国外高等院校土建学科基础教材（中英文对照）

砌体结构

MASONRY CONSTRUCTION

[德] 尼尔斯·库默尔 编著

余流 译

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前　言

砖是一种主要的建筑材料。其形式简单，用途广泛；因地制宜，就地取材，来源丰富；砌块通过砂浆等材料粘结连接，节点形式灵活；同时砌筑的墙面表现丰富。但所有这些的前提是砌块材料必须满足一定的专业要求。

砌体作为建筑艺术的最普通的基本构成要素，路德维希·密斯·凡·德·罗（1886～1969 年，20 世纪最有影响力的艺术家之一，德绍包豪斯的最后一任校长）对其进行了高度赞美。然而砌体形式繁多，很难加以完整概括。从古代的歌剧院、巴比伦神庙到现代博物馆或者简单的居民住宅，都可看到它的身影。众所周知，没有砖和砂浆，对于建筑物来说是难以想像的。

砌体应用广泛，但要使其作用发挥得淋漓尽致，必须满足严格的专业技术标准。从砖到墙体、再到房间，最终到整个建筑的形成，整个过程并不容易。

本基础教材系列以适于实际应用的方式，将砌体专业有关知识向读者娓娓道来，培养他们的专业技能，内容深入浅出。本系列包括若干卷，每卷从一个基本点出发，然后加以深入探讨；引入一个主题，然后进行解释，给读者提供必要的实用专业知识，而不是对专业知识泛泛而谈。

本书向读者系统地介绍了砌体结构。砖和砂浆作为基本的组成要素，常用来砌筑墙体。砌体体系整体构成和材料性能对于理解砌体墙体特性至关重要。本书从砖到墙体，对砌块相互作用、砌体砌筑形式、带缝隙、凹槽和透视投影效果的砌体墙体美学效果均进行了绘声绘色的系统阐述，使读者能够理解、掌握砌体的精髓，并将这种理解直接应用于设计和工程实践。

丛书主编：贝尔特·比勒费尔德

FOREWORD

"The brick is another master-teacher. How profound that little format is, handy, how useful for every purpose. What logic its structure shows in bond. How lively is that play of joints. And what richness even the simplest area of wall possesses. But what discipline this material demands."

What Ludwig Mies van der Rohe (1886–1969), one of the most influential artists of the 20th century and the last director of the Dessau Bauhaus, is enthusiastically celebrating here is nothing other than one of the lowest common denominators and at the same time essential basic elements of any architecture: masonry. It appears in so many different forms that it is scarcely possible to provide a complete survey. Whether you look at ancient amphitheatres, Babylonian temples, modern museums or simple houses: without bare brick combined with simple mortar, architecture as we know it today can scarcely be explained.

But the well-nigh infinite creative variety afforded by masonry conceals strict rules that have to be obeyed if the desired overall impression is to be guaranteed. The pathway from the brick to the wall, to the room and finally to the whole building is neither short nor simple.

The "Basics" series of books aims to present information didactically and in a form appropriate to practice. It will introduce students to the various specialist fields of training in architecture. Content is developed stage by stage, using readily understandable introductions and explanations. The essential points of departure are built up systematically and explored further in the individual volumes. The concept is not to provide a comprehensive collection of expert knowledge, but to introduce the subject, explain it, and provide the necessary expertise for skilled implementation.

The present volume aims to introduce students systematically to the subject of masonry. Bricks and mortar, the elemental basic components, are used to devise rules for building a wall. The emphasis is on the overall systems and material-dependent properties that are essential for understanding a "wall". The interplay of bricks, the forms of masonry bonds, and the aesthetic of masonry walls with apertures, projections and recesses are explained soundly and methodically – from brick to wall – so that students can understand the essence of masonry and apply their insights directly to their designs and projects.

Bert Bielefeld
Editor

INTRODUCTION

Masonry buildings cannot be reduced to any particular tradition, fashion or style: timeless in their flexibility, fundamental to both classical and avant-garde architecture, open to stylistic trends throughout the ages, capable of being both ordinary and experimental. The façades of contemporary high-rise buildings and modern glass structures may manage without classical masonry as a basic architectural principle, but it is difficult to find buildings without a masonry wall somewhere inside, thus reconfirming the existential character of masonry.

