EXAT

การทางพิเศษแห่งประเทศไทย

THE PLANNING AND CONSTRUCTION OF NEW DOUBLE PLANE CABLE-STAYED BRIDGE IN PRRALLEL TO THE EXISTING

Expressway Authority of Thailand (EXAT)

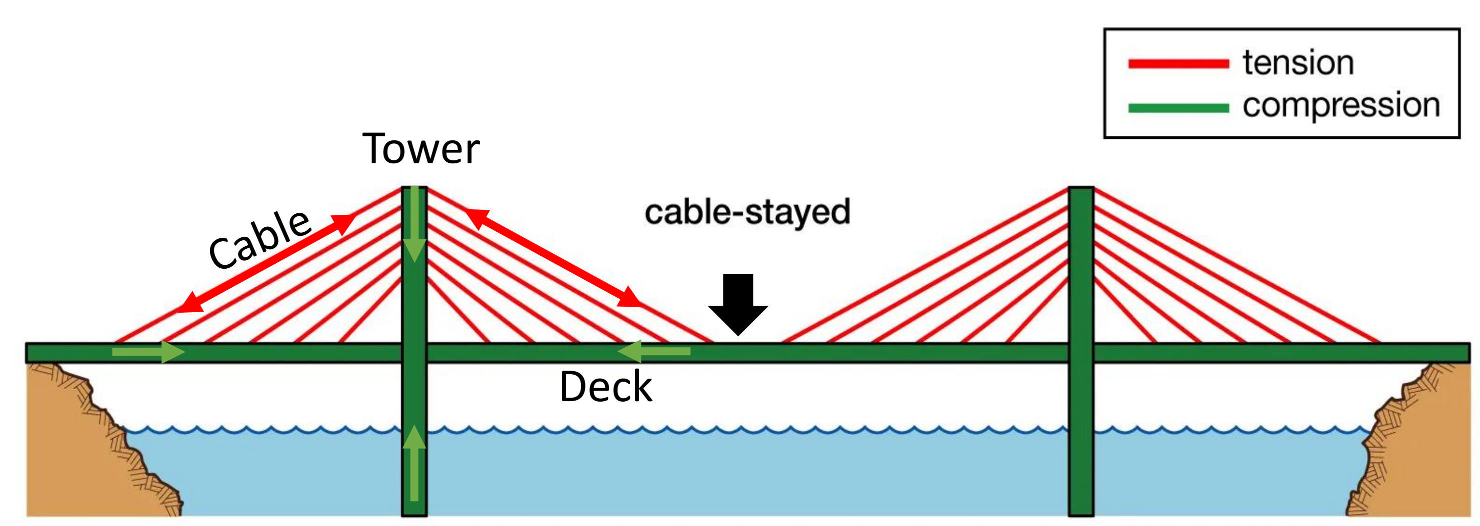
Introduction

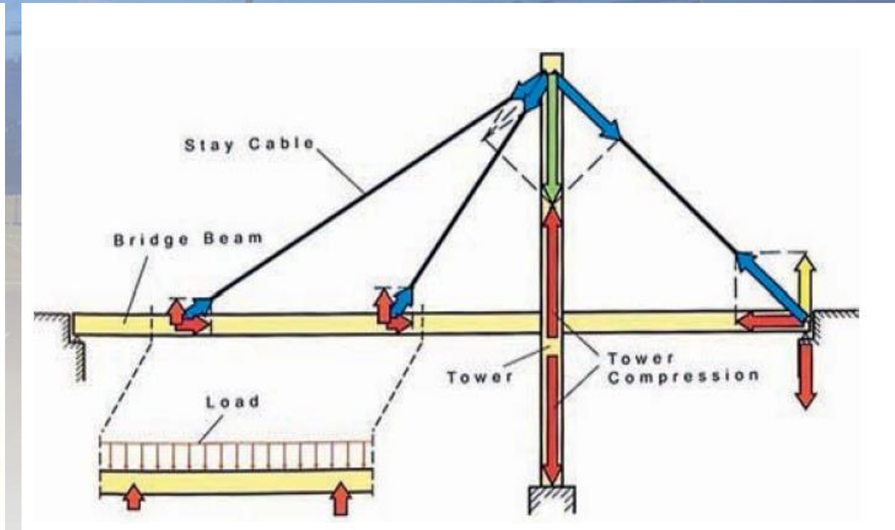
- The 1st Cable-Stayed Bridge (Rama IX bridge) of Thailand was constructed in 1987. Currently, the Raman IX bridge is heavily used with high number of traffic volume.
- Therefore, Expressway Authority of Thailand (EXAT) decided to develop the new mega project by construct another new cable-stayed bridge parallel in the exiting one.
- The new cable-stayed bridge has various improvements from the old one.

