IRF

2023 Global Road Achievement Award

Construction equipment and technology

Pothole Repair Master - Construction method of pothole milling with asphalt concrete brick

Direct General of highways, MOTC

GOLDEN JIANT CP., LTD.

Outline of the presentation

01 Motivation and purpose

02 Pothole repair

03 Construction method of pothole milling with asphalt concrete brick

04 Utilization and effectiveness

05 Conclusions

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01- Motivation and purpose

1-1. Potholes on the road are causing problems

A. The quality of pothole repair is difficult to control

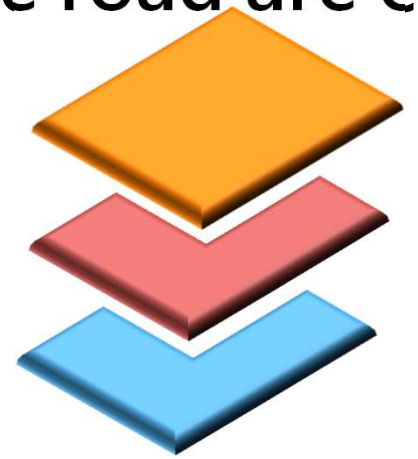
BBC東森新聞 | 39k 人追蹤 ☆ 追蹤

獨／爛路補丁害「死亡搖擺」騎士慘摔噴飛 鎖骨斷3根

東森新聞
2023年2月5日

台北一名林姓騎士日前上班騎車行經羅斯福路六段，不料路面2處補丁讓機車前輪接連彈起，也因為輪胎離開地面再接觸路面時，會有速差問題，導致機車出現了「死亡搖擺」，當下騎士來不及反應，連人帶車噴飛倒地，造成他鎖骨三根斷裂，但類似死亡搖擺其實很常見，專家建議若遇到這狀況，千萬不要剎車緩降速度，也不要緊握龍頭，恐怕造成更嚴重傷害。

騎士好端端騎在馬路上，不料才剛過路口，意外發生了，機車突然出現「死亡搖擺」，騎士還來不及反應，僅僅三秒鐘的時間，連人帶車噴飛倒地，全身傷痕累累，不只多處擦撞傷，鎖骨更因此斷了



Central idea of the DGH of the MOTC

B. Repetitive repairs lead to excessive demand of manpower and time

自由時報

首頁 > 社會

道路坑洞致騎士摔傷 高市養工處判賠69萬

市府養工處積極修補道路坑洞。（高市府提供）

2018/09/25 16:11

〔記者賴清華／高雄報導〕高雄市潘姓女子2015年10月晚間，騎機車行經左營區斯勝街，因路面一處坑洞摔車致成手骨骨折及全身多處擦傷，女子向法院提起國家賠償，求償220餘萬元，橋頭地院認定市府養工處就該路段疏未管理，判賠69萬餘元，全案可上訴。

2015年10月1日晚間9時許，潘姓女子騎乘機車，沿高雄市左營區斯勝街由南往北方向行駛，因路面坑洞摔車，造成右側鎖骨骨折併旋轉肌袖破損、右側手肘撕裂傷及全身多處擦傷。

潘女向高市府提出國家賠償，求償醫療費用7萬2746元；護具等必要費用3152元；計程車資7250元，看護費用12萬元；薪資損失20萬80元；機車修復費用4083元；勞動能力減損60萬9941元，精神慰撫金120萬元，共計221萬7252元。

市府養工處否認潘女摔車與坑洞有關，辯稱原告有可能是因為駕駛過快，精神狀態不佳或是車輛本身機械因素而摔車，並主張，縱使與坑洞有關，坑洞是因台水公司所設之人

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01- Motivation and purpose

1-2. Pothole repair problem

A. Small potholes - Ambient asphalt concrete is used to repair the potholes

A-1. **Insufficient compaction**

⇨ Insufficient material **temperature and compaction energy**, resulting in **weak structural areas**.

⇨ Poor repair quality, **repeated damage occurs within a short period of time**.

B. Large potholes - Square-cut asphalt concrete is used to repair the potholes

B-1. **Long construction time**

⇨ It affects **the movement of the population and results in public grievances**.

⇨ Long traffic control lead to **security problems**.

