Case Studies:

This chapter sets out a series of examples which illustrate briefly some of the problems and solutions described above. The examples are taken very largely from the Author's own practice and experience, except in the very important instance of the studies carried out at Fort Selden in New Mexico.

Uppark, Sussex, England

In the English Renaissance brick and stone were used extensively to build the mansions of the wealthy. Uppark, built in about 1690 stands high on the chalk hills overlooking the English Channel. As chalk is generally not thought to be a suitable building stone the four storey mansion was built in brick with dressings of Bath Stone to the windows, doors and string courses. Some of the interior walls were, however, built in hard chalk known locally as 'clunch'. The brickwork was entirely built with lime mortar which, was of local origin. The floors were fully framed in hardwood, the roof was entirely in timber and the interior was rich with decorative plasterwork of a very high calibre. The house was noted for its contents which were virtually intact and dated from the time of its building. The house was owned by the English National Trust and was normally open to the public.

On August 30th 1989 the roof caught fire during building operations and within 24 hours the interior was gutted, but not before the fittings and furnishings had been removed. The decision to rebuild in exactly the original form was a direct reflection of the view that the interior, although a replica, provides the most fitting background for exhibiting the original paintings and furniture. In consequence a meticulously careful restoration and replication has been undertaken.

The brickwork survived the fire very largely intact and only in very small areas was the mortar sufficiently calcined to have failed completely. All suspect areas of brickwork were rebuilt and the opportunity was taken to verify the history of construction of the house by the alterations in the earlier brickwork which were revealed by the removal of plaster and the loss of panelling. Before any permanent restoration work was carried out a very detailed drawn physical survey was made using computers and photogrammetry to provide a total permanent record. The structure was fully analysed for faults and defects and replacement brickwork was carefully chosen for compatible

bricks and mortars of similar nature and character. Salvaged brick was used as appropriate and in areas where higher stressing is to be anticipated appropriately selected new brickwork was introduced. Floor loads previously taken direct on to brick have been distributed into the structure, reinforced concrete being substituted for embedded timber in the interests of longevity. Where brickwork of visual significance was to be taken down the bricks were numbered, cleaned, set aside and rebuilt in their original positions. Bricks damaged beyond reuse were made to match the originals, and to provide a form of accelerated weathering a wash of soot and water was applied in sensitive external areas.

The original mortar proved, on analysis, to have been a lime/aggregate mix in a ratio of 1:3 which was traditional. However, as much of the aggregate consisted of granular chalk the mortar ultimately contained an unusually high proportion of calcium carbonate. In formulating the new mix an equivalent proportion of ground furnace slag was used. In reconstruction the opportunity was taken to protect timber from the dangers inherent in embedding it in damp masonry. It was also found that ironwork which had been built into the bricks was exfoliating due to rust. This wrought iron was removed and replaced with stainless steel.

Where Portland Stone had been exposed to considerable heat it had failed, partly due to calcining (Portland Stone is a limestone) and partly due to the effects of thermal contraction when doused with cold water. All damaged stonework was removed and replaced with identical material.

In some areas the external brickwork was defaced by molten lead which had cascaded from the melted lead gutters and defaced sections of the external walling. The most effective and least damaging method of removing this lead proved to be by the use of hot air jets and flame torches, but these methods were introduced as a last resort.

In assessing the physical damage suffered as a result of the fire the causes of failure in the brickwork can be enumerated as:–

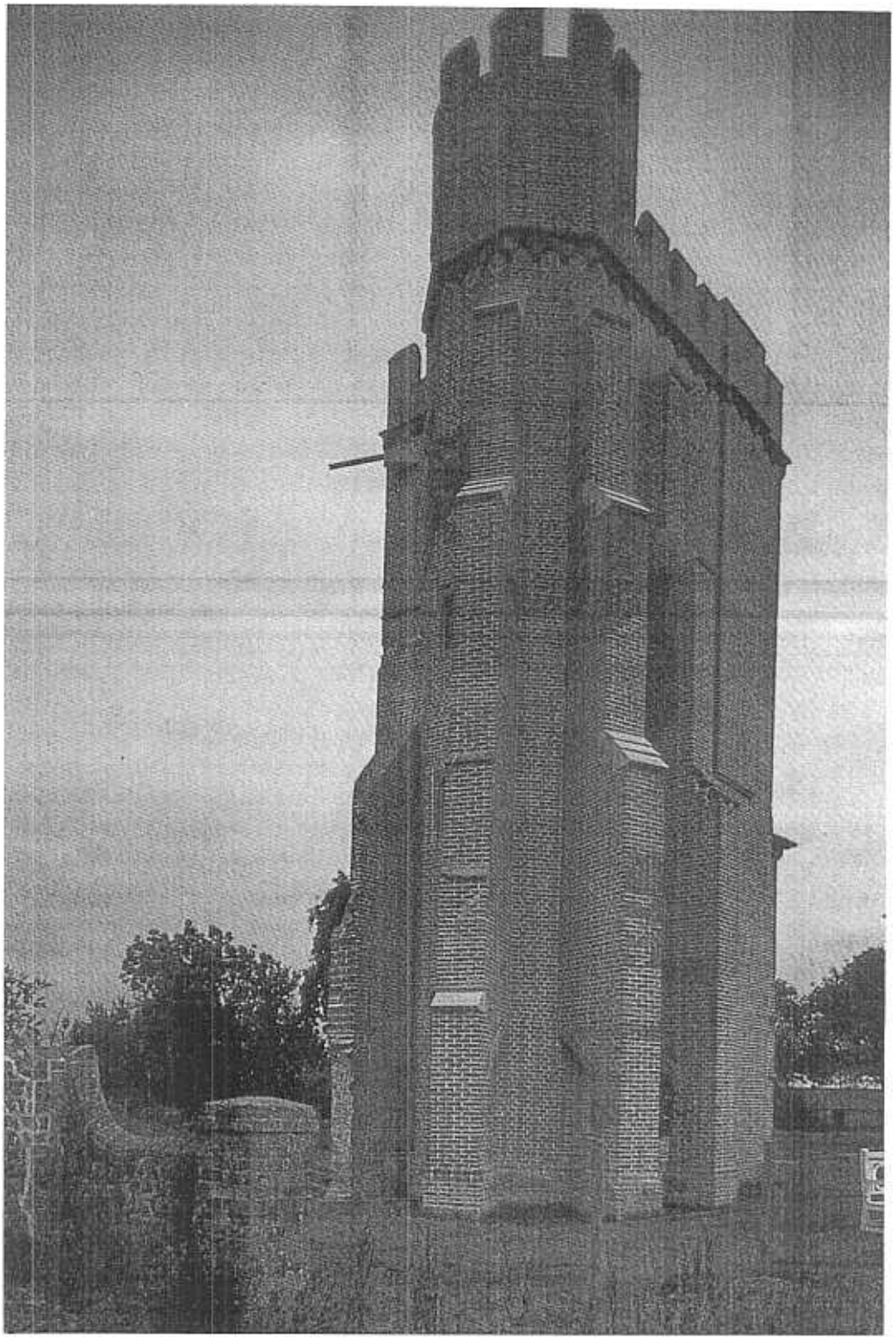
1. The leverage and impact failures caused by the collapse of structural timbers resulting in cracking and in the worst case overturning and toppling of unrestrained sections.
2. Thermal stress caused by heating followed by rapid cooling.
3. Calcining of mortar and limestone in areas subject to heating in excess of 850° C.
4. Fire staining and staining by waterborne materials and molten metal.