The book will present the "Basics" of masonry, together with the demands it makes. First of all we need to look at its basic components, bricks and mortar. The rules for fitting these elements together to make a wall form the theoretical and creative basis in the second chapter for understanding the wall constructions explained in the third. Then, moving from plain brick construction to the completed wall, we arrive in the fourth chapter at the question of which building materials are suitable for the types of work described earlier, thus ending up with the brick again.

MASONRY

Masonry is not a building material like wood or steel, but a combination of two individual materials, bricks and mortar, handled according to the rules of a craft. It is frequently classified as a composite material, and thus more like reinforced concrete than concrete, for example, as the quality of the end product depends on the quality of both the materials and the execution.

Masonry is used primarily for constructing walls, as a loadbearing or partitioning shear wall, as facing to protect or clad, or as infilling between columns and beams. Bricks are also found in vaults or coping, and also as a floor covering.

There are different kinds of bricks and mortar for all these functions and structures. It is therefore important to know the most important properties of the two materials as well as about construction, so that the ideal combination can be achieved.

THE BRICK

Asked about bricks, most people would probably sketch a uniform shape and size: the standard brick. Developed over millennia, bricks lend

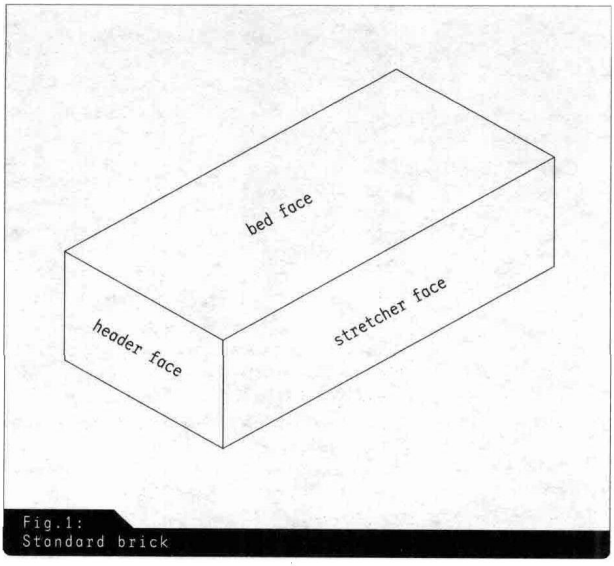

Fig.1:
Standard brick

their character to most masonry façades and are firmly linked with our idea of masonry. But there are a whole variety of different shapes and sizes: flat Roman bricks, large manufactured blocks or octagonal moulded bricks. And the brick forms the basis for the whole set of craft rules of erecting a masonry building, even today. These rules govern the size of rooms and buildings, apertures and built-in features, and they structure façades.

MORTAR FOR MASONRY

The second component of masonry is mortar. It enables the bricks to cover a full area, balances tolerances and ensures that the bricks will hold together strongly, and its finish and colouring influence the look of exposed masonry. It is applied both horizontally between the individual layers of bricks (course joint) and vertically between the individual bricks (perpend). Even though modern manufacturing methods are shrinking the layers of mortar for reasons of cost and structural engineering technology, the combination of brick and mortar is crucial when planning construction. The cohesion of mortar and brick, and thus also the choice of individual components, are important in terms of loadbearing capacity, so that even modern building methods without mortar follow rules based on traditional building.

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RULES OF CONSTRUCTION

As masonry is a craft, there are certain rules for achieving a high-quality finish. The most important aims are:

- Optimizing the loadbearing and resistance properties of the construction
- Minimizing loss of material
- Speeding up the building process
- Executing a design that does justice to material and use

These rules form a theoretical basis for the wall structures given in the third chapter. They show the principles and methods for creating masonry from its components, the preferred dimensions, and how to form connections and apertures correctly for the material. The individual wall will be considered first.

DIMENSIONS AND MODULES

One of the architect's main tasks when planning and constructing a building is to coordinate and combine the various structural and craft services. Shell construction (walls, columns, floors etc.) and finishing (windows, doors, wall and floor coverings etc.) have to be matched in order to build efficiently. The actual building process, as well as planning and finishing, are simplified by repeating elements and sizes. However, fixing grid dimensions is problematical for masonry, as it is impossible to work with the dimensions of the bricks alone, since we must allow for the mortar joints between the bricks as well. Here, a simple device is used to decide when the joint must be added to a wall length or not: the distinction between specified and nominal dimensions.

