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TRƯỜNG ĐẠI HỌC GIAO THÔNG VẬN TẢI

University of Transport and Communications

LIST OF SCIENTIFIC PRODUCT (VERSION 2024)

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ASPHALT CONCRETE

Hot recycling using soybean oil based additives made in Vietnam

- RAP *(Recclaimed Asphalt Pavement)* content: 30-50%
- Producing temperature: 160-165^{0}C
- The design mix parameters satisfy TCVN (Vietnamese Standard) 13567-1: 2022
- Wheel track rutting test according to AASHTO T343: 3-5 mm standard
- Crack resistance index CT_{index} (ASTM D8225): 120-128
- Static elastic modulus (E):
  + 15^{0}C: 750 - 800 MPa
  + 30^{0}C: 300 - 350 MPa
  + 60^{0}C: 220 - 270 MPa
- Dynamic elastic modulus (|E*|, vibration frequency 1Hz):
  + 3,7^{0}C: 7000 - 8000 MPa
  + 21^{0}C: 5000 - 5500 MPa
  + 54^{0}C: 800 - 1000 MPa
- Indirect tensile elastic modulus for repeated loads
  (MR, 20^{0}C): 7000 – 7600 MPa
- Energy consumption: 500-550 MJ/ton *(20-30% reduction compared to traditional hot mix asphalt concrete)*
- Greenhouse gas emissions (CO_{2td}): 40-45 kg/ton *(20-30% reduction compared to traditional hot mix asphalt concrete)*
- Cost: 30-40% lower than traditional hot mix asphalt concrete.
- Tested on Highway 51 *(Bien Hoa - Vung Tau)*.

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ASPHALT CONCRETE

Warm recycling using organic and chemical additives

- RAP *(Recclaimed Asphalt Pavement)* content: 30-40%
- Producing temperature: 120-1300C
- The design mix parameters satisfy TCVN (Vietnamese Standard) 13567-1: 2022
- Wheel track rutting test according to AASHTO T343: 3.5-5.5 mm standard
- Crack resistance index CT_{index} (ASTM D8225): 140-180
- Static elastic modulus (E):
  + 15^{0}C: 700 - 800 MPa
  + 30^{0}C: 300 - 340 MPa
  + 60^{0}C: 220 - 270 MPa
- Dynamic elastic modulus (|E*|, vibration frequency 1Hz):
  + 3,7^{0}C: 7000 - 8000 MPa
  + 21^{0}C: 5000 - 6000 MPa
  + 54^{0}C: 900 - 1000 MPa
- Indirect tensile elastic modulus for repeated loads
  (MR, 20^{0}C): 7500 – 8000 MPa
- Energy consumption: 400-450 MJ/ton *(20-35% reduction compared to traditional hot mix asphalt concrete)*
- Greenhouse gas emissions (CO_{2td}): 30-40 kg/ton *(20-35% reduction compared to traditional hot mix asphalt concrete)*
- Cost: 30-40% lower than traditional hot mix asphalt concrete.
- Tested on Highway 51 (Bien Hoa - Vung Tau).

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ASPHALT CONCRETE

Cool recycling using emulsion combined with cement

- RAP *(Recclaimed Asphalt Pavement)* content: 100%
- Producing temperature: 20-300C
- The design mix parameters satisfy AASHTO MP31
- Static elastic modulus (E):
  + 15^{0}C: 600 - 700 MPa
  + 30^{0}C: 300 - 320 MPa
  + 60^{0}C: 220 - 250 MPa
- Dynamic elastic modulus (|E*|, vibration frequency 1Hz):
  + 3,7^{0}C: 5000 - 6000 MPa
  + 21^{0}C: 3000 - 4000 MPa
  + 54^{0}C: 800 - 900 MPa
- Indirect tensile elastic modulus for repeated loads
  (MR, 200C): 3000 – 4000 MPa
- Energy consumption: 500-550 MJ/ton *(50-60% reduction compared to traditional hot mix asphalt concrete)*
- Greenhouse gas emissions (CO_{2td}): 20-25 kg/ton *(50-60% reduction compared to traditional hot mix asphalt concrete)*
- Cost: 60-70% lower than traditional hot mix asphalt concrete.
- Tested on Highway 51 *(Bien Hoa - Vung Tau).*