In the restoration the original structure has been faithfully restored using materials which are either original or directly comparable but where, in the interests of longevity it has been possible to eliminate other causes of decay unseen modern materials have been introduced.

Architects: The Conservation Practice. (Daryl Fowler).

Laughton Place, near Lewes, England

The brick-built tower which now stands as the only survivor of the mansion at Laughton Place was



Laughton place: the tower after restoration. (Lewes, England).

added in 1534 to a medieval hall, standing in a moated site. The area had been marshy and from the first the building proved heavier than its foundations could withtand, for there is evidence that the structural cracking first became apparent in the building soon after its completion. In the 17th and 18th centuries there were other major additions followed by demolitions of parts of the mansion in the last century which ultimately left the tower standing isolated. The loading and unloading of the relatively soft ground caused differential settlement in the building which would have caused its collapse but for the introduction of steel girders and a reinforced concrete slab at the top level of the tower in 1940 to provide a watching platform for anti-aircraft defence.

The tower was built for William Pelham, a man of high rank, and it was only one of his many properties. It is particularly important, however, for the use of moulded terracotta which had been introduced into England by Italian craftsmen only a short time before. It rapidly went out of fashion. The tower at Laughton Place is, therefore, a rare and important example and it was restored by the Landmark Trust with the assistance of the British Government.

The tower is square, containing only four levels below the roof. It is abutted by a circular staircase tower supported by heavy buttressing. All bricks are of the small size known as 'Tudor' in England and the terracotta was used as mullions and dressings round windows and doors.

During its final decay the tower had lost all its heavy internal timber floors. Major cracks ran vertically through the windows and door openings on the northern and southern sides, from top to bottom of the building. Its parapets had disappeared. All the joinery had gone and with only one exception, the original windows had been lost. There was, however, enough in the detail of the building to allow every original element to be restored with certainty. Even the original pointing of the mortar remained intact and unweathered on the underside of arches in the buttresses. The original lime mortar contained substantial quantities of ground-up sea shells added to provide an improved set — for which purpose it is not likely to have been particularly effective — although the mortar itself has proved strong and very durable. It had also, proved flexible to some extent during the changes in ground loading which had taken place as building work went forward over the centuries.

Once the building had been fully recorded by measured survey and secured by a protective girdle of scaffolding, designed to secure it against further movement the interior was gutted and all later accretions were removed. In replacing the floors a cross lacing of stainless steel reinforcement was used to secure the structure of the tower permanently in the deformed alignment which had been taken up after the differential settlement. The cracks were remade by remodelling the brickwork across the major fractures. Reinforcement was not introduced and the brickwork itself serves as a telltale to identify further movement.

Much of the external brickwork

was damaged by the careless and accidental effects of crude demolition work when adjacent wings of the mansion were removed. These areas were replaced with new facework, bricks matching the original being made to similar profiles and sizes. Where the original terracotta was irretrievably damaged or missing it was replaced with purposemade terracotta elements formed to match the original profiles but omitting the embossed work which distinguished the original dressings and string courses.

The originals had all been cast into moulds which were carefully sculpted to provide bas-relief patterns of wreaths, heraldic motifs and the distinctive buckle which was the mark of William Pelham and his family. Wherever possible the original terracotta was retained and repaired using epoxy resins. Terracotta pieces in which upwards of 75% of the face remained intact, however badly fractured were repaired in this manner irrespective of the extent of the backing which had been lost. It was felt that pieces more fragmentary than this were not justifiably restorable and they were, therefore, replaced, except where they remained in situ. A considerable number of pieces of terracotta were recovered from rubble and from positions where they had been reused in adjacent structures. Laughton Place had a mixed history and at one stage much of the material from the tower was salvaged and carried to another Pelham Mansion at Halland some distance away. However only materials salvaged from the site were reused in the conservation.

