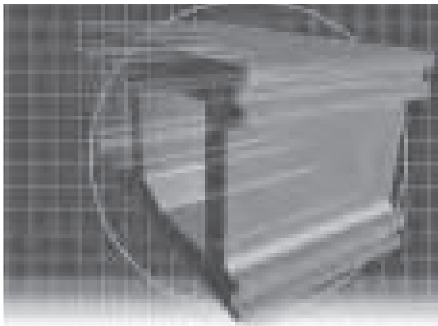
Canadian Concrete Masonry Producers Association
Region 6 of the National Concrete Masonry Association

CCMPA
Building Strength

Metric Technical Manual

Update: September, 2004



Canadian Concrete Masonry Producers' Association

Metric Technical Manual

Table of Contents

Introduction

This is the Fifth Edition of the Metric Technical Manual.

Changes in Building Codes and Standards have led to appropriate amendments, additions and/or deletions.

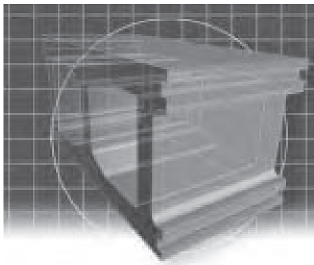
The manual is intended as a working tool to be used in conjunction with Codes and Standards and every effort has been made to ensure that the contents are as accurate and complete as possible, but neither the Canadian Concrete Masonry Producers' Association nor its members can accept responsibility for any errors or omissions.

Comments for improvement are welcome and will be considered for future updates and should be addressed to the Association office.

The manual is available in three formats:

a) as a hard copy in an association binder
b) as a continually updated section of our web site: www.ccmpa.ca
c) in CD format

Please see the materials order form in Section 2, page 2.2.



Metric Units used in this Manual

The Canadian Concrete Masonry Producers' Association
. . . a new and exciting future.

PROPERTY MEASURED	UNIT USED	SYMBOL	IMPERIAL EQUIVALENT
Length	metre	m	1.094 yds.
Mass	kilogram	kg	2.205 lbs.
	tonne	t	2205 lbs.
Volume	cubic metre	m^3	1.308 cu. yds.
Pressure	pascal	Pa	See Below
Heat Flow Rate (Power)	watt	W	See Below
Temperature	degrees celsius	o^C	N.A.
	degrees kelvin	o^K	N.A.
Thermal Resistance		RSI	See Below

PREFIXES	SYMBOL	MEANING	FACTOR BY WHICH METRIC UNIT IS MULTIPLIED
mega	M	one million	1 000 000.
kilo	k	one thousand	1 000.
milli	m	one thousandth of a	0.001
micro	μ	one millionth of a	0.000 001

CONVERSION FACTORS

IMPERIAL	TO	METRIC	MULTIPLY BY A FACTOR OF
inch		millimetre	25.4
p.s.i.		megapascal	0.006 895
lb/cu. ft.		kilograms per cubic metre	16.018
lb		kilograms	0.453 6
lb/sq. ft.		kilograms per square metre	4.882
sq. ft.		square metres	0.093
R (thermal)		RSI	0.176

For Conversion to Imperial Divide Metric Value by Above Factor

Canadian Concrete Masonry Producers' Association

Membership List

Allied Concrete Products
192 Biesenthial Road
Pembroke, Ontario K8A 3E7
Phone: 613-687-8417
Fax: 613-687-6283
Toll-Free: 1-800-882-3782
Contact: Bruce Hoffman

Atlas Block Company Limited (Brockville)
P.O. Box 141, 3007 Hwy 29
Brockville, Ontario K6V 5V2
Phone: 613-342-9815
Fax: 613-342-3606
Toll-Free: 1-800-363-3363
Contact: Henry Bangma
Email: hbangma@atlasblock.com
www.atlasblock.com

Atlas Block Company Limited (Midland)
P.O Box 670, 15288 Hwy. 12
Midland, Ontario L4R 4P4
Phone: 705-534-7219
Fax: 705-534-4125
Toll-Free: 1-800-461-4380
Contact: Don Gordon
Email: dgordon@atlasblock.com
www.atlasblock.com

Atlas Block Company Limited (Orillia)
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Orillia, Ontario L3V 6H3
Phone: 705-326-3543
Fax: 705-326-3865
Toll-Free: 1-800-461-0208
Contact: Dave Alexander
Email: dalexander@atlasblock.com
www.atlasblock.com

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1038 Rife Road, Cambridge
P.O. Box 25059
Kitchener, Ontario N2A 4A5
Phone: 519-622-1131
Fax: 519-622-5451
Toll-Free: 1-800-265-3510
Contact: Jerry DeLuca
Email: jdeluca@boehmerblock.com
www.boehmerblock.com

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3075 Herold Drive
Sudbury, Ontario P3E 6K9
Phone: 705-522-8220
Fax: 705-522-2732
Contact: Manfred and/or Gordon Herold
Email: mkhbrown@isys.ca
www.brownsconcrete.com

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3562 Nugent Road
Port Colborne, Ontario
L3K 5V4
Phone: 905-734-9094
Fax: 905-734-9144
Toll-Free: 1-800-230-5511
Contact: Durk Bylsma
Email: dbylsma@canalblock.com
www.canalblock.com

CCI CMS
9420-52nd Street S.E.
Calgary, Alberta T2C 2R5
Phone: 403-279-8810
Fax: 403-279-5177
Contact: Bruce Clark
Email: cms@cci-industries.com
www.cci-industries.com

CCI Coast
Gate 2, Foot of Nelson Road
PO Box 94580
Richmond, British Columbia V6Y 2V6
Phone: 604-270-8411
Fax: 604-270-8473
Contact: Bruce Clark
Email: coast@cci-industries.com
www.cci-industries.com

CCI Edcon
16333-137 Avenue
P.O.Box 2038
St. Albert, Alberta T8N 2A3
Phone: 780-447-2122
Fax: 780-447-1426
Contact: Bruce Clark
Email: edcon@cci-industries.com
www.cci-industries.com

CCI Interior
230, 1634 Harvey Ave.
Kelowna, British Columbia V1Y 6G2
Phone: 250-862-292
Fax: 250-862-2920
Contact: Bruce Clark
www.cci-industries.com

CCI Tallcrete
1436 Chevrier Boulevard
Winnipeg, Manitoba
R3T 1Y6
Phone: 204-453-8335
Fax: 204-453-5205
Contact: Bruce Clark
Email: tallcrete@cci-industries.com
www.cci-industries.com

Century Concrete Products Ltd.
4170 Midland Ave
Scarborough, Ontario M1V 4S6
Phone: 416-293-1179 Extn: 226
Fax: 416-293-3414
Contact: Martin Stuart
Email: mstuart0403@rogers.com

Cindercrete Products Ltd.
P.O. Box 306
Hwy #1 East
Regina, Saskatchewan S4P 3A1
Phone: 306-789-2636
Fax: 306-789-7499
Contact: Kevin Tell
Email: ktell@cindercrete.com
www.cindercrete.com

Day & Campbell Limited
1074 Upper Wellington Street
Hamilton, Ontario L9A 3S6
Phone: 905-385-5315
Fax: 905-385-8029
Toll-Free: 1-800-263-6787
Contact: Aly Heugh
Email: blocks@daycampbell.com
www.daycampbell.com

Doughty Masonry Center Ltd.
P.O. Box 501, Hwy 7b
Peterborough, Ontario K9J 6Z6
Phone: 705-743-7740
Fax: 705-743-8344
Contact: Carl Doughty
Email: doughtymc@nexicom.net

H.O. Concrete Supplies Limited
6145 75 St NW
Edmonton, Alberta T6E 0T3
Phone: 780-469-8675
Fax: 780-465-7434
Contact: Charlie Hoffermann
Email: hocanpav@telus.net

continued next page

Membership List cont.

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www.lafarge-na.com

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Lethbridge, Alberta T1J 3Z6
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Contact: Jonas Slanisky
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Newcastle Block Ltd.
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Contact: Carl Glahs

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www.niagarablock.com

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Contact: Amy Shanta
Email: ashanta@permacon.ca
www.permacon.ca

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London, Ontario
N5V 2B5
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Toll-Free: 1-888-264-4429
Contact: Bill DeGraaf
Cell Phone: 519-868-2658
Email: bdegraaf@permacon.ca
www.permacon.ca

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R.R. #3, Milton, Ontario L9T 2X7
Phone: 875-4215
Toll-Free: 1-800-265-0692
Contact: Kathy Oates, VP
Cell Phone: 905-975-2185
Email: koates@permacon.ca
www.permacon.ca

Permacon (Oshawa)
1089 Nelson Street
Oshawa, Ontario L1H 5N9
Phone: 905-728-2499
Contact: Amy Shanta
Email: ashanta@permacon.ca
www.permacon.ca

Permacon (Ottawa South)
6860 Bank Street
Metcalfe, Ontario K0A 2P0
Phone: 613-821-0898
Toll-Free: 1-800-361-2707
Contact: Amy Shanta
Email: ashanta@permacon.ca
www.permacon.ca

Permacon (Ottawa West)
6775 Hazeldean Road
Stittsville, Ontario K0Q 2P0
Phone: 613-821-0898
Toll-Free: 1-800-361-2707
Contact: Amy Shanta
Email: ashanta@permacon.ca
www.permacon.ca

Richvale-York Block Inc. (Kingston)
1035 Gardiners Road
Kingston, Ontario K7P 1R5
Phone: 613-384-2555
Fax: 613-384-9363
Contact: Mike Schell
www.richvaleyork.com

Richvale-York Block Inc. (Gormley)
5 Cardico Drive
Gormley, Ontario
L0H 1G0
Phone: 416-213-7444
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Contact: Tino Corrado
Email: tcorrado.richvaleyork@bellnet.ca
www.richvaleyork.com

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P.O. Box 2130
Lantz, Nova Scotia B2S 3G4
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Fax: 908-883-1273
Contact: Terry MacDow
Email: salesinfo@shawbrick.ca
www.shawbrick.com

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N5V 3B5
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Fax: 519-453-0732
Contact: Karen Schmidt
www.richvaleyork.com

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RR #1, McGregor, Ontario N0R 1J0
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Email: angelo@santsar.com
www.santsar.com

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Fax: 519-935-2081
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Email: rob@shouldice.com
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Email: c.gariepy@simcoeblock.com
www.simcoeblock.com

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www.daubois.com

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Email: scostello@daubois.com
www.daubois.com

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www.stlawrencecement.com

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Dundas, Ontario L9H 5M5
Phone: 905-628-9344
Contact: Dave Lawson
Cell Phone: 416-200-2921
Email: dave.lawson@elementis-na.com

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2000 Argentia Road Plaza #3, Suite 270
Mississauga, Ontario L5N 1P7
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Contact: Dave Fleming
Email: dave.fleming@essroc.com
www.essroc.com

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1501 Whistlebare Road
Cambridge, Ontario N1R 5S3
Phone: 519-621-3093
Fax: 519-621-3161
Contact: Dean Garbutt
Cell Phone: 519-240-7265
Email: dgarbutt@forwell.net

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Email: penny@interstar.ca
www.interstar.ca

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Hamilton, Ontario L8H 3Y2
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Email: mike.hesson@lafarge-na.com
http://www.lafargenorthamerica.com

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Email: eoliveri@stlawrencecement.com
www.stlawrencecement.com

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Mississauga, Ontario L5J 1K1
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Contact: Barry Littlemore
Email: blittlemore@stlawrencecement.com
www.stlawrencecement.com

St. Marys Cement Co.
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Toronto, Ontario M4G 3W9
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Contact: Andy Lamovsek
Cell Phone: 416-540-5675
Email: aslamovsek@vcsmc.com
www.stmaryscement.com

Testing Labs

The following facilities are currently employing technicians or supervisors who have successfully completed the McMaster Testing Certification Program.

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3300 Merritville Hwy, Unit 5
Thorold, Ontario L2V 4Y6
Phone: 905-687-6616
Technician/Supervisor: Andrew Markov

Construction Control Inc.
70 Haist Avenue
Woodbridge, Ontario L4L 5V4
Phone: 905-856-1438
Technician: Anthony Davis

Naylor Engineering Associates
353 Bridge St E
Kitchener, Ontario N2K 2Y5
Phone: 519-741-1313
Technician/Supervisor: Anne Allen

Peto McCallum (Hamilton)
45 Burford Road
Hamilton, Ontario L8E 3C6
Phone: 905-561-2231
Technician/Supervisor: Everett Truax

Peto McCallum (Kitchener)
16 Franklin Street South
Kitchener, Ontario N2C 1R4
Phone: 519-893-7500
Technician: Tony Smith

Soil-Mat Engineers and Consultants
130 Lancing Drive
Hamilton, Ontario L8W 3A1
Phone: 905-318-7440
Technician: Jamie Gagne

St. Lawrence Testing & Inspection
P.O. Box 997
Cornwall, Ontario K6H 5V1
Phone: 613-938-2521
Technician/Supervisor: Gaetan Leroux

St. Marys Cement
55 Industrial Street
Toronto, Ontario M4G 3W9
Phone: 416-423-1300
Technician/Supervisor: Stephen Parks

Terraprobe
220 Bayview Drive, Unit 25
Barrie, Ontario L4N 7T3
Phone: 705-739-8355
Technician/Supervisor: Jerry Duguid

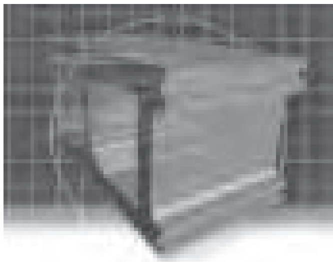
Trow Consulting Engineers
1074 Webbwood Drive
Sudbury, Ontario P3C 3B7
Phone: 705-674-9681
Technician/Supervisor: Robert Ferguson

Representatives Patt Pauze from Atlas Block, John Laporte and Eric Hamdic from Newtonbrook Block, Victoria McCrie from Grace Canada and Peter Burdon from CCMPA have also successfully completed the program and have received certificates.

We encourage CCMPA members to patronize these progressive companies whenever possible as they have demonstrated their intention to supply consistently accurate testing of concrete masonry products by trained technicians.

Canadian Concrete Masonry Producers' Association

Publications & Technical Reference Material



Canadian Concrete Masonry Producers' Association

Publications & Technical References

PUBLICATION LIST

TITLE/DESCRIPTION — **COST**

CMHC Best Practice Guide

$ 89.00 + GST $ 6.23 = TOTAL $ 95.23

Brick Veneer Concrete Masonry Unit Backing
Package includes detail drawings, sample specifications and checklist, based on consultation with the construction industry. (Binder includes CD-ROM)

CCMPA Masonry Specifications

$ 10.00 + GST $ 0.70 = TOTAL $10.70

Intended for designers/contract administrators who are responsible for the preparation of concrete masonry specifications in conformity with the requirements of the C.S.A. Standards. This program was developed under the Master Format guidelines, which includes the following sections:

- Section 4050 Masonry Procedures
- Section 4100 Mortar and Grout for Concrete Block
- Section 4150 Masonry Accessories
- Section 4160 Masonry Reinforcing and Connectors
- Section 4220 Concrete Unit Masonry

Includes installation/operation manual; please specify 3.5"

Concrete Block Metric Technical Manual

Free download from our website: www.ocba.ca

Physical Properties of Block;
Fire Performance Ratings; Thermal;
Sound; Technical Reference Data;
Specifications; Metric Coursing
Tables; Reference Sheet of Standard
Shapes and Sizes; Membership List

Note: *The Metric Technical Manual is also available in* **CD format** *for the same cost as the binder.*

$ 35.00 + GST $2.45 = TOTAL $ 37.45

PUBLICATION LIST

TITLE/DESCRIPTION	COST
Masonry Structures, Behaviour and Design	**$ 70.00 + GST $ 4.90 = TOTAL $ 74.90**

This book attempts to give a broad understanding of masonry to designers and students, ranging from ancient beginnings to modern usage, covering planning, materials science, building science, structural design, and construction. It mostly deals with matters of international validity and is not confined by adherence to any code. This book gives many design examples; the majority using ACI 530/530/ASCE 5/TMS 402 Building Code Requirements for Masonry Structures.

Design Guide for Loadbearing Single Storey Concrete Block Buildings(Based on Engineering Analysis) — **$ 10.00 + GST $ 0.70 = TOTAL $ 10.70**

This design guide is intended to help designers make use of loadbearing concrete block in the construction of single storey block buildings requiring high walls. It is intended to be used in conjunction with CAN3 S304-M84 "Masonry Design for Buildings" as referenced in the Ontario Building Code. In this design guide, designs based on engineering analysis are discussed and illustrated in examples.

National Research Council Concrete Block Sound Transmission Class (STC) Ratings — **$ 5.00 + GST $ 0.35 = TOTAL $ 5.35**

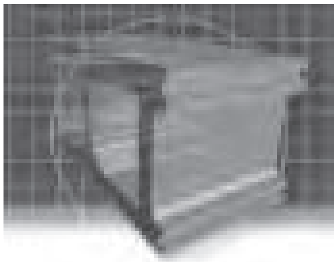
This report presents the results of a series of sound transmission loss measurements carried out under contract for the Ontario Concrete Block Association. The test series was augmented for research purposes by measuring sound transmission losses at different stages in the construction and disassembly of the walls. This report provides an analysis of the information obtained during the complete measurement series.

Masonry LSD 95 Computer Software Program — **CURRENTLY UNDER REVISION**

The eight modules available in this program are as follows:

1) Geometric Physical Properties of Masonry Walls
2) Determination of Specified Compressive Strength
3) Design and Analysis of Masonry Beams/Lintels
4) Design and Analysis of Masonry Load Bearing Walls
5) Design and Analysis of Masonry Columns
6) Design of Masonry Pilasters
7) Design of Masonry Shear Walls
8) Design of Masonry Slender Walls
9) Windows 2000 Compatible

The program is highly interactive and all data entries are organized with windows and clickable "buttons" and the user can verify and make changes to any data at any time. Computations and code requirements are being performed concurrently while the user is informed of various stages of executions in the design process. When computation fails to meet code requirements, a warning will prompt the user to ensure that the necessary changes are made.



CCMPA ORDER FORM

Computer Software Program

MASONRY LSD 95	$349.00 + GST @ 7% ($24.43) = $373.43
Publications	
CMHC BEST PRACTICE GUIDE	$ 89.00 + GST @ 7% ($ 6.23) = $ 95.23
CCMPA MASONRY SPECIFICATION	$ 10.00 + GST @ 7% ($ 0.70) = $ 10.70
CONCRETE BLOCK METRIC TECHNICAL MANUAL:	$ 21.50 + GST @ 7% ($ 1.85) = $ 28.35
DESIGN GUIDE for LOADBEARING SINGLE STOREY CONCRETE BLOCK BUILDINGS	$ 10.00 + GST @ 7% ($ 0.70) = $ 10.70
MASONRY STRUCTURES, BEHAVIOUR AND DESIGN	$ 70.00 + GST @ 7% ($ 4.90) = $ 74.90
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250 Consumers Road, Suite 301, Toronto, Ontario M2J 4V6

OR FAX TO:
416-495-8723
ATTN. Marina de Souza, Managing Director

TECHNICAL REFERENCE MATERIAL FOR
CONCRETE MASONRY CONSTRUCTION

In addition to the information provided in this manual, the following references are listed as further sources:

1.0 Masonry Design for Buildings (Limit States Design)
CAN/CSA-S304.[1]
Published by CSA

2.0 Concrete Masonry Units Specifications
CAN/CSA-A165.[1]
Published by CSA1

3.0 Method of Test for Compressive Strength of Masonry Prisms
CSA-A369.1
Published by CSA[1]

4.0 Connectors for Masonry
CSA-A370
Published by CSA[1]

5.0 Masonry Construction for Buildings
CSA-A371
Published by CSA[1]

6.0 Terms and Definitions for Use in CSA Masonry Standards
A443
Published by CSA[1]

7.0 Concrete Masonry Handbook for Architects, Engineers and Builders
Published by PCA

8.0 Recommended Practices for Laying Concrete Block
Published by PCA[2]

9.0 Portland Cement Plaster (Stucco) Manual
Published by PCA[2]

10.0 Canadian Building Digests Series
Published by NRC

11.0 Tek Note Bulletins
Published by NCMA[5]

12.0 Engineered Masonry Design Manual
Published by Masonry Canada[6]

13.0 Masonry Computer Design Programme
Issued by Masonry Canada[6]

14.0 Tek Note Series
Published by NCMA[5]

15.0 Exterior Wall Construction in High rise Buildings
Published by CMHC[6]

TECHNICAL REFERENCE MATERIAL FOR
CONCRETE MASONRY CONSTRUCTION (notes)

NOTES: [1] Denotes mailing address of above Publishers

1.	CSA -	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario M9W 1R3 (416)848-4364 www.csa.ca
2 .	PCA -	Portland Cement Association Order Processing 5420 Old Orchard Road Skokie, Illinois 6007-9973 (708)966-9559 www.portcement.org
3 .	NRC -	National Research Council, Canada Institute for Research in Construction Ottawa, Ontario K1A 0R6 (416)973-4484 www.nrc.ca/irc
4.	NCMA -	National Concrete Masonry Association P.O. Box 781, 2302 Horse Pen Road Herndon, Virginia, U.S.A. 22070 (703)435-4900 www.ncma.org
5.	CMHC -	Canada Mortgage and Housing Corporation Ontario Regional Office 2255 Sheppard Avenue East, Suite E 222 Willowdale, Ontario M2J 4Y1 (416)495-2000 www.cmhc-schl.gc.ca

Cananadian Concrete Masonry Producers Association

CCMPA Metric Technical Manual

Coursing Tables, Metric Shapes and Sizes

By Gary Sturgeon, B.Eng., MSc., P.Eng.
Technical Services Engineer, CCMPA

3.1 The "Anatomy" of a Standard Concrete Block Masonry Unit

A perspective view of a standard, hollow concrete block masonry unit is shown in Figure 3.1, with associated section cuts provided in Figure 3.2. These figures illustrate key elements of a concrete block masonry unit, and identify terminology commonly used in technical literature and in the field.

Some relevant terms which characterize the size and shape of a concrete block masonry unit include:

Faceshell: A side wall of a concrete block masonry unit.

Web: A cross wall which connects the faceshells, termed either as a "centre web" or an "end web". The webs extend and are fully attached to the faceshells to the full height of a standard concrete block masonry unit.

Cell (or Core): A hollow space (or void) extending fully through a unit.

The webs and faceshells are tapered, forming a tapered cell, which facilitates de-moulding of the unit during its manufacture. Additionally, the webs and faceshells are often flared along one cross-sectional surface (along the lower surface "as made"; its upper surface "as laid"), which provides a grip for handling by the mason, and a wider bed to receive mortar when laying the unit in the course immediately above.

A cell remains ungrouted in hollow, plain masonry or may be grouted in grouted masonry; or it may be grouted and contain vertical steel bar reinforcement to provide reinforced concrete masonry construction.

Two-cell units are typical for hollow concrete block masonry units. Three-cell units are sometimes used for semi-solid units. In general, two-cell design offers larger cells to facilitate the placement of vertical bar reinforcement and grout. (Chapter 4 discusses the terms "hollow", "semi-solid", and "full solid" units).

In plan, the cell is commonly pear-shaped, or may be square.

Ear (or End Flange): The end of a concrete block unit may be flanged (Figures 3.1 and 3.2), or smooth (plain) (Figure 3.4.c). A "frogged" end is an alternative term for a "flanged" end.

A flanged end allows the mason to grip the unit by its end webs, providing "finger room". The flange may be grooved or plain. The groove is intended to help the mason compact mortar into the head joint at the block end. Flanged units are typically built into the field of a masonry element such as a wall.

Plain ends are used where the end of the unit is exposed, such as for corner, pier, and pilaster construction. Where a plain end unit is used in lieu of a flanged end unit, the CSA Masonry Standards and the National Building Code of Canada do not differentiate any relative performances of the constructed masonry related to issues of structure, environmental separation, fire and sound control, and other properties.

3.2 Standard Concrete Block Masonry Units, and Modular Coordination

3.2.1 Standard Overall Dimensions

Requirements for modular and basic/manufactured dimensions for standard concrete block masonry units used in Canada are contained in CSA Standard A165.1-04, *"Concrete Block Masonry Units"*, and are reproduced in Table 3.1, herein.

The terms "modular" and "basic or manufactured" used in the A165.1-04 standard are synonymous with the more commonly-used field terms "nominal" and "actual", respectively.

These modular (nominal) and actual (basic or manufactured) dimensions for width, height, and length of a standard concrete block masonry unit are also illustrated in Figure 3.1.

Standard concrete block masonry units are commonly available in nominal widths of 100 mm, 150, 200, 250, and 300 mm. The typical nominal height is 200 mm; although "ashlar" units (also termed "half-high" units) have a standardized nominal height of 100 mm. The standard nominal length of a unit is 400 mm, with half-length units standardized at 200 mm. Half-high (ashlar units) and half-length units are companion units supplied to the mason by the block producer as a convenience to minimize site-cutting of full units, and to complete patterned work.

Width, mm		Height, mm		Length, mm	
Modular	Basic*	Modular	Basic*	Modular	Basic*
100	90	100	90	200	190
150	140	200	190	400	390
200	190				
250	240				
300	290				

*** or manufactured**

Table 3.1: *Overall Dimensions for Standard Concrete Block Masonry Units (Adapted from Ref. 2)*

The actual dimensions of width, height and length are 10 mm less than the nominal dimensions of a unit, respectively, to accommodate a standard 10 mm mortar joint. By doing so, modular dimensions in all three directions are maintained.

It is common practice when identifying or specifying concrete block masonry units to state the block nominal width, the block (course) nominal height, and the block nominal length, in this order. Hence, a 150 x 200 x 400 mm unit has:

- nominal overall dimensions of: 150 mm wide x 200 mm high, x 400 mm long; and,
- actual overall dimensions of: 140 mm wide x 190 mm high x 390 mm long.

The most commonly used units in Canada for loadbearing structural applications are the 200 and 250 mm nominal width units.

3.2.2 Permissible Dimensions and Permissible Variations

Requirements for permissible dimensions, and permissible variations in dimensions for concrete block masonry units used in Canada are contained in CSA A165.1-04.

For standard concrete block masonry units, CSA A165.1-04 requires the minimum faceshell and web thicknesses shown in Table 3.2.

Actual dimensions of the unit are determined by the producer or certified testing agency by appropriate sampling and physically measuring units using calipers in accordance with the procedures of ASTM C 140-03, *"Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units".*

The minimum thicknesses for faceshells and webs are assigned by the A165.1-04 standard based upon the modular (nominal) width of the unit. They refer to the most limiting width of a tapered faceshell or web in the unit, that is, to the narrowest cross-section and to the average thicknesses measured. In addition to these dimensional limits, the equivalent web thickness (the sum of the minimum web thicknesses in the unit) is assigned a minimum percentage of the overall length of the unit. This ensures that sufficient web material exists to transfer imposed loads in-service from one faceshell to the other faceshell and that unit integrity is maintained during manufacture and handling.

Placing limits on faceshell and web thicknesses ensures that the fundamental assumptions used to predict the performance of masonry elements constructed with standard concrete block units are met under the actions of structural and non-structural loads. For example, CSA S304.1, *"Design of Masonry Structures"*, relies on these fundamental assumptions to predict structural strength and behaviour of concrete block masonry elements.

For standard concrete block masonry units, CSA A165.1-04 also assigns limits on permissible variations in overall dimensions of the units, as stated in Table 3.3.

Placing permissible limits on unit dimensions helps to ensure quality construction. Respecting these limits assists the mason to minimize faceting (small offsets) between the faces of installed adjacent units, and to maintain the required heights and lengths of constructed concrete block masonry elements with acceptable variations in mortar joint widths and joint alignments.

CSA A165.1-04 also limits the maximum variation between units within a job lot, for a specified dimension, to not more than 2 mm.

Modular width of unit, mm	Minimum faceshell thickness, mm	Minimum web thickness, mm	Minimum equivalent web thickness as a percentage (%) of length of unit
100	20	20	15
150	25	25	19
200	30	25	19
250	35	28	21
300	35	30	21

Table 3.2: *Minimum Widths of Faceshells and Webs for Standard Concrete Block Masonry Units (Adapted from Ref. 2)*

Width, mm	Height, mm	Length, mm
±2.0	+2.0, -3.0	±3.0

Table 3.3: *Permissible Variations in Dimensions for Standard Concrete Block Masonry Units (Adapted from Ref. 2)*

CCMPA producers of standard concrete block masonry units ensure that the moulds used to manufacture standard units comply with the actual unit dimensions, and the limiting faceshell and web thicknesses required by CSA A165.1-04. Compliance with the stated dimensional tolerances in CSA A165.1-04 is assured by appropriate manufacturing processes, and verified by in-house quality assurance programs.

Where required, units can be manufactured to closer tolerances than those permitted by CSA A165.1-04. Producers of the desired units should be consulted before specifying more limiting requirements.

3.2.3 Modular Coordination

Because concrete block masonry units can be effectively and readily cut on-site, concrete block masonry structures can be constructed to virtually any dimensional layout. However, there is economy in construction where cutting and fitting of units to suit are minimized. Careful planning by the designer is desirable.

Modular coordination in construction is achievable and practicable where:

1. product component dimensions and their permissible tolerances are specified, readily achievable in production, and verifiable, and for concrete block masonry units, the relevant requirements are stated in CSA A165.1-04;
2. quality assurance in the manufacture of the product component is provided by way of standardized testing and required frequency of testing, and for concrete block masonry units, these requirements are provided in CSA A165.1-04 and ASTM C 140-03 (C140 is a test standard referenced by A165.1-04);
3. required quality of work of the assembly in which the product is included is stated, achievable, and verifiable, and for concrete block masonry construction, these requirements are provided in CSA A371, *"Masonry Construction for Buildings"*; and,
4. on-site programs for assurance of quality of the constructed assembly are prudent and reasonably undertaken, as specified in project construction documents.

Design for modular coordination assigns overall heights, lengths, and widths of a building, and elements included in the building to multiples of the building's basic modular-sized component. In metric modular planning for concrete block masonry construction, horizontal dimensions are typically an even multiple of 200 mm, that is, a multiple of the nominal half-length of a standard concrete block unit. In elevation, vertical dimensions are typically even multiples of a nominal full height standard concrete block unit, that is, of 200 mm.

Modular building layouts to a 200 mm module typically include, but are not limited to:

1. overall wall/pier/pilaster lengths (plan dimensions);
2. overall wall/pier/pilaster heights (elevation dimensions);
3. overall wall/pier/pilaster widths (section dimensions);
4. location and spacing of vertical reinforcement connected to adjacent non-masonry elements such as foundation walls;
5. locations of construction and movement joints;
6. sizes of rough openings for fenestration, penetrations, and other openings; and,
7. distances between rough openings and other discontinuities.

The need for modular coordination becomes particularly important where lengths and heights of a masonry element are relatively small, and the mason cannot sufficiently adjust the construction by slightly increasing or decreasing joint widths to suit. Consequently, horizontal dimensions for piers, pilasters, and short-length walls should be designed as multiples of 200 mm less 10 mm. Similarly, horizontal and vertical dimensions for rough openings should be multiples of 200 mm plus 10 mm.

The basics of modular layout and planning for masonry are illustrated in Figure 3.3.

Where overall lengths of masonry elements are even multiples of 200 mm, concrete block masonry corners are easily constructed with units having a nominal width of 200 mm (with standard nominal length of 400 mm). In this case, with each alternating course, the units of the intersecting walls conveniently overlap by 200 mm. However, this is not the case at corners where the units have a nominal width of other than 200 mm, either larger or smaller. In these cases, a number of layout options are available, including the use of corner block units (L-shaped units) (Figure 3.4.p) where available. These units facilitate corner construction without need for cutting, and without interrupting bond patterns. In lieu of using corner units, while maintaining the required design widths, other detailing options are available which also minimize cutting. It is recommended that a designer discuss the available options with a producer of concrete block masonry units. A variety of corner detailing options are contained in Refs. 6, 7 and 8.

Brick masonry may be used as a veneer over concrete block masonry structural backing, or may be included within the concrete block masonry as an architectural feature. Although brick units are available in a variety of sizes, a standard metric modular unit of size 57 high x 190 long x 90 mm wide uses the same nominal 200 mm vertical and horizontal module as a standard concrete block masonry unit. Three courses of metric modular brick, containing two standard 10 mm mortar beds between each course, maintains the nominal 200 mm vertical module. Although modular planning is an option for a designer, it is not imperative that the bed joints in the brick masonry cladding and the concrete block masonry structural backing align. In cases where bed joints do not align by design, or where it is unlikely that joints will align because of anticipated construction tolerances, the brick veneer may be conveniently connected to the concrete masonry using a variety of adjustable, multi-component, embedded or surface mounted connectors available to designers by the manufacturers of masonry ties.

Metric coursing for modular concrete block and brick masonry is provided in Table 3.4.

3.2.4 Shape and Size Variations of Standard Units

In addition to the standard concrete block masonry unit, a wide variety of block sizes and shapes are available to a designer and to the masonry contractor. Variations of the standard unit are produced to satisfy aesthetics, structural functions, and constructability so that all masonry structures can be built economically regardless of size, configuration and dimension.

Usually, many block options are available. Figure 3.4 provides a small sampling of the most common units used in conventional concrete block masonry wall construction. Most manufacturers produce at least several of these units and most are often available without special order. Where a particular unit is not available, standard units oftentimes can be readily and accurately site-cut to produce the desired unit configuration. Before specifying a particular unit, it is recommended that a designer determine the local availability of the unit by contacting producers that typically supply units to the area in which a project is located.

A standard "stretcher" unit, shown with flanged ends (Figure 3.4.a) is typically used within the field of the masonry wall, away from any discontinuities such as openings, corners, and movement joints. Figure 3.4.b illustrates a full-length corner unit having one flanged end, which would abut the adjacent stretcher unit, and one plain end exposed at the corner. A unit having both ends plain (Figure 3.4.c) may be used where both ends of the unit are exposed, such as in pier or pilaster construction, or alternatively, simply may be included as a stretcher unit within the field of the wall. Open vertical cells permit placement of grout and vertical reinforcement where required.

