国外高等院校土建学科基础教材（中英文对照）

建筑材料
MATERIALS

曼弗雷德·黑格
[德] 汉斯·德雷克斯勒 编著
马丁·祖默
马琴 万志斌 译

BASICS

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前　言

建筑材料对建筑的效果和影响起着至关重要的作用。它们之所以重要，是因为它们不仅是建筑物的基础，而且还是建筑和人之间的协调者。材料体现了建筑的结构和功能。人们通过感官认知表面，体会它所传达的情感。材料可以把建筑向外部世界打开，让它变得明亮而透明，也可以使它变得统一而坚实——选材是设计的一部分，它可以用建筑的语汇达到预期的效果。因此，必须仔细分辨建筑材料的特性，慎重使用。它们必须满足设计的要求，甚至有的地方还可以利用它们来塑造形体。不同材料所带来的可能性千变万化，是建筑师们理想的创作源泉。

这套“国外高等院校土建学科基础教材”系列逐步地建立了一个全新的行为领域中的重要原则，为建筑学的研究提供了一个有效而实用的工具。它们不是专业知识的全集，而是面向学生的深入浅出的阐述，以促进他们对不同学科领域中的重要问题和要素的理解。

《建筑材料》一书的首要目的在于揭示材料和建筑组成部分的本质特征。因此作者没有泛泛而谈，而是专注于基本的设计问题以及认识建筑的方法上。本书的重点在于对不同材料的使用和它们能所带来的多种可能性的独特见解。首先明确了它们的重要特性，这样读者可以从材料的物理和情感特质中理出头绪。本书系统地介绍了最主要的建筑材料类型和它们各自的特性。还对典型的处理材料特性的设计方法和原则进行了说明。

在“国外高等院校土建学科基础教材”丛书的帮助下，学生可以掌握使用不同材料的知识，这样就可以把他们的设计和想法变得更加生动和富有表现力。

编辑：贝尔特·比勒费尔德

FOREWORD

The materials out of which a building is made play a crucial part in its effect and impact. They are important not just as the basis for construction, but also as a mediator between building and people. Materials have a story to tell about the building, its structure and its function. Surfaces are perceived by the senses, and convey feelings. Materials can open a building up to the outside world, can seem light and transparent, and the building can also appear monolithic and solid – the choice of material is part of design, in order to make the desired impression in terms of architectural language. So the material qualities of a building must be chosen and used with care. They should support the design, and where applicable even help to shape it. The possibilities offered by different materials are many and varied, making them an ideal design resource for architects.

The "Basics" series works through the important principles of a new field of activity stage by stage, and provides a sound and useful instrument for studying architecture. It does not set out to be a comprehensive collection of specialist knowledge, but to give students readily comprehensible explanations and foster their understanding of the important issues and parameters in the various subject areas.

The "Materials" volume chooses to address the substantive properties of materials and building components first and foremost. The authors do not therefore provide a comprehensive survey, but concentrate on essential subject matter for design and the way the building is later perceived. The focus is on the insightful use of different materials and the wide range of design possibilities they offer. First, their key properties are identified, so that readers can find their way around the physical and emotional world of material. The book systematically introduces the most important building material types and characterizes their individual properties. Typical design approaches and principles in handing the material quality of buildings are also explained.

With the aid of the "Materials" volume, students will be able to acquire knowledge about using different materials, so that they can make their designs and ideas lively and expressive.

Bert Bielefeld
Editor

INTRODUCTION

Architecture lends material form to a design idea. Translating this idea into built reality and the effect it makes on viewers is essentially determined by the choice of material. An enormous variety of materials is available, but a good design is inevitably restricted to very specific material qualities.

But what does material quality mean? As is common in current architectural discussion, this is a borrowed term, liberally used, but ambiguous and imprecise. The term "material quality" is often applied to the surface of architecture. Materials contribute to the spatial experience by their appearance, how they feel when touched, their smell, and their acoustic characteristics.