General Information and Major Changes between existing bridge and new bridge

	Existing Bridge (Rama IX)	New Parallel Bridge
Length	782 M (mid span 450 M)	781.20 M (mid span450 M)
Full Width	33 M (6 lanes)	42.4 M (8 lanes)
Cable Type	Locked Coil Strand	Parallel Strand
Bridge deck	Orthotropic steel deck	Steel-Composite deck
Cable Arrangement	Single Plane Fan Type	Double Cable Planes Fan Type

Basic Concept of Cable-Stayed Bridge



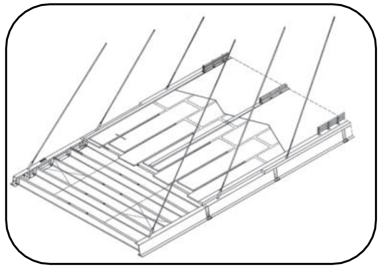


Cable-Stayed bridge is a wide-span crossing structure which consist of towers, cables and bridge deck as main components. The bridge support vertical loads mainly by deck while each of staying cable which directly from the tower the deck provide intermediate support bridge deck so that the bridge and cover a long-distance span length. The cable transfer load from bridge to towers, and finally the towers are the primary load-bearing structures that transmit the bridge load to the lower ground. All these three members are under axial forces, with the cable under tension and both the pylon and the deck under compression

- Cable : Key load carrying and transferring members. Support axial tension force
- Tower/Pylon : Supporting cables and transferring the all loads through the cable to the ground.
- Deck : Resist the compressive forces causes by the cable stays.

Bridge Deck/Girder

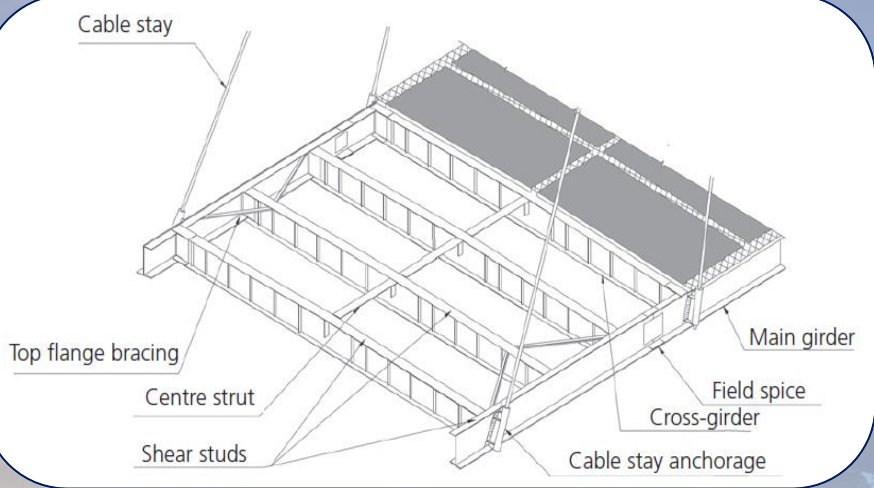
Bridge deck/girder can be designed using various materials and shape. Typical examples are steel , concrete and steel composite. Selection of each types should be planned carefully since it affect to the construction method and technical analysis.

Bridge Deck/Girder type		
Steel deck/girder		- Each shape secure torsional stiffness and section stiffness - Lighter than concrete - Must be concerned for bucking since weak against compressive forces caused by stayed cable
Concrete deck/girder		- High durability and strong in compression - Shorter span compared with steel girder due to heavier weight
Steel composite deck/girder		- Steel is strong in tension while concrete is strong in compression; therefore, a proper synthesis between these two material can produce a lightweight and durable girder

