TECHNICAL ADVANCES IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE IN VIETNAM AND THE REQUIREMENT FOR STEEL MATERIAL

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1. OVERVIEW
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM
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1. OVERVIEW

1.1. TRANSPORT INFRASTRUCTURE SYSTEM

- The transport infrastructure system is developed rapidly and sustainably, compared with 2005:
  - Road network length is increased from 39,646 km to 64,504 km
  - Railway network length is increased from 2,600 km to 3,160 km
  - Inland waterways length network is increased from 15,436 km to 17,232 km
  - The capacity of seaports system is increased from about 32.5 million tons/year to about 550 million tons/year
  - Capacity of Airport system is increased from about 18 million passengers/year to 77.75 million passengers/year

- Apply scientific and technological advances; achieving economic & technical efficiency in investment and construction process;
- Many large scale projects with advanced construction technology are completed by Vietnamese engineers and workers
1. OVERVIEW

1.2. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE SYSTEM

Steel has been widely used in construction of transport infrastructures.

**Advantages:**
- High tensile, compressive, flexure, shear & stress, torsion strength. High strength and elasticity modulus, hardness, small deflection. High ductility
- Light weight, reduce foundation construction cost
- High uniformity, strength and elastic modulus stable
- Easy to fabricate, mechanize in assembly and construction, reduce construction time
- Easy modification and repair, recyclable, high architectural aesthetics

**Disadvantages**
- Susceptible to corrosion, high maintenance costs
- In high temperatures (>500°C), steel loses its properties
- Complicated construction because many components are jointed together by welding or bolts
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

- Apply and improve the technology of reinforced concrete bridge construction such as:
  - The balanced cantilever method for bridge construction with spans up to 150m, Incremental launching method, Movable scaffolding system method (MSS)
  - Span by span method (SBS) in Tân Vũ - Lạch Huyện Bridge and various being implemented at the ring road II project - Hanoi

- Research and transfer construction technology of suspension bridge and large cable-stayed bridges with advanced structure and construction technology via many projects and successfully apply in projects such as: Rach-Mieu bridge, Đakrông bridge, Nhat-Le bridge, Bach-Dang bridge.

- Build a number of bridges with modern and unique architectural, such as Han River Rotating Bridge (in 2000), Thuan Phuoc suspension Bridge (2009), Dragon arch Bridge, Tran Thi Ly Bridge

- Design and construction of Transport infrastructure in complicated topology and with advanced techniques using high quality materials, special construction technologies such as Pa Uon bridge with pier in height of 97.5m, flyover bridge, bridge in Cities and intersections with special technical requirements such as horizontal curved bridge, low-depth beam bridges, bridge cloverleaf etc.
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

HAM LUONG BRIDGE
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM
2.1. BRIDGE CONSTRUCTION TECHNOLOGY

MOVABLE SCAFFOLDING SYSTEM METHOD (MSS)
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

BAI - CHAY BRIDGE
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

RẠCH-MIEU BRIDGE

Rach-Mieu bridge is first cable stayed bridge, which is designed and constructed by Vietnamese engineers with advanced technology.
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

THUAN PHUOC BRIDGE
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

VAM CONG BRIDGE
03 spans: (210+450+210)m; Main span is designed in steel-concrete composite beam with length of 450m; Pylons are designed in H shape in pre-stressed concrete with the height of 150m; Bored piles D2500mm with length of 110m
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

BACH-DANG BRIDGE

Pre-stressed concrete cable stayed bridge with 04 spans (110+2x240+110)m;
Designed and constructed by Vietnamese Engineers; 03 Pylons are designed in H shape in reinforced concrete with height of 150m; Bored piles D2500mm
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

TRAN THI LY BRIDGE
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.1. BRIDGE CONSTRUCTION TECHNOLOGY

DRAGON ARCH BRIDGE
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM
2.1. BRIDGE CONSTRUCTION TECHNOLOGY

INTERSECTION OF VINH TUY BRIDGE AND NATIONAL HIGHWAY NO.5
Research and transfer the NATM technology from Haivan tunnel, Vietnamese engineers had designed and constructed some other tunnel projects as: Deo-Ngang, A-Roong-1 và A-Roong-2

For tunnel in urban: application of under-river tunnel method for Thu Thiem tunnel which is designed to cross the Saigon River in Ho Chi Minh City.
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.3. ROAD CONSTRUCTION TECHNOLOGY

Application of advanced technologies for construction of road embankment and soft ground improvement such as: Prefabricated Vertical Drains (PVD), Sand compaction pile (SCP), Sand drain method (SD), Cement deep mixing Method (CDM), vacuum consolidation method (VCM), etc.
Polymer asphalt concrete, Ultra Thin Bonded Wearing Course (NovaChip) very thin overlays (VTO) has been applied to improve the quality of freeway pavement (good drainage, noise reduction) such as Ho Chi Minh City - Trung Luong freeway, Lang -Hoà Lac freeway, Cau Gie - Ninh Bình freeway, etc.
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.3. ROAD CONSTRUCTION TECHNOLOGY

Improve the quality of safety equipment such as road marking, Guardrail barrier, traffic sign boards.

