ASSESSMENT OF AFS STRUCTURAL WALL SYSTEM

FOR

CBPA NSW, FEBRUARY 2008

1. Introduction

This assessment of the AFS Structural Wall System is based on the following documentation provided by the supplier, Architectural Framing Systems, to Ceramic Advisory Services following a telephone request:

AFS Structural Wall Technical Manual
Acoustic Performance Assessment by PKA Acoustic Consulting
Fire Resistance Test Report FSV 1038 by CSIRO
Marketing Brochures
Accompanying pro forma letter.

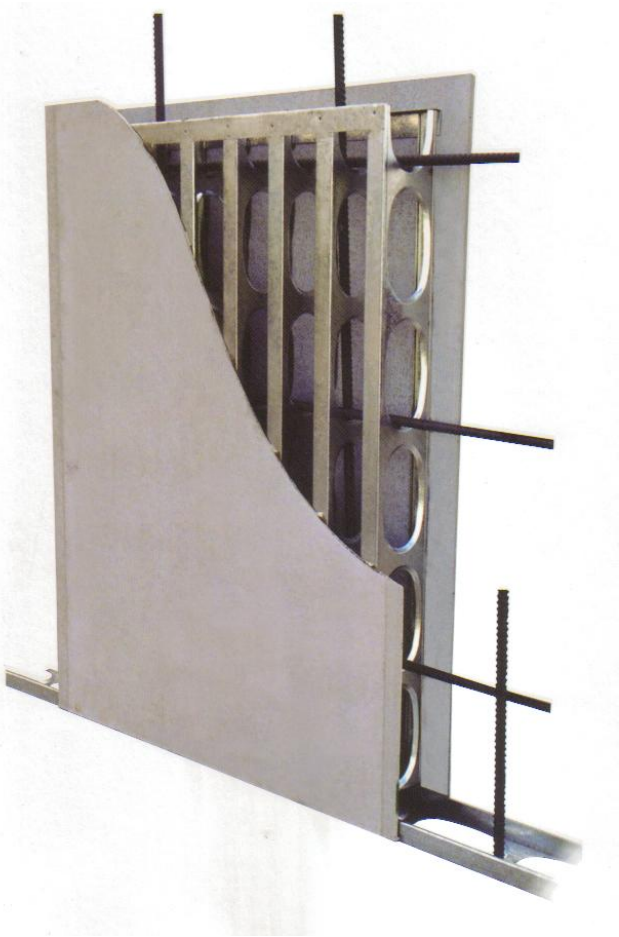
The intent of this assessment is to identify any weaknesses or possible shortcomings of the AFS wall system.

2. Description of System

The system is targeted at multi-storey commercial developments and is branded as AFS LOGICWALL. It is described as a permanent formwork structural walling system. It consists of sandwich panels created by bonding 6mm thick fibre cement sheets to both sides of a galvanised steel stud frame. The panels are erected onsite and then core filled with concrete. The galvanised steel stud frame is perforated to allow both horizontal and vertical steel reinforcement if required.

