# Provincial Highway No. 9 Improvement Project—Anshuo to Caopu Section

**Building a safe, eco-friendly, and carbon-footprint-managed highway**

## Application for the International Road Federation 2022 Global Road Achievement Awards (GRAA) in Environment Mitigation

**MAY 2022**

Directorate General of Highways, Ministry of Transportation and Communications (MOTC)

CECI Engineering Consultants , Inc.

Best View with "Slide Show" Mode

# Taiwan's South Link Highway Project – Anshuo to Caopu Section

1. *Project Overview*
2. *Eco-friendly Design Accommodated*
3. *Eco-friendly Technologies Adopted*
4. *Carbon Emission Managed*
5. *Project Outcomes Delivered*

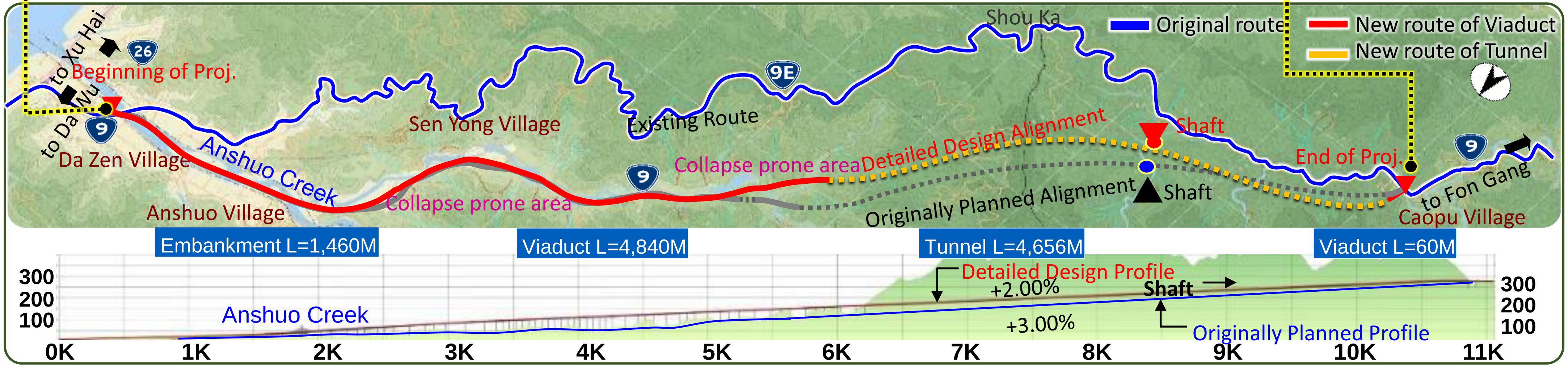
## 1.1 Project Background and Basic Information

- ✓ The South Link Highway belongs to Highway No. 9 and extends from Pingtung county on the west coast to Taitung county on the east coast of Southern Taiwan.
- ✓ This scenic route passes through steep mountains, deep valleys, and a rugged coastline in an environment rich in natural beauty, indigenous culture and rare wildlife.
- ✓ In the past, natural disasters frequently triggered landslides and disrupted transportation all along the original route.
- ✓ The original route was a narrow, winding road with a poor alignment and steep longitudinal slope constrained by high embankments and side slopes which would cause catastrophic damage to the environment if the road was widened.


## 1.2 Project Scope

- ✓ The improvement project was launched in 2009 with the goals of building a new, safer, and more convenient route for drivers, managing a significant reduction in $CO_2$ emissions during the construction, and employed various protective measures for local wildlife. The overall project was completed in December 2019.
- ✓ The newly-improved route eliminated 67 dangerous bends by designing a long tunnel and viaducts while minimizing the adverse impact to the environment.


| Anshuo to Caopu Improvement Section Project | | |
|---|---|---|
| Total length: | Before upgrading: 16.2km | After upgrading: 11.0km |
| Total Width: | Before upgrading: 7.0m | After upgrading: 20.5 – 23.0m |
| Total Construction Cost: | | USD 465.3 Million |

## 1.3 Environmental Mitigation Principles and Measures

1. **Eco-friendly Design Accommodated** Eco-friendly design was based on the prior mapping out of the wildlife habitats using infrared detection technology, ecological surveys, and environmental monitoring in order to move the constructions away from ecologically sensitive areas.

2. **Eco-friendly Technologies Adopted** Environmental monitoring measures, innovative construction, and construction volume reduction technologies were adopted during construction phases in order to mitigate hostile impacts to the local environment and wildlife.

3. **Carbon Emissions Managed** Low-carbon green design principles were applied and the tunnel profile thereafter adjusted from 3% to 2% and an innovative Carbon Inventory System was deployed to during construction to investigate and measure $CO_2$ emissions.

4. **Project Outcomes Delivered** A safer and more convenient new route has achieved to increase the traffic volume, shorten the driving time, reduces accidents, and mitigate environmental impacts. At the same time, the old route has been preserved as a leisure and scenic roadway.

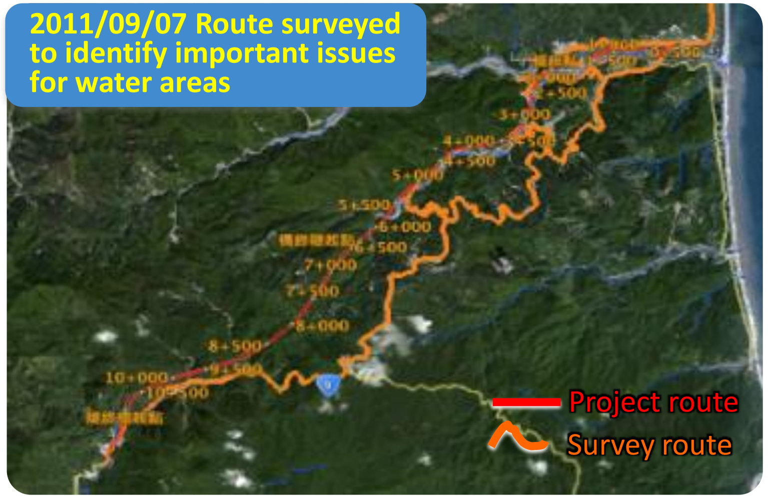
## 2.1 Ecological Survey for Land and Water Areas

| Biological Category of Investigation | Discovered Species | Conservation Species |
|---|---|---|
| Mammals | 20 | 7 |
| Birds | 45 | 13 |
| Reptiles | 15 | 4 |
| Amphibians | 16 | 0 |
| Butterflies | 100 | 1 |
| Dragonflies | 41 | 0 |