Improve the technology of construction of concrete pavement for local roads and national highways;
Apply mechanization in construction to improve the quality of works.

Anti-Glare Panel, traffic sign boards, road marking
Cable barrier
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.4. RAILWAY CONSTRUCTION TECHNOLOGY

- Implementing many technical solutions and technology to upgrading some railway lines to raise the trains speed to 80-90km/h.;
- Applying new material technologies such as: rail welding technologies, accessories for elastic joints, rubber plate for railway crossings;
- Applied new technologies in construction and checking the quality of railway bridges and railways.
- Some urban railway lines in Hanoi and Ho Chi Minh city under construction.
- Research the high speed railway project with advanced technology.
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.5. SEAPORT, MARITIME ROUTES AND INLAND WATERWAY CONSTRUCTION TECHNOLOGY

Construction of seaports for ships of 100,000 tons to 200,000 tons such as Cai Lan, Vung Ang, Cai Mep-Thi Vai Tien Sa.

Construction of Access channels for large vessels such as: Hau River, Quan-Chanh-Bo channel, Cho-Gao channel etc.
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.5. SEAPORT, MARITIME ROUTES AND INLAND WATERWAY CONSTRUCTION TECHNOLOGY

New technology and material are applied as: haro concrete blocks to revetments breakwater (Lạch Giang project); geo-tube, túi cát Sand bag in Tân Vũ - Lạch Huyện project and Lạch Giang project.
2. DEVELOPMENT OF TECHNOLOGY IN CONSTRUCTION OF TRANSPORT INFRASTRUCTURE SYSTEM

2.6. AIRPORT CONSTRUCTION TECHNOLOGY

Applying new technologies in upgrading and expansion of international and domestic airports projects such as Cement deep Mixing method for soft ground improvement, polymer concrete; Asphalt cold recycling technology in Hue airport upgrading and expansion Project; Use of HWD equipment to evaluate of airport pavement; Constructed Noi Bai International Airport Terminal, Hue Airport, Vinh Airport

Noi Bai International Airport Terminal 2
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.1. PROSPECTIVE APPLICATION OF STEEL STRUCTURE IN VIETNAM TRANSPORT NETWORK

- High development demand of the infrastructure network ➔ Quick and effective construction technologies;
- New and replaced urban and rural bridges ➔ Light but durable and advanced building structures;
- Typical tropical monsoon climate leads to quick corrosion conditions ➔ Anti-corrosion and weathering materials;
- Difficult soft ground conditions in river and urban areas ➔ Strong and durable foundation structures.
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.2. ADVANCED STEEL BRIDGES

Existing of many advanced steel bridges in Vietnam:

- Cable stayed bridge;
- Suspension bridge;
- Arch bridge;
- Steel bridge and steel girder with reinforced concrete, etc.

**Advantages:** Longer span, heavy load resistance, remarkable architecture with better aesthetical view.

**Disadvantages:** High material cost, dependence on imported sources, requirement of special technical equipment and solutions;
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.2. ADVANCED STEEL BRIDGES

Bính cable stayed bridge (Hải-Phòng city): First long span steel cable stayed bridge in Vietnam
- Total length: 1280m in 3 main spans and 14 approach spans
- Total width: 22.5m for 4 vehicle lanes and 2 non-motorized lanes
- Design velocity: 80km/h
- Steel girder manufactured in Japan (~6500 tons)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.2. ADVANCED STEEL BRIDGES

Dragon arch bridge (Đà-Nẵng city): Shape of a Lý dynasty dragon
- Total length: 660m, 5 main spans and 3 approach spans
- Total width: 37.5m for 6 vehicle lanes and 2 pedestrian pathways
- Design velocity: 80km/h
- Steel girder manufactured in Vietnam (~9000 tons)
- Grand Award at 2014 Engineering Excellence Award in USA
Thuận-Phước suspension bridge (Đà-Nẵng city): Longest suspension bridge in Vietnam
- Total length: 1855m, 663m in 3 main spans, and 1192m in 24 approach spans
- Total width: 18m for 4 vehicle lanes, 2 pedestrian pathways
- Design velocity: 80km/h
- Steel box girder of main bridge manufactured in China (~9000 tons)
Thuận-Phước suspension bridge (Đà-Nẵng city): Longest suspension bridge in Vietnam
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3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.2. ADVANCED STEEL BRIDGES