Half-length units (Figure 3.4.d) are readily produced and provided to masons to conveniently maintain the 200 mm

VERTICAL DIMENSIONS					
Brick Height: 57mm		Block Height: 190mm			
No. OF BRICKS	No. OF BLOCKS	VERTICAL HEIGHT			
		mm	ft.		ins.
3	1	200		7	7/8
6	2	400	1	3	3/4
9	3	600	1	11	5/8
12	4	800	2	7	1/2
15	5	1 000	3	3	3/8
18	6	1 200	3	11	1/4
21	7	1 400	4	7	1/8
24	8	1 600	5	3	
27	9	1 800	5	10	7/8
30	10	2 000	6	6	3/4
60	20	4 000	13	1	1/2
90	30	6 000	19	8	1/4

VERTICAL DIMENSIONS					
Brick Height: 70mm		Block Height: 190mm			
No. OF BRICKS	No. OF BLOCKS	VERTICAL HEIGHT			
		mm	ft.		ins.
5	2	400	1	3	3/4
10	4	800	2	7	1/2
15	6	1 200	3	11	1/4
20	8	1 600	5	3	
25	10	2 000	6	6	3/4
30	12	2 400	7	10	1/2
35	14	2 800	9	2	1/4
40	16	3 200	10	6	
45	18	3 600	11	9	3/4
50	20	4 000	13	1	1/2
75	30	6 000	19	8	1/4
100	40	8 000	26	3	

Table 3.4: *Metric Modular Coursing*

horizontal module in construction without need for cutting a full-length unit. These are typically used adjacent to openings or at wall ends. Alternatively, an easily-split unit known as a "splitter block" (or "kerf" unit) (Figure 3.4.f), having two closely spaced centre webs, may used by the mason to easily produce a half-length unit on-site.

Half-high units (or "ashlar" units) (Figure 3.4.e) are identical to standard units except that their nominal height is 100 mm, rather than 200 mm.

Special shapes, placed within the field of the wall or over openings, are available to easily include horizontal bar reinforcement and grout in masonry construction:

a. The "single-C" bond beam unit (otherwise termed "U-block", "channel block" or "lintel block") (Figure 3.4.g) has a nominal height of 200 mm, and the "high lintel" (Figure 3.4.h) has a nominal height of 400 mm. These bond beam units have a solid, finished undersurface and are without cross webs. This permits the inclusion of horizontal bar reinforcement, offers full continuity of grout in the horizontal direction without interruption, and prevents the vertical movement of grout down through their underside. These units are typically used over finished openings, and as horizontal beams within the field of a wall containing little to no intersecting vertical reinforcement.

b. "Low-web" bond beam units (Figure 3.4.i) are manufactured with depressed end and centre webs to form a continuous horizontal channel. "Knock-out" bond beam units (Figure 3.4.j) are a convenient variation, having cross webs that are easily removed by the mason on the site (by gently striking the pre-cut or pre-moulded webs). Neither unit has a solid, finished under-surface, but rather, has vertical cells passing through the full height like a standard unit. Lateral free flow of grout is offered by both units because of cross web depression, and additionally, with fully open vertical cells, grout may flow downward into the cells of standard units below. Unlike the "single-C" unit, however, these units have partial webs and do not offer fully uninterrupted continuity of grout in the horizontal direction. These units are typically used at the junctions of vertical and horizontal bar reinforcement within the field of a wall, or over openings where the underside of the unit is not exposed (over openings, temporary shoring must be positioned to prevent loss of grout through the underside).

"A-block" units (Figure 3.4.k) and "H-block" units (Figure 3.4.l) are another variation of the standard concrete block wherein either one end web or both end webs are absent. For these units, the faceshells are thickened at the junction with the cross web to provide robustness during handling and grouting. These open-end units have been developed to accommodate vertical reinforcement, especially where vertical reinforcement is placed frequently in the wall and where the masonry is "heavily" reinforced. The open end facilitates laying the units between tall vertical bars (rather than over the bars), or eliminates need to position vertical reinforcement after the masonry has been laid. Their relatively larger cells also facilitate grout placement. Bond beam units and knock-out units for use with A-block and H-block construction are shown in Figures 3.4.m, 3.4.n, and 3.4.o. Similar to the units with standard block construction, these open-end, depressed-web units facilitate placement of horizontal reinforcement and free flow of grout laterally. Double open-end blocks are typically used in fully grouted walls.

An "L-block" (Fig. 3.4.p), as noted previously, is produced to maintain bond pattern at corners where other than 200 mm width units intersect.

A designer should consult with a manufacturer of concrete block masonry units to ascertain its full product line. Note that thicknesses of webs and faceshells, and depth of channels and web depressions, may vary between manufacturers.

Many of these units have depressed or absent webs, and therefore do not comply with the minimum web thickness and web continuity requirements stated in CSA A165.1-04. However, these units are intended to be fully grouted. The grout will more than replace the absent web material, and allow these units to comply with the intent of the A165.1-04 standard.

Figure 3.5 illustrates where typical concrete block masonry units are used in common concrete block masonry wall construction.

Figure 3.6 is a more comprehensive illustration showing the metric sizes and shapes of a variety of commonly used wall and pier/pilaster units, having solid, semi-solid, or hollow sections (solid content of a unit will be discussed in Chapter 4, Physical Properties).

3.3 Wall Patterns (Bond)

A variety of architectural effects can be achieved with standard concrete block masonry construction simply by varying the pattern (or bond) in which the units are laid, by varying/mixing the face sizes of the units, and by projecting (wider) units beyond the main face of the wall. Some of the more commonly used wall patterns are illustrated in Figure 3.7. The two most common are “running bond” and “stack pattern”.

For reinforced construction, the pattern must provide for cell alignment to permit placing of bar reinforcement and grout.

Forty-two patterns for concrete block masonry construction are illustrated in Ref. 8, *Concrete Masonry Handbook for Architects, Engineers, Builders*.

3.4 Physical Properties of Concrete Block Masonry Units

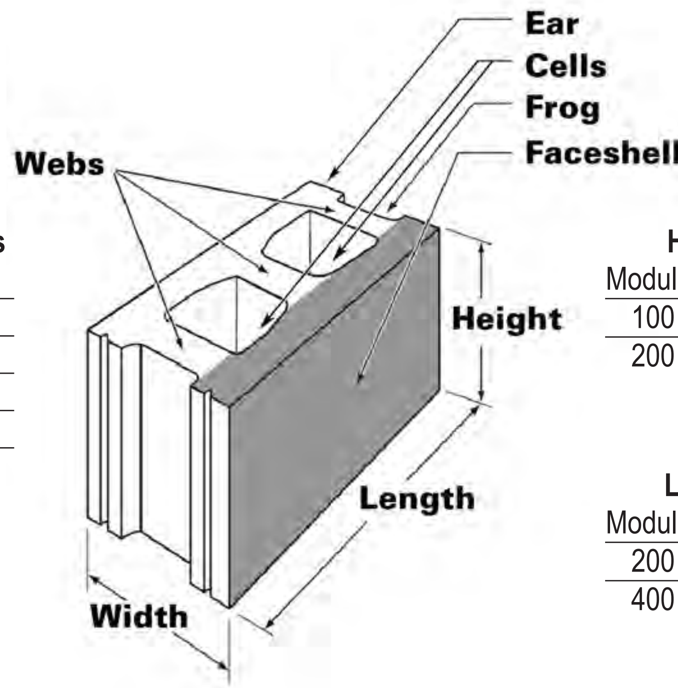
Table 4.1, Chapter 4, offers physical property data for standard concrete block masonry units that comply with the requirements of CSA A165.1-04. They are representative of typical product manufactured by producer members of the Canadian Concrete Masonry Producers Association.

3.5 References

1. ASTM International, “Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units”, ASTM C 140, ASTM, Philadelphia, USA, 2003.
2. Canadian Standards Association, CSA A165.1 “Concrete Block Masonry Units”, CSA A165 Series, CSA, Mississauga, Ontario, Canada, 2004.
3. Canadian Standards Association, CSA A371, “Masonry Construction for Buildings”, CSA, Mississauga, Ontario, Canada, 2004.
4. Canadian Standards Association, CSA S304.1, “Design of Masonry Structures”, CSA, Mississauga, Ontario, Canada, 2004.
5. Concrete Masonry Association of California and Nevada, “2006 Design of Reinforced Masonry Structures”, Citrus Heights, California, USA, 2006.
6. National Concrete Masonry Association, “Annotated Design and Construction Details for Concrete Masonry”, National Concrete Masonry Association, Herndon, Virginia, USA, 2003.
7. National Concrete Masonry Association, “TEK 5-09A Concrete Masonry Corner Details”, National Concrete Masonry Association, Herndon, Virginia, USA, 2004.
8. Portland Cement Association, “Concrete Masonry Handbook for Architects, Engineers, Builders”, Portland Cement Association, Skokie, Illinois, USA, 2008.

Figure 3.1: *Typical Concrete Block Masonry Unit (Hollow Unit, with Flanged Ends) (Ref. 2)*

Modular	Width Actual	Faceshell mm	Webs mm
100	90	20	20
150	140	25	25
200	190	30	30
250	240	35	35
300	290	35	35



Height Modular	Height Actual
100	90
200	190

Length Modular	Length Actual
200	190
400	390

Figure 3.2: *Typical Concrete Block Masonry Unit (Hollow Unit, with Flanged Ends)*

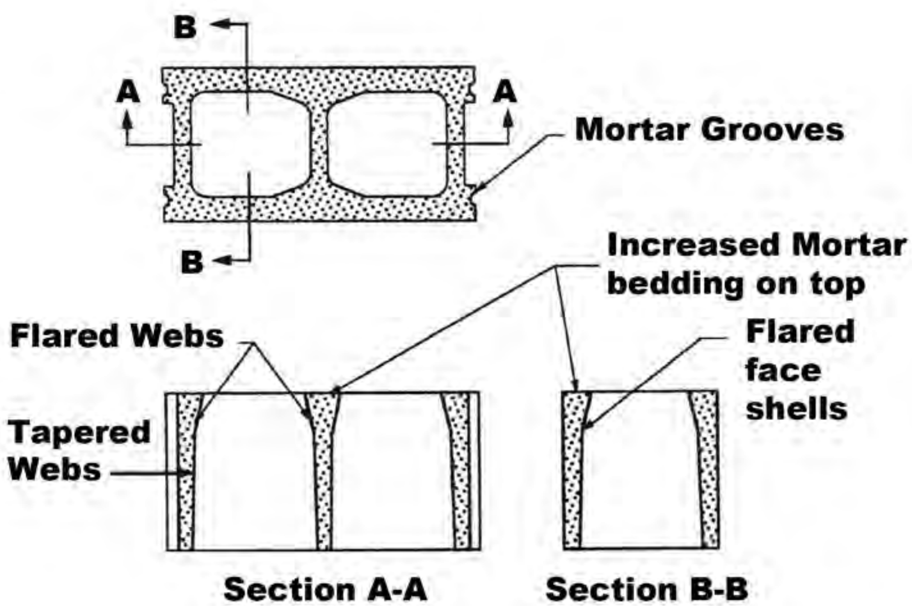
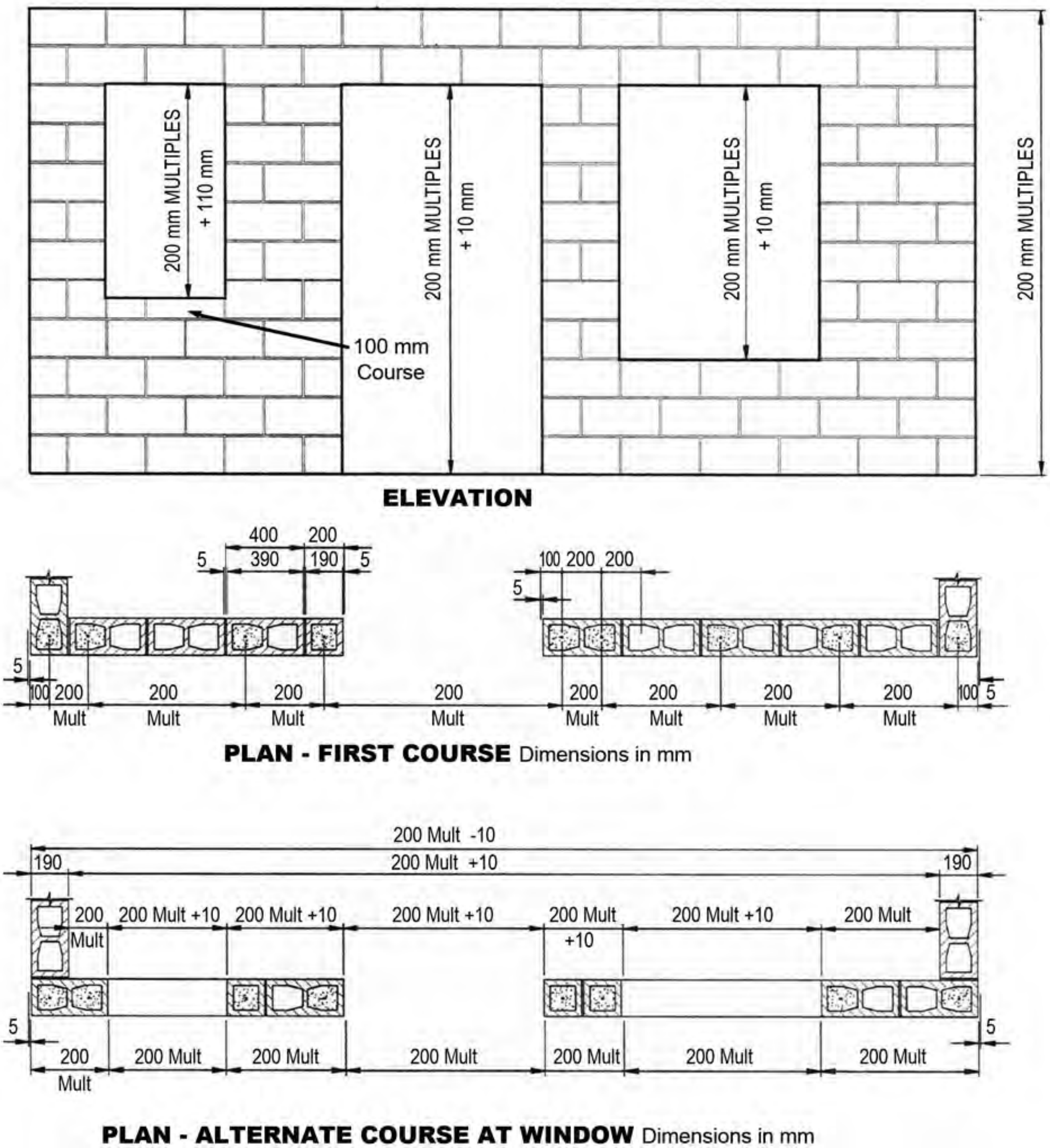


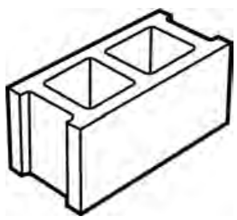
Figure 3.3: *Modular Planning with Concrete Block Masonry (Ref. 5)*



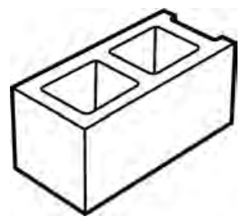
Note: MODULAR DIMENSIONS - Block sizes are 10 mm less in all dimensions so that with the addition of one mortar joint they become multiples of 200 mm. Dimensions are always given in 200 mm multiples.

ACTUAL DIMENSIONS - Outside dimensions and distances between openings are always 10 mm over given dimensions

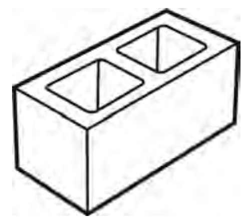
Figure 3.4: *Typical Concrete Block Masonry Units (Variations of a Standard Unit)*



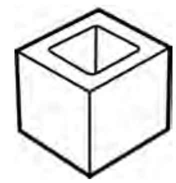
a. Standard Two-Cell Stretcher with Flanged Ends



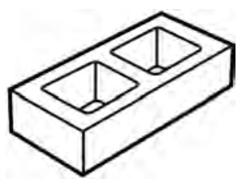
b. Single Corner; Standard with One Plain End



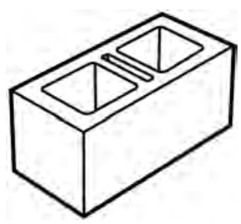
c. Double Corner; Standard with Plain Ends



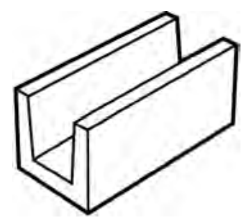
d. Standard Half



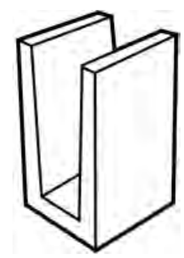
e. Half-high Ashlar



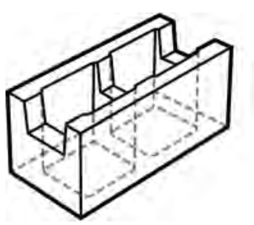
f. Splitter Block



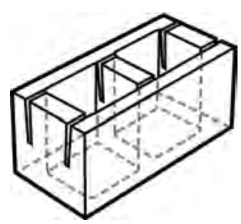
g. Single-C Bond Beam (U-Block, Channel Block) with Solid Bottom



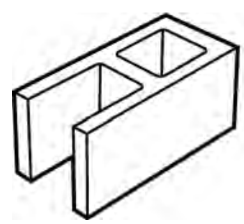
h. High Lintel



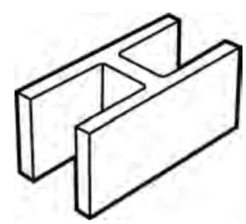
i. Low-web Bond Beam (Open Celled Bottom)



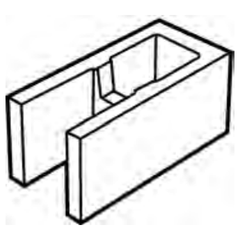
j. Knock-out Web Bond Beam (Open Celled Bottom)



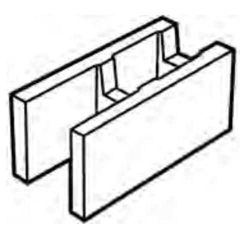
k. A-Block; Open End Standard



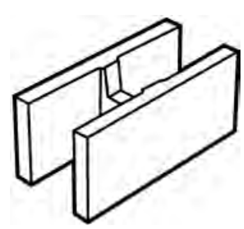
l. H-Block; Double Open End Standard



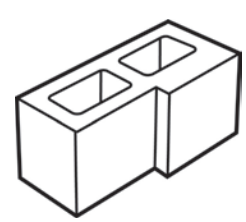
m. Corner, Open End Bond Beam



n. Open End Bond Beam



o. Double Open End Bond Beam



p. L-Corner (Corner Return)

Figure 3.5: *Concrete Block Masonry Units in Common Masonry Wall Elements (Ref. 5)*

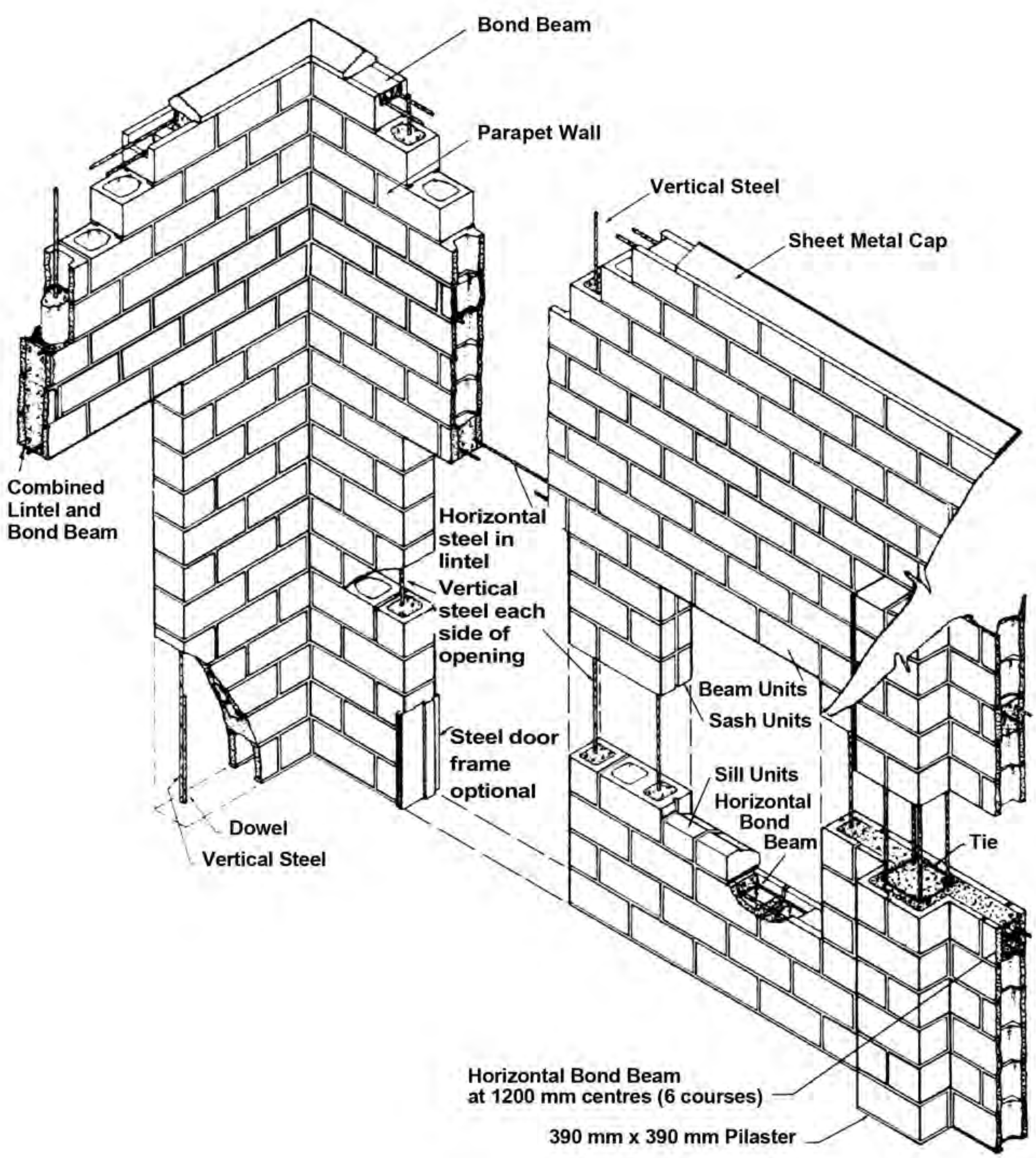
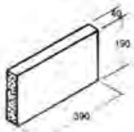


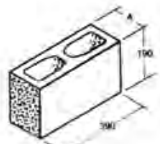
Figure 3.6: *Reference Sheet of Standard Metric Sizes and Shapes*

1. Standard



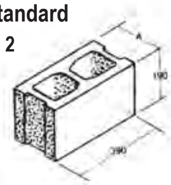
Size Code 5

2. Standard
Note 2



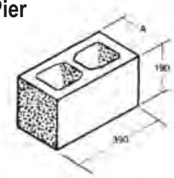
Size Code 10 • 15

3. Standard
Note 2



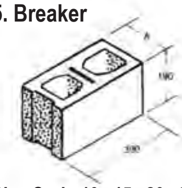
Size Code 20 • 25 • 30

4. Pier



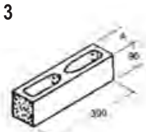
Size Code 20 • 25 • 30

5. Breaker



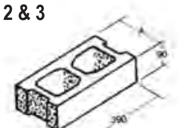
Size Code 10 • 15 • 20 • 25 • 30

6. Ashlar Standard
Note 2 & 3



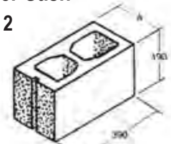
Size Code 10 • 15

7. Ashlar Standard
Note 2 & 3



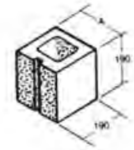
Size Code 20 • 25 • 30

8. Pier Sash
Note 2



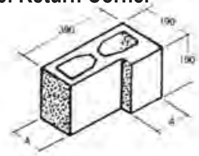
Size Code 20 • 25 • 30

9. Pier Sash Half



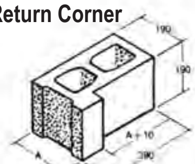
Size Code 20 • 25 • 30

10. Return Corner



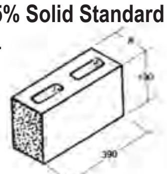
Size Code 10 • 15

11. Return Corner



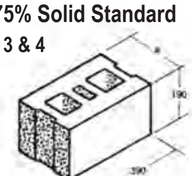
Size Code 25 • 30

12. 75% Solid Standard
Note 4



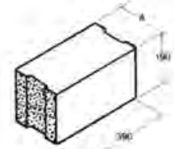
Size Code 10 • 15

13. 75% Solid Standard
Note 3 & 4



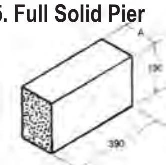
Size Code 20 • 25 • 30

14. Full Solid Standard



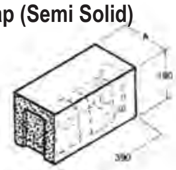
Size Code 20 • 25 • 30

15. Full Solid Pier



Size Code 10 • 15 • 20 • 25 • 30

16. Cap (Semi Solid)

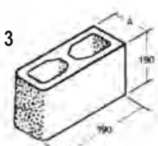


Size Code 20 • 25 • 30

17. Single Bullnose
Note 2 & 3

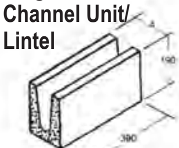
Size Code 10 • 15 • 20 • 25 • 30

18. Double Bullnose End
Note 2 & 3



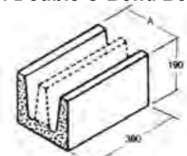
Size Code 20 • 25 • 30

19. Single C-Bond Beam/ Channel Unit/ Lintel



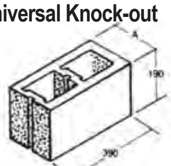
Size Code 10 • 15 • 20

20. Double C-Bond Beam



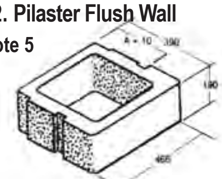
Size Code 20 • 25 • 30

21. Universal Knock-out



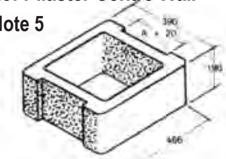
Size Code 15 • 20 • 25 • 30

22. Pilaster Flush Wall
Note 5



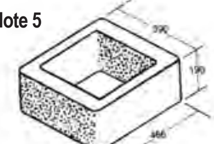
Size Code 20 • 25 • 30

23. Pilaster Centre Wall
Note 5

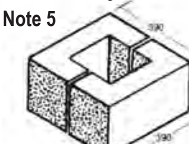


Size Code 20 • 25 • 30

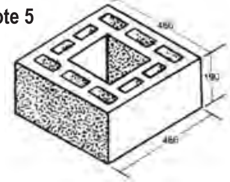
24. Pilaster Pier
Note 5



25. Chimney Block
Note 5



26. Chimney Block
Note 5



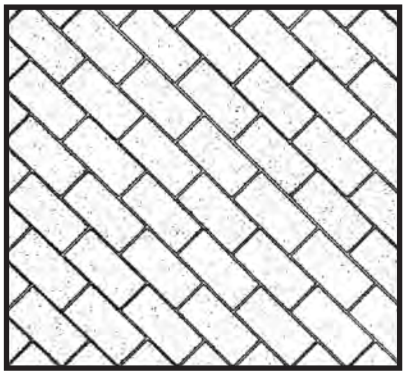
27. Concrete Brick
Note 5

NOTES:
1. Check with individual suppliers for locally available product.
2. May be supplied as a breaker.
3. End configuration may vary from manufacturer to manufacture.
4. Meets National Building Code Req. of solid masonry unit.
5. Outside dimensions may vary.

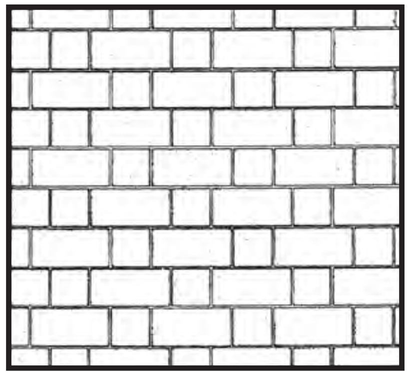
SIZE CODE

NORMAL METRIC SIZE	DIMENSION 'A' ACTUAL MEASUREMENT
5	40mm
10	90mm
15	140mm
20	190mm
25	140mm
30	290mm

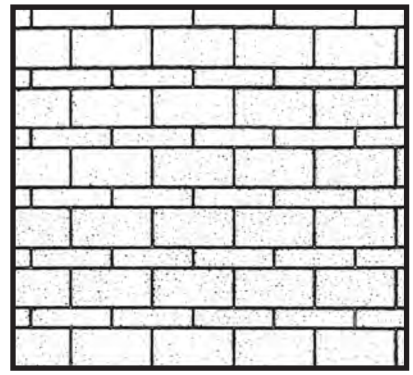
Figure 3.7: *Coursing Design Examples (Ref. 8)*



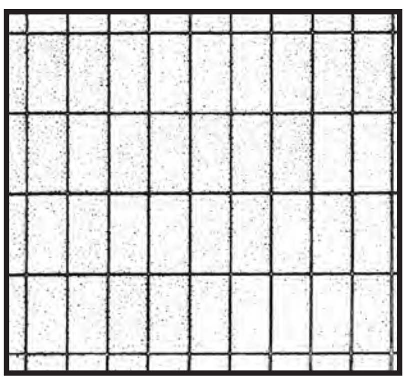
Diagonal Bond
200 x 400



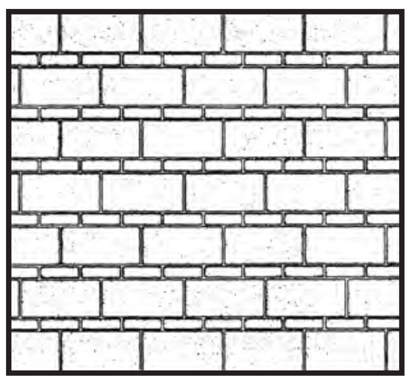
Basket Weave
200 x 200, 200 x 400



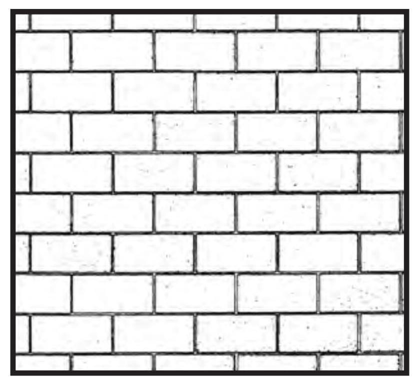
Coursed Ashlar
100 x 400, 200 x 400



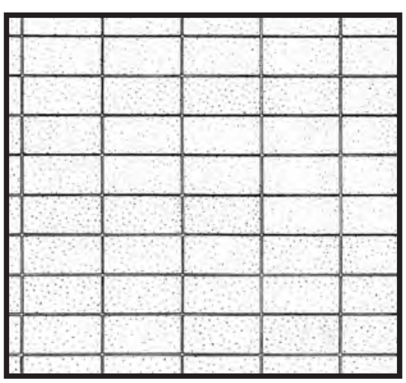
Vertical Stacking
200 x 400



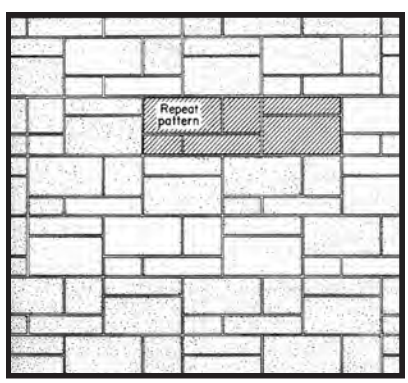
Coursed Ashlar
Brick Size, 200 x 400



Running Bond
200 x 400



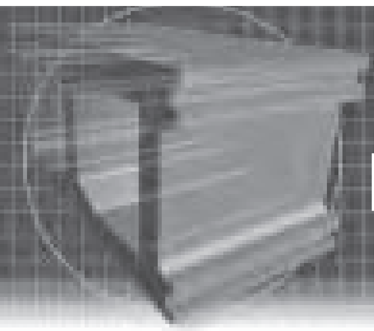
Stack Pattern
200 x 400

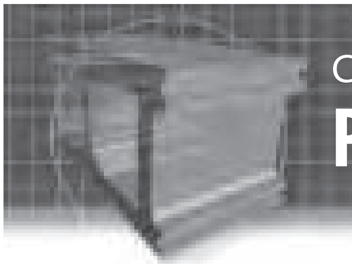


Patterned Ashlar
100 x 200, 100 x 400, 200 x 200, 200 x 400

Canadian Concrete Masonry Producers' Association

Physical Properties





Canadian Concrete Masonry Producers' Association

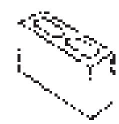
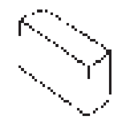
Physical Properties

PHYSICAL PROPERTIES OF STANDARD METRIC SIZE BLOCK

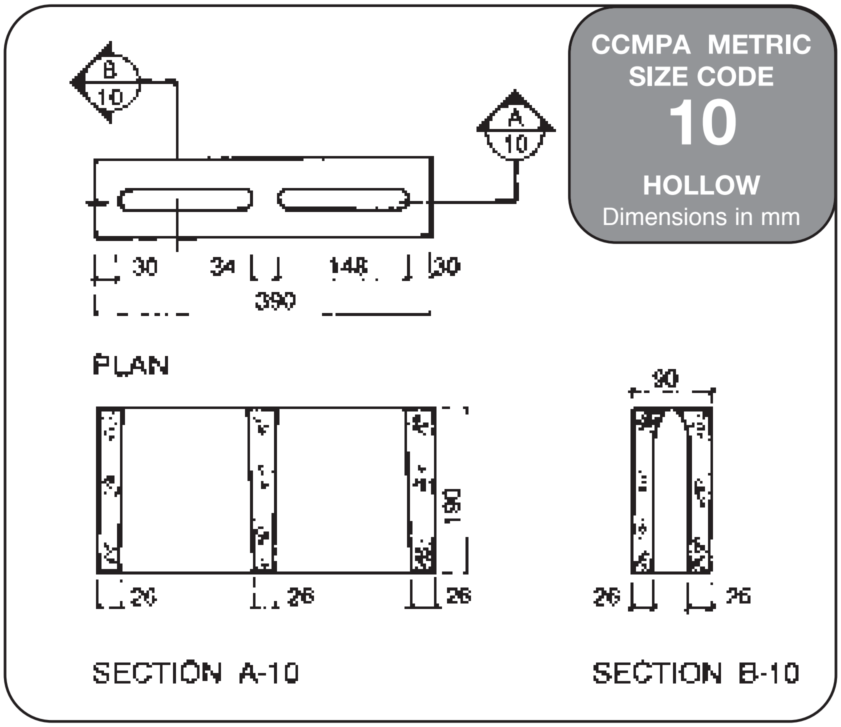
SIZE CODE 10

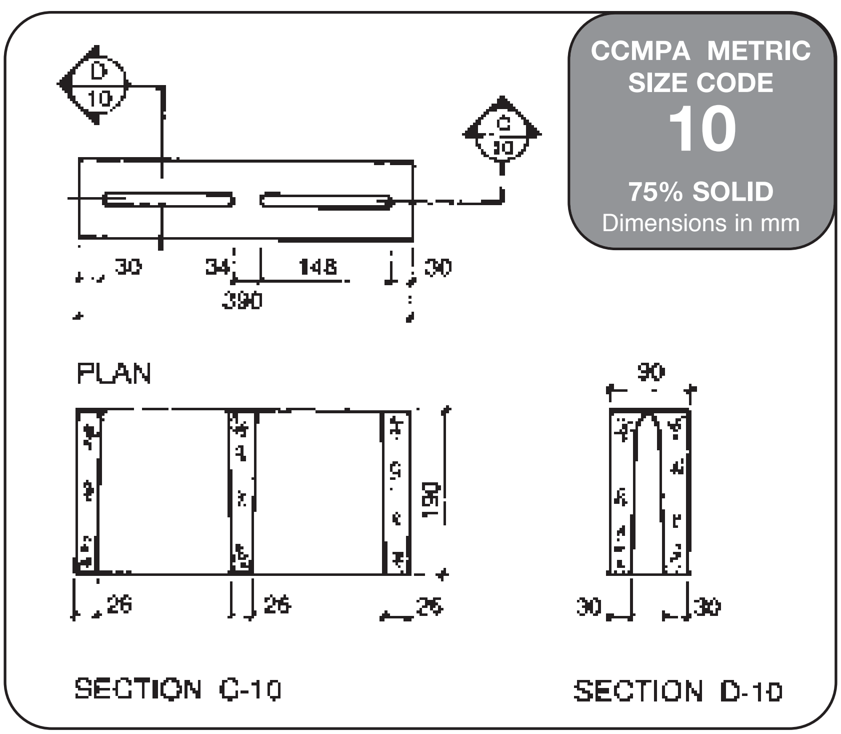
ACTUAL DIMENSIONS (mm)

