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Fire endurance ratings of masonry walls

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No.

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TECHNICAL NOTE

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FOR INTERNAL USE

PREPARED BY M. Galbreath

CHECKED BY

APPROVED BY NBH

DATE August 1961.

PREPARED FOR Fire Rating Board - ACNBC

SUBJECT FIRE ENDURANCE RATINGS OF MASONRY WALLS

The information on fire tests of masonry walls in this Note has been prepared for the use of the Fire Rating Board which will be responsible for the preparation of fire rating information on typical elements of building construction.

This is the first of a series of technical notes covering fire endurance of walls, floors, columns, etc., which will be compiled based on the reports of fire tests published by testing laboratories in United States and Canada including the work of the Fire Section of this Division.

The tables include more detailed information than is supplied in the present Appendix 4.1.B of the National Building Code of Canada (1953) because it is thought that these details will become of greater significance as more knowledge of fire endurance is developed.

All the test results included in the tables have been carried out in accordance with the standard methods of test, either "ASTM E119-55 - Fire Tests of Building Construction and Materials" or "B.S. 476 Part 1 - 1953 Fire Tests on Building Materials and Structures".

Both of these methods of test have been revised from time to time since they were first developed and consequently the earlier tests differ in some details from the more recent ones. All of the tests included however, were conducted on samples over 100 square feet in area and except where noted otherwise all the non-loadbearing walls were tested in a restraining frame to simulate conditions in a skeleton frame building.

A uniform manner of presentation has been attempted in order to simplify reference to, and comparison of, test results. More complete information on any of the tests may be obtained by referring to the original published report in the list of references.

Tables 1 to 19 show the time recorded, after authorized corrections have been applied in a standard fire test and refer only to materials and structures meeting a strict specification of a test panel. Appendix A and Table A-1 is a summary of the information contained in the previous tables with additional estimated figures and is intended to be used in assessing the fire endurance quality of common building materials. For this reason a 20% reduction has been applied to all the test results used and the rating listed in groups of 4, 3, 2, $1\frac{1}{2}$, 1 and $3/4$ hours - the fire endurance ratings required in the National Building Code. The figures in Table A-1 are intended to apply to materials meeting the requirements of the appropriate ASTM, CSA and CGSB standard specification. The 20% reduction has been applied as a safety factor and takes into account variations in the quality and design of materials or the market. Since the inclusion of a safety factor reduces to a degree the significance of the distinction between loadbearing and non-loadbearing wall tests, it is suggested that for the purpose of these general ratings, the distinction should be ignored and only one set of figures shown applicable to either type of wall.

If Table A-1 is adopted as a reference by the Associate Committee on the National Building Code, a builder will have the choice of using the fire endurance listed in the table or of proving to the inspector that his materials comply with those used in one of the tested walls and claiming the higher rating.

Throughout the tables

U.P. means no plaster finish.

P.P. means a finish of gypsum-sand, portland cement sand, gypsum perlite or gypsum vermiculite plaster at least $\frac{1}{2}$ " thick and having not more than three parts of aggregate to one part of cementing material.

P.O. means a plaster finish as above on the side of the wall exposed to the fire.

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APPENDIX A

These notes describe the use of the condensed table of fire endurance ratings (Table A-1).

Combustible members may be framed into masonry walls if the members are embedded in solid masonry extending at least 4 inches below to the sides and ends of such members except that the rating for 8 inch walls with combustible framed-in members may not be assumed to exceed 2 hours.

The ratings for walls of hollow concrete masonry units may be increased by one hour where the units are solid or when the cells are filled with concrete or loose aggregate of groups I or II.

The nature of the aggregate is a factor affecting the fire resistance of concrete. The aggregate materials have therefore been arranged in four groups in decreasing order of fire endurance as follows:

Group I	Aggregates prepared by expanding products such as perlite and vermiculite.
Group II	Aggregates prepared by expanding, calcining or sintering products such as blast-furnace slag, clay, diatomite, flyash, shale or slate.
Group III	Aggregates prepared by processing natural materials such as pumice, scoria or tuff. Burnt clay, blast-furnace slag, cinders containing not more than 25% of combustible material and not more than 5% of volatile material, limestone, calcareous gravel, trap rocks and similar dense materials containing not more than 30% of quartz, chert, flint and similar materials.
Group IV	Granite, quartzite, siliceous gravel, sand-stone, gneiss and other dense materials containing more than 30% of quartz, chert, flint and similar materials.

