USING SILICA FUME AND FLY ASH IN THE PRODUCTION OF NON-ASBESTOS FIBRE CEMENT BOARDS IN VIETNAM

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ABSTRACT

Research on diversified fibre cement boards by producing non-asbestos products on the existing asbestos cement lines, is one of the main activities of Vietnam’s fibre cement industry at the present time. The industry also aims at a suitable quality product at an effective product cost. Silica fume (SF) from Elkem (Norway) and fly ash (FA) of Vietnam were used to produce corrugated and flat-sheets based on cement - PVA fibre by the Hatschek process. Properties such as bending strength, watertightness, mass density, soak-dry and freeze - thaw were tested. The results revealed that using SF and FA is an effective process in improving many mechano-physical properties and durability of the products.

KEYWORDS:

Silica fume, Fly ash, Non-asbestos, Hatschek process.

1.INTRODUCTION

SF has been used as a sheet-forming component for producing fibre cement products based on PVA fibre (PVA/C) by the Hatschek process in many countries all over the world. It has been established to be one of the most effective additives in processing and productivity [1]. There is no production of SF in Vietnam; therefore, the price of SF is very high because of logistical expenses. If using only SF for producing PVA/C, the product cost will be very high. Finding a local low price additive for use with SF is the purpose of this work. We found and used FA from The Pha Lai Thermal Power Plant (Vietnam) for production of fibre cement. Metakaolinite and Bentonite were also tested for reference.

2. RAW MATERIALS

2.1 Additives

- SF from Elkem Materials;
- FA from Pha Lai Thermal Power Plant, was treated and supplied by Hanoi Materials Company;
- Metakaolinite (MK) from Institute for Building Materials (IBM) [2];

Fineness and particle size distribution of the admixtures were tested by LS Particle Size Analyzer (Coulter, USA). The results were shown in table 1.

Table 1: Fineness and particle size distribution of the admixtures

Diameter (μm)	Volume (%)			
	Bentonite	**Metakaolinite**	**Silica fume**	**Fly ash**
1.5	4.59	4.11	0	0
2.5	19.33	14.67	1.52	0.17
5.0	56.69	34.96	15.87	3.97
10.0	86.86	58.67	48.72	14.88
20.0	96.57	77.66	90.27	31.15
30.0	98.62	87.67	98.62	46.52
45.0	99.55	93.20	100	59.86
Dv_{50}	4.56	7.77	10.31	34.16

2.2 PVA fibre : from Kuraray Co. Ltd. (Japan);

2.3 Cement: Blended Portland Cement PCB 40 from Saigon Cement Joint Stock Company.

Properties of the cement were shown in Table 2.

Table 2: Properties of the cement

TT	Properties	Unit	Results
1	Compressive strength - 3 days - 28 days	MPa	 20.7 43.1
2	Cement water ratio	%	28.3
3	Setting time: - Initial - Final	 min. min.	 145 200
4	Soundness (one property of cement, that mean: volume stability during setting of cement)		0.5
5	Fineness: - Retained content on the sieve of 0.08 mm - Blaine	 % cm^2/g	 7.0 3,380
6	Density	g/cm^3	3.05
7	Content of SO_3	%	1.54

2.4 Cement bag pulp: Cement bag was ground until the fineness is 70^0 SR;

2.5 Flocculant: from Cytec Co. Trade name : PAM: 4800 RS.

3. TESTED RECIPES:

- The 3 recipes were tested as shown in Table 3.

Table 3 - Tested recipes

Item	Raw materials	Unit	Recipes		
			RE1	**RE2**	**RE3**
1	Cement PCB 40	%	89	89	85
2	PVA-A8	%	2	2	1.5
3	Cement bag pulp 70^0SR	%	3	3	3
4	Silica fume	%	-	5	5
5	Metakaolinite	%	5	-	-
6	Fly ash	%	-	-	5.5
7	Bentonite	%	1	1	-
8	Flocculant	ppm	300	300	300
Total		%	100	100	100
Batches		-	**25**	**20**	**20**

4. EQUIPMENT:

NAVIFICO's production line was used (Fig.1). Some equipment were added or modified to meet the requirements of the trial production.

