AJ Handbook of Building Enclosure

EDITED BY AJ ELDER AND MARITZ VANDENBERG

AJ handbook of building enclosure

CI/SfB (9-)

Editors, authors and consultants

The authors of each section will be credited at the start of that part of the handbook in which their material appears. The following four consultants have been retained to advise on certain aspects of the building fabric's design on which they have expert knowledge. In addition, the editors wish to thank Michael Rostron and Jan Sliwa for their help and advice.


Vandenberg


Elder


Hodgkinson


Pugh


O'Brien

The editors of this handbook are MARITZ VANDENBERG BA(Arch), *technical editor of The Architects' Journal, and* A. J. ELDER RIBA, *architect in private practice*
ALLAN HODGKINSON, *structural engineer in private practice, consultant on structural considerations*
BRIAN PUGH, *qs in private practice and visiting lecturer in building economics at London University's School of Environmental Studies, consultant on cost considerations*
TURLOGH O'BRIEN, *materials specialist with Ove Arup & Partners and visiting lecturer at London University's School of Environmental Studies, consultant on use and performance of materials*

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EDITOR

Maritz Vandenberg BA(Arch)

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CONSULTANT EDITOR

A. J. Elder RIBA

The Architectural Press, London

Editor's preface

The handbook system

In recent years it has been the practice of the Architectural Press to republish in book form certain Handbooks and other technical material which it is felt members of the building team will want to consult regularly and which for this reason they would want to have in a form more permanent than bound-up issues of the *Architects' Journal*.
Publications which have been produced in this way include the AJ *Handbook of Urban Landscape*, the AJ *Metric Handbook*, the AJ *Handbook of Fixings and Fastenings*, and the AJ *Legal Handbook*.
People who have bought this book and who are not AJ readers will want some introduction to the method in which information is presented. It should be explained that when a handbook is published in the AJ the material does not appear continuously nor in batches of equal size. The information is however carefully structured into coherent units. These consist of three types of presentation: Technical Studies, Information Sheets and Design Guides (see Presentation of Information below).
At the beginning of every major section a chart is given, showing its relationship to material on previous pages and to that which is still to come, so that readers can keep track of the way the content is organised.

This book

The material comprising this book is a revised and updated version of the Handbook of Building Enclosure which was published in the AJ from mid-1971. It was designed to be used as a comprehensive guide to the enclosure problems of any project.
The text was not originally published in its correct sequence although filing under the CI/SfB system was suggested. However, a reassembly of the subject matter into a textually more coherent form has been one of the editors' aims in producing a book version. In addition the following steps have been taken:

1 Each section has been returned to its original author for checking and correction.
2 A considerable amount of feed-back in the form of letters and reference material received from many sources has been incorporated either by the original author or the editors.
3 New information received since the original publication dates has been incorporated and other information updated.
4 Additional information designed to clarify possible obscurities has been added by the editors.

Readers may notice one major omission from this list, namely the question of costs. This is deliberate, especially in view of the very rapid cost escalation which has recently occurred and which is still producing unpleasant surprises. To bring the costs up to date was, after due consideration, considered pointless. It poses the immediate question 'what date?'—presumably the date on which the particular author does the work; then whilst the book is being edited, assembled, printed etc. these new costs are already passing out of date again. It was therefore thought better to leave the rates as they were originally published and simply state that they should be treated as approximately correct (there is no such thing as absolute accuracy in pricing) at about the turn of the year 1971/2. Any QS should be able to produce a factor by which the rates should be multiplied to bring them up to the desired period. Even in their unmodified form they remain useful as a means of comparing relative costs of various systems. It is of course quite possible that some materials have become more costly at a faster rate than others: indeed some may not have increased at all due to improved manufacturing techniques offsetting normal cost increases: in general however the relativity or ratios of one cost to another tend to remain unchanged to any significant degree.
Another important change which has been continuing since the AJ series was first published is metrication. This is now virtually complete and in general all quantities are now given in metric terms. There may be a few imperial survivors and also a few metric quantities which by their clumsiness still display the fact that their origins lie in the Imperial past. There are also a few examples where both figures are given: these are simply perpetuated from the original series as being still, possibly, of some slight use.

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Amendment to Building Regulations

The technical information given in this handbook is based on the Building Regulations 1972. After the main body of the book had gone to press, these Regulations were amended by the Building (First Amendment) Regulations 1973, coming into operation on 31.8.73. These amendments have *not* been incorporated in the Handbook, and readers are advised to consult The Guide to the Building Regulations 1976, 6th Edition (1979) by A. J. Elder (Architectural Press) for up to date information on all matters affected by the Building Regulations.
As a general guide, the 1973 amendments deal principally with:

a an extension of the range of building types in respect of which local authorities acting under delegated powers may in certain circumstances dispense with or relax the provisions relating to structural fire precautions in buildings (regulation 7);
b the substitution of a revised Part E (Structural fire precautions). Some of the previous remain; but elsewhere there have been drafting changes and various substantive changes. The main substantive changes include 1. provisions permitting the use in certain circumstances of electro-mechanical or electro-magnetic devices susceptible to smoke to hold fire-resisting doors open, and 2. amendments to the provisions relating to the penetration of structure by pipes imposing more onerous requirements on pipes made of non-combustible materials which would soften or fracture at a temperature of 800°C and less stringent requirements on pipes of certain combustible materials in particular those made of unplasticised polyvinyl chloride (regulation 16 and Schedule 1);
c the introduction for the first time of regulations (Part EE) relating to means of escape in case of fire from certain flats, maisonettes, offices and shops in new buildings (regulation 17 and Schedule 2);

d the introduction of provisions requiring the erection of barriers around floors and roofs of buildings used as vehicle parks (regulation 18);
e amendments permitting certain domestic oil-burning appliances to be exempted from some of the provisions for the prevention of fire which have applied hitherto (regulation 25); and
f an amendment restricting the types of gas appliance which may be installed in a bathroom for heating water for a bath (regulation 26 and 27).

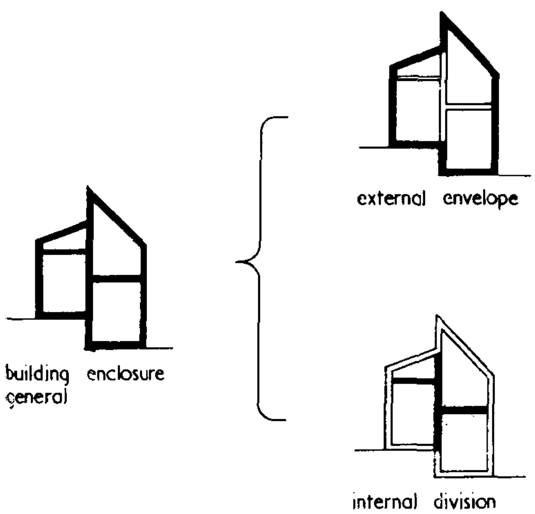
Also, references to various technical publications which are incorporated with the Building Regulations 1972 have been brought up to date as at 30th September 1972.

Scope

The title of the handbook published may mislead some readers into thinking that the handbook deals only with the building's external shell. In fact it covers *all* space-enclosing elements of the building fabric, both external and internal: floors, walls, roofs and ceilings. Whenever possible, these are dealt with as *whole elements* (eg 'external wall' would include secondary elements such as doors and windows, and finishes) to encourage designers to think of these elements in terms of their overall performance.

