

Recommendations for the co-ordination of dimensions in building —

Combinations of sizes

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Co-operating organizations

The following Government departments, professional, scientific and industrial organizations co-operated in the preparation of this document.

Agrément Board*	Component Co-ordination Group
Asbestos Cement Manufacturers' Association	Institution of Civil Engineers
Association of Building Technicians	Institution of Municipal Engineers
Association of Industrialized Building	Institution of Structural Engineers
Component Manufacturers Ltd.*	London Transport Executive
Brick Development Association	Metal Window Federation of G.B.
British Ceramic Research Association	Department of Health and Social Security
British Constructional Steelwork Association	Ministry of Housing and Local Government*
British Plastics Federation	Ministry of Public Building and Works*
British Railways Board	Ministry of Public Building and Works —
British Woodwork Manufacturers' Association	Building Research Station*
Concrete Society Ltd.	Modular Society*
Consortium of Local Authorities Special Programmes	National Council of Building Material Producers*
Consortium for Method Building	National Federation of Building Trades Employers*
Department of Education and Science	National Federation of Clay Industries.
Faculty of Architects and Surveyors	Roofing Tile and Floor Quarry Section, and
Federation of Building Block Manufacturers	Building and Engineering Brick Section
Fibre Building Board Development Organization Ltd.	Pressed Brick Makers Association Ltd.
Flat Glass Manufacturers Association	Royal Institute of British Architects*
Greater London Council	Royal Institution of Chartered Surveyors*
Gypsum Products Development Association	Scottish Development Department
Incorporated Association of Architects and Surveyors	The Society of Railing and Balustrade Manufacturers
	Timber Research and Development Association

The Government departments and scientific and industrial organizations marked with an asterisk in the above list were directly represented on the committee entrusted with the preparation of this PD document.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 21 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Amendments issued since publication

Amd. No.	Date	Comments

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Contents

	Page
Co-operating organizations	Inside front cover
Synopsis	ii
1 Introduction	1
2 Definitions	2
3 Putting components together	3
3.1 Single components	3
3.2 Two components	4
3.2.1 Two components having common factors	5
3.2.2 Two components having no common factors	6
3.3 Arrangements	8
4 More about critical numbers	9
5 Table of critical numbers	10
6 Problem analysis check lists	11
7 Identifying combinations	13
8 The “combigraph”	13
8.7 Deductions to be drawn from the graph	17
9 “Combigraph” and block diagrams combined	18
10 Combinations and arrangements using two components — summary	19
11 Three and more component sizes	19
12 Use of computers	20
13 Use by all industries	20
Appendix A Table of critical numbers	21
Figure 1 — Components 3 units long will fill a space 15 units long	3
Figure 2 — Components 3 units long will not completely fill spaces 16 or 17 units long	4
Figure 3 — Combinations of 2 and 6	5
Figure 4 — Combinations of 3 and 6	6
Figure 5 — Combinations of 3 and 4	7
Figure 6 — Table of possible arrangements	8
Figure 7 — See 8.1	13
Figure 8 — See 8.2	13
Figure 9 — Plotting of component size 3	14
Figure 10 — Plotting of components sizes 3 and 5	15
Figure 11 — See 8.6	16
Figure 12 — See 8.6	16
Figure 13 — Completed plotting of all combinations of sizes 3 and 5	16
Figure 14 — “Combigraph” and block diagrams combined. Component sizes 3 and 5	18

Synopsis

Components add together to fill spaces.
Single components — spaces they will and will not fill.
How two components are represented.
Example: combinations of 2 and 6 showing different arrangements.
Similarly 3 and 6.
Results of combining relatively prime numbers. The critical number.
Example: combinations of 3 and 4 showing how all numbers from 6 onwards (the critical number) are filled and different arrangements occur.
Different arrangements. How the total number of possible arrangements can be found.
Table giving all possible arrangements of sizes A and B.
Importance of critical number. How to find the critical number.
How to use the table of critical numbers for any 2 or any 3 sizes between 2 and 30.
A manufacturer's problem solved.
How to fill in check lists for typical problems. A typical problem with solution.
Factors in manufacturing problems.
How to tell which spaces are filled by using a graph ("combigraph").
How to draw the "combigraph" simply.
Examples.
Identifying every different combination. **All** combinations are identified.
Identifying combinations by both block and graph methods.
Resumé of information from graph. Deductions
How to deal with more than two sizes.
How computers can identify combinations. What computer programs exist.
Methods applicable to all industries.
Table of critical numbers.

Summary of contents

Combinations can help everybody in the construction industry.

They promote economy in building.

Different arrangements are possible. Table of possible arrangements gives up to 8 + 8 of two different sizes.

Critical number (CN) is the sparking point.

CN is a good guide to combinability and flexibility of a component range.

The table of CN gives CN of pairs and trios of component sizes 2 to 30. The table narrows the search.