The repair was destroyed four days later

Longer repair time

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01- Motivation and purpose

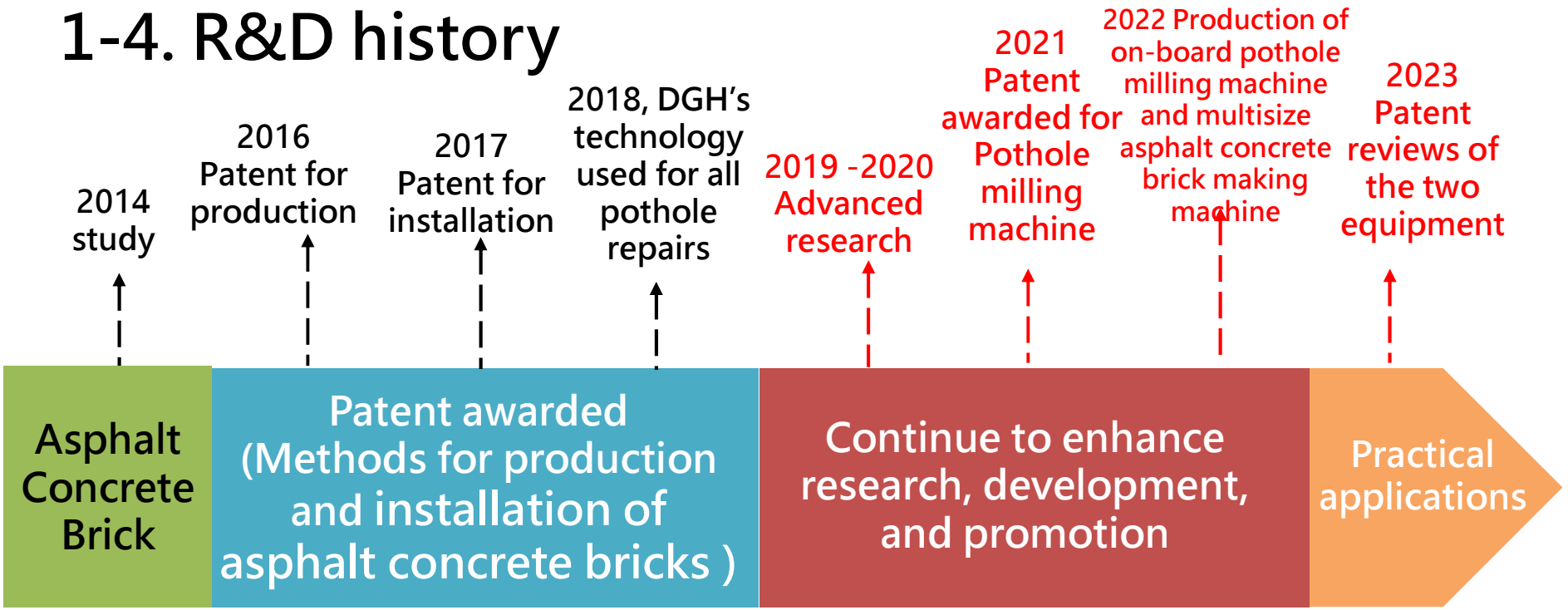
1-3. World's first solution

- Construction method with asphalt concrete brick

- **Developing automatic machines for pressing asphalt concrete bricks** to address insufficient *compaction.*
- **Developing automatic pothole milling machine** to address *streamlining manpower* and *construction time* .
- **Developing a standardized installation method** to address *poor pothole repair quality* .

01- Motivation and purpose

1-4. R&D history



Research refine

- ❑ Used for pothole repairs
  - Fast repair
  - Labor savings

Construction method of pothole milling with asphalt concrete brick

- ❑ Research and development of machinery and equipment
- ❑ Improvement of materials and construction methods

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02 - Pothole repair

2-1. Addressing pothole repairs – Study on asphalt concrete brick

A. Independent study of the DGH of the MOTC

A-1. Topic: Study on applying asphalt concrete bricks to pavements

A-2. Study timeframe: January 2014 ~ December 2014

B. Process for production of asphalt concrete bricks

Step 1

Pour the heated asphalt concrete into the mold and mash the aggregate for 25 times for even mixture

Step 2

Manually place the mold at the base of the compression presser, then place the pressure block on the top

Step 3

Operate the compression presser to press one side of the aggregate first

Step 4

Manually turn the mold over, place the mode at the base of the compression presser, then place the pressure block on the top

Step 5

Operate the compression presser to press the other side of the aggregate

Step 6

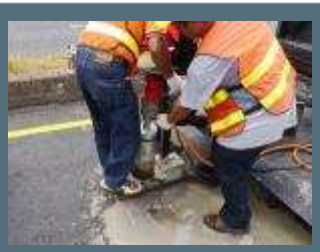
Let the trial asphalt concrete brick sit for one day before ejecting it the next day

The video is available at https://youtu.be/AOWy73J8nfg

02 - Pothole repair

2-1. Solving pothole repairs - asphalt concrete brick research

C. Process for installation of the asphalt concrete bricks



Core boring sampling.

Drain the water in the pothole, and try the wall.

Chip the base flat before placing asphaltic sand

Tamping and leveling.

Coat the wall with emulsified asphalt and the soften the asphalt with a drying lamp.

Put in the trial asphalt concrete brick

Adjust the elevation of the brick to level with the road surface to complete the installation.

