Introduction

The function of this volume is simple: to describe the general principles which underlie the art of conservation as it applies to brickwork and earth structures. It sets out methods of decision-making, strategy and planning.

The art of conservation demands wide expertise; in the nature and materials of the building or artefact, knowledge of its place in history, an assessment of its form and function and, in the case of buildings, skill in team leadership. Throughout the process the mind must be disciplined and the perception as keenly directed to the future as to the past. A building, once conserved, may have a past of 2,000 years and a future of, who knows — two hundred thousand? This awesome thought places on the conservator an onus of responsibility which must temper any wish to express his own personality through the medium of the work in hand.

Brick and earth structures are among the most enduring of mans' built works and by their nature they tend to be massive. They succumb, nevertheless, to the inevitable forces of destruction and of these man himself is one of the most potent. Part of the art, therefore, is in the disposition of the building and its use by mankind. In this social dimension the conservator may be relatively powerless — at best an adviser and facilitator, manipulating law, finding funds and securing effective utilisation.

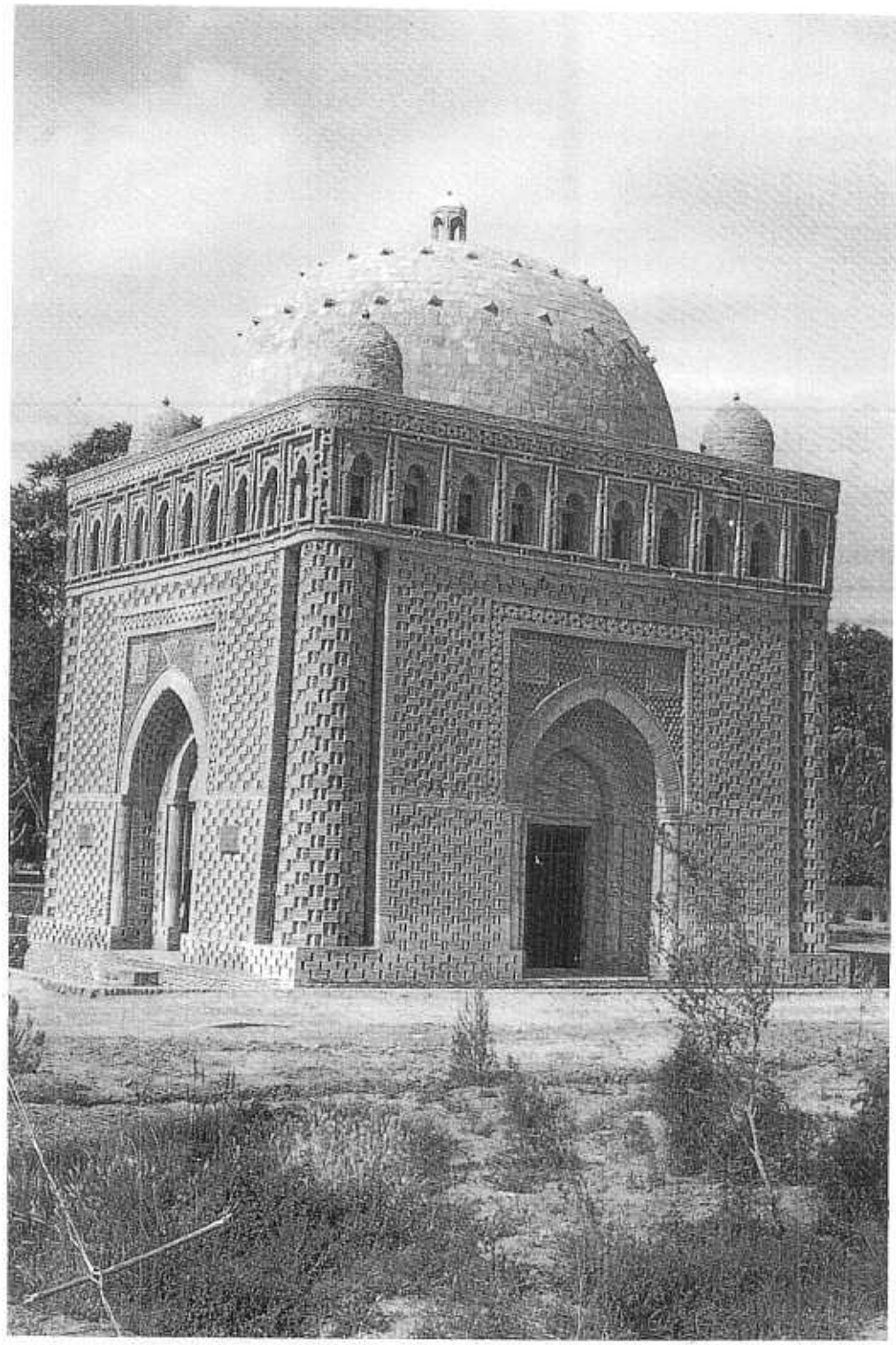
Conservation serves several purposes. In the social context the fabric of mans' built past is meaningful to him in the same fundamental way as the landscape he inhabits, and people deprived of the environmental asset of their past lack a part of the understanding of their own history. The sense of loss can be tangible, resulting in instability and a yearning for environmental security. The distinctive shapes of the earth villages of sub-Saharan Africa provide its inhabitants with evidence of their origins in just the same way as do the mellow brick walls of some Hanseatic town whose burghers sense in their environment the deep roots of their trading past. No conservator need be ashamed of admitting that one fundamental purpose of his work is the retention of a fabric which meets the deep psychological needs of those who inherit it and pass it on.

