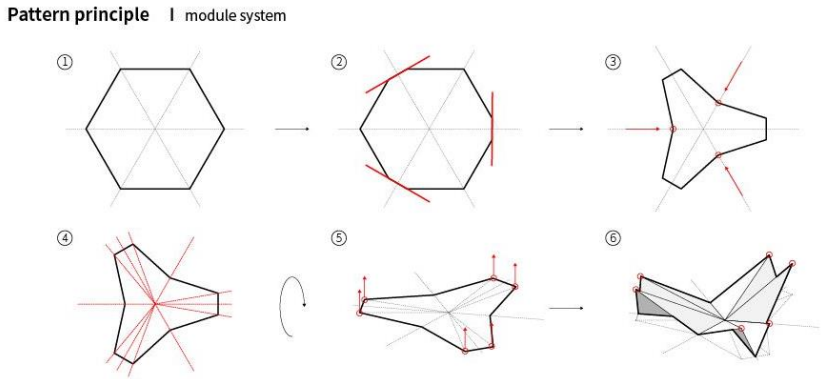


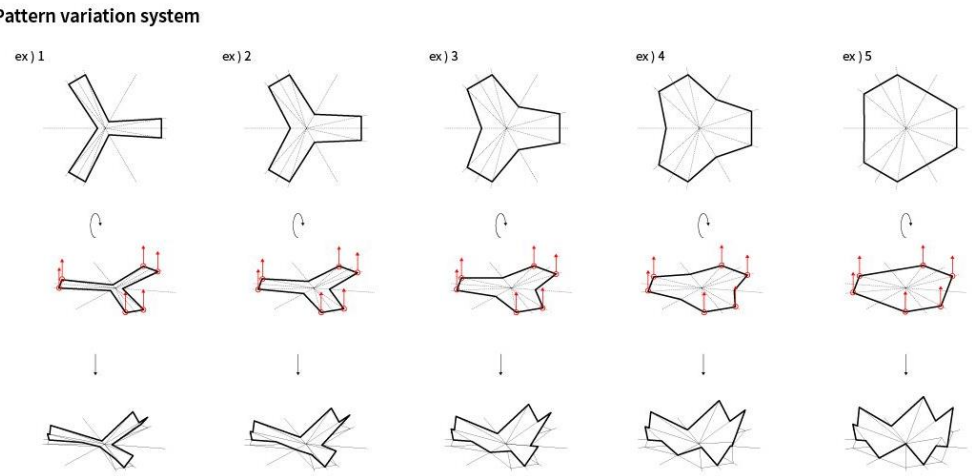




[Case Study] (1/4)DEFINE

Revamping a Department Store Exterior Using Parametric Design

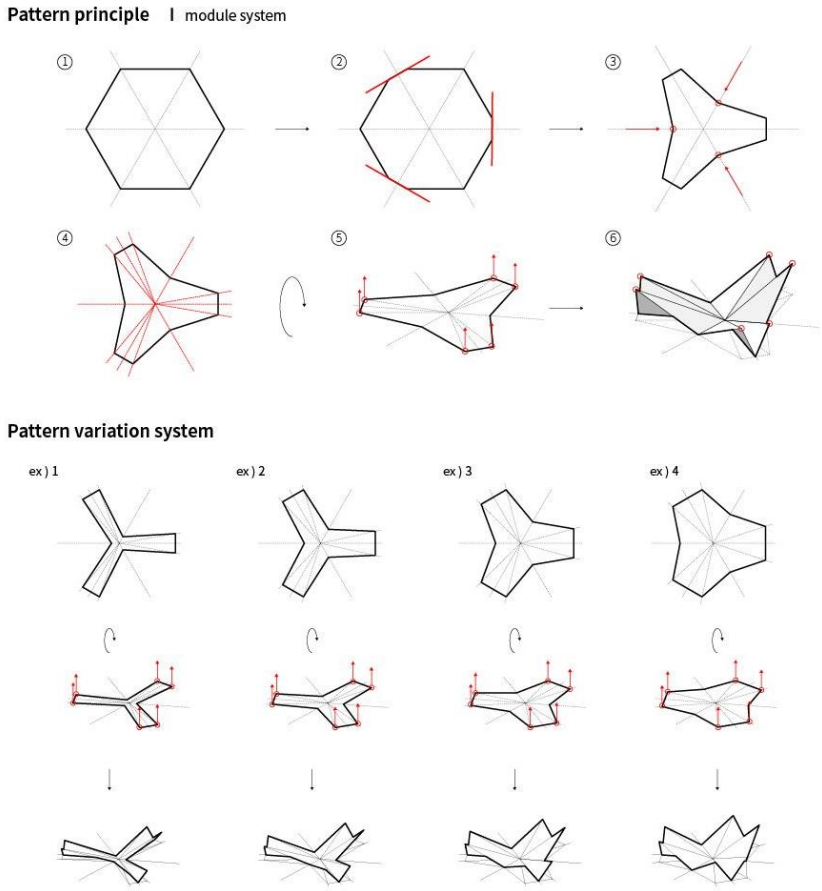




- Exterior Panel
- In the Middle of Downtown
- Flower-shaped Module Different in Size and Shape
- Largest Module more than 2 meters of height
- Construction During Business Hours
- Additional Painting
- Media Façade at Night

