

EXAMINATION OF R.M. X3562 EX FOSCO INC.,
U.S.A. IN PROFAX AND PROFLEX.



Introduction:

This material has been used recently at Fosco Inc. in Profax and Proflex (Asbestos free) recipes with some success as an aid to improving the forming characteristics of these products. Since it was thought that it could fulfil the dual functions of fibre and filler to some extent, the material appeared to be ideal as a means of simplifying the existing recipes, and its cheapness could bring about useful reductions in R.M. costs. The short investigation was carried out to test the properties of the two latest recipes received from U.S.A. (i.e. Proflex XS 1500 and Profax XS 1494) incorporating R.M. X3562.

1) Profax XS 1494.

a) Laboratory Scale Tests.

Small tiles of XS 1494 and Profax 31 were formed on the Profax hand machine and the properties of each product compared. The recipes and mixing procedures are given in Appendix 1.

(1) Experimental results.

	<u>Profax 31</u>	<u>XS 1494</u>
Solids content %	20	23
Suspension (% clear liquid after 24 hours standing - 500 ml cylinder)	12.0 (clear supernatant)	43.0 (clear supernatant)
Formability		
Fill time (secs.)	20	20
Dewatering time (secs.)	15	30
Tile thickness	1½" - 2"	1½" - 2"
Nature of top surface	Flat - no indents	Flat - no indents
Finished product Density (g/cm³)	0.81	0.85
Steel pour test	(See Appendix 2)	
Muffle furnace - Shrinkage test (1400°C)	shrinkage practically nil in all cases (all samples of equivalent hardness when hot).	

(11) Conclusions.

XS 1494 appeared to be equivalent to Profax 31 in its main properties. In order to fully test the slurry forming properties, the above tests were repeated for XS 1494 on the SAM.

(b) SAM tests.

Large boards 1.5 metres x 37 cm were formed since these gave the most severe forming conditions. The properties of XS 1494 were compared with those of Profax 31 formed under similar conditions.

(1) Experimental results.

	<u>Profax 31</u>	<u>XS 1494</u>
Solids content %	18.9	30.0
Machine characteristics - Pressure (line)	40 p.s.i.	
Pump (form) time (secs.)	12.5	15
Dewater time (secs.)	25	45
Tile thickness (inches)	0.9	1.0
Formability	Very smooth top surface - very even fill - no cavitation	Reasonably smooth top surface - even fill - slight cavitation.
Green strength	Good	Adequate for board

Conclusions.

Formability of XS 1494 was almost as good as Profax 31, and most of the other properties were equivalent, with the exception of the dewatering time which was longer. XS 1494 therefore appears to be a satisfactory replacement for Profax 31.

2) Proflex XS 1500.

a) Laboratory scale and SAM tests.

XS 1500 was compared with Proflex G5 using the Hand machine and the SAM as for Profax.

Recipes and mixing procedures are given in Appendix 3A.

(1) Experimental results.

	<u>Hand machine</u>		<u>SAM</u>	
	<u>G3</u>	<u>XS 1500</u>	<u>G3</u>	<u>XS 1500</u>
solids content %	5.9	5.0	4.9	5.0
formability				
fill (pump) time (secs.)	-	20	20	20
watering time (secs.)	-	6	15	10
film thickness	-	20 mm	20-25 mm	ca. 25 mm
formability	Excellent flat surface - no indents.	Slight indentations	Flat surface - no indents.	Board indented.
finished product density (g/cm ³)	-	0.43	-	0.46
flexibility/Compressibility	Good	Excellent Compressibility Slightly flexible	Good	Flexible and compressible but poor strength
cool pour test				
10 strip (1 hour)	Board residue fairly easily removed - clean surface	Back face glowing red before strip - apparent severe penetration	-	-
15 strip	Fairly rough surface with slight burn on	Very severe slagging and penetration.		
1000 Furnace shrinkage Test (1400°C)		Sample intact Poorer hot strength than G3. Area shrinkage 10.9%	Sample remained intact - good hot strength. Area shrinkage 20.7%	

(11) Conclusions.

XS 1500 is an inferior product to Proflex G3 and would be unsatisfactory both for boards and gaskets since the refractoriness is low. Apart from this the SAM tests showed that formability was unsatisfactory and the dry strength of the cured product was poor.

b) Further examination of X3562.

