

CONSERVATION GUIDELINES  
TECHNICAL SUPPLEMENT



UNDERSTANDING  
THE ROOFS

July 1997

SINGAPORE

# CONSERVATION GUIDELINES TECHNICAL SUPPLEMENT



## UNDERSTANDING THE ROOFS

July 1997



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## INTRODUCTION

The majority of the roofs of conservation buildings are pitched roofs. These also exist a minority of buildings with flat roofs. Most of the pitched roofs are finished with small size V-profile or flat interlocking unglazed terra-cotta clay tiles. These traditional roofscapes add to the vibrancy of the cityscape by providing contrast to the form, scale and texture of the modern buildings. It is important that the authenticity of this element in terms of materials, form and construction be retained during restoration.

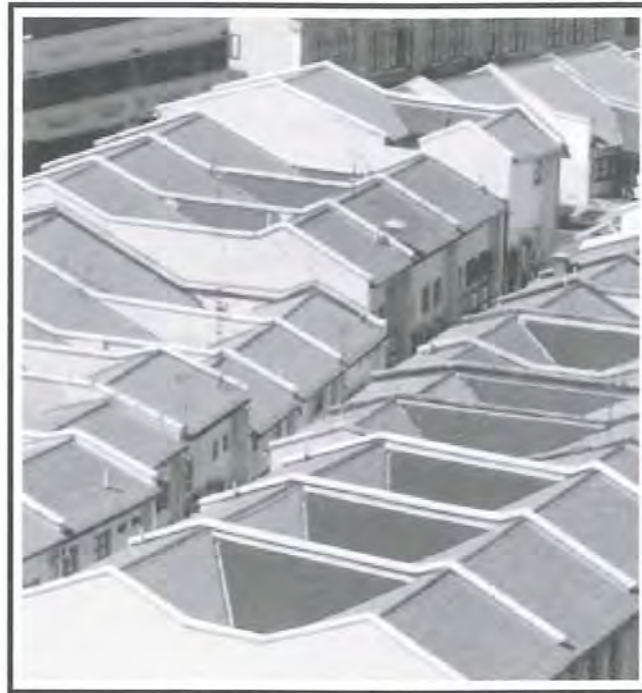


Fig 1: The double-pitched roofs with small size V-profile, unglazed terra-cotta clay tiles.

### Types of Pitched Roofs

The main roofs of conservation buildings are usually double-pitched roofs. The other types of pitched roofs that are found in conservation areas are clerestorey roofs, jackroofs and ornamental green-glazed canopies. These types of roofs, though dissimilar in form and construction, have the same function, that is to provide a shelter over the shophouse and its elements. (See Fig 1 - 4)



Fig 2: The double-pitched jackroof with roof tiles similar to that of the main roof.




Fig 3: The ornamental green glazed canopy at the front facade is a traditional feature of the shophouse.



Fig 4: The cityscape is enhanced by the form, scale and texture of the traditional roofscape, contrasting with that of the modern buildings.





TEMPORARY  
PROTECTION  
AND  
STABILISATION

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Temporary protection may be necessary to prevent further damage or deterioration of the roof. A dry environment, well protected from the weather elements, is required for restoration works to proceed. There is a need to provide adequate weather protection to prevent rainwater penetration and decrease the rate of deterioration of the internal elements, walls and facade features. Upon the removal of the existing roof covering and gutters, a temporary scaffolding, encased or covered with tarpaulin sheet should be erected over the entire roof. Proper drainage through the use of temporary gutters would ensure that there is no flooding within the building envelope during restoration. Upon the completion of the roof, the temporary cover is then removed. (See Fig 5 and Fig 6)

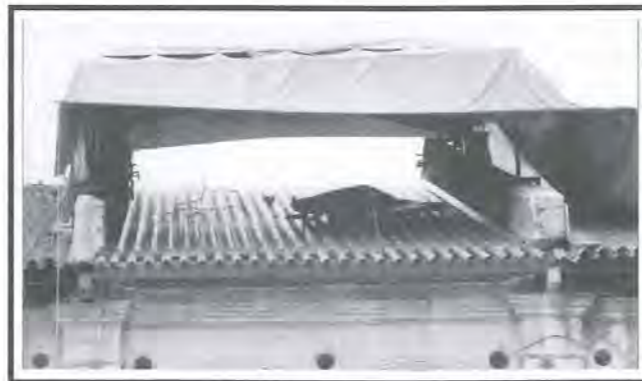


Fig 5: The temporary scaffolding, encased or covered with tarpaulin sheet, is erected over the entire roof upon removal of the existing roof cover.

Fig 6: The temporary protection is removed upon the completion of the restoration works on the roof. This is followed by the restoration works on the other elements of the shophouse.



Proper measures should be taken to ensure the structural stability of the entire building before the restoration process. Shoring and lateral bracing of the structure should be carried out, and the existing timber floor joists should not be removed at this stage in order to maintain the lateral stability of the partywalls. As the timber roof purlins serve as lateral restraints to the party wall, the decayed roof purlins should be replaced and repaired on an elemental basis, i.e., only one or two purlins should be removed and replaced at any one time, so as not to affect the lateral support of the partywalls.

(See Fig 7)

Fig 7: Lateral bracing of the structure, retention of the timber floor boards and joists, and replacement of timber roof purlins on a elemental basis will help to maintain the lateral stability of the partywalls during restoration.