[Case Study] (2/4)IDEATE

Initial Idea for Implementing the Design



PosMAC the high corrosion resistance steel

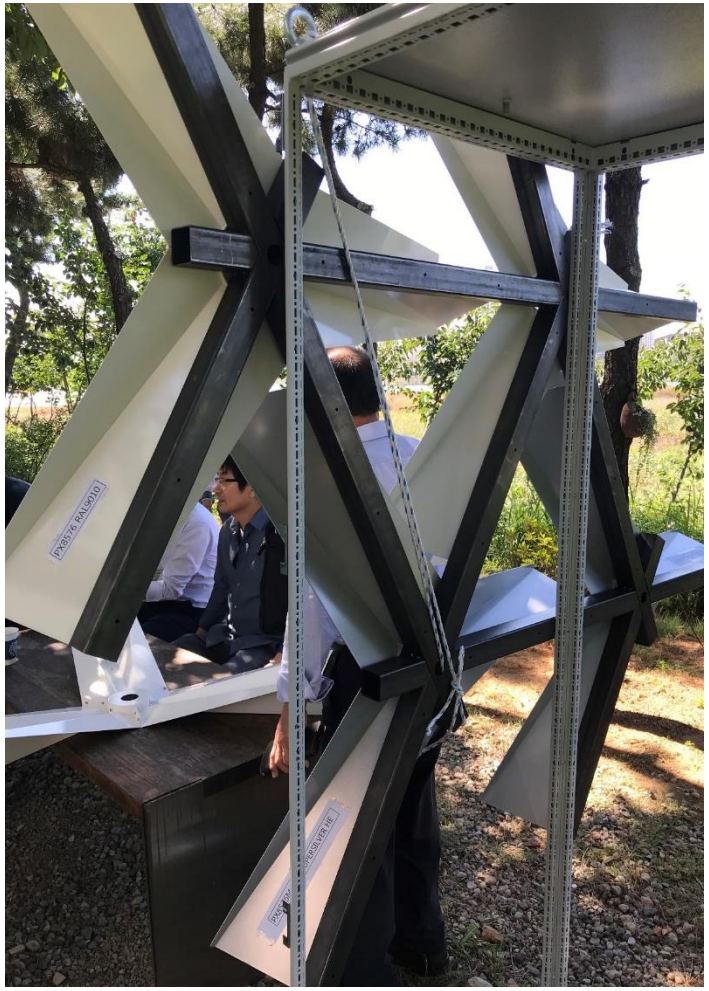
Not using molds or press forming

Not welding but bolting

Additional surface treatment

[Case Study] (3/4)PROTOTYPING

Rapid (first) Prototyping

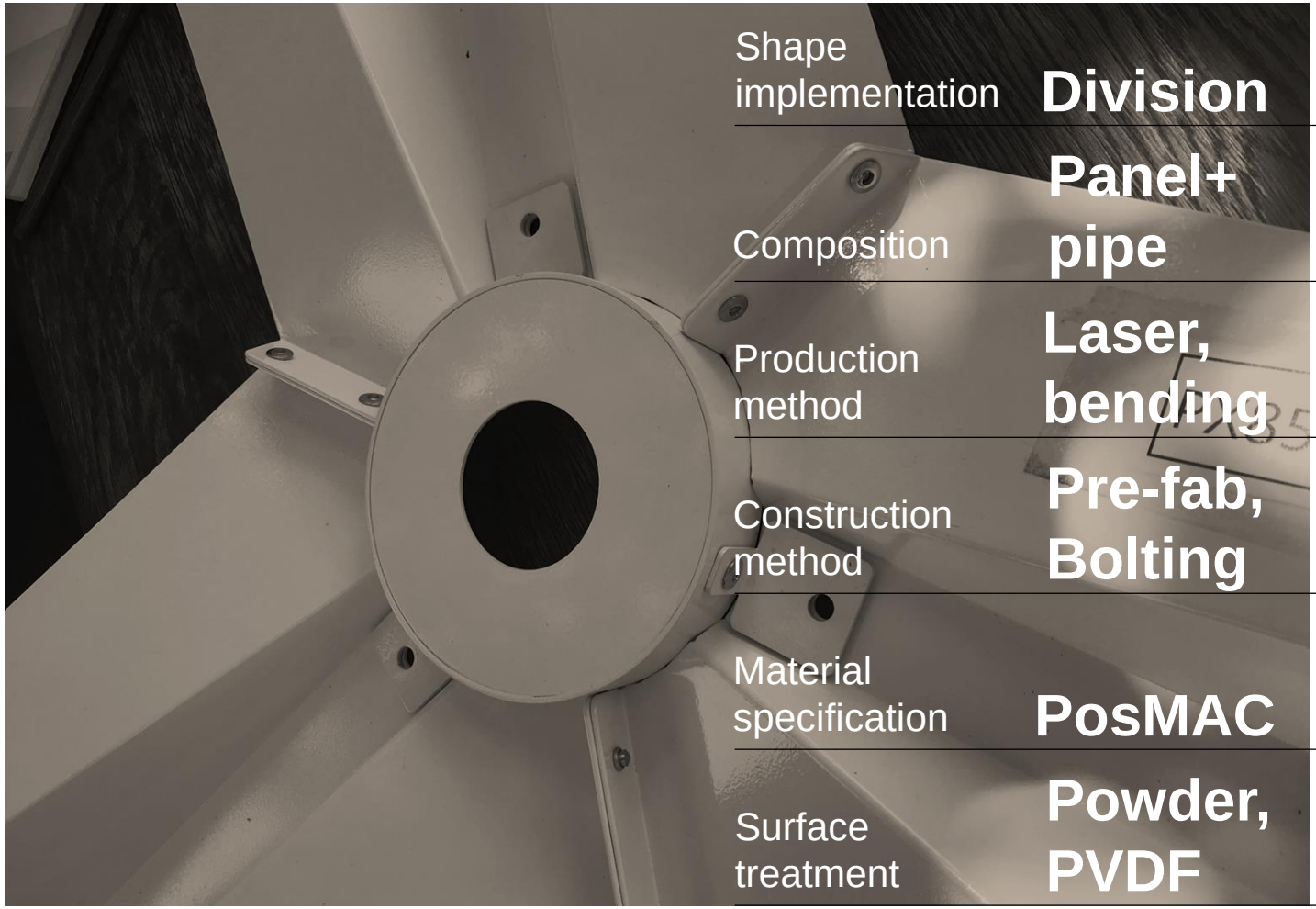


[Case Study] (3/4)PROTOTYPING

Rapid (first) Prototyping

[Case Study] (3/4)PROTOTYPING

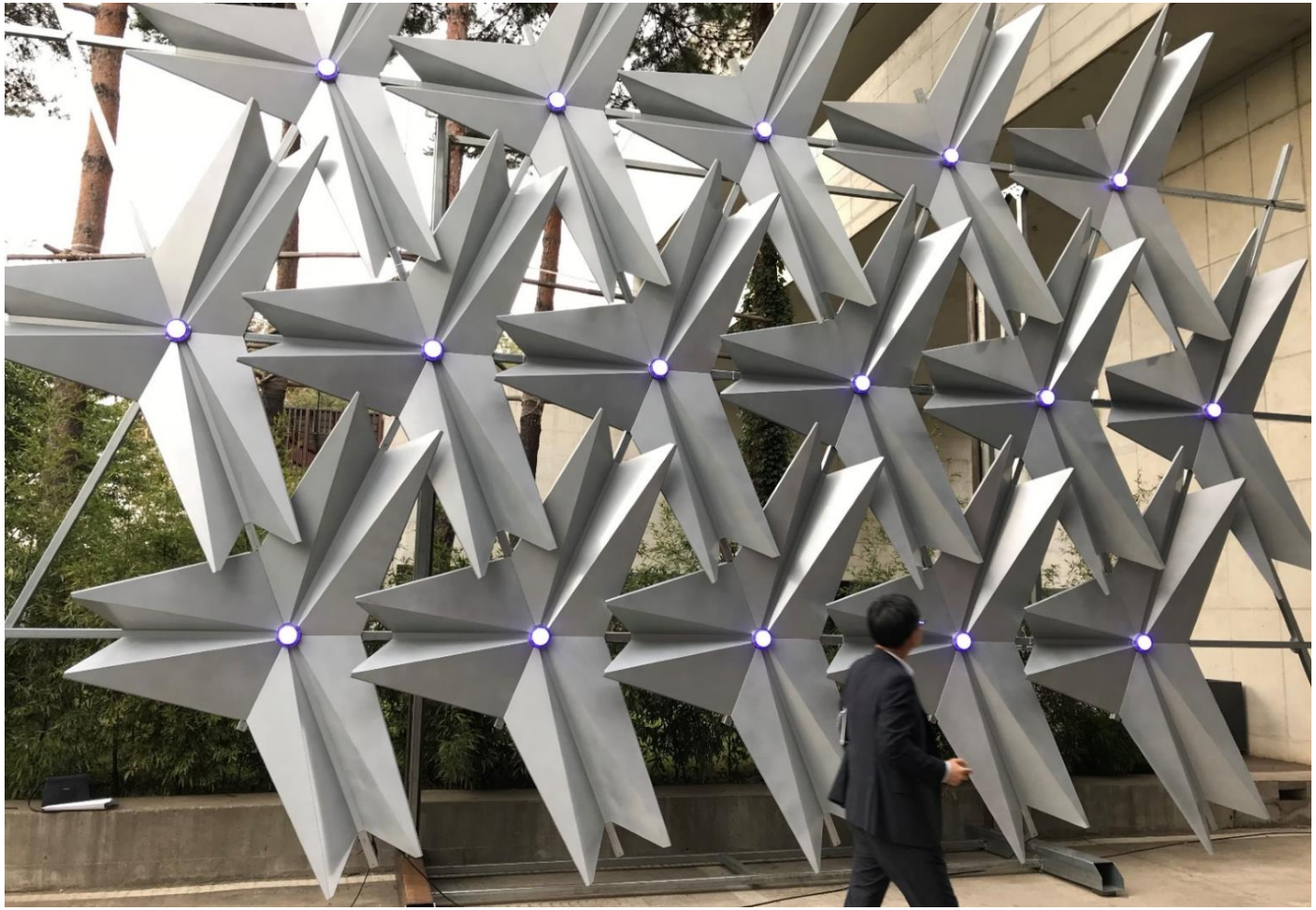
Rapid (first) Prototyping

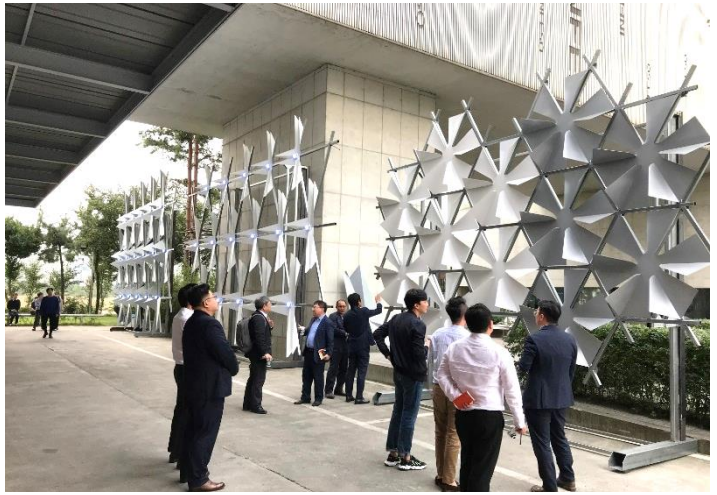


Shape implementation	**Division**	Dividing one petal module into six pieces and assembling them
Composition	**Panel+ pipe**	PosMAC sheet to panel and PosMAC pipe to structural material
Production method	**Laser, bending**	Converting design language into production : shearing, laser cutting and bending
Construction method	**Pre-fab, Bolting**	Pre-manufacturing off-site as much as possible and construction on-site by bolting
Material specification	**PosMAC**	PosMAC 3.0 : 1.2mm in sheet thickness PosMAC 3.0 : 2.3mm and 3.2mm in pipe thickness
Surface treatment	**Powder, PVDF**	Applying powder or PVDF coating depending on Circumstances and optimizing each method