By referring to visible material quality, we attempt to get round the reservation that the surface represents only part of material quality as a whole. But perception involves more human senses than just sight, which suggests that material quality must be more than the structure of a surface.

This point is clarified by a philosophical definition that coined the term material quality. It suggests that a body consists of matter – of a material substance – but also conveys a sense of physical presence. So material quality arises from the material, and in this definition, many aspects of materials fuse into a unity.

However, this explanation does not include all the topics included in the concept of material quality. As well as the surface, the internal structure and the resultant emergence of a physical entity, there is also an associative plane, which is particularly significant in architecture. Materials can be associated with and symbolize states of affairs. The fact that stone stands for wealth and power can be grasped in any banking quarter. Thus, there are three levels of meaning: visible, inner, and associative material quality.

Perceiving material quality is based on a personal, individual position, which is neither right nor wrong. Many distinguished architects have developed their own points of view, which they place in the context of material quality: Alvar Aalto, Tadao Ando, Louis Kahn, to name only a few, have used their choice of materials to put a lasting stamp on their architecture.

Effortless handling of materials and delight taken in experimenting with them enrich architecture. The attraction of the new plays a key part. Every architect is familiar with this. Many use choice of material as an innovative device to make their buildings unique. That choice offers possibilities that are increasingly becoming central themes in architecture.

Variety of material, and its alienation, exploring the limits of what is technically possible, deliberately misusing materials or transferring material from use areas unrelated to architecture are some of the stylistic devices used by today's architects.

Choosing material requires knowledge of a large number of hard facts. But it also needs intuition and a feeling for the suitable material in a particular architectural context. This book will first examine material quality in terms of objectively verifiable, "hard" factors. Important questions include: what external conditions are materials exposed to, and how do these affect them? How can the choice of material be systematized? Once this basis has been established, "soft" factors become central. The book will thus guide readers from the range of possibilities offered by materials via design strategies to possible positions that develop from material quality.

In the chapter "Principles for the choice of materials" the reader will be introduced to the basic issues relating to handling materials. It points out the central influences affecting the course of material life cycles, and provides the means for sensible evaluation. The chapter "Classification of materials" explains criteria for choice, capacities and fields of application for selected building materials. Specifications are given for possible performance based on the properties of materials, and brought together as a material use catalogue. Finally, the chapter "Designing with materials" discusses different ways of designing out of and with materials. The various design approaches or principles are described and explained to give the reader ideas and indicate the field of possibilities for handling materials, or how a design problem can be approached from this perspective.

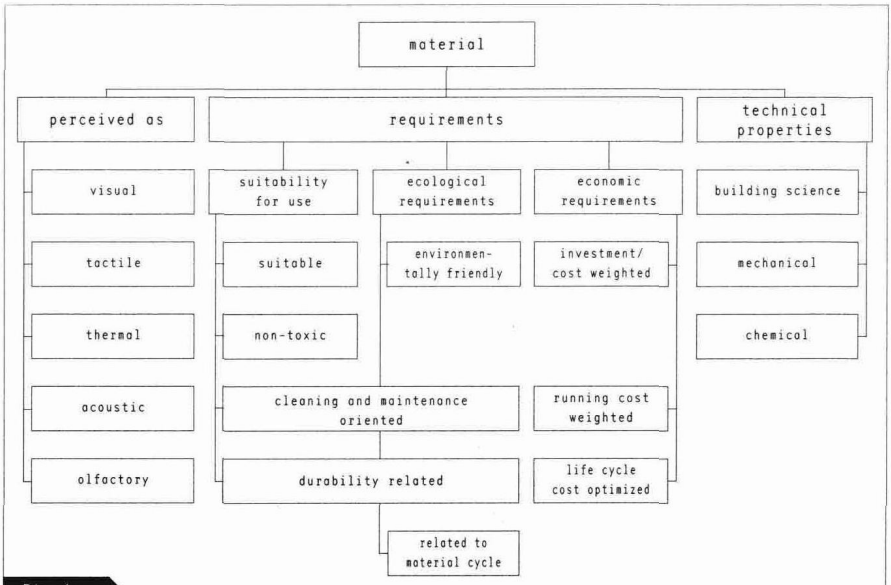

Fig.1:
Properties of materials

PRINCIPLES FOR THE CHOICE OF MATERIALS

For a long time, there was little choice of building materials. There were few materials available, but they were universally known. Knowledge about how to deal with them was developed and handed down over generations. The onset of industrialization gradually broke down this historically matured manageable quality. Today we have an immense number of materials at our disposal. Specialists such as "material scouts" provide architects with information about materials and innovations. The field of possible performance has also grown with the number of materials available.

