Power Plant & Environmental Plant

Thermal Power I New & Renewable Energy I Waste to Energy I Water & Wastewater Plant

PEC's Power Plant & Environmental Plant Division provides sustainable solutions for renewable or combustible power generation, energy recovery from municipal and industrial waste resources to public authorities as well as the commercial sector clients.

Type of Services

The scope of services for our plant engineering consultancy starts from preparation of the initial project brief and concept development to the full feasibility study, preliminary and detailed engineering design, and implementation support for the type of plants including the following:

Power Plant

- Thermal Power Plant
- Bio-mass power plant
- Waste Heat Recovery Power Plant
- Renewable energy

Environmental Plant

- Waste to Energy Plant
- Organic Waste to Energy Plant
- Automated Waste Collection Plant
- Wastewater Treatment & Sewage Treatment Plant

We provide services not only for public sector power producers but also for private industry clients at home and abroad.

Thermal Power Plant

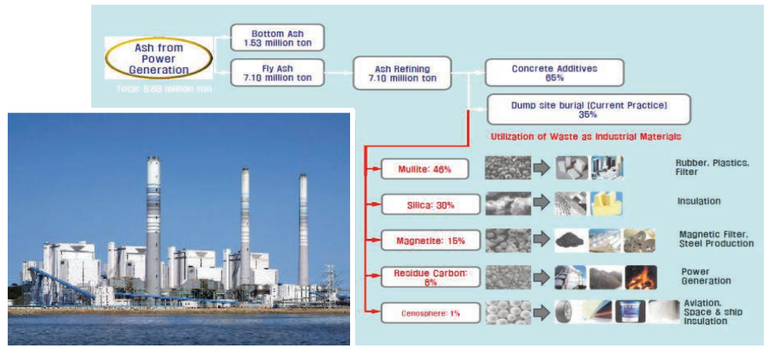
Technical Audit and Design Review of Ansan Combined Cycle Power Plant for Korea Southeast Power Company, Korea:
- 835MW, Gas Turbine (2 units);
- Steam Turbine (1 unit);
- Fuel supply: Natural Gas

Power Plant & Environmental Plant

Thermal Power I New & Renewable Energy I Waste to Energy I Water & Wastewater Plant

Technical Audit on Improvement of Yeosu Co-generation Plant, Korea Southeast Power Co.: Condensing Turbine: 67.9MW (1 unit); Back Pressure Turbine: 24.4MW (2 units); Boiler: CFBC 350ton/hour (2 units)

Industrial Materials Recovery Plant

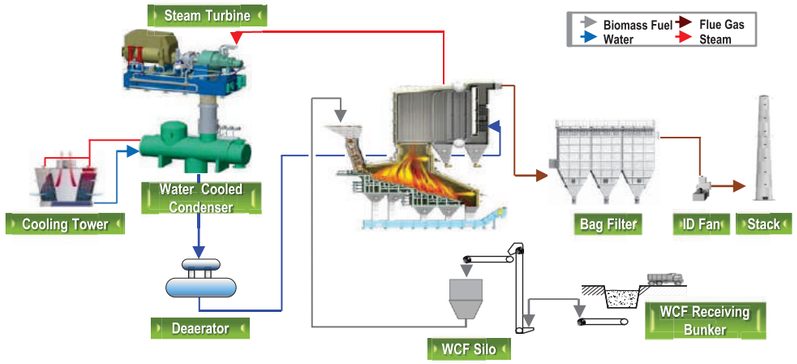


Basic Design of Recovery Facilities for Value Added Industrial Materials from Coal Combustion Fly Ash at Youngheung Thermal Power Station, Korea: Treatment of Coal Ash: 8.64 million ton; Recovery of Fly Ash: 7.10 million ton; Secondary Refining for Industrial Materials: 2.20 million ton; Recovery of Materials: Mullite, Silica, Magnetite, Cenosphere and residue carbon

Waste Heat Recovery Power Plant

Kiln Waste Heat Recovery Power Plant for Ssangyong Cement Factory, Korea: Basic and Detailed Design. Steam Production 190.8 ton/hr; Power Generation 43.5 MW; Steam Turbine (1 unit): AQC Boiler (4 units); PH Boiler (7 units)

Municipal Waste to Energy Plant



Generic Diagram of a Biomass Energy Plant

Ruisita Biomass Plant, the Philippines: Feasibility Study of Power Generation from Rice Husk: 9.9 MW

Small Hydro Power Plant in Famy City, the Philippines: Feasibility Study of 1MW on 3 locations in Lavac River (Mayatba) Basin