## ROOF STRUCTURE

### Assessment

Before restoration works begin on site, careful visual inspection of the existing roof timber support structure should be carried out to determine the extent of decay and structural damage due to various factors such as termite infestation, water penetration, and fungal attack. Areas of rot normally occur at the joints between the roof timber members and the walls. In addition, the type of timber has to be determined and a sample of the timber taken to assess its inherent strength. The use of physical probes on small sections of the less deteriorated timber supports would indicate the breakdown of the timber strength due to decay. (See Fig 8 - 9)



Fig 8: Visual inspection of existing roof support structure should be carried out to determine the extent of decay and structural damage.

Fig 9: Decayed roof timber members, some of which require replacement while others require strengthening.



### Retention and Restoration

Upon the assessment of the timber members for structural soundness, the timber that can be retained should be reinforced through the use of epoxy resin glues or steel reinforcement. After proper cleaning of the timber surfaces, the timber should also be properly treated against any fungal or termite attack with termite resistant paint. The ends of the timber members should be re-treated with an anti-termite paint before being embedded in the partywall.

### Strengthening

The parts of the timber members partly destroyed by rot can be reformed in-situ without extensive reconstruction. This will ensure the reinstatement of the load-bearing capacity of the decayed beams. The use of repair joints at the decayed heads or feet of rafters, and galvanised steel angle plates screwed at the feet of rafters onto the wall plates for strengthening the connections are some ways of repairing and strengthening the old timber structure. (See Fig 10)

### Replacement

Retention of the existing timber may not always be possible as the condition of the element may indicate the need for replacement. The selection of appropriate replacements would depend on the durability, strength, availability and cost of the type of timber. The commonly used timber types would be kapur, chengal and balau. Replacement of the decayed members should be carried out on an elemental basis to ensure the structural stability of the roof during restoration. (See Fig 11)

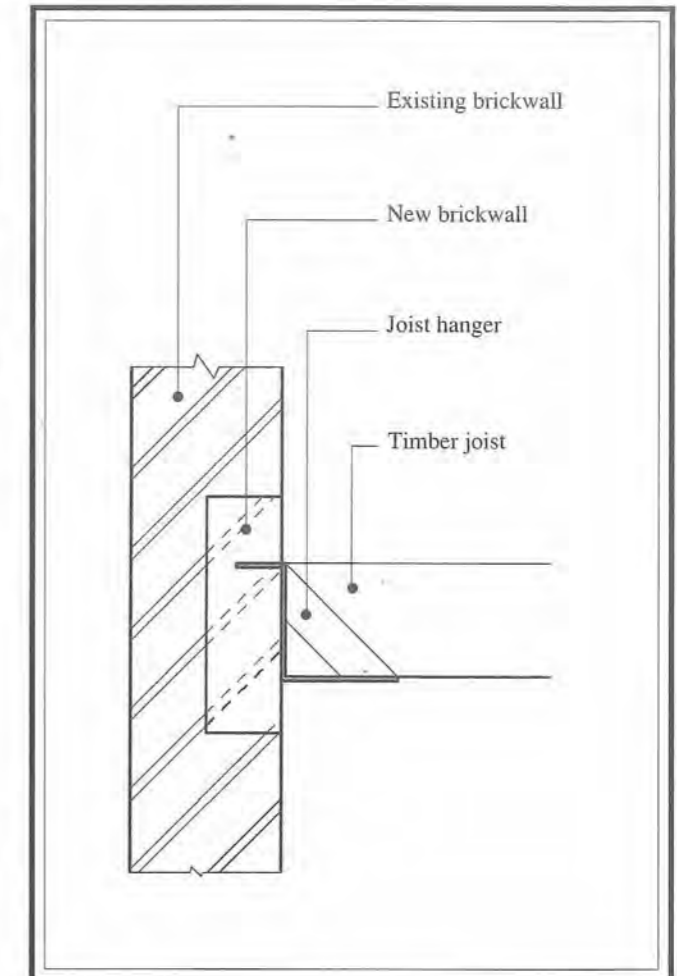


Fig 10: The use of repair joints at the areas of decay of the timber members. These areas of decay normally occur at the joints between the timber members and the walls.

Fig 11: The replacement of the roof timber structure carried out under the temporary protective cover.







ROOF TILES

## Assessment

Visual inspection of the roof tiles would determine the extent of retention and replacement of tiles. The existing old roofs either retain their original tiles or have asbestos sheets or zinc sheets as coverings. The latter are to be replaced with V-profile or flat interlocking clay tiles.

Existing roof tiles should be retained if they are in good condition. Selective replacement of damaged tiles should be carried out carefully to avoid further damage to the tiles on site. Total replacement of existing roof tiles would be required if most of the tiles are badly broken, damaged or beyond repair and cleaning.