The video is available at https://youtu.be/xSJM5AN5NDE

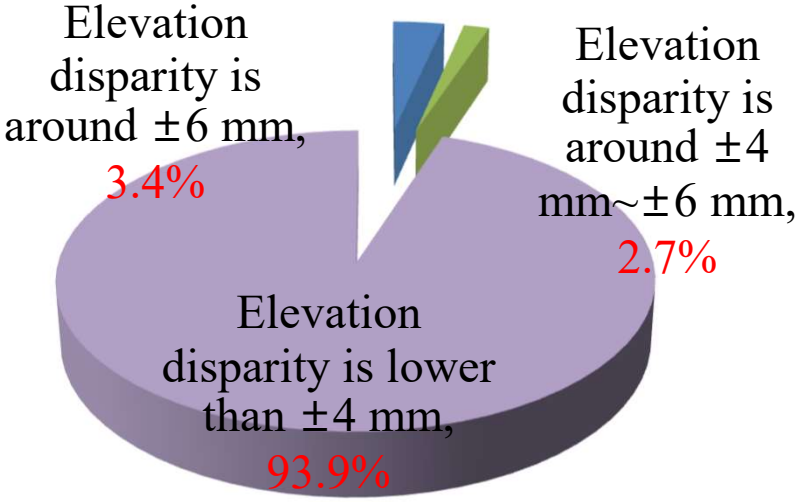
02 - Pothole repair

2-2. Result observations

A. In "2016 Asphalt concrete Performance Project", **148** trial asphalt concrete bricks were tracked on-site for more than one and a half years.

A-1. **Elevation disparity is more than ±6 mm**, with only 5 pieces, accounting for **3.4%** .

A-2. **Elevation disparity is more than ±4 mm**, with only 9 particles, accounting for **6.1%** .



asphalt concrete brick after 4 months

asphalt concrete brick after 36 months

Asphalt concrete in room temperature for 4 months

A-3. Ambient Asphalt concrete is seen with surface damage in **4 months** whereas asphalt concrete brick can last **for 3 years**.

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02 - Pothole repair

2-3. Outcome - Patents


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MINISTRY OF ECONOMIC AFFAIRS
REPUBLIC OF CHINA

Certificate

The Patent entitled : PRODUCTION METHOD FOR ASPHALT CONCRETE BRICKS

has been granted according to the Patent Law of the Republic of China.

The followings are the relevant references:

Patentee(s) : MATERIALS TESTING LABORATORY, DIRECTORATE GENERAL OF HIGHWAYS, MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Inventor(s) : SUNN-JER HWANG; HSIEN-CHOU CHEN; CHI HSU

Patent Number : Invention No. I530892

Term of Patent : From Jun. 21, 2016 to Apr. 29, 2035

This certificate is only for general reference, when legal matter is involved, the original Chinese document shall be referred.

Director General

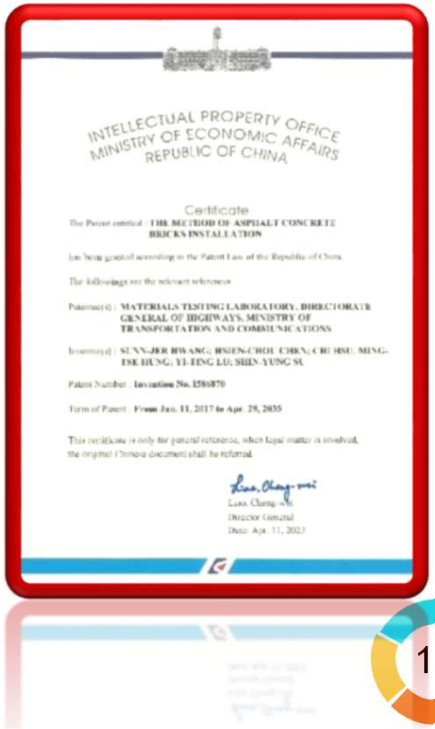
Date: Apr. 11, 2023

A. Patents 1

A-1. Date of approval: June 21, 2016

A-2. Name of invention: **Method for production of asphalt concrete bricks**

A-3. Patent holder: Materials Testing Laboratory (MTL) of the Directorate General of Highways (DGH) of the Ministry of Transportation and Communications (MOTC)


INTELLECTUAL PROPERTY OFFICE
MINISTRY OF ECONOMIC AFFAIRS
REPUBLIC OF CHINA

Certificate

The Patent entitled : THE METHOD OF ASPHALT CONCRETE BRICKS INSTALLATION

has been granted according to the Patent Law of the Republic of China.

The followings are the relevant references:

Patentee(s) : MATERIALS TESTING LABORATORY, DIRECTORATE GENERAL OF HIGHWAYS, MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Inventor(s) : SUNN-JER HWANG; HSIEN-CHOU CHEN; CHI HSU; MING-TSE HUNG; YI-TING LU; SHIH-YUNG SU

Patent Number : Invention No. I581870

Term of Patent : From Jun. 11, 2017 to Apr. 29, 2035

This certificate is only for general reference, when legal matter is involved, the original Chinese document shall be referred.

Director General

Date: Apr. 11, 2023

B. Patents 2

B-1. Date of approval: June 11, 2017

B-2. Name of invention: **Method for installation of asphalt concrete bricks**

B-3. Patent holder: Materials Testing Laboratory (MTL) of the Directorate General of Highways (DGH) of the Ministry of Transportation and Communications (MOTC)

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03 - Construction method of pothole milling with asphalt concrete brick

