TCO Analysis of SFRC Pavement and Concrete Beam for Container Terminal

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Background

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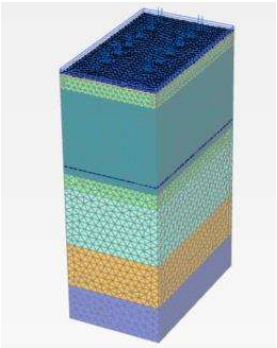
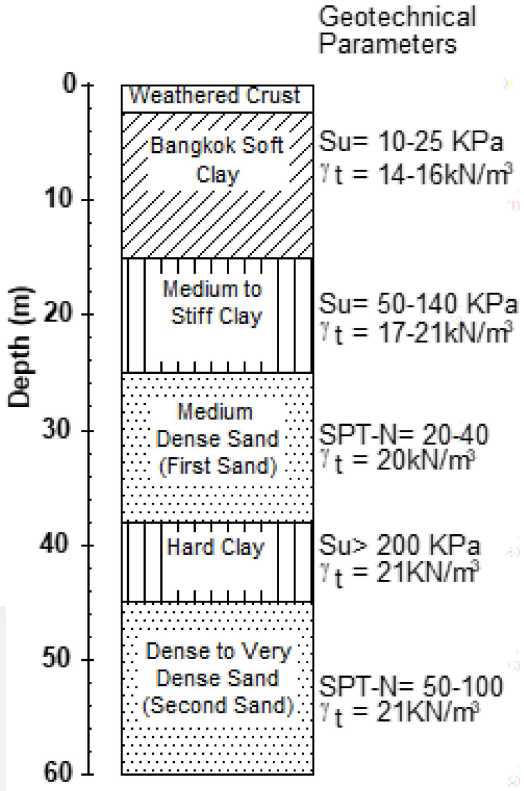
Container Port Terminal