Route and Habitat Survey


Automatic Camera Setup


Bird Survey





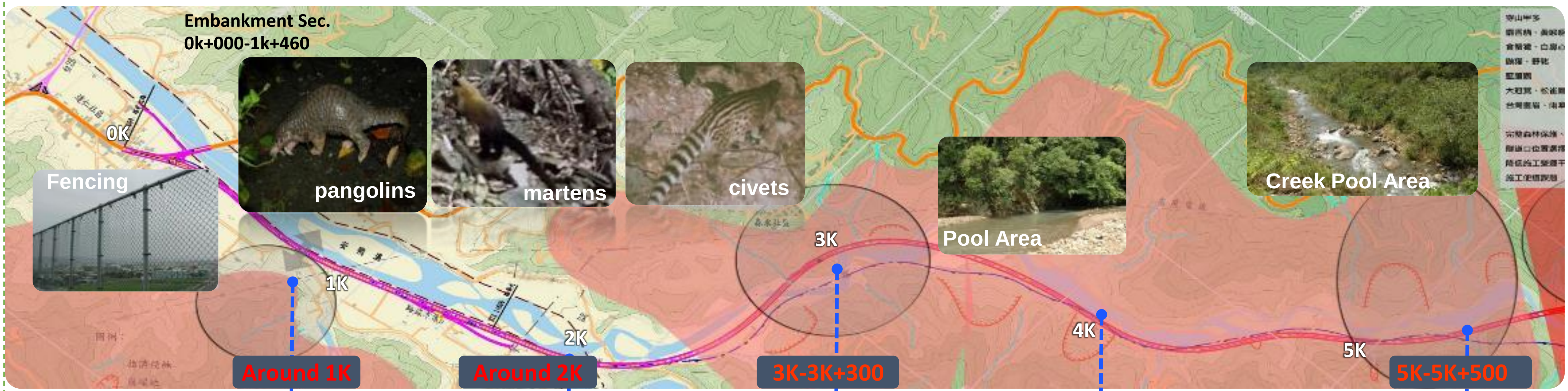

Night Survey


Insect Survey

## 2.2 Ecological Survey - Infrared Photography Survey

24-hour active infrared detection technology was utilized in a survey which lasted several months prior to the commencement of design to observe and investigate animal foraging paths to better protect them

## 2.3 Design Principles and Measures for Protecting the Environment – Viaduct Section




| | Around 1K | Around 2K | 3K-3K+300 | Around 4K | 5K-5K+500 |
|---|---|---|---|---|---|
| **Affected Area** | | Anshuo Creek Downstream | Anshuo Creek Pool Area | Primeval forest | |
| **Objects of potential impact** | Conservation of animal species (e.g. pangolins) | Migratory fish and crab | Aquatic creatures and fireflies | Forest ecosystem species | Aquatic creatures and large trees |

**Principles and Measures**

**Principles**
1. Minimize construction area
2. Prevent animal intrusion

**Viaduct Sec. 1k+460-6k+300**

**Measures**
1. Setting up grid fences
2. Using soundproof walls

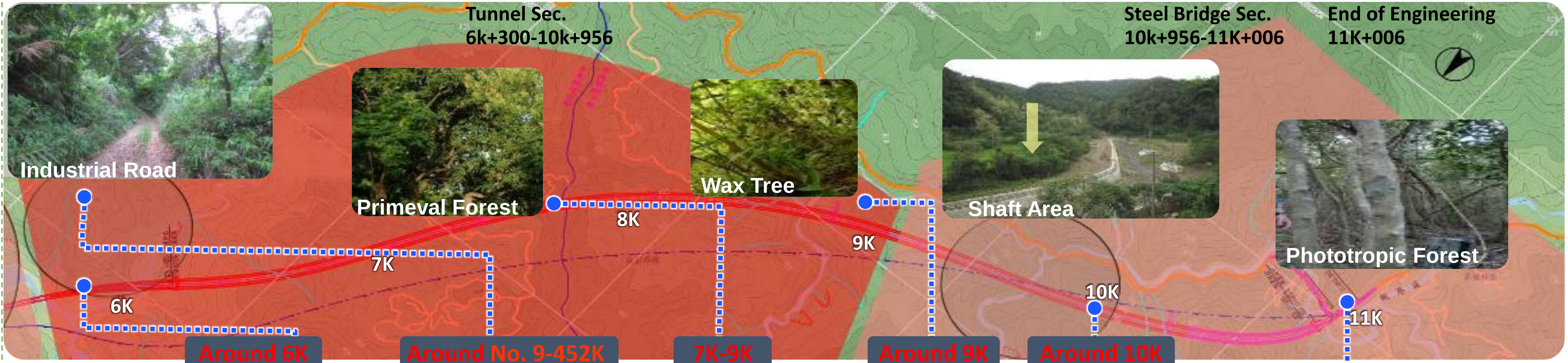
**Principles**
1. Pier placement for avoiding biological activity areas
2. Minimize construction area
3. Restore the area after completion

**Measures**
1. No construction during migratory species' breeding period
2. Use light sources only when necessary

**Principles and Measures**
1. Pier placement to avoid Biological activity areas
2. Minimize construction area
3. Restore the area after completion

**Principles and Measures**
1. Adjust alignment to protect large trees
2. Pier placement to avoid biological activity areas
3. Minimize construction area
4. Restore the area after completion

## 2.4 Design Principles and Measures for Protecting the Environment – Tunnel Section




| Affected Area | Primeval Forest | Industrial Road | Primeval forest | Secondary Forest - the Wax Tree | Primeval Forest | Phototropic Forest |
|---|---|---|---|---|---|---|
| Objects of potential impact | Conservation of animal species and large trees | Secondary forest and small animals | No affected species | Secondary forest species | No affected species | |

**Principles and Measures**

Principles and Measures
1. Adjust the alignment to protect large trees
2. Locate tunnel entrance to avoid biological activity route
3. Minimize tunnel entrance construction area
4. Restore the area after completion
5. Set up temporary barriers during construction

Principles and Measures
1. Minimization of the construction area
2. Area restoration after completion

## 3.1 Automated Construction Technology

The design enabled the use of automated construction of long-span viaducts to avoid damage to the environment, as well as the usage of:

- ✓ Pre-assembled structures and frames to accelerate the construction speed and safety of the high viaduct piers.
- ✓ The free cantilever construction method and the advanced shoring construction method to allow for restoration of ground vegetation and to improve construction safety.