[Case Study] (3/4)PROTOTYPING

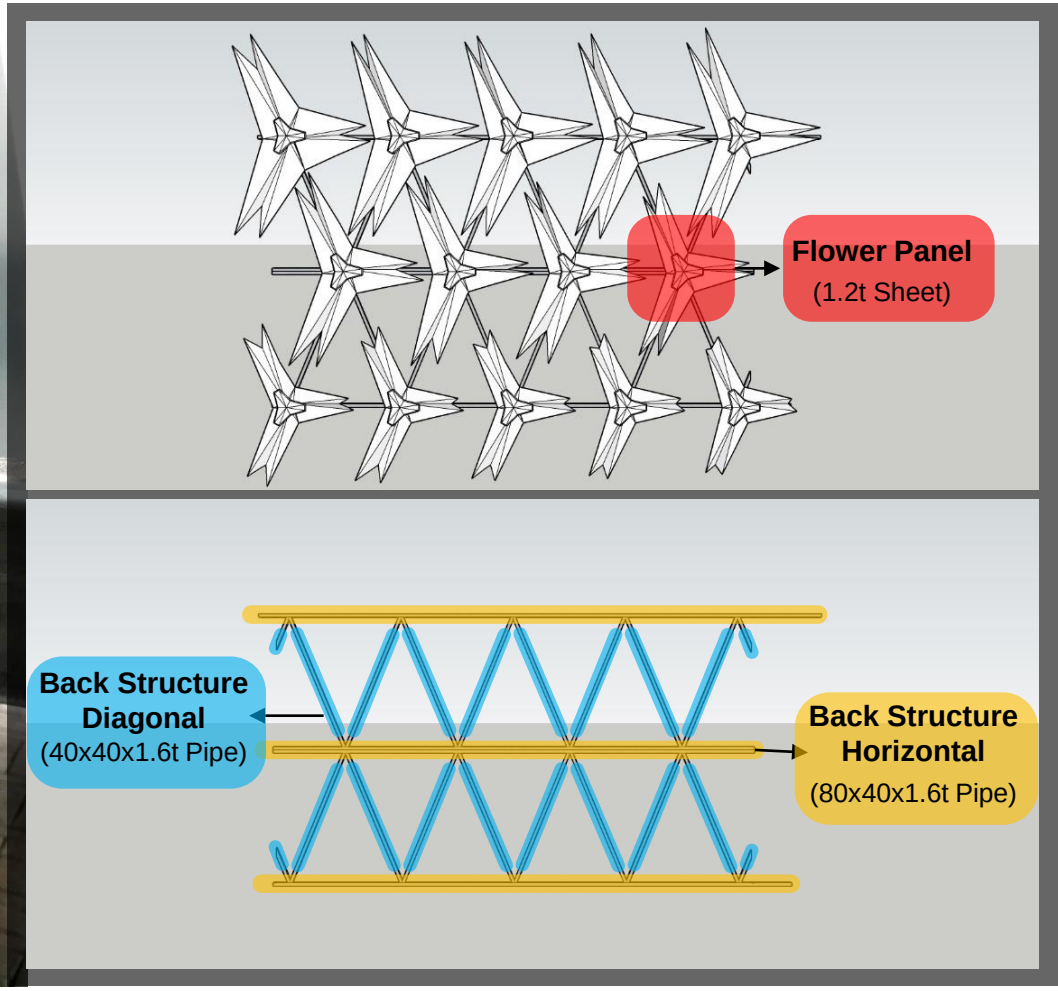
Second Prototyping





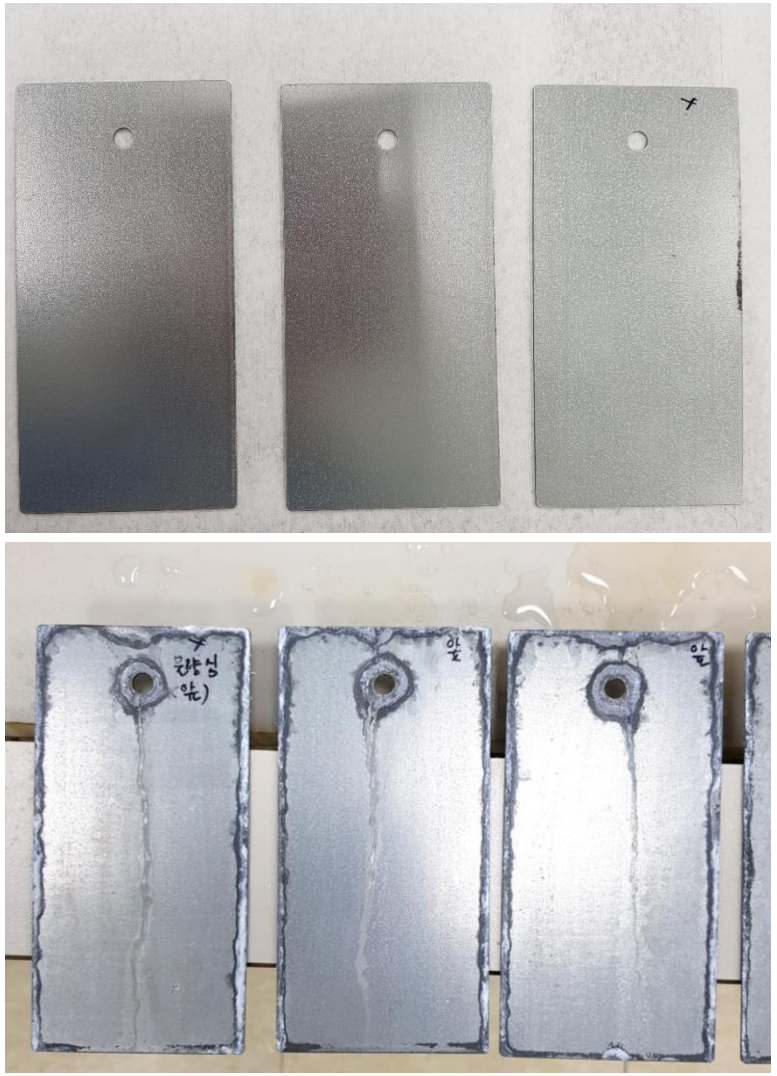
[Case Study] (3/4)PROTOTYPING

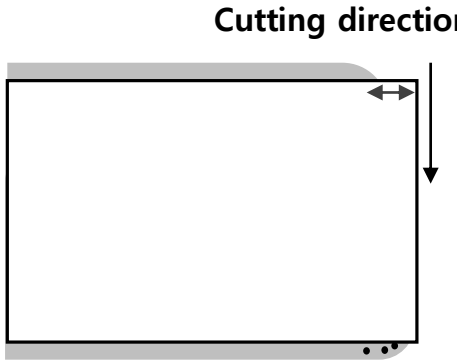
Second Prototyping

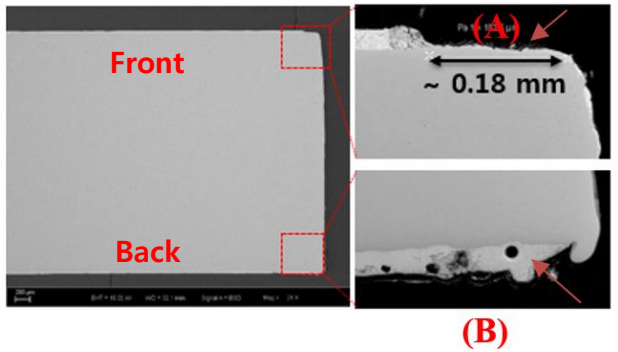


[Case Study] (4/4)OPTIMIZATION