An allied purpose of conservation is the retention of a culture. While the social purpose may be to provide continuity within the historical past

the cultural purpose is to retain the creative achievement represented by the buildings, the town or the landscape. The intellectual endeavour which will have gone into the creation of architecture can only be fully represented by that architecture itself. The level of cultural achievement may not be high but it may nevertheless be important. In the oasis villages of Northern Arabia the patterns and repetitive devices applied by tribesmen to their woodwork and to the mud which coats their buildings has a quality which makes them unique in time and in place; and in that sense they are as important as the great terracottas displayed on Italian Renaissance buildings. The culture is commemorated in the artefact, and the qualities of the society that created a civilisation are measured in the architecture left behind as much as in their literature or their music. Societies may disappear but the cultural artefact remains to provide a direct access to those who created it. There may be no direct continuity between those who retain the structure and those who made it, and at times there may be only a derivative link, but its retention is perhaps all the more important for that reason alone. The Turkish conservator working to preserve the brick vault of a Byzantine church is retaining a past directly relevant to his own society although there is no apparent ethnic continuum.

The very rarity of some fragments of past societies may in itself be a special reason for, and give a particular purpose to, conservation. The city of Bokhara in Uzbekistan preserves a mausoleum with an extraordinary intricacy of patterned brickwork attributable to the tenth century King, Ismail the Samanid. No other comparable building survives. Were it not for this one rich example, patterned like a tribal rug but in solid brickwork, there would be almost no evidence of a culture known otherwise only by fragmentary remains in poetry and literature. Rather more is known of the earlier Sasanian civilization in Mesopotamia but of Sasanian building skills the one structure that gives measure to their achievement is the great parabolic brick vault standing today at Salman Pak, south of Baghdad. This single remaining structure of the great palace of Chosroes Anushirvan at Ctisephon is the single building by which the structural achievement of that world power can now be assessed.

These arguments of purpose are historical and to them must be added one other — science. Any historic fabric is evidence of the circumstances and techniques of its age of construction. The circumstances of its building, determined by available materials and the use of techniques inherited or invented, are the prime evidence of the movement of civilisations and one purpose of conservation must be to retain this evidence. But the artefact encapsulates scientific information. Fragments of organic material permit dating by the measurement of atomic decay — the Carbon 14 technique. Other analytical techniques include Thermoluminescence and Optical Dating, both of which use the effects of long burial to provide alternative methods of dating by sampling. Other techniques are known but



The Mausoleum of Ismail the Samanid, Bokhara, Uzbekistan.

little used — such as the qualitative measurement of saline impregnation; others have yet to be perfected or even to be discovered. The analysis of soil particles and airborne deposits such as pollen can provide evidence of conditions and dates of construction. These and other forms of scientific analysis provide information on sources of materials and distribution of the origins of materials which in the long future of conservation will add to man's knowledge of the past. The loss or destruction of such evidence is to be deplored.

Conservation can serve one further purpose, sometimes treated as a justification:- the economic utilisation of the structures. As has been discovered by many builders in the past it can be less expensive to reuse a building than to build anew. The adaptation of historic structures to new or enhanced usefulness is often an economic ground for conservation. Earths and brickwork are massive and involve substantial labour. Patination and the maturity of age are qualities which they gather and which cannot readily be simulated nor honestly created afresh. Where society has a use for buildings of this calibre there is a strong economic ground for their conservation and skilled repair. To describe a purpose of conservation as economic, however, raises the concern that where economic advantage cannot be demonstrated a converse argument can be used for demolition and it may be more wisely thought that the economic argument is secondary to the fundamental purposes of historic continuity and cultural retention.

Strong in compression and weak in tension, massive by nature and generally heavy, earths and brick are, with stone, the characteristic material of walling. Being inert in a practical, if not a chemical sense, they are durable and take on special hues and characteristics with age. The methods of assembly — bonding — and forms of construction have produced a wide variety of historic characteristics intrinsic to style, age and place. Sympathetic repair requires the use of materials and techniques which are appropriate to the context and produce a result that is acceptable in terms of the historic qualities of the place or building.

If man's earliest constructions were of mud simply piled together and dressed into an homogeneous mass the next step was to provide for the use of hardened mud, easier to transport, to be laid in place and joined with a wetter mud. So the first mortar was created. Only where mud is used in a plastic state can a mortar be avoided, so the form of a masonry structure from earliest times has been significantly dependent on the bonding, the nature of the mortar as well as the character of the brick whether of mud or of burnt clay. Early bricks were of a type known as plano-convex, that is to say having curved upper surfaces, being hand moulded like a lump of dough. These have been exposed in the excavations of the Nile and the Tigris-Euphrates valleys in buildings dating back several millenia but these and many other forms of unbaked earth bricks have been covered with mud or render as an external coating so that the intrinsic nature of the wall structure will have