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TRAFFIC LIGHT CONTROL AND MONITORING SYSTEM

SYSTEMS FEATURES

1.1 Integrated human machine interface (HMI) touch screen, allowing setting up control strategies and monitoring all operating parameters as well as operating status of the system. (intuitive graphical interface, Vietnamese language, easy to use)

1.2 Automatic cooling system, with air vent filter, dust and splash proof design.

1.3 Allow direct connection and control of countdown lights, coordinated control to ensure reliability and meet the requirements of changing light cycle applications.

1.4 Integrated police control panel: Allow forced control of traffic lights at traffic intersections. Control modes include clearance and warning modes.

1.5 Integrate functional blocks to communicate with railway level crossing signals and automatically optimize the system's operating cycle.

1.6 Monitoring and warning function: Allow setting the manager's phone number, automatically sending warning information to the manager or the manager can actively check the system's operation remotely.

1.7 Automatically change the control strategy in real time in configured mode or automatically calculate a control strategy appropriate to reality based on data provided from the peripheral system about traffic flow in the area and cross-road warning signals.

1.8 Automatically optimizes the cycle and controls traffic lights to match the traffic flow in the area through the image processing system.

1.9 Connect to the central software to perform management, monitoring and control functions: connection interface and data format transmitted to the center are built according to prescribed standards; Accurate and complete data information that can be managed at the center; Monitor all information, control strategies, system operating status, power failures, signal light operating status; Force control of the system, set control strategies for the system, control the green wave mode; Intuitive graphical interface, Vietnamese language, easy to use.

CONTROL CABINET SPECIFICATIONS

2.1 Voltage: 22-30VDC or 220VAC

2.2 Power source protection: Circuit breaker against electric shock and short circuit.

2.3 Controller: MCU 16B 16MIPS 256KB I/O RAM52 OTG

2.4 Communication ports: 1 RS232; 1 RJ45; 1 RS485

2.5 Working temperature range: -10^{0}C～＋75^{0}C

2.6 Impedance ≥100MΩ

2.7 Data retention time after power failure: 10 years

2.8 Time error: ±1S

2.9 Power protection Aptomat 20A

2.10 Surge protection: 20 KA

2.11 Number of signal light control boards: 03

2.12 Maximum cabinet output ports: 27, expandable to 54

2.13 Number of colored lights: 9 can be expanded to 18

2.14 Maximum number of strategies: 30

2.15 Size: according to design drawing requirements

2.16 Protection level: IP43

2.17 Material: 1.2mm thick steel, powder coated in gray color

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ULTRA-HIGH PERFORMACE CONCRETE (UHPC)

- At the age of 28 days, with a steel fiber content of 0.5-2.0%, the compressive strength of UHPC can reach 170-200 MPa.
- At the age of 28 days, with a steel fiber content of 0.5-2.0%, the bending strength of UHPC can reach 32-44 MPa.
- With low cement usage from 285-665 kg/m3.

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SELF PROPELLED ROAD SURFACE INSPECTION EQUIPMENT

(UGV Camera-LiDAR self-propelled/moving target tracking)

The main task of checking the current condition of concrete road surfaces or concrete bridges in general, and the inner surface of concrete bridge girder boxes in particular, is to detect cracks and problems, generally called defects, of which the most important are the current condition of cracks and problems such as peeling, rusting, and water leakage.

When defects appear, they need to be located, measured and their main technical parameters determined, from which their development can be statistically predicted to serve the assessment of the condition of the road surface, as well as the health of the bridge.

Surface cracks and failures are one of the important and common criteria used to diagnose the health status and determine the service life of concrete structures in general and concrete bridges and roads in particular.

