



## **THE FIRE RESISTANCE OF CEILING/FLOOR SYSTEMS COMMONLY FOUND IN HERITAGE BUILDINGS**

### **Introduction**

The Fire, Access and Services Panel, a subcommittee of the Heritage Council, is often asked to comment on ways of keeping the ceilings in heritage buildings uncovered when local councils require them to be upgraded to resist fire. The conventional method of upgrading usually involves applying layers of fire-rated plasterboard to the underside of the floor or roof structure above, often concealing decorative or significant heritage features.

In 1993 the Heritage Branch of NSW Department of Planning (now the NSW Heritage Office), which provides the administrative support for the Heritage Council, funded a study of lath and plaster ceilings in NSW. The study surveyed the geographical distribution of lath and plaster ceilings, and arrived at a representative sample of the construction of the ceilings, known as the "NSW Lath and Plaster Ceiling". The study also looked at overseas research into the fire resistance of lath and plaster ceilings and a possible means of upgrading the resistance without concealing the underside of the ceilings.

Stage 2 of the study involved the fire testing of lath and plaster ceiling/floor systems and the proposed method of upgrading. The testing was extended to the fire upgrading of other ceiling/floor systems commonly found in heritage buildings such as fibrous plaster, pressed metal and tongue and groove timber boarding.

### **Design of the Floor Construction for the Fire Test Specimens**

The specimens were designed to represent a "worst case" scenario in terms of timber species and floorboard type. The timber sizes and spacings were based on the "NSW Ceiling" determined by the survey of typical ceilings in the Lath and Plaster Ceiling Study.

The flooring consisted of 100mm x 19mm cypress pine boards butt jointed and nailed to the joists. The floor structure consisted of 250mm x 50mm oregon joists, simply supported at 450mm centres. The joists were strutted at their ends with solid blocking and at mid span with 50mm x 50mm herringbone strutting.

All timber had a moisture content of 15%. The majority of floor/ceiling constructions in heritage buildings consist of well seasoned hardwood joists which should perform better than the test samples.

Full scale specimens had a uniformly distributed load of 5kPa, while the pilot specimens were unloaded.

## The Fire Resistance of a Traditional Lath and Plaster Ceilings/Floor Systems

One aim of the study was to determine the fire resistance performance of a traditional lath and plaster ceiling.

A full scale lath and plaster sample was tested by CSIRO in accordance with Australian Standard 1530, Part 4 - 1990.

To install the ceiling 24mm x 6mm sawn oregon laths were nailed to the joists with 10mm spacing between laths.

The plaster was applied in 2 coats plus a set coat to give a total thickness of 14mm below the laths and bulbs 12mm above. A standard 1:3 (lime:sand) mix was used. Teased cow hair was added to the first coat at a rate of 11.5kg/m<sup>3</sup>.

The specimen described satisfied the following results for the resistance for the periods stated:

Structural Adequacy -	no failure at 36 minutes
Integrity -	22 minutes
Insulation -	22 minutes

In terms of Resistance to Incipient Spread of Fire the following results were obtained:

Underside of laths -	8 minutes
Underside of joists -	18 minutes
Mid height of joist -	22 minutes
Top of joist -	24 minutes

Resistance to Incipient Spread of Fire (ISF) is only relevant when the floor/ceiling, or parts of it, extend horizontally through from one fire compartment to another. For lath and plaster ceilings, if the laths extend through to the adjacent fire compartment, the resistance to ISF is 8 minutes. If only the joists extend through, and the laths stop at the fire barrier, the resistance to ISF is 18 minutes.

From the results of the Fire Test the Fire Advisory Panel concludes that traditional lath and plaster ceilings in reasonably sound condition can give an acceptable level of fire safety for buildings of 3-4 storeys **where additional fire safety measures such as early warning systems or sprinklers are installed**. Minor penetrations should be kept to a minimum and well sealed with fire resisting material and are subject to approval.

An architect experienced in heritage conservation can determine whether the lath and plaster ceiling in your building conforms with the specifications for the test specimen.

## **Achieving a Fire Resistance Level of 60 Minutes for Ceilings Commonly Found in Heritage Buildings.**

As a result of a series of full scale and pilot tests carried out in 1994 (which resulted in CSIRO opinion No. FCO- 0805) the Fire Advisory Panel can now recommend an upgrading method for the following ceiling types to achieve a Fire Resistance Level (FRL) of 60/60/60:

- Lath and Plaster
- Fibrous Plaster
- Pressed Metal
- Tongue and Groove Timber Boarding.

The ceilings must be in a reasonably sound condition with a minimum of service conduits and penetrations.

The upgrading method involves the installation of a foamed vermiculite mix from above the ceiling. A proprietary material known as FOAMED VERMITEX has been successfully tested and is available from:

L & A Fazzini Pty Ltd (LAF)  
23-25 Wentworth Street  
GREENACRE NSW 2190  
Tel. (02) 9642 4745, 9642 8931  
Tel: (02) 9742 5164  
[www.lafgroup.com](http://www.lafgroup.com)

The material must be installed by LAF or a licensed installer in accordance with LAF specifications.