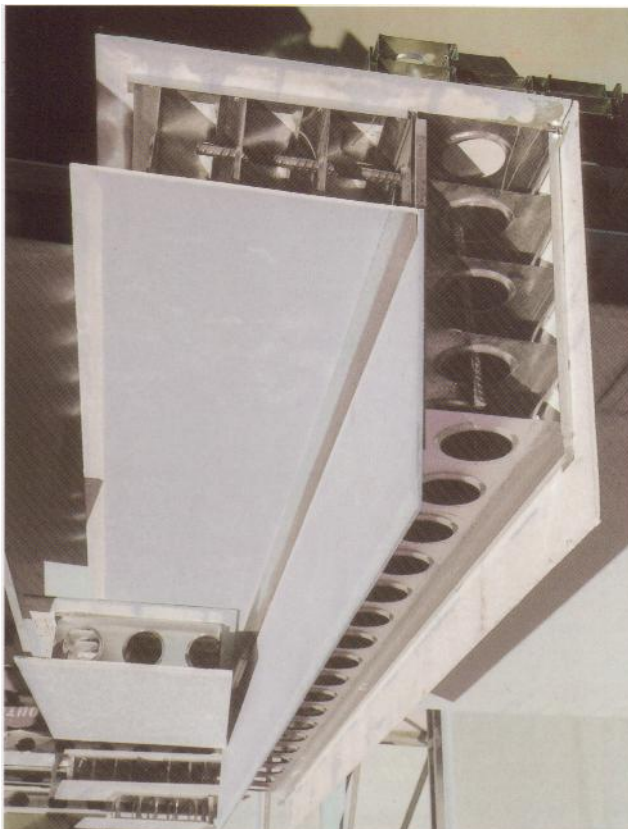
The system is available in wall thicknesses of 120, 150, 162 & 200mm.
A standard panel is 1200mm wide although panels can be manufactured to lesser widths down to 200mm wide to suit intended wall dimensions.
The height of panels can range from 200mm to 4200mm again to suit the intended wall dimensions.
A galvanised steel floor track is supplied to fix panels to the floor or footing.
Panels are joined using a plastic profile strip.
Prefabricated corner panels are available.
Window and door openings are installed into the panels at the factory.

The following photos show some of the elements of the system:



View of system prior to core filling with concrete

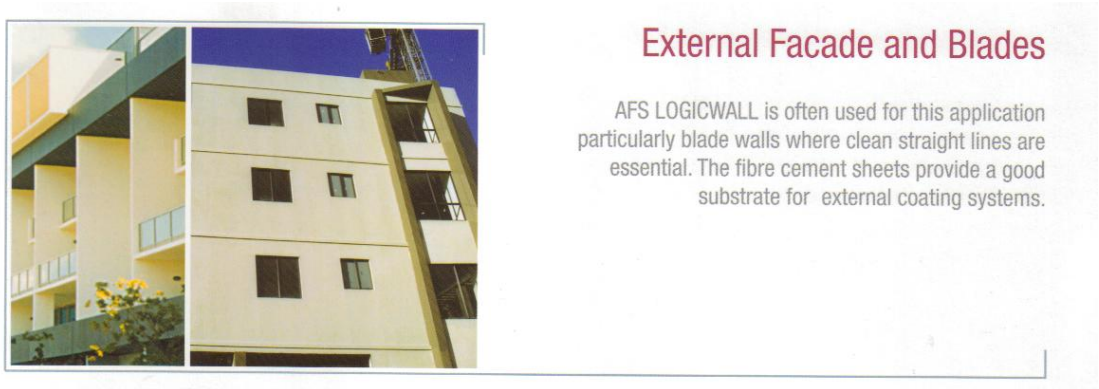
View of plastic panel joiner



View of corner panel prior to core filling with concrete

3. Durability Considerations

The marketing brochures describe the system as being suitable for internal and external walling applications. The external applications suggested are external facades and blades, basements and retaining walls as shown in these images taken form the brochure:



Basements

The structural capacity and clean finish of AFS LOGICWALL makes it the ideal solution for basements and the external fibre cement sheets provide a good substrate for water proofing agents.

Retaining

AFS LOGICWALL is a superior solution for this application because it is fast and clean and non-laborious like conventional systems. Due to its strength AFS LOGICWALL can retain large amounts of backfill.

In many instances these external applications will be Exposure Class locations. In fact the Building Code of Australia Volume 2 classes all retaining walls as Exposure Class conditions. Similarly, the marketing brochures list completed projects many of which are in areas that would most likely be Exposure Class such as Maroubra, Newcastle, The Entrance Wollongong, Brookvale and Dee Why. Therefore, the durability performance of this system is important.

