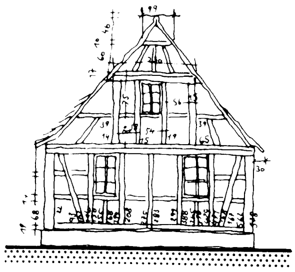
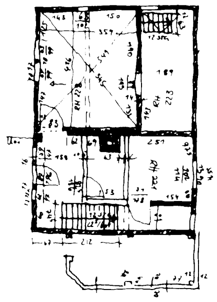
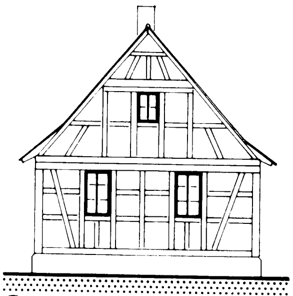
RENOVATION OF OLD BUILDINGS



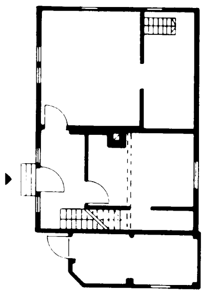
① Survey: measurement sketch



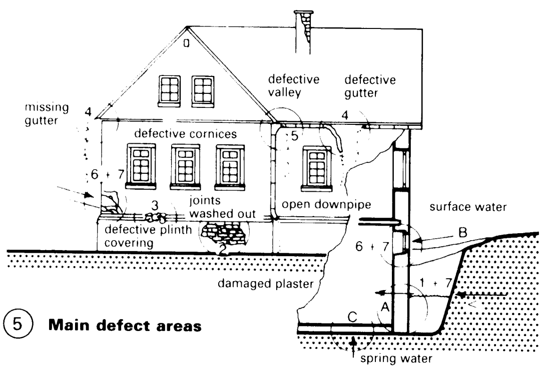
② Survey: plan layout, sketch



③ Survey: elevation drawing



④ Survey: plan layout, drawing



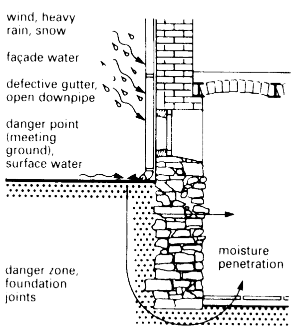
⑤ Main defect areas

Repairing, modernising, converting or adding structural extensions to an old building requires a different approach to the design process than for new buildings. It should be remembered that old buildings are often protected by law (e.g. listed buildings in the UK).

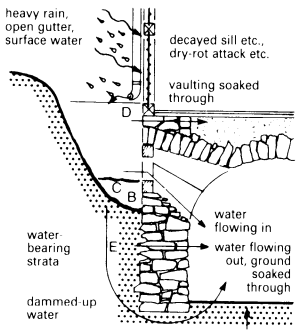
The first task in any renovation project is a thorough survey of the existing structure, in which every important component and detail has to be carefully inspected. The survey begins with a general description of the building (the plot, building specifications, applicable regulations or bylaws, the age of building and any historical design features, the use of the building (domestic or commercial) and any other features of interest) followed by a description of the building materials and the standard of the fittings, the technical building services, the framework and structural characteristics. Details about ownership, tenants and income from rental etc. should also be included. Sketches should be made and measurements taken so that plans of the building can be drawn →①-④.

The survey must also describe the building's condition, with details of specific areas (façades, roof, stairs, cellar, and individual rooms), and all significant defective areas should be noted →⑤. Typical problems include: cracked chimney tops, damaged and leaking roof structure, dry rot or woodworm in the timber (eaves, roof and wall connections, wooden joists in floors, doors, stairs etc.), cracks in the masonry and plaster, structural damage, leaking façades and guttering, no heat insulation and underlay, and cellar walls in need of damp-proofing. If structural steelwork is in place it should be checked for rust.

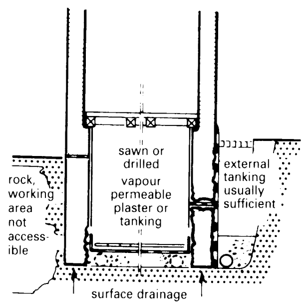
It is common to find that the existing heating and sanitation are unusable and that underground lines and house connections are damaged or possibly underdesigned.



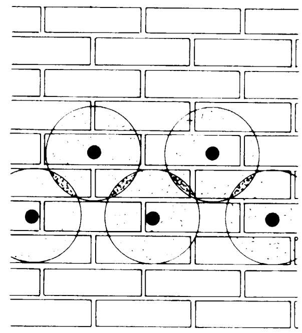
⑥ Main points of attack by non-pressurised water



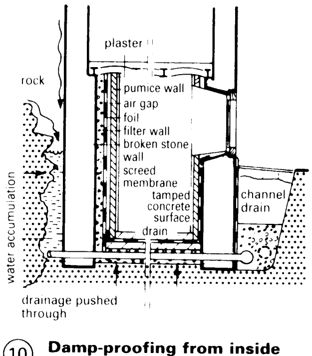
⑦ Main points of attack by pressurised water



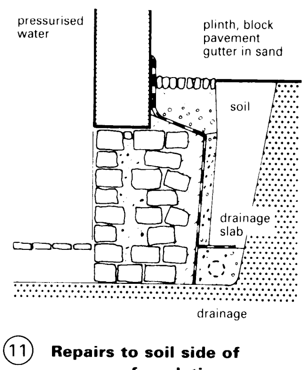
⑧ Retrofitted damp-proofing and drainage in cellar area



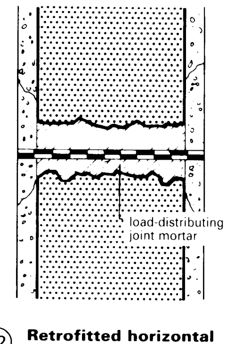
⑨ Injected damp-proofing



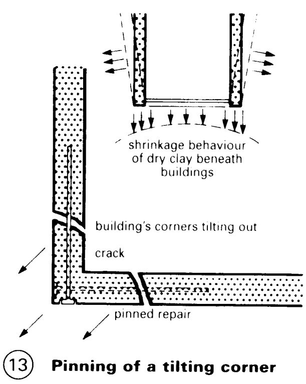
⑩ Damp-proofing from inside with partially inaccessible outer walls



⑪ Repairs to soil side of masonry foundations



⑫ Retrofitted horizontal (damp-proof course)



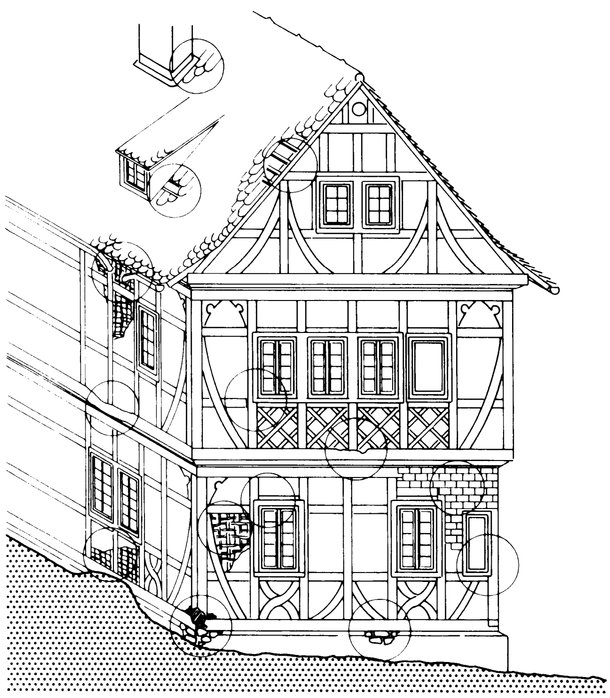
⑬ Pinning of a tilting corner

RENOVATION OF OLD BUILDINGS

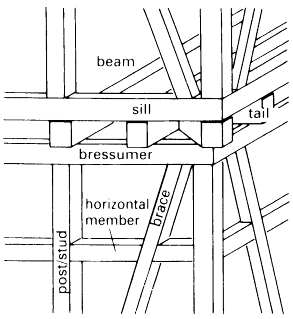
The early half-timbered houses contained no metal (nails, screws etc.) and repairs are possible using only parts made from wood if the intention is to preserve the house in its original state. The filling material used within the framework was traditionally earth or exposed masonry. There is no modern material that can be recommended as a substitute so these panels should be maintained and damaged ones repaired. Infilling with brickwork will stiffen the house and this is contrary to the structural principles of half-timbered structures.