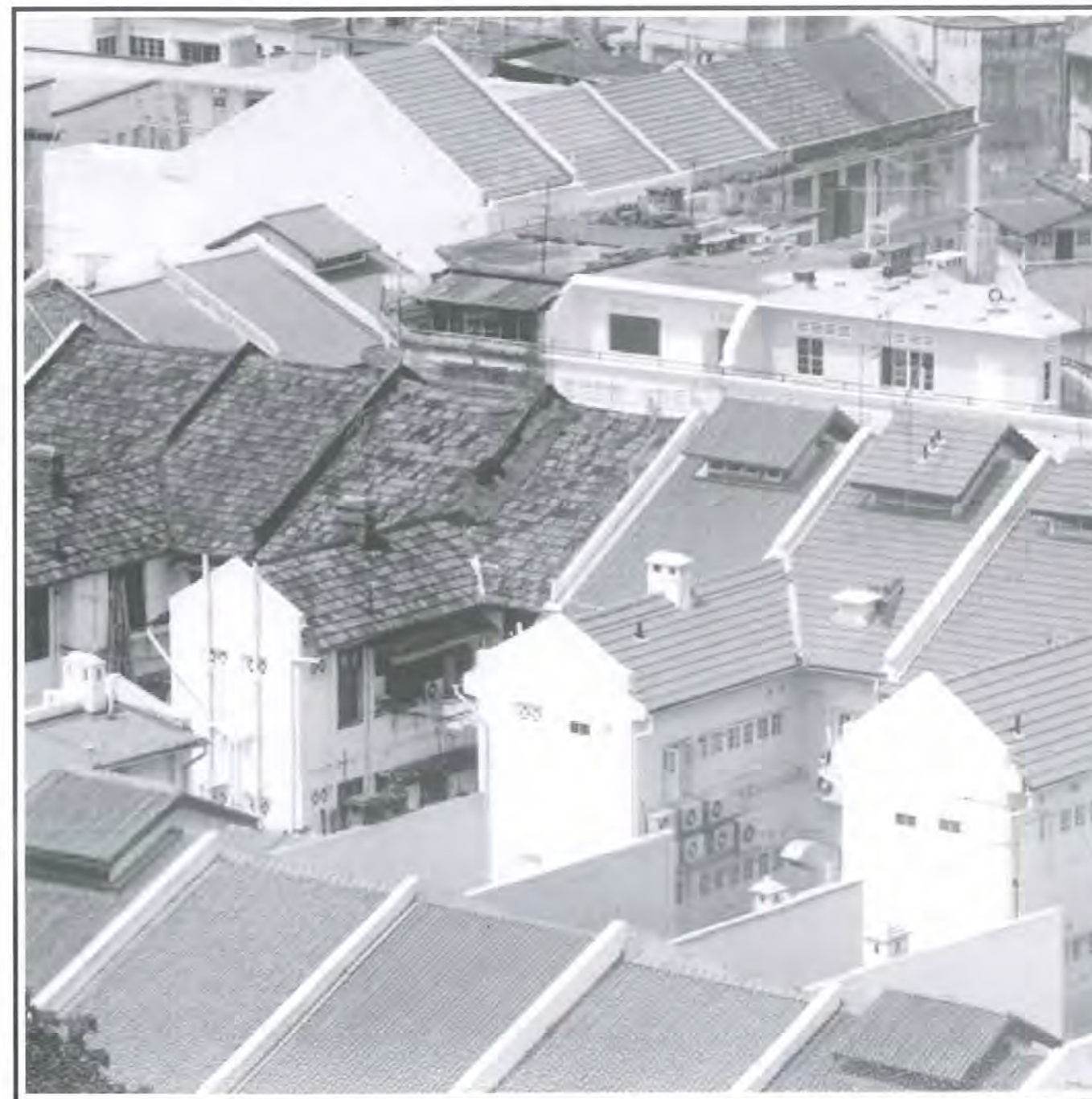
## Retention and Restoration

Where it is possible to retain the tiles, the least harmful method of removing the environmental grime and dirt from the tiles is to spray them with water before gently scrubbing the surfaces with appropriate cleaning agents. Abrasive methods of cleaning such as mechanical cleaning and acid-based cleaning, should be avoided as such methods would cause damage to the fireskin of the tiles.

## Replacement

When retention of the existing tiles is not possible, replacement is usually required. It is important to ensure that the profile and dimension of the new tiles match those of the existing tiles. Damaged areas of the roof tiles should be replaced with similar profile tiles. (See Fig 12)

Fig 12: Old roof tiles and coverings are replaced with new small size V-profile or flat-interlocking unglazed terra-cotta clay tiles.





In order to eliminate the leakage problems that are commonly found in traditional roofs, new improved construction methods and details, that are similar to the traditional construction methods, have been developed. They incorporate better quality materials and fixing details into the historic buildings.

#### New Construction Method\*(with the use of metal decking roof)

This new roofing system adopts a primary metal decking roof below, which helps to keep the roof leak-proof. The roof is also more structural as it is able to withstand additional loading. The metal deck follows the profile of the tiles, thereby creating a snug fit cradle for the tiles. The life of the galvaluminised steel decks can be increased through painting or by having proper metal coating of zinc or zincalume. (See Fig 13 - 15)

Fig 13: The laying of the tiles on the primary metal decking roof.