Study Soil Structure

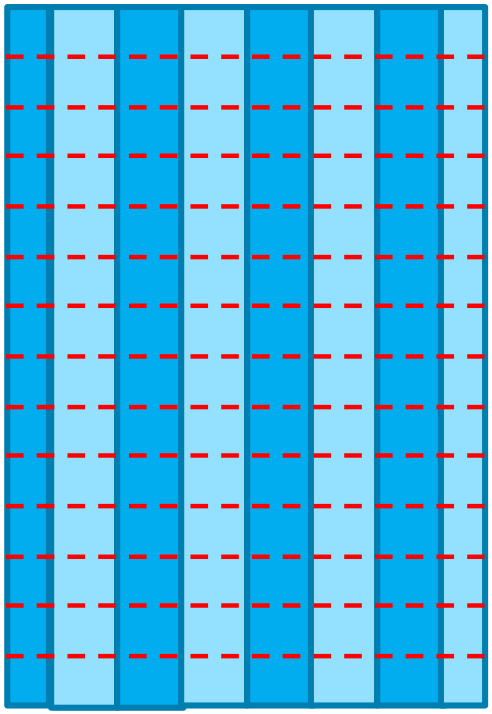




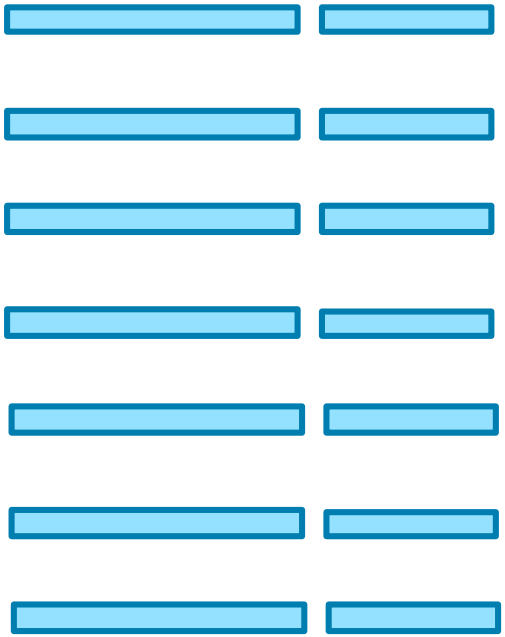
Soil Type	c' (kPa)	ϕ' (°)	Ψ' (°)	E_{50}^{ref} (kPa)	E_{oed}^{ref} (kPa)	E_{ur}^{ref} (kPa)	R_f	m	K_o^{nc}	ν_{ur}	$\gamma_{0.7}$ (%)	G_{max} (kPa)
Medium stiff clay	5.0	27	0	5,150	6,425	19,000	0.9	1.0	0.74	0.2	0.0010	16,000
Soft clay	1.0	27	0	800	850	8,000	0.9	1.0	0.74	0.2	0.0005	5000
Medium stiff clay	5.0	27	0	5,150	6,425	19,000	0.9	1.0	0.74	0.2	0.0010	16,000
Stiff to very stiff clay	11.5	28	0	5,150	6,425	19,000	0.9	1.0	0.5	0.2	0.0010	48,000
Hard clay	11.5	28	0	9,500	12,000	30,000	0.9	1.0	0.5	0.2	0.0015	124,000
Dense sand	0.1	31	5	27,000	27,000	162,000	0.9	0.5	0.5	0.2	0.0140	200,000
Hard clay	11.5	28	0	9,500	12,000	30,000	0.9	1.0	0.5	0.2	0.0015	124,000
Very dense sand	0.1	31	5	27,000	27,000	162,000	0.9	0.5	0.5	0.2	0.0140	200,000

- Base bad reclaiming soil – use Bangkok clay in model to depth of 60m
- With/ Without soil improvement: Dia 600mm Soil Cement Column spacing at 2x2m