The main defects encountered in half-timbered buildings appear in verges, eaves and roof connections, gutters and downpipes, connections on window plinths and other timber joints, where dry rot, fungal growth, mould, insects and water penetration can all cause problems → (1).

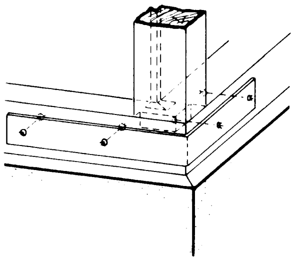
With old stone buildings, which may be either ashlar or 'rubble' construction, the main problems are with bulging/bowing of the walls, often accompanied by cracking, defective pointing, erosion and decay of the stones. As with conventional brick walls, there are effective restoration techniques to deal with these problems but it is important to understand the cause of the damage in order to make the repairs completely effective. If there are clearly major defects professional advice should be sought.



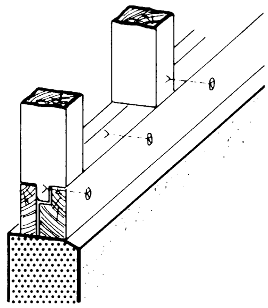
(1) **Main defect areas in half-timbered houses**



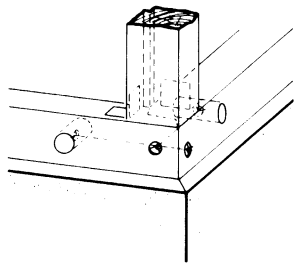
(2) **Framework construction**



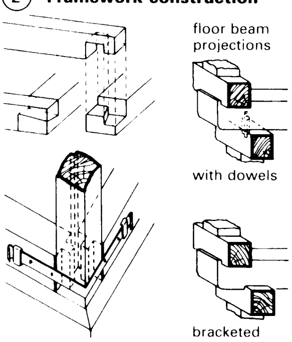
(3) **Corner stiffening with metal anchor**



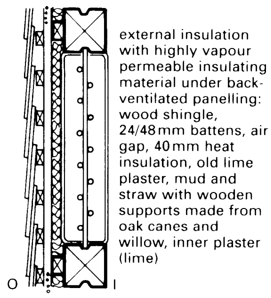
(4) **Sill replacement in two operations**



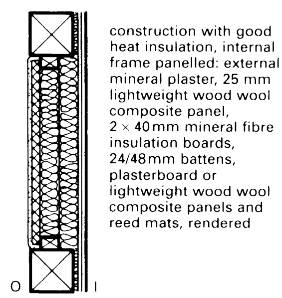
(5) **Sill corner reanchored with cap screws**



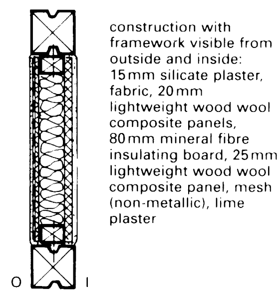
(6) **Corner connections for framework sills**



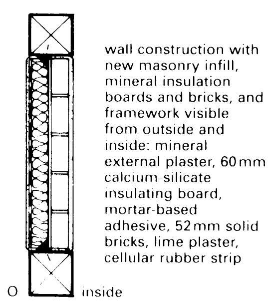
(7) **Exterior panelling**



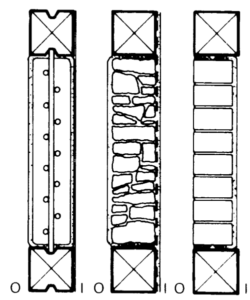
(8) **New panel**



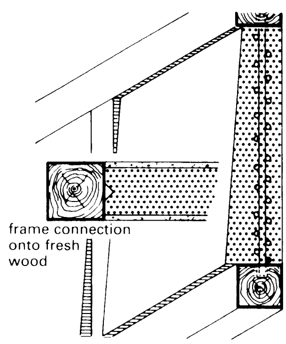
(9) **New panel**



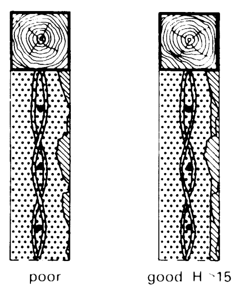
(10) **New panel**



(11) **Panel built up with earth and wooden canes, filled in with building rubble, with klinker nogging**



(12) **Theoretically favourable panel formation**



(13) **Shallow repairs to earth panels**

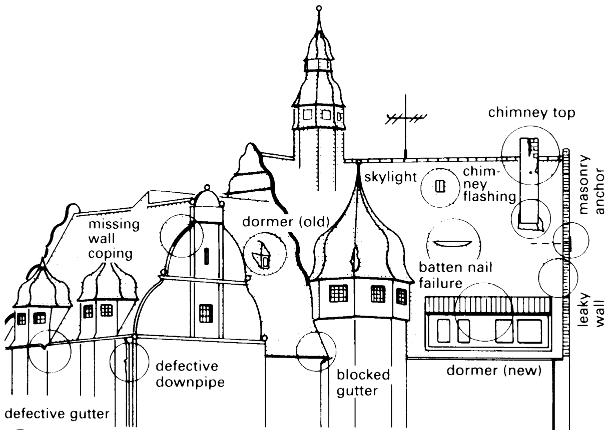
RENOVATION OF OLD BUILDINGS

The roof is the part of a building that is subjected to the worst effects of the weather and roof maintenance is therefore crucial. Small defects, which may go unnoticed, can result in significant damage if left for a period of time. For a renovation project to be successful it is vital to have the roof framework and cover in perfect condition. → ① + ⑤

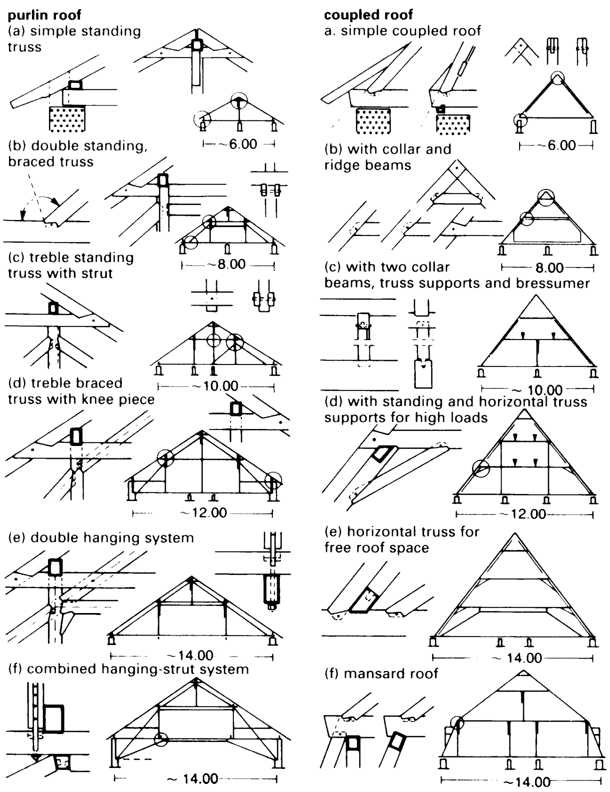
Historically, the material used for roof construction in most parts of the world has been wood and all forms of roof truss are still based on triangular bracing in many different designs → ② – ④.

To avoid later claims for damage, a thorough knowledge of the load distribution is required before carrying out roof renovation. Roof loads do not consist just of the dead weight of the roof and snow loading: rather, because roofs have a high surface area, loads are mainly imposed by wind. The condition and existence of wind bracing is therefore of great significance for the stability of the roof → ④.