Figure 1 – NAVIFICO's Production line.

5. SAMPLE PRODUCTION:

5.1 Mixing:

Cement bag pulp and additives (SF,FA,MK) were stirred in two separate tanks for 5 minutes at 500 rpm. Cement bag pulp was then pumped into the tank of additive.The mixture was stirred for 5 minutes. After that the mixture was pumped into a paste mixing tank; the cement, PVA fibre and water were added ; The mixture was stirred for 5 minutes and then pumped the mixture into distribution tank.

Flocculant was diluted with water and then a dose of flocculant was pumped into a slurry flow before vats at the rate of 16 litres per minute.

5.2 Technical conditions:

Vacuum in the vacuum box: 150 mmHg, in suction box: 250mmHg; rate of running felt : 35 m/minute, formation cylinder pressure: 5 N/mm^2, sieve cylinder with the mesh of #60.

5.3 Curing conditions:

After forming, the product was steam-cured at 65 ^{0}C,100%RH for 7 hours and then removed from the mould. The sheets were then cured in ambient air temperature by manual wetting for 28 days.

6. TESTING OF PRODUCT:

Corrugated sheets were tested conforming to the standard of TCVN 4434:2000 that applies to asbestos-cement sheets.

Flat sheets were tested conforming to the standard of AS/NZS 2908.2:2000 by Instron Universal Tester

7. RESULTS AND DISCUSSIONS

Test results of the corrugated sheets are shown in Table 4.

Test results of the flat sheets are shown in Table 5 and Figure 3 to Figure 8.

Table 4: Test results of the corrugated sheets

Item	Properties	Unit	Recipes		
			RE1	RE2	RE3
1	Dimensions	mm			
	- Length		1,572	1,510	1,515
	- Width		920	920	919
	- Pitch		178	179	178
	- Depth		53	51	52
	- Thickness		6.2	5.4	5
2	Flexural load at failure	N/m	3,709	3,207	3,822
3	Watertightness	hour	>24	>24	>24
4	Mass density	g/cm^3	1.36	1.25	1.35

Table 5 : Test results of flat sheets

Item	Properties	Unit	Recipes		
			RE1	RE2	RE3
1	Bending strength	MPa	7.64	6.37	10.73
2	Watertightness	Hour	>24	>24	>24
3	Soak-dry (the test is conformed to the standard of AS/NZS 2908.2:2000 by Instron Universal Tester.	-	0.85	0.8	0.9

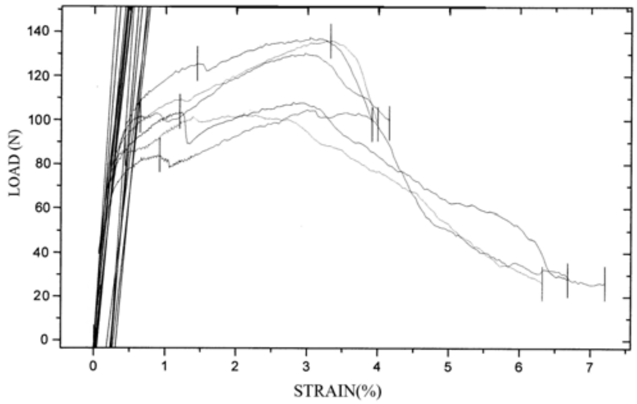

Figure 3:

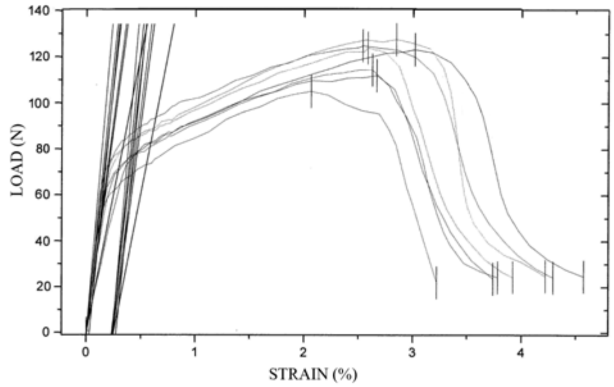

Figure 5

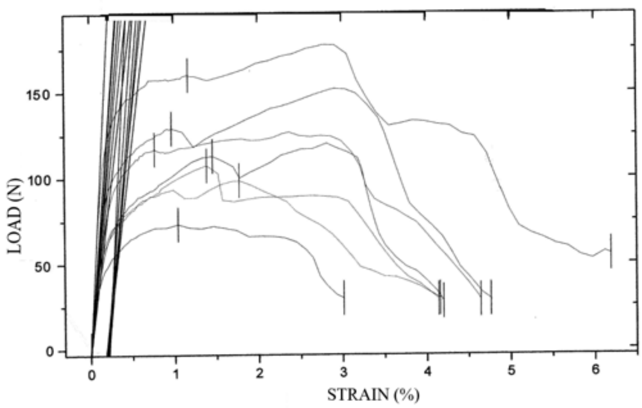

Figure 4

Figure 3: Diagram Load - deformation of RE1.

Figure 4: Diagram Load - deformation of RE2.

Figure 5: Diagram Load - deformation of RE3.