Pre-assembled stirrup frame

Modular construction frame installation



Advanced Shoring construction method


Free Cantilever construction method


## 3.2 Innovative Construction Technology

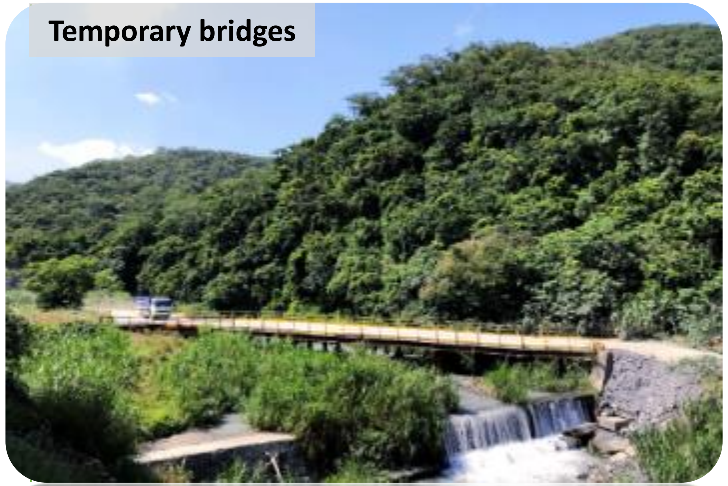
Riverside temporary bridges and roads were utilized to prevent excessive intrusion into the natural environment during construction:

- ✓ Trestles were used for construction to effectively reduce the impact on the ecological environment
- ✓ The project tender documentation specified that construction contractor should use temporary bridges or trestles in a specified manner to preserve the animal foraging paths

Well foundations and “bamboo cut” retaining walls helped reduce excavation to a minimum as well as:

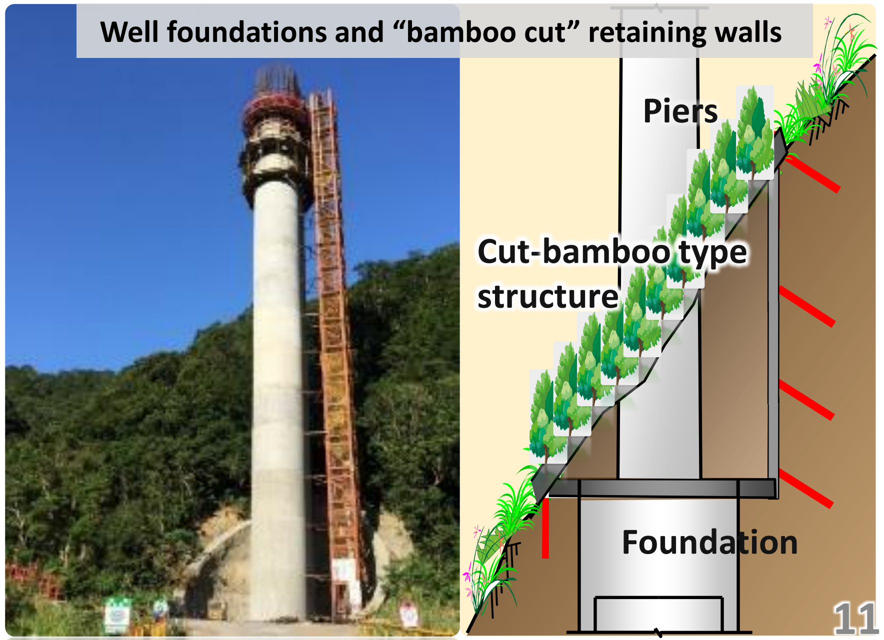
- ✓ Preserved the pristine landscape
- ✓ Enhanced safety and economy during construction
- ✓ Shortened the completion schedule

Temporary bridges



Trestles

Well foundations and “bamboo cut” retaining walls



## 3.3 Advanced Tunnel Fire Emergency Response and Rescue System

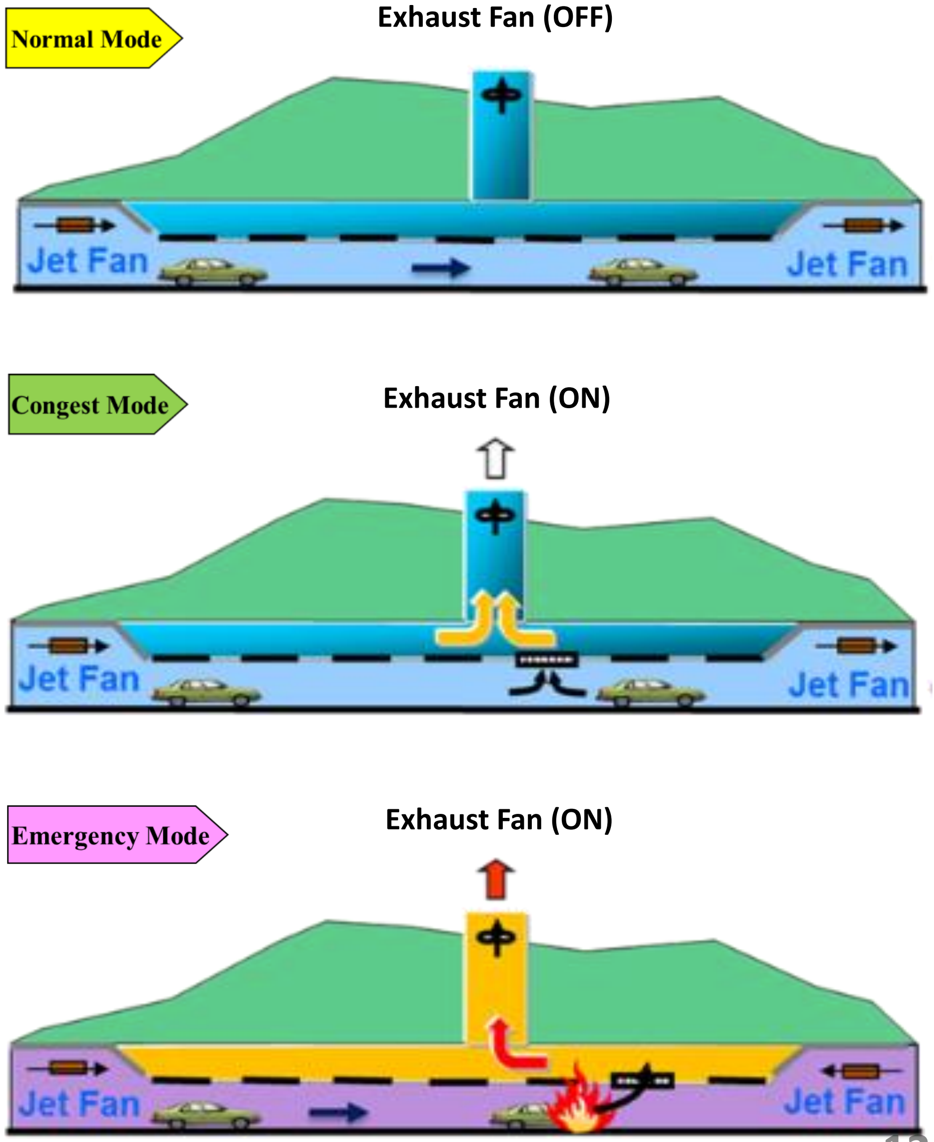
The tunnel features one of the world's most advanced systems: the point-and-row longitudinal flow smoke exhaust tunnel ventilation system, which was designed to ensure minimum impact in the event of a fire for the surrounding forest environment and to provide optimal passenger escape and refuge.