Surface Optimization regarding Laser Cutting

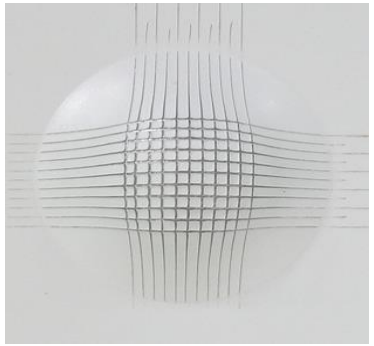


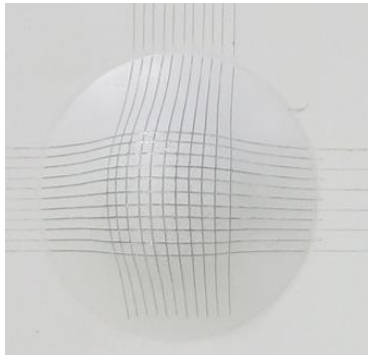


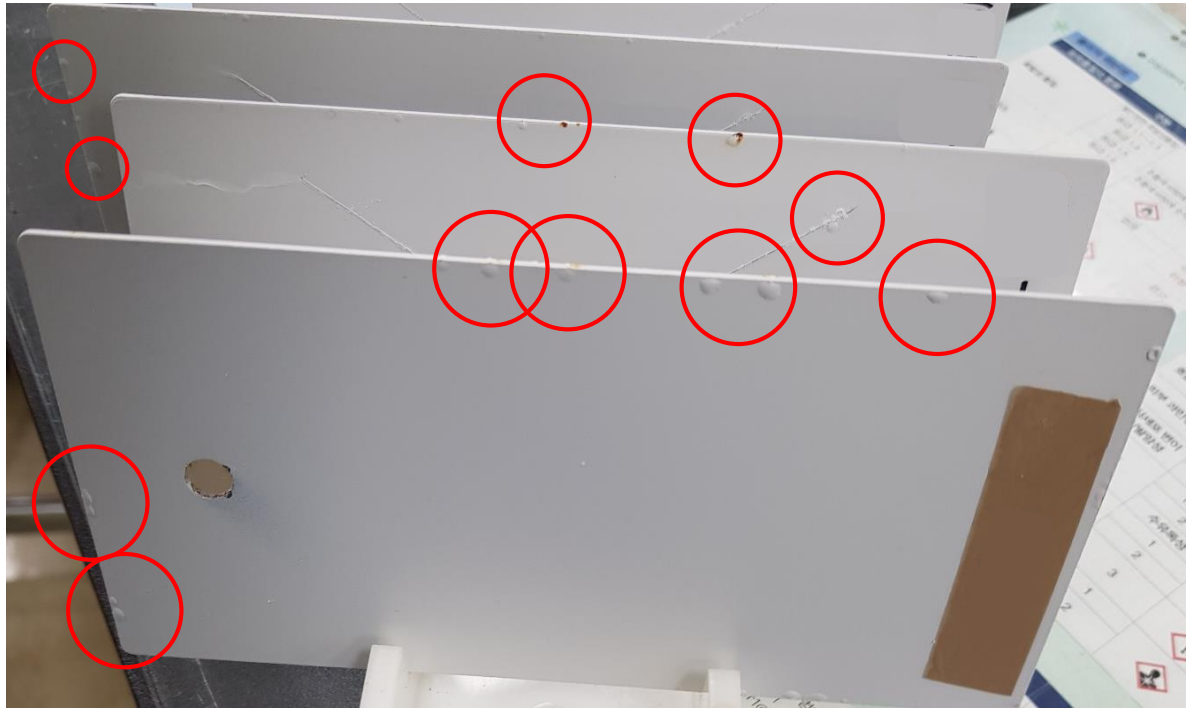


[Case Study] (4/4)OPTIMIZATION

Surface Optimization regarding Coating

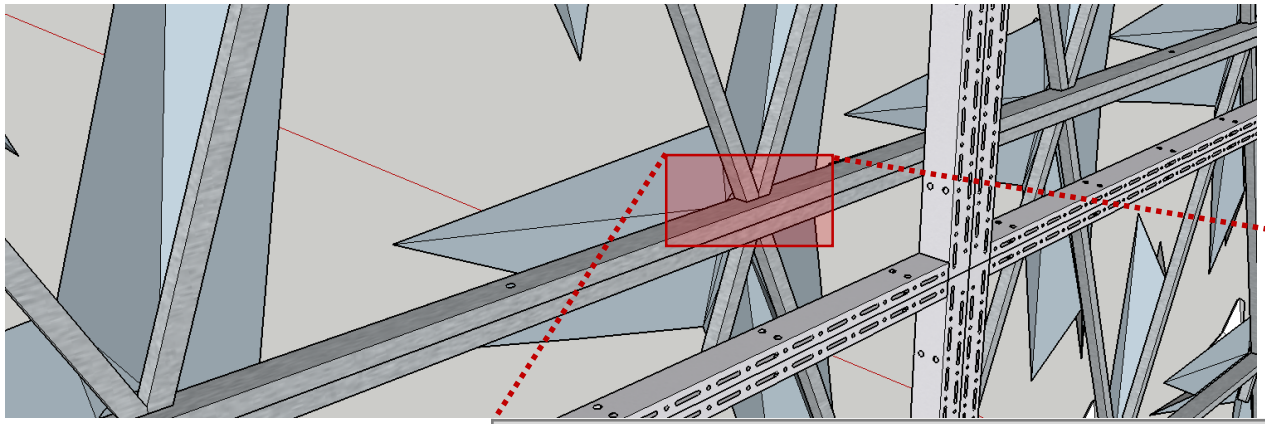


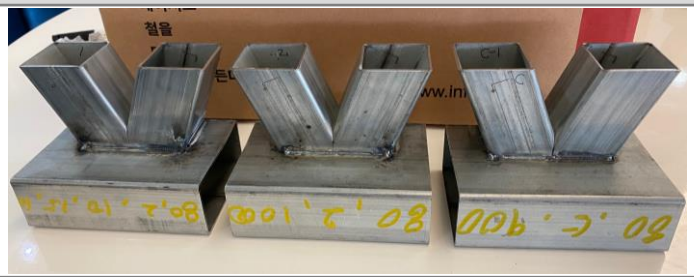




