MC2020 Workshop
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Structural Sustainability

Sumitomo Mitsui Construction
Akio KASUGA

What is the difference?

- Specification
- Creativity
- Over Design
- Technology Progress?

What is the difference?

”Small minds and small rules stifle creativity.” (By Breen)

Vessy Bridge (Maillart, 1937)

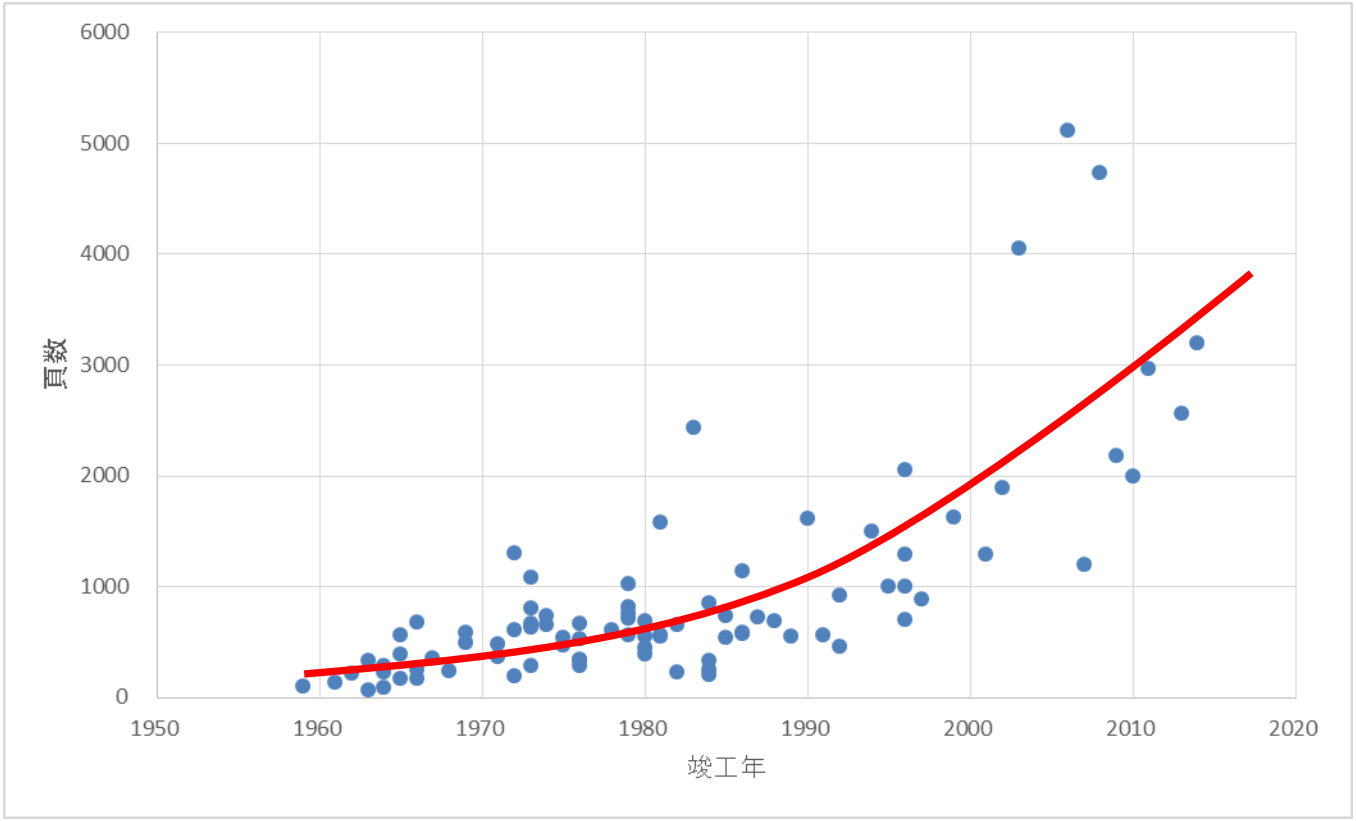
1936

2000

(By JFK)

What is the difference?

Document pages of 3-span box girder bridge



Have our technologies progressed?