TABLE 1

WALLS		CLAY AND SHALE BRICK				LOADBEARING			
REFERENCE		WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combusti- ble built-in members	REMARKS
BMS 143/2	Clay	4	U.P.	2960	-	1 hr 20 min	temp avg	-	
BMS 143/6	Shale	4	U.P.	6450	-	1 hr 30 min	temp avg	-	
BMS 143/18	Clay	8	U.P.	2960	-	6 hr 0 min	set limit	2 hr 16 min	
BMS 143/43	Clay	12	U.P.	2920	-	6 hr 0 min	set limit	6 hr 0 min	
RP 12	Fletton	8 $\frac{3}{4}$	U.P.	1831	6.9% brick 6.8% mortar	6 hr 0 min	set limit		British test
RP 12	London Stock	8 $\frac{3}{4}$	U.P.	683	2.2% brick 8.2% mortar	6 hr 0 min	set limit		British test
RP 12	Wire Cut	9	U.P.	4465	5.6% brick 6.8% mortar	6 hr 0 min	set limit		British test
RP 12	Stairfoot	9	U.P.	7525	1.2% brick 9.7% mortar	6 hr 0 min	set limit		British test
RP 12	Cellular Fletton	8 $\frac{3}{4}$	U.P.	1873	3.6% brick 6.3% mortar	6 hr 0 min	set limit		British test
TNB/124	Clay or Shale	4	U.P.	-	-	1 hr 0 min	-	-	
	Clay or Shale	4	P.P.	-	-	2 hr 30 min	-	-	
	Clay or Shale	8	U.P.	-	-	5 hr 0 min	-	2 hr 0 min	
	Clay or Shale	8	P.P.	-	-	9 hr 0 min	-	4 hr 0 min	
	Clay or Shale	12	U.P.	-	-	10 hr 0 min	collapse	9 hr 0 min	

TABLE 2

WALLS		CLAY AND SHALE BRICK				NON-LOADBEARING			
REFERENCE		WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combusti- ble built-in members	REMARKS
BMS 143/1	Clay	4	U.P.	3280	-	1 hr 37 min	temp avg	-	
BMS 143/7	Clay	4	U.P.	2920	-	1 hr 21 min	temp max	-	
BMS 143/5	Shale	4	U.P.	8110	-	1 hr 19 min	temp avg	-	
RP 12	Fletton	4 $\frac{1}{4}$	U.P.	1831	1.6% brick 6.3% mortar	1 hr 53 min	temp avg	-	British test
RP 12	London Stock	4 $\frac{1}{4}$	U.P.	683	0.9% brick 4.7% mortar	1 hr 52 min	temp avg	-	British test
RP 12	Stairfoot	4 $\frac{1}{4}$	U.P.	7527	1.3% brick 6.6% mortar	1 hr 37 min	temp avg	-	British test
RP 12	Wire Cut	4 $\frac{1}{4}$	U.P.	4465	8.8% brick 5.6% mortar	1 hr 56 min	crack	-	British test
RP 12	Cellular Fletton	4 3/16	U.P.	1873	1.8% brick 5.9% mortar	1 hr 25 min	temp avg	-	British test
BMS 143/11	Clay	8	U.P.	3280	-	5 hr 13 min	temp max	2 hr 26 min	
BMS 143/15	Clay	8	U.P.	3280	-	4 hr 49 min	temp max	2 hr 19 min	
BMS 143/17	Clay	8	U.P.	3130	-	5 hr 1 min	temp avg	1 hr 49 min	
BMS 143/20	Clay	8	U.P.	2920	-	6 hr 1 min	set limit	2 hr 20 min	
BMS 143/21	Clay	8	U.P.	2920	-	6 hr 2 min	set limit	2 hr 15 min	
BMS 143/22	Shale	8	U.P.	8110	-	5 hr 7 min	temp avg	2 hr 39 min	
BMS 143/14	Clay	8	U.P.	3280	-	5 hr 44 min	temp avg	1 hr 40 min	Unrestrained
BMS 143/16	Clay	8	U.P.	3130	-	3 hr 16 min	temp max	2 hr 57 min	Unrestrained
BMS 143/23	Shale	8	U.P.	8110	-	4 hr 41 min	overcrack temp avg	2 hr 27 min	Unrestrained

TABLE 3

WALLS (ROLOK)			CLAY AND SHALE BRICK			LOADBEARING				
REFERENCE			WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH 2 lb/in.	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combusti- ble built-in members	REMARKS
BMS 143/59	Shale	Rolok	8	U.P.	6450	-	6 hr 0 min	set limit	-	
TNB 124	Clay or Shale	Rolok	8	U.P.	-	-	2 hr 30 min	-	2 hr 0 min	to nearest half hour
TNB 124	Clay or Shale	Rolok	8	P.P.	-	-	5 hr 0 min	-	2 hr 30 min	to nearest half hour
TNB 124	Clay or Shale	Rolok	12	U.P.	-	-	5 hr 0 min	-	3 hr 30 min	to nearest half hour
TNB 124	Clay or Shale	Rolok	12	P.P.	-	-	9 hr 0 min	-	6 hr 0 min	to nearest half hour
TNB 124	Clay or Shale	Rolok-Bak	8	P.O.	-	-	5 hr 0 min	-	2 hr 30 min	to nearest half hour