Power Plant & Environmental Plant

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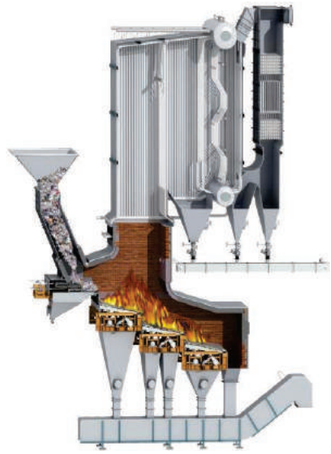
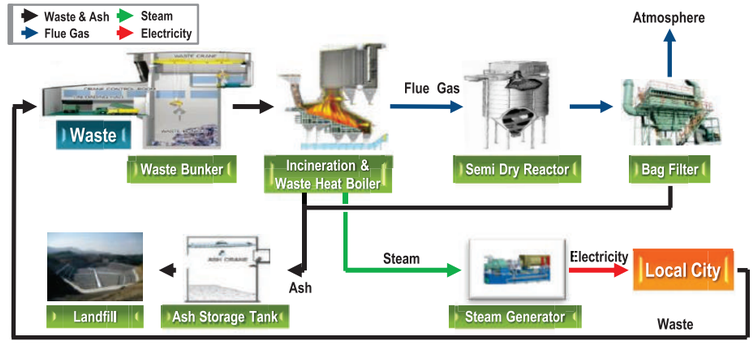
Waste to Energy Plan



Hwaseong RPF Energy Development Project, Korea:
Capacity: 9.0MW, RPF Burner (3 units), Steam Turbine (1 unit)

Sanitary Landfill Gas

Bulacan LFG Collection & Power Generation Project, the Philippines: Feasibility Study
Site Area: 40ha; Capacity: 2000 ton/day for 20 years; Expected Growth Power Generation: 5MW



A Generic Waste to Energy Plant Process

Municipal Waste to Energy Plant

Ulsan Municipal Solid Waste Incinerator, Ulsan city, Korea
- Incinerator type: Stoker / Capacity: 200 ton/day x 2 / Turbine Generator : 1,500kW

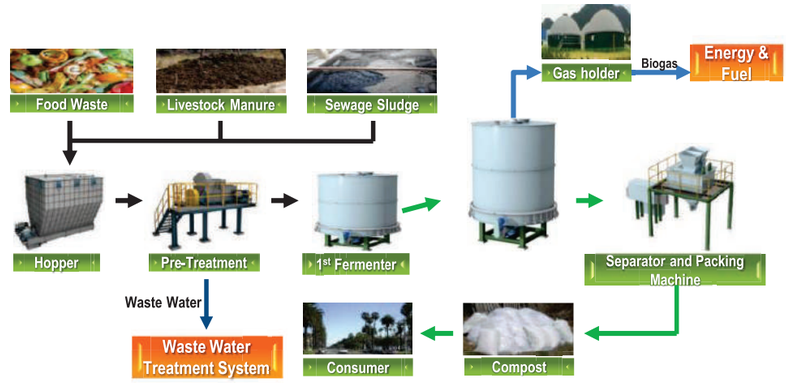
Steam Turbine Capacity Upgrading Project at Kangnam District Heat & Power Plant, Seoul, Korea
- Plant type: Incineration Power Plant, Capacity: 5MW + 21 Gcal/hour; Steam Turbine (1 unit)
- Client: Korea District Heating Corporation

Changwon No.1 MSW Incinerator, Changwon city, Korea
- Incinerator type: Stoker; Capacity: 200 ton/day; Turbine Generator : 1,100kW

Power Plant & Environmental Plant

Thermal Power I New & Renewable Energy I Waste to Energy I Water & Wastewater Plant

Organic Waste to Energy Plant



An Organic Waste to Energy Plant Process

Organic Waste to Bio-gas Facility, Ulsan City, Korea:
- Treatment Process : Anaerobic Digestion & Composting
- Capacity: 150 ton/day (Food Waste 100 ton/day / Livestock Manure 50 ton/day)
- Bio-gas: 9,446 Nm^3/day; Steam: 4 ton/h

Organic Waste to Bio-gas Facility, Yangsan City, Korea:
- Treatment Process : Anaerobic Digestion & Electricity Generation
- Capacity : Food Waste 60 ton/day / Livestock Manure 70 ton/day
- Biogas 6,196N m^3/day and Generation: 534 kW

Food Waste to Energy Plant

Cheongju Food Wastewater to Bio-gas Facility, Korea:
- Treatment Process : Anaerobic Digestion & Electricity Generation
- Capacity : Food wastewater 200 ton/day for power generation of 708 kW

Songdo Food Waste Treatment Plant, Korea:
- Capacity: Food Waste 200 ton/day, Feedstuff 32ton/day