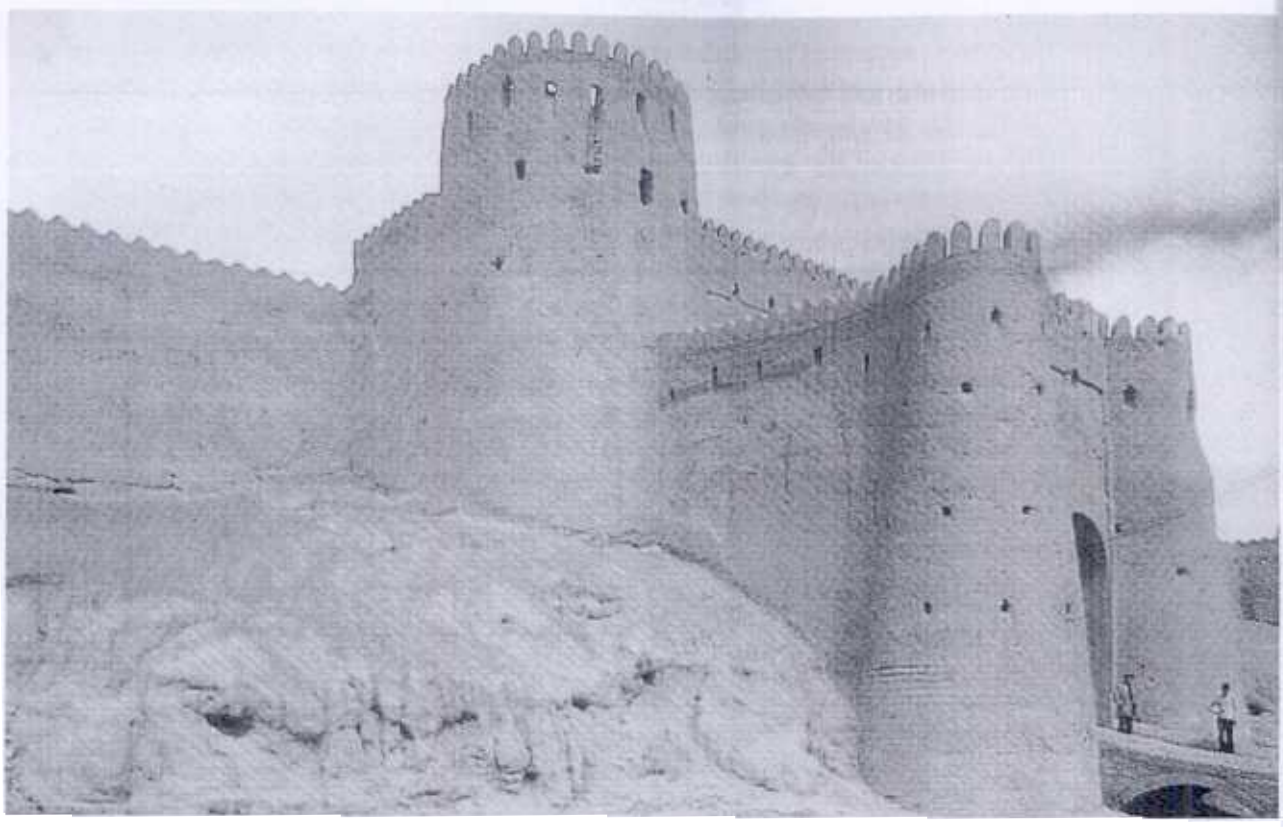
been concealed from the outset. It is the nature of mud brick construction to be rendered over with a mud plaster and the quality that arises in earth structures, therefore, is that of a superficial layer or coating designed to be sacrificial and to be frequently renewed. This layer may be of exactly the same material as the wall. It may be reinforced, perhaps with straw to give it greater cohesion to reduce the nature and size of the cracking and so to give it more weathering resistance and the straw will, itself, become a telling feature in the quality of the surface. It may be coated with a hardened mud, perhaps containing a calcareous material such as crushed lime or chalk. It may have been coated with a material based on burned lime, at the simplest a lime wash, providing decoration and a coating with weather resistant qualities.

The handworked nature of such operations has given a special quality to such walls, many of which defy the normal rules of level and plumb bob, being battered back as they reduce in thickness with height to suit the shape of the building, curving and being modelled with subtle contours that suit the hand and please the eye. Such buildings with natural organic shapes possess special qualities of their own which are best and, perhaps, only perpetuated by the same methods as were used to create them. The batter or inward inclination frequently given to walls built in unbaked earths reflects the natural instincts of the builder in handling material of uncertain compressive strength and although earths under suitable compaction can achieve remarkable values in compression, their tendencies to become fissiparous mean that they are relatively weak structures in tension, capable, nevertheless, of being carried to heights of 30 m.; but it is out of this characteristic that the need for massive lower courses derives and hence the tendency of builders towards the use of a batter rarely found in more robust forms of masonry.

The softness of earths, likewise, causes builders to round corners so that parapets, quoins and sharp edges are softened off with the simple objective of dispersing wear and erosion over a broader surface and thereby minimising its effect. The occasional introduction of other materials to provide drip moulds and to reinforce quoins provides a sharper counterpoint which distinguishes some local styles of building.

Likewise the formation of openings in earth structures takes on special characteristics due to the materials. Openings are generally narrow and where no other material is used for the arch or lintel they tend to be sharply pointed. In consequence some distinctive forms have evolved such as the very distinctive multiple triangular perforations used in the traditional architecture of the Nejed in Saudi Arabia.

In the complexities of traditional roofing, domes and vaults have been elaborated, at times to an astonishing degree. Unreinforced, thin-shelled domes often take a parabolic form, the increasing compressive stress in the lower zones being reflected in greater thickness of the haunches. The naturally circular plan of such structures is sometimes



Typical shapes of earth construction — battered walls and rounded corners. (Bam, Iran)

reflected in the ground plans of the buildings and in consequence in general structural patterns.

In barrel vaulting the thickness of a haunch may be lightened by secondary vaults introduced into the structural mass. In the formation of domes and vaults, ribbing, perhaps using especially dense blocks, has been evolved as a method of breaking down this space into manageable panels and spans and this in turn has given rise to a wide vocabulary of design dominated by the interlocking and intersection of ribs and arches.

Other practical features have evolved from the need to maintain such buildings. Coatings and renders are an inherent and natural method of protecting earth structures from erosion and because of the frequency of treatment, particularly in the case of mud renders, the support systems, have themselves become decorative features, their special characteristics varying with locality. Even in the handling of the rendering, pattern-making becomes distinctive — from the characteristics of providing drip-courses and drip-moulds to the finger marking left by the application of the material.

An even wider variety of character flows from the introduction of many

other materials which go with earth construction. The combination of earth and timbers produces distinctive systems of support from panels of wattle to massive timber framing. These characters vary from region to region and tribe to tribe and sometimes village to village, often intermixed and betraying the long historical evolution which is one of the great social generators of vernacular building. The timber framed panels of northern Europe carrying a wooden weave heavily daubed with earth are, perhaps, an extreme case, where the timber is structurally dominant but equally crucial to the survival of the earths is the stone lower coursing adopted in hotter climates to inhibit the rise of salt laden ground water and to permit evaporation through its joints.

Combinations of materials are common and burned brick is often found in combination with earth and earth block, as a facing material, as a reinforcement to quoins, as foundations and as arch and vault. In such combinations the nature and quality of the mortar can be critical and may be the common element in the structure.

