13th SINGAPORE SYMPOSIUM ON PAVEMENT TECHNOLOGY (SPT 2008)

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High Performance Topping Material for Semi-Rigid Pavement

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1. Introduction

- As traffic intensity / frequency, axle loading and aircraft size continue to increase, so does the demand for improved airfield and road pavements to cater for the increasingly heavy wear and tear of the pavements.

- Challenges:
  - design and construction of <u>durable</u>, <u>low-maintenance</u> and <u>economical</u> pavements;
  - difficulty in scheduling the repair of concrete pavement, e.g. airports, seaports and road junctions (months of demolishing and strength development)

- Composite pavement as a wearing course:
  <u>open AC</u> + <u>topping material</u> = <u>semi-rigid</u> (days of work)

2. Topping Materials

Difficulties in producing topping materials:

For example:

- ❑ **Flowability**
- ❑ **Strengths and Modulus**
- ❑ **Balance of the above two**

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2. Topping Materials

Chemilink™ SS-141

- High performance polymer modified cementitious material
  - High workability ➔ Easy application
  - High early strength ➔ Early opening to traffic
  - High long-term strength ➔ Low maintenance
- Requires only the addition of water to produce a highly flowable mixture
- Result of extensive research work with the introduction of nano-technology.

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2. Topping Materials

Properties		Test Methods	Typical Values of SS-141
Workability (Flowability)		ASTM C939	• 10 ~ 14 seconds
		JASS 15 [1]	• 200 ~ 250 mm
Compressive Strength	12 hrs	EN 12190	• 20 ~ 30 MPa
	1 day		• 55 ~ 70 MPa
	7 days		• 85 ~ 100 MPa
	28 days		• 115 ~ 140 MPa
Flexural Strength at 28 days		EN 196	• 7 ~ 15 MPa
Setting Time		EN 196	• 4 ~ 6 h (normal setting)
			• 2 ~ 3 h (fast setting)

[1] Optional at the jobsite

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2. Topping Materials

Comparison Items		SS-141 [1]	SS-141-A [2]	SS-141-B [3]
Workability (flow), sec		10 ~ 14	10 ~ 14	10 ~ 14
Comp. Strength, MPa	12 hrs	25	10	< 5
	1 day	60	50	15
	7 days	90	80	30
	28 days	130	110	40
Setting Time, hours	Normal	4 ~ 6	7 ~ 9	-
	Fast	2 ~ 3	-	2 ~ 3

[1] typical values; [2] similar to Malaysian Standard; [3] similar to Singapore Standard.

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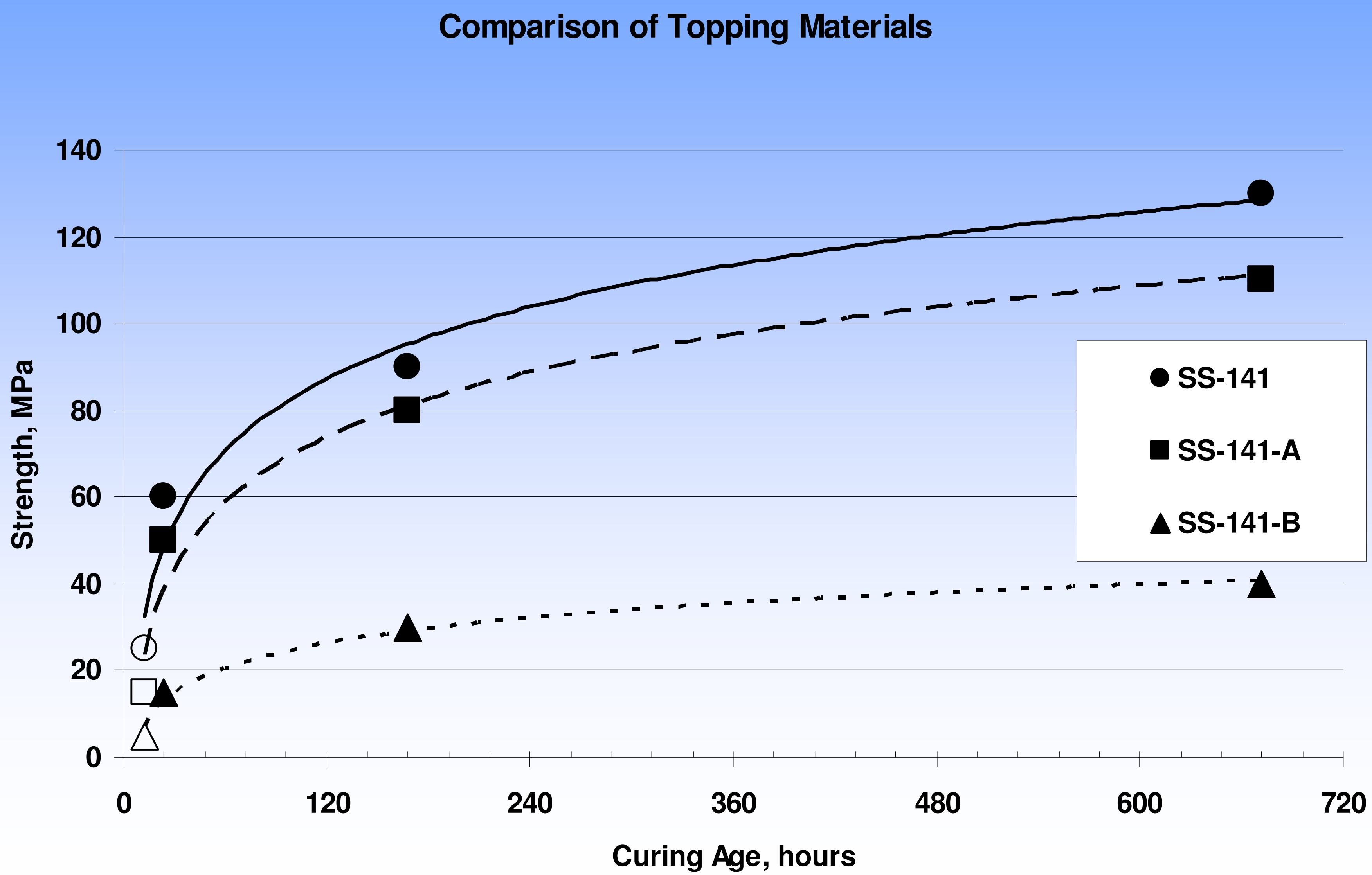
2. Topping Materials