3-1. Study advancement - motivation

A. Past process for pothole repairs with asphalt concrete bricks

Step 1: Break and extract the material

Step 2: Dry up pothole wall

Combine steps 1 and 2

Develop new material breaking and extracting equipment

Step 3: pothole floor leveling

Step 4: Apply emulsified asphalt coating and dry up

Combine steps 3 and 4

Innovation on Material tamping and leveling

Step 5: Place in evenly the trail asphalt concrete brick body

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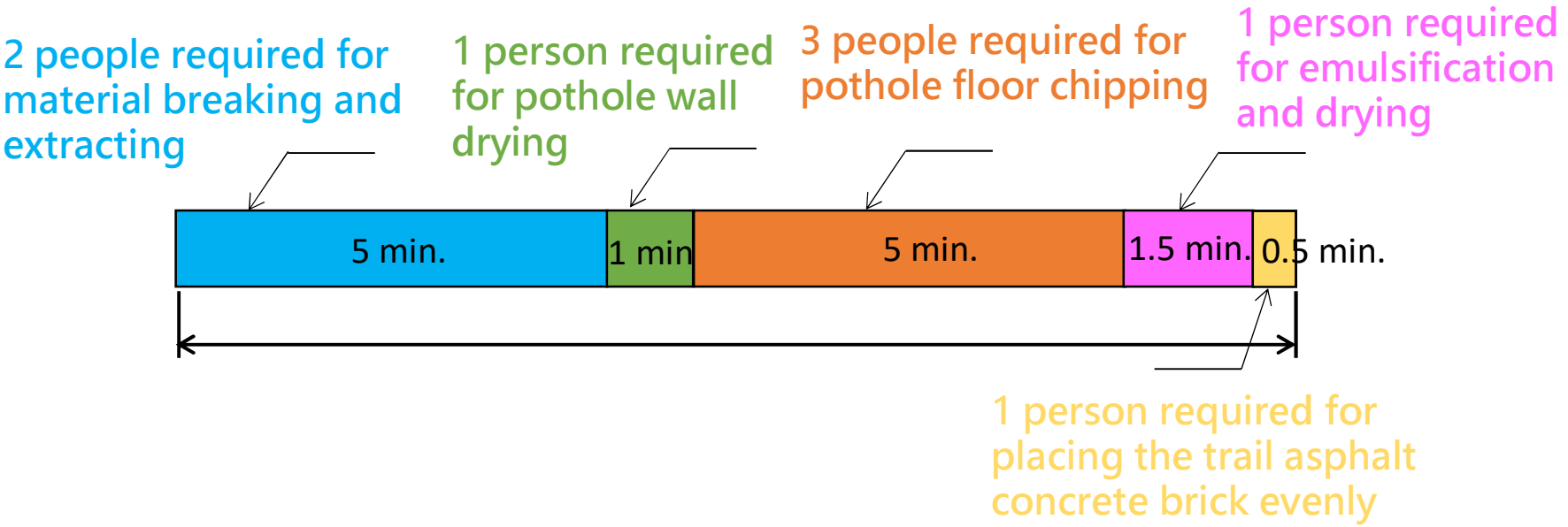
3-1. Study advancement - motivation

B. time and manpower required for the repair of raw asphalt tiles in pothole holes



B-1. Total time required = 13 minutes

B-2. Maximum manpower required = 3 people for the work order

03 - Construction method of pothole milling with asphalt concrete brick

3-2. Study advancement - purpose

A. Self-study by the DGH of the MOTC

A-1. Topic: Study on integrated mechanic construction method for pothole repair with asphalt concrete bricks

A-2. Study period: January 2019 ~ December 2020

Study focus

01 Repair efficiency

02 Streamline workforce

03 Automation

Development of new equipment

Material change

Development of automation equipment

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03 - Construction method of pothole milling with asphalt concrete brick

3-3. Outcomes

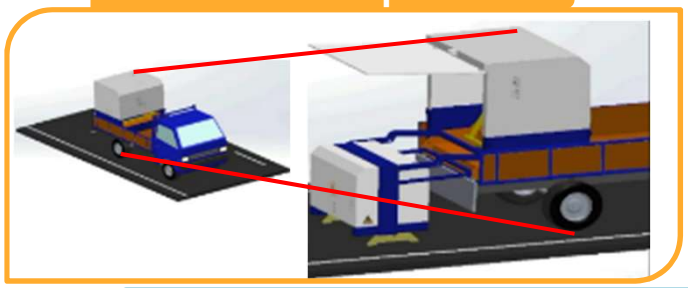
A. Development of new material breaking and extracting equipment

A-1. Develop of **automatic milling machine** to be installed on vehicles.

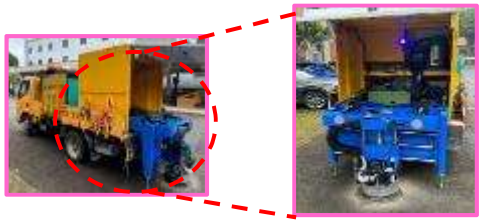
A-2. The equipment is equipped with automatic milling and automatic material picking functions for pothole repair.

A-3. **Pothole repair positioning and information can be uploaded in real time.**

Concept



Commercial production



B. Innovative material tamping and leveling – use along with fast-setting cement

B-1. **asphalt concrete bricks have been physically placed and tested in the field**, showing excellent adhesion.

B-2. **It is good to use in rainy and ponding conditions**.

Mix the water with the fast-setting cement in proportion.

Pour the mixed material into the pothole.