Width 90 **Length 390** **Height 190**

PROPERTIES		NOTES*	STANDARD CONFIGURATION: HOLLOW	75% SOLID	SOLID
					
Dimensions (mm)	Minimum Face Shell Thickness	1	26	30	N/A
	Minimum Web Thickness	1	26	26	N/A
	Equivalent Thickness	2	66	74	90
Area (mm^2)	Gross Area	3	3.51×10^4	3.51×10^4	3.51×10^4
	Net Area	4	2.56×10^4	2.88×10^4	3.51×10^4
	Core Area	5	4.75×10^3	3.15×10^3	N/A
Volume (mm^3)	Gross Volume	6	6.669×10^6	6.669×10^6	6.669×10^6
	Net Volume	7	4.868×10^6	5.469×10^6	6.669×10^6
Percent Solid (%)	Net Volume/Gross Volume		73%	82%	100%
Typical Unit Mass (kg)	CSA "A" - Type "A" Concrete		10.2	11.5	14.0
	CSA "C" - Type "C" Concrete	8	8.5	9.7	11.7
	CSA "D" - Type "D" Concrete		8.0	9.0	11.0
Typical Wall Mass (kg/m^2) (with mortar)	CSA "A" - Type "A" Concrete		138	155	189
	CSA "C" - Type "C" Concrete		115	130	158
	CSA "D" - Type "D" Concrete		109	122	149
Minimum Compressive Strength (Mpa)	Based on Net Area		15.0	15.0	15.0
	Based on Gross Area		10.95	12.3	15.0
Fire Performance Rating (hours)	Normal Weight - N.B.C.		0.8	1.1	1.4
	Light Weight - N.B.C.	9			
	-$L_2$20S		1.1	1.3	1.8
Sound Properties	Sound Transmission Class - (STC)				
	-CSA Type "A" Concrete	10	43	45	47
	-CSA Type "C", "D" Concrete		40	42	45
Thermal Properties (m^2 °C/W)	RSI Factors				
	-CSA Type "A" Concrete	11	.17	N/A	N/A
	-CSA Type "C", "D" Concrete		.24	N/A	N/A
Moment of Inertia (mm^4)	Per Block **I**		22.69×10^6	23.25×10^6	23.69×10^6
	Per Metre **I**m		58.18×10^6	59.61×10^6	60.75×10^6
Section Modulus (mm^3)	Per Block S		0.504×10^6	0.517×10^6	0.527×10^6
	Per Block Sm		1.293×10^6	1.324×10^6	1.350×10^6

* Information to be used in conjunction with explanatory notes on Page 4-11

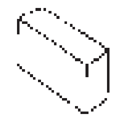

CCMPA METRIC
SIZE CODE
10
HOLLOW
Dimensions in mm
B
10
A
10
30
34
148
30
390
PLAN
90
190
26
26
26
26
26
SECTION A-10
SECTION B-10


CCMPA METRIC
SIZE CODE
10
75% SOLID
Dimensions in mm
D
10
C
10
30
34
148
30
390
PLAN
90
190
26
26
26
30
30
SECTION C-10
SECTION D-10

Physical Properties

PHYSICAL PROPERTIES OF STANDARD METRIC SIZE BLOCK

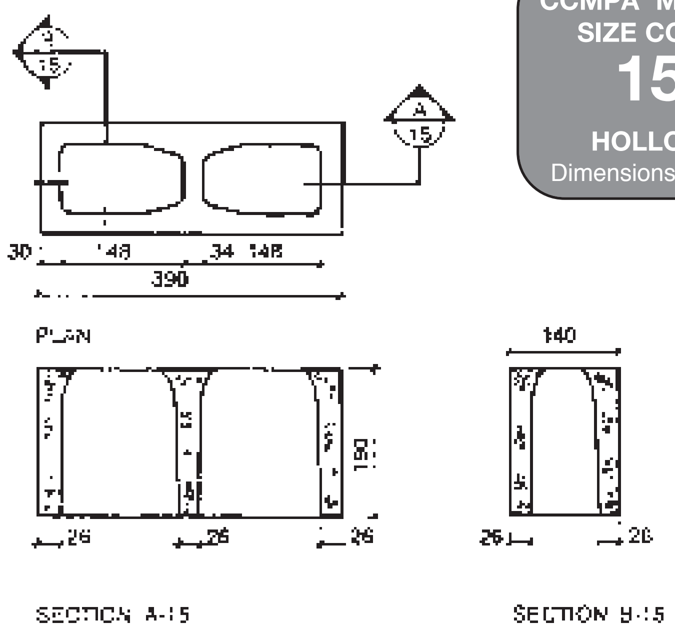
SIZE CODE 15

ACTUAL DIMENSIONS (mm)		NOTES*	STANDARD CONFIGURATION		
Width 140	Length 390 / Height 190		HOLLOW	75% SOLID	SOLID
PROPERTIES					
Dimensions (mm)	Minimum Face Shell Thickness Minimum Web Thickness Equivalent Thickness	1 1 2	26 26 81	44 30 112	N/A N/A 140
Area (mm^2)	Gross Area Net Area Core Area	3 4 5	5.46 x 10^4 3.17 x 10^4 1.145 x 10^4	5.46 x 10^4 4.37 x 10^4 5.45x 10^3	5.46 x 10^4 5.46 x 10^4 N/A
Volume (mm^3)	Gross Volume Net Volume	6 7	10.374 x 10^6 6.017 x 10^6	10.374 x 10^6 8.299 x 10^6	10.374 x 10^6 10.374 x 10^6
Percent Solid (%)	Net Volume/Gross Volume		58%	80%	100%
Typical Unit Mass (kg)	CSA "A" - Type "A" Concrete CSA "C" - Type "C" Concrete CSA "D" - Type "D" Concrete	8	12.6 11.3 10.6	17.4 15.6 14.6	23.3 19.5 18.3
Typical Wall Mass (kg/m^2) (with mortar)	CSA "A" - Type "A" Concrete CSA "C" - Type "C" Concrete CSA "D" - Type "D" Concrete	8	170 153 144	235 210 198	315 263 248
Minimum Compressive Strength (Mpa)	Based on Net Area Based on Gross Area	10	15.0 8.7	15.0 12.0	15.0 15.0
Fire Performance Rating (Hours)	Normal Weight - N.B.C. Light Weight - N.B.C. -$L_2$20S	9	1.1 1.5	2.0 2.8	2.9 4+
Sound Properties	Sound Transmission Class - (STC) -CSA Type "A" Concrete -CSA Type "C", "D" Concrete	10	 46 43	 50 47	 52 50
Thermal Properties (m^2 °C/W)	RSI Factors -CSA Type "A" Concrete -CSA Type "C", "D" Concrete	11	 .19 .26	 N/A N/A	 N/A N/A
Moment of Inertia (mm^4)	Per Block **I** Per Metre **I**m		74.07 x 10^6 189.9 x 10^6	86.86 x 10^6 222.7 x 10^6	89.18 x 10^6 228.7 x 10^6
Section Modulus (mm^3)	Per Block S Per Block Sm		1.058 x 10^6 2.713 x 10^6	1.241 x 10^6 3.182 x 10^6	1.274 x 10^6 3.267 x 10^6

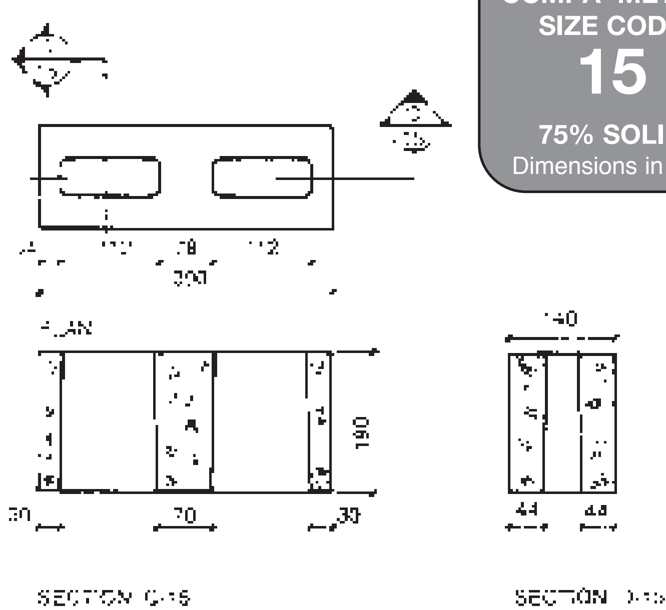
* Information to be used in conjunction with explanatory notes on Page 4-11

Physical Properties

CCMPA METRIC SIZE CODE
15
HOLLOW
Dimensions in mm



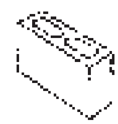
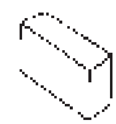
CCMPA METRIC SIZE CODE
15
75% SOLID
Dimensions in mm



Physical Properties

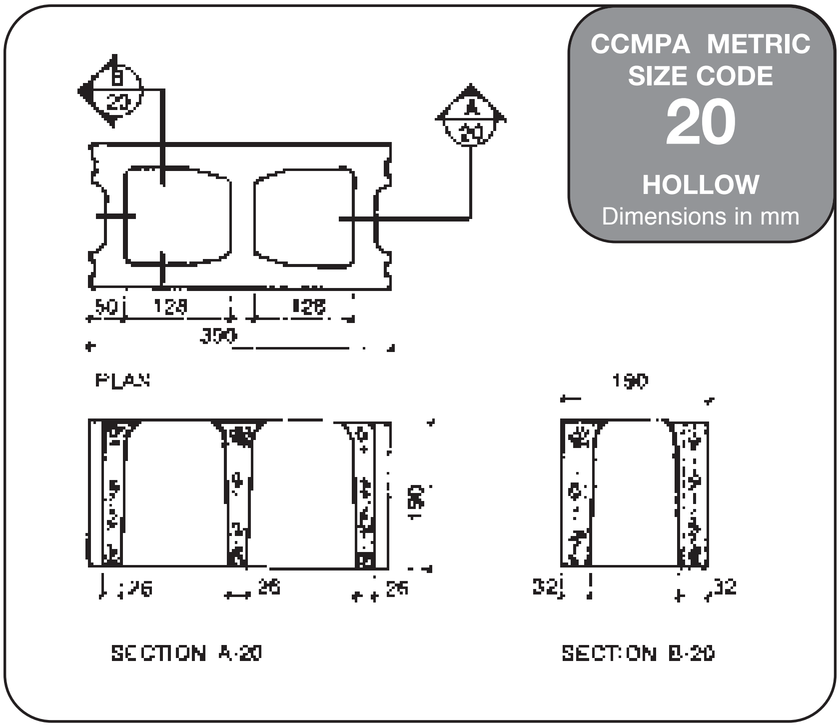
PHYSICAL PROPERTIES OF STANDARD METRIC SIZE BLOCK

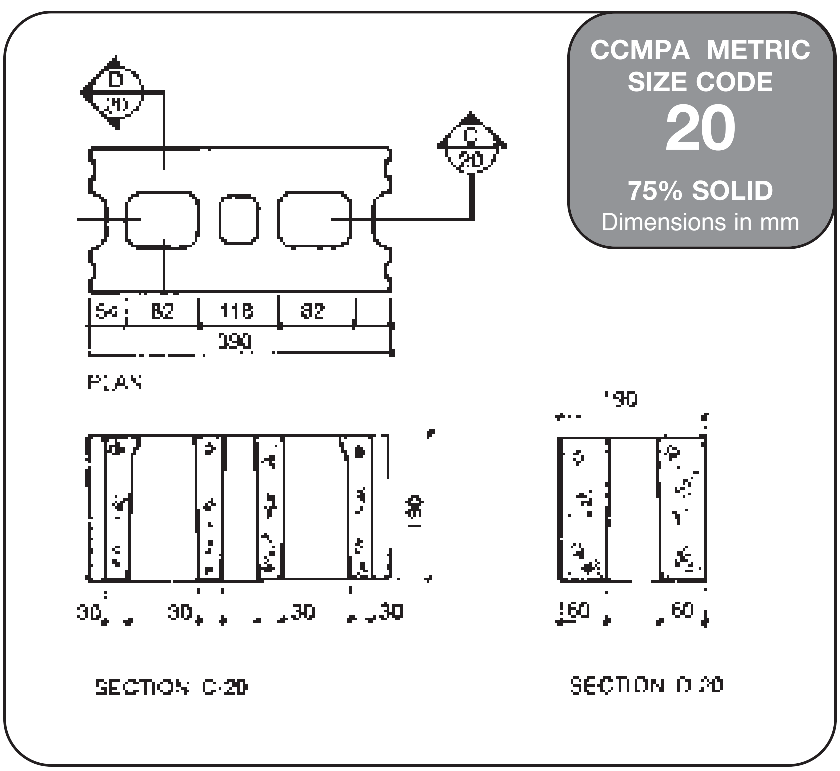
SIZE CODE 20

ACTUAL DIMENSIONS (mm)		NOTES*	STANDARD CONFIGURATION		
Width 190	Length 390 / Height 190		HOLLOW	75% SOLID	SOLID
PROPERTIES					
Dimensions (mm)	Minimum Face Shell Thickness	1	32	60	N/A
	Minimum Web Thickness	1	26	30	N/A
	Equivalent Thickness	2	106	148	190
Area (mm^2)	Gross Area	3	7.41×10^4	7.41×10^4	7.41×10^4
	Net Area	4	4.15×10^4	5.78×10^4	7.41×10^4
	Core Area	5	1.53×10^4	6.75×10^3	N/A
Volume (mm^3)	Gross Volume	6	14.079×10^6	14.079×10^6	14.079×10^6
	Net Volume	7	7.88×10^6	10.97×10^6	14.08×10^6
Percent Solid (%)	Net Volume/Gross Volume		56%	78%	100%
Typical Unit Mass (kg)	CSA "A" - Type "A" Concrete		16.5	23.0	29.6
	CSA "C" - Type "C" Concrete	8	13.8	19.2	24.6
	CSA "D" - Type "D" Concrete		13.2	18.4	23.6
Typical Wall Mass (kg/m^2) (with mortar)	CSA "A" - Type "A" Concrete		223.0	311.0	399.0
	CSA "C" - Type "C" Concrete		186.2	259.4	332.5
	CSA "D" - Type "D" Concrete		175.6	244.5	313.5
Minimum Compressive Strength (Mpa)	Based on Net Area		15.0	15.0	15.0
	Based on Gross Area		8.4	11.7	15.0
Fire Performance Rating (Hours)	Normal Weight - N.B.C.		1.8	3.2	4+
	Light Weight - N.B.C.	9			
	-$L_2$20S		2.5	4+	4+
Sound Properties	Sound Transmission Class - (STC)				
	-CSA Type "A" Concrete	10	50	53	56
	-CSA Type "C", "D" Concrete		46	51	53
Thermal Properties (m^2 °C/W)	RSI Factors				
	-CSA Type "A" Concrete	11	.21	N/A	N/A
	-CSA Type "C", "D" Concrete		.30	N/A	N/A
Moment of Inertia (mm^4)	Per Block **I**		194.2×10^6	217.1×10^6	222.9×10^6
	Per Metre **I**m		498.0×10^6	556.6×10^6	571.6×10^6
Section Modulus (mm^3)	Per Block S		2.045×10^6	2.285×10^6	2.347×10^6
	Per Block Sm		5.242×10^6	5.859×10^6	6.017×10^6

* Information to be used in conjunction with explanatory notes on Page 4-11

Physical Properties

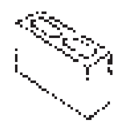
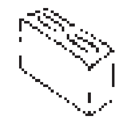
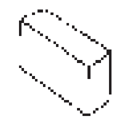




Physical Properties

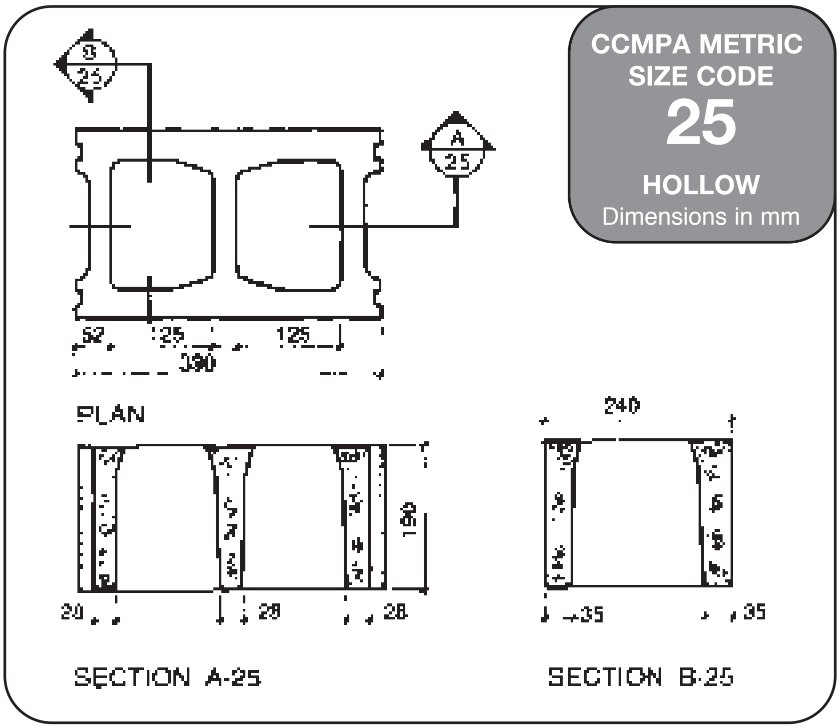
PHYSICAL PROPERTIES OF STANDARD METRIC SIZE BLOCK

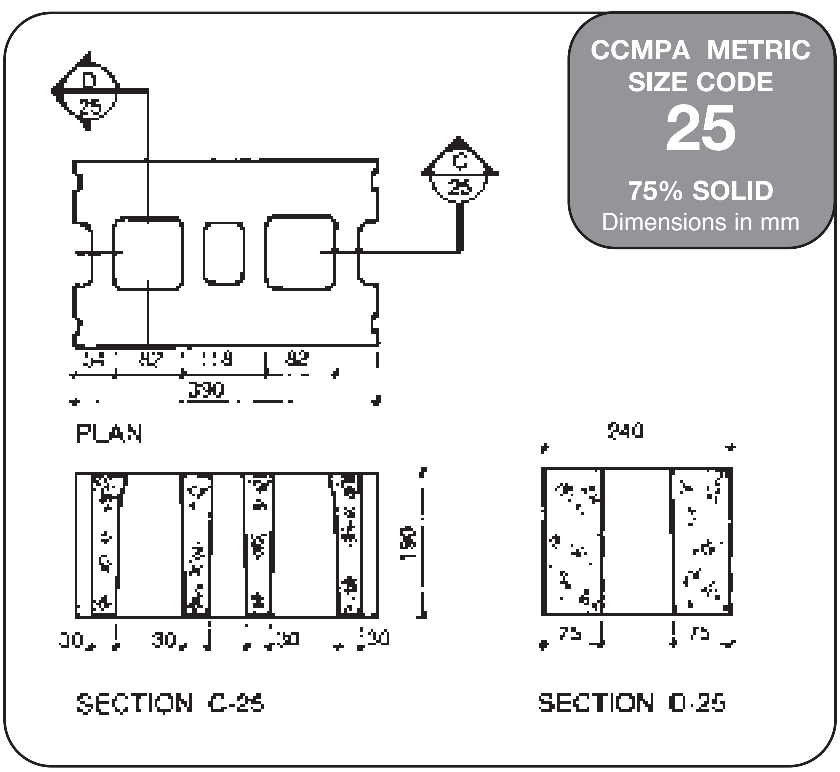
SIZE CODE **25**

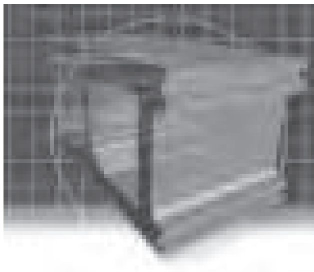
ACTUAL DIMENSIONS (mm)		NOTES*	STANDARD CONFIGURATION		
Width 240	**Length 390 Height 190**		**HOLLOW**	**75% SOLID**	**SOLID**
PROPERTIES					
Dimensions (mm)	Minimum Face Shell Thickness Minimum Web Thickness Equivalent Thickness	1 1 2	35 28 127	75 30 187	N/A N/A 240
Area (mm2)	Gross Area Net Area Core Area	3 4 5	9.36×10^4 4.96×10^4 2.06×10^4	9.36×10^4 7.30×10^4 8.80×10^3	9.36×10^4 9.36×10^4 N/A
Volume (mm3)	Gross Volume Net Volume	6 7	17.784×10^6 9.43×10^6	17.784×10^6 13.87×10^6	17.784×10^6 17.78×10^6
Percent Solid (%)	Net Volume/Gross Volume		53%	78%	100%
Typical Unit Mass (kg)	CSA "A" - Type "A" Concrete CSA "C" - Type "C" Concrete CSA "D" - Type "D" Concrete	8	20.6 17.2 16.2	30.3 25.3 23.8	38.9 32.4 30.6
Typical Wall Mass (kg/m²) (with mortar)	CSA "A" - Type "A" Concrete CSA "C" - Type "C" Concrete CSA "D" - Type "D" Concrete		278.3 231.9 218.4	409.5 341.3 321.8	525.0 437.5 412.0
Minimum Compressive Strength (Mpa)	Based on Net Area Based on Gross Area		15.0 7.9	15.0 11.7	15.0 15.0
Fire Performance Rating (Hours)	Normal Weight - N.B.C. Light Weight - N.B.C. -$L_2$20S	9	2.4 3.5	4+ 4+	4+ 4+
Sound Properties	Sound Transmission Class - (STC) -CSA Type "A" Concrete -CSA Type "C", "D" Concrete	10	 51 49	 56 53	 58 56
Thermal Properties (m^2 °C/W)	RSI Factors -CSA Type "A" Concrete -CSA Type "C", "D" Concrete	11	 .24 .33	 N/A N/A	 N/A N/A
Moment of Inertia (mm^4)	Per Block I Per Metre Im		334.9×10^6 858.8×10^6	437.0×10^6 1131×10^6	449.3×10^6 1152×10^6
Section Modulus (mm^3)	Per Block S Per Block Sm		2.791×10^6 7.156×10^6	3.642×10^6 9.338×10^6	3.744×10^6 9.600×10^6

* Information to be used in conjunction with explanatory notes on Page 4-11

Physical Properties





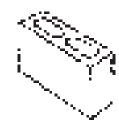
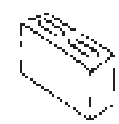
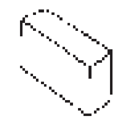


Canadian Concrete Masonry Producers' Association

Physical Properties

PHYSICAL PROPERTIES OF STANDARD METRIC SIZE BLOCK

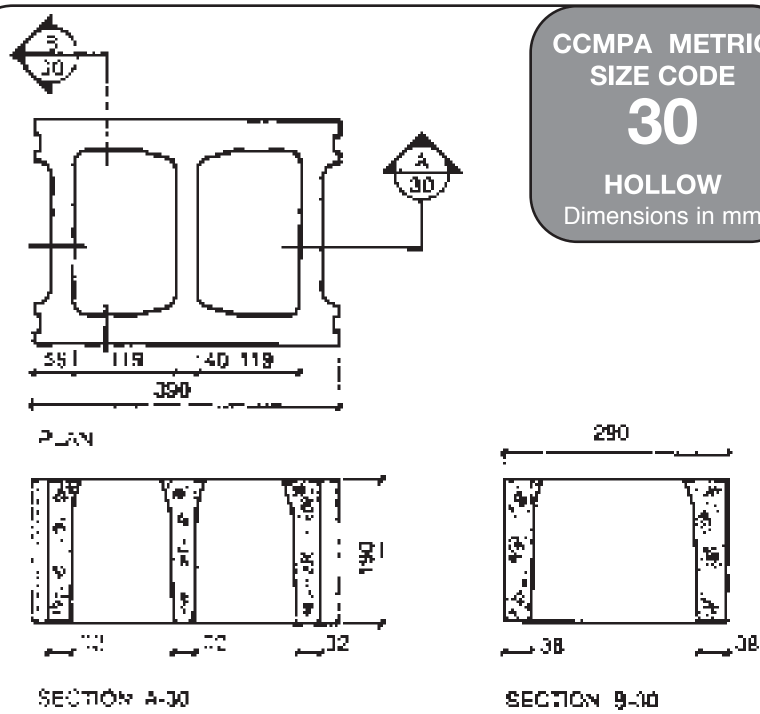
SIZE CODE 30

ACTUAL DIMENSIONS (mm)		NOTES*	STANDARD CONFIGURATION		
Width 290	**Length 390 / Height 190**		**HOLLOW**	**75% SOLID**	**SOLID**
PROPERTIES					
Dimensions (mm)	Minimum Face Shell Thickness Minimum Web Thickness Equivalent Thickness	1 1 2	38 32 148	90 30 227	N/A N/A 290
Area (mm²)	Gross Area Net Area Core Area	3 4 5	11.31×10^4 5.77×10^4 2.50×10^4	11.31×10^4 8.82×10^4 1.07×10^4	11.31×10^4 11.31×10^4 N/A
Volume (mm³)	Gross Volume Net Volume	6 7	21.489×10^6 10.96×10^6	21.489×10^6 16.76×10^6	21.489×10^6 21.49×10^6
Percent Solid (%)	Net Volume/Gross Volume		51%	78%	100%
Typical Unit Mass (kg)	CSA "A" - Type "A" Concrete CSA "C" - Type "C" Concrete CSA "D" - Type "D" Concrete	8	23.0 19.2 18.1	35.2 29.3 27.7	45.1 37.6 35.5
Typical Wall Mass (kg/m²) (with mortar)	CSA "A" - Type "A" Concrete CSA "C" - Type "C" Concrete CSA "D" - Type "D" Concrete		310.6 258.8 244.0	475.0 395.9 373.2	609.0 507.5 478.5
Minimum Compressive Strength (Mpa)	Based on Net Area Based on Gross Area		15.0 7.6	15.0 11.7	15.0 15.0
Fire Performance Rating (Hours)	Normal Weight - N.B.C. Light Weight - N.B.C. -$L_2$20S		3.2 4+	4+ 4+	4+ 4+
Sound Properties	Sound Transmission Class - (STC) -CSA Type "A" Concrete -CSA Type "C", "D" Concrete		 53 50	 58 56	 58 58
Thermal Properties (m² °C/W)	RSI Factors -CSA Type "A" Concrete -CSA Type "C", "D" Concrete		 .26 .36	 N/A N/A	 N/A N/A
Moment of Inertia (mm⁴)	Per Block **I** Per Metre **I**m		570.4×10^6 1463×10^6	771.0×10^6 1977×10^6	792.6×10^6 2032×10^6
Section Modulus (mm³)	Per Block S Per Block Sm		3.934×10^6 10.09×10^6	5.317×10^6 13.63×10^6	5.466×10^6 14.02×10^6

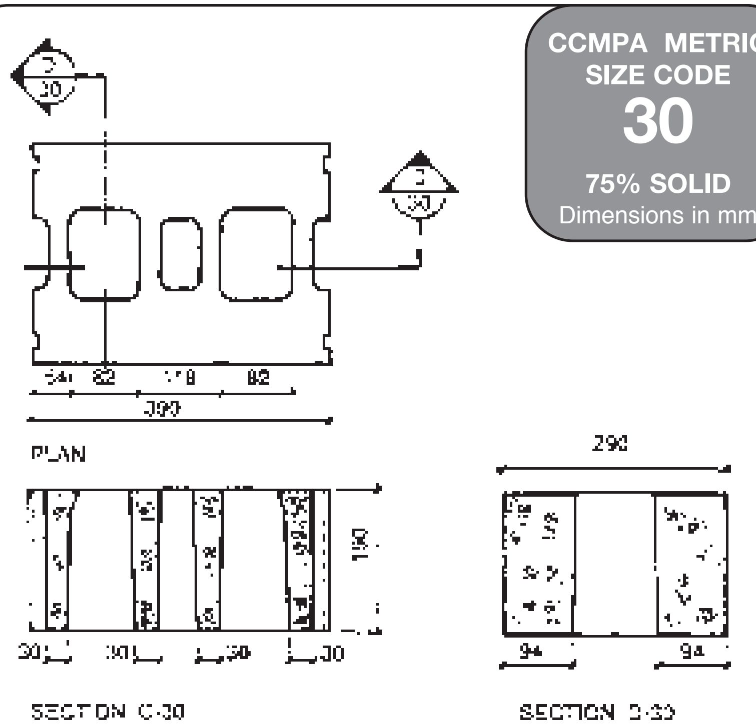
* Information to be used in conjunction with explanatory notes on Page 4-11

Physical Properties

CCMPA METRIC SIZE CODE
30
HOLLOW
Dimensions in mm



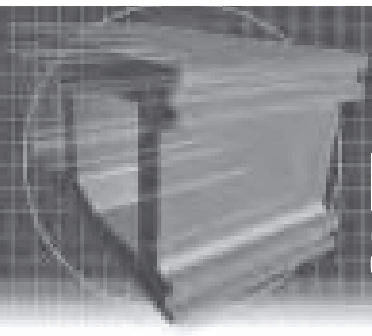
CCMPA METRIC SIZE CODE
30
75% SOLID
Dimensions in mm



Physical Properties

Explanatory Notes

NUMBER	DESCRIPTION
1	Due to manufacturing process, dimensions may exceed minimum requirements.
2	Equivalent thickness is the net thickness of a unit, other than a solid unit, re-shaped to form a voidless unit having the same height and length dimensions (190mm x 390mm) and is a direct function of percentage solid content. Therefore, the overall width of a non-solid unit multiplied by its percentage solid content will arrive at its equivalent thickness ratio. The percentage solid content equals net volume (as defined in The Supplement to the National Building Code) divided by gross volume. e.g. Calculating Equivalent Thickness: 20cm Hollow Concrete Block Percentage Solid 56% as per CCMPA specification Equivalent Thickness = Actual Width x Percentage Solid $= 190\text{mm} \times \frac{56}{100}$ Equivalent Thickness = 106mm
3	Gross Area, defined by the CSA-A165.1, is the area parallel to the bearing surface of the masonry unit by calculating the actual measured overall dimensions of the unit including the voids.
4	Net Area is the net cross-sectional area at mid-depth of the unit. This area can be calculated using actual Gross Area multiplied by percentage solid of unit.
5	Core Area is the measurement of the core areas taken at mid-height of unit.
6	Gross Volume, as defined in Supplement to the National Building Code is: "Equal to the actual length of the unit multiplied by the actual height of the unit multiplied by the actual thickness of the unit."
7	Net Volume, as defined in Supplement to the National Building Code is: "Determined by using a volume displacement method that is not influenced by the porous nature of the unit."
8	Refer to CCMPA Specifications for concrete density (kg/m3). Typical Average Weight of Type "A" Concrete 2100 kg/m^3 Typical Average Weight of Type "C" Concrete 1750 kg/m^3 Typical Average Weight of Type "D" Concrete 1650 kg/m^3
9	Fire Ratings are based on the Supplement to the National Building Code.
10	For more detailed information, refer to Section 7 – Sound Properties.
11	Refer to Section 6 – Thermal Properties, for detailed information.



Canadian Concrete Masonry Producers' Association

Fire Properties & Design Details

FIRE PERFORMANCE PROPERTIES

Introduction

Fire ratings for CCMPA metric concrete masonry units are derived from the Supplementary Guidelines to the 1997 Ontario Building Code and the National Building Code of Canada. The ratings given in the Guidelines are based on those that would be obtained from standard laboratory methods of test, essentially a means of comparing the fire performance of one building component with another.

The fire endurance of concrete masonry units varies by type of aggregate and equivalent thickness of the unit.

Equivalent Thickness

The equivalent thickness of a cored unit is equal to the actual overall thickness of the unit multiplied by the net volume and divided by the gross volume.
For example: 25 cm Hollow Unit
Actual Thickness x Net Volume ÷ Gross Volume
240mm x 9.43mm^3 x 10^6 ÷ 17.784mm^3 x 10^6
= 127.26 mm say 127 mm

Types of Concrete

The available types of concrete mix for O.C.B.A. block are as follows:

NORMAL WEIGHT CONCRETE

- *Type N Concrete*
The coarse aggregate is limestone, calcareous gravel, or similar dense aggregate material.

- *Type S Concrete*
The coarse aggregate is granite, quartzite, siliceous gravel or similar dense material.

LIGHTWEIGHT CONCRETE

- *Type $L^2$20S*
The coarse aggregate is expanded slag, and the fine aggregate is sand and lightweight aggregate in which the sand does not exceed 20% of the total volume of all of the aggregates.

It should be noted that lightweight units exhibit better fire performance and therefore a higher resistance rating is assigned than for the same equivalent thickness of normal weight block.

Fire Endurance Ratings

Fire endurance ratings of standard hollow, 75% solid, and 100% solid metric concrete masonry units in different aggregate types can be found in Table 5.0. The values are typical for CCMPA Members. This section can be used by designers in conjunction with The Supplement to the National Building Code.