Commission 1 (Structure)

TG 1.5 Structural Sustainability

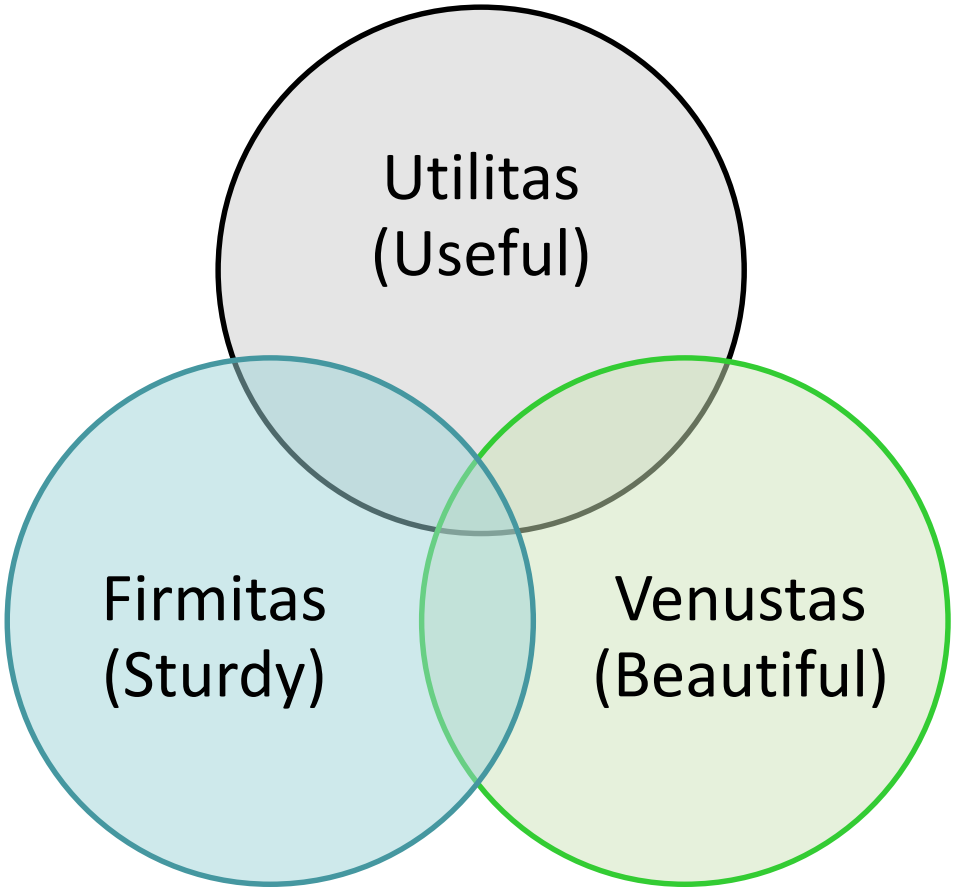
Scope of TG 1.5 Technical Work

- Collecting examples of structural sustainability for bridges and other structures in design and construction.
- Hopefully, some index which can indicate structural sustainability quantitatively will be defined.

through our work…..

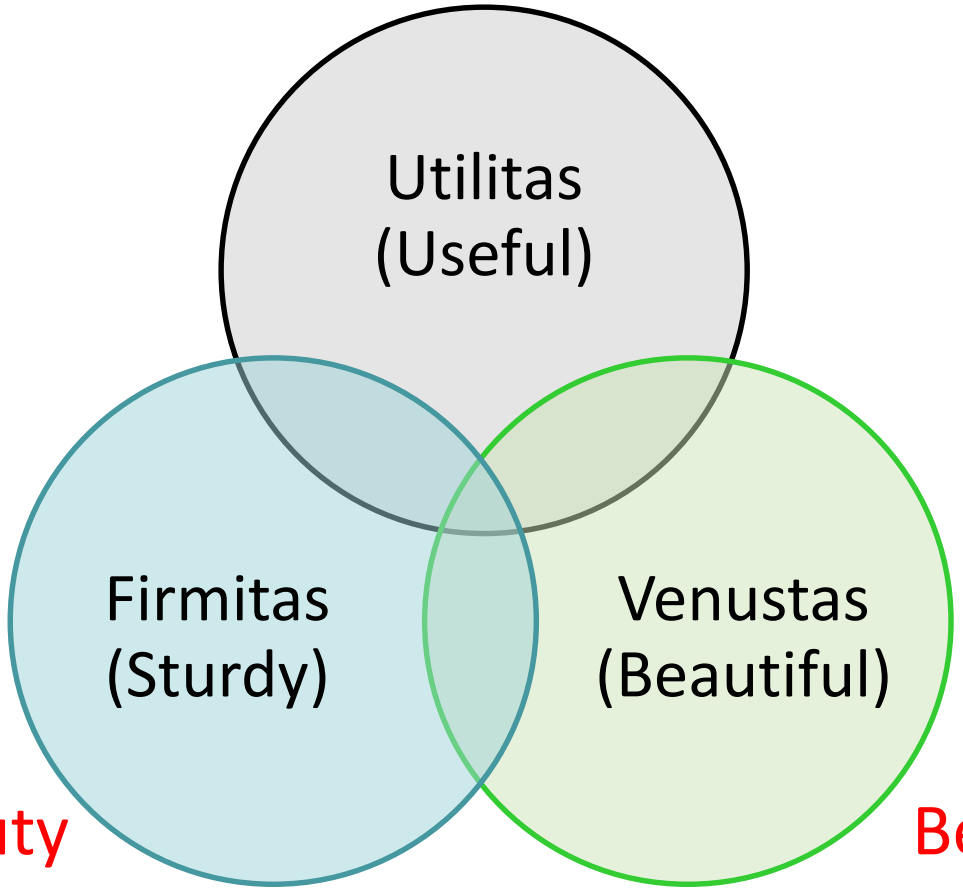
- Warning to young designers.
- Back to the nature of design.
- Learning from the historical masterpiece which leads to the optimum solution.