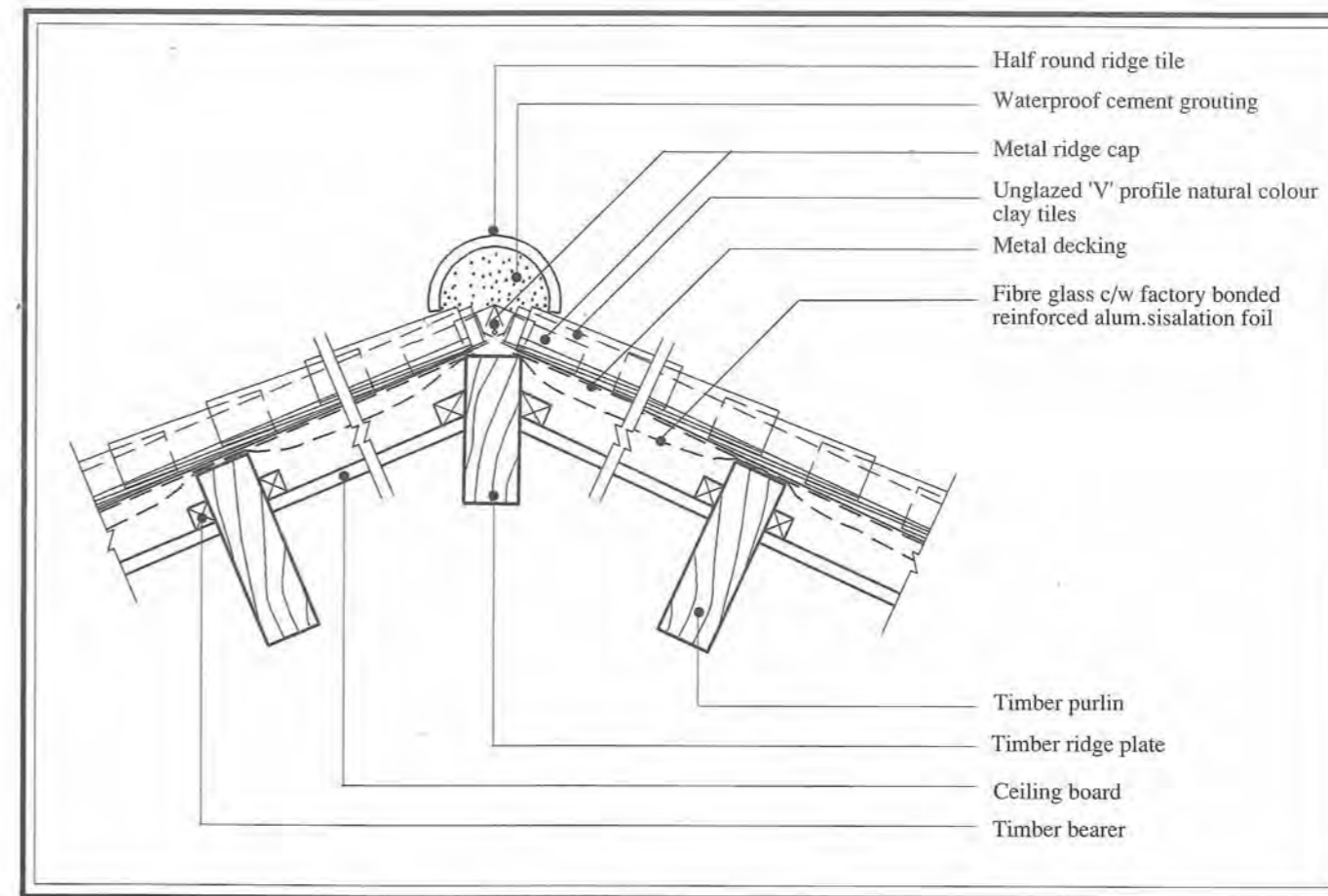
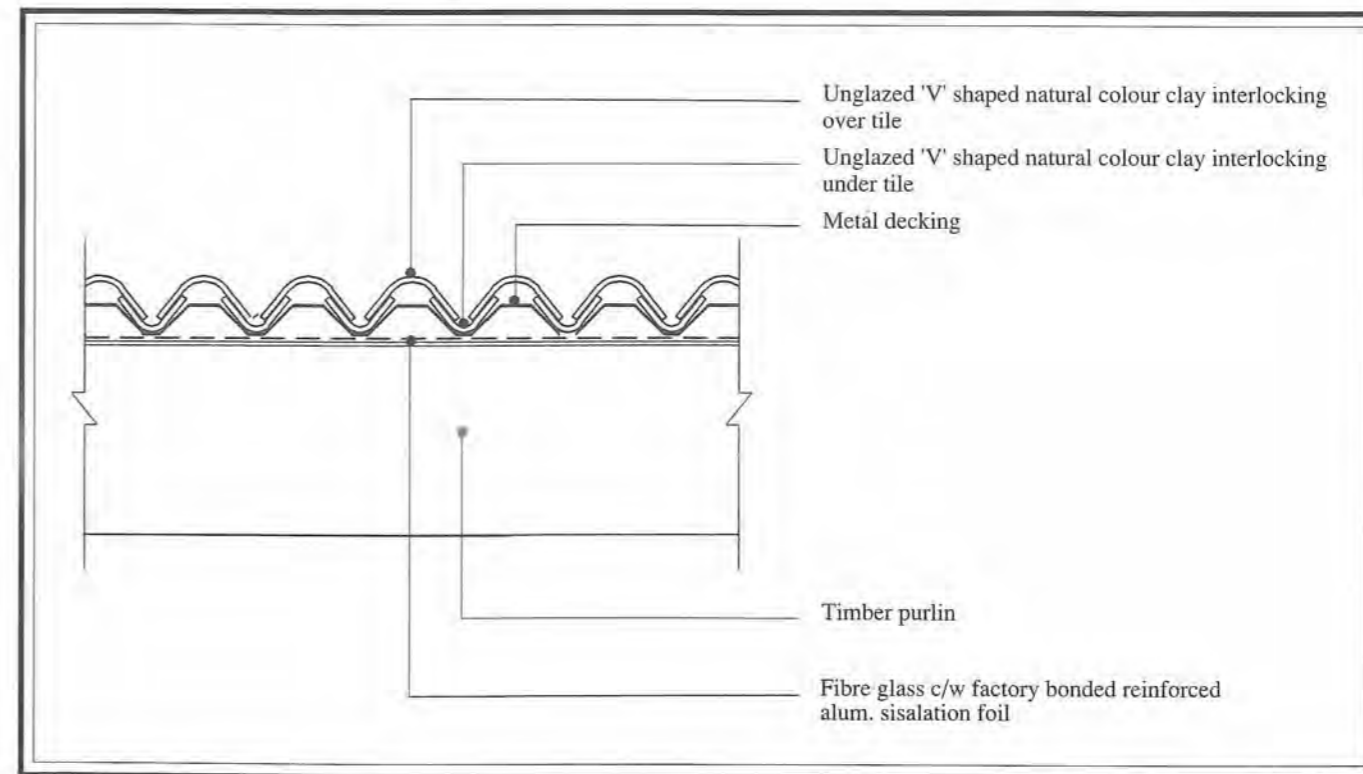


