NOMOGRAMS FOR THICKNESS OF MASONRY WALLS

(First Reprint SEPTEMBER 1991)

(REPRODUCED FROM THE
NATIONAL BUILDING CODE OF INDIA 1970
PART VI STRUCTURAL DESIGN
SECTION 4 MASONRY)

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NOMOGRAMS FOR THICKNESS OF MASONRY WALLS

(Formulated by the Panel on Masonry, BDC 64 : P6, of the Guiding Committee for National Building Code, BDC 64)

0. FOREWORD

0.1 Bricks and other masonry units are the most popular building materials in different parts of the country for load bearing and non-load bearing walls in buildings. A rational approach to the structural design of walls in the building byelaws of the local bodies is more an exception than a rule. Generally local bodies specify minimum thickness of walls for different storeys without taking cognizance of different strengths of bricks and mortar used. The procedure for structural design of masonry walls in buildings has been covered in detail in the National Building Code of India 1970, Part VI Structural Design, Section 4 Masonry; this covers determination of effective length, the basic compressive stress for different masonry units and mortar used, etc.

0.1.1 Residential (Class 200) and office (Classes 300 and 400) buildings are commonly met with. For these loadings, therefore, for different spans and heights of rooms and percentage openings in walls, calculations have been carried out for different strength of masonry. The results of these calculations have been given in the form of nomograms with directions for use.

0.1.2 These nomograms serve as aids to the design engineer for his day-to-day use, to arrive at the solutions for any known conditions for loadings of Classes 200, 300 and 400.

0.2 For other classes of loadings, reference should be made to the procedure for structural design as given in Part VI Structural Design, Section 4 Masonry of the National Building Code of India 1970.

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1. SCOPE

1.1 This publication contains eight nomograms for arriving at the thickness of non-reinforced brick walls for known design parameters. This is reproduced from the National Building Code of India 1970, Part VI Structural Design, Section 4 Masonry.

2. PERMISSIBLE STRESSES

2.1 The permissible compressive stresses recommended in Table 1 apply to masonry walls consisting of squared units built to horizontal courses with broken vertical joints. The permissible compressive stress for masonry is given for any combination of the masonry unit of known crushing strength and mortars of known mix.

3. MINIMUM CALCULATED THICKNESS OF WALL

3.1 General — The thickness of masonry walls for the following spans, storey heights and openings, given by nomograms (*see* Fig. 1), are worked out for three occupancies:

	Occupancy	*Live Loading*	*Refer to Figure No.*	*Height of Rooms in* m	*Span of Rooms in* m	*Percentage of Openings*
a)	Residential buildings	200 kg/m²	1A and 1B	2·8 and 3·2	3·0, 3·6 and 4·2	0 to 50
b)	Office buildings	300 kg/m²	1C, 1D and 1E	3·0, 3·4 and 3·8		
c)	Office buildings	400 kg/m²	1F, 1G and 1H			

3.1.1 The thicknesses are calculated for the different strengths of masonry (brick and mortar) available in the country (*see* IS : 1077-1970*).

3.1.2 Masonry thicknesses are calculated for buildings up to six storeys in height both for interior and exterior walls.

3.2 Procedure for Making Use of Nomograms

3.2.1 *Structure of the Nomograms* — The nomograms for thickness of brick wall consist of nine vertical lines. From left to right, the vertical lines represent the basic stress, storeys, reference line 1, span point, reference line 2, percentage of openings and thickness of walls for spans

*Specification for common burnt clay building bricks (*second revision*).

of 3·0, 3·6 and 4·2 m; details of which are given below:

a) *Basic stress* — The basic stress of masonry, depending on the crushing strength of masonry unit (brick) and mortar used is indicated on the first vertical line. Table 1 gives the basic stress for known values of crushing strength of the masonry unit and the mortar used. Linear interpolation between the limits is permitted.

b) *Storeys* — The second line lists the number of storeys of the masonry building for which the thicknesses of brick wall are available. Masonry thicknesses are arrived at for buildings up to six storeys in height. For use of nomograms in the case of multi-storeyed buildings, the wall thickness at each floor is found by passing the line through the number of storeys above that section. For example, in a four-storeyed building the thickness of wall at the ground floor (Floor 1) is found by passing the line through '4' on the storey line. Similarly, for Floor 2, the line shall be passed through '3' on the storey line; for Floor 3, the line shall pass through '2'.

c) *Reference line 1* — This reference line fixes a point on the line for any combination of values for basic stress and storeys.

d) *Span point* — The fourth line has a span point, through which all lines shall pass through for arriving at the thickness.

e) *Reference line 2* — This reference line also fixes a point on the line for any combination of values for basic stress and storeys.

f) *Percentage of openings* — The openings provided on the walls for windows, ventilators, doors, shelves, etc, are taken care of in the nomograms by this line. Window height is taken as 1·5 m for calculations. Openings which occupy up to 50 percent of the area of wall under consideration, come under the purview of the nomograms.

g) *Thickness* — The last three lines in any nomogram give the thickness of brick wall for a particular loading and a storey height. The three sets of thicknesses are for three spans of the rooms, namely, 3·0, 3·6 and 4·2 m. Thicknesses are indicated on both sides of the lines. The bold markings on the left side of the lines give the thicknesses for external walls and the dotted markings on the right side of the lines give the thicknesses for internal walls. Internal walls are analyzed as walls having spans on either side. The numbers 1, 1½, 2, etc, on these lines indicate the (number of) brick thickness; for example, 1 indicates 1 brick thick. The calculations are valid for the common burnt clay building bricks conforming to IS : 1077-1970*.