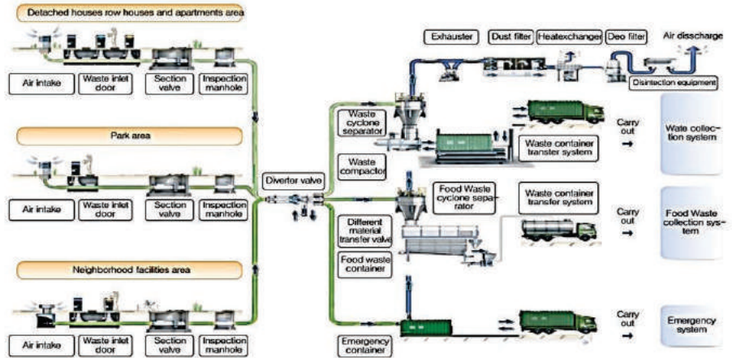
Osan Food Waste Facility Process Restoration , Korea:
- Capacity: Food Waste 80ton/day, compost 17 ton/day

Power Plant & Environmental Plant

Thermal Power I New & Renewable Energy I Waste to Energy I Water & Wastewater Plant

Automated Waste Collection Plant

Automated waste collection is an eco-friendly urban waste collection system. This high-tech system is designed to collect domestic wastes in high-density urban areas by underground vacuum pipelines, for collection and disposal at a central facility.



Automated Domestic Waste Collection Facility for Land & Housing Corporation, Hwasung, Korea
- Collection Area: 2,202,828㎡ / Population: 45,956 persons / Capacity: 24.51 ton/day

Power Plant & Environmental Plant

Thermal Power I New & Renewable Energy I Waste to Energy I Water & Wastewater Plant

Mechanical & Electrical Design of Water & Wastewater Plants

Chungbuk Water Quality Restoration Center, Pyungtaek City, Korea:
Treatment Type: DFS-MBR; Capacity: 8,200 + 800 m^3/day :/ Recycling Water 2,800m^3/day

Youngduk Sewage Treatment Facility, Yongin City, Korea:
Treatment Type: HS-aMBR / Capacity: 13,000m^3/day / Sanitary Sewer 0.96km

Iksan Industrial Complex Wastewater Treatment Plant, Korea
Treatment Type: H-Kumho MBR; Capacity: 5,500m^3/day / Intermediate Pumping Station 3,000m^3/day

05

SUPERVISION & MANAGEMENT

- PMC Consultancy
- Construction Supervision
- Value Engineering

Supervision & Management

Construction Supervision I Project Management Consultancy I Value Engineering

Construction supervision and management services constitute one the two main pillars of our business. We undertake full range of services in all sectors and fields we specialize. The services we provide include, among others:

Key Scope of Services

- Program management, project management and master program budget control;
- Construction supervision, including procurement support, contract administration, independent checking, monitoring and reporting; and
- Construction engineering, design due diligence review, value engineering (VE) and design-build oversight, etc.

PMC Service

Project Management Consultancy Services for the Pulau Muar Besar Bridge, Roads and Utilities Development Project, Bandar Seri Begawan, Brunei Darrusalem

Awendo Region Drinking Water Development Project, Kenya: PMC service from preparation and implementation of the project to improve hygienic conditions of African rural communities. Project components comprised intake weir and conveyance line 3km, treatment (2,000m ^{3}/day) and storage (1,000m^3), treated water conveyance (7km), distribution (15km), and deep-well drillings (2) with 5 distribution kiosks.

Supervision & Management

Construction Supervision I Project Management Consultancy I Value Engineering

Construction Supervision

As a premier transportation infrastructure engineering firm for design and supervision, PEC serves as a leading consultants in Construction Supervision of numerous roads and railroads projects.

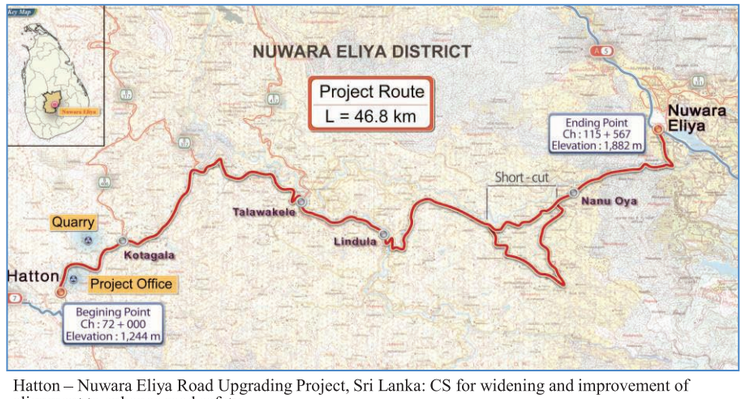
In all of all projects, tunnels and bridges are regular features, and empirical knowledge and expertise to deal with slope protection, subsoil and groundwater hydrology/hydraulics and climate change issues are essential elements, for PEC's engineers and experts have extensive experiences.