Fig 14: The use of the metal decking roof with insulation and ceiling board as a finish in a typical shophouse.

Fig 15: The metal deck provides a snug fit cradle for the tiles.







### New Construction Method (without the use of metal decking roof)

With improved technology, the traditional roof covering, without metal decking, has been re-adopted. This has also resulted in the improvements in the design of the new tiles. The tiles are now thicker so as to minimise breakage and longer to allow for larger overlaps, thus eliminating the problems of water penetration.

The new construction method includes the use of trapezoidal battens, in place of the metal decking, which also provides a snug fit for the roof tiles. This method attempts to eliminate the increased cooling load of the building as a result of the use of metal decking, which results in heat retention. (See Fig 16 - 19)

Fig 16: The use of galvanized nails properly sealed with silicon for fastening the tiles onto the trapezoidal battens.

Fig 17: The use of trapezoidal battens and longer tiles for better overlap.

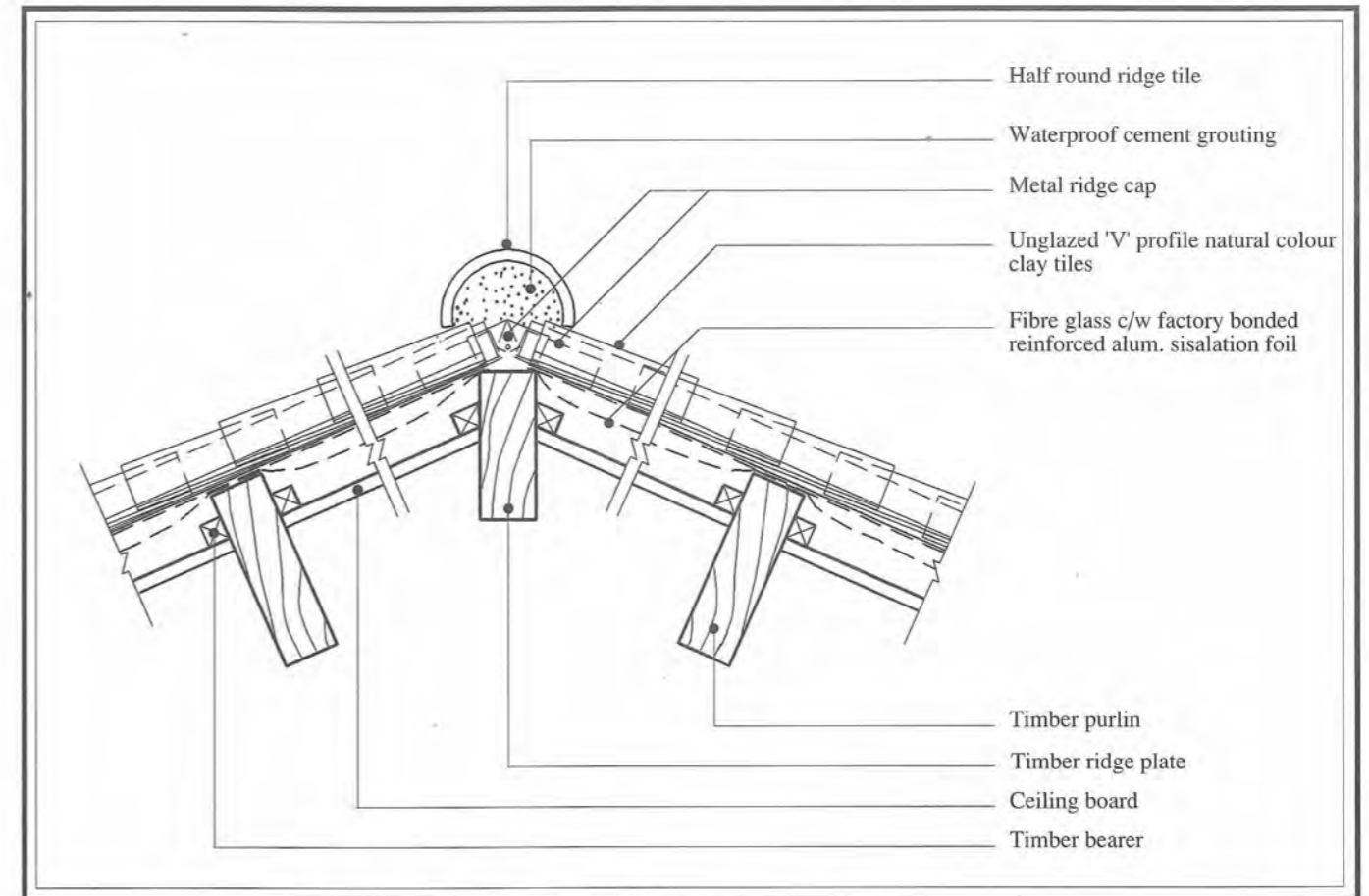
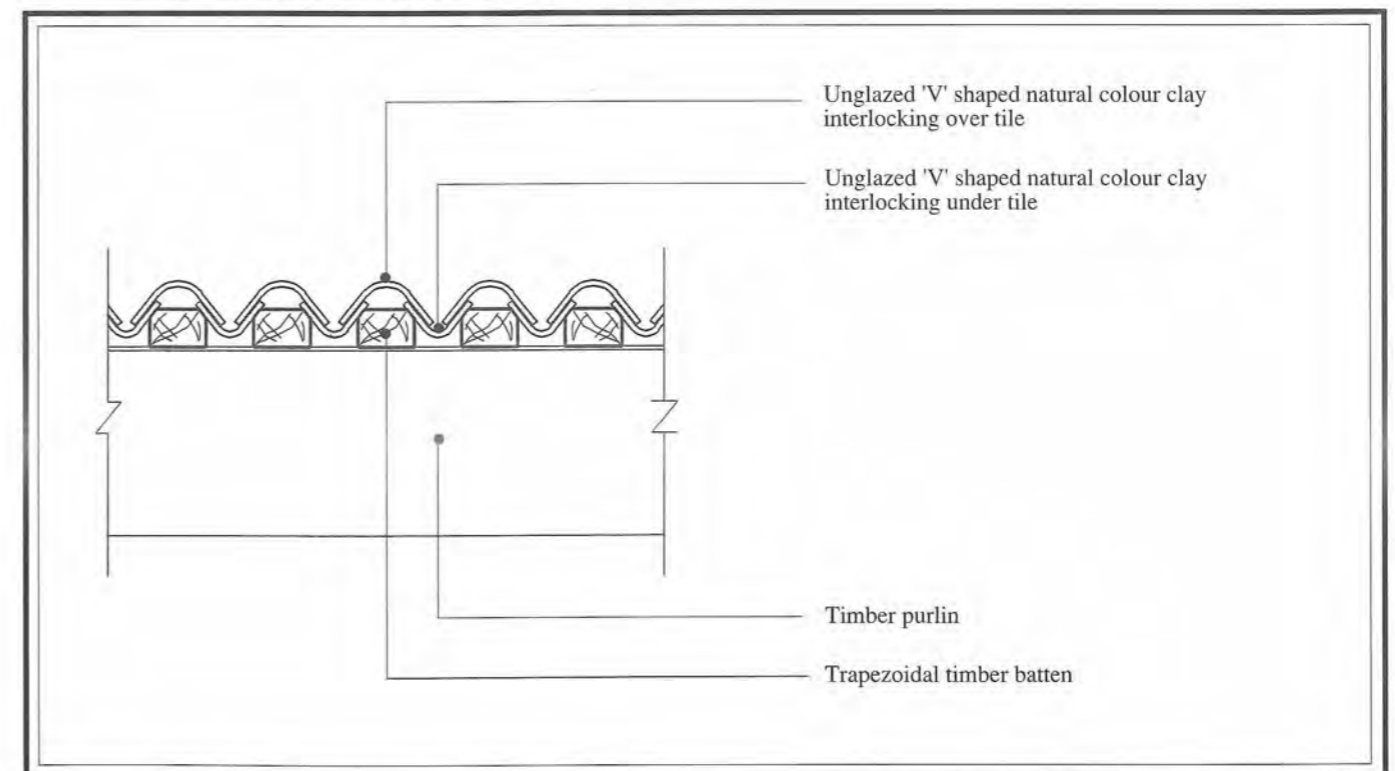


Fig 18: The construction of the traditional roof covering without the use of metal decking.

Fig 19: The use of trapezoidal battens in place of the metal decking roof, giving a snug fit for the roof tiles.





  
**FIRE SAFETY  
 REQUIREMENTS**

In order to meet current fire safety requirements, the existing timber members (when reused) have to be treated with fire-retardant paint. New timber structures have to be impregnated with fire-retardants by pressure treatment in a factory.