*Specification for common burnt clay building bricks (*second revision*).

TABLE 1 BASIC COMPRESSIVE STRESSES FOR MASONRY MEMBERS (AT AND AFTER THE STATED TIMES)

[*Clauses* 2.1 *and* 3.2.1(a)]

Sl No.	Description of Mortar	Mix (Parts by Volume)					Hardening Time After Completion of Work (*see* Note 7)	Basic Stress in kg/cm² Corresponding to Masonry Units with Crushing Strength (kg/cm²)								
		Cement	Lime (*see* Note 5)	Lime Pozzolana Mixture (*see* Note 6)	Pozzolana	Sand		35	70	105	140	175	210	280	350	440
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
i)	Cement	1	0-$\frac{1}{4}$*C**	—	—	3	7	3·5	7·0	10·5	12·5	14·5	16·5	21·0	25·0	30·5
ii)	Cement	1	$\frac{1}{4}$*C**	—	—	4$\frac{1}{2}$	14	3·5	7·0	10·0	11·5	13·0	14·5	17·5	21·0	25·0
iii)	Cement-lime	1	1*C*	—	—	6	14	3·5	7·0	10·0	11·0	12·0	13·0	16·0	19·0	22·0
iv)	Cement-lime	1	2*B*	—	—	9										
v)	Cement	1	—	—	—	6	14	3·5	5·5	8·5	10·0	11·0	12·0	14·5	16·5	19·0
vi)	Lime-pozzolana mixture	—	—	1	—	1$\frac{1}{2}$										
vii)	Cement-lime	1	3*B* or *C*	—	—	12	14	2·5	5·0	7·0	8·0	9·0	10·0	12·0	14·0	16·0
viii)	Hydraulic lime	—	1*A*	—	—	2										
ix)	Lime pozzolana	—	1*C*	—	1	2	14	2·5	5·0	7·0	8·0	9·0	10·0	12·0	14·0	16·0
x)	Lime	—	1*B*	—	—	3	28	2·5	4·0	5·5	6·0	6·5	7·0	7·5	8·5	9·5

NOTE 1 — This table is valid for slenderness ratio 6 and the loading with zero eccentricity.

NOTE 2 — Linear interpolation is permissible for units whose crushing strengths are intermediate between those given in the table.

NOTE 3 — It is advisable to use plasticizers for cement mortars in order to improve properties of the mortar, such as flow and water retentivity. Plasticizers should be used according to manufacturer's instructions.

NOTE 4 — Masonry cement mortars are also advisable and shall be used according to manufacturer's instructions. The mix proportions of masonry cement: sand shall be such as to give comparable mortar crushing strengths with the cement: lime: sand mortar or cement: sand mortar of the particular grade.

NOTE 5 — Lime classification (Classes *A*, *B* and *C*) and building lime shall conform to IS : 712-1964†.

NOTE 6 — For mortar under SI No. (vi) lime-pozzolana mixture shall be of Grade LP 40 conforming to IS : 4098-1967‡.

NOTE 7 — These periods should be increased by the full amount of any time during which the air temperature remains below 4·5°C plus half the amount of any time during which the temperature is between 4·5 and 10°C.

*The inclusion of lime in cement mortars is optional.

†Specification for building limes (*revised*).

‡Sperification for lime-pozzolana mixture.

3.2.2 *Procedure for Use* — The representative dotted lines given in Fig. 1A give the method of arriving at the thicknesses of the wall at ground floor (Floor 1) in a four-storeyed building for known parameters. The following procedure shall be followed for interpreting the nomograms:

In the example given in Fig. 1A, the dotted line starts from 11·0 on the ' Basic stress line ' and connects with 4 on the ' Storey line ', the extension of which cuts ' Reference line 1 ' at *A*. Point *A* is connected through ' Span point ' to cut ' Reference line 2 ' at *B*. Point *B* is joined with ' 50 ' on ' Opening — Percent line ' which when extended intersects the ' Thickness lines ' at *C*, *D* and *E*. The thickness of the wall shall be the value of the dividing line which appears immediately above the point of intersection on the ' Thickness line '. For example, in Fig. 1A, for the points of intersection *C*, *D* and *E*, the following thicknesses are obtained:

Point	*Span*	*Thickness (In Brick Thicknesses)*	
	m	External	Internal
C	3·0	1½	1½
D	3·6	1½	1½
E	4·2	1½	2

The National Building Code of India 1970 consists of the following Parts and Sections:

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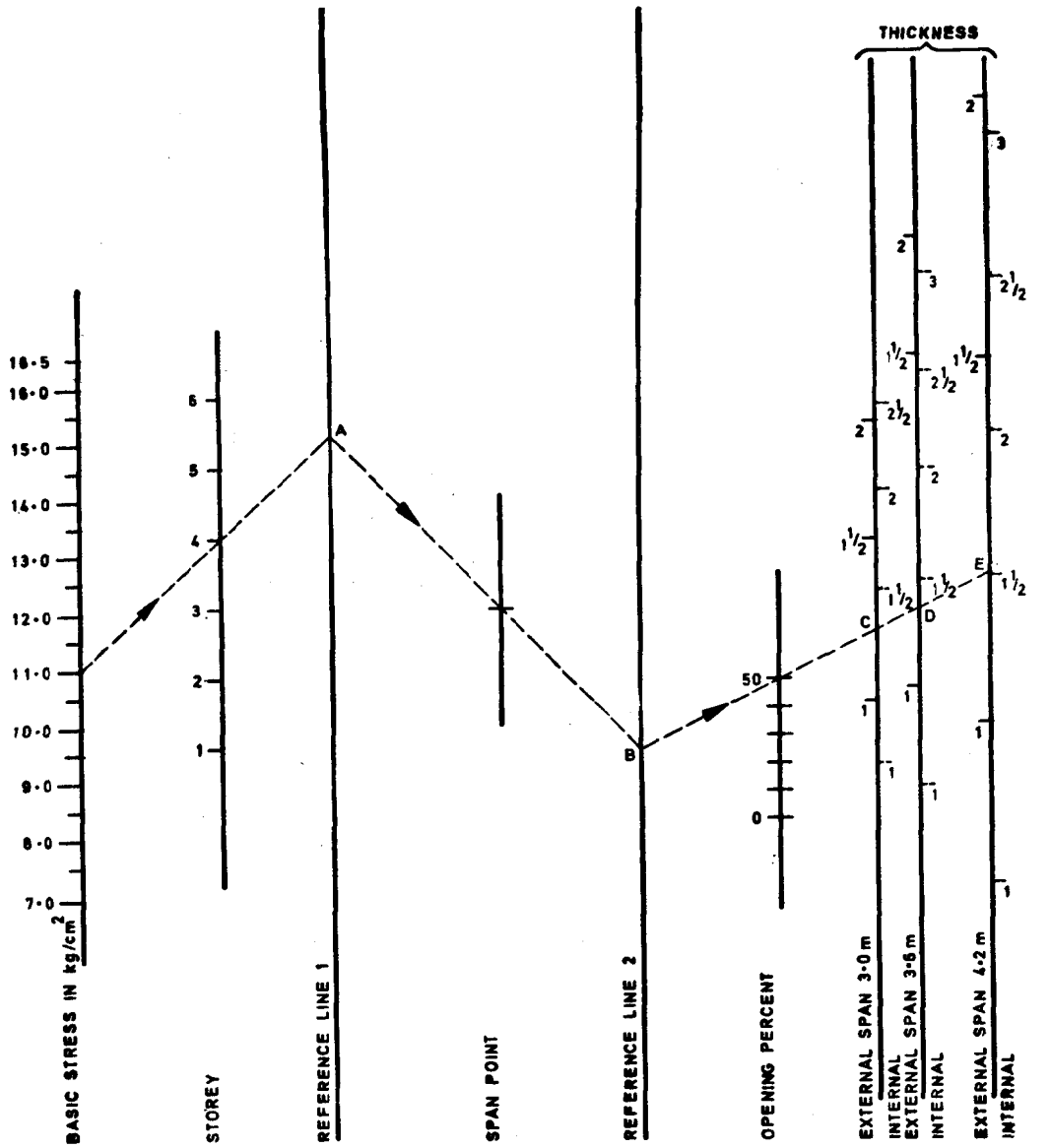


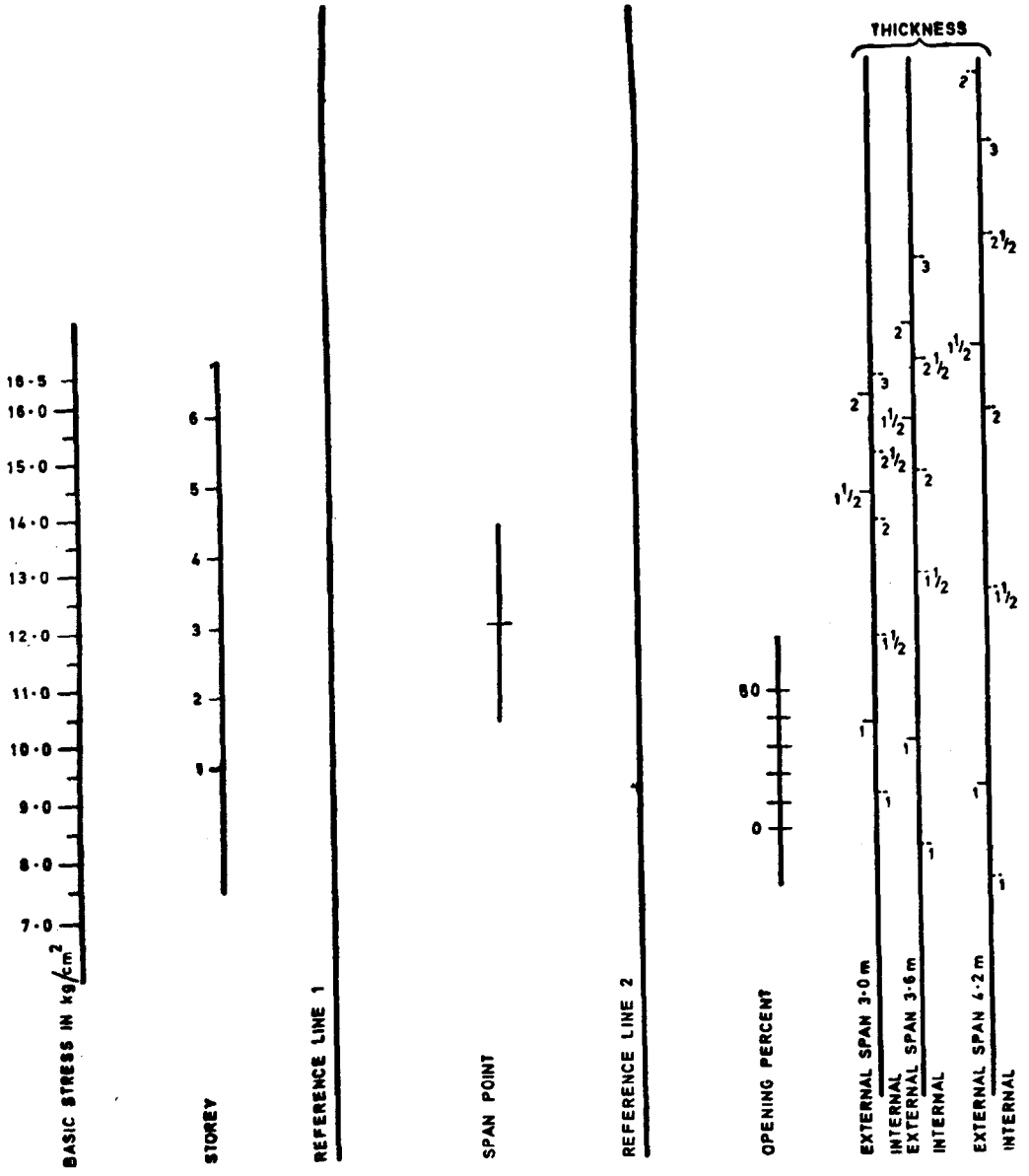
This nomogram is valid for the following conditions:

i) Buildings (residential):
   — Live loading ... 200 kg/m²
   — Dead loading (assumed) ... 415 kg/m²

ii) Storey height ... 2·8 m

IA For Residential Buildings (Class 200 Loading) with 2·8 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS



This nomogram is valid for the following conditions:

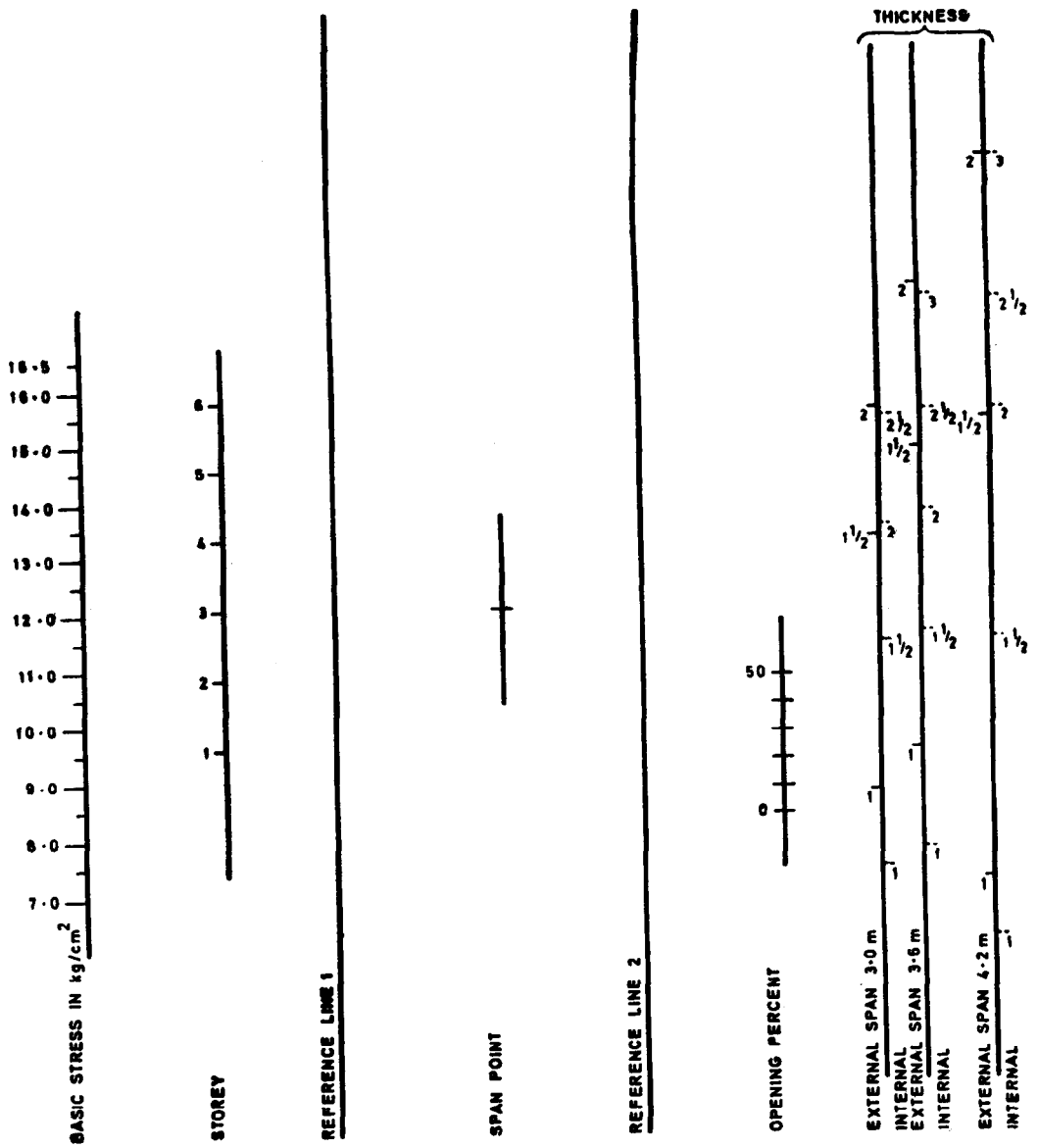
i) Buildings (residential):