Burned brick being very much more rigid than dried earths, exhibits very different characteristics when built into walling. The mortar used is always a different substance with its own special qualities and distinct colour. Bonding, or the arrangement of bricks, in consequence becomes critical to the visual effect. The rigidity of the burned brick is reflected directly in the character of the walling which is necessarily more precise, angled, vertical and methodical than a wall of unburned material. Its greater load bearing capacity allows the construction of wider arches and high straight-profiled walling. Most importantly the body of the material itself becomes the important visual characteristic. The shape, colour, size and the arrangement of the bricks becomes the predominant charactristic. Colour, texture, size, shape and laying of bricks vary from time to time, with region and style and these qualities become predominant in the architecture. Their retention becomes a crucial feature in conservation.

Unlike earths which readily wear away, brick is durable and an exposed surface may last for many centuries with relatively little change: but such changes as do occur can be critically important to the quality of an historic building. Patination, ingrained rain-washed dirt, growth of lichen and algae — even of plants — all contribute to the quality and character of the walling. Brickwork is enhanced by time and the effects of weathering. The durable surfaces reflect the passage of years and rarely require cleaning down and refacing. History becomes ingrained. Not so with earths which wear away and in the process of erosion present problems which the conservator must tackle by renewing the surface just as his predecessors did before him.

In conservation the policies applicable relate to the degree of urgency, the nature of the defects, the type of threat and the intended use of the building, but in deciding on a course of action a number of overriding principles apply. Foremost among these is the principle of MINIMAL INTERVENTION coupled with

REVERSIBILITY. The ideal is that the historic fabric is interfered with as little as possible and that any intervention made should be capable of being withdrawn leaving the fabric as it was. Conservation must always be undertaken with INTEGRITY — the determination that materials appropriate to the purpose are used in a fitting manner. Coupled with this must go SYMPATHY to ensure that new work is consonant with the old. The character and tone of the building are determined by the original work and any intervention must accord with the overriding qualities of the original. HONESTY dictates that all work is what it purports to be and DATABILITY allows that, on analysis, the age and nature of any intervention can be proved. A further principle might be defined as LOCATION, to underscore the relationship of a structure to its site. It is argued that a building is irrevocably a part of its location, being created for and welded by use to its site. While there are some exceptions, in the case of buildings that can be moved, this concept of location does encapsulate an important aspect of the integral relationship of a building to its surroundings.

Fundamentally these principles aim at honesty in expressing the time and nature of the work of conservation, sympathy in ensuring that it does not obtrude, integrity in its being of the appropriate calibre and reversibility where possible so that future conservators need not necessarily be bound by current work. To these some conservators would add a minimalist approach, arguing understandably for doing only what is most essential for structural reasons leaving undone even work necessary to control decay — a philosophy describable as decelerated erosion. Sometimes such principles are clearly in conflict with other objectives and for this reason the conservator must understand the priorities which govern his work and be prepared to use his principles as the overriding criteria.

There can be instances where no action whatever is justified. A surviving structure below ground may be analysed by remote sensing techniques, such as magnetometry and be left undisturbed; but most structures will require some form of repair or restoration if they are to survive.

An example might be a mud-brick structure of antiquity exposed in archaeological excavations. The minimum intervention would be careful exposure and recording followed by careful reburial. Such action, however, would be unattractive to authorities wishing to exploit the site for tourism. They might seek the stabilisation of the remains for purposes of permanent access and this, in turn, might entail the *irreversible* introduction of chemical compounds and the *reversible* building of shelter structures for protection.

The acceptability of such proposals would be weighed against their disadvantages. A less acceptable proposal might be the construction on top of the genuine material of a replica or reconstruction of the original building. However unacceptable this action might appear it could be preferable to a policy of apparent non-intervention, — i.e. of leaving the original structure ex-

posed at the mercy of the elements and visitors. Such a policy would quickly result in the total destruction of the original material. Even reburial might, however, carry with it severe disadvantages where, for instance, the pattern of drainage or vegetation was changed by new circumstances altering the water table or layer allowing root penetration. Sometimes destruction is unavoidable. One archaeological layer might have to be removed in favour of the retention of another! Where major constructional works will eradicate the site the option may be abandonment or removal of the material to an alternative location. The nature of the intervention to stabilise or secure the original construction will be determined by the circumstances and overriding imperatives but the nature of the material also plays a part.

Mudbrick can only be removed with great difficulty and inherent damage to its nature, even though in the final event it may be restored visually. Brickwork, however, may be removed en bloc or piecemeal and reassembled skilfully to recreate the original arrangement, recreating the pattern of wear and weathering very precisely. In the process the mortar may be partially or largely renewed but this renewal is no more than would have been the case had a building remained in situ but required repointing.

In postulating this simple series of possible events a wide range of options become apparent and important definitons arise. They may be summarised:-

- *Deterioration:* controlled or uncontrolled. There is no philosophical compulsion to preserve the artefacts of the past. It is accepted that a mountain should deteriorate naturally without interference and by similar argument a ruined structure may reach a state where its contribution to the landscape is one of decay. Occasionally man is moved to counteract erosion upon a mountain, (particularly if he is the cause of it), and likewise he may feel inclined to slow down or halt the erosion of a monument. Alternatively the structure may be left to decay naturally out of a policy of non-interference or simply as a result of economic necessity.
- *Preservation:* a ruined structure may be 'frozen in time' by judicious protection from erosion. It may be stabilised in a particular state, perhaps paying special attention to the degree of ruination. It might, indeed, be encapsulated in another overriding structure — a process becoming more common as urban archaeology reveals more structures relating to urban history. By the removal of the weathering, decay can be halted without the introduction of special stabilising techniques, but even when the structure is not encapsulated the careful use of techniques which protect the core of the structure can slow down the rate of erosion in brick so that it proceeds very slowly. In earth structures patently this is less easy but more sophisticated techniques of control based on chemical and physical methods of protection will increasingly be able to protect and restrain the rate of loss.
- *Maintained utility:* this is the most common and desirable circumstance for a built structure and

Typical vaulting techniques common to burned and mud-brick construction. (Faraj, Iran)

it presupposes that there can be a continuing function compatible with its original use. In such a case the building continues to serve a useful purpose being maintained with special care so that the structure is not subjected to unnecessary stress, erosion or decay while it continues to serve usefully. Continuous attention must be given to ensure the best possible performance and this will generally mean the maintenance and occasional replacement of building components, some of which last longer than others. The bricks of a wall will survive while the pointing decays and is replaced on a regular cycle. The bricks and the pointing will, perhaps survive longer than lead flashings let into the brickwork which are replaced on a different cycle. Meanwhile the entire structure continues to function carrying loads, providing shelter and acting as an historic monument in a changing society. An earth structure will suffer the decay of its outer skin and consequent renewal on a cycle of high frequency. In some instances an outer protective coat, perhaps of limewash, will be renewed even more frequently and although the use of the structure may change, its condition will be stabilised. Maintenance involves repair. Repair is simply the making good, on a like for like basis, of worn material with a replacement or alternatively of the insertion of compatible material to make good elements which are lost or in the process of decay.