Three Elements of Beauty in Architecture



Three Elements of Beauty in Structure

Functional Beauty



Structural Beauty

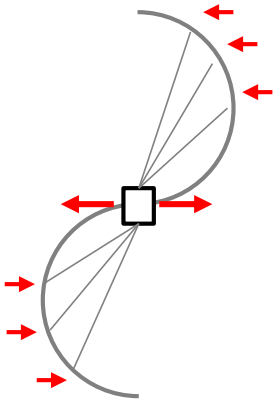
Beauty of Form

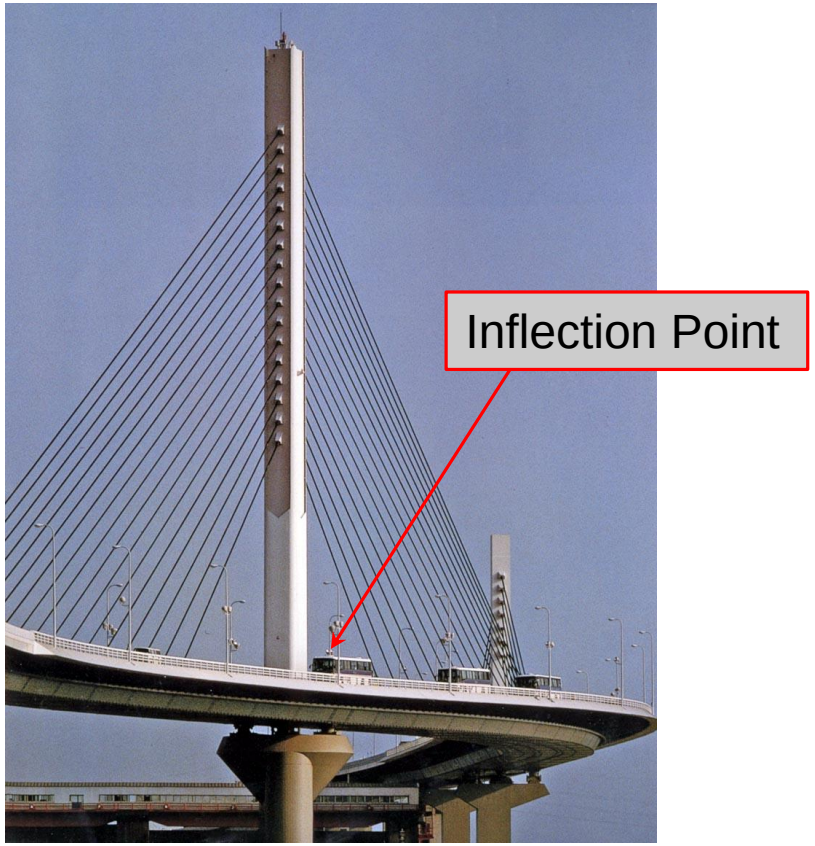
✓ These elements lead to structural elegance.