Further tests were carried out using X3562 in previous Proflex recipes which had shown some promise, and in modifications of XS 1500 to try to overcome its disadvantages.

a) Recipe PB 134.

This was a board recipe which had previously given satisfactory formability using R.M. 131A as filler but the cured boards were too friable. R.M. X3562 was used as a direct substitute for R.M. 131A.

Recipe: (see Appendix 4).

Experimental results: (Hand machine).

Slurry dispersion - good.

Formability - good (flat surface).

Cured tile - good compressibility but no flexibility.

b) Recipes PB 135 and PB 136.

The resin content of PB 134 was reduced in order to improve flexibility (PB 135 contained 0.55 468B, and PB 136 1.05 468B). There was no improvement in flexibility which indicated that it was the X3562 rather than the R.M. 468B which was primarily responsible for the low flexibility. (Microscopic examination of the material showed that it consisted of needle like crystals which it is thought probably interlock to form a rigid structure). It was also observed during this test that the excessive foam produced caused segregation of fibres and filler. (For recipes see Appendix 4).

c) Recipes PB 137, 138 and 139. (Appendix 4).

Recipe PB 137 was made to confirm the apparent "inflexible" properties of R.M. X3562. The board was not flexible and strength was poor. The forming properties were also unsatisfactory (a flat but indented surface was obtained). The compressibility was also low. This test indicated therefore several deficiencies of X3562.

Recipe 138 and 139 were made to try to increase the flexibility of the previous series (PB 134-136) by using an intermediate X2782 content between that used in XS 1500 and in PB 134-136. The results were again disappointing - no improving in flexibility being achieved.

d) Recipe PB 140 and 141. (Appendix 4).

Because of the poor refractoriness of XS 1500 these formulations were tested to try to improve this. The formability of both mixes was not satisfactory - the boards being indented. Flexibility was also poor, but refractoriness as assessed by the Muffle Furnace shrinkage test at 1500°C.

APPENDIX 1A.

Recipes - Profax 31 and XS 1494.

(Hand machine tests).

	<u>Profax 31</u>	<u>XS 1494</u>
R.M. 131C * (131D)	75.92	61.9
447	1.37	1.0
463B * (177A)	4.33	3.0
265A	2.89	-
319	1.06	-
452 * (546)	10.63	-
122A * (X1790)	3.80	2.5
X2782	-	0.5
117	-	1.0
X1281	-	0.1
X3562	-	30.0

* Since the original U.S.A. R.M.'s were not available, the nearest U.K. equivalents were used.

Mixing procedure (Mastermix pulper).

Profax 31:
Solids weight = 3 Kg.
Water addition = 12 Kg.
% Solids = 20.0

- 1) Pulped R.M. 452 with 6 litres water 1 min.
- 2) Pulped R.M. 319 + 265A + 4 litres water $\frac{1}{2}$ min.
- 3) Pulped rest of R.M.'s (except 122A) $\frac{1}{2}$ min.
- 4) Pulped R.M. 122A + 2 litres water 15 secs.

XS 1494:
Solids weight = 3 Kg.
Water addition = 10 Kg.
% Solids = 23.0

- 1) Pulped all R.M.'s except 117, X1281 and 122A with 10 litres water $\frac{1}{2}$ min.
- 2) Sprinkled in R.M. 117 while pulping $\frac{1}{2}$ min.
- 3) + X1281 20 secs.
- 4) + 122A 10 secs.

APPENDIX 12.

Recipes - Profex 31 and XS 1494.

(SAR tests).

	<u>Profex 31</u>	<u>XS 1494</u>
R.M. 131D	-	61.9
447	0.68	1.0
468B * (177A)	4.36	3.0
122A * (X1790)	-	2.5
X2782	-	0.5
X3562	-	30.0
117	-	1.0
X1281	-	0.1
131C * (131D)	76.46	-
265A	2.91	-
319	1.07	-
546	10.70	-
X1790	3.82	-

* U.K. equivalent R.M.'s.

Mixing procedure (90 gall. hydropulper).