[Case Study] (4/4)OPTIMIZATION

Surface Optimization regarding Welding

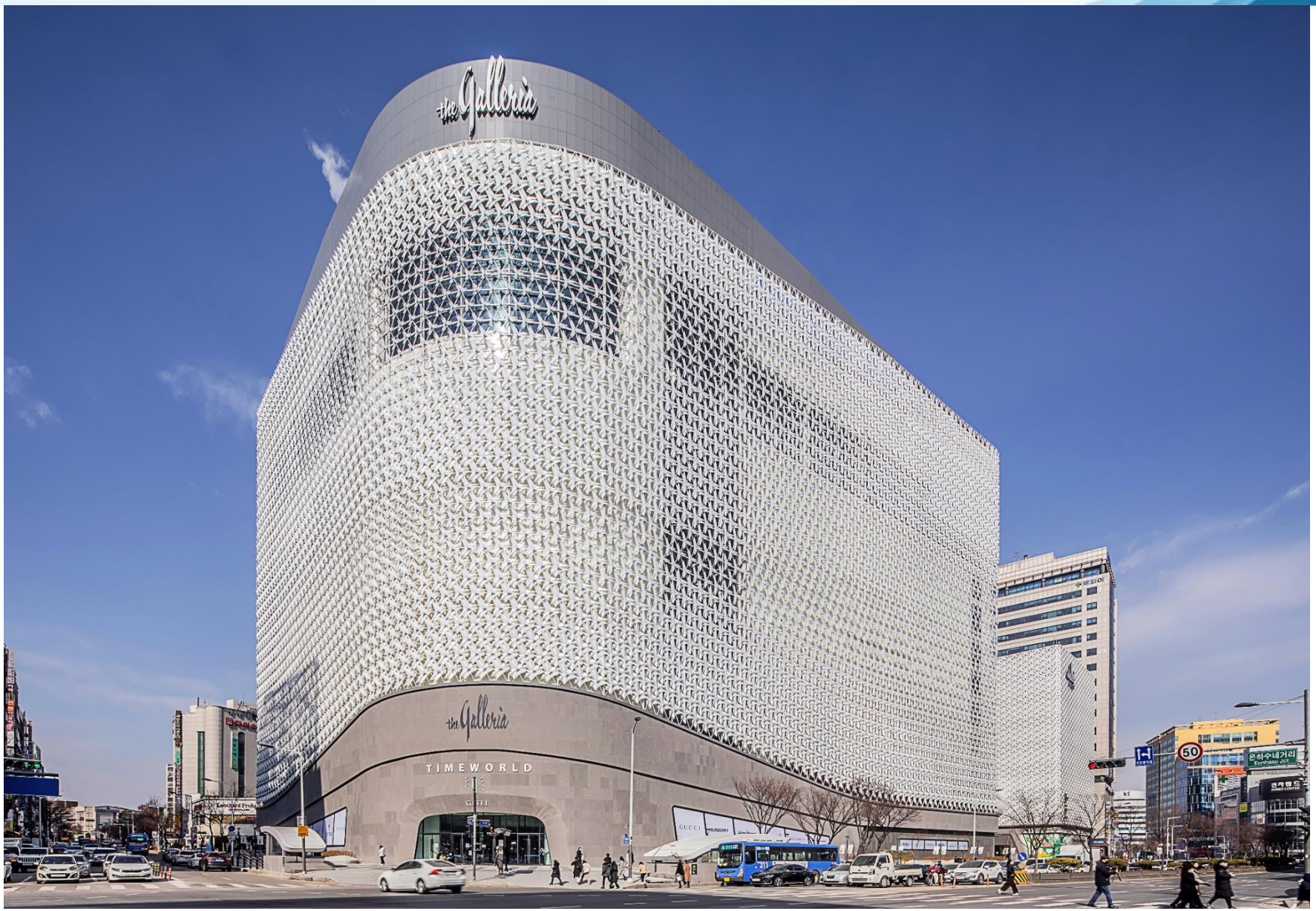


Standard		Marking	
			
Grinding		**Laser**	
			

[Case Study] (4/4)OPTIMIZATION

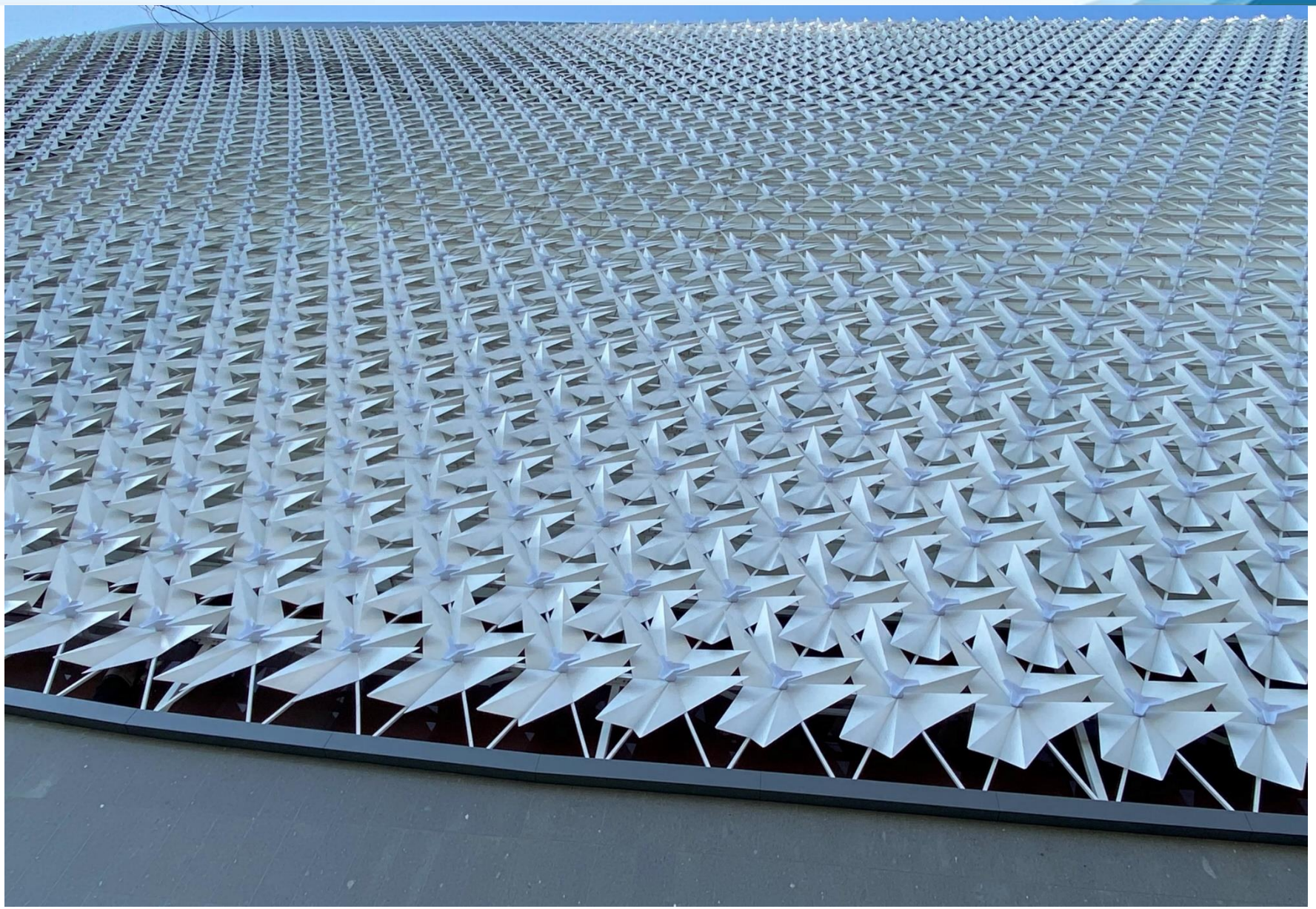
Structure Performance Optimization regarding Wind Pressure

