

Renovation of Buildings using Steel Technologies (ROBUST)

RFCS Project RFSR-CT-2007-0043

WP 3.1

Review of roof-top extensions using light steel construction

Date: 2008
Author: Mark Lawson

ROOF-TOP EXTENSIONS USING LIGHT STEEL CONSTRUCTION

Introduction

Over-roofing is the general term used to describe the installation of a new roof on an existing building. Roof-top extensions combine over-roofing with the creation of new habitable space.

The primary reasons for over-roofing are:

- to reduce heating by improving thermal insulation
- to arrest deterioration of the existing (generally flat) roof
- to overcome leakage problems (by a new pitched roof)
- to improve the appearance of the building
- to create new space for habitable use or building services
- to avoid disruption that is inevitable in the replacement of an existing roof

The economic motivation for over-roofing is mainly to increase the life of the existing building, and to reduce heating costs, but the cost : benefit 'balance' can be improved by new living space that can pay for the major part of the renovation work.

Steel technologies in over-roofing

Light steel framing is an ideal structural solution for over-roofing because it minimises the additional loading on the existing building, and can be pre-fabricated as 2-D panels or as 3-D modules. Load positions are aligned with the columns or load-bearing walls of the existing structure.

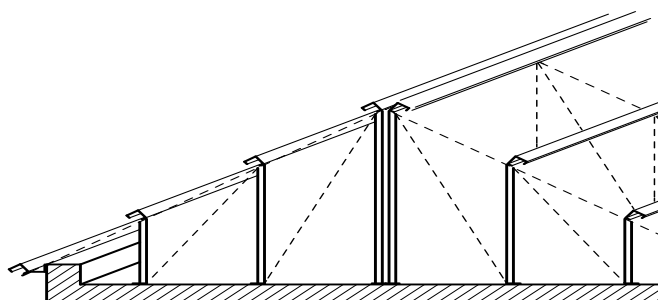
The steel technologies that may be used are:

- 'flat to pitched' roof systems using multiple props supported by the existing roof, so as not to locally over-load the roof
- closely spaced lightweight trusses spanning between façade walls or columns
- purlins or roof panels spanning between cross-walls
- widely spaced trusses with purlins
- steel portal frames (moment-resisting)
- steel beam grillages supporting a new lightweight structure
- modules supported by cross-walls or additional steel beams

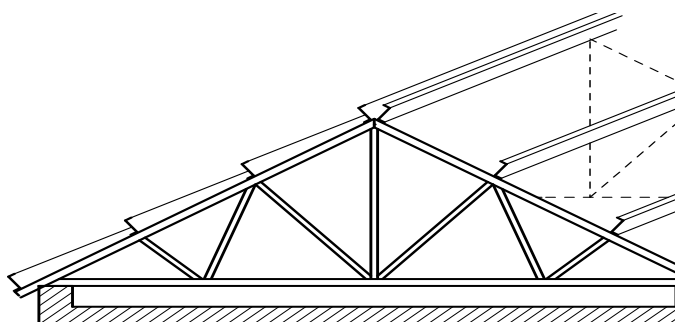
These technologies are illustrated in Figure 1 and Figure 2 . Over-roofing is often combined with over-cladding as part of a comprehensive renovation of the building. Many of these systems are presented in SCI publication 246⁽¹⁾ and Bouwen met Staal publication '*Bouwen Op Toplocaties*'⁽²⁾.

New floors can be installed as light steel panels or as individual joists generally supported by additional beams connected to discrete stub columns. The beams may be 'slim floor' type sections which support the floors within their structural depth in order to reduce the increase in the final overall building height.

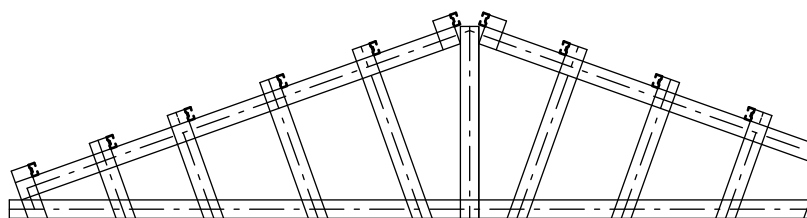
For a 6 storey concrete building, the addition of one new habitable floor will add less than 10% to the loads on the existing building, taking account of the lightweight nature ($< 1.5 \text{ kN/m}^2$ self weight) of the new structure.