The upgrading system involves the removal of 1-2 floorboards at approximately 1.2 metre centres. Reinforcement is then inserted consisting of a 50mm wide by 0.8mm "U-shaped" steel straps spanning from joist to joist. The base of the U lies on the ceiling lining with the uprights fixed with 38mm nails at least 100mm above the top side of the ceiling lining. The straps should be at a maximum of 1400mm centres. In addition a 6mm steel rod is threaded mid way between the joists, supported by the straps (see the diagram below).

Foamed Vermitex is then pumped into the voids between the joists to a depth of 70mm above the top of the ceiling lining (top of the bulbs in the case of lath and plaster) and/or the top of any service pipes or conduits running on the top of the ceiling.

Services which penetrate the floor/ceiling system must incorporate an approved fire stopping system or must be enclosed in fire resisting shafts with a minimum FRL of 60/60/60.

## **Preparation for Upgrading**

Ceilings and the floor or roof structure should be inspected by an architect or builder experienced in heritage conservation before the application of Foamed Vermitex by a licensed operator is considered.

The spaces between the floor or ceiling joists should also be inspected for significant deposits of archaeological relics such as coins, bottles, etc. Where such relics exist, seek the advice of the Heritage Branch, Department of Planning on (02) 9391-2115.

Obstructions which are not part of the floor/ceiling system or which are not essential services installed in accordance with Australian Standards, should be removed.

Lath and plaster ceilings may be stabilised with the "Westox Ceiling Reinstatement System" before the application of Foamed Vermitex without an adverse effect on the fire safety of the floor/ceiling system. (Two bays of the full scale specimen ceiling were sprayed with the Westox system prior to upgrading without any negative effects during the fire test).

Lathe and plaster and fibrous plaster ceilings should have minor penetrations patched and all junctions with walls and ducts sealed with a 1:3 plaster mix.

Pressed metal ceilings should have badly corroded sections replaced and minor penetrations patched with a non-combustible filler.

Timber boards, which have been subject to insect attack or rot, should be epoxy injected or replaced to match existing.

Where a ceiling has deteriorated to such an extent that its structural integrity has failed then the ceiling should be replaced. In such situations alternative fire upgrading solutions may be considered such as the application of fire resisting plasterboard which can then have decorative ceiling linings re-applied below.

## **Curing and Certification of Foamed Vermitex**

The Foamed Vermitex will probably take at least 6 weeks to cure following installation before the FRL of 60/60/60 is achieved.

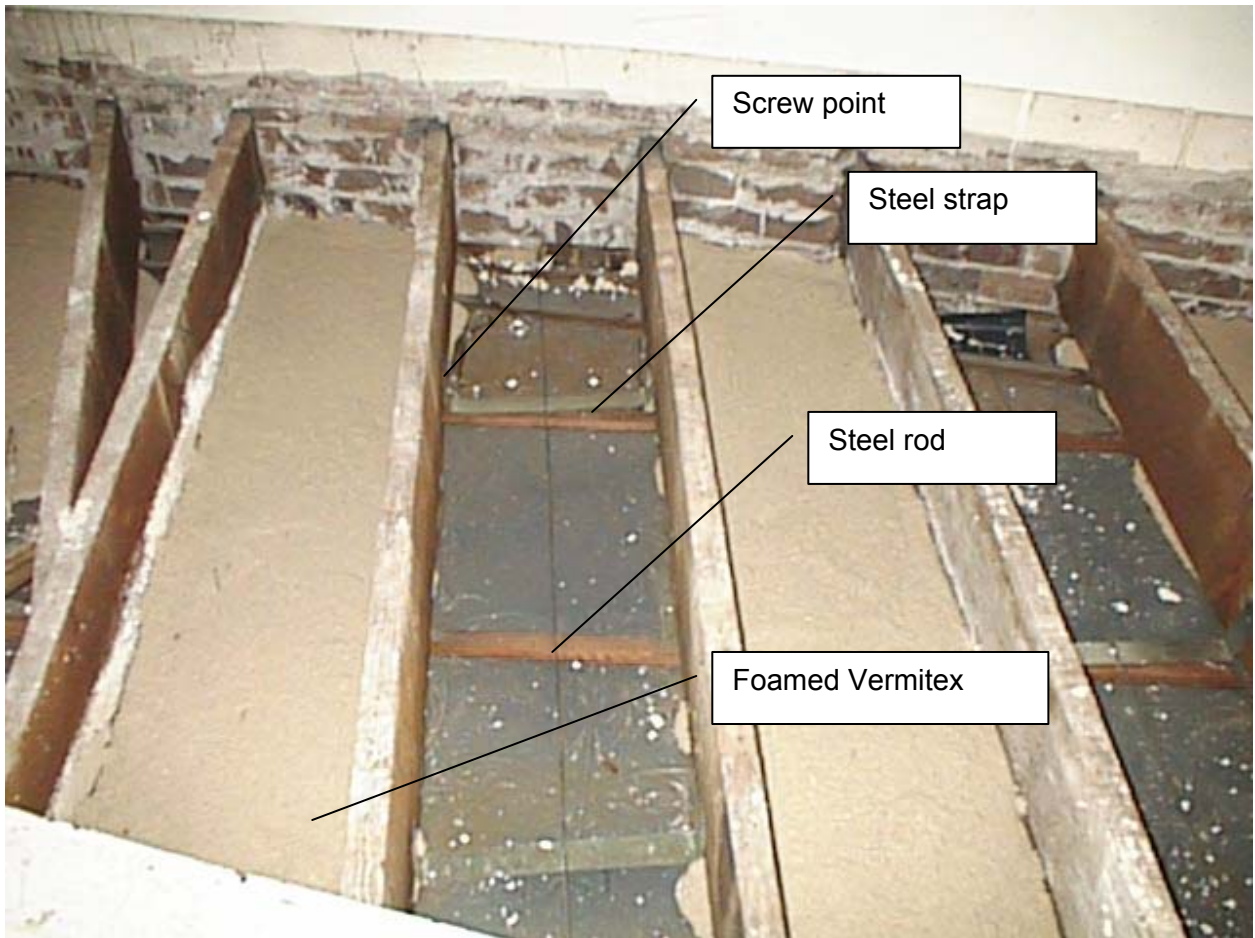
LAF or the licensed installer shall certify the ceiling when the correct water content of the Foamed Vermitex is reached, provided the correct installation procedures have been followed.