Section 4.11 Flashings and Waterproofing of the AFS Structural Wall Technical Manual states under Flashings:

> *"AFS walls provide a cost effective solution to external walls provided the details are chosen carefully"*
>
> *". …the builder and the architect must approve flashing detail for the waterproofing of the building."*
>
> *"AFS accepts no responsibility for the waterproofing of the building."*

The Technical Manual states under Waterproofing:

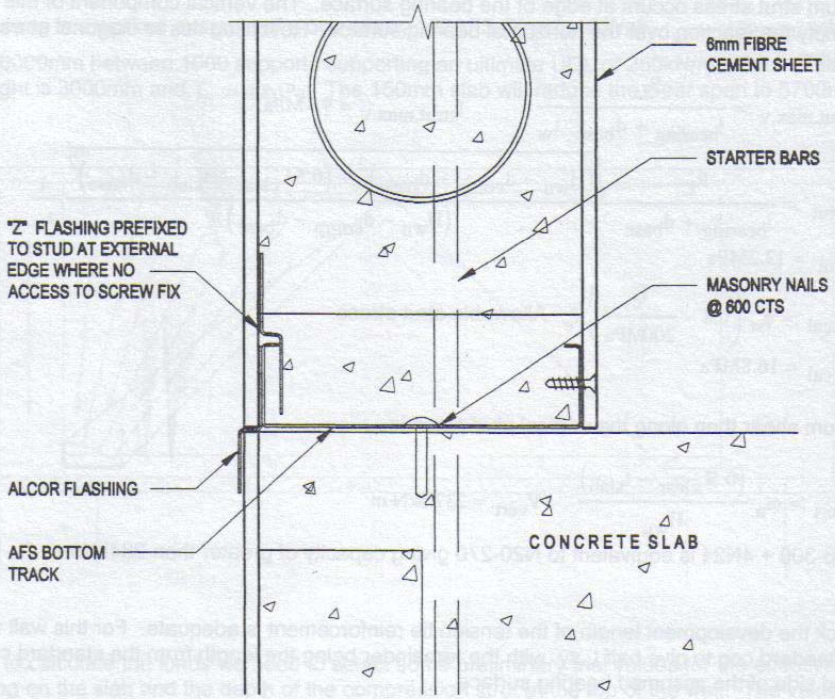
> *"Penetration of water or moisture through the panel face represents a failure in the external membrane system rather than a failure in the AFS wall."*

The following page shows a recommended detail from the Technical Manual for an external wall:

6. Standard Details

DETAIL #1

EXTERNAL WALL/ SLAB JUNCTION
BOUNDARY WALL DETAIL



NOTE: IN BOUNDARY WALL SITUATIONS, CAVITY TO NEIGHBOURING BUILDING SHOULD BE FULLY FLASHED

SECTION DETAIL

This shows that the system is intended to be used as a single skin wall in external applications. Therefore, the system totally depends on the effectiveness and integrity of the waterproofing coating and the flashing (in the drawing above it is shown as Alcor) to prevent moisture from reaching the inside face. There is no cavity to trap moisture before it reaches the inside face.

If the waterproof coating is damaged in any way, or if there is any relative movement between other building elements, or if there is any relative movement between the AFS panels that are joined at 1200mm intervals by a plastic panel joiner strip, there is the potential for moisture to travel straight through the wall. Whilst the AFS Structural Wall Technical Manual probably quite rightly claims this is a failure of the waterproofing system that does not help the client that has moisture coming through to the inside face. It may not be a failure of the AFS system itself but it would be a failure of the wall. The fact that a possible failure of the waterproofing system is even discussed in the AFS Structural Wall Technical Manual suggests that it is a scenario they consider may occur.

If we look at the possibility of failure of the waterproofing coating in an Exposure Class location then the likely durability performance of the elements of the underlying AFS wall have to be examined. Ceramic Advisory Services has inspected a rendered masonry wall in a dwelling located 200m from the surf at Norah Head on the NSW Central Coast. The wall comprised common clay bricks, galvanised corner forms to support the render on each corner, 13mm render and a 3 coat paint system. There was evidence of rust stains leaching through the render and the paint system from the galvanised corner forms on nearly every corner. This shows that the corrosion of seemingly well protected elements can occur. The AFS system comprises 6mm thick fibre cement sheet bonded to steel studs that have a 300g/m^2 galvanised coating. This is a relatively low level of galvanised coating. For instance in Exposure Class locations steel lintels must be 600g/m^2 galvanised coating and built in items that are in the external wall such as wall ties must be stainless steel. Hence, if the waterproofing system fails there is the potential for moisture containing corrosive soluble salts to travel rapidly through the 6mm fibre cement sheets and be in direct contact with the galvanised steel studs that are relatively poorly protected by the level of galvanised coating. At the least this would cause the leaching of rust stains to the surface and at worse the failure of the steel frame.