EQUAL FIRE RATINGS DON'T GUARANTEE EQUAL PERFORMANCE

The ASTM-E 119 (ref. 1) test procedure used to determine fire ratings of wall assemblies can allow significant differences in performance among partitions with the same rating. This test consists of two parts:

1. The fire endurance test, in which a test specimen must withstand a controlled fire for a specific time period (1 hour, 2 hours etc.) and
2. The hose steam test, in which the specimen must withstand the impact of a controlled stream of water after fire exposure.

When a masonry assembly is tested, the hose stream test normally is performed on the specimen that has completed the fire endurance test. For a 2-hour rating, the test wall is exposed to fire for 2h, then subjected to the hose stream.

However, the test need not be conducted this way for a wall assembly to achieve a specific rating. The hose stream test may be performed on a second specimen that has withstood the fire endurance test for one-half the desired rating period.

The result: some 2-hour-rated walls may not maintain integrity but masonry walls withstand the hose stream test after the full 2 hours of exposure to fire. When selecting consider the system's fire resistance characteristics, not just its fire rating.

Reference
ASTM E 119, Standard Methods of Fire Tests of Building Construction & Materials, ASTM, 1916 Race St., Philadelphia PA 19103

Fire Performance Properties

TABLE 5.0
FIRE RESISTANCE RATING OF CONCRETE BLOCK IN HOURS

CCMPA HOLLOW UNITS

SIZE CODE	EQUIVALENT THICKNESS mm	NORMAL WEIGHT N or S	LIGHT WEIGHT $L_2$20s
		HOURS	
10	66	0.8	1.1
15	81	1.1	1.5
20	106	1.8	2.5
25	127	2.4	3.5
30	148	3.2	4+

CCMPA 75% SOLID

SIZE CODE	EQUIVALENT THICKNESS mm	NORMAL WEIGHT N or S	LIGHT WEIGHT $L_2$20s
		HOURS	
10	74	1.1	1.3
15	112	2.0	2.8
20	148	3.2	4+
25	187	4+	4+
30	227	4+	4+

CCMPA SOLID PIER

SIZE CODE	EQUIVALENT THICKNESS mm	NORMAL WEIGHT N or S	LIGHT WEIGHT $L_2$20s
		HOURS	
10	74	1.1	1.3
10	90	1.4	1.8
15	140	2.9	4+
20	190	4+	4+
25	240	4+	4+
30	290	4+	4+

Contribution of Plaster and Wallboard Finish

Improved fire separation endurance can be achieved in concrete masonry walls by the use of plaster or gypsum wallboard, applied directly to the masonry wall. Reference should be made to the Supplementary Guidelines for pertinent details.

For requirements not covered in this section consult a local CCMPA Producer.

Fire Resistance Protection For Steel Columns

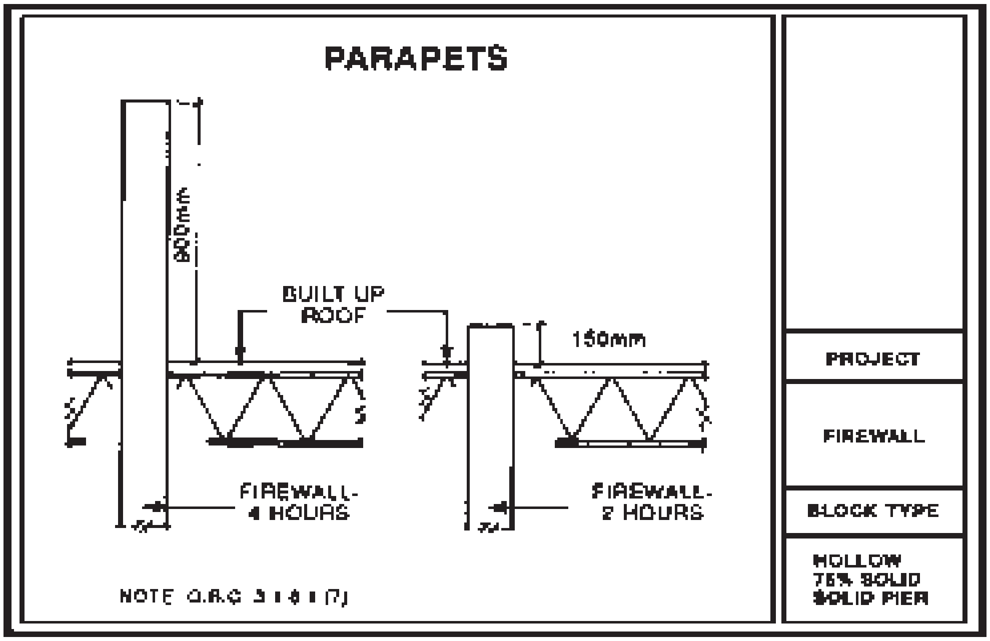
The minimum equivalent thickness of concrete masonry protection for steel columns is given in Table 2.6.1.A of the Guidelines.

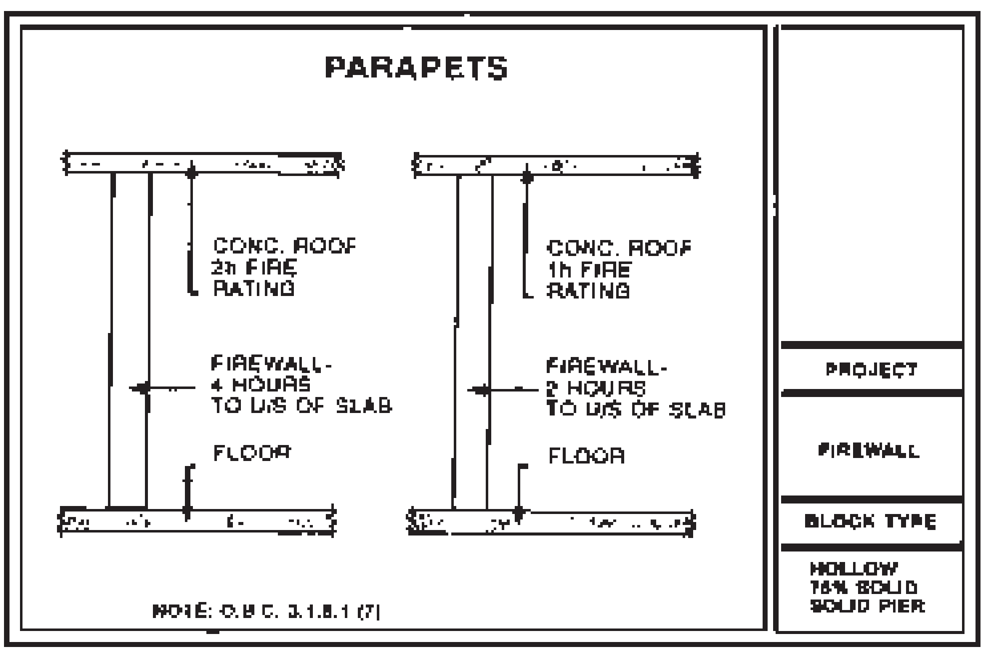
TABLE 5.1
EQUIVALENT THICKNESS OF CONCRETE MASONRY REQUIRED FOR STEEL COLUMNS (mm)

CONCRETE TYPE	FIRE RESISTANCE PROTECTION (IN HOURS)			
	0-1.5	2.0	3.0	4.0
S	50	64	89	115
N OR $L_2$20s	50	50	77	102

An additional requirement when using concrete masonry units as fire protection for steel columns is for joint reinforcement of at least 5.20 mm wire to be laid in every second course. The space between the masonry protection and the steel column need not be filled.

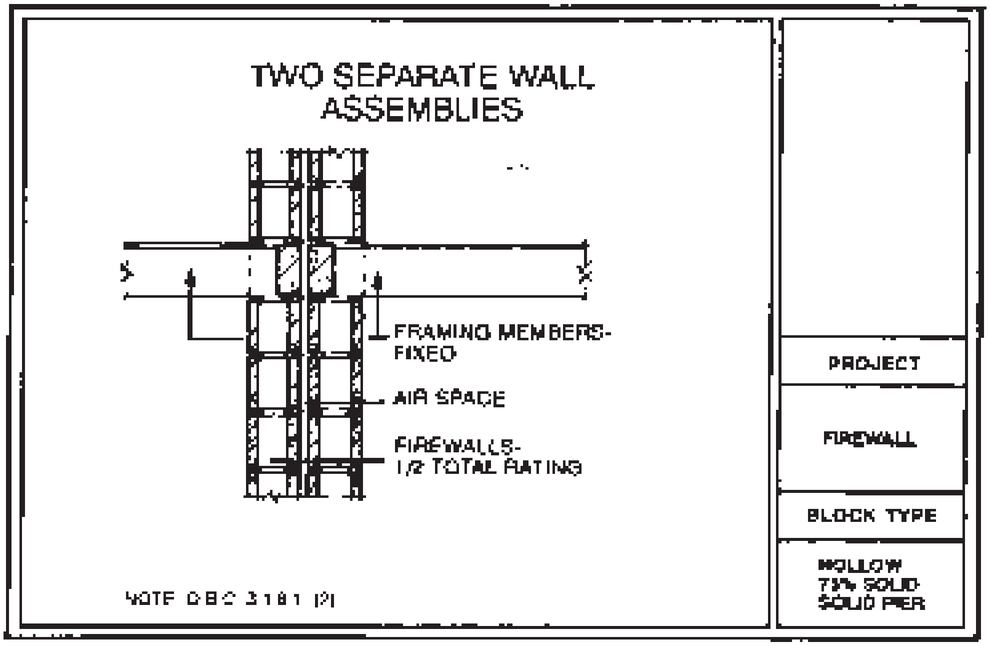
Firewalls

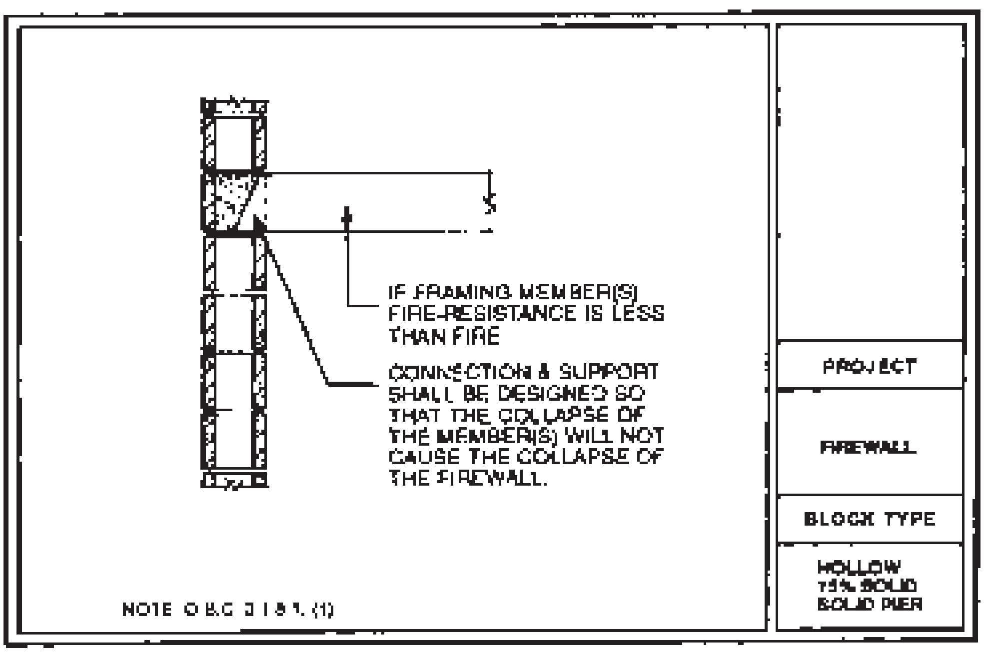


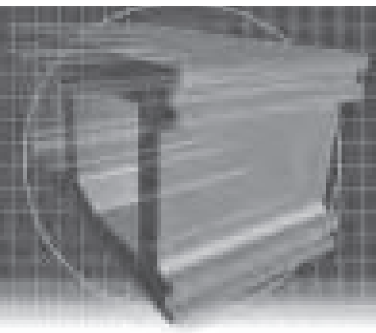


NOTE:
A fire wall is permitted to terminate on the underside of a reinforced concrete roof slab.

Firewalls


TWO SEPARATE WALL ASSEMBLIES
FRAMING MEMBERS-FIXED
AIR SPACE
FIREWALLS-
1/2 TOTAL RATING
NOTE O.B.C. 3.1.8.1.(2)
PROJECT
FIREWALL
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER


IF FRAMING MEMBER(S) FIRE-RESISTANCE IS LESS THAN FIRE
CONNECTION & SUPPORT SHALL BE DESIGNED SO THAT THE COLLAPSE OF THE MEMBER(S) WILL NOT CAUSE THE COLLAPSE OF THE FIREWALL.
NOTE O.B.C. 3.1.8.1.(1)
PROJECT
FIREWALL
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER



Canadian Concrete Masonry Producers' Association

Thermal Properties & Design Details

Thermal Design

Introduction

Energy conservation addresses the thermal performance of the entire building, not just a component or a system. Every aspect must be taken into account and standards that take this overall "thermal performance" into account are ideal.

Performance standards establish energy budgets and then allow designers, builders and owners to achieve this energy budget in the manner best suited to their requirements.

The sun's energy rays can be used to advantage to reduce energy costs. [Refer to Solar Heat Storage by Professor Tang Lee, page 6-11].
There are both "active" and "passive" solar collectors. "Active" solar collectors collect energy from the sun and then use mechanical equipment such as pumps or fans to distribute that energy. "Passive" collectors simply collect the sun's heat and store it until it is released by radiation or conduction. No materials serve as "passive" collectors better than masonry - Concrete Block.

Wall mass from masonry walls keeps buildings warmer in winter, and cooler in summer because they are passive solar collectors even when not designed as such. Furthermore, because masonry mass can reduce and shift energy flow peaks, the size and capital costs of heating and air conditioning (HVAC) systems may be reduced.

Insulation, is the construction material most widely acknowledged to conserve energy. However, it is important to determine the ideal thickness of insulation to achieve cost efficiency. The law of diminishing returns as applied to insulation thickness should be considered to establish the optimum RSI value.

Insulation affects only the loss or gain of heat through conduction, accounting for about 10 percent of a building's total energy use. Air infiltration through the openings of windows and doors, through cracks and inadequately sealed openings is estimated to account for 25 - 30 percent of the heat loss in buildings.

The total resistance (RSI*) to heat flow through a building section equals the sum of the RSI values of the various components of the building section. These components consist of air films, construction materials and air spaces.

The thermal data supplied in this section will assist in calculating Thermal Resistance for masonry wall construction and is intended as a guide for estimating total thermal resistance where more specific information is not available.

**RSI is the metric abbreviation denoting thermal resistance; the conversion has been based on a factor of .176, applied to the Imperial R Values.*

Points to Consider

- *The function of the building envelope is to separate the interior environment from the exterior environment.*
- *The degree of separation is a design decision which depends on, among other things, an economic trade-off between the present cost of improving the envelope and the future cost of energy for space conditioning.*
- *As the desirable degree of separation is driven upward by higher energy costs, the potential for durability and maintenance problems is increased. This is exacerbated by the present trend toward higher interior humidity levels.*
- *The main envelope-related characteristics of a building which determine its energy consumption are its form, size, the thermal resistance of various elements, airtightness and the window area and orientation.*
- *As thermal resistance is increased, each added unit of resistance reduces heat loss less than the preceding unit so that for each part of the building there is an economic optimum thermal resistance level beyond which further increases do not produce savings commensurate with their cost.*
- *Thermal bridges — conductive materials penetrating a major portion of the thickness of the envelope — not only result in additional energy consumption but also cause internal cold spots, in turn leading to condensation and related deterioration of adjacent material.*
- *Leakage of interior air through the building envelope can result in significant quantities of condensation and is a primary cause of moisture-related building problems. These problems can be avoided by a high degree of airtightness built into the building envelope.*
- *The incorporation of insulation in a building assembly reduces its ability to dry itself should rain penetration or exfiltration/condensation occur. Correct selection of construction type and detailing is therefore important.*
- *Favourable orientation of the building on site.*
- *The geometric shape of the building (ratio of length to width).*
- *The number of stories for a given floor area requirement.*
- *Mass and colour of exterior walls.*
- *Shading or reflections from adjacent structures.*
- *Surrounding topographical features and/or landscape considerations.*
- *Opportunities for natural ventilation wind direction and speed.*
- *Reduced air infiltration and efficiently sized mechanical equipment.*
- *Efficient thermal properties of materials.*

Wall Design

Due to the many design requirements which an exterior wall must satisfy, the initial design considerations can become complex.

Exterior walls must address the following:
- Control rain penetration
- Control admittance of natural light and solar radiation
- Control of heat conductance
- Reduce of Sound Transmission

- Control of air movement and water vapour flow through wall
- Stability against wind pressure and the regulation of differential air pressures
- Protection against fire
- Control movement differential
- Control of vibrations and seismic stress
- Durability combined with low maintenance
- Control outdoor noise
- Economy

In designing a wall to fulfill these requirements it is essential to examine each condition in detail to understand the principles and mechanisms involved.

RAIN-SCREEN WALLS

The open rain-screen wall is essentially two walls: the outer layer or wythe being a vented open rain-screen separated from the inner wall by means of an air space. It is the opinion of some designers that air pressure in the air space can be equal to the pressure on the exterior wall surface. Flashing is located at the base to permit any water that has entered to be redirected to the outside.

Openings such as windows, doors and grills in multi-layer walls must be sealed to the air barrier inner wall with projections or bulkheads connecting with the outer rain screen. The air barrier must prevent major air leakage and resist wind loads on the building.

A rain-screen design approach can result in the following advantages:
- Reduces heating/air conditioning loads by placing the insulation on the cold side of the interior wythe, (inside the cavity), so the building envelope is not directly subject to climactic changes.
- Permits rapid drying of cladding material
- Consider cladding movement and crack control
- Permits better positioning of insulation, minimizing condensation risk within the wall
- Structural elements are maintained at a more uniform temperature, with reduced thermal deformation.

WIND PRESSURE

Wind forces acting on a wall can produce positive and negative pressures. Any opening on the windward side of the wall will cause a considerable pressure drop across the wall surface, thus resulting in a pressure difference that can force or draw a considerable amount of rain water through any small opening. Low wind pressures can move water through extremely small openings; but high wind pressures can force water upwards into confined spaces, bridging joints, and similar barriers. It is impossible to control wind pressure effect on wall surface rain water. The provision of an air space immediately behind the exterior facing, with amply controlled openings to the exterior air, acts as an air pressure equalization chamber to counteract the wind pressure force, and reduce rain penetration. The wall construction on the interior of the air space must be designed to resist the maximum wind pressures possible.

SOLAR AIR TEMPERATURE

The sun's effect on the outer wall surface raises the surface temperature above the outside ambient air temperature. The amount of this solar heating effect depends on:

- Time of day, date and latitude of site
- Wall surface colour
- Direction the wall faces

The effects of solar radiation, combined with outside air temperatures give a calculated outside temperature called the Solar Air Temperature.

Balance of Solar Air Temperature

Flow and temperature variations through a wall in summer can be calculated in the same way as for winter, except the Solar Air Temperature is used instead of the outside ambient air temperature.

The maximum Solar Air Temperature of a dark wall surface facing west is approximately 56°C/100°F higher than the outside ambient air temperatures. A white wall surface is only 28°C/50°F higher.

Expansion and contraction of dark coloured wall elements can be affected by direct solar exposure when facing east, south or west. Ensure that adequate thermal expansion joints are provided in the wall.

INSULATION CONSIDERATIONS

The primary function of thermal insulation in exterior walls is to reduce heat flow and maintain desired inside air temperatures in winter and summer. Interior comfort conditions are predicated on maintaining uniform interior temperatures throughout, with inside wall air temperatures that are no more than 3°C (5°F) lower than room air. If this temperature differential is exceeded, occupants feel chilled and uncomfortable working near exterior walls.

The installed position of insulation in exterior walls is an important consideration. To avoid possible air pockets and spaces between the insulation and the wall, one must ensure that insulation is properly installed. Improper installation will reduce thermal efficiency.

The location of insulation within the wall influences the temperature range each element is subjected to throughout the year.

AIR LEAKAGE AND BARRIERS

A certain amount of air exchange between the indoor and outdoor environments is necessary in order to control indoor air quality. The amount varies from building to building depending on such factors as size, type of occupancy, humidity and pollutants. However, for any given building there is a desirable amount of air exchange, usually accomplished with mechanical ventilation systems.

Air leakage is uncontrolled movement of air through walls - both into a building (infiltration) and out (exfiltration). Pressure differences causing infiltration and exfiltration are produced by wind, chimney effect, and mechanical ventilating systems.

Air leakage occurs as a result of air pressure differences. This wind effect and the difference between inside and outside temperatures can create a chimney effect in high rise buildings. Chimney effects can produce air infiltration at the lower levels and air exfiltration at the upper levels. Continuous air barriers at corners of buildings are essential to resist greatly increased wind pressures. Although the volume of air involved may not be significant in terms of heating and ventilating the building, the amount of moisture carried out by air from inside a humidified building may be large enough to cause trouble.

The air barrier must be designed to withstand the combined forces of wind, chimney effects and mechanical imbalances imposed on the assembly in much the same way a window resists such forces. (Figure 1.0) To accomplish this, a set of building elements (not necessarily composed of the same materials), must be linked continuously within the building envelope. This requirement will prevent the passage of outside air into the building, or inside air out of the building. The air barrier assembly should be designed and considered as a separate and distinct function of any wall or roof assembly. It can be formed from materials used to perform other functions but only if all requirements of both functions are met.

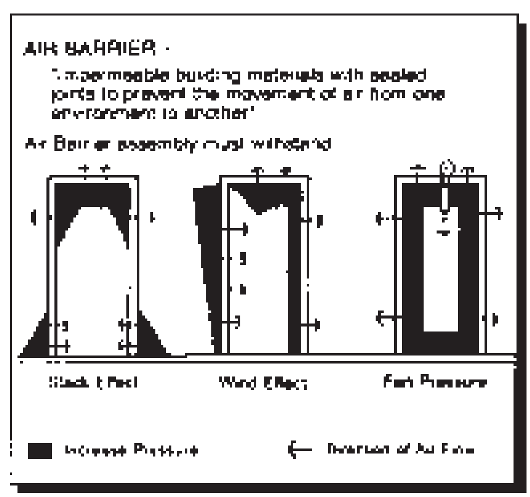


Figure 1.0 Air Barrier Design

Air Barrier Assembly

Based on the best information available, the air barrier assembly should meet the following criteria:

1. It should support and transfer to the structure of the building, any air pressure (e.g. wind loads) acting inwardly or outwardly. The assembly of components should be designed to support this pressure without rupturing, tearing or coming free of its attachment.

2. The materials used as an air barrier should be as "air impermeable" (not necessarily vapour-impermeable) as possible e.g. gypsum board, plywood, concrete, reinforced sheet membrane.

3. It may not be possible to achieve complete air tightness. To avoid a concentration of air leakage, there should be no visible openings, cracks, fissures or holes anywhere on the surface of the air barrier.

4. The air barrier assembly should be rigid so that when subjected to air pressure difference, it can develop a resistance to excessive deflection and span over any openings.

5. The joints between different elements of the air barrier assembly may be flexible. However, they should meet criteria 1, 2 and 3 outlined above.

6. It should perform for the expected life of the building: alternatively provision made to maintenance or replacement.

VAPOUR DIFFUSION AND VAPOUR RETARDERS

Vapour diffusion is a result of vapour pressure difference which causes water vapour molecules to migrate through most materials. The amount of water vapour entering the wall will depend upon the permeance of the wall assembly and the pressure difference between the inside and outside air.

ASHRAE Fundamentals, provides complete data and methods of calculating vapour flow, including examples of walls with interior and exterior insulation.

The function of a vapour retarder is to reduce the diffusion of water vapour. Diffusion is a process by which water molecules permeate through building materials. In Ontario this is generally from the inside of the building to the outside. Speciality constructions and seasonal climate variations may reverse this direction of flow. All building materials offer some resistance to water-vapour diffusion; some materials offer more resistance than others.

The most common available vapour retarders include:

- Polyethylene or vinyl films
- Asphalt coated felts and papers
- Metal foils, copper or aluminium
- Foil/kraft laminates
- Paints and coatings

Important considerations when selecting a vapour retarder in addition to vapour permeability include: tensile strength, tear resistance, pliability under freeze-thaw or wetting and drying conditions.

RELATIVE HUMIDITY AND CONDENSATION CONTROL

The amount of water vapour that air can hold increases with the temperature of the air. Relative humidity is the percentage of water vapour in the air compared to the maximum amount that the air can hold at a given temperature.

The presence of a vapour retarder will not prevent condensation of water on the outside of the retarder as condensation on the surface is controlled by insulation thickness. The thickness should be selected to raise the surface temperature above the dew point.

Since the ability of air to hold water vapour decreases as temperature decreases, a point can be reached where the temperature is cool enough for the water vapour to condense into moisture. This temperature is known as the Dew Point.

DEW POINT

The actual dew point location within exterior wall construction is important. Should the freezing plane be located within the wall elements, serious damage can result from ice lensing expansion and produce wall deterioration and failure.

Thermal Bridges

Thermal bridges are components with relatively low thermal resistance which "bridge" through the insulation layer of the building envelope. The unavoidable small thermal bridges (ties, hangers, shelf angles, insulation fasteners) do not contribute significantly to overall heat losses or gains. They should be placed or detailed to avoid lowering temperatures at the interior surface of other places where condensation and related corrosion or other degradation may occur.

Problems may arise with large thermal bridges such as structural floor, cross wall and partition penetrations through the insulation plane. A serious thermal bridge infraction occurs when the design has the floor slab extending beyond the exterior wall to form the balcony slab (figure 2.0). Actual wintertime temperature measurements on large thermal bridges, such as concrete slabs and cross-walls bridging the interior side insulation, show that interior surface temperatures at these points are as much as 21°C/70°F below the average temperature of surrounding surfaces.

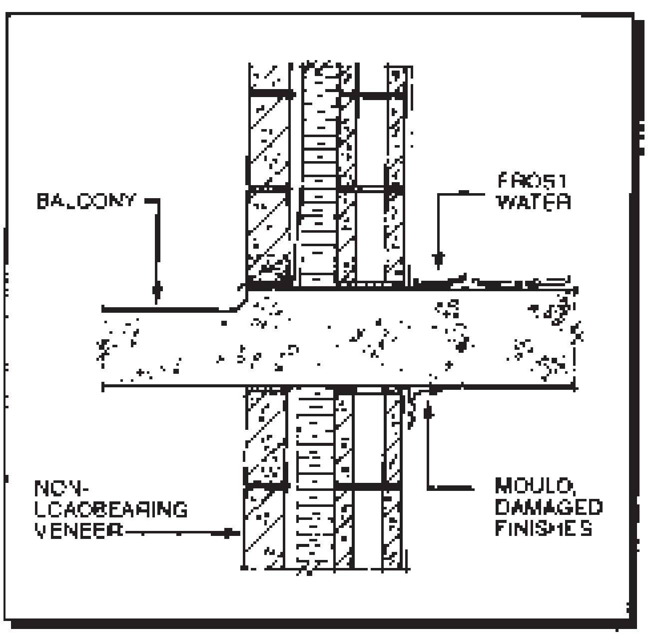


Figure 2.0
Effect of thermal bridge when indoor relative humidity is appreciable (above 20% RH in mid-winter)

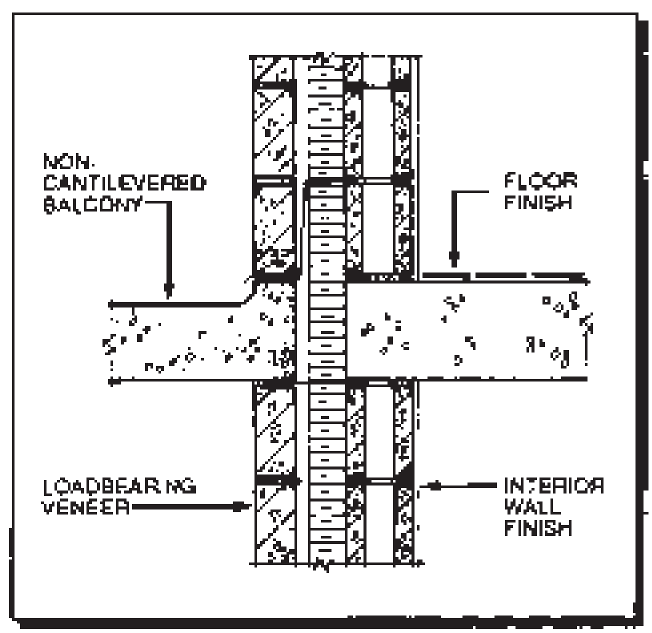


Figure 3.0
Balconies supported from ground

Masonry Walls

DESCRIPTION

Concrete block walls are designed to:

- Resist Rain Penetration
- Control Heat Flow
- Resist Wind Pressure
- Resist Fire
- Control Water Vapour and Air Flow
- Control Noise
- Carry Compressive Loads
- Accommodate Building Movements
- Be Aesthetically Pleasing

In the case of masonry cavity wall construction the wall consists of inner and outer wythes, separated by an air space.

The inner wall (wythe) may be loadbearing, supporting the floors and roof, or may simply be an infill wall. It is tightly sealed to prevent movement of air and water vapour, and is provided with a vapour retarder to prevent water vapour diffusion. The inner wythe is insulated to prevent heat loss in winter and heat gain in summer.

The outer wall (wythe) assists the inner wythe in resisting lateral loads such as wind pressure and protects the inner wythe from the elements.

Good detailing and execution of vents and weepholes prevent moisture from penetrating the inner wall assembly.

All windows, doors, or other openings are tightly sealed to the inner wythe to complete the air barrier. The bottom of the cavity and above all window and door openings are flashed and weep holes are installed to drain any water which may have penetrated to the airspace.

WALL ELEMENTS

Outer Wythe - Concrete Block

Insulation - Select thickness to achieve desired overall thermal resistance. Insulation should be placed in the wall cavity along with an air space. It should be carried over the face of columns and beams to avoid thermal bridges and to protect the structure from temperature differences which would cause the various materials to expand and contract at different rates.

Where additional thermal resistance is desired, insulation may be added to the interior surface of the inner wythe or placed in the unit cores.

Vapour Retarder - If additional insulation is used on the interior of the inner wythe, a vapour retarder should be placed on the warm side of the insulation.

Air Barrier - Is continuous throughout the assembly by caulking and sealing the interior gypsum board assembly, including all penetrations. Alternatively, cement parging can be utilized on the inner wythe of the cavity, taking care to seal all gaps in the wythe. Sheet membranes may also be employed.

Inner Wythe - The use of concrete block, either loadbearing or non-loadbearing when structural rigidityis required for the framing members.

TABLE 6.A
THERMAL RESISTANCE VALUES (R VALUES) FOR VARIOUS CONSTRUCTION MATERIALS

Except where noted, the following values are taken from the model National Energy Code, Table C-2, Thermal Properties for Building Materials.

All values are given in $m^2 \cdot {}^oC/W$

DESCRIPTION	THERMAL RESISTANCE PER mm	THERMAL RESISTANCE FOR THICKNESS LISTED
Air Surface Films		
Still Air: Interior Surface		0.120
Moving Air: (6.7 m/s) Exterior 24Km/h		0.030
Air Spaces: -Faced with Non-reflective Materials- 12 mm Minimum Dimension		
Vertical Space: Heat Flow Horizontal		0.171
Air Spaces Less than 12 mm in Minimum Dimension		0
Air Spaces: -Faced with Reflective Materials*- 12 mm Minimum Dimension		
Vertical Space: Faced 1 Side - Heat Flow Horizontal		0.465
Vertical Space: Faced 2 Sides - Heat Flow Horizontal		0.480
Air Spaces Less than 12 mm in Minimum Dimension		0
Insulation		
Mineral Fibre (range 0.024-0.028)	0.026	
Cellulose Fibre	0.0253	
Vermiculite	0.015	
Expanded Polystyrene		
- TYPE 1	0.026	
- TYPE 2	0.028	
- TYPE 3	0.030	
- Extended Polystyrene	0.035	
Rigid Glass Fibre Roof Insulation	0.0277	
Natural Cork	0.0257	
Rigid Urethane or Isocyanurate Board	0.0420	
Mineral Aggregate Board	0.0182	
Fibreboard	0.0194	
Phenolic Thermal Insulation	0.0304	

NOTE: * These values may not be used in calculations for areas where the mean annual total degree days exceed 4400 Celsius degree days.

TABLE 6.A CONTINUED DESCRIPTION	THERMAL RESISTANCE PER mm	 FOR THICKNESS LISTED
Concrete Block: Rectangular Core, O.C.B.A. Metric Sizes **Normal Density (2100 kg/m3)**		
No Insulation in Cores		
- 90 mm		0.17
- 140 mm		0.19
- 190 mm		0.21
- 240 mm		0.24
- 290 mm		0.26
Cores Filled with Vermiculite		
- 90 mm		---
- 140 mm		0.40
- 190 mm		0.51
- 240 mm		0.61
- 290 mm		0.69
Low Density (1700 kg/m3		
No Insulation in Cores		
- 90 mm		0.24
- 140 mm		0.30
- 190 mm		0.32
- 240 mm		0.33
- 290 mm		0.41
Cores filled with Vermiculite		
- 90 mm		---
- 140 mm		0.58
- 190 mm		0.81
- 240 mm		0.98
- 290 mm		1.06
Sheathing Materials		
Softwood Plywood	0.0087	
Particle Board	0.0087	
Insulating Fibreboard Sheathing	0.016	
Gypsum Sheathing	0.0061	
Sheathing Paper		0.011
Asphalt Coated Kraft Paper Vapour Barrier		Negligible
Polyethylene Vapour Barrier		Negligible
Interior Finish Materials		
Gypsum Board, Gypsum Lath	0.0062	
Gypsum Plaster, Sand Aggregate	0.0014	
Gypsum Plaster, Lightweight Aggregate	0.0044	
Plywood	0.0087	
Hard-Pressed Fibreboard	0.0050	
Insulating Fibreboard	0.0165	
Mat-Formed Particleboard	0.0087	

TABLE 6.B
VAPOUR RESISTANCE VALUES OF VARIOUS MATERIALS

MATERIAL	THICKNESS (mm)	VAPOUR RESISTANCE (Pa•m2•s/ng	VAPOUR RESISTANCE PER mm
Plastic and Metal Foils and Films			
Aluminum Foil	0.025		
Aluminum Foil	0.009	0.35	
Polyethylene	0.05	0.11	21 114.
Polyethylene	0.10	0.22	21 114.
Polyethylene	0.15	0.30	21 114.
Polyethylene	0.20	0.44	21 114.
Polyethylene	0.25	0.58	21 114.
Polyvinylchloride, unplasticized	0.05	0.026	
Polyvinylchloride, plasticized	0.10	0.013-0.023	
Polyester	0.025	0.025	
Polyester	0.008	0.075	
Polyester	0.02	0.22	
Cellulose acetate	0.25	0.0035	
Cellulose acetate	3.18	0.054	
Construction Materials			**(x 10^{-4})**
Concrete (1:2:4 mix)			2.11
Brick Masonry	102.0	0.023	
Concrete Block (cored, limestone aggregate)	203.0	0.007	
Tile Masonry, glazed	102.0	0.145	
Asbestos Cement Board	3.05	0.0018-0.0036	
With Oil Finishes		0.035-0.07	
Plaster on metal lath	19.0	0.0012	
Plaster on wood lath		0.0016	
Plaster on plain gypsum lath (with studs)		0.0009	
Gypsum wall board (plain)	9.5	0.00035	
Gypsum Sheathing (asphalt impreg.)	12.7		0.341
Structural insulating board (sheathing qual.)			0.136-0.341
Structural insulating board (interior, uncoated)	12.7	0.00019-0.00035	
Hardboard (standard)	3.18	0.0016	
Hardboard (tempered)	3.18	0.0035	
Wood, sugar pine			1.29-17.03
Plywood (douglas fir, exterior glue)	6.35	0.025	
Plywood (douglas fir, interior glue)	6.35	0.009	
Acrylic, glass fibre reinforced sheet	1.42	0.145	
Polyester, glass fibre reinforced sheet	1.22	0.035	
Thermal Insulations			
Air (still)			0.057
Cellular glass			∞
Corkboard			2.59-3.27
Mineral wool (unprotected)			0.059
Expanded polyurethane ((r-11 brown) board stock			4.22-17.03
Expanded Polystyrene - extruded			5.65
Expanded Polystyrene – bead			1.16-3.4
Phenolic foam (covering removed)			0.259
Unicellular synthetic flexible rubber foam			45.6-340.6

Tang G. Lee, MRAIC

Introduction

Solar space heating in Canada is not widespread due to its high capital cost.The intermittent and diffuse nature of solar radiation requires large apertures to collect solar heat, and large storage mass for heat storage. One of the most important challenges of the solar heating industry is to reduce the base component cost for solar heating systems.