Fire safety measures include extending the firewalls (to a minimum requirement of 300 mm) on both sides of the shophouse to prevent the spread of fire to adjacent units. (See Fig 20 & 22)

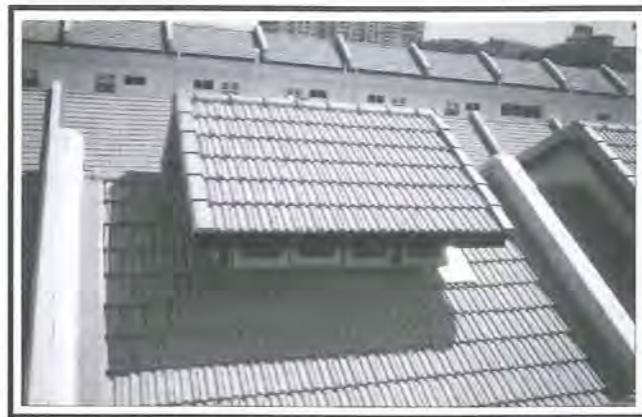
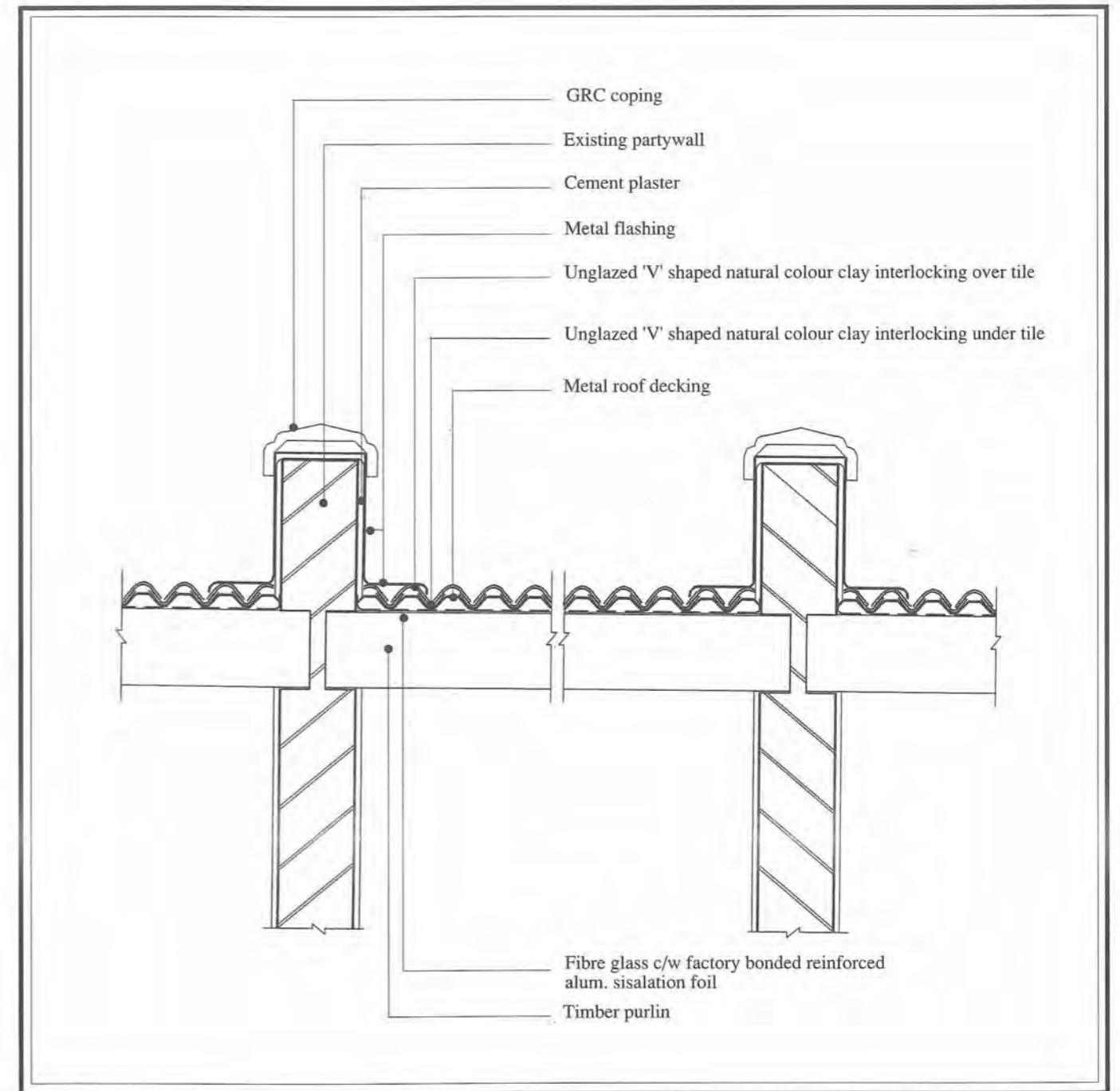


Fig 20: Extended partywalls above the roofs serve to prevent the spread of fire between shophouse units.

Fig 21: The firewalls also contribute to the scale and texture of the roofscape in conservation areas.



Fig 22: The extension of the partywalls on both sides of the roof acts as a fire-breaking device.







MAINTENANCE

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### Regular Checks

The general maintenance of tiled roofs consists of preventing the growth of mosses or lichens and of tending to gutters, flashing and ridges. Periodic inspections of the underside of the roof may reveal leaks in their early stages which can be eliminated at minimal costs.