Arrangement

It will be seen from the diagram below that this handbook deals with its subject in three broad parts. The first part deals with building enclosure *generally;* it gives an overall view of the functions of the building's physical fabric, and gives specific guidance on two constraints which apply to the design of the physical construction as a whole: cost and dimensional considerations.
After this general introduction the handbook divides its subject into two broad element-groups: *external envelope* and *internal space division*. The former covers all those elements separating the internal volume from the external environment: lowest floor, external walls and roof. The latter covers those elements subdividing the building's internal volume: suspended floors and ceilings, and internal partitions. Each of these two parts of the handbook is introduced by a general technical study examining the functions of that particular element group, the problems involved and trends in solving the problems; this general technical study is followed by specific studies and information sheets on the elements involved.
By approaching the problem in this way, starting at the most general level and proceeding gradually to more detailed aspects, it is hoped to overcome the inconsistency and inadequacy, characteristic of much present-day design.

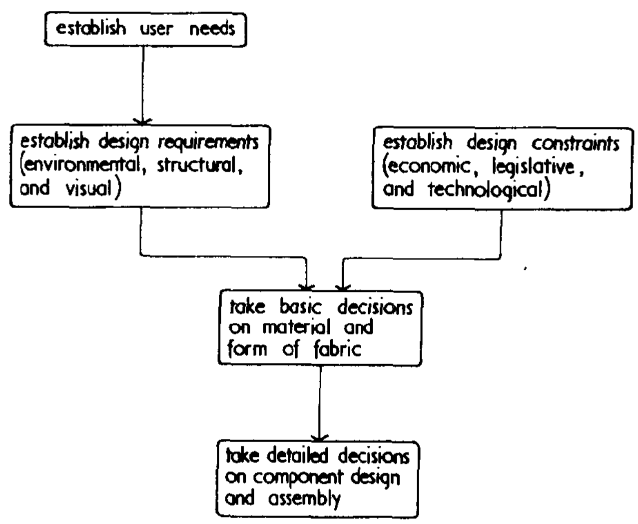


Presentation of information

Information is presented in three kinds of format.
Technical studies are intended to give background understanding and to summarise general principles. They also include information that is too general for direct application.
Information sheets are intended to give specific data that can be applied directly to design.
Design guides are intended to remind designers of the proper sequence in which decisions required in the design process should be taken. They also contain concise advice and references to detailed information required at each stage.
The general pattern of use, then, is first to read the relevant technical studies to understand the design aims, the problems involved and the range of available solutions. The design guides and information sheets are then used as design aids; the former to ensure that decisions are taken in the right sequence and that nothing is left out; the latter as sources of data and design information.

Sequence of decisions

Design guides are based on the following broad sequence of decision-making. This reflects the underlying approach of the handbook as a whole, which is that design should start with the users' needs, and proceed from general decisions on the building's performance as a whole to increasingly detailed decisions on elements and components.



Sources

A source of information, regarded as a necessary reference, will be listed in the bibliography at the end of the technical study or information sheet; sources mentioned in the text, but not regarded as being necessary references, will be described either in the text or in a footnote; they will not be repeated in the list of references at the end.

Contents

References and keywords

The handbook is divided into three parts:
Building enclosure: general
External envelope
Internal envelope

Keywords are used for identifying and numbering technical studies, information sheets and design guides; thus: technical study ENCLOSURE 1: information sheet EXTERNAL ENVELOPE 2; information sheet PARTITIONS 2; and design guide INTERNAL DIVISION.

Section 1 **Building Enclosure: General**

Section 1 Building enclosure: General

Relationship to rest of handbook

The table and diagram on this page show the contents of the handbook as a whole, with the present section highlighted.

Scope

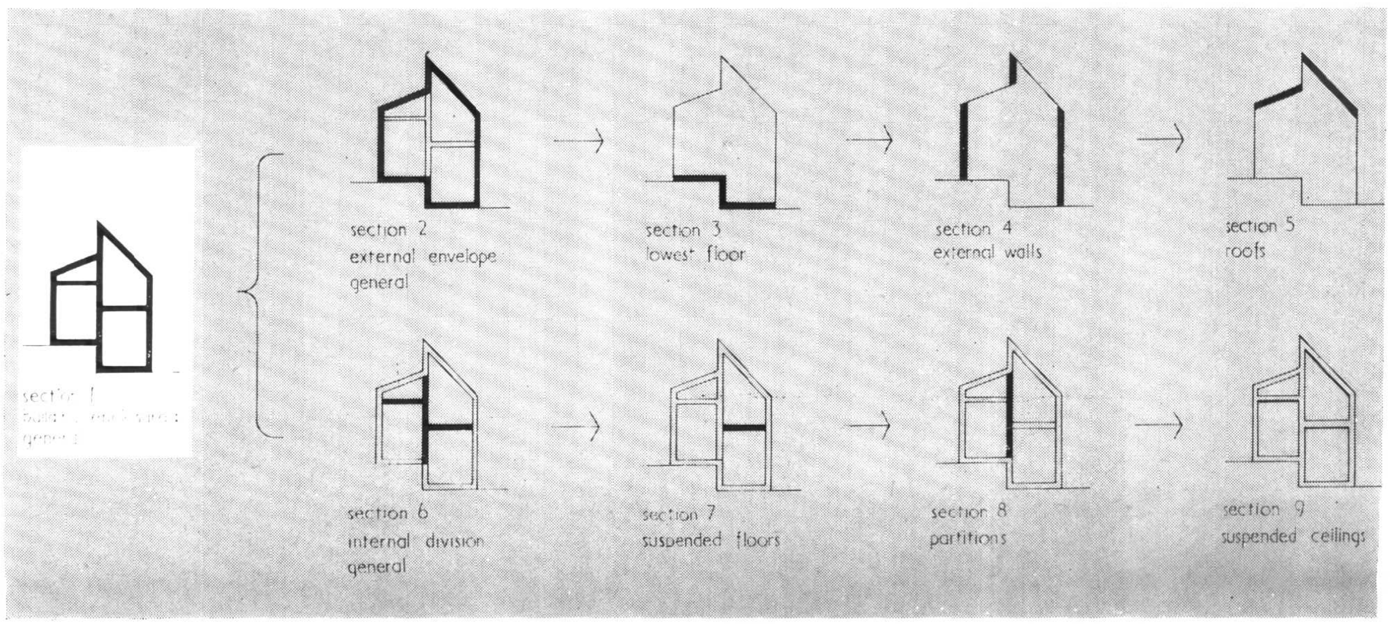
This initial section of the AJ Handbook of Building Enclosure provides an introduction to the design of the building's fabric, at the most general level. It does not deal with the design of any particular part of the building shell: rather, it is intended to give an indication of the basic functions the building fabric is intended to perform, and of the factors which must be taken into account in designing it.

The first technical study in this section looks at one important, and much neglected function—that of environmental control—and shows how the development of modern transparent, lightweight building enclosures has given rise to problems of environmental control. The next study outlines the fundamental design approach that will underlie the rest of the handbook. Then follow two information sheets giving data on two constraints which apply to the design of the building shell *as a whole*, rather than to particular elements: dimensional coordination, and cost planning.

On the basis of this general introduction, section 2 and subsequent sections then go on to deal with the building in greater detail as the diagram below shows.

References and keywords

The keyword by which this section is identified is ENCLOSURE. For a further explanation see page 6.