Construction of Metropolitan Seoul Circular Expressway Project, Korea:

Construction Supervision of Seongsu Bridge Widening & Upgrading Project, Seoul, Korea: Widening of the main steel truss bridge from 4-lane to 6-lane (bridge sections 4,081 m) on the Han River and improvement of access roads system.

Manado Bypass Project, North Sulawesi, Indonesia: Construction supervision, in parallel with fast-track review and re-design for alignment changes.

ADB Northern Roads Connectivity Project (NRCP), Sri Lanka: Post-conflict rehabilitation in the northern provinces . The CS services comprise 6 separate sections of 141.7km for priority rehabilitation.



Hatton – Nuwara Eliya Road Upgrading Project, Sri Lanka: CS for widening and improvement of alignment to enhance road safety

Supervision & Management

Construction Supervision I Project Management Consultancy I Value Engineering

GMS-SCCP Rach Gia Bypass Project, Vietnam: Bypass 20.83km with 22 bridges (3,234m total); Bridge Types: PC Voided Slab, PC I-girder, Super T-girder, PC Box girder; Foundation: CIP Concrete Piles of bored & cast in situ, Precast RC Piles); Extensive soft-soil treatment.

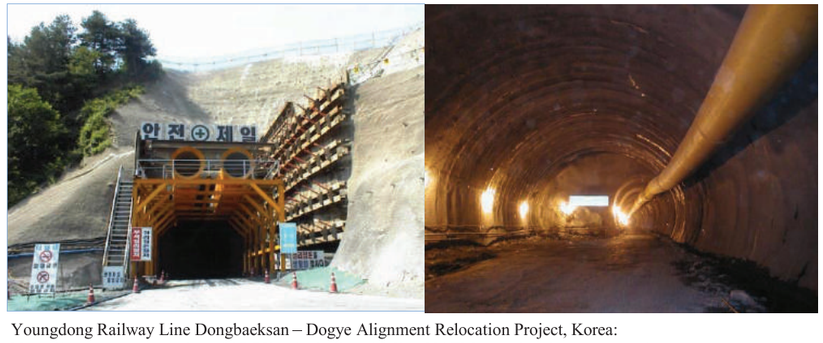
ADB Sustainable Urban Transport Program: Mtkvari Bridge Project, Tbilisi, Georgia: Detailed Design and Construction Supervision

Drainage Sluice Gate Expansion of Asan Bay Tidal Barrage, Korea: Agricultural irrigation/drainage infrastructure for prevention of sea water intrusion comprising construction of drainage sluice gates, expansion and upgrading of bridge.

KTX High-speed Railway Kyeongbu Line Construction Project, Korea: A scene of structural works inspection

KTX High Speed Railway Honam Line Construction Project, Korea: Above photo is Jeongeup Viaduct over the expressway section.

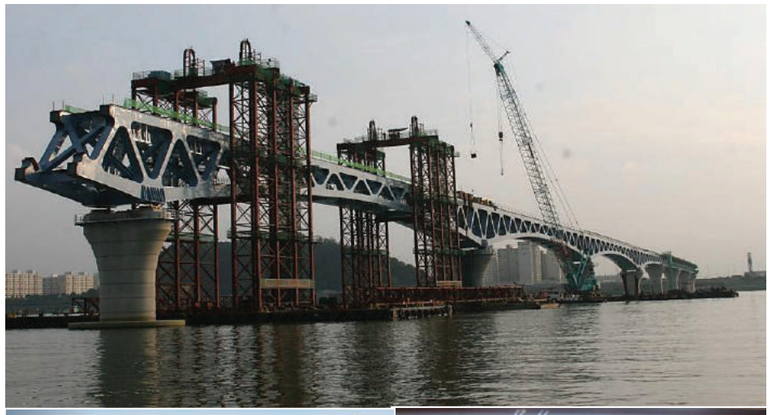
Kyeongchoon Railway Line roject, Korea: Construction supervision of new alignment with tunnels, bridges and stations.



Youngdong Railway Line Dongbaeksan – Dogye Alignment Relocation Project, Korea:
New alignment construction of 17.78km including 15.9km NATM tunnel and two new stations.

Supervision & Management

Construction Supervision I Project Management Consultancy I Value Engineering



Incheon International Airport Express Railway - Phase 2, Seoul, Korea: Construction Supervision including two mid-way stations, 8 bridges (3,653 m) and 3 tunnels (2,740 m).

Vamcong Bridge Construction Project, Vietnam: Preparation of Tender Documents, Procurement Support and Construction Supervision.