1. Voltage: supply for vehicle: 3-4s lipo battery; supply for control computer: 6s lipo battery.
2. Controller: STM32H743.
3. Communication ports: USB, UART, LAN *(Customized for embedded computers and cameras).*
4. Working temperature range: -10^{0}C～＋75^{0}C.
5. Control distance: 10km *(may be larger, depending on integrated media device).*
6. Speed: 1 - 4m/s *(Customizable).*
7. Observation height 60cm *(Customizable).*
8. Detection speed 5-10FPS *(Custom).*

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REMOTE OBJECT CONTROL DEVICE USING ARTIFICIAL INTELLIGENCE

Support for AV operators (UAV/UGV). The device receives data and images from UAV and UGV devices and transmits them to the controller. Data and images received from the controller are encrypted and transmitted to the display part according to the AI processing IP address on the large screen.

Capabilities: Multi-purpose device that supports AV operators in multi-tasking

- Can be used for both UAV and UGV depending on purpose/requirement.
- Set automatic trajectory, capable of autonomous running *(automatically identify objects, avoid obstacles and return to the optimal trajectory or track; tracking and following mobile objects).*
- Direct Control; GCS Interaction performs tasks according to priority modes..

1. **Voltage:** 5VDC for remote control, 19VDC for computer screen.
2. **Controller:** Intel i5 for computer screen, 4 *Cortex A53, 2.4GHz for remote control.
3. **Communication port:** USB.
4. **Working temperature range:** -10^{0}C~+75^{0}C.
5. **Control distance:** 10km *(may be larger, depending on the integrated communication device).*
6. **Processing speed:** 10-17 FPS.
7. **Detection speed:** 5FPS.
8. **2-3s delay on screen.**
9. **Transmission distance:** 10km.
10. **Frequency:** 5GHz, 2.4GHz.
11. **Automatically identify objects of interest to perform tasks:** Take photos, measure cracks on UGVs or detect, track and follow priority objects.
12. **GCS interaction transfers control/control mode/object dynamically.**

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SEARCH AND RESCUE SYSTEM USING UAV INTEGRATED WITH ARTIFICIAL INTELLIGENCE

1. Voltage: 5v for remote control, 14s lipo battery for rescue device.
2. Controller: 32bit ARM® STM32H753 Cortex®-M7 flight controller.
3. Working temperature range: -10^{0}C～+80^{0}C
4. Control distance: 10km *(may be larger, depending on the integrated communication device).*
5. Object detection speed: 30 FPS *(YOLOv8n detect about 0.3s).*
6. Detection speed 5-7FPS 10km *(may be larger, depending on integrated device/AI model).*
7. 2-3s delay on screen.
8. Transmission distance 10km - 20km *(can be larger, depending on the integrated communication device).*
9. Frequency 5GHz, 2.4GHz *(flexible, depending on additional integrated communication/AT equipment).*
10. Flight time 2-2.5h *(using gasoline)*, 20p *(without gasoline).*
11. Flexible flight load 25kg/max 50kg, flying in wind level 4 *(wind limit level 7).*
12. Automatic human detection, drowning victim identification, heat detection, priority object identification and object tracking.
13. Perform specific tasks for search and rescue: Shining lights, dropping buoys, interacting with GCS and command center to transfer control, identifying priority objects for tracking and following.

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APPLICATION
& TECHNOLOGY TRANSFER PRODUCT

HIGH STRENGTH RECYCLED CONCRETE

AUTHORS:

Assoc. Prof. Dr. Nguyen Thanh Sang – Main author, Team leader.

Dr. Thai Minh Quan – Main research member.

MA. Le Thu Trang – Principal Researcher.

MA. Pham Dinh Huy Hoang – Technician

PRODUCT ORIGIN

In 2020, the research team of the University of Transport and Communication collaborated with Toan Cau Company, which is currently receiving a large amount of construction waste in Hanoi, to conduct research to manufacture high-strength recycled concrete product with the aim of promoting the applicability of this type of concrete in construction works.

The research team is collaborating with Prof. Dosho - Meijo University (Japan) to continue research to improve the features of high-strength recycled concrete in various applications.

Recycled concrete with different recycled aggregate contents

SOCIO-ECONOMIC EFFICIENCY

Saving costs and fees for construction waste treatment at landfills, recycled materials have low cost and small volume, so they reduce the self-weight of the foundation structure, minimize transportation costs and import materials for the project, etc.