Technical study Enclosure 1

Section 1 **Building enclosure: General**

Functions of building enclosure

The purpose of this initial technical study is to set the scene for the more detailed sections which will follow, by sketching in broad outline the purpose of building enclosure; by drawing attention to the environmental problem which has arisen in connection with buildings in recent decades; and by indicating an approach which will, in the view of the editors, help designers to avoid some of the present problems and improve the performance of buildings. Many of the aspects touched upon in this general study will be examined in greater depth in subsequent sections of the handbook

1 Introduction

1.01 Subject of handbook

The subject of this handbook is the design of building fabric, and detailed information will be given, in its various sections, on materials, components and products, and on the design, assembly and finishing of these commodities to form a completed building shell and its internal sub-division.

1.02 Poor building performance

It is important for the designer, before getting involved in the minutiae of building construction, to form an understanding of the fabric's functions as a whole: the present paradoxical situation of poor building performance in an age of unprecedented technological expertise can be traced partly to the general lack of an overall, explicit design philosophy or system to govern, and give coherence to, the multitude of detailed decisions which shape the evolving building design.

Such a situation could not exist in design fields where the price of failure is disaster. If a supersonic aircraft, for instance, were to be designed without the discipline of an overall set of controlling functional requirements against which detailed decisions could be tested constantly, the resulting catastrophe would be spectacular. In the case of buildings, the consequences of haphazard decision-taking are less newsworthy: the building merely causes misery to its inhabitants by leaking, overheating, admitting noise, or by streaming with condensation. These inconveniences are more easily ignored than air disasters so architects tend to muddle on in their bad old ways, paying scant regard to the complaints of buildings' users. And the problems mentioned above are with us constantly.

1.03 Need for coherent approach

There are signs that users' and clients' dissatisfaction with the poor performance of many modern buildings will become gradually too vocal to be ignored. In the past, architects have been liable to litigation usually only if a building suffered some specific failure or breakdown in fabric or services, or caused physical injury to a user. However, in a recent American case an architect was taken to court for designing a school which severely overheated in summer—ie for failure of *overall* environmental performance—and the client was awarded substantial damages.

As this trend grows (and it is certain to following the recent revision of CP3 chapter 11*, and the present climate of increasing consumer militancy), architects will have to overhaul their present haphazard procedures, think in a more disciplined way about the functions of the building fabric and the services it incorporates, and ensure that every decision taken—both by themselves and by the growing body of consultants, specialist manufacturers and subcontractors whom they direct—is compatible with the desired (and explicitly formulated) end result.

2 Functions of building

2.01 Need for environmental control

Why does man build? Most of the reason can be summed up in the phrase 'environmental control'. People need shelter from wind, dust, and the various forms of precipitation; they require certain conditions of temperature, humidity and air movement if they are to be physically comfortable; they require security and, at certain times, privacy (which may be visual or aural, or both); they like views of the world outside; they dislike excessive noise; they desire certain conditions of light and dark at particular times; they require appropriate physical surfaces for their activities and the arrangement of their possessions; and they need cooking, drinking, sanitary and storage facilities.

The main purpose of building has always been to provide an environment that will minister to these needs. It is our success in controlling or modifying the natural environment that has enabled mankind to progress gradually from an existence of bare survival to one of ease and comfort.

2.02 Two methods of control

In his efforts to achieve environmental control, man has always had at his disposal two kinds of resources he could manipulate to modify those aspects of the natural environment which did not suit him: physical barriers and energy[1].

* This code lays down, for the first time, standards of thermal insulation in relation to control of internal environment

2.03 Physical barriers

The simplest form of barrier between man and climate is clothing **1,2.** The cloth is a membrane which modifies the relatively hostile external climate to produce a more acceptable 'microclimate' inside, giving the wearer protection against wind, sun, rain, snow or dirt, and providing him with more comfortable temperatures as well as privacy. On this simple level a tent can be seen as an extended form of 'clothing', providing the same kind of climate modification and privacy as clothes by acting as a membrane between man and climate **3**. The principal function of clothing is to entrap a layer (or several layers) of air around man's pitifully unprotected body, which then provides good thermal insulation in the same way as cavity walls and double glazing. This works equally well both ways ie whether it is excessive cold or heat which calls for modification.

In the case of other forms of physical shelter such as caves, or houses **4** to **5**, it is still possible to see them as climate-modifying enclosures analogous to tents or clothes, but the analogy cannot be taken too far because the addition of significant *mass* to the substance of the enclosure gives it special properties not possessed by thin fabric membranes. In addition to becoming relatively immovable, the enclosure also begins to acquire the highly important thermal characteristic of heat storage capacity.

In any but the most temperate climates, the latter property plays a vital role in providing comfortable living conditions. In hot weather the massive structure of a dwelling will absorb solar heat during the day, thereby keeping the inside relatively cool; it then radiates the stored heat into the interior at night (if the night is warm, the unwelcome effect of this thermal radiation can be counteracted by providing adequate through-ventilation). On the other hand, in cold weather the structure will slow down the rate of heat loss from sources of warmth inside the building to the outside, thus helping to keep the interior warm. Heavy structure acts, in fact, as a sort of thermal flywheel. Clothes, tents, and massive enclosures are all examples of the use of physical barriers to help provide the kind of environment man needs or desires.

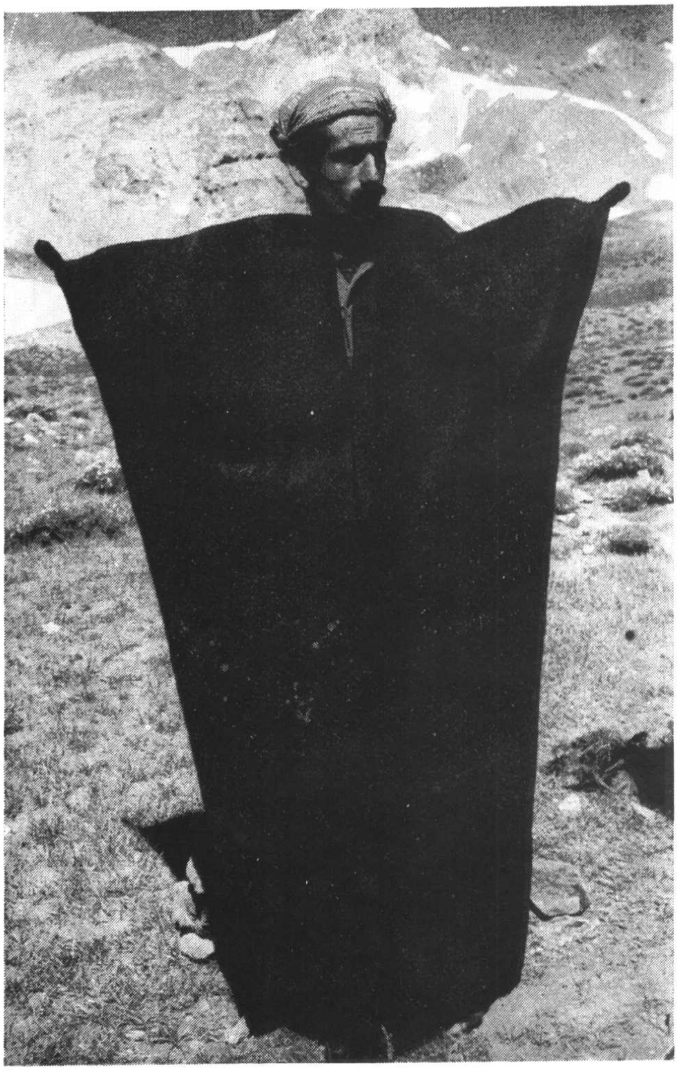
2.04 Energy

However, physical barriers cannot provide light (although they can control it), and while they can conserve heat, they cannot generate it. For these purposes, man has exploited the second of the two kinds of resources available to him—energy. The earliest method of using energy to temper the natural environment was the camp fire which produced both heat and light (and, to a limited extent, security). It has been succeeded by the growing use of increasingly sophisticated methods of exploiting combustion and, more recently, other forms of energy; and today the average citizen in an industrialised society disposes of several kilowatts of environmental energy in his home.