For clarity the other terms commonly used in the processes of conservation are also defined.

— *Renovation or renewal:* where major repair of brick or earth requires the removal of substantial parts of the original fabric and their replacement on an extensive basis, the work is best described as renovation. It is likely to involve the removal and restitution of several elements simultaneously. Problems are often multiple. Rot may have caused the decay of timbers which in turn have affected the stability of brickwork. The renovation will entail the removal of that part of the structure which is no longer viable and its renewal, using the original materials so far as possible.

The loss of part of the original material — timber, plaster, perhaps brickwork, is followed by rebuilding which may include the introduction of some new material. Neither decayed timber nor removed plaster will be suitable for reuse in renovation although the brickwork itself will be repairable. In some circumstances a decorated surface fresco painting or mosaic may be removed and replaced on a renewed plaster substrate.

— *Restoration:* It may be necessary to restore the structure to its original condition and for this purpose later interventions may be altered or removed. A bricked up window may be reopened and in the process the evidence of the bricking up may be destroyed; the material of the bricking up, itself historic, may be removed and new material simulating the original window may be inserted. These actions are only sustainable if they are part of a properly thought through policy of conservation. Overriding policy considerations may demand structural actions involving serious physical alteration in the interests of restoring a struc-

ture to its original form, but such measures are tolerable only in a context which justifies them on a comprehensive assesment.

– *Refurbishment:* Extensive renewal or modification of secondary elements of a building may be required to adapt the structure to a new purpose. The introduction of modern services is perhaps the most common instance and is normally accompanied by redecoration and often by remodelling. The enormous world stock of earth houses is, in broad terms, a stock of structures lacking modern amenities. Their introduction involves extensive refurbishment. New pipes and ducts, cables and fittings are accommodated by cutting into the historic structure which is then repaired or resurfaced. As the environmental consequences of these changes makes its impact on the structure serious deterioration can take place unless they have been foreseen. Water leakage into earth structures can cause dramatic slump and structural failure and the refurbishment itself will induce new patterns of use, new loads, changes in humidity and temperature and physical alterations which may stress an ancient fabric in ways to be foreseen and guarded against only by skill and experience.

– *Reconstruction:* The remaking of a structure by taking apart and reassembly (anastylosis) is a dramatic level of intervention justifiable only by extreme decay or major calamity. An historic earth building shattered by earthquake, brought to collapse by flood, or demolished by bomb may justifiably be reconstructed. Its doors, windows and timber floors may be repaired and reused but the material of its earth walls can only be reused by remixing the material to form new blocks, bricks or mass walling.

Reconstruction may, nevertheless, be justified in historic terms. A brick building may be burned out with the destruction of the plaster on its walls and the timber of its floors. Its roof may be totally destroyed, its slates or tiles shattered, but the brick walls may survive and reconstruction will be justifiable if the interior is to be recreated to match the quality and historic significance of the walls that continue to stand. In essence anastylosis means the rebuilding of a structure in its original form using materials which survive or are identical with those originally used, but rarely does such an operation take place without the introduction of more modern materials or new technology.

Reconstruction may be justified by external and internal contexts. Where the damaged building is a vital part of an urban scene or streetscape, or a focal element in a landscape, reconstruction may be preferable to demolition to preserve the established historic context. Where the contents of an interior have been saved and can be replaced the reconstruction may be justifiable as being the best method of their display in the most meaningful context.

– *Re-erection or relocation:* the building may be removed from its original site and replaced elsewhere. The process may involve reconstruction and anastylosis or in some instances a building may be moved as a complete entity.

The essence of this process is to

extract it from one context where it is archaeologically verifiable to implant it into another which may be synthetic — as in a totally new museum environment, or contextually different as where a building is removed from one part of a town to another. While this process is capable of arousing heated emotion there are many instances where it is acceptable and there are some building types designed or expected to be moved. In some contexts the least harmful of such removals involves relocation on a site very close to its original position — further up a hill whose lower slopes are to be flooded by a new lake, or further down a street when a new road is to obliterate its original site. Such processes have been undertaken throughout the ages where the encroachment of the sea or some other similar problem has made a first site untenable, but it has in recent times been accelerated by the rate of change in modern cities and the growth of museums of buildings, almost all of which treat the built structures as artefacts which can be moved. Care and sensitivity are vital in conservation; in relocating buildings doubly so.

The relocation of earth structures is possible only in the most exceptional cases although earth components, such as panels of wattle and daub are transportable and reusable, if sufficient care and skill is deployed. Brick structures, because of their mass are difficult candidates for such treatment and where such work is done it will normally consist of reconstructing the facing bricks against a core of new material. Although this may be visually satisfactory and, it may be argued, is honest in practical terms, the uncomfortable feeling engendered leaves the conservator ill at ease.

Sometimes entire brick structures are transported without dismemberment, underpinned, supported on steel platforms and lifted by cranes or put on rails.

All historic buildings need care and skill in their maintenance and differing types of structure demand different skills and appropriate routines of care. Both brickwork and earth structures are of such age and continuity that long traditions of maintenance routines have evolved relating both to climate, locality and nature of the materials and these routines have become an established part of the lifestyle and a feature of the configuration in the buildings themselves. The projecting poles and stone corbels of walls and domes that need frequent rerendering with mud are instantly recognisable as design features in the vernacular architecture of the regions where they occur. Many more subtle features model or affect the design of buildings right through the social scale. The drip moulds which protect openings in the brickwork in wet climates have become distinctive as design features illustrating that detailing can be as important a distinction as the material itself.