Using recycled concrete will significantly reduce the amount of sand, gravel, and stone mined from nature, saving natural resources, not affecting the ecological environment, and not polluting the mining area.

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PRODUCT SPECIFICATIONS

Compressive strength: 50-65 MPa
Splitting tensile strength: 2.7-3.8 MPa
Static elastic modulus: 23-36 GPa
Abrasion: <0.3 g/m3
Water absorption: <0.6%
Chloride ion permeability: Low
Dry shrinkage: <0.07%
Volumetric mass density: 2.1-2.3 g/cm3
There is no potential for aggregate alkaline reaction.

Construction waste dump site needs to be treated in Hanoi

PRODUCT APPLICATIONS

Recycled concrete can replace natural aggregate concrete for application in most construction projects using cement concrete.

Applications in traffic works: Making high-durability cement concrete road surface; making precast components such as bridge girders, curbs, port paving bricks, paved roads, etc.

Applications in civil engineering: Used for beams, columns, floors, etc.

Application in hydraulic works: Manufacturing high-strength precast ditch components, etc.

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APPLICATION
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PRE-TENSIONED CONCRETE SLAB FOR RAILWAY CROSSINGS AT ROAD AND RAILWAY INTERSECTIONS

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Dr. Le Anh Dung – Department of Railway

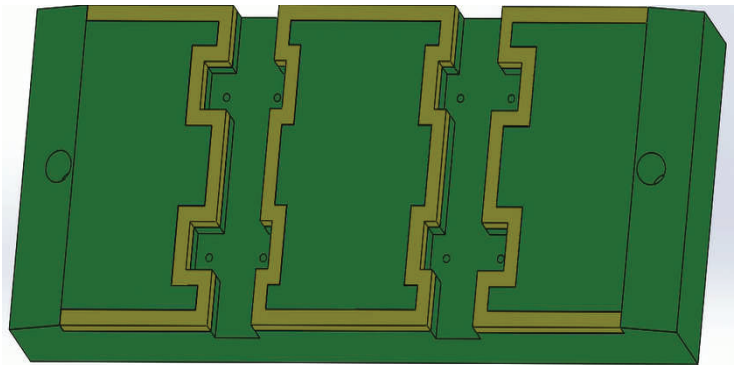
Assoc. Prof. Dr. Tran The Truyen – Department of Bridge & Tunnel

Dr. Nguyen Hong Phong – Ministry of Transport

PRODUCT INTRODUCTION

Railway level crossings made of prefabricated reinforced concrete slabs, asphalt concrete or rubber sheets currently used in Vietnam have disadvantages: not smooth, complicated construction, difficult maintenance and repair, low lifespan and durability.

The structure of prestressed concrete slabs for level crossings ensures all criteria of smoothness, durability, ease of construction, ease of repair, low production and maintenance costs, long life and ensures requirements for traffic speed through railway and road intersections.



Structure of 01 prestressed concrete slab as horizontal road

PRODUCT APPLICATIONS

Prestressed concrete slabs for level crossings are designed at railway and road intersections with a railway gauge of 1000mm.

Prestressed concrete slab with dimensions of length 2.2m, width 1.0m, height 0.33m.

Material characteristics: High strength concrete material class C45/55, prestressed cable bars Φ6.

The structural model is built with prestressed concrete slabs placed on elastic subballast foundation, rails connected to the concrete slab by ω accessories through elastic rubber cushions.

Image of prestressed cross-section during operation

SOCIO-ECONOMIC EFFICIENCY

Currently, Vietnam National Coal - Mineral Industries Group and Construction Joint Stock Company 6 are cooperating with the research group to produce, apply, transfer technology and commercialize products.

The research team is also consulting on the use of prestressed concrete slabs for level crossings for Vietnam Railway Corporation and Apatit Vietnam Company Limited to reduce costs, improve economic efficiency, and create more jobs for businesses.

Prestressed concrete slab products contribute to improving quality, aesthetics, longevity and ensuring train safety at level crossings.