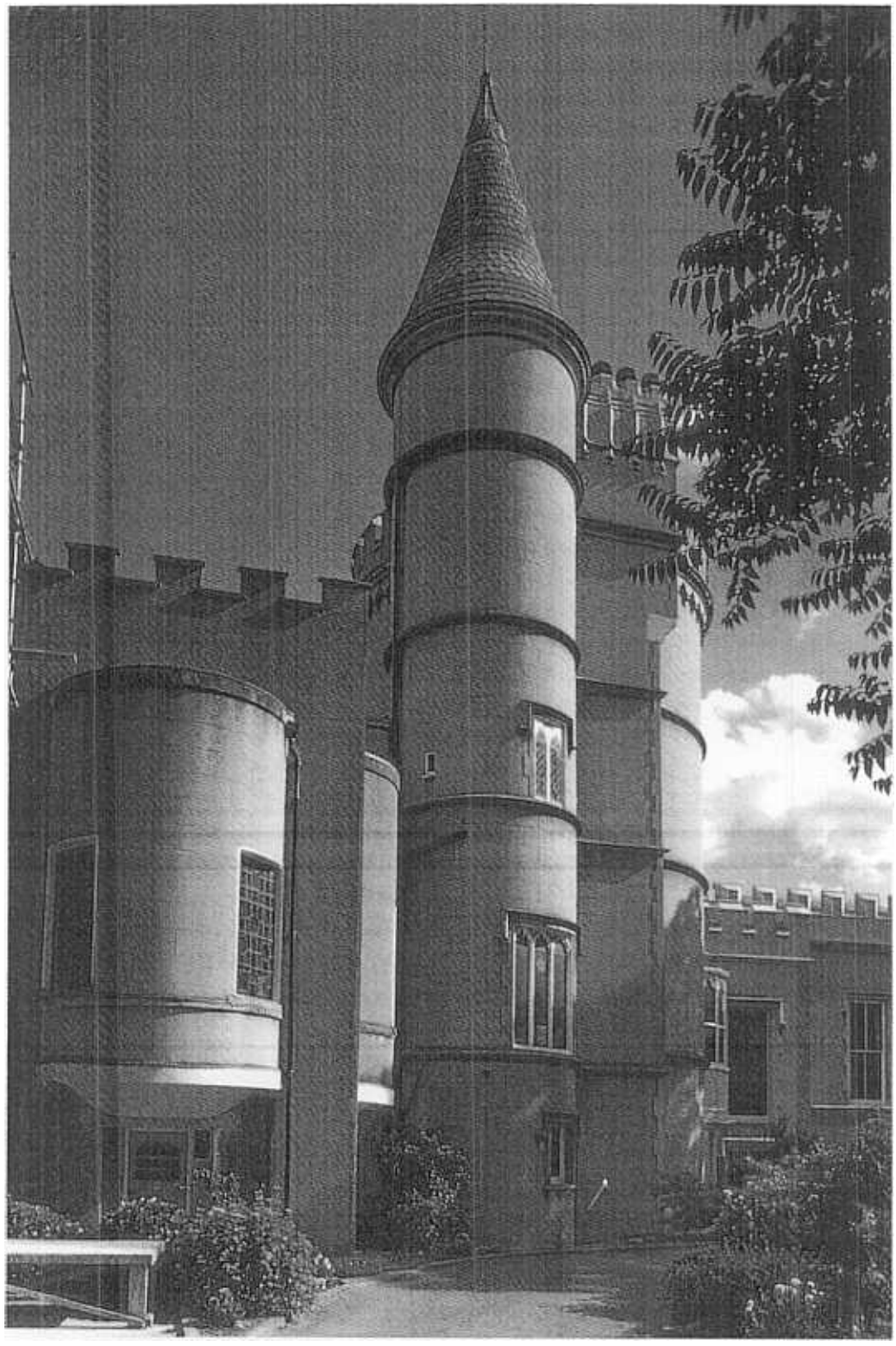
Summarising lengthy analyses it can be said that the foundations of the building were modest, and by modern standards inadequate. The area under the turret containing the stair was loaded even more heavily than other parts and the substratum, (composed of compacted clays and marshland of modest load-bearing capacity) has some powers of recovery after loads have been removed. The differential stresses caused by these loadings are evident as cracks running vertically and some of these occurred so soon after construction that important lower windows were blocked up with additional brickwork to strengthen the building. In the course of restoration these windows came to light once the outer skin of brickwork had been removed and they now provide one of the most attractive features of the building.

It was possible to restore the original battlements on the basis of the one surviving merlon, built into the stair turret where it rises above the roof. As it stands today, therefore, the tower stands complete as it was first built, but in an isolation never intended since the adjacent structures have been destroyed without hope of recovery.

Architects: Architectural and Planning Partnership (The Author).