TABLE 4

WALLS (ROLOK)			CLAY AND SHALE BRICK				NON-LOADBEARING			
REFERENCE			WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combusti- ble built-in members	REMARKS
BMS 143/54	Clay	Rolok	8	U.P.	3280	-	6 hr 1 min	set limit	-	Unrestrained
BMS 143/55	Clay	Rolok	8	U.P.	2920	-	3 hr 58 min	temp max	-	Unrestrained
BMS 143/56	Clay	Rolok	8	U.P.	2920	-	6 hr 1 min	set limit	-	Restrained
BMS 143/57	Clay	Rolok	8	U.P.	2920	-	6 hr 1 min	set limit	-	Restrained
BMS 143/64	Clay	Rolok	12	U.P.	3280	-	5 hr 13 min	equipment failed	-	Unrestrained

TABLE 5

WALLS			CONCRETE AND SAND LIME BRICK				LOADBEARING			
REFERENCE			WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combustible built-in members	REMARKS
LC 229	Concrete	(siliceous sand aggregate)	8	U.P.	2780	-	6 hr 30 min	temp	3 hr 0 min	to nearest half hour
RP 12	Concrete	(siliceous sand aggregate)	8 $\frac{3}{4}$	U.P.	2527	5.5% brick 8.1% mortar	6 hr 0 min	set limit	-	British test
LC 229	Concrete	(siliceous sand aggregate)	12	U.P.	2780	-	15 hr 0 min	temp	12 hr 30 min	to nearest half hour
BMS 143/45	Concrete		12	U.P.	2780	-	6 hr 1 min	set limit	6 hr 1 min	
LC 229	Sand lime	(siliceous sand aggregate)	8	U.P.	1690	-	8 hr 0 min	temp	3 hr 30 min	to nearest half hour
RP 12	Sand lime		9	U.P.	2603	5.6% brick 3.1% mortar	6 hr 0 min	set limit	-	British test
BMS 143/32	Sand lime		8	U.P.	3050	-	6 hr 0 min	set limit	4 hr 9 min	
LC 229	Sand lime		12	U.P.	1690	-	10 hr 0 min	collapse	10 hr 0 min	to nearest half hour

TABLE 6

WALLS		CONCRETE AND SAND LIME BRICK				NON-LOADBEARING			
REFERENCE		WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combustible built-in members	REMARKS
RP 12	Concrete (siliceous sand aggregate)	4 $\frac{1}{4}$	U.P.	2527	3.5% brick 6.9% mortar	2 hr 10 min	temp avg	-	British test
BMS 143/26	Concrete (siliceous sand aggregate)	8	U.P.	2780	-	5 hr 6 min	temp avg	3 hr 33 min	
BMS 143/46	Concrete (siliceous sand aggregate)	12	U.P.	2780	-	6 hr 1 min	set limit	6 hr 1 min	
BMS 143/25	Concrete (siliceous sand aggregate)	8	U.P.	2780	-	6 hr 1 min	set limit	3 hr 21 min	Unrestrained
RP 12	Sand lime (siliceous sand aggregate)	4 $\frac{1}{4}$	U.P.	2603	3.0% brick 1.8% mortar	2 hr 6 min	temp avg	-	British test
BMS 143/29	Sand lime (siliceous sand aggregate)	8	U.P.	4630	-	6 hr 1 min	set limit	3 hr 33 min	
BMS 143/51	Sand lime (siliceous sand aggregate)	12	U.P.	4630	-	6 hr 1 min	set limit	6 hr 1 min	
BMS 143/30	Sand lime (siliceous sand aggregate)	8	U.P.	4630	-	6 hr 1 min	set limit	3 hr 29 min	Unrestrained
BMS 143/31	Sand lime (siliceous sand aggregate)	8	U.P.	2050	-	6 hr 1 min	set limit	3 hr 56 min	Unrestrained

TABLE 7

REFERENCE	WALLS CORED AND HOLLOW CLAY BRICK	LOADBEARING	
		WALL THICKNESS, in.	WALL FINISH
TNB 35	Hollow brick $3\frac{1}{2}$ " x $7\frac{1}{2}$ " x $11\frac{1}{2}$ "	8 U.P. 1 1 1.75 1.5 58 - - 3 hr 0 min temp max	UNITS IN WALL THICKNESS CELLS IN WALL THICKNESS FACE SHELL THICKNESS, in. WEB THICKNESS, in.
TNB 35	Hollow brick $3\frac{1}{2}$ " x $7\frac{1}{2}$ " x $11\frac{1}{2}$ "	8 P.P. 1 1 1.75 1.5 58 - - 5 hr 0 min temp avg	CORE AREA per cent COMPRESSIVE STRENGTH lb/in ² MOISTURE CONTROL FIRE ENDURANCE PERIOD MANNER OF FAILURE
OSU '52	Cored brick $2\frac{1}{4}$ " x $5\frac{1}{2}$ " x $11\frac{1}{2}$ "	6 U.P. 1 2 - - 24 - 2 hr 32 min temp avg	FIRE ENDURANCE with combustible built-in members Two cells in each brick * 2 hr if joists fully embedded * 3 hr if joists fully embedded SCR brick 10 core holes