Building conservation, like medicine provides for preventive treatment, which is often overlooked at great cost. The maintenance of sophisticated machinery on which human life depends has accustomed recent generations to the concept of planned inspections and planned maintenance and also to the idea

that a professional inspectorate is the most efficient answer to the need for planned advice and continuing care. The earliest signs of problems arising are often slight and it is necessary to differentiate between symptons of importance and those which can be disregarded.

Changes in the levels of ground water or loss of wind protection which might have little significance on a brick structure can lead to rapid failure in earth buildings. A bulge in an earth wall may appear to be nothing more than a natural contour but it may presage a significant movement following a change in loading pattern or a loss of internal integrity. The nature of cracking in brickwork will be a consequence of the distribution of loads and stress. The movement or strain will have direct implications for the trained observer alerting him to the nature and point of the application or pressure, the degree of movement and the possible cause.

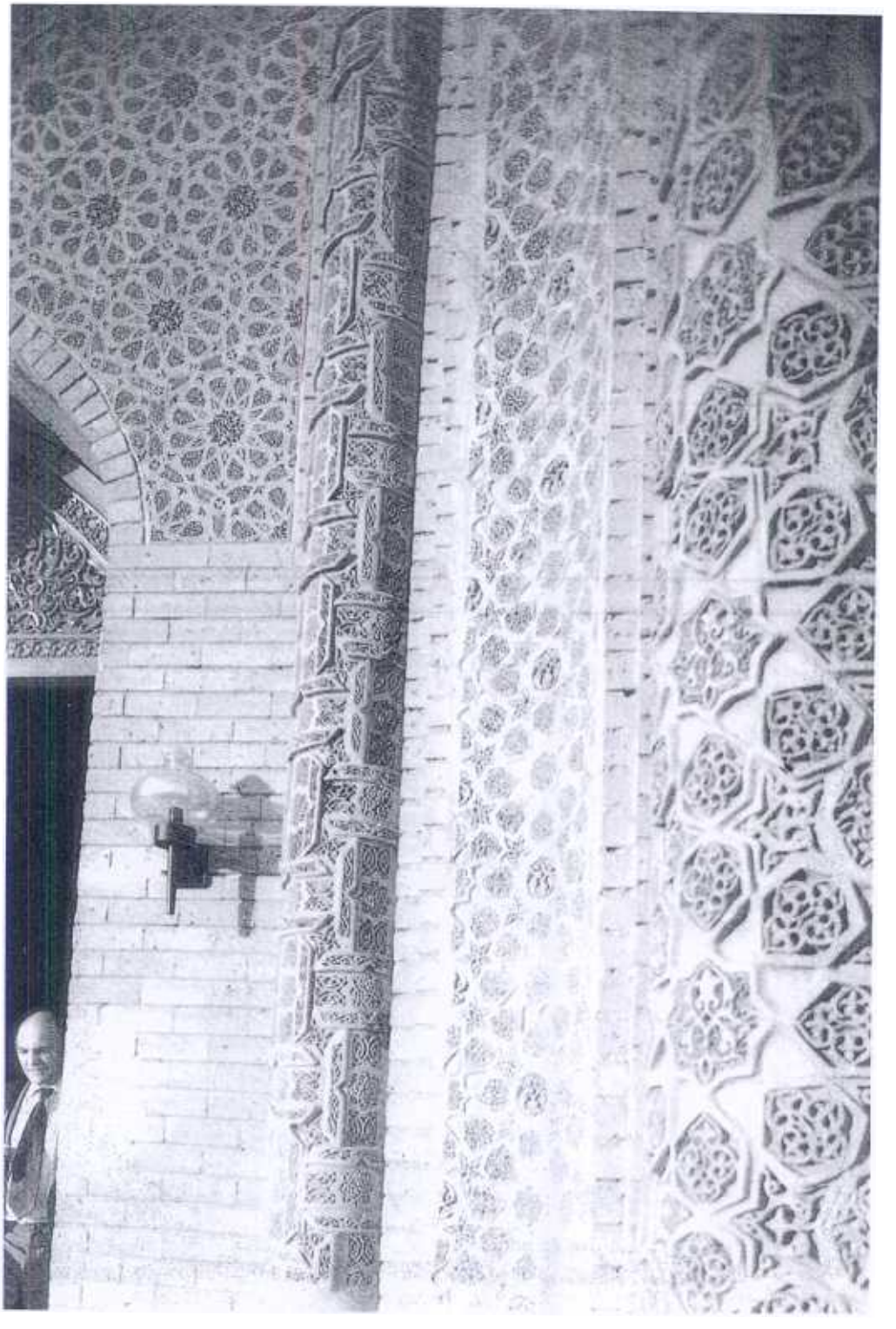
Other forms of maintenance depend on assessing the nature and rate of weathering or erosion and the consequences of the failure of other building components on the brickwork or earth structure. The effects of previous interventions are often ignored, it being assumed that they have been effective. In practice incompatabilities in materials or parts of structure may not become apparent for some considerable time.

Both brick and earths can withstand the incompatibilities of thermal movement to some degree before the effects are readily visible. In the case of earth structures the resulting fractures are prime sources of water entry and decay. In brickwork such discontinuities can alter the loadings on the structure and on other components with further long term consequences, but the direct effects of water entry may be less significant.

An essential part of the continuous care needed by historic buildings is a programme of management. Regular inspection at intervals determined by the nature of the structure must be recorded and reported. Appropriate work, scheduled perhaps well in advance, and a coordinated work programme carried out will economise in labour as well as providing early responses where necessary and effective economic repair.

Historic building is, by nature and definition, long lived, outlasting the generations who use and care for it, and therefore records of work done are of more than passing of interest to future management and historians; they become an important tool and store of knowledge in the operation of maintenance programmes. They should contain information as to the sourcing of materials, the nature and extent of work, the types of work carried out and its sequencing.