4. Fire Resistance

The AFS Structural Wall Technical Manual states in Section 4.9 Fire:

> *"Un-reinforced AFS Structural Walls design tables have been prepared in accordance with AS 3700 Masonry Structures Section 6.0 Design for Fire Resistance. Structural tests and past experience show that AFS Structural Walls achieve similar or greater FRL's."*
> *"Please contact AFS on … for a comprehensive fire test report."*

The Scope of Australian Standard AS 3700-2001 Masonry Structures states:

> *"This Standard sets out the minimum requirements for the design and construction of masonry, including unreinforced reinforced and pre-stressed, using manufactured units of clay, calcium silicate and concrete laid in mortar…"*

The AFS wall system does not comprise manufactured units (i.e. bricks or blocks) laid in mortar. Therefore, the AFS wall system is not covered by AS 3700. AFS has nothing to do with AS 3700 and vice versa. Hence, it is totally incorrect to say that the tables for un-reinforced AFS Structural Walls have been prepared in accordance with AS 3700. They cannot be.

In AS 3700 the structural adequacy component of the Fire Resistance Level depends on the slenderness ratio i.e. the height relative to the length of the wall. This means that the FRL for structural adequacy varies depending on the height of the wall and the length of the wall. Ceramic Advisory Services made a telephone enquiry to the AFS Technical helpline asking how the FRL for the AFS system varied with wall height. The response was that the FRL was the same no matter what length or height. This answer is certainly not in accordance with AS 3700. A further example of this inappropriate application of AS 3700 is shown in the design table taken from the AFS Structural Wall Technical Manual for a 150mm thick wall. The column on the far left shows the wall height increasing while the column on the far right shows the FRL as the same for each height of un-reinforced and reinforced walls:

AFS150

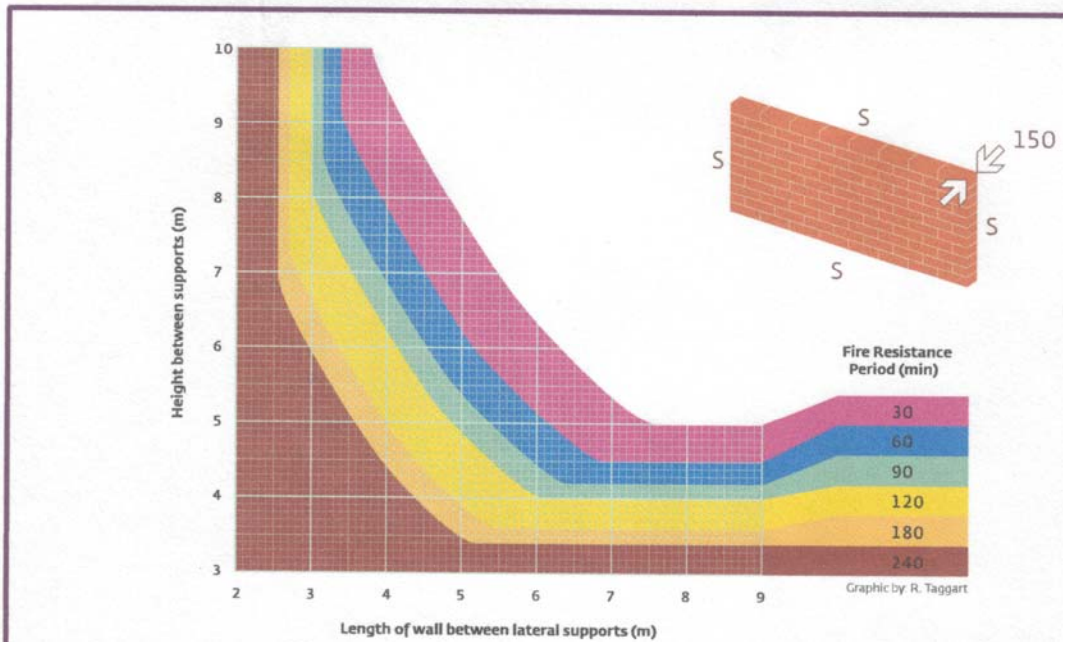
K=0.75	Axial Capacity (ØNu kN/m) Ultimate								
	Continuous Floor e=0.050*t.w				Dis-Continuous Floor e=0.167*t.w				FRL
H.wu (mm)	f'c=25MPa	f'c=32MPa	f'c=40MPa	f'c=50MPa	f'c=25MPa	f'c=32MPa	f'c=40MPa	f'c=50MPa	Adeq/Int/Insu
6000	79	100	126	157					180/180/180
5000	406	520	650	812	235	300	376	469	180/180/180
4500	548	701	876	1,095	376	481	602	752	180/180/180
4200	625	800	1,000	1,251	454	581	726	908	180/180/180
3900	698	893	1,116	1,395	526	674	842	1,053	180/180/180
3600	765	979	1,223	1,529	593	759	949	1,187	180/180/180
3300	826	1,058	1,322	1,653	655	838	1,048	1,310	180/180/180
3000	883	1,130	1,412	1,765	711	910	1,138	1,422	180/180/180
2900	900	1,152	1,440	1,800	729	933	1,166	1,458	120/120/120
2800	917	1,174	1,467	1,834	746	955	1,193	1,491	120/120/120
2700	933	1,195	1,494	1,867	762	975	1,219	1,524	120/120/120
2600	949	1,215	1,519	1,899	778	996	1,245	1,556	120/120/120
2500	964	1,234	1,543	1,929	793	1,015	1,269	1,586	120/120/120
2400	979	1,253	1,566	1,958	808	1,034	1,292	1,615	120/120/120
2100	1,019	1,305	1,631	2,038	848	1,085	1,357	1,696	120/120/120
1800	1,054	1,349	1,687	2,108	883	1,130	1,412	1,765	120/120/120

180/180/180 FRL as an reinforced wall with minimum N12@440 Vert. and N12@450 Hor

120/120/120 FRL as an unreinforced wall

This is compared to the chart for a 150mm thick clay brick wall taken from the Think Brick Australia document Design of Clay Masonry Walls for Fire Resistance which shows the variation in structural adequacy with length and height.

Chart 4.
Structural Adequacy FRP (minutes) for 150 mm Clay Masonry Walls with Simple Supports on Four Sides



As previously mentioned the AFS Structural Wall Technical Manual states:

> "*Structural tests and past experience show that AFS Structural Walls achieve similar or greater FRL's.*"
> *"Please contact AFS on … for a comprehensive fire test report."*

The test report provided by AFS is titled FSV 1038 Fire-Resistance Test on a Load Bearing, Concrete Core, Framed Wall System dated 12 March 2004 by the CSIRO. On pages 2 and 3 of this report it states under Description of Specimen:

> *"The specimen comprised a reinforced concrete wall system of dimensions 2980mm high x 3000mm wide x 150mm thick made up of 3 prefabricated formwork panels filled with insitu concrete after assembly."…*
>
> *"The wall was reinforced with N12 reinforcing bars at 450mm centres, horizontally and vertically."*

Clearly it was a reinforced wall that was tested. The results achieved in this test relate only to walls of the same materials constructed in the same manner i.e. reinforced. Therefore, the test result cannot be applied to unreinforced walls which it strongly appears that AFS are doing in this instance. One can imagine that the CSIRO would have a problem with their report being used in this manner.