TABLE 8

		WALLS		HOLLOW TILE		LOADBEARING	
REFERENCE		LOAD lb/in ²		WALL THICKNESS, in.		WALL FINISH	
B.S. 37/4	80	Shale	8	U.P.	1	UNITS IN WALL THICKNESS	
B.S. 37/5	80	Shale	8	P.O.	1	CELLS IN WALL THICKNESS	
			-		2	FACE SHELL THICKNESS	
			-		-	WEB THICKNESS	
			-		-	CORE AREA	
			-		-	COMPRESSIVE STRENGTH	
			-		-	MOISTURE CONTENT	
			-		2 hr 17 min	FIRE ENDURANCE PERIOD	
			-		temp rise	MANNER OF FAILURE	
			-		-	FIRE ENDURANCE 4 in. from unexposed surface	
						Remarks	
						Gunite (1½:3) on fire exposed side	

TABLE 9

REFERENCE	ARRANGEMENT OF TILES IN WALL	WALLS							HOLLOW CLAY TILE			NON-LOADBEARING			REMARKS
		CELLS IN WALL	THICKNESS	WALL THICK- NESS, in.	WALL FINISH	FACE SHELL THICKNESS, in.	WEB THICKNESS, in.	CORE AREA Per cent	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT lb/cu ft	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combustible built-in member		
BMS 113/1	c	Surface clay	1	3	U.P.	0.72	0.73	-	2480	-	0 hr 21 min	waste ignited	-		
BMS 113/2	e	Surface clay	1	3	P.P.	0.72	0.73	-	2480	-	1 hr 1 min	set limit	-		
BMS 113/3	a	Fire clay	1	3	P.P.	0.60	0.49	-	4100	-	1 hr 6 min	temp max			
BMS 113/4	c	Surface clay	1	4	U.P.	0.73	0.60	-	2220	-	0 hr 25 min	hole through			
BMS 113/5	s	Surface clay	1	4	P.P.	0.73	0.60	-	2220	-	1 hr 59 min	temp max			
BMS 113/6	a	Fire clay	1	4	P.P.	0.56	0.50	-	3560	-	1 hr 19 min	temp max			
BMS 113/7	s	Fire clay	1	4	P.P.	0.64	0.56	-	2430	-	0 hr 50 min	collapse			
BMS 113/8	s	Fire clay	1	4	P.P.	0.68	0.63	-	1300	-	1 hr 34 min	temp max			
BMS 113/9	s	Fire clay (double face shell)	1	4	P.O.	2 at 7/16 in.	-	-	4200	-	0 hr 31 min	hole through			
BMS 113/10	s	Fire clay (double face shell)	1	4	P.O.	2 at 7/16 in.	-	-	4200	-	0 hr 50 min	collapse			
BMS 113/11A	e	Fire clay	1	4	P.O.	1.00	0.73	-	7020	-	1 hr 48 min	temp avg			
BMS 113/11B	e	Fire clay	1	4	P.O.	1.00	0.73	-	7020	-	2 hr 14 min	temp max			
BMS 113/12A	s	Fire clay	2	4	P.P.	0.73	0.60	-	1970	-	1 hr 52 min	temp max			
BMS 113/12B	s	Surface clay	2	4	P.P.	0.60	0.55	-	3670	-	2 hr 53 min	temp max			
BMS 113/13	e	Surface clay	1	6	P.P.	0.80	0.70	-	1280	-	1 hr 23 min	temp max			
BMS 113/14	s	Surface clay	1	6	P.P.	0.80	0.70	-	1280	-	2 hr 0 min	set limit			
BMS 113/15	a	Fire clay	1	6	P.P.	0.59	0.50	-	2640	-	1 hr 54 min	temp avg			
BMS 113/16	a	Fire clay	1	6	U.P.	0.59	0.50	-	2640	-	0 hr 17 min	collapse			
BMS 113/17	c	Surface clay	2	6	U.P.	0.68	0.59	-	1860	-	0 hr 45 min	temp max			
BMS 113/18	s	Fire clay	2	6	U.P.	0.64	0.54	-	2000	-	1 hr 1 min	temp avg			
BMS 113/19	a	Surface clay	2	6	P.P.	0.68	0.59	-	1860	-	1 hr 41 min	temp max			
BMS 113/20	s	Fire clay	2	6	P.P.	0.64	0.54	-	2000	-	2 hr 23 min	temp avg			
RP 12	s	Clay	2	9	P.P.	1.00	-	-	-	-	2 hr 42 min	hole through		British test	