Vàm-Cống steel cable stayed bridge (Mekong delta region): Longest steel bridge in South region
- Total length 2970m in 53 spans, main bridge: 450m cable stayed steel bridge, approach bridge: 2099.4m Super-T PC girder
- Total width 24.5m for 4 vehicle lanes and 2 non-motorized lanes
- Design velocity: 80km/h
- Steel girder manufactured in Vietnam (~7000 tons)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.3. WEATHERING STEEL FOR BRIDGE GIRDER

- **Advantages:** High weathering resistance, low maintenance cost and effective Life Cycle Cost (LCC);
- **Disadvantages:** High material cost, dependence on imported sources; Requirement of special technical equipment and solutions;

- Pilot used at Cho-Thuong railway truss bridge (1999);
- Widely applied for 43 bridges in Project “Safety improvement of railway bridges on Hanoi – HCM city rail line (phase 3)”.
- Also used for rural bridges in Mekong delta region.
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.3. WEATHERING STEEL FOR BRIDGE GIRDER

Xeo-Beo bridge (Cao-Lanh city, Dong-Thap province): **Urban bridge**

- SMA-W weathering steel truss: unpainted steel for upper chords and painted steel for lower chords
- Total length 24m, single span, total width 5m, maximal allowed load 8T
- Steel fabricated in Japan, structure assembled in Vietnam

Cho-Thuong bridge (Duc-Tho, Ha-Tinh province): **Railway bridge**

- Unpainted weathering steel girder
- Total length 250m, 4 spans, total width 4.26m
- Steel fabricated in Japan, structure assembled in Vietnam
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Steel piles:

- **Advantages**: high bearing capacity and flexural strength, high reliability, easy construction, capable for deep foundations, reusable.

- Smaller foundation, short construction times, longer service life.

- **Disadvantages**: High material cost, dependence of imported sources; Requirement of special technical equipment and solutions;

Advanced steel piles in Vietnam:

- Steel Sheet Pile;

- Steel Pipe Sheet Pile;

- Screw pile: TSUBASA pile, ATT, NS Eco pile.
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM
3.4. STEEL PILES FOR BRIDGE FOUNDATION

Steel Sheet Pile:
- Temporal cofferdam for pier’s foundation construction

Steel Sheet Pile
temporal cofferdam for
Thanh-Trì bridge
(Hanoi)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Steel Sheet Pile:

- Retaining wall: used for bank protection in port, embankment, sewer system, water channel, etc.

Steel Sheet Pile retaining wall for Anti-flood project (HCM city)
2. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

2.3. STEEL PILES FOR BRIDGE FOUNDATION

Steel Pipe Sheet Pile Foundation:

- Temporal cofferdam for pier’s foundation construction: Thanh-Trì bridge (Hanoi), Tân-Vũ Lạch-Huyện bridge (Hải-Phòng city);

Steel Pipe Sheet Pile temporal cofferdam of Thanh-Trì bridge (Hanoi)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Steel Pipe Sheet Pile Foundation:

- Temporal cofferdam for pier’s foundation construction;
- **Bridge foundation**: Nhật-Tân bridge, Bình-Kánh and Phước-Kánh bridge (Bến-Lức Long-Thành expressway);

Steel Pipe Sheet Pile well Foundation of Nhật-Tân cable stayed bridge (Hanoi)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Steel Pipe Sheet Pile Foundation:

- Temporal cofferdam for pier’s foundation construction;
- Bridge foundation;
- **Port and harbor foundation:** Dung-Quát port (Quảng-Ngãi province), Cái-Mép Thị-Vãi international port;

Steel Pipe Sheet Pile and Prestressed Concrete Pile mixed foundation of Cái-Mép wharf (Bà-Rịa Vũng-Tàu province)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Steel Pipe Sheet Pile Foundation:
- Temporal cofferdam for pier’s foundation construction;
- Bridge foundation;
- Port and harbor foundation;
- Foundation of sewer system:

Steel Pipe Sheet Pile Foundation of Muong-Chuỗi flood-tide control sewer (HCM city)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Screw pile:

TSUBASA Pile and NS Eco pile:
- Rotary penetration steel pipe pile with a toe wing.
- Advantage: Environmentally friendly, high bearing capacity, easy to pull out, manufactured in Vietnam.