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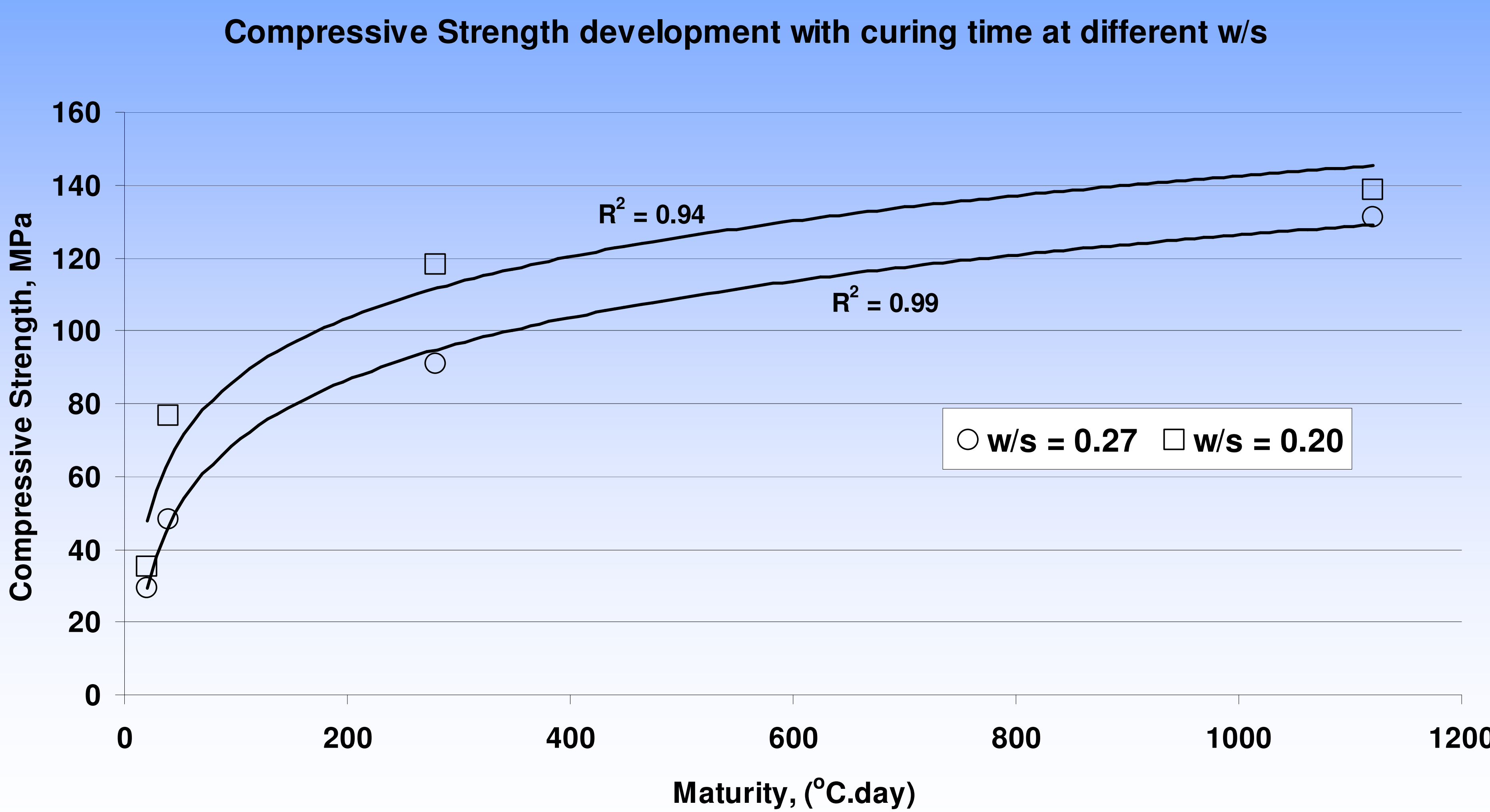
2. Topping Materials