e: tiles laid on end

s: tiles laid on side

a: alternate courses on end and side

c: alternate tiles in each course on end and side

TABLE 10

REFERENCE		WALLS				HOLLOW TILE				NON-LOADBEARING				REMARKS
		WALL THICKNESS, in.	WALL FINISH	UNITS IN WALL THICKNESS	CELLS IN WALL THICKNESS	WEB THICKNESS	CORE AREA	COMPRESSIVE STRENGTH	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE		
B.S. 37/6	Shale	8	U.P.	1	2					2 hr 53 min	temp rise	-	-	Unrestrained
B.S. 37/42	Surface clay	8	U.P.	1	2					4 hr 12 min	temp rise	-	-	Unrestrained
B.S. 37/67	Fire clay	8	U.P.	1	2					6 hr 0 min	set limit	-	-	Unrestrained
B.S. 37/76	Fire clay	8	U.P.	1	2					6 hr 0 min	set limit	-	-	
B.S. 37/132	Fire clay	12	U.P.	1	3					6 hr 0 min	set limit	-	-	Unrestrained
B.S. 37/148	Shale	16	U.P.	2	4					5 hr 11 min	terminated	-	-	fallen shells obstructed burners
B.S. 37/151	Fire clay	16	U.P.	2	4					6 hr 0 min	set limit	-	-	
B.S. 37/159	Fire clay	16	U.P.	2	6					6 hr 0 min	set limit	-	-	

All tiles laid on end unless otherwise noted.

TABLE 11

REFERENCE	WALLS	HOLLOW TILE								NON-LOADBEARING				REMARKS
		WALL THICKNESS, in.	WALL FINISH	UNITS IN WALL THICKNESS	CELLS IN WALL THICKNESS	FACE SHELL THICKNESS, in.	WEB THICKNESS, in.	CORE AREA per cent	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE 4 in. inside un- exposed surface	
ESB/104/2	Shale	4	U.P.	1	1	0.53	0.50	60	3245	-	0 hr 14 min	collapse	-	
EBS/104/2A	Shale	4	U.P.	1	1	0.53	0.50	60	3245	-	0 hr 31 min	temp avg	-	Unrestrained
ESB/104/3	Surface clay	4	U.P.	1	1	0.53	0.50	60	3245	-	0 hr 14 min	collapse	-	
ESB/104/3A	Surface clay	4	U.P.	1	1	0.53	0.50	60	3245	-	0 hr 13 min	collapse	-	
ESB/104/4	Fire clay	4	U.P.	1	1	0.53	0.50	60	3245	-	0 hr 31 min	temp avg	-	
ESB/104/5	Fire clay	4	P.P.	1	1	0.53	0.50	60	3245	-	1 hr 13 min	temp avg	-	
ESB/104/6	Fire clay	4	P.P.	1	1	0.53	0.50	60	1303	-	1 hr 0 min	collapse	-	side construction
ESB/104/7	Fire clay	4	P.P.	1	1	0.53	0.50	60	3245	-	1 hr 3 min	set limit	-	water test applied
ESB/104/7A	Fire clay	4	P.P.	1	1	0.53	0.50	60	3245	-	1 hr 2 min	temp avg	-	retest of no. 7
ESB/104/8	Fire clay	8	P.P.	3	3	-	-	-	3245 on 4" core	-	3 hr 10 min	temp avg	-	4" tile furred both sides with 1½ split furring tile
ESB/104/9	Fire clay	6	P.F.	2	2	-	-	-	3245 on 4" core	-	2 hr 30 min	temp avg	-	4" tile furred exposed side 1½ split furring tile
ESB/104/10	Fire clay	3	P.P.	2	1	0.53	0.50	-	-	-	1 hr 25 min	temp avg	-	two 2" split furring tiles webs staggered
ESB/104/10A	Fire clay	4	P.P.	1	1	0.53	0.50	60	3245	-	1 hr 11 min	temp avg	-	10 and 10A tested as one wall

All tiles laid on end unless otherwise noted.

