THE DESIGN AND CONSTRUCTION PROCEDURE OF INTERLOCKING CONCRETE PAVING BLOCKS FOR THE CIVIL ENGINEERING LABORATORY BUILDING, FACULTY OF ENGINEERING, SRINAKHARINWIROT UNIVERSITY, ONGKHARAK CAMPUS

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Problem Statement

Road and sidewalk growth in Thailand is using up natural aggregates. This study replaces 50% of the fine aggregate in interlocking paving blocks with steel slag. Strength, water contamination and pavement design were checked for practical use.

Design Objectives

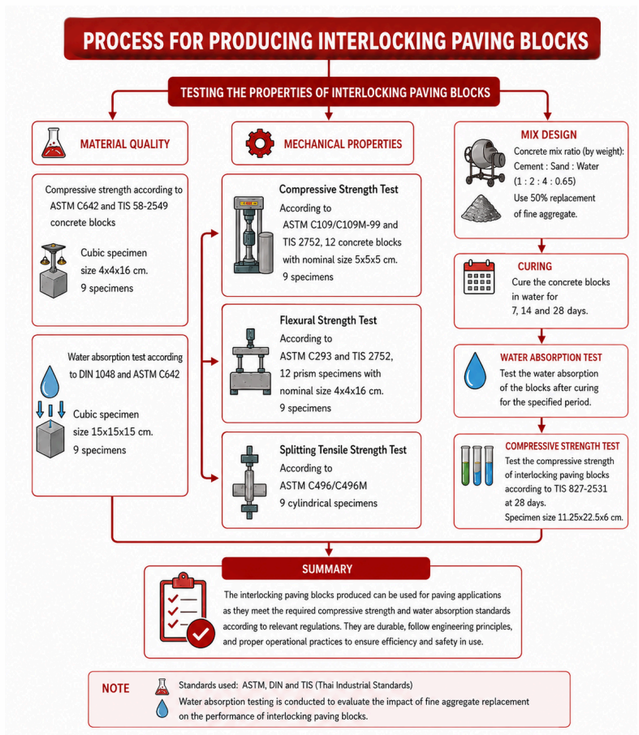
- To design load-bearing interlocking paving blocks with steel slag as fine aggregate.
- To investigate the contamination of water infiltrating through the soil.

Design Specs

- Study key soil properties: Bearing capacity, shear strength, and settlement.
- Study physical and mechanical engineering properties of interlocking blocks made with steel slag.
- Use a concrete mix ratio of 1:2:4:0.65, with steel slag replacing 50% of the fine aggregate.
- Study water contamination during seepage.

Key courses used in the project

- Soil Mechanics; Foundation Engineering: soft soil, bearing capacity
- Concrete Technology; Materials and Testing: steel slag blocks, TIS tests
- Environmental Eng.; Highway Eng.; Surveying: leachate, paving, slopes



Engineering Standards

- ASTM C642
- ASTM C109/C109M-99
- ASTM C293
- ASTM C496/C496M
- DIN 1048

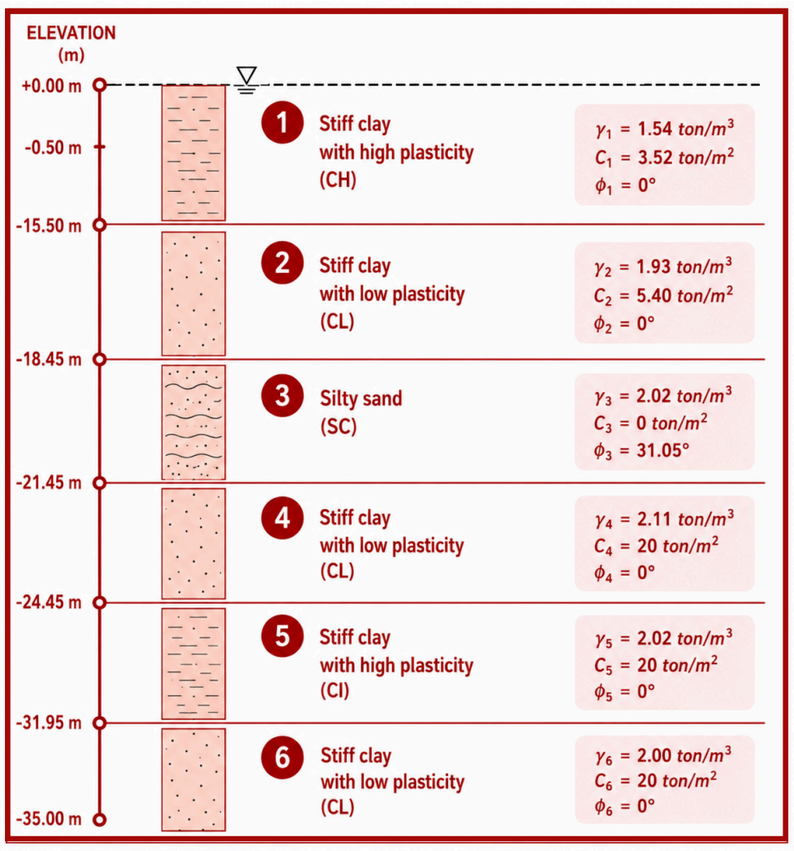
- ASTM C642
- ASTM C109/C109M-99
- ASTM C293
- ASTM C496/C496M

Design Constraints

- Subgrade Bearing Capacity
- Strength of Interlocking Paving Blocks
- Drainage System
- Compaction of Subgrade and Base Layers
- Level and Slope Control
- Block Arrangement
- Joint Sand Filling
- Maintenance After Installation

Design Results

- Soil layers used in the study.