Strawberry Hill, London, England — The Restoration of Horace Walpole's Mansion

Strawberry Hill was inspired by a world of make-believe in the mind of a dilettante of the mid-18 th century, although in detail it is the product of many architects, advisers and designers it is fundamentally the product of the romantic mind of Horace Walpole, who was endowed



Strawberry Hill: Horace Walpole's mansion with Lady Waldegrave's additions. (London, England).

by his father with the means to live a life of idle luxury, but had the instincts of a collector and art connoisseur. He espoused a taste in romantic, Gothick literature, architecture and art and embellished his modest villa by the Thames, near Hampton Court, to the west of London, with a series of fanciful additions which he described as 'his Gothick castle'. Because he did not believe that they would have any importance or last much beyond his lifetime he was prepared to build his Gothick fantasies in second rate materials rather than massive masonry of genuine ancient architecture. Where stone would have been used he built with timber framing, brick infill and an external render of rough cast. The elaborate, fan-vaulted ceilings were ribbed and panelled in plaster rather than stone and the decorative pendants were not carved but modelled in as fragile a material as papier macheπ.

The building suffered many vicissitudes but has always been inhabited and maintained. Nevertheless it is surprising that a structure so fragile, survived some 230 years before much of it faced major overhaul following the discovery of a serious infestation of dry rot in about 1980. Two of Horace Walpole's earliest great additions were the library and the Holbein room — separate structures astride the entrance. Both had been repaired after war damage but further failures in the roof coverings led to serious decay. Much of the failure is to be attributed to a maintenance regime which failed to diagnose aging and fractured leadwork. Much of this leadwork should have been renewed very much earlier and a careful documentation of its age together with regular inspection reports would have alerted the owners to the need for renewal. Lead gutters behind parapets are a particular source of danger to masonry because water cannot get out of the structure once it has entered and, in this case there is very little evidence or warning of the failure until a great deal of damage has been done.

The Holbein Room at Strawberry Hill was constructed on a timber frame with brick infilling. By the eighteenth century the great tradition of oak framed timber buildings stemming from the Middle Ages had moved down the social scale and was not used for first rate construction. Standards, meanwhile deteriorated and joints which would have been made with mortice and tenon were often nailed. Iron was more readily available and softwood was frequently introduced. Horace Walpole's builders used substantial oak for all the main framing — and it is just as well that they did. Between the principal members, posts, bressemers and girders they used a mixture of hardwood and softwood for studs. The wall plates were in oak but the remainder of the roof structure was also in softwood. The framing was filled with brickwork. Timber battens were fixed to the framing internally to carry the wall plaster. Externally a coat of rough cast was applied interrupted by string courses and window dressings formed in Roman cement — if we are to judge by the early engravings of the building. This roughcase was replaced in the 19th century.

The ultimate coat of hard Port-

land Cement rendering was effective in keeping out rain except where it had cracked, but being detached from its background of brick and timber it provided an ideal channel for percolation of water and the build-up of dry rot fungus. Decay in the timber, rusting in the iron fixings and the wholesale penetration by fungus of brick and mortar made conservation of the upper sections of the structure virtually impossible. In major hardwood scantlings where decay had not advanced too far drenching and impregnation were used to stabilise and so retain the principal supports. Likewise the roof timbers were repaired by cutting out affected timber and scarfing. The floor was restored, using timbers to match the original wide boards and these were laid loose for subsequent cramping, tightening and fixing after shrinkage. The ornate diaper plaster ceiling was retained in situ and the brickwork of the walls having been replaced was again used as a background for the plaster. A vapour barrier was, however, incorporated on the inner face and a moisture barrier was incorporated beneath the new rough cast which was designed to simulate as closely as possible the original finish, although now carried on a stainless steel mesh background.

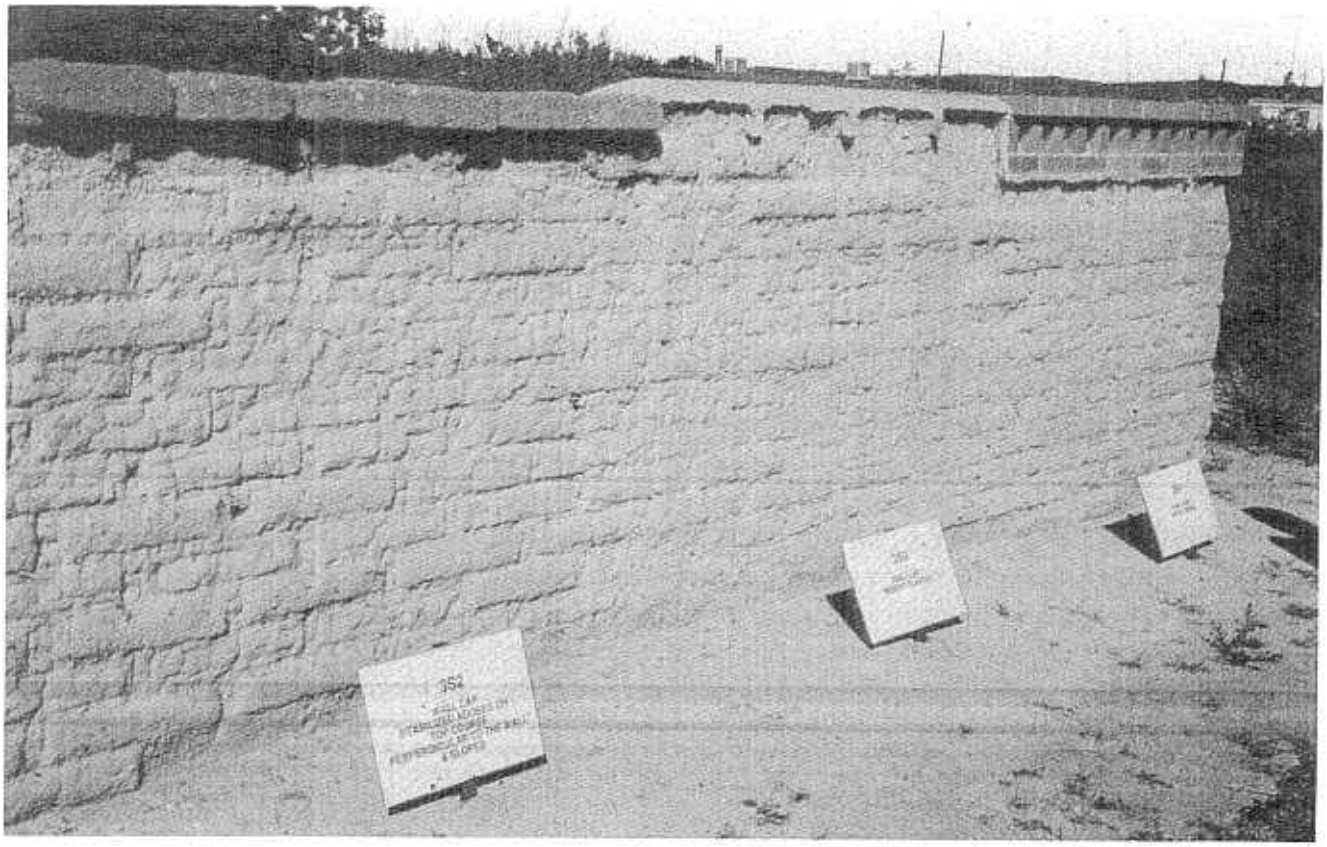
In relaying the lead parapet gutters a secondary waterproofing system was provided beneath the gutters to ensure that in the event of failure or blockage any overflow passing the first protection would be discharged by the second. The structure, therefore, incorporates hidden improvements in materials and in the mechanisms of water shedding. It also moves away from tradition in following modern recommendations for falls and lengths of lead used in guttering, but the visual effect of the building is closer to that designed by Horace Walpole than it has been at any time in the last century.