Profex 31: Solids weight = 40 Kg.
Water addition = 172 Kg.
% Solids = 18.9

- 1) Pulped R.M. 447, 468B, 131C with 81 litres water for 2 mins.
- 2) Added R.M. 265A, 319, 546. plus 60½ litres water - pulped 2 mins.
- 3) Added R.M. X1790 plus 30½ litres water - pulped 1-2 mins.

XS 1494: Solids weight = 50 Kg.
Water addition = 117 Kg.
% Solids = 30%

- 1) Pulped all R.M.'s except 117, X1281, 122A with 110 litres water for ½ min.
- 2) Sprinkled in R.M. 117 during ½ min. while pulping.
- 3) Added X1281 plus 17 litres water - pulped 15 secs.
- 4) Added R.M. 122A - pulped 15 secs.

APPENDIX A.

Profax 31 and XS 1494.

Steel Pour Test.

One tile (10" x 9" x 1") of each material was used to line two sides of a steel box into which molten steel at ca. 1600°C was teemed. After one hour, the box was removed and the tiles stripped from the casting. The surface characteristics of the metal were examined when the casting had cooled.

Profax 31.

XS 1494

Hot Strip
(after 1 hour)

Tile residue fairly
easily removed -
clean surface.

Tile more difficult to
remove - considerable
burn on.

Cold Strip

Fairly smooth surface.
Slight burn on.

Smooth surface, no burn on.
Tile residue next to metal
surface sintered. Easily
removed.

The performance of XS 1494 was considered to be equivalent to that of Profax 31.

APPENDIX V.

Recipes - Proflex G3 and XS 1500.

(Hand machine tests).

	<u>Proflex G3</u>	<u>XS 1500</u>
X2782	6.0	4.0
X3562	-	94.6
468B	2.0	0.8
447	-	0.5
X1281	0.5	0.1
131D	51.0	-
265A	15.0	-
X2286	25.5	-

Mixing procedure (Mastermix pulper).

Proflex G3: Solids weight = 1 Kg.
Water addition = 15 Kg.
% Solids = 5.9%

- 1) Pulped X2782 + X1281 for 1 min. (with 7½ litres water).
- 2) Added R.M. 265A + 2½ litres water - pulp 1 min.
- 3) Added rest of R.M.'s plus 3 litres water, - pulp 1 min.
- 4) Added 3 litres water - pulped ½ min.

XS 1500: Solids weight = 800 gram.
Water addition = 15 litres.
% Solids = 5.0%

- 1) Pulped X2782 + X1281 + 10 litres water - pulp 1 min.
- 2) Added X3562, 468B, 447 - pulp ½ min.
- 3) Added 5 litres water - pulped 15 secs.

APPENDIX 3B.

Recipes -- Proflex G3 and XS 1500.

(SAM tests).

	<u>Proflex G3</u>	<u>XS 1500</u>
X2782	6.0	4.0
X3562	-	94.6
468B	2.0	0.8
447	-	0.5
X1281	0.5	0.1
131D	51.0	
265A	15.0	
X2286	25.5	

Mixing procedure (Mastermix pulper).

Proflex G3: Solids weight ~ 20 Kg.
Water addition = 385 litres.
% Solids = 4.9

- 1) Pulped X2782 + X1281 + 121 litres for 2 mins.
- 2) Added 265A + 60 litres water - pulped 1 min.
- 3) Added rest of R.M.'s and 60 litres water - pulped 2 mins.
- 4) Added rest of water - pulped $\frac{1}{2}$ min.

XS 1500: Solids weight = 10 Kg.
Water addition = 190 litres.
% Solids = 5.0

- 1) Pulped X1281 + X2782 + 110 litres water for 2 mins.
- 2) Added rest of R.M.'s and water - pulped 1 min.

APPENDIX 1.

	PB 134	135	136	137	138	139
X3562	85.7	87.2	86.7	99.0	92.6	90.6
468B	2.0	0.5	1.0	1.0	0.8	0.8
X2782	12.0	12.0	12.0	-	6.0	8.0
447	-	-	-	-	0.5	0.5
X1281	0.3	0.3	0.3	-	0.1	0.1

Mixing procedure: (Mastermix pulper).

P 134, 135, 136, 138, 139.

- 1) Pulped X1281 + X2782 + 10 litres water - 1 min.
- 2) Added other R.M's - pulped $\frac{1}{2}$ min.
- 3) Added 5 litres water - pulped $\frac{1}{2}$ min.