Pavement Slab Panel Arrangement VS Precast Beam Arrangement

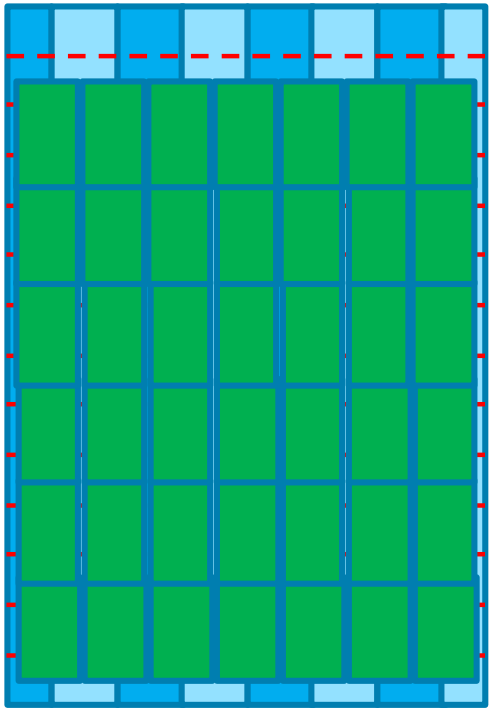


Pavement Slab Panel Arrangement

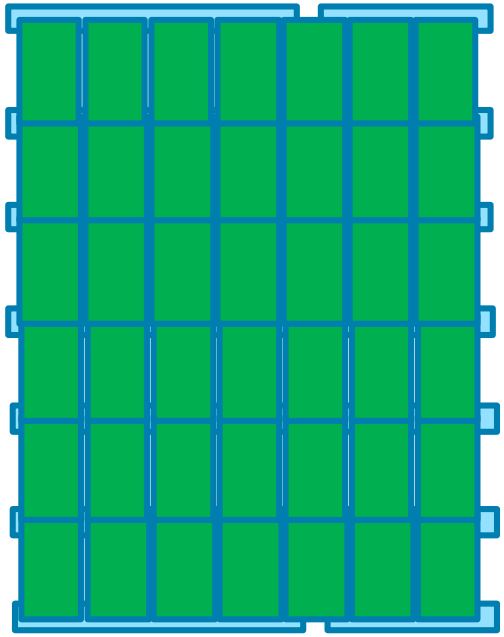


Precast Beam Arrangement

Pavement Slab Panel Arrangement VS Precast Beam Arrangement



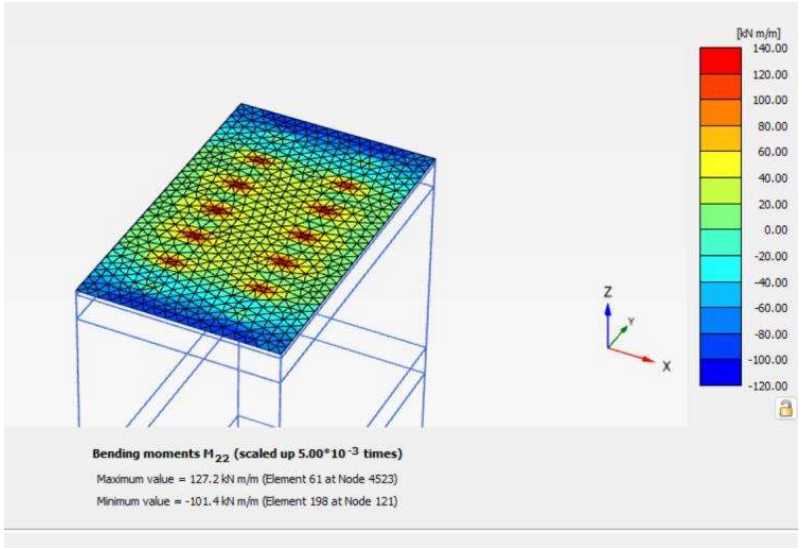
Pavement Slab Panel Arrangement



Precast Beam Arrangement

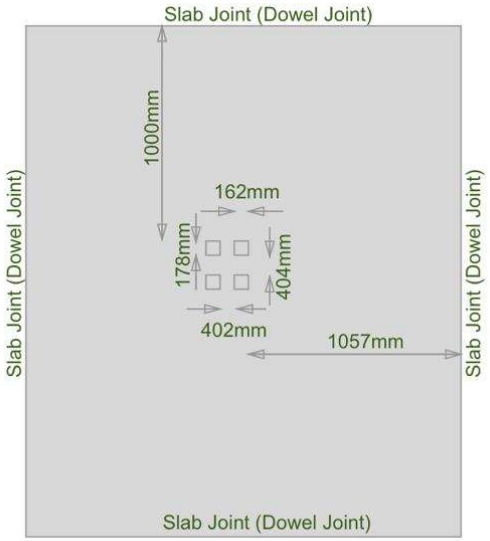
224 kN Container Point load

Settlement Analysis



Container Port Terminal

Pavement Slab Reinforcement

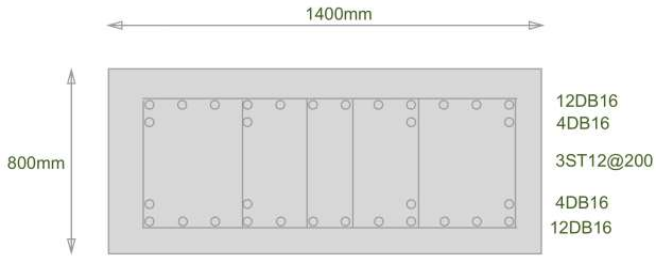


A: Load Placement for Concrete Pavement Case

Floor data			
slab type	Saw Cut Floor		
slab thickness h	225 mm		
separation layer	1 layer PE-foil		(membrane)
maximum joint distance L	6.0 m		
panel size ratio L/l	1.0		
slab exposure	outdoors	ambient conditions	tempered
Dramix® Steel Fibre Concrete			
concrete class	C35/45		(EN)
concrete age at loading	28 days		
Dramix® type	4D 80/60BGE		(EN 14889-1, system "1", structural use)
dosage	30 kg/m³		(recommended dosage for performance testing)