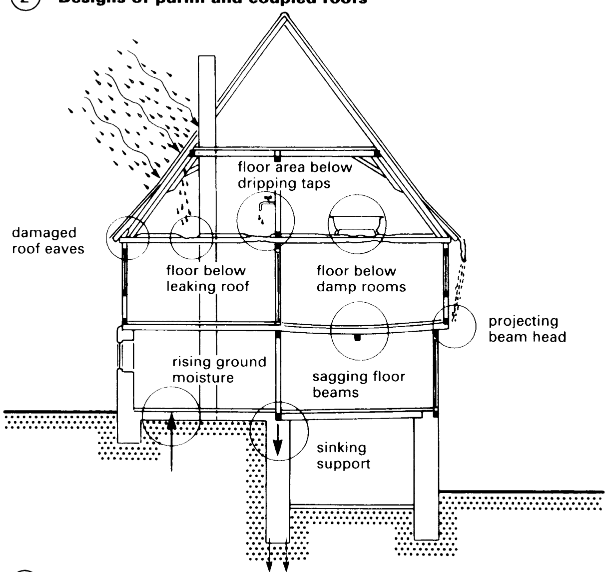
Where there is no cellar below, it is recommended that existing floor coverings with no heat insulation or damp-proof membrane be renewed with a completely new structure → ⑤ + ⑦.



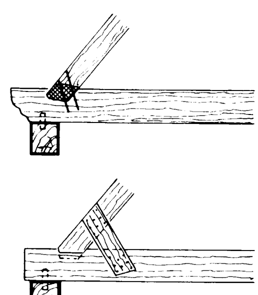
① **Main defect areas in the roof**



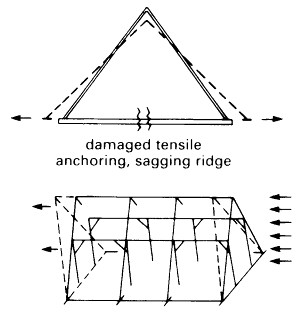
② **Designs of purlin and coupled roofs**



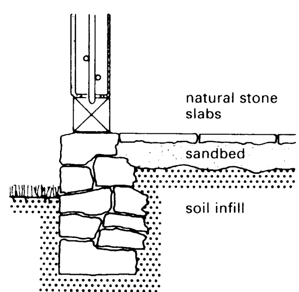
⑤ **Key problems in floors and their causes**



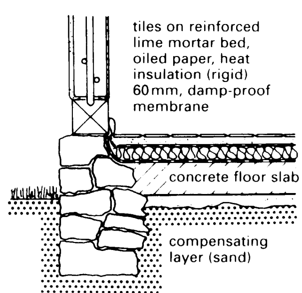
③ **Repair of a coupled roof using plastic joints or wooden joint splicing**



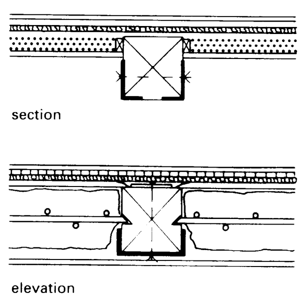
④ **Removal of ties leads to displacement caused by wind pressure**



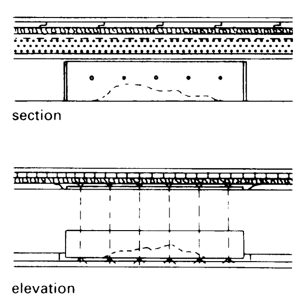
⑥ **Old natural stone flooring in areas with no cellar**



⑦ **Floor renewal on concrete slab**



⑧ **Strengthening weak points in the span**



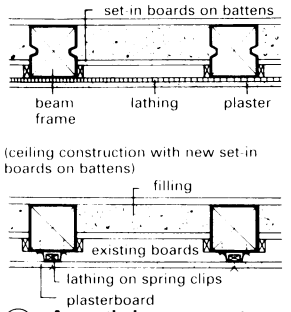
⑨ **Strengthening weak points in the span**

RENOVATION OF OLD BUILDINGS

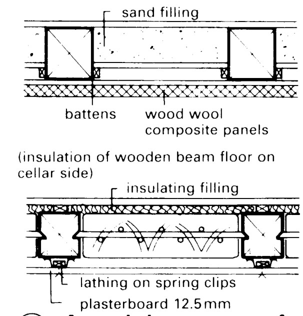
In early times the sizing of load-bearing floor beams in old buildings was calculated empirically by the carpenter. The loads are normally carried by cross-beams which are supported by one or more longitudinal joists.

An old building manual from 1900 gives a ratio of 5:7 for the height and the width of a beam as a starting point for the determination of the required beam strength. Another rule of thumb held that the beam height in cm should be approximately half the size of the room depth in decimetres. Because of these methods, old wooden beam floors often display significant sagging. However, this does not endanger the structural stability as long as the permitted tensions are not exceeded.

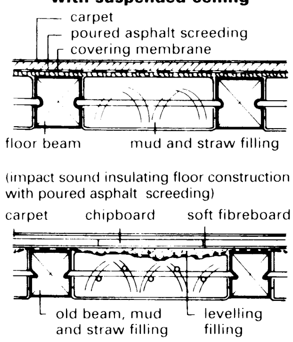
There are several options when carrying out renovation work: for example, joists can be strengthened by adding a second wooden beam and an improvement in load distribution can be achieved with the installation of additional floor beams or steel girders →①–④. In addition, the span can be shortened by installing one or more additional joists or a supporting cross-wall. However, structural changes of the framework must be preceded by an accurate analysis of all load-carrying and stiffening functions and the integrity of all connections must be checked thoroughly.



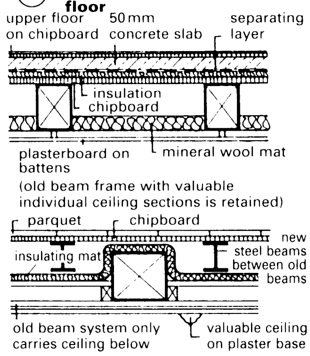
① **Acoustic improvement with suspended ceiling**



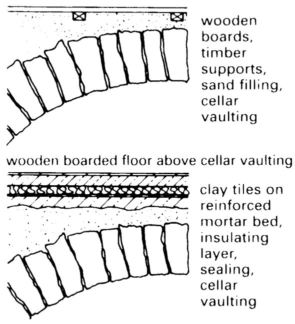
② **Acoustic improvement of floor**



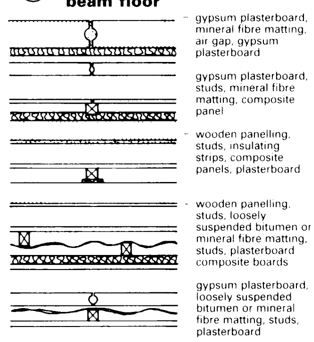
③ **New floor covering (impact sound insulation)**



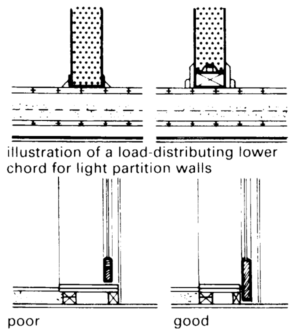
④ **Insertion of new steel beam floor**



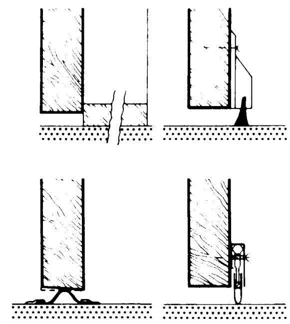
⑤ **Floor above cellar vaulting (new)**



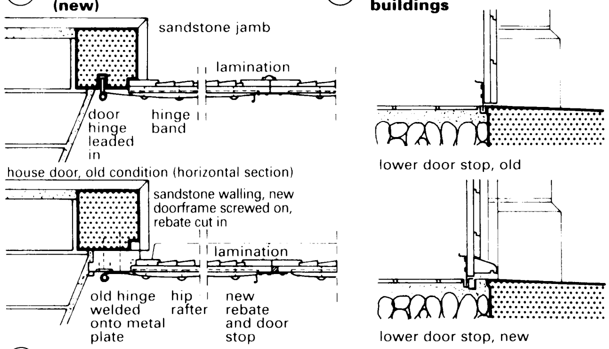
⑥ **Light partitioning for old buildings**