P 137.

- 1) Pulped X3562 + 468B + 10 litres water - 1 min.
- 2) Added 5 litres water - pulped $\frac{1}{2}$ min.

	PB 140	141
X3198	12.0	20.0
X3562	86.0	72.6
X2782	-	6.0
468B	2.0	0.8
447	-	0.5
X1281	-	0.1

Mixing procedure: (Mastermix pulper).

- PB 140
- 1) Pulped X3198 + 10 litres water - 10 secs.
 - 2) Added other R.M's - 30 secs.

- PB 141
- 1) Pulped X3198 + 10 litres water - 10 secs.
 - 2) Added X2782 + X1281 - 30 secs.
 - 3) Added other R.M's - 30 secs.

APPENDIX 5.

Muffle Furnace Shrinkage Test at 1400°C.

XS 1500 and Proflox G3 - Samples remained intact after 1 hour although XS 1500 was more easily broken down.

% shrinkage (area) - G3 30.7%
 XS 1500 10.9%

Recipe 137 - Melted in contact with the silicon carbide plate but to a lesser extent than the fibre alone.

Recipe 141 - completely melted.

X3562 - partial melting in contact with silicon carbide plate.

total of 32 sets were produced with no difficulties in manufacturing. The first five cycles were on the wet side but increasing the dewatering time to 24 seconds corrected the problem. Some of the water entrapped in the tool came down on the pieces as they were blown off. This is a normal situation which shouldn't be but has existed from day one on the four cavity tools.

Two ends and two side boards had a perfect fit in the jig with no shrinkage detected. The boards had a good appearance but were undercured because one board contained approximately 5% moisture and two more were slightly wet when broken open in the center. The boards were to be held but were packaged and shipped. Bill Fletcher is aware and is handling the field tests at Copperweld.

EP 5298 Proflex - #376 Rings on Chicago #7 one-piece

Fifty rings were produced with much difficulty because of a mechanical problem which was not discovered until four hours after the run was discontinued. The vacuum lift was not operating at its full efficiency because of a malfunctioning air regulator. One hundred and fifty rings were produced the following day without supervision. The quality of these were very poor and probably should not have been shipped to the customer. The 50 rings which the Technical Department supervised were of good quality but these were lost and mixed with standard rings.

About 50 rings were tested and every one of these rings were sticking to the casting. Most of the castings had to be scraped at least a little to remove the ring pieces. It has not been determined definitely to what is causing the sticking. A microscopic examination showed that there is a layer of charred material at the surface which has not fully been combusted. The charred material is made up of paper and resin. The heat and casting pressure acting on the ring may be enough to fuse the surface resin to the casting.

A high temperature (1400⁰C) fusion test showed that there were differences in the ring material produced three weeks ago and the recent rings all supposedly from EP 5298.

More rings are in the process of being tested for sticking which are of the earlier production lot.

ED/lr

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TESTING PROGRAMS
IN PROGRESS as 9/28/73

- | | | |
|-----|--------------------|---|
| 1. | Republic Canton | #669 currently testing EP 5465 |
| 2. | Great Lakes | #488, #490, #494, #144, #228 currently testing EP 5453A |
| 3. | Copperweld | #685 currently testing EP 5465 |
| 4. | Harrisburg Steel | #118 currently testing EP 5453A |
| 5. | Carpenter Steel | #357 and #75 currently testing EP 5453A |
| 6. | Armco Kansas City | #593 currently testing EP 5453A |
| 7. | Edgewater Steel | #897 currently testing EP 5453A and EP 5465 |
| 8. | Laclede Steel | #579 currently testing EP 5453A |
| 9. | Kaiser Steel | #861, #636 currently testing EP 5453A |
| 10. | Y. S. & T. Chicago | #777 currently testing EP 5453A |
| 11. | Armco Butler | #373, #604 currently testing EP 5453A |
| 12. | USS Homestead | #708 currently testing EP 5453A |
| 13. | Sharon Steel | #471 currently testing EP 5465 |
| 14. | USS Lorain | #376 currently testing EP 5465 |
| 15. | Republic Chicago | #538 currently testing EP 5465 (modified) |