2.05 Human needs

The history of the built environment, then, is the history of man's manipulation of two resources, physical enclosure and power, to produce an environment suitable for his cultural and psychophysical needs*.

* The term psychophysics refers to the relationship between physical stimul and sensory events, eg the relationship between physical conditions of air temperature, radiative temperature, humidity and air movement, and the subjective sensation of thermal comfort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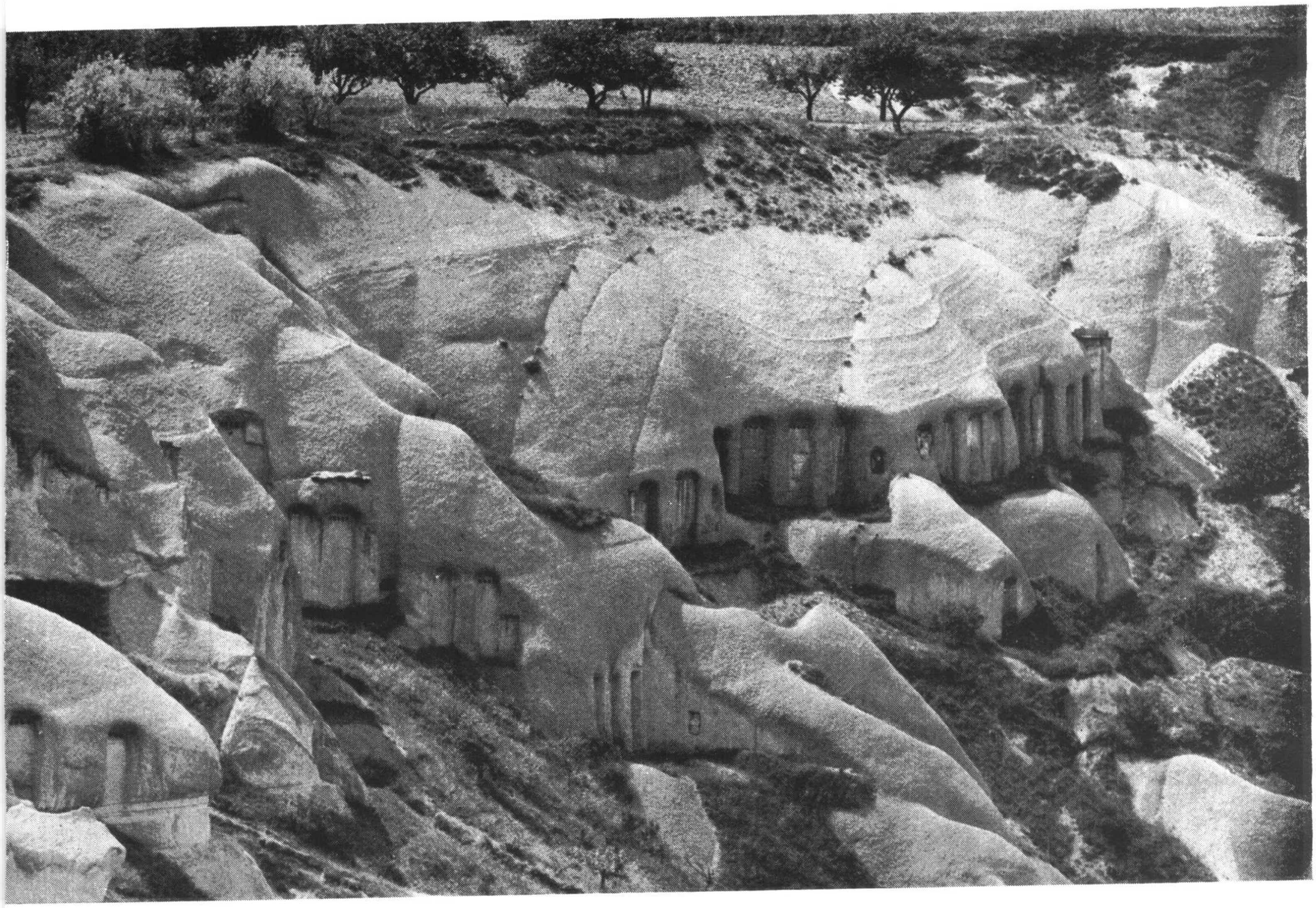

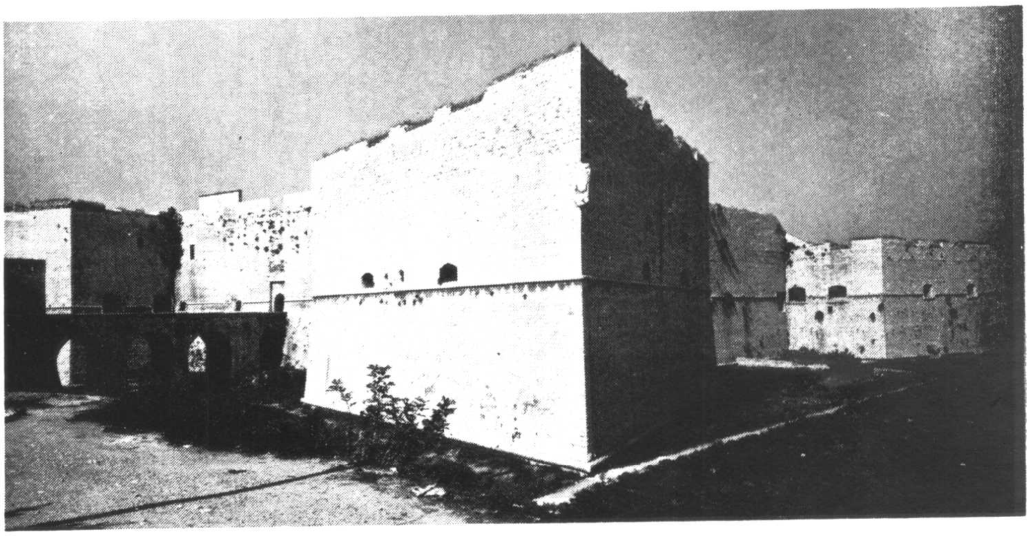

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Simplest form of barrier between man and climate is clothing. Phillipino farmer's palm leaf cone-hat and cape **2** *give shelter from rain and sun; Persian muleteer's black felt garment* **1** *protects from snow and wind. Functional analogy between clothing and simple forms of building enclosure is clearly demonstrated by these examples.* **2** *has similar function to leaf-covered hut, but on different scale;* **1** *is climate-modification membrane similar in some ways to* **3** *Tibetan nomad tents, also made of black felt.*
Massive forms of enclosure, such as caves **4** *or thick-walled dwellings* **5,** *have characteristic of heat storage capacity in addition to thermal insulation qualities. This enables them to absorb heat during day and radiate it into dwelling at night. On the other hand thatched roofs* **6** *give excellent thermal insulation, but low heat storage capacity; heat transmission is therefore reduced, but not distributed over a period of time as with* **4, 5**