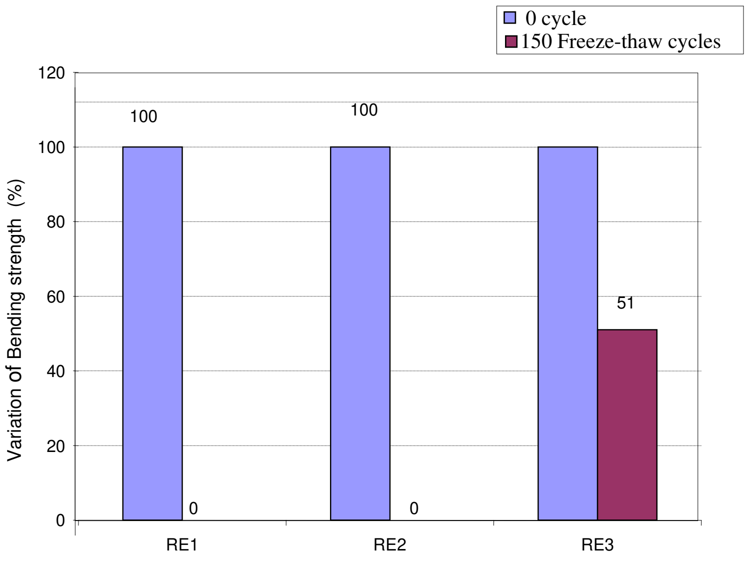

Figure 6: Variation of Bending Strength of PVA/C after F/T test

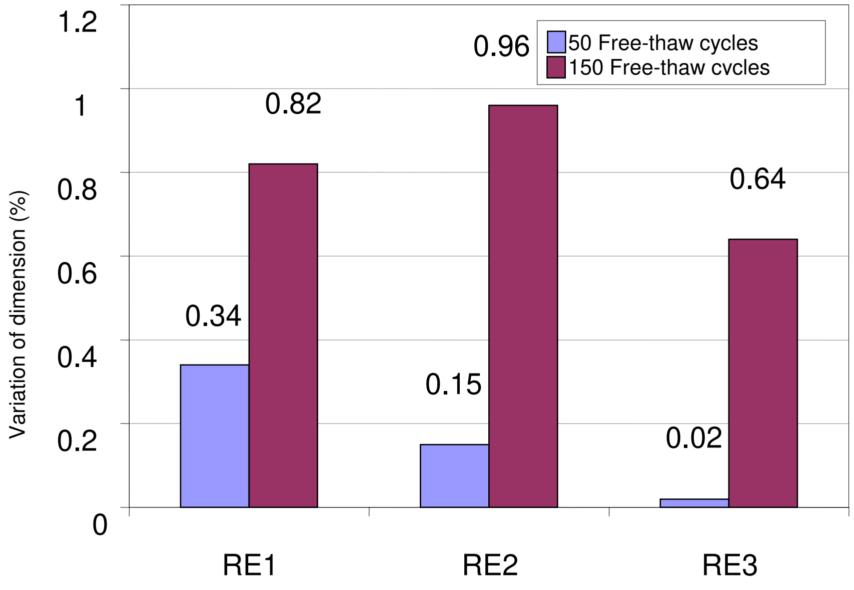

Figure 7 – Variation of dimension of PVA/C after F/T test

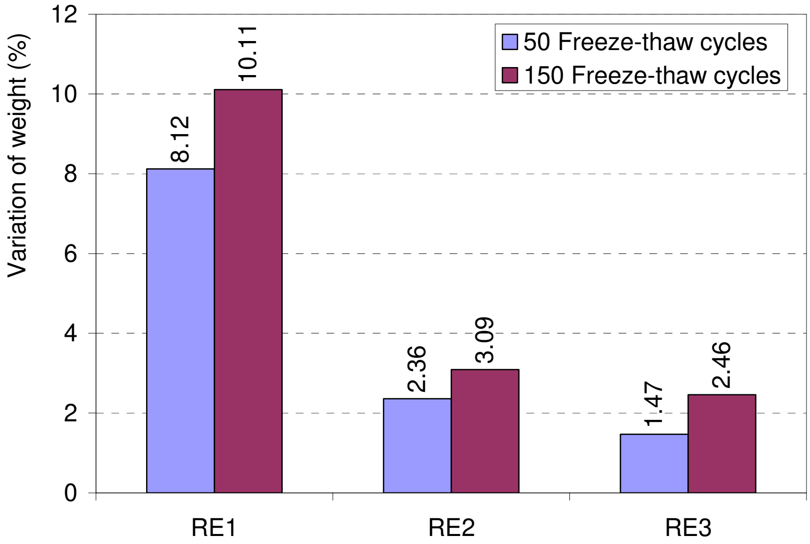

Figure 8 – Variation of weight of PVA/C after F/T test

It is indicated from the tables 4,5 and figures 3-8 above that obtained the following results:

* For the corrugated sheets:

- Flexural load at failure: RE1 and RE3 met the requirement of TCVN 4434:2000 on breaking strength. Only the RE2 did not meet those requirement. PVA content and cement content of RE3 was lowest but RE3's breaking strength is highest. It was indicated that additives (FA, SF) substantially improved breaking strength of the corrugated sheets. RE1's strength was higher than RE2's in spite of SF's activity is higher than MK's. This result is similar to the result that IBM obtained at the test-run in October of 2002 at NAVIFICO [3]. It is said that some technical parameters may be adjusted when SF is used to produce corrugated sheets on the machinery and equipment of NAVIFICO. Up to now, we have not been able to determine these parameters exactly.

- Watertightness: all of the three recipes met the requirements of TCVN 4434:2000.

- Mass density: RE1 and RE3 recipes achieved similar mass densities; RE2 recipe got the lowest density. However, according to TCVN 4434:2000, the density must be higher than 1.5 g/cm^3. It is said that PVA/C corrugated sheets have lower mass density than A/C sheets and therefore, an appropriate standard must be prepared for PVA/C corrugated sheets only.

* For the flat sheets:

All three of the recipes met the requirement of AS/NZS 2908.2:2000. RE3 recipe got highest bending strength, freeze - thaw and soak-dry resistance score. It was indicated from the Figures 3-5 that there were good distribution of PVA fibre in the sheets of RE3 recipe. It is said that using FA + SF can improve distribution of PVA fibre.

CONCLUSION

The following are conclusions from the results above:

- The mix of SF and FA makes good contribution to the final bending strength of PVA/C sheets.

- The mix of SF and FA enhences freeze –thaw and soak-dry resistance of flat sheets. It is very useful to use the sheets in Vietnam's climate.

- The dosage of PVA fibre is decreased when the mix of SF and FA was used. Therefore, the product cost of PVA/C sheets will be decreased. It is very useful for PVA/C sheets to expand in the local market.

- FA is already in Vietnam; therefore, research on using it with larger content is necessary.

ACKNOWLEDGEMENTS

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