This article describes an innovative approach to heat storage using concrete block walls. Significant cost savings are realized when the block wall also serves as a necessary fire separation or a structural element in a building. The concept is referred to as a "building integrated" solar heating system, rather than the traditionally and more costly "component based" system.

Tang G. Lee *is a professor in the Faculty of Environmental Design at The University of Calgary. He maintains a small architectural practice specializing in energy conserving designs and solar heating. He is frequently called upon to testify as an expert witness in civil and criminal courts on matters pertaining building sciences and other construction matters.*

Solar Heat Storage

Trombe Walls Are Ineffective In Cold Climates

Traditional use of masonry walls for solar heat storage is primarily based on the "Trombé" wall concept that was developed in Europe. A massive wall is positioned behind a south facing window where it intercepts heat from the sun. At night the warmed wall radiates heat into the building to counteract heat loss. In cold climates however, more heat is radiated back out the window because the window surface temperature is colder than the interior room temperature. To be effective the window must be better insulated than double glazing. Insulated shutters between the masonry wall and window will reduce the radiant heat loss back out through the window, but current technology is expensive and prone to failure.

The Trombe wall therefore is not suitable for cold climates (Lawand, 1978).

Solar Heat Storage In Concrete Block Walls

Walls used for heat storage must be positioned away from the thermally weak windows to reduce radiant heat loss to the outside. In a remote location, the block wall is able to effectively radiate heat into the building rather than to the exterior.

Calgary Chinese Alliance Church

In 1981, the first Canadian application of a building integrated solar heating system for heat storage was in the Calgary Chinese Alliance Church (Figure 1.0). Solar heat is stored in concrete block walls positioned on the inside of north walls (Lee, 1983b).

The 3000m2 building is constructed as a rain screen masonry wall assembly. The following materials were used:

- 200mm concrete block (interior)
- air barrier
- 100mm rigid insulation
- 50mm air gap
- 100mm face brick (exterior)

Natural gas consumption for the church is 2/3 less per year than churches of similar size and function. With these savings the solar system has paid for itself in a period of 4 1/2 years.

Figure 1.0 Calgary Chinese Alliance Church

Solar Heat Storage

The interior concrete block walls are used as a finishing material, structural wall and for storing solar heat. The interior concrete blocks used were the readily available vertically scored pattern to simulate 100mm x 100mm wall tiles (Figure 2.0). The blocks were stack-bonded to ensure the cores would line up vertically. Blocks with fully grouted cores and bond beams occur only where structural needs deemed it necessary. As such the design and construction of the block wall is no different than that currently in practise.

Air which had been heated by the solar collectors is ducted to the block wall. Lintel block (200mm x 200mm) positioned on its edge, were used at top and bottom of the wall. This technique allowed the solar heated air to enter the wall (Figure 3.0) by means of a `C' shaped heater air duct (Figure 4.0). Depending on the time of year, the forced air travels down and out through the bottom.

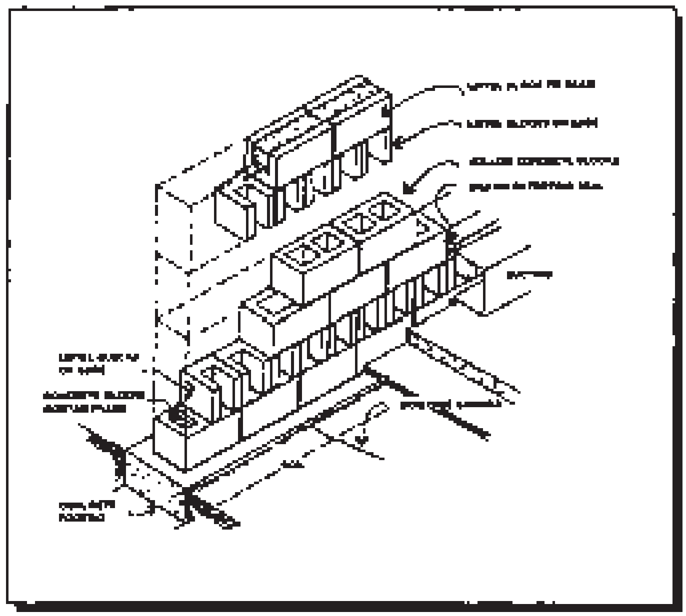


Figure 2.0 Interior Concrete Block Wall (Lee Residence)

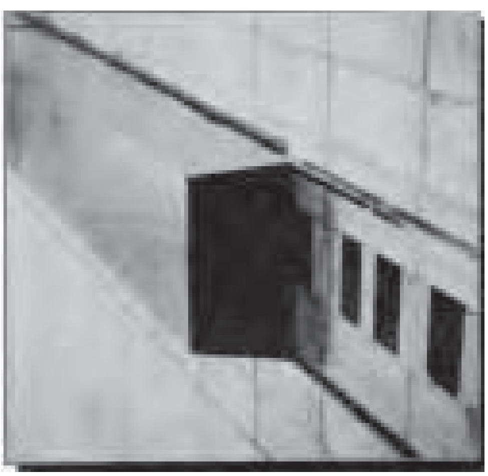


Figure 4.0 `C' Shaped Heater Duct

Figure 3.0 Solar Heat Air Duct (Alliance Church)

Solar Heat Storage

As the hot air migrates through the hollow cores, heat is transferred to the blocks. Exhausted air is at room temperature, indicating that the heat was successfully extracted and stored in the block wall (Figure 5.0). Thermographic scans of the block wall show progressive transfer of heat in the block walls (Lee, 1984).

In the Chinese Alliance Church, there was the opportunity to experiment with filling the cores of the concrete blocks to increase thermal storage and extend lag time between thermally charging the wall and heating the building.

In one of the experimental wall panels, high water ratio concrete filled every other hollow core. In another wall section, the alternate cores were filled with sand. Tests indicate there is very little difference in storage capacity and thermal lag time between the two walls (Lee, 1984). The additional thermal mass took longer before it started to radiate heat into the building, thus more suitable for this type of application and building occupancy.

A computer simulation (Byrne, and Lee, 1986) of the masonry heat storing walls suggests a minimum ratio of 2:1 for wall surface area (for alternate filled cores) to solar collector area or, window area. With cores not filled the ratio should be 4:1 for a concrete block wall to a solar collector or sunspace area.

If the ratio of 5:1 wall area to solar collector is exceeded, the rate of radiant heat loss from the block wall will be compromised.

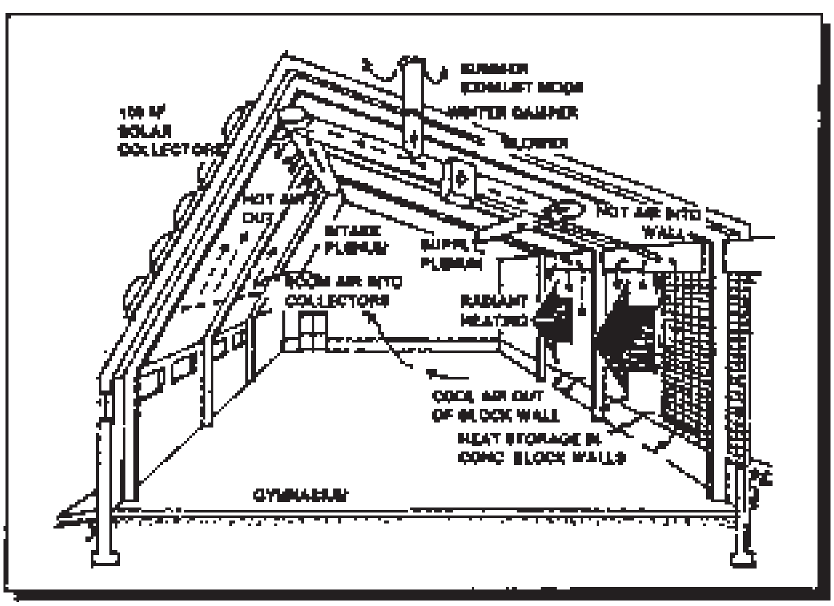


Figure 5.0 Solar System Dynamics (Alliance Church)

Table A
RULES of THUMB for STORAGE GEOMETRY

DESIGN CRITERIA	CONSTRUCTION TECHNIQUES
Thickness	100mm to 200mm thick walls; down to 50mm acceptable with large surface wall area
Surface Area	4 times the aperture when cores not filled or 2 times the aperture for alternate core filled wall
Air Distribution	as evenly distributed as possible
Orientation	vertical walls preferred; horizontal position required more mass on top
Location	interior of building away from windows; lower level preferred
Air Flow	11 e/s per m^2 of aperture (collector)

Table B
SIZING RULES for SOLAR COLLECTOR

ITEM	RULE
Aperture	$1m^2$ per 800 - 1200 kJ(^{0}C.day) of load
Storage	800 - 1200 kJ/^{0}C per m^2 of glazing

Sandstone Valley Ecumenical Centre

Figure 6.0 Sandstone Valley Ecumenical Centre

Other buildings have been designed by the author which incorporate the concrete block walls as an architectural element and to store solar heat. A recent example is the 3 200m^2 Sandstone Valley Ecumenical Centre. This is a Catholic and Lutheran church built in 1988. In this building, the solar heated air is generated by vertical south facing solar collectors which appear to be windows (Figure 6.0). The solar collectors use curtain wall technology which was site installed at the time of construction (Lee, 1987).

Solar heated air is ducted to the northern section of the church where it is stored in a large concrete block wall. This wall is strategically located to provide the necessary fire separation between the gymnasium and the nursery (Figure 7.0). In addition to serving as a solar heat storage and fire separation, this block wall also has a structural responsibility which is to support two floors and the roof. Lintel blocks laid on edge were used again to provide entry to the hollow cores of the block wall. In addition to space heating, the solar system is used to preheat water.

Summer Cooling

During the summer, the concrete blocks can be used to cool the building. Using the same components for solar heating, cool night air is ducted through the block walls. The blocks are thus cooled throughout the night. The cooled block walls provide a large thermal mass to keep the building cool throughout the hot summer day. A simple timer turns on the fan at night and off at sunrise. The amount of electricity consumed by the fan is considerably less than what is consumed by an air conditioner. In addition, the fan uses electricity during off-peak hours, i.e. Midnight to 6:00AM.

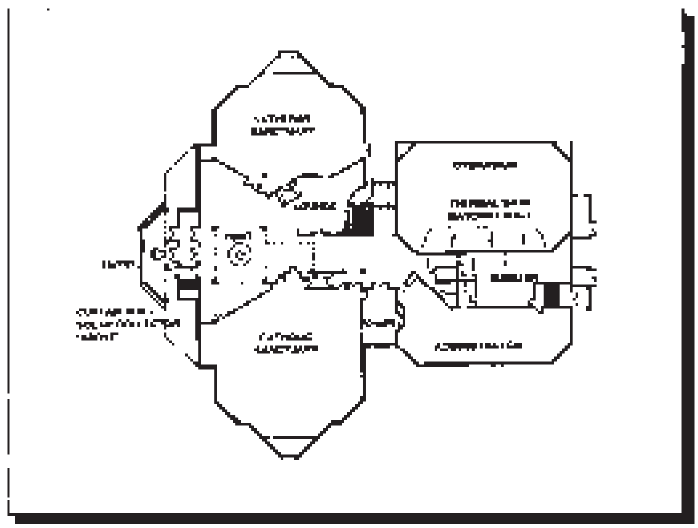


Figure 7.0 Ground Floor Plan (Ecumenical Centre)

Conclusion

Concrete blocks with hollow cores can be used as an air plenum. When air travels through the blocks, heat can be transferred to the blocks or extracted for cooling purposes. The advantages of using the concrete block wall as thermal storage is that it is essentially achieved at no additional cost to the building owner. This assumes the architect strategically positions the block wall to also serve as a structural component, for fire separation or for sound separation purposes.

Whereas traditional solar heat storage dedicates material strictly for heat storage and it occupies valuable interior space, the block walls described here do not require such additional space. The buildings featured here demonstrates the effective use of concrete blocks for solar heat storage.

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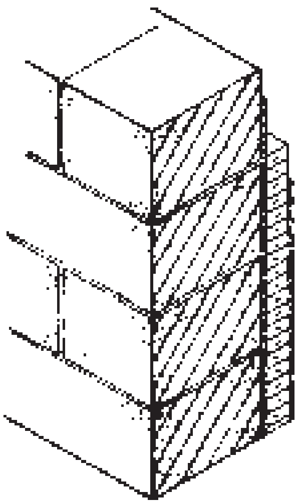
Solar Heat Storage

Wall Components



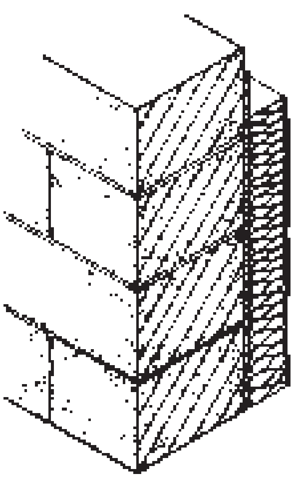
WALL COMPONENTS	RSI VALUE	R VALUE
OUTSIDE AIR FILM	0.03	0.17
25cm ARCHITECTURAL BLOCK C/W INSULATION IN CORES	0.61	3.47
AIR BARRIER PARGING	0.17	0.97
51mm POLYURETHANE INSULATION	2.20	12.5
13mm GYPSUM WALL BOARD	0.08	0.45
INSIDE AIR FILM	0.12	0.68
TOTAL	3.21	18.24

PROJECT

THERMAL RESISTANCE-SINGLE WYTHE WALL

BLOCK TYPE

25cm ARCHITECTURAL



WALL COMPONENTS	RSI VALUE	R VALUE
OUTSIDE AIR FILM	0.03	0.17
25cm ARCHITECTURAL BLOCK C/W INSULATION IN CORES	0.61	3.47
AIR BARRIER PARGING	0.17	0.97
75mm RIGID FIBROUS GLASS INSULATION C/W VAPOUR BARRIER	2.20	12.5
13mm GYPSUM WALL BOARD	0.08	0.45
INSIDE AIR FILM	0.12	0.68
TOTAL	3.21	18.24

PROJECT

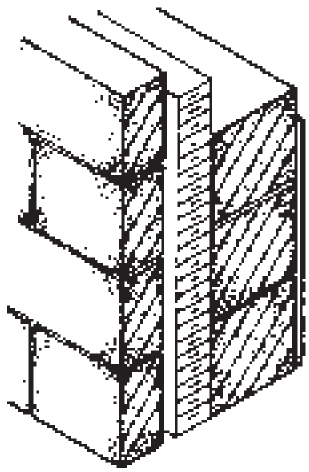
THERMAL RESISTANCE-SINGLE WYTHE WALL

BLOCK TYPE

25cm ARCHITECTURAL

Solar Heat Storage

Wall Components



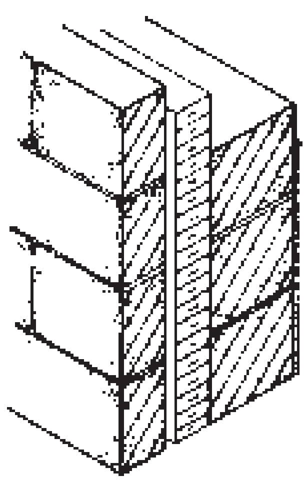
WALL COMPONENTS	RSI VALUE	R VALUE
OUTSIDE AIR FILM	0.03	0.17
10cm ARCHITECTURAL BLOCK	0.17	0.97
25mm AIR SPACE	0.17	0.97
75mm EXPANDED POLYSTYRENE	2.10	11.93
AIR BARRIER	—	—
20cm CONCRETE BLOCK	0.21	1.19
13mm AIR SPACE	0.17	0.97
13mm GYPSUM BOARD	0.08	0.45
INSIDE AIR FILM	0.12	0.68
TOTAL	3.05	17.33

PROJECT

THERMAL RESISTANCE-RAINSCREEN WALL

BLOCK TYPE

10cm ARCHITECTURAL
20cm NW HOLLOW



WALL COMPONENTS	RSI VALUE	R VALUE
OUTSIDE AIR FILM	0.03	0.17
10cm ARCHITECTURAL BLOCK	0.17	0.97
25mm AIR SPACE	0.17	0.97
75mm RIGID FIBROUS GLASS INSULATION	2.20	12.5
AIR BARRIER	—	—
20cm LW CONCRETE BLOCK	0.30	1.70
13mm GYPSUM BOARD	0.08	0.45
INSIDE AIR FILM	0.12	0.68
TOTAL	3.07	17.44

PROJECT

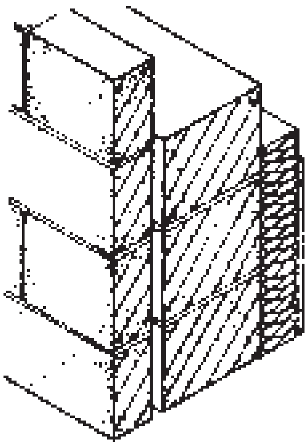
THERMAL RESISTANCE-RAINSCREEN WALL

BLOCK TYPE

10cm ARCHITECTURAL
20cm LW HOLLOW

Solar Heat Storage

Wall Components



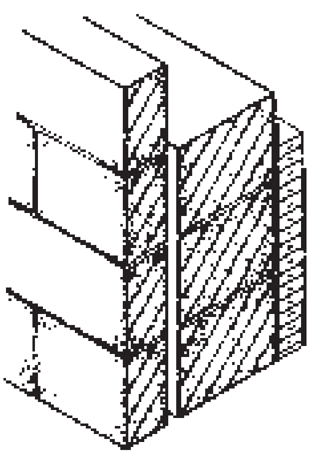
WALL COMPONENTS	RSI VALUE	R VALUE
OUTSIDE AIR FILM	0.03	0.17
10cm ARCHITECTURAL BLOCK	0.17	0.97
25mm AIR SPACE	0.17	0.97
20cm NW CONCRETE BLOCK C/W INSULATION IN CORES	0.51	2.91
AIR BARRIER	—	—
75mm RIGID FIBROUS GLASS INSULATION C/W VAPOUR BARRIER	2.20	[illegible]
16mm GYPSUM BOARD	0.08	0.45
INSIDE AIR FILM	0.12	0.68
TOTAL	3.30	18.75

PROJECT

THERMAL RESISTANCE-COMPOSITE WALL

BLOCK TYPE

10cm ARCHITECTURAL
20cm NW HOLLOW



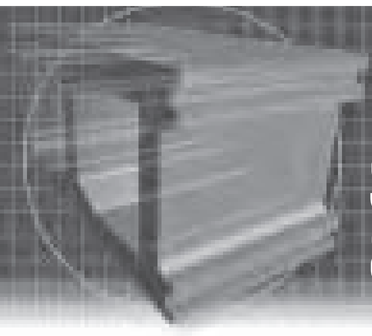
WALL COMPONENTS	RSI VALUE	R VALUE
OUTSIDE AIR FILM	0.03	0.17
10cm ARCHITECTURAL BLOCK	0.17	0.97
25mm AIR SPACE	0.17	0.97
20cm NW HOLLOW C/W INSULATION IN CORES	0.51	2.90
13mm PARGING AIR BARRIER	0.17	0.97
51mm POLYURETHANE	2.20	12.4
13mm GYPSUM BOARD	0.08	0.45
INSIDE AIR FILM	0.12	0.68
TOTAL	3.45	19.61

PROJECT

THERMAL RESISTANCE-COMPOSITE WALL

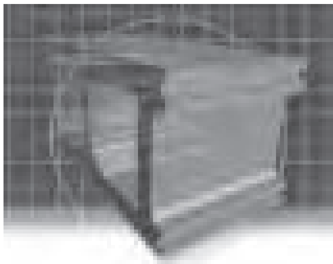
BLOCK TYPE

10cm ARCHITECTURAL
20cm NW HOLLOW



Canadian Concrete Masonry Producers' Association

Sound Properties & Design Details



SOUND TRANSMISSION CLASS RATINGS

The difference in sound (noise) levels from one side of a wall to the other indicates the sound transmitted loss through the wall. For example, if the sound generated inside a room is 80 decibels (db) and 30 db is measured on the other side of the wall (adjoining room), then a reduction of 50 db is achieved.

Acoustic tests relate sound loss through a wall at various frequencies. The results are averaged to provide a single absolute value number. This rating system is necessary when one wishes to compare other wall systems with a specific wall design. This absolute value is known as Sound Transmission Class (STC).

The Ontario Building Code requires an STC rating of 50 as a minimum acceptable value, and STC 55 in specific areas. Due to the changing life styles i.e. condominium living, many builders prefer to design for STC 55 or more if end users are demanding and willing to pay for a higher quality of accommodation.

In addition to the above reasons for selecting a higher STC level, STC findings are based on laboratory results under ideal working conditions. On-site construction conditions are not the same therefore wall assemblies constructed in the field may be significantly less than laboratory ratings.

Lower ratings may result from sound leaks,(a hole representing less than 0.01% of total wall area can reduce the sound blocking ability of the wall from 50 db to 22 db or 56% reduction in performance), departure from design, poor workmanship, damaged materials(s) etc.

Changes to wall construction should not be made based on "gut" feeling without consulting an acoustic professional. Adding extra layers of material, i.e. drywall, to an assembly to reduce sound transmission can in some cases increase sound transmission.

Table 7.1
SOUND TRANSMISSION RATINGS FOR CONCRETE BLOCK WALLS

SIZE CODE	CCMPA BLOCK TYPE					
	HOLLOW		75% SOLID		SOLID	
	A or B	Type C or D	Type A or B	Type C or D	Type A or B	Type C or D
10	43	40	45	42	47	45
15	46	43	50	47	52	50
20	50	46	53	51	56	53
25	51	49	56	54	58	56
30	53	50	58	56	58	58

NOTES:
1.0 Sound transmission loss through a barrier (wall) varies with frequency and use of sound absorbing materials.
2.0 Increased separation and sound absorbing material in the cavity adds to the wall performance.
The sound transmission loss of a cavity wall is frequently about 8 db better than a solid wall of equal weight.

STC RATINGS WITH 20 cm HOLLOW AND 15 cm 75% SOLID CONCRETE BLOCK

TABLE 7.2 - INTERIOR FINISH ON BOTH SIDES

CONSTRUCTION TECHNIQUE	STC RATING
G12.7-WF38-GFB38-BLK140-WF38-GFB38-G12.7	57
G16-WF40-GFB38-BLK190-G16	57
GWF40-GFB38-BLK190-WF40-GFB38-G16	59
G16-ZC50-GFB50-BLK190-ZC50-GFB50-G16	64
G16-ZC75-GFB75-BLK190-SS65-G16	66
G16-SS65-GFB65-BLK140(75%)-WF40-GFB38-G13	67
G16-SS65-GFB65-BLK190-SS65-GFB65-G16	72
G16-ZC75-GFB75-BLK190-SS65-GFB65-G16	73

TABLE 7.3 - INTERIOR FINISH ON ONE SIDE

CONSTRUCTION TECHNIQUE	STC RATING
PAI-BLK190-G16	50
BLK190-RC13-GFB19-G16	54
BLK190-WF40-GFB38-G16	55
BLK140(75%)-WF40-GFB38-G13	55
PAI-BLK140(100%)-WF40-GFB38-G13	58
BLK190-ZC50-GFB50-G16	59
BLK190-SS65-GFB65-G16	60
BLK140(75%)-SS65-GFB65-G16	61

TABLE 7.4 - CAVITY WALL SYSTEMS

CONSTRUCTION TECHNIQUE	STC RATING
BLK90-AIR25-GFRP65-BLK90-G16	62
BLK90-AIR125-BLK90-G16	69
BLK90-AIR60-GFB65-BLK90	73
BLK90-AIR60-GFRP65-BLK90-G16	77
BLK90-AIR100-GFRP65-BLK190-G16	79

Abbreviations:

BLK . .Concrete Block
G . . . .Gypsum Board
WF . .Wood Furring
RC . . .Resilient Metal Channel
GFB . .Glass Fibre Batts
PAI . .Paint
ZC . . .Z-bars
SS . . .Steel Studs
AIR . .Air Space
GFRP Glass Fibre Panels (semi-rigid) Cavity Wall Insulation

NOTES:

A. The numbers following the abbreviations indicate the thickness in millimetres; e.g. GFB65 = Glass Fibre Batts 65mm.
B. The systems' components are arranged in sequence.
C. Hollow Concrete Block is referenced unless otherwise noted; e.g. BLK140(75%) = 140mm Concrete Block, 75% Solid.

* Denotes Type A Concrete

Sound Absorption

Sound absorption reduces the sound energy reverberating within a room. The surface of a masonry wall can absorb a certain portion of sound energy rather than reflect the sound. Sound striking the surface of an open textured concrete masonry wall is trapped within the small pores of the block. Tests at different sound frequencies determine the sound absorption coefficient (SAC).

Noise Reduction Coefficient (NRC) is found by averaging the SAC values at frequencies of 250, 500, 1000 and 2000 HZ. The coefficient factor is an indication of the sound absorbing efficiency of a surface. If a surface can absorb 100% of the sound energy, the wall would have a Noise Reduction Coefficient of 1. Similarly, a wall surface absorbing 45% of the initial sound would have a NRC of 0.45. Listed below you will find approximated NRC values for average textured masonry units.

TABLE 7.5 - NRC VALUES FOR CONCRETE MASONRY UNITS

CONCRETE	SURFACE TEXTURE	APPROXIMATE NRC VALUES	DIRECT db LOSS
Type C or D Unpainted	Coarse	0.50	3.00
	Medium	0.45	2.62
	Fine	0.40	2.25
Type A Unpainted	Coarse	0.28	1.50
	Medium	0.27	1.45
	Fine	0.26	1.40

NOTES:

1.0 It should be noted that the principal uses of sound-absorbing materials are for the control of sound within a space and not for the control of sound transmission loss between spaces.

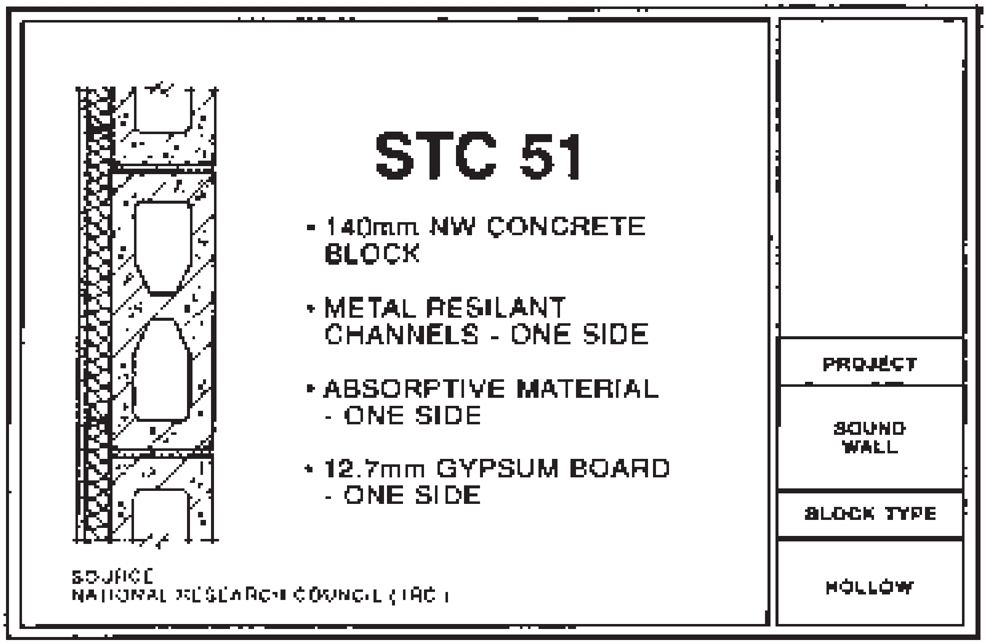
2.0 Selective absorption that matches the frequency of an unwanted sound is obtained by slotting or drilling the face shell of the unit and/or may not require sound absorbing insulation in the block cores.

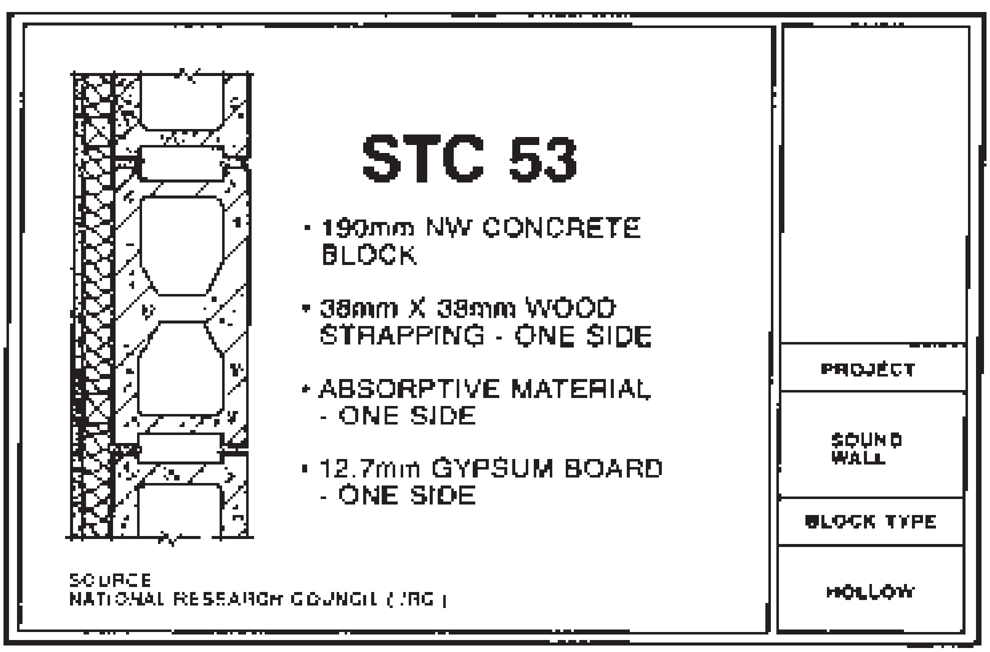
3.0 It is difficult to lose much more than 5 db of sound by absorption.