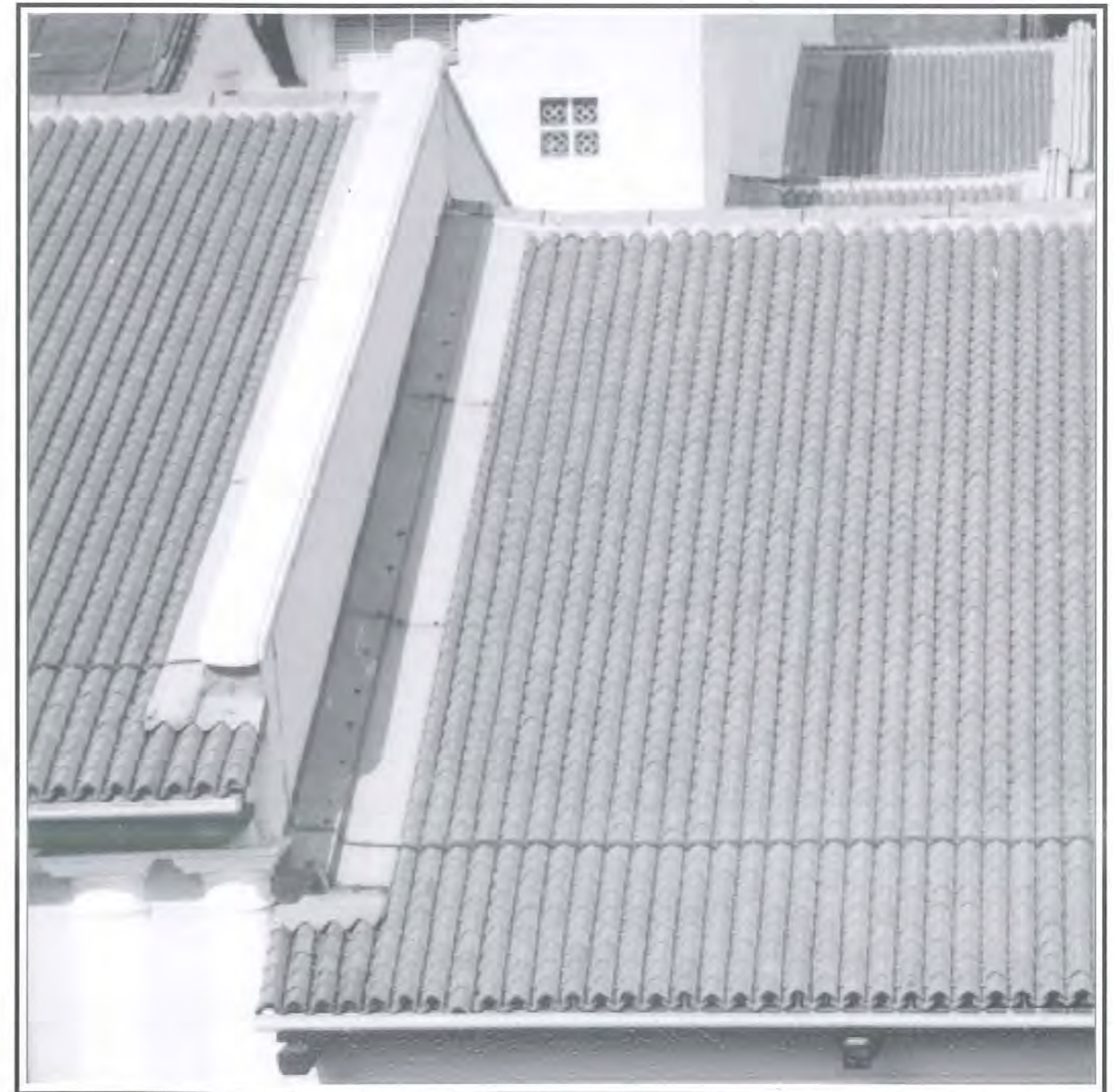
### Installation of Lightning Conductors/ Antennae

It is important to note that measures should be taken for workmen to step on proper supports during the installation of lightning conductors and antennae. This is necessary to avoid applying load at tile joints or the side of tiles as this will cause the tiles to break, thereby increasing the tendency for leakage problems to occur. Lightning conductors should be located along the partywalls and on the ridge of the main roof. During the installation, any puncture should be sealed for water tightness. (See Fig 23 - 24)

*Fig 23: The laying of the lightning conductor along the partywalls and on the ridge of the main roof.*



*Fig 24: The use of flashing at the connection between the roof and the partywalls serve to prevent water penetration of the roof. In cases where metal ridge cap is used for the main roof, the lightning conductors can be installed along the building line of the shophouse.*





Restoration techniques should take into consideration original materials and methods of construction, in order to preserve the historic integrity and appearance of the conservation building. New methods and techniques should only be used where they have proved themselves over a sufficient period of time, and where traditional alternatives cannot be found. In deciding whether to adopt new methods and techniques, it will be necessary to balance the degree of benefit to the building in the long term against any damage which may be caused to its historic integrity or appearance. (See Fig 25 - 27)



## CONCLUSION

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Fig 25: The restored roofscape in Boat Quay.

Fig 26: The restored roofscape in Clarke Quay.



Fig 27: The restored roofscape in the Historic District of Chinatown