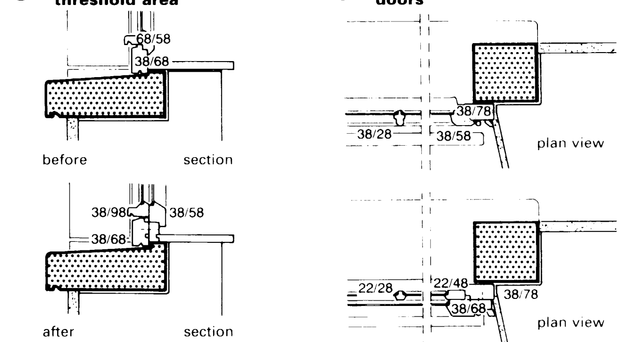
⑦ **Level compensation in threshold area**



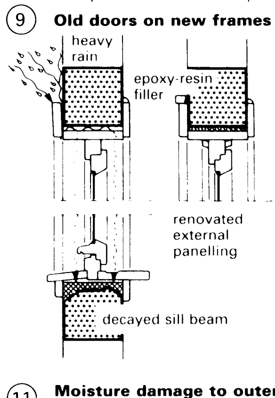
⑧ **Draught excluders for old doors**



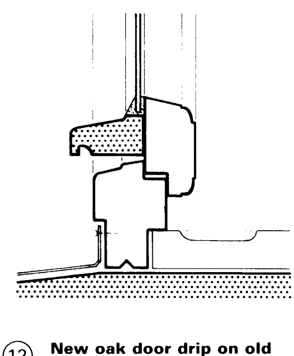
⑨ **Old doors on new frames**



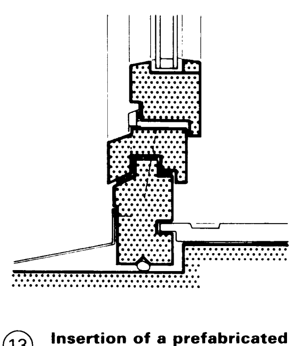
⑩ **Reinforcement of a single-pane window as a composite window**



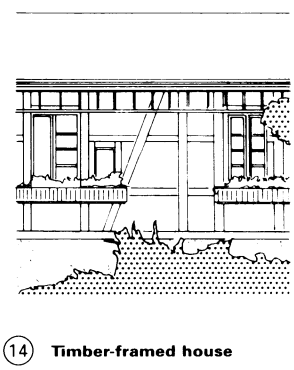
⑪ **Moisture damage to outer cladding**



⑫ **New oak door drip on old wooden frame**

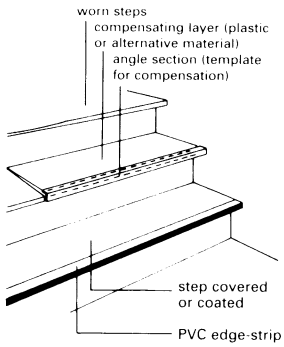


⑬ **Insertion of a prefabricated window**

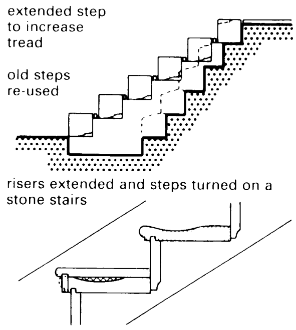


⑭ **Timber-framed house**

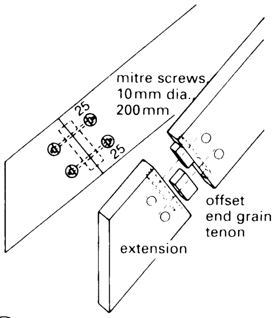
RENOVATION OF OLD BUILDINGS



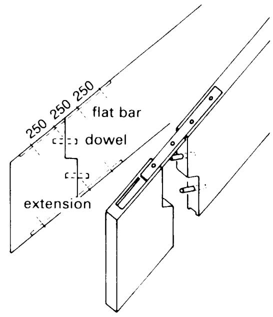
(1) **Renovation of worn steps**



(2) **Extension of worn stairs**



(3) **Extension of stair strings**



(4) **Extension of stair strings**

Stairs

External and internal stairs are significant structural features in old buildings. If the stairs are in poor condition remember the most important rule for repairs is: repair only what can be repaired → (1) – (4).

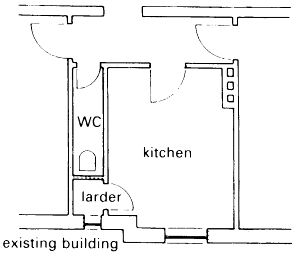
External stairs are mostly made of natural stone and normally serve to reach floor levels on plinths → (2). Worn-down stone steps can sometimes be restored if they are reversed and dressed underneath.

There are many types of design and materials used for internal stairs although the most common material used is wood.

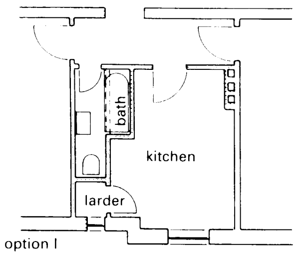
Wet rooms and bathrooms

Improvement in sanitary facilities is one of the most important modernisation tasks. Planning of the new solutions should be highly sympathetic to the existing layout and then coordinated with the technical necessities → (5) – (9).

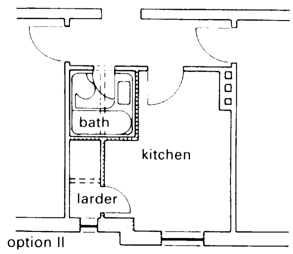
Walls and floors must be planned and installed with care. The most serious damage to be avoided is that associated with leaks around showers and baths → (12) – (14). Faulty or missing vapour barriers mainly on outer walls with internal insulation can also lead to condensation forming in the structure. This is a major cause of rot and the incidence of mould.



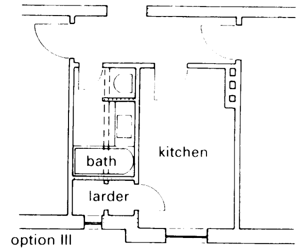
(5) **New bathroom installations → (6) – (8)**



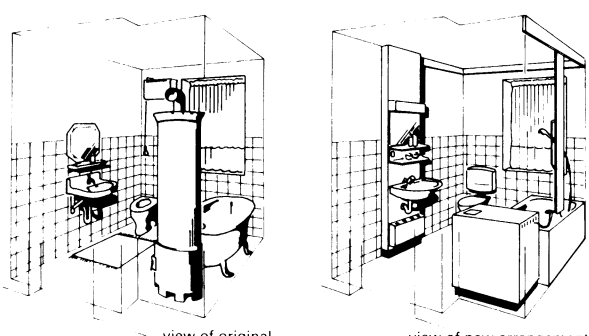
(6) **Increase around bath size**



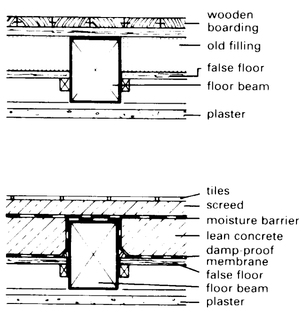
(7) **Prefabricated bathroom made of plastic**



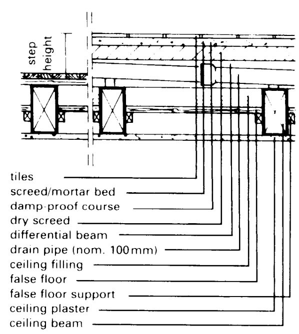
(8) **Widening to bath length**



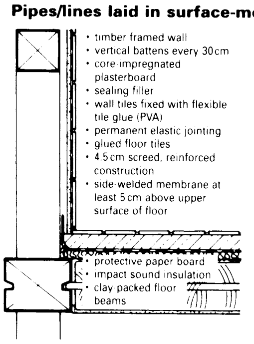
(9) **Pipes/lines laid in surface-mounted ducts**