Functional Beauty

Gateshead Millennium Bridge (UK)

Structural Beauty





Katsushika Harp Bridge (Japan)

Beauty of Form

- ✓ Form has structural reasons

Ebro River Bridge (Spain)

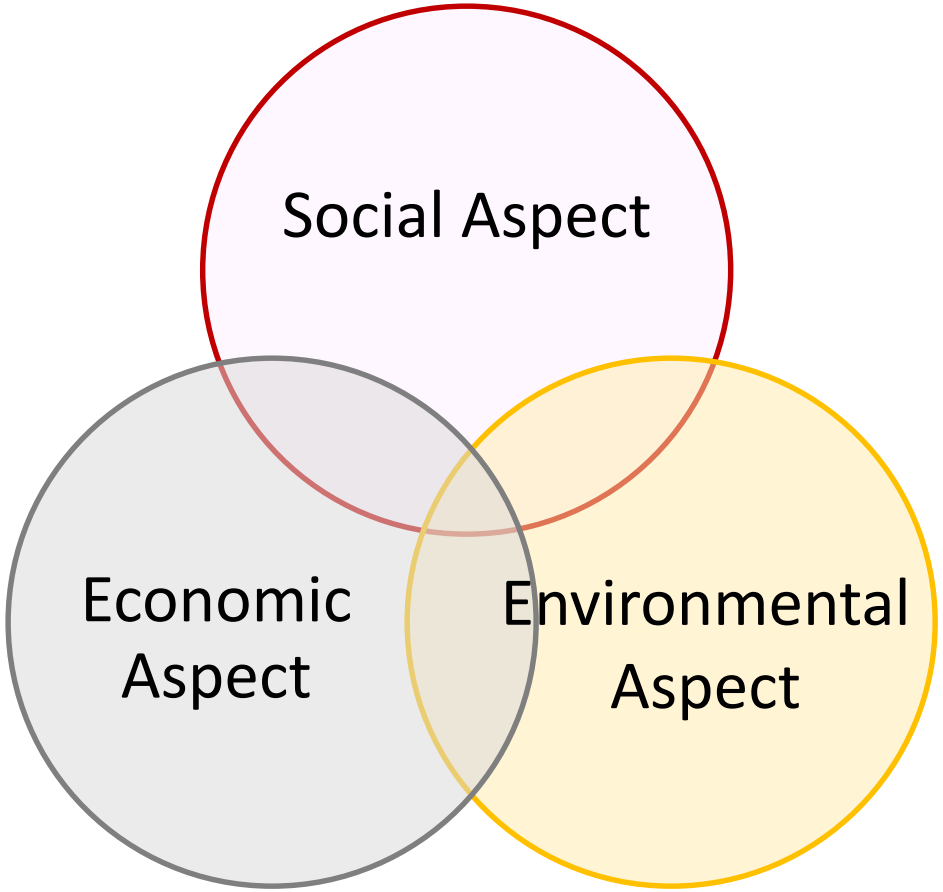
Structural Elegance with **Creativity**

✓Same as three elements of architecture

✓Priority: Functional > Structural > Beauty of Form

- Functional: Multifunction, Harmony, Min. environmental impact
- Structural: Rationality, Simple flow of forces
- Beauty of Form: Accountable for structural reason

Three Aspects of Sustainability



✓ We will discuss three aspects in structural point of view.

Social Aspect

Easy maintenance

Takubogawa Bridge (Japan)

Economic Aspect

Light weight construction

Furukawa Viaduct (Japan)