Composite Bridge Deck

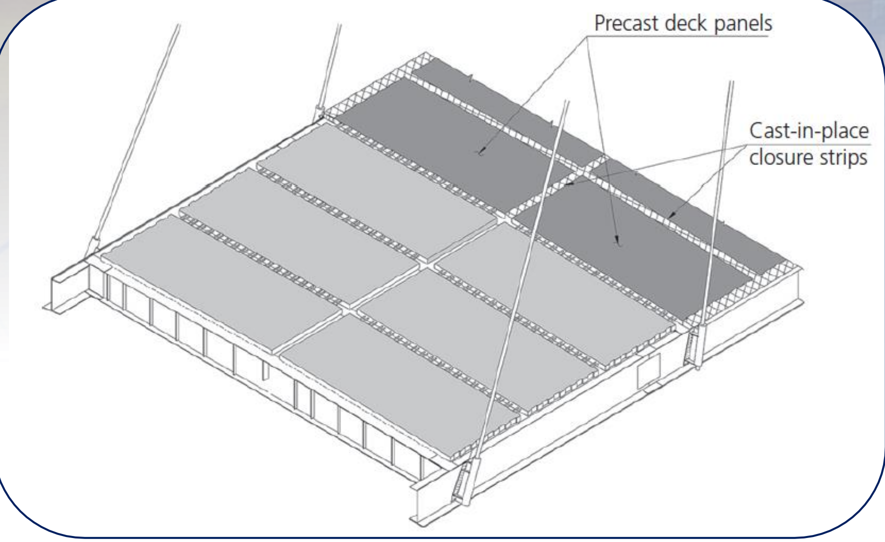
A composite steel-concrete cable-stayed bridge deck can be identified as a deck sections having a concrete slab on the top of steel structure.

For the cable-stayed bridge with spans up to 600m, composite bridge beck may be considered as the most efficient and competitive solution.



The use of steel :

- ✓ Lightweight and high strength deck cross section
- ✓ Enable prefabrication at the construction yard
- ✓ Easy assembly and availability of resistant capacity immediately after erection.

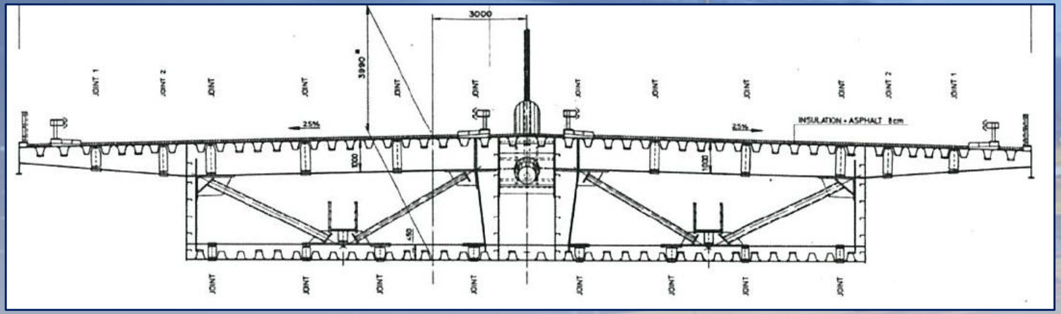


The use of concrete as deck slab :

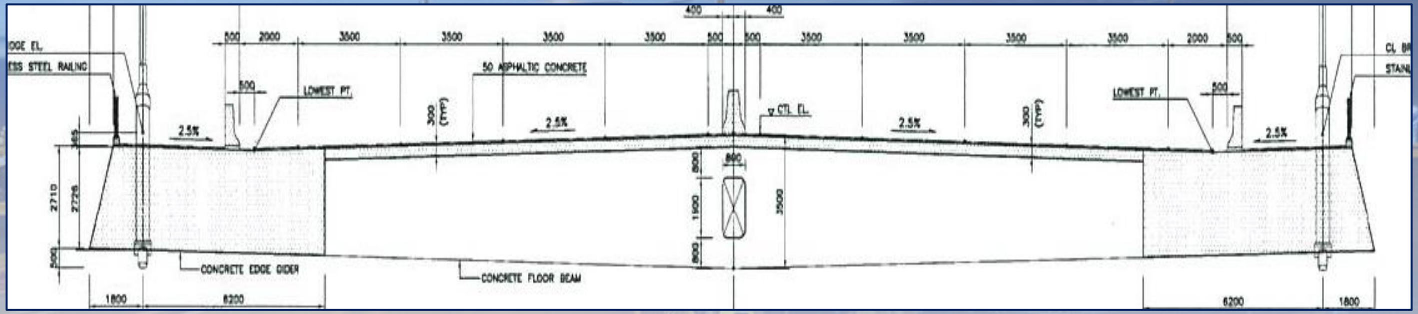
- ✓ Increase deck resistance to axial loads transmitted by the stays
- ✓ Precast slab enhance the speed of deck construction

Assembling steel and concrete together in composite bridge deck provide a lightweight deck solution, easy and fast to build, with high quality and durability.