Put in the asphalt concrete brick

After 5 minutes, ensure that the adhesion is solid without being able to turn.

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03 - Construction method of pothole milling with asphalt concrete brick

3-3. Outcomes

C. Development of multi-size asphalt concrete brick making machines

C-1. Can produce round asphalt concrete bricks with a diameter of 40cm and square asphalt concrete bricks with a lateral length of 40cm

C-2. Fully automated brick tamping and automatic flip function.

Multisize asphalt concrete brick making machine

Square asphalt concrete brick

Round asphalt concrete brick

C-3. Production process

Step 1: Pour the heated asphalt concrete into the mold and mash the aggregate for 25 times for even mixture

Step 2: Operate the compression presser to press one side of the aggregate first

Step 3: The compression presser can automatically flip over to the other side.

Step 4: The compression presser, then press the other side

Step 5: Remove the mode the next day to take out the asphalt concrete brick

The video is available at https://youtu.be/4KF7Q4dTdec

3-3. Outcomes

D. Process for pothole repair with asphalt concrete bricks - **Construction method of milling machine**

Step 1
Repair vehicle to repair point

Step 2
Automatic launch and framework positioning for readiness

Step 3
Milling pothole

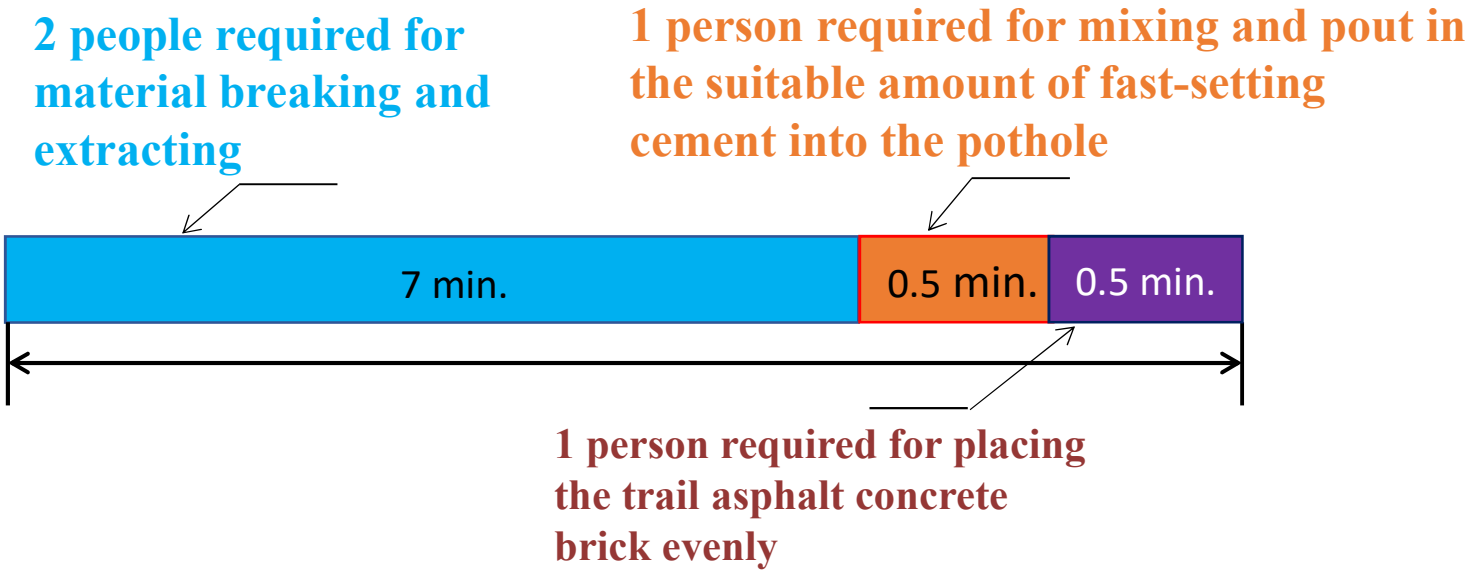
Step 4
Vacuum the aggregates with a vacuum machine at the end of the milling process

Step 5
Pour in and mix the fast-setting cement

Step 6
Put in the asphalt concrete brick

3-3. Outcomes

E. the time and labor required for the pothole repair with the milling machine



E-1. Total time required = 8 minutes

E-2. Maximum manpower required = 2 people for the work order

The video is available at https://youtu.be/_xgWPBSQqpE

03 - Construction method of pothole milling with asphalt concrete brick

3-4. Features

A positioning camera is provided to assist users in work positioning, and a GPS pothole location marking system is also provided. Repaired potholes can be marked for the purpose of observing the benefits of the repair done by this construction method.

This method cab reduce the complexity of pothole repair process, enabling rapid pothole repair by 2 people in a vehicle.

The mechanical structure is designed to reduce noise, and its operating volume is less than 77 dB. Repair construction in the residential area will not cause noise to the surrounding residences.

The system comes with unique dust treatment system for dust-free milling operations: Post-milling waste is centrally disposed of, reducing environmental pollution.

One-touch automatic launch and closure: With a professional remote control, it can be operated by personnel after basic educational training.