TABLE 12

REFERENCE	TYPE OF COARSE AGGREGATE	WALLS				HOLLOW CONCRETE BLOCK				LOADBEARING				REMARKS
		WALL THICKNESS, in.	WALL FINISH	UNITS IN WALL THICKNESS	CELLS IN WALL THICKNESS	WEB THICKNESS, in.	CORE AREA per cent	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT lb/cu ft	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combustible built-in members		
BMS 117/11A	Pumice	10	U.P.	1	1	1.82	-	40	700	11.8	5 hr 20 min	crack	-	
BMS 117/11B	Expanded shale	10	U.P.	1	1	1.80	-	40	1395	5.9	4 hr 42 min	temp avg	-	
BMS 117/10A	Expanded slag	6	U.P.	1	1	2.00	-	24	1075	3.8	3 hr 54 min	temp max	-	
BMS 117/10B	Expanded slag	6	U.P.	1	1	1.99	-	24	1420	3.0	3 hr 55 min	temp max	-	
BMS 120/U1	Calcareous	8	U.P.	1	1	1.37	-	43	1760	-	2 hr 14 min	temp avg	0 hr 56 min	
BMS 120/U2	Calcareous	8	U.P.	1	1	2.25	-	22	2975	-	3 hr 57 min	temp avg	2 hr 28 min	
BMS 120/8B	Siliceous	8	P.P.	1	1	1.22	-	44	1420	-	0 hr 40 min	set limit	-	twin panel 8A collapsed
BMS 120/8A	Siliceous	8	P.P.	1	1	1.35	-	45	605	-	0 hr 32 min	collapse	-	strength less than ASTM requirement
BMS 120/10A	Siliceous	12	U.P.	2	2	1.24 0.99	-	33 43	1040 1300	-	5 hr 33 min	temp max	3 hr 54 min	
BMS 120/10B	Siliceous	12	P.P.	1	1	1.77	-	42	940	-	6 hr 5 min	temp max	2 hr 31 min	

TABLE 13

REFERENCE		WALLS		HOLLOW CONCRETE BLOCK						NON-LOADBEARING				REMARKS
		WALL THICKNESS, in.	WALL FINISH	UNITS IN WALL THICKNESS	CELLS IN WALL THICKNESS	FACE SHELL THICKNESS, in.	WEB THICKNESS, in.	CORE AREA per cent	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT lb/cu ft	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combustible built-in members	
U. L. 2957	Perlite	4	U.P.	1	1	1.5	-	37	665	6.6	1 hr 54 min	temp max	-	cells filled solid perlite mortar
BMS 117/5B	Pumice	4	U.P.	1	1	0.98	-	37	665	1.8	1 hr 16 min	temp avg	-	-
BMS 117/6A	Pumice	4	U.P.	1	1	0.98	-	40	1075	6.3	4 hr 33 min	temp avg	-	-
BMS 117/16A	Pumice	10	U.P.	1	1	1.82	-	24	985	6.2	2 hr 2 min	temp max	-	-
BMS 117/1A	Expanded shale	3	P.P.	1	1	0.93	-	24	985	3.9	1 hr 54 min	temp avg	-	-
BMS 117/2A	Expanded shale	3	P.P.	1	1	0.93	-	24	985	4.5	2 hr 42 min	temp avg	-	-
BMS 117/3A	Expanded shale	4	P.O.	1	1	1.22	-	24	1280	2.3	1 hr 54 min	temp avg	-	-
BMS 117/15B	Expanded shale	6	U.P.	1	1	1.38	-	39	1380	3.2	4 hr 19 min	temp avg	-	-
BMS 117/16B	Expanded shale	10	U.P.	1	1	1.80	-	40	1395	1.1	2 hr 8 min	temp avg	-	-
BMS 117/2B	Expanded slag	3	P.P.	1	1	0.90	-	24	935	1.4	1 hr 9 min	temp avg	-	-
BMS 117/6B	Expanded slag	4	U.P.	1	1	0.84	-	37	895	3.2	1 hr 27 min	temp max	-	-
BMS 117/5A	Expanded slag	4	U.P.	1	1	1.00	-	37	645	1.4	1 hr 30 min	temp avg	-	-
BMS 117/4A	Expanded slag	4	P.O.	1	1	1.00	-	37	550	2.5	2 hr 24 min	temp avg	-	-
BMS 117/3B	Expanded slag	4	P.O.	1	1	1.29	-	24	1090	2.2	2 hr 28 min	temp avg	-	-
BMS 117/7B	Expanded slag	6	P.O.	1	1	1.31	-	50	800	1.3	3 hr 29 min	temp avg	-	-
BMS 117/8B	Expanded slag	6	P.O.	1	1	1.48	-	39	1315	2.6	2 hr 25 min	temp avg	-	-
BMS 117/15D	Expanded slag	6	U.P.	1	1	1.48	-	39	1315	2.6	3 hr 20 min	temp avg	-	-
BMS 117/9B	Expanded slag	6	U.P.	1	1	2.00	-	24	1075	1.8	2 hr 6 min	temp max	-	-
BMS 117/15C	Expanded slag	6	U.P.	1	1	1.99	-	24	1420	1.3	3 hr 29 min	temp avg	-	-
BMS 117/9A	Cinders	6	U.P.	1	1	1.57	-	39	1145	2.7	1 hr 36 min	temp avg	-	-
BMS 117/8A	Cinders	6	P.O.	1	1	1.57	-	39	1145	2.7	2 hr 12 min	temp avg	-	-
BMS 117/7A	Cinders	6	P.P.	1	1	1.03	-	50	705	-	-	-	-	-
BMS 117/15A	Cinders	6	U.P.	1	1	1.48	-	39	1145	2.7	1 hr 37 min	temp avg	-	-
BMS 120/	Calcareous	4	P.P.	1	1	1.00	-	37	500	-	1 hr 51 min	temp avg	-	-
BMS 120/	Siliceous	4	P.P.	1	1	1.24	-	26	1250	-	0 hr 59 $\frac{1}{2}$ min	collapse	-	-
BMS 120/	Siliceous	4	P.P.	1	1	0.90	-	33	1020	-	0 hr 59 $\frac{1}{2}$ min	collapse	-	two walls tested together