Supervision & Management

Construction Supervision I Project Management Consultancy I Value Engineering

Bridges

Mahnama Bridge Post-Tsunami Reconstruction Project, Sri Lanka: Preparation of Fast-track T
key Design and Implementation Support to the Contractor during the Construction Phase.

Construction Supervision of Jinza 2nd Nile Bridge, Kampala, Uganda: Services provided in ass
w/ Oriental Consultants, Japan

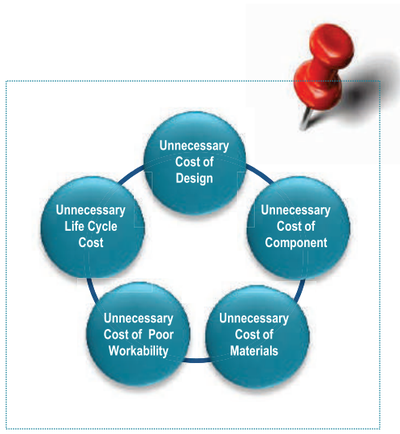
Construction of Gongchon I Bridge, Incheon, Korea: Design and Implementation Methods Ser
for Asymmetric 15-degre Inclined Pylon (109m) Cable Stayed Bridge (300m long with 6-lane

Value Engineering

Design VE I LCC & Options Screening I Risk Advisory

Why the VE?

At PEC, Value Engineering (VE) is an integral part of infrastructure development, and it is the key element integrated into our process for delivery of engineering solutions.



The benefits of VE exercise are that:

- It is not additional expenditure, but it could achieve cost savings by up to 20% in normal case;
- Particularly in infrastructure projects, the cost saving quantum can be much higher;
- The additional benefit of VE is that the final product is safer, more efficient, and saved cost means availability of more fund for the public use.

The VE service is crucial during the early phases of projects as the key issues and difficulties would arise around a vast number of conflicting pressures regarding engineering, operations, cost, safety, schedule, reliability, environmental issues, etc., which require careful scrutiny in an integrated optimization framework methodology.

Within this framework, we assist the client in managing and optimizing the project solutions, taking into account the key elements such as: Functional Design without unnecessary component, Value Creation, Risk Analysis, Options Screening and Cost Estimation Exercise to identify Least Life Cycle Cost.

Recent VE assignments include:

- Authorial Design Supervision and VE Consultancy on the Hanoi-Haiphong Expressway PFI Project in Vietnam;
- Tsunami Defense Wall Construction Project at Masan Old Port;
- Widening and Upgrading of Geumwang – Naesong Highway;
- Construction of Dansan Tunnel and Access Road System;
- Youngduck-Youngtong Link Road Development Project;
- Rehabilitation of Seoho Reservior and Flood Control Structures;
- Baekcheon Eco-Stream Project;
- Korea International Exhibition Complex – Phase 2 Site Civil Works;
- Songdo Free Economic Zone: Lots 5-2/5-3 Urban Infrastructure Project;
- Saemanguem Industrial Zone Reclamation and Site Civil Works;
- New Incheon International Trade Port Sea-Wall Project;
- Aewol Port Phase 2 & Steel Products Wharf for Chejoo Outer Port Projects, etc.

06

TECHNOLOGY DEVELOPMENT

- Infrastructure Technology Research & Development
- Software Development, Products & Services
- Knowledge Sharing Activities

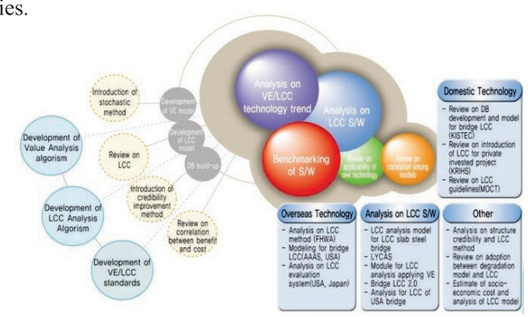
Infrastructure Technology Research & Development

PEC is in the forefront of infrastructure engineering technology advancement, with continuing efforts for R&D on such fields as the engineering software development for climate resilient infrastructure planning and design, technological innovation and value engineering. Our R&D Institutes spearheads and coordinates the overall research and technology development activities.

For major research projects, our R&D Institute coordinates the talents and expertise within the company as well as the resources of the external contributing organizations, if necessary, including government institutes, academia and private sector firms, so that the combined talents of the specialist groups will be mobilized to enhance the quality of research with application of the latest expertise on any challenging issues.

R&D in Smart Highway Technologies:

1) **Development of Smart Highway National Policy & Standard:**
   A study of mainline road geometry to increase design speed, preparation of standards, manuals and explanatory notes on smart highway structures and facilities.