Two main sub-systems are activated during a fire emergency:

- ✓ The Automatic Water Mist Fire Protection System: Heat Release Rate (HRR) is 100MW
- ✓ The Integrated Tunnel Ventilation and Smoke Point Extraction System

Ventilation and Smoke System

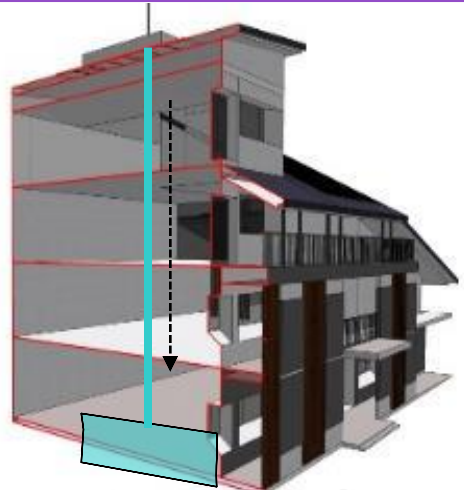
Water Mist Fire System



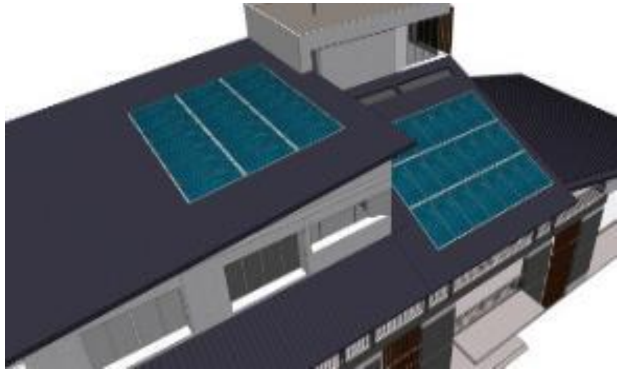
## 3.4 LEED Standards Applied

- ✓ The LEED Green Building design standards and the use of green materials were required to designed and constructed.

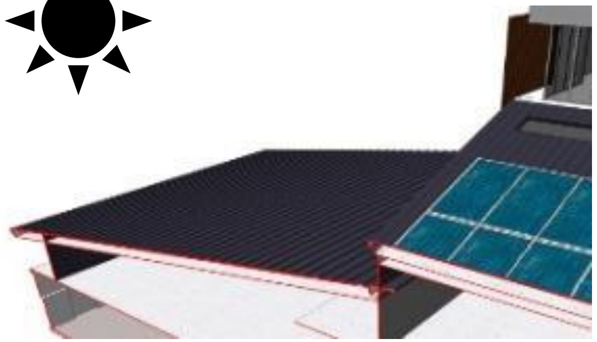
Deep shading and corridor on sunny side



Rainwater recycling



Solar photovoltaic panels



High-performance roof insulation

Fire Station

MINISTRY OF THE INTERIOR 內政部

綠建築標章證書

建築物名稱：台9線南迴公路安朔段交控中心及消防分隊新建工程

建築物概要：地上5層鋼筋混凝土造辦公廳及住宿類建築

建築執照字號：府建管字第C1080215889號

建築地號：達仁鄉達人段453-1地號等7筆

建築物門牌：臺東縣達仁鄉安朔村復興路186號

有效期限：自110年10月27日至115年10月26日

評估版本：基本型（2015年版）

綠建築等級：合格級

內政部 部長 徐國勇

中華民國 110 年 10 月 [illegible] 日

Traffic Control Center

## 3.5 Re-usage of the Tunnel and Viaduct Earthwork

### Excavated Earthwork Used for Backfill

- ✓ In addition to the tunnel and viaduct excavation being used as embankment backfill, the remaining earthwork (total 902,266 $m^3$) was used for a beach regeneration project on the east coast next to the Pacific ocean.

### Creation and Regeneration

- ✓ The regenerated sandy beach protects the erosions of east coast, caused by oceanic waves and typhoon surges.

**Create 21 hectares of new land**

Completion of the beach (north side)


Protect the coastline, improve roadbed safety and accumulate about 100 meters of wide sandy beach

Print from : https://www.google.com.tw/maps/@22.1400931,120.9070562,34548m/data=!3m1!1e3?hl=zh-TW&authuser=0

## 3.6 Environmental Monitored - Enhancement Ecological Sustainability

- ✓ Environmental monitoring of the air and water was carried out with the aim of enhancing ecological sustainability. If the data collected showed exceeding of regulatory standards, then the improvement mechanism were required to be put in place.
- ✓ Separation of waste water and groundwater in the tunnel during construction to reduce the waste water processing (equipment capacity reached 12.6 m3/min ) amount and ensure proper water quality released from the job site.
- ✓ The project adhered to the highest standards for soil and water conservation standards


Ambient air quality monitoring


River water quality monitoring


Waste water processing


Water area ecological survey


Coastal Ecological Monitoring Plan


Geotextile Green Retaining Wall

## 3.7 Ecology Preserved - Protection of the Wildlife including Protected Species

Effective measures were enforced to protect a wide variety of animal species residing in the project area including monkeys, squirrels, civets, muntjacs, serows, martens, etc.

- ✓ Pipe culverts were set up for animals to pass through (similar to biological corridors) and signs installed to remind drivers of the local wildlife
- ✓ The site was fenced off to preclude animals from accidental intrusions

The project is situated within the few ring-necked pheasant's habitats protected by law due to its declining population, related measures included:

- ✓ Completed the species distribution survey
- ✓ Confirmed that there are no ring-necked pheasants at the job site
- ✓ Identified the genetic strains of the ring-necked pheasant within the project area
- ✓ Promoted conservation of the ring-necked pheasant