[Case Study] Completion



[Case Study] Completion

[Case Study] Completion



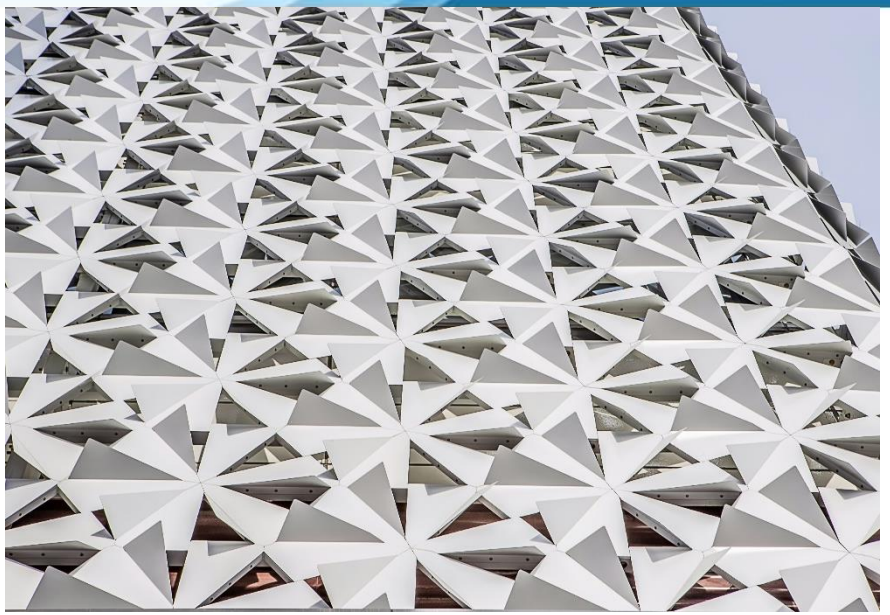
[Case Study] Completion

[Case Study] Completion

[Case Study] Completion

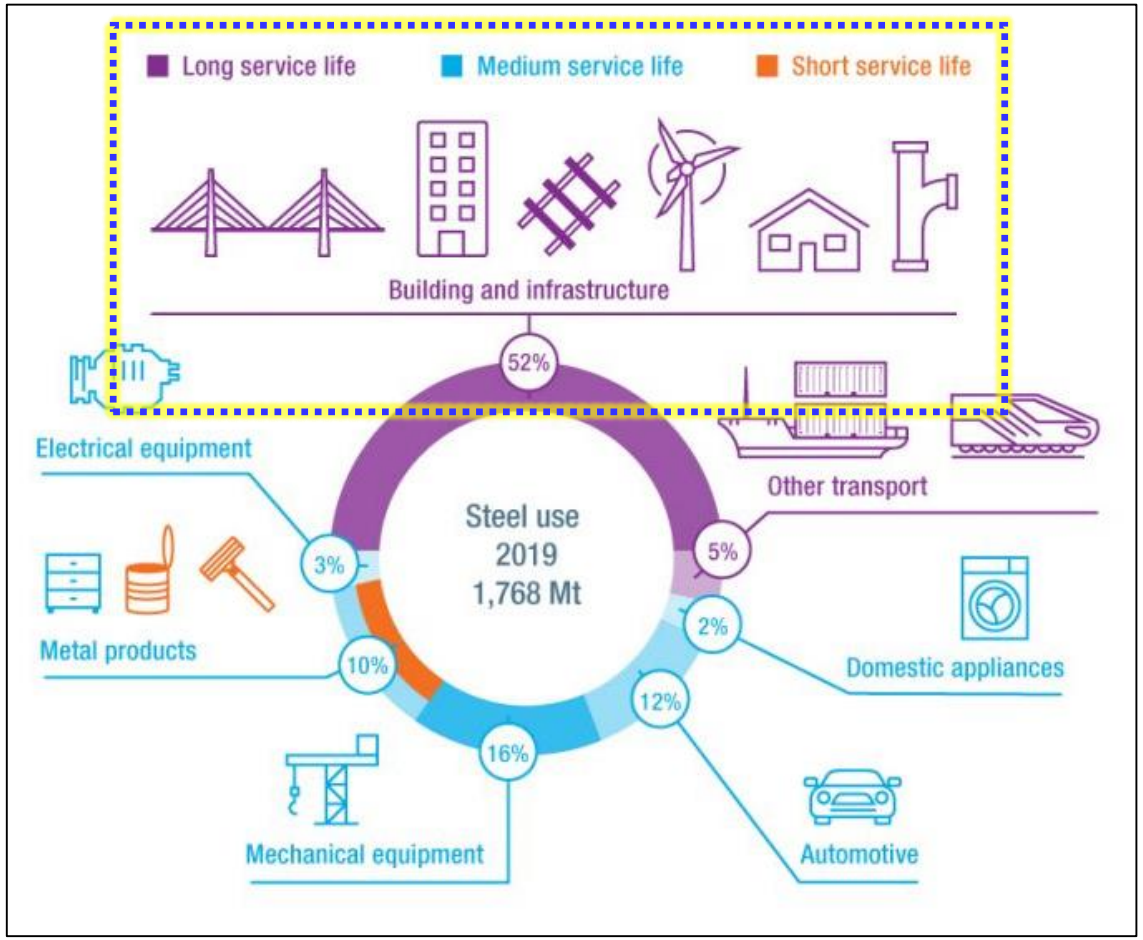
Steel Panel Design

Eco-friendliness

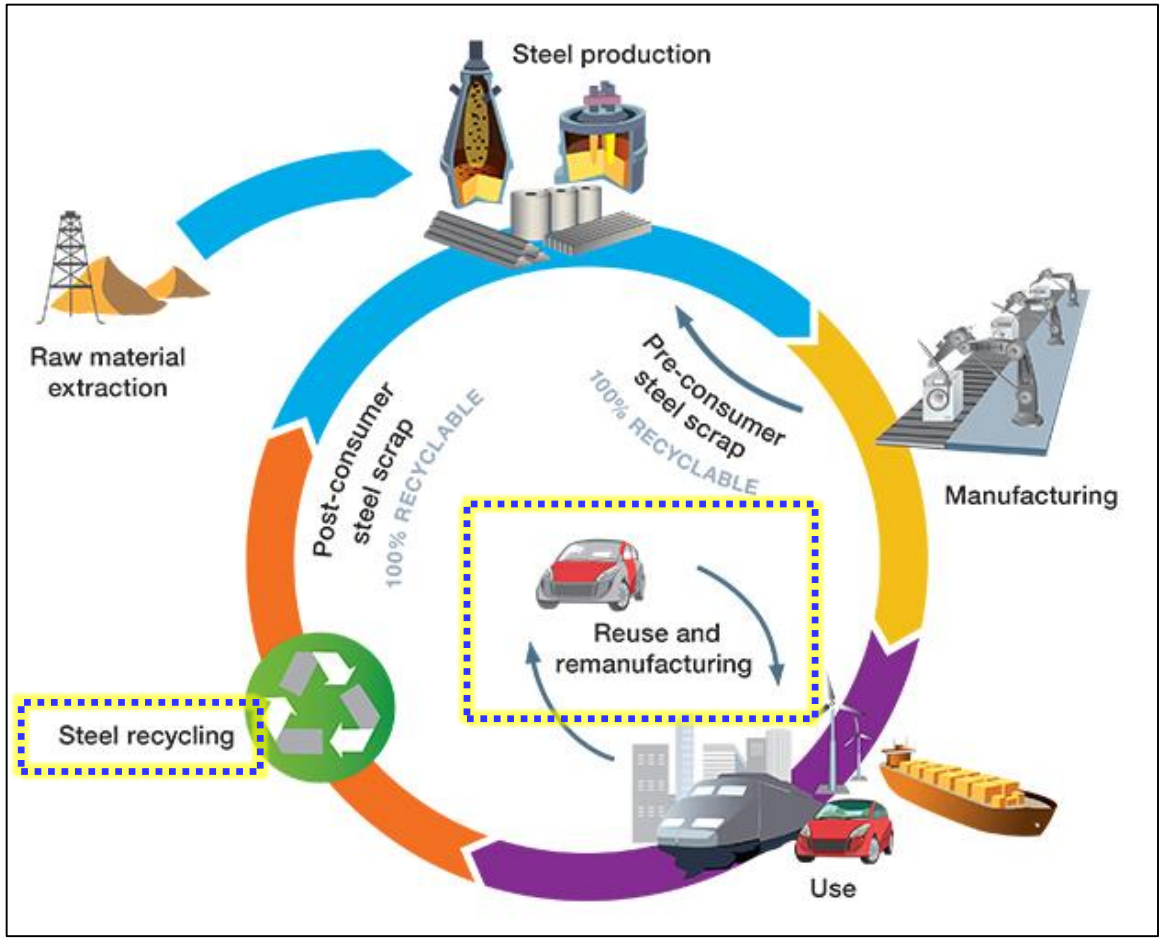


Measuring and Reducing CO_2 Emissions

Eco-friendliness of Steel in Construction Area



Steel Market (WSA, 2019)



Life cycle of Steel (WSA, 2022)

Measuring and Reducing CO_2 Emissions

Introducing "Handprint"

"A contribution that causes positive change in the world - including reductions to your own or somebody else's footprint - is a "handprint." If footprints are what we unavoidably take, handprints are what we intentionally give. Handprints represent the benefits of positive changes that you bring into the world."