2) **Eco-friendly Smart Highway Design Technology:**
   Research to develop methodologies for sustainable and environment-friendly design in harmony with the surrounding ecology.

Roadside Wind Turbines convert turbulence from high-speed traffic to electricity for smart highway equipment

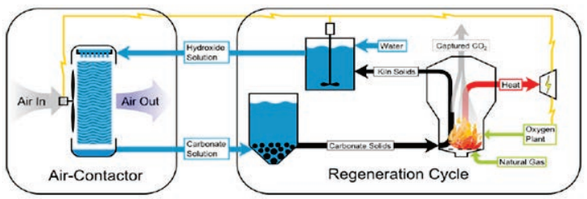
3) **WAVE (Wireless Access in-Vehicle Environment) Network:**

R&D on next generation ITS that interacts with cars on expressways on congestion and enhanced safety alert to drivers for impending/potential dangers from dozing, foreign objects on the road, and breakdowns ahead, etc.

Non-Stop Smart Toll Collection System on Expressway

4) **Development of Bio-Technology Based CO2 Absorption Process** (a); and high efficiency, low cost direct air capture (**DAC) system (b)** for reducing toxic gas emission from the road.

(a) Noise Barrier with CO^2 Absorbing System



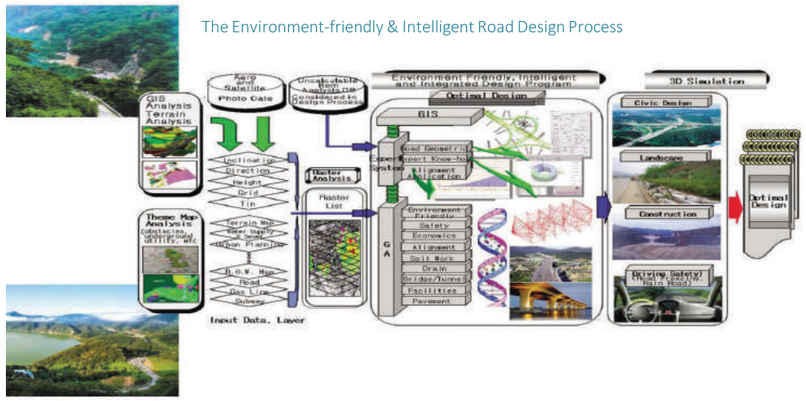
(b) DAC System Concept

Research & Development

Eco-Road Design Technology

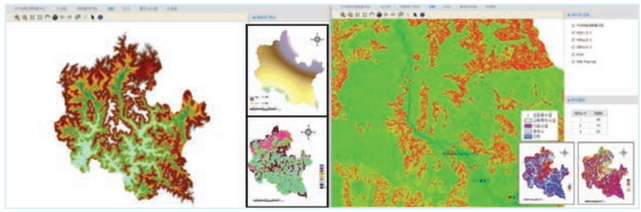
Environment-friendly and Intelligent Road Design Technology Research: Acting as the lead consultant of the research consortium, PEC successfully completed this landmark research of US$17million, 5-year assignment under the Korean Government's **CTRM (Construction Technology Road Map) Program** that involved 27 processional firms and academia.

The Environment-friendly & Intelligent Road Design Process

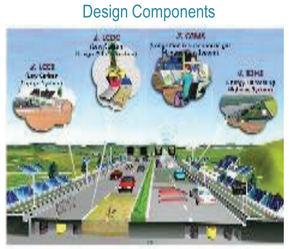


Other Recent Research Activities include:

- **Research on Alignment Planning Methodology Development and Climate Resilient Design Guidelines:** to develop alignment planning and design guides including criteria for preparation of alternatives, evaluation of alignments, aimed at minimizing natural disasters in vulnerable mountain slope and river valley terrains.



Carbon Neutral Road Design Components



- **Carbon-Neutral Road Technology Development:** research focusing on reducing CO^2 from planning and design stage to entire cycle of construction, operation and maintenance, and management to absorb or reduce the toxic gas.
- **Tunnel Pollutants and Toxic Gas Emission Treatment System:** for development of a combined treatment system for removal of polluted air mass and other hazardous substances in tunnel.
- **Improvement of Highway Geometric Structures and Roadway Safety:** improve road safety on research sections and propose advanced standards for road safety enhancement
- **Effects on Government's Policy Changes to Expressway System:** development of strategy and measures to mitigate negative impact on the operators
- **Development of Mechanized Railroad Tunnel Construction Technology**

Research & Development

Bridge Technology

Super Long-Span Bridge Technology R&D:

PEC Structural Engineering Division focuses on developing the bridge technologies that embody science and practical art in addition to revolutionary technological advances. The objective of our R&D is acquisition and upgrading of super long-span bridge construction technology equipped with the highest global standard, economic efficiency and technological competitiveness. The current researches comprise fully independent core technologies on i) Wind Resistance Design and the Test Bed Design, and ii) globally recognized management skills.