Architects: The Architectural and Planning Partnership. (The Author).

The Lavant Building at the Weald and Downland Open Air Museum, Sussex, England

Museums of buildings are now quite common. The Weald and Downland Open Air Museum, (set up by the Author and colleagues in 1967) set out to preserve buildings from the great tradition of timber framing of Southern England.

One of many surprising discoveries was the shell of a brick building of the early 16th century being demolished in the nearby village of Lavant and thought to have dated from the late eighteenth century on the basis of a date stone built into the front. It proved that the date stone commemorated the reconstruction of the interior and roof following a major fire and it was, therefore, decided that the surviving early brickwork should be rebuilt at the Museum in a form representing as closely as possible the original building which probably served as a court house or meeting hall attaching to a manor. This deduction based on the window arrangement and manorial ownerships was necessarily speculative since the building had served as an ordinary dwelling after its repair in 1773. Careful recording and analysis of the earlier and very distinctive brickwork makes an original domestic use unlikely. Once all



Fort Selden: test panels. (Las Cruces, U.S.A.).

the early work had been recorded and analysed the bricks were carefully taken down and all those with specific purpose were marked and identified as belonging to particular sections of the building such as doors and windows.

Resources did not allow the marking of all individual bricks and their precise rebuilding, and these were, therefore, cleaned and rebuilt in approximate sequence. Missing sections of the brickwork were supplied by the use of purpose-made bricks of which the most noteworthy are the moulded bricks which formed the window mullions and surrounds. These reflect exactly the forms adopted for timber and stone mullions at the same period and it is significant that the shapes derived for window surrounds in timber and applied similarly to stone were also echoed in brick.

The building, which so nearly ended up as a heap of rubble is an extreme example of conservation, its retention being possible only by its removal and complete reconstruction on the basis of the evidence its own structure provides and of comparative evidence of similar structures. Anastylosis is justifiable in such cases because it provides the

immense advantage of recreation, research, knowledge and utilisation of materials which would otherwise have been destroyed, but this can never justify the avoidable removal of a building from its original site. In circumstances as unusual as this the conservator has the freedom to interpret on the basis of available evidence while adhering faithfully to the techniques and materials which analysis of the building provides.
Hon. Architect: The Author.

ad Dariye, Saudi Arabia

The sprawling mass of Riyadh, the capital of Saudi Arabia, was preceded in the 19th century by a modest permanent settlement along the Wadi Hanifah which formed a linear oasis north west of Riyadh. The Wadi occasionally floods and the gardens and date plantations are, therefore, raised on low shelves above the winding floor of the valley, which at this point cuts through outcrops of rock leaving low salients ideal for defence and building. Among the palm groves and plantations a number of villages developed and its several townships became the political, cultural and religious focus of the region — the Najd. The Al Saud dynasty was established in Ad Dariya in the 15th century, growing in wealth and influence to control areas as far afield as the Hejaz, Iraq and extreme eastern Syria.

One settlement, al-Turaif, developed into the citadel cut off from the desert plateau by an extensive wall which also girdled its complex perimeter along the wadi. The architecture was distinctive of unbaked earth and earth-mortared stone. This local stone is a relatively friable and easily worked shale which was generally used for the lower courses of the building while the upper walls were built with soil placed in a damp condition and compacted. In some buildings horizontal courses of stone reinforced the earth walls. Roofs were flat, of palm and pole joists, with palm matting overlay and compacted mud surfacing. Fuel being in relatively short supply such lime as was made appears to have been used as a wash for decorative and prestigious purposes.