TABLE 14

WALLS				CONCRETE MONOLITHIC				LOADBEARING			
REFERENCE				WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combustible built-in members	REMARKS
TRBM 44	Siliceous	Aggregate	Unreinforced	8	U. P.	-	-	5 hr 0 min	temp rise	-	
TRBM 44	Siliceous	reinf. with 4" x 4" #6 welded wire fabric near centre of wall		6	U. P.	-	-	2 hr 30 min	temp rise	-	
TRBM 44	Siliceous	reinf. with 4" x 4" #6 welded wire fabric near centre of wall		4	U. P.	-	-	0 hr 45 min	collapse	-	
RP 12	Siliceous	reinf. #2 at 6" o. c. horizontal #3 at 6" o. c. vertical 1" cover		4	U. P.	4020	-	2 hr 10 min	temp rise	-	British test
RP 12	Siliceous	reinf. #3 at 6" o. c. horizontal #4 at 6" o. c. vertical 1" cover		8	U. P.	3220	-	6 hr 0 min	set limit	-	British test

TABLE 15

WALLS			CONCRETE MONOLITHIC			NON-LOADBEARING			
REFERENCE			WALL THICKNESS, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	REMARKS
TRBM 44	Siliceous Aggregate	reinf. 4" x 4" # 6 welded wire fabric near centre of wall	4	U.P.	-	-	1 hr 15 min	temp rise	-
RP 12	Siliceous Aggregate	reinf. # 2 at 8" o.c. horizontal and vertical. 1 1/8" cover	4	U.P.	4340	-	1 hr 40 min	temp rise	British test

TABLE 16

TABLE 17

WALLS (CAVITY)			CLAY AND SHALE BRICK				LOADBEARING				
REFERENCE	LOAD lb/in. ²		WALL THICKNESS, in.	THICKNESS OF WYTHE, in.	WALL FINISH	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT lb/cu ft	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combusti- ble built-in members	REMARKS
BMS 143/70	125	Clay	10	4	U.P.	3580	-	1 hr 17 min	collapse	-	
BMS 143/71	54	Clay	10	4	U.P.	2920	-	5 hr 17 min	temp avg	1 hr 48 min	tested at 1/3 design load for 8" wall
RP 12	-	Clay	11	4 $\frac{1}{4}$	U.P.	2428	-	6 hr 0 min	set limit	-	British test
RP 12	-	Clay	11	4 $\frac{1}{4}$	U.P.	1910	-	6 hr 0 min	set limit	-	British test
RP 12	-	Clay	10	4 $\frac{1}{4}$	U.P.	1910	-	6 hr 0 min	set limit	-	British test
RP 12	-	Clay	9	2 7/8	U.P.	1910	-	0 hr 32 min	collapse	-	brick on edge cavity wall British test

TABLE 18

REFERENCE	WALLS (CAVITY)			CLAY AND SHALE BRICK	NON-LOADBEARING
	WALL THICKNESS, in.	THICKNESS OF WYTHE, in.	WALL FINISH		
BMS 143/72	Clay	10 4	U.P. 2920	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT lb/cu ft
				-	FIRE ENDURANCE PERIOD
				4 hr 56 min temp avg	MANNER OF FAILURE
				1 hr 25 min	FIRE ENDURANCE with combustible built-in members
					REMARKS

TABLE 19

WALLS		BRICK FACED MASONRY							LOADBEARING			
REFERENCE		WYTHE THICKNESS, in.	WALL FINISH	FACE SHELL THICKNESS, in.	WEB THICKNESS, in.	CORE AREA per cent	COMPRESSIVE STRENGTH lb/in. ²	MOISTURE CONTENT lb/cu ft	FIRE ENDURANCE PERIOD	MANNER OF FAILURE	FIRE ENDURANCE with combusti- ble built-in members	REMARKS
BMS 117/13A	Fire Exposed Hollow Cinder Block Side	4	P	1.04	-	37	1015	2.1	6 hr 26 min	temp avg		bricks laid flat; bonding course every second block course
	Unexposed Clay Brick	3 $\frac{3}{4}$	U.P.	-	-	100	-	-				
BMS 117/13B	Fire Exposed Expanded Slag Block Side	4	P	1.00	-	37	990	2.4	7 hr 3 min	temp avg		bricks laid flat; bonding course every second block course
	Unexposed Clay Brick	3 $\frac{3}{4}$	U.P.	-	-	100	-	-				
BMS 117/14A	Fire Exposed Hollow Cinder Block Side	6	U.P.	1.48	-	39	1205	3.3	4 hr 54 min	temp avg		bricks laid on edge; bonding course every second block course
	Unexposed Clay Brick	2 $\frac{1}{2}$	U.P.	-	-	100	-	-				
BMS 117/14B	Fire Exposed Expanded Shale Block Side	6	U.P.	1.38	-	39	1380	4.0	5 hr 26 min	temp avg		bricks laid on edge; bonding course every second block course
	Unexposed Clay Brick	2 $\frac{1}{2}$	U.P.	-	-	100	-	-				