Apart from the incorrect use of AS 3700 and a CSIRO test report that cannot be applied to unreinforced walls, the Technical Manual also cites past experience as a basis for determining the FRL of these walls. One might wonder exactly what that past experience was. Have they measured the time for failure of these walls in a real fire situation? This is probably unlikely. Or are they trying to apply results from other wall types to this system. Whatever the answer, it seems that the stated FRL results for unreinforced walls cannot be justified.

For reinforced walls the AFS Structural Wall Technical Manual states:

> *"Reinforced AFS Structural walls may be designed to AS 3600 Section 5.7 Fire Resistance Periods for Walls."*

AS 3600 is the Australian Standard for Concrete Structures. Therefore, this would be the appropriate Standard for the reinforced AFS wall. Given that the correct Standard has been applied and that the CSIRO test is for a reinforced wall the quoted FRL results for reinforced AFS Structural Walls are acceptable. However, it should be noted that the design tables relate to reinforced walls only above certain walls i.e.

for AFS wall 150mm thick reinforcing starts at 3000mm wall heights,

for AFS wall 162mm thick reinforcing starts at 3300mm wall heights,

for AFS wall 200mm thick reinforcing starts at 3900mm wall heights.

For wall heights below these, which would be the majority of individual storey heights, the unreinforced AFS wall is used and the as previously discussed the FRL's quoted for unreinforced are suspect.

5. Acoustic Performance

The Building Code of Australia permits four different methods for demonstrating compliance of wall or floor system. These are:

a. Measurement of the system in an approved acoustic laboratory.
b. Use of deemed to satisfy system from the BCA.
c. Onsite verification by actual acoustic testing of the completed installation.
d. Expert judgement.

Each of the three main clay brick manufacturers have opted for the measurement of their wall systems in approved acoustic laboratory. This means that the stated results are valid for all applications of that particular wall system.

AFS are using the expert judgement method for demonstrating compliance. They have an Acoustic Performance Assessment by PKA Acoustic Consulting. This assessment is based on one laboratory test of the 162mm thick wall that was not finished for painting, tests on pre-cast concrete panels and an unspecified number of onsite tests of completed installations. Whilst the expert judgement option is valid it could be argued it is one expert's opinion compared to the objective results from the acoustic laboratory testing. The expert judgement is based on the available information and the expert's opinion. It has occurred in the past that the experts are not correct every time. For a long time PKA Acoustic Consulting maintained that the

direct-stick method of applying plasterboard to a masonry wall increased the acoustic performance of the wall. This was based on the logic that increasing the mass of the wall would improve the performance. However, acoustic laboratory testing undertaken by Austral Bricks proved conclusively that the direct-stick method was detrimental to the acoustic performance as there were reverberation effects form the air gaps where the adhesive cover was incomplete. The expert had to change his opinion because of the laboratory testing.

The acoustic data in the AFS Technical Manual does not state how the wall is to be finished in order to achieve the stated results. Should the wall be finished with a skim coating and painting or can it be finished with direct stick plasterboard? Neither the acoustic assessment nor the AFS Technical Manual discusses the deleterious acoustic effects of using direct stick plasterboard as an option for finishing. These types of omissions mean that the data on which a selection decision is based may well be incorrect.

6. Cost Comparison

The pro forma letter supplied by AFS states:

> *"Indicative price for a 152mm AFS Logicwall, including supply, installation, concrete infill… $165/m^2 (excludes freight & wall finishing)."*

The wall finishing required would be at the least a skim coat to provide a suitable finish for painting. The freight costs obviously depend on the number of panels able to be delivered to the job at any one time. These two combined might add say $10/ m^2 to give a finished cost of approximately $175/m^2.

The comparable installed cost of 150mm clay brick wall rendered both sides ranges from approximately $90 for three storey walk up applications to $135/ m^2 for high rise residential (the variation is in the bricklaying cost). This wall system will meet all the FRL and acoustic requirements under the BCA for these applications. This is significantly cheaper than the AFS wall system for three storey walk up applications and marginally cheaper in high rise. However, this is countered by the speed with which the AFS can be erected as it will be faster than conventional bricklaying followed by rendering. The cost benefit of either clay bricks or AFS wall could only be determined on a project by project basis.