## **Further Information**

Further information and copies of the Fire Test Certificates may be obtained from:  
Fire Access & Services Advisory Panel  
NSW Heritage Office  
Locked Bag 5020  
PARRAMATTA NSW 2124

Telephone (02) 9873 8572

Facsimile (02) 9873 8599



ABOVE: THE APPLICATION OF "FOAMED VERMITEX" TO GIVE A FIRE RESISTANCE LEVEL OF 60 MINUTES TO HERITAGE CEILINGS.

Note: pressed metal and tongue ceiling shown in this diagram. The proposed upgrading method is also applicable to fibrous plaster, Lath and Plaster and groove timber boarded ceilings.

*Certificate of Test* No. 506

This is to certify that the element of construction described below was tested by the CSIRO Division of Building, Construction and Engineering (now CSIRO Manufacturing and Infrastructure Technology) in accordance with Australian Standard 1530, Methods for fire tests on building materials, components and structures, Part 4-1990, Fire-resistance tests of elements of building construction, on behalf of

NSW Heritage Office  
Locked Bag 5020  
PARRAMATTA NSW 2124

L & A Fazzini Manufacturing Pty Ltd  
23-15 Wentworth Street  
GREENACRE NSW XXXX

**A full description of the test specimen and the complete test results are detailed in the Division's report. FSH 0262**

**Product Name:** Foamed Vermitex Upgrading for lath and plaster ceilings.

**Description:** The specimen comprised of a lath and plaster ceiling fixed to a timber floor and upgraded with "Foamed Vermitex". The floor/ceiling specimen was 4970mm x 4020mm and the area of the specimen which was exposed to the fire was 4560mm x 3660mm. The floor comprised 250mm x 50mm oregon joists at 450mm centres. The joists were strutted at their ends with 250mm x 50mm solid blocking and at mid span with 50mm x 50mm herringbone strutting. The flooring consisted of 100mm x 19mm cypress pine boards butt jointed after the removal of the tongues. The boards were cramped and nailed to the joists. The laths were 34mm x 6mm of sawn oregon nailed with 25m x 1.6mm nails and spaced out leaving 10mm gaps between laths. All timber had a moisture content of 15%. The plaster was a standard 1:3 mix containing 11% CaO approximately and was applied in two coats and a finishing set coat resulting in a total thickness below the laths of 14mm and an average height of bulb of 12mm above the laths. The two northern bays were sprayed from above with "Westox Ceiling Reinstatement System." The "Foamed Vermitex" was supplied and placed by L & A Fazzini Manufacturing Pty Ltd. Two floor boards were removed every 1200mm to 1400mm and the Foamed Vermitex pumped into the floor/ceiling space to an average thickness of 70mm above the lath and plaster ceiling bulbs. The floor was simply supported over a 3660mm span and carried a Uniformly distributed load of 5kPa. Construction is detailed in the following:

- Drawings numbered HCO1 & HCO2, dated 24 December 1992, by CSIRO Division of Building, Construction and Engineering.
- Specification title "Foamed Vermitex Timber Floor Test for the Fire Access & Services Advisory Panel, Heritage Council of NSW, Lath and Plaster Ceiling Study - Stage Two Fire Testing", dated 11 May 1993, by L & A Fazzini Manufacturing Pty Ltd.

The element of construction described above satisfied the following criteria for fire-resistance for the period stated.

Structural Adequacy -	no failure at 66 minutes
Integrity -	65 minutes
Insulation -	58 minutes

And therefore for the purpose of Building Regulations in Australia achieved a FRL of 60/60/30

Testing Officer: L B Retson Date of Test: 29 September 1993  
Issued on the first day of March 1994 without alterations or additions.