7a

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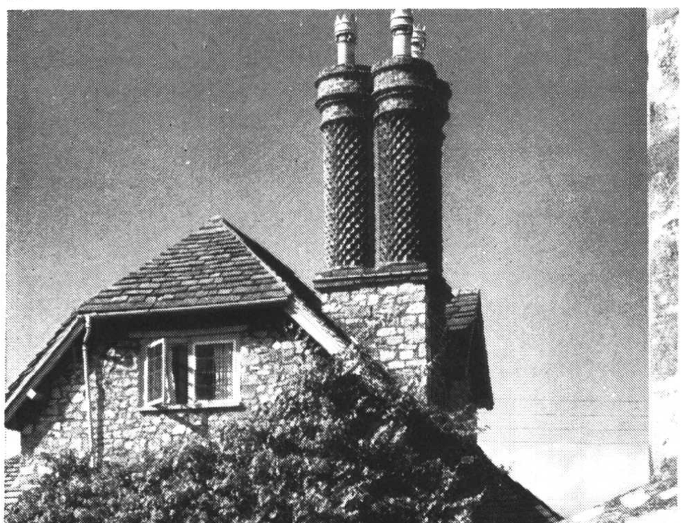

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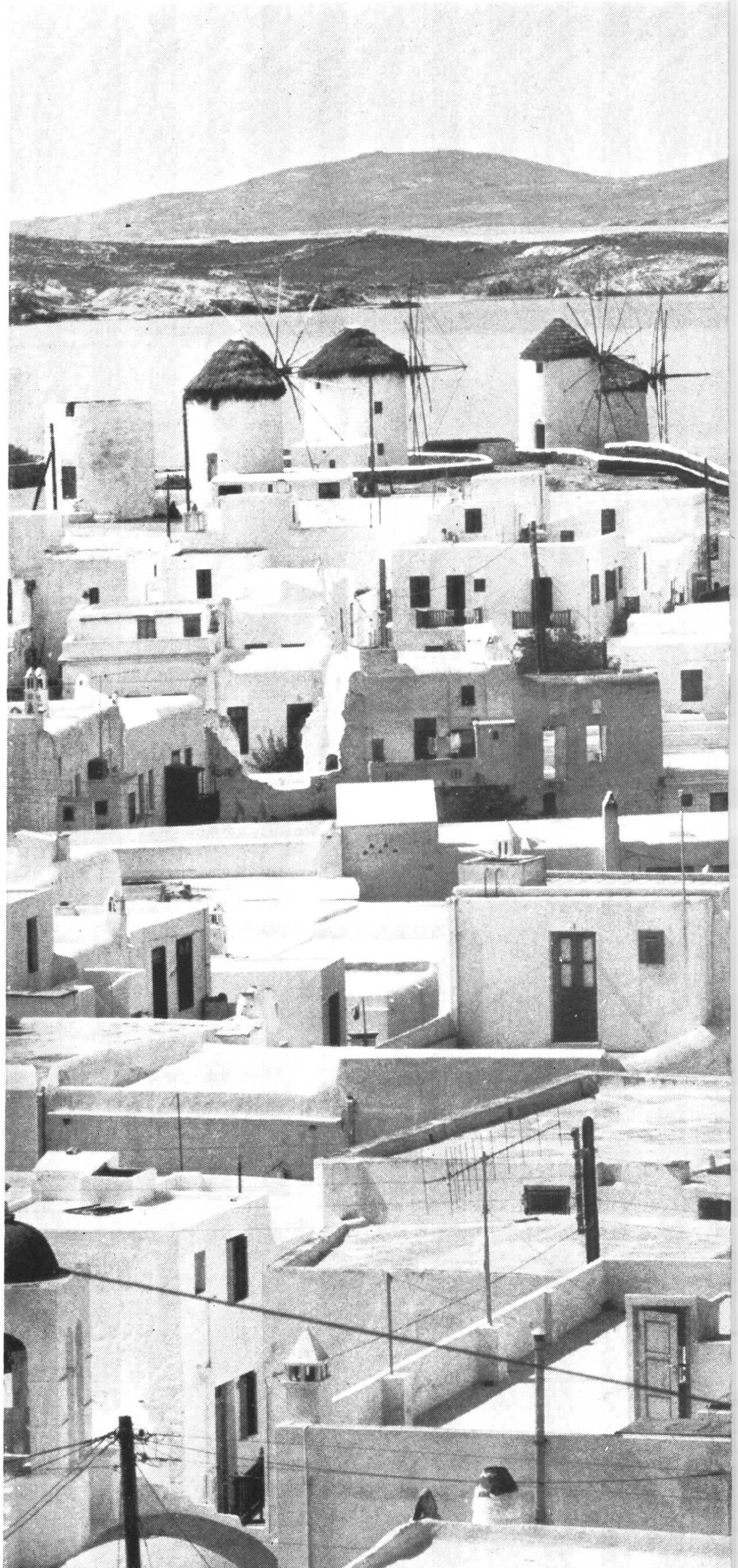

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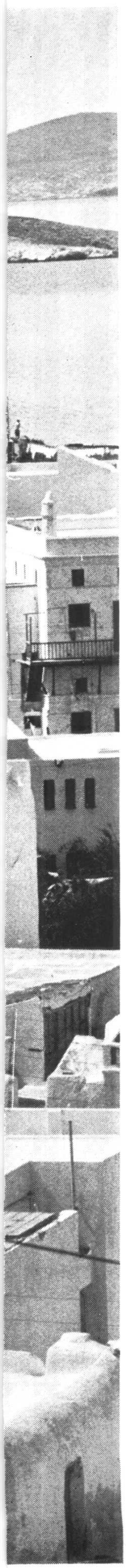