The cutters adopt special alloy and are equipped with a cooling device: Longer blade life, resulting in less waste produced from the industrial operation.

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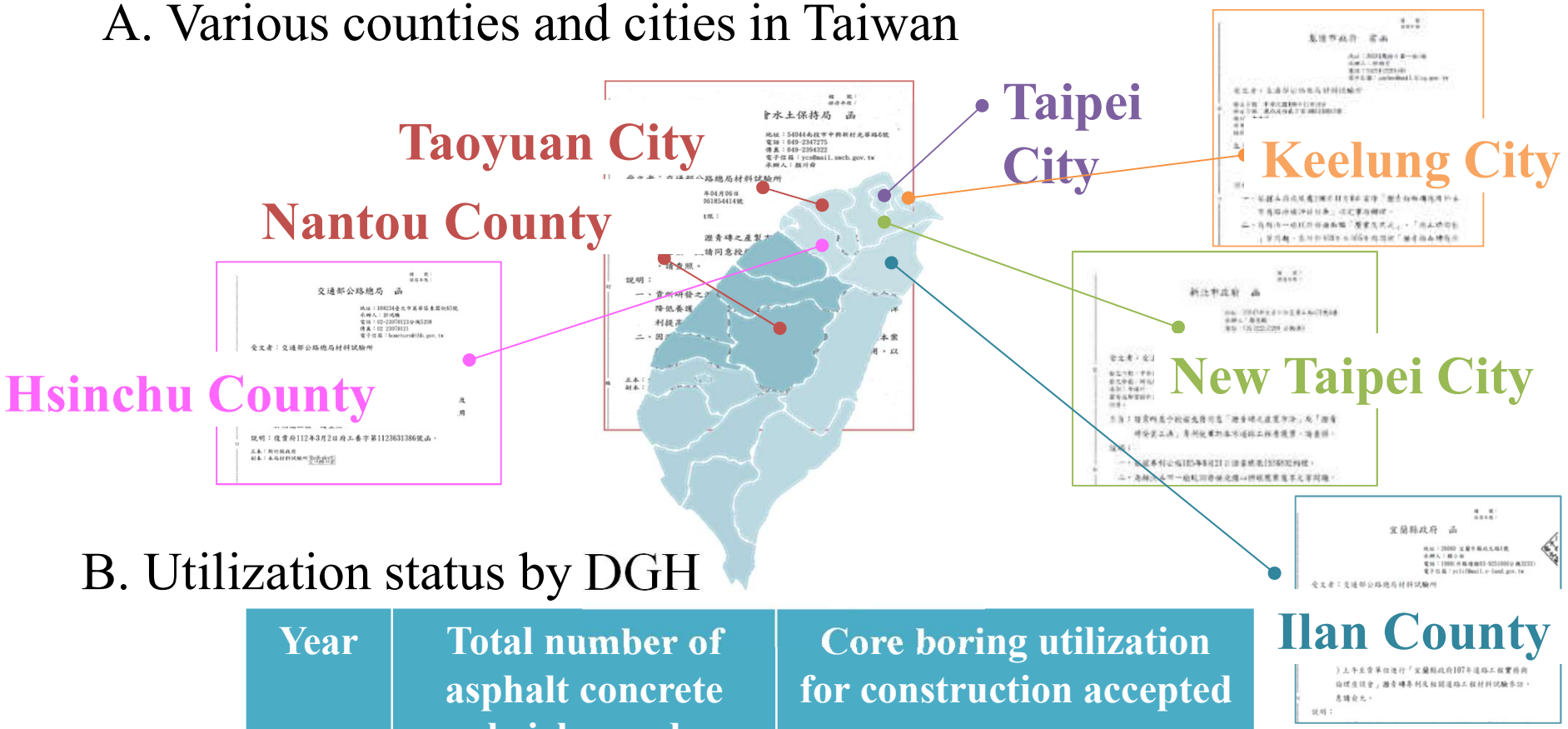
03 - Construction method of pothole milling with asphalt concrete brick

3-5. Who are using the construction method of asphalt concrete bricks

A. Various counties and cities in Taiwan



B. Utilization status by DGH

Year	Total number of asphalt concrete bricks used	Core boring utilization for construction accepted
2018	2,005	48%
2019	11,357	100%
2020	8,081	100%