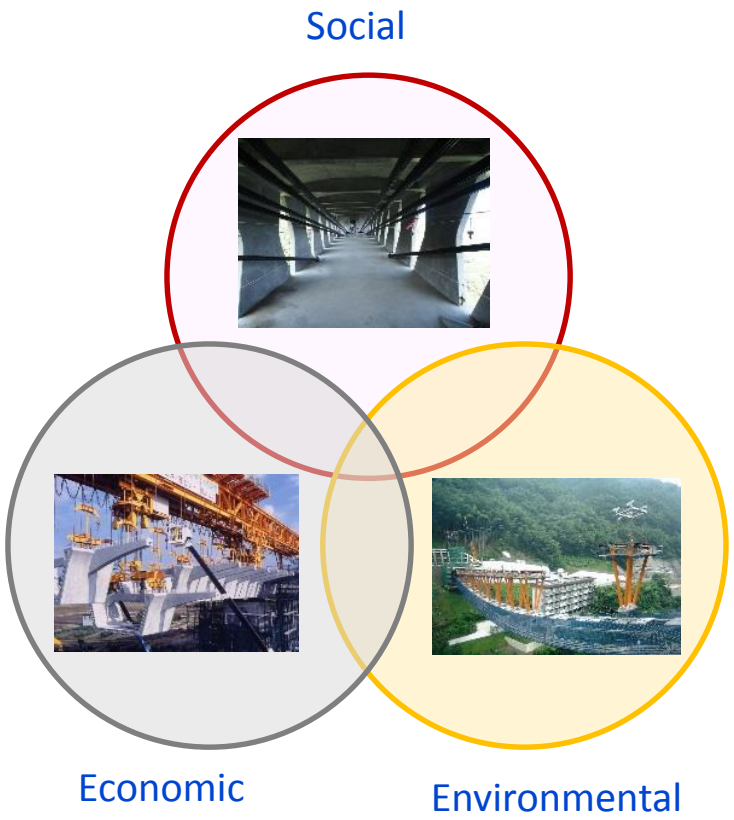
Okegawa Viaduct (Japan)

Environmental Aspect

Low impact construction on environment

Seiun Bridge (Japan, 2006 *fib* Outstanding Structure)

Structural **Creativity** for Sustainability



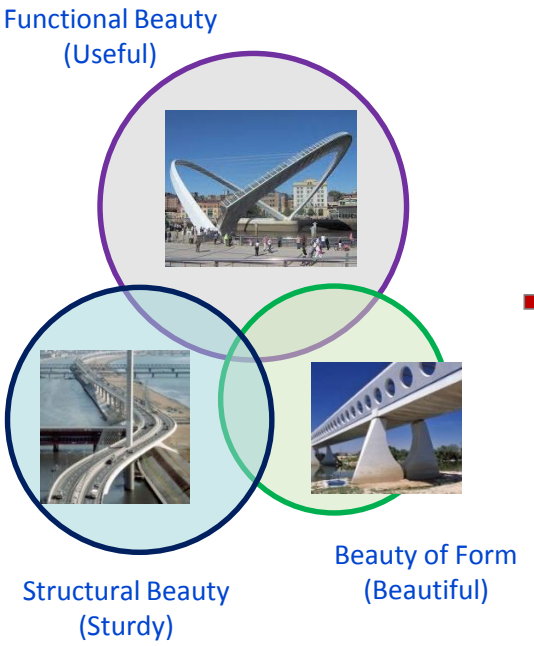
✓Structural creativity gives a sustainable performance to the object

✓Holistic design

- Social: Innovation, Adaptability, Safety, High durability
- Economic: Min. LCC, Max. economic effects
- Environmental: Min. environmental impact, Min. life-cycle energy

Design Philosophy for Structural Sustainability

Structural Elegance with Creativity



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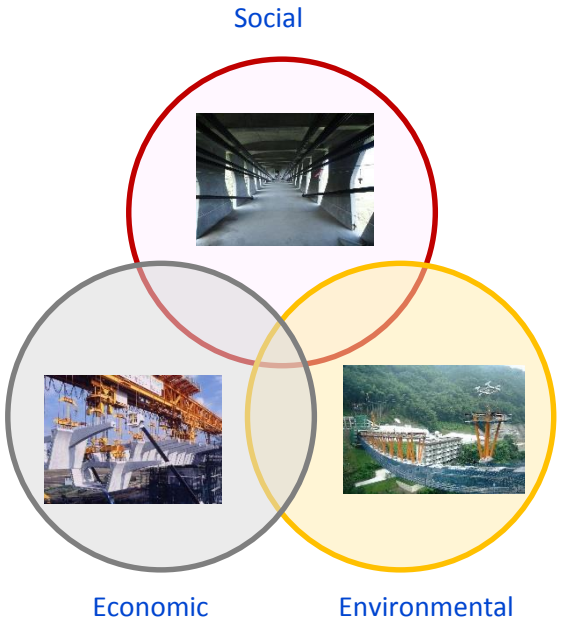
Structural Creativity for Sustainability



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Structural Sustainability

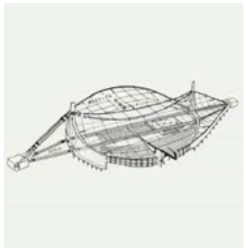
✓Structural sustainability is proved by time.