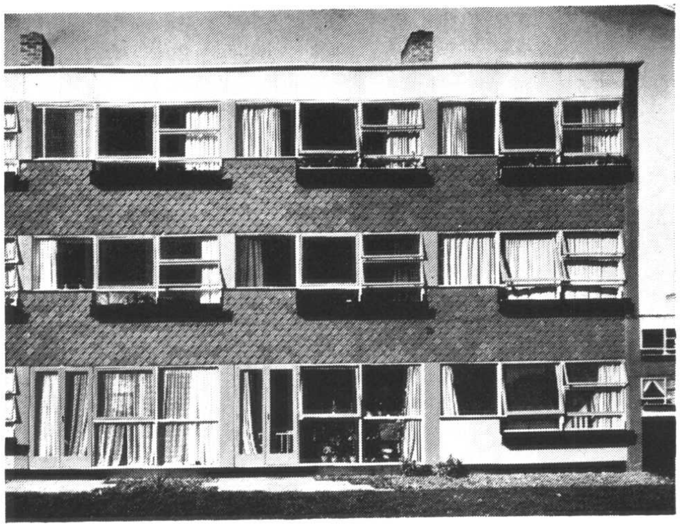

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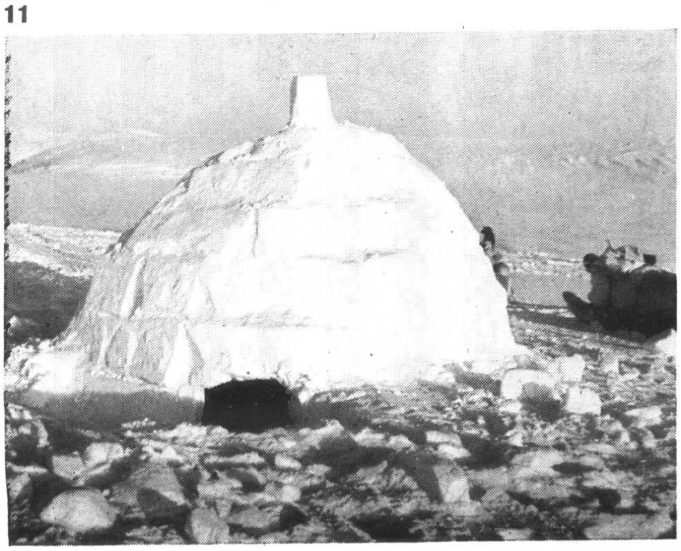
*Thermal advantages of massive, small-apertured construction which characterised European architecture for centuries both in cold climates (***7** *shows 15th century,* **8** *19th century examples) and warm* **9,** *are sacrificed by modern light-clad, large-windowed buildings* **10**

Vernacular building often exploits limited technological resources to produce highly effective environmental performance, eg thatched roof of Samoan chief's house **11** *protects from heat of sun, but as climate is mild air is allowed to circulate freely through dwelling. At night, or when weather is bad, roller blinds can be let down. In arctic conditions of northern Canada, trail igloo* **12,** *built from readily available material in 45 min, offers minimum access to wind, maximum internal volume for minimum surface area and provides surprisingly warm interior*

11



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Just what these needs are constitutes one of the most complex problems facing designers and environmental planners; and their present level of competence in responding to these needs leaves much to be desired.

3 The environmental problem

3.01 Environmental performance of buildings

The important point is that most of the failings of modern buildings mentioned in 1.02 are failings of *environmental performance*. Public dissatisfaction is not merely with the apparently exorbitant cost of building construction and maintenance; it is a growing complaint that too many new buildings provide a disappointing environment both for those who live or work inside them, and for those who use the streets and urban spaces formed by them.

To understand how this environmental problem has arisen, it is necessary to trace briefly certain trends which have appeared in building within the past two centuries, and especially since the last war. It is in this recent history of new aesthetic ideals, new building types, and rapidly changing building technology that the major causes of our problems can be found; and we will not be able to put matters right until we understand where we went wrong.

3.02 Traditional building

Massive enclosure

European buildings of the kind dignified by the description 'architecture' (mainly churches and dwellings for the well-to-do; the poor survived as best they could in hovels, shacks and huts for the most part) have tended for several millennia to consist of massive forms of enclosure. The reasons for this preference were mainly structural and technological (thick walls were better able to resist the load and thrust of the heavy pitched roofs required to give protection against snow), perhaps cultural, and possibly environmental (the high heat storage capacity and good thermal insulation value of thick walls were valuable commodities both in the cold winters of northern Europe and the hot summers of southern Europe).

Judged by the available technological resources of their time, these buildings functioned well environmentally. Those in cold climates had large, massive fireplaces which stored heat during the day and radiated warmth into the dwelling at night after the fire had died; and the thick outer walls helped conserve this warmth **7, 8**. Those in hot climates were shaded from the sun and were provided with good through-ventilation; and the massive construction helped to moderate temperatures inside **9**. Also both types benefited from the good acoustic insulation and security associated with the thick-walled, small-apertured structure.

Vernacular tradition

The reasons for their environmental success can be traced not only to the kind of construction used but to another factor which applies to pre-industrial vernacular building generally. This is that in such societies there are relatively few building types changing relatively slowly, and they are erected by craftsmen with a deep understanding, born of familiarity, of the kind of building desired, the materials available in the locality, the techniques of using them, and the local climatic characteristics. In such a situation of familiar, well understood and gradually evolving building 'models', the fabric of the building tends to be well adapted to its functions and to climatic conditions, and a generally accepted vocabulary of materials usage comes into being, enabling ordinary builders to avoid problems of bad weathering and visual deterioration **13**.

3.03 The industrial revolution

The 18th century saw the beginnings of a radical disturbance of traditional society, and the effects of this revolution on the built environment were as far reaching, and as mixed, as those on the social order. In many respects the consequences of the industrial revolution have proved, ultimately, to be almost miraculously beneficial. Whereas life for most people in pre-industrial societies was short, physically miserable and intellectually limiting, we take for granted in contemporary Europe standards of comfort, well-being and freedom which are very unusual by historical standards.

Loss of coherence

However, we have suffered too. In the architectural context, proliferation of new building types and new inadequately understood materials and methods, building ever faster to keep up with population and economic growth, substitution of formal controls (eg codes, regulations and zoning rules) for the previous informal controls which expressed a consensus of opinion on the way buildings ought to be built, and satisfying the modern craving for novelty and change, have all combined to disorder the previous underlying unity of purpose, and competence of execution, in creating a built environment.

3.04 New building forms

One of the main contributory factors to the present environmental problem mentioned in 3.01 is the radical change which the new technologies of the industrial revolution brought about in building structure. It has been shown how European architecture had traditionally been structurally reliant on massive walls which yielded great incidental benefits in terms of thermal and, to some extent, aural comfort. The development of cast-iron and steel framed building structures in the 19th century, followed by reinforced concrete framed structures in the 20th, put an end to this situation. European architecture found itself liberated from the loadbearing wall, and new buildings with thin-framed façades and large windows began to appear in the second half of the 19th century **14**.

Abolition of solid wall

Soon the theorists of a new architecture began to explore—in drawing board projects and a few real buildings—the possibilities of this liberation and to exploit the potential of the skeleton structure. Two powerful ideas emerged from these explorations: the glass sheathed, almost totally transparent building in which the solid wall was not merely abolished but ostentatiously *shown* to have been abolished (for instance, the Bauhaus **15**), and the tall tower block in which advantage was taken of the steel or concrete frame to provide city dwellers with the fresh air and the wide views which seemed so infinitely desirable in the dark, satanic cities of that time. In many cases (for instance, the prophetic sketches produced by Mies Van der Rohe around 1920) both ideas are combined, and we see the tall, sheer glass-skinned tower block which has since become almost an archetype of modern urban architecture **16**, **17**.

Problems of environmental control

The aesthetic and social motivations which produced this dream-image of tall, airy towers set in park-like surroundings, were admirable; but the attempts to realise this vision in post-war architecture have caused immense problems in environmental control.

If unprotected from the sun, glassy, large-windowed buildings suffer from enormous solar heat gain in summer, leading to high internal temperatures. If the building has a lightweight structure (as tends to be the case with industrialised building), the low thermal capacity of the building aggravates the problem, and large, rapid temperature fluctuations can occur inside the building with little delay between a temperature change outside the building and a corresponding change inside. This is a striking contrast to the situation in traditional, relatively massive enclosures where the building tends to 'iron out' and delay temperature changes, so that the heat of the day is not radiated into the building until night-time when it is less of a nuisance or even a benefit. These new buildings produce great cooling and ventilation problems. In buildings near roads or in urban areas opening the windows for ventilation may let in so much noise and dirt that the inmates prefer to stifle. In high rise buildings opening the windows may create intolerable wind and draught problems.