4.0 A 5 db level decrease of sound within a room will reduce the loudness by 33% (sound pressure level)

5.0 Sound absorption occurs when sound energy is converted to heat energy.

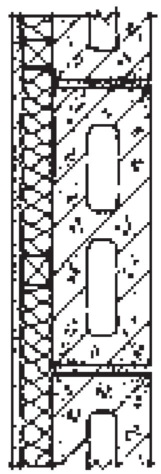
Sound Wall


STC 51
• 140mm NW CONCRETE BLOCK
• METAL RESILANT CHANNELS - ONE SIDE
• ABSORPTIVE MATERIAL - ONE SIDE
• 12.7mm GYPSUM BOARD - ONE SIDE
SOURCE
NATIONAL RESEARCH COUNCIL (IRC)
PROJECT
SOUND WALL
BLOCK TYPE
HOLLOW


STC 53
• 190mm NW CONCRETE BLOCK
• 38mm X 38mm WOOD STRAPPING - ONE SIDE
• ABSORPTIVE MATERIAL - ONE SIDE
• 12.7mm GYPSUM BOARD - ONE SIDE
SOURCE
NATIONAL RESEARCH COUNCIL (IRC)
PROJECT
SOUND WALL
BLOCK TYPE
HOLLOW

Sound Properties & Design Details

Sound Wall

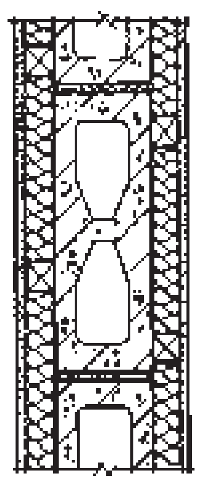


STC 55

- 140mm NW CONCRETE BLOCK
- 38mm X 38mm WOOD STRAPPING - ONE SIDE
- ABSORPTIVE MATERIAL - ONE SIDE
- 12.7mm GYPSUM BOARD - ONE SIDE

SOURCE:
NATIONAL RESEARCH COUNCIL (IRC)

PROJECT
SOUND WALL
BLOCK TYPE
75% SOLID



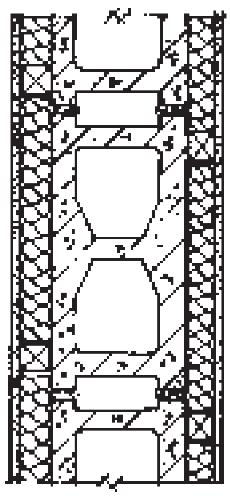
STC 57

- 140mm NW CONCRETE BLOCK
- 38mm X 38mm WOOD STRAPPING - TWO SIDES
- ABSORPTIVE MATERIAL - TWO SIDES
- 12.7mm GYPSUM BOARD - TWO SIDES

SOURCE:
NATIONAL RESEARCH COUNCIL (IRC)

PROJECT
SOUND WALL
BLOCK TYPE
HOLLOW

Sound Wall

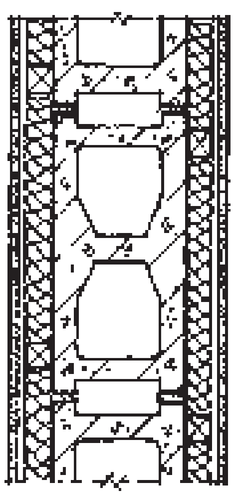


STC 59

- 190mm NW CONCRETE BLOCK
- 38mm X 38mm WOOD STRAPPING - TWO SIDES
- ABSORPTIVE MATERIAL - TWO SIDES
- 12.7mm GYPSUM BOARD - TWO SIDES

SOURCE
NATIONAL RESEARCH COUNCIL (IRC)

PROJECT	SOUND WALL
BLOCK TYPE	HOLLOW



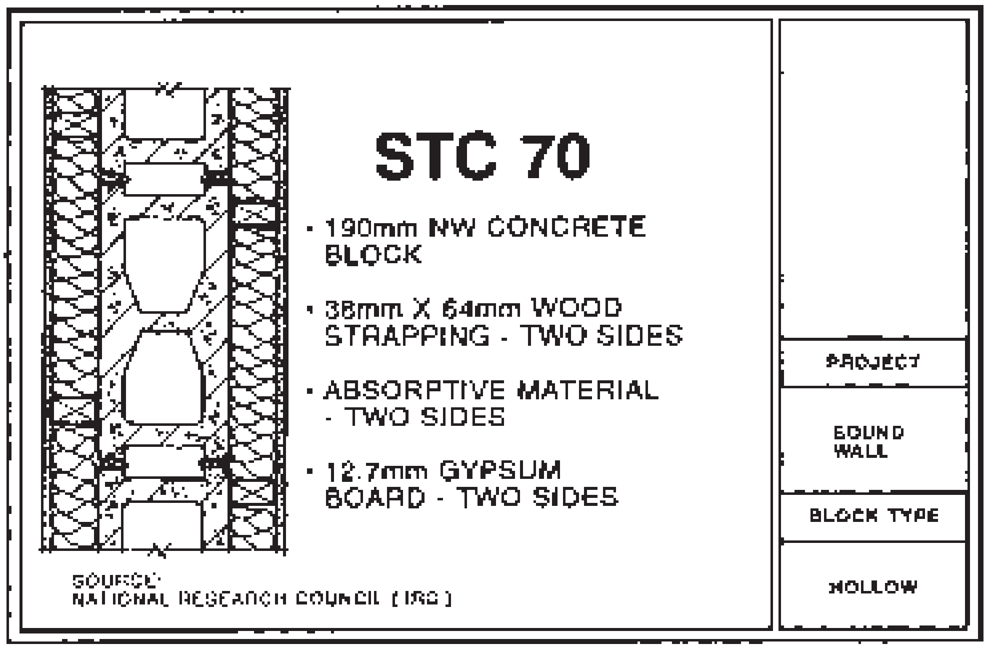
STC 64

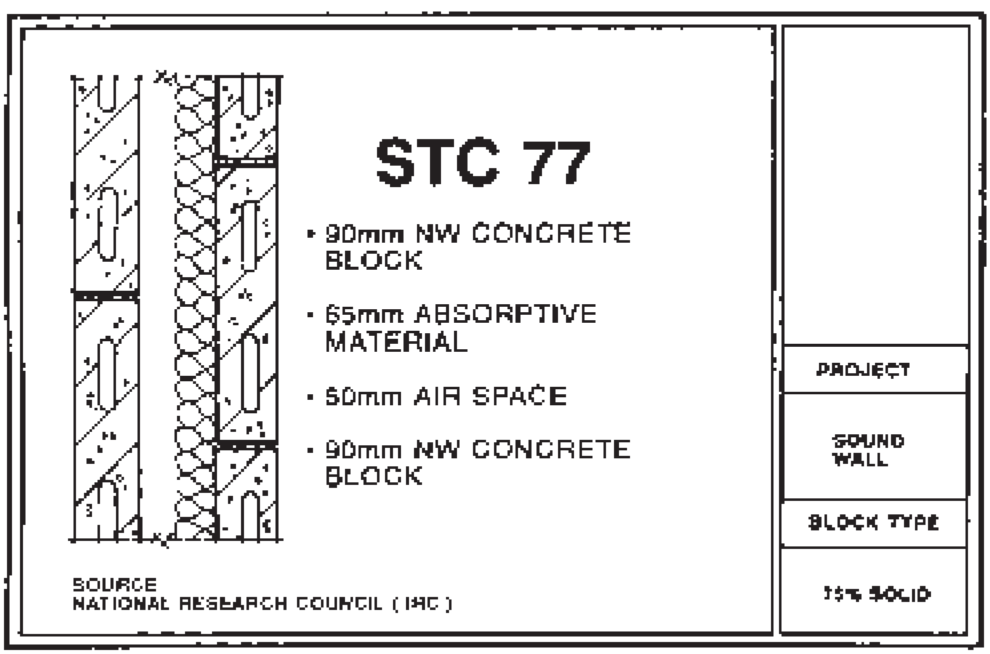
- 190mm NW CONCRETE BLOCK
- 38mm X 38mm WOOD STRAPPING PLUS RESILIENT CHANNELS - TWO SIDES
- ABSORPTIVE MATERIAL - TWO SIDES
- 12.7mm GYPSUM BOARD - TWO SIDES

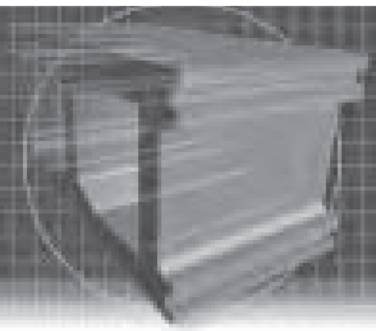
SOURCE
NATIONAL RESEARCH COUNCIL (IRC)

PROJECT	SOUND WALL
BLOCK TYPE	HOLLOW

Sound Wall


STC 70
• 190mm NW CONCRETE BLOCK
• 38mm X 64mm WOOD STRAPPING - TWO SIDES
• ABSORPTIVE MATERIAL - TWO SIDES
• 12.7mm GYPSUM BOARD - TWO SIDES
SOURCE:
NATIONAL RESEARCH COUNCIL (IRC)
PROJECT
SOUND WALL
BLOCK TYPE
HOLLOW


STC 77
• 90mm NW CONCRETE BLOCK
• 65mm ABSORPTIVE MATERIAL
• 50mm AIR SPACE
• 90mm NW CONCRETE BLOCK
SOURCE
NATIONAL RESEARCH COUNCIL (IRC)
PROJECT
SOUND WALL
BLOCK TYPE
75% SOLID



Canadian Concrete Masonry Producers' Association

Empirical Masonry Design Guidelines

EMPIRICAL DESIGN FOR MASONRY BUILDINGS

INTRODUCTION

The Empirical or Conventional Design for Masonry is based on a simplified analysis of the loads and forces acting on the structure. When this approach is utilized, the limitations of height, load location, seismic zone, wind loading, the size of any openings and lateral support requirements must be considered.
Structures resulting from this type of procedure are often described by such phrases as “deemed to perform based on long-term experience”.
Engineered Analysis, results in a more cost effective structure in many instances and must be used whenever the limitations are exceeded.

This chapter is a commentary on selected details of Clause 16, Masonry Design for Buildings (Limit States Design) S304.1-94 does not purport to be a total design analysis.

The Canadian Concrete Masonry Producers' Association gratefully acknowledges the contributions of the following:

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Canadian Portland Cement Association, Toronto, Ontario

This "Guide" is intended to facilitate the use of concrete block construction in accordance with CSA-S304.1, Masonry Design for Buildings, (Limit States Design) Clause 16

APPLICABILITY

The Empirical Rules can be used for non-reinforced Masonry where:

1. Total height of loadbearing walls above the first storey floor does not exceed 11 metres.

2. Total height of exterior non-loadbearing walls above grade does not exceed 20 metres and the 1 in 30 years wind pressure does not exceed 0.5 kN/m^2. (Refer to Table 2.5.1.1, Ontario Building Code, for applicable data).

3. Foundation walls are not subject to lateral pressure. The Ontario Building Code (9.15) allows limited usage on basis of "deems to" i.e. proven, performance. (See Figure 3.0)

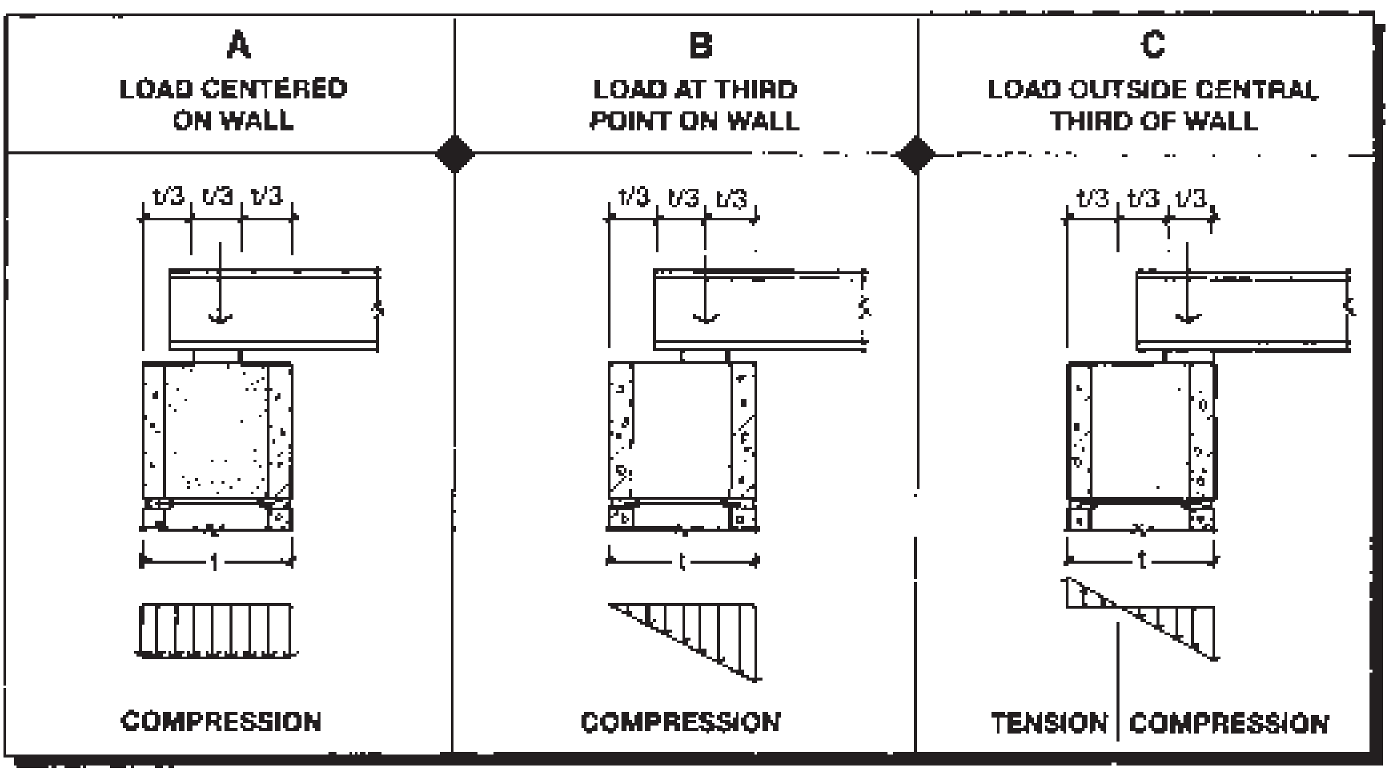
4. The structure is not subjected to lateral pressure other than wind loads.

5. The resultant vertical force of a load falls within the middle third of the wall thickness. (See Figure 1.0)

6. Construction is located within seismic zones 0 and 1. (Refer to Table 2.5.1.1 Ontario Building Code, for applicable data).

7. The Empirical Rules can only be used for plain, non-reinforced masonry. Note that joint reinforcing for bonding or crack control and reinforcing in secondary structural elements such as short span lintels, does not invalidate this design approach.

Figure 1 MIDDLE THIRD RULE



NOTES:
1.0 Conditions `A' and `B' fall within Empirical approach
2.0 Condition `C' requires Engineered Analysis

ALLOWABLE COMPRESSIVE STRESSES

Maximum allowable compressive stresses on masonry, based on gross cross-sectional area, are given in Table 7 in CAN3-S304.1 Where concentrated loads occur, Clause 16.1.6.2 allows maximum stresses to be increased by 25% (But the total load on the masonry cannot exceed value allowable).

Note that the latest specification for concrete block CAN3-A165.1, designates strengths in terms of net area.

TABLE A: MAXIMUM ALLOWABLE COMPRESSIVE STRESS FOR NON-REINFORCED CONCRETE MASONRY BASED ON GROSS CROSS-SECTIONAL AREA (MPa)

WALL TYPES	MORTAR TYPES	
	S	N
SOLID MASONRY 20 MPa & over	1.6	1.4
Solid Unit 12.5 - 20 MPa	1.1	1.0
Hollow Unit 7.5 MPa	0.7	0.6
CAVITY WALL Solid Unit 12.5 MPa	0.9	0.8
Hollow unit 7.5 MPa	0.5	0.4

NOTES:

1.0 For the purposes of Table `A', the conversion from Net to Gross Area strength of standard units is as follows:

See Tables `B' and `C' for allowable loads on standard strength units. 15 MPa net is the standard strength available from CCMPA Members

See Section 11.

UNIT TYPE	NET MPa	GROSS MPa
HOLLOW	15.0	7.5
SOLID	15.0	12.5

2.0 Solid Units with a strength of 20 MPa and over are available on a made to order basis.

3.0 Where masonry is constructed of different types or grades of units or mortar, the allowable stress shall be based on the weakest combination.

4.0 Where the wythes of a cavity wall are of different types of material, it is recommended that only one wythe be loaded. Where only one wythe is loaded, the allowable stress shall be based on the loaded wythe.

TABLE B:
ALLOWABLE LOADS FOR SOLID or SINGLE WYTHE MASONRY
(Standard Strength Concrete Block) (kN/m)

MORTAR TYPE	UNIT TYPE (15 MPa)	ALLOWABLE STRESS MPa	UNIT SIZE 90	140	190	240	290
N	Hollow	0.6	54	84	114	144	174
	Solid 1	1.0	90	140	190	240	290
S	Hollow	0.7	63	98	133	168	203
	Solid 1	1.1	99	154	209	264	319

TABLE C:
ALLOWABLE LOADS FOR LOADED CAVITY WYTHE 2
(Standard Strength Concrete Block) (kN/m)

MORTAR TYPE	UNIT TYPE (15 MPa)	ALLOWABLE STRESS MPa	UNIT SIZE 90	140	190	240	290
N	Hollow	0.4	36	56	76	96	116
	Solid 1	0.8	72	112	152	192	232
S	Hollow	0.5	45	70	95	120	145
	Solid 1	0.9	81	126	171	216	261

NOTES:

1.0 Solid Unit means a structural masonry unit with a net cross sectional area of at least 75% of its gross cross sectional area in any plane parallel to its bearing surface.

2.0 Where the exterior wythe is designed as a veneer, the values in Table `B' may be used for the loadbearing wythe.

**TABLE D:
ALLOWABLE COMBINED LOADS FOR BOTH WYTHES (kN/m)
(Standard Strength Concrete Block)**

MORTAR TYPE	UNIT TYPE (15 MPa)	ALLOWABLE STRESS MPa	WYTHES WIDTH 90 + 90	140 + 140	190 + 190	240 + 240	290 + 290
N	Hollow	0.4	72	92	112	132	152
	Solid	0.8	144	184	224	264	304
S	Hollow	0.5	90	115	140	165	190
	Solid	0.9	162	207	252	297	342

**TABLE E:
ALLOWABLE LOADS FOR HIGH STRENGTH SOLID UNITS
(> 20 MPa)1 (kN/m)**

MORTAR TYPE	ALLOWABLE STRESS MPa	UNIT SIZE 90	140	190	240	290
N	1.4	126	196	266	366	406
S	1.6	144	224	304	384	464

NOTE: 1.0 High strength units are available on a made to order basis only.

**TABLE F:
WALL WEIGHT & MASS FOR STANDARD WEIGHT UNITS (2100 kg/m3)**

MORTAR TYPE	ALLOWABLE STRESS MPa	UNIT SIZE 90	140	190	240	290
WALL MASS (kg/m^2)	Hollow	138	170	223	267	310
	75% Solid	155	235	310	393	475
	Solid	189	294	400	503	609
WALL WEIGHT (kg/m^2)	Hollow	1.35	1.67	2.19	2.62	3.04
	75% Solid	1.52	2.31	3.04	3.85	4.66
	Solid	1.85	2.88	3.92	4.93	5.97

NOTE: 1.0 Wall weight = mass x 9.81 ÷ 1000

Lateral Support

Lateral support must be provided at either horizontal or vertical intervals not exceeding 20 times the actual wall thickness (t) except as follows:

1. For partition walls, lateral support is required at 36t.
2. For cavity walls, the wall thickness shall be based on two thirds (2/3) the sum of both wythes but not less than the thickness of either wythe. This derived effective thickness (t^e) applies irrespective of the loading of the wythes.

Note that raked joints reduce the usable thickness and cannot be used where unit width is less than 90mm.

TABLE G:
HEIGHT & THICKNESS OF SOLID MASONRY1

TYPE OF WALL	HEIGHT/THICKNESS RATIO h/t[2] MAXIMUM h/t[2]	MINIMUM WALL t[3] (mm)	MINIMUM WYTHE t (mm)	MAXIMUM TOTAL HEIGHT
LOADBEARING (Solid or Hollow Units)	20	190	90	11 metres
EXTERIOR NON-LOADBEARING (Solid or Hollow Units)	20	190	75	20 metres
PARTITIONS[4]	36	75	75	72 x actual thickness

NOTES:
1.0 Solid masonry means masonry of solid or hollow units that does not have cavities between the wythes, e.g. single wythe masonry is included in this definition.
2.0 Unsupported height or length of wall between horizontal or vertical lateral supports.

3.0 Minimum thickness may be reduced; the 140mm solid masonry unit can be used
a) in loadbearing applications, the maximum height at eave is 2.8m and 4.6m at the gable (See Figure 2.0)
b) in exterior, non-loadbearing applications, with a maximum height of 3m but Type `S' mortar is required
4.0 Denotes partitions in buildings with small exterior openings or with unbalanced air pressures not exceeding 24 kPa.

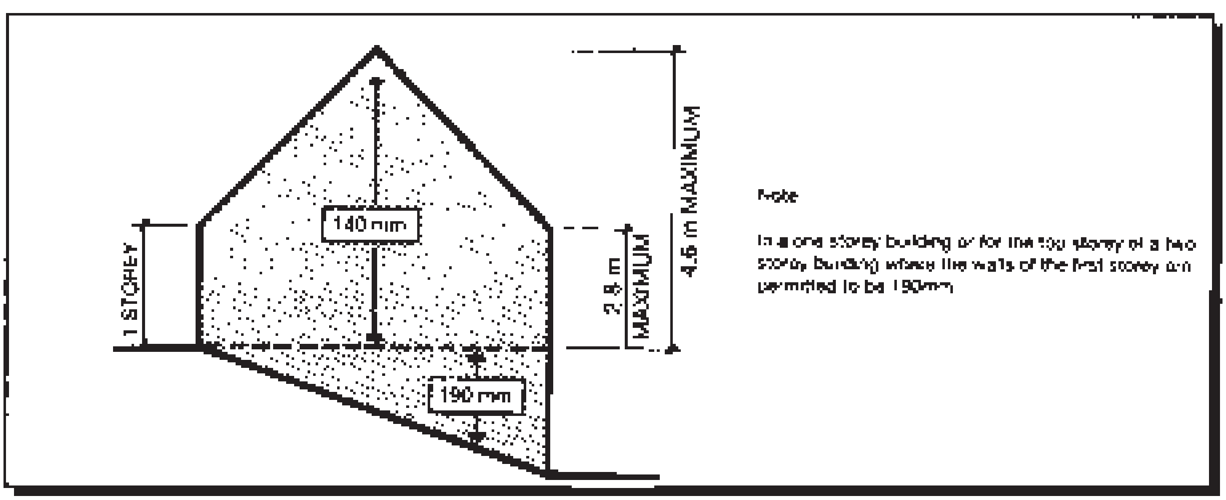


TABLE H:
EFFECTIVE THICKNESS & LATERAL SUPPORT FOR CAVITY WALLS

WYTHES WIDTHS [1]	EFFECTIVE THICKNESS [4] (t^e) (mm)	LATERAL SUPPORT (m)	MAXIMUM BUILDING HEIGHT [3] (m)
90 + 90[3]	120	2.40	11
90 + 140	153	3.06	11
90 + 190	190[2]	3.80	11
90 + 240	240[2]	4.80	11
90 + 290	290[2]	5.80	11

NOTES:
1.0 Other wythe combinations are possible, e.g. 140 and 140mm will produce at te of 186.6mm and allows lateral support at 3.732m.
2.0 Note use of width of thicker wythe to determine te.
3.0 Where both wythes are solid units, one wythe may be 75mm (CAN3-S304, 6.4.4): lateral support is required at 2.4m but maximum building height is limited to 6m above first storey floor.
4.0 For cavity walls, the effective thickness shall be based on two thirds (2/3) the sum of both wythes but not less than the actual thickness of the greater wythe.

WALLS NOT SUPPORTED AT THE TOP
(CAN3-S304, Clause 6.2.3)

PARAPETS

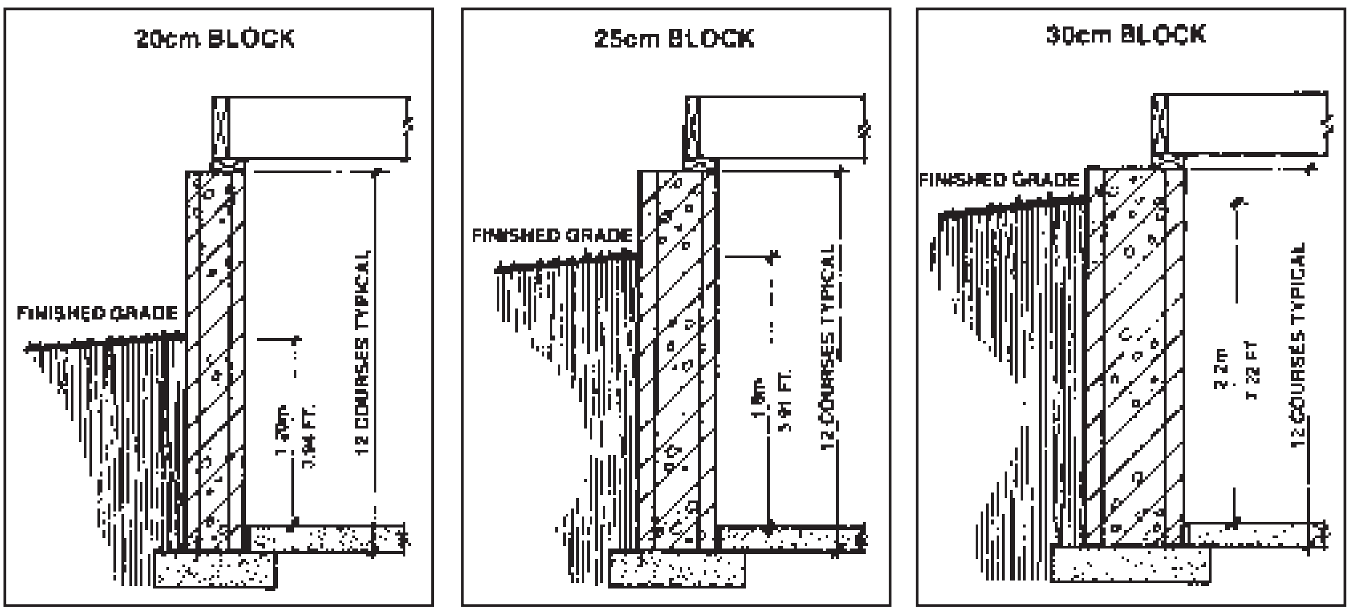
A cantilevered wall cannot exceed a slenderness ratio (h/t) of four, unless horizontal lateral supports are provided in accordance with the requirement of Table 8 in Code. (generally 20t or 20 te for cavity walls)

WINDOW SILLS

The unsupported distance from sill to the floor below cannot exceed a slenderness ratio (h/t) of 3 but only where the length exceeds the requirements of Table 8 in Code. (20t or $20t^e$)

Where lateral support is provided along the top or where the length of wall below the sill is equal or less than permitted, vertical supports are not required.

FIGURE 3.0 DESIGN FOR LATERAL SOIL PRESSURES



NOTES:
1.0 Requirements from 9.15, Ontario Building Code
2.0 Below grade depth measured from top of floor slab

3.0 Footing must be below frost line
4.0 Ontario Building Code 9.15.4 gives lateral support requirements

ALLOWABLE OPENINGS IN EXTERIOR WALLS

Clause 16.7 (S304.1) provides requirements to avoid over stressing walls between openings for doors, windows and ends of wall due to reduced wall area. These requirements apply to walls laterally supported at top and bottom.

Resistance to wind loads is deemed sufficient where a specified percentage of the wall remains. The minimum length depends on the slenderness ratio (h/t): as the ratio increases (i.e. the wall becomes more slender) the required length of wall remaining increases. Calculation of the required percentage remainingis based on the length between centre points of adjacent openings and between centre point of an opening and the end or return of a wall. (See Figure 4.) Where the length of wall remaining is less than 3t, the wall shall be designed as a column with lateral support at 10t.

FIGURE 4.0 ALLOWABLE OPENINGS

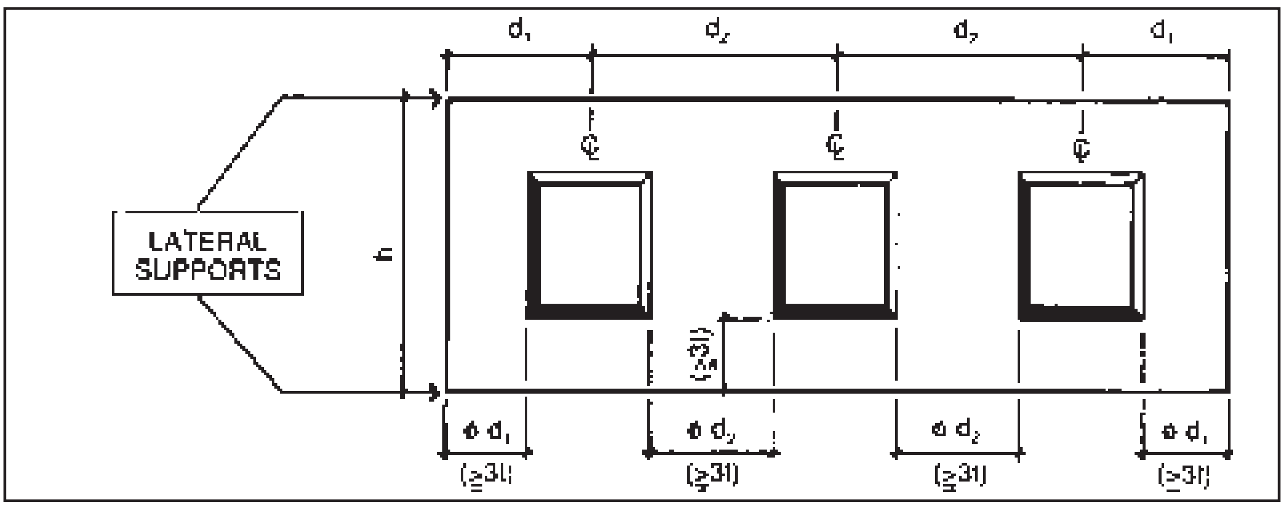
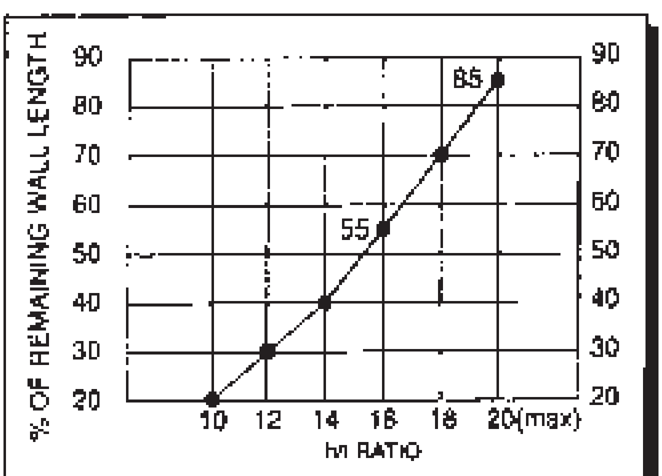
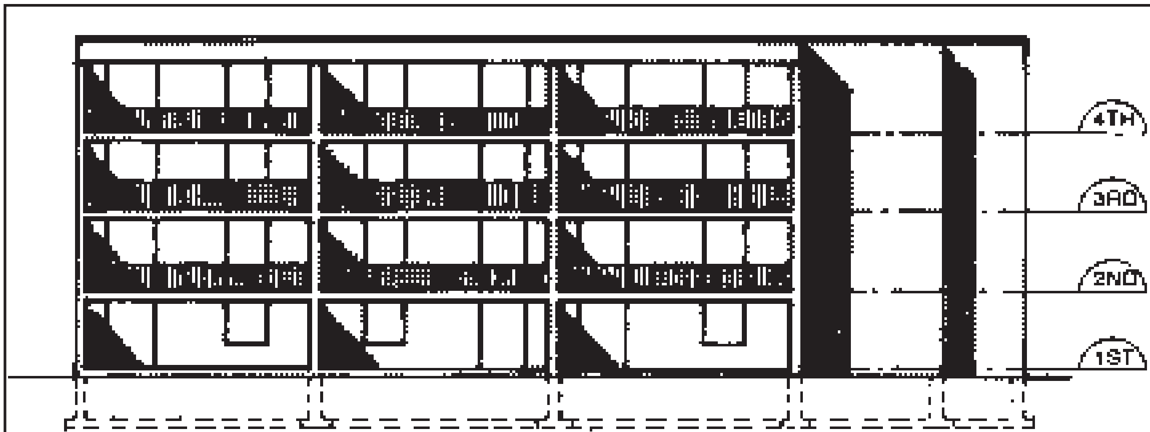


Chart 1 PERCENTAGE OF WALL REQUIRED

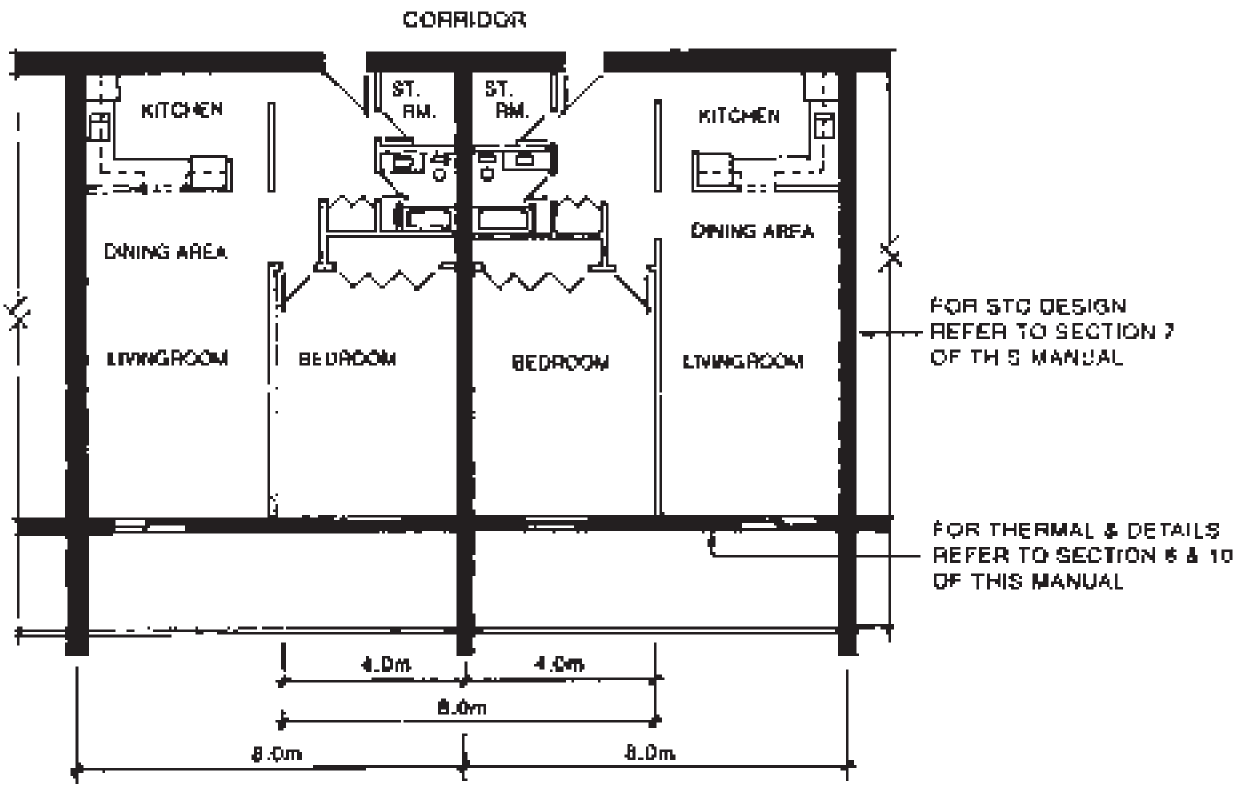


NOTES:
1.0 Chart 1 illustrates values from Table 9 (S304.1).
2.0 Lineal interpolation is permitted e.g. h/t = 13: required wall = 35% of total.
3.0 Allowable openings vary from 80% of total wall (where h/t = 10) to a minimum of 15% (where h/t = 20)

Empirical Design Example
Four Storey Residence

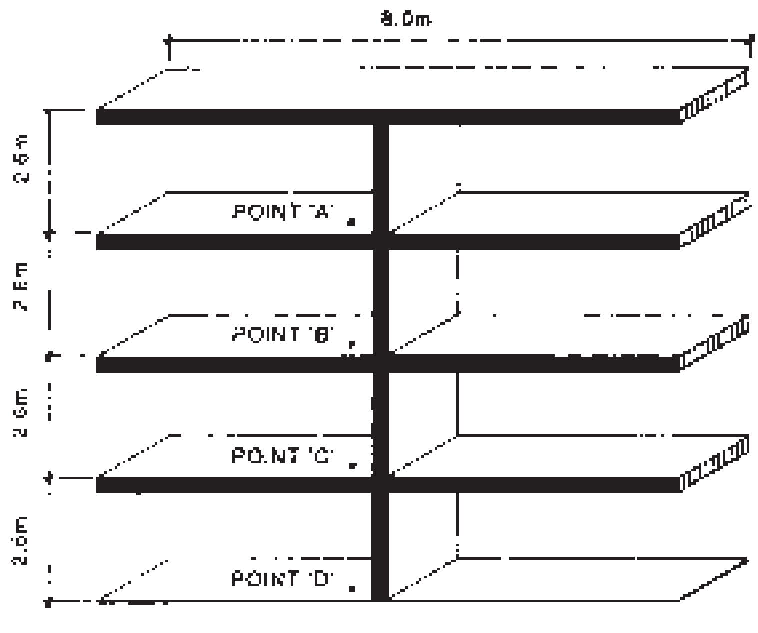


TYPICAL SIDE ELEVATION
N.T.S.