## 4.1 Green Engineering Framework and Carbon Reduction Targets

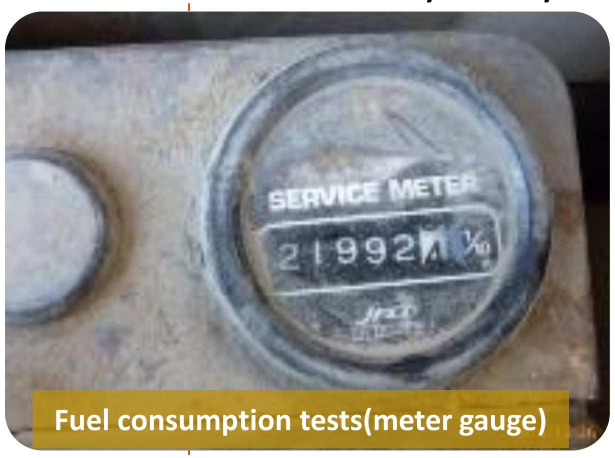
- ✓ An engineering framework integrating 'Green Environment', 'Green Methods', and 'Green Materials' was deployed for protecting the environment and mitigating the impact on the surroundings.
- ✓ Application of low-carbon design principles helped save about 72,600 tons of $CO_2$.
- ✓ The $CO_2$ reduction amount was roughly equivalent to 189 years of carbon fixation by one of Taipei City's main parks – the Da'an Forest Park.
- ✓ $CO_2$ inventory certification was obtained for the viaduct, tunnel and machinery rooms while relevant data and information was made available to the public.

| Green Environment | | Green Methods | | Green Materials | |
|---|---|---|---|---|---|
| **Reduce energy consumption** | Adjust tunnel profile | **Minimum size** | • Bamboo cutting method<br>• Enhance material strength | **Green Concrete** | Pozzolanic materials |
| **Ecology** | Ecological avoidance design | **Automatic methods** | • Automated construction<br>• Enhance construction efficiency | **Green Materials** | Adopt green marking materials |
| **Water retention** | • Use of grass trenches<br>• Rainwater recycling | **Earthwork Reuse** | • Embankment backfill<br>• Beach Regeneration | **Photoelectric energy-saving products** | • Solar panels<br>• LED lamps<br>• LED tunnel lighting |
| **Eco Retaining Wall** | • Natural ecosystems<br>• Slope greening | | | | |

# 4 Carbon Emission Managed

## 4.2 Greenhouse Gas (GHG) Inventory in Construction Stage

- ✓ Construction activity data was continuously collected and the contractors were requested to keep carbon inventory forms based on their purchase orders so as to provide data to the project team for integration to the project activity database.
- ✓ Tests were continuously performed for the main construction equipment to track fuel consumption per unit of time.
- ✓ Inventory tracking was performed at the construction material plants for steel structures, truss support structures, precast cable troughs, etc. with the participation of Donghe Steel, Asian Cement Corporation, and other suppliers.
- ✓ Regular monthly site visits were conducted and meetings arranged for the carbon inventory guidance as well as to discuss the verification methods and work with the agency tasked with verification.
- ✓ The most appropriate carbon emission coefficients were researched and applied.
- ✓ Monthly and yearly inventory reports were prepared and submitted to the verification agency.



Fuel consumption tests(meter gauge)

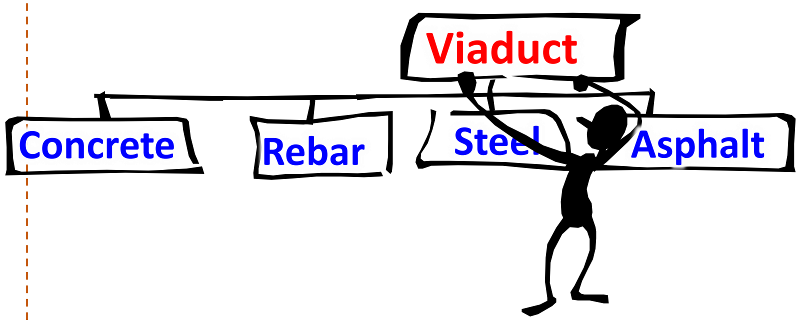

Plant inventory


Fuel consumption tests (machine)


Monthly inventory guidance meetings

## 4.3 Principles of Primary Emission Coefficients Collection and Inventory

### Reductive Carbon Methods and Low Carbon Materials




Construction materials types selected during detailed design

Importance-based materials ranking

Coordination with major suppliers in performing product carbon footprint inventory

Assistance from industry associations

Assisting suppliers with third-party verification to strengthen coefficients / data quality

Rebar Carbon Emission Coefficient Verification Statement

Supplier activity data survey

Integrate the carbon footprint data to create the Taiwan Domestic Emission Coefficients Database

## 4.4 Carbon Emission Statistics of Various Materials

- ✓ One of the few pioneering projects internationally where emissions data was being collected throughout the construction stage to contribute to domestic database establishment and analysis, which will allow to reduce emissions in future projects
- ✓ Collection of reliable and verifiable GHG emissions data for the construction materials was conducted in accordance with the **ISO 14067** standard

| Serial number | Year Applied | Contract | Supplier | Carbon Footprint Inventory Product | Carbon Emission Coefficient |
|---|---|---|---|---|---|
| 1 | 2014 | C2 | Donghe Steel Kaohsiung Plant | Steel Rebar (SD280W) | 0.886kg$CO_2$e/kg |
| 2 | 2015 | C2 | Donghe Steel Taoyuan Plant | Steel Rebar (SD420W) | 0.907kg$CO_2$e/kg |
| 3 | 2015 | C2 | Taiwan Cement Suao Plant | Portland Cement Type II | 1.026kg$CO_2$e/kg |
| 4 | 2015 | C2 | Panxin Concrete Plant | 350kgf/cm$^2$ Concrete | 258.69kg$CO_2$e/m$^3$ |
| 5 | 2017 | C1 | Asian Cement Hualien Plant | Portland Cement Type II | 0.935kg$CO_2$e/kg |
| 6 | 2017 | C1 | KEDGE Construction CO. | 350kgf/cm$^2$ Concrete | 277.07kg$CO_2$e/m$^3$ |
| 7 | 2018 | C1 | Feng Dun Asphalt | Asphalt concrete | 131.96kg$CO_2$e/T |
| 8 | 2018 | C1, C2 | Hong Jun Steel | Steel truss support, rock bolts, bearing plates | 0.722kg$CO_2$e/kg |
| 9 | 2018 | C3 | Hongtai Electric | Power line wiring and cables | 6.310kg$CO_2$e/kg |
| 10 | 2019 | C3 | Geng Hao Enterprise | Switchboard Box | 3.199kg$CO_2$e/kg |
| 11 | 2019 | C3 | Far East Machinery | Galvanized thick steel conduit | 3.27kg$CO_2$e/kg |
| 12 | 2019 | C4 | Tianjiu Industrial | Compressed concrete brick | 10.129kg$CO_2$e/kg |
| 13 | 2020 | C4 | Yongyu Ceramics | Brick Tiling | 0.722kg$CO_2$e/kg |