03 - Construction method of pothole milling with asphalt concrete brick

3-6. Result observations

A. TAI-15 Highway

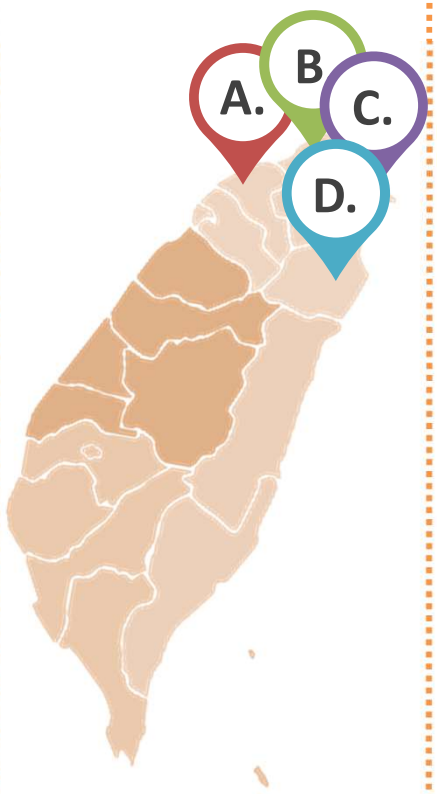
29 June 2022

12 October 2022

B. TAI-2-C-Highway

23 November 2022

04 Jan 2023



C. Keelung City

18 August 2022

6 January 2023

D. TAI-2 Highway

12 January 2023

16 February 2023

03 - Construction method of pothole milling with asphalt concrete brick

3-7. Patents and honors

A. Patents

A-1. Date of approval: May 21, 2021

A-2. New type name: **Road surface excavation device for precise control of pothole size**

A-3. Patent holder: Materials Testing Laboratory (MTL) of the Directorate General of Highways (DGH) of the Ministry of Transportation and Communications (MOTC)

INTELLECTUAL PROPERTY OFFICE
MINISTRY OF ECONOMIC AFFAIRS
REPUBLIC OF CHINA

Certificate

The Patent entitled : **ASPHALT ROAD MILLING DEVICE WITH ACCURATE CONTROL DRILL SIZE**

has been granted according to the Patent Law of the Republic of China.

The followings are the relevant references:

Patentee(s) : **MATERIALS TESTING LABORATORY, DIRECTORATE GENERAL OF HIGHWAYS, MINISTRY OF TRANSPORTATION AND COMMUNICATIONS**

Inventor(s) : **CHAO-YI YEN; CHIEN-TUNG CHU; MING-TSE HUNG; JUNG-PO HUANG; HSIN-YUNG SU; KUN-LIN LEE; YIN-JHEN CHAN**

Patent Number : **Utility Model No. M612293**

Term of Patent : **From May 21, 2021 to Jun. 20, 2031**

This certificate is only for general reference, when legal matter is involved, the original Chinese document shall be referred.

Liao, Cheng-wei
Director General
Date: Apr. 11, 2023

交通部110年創新提案制度獲獎名單

提案獎項	提案機關（單位）	提案名稱
優等獎	高速公路局北區養護工程分局	一本萬利-改善通往林口交通
甲等獎	公路總局材料試驗所	世界首創-瀝青碾壓洞修補整合式機械化工法
	運輸研究所	推動通用計程車特約制度
	高速公路局南區養護工程分局	天坑乾坦
	運輸研究所港灣技術研究中心	航道構件缺失AI辨識系統建置
	臺灣鐵路管理局臺北機廠	EMU700、EMU800、TEMU1000及TEMU2000電聯車主風泵測試台研製
佳作獎	臺灣鐵路管理局臺北運務段	電子票證驗票機QR code提昇使用效率
	公路總局高雄市區監理所	翻轉監理第1台 監理自助種種2.0
	高速公路局中區養護工程分局	引導安全旅程的燈號星光—360°玻璃反光標記施工改良
	鐵道局南部工程處第二工務段	【極限造路】-9天完成中博鋼橋橋梁拆除及平面道路開闢

B. Honors

B-1. Participate in the 2021 Innovation Proposal Contest by MOTC Ministry of Communications

B-2. Participation topic: **World first - Integrated mechanical construction method for pothole repair with asphalt concrete bricks**

B-3. Contest result: Class-A Award

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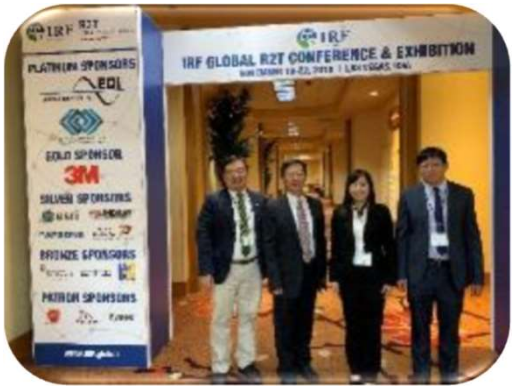
3-8. Publication of results



A. Publication 1

A-1. Conference name: 2019 IRF Global R2T Conference & Exhibition

A-2. Report title: **Laboratory evaluation of asphalt concrete bricks containing basic oxygen furnaces**

B. Publication 2

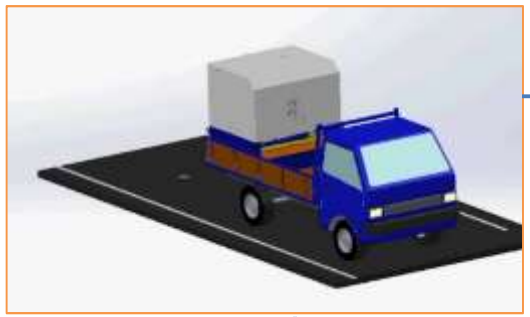
B-1. Conference name: 2022 IRF Global R2T Conference & Exhibition

B-2. Report title: **Development of installing asphalt concrete bricks in conjunction with automatic pothole fixer**