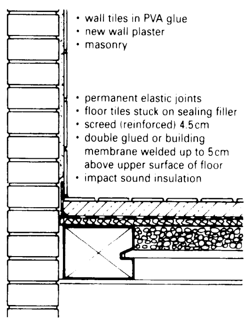
(10) **Sealing options for wooden beam floors**



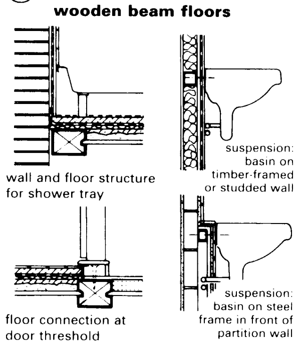
(11) **Laying waste pipe below new floor**



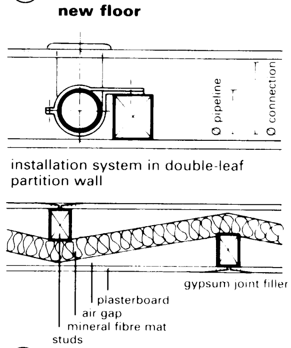
(12) **Floor/wall structure in damp areas in a half-timbered building**



(13) **Floor/wall structure in damp areas in a masonry building with wooden beam floors**

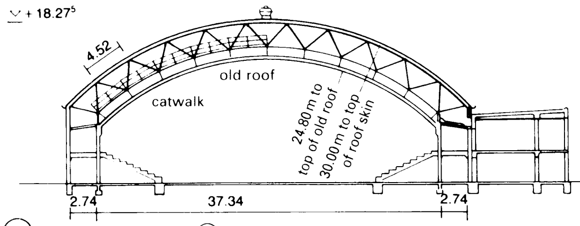


(14) **Important details in damp locations**

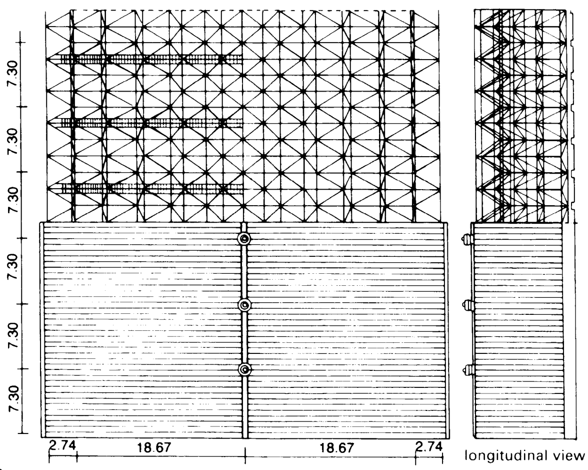


(15) **Noise insulating double-leaf wall construction**

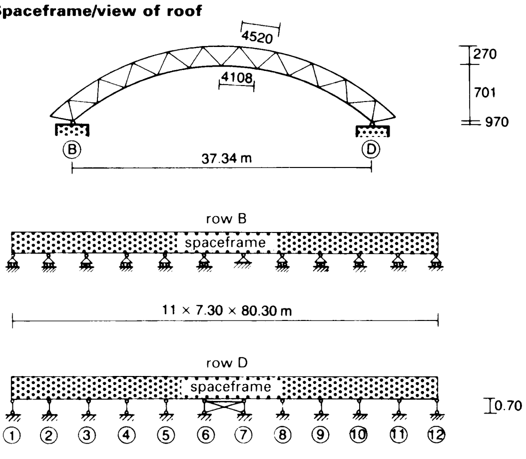
Examples of solutions



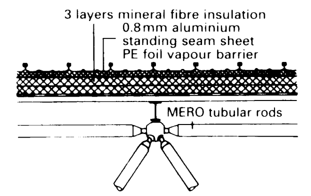
(1) **Cross-section** → (2)



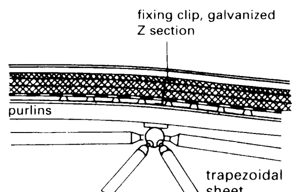
(2) **Spaceframe/view of roof**



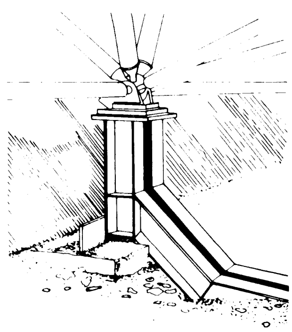
(3) **Static system to allow for movement**



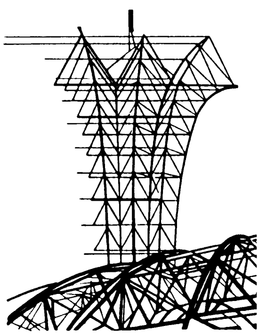
(4) **Roof skin structure, longitudinal view**



(5) **Cross-section** → (4)



(6) **70cm high support allowing one-way movement** → (3)



(7)

In this example, the aim was to preserve an old wooden structure by covering it with an arched steel roof.

The multipurpose hall built in Münster in 1928 was covered over with a steel roof which was so badly damaged in the Second World War that it had to be completely renewed. However, after the war steel was too expensive to consider, so for 35 years the 37 × 80 m hall was covered only by a wooden network shell with no columns. The structure carried just its own weight, snow load or loads such as lighting platforms, and had no heat insulation.

Project requirements

The new roof skin must:

- meet heat insulation regulations;
- insulate the inside from external noises and keep internal reflected sound to a minimum.

The new structure should also:

- carry special loads, such as sporting equipment, backdrops, lighting bridges etc.;
- be sufficiently strong to be walked on;
- be able to be mounted on the existing foundations;
- allow the network construction to be maintained;
- offer planning and manufacturing times as short as possible.

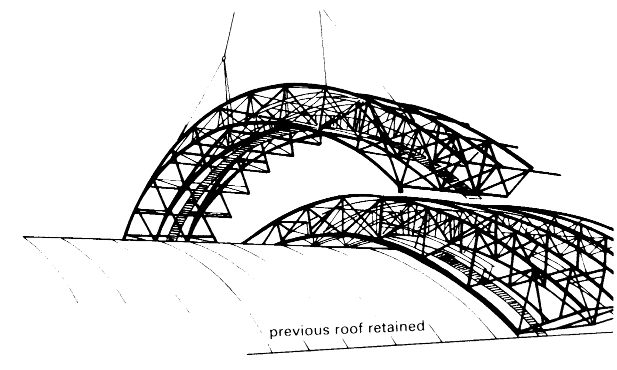
Solution

A spaceframe structure made from circular-section tubes screwed into nodes gave the required minimisation of the total weight and the existing wooden structure was suspended from this → (1). Twenty-two of these spaceframe arches are cross-linked by expanding diagonals and bridge an area of 37.34 × 80.30 m. One of the two 70 cm high rows of supports has sliding bearings to allow movement and the second row is designed as a pin-jointed support system → (6). Ten transverse catwalks are installed in the spaceframe → (1).

Small cranes preassembled seven large-scale structural elements, weighing up to 32 t, which were then put in position in 2½ days with a 500 t crane → (7) - (8).

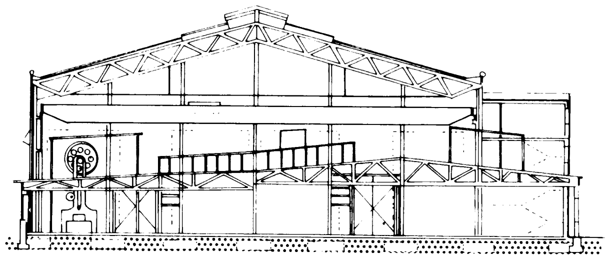
The structure is galvanized and painted with a PVC acrylic paint and a special insulation layer for corrosion and fire protection. The roof skin consists of purlins, steel trapezoidal sheets, a vapour barrier, heat insulation and aluminium standing seam sheeting to protect from rain → (4) - (5).