The “combigraph” gives in relation to spaces:

- composition of all combinations using up to three component sizes;

- total number of all combinations;

- critical number

Problem-analysis check lists for manufacturers, designers and builders define and solve their problems.

Computers work out combinations effectively but preliminary sifting is desirable for economy and understanding.

Combinations can help in other industries.

1 Introduction

The Introduction to PD 6444-1¹⁾ states that in choosing a range of sizes for a modular building component, the objective is “the development of a limited range of sizes giving maximum flexibility of assembly for the component”. Flexibility is given as “the measure of the number of different basic spaces that a component range can fill, both singly and in various assembly combinations”.

The range of sizes for a modular component is expressed in terms of co-ordinating spaces or, for single dimensions, co-ordinating sizes. Thus, in the terminology of dimensional co-ordination, basic spaces are filled by the co-ordinating spaces of individual components. A full explanation of basic space, and co-ordinating space concepts is given in PD 6444.

Components that can be assembled or coupled in combinations, both vertically and horizontally, (so that a small range of such components can fill a wide range of basic spaces), are termed “additive” components. ***The object of this document is to provide further guidance on the selection of limited ranges of co-ordinating sizes for additive components, by an introduction to the use of combinations of numbers, or sizes.*** Other than simple arithmetic, no mathematics are required.

Only one linear dimension, of the basic space or component co-ordinating space, has been considered in the worked examples contained in the document. However, the same procedures can be applied in the selection of sizes for other dimensions.

The guidance contained in this document can assist manufacturers in choosing the right co-ordinating sizes to make, and designers in selecting the most appropriate sizes from those available.

In substance, this document is a simplified and abbreviated version of a book²⁾ and, of necessity, the scope of the guidance given cannot be as extensive as that of the book itself. It does, however, contain some new information which is not in the book.

¹⁾ PD 6444, “Recommendation for the co-ordination of dimensions in building. Basic spaces for structure, external envelope and internal sub-division”, Part 1, “(Functional Groups 1, 2 & 3)”.

²⁾ “Combinations of numbers in building”. Philip Dunstone, The Estates Gazette Ltd., London.

2 Definitions

For the purposes of this document, the following definitions, which are taken from BS 2900³⁾, apply:

Term	Definition
	Co-ordination
dimensional co-ordination	The application of a range of related dimensions to the sizing of building components and assemblies and the buildings incorporating them.
	The Building Reference System
reference system	A system of points, lines and planes to which sizes and positions of a building component or assembly may be related.
reference plane	A plane of a reference system.
basic space	A space bounded by reference planes, assigned to receive a building component or assembly including, where appropriate, allowance for joints and tolerances.
	The Component Reference System
co-ordinating plane	A plane by reference to which a building component or assembly is co-ordinated with another.
co-ordinating space	A space bounded by co-ordinating planes, allocated to a building component or assembly, including allowance for joints and tolerances.
co-ordinating dimension	1) A dimension of a co-ordinating space. 2) A dimension which is common to two or more building components to permit their assembly.
co-ordinating size	The size of a co-ordinating dimension.
	The Building Component and its Sizes
building component	Building material formed as a distinct unit.
modular building component	A building component whose co-ordinating sizes are in accordance with BS 4011 ^a .

^a BS 4011, "Recommendations for the co-ordination of dimensions in building. Basic sizes for building components and assemblies".

³⁾ BS 2900, "Recommendations for the co-ordination of dimensions in building. Glossary of terms".

3 Putting components together

When components and assemblies are put together on site to form a building, they fill spaces. Each space and each component is of a definite size and the components are used additively to fill spaces. This is equally true of traditional buildings as of dimensionally co-ordinated ones designed to the controlling reference system given in BS 4330^a.

The following are examples of components being used additively to fill spaces.

In the examples whole numbers only are used, but these may be regarded as units of any size required. In order to find the *physical* sizes of components or spaces, it is therefore necessary to multiply by the size of the unit selected. For example, in working in units of 100 mm, a space of 29 units long would be $29 \times 100 \text{ mm} = 2\,900 \text{ mm}$ long; with 300 mm units, a component 5 units long would be $5 \times 300 \text{ mm} = 1\,500 \text{ mm}$ long.

For simplicity, examples are worked for sizes of one horizontal dimension only, with the height dimension remaining constant; but the same procedures can be applied for selecting the sizes of other dimensions.

3.1 Single components

NOTE Although this part of the discussion may seem obvious, it is necessary for an understanding of what follows.

A single component, say 3 units long, is represented thus:

3 

When added together, components 3 units long will fill a space 15 units long. In practical terms, panels 300 mm long will make a wall 1 500 mm long. (See Figure 1.)

15 

Figure 1— Components 3 units long will fill a space 15 units long

^a BS 4330, "Recommendations for the co-ordination of dimensions in building. Controlling dimensions."