Such methodical operations will, of course, cover the whole of the building fabric not simply the brick or earth structures, and these, being generally the less vulnerable of the components will probably feature less in the normal maintenance programme. Nevertheless it is helpful to future workers and conservators to know exactly what alterations were made to the brickwork, where the bricks were obtained and where the components for the mortar came



Carved brick creating patterned surfaces. (Baghdad, Iraq).

from. Armed with this information future conservators will be able to assess the effectiveness of the conservation techniques previously used and model their work accordingly.

Spare parts or reserve stocks of material can be retained where special manufacture has to be undertaken. As many a large institution has discovered the retention of appropriate materials can handsomely repay the relatively small cost put into their manufacture and storage. Matching bricks, particularly those made with techniques of firing or modelling no longer available, can be invaluable when replacements are called for. Moulded bricks and special components, tiles, ridge pieces, finials and decorative items are all obvious candidates for deliberate over-production and careful retention of spares. Prudent husbandry coupled with foresight will save much agony and expense in remedial work and, importantly, in conservation of fabric which might otherwise be destroyed.

Sometimes action distant from an historic place can be vital to its future. Diversion of a water course or arterial road may save an earth building from a flash flood or a thin-walled brick structure from the vibrations of heavy traffic that will destroy its lime mortars. Defensive conservation of this sort can be achieved only by foresight, knowledge and skill, coupled, perhaps, with determination and political acumen. Failing the right action at the right time the ensuing and avoidable damage will require repairs which interfere with the historic fabric. Avoidance of loss is a measure of conservation achievement. A mud wall, standing unchanged, may not be apparent as an act of conservation, except to those who installed the drains that kept it dry, avoiding collapse. It is generally true that the less visible the work of conservation, the greater the success of the conservator, providing always that the building remains sound, usable and as long-lived as can be foreseen.

Defining the point at which repair work should be undertaken is a matter of skill and discrete judgement, particularly in worn brick work. The life of an historic building should be extended by simple measures such as minimising wear, providing protection and avoiding unnecessary intervention. Redecorations should be extended to the maximum permissible cycle consistent with longevity and the judicious replacement of components will be governed by a minimalist approach. Better an original brick with a decayed face than an expensive new replica, but better an earth wall under a newly thatched capping than the loss of its topmost course.

New materials in building are legion and all must be regarded as suspect until their characteristics and qualities have been proven in carefully monitored experiment.

The general principle of integrity or fitness for purpose requires that the standards of workmanship and materials are such as to enhance the life of the building while being compatible with the nature of the structure. There is no objection to the introduction or use of new materials provided they fit within these criteria and have sufficient longevity but conservators are aware that the

history of their craft is littered with experiments whose failure has left many historic buildings or artefacts irreparably the worse for the treatment they have suffered. While it is true that cements can be used effectively to stabilise earths their use in earth structures has, on many occasions, proved disastrous. In contemporary terms a wide variety of synthetic polymers are being used as experimental materials in attempts to consolidate earths and prevent erosion and decay. Many failures are already apparent but some materials, carefully tailored to the nature of the original structure offer promise. Careful long term evaluation will be necessary before any conclusions can be reached as to the permanence and effectiveness of these materials. Complex organic compounds (which most of these are, or contain in part) have a relatively short life by comparison with earths and baked bricks. Such organic compounds may break down of their own accord progressively over a long period, they may be susceptible to the effects of temperature, light or other forms of radiation and they may react with water. In addition they are likely to prove susceptible in some form to the myriad lower forms of life as food or as a reagent with the complex organic compounds of the life forms themselves. Some such products are designed to break down leaving residual stable compounds, such as silicates, to provide permanent stabilisation. Others are designed to polymerize or build up molecular components as part of the process of consolidation.

Only long and extensive testing in the field can ultimately determine which materials and under what conditions those materials will be satisfactory. There will be no simple formula although there is an encouraging prospect of the development of ranges of materials of specific usefulness in the consolidation of both earths and burned brick. This prospect coupled with greater knowledge and skill in defensive conservation will supplement the traditional methods of resurfacing and replacement, but it should always be remembered that these fundamentally historical techniques of conservation are not to be superseded lightly since they are, themselves, part of the historic process.

Good methodology in analysis is crucial to success and must extend to perception of changing conditions and developing situations. It is not sufficient simply to analyse faults after their effects have become apparent. Comparable circumstances and estimation of permanence must be used to predict the effects of weathering or change upon a structure. Some materials decay at a known rate — for example lead flashings in brickwork will fail predictably due to crystallisation, — metal fatigue. Monitoring background matters such as changes in water table or temperature regimes, levels of salinity and settlement, all demand an accurate data base. The prudent owner of an historic building will create a background of essential data as a prelude to any intervention.

Good conservation demands methodical procedures in determining the courses of action and in their implementation. In working

with long-lived materials such as brick and earths which are massive, structural, and which have a large surface area there arise problems of scale and consequential cost in addition to those of durability, longevity, visual effect, strength and water penetration. Initial analyses will be aimed at determining the nature of the maintenance problem or fault which is rarely intrinsic to brick, mortar or earth and almost invariably relates to the introduction of stress, water, biological organism or temperature change. Problem analysis will identify cause and only when this is satisfactorily determined can the remedial action be decided upon.

Before any action is taken a programme of physical recording is essential. An historic building stands as a record of the events and circumstances of its building, of those changes and decay which have affected it and of the alterations and improvements which have reshaped it. All historic buildings should, therefore, be recorded and their precise state should be set down permanently before any intervention is allowed. A record of the work as completed is equally essential.

The intervention itself, requiring both honesty and minimal work must also take into account comparable knowledge and experience. The nature of brickwork dictates that on its visible surface, carrying the strains and patination of age, the minimum possible new material should be introduced and that should happen only where there is no alternative course of action.