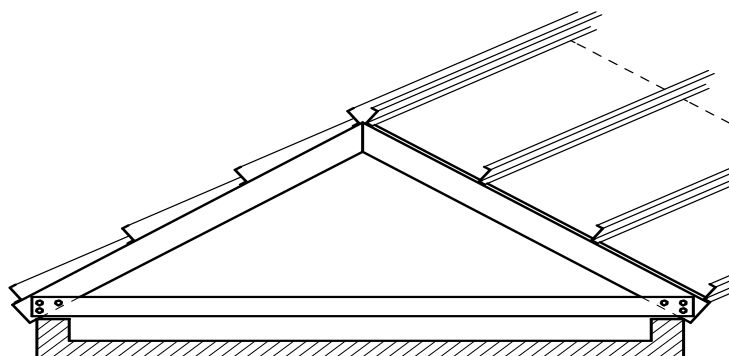
(a) Multiple props



(b) Roof trusses and purlins



(c) Specialist roof trusses



(d) Moment resisting 'open' truss

Figure 1 *Roof trusses for over-roofing projects*

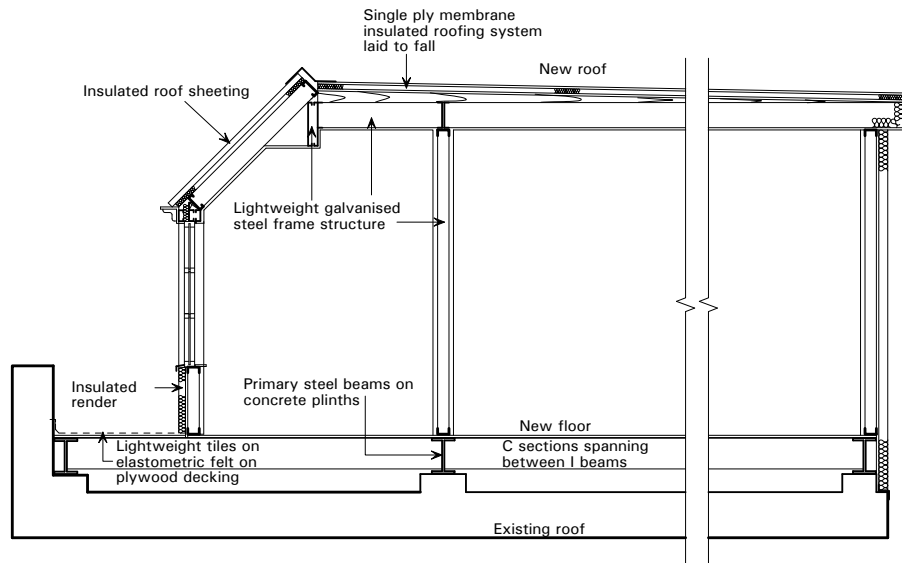


Figure 2 *New habitable roof space supported on I beam*

Examples of over-roofing projects

The following figures illustrate the various forms of over-roofing systems that may be used. The main components are the structure and roofing materials, which can take various forms. Figure 3 and Figure 4 show over-roofing of a single storey medical building.



Figure 3 *Over-roofing of a single storey hospital building*



Figure 4 Completed building (in Figure 3)

The Capella system consists of bolted light steel roof trusses with purlins spanning between, as shown in Figure 5. It is able to span up to 12 m between façade walls.



Figure 5 Capella system by Kingspan using light steel C sections

Roof-top extensions may be designed to match the existing building, as shown in Figure 6. In this case, the load-bearing light steel walls in Figure 7 were supported by the existing roof slab. A roof-top extension project in Rotterdam, called LageLand, was carried out without having to displace the occupants. The completed building is shown in Figure 8



Figure 6 *Two storey extension by Metsek to a residential building in London*



Figure 7 *Light steel framing for the new structure in Figure 6*



Figure 8 *Roof-top extension of a project in Rotterdam*

The roof-top extension may be part of an over-cladding project, as shown in Figure 9. In this project in Copenhagen, the new roof is supported by inclined tubular columns.



Figure 9 *Over-roofing and over-cladding of an existing 4 storey residential building in Denmark*

Two roof-top extension projects in Scandinavia are shown in Figure 10 and Figure 11 below.



Figure 10 *Roof-top extension of a residential building in Finland*



Figure 11 *Roof-top extension of Plannja building (Lulea, Sweden)*

The new roofing materials can be designed to give a more traditional appearance, as shown in Figure 12 below. The thermal insulation level required by modern roofing is as low as $0.15 \text{ W/m}^2\text{C}$ which may require up to 150 mm of mineral wool or 100 mm of polyurethane insulation boards.



Figure 12 *Composite panels with 'roof-tiles' used in refurbishment*

References

- 1 SCI Publication 246 *Over-roofing of Existing Buildings Using Steel*
The Steel Construction Institute, 1998
- 2 BMS Publication '*Bouwen Op Toplocaties*',
Bouwen met Staalk, NL, 2002