สมบัติทางกลและความคงทนของมอร์ตาร์ไหลอัดแน่นด้วยตนเองผสมร่วมขยะจากแผงวงจรพิมพ์และเถ้าลอย

Mechanical Properties and Durability of Self-compacting Mortar Incorporating Printed Circuit Board Waste and Fly Ash

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บทคัดย่อ

20 , 10, 15, ± 15 38.25 8.23 MPa 7.06 55.05

คำสำคัญ , , , ,

Abstract

The purpose of this research was to study the effects on mechanical properties and durability from sulfuric acid corrosion conditions, when waste from printed circuit boards and fly ash are mixed in the production of self-compacting mortar. In the design of the mortar mixture, fly ash was used to replace Type 1 Portland cement in the ratio of 20 percent by weight and printed circuit board waste was added as the binder in the ratio of 5, 10, 15, and 20 by weight of binder. The water to binder ratio was 0.47. The spreading distance of self-compacting mortar was fixed for all mixtures in the range of ± cm. The flowability, compressive strength, flexural strength, water absorption and durability from corrosive conditions of sulfuric acid at the maximum curing time of 90 days. The test results showed that the flowability of self-compacting mortar tended to decrease with the amount of printed circuit boards waste in the mix increase. While compressive strength, flexural strength, water absorption and durability due to sulfuric acid corrosion tends to increase with the amount of printed circuit boards waste in the mix increase. The self-compacting mortar incorporation printed circuit boards in the appropriate amount should not exceed 15 percent, with compressive and flexural strengths of 38.25 and 8.23 MPa, while the percentage of water absorption and Loss of compressive strength from sulfuric acid corrosion was 7.06 and 55.05, respectively.

Keywords: self-compacting mortar, e-waste, printed circuit board waste, mechanical properties, durability

1.คำนำ

(self-compacting mortar) (self-compacting concrete)

(Segregation) (Bleeding)

[1,2]

[3]

[4]

[5]

[6]

(Thermosetting Plastic)

[7]

Nagajothi Felixkala [8]

0, 0.5, 1.5 2.5

28 27.43, 29.8, 35.5 42.4 MPa

2.5 40 MPa

[9]

(Admixture)

(PCBs)

2. วิธีการศึกษา

1

.15 ASTM C150 [10] ( )

2.1.3

( ) ASTM C618 [11]

Printed Circuit Boards, PCBs

( )

Scanning Electron Microscope (SEM)

(4)

2.1.3 ( )

ASTM C33 [12] ( )

2.1.4

pH 6-7

2.1.5 (High Range Water Reducer) F ASTM C494 [13]

2.1.6 H_2SO_4 Lab Grade 98.08 /

/

98 ASTM C267 [14]



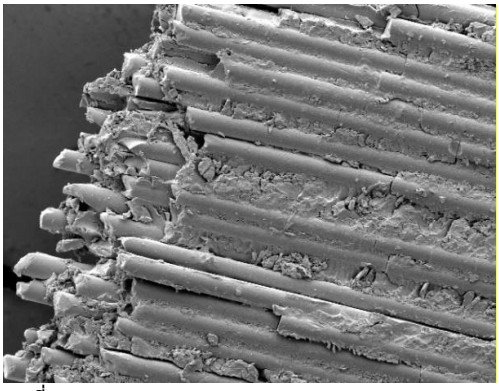
รูปที่ 1 1



รูปที่ 2



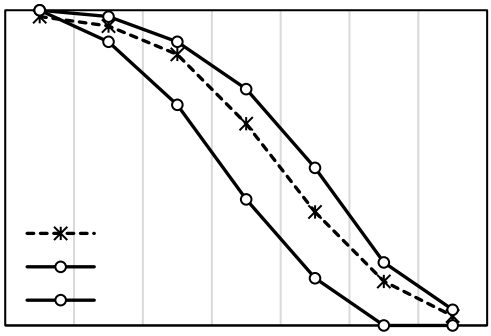
รูปที่ 3



รูปที่ 4 (1000x)



รูปที่ 5



รูปที่ 6 ASTM C33

2.2

2.2.1

Okamura [15]

EFNARC [16]

EFNARC [16]

20

, 10, 15,

1

ASTM C305 [17]

V-Funnel) ( ) EFNARC [16]

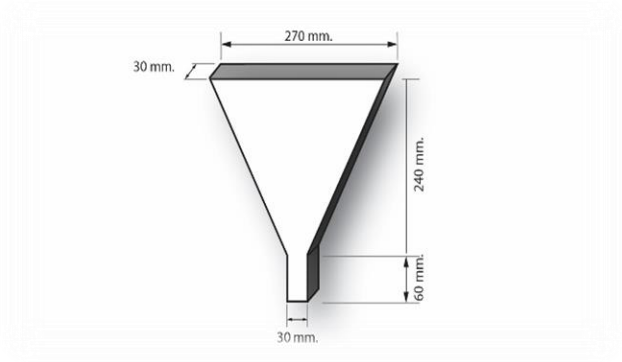
7, 28

ตารางที่ 1 (kg/m^3)

Mix ID (1 m^3)	PCBs	%	PCBs	%	SP (%)
SCM0	550	0.0		20	0.5
SCM5	550	5.0		20	1.7
SCM10	550	10.0		20	4.1
SCM15	550	15.0		20	4.9
SCM20	550	20.0		20	5.3

Slump Flow) Mini Slump Flow Test
EFNARC [16]