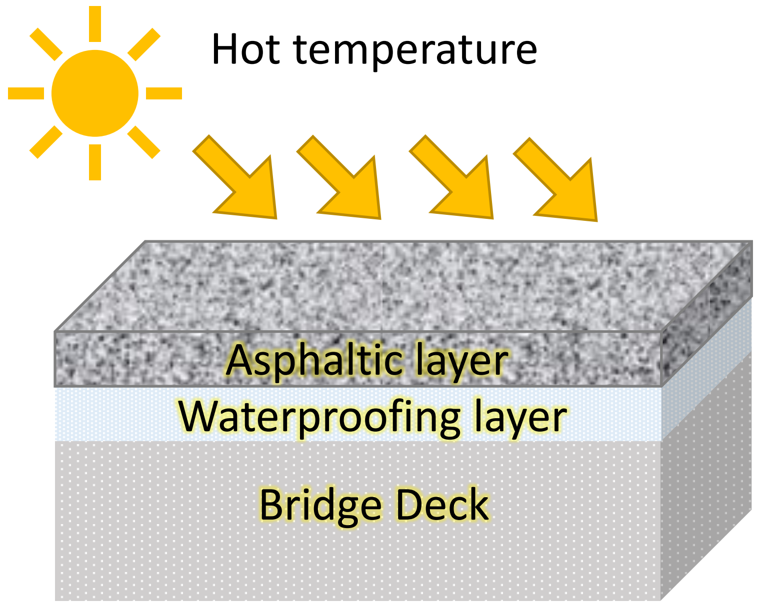
The Rama IX Bridge deck and the New Parallel Bridge deck



The Rama IX Bridge (Existing Bridge)



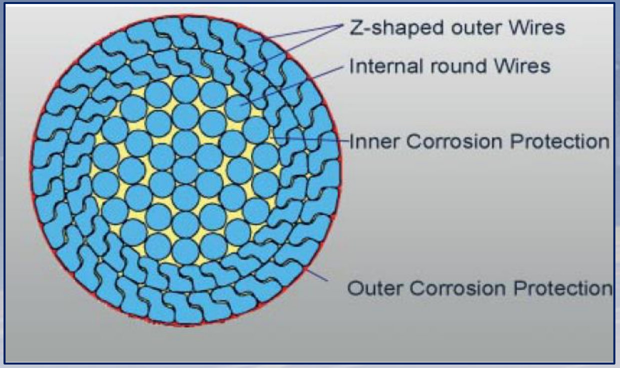
The new parallel bridge

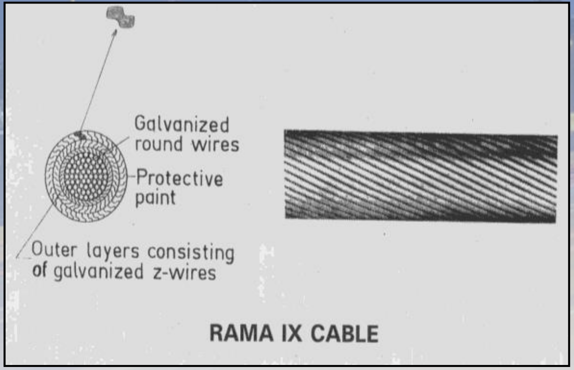


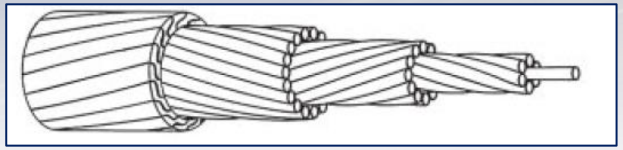
- Orthotropic steel decks have higher cost comparing to the steel-composite decks.
- The asphaltic surface wearing problem from steel plate due to the high temperature is the major problem in the past. This problem may be avoided by using a concreate surface composite in steel-composite bridge deck.