Structural Sustainability Check Sheet

Name of Object : Yoyogi Gymnasium (Structure)

Structural Elegance	Functional Beauty	Structural Beauty	Beauty of Form
	F	S	B

Structural Sustainability Items	So	Ec	En
1. Design			
Adaptability			
Light Weight	F,S		
Contribution to Society	F		
Cost Effectiveness			
Low Impact on Environment			F,S
High Durability			
Sound Conceptual Design	S		
Resilience (Robustness = BCP)			
Minimum Life Cycle Cost			
Minimum Energy Consumption			F
Structural Integration	S		
Minimum Material			S
Extension of Degree of Freedom in Design			
2. Construction			
Accelerated Construction			
Safe Construction			
Wide Availability			
High Level Quality			
Reduction of Constrution Man Power			
3. Maintenance			
Easy Maintenance			
Minimum Maintenance			
Easy Re-construction			



So : Social Aspect
Ec : Economical Aspect
En : Environmental Aspect

Structural Sustainability Check Sheet

Name of Object : Marne Bridges (Structure & Construction)

Structural Elegance	Functional Beauty	Structural Beauty	Beauty of Form
	F	S	B

Structural Sustainability Items	So	Ec	En
1. Design			
Adaptability	F		
Light Weight			
Contribution to Society	F		
Cost Effectiveness		F,S	
Low Impact on Environment			F
High Durability			
Sound Conceptual Design	S		
Resilience (Robustness = BCP)			
Minimum Life Cycle Cost		F,S	
Minimum Energy Consumption			F
Structural Integration			
Minimum Material		F,S	
Extension of Degree of Freedom in Design	F		
2. Construction			
Accelerated Construction	F		
Safe Construction			
Wide Availability	F		
High Level Quality			
Reduction of Constrution Man Power	F		
3. Maintenance			
Easy Maintenance			
Minimum Maintenance			
Easy Re-construction			

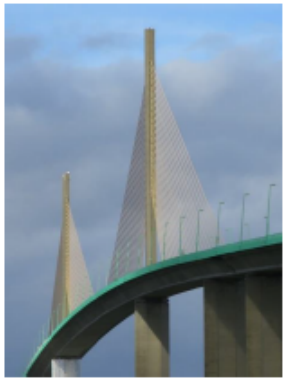
So : Social Aspect
Ec : Economical Aspect
En : Environmental Aspect

Structural Sustainability Check Sheet

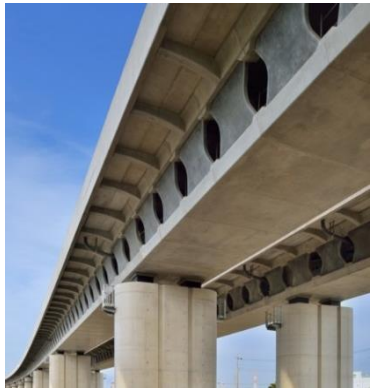
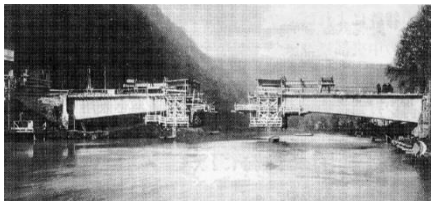
Name of Object : Brotonne Bridge (Structure)

Structural Elegance	Functional Beauty	Structural Beauty	Beauty of Form
	F	S	B

Structural Sustainability Items	So	Ec	En
1. Design			
Adaptability	F		
Light Weight		F,S	
Contribution to Society	F		
Cost Effectiveness		F,S	
Low Impact on Environment			
High Durability			
Sound Conceptual Design			B
Resilience (Robustness = BCP)			
Minimum Life Cycle Cost			
Minimum Energy Consumption			
Structural Integration			
Minimum Material	S		
Extension of Degree of Freedom in Design	S		
2. Construction			
Accelerated Construction			
Safe Construction			
Wide Availability			
High Level Quality			
Reduction of Construtions Man Power	F		
3. Maintenance			
Easy Maintenance			
Minimum Maintenance			
Easy Re-construction			