04 - Utilization and effectiveness

4-1. Technology management

A. Upload pothole repair information in real time



GPS Positioning

Telecom. transmission

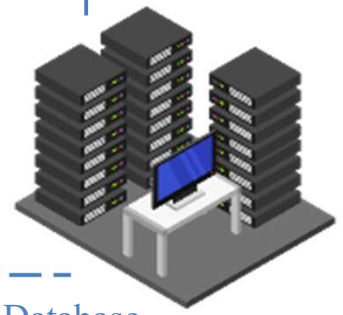
https://dgs.thb.gov.tw/THBPEMS/Default.aspx

Rapid repair and feedback

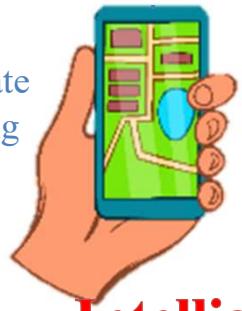
Instant feedback of road information

Road patrolling

IoT Internet of Things



Database



Immediate reporting

Upload hole information in real time to quickly dispatch personnel for repair and report back repair conditions

Intelligent road paving maintenance management system

04 - Utilization and effectiveness

4-2. Sustainable development

Equipment and technology are designed and implemented at the practical stage in line with the 17 sustainable development goals (SDGs) set by the United Nations.

This equipment and technology achieve 8 SDGs

3 GOOD HEALTH AND WELL-BEING

5 GENDER EQUALITY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

17 PARTNERSHIPS FOR THE GOALS

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04 - Utilization and effectiveness

4-3. Cost-effectiveness

A. For a round pothole with 40 cm in diameter and 5 cm in depth, it only requires one repair with asphalt concrete brick in one year, but would require at least five repairs in one year if repair with room-temperature asphalt concrete.

A-1. asphalt concrete brick repair costs:

No.	Item	Units	Quantity	Unit price (NT$)	Compound price (NT$)
1	Workers	Hours	0.5	200	100
2	Material	Times	1	46.4	46.4
3	Trucks (Drivers included)	Hours	0.5	700	350
				Total	**496.5**

A-2. Room-temperature asphalt concrete repair costs:

No.	Item	Unit	Quantity	Unit price (NT$)	Compound price (NT$)
1	Workers	Hours	2.5	200	500
2	Material	Times	5	72.5	362.5
3	Trucks (Drivers included)	Hours	2.5	700	1750
			Total		**2612.5**

Costs

- **Asphalt concrete bricks:** NT$ 496.50
- **Room-temperature asphalt concrete:** NT$ 2,612.50

asphalt concrete bricks can save approximately 4.3 times the cost of room-temperature asphalt concrete

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04 - Utilization and effectiveness

4-4. Carbon efficiency

A. For a round pothole with 40 cm in diameter and 5 cm in depth, it only requires one repair with asphalt concrete brick in one year, but would require at least five repairs in one year if repair with room-temperature asphalt concrete.

Carbon emissions

- **Asphalt concrete bricks**:
  14.5*0.129=1.87 kg CO_2E.
- **Room-temperature asphalt concrete**:
  14.5*0.129*5=9.35kg CO_2E.

asphalt concrete bricks reduce carbon emissions by **4 times** in comparison with asphalt concrete

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4-5. Reduction of compensation by the State

- According to the statistical analysis of the DGH of the MOTC, **the total compensation made by the State amounted to** approximately **NT$31.72 million, including all compensation cases associated with all government authorities between 2016 and 2020.**
- A total of 342 new cases were filed during this period, where **94 cases** were attributed to **“road unevenness such as potholes, dents, or bumps existing on the road surface"**, accounting for approximately **27.5 %** of the total cases, making this type the most commonly seen. Next, 63 cases in the type of “vehicle collisions due to gravels, dead branches, or other foreign objects scattering on the road surface", accounting for **18.2 %**, also 31 cases fewer than that of the most commonly seen, representing a gap of **9.3%**.
- The use of asphalt concrete bricks to repair potholes can maintain the quality of the pavement, indeed reducing the compensation cases associated with the State, thus dropping the compensation made by the State.

05- Conclusion

Concluding remarks

- According to years of research, asphalt concrete brick makes **a cost-effective construction method for accepting core boring repair and road pothole repairs**, improving the efficiency of pothole repairs (shortening the time required) and streamlining workers required for pothole repairs. Such pothole repairs are conducted in **automated smart way**.
- The DGH has been using this equipment for pothole repairs, and various road-related authorities in Taiwan have also adopted this construction method one after another, which overall **improves the efficiency and safety of road pothole repairs**.
- With the recognition of three patents, the R&D results will continue to be promoted to other road-related authorities to **jointly improve the quality of road paving services**.

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05- Conclusion

Concluding remarks

- The world's first approach to pothole repair
  - **Construction method of pothole milling with asphalt concrete brick**

Promote with full force	DGH is fully engaged in the promotion
Study with consideration	Research team take various factors into consideration
Feel at ease solution	Improve road safety and provide peace of mind to road users

IRF Slogan

Better Road.
Better World.

IRF

End of briefing

Comments welcomed!

交通部公路總局 DIRECTORATE GENERAL OF HIGHWAYS, MOTC