In 1818 ad Dariye fell to an Egyptian army of Mohammed Ali sent to restore Ottoman dominion to these independent territories. The buildings were razed but when the storm had passed the Saud dynasty re-established itself in the oasis of nearby Riyadh abandoning Turaif although the Wadi continued as an agricultural settlement and centre of religious activity. The citadel remained, therefore, a ruin, crumbling gently while intermittent development continued in the smaller townships of the Wadi. Recent prosperity has had two effects — on the one hand to cause piecemeal improvement and development to take place in the Wadi itself, suburban villas and precast concrete schools overtaking the traditional village housing and on the other hand to cause sections of the original citadel to be conjecturally rebuilt in response to growing national pride and consciousness. As they stand the ruins of the citadel, al Turaif, are barely comprehensible and of no attraction to the visitor. However, the great wall defending its peninsula from the surrounding desert has now been rebuilt and above it rises

the massive form of the four story Sa'ad Palace. This reconstruction allows the scale and the nature of the architecture to be understood at a glance. The architecture was very distinctive because of its isolation and freedom from external influence. In detail the architecture of ad Dariye is even quite distinctively different in style from that of nearby Riyadh which replaced it, apparently lacking the distinctive string coursing of Riyadh buildings. Those of ad Dariye substituted for windows ranges of triangular perforations framed in shale which still survive on many of the ruined structures. As important as the buildings themselves is the unaltered and readily distinguished street pattern. This plan of an 18th century Najd town is preserved as an outstanding example of its type.

In the remainder of the Wadi the more complex problem is the retention of the traditional architecture and its reuse. The best surviving traditional buildings have been identified and recorded in part and proposals have been made for providing suitable alternative use. These involve the provision of all modern services encapsulated in separate preformed units within the traditional structures. Traditional repair techniques are used but are balanced by the introduction of modern services. Surfaces subject to particular wear and stress are reinforced with modern materials. This applies particularly to floors and to roofs. With the change in use in some buildings from domestic to semi-public purposes different levels of finish are provided within the context of the traditional architectural background.

As this work is carried forward the requirements of urban planning and conservation of the pattern of modest and sometimes very humble structures is crucial to their successful reuse. Ultimately ad Dariye will provide a balance of recreation and cultural conservation in the traditional structures of the Wadi and the restored buildings of the citadel.

Architects:

Architectural and Planning Partnership (The Author)

Wadi Hanifah

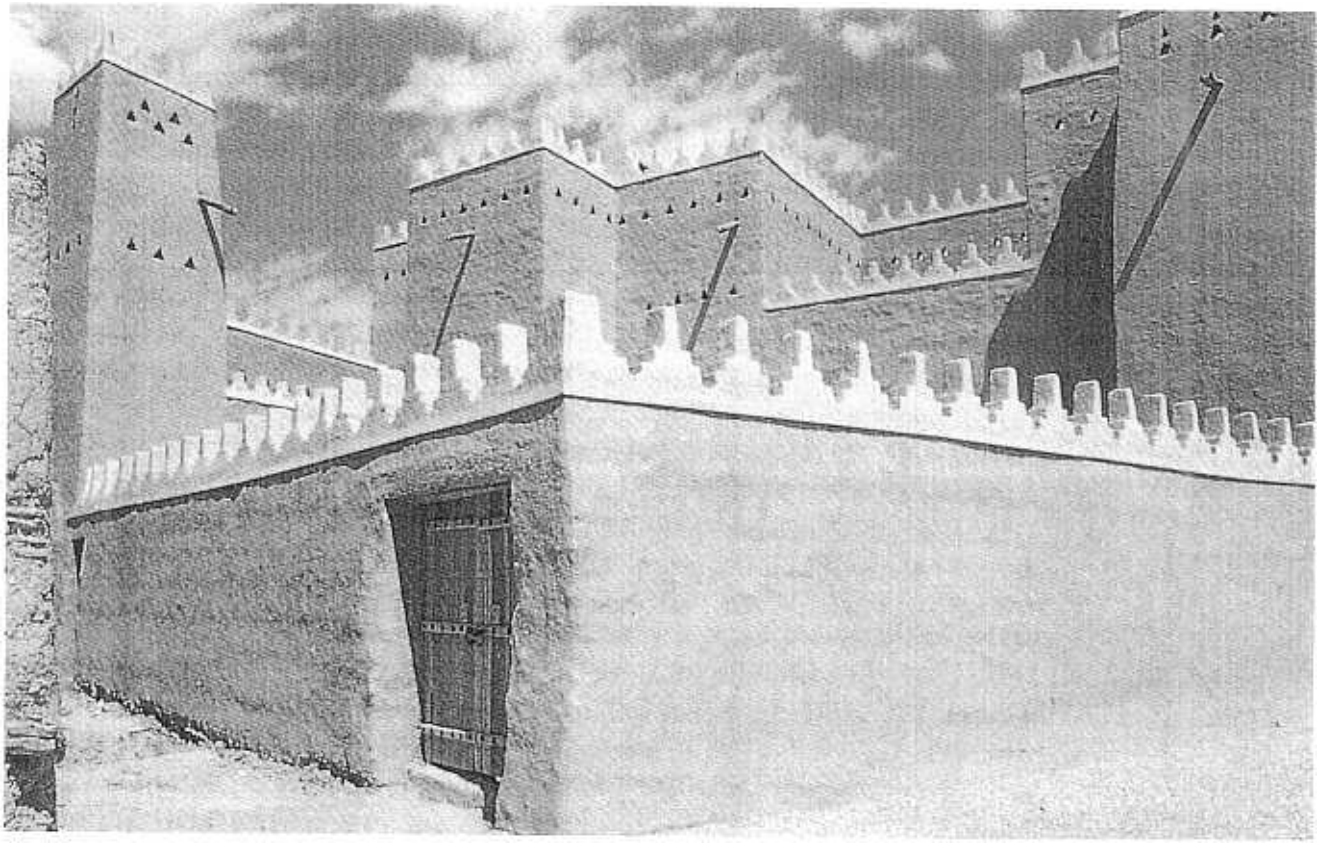
Michael Emrick — al Turaif.