Cable-Stayed System

Locked Coil system (Rama IX bridge)





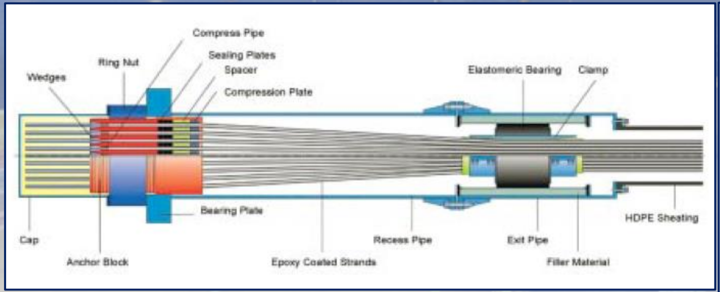


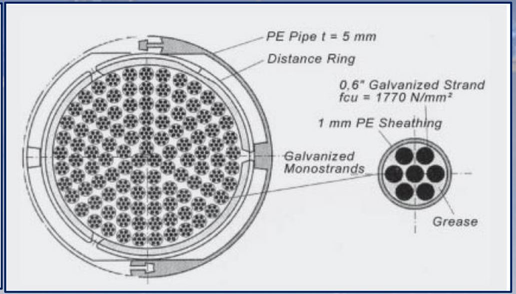
- Completely shop fabricated
- Different wire layers rotate in opposite directions in order to achieve twist-free ropes

Advantages : - good corrosion protection
- simple maintenance

Disadvantages : - reduced stiffness,
- reduced tensile strength & fatigue strength
- subject to creep

Parallel Strand (New bridge)



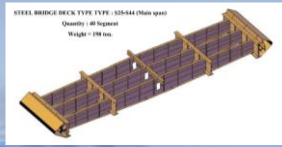


- Developed from strand tendons in order to exploit higher strength
- The cables comprise 7-wire strands with 0.6" (15 mm) diameter. The strands run parallel and are tightly packed over their free lengths. Near the anchorages they spread out, the corresponding deviation forces retained by a tension ring

Advantages : - cost-effective,
- fabrication on site so transportation weights are much smaller
- individual strands can be exchanged.
- Triple corrosion protection of individual mono strands