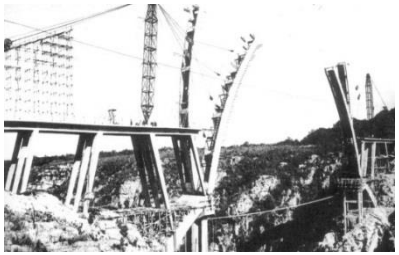


So : Social Aspect
Ec : Economical Aspect
En : Environmental Aspect

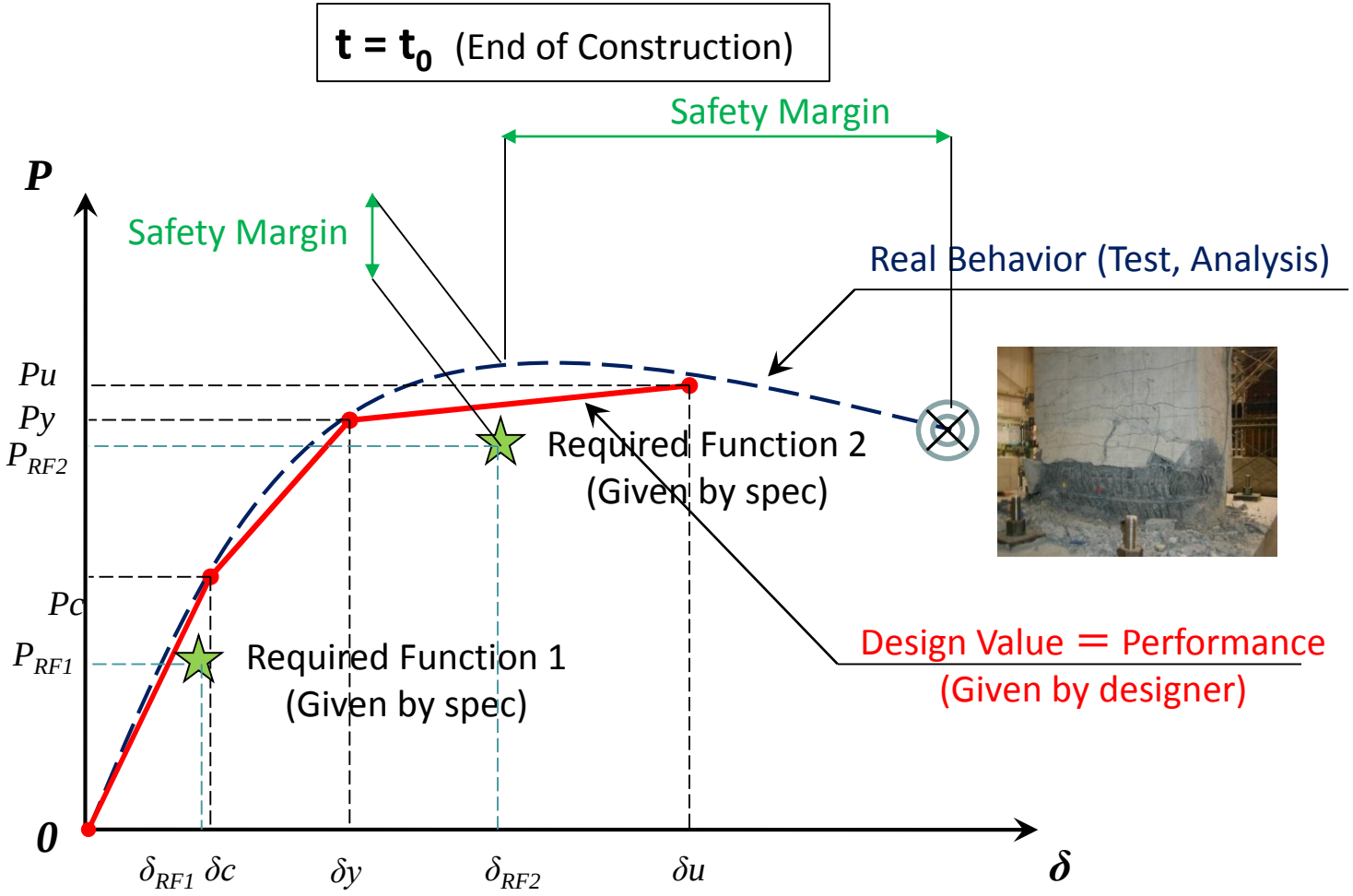






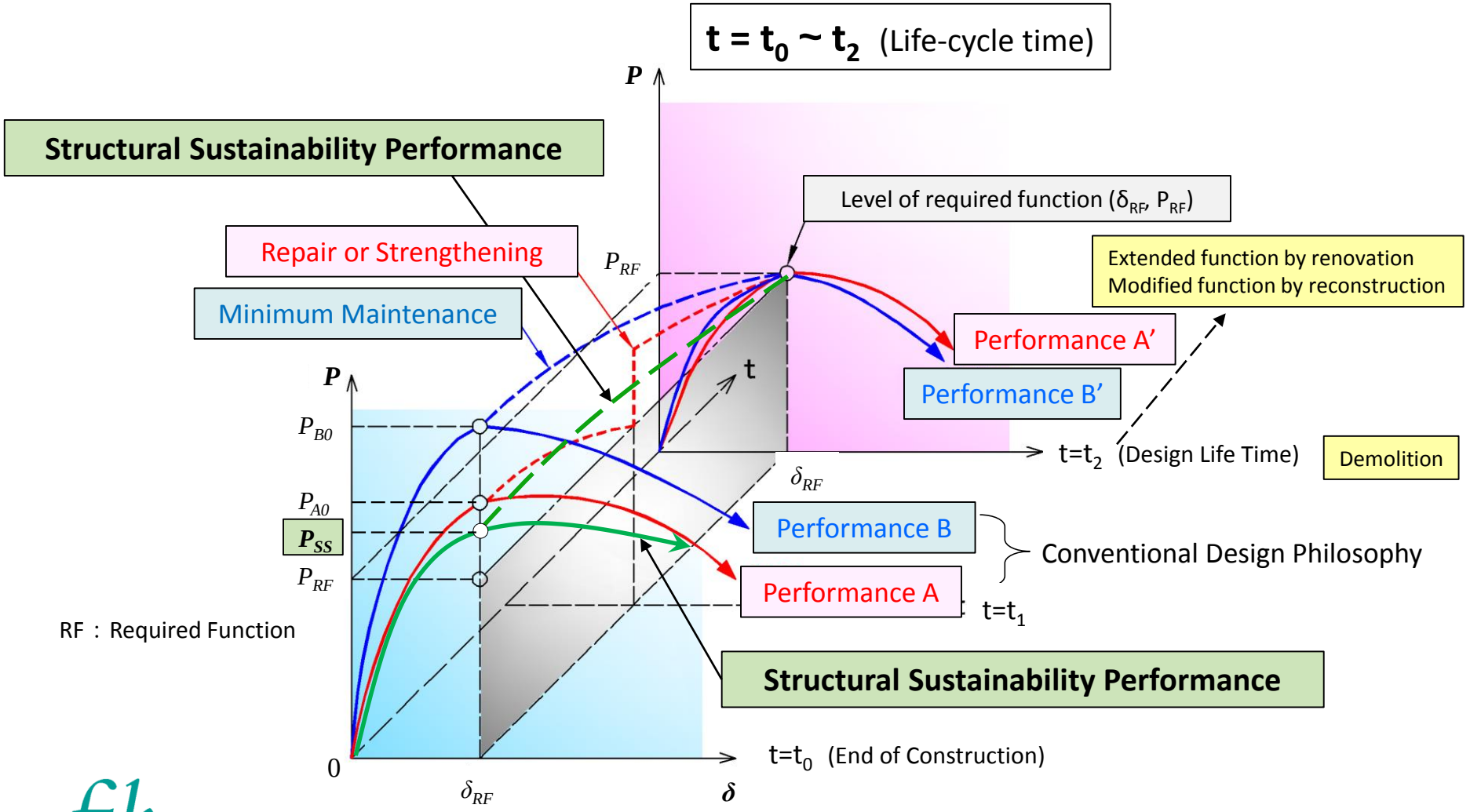


Design Philosophy for Structural Sustainability



Design Philosophy for Structural Sustainability



Definition of Structural Sustainability

- ✓ Design for structural sustainability intends structural elegance and derives optimized structural solutions, which lead to sustainable performance of the object during its life-cycle time including construction and demolition, with **creativity**.

- ✓ Structural elegance with creativity has functional beauty, structural beauty and beauty of form.
- ✓ Structural creativity pursues sustainability by adding structural performance of easy maintenance, high durability to eliminate deterioration factors, low impact on environment and resilience.

We are still receiving the blessings of RC and PC.
But it is time for innovation.