The parties involved were: Münsterlandhalle GmbH, Hochbauamt Münster, MERO spatial structures and numerous specialist engineers.

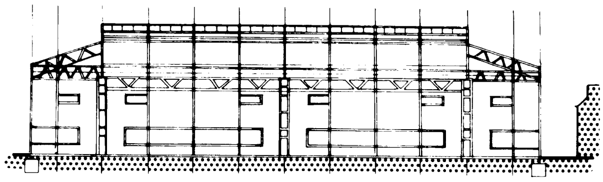


(8) **Lifting a space frame section into place** → (7)

MAINTENANCE AND RESTORATION

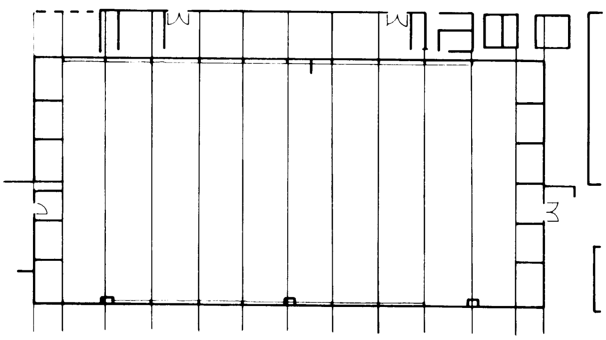


① **Old and new cross-section drawn over one another** → ② + ③



large machines remain in place during conversion

② **Longitudinal section** → ③



③ **Plan view**

In this example a renewal and extension was carried out by building a steel frame over the top of an existing building. On densely built-up land in Munich a light metal works had reached a stage at which it became necessary to renew and extend the forging shop. The old building had already been altered many times and with the installation of new machines had undergone many different roof reconstructions → ① – ③.

The requirements for the new shop were that it should:

- have substantially greater headroom;
- stand within the building lines of the old shop, because there was no possibility of pulling it down and rebuilding;
- not interrupt production for more than 2–3 weeks and keep disruption to the minimum;
- have an aesthetically attractive appearance that is in keeping with the adjacent listed administrative building;
- permit the addition of a second building phase.

Solution

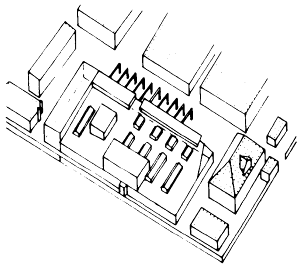
The architects selected a steel structure to take advantage of:

- a column-free building → ② + ③;
- a large span with low dead weight
- opportunities for prefabrication and assembly in a short time with lightweight equipment, a decisive factor in the project.

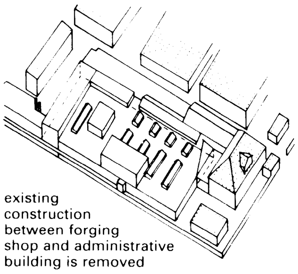
The outer walls consist of suspended concrete-composite prefabricated panels. These provide the high noise insulation mass and robustness required for a forging shop as well as permitting dry assembly.

Conversion work was precisely planned: after assembly of the steel structure the old shell was dismantled with a new, in-house overhead travelling crane and at the same time the new roof covering was progressively fitted → ④ – ⑧.

The sloping roof with trussed rafters is hipped at one end of the building in order to match the hipped roof of the administrative building, to maintain the spacing heights and to permit natural ventilation. Air supply louvres are built into the outer walls and extract air openings are in the roof ridge → ⑨ + ⑩.

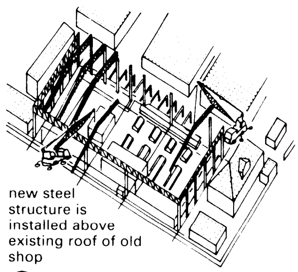


④ **Existing situation when planning started**



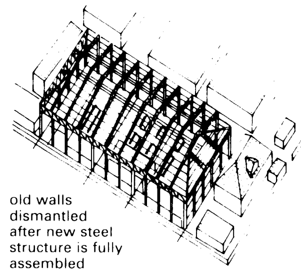
existing construction between forging shop and administrative building is removed

⑤ **First demolition stage**



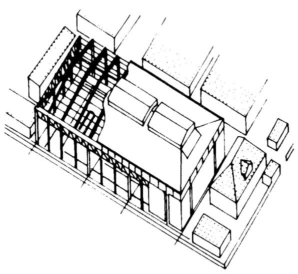
new steel structure is installed above existing roof of old shop

⑥ **Installation of new steel structure begins**



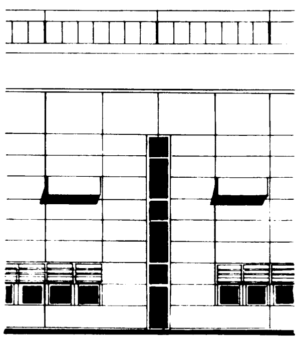
old walls dismantled after new steel structure is fully assembled

⑦ **Dismantling of old walls begins**



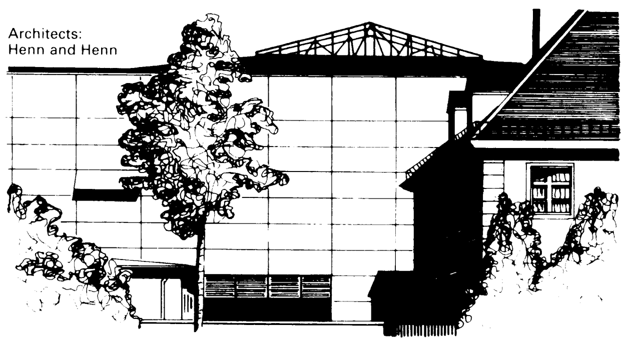
new crane takes over dismantling old roof; parts removed through the still-open west gable; outer walls and roof are then closed up

⑧ **Dismantling of old roof begins**



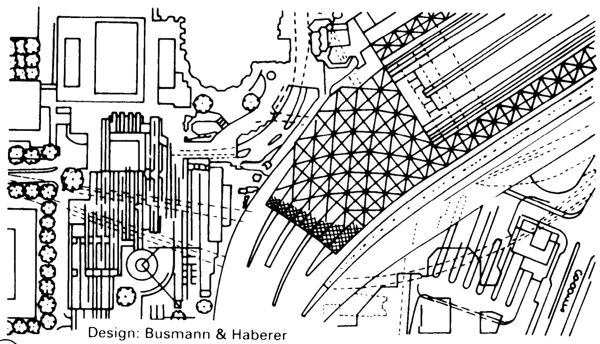
⑨ **Section of façade with fresh air openings**

Architects: Henn and Henn

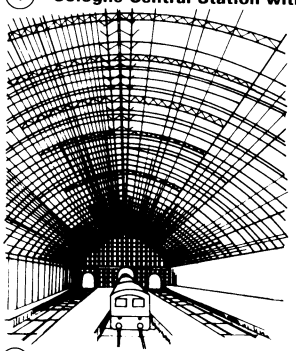


⑩ **The new building is planned with regard to the old one**

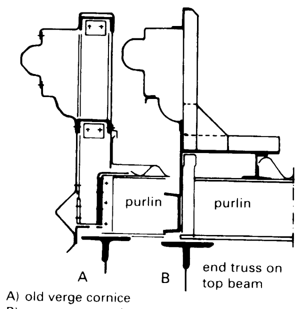
MAINTENANCE AND RESTORATION



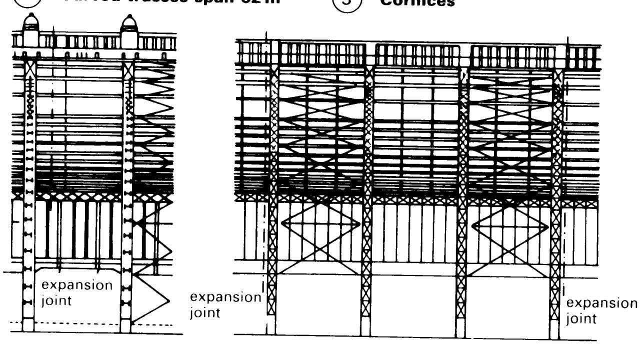
(1) **Cologne Central Station with platform canopies**