TYPICAL FLOOR PLAN
N.T.S.

Four Storey Residence



LOAD BEARING WALL SECTION
N T S

DESIGN LOADS

- Roof Dead Load -2.60 kN/m^2
- Roof Live Loads
  due to snow, ice
  and rain (Sudbury) -1.78 kN/m^2
- Floor Dead Load
  Precast Concrete Slab -2.60 kN/m^2
- Wall Dead Load
  20cm NW Hollow Block -2.19 kN/m^2
  20cm NW 75% Solid Block -3.04 kN/m^2
- Occupancy Load -1.90 kN/m^2

LOAD @ POINT `A'

L_A = Roof Dead Load + Roof Live Load + Wall Dead Load
= [[8m • (2.60 kN/m^2) + (1.78 kN/m^2)] + [2.4m x 2.19 kN/m^2]]
= [20.8 kN/m + 14.24 kN/m + 5.26 kN/m]
= [35.04 kN/m + 5.26 kN/m]
L_a = 40.3 kN/m

LOAD @ POINT `B'

L_B = Floor Dead Load + Occupancy Load + Wall Dead Load + LA
= [[8.0m • (2.60 kN/m^2) + (1.9 kN/m^2)] + (2.4m x 2.19kN/m)] + 40.3 kN/m]
= [[20.8 kN/m + 15.2 kN/m + 5.26 kN/m] + 40.3 kN/m]
= [41.26 kN/m + 40.3 kN/m]
L_b = 81.56 kN/m

LOADS @ POINT `C

L_C = Floor Dead Load + Occupancy Load + Wall Dead Load + LB
= [[8.0m • (2.60 kN/m^2) + (1.9 kN/m^2)] + (2.4m • 2.19 kN/m^2)] + 81.56 kN/m]
= [[20.8 kN/m + 15.2 kN/m + 5.26 kN/m] + 81.56 kN/m]
= [41.26 kN/m + 81.56 kN/m]
= 122.82 kN/m

LOADS @ POINT `D'

L_D = Floor Dead Load + Occupancy Load + Wall Dead Load + LC

= [[8.0m • (2.60 kN/m²) + (1.9 kN/m²)] + (2.4m • 3.03 kN/m²)] + 122.82 kN/m]

= [[20.8 kN/m + 15.2 kN/m + 7.272 kN/m] + 122.82 kN/m]

= [50.54 kN/m + 122.82 kN/m]

L_D = 173.36 kN/m

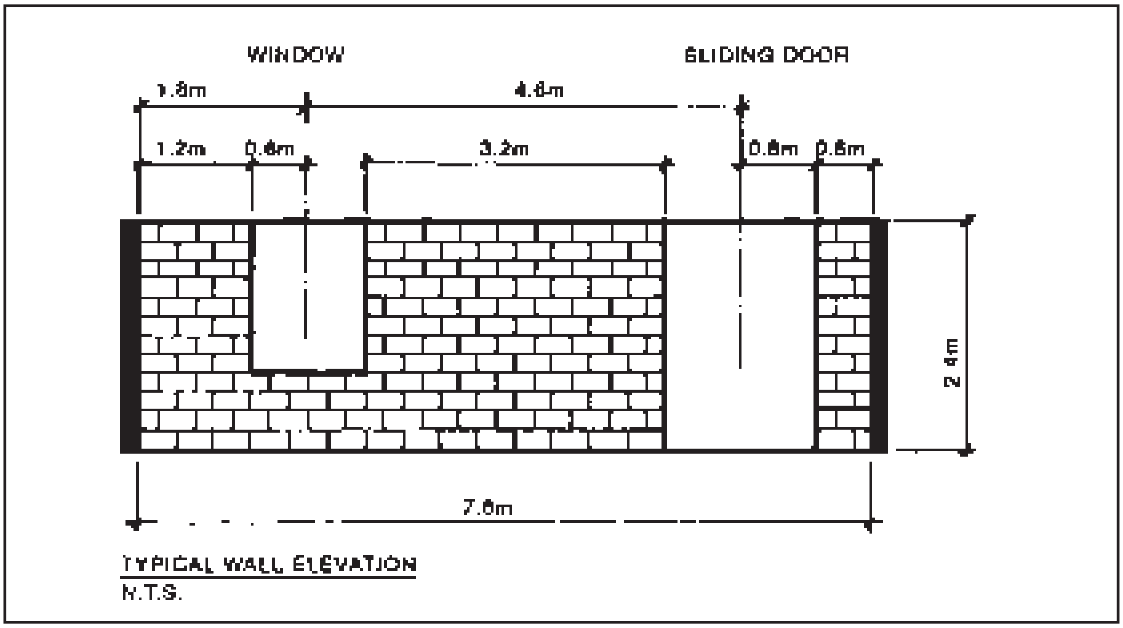
CONSTRUCTION MATERIAL SELECTIONS

1st Floor
- 20cm 75% solid NW concrete block @ 15 MPa strength with Type `S' mortar

2nd Floor
- 20cm Hollow NW concrete block @ 15 MPa strength with Type `S' mortar

3rd Floor
- 20cm hollow NW concrete block @ 15 MPa strength with Type `S' mortar

4th Floor
- 20cm hollow NW concrete block @ 15 MPa strength with Type `S' mortar



ALLOWABLE OPENINGS

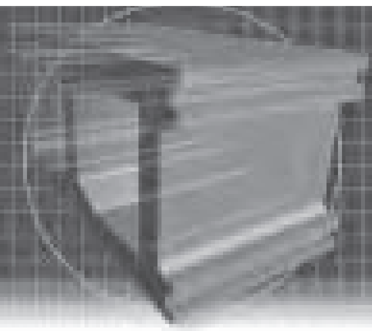
HEIGHT/THICKNESS RATIO
h/t = 2400/190 = 12.6 say 13%
∴ Area of wall required is 35%
(refer to chart on page 8-10)

DISTANCE TO CHECK

1. Distance from centre of window to end of wall
   ∴ 35% of 1.8m = 0.63m
   Actual Distance = 1.2m
   ∵ Actual Distance 1.2m > 0.62m Minimum Allowable
   ∵ Distance 1.2m OK!

2. Distance between opening centres
   ∴ 35% of 4.6m = 1.61
   Actual Distance = 3.2m
   ∵ Actual Distance 3.2m > 1.61m Minimum Allowable
   ∵ Distance 3.2m OK!

3. Distance from centre of door to end wall
   ∴ 35% of 1.4m = 0.49m
   Actual Distance = 0.60m
   ∵ Actual Distance 0.60m > 0.49m Minimum Allowable
   ∵ Distance 0.60m OK!



Canadian Concrete Masonry Producers' Association

CSA 165.1 Specifications & General Specifications Notes

CSA 165.1 Specifications & General Specifications Notes

CCMPA SPECIFICATIONS

All concrete masonry units are manufactured to CCMPA and C.S.A. Standard CAN3-A165.1 requirements. This Standard sets forth the required physical properties for concrete masonry units which are shown in the table below.

TABLE 9.0 - CCMPA SPECIFICATIONS

FACET	SYMBOL	PHYSICAL PROPERTIES			NOTES
FIRST	H	HOLLOW			1.0
	S	SOLID (AS DEFINED)			1.0
	Sc	SOLID (WITHOUT CORES)			3.0
SECOND		**MINIMUM MPa COMPRESSIVE STRENGTH**			
		AVERAGE OF 3 UNITS	UNIT MINIMUM		
	15	15	12.8		1.0
	20	20	17.0		3.0
	30	30	25.5		3.0
THIRD		**CONCRETE DENSITY (kg/m^3)**	**ABSORPTION MAXIMUM (kg/m^3)**		
	A	GREATER THAN 2000	175		1.0
	B	1800 - 2000	200		2.0
	C	1700 - 1800	225		1.0
	D	LESS THAN 1700	300		3.0
	N	NO LIMITS	NO LIMITS		
FOURTH		**LINEAR SHRINKAGE**	**MOISTURE CONTENT MAXIMUM AS % OF ABSORPTION MAXIMUM**		
			RH > 75%	RH < 75%	
	M	LESS THEN 0.03%	45	40	
		0.03% - 0.045%	40	35	
		GREATER THAN 0.045%	35	30	
	O	NO LIMITS	NO LIMITS		

CCMPA SPECIFICATIONS COMMENTARY

Designers should take note that all facet combinations are not normally produced. However, a wide selection of product is commonly available from all Members, thereby ensuring that the majority of technical design challenges can be immediately satisfied with readily available material.

This specification format however, does not address the other familiar block properties such as fire resistance ratings, thermal resistance, sound transmission classifications and unit size. For this information, one must refer to the specific sections within this manual.

This specification identification reference is known as the "Four Facet" system. Each facet is referred to by either a letter or number, never by a combination of two or more symbols per facet and each facet is separated by a slash. e.g. H/15/A/M refers to Hollow 15 MPa Normal Weight block with known moisture content. Unit size distinction is generally placed on the drawings, i.e. floor plan(s) and/or wall section(s).

Explanation

The specification facet breakdown is as follows:

FIRST FACET

This facet identifies the percentage content of the unit. The symbols H, S and Sf indicate less than 75%, greater than 75% but less than 100% and 100% solid content respectively. This percentage is determined by the net cross sectional area as a percentage of the gross cross sectional area of the unit.

SECOND FACET

The concrete material strength is shown in this facet. The metric term "MPa" is an absolute unit of measurement, however for engineering purposes this measurement correlates to kN/mm^2. Therefore 15MPa equals 15 kN/mm^2. The specified strength of the unit is based on test results of three units with a minimum strength as noted.

THIRD FACET

Reference to oven dry concrete density (kg/m^3) in addition to the allowable absorption maximum as a percentage of concrete density. The aggregates that are used in the manufacturing process of concrete block are siliceous gravel, limestone and expanded slag.

FOURTH FACET

This facet represents the maximum moisture content at time of delivery to the job site expressed as a percentage of actual absorption as it relates to climactic relative humidity and linear shrinkage of the concrete unit.

GENERAL SPECIFICATION NOTES
MASONRY PROCEDURES

1 GENERAL

1.1 RELATED WORK

1.1.1 Mortar and Grout for Masonry Section 04100

1.1.2 Masonry Accessories Section 04150

1.1.3 Masonry Reinforcing and Connectors Section 04160

1.2 REFERENCE STANDARD

1.2.1 Do masonry work in accordance with CAN3-A371 except where specified otherwise.

1.3 JOB MOCK-UP

NOTE: For federal government projects refer to 0

1.3.1 Submit mock-ups in accordance with Shop Drawings, Product Data, Samples and Mock-ups.

NOTE: For private sector projects refer to 0

1.3.2 Submit mock-ups in accordance with Quality Control.

1.4 SOURCE QUALITY CONTROL

NOTE: For federal government projects refer to 0

1.4.1 Submit laboratory test reports in accordance with Shop Drawings, Product Data, Samples and Mock-ups and O.C.B.A. Quality Assurance test certificate and the Department of National Defence Construction Materials Board (DND/CMB) Product Acceptance Certificate.

NOTE: For private sector projects refer to 0 and 0

1.4.2 Submit laboratory test reports in accordance with submittal requirements.

1.4.3 Submit laboratory test and O.C.B.A. Quality Assurance test certificate [certifying compliance of masonry units (and mortar ingredients) with specification requirements].

2 PRODUCTS

2.1 SAMPLES

NOTE: For federal government projects refer to 0

2.1.1 Submit samples in accordance with Shop Drawings, Product Data, Samples and Mock-ups.

NOTE: Use 0 for private sector projects

2.1.2 Submit samples in accordance with Submittal requirements.

MASONRY PROCEDURES CONTINUED...

2.1.3 Submit samples:

2.1.3.1 [two] of each type of masonry unit specified
2.1.3.2 [one] of each type of masonry accessory specified
2.1.3.3 [one] of each type of masonry reinforcement and tie proposed for use
2.1.3.4 as required for testing purposes

2.2 PRODUCT DELIVERY, STORAGE AND HANDLING

2.2.1 Deliver materials to job site in dry condition.
2.2.2 Keep materials dry until use.
2.2.3 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.
2.2.4 Protect masonry units from damage.

NOTE: Extra on-site handling of lightweight concrete units should be avoided.

2.3 COLD WEATHER REQUIREMENTS

2.3.1 General Contractor shall provide heat enclosures and heat as required.
2.3.2 Work to be undertaken shall be carried out according to CAN3-A371, Clause 5.15.2.

2.4 HOT WEATHER REQUIREMENTS

2.4.1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.

2.5 PROTECTION

2.5.1 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.

2.5.2 Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.

3 EXECUTION

3.1 WORKMANSHIP

3.1.1 Build masonry plumb, level, and true to line, with vertical joints in alignment.

3.1.2 Lay out coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

NOTE: Mason Contractor must have proven experience on similar job.

MASONRY PROCEDURES CONTINUED...

3.2 TOLERANCES

3.2.1 Tolerances in notes to Clause 5.3 of CAN3-A371 apply.

3.3 EXPOSED MASONRY

3.3.1 Do not use chipped, cracked, and otherwise damaged units in exposed and loadbearing masonry walls.

3.4 MORTAR JOINT

3.4.1 Mortar joint thickness shall conform to CAN3-A371 Standard, Clause 5.2.5.

3.4.2 Exterior - Exposed Wall

3.4.2.1 Allow joints to set just enough to remove excess water, then tool with round jointer to provide smooth, compressed, uniformly concave joints.

*NOTE: All exposed mortar joints shall be conc*ave.

3.4.3 Interior - Exposed and Non-Exposed Walls

3.4.3.1 Allow joints to set just enough to remove excess water, then tool with round jointer to provide smooth, compressed, uniformly concave joints as indicated on drawings.

3.4.3.2 Allow joints to set just enough to remove excess water, then rake joints uniformly to 6 mm depth and compress with square tool to provide smooth, compressed, raked joints of uniform depth where raked joints are indicated on drawings.

3.4.3.3 Strike flush all joints concealed in walls and joints in walls to receive plaster, tile insulation, or other applied material except paint or similar thin finishing coating.

NOTES: 1. Unique designs and applications may require special considerations.
2. Indicate non-concave joint locations.

3.5 CUTTING

3.5.1 Cut out neatly for electrical switches, outlet boxes, and other recessed or built-in objects.

3.5.2 Make cuts straight, clean, and free from uneven edges.

3.6 PRODUCTS BUILT-IN BUT NOT SUPPLIED UNDER THIS SECTION

3.6.1 Build in items required to be built into masonry.

3.6.2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.

3.6.3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.

3.6.4 Metal Fabrications - Section 05500: supply of miscellaneous metal fabrications for installation by this section.

3.6.5 Metal Doors and Frames - Section 08100: supply and setting of metal frames for building in by this section.

MASONRY PROCEDURES CONTINUED...

3.7 PARGING

3.7.1 Use parging mortar specified in `Mortar and Grout' Section 04100.
3.7.2 Parging shall be applied in two coats not less than 10 mm thick.
3.7.3 First coat shall be roughened to provide a good bond for the second coat.
3.7.4 The first coat shall be at least 24 hours old before second coat is applied.
3.7.5 The first coat shall be dampened with water before second coat is applied.

3.8 SUPPORT OF LOADS

3.8.1 Use [______]MPa strength concrete, where concrete fill is used in lieu of solid units.
3.8.2 Use grout to CSA A179 where grout is used in lieu of solid units.
3.8.3 Install building paper below voids to be filled with grout; keep paper 25 mm back from faces of units.

3.9 PROVISION FOR MOVEMENT

3.9.1 Leave [_____] mm deflection space below shelf angles.
NOTE: Re 0 Drawings should show means of stabilizing masonry, and treatment at shelf angles. Specify caulking, angle retainers, and filling of spaces in other Sections, as appropriate.
3.9.2 Leave [_____] mm space between top of non-loadbearing walls/partitions and structural elements. Do not use wedges.

3.10 LOOSE STEEL LINTELS

3.10.1 Install loose steel lintels. Centre over opening width.

3.11 TEMPORARY WALL BRACING

3.11.1 General Contractor shall be responsible for temporary engineered wall bracing design.
3.11.2 Brace masonry walls as indicated by engineered drawing(s) to resist wind pressure and other lateral loads during construction period.

3.12 CONTROL JOINTS

NOTE: Re 12.1 Drawing should show locations and type(s) of control joint(s).
3.12.1 Provide continuous control joints [as indicated].
3.12.2 Contractor shall break vertical mortar bond with [extruded neoprene gasket] or [building paper].
3.12.3 Control joint shall be primed to prevent drying out of caulking material.

MASONRY PROCEDURES CONTINUED...

3.13 TESTING

3.13.1 Inspection and testing will be carried out by Testing Laboratory designated by [Owner] or [Consultant] or his [General Contractor].

NOTE: Use 0 for federal government projects

3.13.2 [Consultant] or [Owner] will pay costs for testing.

NOTE: Use 0 for private sector projects

3.13.3 Cost of testing will be paid from General Contractor's cash allowance.

MORTAR AND GROUT FOR CONCRETE BLOCK

01 GENERAL

1.1 RELATED WORK

1.1.1 Masonry Procedures Section 04050

1.2 REFERENCE STANDARD

1.2.1 Masonry mortar and grout work should be in accordance with CSA A371 except where specified otherwise.
1.2.2 Type S hydrated lime mortar shall conform to ASTM C-207.

1.3 SAMPLES

NOTE: Use 0 for federal government projects
1.3.1 Submit samples in accordance with Shop Drawings, Product Data, Samples and Mock-Ups.

NOTE: Use 0 for private sector projects
1.3.2 Submit samples in accordance with Submittal requirements.
1.3.3 Submit two [_____] size samples of [mortar] [coloured mortar].

2 PRODUCTS

2.1 MATERIALS

2.1.1 Mortar shall conform to CSA A179.
2.1.2 Mortar aggregate shall conform to CSA-A82.56-M1976.
2.1.3 Use aggregate passing 1.18 mm sieve where 6 mm thick joints are indicated.
2.1.4 Colour: ground coloured natural aggregates or metallic oxide pigments.
2.1.5 Dirt resistant additives: aluminum tristearate, calcium stearate or ammonium stearate.
2.1.6 Water: free of deleterious matter and acids or alkalis.

2.2 MATERIAL SOURCE

2.2.1 Use same brands of materials and source of aggregate for entire project.
2.2.2 Air entrained cement and air entrained lime shall not be combined in the same mix.
2.2.3 Admixtures for mortar shall not be used without approval.

MORTAR AND GROUT FOR CONCRETE BLOCK CONTINUED...

2.3 MORTAR TYPES

2.3.1 Mortar for exterior masonry above grade:

2.3.1.1 *Loadbearing:* Type ([N] [S]) based on ([Property] [Proportion]) specifications.
2.3.1.2 *Non-loadbearing*: Type ([N] [S]) based on ([Property] [Proportion]) specifications.
2.3.1.3 *Parapet Walls, Chimneys, Unprotected Walls:* Type ([N] [S]) based on [Property] [Proportion]) specifications.

2.3.2 Mortar for foundation walls and other exterior masonry at or below grade: Type `S' based on ([Property] [Proportion]) specifications.
2.3.3 Mortar for interior masonry:

2.3.3.1 *Loadbearing:* Type ([N] [S]) based on ([Property] [Proportion]) specifications.
2.3.3.2 *Non-loadbearing:* Type ([N]) based on ([Property] [Proportion]) specifications.

2.3.4 Following applies regardless of mortar types and uses specified above:

2.3.4.1 *Mortar for Grouted Reinforced Masonry*: Type ([S]) based on ([Property] [Proportion]) specifications

2.3.4.2 *Mortar for Pointing:* Type [_____] based on Proportion specifications.

2.4 WHITE MORTAR

NOTE: White sand should be used to retain colour balance with concrete masonry units.

2.4.1 *White mortar:* use [white silica sand (or No.6 dolomite sand), white portland cement, and lime] [white silica sand (or No.6 dolomite sand) and white masonry cement] to produce applicable mortar type.

NOTE: Re 0 Indicate area for white mortar.

2.4.2 Use white mortar for [_____].

2.5 COLOURED MORTAR

NOTE: Re 0 Colour match is normally achieved when admixture is between 4 - 5% o cement content by mass.

2.5.1 *Coloured mortar:* colour admixture shall not exceed 10% of cement content by mass, or integrally coloured masonry cement, to produce coloured mortar to match approved sample.

NOTE: Re 0 Indicate masonry work requiring use of coloured mortar. Sample of coloured mortar must be available at time of tendering, as costs vary with colour. Note that when admixtures are used, property specifications alternative of CSA A179 applies.

2.5.2 Use coloured mortar for [_____].

NOTE: Material Source - Refer to CCMPA MASONRY REINFORCING & ACCESSORY SUPPLIERS (Page 1-4)

MORTAR AND GROUT FOR CONCRETE BLOCK

2.6 DIRT-RESISTANT MORTAR

2.6.1 For dirt-resistant mortar add aluminium tristearate, calcium stearate, or ammonium stearate to mortar in amount not exceeding 3% of portland cement weight.

NOTE: Re 0 Indicate masonry requiring use of dirt-resistant mortar. Use where maximum dirt-resistance is desired. Note that when admixtures are used, the Property Specification alternative of CSA A179 applies.

2.6.2 Use dirt-resistant mortar for [_____].

2.7 GROUT

2.7.1 Grout shall conform to CSA A179 Table 3.
2.7.2 Minimum compressive strength [_____] MPa at 28 days.
2.7.3 Grout following masonry components [_____].
2.7.4 Water shall be free of deleterious matter and acids or alkalis.
2.7.5 Grout slump shall be not less than 200 mm and not more than 250 mm.

NOTE: Grout aggregate shall be clean, un-coated grains of sound material and conform to CAN3-A23.1-M90.

2.8 PARGING

NOTE: Re 0 Mortar Types `S' OR `N', are suitable for parging. Match mortar used for masonry, or use Type `N' if masonry mortar is weaker than aforementioned types, or if type is not known.

2.8.1 Parging mortar shall be Type [_____] to CSA A179.

3 EXECUTION

3.1 MIXING

3.1.1 Mix grout to semi-fluid consistency.
3.1.2 Grout Testing shall be in accordance with CSA-A179.
3.1.3 Incorporate [colour] [and (admixtures)] into mixes in accordance with manufacturer's instructions.
3.1.4 Use clean mixer for coloured mortar.
3.1.5 Lime mortar ingredients shall be mixed dry, then mixed again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than 1 hour nor more than 2 hours then remix with sufficient water to produce mortar of proper consistency for pointing.
3.1.6 Use mortar within 2 hours after mixing.
3.1.7 Testing of mortar shall be in accordance with CSA-A179.

MASONRY ACCESSORIES

1 GENERAL

1.1 RELATED WORK

1.1.1 Masonry Procedures Section 04050
1.1.2 Masonry Reinforcing and Connectors Section 04160

1.2 RELATED SECTIONS

1.2.1 Section 03300: Cast-In-Place Concrete
1.2.2 Section 03400: Precast Concrete
1.2.3 Section 05510: Anchors to Masonry
1.2.4 Section 07196: Air Barriers
1.2.5 Section 07270: Fire Stops
1.2.6 Section 07900: Sealants
1.2.7 Section 07620: Parapets and Coping Flashing

2 PRODUCTS

2.1 MATERIALS

NOTE: Re 0 Revise text to suit selected filler

2.1.1 Control joint filler: purpose-made elastomer [_____] durometer hardness to ASTM D2240 of size and shape indicated.
2.1.2 Nailing inserts: 0.6 mm thick purpose-made galvanized steel inserts for setting in mortar joints.

NOTE: Re 0 This is by no means an all inclusive list of approved flashing materials.

2.1.3 Concealed composite masonry flashing:
2.1.3.1 Two (2) 0.05 mm polyethylene film bonding 81.35 g/m² asphalt treated crepe kraft and fibreglass scrim.

2.1.3.2 610 g/m² copper sheet asphalt bonded to two layers of crepe paper [bonded together with asphalt and] reinforced with 50 x 50 mm glass fiber scrim.
2.1.3.3 0.18 mm metal foil and polyester film bonded to fibreglass scrim.
2.1.3.4 0.50 mm minimum thick polyethylene bonded to asphalt treated crepe paper reinforced with 50 x 50 mm glass fibre scrim.
2.1.3.5 0.20 mm vinyl ethylene film bonded to fibreglass reinforcement.
2.1.3.6 Or approved equal to one of the above materials.

2.1.4 Weep hole vents shall be made from [PVC] [galvanized steel], [polypropylene 6 polymer], designed to drain cavity moisture to exterior.

MASONRY ACCESSORIES CONTINUED...

3 EXECUTION

3.1 CONTROL JOINTS

3.1.1 Install control joints at locations indicated to maintain construction integrity.

3.2 WEEP HOLE VENTS

3.2.1 Install weep hole vents in vertical joints immediately over flashings, in exterior wythes of cavity wall and masonry veneer wall construction, at maximum horizontal spacing of 800 mm O.C.

3.3 NAILING INSERTS

3.3.1 Install nailing inserts in mortar joints at 400 mm O.C. each way, for attachment of wall strapping.

3.4 MASONRY FLASHING

3.4.1 Install flashings in masonry in accordance with CAN3-A371 as follows:

3.4.1.1 Install flashings under exterior masonry walls bearing on foundation walls or slabs; shelf angles, and steel lintel angles at wall openings. Install flashing as indicated.

3.4.1.2 In double wythe walls and veneered walls, carry flashings from front edge of masonry, under outer wythes, then up backing not less than 150 mm, and as follows:

3.4.1.2.1 For masonry backing embed flashing 25 mm in joint

3.4.1.2.2 For concrete backing, insert flashing into reglets and caulk joint

3.4.1.2.3 For frame backing, secure flashing to studs (sheathing) behind moisture barrier

3.4.1.3 Lap joints 150 mm and seal with compatible adhesive.

3.4.1.4 Flashing over openings shall be "dams" at both ends to prevent water from travelling horizontally past the flashing ends.

3.4.1.5 Horizontal (base) flashing shall be returned a minimum of 100 mm around corner to overlap abutting flashing. Overlapped flashing shall be sealed with compatible adhesive.

3.4.1.6 Protect base wall flashing from mortar droppings

NOTE: Unprotected base flashing may be damaged during construction.

MASONRY REINFORCING AND CONNECTORS

NOTE: Details of masonry reinforcing and connectors must be indicated on drawings. Their adequacy shall be confirmed by structural design engineer.

1 GENERAL

1.1 REFERENCE STANDARDS

1.1.1 Do reinforcing and connecting of masonry in accordance with CAN3-A370 and CAN3-A371 unless specified otherwise.

1.2 DEFINITIONS

1.2.1 Moist environments referred to in Clause 4.2 of CAN3-A370.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Connectors shall conform to CAN3-A370.
NOTE: Connector selection and spacing in seismic zones 3 and 4 must be engineered.
2.1.2 Reinforcement shall conform to CAN3-A371.
2.1.3 For reinforced masonry requirements refer to structural drawing and specification section [_____].

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install masonry connectors and reinforcement in accordance with CAN3-A370 and as indicated.
3.1.2 Corrugated strip ties shall be spaced [mm] horizontal and [mm] vertical.
3.1.3 `Z' wire ties shall be spaced [mm] horizontal and [mm] vertical.
3.1.4 Rectangular wire ties shall be spaced [mm] horizontal and [mm] vertical.
3.1.5 Continuous welded truss ties shall be spaced [mm] horizontal and [mm] vertical.
3.1.6 Dovetail anchors shall be spaced [mm] horizontal and [mm] vertical.
3.1.7 Corrugated dovetail anchors shall be spaced [mm] horizontal and [mm] vertical.
3.1.8 Bar anchors [ ]W x [ ]T x [ ]L + [ ]hook ends shall be spaced every [mm].
3.1.9 Anchor bolt(s) [mm]0/ at [mm] O.C. as indicated on drawings.
3.1.10 Vertical reinforcing steel shall have a minimum clearance of 12 mm from the masonry and not less than one bar diameter between bars.

MASONRY REINFORCING AND CONNECTORS CONTINUED...

3.1.11 Provide clean-out openings at the bottom of all cores containing vertical reinforcement at each lift or pour.

3.1.12 All block cores containing vertical reinforcement and/or anchor bolts shall be solidly filled with grout.

3.1.13 Steel connections shall be inspected before grouting.

NOTE: Material Source - Refer to CCMPA MASONRY REINFORCING & ACCESSORY SUPPLIER (Page 1-4)

CONCRETE UNIT MASONRY

1 GENERAL

1.1 RELATED WORK

1.1.1 Masonry Procedures Section 04050
1.1.2 Mortar and Grout for Masonry Section 04100
1.1.3 Masonry Accessories Section 04150
1.1.4 Masonry Reinforcing and Connectors Section 04160

2 PRODUCTS

NOTE: For 0 If more than one type of masonry unit required, identify each with a code reference. Describe each type of masonry unit using a separate paragraph. Included below is text for several types.

2.1 Standard concrete masonry units [Type (_____)]: to CAN3-A165.1.

NOTE: Re 0 Refer to CAN3-A165.1 and classify units using four facet system. For example, H/15/A/M means a hollow unit with a 15MPa compressive strength based on net area using normal weight concrete weighing over 2100 kg/m2 and known moisture content.

2.1.1 Classification: [_____]/[_____]/[_____]/[_____]
2.1.2 Size: CCMPA Metric Modular

NOTE: Re 0 Show special shapes and face profiles on drawings

2.1.3 Special shapes: provide [square] [bull-nosed] units for exposed corners. Provide purpose-made shapes for lintels and bond beams. Provide additional special shapes as indicated.
2.1.4 Fire resistant characteristics: refer to The Supplement to the National Building Code for fire resistance ratings based on aggregate type and equivalent thickness of unit.

NOTE: Re 0 In addition to the code reference designation on drawings the fire resistance rating must be indicated for each concrete masonry unit wall requiring such rating, for example a wall requiring a 2 h fire-resistance rating would be designated as "Type [_____] concrete masonry unit 2 h fire-resistance rating".

2.1.5 Special fire resistant concrete masonry units [Type (_____)]: to CAN3-A165.1) as modified below.
2.1.6 Classification: [H/15/C/M] except as modified by fire resistance requirements specified below.
2.1.7 Size: CCMPA Metric Modular.

NOTE: Re 0 Show special shapes on drawings

2.1.8 Special shapes: provide [square] [bull-nosed] units for exposed corners. Provide purpose-made shapes for lintels and bond beams [and provide additional shapes as indicated].
2.1.9 Architectural Concrete Units
2.1.9.1 All units shall conform to CAN3-165.1.

2.1.9.2 Refer to architectural drawings for unit types, quantity required and locations.
2.1.9.3 Colour for architectural concrete units shall be [colour] for [type].

NOTES:
1. *Architectural concrete units are custom manufactured for each order, therefore, one should ensure that correct quantity is ordered to complete the entire job.*
2. *Manufacturer will undertake all the necessary steps, however, colour matching on second orders cannot be guaranteed.*
3. *Client/Manufacturer shall not be held responsible for product over-ordering.*

2.1.10 All damaged units not reported as damaged at time of delivery are presumed to have been damaged after delivery and therefore shall be the responsibility of the contractor to make good.

3 EXECUTION

NOTE: Include under 3.1 requirements that are not covered in Masonry Procedures.

3.1 LAYING CONCRETE MASONRY UNITS

3.1.1 Bond [running] [stack]
3.1.2 Coursing height: [200] mm for one block and one joint
3.1.3 Jointing: concave where exposed or where paint or other finish coating is specified.

3.2 CONCRETE MASONRY LINTELS

3.2.1 Install reinforced concrete block lintels over openings in masonry where steel or reinforced concrete lintels are not indicated.
3.2.2 End bearing: not less than [200] mm [as indicated on drawings].
NOTE: Masonry end bearing area capacity should be verified.

3.3 CLEANING

3.3.1 Allow mortar droppings on unglazed concrete masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block and finally by brushing.