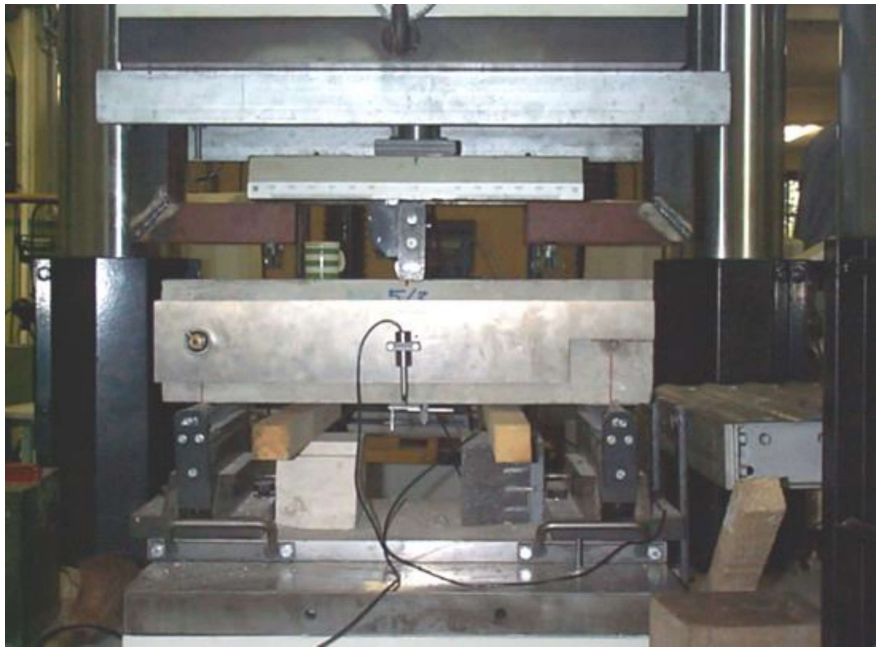
Precast Beam Reinforcement

B: Load Placement for Precast Concrete Block Case

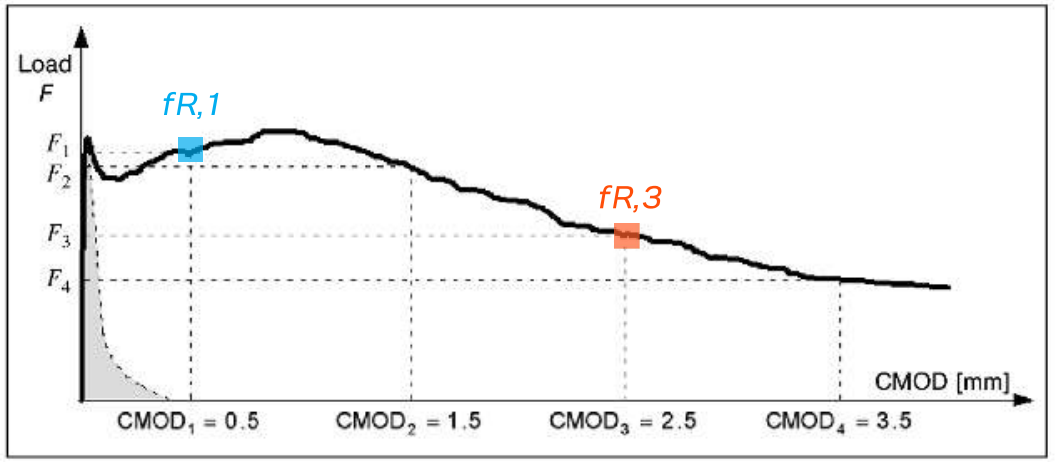


SFRC characterization

Material toughness characterization (e.g. EN 14651 notched beam)