— Live loading	...	200 kg/m²
— Dead loading (assumed)	...	415 kg/m²

ii) Storey height ... 3·2 m

1B For Residential Buildings (Class 200 Loading) with 3·2 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS



This nomogram is valid for the following conditions:

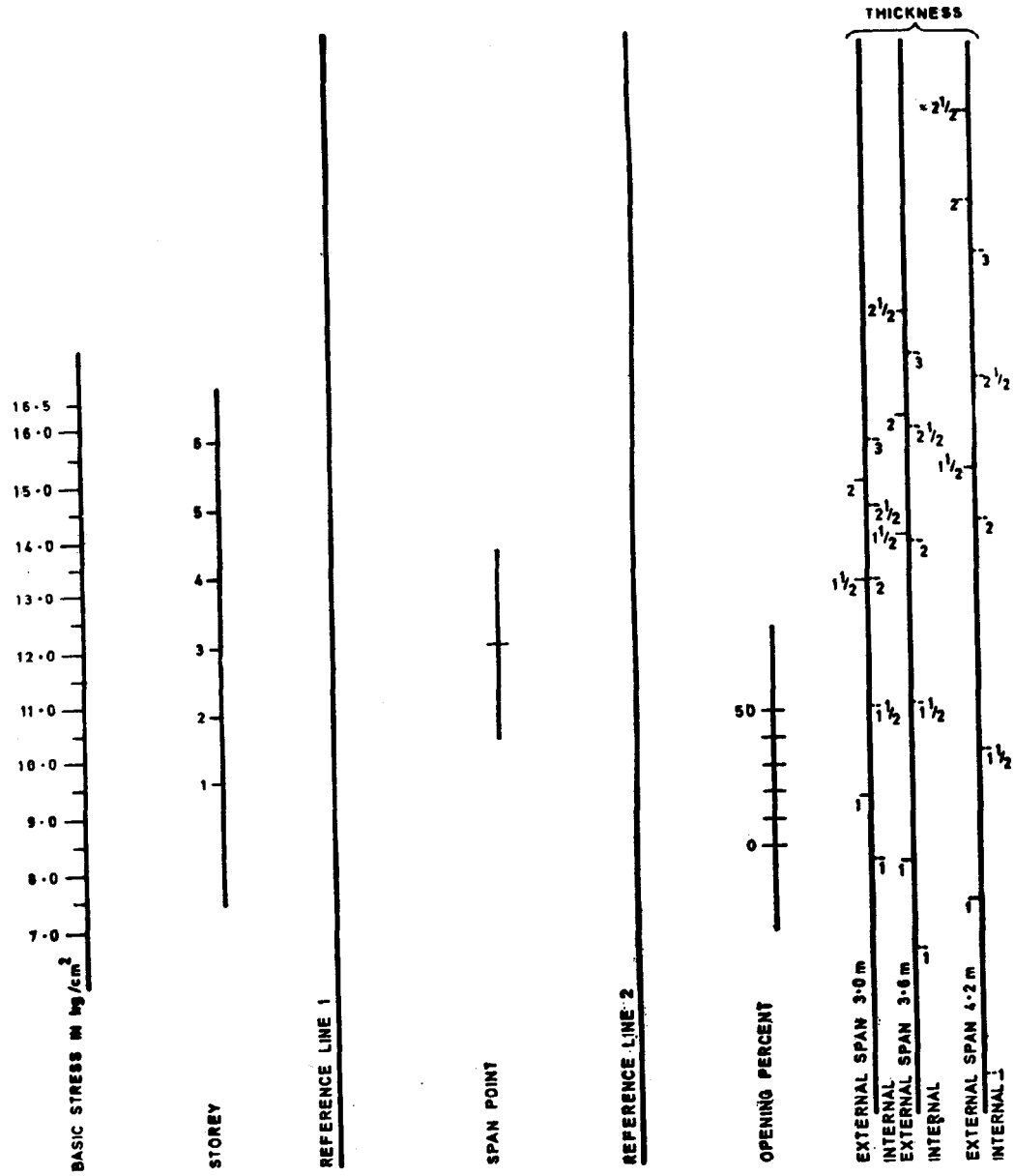
i) Buildings (office):

— Live loading	...	300 kg/m²
— Dead loading (assumed)	...	440 kg/m²

ii) Storey height ... 3·0 m

IC For Office Buildings (Class 300 Loading) with 3·0 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS



This nomogram is valid for the following conditions:

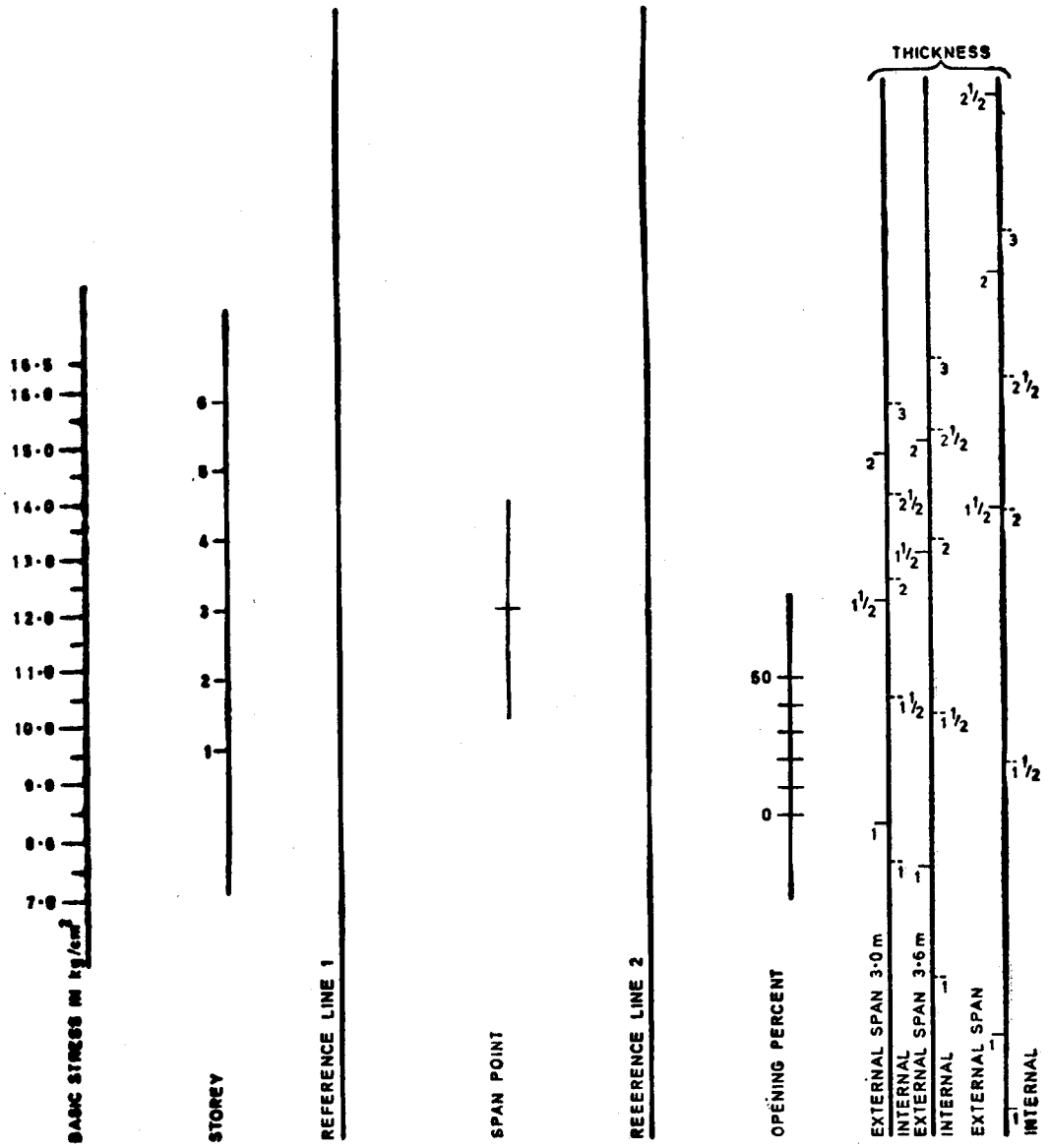
i) Buildings (office):

— Live loading	...	300 kg/m²
— Dead loading (assumed)	...	440 kg/m²

ii) Storey height ... 3·4 m

ID For Office Buildings (Class 300 Loading) with 3·4 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS



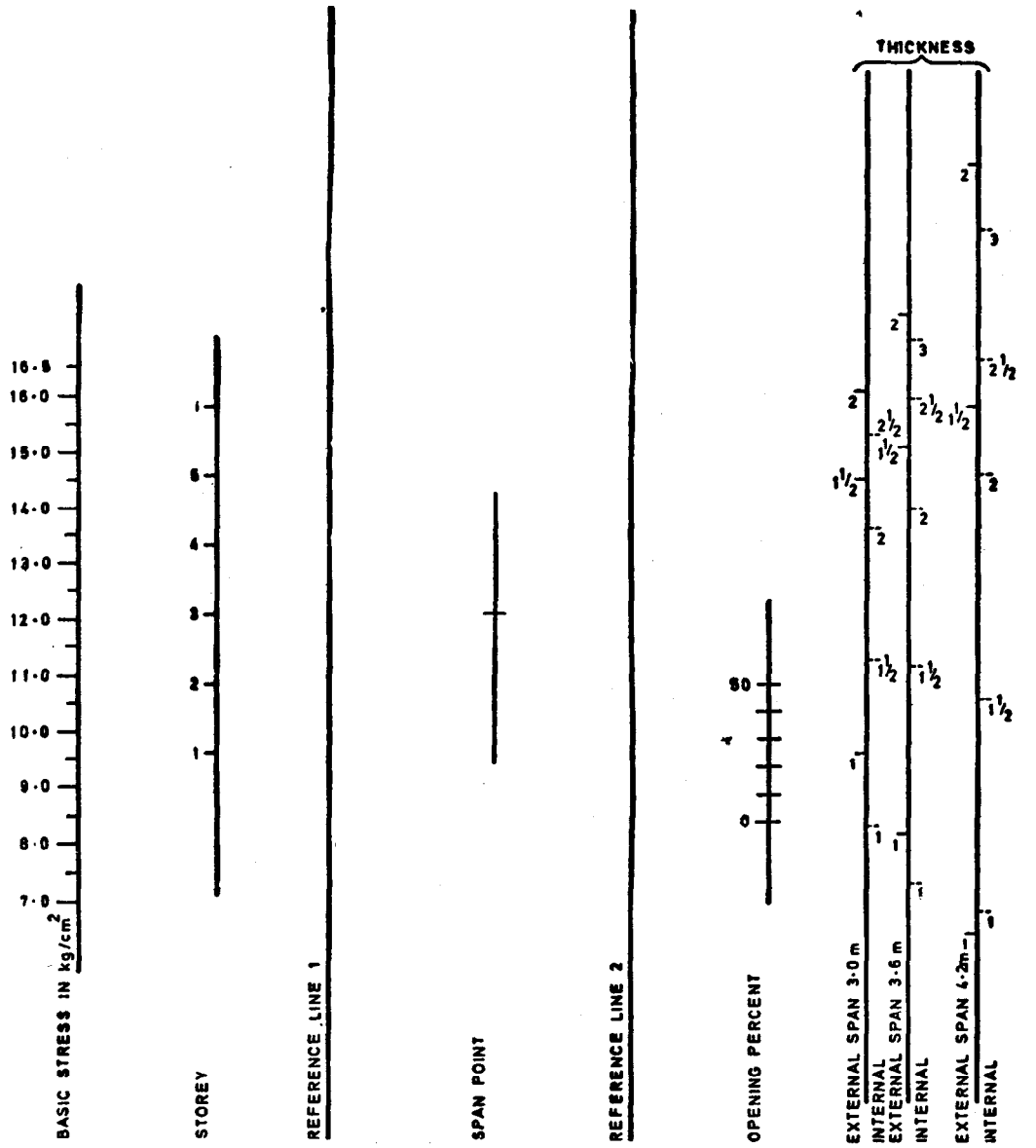
This nomogram is valid for the following conditions:

i) Buildings (office):
— Live loading ... 300 kg/m²
— Dead loading (assumed) ... 440 kg/m²

ii) Storey height ... 3·8 m

IE For Office Buildings (Class 300 Loading) with 3·8 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS



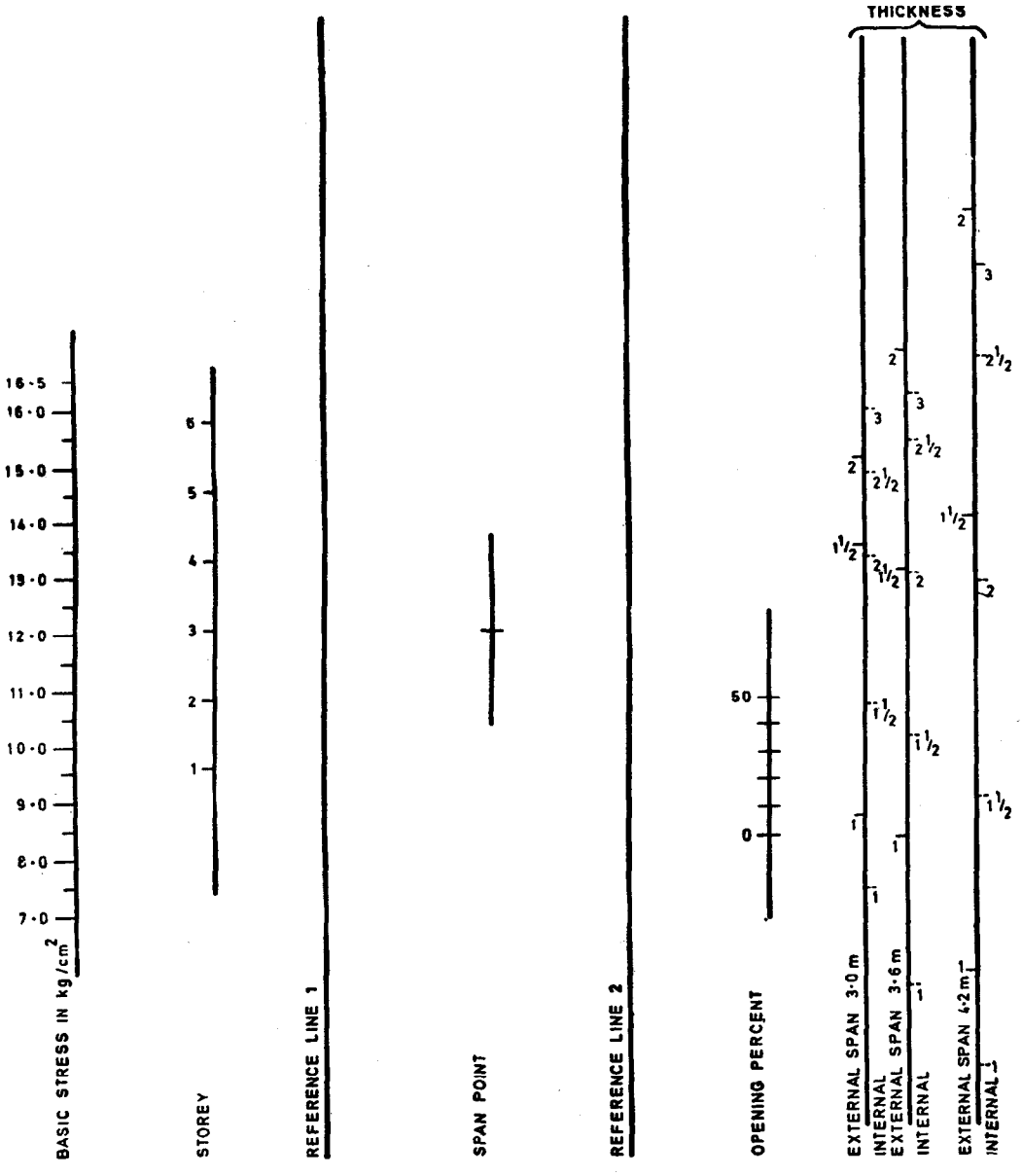
This nomogram is valid for the following conditions:

i) Buildings (office):
   — Live loading ... 400 kg/m²
   — Dead loading (assumed) ... 490 kg/m²

ii) Storey height ... 3·0 m

IF For Office Buildings (Class 400 Loading) with 3·0 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS



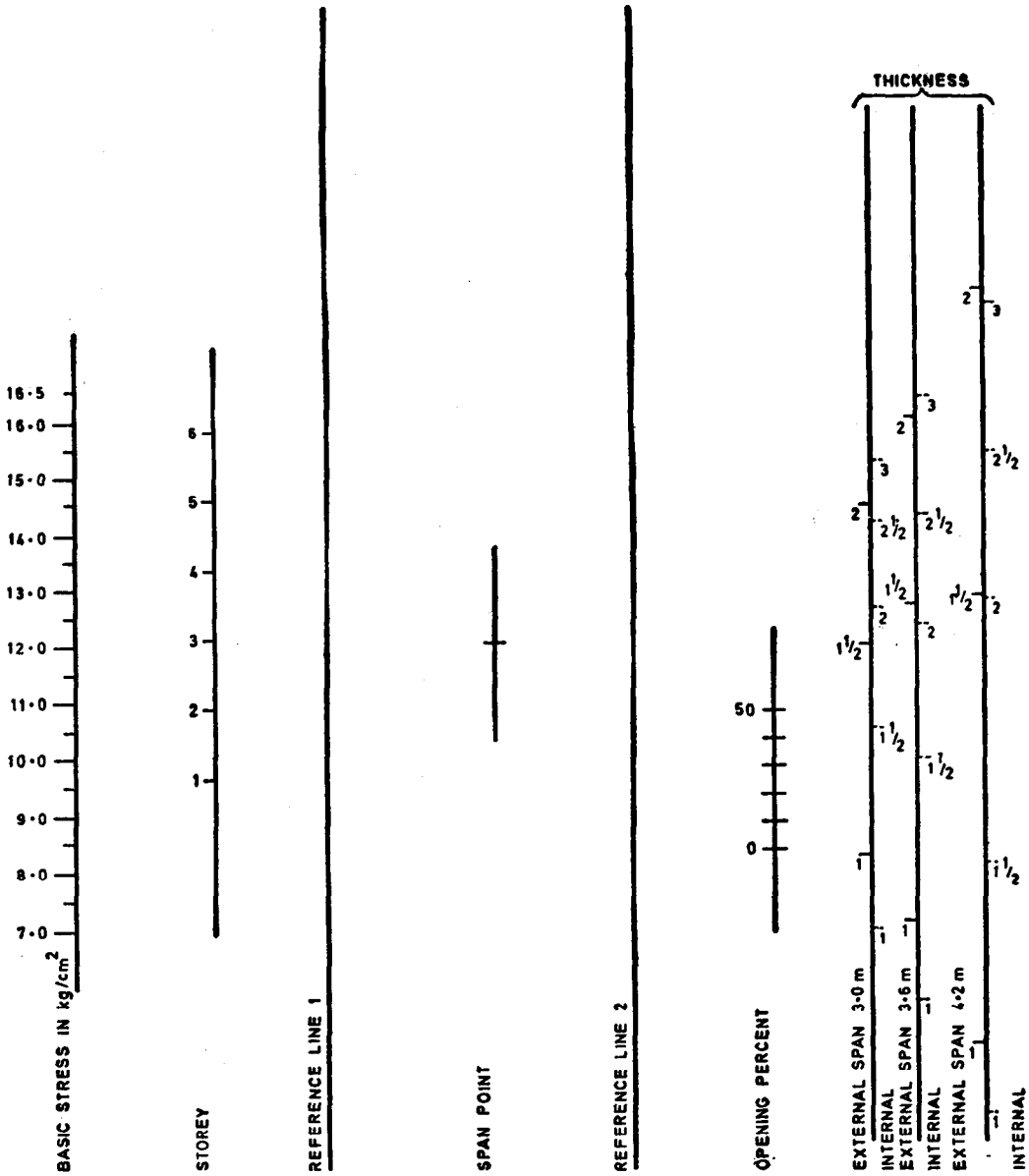
This nomogram is valid for the following conditions:

i) Buildings (office):
   — Live loading ... 400 kg/m²
   — Dead loading (assumed) ... 490 kg/m²

ii) Storey height ... 3·4 m

IG For Office Buildings (Class 400 Loading) with 3·4 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS



This nomogram is valid for the following conditions:

i) Buildings (office):

— Live loading	...	400 kg/m²
— Dead loading (assumed)	...	490 kg/m²

ii) Storey height ... 3·8 m

IH For Office Buildings (Class 400 Loading) with 3·8 m Storey Height

FIG. 1 NOMOGRAMS FOR THICKNESS OF BRICK WALLS