\\Hint:
The term "material scout" is not a precise description of a profession but is a possible area in which an architect can work, researching or developing new and innovative materials, systematizing knowledge about the use of building materials for special purposes, and supporting designing architects by providing creative ideas.

Architects are not expected to be familiar with all these properties in detail, but they should be aware of connections and consequences. They will combine all levels on which materials can be considered in a knowledge of their properties, within a design and in the later execution stages. The design process is driven by properties relating to perception, as well as ecological, economic and technical properties, and those related to use. › Fig. 1

PERCEPTION OF MATERIALS

The effect made by materials is discerned by all the senses. The following come into play:

_ Visual sense – sight
_ Tactile sense – touch
_ Thermal sense – feeling
_ Auditory sense – hearing
_ Olfactory sense – smell

Visual

For humans, about 90 percent of information stimuli are based on the sense of sight. So it is hardly surprising that visual considerations are usually the first basis for making decisions about building materials.

Surface perception

Sight is based on transmitted rays. The corresponding material property is the reflection of rays from the surface of the material. The light striking a material therefore plays a key part in visual perception. The skin of the building materials, from glossy to matte, from light to dark, from homogeneous to textured, is the basis for architectural design. The neutral smoothness of industrially manufactured surfaces can be just as fascinating as sensitively controlled elements of roughness, which are sometimes perceptible only at second glance. Three-dimensional structures acquire greater depth if light strikes the texture at an acute angle. Careful placing of windows or light sources can enhance the three-dimensional quality of the materials. › Fig. 2

Transparency

This effect can be so greatly reinforced by transparent materials that it seems to work regardless of the material used. Semi-transparent, evenly textured planes, such as glass or plastic, can be superimposed; perforated opaque materials can also be used. The effect created – interference – changes the appearance of the building according to the angle from which it is viewed. The building is enlivened, and large even surfaces can acquire an enhanced sense of vivacity. › Fig 3

Colour

A building material's colour also has an important part to play. If the material is light in colour, it makes a particularly strong three-

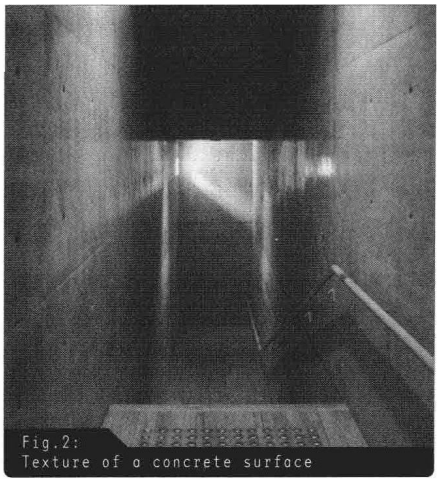

Fig.2:
Texture of a concrete surface

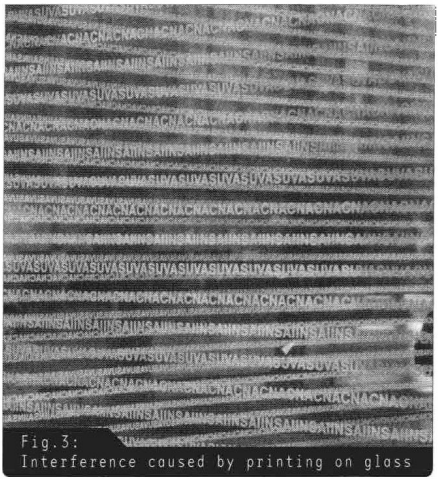

Fig.3:
Interference caused by printing on glass

dimensional impact, as the eye registers the contrast – the difference in brightness – before the colour quality. This contrast is particularly great in light-coloured materials because of shadows cast. Dark materials offer very little contrast, and so their surfaces lose their plastic quality, and tend to look two-dimensional.