Registered Technologies

Our efforts for new technologies have produced patents and utility models with innovative features. Patents and registered technologies include :

- Coffer dam protection method utilizing inflow pipe and gate
- Sight distance calculation utilizing 3-D view software (SD2000)
- A method for choosing safe sight distances in road design
- Block type reinforced earth retaining wall & connection system for uniform settlement
- A built-up drain for use on mountain roads
- A vertical pedestal for forming ceilings
- An apparatus for removing floating particles
- A method for repairing voids under bridge approach slabs
- Construction method of caisson foundation
- A method for excavation of soft soil using block drainage
- Bridge construction method using precast arch segments
- An apparatus and method for determining gradient and horizontal level
- A method of calculation of waterway slope stability
- Use of high-resolution satellite imagery in road design programs
- Design and installation of shock absorbing median guardrail
- Design and installation of uni-directional movable bridge bearings
- Design and method for launching of incremental bridge sections
- Block type reinforced earth retaining wall system for uniform settlement
- Removal of impurities from submerged structure
- Earthquake restraint expansion joints
- Draining Unit for purifying polluted rainwater
- Environmentally friendly prefabricated mat block for embankments
- A structure for preventing erosion of river banks
- Nets for preventions of water pollution
- Pressurized immersed rubber dam with deflectors
- Roller guides for incremental launching of bridge sections
- A sluice gate with system for controlling water levels
- An inclined slope block for construction of fish-ways
- Erosion protection method at curved water courses in the river
- River flow velocity reduction blocks for protection of fish stocks

Software Development, Products & Services

Road & Railroad Design Software

Development of the "RD-2000" Road/Railroad Designer:

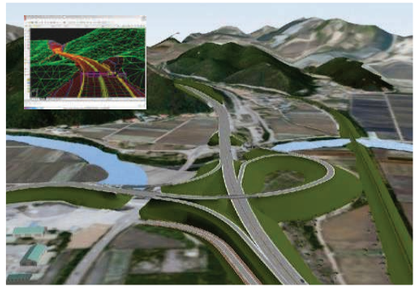
We launched the RD-2000 as our first commercial version of the road and railroad alignment design software in 2000. Operating on AutoCAD platform, RD-2000 featured hassle free horizontal/vertical alignments planning, design, quantity take-off and cost estimation as well as 3-D simulation.

The "RD_SmartPro" Road/Railroad Designer:

Since the first launch in 2000, RD-2000 has gone through a series of upgrading. The RD_SmartPro**,** introduced in 2011 is the latest upgrade, which is equipped with more intuitive user interface and powerful features than its predecessor versions, enabling a more streamlined design process from corridor identification, planning to feasibility level design as well as detailed design with 3-D animation capability and versatility of application in field survey and site civil works beyond the road design.

Salient Features of RD_SmartPro

- To plan and design horizontal alignment, divided carriageways and ramps, etc. with free sketching and mouse clicking only;
- To install/modify super-elevations and generate ground level from TIN;
- To display vertical/horizontal alignments, and automatic quantity take off and cost estimation; and simplified, automatic procedures for such tasks as:



3-D Simulation for Design Checking

- ✓ Bridge/tunnel installation and random modification, and create rock depth TIN;
- ✓ Road facility design such as side ditches and median for divided road, and produce information such as slope, drainage, structural dimensions, and counter-balance at bridge abutments by default;
- ✓ Mass curve generation, earthwork and hauling distance during cross-section design;
- ✓ 3-D simulation and on-screen checking of design error with built-in checking features for compliance with design standard and safety requirements, etc.

Software Technology Dissemination

Pyunghwa Data System (PHDS) is an affiliated company of the PEC organization, dedicated to the continued development, distribution and after-sales technical support of the products. It also disseminates other associate products such as:

- **gnrLAND:** for mapping to determine land acquisition and compensation;
- **gnrROAD:** real time on-screen checking/confirmation of design elements and construction costs;
- **gnrMASS:** optimization of secondary hauling distance and disposal of earthworks.