Canadian Concrete Masonry Producers' Association

Details

PROPERTY SPECIFICATIONS FOR JOB PREPARED MORTAR CSA A179M

MORTAR TYPE	MINIMUM COMPRESSIVE STRENGTH, MPa		MINIMUM WATER RETENTION %
	@ 7 DAYS	@ 28 DAYS	
S	5.0	8.5	70
N	2.0	3.5	70

PROJECT

MORTAR

BLOCK TYPE

HOLLOW
75% SOLID
SOLID PIER

CONCRETE BLOCK MORTAR MIX PROPORTIONS CSA A179M

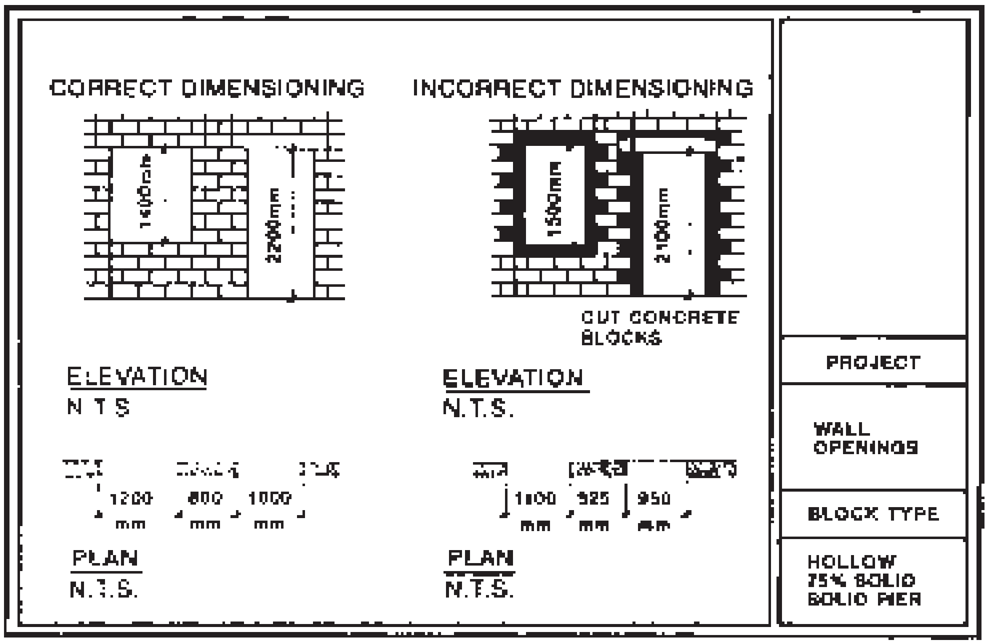
MORTAR TYPE	PARTS BY VOLUME			
	PORTLAND CEMENT	MASONRY CEMENT	HYDRATED LIME OR LIME PUTTY	AGGREGATE
S	1/2	1	—	3 1/2 - 4 1/2
S	1	—	1/2	4 1/2 - 6
N	—	1	—	2 1/4 - 3
N	1	—	1	4 1/2 - 6

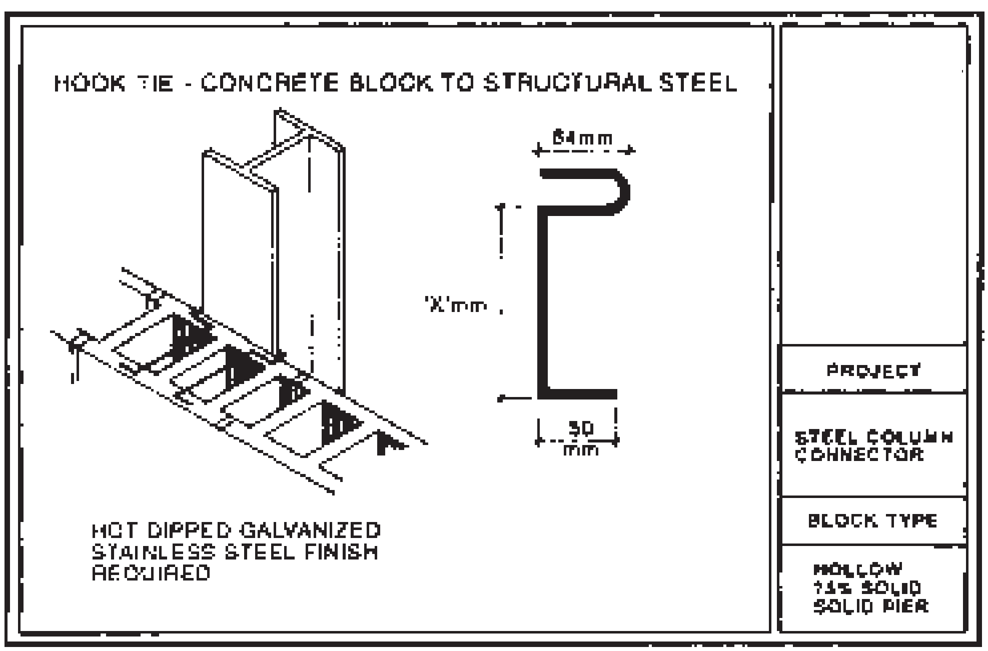
PROJECT

MORTAR

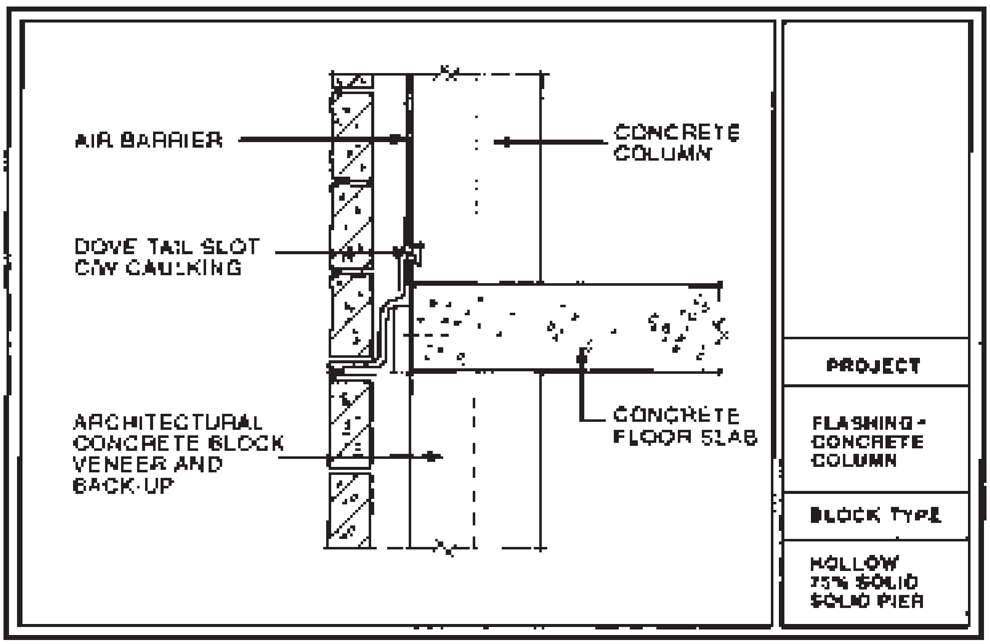
BLOCK TYPE

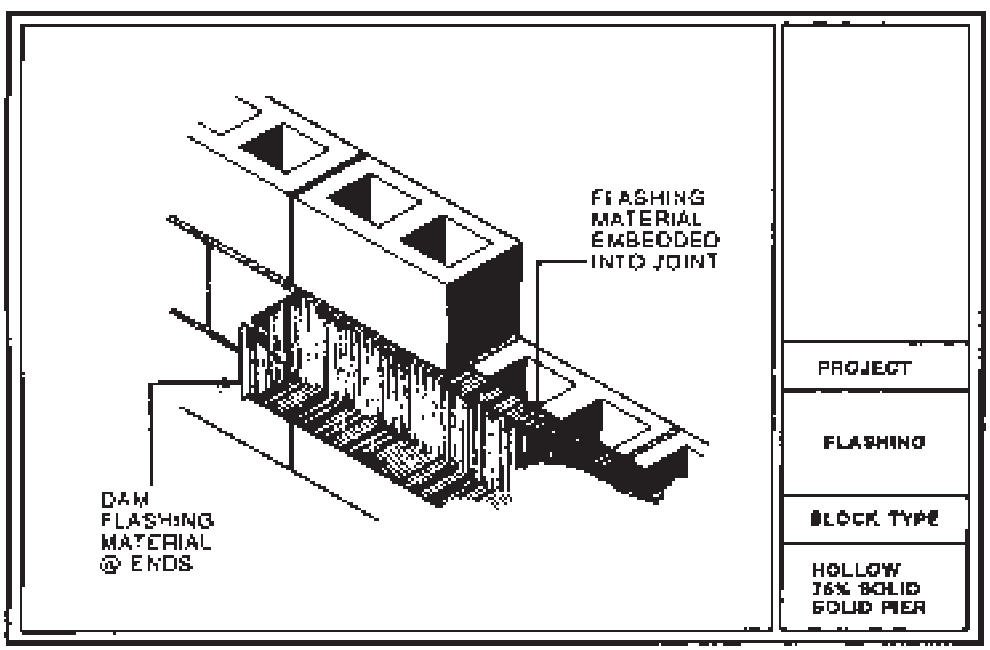
HOLLOW
75% SOLID
SOLID PIER

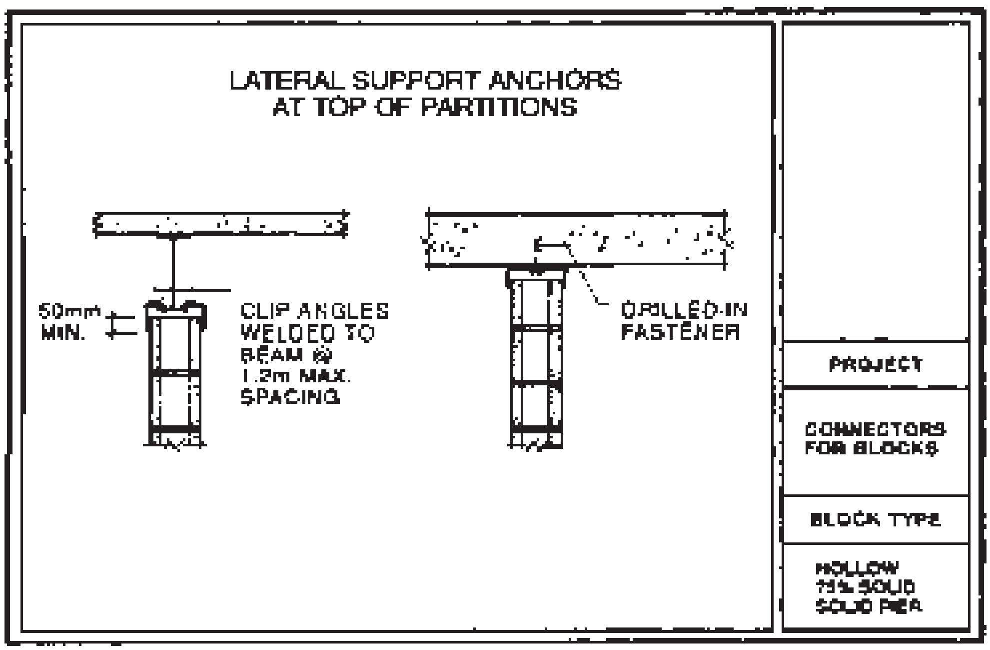

CORRECT DIMENSIONING
INCORRECT DIMENSIONING
1400mm
2200mm
1500mm
2100mm
CUT CONCRETE BLOCKS
ELEVATION
N.T.S
ELEVATION
N.T.S.
1200 mm
800 mm
1000 mm
1100 mm
925 mm
950 mm
PLAN
N.T.S.
PLAN
N.T.S.
PROJECT
WALL OPENINGS
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER

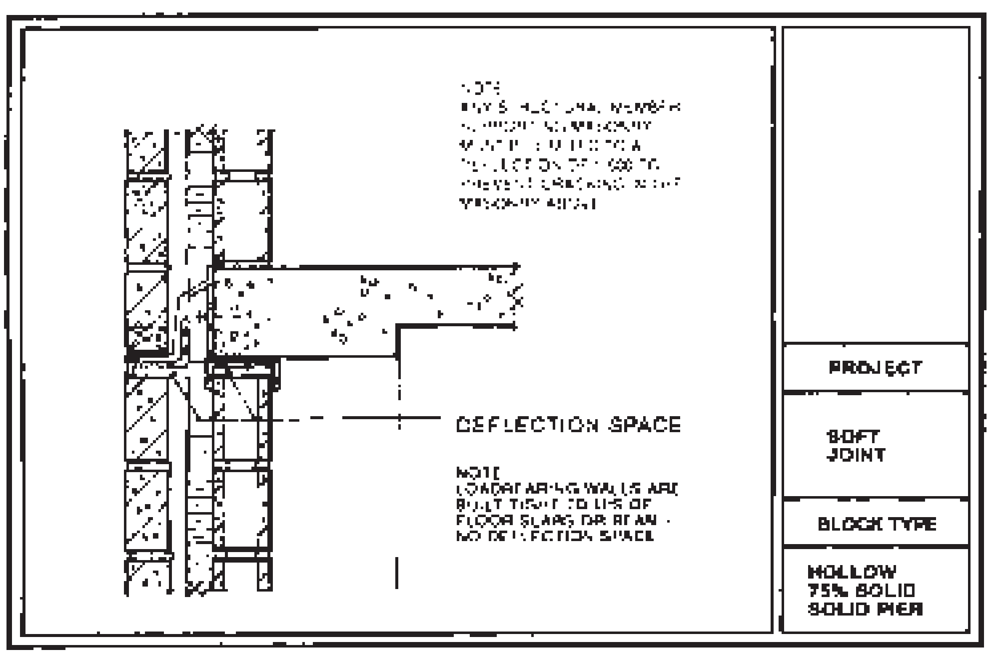

HOOK TIE - CONCRETE BLOCK TO STRUCTURAL STEEL
64mm
'X'mm
50 mm
HOT DIPPED GALVANIZED
STAINLESS STEEL FINISH
REQUIRED
PROJECT
STEEL COLUMN CONNECTOR
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER

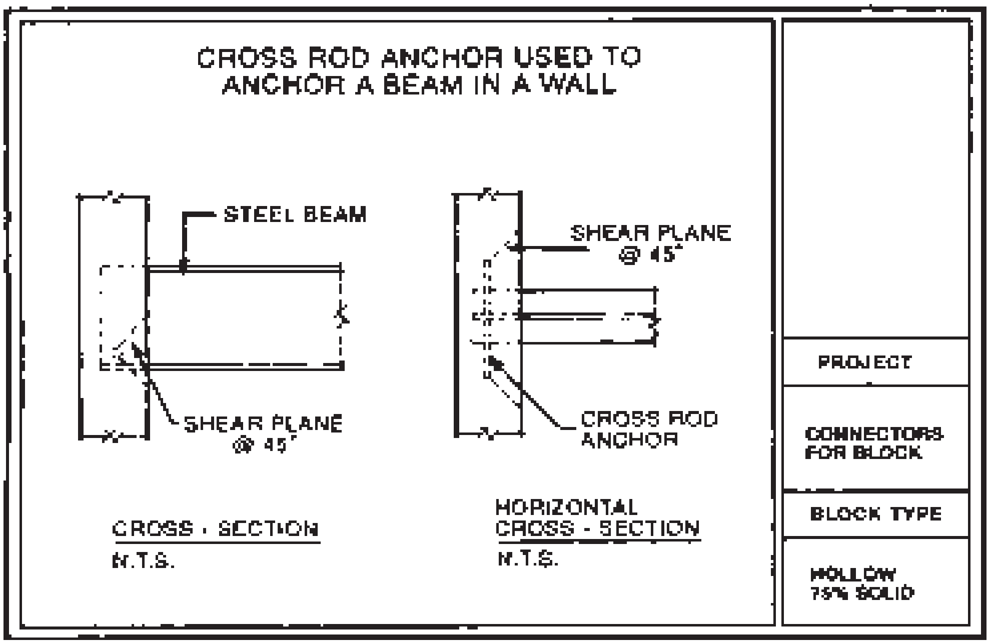
Details

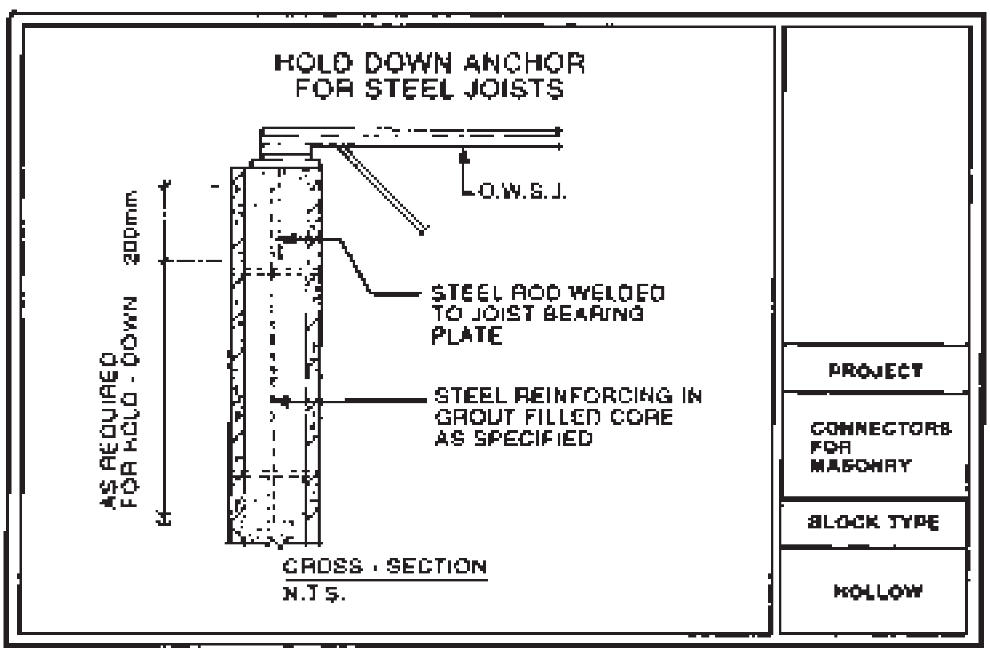

AIR BARRIER
CONCRETE COLUMN
DOVE TAIL SLOT C/W CAULKING
ARCHITECTURAL CONCRETE BLOCK VENEER AND BACK-UP
CONCRETE FLOOR SLAB
PROJECT
FLASHING - CONCRETE COLUMN
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER

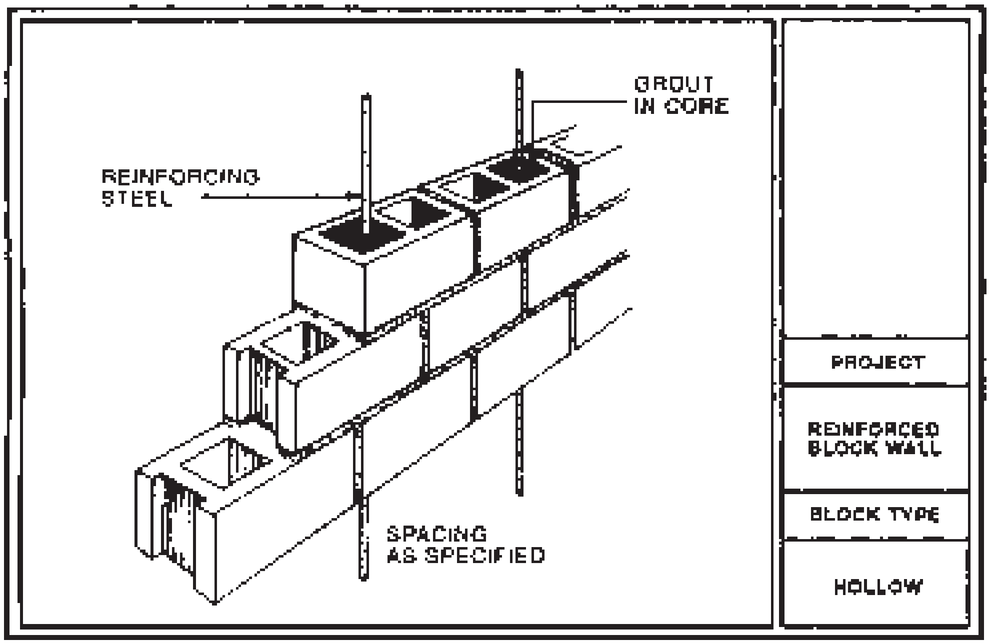

FLASHING MATERIAL EMBEDDED INTO JOINT
DAM FLASHING MATERIAL @ ENDS
PROJECT
FLASHING
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER

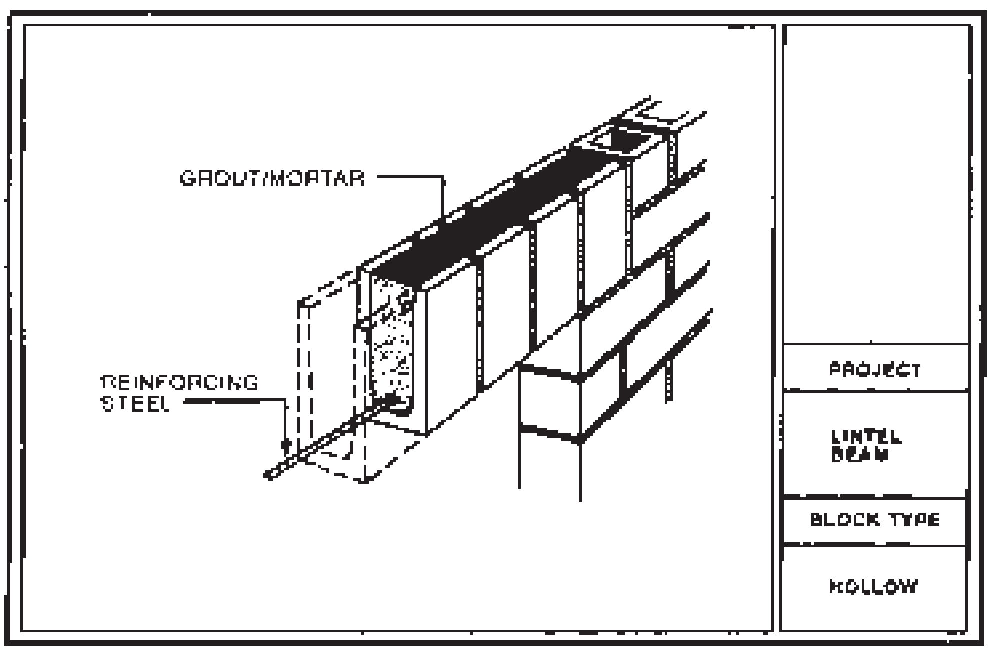

LATERAL SUPPORT ANCHORS
AT TOP OF PARTITIONS
50mm
MIN.
CLIP ANGLES
WELDED TO
BEAM @
1.2m MAX.
SPACING
DRILLED-IN
FASTENER
PROJECT
CONNECTORS
FOR BLOCKS
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER

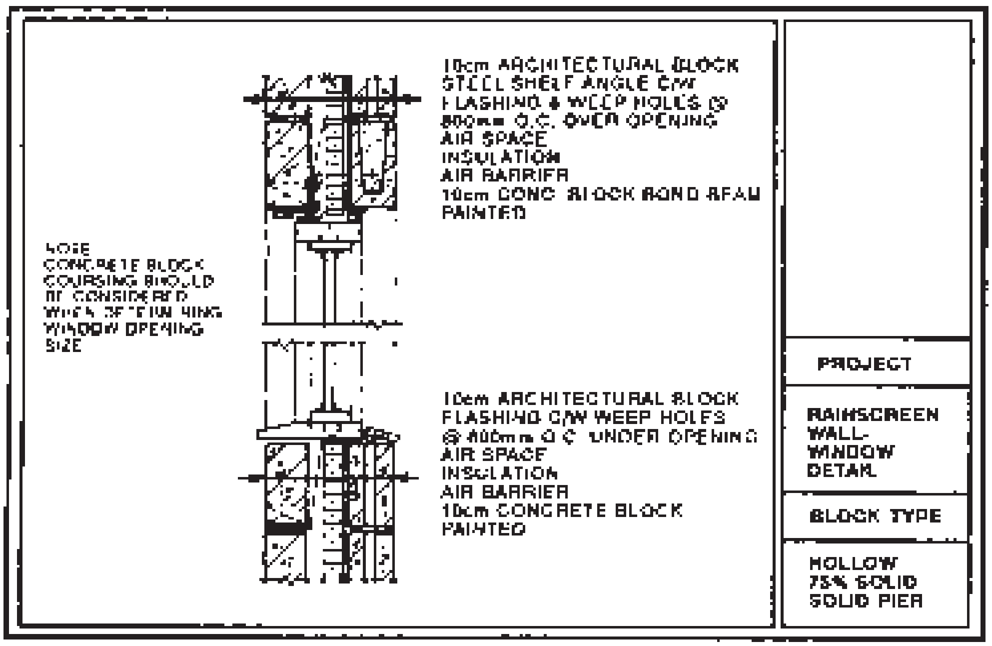

DEFLECTION SPACE
NOTE
LOADBEARING WALLS ARE
BUILT TIGHT TO U/S OF
FLOOR SLABS OR BEAM -
NO DEFLECTION SPACE
PROJECT
SOFT
JOINT
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER

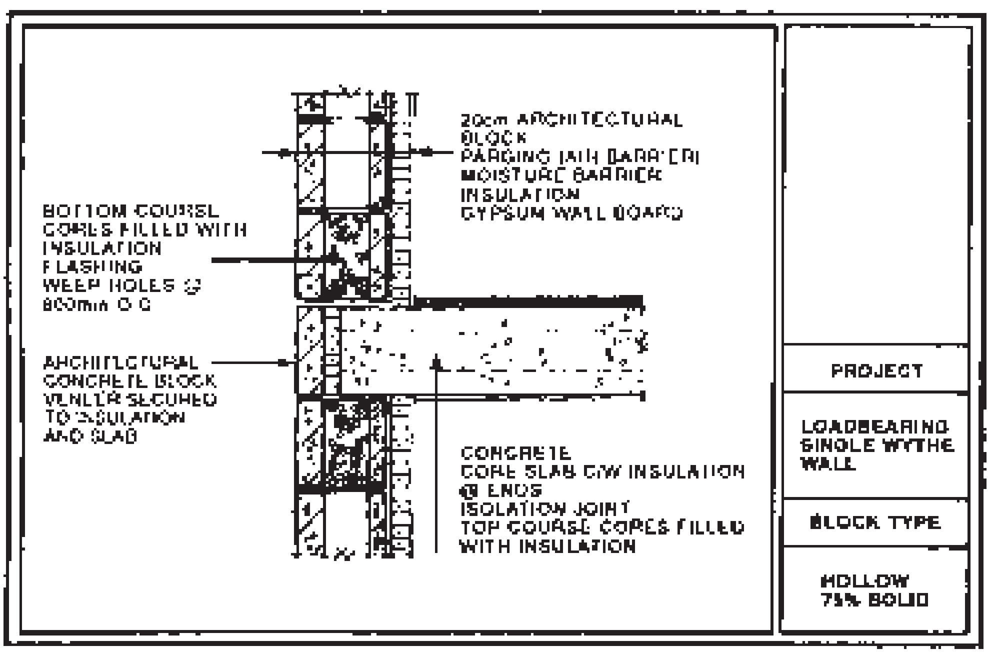

CROSS ROD ANCHOR USED TO
ANCHOR A BEAM IN A WALL
STEEL BEAM
SHEAR PLANE
@ 45°
SHEAR PLANE
@ 45°
CROSS ROD
ANCHOR
CROSS - SECTION
N.T.S.
HORIZONTAL
CROSS - SECTION
N.T.S.
PROJECT
CONNECTORS
FOR BLOCK
BLOCK TYPE
HOLLOW
75% SOLID

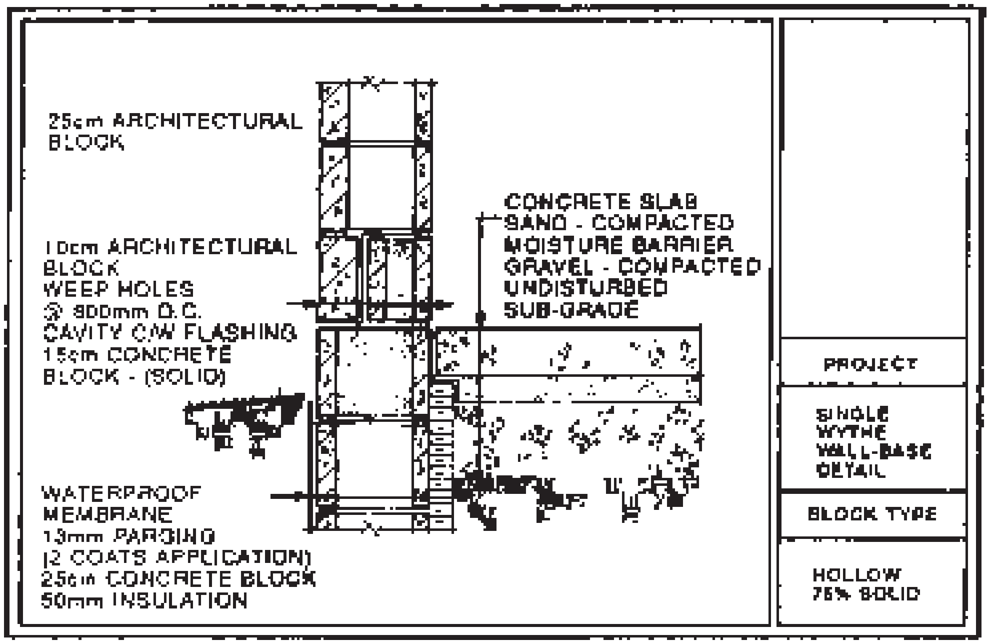

HOLD DOWN ANCHOR
FOR STEEL JOISTS
O.W.S.J.
200mm
AS REQUIRED
FOR HOLD - DOWN
STEEL ROD WELDED
TO JOIST BEARING
PLATE
STEEL REINFORCING IN
GROUT FILLED CORE
AS SPECIFIED
CROSS - SECTION
N.T.S.
PROJECT
CONNECTORS
FOR
MASONRY
BLOCK TYPE
HOLLOW

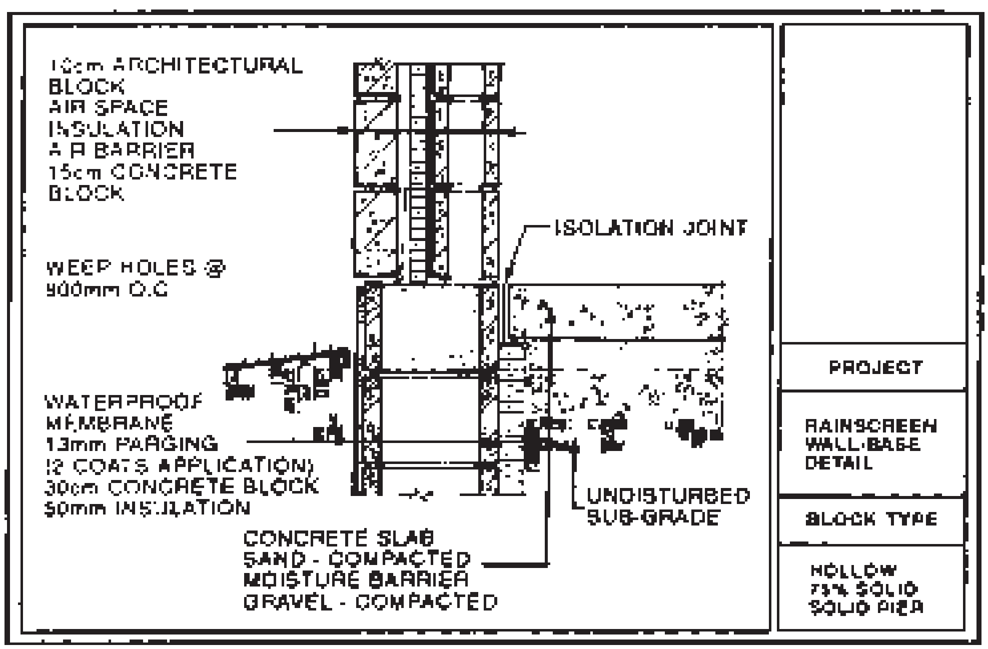

GROUT IN CORE
REINFORCING STEEL
SPACING AS SPECIFIED
PROJECT
REINFORCED BLOCK WALL
BLOCK TYPE
HOLLOW


GROUT/MORTAR
REINFORCING STEEL
PROJECT
LINTEL BEAM
BLOCK TYPE
HOLLOW


10cm ARCHITECTURAL BLOCK
STEEL SHELF ANGLE C/W FLASHING & WEEP HOLES @ 800mm O.C. OVER OPENING
AIR SPACE
INSULATION
AIR BARRIER
10cm CONC. BLOCK BOND BEAM PAINTED
NOTE
CONCRETE BLOCK COURSING SHOULD BE CONSIDERED WHEN DETERMINING WINDOW OPENING SIZE
10cm ARCHITECTURAL BLOCK
FLASHING C/W WEEP HOLES @ 800mm O.C. UNDER OPENING
AIR SPACE
INSULATION
AIR BARRIER
10cm CONCRETE BLOCK PAINTED
PROJECT
RAINSCREEN WALL-WINDOW DETAIL
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER


20cm ARCHITECTURAL BLOCK
PARGING (AIR BARRIER)
MOISTURE BARRIER
INSULATION
GYPSUM WALL BOARD
BOTTOM COURSE CORES FILLED WITH INSULATION
FLASHING
WEEP HOLES @ 800mm O.C.
ARCHITECTURAL CONCRETE BLOCK VENEER SECURED TO INSULATION AND SLAB
CONCRETE CORE SLAB C/W INSULATION @ ENDS
ISOLATION JOINT
TOP COURSE CORES FILLED WITH INSULATION
PROJECT
LOADBEARING SINGLE WYTHE WALL
BLOCK TYPE
HOLLOW
75% SOLID

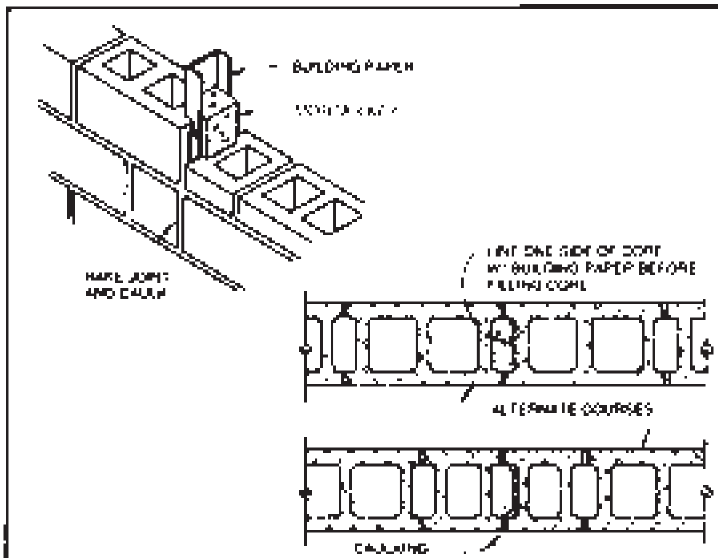

25cm ARCHITECTURAL BLOCK
10cm ARCHITECTURAL BLOCK
WEEP HOLES @ 800mm O.C.
CAVITY C/W FLASHING
15cm CONCRETE BLOCK - (SOLID)
WATERPROOF MEMBRANE
13mm PARGING (2 COATS APPLICATION)
25cm CONCRETE BLOCK
50mm INSULATION
CONCRETE SLAB
SAND - COMPACTED
MOISTURE BARRIER
GRAVEL - COMPACTED
UNDISTURBED SUB-GRADE
PROJECT
SINGLE WYTHE WALL-BASE DETAIL
BLOCK TYPE
HOLLOW
75% SOLID


10cm ARCHITECTURAL BLOCK
AIR SPACE
INSULATION
AIR BARRIER
15cm CONCRETE BLOCK
ISOLATION JOINT
WEEP HOLES @ 900mm O.C
WATERPROOF MEMBRANE
13mm PARGING (2 COATS APPLICATION)
30cm CONCRETE BLOCK
50mm INSULATION
UNDISTURBED SUB-GRADE
CONCRETE SLAB
SAND - COMPACTED
MOISTURE BARRIER
GRAVEL - COMPACTED
PROJECT
RAINSCREEN WALL-BASE DETAIL
BLOCK TYPE
HOLLOW
75% SOLID
SOLID PIER

MAXIMUM SPACING of CONTROL JOINTS	
PANEL LENGTH/HEIGHT RATIO	PANEL LENGTH m
2	12.0
2.5	13.5
3	15.0
4	18.8

NOTE
Each building must be analyzed for potential movement. Above Table should only be used as a guide.

PROJECT
MOVEMENT CONTROL JOINT
BLOCK TYPE
HOLLOW 75% SOLID



STANDARD UNIT DETAIL

PROJECT
MOVEMENT CONTROL JOINT
BLOCK TYPE
HOLLOW 75% SOLID