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3. Composite and Components

- Parallel Model (Iso-strain; upper bound):

$$E_c = E_1V_1 + E_2V_2$$

- Series Model (Iso-stress; lower bound):

$$\frac{1}{E_c} = \frac{V_1}{E_1} + \frac{V_2}{E_2}$$

V_i = volume fraction of components 1 and 2

E_i = modulus of components 1 and 2

E_c = modulus of composite

$\Sigma V_i = 1$, e.g. $V_1+V_2 = 1$

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3. Composite and Components

- Given V_{AC}, V_m and E_{AC} the same for different semi-rigid composites, E_{sr} increases as E_m increases for both parallel and series models.

$$E_{AC}V_{AC} + E_m V_m = E_{sr} \qquad \frac{V_{AC}}{E_{AC}} + \frac{V_m}{E_m} = \frac{1}{E_{sr}}$$

- Similarly, given V_{AC}, V_m and E_m the same, E_{sr} increases as E_{AC} increases

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3. Composite and Components

High quality SS-141 topping material leads to

- high performance at initial stage
- high reliability of semi-rigid pavement
- further development of semi-rigid pavement when asphalt concrete technology advances

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4. Semi-Rigid Pavement

Properties	Test Method	Semi-Rigid Pavement (SS-141 as topping)
Compressive strength at 12 hrs	EN 12190	• 3 ~ 5 MPa
Compressive strength at 1 day		• 6 ~ 8 MPa
Compressive strength at 28 days		• 9 ~ 12 MPa
Flexural strength at 28 days	EN 12190	• ≥ 3 MPa
Modulus	ASTM D4123	• ≥ 6,500 MPa (at 25^{o}C)
Skid Resistance	ASTM E303	• ≥ 50 ~ 60 BPN
Impermeability	DIN 18130	• impermeable
Curing time	-	• 4 ~ 8 hours

4. Semi-Rigid Pavement

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Curing Age	Compressive strength (MPa) of semi-rigid pavement with different topping materials		
	SS-141	SS-141-A	SS-141-B
12 hrs	3 ~ 5	0.5 ~ 2 [1]	
1 day	5 ~ 8	5 ~ 7	<5 [2]
7 days	8 ~ 10	7 ~ 10	-
28 days	9 ~ 12	8 ~ 12	-

[1] or dependent on the properties of the open AC;

[2] the strength of composite pavement is believed to be inadequate.

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5. Application Procedures

Porous asphalt concrete

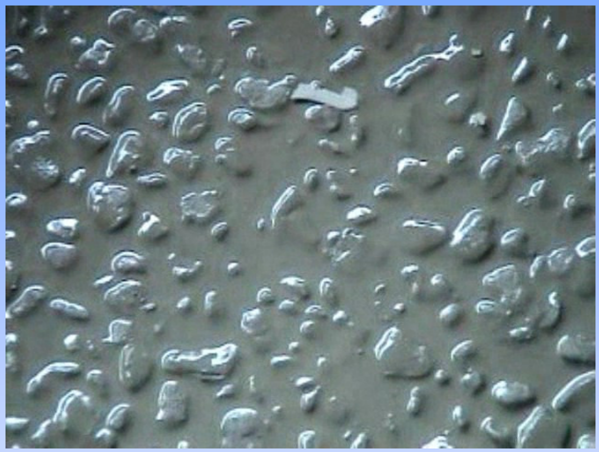
Mixing of SS-141

Flowability Check

Filling into porous asphalt concrete

Scraping

5. Application Procedures



Right after filling

Hardened surface

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6. Completed Projects (Examples)

Singapore Changi Airport Apron 1 (2007)

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6. Completed Projects (Examples)

Singapore Changi Airport Apron 2 (2007)

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6. Completed Projects (Examples)

Heavy Loading Yard (Hanson, Singapore AC Plant, 2005)

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7. Conclusions

- Demand for semi-rigid pavement due to increased heavy wear and tear of pavements and difficulty in scheduling the repair work
- Chemilink™ SS-141 topping
  - Easy application (high flowability)
  - Early opening to traffic (high early strength)
  - Low maintenance (high long-term strength)
- Given the same asphalt concrete and the same mix proportion, a higher quality topping would yield a composite pavement of better performance

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Thank You
for
Your Attention!