Particularly valuable components may be subject to laboratory techniques of consolidation before being replaced, whereas those of a commoner nature might under the same policy and the same constraints be renewed. The case for pointing is different. It is a part of the general expectation and history of brickwork that the pointing is cut out from time to time and is renewed. Where any such renewal is contemplated careful analysis of the original materials will allow a specification to be prepared, ultimately producing the same effect, but the appearance of a repointed wall can be dramatically different from its earlier condition and this is a matter that can require shrewd judgement and considerable justification. Since the external surface of many earth structures is a renewable feature similar arguments apply and entirely acceptable conservation can result in an entire building being made to look as new.

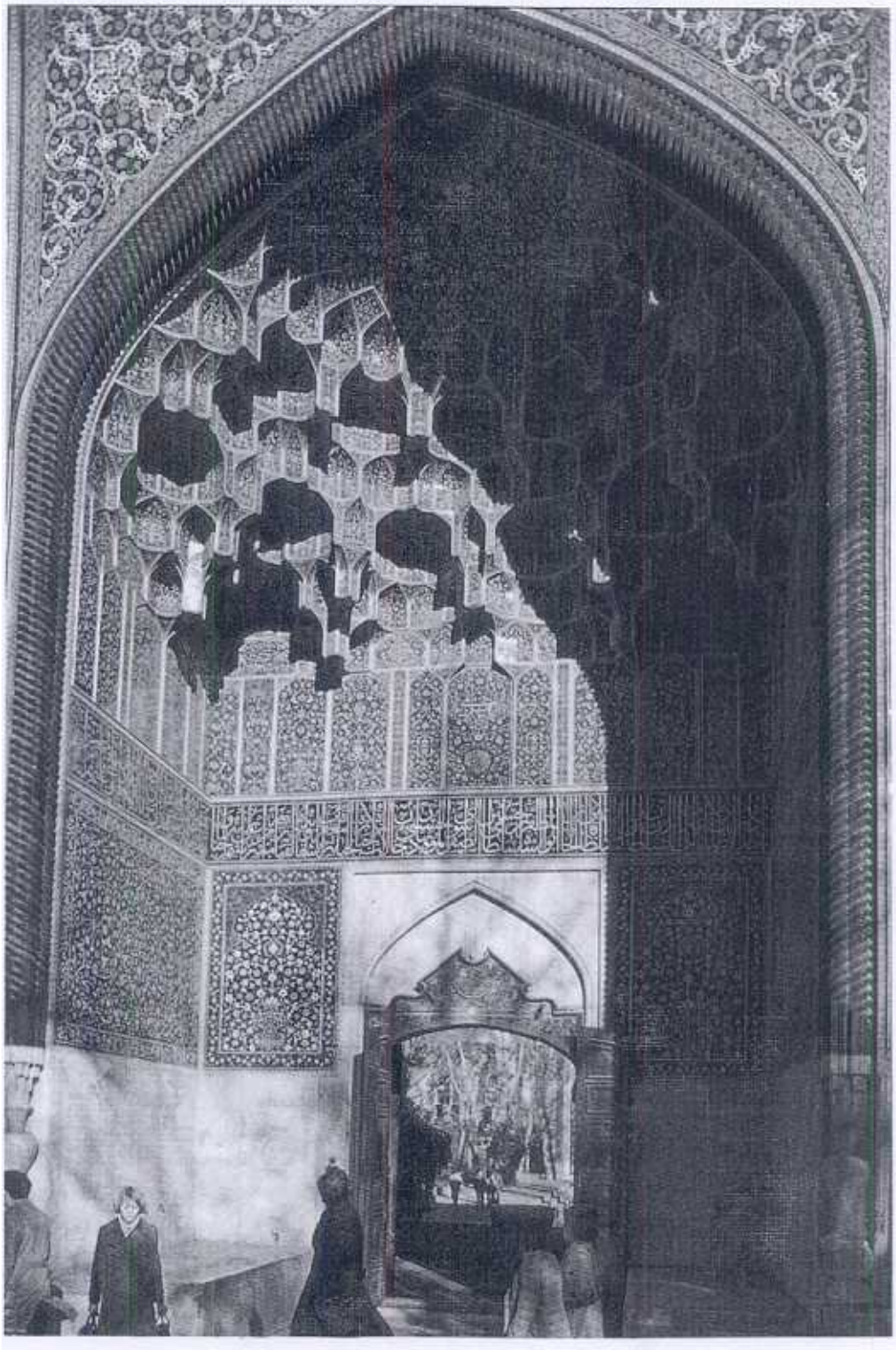
Every management plan for the maintenance of an historic building will allow for and take account of contingencies. Such plans must allow for the safety of persons and for the recovery of all possible artefacts and historic material within a building. The records on which conservators would rely in the case of reconstruction must be housed elsewhere than in the building itself. Among modern techniques both photogrammetry and microfilmed records provide the most convenient and certain method of storage of secondary information and being capable of being duplicated can be held in local and national archives in addition to being held by owners. Brickwork is most effectively recorded by photography and the merit of

Curved and inward sloping walls in brick fortification. (Aldeburgh, England).

photogrammetry in relation to earth structures is the ability to record the uneven and characteristically undulating wall surfaces typical of this type of architecture.

Continuity in historic buildings will imply continuity of use which in turn demands sensitivity to the changing requirements of servicing, safety and precautionary actions, changes in legislation and necessary adaptations. Disfigurement and the acceleration of decay can result if the work is not overseen with care, sympathy and an eye to the long perspective. In brick masonry the pattern of wall openings is extremely sensitive and changes to such patterns should be made only where absolutely unavoidable and where they do not interfere with a signi ficant pattern or predetermined rhythm.

Earth structures are generally characterised by a minimum of openings and although these are often free of a rigid geometry or discernible pattern their frequency and proportion should not be interfered with if the quality and character of the building is to be retained. Such requirements may bring the conservator into conflict with the interests of owners and users and these requirements may relate to and be determined by practical matters or valuations. Inevitably and inextricably such considerations, often of very short term significance, come into focus at critical moments in the very long history of a monument. They may shape its destiny.



Shaped glazed bricks on structural brickwork. (Iran).