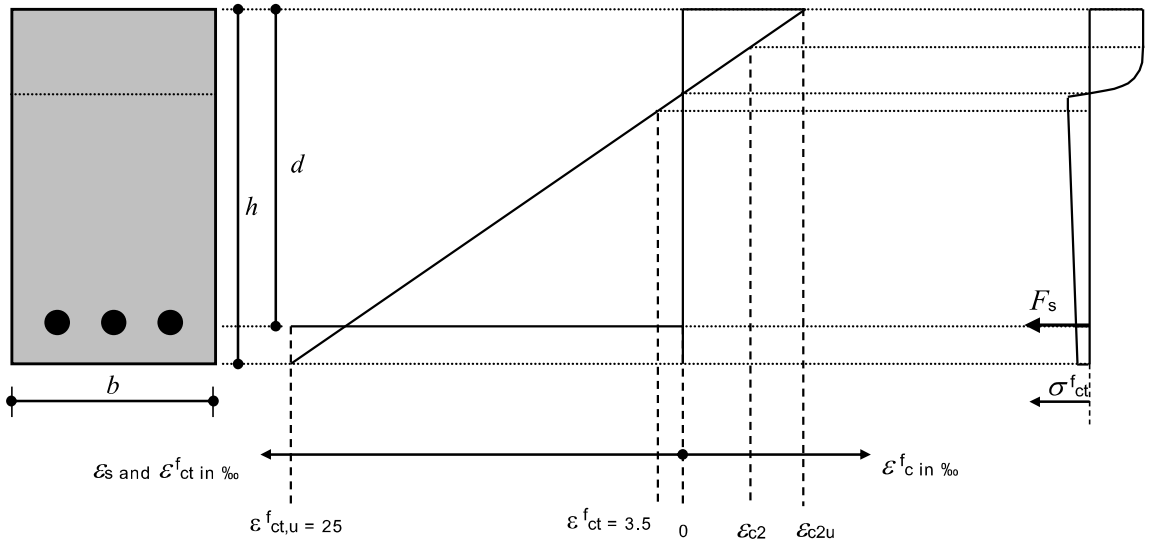
Test set-up (3-point bending test)



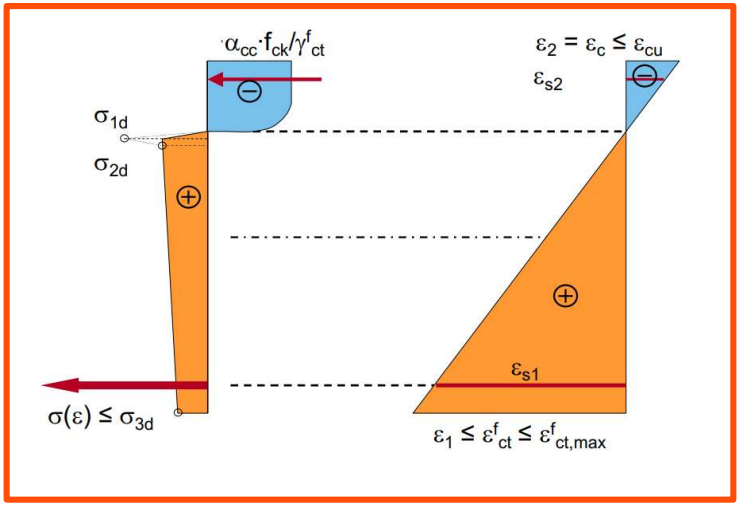
Typical load F-CMOD (crack mouth opening displacement) for plain concrete and FRC