( )

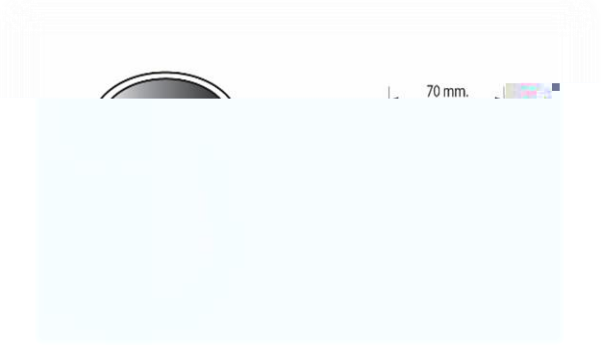


รูปที่ 8 V-Funnel)

(Initial Setting Time)
(Final Setting Time)

2.3.2

x 50 x 50
ASTM C1403
[18]



รูปที่ 7 Mini Slump Flow Test

,
ASTM C349 [19]
x 10 x 35 ( )
ASTM
C348 [20]
( ) x 50 x 50
ASTM C267 [14]



รูปที่ 9



รูปที่ 10



รูปที่ 11

$SiO_2 + Al_2O_3 + Fe_2O_3$

CaO C

ASTM C618 [11] PCBs

SiO_2, Al_2O_3, Fe_2O_3, CaO ,

19.14, 0.01 21.03

1

PCBs 3

ตารางที่ 1

PCBs

			PCBs
Silicon Dioxide (SiO_2)	19.92	33.40	54.30
Aluminium Oxide (Al_2O_3)	5.02	18.60	19.14
Iron Oxide (Fe_2O_3)	2.69	14.40	0.01
Calcium Oxide (CaO)	65.66	20.10	21.03
Magnesium Oxide (MgO)	1.18	2.86	0.63
Potassium Oxide (K_2O)	0.48	2.31	0.03
Sodium Oxide (Na_2O)	0.08	2.49	0.00
Sulfur Trioxide (SO_3)	2.22	3.95	0.00
Loss on Ignition (LOI)	0.96	0.59	27.47
Free lime %	0.57	0.62	0.17

ตารางที่ 3

PCBs

		PCBs	
	3.15	0.69	2.88
	1.00	0.361	0.72
(Strength Index, %)			

3.2

PCBs

3. ผลการทดลอง

3.1

X-ray fluorescence (XRF) 1

PCBs

CaO, SiO_2, Al_2O_3, V-Funnel)

Fe_2O_3 %, 19.92%, 5.02% 2.69% PCBs

SiO_2, Al_2O_3, Fe_2O_3, K_2O, CaO V-Funnel)

Na_2O %, 18.6%, 14.4%, 2.31%, 20.1% % EFNARC [16]

PCBs

V-Funnel)

PCBs –

V-Funnel)



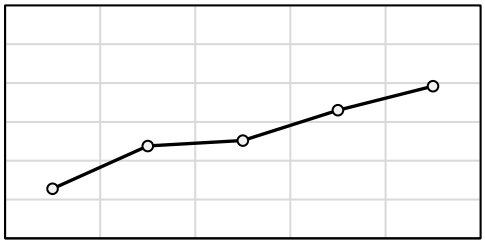
PCBs

3.3

3.3.1 (Compressive Strength)

รูปที่ 12 , 28,

38.25, 37.93, 37.54, 35.54

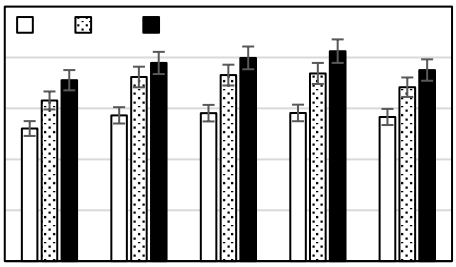


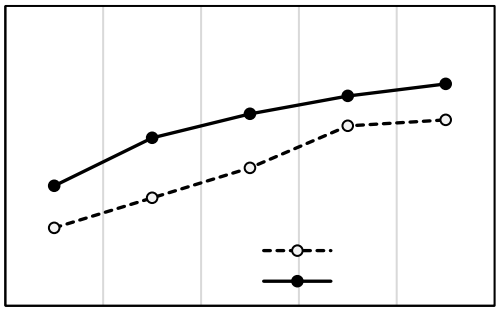
32.98 (Mpa) SCM15, SCM10, SCM5,

SCM20 SCM0

15

รูปที่ 13





รูปที่ 15

3.3.2 (Flexural Strength)

, 28,

รูปที่ 14

, 8.09, 7.83, 7.80

(Mpa) SCM15, SCM10, SCM5, SCM20
SCM0

15

รูปที่ 16

PCBs

PCBs

PCBs

15

3.3.3 (water absorption)

( )

PCBs
SCM , SCM , SCM , SCM SCM
, ,
PCBs

รูปที่ 17

( )

PCBs SCM ,
SCM , SCM , SCM SCM ,
, , (Mpa)

PCBs)

4. สรุป

PCBs)

(Admixture) SiO_2, Al_2O_3, Fe_2O_3,

CaO , 19.14, 0.01 21.03

1

V-Funnel)

4.5

PCBs

4.6

, 60.13, , 55.05

(Mpa)

SCM5, SCM10, SCM0, SCM15

SCM20

5. กิตติกรรมประกาศ

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