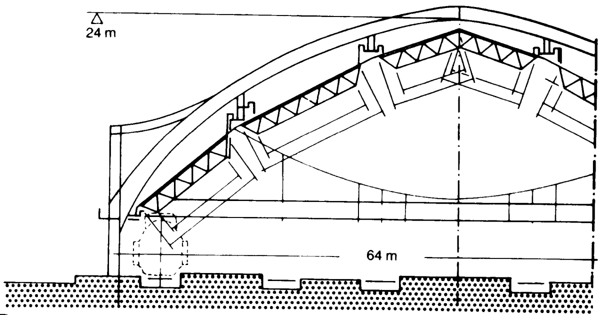
(2) **Curved trusses span 62 m**



(3) **Cornices**



(4) **Old wind bracing installed right down to platform; new bracing with strengthened curved trusses in lower area**



(5) **Section through main hall, with travelling internal scaffolding**

(6) **Design proposal: Planteam West Köln-Aachen**

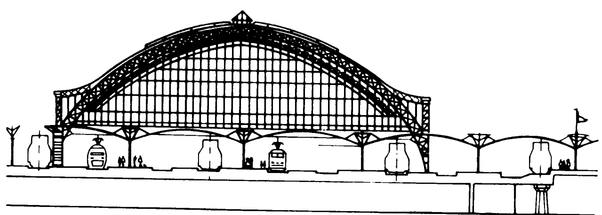
This example examines the refurbishment of the main platform hall of Cologne Central Station. All corrosion and residual war damage was to be removed from the beautiful 80-year-old steel structure, which has 30 main curved trusses. The multilayered roof skin and strip rooflights also had to be renewed. The historical shape had to be retained, despite the use of modern materials, and the building work could not significantly affect railway operations and traffic.

Solution

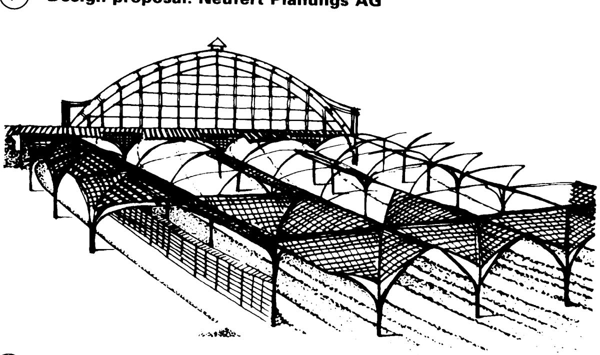
A travelling steel internal scaffolding unit was planned to give simultaneously a working platform and protect the railway operations below from falling tools or building components. It used the MERO nodal rod system, with 1400 nodes and 5000 rods, and consisted of five main components that were connected together to make one 50 tonne element of 38 m × 56 m. It was moved in sections on six tracks and in three-weekly cycles. The individual parts, which were pre-assembled in a goods yard, were mounted on wagons and put together under the main hall arch according to a time plan that had to be accurate to the minute → (5).

An illustration of how new technology was used in the restoration work is shown in the renewal of the transverse wind bracing. The old system connected two curved trusses respectively into one rigid unit and the round steel wind bracing extended right down to the luggage platform. In the new system, four curved trusses are respectively combined in the lower area to make a flexurally rigid frame and the expansion joints reduced → (4). Although the cornice details etc. have a lower number of profiles, they have also been designed to look almost identical to the old ones → (3).

Following completion of the restoration of the main hall it was planned to renew the vaulted roofs to the south east. Being close to the cathedral and a new museum, the requirements went far beyond simple functionalism and the awkward geometry of the tracks added further difficulty. Three proposals were made during an expert survey → (6) – (8). Two used intermediately suspended and differently curved shell construction. The third proposed a spatially effective bearer system, which spans the whole area, like crossed vaulting → (8). Because this system offered considerable advantages it was recommended for further development.



(7) **Design proposal: Neufert Planungs AG**



(8) **Design proposal for implementation by Busmann & Haberer with prof. Polónyi**

CHANGE OF USE

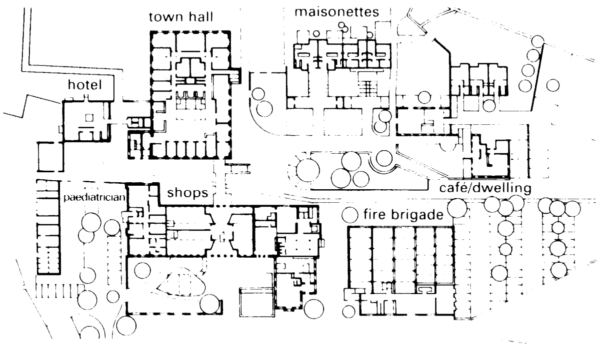
There is currently enormous interest in converting structurally sound old buildings for new uses.

→ ①–③ Previously a textile factory, the spinning hall was converted into a town hall and the textile mill was converted into dwellings and business premises. A hotel was created from the wool store.

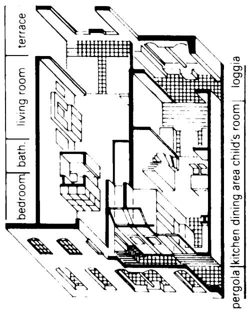
→ ④–⑦ The old market halls at Covent Garden now house shops, restaurants and a pub. Offices have been installed on the upper floor.

→ ⑧–⑨ This silo plant is now an architect's office. Walls had to be taken out and bridge-type platforms installed to connect the silos at different levels.

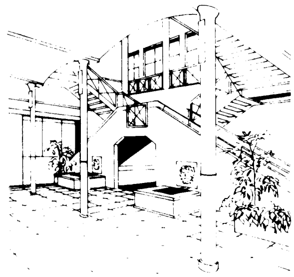
→ ⑩–⑪ A waterworks that supplied Rotterdam with water until 1975 is now an arts centre, with workshops and dwellings too.



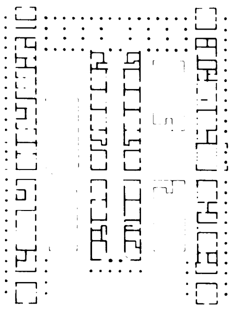
① **Engelskirchen textile factory conversion**



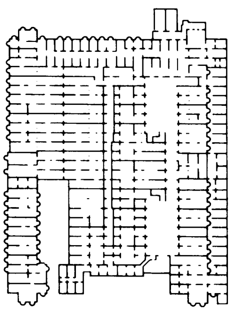
② **Maisonettes** → ①



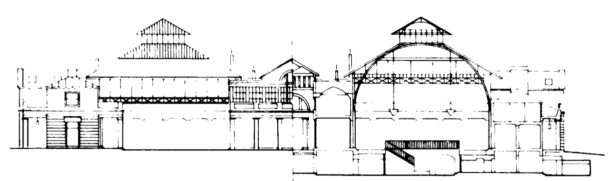
③ **Town hall** → ①



④ **Covent Garden, London** → ⑤–⑦

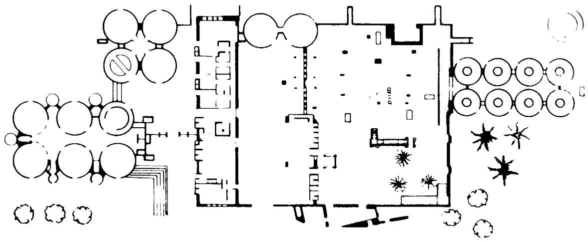


⑤ **Covent Garden, plan**

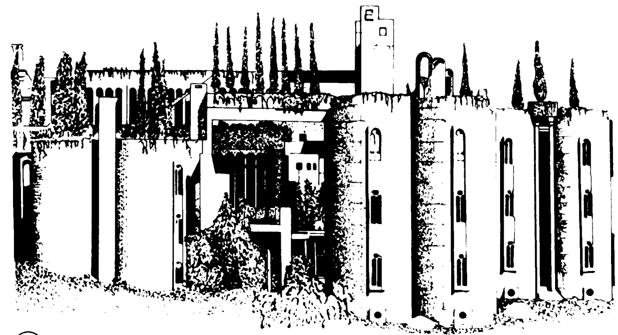


⑥ **Covent Garden, cross-section**

⑦ **Covent Garden: old market halls are now a complex of shops, restaurants and offices**