Designing with SFRC

Cross-sectional analysis: flexural capacity



Strain limits according to
DIN EN 1992-1-1, Section 6



DramixPRO Moment Capacity tool

Container Port Terminal

Pavement Slab Reinforcement

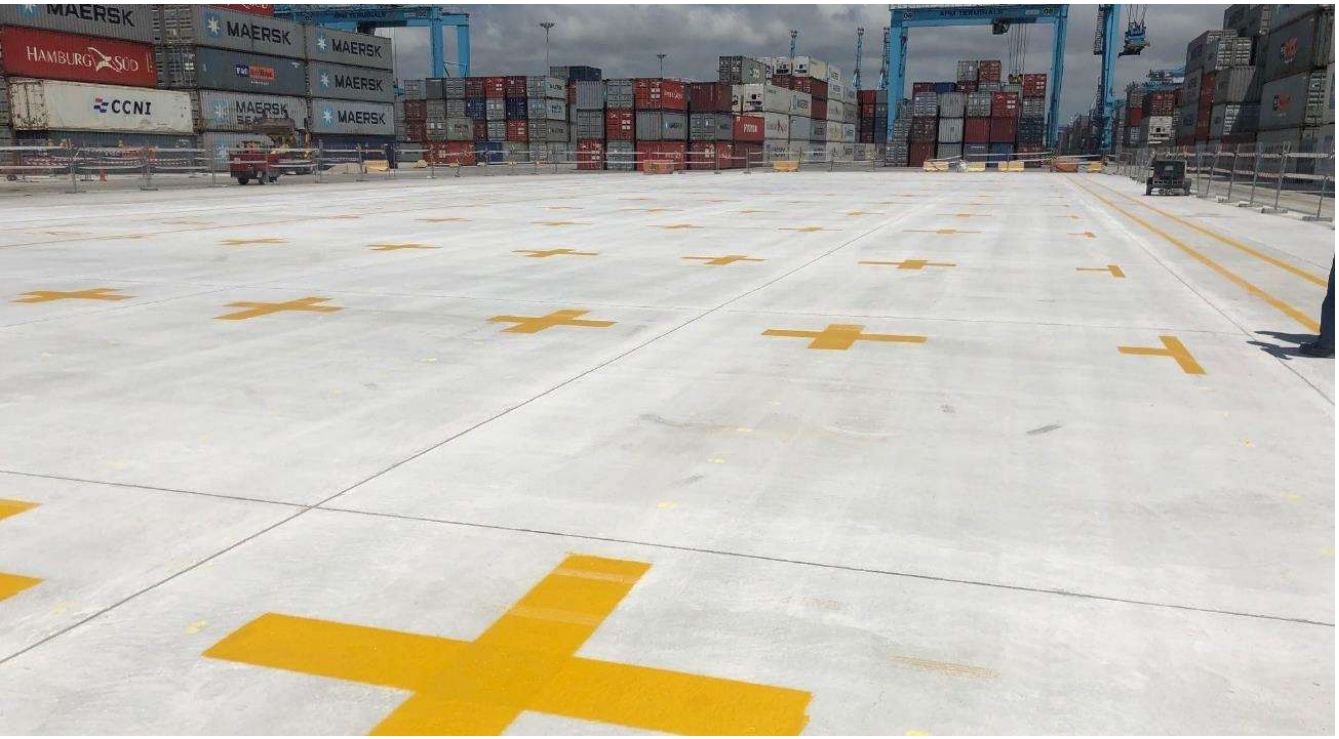
Items	Quantity	Value (THB)
Construction		
- Concrete	22,500 m3	60,975,000
- Steel fibre	675,000 kg	50,625,000
- Formwork	16,075 m2	5,143,906
- Others	1 EA	29,106,403
Total		145,850,309
Maintenance (1 time)		
- Concrete	8,325 m3	24,544,597
- Steel fibre	249,750 kg	18,731,250
- Others	1 EA	20,442,490
Total		63,718,337
Downtime cost		
- Container-days loss	283,200	8,496,000
NPV of 10-years TCO		188,229,197

Precast Beam Reinforcement

Items	Quantity	Value (THB)
Construction		
- Concrete	16,555 m3	43,863,650
- Steel	1,450,605 kg	56,756,780
- Formwork	21,433 m2	4,425,890
- Asphalt	80,292 m2	18,708,050
- Transportation	39,731 Ton	19,865,604
- Others	1 EA	46,012,681
Total		189,632,655
Maintenance (3 times)		
- Precast handling	158,924 Ton	2,325,000
- Asphalt	321,168 m2	56,124,150
- Others	1 EA	34,646,954
Total		93,096,103
Downtime cost		
- Container-days loss	813,750	24,412,500
NPV of 10-years TCO		267,474,071

Container Port Terminal

Non numerical Benefit of SFRC Pavement System



- Flexibility
- Simplify Construction
- Construction Safety
- Corrosion Durability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