Specified dimension and nominal dimension

The specified dimension is the basic theoretical measurement, the grid or the module multiplied to put together the whole masonry construction system. The nominal dimension, however, is the dimension that is actually executed and entered on the construction drawing. This distinction can be used to systematize construction types with joints, and particularly masonry constructions.

Although the nominal and specified dimensions are identical when building without joints, they are treated as follows in construction for building types with joints:

The specified dimension consists of the nominal dimension executed and the corresponding joint, i.e.:

brick dimension + joint

Conversely, the nominal dimension is the brick dimension alone, without joint.

If you now imagine a masonry wall with window apertures and transverse walls, you will very quickly realize that there are different dimensions for the wall width, aperture and projections because of the mortar joints.

External dimension

The external dimension is the wall thickness. One joint must always be subtracted from the specified dimension as there is always one joint missing, regardless of the number of bricks.

External dimension (E) = specified dimension – joint

Aperture dimension

The interior dimension of an aperture always contains an additional joint.

Aperture dimension (A) = specified dimension + joint

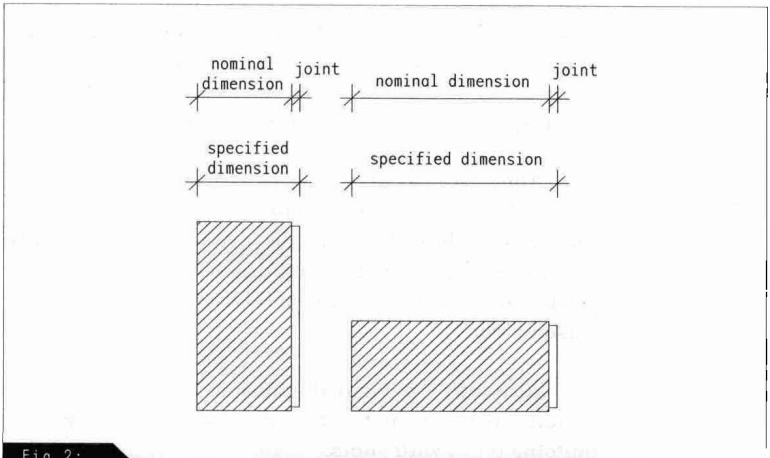

Fig. 2:
Specified dimension and nominal dimension

Projection dimension

The projection dimension measures the piece of wall between opening and wall or wall projections. Here, the missing joint in the external dimension and the additional joint in the aperture dimensions balance each other out.