Disadvantages : slightly reduced stiffness

Bridge Deck Production

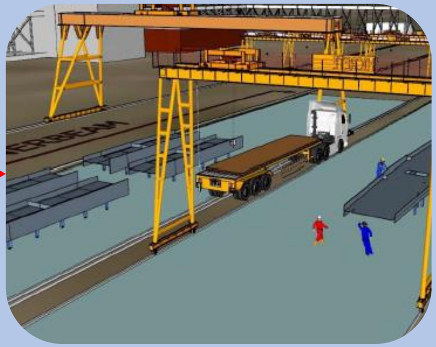


Raw Material

Cutting Process

Built-up Beam

Welding

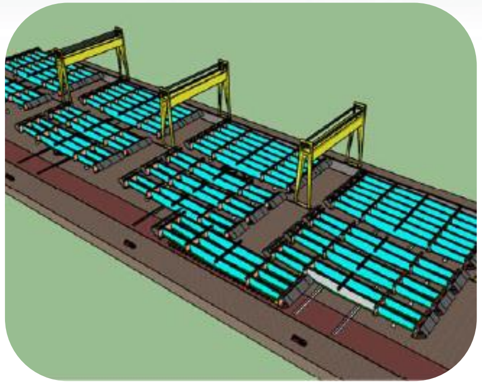


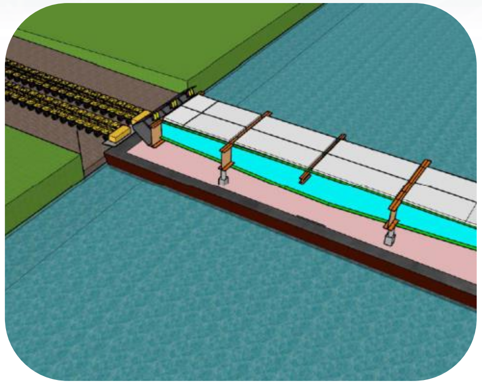
Assembly Accessories

Fabrication → Surface Work → Stock Product → Transport

Sand Blast

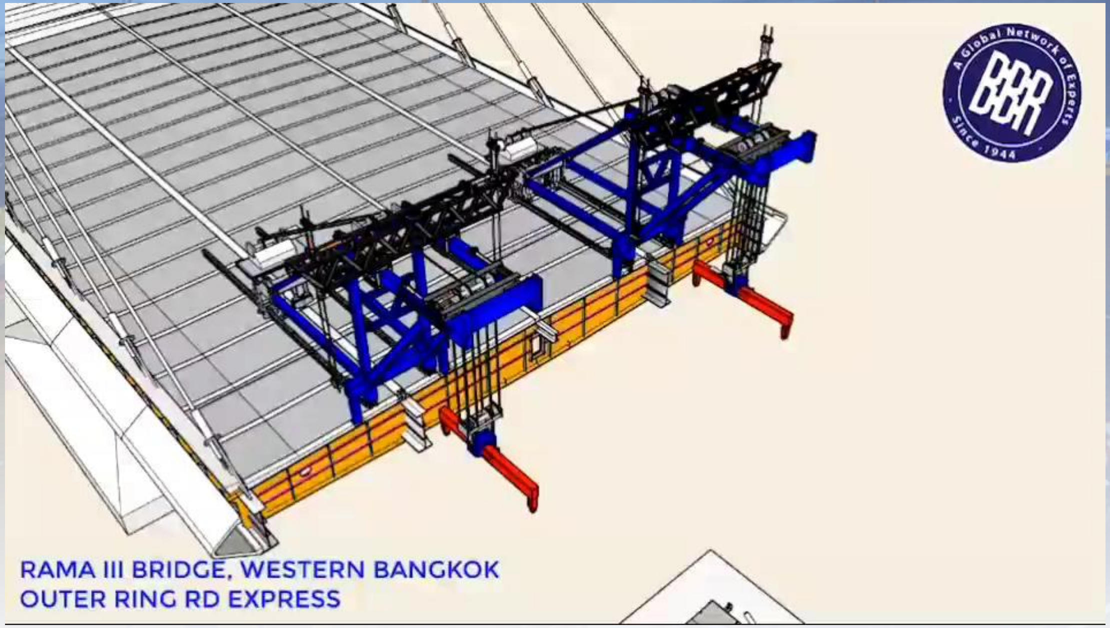
Primer Coat + Top Coat



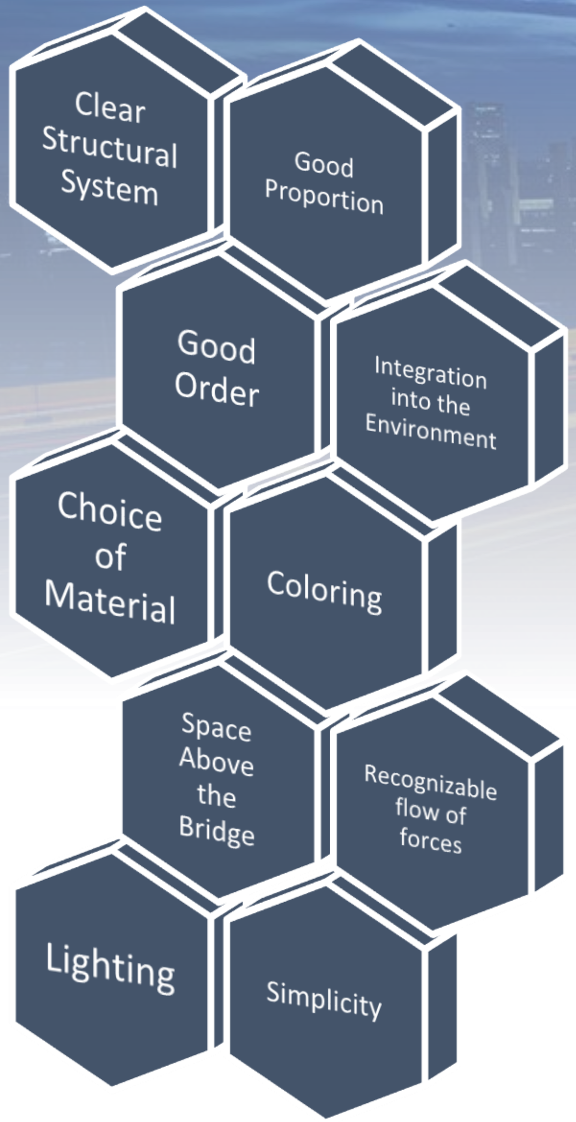


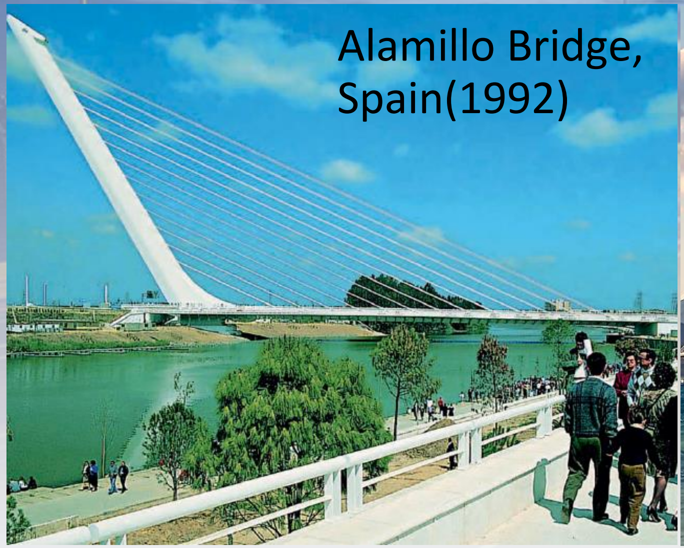
Cable-Stayed Bridge Construction

- The planning of construction of cable-stayed bridge generally uses cantilever approach that is no installation of scaffolding systems under the bridge.
- Each bridge deck segment is transported to construction site by barge. It is lifted by erection equipment and supported by cable running directly to the pylons. Therefore, the bridge decks are required to be strong enough to resist the resulting horizontal compression loads.