## 4.5 Carbon Emission Statistics of Various Structure Components

**C1 Viaduct Contract summed up 6.3km (19m wide) Emissions (ton$CO_2$e) 30,016.31/per km**

| Viaduct Engineering | Pile | Well foundation | Pier | Superstructure | R.C. Retaining wall |
|---|---|---|---|---|---|
| Dimensions | 150cmφ | 14Mφ | Various | 9.5m and 19m wide | -- |
| Length (m) | 5,642 | 321 | 1,887.14 | 91,808 $m^2$ | 2334.5 $m^2$ |
| Emissions per Unit (ton $CO_2$e) | 2.13 (per km) | 36.21 (per km) | 11.02 (per km) | 0.746 (per $m^2$) | 0.30 (per $m^2$) |

**C2 Tunnel Contract summed up 4.6km (2-direction 240 sq m sectional area) Emissions (ton$CO_2$e) 99,298.57/per km**

| Tunnel Engineering | North Main Tunnel | South Main Tunnel | Shaft | Beach Regeneration | Pedestrian/vehicle connecting tunnel |
|---|---|---|---|---|---|
| Item | Tunnel | Tunnel | Shaft + Tunnel | Jetty + Offshore embankment | Shaft + Tunnel |
| Length (m) | 5,642 | 321 | 1,887.14 | 91,808 $m^2$ | 2334.5 $m^2$ |
| Emissions per Unit (ton $CO_2$e) | 2.13 (per km) | 36.21 (per km) | 11.02 (per km) | 0.746 (per $m^2$) | 1.58 (per $m^2$) |

## 4.6 Achievements for Carbon Footprint Lifecycle Inventory

- ✓ Project received internationally recognized carbon footprint inventory statements testifying to its high standard of data reliability
- ✓ Project played a key role in the establishment of Taiwan's national database of carbon emission coefficients
- ✓ Primary coefficient datum for carbon footprint is about 56%
- ✓ GHG Emission result: The proportion of Engineering Material/ Construction machinery is about 92/6 (Viaduct); 84/14 (Tunnel)
- ✓ GHG Emission result: The proportion of Construction/ Operation is about 84/16 (Viaduct); 69/31 (Tunnel)


bsi.
Opinion Statement
Product Carbon Footprint
Verification Opinion Statement
...making excellence a habit™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Opinion Statement
Product Carbon Footprint
Verification Opinion Statement
...making excellence a habit™

## 5.1 Environmental Impacts Mitigated

### Design Stage Strategies

**Application of high-performance materials**

- ✓ Alternative materials used to partially replace cement
- ✓ High-performance concrete applied to reduce the structural volume

**Application of high-performance structural systems**

- ✓ Application of high-strength and high-efficiency support systems
- ✓ Application of renewable high-efficiency materials

**Avoided ecologically sensitive areas and increase ecological spaces**

- ✓ Temporary structures minimized disturbance of biological pathways
- ✓ Permanent structures avoided ecologically sensitive areas

### Construction Stage Strategies

**Application of construction automation methods**

- ✓ Used the less invasive advanced shoring and free cantilever construction methods
- ✓ Viaduct piers and tunnel lining adopted automated formwork construction methods

**Project scale reduction**

- ✓ Reduced the project area and preserved the natural environment
- ✓ Utilized trestles to replace construction access roads

**Construction machinery energy usage reduction**

- ✓ Construction machinery partially used electricity instead of fuel for energy efficiency and cleanliness
- ✓ Carefully planned construction machinery use and methods

### Operation Stage Strategies

**Reduction of vehicle carbon footprint**

- ✓ Keep the route and road surface smooth to reduce the fuel consumption of the vehicle
- ✓ Keep the same vehicle speed and reduce carbon emissions

**Optimize operation management**

- ✓ Strengthen maintenance and operation management mechanisms and models
- ✓ Establish a complete and detailed evaluation mechanism, and develop a facility life extension plan

**Reduction of operation system carbon footprint**

- ✓ Enhancing energy saving in tunnel lighting, ventilation and fire protection systems
- ✓ Set up mechanical plant room to enhance power supply efficiency

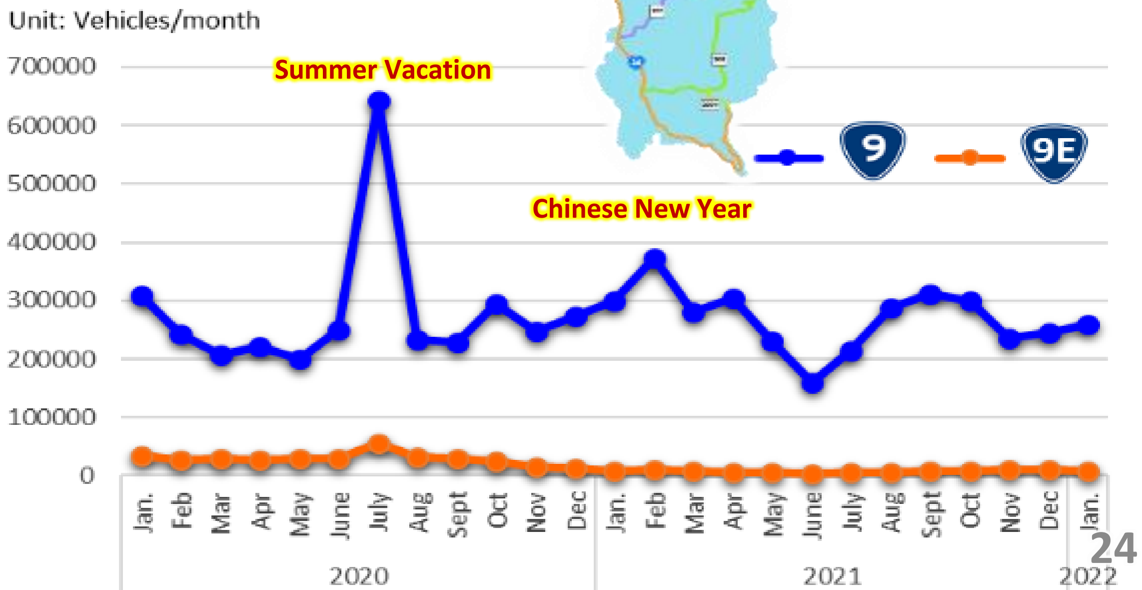
## 5.2 A “two-hour living circle” between Kaohsiung and Taitung Established

### Reduction of traffic flow-related carbon emissions and improvements in the economic development between the east and west coasts of Southern Taiwan

- ✓ Over 95% of traffic volume diverted to new route
- ✓ Traveling time reduced from 30 to 10 minutes for the project section
- ✓ Operation Phase Reduction: The annual carbon emission of traffic flow is reduced from 13,070 $TonCO_2e$ to 6,026 $TonCO_2e$, a reduction of about 54%, due to increased velocity and shortened distance.
- ✓ Establishment, by means of increased driving convenience, of a “two-hour living circle” between Kaohsiung and Taitung.