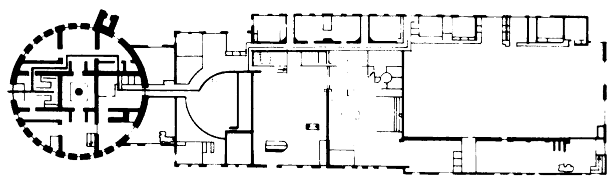


⑧ **Plan: a silo plant converted into an architect's office** → ⑨

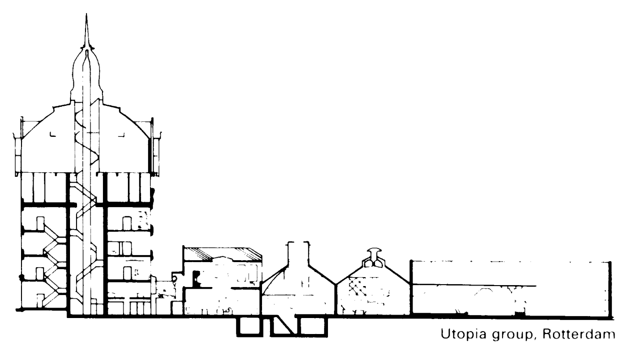


⑨ **General view** → ⑧

Architect: R. Bofill



⑩ **Plan: conversion of Honingerdijk waterworks into an arts centre**



Utopia group, Rotterdam

⑪ **Section** → ⑩

CHANGE OF USE

Flats in Boston, USA

→ ① – ② This former piano factory has four wings surrounding an inner courtyard. The building is narrow and has many window openings, which made it highly suitable for flats.

Pavilion Baltard, Nogent-sur-Marne, France

→ ③ – ④ An old market hall is now a multipurpose hall suitable for events with up to 300 attendees. There are new parking facilities and function rooms in the basement.

Culture centre, Geneva

→ ⑤ – ⑦ This building, which had existed since 1848 and was previously a slaughterhouse, was converted into a culture centre with exhibition rooms, a theatre, music rehearsal room and a restaurant.

Flats, Nestbeth Housing, New York

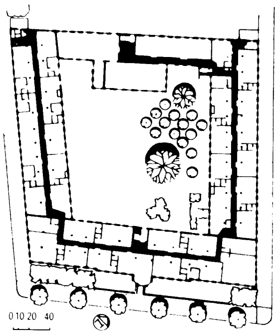
→ ⑧ There are now 384 flats in this former telephone factory. In addition, shops, workshops, exhibition rooms, a cinema and rehearsal rooms were created on the available area of about 60000 m².

Schloß Gottorf, Schleswig

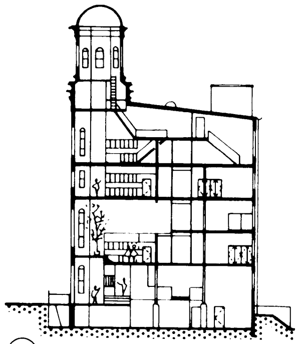
→ ⑨ – ⑪ This former riding hall was converted into a museum and now houses a collection of contemporary art. The building is the most significant cultural building in the region.

School building, San Francisco

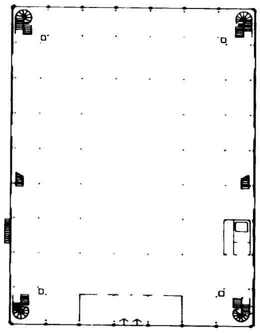
→ ⑫ Originally a storehouse, this building is now a school. The fourth and fifth floors contain training laboratories, the second and third floors house the school and there are more laboratories on the first floor.



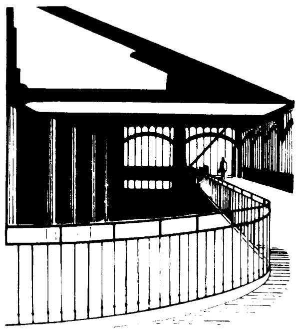
① **Typical plan**



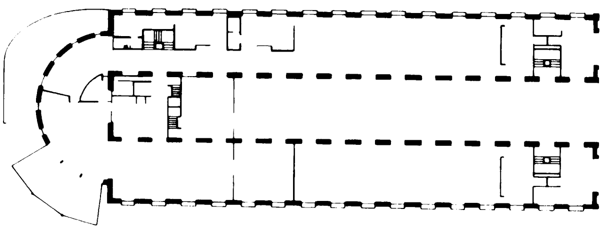
② **Cross-section** → ①



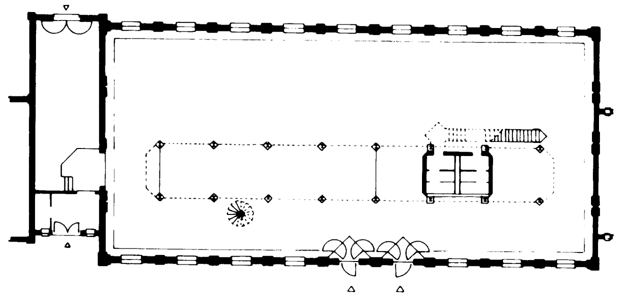
③ **Before: market hall; after: multipurpose hall**



④ **Inside view** → ③



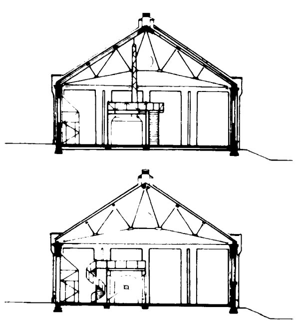
⑤ **Before: slaughterhouse; after: culture centre** → ⑥ – ⑦



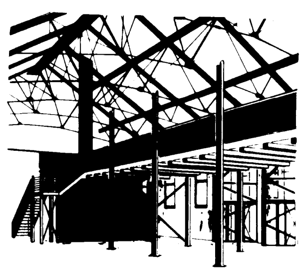
⑨ **Before: riding hall; after: museum** → ⑩ – ⑪

⑥ **Internal view** → ⑤

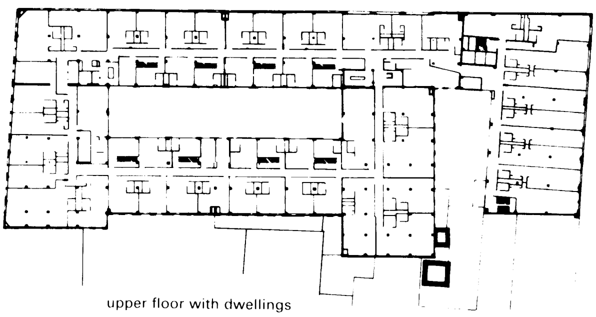
⑦ **General view** → ⑤



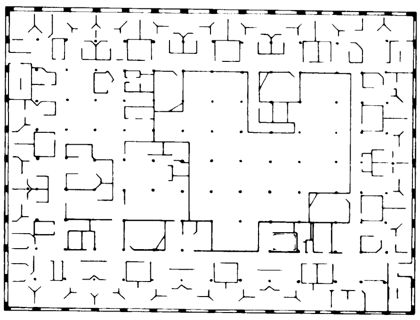
⑩ **Cross-section** → ⑨



⑪ **Internal view of hall** → ⑨



⑧ **Before: telephone factory; after: dwellings**



⑫ **Former storehouse is now a school**