Colours influence the way space is perceived. Warm colours make a space look smaller, while cold ones make it look bigger. Colours can also affect users on a subconscious, emotional plane: cold colours are distancing, but warm colours are stimulating.

Scale

The size and scale of building materials and surfaces also help to determine the impression they make. Different textural dimensions influence perception from close up, and in the middle and far distance. A material's effect is thus defined by the degree of prefabrication, element size, texturing, jointing, and other surface treatments. In this way, the choice of materials can match a particular building to its surroundings or make it stand out from them. › **Fig. 4**

Association

The almost endless variety of visual stimuli is reduced to those that are important for viewers in the perception process, and made into a personal image through their own knowledge. The architect can take advantage of this by playing with familiar associations. For example, using unusual small brick formats on a façade can make a building seem particularly generous, as a result of subconscious assumptions about scale. › **Fig. 5**

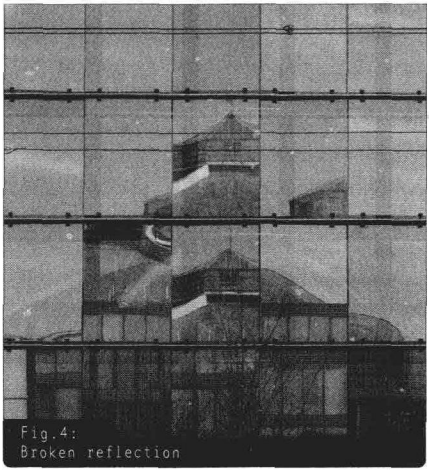

Fig.4:
Broken reflection

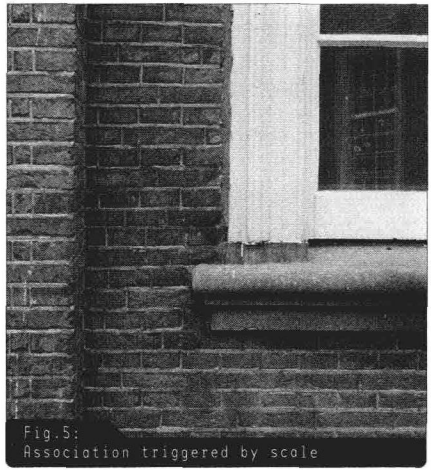

Fig.5:
Association triggered by scale

Tactile

In tactile perception, the whole body becomes a sense organ, and particularly the hands. They explore the contact areas of the materials and their properties: even or rough, smooth or dull, hard or soft, cold or warm. › Fig. 6

Handles and handrails offer a particular good hold if the hand can grasp them completely. Soft materials yield to the hand, and can thus make a handle seem particularly pleasant. Construction elements that seem warm invite touch, and encourage people to use features like parapets and window-seats. › Fig. 7

Surface temperatures, radiation and reflection in construction elements influence thermal sensations via the skin. There is a pleasant and apparently warm impression if the components that are touched draw little heat out of the body, as in materials with a low thermal mass and high radiation. Heavy building materials, such as steel and concrete, draw heat out of the body when touched and thus seem cold.

Thermal

This principle also works without contact, as people register the temperature difference between the air and adjacent surfaces. Lack of radiation is interpreted as cold. In contrast, solid surfaces exposed to the sun can, later, at night, seem to be warm.