### From Anshuo Traffic Control Center

| Destination | Distance (km) | Time (mins) |
|---|---|---|
| 1 Kaohsiung International Airport | 97.5 | 106 |
| 2 Taitung Airport | 63.7 | 72 |
| 3 Zuoying High Speed Rail | 130 | 138 |
| 4 Taitung Train Station | 60.3 | 71 |
| 5 Fangliao Train Station | 50.3 | 57 |
| 6 Dawu Train Station | 11.9 | 16 |



# 5 Project Outcomes Delivered

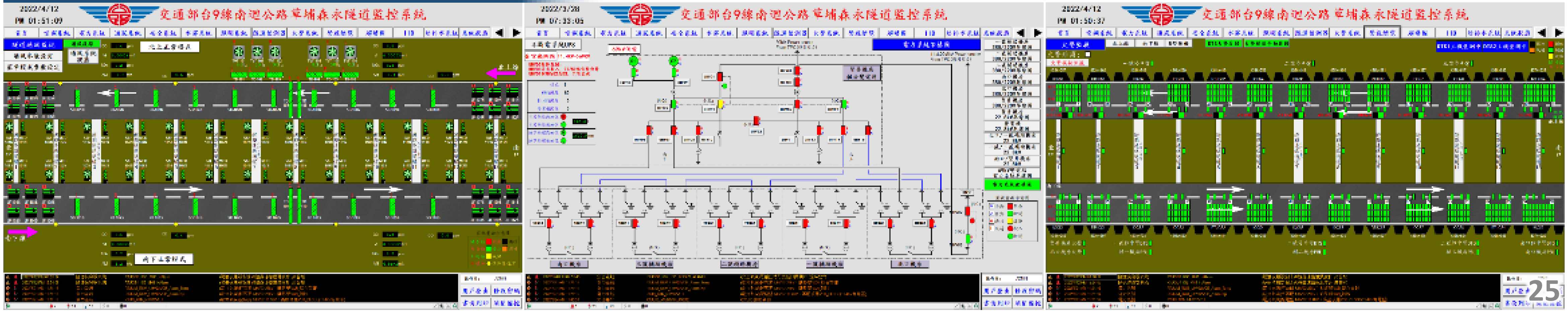
## 5.3 Safety-Oriented Traffic Management and Information System Employed

- ✓ Advanced technologies and Smart Traffic solutions for a safer road and a reduction in accidents
- ✓ Integration of traffic control and E&M equipment information

### Traffic Control Center

### Traffic and Road Conditions Monitoring

### Tunnel E&M Equipment Monitoring



## 5.4 Traffic Safety Improvements and Benefits Achieved

- ✓ After opening to traffic, the reduction in accidents and fatalities shows major improvement in terms of road safety.
- ✓ No A1 fatal accidents* have occurred after the new route has been opened to traffic due to its improved safety and service quality. Additionally, labor costs associated with accident handling are reduced by 40～68%, or an approximate USD 1,801,133 a year.

*"A1 Fatal accident" designates that fatalities occur immediately on site or within 24 hours after the accident.

**Gantries above the highway with clear signs to increase drivers' visual recognition ability**

| Route | Accident Cost | Project Opening to Traffic: Before | | | After | |
|---|---|---|---|---|---|---|
| | | 2017 | 2018 | 2019 | 2020 | 2021 |
| No. 9E | Injured persons | 67 | 69 | 69 | 28 | 26 |
| | Cost | 2,656 | 2,735 | 2,735 | 1,110 | 1,030 |
| | Fatalities | 1 | 0 | 2 | 0 | 1 |
| | Cost | 524 | - | 1,048 | - | 524 |
| No. 9 | Injured persons | - | - | - | 3 | 2 |
| | Cost | - | - | - | 119 | 79 |
| | Fatalities | - | - | - | 0 | 0 |
| | Cost | - | - | - | - | - |
| Total Accident Cost | | 3,180 | 2,735 | 3,783 | 1,229 | 1,633 |

Note:
According to the research by Taiwan MOTC, the average productivity loss expressed in monetary terms for each traffic accident fatality is USD 524,100. The research also indicates that for each injured person the associated cost is USD 39,633 .("Research on Road Traffic Accident Cost Estimation", 2019, Taiwan Ministry of Transportation and Communications)

*Unit for all listed costs: 1000 USD

## 5.5 Project Economic Benefits Delivered

- ✓ According to project estimations, the total associated costs for a 30-year operational period amount to USD$84,743,504, while the overall project benefits USD$202,466,140, returning net benefit of USD$117,722,636.
- ✓ The Cost-Benefit Ratio = 1.27 and the Internal Rate of Return = 5.72%, in 30-year operational period.

TIME SAVING

### Savings in Time & Distance

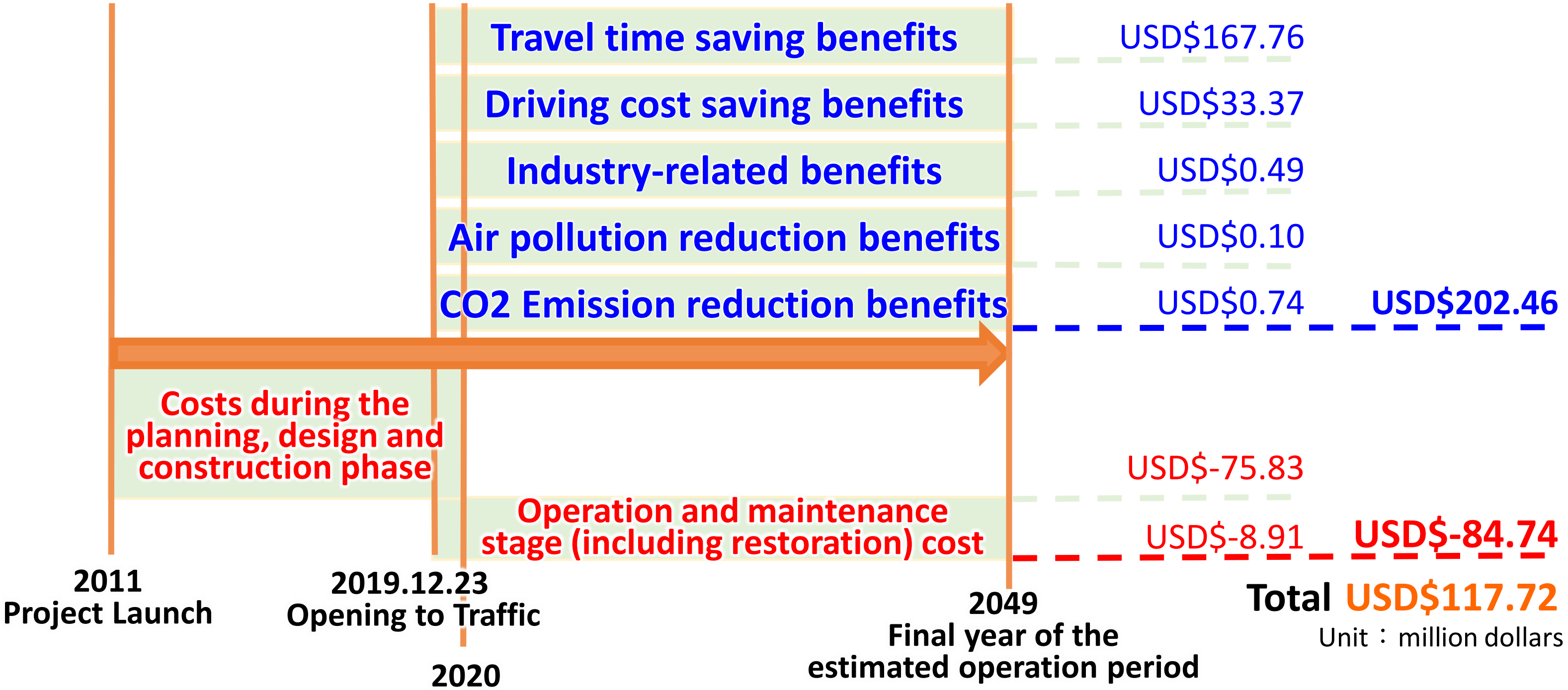
The Anshuo-Caopu section is about 5 km shorter than Highway No. 9E, with a saving in time needed for a round-trip of about 30 minutes.