PRODUCT SPECIFICATIONS

The product has been applied and installed at the following cross-road locations:

1. Crossroad to Deo Nai coal mine - Cam Pha - Quang Ninh. The crossroad is 8m wide. The crossroad is installed from 8 monolithic prestressed concrete slab components. Each prestressed concrete slab has dimensions of 2.2m in length, 1.0m in width and 0.33m in height.

2. Crossroad to Mong Duong coal mine - Cam Pha - Quang Ninh. The crossroad is 12m wide. The crossroad is installed from 12 monolithic prestressed concrete slabs. Each prestressed concrete slab has dimensions of 2.2m long, 1.0m wide and 0.33m high.

3. Crossroad to Coc 6 coal mine - Cam Pha - Quang Ninh. The crossroad is 18m wide. The crossroad is installed from 18 monolithic prestressed concrete slabs. Each prestressed concrete slab has dimensions of 2.2m long, 1.0m wide and 0.33m high.

Prestressed concrete slab installed at the entrance to Deo Nai coal mine - Cam Pha - Quang Ninh

Prestressed concrete slab installed at the entrance to Mong Duong coal mine - Cam Pha - Quang Ninh.

Prestressed concrete slab installed at the entrance to Coc 6 coal mine - Cam Pha - Quang Ninh.

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APPLICATION
& TECHNOLOGY TRANSFER PRODUCT

ARTISTIC CONCRETE
& HIGH-TECH CONCRETE FOR CONSTRUCTION WORKS

AUTHORS:

Assoc.Prof.Dr. Le Thanh Ha - Department of Construction Materials

Dr. Dang Thuy Chi - Department of Construction Materials

PRODUCT INTRODUCTION

Products applied and transferred technology include high-tech concrete types such as: UHPC-Ultra High Performance Concrete, SCC - Self-Compacting Concrete, high-strength light-weight concrete, drainage concrete, micro-crete;... decorative concrete products for interior and exterior construction and high-quality concrete products for construction works, urban infrastructure and traffic.

Dr. Dang Thuy Chi next to a table made from ultra-highstrength concrete at the Vietbuild 2017 Exhibition

Ultra-high strength concrete slats
Villa Vinhomes riverside, Long Bien, Hanoi

PRODUCT SPECIFICATIONS

Some typical products:

1. Concrete slats (Facades) decorate the exterior of the building;
2. Ultra high strength concrete panels, tensile strength: 10 - 20 MPa;
3. Tadao Ando minimalist concrete art table and chairs;
4. 3-layer lightweight composite cement plant pot;
5. High strength concrete tiles replace natural stone;
6. Ultra high strength concrete trash rack, limit load: 250 kN.

Assoc.Prof.Dr.Le Thanh Ha and Mr. Huynh Hoa - Chairman of Khanh Hoa Province Road and Bridge Association. Ultra-high strength concrete trash rack products, exhibited at the 8th National Congress of the Vietnam Union of Science and Technology Associations (VUSTA), 2020.

SOCIO-ECONOMIC EFFICIENCY

Currently, many businesses are interested in and cooperating with the research group to produce and commercialize these products.

Associate Professor, Dr. Le Thanh Ha has also participated in consulting and transferring technology to produce high-quality concrete products, helping to reduce costs, improve economic efficiency and create more jobs for businesses.

High-quality concrete products also contribute to improving the quality, aesthetics and longevity of construction works.

PRODUCT APPLICATIONS

Typical products and application addresses:

- Artificial stone slabs for the parking lot of a 30-storey building, No. 1 Pham Huy Thong, Hanoi.
- Terrazzo pavement tiles instead of natural stone for the Ecopark urban area, Hung Yen.
- Zigzag tiles for TSUCHIYA TSCO Vietnam Co., Ltd factory, Thang Long industrial park, Vinh Phuc.
- Grass planting bricks and UHPC concrete chairs for the Gardencity urban area, Long Bien, Hanoi.
- Concrete panels for Vinhomes Riverside villa, Long Bien, Hanoi...

Artificial stone (800.800.20mm) for paving the parking lot of 30-storey building, No. 1 Pham Huy Thong, Hanoi.

Decorative lightweight cement concrete flower pots

Ultra high strength concrete bench, Gardencity urban area, Long Bien, Hanoi

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