Fort Selden, New Mexico

In the latter part of the 19th century social order and stability was brought to the more remote areas of the U.S.A. by garrisons of troops which in remote situations set up their own barracks. In New Mexico these were constructed in adobe. Fort Selden was abandoned in 1891 and the usable timbers from the roofs were removed leaving the substantial structural walls exposed to the elements for nearly a century before attempts were made to conserve them as an historic monument. Although precipitation is not heavy in the region it is significant. Snow falls in winter and the highest rainfall is in the summer with occasional storm conditions.

After eighty years unprotected weathering many walls had collapsed and many others were close to collapse due to erosion at the base caused by leaching of salts and undercutting by wind-carried sand particles.

The Monument has come under the care of the National Parks Service of the U.S.A. In a most



Restored Palace of the Sauds. (Turaif, Saudi Arabia).

important range of repair and conservation measures many techniques have been employed. Walls have been capped, damp-proofed and stabilised. Undercutting has been eliminated by underpinning with adobe. Drainage has been amended. Soil has been stabilised in surrounding areas and many techniques of structural stabilisation and protection have been employed. In addition a crucially important series of experiments have been run on an adjacent site where ranges of test walls have been erected and experimental panels have been allowed to weather to establish the different efficacy of various forms of natural and synthetic stabilisation and the unstabilised material. The data deriving from these experiments in carefully monitored conditions on identified and carefully analysed soil samples will provide a vital resource of knowledge for conservators. The National Parks Service of the U.S.A. has been assisted by the Getty Conservation Institute in an unparalleled series of investigations which are providing conservations with a fundamentally important resource in knowledge and experience.

National Parks Service: Michael

Taylor — Regional Director.
Getty Conservation Institute: Neville Agnew — Director.

Traditional Courtyard Housing in Baghdad

Baghdad was founded as the capital city of the Abbasid Caliphs in the 8th century and in later medieval times the centres of population and activity moved downstream from the original Round City on the Tigris bank leaving an isolated settlement close by the original northern gate at Kadhimiyeh. There and at Bab al Sheikh in the medieval city, were two of the main concentrations of the traditional courtyard houses of Mesopotamia whose prototypes can be traced back to Sumerian Ur and Babylon.

In 1980 the value of the few surviving groups of traditional houses came to be recognised and a major programme of restoration was begun. The construction is of burned brick for the basements with ribbed vaults often in gypsum mortar, and at ground level in burned brick surmounted by a timber floor. At this level much decorative mosaic brickwork was employed. At the first and second floors the structure would be timber-framed with an infilling of burned or mud-brick and a mortar of gypsum, lime or earth or perhaps a combination of two or three. The roofs were of pole joists covered with palm fibre and finished with a dense platform of mud sometimes incorporating bitumen from the 'wells' at nearby Hit. In almost every sense the construction may be described as mixed and the problems of conservation were manifold. At the basement level there was an incipient and growing problem of damp penetration due to high levels of ground water. This was a relatively new phenomenon and was traced to extensive leakage in the water mains, some of which had been installed during the period of the British Mandate in the 1920s. The remedy, therefore, lay not in the houses or in the porous brick structures themselves but in the services and urban infrastructure. Elimination of salts carried into the brickwork is an extensive problem, demanding the careful use of poulticing coupled with washing. The brick vaults were relatively stable and the foundations were rarely a problem although the bearing capacity of the soils was very poor since they consisted of some 3 m. to 5 m. of urban detritus continually overbuilt as each successive generation renewed decaying properties.

In the timber structures termites are rife — the hot moist conditions suiting several species admirably. The introduction of proofed timber is generally an adequate response where the original member has failed but in cases where elements of joinery and highly decorative material are retained the injection of proofing compounds is complex, laborious and can be dangerous to operatives. It is a process which should be carried out with extreme care and with the benefit of skilled advice and supervision. Termite-proofing of masonry in such situations is exteremely difficult to achieve.

At the upper levels repair of the timber framing is crucial to success. Much of it in its decayed condition was braced by brick panels set in lime-impregnated earth which was

sufficiently pliable to accommodate some movement but could not be retained if the timber framing itself was to be repaired. This brickwork was removed and rebuilt using salvaged materials as far as possible. The mud roofs likewise could not be retained if the pole joisting was decayed. New poplar poles were brought in (from Saudi Arabia!), the roofs relaid and provided with modern insulation and damp proof membranes over a traditional fibre underlay visible from within the rooms and finished with the traditional mud roof where it had been visible.

The majority of roofs, however, were finished with fired brick quarries and these were renewed over a modern lime mortar screed laid to fall. Many ceilings had been boarded and where this had been the case the boarding would be renewed and palm fibre omitted.

Decorative brick mosaic at ground level was often badly damaged and in some cases the tesserae had been lost to the extent that the pattern could be restored only by measuring the indentations in the gypsum background. Templates were always made, tesserae were cut or fired to the appropriate size and then reset in a hydraulic lime mortar rather than gypsum (juss). In some instances damp proof membranes were laid beneath courtyard floors to minimise water entry into the vaults, but this operation was carefully calculated to avoid trapping water which would otherwise rise and evaporate and the preferred system was to provide for rapid run-off in wet weather allowing maximum evaporation for much of the year.