Open-end type

Closed-end type
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Screw pile:

TSUBASA Pile and NS Eco pile:

- Used as foundation for urban steel bridges: Hoàng-Minh-Giám Nguyễn-Chánh flyover (Hanoi)

Bridge overview

Pile installation
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.4. STEEL PILES FOR BRIDGE FOUNDATION

Screw pile:

ATT Pile:
- Combination of steel pipe with spiral wings and cement deep mixing method
- Advantage: Large vertical and horizontal resistance, low noise and vibration during construction, no waste soil during construction;

![Graphs showing load at pile nose and horizontal load vs. horizontal displacement at ground](image)

- Steel pile diameter 190.7mm
- Steel pipe diameter 216.3mm
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.5. STEEL STRUCTURES FOR UNDERGROUND CONSTRUCTION

- Structure steels used as bracing strut during cut-and-cover construction:

Kim-Liên underpass (Hanoi)  Mỹ-Thùy underpass (HCM city)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.5. STEEL STRUCTURES FOR UNDERGROUND CONSTRUCTION

- Structure steels used as bracing strut during cut-and-cover construction;
- Steel guide wall in diaphragm wall for underground station construction:

Guide wall in diaphragm wall

Bến-Thanh Station
(HCM pilot metro line)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.5. STEEL STRUCTURES FOR UNDERGROUND CONSTRUCTION

- Structure steels used as bracing strut during cut-and-cover construction;
- Steel guide wall in diaphragm wall for underground station construction;
- Steel sheet pile for excavation wall protection of underground structure:

Tam-Hieee underpass
Biên-Hòa city, Đồng-Nai)

Ba-Son station
(HCM pilot metro line)
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.5. STEEL STRUCTURES FOR UNDERGROUND CONSTRUCTION

Advantages:
- Light weight,
- High load bearing resistance,
- Reduced critical impacts on neighboring
- Easy to transport,
- high-reusable.

Disadvantages:
- Settlement and deformation prone by water leakage,
- Soil stick and deformation during pull out.
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.6. URBAN STEEL FLYOVER

Steel flyovers constructed at dense interchange in big cities: 8 in Hanoi, 8 in HCM city, 1 in Hai-Phòng, etc.

**Advantage:**
- Lighter weight and slender shape;
- Immediate traffic jam solving at key urban interchanges;
- Short construction period;
- Reduction of environment and social impacts during construction;
- Easy to upgrade and widening in future;
- Lower investment cost (~80% compared to PC bridges);

**Disadvantage:**
- Heavy vehicle restriction;
- Uncompleted intersection solving at interchange;
- Conflict with other elevated routes in future.
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.6. URBAN STEEL FLYOVER

Long-Biên Nguyễn-Văn-Cừ steel flyover (Hanoi):

- Service life: 100 year
- Design live load: HL90
- Design velocity: 80km/h
- Total length: 810m in 5 main spans and 11 side spans
- Total width: 32m in 2 separated direction for 6 vehicle lanes
- Steel box girders and composite RC bridge deck
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.6. URBAN STEEL FLYOVER

Nguyễn-Bình-Khiêm Lê-Hồng-Phong flyover (Hải-Phòng city):

- Service life: 100 year
- Design live load: HL93
- Design velocity: 60km/h
- Total length: 267.6m in 5 spans
- Total width: 16m for 4 vehicle lanes
- Steel arch at main span, steel girders at side spans
3. APPLICATION OF STEEL STRUCTURES FOR TRANSPORT INFRASTRUCTURE IN VIETNAM

3.6. URBAN STEEL FLYOVER

Steel flyover at Cây-Gõ roundabout (HCM city):

- Design live load: 0.5xHL93
- Design velocity: 40km/h
- Consisted of 2 bridges: 1 over Hồng-Bàng street (8 spans), 1 over 03/2 street (6 spans)
- Total width: 15.5m (to Phú-Lâm), 12m (to 5th district), 6.5m at ramp
- Steel box girders and composite RC bridge deck
3. REQUIREMENT FOR STEEL FOR VIETNAM

- **Severe natural conditions:**
  - Tropical monsoon climate;
  - Continuous long coastal line;
  - Heavy rainfall.

**Requirement:** Anti-corrosion, weather resistant, low deteriorated, long-life material
4. REQUIREMENT FOR STEEL FOR VIETNAM

- Complicate and busy infrastructure network but low maintenance budget:
  - ~280,000km highway roads, ~6% of development rate (in 2010);
  - ~2,324,000 million VND for regular, periodic, unscheduled maintenances (in 2010).

Requirement:
Simple, low-cost and low-frequency (seldom) maintenance
4. REQUIREMENT FOR STEEL FOR VIETNAM

- Dependence on imported sources of structural steel for transport construction:
  
  **Requirement:** Sufficient domestic manufacturing capacity.

- Insufficiency of relevant legal and technical documents for the design and construction.
  
  **Requirement:** Technical specification and Legal framework for steel structures.
5. CONCLUSION

- Steel is an advantageous material for transport infrastructure construction in Vietnam.
- Steel has been widely applied for main, auxiliary and supporting structures, foundations of bridges, ports and harbors, sewer systems, underground structures, etc.
- Steel materials are required of long service life, anti-corrosion and weather resistance, more flexible forms and configurations, rational cost and availability.
- Further researches and studies are needed for the good practice of steel transport structures in Vietnam.
THANK YOU FOR YOUR ATTENTION !