Projection dimension (A) = specified dimension

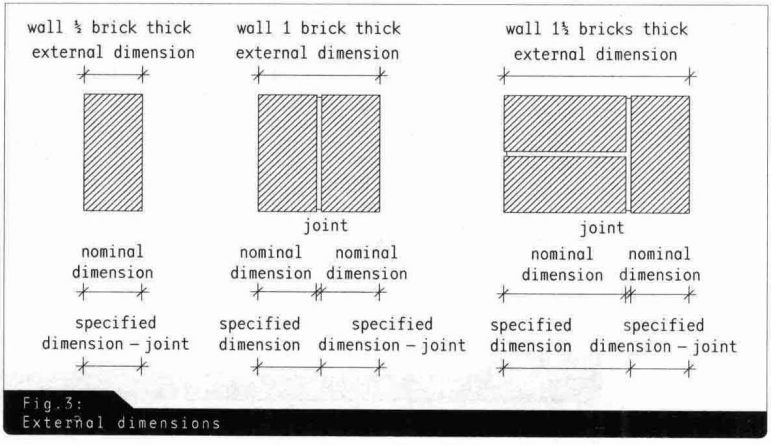

Fig.3:
External dimensions

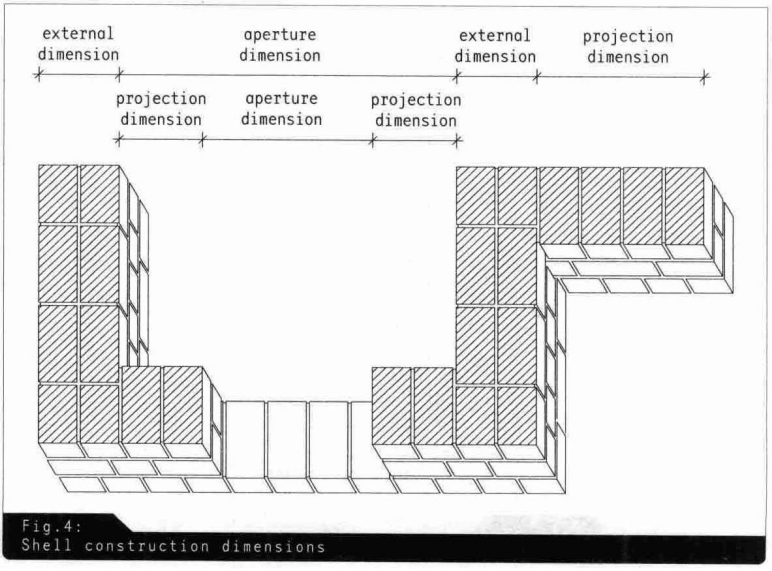

Fig.4:
Shell construction dimensions

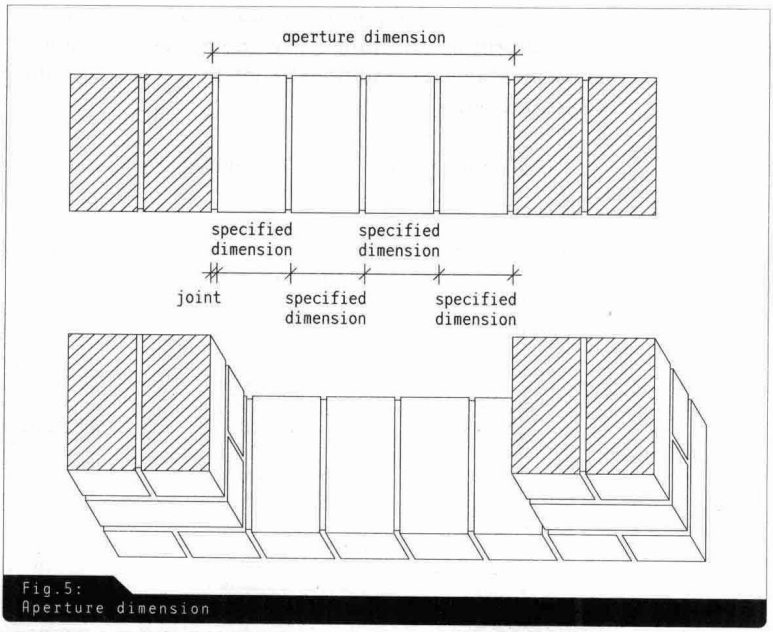

Fig.5:
Aperture dimension

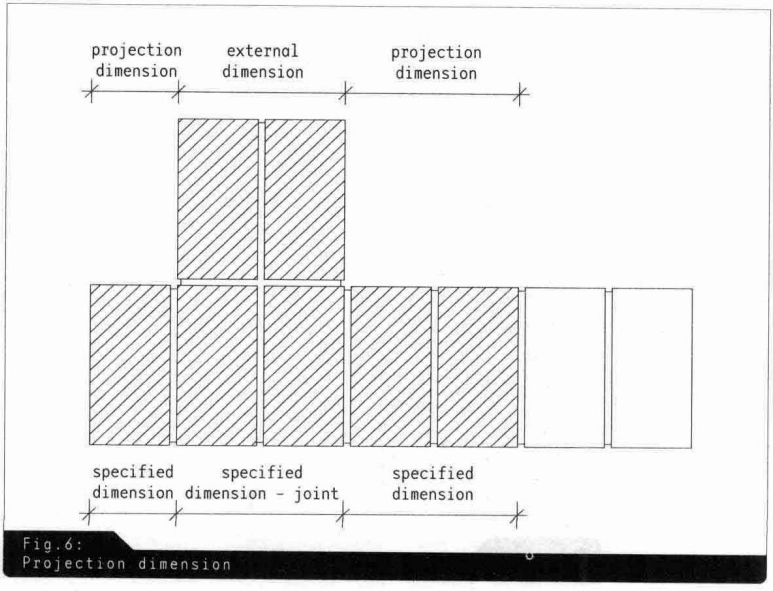

Fig.6:
Projection dimension

UNIT DIMENSIONS AND DESIGNATIONS

These hitherto theoretical definitions have left open the question of actual dimensions, which are independent of the brick and joint sizes chosen. These sizes can vary, and have led to different standards in different countries, according to local traditions.