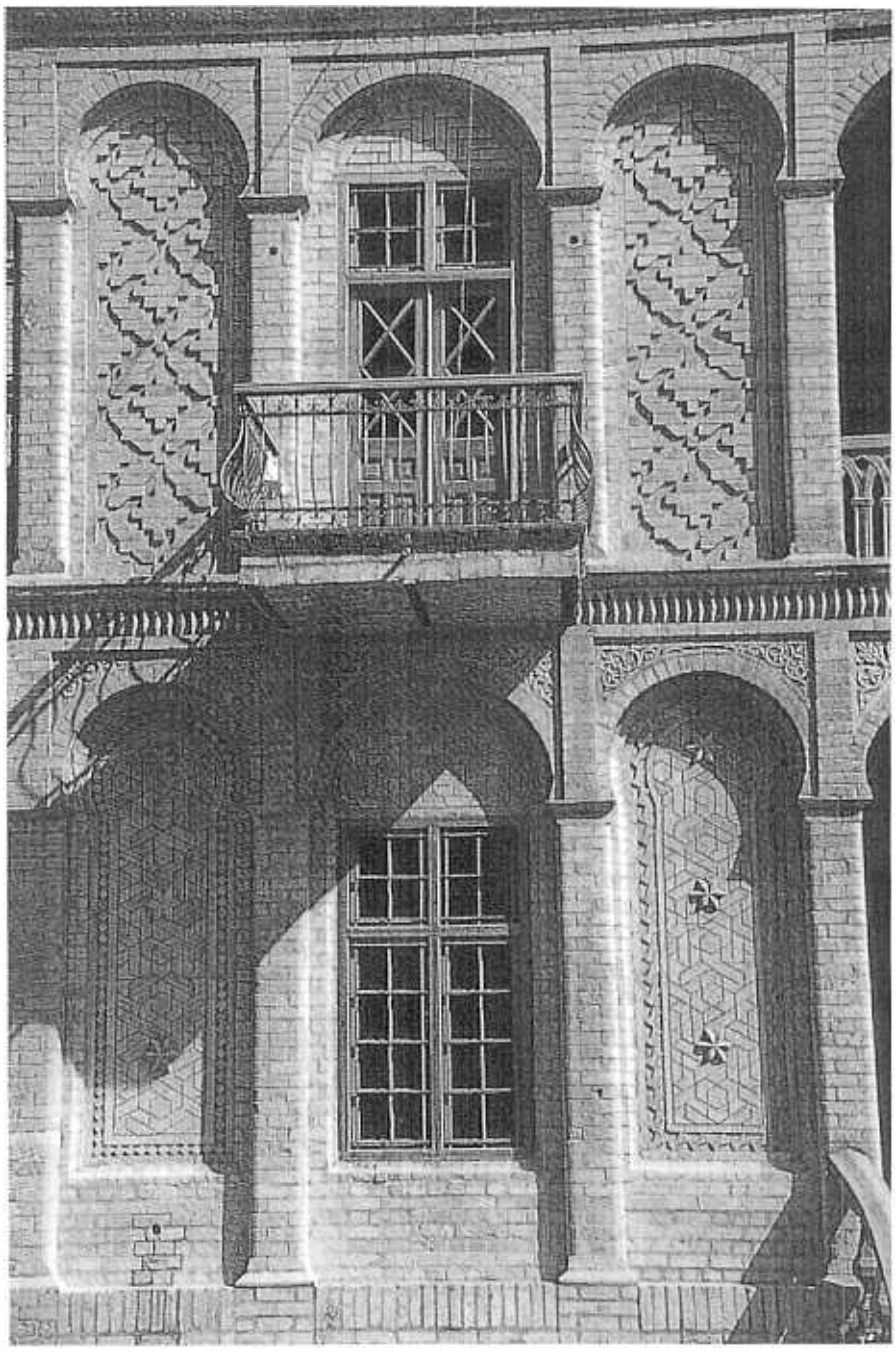
The traditional houses of Baghdad rely for their usefulness on sophisticated systems of ventilation and structural porosity. Ventilation is provided by a series of vertical air channels ducted from the roofs to the basements and the semi-basements. The hot dry winds of summer are thus brought into the cooler damp lower levels of the building, their temperature is reduced by absorption of latent heat as the moisture evaporates and a pleasant micro-climate is obtained. This does much to alleviate the intense summer heats of central Mesopotamea for the inhabitants of cities where the houses are condensed on to small plots, surrounded by party walls, so that the only ventilation is from the roof and on one wall into the street.

If such structures are to be maintained in genuine usefulness they must be provided with modern services and brought up to sound structural standards. The interaction of air conditioning, modern sanitation and heating can be achieved satisfactorily only if the consequences of all conservation and introduced works is thought through with care. Architects: Architectural and Planning Partnership. (The Author).

Every action has a consequent reaction which must be analysed before the work is undertaken. Every defect has a cause which must be understood. Every material has its own characteristics which interact with the other materials chosen for the work.

Conservation must be a test of perception and skill as well as of the purposefulness of the conservator and the context in which his work is carried out.

The purpose of this book has been to integrate the practical problems of conservation in the field with philosophical considerations and the general principles and position of modern technology. Good conservation stems from an understanding of the philosophy and purpose and the capabilities of the materials. Its objective is not to provide prescriptions and specifications: that is the job of the individual conservator. If it has led the conservator further down the path of enquiry into the principles of his craft its work will have been done.



Street facade of a restored town house. (Resafa, Iraq).