A total of four factors play a crucial part in human thermal perception: the speed at which air is moving, air temperature, radiation from

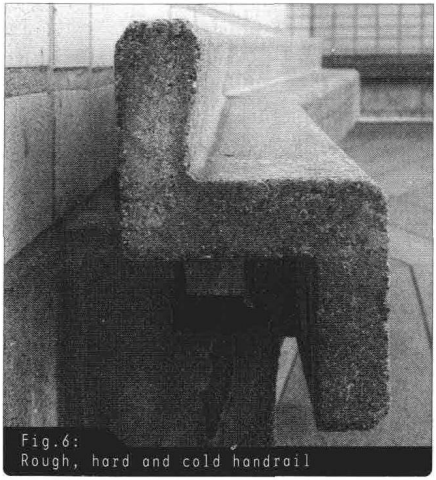

Fig.6:
Rough, hard and cold handrail

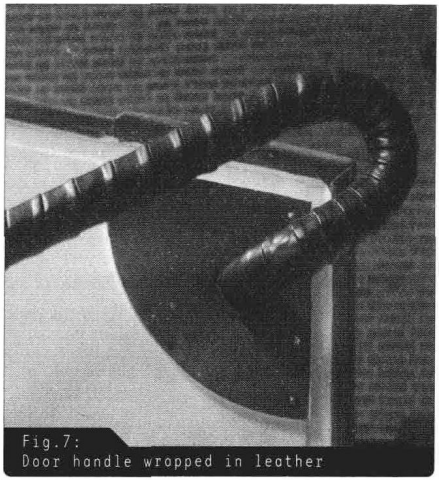

Fig.7:
Door handle wrapped in leather

adjacent surfaces, and air humidity. These factors combine to create the climate within a space. Humidity particularly affects thermal comfort. If it rises, the perceived temperature rises as well. Materials with sorptive properties can regulate humidity. Such materials, particularly plaster and clay, but also other solid building materials, can contribute to a particularly pleasant indoor climate. › Fig. 8

Indoor climate

Materials with a low thermal mass can thus create a "shack climate", which is strongly affected by temperatures brought into the building from the outside – especially when it is extremely hot or cold. The reverse is the "castle climate": heavy building materials with a high thermal mass help to create a stable climate by reducing temperature amplitude, decoupling the space from extreme exterior temperatures.

\\Hint:
Sorption enables a building material to draw moisture out of the air and store it on its surface. Moisture is absorbed or released in relation to humidity.

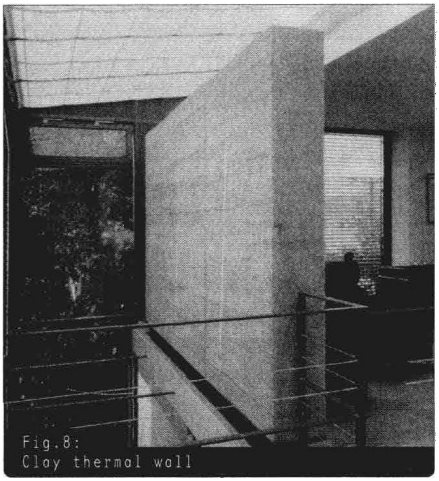

Fig.8:
Clay thermal wall

Senses working together

With sight taking the lead, other sensory experiences help to concretize material qualities. Hearing and smell are important, as well as the senses that have already been mentioned. For example, the muted crunch made by the round grains of sand can be heard when walking along a sandy path. The smell of wood is associated with wellbeing. The more senses a material addresses, the sooner a satisfying overall experience can be created by a material or a space.

Contrast

Designers have two possible ways of deliberately stimulating and enhancing perception: one is to present the channels of perception with contrasting experiences, for example through an unexpected tactile effect contrasting with the visual one. The anticipated sensation is missing, and this sense of disturbance becomes an experience. But it can also produce a subconscious feeling of discomfort if inconsistencies of this kind go beyond a certain level.

Agreement

Conversely, materials can create a particularly all-embracing and harmonious overall image. Agreements, harmony between the visual impression and the other levels of perception create physical wellbeing. The individual impressions complement each other, and combine to form a satisfying overall image. Architecture then achieves its aim through a wide range of perceptions open to simultaneous experience. But this image can tip over as well, in the direction of emotional overload and ultimately banality.