In Germany, masonry is based almost exclusively on the octametric system, which uses an eighth of a metre = 12.5 cm as the specified dimension. The standard brick, so-called "normal format", measures 24×11×7.1 cm (nominal dimensions). When the joint sizes for of 1 cm for the vertical head joints and 1.23 cm for the horizontal course joints are added, this gives specified dimensions of 25×12.5×8.33 cm, multiples of which produce a metre.

Joint sizes can also vary, without changing the system. New manufacturing technology and the need to meet the greater-than-ever demands on masonry for heat and sound insulation, and in terms of loadbearing capacity, mean that masonry technique is no longer based on the centimetre joint. Modern manufactured blocks are finished to such low tolerances that joints need be only a few millimetres thick.

However, to maintain the usual specified dimensions, the unit dimensions have been adapted to ensure that the overall dimensions still fit in with the system:

For example:

Traditional:	German normal format brick	24 cm + 1 cm joint = 25 cm
Modern technique:	Manufactured block	24.7 cm + 3 mm joint = 25 cm

\\Tip:
In Germany, these dimensions are fixed by the DIN 4172 standard dimension in the building industry, which has prescribed a basic module of 25 cm for shell construction since the post-Second World War rebuilding, basing itself on traditional formats. The later DIN 18000 modular standard for building, which promised to be simpler to use with its decimetric basic module of M = 10 cm, has not caught on in Germany.

\\Hint:
Different countries have other standard bricks, based on national traditions or different units (e.g. inches), e.g. 21.5×10.25×6.5 cm in England, 19×9×6.5 cm in Belgium, and 8×4×2.25 inches (20.3×10.2×5.7 cm) in the USA.

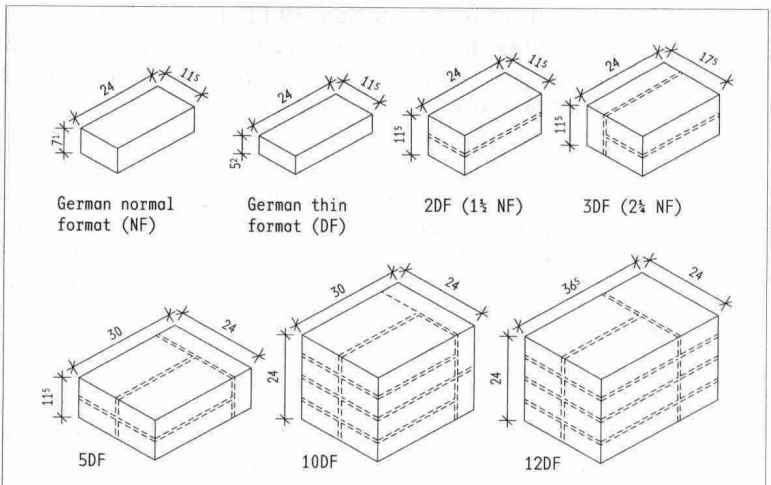

Fig.7:
Brick formats

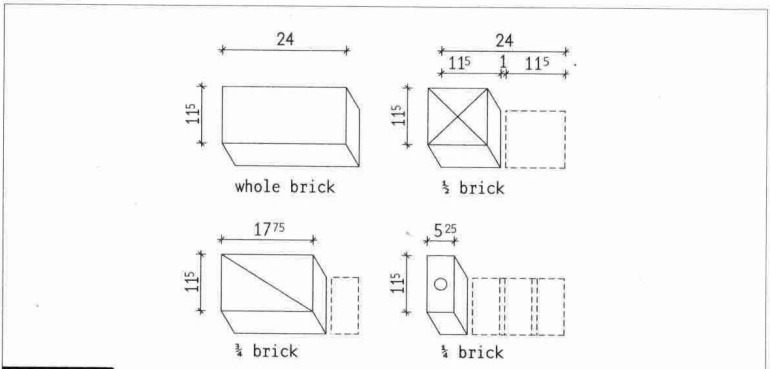

Fig.8:
Cut bricks

\\Hint:
As the same number of thin-format units can be combined in different ways, different formats produce the same designation, e.g. 8DF = 24×24×23.8 cm and 8DF = 24×49×11.3 cm.

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