In winter such buildings will suffer from a converse problem due to the high rate of heat loss.

Enclosure versus energy

Once mistakes of this kind have been made in the design of the building's fabric, and it fails to act effectively as the climate-modifying membrane described in 2.03, the architect has no recourse but to call in the services specialist. Unnecessarily elaborate, expensive and frequently inadequate air-conditioning and heating systems, which are difficult to operate and maintain, are commonly provided today to make up for deficiencies in thermal control which could quite cheaply and effectively have been dealt with by the building's fabric. It is in this context that the changing relationship between our reliance on properly designed enclosure and our reliance on energy, as methods of environmental control, must be seen.

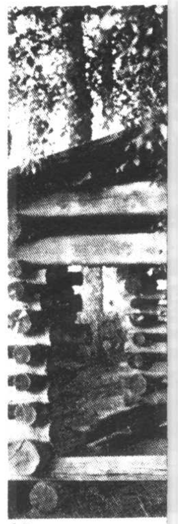
In the past we relied largely on a sensibly designed building fabric to provide us with comfort and amenity, augmented by fire providing light and additional warmth. It is inevitable that we should now be moving towards an increased use of energy for these purposes, as our needs become more complex, our standards rise, and our expertise in handling energy grows. In such conditions it may be cheaper to use energy than physical structure for many purposes of environmental control and manipulation.

Unnecessary complication

But these considerations do not justify the present situation in which the fabric of the building is often designed with flagrant disregard for the needs of the users, necessitating the addition of expensive services (vulnerable to mechanical breakdown and operational difficulties) to make the building comfortable. In addition these energy supplies are costly in use and the recent brouhaha over a possible world energy shortage suggests the need for a reversion to fabric control with correspondingly reduced energy consumption.

3.05 Influence of post-war technology

It has been shown how the transformation in building *form*, in the past century or so, has given rise to problems of environmental control because new forms were adopted without adequate understanding of what the consequences would be. Since the war these problems have been aggravated by the rapid adoption of new *materials* and *assembly techniques*, again without adequate understanding of the likely consequences.



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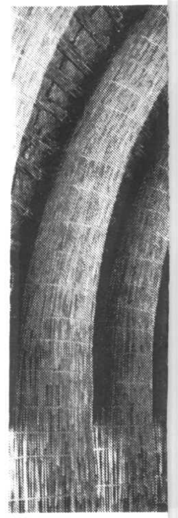

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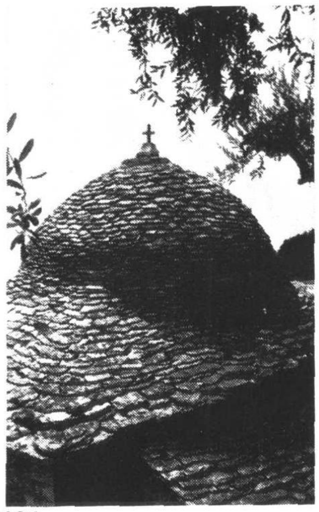
13 *Finnish log boathouse* **a**; *Iraqi reed guesthouse* **b**; *Czechoslovakian wood-shingled belfry* **c**; *Greek and Italian tiled domes* **d**, **e**; *and Iranian mud-brick mosque* **f** *demonstrate appropriateness and beauty of form sometimes achieved by anonymous pre-industrial builders*



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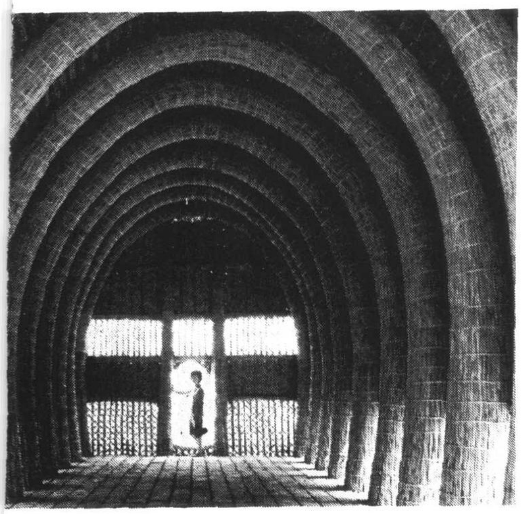

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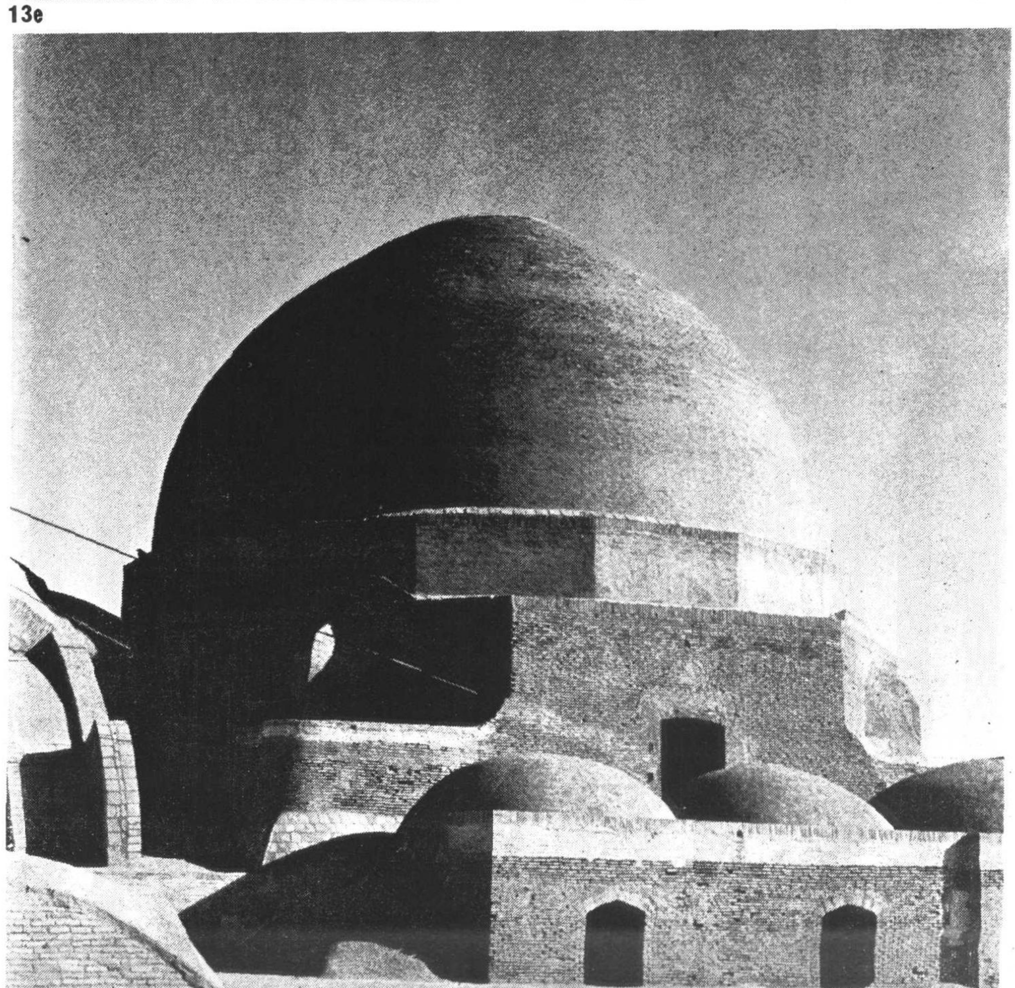


13f

Lightweight construction

For example, the on-site assembly of large prefabricated building components favours the adoption of lightweight construction. The problems of thermal control which have resulted from this trend have already been mentioned in 3.04.