- The material for the bridge deck in this project is A709-50W weathering steel with the precast concrete deck slab on top of steel grid.



Aesthetic Guidelines for Cable-Stayed Bridge




Alamillo Bridge, Spain(1992)


Rion-Antirion Bridge, Greece (2005)


Russky Bridge, Russia (2012)

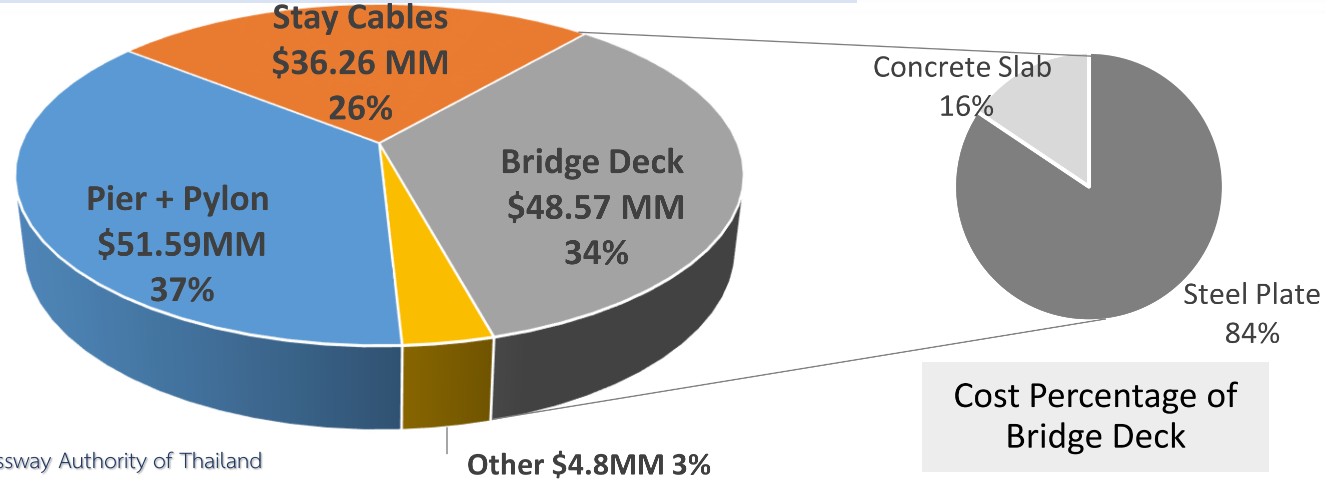

Yavuz Sultan Selim Bridge, Turkey (2020)

Project Summary

Steel Consumption	30,000 Tons
Reinforcement for pile cap, pier, pylon, deck slab	10,410 Tons
Pre-stressed Tendon	730 Tons
Steel Plate A709 50W for bridge deck	15,130 Tons
Pylon Steel Core	1,590 Tons
Cable Stay Strand Grade 270	2,140 Tons

Total Cost of Cable-Stayed bridge Structure : 141 Million USD

Chart of Cost Percentage of Bridge Structure



Cost Percentage of Bridge Deck