- The soil analysis showed that layers 1–3 were soft soils with low shear strength and high compressibility, causing significant settlement, while layers 4–6 had higher shear strength and better stability.
- **Results of the contamination test on water infiltrating through the soil in comparison with Environmental Quality Standards (EQS).**

พารามิเตอร์	บ่อพักตัวอย่าง		ค่ามาตรฐาน (EQS)	วิธีการวิเคราะห์
	0 วัน	28 วัน		
pH (pH)	8.30	10.46	6.50 – 8.50	Electrometric Method (pH meter)
อุณหภูมิ (°C)	12.50	12.63	≤ 25–30	Thermometer
EC (µS/cm)	1,289.00	1,354.00	≤1,500.00	Electrometric Method (Cyberscan CON 11)
Major ions (mg/L)				
แคลเซียม (Ca)	ND	10.00 ± 0.70	≤75.00	EDTA Titrimetric Method
โซเดียม (Na)	ND	13.30 ± 1.31	≤200.00	Flame Photometric Method
โพแทสเซียม (K)	ND	6.63 ± 0.50	≤12.00	Flame Photometric Method
แมกนีเซียม (Mg)	ND	5.83 ± 0.21	≤50.00	EDTA Titrimetric Method
ซัลเฟต (SO_4^{2-})	ND	48.00 ± 2.85	≤250.00	Turbidimetric Method
คลอไรด์ (Cl^-)	ND	127.00 ± 14.11	≤250.00	Argentometric Method

- 28-day leachate pH 10.46 is above the limit; all other parameters meet the standard. Long-term monitoring is recommended.

Design Approach



- All construction procedures must be performed in the correct sequence to ensure structural strength, load-bearing capacity, and reduced settlement problems.

Results of the physical and mechanical property tests at 28 days of curing age.

TEST ITEMS	TEST STANDARDS	REQUIREMENTS	TEST RESULTS
Compressive Strength	CIN 1038 and ASTM C642	2,200–2,400 kg/sq.cm.	2,685.70 kg/sq.cm. ✓
Water Absorption	ASTM C109/C109M-99 and BS EN 2752 Part 12	Not more than 5%	1.68 % ✓
Abrasion Resistance	ASTM C109/C109M-99 and BS EN 2752 Part 12	180–200 cm^3/50 sq.cm.	254.41 cm^3/50 sq.cm. ✓
Flexural Strength	ASTM C293 and BS EN 12 2752 Part 12	30–50 kg/sq.cm.	102.07 kg/sq.cm. ✓
Dimensional Tolerance	ASTM C426/C426M	13.3–22.8 mm/linear m.	13.46 mm/linear m. ✓





- **Compressive strength 573.88 kg/cm², above the TIS 827-2531 minimum of 357 kg/cm².**

Conclusions

The study showed that steel slag can be reused as a fine aggregate replacement in interlocking paving blocks, reducing industrial waste and natural resource consumption. The blocks exceeded Thai Industrial Standard TIS 827-2531 and exhibited high density and low water permeability. Although the leachate had alkaline pH values above the standard limit, other water quality parameters remained acceptable. The combined use of steel slag and cement improved stability and reduced contaminant release, supporting the development of sustainable construction materials.

BOQ / Cost Estimation

BILL OF QUANTITIES

Project: Interlocking paving blocks with 50% steel slag (area 100 m²)

No.	Description	Qty	Unit	Material (THB/unit)	Labour (THB/unit)	Amount (THB)
1. Site preparation and existing subgrade						
1.1	Strip topsoil, clear and level (15 cm)	100.00	m²	0.00	35.00	3,500.00
1.2	Compact existing subgrade (≥ 95% Modified Proctor)	100.00	m²	0.00	25.00	2,500.00
2. Sub-base						
2.1	Crushed rock sub-base 10 cm, compacted (+15% allowance)	11.50	m³	480.00	120.00	6,900.00
3. Bedding sand						
3.1	Coarse bedding sand 4 cm, screeded (+15% allowance)	4.60	m³	450.00	100.00	2,530.00
4. Block paving and joints						
4.1	Interlocking blocks with 50% steel slag, 11.25 × 22.5 × 6 cm (40 pcs/m² + 5%)	4,200.00	pcs	9.50	2.50	50,400.00
4.2	Fine joint sand	0.60	m³	520.00	80.00	360.00
4.3	Plate compaction of blocks	100.00	m²	0.00	25.00	2,500.00
5. Edge restraint						
5.1	Precast concrete kerbs 15 × 30 × 100 cm	40.00	m	140.00	60.00	8,000.00
	Direct cost (materials + labour)					76,690.00
	Factor F (overhead, profit and tax)				15%	11,503.50
	GRAND TOTAL					**88,193.50**
	Cost per m²					**881.94**

Recommendation

- Soil improvement was carried out using geotextile sheets placed between the existing soil and crushed stone layers to prevent stone settlement into the soft soil and to improve load distribution.
- For curb control on soft soil, curbs should be constructed with adequate depth and thickness, and reinforced concrete bases may be used to prevent lateral movement of the interlocking paving blocks and improve structural stability.