The lesson is not that industrialised building or lightweight construction are necessarily bad. Provided the consequences of decisions are carefully thought about, there need be no problem. A proper mix of light and heavy components, considered use of sunbreakers and heat-absorbent glazing, proper insulation of the external skin of the building, an effective ventilation system that will not conflict with the need to exclude outside noise, and a lighting, heating and, perhaps, air-conditioning system designed as a whole concept with no internal conflicts and inconsistencies, will produce a building which can maintain comfortable internal conditions at low cost. The criticism is of the tendency shown in post-war building of hastily, even enthusiastically, adopted new techniques and materials without sufficient understanding of their limitations and consequences.

Condensation

The same lesson can be drawn from the prevalent problem of interstitial condensation—the kind that occurs *inside* the material of building elements rather than on the surface. This troublesome effect is a result not only of the materials used in a wall or roof but also of the sequence in which they occur. Wall panels or roofs consisting of thermal insulation near the inside face and an impermeable outside face virtually invite interstitial condensation; and new types of walls and flat roofs have given rise to endless problems because they are used with insufficient understanding of their thermal and vapour resisting characteristics.

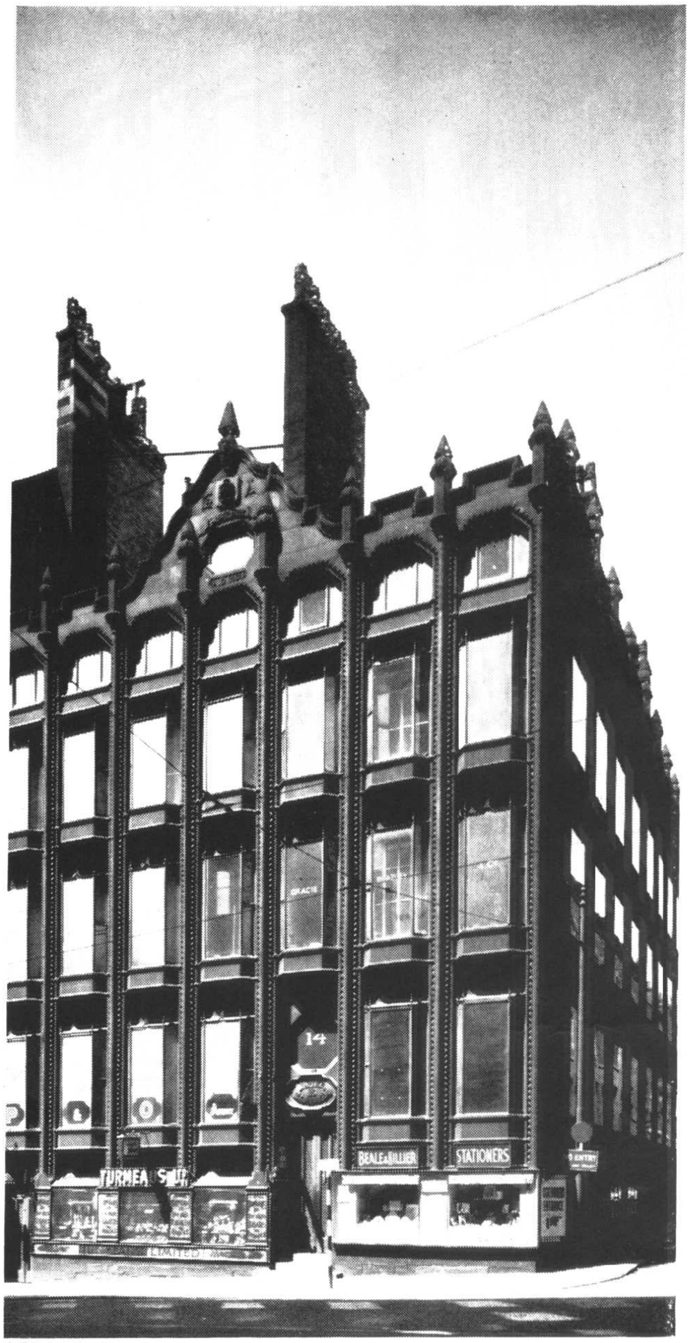
Visual deterioration

Finally, there are the effects of misunderstood or inadequately controlled technology on the visual quality of our environment. These have probably done more to alienate the general public from modern architecture than even the psychophysical failings of new buildings.

The observer does not require an architectural training to perceive the giantism of scale, monotony of form, and crudity of detail which characterise much of our recently built environment **18** and which can be traced partly to architects' willingness to have the form of building components dictated by manufacturing and production considerations, and to have the form of the buildings themselves dictated by site assembly considerations, such as easy crane runs. All too often buildings, which were aesthetically mediocre even when new, are further marred by progressive streaking, staining and discoloration due to faulty detailing of unfamiliar materials **19**.

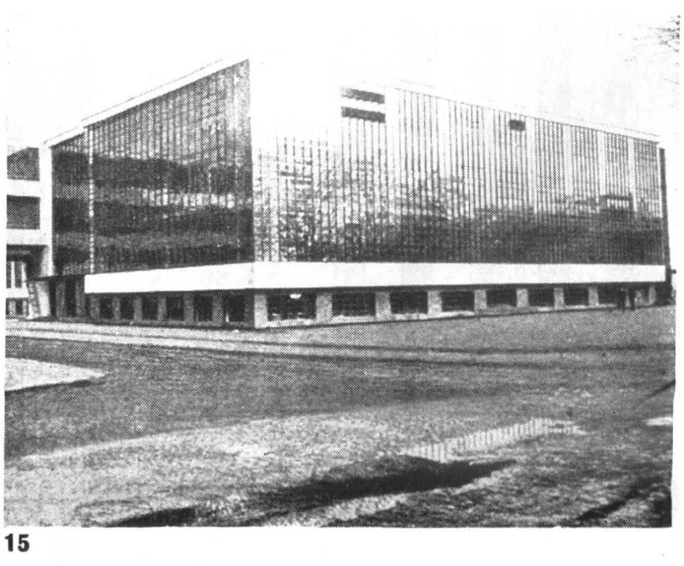
3.06 Causes of dissatisfaction

Admittedly this catalogue of failures presents a one-sided picture: there is no doubt that people today enjoy housing and working conditions which are superior, from a psychophysical point of view, to those available to the mass of society in the past (whether they are aesthetically superior is, however, another matter). What is wrong is that performance falls so far short of the standards we have come to expect in this age of technological wizardry. An attempt will be made in the various sections of this handbook to indicate a coherent approach to the design of the building fabric, which will, it is hoped, eliminate some of the mistakes described in earlier paragraphs.



14

Skeleton-framed construction of 19th century ended need for loadbearing walls and revolutionised building form **14.** *Exciting aesthetic possibilities of lightness and transparency were exploited further in real buildings such as Bauhaus* **15,** *and projects such as Mies's glass tower, 1920-21* **16.** *Latter created archetype now being realised throughout world* **17.** *But new construction technologies tend, if allowed to get out of control, to produce crude, monotonous building form* **18**



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