Software Development, Products & Services

Expert System for Alignment Optimization

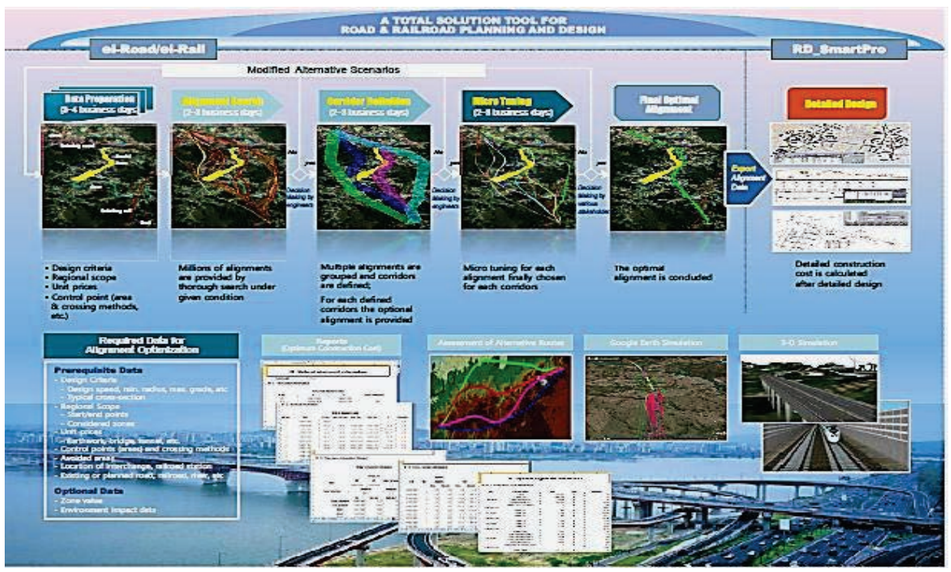
The "Ei-Road" - A Powerful Alignment Optimization Tool:

PEC developed the Ei-Road as an expert system for alignment optimization, which is another breakthrough technology that can optimize highway and railway alignment using Genetic Algorithm and GIS analysis.

By simply providing beginning and ending points and obstacles such as existing roads, rivers and any special areas such as historic monuments, Ei-Road can perform the tedious alignment planning process from corridor identification to full horizontal and vertical alignment optimization within 1-2 days.

Key Features of the Ei-Road Alignment Optimization System

- Ei-ROAD is arguably the most advanced and powerful alignment optimization tool of its kind;
- While other peer planning tools in the market offer horizontal and/or vertical optimization capability only, the Ei-ROAD can offer more power and versatility, with advanced capabilities:
  - ✓ As the design engineers can import the optimized alignment data from the Ei-ROAD output directly into the RD_SmartPro Road/Railroad Designer;
  - ✓ And thus enabling a streamlined process for the detailed design to make the best use of the advanced features of the RD_SmartPro.



The Ei-Road Alignment Optimization Process

Knowledge Sharing Activities

Technology Transfer & Training

We actively participate in international cooperation and knowledge sharing activities such as conferences and seminars, bilateral technical exchange and cooperation events, and provide ad hoc or OJT in our fields of business.

- Application of the RD_SmartPro, Ei-Road and its associated design tools;
- Quality control, laboratory/field tests, monitoring & evaluation;
- Application of new construction technologies and erection methodologies, etc.
- Bilateral Cooperation Delegations to Algeria, Azerbaijan, Russia, Ghana, Sudan, Uganda, UAE, Vietnam, Myanmar, Cambodia, Indonesia, South Africa, Mexico, Peru, Paraguay, USA, etc.

Field briefing on Seoungsu Grand Bridge Project for ASEAN officials

A Session on Alignment Planning, Design & Safety Checking Procedure

Trans-Khmer Highway: Project Meeting on Final Alignment Optimization with Ei-Road

RD_SmartPro Class, Ulaanbaatar, Mongolia

Trans-Caspian Exhibition, Baku, Azerbaijan

Exhibition on 'Autoroute des Hauts Plataux, Saida, Algeria

Indonesia-Korea Road Conference, Jakarta, Indonesia

Experts to Trust

Our vision is to be the trusted provider of services for our clients with added value at all times in our fields of specialization. With continued R&D and technological innovation, we endeavor to understand the client's expectations, and that our designs are flexible to accommodate long-term requirements.

On all projects, we foster a close working relationship with our clients, whenever possible, working closely with the client's staff to ensure that the project requirements are fully understood and met.

This illustrated profile is intended to provide a gist of general information on our capability, experience and expertise that we can offer to our clients.

For further information on our activities, separate sector brochures, leaflets and demonstration materials, etc. are available upon request, or visit our web site at: www.pec.kr

PYUNGHWA ENGINEERING CONSULTANTS

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Annex 1 Doosan Venturedigm Bldg., 415, Heungan-daero Dongan-gu, Anyang-si, Gyeonggi-do, Korea

Annex 2 Doosan Venturedigm 2 Bldg., 250 Hagui-ro, Dongan-gu, Anyang-si, Gyeonggi-do, Korea

Annex 3 Samhomulsan Bldg., 87, Nonhyeon-ro, Seocho-gu, Seoul, Korea