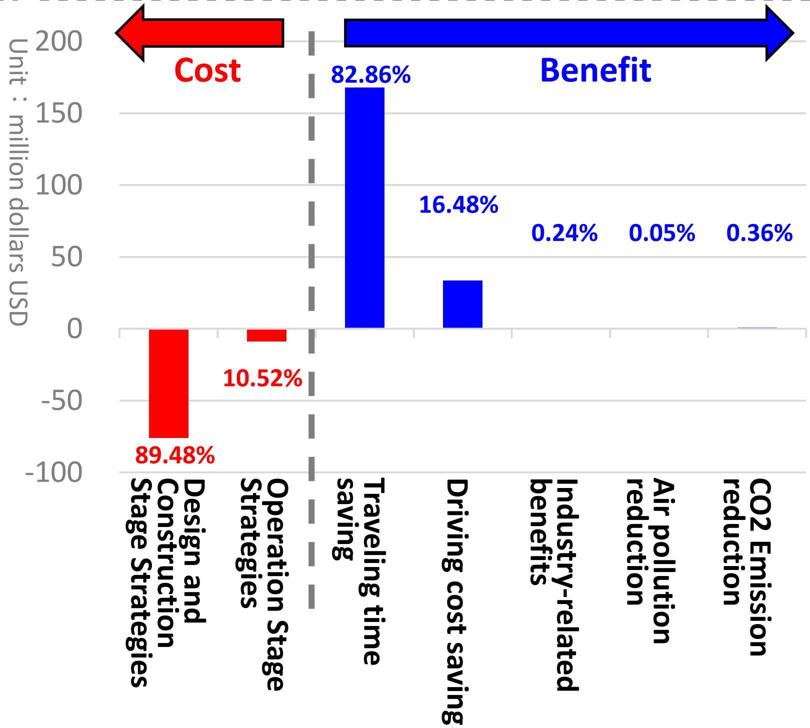
### Road Service Level Upgrade

Currently, the average speed on Highway No. 9 is about 64 km/h, compared with the average speed of 35 km/h on the old route before the new one was opened to traffic. The road service level has thus been significantly increased.

### Boosting Local Tourism

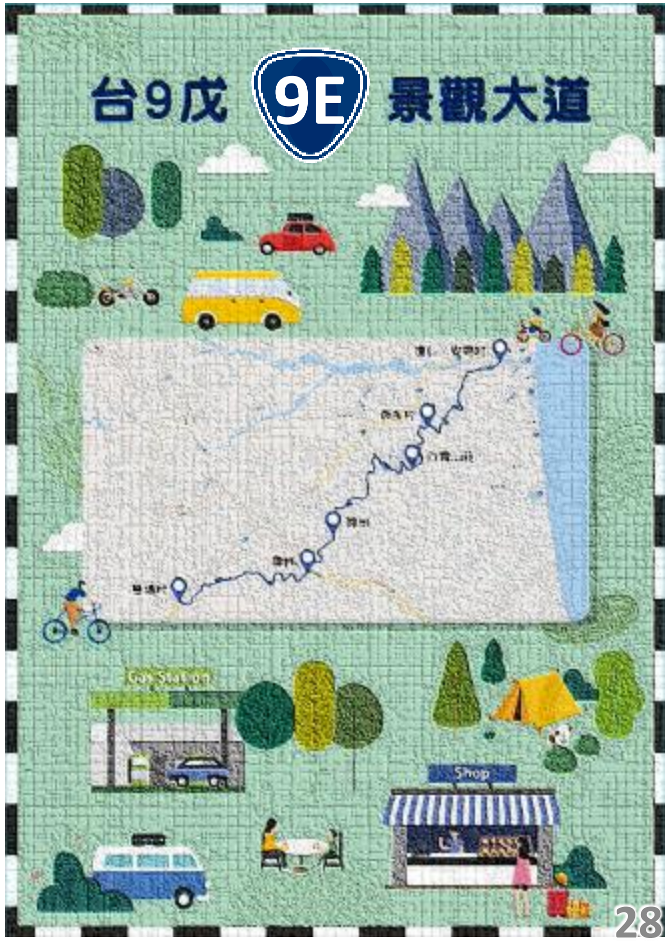
Improving Highway No. 9 brings with it Increased accessibility for tourists and visitors, which is showing in higher numbers of sightseeing trips to the area.



## 5.6 Sightseeing and Leisure Potential Road for Highway No. 9E Reinstated

- ✓ The original route (now numbered as Highway No. 9E) is used primarily as a leisure scenic road with an upgraded safe and intelligent detection and warning system for bicycle travel
- ✓ Signs and markings were established along the route for the dedicated bicycle-only lane
- ✓ Bicycle intelligent detection and warning system were also installed on site


Bicycle route marking

Upgraded traffic barriers

Bicycle fix station

Best View with “Slide Show” Mode

## 5.7 The Local Wildlife and Plants Restored

✓ Due to continuous efforts aimed at local habitats restoration and preservation throughout the project, a noticeable return of the wildlife and plants to the area has been observed that proves the success of the environmental mitigation measures.

Taiwan Barbet

# Restoration of plant and conservation animal habitats

Camera trap observation results after project completion


Crab-eating mongooses at local temple

## 5.8 An Safer and Eco-friendly Highway with Environmental Impacts Mitigated Opened to Serve.