TABLE A-1

	MASONRY WALLS AND PARTITIONS	NO. OF UNITS IN WALL THICKNESS	NO. OF CELLS IN WALL THICKNESS	FACE SHELL THICKNESS (in.)	WALL THICKNESS (in.) FOR FIRE ENDURANCE (hr)					
					4	3	2	1½	1	½
1.	Bricks Clay, Shale, Concrete and Sand Lime (not less than 75% solid)	-	-	-	8 U.P.	-	4 P.P.	4 P.O.	4 U.P.	-
2.	Hollow Bricks Clay or Shale (less than 75% solid)	1	1	1.75	8 P.P.	8 P.O.	8 U.P.	-	-	-
3.	Hollow Tiles Clay or Shale	1	1	0.5						4 P.P.
		1	1	0.75						4 P.P.
		1	2	0.65						4 P.P.
		1	2	0.65						P.O.
		2	2		10 P.P.	6 P.O.				6 U.P.
4.	Hollow Concrete Blocks - Group II Aggregates	1	1	1.0	-	-	-	3 P.P.	4 P.O.	4 U.P.
		1	1	1.25	-	-	4 P.P.	4 P.O.	4 U.P.	-
		1	1	1.5	-	-	6 P.O.	6 U.P.	-	-
		1	1	2.0	-	6 P.O.	6 U.P.	-	-	-
5.	Hollow Concrete Blocks - Group III Aggregates	1	1	1.0	-	-	-	4 P.P.	4 P.P.	4 P.O.
		1	1	1.5	-	-	8 P.P.	8 U.P.	-	-
		1	1	1.5	-	-		6 P.O.	6 U.P.	-
		1	1	2.25	8 P.P.	8 U.P.	-	-	-	-
6.	Hollow Concrete Blocks - Group IV Aggregates	1	1	1.0	-	-	-	-	-	4 P.P.
		1	1	1.75	12 P.P.	-	-	8 P.P.	-	-
		2	2	1.25	12 U.P.	-	-	-	-	-
7.	Solid Concrete Blocks - Group III Aggregates	-	-	-	-	-	-	3 P.P.	-	-
8.	Monolithic Concrete - Group IV Aggregates + reinf.	-	-	-	8 U.P.	-	6 U.P.	-	4 U.P.	-
9.	No. Fines Concrete Block - Group III Aggregates - Group IV Aggregates No. Fines Concrete Monolithic - Group III Aggregates - Group IV Aggregates	-	-	-	6 P.P.	-	6 P.P.	-	-	-
		-	-	-	-	-	6 P.P.	-	-	-
		-	-	-	6 P.P.	-	-	-	-	-
		-	-	-	-	6 P.P.	-	-	-	-
10.	Wood-Fibre Cement Blocks	-	-	-	-	-	3 P.P.	2½ P.P.	2 P.P.	-
11.	Solid Gypsum Block	-	-	-	5 P.P.	5 U.P.	-	-	-	2 U.P.
12.	Hollow Gypsum Block (not less than 70% solid)	1	1	-	-	-	4 P.P.	3 P.P.	-	3 U.P.
13.	Natural Stone	-	-	-	12 U.P.	-	-	-	8 U.P.	-
14.	Cavity Walls - 2" cavity. (i) Brick - Clay, Shale, Concrete or Sand Lime (not less than 75% solid) load not more than 60 lb/in. ² (ii) Hollow Clay Tile - load not more than 60 lb/in. ² (iii) Hollow Concrete Blocks - load not more than 60 lb/in. ² : Group II Aggregates : Group III Aggregates	2	-	-	10 U.P.	-	-	-	-	-
		2	2	-	-	10 P.P.	10 P.O.	-	-	-
		2	2	-	-	10 P.O.	10 U.P.	-	-	-
		2	2	-	-	10 P.O.	10 U.P.	-	10 U.P.	-
15.	Brick Faced Walls, 4" Face Brick Bonded to: (i) 4" Hollow Concrete Block - Group III Aggregate (ii) 4" Hollow Clay Tile	2	1	1.0	8 P.O.	-	-	-	-	-
		2	1	-	8 P.O.	8 U.P.	-	-	-	-