Gregory A. Norris Director of SHINE(Sustainability & Health Initiative for Net-positive Enterprise) MIT, Initiative of the Harvard School of Public Health's Center for Health & the Global Environment

Maximizing Handprint Leading to Societal CO_2 Reduction, Avoided Emissions

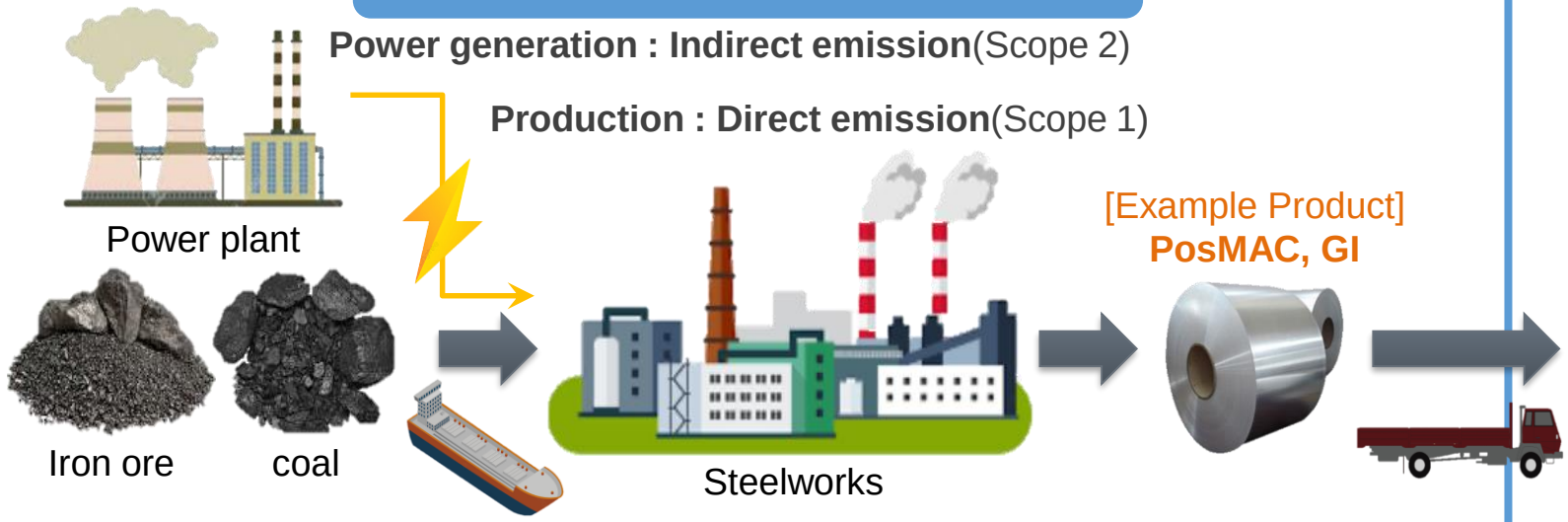
Category		Description
Direct emissions	Scope 1	Emissions that occur from sources that are controlled or owned by an organization
Indirect emissions	Scope 2	Emissions associated with the purchase of electricity, steam, heat or cooling that are a result of the organization's energy use
	Scope 3	Emissions that occur in the value chain of the reporting company, including upstream and downstream emissions
Avoided emissions		Emissions that can be reduced or avoided in life cycle by replacement of low-carbon, eco-friendly products and services produced by an organization

Societal Reduction Guideline (POSCO, KBCSD, KOSA, 2021)

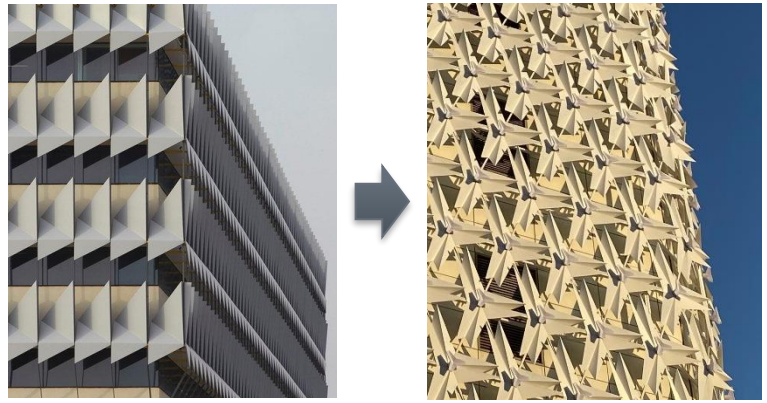
Measuring and Reducing CO_2 Emissions

Steel Panel Design
Eco-friendliness

[Workplace] Reducing Carbon Footprint



[Society] Maximizing Carbon Handprint

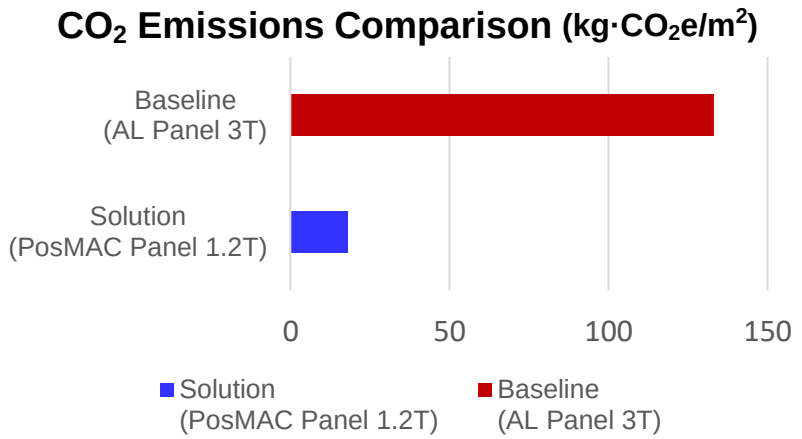


[Conventional]
3.0t Aluminum Panel

[Solution]
1.2t Steel Panel

Lower CO_2 emission rate compared to Aluminum panel → Avoided Emissions

*Based on Data of BSRIA(Building Services Research & Information Asso-ciation, UK) 2019	Emission Unit* ($kg{\cdot}CO_2e/kg$)	Baseline (3t Aluminum)		Solution (1.2t Steel)		Amount of Reduction	Reduc-tion rate (%)
		Usage (kg/m^2)	CO_2 emissions (emission unit x usage, $kg{\cdot}CO_2e/m^2$)	Usage (kg/m^2)	CO_2 emissions (emission unit x usage, $kg{\cdot}CO_2e/m^2$)		
Aluminum	9.18	14.5	133.11	NA	NA		
HR steel	1.07	NA	NA	16.6	17.76		
Zinc galvanizing	3.09	NA	NA	0.09	0.28		
SUM	ΣUsage x emission unit	-	**133.11**(A)	-	**18.04**(B)	115.07(A-B)	86.4



Closing Remarks

- ☑ **In order to respond to the increasingly demanding needs of clients in construction/design area, a comprehensive work process is required.**
- ☑ **The design thinking-based work process can contribute for steel companies to increase steel application and supply for metal façade implementation.**
- ☑ **Rapid prototyping and suggestion are important, due to the nature of construction projects with limited cost and duration.**
- ☑ **By replacing conventional products and measuring each case of CO_2 emissions, steel products can present effects of societal reduction and prove eco-friendliness as building material.**

Thank you for your kind attention